

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

August 19, 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-09425

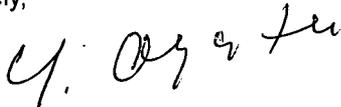
**Subject: Additional Information Concerning Minor Safety Analysis Input/Code Errors  
in the US-APWR Design Certification Application**

At the Nuclear Regulatory Commission ("NRC") public meeting on July 16, 2009, Mitsubishi Heavy Industries, Ltd. ("MHI") presented the plan to submit Revision 2 of the US-APWR Design Control Document ("DCD"). In this presentation, MHI mentioned that previous DCD submittals contained small input/code errors in the safety analysis for the US-APWR DCD, and that MHI is evaluating the impact on the results for the specific analyses.

By copy of this letter, MHI is transmitting to the NRC Staff information describing the plan for submitting affected input decks and code executable files, and their respective submittal dates. In addition, MHI will identify which changes will be included in Revision 2 of the DCD.

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

Sincerely,



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

Enclosure:

1. "US-APWR SAFETY ANALYSIS INPUT AND CODE UPDATES"

CC: H. Hamzehee     NRC  
M. Takacs           NRC  
S. Monarque        NRC  
C. K. Paulson       MNES

DOB  
NRC

Contact Information

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

Enclosure 1

UAP-HF-09425  
Docket No. 52-021

US-APWR

SAFETY ANALYSIS INPUT AND CODE UPDATES

August 2009

## US-APWR SAFETY ANALYSIS INPUT AND CODE UPDATES

MHI presented the revision plan for the Chapter 15 safety analysis in the meeting with the NRC on July 16, 2009. The materials presented in the meeting include the detailed plan of the modifications to the safety analysis computer codes and inputs. A summary of these input modifications and design improvement for the non-LOCA and LOCA analysis, along with the schedule for the sensitivity analysis is shown in Tables 1 and 2, respectively. Other previously submitted materials, such as code input manuals, executable files, and input decks that are affected by these changes are shown in Table 3.

### 1. NON-LOCA ANALYSIS

#### Non-LOCA Analyses in DCD Chapter 15

MHI found that some minor input modifications were necessary for the initial fuel temperature data and the peripheral core geometry data used in some of the Chapter 15 safety analyses. These changes may have a small impact on the analyses. Additionally, the fuel design change associated with the grid spacer position may also have a small impact on some of the analyses.

#### Steam Line Break Mass and Energy Release Analysis in DCD Chapter 6

The thick metal heat capacity data used in the Chapter 6 steam line break mass and energy release analysis requires an input modification, which may have a small impact on the results.

MHI will submit a report evaluating the sensitivity of the analysis results to these input modifications and the design improvements in the non-LOCA analyses by the end of September 2009. Additionally, MHI will submit the associated VIPRE-01M and MARVEL-M code input decks by the end of August 2009 preceding the submittal of the report.

The effects of these changes are expected to be negligible and bounded by the uncertainties assumed in the original DCD analyses. There will not be large differences between the original submittal and the re-calculated results; therefore, MHI does not expect this to have any impact on the NRC review of Chapter 15 and 6.

## 2. LOCA ANALYSIS

MHI found that some minor modifications to the codes used for the US-APWR LOCA analysis were required. These modifications will have a minor impact on the analysis results. MHI has been performing analyses to determine the impact on the US-APWR LOCA results using the modified codes, and the results will be incorporated into DCD Revision 2. MHI also found that some minor modifications to the input data used for the US-APWR LOCA analysis were required. MHI will submit the updated input decks and report the impact on the analysis results at the end of August 2009. DCD Revision 2 will reflect the following modifications and the fuel design change associated with the grid spacer position.

### 2.1 LB-LOCA CODE MODIFICATIONS

#### WCOBRA/TRAC Steam Table Minor Modifications

Subroutines are used in the steam table calculations in WCOBRA/TRAC. The WCOBRA/TRAC code will be updated to incorporate the following changes to the steam tables:

- (i) The coding for the power calculations, which is part of the density calculation in the subroutine; and
- (ii) A typographical error for the coefficient in the subroutine of the steam table.

#### HOTSPOT Burst Temperature Logic Modifications

The HOTSPOT code will be updated to incorporate the following modifications to the burst temperature calculation logic:

- (i) To change the rod internal pressure used to calculate the cladding engineering hoop stress from the value in the previous time step to the value in the current time step;
- (ii) To revise the average cladding heat up rate calculation to reset selected variables to zero at the beginning of each calculation and to use the instantaneous heat up rate when fewer than five values are available; and
- (iii) To reflect the assumed saturation of ramp rate effects above 28°C/s for Zircaloy-4 cladding.

## 2.2 LB-LOCA INPUT MODIFICATIONS

### Fuel Temperature Data in WCOBRA/TRAC and HOTSPOT

It was found that the power density used in the fuel design code did not take into account the change in fuel pellet density due to fuel relocation in the vertical direction. Since in the MHI LOCA analysis the codes reproduce the fuel temperature resulting from the fuel design code analysis as an initial condition, a slightly higher power density will be applied to the fuel performance evaluation for the LOCA analysis, reflecting the revised results from the fuel design code analysis with the effect of fuel relocation.

### Temperature Range of Material Property Data in WCOBRA/TRAC

A value of 70°F is used as the lower bound of the material properties temperature range. It has been found that there was a possibility that the resultant temperature would fall below the current lower bound value. The lower bound value will be modified because.

### Input Calculation Modifications (ACC tank geometry, ECCS actuation signal setpoint and SG secondary mass)

The following minor modifications are necessary in the input calculation:

- (i) The inner diameter of the advanced accumulator tank;
- (ii) The pressure value associated with the ECCS actuation signal setpoint;  
and
- (iii) Calculation to use liquid mass instead of total liquid mass including vapor for the SG secondary mass.

### DVI Line Injection Flow Area in WCOBRA/TRAC

In order to obtain consistency with the injection line, MHI will change the value of the flow area and the hydraulic diameter of the DVI nozzle.

### Input for Thermal Connection with Unheated Conductors

The following minor modifications are necessary for the input of unheated conductors:

- (i) Thermal connection between some of the unheated conductors and hydraulic cells; and
- (ii) The mass calculation for unheated conductors.

## 2.3 SB-LOCA CODE MODIFICATIONS

### M-RELAP5 Reactor Kinetics Routine Modifications

It was found that the reactor point kinetics model, reported to the NRC by MHI letter UAP-HF-08120, dated July 4, 2008, required further modification. The modeling modification will be added to the source code. Note that all the changes for the kinetics model have negligible impact except when the code is used for the reactivity insertion transient analyses.

### M-RELAP5 HTC and Heat Property Routine Modifications

Two modifications are required to the M-RELAP5 heat conduction calculation. The first change is in the steam temperature used to compute steam properties for the modified Bromley correlation. The other change is related to the treatment of the specific heat in the mesh facing the boundary.

### M-RELAP5 Other Minor Modifications (No Impact on PCT)

M-RELAP5 will be also updated to incorporate other minor modifications that are identical to modifications made to the RELAP5-3D code.

## 2.4 SB-LOCA INPUT MODIFICATIONS

### Fuel Temperature Data in M-RELAP5

Please see the description for LB-LOCA.

### RCP Input Data in M-RELAP5

It was found that a part of the RCP homologous data was required modification in the input deck. No significant impact on PCT is expected from this change.

### Loop Pressure Drop Data in M-RELAP5

In the process of SB-LOCA evaluation, the primary loop pressure drop is adjusted to obtain the target steady-state condition prior to the transient calculations. It was found

that a minor modification was necessary to obtain the target pressure drop. This change has negligible impact on the pressure drop calculation.

#### Noding Change for the Steady-State Calculation in M-RELAP5

An additional component modeled for the steady-state calculation will be revised. The model is used to achieve the target steady-state condition. The connection between the pressurizer and other component will be modified. This change does not have any impact on the transient calculation.

Table 1 Non-LOCA Analysis Code and Input Modifications

Categories	Items to be Changed	Impacts on Analysis		Transmittal of Updated Input Deck and Code	Transmittal of Report
		Ch. 15 Non-LOCA Analyses	Ch. 6 MSLB M&E Release		
Design Improvement	✓ Fuel grid spacer position	X	-	Aug. 2009	Sep. 2009
Input Modification	✓ Initial fuel temperature	X	X		
	✓ Peripheral core geometry	X	-		
	✓ Thick metal heat capacity data	-	X	Aug. 2009	Sep. 2009

Table 2 LOCA Analysis Code and Input Modifications

Categories	Items to be Changed	Impacts on Analysis		Transmittal of Updated Input Deck and Code	Transmittal of Report
		LB-LOCA	SB-LOCA		
Design Improvement	✓ Fuel grid spacer position	X	X	Sep. 2009	N/A
Input Modification	✓ Initial fuel temperature	X	X	Aug. 2009	Aug. 2009
	✓ Temperature range of material property				
	✓ ACC tank geometry				
	✓ ECCS actuation signal setpoint				
	✓ SG secondary mass	X	-		
	✓ DVI line injection flow area				
	✓ Thermal connection model				
Code Modification	✓ RCP data				
	✓ Loop pressure drop	-	X		
	✓ Noding change for the steady-state calculation				
	✓ WCOBRA/TRAC Steam table	X	-		
	✓ HOTSPOT Burst temperature logic	X	-		
Code Modification	✓ M-RELAP5 Reactor kinetics routine				
	✓ M-RELAP5 HTC and heat property routine	-	X		
	✓ M-RELAP5 Other				

Table 3 Topical Reports and their Supplemental Submittals

Topical Reports	Computer Codes	Supplemental Submittals			
		Input Manuals	Executables	Input Decks	Other Information
Transient and Non-LOCA MUAP-07010 July 2007	MARVEL-M	UAP-HF-09358 July 2009	UAP-HF-09099 March 2009	UAP-HF-09099 March 2009 UAP-HF-09358 July 2009	UAP-HF-09099 March 2009 Notes from Mtg. on April 22, 2009
	VIPRE-01M	UAP-HF-08092 May 2008	UAP-HF-08092 May 2008	UAP-HF-08092 May 2008	-
	TWINKLE-M	UAP-HF-08138 August 2008	UAP-HF-08138 August 2008 (UAP-HF-07189 December 2007)	UAP-HF-08138 August 2008	-
LBLOCA MUAP-07011 July 2007	WCOBRA/TRAC	UAP-HF-08140 August 2008	UAP-HF-07189 December 2007	*Based on DCD Rev.1 July 2009*	-
	HOTSPOT	UAP-HF-07189 December 2007	UAP-HF-07189 December 2007	*Based on DCD Rev.1 July 2009*	-
SBLOCA MUAP-07013 July 2007	M-RELAP5	UAP-HF-08162 August 2008	UAP-HF-09100 March 2009	UAP-HF-09174 April 2009	UAP-HF-09100 March 2009 UAP-HF-09174 April 2009 Notes from Mtg. on April 22, 2009

Legend:

 : Impacted by input and/or code modification

\* : Input deck for DCD Rev.1 analysis is transmitted by e-mail to the NRC