REQUEST FOR ADDITIONAL INFORMATION 407-3082 REVISION 1

6/24/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 06.03 - Emergency Core Cooling System
Application Section: 6.3

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

06.03-59

RAI 6.3.1.1-1

For clarification, should the bulleted item in Section 6.3 "• Secondary steam system piping failure" be changed to "• Secondary system piping failures" since the feedline break appears to require the SI pumps for cooling the RWSP? The CS/RHR heat exchangers are used for long term cooling by removing heat from the RWSP water, which is recirculated to the reactor vessel by the safety injection pumps. See DCD Section 15.0.0.8, "Long Term Cooling."

As indicated in the technical specification (TS) Bases for B 3.5.4 Refueling Water Storage Pit (RWSP), "*The maximum temperature ensures that the amount of cooling provided from the RWSP during the heatup phase of a feedline break is consistent with safety analysis assumptions; the minimum is an assumption in both the MSLB and inadvertent ECCS actuation analyses, although the inadvertent ECCS actuation event is typically nonlimiting.*" Explain this statement as it does not appear that the feedline break is discussed in DCD Section 6.3.3, "Performance Evaluation." The event is analyzed under DCD Section 15.2, "Decrease in Heat Removal by the Secondary System," in DCD Section 15.2.8," Feedwater System Pipe Break Inside and Outside Containment." The loss of normal feedwater event, analyzed under DCD Section 15.2.7, "Loss of Normal Feedwater Flow," also requires the SI pumps to cool the RWSP. Also state if feedline break is the more limiting of these two events with respect to the TS LCO for the RWSP temperature?

06.03-60

RAI 6.3.2.2-8

In DCD Section 6.3.2.2.2, the text states: "*The required capacity of each accumulator at the large injection flow rate is approximately 1,307 ft^3, which is increased to approximately 1,342 ft^3*," to provide margin. However, in DCD Table 6.3-5, "Safety Injection System Design Parameters," the required capacity is stated to be greater than or equal to 1,326.8 ft^3. This value is also stated in DCD Tier 1 Table 2.4.4-5, "Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria," Design Commitment 7b, Acceptance Criteria 7.b.i. Modify the text in DCD Section 6.3.2.2.2 to be consistent with acceptance criteria and include the evaluation used to develop the required capacity for the large injection flow rate or provide a reference. As appropriate revise the discussion concerning the downcomer and lower plenum volume values to be consistent with the acceptance criterion value.

06.03-61

RAI 6.3.2.2-19

A minimum of 81,230 ft^3 of available water is required in the RWSP. Explain how TS SR 3.5.4.2, to verify RWSP borated water volume is greater than or equal to 329,150 gallons (42,798 ft^3), demonstrates the required minimum volume is available.

06.03-62

RAI 6.3.2.2-20

In DCD Section 6.3.2.2.3 Refueling Water Storage Pit, MHI states "The boric acid water in the RWSP is purified using the refueling water storage system (RWS). The RWS is shown in Figure 6.3-7 and may be cross-connected to one of two SFPCS filter and demineralizer vessels to remove the solid materials and the dissolved impurities for purification. The capacity of the purification subsystem is designed to maintain the chemistry of the spent fuel pool, the refueling cavity, the refueling water storage auxiliary tank, and the RWSP."

In DCD Section 15.6.5.3.1.3 Post-LOCA Long term Cooling Evaluation Model, Borated Water Source, on page 15.6-72, MHI states that "The RWSP, accumulator, and RCS are considered as the only sources of borated water."

1. Identify if there are any other sources of borated water that could enter the containment.
2. If the RWS is cross-tied to the RWSP during a LOCA, an additional source of borated water is introduced. Explain the consequences of this source of borated water and how it would impact boron concentrations in the reactor.
3. If the RWS system is automatically isolated during the LOCA, identify how the additional boric acid left in the piping between the RWSP and the isolation valves is accounted for in the boric acid concentration calculation.

06.03-63

RAI 6.3.2.2-21: Has a calculation been performed demonstrating what the maximum RWSP temperatures are during a SBLOCA and LBLOCA prior to, during and after containment spray? If so, what are the maximum RWSP temperatures and associated pressures for each of the different phases (prior to spray, during and when the CS/RHR discharges back to RWSP)? What conservatisms and/or uncertainties are used in calculating the maximum temperatures?

06.03-64

RAI 6.3.3-1: In places (pages 6.3-17, 6.3-18, and 6.3-20) it is stated “Two radiological doses are less than the guideline value of 10 CFR 50.34 and 10% of guideline value of 10 CFR 50.34, respectively.” This should be rephrased as “*The* radiological doses …,” to clarify that the consequences are all acceptable, not two of some greater set of calculations

06.03-65

RAI 6.3.3-2: In DCD Section 6.3.3.4, “ECCS Flow Performance,” it s stated “High head safety injection flow characteristics for minimum and maximum safeguards are provided for the system in Figures 6.3-15 and 6.3-16. These curves are reproduced in Figure 15.6.5-17, 26 and 35 for the small-break LOCA and in Figure 15.6.5-7 for the large-break LOCA reference case.” The figures in Section 15 are for the resulting accumulator and safety injection mass flowrates for specific breaks, not the SI flow characteristic. Make these consistent.

06.03-66

RAI 6.3.3-3: In DCD Section 6.3.3, “Performance Evaluation,” part A, “Increase in Heat Removal by the Secondary System,” section i. “Inadvertent opening of steam generator relief or safety valve,” it is stated, in part, “radiological doses described in Subsection 15.1.5.” The dose assessment is provided in Subsection 15.1.4.5, “Radiological Consequences,” which points to Section 15.1.5, “Steam System Piping Failures Inside and Outside of Containment,” which includes Subsection 15.1.5.5, “Radiological Consequences.” The text should clarify that the radiological consequences are bounded by the Section 15.1.5 event.

06.03-67

RAI 6.3.3-4: In DCD Section 6.3.3, “Performance Evaluation,” part A, “Increase in Heat Removal by the Secondary System,” section ii., “Steam system piping breaks inside and outside of containment,” the radiological consequences summary should point to DCD Subsection 15.1.5.5.

06.03-68

RAI 6.3.3-5: In DCD Section 6.3.3, “Performance Evaluation,” part B, “Decrease in Reactor Coolant Inventory,” section ii., “Radiological consequences of a steam generator tube failure,” it is stated “The time sequence of the event is provided in Table 15.6.3-1 and 2.” Table 15.6.3-2 is for the Steam Generator Overfill Analysis, performed to demonstrate the two additional MHI acceptance criteria for a SGTR: (1) to not allow steam generator overfill and (2) to maintain the reactor coolant system (RCS) and main steam pressures below 110% of their respective design pressure to assure that rupture of the primary or steam system piping does not occur. The reference to Table 15.6.3-2 should be removed or this section should also summarize the additional acceptance criteria adopted by MHI for the SGTR event. In addition the radiological consequences summary should point to DCD Subsection 15.6.3.5.

06.03-69

RAI 6.3.3-6: In DCD Section 6.3.3, "Performance Evaluation," part B, "Decrease in Reactor Coolant Inventory," section iii., "Spectrum of rod ejection accidents," the radiological consequences summary should point to DCD Subsection 15.4.8.5.

06.03-70

RAI 6.3.3-7: In DCD Section 6.3.3 Performance Evaluation, subsection B. Decrease in Reactor Coolant Inventory, part i. LOCA resulting from a spectrum of postulated piping breaks within the RCPB, MHI states that a detailed description of the large and small break analysis and results is provided in Chapter 15, Subsection 15.6.5. In DCD Section 15.6.5.2.2 Description of Small Break LOCA, Natural Circulation phase, on page 15.6-65, MHI states:

"When the blowdown phase ends, two-phase natural circulation is established in the RCS loops with the decay heat being removed by heat transfer (condensation and convection) to the SG secondary side. The EFW is initiated to maintain the secondary side inventory. As more coolant is lost from the RCS through the break, steam accumulates in the downhill side of the SG tubes and the crossover leg. The natural circulation phase will continue until there is insufficient driving head on the cold leg side of the loops, due to the accumulation of steam in loops between the top of the steam generator tubes and the loop seals."

a) In order to evaluate the blowdown, natural circulation, loop seal clearance, boil-off, core recovery and long term cooling phases of the transient, the staff requests that MHI provide section and plan diagrams showing locations, flows, and elevations of the important events, which include break location, ECCS injection locations and flow with respect to time.

b) Provide these diagrams when describing the small break and large break LOCAs.

06.03-71

RAI 6.3.5.4-1: Add the description of the RWSP temperature monitoring instrumentation and alarms to this section.

06.03-72

RAI 6.3.4.1-2: For test 14.2.12.1.54, "Safety Injection System (SIS) Preoperational Test," Objective 2 is "To verify that the head/flow characteristics of each safety injection pump is approximately the same." Explain what is meant by this? How far apart can the characteristics be and still be acceptable? Shouldn't the objective be the same as Acceptance Criterion 2, "The performance characteristics of safety injection pumps are within design specifications?"

06.03-73

RAI 6.3.4.1-3: For test 14.2.12.1.54, there is no verification of alarms which would indicate pump degradation by unacceptable temperatures within the pump motors, seals, or environment. Are these alarms checked elsewhere? If not, how can the design objective stated in DCD Section 6.3.3.3, "The ECCS is designed with redundancy so that the specified safety functions are performed assuming a single failure of an active component for a short-term following an accident, and assuming either a single failure of an active component or a single failure of a passive component for a long-term following an accident," be assured?

06.03-74

RAI 6.3.4.1-4: For test 14.2.12.1.54, it is stated that "The RWSP contains an adequate supply of demineralized water for test performance." What is an adequate supply, in terms of level and volume, since this should be considered in the duration on the SI flow test time and the determination of adequate NPSH.

06.03-75

RAI 6.3.4.1-5: For test 14.2.12.1.56, "14.2.12.1.56 Safety Injection Check Valve Preoperational Test," the Acceptance Criteria include item 1. "The accumulator discharge and injection line check valves operate as demonstrated by verification of flow through the check valves as described Subsections 6.3.2.2.1 and 6.3.2.2.2." The text should be modified to "and *safety* injection line check valves," to be consistent with the test Objectives (Item 2.)

06.03-76

RAI 6.3.4.1-6: For test 14.2.12.1.57, "Safety Injection Accumulator Test," D. Acceptance Criteria item 1 is "The pressure is controlled properly as designed." E
xplain what this means and how is it verified by the test. Is this referring to the nitrogen charging and overpressure control?

06.03-77

RAI 6.3.4.1-7: For test 14.2.12.1.57, D. Acceptance Criteria item 2 is "The discharge performance is as specified in design specifications (Subsections 6.3.1.1 and 6.3.2.2)." Subsection 6.3.1.1 describes the primary function of the ECCS and the events for which ECCS is required, no performance information is provided. The accumulator performance information is provided in Subsection 6.3.2.2.2, "Accumulators." Explain what information is provided in 6.3.1.1 that is relevant to the test. Should the reference to 6.3.2.2 be changes to 6.3.2.2.2, or is there additional information in the other subsections under 6.3.2.2 relevant to the test?

06.03-78

RAI 6.3.4.1-7: For test 14.2.12.1.57, D. Acceptance Criteria item 2 is "The discharge performance is as specified in design specifications (Subsections 6.3.1.1 and 6.3.2.2)." Subsection 6.3.1.1 describes the primary function of the ECCS and the events for which ECCS is required, no performance information is provided. The accumulator performance information is provided in Subsection 6.3.2.2.2, "Accumulators." Explain what information is provided in 6.3.1.1 that is relevant to the test. Should the reference to 6.3.2.2 be changes to 6.3.2.2.2, or is there additional information in the other subsections under 6.3.2.2 relevant to the test?

06.03-79

RAI 6.3.4.1-9: For test 14.2.12.1.57, there are no tests of the instrumentation used to monitor the accumulator temperature, level (volume) or pressure, or alarms. Where are these tested?

06.03-80

RAI 6.3.3.1-1: The bases for SR 3.5.4.1 states that "The SR is modified by a Note that eliminates the requirement to perform this Surveillance when ambient air temperatures are within the operating limits of the RWSP. With ambient air temperatures within the band, the RWSP temperature should not exceed the limits." Define the meaning of "ambient air temperature." Is this the containment temperature or the environmental temperature? If it is the environmental (outside air) temperature then it may not adequate address the RWSP temperature which could be very different. If it is the containment temperature then the Bases should so indicate. A Note to this effect does not appear in TS 3.5.4, "Refueling Water Storage Pit (RWSP)." Explain or modify the TS appropriately

06.03-81

RAI-6.3.3.2-1: In Table 15.6.5-2, "US-APWR Major Plant Parameter Inputs Used in the Appendix-K based Small Break LOCA Analysis," the accumulator volume is stated to be a nominal value of 2,150 ft^3. Explain this value and its relation to TS 3.5.1, "Accumulators," SR 3.5.1.2 to verify borated water volume in each accumulator is ≥ 19,300 gallons (2,580 ft^3) and ≤ 19,700 gallons (2,633 ft^3), and Table 15.6.5-1, "US-APWR Major Plant Parameter Inputs Used in the Best-Estimate Large break LOCA Analysis," which states the accumulator reference case water volume is 2,152 ft^3.

06.03-82

RAI 6.3.3.3-2: In DCD Section 6.3.3.3 and Table 6.3-6, MHI discusses single failure considerations for the ECCS. Identify whether check valves are considered to be passive components for the failure modes and effects evaluation. If so, then a passive failure could result in total loss of flow.

06.03-83

RAI 6.3.1.2-1 DCD, Chapter 6.3.1.2, Safe Shutdown. Figure 5.4.7-4, Sheet 1 and 2 appear to be identical. Is the valve alignment for safe shutdown (Sheet 2 of 4) the same as Normal Shutdown (Sheet 1 of 4)? From DCD Chapter 15.0.08 the alignment sounds different for LBLOCA where containment sprays, and eventually, the CS/RHR pump discharge is aligned to the RWSP. Is LBLOCA the only Postulated Accident which has a different alignment? Do all Anticipated Operational Occurrences have the valve lineup given in Figure 5.4.7-4, Sheet 2?