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June 12, 2009

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-09313

Subject: MHI's Responses to US-APWR DCD RAI No.369-2625 Revision 1

References: 1) "Request for Additional Information No. 369-2625 Revision 1, SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation, Application Section: 19.1.6," dated May 14, 2009.

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. 369-2625 Revision 1".

Enclosed are the responses to the RAIs that are contained within Reference 1. Of these RAIs, questions #19-336, #19-340, #19-342 and #1-344 will not be answered in this package. MHI committed to submit responses to these RAIs within 60 days after RAI issue date.

This letter includes a copy of the non-proprietary version (Enclosure 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.

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NRO

Enclosure:

1. Responses to Request for Additional Information No. 369-2625 Revision 1 (non-proprietary)

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-09313
Docket Number 52-021

Responses to Request for Additional Information No.369-2625
Revision 1

June, 2009
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/12/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO.369-2625 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.6**
DATE OF RAI ISSUE:	**5/14/2009**

QUESTION NO. : 19-334

(Follow-up to Question 19-234) The response to Question 19-234 indicates that β' (a reduced common-cause failure (CCF) parameter) was used in the residual heat removal (RHR) pump CCF model. The staff needs additional information on this treatment.

a. Chapter 8 of the probabilistic risk assessment (PRA) provides justification for using this parameter for component cooling water (CCW) and essential service water (ESW) pumps, but not for RHR. Justify using this parameter for RHR pumps, or revise the PRA to use typical CCF parameters.

b. It appears that β' may also have been applied for CCF of two running RHR pumps, after which the operator must start a standby pump. The discussion of the revised CCW and ESW parameters indicates that the groups of two standby or running pumps use standard CCF parameters. Discuss the treatment of CCF of two running RHR pumps.

Answer:

a),b)

MHI will revise the PRA to use typical CCF parameters for RHR. This model change has small impact on the results as described in response to Question 19-234.

Impact on DCD

The results of this model change will be reflected to DCD tracking report that will be submitted two to three months from now. Changes resulting from the model change will not impact risk insights.

Impact on COLA

There is no impact on COLA.

Impact on PRA

This response will be reflected in next revision of the PRA. This model change has small impact on the results as described in response to Question 19-234.

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APPLICATION SECTION:	**19.1.6**
DATE OF RAI ISSUE:	**5/14/2009**

QUESTION NO. : 19-335
(Follow-up to Question 19-207) Describe the mechanism for ensuring that the assumptions and insights documented in the response to Question 19-207 remain valid in the PRA for the as-built, as-operated plant. For example, how will training developers know to look at this table to ensure that training assumed in the PRA has been established? This goal could be achieved both individually (by having a disposition linking to a requirement in another part of the DCD) and/or collectively (e.g., by a combined license (COL) item that directs the applicant to confirm the assumptions in the future). Note that the COL items provided in Design Control Document (DCD) Section 19.3.3 direct the COL applicant only to update external events and fragilities.

Answer:

Training programs are described in section 18.9 of the DCD. Development of procedures is raised as COL actions items in section 13.5 as COL 13.5(5), COL 13.5(6) and COL 13.5(7). Development of accident management program is described in section 19.3.3 as COL 19.3 (6). Table of key assumptions will be revised linking DCD sections or directing COL action item to each of the assumptions. The revised table will be included in the DCD tracking report.

<u>Impact on DCD</u>
Table of key assumption in section 19.1 will be revised. Each assumption will be linked to another section of the DCD or COL item.

<u>Impact on COLA</u>
There is no impact on COLA.

<u>Impact on PRA</u>
There is no impact on DCD.

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APPLICATION SECTION:	**19.1.6**
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QUESTION NO. : 19-337
(Follow-up to Question 19-208) Although (per Question 19-208) the PRA does not model starting additional charging or safety injection (SI) pumps that were locked out for low temperature overpressure (LTOP) compliance, operators are likely to enable and start them after initial pumps fail. This insight for risk reduction should be included in the design control document (DCD), such as in Section 19.1.3.1 or where the success criteria for the systems are discussed.

Answer:

MHI will include in the DCD the insight for risk reduction that can be achieved by starting additional charging or safety injection (SI) pumps that were locked out for low temperature overpressure (LTOP) compliance.

Impact on DCD
Insights regarding the use of addition pump that are locked out for LTOP compliance will be included in the DCD.
Section 19.1.6.1, page 19.1-101 of DCD revision 1 will be revised as follows.

"

RCS inventory make-up Functions

- CVCS
  If the RHRS and the SGs heat removal are unavailable, coolant to the RCS is injected by the CVCS in order to prevent bulk boiling and to maintain the RCS inventory. If the operable charging pumps fail, pumps that were locked out for low temperature overpressure (LTOP) compliance can be used if available.

- High head injection system

If the CVCS fails to operate, safety injection pumps are utilized to inject coolant to the RCS in order to maintain coolant inventory. If the operable safety injection pumps fail, pumps that were locked out for low temperature overpressure (LTOP) compliance can be used if available. "

Impact on COLA
There is no impact on COLA.

Impact on PRA
There is no impact on DCD.

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QUESTION NO. : 19-338

(Follow-up to Question 19-209) Question 19-209 addresses forced outages that do not lead to drained maintenance. However, the sensitivity study documented in the response does not consider forced outages leading to drained maintenance (e.g., steam generator inspections needed mid-cycle). Discuss the results of a sensitivity study that addresses all types of forced outages, or justify why forced outages requiring mid-loop operation are not expected for the US-APWR.

Answer:

Sensitivity study shown in response to 19-209 assumes an artificially high frequency of forced outages that lead to non-drained maintenance. On the other hand, forced outages of other types were assumed to occur with a frequency that is close to practical. As it can be seen in table 19-209-1 of response to 19-209, frequencies of POS4-1 and POS4-2 are set to 0.55/Y, which takes into account 0.05/Y frequency of forced outages with drained maintenance. The basis of the value 0.05/Y applied to forced outages with drained maintenance frequency is described in response to 19-25.

The staff requests to perform sensitivity study that address all types forced outages. Since the sensitivity of the frequency of forced outage that lead to non-drained maintenance has already been shown in response to 19-25, additional sensitivity study was performed to investigate the impact of the frequency of forced outages that lead to drained maintenance. The frequency of such forced outages where set to 0.5. Since refueling outages are planned to be performed every 24 months, the annual probability of the plant to be in drained condition is 1.0/Y in this sensitivity case. Forced outages that lead to non-drained maintenance was assumed to occur with a frequency of 0.29 per year, which is considered as a practical frequency as discussed in response to 19-25. Yearly frequency of each POSs assumed in this sensitivity study are shown in table 1.

Calculated CDF for each POSs of this sensitivity study case are shown in table 1. Total CDF is 3.6E-7 /Y, which is 82% higher than the base case CDF. It should be noted that this result is based on conditional core damage frequency calculated for the base case, which is refueling outage with several components out of service. The conditional core damage probability for relatively short outages that do not accompany maintenance outage of multiple components may have a smaller value, so the CDF may be smaller.

US-APWR does not plan to perform steam generator inspection every year so the 1.0 per year frequency of drained maintenance assumed in this sensitivity case is an excessive case. Actual frequency of drained maintenance is expected to be much lower. This sensitivity study shows that even if the frequency of outage that lead to drained maintenance were set to an artificially high value, the CDF will not increase more than factor of two.
Sensitivity studies shown in this response and the response to 19-209 will be incorporated in the DCD.

Table 1 Yearly frequency of each POS for Sensitivity Analysis and resulting CDF

POS	Yearly frequency (/y)				CDF (/y)
	Drained maintenance	Non-drained maintenance	Refueling outage	Total	
POS 3	0.5	0.29	0.5	1.29	3.7E-8
POS 4-1	0.5	NA	0.5	1.0	6.0E-8
POS 4-2	0.5	NA	0.5	1.0	3.2E-8
POS 4-3	N/A	NA	0.5	0.5	3.3E-8
POS 8-1	N/A	NA	0.5	0.5	5.7E-8
POS 8-2	N/A	NA	0.5	0.5	1.5E-8
POS 8-3	N/A	NA	0.5	0.5	1.7E-8
POS 9	0.5	NA	0.5	1.0	3.3E-8
POS 11	0.5	0.29	0.5	1.29	7.8E-8
				Total CDF	3.6E-7

Impact on DCD
Sensitivity studies shown in this response and the response to 19-209 will be incorporated in the DCD.

Impact on COLA
There is no impact on COLA.

Impact on PRA
There is no impact on DCD.

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QUESTION NO. : 19-339
(Follow-up to Question 19-234) The response to Question 19-234 addresses groups of three or four RHR heat exchangers. However, CCF of the two heat exchangers supporting running RHR trains would necessitate operator action to start a standby train. Using the cited beta value and failure rate, a CCF failure rate of 2.3E-7 per hour (/hr) would be expected. However, the cutsets for the RSS8-1 fault tree indicate a CCF probability of 1E-8 for two heat exchangers (quantified over one hour). Discuss how this CCF probability was developed.

Answer:
The value of 2.3E-7, which you calculated, is a CCF probability of the two heat exchangers when CCF group size is two. The value of 1E-8, which the cutsets for the RSS8-1 fault tree indicate, is a CCF probability of the two heat exchangers when CCF group size is three. In this case, the CCF probability of the two heat exchangers should be derived from the calculation method that multiplies a failure rate by not only β but also (1-γ) because triple failure proportion need to be eliminated from double failure proportion when double failure occurs but triple failure does not occur. This value is further divided by 2 because there are two combinations of double failure per heat exchanger, considering that the group size is three. Thus, the value of 1E-8 results from below calculating in Risk Spectrum® code.

$$\frac{(1-\gamma)\beta}{2}\lambda \approx 1E-8$$

,where β is a beta factor, γ is a gamma factor, λ is a failure rate of heat exchanger.

Impact on DCD
There is no impact on DCD.

Impact on COLA
There is no impact on COLA.

<u>Impact on PRA</u>
There is no impact on PRA.

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QUESTION NO. : 19-341

(Follow-up to Question 19-247) The response to Question 19-247 provides information important to understanding the automatic and manual actions needed to support charging injection during shutdown. The descriptions of the two charging top events (MC and CV) in the DCD should be revised to incorporate this information.

Answer:

Based on the response to Question 19-247, the descriptions of MC and CV in section 19.1.6.1. of chapter 19 will be revised as follows:

- MC: RCS makeup by charging pump
  This mitigation measure represents the RCS inventory makeup by using the charging pumps. When a loss of RCS inventory event occurs, RCS water level is expected to be recovered by charging injection pump. The suction of this pump is VCT. When the level of VCT becomes low signal level, the suction of this pump automatically changes to RWSAT. ~~Only a small amount of makeup is needed~~ If further loss of RCS inventory can be prevented, water volume in the RWSAT is enough to raise the level ~~enough~~ to ~~allow~~ enable operation of the standby RHR pump. Thus, this top event does not require RWSAT water makeup. The borated water in the RWSAT is injected into the RCS by the charging pumps. It is assumed that loss of this function occurs through failure of the required manual operation.
- CV: Injection by the CVCS
  If decay heat removal using the RHRS and the SGs fails, in order to avoid loss of coolant and prevent the boiling of coolant, the boric water in the RWSAT is injected into the RCS using the charging pumps. Before the accident, the suction of these pumps is VCT. When the level of VCT becomes low signal level, the suction of these pumps automatically changes to RWSAT. At this timing, with the low VCT level signal, the operator begins to prepare RWSAT water makeup. The operator will open manual valve 026 and 028 to establish the flow path from RWSP to RWSAT. As soon as the RWSAT low level signal is actuated, the operator starts the refueling water recirculation pump to make up the RWSAT. Make-up to the RWSAT is required as the RWSAT does not have sufficient capacity for the

injection over the required mission time. Make-up is achieved via the in-containment RWSP water being pumped by the refueling water recirculation pumps to the RWSAT. It is assumed that loss of this function occurs by failure to inject to the RCS using the make-up pumps, or failure to provide make-up to the RWSAT.

Impact on DCD
The description in this response will be incorporated in DCD chapter 19, section 19.1.6.1.

Impact on COLA
There is no impact on COLA.

Impact on PRA
The description in this response will be incorporated in PRA technical report chapter 20.

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QUESTION NO. : 19-343

(Follow-up to Question 19-45) The response to Question 19-45 credits operator actions to close the pressurizer spray line vent and open the main steam depressurization valve (MSDV) when the steam generators (SG) are used for heat removal during shutdown. These valves do not appear to be included in the reliability assurance program (RAP). (Note that although the response to Question 19-238 indicates that the MSDVs are already included in RAP, they could not be located either by name or component number (NMS-MOV-508A,B,C,D according to DCD Chapter 10) in Table 17.4-1.) Justify their exclusion, or revise the RAP to clearly include these valves.

Answer:

MSDVs are not risk important SSCs for during at power operation. MSDV and pressurizer spray line vent are components used for mitigation of initiating events during LPSD. MSDV and pressurizer spray line vent will be included in Table 17.4-1 incorporating the discussion of expert panel.

<u>Impact on DCD</u>

List of risk significant SSCs will be revised as noted above considering the discussion of expert panel.

<u>Impact on COLA</u>
There is no impact on COLA.

<u>Impact on PRA</u>
There is no impact on DCD.