PUBLIC SUBMISSION

SUNI Review Complete
Template=ADM-013
E-RIDS=ADM-03

ADD: Michael Eudy, Mary Neely
Comment (1)
Publication Date: 2/18/2021
CITATION: 86 FR 10133

As of: 4/14/21 1:47 PM
Received: April 07, 2021
Status: Pending_Post
Tracking No. kn8-4lnf-4k4d
Comments Due: April 19, 2021
Submission Type: Web

Docket: NRC-2020-0245
Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants

Comment On: NRC-2020-0245-0007
Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants

Document: NRC-2020-0245-DRAFT-0009
Comment on FR Doc # 2021-03220

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General Comment

See attached file(s)

Attachments

Comments to DG-1361-j-gleason

Mr. James Gleason: Comments on DRAFT REGULATORY GUIDE DG-1361, ENVIRONMENTAL QUALIFICATION OF CERTAIN ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANTS.
4/7/21

Comment Number	Section	Recommendation
1	Section C. 1, a is confusing and does not state explicitly the equipment important to safety that is defined by 10CFR.50.49. It states: 10 CFR 50.49(e)(5) requires, in part, that equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed-life condition. Therefore, "end condition," as defined in Section 3.10 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, should be considered equivalent to "end-of-installed life." Note: Qualified equipment must be capable of performing its design function at the end-of-installed life. 10CFR50.49 Section j (2) states "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." Thus, the use of design function at the end-of-installed life is confusing and does not explicitly follow 10CFR50.49. RG 1.89 should refer to end of qualified life and the term "end-of-installed life" in IEC/IEEE Std. 60780-323, Edition 1, 2016-02, shall mean end of qualified life.	Change Section C. 1, a to "10 CFR 50.49(e)(5) in part that important to safety equipment 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 term "end-of-installed life" in IEC/IEEE Std. 60780-323, Edition 1, 2016-02, shall mean end of qualified life.
2	Section C. 1, b is confusing and does not state explicitly the equipment important to safety that is defined by 10CFR.50.49.	Replace with: The following description and definition of "important to safety" should be used instead of the definition in Section 3.12 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02: 10CFR50.49 defines equipment important to safety in section (b) as follows. (b) Electric equipment important to safety covered by this section is:

		(1) Safety-related electric equipment. (i) This equipment is that relied upon to remain functional during and following design basis events to ensure— (A) The integrity of the reactor coolant pressure boundary; (B) The capability to shut down the reactor and maintain it in a safe shutdown condition; or (C) The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guidelines in § 50.34(a)(1), § 50.67(b)(2), or § 100.11 of this chapter, as applicable. (ii) Design basis events are defined as conditions of normal operation, including anticipated operational occurrences, design basis accidents, external events, and natural phenomena for which the plant must be designed to ensure functions (b)(1)(i) (A) through (C) of this section. (2) Nonsafety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified in subparagraphs (b)(1)(i) (A) through (C) of paragraph (b)(1) of this section by the safety-related equipment. (3) Certain post-accident monitoring equipment.
3	Section C. 1, c is confusing as it states not to use the definition of qualified life in Section 3.12 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, but does not state explicitly the definition of qualified life to be used and its source. There is no definition of qualified life in 10CFR50.49. 1. IEEE 323-74 definition of Qualified Life: The period of time for which satisfactory performance can be	Use the IEEE 323-74 definition of Qualified Life: The period of time for which satisfactory performance can be demonstrated for a specific set of service conditions. Add that IEC/IEEE 60780-323 term qualified life is not endorsed.

	demonstrated for a specific set of service conditions. 2. IEC/IEEE 60780-323 Definition of Qualified Life: 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. As the IEC/IEEE 60780-323 Definition of Qualified Life expands the definition to include retaining the ability to perform safety functions in accident conditions and earthquakes, it creates backfit and forward fit issues.	
4	Section C. 1, d is confusing since it tries to address the term "service life" and relates service life, qualified life and shelf life. There is no use of service life in 10CFR50.49 and its introduction of a new term "service life" including its relationship to qualified life constitutes a backfit and forward fit.	Delete section C.1 d and all discussion of service life. Add that IEC/IEEE 60780-323 term service life is not endorsed. Please note that that IEC/IEEE 60780-323 proficient use of the term service life and an alternate definition of qualified life may render IEC/IEEE 60780-323 to be not endorsed.
5	Section C. 1, e is confusing as it notes that "The prerequisite for aging electric equipment located in a mild environment is not within the scope of 10 CFR 50.49" and then adds "Requirements, including EMC and seismic requirements, shall be specified in the design/purchase specifications." It is agreed that the prerequisite for aging electric equipment located in a mild environment is not within the scope of 10 CFR 50.49	Modify Section C. 1, e to the following: In IEC/IEEE 60780-323, the discussion of design/purchase specifications requirements and EMC and seismic requirements are not endorsed.

	There is also no requirement for design/purchase specifications in 10CFR50.49 and there is no requirement for EMC in 10CFR50.49. Thus, introductions for design/purchase specifications requirements and EMC requirements constitutes a backfit and forward fit.	
6	Section C. 1, f is confusing as it states "Condition monitoring and associated condition-based qualification methodologies discussed in Section 6.3 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02, represent new approaches for extending or establishing the qualified life of electrical equipment. If used, these methodologies must ensure that equipment important to safety will perform under the conditions specified in 10 CFR 50.49." This appears to misstate the purpose and application of condition monitoring. Section 6.3 of IEC/IEEE Std. 60780-323, Edition 1, 2016-02 States: Condition monitoring for equipment qualification purposes monitors one or more condition indicators to determine whether equipment remains in a qualified condition. Condition monitoring is not a new approach for establishing the qualified life of electrical equipment. The qualified life is established in the regulatory accepted method of aging, including time/temperature effects, radiation and mechanical degradation. Condition monitoring recognizes that when qualified life is established in the	Change Section C. 1, f to Condition monitoring recognizes the fact that the aging process in a 10CFR50.49 test method qualification program can be an acceptable process of determining end of qualified life, if it is proven during a qualification by test program to be a condition indicator that must be measurable, change monotonically with time, be correlated with the safety function performance under DBE conditions, be linked to the functional degradation of the qualified equipment, and have a consistent trend from unaged through the limit of the qualified pre-accident condition.

	regulatory accepted method, the equipment being qualified is placed into a degraded condition, for which there may be one or more relevant condition indicators of the degraded condition. The condition indicator shall be measurable, change monotonically with time, be correlated with the safety function performance under DBE conditions, be linked to the functional degradation of the qualified equipment, and have a consistent trend from unaged through the limit of the qualified pre-accident condition. Therefore, Condition monitoring establishes the degraded condition during the aging part of qualification program. The regulatory statement: "these methodologies must ensure that equipment important to safety will perform under the conditions specified in 10 CFR 50.49," is confusing since condition monitoring is not a qualification method that verifies performance under the conditions specified in 10 CFR 50.49. The qualification methods that ensure performance under the conditions specified in 10 CFR 50.49 are test, analysis, and test and analysis.	
7	Section C. 1, h is confusing in: (2) Electric equipment that may be exposed to low-level radiation doses should not generally be considered exempt from radiation qualification testing. Exceptions may be based on qualification by analysis	Section C. 1, h 2 should be replaced with RG 1.89 Rev 1 section: "(6) Shielded components need be qualified only to the gamma radiation environment provided it can be demonstrated that the sensitive

	supported by test data or operating experience that verifies that the dose and dose rates will not degrade the operability of the equipment below acceptable values. This is new and the following RG 1.89 Rev 1 section is missing: "(6) Shielded components need be qualified only to the gamma radiation environment provided it can be demonstrated that the sensitive portions of the component or equipment are not exposed to significant beta radiation dose rates or that the effects of beta radiation, including heating and secondary radiation, have no deleterious effects on component performance. If, after considering the appropriate shielding factors, the total beta radiation dose contribution to the equipment or component is calculated to be less than 10% of the total gamma radiation dose to which the equipment or component has been qualified, the equipment or component is considered qualified for the beta and gamma radiation environment." The deletion of RG 1.89 Rev 1 section "(6) Shielded components, etc," constitutes a forward backfit as it deletes an acceptable process for addressing beta radiation and the addition of Section C. 1, h 2 is an unjustified increase in requirements and therefore a forward fit.	portions of the component or equipment are not exposed to significant beta radiation dose rates or that the effects of beta radiation, including heating and secondary radiation, have no deleterious effects on component performance. If, after considering the appropriate shielding factors, the total beta radiation dose contribution to the equipment or component is calculated to be less than 10% of the total gamma radiation dose to which the equipment or component has been qualified, the equipment or component is considered qualified for the beta and gamma radiation environment.".
8	Section C. 1, j (1) is confusing as it contains the following: "The synergistic effect is the result of the combined environmental effects of the plant conditions such as radiation, humidity, and temperature that could result in greater degradation of equipment in relation to sequential application of the plant environment under normal, abnormal, and accident conditions.	Section C. 1, j (1) modify to: "Synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance."

	The synergistic effects on materials that are known to have such increased degradation under these conditions should be accounted for when assessing the qualified life." Section 7.4.1.9.3 Age conditioning of IEC/IEEE Std. 60780-323, Edition 1, 2016-02 contains the discussion of synergistic effects. Historically, synergistic effects in qualification are considered in aging and not accident conditions. Therefore, the inclusion of accident conditions in determining synergistic effects creates a new requirement and is a forward fit. The phrase "The synergistic effects on materials that are known to have such increased degradation under these conditions should be accounted for when assessing the qualified life" is confusing and a new requirement. Synergistic effects, as noted in 10CFR50.49 must be considered when these effects are believed to have a significant effect on equipment performance. The requirement that synergistic effects on materials need to be accounted for in qualified life is new, as it requires all synergistic effects of materials to be included and inconsistent with the 10CFR50.49 threshold that they must be considered when these effects are believed to have a significant effect on equipment performance.	
9	Section C. 1, j (3) is confusing in that it 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)."	Section C. 1, j (3) should be deleted.

	It is confusing because it constitutes a significant effort to know each compound and to have Arrhenius test data for Activation Energy on every possible compound and failure mechanism. Additionally, most safety related equipment is made up of many materials, and the basis of aging is to use the lowest activation energy for the assembly when establishing the aging program and qualified life. Thus, materials that are not the lowest activation energy are aged for more degradation equivalency than the qualified life of the lowest activation energy material. The NRC studies, such as NUREG/CR-6384 and NUREG/CR-6704 on Arrhenius Theory and its application to environmental qualification have demonstrated the conservatism to establishing qualified life. Lastly, Activation energy is not a safety function and was never intended to be a quality attribute of a safety related component. Arrhenius theory and activation energy are intended to place a safety related type test specimen in a reasonable facsimile of the degradation to be seen in service when installed in its application in a nuclear power plant.	
10	Section C. 1, k (2) is confusing and unnecessary as it states: “Electric equipment located in an area where rapid pressure changes are postulated simultaneously with the most adverse relative humidity should be qualified to demonstrate that the equipment seals	Section C. 1, k (2) should be deleted.

	and vapor barriers will prevent moisture from penetrating into the equipment to the degree necessary to maintain equipment functionality." IEC/IEEE Std. 60780-323, Edition 1, 2016-02 identifies interfaces and seals as elements to be identified and maintained as part of qualification and the equipment seals and vapor barriers, when required to ensure the safety function performance must operate properly in the environment in which the equipment is being qualified. The highlighting of equipment seals and vapor barriers, only where rapid pressure changes are postulated simultaneously, overlooks applications where seals perform safety functions when no pressure variations are requirements.	
11	Section C. 1, k (4) is confusing and unnecessary as it states: "Performance characteristics that demonstrate the operability of equipment should be verified before, after, and periodically during testing throughout its range of required operability. Variables indicative of momentary failure that prevent the equipment from performing its safety function (e.g., momentary opening of a relay contact) should be monitored continuously to ensure that momentary failures (if any) have been accounted for during testing. For long-term testing, however, monitoring during periodic intervals may be used if justified." 10CFR50.49 j (2) states that equipment must: "Meets its specified performance requirements when it is subjected to the conditions predicted to be present when	Section C. 1, k (4): delete

	it must perform its safety function up to the end of its qualified life." The requirement that testing throughout its range of required operability is to be included goes beyond the requirement to demonstrate the safety function and constitutes a forward fit. Additionally, the phrase: "Variables indicative of momentary failure that prevent the equipment from performing its safety function (e.g., momentary opening of a relay contact) should be monitored continuously to ensure that momentary failures (if any) have been accounted for during testing," is excessive and IEC/IEEE Std. 60780-323, Edition 1, 2016-02 7.4.1.6 Monitoring, already requires "During testing, both the test environment and the equipment's safety function(s) shall be monitored using equipment that provides accuracy and resolution for detecting meaningful changes in the parameters."	
12	Section C. 1, n (1) is confusing and unnecessary as it states: "1) A double-transient should be used with equipment that may be vulnerable to thermal binding from different expansion rates of materials during the initial heatup." Double-transient testing has never been a requirement of 10CFR50.49, DOR Guidelines, RG 1.89, or NUREG-0588. There has been no requirement to evaluate equipment that may be vulnerable to thermal binding from different expansion rates of materials during the initial heatup. This constitutes a forward fit.	Section C. 1, n (1): delete

13	Section C. 1, n (2) is confusing and unnecessary as it states: "(2) The use of double transients could help offset tests where the ramp rate (initial temperature rise) of the test is slower than the required profile. This is commonly the result of test chamber and steam supply limitations." There has been no use of double transients to offset test facility limitations on the initial steam ramp. There is no logical formula for how an offset would be calculated or credited. This constitutes a forward fit.	Section C. 1, n (2): delete
14	Section C. 2, c is confusing and unnecessary as it states: "An additional stressor to be considered in the qualification of digital systems is smoke exposure from an electrical fire. For smoke exposure, important failure mechanisms are not only long-term effects such as corrosion, but also short-term and perhaps intermittent malfunctions, such as leakage current. Smoke can cause circuit bridging and thus affect the operation of digital equipment. Because the edge connections and interfaces are typically uncoated, the most likely effect of the smoke is to impede communication and data transfer between subsystems. RG 1.209 provides several references that detail the effects of smoke exposure." Smoke has never previously been identified to be an environmental parameter or result of a Design Basis Accident. The new requirement to qualify for smoke during a DBA constitutes a forward fit.	Section C. 2, c, starting at "An additional stressor to be considered in the qualification of digital systems is smoke exposure…: delete

15	Section C. 2, e is confusing, contradictory to 10CFR50.49, and unnecessary as it states: " Considerations such as the following should be taken into account when determining the environment for which the equipment is to be qualified: (1) equipment outside containment would generally see a less severe environment than equipment inside containment, (2) equipment whose location is shielded from a radiation source would generally receive a smaller radiation dose than equipment at the same distance from the source but exposed to direct radiation, (3) equipment required to initiate protective action would generally be required for a shorter period of time than instrumentation required to operate during and after an accident, and (4) analyses taking into account arrangements of equipment and radiation sources may be necessary to determine whether equipment needed for mitigation of design basis accidents other than LOCA or high-energy line breaks (HELB) could be exposed to a more severe environment than the plant-specific LOCA or HELB environments." This section has no significance to 10CFR50.49 qualification requirements. Items (1) and (2) are obvious but are irrelevant since 10CFR50.49 requires equipment in DBA environments to be qualified. Item (3) discusses equipment performing "protective action", but 10CFR50.49 requires equipment be qualified for its safety function. Item (4) discusses mitigation of design basis accidents instead of 10CFR50.49	Section C. 2, e: delete

	requirements on qualifying equipment's safety function. Additionally, Item (4) discusses environments more severe environment than the plant-specific LOCA or HELB environments, instead of 10CFR50.49 requirements to qualify for Design Basis Accidents and states that may be necessary to investigate these potentially worser environments than the DBA.	
16	Section C. 2, f is confusing, contradictory to 10CFR50.49, and unnecessary as it states: "Electric equipment to be qualified in a nuclear radiation environment should be exposed to radiation, before testing, that simulates the calculated integrated dose (normal and accident) that the equipment must withstand before completion of its intended safety functions." The requirements in 10CFR50.49 are: (4) Radiation. The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects. The phrase "should be exposed to radiation, before testing, that simulates the calculated integrated dose (normal and accident) that the equipment must withstand before completion of its intended safety functions" contradicts 10CF50.49 in that radiation exposure is	Section C. 2, f change "Electric equipment to be…. intended safety functions." To: "The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects."

	testing and exposure before testing is confusing. The phrase "withstand before completion of its intended safety functions" contradicts 10CF50.49 in that radiation exposure should be the normal does plus the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional.	
17	Section C. 2, f is confusing, contradictory to 10CFR50.49, and unnecessary as it states: "In 10 CFR 100.11, "Determination of exclusion area, low population zone, and population center distance" (Ref. 36), the NRC provides criteria for evaluating the radiological aspects of the proposed site. A footnote to 10 CFR 100.11 states that the fission product release assumed in these evaluations should be based upon a major accident involving substantial meltdown of the core with subsequent release of appreciable quantities of fission products. The NRC cites Technical Information Document (TID) 14844, "Calculation of Distance Factors for Power and Test Reactor Sites" (Ref. 37), in 10 CFR Part 100, "Reactor Site Criteria," as a source of further guidance on these analyses. Although initially used only for siting evaluations, the TID 14844 source term has been used for design-basis applications, such as EQ of equipment under 10 CFR 50.49. Regulations in 10 CFR 50.67, "Accident source term," allows licensees to revise the accident source term used in design-basis radiological consequence analyses."	Section C. 2, f change "Determination of exclusion area, …. radiological consequence analyses." To: "The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects."

	10CFR50.49 states: "(4) Radiation. The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects." Since this section uses the radiation from "these evaluations should be based upon a major accident involving substantial meltdown of the core with subsequent release of appreciable quantities of fission products" and not the radiation environment associated with the most severe design basis accident, it exceeds the requirements of 10CFR50.49 and is a forward fit.	
18	Section C. 2, f is confusing, contradictory to 10CFR50.49, and unnecessary as it states: "RG 1.183 establishes an acceptable alternative source term (AST) and identifies the significant attributes of other ASTs that the NRC staff may find acceptable. For new reactor applications, the safety analysis requirements in 10 CFR 50.34(a)(1) and 10 CFR Part 52 (as applicable) include footnotes describing a fission product release similar to the one in the footnote to 10 CFR 100.11 described above. Although 10 CFR 50.49 does not include a similar footnote, power reactor license applicants have typically considered a core melt accident source term for the 10 CFR 50.49 EQ evaluation consistent with the footnote.	Section C. 2, f change ""RG 1.183 establishes …. guidance on radiation EQ." To: "The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects."

	Appendix D to this guide includes additional guidance on radiation EQ." 10CFR50.49 states: "(4) Radiation. The radiation environment must be based on the type of radiation, the total dose expected during normal operation over the installed life of the equipment, and the radiation environment associated with the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects." Since this section uses the radiation "from a core melt accident source term" and not the radiation environment associated with the most severe design basis accident, it exceeds the requirements of 10CFR50.49 and is a forward fit.	