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April 20, 2011

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-11115

Subject: **MHI's Response to US-APWR DCD RAI No. 721-5535 Revision 2 (SPR 09.01.04)**

Reference: 1) "Request for Additional Information No. 721-5535 Revision 2, SRP Section 09.01.04 – Light Load Handling System (Related to Refueling) - Application Section: 9.1.4", dated March 21, 2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 721-5535 Revision 2."

Enclosed is the response to a question 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. Response to Request for Additional Information No. 721-5535 Revision 2

CC: J. A. Ciocco
C. K. Paulson

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NRO

Enclosure 1

UAP-HF-11115
Docket No. 52-021

Response to Request for Additional Information No. 721-5535
Revision 2

April 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/20/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 721-5535 REVISION 2**
SRP SECTION:	**09.01.04 – LIGHT LOAD HANDLING SYSTEM (RELATED TO REFUELING)**
APPLICATION SECTION:	**09.01.04**
DATE OF RAI ISSUE:	**03/21/2011**

QUESTION NO.: 09.01.04- 22 Follow Up to RAI 9.1.4-21

The staff requested Mitsubishi Heavy Industries, LTD (MHI) to address operating experience considerations associated with refueling cavity seals in Request for Additional Information (RAI) 09.01.04-16 dated December 15, 2009, and supplemental RAI 09.01.04-21 dated September 17, 2010. Based on a review of MHI's supplemental response to RAI 9.1.4-21, in a letter dated October 21, 2010, the staff determined that the DCD markup provided in the RAI response did not include the necessary level of detail. Consequently, the following information is needed:

1. Descriptive information of the permanent cavity seal (PCS) provided in RAI response 09.01.04-16 and supplemental response 09.01.04-21, in addition to the figure for illustrative purposes, should be added to Tier 2 of the DCD. This information should include:
   a. functional description of the seal
   b. material and codes/standards used
   c. justification for how the seal is protected from dropped loads
   d. description of the leak detection system
   e. any level alarms that would alert an operator of a pool draindown, including alarm location
   f. description of the safe location where fuel in transit can quickly be placed

2. The NRC staff feels that the proposed information in Section 9.1.4.2.2.2 concerning procedures is thorough and complete, however the requirement for the COL applicant to develop these procedures should also be included in the DCD as a COL information item.

3. The response to RAI 09.01.04-16 indicated that in the event of low refueling cavity water level, makeup water can be provided to the refueling cavity from the refueling water storage pit (RWSP) or refueling water storage auxiliary tank (RWSAT) via the refueling water recirculation pump. Since the RWSP is used to initially fill the refueling cavity, it was not clear to the staff how much water remained in the RWSP

to provide the makeup capability following a decrease in refueling cavity water level. Provide additional information in the DCD to describe this makeup capability and to justify the amount of water available from the RWSP and RWSAT during refueling operations when the reactor cavity is full.

4. The response to RAI 09.01.04-21 provided a drawing that included the leakage detection design. From the information contained in the drawing and description in the RAI response, it was not clear to the staff that all of the expected leakage would be directed into the leakage detection pipe. Additional information regarding the leakage detection design is needed in the DCD, including assurance that all leakage from the PCS will enter the leakage detection pipe.

ANSWER:

Item No.1

MHI will add the additional descriptive information specified in this RAI in Tier 2 of the DCD Chapter 9 Section 9.1.4.2.1. See "Impact on DCD" for a new Section 9.1.4.2.1.13 to be added.

Item No.2

DCD Section 9.1.4.2.2.2 states that "Refueling operations are outlined below and performed in accordance with operating procedures defined in Subsection 13.5.2." This existing DCD text adequately establishes a commitment for developing operating procedures for refueling operations as described in DCD Section 9.1.4.2.2.2. COL applicants that reference the US-APWR DCD will incorporate this statement by reference into the COL application and will be required to implement the commitment. The operations procedure development program is required to be described in COL application FSAR Section 13.5 in accordance with COL item 13.5(5). Hence, there is no need for additional COL items in this DCD section.

Item No.3

Regarding water volume, the capacities of the RWSP and the refueling cavity are 81,230 ft^3 (2,300 m^3) and 70,630 ft^3 (2,000 m^3), respectively. During refueling, more than 4,600 ft^3 (130 m^3) of water in the RWSP remains above the minimum level required to operate the refueling water recirculation pump, and is available for makeup capability of the refueling cavity.

The capacity of the RWSAT is 29,410 ft^3 (830 m^3). While the transfer canal, inspection pit and cask pit are filled with water, more than 280 ft^3 (8 m^3) of the water in the RWSAT remains above the minimum level required to operate the refueling water recirculation pump.

Note that it is not necessary to fill the cask pit during refueling. When the cask pit is not filled with water during refueling, the available water remaining in the RWSAT increases to 8,500 ft^3 (240 m^3).

Therefore, at least 4,800 ft^3 (135 m^3) water as a total volume remains in the RWSP.

Meanwhile, regarding leakage rate, before filling the refueling cavity, the PCS is inspected visually and the valves are checked for their position. Therefore, the probability of a rapid drain down event at a flow rate of more than 1 gpm is very low. Since the volume of available water for makeup which remains in the RWSP is 4,600 ft^3 (130 m^3) and the capacity of the refueling water recirculation pump is 200 gpm, even though the leakage from the refueling cavity at a flow rate of 10 gpm is assumed conservatively, there is sufficient capacity for makeup.

MHI will add the description bellow in Tier 2 of DCD Chapter 9 Section 9.1.4.2.2.2. See "Impact on DCD".

Item No.4

MHI will provide additional information regarding the leakage detection design in Tier 2 of DCD Chapter 9 Section 9.1.4.2.1. See the fourth paragraph in the new Section 9.1.4.2.1.13 "Permanent Cavity Seal (PCS)" to be added.

Impact on DCD

See Attachment 1 for the mark-up of DCD Tier 2, Section 9.1, changes to be incorporated.

- Add the following section in Tier 2 of the DCD Chapter 9 Section 9.1.4.2.1:

  "9.1.4.2.1.13 Permanent Cavity Seal (PCS)

  The Permanent Cavity Seal (PCS) has a function to maintain water level in the refueling cavity during refueling operation by sealing an annular gap between the reactor vessel flange and the refueling cavity floor.

  The seal is made of a stainless steel structure and permanently attached to the vessel and the floor with bolts and welds. Appropriate sections of the ASME Code, or codes and standards recommended by manufacturers shall be applied in selection of material and manufacture of the seal.

  Should a load, such as a fuel assembly, suspended from the polar crane or refueling machine, which are designed as single failure proof, be dropped on the seal, damage to the seal is prevented by a stainless steel guard plate (curing lid) which is installed over the PCS. Moreover, since the PCS and the guard plate are washed thoroughly with demineralized water after the draining of the refueling cavity water to remove extraneous materials such as sludge, these structures do not degrade over time.

  Leakage detection systems are utilized for the PCS. Two leakage detection pipes are installed under the ring-shaped PCS directly opposite each other across the reactor vessel. Wherever around the seal leakage from the PCS should occur, the leakage water flows and accumulates into an annular space between a vertical cylindrical plate, which is attached to support ring, and the PCS, and eventually flows into one or both of the detection pipes. Once water flows into the leakage detector via the leakage detection pipe, the leak detection system provides an alarm signal to alert operators in the MCR and in the vicinity of the fuel handling system that an abnormal water level condition exists in the refueling cavity.

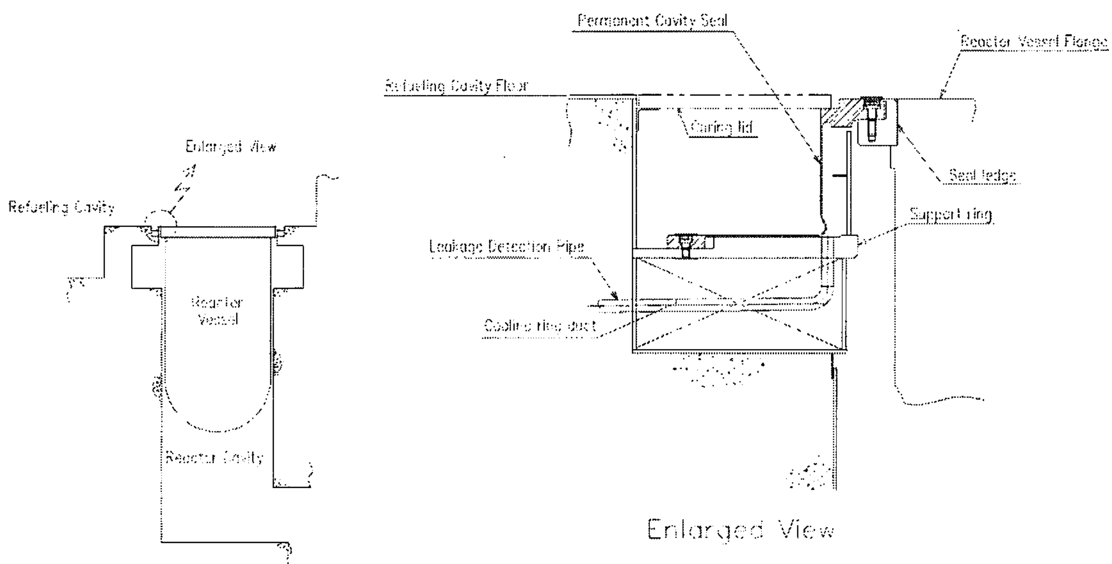
  The refueling cavity water High and Low level is monitored by a refueling cavity water level indicator and an alarm, which are shown as "LIA 011-N" in Tier 2 of the DCD Rev. 2 Figure 5.1-2 (Sheet 3 of 3).

  Although a rapid cavity drain-down event is unlikely, if such an event should occur, upon alarm the workers immediately place a fuel assembly in transfer into a containment rack. Since the seal is visually inspected before filling the cavity, the possibility of a rapid cavity drain-down event at a flow rate of more than 1 gpm, resulting from a large crack, which would be detected through visual inspection, is excluded. Therefore, sufficient time will be available to place the fuel assembly in the containment rack before the refueling cavity water level drops below the minimum level necessary to maintain proper shielding."

- Add the following description in Tier 2 of the DCD Chapter 9 Section 9.1.4.2.2.2;

  During refueling, the refueling cavity is filled with water transferred from the RWSP. If leakage from the refueling cavity occurred, the water level drops and alarms the MCR. Upon alarm and MCR action, the water level will be recovered by transferring water from the RWSP, using the refueling water recirculation pump. A sufficient quantity of water remains in the RWSP after the refueling cavity is initially filled with water to maintain the water level of the refueling cavity.

- Add the following figure in Tier 2 of the DCD Chapter 9 Section 9.1;



Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on the PRA.

This completes MHI's response to the NRC's question.

handling tool is lowered onto the fuel assembly. The latching mechanism is lowered to the rod control cluster, the rod control cluster is latched, and then the latching mechanism and rod control cluster are pulled up into the guide tube. The tool is then raised, the crane is repositioned over the target fuel assembly, and the tool is lowered onto the fuel assembly. The latching mechanism and the rod control cluster are then lowered through the guide tube until the rod control cluster is resting in the target fuel assembly. The rod control cluster is then unlatched and the tool is lifted from the target fuel assembly.

9.1.4.2.1.10 Thimble Plug Handling Tool

The thimble plug handling tool is utilized to remove and transfer a thimble plug from one fuel assembly to another. This operation is performed from the bridge of the fuel handling machine by hand.

9.1.4.2.1.11 Burnable Poison Rod Assembly Handling Tool

The burnable poison rod assembly handling tool is used to transfer a burnable poison rod assembly between fuel assemblies and/or burnable poison rod assembly storage fixture.

9.1.4.2.1.12 Control Rod Drive Shaft Handling Tool

The control rod drive shaft handling tool is used to latch and unlatch the control rod drive shaft from the rod control cluster. It is suspended from the auxiliary hoist of the refueling machine.

9.1.4.2.1.13 Permanent Cavity Seal

The Permanent Cavity Seal (PCS) has a function to maintain water level in the refueling cavity during refueling operation by sealing an annular gap between the reactor vessel flange and the refueling cavity floor.

The seal is made of a stainless steel structure and permanently attached to the vessel and the floor with bolts and welds. Appropriate sections of the ASME Code, or codes and standards recommended by manufacturers shall be applied in selection of material and manufacture of the seal.

Should a load, such as a fuel assembly, suspended from the polar crane or refueling machine, which are designed as single failure proof, be dropped on the seal, damage to the seal is prevented by a stainless steel guard plate (curing lid) which is installed over the PCS. Moreover, since the PCS and the guard plate are washed thoroughly with demineralized water after the draining of the refueling cavity water to remove extraneous materials such as sludge, these structures do not degrade over time.

Leakage detection systems are utilized for the PCS. Two leakage detection pipes are installed under the ring-shaped PCS directly opposite each other across the reactor vessel. Wherever around the seal leakage from the PCS should occur, the leakage water flows and accumulates into an annular space between a vertical cylindrical plate, which is attached to support ring, and the PCS, and eventually flows into one or both of the detection pipes. Once water flows into the leakage detector via the leakage detection pipe, the leak detection system provides an alarm signal to alert operators in the MCR and in the vicinity of the fuel handling system that an abnormal water level condition exists in the refueling cavity.

The refueling cavity water High and Low level is monitored by a refueling cavity water level indicator and an alarm, which are shown as "LIA 011-N" in Tier 2 of the DCD Rev. 2 Figure 5.1-2 (Sheet 3 of 3).

Although a rapid cavity drain-down event is unlikely, if such an event should occur, upon alarm the workers immediately place a fuel assembly in transfer into a containment rack. Since the seal is visually inspected before filling the cavity, the possibility of a rapid cavity drain-down event at a flow rate of more than 1 gpm, resulting from a large crack, which would be detected through visual inspection, is excluded. Therefore, sufficient time will be available to place the fuel assembly in the containment rack before the refueling cavity water level drops below the minimum level necessary to maintain proper shielding.

9.1.4.2.2 Fuel Handling Operations

9.1.4.2.2.1 New Fuel Receipt

New fuel is shipped to the site in a new fuel shipping container. The new fuel shipping container is received into the R/B by way of the refueling area truck access bay at elevation 3 ft - 7 in.

The new fuel shipping container is raised from the truck using the auxiliary hoist on the spent fuel cask handling crane through the access hatch in the refueling area floors at elevations 25 ft - 3 in and 76 ft - 5 in. Elevation 76 ft - 5 in is the operating level of the refueling area.

The new fuel container is set on the operating floor. Using the suspension hoist on the spent fuel cask handling crane, new fuel is removed from the shipping container and stored in the new fuel storage pit. During this operation, the new fuel assemblies are suspended using a short fuel handling tool to permit surface inspection prior to being placed into a new fuel storage rack.

A new fuel assembly stored in the new fuel storage racks is transferred to the spent fuelpit to prepare for refueling.

A new fuel assembly stored in the new fuel racks is lifted using the suspension hoist ofthe spent fuel cask handling crane, and transferred to the new fuel elevator located in thefuel inspection pit. The new fuel assembly is then lowered using the new fuel elevator foraccess by the fuel handling machine. The new fuel assembly is latched by the spent fuelassembly handling tool on the fuel handling machine, and is lifted using the fuel handlingmachine mast tube or auxiliary hoist and then transferred to the spent fuel pit fortemporary storage in the spent fuel rack.

General arrangement figures for the US-APWR are presented in Subsection 1.2.1.7.

9.1.4.2.2.2 Reactor Refueling Operations

Plant procedures contain measures to prevent and mitigate inadvertent reactor cavity drain-down events. Reactor refueling procedures require that valve positions of potential reator cavity drain paths are verified prior to filling the refueling cavity. Operating procedures direct operators to monitor control room indications for reactor cavity seal leakage during refueling operations. Maintenance procedures address periodic maintenance and inspection of the permanent cavity seal and other seals and plugs in accordance with vendor recommendations. Emergency response procedures provide direction to operators regarding the proper response to pool drain down events.

9.1.4.2.2.3 Spent Fuel Storage

The spent fuel assemblies are stored in the SFP until fission product activity is low enough to permit shipment from the site or to be placed in dry storage. Spent fuel storage and cooling is discussed in Subsections 9.1.2 and 9.1.3, respectively.

9.1.4.2.2.4 Spent Fuel Shipment

Add following description:
"During refueling, the refueling cavity is filled with water transferred from the RWSP. If a leakage from the Refueling Cavity occurred, the water level drops and alarms the MCR. Upon alarm and MCR action, the water level will be recovered by transferring water from the RWSP, using the refueling water recirculation pump. A sufficient quantity of water remains in the RWSP after the Refueling Cavity is initially filled with water to maintain the water level of the refueling cavity."

...:

...way of the refueling area truck ...el cask is raised from the truck ...h the access hatch in the floors at ...ueling area.

...nd washed to clean off dust and adhered material from the outside surface of the cask.

- The cask lid is removed and lay down on the operating floor. Then, O-ring of the lid is visually inspected.
- The cask is then placed into an encapsulating flexible barrier (baggy) to the top flange to prevent surface contamination. Additionally, the cask is filled with clean demineralized water.
- The water levels are raised in the refueling canal and the cask pit. The water is supplied from the refueling water auxiliary tank. Prior to opening the SFP and cask pit gates, the SFP water level is confirmed to be equalized with the refueling canal and cask pit water levels.
- The cask is transferred from the cask washdown pit to the cask pit using the cask handling tool to prevent crane wire rope oil from contaminating the cask pit water. When the cask is being lifting down in the filled cask pit, the baggy is filled by demineralized water to prevent the SFP water from entering in the baggy. The gate between cask pit and refueling canal is closed until the cask is completely settled on the pit floor.
- The fuel handling machine is indexed over the spent fuel asembly to be transported out of the spent fuel rack. The spent fuel is picked up to a designated height clearing the rack top and maintaining sufficient water depth for radiation