

**REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1**

10/29/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation

Application Section: 19.1.6

QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1 (AP1000/EPR Projects) (SPLA)

19-136

Clarify the criterion for declaring that shutdown probabilistic risk assessment (PRA) sequences lead to core damage (e.g., water level, boiling, peak clad temperature). Describe the thermal-hydraulic analyses that were performed for each scenario to determine whether core damage occurs.

19-137

Revise the design control document (DCD) to include additional information on the reduction factors used in POS other than 8-1 based on the number of mitigation systems and human error dependency, similar to that provided on page 20-22 of the PRA technical report (MUAP-07030). In addition, provide the following information:

- a. How the “conservative value of human error” was chosen, as well as a justification that it is conservative
- b. Why exceptions were taken to use higher values for certain combinations of mitigating systems or functions
- c. How the number of operation tasks for each scenario were determined, given that procedures are not yet complete

19-138

Page 19.1-128 states that “important SSCs [structures, systems, and components] and operator actions of other POS are qualitatively extracted based on the mitigation system which is available for each POS...[p]assive components are excluded from important SSCs because generally the failure rate of passive mode is lower than active mode.” State which passive components were excluded based on this assumption. Provide additional justification for this assumption, given that components with an assumed low failure rate may have extremely high risk achievement worth (RAW) values, and attention to these components is important to ensure that plant risk is as low as was assumed during design certification.

## REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1

19-139

(Follow-up to Question 19-46) The response to Question 19-46 indicates that during POS 3 and portions of POS 4, a single residual heat removal (RHR) train does not remove enough decay heat to prevent boiling, but that “RHR will continuously remove decay heat until RHR function degrades.” Provide a justification for assuming that the RHR pump will continue to operate when there is boiling in the reactor coolant system (RCS). How long will the single RHR pump continue to operate before “function degrades” and a loss of RHR occurs? When will the core be uncovered in this scenario? If the RHR pump cannot function for its entire mission time in POS 3 and portions of POS 4, losses of RHR and subsequent mitigation strategies should be quantitatively evaluated in these POS using two trains of RHR as the success criterion.

19-140

(Follow-up to Question 19-47) Question 19-20(c) requested a sensitivity study for the shutdown PRA that credits only the systems required to be operable according to technical specifications (TS), since voluntary measures that are not required by current regulations could be withdrawn by licensees without NRC approval. The response to Question 19-47 clarified that the sensitivity study credited automatic isolation of the low pressure letdown line on low level, the charging pumps, the refueling water storage pit (RWSP), and the refueling water storage auxiliary tank (RWSAT) despite the fact that there are no TS requiring these components to be available during MODES 5 and 6.

Standard Review Plan (SRP) Section 19.0 states that the design-phase PRA is used to demonstrate whether the plant design, including the impact of site-specific characteristics, represents a reduction in risk compared to existing operating plants. The PRA is also used to identify and support the development of specifications such as inspections, tests, analyses, and acceptance criteria (ITAAC); reliability assurance program (RAP); TS; and combined license (COL) items. So that the staff can make these conclusions in its final safety evaluation report (FSER):

a. Provide the results of a sensitivity study that specifies guaranteed failure for all operator actions, equipment, and sensors related to systems that are not required to be operable during shutdown, including those listed above.

b. Since the response to Question 19-20(a) states that shutdown risk will be ensured through the configuration risk management program (part of the maintenance rule), provide the incremental core damage probability (ICDP) and incremental large release probability (ILRP) for each POS (where incremental is defined between the zero-maintenance shutdown PRA and the sensitivity study performed for part (a) above). Describe how the values were calculated, including how demand-based events such as overdrain were treated separately. Compare the values to the guidelines in NUMARC 93-01, Section 11, and discuss what risk management actions, if any, would be needed if minimum TS compliance were planned.

## REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1

19-141

(Follow-up to Question 19-56) Provide additional information on flow diversions during shutdown. Specifically:

a. Revise page 19.1-102 of the DCD to clarify which valves can cause flow diversion to the RWSP if they are inadvertently opened. Include both the valve numbers from the PRA (9815A/B/C/D) and the valve numbers from the design piping and instrumentation diagrams (P&ID) in the rest of the FSAR, so that input to other programs such as human factors is accurate. (Note that valves 9815A/B/C/D in Figure 19.1-2, Sheet 4, appear to be the same as valves MOV-025A/B/C/D in Figure 5.4.7-2, but that the P&ID-to-PRA reference table submitted to the NRC on March 3, 2008, indicates that valves 9815A/B/C/D correspond to MOV-021A/B/C/D.)

b. Tier 1, Table 2.4.5-2 indicates that the active safety function of MOV-025A/B/C/D is to transfer open. Describe the scenarios for which MOV-025A/B/C/D are expected to transfer open to perform a safety function, and discuss the impact on plant operations of the design change to lock these valves closed. Discuss whether the valves can still be operated remotely, as stated in Table 2.4.5-2, if they are locked closed. Confirm that the impact of this design change has been addressed in analyses or documentation related to section 5.4.7 of the DCD. Revise the DCD as needed to reflect the response.

c. Revise Tier 1, Figure 2.4.5-1, to indicate that valves MOV-025A/B/C/D are now locked closed.

d. Revise Figure 19.1-2, Sheet 4, to indicate that valves 9815A/B/C/D are now locked closed.

19-142

(Follow-up to Question 19-61) The statement about mid-loop water level in the response to Question 19-61 is still unclear. The proposed paragraph would read:

“The level in the primary system is lowered to near the mid-line of the hot and cold legs. The RCS water level should be higher than 0.33 feet above the mid-loop and the RHR flow of 1,550 to 2,650 gpm should be supplied. At this water level, the air/water interface is at close proximity to the RHR suction nozzles located on the hot legs, but the higher RCS water level applied for the US-APWR design reduces the possibility of air entrainment into the RHR pump suction.”

Even as revised, it appears that the antecedent of “this water level” is “0.33 feet above the mid-loop” and the statement continues to contradict itself. If the intention, as stated in the response to Question 19-61, is that “this water level” refers to the mid-loop water level used in conventional plants, the discussion in section 5.4.7.2.3.6 should be revised to state this intention.

19-143

(Follow-up to Questions 19-65) The response to Question 19-65 states that a vent valve in the pressurizer spray system is opened during draining of the RCS. Clarify by both

## REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1

P&ID and PRA number which valve is opened, and provide the effective area of this vent path.

19-144

(Follow-up to Questions 19-65 and 19-75) The response to Question 19-75 states that "[d]uring POS 4-3 and 8-1, there is a period of time where the reactor vessel upper plenum is closed and the RCS vent paths are opened. If loss of RHR occurs during this condition, RCS pressure may exceed the design pressure of nozzle dams after initiation of bulk boiling in the RCS." The list of expeditious actions in Generic Letter (GL) 88-17 includes a direction to "[i]mplement procedures and administrative controls that reasonably assure that all hot legs are not blocked simultaneously by nozzle dams unless a vent path is provided that is large enough to prevent pressurization of the upper plenum of the [reactor vessel]."

- a. Provide a description and results of calculations of RCS pressure following loss of RHR in POS 4-3 and 8-1.
- b. Provide a description and results of the calculation to determine adequate vent size to meet GL 88-17.
- c. Discuss how the direction in GL 88-17 to prevent pressurization is met if RCS pressure can exceed the design pressure of the nozzle dams.
- d. Discuss the impact on plant operations of loss of reactor coolant via the steam generator manways following overpressure of the nozzle dams. How has this scenario been addressed in the PRA? Are the success criteria and timing for safety injection in this scenario different from the injection functions already postulated in the loss of RHR event tree?

19-145

(Follow-up to Question 19-44) Provide the volume of water in the spent fuel pool (SFP) above the level of the gravity drain suction nozzle. State how long it would take for this water volume to be exhausted at the expected flow rate. If exhaustion would occur before the mission time of the shutdown PRA, discuss what strategy would be necessary following exhaustion (e.g., makeup from another water source) and how this strategy is addressed both in the PRA and in programs that receive input from the PRA (e.g., RAP, ITAAC, TS, human factors).

19-146

(Follow-up to Question 19-44) Clarify which valves must be opened to begin a gravity drain from the SFP. The response to Question 19-2 indicates that valves RHR-VLV-031A/D and RHR-VLV-032A/D must be opened, but Figures 5.4.7-2 and 9.1.3-1 (transfer points 2949 and 3806) indicate that the two cross-tied drain lines from the SFP connect to the RHR system via locked-closed valves VLV-033A/D and VLV-034A/D.

## REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1

Confirm that the correct valve numbers have been used in programs that receive input from the PRA (e.g., RAP, ITAAC, TS, human factors).

19-147

(Follow-up to Question 19-44) Additional information is needed on the elevation of the gravity drain line suction nozzles in the SFP. Specifically:

- a. Provide the elevation of the top of the spent fuel in the SFP.
- b. Confirm that 23 feet of water, as required by TS 4.3.2, can be maintained above the spent fuel even in the scenario of gravity injection to the RCS.
- c. Revise Figure 9.1.3-1, which depicts the drain lines near the top of the spent fuel, as needed.
- d. Revise the description of and ITAAC for the SFP in Tier 1, section 2.7.6.2, as needed, to ensure that the SFP is constructed and inspected with a gravity injection nozzle at an elevation that will not allow the spent fuel to be endangered during draining.

19-148

(Follow-up to Question 19-44) Clarify in which POS gravity injection is credited as a mitigation strategy, and whether the reactor vessel head is removed in these POS. If the RCS is vented with a high elevation vent rather than with the head removed, surge line flooding could impede gravity injection (see the related notification from Westinghouse, Agencywide Documents Access and Management System (ADAMS) Accession No. ML013380174). Discuss how the surge line flooding issue has been addressed, if applicable.

19-149

(Follow-up to Question 19-76) The figures provided in response to Question 19-76 do not include enough detail for the staff to understand the US-APWR shutdown strategy. Supplement the figures with a text description, including systems and equipment in use (e.g., for depressurization, air injection to steam generator tubes, and vacuuming), necessary operator actions, and indication of when MODE and POS changes occur.

19-150

(Follow-up to Question 19-77) Additional information is needed on the use of RHR relief valves as the bleed path for feed-and-bleed operation during shutdown. Specifically:

- a. Why are the RHR relief valves used instead of the pressurizer safety depressurization valves, which are used for feed and bleed at power?
- b. Can the RHR relief valves be opened manually from the control room? If so, describe the cues and procedural guidance that would direct the operators to open the valves. If

## REQUEST FOR ADDITIONAL INFORMATION 88-1438 REVISION 1

not, discuss how long it would take for pressure to increase to the RHR relief valve setpoint, the effect of the pressure increase on temporary pressure boundaries (e.g., nozzle dams), and how the PRA addresses this scenario.

c. The RHR relief valves appear not to be included in the RAP equipment list in section 17.4 of the DCD. Given that these valves are used both for LTOP protection and a primary bleed path, discuss the quantitative and qualitative justification for their exclusion from RAP. If the valves were deliberately excluded from other programs that receive input from the PRA, discuss these exclusions as well.