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TOKYO, JAPAN

November 22, 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-11405

Subject: Amended MHI's Response to US-APWR DCD RAI No. 419-3126 Revision 0 (SRP 08.04)

References: 1) "Request for Additional Information No. 419-3126 Revision 0, SRP Section: 08.04 STATION BLACKOUT, Application Section: 8.4," dated (July 6, 2009).
2) "MHI's Response to US-APWR DCD RAI No. 419-3126 Revision 0", dated August 21, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Amended Response to Request for Additional Information No. 419-3126 Revision 0." This amended response is submitted to address SER Open Item 08.04-1.

Enclosed is the response to Question 08.04-12 that is contained within 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,

Atsushi Kumaki for

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

Enclosures:

1. Amended Response to Request for Additional Information No. 419-3126 Revision 0

D081
NRO

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

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Docket No. 52-021
MHI Ref: UAP-HF-11405

Enclosure 1

UAP-HF-11405
Docket No. 52-021

Amended Response to Request for Additional Information
No. 419-3126 Revision 0

November, 2011

SUPPLEMENTAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

11/22/2011

US APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 419-3126 REVISION 0**
SRP SECTION:	**08.04 - STATION BLACKOUT**
APPLICATION SECTION:	**8.4**
DATE OF RAI ISSUE:	**7/6/2009**

QUESTION NO. : 08.04-12

By RAI-08.04-007, the staff asked MHI to provide additional information on the systems and equipment required for coping for 1 hour without ac power for the following:

a. The staff asked MHI to provide additional information on RCS inventory taking into consideration shrinkage, leakage from pump seals, and inventory loss from letdown or other normally open lines. MHI responded by stating that the RCS is not in shrinkage condition, because plant is operated with keeping the RCS temperature during SBO. The seal return line is closed, and leakage of pump will not occur. Also letdown line and any other lines are closed, any inventory loss does not occur during SBO condition.

During the March 12, 2009, teleconference MHI stated that the wording "leakage of pump will not occur" stated in its response is not appropriate. It should be stated "leakage of pump will be limited". There is small leakage through RCP No.2 seal which is expected to be approximately 0.2 gpm (40 litters) per hour under SBO condition.

This leakage is very small compared to RCS inventory and no significant inventory loss will occur during SBO.

Based on MHI's revised statements on the issue of RCS inventory during the March 12, 2009 Teleconference, MHI is requested to provide the following information and clarification regarding the RCS inventory and core coverage.

1) Provide detailed description of the reactor coolant pump (RCP) seal return system and explain how the RCP seal leak flow at lower pressure could return to the reactor at higher pressure to avoid loss of reactor coolant inventory during a station blackout (SBO) event.

2) Perform an SBO coping analysis to demonstrate that reactor core will remain covered during the SBO time period assuming loss of coolant inventory by (a) steaming from the reactor through safety relief valves to carry out decay heat from the core, (b) assuming maximum RCS unidentified leakage defined in technical specifications, and (c) appropriate amount of RCP seal leakage (at 25 gpm per pump per NUMARC 87-00, 2.5.2) unless justified in item 1 above.

ANSWER:

1) Attachment 1 shows the configuration of the RCP seal return system. As described in Section 5.4.1.4.9, the leakage from the RCP is controlled by three shaft seals arranged in series. Normally, the seal injection water is supplied and the seal injection inside the pump is separated into two directions. One injection flows down to cool the bearing and enters the RCS, while the other injection flows up the shaft through the seals. After passing through the No. 1 seal, most of the flow leaves the pump via the No. 1 seal leak-off line. Minimal flow passes through the No. 2 seal to its leak-off line. The No. 1 seal leak-off is routed to the volume control tank and the No. 2 and 3 seal leak-offs are routed to the containment vessel reactor coolant drain tank (CVDT).

After SBO occurs, when the seal injection to the RCPs stops, the isolation valves on the No. 1 seal leak-off line of each RCP are closed by the undervoltage signal. Thus, the No. 2 seal leak-off is the only pathway for reactor coolant leakage through the RCPs. The leakage through the No. 2 seal is limited and is expected to be approximately 0.2 gpm per RCP under SBO condition.

The No. 2 RCP seal is designed to keep seal leakage below 0.2 gpm, with full pressure across No. 2 seal under the allowable and expected temperature of the seal. The water temperature around No. 2 seal under the condition of closed No. 1 seal leak-off line was calculated. The temperature will remain below 113°C, which is the upper limit temperature of the heat non-resistant O-ring, for greater than one hour.

Please refer to the "Attachment to answer to question 19-273 (Endurance of RCP shaft seal at SBO)," located at the end of the answer, to RAI No.148-1700, Question 19-273. The attachment is an examination of the RCP shaft seal at SBO conditions. It contains sections that address evaluation conditions, calculation method, evaluation result, temperature rise, and conclusion, of the examination of the RCP shaft seal at SBO conditions. The conclusion of the examination is that the temperature of the seal may rise as high as 106.2°C, which is lower than the upper limit temperature of the O-ring specified in the equipment instruction manual; therefore, the SBO temperature conditions will not deteriorate the seal function for one hour after SBO initiation.

2) Until AAC GTG restores power to the Class 1E power system within one hour after SBO occurs, the loss of coolant inventory with regard to item (a), (b) and (c) stated in the question are assumed as the following;

   (a) By steaming through the main steam relief valves, the decay heat of the core is removed and the plant is kept in a condition similar to hot shut down. This steaming is performed in the secondary system and relief through the valves around the pressurizer in the RCS will not occur. Therefore, it does not result in the loss of coolant inventory in the RCS.
   (b) The maximum RCS unidentified leakage defined in the technical specifications is 0.5 gpm and the loss of coolant inventory within 1 hour is expected not to exceed 30 gallons. (RCS unidentified leakage limit in technical specifications has changed to 0.5 gpm. The change was described to the NRC in RAI No. 217-2025, Revision 1, Question No 3.6.3-15, which was submitted by MHI letter UAP-HF-09103, dated March 24, 2009.)
   (c) The leakage of reactor coolant through the seals of each RCP is assumed to be 0.2 gpm as described in the response to question 1) above. Therefore the total loss of coolant inventory within 1 hour from the seals on all four RCPs is expected to be 48 gallons.

   Based on the above, the total RCS inventory loss during the first hour after SBO is determined to be less than 78 gallons, which corresponds to approximately 10.4 ft^3 at standard condition. This amount is less than 1% of the normal operating water volume in the pressurizer, which is approximately 1,300 ft^3(approximately 45% of the free internal volume of the pressurizer). Thus, the water in the pressurizer is maintained and the

reactor core will remain covered during the SBO time period.

After AAC GTG has restored power to the Class 1E power system, the coolant inventory will be maintained by supplying water by auxiliary systems.

The descriptive text and statements contained within Item 2.(1) of DCD Subsection 8.4.2.1.2 are considered redundant and unnecessary. In order to avoid possible confusion this subsection is being deleted from the DCD.

Impact on DCD

DCD Rev. 3 Section 8.4.2.1.2, Item 2.(1) will be deleted, as described above and as shown below and in the attached DCD markup(Attachment 2).

8.4.2.1.2 Station Blackout Coping Analysis

~~(1) Core and reactor coolant system (RCS) condition~~

~~Until AAC GTG restores the Class 1E power system within one hour after SBO occurs, all pumps and fans cannot be operated. However, during this time, the plant is in a condition similar to hot shut down. Turbine driven (T/D) emergency feedwater (EFW) pump and, main steam relief valve remove the decay heat of the core through natural circulation of the reactor coolant and the core and the RCS are kept in a safe mode. After SBO occurs, the isolation valves on No. 1 seal leak-off line of each RCP are closed by the undervoltage signal. The leakage through the No.2 seal is limited and minimal. Thus, the reactor core will remain covered.~~

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

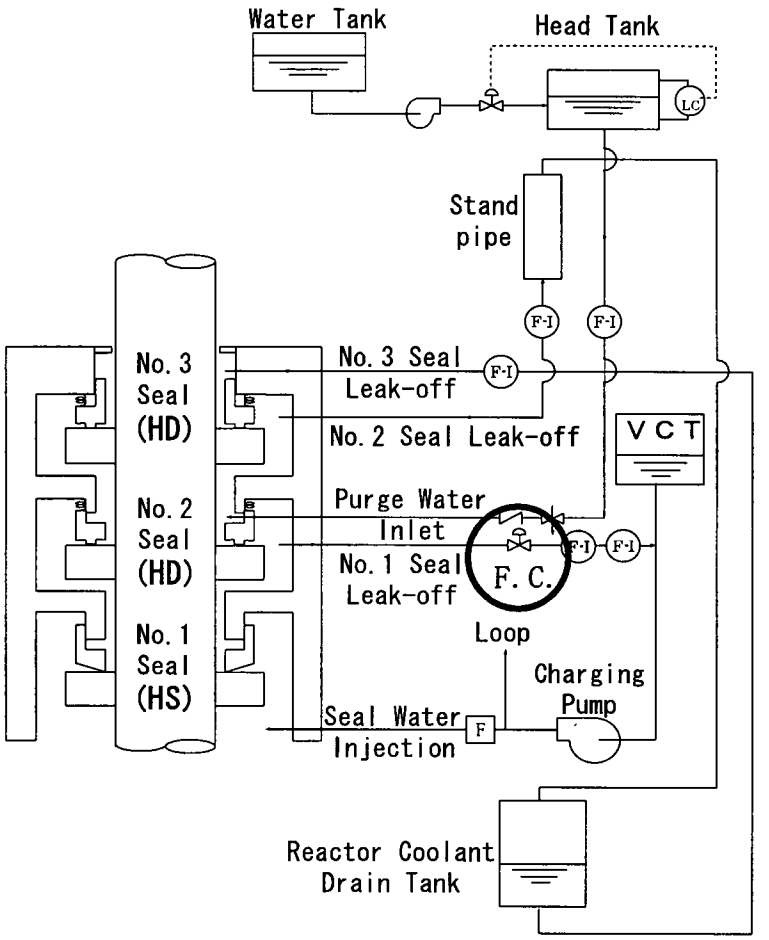
There is no impact on the PRA.

Impact on Technical/Topical Report

There is no impact on a Technical/Topical Report.

ATTACHMENT 1
To RAI No. 419-3126, Rev. 0
Question No. 08.04-12

SEAL WATER FLOW DIAGRAM

Seal Type	MHI
No.1 seal	Hydrostatic Seal (HS)
No.2 seal	Hydrodynamic Seal (HD)
No.3 seal	Hydrodynamic Seal(HD)
Seal Water Flow Diagram	
Remarks	MHI Seal is conposed of three seals; No.1 seal is Hydrostatic seal and No.2 and No.3 seals are Hydrodynamic seal. No.1 seal leak-off line of MHI is closed under the SBO condition. Therefore, reactor coolant water doesn't leak from No.1 seal leak-off line. No.2 seal of RCP is designed to keep seal leakage less than 0.2gpm, if the full pressure is placed on No.2 seal under allowance temperature. And MHI calculated the temperature of No.2 seal under the condition of closed No.1 seal leak-off line. And MHI checked that the seal temperature can be kept lower than 113°C of the heat-resistant temperature of O-ring for more than an hour.

Note 1 F.C.: Fail Close

8.4.2.1.2 Station Blackout Coping Analysis

The SBO rule in accordance with 10 CFR 50.63 (Reference 8.2-5) states that no coping analysis is required if the AAC sources can be demonstrated by test to be available to power the shutdown buses within 10 minutes of the onset of an SBO.

Two GTGs of a different ~~rating with diverse starting mechanism~~ manufacturer's product from the Class 1E GTGs are provided as AAC sources. These AAC GTGs are independent from the Class 1E GTGs and do not share any common auxiliaries or support systems. The AAC GTGs are not normally connected to the plant offsite or onsite power systems. The AAC GTGs are electrically isolated from the emergency Class 1E power supply systems by a non-Class 1E disconnect switch and a Class 1E circuit breaker. The disconnect switch and the Class 1E circuit breaker connecting the AAC GTG to the Class 1E buses are normally open, and would be manually closed during an SBO to restore the power supply to one of the Class 1E 6.9 kV buses A or B, or C or D. The AAC GTGs are automatically started by the undervoltage signal on the 6.9kV permanent buses P1 or P2 and connected to the respective 6.9kV permanent bus P1 or P2 during LOOP. The AAC GTGs can also be manually started and connected to the Class 1E emergency buses. The AAC GTGs start and reach the rated frequency and voltage and are ready to be loaded within 100 seconds. Each AAC source is capable of providing adequate power to the emergency shutdown buses. The power supply from the AAC GTG to one of the Class 1E buses can be restored within 60 minutes. Availability of power from the AAC GTG to one Class 1E 6.9kV bus within 60 minutes is verified by actual field testing. Since the power supply from the AAC GTG to the Class 1E buses cannot be restored within 10 minutes, the following coping analysis is performed for the US-APWR in accordance with the requirements of Section C.3.2 of RG 1.155 (Reference 8.3.1-21): DCD_08.03.01-38

1. After SBO occurs, all ac power sources including all Class 1E GTGs, are lost, except for ac power from the UPS. Power from the AAC GTG will be restored to the required Class 1E power system within 60 minutes. During the 60 minutes, no pumps and fans connected to the Class 1E 6.9kV and 480V ac buses can be operated.

2. With the plant be in above condition, the systems can be kept in safe condition as described below:

   (1) ~~Core and reactor coolant system (RCS) condition~~ DCD_08.04-12

   ~~Until AAC GTG restores the Class 1E power system within one hour after SBO occurs, all pumps and fans cannot be operated. However, during this time, the plant is in a condition similar to hot shut down. Turbine driven (T/D) emergency feedwater (EFW) pump and, main steam relief valve remove the decay heat of the core through natural circulation of the reactor coolant and the core and the RCS are kept in a safe mode. After SBO occurs, the isolation valves on No. 1 seal leak-off line of each RCP are closed by the undervoltage signal. The leakage through the No.2 seal is limited and minimal. Thus, the reactor core will remain covered.~~