Design Implementation Plan

Technical Report

Non-proprietary

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REVISION HISTORY

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1. Overview

1.1. Purpose

The purpose of this plan is to provide the design implementation plan for the human-system interface (HSI) design of APR1400.

This activity includes three objectives: 1) identifying aspects of the design to be verified, 2) verifying the design aspects, and 3) identifying human engineering discrepancies (HEDs).

1.2. Scope

The scope of this analysis includes the full ranges of operating conditions, i.e., normal, abnormal, and emergency operating conditions, plant maintenance, plant surveillance, and testing, as required by 10 CFR 50.54 (Reference 2.1).

The scope of design implementation includes the following facilities, which is consistent with the Human Factors Engineering Program Plan (HFEPP) (Reference 2.2).

- Main control room (MCR)
- Remote shutdown room (RSR)
- Local control stations (LCS) associated with important human actions (IHAs)

1.3. Acronyms

HA	human action
HED	human engineering discrepancy
HF	human factors
HFE	human factors engineering
HFEPP	human factors engineering program plan
HSI	human-system interface
IHA	important human action
LCS	local control stations
MCR	main control room
RSR	remote shutdown room
V&V	verification and validation

2. APPLICABLE REFERENCES

2.1 10 CFR 50.54, US Code of Federal Regulations, Part 50, Conditions of Licenses
2.2. KHNP APR1400-E-J-NR-12002-P, Human Factors Engineering Program Plan
2.3. NUREG-0700, Human-System Interface Design Review Guidelines, Rev. 2
2.4. KHNP APR1400-E-J-NR-12010-P, Human Factors Verification and Validation Implementation Plan

3. METHOD

The design implementation activity consists of three tasks: 1) identify aspects of the design to be verified, 2) verify the design aspects, and 3) identify HEDs and resolve the HEDs.

The first task identifies: 1) design aspects that may have not evaluated in the HF V&V, 2) HED that have not been resolved in the V&V, and 3) design change made after the V&V, or 4) design features that are not feasible to the V&V test bed.

The second task verifies that the as-built design conforms to the verified and validated design and human factors engineering guidelines.

The third task identifies all HEDs and issues that arose in the previous task. Then, the HEDs and issues are transferred to the issue tracking system.

4. IMPLEMENTATION

4.1. Assumption

This implementation plan is applied to the final as-built design to ensure that it conforms to the final approved design documents. Since this is the last design activity prior to the operation, it also has to ensure that all HEDs and issues raised in the previous HFE elements were correctly resolved.

If any HSI design element is not evaluated in the HF V&V element, it will be tested in the final implemented design. The overall procedure for the design implementation is represented in Figure 1.

4.2. Input

The inputs to the design implementation include:

- As-built design,
- Final design documents,
- HFE guidelines (e.g., NUREG-0700 (Reference 2.3)),
- Issue tracking systems, and
- Important human actions (Has).

4.3. Process

The design implementation activity consists of three tasks: 1) identifying aspects of the design to be, 2) verifying the design aspects, and 3) identifying HEDs.

1) Identifying aspects of the design to be verified.

Because of the limitation of V&V test bed, some elements may not have been evaluated sufficiently in the HF V&V, including:

- Environment of MCR including lighting system, communication system and habitability systems
- HEDs that have not been resolved in the V&V
- Design changes after HF V&V during installation of HSI

- Design features that are not feasible to the V&V test bed (e.g., alarm sound and readability of large display panel)

Those aspects will be evaluated by walkthroughs, measurements of conditions, and performance based tests in the as-built MCR. Any identified discrepancies identified through this verification will be corrected or justified.

2) Verifying the design aspects

As-built HSI design needs to be evaluated so that it conforms to the final design documents and human factors engineering guidelines. This activity ensures that the HSI design is implemented correctly by comparing the final design documents to the actual HSIs. The design elements are evaluated through the following methods.

a. Environmental conditions of MCR

The environmental conditions, i.e., temperature, humidity, intensity of illumination, and noise, are evaluated by the following process.

i) Selection of measuring points

This step chooses the measuring points of main control room, remote shutdown room, technical support center, emergency operation facilities, and safety-related local control station. The points in each facility are determined by considering the operator's working boundary and average physical conditions (e.g., height).

ii) Measurement of conditions

The conditions are measured by using the instruments. The measurements are performed at least three times at the vicinity of each point. Then, the arithmetic mean value of measurements is calculated.

iii) Verification of conditions

This step checks whether the mean values of conditions are within the boundary recommended by the human factors engineering guidelines. If any HED is found, it is transferred into the issue tracking system to resolve.

b. HEDs that have not been resolved in the V&V

This step verifies that all the HEDs that still remain as a result of the V&V are resolved in the as-built design. This step uses a checklist for the remaining HEDs and verifies the as-built design based on the applicable human factors engineering guidelines. If any HED is found, it is transferred into the issue tracking system to resolve.

c. Design changes after the V&V

Any design change that has made after the V&V is verified in the step. The method is identical to that for the HEDs that have not been resolved in the V&V in (b).

d. HFE features that are not feasible to the V&V test bed

This step verifies any HSI design features that are not feasible in the V&V test bed and so necessary to evaluate in the as-built design. Examples of the features are the audibility of alarm sound and the

readability of large display panel. The method is as follows.

i) Preparing the checklist

This step prepares the checklist for the feature to be verified. For the audibility of alarm sound, the checklist includes the audibility of alarm at each position and the discriminability of alarms in the case of multiple alarms. For the readability of large display panel, the checklist includes the readabilities of texts, symbols, process parameters, component status indications, and system mimics.

ii) Collecting data

This step collects the data for the evaluation. If necessary, operating personnel may participate in the evaluation as subjects. In this case, at least three shifts of operators will answer the questionnaire about the checklist after walking through the design and the in-depth briefing will be also conducted to gather the information for determining the acceptability of the design feature.

iii) Determining the acceptability

This step determines the acceptability of the design features. It verifies that the design feature conforms to the human factors engineering guidelines. If necessary to determine the acceptability, statistical analyses can be used for the data collected from the operating personnel. If any HED is found, it is transferred into the issue tracking system to resolve.

3) Identifying HEDs

This task identifies the HEDs that arose in the design implementation activity. The process to identify HEDs is same as that in the Section 6 of Human Factors Verification and Validation Implementation Plan (Reference 2.5). The HEDs and issues are registered in the ITS for resolution.

4.4. Output

The final verified and validated as-built design will be produced through this activity.

Figure 1. Process of Design Implementation

5. RESULTS

The results of the design implementation are summarized in the Design Implementation Results Summary Report.