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TOKYO, JAPAN

July 5, 2013

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-13174

Subject: MHI's Response to US-APWR DCD RAI No. 1035-7064 (SRP 05.04.07)

Reference: 1) "Request for Additional Information No. 1035-7064, SRP Section 05.04.07 – Residual Heat Removal (RHR) System", dated May 20, 2013.

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. 1035-7064."

Enclosed is the response to questions contained within Reference 1.

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

Sincerely,

Y. Ogata

Yoshiki Ogata,
Executive Vice President
Mitsubishi Nuclear Energy Systems, Inc.
On behalf of Mitsubishi Heavy Industries, Ltd.

Enclosure:

1. Response to Request for Additional Information No. 1035-7064

D081
NRO

CC: J. A. Ciocco
J. Tapia

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Enclosure 1

UAP-HF-13174
Docket No. 52-021

Response to Request for Additional Information No. 1035-7064

July 2013

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

07/04/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 1035-7064**
SRP SECTION:	**05.04.07–Residual Heat Removal (RHR) System**
APPLICATION SECTION:	**5.4.7**
DATE OF RAI ISSUE:	**05/20/2013**

QUESTION NO.05.04.07-17:

This RAI is a follow on to RAI 6540, Question 6.2.1-24 which questioned what fouling factor is used in determining the RHR/CS heat exchanger heat transfer rate. The heat transfer rate of17.1x10^6 Btu/h is given in DCD Table 5.4.7-2, Equipment Design Parameters for the containment spray/residual heat exchanger. In a public meeting held on 3/18/13 the applicant stated that the minimum heat transfer rate is set by the cooldown rates given in Chapter 5.4.7(i.e., the RHR system) and the not CS heat removal capability to limit peak containment pressure. Based on the public meeting the staff has the following questions regarding the RHR/CS heat transfer rate given in Table 5.4.7-2:

1. What decay heat curve, and associated uncertainty, is used to determine the normal operation and safe plant shutdown temperatures and times in DCD Section 5.4.7.1?

2. Using the decay heat curve from question 1, calculate the minimum heat transfer rate needed to achieve the normal operation and safe plant shutdown temperatures and times given in DCD Section 5.4.7.1. How does the calculated heat transfer rate compare to that given DCD Table 5.4.7-2 including the effects of the assumed fouling factor given in your response to RAI 6540, Question 6.2.1-24.

3. Provide a basis for the shell and tube side fouling factors used. Due to the random nature of fouling over time what other conservatisms, if any, are including in the CS/RHR heat exchanger heat removal capability?

ANSWER:

1. The decay heat curve for calculations for the RHR system performance described in DCD 5.4.7 is conservatively based on SRP 9.2.5 Revision 2 ASB 9-2. The decay heat curve includes uncertainty described in SRP 9.2.5 Rev. 2 ASB 9-2 as follows:

   Uncertainty : 20% ($0 \le ts < 10^3$ seconds),
   : 10% ($10^3 \le ts < 10^7$ seconds)
   ts: time after shutdown

2. The UA value described in the DCD is already the overall design basis value for the CS/RHR heat exchanger. This value includes the effect of the assumed fouling factor of 0.0005 h ft^2°F/Btu which is listed in Table 5.4.7-2. The exact U and A values will be determined during the detail design phase in consideration of the assumed fouling factor and design bases. The UA and fouling factors specified in Table 5.4.7-2 will be clarified per the attached DCD mark-up.

   In Part 3 of this RAI response it will be demonstrated that, even if the fouling factor doubles to 0.001 h ft^2°F/Btu, the criteria for safe shutdown can still be achieved (RCS temperature reduced to 200 deg F within 36 hours of reactor trip). Normal shutdown criteria are not considered in this analysis since abnormal heat exchanger performance degradation would impact the plant refueling schedule which is a non-safety related criterion of the RHRS.

3. As described in the response to RAI 06.02.01-20, RAI 623-4942, UAP-HF-10261, the assumed, tabulated fouling factors are based on values given by Tubular Exchanger Manufacturers Association (TEMA) standards. Since the water chemistries of the tube side (RHRS RCS Water) and the shell side (CCWS) are both administratively controlled and reasonably expected to contain minimal contaminants, this value is selected for both the tube and shell sides of the heat exchangers. In the unlikely event that the fouling factor exceeds the assumed value over the plant life, it would not immediately impact the safe shutdown capability of the RHRS. If the fouling factor is assumed to become double the tabulated value (0.001 h ft2°F/Btu), the UA value is calculated to decrease approximately 30% from the design basis value which is based on a generic RHR heat exchanger (since a heat exchanger vendor has not been selected at this time). Assuming a 30% decrease of the UA value, the cool-down performance during safe shutdown for the US-APWR is demonstrated in Figure 1. As shown in Figure 1, in the case of the decreased UA, the safe shutdown criteria are still achieved (safe shutdown within 36 hours and RCS temperature below 200 deg F). Therefore, in addition to consideration of the listed fouling factors in Table 5.4.7-2, should an unexpected rate of fouling occur in the tube and shell sides of the CS/RHR heat exchangers, sufficient margin is also built into the design basis UA specification of the CS/RHR heat exchanger to account for any uncertainties as demonstrated by the preceding analysis. Discussion of this analysis in the DCD will be included as part of the DCD mark-ups for the response to RAI 1036-7079.

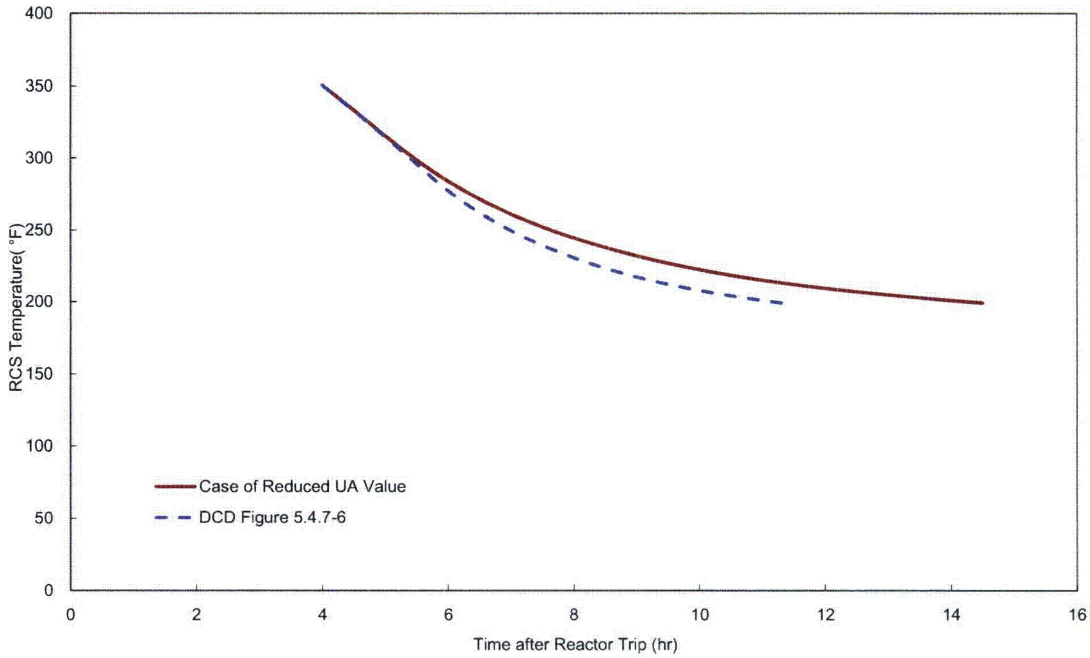

Figure 1 RCS Temperature Transient Curve (Safe Shutdown)

Impact on DCD

Refer to attached mark-ups for DCD section 5.4.7.

Impact on R-COLA

There is no impact on the R-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical Report

There is no impact on Technical/Topical Reports.

Table 5.4.7-2 Equipment Design Parameters (Sheet 2 of 2)

Containment Spray / Residual Heat Exchanger		
Number	4	
Type	Horizontal U-tube type	
Heat Transfer Rate (Btu/h)	17.1 x 10^6	
Design Basis Overall hHeat Transfer Coefficient and the eEffective hHeat tTransfer aArea, UA (Btu/h/° F)	1.852 x 10^6	
	Tube side	Shell side
Design Pressure (psig)	900	200
Design Temperature (° F)	400	200
Design Flow Rate (lb/h)	1.5 x 10^6	2.2 x 10^6
Design Inlet Temperature (° F)	120	99.7
Design Outlet Temperature (° F)	108.7	107.4
Fouling Factor (h ft^2 °F/Btu)*	0.0005	0.0005
Material	Stainless steel	Carbon Steel
Fluid	Reactor coolant, boric water	Component cooling water
Radioactive Concentration (kBq/cm^3)	≥ 37	<37
Equipment Class	2	3

DCD_05.04.07-17

DCD_06.02.01-24
DCD_05.04.07-17

*: The tabulated tube and shell fouling factors are considered in the design basis UA value of the CS/RHR heat exchanger.

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