KHNPDCDRAIsPEm Resource

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Sent: Friday, October 21, 2016 5:59 PM
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Subject: APR1400 Design Certification Application RAI 527-8686 [3.11 - Environmental Qualification of Mechanical and Electrical Equipment]
Attachments: APR1400 DC RAI 527 EEB 8686.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 527-8686

Issue Date: 10/21/2016
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 03.11 - Environmental Qualification of Mechanical and Electrical Equipment
Application Section:

QUESTIONS

03.11-18

Background

10 CFR 50.49, “Environmental qualification for electric equipment important to safety for nuclear power plants,” provides specific requirements pertaining to qualification of certain electric equipment important to safety. Section 50.49 requires that three categories of electric equipment important to safety be qualified for their application and specified performance and provides requirements for establishing environmental qualification methods. These three categories are: (1) safety-related electric equipment (Class 1E), (2) non-safety-related electric equipment (non-Class 1E) whose failure under postulated environment conditions could prevent satisfactory accomplishment of safety functions by safety-related equipment, and 3) certain post-accident monitoring equipment. Regulatory Guide (RG) 1.89, Revision 1, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,” describes a method acceptable to the NRC staff for complying with § 50.49. RG 1.89 endorses IEEE Std. 323-1974, “IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations.” The procedures described by IEEE Std. 323-1974 are acceptable to meet the requirements in 10 CFR 50.49 to ensure that the Class 1E equipment can perform its safety functions in harsh environments.

Federal Register (FR) 2729, Vol. 48, No. 15 of January 21, 1983 provides the statements of consideration for the issuance of 10 CFR 50.49. The FR states in part that, 10 CFR 50.49 rule is based on "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors," November 1979 (DOR Guidelines) and NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." NUREG-0588 contains two sets of criteria: the first for plants originally reviewed in accordance with IEEE Std. 323-1971 and the second for plants reviewed in accordance with IEEE Std. 323-1974. Thus, 10 CFR 50.49 is based only on IEEE Std. 323-1971 and IEEE Std. 323-1974.

Issue

By letter dated June 15, 2015, NRC issued RAI-7944, Question 03.11-1 regarding the applicant’s use of IEEE Std. 323-2003 for environmental qualification of Class 1E electrical equipment located in harsh environments. The NRC staff has not endorsed IEEE Std. 323-2003 for environmental qualification of Class 1E electrical equipment located in a harsh environment. However, NRC approved IEEE Std. 323-2003 only for environmental qualification of safety-related computer-based I&C systems located in a mild environment as addressed in RG 1.209, “Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants,” (March 2007). Since IEEE Std. 323-1974 remains the current standard of record and is endorsed by RG 1.89 for environmental qualification, the staff asked the applicant to provide the justification why IEEE Std. 323-2003 is

acceptable for qualification of Class 1E electrical equipment located in harsh environment or, otherwise, revise Section 3.11 of the DCD Tier 2 to reflect the change from IEEE Std. 323-2003 to IEEE Std. 323-1974.

By letter dated July 17. 2015 (ADAMS Accession No. ML15198A260), the applicant responded to RAI-7944, Question 03.11-1, stating that Standard Review Plan (SRP) 3.11 allows the use of information of other standards not endorsed by regulatory guides if appropriately justified. The applicant provided a justification for the use of IEEE Std. 323-2003, stating that it conforms with 10 CFR 50.49, that there are no technical differences between the 2003 and 1974 versions of the IEEE Std. 323, and that IEEE Std. 323-2003 reflects current practices for environmental qualifications. In addition, the applicant provided a basic table comparing the guidance contained in IEEE Std. 323-1974 and IEEE Std. 323-2003.

The staff evaluated the response from the applicant and recognizes that the applicant can use the other standards not endorsed by the NRC in regulatory guidance. However, the staff has identified issues discussed in the following questions with regards to the definitions and content of IEEE Std. 323-2003, and therefore requests that the applicant address them.

Regulatory Basis:

10 CFR 50.49(b)(1)(i) states, in part, that "[Safety-related electric equipment] is that relied upon to remain functional during and following design basis events."

Questions:

a) Definition 3.4, "Condition-based qualification," in IEEE Std. 323-2003 is defined as "Qualification based on measurement of one or more condition indicators of equipment, its components, or materials for which an acceptance criterion can be correlated to the equipment's ability to function as specified during an applicable design basis event" (emphasis added).

   The staff finds that the definition of condition-based qualification does not address that the equipment should remain functional following a design basis event (DBE), consistent with 10 CFR 50.49(b)(1)(i). Therefore, the staff requests that the applicant clarify its definition of condition-based qualification to include the verification that SSCs can perform their safety function during and following DBEs.

b) IEEE Std. 323-2003 Section 4.4, "Qualification Documentation," states that "the results of a qualification program shall be documented to demonstrate the equipment's ability to perform its safety function(s) during its qualified life and applicable design events."

   The staff finds that the IEEE Std. 323-2003 requirement for Qualification Documentation does not verify that the equipment can perform its safety function during and following a design basis event as applicable, consistent with 10 CFR 50.49(b)(1)(i). Therefore, the staff requests that the applicant clarify that the qualification documentation will provide auditable records that show that equipment can perform its safety function during and following a DBE, as applicable.

03.11-19
Regulatory Basis:

10 CFR 50.49(b)(1)(ii) states, in part, that DBEs 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 the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures.

Questions:

a) Definition 3.11, "Harsh environment," in IEEE Std. 323-2003 is defined as "an environment resulting from a design basis event, i.e. loss-of-coolant accident (LOCA), high-energy line break (HELB), and main steam line break (MSLB)." IEEE Std. 323-2003, Definition 3.6, defines DBEs as "Postulated events used in the design to establish the acceptable performance requirements for the structures, systems, and components."

   However, 10 CFR 50.49 defines DBEs more broadly to include anticipated operating occurrences (AOOs) and would include a small-break LOCA (SBLOCA), for example. The staff requests that the applicant address SBLOCA and discuss postulated AOOs that may create harsh environments, consistent with the definition of DBE in 10 CFR 50.49.

b) Definition 3.16, "Qualified Life," is defined in IEEE Std. 323-2003 as "the period of time, prior to the start of a design basis event, for which the equipment was demonstrated to meet the design requirements for the specified service condition." IEEE Std. 323-2003 Section 5.3, "Condition monitoring," states that "condition monitoring may be used with or independently from the concept of qualified life. As the qualified equipment approaches the end of its theoretical qualified life, periodic condition monitoring may be implemented to determine if actual aging is occurring at a slower rate, and if further qualified service is possible based on the condition monitoring results."

   The definition of qualified life in IEEE Std. 323-2003 does not include a DBE. Therefore, the staff determines that DBE capability must be addressed in order to use condition monitoring as a method to determine if further qualified service is possible, as the plant must be designed to ensure functions during DBE. Staff requests the applicant to explain how condition monitoring addresses DBEs.

c) IEEE Std. 323-2003 Section 6.1.2, "Interfaces" states that "material incompatibilities at interfaces shall be considered and evaluated."

   The staff requests that the applicant confirm that material incompatibilities at interfaces are demonstrated under the worst case environmental conditions that it will be exposed, such as DBE as defined in 10 CFR 50.49(b)(ii).

d) Section 6.1.5.2, "Design basis event conditions," of IEEE Std. 323-2003 states that "the postulated design basis event conditions including specified high-energy line break, loss-of-coolant accident, main steam line break, and/or safe shutdown seismic events, during or after which the equipment required to perform its safety function(s), shall be specified."

   The staff requests the applicant to discuss the other applicable DBE conditions and how the design is demonstrated to conform to 10 CFR 50.49.

03.11-20

Regulatory Basis:

10 CFR 50.49(e)(8) states in part that “margins must be applied to account for unquantified uncertainty, such as the effects of production variations and inaccuracies in test instruments. These margins are in addition to any conservatisms applied during the derivation of local environmental conditions of the equipment unless these conservatisms can be quantified and shown to contain appropriate margins.”

Questions:

a) Definition 3.13, “Margin,” in IEEE Std. 323-2003 is defined as “The difference between service conditions and the conditions used for equipment qualification.” Section 6.3.1.5, “Margin,” in IEEE Std. 323-1974 defines margin as, “the difference between the most severe specified service conditions of the plant and the conditions used in type testing to account for normal variations in commercial production of equipment and reasonable errors in defining satisfactory performance.”

   The staff requests that the applicant confirm that margin is applied on the most severe service condition as specified for temperature, pressure, chemical spray and radiation condition during and following design basis accident in 10 CFR 50.49(e).

b) IEEE Std. 323-2003, Section 6.3.1.6, “Margin” states that lesser values of margin may be adequate based on factors such as product design control, test sample size and test measurement accuracy.

   The staff requests that the applicant confirm that the margins will meet the requirement in 10 CFR 50.49(e)(8) and, if seeking to use lesser values of margin, discuss how product design control, test sample size, and test measurement accuracy are addressed.

03.11-21

Regulatory Basis:

10 CFR 50.49(e)(7) states in part that “synergistic effects must be considered when these effects [temperature, pressure, humidity, chemical effects, radiation, aging, and submergence] are believed to have a significant effect on equipment performance.”

Questions:

a) IEEE Std. 323-1974, Section 5.1, “Type Testing,” states that ”type test qualifications must consider synergistic effects during the testing in order to address the worst effects in accordance with 10 CFR 50.49 (e)(7). In contrast, IEEE Std. 323-2003 Section 5.1.1, “Type Testing,” does not address synergistic effects during the type tests. Although DCD Tier 2 section 3.11.2.3(a) states that synergistic effects are considered in the aging program, the use of IEEE Std. 323-2003 does not address synergistic effects. RG 1.89 position C.5.a states that if synergistic effects have been identified prior to the initiation of qualification, they should be accounted for in the qualification program.

   The staff requests that the applicant clarify the discrepancy and explain how synergistic effects are considered for type test qualification.

b) RG 1.89 Position C.5.a states that if synergistic effects have been identified prior to the initiation of qualification, they should be accounted for in the qualification program. The RG also states: “The procedures described by IEEE Std 323-1974, "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations,"' are acceptable to the NRC staff for satisfying the Commission's regulations pertaining to the qualification of electric equipment for service in nuclear power plants.” IEEE Std. 323-1974, Section 4, “Introduction” states that “Qualification by analysis must include justification of methods, theories, and assumptions used. In general, electric equipment is too complex to be qualified by analysis alone.

   The staff finds that qualification by analysis will not address the combined effects of the operating environment. If qualification by the method of analysis is used, the staff requests information on 1) how synergistic effects are addressed, and 2) add justification of methods, theories, and assumptions would be included.

03.11-22
Regulatory Basis:

10 CFR 50.49(e)(5) states that "Equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed life condition. Consideration must be given to all significant types of degradation which can have an effect on the functional capability of the equipment. If preconditioning to an end-of-installed life condition is not practicable, the equipment may be preconditioned to a shorter designated life. The equipment must be replaced or refurbished at the end of this designated life unless ongoing qualification demonstrates that the item has additional life."

10 CFR 50.49(b)(1)(ii) states, in part, that DBEs 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 the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safe shutdown condition, or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures.

Question:

a) IEEE Std. 323-2003 Section 6.3.1.8.1, "Natural aging," states that natural aging may be supplemented by analysis to account for differences between the specified service and the natural aging conditions to justify the qualified life of the sample.

   Please discuss how natural aging supplemented by analysis addresses the end-of-installed-life condition and demonstrates that the equipment remains functional during and following design basis events, in accordance with 10 CFR 50.49(e)(5).

03.11-23
Regulatory Basis:

10 CFR 50.49(d)(3) states that environmental conditions, including humidity, at the location where the equipment must perform should be included in the qualification file. Furthermore, 10 CFR 50.49(e)(5), "Aging" states that "Equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed life condition. Consideration must be given to all significant types of degradation which can have an effect on the functional capability of the equipment."

Question:

a) IEEE Std. 323-2003 Section 6.3.1.8.2, "Age conditioning," states that age conditioning generally involves applying simulated in-service stresses, typically thermal, radiation, wear, and vibration, as appropriate, at magnitudes or rates that are more severe than expected in-service levels, but less severe than levels that cause aging mechanisms not present in normal service. It is the intent of the age conditioning process to put the test sample in the worst state of degradation that it would experience during the qualified life, prior to the design basis event." Thus, during age-conditioning humidity should be considered if it has an effect on the functional capability of the equipment.

   Please demonstrate how humidity is considered during age conditioning, in accordance with 10 CFR 50.49.

03.11-24

Regulatory Basis:

10 CFR 50.49(f) states:

"(f) Each item of electric equipment important to safety must be qualified by one of the following methods:

(1) Testing an identical item of equipment under identical conditions or under similar conditions with a supporting analysis to show that the equipment to be qualified is acceptable.

(2) Testing a similar item of equipment with a supporting analysis to show that the equipment to be qualified is acceptable.

(3) Experience with identical or similar equipment under similar conditions with a supporting analysis to show that the equipment to be qualified is acceptable.

(4) Analysis in combination with partial type test data that supports the analytical assumptions and conclusions."

Question:

a) IEEE Std. 323-2003 Section 6.3.3, "Analysis," states that "analytical techniques are limited for many types of equipment, and analysis supplemented by test data or operating experience is usually needed for a comprehensive qualification program."

Discuss how it is ensured that the qualification requirements of 10 CFR 50.49(f) will be met when using the method allowed under 10 CFR 50.49(f)(4), considering that IEEE Std. 323-2003 only recommends analysis should be supplemented with test data.