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From: Jeff Ciocco
Sent: Thursday, April 17, 2008 1:28 PM
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Cc: Theresa Clark; Lynn Mrowca; Jin Chung; Larry Burkhart
Subject: US-APWR Design Certification Application RAI No. 1
Attachments: US-APWR DC RAI 1 SPLA 45.pdf

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MHI,

Attached please find the subject request for additional information (RAI). A draft of this RAI was discussed with your staff. The schedule we are establishing for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule. Please submit your RAI response to the NRC Document Control Desk.

Thanks,

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REQUEST FOR ADDITIONAL INFORMATION NO. 1 REVISION 0

4/17/2008

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
SPLA Branch

QUESTIONS

19-1

Please provide more information on how the event tree top events MC (reactor coolant system (RCS) makeup by charging pump), SG (decay heat removed from the RCS via steam generators), GI (gravitational injection), and AC (offsite power recovery) were modeled and quantified for each Plant Operating State (POS), including a summary and results of success criteria calculations for each, at a level of detail similar to that provided for other top events. These events do not appear in the summary of front-line system failures (Table 19.1-82) or in the detailed modeling discussion in the Probabilistic Risk Assessment (PRA) Technical Report.

19-2

For the GI top event, please discuss the operator actions needed given that the spent fuel pool (SFP) valves are shown as locked closed on system diagrams. Also, identify the minimum vent size needed for success of gravitational injection and discuss how the necessary vent is ensured.

19-3

At what point in a normal shutdown is the RCS expected to be opened (e.g., by opening a pressurizer manway)? Table 19.1-76 indicates that the RCS is closed until the SG manhole lids are removed and makes associated assumptions about the availability of the steam generators.

19-4

Please clarify when (e.g., by identifying pressure, temperature, and vent status) the steam generators can be used for heat removal. Discuss how the repressurization (if any) required to use the steam generators for heat removal challenges temporary pressure boundaries such as nozzle caps or thimble seals.

19-5

The discussion on page 19.1-100 states that the SG function is "unavailable if there is a large breach in the RCS." Discuss how the assumed flow diversion from inadvertent transfer to the refueling water storage pit (RWSP) from residual heat removal (RHR) compares in size to the stated "large breach." Is the RWSP flow diversion the largest postulated breach during shutdown?

19-6

Please provide a more detailed discussion, including specific references to previous PRA studies and design-specific calculations, related to the statement on page 19.1-104 that "it is assumed that reflux cooling with the SGs is effective" at mid-loop.

19-7

Regulatory Guide (RG) 1.206 requests descriptions and mean values for significant initiating events, failures, and core-damage sequences for each POS. Chapter 19 of the Design Control Document (DCD) states only that POS 8-1 is a "bounding" POS and other POS were "evaluated conservatively using the values of human errors in consideration of the dependability between tasks." Please provide additional information in the DCD on the assessment of other shutdown POS, including the following topics: (a) Detailed description of the methodology used to evaluate other POS, similar to that provided in the PRA technical report (b) Identification of the significant initiating events, including both internal and external events, for each POS (c) Description of the significant core-damage sequences and their estimated frequencies for each POS (d) Identification of significant functions; structures, systems, and components (SSCs); and operator actions for each POS. Tables 19.1-97 through 19.1-112 provide failure information for POS other than 8-1, but not to the level of detail of that provided for 8-1. It appears from the current tables that many of the significant failures are the same; therefore, it is appropriate to list only the differences for each POS. Tables 19.1-105 through 19.1-112 provide condensed information for 10 systems; a similar table for POS 8-1 would be helpful for comparison.

19-8

The success criteria for the chemical and volume control system (CVCS) provided in Table 19.1-81, sheet 1, state that one of two charging pumps is required in POS 8-1 and that both pumps are in a standby state. Table 19.1-80 shows one pump in outage and one in standby in POS 3 and 4; both pumps in standby in POS 8-1; and one pump running and one in standby in POS 8-2, 8-3, 9, and 11. The technical specification (TS) for the low temperature overpressure protection (LTOP) system (TS 3.4.12), however, states that "a maximum of ... one charging pump capable of injecting into the RCS" shall be operable in MODE 4 when any RCS cold leg temperature is lower than the LTOP arming temperature, MODE 5, and MODE 6 when the reactor vessel head is on. Please provide further discussion of the system availability during shutdown: (a) How is the LTOP requirement of a maximum of one charging pump "capable of injecting" satisfied during shutdown (e.g., by locked-closed valves or similar)? (b) If only one charging pump is capable of injecting, please justify the classification of the pumps as running or standby (rather than one in outage) in POS 8, 9, and 11, with sensitivity studies for success criteria as appropriate. (c) Similarly, justify the indication in Table 19.1-80 that four safety injection (SI) pumps are in a standby state in POS 9 and 11, given that TS 3.4.12 requires that a maximum of two SI pumps be capable of injecting into the RCS. (Note that the success criteria in Table 19.1-81, sheet 1, indicate 1 of 2 pumps required in accordance with the LTOP requirement.)

19-9

Please specify which motor-driven valve is referred to in this statement on page 19.1-99: "In this evaluation, inadvertent transfer to the RWSP from the RHR [residual heat removal system] is assumed. This diversion can happen if a motor-driven valve is opened."

19-10

Section 19.1.6.3.3 includes a statement that the at-power flooding frequency is applied to the shutdown state. Please discuss how potential removal of flood barriers during shutdown is expected to affect flood propagation.

19-11

Key assumption (h) on page 19.1-106 states that "potential plugging of the suction strainers due to debris is excluded from the PRA modeling." Please clarify whether the plugging failure mode is removed completely from the model, or whether the failure rate is simply unchanged from the at-power model as a result of foreign materials exclusion program assumptions during shutdown.

19-12

The discussion of low power states in section 19.1.6.1 states that low power states are "usually bounded by the full power case" and are "not explicitly analyzed herein at this stage." Under what conditions might a low power state not be bounded by the full power case? Is it expected that combined license (COL) applicants will analyze other low power states explicitly at another stage of the design?

19-13

Please provide a more detailed description of POS 10, the RCS leakage test state, in addition to that provided in Table 19.1-78. Table 19.1-79 indicates that this POS is expected to last 20.5 hours. How is decay heat removed during this POS? How do the time to boil and time to core uncovery compare to the expected duration of this POS?

19-14

Page 19.1-110 provides the results of a sensitivity study in which all human error probabilities (HEPs) are set to 0. Please provide a discussion of how important operator failures are to overall shutdown risk (i.e., what is the effect of the reverse situation, in which HEPs are set to a high value such as the 95th percentile values or 1.0?).

19-15

The PRA uses emergency diesel generator (EDG) failure data rather than gas turbine generator (GTG) failure data. Please discuss whether EDG common-cause failure probabilities were used as well, and justify use of EDG failure data for common-cause failure of the GTGs.

19-16

Please clarify this statement on page 19.1-99: "Two normally closed motor-operated valves are aligned in series in each of four RHR train suction lines between the RCS and the [containment spray] CS/RHR pump." Does the statement refer to valves 9000 and 9001 (shown in Figure 19.1-2, sheets 4 and 5)? Please clarify that these valves are normally closed (9001 appears to be locked closed as well) during operation, but normally open during shutdown RHR operation.

19-17

The discussion of failure to maintain water level on page 19.1-101 states that this sequence does not apply to POS 8-1. Please describe this event tree as it applies to other POS and include with the other event tree figures.

19-18

Section 19.1.6.3.2 provides a set of internal fire initiating events that excludes three initiators evaluated in the internal events shutdown analysis: loss of RHR caused by failing to maintain water level, loss of RHR caused by all other failures, and loss of component cooling water (CCW) or essential service water (ESW). Additionally, loss of CCW was evaluated in the at-power fire analysis. Please justify the exclusion of these three initiating events.

19-19

Please clarify this statement on page 19.1-114: "For internal fires, risk significant POS 8-1 of LPSD [low power and shutdown] has been estimated using the same methodology at power though the transient fire due to welding and cutting works and access for maintenance works have been specially reflected." How were fire initiation and propagation values adjusted to account for hot work and maintenance, which could both increase the likelihood of a fire and remove barriers to propagation of fires?

19-20

Table 19.1-1 describes design features to reduce losses of RHR during plant shutdown. However, most of these features appear to have limited or no coverage in TS. Considering this table, please: (a) Discuss how the availability of these features designed to reduce shutdown risk will be ensured in TS or by other administrative controls. (b) Discuss how each feature is credited in the shutdown PRA. (c) Provide a sensitivity study for the shutdown PRA that credits only the systems required to be operable according to TS, since voluntary measures that are not required by current regulations could be withdrawn by licensees without NRC approval.

19-21

Page 19.1-102 states that "the configuration of offsite power in the shutdown PRA is considered the same as for the full power operations PRA." Table 19.1-80 indicates that the offsite power transformers are in standby status during shutdown. Please clarify the assumptions made about switchyard maintenance and other activities that could affect offsite power availability during shutdown.

19-22

POS 3 and 11 both span MODES 4 and 5, which have different TS requirements and potentially different systems available to mitigate accidents. Therefore, please justify the modeling of these two POS as single states and describe how available mitigation strategies in each MODE are addressed in the detailed system modeling.

19-23

Please clarify the isolation of letdown line (LOB) top event used in the "loss of RHR due to over-drain" (OVDR) event tree. Following an over-drain event, is it expected that the operator must always close the CLVD01 air-operated valve? (Note that this valve is downstream of the letdown isolation valves that are automatically closed on low loop level.) How is the failure probability of the automatically operated letdown isolation valves treated in the OVDR model?

19-24

Please provide additional information on the operator actions required to successfully provide alternate component cooling water via the fire suppression system. The fault trees provided in the PRA Technical Report do not appear to include operator actions; however, Table 19.1-113 states that the operator will establish "the injection flow path from fire suppression tank to charging pump and from charging pump to fire suppression tank, and starting the fire suppression pump." What assumptions are made about procedures, cues, and other performance shaping factors related to these actions? For comparison, the human reliability analysis (HRA) portion of the PRA Technical Report includes an analysis of a similar failure (ACWOO02FS) with a failure probability that is higher than the front-line system failure probability for the shutdown PRA cited in Table 19.1-82.

19-25

The discussion of outage types in section 19.1.6.1 acknowledges that reduced inventory states can occur in outage type B (maintenance shutdown), but only the expected frequency of type C outages (refueling outages) is considered when calculating initiating event frequencies, as for LOCA on page 19.1-99. Please justify the 0.5 events per year shutdown frequency based on the expected frequency of all types of outages that result in reduced inventory.

19-26

Please identify how the US-APWR design has considered the Shutdown Management Guidelines in NUMARC 91-06, including how containment closure can be achieved in sufficient time to prevent potential fission product release (NUMARC Guideline 4.5).

19-27

Table 19.1-113 provides several assumptions related to operator actions at shutdown, but no disposition (e.g., Tier 2, Tier 1, TS, or emergency response guidelines). Additionally, the table is missing key US-APWR features that reduce shutdown risk and their disposition. Please augment this table in the following areas of shutdown risk (the examples are not inclusive): (a) Key design features or SSCs that reduce the potential of reactor coolant diversion from the vessel through the RHR/CVCS systems (e.g., automatic closure of CVCS low-pressure letdown isolation valves on low RCS loop level) (b) Key design features, if any, that automate the response to losses of RHR (c) Key design features, if any, that automate RCS injection following loss of RHR, reactor coolant diversions, and LOCAs (d) Key operator actions and key pieces of instrumentation that are needed to support the associated operator actions (e.g., operator opening a gravity injection flow path) (e) Key SSCs that need to be available at shutdown to provide an alternate decay heat removal path using low pressure makeup and primary pressure relief (f) Key SSCs that are needed to reduce fire risk at shutdown and validate fire risk estimates (e.g., capability of fire watches when fire barriers are not intact)