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

October 27, 2011

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-11366

**Subject: MHI's Responses to US-APWR DCD RAI No. 797-5835 REVISION 3 (SRP 18)**

**Reference:** 1) "Request for Additional Information No. 797 COLP 5835 REVISION 3, SRP Section: 18 - Human Factors Engineering, Application Section: 18.7" 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. 797-5835 Revision 3."

Enclosed are the responses to the RAIs contained within Reference 1.

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

Sincerely,

Y. Ogata

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

Enclosure:

1. Responses to Request for Additional Information No. 797-5835 REVISION 3

CC: J. A. Ciocco
C. K. Paulson

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NRO

Enclosure 1

UAP-HF-11366
Docket No. 52-021

Responses to Request for Additional Information No. 797-5835
REVISION 3

October 2011

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**10/27/2011**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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|---|---|
| **RAI NO.:** | **NO. 797 COLP 5835 REVISION 3** |
| **SRP SECTION:** | **18. - HUMAN FACTORS ENGINEERING** |
| **APPLICATION SECTION:** | **18.7** |
| **DATE OF RAI ISSUE:** | **8/3/2011** |

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**QUESTION NO. : 18-178**

**Acceptance Criteria:**
10 CFR 52.47: The application must contain a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that construction conforms to the design and to reach a final conclusion on all safety questions associated with the design before the certification is granted.

**Evaluation:**
DCD, Chapter 18, Section 18.7, "Human-System Interface Design" does not reference MUAP-10009, ""US-APWR HSI Design Implementation Plan" of April, 2010. This document provides additional detail the staff used to reach their conclusion on safety.

**Information Request:**
With the next revision of the DCD ensure that MUAP-10009 is appropriately referenced to include the information it provides.

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**ANSWER:**

In DCD Section 18.7, the MUAP-10009 will be added as a reference.

**Impact on DCD**

The reference MUAP-10009 will be added as a reference in Section 18.7.5;

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

The first sentence in Section 18.7.3.3 will be revised as follows (See Attachment-1.);

> The HFE Design Report (Reference 18-.7-5) and HSI Design Implementation Plan (Reference 18.7-6) documents the process for the following HSI changes:

**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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**10/27/2011**

**US-APWR Design Certification**

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**QUESTION NO. : 18-179**

**Acceptance Criteria:**
MUAP-10009, revision 0, Section 2.0, "Scope," states that phase 2 does not change the US-Basic design *unless Phase 2 V&V indicates a design change is needed.*

**Information Request:**
Please clarify how this feedback will be accomplished. Are there changes to the US Basic HSI design that will be added to MUAP-07007 before the NRC SER is issued? Are changes made as part of the US-APWR submittal?

Note: The staff's intent with this question is to understand whether there is potential for iterative reviews of MUAP-07007 that could affect the schedule for completing the USAPWR review.

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**ANSWER:**

Phase 2 V&V (which represents NUREG 0711 Element 11, Human Factors Verification & Validation) is planned to be executed after MUAP-07007 SER. In case of the design change is needed based on Phase 2 V&V results, the change results will be documented in the V&V result summary report and the final design will be also documented in the design implementation result summary report. Therefore, any changes to the US-Basic HSI that are made for the US-APWR will be documented in US-APWR reports. Both of the documents will be reviewed in the ITAAC process. These changes above are controlled in accordance with the HSI design implementation plan.

**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

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**QUESTION NO. : 18-180**

**Acceptance Criteria:**
NUREG-0711 Criterion 8.4.4(2): Alternative approaches for addressing HSI functional requirements should be considered. A survey of the state-of-the-art in HSI technologies should be conducted to:

- Support the development of concept designs that incorporate advanced HSI technologies
- Provide assurance that proposed designs are technically feasible
- Support the identification of human performance concerns and tradeoffs associated with various HSI technologies

Also criteria 8.4.4(3)-(5)

**Evaluation:**
DCD, Section 18.7.2.4 and MUAP-10009, Section 4.4 both discuss alternative design approaches and state-of-the-art surveys relative to the US-Basic HSI design. The MUAP in particular indicates, "Additional approaches for addressing HSI functional requirements will be assessed for resolving Phase 1 design related HEDs." Phase 1 develops the US-Basic HSI design not the US-APWR design. The list of changes in the US-APWR HSI design (Section 18.7.2.4) contains several changes that would appear to warrant application of this criterion. (For example: automatic isolation of a failed SG, automatic recirculation, accommodations for 2 operators).

**Information Request:**

1. Explain how this criterion is applied within the US-APWR HSI design process.
2. Similarly, explain how criteria 8.4.4(3), (4), and (5) are applied to the US-APWR HSI design process. The staff understands that the US-Basic HSI design is the foundation for the USAPWR design and therefore the 3 criteria referenced above are addressed via the incorporation of the US-Basic HSI design. What is not clear is why these 3 criteria wouldn't still be applicable to design work specific to the US-APWR.
3. If these criteria are not applicable to the US-APWR HSI design, explain why.
4. Also please explain why MUAP-10009 refers to resolving Phase 1 design related HEDs in the future tense. It is the staff understands that these HED's were resolved in phase 1b the results of which are summarized in MUAP-09019 and will be (?) reflected in

MUAP-07007 revision 4. (The staff is trying to understand where phase 1B stops and 2A begins. The descriptions of the phases are clear. Where the results of phase 1B will be documented is still confusing.)

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**ANSWER:**

1. The Phase 1a/1b V&V was conducted to develop the US Basic HSI System, based on technology already in use a predecessor plant, and the Phase 2 design develops the US-APWR HSI design. The alternative design approach of the Phase 2 design including assessment for resolving the design related HEDs is same approach as Phase 1 design as stated in MUAP-10009. The HED resolutions, which include alternative design evaluations, is an evaluation to provide reasonable assurance that the HEDs identified during the V&V activities have been acceptably assessed and resolved. All HEDs generated through the Phase 1a/1b V&V program along with those that resulted from all other sources were evaluated by a multidiscipline HFE team. As a result of the evaluation, the alternative approach is raised and designed. As for the evaluation of the design result, the HSI design team conducts the review process, which is directed by working level procedure "New Design/Method Control Procedure," to comply with latest state-of-art technology is adequately applied. NUREG 0711 8.4.4-2 design criteria 1 is met by the state of the art review that was the bases of the predecessor plant, criteria 2 is meet by the fact that the predecessor plant has demonstrated feasibility by its operation, and criteria 3 is meet through the iterative test and design and HED resolution process.

   The last paragraph in Section 4.4, 2) MUAP-10009 will be revised as follows;

   > The US-Basic HSI design (Topical Report MUAP-07007) addressed "alternative approaches for addressing HSI functional requirements". Additional approaches for addressing HSI functional requirements ~~will be~~ are assessed for resolving Phase 1, 2 and 3 design related HEDs.

   Regarding the automatic isolation of a failed SG, this refers to Emergency Feedwater Isolation for a Main Steam Line Break, not a SGTR. See the response to Question 18-143.

2. The process shown in Section 4.4 of the MUAP-10009 is applied to both US Basic HSI system and the US-APWR HSI design process.

   The last paragraph in Section 4.4, 3) MUAP-10009 will be revised as follows;

   > Alternate approaches for addressing HSI functional requirements ~~will be~~ are assessed for resolving Phase 1, 2 and 3 design related HEDs.

   The last paragraph in Section 4.4, 4) MUAP-10009 will be revised as follows;

   > The same process of evaluations and design reviews ~~will be~~ are applied to any design changes resulting from the resolution of Phase 1, 2 and 3 design related HEDs.

   The last paragraph in Section 4.4, 5) MUAP-10009 will be revised as follows;

The US Basic HSI System design ~~concept will be updated to~~ reflects the resolution of the significant HEDs from Phase 1 ~~design related HEDs~~. Other Phase 1 HEDs will be addressed in either the generic US-APWR HSI System design developed in Phase 2 or the site specific US-APWR HSI System design developed in Phase 3, as appropriate. The US Basic HSI System design, as documented in Topical Report MUAP-07007, will not be revised unless this simplifies the licensing application for a future project which references that Topical Report.

3. As described above, NUREG-0711 criteria are applied to the US-APWR design process.

4. As shown in answer No.1 and 2 above, the future tense will be revised.

**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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**10/27/2011**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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**QUESTION NO. : 18-181**

**Acceptance Criteria:**
Criterion 8.4.5(6): Personnel and task performance should be supported during minimal, nominal, and high-level staffing.

**Evaluation:**
Minimal and nominal staffing are satisfactorily defined, described, quantified and incorporated into the HSI design and V&V activities. Maximum staffing is satisfactorily incorporated in the HSI design and V&V activities but there is no description of what constitutes maximum staffing.

**Information Request:**
Describe the maximum staffing assumption used as input to the HSI design and V&V activities. How many people are considered and what are their backgrounds? (Maximum operations staffing is clear; support staffing levels are not)

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**ANSWER:**

As is answered in the response to RAI 725 COLP-5408 18-98 (MHI Ref. UAP-HF-11124 (ML1119A208)), the US-APWR HSI design activities assumes the following:

The initial starting point for the maximum staffing in the staffing and qualification analysis is based on providing HSI accommodations (i.e., space and layout) in the MCR for the following personnel:

- Two reactor operators (RO), responsible for the operation of controls in MCR
- One Control Room Supervisor (CRS) (Licensed senior reactor operator (SRO)), responsible for the direct supervision of the ROs in MCR
- One shift manager (SM), responsible for overall plant operation (SRO)
- One shift technical advisor (STA), responsible for providing engineering support

The initial starting point for the maximum staffing in the staffing and qualification analysis is based on providing physical and habitability accommodations within the MCR envelope for the following active observers:

- One shift crew assistant, responsible for assisting the shift supervisor and handling communications
- One additional RO, responsible for assisting the above two ROs and interacting with other members of the plant staff
- One NRC representative
- One from the Plant Owner's management
- Two equipment operators

**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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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**QUESTION NO. : 18-182**

**Acceptance Criteria:**
Criterion 8.4.5(8): HSI characteristics should support human performance under the full range of environmental conditions, e.g., normal as well as credible extreme conditions. For the main control room requirements should address conditions such as loss of lighting, loss of ventilation, and main control room evacuation. For the remote shutdown facility and local control stations, requirements should address constraints imposed by the ambient environment (e.g., noise, temperature, contamination) and by protective clothing (if necessary).

**Evaluation:**
The Topical Report, Section 5.7.3.2 states, "The HSI characteristics support human performance under a full range of environmental conditions. The control of the control room environmental conditions, including emergency lighting, ventilation, and control room habitability, are discussed in plant licensing documentation."

RAI response 412 COLP-2546, Question 18-60 states that extreme conditions are addressed in Table 5.4-1 of the Topical report. The table lists lighting, temp, and noise as examples of extreme environmental conditions considered during the task analysis. The DCD, Section 18.7.2.5 states, "How the HSI characteristics support human performance under a full range of environmental conditions – highly controlled environment without a significant fluctuation of environmental conditions, including emergency lighting, Subsection 9.5.3; ventilation, Section 9.4; and control room habitability, as discussed in Section 6.4." MUAP-09019, Section 2.4.2.2.1 states, "Specific elements of the overall work environment (e.g., temperature, humidity, ventilation, illumination, and noise) that are not anticipated to influence the specific HA are not required to be identified. The range of situational factors that are known to challenge human performance are specified, including adverse or inhospitable environmental conditions such as poor lighting, extreme temperatures, high noise, and radiological issues (dose rate or contamination).

When evaluating performance associated with the use of HSI components located remotely from the main control room, the specific effects on crew performance due to potentially harsh environments (i.e., high radiation) are considered (i.e., additional time to don protective clothing and access radiologically controlled areas)."

**Information Request:**

With respect to the control room, clarify how environmental conditions are evaluated. Specifically address the following points.

- The documents provide a clear commitment to evaluate environmental conditions but the staff is not clear on the process being used to complete the evaluation. The Topical Report and the DCD both appear to be implying that emergency lighting and ventilation bound certain environmental conditions but this is not clearly stated. The limits on environmental conditions imposed by these systems (or how these limits will be identified) are not specified.
- The DCD uses the phrase, "highly controlled environment without a significant fluctuation of environmental conditions." It is unclear how this phrase is being applied.
- MUAP-07007 refers to plant licensing documentation. This could imply the COL applicant is responsible for this work. This seems inconsistent with the other documentation.
- Is the first sentence from MUAP-09019 quoted above just saying you are not going to document environmental conditions that do NOT affect task performance or is there additional context we are missing?

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**ANSWER:**

1. The limits on environmental conditions imposed by the systems such as ventilation and lighting are specified in the design basis and system description of the DCD. For example, the MCR HVAC is designed as stated in DCD Chapter 9.4.1; "The MCR HVAC System is designed to provide and control the proper environment in the MCR and other areas within the control room envelope (CRE) as defined in Chapter 6, Section 6.4."
Additionally, the MCR HVAC is designed to comply with the regulatory requirements such as CFR and RGs. Therefore, the HSI design implementation plan refers to the DCD Chapter 9.

2. The phrase in Chapter 18 "highly controlled environment without a significant fluctuation of environmental conditions." will be revised as follows;

> 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.

3. The License Amendment Request or Final Safety Analysis Report described in Topical Report Section 5.7.3.2 intended the DCD and the reports.

4. The sentence in MUAP-09019 Section 2.4.2.2.1 B, second sentence will be deleted as follows;

> Environmental influences typically refer to ambient conditions that could have a negative influence on successful performance of the HA. (e.g., contribute to performance shaping factors that reduce the probability of success). ~~Specific elements of the overall work environment (e.g., temperature, humidity, ventilation, illumination, and noise) that are not anticipated to influence the specific HA are not required to be identified~~.....

**Impact on DCD**

The phrase in Section 18.7.2.5 "highly controlled environment without a significant fluctuation of environmental conditions." will be revised as follows (See Attachment-1.);

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.

**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

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**10/27/2011**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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**QUESTION NO. : 18-183**

**Acceptance Criteria:**
NUREG-0711, Sections 8.4.6.1 and 8.4.6.2 contain specific criteria for trade-off evaluations and performance-based tests to be incorporated within the HSI design.

**Evaluation:**
The RAI response to DCD RAI no. 412 COLP-2546 (UAP-HF-09398) states the criteria referenced above are addressed in appendix A, B and C of MUAP 07007. The staff used this information plus that provided in MUAP-08014, Part 1 and MUAP-09019, Part 3 as input to the evaluation of the Topical Report since this material is all described as being part of Phase 1 and thus applicable to the US-Basic HSI design.

If these practices are carried over into phase 2, the staff believes that the NUREG-0711 test and evaluation criteria would be satisfied. MUAP-09019, Section 1 seems to imply they are saying, "The iterative process of analysis, design and test will continue over the next 2 years as the HSI for the US-APWR is refined, leading up the full Verification and Validation as recommended by NUREG-0711 Rev.2, in Phase 2 as described earlier in this report." However, no specific criteria were found for performing the iterative testing.

MUAP-08014, Section 2.3.3 mentions a static portable HSI system analysis tool but it does not provide the detail necessary for the staff to understand how the test and evaluation criteria are applied. That being said, the staff realizes phase 2 develops the HSI inventory rather that the physical HSI design and so, perhaps testing and evaluation of design assumptions is unnecessary given the integrated System Validation will be performed.

**Information Request:**

1. Will validation activities similar to what is described for phase 1 be accomplished during phase 2? (This would be validation activities that precede the Integrated System Validation.) If so, when are they done and what do they evaluate? Can the staff assume the methods described for phase 1 continue into the phase 2 validation? If not, why? Is it because minimum testing and evaluation of design assumptions is unnecessary?

2. MUAP-08014, Section 2.3.3 states that the static portable HSI system analysis tool is used to evaluate the consistency of the HSI inventory between displays and operating procedures. This appears to be a method used to verify completeness rather than test or evaluate a design option. Is this correct? If not, please explain its purpose and how the NUREG criteria

referenced above are addressed.

3. Please provide any additional information that would help the staff understand the relevancy of the referenced NUREG criteria to the design processes used in Phase 2.

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**ANSWER:**

1. The validation activities and the methods for Phase 2 are the same as described for phase 1a/1b, because the HSI design process is interactive. In the Phase 2 the US-APWR HSI inventory will be designed, and verified and validated in Phase 2b ISV, currently scheduled for 2016.
2. The static portable HSI system analysis tool is planned to be used to evaluate the consistency of the HSI inventory between displays, as needed supplement to the simulator displays for design verification to the HSI Style Guide and to the plant procedures prior to the ISV, in order to verify completeness. It is not used to evaluate design options.
3. MHI considers, and has been demonstrated in the Phase 1a/1b tests, the above iterative test-design-test process (item 1) to be an important part of trade-off evaluations and performance-based tests prior to manufacture of the final complete HSI for ISV (i.e., full set of HSI system and simulator). It supports realistic evaluations, with operators in the loop, of design options based on results from past tests and potential resolutions to HEDs. This testing process also allows a dynamic way to evaluate a design changes global impact on the integrated HSI. HSI items to be tested are selected by a joint decision between the designers, V&V team, client representatives and the Design Review Team based on importance of the design changes.

**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

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**QUESTION NO. : 18-184**

**Acceptance criteria:**
Not applicable

**Evaluation:**
MUAP-09019, Part 1 contains multiple references to a "Reference 0." The reference list at the end of the section does not contain a Reference 0.

**Information request:**
Provide corrected referencing in MUAP-09019, Part 1.

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**ANSWER:**

MHI will correct MUAP-09019, Part 1 of multiple references to a "Reference 0."

**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

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**QUESTION NO. : 18-185**

NUREG-0711, Section 8.4.7, Criterion 1 The HSI design should be documented to include:

- The detailed HSI description including its form, function and performance characteristics
- The basis for the HSI requirements and design characteristics with respect to operating experience and literature analyses, tradeoff studies, engineering evaluations and experiments, and benchmark evaluations
- Records of the basis of the design changes.

**Evaluation:**
DCD, Section 18.7.3 states that the US-APWR HSI design results and description are documented in the HSI Design Technical Report and references MUAP-09019. The material that appears in the subsequent subsections is not addressed in MUAP-09019.

Similarly, DCD, Subsections 18.7.3.2 and 18.7.3.3 reference MUAP-09019 but subsequent topics are not addressed in this MUAP.

The staff does not understand how the US-APWR specific HSI design is documented.

MUAP-10009 provides a succinct summary of documentation associated with the US Basic HSI design but limits the explanation of the US-APWR documentation to the statement, "The design documentation for the US-APWR HSI is developed based on the US Basic HSI design documentation."

**Information request:**

1. Correct the referencing referred to above or add the relevant information to MUAP-09019.
2. Explain how US-APWR specific design information is documented. Ensure the explanation includes how design details needed for procurement, construction and inspection activities are documented. For example: Will there be detailed specifications for the US-APWR specific design that supplement the specifications that exist for the US-Basic design (like the ones reviewed during the audit)?
3. Explain how the basis for the US-APWR specific design is documented.

Note: The staff understands that US-Basis HSI design documentation exists and is the foundation for the US-APWR. The DCD need only reference this in a generic manner, similar to the way it is done in MUAP-10009, since MUAP-07007 is being approved under a separate safety evaluation.

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**ANSWER:**

1. MHI will correct the reference information as follows;

The sentence in Section 18.7.3 will be revised as follows;

The US-~~APWR~~ Basic HSI design results and description are documented in the HSI/HFE Topical Report (Reference 18.7-1) ~~HSI Design Technical Report (Reference 18.7-5)~~. The US-APWR HSI Design results and description which combines the generic US-Basic HSI design with the specific HSI inventory for the US-APWR, will be documented in the "US-APWR HSI Design Specification".

The first sentence in Section 18.7.3.2 will be revised as follows;

The ~~US-APWR~~ HSI/HFE ~~Design Technical~~ Topical Report (Reference 18-7-~~5~~1) also describes the US-~~APWR~~ Basic ~~specific~~ design implementation of the following safety aspects of the HSI, which are coordinated with the I&C design, are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification":

Also, the second sentence in Section 18.7.3.2 will be revised as follows;

In addition, the HSI/HFE ~~Design Technical~~ Topical Report (Reference 18.7-~~5~~-1) describes the minimum Inventory of HSIs for the US-~~APWR~~-Basic HSI design, which are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification". This includes:

2. Since the HSI design activity takes the phased approach, the US-APWR HSI design documentation is based on and will be similar to the documentation of the US-Basic HSIS. The "US-APWR HSI Design Specification" includes and supplements the specifications that exist for the US-Basic HSI design. The supplemented information within the "US-APWR HSI Design Specification" includes the inventory of displays on the LDP, the inventory of alarms in the alarm system, and the inventory of controls, displays and alarms for the remote shutdown console. The design details needed for procurement, construction and inspection activities are documented in accordance with the US-APWR Quality Assurance Manual which includes fundamental process to conduct the design and develop the document.

3. The US Basic HSI design, as documented in MUAP-07007 and the "US Basic HSI Design Specification", encompasses the basic element or rule of the HSI development such as style guide, basic alarm design and basic display design. The "US-APWR HSI Design Specification" is developed in accordance with the basic direction written in the US Basic HSI Design documents (MUAP-07007 and the "US Basic HSI Design Specification") and then additional detail information of the US-APWR is incorporated into the design. The design changes are captured and controlled in accordance with the US-APWR design change control procedure which includes design change proposal, effect evaluation of the change and the implementation of the design change.

**Impact on DCD**

The sentence in Section 18.7.3 will be revised as follows (See Attachment-1.);

The US-~~APWR~~ Basic HSI design results and description are documented in the HSI/HFE Topical Report (Reference 18.7-1) ~~HSI Design Technical Report (Reference 18.7-5)~~. The US-APWR HSI Design results and description which combines the generic US-Basic HSI design with the specific HSI inventory for the US-APWR, will be documented in the "US-APWR HSI Design Specification".

The first sentence in Section 18.7.3.2 will be revised as follows;

The ~~US-APWR~~ HSI/HFE ~~Design Technical~~ Topical Report (Reference 18-7-~~5~~1) also describes the US-~~APWR~~ Basic ~~specific~~ design implementation of the following safety aspects of the HSI, which are coordinated with the I&C design, are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification":

Also, the second sentence in Section 18.7.3.2 will be revised as follows;

In addition, the HSI/HFE ~~Design Technical~~ Topical Report (Reference 18.7-~~5~~-1) describes the minimum Inventory of HSIs for the US-~~APWR~~-Basic HSI design, which are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification". This includes:

**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

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

- 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.

### 18.7.3 Results

The US-~~APWR~~Basic HSI design results and description are documented in the ~~HSI Design Technical Report (Reference 18.7-5)~~HSI/HFE Topical Report (Reference 18.7-1). The US-APWR HSI Design results and description which combines the generic US-Basic HSI design with the specific HSI inventory for the US-APWR, will be documented in the "US-APWR HSI Design Specification." DCD_18-185

#### 18.7.3.1 Overview of HSI Design and Its Key Features

The HSI/HFE Topical Report (Reference 18.7-1) describes the overall HSI design concept and its rationale. This description is applicable to the MCR, remote shutdown console (RSC), and TSC. Key features of the design, such as information display, "soft" controls, CBPs, alarm processing, and control room layout, are described. The HSI Topical Report (Reference 18.7-1) includes the following:

- The detailed HSI description, including its form, function and performance characteristics
- The basis for the HSI requirements and design characteristics with respect to operating experience and literature analyses, tradeoff studies, engineering evaluations and experiments, and benchmark evaluations
- The basis of any design changes from the Japanese APWR HSI design
- The outcomes of tests and evaluations performed in support of HSI design

#### 18.7.3.2 Safety Aspects of the HSI

The ~~US-APWR HSI Design Technical Report (Reference 18.7-5)~~HSI/HFE Topical Report (Reference 18.7-1) also describes the US-~~APWR~~Basic design specific implementation of the following safety aspects of the HSI, which are coordinated with the I&C design, are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification": DCD_18-185

- Safety function monitoring
- Periodic testing of protection system actuation functions
- Bypassed and inoperable status indication for plant safety systems
- Manual initiation of protective actions
- Instrumentation required to assess plant and environmental conditions during and following an accident
- Setpoints for safety-related instrumentation

- HSIs for the ~~emergency response facilities (~~TSC~~ and EOF, where TSC and EOF utilize common technologies)~~ DCD_18-129

The information needed to be displayed at the EOF is identified through the US-APWR HFE program. However, the actual design of HSIs for the site specific EOF is outside the scope of the US-APWR HFE program. These HSIs will be designed in accordance with the site specific HFE program for compliance with NUREG-0696.

In addition, the ~~HSI Design Technical Report (Reference 18.7-5)~~HSI/HFE Topical Report (Reference 18.7-1) describes the minimum Inventory of HSIs for the US-~~APWR~~Basic HSI Design, which are applicable to the US-APWR and will be documented in the "US-APWR HSI Design Specification." This includes: DCD_18-185

- Fixed position continuously visible HSI provided by:
  - The fixed area of the LDP (Table 18.7-1) - Section 4.9 "Large Display Panel" of Reference 18.7-1 provides the design basis and description of all LDP indications and alarms, which includes:
    - Bypassed and inoperable status indication (BISI) parameters
    - Type A and B post monitoring (PAM) variables (Section 7.5, Table 7.5-3)
    - Safety parameter displays including status of critical safety functions and performance of credited safety systems and preferred non safety systems
    - Prompting alarms for credited manual operator actions and risk important HAs identified in the HRA
  - PAM displays for Type A and B variables on the safety VDUs (Subsection 7.5.1.1)
  - Conventional switches on the MCR operator console for system level actuation of safety functions such as reactor trip, engineering safety features actuation system (ESFAS) actuation, etc. (Tables 7.2-6 and 7.3-5)
- Class 1E HSI for control of all safety-related components and monitoring of all safety-related plant instrumentation is provided on the safety VDUs, located on the MCR operator console and the remote shutdown console (Section 7.1).
- Minimum inventory for degraded HSI conditions - Section 4.11 "Response to HSI Equipment Failures" of Reference 18.7-1 provides the design basis and description of redundant and diverse HSI which supports the following degraded operating conditions:
  - Degraded operations based on loss of non safety HSI. The plant is maintained in a stable condition through continued operation of normal automatic control systems and monitoring and controlling of critical safety functions through safety VDUs.

- Degraded operations based on loss of safety and non safety HSI due to common cause failure. HSI for accident mitigation and achieving safe shutdown is provided by the DHP (Subsection 7.8.3).

- Degraded operations based on evacuation of the MCR. Safe shutdown is achieved through HSI at the RSC (Subsection 7.4.1.5).

- Degraded operations based on single HSI failures. All information and controls are available to continue normal plant operation, manage accidents and achieve safe shutdown through alternate HSI devices (Reference 18.7-1, Subsection 4.11.2).

#### 18.7.3.3 HSI Change Process

The HFE Design Report (Reference 18-7-5) and HSI Design Implementation Plan (Reference 18.7-6) documents the process for the following HSI changes: DCD_18-178

- Topical Report (Reference 18.7-1 Subsection 4.5.2 "Operation Method") describes HSI for setpoints that are expected to be changed by operators during normal operations.

- HSIs designs that are modified and updated on a permanent basis (see Section 18.11).

- Temporary setpoint modifications. These changes are made through changes in the PSMS or plant control and monitoring system (PCMS) software. The software management life cycle process is described in Subsection 7.1.3.17.

- Configuration of operator-managed trend displays and operator-managed alarms. Operators can configure new trend displays and new alarms that are not pre-configured in the HSI design. The configuration tools ensure consistency with the HSI style guide. This operator configured HSI does not change any pre-configured HSI. Operator-managed trend displays and operator-managed alarms are controlled through administrative procedures.

- Data entry into the PCMS for maintenance related work order management (Reference 18.7-1 Subsection 4.5.3). This function is administratively controlled.

### 18.7.4 Combined License Information

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

*COL 18.7(1) Deleted*

### 18.7.5 References

18.7-1 HSI System Description and HFE Process, MUAP-07007-P (Proprietary) and MUAP-07007-NP (Non-Proprietary), Revision 3, October 2009.

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