ENCLOSURE 3

UAP-HF-12086
Docket No. 52-021

Responses to Request for Additional Information No. 891-6268
REVISION 3

April 2012

(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/23/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-59

In Request for Additional Information (RAI) 17.04-52, the process for determining dominant failure modes, which is described in DCD Section 17.4.7.1, Part b (Dominant Failure Mode Identification), should include the review of industry operating experience. In response to this RAI, dated September 3, 2010, the applicant proposed to add the following statement in Revision 3 of DCD Section 17.4.7.1, Part b:

> "In the expert panel's discussion, review of dominant failure modes are also considered in order to reflect industry operating experience."

The staff found the applicant's response to be acceptable. However, in Revision 3 of the DCD, the proposed statement was placed under the first paragraph in DCD Section 17.4.7.1, rather than in Part b of this section that describes the process for determining dominant failure modes. The staff requests that the applicant place the proposed statement in Part b of DCD Section 17.4.7.1 as originally proposed, or provide a justification for not making this change.

ANSWER:

MHI will move the statement from the first paragraph in DCD Section 17.4.7.1 to Part b.

Impact on DCD

As depicted in attached markup, the first paragraph in DCD Section 17.4.7.1 "In the expert panel's discussion, review of dominant failure modes are also considered in order to reflect industry operating experience." will be deleted and inserted into Part b.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

17.4.7.1 SSCs Identification

During the US-APWR design phase, risk-significant SSCs are identified for inclusion in the scope of the D-RAP. A list of risk-significant SSCs is developed and controlled as a design input for consideration during the design phase. The list of risk-significant SSCs is initially based on the results of the PRA and the EP. For further discussion on PRA, refer to Chapter 19, Section 19.1, of this DCD. In addition to the PRA input, information from operating experience of Japanese design plants, as well as US industry experience is considered for identification of risk-significant SSCs. The list of risk-significant SSCs identified during the design phase is updated when the plant-specific PRA is developed. ~~In the expert panel's discussion, review of dominant failure modes are also considered in order to reflect industry operating experience.~~ DCD_17.04-59

a. Risk-Significant SSCs Identification

Importance Analysis based on the PRA Results

The PRA is used to identify risk-significant SSCs based on risk achievement worth (RAW) and Fussell-Vesely (FV) importance. Risk-significant SSCs are identified using importance criteria of FV importance greater than 0.005 and RAW greater than 2. In the US-APWR RAP, these criteria have been applied to both single failure basic events and common cause failure (CCF) basic events. Risk-significant SSCs identified by RAW greater than 2 cover sufficiently those identified by RAW greater than 20, which is the RAW criterion for common cause basic events per NEI-00-04 (Ref. 17.4-4). Component based FVs are also estimated and used to identify risksignificant SSCs. These RAW/FV criteria are applied to the results of each risk hazard model separately and not to the combined / integrated results. For seismic margin analysis(SMA), risk-significant SSCs are identified according to the approach provided by NEI 00-04, Revision 0 (Ref. 17.4-4).

Engineering Judge based on the PRA Assumption and Results

For SSCs

- for which RAW/FV values have not been quantified

  or

- whose RAW/FV results do not exceed the criteria,

risk significance are also identified by engineering judge from the following points of view:

- Attribution to required mitigation functions during the accident
- Similarity of the impact of failure with other risk-significant SSCs
- Impact on risk-significant human actions or signals

For LPSD, importance analysis was performed for the representative plant operation state (POS), which is mid-loop operation, for that PRA has been performed. For POSs RAW/FV values have not been quantified. SSCs that were not credited as mitigation function in the representative POS but can be used to mitigate accidents during other POSs were all included in the list of risk-significant SSCs.

For severe accident management SSCs, SSCs required to satisfy the requirement of 10 CFR are identified as risk-significant SSCs (e.g. igniter). And SSCs that are not modeled in the PRA but the loss of whose functions may directly result in large release, are identified as risk-significant SSCs (e.g. containment vessel).

Expert Panel’s Discussions and Results

A third source in the D-RAP process for identifying risk-significant SSCs is the use of an EP consisting of representatives from Design Engineering, PRA, as well as other highly qualified individuals with operations, and maintenance experience who are independent of the PRA Section. The EP also reviews the categorization of SSCs determined to be not risk-significant (NRS) from quantified PRA results (e.g., technical adequacy of the basis used in the categorization, review of defense-in-depth implications, review of safety margin implications). As part of the D-RAP process, the PRA analytical results, operating experience, and an EP process are combined to develop a comprehensive list of risk-significant SSCs.

b. Dominant Failure Mode Identification

The PRA models failure modes of SSCs that can potentially degrade the operability of mitigation functions as basic events. Since the results of importance analysis are the RAW/FV importance of each basic event, dominant failure modes can be identified for each risk-significant SSCs. For risk-significant SSCs that are chosen based on engineering judge, dominant failure modes are supposed from the importance results of components that have similar impact on the system when a failure has occurred. In the expert panel's discussion, review of dominant failure modes is also considered in order to reflect industry operating experience. DCD_17.04-59

17.4.7.2 Expert Panel

An EP, consisting of at least one person with design engineering experience, at least one person with PRA experience, at least one person with operations and maintenance experience, and at least one person with quality assurance experience, is responsible for the final selection of the SSCs included in the D-RAP. Industry operating experience and use of the Expert Panel are used as the part of deterministic approach and other processes, and engineering judgment are employed in considering the addition of SSCs to the D-RAP. The level of education and experience of voting member of the RAP EP is defined in the Expert Panel Implementing Procedure for US-APWR Reliability Assurance Program as follows:

- For a person who has a science or technical/engineering degree, more than 10 years of experience in the specific area of Nuclear Power Plant, such as design, or identical experience, is required.

- For a person who does not have a science or technical/engineering degree, more than 15 years of experience in the specific area of Nuclear Power Plant, such as design, or identical experience, is required.

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Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-60

Reference 17.4-8 in DCD Section 17.4.10, Revision 3, refers to Revision 2 of MUAP-07030-P.

The staff requests that the applicant clarify whether this reference should be Revision 2 or 3, and update DCD Section 17.4.10 as appropriate.

ANSWER:

MUAP-07030 “US-APWR Probabilistic Risk Assessment” Revision 3 is the latest issue of the US-APWR PRA. The revision number and publish date in Section 17.4-10 shall be revised in accordingly in the next DCD revision.

<u>Impact on DCD</u>

Reference 17.4-8 will be revised, as depicted in the attached markup.

<u>Impact on R-COLA</u>

There is no impact on R-COLA from this RAI.

<u>Impact on S-COLA</u>

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical/Technical Report

There is no impact on Topical and Technical Reports from this RAI.

Generating Stations, IEEE Std. 500, Appendix D, Institute of Electrical and Electronics Engineers, New York, NY, 1984.

17.4-7 Analysis of Core Damage Frequency: Internal Events Methodology, NUREG/CR-4550 Volume 1, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, DC, January 1990.

17.4-8 US-APWR Probabilistic Risk Assessment, MUAP-07030-P Rev. ~~2~~3 (Proprietary), Mitsubishi Heavy Industries, ~~December 2009~~June 2011. DCD_17.04-60

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-61

DCD Section 17.4.7.3, Revision 3, states:

> "Boundary for the RAP SSCs is applicable to components and that for system or structure represents itself."

The following text in the above statement is unclear: "and that for system or structure represents itself." This text can be interpreted to mean that the boundaries of the systems and structures are defined by the appropriate sections of the DCD.

The staff requests that the applicant clarify in DCD Section 17.4.7.3 the above statement.

ANSWER:

MHI will clarify the aforementioned statement by revising DCD Section 17.4.7.3.

Impact on DCD

DCD Section 17.4.7.3 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

17.4.7.3 Phase I D-RAP Implementation and SSCs included

The implementation of the Phase I D-RAP is the responsibility of MHI as it applies to the reactor design process. The SSCs included in this phase are listed in Table 17.4-1. The boundary for the SSCs listed ~~in the table can be identified~~Table 17.4-1 is defined as follows: DCD_17.04-61

1. ~~Boundary for the RAP SSCs is applicable to components and that for system or structure represents itself.~~The boundary for a given RAP SSC encompasses only the components and/or structure from that particular SSC and does not include any supporting or backup SSCs. DCD_17.04-61

2. ~~The boundary for the components modeled in the PRA is basically referred from US-APWR PRA technical report (Ref. 17.4-8), which is based on the general failure data.~~System and structure boundaries are evaluated consistent with the system and structure definitions in the corresponding sections of the DCD. Components boundaries are evaluated consistent with the definitions used to establish the component failure data applied in the PRA model (Ref. 17.4-8).

The phase I activities shall include a review of Key Insights and Assumptions listed in DCD Table 19.1-119. DCD_17.04-65

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-62

In accordance with Acceptance Criteria A.2.c in interim staff guidance DC/COL-ISG-018 (ADAMS Accession Number ML103010113), D-RAP activities should be prescribed by detailed procedures or instructions to direct the performance of these activities. DCD Section 17.4.4, Revision 3, Part c (Procedures and Instructions), states: “General Manager, US-APWR project or his designated representative has prepared the procedures and instructions used in implementation of the D-RAP.” DCD Section 17.4.7.2, Revision 3, states: “The level of education and experience of voting member of the RAP EP is defined in the Expert Panel Implementing Procedure for US-APWR Reliability Assurance Program.

The staff requests that the applicant submit a copy of these procedures for the staff’s review. Alternatively, the applicant can provide an overview of these procedures (including a description of the key elements of the procedures).

ANSWER:

Requirements for implementing the activities associated with the essential elements of D-RAP are defined in four D-RAP specific procedures in addition to the procedures commonly used for US-APWR design activities (including the QAPD and procedures used for design change control). The following procedures are specific to D-RAP:

- UES-UAP-20120001, "US-APWR, Procedure for Reliability Assurance Program (RAP)".
  This document outlines the methods and criteria for evaluation/identification of risk-significant SSCs, creation of draft of risk-significant SSCs list for D-RAP, Expert Panel (EP),

the issuance of list of risk-significant SSCs for D-RAP, incorporation in design, confirmation of assumed conditions, and QA records.

- 5AB61-190, "Procedures for Expert Panel Meeting for US-APWR Design Reliability Assurance Program (D-RAP)."
  This document provides information for general provisions such as EP meeting procedures, scope of EP meeting, EP composition, EP meeting chair, EP coordinator appointment, EP expert certification and revocation, and EP member prerequisites. The document also has provisions for EP meetings such as meeting procedures, proceedings, resolutions, and recording and keeping of minutes.

- 5AB61-191, "Roles of the Reactor Safety Engineering Department in the US-APWR Design Reliability Assurance Program (D-RAP)".
  This document provides information of the roles of the Reactor Safety Engineering Department ("RSED") regarding D-RAP activities for US-APWR described in UES-UAP-20120001, "US-APWR, Procedure for Reliability Assurance Program (RAP)."

- 5AB61-192, "Procedures for Evaluating SSCs for the Purpose of Selecting Risk-Significant SSCs Regarding the US-APWR Design Reliability Assurance Program (D-RAP)".
  This document provides information for selecting candidate risk-significant SSCs using PRA importance analysis and selecting candidate risk-significant SSCs using methods other than PRA importance analysis. Furthermore, this document also provides information for evaluating SSCs to select risk-significant SSCs using safety classification SSCs list based on the deterministic approach.

The key elements of the D-RAP activities are described in these procedures. An overview of the key elements, with references to the appropriate procedures, is provided below. Information is presented consistent with the format used in ISG-018 Sections A.2 through A.4, which encompass the relevant procedures.

A.2.a) Organization

- Responsible Organizations

Responsible organizations for implementing D-RAP activities are described in UES-UAP-20120001. Organizations supporting the D-RAP activities and their responsibilities are defined in Section 3.0 "Responsibility of Each Organization".

- Organizational Interfaces

The involvement of organizations in the expert panel to ensure that the integrated decision resulting from risk insights and deterministic methods are incorporated into the D-RAP activity is described in Section 5.3 "Expert Panel (EP)". Notification of the changes in the D-RAP SSC list to the organizations that develop, coordinate, or implement D-RAP activities is prescribed in Section 5.4 "Issuance of List of Risk-Significant SSCs for D-RAP". Implementation of the D-RAP activity in organizations involved with the design is defined in Section 5.5 "Incorporation in Design".

A.2.b) Design Control

Notification of Plant Changes Affecting D-RAP

Design change control is performed in accordance with UES-20080024, "Quality Assurance Program Manual (US-APWR Project Addenda)," Section 1 "Order Entry and Design Control". When implementing a design change, the design change information will be distributed to relevant organizations associated with design and PRA, and an impact assessment of the change will be performed and reported. The organization(s) involved in design activities of the D-RAP SSCs will be notified of the design change through this process. The PRA organization will be notified of the design change and the impact on the PRA and risk insights prior to the implementation of the design change.

- Updating D-RAP inputs

If the design change has a significant impact on the PRA and/or the risk insights, the D-RAP SSCs will be reviewed in accordance with 5AB61-191, Section 6.3 "Reviewing Risk-Significant SSCs". 5AB61-191 prescribes that the D-RAP SSCs shall be reviewed whenever significant changes are made to the PRA or when changes to risk insights have been identified.

- Notification of Changes to D-RAP Inputs

Interface with the design organization during the design control process is prescribed in UES-UAP-20120001, Section 3.0 "Responsibility of Each Organization".

- Quality Controls

Quality controls are governed in accordance with quality assurance procedure UES-20080024. The quality controls of PRA inputs are described in DCD Subsection 19.1.2.

- Configuration Control

Procedure UES-UAP-20120001, Section 5.4 "Issuance of List of Risk-Significant SSCs for D-RAP" requires that the Reactor Safety Engineering Department issue and distribute the RAP SSC list to the design organizations. Section 5.5, "Incorporation in Design", prescribes that the design organization shall utilize and control the RAP SSC list as a design input in the design process.

A.2.c) Procedures and Instructions

Procedures and instructions are as described in this response.

A.2.d) Corrective Action

Corrective actions in the D-RAP activities will be performed in accordance with UES-20080024, "Quality Assurance Program Manual (US-APWR Project Addenda)", Section 18 "Corrective Action, Preventative Action and Lessons Learned".

A.2.e) Records

UES-UAP-20120001, Section 5.7 "QA Records", prescribes that the D-RAP SSC list and the minutes and summaries of the Expert Panel meeting shall be maintained as QA records.

5AB61-190, Section 7.4 "Recording and Keeping of Minutes" prescribes Expert Panel meeting minutes and supporting documents shall be maintained as QA records.

Controls for quality assurance records are prescribed in UES-20080024, Section 13 "Control of Quality Assurance Records".

A.2.f) Audits

D-RAP audits will be conducted in accordance with UES-20080024, Section 19 “Internal Audit".

A.3 Methodology

The methodology to identify RAP SSCs is described in UES-UAP-20120001, Section 5.1 "Methods and Criteria for Evaluation /Identification of Risk-Significant SSCs" and in 5AB61-192, "Procedures for Evaluating SSCs for the Purpose of Selecting Risk-Significant SSCs Regarding the US-APWR Design Reliability Assurance Program (D-RAP)". These procedures prescribe the PRA organization to identify the risk important SSCs considering importance measures and risk insights, and provide the information as input to the expert panel for deliberation.

5AB61-190, Section 7 "EP Meeting" requires that the expert panel members shall review the adequacy of the SSCs from various perspectives, including but not limited to PRA, design, construction, and maintenance/operation experience, and quality assurance.

A.4 Expert Panel

- While the roles and responsibilities of the expert panel(s) are provided in 5AB61-190, Section 6.2 "Scope of EP Meeting", the qualification requirements are provided in 5AB61-190, Section 6.6 "EP Expert Prerequisites."

Impact on DCD

There is no impact on DCD from this RAI.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-63

In accordance with Acceptance Criteria A.2.d in interim staff guidance DC/COL-ISG-018 (ADAMS Accession Number ML103010113), the corrective action process applied to D-RAP activities should ensure that any D-RAP activity determined to be in error, failed, deficient, defective, or nonconforming are promptly identified, reported, and corrected. For example, information used to identify the RAP SSCs may be determined to be incorrect, or there may be a failure to communicate a key assumption to the design engineering organization. Therefore, the corrective action process for D-RAP that is described in DCD Section 17.4.4, Revision 3, Part e (Corrective Action), is limiting or restrictive, because it applies to only design documents that address SSC reliability assumptions.

The staff requests that the applicant clarify DCD Section 17.4.4, Part e, to be applicable to all D-RAP activities (e.g., RAP activities determined to be in error, deficient, defective, or nonconforming shall be entered into the corrective action program (CAP) system and addressed appropriately. The CAP utilized to support the QAPD is used to implement the corrective actions related to the RAP).

ANSWER:

MHI will clarify DCD Section 17.4.4, Part e, to state that the CAP is applicable to all D-RAP activities.

<u>Impact on DCD</u>

Section 17.4.4, Part e of the US-APWR DCD will be revised as shown in attached markup.

<u>Impact on R-COLA</u>

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

The risk and reliability organization is also responsible to involve in the design review.

b. Design Control

The list of risk-significant SSCs for the D-RAP as well as the associated risk insights and ~~its~~ key assumptions shall be maintained by the risk and reliability organization. The list and changes thereof shall be approved by the EP and be provided to design engineering and QA staff working on the US-APWR project. DCD_17.04-64

~~The risk and reliability organization shall ensure that the design engineers are provided the list of risk-significant SSCs for the D-RAP and its key assumption. The design engineers shall take into account the list of the risk-significant SSCs for the D-RAP and its key assumptions in their design activities and give some feedback to the risk and reliability organization in order to ensure that the key assumptions are realistic and achievable, if necessary.~~The risk and reliability organization shall ensure that the design engineers are provided the list of risk-significant SSCs for the D-RAP including the associated risk insights and key assumptions listed in DCD Table 19.1-119. The design engineers shall take into account for the list of risk-significant SSCs for the D-RAP as well as the risk insights and key assumptions in their design activities. Based on this information, design engineers shall provide feedback to the risk and reliability organization in order to ensure that the risk insights and key assumptions are appropriately incorporated into the design, construction, and operational protocol. DCD_17.04-64

c. Procedures and Instructions

General Manager, US-APWR project or his designated representative has prepared the procedures and instructions used in implementation of the D-RAP. General Manager, US-APWR project is responsible for development and verification of implementation of the D-RAP, and for assuring all affected MHI organizations are aware of the D-RAP.

d. Records

Records related to the D-RAP which are required to be maintained include the following:

- List of Risk-Significant SSCs
- EP meeting minutes/summaries
- Other quality assurance program records in accordance with the US-APWR QAPD (Ref. 17.4-2) for design certification.

e. Corrective action

~~Deficiencies identified where design documents address SSC reliability assumptions which are not compatible with the reliability assumptions of the PRA, or are not achievable or are unrealistic shall be entered into the corrective action program (CAP) system and addressed appropriately. The CAP utilized to support the QAPD is used to implement the corrective actions related to the RAP.~~RAP activities determined to be in error, deficient, defective, or nonconforming shall be entered into the corrective action program (CAP) system and addressed appropriately. The CAP utilized to support the QAPD is used to implement the corrective actions related to the RAP. DCD_17.04-63

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Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-64

In accordance with interim staff guidance DC/COL-ISG-018, one purpose of the RAP is to provide reasonable assurance that the plant is designed, constructed, and operated in a manner that is consistent with the "risk insights" and "key assumptions" from the probabilistic, deterministic, and other methods of analysis used to identify and quantify risk. [From ASME/ANS RA-Sa–2009, a "key assumption" is a decision or judgment that is made in the development of the PRA model that may influence (i.e., have the potential to change) the decision being made.] "Key assumptions" can include both "reliability assumptions" and other PRA assumptions that are not solely based on numerical reliability values (e.g., the following is a key assumption that is not based on numerical reliability values and should be identified by the risk and reliability organization and reviewed by the design engineering organization: room temperature will not exceed the limits of the safety injection pumps during its mission time given room cooling is unavailable). However, throughout DCD Section 17.4, Revision 3, (e.g., Sections 17.4.2, 17.4.3, and 17.4.4) the terms "reliability assumptions" and "assumed equipment reliability" are often used in place of the term "key assumptions." In addition, the term "risk insights" is often omitted from text in DCD Section 17.4. For example, in Section 17.4.4, Part b, the risk and reliability organization should not only maintain and provide the list of risk significant SSCs and key assumptions, but also maintain and provide the risk insights. The design engineering group should review the key assumptions and take into consideration the risk insights.

Based on the above comments, the staff requests that the applicant update DCD Section 17.4 to ensure consistent use of the terms "key assumptions" and "risk insights."

ANSWER:

MHI will revise DCD Tier 1 section 2.13, Tier 2 sections 14.3 and 17.4.2 through 17.4.5 so as to refer to *risk insights* and *key assumptions* consistently.

Impact on DCD

DCD Tier 1 Section 2.13, Tier 2 Sections 14.3 and 17.4.2 through 17.4.5 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

2.13 DESIGN RELIABILITY ASSURANCE PROGRAM

2.13.1 Design Description

The purpose of the US-APWR design reliability assurance program (D-RAP) is to provide reasonable assurance that:

- The US-APWR is designed and constructed in a manner that is consistent with the key assumptions and risk insights for the risk-significant structures, systems, and components (SSCs). DCD_17.04-64
- The risk-significant SSCs function reliably when challenged.

The risk-significant SSCs including both safety-related and non safety-related SSCs are identified for inclusion in the D-RAP using the results of the probabilistic risk assessment (PRA), an expert panel, deterministic methods, or using other methods.

1. For structures, systems, and components within the scope of the reliability assurance program (RAP SSCs), the design is consistent with risk insights and key assumptions from probabilistic, deterministic, and other methods of analysis used to identify and quantify risk.

2.13.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.13-1 describes the ITAAC for the D-RAP.

- The amount of information depicted is based on the safety significance of the SSCs, with figures for non safety-related systems having less detail than figures for safety-related systems
- The figures show components discussed in the design description
- The figures clearly delineate system boundaries with other systems
- Symbols used on the figures are similar to those used for Tier 2 figures, with any symbols unique to Tier 1 being consistent with industry practice or NRC usage

The Tier 1 introductory material includes a legend for the symbols used, as noted previously.

14.3.3.5 Safety Analyses and Probabilistic Risk Assessment Risk Insights and Key Assumptions DCD_17.04-64

The top-level requirements included in Tier 1 are selected based on risk insights regarding the safety significance of the SSCs, their importance in safety analyses, and their functions with respect to defense-in-depth considerations. Among the selection factors considered are the following:

- The presence of features or functions necessary to satisfy the NRC's regulations in 10 CFR 20 (Reference 14.3-19), 10 CFR 50 (Reference 14.3-20), 10 CFR 52 (Reference 14.3-21), 10 CFR 73 (Reference 14.3-22), or 10 CFR 100 (Reference 14.3-23)
- Whether the SSC is safety-related
- Whether the SSC includes one or more severe accident design features
- Whether there are ~~important~~risk insights ~~or~~and key assumptions from the probabilistic risk assessment (PRA) related to the SSC DCD_17.04-64
- Relevant operating experience, including that documented in unresolved safety issues, generic safety issues, and TMI items, as well as that documented in NRC generic correspondence such as bulletins, circulars, and generic letters
- ~~Assumptions and insights~~Risk insights and key assumptions from key safety and integrated plant safety analyses in Tier 2, where plant performance is dependent on contributions from multiple systems of the design; DCD_17.04-64

The guidance of RG 1.206 and individual SRP14.3 subsections cover the above selection criteria so that the significant parameters are addressed in the US-APWR Tier1. Tables 14.3-1a through 14.3-1f in this section summarizes information particularly significant to selection of top-level requirements for Tier 1. They cross reference the important design information and parameters used in key safety and integrated plant safety analyses to their treatment in Tier 1, and are divided into the following categories:

Table 14.3-1a Design Basis Accident Analysis Key Design Features

Table 14.3-1b Internal and External Hazards Analysis Key Design Features

Table 14.3-1c Fire Protection Key Design Features

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features

Table 14.3-1e ATWS Key Design Features

Table 14.3-1f Radiological Analysis Key design features

The information in these tables is sufficiently detailed to assist a COL Applicant or licensee in determining whether a proposed design change impacts the treatment of these parameters in Tier 1. These tables, especially Table 14.3-1d, also contain ~~key~~risk insights and key assumptions identified through the PRA (i.e. major risk significant SSCs). DCD_17.04-64

Certain design features included in the tables for their importance to DBA analysis, hazards analysis, fire protection, ATWS or radiological analysis, are also identified as features considered in severe accident prevention or mitigation, or PRA insights. These features are presented in the appropriate tables, with reference to the Chapter 19 information for PRA (Section 19.1) or severe accident (Section 19.2) information. These key designs features are derived from appropriate Tier 2 chapters such as Chapters 2 through 10, 15, 16 and 19.

Because Tables 14.3-1a through 14.3-1f provide DCD Tier 1 to Tier 2 cross-references, their focus is on design features. Programmatic, operational aspects of the SSCs, such as system lineup during normal operation or maintenance requirements, are generally not the subject of Tier 1 information and are likewise excluded from Table 14.3-1a through 14.3-1f.

14.3.3.6 Consistency in Design Description Style

Consistency in style in design descriptions and the associated tables and figures is important and the following general guidelines are followed:

- Standard terminology as used in NRC RGs and the NUREG-0800 SRPs is used, consistent with Tier 2 terminology, and new terminology is avoided
- The term "associated" is generally not used to avoid possible confusion with the use of this term in control systems, where it has a particular meaning
- The present tense is consistently used, rather than the future tense
- The term "division" is consistently used instead of train
- Systems are described as safety-related (including Class 1E) or non safety-related (including non-Class 1E), instead of as essential and non-essential in general

ITAAC are also provided for documentation of a high-quality software design process consistent with each of the management, implementation, and resource characteristics shown in branch technical position (BTP) 7-14, "Guidance on Software Reviews for Digital Computer-Based Instrumentation and Controls Systems," (Ref 14.3-28) in SRP Chapter 7 (Ref 14.3-29).

Conformance of the I&C systems' design to criteria in IEEE 603-1991, with cross references to applicable Tier 1 information including ITAAC, is provided in Table 14.3-8.

Design descriptions for I&C equipment follow guidelines of Appendix C.II.1-A of RG 1.206 (Reference 14.3-1) and address the following matters:

- Hardware architecture, describing all hardware modules, cabinet layout and wiring, seismic and environmental control requirements, and power sources
- Software architecture, describing design specifications, code listings, and build documents and providing installation configuration tables
- RGs that have specific recommendations
- Operating experience, including safety-significant problems identified by NRC
- Policy issues raised for the standard designs
- New design features, such as communications between various portions of the digital system or other systems
- Any risk insights ~~or~~and key assumptions identified through the PRA (Table 14.3-1) DCD_17.04-64
- Generic safety issue resolutions that have resulted in design/operational features
- Post-TMI requirements such as post-accident monitoring

NRC style guidelines for I&C systems ITAAC in Appendix C.II.1-A of RG 1.206 (Reference 14.3-1) are also followed.

The systems specified in Table 14.3-4 are addressed in the Tier 1.

14.3.4.6 ITAAC for Electrical Systems

Section 2.6 of Tier 1, which addresses electrical systems, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 14.3.6 (Reference 14.3-10). ITAAC are provided for the entire station electrical system, including Class 1E portions of the system, the offsite power system (including site-specific interfaces addressed in Tier 1 Chapter 3), equipment qualification, major portions of the non-Class 1E system, and portions of the plant lighting, grounding, lighting systems, and containment electrical penetrations. ITAAC for electrical systems and equipment verify the following:

Design descriptions also address additional relevant factors related to the electrical equipment that are not part of the Class 1E system, but are included to improve the reliability of the individual Class 1E divisions. Brief design descriptions are included for the non-Class 1E portions of the electrical system that power the balance of plant loads; these generally focus on the aspects needed to support the Class 1E portion.

Consistent with these criteria, the electrical system design descriptions address the following equipment:

- The overall Class 1E electric distribution system
- Power sources
- Other electrical features, such as containment electrical penetrations and cable ampacity and derating criteria
- Lightning protection, which involves a general configuration type check
- Grounding, which also involves a configuration type check
- Lighting for the main control room and remote shutdown console room
- Requirements specified by GDC 17, "Electric Power Systems," and GDC 18, "Inspection and Testing of Electric Power Systems"
- Other specific rules and regulations that are applicable to electrical systems, such as the SBO rule (10 CFR 50.63 (Reference 14.3-30))
- RGs that have specific recommendations
- Safety-significant operating experience problems that have been identified, particularly through electrical distribution system functional inspections, generic letters, circulars, regulatory issue summaries, NRC bulletins, and in some cases, information notices
- Policy issues raised for the standard designs
- New features in the design significant enough to warrant Tier 1 treatment
- Risk Iinsights orand key assumptions from the PRA, which typically involves SBO, which should already receive treatment in ITAAC because of consideration given to SBO as indicated previously DCD_17.04-64
- Severe accident features added to the design
- Post-TMI requirements such as power to the power-operated relief valves, block valves, and pressurizer heaters

System tests of physical protection systems and related design features are performed as acceptance tests under the US-APWR Test Program Description, MUAP-08009 (Reference 14.3-39). Tests of installed physical security hardware to verify proper installation and functionality of security hardware components are performed as construction acceptance tests and installation tests as specified in MUAP-08009 (Reference 14.3-39). The organization, processes and controls for system acceptance tests, construction acceptance tests, and installation tests are as specified by MUAP-08009 (Reference 14.3-39). Descriptions of the specific inspections, tests and analyses for US-APWR physical protection systems provided in Table 2.12-1 of Tier 1 of the DCD are specified in “US-APWR Physical Security Hardware ITAAC Abstracts, “MUAP-10003”(Reference 14.3-40)

The COL Applicant provides ITAAC for the facility’s physical security hardware not addressed in the DCD, in accordance with RG 1.206 (Reference 14.3-1) as appropriate, and provides abstracts describing the specific inspections, tests and analyses for the facility’s physical security hardware ITAAC not addressed in the DCD.

14.3.4.13 ITAAC for the Design Reliability Assurance Program

Section 2.13 of Tier 1, which covers the design reliability assurance program, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 17.4 (Reference 14.3-36).

Section 17.4 describes the design reliability assurance program, which is developed in accordance with guidance in NUREG-0800, SRP 17.4 (Ref 14.3-36). The purposes of this program are to provide reasonable assurance that: (1) the US-APWR is designed and constructed in a manner that is consistent with the ~~assumptions and~~ risk insights and key assumptions for the SSCs and (2) the risk-significant SSCs function reliably when challenged. An additional goal is to facilitate communication among the PRA, the design, and the ultimate COL activity to assure that the design is consistent and integrated with the procurement process. To this end, Table 17.4-1 identifies risk-significant SSCs for the US-APWR design. DCD_17.04-64

Section 2.13 of Tier 1 contains a brief summary of the design reliability assurance program based on details provided in Section 17.4. The risk significant SSCs will be identified by introducing site-specific information to the list shown in Table 17.4-1. A single ITAAC is provided to verify that that the design reliability assurance program provides reasonable assurance that the designs of these SSCs are consistent with the risk insights and key assumptions used in the associated risk analyses. DCD_17.04-64

14.3.4.14 ITAAC for the Initial Test Program

Section 2.14 of Tier 1, which addresses the initial test program, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 14.2 (Reference 14.3-37).

Section 14.2 describes the initial test program for the US-APWR plant, which is developed in accordance with guidance in RG 1.68 (Reference 14.3-38), RG 1.206 (Reference 14.3-1) and SRP 14.2 (Reference 14.3-37). Some of the activities associated with the initial test program occur as a part of the initial plant startup.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 6 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.11.1.1 Table 2.11.1-2 ITAAC #6	The geometry of the reactor cavity is designed to assure adequate core debris coolability. Sufficient reactor cavity floor area and appropriate reactor cavity depth are provided to enhance spreading debris bed for better coolability to support severe accident mitigation.	19.1.3.2 Table 19.1-119 19.2.3.3.3
2.11.1.1 Table 2.11.1-2 ITAAC #7	There is a liner-plate-covering concrete as the floor surface of the reactor cavity, which supports severe accident mitigation by protecting against short-term attack by relocated core debris.	Table 19.1-119 19.2.3.3.3
2.11.2.1 Table 2.11.2-2 ITAAC #14	Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.	8.3.1.1.5 Table 8.3.1-10 Table 19.1-1 Table 19.1-119
2.11.4.1 Table 2.11.4-1 ITAAC #1, #3, #4, #5, #6	The CHS includes 1. a single hydrogen monitor located outside of containment that measures hydrogen concentration in containment air extracted from the containment. 2. 20 igniters installed inside the containment, designed to burn hydrogen continuously to maintain hydrogen concentration below the low limit of global burn (approximately 10% hydrogen in air), thereby preventing further hydrogen accumulation that could become a threat to containment integrity. 3. The igniters start upon receipt of an ECCS actuation signal and are powered by two non-class 1E buses with non-class 1E GTGs.	6.2.5 Figure 6.2.5-1 19.1.3.2 19.2.3 Table 19.1-119
2.13 Table 2.13-1 ITAAC #1	US-APWR design reliability assurance program provides reasonable assurance that: 1) the US-APWR is designed and constructed in a manner that is consistent with the ~~assumptions and~~ risk insights and key assumptions for the SSCs and 2) the SSCs function reliably when challenged.	17.4 Table 17.4-1

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

DCD_17.04-64

17.4 Reliability Assurance Program

This section presents the US-APWR reliability assurance program (RAP).

17.4.1 New Section 17.4 in the Standard Review Plan

As noted in Item E of SECY 95-132 (Ref. 17.4-1), an applicant for design certification should establish the scope, purpose, objective, and essential elements of an effective DRAP and would implement those portions of the D-RAP that apply to design certification. A COL Applicant is responsible for augmenting and completing the remainder of the DRAP to include any site-specific design information and identify the risk-significant SSCs. Once the site-specific D-RAP is established and the risk-significant SSCs are identified, the procurement, fabrication, construction, and preoperational testing can be implemented in accordance with the COL holder's D-RAP or other programs and would be verified using the inspections, test, analyses and acceptance criteria (ITAAC) process.

17.4.2 Introduction

The purposes of the US-APWR RAP are to provide reasonable assurance that: 1) the US-APWR is designed, constructed, and operated in a manner that is consistent with the key assumptions and risk insights for the risk-significant SSCs, 2) the risk-significant SSCs do not degrade to an unacceptable level during plant operations, 3) the frequency of transients that challenge risk-significant SSCs is minimized, and 4) the risk-significant SSCs function reliably when challenged. An additional goal is to facilitate communication between the probabilistic risk assessment (PRA), the design, and the ultimate COL activity. DCD_17.04-64

The PRA evaluates the US-APWR design response to a spectrum of initiating events to ensure that plant damage has a very low probability and that risk to the public is minimized. The risk-significant SSCs including both safety-related and non safety-related SSCs for the US-APWR design control document (DCD) are identified and made available to the design organization.

The US-APWR D-RAP process is implemented in several phases. Phase I, the Design Certification phase, collects system information and develops a system model. This system information and model is used as input to the design phase PRA, an operating experience review, and a review for external events. The goal of the RAP during this stage is to ensure that the reactor design meets the purposes above, through the design, procurement, fabrication, construction and preoperational testing activities and programs. The results of each of these activities are provided to an expert panel (EP) which identifies risk-significant items using probabilistic, deterministic, and other methods for inclusion in the program. Phase II, the site-specific phase, introduces the plant's sitespecific information to the D-RAP process. During Phase II, the site-specific SSCs are combined with the US-APWR design SSCs into a list for the specific plant. Phase III, the last phase of the D-RAP, implements the procurement, fabrication, construction, and preoperational testing. The designer, MHI, is responsible for Phase I of the D-RAP The site-specific list of SSCs is also provided as an input to reliability assurance program during the operations phase (O-RAP), which addresses the specific plant operation and maintenance activities. The objective during this stage is to ensure that the reliability for the SSCs within the scope of the RAP is maintained during plant operations. Phases II and III of the D-RAP and the O-RAP are the responsibility of the COL Applicant. The COL Applicant will specify the policy and implement procedures to address the specific plant operation and maintenance activities associated with the risk-significant SSCs identified by the D-RAP.

The non safety-related RAP SSCs would be subjected to the appropriate QA controls that are described in the Section 17.5 of the US-APWR DCD for the phase I of the D-RAP, and in Section 17.5 of the site specific COL for the phase II and III of the D-RAP.

17.4.3 Scope

The US-APWR D-RAP identifies risk-significant SSCs and ~~provides~~considers risk insights and ~~reliability assumptions for~~key assumptions from the aspect~~s~~ of plant operation, maintenance, and performance monitoring to be addressed to ensure safe, reliable plant operation or mitigate plant transients or other events that could present a risk to the public. The risk-significant SSCs are identified using PRA, deterministic, or other methods of analysis, including industry experience, and EPs. DCD Table 19.1-119 provides a comprehensive list of risk insights and key assumptions applicable to the US-APWR for activities such as Expert Panel D-RAP deliberations. DCD_17.04-64 DCD_17.04-64

17.4.4 Quality Controls

a. Organization

The MHI is responsible for Phase I of the D-RAP.

General Manager, US-APWR project: The General Manager, US-APWR project is overall responsible for the establishment of and implementation of the US-APWR D-RAP. In this regard, the General Manager or his designated representative is responsible to assure all affected organizations are aware of the D-RAP, its purpose, and the requirements herein.

General Manager, Reactor and Plant Safety: The General Manager, Reactor and Plant Safety, is responsible for the use of the PRA results and risk insights for the EP, and for the conduct and coordination of the EP. The Reactor and Plant Safety organization includes the risk and reliability organization.

General Manager, QA: The General Manager, QA is responsible to assure proper implementation of QA program elements. This includes design control, procedures and instructions, records, corrective actions and audits pertaining to the D-RAP.

General Managers, Design Engineering: The General Managers, Design Engineering, are responsible to implement this D-RAP and specifically to assure that the US-APWR is designed consistent with ~~the reliability assumptions and insights of the PRA for~~the risk insights and key assumptions for risk significant SSCs. DCD_17.04-64

The risk and reliability organization is responsible to ask the related design engineering sections to review key assumptions and to feed back their comments to ensure key assumptions are realistic and achievable.

The risk and reliability organization is responsible to provide the RAP related inputs in the design process by participating in the design change process.

The risk and reliability organization is also responsible to involve in the design review.

b. Design Control

The list of risk-significant SSCs for the D-RAP as well as the associated risk insights and ~~its~~ key assumptions shall be maintained by the risk and reliability organization. The list and changes thereof shall be approved by the EP and be provided to design engineering and QA staff working on the US-APWR project. DCD_17.04-64

~~The risk and reliability organization shall ensure that the design engineers are provided the list of risk-significant SSCs for the D-RAP and its key assumption. The design engineers shall take into account the list of the risk-significant SSCs for the D-RAP and its key assumptions in their design activities and give some feedback to the risk and reliability organization in order to ensure that the key assumptions are realistic and achievable, if necessary.~~ The risk and reliability organization shall ensure that the design engineers are provided the list of risk-significant SSCs for the D-RAP including the associated risk insights and key assumptions listed in DCD Table 19.1-119. The design engineers shall take into account for the list of risk-significant SSCs for the D-RAP as well as the risk insights and key assumptions in their design activities. Based on this information, design engineers shall provide feedback to the risk and reliability organization in order to ensure that the risk insights and key assumptions are appropriately incorporated into the design, construction, and operational protocol. DCD_17.04-64

c. Procedures and Instructions

General Manager, US-APWR project or his designated representative has prepared the procedures and instructions used in implementation of the D-RAP. General Manager, US-APWR project is responsible for development and verification of implementation of the D-RAP, and for assuring all affected MHI organizations are aware of the D-RAP.

d. Records

Records related to the D-RAP which are required to be maintained include the following:

- List of Risk-Significant SSCs
- EP meeting minutes/summaries
- Other quality assurance program records in accordance with the US-APWR QAPD (Ref. 17.4-2) for design certification.

e. Corrective action

~~Deficiencies identified where design documents address SSC reliability assumptions which are not compatible with the reliability assumptions of the PRA, or are not achievable or are unrealistic shall be entered into the corrective action program (CAP) system and addressed appropriately. The CAP utilized to support the QAPD is used to implement the corrective actions related to the RAP.~~ RAP activities determined to be in error, deficient, defective, or nonconforming shall be entered into the corrective action program (CAP) system and addressed appropriately. The CAP utilized to support the QAPD is used to implement the corrective actions related to the RAP. DCD_17.04-63

f. Audit

Audit plans shall include for consideration, sampling the effectiveness of implementation of RAP implementation procedure. Audits shall consider several key aspects of the RAP including the identification of risk-significant SSCs, ~~whether design and procurement information is consistent with the risk insights from the PRA, and whether assumed equipment reliability is determined to be practicable or achievable~~process and controls that ensure that the plant will be designed and constructed in a manner that is consistent with the risk insights. DCD_17.04-64

17.4.5 Integration into Existing Operational Programs

The US-APWR D-RAP is a source to other administrative and operational programs. Certain risk-significant SSCs identified in the D-RAP are included in existing operational programs such as the technical specifications surveillance requirements and provide assurance that the reliability values assumed in the PRA will be maintained throughout the plant life. The O-RAP implements the measures that yield the significant improvements in the PRA through the plant's existing programs for maintenance or QA. Implementation of the Maintenance Rule requirements contained in 10 CFR 50.65 (Ref. 17.4-3) is an example of how the plant could address the enhanced treatment of certain SSCs in the O-RAP. Per SECY 95-132, the COL Applicant may meet most of the objectives of the O-RAP via existing programs such as maintenance rule, in-service testing, and QA. The COL Applicant must address non-safety risk-significant SSCs.

17.4.6 Operating Experience

Consideration and use of operating experience is vital to the overall objective of the D-RAP. Operating experience is considered along with various PRA analytical and importance measures when developing a comprehensive risk analysis. The EP considers component operating history and industry operating experience when it can be applied to assessing risk significance. For example, operating experience indicates that motor driven and turbine driven pumps may have different reliability.

The review of operating experience investigates situations where previous failures of components in similar design applications have led to functional failures of SSCs. The review of operating experiences is not limited to hardware failure but also extends to situations where human performance led to functional failures of SSCs of a similar system design. As an example, the US-APWR design improves reliability and eliminates required operator actions to switch over from injection to recirculation typical in conventional PWRs.

17.4.7 D-RAP

As discussed in Section 17.4.2, Phase I of the D-RAP includes the initial identification of SSCs to be included in the program, implementation of the aspects applicable to design efforts, and definition of the scope, requirements, and implementation options to be included in the later phases.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/23/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.:	**NO. 891-6268 REVISION 3**
SRP SECTION:	**17.04 – Reliability Assurance Program (RAP)**
APPLICATION SECTION:	**17.4 Reliability Assurance Program**
DATE OF RAI ISSUE:	**1/17/2012**

QUESTION NO. : 17.04-65

As described in DCD Section 17.4.1, Revision 3, one purpose of the US-APWR RAP is to provide reasonable assurance that the US-APWR is designed, constructed, and operated in a manner that is consistent with the key assumptions and risk insights for the risk-significant SSCs. DCD Table 17.4-1 provides some of these risk insights and key assumptions for the risk-significant SSCs. However, DCD Chapter 19, Revision 3, provides a more comprehensive list of risk insights and key assumptions that DCD Section 17.4 should cross-reference. The staff requests that the applicant provide in DCD Section 17.4 (e.g., Section 17.4.3, Section 17.4.7.3, or Table 17.4-1) a cross reference to the risk insights and key assumptions in DCD Chapter 19.

ANSWER:

MHI will add a reference to Table 19.1-119, Key Insights and Assumptions, in DCD Section 17.4.3.

Impact on DCD

DCD Section 17.4.3 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

17.4.7.3 Phase I D-RAP Implementation and SSCs included

The implementation of the Phase I D-RAP is the responsibility of MHI as it applies to the reactor design process. The SSCs included in this phase are listed in Table 17.4-1. The boundary for the SSCs listed ~~in the table can be identified~~Table 17.4-1 is defined as follows: DCD_17.04-61

1. ~~Boundary for the RAP SSCs is applicable to components and that for system or structure represents itself.~~The boundary for a given RAP SSC encompasses only the components and/or structure from that particular SSC and does not include any supporting or backup SSCs. DCD_17.04-61

2. ~~The boundary for the components modeled in the PRA is basically referred from US-APWR PRA technical report (Ref. 17.4-8), which is based on the general failure data.~~System and structure boundaries are evaluated consistent with the system and structure definitions in the corresponding sections of the DCD. Components boundaries are evaluated consistent with the definitions used to establish the component failure data applied in the PRA model (Ref. 17.4-8).

The phase I activities shall include a review of Key Insights and Assumptions listed in DCD Table 19.1-119. DCD_17.04-65

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/23/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-66

Table 17.4-1 (Risk-Significant SSCs) of the US-APWR DCD, Revision 3, provides the dominant failure modes for each risk-significant SSC. The staff requests that the applicant address the following comments related to the dominant failure modes.

(a) For the following risk-significant SSCs, provide the basis for not including the associated failure modes in DCD Table 17.4-1.

Component ID in DCD Table 17.4-1 Potentially Dominant Failure Mode

SIS-MOV-101A, B, C, D (Item # 3 on page 17.4-7 of DCD): CD, OM

[Note, risk-significant operator action PZROO02PORV-DP3 requires these valves to be closed (see page 9-36 of the US-APWR PRA, MUAP-07030(R3)).]

NCS-MOV-323A(B) and NCS-MOV-326A(B) (Item # 51 on page 17.4-16 of DCD): OD, CM, PR

[Note, risk-significant operator action ACWOO02CT-DP2 requires opening these valves (see page 9-19 of the US-APWR PRA).]

VWS-MOV-401 and VWS-MOV-409 (Item # 2 on page 17.4-29 of DCD): CD, OM, IL

[Note, risk-significant operator action NCCOO02CCW requires closing these valves (see page 9-34 of the US-APWR PRA).]

MSS-TCV-550A,B,C,D,E,F,G,H,J,K,L,M,N,P,Q (Item # 6 on page 17.4-40 of DCD): OD, CM

[Note, risk-significant operator action MFWOO02R requires opening these valves (see page 9-29 of the US-APWR PRA).]

(b) Based on request for additional information (a) above, various dominant failure modes may not have been identified in DCD Table 17.4-1 from the risk-significant operator actions in the US-APWR PRA. Therefore, the applicant should ensure that DCD Table 17.4-1 captures the dominant failure modes from the risk-significant operator actions.

(c) Various seismic failure modes may not have been identified in DCD Table 17.4-1 from the seismic margins analysis (SMA). For example, based on a cursory review of DCD Tables 19.1-54 and 19.1-55, the seismic failure modes for the refueling water storage pit (RWS-MCP-001), essential chilled water pumps (VWS-MPP-001B,C), turbine driven emergency feedwater pump actuation valves (EFS-MOV-103A,D), and feedwater line check valves (EFS-VLV-018A,B,C,D) were not included in DCD Table 17.4-1. Therefore, the applicant should ensure that DCD Table 17.4-1 captures the dominant seismic failure modes from the SMA.

(d) For the following risk-significant SSCs, provide the basis for including the associated failure modes in DCD Table 17.4-1.

<u>Component ID in DCD Table 17.4-1 Failure Mode in DCD Table 17.4-1</u>

NCS-MTK-001B (Item # 44 on page 17.4-16 of DCD) IL, OM

Piping (Item # 49 on page 17.4-16 of DCD) IL

STP1 (2) (Item # 9 on page 17.4-27 of DCD) SO

ANSWER:

a & b)

For SSCs related to risk-significant operator actions, MHI performed systematic search as follows:

1. For SSCs utilized for risk-significant operator actions *that are* modeled in the PRA, the estimated risk importance measures used to determine risk significance are FV importance and RAW. The threshold for determining risk-significance for each SSC is a FV ≥ .005 and/or RAW≥ 2.0.

2. For those SSCs which *are not* explicitly modeled in the PRA, risk importance for a given SSC is determined according to the risk importance measures associated with the operator actions listed in Tables 17.04.66-1 through 17.04.66-3. These tables list risk importance measures for operator actions for Level 1 and Level 2 PRA at-power and low-power shutdown (LPSD). When screening SSCs according to this method, considering that the RAW for an operator failure has the same impact on CDF as a component failure, SSCs having an operator action with a RAW value ≥ 2.0 are considered risk significant. Similarly, the FV importance of the SSC failure can be approximated from the relative contribution of the human error probability *and* the probability of *the SSC failure mode of interest*. If the estimated FV of the SSC failure mode exceeds the risk significance criteria, the SSC failure mode are identified as risk significant.

SSCs cited in Question (a) are evaluated using these criteria, as summarized above:

SIS-MOV-101A, B, C, D

The US-APWR PRA does not explicitly model “failure-to-close” (CD) for these valves. However the importance of this failure mode can be estimated based on the importance of the operator action. Basic events PZROO02PORV, PZROO02PORV-DP2, and PZROO02PORV-DP3 represent unsuccessful operator actions to depressurize the RCS. The cumulative Level 2 FV importance for these events is approximately 2.0E-02. Based on this cumulative FV importance and nominal HEP, 6.2xE-3 for PZROO02PORV (the smallest of the three events per Table 17.04-66.2), the estimated FV importance value for *each* valve (given a probability of 1.0E-3 for CD) is smaller than 3.3xE-3. (Failure probability of “OD” is approximately one-sixth of the HEP so that FV importance of “OD” is also approximately one-sixth of that of the HEP) Because the failure mode CD does not meet the FV criterion for risk significance (≥5E-3), “CD” is not identified as risk-significant.

The spurious open failure mode “OM” is much less probable than that of failure mode “CD” (Table 7.1-2 of MUAP-07030). Therefore spurious open failure mode “OM” is not identified as risk-significant.

If the RAW values for the failure modes CD and OM are assumed equal to that of the RAW values for the human error PZROO02PORV, PZROO02PORV-DP2, and PZROO02PORV-DP3 in this sequence, then the calculated RAW values associated with CD and OM do not exceed 2.0.

In summary, the CD and OM failure modes for these valves will not be added to Table 17.4-1 based on the estimated RAW or FV values.

NCS-MOV-323A, B and -326A, B

Whereas the operator action associated with these valves has a FV of 0.17, each failure mode for these SSC and basic event were also explicitly modeled and the *greatest* SSC FV and RAW values for failure mode OD at power are 4.4E-6 and 1.01 respectively. Similarly, the FV and RAW values OD for CDF and LRF for Fire, Flooding and LPSD modes 4-3 and 8-1 are also below the risk significance threshold. Regarding failure modes CM and PR, there is negligible contribution to risk. Therefore, it is inappropriate to add failure modes OD, CM, and PR in Table 17.4-1.

VWS-MOV-401 and 409

As pointed out in the Q17.04-67(i), MHI has revised the fault tress associated with these particular valves. Accordingly, failure modes CD, IL, and OM will be added to corresponding Table 17.4-1 entry.

MSS-TCV-550

The operator action associated with these valves has a RAW value of 2.5. Closure of these valves is essential to success of this operator action; therefore the RAW value to close and maintain isolation should be approximately the same. The failure modes OD and CM will be added to Table 17.4-1.

The same approach was applied to SSCs related to risk-significant human errors not discussed above and no other risk important failure modes have been identified.

c)

Results of the SMA have been reviewed to identify seismic failure modes that should be identified in DCD Table 17.4-1, in accordance with NEI 00-04, “10 CFR 50.69 SSC Categorization Guideline,” Section 5.3 if they are credited as part of the safe shutdown path. Likewise, although failure of ceramic insulators used in the offsite power system will lead to a loss of offsite power (LOOP) initiating event, they are not essential SSCs for safe shutdown and therefore are not risk significant. Table 17.4-1 will be revised to be consistent with SSCs and their failure modes listed in Table 19.1-54, as shown in attached markups.

d)

Considering the risk significant failure modes “IL” and “OM” are specific to valves, MHI will delete failure mode “OM” for NCS-MTK-001B and failure modes “IL” for NCS-MTK-001B and CCWS Piping, as shown in attached markups. Similarly, considering failure mode SO is specific to circuit breakers, MHI will delete this failure mode for STP1 (2).

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Impact on DCD

DCD Table 17.4-1 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

PRA model for alternate containment cooling will be revised after closure of all RAIs that require PRA model changes.

Impact on Technical/Topical Report

PRA Technical Report, MUAP-07030 “US-APWR Probabilistic Risk Assessment”, will be revised after the PRA model updating.

Table 17.4-1 Risk-significant SSCs (Sheet 1 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
1	**Accumulator injection system**				
1	Discharge line secondary isolation check valves [SIS-VLV-102A (B, C, D)]	RAW(L1, L1-CC, L2-CC) SM	OD, EL, PR, FS	The accumulator provides safety injection function for refill and re-flooding of the reactor vessel following a loss of coolant accident (LOCA). Also provides negative reactivity to shutdown the reactor. Single failure of any SSCs listed here has potential to cause failure of its dedicated train to inject coolant to RCS.	DCD_17.04-66
2	Boundary check valves (Discharge line) [SIS-VLV-103A (B, C, D)]	RAW(L1, L1-CC, L2-CC) SM	OD, EL, PR, FS		DCD_17.04-66
3	Discharge line isolation motor operated valves [SIS-MOV-101A (B, C, D)]	RAW(L1)	EL, PR		
4	Discharge line orifices train A through D [SIS-SRO-006A (B, C, D)]	RAW(L1)	PR		
5	Piping train A through D (Accumulator injection line)	RAW(L1) SM	EL, SS		
6	Accumulators [SIS-MTK-001A (B, C, D)]	EJ SM	SR, SS		

Table 17.4-1 Risk-significant SSCs (Sheet 7 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
3	**Component cooling water system (CCWS)**			
1	CCW pump discharge line check valves [NCS-VLV-016A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2, FR1, FR1-CC, FR2) SM	EL, PR, OD, FS	The component cooling water system (CCWS) transfer heat from plant safety-related components to the essential service water system (ESWS). This system supports various safety and non-safety mitigation systems. Accordingly, reliability of CCWS emergency feedwater system (EFWS) has significant impact on risk. CCWS has four trains, each having a component cooling water pump and a component cooling water heat exchanger. Two trains compose a subsystem, which shares a supply / return header and a surge tank. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause large external leak are risk significant. Since the two trains that compose a subsystem are not physically isolated, large external leak from SSCs that result in loss of inventory is assumed to result in degradation or failure of two trains.
2	Component cooling water pumps [NCS-MPP-001A (B, C, D)]	FV(L1-CC, L2-CC, LP- CC, FL1, FL2, RF2-SUM) RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2-CC, FL2, FR1, FR1-CC, FR2, FR2-CC,) SM	BD, YR, EL, SS, FS	
3	Component cooling water heat exchangers [NCS-MHX-001A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2, FR2-CC) SM	PR, EL, SS	
4	CCW pump discharge cross tie-line motor operated valves [NCS-MOV-020A (B, C, D)]	RAW(L1- CC, L2, L2-CC, LP, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2-CC) SM	CD, EL, OD, FS	
5	CCW pump suction line cross tie-line motor operated valves [NCS-MOV-007A (B, C, D)]	RAW(L1-CC, L2, L2-CC, LP, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2-CC) SM	CD, EL, OD, FS	
6	CCW surge tank outlet manual valves [NCS-VLV-005A (B, C, D)]	EJ RAW(L1,L2, LP, FL1,FL2, FR1, FR2)	PR, EL	
7	CCW pump inlet manual valves [NCS-VLV-008 A (B, C, D)]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	PR, EL	
8	CCW heat exchanger outlet manual valves [NCS-VLV-018 A (B, C D)]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	PR, EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 11 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
43	B-CCW Surge tank vent valves [NCS-RCV-056B]	RAW/(L2)	EL, IL, OM	The "Insights and Assumptions" for these SSCs are described on the previous page.
44	B-Component cooling water surge tank [NCS-MTK-001B]Component cooling water surge tank [NCS-MTK-001A (B)]	RAW/(L2) SM	EL, SS, IL, OM	
45	B-CCW Surge tank safety valve [NCS-SRV-003B]	RAW/(L2)	OM	
46	B-CCW Surge tank nitrogen supply stop bypass valve [NCS-VLV-045B]	RAW/(L2)	EL	
47	Charging pump alternate CCW supply line valves [NCS-MOV-322A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	EL, OD, CM, PR	
48	Charging pump alternate CCW return line valves [NCS-MOV-324A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	CM, EL, OD, PR	
49	Piping (Fire service water tank line Piping, Alternate charging pump cooling suction line piping, Alternate charging pump cooling discharge line piping, CCW surge tank line piping, CCWS train piping, CCWS heater piping)	RAW(L1, L2, LP, FL1) SM	EL, ILSS	
50	FSS - CCWS boundary motor operated valves [NCS-MOV-321A (B)] [NCS-MOV-325A (B)]	FV(LP) RAW(L1, L1-CC, L2, LP)	CM, EL, OD, PR	Large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, external leak from other SSCs degrade the fire protection water supply system but the non-essential chilled water system is still available for alternative component cooling. Therefore these valves are risk-significant SSCs in preventing core damage.
51	CCWS - non-essential chilled water system boundary motor operated valves [NCS-MOV-323A (B)] [NCS-MOV-326A (B)]	RAW(L1, L2, LP)	EL, IL	

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Table 17.4-1 Risk-significant SSCs (Sheet 13 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
7	Containment low volume purge supply containment isolation valves [VCS-AOV-356], [VCS-AOV-357]	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 14 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
6	**Emergency feedwater system (EFWS)**				
1	EFW pit discharge line check valves [EFS-VLV-008A (B)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS	The emergency feedwater system (EFWS) supplies feedwater to the steam generators in order to remove reactor decay heat and RCS residual. This system is required after all initiating events exceeding large and medium LOCA. Accordingly, reliability of EFW system has significant impact on risk. Two trains share one emergency feedwater pit, which has 50% capacity to perform cold shutdown. Large leak from SSCs or failure that result in degradation of water supply from EFW pit will lead to lack of EFW. In this case manual action to supply feedwater from Secondary Demineralizer Water Tank is required. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause large leak or failure that result in degradation of water supply from EFW pit will lead are risk important. If such failure occurs, manual action to supply feedwater from secondary demineralizer water tank will be required.	DCD_17.04-66 DCD_17.04-66
2	Turbine driven emergency feedwater pump actuation valves [EFS-MOV-103A (D)]	FV(FR2) RAW(L1, L1-CC, L2, L2-CC FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC LP SM	CM, EL, OD, PR, FS		DCD_17.04-66 DCD_17.04-66
3	Motor driven emergency feedwater pumps [EFS-MPP-001B (C)]	FV(FL2) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	AD, EL, LR, SR, FS		
4	Turbine driven emergency feedwater pumps [EFS-MPP-001A (D)]	FV(L1, L1-CC, L2, L2- CC, L2-SUM, FL1, FR1, FR1-SUM, FL2 ,FR2, FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC) LP SM	AD, EL, LR, SR, FS		
5	Feedwater line check valves [EFS-VLV-018A (B, C, D)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS		DCD_17.04-66 DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 15 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	EFW pump discharge line check valves [EFS-VLV-012A (B, C, D)]	FV(FR2-CC) RAW(L1, L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Minimum/Full flow line check valves [EFS-VLV-020A (B, C D)] [EFS-VLV-022A (B, C, D)]	RAW(L1, L2, FL1) LP	EL	
8	Minimum/Full flow line manual valves [EFS-VLV-021A (B, C, D)] [EFS-VLV-023A (B, C, D)]	RAW(L1, L2 , FL1, FR1, FR2) LP	EL, IL	
9	Emergency feedwater control valves [EFS-MOV-017A (B, C, D))	FV(FL1-SUM, FR1-SUM, FR2-SUM) RAW(L1, L1-CC, L2, L2- CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC) LP SM	CM, IL, PR. EL, FC, FS	
10	Emergency feedwater isolation valves [EFS-MOV-019A (B, C, D)]	RAW(L1, L2, FL1, FR1, FL2, FR2) SM	CM, PR, EL, FS	
11	Emergency feedwater line orifices [EFS-FE-016 (026, 036, 046)]	RAW (FL1, FR1, FL2, FR2)	PR	
12	Emergency feedwater line tie-line valves [EFS-MOV-014A (B, C, D)]	RAW(L1, L2, L2-CC, FL1, FL2, FR1, FR1-CC, FR2, FR2-CC)	OD, EL	
13	EFW system pipng (EFW pit discharge line piping, EFW pit discharge line tie-line piping, A~D-emergency feedwater line piping, Minimum/Full flow line piping)	RAW(L1, L2, LP, FL1) SM	EL, SS	

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Table 17.4-1 Risk-significant SSCs (Sheet 16 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
14	T/D EFW pump steam supply line piping	RAW(L1,L2, FL1)/LP/SM	EL, SS	The "Insights and Assumptions" for these SSCs are described on the previous page.
15	Emergency feedwater pits [EFS-MPT-001A (B)]	RAW(L1, L2, FL1, FR1, FR2) LP / SM	EL, SS	
16	Minimum/Full flow line manual valves [EFS-VLV-026A (B)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL	
17	EFW pump suction line manual valves [EFS-VLV-009A (B, C, D)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL, PR	
18	EFW pump discharge line manual valves [EFS-VLV-013A (B, C, D)]	RAW(L1, L2, FL1, FR1, FR2) LP	EL, PR	
19	EFW pit discharge line manual valves [EFS-VLV-007A (B)]	FV(FL1, FL2, FR2-SUM) RAW(L1, L2, FL1, FL2, FR1, FR2)	CD, EL, PR	
20	Secondary demineralizer water tank discharge line manual valves [EFS-VLV-006A (B)]	FV(FL1, FL2, FR2-SUM) RAW(L1, L2, FL1, FL2, FR1, FR2) LP	EL, OD,PR	
21	Secondary demineralizer water tank discharge line check valve [EFS-VLV-005]	RAW(L1, L2, FL1)	EL, OD,PR	
22	Secondary demineralizer water tank discharge line manual valve [EFS-VLV-004]	FV(FL1) RAW(FL1, FL2)	EL, OD,PR	
23	Turbine driven pump steam supply line check valves [EFS-VLV-102A (B, C, D)]	SM	FS	
24	Emergency feedwater pump actuation cabinets	SM	FS	
25	Turbine driven EFW pump steam supply line motor-operated valves [EFS-MOV-101A (B, C, D,)]	EJ	CM, EL, PR	
26	EFW outlet flow control valve panels	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 17 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
7	Emergency power source (EPS)				
1	Class 1E 480V motor control centers (MCC) [MCC-A (B, C, D)], [MCC-A1 (D1)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP SM	FF,~~SS~~FS	The EPS consists of four separate trains. Each safety train consists of one 6.9kV AC medium voltage bus and 480V AC low voltage buses (Load Centers, Motor Control Centers). Each AC medium voltage bus connects to class 1E gas turbine generator. This system supports various safety mitigation systems and therefore, reliability of the EPS system has significant impact on risk. Since the EPS consists of four separate trains, single failure in trains not significantly impact risk. However, failure of multiple trains is have significant impact on risk. Accordingly, SSCs that have potential to cause common cause failures among multiple trains are risk significant	DCD_17.04-66
2	Class 1E 480V load centers [LC-A (B, C, D)], [LC-A1 (D1)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP SM	FF,~~SS~~FS		DCD_17.04-66
3	Class 1E 6.9kV switchgears [MC-A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) EJ / LP / SM	FF, ~~SS~~ FS		DCD_17.04-66
4	Class 1E DC switchboards [DCC-A (B, C, D)], [DCC-A1 (D1)]	RAW (L1, L2, LP, FL1, FR1, FL2, FR2) SM	FF, FS		DCD_17.04-66
5	Class 1E AC 120V panelboards [IBD-A (B, C, D)]	RAW(L1, L2, FL1, FR1, FL2, FR2) SM	FF, FS		
6	Circuit breakers between Class 1E 480V load centers A, B (C, D) and A1(D1) [52/LLAA, LLBB, LLDA, LLBA] [52/LLBC, LLAD, LLBD, LLDD]	RAW(L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC)	SO		
7	Class 1E Batteries and racks [BAT-A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC ,FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) LP SM	FF, SO, FS		DCD_17.04-66 DCD_17.04-66
8	Class 1E Battery chargers [BCP-A (B, C, D)]	RAW(FL1) SM	FF, WR, ~~SS~~FS		DCD_17.04-66

Table 17.4-1 Risk-significant SSCs (Sheet 19 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
15	Class 1E gas turbine generators [A (B, C, D)-EGTG]	FV(L1,L1-CC,L1-SUM, L2, L2-CC, L2-SUM, LP, LP-CC, FL1, FL1-SUM, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC,) RAW(L1-CC, L2-CC, LP-CC, FL1-CC, FR1-CC, FL2, FL2-CC, FR2-CC) LP SM	AD, LR, SR, FS	The “Insights and Assumptions” for these SSCs are described on the previous page.

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Table 17.4-1 Risk-significant SSCs (Sheet 20 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
16	Class 1E gas turbines generator sequencers [EPBA (B, C, D)]	FV(L1-CC, L2-CC, L2-SUM, FL2-SUM, FR1, FR1-CC) RAW(L1-CC, L2-CC, LP-CC, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2-CC) LP	FF	The "Insights and Assumptions" for these SSCs are described on the previous page.
17	MOV Inverters [MVIA1, MVIA2, MVIB, MVIC, MVID1, MVID2]	RAW(L1-CC, L2-CC, FL1, FL1-CC, FL2, FL2-CC, FR1-CC, FR2, FR2-CC)/ LP / SM	FF, FS	
18	Main transformers [MT]	RAW(L2, FL1, FL2)	FF	
19	Reserve auxiliary transformer 3 and 4 [RAT3(4)]	RAW(L2, FL1, FL2, PL)	FF	
20	Class 1E station service transformers [STA (B, C, D)]	RAW(L1, L2, PL, FL1, FR1, FL2, FR2) / LP SM	FF, FS	
21	Circuit breakers between AAC and Class 1E 6.9kV switchgear [52/AACA (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC, FR2-CC)	FC, SO	
22	Circuit breakers between Class 1E 480V load center A1 (D1) and MCC A1 (D1) [52/LCA1 (D1)]	RAW(L1, L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1, FR1-CC, FR2, FR2-CC)	SO	
23	Circuit breakers between Class 1E 480V load center and Class 1E station service transformer [52/STLA (B, C, D)]	FV(L2-CC) RAW(L1, L1-CC, L2, L2-CC,LP, LP-CC, FL1, FL1-CC, FL2, FL2-CC, FR1, FR1-CC, FR2, FR2-CC)	SO	
24	Circuit breakers between Class 1E UPS unit and Class 1E AC 120V panelboard [52/UAA (B, C,D)]	RAW(L1-CC, L2-CC, LP-CC, FR1-CC)	SO	

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Table 17.4-1 Risk-significant SSCs (Sheet 21 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions	
25	Circuit breakers between unit auxiliary transformer and Class 1E 6.9 kV switchgear [52/UATA (B, C, D)]	FV(L1-CC, L2-CC, LP-CC, LP-SUM, FL2, FR1-SUM) RAW(L1, L1-CC, L2, L2-CC,LP, LP-CC, FL1, FL1-CC, FR1-CC, FL2, FL2-CC, FR2-CC)	FO,SC	The "Insights and Assumptions" for these SSCs are described on the previous page.	
26	Circuit breakers between Class 1E DC switchboard and Class 1E UPS unit [72/AUA (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FR1-CC)	SO		
27	Circuit breakers between Class 1E battery and Class 1E DC switchboard [72/DBA (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FR1, FR1-CC, FL2, FR2, FR2-CC)	SO		
28	Circuit breakers between Class 1E DC switchboard and DC Switchboard A1 (D1) [72/DDAA (DDBB, DDBC, DDAD)] [72/DDDA (DDBA, DDBD, DDDD)]	RAW(L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR2)	SO		
29	Class 1E UPS Units [IBC-A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL2-CC, FR1-CC, FR2-CC) SM	~~FF~~FS		DCD_17.04-66
30	Class 1E Gas turbine generators control centers	SM	FS~~, SS~~		DCD_17.04-66
31	Class 1E I&C power transformers [IBB-A (B, C, D)]	SM	~~SS~~FS, FF		DCD_17.04-66
32	Cable trays (safety related SSCs)	SM	~~FS~~SS		DCD_17.04-66
33	Switches between Class 1E MOV 480V MCC and MOV inverter	RAW(L2-CC) SM	FF, FS		DCD_17.04-66
34	Breakers between Class 1E 480V MCC and switch	RAW(L2-CC)	SO		
35	Class 1E MOV 480V MCC [MVCA1, MVCA2, MVCB, MVCC, MVCD1, MVCD2]	Raw(L1, L2, FL1, FL2, FR1, FR2) SM	FF, FS		DCD_17.04-66

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
36	Breakers between Class 1E DC switchboard and MOV inverters [DUA1, DUD1]	RAW(L2-CC)	SO	
37	Class 1E gas turbine generator control cabinet	SM	FS	
38	Solenoid distribution panels	SM	FS	
39	Safety logic system cabinet	SM	FS	
40	Reactor protection system cabinets	SM	FS	
41	ESF actuation system cabinet	SM	FS	
42	Safety remote I/O cabinets	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 23 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
8	**Alternative AC power sources (Permanent bus)**			
1	Non-Class 1E gas turbine generators (AAC) [ACC-A(B)]	FV(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1-SUM, FR1, FR1-CC, FR1-SUM, FR2, FR2-CC, FL2) RAW(L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC, FR2-CC, FL2, FL2-CC) LP	AD, SR, LR	Two non-safety buses called "Permanent bus", which is connected to Alternative AC (AAC), which consists of non-class 1E gas turbine generators respectively. Each non-class 1E gas turbine generators is manually connected to two safety medium voltage buses via selector circuit under the occurrence of loss of safety AC power. The AAC is a countermeasure against station blackout events. SSCs that have potential to cause failures that degrade the availability to supply AAC power to safety medium voltage are risk significant. Systems for the mitigation of core damage accident are connected to permanent bus.
2	P1, P2 Non-Class 1E 480V load center [LC-P1 (P2)]	RAW(L2)	FF	
3	P1, P2 Non-Class 1E 6.9kV switchgears [MC-P1 (P2)]	RAW(L2)	FF	
4	Circuit breakers between P1 (P2) Non-Class 1E 6.9kV switchgear and station service transformer [52/STHP1 (2)]	RAW(L2, L2-CC, FL1, FR1, FR2)	SO, WR	
5	N1, N2 Non-Class 1E batteries [BAT-N1(N2)]	RAW(FR1-CC) LP	FF,	
6	Circuit breakers between Non-class 1E gas turbine generator (AAC) and P1 (P2) Non-Class 1E 6.9kV switchgear [52/AACP1 (2)]	RAW(FR1-CC, FR2-CC) LP	TD	
7	Circuit breakers between Non-Class 1E gas turbine generator (AAC) and selector switch [52/AACAP (52/AACBP)]	RAW(L1-CC, L2, L2-CC, LP, LP-CC, FR1-CC,FR2-CC) LP	FC, SO	
8	Non-Class 1E gas turbine generators (AAC) sequencers [AAS-A (B)]	FV(L2, LP) RAW(L1-CC, L2, L2-CC, LP, LP-CC, FL2, FR1-CC, FR2-CC)	FF	
9	P1, P2 Non-Class 1E station service transformers [STP1 (2)]	RAW(L2, L2-CC) LP	FF~~, SO~~	

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Table 17.4-1 Risk-significant SSCs (Sheet 25 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
9	**Non-essential chilled water system**			
~~1~~	~~Non-essential chilled water system CCWS boundary motor operated valves [VWS-MOV-424] [VWS-MOV-425]~~	~~FV(L2) RAW(L2) LP~~	~~CM, EL, OD, PR~~	In the case of loss of component cooling water events, non-essential chilled water system or fire protection water supply system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection. These SSCs are risk significant because large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, failure of other SSCs of this system affects only the non-essential chilled water system itself.
~~2~~1	Containment fan cooler unit supply line changeover valve [VWS-MOV-401] [VWS-MOV-409]	FV(L2) RAW(L2)	EL,CD,IL,OM	
~~3~~2	Containment fan cooler unit containment isolation valves [VWS-MOV-403] [VWS-MOV-407] [VWS-MOV-422]	FV(L2) RAW(L2)	CM,EL,OD,PR	
~~4~~3	Containment fan cooler unit cooling coil inlet valve [VWS-MOV-411A (B,C,D)]	FV(L2) RAW(L2, L2-CC)	CM, EL, OD, PR	
~~5~~4	CRDM cooling unit cooling coil inlet valve [VWS-MOV-414]	FV(L2) RAW(L2)	CD, EL, IL, OM	
~~6~~5	Containment fan cooler unit line piping	RAW(L2)	EL	
~~7~~6	Containment fan cooler unit outlet air operated valves [VWS-TCV-041A (B), 042A (B)]	RAW(L2)	CM, EL, PR	
~~8~~7	Containment fan cooler unit outlet manual valves [VWS-VLV-412A (B,C,D)]	RAW(L2)	EL, PR	

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Table 17.4-1 Risk-significant SSCs (Sheet 28 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
11	High head safety injection system			
1	Safety injection pump discharge check valves [SIS-VLV-004A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	EL, OD, PR, FS	In the case of LOCA, high head safety injection system injects coolant from refueling water storage pit (RWSP) into the reactor vessel via the Direct Vessel Injection (DVI) line by the safety injection pumps. This system is also essential for bleed and feed operation. Since this system consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains are risk significant. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause loss of RWSP inventory out side the containment due to large external leaks. Loss of RWSP inventory impacts not only all four trains of high head safety injection system but also other systems that use RWSP as water source.
2	Safety injection pump outlet orifices [SIS-FE-062 (063, 064, 065)]	RAW(FL1, FR1)	PR	
3	Minimum flow line orifices [SIS-FE-072 (073, 074, 075)]	RAW(FL1, FR1)	PR	
4	Containment isolation check valves [SIS-VLV-010A (B, C, D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD, EL, PR, FS	
5	Containment isolation motor operated valves [SIS-MOV-011 A(B, C, D)]	RAW(L2, FL1, FR1) FV(FL1)	FF, CM, EL, PR	
6	RV injection line orifices [SIS-SRO-001A (B, C, D)]	RAW(FL1, FR1)	PR	
7	Injection line secondary isolation check valves [SIS-VLV-012A (B,C,D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD,EL,PR,FS	
8	Injection line boundary check valves [SIS-VLV-013A (B,C,D)]	RAW(L1-CC, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2-CC, FR2-CC) SM	OD, EL, PR,FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 30 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[(1)]	Failure Mode[(2)]	Insights and Assumptions
12	**Heating, ventilation, and air conditioning (HVAC) system**			
1	B,C-Emergency feedwater pump room fans [VRS-MFN-401B, C]	FV(FL1, FR2) RAW(FL1, FL1-CC, FR1, FR1-CC, FR2, FR2- CC), LP	AD, LR, SR	EFW M/D pump room fans maintain room temperature when pumps are running. EFW M/D pumps are assumed to be unavailable within the mission time without room cooling due to high room temperature. HVAC systems of other rooms are considered not to be risk significant for the following reasons. - HVAC of emergency gas turbine room Gas turbine units itself has function to intake outer air to remove heat out to atmosphere. Accordingly, HVAC is considered not essential to maintain gas turbine function. - HVAC of ESF room (RHR/CSS pump, SI pump) According to room temperature analysis, room temperature will not exceeds limit of the system during the mission time regardless of availability of HVAC. - HVAC of class1E electric power room (Class 1E I&C, switch gear, battery, battery charger) This system is running during normal operation and continues to run after initiating events. Reliability of normally operating HVAC systems are considered to be high and failure of this system is unlikely to occur during the mission time. - HVAC of EFW T/D pump room Since T/D driven EFW pump room can operate under high room temperature conditions, they are assumed to be available regardless of room cooling during the mission time.
2	B,C-Emergency feedwater pump air handling unit [VRS-MAH-401B, C]	FV(FR1-SUM, FR2) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) SM	AD, LR, SR, FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 36 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[(1)]	Failure Mode[(2)]	Insights and Assumptions
17	**Main feedwater system (MFWS)**			
1	Main feedwater system	FV(L1)	SR	The Main feedwater system is credited as a function to secondary side cooling during general transients, which does not involve loss of main feedwater.
2	Main feedwater isolation check valves [FWS-VLV-511A (B, C, D)]	SM	FS	
3	Main feedwater isolation valves [FWS-SMV-512A (B, C, D)]	SM	FS	
18	**Main steam supply system (MSS)**			
1	Main steam isolation valves [MSS-SMV-515A (B,C,D)]	FV(L1-SUM ,FR1, FR1-CC, FR2-CC) RAW(L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) SM	CD, IL, OM, FS	Main steam isolation valve isolates the ruptured Steam Generator (SG) at the Steam Generator Tube Rupture (SGTR). In case of secondary line break, main steam isolation is required to prevent unlimited steam release. DCD_17.04-66 Main steam line piping is required to be intact to isolate the ruptured SG at SGTR events. DCD_17.04-66
2	Main steam bypass isolation valves [MSS-HCV-565 (575, 585,595)]	FV(FR2) RAW(L2, FR1, FR2)	IL, OM	
3	Main steam line piping	RAW(L1, L2) SM	EL, SS	
4	Main steam line isolation check valves [MSS-VLV-516A(B, C, D)]	RAW(L1, FL1)	CD, IL	

Table 17.4-1 Risk-significant SSCs (Sheet 37 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
5	-Main steam safety valves [MSS-SRV-509A (B, C, D)] [MSS-SRV-510A (B, C, D)] [MSS-SRV-511A (B, C, D)] [MSS-SRV-512A (B, C, D)] [MSS-SRV-513A (B, C, D)] [MSS-SRV-514A (B, C, D)]	RAW(L1, L2)	CD, OM	Main steam safety valves are designed to have different actuation pressure and relieving capacity.
6	A,B,C,D,E,F,G,H,J,K,L,M,N,P,Q-Turbine bypass valves [MSS -TCV-550A(B,C,D,E,F,G,H,J,K, L,M,N, P,Q)]	FV(L1, L2-SUM) RAW(L2)	CD, OD, CM	
7	Main steam relief valve isolation valves [MSS -MOV-507A (B,C,D)]	RAW(L2)	CD	
8	Main steam depressurization valves [MSS -MOV-508A (B,C,D)]	RAW(L2-CC) LP	OD, CD	
9	Main steam relief valves [MSS -PCV-515 (525, 535, 545)]	RAW(L2, L2-CC)	OD, CD	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
21	Containment spray / residual heat removal (CS/RHR) system			
1	Heat exchanger bypass valves [RHS-FCV-021] [RHS-FCV-031]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL, OM	The Containment Spray / Residual Heat Removal (CS/RHR) System consists of four independent trains. The CS/RHR System has the following three functions. a. Containment Spray b. Alternative Core Cooling c. RHR Operation during operating modes 4 , 5 and 6.. Since CS/RHR system consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains are risk significant. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Common cause failure of such system will result in loss of multiple trains. - SSCs that have potential to cause loss of RWSP inventory outside the containment due to large external leaks. Loss of RWSP inventory impacts not only all four trains of CS/RHR system but also other systems that use RWSP as water source.
2	RHR line heat exchanger discharge air operated valves [RHS-HCV-023] [RHS-HCV-033]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL, CM, PR	
3	Pump suction line check valves [RHS-VLV-004A (B, C, D)]	RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1- CC, FL2, FL2-CC, FR2,FR2-CC) SM	EL,OD,PR, FS	
4	RHR line containment isolation check valves [RHS-VLV-022A (B, C, D)]	RAW(LP, LP-CC)	OD,PR	
5	RHR line containment isolation motor operated valves [RHS-MOV-021A (B, C, D)]	RAW(L1, L2, LP, LP-CC, FL1, FR1, FR2)	CM, PR, OD, EL	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
11	CS line containment isolation motor operated valves [CSS-MOV-004A (B, C, D)]	FV(L2-SUM, FR1-CC, FL1, FL1-CC, FL2, FL2-CC, FR2, FR2- CC,) RAW(L1,L1-CC,L2,L2- CC,LP, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	OD, CM, EL, FC, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
12	CS line check valves [CSS-VLV-005A (B, C, D)]	RAW(L1,L1-CC, L2, L2-CC, FL1, FL1-CC, FR1, FR1- CC, FL2, FL2-CC, FR2, FR2-CC) SM	EL, OD, PR, FS	
13	Piping (between RWST and CSS-MOV-001A (B, C, D), between RHS-MOV-034A (D) and CS/RHR Pump, between RHS-VLV-031A (D) and alternate core cooling, RHS-FCV-021 (031) line, between CSS-MOV-001A (B, C, D) and A (B, C, D)- CS/RHR pump, A (B, C, D)--CS/RHR pump line, CS/RHR pump line, alternate core cooling line A (B, C, D) (outside C/V) piping, Containment spray nozzles)	RAW(L1, L2, LP) SM	EL, SS	
14	CS line heat exchanger discharge manual valves [CSS-VLV-002A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
15	Minimum flow line manual valves [RHS-VLV-013A (B, C, D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
16	Minimum flow line orifices [RHS-SRO-001A (B, C, D)]	RAW(LP, FL1, FR1, FL2, FR2)	PR	
17	Minimum flow line orifices [RHS-FE-014 (024, 034, 044)]	RAW(LP, FL1, FR1, FL2, FR2)	PR	
18	CS/RHR - spent fuel pit boundary manual valves (discharge line) [RHS-VLV-031A (D))	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
22	Refueling water storage system (RWS)			
1	Refueling water storage pit (RWSP) sump strainers [SIS-SST-001A (B, C, D)]	FV(L1-CC, L2-CC, LP- CC, FL1-SUM, FL2-CC, FL2, FR2-SUM) RAW (L1, L1-CC, L2, L2-CC, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC, FR2, FR2-CC) SM	PR, SS	The RWSP is the source of borated water for containment spray and safety injection. During LPSD operation, RWSS has the following functions. a. Refill refueling water strage auxiliary tank (RWAT) for RCS injection via charging pumps. b. Refill SFP for gravitational injection to RCS. SSCs that have either of the following characteristics are risk significant. - SSCs that have potential to cause common cause failures among multiple trains. Sump strainers have potential of sump screen, which may occur in multiple trains. - SSCs that have potential to cause resulting loss of RWSP inventory out side the containment due to large external leaks are risk significant, since such failure impacts all systems that use RWSP as water source. SSCs that have potential to cause failure to supply RWSP water to RWAT or SFP during LPSD operation are also considered risk significant.
2	Refueling water storage pit [RWS-MCP-001]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) SM	EL, FS	
3	Refueling water recirculation pump suction line manual valves [RWS-VLV-006A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
4	Refueling water recirculation pump discharge line check valves [RWS-VLV-012A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
5	Refueling water recirculation pump discharge line manual valves [RWS-VLV-013A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
6	RWSP discharge line containment isolation motor operated valves [RWS-MOV-002] [RWS-MOV-004]	RAW(L1, L2, LP, FL1, FR1, FR2) SM	EL, CM, PR, FS	
7	Refueling water recirculation pumps [RWS-MPP-001A (B)]	RAW(L1, L2 ,LP, LP-CC, FL1, FL2, FR1, FR2)	EL, AD, LR, SR	
8	RWSP discharge line manual valve [RWS-VLV-001]	RAW(L1, L2, LP, FL1, FL2, FR1, FR2)	EL, PR	
9	Refueling water recirculation pump suction cross tie line manual valve [RWS-VLV-005]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
10	Refueling water recirculation pump discharge cross tie line manual valve [RWS-VLV-014]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	The "Insights and Assumptions" for these SSCs are described on the previous page.
11	Refueling water storage auxiliary tank [RWS-MTK-002]	RAW(L1, L2, LP)	EL	
12	Refueling water storage auxiliary tank inlet line manual valve [RWS-VLV-052]	RAW(LP)	EL, OD, PR	
13	Refueling water storage auxiliary tank discharge line manual valve [RWS-VLV-101]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
14	Refueling water storage auxiliary tank suction line manual valves [RWS-VLV-021], [RWS-VLV-051]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL,OD,PR	
15	Refueling water storage auxiliary tank line orifice	RAW(LP)	EL	
16	RWSP suction line containment isolation air operated valve [RWS-AOV-022]	LP, SM	EL, CD, OM, FS	
17	RWSP return line check valve [RWS-VLV-023]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) SM	EL, FS	
18	RWSP Return Line Manual Valve [RWS-VLV-024]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL	
19	Piping (between RWSP and RWS-VLV-023 ,between RWSP and RWS-MOV -002, between RWS-MOV-002 and RWS-MOV -004 ,between RWS-MOV -004 and RWSAT ,between RWS-VLV-021 and RWSAT)	RAW(L1, L2, LP, FL1, FR1)	EL	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions	
23	**Reactor trip system (RTS)**				
1	Reactor trip breakers	RAW(L1-CC, L2-CC)	FF	These systems are necessary to provide negative reactivity for plan t trip.	
2	Control rods	FV(L1) RAW(L1,L2, L1-CC, L2-CC)	FS, FR		
3	Control rod drive mechanism	RAW(L1, L2) SM	~~FS~~SS		DCD_17.04-66
4	Fuel assembly (Reactor internals and core assembly)	SM	~~FS~~SS		DCD_17.04-66
24	**Chilled water system (VWS)**				
1	Essential chiller units [VWS-MEQ-001B (C)]	FV(L1, FL1, FR1, FR2, FR2-SUM) RAW(L1-CC, L2-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) LP SM	YR, BD, SS, FS	The safety related water system supplies chilled water to safety related HVAC systems. SSCs that have potential to cause common cause failures among trains B and C are risk significant since such failures results in loss room cooling in M/D EWF pump area. SSCs that compose train A and D are not risk significant because the PRA assumes only the M/D EFW pumps to be dependent on room cooling during the mission time.	
2	Essential chilled water pumps [VWS-MPP-001B (C)]	RAW(L1-CC, FL1, FL1-CC, FR1, FR1-CC, FR2, FR2-CC) LP SM	BD, YR, FS		DCD_17.04-66 DCD_17.04-66
3	Essential chilled water compression tanks [VWS-MTK-001B (C)]	RAW(FL1) SM	~~FS~~SS, EL		DCD_17.04-66
4	HVAC chiller system piping	RAW(FL1) SM	~~FS~~SS, EL		DCD_17.04-66
5	Essential chilled water pump discharge line check valves [VWS-VLV-005B (C)]	RAW(FL1, FR2) EJ SM	OD, EL, PR, FS		DCD_17.04-66 DCD_17.04-66
6	Essential chilled water system orifice [VWS-FE-051, 101]	RAW(FL1, FR2)	PR		

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
7	Essential chilled water system three way valve [VMS-TMV-412 and 422]	RAW(FL1)	CM, EL, PR	
8	Essential chilled water inlet manual valve [VWS-VLV-001B, C]	RAW(FL1)	EL, PR	
9	Essential chilled water system manual valve [VWS-VLV-006B, C]	RAW(FL1)	EL, PR	
10	Emergency Feedwater pump air handling unit manual valve [VWS-VLV-101B, C]	RAW(FL1)	EL, PR	
11	Emergency Feedwater pump air handling bypass line valve [VWS-VLV-102B, C]	RAW(FL1)	EL	
12	Emergency Feedwater pump air handling unit manual valve [VWS-VLV-105B, C)	RAW(FL1)	EL, PR	
13	Ventilation chiller control cabinets	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 47 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
25	**Essential service water system (ESWS)**			
1	EWS pump discharge line check valves [EWS-VLV-502A (B,C,D)]	RAW(L1, L1-CC, L2,L2-CC, LP ,LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FR2, FR2-CC,) SM	EL,PR,OD, FS	The essential service water system (ESWS) transfers heat from the CCW system as Ultimate Heat Sink (UHS). This system supports the CCW system, which supports various safety and non-safety mitigation systems. Accordingly, reliability of CCWS EFW system has significant impact on risk. Since ESWS consists of four independent trains, failure of one train does not have significant impact on risk. However, failures of SSCs that impact multiple trains have risk-significant impact on risk. Accordingly, SSCs that have potential to cause common cause failures among multiple trains are risk significant.
2	Essential service water pumps [EWS-MPP-001A (B,C,D)]	FV(L1-CC, L2-CC, LP-CC, FL1, FR1-CC, FR1-SUM, FL2, FR2, FR2-CC) RAW(L1, L1-CC, L2, L2-CC, LP, LP-CC, FL1, FL1-CC, FR1, FR1-CC, FL2, FL2-CC,FR2, FR2-CC) SM	BD, YR, EL, SS, FS	
3	CCW heat exchanger inlet strainers [EWS-SST-003A (B, C, D)]	FV(FL2) RAW(L1, L2, LP, FL1, FR1, FL2, FR2) LP	PR	
4	Essential service water pump outlet strainers [EWS-SST-001A (B,C,D)] [EWS-SST-002A(B,C,D)]	FV(FL2) RAW(L1, L2, LP, FL1, FR1, FR2, FL2)	PR	
5	Main piping orifices [EWS-FE-034(035, 036, 037)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2) / SM	PR, SS	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	ESW pump discharge line motor operated valves [EWS-MOV-503 A(B,C,D)]	FV(FL2, FR2) RAW(L1, L2, LP, LP-CC, FL1, FR1, FL2, FR2) SM	CM, EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Manual valves in main piping [EWS-VLV-506 A(B,C,D)] [EWS-VLV-507 A(B,C,D)] [EWS-VLV508 A(B,C,D)] [EWS-VLV-509 A(B,C,D)] [EWS-VLV-511 A(B,C,D)] [EWS-VLV-514 A(B,C,D)] [EWS-VLV-517 A(B,C,D)] [EWS-VLV-520 A(B,C,D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
8	Piping [ESW pump discharge line, ~~ESW pump cooling line,~~ CCW Hx cooling line A(B,C,D)]	RAW(L1, L2, LP, FL1) SM	EL, SS	
9	Orifices (between EWS-FE-034 (035, 036, 037) and EWS-VLV-520A (B, C, D)	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	PR	

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#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
10	Essential chiller unit cooling line manual valves [EWS-VLV-701A (B-D)] [EWS-VLV-704A (B-D)]	RAW(L1, L2, FL1) EJ*1	EL, PR	
11	Essential service water intake structure	SM	~~FS~~SS	
12	Essential service water pipe tunnel	SM	~~FS~~SS	
13	Essential chiller unit cooling line orifice [EWS-SRO-003B, C]	RAW(FL1, FR2)	PR	
14	Essential chiller unit cooling line flow mater [EWS-FE-055, 056]	RAW(FL1, FR2)	PR	

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Table 17.4-1 Risk-significant SSCs (Sheet 50 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
26	**Spent fuel pit cooling and purification system (SFPCS)**			
1	RWS - SFP inlet line boundary check valves [SFS-VLV-027]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	Large external leak of valves that form boundary between RWS result in loss of inventory of the RWS system. Accordingly, systems that relies on the RWS as water source is affected by failure of these valves. During RCS is atmospheric pressure at LPSD operation, the spent fuel pit is used as water source of gravitational injection in case loss of decay heat removal function occurs. SSCs associated with gravitational injection line are considered to be risk significant.
2	RWS - SFP inlet line manual valve [SFS-VLV-028]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
3	RWS - SFP demineralizer line boundary manual valves [SFS-VLV-103A (B)]	RAW(L1, L2, LP, FL1, FR1, FR2)	EL	
4	RWS - SFP inlet line manual valves [SFS-VLV-029] [SFS-VLV-015] [SFS-VLV-017]	LP	EL	
5	Spent fuel pit [SFS-MPT-001]	LP / SM	EL, SS	
6	Spent fuel pit strainers	LP	EL	
7	Spent fuel pit discharge line manual valves [SFS-VLV-021A(D)]	LP	EL	
8	Spent fuel pit discharge cross tie-line manual valve [SFS-VLV-022]	LP	EL	
9	Spent fuel pit heat exchangers [SFS-MHX-001A(B)]	SM	~~FS~~SS	DCD_17.04-66
10	Spent fuel pit pumps [SFS-MPP-001A(B)]	SM	SS, FS	
11	Spent fuel pit water cooling system piping	SM	SS	
27	**Remote Shutdown Panel (RSP)**			
1	Remote shutdown console	EJ	FF	In case of Fire event at power some operations are required to be carried out in remote shutdown panel therefore remote shut down panel are considered risk significant.
2	Transfer switches	EJ	FF	The switch can transfer the plant control system from the MCR to remote shutdown console.

Table 17.4-1 Risk-significant SSCs (Sheet 51 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
28	**Buildings**			
1	Reactor building	SM	~~FS~~SS	Considering the secondary effect to Reactor building and Safety power source buildings, Turbine building, Auxiliary building are risk significant.
2	Safety power source	SM	~~FS~~SS	
3	Turbine building	SM	FS	
4	Auxiliary building	SM	FS	
29	**Reactor Coolant System**			
1	Steam generators (including Steam generator tubes) [RCS-MHX-001A (B,C,D)]	SM	~~FS~~SS	SSCs that compose boundary with primary system are risk significant.
2	RCS piping	SM	~~FS~~SS	
3	DVI piping	SM	~~FS~~SS	
4	Reactor coolant pumps [RCS-MPP-001A (B,C,D)]	SM	~~FS~~SS	
5	Reactor vessel [RCS-MTK-001]	SM	~~FS~~SS	
6	RCS instrumentation letdown piping	SM	~~FS~~SS	
7	In-core instrumentation tube	SM	~~FS~~SS	
8	Emergency letdown piping	SM	~~FS~~SS	
30	**Other Equipments**			
1	Flood barriers	SM	FS	The flood barriers that separate the reactor building between east side and west side and between restricted area and non-restricted area are important to safety for the operation of the facility.

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/23/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-67

Table 17.4-1 of the US-APWR DCD, Revision 3, provides the list of risk-significant SSCs. The staff requests that the applicant address the following comments related to the list of risk-significant SSCs.

(a) Condenser water pump VWS-MPP-351A and cooling tower fan VWS-MEQ-371A (see Figure 4.1-21 of the US-APWR PRA (MUAP-07030(R3)) are not considered risk-significant in DCD Table 17.4-1. However, risk-significant operator action ACWOO02CT-DP2 (failure to establish the alternate CCWS by non-essential chilled water system cooling tower) requires starting and running these SSCs (see page 9-19 of the US-APWR PRA). This may suggest that these SSCs are risk-significant.

Provide the basis for not including these SSCs in DCD Table 17.4-1.

(b) Based on request for additional information (a) above, various risk-significant SSCs may not have been identified in DCD Table 17.4-1 from the risk-significant operator actions (e.g., equipment manipulated for risk-significant local operator actions).

Therefore, the applicant should ensure that DCD Table 17.4-1 captures the risk significant SSCs from the risk-significant operator actions.

(c) Chapter 22 of the US-APWR PRA describes the internal flood risk assessment and states:

"Flooding by the ESW system is assumed to be isolated within 15 minutes. If the isolation is failed, flood water released from the ESWS is assumed to be propagated to other areas (including areas in the upper floors) in the east side (or west side) non-restrictive area in the R/B. Flooding from the ESW system is assumed to be detectable using the leak detectors.”

Provide the basis for not including these leak detectors in DCD Table 17.4-1.

(d) Item # 42 on page 17.4-11 of DCD Table 17.4-1 identifies as risk-significant the "CVS charging injection line piping between RWSAT and CVS-VLV-595". However, this is not consistent with the piping defined under basic events CHIPNELPIPE1 (CVS charging injection line piping external leak large) and CHIPNELPIPE2 (CVS piping between RWSAT and CVS pump external leak large), which are considered risk significant based on their risk importance in Tables 18.2-2 and 20.11-4 of the USAPWR PRA, respectively. Clarify in DCD Table 17.4-1 the risk-significant piping for the CVS system.

(e) Item # 4 on page 17.4-31 of DCD Table 17.4-1 identifies the following FSS piping as risk-significant: "from tank to tie line piping" and "from FWT to tie line." However, these two piping segments seem redundant. Clarify in DCD Table 17.4-1 the risk significant piping for the FSS system.

Also, the FSS injection line piping does not appear to be risk-significant based on DCD Table 17.4-1. However, the SSCs on the FSS injection line piping (e.g., FSSVLV-006, FSS-MOV-004, Orifice FSO2) are risk-significant in DCD Table 17.4-1.

Provide the basis for not including the FSS injection line piping in DCD Table 17.4-1.

(f) Item # 44 on page 17.4-16 of DCD Table 17.4-1 identifies NCS-MTK-001B (B component cooling water surge tank) as risk-significant and does not include the A component cooling water surge tank. However, based on DCD Tables 19.1-54 (page 19.1-509) and 19.1-55 (page 19.1-516) for the SMA and using the methodology in DCD Section 17.4.7.1, both the A and B component cooling water surge tanks appear to be risk-significant. Provide the basis for not including the A component cooling water surge tank in DCD Table 17.4-1.

(g) Based on request for additional information (f) above and a cursory review of DCD Tables 19.1-54 and 19.1-55, various risk-significant SSCs may not have been identified in DCD Table 17.4-1 from the SMA (e.g., offsite power system ceramic insulators, battery racks). Therefore, the applicant should ensure that DCD Table 17.4-1 captures the risk-significant SSCs from the SMA.

(h) Item # 49 on page 17.4-16 of DCD Table 17.4-1 identifies the risk-significant piping for the component cooling water system. The staff found the text "CCWS heater piping" in Item # 49 to be unclear (i.e., this may be CCWS header piping). Clarify in DCD Table 17.4-1 the "CCWS heater piping."

(i) Item # 2 on page 17.4-29 of DCD Table 17.4-1 identifies VWS-MOV-401 and VWSMOV-409 as risk-significant with external leakage as their dominant failure mode.

For alternate containment cooling, the text in Section 6A.14.1 (Part b on page 6A.14.1-3) of the US-APWR PRA suggests that both VWS-MOV-401 and VWSMOV-409 need to close to isolate the non-essential chilled water system in order to prevent CCWS pump run out and to maintain heat removal capability. Therefore, isolation failure of the non-essential chilled water system occurs if VWS-MOV-401 **or** VWS-MOV-409 fails to close. However, fault tree event NCC-02-2 in Section 6A.14.1.B (page 6A.14.1.B-3) of the US-APWR PRA suggests that isolation failure of the non-essential chilled water system occurs if VWS-MOV-401 **and** VWS-MOV-409 fail to close. Clarify whether both VWS-MOV-401 and VWS-MOV-409 need to close to isolate the non-essential chilled water system for alternate containment cooling.

Also, clarify whether the gate under fault tree event NCC-02-2 should be an AND gate or an OR gate. The US-APWR PRA and DCD should be updated accordingly.

(j) DCD Section 9.2.1.2.2.1 (ESWPs) states: “The mode of cooling of the ESWP motors is site-specific and will be determined by the COL Applicant.” US-APWR PRA Section 6A.9.1.1 (System Description) states: “ESW pump motor is supported by either air cooling or water cooling, which is chosen by COL Applicant.” The US-APWR PRA model assumes the ESW pump motors are water cooled and provides a simplified system diagram for water cooling of the ESW pump motors. However, DCD Table 17.4-1 assumes the ESW pump motors are air cooled (i.e., identifies the ESW pump room exhaust fans as risk-significant). Since no design-specific information is provided for the ESW pump motor air cooling system, the staff is not able to determine whether the identification of risk-significant SSCs for the ESW pump motor air cooling system in DCD Table 17.4-1 is acceptable. It may be more appropriate, during the design certification phase, not to include in DCD Table 17.4-1 the SSCs associated with ESW pump motor cooling, because the design of this system is site specific and determined by the COL applicant. Alternatively, it would be acceptable to simply specify the risk-significant SSCs of this system at the system level (i.e., specify in DCD Table 17.4-1 the ESW pump motor cooling system). It should be mentioned that Item # 8 on page 17.4-51 of DCD Table 17.4-1 includes the text “ESW pump cooling line,” which may no longer be applicable. The US-APWR DCD should be updated accordingly.

(l) Based on Table 18.3-1 in the US-APWR PRA, containment isolation valves VCS-AOV-356 and 357 appear to be risk-significant (basic event CIACF2AVCDCIV-ALL in Table 18.3-1). Also, these valves appear to be risk-significant based on the SMA (page 19.1-526 of DCD Table 19.1-55). However, these valves do not appear in DCD Table 17.4-1. Provide the basis for not including in DCD Table 17.4-1 these containment isolation valves. Include in your discussion: the associated risk importance measures (e.g., RAWs and FVs), if available, the consideration of risk evaluations that cover the full spectrum of potential events and the range of plant operating modes considered in Chapter 19 of the US-APWR DCD, and the expert panel’s deliberation for not including this SSC in RAP

ANSWER:

The following addresses each aspect of Question 17.04-67:

a)

As per RAI question, as described in Table 17.04.66-1, FV importance of ACWOO02CT-DP2 exceeds 0.005 and would be identified as a risk significant human error. Because these SSCs used in the operator action (condenser water pump VWS-MPP-351A and cooling tower fan VWS-MEQ-371A) have been modeled in the US-APWR PRA, inclusion into Table 17.4-1 was discussed using risk importance measures of not operator actions but these SSCs.

The estimated FV importance and RAW of the SSCs were less than 0.005 and 2.0, respectively. The estimated risk importance measures did not exceed the criterion for risk-significant SSCs. Therefore, SSCs with regard to the operator actions will not be inserted in Table 17.4-1. Refer to Table 18.2-1 in the US-APWR PRA.

b)

Risk significant human errors are identified using risk importance measure, i.e., FV importance and RAW. Human errors having FV importance with greater than or equal 0.005 and/or RAW with greater than or equal 2.0 can be identified as risk significance.

For SSCs regarding to risk significant human error identified by the above, see the response to RAI #891-6268 Question 17.04-66 (a & b).

c)

MHI has identified the Component Cooling Water Pump Room Floor Drain Pit Water Level Sensors as a risk significant SSC in light of their functionality being cited as a key assumption in DCD Rev.3 Ch 19 Table 19.1-119. The sensors will be added to the D-RAP list under the rationale engineering judgment having a failure to operate (FF) failure mode, as depicted in the attached markup.

d)

MHI will revise the description for CVCS Piping, as depicted in the attached markup to clarify the risk significant CVCS piping.

e)

MHI will clarify the entry for FSS Piping by replacing the existing description with the following:

> Piping between the FWT, the FSS-CSS line connection, and the injection line to the reactor cavity.

f)

MHI will add CCW surge tank, NCS-MTK-001A, under the rationale SM having a SS failure mode.

g)

See the response to Q17.4-16(c).

h)

MHI will revise the CCWS item # 49 to read CCWS ~~heater~~ header piping.

i)

See the response to Question 17.04-66 (a & b).

j)

In the response to DCD RAI Question RAI 585-4464, Q09.02.01-32, the ESWP motors are specified as to be air cooled. See the accompanying markup of DCD Rev. 3 Section 9.2.1.2.2.1.

Table 17.4-1 is also developed, in accordance with the EFW pump motor cooling system in DCD Section 9.2.1.2.2.1. On the other hand, PRA assumes that EFW pump motors are water cooled, which is one assumption in used in the PRA.

In addition to the above, MHI will revise DCD Ch 17.04-1 to delete the reference to the *ESW pump cooling line* in description for ESWS risk significant piping.

l)

The basic event corresponding to common cause failure of these valves (i.e., VCS-AOV-356/357) to close has a RAW value of greater than 2.0 for large release risk at power operation. The valves will be added to Table 17.4-1 under the rationale RAW (Level 2 for internal, internal flood and internal fire) having the failure mode CD (failure to close).

Impact on DCD

DCD Tables 17.4-1 will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

The US-APWR PRA will be revised in accordance with the response to Q17.04-67(i).

Impact on Topical/Technical Report

There is no impact on Topical and Technical Reports from this RAI. (See the response to Q17.04-66)

Table 17.4-1 Risk-significant SSCs (Sheet 6 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
42	Piping ~~(CVS charging injection line piping between RWSAT and CVS-VLV-595)~~(Charging pump suction line from volume control tank (VCT) and from RWSAT, CVS charging injection line to RCP seal and to RCS cold leg)	RAW(L1, L2, LP)	EL	

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Table 17.4-1 Risk-significant SSCs (Sheet 11 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[(1)]	Failure Mode[(2)]	Insights and Assumptions
43	B-CCW Surge tank vent valves [NCS-RCV-056B]	RAW/(L2)	EL, IL, OM	The "Insights and Assumptions" for these SSCs are described on the previous page.
44	~~B-Component cooling water surge tank [NCS-MTK-001B]~~Component cooling water surge tank [NCS-MTK-001A (B)]	RAW/(L2) SM	EL, SS~~, IL, OM~~	
45	B-CCW Surge tank safety valve [NCS-SRV-003B]	RAW/(L2)	OM	
46	B-CCW Surge tank nitrogen supply stop bypass valve [NCS-VLV-045B]	RAW/(L2)	EL	
47	Charging pump alternate CCW supply line valves [NCS-MOV-322A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	EL, OD, CM, PR	
48	Charging pump alternate CCW return line valves [NCS-MOV-324A (B)]	FV(LP) RAW/(L1, L1-CC, L2, L2-CC, LP)	CM, EL, OD, PR	
49	Piping (Fire service water tank line Piping, Alternate charging pump cooling suction line piping, Alternate charging pump cooling discharge line piping, CCW surge tank line piping, CCWS train piping, ~~CCWS heater~~ piping)	RAW(L1, L2, LP, FL1) SM	EL, ~~IL~~SS	
50	FSS - CCWS boundary motor operated valves [NCS-MOV-321A (B)] [NCS-MOV-325A (B)]	FV(LP) RAW(L1, L1-CC, L2, LP)	CM, EL, OD, PR	Large external leak from these valves result in loss of alternative component cooling water from both non-essential chilled water system and fire protection water supply system. On the other hand, external leak from other SSCs degrade the fire protection water supply system but the non-essential chilled water system is still available for alternative component cooling. Therefore these valves are risk-significant SSCs in preventing core damage.
51	CCWS - non-essential chilled water system boundary motor operated valves [NCS-MOV-323A (B)] [NCS-MOV-326A (B)]	RAW(L1, L2, LP)	EL, IL	

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Table 17.4-1 Risk-significant SSCs (Sheet 13 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[1]	Failure Mode[2]	Insights and Assumptions
7	Containment low volume purge supply containment isolation valves [VCS-AOV-356], [VCS-AOV-357]	SM	FS	

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Table 17.4-1 Risk-significant SSCs (Sheet 27 of 54)

#	Systems, Structures and Components (SSCs)	Rationale[(1)]	Failure Mode[(2)]	Insights and Assumptions
10	**Fire protection water supply system (FSS)**			
1	FSS pump discharge motor operated valve	FV(L2) RAW(L2)	EL, OD, PR	In the case of core damage accident, fire protection water supply system (FSS) injects water from Raw Water Tank into the reactor cavity via the direct injection line by the fire water pumps. The containment spray system and/or safety injection system perform the reactor cavity flooding through the drain line at loop compartment to prevent core-concrete interaction when the reactor vessel is failed. The FSS performs as alternative function for the reactor cavity flooding. In the case of loss of component cooling water events, FSS or non-essential chilled water system provides alternative component cooling water to charging pumps in order maintain RCP seal water injection.
2	FSS pump discharge flow meter	RAW(L2)	FF, PR	
3	Reactor cavity injection line orifice	RAW(L2)	PR	
4	FSS piping ~~(from tank to tie line piping, from tie line to CSS-VLV-012 piping, from FWT to tie line)~~between the fire suppression water tank, the FSS-CSS line connection, and the injection line to the reactor cavity	RAW(L2)	EL	
5	Fire suppression water tank	RAW(L1, L2)	EL	
6	FSS pump discharge manual valve	RAW(L2, LP)	EL,PR	
7	Motor driven fire suppression pump	EP	BD, YR, EL	
8	Diesel driven fire suppression pump	EP	BD, YR, EL	
9	Reactor cavity injection line motor operated valve [FSS-MOV-004]	EJ	EL, OD, PR	
10	Reactor cavity injection line check valve [FSS-VLV-006]	EJ	EL, OD, PR	
11	Reactor cavity injection line orifice	EJ	PR	

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Table 17.4-1 Risk-significant SSCs (Sheet 35 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
22	Reactor coolant hot leg temperature sensor (Wide range) [RCS-TE-020 (030, 040, 050)]	EJ	FF	These sensors are necessary to perform operator action.
23	Reactor coolant cold leg temperature sensor (Wide range) [RCS-TE-025 (035, 045, 055)]	EJ	FF	
24	Reactor coolant pressure sensor [RCS-PT-020 (030, 040, 050)]	EJ	FF	
25	Pressurizer water level sensor [RCS-LT-061 (062, 063, 064, 065)]	EJ	FF	
26	RCS mid-loop water level sensor (Wide range) [RCS-LT-011]	EJ	FF	
27	Boric acid transfer tank water level transmitter [CVS-LT-116, 118]	EJ	FF	
28	Core exit thermocouples	EJ	FF	
29	Component cooling water pump room floor drain pit water level sensors	EJ	FF	Flooding in the ESWS is isolated within 15 minutes upon room floor drain pit water level a signal from these water level sensors to prevent its sensors propagation to other areas.
16	**Waste management system (WMS)**			
1	Refueling water storage (RWS) system - WMS line boundary check valve [LMS-VLV-037]	RAW(L1, L2, PL, FL1, FR1, FR2)	EL	Large External leak of the boundary check valve results in loss of inventory from the RWS system. Systems that relies on the RWS as water source is affected by this failure mode.

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Table 17.4-1 Risk-significant SSCs (Sheet 48 of 54)

#	Systems, Structures and Components (SSCs)	Rationale(1)	Failure Mode(2)	Insights and Assumptions
6	ESW pump discharge line motor operated valves [EWS-MOV-503 A(B,C,D)]	FV(FL2, FR2) RAW(L1, L2, LP, LP-CC, FL1, FR1, FL2, FR2) SM	CM, EL, OD, PR, FS	The "Insights and Assumptions" for these SSCs are described on the previous page.
7	Manual valves in main piping [EWS-VLV-506 A(B,C,D)] [EWS-VLV-507 A(B,C,D)] [EWS-VLV508 A(B,C,D)] [EWS-VLV-509 A(B,C,D)] [EWS-VLV-511 A(B,C,D)] [EWS-VLV-514 A(B,C,D)] [EWS-VLV-517 A(B,C,D)] [EWS-VLV-520 A(B,C,D)]	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	EL, PR	
8	Piping [ESW pump discharge line, ~~ESW pump cooling line,~~ CCW Hx cooling line A(B,C,D)]	RAW(L1, L2, LP, FL1) SM	EL, SS	
9	Orifices (between EWS-FE-034 (035, 036, 037) and EWS-VLV-520A (B, C, D)	RAW(L1, L2, LP, FL1, FR1, FL2, FR2)	PR	

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

04/23/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 891-6268 REVISION 3**

SRP SECTION: **17.04 – Reliability Assurance Program (RAP)**

APPLICATION SECTION: **17.4 Reliability Assurance Program**

DATE OF RAI ISSUE: **1/17/2012**

QUESTION NO. : 17.04-68

The D-RAP ITAAC described in US-APWR DCD Tier 1, Section 2.13, Revision 3, is consistent with the guidance provided in interim staff guidance DC/COL-ISG-018.

However, the discussion of the D-RAP ITAAC in DCD Tier 2, Section 17.4.8, Revision 3, may not be consistent with DCD Tier 1, Section 2.13, Revision 3. The staff requests that the applicant clarify the discussion of the D-RAP ITAAC in DCD Tier 2, Section 17.4.8.

ANSWER:

MHI will clarify the discussion of the D-RAP ITAAC in DCD Tier 2, Section 17.4.8.

Impact on DCD

The last paragraph and bulleted statements contained therein will be revised as depicted in the attached markup.

Impact on R-COLA

There is no impact on R-COLA from this RAI.

Impact on S-COLA

There is no impact on S-COLA from this RAI.

Impact on PRA

There is no impact on PRA from this RAI.

Impact on Topical / Technical Reports

There is no impact on Topical and Technical Reports from this RAI.

17.4.8 ITAAC for the D-RAP

Tier 1 ITAAC are proposed to verify that the D-RAP provides reasonable assurance that the plant is designed and constructed in a manner that is consistent with the key assumptions and risk insights for risk-significant SSCs. The list of risk-significant SSCs for ITAAC will be prepared by introducing the plant's site-specific information to the list shown in Table 17.4-1 in the Phase II of the D-RAP. The ITAAC acceptance criteria are established to ensure that for all SSCs that are within the scope of RAP when the COL is issued, the initial design has been subject to the applicable reliability assurance activities of the D-RAP.The ITAAC acceptance criteria are established to ensure that the following three (3) major elements are taken into consideration: DCD_17.04-68

- Identification of all as-built SSCs in the scope of the D-RAP
- Description of the methodology used to identify the as-built SSCs in scope of the D-RAP
- For the as-built SSCs in scope of D-RAP, identify and describe the reliability assurance activities that are accomplished prior to the initial fuel load, which provide reasonable assurance that the plant is designed and constructed in a manner that is consistent with the key assumptions (including reliability and availability assumptions in PRA, when applicable) and risk insights for the risk-significant SSCs.

17.4.9 Combined License Information

COL 17.4(1) *The COL Applicant shall be responsible for the development and implementation of the Phases II and III of the D-RAP, including QA requirements. In the Phase II, the plant's site-specific information should be introduced to the D-RAP process and the site-specific risk-significant SSCs should be combined with the US-APWR design risk-significant SSCs into a list for the specific plant. Phase II is performed during the COL application phase and updated/maintained during the COL license holder phase. In the Phase III, procurement, fabrication, construction, and test specifications for the SSCs within the scope of the RAP should ensure that significant assumptions, such as equipment reliability, are realistic and achievable. The QA requirements should be implemented during the procurement, fabrication, construction, and pre-operation testing of the SSCs within the scope of the RAP. Phase III is performed during the COL license holder phase and prior to initial fuel loading. The COL Applicant will propose a method by which it will incorporate the objectives of the reliability assurance program into other programs for design or operational errors that degrade nonsafety-related, risk-significant SSCs.*

COL 17.4(2) *The COL Applicant shall be responsible for the development and implementation of the O-RAP, in which the RAP activities should be integrated into the existing operational program (e.g., Maintenance Rule, surveillance testing, in-service inspection, in-service testing, and QA). The O-RAP should also include the process for providing*