1) What is the Arrhenius methodology?

NEW QUESTION

Response:

Thermal aging using the Arrhenius methodology has been addressed in various venues, including at least one initial licensing proceeding. *Carolina Power & Light Co. and North Carolina Eastern Municipal Power Agency*, Shearon Harris Nuclear Power Plant, LBP 85-28, 22 NRC 232, 275-78 (1985) (addressing a contention concerning thermal aging of resistance temperature detectors (RTDs)), aff'd ALAB-856, 24 NRC 802. In the relevant section of LBP-85-28, the Board discussed application of the Arrhenius methodology, writing:

> 46. Thermal aging is a temperature-dependent chemical process which can lead to changes in the properties of organic materials over a period of time. Since real-time aging is not practical over the long periods of time over which electrical equipment must be qualified for nuclear power plants, accelerated processes have been developed to simulate a defined life over a much shorter period of time.
>
> 47. The Arrhenius methodology has been developed to simulate accelerated aging. This methodology is based on the premise that deterioration of materials in service is due to chemical reaction. These occur internally, sometimes between components of the material, and sometimes with compounds in the environment such as oxygen or water vapor. Chemical reactions occur more rapidly at higher temperatures. Arrhenius showed that temperature dependence of chemical reactions follows an exponential equation. He postulated a consistent correlation between the amount of physical change and chemical reaction so that the time to reach a selected amount of physical change will vary according to an equation. The rate of thermal aging is the slope of the graph using the Arrhenius equation. It is Applicants' conclusion that other than testing of the material or system for the predicted years of service, this is the most logical scientific way of predicting whether a material or system will be reliable. Type tests for thermal aging are made from 1 to 2 years. After the linearity of the Arrhenius graph for a particular material is confirmed, then

> short-time, more accelerated tests are acceptable to evaluate small changes in materials or application conditions. Generally, the experience has been excellent in confirming the predictions.

Shearon Harris, LBP-85-28, 22 NRC at 275-76 (1985) (internal citations omitted). The Board also described the Staff's view of the Arrhenius methodology thusly:

> 48. The NRC Staff has concurred in the use of the Arrhenius methodology for thermal aging.
>
> …
>
> 58. … The Staff is aware of the inadequacies in the Arrhenius methodology. However, it is the best approach currently available to address accelerated thermal aging and has been used in Equipment Qualification Programs of every nuclear power plant in the country. The Staff does not allow reliance exclusively on the Arrhenius methodology of accelerated aging to address the requirements for establishing a qualified life for equipment. Applicants must have a surveillance and maintenance program to account for unanticipated degradation which is not reflected in the results of the accelerated aging process. Combined with the surveillance program, the Arrhenius methodology is considered acceptable for aging to establish a qualified life.

Shearon Harris, LBP-85-28, 22 NRC at 276 & 277-78 (1985) (internal citations omitted)

2) What is the regulatory guidance (i.e., Regulatory Guide (RG), Standard Review Plan (SRP), Interim Staff Guidance (ISG), Branch Technical Position (BTP), etc.) for applying the Arrhenius Methodology to establish the qualified life of EQ components?

FORMER FAQ #1

What is the proper application of the Arrhenius methodology to extend the qualified life of an EQ component in the evaluation to extend its original life?

Response:

There is no specific regulatory guidance for how to apply the Arrhenius Methodology for determining the qualified life of components. However, 10 CFR 50.49(e)(5), and NUREG 0588, Revision 1, Regulatory Guide 1.89, Revision 1, IEEE Std. 323-1974, NUREG 1800, and NUREG-1801 include requirements and guidance for addressing thermal aging using the Arrhenius Methodology to qualify electric equipment.

In 1982, the Nuclear Regulatory Commission proposed to amend its regulations applicable to nuclear power plants to clarify and strengthen the criteria for environmental qualification of electric equipment. Proposed Rule, Environmental Qualification of Electrical Equipment for Nuclear Power Plants, 47 Fed. Reg. 2876 (Jan 20, 1982). In doing so, the NRC noted that then-current specific qualification methods contained in national standards, regulatory guides, and certain NRC publications for equipment qualification had been given different interpretations and had not had the legal force of an agency regulation. *Id.* The 1982 proposed rule would codify these environmental qualification methods and clarify the Commission's requirements in this area. *Id.*. The Commission noted:

> The NRC has used a variety of methods to ensure that these general requirements are met for electric equipment important to safety. Prior to 1971, qualification was based on the fact that the electric components were of high industrial quality. For nuclear plants licensed to operate after 1971, qualification was judged on the basis of IEEE 323–1971. For plants whose Safety Evaluation Reports were issued since July 1, 1974, the Commission has used Regulatory Guide 1.89, "Qualification of Class IE Equipment for Light-Water-Cooled Nuclear Power Plants," which endorses IEEE 323–1974,[] "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," subject to supplementary provisions.
>
> Currently, the Commission has underway a program to reevaluate the qualification of electric equipment important to safety in all operating nuclear power plants. As a part of this program, more definitive criteria for environmental qualification of electric equipment have been developed by the NRC. A document entitled "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors" (DOR Guidelines) was issued in November 1979. In addition, the NRC has issued NUREG–0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," which contains two sets of criteria: the first for plants originally reviewed in accordance with IEEE 323–1971 and

> the second for plants reviewed in accordance with IEEE 323–1974.

Subsequently, the Commission finalized the environmental qualification rules. Environmental Qualification of Electrical Equipment Important to Safety, 48 Fed. Reg. 2729 (Jan 31, 1983) (the rule was subsequently corrected in via a direct final rule (Definition of Safety-Related Structures, Systems, and Components; Technical Amendment, 62 Fed. Reg. 47268 (Sept. 8, 1997))). Concerning guidance, when publishing the final rule, the Commission stated:

> Included in the final rule are specific technical requirements pertaining to (a) qualification parameters, (b) qualification methods, and (c) documentation. Qualification parameters include temperature, pressure, humidity, radiation, chemicals, and submergence. Qualification methods include (a) testing as the principal means of qualification and (b) analysis in combination with partial type test data or operating experience. The final rule requires that the qualification program include synergistic effects, radiation, environmental conditions and margin considerations. Also, a record of qualification must be maintained. Proposed Revision 1 to Regulatory Guide 1.89, which has been issued for public comment, describes methods acceptable to the NRC for meeting the provisions of this rule and includes a list of typical equipment covered by it. Revision 1 to Regulatory Guide 1.89 will be issued after resolution of public comments.

48 Fed. Reg. at 2731.

In July of 1984, the NRC issued Regulatory Guide (RG) 1.89, Rev. 1, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,” dated July 1984. It endorses, with certain exceptions identified in Section C, ‘Regulatory Position’, IEEE Std. 323-1974, “IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations,” and describes a method acceptable to the NRC Staff for complying with 10 CFR 50.49, “Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants.”

Section C.5 of RG 1.89 states in part:

> “Section 6.3.3, “‘Aging’” of IEEE Std. 323-1974; and paragraph 10 CFR 50.49(e)(5) should be supplemented with the following:
> ...

b. The expected operating temperature of the equipment under service conditions should be accounted for in thermal aging. The Arrhenius methodology is considered an acceptable method of addressing accelerated thermal aging within the limitation of state-of-the-art technology. Other aging methods will be evaluated on a case-by-case basis.

c. The aging acceleration rate and activation energies used during qualification testing and the basis upon which the rate and activation energy were established should be defined, justified, and documented."

In section B of RG 1.89, the NRC discussed preconditioning, stating in part:

> For the purposes of this guide, "qualification" is a verification of design limited to demonstrating that the electric equipment is capable of performing its safety function under significant environmental stresses resulting from design basis accidents in order to avoid common-cause failures. Paragraph 50.49(e)(5) calls for equipment qualified by test to be preconditioned by natural or artificial (accelerated) aging to its end-of-installed-life condition and further specifies that consideration must be given to all significant types of degradation that can have an effect on the functional capability of the equipment. There are considerable uncertainties regarding the processes and environmental factors that could result in such degradation. Oxygen diffusion, humidity, and accumulation of deposits are examples of such effects. Because of these uncertainties, state-of-the-art preconditioning techniques are not capable of simulating all significant types of degradation, and natural pre-aging is difficult and costly. As the state of the art advances and uncertainties are resolved, preconditioning techniques may become more effective. Experience suggests that consideration should be given, for example, to a combination of (1) preconditioning of test samples employing the Arrhenius theory and (2) surveillance, testing, and maintenance of selected equipment specifically directed toward detecting those degradation processes that, based on experience, are not amenable to preconditioning and that could result in common-cause functional failure of the equipment during design basis accidents.

Section 6.3.3 of IEEE Std. 323-1974 notes that IEEE Std. 101-1972, "Guide to Statistical Analysis of Thermal Life Test Data," may be used as a basis for selecting aging time and temperature.

According to the Guidelines for Evaluating Qualification of Class 1E Electrical Equipment in Operating Reactions (commonly referred to as DOR [Division of Operating Reactor] Guidelines, ML032541214), aging was to be evaluated as follows:

> Tests which were successful using test specimens which had not been pre-aged may be considered acceptable provided the component does not contain

> materials which are known to be susceptible to significant degradation due to thermal and radiation aging (See Section 7.0). If the component contains such materials, a qualified life for the component must be established on a case by case basis. Arrhenius techniques are generally considered acceptable for thermal aging" (DOR Guidelines, Section 5.2.4).

As described in NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Rev. 1, page 2:

> As part of the staff reviews of operating license applications, a number of positions have been developed on the methods and procedures used to environmentally qualify safety-related electrical equipment. These positions, which are described in the following sections of this report, supplement the requirements found in the 1971 and the 1974 version of IEEE Standard 323*. While alternatives to these positions may be proposed, the positions will be used, together with the standards, as the basis for reviewing all license applications. The positions are divided into two categories. Category I positions apply to equipment qualified in compliance with IEEE Std. 323-1974 and Category II positions apply to equipment qualified in compliance with IEEE Std. 323-1971.
>
> The positions are divided into two categories. Category I positions apply to equipment qualified in compliance with IEEE Std. 323-1974 and Category II positions apply to equipment qualified in compliance with IEEE Std. 323-1971.
>
> Section 1 of the [] table [in NUREG-0588] contains positions related to the establishment of the service conditions for areas inside and outside containment to which equipment should be qualified. It includes guidance for calculating the pressure and temperature conditions that result from a high energy line break (LOCA and/or MSLB), and also provides guidance for determining the chemical spray and the radiation environments expected to occur during a design basis event condition. Section 2 provides guidance on the selection of qualification methods (that is, testing, analysis, etc.) to be used for equipment located inside and outside containment. Sections 3, 4, and 5 provide guidance on the selection of margins, aging and the preparation of qualification documentation. The appendices supplement the positions and identify specific codes, sample calculations, and procedures that should be used when qualifying equipment. The term "equipment" referred to in the following sections applies to safety-related electrical equipment required for accident mitigation, post-incident monitoring, and safe shutdown.

NUREG 0588, Rev. 1, Section 4, paragraph 2 (pg 15) states for Category II equipment for aging that:

> For other equipment, the qualification programs should address aging only to the extent that equipment that is composed, in part, of materials' susceptible to aging

> effects should be identified, and a schedule for periodically replacing the equipment and/or materials should be established. During individual case reviews, the staff will require that the effects of aging be accounted for on selected equipment if operating experience or testing indicates that the equipment may exhibit deleterious aging mechanisms. Thus, Arrhenius methodology can be used in Cat II.

EQ component reanalysis attributes are described in Section X.E1 "Environmental Qualification (EQ) of Electric Components," of NUREG-1801, "Generic Aging Lessons Learned (GALL) Report - Final Report," Rev. 2, which states:

> The reanalysis of an aging evaluation is normally performed to extend the qualification by reducing excess conservatism incorporated in the prior evaluation. Reanalysis of an aging evaluation to extend the qualification of a component is performed on a routine basis pursuant to 10 CFR 50.49(e) as part of an EQ program. While a component life limiting condition may be due to thermal, radiation, or cyclical aging, the vast majority of component aging limits are based on thermal conditions. Conservatism may exist in aging evaluation parameters, such as the assumed ambient temperature of the component, an unrealistically low activation energy, or in the application of a component (de-energized versus energized). The reanalysis of an aging evaluation is documented according to the station's quality assurance program requirements, which requires the verification of assumptions and conclusions.

Furthermore, NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," Rev. 2, Section 4.4, "Environmental Qualification of Electric Equipment," discusses equipment qualification in relation to license renewal.

References: 10 CFR 50.49(e); DOR guidelines; NUREG-0588, Rev. 1; NUREG 1800, Section 4.4; NUREG-1801, Rev. 2 (GALL Report), Section X.E1; RG 1.89, Revision 1; IEEE Std. 101; IEEE Std. 323-1974.

3) Are licensees required to validate the information contained in the EQ reports (e.g., activation energy) provided by Appendix B vendors? If so, what are the requirements?

FORMER FAQ #2

Do vendors and licensees need to validate the activation energy (lower activation energy results in reduced longevity of an EQ component) of replacement EQ parts qualified through their respective commercial grade dedication process?

Response:

Beyond ensuring that vendor programs satisfy the 10 CFR Part 50, Appendix B, requirements and confirming that the EQ equipment is received as procured, no. The inspectors should identify, document, and forward any technical issues with vendor-selected parameters to the designated NRC HQ EQ subject matter expert/point-of-contact and the Vendor Inspection Branch for review and potential vendor inspection.

Equipment qualification is governed by 10 CFR Part 50, Appendix B and the regulation for environmental qualification of electrical equipment important to safety is 10 CFR 50.49.

According to the 1995 NRC Enforcement Policy (1995 WL 509922):

> When inspections determine that violations of NRC requirements have occurred, or that vendors have failed to fulfill contractual commitments (e.g., 10 CFR Part 50, Appendix B) that could adversely affect the quality of a safety significant product or service, enforcement action will be taken. Notices of Violation and civil penalties will be used, as appropriate, for licensee failures to ensure that their vendors have programs that meet applicable requirements. Notices of Violation will be issued for vendors that violate 10 CFR Part 21. Civil penalties will be imposed against individual directors or responsible officers of a vendor organization who knowingly and consciously fail to provide the notice required by 10 CFR 21.21(b)(1). Notices of Nonconformance will be used for vendors which fail to meet commitments related to NRC activities.

In accordance with 10 CFR 50.49(d):

> The applicant or licensee shall prepare a list of electric equipment important to safety covered by this section. In addition, the applicant or licensee shall include the information in paragraphs (d)(1), (2), and (3) of this section for this electric equipment important to safety in a qualification file. The applicant or licensee shall keep the list and information in the file current and retain the file in auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for future use to permit verification that each item of electric equipment is important to safely meet the requirements of paragraph (j) of this section.
>
> (1) The performance specifications under conditions existing during and following design basis accidents.
>
> (2) The voltage, frequency, load, and other electrical characteristics for which the performance specified in accordance with paragraph (d)(1) of this section can be ensured.

(3) The environmental conditions, including temperature, pressure, humidity, radiation, chemicals, and submergence at the location where the equipment must perform as specified in accordance with paragraphs (d)(1) and (2) of this section.

In accordance with 10 CFR 50.49(j):

> (j) A record of the qualification, including documentation in paragraph (d) of this section, must be maintained in an auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for future use to permit verification that each item of electric equipment important to safety covered by this section:
>
> (1) Is qualified for its application; and
>
> (2) Meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform its safety function up to the end of its qualified life.

As used in 10 CFR Part 21, “Dedication”, is defined in 10 CFR 21.3 as:

> (1) When applied to nuclear power plants licensed pursuant to 10 CFR part 50, dedication is an acceptance process undertaken to provide reasonable assurance that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed equivalent to an item designed and manufactured under a 10 CFR part 50, appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptability by inspections, tests, or analyses performed by the purchaser or third-party dedicating entity after delivery, supplemented as necessary by one or more of the following: commercial grade surveys; product inspections or witness at hold points at the manufacturer's facility, and analysis of historical records for acceptable performance. In all cases, the dedication process must be conducted in accordance with the applicable provisions of 10 CFR part 50, appendix B. The process is considered complete when the item is designated for use as a basic component.

RG 1.164, “Dedication of Commercial Grade Items for use in Nuclear Power Plants,” Section B, “Discussion,” Rev. 0, states that:

> …equipment qualification is a part of the design process covered under 10 CFR Part 50, Appendix B, Criterion III, which demonstrates that an item exhibits design characteristics that allow it to function or survive a set of environmental conditions and/or seismic spectra. The purpose of the commercial grade

> dedication acceptance process is to provide reasonable assurance that the commercial item intended to be used as a basic component will perform its intended safety function. Therefore, equipment qualification requirements become an important input to the commercial-grade acceptance process when the selection of critical characteristics is performed.

RG 1.164 further states that:

> …attempting to use one process to accomplish the objectives of both qualification and commercial-grade dedication is inappropriate because it could result in inadequately qualified equipment or specification of unnecessary acceptance requirements.

While commercial grade dedication can be utilized to establish similarity to previously qualified equipment it does not provide the methods for establishing environmental qualification. However, the commercial grade dedication process can provide reasonable assurance that a commercially procured replacement part is sufficiently similar to one that was originally qualified

10 CFR 50, Appendix B, Criterion III, “Design Control,” requires that licensees verify or check the adequacy of the design. Commercial grade items could be environmentally qualified, provided that there is a documented and acceptable material verification to ensure the replacement items are similar to those originally qualified items and the original qualification tests and analysis remain valid. Qualification of replacement components should be established based on qualification methods specified in 10 CFR 50.49(f) (e.g. environmental qualification via analysis with partial type test data or similarity to gain confidence that the component can perform its function in the required harsh environment). Per 10 CFR 50.49(f), each item of electrical equipment important to safety must be qualified by testing, analyses and/or experience. Per 10 CFR 50.49(k), “Applicants for and holders of operating licenses are not required to requalify electric equipment important to safety in accordance with the provisions of this section if the Commission has previously required qualification of that equipment in accordance with "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors," November 1979 (DOR Guidelines), or NUREG-0588 (For Comment version), "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." Further guidance was provided in Regulatory Guide 1.89, Rev 1, issued in June 1984.

Per RG 1.89, Rev. 1, Section C.5.:

> Section 6.3.3, [‘] Aging, [’] of IEEE Std. 323-1974 and paragraph 50.49(e)(5) should be supplemented with the following: Section (c) which states, “The aging acceleration rate and activation energies used during qualification testing and the

basis upon which the rate and activation energy were established should be defined, justified, and documented."

Changes made by the licensee to materials or manufacturing processes between the original and the replacement parts should be evaluated for their impact on qualification. This could include how such changes might impact the activation energies used in the thermal aging analyses. Licensees and vendors may rely on industry consensus standards and quality databases to obtain a new activation energy value for a specific material; the selected value must be supported by auditable background information.

The licensee's (or vendor's) justification should include an appropriate analysis showing that the selected activation energy is suitable and/or applicable to replace the existing value (e.g., same material, use of testing to demonstrate similar failure parameter or degradation mechanism, similar temperature range, same chemical reaction).

NRR should be consulted in cases where inspectors cannot reach a reasonable conclusion on the qualified status of the EQ components. If the NRC staff currently has concerns with existing specific methodologies or values for EQ, but the information was previously approved by the NRC, then the staff should generally not cite a violation. Instead, the staff should consider a backfit assessment for addressing the issue, commensurate with the safety and/or risk significance.

The licensee or the supplier performing the dedication under 10 CFR 50 Appendix B would need to demonstrate similarity to the originally tested and qualified parts and this could include performing tests and/or analyses to provide an appropriate level of confidence that the replacement part will perform in a similar manner as the part originally qualified and tested, both during assumed accident conditions as well as in normal operation.

References: 10 CFR Part 21; 10 CFR 50.49; 10 CFR Part 50, Appendix B; IEEE Std. 323-1974, RG 1.89; and RG 1.164.

4) Are licensees that were licensed to meet the DOR Guidelines for EQ required to upgrade the qualification of EQ components to the CAT I criteria of NUREG-0588, Rev. 1, when they enter the period of operation beyond the original 40-year license?

FORMER FAQ #3

Do licensees need to upgrade the qualification requirements for components initially licensed under DOR guidelines, requirements grandfathered under the 10 CFR 50.49 regulation, as they transition into the extended period of operation?

Response:

No, unless the renewed license contains specific license conditions that require them to.

Per 10 CFR 50.49(k):

> Applicants for and holders of operating licenses are not required to requalify electric equipment important to safety in accordance with the provisions of this section if the Commission has previously required qualification of that equipment in accordance with “Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors,” November 1979 (DOR Guidelines), or NUREG–0588 (For Comment version), “Interim Staff Position on Environmental Qualification of Safety–Related Electrical Equipment.”

Per 10 CFR 50.49(l):

> Replacement equipment must be qualified in accordance with the provisions of this section unless there are sound reasons to the contrary.

Section 6 of RG 1.89, Rev. 1, states:

> Replacement electric equipment installed subsequent to February 22, 1983, must be qualified in accordance with the provisions of § 50.49 unless there are sound reasons to the contrary. The NRC staff considers the following to be sound reasons for the use of replacement equipment previously qualified in accordance with the DOR Guidelines or NUREG-0588 in lieu of upgrading:
>
> a. The item of equipment to be replaced is a component of equipment that is routinely replaced as part of normal equipment maintenance, e.g., gaskets, o-rings, coils; these may be replaced with identical components.
> b. The item to be replaced is a component that is part of an item of equipment qualified as an assembly; these may be replaced with identical components.
> c. Identical equipment to be used as a replacement was on hand as a part of the utility's stock prior to February 22, 1983.
> d. Replacement equipment qualified in accordance with the provisions of § 50.49 does not exist.
> e. Replacement equipment qualified in accordance with the provisions of § 50.49 is not available to meet installation and operation schedules. However, in such case, the replacement equipment may be used only until upgraded equipment can be obtained and an outage of sufficient duration is available for replacement.
> f. Replacement equipment qualified in accordance with § 50.49 would require significant plant modifications to accommodate its use.

g. The use of replacement equipment qualified in accordance with § 50.49 has a significant probability of creating human factor problems that would negatively affect plant safety and performance, for example:

(1) Knowledge, skills, and ability of existing plant staff would require significant upgrading to operate or maintain the specific replacement equipment;
(2) The use of the replacement equipment would create a one-of-a-kind application; or
(3) Maintenance, surveillance, or calibration activities would be unnecessarily complex.

Per 10 CFR 54.21(c), “Contents of Application – Technical Information,”, each application for a renewed operating license must contain an evaluation of time-limited aging analyses (TLAAs) as defined in 10 CFR 54.3, “Definitions,” (stating in part that TLAAs are those licensee calculations and analyses that consider the effects of aging, involve time-limited assumptions defined by the current operating term (e.g., 40 years)). Per 10 CFR 54.21(c)(1):

> A list of time-limited aging analyses, as defined in § 54.3, must be provided. The applicant shall demonstrate that--
> (i) The analyses remain valid for the period of extended operation;
> (ii) The analyses have been projected to the end of the period of extended operation; or
> (iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Section VI B of NUREG-1801, Rev. 2, addresses electrical equipment subject to 10 CFR 50.49 EQ requirements. As noted on page VI B-2, EQ is a TLAAs to be evaluated for the period of extended operation. Further, Standard Review Plan, Section 4.4, "Environmental Qualification (EQ) of Electrical Equipment," provides acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii). Chapter X.E1, "Environmental Qualification (EQ) of Electric Components," of NUREG-1801, Rev. 2, provides an acceptable method for meeting the requirements of 10 CFR 54.21(c)(1)(iii). Meeting 10 CFR 54.21(c)(1)(i)-(iii) is the licensee’s burden, but the licensee can select which method(s) to use. The licensee would have to examine each TLAA and demonstrate in its license renewal application that each TLAA remains valid, has been projected, or how the effects of aging will be managed.

References: 10 CFR 50.49; 10 CFR 54.21; 10 CFR 54.3; DOR guidelines; RG 1.89, Rev. 1; NUREG-0588, Rev. 1; NUREG-1801, Rev. 2 (GALL Report), Section X.E1.

5) What are the governing requirements for licensees to accept and verify activation energies from Appendix B vendors are technically justified for the application and/or applicable to the service conditions.

Response:

See response to Question number 3 above.

6) What are the requirements for replacing EQ components?

FORMER FAQ #5

Do licensees have to adhere to the same standard that was used by the original qualifying body (laboratory, etc.) for EQ components that the license has replaced or will be replacing?

Response:

Per 10 CFR 50.49(l):

> Replacement equipment must be qualified in accordance with the provisions of this section unless there are sound reasons to the contrary.

While not a requirement, Section 6 of RG 1.89, Rev. 1, states:

> Replacement electric equipment installed subsequent to February 22, 1983, must be qualified in accordance with the provisions of § 50.49 unless there are sound reasons to the contrary. The NRC staff considers the following to be sound reasons for the use of replacement equipment previously qualified in accordance with the DOR Guidelines or NUREG-0588 in lieu of upgrading:
>
> a. The item of equipment to be replaced is a component of equipment that is routinely replaced as part of normal equipment maintenance, e.g., gaskets, o-rings, coils; these may be replaced with identical components.
> b. The item to be replaced is a component that is part of an item of equipment qualified as an assembly; these may be replaced with identical components.
> c. Identical equipment to be used as a replacement was on hand as a part of the utility's stock prior to February 22, 1983.
> d. Replacement equipment qualified in accordance with the provisions of § 50.49 does not exist.
> e. Replacement equipment qualified in accordance with the provisions of § 50.49 is not available to meet installation and operation schedules. However, in such case, the replacement equipment may be used only

until upgraded equipment can be obtained and an outage of sufficient duration is available for replacement.

f. Replacement equipment qualified in accordance with § 50.49 would require significant plant modifications to accommodate its use.

g. The use of replacement equipment qualified in accordance with § 50.49 has a significant probability of creating human factor problems that would negatively affect plant safety and performance, for example:

(1) Knowledge, skills, and ability of existing plant staff would require significant upgrading to operate or maintain the specific replacement equipment;
(2) The use of the replacement equipment would create a one-of-a-kind application; or
(3) Maintenance, surveillance, or calibration activities would be unnecessarily complex.

References: 10 CFR 50.49; DOR guidelines; NUREG 0588 (For Comment Version), RG 1.89, Rev. 1.

7) What are the requirements that specify what must be done if the DOR Guidelines do not address a particular area of EQ (i.e., Did the commission state what to do if the DOR Guidelines are unclear?)?

FORMER FAQ #6

Should licensees apply NUREG-0588 CAT II requirements to EQ components licensed under DOR Guidelines?

Response:

There are no requirements that specify what must be done if the DOR Guidelines do not address a particular area of EQ.

10 CFR 50.49(k) states:

> Applicants for and holders of operating licenses are not required to requalify electric equipment important to safety in accordance with the provisions of this section if the Commission has previously required qualification of that equipment in accordance with "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors," November 1979 (DOR Guidelines), or NUREG-0588 (For Comment version), "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment."

However, the NRC staff provided the following clarification under the 'Aging' Section for Category II equipment in NUREG 0588, Rev. 1, in response to comments received on the For Comment version of NUREG 0588:

> For other equipment, the qualification programs should address aging only to the extent that equipment that is composed, in part, of materials' susceptible to aging effects should be identified, and a schedule for periodically replacing the equipment and/or materials should be established. During individual case reviews, the staff will require that the effects of aging be accounted for on selected equipment if operating experience or testing indicates that the equipment may exhibit deleterious aging mechanisms

Furthermore, NUREG-0588, Rev. 1, pages ix and x states:

> All reactors with Operating Licenses as of May 23, 1980 will be evaluated by the staff against the DOR guidelines (Division of Operating Reactors – 'Guidelines for Evaluating Environmental Qualification of Class IE Electrical Equipment in Operating Reactors,' dated November 13, 1979). In cases where the DOR guidelines do not provide sufficient detail but NUREG-0588 Category II does, NUREG-0588 will be used.

It should be noted that the expectations identified above would only be applicable for licensees that have licensing commitments to conform to the guidance in NUREG 0588, Rev. 1.

References: 10 CFR 50.49; DOR guidelines; NUREG-0588, Rev. 1

8) Do licensees have to apply the methodology described in IEEE standards used for the original EQ qualification for extending the qualified life of EQ components past 40 years?

Former FAQ #7

Response:

See response to Question number 4 above.

9) What are the requirements or guidance for determining the activation energy for materials in EQ components?

Former FAQ #8

Qualification files have shown various levels of rigor in establishing activation energies. What is the acceptable level of technical basis and/or justification involved in determining the correct activation energy?

Response:

There is no requirement establishing a level of technical basis for acceptable activation energy.

While there are no specific requirements on the level of technical basis for acceptable activation energy, RG 1.89, Rev. 1, Section C.5 states:

> "Section 6.3.3, 'Aging' of IEEE Std. 323-1974; and paragraph 10 CFR 50.49(e)(5) should be supplemented with the following:
> ...
> c. The aging acceleration rate and activation energies used during qualification testing and the basis upon which the rate and activation energy were established should be defined, justified, and documented."

Changes to materials or manufacturing processes between the original and replacement parts should be evaluated for their impact on qualification. This could include how such changes might impact the activation energies used in the thermal aging analyses. Licensees and vendors may rely on industry consensus standards and quality databases to obtain a new activation energy value for a specific material; the selected value must be supported by auditable background information. The licensee's (or vendor's) justification should include an appropriate analysis showing that the selected activation energy is suitable and/or applicable to replace the existing value (e.g., same material, use of testing to demonstrate similar failure parameter or degradation mechanism, similar temperature range, same chemical reaction).

References: RG 1.89, Rev. 1; IEEE Std. 323-1974.

8) a) What are the regulatory requirements associated with the EQ files and what information must be contained in the EQ files?
b) What is the purpose of the EQ files?
c) Has the NRC staff reviewed and approved the EQ files and/or established staff positions on EQ files?

Former FAQ #9

Did the licensee's EQ files establish licensing basis regarding environmental qualification (e.g., activation energy)?

Response:

a) EQ files themselves are required by 10 CFR 50.49(d) and (j). 10 CFR 50.49(d) and (j), respectively, require, in part:

> (d) The applicant or licensee shall prepare a list of electric equipment important to safety covered by this section. In addition, the applicant or licensee shall include the information in paragraphs (d)(1), (2), and (3) of this section for this electric equipment important to safety in a qualification file. The applicant or licensee shall keep the list and information in the file current and retain the file in auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for future use to permit verification that each item of electric equipment is important to safely meet the requirements of paragraph (j) of this section.
>
> (j) A record of the qualification, including documentation in paragraph (d) of this section, must be maintained in an auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for future use to permit verification that each item of electric equipment important to safety covered by this section:
>
> (1) Is qualified for its application; and
>
> (2) Meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform its safety function up to the end of its qualified life.

The applicable requirements for qualifying electrical equipment are dependent on the issuance date of a nuclear power facility's Construction Permit, and other regulatory commitments.

b) EQ files contain specific information such as equipment data, operating parameters, accident profile, procurement information, or test parameters; a detailed explanation of test procedures and the results thereof which establish the basis for qualified life of an equipment are considered supporting documents relied on for establishing compliance with 10 CFR 50.49.

c) In the early 80's, the NRC contracted Franklin Research to review each licensees EQ program including the EQ files. Although the resultant Technical Evaluation Reports (TERs) and Safety Evaluation Reports (SERs) are not part of a plant's licensing basis, they may contain staff positions and state what the NRC has accepted as part of each licensee's EQ program. Nonetheless, whether or not the TERs, SERs, and staff positions are part of the licensee's licensing basis is moot, as each licensee is required to satisfy the 10 CFR 50.49 requirements.

References: 10 CFR 50.49