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

January 6, 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- 12003

Subject: **MHI's Response to US-APWR DCD RAI No. 867-6174 Revision 3 (SRP 06.03)**

Reference: 1) "Request for Additional Information No. 867-6174 Revision 3, SRP Section: 06.03 – Emergency Core Cooling System – Application Section: 6.3" dated November 14, 2011.

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. 867-6174 Revision 3".

Enclosed is the response to Question 06.02.04-103 that is contained within Enclosure 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,
Director - APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Response to Request for Additional Information No. 867-6174 Revision 3

A002
D081
NRO

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

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Docket No. 52-021
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Enclosure 1

UAP-HF-12003
Docket No. 52-021

Response to Request for Additional Information No. 867-6174
Revision 3

January 2012

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

01/06/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	NO. 867-6174 REVISION 3
SRP SECTION:	06.03 – EMERGENCY CORE COOLING SYSTEM
APPLICATION SECTION:	6.3
DATE OF RAI ISSUE:	11/14/2011

QUESTION NO.: 06.03-103

The US-APWR safety injection (SI) pumps will be required to mitigate the entire range of small and large break loss of coolant accidents (LOCAs). The US-APWR Design Control Document (DCD) states that the design flow of each pump is 1540 gallons per minute (gpm) and the minimum flow is 265 gpm through the pump minimum-flow loop.
Therefore, the pumps will be required to operate at flows significantly less than their best efficiency flow condition. When the pumps automatically actuate following a LOCA occurrence, they will run at these lesser flow conditions for a significant period of time before system pressure drops sufficiently to allow flow closer to the best efficiency point.
Even with only one pump running, the smallest break LOCA would result in flows significantly less than best efficiency flow. When running at these low flow conditions the SI pumps may encounter recirculation cavitation. Recirculation cavitation is known to cause significant vibration and can damage pump impellers, wear rings, seals, shafts, and bearings within a short time period. By RAI 6.3-85, the NRC staff requested MHI to provide a description of the pump functional qualification and testing that will demonstrate the design-basis capability of the pumps for their required mission times under recirculation cavitation conditions. By letter dated July 8, 2011, MHI provided design criteria for the pumps and stated that MHI would request time-proven pumps to the vendors or request evaluations for pumps that do not have enough past records. The NRC staff does not consider the MHI response to fully describe the functional qualification and testing to demonstrate SI pump capability under recirculation cavitation conditions. Therefore, the staff requests MHI to specify in the US-APWR DCD that SI pump functional qualification will be accomplished in accordance with ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," as accepted in Revision 3 to Regulatory Guide 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," and will demonstrate the design-basis capability of the pumps for their required mission times under recirculation cavitation conditions. In addition, the staff requests that MHI specify in the US-APWR DCD that the US-APWR will be designed to allow full flow testing of safety-related pumps in the Inservice Testing Program consistent with Commission policy for new reactor designs.

ANSWER:

Functional qualification and Inservice Testing Programs for safety-related pumps are described in Subsection 3.9.6. Subsection 3.9.6 was recently revised in MHI's response to RAI 801-5897 to

describe that functional qualification will be in accordance with QME-1-2007 (see MHI Letter UAP-HF-11375, dated 11/2/2001). MHI will confirm the capability during minimum flow rate conditions in the functional qualification and Inservice Testing Program.

Subsection 6.3.2.5 is revised in the attached mark-up to state that operation during minimum flow conditions is confirmed during functional qualification and Inservice Testing Program as discussed in Subsections 3.9.6.1 and 3.9.6.2, respectively.

Impact on DCD

Please see the attached mark-up (Attachment-1).

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

operation, which includes both power generation and hot standby modes. The SI pumps are in standby, ready for automatic initiation, with the pumps taking suction from the RWSP and injecting into the RCS through the DVI nozzles. The accumulators are in standby, aligned for passive actuation of injection to the RCS cold legs if the RCS pressure decreases below the accumulator pressure.

Each SI pump train discharge containment isolation valve is normally open. The system is designed with suitable capacity and redundancy for single failure considerations, as well as an unavailable train (e.g., maintenance). Chapter 15, Subsection 15.0.0.4, discusses single active failure and potential passive failure and their application to event analysis. Table 6.3-6 presents a failure modes and effect analysis for the ECCS.

During long term cooling, the most limiting active failure, or a single passive failure, equal to the leakage that would occur from a valve or pump seal failure, may occur. Leakage is detected and alarmed in the MCR. The SIS consists of four separate 50% capacity trains. The ECCS performance objectives are achieved by isolation of the affected train.

As noted in Chapter 7, separate, independent, and redundant system initiating detectors and instrument racks are located in, around, and outside the containment structure. Instrument wiring is routed through widely separated and protected cable trays to initiate and control SI functions. Similarly, highly reliable separate, independent, and redundant power sources are available for instrumentation and prime movers (SI pump motors).

Chapter 14 discusses the construction and pre-operational testing, as well as system and integrated tests performed prior to commencement of full power. Further, component and system reliability is enhanced by inservice pump and valve testing required by Chapter 16, "Technical Specifications."

Requirements for functional testing of ECCS valves and pumps are provided in Subsection 3.9.6. SI pump head is periodically verified as required by the Technical Specifications, SR 3.5.2.3, and SR 3.5.3.1. Implementation of inservice test programs is described in Subsection 13.4.

MUAP-08013-P (Ref. 6.2-36) contains requirements for design and evaluation of ECCS and CSS ex-vessel downstream components to ensure the ECCS and CSS systems and their components will operate as designed under post-LOCA conditions. DCD_06.02.02-84

The SI pump capability during minimum flow rate conditions is confirmed during the functional qualification and Inservice Testing Program as discussed in Subsection 3.9.6.1 and 3.9.6.2, respectively. DCD_06.03-103

6.3.2.6 Protection Provisions

As noted above, many and varied provisions are provided to protect the ECCS. The details are provided in the following Chapters and sections:

- Internal flooding is discussed in Chapter 3, Section 3.4
- Missile protection is discussed in Chapter 3, Section 3.5