US-APWR

Design Implementation Implementation Plan

Non-Proprietary Version

June 2013

Revision History

Revision	Date	Page (Section)	Description
0	April 2010	All pages	Original issued
1	December 2011	General	Revised “V&V’ed” to “V&V’d””
		p.2 (Section 2.0)	Revised description of first sentence for response to RAI 755 (Question No. 18-115))
			Revised description of item 1
			Revised description of item 3 for response to RAI 755 (Question No. 18-115))
		p.4 (Section 4.0)	Revised “the Waste Processing System” to “the HSI for the Radioactive Waste Disposal System”
			Added a paragraph about objective for response to RAI 755 (Question No. 18-117))
			Added a paragraph about evaluation
		p.5 (Section 4.1.2)	Added description about evaluation
		p.5 (Section 4.1.3)	Added description about evaluation
		p.5 (Section 4.1.4)	Added description about evaluation
		pp.6–7 (Section 4.2.2)	Revised description about RSR software configuration check
		p.7 (Section 4.2.3)	Revised description about RSR hardware configuration check
		p.8 (Section 4.3.2)	Revised description about TSC software configuration check

Revision	Date	Page (Section)	Description
		p.8 (Section 4.3.3)	Revised description about TSC hardware configuration check
		p.8 (Section 4.4)	Revised “flux mapping system” to “Incore Nuclear Instrumentation System (for flux mapping)”)”
			Revised “waste process system” to “Radioactive Waste Disposal System”
		p.8 (Section 4.4.2)	Deleted “in-situ” for response to RAI 755 (Question No. 18-118))
			Added “Configuration and Suitability” to the section title for response to RAI 755 (Question No. 18-118))
		p.9 (Section 4.6.1)	Added “is”
			Revised “see” to “confirm that”
		pp.9–10 (Section 4.7)	Added the new Section 4.7 (this new section is based on the previous Section 4.1.5) and revised description for response to RAI 755 (Question No. 18-118))
			Revised the section title ”MCR In-Situ Check” to “HSI Regression Analysis” for response to RAI 755 (Question No. 18-118))
		p.10 (Section 4.8)	Added the new section 4.8 “Summary report” for response to RAI 755 (Question No. 18-119))
		p.11 (Section 5.0)	Revised description of references
2	October 2012	All pages	Revised to incorporate comments by the NRC in March 2012 to keep consistency in technical description with DCD Chapter 18, MUAP-09019, MUAP-10008, MUAP-10009, MUAP-10012, MUAP-10013, and MUAP-10014
3	June 2013	All pages	Complete re-write Revised to align closely with NUREG-0711 order and format

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Abstract

This document describes the implementation plan (IP) for the design implementation (DI) human factors engineering (HFE) program element, which demonstrates that the “as-built” design accurately reflects the verified and validated design for a US Advanced Pressurized Water Reactor (US-APWR). For human system interface (HSI) features that were not evaluated in the US-APWR human factors verification and validation (V&V) program element, the V&V is part of DI.

One objective of DI is to demonstrate systematically that the HSI design that is implemented (i.e., the as-built design) accurately reflects the design that has been verified and validated in the V&V program element, including the HSI employed for important human actions (IHAs). For the US-APWR site-specific HSI system (HSIS), this is primarily a demonstration of configuration control for conformance with the simulator used for integrated system validation (ISV). For the US-APWR site-specific Local HSIs, a more detailed implementation review is conducted because this HSI is not simulated during ISV.

DI confirms that the as-built configuration of the facilities in which the HSI resides is consistent with the documentation approved by the HF V&V team. This includes the main control room (MCR), remote shutdown room (RSR), and technical support center (TSC) for any aspects that impact HFE issues and must be consistent with the ISV simulation (e.g., lighting and background noise) or that are pertinent to HFE but were not accurately simulated in the ISV (e.g., RSR and TSC layout). DI also confirms the as-built configuration of the locations of the US-APWR site-specific Local HSIs for any aspects that are pertinent to HFE and the inclusion of the US-APWR HSIS information requirements in the emergency operations facility (EOF). A plant walkdown confirms the as-built implementation for these HSI facilities.

The US-APWR HSIS and US-APWR Local HSIs include site-specific assumptions to encompass a complete plant design (e.g., switchyard, ultimate heat sink (UHS)). Therefore, DI also evaluates and confirms the actual site-specific design. Where the site-specific configuration does not conform to the plant design, DI identifies areas that are different from the US-APWR HSIS or US-APWR Local HSIs, including HSI design changes that occur after V&V. While successful ISV marks the end of the US-APWR human factors V&V program element, evaluation of the HSI design will continue during site-specific operator training. Human engineering discrepancies (HEDs) generated during V&V that do not affect the ISV acceptance criteria or conclusions and any HEDs generated after completion of V&V are resolved during DI in accordance with the process described in the HFE program management plan (PMP).

For changes to the US-APWR HSIS or US-APWR Local HSIs that occur after V&V, DI conducts a design change analysis (DCA) that defines the extent of re-performance required for each prior HFE program element. Site-specific activities, including the DCA, any reanalysis, incorporation of changes to the US-APWR HSI design, and any additional V&V are governed by the DI IP and conducted within DI.

This IP also describes the requirements for documenting the completion of DI in the DI results summary report (ReSR). The ReSR is used to demonstrate that the implementation of the as-built design was confirmed in accordance with this IP. Confirmation documentation through the ReSR is a requirement for Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) closure.

Table of Contents

List of Tables

Acronyms

CBP	computer-based procedure
COL	combined license
DCA	design change analysis
DCD	design control document
DHP	diverse human-system interface panel
DI	design implementation
EOF	emergency operations facility
HED	human engineering discrepancy
HF	human factors
HFE	human factors engineering
HSI	human-system interface
HSIS	human-system interface system
HVAC	heating, ventilation, and air conditioning
ID	identifier
IHA	important human action
I&CE	instrumentation and control engineering
IP	implementation plan
ISV	integrated system validation
ITAAC	inspection, test, analysis, and acceptance criteria
LCS	local control station
LDP	large display panel
MCR	main control room
NRC	U.S. Nuclear Regulatory Commission
PBP	paper-based procedure
PMP	program management plan
RSC	remote shutdown console
RSR	remote shutdown room
ReSR	results summary report
SME	subject matter expert
SPDS	safety parameter display system
TSC	technical support center

UHS	ultimate heat sink
U.S., US	United States
US-APWR	US Advanced Pressurized Water Reactor
V&V	verification and validation
VDU	visual display unit

1.0 PURPOSE

This document describes the implementation plan (IP) for the design implementation (DI) human factors engineering (HFE) program element, which demonstrates that the “as-built” design accurately reflects the verified and validated design for a US Advanced Pressurized Water Reactor (US-APWR), including the human-system interface (HSI) employed for important human actions (IHAs). This includes the US-APWR site-specific HSI system (HSIS), the US-APWR site-specific Local HSIs, and the facilities in which they reside. For HSI features that were not evaluated in the human factors verification and validation (V&V) program element, the V&V is part of DI.

One purpose of DI is to demonstrate systematically that the HSI design that is implemented (i.e., the as-built design) accurately reflects the design that has been verified and validated in the V&V program element. This includes US-APWR site-specific HSISs and US-APWR site-specific Local HSIs.

DI also confirms that the as-built configuration of the facilities in which the HSI resides is consistent with the documentation approved by the human hactors (HF) V&V team. This includes the main control room (MCR), remote shutdown room (RSR), and technical support center (TSC) for any aspects that are pertinent to HFE and must be consistent with the integrated system validation (ISV) simulation (e.g., lighting and background noise) or that are pertinent to HFE but were not accurately simulated in the ISV (e.g., RSR and TSC layout). DI also confirms the as-built configuration of the locations of the US-APWR site-specific Local HSIs for any aspects that are pertinent to HFE and the inclusion of the US-APWR HSIS information requirements in the emergency operations facility (EOF) meets the HFE IP requirements.

The US-APWR HSIS and US-APWR Local HSIs include site-specific assumptions to encompass a complete plant design (e.g., switchyard, ultimate heat sink (UHS)). Therefore, DI also evaluates and confirms the actual site-specific design. Where the site-specific configuration does not conform to the plant design, DI identifies areas that are different from the US-APWR HSIS or Local HSIs, including HSI design changes that occur after V&V. Human engineering discrepancies (HEDs) generated after completion of V&V are resolved during DI in accordance with the process described in the HFE program management plan (PMP) (Reference 8-1).

Any reevaluation or program element re-performance activities for changes to the US-APWR HSIS or US-APWR Local HSIs that are needed after V&V are conducted and documented in DI.

This IP also describes the requirements for documenting the completion of the DI IP in the DI results summary report (ReSR). The ReSR is used to demonstrate that the implementation of the as-built design was confirmed in accordance with this IP. Confirmation documentation through the ReSR is a requirement for inspections, tests, analyses, and acceptance criteria (ITAAC) closure. Completion of the DI ITAAC is the final HFE activity required for site-specific fuel load. Therefore, there is no downstream HFE IPs that use the output of this IP.

This DI program element conforms to the guidance and satisfies the acceptance criteria of NUREG-0711, Revision 2, “Human Factors Engineering Program Review Model,” issued February 2004, Section 12.4.6 (Reference 8-2). Section 7.0 of this IP summarizes this compliance.

2.0 SCOPE

This plan addresses all the HSIs within the scope of the US-APWR HFE program by dividing that scope into four categories:

- US-APWR HSIS
- Derivatives of the US-APWR HSIS
- US-APWR Local HSIs
- HSI facilities

The MCR employs the US-APWR HSIS. The US-APWR HSIS employs the alarm, indication, control, and computer-based procedure (CBP) methods defined by the US-Basic HSIS (Reference 8-3). These HSI methods are used to implement the US-APWR HSI inventory of alarms, indications, controls and procedures, which is developed through other US-APWR HFE IPs. Although the US-APWR plant design defined by the design control document (DCD) is limited, the US-APWR HSIS encompasses a complete plant through site-specific assumptions that address the portions of the plant not included in the DCD. A US-APWR site-specific HSIS confirms those assumptions or changes the design to accommodate an actual site-specific location.

Derivatives of the US-APWR HSIS are configured to provide the functionality needed for the purpose of a specific facility. The HSISs for the RSR and the TSC are derivatives of the US-APWR HSIS. A portion of the HSI for the EOF is also a derivative of the US-APWR HSIS. This portion is limited to the safety parameter display system (SPDS). Therefore, the scope of the US-APWR HFE program and this DI IP for the EOF is limited to the information requirements for the EOF's SPDS.

Local control stations (LCSs) are unique to a specific piece of plant equipment (e.g., pump, valve, radiation monitor) or a specific plant function whose primary control is located outside the MCR (e.g., waste management). The LCS scope encompassed by the US-APWR HFE program and included in this DI IP are the LCSs used by plant operations personnel. These are referred to as US-APWR Local HSIs.

The HSI scope included in the DI IP includes the operating procedures and training material that are used for the scenarios conducted during ISV. Other procedures and training material that are unrelated to the V&V scenarios are not in the scope of the DI IP because they have their own verification programs.

The US-APWR HSIS, derivatives of the US-APWR HSIS, and US-APWR Local HSIs reside in facilities that also require as-built confirmation of aspects that are pertinent to HFE, such as environmental characteristics and telecommunications. The facilities encompassed by the US-APWR HFE program and included in this DI IP are the MCR, RSR, TSC, and LCSs. The complete EOF facility is the scope of the combined license (COL) applicant; therefore, the EOF facility is outside the scope of the US-APWR DI IP.

For HSI features that have been included within each HFE program element but were not evaluated in the V&V program element, a specific method of V&V is determined. This V&V is part of this DI program element.

3.0 METHODOLOGY OVERVIEW

4.0 METHODOLOGY

4.1 Main Control Room

4.1.1 MCR US-APWR HSIS Software Configuration

Table 4-1 MCR US-APWR Site-Specific HSIS Software Configuration Evaluation

4.1.2 MCR US-APWR HSIS Hardware Configuration

Table 4-2 MCR US-APWR Site-Specific HSIS Hardware Configuration Evaluation

4.1.3 MCR Facility Configuration

Table 4-3 Site-Specific MCR Facility Evaluation

4.2 Remote Shutdown Room

4.2.1 RSR US-APWR HSIS Software Configuration

4.2.2 RSR US-APWR Hardware Configuration

4.2.3 RSR Facility Configuration

4.3 Technical Support Center

4.3.1 TSC US-APWR HSIS Software Configuration

4.3.2 TSC US-APWR Hardware Configuration

4.3.3 TSC Facility Configuration

4.4 Emergency Operations Facility

Table 4-4 EOF SPDS Data Evaluation

4.5 Local HSIs

4.5.1 Local HSI Design

Table 4-5 Local HSI HFE Review

4.5.2 Local HSI Facilities

4.6 Training

Table 4-6 Site-Specific Training Material Evaluation

4.7 Excluded HSI Features

4.8 Human Engineering Discrepancies

4.9 HFE Design Change Analysis

4.10 Design Implementation Output Review

5.0 IMPLEMENTATION TEAM

The SMEs who conduct the DI program element are described in Section 4 above and summarized in Table 5-1.

Table 5-1 SMEs for Design Implementation Activities

Implementation Activity	Section	Subject Matter Expert
MCR software configuration	4.1.1	Computer system engineering
MCR hardware configuration	4.1.2	HSI/I&C Engineering
MCR facility	4.1.3	Plant operations
RSR software configuration	4.2.1	Computer system engineering
RSR hardware configuration	4.2.2	I&CE
RSR facility	4.2.3	Plant operations
TSC software configuration	4.3.1	Computer system engineering
TSC hardware configuration	4.3.2	I&CE
TSC facility	4.3.3	Plant operations
EOF software configuration	4.4	Computer system engineering
Local HSI design configuration	4.5.1	I&CE
Local HSI HFE review	4.5.1	HFE
Local HSI facilities	4.5.2	Plant operations
Training	4.6	Personnel training
Excluded HSI features	4.7	HFE
HED	4.8	Expert panel
HFE DCA	4.9	HFE
HFE program element rework	4.9	Same as original IP
DI output review	4.10	Same as output originator

The SME qualifications are defined in the HFE PMP (Reference 8-1).

6.0 RESULTS SUMMARY REPORT CONTENT

All results of the DI program element are compiled in an ReSR. This report is used to demonstrate that the implementation of the as-built design was confirmed in accordance with this IP. Confirmation documented through this ReSR is a requirement of the ITAAC closure defined in the US-APWR DCD Tier 1.

The ReSR includes the following:

- Each implementation team member's name and SME position that they fulfill
- Each DI output reviewer's name and SME position that they fulfill
- The DI results overview, including the principal findings of the HFE program element
- The DI execution results, including all details that demonstrate compliance to the methodology section of this IP using the table output format defined in Section 4, including—
  - The configuration control identification of the documentation that defines the US-APWR HSIS and US-APWR Local HSIs (including procedures and training material) and the MCR, RSR, TSC, EOF, and Local HSI facilities
  - The configuration control identification of the documentation that defines the as-built US-APWR site-specific HSIS and US-APWR site-specific Local HSIs (including procedures and training material) and the US-APWR site-specific MCR, RSR, TSC, EOF, and Local HSI facilities
  - Identification of HSI and facility differences and the justification for those differences or identification of the HEDs used to track the resolution of those differences
  - Identification of any HSI features that were excluded from the US-APWR V&V, and the alternate method of V&V
  - DCA and results for resolution of HEDs, including those for any new HSI features or site-specific HSI changes that were not included in the US-APWR HF V&V
  - HFE program element re-performance analysis and results
- A conclusion that the DI program element has been conducted in accordance with the DI IP, that the as-built HSIS and corresponding facilities are the same as those included in the US-APWR human factors V&V program element, or that differences or elements that were not included in the V&V do not adversely impact the V&V results.

7.0 COMPLIANCE WITH NUREG-0711

Table 7-1 shows the compliance of this IP to the NUREG-0711 criteria for the DI program element (Reference 8-2).

Table 7-1 Compliance with NUREG-0711

Review Criteria Stated in NUREG-0711, Rev. 2	DI IP Section No. and Paragraph
12.4 Review Criteria (The first five sections of review criteria are for the review of plant modifications only. Section 12.4.6, Final Plant HFE Design Verification, applies to both new and modified plant designs.)	N/A
12.4.6 Final Plant HFE Design Verification (1) Aspects of the design that were not addressed in V&V should be evaluated using an appropriate V&V method. Aspects of the design addressed by this criterion may include design characteristics such as new or modified displays for plant-specific design features and features that cannot be evaluated in a simulator such as CR lighting and noise.	Section 3.0, paragraph 3 Section 4.1.3 , paragraph 1
(2) The final (as-built in the plant) HSIs, procedures, and training should be compared with the detailed design description to verify that they conform to the design that resulted from the HFE design process and V&V activities. Any identified discrepancies should be corrected or justified.	Section 3.0, paragraphs 5 and 6 Section 4.1.1, paragraph 1 Section 4.1.2, paragraph 1 Section 4.1.3, paragraph 1 Section 4.2.1, paragraph 1 Section 4.2.2, paragraph 1 Section 4.3.1, paragraph 1 Section 4.3.2, paragraph 2 Section 4.5.1, paragraph 2 Section 4.5.2, paragraph 2 Section 4.6, paragraph 1
(3) All HFE-related issues documented in the issue tracking system should be verified as adequately addressed.	Section 3.0, paragraphs 6 and 7 Section 4.8, paragraphs 1 and 2

8.0 REFERENCES

8-1 Human Factors Engineering Program Management Plan, MUAP-09019, Revision 3, MHI, June 2013.

8-2 Human Factors Engineering Program Review Model, NUREG-0711, U.S. Nuclear Regulatory Commission, Revision 2, February 2004.

8-3 HSI System Description and HFE Process, MUAP-07007, Revision 5, MHI, November 2011.

8-4 Human Factors Verification and Validation Implementation Plan, MUAP-10012, Revision 3, MHI, July 2013.