

A Study on Human Performance Monitoring for APR1400 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, and the human performance should be maintained during the plant operation. Accordingly, the activities for maintaining the acceptable level of human performance should continue until the end of the plant's operation.

In the nuclear plant construction phase, the assessment of human performance mainly focuses on main control room (MCR) operators in the process of MCR design verifications and validations (V&V). However, in the plant operation phase, the assessment of human performance can be more various than the construction phase. Because there can be several factors such as human error, operating procedure change, and design change which affect human performance. Therefore the human performance in the operation phase needs to be considered the factors including MCR operators' ability. This paper presents a method to manage HPM effectively based on APR1400 plants.

2. Methods

This study is considering the human performance in the aspects of 3 factors such as operator's human performance monitoring, human error management, and design change (including procedure change) management. KHNP has already independent programs of human error management and design change management respectively, each program has the processes to deal with issues related to human performance in its field. But the program of operator's human performance monitoring is under development. Accordingly, this study proposes an operator's human performance monitoring program, and a method to links and integrate the 3 factors for analyzing the trend of the plant's human performance.

For overall plant human performance monitoring, the results related to human performance of each independent program are collected and analyzed periodically, and the trend of plant human performance is found out. If there is degradation of human performance then corrective action is conducted through corrective action program [2]. Fig.1 shows the overall

strategy diagram of plant's human performance monitoring.

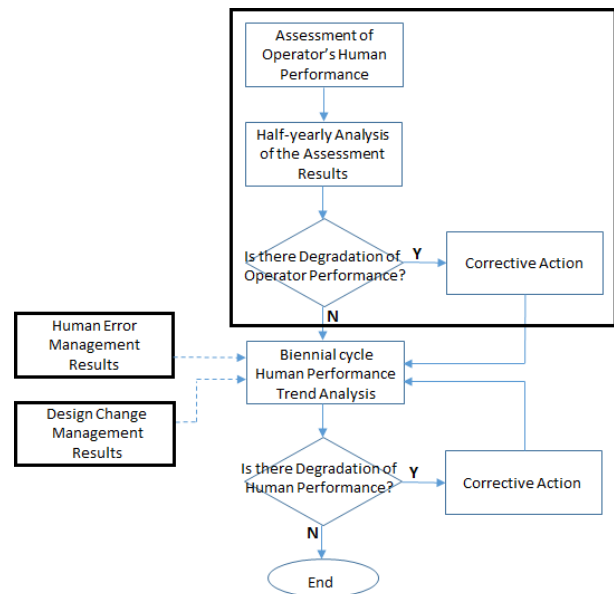


Fig. 1. Strategy for the Plant's Human Performance Monitoring on a two-year cycle.

2.1 Operator's Human Performance Monitoring

The assessment of operator's human performance is continuously conducted in regular training course. MCR operators take the training periodically at least 2 times a year to enhance their operation skill at the MCR simulator.

The assessment of operator's human performance consists of 4 elements such as critical operator action assessment, situation awareness (SART), task load (NASA-TLX), and cooperation & capability assessment. The assessment is conducted in the operating test which operators fulfill operation scenarios including COA (critical operator actions) at the MCR simulator. The assessors evaluate the operator's abilities such as COA and cooperation & capability using assessment sheets which include a valuation basis, and the operators evaluate situation awareness and task load by themselves using SART and NASA-TLX forms.

The analysis of the assessment results is conducted by statistical method and expert opinion. The statistical method includes average and dispersion for 4 elements, and operator's human performance index (HPI). The HPI is found out using statistical values and each

element weight. Equation (1) shows the calculating method of HPI. Expert opinion is as a qualitative method, human factors engineering expert or operation expert presents the level of operator's human performance and the reasons based on statistical values and HPI. After the analysis, if there is degradation of human performance then corrective actions are carried out through CAP (corrective action program).

$$HPI = \sum_{i=1}^4 ((element\ statistical\ value)_i (element\ weight)_i) \quad (1)$$

All the data of operator's human performance monitoring results are recoded and managed continuously after the assessment and the analysis. The accumulated data are used as a factor to analyze the trend of plant's human performance.

2.2 Human Error Management

When human error occurs during the plant operation, human error management is to prevent the recurrence of the human error, and to enhance plant safety and credibility through human performance improvement [3]. Human error management includes root cause analysis according to error severity, and corrective action implementation process. Corrective action is conducted through CAP. KHNP has managed the human error management program independently. The results of human error management activity are also used as a factor to analyze the trend of plant's human performance.

2.3 Design Change Management

If there is any design change issue during the plant operation, design change processes are accomplished according to the design change management program [4]. The program has a process which is to review human factors suitability in the design change. The human factors suitability review is to verify and review the design change issue in accordance with 12 elements of NUREG-0711. The results of human factors suitability review are also used as a factor to analyze the trend of plant's human performance.

2.4 Human Performance Trend Analysis

Human performance trend analysis refers to the result data of 3 factors such as operator's human performance monitoring, human error management, and design change management. Each factor has an independent program to deal with some issues in each field and the managed results of each field become useful data to understand the plant human performance trend. If there is degradation related to human performance in the process of trend analysis then the cause of the degradation is analyzed and corrective action according

to degradation severity is conducted through corrective action program (CAP).

3. Conclusions

According to NUREG-0711 (Rev2), a system or program is needed to manage human performance. KHNP has conducted various programs for human performance monitoring in the each field of the nuclear power plant. But, there was not any program for MCR operator's human performance. This study proposed a method to monitor operator's human performance and to manage the overall plant human performance.

REFERENCES

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