REQUEST FOR ADDITIONAL INFORMATION NO. 149-1744 REVISION 1

1/9/2009

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

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

19-278

The following statement is made in Section 7.3 “Other Data” of Revision 1 of the US-APWR PRA report: “The hardware failure probability of main feedwater is discussed in Attachment 6A.14.5 and is assessed to be 1E-1/d.” However, such a discussion is not provided in Attachment 6A.14.5 where it is simply stated that “the unavailability of MFWS is conservatively judged to be 1E-1.” Please provide the basis for stating that the hardware failure probability of main feedwater is conservatively judged to be 1E-1. Also, in evaluating the probability of operator failure to recover main feedwater (event MFWOO02) it was assumed a “moderately high” operator stress level. Given loss of emergency feedwater and the time constraints to use the next line of defense (feed and bleed) should the main feedwater recovery fails, the use of an “extremely high” operator stress level seems more appropriate. Please discuss.

19-279

The following statement is made in Section 8.7 “Modeling for Asymmetrical Pump Configurations” of Revision 1 of the US-APWR PRA report: “The parameters obtained from NUREG/CR-5497 are overly conservative results as there has never been any CCF of normally running CCW or ESW pumps. All the CCF events cited in the NUREG report were reviewed but there was no CCF event in this database that involved the simultaneous failure of all normally operating pumps. Hence beta is reduced in relation to that listed for standby pumps to account for this. Based on engineering judgment, beta [prime] = 0.001 is assumed….” The staff requests more detailed information regarding the review of CCF to run events for CCW/SWS pumps reported in NUREG/CR-5497. Please provide a list of the events that were reviewed, including a summary of the review approach, assumptions and results that support the assumed beta value of 0.001. In addition, the assumption that the CCW/SWS pumps A and C are normally running and pumps B and D are normally standby simplifies PRA modeling but distorts the results and complicates their interpretation and use in risk informed applications, such as the proposed risk-managed technical specifications (RMTS) initiatives 4b and 5b. Please discuss.

19-280

The following statement is made in Section 9.3.3 "Type C Human Actions" of Revision 1 of the US-APWR PRA report: "…the time available to complete actions is not estimated at the design certification stage, but an evaluation is performed to assure that identified type C human actions are possible to perform in the time available." Please discuss the nature of the evaluation that was performed to assure that there is adequate time available for operators to complete each identified action. Also, for each identified type C action, list the estimated average time that it will take the operators to complete the action and the assumed available time window, and include a brief discussion on how these times impact the various factors used in calculating the human error probabilities.

19-281

The following statement is made in Section 9.3.3 "Type C Human Actions" of Revision 1 of the US-APWR PRA report: "….. human error probabilities can be updated as more specific US-APWR design and updated thermal-hydraulic analyses become available." Per RG 1.206, the detailed design will have to be consistent with all important assumptions, regarding design and operational features and related characteristics, made in the design certification PRA. These assumptions need to be identified at the design certification phase and be verified through appropriate requirements, such as ITAAC and COL action items, to ensure that they will remain valid for the as-to-be-built, as-to-be-operated plant. The staff expects MHI to perform a systematic search to identify a more complete list of important assumptions made in the human reliability analysis (HRA) as well as in all chapters of the US-APWR PRA and, for each of such assumptions, indicate how it will be ensured that they will remain valid for the as-to-be-built, as-to-be-operated plant. This information should be documented in Table 19.1-115 (Section 19.1.7) of the design control document (DCD).

19-282

Please provide the 10 top cutsets for each of the 17 initiating event (IE) categories modeled in the US-APWR PRA for internal events at power operation (or the number of cutsets which contribute to 95% of an IE category's core damage frequency, if smaller than 10). For each cut set, please include information similar to that reported in Table 10.5-3 of the US-APWR PRA report.

19-283

Please address the following questions regarding the sensitivity analysis discussed in Section 18.3 of the US-APWR PRA report:

(a) It was estimated that in case one safety train is out of service throughout the year (Sensitivity Case 1-1), the core damage frequency (CDF) from internal events at power operation would increase about four times (from 1.2E-6/yr to about 5E-6/yr). The risk insight from this sensitivity case appears to be included in the following statement: "This is small in consideration that trains are not normally out of severe [service]." In this statement it is implicitly recognized that a four times increase in CDF is significant but it is assumed that safety trains, normally, are not going to be out of service for extended periods, even though the technical specifications (TS) allow it. However, it is not stated

how this PRA assumption about a future plant's operation will remain valid for the as-to-be-built, as-to-be-operated plant (see RG 1.206, Section C.I.19.2 item C on results and insights, and Section 19.1.7.1 of Appendix A on "PRA input to design programs and processes.") Would all safety trains be in the D-RAP program and each safety train be expected to meet appropriate availability goals, as required by the Maintenance Rule? This is an example of how the integrated results and insights from the importance, sensitivity and uncertainty analysis can be used together with important "assumptions" made in the PRA about design and operational features, in order to identify specific design certification requirements to ensure that these assumptions will remain valid for the as-to-be-built, as-to-be-operated plant. A systematic search is needed to identify such important "assumptions" and discuss how these assumptions will remain valid for the as-to-be-built, as-to-be-operated plant. This discussion often will include a reference to already proposed design material and certification requirements (e.g., cross-references to certified material in other DCD chapters, ITAAC, TS, D-RAP and COL action items) or will identify new design certification requirements, if necessary. This kind of information should be included in Section 19.1.7 (Table 19.1-115) of the DCD.

(b) For Sensitivity Cases 1-2, 1-3 and 1-4, the incremental conditional core damage probability (ICCDP) was assessed, starting with the plant configuration of Case 1-1 (one safety train out throughout the year), and assuming that a second safety train of a single safety system becomes unavailable for a certain time interval. A more detailed discussion is needed about the objectives of these sensitivity cases and what is the basis of the time intervals assumed in assessing the various ICCDP values. Could such sensitivity cases be interpreted, and expanded if needed, to gain insights about available margins in the implementation of risk managed technical specifications (RMTS) initiatives, such as initiative 4b (risk managed completion times)? In your discussion please include the reason for not considering the "zero maintenance" plant configuration in estimating the ICCDP values.

(c) The results of Sensitivity Cases 2-1 and 2-2 indicate that the operators are assumed to be very effective in mitigating accidents (the CDF without operator actions would increase 1400 times while if the operators never failed the CDF would decrease only 2.5 times). This risk insight underlines the importance of a systematic search to identify assumptions made in the human reliability analysis (HRA) and, for each of these assumptions, indicate how it will be ensured that they will remain valid for the as-to-be-built, as-to-be-operated plant. This information should be documented in Table 19.1-115 (Section 19.1.7) of the design control document (DCD).

(d) Sensitivity Case 3-3 involves the common cause failure of all sump screens due to clogging. It is stated that "…the probability of all four sump screens to clog at large LOCA has been assumed to be 0.0625 …" Please explain the basis for this probability.

(e) Sensitivity Case 3-4 assumes that "all application software for digital systems, excluding that of the alternate ac power (AAC) system, is dependent and has no diversity." This statement appears to imply that it was also assumed that the application software of the diverse actuation system (DAS) is not diverse. Please verify and state the important features and characteristics of the AAC power application software that make it diverse compared to all other application software. The "assumption" in the PRA about these "features and characteristics" that make the AAC application software diverse should remain valid for the as-to-be-built, as-to-be-operated plant. Therefore, this information should be included in Section 19.1.7 (Table 19.1-115) of the DCD.

(f) MHI should consider, if necessary, the performance of additional studies to investigate the sensitivity of PRA results and insights to some of the issues raised by the staff through the RAI process (e.g., failure rates and human error probabilities).

19-284

The results of importance analyses include many artificial “asymmetries” due to simplifying modeling assumptions (e.g., LOCA always occurs in loop A) made in the PRA. These asymmetries make some trains of the same system appear to be artificially much less important than others. This is an issue that needs to be addressed before the PRA can be used effectively to support risk-informed applications, such as risk-managed technical specifications (RMTS). In addition, there are some results of the risk importance analysis that cannot be explained solely on the basis of simplifying assumptions. For example, the common cause failure of all emergency feedwater (EFW) pump discharge line check valves VLV-012A, B, C and D to open on demand (event EFWCF4CVODXW1-ALL) has a risk achievement worth (RAW) value of 1 for internal events CDF but RAW values of 8.5E+2 for internal events LRF, 6E+2 for internal fires CDF, and 4.4E+2 for internal flooding. Please discuss.