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TOKYO, JAPAN

February 16, 2012

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-12038

Subject: MHI's Responses to US-APWR DCD RAI No. 796-5728 REVISION 3 (SRP 18.10)

Reference: 1) "Request for Additional Information No. 796-5728 Revision 3, SRP Section: 18 - Human Factors Engineering, Application Section: 18.10" dated August 3, 2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 796-5728 REVISION 3."

Enclosed is the response to the RAI contained within Reference 1.

As indicated in the enclosed materials, this document contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential. A non-proprietary version of the document is also being submitted with the information identified as proprietary redacted and replaced by the designation "[ ]".

This letter includes a copy of the proprietary version (Enclosure 2), a copy of the non-proprietary version (Enclosure 3), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Yoshiki Ogata,
Director- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

D081
NRO

Enclosures:

1. Affidavit of Yoshiki Ogata

2. Responses to Request for Additional Information No. 796-5728 REVISION 3 (Proprietary version)

3. Responses to Request for Additional Information No. 796-5728 REVISION 3 (Non-proprietary version)

CC: J. A. Ciocco
J. Tapia

Contact Information
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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-12038

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, state as follows:

1. I am Director, APWR Promoting Department, of Mitsubishi Heavy Industries, LTD ("MHI"), and have been delegated the function of reviewing MHI's US-APWR documentation to determine whether it contains information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential.

2. In accordance with my responsibilities, I have reviewed the enclosed document entitled "Responses to Request for Additional Information No. 796-5728 REVISION 3" dated February 2012, and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages containing proprietary information are identified with the label "Proprietary" on the top of the page and the proprietary information has been bracketed with an open and closed bracket as shown here "[ ]". The first page of the document indicates that all information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

3. The information identified as proprietary in the enclosed document has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.

4. The basis for holding the referenced information confidential is that it describes the unique design information and analysis of Human Factors Engineering, developed by MHI and not used in the exact form by any of MHI's competitors. This information was developed at significant cost to MHI, since it required the performance of Research and Development and detailed design for its software and hardware extending over several years.

5. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.

6. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

7. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without incurring the costs or risks associated with the design of the subject systems. Therefore, disclosure of the information contained in the referenced document would have the following negative impacts on the competitive position of MHI in the U.S. nuclear plant market :

A. Loss of competitive advantage due to the costs associated with development of the US-APWR Human Factor Engineering. Providing public access to such information permits competitors to duplicate or mimic the Human Factor Engineering information without incurring the associated costs.

B. Loss of competitive advantage of the US-APWR created by benefits of enhanced US-APWR Human Factor Engineering development costs associated with the Human System Interface System.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 16th day of February, 2012.

Y. Ogata

Yoshiki Ogata,
Director- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Docket No. 52-021
MHI Ref: UAP-HF-12038

Enclosure 3

UAP-HF-12038
Docket No. 52-021

Responses to Request for Additional Information No. 796-5728
REVISION 3

February 2012
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 796-5728 REVISION 3**
SRP SECTION:	**18. - HUMAN FACTORS ENGINEERING**
APPLICATION SECTION:	**18.10 – HUMAN FACTORS VERIFICATION AND VALIDATION**
DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-150

SRP 14.3.9, II, Acceptance Criterion 2 states "If an implementation plan, rather than a completed HFE element, was accepted as part of the design certification process, then ITAAC should address the completion of the HFE program element." This RAI has two parts.

Part 1: The applicant's Verification and Validation (V&V) program is described in DCD, Tier 2, Section 18.10. The DCD references MUAP-07007, HSI System Description and HFE Process, for detailed information the US-APWR V&V program. Information about V&V is also presented in the V&V Implementation Plan (MUAP-10012, R0). However, this document is not referenced by either the DCD or MUAP-07007. The NUREG-0711 Compliance Roadmap (MUAP-09024, R0) indicates that a detailed Phase 2b V&V procedure describes the design verification. Which document is this referring to? V&V is addressed in DCD, Tier 1, Section 2.9, Table 2.9-1, Design Commitment 10. The commitment is to conduct the V&V program in accordance with the V&V Program Implementation Plan. However, no specific plan is referenced, thus there is some ambiguity over which document (07007 or 10012) is the plan. Please clarify which document is the implementation plan, the relationship between the documents, and reference it in the Tier 1 and Tier 2 portions of the DCD.

Part 2: DCD, Section 18.10, the V&V IP, and the US-APWR NUREG-0711 Compliance Roadmap, Sec. 11, V&V, refer to various other documents, containing various amounts of detail on V&V. These include MUAP-07007-P(R3), MUAP-08014-P(R0) [NOTE: Revision 1 was issued 5/31/2011, after this question was written], and MUAP-09019-P(R0). From the review performed by staff to date, it appears that all of these documents are needed to obtain the full commitment to the NUREG-0711 criteria and to understand the details of the US-APWR V&V program. If this "diffuse" structure is maintained, they should all be referenced in the DCD. Also NRC and MHI will need to agree whether all these should be designated as Tier 2*. Further, the staff has concerns whether the applicant V&V team can adequately construct and implement an Integrated System Validation that will effectively address regulatory guidance, when the program commitments are so diffuse over many documents. Please address.

ANSWER:

Part1:
MUAP-10012 is the V&V Implementation Plan for the US-APWR. All references to the V&V implementation Plan in the DCD will be revised to reference MUAP-10012. MHI will add the V&V Implementation Plan (MUAP-10012) to the DCD. The Compliance Roadmap, MUAP-09024, was written before MUAP-10012 and is superseded by MUAP-10012 and therefore no longer applicable.
The topical report MUAP-07007 is not restricted only to the US-APWR Design Certification but also to operating plants' Licensing Amendment Request.

Part2:
As is described above, MHI considers that MUAP-10012 is the only document for US-APWR V&V Implementation Plan, and as such it contains full commitment to NUREG 0711 through its content or by reference to MUAP-07007, MUAP-08014 and MUAP-09019. MUAP-10012 will be revised to include additional details and program commitments as discussed in responses to questions 18-152 through 18-177 of this RAI (COLP 796-5728).

Impact on DCD

The DCD Section 18.1, 18.7 18.8 and 18.10 will be revised as follows: (Please also see Attachment 1 of marked-up DCD)

Section 18-1

Section 18.1.2.3.2 first sentence:

> The V&V team conducts the HFE V&Vs in accordance with the US-APWR HSI V&V Implementation plan (~~Section 18.10~~**Reference 18.1-17**). The V&V team includes personnel with the following technical skills:

Section 18.1.5 last bullet will be revised as follows:

- HFE Verification and Validation – Section 18.10
  - Section 18.10 – U.S. Operator V&V Technical Report (Phase 1**a & b**) ~~and US-APWR HF V&V Report (Phase 2)~~**(Reference 18.1-12 and 18.1-13)**
  - **Section 18.10 – US-APWR Verification and Validation Implementation Plan (Reference 18.1-17)**

Section 18-7

Section 18.7.2.6 will be revised to add last words:

> The control room HSI development of the Japanese APWR, as described in Reference 18.7-1 Appendix A, included trade-off evaluations and performance-based tests. The evaluations and testing associated with this HSI development is described in a series of historical project summary reports. This work was conducted in conjunction with Japanese nuclear utilities that provided the nuclear plant operating staff that supported the testing efforts. The performance of the operating staff was evaluated as described in Reference 18.7-1 Appendix B and the associated references. Additional tests and

evaluations for the US-APWR HSI design are described in Section 18.10 **and Reference 18.7-7**.

The following reference will be added to Section 18.7.5;

18.7-7 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012.

Section 18.8

Section18.8.2.4 Page 18.8-4

The V&V program **(Reference 18.8-7)** evaluates the performance of operating crews utilizing CBPs under normal and abnormal operating conditions, and using paper procedures under the following degraded HSI conditions:

The following Reference will be added to 18.8:

18.8-7 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012.

Section 18.10

Subsection 18.10.1 first paragraph will be revised as follows:

V&V evaluations **(Reference 18.10-5)** comprehensively determine that the US-APWR design conforms to HFE design principles and that it enables plant personnel to successfully perform their tasks to achieve plant safety and other operational goals. The V&V methodology has the following four major activities:

Subsection 18.10.2 second paragraph will be revised as follows:

Reference ~~18.10-2 Section 5.10~~**18.10-5** provides a description of the US-APWR HFE V&V program, including the methodology used to develop that program. The US-APWR HFEV&V program is based on the V&V program for the Japanese APWR HFE, which encompasses the HSI design and procedure development. The Japanese and international standards, Japanese nuclear power plant operating experience, and NRC directed operating considerations have been applied to the V&V program and are discussed in Reference ~~18.10-2, Appendices A and B~~**18.10-5**.

Subsection 18.10.2.1 last paragraph will be revised as follows:

The operational scenarios, events, transients, and accidents used in V&V are based on their risk importance. The complete basis for operational conditions sampling is described in Reference ~~18.10-2 Subsection 5.10.2.1~~**18.10-5**. The selected operational conditions and their selection basis are documented in the HFE V&V implementation plan...

Subsection 18.10.2.3 second paragraph will be revised as follows:

> Integrated system validation is conducted using actual dynamic HSI with high fidelity plant model simulation of the operational conditions samples. Reference ~~18.10-2, Subsection 5.10.2.2.4~~**18.10-5**, describes the process for the integrated system validation methodology.

Section 18.10.2.3 last paragraph will be revised as follows:

- Phase 1 **(References 18.10-6 and 18.10-7)** - This phase validates the basic US-APWR HSI design.
  - For this phase, the Japanese standard HSI design and procedures are converted to the English language and English units of measure
  - This phase is conducted by a sample of US operations crews who are previously trained on the utilization of the Japanese HSI and procedures, and operation of the Japanese standard 4-loop PWR
  - Operational conditions samples used during this phase are those that assist with validation of the basic HSI design for cross-cultural differences and population stereotypes
  - This phase is documented in the U.S. Operator V&V Technical Report
- Phase 2 **(Reference 18.10-5)** - This phase validates the final US-APWR HSI design and procedures.

The following References will be added to Section 18.10.5:

> **18.10-5 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012.**
>
> **18.10-6 US-APWR Human System Interface Verification and Validation Phase 1a, MUAP-08014, Revision 1, May 2011.**
>
> **18.10-7 US-APWR Human System Interface Design, MUAP-09019, Revision 1, December 2011.**

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on the Topical/Technical Reports.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 796-5728 REVISION 3**
SRP SECTION:	**18. - HUMAN FACTORS ENGINEERING**
APPLICATION SECTION:	**18.10 – HUMAN FACTORS VERIFICATION AND VALIDATION**
DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-151

The NRC is reviewing V&V at an implementation plan level of review. Per NUREG-0711, an implementation plan gives the applicant's proposed methodology for meeting the acceptance criteria of the element. Since the implementation plan is the basis of the NRC's safety finding for HFE activities that are yet to be completed, the staff must understand in detail how the methodology will be implemented; and must be confident that it can be reliably conducted by design personnel and that it will provide acceptable results.

Many aspects of MHI's V&V plan are not at a sufficient level of detail. For example, the staff expects to see the detailed scenario descriptions, the exact performance measures to be collected for each scenario, and the specific acceptance criteria for each performance measure. These details are not provided. Many of the more specific RAIs request these details. The current V&V documentation rests heavily on Phase 1 tests that serve as an illustration of how V&V will be conducted. However, that is not an implementation plan as described above. Please provide an implementation plan for USAPWR V&V at the level of detail necessary for staff review.

ANSWER:

MHI will revise and add more detailed descriptions to show the compliance to NUREG-0711 acceptance criteria in responses to questions 18-152 through18-177 of this RAI (5728). As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012 as Attachment 2.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer (Please also see Attachment 2)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

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QUESTION NO. : 18-152

The various MHI documents discuss four versions of the MHI HSI. It appears that the Generic US-APWR HSI is the version that will receive the V&V that is being described in the DCD and in the V&V IP. However neither the DCD nor the V&V IP specifically state that. Further, the compliance roadmap frequently refers to the US-APWR plant specific V&V, rather than the Generic US-APWR V&V. Please clarify which version of the HSI will be the subject of the V&V for the US-APWR design certification.

ANSWER:

The US-APWR design certification will be based on the HSI design for Phase 2b V&V. The V&V Implementation Plan will be revised to clarify above. The Roadmap is no longer applicable since the Implementation Plan, MUAP-10012 is a later document and is the governing document for the V&V.

The following will be added to the Abstract and Scope of MUAP-10012:

> **The V&V described in this Implementation Plan will utilize the US-APWR generic design that is the bases of the US-APWR design certification.**

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 796-5728 REVISION 3**
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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-153

The DCD and MUAP-07007 indicate that V&V is a phased activity and that the results from earlier V&V activities will not be repeated. For example, DCD Revision 3, Section 18.10.2, Methodology, states, "The US-APWR HSI and procedures are based on the Japanese APWR HSI and procedures. The changes to HSI and procedures are described in Sections 18.7 and 18.8, respectively. Therefore, the US-APWR HFE V&V program focuses on these changes."

MUAP-07007, revision 3, section 5.10 states that:
The V&V program is conducted in multiple phases, as described at a high level in Appendix C, and in more detail in the each plant specific V&V Implementation Plan... The V&V program activities conducted during Phase 1, which applies to the Basic HSI System, is generically applicable to all applications of the US Basic HSI System (i.e. to the US-APWR and operating plant upgrades). Phase 1 V&V will not be repeated.

The staff V&V review is conducted on the V&V activities performed for the final design (the Generic US-APWR HSI in this case). The staff typically does not consider interim tests and evaluations that are performed during the design process as the V&V. As noted in NUREG-0711, section 11.1:
"Many design documents (e.g., ISO 11064) recommend conducting V&V throughout the design process. This document <NUREG-0711> agrees with that recommendation, with these activities called "HSI Tests and Evaluations" (see the HSI Design element, Section 8.4.6). ... V&V is considered a test that final design requirements are met."

The staff's V&V review for a DCD application is directed at the final design that is to be certified. Please clarify the relation between Phases 1a/1b and Phase 2. Confirm that the Phase 2 V&V will be complete. If not complete, describe how you plan to "take credit" for Phases 1a/1b, especially considering the fact that the HSI tested will be different between the Phases.

ANSWER:

Phases 1a/1b V&V design tests were conducted to establish input conditions to the US-APWR generic HSI design and as a way to develop and exercise a testing process that will fully meet NUREG 0711 criteria. The application of the process which forms the bases of MUAP-10012, however, was limited in Phase 1a/1b based on the test goals of those tests. The results presented in MUAP-08014 and MUAP-09019 represents detailed examples of how the process was applied in Phase 1a/1b and will be applied in Phase 2b. These documents therefore supplement the actual Implementation Plan, MUAP-10012 as illustrative detailed examples of the process.

The Phase 2b V&V, as called for by NUREG-0711, will be completed on the US-APWR HSI generic design to be certified by the NRC and no direct credit is being taken for the Phase 1a/1b tests in the final Phase 2b V&V program.

The Phase 2b V&V program will use, and expand on the same testing process to fully meet NUREG 0711, that was developed for and applied in the Phase 1a&b V&V tests.

The following will be added to section 2.1 of MUAP-10012:

> The methodology and results of this effort are referenced throughout this V&V implementation plan and are reported in MUAP-08014 and MUAP-09019 (ref 3 and 4). **The purpose of the tests reported in References 3 and 4 was to establish input conditions to the US-APWR generic HSI design and to support the development of the methodology that is described here in, MUAP-10012, for application in the final Verification and Validation as per NUREG 0711. References 3 and 4 are, therefore, not taken credit for as any part of the final NUREG-0711 V&V, but instead are a bases for the HSI design and this Implementation Plan and as such are viewed as supplemental information .**

Impact on DCD

Following sentence will be added to the last paragraph of the DCD Section 18.10.3. (Please also see Attachment 1.)

> **MUAP-10012 (Reference 18.10-5) are not taken credit for as any part of the final NUREG-0711 V&V, but instead are a bases for the HSI design and this Implementation Plan and as such are viewed as supplemental information.**

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer .

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-154

MUAP-07007, revision 3, section 5.10 states that plant specific V&V activities will be conducted.

> The V&V program is conducted in multiple phases, as described at a high level in Appendix C, and in more detail in the each plant specific V&V Implementation Plan.
>
> The V&V program activities conducted during Phases 2/3, as described in Appendix C for the US-APWR, will be uniquely repeated for all plant/site specific applications. Phases 2/3 are carried out on final plant/site specific HSI design.

This appears to state that Phase 2/3 V&V activities will be conducted for each site using a site specific V&V implementation plan.

The Generic US-APWR HSI Design will have been verified and validated in Phase 2. Please explain what will be verified and validated in Phase 3 and how complete this V&V will be.

ANSWER:

Phase 3 V&V will only be conducted to evaluate any site specific HSI design differences from the US-APWR HSI generic design that will undergo V&V in Phase 2b. Any Phase 3 V&V required will follow MUAP-10012. As needed, Phase 3 will complete a site specific ITAAC for the subsequent COL applications after the Phase 2 applicant.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on Topical/Technical Reports

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QUESTION NO. : 18-155

NUREG-0711, Criterion 11.4.1.2.2, Identification of Scenarios, and 11.4.3.2.4, Scenario Definition, address the Integrated System Validation (ISV) scenarios. As summarized in the Compliance Roadmap, the MHI V&V documents do not specifically address all of the review criteria for the scenarios. Rather the documents refer to the Phase 1a and 1b V&V testing done on the US-Basic HSI and generally state that the results reports for this earlier V&V provide an illustration of the V&V to be done for the US-APWR. This general reference to earlier V&V does not provide a sufficient commitment to allow design certification of the US-APWR.

Further, based on a brief review of the Phase 1a and 1b scenarios, they do not seem to address all of the sampling dimensions of NUREG-0711, item 11.4.1.2.1.

ANSWER:

The compliance roadmap, MUAP-09024, is no longer applicable and has been replaced by the V&V Implementation Plan MUA-10012.
The Phase 1a/ 1b scenarios were selected to clarify the differences between Japanese HSI design from that for U.S, and to establish inputs to the US-APWR HSI generic design. As such they were not intended to address all of the NUREG-0711 sampling dimensions. They were however, included in the topical report, MUAP-09019, as examples of the level of detail intended for the scenarios selected.

All use of inexplicit usage of "etc." will be removed from MUAP-10012 pages, iii, 1, 2, 3, 5, 6, 7, 8, 9, 16 &17.

The V&V IP, MUAP-10012, section 4.3.4 will be revised to describe that

> The Phase 2 V&V scenarios will meet the Operational Conditions Sampling (OCS), criteria of NUREG-0711 section 11.4.1.2.1, 11.4.1.2.2 and 11.1.3.2.4. Individual sampling dimensions will be combined through expert judgment by the Scenario Developers, of the MHI V&V Team, as part of their responsibilities as described in section 4.1, above.

Resulting scenarios will combine into realistic events, multiple characteristics identified from the OCS process. The Scenario Developers will assure that the scenarios are not biased by representing only positive outcomes, easy to conduct, or well structure and practiced. Scenarios will stress the crew through both normal and challenging events containing multiple and unanticipated failures. As guidance, the Scenario Developers will use References 3, 4 and 6. The process and resulting scenarios will be documented by the Scenario Developers and be independently reviewed before application in the V&V program.

The Phase 2 V&V scenarios selection dimensions will meet the criteria of NUREG-0711 section 11.4.1.2.1 and will include considerations of:

- Scenarios of full range of plant operating modes, including startup, shut down, significant power changes, refueling and normal operations
- Scenarios of abnormal and emergency operations, transient conditions, and low-power and shutdown conditions which includes credited operator's action in the DCD Chapter 15.
- Description of the scenario and any pertinent "prior history" necessary for personnel to understand the state of the plant upon scenario start-up
- Specific initial conditions (precise definition provided for plant functions, processes, systems, component conditions and performance parameters, e.g., similar to plant shift-turnover)
- Events (e.g., failures) to occur and their initiating conditions, e.g., time, parameter values, or events
- Precise definition of workplace factors, such as environmental conditions
- Task support needs (e.g., procedures and technical specifications)
- Staffing objectives
- Communication requirements with remote personnel (e.g., load dispatcher via telephone)
- The precise specification of what, when and how data are to be collected and stored (including videotaping requirements, questionnaire and rating scale administrations)
- Specific criteria for terminating the scenario.
- HAs that have been found to affect plant risk by means of PRA importance and sensitivity analyses should also be considered risk-important. Internal and external initiating events and actions affecting the PRA Level I and II analyses of Chapter 19. This will include all risk important human actions determined from the HRA.
- HAs identified by the OER.
- Failure of digitalized I&C systems with above scenarios
- HAs with computer based systems, such as alarms and CBP system
- HAs in monitoring automated systems and in assuming control when automation fails
- Failure of all non-safety HSI system
- Operation from the remote shutdown console to safe shutdown
- System interconnections as they relate to failures

- Full range of procedure, knowledge based, cognitive and tasks including personnel interactions within and external to the control room
- Situations that stress navigational requirements
- Full range of situational factors such as operational difficult tasks, error forcing events, high physical and mental workload, and environmental as applicable for the specific location of the operation.
- As well as factors and HEDs that were found to be significant during the Phase 1a/1b V&V testing program.

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012. Reference the response to 18-151.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer. (Reference RAI NO. 18-151)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

02/16/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 796-5728 REVISION 3**
SRP SECTION:	**18. - HUMAN FACTORS ENGINEERING**
APPLICATION SECTION:	**18.10 – HUMAN FACTORS VERIFICATION AND VALIDATION**
DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-156

Section 5.0 of the V&V IP (MUAP-10012) is References. Reference 6 is referred to on page 8 of the IP as the training simulator standard (ANS 3.5), however the reference citation in Section 5.0 appears to have mixed together two ANS standards into one reference, ANSI/ANS 3.5 1998 and ANSI/ANS 3.1 1993, reaffirmed 1999. Please correct.

ANSWER:

MHI will correct the citation of the references from ANSI/ANS 3.1 1993 reaffirmed 1999 to ANSI/ANS3.5 1998 in the next revision to MUAP-10012.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-157

NUREG-0711, Section 11.4.1.2.1, includes plant conditions, personnel tasks, and situational factors known to challenge personnel performance and that should be included in the Operational Conditions Sampling (OCS) for V&V.

Section 4.3.4 of the V&V IP provides only a high level commitment to these OCS criteria. More detailed OCS specifics (but not all that is in the NUREG-0711 criteria) are given in MUAP-07007, Section 5.10.2.1. MHI should provide an appropriate commitment to the added details from the criteria.

ANSWER:

Reference the response to 18-155 that will revise section 4.3.4 of V&V IP, MUAP-10012.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.
(Reference RAI NO. 18-155)

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-158

NUREG-0711, item 11.4.1.2.2(1) specifies that the results of the OCS should be combined to identify a set of scenarios. The V&V IP, Section 4.1 provides an overview of the OCS process. However, MHI needs to either define in some detail the process for identifying the scenarios based on the OCS process, or present the list of scenarios to be used, together with a justification or table that shows how they satisfy the OCS criteria. Currently neither has been done, rather scenarios selected for the earlier Phase 1a and 1b V&V testing are generally refered to. This set of scenarios is not sufficiently complete to serve as the Phase 2 (US-APWR generic HSI). On the other hand, Section 4.3.4 of the IP states that scenarios will include all normal evolutions and malfunctions per ANSI/ANS 3.5. This appears to be a larger number than typically used for ISV. Please provide this information.

ANSWER:

The scenarios used for the Phase 1a/b tests were identified to meet the goals of the Phase 1b/1b V&V tests only. The MUAP-09019 scenarios were referenced in MUAP-10012 only for information as examples to demonstrate the V&V process as used and refined in Phase 1a/1b, and were not intended to represent the complete set of scenarios that will be used in the Phase 2b V&V. It was always intended to meet the NUREG-0711 selection criteria. The identification of the V&V scenarios will meet the criteria of section 11.4.1.2 of NUREG-0711, reference the response to 18-155 for the revision to section 4.3.4 of the V&V IP, MUAP-10012 for a discussion of the methodology for combining the results of the sampling in to the scenarios.

The following sentence from MUAP-10012 section 4.3.4 will be deleted:

> ~~Test scenarios will include, as a minimum, all normal evolutions and malfunctions as defined in ANS1/ANS 3.5 (ref 6) for training simulator capabilities.~~

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-159

NUREG-0711, item 11.4.3.2.4(1) specifies information that should be defined for each scenario. The US-APWR HFE Program NUREG-0711 Compliance Roadmap (MUAP-09024) refers to the Phase 1a and 1b summary results for an illustration of the level of detail for test scenario definitions. However, the Phase 1a and 1b summaries do not provide all of the information in the criterion. Please provide a satisfactory commitment to the detailed information needs of this criterion. In addition provide a sample of at least 3 completed scenarios.

[eRAI question ID 20935]

ANSWER:

The Compliance Roadmap, MUAP-09024, is replaced by MUAP-10012 the V&V implementation Plan.

The following commitment to NUREG 0711 section 11.4.3.2.4 will be added to MUAP-10012, page 8 under Scenario Definitions:

The scenario definition for each scenario included in the V&V will include:

(1) The operational conditions selected for inclusion in the validation tests should be developed in detail so they can be performed on a simulator. The following information should be defined to provide reasonable assurance that important performance dimensions are addressed and to allow scenarios to be accurately and consistently presented for repeated trials:

- **description of the scenario and any pertinent "prior history" necessary for personnel to**
- **understand the state of the plant upon scenario start-up**
- **specific initial conditions (precise definition provided for plant functions, processes, systems, component conditions and performance parameters, e.g., similar to plant shift turnover)**

- **events (e.g., failures) to occur and their initiating conditions, e.g., time, parameter values, or events**
- **precise definition of workplace factors, such as environmental conditions**
- **task support needs (e.g., procedures and technical specifications)**
- **staffing objectives**
- **communication requirements with remote personnel (e.g., load dispatcher via telephone)**
- **the precise specification of what, when and how data are to be collected and stored (including videotaping requirements, questionnaire and rating scale administrations)**
- **specific criteria for terminating the scenario.**

(2) Scenarios should have appropriate task fidelity so that realistic task performance will be observed in the tests and so that test results can be generalized to actual operation of the real plant.

(3) When evaluating performance associated with operations remote from the main control room, the effects on crew performance due to potentially harsh environments (i.e., high radiation) should be realistically simulated (i.e., additional time to don protective clothing and access radiological controlled areas).

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012. Reference the response to 18-151.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer. (Reference RAI NO. 18-151)

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-160

Per NUREG-0711, Section 11.4.3.2.5.1, Review Criterion 1, MHI does not discuss the characteristics of the performance measures to be used in ISV. The DCD states that the ISV methodology will address measurement characteristics but does not provide any information. Nor is the information provided in any of the following documents: MUAP-07007; MUAP-10012, R0; MUAP-09019; or MUAP-08014-P, R0. The NUREG-0711 Compliance Roadmap (MUAP-09024, R0) states that measurement characteristics are "satisfied" by the use of "converging measures logic." The Roadmap references MUAP-08014-P, R0, Part 1 for an explanation of the approach. We do agree with the importance of converging measures to the validation and HED evaluation process. In fact, that is addressed in NUREG-0711, Section 11.4.3.2.7, Data Analysis and Interpretation. Criterion 3 states that "the degree of convergent validity should be evaluated, i.e., the convergence or consistency of the measures of performance." However, it does not address the measurement characteristics of the measures. To illustrate, assume there are three measures of workload and the results of the ISV testing does not indicate a workload problem on any of the three measures. Thus, a converging measures logic leads to the conclusion that workload is acceptable. However, if the three measures have poor construct validity (that is, do not provide good measures of workload), then the conclusion may be false. A converging measures logic should only be used when the measures have acceptable measurement characteristics. Otherwise, misleading or incorrect conclusion may result.

The staff recognizes that most of the measurement characteristics identified in Review Criterion 1 in NUREG-0711, Section 11.4.3.2.5.1 will not be applicable to many of the measures, but MHI should minimally identify and address the characteristics that are applicable. For example, the applicant should explain how a questionnaire used to assess workload or situation awareness was developed and why the approach to measuring these variables in this way is a good one.

ANSWER:

The compliance Roadmap is superseded by MUAP-10012, the V&V Implementation Plan. The DCD will be revised to reference the Implementation Plan as per response 18-150. MUAP-10012 section 4.3.5, Performance Measures, describes the characteristics of the measurement tools. The measurement tools selected and demonstrated in the Phase 1a/1b tests rely on well accepted practice. The use of the complement of different tools, the specified application of converging measures, test observer training and the use of independent data analysis and results verification, assure compliance with the measurement characteristics addresses in NUREG-0711 section 11.4.3.2.5.1. The examples for typical questionnaire used to assess workload or situation awareness are shown in the Attachment 2 of 3 scenarios.

Impact on DCD

Same as RAI NO. 18-150.

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer
(Please also see Attachment 2)

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QUESTION NO. : 18-161

The DCD, section 18.10.2.3 references MUAP-07007, Section 5.10.2.2.4, Integrated System Validation, Part e, Performance Measurement, for information on performance measure. It states that a hierarchal set of performance measures will be used; however, there is no discussion of anthropometric/physiological factors. The NUREG-0711 Compliance Roadmap (MUAP-09024, R0) indicates that anthropometric/physiological factors were measured in the Phase 1 tests and that a "concrete illustration" of them are in MUAP-08014-P (R0) and the measures will be used in the US-APWR ISV test. However, their absence from the DCD and from MUAP-07007 leaves the status of these measures unclear. Please identify how these factors will be addressed.

ANSWER:

The DCD is being modified to reference MUAP-10012 as the V&V Implementation Plan, reference 18-150. Therefore MUAP-07007 will be replaced for this purpose and MUAP08014 should be considered only as a reference for the application of the process to be used in the phase 2b V&V.

MHI will revise the Implementation Plan, MUAP-10012 section 4.4 paragraph 2, to include the following description of the anthropometric/ physiological performance measures, in the design verification and validation to be performed in Phase 2b:

When designing the V&V tests consideration will be given to anthropometric and physiological factors that may affect performance. The test facility will simulate and the scenario definitions will specify expected plant conditions such as layout and work station dimensions, background noise, lighting, display characterization. The control room will include miscellaneous equipment that may add clutter. In areas outside of the control room special environmental stressors such as temperature and radiation will also be included in the tests.

Impact on DCD

Same as RAI NO. 18-150.

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-162

The DCD references MUAP-07007, Section 5.10.2.2.4, Integrated System Validation, Part e, Performance Measurement, for information on performance measure. There is no discussion of pass/fail measures in the DCD or MUAP-07007. Pass/fail measures are discussed in the V&V Plan (MUAP-10012, R0), Section 4.3.5, "Performance Measures. However, MHI does not specifically identify which measures are pass/fail and which are used for performance analysis. Please identify which specific measures are to be used as pass/fail measures.

ANSWER:

Based on the experience gained in the Phase 1a/1b tests, the pass fail performance measures discussed in Section 4.3.5 of MUAP-10012 will be scenario dependent.

The following will be added to MUAP-10012 section 4.5 "Analysis of Pass/Fail Indicators"

> **As a general rule, in most cases objective, time dependent histories of specific plant parameters (temperature, pressure, flow rate, radiation level, water level and environmental release), component position or operations (pump on or off, valve open or closed) and operator actions (assuming control of an automated action) will be used as pass fail measures. These values will be downloaded from the simulator and assessed for each scenario.**
> **In addition subjective measures of scenario specific significant factors, i.e., situation awareness that indicate a significant loss of awareness, may, in addition, be used as pass fail performance measures for selected scenarios. This will be at the discretion of the test observers/administrators.**

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-163

Please identify the specific plant performance measures that will be used for the specific scenarios being used in the tests. In lieu of the complete set of measures for each ISV scenario, the staff will accept a sample of three detailed scenarios, as per the previous RAI question ID number 20935.

ANSWER:

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012.Reference the response to 18-151.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer (Reference RAI NO. 18-151)

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-164

Please identify the specific personnel task measures that will be used for the specific scenarios being used in the tests. In lieu of the complete set of measures for each ISV scenario, the staff will accept a sample of three detailed scenarios, as per RAI question ID 20935.

ANSWER:

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012. Reference the response to 18-151.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.
(Reference RAI NO. 18-151)

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-165

MUAP-07007, section 5.10.2.2.4 Part e, indicates that situation awareness measure will not be used (p. 159), yet the V&V Implementation Plan (MUAP-10012, R0) and the NUREG-0711 Compliance Roadmap (MUAP-09024, R0) indicates SA measures will be used. Please clarify.

To the extent that these measures are scenario specific, please identify the specific measures that will be used for the specific scenarios being used in the tests. In lieu of the complete set of measures for each ISV scenario, the staff will accept a sample of three detailed scenarios, as per RAI question ID 20935.

ANSWER:

The compliance Roadmap has been superseded by the Implementation Plan, MUAP-10012 for 18.10, and MUAP-10012 will be used for this V&V implementation purposes in place of MUAP-07007. The DCD will be revised to reference MUAP-10012 as the Implementation Plan as per response to 18-150. Situation awareness will be measured in the Phase 2b V&V, as it was in Phase1a/1b, and as discussed in MUAP-10012 sections 4.3.1 bullet 8, 4.3.5 item E and section 4.3.5 of "Measures of Situation Awareness".

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as an appendix to MUAP-10012. Reference the response to 18-151.

Impact on DCD

Same as RAI NO. 18-150.

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer. (Reference RAI NO. 18-151)

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-166

MUAP-07007, Section 5.10.2.2.4, Integrated System Validation, Part e, Performance Measurement, states that cognitive workload will be measured by methods described in Section 5.4.3.2. However, in that section, the use of a human information processing model to evaluate workload as part of task analysis is described. We do not see how this is applicable to measuring workload as part of dynamic scenarios during ISV. The NUREG-0711 Compliance Roadmap (MUAP-09024, R0) references MUAP-07007, but identifies the use of multiple converging measures of workload, based on operator and observer ratings, as was used in the Phase 1 evaluation. The V&V Implementation Plan (MUAP-10012, R0), Section 4.3.5, indicates workload will be measured using rating scales administered to operators after each scenario. The V&V Implementation Plan also states that workload will be assessed by expert observer evaluations. This description is consistent with the Roadmap, but not with MUAP-07007 which is referenced by the DCD. Please clarify the approach to workload measurement in the ISV tests.

ANSWER:

The DCD will be revised to reference MUAP-10012 as the Implementation Plan instead of MUAP−07007, see response to 18-150. Cognitive workload will be measured in the Phase 2b V&V as described in the MUAP−10012.

Impact on DCD

Same as RAI NO. 18-150.

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on the Topical/Technical Reports.

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QUESTION NO. : 18-167

The NUREG-0711 Compliance Roadmap (MUAP-09024, R0) identifies criteria, but does not reference the DCD or MUAP-07007. Instead it discusses the Phase 1 evaluation described in MUAP-08014-P, R0 [Revision 1 was received after the question was written.] and MUAP-09019-P, R0. The Roadmap states that the same approach will be used in US-APWR ISV. An examination of the Phase 1b criteria found in MUAP-09019-P, R0, Part 3, Appendix 8.4, revealed that specific plant and operator action criteria were identified for each scenario along with the basis for each is identified. No criteria for other types of performance measures are provided. Section 4.3.4, Scenario Definition, of the V&V Implementation Plan (MUAP-10012, R0) discusses the applicant's general approach to defining acceptance criteria. The Plan states that performance criteria are established for each scenario in terms of plant and human performance. The criteria are defined by operations subject matter experts and make use of industry standards and guidelines, such as those established by INPO and the NRC.

Page 9 of the Plan references "Appendices of this plan" for examples. However, MUAP-10012, R0 does not include any appendices.

Therefore, please identify the specific performance criteria and bases for the measures that will be used for the specific scenarios being used in the US-APWR ISV tests. In lieu of the complete set of measures for each ISV scenario, the staff will accept a sample of three detailed scenarios, as per RAI question ID 20935.

ANSWER:

MUAP-10012 supersedes the Compliance Roadmap, MUAP-09024. The appendix referenced on section 5.0 of the IP, MUAP-10012, will be added to the next revision.

As detailed examples of the application of the guidance in MUAP-10012, the following specific scenario selection criteria, performance measures, success criteria and scenario description for 3 representative scenarios will be added as the referenced appendix to MUAP-10012. Reference the response to 18-151.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.
(Reference RAI NO. 18-151)

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QUESTION NO. : 18-168

NUREG-0711 criterion 11.4.3.2.6.2 (1) states that detailed, clear, and objective procedures should be available to govern the conduct of the ISV tests. A number of subcriteria are given, and sub-criterion (2) notes one added area. MUAP-07007P (R3), Section 5.10.2.2.4.f, Test Design, states that test procedures are prepared that meet these criteria. However, details are not provided. The MHI Roadmap states that such procedures were available and used for the Phase 1a and 1b validation testing. If credit is to be taken for this earlier set of test procedures, they will need to be made available for staff audit. Please provide the information on how the criterion is met.

ANSWER:

The Compliance Roadmap is superseded by the Implementation Plan, MUAP-10012. Section 4.4.2 of MUAP-10012 calls out the use of detailed test procedures for the Phase 2b V&V. The test procedures for both the design validation tests conducted as part of the Phase 1a/1b tests, reported in MUAP-08014 and MUAP–09019 respectively, were used only for those respective tests and represent examples of how test procedures will be developed for the Phase 2b V&V program.
In addition, Attachment 2 of this RAI responses addresses typical procedures (ARPs, GOPs and ERGs) to be used in 3 examples of events.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.
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APPLICATION SECTION:	**18.10 – HUMAN FACTORS VERIFICATION AND VALIDATION**
DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-169

MUAP-10012, R0 indicates that the analysis of pass/fail measures addresses objective quantitative measures and will be accomplished in two stages. The first is the comparison of performance of each crew to the acceptance criteria to determine whether the crew has passed or failed. The second analysis combines the results across crews to determine the proportion of crews that passed to the total number of crews. The former is based on criteria established for individual measures (see RAI Question #20943). However, the acceptance criteria for combining data across crews are not presented. The Plan only provides an example. Information is needed as to the precise criteria that will be used to determine the acceptability of the design. Please provide these criteria.

ANSWER:

MUAP-10012 section 4.5 discusses that data across crews will be combined through the use of mean scores across crews and observers for each scenario. Additionally all data will be evaluated in a spreadsheet and the number of crews showing a similar problem in the scenario will be assessed on a 5 point scale with 3 being the acceptable rating. Details of the use of the 5 point scale are discussed in MUAP-10012.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on the Topical/Technical Reports.

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-170

MUAP-10012, R0, page 20, indicates that the analysis of non-pass/fail measures will be used to identify HEDs. The results will be assessed across measures to identify HEDs using the converging measures logic. However, additional information is needed to identify when an HED is identified, e.g., how is the convergence of measures used to identify HEDs. Please provide the criteria.

ANSWER:

HEDs were identified by all individuals involved in the Phase 1a/b tests. These HEDs are then prioritized and evaluated for design impact by an independent panel of experts, the Expert Panel or the Design Review Team. Converging measures were not directly used to identify HEDs. Instead the method was used to identify HFE issues based on the design and then converted into HEDs by the test administrators, consisting of at least one HFE expert and one operator/plant systems expert, or the independent panel. Converging measures were also used as one method to identify the extent of a specific identified HSI issue across the HSI.

To clarify the HED process, the following will be added to MUAP-10012 Section 4.5 "Analysis of Other Performance Measures";

...to identify HEDs. **MUAP-09019, part 1section 6, describes the full HED process.** These include:

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-171

MUAP-07007, revision 3, HSI System Description and HFE Process, 5.10.2.2.4 part g, provides a commitment for independent verification of the data analysis, but no methodology for achieving the commitment is presented in the documentation reviewed. Please provide a methodology to accomplish this commitment.

ANSWER:

The DCD will be changed to reference MUAP-10012 as the V&V Implementation Plan, reference 18-150. MUAP-10012 section 4.2.3 discussed a sampling process to verify design verification outcomes. That address the use of an HFE expert not present at the tests to review independently, the test video and audio tapes as verification of results. The following statements will be added to MUAP-10012 to address data analysis verification in task support verification and the integrated validation:

Section 4.2.2

If only one team member has performed the verification assessment, then a sampling process will be adopted for a second analyst to verify the assessment and its results.

Section 4.6

An Independent panel of experts will be used to sample the Validation results and verify the data analysis and the V&V results.

Impact on DCD

Same as RAI NO. 18-150.

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer

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DATE OF RAI ISSUE:	**08/03/2011**

QUESTION NO. : 18-172

MUAP-07007, revision 3, HSI System Description and HFE Process, 5.10.2.2.4 part g, provides a commitment for use of a margin-of-error in the analysis, but no methodology for achieving the commitment is presented in the documentation reviewed. Please provide a methodology to accomplish this commitment.

ANSWER:

MUAP-07007 has been superseded by MUAP-10012 for implementation Plan details. Margin of error is a statistical term used to describe the range that a true value could fall within, the validation data analysis will calculate this using standard statistical techniques based on the test observers/administrators determination of a confidence level for each scenario.

The following will be added to MUAP-10012, section 4.5

> Computing descriptive statistics (e.g., mean, standard deviation**, confidence limits and margin of error**)...

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.

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QUESTION NO. : 18-173

NUREG-0711 Section 11.4.4.2, Criterion 1, states that discrepancies may be acceptable if sufficient justification exists. The V&V IP Section 4.7, V&V HED Resolutions, is brief and merely states that HEDs will undergo the same evaluation program as described in MUAP-08014 and MUAP-09019. The compliance roadmap refers only to MUAP-09019, Sections 6 & 7. The justification per this criterion appears to be in MUAP-09019, Section 6.5, HED Resolution, Item 8, but this does not explain what would be a sufficient "basis" for such closure. Also, Section 6.6, HED Closure, states that closure does not require demonstration of a successful solution. This does not appear appropriate. Please clarify and provide sufficient information to address Criterion 1.

ANSWER:

The Compliance Roadmap has been superseded by the Implementation Plan, MUAP-10012. This statement inMUAP-09019 was intended to handle the HEDs found during the Phase 1a/1b V&V design tests where the HED specific closure criteria was to perform an intermediate step, such as a redesign or the inclusion of new information in documents. In these cases, at this stage of the design, there is a way to demonstrate material being added to documents, completion of an analysis or a redesign that was specified in the HED closure statement, however, there may be no definitive way to demonstrate success until the phase 2b V&V. Therefore in these cases, success would be measured by the Phase 2b V&V program. If the original HED resolution was not successful a new HED would be initiated during phase 2b.
In addition, NUREG0711 section 11.4.4.1 and 11.4.4.2 does not require that all HEDs be resolved as long as an analysis and justification is completed.

MUAP-10012 section 4.7 will be revised to include

HEDs identified during the phase 2b V&V will be documented along with their resolution. If it is determined that a specific Phase 2b HED is acceptable,

resulting in a decision not to act on its closure, an analysis and justification for the decision will be documented in the results report.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer.

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QUESTION NO. : 18-174

NUREG-0711, Section 11.4.4.2, provides several criteria for HED resolution. An area in two criteria, (2) and (5), of 11.4.4.2 that appeared not to be contained in the MHI documentation was the evaluation of possible cumulative effects and interrelations of multiple HEDs or when HEDs are potentially indicative of a broader problem. Please address.

ANSWER:

The concern of HEDs potential cumulative effects, interrelationships and their possible extent across the HSI was address in Phase 1a/1b and will be addressed in Phase 2b V&V through the data analysis methodology and independent HFE Expert Panel and the Design Review Team process. See the response to 18-170.

The following will be added to MUAP-10012, section 4.5 second paragraph

> **The extent, relationship across the HSI indicative of a broader issue, of an HED and the interrelationships between HEDs are address at three levels. First, the test participants are asked explicitly in both the questionnaires and structured verbal debriefing if they believe the HED is representative of a larger or underlying problem. Second, at the end of each day of testing, the test observers are instructed to review each HED and reach consensus on each HED's relationship to other HEDs and the possible extent of the HED and third, the expert panel reviews each HED during one of their regular scheduled meetings. Part of their review explores this issue. Each of these reviews is documented.**

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer

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QUESTION NO. : 18-175

This RAI has two parts.

Part 1 - HFE V&V of the US-APWR is identified as Design Commitment 10 in Table 2.9-1 of Section 2.9 in the Human Factors Engineering Design Control Document for the USAPWR, Tier 1, MUAP-DC020, Revision 3 (March 2011). The commitment is to conduct the V&V program in accordance with the V&V Program Implementation Plan. However, there is some ambiguity over which document is the plan. The DCD Tier 2 description references MUAP - 07007, HSI System Description and HFE Process for "a description of the US-APWR HFE V&V program. However, MUAP-10012, R0 is identified as the V&V Implementation Plan, yet it is not referenced in the Tier 2 description. The V&V Implementation Plan referenced in the ITAAC design commitment should be specifically identified. Please clarify which document is the implementation plan.

Part 2 - In addition, the Acceptance Criterion simply states that a results summary report exists and concluded that the V&V program was conducted in accordance with the V&V IP. More detailed acceptance criteria are needed to support ITAAC inspections. Please provide more explicit acceptance criteria design commitment 10.

ANSWER:

Part 1- MUAP-10012 represents the V&V Implementation Plan. Reference the response to 18-150.

Part 2- As discussed with the NRC staff, the Results Summary report will not only contain the V&V results it will describe the details of the testing program, its scenarios, acceptance criteria, resulting HEDs and their disposition, and the data analysis. Based on this level of detail, the Results Summary report is supportive of ITAAC inspections.

The following section 4.6 of MUAP-10012 will be revised as follows to clarify above descriptions:

4.6 ~~Validation~~ Conclusions

The conclusions of the integrated system validation will be based on;

- The specific HEDs as well as the extent of the identified performance issue,
- The absolute number of new HEDs identified,
- The performance of the HSI with the human in the loop as compared to the pre test developed success criteria,
- The consensus of the observer's technical opinion, and
- Rigorous statistical data analysis following that discussed in MUAP-08014 and MUAP-09019 (~~ref 3 and 4~~**Reference 5-3 and 5-4**).

The Verification and Validation results will be documented in a Results Summary Report, in accordance with Reference 5-7 section 11.3. The Results Summary report will include:

- **Verification;**
  - **A description of the application of this Implementation Plan in conducting the Verification program**
  - **Verification results based on Reference 5-5, examples of results presentation are contained in References 5-3 and 5-4**
- **Validation;**
  - **A description of the application of this Implementation Plan in conducting the Validation program**
  - **A copy of the Validation test procedures**
  - **A description of the test personnel and plant test crew training program.**
  - **Qualifications of the test personnel, scenario developers and plant test crew.**
  - **A description of the test bed**
  - **A detailed description of all specific scenario sets used in the testing, including plant initial conditions, plant parameters of importance, event timing including expected operator actions, and applicable, scenario specific, performance measures and acceptance criteria**
  - **Data analysis at the level of depth as reported, as examples, in References 5-3 and 5-4**
  - **Validation results and conclusions as compared to the minimum set of test objectives described in section 4.3.1.**
  - **A copy of the test data collection instruments used in the Validation**

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

The impact on Technical Report MUAP-10012 is described in above answer. (Reference RAI NO. 18-150)

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QUESTION NO. : 18-176

Different methodologies for conducting HFE Design Verification are described in DCD (Section 18.10.2.2, Design Verification), MUAP-07007 (Section 5.10.2.2.3, HFE Design Verification), and Section 4.2.3, Design Verification, of the V&V Implementation Plan (MUAP-10012, R0). The DCD describes the use of the style guide and NUREG-0700 to review actual HSI, MUAP-07007 describes the use of NUREG-0700 to review the style guide; and the IP describes the use of the style guide to verify HSIs in a training simulator. Please clarify the methodology to be used for HFE Design Verification. Also, please clarify the use of the style guide for the U.S. APWR Design.

ANSWER:

The use of the NRC reviewed HSI Design Style Guide, JEJC-1763-1001, as stated in MUAP-10012, will be the methodology for the Phase 2b Design Verification of US-APWR. MUAP-10012 supersedes MUAP07007 as the US-APWR Implementation Plan.
While, MUAP-07007 may be applied to modernization programs for existing operating plants an HSI style guide equivalent to JEJC-1763-1001 will be developed and applied to such programs and referred in the specific Licensing Amendment Request.

Impact on DCD

There is no impact on the DCD

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on the Topical/Technical Reports.

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QUESTION NO. : 18-177

DCD Section 18.10.2.2 states that "Unique US-APWR HFE verification activities are not required for the basic HSI design characteristics of control, alarms, and indications, since this verification activity was conducted during Japanese human factors (HF) V&V program activities. HF verification is conducted for any changes to the Japanese HSI design." The V&V Implementation Plan (MUAP-10012, R0), Section 4.2.3, Design Verification, states that 100% of the HSI will be evaluated. Please clarify the scope of the design verifications.

ANSWER:

As stated in MUAP-10012, 100% of the main control room HSI will undergo design verification to the HSI Design Style Guide, JEJC-1763-1001.

Impact on DCD

The last paragraph of DCD section 18.10.2.2 will be deleted and replaced by-" 100% of the HSI will be evaluated in the design verification." (Please also see Attachment 1.)

Impact on R-COLA

There is no impact on the R-COLA

Impact on S-COLA

There is no impact on the S-COLA

Impact on PRA

There is no impact on the PRA

Impact on Topical/Technical Reports

There is no impact on the Topical/Technical Reports.

This completes MHI's responses to the NRC's questions.

18.1.2.3.2 HFE V&V Team Organization Composition

The V&V team conducts the HFE V&Vs in accordance with the US-APWR HSI V&V implementation plan (~~Section 18.10~~Reference 18.1-17). The V&V team includes personnel with the following technical skills: DCD_18-150

- HFE
- Plant operations
- Operator training
- HSI design

The V&V team adds other technical disciplines as needed during the V&V process.

18.1.2.4 HFE Organizational Staffing

The HFE team staffing is described in terms of minimum qualifications and job descriptions of team personnel. The minimum qualifications and job descriptions of team personnel are documented in Reference 18.1-12, Part 1, Section 3.1 and Section 6.1 for HFE expert panel, and controlled as required by Reference 18.1-6. DCD_18-114

The requisite professional experience is satisfied by the HFE design team as a collective whole. Therefore, the satisfaction of the professional experience requirements associated with a particular skill area may be realized through the combined professional experience of two or more members of the HFE design team who each, individually, satisfies the other defined credentials of the particular skill area but who does not possess all of the specified professional experience. It is recognized that one person may possess multiple skills and that people may have additional responsibilities beyond the HFE design team. The roles and responsibilities for the key sections of the organization are described in Reference 18.1-12, Part 1 Section 3.2. ~~Subsection 5.1.2.2.~~ DCD_18-106

Alternative personal credentials may be accepted as the basis for satisfying the minimum personal qualification. Acceptance of such alternative personal credentials is evaluated on a case-by-case basis and approved, documented, and retained in auditable project files as described in Reference 18.1-6.

18.1.3 HFE Process and Procedures

Activities performed relating to HFE are performed in accordance with documented procedures under the QA Program for the US-APWR (Reference 18.1-6). These procedures provide the control over the HFE processes as described below.

18.1.3.1 General Process Procedures

The processes through which the team executes its responsibilities include procedures for:

- Assigning HFE activities to individual team members

- GDC 3 – Fire Protection
- GDC 13 – Instrumentation and Control
- GDC 17 – Electric Power Systems
- GDC 19 – Control Room
- GDC 34 – Residual Heat Removal
- GDC 35 – Emergency Core Cooling System
- GDC 38 – Containment Heat Removal
- GDC 44 – Cooling Water

- Safety margins are often used in deterministic analyses to account for uncertainty and incorporate an added margin to provide adequate assurance that the various limits or criteria important-to-safety is not violated.

The technical information generated from the HFE program activities are documented in technical reports covering the associated sections of this chapter:

- HFE Analysis – Sections 18.2, 18.3, 18.4, 18.5, and 18.6
  - Section 18.2 – US-APWR operating experience review report
  - Section 18.3 – functional requirements analysis/function allocation (FRA/FA) report
  - Section 18.4 – task analysis report
  - Section 18.5 – staffing and qualifications analysis report
  - Section 18.6 – HFE/HRA integration report
- HFE Design – Sections 18.7, 18.8, and 18.9
  - Section 18.7 – HSI Design Technical Report
  - Section 18.8 – US-APWR procedure system report
  - Section 18.9 – training program report
- HFE Verification and Validation – Section 18.10
  - Section 18.10 – U.S. Operator V&V Technical Report (Phase 1a & b) ~~and US-APWR HF V&V Report (Phase 2)~~(Reference 18.1-12 and 18.1-13) DCD_18-150
  - Section 18.10 – US-APWR Verification and Validation Implementation Plan (Reference 18.1-17)

- If an operator action erroneously disables a safety function or erroneously creates a condition that threatens a critical safety function, BISI and CSF alarms are provided on the LDP.

- The basis for allocation of HSI functions to either the main control room or LCS. All control functions are accessible in the main control room and no LCS controls are credited for normal operation or accident condition operator response. The basis for the control room layout, and the organization of HSIs within consoles, panels, and workstations – the MCR is designed to support the range of crew tasks and staffing (MCR layout is discussed in Reference 18.7-1 Subsection 4.3.1); operational VDUs which are used during all normal and emergency modes of operation are centrally located.

- How the control room supports a range of anticipated staffing situations – the design accommodates minimum and nominal staffing, as described in Section 18.5; in addition, sufficient space is available to accommodate shift turnover transitions.

- How the HSI characteristics mitigate excessive fatigue – lighting, as described in Subsection 9.5.3, and ergonomics, as described in Reference 18.7-1, Section 4.3, Layout Design.

- How the HSI characteristics support human performance under a full range of environmental conditions – ~~highly controlled environment without a significant fluctuation of environmental conditions~~normal as well as credible extreme conditions, including emergency lighting, Subsection 9.5.3; ventilation, Section 9.4; and control room habitability, as discussed in Section 6.4. DCD_18-182

- The means by which inspection, maintenance, tests, and repair of HSIs is accomplished without interfering with other control room tasks – Reference 18.7-1, Section 4.11 "Response to HSI Equipment Failures" discusses response to HSI equipment failures without impacting plant control functions.

Overall HFE issues associated with the central alarm station (CAS) and the secondary alarm station (SAS) are discussed in Section 13.6, Security. The HSI Detailed Design and Integration process encompasses the HSI design aspects of the CAS and SAS.

18.7.2.6 HSI Tests and Evaluations

The control room HSI development of the Japanese APWR, as described in Reference 18.7-1 Appendix A, included trade-off evaluations and performance-based tests. The evaluations and testing associated with this HSI development is described in a series of historical project summary reports. This work was conducted in conjunction with Japanese nuclear utilities that provided the nuclear plant operating staff that supported the testing efforts. The performance of the operating staff was evaluated as described in Reference 18.7-1 Appendix B and the associated references. Additional tests and evaluations for the US-APWR HSI design are described in Section 18.10 and Reference 18.7-7. DCD_18-150

18.7-2 U.S. Nuclear Regulatory Commission, Human-System Interface Design Review Guidelines, NUREG-0700, Revision 2, May 2002.

18.7-3 Design for Control Rooms of Nuclear Power Plants, IEC 964, International Electrochemical Commission, 1989.

18.7-4 Post-TMI Requirements, NRC Regulations Title 10, Code of Federal Regulations, Part 50.34.

18.7-5 HSI Design, MUAP-09019-P (Proprietary) and MUAP-09019-NP (Non-Proprietary), Revision 0, June 2009.

18.7-6 HSI Design Implementation Plan, MUAP-10009, Revision 0, April 2010. DCD_18-178

18.7-7 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012. DCD_18-150

As in the Japanese APWR HSI design, the US-APWR HSI design includes backup paper procedures to accommodate degraded CBP conditions. The US-APWR procedures writer's guide includes requirements that ensure consistency and ease of transition between CBPs and paper procedures. Both CBPs and paper procedures are included in the V&V program, including transition for degraded HSI conditions, as described in Section 18.10. The V&V program (Reference 18.8-7) evaluates the performance of operating crews utilizing CBPs under normal and abnormal operating conditions, and using paper procedures under the following degraded HSI conditions: | DCD_18-150

- Degraded operations based on loss of non safety HSI.
- Degraded operations based on loss of safety and non safety HSI due to common cause failure.
- Degraded operations based on evacuation from the MCR.

18.8.2.5 Ergonomics Issues in Procedure Usage

The physical means by which operators access and use procedures, especially during operational events, is evaluated as part of the HFE design process. This criterion generally applies to both paper procedures and CBPs, although the nature of the issues differs somewhat depending on the implementation. For example, the process addresses the storage of procedures, the ease of operator access to the correct procedures, and the lay down of paper procedures for use in the MCR, RSR, TSC, and LCSs. Section 4.8 of Reference18.8-2 describes the access methods for CBP. Section 4.2 of Reference 18.8-2 describes storage and lay down of paper procedures in the MCR and RSR.

18.8.3 Results

The US-APWR procedure system report lists operating and emergency procedures developed for the US-APWR, with a brief descriptive summary for each procedure. Additionally, the report contains a summary of the content of the US-APWR procedure writer's guide.

Maintenance and control of updates to paper procedures and CBP are managed under the configuration control program of the US-APWR Quality Assurance Plan, as discussed in Section 18.1. Normal changes to CBPs, such as changes to procedure steps, do not affect the basic CBP software. Therefore, these changes are considered data changes and do not undergo software V&V, in accordance with the software life cycle management program (see Section 7.1). Changes to the basic CBP software do undergo V&V in accordance with the Software Lifecycle Management Program.

Procedure modifications are integrated across the full set of procedures; alterations in particular parts of the procedures are made to be consistent with other parts. Changes to procedures are documented and analyzed for their potential impact on HSI. Any procedure implementation issues that negatively affect Human Performance are identified as HEDs. The HEDs are tracked and dispositioned.

18.8.4 Combined License Information

No additional information is required to be provided by a COL Applicant In connection with this section.

COL 18.8(1) Deleted

18.8.5 References

18.8-1 U.S. Nuclear Regulatory Commission, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, Subsection 13.5.2.1 "Operating and Emergency Operating Procedures," March 2007.

18.8-2 HSI System Description and HFE Process, MUAP-07007-P (Proprietary) and MUAP-07007-NP (Non-Proprietary), Revision 3, October 2009.

18.8-3 Plant Procedures, Inspection Procedure, IP-42700, November 1995.

18.8-4 Emergency Operating Procedures, Inspection Procedure, IP-42001, June 1991.

18.8-5 U.S. Nuclear Regulatory Commission, Guidelines for the Preparation of Emergency Operating Procedures, NUREG-0899, August 1982.

18.8-6 US-APWR Procedure Development Implementation Plan, MUAP-10010, Revision 0, April 2010. DCD_18-188

18.8-7 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012. DCD_18-150

18.10 Verification and Validation

18.10.1 Objectives and Scope

V&V evaluations (Reference 18.10-5) comprehensively determine that the US-APWR design conforms to HFE design principles and that it enables plant personnel to successfully perform their tasks to achieve plant safety and other operational goals. The V&V methodology has the following four major activities: DCD_18-150

- Operational conditions sampling
- Design verification
- Integrated system validation
- HEDs Resolution

The scope of the V&V activity encompasses the MCR, RSC, TSC~~, EOF (information requirements and communications),~~ and LCSs. V&V of the EOF is outside the scope of the US-APWR V&V program; V&V will be conducted in accordance with the site specific HFE program to confirm compliance to NUREG-0696. All aspects of the MHI US-APWR V&V program are controlled by the appropriate sections of Reference 18.10-1. DCD_18-129

18.10.2 Methodology

The V&V methodology addresses the following topics:

- Operational conditions sampling: the selection of operational scenarios to be used in V&V
- HSI design verification: the evaluation of the HSI design for meeting tasks requirements and HFE guidelines
- Integrated system validation: the evaluation of whether the integrated system (hardware, software, and crew) meets performance requirements
- HED resolution: the resolution of potential human performance issues identified in V&V evaluations

Reference ~~18.10-2 Section 5.10~~18.10-5 provides a description of the US-APWR HFE V&V program, including the methodology used to develop that program. The US-APWR HFE V&V program is based on the V&V program for the Japanese APWR HFE, which encompasses the HSI design and procedure development. The Japanese and international standards, Japanese nuclear power plant operating experience, and NRC directed operating considerations have been applied to the V&V program and are discussed in Reference ~~18.10-2, Appendices A and B~~18.10-5. DCD_18-150 DCD_18-150

The US-APWR HSI and procedures are based on the Japanese APWR HSI and procedures. The changes to HSI and procedures are described in Sections 18.7 and

18.8, respectively. Therefore, the US-APWR HFE V&V program focuses on these changes.

18.10.2.1 Operational Conditions Sampling

This portion of the V&V process identifies a sample of operational conditions that is to be used as the basis for V&V activities. This sample:

- Includes conditions that are representative of the range of events that could be encountered during operation of the plant
- Reflects the characteristics that are expected to contribute to system performance variation
- Considers the safety performance of HSI components

The operational scenarios, events, transients, and accidents used in V&V are based on their risk importance. The complete basis for operational conditions sampling is described in Reference ~~18.10-2 Subsection 5.10.2.1~~18.10-5. The selected operational conditions and their selection basis are documented in the HFE V&V implementation plan. DCD_18-150

18.10.2.2 Design Verification

The operations conditions sample defines the scope of the V&V activities. The V&V activities are conducted using actual HSI displays generated by system software and actual HSI control panels. The aspects of the HFE design verification that are addressed are discussed below. Reference 18.10-3 is used as the principle source of detailed HFE design guidelines for the verification process.

- The design verification confirms that the inventory and characterization of all HSI components (alarms, controls, displays and related equipment) meet the HSI inventory and characterization requirements defined in the task analysis. This activity is sometimes referred to as HSI Task Support Verification
- The design verification confirms that the characteristics of the HSI, and the environment in which it is used, conform to HFE guidelines, as defined in the HSI design style guide. Reference 18.10-3 is used for confirmation of detailed characteristics that may not be included in the HSI design style guide
- The design verification identifies any inventory or characterization non-conformance. Non-conformances that are accepted are documented with appropriate evaluation criteria and the basis for those criteria. Non-conformances that are not accepted are identified as HEDs

~~Unique US-APWR HFE verification activities are not required for the basic HSI design characteristics of control, alarms, and indications, since this verification activity was conducted during Japanese human factors (HF) V&V program activities. HF verification is conducted for any changes to the Japanese HSI design.~~100% of the HSI will be evaluated in the design verification. DCD_18-177

18.10.2.3 Integrated System Validation

The integrated system validation is the process by which an integrated system design (i.e., hardware, software, and personnel elements) is evaluated to determine whether it acceptably supports safe operation of the plant. This process evaluates the acceptability of those aspects of the design that cannot be determined through such analytical means as HSI task-support verification and HFE design verification.

Integrated system validation is conducted using actual dynamic HSI with high fidelity plant model simulation of the operational conditions samples. Reference ~~18.10-2, Subsection 5.10.2.2.4~~18.10-5, describes the process for the integrated system validation methodology. DCD_18-150

The methods for integrated system validation include the following aspects of the validation methodology:

- Test objectives
- Validation test beds
- Plant personnel
- Scenario definition
- Performance measurement
  - Measurement characteristics
  - Performance measure selection
  - Performance criteria
- Test design
  - Coupling crews and scenarios
  - Test procedures
  - Test personnel training
  - Participant training
  - Pilot testing
- Data analysis and interpretation
- Validation conclusions

Plant personnel performing operational events for the validation use a simulator or other suitable representation of the system (referred to as a test bed) to determine its adequacy

to support safety operations. The test bed of the MCR is a full-scope US-APWR control room simulator meeting the requirements of Reference 18.10-4. Other test beds modeling locations outside the MCR are represented by part task or limited scope simulations, meeting the guidelines of Reference 18.10-4, Appendix D, or by mockups or analysis. Deviations from the requirements of Reference 18.10-4 that are judged to be acceptable for the purposes of HSI validation, as compared to operator training, are documented and justified in the HSI V&V procedure.

The validation is undertaken after significant HEDs that were identified in verification reviews have been resolved, since these can negatively affect performance and the results of validation. A description of HEDs identified during the validation and their resolution is documented.

The US-APWR HSI design and procedures are based on the Japanese standard HSI design and procedures that were validated, as described in Reference 18.10-2, Appendices A and B. Validation for the US-APWR HSI design and procedures are conducted in two phases, as follows.

- Phase 1 (References 18.10-6 and 18.10-7) - This phase validates the basic US-APWR HSI design. DCD_18-150

  - For this phase, the Japanese standard HSI design and procedures are converted to the English language and English units of measure

  - This phase is conducted by a sample of US operations crews who are previously trained on the utilization of the Japanese HSI and procedures, and operation of the Japanese standard 4-loop PWR

  - Operational conditions samples used during this phase are those that assist with validation of the basic HSI design for cross-cultural differences and population stereotypes

  - This phase is documented in the U.S. Operator V&V Technical Report

- Phase 2 (Reference 18.10-5) - This phase validates the final US-APWR HSI design and procedures. DCD_18-150

  - This phase is conducted by US operations crews who are previously trained on the utilization of the US-APWR HSI and procedures, and operation of the US-APWR plant systems

  - Operational conditions samples used during this phase conform to all of the selection criteria in Subsection 18.10.2.1

  - This phase is documented in the US-APWR HF V&V report

18.10.2.4 Human Engineering Discrepancy Resolution

HED resolution is performed iteratively throughout all V&V activities. HEDs identified during a V&V activity are evaluated to determine if they must be resolved prior to

conducting other V&V activities. The purpose of the HED resolution is to verify the adequate completion of the following tasks:

- Evaluation of HEDs to determine the need for their correction including their prioritization and organization responsible for resolution
- Identification of design solutions to address significant HEDs along with an indication of their current status (implemented or scheduled to be implemented)
- Determination of the HFE Program activities that must be re-performed to satisfy the requirements of the limited reapplication of the HFE analysis processes in Sections 18.3 through 18.6
- Verification of the implementation of the design solutions resolving HEDs including how the change complies with the V&V evaluation criteria

HEDs are not considered in isolation and, to the extent possible, their potential interactions are considered when developing and implementing solutions. For example, if the HSI for a single plant system is associated with many HEDs, then the set of design solutions are coordinated to enhance overall performance and avoid incompatibilities between individual solutions. Approaches that develop design solutions to some HEDs before all have been identified from a particular verification or validation activity are acceptable provided that the potential interactions between HEDs are specifically considered prior to implementing the design solutions.

18.10.3 Results

The V&V Phase 1 results are to be documented in the US Operator V&V Technical Report. The Phase 2 results, to include V&V program staffing and resources, the detailed procedures for conducting the V&V program, the V&V program data, analysis, and results, identification, and resolution of HEDs, and the major conclusions from these activities along with their bases, are to be issued in the US-APWR HF V&V report.

MUAP-10012 (Reference 18.10-5) are not taken credit for as any part of the final NUREG-0711 V&V, but instead are a bases for the HSI design and this Implementation Plan and as such are viewed as supplemental information. DCD_18-153

18.10.4 Combined License Information

No additional information is required to be provided by a COL Applicant in connection with this section.

COL 18.10(1) *Deleted*

COL 18.10(2) *Deleted*

18.10.5 References

18.10-1 Quality Assurance Program (QAP) Description for Design Certification of the US-APWR, PQD-HD-19005, Revision 3, Mitsubishi Heavy Industries, Ltd., September 2009.

18.10-2 HSI System Description and HFE Process, MUAP-07007-P (Proprietary) and MUAP-07007-NP (Non-Proprietary), Revision 3, October 2009.

18.10-3 U.S. Nuclear Regulatory Commission, Human-System Interface Design Review Guidelines, NUREG-0700, Revision 2, May 2002.

18.10-4 Nuclear Power Plant Simulators for Use in Operator Training, ANSI/ANS 3.5, 1998.

18.10-5 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 1, February 2012. DCD_18-150

18.10-6 US-APWR Human System Interface Verification and Validation Phase 1a, MUAP-08014, Revision 1, May 2011.

18.10-7 US-APWR Human System Interface Design, MUAP-09019, Revision 1, December 2011.

Attachment 2

Appendix 1 Examples of Scenarios of Design Certification Validation Phase 2b Scenario Event Sequence Descriptions and Acceptance Criteria