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April 23, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09198

Subject: MHI's Response to US-APWR DCD RAI No. 222-1933

References: 1) "Request for Additional Information No. 222-1933 Revision 1, SRP Section: 14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria: 14.3.4.11," dated February 26, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 222-1933 Revision 1".

Enclosure 1 provides the response to the 10 questions that are contained within Reference 1.

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

Sincerely,

Y. Ogata

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

1. Response to Request for Additional Information No. 222-1933 Revision 1

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-09198
Docket No. 52-021

Response to Request for Additional Information No. 222-1933
Revision 1

April 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 222-1933 REVISION 1**
SRP SECTION:	**14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**
APPLICATION SECTION:	**14.3.4.11**
DATE OF RAI ISSUE:	**2/26/2009**

QUESTION NO.: 14.03.11-18

Clarify the key design features of the CHS system that are to be verified via ITAAC

The staff requested, in RAI 14.3.4.11-1, that the applicant provide additional key design features to be verified via ITAAC for the CHS system, or a discussion justifying why such information is not required. The staff requested that the applicant address the quantity and location of the hydrogen igniters in particular, and a discussion of the roadmaps used to develop the key design features of the CHS system Tier 1 information from the severe accident analysis.

In a letter dated September 18, 2008, Mitsubishi responded to RAI 14.3.4.11-1 that Section I.A.(3), Appendix C.II.1-A of RG 1.206 discusses the ITAAC for the severe accident features, as follows.

"The design description should describe these features, and the functional arrangement ITAAC should verify that they exist. In general, the ITAAC need not include the capabilities of these features." Thus, ITAAC for the non-safety systems with severe accident features should focus on verification of the existence (not capabilities) of the systems, components, or equipment, and the ITAAC for the severe accident features which are linked to the capabilities are not proposed in Tier 1. MHI will revise the "key design features" and "location and functional arrangement" in Section 2.11.4 of Tier 1 to state that: "There are 20 igniters strategically located in containment areas and subcompartments where hydrogen may be produced, transit or collect."

MHI also stated that they will revise the DCD to expand Table 14.3-1 (Safety Analysis and PRA insights and Assumptions) to incorporate the added key design features of the CHS.

The staff has reviewed the response and has identified that the following needs to be addressed by the applicant:

1) In addition to the DCD changes cited in the RAI 14.3.4.11-1 response, revise the DCD to add Tier 2 figure 6.2.5-1. Include ITAAC to verify the specific location of each hydrogen igniter in the containment.

ANSWER:

MHI will add new DCD Tier 1 Figure 2.11.4-1, based on Tier 2 Figure 6.2.5-1. The CHS functional arrangement ITAAC (Item 1 in Table 2.11.4-1) and the CHS design description in Subsection 2.11.4 will be revised to refer to Figure 2.11.4-1. As requested, an ITAAC to verify the location of the hydrogen igniters will be added to Table 2.11.4-1. These changes will be coordinated with the changes to Subsection 2.11.4 previously described in response to RAI 14.3.4.11-1 (MHI Ref: UAP-HF-08183, dated September 18, 2008), and response to questions 14.03.11-20 and 14.03.11-24 of this RAI.

Impact on DCD

This revision affects DCD Revision 1. MHI will revise DCD Tier 1 Subsection 2.11.4 as described below, including those changes described in MHI's response to RAI 14.3.4.11-1.

Tier 1 Subsection 2.11.4.1 will be revised as follows:

"Location and Functional Arrangement

As shown in Figure 2.11.4-1, there are a set of 20 igniters strategically located in containment areas and subcompartments where hydrogen may be produced, transit, or collect. ~~The igniters are located within the containment.~~ The hydrogen detector is located outside of containment and measures hydrogen concentration in containment air extracted from the containment. The CHS includes a single hydrogen monitor **with MCR alarm and display capability** and a set of igniters."

"Key Design Features

The CHS consists of the hydrogen monitoring system and the hydrogen ignition system. The hydrogen monitoring system consists of a single hydrogen detector. The hydrogen ignition system consists of ~~a set of~~ **20** igniters **installed inside the containment**, designed to burn hydrogen continuously at a low concentration. The hydrogen igniters burn off hydrogen starting at the low flammability limit (approximately 10% hydrogen in air), thereby preventing further hydrogen accumulation that could become a threat to containment integrity."

Table 2.11.4-1, *Containment Hydrogen Monitoring and Control System Inspections, Tests, Analyses, and Acceptance Criteria*, will be revised as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the CHS is as described in the Design Description of this Subsection 2.11.4 **and as shown in Figure 2.11.4-1**.	1. Inspections of the as-built CHS will be performed.	1. The as-built CHS conforms with the functional arrangement as described in the Design Description of this Subsection 2.11.4 **and as shown in Figure 2.11.4-1.**
2. The hydrogen igniters are located in the PCCV as shown in Figure 2.11.4-1.	**2. An inspection of the as-built hydrogen igniters will be performed.**	**2. The as-built hydrogen igniters are located in the PCCV as shown in Figure 2.11.4-1.**

Figure 2.11.4-1 will be added to Tier 1 section 2.11.4 as shown in Attachment 1.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 222-1933 REVISION 1**

SRP SECTION: **14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**

APPLICATION SECTION: **14.3.4.11**

DATE OF RAI ISSUE: **2/26/2009**

QUESTION NO.: 14.03.11-19

Indicate and include ITAAC items that provide verification of critical assumptions from Containment Transient and Accident Analyses.

The staff requested, in RAI 14.3.4.11-2, that the applicant provide additional information on how critical assumptions from transient and accident analyses are verified by ITAAC.

The Staff asked the applicant to provide, the cross references from containment safety analyses that are used to define specific ITAAC. The staff asked the applicant to discuss how the cross references have been used in developing the ITAAC, and for each ITAAC item identified, a discussion on how the ITAAC acceptance criteria will provide verification of the critical assumption from containment safety analyses.

In a letter dated September 18, 2008, Mitsubishi responded to RAI 14.3.4.11-2 that DCD Tier 2 Table 14.3-1 addresses the cross-reference with Tier 1 and Tier 2, and also includes key parameters (specifications) in the containment transient and accident analyses. This table especially focuses on the numerical performance parameters of the safety function, flood protection, fire protection, severe accident function and so on per SRP 14.3.

These key parameters are directly incorporated in the corresponding design description of the referenced Tier 1 section, and are verified in the ITAAC.

MHI stated that they will expand Table 14.3-1 and directly extract the design commitments from Section 6.2.1 of Tier 2 regarding the containment transient and accident analyses. The comparison with the assumptions in the containment transient and accident analyses will be resolved with the enhancement of Table 14.3-1

The staff has reviewed the response and has identified that the following needs to be addressed by the applicant:

1) In addition to the DCD changes cited in the RAI 14.3.4.11-2 response, revise DCD Tier 2 Table 14.3.-1 to identify which particular analysis (DBA, Severe Accident, Flooding, etc) was used to create each assumption in the table. In addition, relate each assumption or key design feature to the specific ITAAC defined to address it.

ANSWER:

Tier 2 Table 14.3-1 will be expanded to address various categories of design features as described in response to question 14.03.11-20.

Impact on DCD

See Attachment 2 for a mark-up of DCD Tier 2, Section 14.3.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2008

US-APWR Design Certification

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Docket No. 52-021

RAI NO.: NO. 222-1933 REVISION 1

SRP SECTION: 14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria

APPLICATION SECTION: 14.3.4.11

DATE OF RAI ISSUE: 2/26/2009

QUESTION NO.: 14.03.11-20

Discuss how the ITAAC were developed to verify the existence of severe accident prevention and mitigation features.

The staff requested, in RAI 14.3.4.11-3, that the applicant provide cross-references or roadmaps from severe accident analyses that are used to define specific ITAAC addressing severe accident prevention and mitigation features. Also, for each ITAAC item identified, the staff requested a discussion on how the ITAAC acceptance criteria provide verification of the critical assumptions/requirements in severe accident analyses.

In a letter dated September 18, 2008, Mitsubishi responded to RAI 14.3.4.11-3 that:

MHI will revise the title of Table 14.3-1 to "Tier I and Tier 2 Cross-References". Also, the title of the middle column will be changed to "Key Design Features/PRA Insights/Severe Accident Mitigation Features". For example, the key design features of diverse actuation systems has been addressed in Table 14.3-1 (Sheet 3 of 6) of Tier 2 and Subsection 2.5.3.1 of Tier 1 as an ATWS feature specified in Subsection 19.2.2.1. And, two independent alternative ac power sources have been also addressed in Table 14.3-1 (Sheet 3 of 6) of Tier 2 and Subsection 2.6.5.1 of Tier 1 as a station blackout feature specified in Subsection 19.2.2.3. These design features are verified in the individual ITAAC in the corresponding Tier 1 sections and tables.

In the RAI response, the applicant provided a comparison table of the US-APWR design features for mitigating severe accidents, with the location of Tier 1 information and Tier 2 information.

The applicant pointed out that some of the severe accident mitigation features are not specified in Table 14.3-1, but the existence of these features is verified in the ITAAC as mostly inspections of the functional arrangement and/or design description.

Thus, the verification of the existence of design features for severe accident prevention and mitigation is accomplished in the simple ITAAC as the inspection of the functional arrangement and/or design description in general, but some of the specific design features are verified in a separate ITAAC per the specific requirement of RG 1.206 and SRP 14.3.

The applicant indicated that as part of its RAI response process, MHI found that some of the design features were not specified in Table 14.3-1 and the existence of the SSCs used as the severe accident prevention and mitigation features were not clearly described in Tier 1. The applicant stated that MHI will add these unspecified design features in each design description in Tier 1 and provide the corresponding cross-reference in Table 14.3-1 of Tier 2, respectively.

The staff has reviewed the response and has identified that the following needs to be addressed by the applicant:

1) Table 14.3-1 provided in the Tier 2 DCD and the modification planned in response to RAI 14.3.4.11-3 does not provide a roadmap or show how key insights and assumptions from PRA and severe accident analyses are addressed in the design information in the DCD. Table 14.3-1 lists (or will list) the key design features/PRA insights/severe accident mitigation features along with references to the applicable sections in Tier 1 and Tier 2 DCD. The table or the accompanying discussion should also identify the specific design feature(s) that should be verified for each of the item and the ITAAC defined to address them. Essentially, the steps or the analyses conducted to develop Table 14.3-1 should be included in accompanying discussion or should be apparent from the information provided in the table. Some of the discussions provided in response to RAI 14.3.4.11-3 presents the analysis being conducted and such analyses, as completed to address all relevant issues, should be included in Section 14.3.4.11.

ANSWER:

Table 14.3-1 will be expanded into 6 tables labeled as follows:

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 Tier 2 information reviewed to develop Table 14.3-1a includes key assumptions and analytical inputs for the safety analysis, containment analysis, overpressurization assumptions, important generic safety issues from NUREG-0933, TMI items from 10 CFR 50.34(f). Generic safety issues and TMI items are detailed in Tier 2 Section 1.9, with cross-references to the Tier 2 information that describes the features applicable to the generic issues. The Section 14.3 tables refer to the primary sources of Tier 2 information and generally do not refer to the Tier 2 Section 1.9 description of the generic issues. Table 14.3.1-a is concerned primarily with fission product barriers, accident mitigating systems and key support systems.

Table 14.3-1b will include references to key design features and parameters for internal and external hazards not covered in the other tables, including:

- flood protection
- key site parameters (seismological, geotechnical and meteorological)
- protection against the dynamic effects of pipe break
- internal and external missile hazards
- environmental qualification (EQ) of equipment

Table 14.3-1c contains significant fire protection design features including fire detection and fire suppression features.

Table 14.3-1d is based on reviews of DCD Tier 2 Chapter 19. It includes features identified as significant for preventing or mitigating severe accidents, or risk-significant as determined by the PRA. As noted above, the other Section 14.3 tables also include features important to severe accidents or PRA, and are cross-referenced to applicable Chapter 19 information. The final reconciliation of the roadmap to Chapter 19 information will be performed in the next revision of DCD for the consistency with Chapter 19 RAI resposnes.

Table 14.3-1e contains the safety significant design features used at address ATWS and 10CFR50.62.

Table 14.3-1f contains the design input and safety significant parameters used for the radiological analyses.

Tier 2 Section 14.3 will be also revised to refer to all the above tables and provide additional explanation of the development of their related ITAAC. The revised tables will provide cross references to applicable Tier 1 sections related to the design features.
In this table, rated reactor core thermal power level is a key design feature but is not verified by ITAAC. Rated core thermal power is controlled by license condition and Technical Specifications, and therefore reasonable assurance of adhering to the power limit is provided outside of the ITAAC process.

Based on the additional DCD reviews conducted by MHI in developing the response to this question, additional features will be included in the revised Section 14.3 tables, for example:

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

- Reactor core rated thermal power
- Reactor coolant pressure boundary (RCPB) features including fracture toughness
- Related to containment analyses, RWSP peak water temperature,
- EFW cross-tie capability

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

- Key site parameters
- Internal and external missile hazard protection
- Pipe break protection
- Environmental qualification (EQ)

Table 14.3-1c Fire Protection Key Design Features

- Clarify redundant and diverse fire water pump design
- Fire detection indication to main control room
- Expanded safe shutdown design features

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

- Expanded description of the containment hydrogen monitoring and control system (CHS)
- Alternate containment cooling using fan coolers
- Drain line from SG compartment to reactor cavity for cavity flooding
- Depressurization valves to prevent severe accidents
- Low pressure letdown isolation to prevent RCS inventory loss during mid-loop operations

Table 14.3-1e ATWS Key Design Features

- Diverse actuation system (DAS) design features

Table 14.3-1f Radiological Analysis Key design features

- Atmospheric dispersion factors used in radiological analyses
- Containment leak rate

Based on the revised Table 14.3-1, new ITAAC and/or changes to Tier 1 will be required. These changes are shown below.

Impact on DCD

This revision affects DCD Revision 1.

See Attachment 2 for a mark-up of DCD Tier 2, Section 14.3, Revision 2.
See Attachment 3 for a mark-up of DCD Tier 1, Section 2.11, Revision 2. (affected portion is also described below.)

The last sentence in Subsection 2.2.2.1 "External Flooding" will be deleted due to the consistency between Tier 1 and Tier 2 description.

2.2.2.1 External Flooding
Protection against external flooding is provided to preserve the safe shutdown capability. The main components protected against external flooding are listed in Table 2.2-3. The external walls that are below flood level are adequate thickness to protect against water seepage, and penetrations in the external walls below flood level are provided with flood protection features. Construction joints in the exterior walls and base mats are provided with water stops to prevent seepage of ground water. Additional protection is provided using a waterproofing system applied to below-grade surfaces. ~~The waterproofing system primarily consists of a waterproofing membrane applied to the below-grade building exterior surfaces and/or the use of a concrete design mix, which has reduced porosity, for exterior walls and foundation.~~

The following will be added at the end of the first paragraph in Tier 1 Subsection 2.2.1.8, *Turbine Building:*

The electrical equipment room of T/B is designed to be waterproof and the first floor of T/B is equipped with relief panels. These measures prevent loss of alternate ac power due to flood in the T/B.

Tier 1 Table 2.2-4, *Structural and Systems Engineering Inspections, Tests, Analyses, and Acceptance Criteria,* will be revised to add the following ITAAC Items:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
21. Relief panels exist on the first floor of the T/B.	**21. An inspection will be performed of the as-built T/B.**	**21. The relief panels exist on the first floor of the as-built T/B.**
22. The electrical room in the T/B is waterproof.	**22. An inspection will be performed of the as-built T/B.**	**22. The as-built electrical room in the T/B is waterproof.**

The following bullet will be added to the residual heat removal system (RHRS) design description in Tier 1 Subsection 2.4.5, under "Key Design Features:".

• The RHRS is used as an alternate core cooling / injection in case all safety injection system fails.

The following sentence will be added to the alternate AC power source design description in Tier 1 Subsection 2.6.5.1:

Circuit breaker panels of the alternate ac system and cables associated with alternate ac power to safety buses in the T/B are segregated into two groups by qualified fire barriers.

Tier 1 Table 2.6.5-1 will be revised to add the following ITAAC Item:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
12. Circuit breaker panels of the alternate ac system and cables associated with alternate ac power to safety buses in the T/B are segregated into two groups by qualified fire barriers.	**12. An inspection will be performed of the as-built circuit breaker panels and cables.**	**12. Circuit breaker panels of the as-built alternate ac system and cables associated with as-built alternate ac power to safety buses in the as-built T/B are segregated into two groups by qualified fire barriers.**

The following bullet will be added to the non-essential chilled water system design description in Tier 1 Subsection 2.7.3.6.1, under "Key Design Features:"

- **Provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection.**

Tier 1 Table 2.7.3.6-1 will be revised to add the following ITAAC Item:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. Non-essential chilled water system provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection.	**3. Tests will be performed to verify the as-built non-essential chilled water system provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection**	**3. The as-built non-essential chilled water system provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection**

The following bullet will be added to Tier 1 Subsection 2.7.6.3 "System Purpose and Functions".

• Supply water for RCS makeup by gravity injection from spent fuel pit as a countermeasure for loss of RHR.

The following text will be added to Tier 1 Subsection 2.11.2.1 "Key Design Features".

Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.

Tier 1 Table 2.11.2-2 will be revised as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
14. Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.	14. Tests of the as-built valves will be performed under the conditions that SBO occurs and alternative ac generators are not available.	14. Upon loss of ac power condition, each as-built remotely operated valve identified as the followings can be closed automatically. - CVS-MOV-203, 204 - LMS-AOV-104, 105 - CAS-MOV-002 - VCS-AOV-306, 307, 356, 357

The following text will be added to Tier 1 Subsection 2.11.4.1 "Key Design Features"

The CHS will automatically actuate upon the receipt of an ECCS actuation signal.

Tier 1 Table 2.11.4-1 will be revised as follows (the unaffected rows are not shown; also please refer to question 14.03.11-18 for the addition of ITAAC Item 2):

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The hydrogen igniters, identified on Figure 2.11.4-1, start after receiving an ECCS actuation signal.	3. Tests will be performed on the as-built hydrogen igniters, identified on Figure 2.11.4-1, using a simulated signal.	3. The as-built hydrogen igniters, identified on Figure 2.11.4-1, start after receiving a simulated signal.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 222-1933 REVISION 1**
SRP SECTION:	**14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**
APPLICATION SECTION:	**14.3.4.11**
DATE OF RAI ISSUE:	**2/26/2009**

QUESTION NO.: 14.03.11-21

Explain and specify the severe accident analysis requirements to be satisfied in the Design Commitment and Acceptance Criteria of ITAAC # 4, 5, 6, and 7 in Table 2.11.1-2, Containment Vessel ITAAC.

The staff requested in RAI 14.3.4.11-4 that the applicant explain and specify the severe accident analysis requirements to be satisfied in the Design commitment and Acceptance Requirements Columns for ITAAC #4,5,6 and 7 in Table 2.11.1-2, "Containment Vessel ITAAC"

In a letter dated September 18, 2008, Mitsubishi provided the following response for RAI 14.3.11.4:

"Severe accident analysis requirements of ITAAC #4, 5, 6 and 7 in Table 2.1.1-2 of Tier 1 correspond to items shown in Table 19.1-115, Key Assumptions (Sheet 3 of 4), as follows:

g. Reactor cavity has a core debris trap area to prevent entrainment of the molten core to the upper part of the containment.

h. The other cavity flooding system is a set of drain lines from SG compartment to the reactor cavity. Spray water which flows into the SG compartment drains to the cavity and cools down the molten core after reactor vessel breach.

i. Reactor cavity is designed to ensure thinly spreading debris by providing sufficient floor area and appropriate depth.

j. Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through. As stated in the response to Question No. 14.03.11-1, ITAAC for the non-safety systems with severe accident features should focus on verification of the existence (not capabilities) of the systems, components, or equipment, and the ITAAC for the severe accident features, which are linked to the capabilities but are not proposed in Tier 1. Based on the above consideration, ITAAC need not address additional requirements, functions or capabilities for the severe accident."

The staff has reviewed the response and has identified the following needs to be addressed by the applicant:

1) Please include the discussion presented in response to RAI 14.3.4.11-4 as part of the key design features section 2.11.1 of tier 1 of the DCD.

2) The wording of the Design commitment and Acceptance Requirements Columns for ITAAC #4,5,6 and 7 in Table 2.11.1-2, "Containment Vessel ITAAC" should be revised to clearly state that inspections verify only the existence of the design feature. The wording should remove the impression that such inspections are to ensure that specific design feature capabilities are being met.

ANSWER:

1) DCD Tier 1 Subsection 2.11.1. The "Key Design Features" will be revised to address each of the severe accident features described in MHI's response to RAI 14.3.4.11-4 (MHI Ref: UAP-HF-08183, dated September 18, 2008). In addition, a cross reference to the CSS and fire protection system (FPS) water supply for reactor cavity injection will be included in the Key Design Features of Subsection 2.11.1.

2) In Table 2.11.1-2, *Containment Vessel Inspections, Tests, Analyses, and Acceptance Criteria*, ITAAC Items 4, 5, 6 and 7 will be revised to remove the phrase "that meets the severe accident analysis requirements," and focus on the existence of the severe accident design features.

Impact on DCD

This revision affects DCD Revision 1. DCD Tier 1, Subsection 2.11.1 will be revised as follows (see attachment 3):

Revise Subsection 2.11.1 "Key Design Features" as follows (affected paragraphs are shown):

"The fundamental design concept of the US-APWR for severe accident termination is reactor cavity flooding and cool down of the molten core by the flooded coolant water.

Reactor cavity flooding to enhance the cool down of the molten core ejected into the reactor cavity is achieved by the CSS, whose operation during a design basis accident is described in Subsection 2.11.3. Drain lines are used to drain spray water, which flows into the SG compartments, to the reactor cavity and cools the molten core. Fire protection system (FPS) water injection may also be used to inject water to the drain lines from the SG compartment to the reactor cavity. The FPS water supply is described in Subsection 2.7.6.9.1.

The geometry of the reactor cavity is designed to assure adequate core debris coolability. ~~Sufficient r~~**R**eactor cavity floor area and ~~appropriate~~ reactor cavity depth ~~are~~ provided ~~to~~ enhance**d** spreading **of the** debris bed for ~~better~~ coolability.

~~Even if the depressurization of the reactor coolant system (RCS) fails,~~ **T**he consequences of a postulated high pressure melt ejection (HPME) **severe** accident are mitigated by the consideration of reactor cavity geometry and containment layout. The consequences of a postulated HPME are mitigated by a **core** debris trap in the reactor cavity as well as no direct pathway to the upper compartment ~~for the~~**. These features prevent entrainment of the molten core to the upper part of the containment and** impingement of debris on the containment shell.

Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through. ~~There is a liner plate covering concrete as the floor surface of the reactor cavity, which gives a protection of short-term attack by relocated core debris~~."

ITAAC Items 4, 5, 6 and 7 in Table 2.11.1-2 will be revised as follows:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4. **A set of** ~~The~~ drain line**s** **from the SG compartments** to the reactor cavity exists. ~~that meets severe accident analysis requirements~~.	4. Inspections of the as-built drain line**s** to the reactor **cavity** will be performed.	4. **A report exists and concludes** ~~The~~ **that the** as-built drain line**s** **from the SG compartments** to the **as-built** reactor cavity exist~~s~~. ~~that meets severe accident analysis requirements~~.
5. The reactor cavity includes a core debris trap. ~~that meets severe accident analysis requirements.~~.	5. Inspections of the as-built reactor cavity will be performed.	5. **A report exists and concludes** ~~The~~ **that the** ~~core debris trap exists in the~~ as-built reactor cavity **includes a core debris trap** ~~exists in the as-built reactor cavity that meets severe accident analysis requirements~~.
6. The reactor cavity ~~includes the sufficient~~ floor area and ~~appropriate~~ depth **provide enhanced spreading of the debris bed for coolability.** ~~that meets severe accident analysis requirements.~~.	6. Inspections of the as-built reactor cavity will be performed.	6. **A report exists and concludes that reactor cavity floor area and depth provide enhanced spreading of the debris bed for coolability.** ~~The sufficient floor area and appropriate depth exists in the as-built reactor cavity that meets severe accident analysis requirements.~~
7. **Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through**. ~~The reactor cavity includes a cover concrete on the PCCV liner plate that meets severe accident analysis requirements.~~.	7. Inspections of the as-built reactor cavity will be performed.	7. **A report exists and concludes** ~~The~~ **that the as-built reactor cavity includes cavity floor concrete which is provided to protect against challenge to liner plate melt through.** ~~cover concrete on the PCCV liner plate exists in the as built reactor cavity that meets severe accident analysis requirements.~~

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

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Docket No. 52-021

RAI NO.: **NO. 222-1933 REVISION 1**

SRP SECTION: **14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**

APPLICATION SECTION: **14.3.4.11**

DATE OF RAI ISSUE: **2/26/2009**

QUESTION NO.: 14.03.11-22

Revise applicable system ITAAC and associated tables to assure verification of the containment isolation functions of different systems.

The staff requested the applicant revise the ITAAC tables for systems that have containment isolation functions assure verification of containment isolation function The Staff requested that the applicant provide a list of the revisions made or a list of ITAAC addressing containment isolation functions of valves.

In a letter dated September 18, 2008, Mitsubishi responded to RAI14.3.4.11-6 that MHI will perform a confirmatory review to ensure containment isolation system components that require verification of function have an ITAAC. MHI will revise the associated tables to assure verification of containment isolation function for the different systems. Tier 1 of the DCD will be revised to include the following, and any other missing ITAAC for containment isolation functions that turn-up from the results of our confirmatory review:

CVS-VLV-202 will be added in Table 2.4.6-2. NCS-VLV-403A and B will be added in Table 2.7.3.3-2. ITAAC for containment isolation function will be added in Table 2.7.1.10-3 and Table 2.7.3.3-5. These revisions will be reflected to the DCD Revision 2.

The staff has reviewed the response and has identified that when the applicant provides the missing/revised ITAAC, the staff will review the revision for acceptability. The following also needs to be addressed by the applicant:

1) As a minimum, ensure the following systems with CIS functions is addressed in your review:

- Chemical and Volume Control System (CVCS)
- Emergency Core Cooling System (ECCS)-Safety Injection System (SIS)
- Residual Heat Removal System (RHRS)
- Condensate and Feedwater System (FWS)
- Emergency Feedwater System (EFS)
- Main Steam System (MSS)

- Containment Spray System (CSS)
- Component Cooling Water System (CCWS)
- Process and Post-accident Sampling System (PSS)
- Steam Generator Blowdown System (SGBDS)
- Reactor Coolant System (RCS)
- Waste Management System (WMS)
- Refueling Water Storage System (RWS)
- Fire Protection Water Supply System (FSS)
- HVAC System (Non-essential Chilled Water System) (VWS)
- HVAC System (Containment Purge System)
- Primary Makeup Water System (PMWS)
- Instrument Air System (IAS)
- Station Service Air System (SSAS)
- In-Core Instrument Gas Purge System (ICIGS)
- Leak Rate Testing System (LTS)
- RCP Motor Oil Cooling System (RLS)

2) As a minimum, for those systems with containment isolation functions, ensure ITAAC is created similar to Table 2.11.2-2 ITAAC #2b,3b,4b. Ensure that the system piping/lines these ITAAC apply to is clearly specified in Tier 1.

3) Section 2.11.2, Containment Isolation System, of the Tier 1 DCD does not provide any discussion of the systems that contain components that function as part of the containment isolation system. This information can only be gleaned through Figure 2.11.2-1. Section 2.11.2 should mention this and clarify interfaces. This discussion can be included within the Interface Requirements under Section 2.11.2.1, Design Description.

ANSWER:

Item 1 and 2:

In MHI's response to RAI 14.3.4.11-6 (MHI Ref: UAP-HF-08183, dated September 18, 2008), the following containment isolation valves were identified as missing from Tier 1:

- CVC-VLV-202
- NCS-VLV-403A
- NCS-VLV-403B

As indicated in the response, CVS-VLV-202 will be added in Table 2.4.6-2 and NCS-VLV-403A and NCS-VLV-403B will be added in Table 2.7.3.3-2. During a subsequent review by MHI, containment isolation valves (CIVs) NCS-VLV-437A and NCS-VLV-437B were also identified as missing from Table 2.7.3.3-2, and will be added as part of the changes incorporated in response to this RAI.

In addition, Table 2.11.2-1, *Containment Isolation System Equipment Characteristics* will be revised to consolidate CIVs in a single Tier 1 table. The changes to Table 2.11.2-1 will include the addition of CIVs found in the equipment characteristics tables for each of the systems that include CIVs. In this manner, the CIV's will be referenced by the ITAAC in Table 2.11.2-2, *Containment Isolation System Inspections, Tests, Analyses, and Acceptance Criteria*. To avoid duplication of data, the CIVs being added to Table 2.11.2-1 are cross-referenced to the Tier 1 tables that contain the CIVs' equipment characteristics and alarms, displays and controls information. MHI's response to question 14.03.11-24 addresses the DCD Tier 1 changes to assure each of the CIVs in revised Table 2.11.2-1 is addressed by the Table 2.11.2-2 ITAAC for alarms, displays and controls.

The piping ITAAC items 2b, 3b and 4b in Table 2.11.2-2, apply to all ASME Code Section III CIS piping. There is some duplication between ITAAC items 2b, 3b and 4b in Table 2.11.2-2, and the piping ITAAC for the systems with piping penetrating containment. There is no separate piping characteristics table for Tier 1 Subsection 2.11.2. Therefore, the addition of CIVs to Table 2.11.2-1 does not involve any changes to piping tables.

MHI's response to RAI 184-1912 question 14.03.07-27 contains additional changes to DCD Tier 1, including ITAAC, for CIVs.

Item 3:

The "Interface Requirements" sections of the Tier 1 design descriptions are used to address interfaces of the site-specific portions of the design with the standard plant design. Therefore, the "Interface Requirements" section is not used to describe systems in the scope of the certified design that include a containment isolation function. For each system that includes a containment isolation function, the system design description and each system subsection labeled "Inspections, Tests, Analyses, and Acceptance Criteria" will include a reference to the CIS design description and Table 2.11.2-2. MHI's response to RAI 184-1912 question 14.03.07-27 addresses these cross references.

Impact on DCD

This revision affects DCD Revision 1. Tier 1 Table 2.4.6-2, *Chemical and Volume Control System Equipment Characteristics,* will be revised to add CVS-VLV-202 as follows (not all table rows are shown):

Table 2.4.6-2 Chemical and Volume Control System Equipment Characteristics (Sheet 3 of 4)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Active Safety Function	Loss of Motive Power Position
RCP Seal Return Line Containment Isolation Valve	CVS-MOV-203	2	Yes	Yes	Yes/Yes	Transfer Closed	As Is
RCP Seal Return Line Containment Isolation Check Valve	**CVS-VLV-202**	**2**	**Yes**	**No**	**—/—**	**Transfer Closed**	**—**
Primary Makeup Water Supply Isolation	CVS-FCV-218, 219	3	Yes	Yes	Yes/No	Transfer Closed	As Is
Excess Letdown Isolation Valve	CVS-AOV-221, 222	1	Yes	Yes	Yes/Yes	Transfer Closed	Closed
RCP Seal Return Line Containment Isolation Valve	CVS-MOV-204	2	Yes	Yes	Yes/No	Transfer Closed	As Is

Tier 1 Table 2.7.3.3-2, *Component Cooling Water System Equipment Characteristics,* will be revised as follows (not all table rows are shown):

Table 2.7.3.3-2 Component Cooling Water System Equipment Characteristics (Sheet 1 of 3)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Active Safety Function	Loss of Motive Power Position
RCP CCW supply line outside containment isolation valves	NCS-MOV-402 A, B	2	Yes	Yes	Yes/No	Transfer Open/ Transfer Closed	As Is
RCP CCW supply line inside containment check valves	**NCS-VLV-403 A, B**	**2**	**Yes**	**-**	**-/-**	**Transfer Open/ Transfer Closed**	**-**
RCP CCW supply line outside containment isolation valve bypass valves	NCS-MOV-445 A, B	2	Yes	Yes	Yes/No	Transfer Open/ Transfer Closed	As Is
RCP CCW return line inside containment isolation valves	NCS-MOV-436 A, B	2	Yes	Yes	Yes/Yes	Transfer Open/ Transfer Closed	As Is
RCP CCW return line inside containment check valves	**NCS-VLV-437 A, B**	**2**	**Yes**	**-**	**-/-**	**Transfer Closed**	**-**

Tier 1 Table 2.11.2-1, *Containment Isolation System Equipment Characteristics*, will be revised as shown in Attachment 3. Refer to MHI's response to question 14.03.11-24 for related changes to CIV alarms, displays and controls.

Refer to MHI's response to RAI 184-1912 question 14.03.07-27 for additional Tier 1 changes for CIVs, including ITAAC.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.: **NO. 222-1933 REVISION 1**

SRP SECTION: **14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**

APPLICATION SECTION: **14.3.4.11**

DATE OF RAI ISSUE: 2/26/2009

QUESTION NO.: 14.03.11-23

Provide verification through ITAAC that the location of the outermost isolation valve is such that the length of the pipe from containment to the valve is not greater than the specified value.

The staff requested in RAI 14.3.4.11-7 that the applicant provide verification through ITAAC that the location of the outermost isolation valve is such that the length of the pipe from containment to the valve is not greater than the specified value.

In a letter dated September 18, 2008, Mitsubishi provided the following response for RAI 14.3.11.7:

"MHI believes that the length of the pipe does not reach the safety significance threshold for an ITAAC. The shorter the length of pipe run between the CIV and containment the likelihood of a pipe break is only incrementally less, but the consequences remain unchanged. GDC 55, 56 and 57 state that isolation valves outside containment shall be located as close to containment as practical. MHI understands the basis of this requirement but this requirement is not directly related to safety because it does not adversely affect the safety if the as-built length of the pipe does not meet the value of Tier 2 Table 6.2.4-3. This is consistent with the assumptions for US-APWR ITAAC as described in DCD Chapter 14, Section 14.3 and consistent with the NRC staff position on ITAAC for the containment isolation system. As-built pipe length will be demonstrated as described in COL item 6.2(6)."

Subsequently in a letter dated November 7, 2008, Mitsubishi informed the staff that DCD COL item 6.2(6) will be deleted from the COL.

The staff has reviewed the responses and has identified that the following needs to be addressed by the applicant:

Provide ITAAC that verifies, for each containment penetration, that the no greater than distances from containment to the outermost isolation valve listed in DCD Tier 2 Table 6.2.4-3 are not exceeded.

ANSWER:

NRC guidance for the containment systems ITAAC is located in NUREG-0800 Standard Review Plan (SRP) section 14.3.11. Based on a review of SRP and NRC Regulatory Guide (RG) 1.206 ITAAC guidance, no criteria were found that require the piping length from the containment to the outside containment isolation valve be verified by ITAAC. GDC 55, 56, and 57 require the valves located outside containment be located as close as practical to the containment wall. SRP section 14.3 Appendix A Section IV.4.A states the following concerning key parameters and numeric performance values in ITAAC:

> *"Numeric performance values and key parameters in safety analyses should be specified in the design descriptions based on their safety significance; however, numbers for all parameters need not be specified unless there is a specific reason to include them (e.g., important to be maintained for the life of the facility)."*

The location of the valves relative to the containment wall is not a key parameter in the safety analysis. MHI considers the maximum piping lengths from the CIVs to the containment wall to be beyond the level of detail for Tier 1. The maximum piping length from the containment to the outermost isolation valve is provided in DCD Tier 2 Table 6.2.4-3 for each penetration with isolation valve(s). Therefore, COL holders referencing the US-APWR certified design would be required to address any changes from the standard plant maximum piping lengths subject to the provisions of 10CFR50.59 and 10CFR52.63(b)(2), and with consideration of the GDC criteria to locate containment isolation valves as close as practical to the containment wall.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

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APPLICATION SECTION:	**14.3.4.11**
DATE OF RAI ISSUE:	**2/26/2009**

QUESTION NO.: 14.03.11-24

Indicate ITAAC items that provide verification of the minimum inventory of alarms, displays and controls for the CHS and CIS systems.

The staff requested the applicant provide ITAAC required to verify the minimum inventory of alarms, displays and controls associated with the containment instrumentation shown on Figure 2.11.2-1, that are not listed in Table 2.11.2-1, and to amend Table 2.11.2-1 as required. The staff also requested that for systems with containment isolation functions (e.g., CVCS, SGBDS, PSS), the applicant provide ITAAC to verify the display of position indication of the containment isolation valves in the MCR, to Include the displays of the CIV positions in the respective system tables. The staff requested the applicant provide ITAAC required to verify the minimum inventory of alarms, displays and controls are provided for the CHS system, as described in the design description paragraph 2.11.4.1.

In a letter dated September 18, 2008, Mitsubishi responded to RAI14.3.4.11-8 that:

- Tier 1 of the DCD Revision 2 document will be revised to add the instruments (PT-2390 and 2391') in Table 2.11.2-1
- ITAAC to verify the display of position indication of the containment isolation valves in the MCR will be added in the respective system tables.
- Containment isolation valves in CVCS will be added in Tier 1 Table 2.4.6-4.
- SGBDS and PSS tables of equipment, alarm, displays, and control functions for containment isolation valves will be added and containment isolation valves will be listed in these tables. ITAAC for containment isolation function will be added in Table 2.7.1.10-3 (SGBDS).

The staff has reviewed the response and has identified that when the applicant provides the missing/revised ITAAC, the staff will review the revision for acceptability. The following also needs to be addressed by the applicant:

1) Apart from the DCD revision 2 changes committed to in the RAI response for the CIS, you state the following regarding the CHS System:

"CHS System

The ITAAC #1 of Table 2.11.4-1 covers the verification of the existence of the inventory of displays because the design commitment and acceptance criteria of the ITAAC table refer to the' Design Description of Subsection 2.11.4 directly. Therefore, the current ITAAC meets the guidance of SRP 14.3 for this system."

The staff believes that ITAAC to verify the alarm function of the CHS system is appropriate. You have stated in RAI responses in section 6.2.5, that an alarm function will be required for the hydrogen monitor. (see response to RAI 6.2.5-4) Therefore a discreet ITAAC to verify the alarm function for this system would be consistent with the Containment Isolation System ITAAC selection criteria specified in Tier 2 chapter 14.3.4.11 and similar practice in the other Tier 1 ITAAC tables.

Provide ITAAC required to verify the minimum inventory of alarms, displays and controls are provided for the CHS system

2) As a minimum, for those systems with containment isolation functions, ensure ITAAC is created to verify the display of position indication of the containment isolation valves in the MCR in the respective systems listed in RAI 14.3.4.11- 22.

ANSWER:

1) The CHS design description in Subsection 2.11.4.1 will be revised to add the hydrogen concentration alarm to the "Location and Functional Arrangement" description, which is subject to ITAAC Item 1 in Table 2.11.4-1. MHI considers this to be the appropriate level of detail for the non-safety related CHS functions. This change is included in the response to question 14.03.11-18.

2) The containment isolation valves will be consolidated into Tier 1 Table 2.11.2-1 per MHI's responses to question 14.03.11-22 and RAI 184-1912 question 14.03.07-27. Therefore, the containment isolation ITAAC in Table 2.11.2-2, *Containment Isolation System Inspections, Tests, Analyses, and Acceptance Criteria* will apply to all of the CIVs in the expanded Table 2.11.2-1. ITAAC Item 11 in Table 2.11.2-2 will verify the as-built MCR displays for CIVs. MHI will revise DCD Tier 1 as needed to ensure each of the CIVs in revised Table 2.11.2-1 is included in its appropriate table of alarms, displays and controls.

Impact on DCD

This revision affects DCD Revision 1. The columns in the affected tables shown below reflect the changes similar to those described in MHI's Response to RAI 191 Question 14.03.05-05, to clarify the presentation of MCR and RSC alarms, displays and controls.

(1) Tier 1 Table 2.4.4-4 will be revised as follows (affected row is shown):

Equipment/Instrument Name	MCR/ RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Accumulator Nitrogen Supply Containment Isolation Valve SIS-AOV-114	No	Yes	Yes	Yes

(2) Tier 1 Table 2.4.6-4 will be revised as follows:

Equipment Name	MCR /RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Charging Pump (Run Status)	No	Yes	Yes	Yes
Charging Flow	Yes	Yes	Yes	Yes
Letdown Flow	Yes	Yes	Yes	Yes
RCP Seal Injection Flow	Yes	Yes	Yes	Yes
Primary Makeup Water Supply Flow	Yes	Yes	Yes	Yes
Volume Control Tank Water Level	Yes	Yes	Yes	Yes
Letdown Containment Isolation Valve (CVS-AOV-005,006)	No	Yes	Yes	Yes
CVCS Charging Line Containment Isolation Valves (CVS-MOV-152)	No	Yes	Yes	Yes
RCP Seal Injection Line Containment Isolation (CVS-MOV-178 A, B, C, D)	No	Yes	Yes	Yes
RCP Seal Return Line Containment Isolation Valve (CVS-MOV-203,204)	No	Yes	Yes	Yes

(3) Revise the paragraph in Tier 1 Section 2.7.1.10.1 under "Alarms, Displays, and Controls" as follows:

> ~~There are no important alarms, displays, and controls.~~ **Table 2.7.1.10-3 identifies alarms, displays, and controls associated with the SGBDS that are located in the main control room.**

(4) The following Table will be added to Tier 1 Section 2.7.1.10

Table 2.7.1.10-3 Steam Generator Blowdown System Equipment, Alarms, Displays, and Control Functions

Equipment Name	MCR /RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
SG blowdown Isolation valves (SGS-AOV-001 A,B,C,D)	No	Yes	Yes	Yes
SG Blowdown sampling line Isolation valves (SGS-AOV-031 A,B,C,D)	No	Yes	Yes	Yes

(5) Table 2.7.1.10-3 will be re-numbered as follows:

Table 2.7.1.10-~~3~~ 4 Steam Generator Blowdown System Inspections, Tests, Analyses, and Acceptance Criteria

(6) Subsection 2.7.1.10.2 will be revised as follows:

Table ~~2.7.1.10-3~~ **2.7.1.10-4** describes the ITAAC for the SGBDS.

(7) Add the following ITAAC to (re-numbered) Table 2.7.1.10-4:

10. MCR alarms and displays of the parameters identified in Table 2.7.1.10-3 can be retrieved in the MCR.	**10. Inspections will be performed for retrievability of the SGBDS parameters in the as-built MCR.**	**10. The MCR alarms and displays identified in Table 2.7.1.10-3 can be retrieved in the as-built MCR.**
11. Remote shutdown console (RSC) alarms, displays and controls are identified in Table 2.7.1.10-3.	**11. Inspections of the as-built RSC alarms, displays and controls will be performed.**	**11. Alarms, displays and controls exist on the as-built RSC as identified in Table 2.7.1.10-3.**

(8) Tier 1 Section 2.7.6.7.1 under "Alarms, Displays, and Controls" will be revised as follows:

Table 2.7.6.7-3 identifies alarms, displays, and controls associated with the PSS that are located in the main control room. ~~There are no important alarms, displays, and controls.~~

(9) Insert the following table into Tier 1 Section 2.7.6.7:

Table 2.7.6.7-3 Process and Post-accident Sampling System Equipment, Alarms, Displays, and Control Functions

Equipment Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Containment isolation valve inside CV on gas sample from Pressurizer (PSS-AOV-003)	No	Yes	Yes	Yes
Containment isolation valve inside CV on liquid sample from Pressurizer (PSS-MOV-006)	No	Yes	Yes	Yes
Containment isolation valves inside CV on sample from RCS Hot Leg (PSS-MOV-013,023)	No	Yes	Yes	Yes
Containment isolation valves outside containment on sample from RCS Hot Leg (PSS-MOV-031A,B)	No	Yes	Yes	Yes
Containment isolation valves inside CV on sample from Accumulator (PSS-AOV-062 A,B,C,D)	No	Yes	Yes	Yes
Containment isolation valve outside CV on sample from Accumulator (PSS-AOV-063)	No	Yes	Yes	Yes
Containment isolation valve outside CV on post-accident liquid sample return to containment sump (PSS-MOV-071)	No	Yes	Yes	Yes
Isolation valves on RHR down stream of containment spray and residual heat removal heat exchanger (PSS-MOV-052 A,B)	No	Yes	Yes	Yes

(10) Re-number Table 2.7.6.7-3 as follows:

Table 2.7.6.7-~~3~~ 4Process and Post-accident Sampling System Inspections, Tests, Analyses, and Acceptance Criteria

(11) Revise Subsection 2.7.6.7.2 as follows:

Table ~~2.7.6.7-3~~ **2.7.6.7-4** describes the ITAAC for process and post-accident sampling system.

(12) Insert the following ITAAC Item into (re-numbered) Table 2.7.6.7-4:

12. MCR alarms and displays of the parameters identified in Table 2.7.6.7-3 can be retrieved in the MCR.	12. Inspections will be performed for retrievability of the PSS parameters in the as-built MCR.	12. The MCR alarms and displays identified in Table 2.7.6.7-3 can be retrieved in the as-built MCR.

13. Remote shutdown console (RSC) alarms, displays and controls are identified in Table 2.7.6.7-3.	13. Inspections of the as-built RSC alarms, displays and controls will be performed.	13. Alarms, displays and controls exist on the as-built RSC as identified in Table 2.7.6.7-3.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

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APPLICATION SECTION:	**14.3.4.11**

DATE OF RAI ISSUE: 2/26/2009

QUESTION NO.: 14.03.11-25

Define ITAAC to verify the automatic activation of the hydrogen igniters when required.

In a letter dated September 18, 2008, Mitsubishi responded to RAI 14.3.4.11-9 that:

The igniters are activated automatically upon the receipt on an ECCS actuation signal. For severe accident events, actuation of the igniters before the onset of core damage is necessary. However, the igniter requirement is for a severe accident event, so that activation of the igniter by an ECCS actuation signal is not safety-related function, and an ECCS actuation signal for the igniter is required to be appropriately isolated from the safety divisions. All safety signals, including an ECCS actuation signal, are isolated between safety and non-safety divisions in the communication systems as described in Section 2.5.1 of Tier 1, and this isolation feature is verified in ITAAC #10J.3 of Table 2.5.1-5.

The NRC staff has reviewed the response and has identified that the following needs to be addressed by the applicant:

1) Confirm that the ITAAC to which you refer is #10.J.3 of Table 2.5.1-5 or #10i.3 of Table 2.5.1-5.

2) Based on you response, it is not clear how the igniters will activate automatically upon receipt of an ECCS signal. Provide clarification on how automatic activation of the hydrogen igniters will be accomplished.

ANSWER:

1) The intended ITAAC reference is Item 10.i.3 in Table 2.5.1-5.

2) DCD Tier 2 Subsections 6.2.5 and 7.3.1.5.1 describe hydrogen igniter actuation. The hydrogen igniters are provided for beyond design basis events. They are automatically actuated upon receipt of an ECCS actuation signal. They may also be actuated remote manually in the MCR. As further described in Tier 2 Subsection 7.3.1.5.1, hydrogen igniter actuation is a

non-safety related function actuated by the protection and safety monitoring system (PSMS). Isolation is provided within PSMS for this function.

An ITAAC item will be added to verify the ECCS actuation signal to start the hydrogen igniters. Refer to MHI's response to question 14.03.11-20.

Impact on DCD

Refer to MHI's response to question 14.03.11-20.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

4/23/2009

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APPLICATION SECTION:	**14.3.4.11**
DATE OF RAI ISSUE:	**2/26/2009**

QUESTION NO.: 14.03.11-26

Clarify ITAAC to verify containment isolation valve electrical redundancy.

The staff requested, in RAI 14.3.4.11-15, that the applicant provide justification for the lack of ITAAC that verifies independent power sources for containment isolation valves located in series on the same containment penetration.

In a letter dated September 18, 2008, Mitsubishi responded to RAI 14.3.4.11-15 that MHI believes that electrical redundancy is verified by the current ITAAC. ITAAC #6.b states that the Class 1E components, identified in Table 2.11.2-1, are powered from their respective Class 1 E division. ITAAC #6.c also states that separation is provided between Class 1 E divisions, and between Class 1 E divisions and non-Class 1 E cable. These ITAAC are to verify electrical redundancy and independence. So, these ITAAC cover the corresponding this key design feature, which states where actuation of two power-operated isolation valves on the same penetration (in series) is required, electrical redundancy is provided by independent power sources.

The staff has reviewed the response and has identified that the following needs to be addressed by the applicant:

1) Please provide a separate ITAAC item that verifies that redundant Containment isolation valves which require electrical power are powered from different Class 1E divisions. Alternatively, the verification of independent power sources for redundant containment isolation valves in series can be carried out through the existing ITAAC if additional information is provided in Table 2.11.2-1. The table should include the valve locations (i.e., the specific containment penetration line) and the power sources of the valve. A review of this information along with the existing ITAAC #6b and #6c will verify the electrical redundancy and independence.

ANSWER:

As stated in the containment isolation system (CIS) Key Design Features of Tier 1 Subsection 2.11.2, electrical redundancy is provided where actuation of two power-operated isolation valves on the same penetration (in series) is required. MHI will add an ITAAC item to Table 2.11.2-2 to specifically verify this feature.

Impact on DCD

This revision affects DCD Revision 1. See Attachment 3 for a mark-up of DCD Tier 1, Section 2.11, Revision 2. (affected portion is also described below.)

Tier 1 Table 2.11.2-2 *Containment Isolation System Inspections, Tests, Analyses, and Acceptance Criteria* will be revised to add the following ITAAC item:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
15. CIVs listed in Table 2.11.2-1 for which actuation of two power-operated isolation valves on the same penetration (in series) is required, have electrical redundancy provided by independent power sources.	15. Inspection of the as-built CIVs will be performed.	15. A report exists and concludes that the CIVs listed in Table 2.11.2-1 for which actuation of two power-operated isolation valves on the same penetration (in series) is required, have electrical redundancy provided by independent power sources.

Impact on COLA

There is no impact to the COLA.

Impact on PRA

There is no impact to the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/23/2009

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SRP SECTION:	**14.03.11 – Containment Systems and Severe Accidents – Inspections, Tests, Analyses, and Acceptance Criteria**
APPLICATION SECTION:	**14.3.4.11**
DATE OF RAI ISSUE:	**2/26/2009**

QUESTION NO.: 14.03.11-27

Specify discrete valve closure time acceptance criteria for ITAAC related to verification of valve closure times.

The US-APWR DCD Tier 1 Table 2.11.2-2 Containment Isolation System Inspection, Tests, Analyses, and Acceptance Criteria does not contain specific Acceptance Criteria (i.e. valve closure times) for ITAAC item 8, related to the verification that containment isolates within the design time limit.

The US-APWR DCD Tier 1 Table 2.11.2-2, Design commitment #8, and other system ITAAC tables in Tier 1 which include similar containment isolation design commitments, do not specify the valve closure time limits for each CIV in the system.

DCD Tier 2 Chapter 14.3.4.11 lists valve closure times as one of the design commitments to be verified when developing Containment Isolation System ITAAC. Likewise, RG 1.206 C.II.1.2.11 states that applicants for a design certification should develop ITAAC to verify containment isolation valve closure times. RG 1.206 C.II.1, "Design Description and ITAAC Design Description" State that the Acceptance criteria should identify the proposed specific acceptance criteria, and such acceptance criteria should be objective and unambiguous in order to prevent misinterpretation. Numeric performance values for SSCs may be specified as ITAAC when values consistent with the design commitments are possible or when failure to meet the stated acceptance criterion would clearly indicate a failure to properly implement the design.

Specific CIV closure times are provided in DCD Tier 2, Table 6.2.4-3. These values are used by the NRC staff to evaluate the adequacy of the containment isolation system as it relates to isolation of the containment.

Revise Tier 1 Table 2.11.2-2, and other Tier 1 tables that contain containment isolation valves to reference a discrete closure time for each valve.

ANSWER:

CIV closure times will be added to the ITAAC acceptance criteria for valves in DCD Tier 2 Table 6.2.4-3 that have an automatic actuation function and an associated closure requirement. Refer to MHI's response to RAI 184-1912 question 14.03.07-27 for more details concerning CIV closure times.

Impact on DCD

Refer to MHI's response to RAI 184-1912 question 14.03.07-27.

Impact on COLA

There is no impact on the COLA.

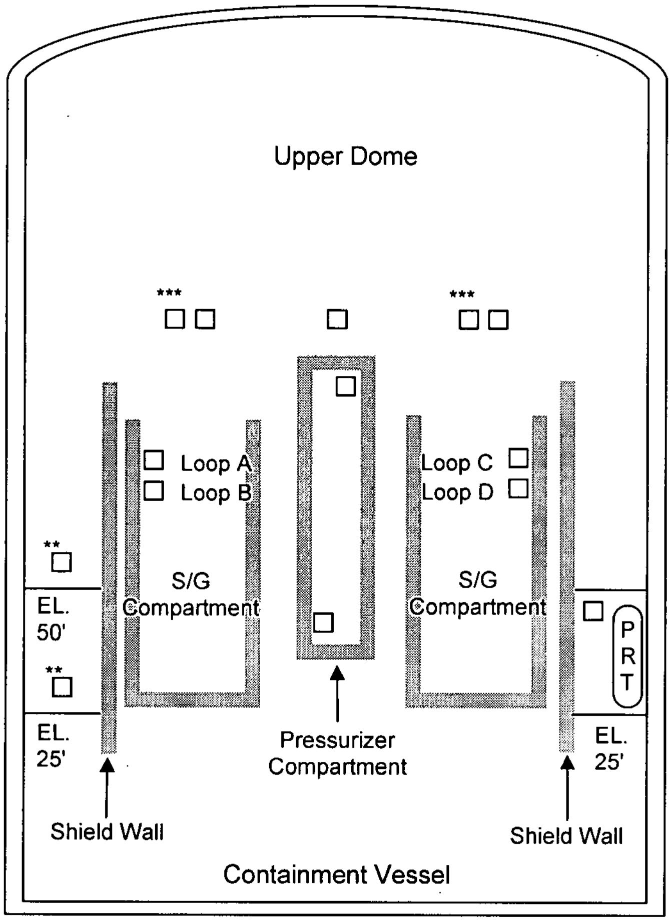
Impact on PRA

There is no impact on the PRA.

Attachment 1

US-APWR DCD Tier 1 New Figure 2.11.4-1

RESPONSE TO RAI No. 222-1933



Notes:

This schematic provides only approximate location of Igniters and is not to scale

** Igniters located in ~90^0 locations around the CV, two each are powered from separate power supply panels

*** Igniters installed above S/G and Pressurizer compartments

☐ Hydrogen Igniters

Figure 2.11.4-1 Containment Hydrogen Monitoring and Control System

Attachment 2

US-APWR DCD Tier 2 Section 14.3 Mark-up

RESPONSE TO RAI No. 222-1933

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- 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 Insights and Assumptions

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 insights or assumptions from the probabilistic risk assessment (PRA) related to the SSC
- 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 from key safety and integrated plant safety analyses in Tier 2, where plant performance is dependent on contributions from multiple systems of the design;

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. ~~It~~ They cross references 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

~~with t~~The information in these tables is ~~provided~~ sufficiently detailed to ~~allow~~ assist a COL applicant or licensee ~~to consider~~ in determining whether a proposed design change impacts the treatment of these parameters in Tier 1. ~~This~~ These tables, especially Table 14.3-1d, also contains key insights and key assumptions identified through the PRA (i.e. major risk significant SSCs).

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.

~~The process used to develop Table 14.3-1 involved consideration of the results of analyses related to flooding, safety analysis, fire protection, transients, anticipated transients without scram (ATWS), and radiological accidents.~~ These key designs features are derived from appropriate Tier 2 chapters such as Chapters 2 through 10, 15, 16 and 19.

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
- Numbers are expressed in English units
- Pressures are expressed in units that indicate whether the value is absolute, gauge, or differential

14.3.3.7 ITAAC Tabular Format and General Content

Table 14.3-2 provides examples of the arrangement of the ITAAC tables in Tier 1 and of typical content. All ITAAC are numbered similar to those shown in the table.

The first column of the ITAAC table identifies the proposed design requirement and/or commitment to be verified. This column contains the specific text of the design commitment, which is extracted from the design description. In cases where the specific design commitment is summarized, the statement in the first column retains the principal performance characteristics and safety functions of the design feature to be verified.

The second column of the ITAAC table identifies the proposed method – inspection, testing, analysis, or some combination of the three – by which the licensee will verify the design requirement/commitment described in first column.

The third column of the ITAAC table identifies the proposed specific acceptance criteria for the inspections, tests, and/or analyses described in second column that, if met, demonstrate that the licensee has met the design requirements/commitments in first column. These criteria are intended to be objective and unambiguous to prevent misinterpretation. When numeric performance values for SSCs are specified, these values are those assumed in the safety analyses, rather than the design values.

Criteria used for determining the most appropriate inspection, test, or analysis (or the appropriate combination of the three) for different types of SSCs are discussed in Subsections 14.3.4.2 through 14.3.4.13.

14.3.4 Chapter 2 of Tier 1, Development of Specific ITAAC

This subsection summarizes how ITAAC are developed for the various sections of Chapter 2. To completely define the US-APWR design as it is to be certified by the NRC, it is necessary to address major plant systems. Tables 14.3-3 through 14.3-7 identify the systems considered for ITAAC purposes by category, with the categories as follows:

- Reactor systems
- Instrumentation and control systems
- Electrical systems
- Plant systems
- Containment systems

System ITAAC differ depending on the type of system, with differences among fluid systems, I&C systems, and electrical systems. In some cases, ITAAC are provided for key parameters for accident analyses using information summarized in Tables 14.3-1a through 14.3-1f. Examples of typical ITAAC are provided in Table 14.3-2.

The ITAAC design commitments are developed from the Tier 1 design descriptions and are subject to a similar approach to determining level of detail, as described in

Subsection 14.3.3.2. ITAAC for non-safety related SSCs in the certified design may be limited to inspection of the functional arrangement to verify conformance with the design description. Non-safety SSCs that are risk-significant, or that have a severe accident mitigation or prevention function, are verified to exist in the as-built plant by ITAAC.

14.3.4.1 ITAAC for Site Parameters

Section 2.1 of Tier 1, which addresses site parameters, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 2.0 (Reference 14.3-5). No ITAAC are provided for site parameters. Instead key site design parameters associated with the US-APWR standard design are identified and their values specified; these values are selected to accommodate a wide range of potential sites. An actual site for construction of a US-APWR plant will be acceptable if its characteristics fall within the specified design parameter values.

14.3.4.2 ITAAC for Structural and Systems Engineering

Section 2.2 of Tier 1, which addresses structural and systems engineering, is prepared in accordance with the guidance in RG 1.206 (Reference 14.3-1), SRP 14.3 (Reference 14.3-2), and SRP 14.3.2 (Reference 14.3-6). ITAAC for structural and systems engineering focus on building structures. The design for the structural aspects of major components, such as the reactor vessel, pressurizer, and steam generator is addressed in Sections 2.3 and 2.4 of Tier 1. The different matters are addressed for each building as applicable. These matters and the associated General Design Criteria (GDC) of Appendix A to 10 CFR 50 (Reference 14.3-24) are as follows:

- Pressure boundary integrity (GDC 14, "Reactor Coolant Pressure Boundary, GDC 16, "Containment Design," and GDC 50, "Containment Design Basis")
- Normal loads (GDC 2, "Design Bases for Protection Against Natural Phenomena")
- Seismic loads (GDC 2)
- Flood, wind, and tornado (GDC 2)
- Rain and snow (GDC 2)
- Pipe rupture (GDC 4)
- Codes and standards (GDC 1, "Quality Standards and Records")
- Containment integrity (GDC 16, "Containment Design")
- As-built reconciliation

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Table 14.3-1 Safety Analyses and PRA Insights and Assumptions

(Sheet 1 of 6)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.1-1.	Key site parameters are specified in Table 2.1-1.	Table 2.0-1
Subsection 2.2.2.1	The external walls that are below flood level are adequate thickness to protect against water seepage, and penetrations in the external walls below flood level are provided with flood protection features.	Subsection 3.4.1.2
Subsection 2.2.2.1	Construction joints in the exterior walls and base mats are provided with water stops to prevent seepage of ground water.	Subsection 3.4.1.2
Subsection 2.2.2.1	The waterproofing system primarily consists of a waterproofing membrane applied to the below-grade building exterior surfaces and/or the use of a concrete design mix, which has reduced porosity, for exterior walls and foundation.	Subsection 3.4.1.2
Subsection 2.2.2.2	Elevation -26 ft, 4 in. in radiological controlled area (RCA) of the R/B is divided into four areas, by concrete walls and water-tight door. Water-tight doors are provided in each Spray/RHR pumps and SIS pumps rooms, and also provided in doorways between A/B and R/B.	Subsection 3.4.1.5.2.1
Subsection 2.2.2.2	Elevation -26 ft, 4 in. in the non-radiological controlled area (NRCA) of the R/B is divided into two areas by concrete walls and water-tight door installed in the corridor. The two trains of four emergency feed water pump rooms are isolated by concrete walls and water-tight door. Water tight doors are provided in doorways at ground level between T/B and R/B.	Subsection 3.4.1.5.2.2
Subsection 2.2.2.3	Redundant safe shutdown components and associated electrical divisions outside the containment and the control room complex are separated by 3-hour rated fire barriers to preserve the capability to safely shutdown the plant following a fire. The 3-hour rated fire barriers are placed as required by the fire hazard analysis.	Subsection 9.5.1.2.1
Subsection 2.2.2.3	All penetrations and openings through the fire barriers are protected with 3-hour rated components (i.e. fire doors in door openings, fire dampers in ventilation duct openings, and penetration seals).	Subsection 9.5.1.2.1

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

Table 14.3-1 Safety Analyses and PRA Insights and Assumptions

(Sheet 2 of 6)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.4.2-5	The sum of the capacities of the pressurizer safety valves exceeds 1.728×10^6 lb/hr.	Subsection 5.2.2
Table 2.4.2-5	Pressurizer safety valves set pressure; ≥ 2435 psig and ≤ 2485 psig	Section 16.1 (3.4.10)
Table 2.4.2-5	The reactor coolant flow rate per loop with 10% steam generator plugging is at least 112,000 gallons per minute.	Section 5.1 Table 5.1-3
Table 2.4.4-5	The water volume injected from each accumulator into reactor vessel is ≥2126 ft^3. The water volume injected from each accumulator into reactor vessel during large flow is ≥1326.8 ft^3. The calculated resistance coefficient of the accumulator system (based on a cross-section area of 0.6827 ft^2) meets the requirements shown in Table 2.4.4-6.	Section 6.3 Table 6.3-5
Table 2.4.4-5	Each safety injection pump has a pump differential head of no less than 3937 ft and no more 4527 ft at the minimum flow, and injects no less than 1259 gpm and no more than 1462 gpm of RWSP water into the reactor vessel at atmospheric pressure.	Section 6.3 Figure 6.3-4 Figure 6.3-15 Figure 6.3-16
Table 2.4.4-5	The volume of the accumulator and RWSP is as follows: Each accumulator: at least 3,180 ft^3 RWSP: at least 81,230 ft^3	Section 6.3 Table 6.3-5
Table 2.4.4-5	The sodium tetraborate decahydrate (NaTB) baskets exist, with a total calculated weight of NaTB of 44,100 pounds.	Section 6.3 Table 6.3-5
Subsection 2.4.5.1	The RHRS limits the in-containment RWSP water temperature to not greater than 120° F during normal operation.	Subsection 5.4.7.1

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

Table 14.3-1 Safety Analyses and PRA Insights and Assumptions

(Sheet 3 of 6)

Tier 2 Ref.(1)	Key Design Features	Tier 1 Location(2)
Table 2.4.5-5	The product of the overall heat transfer coefficient and the effective heat transfer area, UA, of each as-built CS/RHR heat exchanger is greater than or equal to 1.852×10^6 Btu/hr-°F.	Subsection 5.4.7 Table 5.4.7-2
Table 2.4.5-5	Each CS/RHR pump is sized to deliver 3,000 gpm at a discharge head of 410 ft, and provides at least 2645 gpm net flow to the RCS when the RCS is at atmospheric pressure.	Subsection 5.4.7 Table 5.4.7-2 Figure 5.4.7-4
Table 2.4.5-5	The relief valve opens at a pressure not greater than the set pressure required to provide low temperature overpressure protection for the RCS, as determined by the LTOP system	Subsection 5.4.7.1
Table 2.4.6-5	Each CVCS charging pump provides a flow rate of greater than or equal to 160 gpm.	Subsection 9.3.4 Table 9.3.4-2
Subsection 2.5.1.1	The PSMS initiates automatic reactor trips and ESF actuations. (Table 2.5.1-2 and 2.5.1-3)	Table 7.2-3 Table 7.3-4
Subsection 2.5.3.1	The DAS is a non-safety system that is diverse from the software of the PSMS, and is also diverse from the hardware used in the reactor trip function of the RT system.	Section 7.8
Subsection 2.5.3.1	The DAS provide automatic actuation functions for conditions where there is insufficient time for manual operator action needed for the accident mitigation. (Tables 2.5.3-2 and 2.5.3-3)	Table 7.8-4 Table 7.8-5
Subsection 2.6.4.1	The Class 1E emergency power sources (EPSs) are capable to provide power at set voltage and frequency to the Class 1E 6.9kV buses within 100 seconds from the start signal.	Subsection 8.3.1.1.3
Subsection 2.6.5.1	AAC power sources are non-Class 1E and non-seismic. The AAC power sources are of different size and have different starting system from the EPSs.	Subsection 8.4.1.3

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

Table 14.3-1 Safety Analyses and PRA Insights and Assumptions

(Sheet 4 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
Subsection 2.7.1.2.1	Six main steam safety valves (MSSVs) are provided per main steam line. MSSVs with sufficient rated capacity are provided to prevent the steam pressure from exceeding 110 percent of the MSS design pressure.	Subsection 10.3.2.3.2
Table 2.7.1.2-4	The valves close within the following times after receipt of an actuation signal. The main steam isolation valves (MSIVs) close within 5 seconds. The main steam relief valve block valves (MSRVBVs) close within 30 seconds.	Subsection 10.3.2.3.4
Table 2.7.1.2-4	The sum of the rated capacities of the MSSVs exceeds 21,210,000 lb/hr.	Subsection 10.3.2 Table 10.3.2-2
Table 2.7.1.2-4	The flow restrictor within the SG main steam line discharge nozzle does not exceed 1.4 sq. ft.	Subsection 15.1.5.2
Table 2.7.1.9-5	The valves close within the following times after receipt of an actuation signal. The main feedwater isolation valves (MFIVs) close within 5 seconds.	Subsection 10.4.7.2.2
Subsection 2.7.1.11.1	The EFWS has the capability to permit operation at hot shutdown for eight hours followed by six hours of cooldown to the initiation temperature of residual heat removal system.	Subsection 10.4.9.1
Table 2.7.1.11-5	Two of the EFW pumps deliver at least 705 gpm to the any of two SGs against a SG pressure up to the set pressure of the first stage of main steam safety valve plus 3 percent.	Subsection 10.4.9.2.1 Table 10.4.9-2
Table 2.7.1.11-5	The usable volume of the each EFW pit is greater than or equal to 186,200 gallons.	Subsection 10.4.9.3
Table 2.7.1.11-5	The motor-driven EFW pumps start within 140 seconds. The turbine-driven EFW pumps start within 60 seconds.	Subsection 10.4.9.3

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

Table 14.3-1 Safety Analyses and PRA Insights and Assumptions

(Sheet 5 of 6)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Subsection 2.7.5.1.1	Performance values of the MCR HVAC system used in the safety analysis are shown as below: Unfiltered inleakage via ingress/egress : 120cfm Filtered air intake flow : 1200 cfm Filtered air recirculation flow : 2400 cfm Filter efficiency Elemental iodine : 95% Filter efficiency Organic iodine : 95% Filter efficiency Particulates : 99%	Table 15.6.5-5
Subsection 2.7.5.2.1.1	Penetration and Safeguard Component Areas negative pressure arrival time : 240 sec Filter efficiencies for Particulates : 99%	Table 15.6.5-4
Subsection 2.7.6.9.1	The seismic standpipe system can be supplied from a safety-related water source which capacity is at least 18,000 gallons.	Subsection 9.5.1.2.4
Subsection 2.7.6.9.1	Provide sufficient water for the largest sprinkler system plus manual hose streams to support fire suppression activities for two hours or longer, but not less than 300,000 gallons. Redundant water supply capability is provided.	Subsection 9.5.1.1
Subsection 2.7.6.9.1	The fire protection system (FPS) fire water supply is available as an alternative component cooling water source for severe accident prevention.	Subsection 9.5.1.2.2
Subsection 2.7.6.9.1	The FPS water supply is available to the containment spray system and water injection to the reactor cavity for severe accident mitigation.	Subsection 9.5.1.2.2
Subsection 2.2.1.1 Table 2.11-1	The containment design pressure is 68 psig. The PCCV is designed for an external pressure of 3.9 psig. The containment design temperature is 300° F. Free volume of containment is 2,800,000 ft^3.	Table 3.8.1-1 Table 6.2.1-2 Table 6.5-5
Subsection 2.11.1.1	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.	Subsection 19.2.3.3.3

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

~~Table 14.3-1 Safety Analyses and PRA Insights and Assumptions~~

~~(Sheet 6 of 6)~~

~~Tier 1 Ref.~~[(1)]	~~Key Design Features~~	~~Tier 2 Location~~[(2)]
~~Subsection 2.11.1.1~~	~~The consequences of a postulated high pressure melt ejection accident are mitigated by a debris trap in the reactor cavity as well as no direct pathway to the upper compartment for the impingement of debris on the containment shell.~~	~~Subsection 19.2.3.3.4~~
~~Subsection 2.11.1.1~~	~~There is a liner plate covering concrete as the floor surface of the reactor cavity, which gives a protection of short-term attack by relocated core debris.~~	~~Subsection 19.2.3.3.3~~
~~Table 2.11.3-5~~	~~Two CS/RHR pumps deliver no less than 5290 gpm of RWSP water into the containment.~~	~~Subsection 6.2.1 and Table 6.2.1-5~~
~~Subsection 2.11.4.1~~	~~The CHS includes a single hydrogen monitor and a set of igniters.~~	~~Subsection 6.2.5~~
~~Section 2.13~~	~~US-APWR design reliability assurance program provides reasonable assurance that: 1) the US-APWR is designed, constructed, and operated in a manner that is consistent with the assumptions and risk insights for the SSCs, 2) the SSCs do not degrade to an unacceptable level during plant operations, 3) the frequency of transients that challenge SSCs is minimized, and 4) the SSCs function reliably when challenged.~~	~~Section 17.4~~

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

<u>Table 14.3-1a Design Basis Accident Analysis Key Design Features</u>

<u>(Sheet 1 of 7)</u>

Tier 1 Ref.[(1)]	Key Design Features	Tier 2 Location[(2)]
1.2	US-APWR rated reactor core thermal power is 4451 MWt.	1.1.4 Table 4.4-1 Table 6.2.1-4 Table 15.0-2 Table 15.6.5-1 Ch. 16, TS 1.1

Table 2.2-4 Table 2.3-2 2.4.1, 2.4.2 2.4.4, 2.4.5 2.4.6	RCPB components are designed and fabricated in accordance with 10 CFR 50.55a which requires compliance with the requirements for Class 1 components in the American Society of Mechanical Engineers (ASME) Code.	5.2 6.3 9.3.4
2.4.1 Table 2.4.1-2	Ferritic reactor coolant pressure boundary materials meet 10CFR50 Appendix G fracture toughness criteria and requirements for testing.	5.2.3.3 5.3.1
2.4.2.1 Table 2.4.2-5	The pressurizer safety valves provide overpressure protection in accordance with the ASME Code Section III. This overpressure protection is provided for the following bounding events • Loss of external electrical load. • Loss of normal feedwater flow. • Reactor coolant pump shaft break. • Uncontrolled rod cluster control assembly bank withdrawal from a subcritical or low-power startup condition. • Spectrum of rod ejection accidents. The sum of the capacities of the pressurizer safety valves exceeds 1.728×10^6 lb/hr (432,000 lb/hr per valve).	5.2.2.1 Table 5.2.2-1
Table 2.4.2-5	Pressurizer safety valves set pressure; ≥ 2435 psig and ≤ 2485 psig	Table 5.2.2-1
Table 2.4.2-5	The reactor coolant flow rate per loop with 10% steam generator tube plugging is at least 112,000 gallons per minute.	Table 5.1-3

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

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

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Tier 1 Ref.[(1)]	Key Design Features	Tier 2 Location[(2)]
Table 2.4.5-5	The CS/RHR relief valves open at a pressure not greater than the set pressure required to provide low temperature overpressure protection for the RCS, as determined by the LTOP system	5.4.7.1
2.2.1.2 Table 2.2-4 Table 2.11.1-1 Table 2.11.1-2	The PCCV is a prestressed concrete structure designed to endure the peak pressure and temperature for LOCA, and steamline and feedline break conditions.	3.8.1.3 Table 3.8.1-1 6.2.1.1 Table 6.2.1-2
Figure 2.11.1-1 Table 2.11.1-2	The inner height of the containment is approximately 226.5 ft and the inside diameter of the containment cylinder measures approximately 149 ft. The containment dome is 3 ft.-8 in. or 4 ft.-4 in. thick, while the containment wall thickness is 4 ft.-4 in. The inner surface of containment includes a 0.25 in. welded steel plate liner anchored to the concrete.	6.2.1.1.2
Table 2.2-1 Table 2.2-4 2.11.1.1 Table 2.11.1-2	The PCCV is designed and constructed in accordance with ASME Code, Section III, and the PCCV is classified as seismic Category I structure.	3.8.1.2 6.2.7
2.2.1.2 Table 2.2-4	The liner plate is not designed or analyzed as a strength structural element. The minimum concrete design compressive strength (f'c) for the PCCV is 6000 psi. The minimum concrete design compressive strength (f'c) for the basemat is 4000 psi. The ultimate capacity for the PCCV is estimated based on cumulative yield strength of steel materials such as rebars, tendons, and liner plate.	3.8.1.1.1 Table 6.2.1-2 19.2.4.1
Table 2.11.1-1 Table 2.11.1-2	The containment design pressure is 68 psig. The PCCV is designed for an external pressure of 3.9 psig based on conservative analysis of inadvertent CSS operation. The containment design temperature is 300°F. Free volume of containment is 2,800,000 ft^3.	Table 3.8.1-1 6.2.1.5.3 Table 6.2.1-2 Table 6.5-5 15.4.8.4 15.6.5

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

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

(Sheet 3 of 7)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
Table 2.4.2-5	RCPs have a rotating inertia to provide coastdown flow.	5.4.1 15.3.1.1 15.6.5.2
Table 2.4.4-5	Each safety injection pump has a pump differential head of no less than 3937 ft and no more 4527 ft at the minimum flow, and injects no less than 1259 gpm and no more than 1462 gpm of RWSP water into the reactor vessel at atmospheric pressure.	Table 6.2.1-5 6.3 Figure 6.3-4 Figure 6.3-15 Figure 6.3-16
2.4.4.1 Table 2.4.4-5	Four (4) ECCS accumulators store borated water under pressure and automatically inject it into the RCS if the reactor coolant pressure decreases below the accumulator pressure. The volume of each accumulator is at least 3,180 ft^3, considering the total water volume and adding the volume of gas space and dead water volume.	Table 6.2.1-4 Table 6.2.1-5 6.3.2.2.2 Table 6.3-5
Table 2.4.4-5	The water volume injected from each accumulator into reactor vessel is $\geq$2126 ft^3. The water volume injected from each accumulator into reactor vessel during large flow is $\geq$1326.8 ft^3. The calculated resistance coefficient of the accumulator system (based on a cross-section area of 0.6827 ft^2) meets the requirements shown in Table 2.4.4-6.	6.3 Table 6.3-5
2.4.4.1 Table 2.4.4-5	The RWSP is the source of borated water for emergency core cooing and containment spray systems. The volume of the RWSP is at least 81,230 ft^3 taking into account ineffective pit volume and containment cavities and pits where water may be trapped and not drain to the RWSP.	6.2.2.2.5 Table 6.2.1-3 Table 6.2.1-4 Figure 6.2.2-7 6.3 Table 6.3-5
2.4.5.1	The RHRS limits the in-containment RWSP water temperature to not greater than 120° F during normal operation.	5.4.7.1 Table 6.2.1-4 Ch. 16 TS 3.5.4

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

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

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Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.4.5-5	Each CS/RHR pump is sized to deliver 3,000 gpm at a discharge head of 410 ft, and provides at least 2645 gpm net flow to the RCS when the RCS is at atmospheric pressure.	5.4.7 Table 5.4.7-2 Figure 5.4.7-4 6.2.2 Table 6.2.1.5
Table 2.4.5-5	The product of the overall heat transfer coefficient and the effective heat transfer area, UA, of each as-built CS/RHR heat exchanger is greater than or equal to 1.852×10^6 Btu/hr-°F.	5.4.7 Table 5.4.7-2 6.2.2 Table 6.2.1-5
Table 2.4.6-5	Each CVCS charging pump provides a flow rate of greater than or equal to 160 gpm.	9.3.4 Table 9.3.4-2
2.5.1.1 Table 2.5.1-5	The PSMS initiates automatic reactor trips and ESF actuations, when the plant process signals reach a predetermined limit. (Table 2.5.1-2 and 2.5.1-3)	7.2 7.3 Table 7.2-3 Table 7.3-4
2.5.4.1 Table 2.5.4-2	The PSMS and PCMS provide plant operators with information systems important to safety for: (1) assessing plant conditions and safety system performance, and making decisions related to plant responses to AOOs; and (2) preplanned manual operator actions related to accident mitigation.	7.5
2.5.4 Table 2.5.4-2	For the monitoring of the post-accident inadequate core cooling, degree of subcooling, RV water level and core exit temperature will be measured.	4.4.6.4 7.5 7.5.1.1.3

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

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

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Tier 1 Ref.[(1)]	Key Design Features	Tier 2 Location[(2)]
2.6.4.1 Table 2.6.4-1	The Class 1E emergency power sources (EPSs) are capable to provide power at set voltage and frequency to the Class 1E 6.9kV buses within 100 seconds from the start signal.	8.3.1.1.3
2.6.4.1 Table 2.6.4-1	Each of the four divisions of the Class 1E power distribution systems is provided by a Class 1E gas turbine generator (GTG) to supply power to its dedicated safety bus as a counter measure against loss of offsite power. When loss of offsite power occurs, GTGs automatically start and would accept load in less than or equal to 100 seconds after receiving the start signal.	8.1.3.1 8.3.1.1.3
2.7.1.2.1 Table 2.7.1.2-5	Six main steam safety valves (MSSVs) are provided per main steam line. MSSVs with sufficient rated capacity are provided to prevent the steam pressure from exceeding 110 percent of the MSS design pressure. The sum of the rated capacities of the MSSVs exceeds 21,210,000 (lb/hr) for all 24 valves.	10.3.2.3.2
Table 2.7.1.2-4	The flow restrictor within the SG main steam line discharge nozzle does not exceed 1.4 sq. ft.	15.1.5.2
2.7.1.2.1 Table 2.7.1.2-4	The valves close within the following times after receipt of an actuation signal. The main steam isolation valves (MSIVs) close within 5 seconds to limit uncontrolled steam release from one SG in the event of steam line break. The main steam bypass isolation valves close within 20 seconds. The main steam relief valve block valves (MSRVBVs) close within 30 seconds. Main steam relief valve isolation is a severe accident prevention feature.	6.2.1.4.1 10.3.2.3.4
2.7.1.9.1 Table 2.11.2-2	The main feedwater isolation valves (MFIVs) close within 5 seconds after receipt of an actuation signal, to limit the mass and energy release to containment consistent with the containment analysis.	6.2.1.4.1 10.4.7.2.2
2.7.1.11.1 Table 2.7.1.11-5	Each EFW pump discharge line connects with a cross-tie line using normally closed motor-operated isolation valves to provide separation of four trains. Operation to open EFW the cross-tie valve when an EFW pump is not available is an important feature to reduce core damage frequency.	10.4.9.2 19.1.4.1 19.2.2

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

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

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Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.7.1.11-5	Two of the EFW pumps deliver at least 705 gpm to the any of two SGs against a SG pressure up to the set pressure of the first stage of main steam safety valve plus 3 percent.	10.4.9.2.1 Table 10.4.9-2
Table 2.7.1.11-5	The usable volume of each EFW pit is greater than or equal to 186,200 gallons.	10.4.9.3
Table 2.7.5.3-1	The containment fan cooler system is designed to maintain containment air temperature below 120°F during the normal operation of the plant. 120°F is used as the maximum containment temperature initial condition in the safety analyses.	6.2.1.1.3.5 Table 6.2.1-4 6.3.2.1 Ch. 16 TS 3.6.5
2.7.6.2.1 Table 2.7.6.2-1	To preclude unanticipated drainage, the spent fuel pit is not connected to the equipment drain system. A weir and gate provide physical isolation of the refueling canal from each of the pits. All the gates are located above the top elevation of the fuel seated in the SFP racks: they are normally closed and only opened as required.	9.1.3.1
Table 2.11.3-5	Two CS/RHR pumps deliver no less than 5290 gpm of RWSP water into the containment.	6.2.1 Table 6.2.1-5

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

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

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Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.5.4-2	The minimum inventory of HSIs are • Fixed position continuously visible HSI • Class 1E HSI for control of all safety-related components and monitoring of all safety-related plant instrumentation is provided on the safety VDUs, located on the MCR operator console and the remote shutdown console (Section 7.1). • Minimum inventory for degraded HSI conditions	7.1 18.7.3.2 Table 18.7-1
Table 2.5.4-2	The fixed position continuously visible HSI are provided by: The fixed area of the LDP provides indications and alarms which include : • Bypassed and inoperable status indication (BISI) parameters • Type A and B post monitoring (PAM) variables (Section 7.5, Table 7.5-3) • Safety parameter displays including status of critical safety functions and performance of credited safety systems and preferred non safety systems • Prompting alarms for credited manual operator actions and risk important HAs identified in the HRA PAM displays for Type A and B variables on the safety VDUs (Subsection 7.5.1.1) Conventional switches on the MCR operator console for system level actuation of safety functions such as reactor trip, engineering safety features actuation system (ESFAS) actuation, etc. (Tables 7.2-6 and 7.3-5)	Table 7.1-1 Table 7.2-6 Table 7.3-5 7.5 Table 7.5-3 18.7.3.2

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

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

(Sheet 1 of 2)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.1-1	Key Site Parameters (Meteorology, Hydrologic Engineering, Geology, Seismology, and Geotechnical Engineering)	Table 2.0-1
2.2.2.1 Table 2.2-4	The external walls of Seismic I and II structures that are below flood level are adequate thickness to protect against water seepage.	3.4.1.2
Table 2.2-4	Penetrations in the external walls below flood level are provided with flood protection features.	3.4.1.2
2.2.2.1	Construction joints in the exterior walls and base mats are provided with water stops to prevent seepage of ground water.	3.4.1.2
2.2.2.2 Table 2.2-4	Elevation -26 ft, 4 in. in radiological controlled area (RCA) of the R/B is divided into four areas, by concrete walls and water-tight door. Water tight doors are provided in each Spray/RHR pumps and SIS pumps rooms, and also provided in doorways between A/B and R/B.	3.4.1.5.2.1
2.2.2.2 Table 2.2-4	Elevation -26 ft, 4 in. in the non-radiological controlled area (NRCA) of the R/B is divided into two areas by concrete walls and water-tight door installed in the corridor. The two trains of four emergency feed water pump rooms are isolated by concrete walls and water-tight door. Water tight doors are provided in doorways at ground level between T/B and R/B.	3.4.1.5.2.2
2.2.2.2 Table 2.2-4	Divisional walls and water tight doors provide train separation and flood barriers to prevent flood water from spreading to adjacent divisions.	3.4.1.5.2.1
2.7.6.8 Table 2.7.6.8-1	Flood will not propagate to other areas due to the drain systems.	3.4.1.5.2 19.1.5.3 Table 19.1-115
Table 2.2-4 2.7.6.8 Table 2.7.6.8-1	R/B is divided to two divisions (e.g. east side and west side) and thus flood propagation to all four trains is prevented.	3.4.1.5.2 19.1.5.3 Table 19.1-1 Table 19.1-115

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

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

(Sheet 2 of 2)

Tier 1 Ref.[(1)]	Key Design Features	Tier 2 Location[(2)]
2.2.2 Table 2.2-4	Areas between the reactor building and the turbine building are physically separated by flood prevention equipment.	19.1.5.3 Table 19.1-115
2.3.1 Table 2.3-2	Pipe breaks (circumferential and longitudinal) are evaluated for the entire range of effects, including dynamic effects (i.e., pipe whip, jet impingement, jet thrust forces, internal forces due to system decompression, sub-compartment pressurization), environmental conditions, spray wetting, and flooding. When LBB criteria are successfully applied, evaluation of dynamic effects is not required.	3.6 6.2.1.2
2.3.1 Table 2.3-2	SSCs needed to achieve and maintain safe shutdown are protected or analyzed to mitigate the impacts of internal and external missile hazards	3.5
Applicable Tier 1 System Sections	Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.	3.11

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

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Table 14.3-1c Fire Protection Key Design Features

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.2.2.3 Table 2.2-4	Redundant safe shutdown components and associated electrical divisions outside the containment and the control room complex are separated by 3-hour rated fire barriers to preserve the capability to safely shutdown the plant following a fire. The 3-hour rated fire barriers are placed as required by the fire hazard analysis and support prevention of severe accidents due to loss of multiple trains by fire.	9.5.1.2.1
2.2.2.3 Table 2.2-4	All penetrations and openings through the fire barriers are protected with 3-hour rated components (i.e. fire doors in door openings, fire dampers in ventilation duct openings, and penetration seals).	9.5.1.2.1
2.7.6.9.1 Table 2.7.6.9-2	The seismic standpipe system can be supplied from a safety-related water source which capacity is at least 18,000 gallons.	9.5.1.2.4
2.7.6.9.1 Table 2.7.6.9-2	Two 100% capacity fire water pumps are provided: one pump is diesel-driven and one pump is electric motor-driven. Each pump provides sufficient water for the largest sprinkler system plus manual hose streams to support fire suppression activities for two hours or longer, but not less than 300,000 gallons. Redundant water supply capability is provided.	9.5.1.1
2.5.2.1 Table 2.5.2-3	Independent means to achieve safe shutdown of the reactor is provided should a fire in the MCR result in operator evacuation.	7.4.1.5
2.7.6.9.1 Table 2.7.6.9-2	Means are provided to detect and locate fires and are indicated to control room operators	9.5.1.2.6

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

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

(Sheet 1 of 4)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.2.2 Table 2.2-4	The electrical equipment room of T/B is designed to be waterproof and the first floor of T/B is equipped with relief panels. These measures prevent loss of alternate ac power due to flood in the T/B.	19.1.5.3 Table 19.1-115
2.4.2.1 Table 2.4.2-2 Figure 2.4.2-2 Table 2.4.2-5	The reactor vessel head vent valves; the safety depressurization valve (SDV) and depressurization valves (DV) could be used for high point vents to support prevention of beyond design basis events and severe accident mitigation.	5.4.12 Table 5.4.12-3 19.1.3.1 19.1.3.2 19.2.3.3 Table 19.1-1
2.4.5.1 Table 2.4.5-5	Alternate core cooling/injection utilizing CSS/RHRS is available in case all safety injection fails.	Table 19.1-1 Table 19.1-11 19.2.2
2.4.5.1 Table 2.4.5-5	Upgraded piping design pressure for the residual heat removal system (RHRS) results in a negligible frequency of occurrence of an inter-system LOCA.	19.1.3.4 Table 19.1-1
2.4.5.1 Table 2.4.5-5	To prevent loss of RCS inventory during mid-loop operation and support severe accident prevention, the low-pressure letdown line isolation valves are automatically closed and the CVCS is isolated from the RHRS, after receiving a RCS loop low-level signal.	5.4.7.2 19.1.3.4 Table 19.1-1 Table 19.1-115 19.2.2.2
2.6.5.1 Table 2.6.5-1	The AAC power sources are of different size, have different starting system from the EPS.	8.4.1.3

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

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

(Sheet 2 of 4)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.6.5.1 Table 2.6.5-1	Alternate ac power supported by two non-Class 1E GTGs is incorporated as a countermeasure against SBO. Alternate ac power sources can supply power to two of the four safety buses in case class 1E GTGs fail during loss of offsite power. AAC power sources are non-Class 1E and non-seismic. AAC power sources supply power to loads required to bring and maintain the plant in a safe shutdown condition for a station blackout (SBO) condition.	8.4.1.3 19.1.3.1 19.1.3.4 19.1.4.1 Table 19.1-1 19.2.2
2.6.5.1 Table 2.6.5-1	Circuit breaker panels of the alternate ac system and cables associated with alternate ac power to safety buses in the T/B are segregated into two groups by qualified fire barriers.	19.1.5.2 Table 19.1-1
2.7.3.6.1 Table 2.7.3.6-1	Non-essential chilled water system provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection.	Table 19.1-1
2.7.5.3.1.2 Table 2.7.5.3-1	Alternate containment cooling using the containment fan cooler system is provided to prevent containment over pressure even in case of containment spray system failure. The fan cooling units are cooled by the component cooling water system. The containment fan cooler system enhances condensation of surrounding steam by natural convection and thus enhances continuous depressurization of the containment.	9.4.6.2 19.1.3.1 Table 19.1-1 19.1.3.2 19.2.3.3.8
2.7.6.3 Table 2.7.6.3-5	As a countermeasure for loss of RHR, RCS makeup by gravity injection from spent fuel pit is available when the RCS in atmospheric pressure.	19.1.6.1 Table 19.1-1
2.7.6.9.1 Table 2.7.6.9-1	The fire protection water supply system (FSS) is available as an alternative component cooling water source for severe accident prevention, including support of CVCS for RCP seal water injection	9.5.1.2.2 19.1.3.2 19.1.5.3.2 19.2.3.3.3

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

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

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Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.7.6.9.1 Table 2.7.6.9-1	The FSS is available to the containment spray system and water injection to the reactor cavity for severe accident mitigation.	9.5.1.2.2 19.1.3.2 19.2.3.3.3
Table 2.11.1-2	A drain line is provided from the steam generator compartment to the reactor cavity to flood the reactor cavity with containment spray water during severe accidents.	19.1.3.2
2.11.1.1 Table 2.11.1-2	The core debris trap enhances capturing of ejected molten core in the reactor cavity to support severe accident mitigation. The consequences of a postulated high pressure melt ejection accident, including direct containment heating, are mitigated by the debris trap in the reactor cavity as well as no direct pathway to the upper compartment for the impingement of debris on the containment shell.	19.1.3.2 Table 19.1-1 19.2.3.3.4
2.11.1.1 Table 2.11.1-2	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 19.2.3.3.3
2.11.1.1 Table 2.11.1-2	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.	19.2.3.3.3
2.11.2.1	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 19.1-115

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

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

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Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.11.4.1 Table 2.11.4-1	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 starting at the low flammability limit (approximately 10% hydrogen in air), thereby preventing further hydrogen accumulation that could become a threat to containment integrity.	6.2.5 Figure 6.2.5-1 19.1.3.2 19.2.3
2.13 Table 2.13-1	US-APWR design reliability assurance program provides reasonable assurance that: 1) the US-APWR is designed, constructed, and operated in a manner that is consistent with the assumptions and risk insights for the SSCs, 2) the SSCs do not degrade to an unacceptable level during plant operations, 3) the frequency of transients that challenge SSCs is minimized, and 4) 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.

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Table 14.3-1e ATWS Key Design Features

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.5.3.1 Table 2.5.3-4	The DAS is a non-safety system that is diverse from the software of the PSMS, and is diverse from the hardware used in the reactor trip function of the RT system. The DAS equipment is used for the ATWS mitigation and a countermeasure to common cause failure (CCF).	7.8

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

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Table 14.3-1f Radiological Analysis Key design featur

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Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
Table 2.1-1.	The χ/Q values used in determining the radiological consequences of postulated accidents (other than the MCR and the TSC).	Table 2.0-1 Table 15.0-13 Table 15A-17
Table 2.1-1	The MCR and the TSC χ/Q values used in determining the radiological consequences of postulated accidents as follows: - Steam system piping failure analysis - RCP rotor seizure analysis - Rod ejection accident analysis - Failure of small lines carrying primary coolant outside containment and SGTR analysis - LOCA analysis - Fuel handling analysis	Table 2.0-1 Table 15A-18 Table 15A-19 Table 15A-20 Table 15A-21 Table 15A-22 Table 15A-23
2.2.1.1 Table 2.2-4 Table 2.11.1-1	Containment leak rate, 0-24 hr following LOCA, is 0.15 %/d.	6.2.1 Table 6.2.1-2 15.4.8.5 Table 15.4.8-3 15.6.5.5 Table 15.6.5-4
2.4.4.1 Table 2.4.4-5	The sodium tetraborate decahydrate (NaTB) baskets, which provide containment pH control during a LOCA, have a total calculated weight of NaTB of 44,100 pounds.	6.3.2.2.5 Table 6.3-5
2.7.5.1.1 Table 2.7.5.1-3	Performance values of the MCR HVAC system used in the safety analysis are: Unfiltered inleakage via ingress/egress : 120 cfm Filtered air intake flow : 1200 cfm Filtered air recirculation flow : 2400 cfm Filter efficiency Elemental iodine : 95% Filter efficiency Organic iodine : 95% Filter efficiency Particulates : 99%	6.4.2.3 Table 15.6.5-5

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

Table 14.3-1f Radiological Analysis Key design features

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Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.7.5.2.1.1 Table 2.7.5.2-3	Penetration and Safeguard Component Areas negative pressure arrival time : 240 sec Filter efficiencies for particulates: 99%	6.5.1 Table 15.6.5-4
Table 2.11.2-2	The low volume containment purge isolation valves response time is within 15 seconds.	15.6.5.5.1.1 Table 15.6.5-4 Chapter 16 Bases 3.6.3
Table 2.2-2 Table 2.8-1 Table 2.8-2	Shielding walls and floors for safety-related structures are provided to maintain the maximum radiation levels to meet the radiation zone.	3.8.3 Table 12.3-1 12.3.2.2
Table 2.8-1 Table 2.8-2	Shielding walls and floors for the Auxiliary Building are provided to maintain the maximum radiation levels to meet the radiation zone.	Table 12.3-1 12.3.2.2
2.2.1.1 Table 2.2-2 Table 2.2-4 2.11.1.1 Table 2.11.1-1 Table 2.11.1-2	The PCCV is comprised of the containment vessel and the annulus enclosing the containment penetration area, and provides an efficient leak-tight barrier and environmental radiation protection under all postulated conditions, including LOCA.	3.8 6.2.1 Table 6.2.1-2

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

Attachment 3

US-APWR DCD Tier 1 Table 2.11 Mark-up

RESPONSE TO RAI No. 222-1933

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The fundamental design concept of the US-APWR for severe accident termination is reactor cavity flooding and cool down of the molten core by the flooded coolant water.

Reactor cavity flooding to enhance the cool down of the molten core ejected into the reactor cavity is achieved by the CSS, whose operation during a design basis accident is described in Subsection 2.11.3. Drain lines are used to drain spray water, which flows into the SG compartments, to the reactor cavity and cools the molten core. Fire protection system (FPS) water injection may also be used to inject water to the drain lines from the SG compartment to the reactor cavity. The FPS water supply is described in Subsection 2.7.6.9.1.

The geometry of the reactor cavity is designed to assure adequate core debris coolability. Sufficient rReactor cavity floor area and appropriate reactor cavity depth are provided to enhanced spreading of the debris bed for better coolability.

Even if the depressurization of the reactor coolant system (RCS) fails, tThe consequences of a postulated high pressure melt ejection (HPME) severe accident are mitigated by the consideration of reactor cavity geometry and containment layout. The consequences of a postulated HPME are mitigated by a core debris trap in the reactor cavity as well as no direct pathway to the upper compartment for. These features prevent entrainment of the molten core to the upper part of the containment and the impingement of debris on the containment shell.

Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through.There is a liner plate covering concrete as the floor surface of the reactor cavity, which gives a protection of short-term attack by relocated core debris.

Seismic and ASME Code Classifications

The PCCV is designed and constructed in accordance with ASME Code, Section III, and the PCCV is classified as seismic Category I structure.

System Operation

The containment itself is passive in nature. The related active functions are performed by other systems, and include containment isolation described in Subsection 2.11.2, actuation of containment spray described in Subsection 2.11.3, and hydrogen monitoring and control described in Subsection 2.11.4.

Alarms, Displays, and Controls

Instruments are installed to monitor conditions inside the containment and actuate appropriate safety functions when an abnormal condition is sensed. These instruments monitor containment pressure, temperature, hydrogen concentration, radioactivity, and air effluent for containment depressurization. Their design features include the following:

- Containment pressure activates logic to initiate a variety of engineered safety feature (ESF) functions.

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Table 2.11.1-2 Containment Vessel Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The PCCV pressure boundary is designed to meet ASME Code, Section III requirements.	1. Refer to Section 2.2 ITAAC.	1. Refer to Section 2.2 ITAAC.
2. The PCCV retains structural integrity under design pressures of 68 psig.	2. Refer to Section 2.2 ITAAC.	2. Refer to Section 2.2 ITAAC.
3. The PCCV structural configuration is as shown in Table 2.2-2, Figures 2.2-3 through 2.2-11 and Figure 2.11.1-1.	3. Inspections of the as built PCCV will be performed.	3. The as-built PCCV configuration is reconciled with descriptions in Table 2.2-2, Figures 2.2-3 through 2.2-11 and Figure 2.11.1-1.
4. The A set of drain lines from the SG compartments to the reactor cavity exists.-that meets severe accident analysis requirements.	4. Inspections of the as-built drain lines to the reactor cavity will be performed.	4. A report exists and concludesThe that the as-built drain lines from the SG compartments to the as-built reactor cavity exists-that meets severe accident analysis requirements.
5. The reactor cavity includes a core debris trap.-that meets severe accident analysis requirements..	5. Inspections of the as-built reactor cavity will be performed.	5. A report exists and concludes that the The core debris trap exists in the as-built reactor cavity includes a core debris trap.that meets severe accident analysis requirements.
6. The reactor cavity includes the sufficient floor area and appropriate depth provide enhanced spreading of the debris bed for coolabilitythat meets severe accident analysis requirements..	6. Inspections of the as-built reactor cavity will be performed.	6. A report exists and concludes that reactor cavity floor area and depth provide enhanced spreading of the debris bed for coolability.The sufficient floor area and appropriate depth exists in the as-built reactor cavity that meets severe accident analysis requirements.
7. Reactor cavity floor concrete is provided to protect against challenge to liner plate melt through.The reactor cavity includes a cover concrete on the PCCV liner plate that meets severe accident analysis requirements..	7. Inspections of the as-built reactor cavity will be performed.	7. A report exists and concludesThe that the as-built reactor cavity includes cavity floor concrete which is provided to protect against challenge to liner plate melt through.cover concrete on the PCCV liner plate exists in the as-built reactor cavity that meets severe accident

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Table 2.11.1-2 Containment Vessel Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
		analysis requirements.

Where remote-manual valves are acceptable and employed, local and remote position indication is provided.

Fluid system mechanics (e.g., erosion and water hammer) and the possible effects of too-rapid closure time on valve reliability are considered in the system design.

All pneumatic containment isolation valves fail in the closed position.

Mechanical redundancy is provided by two barriers, and where actuation of two power-operated isolation valves on the same penetration (in series) is required, electrical redundancy is provided by independent power sources.

Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.

Seismic and ASME Code Classifications

The CIS is designed and constructed to meet seismic Category I and ASME Code Section III requirements, as indicated in Table 2.11.2-1. Pressure boundary welds in CIS components identified in Table 2.11.2-1 meet ASME Code Section III requirements and the welding materials used are qualified to these requirements.

System Operation

Penetrations that are normally open and are required to close have remote operated valves for isolation that close automatically on a containment isolation signal. Containment isolation valve operator data is included in Table 2.11.2-1.

Alarms, Displays, and Controls

The active components identified in Table 2.11.2-1 have safety-related displays and controls in the MCR.

Logic

The containment isolation signal is generated and actuated by the protection and safety monitoring system (PSMS).

Interlocks

There are no interlocks needed for direct safety functions related to the CIS.

Class 1E Electrical Power Sources and Divisions

The components identified in Table 2.11.2-1 as Class 1E are powered from their respective Class 1E division. Separation is provided between these Class 1E divisions and between non-Class 1E divisions and non-Class 1E electrical cable.

Equipment to be Qualified for Harsh Environments

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Table 2.11.2-1 Containment Isolation System Equipment Characteristics (Sheet 5 of 9)

System Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Safety-Related Display	Control PSMS	Active Safety Function	Loss of Motive Power Position
SIS	SIS-VLV-115	Refer to Tables 2.4.4-2 and 2.4.4-4							
SIS	SIS-AOV-114								
SIS	SIS-VLV-010 A,B,C,D								
SIS	SIS-MOV-009 A,B,C,D								
SIS	SIS-MOV-001 A,B,C,D								
CVCS	CVS-AOV-005	Refer to Tables 2.4.6-2 and 2.4.6-4							
CVCS	CVS-AOV-006								
CVCS	CVS-MOV-152								
CVCS	CVS-VLV-153								
CVCS	CVS-MOV-178 A, B, C, D								
CVCS	CVS-VLV-179 A,B,C,D								
CVCS	CVS-MOV-203								
CVCS	CVS-VLV-202								
CVCS	CVS-MOV-204								

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Table 2.11.2-1 Containment Isolation System Equipment Characteristics (Sheet 6 of 9)

System Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Safety-Related Display	Control PSMS	Active Safety Function	Loss of Motive Power Position
RHRS	RHS-MOV-002 A,B,C,D	Refer to Tables 2.4.5-2 and 2.4.5-4							
RHRS	RHS-VLV-003 A,B,C,D								
RHRS	RHS-MOV-021 A,B,C,D								
RHRS	RHS-VLV-022 A,B,C,D								
MSS	NMS-AOV-515A, B, C, D	Refer to Tables 2.7.1.2-2 and 2.7.1.2-4							
MSS	NMS-HCV-3615, 3625, 3635, 3645								
MSS	NMS-VLV-509 A,B,C,D NMS-VLV-510 A,B,C,D NMS-VLV-511 A,B,C,D NMS-VLV-512 A,B,C,D NMS-VLV-513 A,B,C,D NMS-VLV-514 A,B,C,D								

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Table 2.11.2-1 Containment Isolation System Equipment Characteristics (Sheet 7 of 9)

System Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Safety-Related Display	Control PSMS	Active Safety Function	Loss of Motive Power Position
MSS	NMS-MOV-507 A,B,C,D	Refer to Tables 2.7.1.2-2 and 2.7.1.2-4							
MSS	NMS-MOV-701 A,B,C,D								
FWS	NFS-VLV-512 A,B,C,D	Refer to Tables 2.7.1.9-2 and 2.7.1.9-4							
SGBDS	SGS-AOV-001 A,B,C,D	Refer to Tables 2.7.1.10-1 and 2.7.1.10-3							
SGBDS	SGS-AOV-031 A,B,C,D								
EFWS	EFS-MOV-101 A,B,C,D	Refer to Tables 2.7.1.11-2 and 2.7.1.11-4							
EFWS	EFS-MOV-019 A,B,C,D								

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Table 2.11.2-1 Containment Isolation System Equipment Characteristics (Sheet 8 of 9)

System Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Safety-Related Display	Control PSMS	Active Safety Function	Loss of Motive Power Position
CCWS	NCS-MOV-402 A, B								
CCWS	NCS-VLV-403 A, B								
CCWS	NCS-MOV-445 A, B								
CCWS	NCS-MOV-436 A, B								
CCWS	NCS-VLV-437 A, B								
CCWS	NCS-MOV-447 A, B	Refer to Tables 2.7.3.3-2 and 2.7.3.3-4							
CCWS	NCS-MOV-438 A, B								
CCWS	NCS-MOV-448 A, B								
CCWS	NCS-MOV-531								
CCWS	NCS-MOV-537								
CCWS	NCS-MOV-511								
CCWS	NCS-MOV-517								

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Table 2.11.2-1 Containment Isolation System Equipment Characteristics (Sheet 9 of 9)

System Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	Safety-Related Display	Control PSMS	Active Safety Function	Loss of Motive Power Position
PSS	PSS-MOV-013,023	Refer to Table 2.7.6.7-1 and 2.7.6.7-3							
PSS	PSS-MOV-031A,B								
PSS	PSS-MOV-071								
PSS	PSS-VLV-072								
PSS	PSS-AOV-003								
PSS	PSS-MOV-006								
PSS	PSS-AOV-062A,B,C,D								
PSS	PSS-AOV-063								
CSS	CSS-MOV-001 A, B, C, D	Refer to Table 2.11.3-2 and 2.11.3-4							
CSS	CSS-MOV-004 A, B, C, D								
CSS	CSS-VLV-005 A, B, C, D								

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Table 2.11.2-2 Containment Isolation System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 5 of 5)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
14. Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.	14. Tests of the as-built valves will be performed under the conditions that SBO occurs and alternative ac generators are not available.	14. Upon loss of ac power condition, each as-built remotely operated valve identified as the followings can be closed automatically. - CVS-MOV-203, 204 - LMS-AOV-104, 105 - CAS-MOV-002 - VCS-AOV-306, 307, 356, 357
15. CIVs listed in Table 2.11.2-1 for which actuation of two power-operated isolation valves on the same penetration (in series) is required, have electrical redundancy provided by independent power sources.	15. Inspection of the as-built CIVs will be performed.	15. A report exists and concludes that the CIVs listed in Table 2.11.2-1 for which actuation of two power-operated isolation valves on the same penetration (in series) is required, have electrical redundancy provided by independent power sources.

2.11.4 Containment Hydrogen Monitoring and Control System (CHS)

2.11.4.1 Design Description

System Purpose and Functions

The CHS is non safety-related system. The purpose of the CHS is to continuously monitor hydrogen concentration within the containment and to reduce the concentration of this combustible gas. The potential for hydrogen gas to be generated may arise from an accident that is more severe than a postulated design-basis accident (DBA).

Location and Functional Arrangement

As shown in Figure 2.11.4-1, there are a set of 20 igniters strategically located in containment areas and subcompartments where hydrogen may be produced, transit or collect.~~The igniters are located within the containment.~~ The hydrogen detector is located outside of containment and measures hydrogen concentration in containment air extracted from the containment. The CHS includes a single hydrogen monitor with MCR alarm and display capability and a set of igniters.

Key Design Features

The CHS consists of the hydrogen monitoring system and the hydrogen ignition system. The hydrogen monitoring system consists of a single hydrogen detector. The hydrogen ignition system consists of 20 igniters installed inside the containment,~~a set of igniters~~ designed to burn hydrogen continuously at a low concentration. The hydrogen igniters burn off hydrogen starting at the low flammability limit (approximately 10% hydrogen in air), thereby preventing further hydrogen accumulation that could become a threat to containment integrity. The CHS will automatically actuate upon the receipt of an ECCS actuation signal.

Seismic and ASME Code Classifications

The CHS is not designed for seismic Category I requirements. The components of the CHS are not designed or constructed to ASME Code Section III requirements.

System Operation

The CHS operates during accident conditions.

Alarms, Displays, and Controls

The following CHS variables are monitored in the MCR:

- Display of hydrogen concentration.
- Display of hydrogen igniter status.

Logic

There is no logic needed for direct safety functions related to the CHS.

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Table 2.11.4-1 Containment Hydrogen Monitoring and Control System Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The functional arrangement of the CHS is as described in the Design Description of this Subsection 2.11.4 and as shown in Figure 2.11.4-1.	1. Inspections of the as-built CHS will be performed.	1. The as-built CHS conforms with the functional arrangement as described in the Design Description of this Subsection 2.11.4 and as shown in Figure 2.11.4-1.
2. The hydrogen igniters are located in the PCCV as shown in Figure 2.11.4-1.	2. An inspection of the as-built hydrogen igniters will be performed.	2. The as-built hydrogen igniters are located in the PCCV as shown in Figure 2.11.4-1.
3. The hydrogen igniters, identified on Figure 2.11.4-1, start after receiving an ECCS actuation signal.	3. Tests will be performed on the as-built hydrogen igniters, identified on Figure 2.11.4-1, using a simulated signal.	3. The as-built hydrogen igniters, identified on Figure 2.11.4-1, start after receiving a simulated signal.

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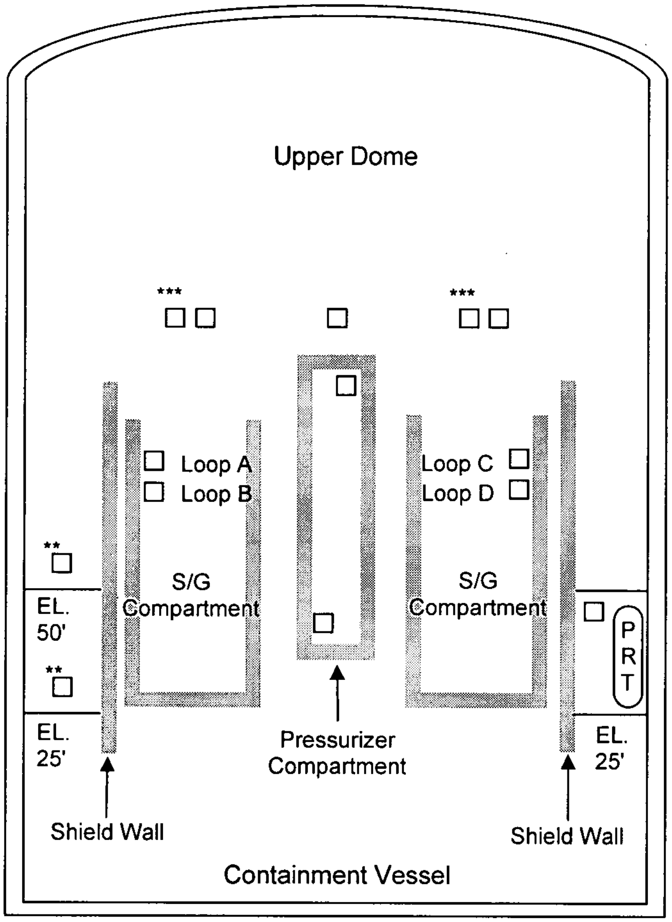

Notes:

This schematic provides only approximate location of Igniters and is not to scale

** Igniters located in ~90^0 locations around the CV, two each are powered from separate power supply panels

*** Igniters installed above S/G and Pressurizer compartments

□ Hydrogen Igniters

Figure 2.11.4-1 Containment Hydrogen Monitoring and Control System