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Sent: Thursday, August 21, 2008 11:00 AM
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Subject: US-APWR Design Certification Application RAI No.56-999
Attachments: US-APWR DC RAI 56 SPLA 999.pdf

MHI,

Attached please find the subject request for additional information (RAI). This RAI was sent to you in draft form. The schedule we established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. Please submit your RAI response to the NRC Document Control Desk.

Thanks,

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REQUEST FOR ADDITIONAL INFORMATION NO. 56-999 REVISION 0

8/21/2008

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

19-106

More detailed, specific and clear information about the transient progression (plant response) is needed in the "Event Description" sections in Chapter 3 of the PRA report (Sections 3.2.1.1 to 3.2.17.1). For example, the steam generator tube rupture (SGTR) event described in 3.2.5.1 is not clear or detailed enough for the staff to understand how the complex transient progression of a SGTR accident and its mitigation was modeled in the PRA. It is stated that "MSIV and turbine by-pass valves will be automatically closed by CV isolation signal." It is not clear whether the CV isolation signal closes automatically all MSIVs and turbine by-pass valves (TBVs) or just those associated with the faulted SG line. If the latter is true, please list the design features used in conjunction with the CV isolation signal to isolate the faulted SG. Also, it is stated that "the main steam relief valve, main steam safety valves are required to re-close to isolate failed SG." Since the re-closure of the main steam safety valves (MSSVs) depends on the RCS primary pressure and the primary to secondary leak rate, a discussion is needed to explain how this is achieved (e.g., systems used, timing of events, operator actions, success criteria and assumptions made) under the various conditions encountered in the expected accident sequences (e.g., failure of TBVs).

19-107

Note (1) in Table 3.2.5.3-1 "Steam Generator Tube Rupture Event Success Criteria" of the PRA report states: "SG isolation utilizing the following valves but not all: EFW isolation valves, main steam relief valve, main steam relief valve stop valve, main steam dump valve, MSIV, turbine bypass valve, and main steam relief valve." This statement does not appear to be in complete agreement with the definition of the top event SGI (Ruptured SG Isolation). SGI is defined (page 3-21) as follows: "The failure of isolation of failed SG is caused by the main steam relief valves fail to close, the turbine by-pass valve fail to close, the main steam safety valve fail to close." Please clarify by stating which valves are utilized to isolate the ruptured steam generator, what assumptions are made and what operator actions are required.

19-108

The US-APWR SGTR event tree does not explicitly model some potential plant responses and associated human actions that are usually considered in operating reactor PRAs. Examples are: (1) Lifting of main steam safety valve (MSSV) on each SG due to secondary pressure spikes following turbine trip but prior to the opening of the turbine bypass valves (TBVs); (2) Operator actions to depressurize the RCS below the lower SG relief valve setpoint before the faulted SG can be isolated (although in the US-APWR the non-safety air-operated MSRV can be isolated by valve MOV 523X, this could cause one or more MSSVs to open if the RCS pressure remains above their setpoints). It appears that the US-APWR PRA assumes (1) no MSRV or MSSV lift occurs unless at least one of the associated TBVs fails to open, and (2) the operation of the EFW system (2 pumps to 2 intact SGs) is adequate to depressurize the RCS below the lower SG relief or safety valve setpoint and keep the core covered with water (even if the high head injection fails), thus no operator action is needed before the faulted SG can be isolated. Please verify these assumptions, discuss their basis, and list any important design and operational features of the US-APWR design that improve the response to SGTR accidents as compared to operating PWR designs.

19-109

In the US-APWR PRA it is assumed that the RCS pressure does not reach the pressurizer safety valve (PSV) lift setpoint and, therefore, no failure to re-close is modeled in most event trees (except for total or partial loss of component cooling water). The same assumption is made regarding accident sequences that could challenge the secondary side main steam safety valves (MSSVs). Please explain the basis for not modeling failure to re-close of PSVs and MSSVs in event trees other than LOCCW and PLOCW.

19-110

Please explain and address the following information in the PRA documentation in Chapter 3 (event trees) and Chapter 6 (system analysis):
(a) MLOCA and SLOCA event tree top event HIB (High Head Injection System) success criteria: 1 of 3 in Chapter 3 and 2 of 3 in Chapter 6.
(b) The top event BLA stands for "bleed" for most event trees (SLOCA, VSLOCA, SGTR, SLBO, SLBI, FWLB, TRANS, PLOCW and LOOP) and Tables 3.2.1.2-1 to 3.2.17.2-1 indicate that event BLA has as input event (fault tree top event) the event FAB. However, in Chapter 6 (Section 6A.1.4.1) the fault tree HPI-FAB is defined for "feed and bleed" and FAB is not defined (a fault tree labeled FAB is shown in Appendix 6A.1.B just for "bleed"). Also, for event trees where high head injection is not possible without "bleed" should not the event BLA precede the event for high head injection? In addition, for SGTR, event BLA has an additional input event named FAB-SG-DP2 which is not defined.
(c) The top event CHI (Charging Injection System) in the VSLOCA event tree has input event CHI-VS (Table 3.2.4.2-1). However, Section 6A.4.4.1 states that the fault tree of the charging injection system is CHI and Table 6A.4-2 indicates that the "System Identifier" is HIA.
(d) Several fault tree top events for the Alternate Containment Cooling System (e.g. NCC-VS-DP2, NCC-VS-DP3 and NCC-VS-DP4) are listed in Tables of Chapter 3 without any definitions in either Chapter 3 or Chapter 6.

(e) Table 3.2.5.2-1 indicates that top event SRB in the SGTR event tree has MSP-SG-DP1 as the input event (fault tree). However, Table 6A.6-1 defines fault tree MSP-SG but not MSP-SG-DP1. Also, it is not clear what the success criteria for SRB are: 2 of 3 EFW pumps according to Table 3.2.5.3-1; 1 of 4 EFW pumps according to Note (2) of Table 3.2.5.3-1; 2 out of 4 EFW pumps to 3 intact SGs according to Table 6A.5-2; 2 of 3 EFW pumps according to Table 6A.5-5; and 1 of 3 EFW pumps according to the MSP-SG fault tree (page 6A.6.B-42).
(f) Table 3.2.5.2-1 indicates that top event HT in the SGTR event tree has HIT-SG-DP1 as the input event (fault tree). However, fault tree HIT-SG-DP1 is not defined anywhere in Chapter 3 and 6. It appears that the fault tree HIT-SG-DP1 was renamed to HIT (included in Attachment 6A.14.6.B) without reference or link.
(g) The success criterion for Alternate Containment Cooling event FNA8 (SGTR event tree) is stated in Chapter 3 (Table 3.2.5.3-1) as supplying water to the containment vessel recirculation unit by 1 of 4 CCW pumps. However, in Chapter 6 of the PRA (Section 6A.14.1.2.2) it is stated that 2 of 4 CCW pumps are required.
(h) Table 3.2.7.2-1 indicates that top event EFB in the SLBO event tree has EFW-SLBO as the input event (fault tree). However, fault tree EFW-SLBO is not defined anywhere in Chapter 3 and 6. It appears that the fault tree EFW-SLBO was renamed to EFW-SB (included in Section 6A.5.4.1) without reference or link. Also, it is not clear what the success criteria for top events EFB (applied to the SLBO event tree) and EFD (applied to the SLBI event tree) are: 1 of 4 EFW pumps to 2 of 3 intact SGs according to Note (1) of Tables 3.2.7.3-1 and 3.2.8.3-1 but 2 of 4 EFW pumps are required according to Table 6A.5-2.
(i) The top event designator EFD for "Emergency Feedwater system" appears in event trees SLBI and FWLB, including Tables 3.2.8.2-1 and 3.2.9.2-1. However, in Section 3.2.8.2 (page 3-31) the designator for the same event is EFB. Also, the success criterion for EFD (or EFB?) in event tree FWLB is not clear. Note (1) of Table 3.2.9.3-1 indicates that supply of water by 1 out of 3 EFW pumps to 2 out of 3 intact SGs is required while Table 6A.5-2 indicates that supply by 2 out of 4 EFW pumps to 2 out of 3 intact SGs is required.
(j) The top event MSI (Main steam line isolation) in the FWLB event tree has input event MSR-I-00. However, in Chapter 6 (Section 6A.8.4.1), fault tree MSR-I-00 is not given as been applicable to FWLB. Also, please explain why fault tree MSR-I-00 (main steam line isolation failure) is applicable to both SLBI and FWLB accident sequences.
(k) The top event FBA1 (Bleed and Feed) in the TRANS event tree has input event HPI-FAB-TR- DP1 (Table 3.2.10.2-1). However, event HPI-FAB-TR- DP1 is not defined and Section 6A.1.4.1 states that the fault tree for "bleed and feed" is HPI-FAB.
(l) The top event CRB2 (Alternate core injection) in the PLOCW event tree has three input events (RSS-RHR-SL, RSS-RHR-SLPL-DP2, and RSS-RHR-SLPL-DP3 in Table 3.2.13.2-1). However, the last two input events are not defined.
(m) Top events ROD (reactor trip control rod) and SCF (reactor trip digital system) in the ATWS event tree have input events that are not discussed in Chapter 6.