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June 4, 2012

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- 12148

Subject: MHI's Response to US-APWR DCD RAI No.917-6272 Revision 3 (SRP 06.04)

Reference: 1) "Request for Additional Information No. 917-6272 Revision 3, SRP Section: 06.04 – Control Room Habitability System Application Section: Section 6.4 & 9.4.3" dated April 3, 2012.

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.917-6272 Revision 3 (SRP 06.04)".

Enclosed is the response to the question contained within Reference 1.

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

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

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NRO

Enclosure:

1. Response to Request for Additional Information No. 917-6272 Revision 3 (SRP 06.04)

CC: J. A. Ciocco
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Contact Information

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Enclosure 1

UAP-HF-12148
Docket No. 52-021

Response to Request for Additional Information No. 917-6272
Revision 3 (SRP 06.04)

June 2012

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

6/4/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 917-6272 REVISION 3**
SRP SECTION:	**06.04 – CONTROL ROOM HABITABILITY SYSTEM**
APPLICATION SECTION:	**6.4 & 9.4.3**
DATE OF RAI ISSUE:	**4/3/2012**

QUESTION NO.: 06.04-15:

This is a follow-up RAI to the DCD (MHI) RAI series RAI No. 49-895 Question No. 06.04-19 and RAI 338-2325, Question No. 06.04-6 (ML091700682); RAI No. 559-4387; Question No. 06.04-13 (ML101450208) and RAI No. 5410 Question 06.04-14 (ML110740081)

Industry Events involving Refrigerant leaks:

Hope Creek September 29, 1999: see last two pages of press release http://www.nrc.gov/reading-rm/doc-collections/event-status/event/1999/19990930en.html

Quad Cities Unit 1, May 19, 2010: NRC Integrated Inspection Report 05000254/2010003; 05000265/2010003 (page 38) http://pbadupws.nrc.gov/docs/ML1021/ML102180023.pdf

Callaway Unit 1, September 18, 2011 - Preliminary Notification of Event or Unusual Occurrence -- PNO-IV-11-007: ADAMS Accession Number: ML 112620137

ASHRAE Standard 15 Comparison to the US-APWR Design:

The staff requests additional information about the following issues:

(1) Non-Essential Chiller Machinery Room Isolation

The applicant's response in part read *"The US-APWR plant is classified as industrial occupancy in accordance with ANSIIASHRAE Standard 15, Section 4 since access to the plant is limited to authorized persons and not open to the public."* Staff agrees with the applicant's conclusion that the *US-APWR plant is classified as industrial occupancy in accordance with ANSIIASHRAE Standard 15. This classification applies to both* the CRE and the power block as a whole. The whole of the power block will have plant workers performing maintenance activities that need protection from a significant refrigerant/ oil vapor leak. The equipment room in Fire Zone FA4-101-18 for the non-essential chillers will house maintenance activities on a periodic basis for each of the four chillers. In addition, other equipment that share Fire Zone FA4-101-18 (i.e. the ABVS AHUs and the non-Class 1E AHUs) will have periodic maintenance activities.

The applicant concluded that the ECWS and non-ECWS chillers are indirect closed systems based on the definition in ANSI/ASHRAE Standard 15, Section 5.1.2.3. The applicant went on to conclude that '*This type of refrigeration system is classified as a low probability system in ANSI/ASHRAE Standard 15, Section 5.2, meaning that leakage from a failed connection, seal, or component in the refrigerant system cannot enter the occupied space being cooled* *by the chilled water systems.'* The staff notes that the closing clause "being cooled by the chilled water systems" is not part of the ANSI/ASHRAE Standard 15, Section 5.2.2 definition for a "Low–Probability System".

Section 5.2.1 of Standard 15 reads "A high-probability system is any system in which the basic design, or the location of the components, is such that a leakage of refrigerant from a failed connection, seal or component will enter the occupied space." Given that the equipment room of the non-essential chillers communicates with all of Fire Area FA4-101-18 which is "an industrial occupied space" housing other plant equipment, the non-essential chillers more nearly fit the definition of a "high probability system". Fire Area FA4-101-18 also houses the A/B Air Handling Units and the non-Class 1E Electrical Room Air Handling Units (Figure 9a-16). These AHUs (including ductwork to the non-Class 1E AHUs) up to the fan will be under negative pressure relative to the room ambient conditions. This violates the guidance provided in Standard 15 Subsections 8.11.7. Therefore to prevent the transmission of a leaking refrigerant/oil fog to other power block areas, the area that houses the non-essential chillers needs to be isolated (e.g. a self closing tight fitting doors) from the rest of Fire Area FA4-101-18 and fire areas above and below to create a Standard 15 compliant "Low–Probability System" machinery room.

The staff notes that DCD Figure 9A-11, Figure 9A-16, Figure 1.2-35, Figure 1.2-26, subsection 9.2.7.2.1 and 9.2.7.2.2 may all need revision to reflect self-closing tight fitting doors. Similarly, the attribute of self-closing doors is not reflected in DCD subsection 9.2.7.2.1 and 9.2.7.2.2. These subsections should also state that alarms are annunciated inside and outside the rooms (Ref. Standard 15, subsection 8.11.2.1).

(2) Essential Chiller and Non-Essential Chiller Machinery Rooms Ventilation

Based on a total amount of refrigerant charge (i.e. approximated at 2,750 lb/nonessential chiller and 1900lb/essential chiller) for four essential chillers and one nonessential chiller, and based on the equation in Standard 15 Subsection 8.11.5, the total combined flow to/from the single non-essential chiller room and four essential chiller rooms would equate to 20,000 to 25,000 cfm. The total design exhaust flow for the ABVS equals 216,000 cfm. It is unclear if the applicant considered this Standard 15 guidance in determining the total design exhaust flow rate for the ABVS?

To ensure Standard 15 conformance, the staff requests that the Acceptance Criteria of 14.2.12.1.99 "Auxiliary Building HVAC System Preoperational Test" and that Section 9.4.3 "Auxiliary Building Ventilation System" be amended to capture the need for adequate ventilation to the machinery rooms of the essential and non-essential chillers. Also, a separate HVAC supply and exhaust is required to/from the non-essential chiller machinery room and to/from the rest of fire area FA4-101-18. However, Figure 9.4.3-1 does not reflect this attribute.

(3) Refrigerant Type and Amounts

The applicant responded that "*The refrigerant type used in ECWS and non-ECWS chillers will be of lower flammability and toxicity level included in Safety Group AI.*" Since compliance with the guidance of Standard 15 depends on the refrigerant type (i.e. Safety Group) and amount per chiller, the staff request that the applicant capture the limits in the DCD to ensure Standard 15 compliance.

(4) Chiller Room Fire Hazard's Analysis

The staff notes from the "Fire Hazard Analysis Summary" that Fire loading within the Essential Chiller Rooms [Fire Zones FA3-101-01 (page 9A-484), FA3-102-01 (page 9A-485), FA3-108-01 (page 9A-496), FA3-110-01 (page 9A-500)] that potential combustible equals lube oil 2.0E+6 Btu per chiller machinery room. From the "Fire Hazard Analysis Summary" (page 9A-537) for the Non–Essential Chiller Rooms: Fire Zone FA4-101-18 that potential combustibles equals lube oil 8.0E+6 Btu for the entire room. The staff request additional information about how these fire loading values were derived.

ANSWER:

Part (1)

DCD Subsections 9.2.7.2.1 and 9.2.7.2.2 state that the chiller mechanical equipment rooms are equipped with tight-fitting doors, and no occupied spaces are ventilated from the chiller equipment rooms. In addition, the supply and exhaust air to the chiller mechanical equipment rooms are ducted to prevent airflow from the chiller mechanical equipment rooms to occupied spaces. Therefore, the type of refrigeration system is classified as a *low probability system* in ANSI/ASHRAE Standard 15, Section 5.2, meaning that leakage from a failed connection, seal, or component in the refrigerant system cannot enter the occupied space being cooled by the chilled water systems and this does not violate the guidance provided in ANSI/ASHRAE Standard 15, Subsection 8.11.7.

DCD Subsections 9.2.7.2.1 and 9.2.7.2.2 are revised to clarify that the doors are self-closing and that the refrigerant leak detectors alarms annunciate inside and outside of the chiller rooms. DCD Figures 9A-11, 9A-16, 1.2-35, and 1.2-26 do not show a level of detail to include doors to the chiller rooms. Therefore, the tight-fitting doors are not shown on the figures.

Note that the non-essential chillers are located in chiller mechanical equipment rooms that are separated from the area within Fire Zone FA4-101-18 housing air handling units, as indicated in DCD Figure 9A-16.

Part (2)

The design exhaust flow for the essential chiller room and the non-essential chiller room is determined in accordance with ANSI/ASHRAE Standard 15, Subsections 8.11.4 and 8.11.5.

DCD Subsection 9.4.3.2.1 is revised to show that the auxiliary building HVAC system (ABVS) exhausts a sufficient quantity of air from each of the essential chiller mechanical equipment rooms and non-essential chiller mechanical equipment room to meet ANSI/ASHRAE Standard 15 requirements.

As shown in the third acceptance criteria of 14.2.12.1.99 "Auxiliary Building HVAC System Preoperational Test", the ventilation flow balancing of the auxiliary building HVAC system is performed to meet the commitment described in DCD Subsection 9.4.3. Therefore, the exhaust airflow rate from the essential chiller mechanical equipment rooms and non-essential chiller mechanical equipment room is confirmed to meet ANSI/ASHRAE Standard 15 requirements under this acceptance criterion.

DCD Subsection 9.2.7.2.1 is revised to discuss separate supply and exhaust ducting for the chiller machinery rooms. However, DCD Figure 9.4.3-1 is a simplified flow diagram of the ABVS for which this level of detail is not appropriate.

Part (3)

DCD Subsections 9.2.7.2.1.1 and 9.2.7.2.2 are revised to indicate that Safety Group A1 refrigerants are used. The amount, or quantity, limits provided in ANSI/ASHRAE Standard 15, Table 1 are not applicable since the chillers, and refrigerant, are wholly contained in the chiller mechanical equipment rooms. The non-essential chillers are located in chiller rooms that are separated from the area housing air handling units. The chiller rooms are equipped with tight-fitting doors.

Part (4)

The combustible loading for lube oil is estimated as 2.0E+06 Btu per chiller, since the lube oil of each chiller unit is 12.4 gallons based on Japanese PWR plant. The lube oil combustible loading for Fire Zones FA3-101-01, FA3-102-01, FA3-108-01, and FA3-110-01 (the essential chiller equipment rooms) is for a single chiller in each room (2.0E+06 Btu per room). The loading for Fire Zone FA4-101-18 is the total for all four non-essential chillers in this zone (8.0E+06 Btu). The final Fire Hazards Analysis is performed based on the final plant cable routing, fire barrier ratings, fire loading, ignition sources, purchased equipment and equipment arrangement.

Impact on DCD

DCD Subsections 9.2.7.2.1, 9.2.7.2.1.1, and 9.2.7.2.2 will be revised as shown in Attachment 1 to be consistent with the proposed changes identified above.

DCD Subsection 9.4.3.2.1 will be revised as shown in Attachment 2 to be consistent with the proposed changes identified above.

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 Topical Report / Technical Report

There is no impact on the Topical Report / Technical Report.

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chilled water pump, a compression tank with a make-up water line, a chilled water distribution loop, and instrumentation and control system. The condenser (heat rejection) section of each chiller is supplied with cooling water from the respective essential service water system during both normal and emergency operating conditions. The ECWS heat transfer and flow requirements for normal plant operation and abnormal conditions are shown in Table 9.2.7-2.

The motor operated three-way control valves are located on the retune lines from each safety-related air handling unit cooling coils. These valves control the heat removal capacity by modulating the flow rate of chilled water through the AHU cooling coils in response to a temperature control signal. The motor operated three-way control valves fail "as is" upon a loss of control signal or electrical power.

During LOOP, each of the essential chilled water system is powered from the respective safety emergency power source. The essential chiller units stop for one hour after a SBO occurs until alternate ac gas turbine generator restores power (Chapter 8, Section 8.4). DCD_09.02.02-72

The chiller of each essential chilled water system is equipped with an integral chilled water temperature control system.

The chillers are protected by ~~a~~ pressure-relief devices to safely relieve overpressure, which ~~and~~ are ventedpiped~~piped~~ to the outside of the building in accordance with ANSI/ASHRAE Standard 15 to prevent the discharge from entering any building. ~~And t~~The chiller mechanical equipment rooms meet ANSI/ASHRAE Standard 15 requirements for refrigerating machinery rooms including being equipped with refrigerant leak detectors that can actuate an alarm inside and outside of the equipment room and in the MCR. ~~and~~The rooms are equipped with tightfitting doors. The supply and exhaust air to and from the chiller mechanical equipment rooms are ducted to prevent airflow from the mechanical equipment rooms to occupied spaces.~~The pressure-relief device for each chiller is designated to prevent the discharge from entering any building.~~ DCD_06.04-14 DCD_06.04-14 DCD_06.04-15

The essential chilled water system control maintains the chilled water supply temperature. The compression tank maintains the system pressure within the design operating range.

Upon receipt of an ECCS actuation signal, the operating essential chillers and pumps continue to run and the standby essential chillers and pumps start.

Essential chilled water system heat removal capacity is determined from the design requirements for the air handling unit cooling coils for safety-related HVAC systems, which include a conservative design margin (Section 9.4). The flowrate requirements for the chilled water pumps are determined by the heat removal requirements of the system loads. The required flowrate limits the temperature rise across individual AHU cooling coils to 16° F. The total pump flowrate is that required for all cooling coils in the train. Flowrate and heat load for each cooling load are provided in Table 9.2.7-2. DCD_09.02.02-72

Demineralized quality water with corrosion inhibitors is circulated in the ECWS. No outside impurities are expected to be infiltered in the system, therefore, the ECWS filter is not necessary.

Attachment 1 to RAI 917-6272

~~Water~~The ECWS is a closed-loop system and water chemistry control of ECWS is performed by adding chemicals to the chemical feed tanks to prevent long-term corrosion that may degrade system performance. The chemical feed tanks are constructed of carbon steel. The chemical feed tanks are designed as non safety-related but seismic category II and are designed in accordance with ASME Section VIII. Manual isolation valves are installed in the piping between the chemical feed tank and the ECWS piping. These valves are normally locked closed. DCD_09.02.02-72

The essential chilled water system is designed in consideration of the water hammer prevention and mitigation of its in accordance with the following as discussed in NUREG-0927.

- A compression tank to keep the system filled
- Vents for venting components and piping at all high points in the system.
- After any system drainage, venting is assured by personnel training and procedures.
- System valves are slow acting.

The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention. The procedures should address the plant operating and maintenance procedures for adequate measures to avoid water hammer due to a voided line condition.

In the case of loss of component cooling water events for severe accidents, the non-ECWS could be aligned to the CCWS to provide alternative component cooling water to the charging pumps. The water supply path from the non-ECWS to the charging pumps is discussed in Section 19.2. The CCWS may also be aligned to the non-ECWS to provide an alternative cooling water source for the containment fan coolers. The alternative cooling water supply to the containment fan coolers is discussed in Section 19.2. DCD_09.02.02-80

9.2.7.2.1.1 Component Descriptions

The ECWS components are described below.

Essential Chiller Unit

The essential chiller unit is water-cooled type. Each essential chiller unit is designed to remove heat load from all the cooling coil of safety-related HVAC system of respective train it serves during all plant condition. Each essential chiller unit is designed to provide a sufficient quantity of chilled water to associated HVAC system chilled water cooling coils at a minimum 40°F of water temperature. Environmental safe, Safety Group A1 (ANSI/ASHRAE Standard 34) refrigerants are being utilized in the chilled water systems chillers. DCD_06.04-15

Essential Chilled Water Pump

Each essential chilled water pump is designed to supply chilled water to all the cooling coils of safety-related HVAC system for the respective train it serves during all plant

Attachment 1 to RAI 917-6272

the LOOP load sequence signal. As a minimum, two trains are required to operate during a LOOP. DCD_09.02.02-72

9.2.7.2.1.2.3 Loss of Coolant Accident

In the event of a LOCA, four essential chilled water pumps and four essential chiller units are actuated automatically upon receipt of the ECCS actuation signal, and are loaded onto their respective Class 1E power source. As a minimum, two trains are required to operate during a LOCA.

9.2.7.2.2 Non-Essential Chilled Water System

The non-essential chilled water system flow diagram is shown in Figure 9.2.7-2. The non-essential chilled water system consists of four water-cooled chillers, four chilled water pumps, a compression tank with a make-up water line, a chilled water distribution loop, and an instrumentation and control system. The condenser (heat rejection) section of each chiller is supplied with cooling water from a dedicated cooling tower. Each chiller is sized for one-third of the total non-essential chilled water load.

The chillers are protected by ~~a~~ pressure-relief devices to safely relieve overpressure, which are vented ~~and are piped~~ to the outside of the building in accordance with ANSI/ASHRAE Standard 15 to prevent the discharge from entering any building. ~~And t~~The chiller mechanical equipment rooms meet ANSI/ASHRAE Standard 15 requirements for refrigerating machinery rooms including being equipped with refrigerant leak detectors that can actuate an alarm inside and outside of the equipment room and in the MCR. ~~and~~The rooms are equipped with tightfitting doors. ~~The pressure relief device for chiller is designed to prevent the discharge from entering any building.~~No occupied spaces are ventilated from the chiller equipment rooms. Environmental safe, Safety Group A1 (ANSI/ASHRAE Standard 34) refrigerants are being utilized in the chilled water systems chillers. DCD_06.04-14 DCD_06.04-14 DCD_06.04-15

When the non-essential chilled water system is energized, the chilled water pump, the condenser water pump, and the cooling tower fans will start. When both the chilled and condenser water flows are established, the chillers will start to satisfy the plant non-safety cooling load. The non-essential chilled water system control maintains the chilled water supply temperature at the design setpoint. The compression tank maintains the system pressure within the design operating range.

During the LOOP condition, the non-essential chilled water system is powered from the alternate ac power source.

The non-ECWS is capable of performing alternate cooling of the containment fan cooler units through CCWS and the alternate source of component cooling water to the charging pump in a severe accident. The non-ECWS cooling tower and condenser water pump are capable of providing the alternate source of component cooling water to the charging pump in order to maintain RCP seal water injection. DCD_09.02.02-72

Attachment 2 to RAI 917-6272

The penetration of the penetration and safeguard component area and the discharge duct of the auxiliary building HVAC system are provided with safety-related isolation dampers that automatically close upon receipt of the ECCS actuation signal. The penetration and safeguard component area supply and exhaust line isolation damper assemblies, and the auxiliary building HVAC system exhaust line isolation damper assemblies are equipment class 2, seismic category I.

There is no separate spent fuel pool ventilation system. The fuel handling area in the reactor building is serviced by the auxiliary building HVAC system. There are supply and exhaust ductwork branches from the auxiliary building HVAC system that enter into the fuel handing area. The exhaust air duct from the fuel handling area is monitored for airborne radioactivity (Subsection 12.3.4.2.8).

During normal plant operation, the two air handling units and two exhaust fans are placed into operation. The total supply airflow of two air handling units is 196,000 ft^3/min and the total exhaust airflow of two exhaust fans is ~~208,000~~216,000 ft^3/min. Upon energizing the air handling unit, its isolation dampers automatically open. Upon energizing the two exhaust fans, their airflow is continuously and automatically controlled at a predetermined value to ~~maintain a slightly negative pressure in~~provide control of the release of potentially radioactive airborne materials from the controlled areas within A/B, R/B, including the fuel handling area, and AC/B ~~to minimize exfiltration from the radiological controlled areas~~. The design exhaust flowrate is maintained with or without the low volume or high volume containment purge exhaust in operation. The fuel handling area is supplied airflow of 21,800 ft^3/min from auxiliary building HVAC system air handling units and exhausts an airflow of 24,000 ft^3/min from this area. The airflow to radiological controlled area is adjusted by the balancing damper located in supply and exhaust duct branch throughout the system. Backdraft dampers are provided in the ventilation duct supplying and exhausting uncontrolled areas to prevent backflow from the auxiliary building HVAC system.

DCD_09.04.03-16

DCD_09.04.03-18

DCD_09.04.03-15

The auxiliary building HVAC system exhausts a sufficient quantity of air from each of the essential chiller mechanical equipment rooms and non-essential chiller mechanical equipment room to meet ASHRAE Standard 15 requirements to prevent an excessive concentration of refrigerant within the chiller room in the event of a leak or rupture from a chiller.

DCD_06.04-15

In summer, the outside supply airflow is cooled by the air handling unit's chilled water cooling coil. Upon supply air temperature rise, as sensed by thermostats located in the supply air duct, the air handling unit's chilled water control valves allow for an increase in the chilled water flow through the cooling coils.

In winter, the supply air is heated by the air handling unit steam heating coil to maintain the supply air temperature at the design set point. Supplemental heating with local unit heaters or in-duct heaters, that are non-safety related equipment and locally installed, is provided in areas with higher heat loss, due to their proximity to exterior walls.

Airborne radioactivity is monitored inside the exhaust air duct from the fuel handling area, penetration and safeguard component area, R/B controlled area, A/B controlled area, and sampling/laboratory area (AC/B controlled area) (Subsection 12.3.4.2.8). An alarm will