A Strategy for Accomplishing Human-Performance Monitoring of Constructing NPPs

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1. Introduction

Human performance monitoring(HPM) is one of the twelve elements referred to NUREG-0711 which defines human factor engineering activities for nuclear power plants[1]. The main purpose of HPM is that no significant safety degradation occurs due to changes in design, procedures, training, or staffing during the plant operation. Accordingly, the strategy for accomplishing HPM should be to maintain the acceptable level of human performance for safety operation. This paper presents a strategy to fulfill HPM effectively for constructing NPPs in Korea.
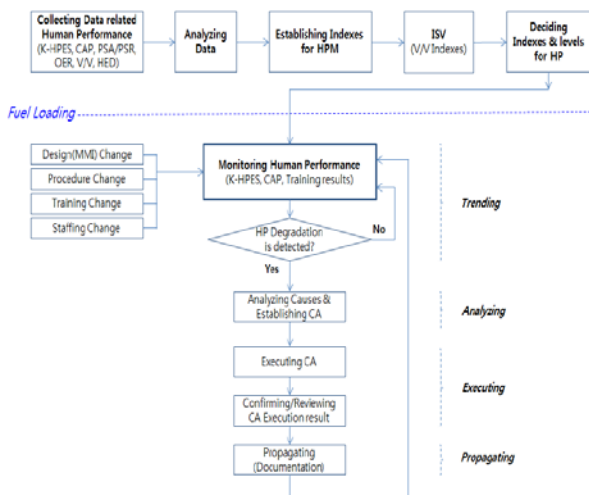
2. Methods

Fig. 1. Strategy for Human Performance Monitoring

The strategy for HPM is divided into two large parts based on the fuel loading and each part includes detailed activities as figure 1. The activities before the fuel loading are finding out indexes for HPM, determining the levels of the indexes, and validating the indexes' levels through integrated system validation(ISV). The human performance indexes' levels determined from ISV should be maintained during the plant operations for ensuring no significant safety degradation. After the fuel loading, activities for HPM are trending human performance, analyzing causes of human performance degradation, executing corrective actions and propagating the results for preventing recurrence. The HPM activities during plant operations are performed with the existing programs

such as CAP(Corrective Action Plan)[2], K-HPES(Korea-Human Performance Enhancement System)[3], and etc. in order to enhance human performance. The essential activities for monitoring human performance are as follows;

2.1 Establishing HPM indexes

Human performance(HP) is a result of various elements such as MMI, procedure, and human error prevention tools. Therefore it is not easy to define a single HPM index. Human performance might be measured by various indexes. To establish human performance indexes for important human actions, the following activities should be performed. These activities are accomplished before fuel loading.

. Reviewing HPM indexes from INPO and other nuclear power plants
. Evaluating/Analyzing HED(Human factor Engineering Deficiency) of HFE V&V, OER, CAP, K-HPES, KONIS and PSA/PSR in view of HPM
. Determining HPM Indexes
. Establishing acceptance criteria(level) of each HPM index from ISV

2.2 Trending Human Performance

The trend of HPM indexes and their acceptable levels should be monitored to prevent human performance degradation after design(MMI) change, procedure change, training change and staffing strategy change during the plant operation. Design change principally includes modifications of man-machine interface(MMI) in MCR(Main Control Room), RSR(Remote Shutdown Room), and LCS(Local Control Station). Procedure change includes operating procedures such as EOP, AOP, ARP, GOP and SOP. Also, changes of training and staffing affect human performance. TMI accident caused staffing change and became a chance to consider the importance of staffing and training in view of human performance.

In addition, the HPM trend should be also managed when events in connection with human performance occur. The information related to the events is provided in the existing programs(CAP, K-HPES, Training program and etc.).

. Managing the trends of HPM indexes periodically

. Reviewing HP if modifications(design, procedure, training or staffing) or events occur
. Analyzing data trends of each HPM index
. Determining whether HP degradation is detected

2.3 Analyzing Causes

It is essential to analyze the causes if there is a likelihood affecting human performance. The analysis may be performed through the existing programs(CAP, K-HPES) or the available information that closely approximates performance data like a simulator. After completion of analysis, corrective action plan for maintaining human performance is established.

. Analyzing root cause of HP degradation
. Establishing corrective action plans

2.4 Executing Corrective Action

According to the established corrective action plan, corrective actions for human performance are executed. There are various corrective actions such as procedure modification, training program enhancement, design change, or system upgrade. These actions are fulfilled by appropriate procedures corresponding to each corrective action. After corrective action execution, confirmation and review for the result of the corrective action is followed.

. Modifying procedures
. Enhancing training programs
. Upgrading or changing design(or systems)
. Confirming the completion of CAs

2.5 Propagating Results

Root cause affecting human performance degradation and its corrective action should be documented, managed, and propagated to prevent recurrence of the human performance deficiency. KHNP has procedures for conducting this process and built a module into CAP and K-HPES.

. Documenting the information related to HPM
. Propagating

The level of human performance has to be monitored during the operation based on safety importance. Existing programs(CAP, K-HPES, and etc.) include appropriate data for trending human performance as well as other performance indicators for the plant. This human performance monitoring strategy uses existing programs or adjusted existing programs for data collection, trending and propagating rather than developing new monitoring programs.

When actual conditions cannot be simulated, monitored, or measured, the available information that most closely approximates performance data in actual conditions should be used.

2.6 Other Activities for Human Performance

Human performance is affected by operator's experience and knowledge as well as the changes of design, procedure, training, and staffing. Human-error prevention technique is a tool to reduce and prevent human errors, the activity assessing this tool's effectiveness for operators is in charge of an important role that manages and enhances human performance.

Applying operation experiences from domestic and foreign plants is essential to maintain human performance. KHNP has KONIS(KHNP Nuclear Information System) that manages the information about operation experiences from nuclear plants all over the world including domestic plants. These operation experiences through KONIS can be also applied to constructing plants as well as operating plats for improving human performance as other domestic plants.

Safety culture is a factor that affects directly human performance. Though safety culture is an attribute of organization, it has a direct/indirect influence on human performance of members. Nuclear plants in Korea have been conducting safety culture assessment periodically and managing safety culture as an important factor affecting human performance.

3. Conclusions

Activities for HPM in constructing plants need to be divided into two large parts on the basis of the fuel loading, which could be a good strategy to accomplish HPM effectively. That is, the activities such as making HPM plan and developing its indexes are performed before the fuel loading, while the activities of maintaining acceptable HP levels are conducted after the fuel loading.

This HPM strategy includes not only maintaining the criteria of human performance established during ISV, but also improving human performance through existing activities during the plant operation. Constructing plants will also make actively use of the existing programs for enhancing human performance.

REFERENCES

[1] NRC, Human Factors Engineering Program Review Model, NUREG-0711, Rev.2, 2004
[2] KHNP, Corrective Action Program(CAP), Standard Administration Procedure-2036, Rev.1, 2014
[3] KHNP, Korea-Human Performance Enhancement System(K-HPES), Standard Administration Procedure-2035B, Rev.0