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October 14, 2010

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-10277

Subject: MHI's Responses to US-APWR DCD RAI No.628-4866 Revision 2

References: 1) "Request for Additional Information No. 628-4866 Revision 2, SRP Section: 19.01 – Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed," dated September 7, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 628-4866 Revision 2".

Enclosed are the responses to the RAI that are contained within Reference 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

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

Enclosure:

1. Responses to Request for Additional Information No. 628-4866 Revision 2

CC: J. A. Ciocco
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NRO

Enclosure 1

UAP-HF-10277
Docket Number 52-021

Responses to Request for Additional Information No.628-4866
Revision 2

October, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/14/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 628-4866 REVISION 2**
SRP SECTION:	**19.01 – Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed**
APPLICATION SECTION:	**19**
DATE OF RAI ISSUE:	**09/07/2010**

QUESTION NO. : 19.01-8

The staff has reviewed MHI's response to RAI 4482. In the response to RAI 4482, MHI acknowledged that the interlock for abnormal mid-loop water level decrease is risk important and proposed changes to TS 3.4.8 and associated bases in accordance with Criterion 4 of 10 CFR 50.36 (c)(2)(ii). The staff noted that mid-loop operations span both Modes 5 and 6, and the proposed changes to TS 3.4.8 cover only the Mode 5 portion. TS 3.9.6 covers the Mode 6 portion. MHI's position is that operability of the related midloop water level instrumentation can be indirectly covered by the operability of the low-pressure letdown isolation valve in TS 3.4.8 and is not required to be listed in TS 3.3.1. However, the setpoints for the mid-loop level instrumentation should be documented in TS 3.3.1, because the instrumentation needs to have the requisite channel checks, calibrations, etc. and assurance that the limits are adequately described in the technical specifications. The staff also believes changes should be made to Chapter 7 to capture design features for this mid-loop water level instrumentation. Therefore, the staff requests MHI to provide further clarifications and changes to the APWR DCD or justifications if MHI decides that no further changes will be necessary.

ANSWER:

The interlock for the automatic isolation of the low-pressure letdown line is the effective function when the RCS inventory is controlled by the chemical and volume control system (CVCS), which occurs during mid-loop operation. Since the RV head closure bolts are loosened or tightened during mid-loop operation, mid-loop operation includes Modes 5 and 6. On the other hand, during the period other than mid-loop operation, the RCS inventory is increased or decreased by the CS/RHR pumps so that the interlock for the automatic isolation of the low-pressure letdown line is unnecessary regardless of the mode. For this reason, the interlock is considered to be risk significant only during mid-loop operation where the RCS inventory is controlled by the CVCS. Therefore, the function will be added in TS 3.9.6 (MODE 6 with the water level < 23 ft above the top of reactor vessel flange).

MHI thinks that the mid-loop water level instrumentation is not required to be listed in TS 3.3.1. This is because a decrease of the RCS water level below the setpoint for the operability of low-pressure letdown

isolation valves does not result in the loss of the RHR function immediately. Therefore, the strict control of the instrumentation and its inclusion in TS 3.3.1 is considered to be not required. As mentioned in the response to RAI 577-4482, operability of the instrumentation and its control is included in operability of low-pressure letdown isolation valves listed in TS 3.4.8(MHI add the description in TS BASES SR3.4.8.3 to clarify it.). In addition, its operability will be inserted in TS 3.9.6 to reflect the response to this RAI.

The description of low-pressure letdown line isolation valves has been added in Chapter 7 (Subsection 7.6.1.7) as the Interlock system important to safety, which has been described in the response to question No.19-421 of RAI 528-4023.

Impact on DCD
TS 3.4.8 and TS 3.9.6 in Chapter 16 will be revised as shown in the mark-ups provided in Attachments A and B.

Impact on COLA
There is no impact on COLA.

Impact on PRA
There is no impact on PRA.

3.9 REFUELING OPERATIONS

3.9.6 Residual Heat Removal (RHR) and Coolant Circulation - Low Water Level

LCO 3.9.6 Three RHR loops shall be OPERABLE, and two RHR loops shall be in operation, and low-pressure letdown line isolation valve shall be OPERABLE.

----------NOTES----------

1. All RHR pumps may be removed from operation for ≤ 15 minutes when switching from one train to another provided:

   a. The core outlet temperature is maintained > 10 degrees F below saturation temperature,

   b. No operations are permitted that would cause introduction of coolant into the Reactor Coolant System (RCS) with boron concentration less than that required to meet the minimum required boron concentration of LCO 3.9.1, and

   c. No draining operations to further reduce RCS water volume are permitted.

2. One required RHR loop may be inoperable for up to 2 hours for surveillance testing, provided that the other RHR loops are OPERABLE and in operation.

APPLICABILITY: MODE 6 with the water level < 23 ft above the top of reactor vessel flange.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Less than the required number of RHR loops OPERABLE.	A.1 Initiate action to restore required RHR loops to OPERABLE status. OR	Immediately

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
	A.2	Initiate action to establish ≥ 23 ft of water above the top of reactor vessel flange.	Immediately
B. One low-pressure letdown isolation valve inoperable.	B.1	Initiate action to restore low-pressure letdown line isolation valve to OPERABLE status.	Immediately
~~B~~C. No RHR loop in operation.	~~B~~C.1	Suspend operations that would cause introduction of coolant into the RCS with boron concentration less than required to meet the boron concentration of LCO 3.9.1.	Immediately
	AND		
	~~B~~C.2	Initiate action to restore two RHR loops to operation.	Immediately
	AND		
	~~B~~C.3	Close equipment hatch and secure with four bolts.	4 hours
	AND		
	~~B~~C.4	Close one door in each air lock.	4 hours
	AND		

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
	~~B~~C.5.1 Close each penetrations providing direct access from the containment atmosphere to the outside atmosphere with a manual or automatic isolation valve, blind flange, or equivalent. OR ~~B~~C.5.2 Verify each penetration is capable of being closed by an OPERABLE Containment Purge and Exhaust Isolation System.	4 hours 4 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.9.6.1	Verify two RHR loops are in operation and circulating reactor coolant at a flow rate of ≥ 2645 gpm per pump.	[12 hours OR In accordance with the Surveillance Frequency Control Program]
SR 3.9.6.2	Verify correct breaker alignment and indicated power available to the required RHR pump that is not in operation.	[7 days OR In accordance with the Surveillance Frequency Control Program]

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.9.6.3	Perform a complete cycle of each low-pressure letdown line isolation valve.	[24 months OR In accordance with the Surveillance Frequency Control Program]

RAI No.577-4482

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.8.3

RAI No.628-4866

SR 3.4.8.3 requires ~~a complete cycle of each low-pressure letdown isolation valve.~~ This requirements mean confirmation of OPERABILITY of Instrumentation and its control (Setpoints, Channel Checks, Channel Calibrations) and valve. ~~Operating a low-pressure letdown isolation valve~~ through one complete cycle ensures that the low-pressure letdown isolation valve can be automatically actuated ~~for mitigation~~ to mitigate the effects for loss of RCS inventory. [The Frequency of 24 months is based on engineering judgment, taking into consideration the ~~unit~~ conditions required to perform the Surveillance, and is intended to be consistent with expected fuel cycle length. This equipment is not at risk of imminent damage as it is designed to remain functional and in good condition while in operation, thus significant degradation due to a longer surveillance interval should not be of major concern. The design reliability is, therefore, maintained by taking these considerations into account based on sound engineering judgment. OR The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

REFERENCES None.

B 3.9 REFUELING OPERATIONS

B 3.9.6 Residual Heat Removal (RHR) and Coolant Circulation - Low Water Level

BASES

BACKGROUND

The purpose of the RHR System in MODE 6 is to remove decay heat and sensible heat from the Reactor Coolant System (RCS), as required by GDC 34, to provide mixing of borated coolant, and to prevent boron stratification (Ref. 1). Heat is removed from the RCS by circulating reactor coolant through the Containment Spray (CS)/RHR heat exchangers where the heat is transferred to the Component Cooling Water System. The coolant is then returned to the RCS via the RCS cold leg(s). Operation of the RHR System for normal cooldown decay heat removal is manually accomplished from the control room. The heat removal rate is adjusted by controlling the flow of reactor coolant through the CS/RHR heat exchanger(s) and the bypass lines. Mixing of the reactor coolant is maintained by this continuous circulation of reactor coolant through the RHR System.

In MODE 6 Low Water Level, low-pressure letdown line isolation valves are automatically closed upon detection of RCS loop low-level signal to prevent loss of RCS inventory.
The function is effective to prevent core damage during plant shutdown, based on probabilistic risk assessment.

APPLICABLE SAFETY ANALYSES

While there is no explicit analysis assumptions for the decay heat removal function of the RHR System in MODE 6, if the reactor coolant temperature is not maintained below 200°F, boiling of the reactor coolant could result. This could lead to a loss of refueling cavity water level. Additionally, boiling of the reactor coolant could lead to a reduction in boron concentration in the coolant due to the boron plating out on components near the areas of the boiling activity. The loss of reactor coolant and the reduction of boron concentration in the reactor coolant will eventually challenge the integrity of the fuel cladding, which is a fission product barrier. Three trains of the RHR System are required to be OPERABLE, and two trains in operation, in order to prevent this challenge.

RHR and Coolant Circulation – Low Water Level satisfies Criterion 4 of 10 CFR 50.36(c)(2)(ii).

LCO

In MODE 6, with the water level < 23 ft above the top of the reactor vessel flange, three RHR loops must be OPERABLE. Additionally, two loops of RHR must be in operation in order to provide:

a. Removal of decay heat,

b. Mixing of borated coolant to minimize the possibility of criticality, and

BASES

LCO (continued)

c. Indication of reactor coolant temperature.

The LCO requires the low-pressure letdown line isolation valves to be OPERABLE to mitigate the effects associated with loss of RCS inventory.

This LCO is modified by two Notes. Note 1 permits the RHR pumps to be removed from operation for ≤ 15 minutes when switching from one train to another. The circumstances for stopping all RHR pumps are to be limited to situations when the outage time is short and the core outlet temperature is maintained > 10 degrees F below saturation temperature. The Note prohibits boron dilution or draining operations when RHR forced flow is stopped.

Note 2 allows one RHR loop to be inoperable for a period of 2 hours provided the other loops are OPERABLE and in operation. Prior to declaring the loop inoperable, consideration should be given to the existing plant configuration. This consideration should include that the core time to boil is short, there is no draining operation to further reduce RCS water level and that the capability exists to inject borated water into the reactor vessel. This permits surveillance tests to be performed on the inoperable loop during a time when these tests are safe and possible.

An OPERABLE RHR loop consists of an CS/RHR pump, a heat exchanger, valves, piping, instruments and controls to ensure an OPERABLE flow path and to determine the low end temperature. The flow path starts in one of the RCS hot legs and is returned to the RCS cold legs.

All RHR pumps may be aligned to the Refueling Water Storage Pit to support filling or draining the refueling cavity or for performance of required testing.

APPLICABILITY

Three RHR loops are required to be OPERABLE, and two RHR loops must be in operation in MODE 6, with the water level < 23 ft above the top of the reactor vessel flange, to provide decay heat removal and mixing of the borated coolant. Requirements for the RHR System in other MODES are covered by LCOs in Section 3.4, Reactor Coolant System (RCS), and Section 3.5, Emergency Core Cooling Systems (ECCS). RHR loop requirements in MODE 6 with the water level ≥ 23 ft are located in LCO 3.9.5, "Residual Heat Removal (RHR) and Coolant Circulation - High Water Level."

In MODE 6 Low Water Level, low-pressure letdown line isolation valves are automatically closed upon detection of RCS loop low-level signal to prevent loss of RCS inventory.

BASES

APPLICABILITY (continued)

The function is effective to prevent core damage during plant shutdown, based on probabilistic risk assessment.

ACTIONS

A.1 and A.2

If less than the required number of RHR loops are OPERABLE, action shall be immediately initiated and continued until the RHR loop is restored to OPERABLE status and to operation or until ≥ 23 ft of water level is established above the reactor vessel flange. When the water level is ≥ 23 ft above the reactor vessel flange, the Applicability changes to that of LCO 3.9.5, and only one RHR loop is required to be OPERABLE and in operation. An immediate Completion Time is necessary for an operator to initiate corrective actions.

B.1

If one low-pressure letdown isolation valve is inoperable, the automatic isolation function to prevent loss of RCS inventory is lost. Action must be initiated to restore the valve to OPERABLE status. The immediate Completion Time reflects the importance of maintaining the availability of three paths for heat removal.

~~B~~C.1

If no RHR loop is in operation, there will be no forced circulation to provide mixing to establish uniform boron concentrations. Suspending positive reactivity additions that could result in failure to meet the minimum boron concentration limit is required to assure continued safe operation. Introduction of coolant inventory must be from sources that have a boron concentration greater than that what would be required in the RCS for minimum refueling boron concentration. This may result in an overall reduction in RCS boron concentration, but provides acceptable margin to maintaining subcritical operation.

~~B~~C.2

If no RHR loop is in operation, actions shall be initiated immediately, and continued, to restore two RHR loop to operation. Since the unit is in Conditions A and B concurrently, the restoration of three OPERABLE RHR loops and at least two operating RHR loop should be accomplished expeditiously.

BASES

ACTIONS (continued)

~~B~~C.3, ~~B~~C.4, ~~B~~C.5.1, and ~~B~~C.5.2

If no RHR is in operation, the following actions must be taken:

a. The equipment hatch must be closed and secured with four bolts,

b. One door in each air lock must be closed, and

c. Each penetration providing direct access from the containment atmosphere to the outside atmosphere must be either closed by a manual or automatic isolation valve, blind flange, or equivalent, or verified to be capable of being closed by an OPERABLE Containment Purge and Exhaust Isolation System.

With RHR loop requirements not met, the potential exists for the coolant to boil and release radioactive gas to the containment atmosphere. Performing the actions stated above ensures that all containment penetrations are either closed or can be closed so that the dose limits are not exceeded.

The Completion Time of 4 hours allows fixing of most RHR problems and is reasonable, based on the low probability of the coolant boiling in that time.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.9.6.1

This Surveillance demonstrates that two RHR loops are in operation and circulating reactor coolant. The flow rate is determined by the flow rate necessary to provide sufficient decay heat removal capability and to prevent thermal and boron stratification in the core. In addition, during operation of the RHR loops with the water level in the vicinity of the reactor vessel nozzles, the CS/RHR pump suction requirements must be met. [The Frequency of 12 hours is sufficient, considering the flow, temperature, pump control, and alarm indications available to the operator for monitoring the RHR System in the control room. OR The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

SR 3.9.6.2

Verification that the required pump is OPERABLE ensures that an additional RCS or RHR pump can be placed in operation, if needed, to maintain decay heat removal and reactor coolant circulation. Verification is performed by verifying proper breaker alignment and power available to the required pump. [The Frequency of 7 days is considered reasonable in view of other administrative controls available and has been shown to be acceptable by operating experience. OR The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

SR 3.9.6.3

SR 3.9.6.3 requires a complete cycle of each low-pressure letdown isolation valve. This requirements mean confirmation of OPERABILITY of Instrumentation and its control (Setpoints, Channel Checks, Channel Calibrations) and valve. Operating a low-pressure letdown isolation valve through one complete cycle ensures that the low-pressure letdown isolation valve can be automatically actuated to mitigate the effects from loss of RCS inventory. [The Frequency of 24 months is based on engineering judgment, taking into consideration the conditions required to perform the Surveillance, and is intended to be consistent with expected fuel cycle length. This equipment is not at risk of imminent damage as it is designed to remain functional and in good condition while in operation, thus significant degradation due to a longer surveillance interval should not be of major concern. The design reliability is, therefore, maintained by taking these considerations into account based on sound engineering judgment. OR The Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.]

BASES

REFERENCES 1. Subsection 5.4.7.