HFE Program for the APR1400

Responses to the June 3 through 7 HFE Audit Recommendations

August 13, 2013

Korea Hydro and Nuclear Power Co., Ltd.

Meeting Objective

To discuss revisions, based on the June 3 through 7 NRC Audit, of the KHNP HFE program and its documentation as contained in the DCD Chapter 18 and the HFE Implementation Plans

Presentation Outline

1. Proposed List of HFE Documents for DC
2. Major Pre-audit Observation
3. Response Example – V&V IP
4. Detail Audit Observations and Response
5. Questions

HFE Documents for DC

- DCD Tier 1 for HFE and Tier 2 Chapter 18
- HFE Implementation Plans
  1) HFE Program Plan
  2) OER
  3) FRA/FA
  4) TA
  5) S&Q
  6) TIHA
  7) HSI Design
  8) HFE V&V
  9) Design Implementation
  10) HPM
- Technical Reports
  1) Basic HSI Platform
  2) Style Guide
  3) V&V Scenarios
- Result Summary Reports
  1) OER Report (*)
  2) FRA/FA Report (*)

  * DC scope only, 15 months after Docketing

Major NRC Audit Observation

There is a substantial amount of technical information missing.
Examples include:

KHNP Response;

- All IPs are reviewed against NUREG-0711 Rev. 3 for completeness
- All IPs and Technical Reports are revised to remedy the findings in the June NRC Audit

Generic Revisions to the DCD Chapter 18 and the HFE Implementation Plans

- Ch18 and all Implementation Plans (IPs) are revised, based on the June NRC Audit
- Consistency between Ch 18 and the IPs, and between IPs
- Alignment of IPs to NUREG-0711 Rev 3 structure and content
- Expanded level of detail and added acceptance criteria
- Special emphasis placed on the most challenging and complex IPs;
  - Verification and Validation
  - Task Analysis
  - Functional Requirements Analysis / Function Allocation
- Editorial/English reviews

Response Example - V&V IP (1/10)

Sampling of Operational Conditions for ISV

Sampling Dimension;

- A multidimensional sampling strategy is applied for the Sampling of Operational Conditions

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Response Example - V&V IP (2/10)

Sampling of Operational Conditions for ISV

Plant Conditions Mapping Tables

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Response Example - V&V IP (3/10)

Sampling of Operational Conditions for ISV

Plant Conditions Mapping Tables (continued)

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Response Example - V&V IP (4/10)

Sampling of Operational Conditions for ISV

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Current Status of SOC;

Response Example - V&V IP (5/10)

Scenario Outline

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Response Example - V&V IP (6/10)

Scenario #1: SBLOCA with CBP/Displays Failures

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Response Example - V&V IP (7/10)

Preparation of Evaluation

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Response Example - V&V IP (8/10)

Major Steps of Scenario

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Response Example - V&V IP (9/10)

Primary Task Performance Measures

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Response Example - V&V IP (10/10)

Subjective Questionnaire

Audit Observation 1

The process used for determining the sample of operational conditions to be tested during the verification and validation phase of the HFE program.

KHNP Response; V&V

- A detailed process for the sampling of operational conditions has been added to the V&V IP *(section 3.1, page 3-1)*
- The application of this SOC process to the definition of scenarios is further defined in the Technical Report containing the scenarios *(section 3.1, page 3-1)*

Audit Observation 2

The methodology for conducting Task Analysis was not completely described.

KHNP Response; TA

- The Task Analysis application of the Hierarchical Task Analysis and its use of workload analysis, time available, time required, crew staffing needs and crew qualification requirements has been added *(section 3.3 and 3.3.6, page 3-8)*
- A detailed approach to the methodology description with an illustrative example will be submitted

Audit Observation 3

Scenarios to test operator performance and the adequacy of human system interfaces were not provided as part of the Integrated System Validation (ISV).

KHNP Response; V&V scenarios

- Using the SOC a set of seven complete scenarios have been defined and are included in a separate Technical Report
- Scenarios include:
  - Small Break Loss of Coolant Accident w/CBP/Displays Failures
  - Anticipated Transient Without Trip w/DCS Failure
  - Excessive Steam Demand w/Alarm Failures
  - Loss of all Feed Water
  - Station Blackout
  - Steam Generator Tube Rupture
  - Main Control Room Fire
- Application matrix demonstrating all SOC have been applied in the scenario set
- Scenario summary has been added to the report

Audit Observation 4

Performance measures used during ISV testing to measure plant and personnel performance were not provided.

KHNP Response; V&V performance measures

- Explicit pass/fail and diagnostic performance measures have been described *(section 5.5, page 5-4)*
- Performance measures are mapped into each scenario *(section 5.5.1, page 5-5)*

Audit Observation 5

An explanation for the basis for the Basic HSI Design platform was not provided.

KHNP Response; Basic HSI Platform

- The Basic HSI Platform design describes the HSI design inputs, concept of operations, and design description of HSI.
  (section 1.2, page 1)
- The basis for the Basic HSI in the CE System 80+ and the SKN 3&4 design is described in the Basic HSI Platform Technical Report.
  (section 2.0, page 2)

Audit Observation 6

NUREG-0711 Task Analysis acceptance criterion 6 (related to number of personnel needed to do the task) and criterion 7 (related to knowledge and abilities required to perform the task) were not addressed.

KHNP Response; TA

- The TA methodology and IP have been revised to include the assessment of the number of personnel required to do the task, their knowledge and their abilities *(section 3.1, page 3-1, page 3-11)*
- The IP revision also includes an expanded discussion of criteria 1 (scope), 4 (relationships among tasks), and 9 (IHA)
  (page 1-2, page 3-10, page 4-1)
- All task considerations from NUREG-0711 Rev 3 Table 5-1 have been included *(section 3.2, page 2-3)*

Audit Observation 7

NUREG-0711 OER acceptance criterion 4 (related to using interviews to identify operating experience) and criterion 5 for (related to identifying important human actions from predecessor designs) were not addressed.

KHNP Response; OER

- Operator interviews have been and are used to identify OE for the 6 sub criteria of criteria 4 of NUREG-0711 Rev 3. The description of this process has been expanded *(section 4.1, page 4-1)*
- Identification of HAs from predecessor designs and the determination of their relevance to the APR1400 design descriptions are added *(section 3.1, page 3-1)*

Audit Observation 8

HFE process elements mentioned in the DCD are not included in the corresponding Verification and Validation Implementation Plan (e.g., sampling of operational conditions, operational sequence diagrams).

KHNP Response; V&V, TA

- SOC has been added to the V&V IP and applied in the scenario definition *(section 3.0, page 2-3)*
- Methodology for the TA has been unified between the IP and Ch 18, OSD is deleted from the TA method

Audit Observation 9

Numerous grammatical and sentence structure issues contribute to making the meaning of the material unclear.

KHNP Response;

- An editorial review has been made of all the IPs and the DCD chapter 18 for;
  - — Korean to English translation clarity and meaning
  - — Grammar, sentence structure, and understandability
  - — Use of ambiguous terminology in commitments

Audit Observation 10

The task analysis IP defines Hierarchal Task Analysis and Task Decomposition but does not describe how the methods will be implemented (i.e. who is responsible, how these will be integrated).

KHNP Response; TA

- A detailed level of description to the application of the TA method has been added, including an illustrative example *(section 3.0, page 3-1)*
- The IP contains a description of the TA team, their minimum qualifications and how they apply subject matter experience *(section 3.1.8)*
- Integration of the TA results in the HFE program is now described *(section 3.4, page 3-10)*

Audit Observation 11

The description for the APR1400 HFE design team placement and authority lacks sufficient detail to determine where the team fits into the overall engineering organization, its reporting relationship, and authority.

KHNP Response; HFE PP

- The placement of the HFE design team and its authority in the design process has been clarified *(section 2.2, page 2)*
- The HFE design teams decision making process and its lines of coordination have been clarified *(section 3.4, Figure 3, page 9)*
- The organization chart contained in the HFE Program Plan has been expanded to one additional level up in the organization, as per discussions during the June Audit *(section 2.2, Figure 1, page 2)*

Audit Observation 12

Although the FRA/FA mentions “success paths” for accomplishing functions, the concept of success paths is merely mentioned but not explained or illustrated.

KHNP Response; FRA/FA

- A more detailed discussion of success paths has been added *(section 4.1.2, page 9)*
- The relationship between the APR1400’s success paths and those of the CE System 80+ is described in a new table *(Table 2)*

Audit Observation 13

The current ITAAC format is not sufficient to determine element completion. The acceptance criteria do not reflect that a Results Summary Report must be provided to document the final design product and evaluation results must be presented that demonstrate the HFE design process was implemented as described in the DCD.

KHNP Response; ITAAC

- The ITAAC format and content is being revised to match the sample format and content provided by the NRC Staff during the June Audit

Summary

- KHNP has carefully reviewed the results of the June 3 through 7 Audit, including the Audit Report and the discussion that took place during the Audit
- Observations reported in the Audit Report were treated as generic issues, resulting in the revision of the DCD Chapter 18 and all Implementation Plans
- Technical information and review criteria contained in NUREG-0711 Rev 3 has been added to the documents
- Translation, grammatical and sentence structure issues have been corrected resulting in more understandable reports
- The HFE ITAAC format, IP acceptance criteria and Results Summary Report content will demonstrate that the HFE design process was implemented as described in the DCD

Questions

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Abbreviation List

AOP	abnormal operating procedure
APR1400	Advanced Power Reactor 1400
CBP	computer-based procedure
DCS	distributed control system
DA	diagnostic action
EOP	emergency operating procedure
FRA/FA	functional requirements analysis / function allocation
HAs	human actions
HFE	human factors engineering
HPM	human performance monitoring
HSI	human-system interface
IHA	important human actions
TIHA	treatment of important human action
IP	implementation plans
ISV	integrated system validation
KHNP	Korea Hydro and Nuclear Power Co., Ltd
OE	operating experience
OSD	operational sequence diagrams
SKN 3&4	Shin Kori Unit 3 and 4
S&Q	staffing and qualifications
SOC	sampling of operational conditions
SOP	system operating procedure
SPTA	standard post trip action
TA	task analysis
V&V	verification and validation