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September 3, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10245

Subject: MHI's Responses to US-APWR DCD RAI No.609-4762 Revision 2

References: 1) "Request for Additional Information No. 609-4762 Revision 2, SRP Section: 19 – Probabilistic Risk Assessment and Severe Accident Evaluation," dated July 20, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 609-4762 Revision 2".

Enclosed are the responses to the RAI that are contained within Reference 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Responses to Request for Additional Information No. 609-4762 Revision 2

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-10245
Docket Number 52-021

Responses to Request for Additional Information No.609-4762
Revision 2

September, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

09/03/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 609-4762 REVISION 2**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19**
DATE OF RAI ISSUE:	**07/20/2010**

QUESTION NO. : 19-441

The staff has found that two plant operational states (POSs) were missing from the POS evaluation in Section 20.1.2 of the PRA and page 19-103 of the US-APWR DCD. The staff does not have enough information to conclude that POS 8-1, midloop after refueling, is bounding for the low power/shutdown (LPSD) PRA. These two plant POSs include:

(1) the RCS starts at midloop and is filled for refueling. This POS includes reactor vessel head removal. When the reactor vessel head is removed, the RCS water level is typically a foot below the reactor vessel flange. Since this plant operational state occurs before refueling, the time to RCS boiling can be under thirty minutes in operating plants.
(2) the RCS is initially filled and is drained to midloop conditions after refueling. This POS includes reactor vessel head installation. When the vessel head is installed, the RCS water level is typically a foot below the reactor vessel flange resulting in reduced times to RCS boiling.

The staff is requesting MHI to quantitatively assess these POSs separately, or justify why these POSs are bounded by POS 8-1. If these two POSs are bounded by POS 8-1:

(1) the duration of time in these POSs should be added to POS 8-1.
(2) the duration of time in these POSs should be included in each initiating event frequency calculation for POS 8-1 which includes internal events, fires, and floods.

ANSWER:

MHI understood the NRC comment.
The current LPSD PRA model includes the duration time to change the RCS inventory; however, the definition of POS 4-3 (keep and increase of the RCS inventory) and POS 8-1 (decrease and keep of the RCS inventory) is not adequate. MHI will revise the definition to clarify the plant state and the PRA model

will remain unchanged. The following provides the basis that the current PRA model is correct using the figure and table:

The postulated outage schedule in this LPSD PRA, focused between POS 4-3 and POS 8-1, is shown in Figure 19.441-1 and Table 19.441-1.

POS 4-3 has originally been defined to include 5 plant configurations described in Table 19.441-1 (POS 4-3 A to POS 4-3 E). Duration has been assumed taking into account these plant configurations. As a result, duration of POS 4-3 has been assumed to be 6 hours in this LPSD PRA.

POS 8-1 has originally been defined to include 7 plant configurations described in Table 19.441-1 (POS 8-1 F to POS 8-1 L). Duration has been assumed taking into account these plant configurations. As a result, duration of POS 8-1 has been assumed to be 55.5 hours in this LPSD PRA.

In fact, POS 4-3 and POS 8-1 have been modeled by the representative and most severe plant configurations among several conditions in each POS. In case of POS 4-3, there is the possibility of failure of water level to maintain (FLML) in POS 4-3 A where the RCS inventory is controlled by chemical and volume control system (CVCS). POS 4-3 A has been selected as a representative and severe condition due to the highest decay heat, the lowest loop level and the maximum number of initiating events. In case of POS 8-1, there is also the possibility of over-drain (OVDR) or FLML in POS 8-1 I, J, K and L where the RCS inventory controlled by CVCS and the possibility of FLML is considered in the OVDR event. POS 8-1 I, J, K and L have been selected as representative and severe conditions due to the lowest loop level and the maximum number of initiating events. POS 8-1 has the longest duration time in all POSs, has impact on the risk during LPSD operation and has been identified as the representative POS.

In conclusion, the current LPSD PRA model can be kept because even if these POSs are considered separately in detail, the result seems to hardly change by the selection of appropriate representative POS.

Impact on DCD
The DCD will be revised as follows:

Page 19.1-103

- POS 4: RHR cooling (mid-loop operation)

  POS 4 is a mid-loop operation state with cooling by the RHRS before refueling. The POS begins at the initiation of the drain down process to the mid-loop water level. To perform the aeration of the RCS and the eddy current test on the SGs, the SG nozzle lids are installed and the upper lid on the RV is removed. The RCS water level is decreased to near the center of the reactor nozzle. Because the RCS inventory is decreasing, the possibility of the RHR pump failure due to the pump cavitations is considered. Also, the time required for loss of inventory and subsequent fuel damage is less than for other states in the event of loss of decay heat removal. At the end of POS 4, the reactor cavity is filled with water for refueling.

  POS 4 or a mid-loop operation is further divided according to the plant states. The subdivided POSs are shown in Table 19.1-79 and Figure 19.1-13 to Figure 19.1-15.

Page 19.1-103-104

- POS 8: RHR cooling (mid-loop operation after refueling)

  POS 8 is a mid-loop state with cooling by the RHRS after refueling. The POS begins at the

initiation of the drain down process from cavity full to the mid-loop water level. In order to install the upper lid on the RV and to remove the SG nozzle lids, the RCS water level is decreased to near the center of the reactor nozzle. Because the RCS inventory is decreased, there is a possibility of the RHR pump failure by cavitation and this is considered. Also, the time to act to avoid reactor core damage in this state is less than in other states because the RCS inventory is decreased. At the end of POS 8, the RCS is filled with water.

POS 8 or a mid-loop operation is further divided according to plant states. The subdivided POSs are shown in Table 19.1-80 and Figure 19.1-13 to Figure 19.1-15.

Table 19.1-79 Subdivided State of POS 4 (Mid-Loop Operation) for LPSD PRA

	Open S/G manhole lid ↓		Install S/G nozzle lid ↓	Remarks
RCS water level	RCS full	Mid-loop (nozzle center)	Reactor cavity full	
POS	(POS4-1)	(POS4-2)	(POS4-3)	
RCS conditions	RCS close	RCS open	RCS open SG Isolated	
Mitigating systems				
SG and secondary systems	×	N/A	N/A	
Gravitational injection	N/A	×	N/A	
Initiating events				
Over-drain	×	N/A	N/A	
Fail to maintain water level	N/A	×	×	

Table 19.1-80 Subdivided State of POS 8 (Mid-Loop Operation) for LPSD PRA

	Open S/G manhole lid ↓	Install S/G nozzle lid ↓		Remarks
RCS water level	Reactor cavity full	Mid-loop (nozzle center)	RCS Full	
POS	(POS8-1)	(POS8-2)	(POS8-3)	
RCS conditions	RCS open SG isolated	RCS open	RCS close	
Mitigating systems				
SG and secondary systems	N/A	N/A	×	
Gravitational injection	N/A	×	N/A	
Initiating events				
Over-drain	×	N/A	N/A	
Fail to maintain water level	N/A	×	×	

Impact on COLA
There is no impact on COLA.

Impact on PRA
There is no impact on PRA.

Table 19.441-1 Plant Configurations for POS 4-3 and POS 8-1

POS		RV Head	Duration Time [Hr]		Inventory transition		Supplied or drained by	Possibility of OVDR or FLML	Effectiveness of LP letdown line isolation valves	RCS Vent	Gravity Injection	Remark
					From	To						
POS 4-3	A	On			Mid-loop	Mid-loop	No drain but controled by CVCS	Yes	Yes	Pressurizer Safety Valve	Yes	POS 4-3 in LPSD PRA conservatively assumes "POS 4-3A" configuration which is the most severe plant condition in POS 4-3.
	B	On	6		Mid-loop	Flange level	RW pump	Negligible	NA	Pressurizer Safety Valve	Yes	The RCS inventory increases up to the cavity full by RW pump and CS/RHR pump. Possibility of over-drain and failure to maintain of water level can be negligible. When the RV head is installed, pressurizer safety valves are removed due to the RCS vent.
	C	On			Flange level	Flange level	No drain	Negligible	NA	Pressurizer Safety Valve	Yes	
	D	Off			Flange level	Flange level	No drain	Negligible	NA	RV head off	Yes	
	E	Off			Flange level	Cavity Full	CS/RHR pump	Negligible	NA	RV head off	Yes	
POS 8-1	F	Off			Cavity Full	Flange level	CS/RHR pump	Negligible	NA	RV head off	Yes	The RCS inventory decreases down to the flange level using CS/RHR pump and down to mid-loop water level using CVCS. RW pump is used to drain water outside flange. Possibility of over-drain and failure to maintain of water level can be negligible. When the RV head is installed, pressurizer safety valves are removed due to the RCS vent.
	G	Off			Flange level	Flange level	RW pump	Negligible	NA	RV head off	Yes	
	H	On			Flange level	Flange level	RW pump	Negligible	NA	Pressurizer Safety Valve	Yes	
	I	On	55.5	8	Flange level	RCS full	CVCS	Yes	Yes	Pressurizer Safety Valve	Yes	POS 8-1 in LPSD PRA conservatively assuemes "POS 8-1 I, J, K and L" configurations which are the most severe plant conditions in POS 8-1
	J	On			RCS full	RCS full	No drain but controled by CVCS	Yes	Yes	Pressurizer Safety Valve	Yes	
	K	On			RCS full	Mid-loop	CVCS	Yes	Yes	Pressurizer Safety Valve	Yes	
	L	On		47.5	Mid-loop	Mid-loop	No drain but controled by CVCS	Yes	Yes	Pressurizer Safety Valve	Yes	

Note

OVDR: Over-drain

FLML: Fail to maintain water level

RW pump: Refueling water recirculation pump

CVCS: Chemical and volume control system

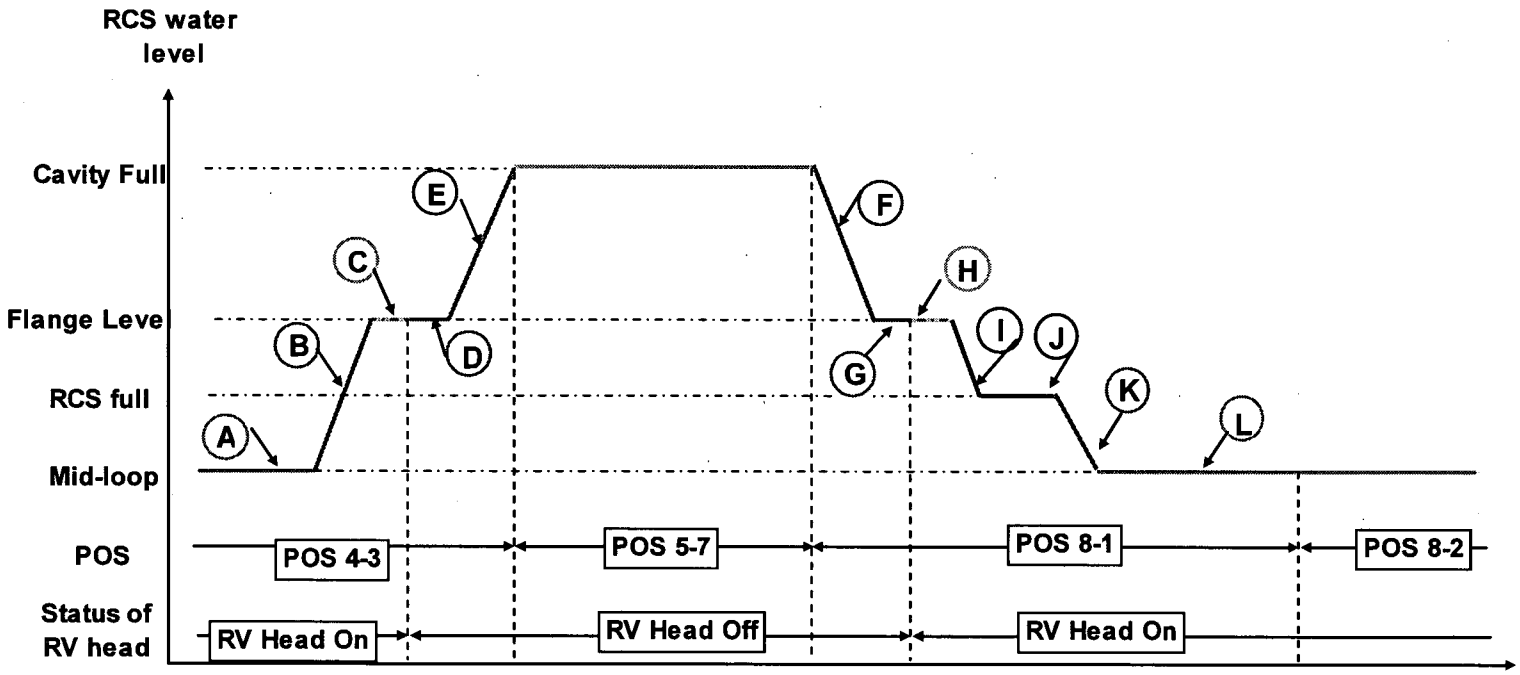

Figure 19.441-1 Postulated Water Level