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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

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

19-116

The definition of top event EFA (emergency feedwater system) in the total loss of component cooling water event tree (LOCCW) states that both motor-driven (M-D) EFW pumps are assumed to be unavailable due to loss of room cooling. Similarly, event EFA in the partial loss of component cooling water event tree (PLOCW) states that one M-D EFW pump is assumed to be unavailable due to loss of room cooling. However, the documentation in both Chapter 3 and Chapter 6 states as the input event (fault tree), EFW-SL, for both cases (this fault tree does not assume unavailability of M-D pumps) and the success criteria are stated as 2 of 4 (instead of 2 of 2 and 2 of 3, respectively). It appears (Attachment 6A.5A&B) that different fault trees exist for LOCCW and PLOCW (fault trees EFW-SL-LC and EFW-SL-PC, respectively) but these fault trees are not included in the submittal and no discussion is provided to explain how these fault trees are obtained from the included EFW-SL fault tree. Also, no discussion is provided on the CCF probabilities that are used given LOCCW or PLOCW. Please explain.

19-117

The top event HIC (High Head Injection System) in the partial loss of component cooling water event tree (PLOCW) has HPI-SL as input event (fault tree). However, this fault tree does not appear to account for the unavailability of two High Head Injection System (HHIS) pumps due to the partial loss of CCW. Also, the success criterion for HHIS is listed as 1 of 4 pumps in Table 3.2.13.3-1. Please explain. The same question applies, also, to top event FNA7 (Alternate Containment Cooling, which requires supplying CCW through the containment fan cooler system). Please explain.

19-118

The loss of offsite power (LOOP) event tree (Figure 3.2.14-1) shows as successful the following sequences: #53 in Sheet 1, #54 in Sheet 2, # 45 and #47 in Sheet 3, and # 14 and #16 in Sheet 4. The staff believes that these sequences either lead to core damage or need to be further developed. Please explain.

19-119

The anticipated transients without scram (ATWS) event tree assumes no core damage occurs given that all of the following four conditions apply: (1) there is not an unfavorable moderator temperature coefficient (MTC) present, (2) automatic turbine trip occurs, (3) all four pressurizer safety valves (PSVs) open, and (4) all four emergency feedwater (EFW) pumps deliver water to the steam generators (SGs). However, the staff notices that the US-APWR ATWS event tree does not model the need for emergency boration and reactor coolant makeup that is considered in operating reactor PRAs. In addition, some potential failures, such as stuck open PSV's and consequential SG tube ruptures, are not modeled or discussed. Please explain.

19-120

In Chapter 6 of the US-APWR PRA (MUAP 07030) there are four fault trees discussed (HPI-LL, HPI-ML, HPI-SL and HPI-FAB). However, in Attachment 6A.1.B there are five fault trees presented (HPI-LL, HPI-ML, HPI-SL, HPI-FAB and FAB) and in Attachment 6A.1.A (minimal cut sets) there are thirteen fault trees listed. Please provide a discussion in Chapter 6 of the PRA explaining the information provided in the two Attachments to Chapter 6. In addition, the provided fault trees in Attachment 6A.1.B do not include common cause failures and some human errors (e.g., HPIOO02MP and HPIOO02MP-DP2) are not defined or included in the database. Please explain.

19-121

The event HPIPNELTESTCA (Table 6A.1-7) is described as "Piping non-service water system external leak L close side." Please clarify this description and explain what is meant by "non-service water system" (both in general terms and as it relates to the high head injection system (HHIS)).

19-122

It is stated (page 6-2 of the PRA report) that for standby fluid systems that require fluid flow after demand, plugging during the 24-hour mission time is modeled. However, no common cause failure to plug was considered for the containment isolation motor-operated valves (MOVs) MOV-001A,B,C,D (in PRA labeled as 8820A,B,C,D) located at the suction of the high head safety injection (HHSI) pumps downstream from the refueling water storage pit (RWSP). Since the RWSP is located inside the containment, unlike in operating reactor designs, it seems reasonable to assume that particulates, insulation and other debris can accumulate in the RWSP following a LOCA and increase the individual and common cause plugging probabilities of components such as MOV-001A,B,C,D as compared to the equivalent high pressure safety injection (HPSI) systems at operating PWR designs. Please provide information to justify the assumption that the plugging rate of MOV-001A,B,C,D can be based on operating reactor experience and that the CCF due to plugging of two or more of these valves is negligible.

19-123

It is stated (Section 6.1.2.3.1 of the PRA document), without any explanation or justification, that "Common cause failures across systems and across units are not included." The staff believes that common cause failure (CCF) should be considered in the case of same or similar components across systems and across units, especially those located in same plant areas. For example, what is the justification for not considering CCF among check valves in the high head injection (HHSI) and accumulator injection lines?

19-124

The unavailability of a high head safety injection (HHSI) system pump due to outage for test and maintenance was based on operating reactor experience and assumed to be 4E-3, which corresponds to about 1.5 days per year. However, operating plants have less HPSI pumps and, therefore, more strict TS requirements than the US-APWR. For example, the US-APWR TS require only 3 of the 4 HHSI pumps to be operable and if only two trains are operable, the completion time (CT) for restoring a third train to operable status is 72 hours. Therefore, it is reasonable to assume that the average outage time per pump is less for operating reactors than it is for US-APWR. An investigation is needed to address the applicability of operating experience to the assumed outage times for US-APWR for all important equipment modeled in the PRA in the light of design and operational differences, such as higher redundancy and less strict TS requirements. Please discuss.

19-125

The basic events HPIMVFC8820A, B, C, D (Table 6A.1-7 of the PRA report) represent single failures to "control" the high head safety injection (HHSI) system pump suction isolation valves MOV-001A, B, C, D (labeled as valves 8820A, B, C, D in the PRA report). These events are not shown in the system fault trees of Attachment 6A and do not appear in any of the reported minimal cutsets. Furthermore, as the system information provided in Section 6A.1.1 of the PRA report indicates, the DVI line isolation valves MOV-011A, B,C, D have throttling capability which can control the flow downstream of each of the four DVI lines inside the containment. However, no failure to control these valves is modeled in the PRA. In addition, no common cause failure to "control" was considered. Please discuss the nature and mechanism of these failure to "control" events, whether such a failure should be considered for MOV-011A, B,C, D, and whether CCF for the failure to "control" events should be added.

19-126

The information provided in Chapter 6 "System Analysis" of the PRA report on the assumed testing intervals in calculating failure probabilities is sparse. For each system discussed in Chapter 6, a list of the testing intervals for all the system's equipment modeled in the PRA is needed. Additional information, such as valve position indication and alarming features available to the operator in the control room, that are credited in the PRA should also be included.

19-127

The high head safety injection (HHSI) system includes several normally open motor-operated valves (MOVs) in each of the four independent trains of the system. These valves must remain open for the successful injection of makeup water through the associated direct vessel injection (DVI) lines. In the US-APWR PRA, the failure of these valves to remain open was modeled by two kinds of basic events: (1) failure of the associated limit switch (e.g., event HPILSFF8805A) and (2) failure by “mis-closing” (e.g., event HPIMVCM8805A). The probability of the first kind of failures was calculated based on an exposure time for the limit switches of three months (i.e., equal to the testing interval). However, the probability of the second kind of failures was calculated based on an exposure time for valve “mis-closing” of 24 hours (i.e., the system’s mission time in mitigating accidents). Please define a valve “mis-closing” failure and explain the basis for the assumed exposure time of 24 hours instead of the testing interval.