US-APWR
Design Implementation Plan

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Abstract

This document presents the Implementation Plan for the HSI design implementation of safety significant HSI for a site specific US-APWR. Hereafter, the plan is referred to as the “HSI Design Implementation Plan.”

The plan addresses the task by first dividing the implemented HSI into categories and then defining a detailed HSI design implementation plan for each category.

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List of Acronyms

AOO	anticipated operational occurrence
CFR	Code of Federal Regulations
COL	combined license
COLA	combined license application
DAS	diverse actuation system
DCD	design certification document
DHP	diverse HSI panel
EOF	emergency operations facility
EOP	emergency operating procedure
ERG	emergency response guidelines
GDC	general design criteria
HA	human action
HFE	human factors engineering
HSI	human-system interface
HSIS	human system interface system
HED	human engineering discrepancy
HFE	human factors engineering
HSI	human-system interface
HSIS	human system interface system
I&C	instrumentation and control
ITAAC	inspection, test, analysis, and acceptance criteria
ITV	industrial television
LCS	local control station
LDP	large display panel
MCR	main control room
NRC	Nuclear Regulatory Commission, U.S.
PA	postulated accidents
PAM	post-accident monitoring
QA	quality assurance
RG	Regulatory Guide
RO	reactor operator
RSC	remote shutdown console
RSR	remote shutdown room

SRO	senior reactor operator
TSC	technical support center
US-APWR	United States – Advanced Pressurized Water Reactor
V&V	verification and validation
VDU	visual display unit

1.0 Purpose

This document provides the implementation plan for the HSI design for a site specific US−APWR.

The implementation plan defines the set of activities that demonstrate that the implemented HSI (i.e., the “as-built” HSI) conforms to the HSI design that was created by the US-APWR HFE process.

2.0 Scope

This plan covers all the safety significant HSI in the as-built US-APWR plant.

For a site specific US-APWR the implementation phase is well defined and carefully monitored to determine:

1. That the HSI design that is implemented (i.e., the “as built” HSI) matches the US−APWR HFE program verified and validated (V&V’ed) HSI design and corresponds with other aspects of the plant that were encompassed by the final V&V program (e.g. lighting and noise);
2. That HSI or plant changes that occur after final V&V, but prior to fuel load, are adequately evaluated and addressed from an HFE perspective;
3. That the other plant safety significant HSI that have been included in the US-APWR HFE program but have not been encompassed by the HFE program HSI V&V activity (e.g. local controls, EOF) meet the previously established HFE requirements.

Any design modifications that may occur after completion of the V&V part of the HFE program shall be evaluated and managed in accordance with the design change process described in Reference 5-2 Section 5.11.

3.0 Applicable Codes, Standards, and Regulatory Guidance

The compliance to the applicable codes and standards for the US-APWR HSIS design is identified in section 3.0 of the topical report “HSI System Description and HFE Process”, MUAP-07007 (Reference 5-2). The topical report includes following standards and guidelines.

- Code of Federal Regulations
- Staff Requirements Memoranda
- NRC Regulatory Guides
- NRC Branch Technical Positions
- NUREGs
- Other Reference Guidelines

4.0 Implementation Plan

This plan addresses all the safety significant US-APWR HSI by dividing them into three categories:

1. The main control room (MCR)
2. Derivatives of the main control room
3. Single purpose HSI

Derivatives of the main control room are subsets of the main control room HSI configured to provide the functionality needed for the purpose of the facility. The HSI for the remote shutdown room and the technical support center are derivatives of the main control room.

Single purpose HSI is an HSI interface that is unique to a specific piece of plant or plant equipment type. Examples of single purpose HSI are the Waste Processing System and local controls.

4.1 The Main Control Room

The MCR is the place for process control and supervision in all plant situations. In addition, it provides the means for communication to others outside the plant. Finally, it is the center to initiate the maintenance of process-related equipment.

In general, the US-APWR main control room HSI has been verified and validated as a complete and integrated design. However, for practical reasons there may be differences between the verified and validated HSI design and an implemented site specific US-APWR main control room. The following specific checks shall be preformed.

4.1.1 MCR Functional Check

The as-built MCR shall be checked against the MCR functional specification to verify that all functions specified are provided by facilities within the room.

4.1.2 MCR Software Configuration Check

The MCR configuration check shall demonstrate the software configuration of the as-built design matches the V&V'ed design. The assessment shall be accomplished by checking that the versions of the MCR HSI software data match the V&V'ed design software data for:

1. Large display panel displays
2. Large display panel display logic
3. Visual display units operation displays
4. Visual display units operator control stations
5. Visual display units operation displays and operator control stations logic
6. Safety displays
7. Safety displays operator control stations
8. Safety displays and operator control stations logic
9. The alarm display logic
10. The alarm messages database

11. The operating procedures database for normal operations, anticipated operational occurrences, and emergency operations
12. The safety controls operating procedures off-line computer data files for paper procedures
13. The diverse actuation system operating procedures off-line computer data files for paper procedures

The MCR software configuration assessment shall check the versions of one hundred percent of the software data files that define the HSI operation of the main control room.

4.1.3 MCR Hardware Configuration Check

For the hardware configuration the assessment shall be accomplished by checking that the MCR HSI panels match the V&V'ed HSI panels.

4.1.4 MCR Dedicated Controls Check

The MCR dedicated controls check shall demonstrate that the as-built dedicated controls match the V&V'ed design. The assessment shall be accomplished by checking that the as−built physical implementation match the V&V'ed design for:

- Safety switches
- Diverse HSI Panel (DHP) indicators
- Diverse HSI Panel (DHP) switches

4.1.5 MCR In-Situ Check

For aspects of the MCR that differ from the V&V'ed design an in-situ assessment shall be performed.

A regression analysis shall be conducted for control room equipment or interfaces, which were part of the V&V'ed HSI design, which differ from the V&V'ed HSI design. The analysis shall determine the significance of the change and the extent of HFE re-analysis and retesting that is needed.

Control room equipment or interfaces that were not included in the V&V'ed design (i.e., ITV, temporary HSI for testing and maintenance) shall be checked in-situ to assure it does not interfere with accomplishing the V&V'ed HSI functions.

Control room equipment with safety significant HSI that were not included in the V&V'ed design shall be checked for conformance to the documented HFE requirements. If there are no specific HFE requirements, suitability shall be checked with respect to the intended function in accordance with NUREG-0700.

4.2 Remote Shutdown Room (RSR)

The RSR is a derivative of the MCR.

The Remote Shutdown Room (RSR) is located in a different fire zone than the MCR. The Remote Shutdown Console (RSC), which is located in the RSR, has capabilities to achieve and maintain cold shutdown.

Operators can monitor and control the plant using the VDUs on the RSC to shutdown the plant, to maintain a hot shutdown condition and also transfer to maintain a cold shutdown condition.

VDUs on the RSC provide the same screens as that of the main control room, this reduces the need for additional training and minimizes the potential for human error.

4.2.1 RSR Functional Check

The as-built RSR shall be checked against the RSR functional specification to verify that all functions specified are provided by facilities within the room.

4.2.2 RSR Software Configuration Check

The RSR configuration check shall demonstrate the software configuration of the as-built design matches the V&V'ed design. The assessment shall be accomplished by checking that the versions of the RSR HSI software data match the MCR V&V'ed design software data for:

1. Visual display units operation displays
2. Visual display units operator control stations
3. Visual display units operation displays and operator control stations logic
4. Safety displays
5. Safety displays operator control stations
6. Safety displays and operator control stations logic
7. The alarm display logic
8. The alarm messages database
9. The operating procedures database for normal operations, anticipated operational occurrences, and emergency operations
10. The safety controls operating procedures off-line computer data files for paper procedures

The RSR software configuration assessment shall check the versions of one hundred percent of the software data files that define the HSI operation of the remote shutdown room. A regression analysis shall be conducted for remote shutdown room software that differ from the V&V'ed HSI design. The analysis shall determine the significance of the change and the extent of HFE re-analysis and retesting that is needed.

4.2.3 RSR Hardware Configuration Check

The RSR HSI hardware configuration and plant interfaces shall be assessed against and be compliant with NUREG 0700.

4.3 Technical Support Center (TSC)

The TSC is a derivative of the MCR.

The TSC has facilities to support the plant management and technical personnel who will be assigned there during an emergency and will be the primary onsite communications center for the plant during the emergency.

The facility consists of a plant data display system using VDUs (only for monitoring functions) and a LDP, data communication system, tele-communication system of telephones and facsimiles by multiple methods of transmission including private and public lines, satellite communications and adequate working area.

The TSC working space is sized for a minimum of 25 persons, including 20 persons designated by the licensee and five NRC personnel. The minimum size of the working space provided is approximately 75 sq ft/person.

4.3.1 TSC Functional Check

The as-built TSC shall be checked against the TSC functional specification to verify that all functions specified are provided by facilities within the room.

4.3.2 TSC Software Configuration Check

The TSC configuration check shall demonstrate the software configuration of the as-built design matches the V&V'ed design.

For the software the assessment will be accomplished by checking that the versions of the TSC HSI software data match the MCR V&V'ed design software data for:

1. Large display panel displays
2. Large display panel display logic
3. Visual display units operation displays
4. Visual display units operation displays logic
5. The alarm display logic
6. The alarm messages database
7. The operating procedures database for normal operations, anticipated operational occurrences, and emergency operations

The TSC software configuration assessment shall check the versions of one hundred percent of the software data files that define the HSI operation of the technical support center. A regression analysis shall be conducted for technical support center software that differ from the V&V'ed HSI design. The analysis shall determine the significance of the change and the extent of HFE re-analysis and retesting that is needed.

4.3.3 TSC Hardware Configuration Check

The TSC HSI hardware configuration and plant interfaces shall be assessed against and be compliant with NUREG 0700.

4.4 Single Purpose HSI

Other departments and groups provide plant design outputs with HSI, such as local controls on motor control centers and skid mounted equipment.

Single purpose HSI also includes HSI for plant supporting processes such as the flux mapping system and the waste process system.

4.4.1 Inclusion in the HFE Process

HSI design outputs that have HSI safety significance are included in the US-APWR HFE Process. In order to assure HSI across the nuclear plant systems and components conform to industry accepted HFE practices and do not represent conflicts with the V&V'ed US-APWR HSI or with one another, the HFE team interacts with the rest of the plant design teams to review and control design products that contain information related to safety significant HSI. This HFE review and control of the HSI applies to both internal and external suppliers of

unique systems or systems with local controls. For example, HFE review and control shall apply to local skid mounted HSI and local controls that may be supplied as part of a pump or valve.

If those components are safety related and the local HSI will be used to support safety significant testing or maintenance activities, as follows:

- On-line testing, radiological protection activities, and required chemical monitoring supporting technical specifications
- Maintenance required by technical specifications
- Emergency and abnormal conditions response

Then the HSI shall be included in the US-APWR HFE process.

4.4.2 Single Purpose In-Situ Check

The single purpose HSI in-situ assessment shall be accomplished by checking the single purpose HSI implementation against the documented HFE requirements.

If there are no specific HFE requirements, suitability shall be checked with respect to the intended function in accordance with NUREG-0700.

4.5 Emergency Operations Facility (EOF)

The emergency response facility (EOF) may be either a derivative of the MCR HSI design or a single purpose HSI or combination of both. Whichever is the case, the EOF HSI design implementation shall follow the relevant method(s) defined in this implementation plan.

4.6 QA Supervision

In addition to the normal QA supervision associated with a nuclear power plant project, there is unique QA supervision associated with HSI design implementation.

4.6.1 Human Engineering Discrepancies (HED)

Any HFE issue arising during the HSI design implementation phase shall documented as a human engineering discrepancy (HED). These HEDs shall follow the same process to closure as all other HEDs. That is, they shall be captured and tracked to close using the HED database. It is the responsibility of the HSI Design Team to develop the solution. And it the responsibility of the V&V team to see the closure requirements are met.

4.6.2 Other Plant Organizations

The interaction between the HFE Design/V&V Teams and other plant organizations shall be included in the QA procedures governing plant implementation activities for safety significant HSI. HFE comments that cannot be resolved through mutual agreement between the HFE organization and the plant organizations shall be brought to management attention for resolution.

5.0 References

5-1 Design Control Document for the US-APWR, Chapter 18, Human Factors Engineering, MUAP-DC018 , Revision 2, October 2009

5-2 MUAP-07007, “HSI System Description and HFE Process,” Revision 3, October 2009

5-3 MUAP-08014, “Human System Interface Verification and Validation (Phase1a),” Revision 0, December 2008

5-4 MUAP-09019, “HSI Design,” Revision 0, June 2009

5-5 MUAP-10009, ”HSI Design Implementation Plan,” April 2010

5-6 MUAP-10010, ”Procedure Development Implementation Plan,” April 2010

5-7 MUAP-10011, ”Training Program Development Implementation Plan,” April 2010

5-8 MUAP-10012, ”Verification and Validation Implementation Plan,” April 2010