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Subject: **Response to Nuclear Regulatory Commission Request for Additional Information Letter No. 378 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.11 - Environmental Qualification of Mechanical and Electrical Equipment; RAI Number 3.11-39**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 378 sent by NRC letter dated October 8, 2009 (Reference 1). RAI Number 3.11-39 is addressed in Enclosure 1. Enclosure 2 contains the DCD changes as a result of GEH's response to this RAI.

If you have any questions or require additional information, please contact me.

Sincerely,

FOR

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-641 Letter from U.S. Nuclear Regulatory Commission to J. G. Head, GEH, *Request For Additional Information Letter No. 378 Related to ESBWR Design Certification* Application dated October 8, 2009

Enclosures:

1. Response to NRC RAI Letter No. 378 Related to ESBWR Design Certification Application - Environmental Qualification of Mechanical and Electrical Equipment; RAI Number 3.11-39

2. Response to NRC RAI Letter No. 378 Related to ESBWR Design Certification Application - Environmental Qualification of Mechanical and Electrical Equipment; DCD Markups for RAI Number 3.11-39

cc:	AE Cubbage	USNRC (with enclosures)
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	eDRF Section	0000-0109-2638 (RAI 3.11-39)

MFN 09-701

Enclosure 1

Response to NRC Request for Additional Information Letter No. 378 Related to ESBWR Design Certification Application

Environmental Qualification of Mechanical and Electrical Equipment

RAI Number 3.11-39

NRC RAI 3.11-39

1. DCD Tier 2 Table 1.9-22 references Electric Power Research Institute (EPRI) TR-102323 Revision 3, 2004, which has not been reviewed or accepted by the NRC. The NRC has reviewed and accepted TR-102323 Revision 0, 1994 as discussed in RG 1.180-2003, "The NRC staff accepted the Electric Power Research Institute (EPRI) topical report TR-102323, "Guidelines for Electromagnetic Interference Testing in Nuclear Power Plants," in a Safety Evaluation Report (SER) by letter dated April 17, 1996, as one method of addressing issues of electromagnetic compatibility (EMC) for safety-related digital I&C systems in nuclear power plants. The original Regulatory Guide 1.180 (January 2000) and this revision complement the position set forth in the SER." The staff notes that TR-102323 Revision 2 was reviewed by the NRC and not accepted.

Revise the reference for TR-102323 to the approved 1994 version (noting the 1996 SER) or submit TR-102323 Revision 3, 2004 for staff review.

2. In DCD Tier 2 Section 3.11 and 7.1, GEH committed to comply with RG 1.180 and RG 1.209.

RG 1.180 Section A states in part,

> *"Methods for addressing electromagnetic compatibility (EMC) constitute Tier 2* information under the 10 CFR Part 52 requirements." (Last sentence in top paragraph on page 2)*

DCD Tier 2 Section 3.11.4.4 references NEDE-24326-1-P, "General Electric Environmental Qualification Program," January 1983 as part of the environmental qualification licensing basis. However, NEDE-24326-1-P does not address conformance to RG 1.180 and RG 1.209 and neither NEDE-24326-1-P nor the DCD provide methods for Q-DCIS electromagnetic and radio-frequency interference (EMI/RFI) qualification. Provide methods for Q-DCIS EMI/RFI qualification.

3. DCD Tier 1, Table 3.8-1, Item 3 provides ITAAC for the equipment qualification safety-related digital I&C equipment.

Inspection, Test, Analyses 3.ii. states,

> *"Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment qualification program's digital I&C equipment located in a mild environment."*

The DCD identifies conformance to RG 1.180 and IEEE STD 323-2003. However the DCD statement above is inconsistent IEEE STD 323-2003, Section 5.1.3, "Analysis," which states in part,

> *"However, analysis alone cannot be used to demonstrate qualification."*

Revise DCD Tier 1, Table 3.8-1, Item 3 to remove the option of demonstrating qualification by analysis alone and revise DCD Tier 2 Section 3.11.4.3 to state that analysis alone cannot be used to demonstrate qualification.

GEH Response to RAI 3.11-39

Question 1

1. DCD Tier 2 Table 1.9-22 references Electric Power Research Institute (EPRI) TR-102323 Revision 3, 2004, which has not been reviewed or accepted by the NRC. The NRC has reviewed and accepted TR-102323 Revision 0, 1994 as discussed in RG 1.180-2003, "The NRC staff accepted the Electric Power Research Institute (EPRI) topical report TR-102323, "Guidelines for Electromagnetic Interference Testing in Nuclear Power Plants," in a Safety Evaluation Report (SER) by letter dated April 17, 1996, as one method of addressing issues of electromagnetic compatibility (EMC) for safety-related digital I&C systems in nuclear power plants. The original Regulatory Guide 1.180 (January 2000) and this revision complement the position set forth in the SER." The staff notes that TR-102323 Revision 2 was reviewed by the NRC and not accepted.

Revise the reference for TR-102323 to the approved 1994 version (noting the 1996 SER) or submit TR-102323 Revision 3, 2004 for staff review.

GEH Response

GEH concurs and will revise the DCD.

Table 1.9-22 will be revised to reference TR-102323–1994 *"Guidelines for Electromagnetic Interference Testing in Nuclear Power Plants,"* which is the approved version based upon the 1996 SER.

DCD Impact

DCD Tier 2, Table 1.9-22 will be revised as noted in the attached markup.

Question 2

2. In DCD Tier 2 Section 3.11 and 7.1, GEH committed to comply with RG 1.180 and RG 1.209.

RG 1.180 Section A states in part,

> *"Methods for addressing electromagnetic compatibility (EMC) constitute Tier 2* information under the 10 CFR Part 52 requirements." (Last sentence in top paragraph on page 2)*

DCD Tier 2 Section 3.11.4.4 references NEDE-24326-1-P, "General Electric Environmental Qualification Program," January 1983 as part of the environmental qualification licensing basis. However, NEDE-24326-1-P does not address conformance to RG 1.180 and RG 1.209 and neither NEDE-24326-1-P nor the DCD provide methods for Q-DCIS electromagnetic and radio-frequency interference (EMI/RFI) qualification. Provide methods for Q-DCIS EMI/RFI qualification.

GEH Response

GEH concurs and will revise the DCD.

For Harsh Environments there is no change in the DCD. As stipulated in 3.11.4.1 "Electromagnetic interference (EMI)/radio frequency interference (RFI) and Voltage Surges" for a harsh environment, EMI qualifications follow the requirements defined in MIL-STD 461E and IEC 61000-4. The qualification for EMI/RFI and voltage surges for EQ equipment in harsh and mild environments is by test, consistent with RG 1.180.

For Mild Environments, the following clarifications will be added to section 3.11.4.2.

> "Safety-related equipment located in a mild environment will be qualified per guidelines of Regulatory Guide 1.209-2007 and IEEE 323-2003 for qualification of Safety Related or Important to Safety digital I&C to be installed in a mild environment."

For EMI/RFI, qualification methodology shall be in compliance with EPRI TR-102323-1994 (as approved in 1996 NRC SER), Mil Std 461E or IEC 61000 Series (as endorsed in RG 1.180, Rev 1.)

In addition, the last paragraph of section 3.11.4.4 will be deleted. The reference to NEDE-24326-1-P does not add useful information for this section.

DCD Impact

DCD Tier 2, Sections 3.11.4.2 and 3.11.4.4 will be revised as noted in the attached markup.

Question 3

3. DCD Tier 1, Table 3.8-1, Item 3 provides ITAAC for the equipment qualification safety-related digital I&C equipment.

Inspection, Test, Analyses 3.ii. states,

> *"Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment qualification program's digital I&C equipment located in a mild environment."*

The DCD identifies conformance to RG 1.180 and IEEE STD 323-2003. However the DCD statement above is inconsistent IEEE STD 323-2003, Section 5.1.3, "Analysis," which states in part,

> *"However, analysis alone cannot be used to demonstrate qualification."*

Revise DCD Tier 1, Table 3.8-1, Item 3 to remove the option of demonstrating qualification by analysis alone and revise DCD Tier 2 Section 3.11.4.3 to state that analysis alone cannot be used to demonstrate qualification.

GEH Response

Section 3.11.4.3 will be updated to include the following text (excerpt from 10CFR50.49, part (f)).

> "In addition to Type Testing, analysis may be utilized per 10CFR50.49 to support digital I&C qualification in a mild environment via;
>
> (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."

Additionally, Table 3.8 –1, item 3 ii will be updated to reflect analysis will be consistent with 10CFR50.49 (f).

Qualification by analysis only will not be the sole determining factor for defining the Environmental Qualification of a component. However, as endorsed by 10CFR50.49, IEEE 603 -1991, and Reg. Guide 1.89, analysis has a role in defining acceptability of a component for its intended environmental environment.

Section 5.4 of IEEE 603-1991 "Equipment Qualification" states the following;

Safety system equipment shall be qualified by type test, previous operating experience, or analysis, or any combination of these three methods, to substantiate that it will be capable of meeting, on a continuing basis, the performance requirements as specified in the design basis. Qualification of Class 1E equipment shall be in accordance with the requirements of IEEE Std 323–1983 [2] and IEEE Std 627–1980 [11].

Reg Guide 1.189 R1, Appendix E, # 6 states the following;

Provide a summary of the test results that demonstrates the adequacy of the qualification program. If any analysis is used for qualification, justification for all analysis assumptions must be provided.

EPRI 107330 Section 6.1.1 "PLC System Qualification Overview" states the following;

Equipment can be qualified for safety-related use based on several methods individually or in combination (Section 4 of IEEE 323 - 1983) The PLC qualification is based on testing and analysis.

Qualification by analysis only will not be the sole determining factor for defining the Environmental Qualification of a component. However, as endorsed by 10CFR50.49, IEEE 603 -1991, and Reg. Guide 1.89, analysis has a role in defining acceptability of a component for its intended environmental environment.

In some cases, analysis may be performed to extend the qualification of a component to accommodate changes to a components position or orientation, account for physical changes to a component, or to fill in gaps in it's qualification. Experience has shown a need to perform analysis at times to ensure qualification test meet the final system configuration. The following examples come from real life experiences in which analysis was required to qualify a component, to ensure physical changes to a component did not affect it's qualification or to extend the type testing qualification of singular components to account for assembling the components into larger assemblies.

Example 1 - A relay was qualified per type testing. This relay was replaced with a newer model by the manufacturer and its part number was revised. The new relay is similar or identical in all critical properties to the existing one. An analysis is performed of all critical parameters (temp, RH, EMI, seismic, electrical separation) to ensure the new relay will exhibit the same characteristics as the relay originally qualified via type testing. In this case, engineering analysis of critical characteristics between the two relays could be expected to yield reasonable assurance that the new relay will perform in the same manner as the original.

Example 2 – An electronic assembly is qualified by type testing. All components inside are shown to be qualified as well as the complete assembly. Per IEEE 323 "Qualification of equipment mounted in other than the tested configuration requires analysis showing that equipment performance is not degraded by the differing configuration." Consequently, to accommodate different configurations or component combinations within the assembly, an analysis may be utilized to demonstrate continued qualification of the different versions of the assembly.

Example 3 - In some instances, it may not practical to qualify the equipment by type testing. This may be due to the size of the equipment, its complexity or the inability to establish a credible test environment. In these cases, analysis utilizing simulation or computer modeling may be required to demonstrate compliance with one or more of the EQ parameters. (ex. thermal ageing)

Example 4 – A grounding buss bar was qualified for terminating ground wires. The qualification test utilized clips to terminate the ground wires. But, upon delivery, the customer demanded that the buss bar be drilled so that grounding wires could be bolted to the buss bar. Analysis confirmed the integrity of the buss bar was not compromised nor was its electrical properties.

The above examples are typical instances in which analysis may be utilized in lieu of or in combination with type testing to recertify a component or to accommodate changes.

It will be difficult to define within the DCD an explanation of each instance we may use analysis as a part of the qualification process. But in all cases, analysis will be utilized following sound engineering practices and in compliance with 10CFR50.49, part (f).

DCD Impact

1. DCD Tier 2, Section 3.11.4.3 will be revised as noted in the attached markup.

2. DCD Table 3.8-1, Item 3ii will be revised as noted in the attached markup.

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Enclosure 2

Response to NRC Request for Additional Information Letter No. 378 Related to ESBWR Design Certification Application

Environmental Qualification of Mechanical and Electrical Equipment

DCD Markups for RAI Number 3.11-39

Table 1.9-22

Industrial Codes and Standards[1] Applicable to ESBWR

Code or Standard Number	Year	Title
STD-146 (95)	1995	Standard for Water Flow Measurement
Electric Power Research Institute (EPRI)		
NP-495	1978	Sources of Radioiodine at Boiling Water Reactors
NP-1831	1981	An Engineering Approach for Elastic-Plastic Fracture Analysis
NP-3540-LD	1984	Two Phase Flow Through Intergranular Stress Corrosion Cracks and Resulting Acoustic Emission
NP-3596-SR	1981	PICEP: Pipe Crack Evaluation Program, Special Report, Revision 1
NP-3607	1984	Advances in Elastic-Plastic Fracture Analysis
NP-3915	1985	Guidelines for Nuclear Power Plant Performance Data Acquisition
NP-4867M	1987	Concrete Containment Tests, Phase 2: Structural Elements with Liner Plates
NP-4869M	1987	Methods for Ultimate Load Analysis of Concrete Containments: Second Phase
NP-4946-SR	1988	BWR Normal Water Chemistry Guidelines
NP-4947-SR	1987	BWR Hydrogen Water Chemistry Guidelines
NP-5283-SR-A	1987	Guidelines for Permanent BWR Hydrogen Water Chemistry Installations
NP-5380	1987	NCIG-01 – Visual Weld Acceptance Criteria for Structural Welding at Nuclear Power Plants, Revision 2, September 1987.
NP-5479	1993	Application Guidelines for Check Valves in Nuclear Power Plants, Revision 1
NP-5930	1988	A Criterion for Determining Exceedance of the Operating Basis Earthquake
NP-6559	1989	Voice Communication System Compatible with Respiratory Protection
NP-6695	1989	Guidelines for Nuclear Plant Response to an Earthquake
NSAC-202L	1999	Recommendations for an Effective Flow-Accelerated Corrosion Program, Revision 2
TR-100082	1991	Standardization of Cumulative Absolute Velocity
TR-1008192	2004	BWRVIP-130: BWR Vessel and Internals Project, BWR Water Chemistry Guidelines
TR-102323	~~2004~~1994	Guidelines for Electromagnetic Interference Testing ~~o~~in Power Plants, Rev. ~~3~~0 (as approved by NRC Safety Evaluation Report dated April 16, 1996)
TR-106439	1996	Guidelines on Evaluation and Acceptance of Commercial Grade Digital Equipment for Nuclear Safety Applications
URD	1997	Advanced Light Water Reactor Utility Requirements Document, Volume III, Revision 6, May 1997 and Volume II, Chapter 1 Appendix A, PRA Key Assumptions and Groundrules", Revision 6, December 1993.

ESBWR's equipment qualification type test process for batteries includes evaluation of significant aging mechanisms that are related to failure mechanisms from radiation exposure, time-temperature aging, and cycle aging; age testing for significant aging mechanisms for a 20-year qualified life; seismic test; and performance testing for the 72-hour duty cycle (see Reference 3.11-6).

3.11.4.2 Mild Environment Qualification

EQ safety-related equipment located in a mild environment is qualified ~~as follows~~per guidelines of Regulatory Guide 1.209 – 2007 and IEEE 323-2003 for qualification of Safety Related or Important to Safety digital I&C to be installed in a mild environment.

For EMI/RFI qualification, as endorsed in Regulatory Guide 1.180, Rev 1, qualification methods shall be per EPRI TR-102323 –1994 (as approved by NRC Safety Evaluation Report dated April 16 1996), Mil Std 461E or IEC 61000 Series:

To assure EQ safety-related equipment located in a mild environment meets its safety-related functional requirements during normal environmental conditions and AOOs, the environmental design basis for normal environmental conditions and AOO requirements is specified in the design/purchase specifications. A qualified life is not required for equipment located in a mild environment that has no significant aging mechanisms.

For all EQ safety-related equipment, excluding EQ safety-related computer-based I&C systems, a Certificate of Conformance from the vendor of the safety-related equipment to be located in a mild environment needs to certify performance to the environmental design basis for normal environmental conditions and AOO requirements for the equipment location for the time that the safety-related function is required.

3.11.4.3 Computer-based Instrumentation and Control Systems

EQ safety-related computer-based I&C systems comply with RG 1.209 and RG 1.180. For all EQ safety-related computer-based I&C systems, located in a mild environment, type testing is the preferred qualification method to demonstrate performance to the environmental design basis for normal environmental conditions and AOO requirements for the equipment location for the time that the safety-related function is required.

Type tests may be separate laboratory or manufacturer's tests that document performance to the applicable service conditions with due consideration for synergistic effects, if applicable.

When computer-based I&C systems type testing is performed:

- The system under test functions and performs with safety-related software that has been validated and verified and is representative of the software to be installed in the nuclear power plant.
- Testing demonstrates performance of safety-related functions at the specified environmental service conditions, including AOOs.
- Testing exercises all portions of the system under test that are necessary to accomplish the safety-related functions and those portions whose operation or failure could impair the safety-related functions.

- Testing confirms the response of digital interfaces and verifies that the design accommodates the potential impact of environmental effects on the overall response of the system.
- Testing of a complete system is preferred.
- When testing of a complete system is not practical, confirmation of the dynamic response to the most limiting environmental and operational conditions is based on type testing of the individual modules and analysis of the cumulative effects of environmental and operational stress on the entire system to demonstrate required safety-related performance.

In addition to Type Testing, analysis may be utilized per 10CFR50.49 to support digital I&C qualification in a mild environment via;

(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.

~~□~~The evidence of qualification in a mild environment is consistent with the guidance given in IEEE 323-2003 Section 7.~~2~~1.

3.11.4.4 Environmental Qualification Documentation

The procedures and results of qualification by tests, analyses or other methods are documented, maintained, and reported in accordance with requirements of 10 CFR 50.49(j), RG 1.209, and IEEE 323-2003 Section 7.~~2~~1. The EQD summarizes the qualification results for all equipment identified in Subsection 3.11.2. The EQD is developed during program implementation and includes the following:

- The environmental parameters and the methodology used to qualify the equipment for harsh and mild environments.
- The System Component Evaluation Work sheets which include a summary of environmental conditions and qualified conditions.

~~The compliance with the applicable portions of the GDC of 10 CFR 50, Appendix A, and the Quality Assurance Criteria of 10 CFR 50, Appendix B are described in the NRC approved Licensing Topical Report on GE's environmental qualification program (Reference 3.11-3).~~

The COL Applicant will provide a full description and milestone for program implementation of the environmental qualification program that includes completion of the plant specific EQD. (Refer to Subsection 3.11.7, Item 3.11-1-A).

Table 3.8-1

ITAAC For Environmental and Seismic Qualification of Mechanical and Electrical Equipment

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	ii. Type tests, analyses, or a combination of type tests and analyses consistent with 10CFR50.49 (f), will be performed on the equipment qualification program's digital I&C equipment located in a mild environment.	ii. The equipment qualification program's safety-related digital I&C equipment (including digital components in the safety-related electrical distribution system) located in a mild environment is qualified to perform its safety function during the applicable normal and abnormal environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.
	iii. Inspection will be performed to verify the equipment qualification program's as-built digital I&C equipment located in a mild environment	iii. The equipment qualification program's as-built safety-related digital I&C equipment (including digital components in the safety-related electrical distribution system) and the associated wiring, cables, and terminations located in a mild environment are qualified for a mild environment and are bounded by type tests, analyses, or a combination of type tests and analyses.