

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

1/21/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 10.04.09 - Auxiliary Feedwater System (PWR)

Application Section: 10.4.9 - Emergency Feedwater System

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

10.04.09-1

RAI 10.4.9-1

DCD Tier 1, Section 2.7.1.11.1, states that all of the emergency feedwater system (EFWS) components are located in the Reactor Building. However, Sheet 1 of DCD Tier 1 Table 2.7.1.11-1 indicates that the "A-emergency feedwater isolation valve" is located inside containment. Also, in DCD Tier 2 Section 10.4.9.1, the third bulleted item references "buildings where the EFWS components are located," thus implying that EFWS components are distributed among multiple buildings.

GDC 2 establishes requirements with respect to the EFWS design regarding protection against the effects of natural phenomena such as earthquakes, tornados, hurricanes and floods.

Verify the location of the EFWS components as presented in the DCD and update this information if necessary. If there are any EFWS components located outside the Reactor Building, explain how these components are protected against natural phenomena in accordance with the requirements of GDC 2. Include this information in the DCD and provide a markup in your response.

10.04.09-2

RAI 10.4.9-2

The EFW pits are seismic category I as indicated in DCD Tier 1 Table 2.7.1.11-2, DCD Tier 2 Table 3.2-2, DCD Tier 1 Figure 2.7.1.11-1, and DCD Tier 2 Figure 10.4.9-1. However, the seismic categorization of the EFW pit breather lines (vent lines) does not appear to be explicitly identified in the DCD.

GDC 2 establishes requirements with respect to the EFWS design regarding protection against the effects of natural phenomena, including earthquakes.

Identify the seismic classification of the EFW pit breather lines (vent lines). If these lines are not seismic category I, explain how the design of these lines meets the requirements of GDC 2. Include this information in the DCD and provide a markup in your response.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

10.04.09-3

RAI 10.4.9-3

Section 10.4.9.3 of the Tier 2 DCD states that safety-related portions of the EFWS are protected from missiles as described in Section 3.5. However, based on the review of the information in the DCD, the staff could not find sufficient information in regard to the provisions and plant design features to ensure adequate protection of the EFWS against the effects of internally and externally generated missiles.

GDC 4 establishes requirements with respect to the EFWS design regarding the capability of the system and the structure housing the system to withstand the effects of internally and externally generated missiles.

Provide an explanation of the provisions and plant design features to ensure adequate protection of the EFWS against the effects of internally and externally generated missiles, in accordance with the requirements of GDC 4. Include this information in the DCD and provide a markup in your response.

10.04.09-4

RAI 10.4.9-4

In DCD Tier 2 Section 14.2, the applicant includes instructions for the COL Holder to check for water hammer during normal system startup and operation conditions during motor-driven EFWS preoperational testing (14.2.12.1.24) and during turbine-driven EFWS preoperational testing (14.2.12.1.25). The COL Holder is also instructed to check for unacceptable water hammer during restoration of normal steam generator level from low water level as part of feedwater preoperational testing (14.2.12.1.29). The staff reviewed the design and test provisions, and considered them to be appropriate for minimizing water hammer events, but there was no information presented in the DCD that will ensure development of operating and maintenance procedures by the COL applicant that will minimize the potential for water hammer in the EFWS during operation. Additionally, there is no mention that lines need to be water-solid to prevent air entrainment.

Compliance with the requirements of GDC 4 includes meeting the guidance of Branch Technical Position (BTP) 10-2, "Design Guidelines to Avoid Water Hammer in Steam Generators." Also, Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," states that lines should be sufficiently filled with water to ensure that any gas accumulation is below the amount needed to challenge system operability.

Explain how the DCD will ensure development of operating and maintenance procedures by the COL applicant that will minimize the potential for water hammer in the EFWS during operation. Also, explain how the DCD will ensure that the COL applicant will maintain EFWS piping sufficiently filled with water such that any gas accumulation is

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

below the amount needed to challenge system operability. Include this information in the DCD and provide a markup in your response.

10.04.09-5

RAI 10.4.9-5

In DCD Tier 2 Section 10.4.9.2.2, Item A (b) "Normal Plant Operation," p.10.4-83, the second paragraph states the following: "The manual valves in the suction line flow paths from the EFW pits to the M/D and T/D EFW pumps are normally closed." However, in Figure 10.4.9-1, it appears that these pump suction valves are normally open.

Compliance with the requirements of GDC 34 and 44 includes the capability to transfer heat loads from the reactor system to a heat sink under both normal operating and accident conditions.

Correct the apparent discrepancy between the discussion in DCD Tier 2 Section 10.4.9.2.2 Item A (b) and Figure 10.4.9-1 with regard to the normal position of the EFWS suction valves. If the suction valves are normally closed, demonstrate how the EFWS can operate in a timely manner to provide heat removal given that local operator action would be required to open the valves prior to establishing injection flow from the EFWS. Include this information in the DCD and provide a markup in your response.

10.04.09-6

RAI 10.4.9-6

The DCD does not appear to describe methods used to protect the purity and cleanliness of the EFW pit inventory.

Per SRP 9.2.6 Section III, Item 1.C, the applicant should discuss methods to protect the purity and cleanliness of the EFW pit inventory. Methods might include, for example, pit coatings, covers, and filtration.

Describe methods used to protect the purity and cleanliness of the EFW pit inventory. If filtration is required, explain how it will be ensured that clogging of filters would not impact EFWS availability. Include this information in the DCD and provide a markup in your response.

10.04.09-7

RAI 10.4.9-7

In accordance with DCD Tier 2 Figure 10.4.9-1 and DCD Tier 2, Chapter 16, p. B 3.3.2-24, the demineralized water storage tank (DWST) provides a direct backup source for

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

EFWS. If the water level of EFW pit reached low-low level, operators are given alarm in main control room. Then the EFW pumps will be stopped or the water source will be switched to the DWST manually to maintain sufficient EFW flow.

In accordance with SRP 10.4.9 Section III, Item 3, the EFWS design should have features to meet the generic recommendations of NUREG-0611 and NUREG-0635. Generic Short Term Recommendation No. 4 (GS-4) recommends emergency procedures be available for transferring to alternate sources of EFW supply.

DCD Tier 2 Section 13.5.3 states that the COL Applicant is to describe the program for developing and implementing emergency operating procedures. However, the staff could not find a specific commitment that the COL Applicant would develop emergency procedures that specifically address the switchover of water to the DWST. Demonstrate how it will be assured that emergency procedures will be developed for switchover of water to the DWST. Include this information in the DCD and provide a markup in your response.

10.04.09-8

RAI 10.4.9-8

The staff could not find in the DCD a statement regarding the amount of time that the turbine-driven EFWS pump trains could supply flow to the plant in the absence of all ac power.

In accordance with SRP 10.4.9 Section III, Item 3, the EFWS design should have features to meet the generic recommendations of NUREG-0611 and NUREG-0635. Generic Short Term Recommendation No. 5 (GS-5) recommends the plant be capable of providing required EFW flow for at least two hours from one EFWS pump train independent of any ac power source.

Demonstrate how the EFWS design meets Generic Short Term Recommendation No. 5 (GS-5) listed in NUREG-0611 and NUREG-0635. Considerations related to extended turbine-driven pump operation without ac power include, for example, the continued availability of instrumentation and control (I&C) and pump room cooling. Include this information in the DCD and provide a markup in your response.

10.04.09-9

RAI 10.4.9-9

The staff could not find a specific commitment that the COL Applicant would develop procedures and Technical Specification requirements that specifically require confirmation of the availability of an EFW flow path that has been previously taken out of service to perform periodic testing or maintenance, including independent verification by a second operator.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

In accordance with SRP 10.4.9 Section III, Item 3, the EFWS design should have features to meet the generic recommendations of NUREG-0611 and NUREG-0635. Generic Short Term Recommendation No. 6 (GS-6) recommends confirmation of availability of an EFW flow path that has been taken out of service to perform periodic testing or maintenance, including Technical Specification requirements and procedures that require an operator to verify proper alignment of the flow path. The procedures should include an independent check by a second operator to verify the flow path alignment.

Provide the procedure that demonstrates how the EFWS design meets Generic Short Term Recommendation No. 6 (GS-6) listed in NUREG-0611 and NUREG-0635. Include this information in the DCD and provide a markup in your response.

10.04.09-10

RAI 10.4.9-10

It does not appear that the DCD has demonstrated that the low level alarm setpoint on the EFW pits allows at least 20 minutes for operator action, assuming the largest capacity EFW pump is operating.

In accordance with SRP 10.4.9 Section III, Item 3, the EFWS design should have features to meet the generic recommendations of NUREG-0611 and NUREG-0635. In the additional short-term recommendation "Primary EFW Water Source Low Level Alarm," the pit low level alarm setpoint should allow at least 20 minutes for operator action, assuming the largest capacity EFW pump is operating.

Demonstrate how the EFWS design meets the additional short-term recommendation "Primary EFW Water Source Low Level Alarm" listed in NUREG-0611 and NUREG-0635 with regard to time available for operator action. Include this information in the DCD and provide a markup in your response.

10.04.09-11

RAI 10.4.9-11

The staff could not find a commitment regarding an endurance test for the EFWS pumps.

In accordance with SRP 10.4.9 Section III, Item 3, the EFWS design should have features to meet the generic recommendations of NUREG-0611 and NUREG-0635. In the additional short-term recommendation "EFW Pump Endurance Test," it is requested that a 72-hour endurance test be performed on all EFWS pumps. Following the 72-hour pump run, the pumps should be shut down and cooled down and then restarted for one hour. In accordance with SRP 10.4.9 Section III, Item 3, a 48-hour test is acceptable rather than the 72-hour test.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

Demonstrate how the EFWS design meets the additional short-term recommendation "EFW Pump Endurance Test" listed in NUREG-0611 and NUREG-0635. Include this information in the DCD and provide a markup in your response.

10.04.09-12

RAI 10.4.9-12

As indicated in DCD Tier 2 Figures 1.2-9, 1.2-10, 9A-8, and 9A-9, each EFW pit is located in the Reactor Building within its own cubicle. However, these figures do not indicate doorways or other means of entry to these cubicles to facilitate inspections of the pits.

GDC 45 requires that systems providing essential cooling for safety-related equipment be designed to permit appropriate periodic inspection of important components.

Explain how EFW pit inspections will be accomplished in accordance with the requirements of GDC 45. Include this information in the DCD and provide a markup in your response.

10.04.09-13

RAI 10.4.9-13

The DCD does not appear to confirm that the testing of the EFWS will include transfer between normal and emergency buses.

In accordance with GDC 46 and SRP 10.4.9 Section IV, Item 9, testing of the EFWS should include transfer between normal and emergency buses.

Demonstrate how the EFWS is tested with regard to transfer between normal and emergency buses. Include this information in the DCD and provide a markup in your response.

10.04.09-14

RAI 10.4.9-14

The US-APWR has design provisions that detect and mitigate steam binding of the EFWS pumps due to back-leakage from the SGs to the EFWS. Steam leakage from the SGs to the EFWS pumps during standby conditions is prevented by a series arrangement of two check valves in each pump train, as shown in DCD Tier 2 Figure 10.4.9-1. The applicant states in Tier 2, Section 10.4.9.3, that temperature monitoring is performed in the EFW discharge lines as a means to detect back leakage.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

The EFW system design for recognizing the effects of steam binding of EFW pumps is consistent with guidance in Generic Safety Issue (GSI)-93, "Steam Binding of Auxiliary Feedwater Pumps," and associated Generic Letter 88-03, "Resolution of Generic Safety Issue 93." Generic Letter 88-03 specifically recommends that procedures be in place for recognizing steam binding and for restoring the EFWS to operable status if steam binding is detected. However, the staff could not find any information in the DCD to ensure that the COL applicant develops operating and maintenance procedures to address steam binding issues.

Provide the operating and maintenance procedures that address EFWS steam binding issues. Include this information in the DCD and provide a markup in your response.

10.04.09-15

RAI 10.4.9-15

The staff reviewed design provisions that have been incorporated to provide minimum flow for EFWS pump cooling. Minimum flow check valves for each EFWS pump are depicted in DCD Tier 2 Figure 10.4.9-1. The pump minimum flow recirculation lines discharge recirculation water back into the EFW pits.

There does not appear to be a discussion in DCD about pump minimum flow requirements addressed in NRC IE Bulletin IEB 88-04, "Potential Safety-Related Pump Loss." This bulletin discusses, in part, pump minimum flow requirements as they relate not only to pump cooling due to fluid temperature rise, but also to hydraulic instability due to insufficient minimum flow, resulting in pump cavitation and potential damage of the impeller. This bulletin recommends that the limitations associated with these hydraulic phenomena be considered when specifying minimum flow capacity.

Demonstrate how the EFWS design meets the pump minimum flow requirements listed in NRC IE Bulletin IEB 88-04, "Potential Safety-Related Pump Loss." Include this information in the DCD and provide a markup in your response.

10.04.09-16

RAI 10.4.9-16

The DCD does not appear to include testing of the EFW pits with regard to water chemistry and water quality.

10 CFR 52.47(a) 11) states that a design certification applicant is to propose Technical Specifications in accordance with 10 CFR 50.36 and 50.36a. 10 CFR 50.36(c)(3) requires that proposed Technical Specifications include Surveillance Requirements to assure that the necessary quality of systems and components is maintained and to meet LCOs.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

Add a surveillance requirement to the Technical Specifications that ensures that the EFW pit water chemistry and quality is appropriately maintained. Include this information in the DCD and provide a markup in your response.

10.04.09-17

RAI 10.4.9-17

As described in DCD Tier 2 Section 10.4.9.2.1, Item D “Emergency Feedwater Pits,” the EFW pits are connected by a tie line with two normally closed manual valves. If these valves are not maintained closed, it might be possible for a fault in one pit (e.g., a leak) to drain inventory from the remaining pit. However, a surveillance requirement for maintaining the EFW pit cross tie valves in the closed position is not provided.

10 CFR 52.47(a) 11) states that a design certification applicant is to propose Technical Specifications in accordance with 10 CFR 50.36 and 50.36a. 10 CFR 50.36(c)(3) requires that proposed Technical Specifications include Surveillance Requirements to assure that the necessary quality of systems and components is maintained and to meet LCOs.

Add a surveillance requirement to the Technical Specifications that ensures the EFW pit cross connect valves are normally maintained in the closed position. Include this information in the DCD and provide a markup in your response.

10.04.09-18

RAI 10.4.9-18

Section 2.7.1.11.1 of the Tier 1 DCD indicates that the EFWS is designed to remove decay heat and sensible heat during various transient and accident conditions, including main steam line break (MSLB) and steam generator tube rupture (SGTR). The EFWS should be designed to limit the maximum amount of feedwater that can be discharged following a MSLB to prevent excessive SG feedwater flow and pump runout. Furthermore, the EFWS should be designed to limit the maximum amount of feedwater that can be discharged into a failed steam generator so that steam generator overfill is prevented. However, the staff could not find an ITAAC entry or DCD Tier 1 discussion that specifically addresses limitations on maximum flowrates. Limitations on maximum EFW flow rates are, however, discussed in DCD Tier 2 Sections 10.4.9.2 and 10.4.9.2.1.

SRP 14.3, Appendix C, Item II.B.i states that operational/functional aspects of the system should be verified by ITAAC.

Demonstrate how it will be assured that limitations on maximum flowrates will be addressed as part of the ITAAC process, consistent with SRP 14.3, Appendix C, Item II.B.i. Include this information in the DCD and provide a markup in your response.

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

10.04.09-19

RAI 10.4.9-19

Section 2.7.1.11.1 of the Tier 1 DCD describes flow recirculation lines from each EFW pump that permit testing of each EFW pump at full flow. Figure 2.7.1.11-1 of the Tier 1 DCD displays flow recirculation lines that are connected to pump discharge paths.

General Design Criteria (GDC) 46 requires that the EFW system be designed to permit functional testing. This testing assures the integrity and operability of the EFW system and its components necessary for the removal of reactor core decay heat and reactor coolant system (RCS) sensible heat through the steam generators following transient conditions or postulated accidents. SRP 14.3, Appendix C, Item I.A.xiv states that normally, all design commitments in Tier 1 should be verified by a specific inspections, tests, analyses, and acceptance criteria (ITAAC) entry, unless there are specific reasons why this is not necessary. SRP 14.3, Appendix C, Item II.B.iv states that online test features should be verified by ITAAC. However, the staff could not locate supporting information that specifically demonstrates how the capability of EFW pump flow test features will be verified through the ITAAC process (e.g., functional flow tests).

Demonstrate how it will be assured that EFWS online test features will be addressed as part of the ITAAC process, consistent with SRP 14.3, Appendix C, Item I.A.xiv and SRP 14.3, Appendix C, Item II.B.iv. Include this information in the DCD and provide a markup in your response.

10.04.09-20

RAI 10.4.9-20

Figure 2.7.1.11-1 of the Tier 1 DCD illustrates the arrangement of EFW components by means of a flow diagram. A more detailed version of the EFW configuration is provided in the Figures 10.4.9-1 and 10.4.9-2 of the Tier 2 DCD. The set of additional details provided in Figures 10.4.9-1 and 10.4.9-2 of the Tier 2 DCD includes various check valves. By comparison, Figure 2.7.1.11-1 of the Tier 1 DCD does not include any check valves. It appears that at least some of the check valves shown in Figures 10.4.9-1 and 10.4.9-2 of the Tier 2 DCD have a safety related function (e.g., some check valves would prevent flow diversion of water through an inactive pump). Also, EFWS check valves are not explicitly identified in the ITAAC shown in Table 2.7.1.11-5 of the Tier 1 DCD.

SRP 14.3, Appendix C, Item I.B.ix states that Tier 1 figures for safety-related systems should include most of the valves on the DCD Tier 2 P&ID except for items, such as fill, drain, test tees, and maintenance isolation valves. The scope of valves to be included on the figures are those motor-operated valves (MOVs), power-operated valves (POVs), and check valves with a safety related active function. Also, SRP 14.3, Appendix C, Item II.B.i states that, typically, the system ITAAC specify functional tests or tests and analyses, to verify the direct safety functions for the various system operating modes.

Demonstrate how it will be assured that EFWS check valves will be addressed as part of the ITAAC process, consistent with SRP 14.3, Appendix C, Item II.B.i. Include this

REQUEST FOR ADDITIONAL INFORMATION NO. 160-1848 REVISION 0

information in the DCD and provide a markup in your response, including updates to Tier 1 flow diagrams to explicitly show EFWS check valves that have a safety function.

10.04.09-21

RAI 10.4.9-21

There is a Technical Specification surveillance requirement (SR) for the EFW pits, namely that the pit level be maintained at or above 204,850 gallons (SR 3.7.6.1). Also, DCD Tier 2 Section 10.4.9.3 states that the useable volume per pit is 204,850 gallons. However, the Acceptance Criteria for ITAAC 13 as shown in DCD Tier 1 Table 2.7.1.11-5 states that the water volume of each pit must be greater than or equal to 186,200 gallons. Thus, it appears that ITAAC 13 is not consistent with SR 3.7.6.1 and DCD Tier 2 Section 10.4.9.3.

SRP 14.3, Section III, "Review Procedures," Item 10 directs the reviewer to ensure that the ITAAC are compatible with the Technical Specifications.

Reconcile the discrepancy between the minimum pit capacity cited in the ITACC and the minimum pit capacity cited in the Technical Specifications and DCD Tier 2 Section 10.4.9.3. Include this information in the DCD and provide a markup in your response.

10.04.09-22

RAI 10.4.9-22

The DCD does not appear to include testing of the EFW pits with regard to water chemistry and water quality.

In accordance with SRP 14.2, the applicant should verify the performance capabilities of SSCs that are used for safe shutdown of the reactor under transient conditions (SRP 14.2 Acceptance Criteria Item II.5.ii), are assumed to function in the facility accident analysis (SRP 14.2 Acceptance Criteria Item II.5.v), or are identified as risk significant in the design-specific PRA (SRP 14.2 Acceptance Criteria Item II.5.viii).

Demonstrate how it will be assured that water chemistry and water quality associated with the EFW pit inventory will be tested, consistent with the SRP 14.2 Acceptance Criteria. Include this information in the DCD and provide a markup in your response