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

October 29, 2010

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-10297

Subject: MHI's Responses to US-APWR DCD RAI No.641-5045 Revision 1 (SRP 19)

References: 1) "Request for Additional Information No. 641-5045 Revision 1, SRP Section: 19 – Probabilistic Risk Assessment and Severe Accident Evaluation," dated September 27, 2010.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 641-5045 Revision 1".

Enclosed are the responses to all of the RAIs that are contained within Reference 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,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Responses to Request for Additional Information No. 641-5045 Revision 1

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

D081
NRO

Enclosure 1

UAP-HF-10297
Docket Number 52-021

Responses to Request for Additional Information No.641-5045
Revision 1

October, 2010

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-473

Table 23.8-1 of the US-APWR PRA indicates that there are only 2 fire areas with fire induced LOOP assigned to them. Are there any other fire areas besides "FA6-101-04" and "Switchyard" that fire could cause a LOOP event to occur? If there are other areas, please explain why they were excluded from the fire PRA.

ANSWER:

Although the single compartment fire scenario that will induce LOOP includes only two fire scenarios, multiple compartment fire scenario induced LOOP is also postulated between FA6-101-03 (Electrical room: 1F) and FA6-101-14 (Electrical room: 2F) in the T/B (Turbine Building) because FA6-101-03 contains the A train and B train of safety-related buses and FA6-101-14 contains the C train and D train of safety-related buses.

These multiple compartment fire scenarios are "FA6-101-M-02" and "FA6-101-M-29," listed in Table23P-1(26/28) and Table23P-1(27/28), respectively, of the PRA Report Attachment 23P.

A fire in any fire compartment of the R/B (Reactor Building) and PS/B (Power Source Building) will not damage all safety-related buses simultaneously because all fire compartments in the R/B and PS/B are separated by a fire resistant barrier. Also, not every fire compartment in the A/B (Auxiliary Building) and AC/B (Access Building) contains safety-related components. Therefore, a fire in fire compartments in R/B, PS/B, A/B and AC/B will not cause LOOP.

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 641-045 REVISION 1**

SRP SECTION: **19 – Probabilistic Risk Assessment and Severe Accident Evaluation**

APPLICATION SECTION: **19.1.5.2**

DATE OF RAI ISSUE: **09/27/2010**

QUESTION NO. : 19-474

Table 23.3-1 on Page 23-13 of the US-APWR PRA identifies the potential initiating events considered in the fire PRA. Nonetheless, the following initiators are not included in the hierarchy event tree on Page 23-38 and are not discussed in the fire PRA document:

- Loss of Main Feed Water (LOFF)
- Total Loss of Component Cooling Water (PLOCW)
- Medium Loss-of-Coolant Accident (MLOCA)
- Very Small Loss-of-Coolant Accident (VSLOCA)

Please explain why these initiators are excluded from the event tree model.

ANSWER:

(1) Loss of Main Feed Water (LOFF)

As described in Attachment 23H of the PRA, the difference between the event tree (ET) models for LOFF and general transient (TRANS) is whether top event "main feed water recovery" is modeled or not. Other top events and success criteria of TRANS are the same as those of LOFF. Therefore, the CCDP of LOFF can be estimated using the ET of TRANS which sets the failure probability of "main feed water recovery" to 1.0. Therefore, this initiator is not included in the hierarchy event tree.

(2) Other initiating events

The initiators LOCCW, MLOCA and VSLOCA, will not occur in the US-APWR: therefore, these initiators have not been included in the hierarchy event tree. The reasons why these initiating events will not occur are described on page 23-11 of the PRA Report as follows:

- The fire-induced concurrent spurious opening of the ELDV may cause a medium LOCA. The control circuits have the potential to induce the spurious operation of these two valves and are independent between the two valves. These circuits are separated physically by the fire-resistant barriers without any openings. Therefore, a fire affecting one valve is very unlikely to affect the other.

- The fire-induced concurrent spurious opening of the reactor vessel top vent valves may cause a very small LOCA. The control circuits have the potential to induce the spurious operation of these two valves and are independent between the two valves. These circuits are separated physically by fire resistant barriers without any openings. Therefore, a fire affecting one valve is very unlikely to affect the other.
- Each safety division of CCW pumps and associated valves and their cables is separated by fire-resistant barriers. Therefore, a fire event is very unlikely to cause total loss of component cooling water.
- Each safety division of essential service water pumps and associated valves and their cables is separated by fire resistant barriers. Therefore, a fire event is very unlikely to cause total loss of essential service water.

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-475

Section 23.6.2 of the US-APWR PRA integrates Loss of Main Feed Water (LOFF), Loss of Vital AC Bus (LOAC), and Loss of Vital DC Bus (LODC) into one general transient initiating event. Please justify this treatment and why it is acceptable to have these three initiators combined given the differences among the events trees provided in the PRA Chapter 3.

ANSWER:

(1) Loss of Main Feed Water (LOFF)

As described in Attachment 23H of the PRA Report, the difference between the event tree (ET) models for LOFF and general transient (TRANS) is whether a top event "main feed water recovery" is modeled or not. Other top events and success criteria of TRANS are the same as those of LOFF. Therefore, the CCDP of LOFF can be estimated by using the ET of TRANS, which sets the failure probability of "main feed water recovery" to 1.0.

(2) Loss of Vital AC Bus (LOAC)

LOAC is one of the general transient events that postulate the loss of one train of the safety AC power source. The ET of LOAC is a modified ET of TRANS, which has set the failure probability of one train of the safety AC power source to 1.0. Therefore, the CCDP of LOAC is estimated by using the ET of TRANS.

(3) Loss of Vital DC Bus (LODC)

LODC is one of the general transient events that postulate the loss of one train of the safety DC power source. The ET of LODC is a modified ET of TRANS, which has set the failure probability of one train of the safety DC power source to 1.0. Therefore, the CCDP of LODC is estimated by using the ET of TRANS.

<u>Impact on DCD</u>

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-476

For the control room fire analysis in Section 23.6.2 of the US-APWR PRA, please provide additional information and revise the fire PRA accordingly for the following:

- Timing and location of transfer switch required for transferring control of the plant to the remote shutdown console
- Systems/functions that could be controlled from the remote shutdown console
- Random failure probability of remote shutdown console given a successful transfer.

In addition, is the MCR to remote shutdown panel transfer switch [and circuitry] included in the D-RAP list? If not, please explain why.

ANSWER:

1. Timing and location of the transfer switch required for transferring control of the plant to the remote shutdown console

   When a fire in the main control room (MCR) has the possibility of loss of a critical control function or control room habitability is in jeopardy, the operator will abandon the MCR and evacuate to the RSC room, continuing the plant shutdown from the remote shutdown console (RSC).

   When evacuating the MCR, both the switch on RSC Changing Board (1) installed in the fire division FA 2-504 (Remote Shutdown Console Room) and the switch on RSC Changing Board (2) installed in FA 2-501 (Emergency Feedwater Pit Area/East side corridor) are switched to transfer control from the MCR to the RSC. The transfer of the control function from the MCR to the RSC is not due to the change of only one switch, but of both switches.

2. Systems/ functions that could be controlled from the remote shutdown

   Systems/ functions that are controlled from the remote shutdown console are shown in Section 6.2.2, 6.3.2 and 6.3.5 of DCD Chapter 6.

Much more may be controlled from the RSCs as discussed in DCD Sections 7.4.1.5 and 7.4.1.6, and there is a list in Tables 7.4-1 (controls) and 7.4-2 (indications).

3. Random failure probability of remote shutdown console given a successful transfer

   The design of the remote shutdown console control equipment is equivalent to that of the operational VDUs and the safety VDUs installed in the MCR. Therefore, the reliability of the remote shutdown console equipment is equivalent to that of the equipment in the MCR. Random failure probability of the VDUs is not taken into account in the internal events PRA, and therefore is not taken into account in the fire PRA.

4. Inclusion of transfer switches in D-RAP list

   Transfer switches, which transfer the plant control system from the MCR to the remote shutdown panel, are not included in the D-RAP list. It will be included in Table 17.4-1 of DCD Chapter 17 incorporating the discussion of (D-RAP) expert panel.

<u>Impact on DCD</u>

Table 17.4-1 of DCD Chapter 17 will be revised incorporating the discussion of (D-RAP) expert panel.

<u>Impact on COLA</u>

There is no impact on COLA.

<u>Impact on PRA</u>

Revise the PRA technical report MUAP-07030(R2) Chapter 23 to include the above discussion.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-477

For the fire event trees currently reported in Chapter 23 and Appendix 23H of the USAPWR PRA, the staff review notes that there is no description of the event tree top events and that the success criteria for each top event are not stated in the fire PRA. Please provide this information and revise the fire PRA accordingly (e.g., a table could be added that includes a description and the success criteria for each top event identifier).

ANSWER:

The success criteria of each top event of all event trees (ETs) except MCR ET shown in Attachment 23H of the PRA Report is the same as that of the internal events PRA model described in Chapter 3 of the PRA Report.

Moreover, because it is assumed that any fire in the MCR will not damage the mitigation function, the MCR ET has been developed based on the TRANS ET of the internal events PRA, but EVA has been added as the top event of the MCR event tree. The MCR ET is shown in Figure 1.

The success criteria of the MCR ET are equivalent to those for the TRANS ET.

All fault trees (FTs) linked to the MCR ET top event except EVA are the same as those of the TRANS ET as shown in Table 1. The operator action from the RSC has been added to the gate of the fault trees (FTs) by the sub-tree shown in Figure 2.

As a result, the MCR ET has been modeled so that operator actions in RSC may be assessed in the case of evacuation from the MCR.

<u>Impact on DCD</u>

There is no impact on DCD.

<u>Impact on COLA</u>

There is no impact on COLA.

Impact on PRA

Revise the PRA technical report MUAP-07030(R2) Chapter 23 to include above discussion.

Table 1 Descriptions and Fault Trees of MCR Event Tree Top Events

Event Tree Top events	System Name	ALT	Top Events Fault Trees
EVA	Evacuation to RSC from MCR	1	RSP-EVA
RTA	Reactor Trip	1	RTP-MF
EFA	Emergency Feedwater System	1	EFW-SL
FBA	Feed and Bleed	1	HPI-FAB
CSA	CS/RHRS (CV Spray Injection)	1	RSS-CSS
CXA	CS/RHRS (Heat Removal)	1	RSS-CSS-HR
FNA3	Alternative CV Cooling	1	NCC
		2	NCC-LF-DP2

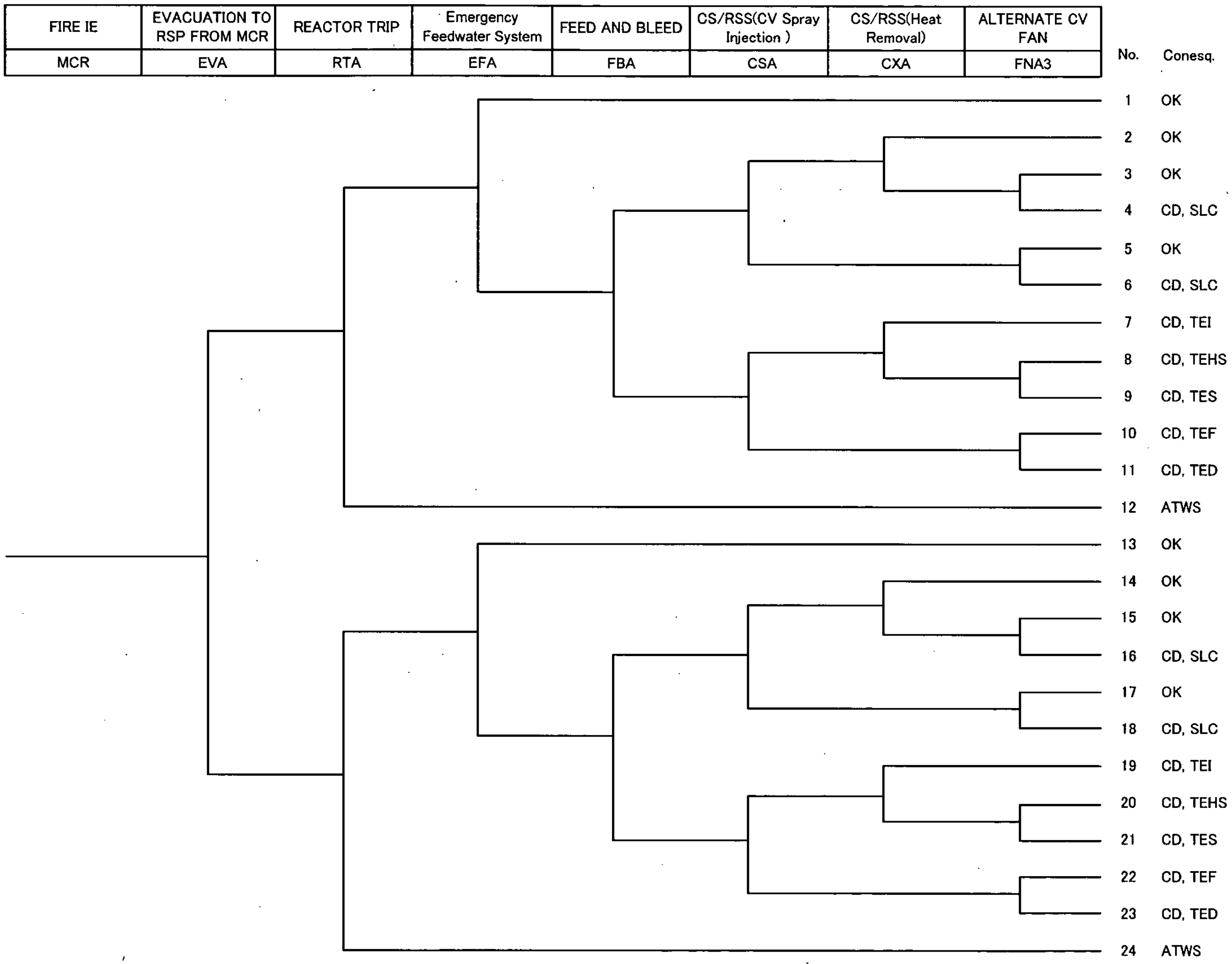

Figure 1 MCR Event Tree

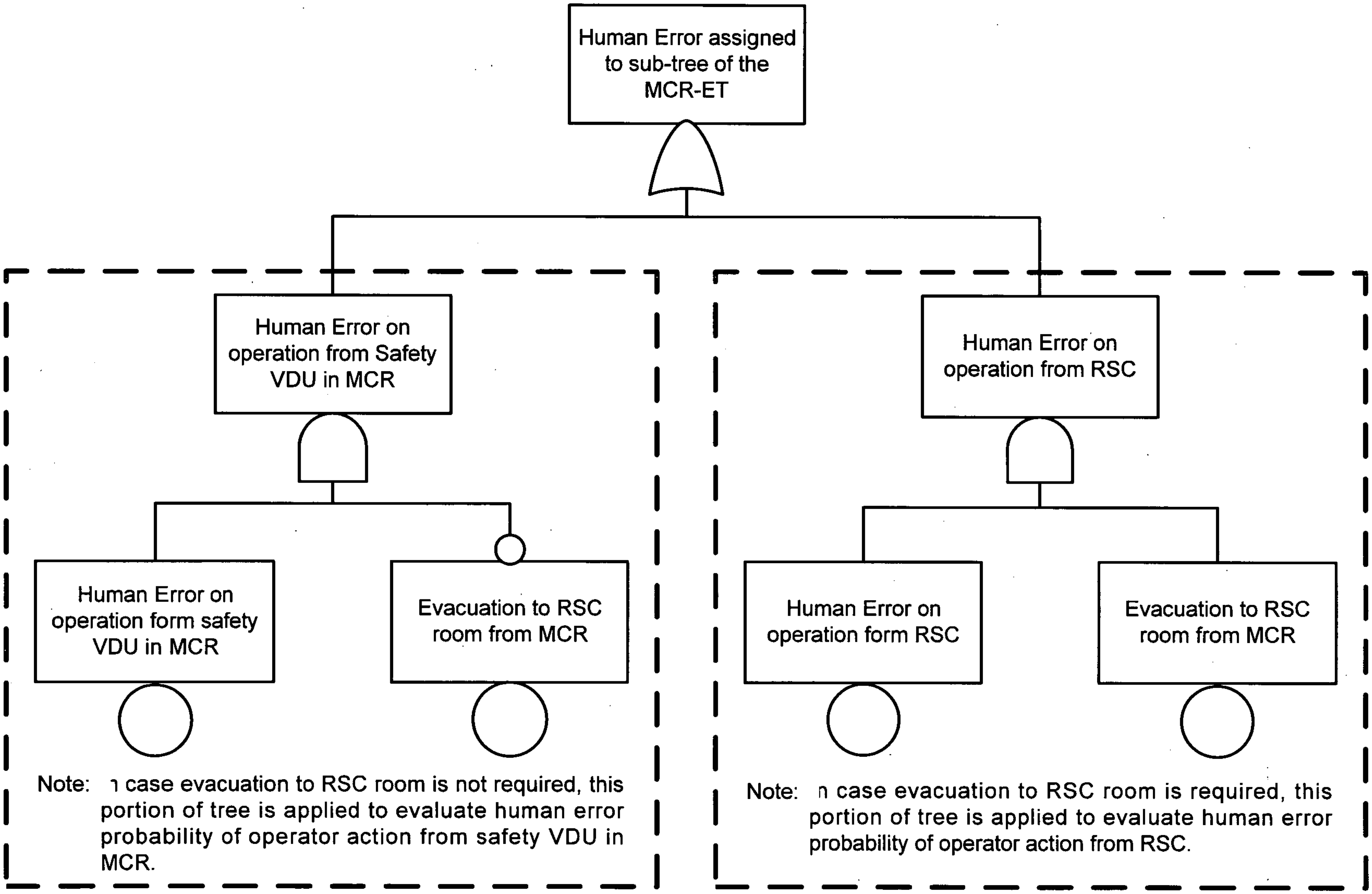

Figure 2 Human Error Probability Assignment Sub-tree for MCR Event Tree

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-478

According to the guidance in RG 1.206, Appendix C.I.19-A, Section 19.1.5.2.1, the following information must be summarized and included in the DCD:

- Explain how the fire initiation frequencies were estimated.
- Describe the propagation of fires, and identify any computer codes used.
- Describe the fire damage modeling, and identify the specific fire-induced failure modes considered in the evaluation.
- Describe the plant response analysis and modeling.

Although the above information is briefly mentioned in the DCD and specifically discussed in the fire PRA, the DCD should present greater details to demonstrate compliance with the referenced fire PRA methodology/guidance of NUREG/CR-6850 and to support the fire PRA results and insights currently presented in the DCD. Please revise the DCD accordingly.

ANSWER:

A summary of information requested by RG 1.206 is as follows:

(1) Estimation process of fire ignition frequencies (PRA Report Chapter 23 Section 23.7)

Fire ignition frequencies of each fire compartment of the US-APWR are estimated using the methodology and generic fire mean frequencies of NUREG/CR-6850. The estimation process for the fire ignition frequency for each fire compartment of the US-APWR is shown below:

- Mapping Plant Ignition Source to Generic Source
  In this step, the ignition sources of the US-APWR are assigned to the ignition source bins in Table 6-1 of NUREG/CR-6850.
- Fixed Fire Ignition Source Counts
  In this step, the types, amounts and location of existing fire ignition sources are identified.
- Calculation of Ignition Source Weighting Factor

Using the counts of the preceding step, ignition source weighting factors are calculated for each fire compartment. For transient fires, the weighting factors are estimated using best estimates of anticipated conditions of the US-APWR plant.

- Ignition Source and Compartment Fire Frequency Evaluation
  Using the ignition source weighting factor of the preceding step and the fire mean frequency of Table 6-1 of NUREG/CR-6850, the fire ignition frequencies associated with each compartment are estimated.

At the design certification stage of the US-APWR, no plant-specific fire event data exist: therefore, the following tasks are not applicable to the US-APWR fire PRA.

- Plant Fire Event Data Collection and Review
- Plant Specific Updates of Generic Ignition Frequencies

(2) Fire propagation analysis (PRA Report Chapter 23 Section 23.10.4.2)

A fire inside the containment vessel (CV) may spread to multiple fire PRA compartments of the CV because the boundaries of each fire PRA compartment in the CV are not composed of fire-resistant barriers. In this analysis, the CFAST code is used to simulate the fire behavior inside the CV and fire effects in the fire origin compartment and adjacent compartments. According to the results of the CFAST simulation, it is confirmed that there is no fire in the CV that spreads to adjacent fire compartments in the CV. Therefore, the multiple compartments fire scenario for fire compartments in the CV is not developed in this evaluation.

Conditions for CFAS simulation:

- Fire origin compartment is FA1-101-18 (A-Accumulator area),
- Adjacent compartments are FA1-101-15 (B-Accumulator area) and FA1-101-17 (D-Accumulator area),
- Heat release rate given in Chapter 11 of NUREG/CR-6850 is used,
- Damage temperature of the thermoplastic cable shown in Appendix H of NUREG/CR-6850 is applied.

(3) Fire damage modeling and fire-induced failure mode (PRA Report Chapter 23 Section 23.9)

The fire-induced failure mode of various components is studied by considering the component status in the normal operation mode and the function required for post-accident mode. The fire-induced failure modes considered in the fire PRA of the US-APWR are as follows:

- Spurious Operation
- Fail to Start/Run
- Fail to Close/Open

The failure modes of components with fire-damaged cables or circuits are identified by the detailed circuit failure analysis. The process of the detailed circuit failure analysis in this evaluation is shown below:

- Compile and Evaluate Prerequisite Information and Data
  In this step, the components and their cables subjected to circuit failure analysis are identified.
- Perform Detailed Circuit/Cable Failure Analysis
  In this step, a circuit analysis per NUREG/CR-6850 is conducted to establish the possibility of spurious actuation due to fire-induced circuit failure. Typical circuit failure modes described in Figure B3.3 of NFPA 805 and associated circuits shown in Figure B.3.4 of NFPA 805 are used as a reference.
- Generic Equipment Failure Response Analysis
  In this step, a matrix of fire compartments, fire PRA components in each compartment (including associated cables) and damage states of components due to fire are developed.

(4) Plant response analysis and modeling (PRA Report Chapter 23 Section 23.10)

To evaluate plant response to a fire, the following three groups of fire scenarios are developed:

- Single compartment fire scenario
- MCR (Main Control Room) fire scenario
- Multiple compartments fire scenario

For a single compartment fire scenario, it is assumed that a fire would have widespread impact within the concerned compartment, and the fire risk is evaluated by identifying the fire-induced initiating event and the fire mitigation function. For the MCR fire scenario, fire risk is evaluated by considering evacuation to the RSC (Remote Shutdown Console) room from the MCR and shutdown from the RSC. The multiple compartments fire scenario is developed following the steps described in Task 11 of NUREG/CR-6850, and the fire risk of each multiple compartments fire scenario is estimated by assuming that a fire would have widespread impact within the compartments concerned similar to the single compartment fire scenario.

Impact on DCD

Subsection 19.1.5.2.1 of DCD Chapter 19 will be revised to include the following paragraphs.

(Insert the paragraph after the last paragraph of Subsection 19.1.5.2.1)

The fire ignition frequencies, fire propagation analysis, fire damage modeling and fire-induced failure mode, and plant response analysis and modeling are evaluated as follows.

(1) Estimation process of fire ignition frequencies

Fire ignition frequencies of each fire compartment of the US-APWR are estimated using the methodology and generic fire mean frequencies of NUREG/CR-6850. The estimation process for the fire ignition frequency for each fire compartment of the US-APWR is shown below:

- *Mapping Plant Ignition Source to Generic Source*
  In this step, the ignition sources of the US-APWR are assigned to the ignition source bins in Table 6-1 of NUREG/CR-6850.
- *Fixed Fire Ignition Source Counts*
  In this step, the types, amounts and location of existing fire ignition sources are identified.
- *Calculation of Ignition Source Weighting Factor*
  Using the counts of the preceding step, ignition source weighting factors are calculated for each fire compartment. For transient fires, the weighting factors are estimated using best estimates of anticipated conditions of the US-APWR plant.
- *Ignition Source and Compartment Fire Frequency Evaluation*
  Using the ignition source weighting factor of the preceding step and the fire mean frequency of Table 6-1 of NUREG/CR-6850, the fire ignition frequencies associated with each compartment are estimated.

At the design certification stage of the US-APWR, no plant-specific fire event data exist: therefore, the following tasks are not applicable to the US-APWR fire PRA.

- *Plant Fire Event Data Collection and Review*
- *Plant Specific Updates of Generic Ignition Frequencies*

(2) Fire propagation analysis

A fire inside the containment vessel (CV) may spread to multiple fire PRA compartments of the CV because the boundaries of each fire PRA compartment in the CV are not composed of fire-resistant barriers. In this analysis, the CFAST code is used to simulate the fire behavior inside the CV and fire effects in the fire origin compartment and adjacent compartments. According to the results of the CFAST simulation, it is confirmed that there is no fire in the CV that spreads to adjacent fire compartments in the CV. Therefore, the multiple compartments fire scenario for fire compartments in *the CV is not developed in this evaluation.*

Conditions for CFAS simulation:

- *Fire origin compartment is FA1-101-18 (A-Accumulator area),*
- *Adjacent compartments are FA1-101-15 (B-Accumulator area) and FA1-101-17 (D-Accumulator area),*
- *Heat release rate given in Chapter 11 of NUREG/CR-6850 is used,*
- *Damage temperature of the thermoplastic cable shown in Appendix H of NUREG/CR-6850 is applied.*

(3) Fire damage modeling and fire-induced failure mode

The fire-induced failure mode of various components is studied by considering the component status in the normal operation mode and the function required for post-accident mode. The fire-induced failure modes considered in the fire PRA of the US-APWR are as follows:

- *Spurious Operation*
- *Fail to Start/Run*
- *Fail to Close/Open*

The failure modes of components with fire-damaged cables or circuits are identified by the detailed circuit failure analysis. The process of the detailed circuit failure analysis in this evaluation is shown below:

- *Compile and Evaluate Prerequisite Information and Data*
  In this step, the components and their cables subjected to circuit failure analysis are identified.
- *Perform Detailed Circuit/Cable Failure Analysis*
  In this step, a circuit analysis per NUREG/CR-6850 is conducted to establish the possibility of spurious actuation due to fire-induced circuit failure. Typical circuit failure modes described in Figure B3.3 of NFPA 805 and associated circuits shown in Figure B.3.4 of NFPA 805 are used as a reference.
- *Generic Equipment Failure Response Analysis*
  In this step, a matrix of fire compartments, fire PRA components in each compartment (including associated cables) and damage states of components due to fire are developed.

(4) Plant response analysis and modeling

To evaluate plant response to a fire, the following three groups of fire scenarios are developed:

- *Single compartment fire scenario*
- *MCR (Main Control Room) fire scenario*
- *Multiple compartments fire scenario*

For a single compartment fire scenario, it is assumed that a fire would have widespread impact within the concerned compartment, and the fire risk is evaluated by identifying the fire-induced initiating event and the fire mitigation function. For the MCR fire scenario, fire risk is evaluated by considering evacuation to the RSC (Remote Shutdown Console) room from the MCR and shutdown from the RSC. The multiple compartments fire scenario is developed following the steps described in Task 11 of NUREG/CR-6850, and the fire risk of each multiple compartments fire scenario is estimated by assuming that a fire would have widespread impact within the compartments concerned similar to the single compartment fire scenario.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-479

For fire area "FA4-101", please explain why the CCDP for this scenario on Page 23-78 of the US-APWR PRA is lower than the SLBO CCDP on Page 19.1-248 of the US APWR DCD.

ANSWER:

Re-quantification of fire risk has not been executed in the DCD Revision 2 stage. This is because the design changes or internal event model changes were not expected to significantly increase the risks of fire events. The internal events PRA has been revised in MUAP-07030 Revision 2 to reflect PRA model modifications for internal events based on responses to requests for additional information (RAIs).

The following is a comparison of the CCDP of internal events for steam line break downstream MSIV (SLBO) between DCD Revision 1 and DCD Revision 2:

CCDP of SLBO

DCD Revision 1	1.9E-06
DCD Revision 2	3.6E-06

The CDF of fire scenario FA4-101 will increase to 9.0E-08/RY from 4.6E-08/RY if the CCDP of SLBO of DCD Revision 2 is incorporated. However, the result of this scenario will not increase the total fire risk significantly because the contribution of this scenario is small. The risk contributed fire scenarios are loss of offsite power (LOOP) due to Yard fire. The CCDP of LOOP is reduced to 1.2E-05 from 1.5E-05 and the CDF of LOOP will be reduced to 1.0E-06/RY from 1.2E-06/RY. Therefore the total fire risk will be reduced.

The fire PRA will be updated in consistency with the latest internal events PRA model and design information in DCD Revision 3. This was discussed in the schedule for updating the DCD and PRA in Question no.19-483's response.

<u>Impact on DCD</u>

Subsection 19.1.5.2 of DCD Chapter 19 will be updated based on the revised fire PRA.

Impact on COLA

There is no impact on COLA..

Impact on PRA

PRA technical report MUAP-07030(R2) Chapter 23 Internal fire PRA will be updated.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-480

Table 23J-3 "Fire Frequency Bins and Generic Frequencies" of the US APWR PRA, Bin 26 "Ventilation systems," the total number of ventilation systems of 173 provided in the sixth column could be significantly over-estimated. Please provide an explanation and revise this number as necessary to ensure that the ignition source weighting factors remain accurate.

ANSWER:

In this analysis, components such as air conditioning units, chillers, fan motors, air filter units, and dampers have been identified as the ignition sources in the ventilation system.

The total number of ventilation systems sources has been counted based on the US-APWR design information, and on the fire hazard analysis data of the current fleet of operating PWR plants. Therefore, we believe that this result has not been over-estimated and that the ignition source weighting factors have been suitably estimated.

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-481

Please explicitly describe the uses of the fault trees provided in Attachment 23C in the fire CDF quantification process.

ANSWER:

Using the fault tree FT23C-1 in the PRA report as an example, the method to estimate the CDF for a fire scenario is as follows:

Step1: Identification of fire-induced initiating events

In the evaluation of a compartment fire, the fire-induced PRA components' damage and associated initiating event have been identified by referring to the "Fire Scenario Table" shown in Attachment 23M.

Step2: Estimation of the conditional probability of initiating event occurrence

The conditional probability of an initiating event occurrence is estimated using fault trees (FTs) of the initiating event, as shown in Attachment 23C. In the example of FT23C-1, the probability of SLOCA in the fire compartment "FA2-202" is estimated to be 2.6E-3 by inputting the following value to the basic event of the FT of SLOCA.

- RCS-MOV-117A (A-SDV Spurious Open)
  This basic event probability is set to 1.0 because the hot-short probability of a control cable is conservatively assumed to be 1.0.
- OPERATOR ERROR-116A
  This basic event probability is set to 2.6E-3, which is the same failure probability of an operator isolation action of the A-SDV estimated in Section 2-2 of Attachment 23R.

However, "RCS-MOV-116A (A-SDV Isolation Valve Fail)" is not taken into account because the failure probability of this basic event is negligible. Moreover, the failure probability of basic events which compose gate "23C-1-3" is set to 0.0 because a fire in FA2-202 will not induce spurious actuation of the

"B-SDV."

Step3: Estimation of CCDP

Using the "Fire Scenario Table" shown on Attachment 23M, the components which have the potential to be affected by a fire are identified in each fire compartment. The B.C. set list is a list of the basic events affected by a fire in each fire compartment. This list and the CCDP are estimated by inputting the data of the B.C set into the system analysis tool "Risk Spectrum." As a result, the CCDP of a SLOCA in FA2-202 is estimated to be 2.5E-4.

Step4: Estimation of CDF

The CDF is estimated by inputting the fire ignition frequency, the conditional probability of an initiating event, and the CCDP into the formula below. For example, since fire ignition frequency in FA2-202 is 2.3E-3 (/RY), the CDF of a SLOCA in FA2-202 is estimated as follows:

CDF ="Fire ignition frequency" × "conditional probability of initiating event" ×"CCDP"
= 2.3E-3 (/RY)×2.6E-3×2.5E-4
= 1.5E-9 (/RY)

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-482

In Table 23E-1 of Appendix 23E of the US-APWR PRA, please provide the basic event assigned to each cable listed in this table and discuss the treatment of the information provided in this table in the quantification process.

ANSWER:

The basic event assigned to each cable listed in Table 23E-1 of Attachment 23E has been identified and assigned as follows:

Step1: Identification of fire PRA components and cables which are associated with initiating events and their mitigation functions

Fire PRA components which have the potential to cause initiating events or the function to mitigate them are identified by the "Fire PRA Component Selection" shown in Section 23.3. Identified results in each fire compartment are shown in Table 23L-2 of Attachment 23L, "Spurious Actuation Analysis of Fire PRA Equipment." They are also in Attachment 23M, "Single Compartment Fire Scenario."

Step2: Basic events are assigned to the PRA components and cables

Given the adverse effect due to the fire in each fire compartment, basic events are assigned to each fire PRA component and cable identified in Attachment 23M.

In addition, the possibility of a basic event occurrence due to the fire-induced circuit failure was studied for the cable by the task "Circuit Failure Mode Analysis and Likelihood Analysis" shown in section 23.9.

The assigned basic event corresponding to each fire PRA component and cable is provided in Attachment 23R-1, "B.C. Set" of the PRA Report.

Impact on DCD

There is no impact on DCD.

Impact on COLA

There is no impact on COLA.

Impact on PRA

There is no impact on PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

10/29/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 641-5045 REVISION 1**
SRP SECTION:	**19 – Probabilistic Risk Assessment and Severe Accident Evaluation**
APPLICATION SECTION:	**19.1.5.2**
DATE OF RAI ISSUE:	**09/27/2010**

QUESTION NO. : 19-483

The staff identified multiple inconsistencies between the updated internal events PRA information and the fire PRA information submitted in the current DCD Revision 2. It is observed that the fire PRA information currently presented in the US-APWR DCD Revision 2 is developed and quantified using the internal events PRA provided in the DCD Revision 1. Please describe the plan for updating the fire PRA to be consistent with the latest internal events PRA.

ANSWER:

The internal fire risk evaluation is not re-quantified for DCD Revision 2. This is because it is judged that the design changes and internal events model changes will not increase the risk of internal fire.

For the internal fire, loss of offsite power (LOOP) by the Yard fire scenario contributes the fire risks. CCDP of LOOP is reduced from 1.5E-05 to 1.2E-05 and CDF of LOOP will be reduced from 1.2E-06/RY to 1.0E-06/RY. Therefore the total internal fire risk will be reduced.

MHI is planning to perform the fire PRA to be consistent with the latest internal events PRA model and design information and to consider a more realistic approach to reduce fire risk.

MHI is planning to update DCD section 19.1.5.2 by the end of March, 2011, in DCD Revisions 3.

<u>Impact on DCD</u>

Subsection 19.1.5.2 of DCD Chapter 19 will be updated based on the revised fire PRA.

<u>Impact on COLA</u>

There is no impact on COLA.

<u>Impact on PRA</u>

PRA technical report MUAP-07030(R2) Chapter 23 on internal fire PRA will be updated.