

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

11/12/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 17.04 - Reliability Assurance Program (RAP)

Application Section: 17.4 Reliability Assurance Program

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

17.04-1

Section 17.4.7.1 of the US-APWR DCD, Revision 1 describes the methodology for identifying risk significant SSCs and references Section 19.1.7.4 of the US-APWR DCD, Revision 1, which states "Risk significant SSCs are identified for the RAP (Chapter 17, Section 17.4). Key risk significant SSCs are organized by a FV importance greater than 0.005 and RAW greater than 2 in accordance with Reference 19.1-42. These thresholds are consistent with Reference 19.1-43." The stated Reference 19.1-43 refers to "10 CFR 50.69 SSC Categorization Guideline" (NEI 00-04, Revision 0), which uses, in addition to the criteria stated above, a common cause basic event RAW criteria of greater than 20 for identifying risk significant SSCs. It is not clear from Sections 17.4.7.1 and 19.1.7.4 of the US-APWR DCD, Revision 1, as to what RAW criteria (e.g., 2, 20, or some other value) was used for common cause basic events by the applicant during risk significant SSC identification.

The staff requests that the applicant clarify in the US-APWR DCD the RAW criteria used for common cause basic events in developing the list of risk significant SSCs.

17.04-2

Section 17.4.7.1 of the US-APWR DCD, Revision 1 describes the methodology for identifying risk significant SSCs and references Section 19.1.7.4 of the US-APWR DCD, Revision 1, which states "Risk significant SSCs are identified for the RAP (Chapter 17, Section 17.4). Key risk significant SSCs are organized by a FV importance greater than 0.005 and RAW greater than 2 in accordance with Reference 19.1-42. These thresholds are consistent with Reference 19.1-43. In addition, risk significant information based on LPSD PRA and external PRA, SSCs related Initiating events, and key assumptions are identified." The applicant computed RAWs/FVs for various risk hazards (e.g., internal events/internal fire/internal flood at power and shutdown). It is not clear from Sections 17.4.7.1 and 19.1.7.4 of the US-APWR DCD, Revision 1, as to how the risk importance criteria (i.e., FV importance greater than 0.005 and RAW greater than 2) were applied to the various risk hazard models that computed RAWs and FVs (i.e., were the RAW/FV criteria applied only to the internal events model, or applied to each risk hazard model separately, or applied to the combined/integrated results of the risk hazard models). Based on the stated Reference 19.1-43 ("10 CFR 50.69 SSC Categorization Guideline," NEI 00-04, Revision 0) each risk hazard should be:

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

- a) Evaluated separately to avoid reliance on a combined result that may mask the results of individual risk contributors, and
- b) Combined in an integrated importance assessment to understand risk significance from an overall perspective (see Section 5.6 of Reference 19.1-43).

The staff requests that the applicant clarify in the US-APWR DCD how the risk importance criteria (i.e., FV importance greater than 0.005 and RAW greater than 2) were applied to the various risk hazard models that computed RAWs and FVs (e.g., were each risk hazard model evaluated separately, or risk hazard models combined in an integrated importance assessment).

17.04-3

Risk Achievement Worth (RAW) and Fussell Vesely (FV) were not determined for various probabilistic risk assessment (PRA) models described in Chapter 19 of the US-APWR DCD, Revision 1. These PRA models include: internal events (Level 1, 2) at low-power and shutdown (LPSD) for various plant operational states (POS), internal fire (Level 2) at power, internal fire (Level 1) at LPSD, internal flood (Level 2) at power, internal flood (Level 1) at LPSD. Since the RAWs/FVs were not determined for these models, it is not clear from Sections 17.4.7.1 and 19.1.7.4 of the US-APWR DCD, Revision 1, how these models were used to identify risk significant SSCs.

The staff requests that the applicant describe in the US-APWR DCD the process used for identifying risk significant SSCs from PRA models for which RAWs/FVs were not computed. If these PRA models were not used in identification of risk significant SSCs, then incorporate the use of these PRA models for identifying risk significant SSCs; otherwise, provide the basis for not considering these PRA models for identifying risk significant SSCs.

17.04-4

From Chapter 19 of the US-APWR DCD, Revision 1, the evaluation of seismic external events is based on a seismic margin analysis (SMA). According to SECY 93-087, this method identifies potential design-specific seismic vulnerabilities that may be useful in developing the RAP. Sections 17.4.7.1 and 19.1.7.4 of the US-APWR DCD, Revision 1, do not describe how the SMA was used to identify risk significant SSCs. Furthermore, the absence of SMA in the rationale that is provided in Table 17.4-1 of the US-APWR DCD, Revision 1, suggests that SMA was not considered in identifying risk significant SSCs. SSCs under SMA are credited as part of the safe shutdown paths evaluated under the SMA. In addition to being capable of withstanding seismic events, these SSCs need to have high reliability and availability in order to perform their safe shutdown functions. Therefore, these SSCs should be in scope of D-RAP. The SMA is another tool used to identify risk-significant SSCs for D-RAP in accordance with SECY 95-132. The reliability of SSCs that are outside the PRA study (e.g., structures) could be monitored qualitatively through operational programs.

The staff requests that the applicant include in D-RAP the SSCs identified as risk-significant under SMA ("10 CFR 50.69 SSC Categorization Guideline," NEI 00-04,

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

Revision 0, provides an acceptable approach), or justify why they should not be included. The US-APWR DCD should be updated accordingly.

17.04-5

Section 17.4.7.1 of the US-APWR DCD, Revision 1 describes the methodology for identifying risk significant SSCs and references Section 19.1.7.4 of the US-APWR DCD, Revision 1, which states "Risk significant SSCs are identified for the RAP (Chapter 17, Section 17.4). Key risk significant SSCs are organized by a FV importance greater than 0.005 and RAW greater than 2 in accordance with Reference 19.1-42. These thresholds are consistent with Reference 19.1-43." FV importance can be computed at a basic event (failure mode, e.g., fail to start, fail to run) level and at a component level (i.e., sum of FVs for all basic events, or failure modes, modeling the component of interest, including common cause events). Based on the stated References 19.1-42 (NUMARC 93-01, Revision 3) and 19.1-43 (NEI 00-04, Revision 0) the component FV importance should be applied to the FV criteria of 0.005. However, Sections 17.4.7.1 and 19.1.7.4 and Table 17.4-1 of the US-APWR DCD, Revision 1, suggest that basic event FV importance was applied to the FV criteria of 0.005, which may not be appropriate.

The staff requests that the applicant clarify in the US-APWR DCD the use of FV importance in identifying risk significant SSCs (i.e., were basic event FVs or component FVs applied to the FV criteria of 0.005). If basic event FVs were applied to the FV criteria, then incorporate the use of component FVs ("10 CFR 50.69 SSC Categorization Guideline," NEI 00-04, Revision 0, provides an acceptable approach); otherwise provide the basis for applying basic event FVs (as opposed to component FVs) to the FV criteria.

17.04-6

Based on Sections 17.4.7.1 and 19.1.7.4 of the US-APWR DCD, Revision 1, it is not clear whether the expert panel reviewed the categorization of SSCs determined to be not risk-significant (NRS) from quantified PRA results. The expert panel plays an important role in reviewing the information that lead to these NRS determinations (e.g., assure the basis used in the categorization is technically adequate, review defense-in-depth implications, review safety margin implications, for additional information see Sections 9.2.2 and 9.2.3 of technical guidance report NEI 00-04, Revision 0). This is particularly important for those safety-related SSCs determined to be NRS from these processes.

The staff requests that the applicant incorporate into their risk significance methodology the use of an expert panel to review the categorization of SSCs that were determined to be not risk-significant from quantified PRA results. The US-APWR DCD, Revision 1, should be revised, accordingly, to describe the role that the expert panel has in reviewing these NRS determinations (e.g., assure the basis used in the categorization is technically adequate, review defense-in-depth implications, review safety margin implications).

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

17.04-7

Section 17.4.7.2 of the US-APWR DCD, Revision 1, states "An EP, consisting of highly qualified representatives of Reliability and PRA Engineering, as well as representatives independent of the PRA process from Design and Plant Engineering is responsible for the final selection of the SSCs included in the D-RAP. Industry operating experience when it can be applied to assessing risk significance, and engineering judgment are employed in considering the addition of SSCs to the D-RAP. Each voting member of the RAP EP should have the level of education and experience defined by the RAP implementing procedure." PWR operations and maintenance experience is an important expert panel (EP) attribute, which is not discussed in the above statement, though it is suggested in Section 17.4.7.1 of the US-APWR DCD, Revision 1.

The staff requests that the applicant clarify the EP experience in Section 17.4.7.2 of the US-APWR DCD by including experience in operations and maintenance; otherwise provide a justification for not including operations and maintenance experience on the EP.

17.04-8

Section 17.4.2 of the US-APWR DCD, Revision 1, states "The results of each of these activities are provided to an expert panel (EP) which identifies risk significant items using probabilistic, deterministic, and other methods for inclusion in the program." Section 17.4.3 states "The risk-significant SSCs are identified using PRA, deterministic, or other methods of analysis, including industry experience, and expert panels." It is unclear as to what "deterministic and other methods" were used by the EP in the risk significant SSC determination process.

The staff requests that the applicant clarify in Section 17.4 of the US-APWR DCD the "deterministic and other methods" that were used by the EP in the risk significant SSC determination process.

17.04-9

SECY 95-132, Item E, states "An application for advanced reactor design certification or a combined license must contain: (1)... and (4) for those structures, systems, and components designated as risk significant: (i) a process to determine dominant failure modes that considered industry experience, analytical models, and applicable requirements; and (ii)..." Section 17.4 of the US-APWR DCD, Revision 1, does not describe a process to determine dominant failure modes for risk significant SSCs as required by SECY 95-132.

The staff requests that the applicant describe in Section 17.4 of the US-APWR DCD the process to determine dominant failure modes for risk significant SSCs that considers industry experience, analytical models, and applicable requirements (e.g., consideration of operating experience, PRA importance analyses, root cause analyses, failure modes and effects analyses, equipment performance information, including vendor manuals, and technical specifications). Also, describe who is responsible (e.g., DC applicant, COL applicant, or COL license holder) for determining the dominant failure modes of risk-

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

significant SSCs and include this as a COL action item, if necessary, in Section 17.4.9, "Combined License Information" of the US-APWR DCD.

17.04-10

COL Information Item 17.4(2) in Section 17.4.9 of the US-APWR DCD, Revision 1, states "The COL Applicant shall be responsible for the development and implementation of the O-RAP, in which the RAP activities should be integrated into the existing operational program (i.e., Maintenance Rule, surveillance testing, in-service inspection, in-service testing, and QA). The O-RAP should also include the process for providing corrective actions for design and operational errors that degrade nonsafety-related SSCs within the scope of the RAP."

In accordance with SECY-95-132, Item E, and Standard Review Plan, Chapter 17.4 (NUREG-0800), integrating RAP activities into existing operational programs should also address:

- a) Establishing reliability performance goals for SSCs within the scope of the RAP (for example, implementation of the maintenance rule following the guidance contained in Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," is one acceptable method for establishing performance goals provided that SSCs are categorized as high-safety-significant within the scope of the Maintenance Rule program).
- b) Establishing performance and condition monitoring requirements to provide reasonable assurance that risk significant SSCs do not degrade to an unacceptable level during plant operations (the reliability performance monitoring does not need to statistically verify the numerical values used in the PRA; however, it would provide a feedback mechanism for periodically evaluating reliability assumptions on the basis of actual equipment, train, or system performance and other operational experience).

The staff requests that the applicant address the above comments (in particular, those SSCs within the scope of the RAP should be categorized as high-safety-significant within the scope of Maintenance Rule) in COL Information Item 17.4(2) in Section 17.4.9 of the US-APWR DCD.

17.04-11

COL Information Item 17.4(1) in Section 17.4.9 of the US-APWR DCD, Revision 1, states "The COL Applicant shall be responsible for the development and implementation of the Phases II and III of the D-RAP. In the Phase II, the plant's site-specific information should be introduced to the D-RAP process and the site-specific SSCs should be combined with the US-APWR design SSCs into a list for the specific plant. ..."

Referring to the above quoted statement, the use of "site-specific risk significant SSCs" appears to be more appropriate than "site-specific SSCs", and the use of "design risk significant SSCs" appears to be more appropriate than "design SSCs". The staff

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

requests that the applicant make these appropriate changes in COL Information Item 17.4(1) in Section 17.4.9 of the US-APWR DCD; otherwise provide a justification for not making these changes.

17.04-12

Section 17.4.2 of the US-APWR DCD, Revision 1, states "The purposes of the US-APWR RAP are to provide reasonable assurance that: 1) the US-APWR is designed, constructed, and operated in a manner that is consistent with the assumptions and risk insights for the SSCs, 2) the SSCs do not degrade to an unacceptable level during plant operations..."

Referring to the above quoted statement, the use of "risk significant SSCs" appears to be more appropriate than "SSCs". The staff requests that the applicant make these appropriate changes in Section 17.4.2 of the US-APWR DCD; otherwise provide a justification for not making these changes.

17.04-13

Section 2.13.1 of the US-APWR DCD, Tier 1, Revision 1, states "The purposes of the US-APWR design reliability assurance program (D-RAP) are to provide reasonable assurance that: The US-APWR is designed, constructed, and operated in a manner that is consistent with the assumptions and risk insights for the structure, system, and components (SSCs). ..."

Referring to the above quoted statement, the use of "risk significant structure, system, and components (SSCs)" appears to be more appropriate than "structure, system, and components (SSCs)". The staff requests that the applicant make this appropriate change in Section 2.13.1 of the US-APWR DCD, Tier 1; otherwise provide a justification for not making this change.

17.04-14

Section 17.4.4 (c) (Procedures and Instructions) of the US-APWR DCD, Revision 1, states "General Manager, US-APWR project or his designated representative has prepared the procedures and instructions used in implementation of the D-RAP." Section 17.4.7.2 (Expert Panel) states "Each voting member of the RAP EP should have the level of education and experience defined by the RAP implementing procedure." These procedures and instructions are not provided in the US-APWR DCD; therefore, it is not clear what is meant by "level of education and experience defined by the RAP implementing procedure."

The staff requests that the applicant describe in Section 17.4.7.2 of the US-APWR DCD the level of education and experience defined by the RAP implementing procedure.

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

17.04-15

The applicant did not include in Table 17.4-1 of the US-APWR DCD, Revision 1, motor driven/diesel driven fire suppression pumps. The evidence presented below suggests these pumps are risk-significant and should be included in D-RAP:

- a) Important insights from Table 17.4-1 of the US-APWR DCD, Revision 1, include:
- Given a core damage accident, the fire suppression system (FSS) injects water from Raw Water Tank into the reactor cavity via the direct injection line by the fire water pumps.
 - Given a loss of component cooling water event, fire suppression system or non-essential chilled water system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection.
- b) Table 19.1-106 (Important SSCs of each System in POS 8-1) states that the motor driven/diesel driven fire suppression pumps are important SSCs.

The staff requests that the applicant include in Table 17.4-1 of the US-APWR DCD, Revision 1, the motor driven/diesel driven fire suppression pumps. Otherwise, provide the basis for not including these pumps in Table 17.4-1 of the US-APWR DCD. Please include, in your discussion, the associated risk importance measures (e.g., RAWs and FVs), consideration of deterministic methods (e.g., defense-in-depth), and the expert panel's deliberation for not including these pumps in D-RAP.

17.04-16

The Main Control Room (e.g., 1E displays and system controls) and Remote Shutdown Panels necessary to initiate important operator actions (e.g., valve position verifications, actuation of fire suppression injection into reactor cavity) are not considered risk-significant in Table 17.4-1 of the US-APWR DCD, Revision 1.

The staff requests that the applicant include the main control room displays/controls and remote shutdown panels in Table 17.4-1 of the US-APWR DCD. Otherwise, provide the basis for not including these SSCs in Table 17.4-1 of the US-APWR DCD.

17.04-17

The applicant included "software" of instrumentation and control (I&C) systems in Table 17.4-1 of the US-APWR DCD, Revision 1. However, "hardware" of these systems are not included in Table 17.4-1 of the US-APWR DCD. If the "software" is considered risk-significant, then the associated "hardware" could also be considered risk-significant. Also, uncertainties inherent with the PRA modeling of digital hardware/software are large; therefore, it is inappropriate to specifically rely on PRA models alone to show that hardware of digital systems are not risk-significant. Other methods would need to be assessed (e.g., deterministic methods, defense-in-depth, expert panel).

The staff requests that the applicant include "hardware" of instrumentation and control (I&C) systems in Table 17.4-1 of the US-APWR DCD. Otherwise, provide the basis for not including hardware in Table 17.4-1 of the US-APWR DCD (in this basis include a

REQUEST FOR ADDITIONAL INFORMATION 101-1474 REVISION 1

discussion of the consideration of deterministic methods, and the expert panel's deliberation for not including hardware in D-RAP).

17.04-18

In accordance with SECY 95-132, Item E, structures in addition to systems and components (i.e., SSCs) should be considered for D-RAP. Also, in accordance with SECY 95-132, Item E, SSCs that are not modeled in the PRA should be considered for D-RAP. Deterministic and other methods of analysis can be used to identify the risk-significant SSCs outside the scope of PRA. The reliability of SSCs that are outside the PRA study could be monitored qualitatively through operational programs. Therefore, in general, structures that house risk-significant SSCs should be included in D-RAP (e.g., reactor building, safety power source buildings, essential service water intake structure/tunnel, auxiliary building, reactor pressure vessel and internals).

The staff requests that the applicant include risk-significant structures in Table 17.4-1 of the US-APWR DCD. Otherwise, provide the basis for not including these structures in Table 17.4-1 of the US-APWR DCD.