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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-11049

Subject: MHI's Response to US-APWR DCD RAI No. 687-5394 Revision 2 (SRP 15.0.0.7 and 08.02.03)

Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the document entitled "MHI's Response to US-APWR DCD RAI No. 687-5394 Revision 2 (SRP 15.0.0.7 and 8.2.3)". The material in Enclosure 1 provides MHI's response to the NRC's "Request for Additional Information (RAI) 687-5394," dated January 27, 2011.

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,

Y. Ogata

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

Enclosures:

1. MHI's Response to US-APWR DCD RAI No. 687-5394 Revision 2 (SRP 15.0.0.7 and 8.2.3) (non-proprietary)

CC: J. A. Ciocco
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ENCLOSURE 1

UAP-HF-11049
Docket No. 52-021

MHI's Response to US-APWR DCD RAI No. 687-5394 Revision 2
(SRP 15.0.0.7 and 8.2.3)

February 2011

(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

2/24/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 687-5394 REVISION 2**
SRP SECTION:	**15 – INTRODUCTION – TRANSIENT AND ACCIDENT ANALYSES)**
APPLICATION SECTION:	**15.0.0.7 and 8.2.3**
DATE OF RAI ISSUE:	**1/27/2011**

QUESTION NO.: 15.0.0-24

The NRC staff notes that there is an inconsistency between Chapter 8 and Chapter 15 with respect to the basis for the 3 second time delay between a reactor trip and the loss of offsite power (LOOP). Per DCD Section 15.0.0.7, the safety analyses assume that a LOOP occurs a minimum of 3 seconds after a reactor/turbine trip to account for the time it would take for grid instability, caused by the turbine-generator trip, to propagate through the grid to the plant offsite power source. However, Section 8.2.3 states that in the event of a LOOP concurrent with reactor/turbine trip, the main generator remains connected to the grid powering reactor coolant pumps (RCPs) thru the UATs and that the large inertia of the turbine–generator will maintain voltage and frequency for more than 3 seconds.

Remove the apparent inconsistency between Chapter 8 and chapter 15 and provide the following:

a) If the statement in Section 8.2.3 provides the relied-upon basis, describe in detail how the large inertia of the turbine generator would maintain adequate voltage and frequency to the RCPs for an additional 3 seconds, assuming that a LOOP occurs concurrently with a reactor/turbine trip. The staff is concerned that during this event the main generator would attempt to power the grid and may not be able to support adequate voltage and frequency for the RCPs for 3 seconds to satisfy the Chapter 15 safety analysis assumptions. Therefore, the applicant needs to show that adequate voltage and frequency will be maintained during this scenario before the generator is separated from the grid.

b) If the statement in Section 15.0.0.7 of the DCD provides the relied-upon basis, provide an analysis that demonstrates that a LOOP occurs a minimum of 3 seconds after a reactor/turbine trip to support this assumption. As part of this analysis, provide the basis for the conclusion that this is a bounding situation given the site-specific nature of such analysis.

ANSWER:

MHI believes that the descriptions in DCD Chapter 15 and Chapter 8 are consistent with each other and provides the following clarification.

First, note that DCD Section 8.2.3 refers to two different delay periods related to maintaining power to the RCPs:

A. The first is the time between a reactor (turbine/generator) trip and a possible LOOP that is caused by the grid disturbance generated by the reactor (turbine/generator) trip. This time period is a characteristic of the offsite power system and not a design feature of the US-APWR.
B. The other period is the time for which the RCPs remain powered following a turbine/generator trip or loss of offsite power (LOOP) due to the design features of the US-APWR.

Next, the safety analyses in DCD Chapter 15 consider a LOOP as part of a plant transient in two ways:

1) The LOOP is the initiating event.
2) The LOOP occurs as a secondary effect during the transient as a result of grid disturbances caused by a turbine-generator trip.

In the first case, where the LOOP is the initiating event, this event is explicitly analyzed in DCD Section 15.2.6. In the Section 15.2.6 safety analysis, the RCPs are assumed to trip (and begin to coast down) at the same time as the LOOP (no delay). In this case, neither of the 3 second periods identified in "A" or "B" above are credited. Therefore, there is no required relied-upon basis for the assumption in Section 15.2.6.

The second case, where the LOOP is a secondary event during the transient, is described in DCD Section 15.0.0.7. Certain Chapter 15 events result in a reactor trip. A reactor trip causes a turbine/generator trip. It is assumed that this turbine/generator trip could cause a grid disturbance which could ultimately result in a LOOP. As described in Section 15.0.0.7, MHI assumes that it takes a minimum of 3 seconds for the grid disturbance caused by the turbine-generator trip to propagate through the grid and cause a LOOP. Since the LOOP does not occur until at least 3 seconds after the reactor (turbine/generator) trip, the RCPs are assumed to continue to run during this time. When the LOOP does occur, then the RCPs are assumed to trip and begin to coast down. This is consistent with the description in DCD Section 8.3.2 which says:

> "Following a reactor/turbine trip, stability of the offsite power is expected to be maintained, including the power supply to the RCPs."

Therefore, the Chapter 15 analysis for the applicable events are crediting the 3 second period identified as "A" above. The relied-upon basis for this 3 seconds assumption is a grid stability analysis that shows the grid remains stable for at least 3 seconds following a turbine/generator trip. The grid stability analysis is described in Section 8.2.3 and is currently defined by COL action item COL 8.2(11).

In order to confirm the consistency between DCD Chapters 8 and 15 and clearly define the requirements for the COL action item, DCD Chapter 8 will be revised as shown in the "Impact on DCD" section below.

Impact on DCD

DCD Subsection 8.2.3 will be revised as follows:

> The interface requirement for offsite power is maintaining a transmission system operating voltage of ±10% and a frequency of ±5% at the interface point between the transmission and offsite power system as defined in DCD Section 8.1.2.2. The COL applicant is to perform a grid stability analysis to confirm this interface requirement.
>
> Transmission system stability is consistent with the condition of the transient and accident analysis in Chapter 15. It is assumed that the power supply to RCPs following a reactor/turbine trip is maintained at least 3 seconds by ~~the main generator (turbine generator coast down) or~~ the offsite power in Chapter 15. Following a reactor/turbine trip, stability of the offsite power is expected to be maintained, including the power supply to

the RCPs. Meeting the interface requirement, as described above, will ensure the availability of the power supply to the RCPs as assumed in Chapter 15. In addition, when the offsite power is lost concurrent with a reactor/turbine trip, the turbine-generator is still connected to the UATs and RCPs are powered by turbine-generator. The large inertia of the turbine-generator will maintain voltage and frequency more than 3 seconds. In case of a unit trip due to an electrical fault, the main transformer circuit breaker opens and the non-Class 1E buses are powered continuously via RAT. The transient and accident analysis in Chapter 15 ignores this design feature. ~~The COL applicant is to perform grid stability analysis to confirm the assumption in Chapter 15.~~

COL Item 8.2(11) will be revised as follows:

The COL applicant is to address the stability and reliability study of the offsite power system. Stability study is to be addressed in accordance with BTP 8-3 (Reference 8.2-17). The study addresses the loss of the unit, loss of the largest unit, loss of the largest load, or loss of the most critical transmission line including operating range, for maintaining transient stability. A failure modes and effects analysis (FMEA) is to be provided.

The grid stability study shows in part that, with no external electrical system failures, the grid will remain stable and the transmission system voltage and frequency will remain within the interface requirements (±10%for voltage and ±5% for frequency) to maintain the RCP flow assumed in the Chapter 15 analysis for a minimum of 3 seconds following reactor/turbine (generator) trip.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.