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July 16, 2009

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-09388

Subject: MHI's Responses to US-APWR DCD RAI No. 362-2278

Reference: [1] "Request for Additional Information No. 362-2278 Revision 0, SRP Section: 09.02.02 – REACOR AUXILIARY COOLING WATER SYSTEM – Design Certification and New License Applicants, Application Section: 9.2.2," dated May 13, 2009.

[2] Letter MHI Ref: UAP-HF-09333 from Y. Ogata (MHI) to the U.S. NRC, "MHI's Response to US-APWR DCD RAI No. 362-2278 REVISION 0," dated 6/19/2009.

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. 362-2278 Revision 0".

Enclosed are the second responses to the RAIs (Questions 9.2.2-26, 27, 28, 31, 33, 37, 38 and 44) contained within Reference 1. The initial responses (Questions 9.2.2-22, 23, 24, 25, 29, 30, 32, 34, 35, 36, 39, 40, 41, 42, 43 and 45) have been submitted with 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,

Y. Ogata

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

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NRO

Enclosure:

1. Responses to Request for Additional Information No. 362-2278 Revision 0

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

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Enclosure 1

UAP-HF-09388
Docket No. 52-021

Responses to Request for Additional Information
No. 362-2278 Revision 0

July 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-26

NRC Generic Letter (GL) 96-06 identifies concerns with hydrodynamic effects of water hammer during design events such as loss of coolant accidents. Describe how the design and operation of the US-APWR address the water hammer and two-phase flow concerns discussed in GL 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," and explain why these issues do not pose a problem for CCWS. Note that guidance for water hammer prevention and mitigation is provided in NUREG-0927, "Evaluation of Water Hammer Occurrence in Nuclear Power Plants."

ANSWER:

At the RCP thermal barrier part, it is possible the two-phase flow is generated because of the temperature rise due to the isolation of the header or the containment, etc. during an accident. In this case, water hammer is prevented by the operations such as following a valve opening procedure or very small opening of the inching valves.
Although requirements for the CCWS are not described in NUREG-0927, which summarizes the countermeasure against water hammer, usual measure against water hammer is the prevention of generation of low-pressure void in standup piping by the pressurization by the high elevation installation of the surge tank, or sufficient vent at the time of water filling.

From the above, DCD Tier 2 Section 9.2.2 will be revised to describe that the operation procedure which includes a water hammer protection is described in Chapter 13.5 as a COL item.

Impact on DCD

• MHI will add the following description in the DCD Section 9.2.2 of Tier 2.

> **The component cooling 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.**

- **An elevated surge 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 Combined License Applicant is to develop a milestone schedule for implementation of the procedure operating and maintenance procedures for water hammer prevention. The procedures should address the operating and maintenance procedures for adequate measures to avoid water hammer due to a voided line condition.

• MHI will add the following COL item to DCD section 9.2.10 Combined License Information:

COL 9.2(xx) **The COL Applicant is to develop a milestone schedule for implementation of the operating and maintenance procedures for water hammer prevention.**

Impact on COLA

The resolution regarding COL 9.2 (xx) that describes a milestone schedule for implementation of the procedures will be added to FASR chapter 9.2.2.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification
Mitsubishi Heavy Industries
Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**
SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**
APPLICATION SECTION: 9.2.2
DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-27

Standard Review Plan (SRP) 9.2.2 Section III instructs the staff to confirm the overall arrangement of the component cooling system (CCWS). While the Design Control Document (DCD) Tier 1 flow diagrams, Figure 2.7.3.3-1, "Component Cooling Water System" and Tier 2 piping and instrumentation diagrams (P&IDs) in the Design Control Document (DCD), Figure 9.2.2-1, "Component Cooling Water System Piping and Instrumentation Diagram," show the component cooling water system (CCWS) components and identifies the boundaries between safety-related and non-safety-related parts of the system, some of the information is incomplete, inaccurate, or inconsistent.
Revise the DCD, Tier 1 and Tier 2 figures to address the following considerations in this regard:

- Pipe sizes need to be shown on the flow diagrams (Tier 1, DCD Figure 2.7.3.3-1), and the system description does not explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).
- The system description in DCD, Tier 2 Section 9.2.2 needs to provide design details such as system operating temperatures, pressures, and flow rates for all operating modes and alignments.
- DCD, Tier 2 Figure 9.2.2-1 needs to show specific set point for alarms and relief valves. Also, the bases for these set points need to be explained in the system description.
- In DCD Tier 1, power supplies need to be listed for key electrical components such as motor operated valves, pumps, etc. For example, the 1E power supplies are not listed for various header isolation valves and for the non-safetyrelated (NSR) loads for header A-2 and C-2.
- In DCD Tier 1, Figure 2.7.3.3-1, sheet 2 of 2, the description has the equipment inside/outside containment reversed.
- In DCD Tier 1, Figure 2.7.3.3-1, safety-related support equipment is missing from the surge tank.
- In DCD Tier 2, Figure 9.2.2-1, sheet 4 of 9, the "C" and "D" CCWS pump return needs to show the correct return headers, headers "C" and "D". The figure incorrectly shows the return headers as "A" and "B".

ANSWER:

• Question 1

Pipe sizes need to be shown on the flow diagrams (Tier 1, DCD Figure 2.7.3.3-1), and the system description does not explain the criteria that were used in establishing the appropriate pipe sizes (such as limiting flow velocities).

• Answer 1

As noted in the RAI, pipe sizes are provided on the Tier 2 P&IDs and as such are available for review. Inclusion for certification in the Tier 1 flow diagrams is not warranted in that it is not high level information and, based on review of certified design's DCDs, has not been needed in the past. Pipe sizing for all systems including the CCWS has been conducted in accordance with accepted engineering practices and in conformance with the appropriate codes and standards as described in DCD Tier 2 section 3.12.2

• Question 2

The system description in DCD, Tier 2 Section 9.2.2 needs to provide design details such as system operating temperatures, pressures, and flow rates for all operating modes and alignments.

• Answer 2

Refer to the answer to RAI.362-2278 question 09.02.02-30

• Question 3

DCD, Tier 2 Figure 9.2.2-1 needs to show specific set point for alarms and relief valves. Also, the bases for these set points need to be explained in the system description.

• Answer 3

As a general practice alarm and relief valve set points are not shown on flow diagrams or P&IDs nor have they been included on these drawings in the DCDs of certified designs. Relief valve set points are determined in accordance with accepted engineering practices and in conformance with the appropriate codes and standards as described in DCD Tier 2 sections 3.12.2 and 3.12.5.11. Please refer to DCD Tier 2 sections 7.2.2.7 and 7.3.2.7, regarding instrumentation set point determination.

• Question 4

In DCD Tier 1, power supplies need to be listed for key electrical components such as motor operated valves, pumps, etc. For example, the 1E power supplies are not listed for various header isolation valves and for the non-safetyrelated (NSR) loads for header A-2 and C-2.

• Answer 4

The list of equipment powered from Class 1E power source are described in the section for "Class 1E/Qual. For Harsh Envir." in Table 2.7.3.3-2. Also, with regard to the power supplies, they are stated in Section 2.6.

• Question 5

In DCD Tier 1, Figure 2.7.3.3-1, sheet 2 of 2, the description has the equipment inside/outside containment reversed.

• Answer 5

DCD Tier 1 Figure 2.7.3.3-1 will be revised per that attached mark up to show the correct inside / outside containment orientation.

• Question 6

In DCD Tier 1, Figure 2.7.3.3-1, safety-related support equipment is missing from the surge tank.

• Answer 6

The support equipment of the surge tank is the components that are not directly significant to the safety function of the CCWS. Also, there are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the support equipment of the surge tank which is not directly significant to safety as the Tier 1 item.

• Question 7

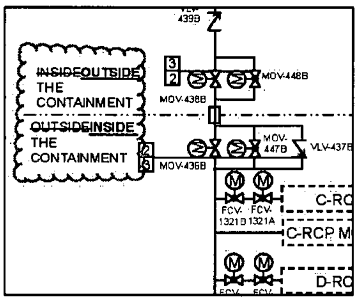
In DCD Tier 2, Figure 9.2.2-1, sheet 4 of 9, the "C" and "D" CCWS pump return needs to show the correct return headers, headers "C" and "D". The figure incorrectly shows the return headers as "A" and "B".

• Answer 7

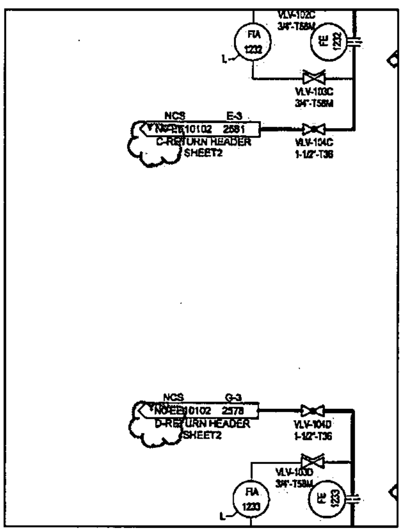
DCD Tier 2, Figure 9.2.2-1, sheet 4 of 9 will be revised per the attached mark up to correct the header label.

Impact on DCD

• Mark up for Figure 2.7.3.3-1 (Sheet 2 of 2):



• Mark up for Figure 9.2.2-1 (sheet 4 of 9):



Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-28

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important-to-safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. In order for the staff to confirm that the CCWS has been adequately sized, the applicant needs to include additional information in Tier 2 of the Design Control Document (DCD), Section 9.2.2, to fully describe and explain what the minimum system heat transfer and flow requirements are for normal operating, refueling, and accident conditions, the bases for these requirements including limiting assumptions that apply (such as temperature considerations), how much excess margin is available and how this was determined, and what limiting system temperatures and pressures are assumed with supporting basis. In addition, the mechanism to control CCWS temperature to less than 37.8 °C (100 °F) in the system was not fully explained in the DCD in Section 9.2.2.

ANSWER:

DCD Tier 2 sections 9.2.2.1.1 Safety Design Bases and 9.2.2.1.2 Power Generation Design Bases will be revised per the attached markup to clarify sizing bases.
DCD Tier 2 section 9.2.2.2.2.1 Normal Power Operation will be revised per the attached markup to clarify CCWS temperature control

Impact on DCD

• The following will be added to Tier 2, DCD Section 9.2.2.1.1

- **The CCWS, in conjunction with the Essential Service Water System (ESWS) and the Ultimate Heat Sink (UHS), is capable of removing sufficient heat from the essential heat exchangers to ensure a safe reactor shutdown and cooling following a postulated accident coincident with a loss of offsite power and assuming one train is unavailable due to maintenance and a single active failure in a second train.**

- **The CCWS, in conjunction with the ESWS, is capable of maintaining the outlet temperature of the component cooling water (CCW) heat exchanger below the limits of 110°F during a design basis accident with loss of offsite power.**

• The following will be added to Tier 2, DCD Section 9.2.2.1.2

- Provide sufficient cooling capacity for the components required during normal operating conditions such as normal power operation, normal shutdown and refueling **as described below.**

9.2.2.1.2.1 Normal Operation

The CCWS is designed to transfer heat from the plant components required to support normal power operation with one train (pump and heat exchanger) unavailable due to on line maintenance and a single active component failure. The component cooling water system is sized such that the component cooling water supply temperature to plant components is not more than 100°F. Normal operating heat loads are Reactor Coolant Pump, Charging Pump, Letdown Heat Exchanger, Instrument Air, Spent Fuel Pool Cooling Heat Exchanger, Sample Heat Exchanger, Seal Water Heat Exchanger, Blowdown Sample Cooler, B.A. Evaporator, Waste Gas Compressor, and so on. The component cooling water system provides sufficient surge tank capacity below the low level alarm to allow for operators to take action.

9.2.2.1.2.2 Normal Plant Cooldown

The component cooling water system is designed to remove both decay and sensible heat from the core and the reactor coolant system in addition to some normal operating heat loads during the latter stages of plant cooldown. The component cooling water system is sized to reduce the temperature of the reactor coolant system from 350°F at approximately 4 hours after reactor shutdown to 140°F using 4 trains while maintaining the component cooling water supply below 110°F. Failure of one train of CCW with another train unavailable due to maintenance will not prevent achieving cold shutdown conditions. The component cooling water system continues to provide cooling water to the residual heat removal system throughout the shutdown after cooldown is complete.

9.2.2.1.2.3 Refueling

During refueling, cooling water flow is provided to spent fuel pool heat exchangers to cool the spent fuel pool. For a full core off-load cooling water is also supplied to a normal residual heat removal heat exchanger as part of spent fuel pool cooling. The component cooling water system maintains the spent fuel pit water temperature below 120°F. System operation is with both component cooling water system divisions available.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

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RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-31

Standard Review Plan (SRP) 9.2.2 Section III, instructs the staff to confirm the overall arrangement of the component cooling system (CCWS). Tier 2, Design Control Document (DCD) Section 9.2.2.2.1.5 and Section 9.2.2.2.4 provided a description that the header isolation valves close on valve closure signals from emergency core cooling system (ECCS) actuation signal, with bus under voltage, containment spray signal, or low-low surge tank level signal. In order for the staff to complete its evaluation associated with the header isolation valve, the DCD needs to be revised as appropriate.

- Discuss in the DCD that if a closure signal is received and a safety train feeding the common header is lost, what design features are in place to permit the header isolation valves to be opened to provide cooling supply to the spent fuel pool heat exchanger and reactor coolant pumps thermal barriers. Describe available main control room (MCR) controls and permissives or interlocks that have to be bypassed for this function to be established. Describe if the cooling water supply to headers A-2 or C-2, which is cooling to non-safety components, can be isolated from the MCR before flow is re-established to the spent fuel pool heat exchanger and reactor coolant pumps seals.
- Discuss in the DCD the impact of a single failure of a header isolation valve to close on a demand signal.
- Discuss in the DCD the closure times for the header isolation valves.
- Discuss in the DCD the header isolation valve seat leakage for the isolation between safety-related CCWS trains.
- Discuss in the DCD if the header isolation valves remain open with the CCWS train in standby (normal operations).

ANSWER:

- Question 1

  Discuss in the DCD that if a closure signal is received and a safety train feeding the common header is lost, what design features are in place to permit the header isolation valves to be opened to provide cooling supply to the spent fuel pool heat exchanger and reactor coolant pumps thermal barriers. Describe available main control room (MCR) controls and permissives or interlocks that have to be bypassed for this function to be established. Describe if the cooling water supply to headers A-2 or C-2, which is cooling to non-safety components, can be isolated from the MCR before flow is re-established to the spent fuel pool heat exchanger and reactor coolant pumps seals.

• Answer 1

A header tie line separation valve is automatically closed by the S+UV signal or P signal in case of an accident.
Then, in order to resume supply of the cooling water to the RCP thermal barrier heat exchanger and the spent fuel pit heat exchanger, the valve close signal currently sent is made to bypass and the valve is made to open.
The above contents are added to DCD Teir2 Sec.9.2.2.2.1.5.

• Question 2

Discuss in the DCD the impact of a single failure of a header isolation valve to close on a demand signal.

• Answer 2

Header isolation can be attained even if it assumes single failure, since there are two header tie line isolation valves.
The above contents are added to DCD Teir2 Sec.9.2.2.2.1.5.
In addition, when one valve is not closed, a flow rate is satisfactory in pumping power.

• Question 3

Discuss in the DCD the closure times for the header isolation valves.

• Answer 3

Since a header tie line isolation valve will be closed in about 10 seconds or less, it is satisfactory to isolate by S+UV signal, P signal, and surge tank water low-low level.
The above contents are added to DCD Teir2 Sec.9.2.2.2.1.5.

• Question 4

Discuss in the DCD the header isolation valve seat leakage for the isolation between safety-related CCWS trains.

• Answer 4

Refer to the answer to RAI.288-2274 question 03.09.06-26

• Question 5

Discuss in the DCD if the header isolation valves remain open with the CCWS train in standby (normal operations).

• Answer 5

CCW pumps are designed such that one CCW pump can supply water to A, B, A1 and A2 trains (or C, D, C1 and C2 trains) during normal operation. Therefore, the header isolation valves are maintained to be open.
The above contents are added to DCD Teir2 Sec.9.2.2.2.

Impact on DCD

• DCD Subsection 9.2.2.2.1.5 (Heading: Header tie line isolation valve) will be revised to add the following at the end of this Subsection:

"**Header isolation can be attained even if it assumes single failure, since there are two header tie line isolation valves. Since a header tie line isolation valve will be closed in about 10 seconds or less, it is satisfactory to isolate by S+UV signal, P signal, and surge tank water low-low level.**
Then, in order to resume supply of the cooling water to the RCP thermal

barrier heat exchanger and the spent fuel pit heat exchanger, the valve close signal currently sent is made to bypass and the valve is made to open.

CCW pumps are designed such that one CCW pump can supply water to A, B, A1 and A2 trains (or C, D, C1 and C2 trains) during normal operation. Therefore, the header isolation valves are maintained to be open."

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-33

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. In order to satisfy system flow requirements, the CCWS design must assure that the minimum required net positive suction head (NPSH) for the CCWS pumps will be met for all postulated conditions, including consideration of vortex formation. The staff found that the minimum required NPSH for the CCWS pumps was not specified and Tier 2, Design Control Document (DCD) Section 9.2.2 did not describe how the CCWS design will assure that the minimum required NPSH for the CCWS pumps is satisfied (including consideration of vortex formation) and how much excess margin is provided by the CCWS design for the most limiting assumptions.
Consequently, the DCD needs to be revised to address the following considerations:

- The minimum NPSH that is needed for CCWS operation needs to be specified and explained, including how this required minimum NPSH is satisfied by the system design when taking vortex formation into consideration and how much excess margin is available for the most limiting case. Sufficient information is needed to enable the staff to independently confirm that the design is adequate in this regard, including limiting assumptions that were used along with supporting justification. These calculations should be made available for staff audit.
- As discussed in Tier 2, DCD Section 9.2.2.3.2, "If the water level of the surge tank further decreases, the surge tank low-low water level signal is transmitted to the MCR and the header tie line isolation valves automatically close. Since the subsystem consists of two individual trains, the train with the leak can be isolated and the other train can be operated." The bases for the surge tank setpoints water level needs to be explained in the DCD. Surge tank design details such as system internal volume, temperature extremes that are accommodated by the design, and the maximum leakage rate that is assumed including justification are some of the factors that need to be addressed. Provide in the DCD key assumptions and conclusion from the design calculations used for sizing the component cooling water system surge tanks. Since one tank services two safety related CCWS trains, internal surge tank separation plates, level instrument interactions, instrument logic,

and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.

- As discussed in Tier 2, DCD Section 9.2.2.5.6, "The CCW surge tank pressure is locally indicated. The surge tank nitrogen cover gas supply valve and tank vent valve are controlled with open-closed control so that the tank pressures are maintained within a pre-set range. High and low surge tank pressures are alarmed in the MCR." The bases for the surge tank setpoints needs to be explained in the DCD. Describe the relationship between the required minimum NPSH and the pressure which is to be maintained in the surge tanks. Describe if the control valves from the nitrogen system fails to open, the required actions that are needed to maintain the system operable to perform its intended safety function. Since one tank services two safety related CCWS trains, instrument interactions, instrument logic, and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.
- Tier 2, DCD Section 9.2.2.2.1.3 states that "...primary makeup water and refueling water may be used during an emergency. Refueling water storage pit is water source of seismic category I." Additional details are needed related to this being a sufficient water source capacity to provide for seven days of makeup water.
  The basis for this conclusion (e.g. required makeup rate and volume) needs to be explained in the DCD. The source of water and flow path to the surge tanks should be safety-related, protected from internal and external hazards, and capable of performing its makeup function in the event of a single failure with and without off-site power available. Describe how the makeup volume is assured, indications and alarms that are available in the control room and at the remote shutdown panels, and actions that plant operators have to take to provide emergency makeup water to the surge tanks. This emergency water source (which is shown in Tier 2, DCD Figure 9.2.2-1) should be included on the system diagram in Tier 1, DCD Section 2.7.3.3 and appropriate Tier 1 requirements need to be established for the makeup function.
- Discuss the bases of the vacuum breakers in the DCD which are located on each surge tank (as shown in Tier 2, DCD Figure 9.2.2-1). Also, determine the safety classification of the vacuum breakers and add these components to Tier 1, DCD Section 2.7.3.3.
- Provide a discussion in Tier 2, DCD Section 9.2.2 related to the 'protection functions' statement in the Technical Specifications Basis, Section B3.7.7 which state the surge tanks in the system provide pump trip protection functions to ensure that sufficient net positive suction head is available.

ANSWER:

- Question 1

  The minimum NPSH that is needed for CCWS operation needs to be specified and explained, including how this required minimum NPSH is satisfied by the system design when taking vortex formation into consideration and how much excess margin is available for the most limiting case. Sufficient information is needed to enable the staff to independently confirm that the design is adequate in this regard, including limiting assumptions that were used along with supporting justification. These calculations should be made available for staff audit.

- Answer 1

  In the CCWS, static head of the surge tanks ensures the NPSH of the CCWS pumps. Since the difference of installation elevation between the surge tanks and the pumps is large enough (about 125ft), as NPSH available, there is sufficient margin. In addition, the air is not sucked to the pump suction because the low water level and

the low-low water level alarm to detect the water level lowering for an abnormal time are set.
From the above, to Tier 2, DCD Section 9.2.2.2.1.2, the statement "Since the difference of installation elevation between the surge tanks and the pumps is large enough, as NPSH available, there is sufficient margin." will be added.

- Question 2

  As discussed in Tier 2, DCD Section 9.2.2.3.2, "If the water level of the surge tank further decreases, the surge tank low-low water level signal is transmitted to the MCR and the header tie line isolation valves automatically close.
  Since the subsystem consists of two individual trains, the train with the leak can be isolated and the other train can be operated."
  The bases for the surge tank setpoints water level needs to be explained in the DCD. Surge tank design details such as system internal volume, temperature extremes that are accommodated by the design, and the maximum leakage rate that is assumed including justification are some of the factors that need to be addressed.
  Provide in the DCD key assumptions and conclusion from the design calculations used for sizing the component cooling water system surge tanks.
  Since one tank services two safety related CCWS trains, internal surge tank separation plates, level instrument interactions, instrument logic, and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.
- Answer 2

  Reflecting the NRC comment, description of the surge tank volume will be added.
  Also, the logic that describes internal surge tank separation plates is described at Section 9.2.2.2.1.3.

- Question 3

  As discussed in Tier 2, DCD Section 9.2.2.5.6, "The CCW surge tank pressure is locally indicated. The surge tank nitrogen cover gas supply valve and tank vent valve are controlled with open-closed control so that the tank pressures are maintained within a pre-set range. High and low surge tank pressures are alarmed in the MCR."
  The bases for the surge tank setpoints needs to be explained in the DCD. Describe the relationship between the required minimum NPSH and the pressure which is to be maintained in the surge tanks. Describe if the control valves from the nitrogen system fails to open, the required actions that are needed to maintain the system operable to perform its intended safety function. Since one tank services two safety related CCWS trains, instrument interactions, instrument logic, and instrument separations between trains needs to be fully explained. These calculations should be made available for staff audit.
- Answer 3

  The purpose of the N2 supply to the surge tank is to prevent the mixing of oxygen into the component cooling water as indicated to DCD Tier 2 Section 9.2.2.2.1.5, and is not to pressurize the tank to ensure the NPSH. Therefore, the loss of N2 supply would not affect the system function of the CCWS.

- Question 4

  Tier 2, DCD Section 9.2.2.2.1.3 states that "...primary makeup water and refueling water may be used during an emergency. Refueling water storage pit is water source of seismic category I."
  Additional details are needed related to this being a sufficient water source capacity to provide for seven days of makeup water.

The basis for this conclusion (e.g. required makeup rate and volume) needs to be explained in the DCD. The source of water and flow path to the surge tanks should be safety-related, protected from internal and external hazards, and capable of performing its makeup function in the event of a single failure with and without off-site power available.
Describe how the makeup volume is assured, indications and alarms that are available in the control room and at the remote shutdown panels, and actions that plant operators have to take to provide emergency makeup water to the surge tanks. This emergency water source (which is shown in Tier 2, DCD Figure 9.2.2-1) should be included on the system diagram in Tier 1, DCD Section 2.7.3.3 and appropriate Tier 1 requirements need to be established for the makeup function.

• Answer 4

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.
In addition, since the valves are operated locally by the operator for the makeup, it is considered unnecessary to assume a single failure of the valve. Also, since there are two units of RWS pumps in the makeup water source, supply of makeup water is possible even when single failure is assumed.
From the above, to Tier 2, DCD Section 9.2.2.2.1.3, the statement "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." and "Makeup water supply is performed by an operator by locally operating the manual valves." will be added.
However, the makeup water source of the RWSP is the components that are not directly significant to the safety function of the CCWS. Also, there are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the makeup water source of the RWSP which is not directly significant to safety as the Tier 1 item.

• Question 5

Discuss the bases of the vacuum breakers in the DCD which are located on each surge tank (as shown in Tier 2, DCD Figure 9.2.2-1). Also, determine the safety classification of the vacuum breakers and add these components to Tier 1, DCD Section 2.7.3.3.

• Answer 5

Reflecting the NRC comment, a description regarding the vacuum breakers will be added to Tier 2, DCD Section 9.2.2.2.1.3.
In addition, the safety classification is EC3 in the same way as the tank.
However, the vacuum breakers are the components that are not directly significant to the safety function of the CCWS. Also, there are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the vacuum breakers which are not directly significant to safety as the Tier 1 item.

• Question 6

Provide a discussion in Tier 2, DCD Section 9.2.2 related to the 'protection functions' statement in the Technical Specifications Basis, Section B3.7.7 which state the surge tanks in the system provide pump trip protection functions to ensure that sufficient net positive suction head is available.

• Answer 6

Refer to the answer 1 to RAI.362-2278 question 09.02.02-33

Impact on DCD

- The description below will be added to DCD Tier 2 Section 9.2.2.2.1.2.

  "**Since the difference of installation elevation between the surge tanks and the pumps is large enough, as NPSH available, there is sufficient margin.**"

- The description below will be added to DCD Tier 2 Section 9.2.2.2.1.3.

  "**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.**"

- The description below will be added to DCD Tier 2 Section 9.2.2.2.1.3.

  "**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.**"

- The description below will be added to DCD Tier 2 Section 9.2.2.2.1.3.

  "**Vacuum Breaker is installed in the surge tank as a countermeasure of the negative pressure in a tank at the time of a sudden fall of tank water level.**"

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-37

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. System design features, operating procedures, and surveillance testing need to provide adequate assurance that the CCWS safety functions will not be compromised due to damaging water hammer events. Two of the four safetyrelated trains are normally in operation with the remaining two trains in standby. During a plant shutdown or refueling outage, three or four CCWS trains may be in operation at the same time as described in Tier 2, DCD Section 9.2.2.2.2. As stated in Tier 2, DCD Section 9.2.2.1.1, the "CCWS is protected against adverse environmental, operating, and accident conditions that can occur, such as flooding, high energy line break (HELB), thermal over-pressurization, and water hammer." In addition, Section 9.2.2.3 states that the "CCWS is a closed system that is maintained in a water solid condition with a surge tank located at the highest point in the system thus preventing the potential for water hammer." The CCWS description does not adequately consider and address water hammer vulnerabilities in the Design Control Document (DCD) and does not explain how system design features, operating procedures, and periodic surveillance tests provide adequate assurance that the CCWS safety functions will not be compromised by water hammer events. The DCD needs to be revised to provide additional information to address water hammer considerations.

ANSWER:

Refer to the answer to RAI.362-2278 question 09.02.02-26.

Impact on DCD

Refer to the answer to RAI.362-2278 question 09.02.02-26.

Impact on COLA

Refer to the answer to RAI.362-2278 question 09.02.02-26.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 362-2278 REVISION 0**

SRP SECTION: **09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**

APPLICATION SECTION: 9.2.2

DATE OF RAI ISSUE: **5/13/2009**

QUESTION NO.: 09.02.02-38

The component cooling water system (CCWS) must be capable of removing heat from systems, structures and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with General Design Criteria (GDC) 44 requirements. Also, 10 CFR 52.47(a)(22) requires that information demonstrating how operating experience insights have been incorporated into the plant design be included in the Design Control Document (DCD). During a recent review of industry operating experience (Information Notice 2007-06, *Potential Common Cause Vulnerabilities in Essential Service Water Systems*, dated February 9, 2007), the staff found that some licensees were experiencing significant wall thinning of pipe downstream of butterfly valves that were being used to throttle service water flow. In order to assure that this will not occur in the CCWS for the US-APWR design, the applicant needs to provide additional information in Tier 2, DCD Section 9.2.2 to describe to what extent butterfly valves will be used to throttle CCWS flow and design provisions that will be implemented to prevent consequential pipe wall thinning from occurring.

ANSWER:

The Information Notice has been reviewed as part of operational experience reviews for the US APWR. Butterfly valves are used to set or adjust flow for some components in the CCWS design. Primarily these are the larger heat exchangers (Spent Fuel and CS/RHR). However, severe throttling, resulting in large pressure drops and cavitations are avoided through appropriate sizing. Testing and flow balancing will verify the sizing. Once positioned, frequent repositioning of the valves is not intended.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

7/16/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 362-2278 REVISION 0**
SRP SECTION:	**09.02.02 – REACTOR AUXILIARY COOLING WATER SYSTEM**
APPLICATION SECTION:	**9.2.2**
DATE OF RAI ISSUE:	**5/13/2009**

QUESTION NO.: 09.02.02-44

10 CFR 52.47(b)(1) requires the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that the plant will be built in accordance with the certification. The staff found that the Tier 1 information is incomplete, inconsistent, inaccurate, and that clarification is needed to revise the Tier 1 information to address the following concerns:

- Although the Introduction Section in Chapter 1 of the Tier 1 DCD states that the information in the Tier 1 portion of the DCD is derived from the detailed information contained in Tier 2, the staff found that much of the information provided in DCD Tier 1 is not described in Tier 2, DCD Section 9.2.2 (e.g., equipment locations, valve functional requirements, indication and control information, priority actuation and control system description and functions, automatic actuation and interlock details, valve failure modes, and harsh environment considerations). Add the above information in Tier 2 of the DCD.
- The specifications need to stipulate that the CCWS is accessible for performing periodic inspections as required by GDC 45.
- The specification need to stipulate that the CCWS design provide for flow testing of the pumps during operation, in that it needs to specify provisions for flow testing all the individual component flow paths to verify flow balance requirements.
- System filters need to be described in Tier 2 or Tier 1 and should be shown on the Tier 1 drawings (if required).
- Specifications to assure that the relief valves satisfying design and performance requirements need to be provided.
- Figure 2.7.3.3-1, "Component Cooling Water System," needs to show nominal pipe sizes, which are necessary for design certification.
- Figure 2.7.3.3-1 needs to show flow control valves for the individual flow paths of the components being cooled, and these components need to be listed in the applicable tables, which is necessary for design certification.
- In Table 2.7.3.3-1, "Component Cooling Water System Location of Equipment and Piping," the statement "Component cooling water system containment isolation valves and piping between the valves," is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor

building. In general, this table is confusing and many of the components on this table need to be shown in Figure 2.7.3.3-1.

- In Table 2.7.3.3-3, "Component Cooling Water System Piping Characteristics," the statement "Component cooling water system containment isolation valves and piping between the valves", is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor building. In general, this table is confusing.
- The piping system association with the surge tank needs to be describes in various tables such as Table 2.7.3.3-1, Table 2.7.3.3-2 and Table 2.7.3.3-3. One example is NCS LCV-1200 and other safety-related piping systems at the surge tank should also be included in the Tier 1 tables.
- In Table 2.7.3.3-2, "Component Cooling Water System Equipment Characteristics," 'yes' is misspelled as 'yse' on sheet 2 of 3. All items described in this table need to be shown in Figure 2.7.3.3-1, such as the instrumentation.
- The thermal barrier cross-tie needs to be described in Tier 1.
- The power supplies for the CCWS need to be shown in Tier 1. This is important for understanding how any cross-tie functions during a loss of power event.
- In Table 2.7.3.3-4, "Component Cooling Water System Equipment Alarms, Displays, and Control Functions," radiation alarms need to be described and reactor coolant pump and thermal barrier flow need to be described. In addition, remote shutdown console controls (RSC) are not listed for the CCWS and should be described.
- Figure 2.7.3.3-1, "Component Cooling Water System," is not drawn correctly as compared to the Tier 2 drawings. For example, the cross-connect between the A/B and C/D headers is out of place.

ANSWER:

• Question 1

Although the Introduction Section in Chapter 1 of the Tier 1 DCD states that the information in the Tier 1 portion of the DCD is derived from the detailed information contained in Tier 2, the staff found that much of the information provided in DCD Tier 1 is not described in Tier 2, DCD Section 9.2.2 (e.g., equipment locations, valve functional requirements, indication and control information, priority actuation and control system description and functions, automatic actuation and interlock details, valve failure modes, and harsh environment considerations). Add the above information in Tier 2 of the DCD.

• Answer 1

The cumulative answers to this and the other RAIs will result in the incorporation of the requested information into DCD Tier 2 Section 9.2.2

• Question 2

The specifications need to stipulate that the CCWS is accessible for performing periodic inspections as required by GDC 45.

• Answer 2

DCD Tier 2 Section 9.2.2.1.1 states "• The CCWS is designed for periodic inservice testing and inspection of components in accordance with ASME Code Section XI." Additionally accessibility for inservice inspection for all systems including CCWS is addressed in DCD Tier 2 Section 6.6.2

• Question 3

The specification need to stipulate that the CCWS design provide for flow testing of the pumps during operation, in that it needs to specify provisions for flow testing all the individual component flow paths to verify flow balance requirements.

- Answer 3

  DCD Tier 2 Section 9.2.2.4.1 will be revised per the attached markup to address pump flow testing and balancing.

- Question 4

  System filters need to be described in Tier 2 or Tier 1 and should be shown on the Tier 1 drawings (if required).
- Answer 4

  No System filters are required.

- Question 5

  Specifications to assure that the relief valves satisfying design and performance requirements need to be provided.
- Answer 5

  Relief valve requirements for the CCWS as well as other systems are described in DCD Tier 2 sections 3.12.2 and 3.12.5.11.

- Question 6

  Figure 2.7.3.3-1, "Component Cooling Water System," needs to show nominal pipe sizes, which are necessary for design certification.
- Answer 6

  Please see the response to RAI 09.02.02-27 regarding the inclusion of pipe sizes in Tier 1 material.

- Question 7

  Figure 2.7.3.3-1 needs to show flow control valves for the individual flow paths of the components being cooled, and these components need to be listed in the applicable tables, which is necessary for design certification.
- Answer 7

  Flow control valves are the components that are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include flow control valves which are not directly significant to safety as the Tier 1 item.

- Question 8

  In Table 2.7.3.3-1, "Component Cooling Water System Location of Equipment and Piping," the statement "Component cooling water system containment isolation valves and piping between the valves," is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor building. In general, this table is confusing and many of the components on this table need to be shown in Figure 2.7.3.3-1.
- Answer 8

  Refer to the answer to RAI.362-2278 question 09.02.02-23

  In addition, the support equipment of the surge tank is the components that are not directly significant to the safety function of the CCWS. Also, there are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the support equipment of the surge tank which is not directly significant to safety as Table2.7.3.3-1 and Table 2.7.3.3-3 item. From the above, description of the support equipment of the surge tank will be deleted from Table2.7.3.3-1 and Table 2.7.3.3-3.

• Question 9

In Table 2.7.3.3-3, "Component Cooling Water System Piping Characteristics," the statement "Component cooling water system containment isolation valves and piping between the valves", is repeated several times. These statements need to be clarified since this is describing equipment not location within the reactor building. In general, this table is confusing.

• Answer 9

Refer to the answer to RAI.362-2278 question 09.02.02-23

• Question 10

The piping system association with the surge tank needs to be describes in various tables such as Table 2.7.3.3-1, Table 2.7.3.3-2 and Table 2.7.3.3-3. One example is NCS LCV-1200 and other safety-related piping systems at the surge tank should also be included in the Tier 1 tables.

• Answer 10

The support equipment of the surge tank is the components that are not directly significant to the safety function of the CCWS. Also, there are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the support equipment of the surge tank which is not directly significant to safety as Table2.7.3.3-1, Table 2.7.3.3-2 and Table 2.7.3.3-3 item.

• Question 11

In Table 2.7.3.3-2, "Component Cooling Water System Equipment Characteristics," 'yes' is misspelled as 'yse' on sheet 2 of 3. All items described in this table need to be shown in Figure 2.7.3.3-1, such as the instrumentation.

• Answer 11

Spelling error on Table 2.7.3.3-2 Sheet 2 will be corrected.
In addition, the instrumentation is the components that are no specific requirements in SRP 14.3 Appendix C I "Design Description and Figures". Therefore, MHI believes it is unnecessary to include the instrumentation in Figure 2.7.3.3-1.

• Question 12

The thermal barrier cross-tie needs to be described in Tier 1.

• Answer 12

Identification of the A-1 to C1 Cross Tie Valves will be included as a key feature in DCD Tier 1 section 2.7.3.3.1 per the attached mark up.

• Question 13

The power supplies for the CCWS need to be shown in Tier 1. This is important for understanding how any cross-tie functions during a loss of power event.

• Answer 13

See the response to RAI 09.02.02.07-27 regarding the identification of 1E power supplies in DCD Tier 1 Section 2.7.3.3.

• Question 14

In Table 2.7.3.3-4, "Component Cooling Water System Equipment Alarms, Displays, and Control Functions," radiation alarms need to be described and reactor coolant pump and thermal barrier flow need to be described. In addition, remote shutdown console controls (RSC) are not listed for the CCWS and should be described.

• Answer 14

The radiation monitor and reactor coolant pump motor flow is the components that

are not directly significant to the safety function of the CCWS. Therefore, MHI believes it is unnecessary to include the radiation monitor and reactor coolant pump motor flow which is not directly significant to safety as Table2.7.3.3-4 item.
From the above, Table 2.7.3.3-4 will be revised per the attached mark up to show thermal barrier flow alarms and control functions.

- Question 15
  Figure 2.7.3.3-1, "Component Cooling Water System," is not drawn correctly as compared to the Tier 2 drawings. For example, the cross-connect between the A/B and C/D headers is out of place.
- Answer 15
  The header cross connect configurations of the Tier 1 and Tier 2 system drawings are schematically equivalent.

Impact on DCD

- Mark up for section DCD Tier 2 section 9.2.2.4.2:
  "During normal operation, the standby pump and CCW HX are periodically tested for operability or, alternatively, placed in service in place of the train which has been operating. **Additionally periodic flow testing is performed to verify correct flow balancing among individual heat loads.**"

- DCD Tier 1 Table 2.7.3.3-1 will be revised to delete the following:

System and Components	Location
~~Component cooling water system piping from component cooling water surge tank to and including the valve(NCS-VLV-003A,NCS-RCV-056A,NCS-PCV-1202,NCS-VLV-045A,NCS-VLV-047A)~~	~~Reactor Building~~
~~Component cooling water system piping from component cooling water surge tank to and including the valve(NCS-VLV-003B,NCS-RCV-056B,NCS-PCV-1212,NCS-VLV-045B,NCS-VLV-047B)~~	~~Reactor Building~~

- DCD Tier 1 Table 2.7.3.3-3 will be revised to delete the following:

Pipe Line Name	ASME Code Section III Class	Seismic Category I
~~Component cooling water system Piping from component cooling water surge tank to and including the valve(NCS-VLV-003A,NCS-RCV-056A,NCS-PCV-1202,NCS-VLV-045A,NCS-VLV-047A)~~	~~3~~	~~Yes~~
~~Component cooling water system Piping from component cooling water surge tank to and including the valve(NCS-VLV-003B,NCS-RCV-056B,NCS-PCV-1212,NCS-VLV-045B,NCS-VLV-047B)~~	~~3~~	~~Yes~~

• DCD Tier 1 Table 2.7.3.3-2 will be revised to correct the following:

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
RCP motor CCW supply line isolation valves	NCS-MOV-446 A, B,C,D	3	~~Yes~~ Yes	Yes	Yes/Yes	Remote Manual	Transfer Closed	As Is

• Mark up to DCD Tier 1 Section 2.7.3.3.1:
Key Design Features of the CCWS are provided below:

- **A-1 to C1 Cross Tie Valves function to supply cooling water to the RCPs of header A-1 (or C-1) in the event cooling is lost due to a single failure during on-line maintenance of a CCW pump.**

• Mark up additions to DCD Tier 1Table 2.7.3.3-4:

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
RCP Thermal Barrier Flow NCS-FT-1319A,B,1320A,B,1321A,B,1322A,B	Yes	Yes	No	Yes

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.