

# REQUEST FOR ADDITIONAL INFORMATION 511-3739 REVISION 0

12/15/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.11 - Environmental Qualification of Mechanical and Electrical Equipment  
Application Section: 3.11

QUESTIONS for Electrical Engineering Branch (EEB)

03.11-17

This Request for Additional Information (RAI) was written prior to the receipt of MUAP-08015, Revision 1. Rather than delay issuance of the RAI to review Revision 1, the RAI is being issued as written.

Section 6.2.2, "Substitution", of MHI Technical Report MUAP 08015 (R0) states: "Substitution of parts or materials is acceptable if a comparison or analysis of their fit, form and function supports the conclusion that the equipment performance is equal to or better than the originally qualified equipment." This approach as stated contains some of the necessary elements, i.e., form, fit and function. However, those elements alone are not sufficient because they do not take materials or manufacturing process into account, both of which have the most significant effect on equipment performance in a harsh environment, especially prolonged exposure to elevated temperatures, moisture and radiation. Revise Section 6.2.2 of MUAP 08015, to reflect analysis of substitute parts or materials that takes the material properties required in a harsh environment and manufacturing processes that could affect equipment performance in a harsh environment into account, or using partial test data (or applicable operating experience data) to support the analyses as required by 10 CFR 50.49(f) when analysis is used in combination with other methods for qualification.

03.11-18

Section 6.2.1, "Similarity," of MHI Technical Report MUAP 08015, Rev 0, states, "If the qualified life of one module can be established, then modules of similar types will have an equivalent qualified life if the modules have similar failure mechanisms." Section 6.2.1 then delineates the attributes that are to be compared to define and establish similarity under the MHI EQ program. These attributes are: "Type of technology used to design and manufacture the module," "Type of critical components," "Packaging, mounting and type of connections," "Service conditions," and "Safety functions." However, these attributes are not sufficient to establish similarity in terms of durability and satisfactory application-specific performance in a harsh environment at end-of-life conditions, because they lack consideration of material properties that determine the critical materials' durability, aging characteristics, and application-specific harsh environment performance in end-of-life condition. For example, it is not sufficient to consider only failure mechanisms when using similarity analysis for qualified life comparison. Revise Section 6.2.1 of MUAP-08015, to include consideration of key

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material properties and aging characteristics (e.g., application/failure mode-specific activation energy), known exposure sequence effects, known radiation type/dose rate/configuration effects and known synergistic effects for all application-relevant environmental stressors, including thermal and radiation as required, that can affect accelerated aging equivalent degradation and end-of-life harsh environment durability and performance.

03.11-19

MHI Technical Report MUAP 08015, Rev 0, Section 3.11, titled "10 CFR 50.49 Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," states: "An alternate methodology for qualifying equipment in harsh environments is to follow commercial dedication procedures, where applicable, in EPRI and NRC approved EPRI topical reports." Also, MUAP- 08015, Rev 0, Section 3.7, states, in part: "EPRI commercial-grade dedication methodologies, as approved by the NRC, are encompassed in the US-APWR EQP." Section 3.7 further states: "NUPIC [Nuclear Procurement Issues Committee] commercial dedication methodologies, as approved by the NRC, are encompassed by the US-APWR EQP." However, with the exception of NRC's SERs, which approved the use of TR-106439 and TR-107330 by the Electric Power Research Institute (EPRI) for mild-environment qualification of a specific vendor's digital I&C equipment, there are no topical (or technical) reports on commercial-grade dedication produced by EPRI that the NRC has approved for use specifically as a method of harsh environmental or dynamic qualification. In addition, while the cited references provide general guidance on commercial-grade dedication, they do not provide specific guidance on demonstrating EQ of each commercial-grade item production unit (designed and built without the benefit of a 10CFR Part 50, Appendix B, Quality Assurance Criteria) without degrading or destructive type tests on each unit. Revise Section 3.7 of MUAP 08015, to describe how the applicant's EQ program will provide for EQ of commercial-grade items, especially those that will be located in a harsh environment.

03.11-20

Under Section 4.0, "Qualification Criteria," of MUAP 08015, Rev 0, Section 4.2 and Section 4.5.2 address aging. Section 4.2 is very general and simply describes the relevant regulatory requirements in 10 CFR 50.49(d)(5), stating that aging requirements are SSC-specific and are implemented on a project-specific basis. Section 4.5.2 provides guidance on thermal aging parameters, including that the aging period must be at least 100 hours, the aging temperature must be greater than assumed normal service conditions, but less than the state-change temperature for materials critical to the performance of the safety function in a harsh environment, and that a conservative, material property-relevant activation energy is used for critical materials in the aging calculation. Provide additional information on how the applicant's EQ program provides for verification that the assumptions used in qualified life calculations remain valid, or how adjustments are to be made if they are found not to be valid and how components will be examined periodically to determine if they are aging faster than predicted in a manner that could shorten qualified life, and how to deal with that situation.

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03.11-21

Under the center columns, "Inspections, Test and Analyses," of the ITAAC tables for the applicable subsystems in DCD Tier 1, Sections 2.4, "Reactor Systems," Section 2.5, "I&C Systems," Section 2.6, "Electrical Systems," and Section 2.7, "Plant Systems," the inspections, tests and analyses that correspond to the design commitments relating to EQ ("6.a," being the most common item number) use very similar language. Most state: "Type tests and/or analyses will be performed on the Class 1E equipment located in a harsh environment." Some state: "Type tests or analyses will be performed on the specified equipment to verify that it can withstand the postulated environmental conditions." Since harsh environment qualification by analysis alone is not in non-compliance with 10 CFR 50.49(f), revise the above ITAAC tables to reflect that "Type tests or testing and analysis in accordance with 10 CFR 50.49(f) will be performed.

03.11-22

In DCD Tier 1, Section 2.4, 2.5, 2.6 and 2.7 ITAAC tables, the center column of each table, "Inspections, Tests and Analyses," (ITA) states that type tests and/or analyses will be performed on Class 1E equipment located in a harsh environment, and an inspection will be performed on the as-built Class 1E equipment and associated wiring, cables and terminations located in a harsh environment (e.g., ITA 9.a.i for the RCS in Table 2.4.2-5). However, for several systems that have equipment that is required to be qualified for a harsh environment, no field inspection was specified. For example, ITAAC tables for reactor systems (Table 2.4.1-2), electrical penetration assemblies (Table 2.6.8-1), and the containment high-range radiation monitor (Table 2.7.6.13-3), require no inspection. Revise all ITAAC tables as required to indicate that all as-built or as-installed equipment required to be qualified by 10 CFR 50.49, including associated wiring, cables, connections, and terminations, is to be inspected to verify that it is installed properly and in a manner that is consistent with or enveloped by the configuration in which the EQ samples on which its EQ is based were qualified by type test or provide justification for not performing such inspections.

03.11-23

DCD Tier 1, Table 2.7.1.10-1, "Steam Generator Blowdown System (SGBS) Equipment Characteristics," lists certain steam generator blowdown isolation valves and sampling isolation valves and indicates that they include Class 1E equipment that is to be qualified for a harsh environment. However, Table 2.7.1.10-3, SGBS ITAAC, does not show any EQ-related ITAAC. Revise Table 2.7.1.10-3 to include complete "EQ-related ITAAC" as explained in other RAI input questions in this group and confirm that there are no other Sections in DCD Tier 1 with a similar discrepancy, and if any are found, correct them accordingly.

03.11-24

DCD Tier 1, Section 2.7.3.5.1, "Essential Chilled Water System," (ECWS) page 2.7-104, under "Equipment to be Qualified for Harsh Environments," refers to "...equipment identified in Table 2.7.3.5-2 as being qualified for a harsh environment...". However, the column for harsh environment qualification indicates 'No' for all equipment listed in Table

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2.7.3.5-2. Accordingly, there is no EQ-related ITAAC in the corresponding ITAAC table (2.7.3.5-5). It was not clear from the piping and instrumentation diagram (P&ID) on Pages 2.7-114, 115 whether any ECWS equipment is located in a harsh environment. The same is true for Spent Fuel Pit Cooling & Purification System, Subsection 2.7.6.3.1 and Area Radiation Airborne Radioactivity Monitoring System (ARARMS), Subsection 2.7.6.13.1. Clarify or confirm that there is indeed no equipment in the ECWS, the SFPC&PS (or any other system with a similar discrepancy), and ARARMS, that is required to be qualified for a harsh environment.

03.11-25

DCD Tier 2, Subsection 3.11.2, "Qualification Tests and Analyses", states that "equipment will be qualified for aging by test or analysis, while 10 CFR 50.49(d)(5) states that "equipment qualified by test must be preconditioned by natural or artificial (accelerated) aging to its end-of-installed life condition." From the language of Subsection 3.11.2, it is not clear that EQ test samples for all equipment required by 10 CFR 50.49 to be qualified by test would be preconditioned. Revise by deleting "or analysis" from Subsection 3.11.2 and add language to make it clear that the requirements of 10 CFR 50.49(d)(5) will be met.

03.11-26

Section 4.1.1 of MUAP 08015, Rev 0, states: "Compliance by the licensee (owner) with 10 CFR 50.65, "Requirements for monitoring the effectiveness of maintenance at nuclear power plants," and the associated guidance in RG 1.160 is considered sufficient to provide reasonable assurance that environmental considerations established during design are reviewed every refueling outage and maintained on a continuing basis to ensure that the qualified design life has not been reduced by thermal, radiation, and/or cyclic degradation resulting from unanticipated operational occurrences or service conditions." This statement is incorrect because compliance with the minimum requirements of 10 CFR 50.65, the Maintenance Rule, provides no reasonable assurance whatsoever that the specific areas in question are reviewed, such as environmental considerations for every refueling outage. Revise Section 4.1.1 of MUAP 08015, to state how specific maintenance requirements provided by vendors and determined by engineering judgment (periodic tests, calibrations, and inspections) for EQ, condition monitoring and preventive maintenance activities should provide reasonable assurance that the qualified design life has not been reduced and remains capable of fulfilling its intended function.

03.11-27

In US-APWR, DCD, Tier 2, Section 3.11, an equivalent qualification process is used for qualifying equipment subject to a loss of ventilation (3.11.4), estimated chemical and radiation environment (3.11.5), and mechanical equipment (3.11.6). All site-specific equipment will be qualified by using the equivalent qualification process "to that delineated for the US-APWR standard plant." By contrast, equipment subject to chemical and radiation exposures under Chemical Environment (3.11.5.1) and Radiation Environment (3.11.5.2) indicated to be qualified "pursuant to the implementation of the

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US-APWR EQ program.” Explain the difference in equipment qualification that is performed by the equivalent qualification process vs. the US-APWR EQ program. Provide details of what parameters are used to establish the equivalency in the process. Identify where the equivalent qualification process is defined or explained.

03.11-28

The ITAAC for systems that contain equipment required to be qualified for a harsh environment typically only mention Class 1E (safety-related) electrical equipment. This language would include equipment in these systems required by 10 CFR 50.49(b)(1) to be qualified, but does not state whether the applicant has determined that there is no equipment that is non-Class 1E, the failure of which could impact a safety function, which equipment, if any, would be required to be qualified under 10 CFR 50.49(b)(2). In addition, such equipment, if any, must not fail in a manner adverse to safety, nor mislead the operator. Therefore, the applicant is requested to provide additional information, specifically to revise its ITAAC to address all applicable equipment important to safety that would be required to be qualified by 10 CFR 50.49(b)(1) and (b)(2), if any, or explain whether it has determined, and the basis for that determination, that there is no 50.49(b)(2) equipment among these systems.