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

June 12, 1994

MEMORANDUM FOR: Ashok C. Thadani, Associate Director
for Inspection and Technical Assessment

FROM: Martin J. Virgilio, Acting Director
Division of Systems Safety and Analysis

SUBJECT: RESULTS OF THE SURVEY OF EQ EXPERTS (EQ-TAP ACTION ITEM 3.c)
(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 environmental qualification (EQ) for electrical equipment. Our efforts in this regard are specifically defined under Action Item 3 of the EQ-TAP, which includes the following elements:

3.a Review License Renewal Background Information

3.b Review Fire Protection Reassessment Report

3.c Elicit Opinions from Others (Regions, EQ Experts)

3.d Review Existing EQ Program Requirements

3.e Review NRC Audit/Inspection Practices

3.f Review Licensee Implementation Practices

3.g Finalize Review Results

Our objective in completing items 3.a through 3.f (above) is to identify potential EQ issues and concerns that may deserve further staff consideration. It is important to recognize that this part of our programmatic review is not intended to resolve or to otherwise address any of the EQ issues that are identified. After items 3.a through 3.f of the EQ-TAP have been completed, all of the EQ issues will be consolidated and specifically addressed in the staff's final report under item 3.g, "Finalize Review Results," which will include recommendations as appropriate. Our final report is scheduled to be completed by August 30, 1994.

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With this report we have completed the review associated with item 3.c of the EQ-TAP, "Elicit Opinions from Others (Regions, EQ Experts)," and our evaluation is enclosed for your information. The potential issues that were identified during this review will be assembled and addressed in our final report along with any other potential issues that are identified as we complete the other items in the EQ-TAP. Please contact me if you should have any questions regarding the enclosed evaluation.

Original Signed By

Martin J. Virgilio, Acting Director
Division of Systems Safety and Analysis

Enclosure:
EQ SURVEY RESULTS OF NRC AND INDUSTRY EQ EXPERTS
Appendix A - Environmental Qualification Survey
Appendix B - Outstanding Issues, Problems, and Recommendations Identified by Survey Participants
Appendix C - Environmental Qualification Survey Full-Text Responses from NRC and Industry Experts

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Enclosure 1

EQ SURVEY RESULTS OF NRC AND INDUSTRY EQ EXPERTS (TAC NO. M85648)

1.0 INTRODUCTION

As discussed in the Environmental Qualification Task Action Plan (EQ-TAP) of June 16, 1993, the staff is performing a reassessment of the NRC environmental qualification requirements for electrical equipment. 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 particular evaluation is intended to address EQ-TAP Action Item 3.c, "Elicit Opinions from Others (Regions, EQ Experts)." The specific objective of this evaluation is to identify potential EQ issues and concerns by surveying EQ experts within the NRC and the industry. The EQ survey was not intended to be a comprehensive review of all issues related to EQ, but rather a format for a target group of experts to express their opinions and concerns regarding the development and implementation of the EQ rule, and other issues related to EQ.

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

2.0 PURPOSE AND SCOPE OF THE SURVEY

The EQ-TAP includes, among other things, a programmatic review of the NRC EQ program. As part of the EQ programmatic review, the staff developed a survey to gather information from NRC and industry EQ experts so that potential problems that may still exist with the current EQ regulations could be identified, documented, and addressed as part of the task action plan.

The staff selected 20 NRC and 14 industry experts to participate in the survey. The survey participants represented a wide range of EQ expertise, from inspectors involved in EQ compliance inspections, to NRC managers responsible for EQ program development, to industry consultants responsible for implementing licensee EQ programs, to test engineers at private and public laboratories responsible for conducting the EQ qualification testing. The survey was voluntary and the participants were instructed to answer only those questions in their areas of expertise. The staff advised the NRC regional office experts that their individual expertise was desired and that a "regional" response was not required. Of the 34 EQ experts solicited for this survey, 22 provided written responses for a response rate of approximately 65%.

The survey gathered information about four areas related to the development and implementation of the EQ rule (10 CFR 50.49); namely "Programmatic Requirements," "Operating Experience," "EQ Inspections," and "Miscellaneous." The topics were selected to give the participants the opportunity to express their views on a wide variety of topics related to EQ. A copy of the survey sent to the industry EQ experts is attached as Appendix A. While it was the intent of the staff to keep the NRC and industry surveys identical, one question (NRC Question D5), requesting the names of additional EQ experts to be contacted in this effort, was not included in the industry's version of the survey and was replaced with another EQ-related question.

The staff contacted each participant by phone prior to distributing the survey. The participants were briefed on the purpose of the survey and given the opportunity to ask questions. The participants were given 30 days to complete the survey.

3.0 SUMMARY OF THE EQ SURVEY RESPONSES

A summary of the comments, opinions, and recommendations made by the experts participating in the survey is provided below. The outstanding issues, problems, and recommendations contained within the responses to the survey have been extracted and are included as Appendix B.

Not all experts answered all questions, therefore, the synopses given below are representative of only those experts that did provide a response to a particular question. A complete, unedited text of all survey responses is provided in Appendix C.

3.1 Programmatic Requirements - Section A

Question A1: **Are the regulations (10 CFR 50.49) adequate to ensure plant safety during and following design basis events? Do you believe there are unwarranted requirements? Are the differences in EQ requirements for older vs. newer plants justified? What specific changes would you recommend?**

Even though most respondents replied that the current requirements (e.g., 10 CFR 50.49) were adequate to ensure plant safety during and after a design basis accident, and that the regulations were neither too strict nor unwarranted, many respondents provided recommendations for improvements in the requirements. Some respondents stated that some issues, for example, allowing older plants to be qualified to requirements other than NUREG-0588, Category I, and using of "sound reasons to the contrary" when replacing EQ equipment, may be inadequate to ensure plant safety. These issues have been identified by the staff as outstanding problems and included in Appendix B. Approximately half of the respondents stated that the differences in the requirements between older plants and newer plants were justified; the respondents were equally split on whether the marginal safety benefit gained from upgrading older plants to the newer standard was justified by the significant costs associated with upgrading the plants.

Question A2: Does the existing qualification methodology provide sufficient basis to conclude that electrical equipment will be able to mitigate the effects of all postulated accidents over the entire range of qualified life? Are the current standards, procedures, and techniques used to conduct component type-testing satisfactory for establishing the bases for environmental qualification? What specific comments and recommendations would you make relative to the qualification methodology for: a) older plants? b) newer plants?

Most respondents felt the existing qualification methodology provided a sufficient basis to qualify equipment. However, some respondents expressed concerns over the standards, procedures and techniques used to type-test individual components. The respondents also provided some specific recommendations on improving qualification methodology, which have been included in Appendix B.

Question A3: Is the burden of qualification appropriate to the importance of the equipment being qualified? Does the safety significance of the equipment justify the EQ requirements that are being imposed? What role, if any, should risk significance (e.g. probabilistic risk assessment) play in formulating EQ requirements? What changes would you recommend?

While most of the respondents agreed that the burden of qualification was appropriate to the importance of the equipment being qualified, some commented that the scope of the equipment (e.g., equipment in radiation harsh only areas) included in the rule should be reevaluated. While there was no consensus about the benefits of incorporating risk analysis into the EQ process, the respondents provided a broad range of opinions and recommendations about the safety significance of EQ equipment and the role that probabilitistic risk assessment (PRA) should play in EQ regulation, some of which have been included in the outstanding issues and recommendations in Appendix B.

Question A4: What are the strengths and weaknesses of the existing EQ requirements as they portain to: a) older plants? b) newer plants?

The major strengths attributed to the EQ requirements as seen by the respondents included:

EQ regulations are based on (1) the collective technical know-how and judgment of utilities (including EPRI), standards committees (including NRC participants), national laboratory staffs, and the NRC staff who issued the requirements, and (2) twenty years of qualification testing experience, about fifteen years of research testing at Sandia, hundreds of years of plant operating experience, and accident experience at TMI.

- For newer plant equipment, the LOCA/MSLB testing of aged samples resulted in somewhat more realistic predictions of equipment performance under accident conditions as opposed to the older plant equipment which could be qualified using separate effects/analytical consideration of aging.

- Some viewed the significant environmental and operating time conservatism inherent in the qualification process as a strength.

The major weaknesses identified by the respondents are presented here and have been consolidated and included in the list of issues and problems in Appendix B.

- Some of the terms and acceptance criteria for qualification used in the rule need to clarified so that the implementation of the rule will be more consistent.

- A component needs to successfully pass only a single test to be qualified.

- The requirements to qualify equipment at older plant were not as stringent as those at newer plants; for example, requirements covering aging, margin, and synergistic effects.

- No provisions are made in the qualification testing of EQ equipment to account for abuses seen during the normal service life; for example, cable damage from trampling.

- Older plants were allowed to qualify components using analysis for some effects, such as the effect of spraying.

- The EQ process does not adequately account for the "weak links" in safety systems; such as cable installation damage.

- Mild environment equipment is not covered by current regulations.

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

Question A5: Are you aware of any specific problems or difficulties that currently exist or that existed in the past with implementing EQ program requirements? Please distinguish between older and newer plants.

Although many respondents replied that they knew of no specific problem that currently exists, some respondents did identify some problems that they consider unresolved. A summary of the problems is included below and have also been included in the problems listed in Appendix B.

- Licensees need to walkdown and document the location of all safety equipment so that appropriate DBA parameters can be used to qualify the equipment.

- The NRC currently recognizes three different qualification standards.

- Interpreting the test data and standards by the NRC and the licensees has caused problems.

- When qualifying equipment, licensees use bulk containment temperatures instead of more accurate localized temperatures.

- Adequate similarity between the tested equipment and the equipment installed in the plant has been a problem.

- Plants built before the current qualification standards were subject to purchasing requirements that contained little in the way of performance standards for cable systems (i.e., cables and their connectors) in harsh conditions.

- The cost of EQ testing is a barrier to entry for the introduction of new product and new technologies.

- Several problems exist with EQ testing, such as, inadequate simulation of containment spray effects, improper use of accelerated aging techniques, a lack of consistency in what is required to be included in the test program (especially in older plants), and test requirements that are too conservative.

- Documentation requirements are too burdensome with little safety benefit.

Question A6: Are the current EQ requirements for older and newer plants adequate for plant operations beyond the current 40-year operating license (i.e., for license renewal)? Which EQ issues need to be addressed for continued plant operations beyond 40 years? What modifications would you make to the existing EQ requirements for license renewal?

Most respondents agreed that the current regulations were adequate for operations beyond 40 years, although many respondents also included recommendations for modifications and improvements that would enhance the regulations.

NRC respondents cited aging, margins, synergistic effects, differing testing and documentation requirements (between the qualification standards), lack of continuing inspector training on EQ, lack of a continuing EQ inspection program, and the identification of maintenance activities necessary to extend the life of components to the end of the renewal period as issues that need to be addressed for continued plant operation beyond 40 years. Industry respondents stated that there were no specific EQ issues to address, but noted that licensees should be allowed more flexibility to develop analytical solutions to specific EQ-related equipment issues.

Outstanding issues and recommendations on this subject have been incorporated into Appendix B.

3.2 Operating Experience - Section B

Question B1: In general, how is EQ equipment actually aging (in service) compared with the equipment's predicted life?

Most respondents stated that, generally speaking, qualified equipment is aging as expected or more slowly than expected. Respondents acknowledged several instances where equipment failed due to thermal aging, but explained that in the majority of those cases the service environment was more severe than the design environment. Most of the NRC experts responded that they had insufficient information regarding the condition of equipment to make an informed response.

Question B2: Describe problems you have encountered with EQ equipment. Do some components routinely fail before the end of qualified life? Are component qualified temperatures and radiation exposure levels consistent with their actual in-service environment?

Most respondents agreed that equipment is not routinely failing due to aging effects; however, qualified components that have failed due to the effects of aging have been the subject of Information Notices, Bulletins, and other generic communications. Industry experts responded that the actual operating environments have consistently lower temperatures than the predicted temperatures used in the qualified life calculations, while NRC experts noted that, even in service conditions milder than the design environment, cables and other components have failed due to higher than predicted localized temperatures or radiation.

Question B3: Do you believe that maintenance performed on qualified equipment is sufficient to maintain the equipment's qualification? Is there maintenance being performed on equipment or components that may have an adverse affect on EQ?

Most respondents believe that maintenance practices at nuclear power plants are adequate to maintain the qualification of EQ equipment. Maintenance practices identified as problematic in the past and documented in NRC inspection reports have been addressed. Most respondents also stated that current maintenance practices are not having an adverse effect on EQ equipment.

Question B4: Discuss your views and opinions of specific cases (current) where replacement equipment was not upgraded to 10 CFR 50.49 requirements because licensees reference "sound reasons to the contrary (R.G. 1.89)?"

Most industry respondents agreed that older equipment is appropriately being upgraded to the requirements of 10 CFR 50.49 and that the use of "sound reasons to the contrary" is measured and justified. Some NRC respondents believe that the sound reasons to the contrary were intended to be used on a one-time basis and not to be used repeatedly as an excuse not to upgrade equipment as it is replaced. Refer to the full text responses appearing in Appendix C for a complete discussion of this topic.

3.3 EQ Inspection Activities - Section C

Question C1: Were the NRC EQ inspections conducted with the appropriate scope and depth and in a consistent manner? Are you aware of any specific weaknesses associated with those inspections that need to be addressed relative to: a) older plants? b) newer plants?

Both industry and NRC respondents stated that the inspections of EQ programs conducted in the mid-1980s were performed with the appropriate scope and depth. No weaknesses in scope or depth were cited, though some inspectors stated that the four days (or less) of actual inspection time did not allow them to perform as in-depth an assessment of the licensee's program as some had desired. Some respondents noted that the consistency between inspections may have varied, but that it was to be expected, and the teams became more consistent after gaining experience.

Outstanding issues and problems associated with EQ inspection activities have been incorporated into Appendix B.

Question C2: What safety-significant issues have been identified as a result of EQ inspections? In your opinion, have these issues been adequately resolved?

The respondents, mostly NRC experts, described some of the safety issues identified during the EQ program inspections. According to the respondents, no safety significant issues remain outstanding, and the issues identified and the enforcement action taken are well documented in the inspection reports. One respondent stated that the benefit of the EQ inspections was to refocus the EQ activities on the actual installed condition of the equipment rather than just on the adequacy of documentation.

Question C3: Is sufficient emphasis being placed on EQ in the current inspection program? Are inspectors sufficiently trained? What changes would you recommend?

Many of the respondents answered that little or no routine inspection activity is conducted in the area of EQ. NRC respondents stated that this has resulted in a reduction in regional expertise. To address this issue, the NRC respondents suggested developing training modules, including the discussion of EQ topics during inspector counterparts meetings, and development of a periodic inspection program.

3.4 Miscellaneous - Section D

Question D1: To what extent should maintenance and surveillance/condition monitoring be credited for demonstrating continued equipment qualification? Are you aware of any surveillance or condition monitoring techniques that can be used to provide some assurance of remaining service life? Do you have any specific recommendations in this regard?

Most respondents agreed that condition monitoring should be an important part of any continuing aging management program, although many suggested that more research is needed to develop useful condition monitoring techniques. The ability to determine whether EQ equipment maintains the margin to withstand the effects of an accident is still a concern. Some stated that routine surveillances and maintenance alone are not enough to verify continued qualification of most equipment. Specific recommendations have been included in Appendix B.

Question D2: Should credit be given for other initiatives such as the maintenance rule for establishing and monitoring\maintaining equipment qualification? Do you have any specific recommendations in this regard?

Most respondents stated that the information obtained through activities related to the maintenance rule should help in determining the qualification status of EQ equipment, but that the information should not be the sole basis in determining the equipment's qualification. The performance-based approach to the maintenance rule would identify cases where harsh environment equipment experiences unacceptable failure rates during operation. It would not identify aging degradation that is not advanced enough to impact the equipment failure rate in the benign environments of plant operation, but may be advanced enough to compromise the safety function of the equipment under harsh environment common cause stressors in a design basis accident. This reduction in margin can only be addressed by environmental qualification testing.

Question D3: What other options or approaches to establishing and maintaining EQ requirements would you recommend?

The respondents provided several alternative approaches for establishing and maintaining EQ requirements, some of which have been incorporated into the outstanding issues found in Appendix B. For a complete summary of options and approaches provided by the respondents, refer to Appendix C.

Question D4: (Industry Only) Describe any specific EQ issues or topics that you believe deserve further research.

Three EQ issues were identified by respondents as needing further research. The first postulated that mild environment components subjected to severe operating conditions, such as self-heating, should be required to determine a qualified life. The second involved whether the actual installed stresses seen by cable systems are represented in the EQ programs for qualification. The final respondent offers a recommendation to develop a joint NRC/industry research program to test equipment from plants that have operated for longer than 20 years.

Question D5: (NRC Question D4) Do you have any additional comments or observations relative to the adequacy of EQ or EQ program requirements at commercial nuclear power plants?

Several comments related to the adequacy of EQ program requirements were made by the respondents. See Appendix C for the full text responses to this question.

One IQ related issue was identified and included in Appendix B. The issue discusses the ineffective policy providing prescriptive regulation for complex technical issues such as aging.

Questions D6 Do you know of any literature that may be helpful in addressing this issue, such as published reports, studies, articles, etc.?

Appendix C contains the complete list of literature recommended by the participants.

4.0 SUMMARY

The purpose of this survey was to identify potential issues that may still exist with the current IQ regulations so that they could be addressed as part of the IQ TAP. The staff has reviewed the survey responses and assembled a list of issues, problems, and recommendations that were identified by the NRC and industry experts and has included them in Appendix B. The staff included only those issues and problems adequately described by the survey respondents and consolidated those issues and problems with a common theme.

The results of the survey have also been shared with the Office of Research for their use in developing the research efforts called for in the IQ-TAP. In addition, members of Plant Systems Branch used the survey results to develop IQ related discussion topics for the information gathering site visits conducted under Task 3.f of the IQ TAP.

ENVIRONMENTAL QUALIFICATION SURVEY

Background Information

Name (Optional): ______________________________

EQ Experience: ______________________________

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NOTE: For the purpose of this survey, "older plants" will be those plants qualified under the Division of Operating Reactors' (DOR) Guidelines, or NUREG-0588, Category II requirements; "newer plants" will be those plants qualified under the NUREG-0588, Category I requirements. If you need copies of these documents to respond to this survey, please contact Christopher Gratton.

A. <u>Programmatic Requirements</u>

1. Are the regulations (10 CFR 50.49) adequate to ensure plant safety during and following design basis events? Do you believe there are unwarranted requirements? Are the differences in EQ requirements for older vs. newer plants justified? What specific changes would you recommend?

2. Does the existing qualification methodology provide sufficient basis to conclude that electrical equipment will be able to mitigate the effects of all postulated accidents over the entire range of qualified life? Are the current standards, procedures, and techniques used to conduct component type-testing satisfactory for establishing the bases for environmental qualification? What specific comments and recommendations would you make relative to the qualification methodology for: a) older plants? b) newer plants?

3. Is the burden of qualification appropriate to the importance of the equipment being qualified? Does the safety significance of the equipment justify the EQ requirements that are being imposed? What role, if any, should risk significance (e.g. probabilistic risk assessment) play in formulating EQ requirements? What changes would you recommend?

4. What are the strengths and weaknesses of the existing EQ requirements as they pertain to: a) older plants? b) newer plants?

5. Are you aware of any specific problems or difficulties that currently exist or that existed in the past with implementing EQ program requirements? Please distinguish between older and newer plants.

6. Are the current EQ requirements for older and newer plants adequate for plant operations beyond the current 40-year operating license (i.e., for license renewal)? Which EQ issues need to be addressed for continued plant operations beyond 40 years? What modifications would you make to the existing EQ requirements for license renewal?

B. Operating Experience

1. In general, how is EQ equipment actually aging (in service) compared with the equipment's predicted life?

2. Describe problems you have encountered with EQ equipment. Do some components routinely fail before the end of qualified life? Are component qualified temperatures and radiation exposure levels consistent with their actual in-service environment?

3. Do you believe that maintenance performed on qualified equipment is sufficient to maintain the equipment's qualification? Is there maintenance being performed on equipment or components that may have an adverse affect on EQ?

4. Discuss your views and opinions of specific cases (current) where replacement equipment was not upgraded to 10 CFR 50.49 requirements because licensees reference "sound reasons to the contrary (R.G. 1.89)?"

C. EQ Inspection Activities

1. Were the NRC EQ inspections conducted with the appropriate scope and depth and in a consistent manner? Are you aware of any specific weaknesses associated with those inspections that need to be addressed relative to: a) older plants? b) newer plants?

2. What safety-significant issues have been identified as a result of EQ inspections? In your opinion, have these issues been adequately resolved?

3. Is sufficient emphasis being placed on EQ in the current inspection program? Are inspectors sufficiently trained? What changes would you recommend?

D. Miscellaneous

1. To what extent should maintenance and surveillance/condition monitoring be credited for demonstrating continued equipment qualification? Are you aware of any surveillance or condition monitoring techniques that can be used to provide some assurance of remaining service life? Do you have any specific recommendations in this regard?

2. Should credit be given for other initiatives such as the maintenance rule for establishing and monitoring maintaining equipment qualification? Do you have any specific recommendations in this regard?

3. What other options or approaches to establishing and maintaining EQ requirements would you recommend?

4. Describe any specific EQ issues or topics that you believe deserve further research.

5. Do you have any additional comments or observations relative to the adequacy of EQ or EQ program requirements at commercial nuclear power plants?

6. Do you know of any literature that may be helpful in addressing this issue, such as published reports, studies, articles, etc.?

Outstanding Issues, Problems, and Recommendations Identified by Survey Participants

The staff reviewed all of the responses submitted as part of this survey and extracted those responses containing issues or problems related to EQ. Responses with similar issues or problems were consolidated into single statements. The full text of all responses is provided in Appendix C.

The following issues, problems, and recommendations are presented for further consideration by the staff:

(a) The following issues and problems relate to the current qualification testing methodology:

The test conditions require environments that could never occur simultaneously or sequentially to any device. The requirements for outside containment HELB equipment and radiation harsh only equipment are also not credible.

There are currently three different qualification methods accepted by the NRC. This creates confusion for the licensee and inconsistency for the regulator.

The sequence of exposing samples to full radiation dosages before LOCA exposure is unrealistic and too conservative.

A single qualifying methodology for all EQ equipment is not cost- or safety-effective.

Allowing qualification of EQ equipment based on the results of a single laboratory test without requiring periodic retests does not provide enough information on which to base qualification.

Worst case voltage during the accident is not a qualification test requirement.

Time and dose rate requirements for testing suggest that equipment qualification extends beyond the DBA and into severe accident space.

Testing does not account for steam leaks and inadvertent spray actuations during normal operation (DOR plants), and the self-heating effects of cables in the worst case cable bundle.

The effects of containment spray have not been adequately simulated during qualification testing.

Cable qualification does not account adequately for deformation of jacket and insulation at high stress points, the effects of high humidity and high temperature, and local vibration.

Older plant equipment qualification is not as rigorous as NUREG-0588 because the components have been qualified without aging, margins, or considering synergistic effects.

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

Mandrel bend testing EQ cable samples does not simulate the conditions seen in the plant.

There is no regulatory guidance on the accuracy of instrumentation during EQ testing.

Thermally based aging calculations are not precise and maintenance and inspection activities have not been developed to assist in the aging management of EQ components.

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

Synergistic effects policy should be reevaluated because in most plants, the radiation dose rates are low enough that the threshold for synergistic effects is never reached.

The use of the tests of commercial or generically named components is a problem when these tests cover various manufacturers, vintages, or designs of cables and interfacing components.

The following testing concerns remain unaddressed:

(i) interface effects between components tested separately for qualification;
(ii) the effects of mechanical installation stresses on cables;
(iii) continuous submergence prior to harsh exposure; and
(iv) the momentary electrical effects from the postulated initial peak temperature and radiation stresses.

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

(b) The following issues and problems relate to the use of risk assessments in EQ programs:

- PRAs should be used as the basis for developing graded EQ standards. A post-accident needs analysis should also factor into which EQ systems and components are required.

- PRAs do not model passive components, such as cable systems.

- The accuracy and availability of the data upon which PRAs are based does not match the mathematical sophistication of the models. Consensus of expert opinion would be preferable.

- Several levels of qualification would be expensive to implement. licensees would ultimately qualify equipment to the most severe application at the plant.

The following recommendations and discussions taken from the responses in Appendix C generally support the role of PRA in the development and implementation of EQ regulation:

- Both the Sandia EQ Scoping Study and an EPRI report on the risk significance of equipment show that a risk-based approach to safety classification would lead to a substantially different list of Class 1E equipment than given by traditional deterministic methods. Criteria for the safety classification of equipment based on safety analysis should be developed to allow utilities to reclassify their equipment. Allow the approach to be voluntary.

- PRA should play a <u>major</u> role in formulating EQ requirements such as: time windows of operability, instrument accuracy requirements, circuit design requirements for continuous indication of circuit condition, and testability in normal conditions of the potential circuit integrity under harsh environments...PRAs must be realistic if they are to be used and they should be used to focus the licensee's limited resources on the vital circuits.

By contrast, these recommendations also taken from Appendix C generally do not support the use of PRA in the development and implementation of EQ regulation:

- Risk analyses should only play a secondary role in deciding safety issues and influencing EQ.

- Risk significance should play a minimal role in developing requirements. Risk significance depends on component failure rates during DBE and this data is simply not available.

- Do <u>not</u> try to classify "levels of risk" or "importance to safety" unless a better method is developed, and only then if there is a very great potential for improvements in safety and performance at reasonable cost.

(c) The following problems relate to the NRC's EQ inspection activities of the mid-1980s and include problems with the current inspection program:

- The mid-1980s inspections emphasized documentation, without a corresponding emphasis on the equipment's safety significance.

- The mid-1980s inspections found that many programs lacked the documentation necessary to support the EQ inspection activities, especially at the older plants.

- The EQ inspections were conducted on a one-time basis. A periodic inspection program is not being conducted.

- Current inspectors are not sensitive to EQ issues, they do not receive training on EQ issues and standards, and did not participate in the 1980s EQ inspections.

- There were inconsistencies in the interpretation of requirements and test results.

(d) The following methods are presented as recommendations for addressing EQ at license renewal:

- To continue the qualified life of equipment beyond 40 years, submit a revised qualification package. Any aging mechanism that might become significant only during the last 20 years of operation would have to be addressed, which is the standard practice in any qualification program. The original aging and type-testing program could be reevaluated to justify a 60-year life because the utility would present measured operating environments that are far less severe than the conservative design values used in the original qualification program. This reevaluation would need to demonstrate the same degree of margins required by standards and regulations. If the reevaluation does not support a 60 year life, new qualification test data may have to be generated, or the environment of the equipment may have to be mitigated, or condition monitoring could be used to show that the actual aging degradation of the item is less than that in the original qualification program. The last resort would be to replace the item. Extension of qualification would be governed by the EQ requirements appropriate to the current licensing basis of the plant.

- Maintenance programs for equipment in harsh environments should include monitoring of certain critical characteristics. The actions required for license renewal should consist of the following steps:

  i. Review all maintenance and replacement activity procedures and records to assure that the equipment has been maintained in a manner which retains the qualification status.

  ii. Determine whether the equipment has been operated in the environments for which it was qualified.

  iii. Determine whether the equipment has been operated in the manner (modes) for which it was qualified.

  iv. Determine whether age is a significant failure mechanism in properly maintained equipment.

(e) Moisture transmission through cracks in cable insulation or into the cable core through diffusion may compromise an adjacent connector or terminal equipment not designed to withstand cable transmitted water.

(f) EQ requirements should not include equipment located outside the containment and exposed to short-term steam conditions or radiation harsh only equipment due to their low probability of causing core damage and their brief exposure to the harsh environment (compared with components inside containment).

(g) Maintenance programs should be required to monitor characteristics critical for maintaining EQ.

(h) The maintenance required to maintain EQ equipment in a qualified configuration and the maintenance frequency interval should be specified.

(i) Documentation requirements for EQ components are too burdensome with little safety benefit, especially for equipment stored for future use.

(j) The NRC and the industry should endorse a list of EQ components to eliminate the differences in interpreting EQ test data. The testing of all listed EQ components should be approved by the NRC.

(k) There has been insufficient testing on condition monitoring techniques or on the parameters to be trended to allow a technique to be used to determine remaining service life.

(l) Research on naturally aged cables should be conducted so that the current aging formulas can be validated. The NRC and the industry should also cooperate to develop a program for the testing of other equipment removed from plants after 20 or more years of service.

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

(n) Licensees do not adequately evaluate the ambient temperatures around EQ equipment, relying on the average bulk temperature instead of the local temperature.

(o) 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. These important performance parameters are not included in the regulations under "sound reasons to the contrary."

(p) "Sound reasons to the contrary" were originally intended to ease the transition into the EQ equipment replacement requirements of 10CFR50.49. Those provisions have become outdated and should be removed from the regulation.

(q) 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 not generally in place at these plants.

(r) 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.

(s) 10CFR50.49 does not define the terms "similar" and "significant." Guidance on how to use these terms should be made available.

(t) The regulations do not clearly state the acceptance criteria for qualifying a component based on operating experience.

(u) 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.

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

(w) Safety-related equipment located in a mild environment and that experiences severe environmental conditions due to its operating condition, such as self-heating from being continually energized, should be evaluated for a qualified life.

(x) Prescriptive regulatory approaches for complex issues, such as aging, are typically ineffective. It is recommended that utilities be allowed to analyze solutions to aging and other EQ-related issues.

(y) Maintenance data for older plants should be compared with newer plants to see whether the newer, more stringent EQ requirements resulted in better equipment being installed.

(z) Licensees need to walkdown and document the location of all safety equipment so that appropriate DBA parameters can be used to qualify the equipment.

ENVIRONMENTAL QUALIFICATION SURVEY FULL-TEXT RESPONSES FROM NRC AND INDUSTRY EXPERTS

NOTE: This survey was conducted anonymously. Each respondent has been given a unique identifier (e.g., (a), (b)) for cross-referencing of responses, and the responses have been alphabetically arranged for each question.

A. Programmatic Requirements

1. Are the regulations (10 CFR 50.49) adequate to ensure plant safety during or following design basis events?

(a) Severe accident\degraded core should be considered in source term. Guidance on EQ of CGI's. Rule for seismic and mechanical EQ. Seismic SQUG doesn't recognize performance requirements during DBE, only the damage after.

(d) Region V believes that the regulations are adequate for design basis events. There have been occasions where our inspectors have seen where not all the proper requirements were met.

(e) Category I are adequate. Category II and DOR may not be, especially due to aging effects.

(g) Synergism and dose rate effects need better treatment. "Engineering judgement" should be addressed.

(i) Yes

(j) The qualification requirements are adequate to assure qualification if reasonably applied. They can be easily over applied causing more severe qualification requirements than necessary. One such method of making requirements too stringent is the desire for one all encompassing accident environment test profile. The resulting profile contains conditions that could never occur simultaneously or sequentially to any device. DOR and NUREG 0588, Category II qualifications are satisfactory as long as normal conditions are not severe and reasonable replacement frequencies are in place. For inside containment, the accident condition is generally much more severe than the aging condition except for components on hot process lines or continuously energized solenoids where care must be taken to control aging. I don't believe changes are necessary to the rules. When replacements are required, the components should either be replaced with 50.49 qualified devices or retested to 50.49 requirements.

(k) The current regulations are adequate but could be improved.

(l) The regulations are deficient in the area of equipment upgrades. They only require that the licensee document reasons to the contrary for not upgrading to 50.49. Thus equipment may never be upgraded to 50.49. The regulation also does not tie together the requirements of NUREG-0588 Category I, and RG 1.89 as being an acceptable methods for meeting the regulation. What is happening is that newer standards have been issued which do not have the same requirements for example as IEEE 323-1974 which is endorsed by RG 1.89 and NUREG-0588. The NRC guidance has not kept up with the industry. Things have become stagnant in this area.

(m) Most licensees put in place an EQ program in the late eighties. I don't think the program is well implemented. When NRC backed off from the EQ inspections, licensees dissolved the EQ group and treated it as everybody's responsibility.

The regulation as such is good enough but I doubt if there is adequate adherence to the requirements.

(n) The regulations are, in my opinion, generally adequate. However, our experience shows areas where improvements can be made. These are covered in the comments that follow. One of the most significant contributions made by 50.49 was the requirement in [paragraph] (d) to generate the now famous Q List. I believe this has done almost as much for plant safety as has the entire EQ program! This is due to the fact that the Q-List gave a focus to the safety features of the plant equipment that had not been available previously. The very method needed to generate such a list forced the plant operators to analyze their systems' and components' functions and gave them a tool (the List) for establishing, tracking, and controlling maintenance, replacement, and other activities affecting this important equipment. I trust the Commission is maintaining vigilance in this area and not allowing this valuable tool to rust away.

(o) Regulations and the existing qualification methodology are adequate to ensure plant safety during and following design basis events. I believe that the requirements are warranted and appropriate in view of the critical functions provided by qualified equipment.

(p) The principal distinction between these two requirements is that DOR and Category II permit equipment aging to be evaluated by analysis whereas Category II requires that aging be addressed by testing. The introduction of age conditioning in IEEE Std 323-73 and its endorsement by RG 1.89 appeared to be sensible when it took place. However, the deficiencies of aging technology became immediately so evident that IEEE quickly published an addendum to IEEE Std 323 stating it was not its intent that industry should undertake research to advance the state of the art to address the aging requirement in qualification.

The gap between the requirement to demonstrate a qualified life by accelerated aging (other options rarely being viable) and the status of aging technology created a dilemma for those engaged in EQ. Manufacturers, utilities, and test laboratories did the best they could; gradually the NRC accepted certain approaches; and these were adopted as benchmarks by the industry.

In the aftermath of TMI, the NRC began to question whether the EQ programs that the utilities had been accepting were indeed in compliance with regulatory requirements. A broad EQ review undertaken at that time revealed extensive deficiencies, most of which were generously labelled as deficiencies in documentation. The deficiencies were ultimately resolved: mostly by analysis, but in some cases by additional testing.

My own approach to the dilemma was to conduct EQ programs as well as possible within the limits of existing technology, to urge strongly that the technological limitations be taken into account in interpreting the results, and to recommend that other approaches assuring plant safety (e.g., condition monitoring, surveillance, service condition monitoring, failure analysis and feedback) be given more emphasis than they were receiving at that time. For example, I took the position that a qualified life (QL) established by an accelerated aging program was at best an estimate with a large uncertainty; I felt that QL estimates should be subject to revision as more information became available about service conditions and equipment performance and as aging technology advanced. I repeatedly pointed out that lifetime predictions of hundreds, and even thousands, of years were practically meaningless, because the uncertainties in such predictions could be comparable to the numbers themselves. Similarly, the claimed or implied accuracy of QLs established by age conditioning were exaggerated, e.g., it made no sense to report a QL of 41 years and claiming a margin of 1 year, if one neglected to evaluate the uncertainty in the QL. In careful laboratory experiments on slabs of insulating materials (with an accuracy far exceeding that achievable with equipment such as cables) typical uncertainties were of the order of -10 and +100 years.

Sandia National Laboratories (SNL) has achieved high accuracy in the accelerated aging of cable insulation as demonstrated by the self-consistency of the experimental results and agreement of the data with a theory of the superposition of thermal and radiation aging effects. However, the precision of SNL's work is not at all typical of the accelerated aging conducted in EQ programs. Furthermore, the evidence that the conditions produced by accelerated aging are the same as those produced by aging in service is still far weaker than the evidence of self-consistency.

The age-conditioning of even relatively simple devices has sometimes proved surprisingly difficult. As an example, one can cite the NRC research on solenoid-operated valves (SOVs). Although the program allotted far more resources than would be devoted to equipment aging by industry, unexpected difficulties caused the quality of the aging achieved to fall significantly below the goals that had been set.[1]

It is generally recognized that it is easier to accommodate the aging component of EQ by analysis than to do so by testing. That is, it is easier to satisfy regulatory requirements by analysis; but it is doubtful that analysis produces the same level of technical rigor as that which can be accomplished by testing. At a recent technical meeting, a utility representative reported that analysis predicted a life in excess of 1000 years (given to four significant digits!) while testing failed to produce even a 40-year life for the same equipment. As discussed above, both methods are subject to considerable uncertainty; but experience shows that testing is the more realistic of the two methods.

Conclusion: The bottom line of the foregoing discussion is that neither Category I nor Category II are ideal approaches to EQ. However, especially for equipment subject to harsh environments, the Category I approach is superior: if equipment can pass an accident simulation after it has been degraded by age-conditioning, one has greater confidence in its capability than one could have if the accident simulation were not preceded by age-conditioning.

(q) "Adequate to ensure plant safety" is used as if it were a definite condition or criteria. It is not, of course, as is implicit in the NRC's defining this adequacy differently for two identical plants differing in nothing but the date of construction and/or licensing. Therefore the question only has rationality if one is prepared to speak in relative terms such as, "Is plant A as safe now as it would be with some changed requirement?" or "--as it would be with $1 million spent for certain equip changes?" or "as safe as plant B built to some different criteria?" etc. I personally believe there are some shortcomings in the basic grandfathering premises involved in 50.49 as will be clear from further comments below.

(r) Comment 1: Requirements are adequate and warranted.

Comment 2: No. The current acceptance of separate effects testing as a bases precludes consideration of potential synergies for older equipment. A test-based determination of qualified life is necessary. Further, many older plants do not regard 10 CFR 50.49 (J) as meaningful, lacking a real NRC effort to enforce it.

Comment 3: Older plants' requirements are lacking in the seismic area. SQUG is a step in the right direction, but not good enough. Need to consider more specific seismic qualification of equipment. Similarity arguments of SQUG are too shallow.

Comment 4: Justifiable only on a practical basis that replacement or upgrading would be more detrimental to safety.

(s) The regulations in 10 CFR 50.49 have been adequate to ensure plant safety in the ten years since they were published (no one has challenged their adequacy) and in the past few years the utility industry has given strong arguments for the appropriateness and adequacy of the same Rule for establishing qualified lives as long as 60 years.

(t) The regulations (50.49) provide a basis for an effective program to establish the qualification of electrical equipment important to safety. The regulations do not, however, ensure safety. Implementation of the EQ program ensures plant safety.

(u) This question is somewhat misleading since compliance with 50.49 alone cannot ensure plant safety. The more appropriate question would be does the regulation ensure adequate electrical equipment performance during events. I believe the answer to this question is yes, since 50.49 is broadly written to address: equipment scope, aging, event stressors, and methods of qualification. The broad tenants of the regulation provide appropriate consideration of the critical elements of environmental qualification. However, portions of NRC EQ guidance documents, (e.g., Regulatory Guide 1.89, DOR Guidelines), or NRC staff interpretations are unnecessarily restrictive. These are described elsewhere in this survey response.

(v) 10 CFR 50.49 provides adequate guidance to ensure plant safety during and following a design basis event when used in conjunction with other requirements such as calibration and maintenance and the resulting data is evaluated for impact on qualified life and performance during and after an accident. Tracking and trending of a component performance is critical to maintain confidence that the component will perform its function.

Are any of the requirements too strict or unwarranted?

(b) I do not believe that the EQ requirements a.e too strict! The question is really quite simple: a system must be in service for an extended period of time, what is necessary to demonstrate that it will work? Testing new equipment clearly won't do it unless it is clear that the equipment will not be adversely affected during its service life. Since we know that radiation and temperature both degrade cable insulation and other material, the test-it-new approach doesn't wo k without a lot of additional information.

(e) None of the requirements are too strict or unwarranted because EQ can be justified by a single sample and this justifies the extra margin.

(f) No. They are not strict enough.

(h) I believe that the regulations are adequate and not too strict or unwarranted.

(i) No

(q) At this time of writing, I do not have the 50.49 text available for detailed review, but one outstanding aspect of unwarranted requirement comes to mind. The almost simultaneous peak radiation and temperature conditions postulated for LOCA is incredible in the minds of all the physicists and engineers of the national labs. and at MIT with whom I have discussed the matter. My concern has been that my evaluation of the operability of many cable systems <u>through</u> such a condition indicated clearly that failure would occur. This was reported in some detail by the writer to the ACRS many years ago. The net result has been that those who understand the problem are politically forced to ignore the unrealistic requirement and supply equipment without a complete EQ demonstration. Flawed requirements giving rise to flawed responses does not seem to be a smart or ethical approach to public safety. What other response can the industry make?

(s) I know of no unwarranted requirements.

(t) Yes, in the area of qualifying equipment located outside containment and those components subjected to radiation only. Outside containment equipment exposed to HELB's are typically not contributors to an increase in core melt frequency. Qualification of equipment to Post-LOCA radiation is based on very conservative source terms.

(u) If one limits requirements to the provisions of 50.49 then two requirements may be considered as unwarranted. First, the requirement to age precondition for all significant aging mechanisms prior to accident testing appears overly restrictive in practice. The effects of some aging mechanisms simply cannot be accelerated. In other cases, traditional stressors (e.g., temperature) may simply not be significant, yet, Staff interpretations generally consider thermal and radiation aging to be absolute requirements. If the term "significant" was properly clarified then the regulatory objective may be more appropriately achieved. The second unwarranted requirement, contained in 10CFR50.49(j), requires qualification documentation to be maintained for equipment "stored for future use". If this were deleted the existing language would still ensure that documentation was maintained for the equipment's entire installed duration. Further, this requirement is confusing.

As noted in below, the application of a uniform methodology for all equipment within the scope of 50.49 is unwarranted. It is simply not cost or safety-effective to apply the same methodologies to an in-containment device requiring active performance during severe LOCA steam and radiation conditions and to some outside containment device experiencing, in comparison, relatively benign radiation-only conditions.

(v) Unwarranted requirements imposed on or assumed by licensees stem from different interpretations made by the NRC with respect to the documentation and data needed to prove qualification to 10 CFR 50.49. Consistent application of the rules and regulations by the NRC would eliminate this.

Are differences in EQ requirements for older vs. newer plants justified?

(a) No.

(e) The differences between newer and older plant EQ requirements have never been technically justified in-depth.

(f) No they are not justified. Safe shut down of the plant must be a requirement (primary concern). (Improper) Maintenance and (deviations in) in-service condition has not been factored into the qualification of the equipment.

(i) No

(k) Differences in the treatment of old vs. new plants are justified.

(n) I cannot state unequivocally that the differences in requirements for older vs. newer plants are justified but, as a practical matter, I still believe it was the only practical thing to do at the time and I further believe time has shown the wisdom of the decision. In fact, as I will discuss further in [question] 2., it may be that the decision to make the requirements tougher for newer plants was the questionable one!

(o) The issue of the adequacy of the EQ for older plants versus newer plants is difficult, at best - particularly when the issue of continued operation beyond 40 years is considered. Newer plants who properly performed EQ have actual aging related data for lifetimes up to 40 years and should be in a good position to project life beyond 40 years using tools such as the Arrehnius model. However, this is not true for older plants. Many older plants do not have aging data for the equipment of concern, and at best only have test data for some of the materials in the equipment. To show qualification to 40 years required considerable analysis. The Arrehnius model assumes a basis of known performance at known conditions from which to project performance at different, but less severe conditions. Because older plants would probably begin from a basis that made heavy use of analysis rather than actual data, they may not be able to justifiably use the Arrehnius model and may not have a good basis from which to show life beyond 40 years. They would probably have to repeat their original analysis and provide a sound technical basis to show that a lifetime greater than 40 years, such as 60 years is expected. This issue is most difficult for electrical equipment whose performance or condition has not been periodically verified to be as expected, such as electrical cables. While most items of equipment can be tested, inspected, or monitored, cables have not been the subject of a regular maintenance program of inspection and monitoring. If such a program was in place the licensee could take advantage of the provisions of Regulatory Guide 1.89, paragraph C.5.d., which indicate that the results of periodic surveillance and testing programs would be acceptable as ongoing qualification to modify qualified life. However, I am not aware that this type of information is available for electrical cables.

The present EQ programs do not provide for data that could be of value when attempting to use in-situ testing to show that there is remaining useful life. Specifically, critical properties are not evaluated at the end of the preaging period and prior to testing at simulated accident conditions. As a result it is nearly impossible to determine how much margin is required at the end of qualified life for a particular item of equipment to survive design basis accidents. It is this margin that must be maintained throughout equipment life, including extended life. The emphasis of existing EQ is to show that equipment can age for the specified period of time (40 years) and then survive design basis accidents.

Regarding the issue of the adequacy of current EQ requirements for older and newer plants for operations beyond 40 years, I believe that the current practices are adequate for newer plants that have preaged electrical equipment and that the current requirements may not be adequate for older plants where preaging was not performed. I believe that the preferred approach would be if environmental qualification (EQ) was demonstrated to include the license renewal period (typically qualified for 60 years) and the EQ was based on actual test data in accordance with Regulatory Guide 1.89 and IEEE Std 323-1974. This would include preaging based on the specified service conditions for a period of time that included the license renewal period or demonstrating that previous preaging (typically based on 40 years of service life) contained sufficient conservatism to be valid for the license renewal period. When conservatism is utilized the amount of conservatism must have a documented technical basis that thoroughly justifies its use. When EQ for the license renewal period cannot be established for the identical type of equipment, EQ may be established by demonstrating similarity to equipment that was qualified to the specifications of IEEE Std 323-1974.

For older plants where equipment whose original EQ did not require preaging, the minimum acceptable approach should be to establish EQ through the license renewal period by a combination of reanalysis and information obtained from the required on-going programs that review surveillance and maintenance records to assure that equipment which is exhibiting age related degradation will be identified and replaced as necessary. (See discussion in paragraph C. below.) The reanalysis must be based on technically justified information concerning the aging of the materials and the assumed service conditions. However, this is not the preferred approach. The preferred approach would be if EQ was established to include the license renewal period based on actual test data in accordance with Regulatory Guide 1.89 and IEEE Std 323-1974, as discussed above.

(q) From a pure engineering perspective, definitely not. The heavy responsibility for preventing the terrible consequences of an uncontrolled accident, both for innocent victims and for the electrical industry itself, would strongly point to the grandfathering of less rigorous practices only if supplementary design features, operating conditions, or experience factors indicate the risk of serious failure is insignificant (PRA?) or incredible. For passive equipment, normal experience as an indicator of adequacy is, however, almost useless when considering equipment operability under LOCA or HELB conditions.

(s) The differences in EQ requirements for older vs. newer plants are justified by the well-established grandfathering principle. To justify the cost of backfitting requirements to plants already constructed and operating it must be demonstrated that the original requirements and standards were inadequate in terms of safety. The introduction of the

Guidelines states "The objective of the evaluations using these guidelines is to identify Class 1E equipment whose documentation does not provide reasonable assurance of environmental qualification." The DOR Guidelines do require that aging effects be accounted for in establishing the installed life of a component (note that for DOR Guideline equipment the installed life is tantamount to the qualified life). The document states "This position [of not having to demonstrate a specific qualified life] does not, however, exclude equipment using materials that have been identified as being susceptible to significant degradation due to thermal and radiation aging."

(t) Yes. The regulations require upgrading of equipment for older plants unless there is sound reason to the contrary. Essentially, there is no difference in the requirements except for pre-aging prior to LOCA. Industry operating experience indicates that the pre-aging is very conservative in that equipment is not aging as fast as predicted by accelerated aging methodology. Imposing this requirement on older plant is not justified.

(u) The two most significant differences between "grandfathered" and new requirements are the method of addressing preaging and margin considerations. The exclusion of margin is justified based on the conservatisms inherently contained in most environmental definitions and performance requirements. The lack of preaging prior to accident testing difference is also justified since aging, per se, must still be addressed in the qualification evaluation (for grandfathered equipment greater reliance on analysis, coupled with some material aging information, is permitted). Conceptually, both aging approaches are appropriate. In practice, adequacy depends on the quality, completeness, and conservatism of each analysis. As noted above, it is impossible to adequately accelerate all aging mechanisms. Consequently, some form of aging management may be appropriate for the success of either aging approach.

What specific changes would you recommend?

(a) Phased upgrade or retesting [of the older plant to meet the new plant requirements]. Develop method (eg., EPRI indenter) for in-situ condition monitoring.

(b) Clearly a single standard must be developed. The Commission was very clear in its direction to the staff to develop a single standard, and recognized that potential differences would exist, and the importance of providing a technical justification for accepting differences from the standard. The older standard - no pre-aging prior to LOCA testing- is in my opinion, clearly not adequate to provide reasonable assurance that electrical equipment will function after an extended service life. The acceptability of the older standard has not been justified.

(e) All plants should be made to meet the Category I(323-71) guidelines.

(h) I believe that the differences in requirements for the replacement/upgrade of components should be modified to require the older plants to upgrade to

Category I when components are replaced, either at the end of life or for corrective maintenance.

(i) I would add a paragraph to require plants licensed after November 30, 1985, to be in full compliance prior to licensee issuance. (The present rule does not address these plants.)

(j) More uniform guidance for interpretation of requirements might be useful especially for organizations with high turnover.

(k) Would consider adding the requirements for surveillance and/or condition monitoring to both plant categories.

(n) Rather than "specific changes", I recommend some specific courses of action below which may or may not lead to changes.

(p) Conclusion: The bottom line of the foregoing discussion is that neither Category I nor Category II are ideal approaches to EQ. However, especially for equipment subject to harsh environments, the Category I approach is superior: if equipment can pass an accident simulation after it has been degraded by age-conditioning, one has greater confidence in its capability than one could have if the accident simulation were not preceded by age-conditioning.

(s) I would not recommend any changes. However, what I would recommend is that the NRC either accept (as it has during the past ten years) the qualified status of equipment in licensed older operating plants or initiate a review of qualification packages for that equipment. In either case, the DOR Guidelines requirements should remain the criteria. I feel that the requirements are adequate, but it is incumbent upon the NRC to render sound engineering judgments on whether the basis for qualification documented by the licensee is adequate.

(t) Re-evaluation of source terms and the need to qualify equipment located outside containment, and equipment subjected to a radiation only harsh environment.

(u) I will limit this input to the following three areas: methodology, documentation, and accident scope. Currently, a single methodology, (preaging combined with accident simulation testing) is viewed as the only acceptable method of complying with 50.49. This methodology (and all the documentation and related licensee activities associate with it) is applied to all equipment with the scope of 50.49 regardless of its safety-significance or the severity of its accident environment. Consequently, qualification of inside containment PORVs (very safety significant and exposed to severe LOCA conditions) and outside containment position indication limit switches on a cooling water containment isolation valve (little safety significance and exposed to moderate LOCA radiation and possibly a moderate short-time steam exposure from a HELB) must comply with the same EQ methodologies.

Secondly, individual utilities expend significant resources refining and updating EQ documentation. Much of the current documentation framework is derived from the NRC preferences during prior NRC audits. In France, EDF approved equipment manufacturers (coupled with EDF review and acceptance) are responsible for maintaining the adequacy of qualification documentation and its applicability for supplied equipment. Each French plant need not maintain EQ files. Absent standardization, we are apparently unable to apply the French approach to current plants. However, some measures (not suggested here) should be implemented to minimize much of the unnecessary paperwork burden associated with maintaining EQ files. Regarding the advanced reactors, I would strongly urge that standardized EQ programs, including single sets of normal operation and accident conditions, be implemented. These efforts should be focused on minimizing individual utility EQ paperwork cost burdens.

Lastly, I have several observations regarding accident scope and qualification. Currently, in-containment steam, temperature, pressure, and submergence qualification is based on DBA (double-ended break) LOCA and MSLB conditions. It appropriately assumed that adequate performance for the DBA environmental conditions provides reasonable assurance of equipment performance for other LOCA and MSLB events with potentially (but slightly) different conditions and performance needs. For outside containment pipe breaks, DBA break conditions typically produce the highest pressures and temperatures but can be of significantly shorter duration than smaller size breaks.

However, two in-containment requirements, DBA radiation doses per TID-14844 and the "one hour minimum" operating condition, suggest that the qualification provisions extend (rather informally) beyond DBAs into the area of severe accidents. The need for these two provisions, assuming qualification is limited to DBAs, has never been clearly articulated. The rationale for these provisions becomes somewhat clearer if one assumes, within the context of defense-in-depth, they exists to provide some assurance that the equipment will function for some severe accidents with delayed ECCS (one hour minimum operating time) and some significance core damage (TID 14844). Unfortunately, since these provisions exist within the context of DBA qualification they can create qualification problems that are perceived as DBA and not severe accident related. For example, most materials, particularly cable insulation/ jackets, are significantly degraded by the in-containment TID-14844 doses. Yet, DBA mitigated LOCAs exhibit only a fraction of the radiation assumed by TID-14844.

Further, much of the LOCA mitigating equipment, particularly the sense and command features (e.g., transmitters) and associated equipment (e.g., cables, splices, penetrations) have little significance for most severe accidents. The NRC should either delete these apparently beyond DBA provisions or clarify the basis for their need.

(v) For older plants 10 CFR 50.49 should be implemented in conjunction with a condition monitoring program. The condition evaluation will eliminate the assumptions made by older plants in their EQ evaluation.

2. Does the existing qualification methodology provide sufficient basis to conclude that electrical equipment will be able to mitigate the effects of all postulated accidents over the entire range of qualified life?

(a) [Methodology] does not recognize that some things are more vulnerable at BOL.

(b) The 323-1974 Std is a pretty good start. However, only testing a single component such as a cable once and not requiring periodic testing is not as meaningful as may be required. In the long run 323-1974 plus additional testing by the vendor or by licensees may be found to be appropriate.

(d) Region V believes that the current qualification methodologies are adequate to conclude that the electrical equipment will be qualified. However, the Arrhenius equation may be too conservative [and underestimate useful life].

(e) Adequate for the newer plants.

(h) If we assume that qualified life means 40 years and that the Arrhenius calculations are acceptable, then the proper maintenance of equipment is required to ensure that age sensitive components are replaced periodically to extend the life to 40 years. I am not certain that the present test data could demonstrate a qualified life beyond 40 years for most of the equipment.

(i) If we accept Arrhenius predictions, present methodology and testing are marginally adequate.

(j) Yes.

(l) The methodologies used to qualify equipment were based on the most current NRC information and EQ testing conducted in the industry. This provided reasonable baseline data on the capabilities of EQ equipment assuming that required maintenance was performed. Mechanical aging which should also include seismic aging is necessary to predict satisfactory performance over the range of the qualified life. However, operational occurrences such as steam leaks and inadvertent containment spray actuations can cause degradation of equipment beyond that initially evaluated in EQ test results. The regulations do not provide for considering these occurrences in the test program. Also using Arrehnius methods to extend the qualified life beyond the actual tested profile does not appear to be the most prudent action to take when a device is needed for long periods of time such as 30 days or 1 year post DBA. The industry has over-used Arrehnius in this regard to extend test data to envelope a longer qualified life.

(n) I believe it does. In fact it may be excessive (see following comments). In fact, it may be flawed (See A. 5.).

(q) Regulations are definitely not adequate for cable systems (cable, connections, seals).

(r) Comment 1: Have less confidence in equipment where qualified life is extrapolated to 40 years based on short aging time.

Comment 2: Bases for determining a mandatory replacement interval for Class 1E equipment in older plants is weak or lacking. Older plants should have a requirement to upgrade.

Comment 3: Environmental record keeping for equipment location, DBE testing of in-plant equipment.

(s) It is my judgment that the existing qualification methodology is adequate, so long as due attention is paid to areas of uncertainty that are well known thanks to the extensive attention that has been and is being paid to them over the last two decades. This attention has been mainly in the form of research conducted by Sandia National Laboratories under NRC sponsorship and by several investigators under EPRI sponsorship. These include such areas as limitations of aging models (Arrhenius for thermal aging and the equal-dose/equal-damage model for radiation aging), differences between simultaneous and sequential imposition of aging and accident stressors, dose-rate effects, and differences between natural and artificial aging. Sandia has extensively researched all these areas but the last, which is now underway in the University of Connecticut Inplant Natural vs. Artificial Aging Program sponsored by EPRI ("Natural Versus Artificial Aging of Nuclear Power Plant Components," EPRI Interim Report TR-100245, January 1992). All of these research efforts are described and referenced in the EPRI Equipment Qualification Reference Manual (Technical Report 100844, November 1992), especially Section 13.[1] This section also gives an overview of the NRC Nuclear Plant Aging Research (NPAR) program studies that are pertinent to equipment aging and qualification. It is important to note that many of the lessons learned from all this research has had an effect on standards and requirements (e.g. known synergistic, dose-rate, and sequential effects on aging simulation must be accounted for), but none of the research results has invalidated the basic qualification methods established by IEEE and endorsed by NRC requirements. Any such invalidation could have been reflected in the 1983 version of IEEE 323, but the methods in that version are essentially those in the 1974 version. The bottom line is that, in the judgment of standards writers, qualification engineers should be aware of the areas of uncertainties identified by all this research and should account for them in specifying qualification tests or in performing qualification evaluations, but none of the research findings invalidate the approaches to qualification referenced by standards and regulations.

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[1]The NRC staff involved in evaluating the results of this survey could benefit from the in-depth treatment of EQ uncertainties in this section of the EQ Reference Manual. In the spirit of EQ research cooperation that has existed between EPRI and the NRC since the mid-1970's, EPRI, in keeping with its long-established policy, sent copies of the manual to more than 20 members of the NRC staff at no cost. Unfortunately, I have been informed that these manuals are being returned to EPRI because an NRC lawyer views these important technical reports as inappropriate personal gifts to NRC staff members!

The following quotes from a section titled "Evaluating the Qualification Information" on pages 7-14 and 7-15 of the reference manual are just small examples of the guidance to utilities regarding the establishment of a qualified life for equipment in newer and older plants: "The equipment's installed life may be limited not by thermal aging effects but by other aging mechanisms (e.g., operational cycles). All significant operational and environmental aging mechanisms should be addressed and the life-limiting mechanism determined. Every effort should be made, either quantitatively, through the use of accelerated aging data, or qualitatively relying on experience, inspections, and maintenance, to define a qualified life."...."Early environmental tests were often conducted without preaging of the specimens. When using these test data, the plant-specific evaluation must attempt to determine the permissible level of inservice deterioration that would not invalidate the test conclusions."...."Finally, inservice inspections, tests, and maintenance may be used to ensure the equipment remains in a condition bounded by results of the aging evaluation."

(t) The existing qualification methodology provides an excellent basis to conclude that electrical equipment will be able to mitigate the effects of all postulated accidents over the entire range of qualified life. Additional to the testing, ongoing evaluation, trending and monitoring of equipment for the installed locations provide reinforcement to that basis. Part 21's, IE Notices and industry groups also provide valuable information for evaluating testing assumptions and results.

(u) This question addresses equipment adequacy for all "postulated accidents". I assumed this is intended to mean design basis accidents (DBAs). See the prior response regarding EQ requirements that appear to be related to beyond DBA conditions. In my opinion the simple answer to this question is yes. The fundamental purpose of EQ is to provide a basis for concluding that equipment is designed, installed, and maintained such that limiting harsh accident conditions in combination with operational aging will not result in equipment common-mode failures. Qualification of representative equipment, including the limiting case of single test samples, coupled with proper manufacturing, installation, maintenance, and operation provides reasonable assurance that environmental or aging induced common-mode failures will not occur. This adequacy is based in large part on the conservatisms associated with the harsh environmental conditions used for EQ when compared to the conditions potentially occurring during the most probable accidents.

Virtually all EQ equipment potentially exposed to pipe-break steam conditions are qualified by simulation tests. Since the assumed environmental conditions reflect very conservative analyses of mass, energy, and heat sink characteristics for guillotine double-ended breaks and severe core degradation for radiation conditions, they are conservative representations of the conditions possible during the most likely accidents. Further, much of the equipment is tested to generic profiles that contain additional conservatism when compared to plant-specific conditions. If representative equipment can survive these steam test conditions and subsequently installed equipment is properly manufactured, installed, and maintained, then the installed equipment should be capable of similar functionality under plant accidents.

Further conservatism is derived from the assumed accident radiation conditions which do not represent those resulting from a DBA mitigated LOCA and are, in fact, significantly more severe. For many materials these extremely conservative radiation dose assumptions produce degradation that far exceeds the degradation experienced by prolonged exposure to normal operating temperatures. Recognizing that the conservative accident radiation exposure can account somewhat for the effects of thermal aging, even the test performance of some "unaged" equipment is reflective of a significant degree of material degradation. When thermal aging is addressed through either preaging or thermal aging analysis, additional assurance of equipment performance in the aged state is obtained. For "grandfathered" equipment, I believe aging analysis when properly performed with an adequate level of analytical conservatism can address the significance of operational, thermal, and radiation aging mechanisms.

(v) The standards are sufficient, however, what is most important is that the actual test itself duplicate the components plant configuration and the environment that the equipment will be subjected to. Certain techniques are overly conservative, such as the requirement to use a mandrel for cable testing (this does not reflect in plant conditions), while the standards lack guidance on instrument accuracy with respect to harsh environments.

Most tests did not simulate worst case voltage conditions that can exist during all postulated accidents. The worst case voltage will influence the operability of the safety-related equipment. This applies to both older and newer plants.

Are the current standards, procedures, and techniques used to conduct component type-testing (by both research and development labs and qualification testing labs) satisfactory for establishing the bases for environmental qualification?

(a) Synergistic effects are not well documented.

(e) Current standards, procedures and techniques are sat. (323-71).

(g) Instrument loop accuracy was often poorly addressed as it related to functional requirements for terminal blocks and seals.

(j) Yes. Reasonable application of current guidance is adequate for performing qualification.

(n) My experience leads to the belief that the requirements to perform all tests on a single sample (see f.1 of 50.49) to try to stimulate all of the conditions expected to be experienced by the equipment during its lifetime may not be necessary. Test results seem to indicate that failure to perform to specifications was always (I cannot remember a single exception) due to a design weakness that showed up when that weakness was tested. By this, I mean the equipment failed when exposed to radiation because there were components or materials with unacceptable sensitivity to radiation, or pressure, or power source variation, or seismic/dynamic vibration/acceleration, or moisture, or temperature. I cannot remember any that were due to age (except radiation degradation which is a special case of material and component selection) or combination testing. Operational testing to worst case extremes exposed all of the design flaws I can remember.

(q) EQ requirements should be less stringent for some cable systems and more stringent for others, depending upon safety significance re PRA type analysis or time of and duration of functional need.

(t) Yes. If anything the existing qualification methodology is too conservative. For example, standards require that a piece of equipment be exposed to the full LOCA radiation dose prior to LOCA testing even though the equipment may only be required to operate for 5 minutes into the accident and would not see an increase in radiation during the time it must perform its safety function. Additionally, emphasis should be placed on appropriate application and function of equipment within the design of that equipment instead of relying on deterministic methodologies that are at best uncertain.

(u) In general, current standards, procedures, and qualification techniques are adequate for addressing harsh environment conditions and the effects of those aging mechanisms that can be reasonably accelerated. There has historically been excessive reliance by the NRC, IEEE, and the industry on accelerated aging to precisely define a "qualified life". There has been a growing industry recognition that these thermally-based life calculations are not precise and that other aging effects which cannot be accelerated must be addressed by maintenance and inspections. I note that the EQ requirements from several nations (e.g., France and Japan) with advanced nuclear programs do not include provisions for defining equipment qualified life values. Recognizing the uncertainty in such life definitions, these countries have focused on maintenance and inspections as the aging management methods and have included some form of aging simulation (without a qualified life definition) in their qualification testing programs. In large measure, I agree with their approach.

What specific comments and recommendations would you make relative to the qualification methodology for: a) older plants? b) newer plants?

(b) Whether or not adequate periodic testing methods can be developed to determine the "state of qualification" is a matter of conjecture. I believe that any such tests are years in the future.

Specific comments/recommendations may be made but unless each is justified technically, they are more wishful thinking than anything else. As we move forward to resolve the various EQ questions it is important not to repeat the mistakes made in the past. The recommendations and positions should have a solid technical base and any exceptions clearly identified.

Perhaps the biggest contribution to resolution of this issue will be the NRC's resolve to clearly state the issues and then answer them.

(g) Older plants should be brought up to the newer standards. This is very important for operations beyond 40 years.

(h) I believe that the industry and the NRC should work together to develop a list of qualified components that both groups can agree to. This would make compliance easier for the licensees. I think that the qualification testing should be approved and accepted by the NRC prior to a component being placed on the list of qualified components.

(j) I do believe that there is needless fear of synergistic effects which do not seem to be important for the bulk of the power plants. Most power plants have low aging doses such that the threshold for synergism is not reached.

(k) The existing qualification methodology is generally adequate, however results should be indexed against actual in-plant samples exposed to normal aging conditions and appropriate adjustments made. This would be most appropriate when qualified life extensions are considered.

(n) If my experience is representative, I would recommend that the wealth of data resulting from the EQ Program be analyzed and, if justified by the data, major steps be taken to bring the requirements more in line with experience. Perhaps EPRI could be given the task to collect (they have most of the data now) and evaluate EQ failure data. They should look at older and newer plants' EQ results, especially where the same equipment was qualified both ways. They should also evaluate maintenance and failure (replacement) data for older and newer plants. If the increased requirements for EQ for newer plants resulted in better equipment being installed (it should have if the newer requirements are meaningful) there should be fewer failures.

You have no idea how much it troubles me to say this, because I was one of the developers of the concept of combination testing, aging, and the rest. It seemed the right thing to do at the time because no one was able to prove it wasn't needed and the arguments pro and con were unresolved.

Since the work is essentially finished and the money spent, you may ask why we should bother. Talking to several old colleagues who are still in the business, I find that the added cost of our present EQ program requirements coupled with the small market presented by the waning nuclear power option dampens the developmental ardor of both the suppliers and the plant operators. Even though operating experience is excellent in the U.S., I believe the performance, safety, and reliability could be significantly improved with the development of more modern control and safety system equipment (distributed intelligence to name just one). All avenues including reduced EQ costs should be examined and steps taken where possible to encourage development activity.

(q) I need 50.49 text to adequately respond. Sorry.

(t) Trending and condition monitoring for both older and newer plants is established or is being established in most utilities. Additional evaluation of equipment will be required under the maintenance rule. Therefore, there is no need for additional recommendations relative to the EQ methodology.

(u) I believe current practice for the qualification of most outside containment equipment exposed to short-time steam conditions is unnecessary. For much of this equipment, the harsh conditions, low temperature wet steam (e.g., 100% humidity at 175°F and extremely low pressures) for fractions of an hour, are not sufficiently severe to threaten operability of properly designed equipment. This coupled with the lower core-damage threat suggests that the use of equipment designed for these higher temperatures coupled with thermal proof-tests, protective enclosures, and maintenance based aging management is sufficient to establish operability. It should be noted that for EQ equipment, including equipment qualified for outside containment pipe-breaks, the single failure criterion must be preserved. Yet, regulations related to other plant events, such as fire, require only one train to be free of damage.

Secondly, it appears the current TID-14844 radiation dose requirements coupled with the common practice of subjecting the equipment to a radiation simulation prior to the LOCA steam exposure is excessively conservative. For many materials and electronic equipment this radiation and not thermal aging or steam testing is the most significant stressor. For many insulating materials (e.g. XPLE) this radiation and not thermal aging results in significant loss of elongation and brittleness. Further, subjecting equipment to radiation degradation prior to the peak accident steam conditions is mechanistically incorrect and overly severe. For most mitigated DBAs these radiation levels are unrealistic. Even for events with delay ECCS actuation, significant releases would not occur until after the peak temperature conditions.

Lastly, current practice results in utilities establishing post-accident long-term operability for durations of 30 days to beyond 1 year. The often significant efforts associated with establishing long-term operability appear unwarranted. I believe operability only for accident mitigation is necessary. Several days post-reactor trip, decay heat levels are sufficiently low that natural convective containment cooling may be sufficient to maintain temperatures and pressures within acceptable limits. Under these conditions no subsequent in-containment equipment operability may be necessary to provide adequate plant safety.

3. Is the burden of qualification appropriate to the importance of the equipment being qualified?

(b) This is an interesting question. EQ discussions frequently focus on this question and the result is a misconception that perhaps the scope of the EQ rule is too broad or that qualification should not be required. The scenarios in which EQ may be important are not limited to a major pipe rupture. A steam environment in a small area due to a minor gasket leak or valve packing leak could provide enough humidity to cause electrical equipment in the area to begin to short-out, and to cause instruments and/or their cables to have higher current to ground values. The results could be inoperable equipment and inoperable or inaccurate instruments. Inoperable equipment in and of itself is significant. The issue is a potential loss of redundancy and diversity compounded by additional failures.

In addition to inoperable equipment think what this could mean at 4:00 am during a normal plant evolution or transient. Which instruments and annunciators will the operators rely upon? At TMI-2, the transient turned into an accident when operators did not understand that a single non safety-related valve indication was not a position indication but a demand signal. If they had shut a single non safety-related valve the transient would have been stopped. Since March 28, 1979 we have learned a lot about operators and control room instrumentation. One of the things that we see in daily reports is that operators, when faced with different indications/alarms can and do make mistakes.

The burden of qualification is not too great. The safety significance of potential common mode failures of multiple systems and instruments is great.

(d) Our inspectors have an impression that the documentation to prove qualification seems excessive.

(e) The burden is justified for SSE

(f) Yes, definitely.

(h) I believe so.

(k) The EQ burden is appropriate and justified in terms of safety significance.

(j) Many of the outside containment components in rad only areas seem to have excessive expenditures to cover the qualification given that many of these components will not be exposed to any real challenge. In- containment and HELB area qualifications are necessary.

(l) Yes. I believe the burden of qualification is appropriate for the importance and safety significance of the equipment being qualified.

(n) This is an excellent question and one I have thought about, and argued about for a long, long time (actually, ever since Jacobs, Gallagher, etc. first proposed the concept). I presently hold the position that all plant equipment should be designed, manufactured, installed, and operated in accordance with the determined requirements regardless of "importance to safety" because the continued operation of the plant is as important to the peace and well-being of the public as is the safety of the plant. Obviously for legal and regulatory reasons, safety is the major concern, but if all equipment were treated the same, in my opinion, many benefits would accrue. Furthermore, there has not yet been a fool-proof methodology developed for quantification of safety importance that I can support. We tried an experiment on the IEEE Nuclear Power Engineering Committee (NPEC) a few years ago. We gave a group of industry experts (an NPEC Subcommittee) the guidelines in effect at the time and had them evaluate a list of equipment from various systems. We had each of the experts rate all of the equipment on the list and compared the results for consistency. The results were not completely random but so scattered as to make it quite evident that the method was severely flawed. The method was later adopted in Europe but I don't see how it could possibly be of any practical use to them. Perhaps the NRC should check with their European colleagues on this. Especially to find out if it has been of any measurable benefit.

(r) Comment 1: Yes. The cost of qualification, at present, is generally minimal. Programs are generally in a maintenance mode. Significant investment is only realized in mandatory replacement of equipment.

Comment 2: Yes. The safety significance does justify the cost.

Comment 3: PRA methods and tools, at present, lack sufficient refinement and rigor to contribute significantly in the formulation of specific EQ requirements.
However, it should be used to determine which equipment should receive higher levels of scrutiny would be in order, particularly in the case of older plants. The risk-based significance of equipment located in mild-environments should be as a basis for determining an expansion of the existing 10CFR 50.49 scope.

(t) For the equipment truly important to safety, the burden of qualification is appropriate. But as implied above, the scope of equipment in the program as required by regulation is too big and therefore burdensome.

Does the safety significance of the equipment justify the EQ requirements that are being imposed?

(e) The safety significance of the equipment justifies the requirements.

(n) I think I covered this in the above response. We should definitely not try to classify "levels of risk" or "importance to safety" unless a better method is developed and only then if there is very great potential for improvements in safety and performance at reasonable cost.

(q) I believe that, yes, the importance of the equipment should dictate different levels of design criteria and thus different qualification criteria.

(q) In my mind the NRC was correct in placing clearly different burdens on equipment in harsh vs normal or mild environments (better than the IEEE). However, now that tools are better (PRA and other analytical experience) to differentiate in the functions of and safety significances of equipment, that too should be reflected in different EQ burdens.

What role, if any, should risk significance play regarding EQ requirements? What changes would you recommend?

(a) PRA should only be used to prioritize EQ actions.

(e) Risk significance should play a minimal, if any, role in the requirements. Risk sign depends on component failure rates during DBE and this data is simply not available. Recommend that all plants be brought to the current standards.

(f) PRA should not be a factor in determining EQ requirements. Requirements should be based on reality (facts, occurrences) rather than PRA charts. Recommendations: the licensees should be required to conduct in-service testing to prove continued qualification.

(g) Some sort of graduated requirement system would be a good idea. It should be based on the safety importance or risk of the equipment - not on what distinction can be easily implemented - and I believe that would be difficult to accomplish.

(h) I would not recommend that risk significance be brought into the issue. It would only make things more difficult than they already are.

(i) I would make no changes based on someone's determination of importance. The additional complication would be an unnecessary burden.

(k) Risk significance should not play a major role in the assessment of EQ requirements since common mode failure is the major concern and the probability of initiating events (LOCA/MSLB) are not insignificant.

(j) It is not clear that changing levels of qualification to agree with risk significance would save much funds. The analysis to justify the levels would be expensive. Since similar components are used in multiple applications, the most severe application would govern the qualification requirements anyhow.

(j) I would allow the option to grade qualification, but I'm not sure that I would use the option.

(l) Risk significance was considered when the master list of EQ equipment was developed. The components on the list are those required to mitigate the design basis accidents. I would not recommend any changes in regards to risk significance.

(n) How would you graduate qualification? Smaller margins? Half the SSE? Two thirds of a LOCA? Nonsense! Test to the performance requirements. Everything in the plant should be designed and proven to meet specifications. We need nuclear power and we need positive public opinion. Be firm in your requirements and publicize them - you (NRC) do not do enough of this, by the way. None [changes], in this area.

(p) I believe risk analyses should play a secondary role in deciding safety issues and influencing EQ. It is my impression that the accuracy of the data used does not match the sophistication of the mathematical methods. In particular, analyses which have attempted to take aging into account do not appear very convincing. Efforts to use plant experience to estimate the effect of aging on equipment failure rates have not been successful. In large part the reason is that maintenance and refurbishing tend to diminish the effect of aging: instead of regretting that this prevents us from obtaining the type of failure data desired for the risk analyses, we should be happy that maintenance is doing its job. Moreover, it is not failure in normal service that should interest us; obviously, if equipment has a history of failure in normal service, it might not be able to perform its safety function under conditions of an applicable accident - even if it were in satisfactory condition prior to the accident. More to the point than failure rates in normal service should be the failure rate under accident conditions, but such data are clearly not available.

I would tend to place more confidence on the consensus of expert opinion on the relative importance of safety-related equipment than on the outcome of risk analyses.

(q) It should play a <u>major</u> role in formulating EQ requirements such as: time windows of operability, or accuracy, circuit design requirements for continuous indication of circuit condition, and testability in normal conditions of the potential circuit integrity under wet conditions.

The question invites a long treatise. One immediate thought only: PRAs now seem to deal with reliability numbers for active components only while completely ignoring the cable systems upon which almost all other electrical equipment depends. This is understandable and perhaps justifiable for equipment in mild environments where cable system reliability is excellent, but seems unreasonable and inexcusable when considering either young or aged cable, connectors, and seals when under harsh accident conditions. PRAs must be realistic and honest if they are to be used and they should be used to focus on the vital circuits in order to spend limited funds to harden-up only the most critical circuits by better designs and EQ practices.

(s) Both the Sandia EQ Scoping Study (NUREG/CR-5313, "Equipment Qualification (EQ) Risk Scoping Study," Sandia National Laboratories and SAIC, January 1989) and an EPRI report on the risk significance of equipment ("Use of Safety Importance Rankings in Equipment Qualification: A Study of Big Rock Point," EPRI Final Report NSAC-036, January 1984) show as expected that a risk based approach to safety classification would lead to a substantially different list of Class 1E equipment than given by traditional deterministic methods.

I recommend that the NRC develop criteria for the safety classification of equipment based on risk /PRA and allow utilities to use the approach and criteria for reclassifying their equipment. I feel the approach should be voluntary (based on economic considerations by utilities) and not compulsory, because it is highly unlikely that the new approach would find that any risk-significant equipment was not already classified as 1E. The first several plant applications could be used to confirm this.

(t) PRA's should be considered in identifying those function which truly contribute to an increase of core meltdown frequency and enable the utilities to dedicate resources in more significant safety areas.

Consider PRA's, new source terms, and the safety significance of outside containment HELB's in identifying those safety function which should be within the scope of the EQ program.

(u) To date PRA has played an insignificant role in EQ. In order for EQ to be more cost and safety-effective, PRA insights should be integrated into the EQ standards. Since PRA is one of the few tools we have to address relative safety significance, we should use it to identify the safety significant EQ equipment and issues. Regarding PRAs and the TAP, I am concerned that the current TAP efforts are focused on simply modeling EQ equipment and accident failure rates. Although helpful, these difficult activities will not provide short-term assistance prioritizing EQ issues. Without performing any additional analyses, PRA practitioners can provide insights regarding the need for long-term post-accident operability, the relative safety-significance of certain systems and functions, the relative importance of different types of in-containment primary equipment, the apparent frequency of differing types of initiating events requiring EQ, and the importance of non-EQ equipment in accident mitigation.

(v) Probability Risk Assessment based on Core Meltdown Frequency may play a significant role in establishing the acceptance criteria that a component must meet for use in EQ applications. Current methodology may test a component whose function in accident mitigation is minimal to the safe criteria as a component that has a significant role in accident mitigation

4. What are the strengths and weaknesses of the existing EQ requirements as they pertain to: a) older plants? b) newer plants?

(a) [Weakness: Need to have a] better definition of "similarity" and how to verify it and the performance requirements. (e.g., "like-for-like" definition in GL-91-05)

(b) One of the weak areas in the current EQ rule is the concept of "harsh" environments. The basis for this conclusion is that normal service conditions of high temperature, for example greater than 150 degrees F, may not be classified as harsh since no DBA is involved. But day in and day out electrical components may see these high temperatures and not be in an EQ program. The issue is really one of design and selection of equipment. What we have found over the years is that temperatures are significantly higher than originally expected during the design process.

Without pre-aging, and recognizing the recent failures during testing of cables, the question which needs to be answered is: What test/qualification process is technically sufficient to provide an adequate or reasonable level of confidence that electrical equipment will perform its intended function in the 40th year of plant operation? The answer to this question will dominate the answers to the majority of the EQ questions. The requirements are weak in that a single test success is valid forever. This aspect of the qualification process should be changed.

(e) Older plant are not required to consider aging, margin, or synergistic effects of radiation and temperature. Weakness in older plants include relaxation in testing and documentation requirements. Strengths in newer plants are more stringent requirements that simulate actual plant conditions.

(f) Weakness of both requirements is that the qualification comes at the beginning. Over time, components are abused in situ. These in service problems are not accounted for in the service life. Example: Cables are often trampled or stepped on during outages possibly damaging them, shortening their useable life. However, no in service testing is done to prove the appropriate IR.

(h) A major weakness with the EQ rule is that licensees requesting construction permits/operating licenses after November 30, 1985, are not covered by the rule.

(i) I find no strengths in this regulation. Newer plants are excluded.

(j) The strengths and the weaknesses are within the individual applications of the requirements not necessarily the requirements. Some DOR qualifications are very strong. Some NUREG-0588 Category I qualifications are weak. It depends on the nature of the qualification test and the subsequent activities to assure that it is adequate. The documentation can be strong with a weak installation means the device is not adequate. Perhaps where the standards become weak is that they are not strong on as-installed meeting the as qualified condition.

(k) For newer plant equipment the LOCA/MSLB testing was required to be performed on aged (accelerated) specimens resulting in somewhat more realistic prediction of equipment behavior as opposed to the older plant equipment which could be qualified using separate effects/analytical consideration of aging.

(l) Obviously the DOR guidelines did not require pre-aging or testing for spray effects. It allowed the licensee to perform an analysis for these effects. Unless the licensee replaces DOR items and does not document reasons to the contrary DOR qualified items could remain in the plant forever. I believe this is a problem and should be addressed in any future regulations for older plants.

(n) My major concern for all plants regarding EQ, both older and newer, is whether or not the operating conditions assumed during the qualification (many of which were generic in order to cover a multitude of plants using the same equipment) accurately reflect the actual plant operating conditions during the intervening years and at present. Is new or replacement equipment being qualified to hypothesized conditions that are too stringent or not stringent enough? Do we have data on present plant operating conditions to justify the qualification envelopes? One area I was never comfortable with is the actual temperature rise in the center of the worst bundle of safety-related cables in the Cable Spreading Room. How many are and have ben at temperatures far in excess of those used in qualification? What about the hot spot temperatures in the densely packed control room panels. Admittedly, I am less concerned about equipment in mild (accessible) locations but still concerned about unexpected multiple failures during a potentially common cause event (earthquake, HVAC failure). Maybe you have covered this area with regulatory action since I've been busy with other things, if so, fine. My concern may seem frivolous in view of my stated experience regarding aging, but the concern is more directed to possible unknown cases in which the operating environment may be (and have been) in excess of the design capabilities (i.e., material state changes) as opposed to operation within acceptable limits over long periods of time.

(p) A major deficiency of the EQ process is that it does not account for many of the weak links in safety systems. In the case of cables, for example, EQ does not account adequately for installation damage, deformation of jacket and insulation at high stress points, the effects of high humidity and high temperature (i.e., in excess of levels assumed as the service conditions), and local vibration. While such conditions are evaluated when uncovered in a plant, the analyses usually performed do not provide firm evidence that the weak links would survive accident conditions.

(r) Comment 1: Most significant to all plants, no attention has been paid to mild-environment equipment. Many newer plants initiated mild-environment EQ programs, but have since deleted them in the absence of any NRC effort for follow through in this area.

Comment 2: Problems are with implementing requirements. Test sequences cause conservatism, but is the only practical method.

Comment 3: For older plants, weakness lies in specific seismic qualification tests and too loose an interpretation of similarity.

Comment 4: Strengths--more inspections to observe degradation on older plants, qualification demonstrated by test on newer plants. Weaknesses--non-conservative testing and more analysis used on older plants, reliance on qualified life and less inspections on newer plants.

(s) The strengths for both older and newer plants are that they are based on (1) the collective technical know-how and judgment of utilities (including EPRI), standards committees (including NRC participants), national laboratory staffs, and the NRC staff who issued the requirements and (2) twenty years of qualification testing experience, about fifteen years of research testing; at Sandia, hundreds of years of plant operating experience, and an accident at TMI.

The weaknesses are rooted in the same problems that pertain to any requirement: they are weakened by less-than-perfect clarity of wording, uneven interpretation and completeness in implementation, and uneven enforcement. None of these problems justify significant efforts to revise requirements.

(t) As stated above, the requirements for older vs. newer plants are essentially the same. The only exception is the requirement for pre-aging prior to LOCA testing in older, DOR guideline, plants. It should be noted that industry experience indicates the present methodology for pre-aging is extremely conservative, in that equipment is not aging at the rates predicted by accelerated aging. Otherwise the requirements provide the basis for insuring equipment will perform its safety function under harsh conditions.

(u) These are generally discussed elsewhere in the survey response. The most important strength is the significant environmental and operating time conservatism inherent in the qualification process. Two possible weaknesses may be excessive reliance on analytical aging calculations and adequate consideration of the combined effects of manufacturing/material changes when old qualification testing is applied to newly manufactured equipment.

(v) With respect to both older and newer plants the NRC should clearly state the acceptance criteria for qualifying a component based on operating experience (while the industry standards allow the use of operating experience, it is not clear where the NRC stands and what is and is not acceptable).

5. **Are you aware of any specific problems or difficulties that currently exist or that existed in the past with implementation of EQ program requirements? Please distinguish between older and newer plants.**

(a) Many - Just read some of my inspection reports. For example: Use of generic "so-called" worst case DBA parameters! but old plants don't know where equipment is. A major effort is needed to walk down and document for older plants just what equipment they have, where and what are the actual ambient/service conditions. (Long term)

(b) The primary problem was the NRC staff's changing position on EQ and what was required. The result was confusion in the staff as well as in the industry. To a large extent it still exists today and is evidenced by a number of the questions in this survey, i.e. What is required? Why is it required?.

(e) The biggest problem is the 3 levels of EQ requirements. It existed in the past, exists now and will continue to exists unless the NRC fixes it. I don't believe the older plants are as safe as the newer plants when it comes to EQ protection against DBEs.

(f) Many documented EQ stories - Butyl cable, incompatible lubricants in Limitorque valves, others. All those in Region III have been addressed.

(h) The largest issue has been the differences in interpreting the test data. By developing a standard list of components, this could be eliminated.

Another problem has been licensees failing to adequately evaluate the ambient temperatures that equipment is subjected to. Many want to rely on average bulk temperatures, rather than localized temperatures.

Another issue is what maintenance is required to maintain the equipment in a qualified configuration and how often should it be done.

(i) Interpretation disagreements between licensees and NRC.

(j) Resolution of such problems is my work. There is no one specific set of problems.

(k) One of the more difficult areas in establishing qualification bases or in reviewing the adequacy of qualification has been in determining whether adequate similarity exists between the item qualified and the item installed in the plant (differences in material formulation, configuration, arrangement).

(l) I am not aware of any specific problems or difficulties that currently exist with implementation of EQ program requirements.

(n) I am only aware of those problems mentioned in the preceding paragraphs. In addition, I share with others some concern that there may be excessive optimism that accelerated aging truly represents real time aging. I heard some programs being discussed some time back to do some additional investigations. Hope they are being implemented. My comfort zone would be greatly improved if we relied less on accelerated aging and more on surveillance and degradation monitoring in real time.

(q) The writer's experience has been that for earlier plants the purchaser's specs for cable contained little in the way of performance requirements aimed at adequate performance of cable <u>systems</u> under harsh conditions. Reference was made to standard specs plus limited radiation <u>aging</u> resistance and ability to operate through a high temperature cycle. Not until the middle to late '70s did more focused requirements come to cable and connector manufacturers. Even at present, inadequate performance requirements are used -- as indicated by other survey responses of the writer.

A second serious weakness frequently observed is the acceptance by users and the NRC of EQ tests of commercial or generically named components as covering various manufacturers or vintages or construction designs of cables and interfacing components. It is well known and has been often demonstrated that great variation exists in the aging effects and harsh environment performance of components subject to these variations. In mild environments most of these variations are inconsequential, but in potentially harsh environments they may be critically important.

Perhaps an underlying problem with our EQ practices has been our lumping together active and passive equipment in our EQ thinking for performance requirements, design requirements (single failure criterion, for example), maintenance programs - (testability), and importance-to-safety priority differentiation. Unless we focus sharply on the functionally most critical cable systems and spend our limited staff and dollars on these, I believe it is very unlikely any significant improvement will be made in public safety through accident mitigation related to cable systems. The overall class 1E cable plant in a nuclear station is just too massive and costly to upgrade.

The NRC has done better than the balance of the industry, I believe, in focusing the EQ program on harsh environment areas. As a WG participant on IEEE 323 and 383 I have repeatedly advocated that we should focus on common cause failure prevention during and after DBEs and that little EQ emphasis should be put on normal performance where good industrial practice and utility self-interest in keeping failures low should suffice. Even today, a cursory survey of EQ-related technical papers shows (with a few notable exceptions) a preponderant emphasis on normal service failure rates, wear out, drift, replacement parts, shelf life, leakage rates, etc., and a relatively cursory, "oh yes, and be sure it will be functional if it's in an accident or other DBE environment." Common cause failures are given little, if any, attention in many (most?) EQ papers.

The only way the writer can see to break today's impasse for upgrading public safety by improving cable systems in either old or new stations is to start with only the few most critically important systems as revealed by PRA or other acceptable methodologies. An objective and careful removal, analysis, and test of those few components removed in any such program should quickly reveal the justification or lack thereof for continuance of or extension of the program to lower priority systems.

(r) Comment 1: Costs of testing. This is a barrier to the introduction or adaptation of new products to the nuclear industry. This is a particular barrier in the I&C world. The rapid advance of technology has created a dilemma for maintainability of certain qualified systems. For older plants, this coupled with uncertainty in the licensing process of state of the art systems, prevents modernization which may ultimately drive plants of older vintage into early retirement.

Comment 2: NRC hesitancy define the necessary rigor for Analysis-based methods. In general, much of the industry assumes that qualification based solely on analyses are taboo, even where sufficient rigor can adequately be achieved.

Comment 3: For older plants, the use of "engineering judgement" and the "spirit of SQUG" is being abused.

Comment 4: Adequate simulation of effects of containment spray, abusing accelerated aging, lack of consistency in qualification programs (primarily on older plants), sequential testing too conservative.

(s) I know of no specific problems or difficulties that currently exist or that existed in the past with implementing EQ program requirements.

(t) In the EQ "world", the burden of maintaining EQ "PAPER" has always been costly and cumbersome with no significant safety benefit. This is true for both older and newer plants.

(u) This is much too broad a topic to be adequately discussed in this survey. However, one philosophical observation may help the NRC staff in its TAP efforts. As noted long ago by Sandia's Lloyd Bonzon, much of the difficult in the EQ arena stems from the NRC and industry's difficulty defending the state-of-the-art. EQ unlike many other technical areas is not precise. The objective is achieving reasonable assurance of operability. Yet, we often engage in evaluations and "discussions" on specific technical issues that appear to presuppose an overall analytical certainty that generally does not exist. This often unjustified focus on precision can expend significant resources arguing and fine-tuning positions that may have little importance when overall EQ uncertainties and safety significance are considered.

(v) No.

6. **Are the current EQ requirements for older and newer plants adequate for plant operations beyond the current 40-year operating license (i.e., for license renewal)?**

(b) (This is perhaps my favorite question on the survey.) Given that IEEE 323-1974 is the requirement for newer plants and it requires pre-aging to determine qualified life, the qualified life for many long lived electrical components such as cables is typically 40 years. What is the technical justification to conclude that these cables are qualified for 50, 60, 65 years? Maintaining the CLB for older plants leads to the conclusion that older cables are qualified forever or until they fail which ever comes first. I believe that given the current EQ requirements, the BIP for EQ and Renewal is the best approach.

(e) EQ requirements for newer plants are adequate for renewal. Older plant requirements are not adequate for renewal.

(g) Two concerns: (a) Arrhenius is not good for 60 years - as a minimum, need some sort of benchmark along the way. (b) Provision should be made to requalify a given design periodically, maybe every 20 years or so.

(h) As I stated above, I believe the replacement clause should be modified to remove the statement "unless there are sound reasons to the contrary."

(i) The present rule is barely adequate for the original term of the license. Extension of the term of the licensee should include a verification that all age and environment conditions that have existed and that can potentially occur are considered in reevaluating continued qualification.

(j) The current licensing basis can be used successfully if adequate steps are taken to assure that aging is not causing significant deterioration. The nature of the beast is that by 40 years very few DOR components will remain. Cables, penetrations and motors are what would be expected. Any other components would have to be in very benign locations, and if they were, aging would not be a concern. I have a belief that for those components that will be used for more than 40 years, condition monitoring should be used to assure continued safe use in qualified application. This would cover any uncertainties in aging models. I would not change existing qualification rules for license renewal.

(k) No. Need to have a better assessment of aging effects (thermal and radiation).

(l) The current EQ requirements for older and newer plants may not be adequate for plant operations beyond the current 40 year operating license. The effects of aging/qualified life would be one of the areas that comes to mind that should be considered as part of plant life extension. The older plants did not have to pre-age components as part of the test program and operational occurrences such as steam leaks and inadvertent spray actuations could cause degradation of equipment. These events were not considered by the licensee's when they established qualification for their EQ equipment. Also test programs utilized Arrhenius calculations to demonstrate qualification for periods of time far beyond the tested duration. These tests may not have been adequate to extend the life of equipment beyond the 40 year plant life.

(n) First of all, the maintenance program for the equipment in harsh environments should include monitoring of certain critical characteristics. Our TMI-2 Technical Evaluation Group discovered that equipment survived the accident and worked properly only if properly applied (i.e., application requirements consistent with design specifications) and maintained. A significant number of failures could be traced to seal failure. Had the maintenance program included seal evaluation and surveillance the overall outcome might have been different.

Based on my aforestated experience, I believe that action that should be required for EQ for license renewal should consist of the following steps:

i. Review all maintenance and replacement activity procedures and records to assure that the equipment has been maintained in a manner which is consistent with the need to retain the qualification status. By this I mean, critical characteristics (materials, parts, etc.) were not degraded by either maintenance action or design change.

ii. Determine whether or not the equipment has been operated in the environments for which it was qualified.

iii. Determine whether or not the equipment has been operated in the manner (modes) for which it was qualified.

iv. Based on my suggestions in 2., determine whether or not age is a significant failure mechanism (other than uniform random) in properly maintained equipment.

This should be all that is necessary. We should strive toward this kind of quality, cost-effective approach. Make history work for us.

(p) For equipment that has been qualified in accordance with Category I, it would be only slightly facetious to state that 20 years of additional service falls within the noise level of the accuracy of the qualified lives established. For equipment qualified in accordance with Category II and also subject to harsh environments, additional testing to comply with Category I would increase confidence in the equipment's functional capability. Even for Category II equipment in mild environments, a blanket exemption from additional testing is not advisable. Continuously energized equipment and equipment subject to high load rates might have failure rates near the end of their qualified lives that are inconsistent with the dependability desired after an accident, even though the service conditions do not change.

(q) In principle I see no engineering justification for judging a station's EQ adequate at 39 and inadequate at 41. It is unfortunate that the fuzzy concept "adequate" has already been stretched to incredulity by the grandfathering of less stringent EQ practices for older plants. How can it be a justifiable reference in considering license renewal? I believe EQ "adequacy" should be considered at all times <u>when issues come to light</u> and that the license renewal ritual should be to double check that, in fact, was being done all during the initial license period.

I can think of <u>nothing</u> relative to cable systems which one could judge adequate at 39 and then questionable at 41. <u>If</u> questionable at 41, then we better assess the situation and be prepared for corrective action at 25 or 30.

(r) Comment 1: The lesser rigor in EQ requirements for older plant makes them resistant to upgrades of equipment. The impact of this will be a steep investment necessary to extend plant life beyond 40-years. Some degree of compromise may be warranted, but requirements as currently written, interpreted and enforced will preclude older plants from upgrading on an ongoing basis to an extent that the plant life extension is economically viable.

Comment 2: Most programs don't really justify 40 years and replacement of equipment should occur periodically. If 40 years has been accepted then it probably can be extrapolated on the same basis.

Comment 3: Emphasize more testing on naturally aged equipment.

(s) The EQ requirements for determining qualification up to 40 years are perfectly valid and adequate for determining qualification up to 60 years. To continue the qualified life of equipment beyond 40 years, the license renewal applicant would have to submit a revised qualification package to the NRC. Of course any aging mechanism that might become significant only during the last 20 years of operation would have to be addressed, but this is a standard part of any qualification method. In many cases the original aging and type-testing program could be reevaluated to justify a 60-year life because the utility would present measured operating environments that are far less than the conservative design values that were used in the original qualification program. This reevaluation would need to demonstrate the same degree of margins required by standards and regulations.

If the reevaluation does not demonstrate a 60-year life, new qualification test data may have to be generated. Or the environment of the equipment may have to be mitigated. Or condition monitoring could be used to show that the actual aging degradation of the item is less than that in the original qualification program. The last resort would be to replace the item. But all this would be governed by the EQ requirements appropriate to the current licensing basis of the plant.

Evidently, some are questioning the adequacy of the EQ requirements in the DOR Guidelines for justifying a 60-year qualified life. These persons may not be giving enough credit to th key requirements contained therein. The DOR Guidelines require specificat on of service conditions including margins and conservatisms on accid nt conditions, and type testing under accident conditions with aging conditions evaluated by analysis "supported by test data" and a surveillance and maintenance program "to assure that equipment which is exhibiting age related degradation will be identified and replaced as necessary." The key message is that the DOR Guidelines explicitly address the same "age related degradation" that is of concern for license renewal. There is no basis for disallowing the use of DOR Guidelines to qualify equipment for 60 years. It is up to the regulators to exercise their duty and professional judgment as to the adequacy of the DOR qualification package submitted in conjunction with a license renewal application.

(t) Unequivocally, yes.

(u) The current regulatory and technical EQ framework is adequate for plant operation beyond 40 years. I do not believe existing EQ regulations or guidance documents need modification specifically to address EQ technical issues in the license renewal period. However, the safety-significant technical issues must continue to be adequately addressed by ongoing EQ programs. The most technically justified license renewal EQ concern relates to the condition of long lived equipment when compared to the equipment's calculated life. Even in this context current guidance appears adequate. For example, Regulatory Guide 1.89 Rev. 1 currently states that "... *state-of-the-art preconditioning techniques are not capable of simulating all significant types of degradation ... Experience suggests that consideration should be given to a combination of (1) preconditioning ... and (2) surveillance, testing, and maintenance.*"

(v) License renewal should be based upon condition assessment and objective evidence that the installed equipment will survive beyond its qualified life plus accident exposure.

Which EQ issues need to be addressed for continued plant operations beyond 40 years?

(e) The main issues for older plants are aging, margin, synergistic effects, relaxed testing requirements and documentation requirements.

(f) Inspectors should be trained and check EQ on a continuing basis, not when problems arise.

(h) The issues that need to be addressed are what components are qualified, what their qualified life is, and what maintenance activities are required to extend the life to the end of the renewal period.

(t) There are no specific "EQ Issues" to be addressed for license renewal. There are, however, specific equipment issues which need to be addressed to comply with the license renewal rule. Under the rule, EQ is covered under the current licensing basis and the utilities should be allowed to "engineer" into the license renewal period. This engineering may include sound analyses and/or testing, or wholesale replacement. The important aspect is that the rule and regulations are adequate.

What modifications would you make to the existing EQ requirements for license renewal?

(e) For license renewal, modify 10CFR 50.49 to upgrade older plants.

(f) All plants should be required to meet the requirements of the rule for license renewal. In addition, all equipment should be requalified for life beyond 40 years. Due to the environment the equipment has seen for its service life, there is no guarantee that its qualification is still good. Some method of in situ testing or the taking of samples would suffice for this requirement.

(k) Consideration should be given to LOCA-testing selected samples of plant equipment (primarily cable) before and after additional aging.

(t) None, except for those points made in other parts of this section.

B. Operating Experience

1. **In general, how is EQ equipment actually aging (in service) compared with the equipment's predicted life?**

(a) Anecdotal data only, need more testing.

(b) (I'm not sure that you can get a good answer to this question.) The reporting data bases such as NPRDs and LERs will only give us part of the answer. We do know that a lot of equipment, including cables, is being replaced as a result of aging/failures. To the extent that the equipment was qualified for 40 years, the actual service life is much less than the qualified life.

(d) Generally, the EQ equipment is aging slower that predicted.

(e) Don't know,-NRC /industry hasn't looked.

(f) Unknown, must wait and see. Especially for components that are effected by low levels of radiation, etc.

(h) In cases of ASCO solenoid operated valves, we have seen what appeared to be premature failures until the actual operating conditions (ambient temperature and normally energized/deenergized) were properly evaluated. When that was done, the calculated life closely approximated the actual life prior to failure.

(i) This area is not being inspected at this time; therefore, I have no comments.

(j) Most applications are aging more slowly. Thermal conditions that dominate most component aging are less severe for the bulk of equipment. Localized hotspots are causing some components to age relatively fast but not at a rate faster than models suggest when actual conditions are considered.

(n) I am not qualified to answer these questions although I do have opinions on some of them!

(o) Some of the previous discussion is applicable to this section.

It has not been uncommon for electrical cables to fail because local operating conditions were more severe than estimated. Some have argued that this is not the fault of the equipment but is evidence of misapplication. While there is some truth to this argument, it appears that EQ didn't cut the mustard, even if the problem was improperly specified conditions. Specification of conditions is a part of EQ. Because of these events, it seems reasonable to ask, how many other similar conditions exist but are not known because the cable didn't fail, yet the cable might not be adequate to survive an accident? This relates directly to the discussion above about the fact that cables are not subjected to a program of periodic surveillance and testing.

(q) In general, aging effects are being found favorable compared to what would have been expected under the postulated conditions. Where ambient conditions were wet, or as high a temperature as specified, or as high radiation, premature aging or failures have been found on a number of cable system components. Of course, ambients more severe than specified have also caused failures. Most ambients are well below the specified values (and equipment ratings) so that failures in normal service are rare and aging rates low. Service experience with cable systems gives only minimal relevant information as to its operability under accident conditions.

(r) Comment 1:
Except for rare cases of gross error, where equipment has failed in-service due to much higher than estimated service conditions (e.g., normally energized solenoid valves), little work is being done on which to base a general assessment. In general, plants are taking a hands-off approach fearing less than desirable results.

Comment 2:
Experience indicates that components that have problems in service do so because assumptions in determining life prove inadequate, e.g. service temperature higher than anticipated, self-heating not properly accounted for, materials changing (poor QA).

(s) I have no direct knowledge of how EQ equipment is actually aging in service compared with the equipment's predicted life. However, the EPRI in-plant study has specimens of cables and small electrical components installed in nine operating reactors since 1985, but they have not been aging long enough to come to conclusions regarding in-plant versus artificial aging. Also, a Sandia study for life extension of cables (DuCharme, A. R. and L. D. Bustard, "Technical Evaluation of In-Containment Cables for U.S. Nuclear Plant Life Extension," Proceedings of the International Conference on Operability of Nuclear Systems in Normal and Adverse Environments, OPERA 89, Vol. I, Lyon, France, September 18-22, 1989, p. 605.) has concluded that there have been only a handful of LERs that indicate any aging degradation of cables.

(t) Generally, equipment is aging at a rate significantly slower then predicted by aging methodology typically used in EQ testing.

(u) This question is best directed to utilities but I have several observations. With the possible exception of cable, utilities generally do not compare the equipment condition at the end of its qualified life with some "predicted" condition. Since most qualification test programs do not measure equipment properties after accelerated aging, no baseline end of life condition data is available to support such a comparison. However, for in-containment LOCA qualified equipment, the condition at the end of qualified life is generally excellent. Utility maintenance personnel often question why equipment, in apparently like-new condition, is being replaced when it has reached its end of qualified life. This excellent condition generally stems from minimum thermal and other aging degradation. As an illustration, please reference the attached curves for the Raychem WCSF material. Based on Arrhenius, the 40 year at 90°C thermal aging line (Figure 2 Curve B) results in approximately 60% retention of the original unaged ultimate elongation (513%). (See Figure 1 using two Curve B data points - 800 hours at 150°C and 2500 hours at 136°C). In other words, after material thermal aging to the equivalent of 40 years at 90°C this material has an ultimate elongation in excess of 300%. Since actual operating temperatures are generally below those assumed for qualification, even less thermal degradation should occur. Qualification and research tests have shown that cables typically fail only after significant degradation results in material cracking (i.e., the material has essentially retained no elongation capability). One could conclude that temperature is not a significant aging mechanism for this material. For many equipment materials, the accident LOCA dose (e.g., 200 Mrads) and not normal aging causes the most significant degradation.

(v) Most of EQ equipment has not aged as fast as predicted by equipment qualified life. However, certain equipment is degrading at a faster rate (i.e., Kerite cable).

2. **Describe problems you have encountered with EQ equipment. Do some components routinely fail before the end of qualified life?**

(e) Many of the problems are described in the numerous INs, Bulletins, and GLs issued on EQ.

(f) Many maintenance personnel are unfamiliar with EQ requirements and conduct repairs or maintenance that "unqualifies" the equipment. Example - transmitter seals. If they are not replaced during the component repair, qualification can not be assured.

Other physical problems, like water (condensation) in closed cable conduits, and splice practices that are not IAW the EQ instructions (that are stricter than normal electrical spice practices).

(h) As I stated above, many licensees do not know what the local temperature of components are. As a result, the calculated life is often much longer than the actual life.

(j) Very few components are failing. Some are found deteriorated more than one would like but failures of qualified equipment are not frequent. Most radiation conditions are at or below design conditions. Current 40 year doses for many plants are 2 Mrad or less. (Some have 10 Mrad doses but those seem to be in the minority). None have the 50 Mrad doses suggested by IEEE 323-1974.

(l) Components may fail for various reasons which may or may not be related to EQ attributes. However, components have failed from steam leaks. As far as component qualified temperatures and radiation exposures I believe that these environmental parameters have been adequately addressed by the licensee's EQ programs through detail analysis and study of the areas for such problems as hot spots. However steam leaks and spray downs have not been adequately addressed.

(q) See 1 above.

(r) Comment:
For older plant, revised accident analysis create a substantial increase in accident environment conditions. This is due to many factors, most significant are fuel upgrades and pump and fan cooler degradation. At issue is the fact that qualification per the DOR guidelines is marginal, at best, to the original EQ requirements. Upward revision of the EQ requirements can be costly.

TID 14844 is viewed as excessively conservative. Current requirements include a 10% margin in addition to the TID 14844 based values. A more realistic basis for determination of radiation accident environments is needed.

(s) I have encountered no problems with EQ equipment. Certainly, I have no knowledge of components that "routinely fail before the end of qualified life." Any such knowledge would appear to be reportable under part 21 and not through a survey.

The EPRI plant aging study is showing that component qualified temperatures and radiation exposure levels are not consistent with their actual in-service environment -- almost all measured temperatures are less than qualification temperatures and all measured radiation doses are much less than qualification doses.

(t) We have experienced no problems with EQ equipment and we have not experienced routine failures of EQ equipment before the end of qualified life. It should be noted that EQ equipment is no different from other equipment except for the testing which has been done to it and the requirements to maintain its qualified configuration (i.e., sealing, mounting, qualified life, etc.). Therefore, the data base for equipment trending and failure rates is much larger then just the equipment in the EQ program.

(u) These operational and equipment failure questions are best directed to utilities. Regarding operational vs. assumed environments, I have several comments. For virtually all equipment, the actual operational radiation level is significantly below the assumed normal radiation dose (often assumed as 50 Mrads.) and material damage thresholds. Similarly, operating temperatures are generally below those assumed for qualification purposes. Further, plant temperatures fluctuate due to seasonal and operational changes while for qualification purposes utilities typically assume a single continuous value (e.g., peak normal or maximum design temperature). The one possible exception, plant hot-spot areas, are generally addressed by monitoring and other methods.

(v) Equipment reliability can be enhanced by using "sound reasons to the contrary." A more stringent requirement for replacement parts and components are required to enhance equipment reliability.

Are component qualified temperatures and radiation exposure consistent with their actual in-service environment?

(a) In many cases, no. Example: the ANO fiasco.

(d) The problems we've seen are where the full expected temperature range was not considered, or considered inappropriately. Specifically, some outdoor transmitters not fully qualified for cold temperatures or the high temperature next to a steam line were not adequately calculated or measured.

(e) Some components like cables have failed in normal environs prior to the end of their qualified life. While industry argues the actual temp/radiation levels are lower in-service than that assumed for EQ, there have been many instances of equipment damage due to temperature/radiation hotspots.

(h) As for radiation, the level of radiation is almost always an assumption based on calculations. I do not know of any licensee who has measured localized radiation levels during plant operation.

(j) Most temperatures are averaging 20°F or more below design normal maximums. A few locations near MSIVs, pressurizers, and primary loops are higher. Some plants have summer containment temperatures that are higher than originally expected, but even for these the aging rate is not excessive for the bulk of the equipment.

(t) Typically, the actual in-service temperatures and radiation levels are lower than qualified parameters.

3. **Are you aware of any weaknesses associated with the maintenance practices being performed on EQ equipment?**

(a) Surveillance and maintenance in general could be much improved.

(d) Region V is not aware of any poor maintenance practices associated with EQ equipment.

(e) Maintenance in general appears to be good and has not resulted in significant EQ problems. As components age, this issue needs to be looked at in more detail.

(g) The EQ inspections often showed that EQ engineers and plant personnel did not always interface well. Check the escalated enforcement files. Lubricants and tape splices were two problem areas. Some plants addressed maintenance requirements much better than others in the EQ documentation.

(h) Many licensees take a very narrow approach to required EQ maintenance. They consider recommendations of maintenance by the vendor as just that, recommendations. In many instances, the vendors make statements that they assume a periodic preventive maintenance program, as identified in the technical manual, is being implemented in order to ensure the equipment remains in a qualified condition. That is because some age sensitive components (e.g. lubricants) were not subjected to thermal or radiation aging.

(j) The bulk of the maintenance is adequate. Some plants have better control over actual installed conditions. Most current maintenance is related to replacement except for MOVs and motors. I don't see maintenance as being adverse for EQ equipment.

(l) I am not aware of any weaknesses associated with the maintenance practices being performed on EQ equipment. I believe for those EQ components where maintenance is required for qualification that it is adequate. However, all EQ components do not have required routine EQ maintenance.

(q) For passive cable systems, no. Maintenance activities on passive, mostly inaccessible components are minimal, yield very limited useful data and, if it involves the movement of cable components, may adversely affect operability of the equipment if subjected to a harsh environment.

(r) Comment 1: For many Class 1E components this is not an option. Warranty and liabilities issues, not specific to the nuclear industry, have forced some manufacturers to curtail the sale of refurbishment kits. This is a particularly problem for AOV appurtenances.

In some cases, maintenance activities of any sort is strongly discouraged. Vendors of Class 1E equipment are forced to forbid maintenance, and encourage full replacement. Current EQ programs do not qualify maintenance activities, and little benefit would be realized for undertaking substantial investment to do so.

Comment 2: Maintenance that is required to maintain qualification should be specified by the qualifying party and become mandatory at the plant. Routine maintenance programs must be reviewed to determine potential effect on the qualified product. Maintenance indicated by more recent programs may not be backfit.

(s) I have seen no evidence that maintenance performed on qualified equipment in keeping with the qualification program is not sufficient to maintain the equipment's qualification. I have seen no evidence that properly performed maintenance has ever had an adverse affect on EQ.

(t) Routine maintenance programs are structured to include specific "EQ maintenance" and therefore are adequate to maintain qualification.

(u) I have several perspectives regarding "sound reasons to the contrary". Upgrading, simply to have qualification based on testing that includes preaging, is unnecessary for equipment not experiencing significant degradation due to normal or accident conditions. As a broad generalization, most outside containment equipment should fall into this category of no significant aging degradation. For example, with few exceptions, equipment materials are highly tolerant of the several Mrds of post-LOCA radiation occurring outside containment and do not experience significant aging during normal operation. Yet, on replacement this equipment must be replaced with other equipment which has been qualified using tests with preaging and bounding accident conditions. An analogous situation exists for outside containment equipment experiencing relatively low-temperature (e.g., 175°F) short-time (e.g., 30 minutes) pipe-break steam conditions. All else being equal, the upgraded qualification is somewhat beneficial by reducing qualification uncertainties. The upgraded equipment could, but not always, exhibit other performance or operational improvements over the existing equipment. However, in many cases there can be negative upgrading effects. Importantly and based on experience, the current equipment is generally well suited to its applications from reliability, performance, operation, and maintenance perspectives. The new equipment, although EQ upgraded, may be less suited to the application from these perspectives. Yet, these important operational considerations are not currently identified as example sound reasons in Regulatory Guide 1.89.2/ I believe overall suitability and not solely EQ should form the basis for utility decisions regarding the use of upgraded equipment. Finally, the use of upgraded equipment inevitably involves some design and physical plant changes to accommodate differing characteristics. Always present is the potential for problems arising from such changes or lack of experience with the new equipment.

Is the maintenance performed on EQ equipment sufficient to maintain equipment qualification?

[There were no responses to this question]

Is there maintenance being performed on equipment or components that may have an adverse affect on EQ?

(h) I do not know of any maintenance that is being performed that is detrimental to the equipment, however, maintenance that should be performed and is not may be detrimental.

(l) I am not aware of any maintenance being performed on equipment or components that may have an adverse affect on EQ.

(t) Not to our knowledge. This is why utilities have elaborate review processes for procedures and training to avoid just this type of problem.

2/ Interestingly, performance and reliability considerations were addressed in the original sound reasons discussion contained in an NRC generic letter but were specifically excluded by the Staff when the regulatory guide was issued.

4. Discuss your views and opinions of specific cases (current) where replacement equipment was not upgraded to 10 CFR 50.49 requirements because licensees reference "sound reasons to the contrary (R.G. 1.89)?"

(a) This often leads to trying to qualify what are now parts and subcomponents that are ??? only [rarely] available - if at all. As CGI's - this is not easy.

(e) The sound reasons to the contrary were intended to be used on a onetime basis and not intended to be used repeatedly as an excuse not to upgrade equip as it is replaced. RG 1.89 should be modified to eliminate this windfall for the industry. There should be no need to invoke this any longer. We need to find out from the industry to what extent this is still being used.

(g) [No]

(h) I do not know of any cases at this time where I disagreed with a licensee on the determination of sound reasons to the contrary. I do feel that by the time the older plants request a license extension, much of its equipment will be obsolete and will require replacement with equipment qualified to the higher standard of 10 CFR 50.49.

(i) I know that equipment is not being upgraded due to "sound reasons to the contrary" however I do not have a current specific case because I have not performed many EQ inspections over the past 3 years. I do know that most of the licensee's EQ programs have provisions for documenting "sound reasons to the contrary" for not upgrading to 10 CFR 50.49.

(j) I don't see sound reasons to the contrary as a big problem. Most plants are replacing components to modern standards when end of life occurs for a DOR or Category II device.

(r) Performance of equipment during and following the accident has not been adequately addressed by regulations. The credibility of values used in determining setpoints is questionable. Some are held to a 95/95 determination and others are not. It may be useless to qualify equipment if performance is ignored.

(r) Comment: R.G. 1.89 is too loose in this area. Equipment should be upgraded (or at least reviewed for adequacy) unless by some justification the upgrade would have a negative impact on safety.

(t) The seven "Sound Reasons to the Contrary" (SRC's) appropriately maintain emphasis on safety while not adding to the complexity of the already complex maintenance task. We have no knowledge of misuse of the SRC's and typically the emphasis is biased toward upgrade rather that invoking the SRC's.

C. EQ Inspection Activities

1. **Were the NRC EQ inspections conducted with the appropriate scope and depth and in a consistent manner?**

(a) More scope and depth would have been better.

(d) Region V is not aware of any specific weaknesses of the 'scope' of previous EQ inspections. The EQ inspection program conducted some years ago was of sufficient scope and depth.

(e) They were conducted consistently with appropriate scope and depth (conducted 15).

(f) Yes. There did appear to be regional differences implementing the DOR guidelines.

(h) I am not sure that we were very consistent (as an agency) in looking at the maintenance activities, or the selection of ambient conditions, for example. I think we learned as we went and I believe we tried to maintain consistency. I do believe, however, that we did lack consistency in the area of the two examples above.

(k) Inspections were appropriate in scope and were consistently performed. I am not aware of any specific weaknesses associated with these inspections.

(l) The EQ inspections were in my opinion conducted with the appropriate scope and depth and were done in a consistent manner. Team leaders and members received hours of training on EQ. The regional teams would always have a representative from the Vendor Inspection Branch on the team as an Assistant Team Leader or the Team Leader. Region II performed the inspections using inspectors out of the Plant System Section in DRS. The inspectors were either Electrical engineers or had several years of experience in EQ. In addition, the EQ files reviewed by the EQ Team were principally reviewed by NRC contractors hired for their EQ expertise. I am not aware of any weaknesses associated with those inspections.

(n) I am not qualified to answer these questions although I do have opinions on some of them!

(s) I have little to no knowledge of the scope and depth of the NRC EQ inspections. I do know however, that a number of utilities were fined for inadequacies in their programs as a result of the inspections. That tells me there was some robustness to their scope and depth.

(t) The NRC EQ inspections were consistent with a broad scope and to considerable depth. Please note that we were inspected under both DOR and Category II requirements.

(u) These questions are best addressed by NRC personnel. However, except for the NRC Staff activities in support of original plant operation, I believe the NRC EQ inspections were the most comprehensive compliance evaluations that the NRC has ever performed.

(v) The NRC EQ inspection process lacked adequate depth and consistency from Region to Region. The process typically allowed 1 week for preparation, 1 week on-site and 1-2 weeks for inspection report preparation and approval and the inspection team generally consisted of 5-6 people. This equates to about 3 1/2 to 4 days of actual inspection. The scope of the inspection in terms of the components selected for review was adequate but not enough time was allotted to conduct a thorough in-depth investigation.

Are you aware of any specific weaknesses associated with those inspections that need to be addressed relative to: a) older plants? b) newer plants?

(e) The documentation in the older plant supporting the EQ inspections were a problem. They were not as good as the newer plants.

(f) Not from the Region III plants.

(g) Instrument loop accuracy was sometimes overlooked, depending on inspection team leader and members.

(i) The area of EQ should be reinspected on a periodic schedule. At present only random issues identified during other activities are evaluated.

(m) EQ knowledge does not exist in the working level because of reduced emphasis. This is the case with NRC inspectors as well as licensees. The population that gained a good working knowledge of EQ has moved on to higher positions or different positions. In my experience of second round audits to look at previous open items, maintenance was the weak area.

(o) DOR Guidelines Section 7.0, Aging, states (underlining has been added for emphasis):

> Implicit in the staff position in Regulatory Guide 1.89 with regard to backfitting IEEE Std. 323-1974 is the staff's conclusion that the incremental improvement in safety from arbitrarily requiring that a specified qualified life be demonstrated for all Class 1E equipment is not sufficient to justify the expense for plants already constructed and operating. This position does not, however, exclude equipment using materials that have been identified as being susceptible to significant degradation due to thermal and radiation aging. Component maintenance or replacement schedules should include considerations of the specific aging characteristics of the component materials. <u>Ongoing programs should exist at the plant to review surveillance and maintenance records to assure that equipment which is exhibiting age related degradation will be identified and replaced as necessary.</u>

I am not aware that the above stated ongoing programs generally exist for cables, which certainly contain material known to be susceptible to both thermal and radiation aging effects. It appears that NRC's inspection activities may be lacking in this area.

(t) The emphasis was biased toward "paper" without a corresponding emphasis toward the safety significance of the equipment.

2. **What safety-significant issues have been identified as a result of EQ inspections?**

(d) At Trojan, there has been a significant safety-related issue associated with the qualification of containment electrical penetrations assemblies (EPAs). The enforcement actions have been deferred due to potential wrongdoing by the licensee. These issues are still being inspected. The EPA seals were replaced prior to restart from the refueling outage.

(e) Cable problems, Limitorque MOVs, solenoid valves, terminal blocks, penetrations, grease, and transmitters were identified.

(h) I cannot recall all the safety significant issues, however, they were well documented.

(i) The findings and resultant actions were documented in inspection reports.

(j) The benefit of the EQ inspections was to refocus the EQ activities towards the actually installed condition rather than just towards having adequate documentation.

(k) A number of safety issues including inadequate qualification of cable, cable splices, containment penetrations, solenoid valves, valve operators, terminal blocks, etc. were identified.

(l) Numerous EQ issues were identified based on specific EQ problems at certain sites. A good portion of the problems dealt with the qualification of electrical interfaces (i.e., splices and terminations). Several escalated enforcement cases were handled dealing with these issues. Limitorque MOV qualifications were also a problem and the subject of numerous NRC Notices. This was basically resulting from the fact that the installed configurations did not match the tested configuration. Most of the EQ issues were resolved at the end of the first round of EQ inspections.

(r) The inspections identified generic issues such as MOV testing and application of heat shrink splices. The inspections also highlighted the need for training and configuration control.

(s) I take it this question is directed mainly to NRC staff who are in the best position to say what safety-significant issues have been identified as a result of NRC EQ inspections.

(u) This question is best addressed by NRC and utility personnel. Without commenting on their safety-significance, I believe that most EQ issues described by NRC Bulletins, Information Notices, and Generic Letters were originally self-identified by utilities and manufacturers or resulted from research or EQ qualification testing.

(v) Failure of AMP Nylon and Kynar splices to perform their safety function when subjected to postulated accident conditions.

What enforcement actions have been taken?

(a) See the Record.

(e) About 20 utilities received fines for EQ infractions from these inspections.

(g) Review of the escalated enforcement records would be useful. There were about 30.

(h) Many enforcement actions were taken, including ASLB hearings for the Farley case.

(k) Enforcement actions, including civil penalties, were taken against several utilities relative to those issues. The significant inspection issues have been satisfactorily resolved.

Have all significant inspection issues been adequately resolved?

(a) No

(b) You should take a look at the proposed enforcement actions to get a feel for the answer to this one.

(e) All significant issues have been resolved.

(h) To the best of my knowledge, the issues have been resolved.

3. Is sufficient emphasis being placed on EQ in the current inspection program?

(a) No.

(d) Sufficient emphasis was placed upon EQ during the last round of inspections. As a result, licensee's established an acceptable set of proceduralized administrative controls over the EQ area. Assuming that licensees are following those controls, one would conclude that licensees are placing sufficient emphasis on EQ.

(e) The current inspection program is really not looking at EQ. The '84-'86 EQ inspections are considered complete and no further inspections are warranted (many NRC/industry people believe this). I believe periodic inspections should be conducted. Since no EQ inspections are being conducted, the regional expertise is fading away.

(g) I don't know. The regions still have a few inspectors with some 1980s experience plus maybe others with some knowledge. I believe that most people don't understand EQ well.

(h) There is no real emphasis placed on EQ in the inspection program. I attempt to look at the EQ issues when possible, but that is not really good enough.

(i) There is no emphasis being placed on EQ in the inspection program and no training is taking place nor are EQ issues being highlighted.

(j) EQ focus varies greatly from region to region. Regions 1 and 2 seem to have a stronger focus. Region 3 doesn't seem to have as much interest. There do not seem to be a large number of personnel that understand EQ intimately.

(l) As far as I know, EQ is not being inspected as part of the routine inspection program in Region II. It is typically examined as part of the reactive inspection program. There has been no formalized EQ training in NRC since 1987. I would say that most inspectors do not thoroughly understand the past positions NRC has taken in regard to environmental qualification.

(s) I didn't even know that there are "current" EQ inspection programs.

(t) Yes. The original inspections verified that programs within the utilities were established to meet the requirements of 10CFR50.49 and the present inspection program ensures the implementation is being maintained.

(v) It appears that EQ is not a focus at the Regional level.

Are inspectors sufficiently trained?

(a) No.

(d) If the NRC wishes to re-examine the EQ area, an inspection cadre would have to be trained and the inspection plans redefined.

(g) I don't know what, if any, EQ training is provided.

(h) Inspectors, in general, are not very well trained in EQ. There are very few inspectors that I believe are adequately trained and qualified to inspect in this area. There are probably more inspectors who could evaluate test reports that could adequately determine if its installation and care and handling are appropriate. In order to inspect any new plants that are built, additional training will be necessary. This is to ensure adequacy of the inspection efforts as well as obtain some degree of consistency.

(t) Most inspectors are not familiar with some of the unique knowledge particular to EQ (i.e., Arrhenius, LOCA profile requirements, etc).

(v) It appears that "new" Region based inspectors that have EQ responsibilities have not received training.

What changes would you recommend? Is the inspection plan focus, scope, and depth adequate?

(a) It appears to be haphazard now.

(l) I believe the regulations should be updated to reflect our current positions on EQ. If EQ is going to be part of the routine inspection program there should be some type of formal NRC training and a module developed for the inspection effort. In addition, counterpart meetings should be held to keep inspectors abreast of EQ issues in the industry.

(t) All inspectors should be consistent in their technical interpretations of EQ adequacy. For example, if a utility can demonstrate that a technical concern was adequately addressed in a prior inspection, the "rehashing," of the issue because of a technical difference in opinion between inspectors is not warranted in a new inspection but should be dealt with among the inspectors.

(v) Additional training and including EQ as part of other inspection activities.

D. Miscellaneous

1. To what extent should maintenance and surveillance/condition monitoring be credited for demonstrating continued equipment qualification?

(a) To the extent that the aging mechanisms and symptoms are well known, backed up by continued sampling and testing. Need more [heat rise?] monitoring. Effects of chemical contamination (including self-sources like off gassing and ????. The parameter most likely to be found inaccurate is the activation energy - then is the [actual vs assumed] service condition.

(d) Region V does not recommend any change to EQ requirements for equipment in harsh (e.g. containment) environments. For equipment in mild EQ environments, we think that a PM program to replace certain critical parts (e.g O rings) along with surveillance testing should be sufficient.

(e) Maintenance and surveillance/-ondition monitoring can only be used to detect and mitigate aging. Zero credit should be given to demonstrating continued EQ. EQ should only be demonstrated using LOCA testing on preaged samples.

(f) Condition monitoring should get a lot of credit toward qualification.

(g) Condition monitoring is more of a dream than a reality. For much equipment, the normal environment degradation is small compared to accident effects, and the small changes that may occur in normal service are difficult to measure and not very important. The EPRI cable condition monitor should be useful to determine the specific location of maximum cable degradation, so that we can ensure that the environment at those locations is taken into account

(h) I do not believe that routine maintenance and surveillance activities alone are adequate to determine or maintain the qualification of equipment.

(i) Routine maintenance and surveillance can not be used to verify continued qualification of most equipment.

(k) I am not aware of any reliable and proven condition monitoring or surveillance techniques that could be reliably used in a quantitative way to determine the remaining service life of qualified equipment.

(j) For components that will actually be used for long durations, condition monitoring with acceptance criteria related to accident capability will assure that continued use is conservative. Of course such CM techniques may not be developable or implementable at a reasonable cost. In that case, other alternatives should be considered. Indenter and OIT seem promising. Techniques for penetrations are desirable.

(l) The problem with condition monitoring as a means for demonstrating continued equipment qualification is that not enough testing has been performed to establish which parameters should be trended to determine remaining service life. The bulk of the qualification testing done to date only looked at insulation resistance values for electrical performance during the actual test. If the values exceeded a typical acceptance criteria of 1 meg ohm the specimen passed the test. However, this parameter alone may not be enough to demonstrate continued equipment qualification. I believe more testing is necessary to correlate measured test parameters with direct attributes of degradation.

(n) For equipment in mild environments, routine calibration, maintenance, and surveillance testing should suffice. The question becomes much more difficult to answer for harsh environments. As I stated above in A.6., historical data and inclusion of the periodic measurement of those characteristics critical to the proper operation of the equipment and the maintenance activities required for mitigation should suffice for the rest (including surveillance, etc.).

(o) I believe that maintenance and surveillance/condition monitoring should be credited to demonstrating continued EQ only if it effectively assures that the margin required for successful performance during accident conditions is maintained at all times during the life of the equipment. As previously discussed, this maybe nearly impossible for some items of equipment where the required margin is not known.

(p) At this stage in the life of operating plants, maintenance is relatively more important than qualification. A key element of this collection of activities should be engineering evaluation of maintenance problems and failures coupled with feedback to increase the assurance of safety by warranted changes in equipment, service conditions, and operating conditions. We must avoid the type of incident in which post evaluation reveals that prior events warning of a problem had been ignored.

(q) Refer to [my] B3 response.

(r) Yes, the monitoring of environments can be significant in demonstrating excess conservatism in estimates of service conditions. In many cases the basis assumption that the maximum normal ambient temperature MUST be the basis for calculating qualified life is unduly punitive. TID 14844 based radiation lives are equally excessive in conservatism. This is particularly the cases where single node dosages are determined to envelop the entire containment building. Equipment, such as the Westinghouse Lifetime monitor (this is not a commercial), has been designed specifically to monitor local temperature and radiation environments.

(s) Part of proper qualification is the specification of the maintenance and surveillance actions that are necessary to support the established qualified life (see Section 9 of the EQ Reference Manual). Condition monitoring (which measures condition indicators that can be trended)3/ is normally not performed because (1) condition monitoring is easier said than done -- these is a scarcity of proven methods for in-situ measurements that quantify the remaining life of equipment (see for example "Condition Monitoring of Nuclear Plant Electrical Equipment," EPRI Final Report NP-3357, February 1984 and many NPAR reports that address condition monitoring) and (2) traditional EQ methods rely almost exclusively on testing, analysis, and maintenance/surveillance, which are viewed as adequate without condition monitoring. Condition monitoring is used fairly extensively in plants when life-cycle decisions on expensive equipment like generators and large motors are being made or when a problem with any type of equipment is observed.

Because cables are so expensive to replace a lot of attention has been given to their condition monitoring. EPRI has held two industry workshops on cable condition monitoring and has developed a commercialized technique, the indenter aging monitor (Toman, G., "Cable Life Evaluation Services, Cable Indenter Aging Monitor," Ogden Environmental and Energy Services Company, 1991). Although this technique can be used to troubleshoot cables that are suspected of being prematurely aged (e.g. cable subjected inadvertently to periods with greater-than-usual temperatures), it may prove to be most beneficial as a last resort method (short of replacement) for justifying 20 years of life extension for some cables during license renewal (see response to A6). I also feel that more use should be made of the indenter in technical support of research efforts. For example, it is unfortunate that the indenter was not used to characterize the aged condition of the Okonite cables tested in a recent aging and LOCA test program at Sandia. This data would have gone a long way in comparing the aged condition of these cables to the condition of similar cables aged and tested in a previous Sandia cable program (which, by the way, were tested with the indenter - back in the days of William Farmer, NRC Research, when we had the common sense to coordinate industry and NRC research programs).

(t) Maintenance and surveillance/condition monitoring are tools of a complete program to demonstrate equipment qualification. Operating experience and trending are also part of these programs.

(u) I believe that equipment inspection, maintenance, surveillance, and condition monitoring (if available) should be important elements of aging management. Since accelerated aging simulations cannot address the effects of all significant aging mechanisms, there should be reliance on such on-going activities. For many EQ equipment applications, particularly outside containment equipment not experiencing significant aging or accident stresses, I believe these on-going aging management

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3/ There is a distinction between the terms "surveillance" (go-no-go tests) and "condition monitoring" (trending). I recommend that NRC staff persons involved in the EQ Task Action Plan use the terminology in Nuclear Power Plant Common Aging Terminology, EPRI Final Report TR-100844, December 1992. The NRC participated in developing this.

techniques are preferred to reliance on preaging simulations. For the sake of brevity, I will reserve my input regarding such techniques until the November workshop.

(v) Non-intrusive types of monitoring needed to be explored as a means to monitor equipment qualification. There were many methods discussed at the NRC Aging Conference which may be useful for EQ. Motor current signature and cable indenter methodologies are examples of non intrusive measures that could be used to demonstrate remaining life.

Are you aware of any surveillances or condition monitoring techniques that can be used to provide some assurance of remaining service life? Do you have any specific recommendations in this regard?

(a) The EPRI indenter looks promising.

(e) For cables, break point elongation and indenter may be useful in determining whether or not a cable is aging and thus becoming more brittle. It will not tell you whether a cable will pass an LOCA test. LOCA testing is the preferred method of demonstrating qualification.

(h) I am not aware of any monitoring methods that could determine remaining service life, however, that does not mean that some do not exist or could be developed in the future.

(j) Some of the indentation test methods for cable monitoring appear to have a potential for producing useful results if indexed against samples of similar materials of known amount of degradation. Such methods could be applied on a case by case basis.

(n) Techniques and equipment are available to measure the electrical characteristics of insulated wires and cables such that methods and requirements could be developed to allow periodic evaluation of the "health" of such components. Some newly developed I&C equipment (primarily for Control Room use) have microprocessor-based self testing systems that can be quite sophisticated. These could be developed further to test certain critical characteristics that would be measures of "health" and periodically (or on demand) report them to the operator. Since microprocessors do not work too well in harsh environments, I visualize a dedicated "health monitor" remotely connected to critical components of various transmitters, motors, etc. constantly evaluating their condition. This could supplement operational surveillance testing should you determine it is necessary. The technology is available.

(q) I have worked extensively in this area and have imparted my ideas in the context of EPRI-sponsored Cable Condition Monitoring Workshops. For lack of time, may I note only one item here; - I believe the current lack of concern for moisture transmission through jackets by their cracking or by transmitting of moisture into the cable core by diffusion has been wrongly ignored in that it may quickly compromise an adjacent connector or terminal equipment that was not designed to withstand cable-transmitted water. Therefore jacket condition monitoring can be important. I believe the only method of cable jacket condition monitoring used today is visual or "feel" observations at points (usual terminal or junction boxes) accessed in the course of other equipment maintenance/surveillance activities. Other methods of ascertaining the presence of mechanical integrity of jackets are the use of moderate voltage electrical testing from cable shields to ground or pneumatic testing. These would be applicable to many cable designs but by no means all. Use of the cable indenter test can reveal the jacket (and by inference, the insulation) condition somewhat qualitatively to allow some life predictions for many cables. No sophisticated research is needed to evaluate and implement such tests; simply an impetus to overcome utilities' inertia and their dread of any new test that <u>might</u> yield bad news.

(t) EPRI has several ongoing programs, such as the cable indentor, which show promise. Predicting remaining life of components through deterministic methodology is still in its infancy.

A logical approach would be to (1) reproduce the accelerated aging which was part of an EQ test and (2) compare the installed equipment condition to the condition predicted by the accelerated aging. As long as the installed equipment is not degraded to the tested degradation there is relative assurance of remaining service life. However, it should be noted that any condition monitoring technique which requires removing or extensive handling of aged equipment may result in inducing further degradation not representative of the installed condition.

2. Should credit be given for other initiatives such as the maintenance rule for establishing and monitoring maintaining equipment qualification? Do you have any specific recommendations in this regard?

(a) Yes, if EQ concerns are covered.

(d) Region V does not think the maintenance rule should be given credit in assessing EQ requirements for <u>Harsh</u> environments. We think that credit can be given from the maintenance rule to relax EQ requirements for mild environments (e.g. auxiliary building).

(e) The main rule does nothing for demonstrating qualification and no credit should be given for it.

(f) The maintenance rule does not get into EQ at all.

(g) I have not worked with the maintenance rule. It should definitely address EQ.

(h) Only if the maintenance rule requires the performance of maintenance activities to ensure the equipment remains in a qualified condition. The maintenance requirements should be spelled out very clearly and, if not strictly adhered to, enforcement action should be taken.

(i) No

(j) EQ already requires maintenance at the end of qualified life. If inservice failures occur on qualified equipment, action is needed to determine what was the cause. I don't believe that the Maintenance Rule will cause much change to the EQ arena.

(l) I am not familiar with the maintenance rule and how it will be implemented. But as I stated earlier several EQ items may not have required maintenance. So the maintenance rule will not impact these components.

(n) Based on my previous statements, my answer is obvious, "Absolutely!"

(q) Cable and most connections being totally passive components in safety-related systems are related only very tangentially to the usual maintenance programs.

(r) Degradation of components could be detected by evaluation of surveillance data. Given sufficient attention to this purpose in maintenance program planning, significant benefits could be realized.

(s) The maintenance rule can be given a lot of credit for establishing and maintaining equipment qualification for equipment in a mild environment (in fact, the effectiveness of such maintenance for ensuring that aging does not produce common mode failures is one of the main reasons the NRC did not include mild environment equipment in the scope of 10 CFR 50.49). For harsh environment equipment, the maintenance rule can be given credit for promoting the implementation of surveillance and servicing that may be <u>necessary</u> for maintaining the qualified status of equipment (although such measures are necessary even without the maintenance rule). The performance-based approach in the rule would identify cases where harsh environment equipment experiences unacceptable failure rates during operation. But it would not identify cases where aging degradation is not advanced enough to impact the failure rate of the equipment during the benign environments of plant operation, but may be advanced enough to compromise the safety function of the equipment under harsh-environment common cause stressors in a design basis accident. It is this eventuality that is addressed by environmental qualification. Thus, the maintenance rule is not <u>sufficient</u> to ensure the qualified status of equipment in a harsh environment -- a sound EQ program, including EQ maintenance, is sufficient.

(t) Yes, this would be part of the overall program referred to above. The Industry programs for maintaining equipment, both periodic and preventative, are designed and tailored to maintain equipment in optimal condition for safety and operational reasons. Maintaining equipment in optimal condition contributes to relative assurance that the equipment will perform its safety function if required in a harsh environment.

Maintenance of EQ equipment is only part of an integrated maintenance program which enhances not only EQ but safe and efficient operation of plants. Utilities should be allowed to demonstrate the ability of these programs to maintain EQ but EQ should not be driving maintenance.

(u) In a word - Yes. See response to question D.1.

(v) Yes, I think that to the extent that a maintenance activity is a detailed evaluation of a component (detailed piece part inspection, test etc.) the maintenance rule should allow a licensee to take credit for this data in evaluating equipment qualification.

3. **What other options or approaches to establishing and maintaining EQ requirements would you recommend?**

(e) Periodic DBE testing of components is the only way to assure that they will function during and following a DBE. A single test good for 40 years is a scary thing.

(f) Periodic testing is the only to know absolutely the status of qualified equipment.

(h) I would recommend that a group be formed in HQ that would develop an inspection procedure and periodically inspect all the plants in the country to ensure licensee are complying with the rule and to have consistency.

(i) I recommend that the licensees continue to implement an EQ program that is periodically inspected.

(k) Should attempt to get more realistic assessment of equipment aging (cable insulation, splices, etc.) by obtaining and testing specimens of in-plant equipment and comparing the results to accelerated aging predictions. This information should be used to reassess the existing EQ requirements.

(l) As stated earlier, the EQ rule should be updated and maintained current. The EQ standards are being revised by the industry; however, NRC has not adopted any of the later standards in Regulatory Guides.

(q) This subject is covered in other responses given.

(s) Since it is my judgment that current approaches for establishing and maintaining EQ in older and newer plants are sufficient, I do not recommend any other options or approaches.

(t) Put less emphasis on "paper" and more emphasis actual operating experience and condition of equipment.

(u) See responses to A.1 and A.2. As noted above I maintain that the current approach of applying a consistent methodology to all equipment within the scope of 50.49 is inappropriate. Rigorous qualification combined with inspections and aging management should be applied to the most safety significant equipment located inside containment. Little, if any, 50.49 type qualification need be applied to radiation-only harsh and outside containment equipment exposed to short-time low-temperature steam effects. For other equipment, varying approaches could be applied. I suspect an overall safety gain would result, if existing industry EQ resources were redirected and focused on a narrower equipment scope with more rigorously maintained and scrutinized equipment performance and qualification.

4. **Describe any specific EQ issues or topics that you believe deserve further research.**

(f) Emphasis should be placed on training workers and contractors to recognize EQ requirements. Even if they aren't working on EQ systems they can damage components and affect their qualification.

(p) I recommend that the NRC and industry cooperate to develop a program for the testing of equipment removed from plants after 20 or more years of service. Whenever a question arises about the adequacy of installed equipment, it appears that industry has invariably insisted that the problem could be addressed by analysis and has objected to testing. A prime concern is that a test failure could have major consequences, even if there were evidence that the failure was caused by equipment handling and other factors not related to equipment capability. Consequently, it is essential that the proposed program be designed to eliminate the risk of the feared consequences. The objective should be to obtain information on the effects of real aging on installed equipment and thereby overcome some of the deficiencies of the traditional methods of evaluating aging effects. The NRC's Nuclear Plant Aging Research Program has done some of this, but little of it has involved equipment in current use in operating plants. To reduce the overall cost of such an undertaking, the program could be limited to equipment considered to have the greatest impact on safety, and each utility (or group of utilities) would be assigned one item to test.

This suggestion is undoubtedly controversial, and great effort would be required for its successful planning; however, I have long felt that there is no substitute for testing equipment that has seen long service in an operating plant. The adversarial atmosphere that often exists between the NRC and industry would have to be overcome in the common interest of public safety.

THE FRENCH APPROACH

To the extent that I am familiar with it, I think the basic elements of the French approach to EQ, are a relatively standardized age-conditioning coupled with an effort to develop condition monitoring methods capable of revealing when equipment is approaching the point where it will no longer be able to perform its safety function. While standardized age-conditioning eliminates the variableness in approaches by different manufacturers and utilities, it does not account for the different aging rates of different materials and parts. However, the weakest point in the French approach is the expectation that predictive condition monitoring techniques can be developed in time to be used effectively. At present, I am not aware of any viable predictive condition monitoring methods; and the rate at which their development is taking place is not very promising.

(q) Some of the concerns of the writer have been those expressed in two publications known to NRC staff (Ref. below). They deal dominantly with harsh wet environment effects that have rarely, if ever, been part of cable system EQ programs. Examples are: interface effects between components tested separately; use of a single test for widely different designs, vintages, and manufacturers; mechanical installation stresses on cable (sharp bends, vertical supports, seal compression deformation); continuous submersion prior to harsh exposure; and combined momentary electrical effects from postulated initial peak tempe ature and radiation stresses. These are concerns that are applicable to all plants young or old. The degree of concern for such items as noted would vary substantially from station to station depending upon the specific cable designs, component designs, installation practices and EQ program of the station. Although these generic issues have been raised in the past, I understand that there are no outstanding cable generic issues on the NRC agenda. What is the proper venue to address these concern ?

(s) Utilities must ensure that plant-specific environments or maintenance practices do not negatively affect the qualified status of their equipment. In this regard I take this opportunity to reinforce previously issued guidance regarding the qualified status of polyamide insulated wire (virtually all of it in nuclear plants is Kapton, trade mark of DuPont) used for electrical leads for containment penetrations and other safety-related electrical equipment. The qualified status of such leads is maintained only if they are (1) installed and maintained with meticulous compliance with manufacturers' instructions to avoid sharp bends and inadvertent damage, (2) kept free of wetting for long periods during plant operation to minimize the aging mechanism of hydrolysis in tight bends, and (3) protected during an accident from direct spray impingement more aggressive than the spray conditions for which it was qualified by test. Also, handling of "Kapton" insulated wire after exposure to a radiation dose of more than 1 Mrad should be minimized due to the potential failure of degraded "Teflon" adhesive, which holds the spiral-wrapped polyamide tape insulation in place. Problems due to handling damage of "Kapton" wire led the Nuclear Regulatory Commission to issue an Information Notice (No. 88-89). EPRI published the report "Review of Polyamide Insulated Wire in Nuclear Power Plants," Final Report NP-7189, February 1991, to provide utilities with guidance on practices that will maximize its reliability under operating and accident conditions. The report states that "If plant conditions approach levels identified in this report, it would be prudent to review the qualification file and as-built configurations related to the technical issues covered here."

(v) There are safety-related components located in a "mild environment" which experience a "harsh" environment due to their operating condition. These components (i.e., continuously energized solenoid valve) should be evaluated for a qualified life.

NRC information Notices should contain more specific information regarding the identified problem. The identified problem or concerns should be addressed by each licensee that is affected.

(w) Bonded jacket cables - Based on the fact that I&C cables with thin jackets (<45 mils) were not specifically qualification tested, are these Okonite cables qualified today? Should they be qualification tested? What do we do to resolve overall bonded jacket cable issue?

5 Do you have any additional comments or observations relative to the adequacy of EQ or EQ program requirements at commercial nuclear power plants?

(e) The industry has adopted a status quo attitude on EQ and it's time for the NRC to shake the tree. EQ is not a one time issue that gets resolved for 40 to 60 years. Periodic verification of component qualified life is warranted.

(h) I sometimes get the feeling that licensees, and sometimes NRC personnel, think that the EQ issue is dead.

(k) Have no direct knowledge but suspect that overall emphasis on EQ has significantly diminished since the completion of the NRC EQ inspections.

(m) I don't think the approach of establishing qualified life with replacement equipment is properly handled. The design changes that go into a later model of a product may make the qualification much worse and sometimes better. The licensee is going to refer to the spec., and the salesman will rely on his catalogue for supplying the equivalent product.

I think it is time we revisited this issue to look at the effectiveness of the licensee's EQ program.

(t) Prescriptive regulatory approaches for complex issues, such as aging, are typically ineffective. The result is to "meet the rule" and not to proactively "engineer" resolutions and enhancements. Utilities should be allowed to "engineer" through the aging, and other EQ issues, in concert with the NRC to insure compliance with regulatory requirements are met and safe, efficient operations of commercial nuclear power plants.

(w) With regards to the Okonite aging methodology - Is it acceptable? If we determine that condition monitoring, in situ testing, or some other test method (IST?) is acceptable, does it matter? How conservative is accelerated aging versus natural aging?

If we determine that condition monitoring, in situ testing, or some other test method (IST?) is required to assure that qualified equipment is still good, is that sufficient for license renewal or do utilities still have to prove qualification for the additional renewal period. In other words do they have to do additional qualification testing to prove equipment is qualified for 60 years.

6. Do you know of any literature that may be helpful in addressing this issue, such as published reports, studies, articles, etc.?

(d) EPRI has published a manual (Nuclear Power Plant Equipment Qualification Reference Manual) and the survey may benefit from inquiring whether licensees consider the manual to provide proper guidance, whether licensees are using the manual and whether it would be useful for the NRC to recognize the manual via a Reg. Guide. It looks like there is an industry standard on EQ which the NRC should address in some way.

(e) S Aggarwal has a compendium of EQ information.

(j) EPRI Cable Condition Monitoring Workshop, February 1993. (Papers)

(n) The I&C TEG report on TMI-2 might be of interest since it addresses instrument failures in accident conditions. If you can find and contact F.E. Tooper in DOE Headquarters or R.D. Meininger at EG&G Idaho, Inc., you may be able to get a copy. I have a draft but loaned my final version to someone and did not get it back.

I've been away from EQ for about three years so was not able to answer all your questions, but I hope this helps. It appears from the questions you are headed in the right direction. Good fortune.

(p) I have enclosed a copy of a paper I prepared for an NRC workshop on plant aging in 1982, which I believe still has pertinent information.

(q) References expressing the writer's concerns are: NUREG/CR4731 "Residual Life Assessment of Major Light Water Reactor Components - Overview" Vol. 2, Chap. 13 Cables & Connections in Containment (Nov. 1989), and Proc: 1993 EPRI Workshop on Power Plant Cable Condition Monitoring pp. 2-1 thru 2-10 "Cable Condition Monitoring - The Challenge Before Us." An example of proper EQ perspective is given in IEEE Trans. on Nuclear Science, Aug. '93, p. 1263 "Role of Training in Maintaining Equipment Qualification" by Sliter & Kasturi (first two paragraphs).

(s) Yes, I know literature that may be helpful in addressing this issue. There are over 500 references cited in EPRI's Equipment Qualification Reference Manual. The stated objectives of the manual are:

- Consolidate and preserve the substantial, but scattered, body of equipment qualification technology developed in the past decades
- Sustain uniform good practice of equipment qualification during long-term plant operation
- Facilitate the training of future equipment qualification engineers and other plant personnel for whom equipment qualification is important, but may not their primary job responsibility
- Support utility programs for maintaining the qualified status of existing equipment and qualifying replacement equipment, in turn minimizing forced outages
- Enhance and promote the economic benefits of equipment life extension and plant license renewal

Point out areas in which equipment qualification technology is still developing and may be further improved

The entire manual is pertinent to the questions asked by this survey. Section 12 "Qualification Experience" is especially pertinent. It is intended to "bring to the user's attention factual information regarding the performance of certain equipment types in past tests or plant service."

The manual is an example of the many ways that the utility industry constantly promotes good practices and learns from experiences in EQ. As problems are identified, they are addressed generically or within individual utility EQ programs. I am confident that any valid concerns identified by NRC's reassessment of EQ program requirements will be addressed by the industry. I am equally confident that the reassessment will not identify any valid cause for modifying existing time-tested EQ methods and requirements.

(u) The literature associated with qualification testing and aging simulations for nuclear power plant and other related information is vast and too extensive to be provided here. Suggested reading are NUREG/CR-4301, Status Report on Equipment Qualification Issues Research and Resolution, and the EPRI EQ Reference Manual. During the past few years it has been my experience that many in the NRC Staff involved with EQ, some viewed as EQ knowledgeable, are not conversant with the insights provided by most of the more accessible literature sources (outside the applicable standards and regulations). I have wondered if the EQ-TAP and the significant Staff and industry resources that will be consumed by the program have been catalyzed by this lack of insight and historical perspective.