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

July 29, 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-11240

**Subject: MHI's Revised Responses to US-APWR DCD RAI No. 699-5368 Revision 0**

**Reference:** [1] "Request for Additional Information No. 699-5368 Revision 0, SRP Section: 09.02.02 – REACOR AUXILIARY COOLING WATER SYSTEM – Design Certification and New License Applicants, Application Section: 9.2.2," dated Feb 28, 2011.
[2] MHI letter UAP-HF-11172 "MHI's Responses to US-APWR DCD RAI No. 699-5368 Revision 0," dated June 06, 2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Revised Response to Request for Additional Information No. 699-5368 Revision 0". This transmittal amends the Reference 2 response for question 09.02.02-81.

Enclosure 1 is the revised responses question 09.02.02-81 which is contained within Reference [2].

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. Revised Responses to Request for Additional Information No. 699-5368 Revision 0

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

D081
NRO

Contact Information
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

# Enclosure 1

UAP-HF-11240
Docket No. 52-021

# Revised Responses to Request for Additional Information No. 699-5368 Revision 0

July 2011

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**07/29/2011**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

| | |
|---|---|
| **RAI NO.:** | **NO. 699-5368 REVISION 0** |
| **SRP SECTION:** | **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM** |
| **APPLICATION SECTION:** | **9.2.2** |
| **DATE OF RAI ISSUE:** | **2/28/2011** |

---

**QUESTION NO.:** 09.02.02-81

Based on the staff's review of the applicant's response to RAI 09.02.02-23, the following item should be addressed related to item 6 (plate type heat exchangers):

The RAI response stated that since deminerlized quality water with corrosion inhibitors will be utilized in the CCWS and no outside impurities are expected to be infilterated in the system; CCWS system filters are not deemed necessary and not provided.

Operating experiences related to plate type heat exchangers have identified very small amounts of debris will cause the heat exchangers to be inoperable due to high differential pressure across the plate type heat exchangers. In addition, EPRI's technical report, "Plant Support Engineering: Guidance for Replacing Heat Exchangers at Nuclear Power Plants with Plate Heat Exchangers," Section 3.1.3, "Disadvantages of the Plate Type Heat Exchangers," states that chemical addition systems are essential to maintain the surfaces free of microbiological fouling. More important is the need to have relatively fine strainers rated for <2 mm (<0.08 in) because of the narrow passages within the plates.

Provide in the DCD a discussion related to an evaluation of the CCWS heat exchanger and the ESWS side (Section 9.2.1) to address the prevention of high differential pressures due to the relative small heat exchanger internal clearances and potential system debris.

In addition, this DCD discussion should be expanded to all safety related plate type heat exchangers which includes the spent fuel pit heat exchanger which is cooled by CCWS which is described in Section 9.1.3 of the DCD.

---

**ANSWER:**

Two safety-related plate type heat exchangers are used in the US-APWR: component cooling water (CCW) heat exchangers NCS-MHX-001A/B/C/D and the spent fuel pit (SFP) heat exchangers SFS-MHX-001A/B. As indicated in Table 9.1.3-3 and Table 9.2.2-2, respectively, the SFP heat exchangers are stainless steel and the CCW plates are titanium. Both materials are resistant to corrosion as discussed in EPRI TR 1013470. The hot side of a CCW heat exchanger is component cooling water and the cold side of a CCW heat exchanger is essential service water (ESW). The hot side of a SFP heat exchanger is spent fuel pit water and the cold side of a SFP heat exchanger is component cooling water. Thus, three fluid conditions are seen in the safety-related plate type heat exchangers: Component Cooling water, Essential Service water and Spent Fuel Pit water. Prevention of high differential pressures and potential clogging is achieved based on water quality, filtration and backwashing depending on water conditions.

(Note that the DCD references in the following discussion refer to DCD Revision 3 submitted via MHI letter UAP-HF-11078, dated 31March 2011.)

Component Cooling water

As indicated in DCD Subsection 9.2.2.2 and 9.2.2.3.4, CCW water is controlled to a high purity level through the use of demineralized water with corrosion inhibitors, as well as a nitrogen blanket on the surge tank. Due to the water quality of the closed CCW system, a strainer is not required; this is consistent with operating experience in Japan.

In the event of a safe shutdown earthquake, makeup to the surge tank is available from a seismically qualified water source using an FSS piping connection, if necessary. A strainer is installed in the water supply piping from the FSS to prevent potential clogging of the CCW heat exchanger, if this source were used. Based on heat exchanger flow passage dimensions, a strainer mesh size of 3mm will be used. The response to RAI 571-4365, Question 9.2.2-69 updates Tier 2 Figure 9.2.2-1 to add this strainer (NCS-SST-002A/B).

(Note: DCD Revision 3 Tier 1 provides ITAAC to verify CCW, ESW, and SFP cooling system functionality and performance in Table 2.7.3.3-5, ITAAC #7; Table 2.7.3.1-5, ITAAC #7; and Table 2.7.6.3-5, ITAAC #8, respectively.)

Essential Service water

The Essential Service Water System (ESWS) circulates water from the Ultimate Heat Sink and returns the effluent water to the UHS. Because water quality cannot be controlled to the level of the closed CCWS, additional controls to prevent potential heat exchanger clogging are used. As indicated in EPRI TR 1013470 Section 3.1.3, plate-type heat exchangers can require a relatively fine strainer (<2 mm mesh), particularly with the use of raw water. Also as indicated in EPRI TR 1013470 Section 3.2, there is a size range for the gap forming the flow channel for each plate type heat exchanger. Thus, it is appropriate that a strainer mesh size, if needed, be determined based on the plate heat exchanger dimensions. As discussed in DCD Subsection 9.2.1.2.2.2, the minimum flow passage of the CCW heat exchanger is 3 to 6mm. Therefore, the strainer mesh size is 3mm on the ESW pump discharge (CCW heat exchanger inlet). Smaller mesh size is judged to result in increased potential for clogging or excessive backwash operations. Strainer backwashing is initiated on a high differential pressure as discussed in Subsection 9.2.1.2.2.2 to prevent strainer clogging.

Spent Fuel Pit water

As described in DCD Section 9.1.3.2, the Spent Fuel Pit Cooling and Purification System (SFPCS) has a purification function. One train of the SFPCS is continuously running to provide the purification function; the second train is available as backup. Each train includes a strainer at the spent fuel pit to remove relatively large size solid materials, Each train has a filter with particle removal efficiency of approximately 98 % for 1 micrometer particle and a demineralizer to remove ionic impurities. The filter size, which is much smaller than the heat exchanger flow passage dimensions of approximately 3 mm, is small enough to prevent clogging of the heat exchanger passages. The DCD will be modified to reflect this perspective. When the SFP filter differential pressure exceeds the set value, a high differential pressure alarm indicates a clogged filter that should be replaced. The continuous purification operation prevents SFP heat exchanger clogging, as confirmed by operating experience in Japan.

The purification portion of the SFPCS is not safety-related, so it is assumed not to be available during an accident condition. However, water at the start of the accident would be expected to be of high quality. Thus, heat exchanger performance would not be affected for an extended period even if the purification portion of the system were unavailable.

A commitment to EPRI TR 1013470 with regard to incorporating lessons learned from operating experience for plate-type heat exchangers will be added to the DCD for both the CCW and SFP heat exchangers.

Reference: EPRI Technical Report 1013470, "Plant Support Engineering: Guidance for Replacing Heat Exchanger at Nuclear Power Plants with Plate Heat Exchangers"

**Impact on DCD**

DCD Tier 2 Subsection 9.1.3.2.1.3 will be revised as follows:

- Add reference to EPRI TR 1013470 for industry lessons learned on potential blockage.

DCD Tier 2 Subsection 9.1.3.2.1.4 will be revised as follows:

- Clarify filter capability with respect to heat exchanger flow passages.

DCD Tier 2 Subsection 9.2.1.2.2.3 will be revised as follows:

- Add reference to EPRI TR 1013470 for industry lessons learned on potential blockage and leakage.

DCD Tier 2 Subsection 9.2.2.2.1.3 will be revised as follows:

- Add discussion regarding strainers in piping from surge tank makeup sources.

**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.

The SFP pumps are horizontal centrifugal type, and the wetted area in contact with the fuel pit water is of stainless steel material.

#### 9.1.3.2.1.3 Spent Fuel Pit Heat Exchangers

Two SFP heat exchangers are provided to remove decay heat from the SFP, as specified in Subsection 9.1.3.2.2.2. These heat exchangers are plate-type heat exchangers constructed of austenitic stainless steel. The SFP water circulates through one side of the heat exchanger while the CCW circulates through the other side. The design of SFP heat exchangers will incorporate specific features regarding industry operating experience as discussed in EPRI TR 1013470 to minimize leakage from Plate type heat exchangers, (Ref. 9.1.7-27).

**and potential blockage of the heat exchanger flow passages**

#### 9.1.3.2.1.4 Spent Fuel Pit Filters

Two vertical, cylindrical cartridge-type SFP filters are provided in the purification portion of the SFPCS. Each cartridge filter is designed for a flow rate of approximately 265 gpm. The filter is used to improve the pit water clarity by removing solid particles. The filter assembly is constructed of austenitic stainless steel with disposable filter cartridges.

**The filters have a combined particle removal efficiency of approximately 98% for 1 μm particles, which, in combination with the spent fuel pit strainers, effectively removes debris from the system that could clog the SFP plate heat exchangers, which have flow passages of approximately 3 mm in diameter.**

#### 9.1.3.2.1.5

Two vertical, cy
for a flow rate o
the SFP water before being circulated back to the SFP. The vessels are constructed of austenitic stainless steel.

#### 9.1.3.2.1.6 Spent Fuel Pit Strainers

Spent fuel pit strainers are provided at the intake of the SFP to remove relatively large size solid materials for SFP and CS/RHR pump protection. The strainer is made of stainless steel.

#### 9.1.3.2.1.7 Valves

Manual valves are used to isolate the cooling portion of the SFPCS from the purification portion. Manual valves are used to isolate components that could develop leaks or failures. Manual throttle valves are provided for flow control. Valves in contact with SFP water are made of stainless steel.

#### 9.1.3.2.1.8 Piping

All piping in contact with SFP water is made of stainless steel. The piping is welded, except for flanged connections for the pumps and heat exchangers.

The strainer backwash line is installed with a normally open isolation valve. The COL Applicant is to determine the backwash line discharge location in accordance with the type of the UHS used. This normally open isolation valve in the backwash line and the strainer integral backwash control valve are interlocked to close at a pump stop signal to prevent water drainage that could potentially lead to water hammer. The isolation valve is also provided with remote manual control from the MCR to enable remote manual isolation during accidents. The backwash line valves are powered by a Class 1E DC source so that they close upon loss of offsite power. An automatic vent valve is also installed to sweep out air introduced into the piping system by the vacuum breakers installed for prevention of water hammer.

The automatic strainers have a 3 mm mesh which is considered to effectively remove debris from the system that could clog the CCW plate heat exchangers with flow passages approximately 3~6 mm in diameter. Since the essential chiller units, being shell and tube type heat exchangers, have a much larger flow path than the CCW heat exchangers, no strainer for additional filtering is deemed necessary. [[The 3mm mesh of the strainer element also assures that potential clogging of the cooling tower nozzles is avoided.]]

The ESWP discharge strainers are designed per ASME Boiler and Pressure Vessel Code Section III, Division I, Subsection ND - Class 3 Components and ASME NQA-1 – Quality Assurance Requirements for Nuclear Facility Applications.

The COL Applicant is to provide the design details of the strainer backwash line, vent line, and their discharge locations.

### 9.2.1.2.2.3 CCW HX

Four 50% capacity plate type HXs, one per train, are provided. A detailed description of the HXs is given in Subsection 9.2.2.

A backflushing line is provided for each CCW HX to enable backflushing of the heat exchanger following a high differential pressure alarm that may likely be caused by accumulation of debris materials inside the heat exchanger plate flow channels.

### 9.2.1.2.2.4 Essential Chiller Units

Four 5 ... n of the essenti ...

**The design of CCW heat exchangers will incorporate specific features regarding industry operating experience as discussed in EPRI TR 1013470 to minimize leakage from plate-type heat exchangers and potential blockage of the heat exchanger flow passages (Ref. 9.1.7-27).**

### 9.2.1.2.2.5 Piping

Carbon steel piping designed, fabricated, installed and tested in accordance with ASME Section III, Class 3 requirements, is used for the safety-related portion of the ESWS. Piping is arranged to permit access for inspection. The essential service water pipe tunnel (ESWPT), including the ESW piping from this tunnel to the ESW pump intake and discharge structures and the UHS, is site specific but the existence and function of which are required in the standard design. The COL Applicant is to locate the pipes entering and exiting the pipe tunnel based on the location of the UHSRS, as required. [[The piping

The CCW surge tank is designated quality group C as defined in Regulatory Guide 1.26, seismic category I, and is designed to the requirements of the ASME Section III, class 3.

In case of a small leak out of the system, makeup water is supplied as necessary until the leak is isolated.

The makeup water can be supplied from the following systems:

- Demineralized water system (DWS) which supplies the demineralized water
- Primary makeup water system (PMWS) which supplies the deaerated water and primary makeup water
- Refueling water storage system (RWS) which supplies the refueling water

Deaerated water is used for initial fi
for automatic makeup when the tan

**Strainers are provided in piping connecting makeup water sources to the surge tank; based on heat exchanger flow passage dimensions, the strainer mesh size is 3mm.**

If necessary, primary makeup water and refueling water may be used during an emergency. Refueling water storage pit is water source of seismic category I.

Water chemistry control of CCWS is performed by adding chemicals to the CCW surge tank to prevent long term corrosion that may degrade system performance. The CCW in the surge tank is covered with nitrogen gas to maintain water chemistry.

In order to provide redundancy for a passive failure (a loss of system integrity resulting in abnormal leakage), an internal partition plate is provided in the tank so that two separate surge tank volumes are maintained.

The CCW surge tank capacity of 50% is able to receive the amount of inleak from RCP thermal barrier Hx in consideration of isolation time. Regarding the makeup water source of the RWSP to be seismic category I, this makeup water source provides capacity to accommodate system leakage for seven days. Makeup water supply is performed by an operator by locally operating the manual valves. A vacuum breaker is installed on the surge tank to prevent damaging the tank in the event of a sudden decrease in water level.

#### 9.2.2.2.1.4 Piping

Carbon steel is used for the piping of the CCWS. Piping joints and connections are welded, except where flanged connections are required.

#### 9.2.2.2.1.5 Valves

- **Header tie line isolation valve**

The function of this motor operated valve is to separate each subsystem into two independent trains during abnormal and accident conditions. This ensures each safety train is isolated from any potential passive failure in the non-safety portion or another safety train of the CCWS. This valve automatically closes at once upon the following signals: