

APR1400 DCD Chapter 18. Human Factors Engineering

Response to the Significant Issues Identified during the Acceptance Review

December 12, 2013

Korea Hydro & Nuclear Power Co., Ltd

Presentation Outline

1. Background

- 10 significant issues identified during NRC Acceptance Review (Transmitted to KHNP on November 25, 2013)
- The discussions with the NRC Staff during the conference call on November 26, 2013

2. Contents of Presentation

- Responses to specific NRC questions
- Resolution Plan to enhance the interaction and communication with NRC staff

HFE Issue Summary

No	Issues	HFE Element	Resolution Plan
1	Documents lack clarity and conciseness	All	Refer to resolution plan
2	Documents lack technical information needed	All	Refer to resolution plan
3	Non-licensed operator in MCR	Staffing	Revise IP
4	ITAAC for OER IP and FRA/FA IP	OER, FRA/FA	Revise ITAAC
5	ITAAC for HPM	ITAAC	Revise ITAAC
6	Interface between the HSI DIP and Basic HSI Platform	HSI	Refer to resolution plan
7	Basic HSI Platform lacks level of detail	HSI	Refer to resolution plan
8	V&V IP editorial problems	V&V	Revise V&V IP
9	V&V IP needs clarifications	V&V	Refer to resolution plan
10	Proprietary portions need re-evaluation	All	Revise all IPs

NRC Findings (1.a)*

Definitions of Validation and Verification are significantly different from how they are used in NUREG-0711 and don't clearly communicate the intent of these activities. The definition of Validation requires interpretation to understand because of the sentence structure used.
(HFEPP, Section 1.3)

Response

- **Definitions of terminologies including Validation and Verification will be revised according to NUREG-0711, revision 3 in the next revision.**

* Numbers denoted form NRC Issues List (Nov. 26, 2013)

NRC Findings (1.b)

The grammar in the second sentence describing project manager responsibilities requires staff interpretation. The grammar in the sentence describing quality assurance responsibilities requires staff interpretation.

(HFEPP, Section 2.2)

Response

- The responsibilities for project manager and descriptions of quality assurance group will be revised in the next revision as follows:

“Project manager performs the following activities:

- Take overall responsibility for project management, project quality, costs, and revenue
- Represent the HFE team to control external and internal matters of the project,
- Establish and control of overall plans for the project implementation

NRC Findings (1.b)

Response (Con'd)

- **Quality assurance group performs the following quality-related activities:**
 - Preparation of the Quality Assurance Manual and related procedures
 - Establishment and implementation of performance plan for project quality assurance activities
 - Conducting quality assurance audit
 - Project quality assurance indoctrination
 - Management for resolving correction action requests (CAR) and recommendations by external quality assurance audits

NRC Findings (1.c)

*The relationship of first paragraph to overall OER IP is unclear.
(OER IP Section 1.1)*

Response

- The first paragraph of the Section 1.1 “Purpose” intended to explain relationship among Project Procedure Manual, HFE Program Plan, and OER IP.
- The paragraph is not closely related to the purpose of OER IP. The paragraph will be removed at next revision.

NRC Findings (1.d)

The meaning of the following paragraph is unclear: “The TIHA plays a vital role in the overall design of the HSI by identifying expected human response times, automation needs and IHAs that must be considered in the design. It is also used to evaluate HSI design changes based on identification of controlling mechanisms to minimize the impact of the TIHAs and on design changes that come from the other elements of the overall HFE program.” The following statement is unclear --- “TA provides detailed task requirements for IHA to treatment of IHA. (TIHA IP, Section 4.1)

Response

- The statement will be revised and replaced in the next revision.
- Detailed task requirements will include followings;
 - Time available
 - Time required
 - Estimated time
 - Information and Control Requirements

NRC Findings (1.e.i)

*Page ii – last paragraph, last sentence... “as integrated fashion;”
(HSI Design IP)*

Response

- Page ii – last paragraph, last sentence... “as integrated fashion;” will be revised as follow:

[Current]

“The critical function monitoring, success path monitoring, accident monitoring instrumentation, and bypassed and inoperable status indication are implemented using the HSI resources as integrated fashion.”

[New]

“The critical function monitoring (CFM), success path monitoring (SPM), and bypassed and inoperable status indication (BISI) are integrated in the Large Display Panel, and the accident monitoring instrumentation (AMI) is provided in the Safety Console.”

NRC Findings (1.e.ii)

*“Analysis Phase” first paragraph... wording is unclear;
(HSI Design IP, Section 2.1.2)*

Response

- The description for the “Analysis Phase” and Figure 1 HSI Design Process will be revised in the next revision.
- Figure 1 will be revised to show relationship that the analysis result from FRA/FA and TA are provided to the Basic HSI Platform.

NRC Findings (1.e.iii)

*The third paragraph wording is not clear... one item that stands out is the term “technology possible.” What does this mean?
(HSI Design IP, Section 2.2)*

Response

- The third paragraph will be revised in the next revision.

NRC Findings (1.e.iv)

States the two rear consoles features are for monitoring only, but the next sentence it states that they can be used for plant control. (HSI Design IP, Section 2.3.2.1)

Response

- Normally, SS and STA consoles are used for monitoring only and all controls are disabled by special hardware switches.
- If SS or STA console are required to use for control, control capability can be restore using theses hardware switches (ESCM Disable Switch).

NRC Findings (1.f)

The terms Information display, IPS, VDU, FPD, and operator console seem to be used interchangeably making it difficult to understand the detailed design. (HSI Design IP and Basic HSI Platform)

Response

- The Information Processing System (IPS) is a plant information processing system. The IPS provides all plant information to the operator console flat panel displays (FPDs) and a LDP.
- A FPD is one type of Video Display Unit (VDU).
- FPD means hardware(monitor), and display means display page shown on the FPD.
- Each Operator Console has four FPD for monitor and non-safety control, and four small FPDs for ESF component control.

NRC Findings (1.g)

Generic words like “Deemed important enough,” “provides text of sufficient size and with acceptable characteristics to permit viewing from expected MCR locations,” “plant important alarms,” “Specific features are considered for error prevention,” “typically have,” “appropriate coding,” “Should provide” and “sufficient means,” do not provide sufficient specificity for the staff to evaluate the HFE design or understand the underlying criteria used to define what is meant by terms like important, sufficient, appropriate, considered, and typically. (Basic HSI Platform)

Response

- The unclear or improper terms will be revised in the next revision.
 - For example;
“LDP provides text of the size specified in Section 2.4.1.1.C in Style Guide (i.e., 11minute of arc) to permit viewing from expected MCR locations.”

NRC Findings (2.a)

Acceptance criterion 2.4.2 (2), second bullet, “The team should have the authority and organizational placement to reasonably assure that all its areas of responsibility are completed, and to identify problems in establishing the overall plan or modifying its design,” is not addressed.
(HFEPP, Section 2.2)

Response

- Organizational Placement and Authority will be revised in the next revision.

NRC Findings (2.b)

***Acceptance criterion 2.4.4 (2), first bullet, “establish criteria for when issues are entered into the system”, is not addressed.
(HFEPP, Section 2.2)***

Response

- The criteria for when issues are entered into the system will be added in the next revision.
- To enter issues, following documents are referred to decide whether the response or resolution can commit acceptance level or not.
 - Style guide
 - System design criteria for alarm, display, control, LDP, MCR/RSR, TSC, and EOF.
 - OER, TA, TIHA, FRA/FA
 - Human Engineering Discrepancy from V&V

NRC Findings (2.c)

Material is not sufficiently specific to address acceptance criterion 2.4.4 (2), second bullet, “track issues until the potential for negative effects on human performance is reduced to an acceptable level”. (HFEPP, Section 4.2.4)

Response

- The criteria for when issues are closed will be added in the next revision.
- To close issues, following documents are referred to decide whether the response or resolution can commit acceptance level or not.
 - Style guide
 - System Design Criteria for alarm, display, control, LDP, MCR/RSR, TSC, and EOF.

NRC Findings (2.d)

*The description of development and implementation of operator interview questionnaires does not provide a description of the questionnaire content or protocol for administering it.
(OER IP Section 4.1)*

Response

- The questionnaires and implementation process will be included in the next revision of OER IP.

NRC Findings (2.e)

The statement is made that, “The resulting list of IHAs is then reviewed and incorporated into the HFE program element by expert judgment.” This seems contradictory to NUREG-0711 guidance as there are a number of acceptance criteria that provide specific guidance on how IHA’s are incorporated in the program. Specific information on how expert guidance will be used in this area is needed.

Response

- TIHA IP will be revised in the next revision to use NUREG-0711 guidance instead of expert judgment.

NRC Findings (2.f)

This section describes the overall method that will be used to develop the HSI design for the APR1400. The description of the overall method is not clear. Correlating the text to Figure 1 was difficult (was not able to discern which box/item was in which phase). The confusion does not allow a clear picture of the scope of each element within the process. Section 2.1.2, “Analysis Phase” appears to contradict the figure in that FRA/FA and TA provide the basis for the Basic HSI Platform yet are only shown as inputs into the “HSI Detail Design” box. (HSI Design IP, Section 2.3.2.1)

NRC Findings (2.f)

(02-06) Response

Proprietary

Response

- The description of the overall method will be revised in the next revision.
- Figure 1 and the correlated text will be revised consistently in the next revision.

NRC Findings (2.g)

The SGTR scenario is not complete. There are 70 pages with section titles and proprietary markings but are otherwise left completely blank. (HF V&V Scenarios, App. 6)

Response

- The proprietary document will be submitted ASAP for staff review.

NRC Findings (2.h)

The Section 3.0 tables lack keys that explain how to use them. For instance, what do the numbers within the cells represent? These tables are presumably related to the OCS described in the V&V IP however there is no reference in the IP to this report or these tables. (HF V&V IP)

Response

- The numbers of the Section 3.0 tables refer to the event numbers described in Section 5.0 V&V Scenarios.
- The revised document will include explanation for the relation between Section 3.0 and 5.0 in the next revision.

NRC Findings (2.i)

The IP does not include a description of how the HFE program addresses each important Human Action as stated in criterion 12.4.1(4). (Design Implementation IP)

Response

- The IP will be revised to include that verify all IHAs are properly implemented.

NRC Findings (2.j)

Criterion 12.4.1(3) states that “The applicant should verify all HFE-related issues...” There are several commitments addressing some HFE-related issues; however there is no commitment that addresses “all HFE-related issues” as described in the criterion. For instance: Section 3 states “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.” This implies that HEDs from tasks prior to the “previous task” may or may not be included in this process. (Design Implementation IP)

Response

- The sentence will be revised to have clear meaning of that all HEDs are included.

NRC Findings (2.k)

If the COL is responsible for implementing the HPM, there should be a COL item associated with this element. However, the DCD states that No COL information is needed. The IP (P. 1), however, states that the IP for HPM “supports the COL...” The IP (P.1) further states, “The COL applicant is expected to develop and operate a human performance monitoring program for this activity.” Also, the IP (P. 2) states, “Human performance monitoring will be implemented by a systematic program of the COL applicant.” There is inconsistency between the DCD and the IP regarding the COL responsibility for HPM. (DCD, Section 18.12.4)

Response

- DCD will be revised to include HPM program development activity as COL item.

NRC Findings (2.I)

The Acceptance Criteria do not contain the quantitative measures needed for ITAAC closure. The existence of a report that concludes that various processes were followed does not provide evidence needed to demonstrate (using various calculations, summaries, examples and other forms of data) that the process in the Implementation Plans was carried out as approved. Acceptable wording was provided subsequent to the readiness review. Applicants are not required to follow the template provided, however wording currently used in Table 2.9-1 does not meet the current standard. (ITAAC, Table 2.9-1)

Response

- ITAAC Table 2.9-1 will be revised according to NRC provided template and correct wording.

NRC Findings (3)

The use of a non-licensed electric operator in the does not conform to 10CFR50.54(i) and (j). The basis for an exemption has not been provided. (Staffing & Qualifications)

Response

- The staffing assumption will be revised to meet 10 CFR 50.54(j).

NRC Findings (4)

A complete Design Certification must be submitted. For Chapter 18 there are two alternatives. The first alternative is to submit detailed Implementation Plans documenting how the final design will be achieved and supporting ITAAC committing to an inspection, test or analysis that verifies the implementation plan was followed. The second alternative is to submit a general implementation plan and the associated results summary report. Currently the milestones indicate OER and FA/FRA will have a results summary report submitted by the end of year two. This is good information but the OER and FA/FRA elements, at this point, are still being reviewed at an implementation plan level. ITAAC have not been provided for these two element. (ITAAC, Table 2.9-1)

Response

- OER and FRA/FA IP elements will be added in the ITAAC Table 2.9-1.

NRC Findings (5)

NUREG-0711, Section 13.3, states that submittal of a results summary report is not expected. The milestones table implies that a results summary report will be submitted. Also the ITAAC table includes an ITAAC for this element which it should not. The Human Performance Monitoring element only requires a plan for monitoring. The implementation of the plan is accomplished via operating programs which are inspected as part of the operating plant inspection program. Staff guidance states that ITAAC should not be assigned to elements associated with operating programs. (HPM)

Response

- ITAAC for HPM will be removed.
- The HFE milestone activity for HPM will be removed.

NRC Findings (6)

The staff does not understand the interface between the HSI design implementation plan and the Basic HSI Platform. There appears to be significant overlap in the material presented in the two documents. The following 3 approaches have been used in the past but the HSI design element does not appear to fall cleanly into any of these 3 approaches (HSI Design IP and Basic HSI Platform)

- A completed HFE design is explained*
- The process that will be used to develop a complete design is explained and ITAAC is used to track and verify completion of the design*
- The HFE design is split into two pieces. The first piece is focused on the Control Room layout and the Human System Interfaces (Commonly called the Basic HSI platform). This piece must be explained in sufficient detail that reviewers can verify the guidance in NUREG-0700 (which is also verified to be included in the applicant's style guide) has been implemented. The second piece develops the control room inventory (controls, displays, alarms, operating aids) in accordance with NUREG-0711. The HSI design element includes an explanation of how the inventory will be incorporated within the Basic HSI platform. This approach is typically used when a predecessor plant has already used the Basic HSI platform and demonstrated its effectiveness.*

Response

- HSI design implementation plan describes the HSI design process, while the Basic HSI Platform provides an overview of the APR1400 HSI design.
- Interface between HSI Design IP and Basic HSI Platform will be revised in the next revision.

NRC Findings (7)

The Level of detail in the current HSI Basic Platform is not sufficiently detailed to demonstrate how the NUREG-0700 guidance is implemented. Instead the document provides high-level design principles. The principles are consistent with 0700 and facilitate staff review but there is not sufficient detail for the staff to conclude that the actual design has implemented the principle. For example: (Basic HSI Platform)

“Environmental Design Criteria” – This section frequently uses the phrase, “in accordance with the HFE criteria.” The actual design criteria being used is desired so that the staff can independently verify that the design criteria conforms to the HFE guidance.

(Basic HSI Platform, Section 3.2.1)

“Visibility Evaluation” – The figures do not include distances or viewing angles therefore the staff cannot reach conclusions as to whether HFE guidance is met.

(Basic HSI Platform, Section 3.2.3.1)

NRC Findings (7)

Response

- The Basic HSI Platform will have sufficient details to demonstrate how the NUREG-0700 guidance is implemented.
- For example - Environmental Design Criteria
[Humidity, Temperature, and Ventilation]
 - Temperature and humidity levels are maintained within comfort climate level in accordance with the HFE criteria.
 - The MCR should maintain temperatures of 20-26 °C (68-79 °F) for all seasons. Temperature difference from the head level to the floor level should not exceed 6 °C (10 °F)
 - Humidity should be maintained at 20 to 60 % relative humidity.
 - Heating, ventilation and air conditioning (HVAC) system is capable of introducing sufficient fresh air in accordance with HFE criteria
 - The ventilation system should be capable of introducing outdoor air into the MCR at a rate of at least 0.42 cubic meters per minute (14.8 cubic feet per minute) per occupant.
 - HVAC ducts should be designed such that hot or cold air should not blow directly on operators.

NRC Findings (7)

Response (Con'd)

- For example - Visibility Evaluation
 - The Figures will include distance and viewing angles

Proprietary

NRC Findings (7)

Response (Con'd)

- For example - Visibility Evaluation
 - The Figures will include distance and viewing angles

Proprietary

NRC Findings (8.a)

There are several problems with references throughout the V&V IP such as:

*The implementation plan does not specifically reference the scenario report. Implementation plans should stand alone and explicitly refer to documents needed to fulfill requirements.
(V&V IP, Section 2.0)*

Response

- The following information will be added to the Section 2.0 Reference in the next revision.
 - KHNP, APR1400-E-NR-13002-P, “HF V&V Scenarios,” September, 2013.

NRC Findings (8.b)

Figures throughout the document are inappropriately labeled. Figure numbers do not correspond with references to the figures embedded in the text. (V&V IP, Section 4.0 and 5.0)

Response

- Inappropriately labeled information will be revised in the next revision.
 - Figure No. 1 will be modified to No. 2 (p. 29)
 - Figure No. 2 will be modified to No. 3 (p. 56)

NRC Findings (8.c)

Page v. “List of Figures” – A caption on the list contains text which has not been translated to English. (V&V IP)

Response

- In the process of the file conversion, this page number was omitted.
- The page number of the Figure 1 will be revised in the next revision.

NRC Findings (9.a)

Several V&V areas will need further clarification in order to complete the safety review. A few examples include:
“Types of Performance Measures” – Part 2 “Primary Task Measures” describes the use of subjective reports as a performance measure but does not describe how this information will be collected, analyzed, or used.
(V&V IP, Section 5.5.1)

Response

- The subjective report of participants will be used to evaluate performance measures during ISV.
- An example of the questionnaire will be developed to collect the information.
- The analysis and utilization of the collected information including questionnaire will be described in the next revision of the V&V IP.

NRC Findings (9.b)

***“Types of Performance Measures” – Part 4 “Situation Awareness” states that five methods are used to measure situation awareness. However later in the section it is stated that only a single method (SAGAT) will be used.
(V&V IP, Section 5.5.1)***

Response

- The V&V IP describes the five available method for situation awareness, and describes bases for SAGAT selection.
- The description will be revised as follows:

[Current]

“Five methods are used to measure situation awareness: ...”

[New]

“Five methods are considered to measure situation awareness: ...”

NRC Findings (9.c)

“Types of Performance Measures” – Part 5 “Workload” describes a non-standard application of NASA-TLX which omits the pair-wise comparison portion of the measure. The text suggests that this may improve the reliability of the measure however evidence, such as a reference to an appropriate research study should be included to validate this claim. This discussion appears to be in the subsection labeled “Physiology Measures.” (V&V IP, Section 5.5.1)

Response

- The suggested methodology, which was used on the Reference plant, is based on the following research study
 - *Nygren, T. E. (1991), Psychometric properties of subjective workload measurement techniques: Implication for their use in the assessment of perceived mental workload, Human Factors, Vol. 33, pp. 17-33*
- Standard application of NASA-TLX including the pair-wise comparison will be included in the next revision.
- The final selection of NASA-TLX will be separated from the *Physiology Measures* section.

NRC Findings (9.d)

Section 5.5.2 “Performance Measure Information and Validation Criteria” describes the ability for the operations experts to override a failing score based on expert judgment. Additional information will be necessary regarding this strategy to determine if this meets the intent of the requirement. Allowing experts to override pass/fail performance measures may subvert the use of pass/fail criteria all together. (V&V IP, Section 5.5.2)

Response

- The plant variables logging data from simulator are used to evaluate the plant performance measures by operations experts.
- The plant performance measure can be accepted by the experts, even when some variables go out of the predetermined range.
- The specific acceptance criteria to evaluate for the primary task will be added in the next revision.

NRC Findings (9.e)

The description of the use of t-Tests on page 59 is different than the one on page 61 (and elsewhere in the document). It is unclear why the same statistical method would be described differently in these two circumstances.

(V&V IP, Section 5.7)

Response

- The t-Test for BARS is to compare the collaboration level of operators groups (e.g., the difference between 1st and 2nd group)
- The t-Test for Situation Awareness is to evaluate the level of cognitive workload based on the reference plant.
- The different description of t-Tests will be revised in the next revision.

NRC Findings (10)

Large portions of the V&V IP text are marked as proprietary. Often this includes descriptions of statistical analysis methods or commonly used human factors methodologies (i.e. NASA-TLX) and information that is commonly available in non-proprietary resources. This may present challenges when issuing RAIs and other formal interactions.

(V&V IP, all Sections)

Response

- The scope of proprietary will be excluded for the followings:
 - Commonly available statistical analysis methods
 - Commonly used human factors methodologies

Issue Summary

1. The documents lack clarity and conciseness

- The meaning of specific words and sentences leave the reviewer to have to assume their intent
- Many problems were found that may be the result of translation between Korean and English

2. The documents lack technical information needed

- The reports still do not have explicate measurable criteria

3. Other Issues

- Non licensed operator
- ITAAC for OER, FRA/FA, HPM
- Basic HSI Platform level of detail
- Clarification for V&V IP
- Proprietary mark-up

Resolution Plan

Proprietary

APR1400 Human Factors Engineering

Resolution Plan

Proprietary

Resolution Plan

Proprietary

Resolution Plan

Proprietary