

  
**MITSUBISHI HEAVY INDUSTRIES, LTD.**  
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TOKYO, JAPAN

December 9, 2011

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

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021  
MHI Ref: UAP-HF-11428

**Subject: MHI's Revised Responses to US-APWR DCD RAI No. 808-5921 Revision 3 (SRP 15.6.3)**

References: 1) "REQUEST FOR ADDITIONAL INFORMATION 808-5921 REVISION 3" dated August 22, 2011 (ML112360607).  
2) "MHI's Response to the US-APWR DCD RAI No. 808-5921 Revision 3 (SRP 15.6.3)", MHI Letter UAP-HF-11323, dated September 22, 2011 (ML11269A038).

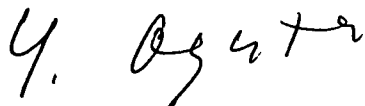
With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the document entitled "MHI's Revised Responses to US-APWR DCD RAI No. 808-5921 Revision 3 (SRP 15.6.3)". In Reference 2, MHI provided the original response to the NRC's Request for Additional Information ("RAI") in Reference 1.

MHI has revised the responses for Questions 15.06.03-3 and 15.06.03-8 of Reference 2 based on prior discussions between MHI and the NRC. The material in Enclosure 1 provides MHI's revised response to Questions 15.06.03-3 and 15.06.03-8 of the NRC's "Request for Additional Information (RAI) 808-5921," dated August 22, 2011 (Reference 1).

The responses in Enclosure 1 supersede the responses for these questions previously provided in Reference 2. All other questions remain unchanged from the version submitted in 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 this submittal. His contact information is provided below.

Sincerely,



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

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Enclosures:

1. MHI's Revised Responses to US-APWR DCD RAI No. 808-5921 Revision 3 (SRP 15.6.3)  
(non-proprietary)

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

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**ENCLOSURE 1**

UAP-HF-11428  
Docket No. 52-021

MHI's Revised Responses to US-APWR DCD RAI No. 808-5921  
Revision 3 (SRP 15.6.3)

December 2011

(Non-Proprietary)

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**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

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12/09/2011

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

**RAI NO.:** NO. 808-5921 REVISION 3  
**SRP SECTION:** 15.06.03 - RADIOLOGICAL CONSEQUENCES OF STEAM GENERATOR TUBE FAILURE (PWR) 07/1981  
**APPLICATION SECTION:** 15.6.3  
**DATE OF RAI ISSUE:** 8/22/2011

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**QUESTION NO.: 15.06.03-3**

The design basis analysis of the steam generator tube rupture (SGTR) event, described in DCD Section 15.6.3, assumed a series of operator actions as a part of mitigating and recovery procedures to stabilize the plant in a timely manner to terminate the primary-to-secondary break flow, and minimize contamination of the secondary system and the release of radioactivity to the atmosphere. It is also stated that the operator actions for SGTR recovery are proceduralized in the emergency operating procedures (EOP). However, the plant-specific EOPs are not yet available as they will be developed based on the emergency response guidelines (ERG). The staff will review the ERGs to assure that the design basis operator action assumptions in the safety analysis are consistent with the ERG-specified steps and bound the operator response times.

- (a) Provide the US-APWR ERG for the SGTR event.
- (b) Provide an evaluation of the operator actions and completion times credited in the SGTR analysis. The evaluation should consider each operator action for consistency with the corresponding steps in the ERG, the alarms and indications of event symptoms, quality and adequacy of diagnostic instrumentation, and training which would enable the operators to properly interpret the symptoms to take proper action within the assumed operator response time. The operator actions assumed in the SGTR analysis for the radiological dose evaluation case include:
- Manual reactor trip and main feedwater (MFW) isolation at 15 minutes
  - Identification and isolation (main steam isolation valve closure) of the ruptured SG at 20 minutes
  - Opening of intact SG main steam depressurization valves (MSDV) at 25 minutes
  - Opening of pressurizer safety depressurization valve (SDV) at ~45.3 minutes
  - Closure of SDV at ~47.5 minutes
  - Manual termination of ECCS at 48 minutes

**ANSWER:**

(a)  
As described in the response to RAI 297-2287 Question 15.0.0-12 (MHI letter UAP-HF-09340, dated July 3, 2009), MHI is currently developing Emergency Response Guidelines (ERGs) for the US-APWR for the purpose of supporting plant-specific Emergency Operating Procedures (EOPs). Per COL 13.5(6) the responsibility for the development and implementation of plant-specific EOPs lies with the COL Applicant. The development of ERGs is expected to result in the US-APWR ERG Revision 0 at the end of December 2011 to support this COL Applicant activity.

Verification that the design basis operator action assumptions in the Chapter 15 safety analysis are consistent with the ERG-specified steps and bound the operator response times will be evaluated by the task analysis and verification and validation (V&V) activities in Chapter 18 during EOP development. Confirmation of the V&V activity is assured by the ITAAC provided in Tier 1 Table 2.9-1 Item 10.

(b)

Table 15.06.03-3.1 provides a list of the manual operator actions assumed in the DCD Section 15.6.3 analysis. For each action, the table provides the corresponding step that performs this function in the ERG. The table also provides the alarms and/or indications that are used to assist the operator in performing the step. The quality and adequacy of this instrumentation is described in detail in the response to Question 15.06.03-8 of this RAI. Finally, the table shows the time available and time required to perform each action. The time available is defined as the total time in which the operator has to perform the action. It is determined based on the DCD analysis assumptions for the times at which the actions are performed. The time required is defined as the amount of time the operator would take to complete the action based on the future task analysis and HFE V&V. In each case, the time required has margin to the time available assumed in the safety analysis.

The training of operators to use the applicable procedures is discussed in DCD Section 13.2.

**Table 15.06.03-3.1: Manual Action Times for Steam Generator Tube Rupture (sheet 1 of 2)**

<b>DCD Chapter 15 Manual Action</b>	<b>Corresponding Step(s) in ERG</b>	<b>Alarms and Indications of Event Symptoms (Necessary for Manual Actions)</b>	<b>Elapsed Time to Completion</b>	<b>Time Available</b>	<b>Time Required</b>
SGTR occurs	NA	NA	0 min	NA	NA
Operators manually trip reactor	Abnormal Operating Procedure (AOP) -or- Alarm Response Procedure (ARP)	<ul style="list-style-type: none"> <li>· High Sensitivity Main Steam Line Radiation (N-16) Alarms</li> <li>· Pressurizer Water Level Indication</li> </ul>	15 min	15 min	5 min
	E-0 (Verify Reactor Trip)	-			
Identification of the SGTR event	E-0 (Check if SG Tubes Are Not Ruptured)	<ul style="list-style-type: none"> <li>· High Sensitivity Main Steam Line Radiation (N-16) Alarms</li> <li>· Radiation Monitors (any of the following: main steam line, condenser vacuum pump exhaust line, SG blowdown water)</li> </ul>	20 min	5 min	4 min
Identification and isolation (main steam isolation valve closure) of the ruptured SG	E-3 (Identify Ruptured SG(s))  E-3 (Isolate Flow From Ruptured SG(s))	<ul style="list-style-type: none"> <li>· SG Water Level (narrow range) Indications</li> <li>· High Sensitivity Main Steam Line Radiation (N-16) Alarms</li> <li>· Radiation Monitors (any of the following: main steam line, SG blowdown water)</li> </ul>			

**Table 15.06.03-3.1: Manual Action Times for Steam Generator Tube Rupture (sheet 2 of 2)**

DCD Chapter 15 Manual Action	Corresponding Step(s) in ERG	Alarms and Indications of Event Symptoms (Necessary for Manual Actions)	Elapsed Time to Completion	Time Available	Time Required
Opening of intact SG main steam depressurization valves	E-3 (Initiate RCS Cooldown)	<ul style="list-style-type: none"> <li>· RCS Hot Leg Temperature (wide range) Indications</li> <li>· Main Steam Line Pressure Indications</li> </ul>	25 min	5 min <sup>Note 1</sup>	4.5 min
Opening of pressurizer safety depressurization valve (SDV)	E-3 (Depressurize RCS Using PZR SDV to Minimize Break Flow and Refill PZR)	<ul style="list-style-type: none"> <li>· RCS Pressure Indication</li> <li>· RCS Subcooling Indication</li> <li>· Pressurizer Water Level Indication</li> </ul>	~ 45.3 min		
Closure of SDV			~ 47.5 min		
Manual termination of ECCS	E-3 (Check if SI Flow Should be Terminated)  E-3 (Stop SI Pumps and Place in Standby)	<ul style="list-style-type: none"> <li>· RCS Pressure Indication</li> <li>· RCS Subcooling Indication</li> <li>· EFW Flow Indication</li> <li>· Pressurizer Water Level Indication</li> <li>· SG Water Level (narrow range) Indications</li> </ul>	~ 48.0 min		

Note 1: Depressurization of the RCS (opening and closing the SDV) and termination of SI are performed when appropriate conditions are met. The conditions for performing these actions can be monitored during the RCS cooldown. Therefore, the time available to complete all of these actions is measured from the start of the isolation of the ruptured SG and is at least 5 minutes.

**Impact on DCD**

There is no impact on the DCD.

**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 Technical/Topical Report**

There is no impact on a Technical/Topical Report.

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



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**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

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12/09/2011

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

**RAI NO.:** NO. 808-5921 REVISION 3  
**SRP SECTION:** 15.06.03 - RADIOLOGICAL CONSEQUENCES OF STEAM GENERATOR TUBE FAILURE (PWR) 07/1981  
**APPLICATION SECTION:** 15.6.3  
**DATE OF RAI ISSUE:** 8/22/2011

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**QUESTION NO.: 15.06.03-8**

List systems, components and instruments that are credited in the SGTR analysis. Discuss whether each system and component is safety grade. For non-safety grade systems and components, discuss whether safety grade backups are available which can be expected to function, or justify that non-safety grade systems and components can be used for the SGTR analysis.

**ANSWER:**

Table 15.06.03-8.1 provides a list of the systems, components, and instrumentation which are credited for mitigation in the safety analysis of an SGTR. All of the primary systems and components credited for the mitigation of the event are safety grade. In addition, most of the backup components are also safety grade. Instrumentation such as the radiation alarms and monitors that may be used to detect the event and identify the ruptured SG are non-safety grade. However, other safety grade instrumentation such as SG water level indication can be used to detect the event and identify the ruptured SG as backup to the radiation alarms and monitors.

**Impact on DCD**

There is no impact on the DCD.

**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 Technical/Topical Report**

There is no impact on a Technical/Topical Report.

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

**Table 15.06.03-8.1 Systems, Components, and Instrumentation Credited for SGTR Mitigation (Sheet 1 of 3)**

Item	Function in SGTR Analysis	Safety Grade Status	Available Backups
RTS	Trip the reactor	Safety Grade	N/A
EFWS	Supply EFW to SGs	Safety Grade	N/A
EFWIV	Close to isolate ruptured SG	Safety Grade	N/A
MSRV/associated block valve	Close to isolate ruptured SG (*1)	Safety Grade	N/A
MSDV	1) Open for RCS cooldown 2) Close when RCS cooldown completed	Safety Grade	N/A
Pressurizer SDV	1) Open for RCS depressurization 2) Close when RCS depressurization completed	Safety Grade	N/A
GTG	Provide power to SI and EFW pumps during LOOP	Safety Grade	N/A
MSIV	Close to isolate steam flow from SGs	Safety Grade	N/A
MFIV	Close to isolate MFW to ruptured SG	Safety Grade	N/A
MSSV	Automatically open/close to relieve SG pressure	N/A (code safety valve)	N/A

(\*1) The analysis assumes a stuck open MSRV. The MSRV automatically opening and failing to automatically close increases the ruptured SG steam release and keeps its pressure low. A lower ruptured SG pressure results in increased primary-to-secondary leakage. Therefore, the MSRV of the ruptured SG automatically opening and then failing to close is a conservative assumption and not a mitigative function for SGTR. The analysis then later assumes the associated MSRV block valve automatically closes to isolate the ruptured SG. The closure function on low main steam line pressure is safety grade.

**Table 15.06.03-8.1 Systems, Components, and Instrumentation Credited for SGTR Mitigation (Sheet 2 of 3)**

<b>Item</b>	<b>Function in SGTR Analysis</b>	<b>Safety Grade Status</b>	<b>Available Backups</b>
SI Pump Switches	Stop SI pumps to terminate SI	Safety Grade	N/A
Pressurizer Water Level Indication	<ol style="list-style-type: none"> <li>1) Detect event</li> <li>2) Monitor RCS depressurization criteria</li> <li>3) Verify pressurizer level for SI termination</li> </ol>	Safety Grade	N/A
SG Water Level (narrow range) Indications	<ol style="list-style-type: none"> <li>1) Detect event*<sup>1</sup></li> <li>2) Identify ruptured SG</li> <li>3) Verify feedwater isolation to ruptured SG</li> <li>4) Verify SG level during RCS cooldown</li> <li>5) Verify heat sink for SI termination</li> </ol>	Safety Grade	N/A
High Sensitivity Main Steam Line Radiation (N-16) Alarms	<ol style="list-style-type: none"> <li>1) Detect event</li> <li>2) Identify ruptured SG</li> </ol>	Non-Safety Grade	<p>For all functions, two channels per loop are available.</p> <p>For Function 1, the pressurizer water level indication provides backup (see item above).</p> <p>For Functions 1 and 2, the SG water level (narrow range) indications and other radiation monitors provide backup (see items above and below).</p>

\*<sup>1</sup> Generally not the primary means to detect the event, but is available as a backup.

**Table 15.06.03-8.1 Systems, Components, and Instrumentation Credited for SGTR Mitigation (Sheet 3 of 3)**

Item	Function in SGTR Analysis	Safety Grade Status	Available Backups
Radiation Monitors (any of the following: main steam line, condenser vacuum pump exhaust line, SG blowdown water)	<ol style="list-style-type: none"> <li>1) Detect event</li> <li>2) Identify ruptured SG<sup>*2</sup></li> </ol>	Non-Safety Grade	<p>For Function 1, the pressurizer water level indication provides backup (see item above).</p> <p>For Functions 1 and 2, the SG water level (narrow range) indications and high sensitivity main steam line (N-16) radiation alarms provide backup (see items above).</p>
RCS Hot Leg Temperature (wide range) Indications	Monitor RCS cooldown	Safety Grade	N/A
Main Steam Line Pressure Indications	Monitor RCS cooldown	Safety Grade	N/A
RCS Pressure Indication	<ol style="list-style-type: none"> <li>1) Monitor RCS depressurization</li> <li>2) Verify RCS pressure for SI termination</li> </ol>	Safety Grade	N/A
RCS Subcooling Indication	<ol style="list-style-type: none"> <li>1) Monitor RCS depressurization</li> <li>2) Verify subcooling for SI termination</li> </ol>	Safety Grade	N/A
EFW Flow Indication	<ol style="list-style-type: none"> <li>1) Verify feedwater flow during RCS cooldown</li> <li>2) Verify heat sink for SI termination</li> </ol>	Safety Grade	N/A

\*2 Condenser vacuum pump exhaust line monitors can be used to detect the event, but not to identify the ruptured SG.