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Regulatory Positions for Human-System Interfaces Modernization of Nuclear Power Plants; A Perspective of Human Factors Engineering

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1. Introduction

US Electric Power Research Institute (EPRI) states that there are many reasons for modernization activities in Human-System Interfaces (HSIs) of nuclear power plants, including; (1) to address obsolescence and lack of spare parts, (2) to improve plant performance, HSIs functionality, and reliability, and (3) to enhance operator performance and reliability, etc [1]. In these regards, in the case of Korea nuclear power industry, several NPPs have plan for plant modification. For an example, Kori 1 NPP was designed and built by thirty years ago and problems were foreseen with difficulty of abstaining spare parts, increased maintenance cost, and lack of competence related the operation with the old HSIs. According to these backgrounds, Korea Hydro and Nuclear Power Company (KHNP) is designing the new control room of Kori-1, including remote shutdown room and safety parameter display system (SPDS).

For these plant modernization, Korea Institute of Nuclear Safety (KINS) is responsible for reviewing the safety of Human-System Interfaces and other-related activities. In this regard, the objective of this paper is to present the general regulatory positions on reviewing the HSIs modernization process.

2. General Regulatory Positions

2.1 Regulatory Requirements and Guidelines

The details of Human Factors Engineering (HFE) activities for the HSIs modernization will be primarily described in Safety Analysis Report (SAR) and in several related topical reports published by the applicant. The HFE criteria used to review the acceptance of new HSIs is primarily base on the review requirement and guidelines of KINS.

<u>High-level requirements</u>

The following high-level safety requirements and criteria will be applied in the review of the new HSIs;

- KINS Safety Principle 3, Consideration of Human Factors:
- KINS General Safety Criteria II-9.2, Human Factors:
- KINS General Safety Criteria II-30.2 Control Room

<u>Specific requirements and guidelines</u>

The following regulatory requirements and guidance will be applied in the review of the new HSIs [2, 3, 4, 5, 6];

- KINS Safety Regulatory Guideline (SRG) 9.10: Bypassed and Inoperable Status Indication of Protection System and Safety Related I&C System
- KINS SRG 9.13: Instrumentation for Post Accident Monitoring
- KINS SRG 9.15: Reliability of Control Room Annunciator Systems
- KINS SRG 11.4: Habitability of a Control Room
- KINS SRG 15.1: HFE program Plan
- KINS SRG 15.2: HFE Analysis
- KINS SRG 15.3: HFE Design
- KINS SRG 15.4: HFE Verification and Validation

However, there are some limitations on these specific requirements and guidelines. The one limitation is that the current guidelines have focused on HFE activities of the new construction of NPPs; that is, the KINS SRG has not some specific points relating to the modification and modernization of HSIs. Therefore, in this regard, the staff will use guidance from the U.S. Nuclear Regulatory Commission (NRC) NUREG-0711 to review more comprehensively in the perspectives on the control room modifications [7].

2.2 Regulatory Positions to Review the modernization of HSIs

NUREG-0800 Section B states the regulatory positions review of the HFE aspects for the control room modification as follows [8];

> *"Review of the HFE aspects of HSI Modifications "License amendments involving major changes to the HSIs, such as control room modernization, should be reviewed using the guidance contained in Section II.A of this chapter (review of HFE aspects of a new plant). However, since the extent of such modifications can vary, the staff's review should be tailored using the additional guidance presented in this section."*

According to this guideline, the regulatory position about plant modification provides under assumption that corresponding plant applied the HFE program during the construction phase. Therefore, we should consider following question; Does an corresponding NPP apply the systematic HFE program at that time of construction?

If the corresponding NPP didn't perform the HFE activities, KINS should conduct the safety review of the new HSIs as the same level of construction permit (CP) and operating license (OL) process for new design of NPP. Especially, for, KINS staff would focus the following points and issues in the perspectives on HFE for the submitted applicant's SAR;

Scope of HFE program management

As described earlier, if the corresponding NPP didn't perform the HFE activities at that time of contruction, KINS should conduct the safety review of the new HSIs as the same level of CP and OL process for new design of NPP. According to KINS SRGs, therefore, the area of HFE review should include the following all areas of HFE program elements; (1) HFE program management, (2) operating experience review (OER), (3) functional requirements analysis & function allocation, (4) task analysis, (5) staffing, (6) human reliability analysis (HRA), (7) procedure development, (8) training program, (9) HSI Design, (10) HFE verification & validation (V&V), (11) design implementation, & (12) human performance monitoring. To review the specific HFE aspects of the control room modification, according to NUREG-0711, the effects of modifications on human performance should be considered in HFE program management including (1) the plan of the installation to minimize disruptions to work and (2) the coordination plan of training and procedure modifications with the HSIs modification.

Scope of operating experience review (OER)

According to KINS SRGs and NUREG-0711, the scope of OER should include the predecessor plant and systems, recognized industry HFE issues, related HSI technology, and operator interviews. To perform the more comprehensively for the control room modification, OER should focus to attain information relevant to HSIs, procedures, or training that is being modified.

Scope of task analysis

The applicant should conduct task analysis for selected representative and important tasks from all areas of operations, maintenance, test, inspection, and surveillance. Especially, the identification of the difference of the design characteristics should be considered between the existing and the modified HSIs.

Scope of human reliability analysis (HRA)

The most important review point in HRA, according to NUREG-0711, is that when modifying the HSIs, procedures, and training by the design of the new control room, the scope of HRA should consider personnel actions resulting from the modifications. Therefore, the applicant should confirm the following aspects of HRA; (1) the original HRA assumptions are valid even if the design modification be conducted, (2) the human error types and mechanism in the existing HRA are still valid, (3) the human error probabilities by operators and maintenance personnel are considered in terms of the modified human actions resulting from the modifications.

Scope of HFE verification & validation (V&V)

In relating to HFE V&V, the applicant should conduct HFE V&V with respect to the general criteria of KINS SRG and NUREG-0711 including following activities; operational condition sampling, design verification, integrated system validation, and human engineering discrepancy resolution. Among these, the KINS staff would focus on the review of integrated system validation because this activity is the process guarantying the safe operation of the plant. In this regard, the applicant should confirm the criteria satisfaction of integrated system validation in the implementation plan such as; validation test beds, validation team, scenario definition and development, performance measurement characteristics, selection, and criteria, test design, data analysis and interpretation, etc.

3. Conclusion

In this paper, we provide some important regulatory positions for the representative HFE programs, that is, review scope of HFE program management, operating experiences, task analysis, human reliability analysis, and HFE verification and validation. The applicant should consider these positions as the basis of the modification process of the control room. Furthermore, the HFE programs for the submitted SAR will be acceptable and satisfied when the applicant successfully addresses the HFE activity issues

REFERENCES

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