Jeff Ciocco

From: Jeff Ciocco
Sent: Tuesday, July 29, 2008 11:09 AM
To: us-apwr-rai@mhi.co.jp
Cc: Nicholas Saltos; Lynn Mrowca; Jin Chung; Ruth Reyes; Larry Burkhart; Harrison Botwin
Subject: US-APWR Design Certification Application RAI No. 40-610
Attachments: US-APWR DC RAI 40 SPLA 610 _2_.pdf

MHI,

Attached please find the subject request for additional information (RAI). This RAI was sent to you in draft form. The schedule we are establishing for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. However, RAI question 19-90 starting "The event trees for internal events..." may be submitted in 60 days as requested. Please submit your RAI response to the NRC Document Control Desk.

Thanks,

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REQUEST FOR ADDITIONAL INFORMATION NO. 40-610 REVISION 0

7/29/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

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

Application Section: PRA

SPLA Branch

QUESTIONS

19-86

It is stated (DCD Section 19.1.3 "Special Design/Operational Features") that the residual heat removal system (RHRS) piping is designed to withstand a higher pressure than operating plants. This design feature was used in modeling interfacing systems LOCA in the PRA. It was assumed that following a break of the reactor coolant system (RCS) boundary at the RHRS suction or injection lines, the reactor coolant will flow to the refueling water storage pit (located inside the containment) unless a break occurs at the RHRS piping outside the containment. The probability that a break will occur at the RHRS piping outside containment, given RHRS over-pressurization, was based on a piping rupture rate of 1.5E-10/hr-ft. Even though the RHRS piping is designed to withstand higher pressures than operating plants, this rupture rate is not applicable to piping that may be pressurized above its design capability. Please provide information that justifies the assumed rupture rate for over-pressurized RHRS piping. Also, please summarize the interfacing systems LOCA risk evaluation in Chapter 19 of the DCD by including (1) important results, (2) risk insights regarding the design and operational features which contribute to the low risk associated with interfacing systems LOCA, and (3) key assumptions made in the analysis.

19-87

The initiating event categories, with their respective frequencies, are listed in Table 19.1-2 of the DCD. The frequency of each category is listed without any information about its uncertainty (e.g., error factor). Error factors associated with these frequencies, with the exception of the total loss of component cooling water/emergency service water (CCW/ESW) initiating event frequency, are reported in the references (NUREG/CR-6928 and NUREG/CR-5750) provided in Table 19.1-2 of the DCD. Regarding the total loss of CCW/ESW initiating event frequency, it is not clear whether its error factor was assessed. The error factors reported in NUREG/CR-6928 and NUREG/CR-5750 indicate that the uncertainty in some initiating events may be major contributors to the uncertainty of the estimated risks (e.g., CDF). Please explain how these uncertainties are addressed in the PRA.

19-88

The total loss of component cooling water/emergency service water (CCW/ESW) initiating event frequency was estimated, by using fault tree analysis (FTA), to be 2.3E-5/yr (Table 19.1-2 of the DCD). This frequency estimate is significantly lower than what is historically used in PRAs for similar operating reactors (e.g., NUREG/CR-6928 recommends a frequency of 8E-4 for the total loss of CCW/ESW initiating event). The staff notes that the US-APWR design has a four CCW/ESW train configuration completely separated into two independent subsystems. However, only two pumps are normally running and one of the two standby trains has no TS outage requirements. The information provided in Section 6A.16 of the PRA (MUAP-07030, Rev 0) is not adequate for the staff to understand how the frequency of total CCW/ESW loss was estimated. Please explain the methodology that was used and state the assumptions that were made in the FTA. Also, please clarify the following: (1) how the mission time of one year (item e on page 6A.16-1) was used in the FTA; (2) the meaning of the 24-hour mission time shown in the list of basic events (Table 6A.16-1); (3) the meaning of CCF events reported in Table 6A.16-2 and their assumed probabilities; and (4) how the basic events reported in Tables 6A.16-1 and 6A.16-2 are related to the basic event identifiers used in fault tree IE-CCW-SWS and in the minimal cut sets.

19-89

It is stated (DCD Chapter 19, page 19.1-16) that "Fault tree definition includes the development of dependency matrices that identify .... the dependencies between initiating events and systems." The staff could not find where the dependencies between the initiating events and the systems are discussed and documented. Please clarify.

19-90

The event trees for internal events and power operation are reported in Figure 19.1-1 of the DCD (19 sheets). The staff notes that there is no description of the event tree top events and that the success criteria for each top event are not stated in the DCD. Although this information is provided in the PRA document, a summary must be included in the DCD per RG 1.206 (Appendix C.I.19-A) guidance. For example, a table could be added that includes a brief description and the success criteria for each top event identifier.

19-91

There is an apparent discrepancy between the success criteria for prevention of core damage (PRA report page 3-5) and the large LOCA (LLOCA) event tree (page 3-111). On page 3-5 of the PRA document, it is stated: "Heat removal from containment: The combination of CS/RHR (CV Spray injection) (CSA) and CS/RHR (Heat Removal) (CXC) or Alternate CV Cooling (FNA) is necessary." However, the LLOCA event tree shows CS/RHR (Heat Removal) alone, top event CXC, as providing adequate heat removal from the containment (e.g., accident sequence #4). Please clarify.

19-92

On page 3-3 of the PRA document it is stated that the "Alternate core injection" function, top event CRC, is not credited for large LOCAs. However, Section 3.2.1.3.2 "Success Paths for Prevention of Core Damage," Table 3.2.1.2-1, the LLOCA event tree and Table 6A.3-2 "Success Criteria (Alternative Core Cooling) indicate that credit is taken for the "Alternate core injection" function (top event CRC). Please clarify and revise, as necessary.

19-93

It is stated in Chapter 19 of the DCD (page 19.1-19) that the mitigating systems and operator actions in accident sequences are determined as given in Tables 19.1-10 and 19.1-11. The staff notices that some mitigating systems and operator actions are not included in these two tables, such as the Alternate Containment Cooling (CSR). Please explain and revise accordingly, as necessary.

19-94

The definition and criteria of core damage are stated on page 19.1-19 of the DCD. It is stated that the measure (plant parameter) used for core damage is the "core peak-node temperature" and the acceptance criteria are (1) 2,200 degrees F predicted by a code with detailed core modeling, and (2) 1,400 degrees F predicted by a code with simplified modeling of the core. This statement implies that codes with detailed as well as simplified core modeling were used for thermal-hydraulic calculations to determine whether an accident sequence leads to core damage and the success criteria for the mitigating systems and operator actions. Please verify this statement and state in the DCD the names of the codes that were used and for what accident sequences a code with detailed core modeling was used. Also, please clarify the reference to peak clad temperature (PCT) while the measure selected is the "core peak-node temperature" instead.

19-95

The following statement is made in Chapter 19 of the DCD (page 19.1-19): "Twenty-four hours was selected as an allowable mission time for the sequences. If a stable plant condition cannot be achieved within 24 hours for a specific sequence, additional evaluation of the sequence is performed to determine an appropriate PDS, to extend the mission time, and/or to model additional system recovery." Please clarify this statement which implies that the mission time for some sequences is not 24 hours. Are there any sequences in the US-APWR PRA for which a stable plant condition cannot be achieved within 24 hours? If this is correct, please discuss such sequences and what additional systems or operator actions are needed at some time beyond the 24-hour period.

19-96

The following statement is made in Chapter 19 of the DCD (page 19.1-20): "MAAP 4.0.6 code as well as analysis results described in Chapter 15 are used to determine success criteria." However, all "typical" results of thermal/hydraulic (T/H) analysis shown in Table 19.1-12 (page 19.1-140), were obtained by using the MAAP code. Please explain what success criteria were determined by using Chapter 15 analysis results. Also, please discuss how the reliability of the MAAP 4.0.6 code results was verified so that these results can be used to determine PRA success criteria (e.g., benchmarking with a more sophisticated T/H code).

19-97

Table 19.1-12 of Chapter 19 of the DCD (page 19.1-140) shows "typical" results of thermal/hydraulic (T/H) analysis obtained by using the MAAP code. The first column, labeled "Accident Sequence Designator," does not give much information about the accident sequence that is analyzed. For some cases, Table 19.1-12 provides only a partial list of the equipment that is operating. For other sequences, Table 19.1-12 lists as operating a larger set of mitigating equipment than the minimum set required according to the success criteria (e.g., the last case assumes operation of all accumulators and all emergency feedwater pumps). This table is included in Chapter 19 of the DCD without any accompanying discussion. Please provide a complete definition of the sequences used in each case, state the objective of each case, and explain how these "typical" results have been used to determine PRA success criteria. In the third column, labeled "Results," please include the estimated core peak-node temperature instead of just stating whether the core damage criterion was met or not.

19-98

The following statement is made about the PRA success criteria on page 19.1-21 of the DCD: "Final success criteria, shown in Table 19.1.13, are determined from the design, engineering judgment and thermal/hydraulic analysis results in a manner that allows a margin for the uncertainties that attribute models of the thermal/hydraulic analyses and grouping of initiating events." This statement appears to imply that Table 19.1.13 provides a compete list of PRA success criteria which is not the case. A complete list of PRA success criteria should be included in the DCD (per R.G. 1.206, Section 19.1.4.1.1 of Appendix A). Also, please discuss (with reference to Appendix 5A "Thermal/Hydraulic Analysis for Success Criteria" of the PRA report) what design and engineering judgment results were used in conjunction with thermal/hydraulic (T/H) analysis results to account for code and T/H modeling uncertainties and for the purpose of grouping initiating events. A summary discussion, including important assumptions made, should be included in the DCD.

19-99

Several event trees (e.g., MLOCA, SLOCA and SGTR) assume that containment heat removal by the CS/RHR system is possible (e.g. top event CXC in the MLOCA event tree) given failure of containment spray injection by the CS/RHR system (e.g., top event CSA in the MLOCA event tree). Based on the definitions of top events CSA and CXC (Section 3.2.2.2 of the PRA report), it appears that the only difference between these two top events is that CXC requires operation of the CS/RHR heat exchangers while CSA does not. If this is correct, CXC cannot succeed when CSA fails. However, a branch is shown in the event tree indicating that CXC can succeed even when CSA fails. Please explain.

19-100

It is stated in the PRA report (page 3-12) that top event SRA "Secondary side cooling to depressurize the RCS" is effective when "CS/RHR (Spray injection) System is not available, this measure depresses RCS pressure and enables to actuate CS/RHR (alternate injection System) and CS/RHR (heat removal) System." It is not clear how CS/RHR (heat removal) can be successful given CS/RHR (spray injection) is unavailable. Also, terminology used in Table 3.2.3.3-1 "Small LOCA Event Success Criteria" is inconsistent and confusing. For example, while the definition of "RCS depressurization by secondary side cooling" includes both operation of EFW and opening of MSRVs, only the success criteria for the MSRVs are listed (with a note stating that 2 EFW pumps are also needed while the previous column shows that 3 EFW pumps are needed). In addition, Table 3.2.3.2-1 (page 3-81) shows two fault tree identifiers (RSS-CSS-HR and RSS-RHR-HRSL) associated with SLOCA event tree top event CXB. This appears to be conflicting with Table 6A.3-2 "Success Criteria (Containment Spray)" which shows CXB associated only with fault tree identifier RSS-RHR-HRSL. Please clarify.