REQUEST FOR ADDITIONAL INFORMATION 222-1933 REVISION 1

2/26/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 14.03.11 - Containment Systems and Severe Accidents - Inspections, Tests, Analyses, and Acceptance Criteria
Application Section: 14.3.4.11

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

14.03.11-28

RAI 14.3.4.11-18:

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.

14.03.11-29

RAI 14.3.4.11-19:

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.

14.03.11-30

RAI 14.3.4.11-20:

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.

14.03.11-31

RAI 14.3.4.11-21

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.

14.03.11-32

RAI 14.3.4.11-22:

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.

14.03.11-33

RAI 14.3.4.11-23

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.

14.03.11-34

RAI 14.3.4.11-24:

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.

14.03.11-35

RAI 14.3.4.11-25:

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

The staff requested, in RAI 14.3.4.11-9, that the applicant define an ITAAC for automatic activation of the hydrogen igniters.

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.

14.03.11-36

RAI 14.3.4.11-26:

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.

14.03.11-37

RAI 14.3.4.11-27:

<u>Specify discrete valve closure time acceptance criteria for ITAAC related to verification of valve closure times.</u>

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.