**MITSUBISHI HEAVY INDUSTRIES, LTD.**
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

January 29, 2009

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

Attention: Mr. Jeffrey A. Ciocco

NRC Docket No. 52-021
MHI Ref: UAP-HF-09026

**Subject:** MHI's Responses to US-APWR DCD RAI No. 131-1609 Revision 1

**Reference:** 1) "Request for Additional Information No. 131-1609 Revision 1, SRP Section: 09.01.03 Spent Fuel Pool Cooling and Cleanup System, Application Section: 9.1.3, dated December 18, 2008.

With this letter, Mitsubishi Heavy Industries, Ltd. (MHI) transmits to the U.S. Nuclear Regulatory Commission (NRC) the document entitled, "Response to Request for Additional Information No. 131-1609 Revision 1."

Enclosed are the responses to 3 RAIs contained within Reference 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. for questions concerning any aspect of the submittals. His contact information is found at the end of this letter.

Sincerely,

Y. Ogata

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

Enclosure:

1. Responses to Request for Additional Information No. 131-1609 Revision 1

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

D081
NRO

<u>Contact Information</u>

C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Docket No. 52-021
MHI Ref: UAP-HF-09026

# Enclosure 1

UAP-HF-09026
Docket No. 52-021

# Responses to Request for Additional Information No. 131-1609 Revision 1

January 2009

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/29/2009

**US-APWR Design Certification**

**Mitsubishi Heavy Industries, Ltd.**

**Docket No. 52-021**

**RAI NO.:** NO. 131-1609 REVISION 1

**SRP SECTION:** 9.1.3 – Spent Fuel Pool Cooling and Cleanup System

**APPLICATION SECTION:** 9.1.3

**DATE OF RAI ISSUE:** 12/18/2008

---

**QUESTION NO.: 09.01.03-01**

[9.1.3-1] As described in the DCD Tier 2, the spent fuel pool (SFP) is initially filled with water having a boron concentration of approximately 4000 parts per million (ppm). Table 9.1.3-3 reports that the boron concentration is 4000 ppmB. This new unit (ppmB) has not been defined by the applicant. The staff understands that this "new unit" is an editorial error. The staff requests the applicant update the DCD to correct this editorial error or to define this new unit.

---

**ANSWER:**

The term ppmB is a typographical error and is intended to express concentration of elemental boron (B) as ppm B. Appropriate corrections in the next DCD revision will be made by deleting B in "ppmB" to remove confusion.

**Impact on DCD**

The change mentioned above will be made to the DCD.

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/29/2009

**US-APWR Design Certification**

**Mitsubishi Heavy Industries, Ltd.**

**Docket No. 52-021**

**RAI NO.:** NO. 131-1609 REVISION 1

**SRP SECTION:** 9.1.3 – Spent Fuel Pool Cooling and Cleanup System

**APPLICATION SECTION:** 9.1.3

**DATE OF RAI ISSUE:** 12/18/2008

---

**QUESTION NO.: 09.01.03-02**

**[9.1.3-2]** Standard Review Plan (SRP) Section 9.1.3.III.1.F discuss the appropriate design of the makeup system. In DCD Tier 2 Section 9.1.3, the applicant has not provided the basis for the boil-off rate calculations. The applicant does not specify the worst boil-off rates for the different offloading scenarios (normal and full core offloads), the minimum required makeup for the different offloading scenarios, and the flow rate capabilities of the various make up systems for the SFPCS. The staff requests the applicant to update DCD Tier 2 to include this missing information and the basis, assumptions, and results of the spent fuel pool cooling and purification system thermal analysis.

---

### ANSWER:

The SFP cooling system design does not allow boiling of the SFP water at any time, including misloading or dropping accidents of a fuel assembly between or on top of fully loaded racks. The 4000 ppm boric acid concentration is maintained to keep the fuel subcritical during adverse conditions of the accidents just mentioned; hence, no abnormal temperature increases that could lead to boil-off events are expected to occur. The most severe condition that can happen within the life of the plant would be an SBO event (where there is total loss of cooling function) during full core offloading with a fully loaded SFP, i.e. containing 10 years worth of previously offloaded fuel. At the onset of an SBO, an alternate AC (AAC) source is promptly activated within 60 minutes so that one train of cooling water pumps, including one SFP pump, is restored thus precluding SFP water boiling. Furthermore, the SFP water inventory is large enough to handle removal of heat for approximately 2.5 hours before the unlikely boiling of SFP water during a total loss of cooling condition.

Although the SFP design gives no credit to boiling events, redundant Seismic Category I water makeup connections are provided to compensate for loss of adequate SFP water inventory due to natural evaporation losses. The refueling water storage pit (RWSP), which is the main makeup water source, is able to supply 200 gpm of borated water, and the backup emergency feedwater pit (EFW) is able to supply nonborated water at 100 gpm by gravity draining. Another possible option for emergency makeup is through the nonseismic demineralized water (DW) tank that has a makeup capacity of up to 150 gpm. The makeup rates from all sources exceed the evaporation rate of approximately 100 gpm that is necessary to remove residual heat equivalent to 0.3% of rated thermal power (i.e. 4451 MW × 0.003/2260 kJ/kg).

Thermal analysis on the SFP will be submitted as an integral part of the thermal-hydraulic analysis which will be completed within the month of May 2009.

**Impact on DCD**

A similar discussion will be added in DCD Subsection 9.1.3.3.2 for the next revision, and the corresponding changes will be as shown below:

"Borated water is initially pumped from the CVCS to the SFP. The RWSP, as a primary water source of the SFP, is a seismic category I structure. Approximately 400, 000 gallons of borated water is injected to the SFP.
As the SFP cooling process progresses, natural evaporation losses that accompany temperature fluctuations dependent on the different operating modes are expected to occur. The SFP stainless steel liner, which is a seismic category I structure, is designed to withstand perforations due to a dropped fuel assembly and effects of design basis events previously described, hence leakage is unlikely to occur. Consequently, makeup water connections shall be required to compensate for the water lost based on the assumed natural evaporation loss events.

~~The safety-related boric acid water makeup line is provided from the RWSP to the SFP due to the evaporative loss of the SFP water or minor leakage from the SFPCS. The RWSP, as a primary water source of SFP, is seismic category I. The makeup line from the RWSP to the SFP is seismic category I, ASME Code section III Class 3.~~

~~As a backup of the safety-related makeup, a makeup line is also provided from the emergency feedwater (EFW) pit to the SFP. The EFW pit, as a back up water source of the RWSP, is also seismic category I. The backup line from EFW pit to SFP is non-seismic.~~

Boiling events in the SFP at any time throughout the life of the plant are not given credit in the SFPCS design, including fuel assembly misloading or dropping accidents between or onto fully loaded racks. Criticality issues that may arise from these accidents that subsequently cause SFP temperature to rise and finally boiling due to increased spent fuel heat generation rates are precluded from the high boron concentration of the SFP water maintained at 4000 ppm. The most critical condition that could challenge SFP integrity is an SBO event (where there is total loss of cooling functions) during a full core offload and the SFP loaded with 10 years worth of spent fuel. One alternate AC (AAC) power source is promptly activated within 60 minutes from the onset of SBO where one train of SFPCS equipment is reactivated to resume SFP cooling, thus precluding boiling. Furthermore, the SFP water volume allows an approximate 2.5-hour margin prior to an unlikely boiling of SFP water during a total loss of cooling condition or SBO.

The need for SFP water makeup, therefore, is ultimately based on natural evaporation losses. Since the quantity of water lost from this event is very small compared to the evaporation rate necessary to remove decay heat equivalent to 0.3% of rated thermal power, makeup rates from the different sources discussed hitherto are based on the latter. The calculated rate is approximately 100 gpm and is assumed to be the most limiting.

Redundant seismic category I sources are provided for SFP water makeup. The seismic RWSP is able to supply 200 gpm of boric acid water through a seismic makeup line to the SFP. The EFW pit, which itself is seismic category I, backs up the RWSP through a nonseismic connection to the SFP with a makeup capacity of 100 gpm. Makeup from the EFW pit is performed through gravity injection, hence eliminates the need for pumps. The nonseismic DW tank also has nonseismic connections to the SFP with a makeup capacity of up to 150 gpm."

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/29/2009

**US-APWR Design Certification**

**Mitsubishi Heavy Industries, Ltd.**

**Docket No. 52-021**

**RAI NO.:** NO. 131-1609 REVISION 1

**SRP SECTION:** 9.1.3 – Spent Fuel Pool Cooling and Cleanup System

**APPLICATION SECTION:** 9.1.3

**DATE OF RAI ISSUE:** 12/18/2008

---

**QUESTION NO.: 09.01.03-03**

[9.1.3-3] The US-APWR design provides instrumentation to measure temperature, pressure, flow, radioactivity and water level in the SFP. The temperature, radiation and water levels are equipped with alarms to warn the operators of dangerous conditions. However, the applicant has not proposed to include a low flow rate alarm. This is not consistent with the recommendations of SRP 9.1.3 Section IV.5. The staff requests the applicant to include in the DCD a justification for not having this low flow rate alarm.

---

**ANSWER:**

Low flow rates and eventual loss of flow through the SFP can be indirectly determined by the unstable rise and fall of SFP temperatures due to pump fluctuations or stoppage. Deviations from allowable temperature limits as temperatures continue to rise and subsequent decreases in SFP water inventory through evaporative losses are both alarmed in the MCR. This rationale has been deemed to be adequate in mitigating abnormal SFP conditions. Nonetheless, a flow alarm annunciator will be incorporated in the flow metering system of each cooling train to ascertain indication of low flow rates at all operating conditions.

**Impact on DCD**

A discussion on the use of flow alarm annunciators will be added at the end of the first paragraph of DCD Subsection 9.1.3.5.3, as well as make the necessary changes in Figure 9.1.3-1, "Schematic of Spent Fuel Pit Purification and Cooling System (Cooling Portion)" in the next DCD revision. The statement to be in the DCD will be as shown below:

"Alarms to indicate low flow rates and eventual loss of flow that indicates a loss of cooling function is also integrated to inhibit abnormal temperature increases and eventual increases in radiation levels."

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

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