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General Comment

See Attached files for comments from Curtiss-Wright's Equipment Qualification Power Suite (EQPS) service.

Attachments

EQPS RG 1.89 Comments Final

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April 14, 2021

Mr. Meraj Rahimi,
Chief Regulatory Guidance and Generic Issues Branch
Division of Engineering
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Comments on Draft Regulatory Guide DG-1361, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants"

Dear Mr. Rahimi,

Curtiss-Wright hereby submits comments on draft Regulatory Guide DG-1361, "Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants," which is to become Revision 2 of Regulatory Guide 1.89, of the same title. See 85 Fed. Reg. 81958, December 17, 2020. Curtiss-Wright thanks the NRC for extending the comment period so meaningful, constructive, well-supported comments could be developed.

As stated in my extension request of February 9, 2021, Curtiss-Wright manages and provides access to the Equipment Qualification Power Suite™ (EQPS), which among other things provides members with access to databases containing activation energy information. Licensees, vendors, test laboratories, and architect engineering firms domestically and abroad are members of this service, including over 75% of the operating nuclear power plants in the United States. This service began with the development and licensure of the Equipment Qualification Data Bank in 1981 for the purpose of exchanging information and data related to equipment qualification. For over three decades, Curtiss-Wright and its predecessor companies have hosted the annual EQ Technical Meeting (EQTM), which has had the participation of many NRC staff members. For most of that time the EQTM has been co-hosted by Curtiss-Wright and the Nuclear Utility Group on Equipment Qualification (NUGEQ).

A revision to Regulatory Guide (RG 1.89) is much needed. The standard that it endorses, IEEE Standard 323 (now the joint standard IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 (JLS)), has been revised and reaffirmed several times in the 37 years since RG 1.89's last revision. However, DG-1361 is not ready for issuance. Instead of providing updated regulatory guidance recognizing the current version of the industry standard that was developed with participation of NRC staff members, DG-1361 presents regulatory positions that conflict with the advances in the industry standard. The draft guide contains regulatory positions that perpetuate issues the NRC has specifically researched and considered resolved or insignificant enough to warrant no further research. The draft guide is not a step forward to the future, but a regression to the past.

Additionally, the draft guide fails to make clear that it is describing methods acceptable to the NRC Staff for meeting 10 CFR 50.49. The scope of the new joint logo standard is clearly broader than the scope of 10 CFR 50.49. The draft guide struggles to differentiate between methods acceptable to the NRC Staff for meeting 10 CFR 50.49 and basic requirements for the broader scope of equipment qualification delineated in the JLS. There are regulatory positions stating that parts of the JLS are beyond the scope of 10 CFR 50.49, such as aging of electric equipment in mild environments, but there are other parts of the JLS that are clearly beyond the scope of 10 CFR 50.49, such as design extension conditions, that have no regulatory positions. The scope of the Regulatory Guide needs to be more clearly stated and limited to acceptable methods of meeting 10 CFR 50.49. Expanding the scope of the Regulatory Guide would require a backfit evaluation.

The industry wants and needs endorsement of the current version of the industry standard. Resolution of industry comments may be best achieved by first endorsing the Standard with the minimum necessary regulatory positions. More detailed guidance, capturing and summarizing industry and NRC research and acceptable practices, could be provided in a different document similar to the DOR Guidelines, NUREG-0588 or working with industry to endorse an updated Equipment Qualification Reference Manual[1].

Curtiss-Wright also requests an opportunity to meet with the NRC Staff in a public meeting to discuss these comments and other comments submitted by industry prior to publication of the revised Regulatory Guide.

Best Regards,

Richard J Weinacht

Rick Weinacht
Manager Nuclear Technical Support

cc: Mr. Michael Eudy, Office of Nuclear Regulatory Research
Mr. Matthew McConnell, Office of Nuclear Reactor Regulation

Attachment 1: EQPS Comments on DG-1361

[1] The EPRI Report 1020167, *Nuclear Power Plant Equipment Qualification Reference Manual, Revision 1*, was last published in 2010 would also require some updating to fully recognize the current version of the JLS.

EQ Power Suite (EQPS) Comments on DG-1361

Regulatory Positions Recommended for Deletion

1. Regulatory Position C.1.a should be deleted. It is not necessary to provide clarification of the definition of "end condition" in order to use IEC/IEEE 60780/323 to meet 10 CFR 50.49. The proposed clarification treats end condition as a condition of an installed component, when the Standard is using it to define the condition of a test specimen. Moreover, it defines a condition, not a time. End condition, therefore, cannot be equivalent to "end-of-installed life." End condition could be said to be the condition of a component at the end of installed life, but the Standard already makes this clear. Finally, the Note at the end of the regulatory position uses the term "design function." This is confusing because the term "safety function" is used elsewhere in DG-1361. If not deleted, Regulatory position C.1.a should at a minimum be reworded to say: ... "end condition," as described in Section 3.10 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, should be considered equivalent to "end-of-installed life condition."
2. Regulatory Position C.1.b should be deleted or reworded to simply refer to the 10CFR50.49 definition of important to safety. The regulation is already clear that equipment meeting the 10CFR50.49 definition of important to safety must be qualified. The definition of important to safety in Section 3.12 of IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 does not change the regulatory definition in 10CFR 50.49. Regulatory Position C.1 in Revision 1 of RG 1.89 is much more clearly worded.
3. Regulatory Position C.1.c. should be deleted or reworded. Restating text from 10CFR50.49 is entirely unnecessary. It appears that this regulatory position is attempting to provide clarification of the definition of safety function. Defining safety function does not require a change or clarification to the definition of qualified life.
4. Regulatory Position C.1.d should be deleted. The definition in Section 3.22 of IEC/IEEE 60780-323 makes no implication of aging effects. The proposed regulatory position attempts to add the period prior the operation phase to the service life. This is contrary to long-standing definitions of service life. The addition of the Note is not necessary. The standard already requires equipment to be tested in its end of life condition, including any adverse aging caused by the pre-operational period.
5. Regulatory Position C.1.e should be deleted or reworded. It is not necessary to amend the Standard to limit its scope to match that of 10CFR50.49. If EMC and seismic requirements are not within the scope of 10CFR50.49, then those portions of the Standard are not necessary to be followed to meet the regulation. A much clearer statement of the regulatory position would be: Portions of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, applicable only to equipment in mild environments, such as the fourth paragraph of Section 5.1, are beyond the scope of 10 CFR 50.49.
6. Regulatory Position C.1.f creates regulatory confusion instead of clarification by implying that using the new qualification methodologies may not meet 10CFR50.49. If there is concern that the methodologies may not be acceptable, then the Regulatory Guide should stipulate methods that the NRC considers acceptable. The stated object of the IEEE Standard is to demonstrate and document that equipment can perform safety functions under applicable service conditions. If there is no clarification to the condition monitoring and condition-based qualification methodologies in the Standard, this regulatory position should be deleted.
7. Regulatory Position C.1.j.(3) presents new requirements for justification of activation energies that has rarely been met in past qualification efforts, will increase the time and cost of qualification without a substantial increase in product quality or capability, and fails to recognize the great amount of engineering judgement used and needed to establish a qualified life. The regulatory position should end after the first sentence.

Regulatory Positions Needing Additional Clarity or Guidance

I have identified nine areas where additional regulatory clarity is needed in the draft regulatory guide. As I stated in my letter, these comments may be best addressed outside the regulatory guide. It has been over 40 years since the NRC has issued comprehensive, detailed guidance that NRC inspectors can use to assess the adequacy of licensee environmental qualification programs. (NRC Inspection Procedure 71111.21N offers some detailed guidance, but the guidance is not nearly as comprehensive as the guidance in NUREG-0588, Revision 1, *Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment* or the DOR Guidelines, *Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors* (Enclosure 4 to NRC Bulletin 79-01B).

The nine areas I have identified are:

1. **Definitions**
   The Draft Regulatory Guide provides several alternate or modified definitions or implies definitions of terms defined in the Standard. The modified, alternate, or implied definitions become regulatory terms and Regulatory Guides are not regulations. There are other more appropriate places to provide definitions, such as in 10 CFR 50.49 itself, 10CFR50.2 Definitions, or in the NRC Basic References Glossary. EPRI Report TR-100844, *Nuclear Power Plant Common Aging Terminology*, provides another document where industry consensus definitions and explanations of the definitions can be captured. As the Director of the Office of Nuclear Regulatory Research (NRR), Eric Beckjord, stated in a letter included in TR-100844, "Both the NRC and the industry's programs involving research, regulations, and the development of appropriate codes and standards will benefit from the common understanding and the uniform interpretation and use of the consensus terminologies related to plant aging." Specific definitions used or implied in the draft regulatory guide are discussed in more detail below.
   - **end condition** – It is agreed that the definition of end condition, defined in Section 3.10 of IEC/IEEE Standard 6078-323, is synonymous with end-of-installed life condition as described in 10CFR50.49(e)(5). The clarification of Regulatory position C.1.a is not necessary.
   - **important to safety** – Regulatory Position C.1.b does not provide a definition of important to safety. IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 and 10 CFR 50.49 contain definitions of important to safety. The description and definition provided in DG-1361 includes the requirement to environmentally qualify equipment important to safety. The requirement to qualify should not be part of the definition or description. DG-1361 endorses IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 with clarifications as an acceptable approach for meeting environmental qualification regulatory requirements. Because IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 addresses a larger scope of equipment than 10 CFR 50.49 does, it is expected that their definitions of important to safety would differ. Licensees will refer to 10 CFR 50.49 to determine which equipment important to safety must be environmentally qualified, then refer to IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 to determine if the method used to environmentally qualify equipment is acceptable to the NRC. Regulatory position C.1.b is unnecessary. It could be greatly simplified by stating:
     10 CFR 50.49 only requires environmental qualification of electrical equipment installed in harsh environments meeting the 10 CFR 50.49 definition of important to safety as described in 10 CFR 50.49(b).
   - **Qualified Life** – A definition is not provided in 10CFR 50.49, 10 CFR 50.2 or the NRC Basic References Glossary.
     Regulatory position C.1.c of DG-1361 proposes an alternate definition to the one provided in Section 3.20 of IEC/IEEE STD. 60780-323, EDITION 1, 2016-02, contrary to the recommendation in from NRC-sponsored research documented in Brookhaven National Laboratory Technical Report TR-6169-9/97, *Supplemental Literature Review on the Environmental Qualification of Safety Related Electric Cables*, which states, "…it is recognized that the qualified life is defined in the applicable IEEE standards, and the current definition should be adhered to." The two definitions are repeated below with the differing portion of the proposed revision of the DG-1361 definition highlighted.

     IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 Definition: period for which an equipment has been demonstrated, through testing, analysis and/or experience, to be capable of functioning within acceptance criteria during specific operating conditions while retaining the ability to perform its safety functions in accident condition or earthquake.

Proposed DG-1361 Definition: period for which an equipment has been demonstrated, through testing, analysis and/or experience, to be capable of remaining functional during and following design basis events to ensure that the criteria specified in 10 CFR 50.49(b)(1)(i)(A), (B) and C are satisfied.

The purpose of proposed wording is not clear. It appears the proposed definition is intended to provide terminology consistent with the regulation. However, the repeating of the text from 10 CFR 50.49 following the definition is unnecessary. Furthermore, the quoted section of 50.49(b)(1) is defining the equipment that is safety related, not criteria for remaining functional. Reference only to 10 CFR 50.49(b)(1) gives the implication that qualified life does not apply to the additional equipment within the scope of 10CFR50.49 as defined in paragraphs 10 CFR 50.49(b)(2) and (b)(3). The definition in the Standard is adequate, consistent with the regulation and essentially identical to the definition in EPRI TR-100844. It is recommended that Regulatory position C.1.c be deleted and the definition in the Standard be accepted without modification or clarification.

- **Service Life** - IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 Section 3.22 provides a definition of service life. EPRI TR-100844 provides a nearly identical definition using the term "retirement" in place of "final withdrawal from service." The term service life is not used in 10 CFR 50.49. There is no need for a clarification of the definition of service life in DG-1361. Furthermore, contrary to Regulatory position C.1.d, Section 3.22 of IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 makes no implications of aging effects. Regulatory position C.1.d should be deleted.
- **significant aging mechanism** – Section 3.24 of IEC/IEEE STD. 60780-323, EDITION 1, 2016-02 provides the following definition of significant aging mechanism: "ageing mechanism that, under normal and abnormal conditions, causes degradation of equipment that progressively and appreciably renders the equipment vulnerable to failure to perform its safety function(s) during the design basis event conditions." Section 7.4.1.9.1 of the JLS clearly states that when significant aging mechanisms are identified, suitable age conditioning shall be included in the type test. This implies if the aging effects assessment determines aging mechanisms are not significant, age conditioning for these aging mechanisms does not need to be included.

  10 CFR 50.49(e)(5) requires that consideration must be given to all significant degradation that can have an effect on the functional capability of the equipment. A regulatory position should be provided that acknowledges that aging is only required for significant aging mechanisms as defined in Section 3.24 of IEC/IEEE STD. 60780-323, EDITION 1, 2016-02. During the EQ Design Bases Assurance Inspections (DBAIs), some inspectors questioned if the wording of IEEE Std. 323-1974, Section 6.3.2(4) specifically stating the conditions under which radiation aging would not need to be included as part of aging, precluded a similar approach for other types of aging, such as thermal aging. Memorandum from H. R. Denton, Director ONRR, to Commissioner Kennedy dated 8/24/1979 comparing the 1971 and 1974 versions of IEEE Std. 323 (ADAMS Accession No. 7909210029), clearly demonstrates that the NRC Staff interpretation has always been that consideration and inclusion of aging effects is only required if the aging effect is significant, stating:

  > "The staff guidelines mentioned above will require that aging be considered, but only for that equipment identified as being susceptible to significant aging effects."

  Additionally, it would be helpful if thermal and radiation susceptibility data, such as the data in Table C-1 of the DOR Guidelines were provided and updated for service lives of 60 and 80 years.

  Finally, a regulatory position providing guidelines for adequate justification of exempting pre-aging would be useful.

2. Shelf Life and Qualified Life

DG-1361 Regulatory Position C.1.d states that shelf life can adversely impact qualified life and Regulatory Position C.2.a(3) states the shelf life should be addressed for potential impact on qualified life of equipment that was in utility stock prior to February 22, 1983 and may be used as replacement equipment in lieu of upgrading. Evaluation of shelf life's impact on qualified life as an environmental qualification requirement is a new regulatory interpretation that needs to be evaluated as a backfit. These new regulatory positions imply that the evaluations should be incorporated into environmental qualification documentation. While in some mostly rare cases, qualified life can be impacted by storage time, it has been long understood that shelf life is a period prior to installation and qualified life begins at installation or operation. The original EQ Reference Manual, EPRI Report TR-100516 (published in 1992), Figure 4.13 shows storage occurring before qualified life and service. This figure is unchanged in Revision 1 of the EQ Reference Manual, EPRI Report 1021067. EPRI Report 1021067, Appendix I discusses the relationship between shelf life and qualified life and recognizes that nuclear power plant practice assumes shelf life does not impact qualified life. NRC Equipment Qualification Training Manual for Nuclear Regulatory Commission Technical Reviewers and Inspectors (ADAMS Accession Number ML16252A163) Slide 225 recognizes this common practice as well. EPRI Report 10229259, *Plant Engineering: Guidelines for Establishing, Maintaining, and Extending the Shelf Life Capability of Limited Life Items, Revision 1 of NP-6408 (NCIG-13),* provides industry guidance on establishing shelf lives. Section 2.1 of EPRI 1022959 notes that one of the underlying assumptions of the guidance is that shelf lives do not impact qualified life except in special circumstances. It has already been recommended that Regulatory Position C.1.d in DG-1361 be deleted. The second sentence of Regulatory Position C.2.a(3) in DG-1361 should also be deleted.

Any discussion of shelf life impacting qualified life in DG-1361 should:
1. recognize the industry guidance in EPRI 1022959
2. clarify that shelf life does not normally impact qualified life, and
3. clarify that shelf life evaluations are not expected to be included in environmental qualification documentation.

Regulatory Position C.2.a.(3) adds a new requirement to address the impact of shelf life of replacement equipment on qualified life. The sentence regarding shelf life should be deleted. Licensees have already has addressed the impact of shelf life on qualified life of the equipment in licensee stock via the licensee's Quality Assurance Program and licensee's procedures and processes. This additional sentence adds regulatory ambiguity because it neither recognizes the most common relationship between shelf life and qualified life (one does not impact the other), nor does it present any method acceptable to the NRC for addressing this potential impact.
In the presentation *Maintaining Qualified Life Equipment and Parts in NPPs* from Proceedings of the Workshop on Nuclear Power Plant Aging (NUREG/CP-0036) (1982), Agnihotri poses the question of whether storage time should be included in qualified life and recommends the question be answered by the USNRC or through industry research. The EPRI Guidance on shelf life in EPRI 1022959 provides industry research and consensus practices regarding shelf life. Regulatory Position C.2.a.(3) essentially re-asks this forty-year-old question without recognizing the industry research or detailing a practice acceptable to the NRC.

3. Condition based Qualification

Regulatory Position C.1.f states that condition monitoring and associated condition-based qualification methodologies in section 6.3 of IEC/IEEE 60780-323, Edition 1, 2016-02 must, if used, ensure the equipment will perform under the conditions specified in 10 CFR 50.49. It is unclear why a regulatory position specific to condition monitoring and associated condition-based qualification is necessary. All qualification methodologies must ensure the equipment will perform under the conditions specified in 10 CFR 50.49. The draft guide states its purpose is to describe an approach to the NRC for meeting EQ regulatory requirements and that it endorses IEC/IEEE 60780-323, Edition 1, 2016-02. The Standard clearly states that condition-based qualification is an adjunct to type testing. Regulatory Position C.1.f provides no clarification, seems to indicate some reluctance in accepting condition monitoring and condition-based qualification as an acceptable practice. Condition Monitoring was Technical Issue 6.b of the EQ Task Action Plan (ADAMS Accession Number 95050236). The methods described in Section 6.3 of IEC/IEEE 60780-323, Edition 1, 2016-02 are consistent with conclusions of the research conducted under the EQ Task Action Plan and Generic Safety Issue 168 (ADAMS Accession Number ML021360234).
Regulatory Position C.1.f should be deleted.

4. Radiation Considerations and Beta Dose Reduction Methods

Regulatory position C.1.h. should incorporate beta dose reduction methods from Section 4.1.2 of the DOR Guidelines and include the allowance to remove the requirement for additional radiation margin if approved, conservative dose calculations methods are used as stated in NUREG-0588, Category I, Section 1.4 and RG 1.89, Revision 1, regulatory Position C.2.c(6). Specifically, the regulatory guide should confirm:

- Beta dose may be reduced by a factor of 10 for the first 30 mils of cable insulation and an additional factor of 10 for the next 40 mils of insulation.
- Cables arranged in cable trays inside of containment shall be assumed to be exposed to half the beta dose plus the gamma dose at the containment centerline.
- Equipment shall be considered qualified, without any additional radiation margin, if qualified to radiation doses using the methods of Appendix D.

- If analysis shows that beta dose to sensitive equipment internals is less than or equal to 10% of the gamma dose, the equipment is considered qualified if qualified to the gamma dose.

The methods for addressing beta radiation are based on sound principles that are irrespective of the regulatory basis for qualification (i.e., DOR/NUREG-0588/10CFR50.49).

Regulatory position C.1.h.(2) should provide more detailed guidance about acceptable radiation exemption analysis (threshold) and pedigree of “test data”. A table similar to Table C-1 of the DOR Guidelines detailing agreed upon radiation threshold and allowable levels would be very helpful in clearly communicating the amount and pedigree of additional data that is necessary to exempt radiation. At a minimum, Table C-1 of the DOR Guidelines should be validated as an acceptable reference.

5. Acceptable methods for addressing synergistic effects

Regulatory position C.1.j(1) provides statements intended to supplement the guidance of Section 7.3.2 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02. The supplemental statements in the draft guide are not appropriate solely for Section 7.3.2 as synergistic effects are discussed throughout the Standard. The basic point of Section 7.3.2 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, is that the Qualification Plan shall address aging effects. It could be reasonably argued that synergistic effects should be added to Section 7.3.2 as an aging factor that should be considered, but other sections of the Standard adequately cover synergistic effects.

The supplemental statements in the draft guide do not provide regulatory clarity as to what constitutes acceptable accounting for synergistic effects. Examples:

- Revision 1 of RG 1.89 clearly states the known synergistic effects at the time of its publication, namely dose rate effects and sequence effects. Similar clarity should be provided by the next revision of RG 1.89. The Regulatory Guide should state what the known synergistic effects are, what materials are known to be affected by them, and the acceptable methods for adequately accounting with those affects.
- Regulatory position C.2.d adds to the regulatory ambiguity regarding synergistic effects, stating “Diffusion-limited oxidation, synergisms, dose-rate effects, and inverse temperature are examples” of uncertainties related to aging degradation. The following confusion is created:
    - It is unclear what is meant by synergisms in this statement.
    - It is unclear why dose-rate effects are listed separately from synergistic effects.
    - While research has shown that diffusion-limited oxidation (DLO) can lead to heterogenous material conditions, this uncertainty has not been shown to impact LOCA performance. The recommendation for Issue A.2 (does DLO impact qualification test results using accelerated aging?) in NUREG/CR-6384, Volume 2, states:

      “Research has not shown a difference in LOCA performance for cables with and without oxidation diffusion. This issue is not resolved, however, no further research on oxygen diffusion limitation is recommended.”

      The recommendation for Issue C.4 (is material geometry (slabs vs. cables) important?) in NUREG/CR-6384, Volume 2, states:

      “… past work has not shown any conclusive evidence that these effects would significantly affect qualification results. Therefore, no further studies are recommended in this area.”

  The Regulatory Guide should clearly state that current qualification practices adequately compensate for any uncertainty created by DLO. If the NRC Staff disagrees that the current qualification practices are sufficient to account for DLO, contrary to its recommendation against further research in this area, the Regulatory Guide should describe acceptable methods for accounting for DLO.
- There is no industry consensus that inverse temperature effects have a significant impact on aging degradation. Possible concerns with an inverse temperature effect for some formulations of some compounds is discussed in NUREG/CR-7153, Volume 5*, Expanded Materials Degradation Assessment (EMDA), Volume 5: Aging of Cables and Cable Systems*. [NUREG/CR-7153 falsely asserts that inverse temperature considerations are summarized in Volume 1 of NUREG/CR-6384, *Literature Review of Environmental Qualification of Safety-Related Electric Cables,* as an uncertainty in the Arrhenius methodology. The term “inverse temperature” is not used anywhere in NUREG/CR-6384, Volume 1. The manuscript for NUREG/CR-6384, Volume 1 was completed in October 1995. All but one of the references cited in NUREG/CR-7153 for observation of inverse temperature effects were published after that date. The lone reference published prior to October 1995 was published in 1994. This reference is not cited in NUREG/CR-6384, Volume 1.]

It is recommended that the draft guide be revised to summarize research to date and provide acceptable practices for addressing synergistic effects. Where available, the practices outlined should identify:

- Materials for which synergistic effects have been shown to be significant, and best method for addressing those synergies,
- Materials for which synergistic effect have been shown to be minimal and test methods that are adequate,
- Dose rates that are generally acceptable, and specifically acceptable for certain materials,
- Conservatisms and test condition practices known to eliminate or minimize synergistic effects, such as total test doses above 200 Mrad applied at dose rates less than 1 Mrad/hr,
- Material types shown to have more degradation when exposed to a particular sequential test sequence as compared to another,
- Acceptable or preferred practice when no data is available to indicate if a material is subject to synergistic effects,
- Clear statement of known, significant synergistic effects at the time of regulatory guide development,
- Areas currently being research for possible synergistic effects, but for which there is currently insufficient data to determine if the synergistic effect is significant. Inverse temperature effect is one such area.

6. Acceptable justification of activation energies

DG-1361, Section C.1.j(3) states “Activation energy values should be based on the testing of the specific compound used in the equipment and on the most relevant material property and property endpoint (i.e., failure mechanism). It also states, “The selected activation energy values should be traceable to a specific test report for which these values were established, including the specific material property for which the activation energy was developed and how that material property is related to the function of the material in question.” These statements show a lack of recognition of the limited availability of activation energies for specific compounds, material properties and material endpoints, and does not recognize the substantial cost and time required to develop activation energies. These statements represent guidance for definition, justification and documentation of activation energies that goes beyond what is currently required by the regulation, 10 CFR 50.49, and the Standard which the draft guide is attempting to endorse.

Examination of some Unresolved Issues (URIs) issued during the recent round of NRC Inspections under Inspection Procedure 71111.21N will demonstrate the inadequacy of this guidance. URI 05000390, 391/2017007-05 (Watts Bar Inspection Report 2017-007 (ADAMS Accession Number ML17220A153)) and URI 05000395/2018010-06 (VC Summer Inspection Report 2008-010 (ADAMS Accession Number ML18094A162)) both raise issues with the activation energy for electronic components in Barton transmitters. In these two URI cases, an extremely conservative original activation energy of 0.5 eV was assigned by the supplier, Westinghouse. The Westinghouse activation energy basis does not meet the specific compound, material property and material endpoint criteria of DG-1361. The manufacturer, Barton, assigned a higher activation energy of 0.78 eV for the electronic components in later qualification reports. In fact, the activation energy of 0.78 eV has been widely used for electronic components in transmitters of other manufacturers, often citing the same space program report cited in the VC Summer Inspection Report, as well as for other equipment. Although both cited URIs were eventually closed as violations, neither closure resolved the original issue of whether the activation energy used by the licensee was appropriate or adequately justified and documented. Without additional clarification in a revision to RG 1.89 concerning definition, justification and documentation of activation energy bases, future unresolved issues are likely.

Many additional examples could be discussed, but more examples would only bring additional, unwarranted attention to the qualification significance of thermal qualified lives determined using the Arrhenius methodology and a conservatively selected activation energy based on the best data available at the time.

The issue can be summarized with two main points:

1. Activation energy selection and use in qualified life calculations requires the use of a great deal of engineering judgement.
   Dr. Sal Carfagno, aging expert and NRC consultant, succinctly makes this point in his paper presented at the 1982 Workshop on Nuclear Power Plant Aging (NUREG/CP-0036). Dr. Carfagno offers:
   "…it becomes all the more obvious that engineering judgment is not only an essential factor in establishing qualified life, it is actually the dominant factor."
   NRC Staff has also made similar statements. In the Staff's letter to the Commission dated August 24, 1979 (Accession Number 7909210029) Harold Denton writes:
   "However, even with its greater detail, IEEE Std. 323-1974 still requires a significant amount of engineering judgement in its implementation especially in the area of aging and margins."
2. Establishing a thermal qualified life has only marginal significance in the safety of a commercial nuclear power plant.
   The NRC has concluded that requirements to establish a qualified life and other differences in the 1974 version of IEEE Std. 323 are not safety significant, represent only an incremental improvement and do not warrant backfitting. These conclusions were reached,
   1. After release of IEEE 323-1974
   2. During the promulgation of the EQ rule in 1983,
   3. As part EQ Task Action Plan, Item 3.f begun in 1993

   The November 15, 1996 Status Report on the EQ Task Action Plan to the Commission (Accession Number 9611200041) states, "At the time of its release, the NRC considered backfitting IEEE 323-1974 to older plants, but recommended against it because the incremental improvements provided by the new standard were not considered safety significant and full implementation of IEEE 323-1974 required further development of other ancillary standards. Public comments and a review by the Advisory Committee on Reactor Safeguards (ACRS) did not alter the recommendation concerning backfitting the standard."
   In the Staff's letter to the Commission dated August 24, 1979 (Accession Number 7909210029) Harold Denton writes:
   "The benefit of backfitting either the aging or the margin requirements of the 1974 Standard is a small, unquantifiable increase in the level of assurance that equipment is qualified. Yet the costs in terms of manpower, the testing required to implement these provisions and the possible delay in the staff review effort may be significant."
   In the November 15, 1996 Status Report on the EQ Task Action Plan to the Commission, the Staff re-validates the conclusions made in 1979 and after release of IEEE Std. 323-1974:
   "The staff, therefore, has reasonable assurance that its decision not to backfit older plants to the newest EQ requirements was not flawed and remains valid."
   The NRC has repeatedly asserted that requirement to establish a qualified life and pre-age equipment has, at best, an incremental improvement on assurance equipment will perform as required. New requirements on the justification of activation energy are wholly unwarranted and should be deleted.

7. Selection of aging temperatures/extrapolation

Regulatory Position C.1.m states: Section 7.4.1.9.3 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, should be supplemented with the following: "For insulating materials, a regression line (IEEE Std. 101, IEEE Guide for the Statistical Analysis of Thermal Life Test Data'" (Ref. 32)), may be used as a basis for selecting the aging time and temperature. Sample aging times of less than 100 hours should not be used."

This regulatory position is supplementing the current standard with an exact statement from the 1974 version of IEEE 323-1974. In practice, this supplemental statement has very little impact on qualification practices. However, it represents a failure of the regulatory guidance to embrace the updates to the Standard. It also could be misinterpreted to imply that the Arrhenius methodology and use of regressions lines only applies to insulating materials.

A regression line alone does not actually form a basis for the aging time and aging temperature. It provides an activation energy proportional to the slope of the regression line that can be used to determine the amount of time at the aging temperature to cause thermal aging equivalent to aging that would occur during the desired service life at the service temperature. The aging time and aging temperature are not a point on the regression line. Once the activation energy is determined, an aging time can be calculated for an assumed aging temperature or an aging temperature can be calculated for an assumed aging time. There are countless aging time and temperature combinations that can be determined from a regression line.

This regulatory position should be deleted, or additional guidance should be provided for materials that are not insulating materials.

Regulatory Position C.1.j.(3) states “data extrapolations should be minimized by using activation energy values within the temperature range of interest.” and “the activation energy should be selected based on the temperature range of the equipment in service”. While these statements are consistent with guidance in the relevant IEEE Standards, they fail to provide guidance against which acceptable extrapolation and activation energy selection can be judged. Terms such as “range of interest,” “applicable temperature range,” and “good fit” are too vague to allow objective agreement if the activation energy is adequately justified. Many Electrical Insulating Material test programs recommend a minimum of 5000 hours at the lowest aging temperature. Even this aging temperature may be well above the service temperature. One could follow the recommendations in the IEEE Standards for development of thermal indices and still be questioned as to whether they met the requirements of the draft guide.

Design Bases Assurance Inspections at Sequoyah, Brunswick, Summer, Watts Bar and St. Lucie all raised issues related to the extrapolation of Arrhenius data. The draft guide offers no guidance that would allow an inspector to ascertain if the extrapolations were proper and within regulatory requirements.

Regulatory Position C.1.j.(3) should be reworded to remove ambiguity and recognize which standards, if followed, are adequate for the purposes of defining, justifying, and documenting the basis for activation energy.

8. Ramp Rate and Double vs. Single Transient

Regulatory Position C.1.n discusses the use of double-transient test profiles, explaining the outdated stipulation for using double-transient test profiles as a method for adding margin in the 1974 version of IEEE Std. 323.

Regulatory position C.1.n introduces regulatory ambiguity by implying:

1) A double-transient test profile should be used in some circumstances
2) A double-transient test profile is an adequate method to compensate for test profiles that have ramp rates ramp (initial temperature rise) slower than the required profile.
3) A test profile with a slower ramp rate than the required profile is inadequate for qualification.

There is no regulatory basis or research data supporting this regulatory position. It should be deleted.

In fact, NRC-sponsored research has already concluded that “single transient DBA testing is acceptable, and double transient DBA testing may be superfluous.” as documented in NUREG/CR-6384, Volume 2, *Literature Review of Environmental Qualification of Safety-Related Electric Cables.* Use of single transient versus double transient was one of the questions raised as part of the EQ Task Action Plan. The research concluded that this issue was resolved, and no further research was required.

Test laboratories typically meet ramp rate on a best-effort basis. This stipulation is often included in contracts and test plans. Efforts to meet a specified ramp rate as an acceptance criterion often results in significant overshoot and test profile instability. Adequate accident chambers can easily meet peak temperatures typical of most LOCAs in times much less than one minute. Thermal lag analysis shows the difference in equipment temperatures varies little between for test times to peak temperatures of less than one minute compared to a conservatively postulated times on the order of 10 seconds. The regulatory guidance should clearly state that time to reach peak temperature, so long as it is less than one minute or so, is of no consequence to qualification test results.

Other Miscellaneous Editorial Comments

Page 4: The description of RG 1.40 does not match the RegGuide number and title. The description matches the RG 1.140 subject matter. Since RG 1.140 does not provide detail for qualifying equipment, it does not belong in this list. The description of RG 1.40 needs to be revised to match the subject matter of RG 1.40.

Page:7 The word "provides" should be changed to "provide" in the second Background paragraph (Chapter 11 and Appendix A…..provide)

Page:17 Regulatory Position C.2.f is less clear than Regulatory Position C.2.c.(5) of RG 1.89, Revision 1. The new regulatory position mixes in concepts covered in other sections of the Draft Guide. This regulatory position would be clearer if it remained focused on considerations for determining the required radiation dose. Calculational methods should be discussed in a separate regulatory position.