REQUEST FOR ADDITIONAL INFORMATION 369-2625 REVISION 1

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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)

19-334

(Follow-up to Question 19-234) The response to Question 19-234 indicates that β' (a reduced common-cause failure (CCF) parameter) was used in the residual heat removal (RHR) pump CCF model. The staff needs additional information on this treatment.

a. Chapter 8 of the probabilistic risk assessment (PRA) provides justification for using this parameter for component cooling water (CCW) and essential service water (ESW) pumps, but not for RHR. Justify using this parameter for RHR pumps, or revise the PRA to use typical CCF parameters.

b. It appears that β' may also have been applied for CCF of two running RHR pumps, after which the operator must start a standby pump. The discussion of the revised CCW and ESW parameters indicates that the groups of two standby or running pumps use standard CCF parameters. Discuss the treatment of CCF of two running RHR pumps.

19-335

(Follow-up to Question 19-207) Describe the mechanism for ensuring that the assumptions and insights documented in the response to Question 19-207 remain valid in the PRA for the as-built, as-operated plant. For example, how will training developers know to look at this table to ensure that training assumed in the PRA has been established? This goal could be achieved both individually (by having a disposition linking to a requirement in another part of the DCD) and/or collectively (e.g., by a combined license (COL) item that directs the applicant to confirm the assumptions in the future). Note that the COL items provided in Design Control Document (DCD) Section 19.3.3 direct the COL applicant only to update external events and fragilities.

19-336

(Follow-up to Question 19-207) The staff observes that many important insights and assumptions related to the shutdown PRA were added to Table 19.1-115 in response to Question 19-207; however, additional clarifications are needed as discussed below. Please address these areas. In addition, perform a systematic search to ensure all important assumptions in the shutdown PRA are included and appropriate dispositions recorded before the revised table is added to the DCD.

a. The disposition for Item 28 in the “Design features and insights” section (bottom vessel head without penetrations) should refer to the portion of the DCD where this design is discussed (e.g., Tier 1 description and figures), not to the RAI response.

b. The “Operator actions during LPSD [low power and shutdown] events and assumptions” section includes two entries describing each operator action. Specific operator actions that are already in tables of risk-important basic events do not need to be listed, but the assumption that these operator actions are included in procedures and training should be listed with an appropriate disposition (e.g., DCD Section 18.6).

c. The “Operator actions during LPSD events and assumptions” mentions the indication used to perform various operator actions. In addition, item 11 in the “LPSD other assumptions” section states “[t]he controls that ensure the indication are available during shutdown” without specifying which controls or indication. The disposition for this item refers to Question 19-73, in which these indications were specifically stated, and to “COL 13.5,” which is unclear. The assumption that certain specific indications are available during shutdown should be recorded in Table 19.1-115 with an appropriate disposition.

d. Item 5 in the “LPSD other assumptions” section is unclear. The response to Question 19-11 stated that the failure rate of the suction strainer is unchanged from the at-power model, which has a different meaning from “potential plugging of the suction strainers due to debris is excluded from the PRA modeling.” In addition, the disposition should refer to the specific DCD section or program (e.g., containment cleanliness) that ensures this assumption is valid.

e. Item 9 in the “LPSD other assumptions” section should be more explicit. The response to Question 19-45 provided detailed information from analyses showing that the pressurizer spray line vent needs to be closed to prevent inventory loss and core damage. In addition, a more appropriate disposition is needed to ensure that the importance of this action (which is not modeled explicitly in the PRA and therefore does not appear in the list of risk-important human actions) is emphasized in procedures and training.

f. Items 21 and 24 in the “Internal flood risk assumption” section are identical.

g. Item 23 in the “Internal flood risk assumption” section is an extremely important operational insight, but the disposition refers only to the PRA maintenance section of the DCD. It is unclear how the requirement to have specific trains available during shutdown will be translated into procedures and training.

19-337

(Follow-up to Question 19-208) Although (per Question 19-208) the PRA does not model starting additional charging or safety injection (SI) pumps that were locked out for low temperature overpressure (LTOP) compliance, operators are likely to enable and start them after initial pumps fail. This insight for risk reduction should be included in the design control document (DCD), such as in Section 19.1.3.1 or where the success criteria for the systems are discussed.

19-338

(Follow-up to Question 19-209) Question 19-209 addresses forced outages that do not lead to drained maintenance. However, the sensitivity study documented in the response does not consider forced outages leading to drained maintenance (e.g., steam generator inspections needed mid-cycle). Discuss the results of a sensitivity study that addresses all types of forced outages, or justify why forced outages requiring mid-loop operation are not expected for the US-APWR.

19-339

(Follow-up to Question 19-234) The response to Question 19-234 addresses groups of three or four RHR heat exchangers. However, CCF of the two heat exchangers supporting running RHR trains would necessitate operator action to start a standby train. Using the cited beta value and failure rate, a CCF failure rate of 2.3E-7 per hour (/hr) would be expected. However, the cutsets for the RSS8-1 fault tree indicate a CCF probability of 1E-8 for two heat exchangers (quantified over one hour). Discuss how this CCF probability was developed.

19-340

(Follow-up to Question 19-222) The response to Question 19-222 states that a different window on the same display screen can be considered a different location for purposes of human action dependence, because it gives more information and could calm down the operator similarly to a different physical location in a traditional control room. The staff needs additional information to accept this assumption.

a. Provide additional justification for the assumption that these locations can be considered "different." For each series of dependent actions modeled in the PRA, confirm that they are performed in different windows, describe the additional information provided to the operators in the different windows, and discuss the differences, if any, in the layout or appearance of controls in different windows that would make the operators perceive them as different locations.

b. Provide the results of a sensitivity study in which all series of actions performed on a single display screen are considered to be the same location for purposes of human action dependence.

c. Document this assumption and associated uncertainty in the DCD.

19-341

(Follow-up to Question 19-247) The response to Question 19-247 provides information important to understanding the automatic and manual actions needed to support charging injection during shutdown. The descriptions of the two charging top events (MC and CV) in the DCD should be revised to incorporate this information.

19-342

(Follow-up to Question 19-249) The response to Question 19-249 describes the automatic valve operations needed to ensure continued water supply for charging injection and states that instrumentation and control (I&C) failures are not modeled because they are unlikely compared to the human error. If this system is also used (either automatically or by the operators) to perform other actions modeled in the shutdown PRA, failure of the system could result in dependent failure of multiple functions and should be modeled. In addition, risk achievement worth (RAW) values of these failures could be as high as those of the operator actions.

a. Provide a comprehensive list of operations (automatic or manual) for which I&C failures (e.g., actuation signals) are currently excluded from the PRA based on a similar argument.

b. Clarify the I&C system that is required for each action.

c. Discuss future plans to model I&C failures currently not included in the shutdown PRA.

19-343

(Follow-up to Question 19-45) The response to Question 19-45 credits operator actions to close the pressurizer spray line vent and open the main steam depressurization valve (MSDV) when the steam generators (SG) are used for heat removal during shutdown. These valves do not appear to be included in the reliability assurance program (RAP). (Note that although the response to Question 19-238 indicates that the MSDVs are already included in RAP, they could not be located either by name or component number (NMS-MOV-508A,B,C,D according to DCD Chapter 10) in Table 17.4-1.) Justify their exclusion, or revise the RAP to clearly include these valves.

19-344

(Follow-up to Question 19-219) “Lower bound” human error probabilities (HEP) were used for certain operator actions for which frequent training was assumed. Given that the lower bound HEPs are much lower than the mean HEPs, this assumption could result in an area of significant uncertainty. The staff needs additional information on this assumption.

a. Given that the lower bound HEPs are much lower than the mean HEPs, this assumption results in an area of significant uncertainty. Provide the results of a sensitivity study in which mean HEPs, rather than lower bound HEPs, are used in the quantification of the PRA, both at-power and shutdown. If the differences are significant, document the area of uncertainty and associated sensitivity study in the DCD.

b. In response to Question 19-219, this assumption was included in DCD Table 19.1-115. However, the assumption was no longer included in the revised table provided with the response to Question 19-207. These specific operator actions for which “lower bound” HEPs were used should be clearly described (i.e., not just by title) in the DCD,

although not necessarily in the table of assumptions. In addition, the overall assumption should be included in DCD Table 19.1-115 with an appropriate disposition.

c. If any of the actions that were assigned lower bound HEPs are not included in the lists of risk-important human actions provided to the developers of procedures and training per DCD Section 18.6, discuss the mechanism for ensuring that “frequent training” on these accident sequences occurs.