

A Study on Monitoring Human Performance of MCR Operators

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1. Introduction

Maintaining human performance during plant operation is very important for nuclear plant safety, and it is necessary to manage continuously human performance. NUREG-0711 refers to the importance of human performance monitoring (HPM) strategy for ensuring that no significant safety degradation occurs because of any changes that are made in the plant [1].

In the construction phase of nuclear plant, the assessment of human performance is conducted in the process of MCR (Main Control Room) design verifications and validations (V&V), and integrated system validation (ISV). Accordingly, for the plant safety operation the level of human performance in the construction phase needs to be maintained continually in the operation phase of plant. This paper presents a method to manage the human performance of MCR operators based on APR1400 plants during the plant operation.

2. Methods

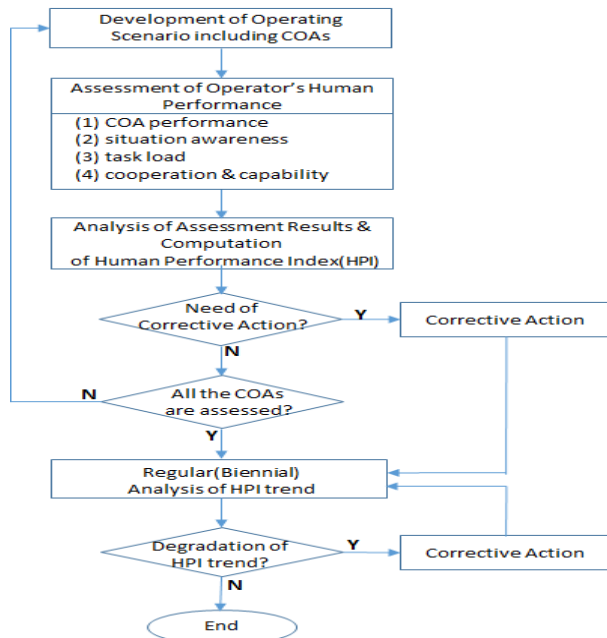


Fig. 1. Strategy for Monitoring Human Performance of MCR Operators

Managing human performance of plant personnel is needed in the areas of important activities such as

design change, procedure change, staffing change, training change, etc. This study is considering the human performance of MCR operators. Because human performance of other areas except for MCR operators is already managed through independent programs respectively.

MCR operators take the training periodically at least 2 times a year to enhance their operation skill at the MCR simulator [3]. So during the training, it is possible to assess operator's human performance. Fig 1 shows the overall strategy for monitoring operator's human performance.

2.1 Development of Operating Scenarios for Assessment

The assessment of operator's human performance is carried out in the process of the operating scenario exercise. Therefore it needs operating scenarios and the scenarios should include critical operator actions (COAs) because COA performance is one of assessment elements.

2.2 Assessment of Operator's Human Performance

The assessment for operator's human performance consists of 4 elements such as critical operator action performance, situation awareness, task load, and cooperation & capability [2]. The assessment is conducted at the MCR simulator by HFE expert or nuclear plant operation expert. The assessors evaluate the operator's abilities of COA and cooperation & capability using assessment sheets which include a valuation basis (refer to Fig 2.), and the operators evaluate situation awareness and task load by themselves using SART and NASA-TLX forms.

주요 운전직무 평가표

※ 평가 기준 : 제한시간내 필수운전원조치 사항 수행

순번	필수 운전원 조치사항	제한 시간	해당 절차서	평가 결과	불만족시 조치	후속조치사항	비고
1	· SOTR 후 RCS를 신속히 감압하여 온상 SG와 RCS 압력 ± 3.5KSC 이내 유지	12시간 이내	비상-03 (SGTR)	<input type="checkbox"/> 만족 <input type="checkbox"/> 불만족			
2	· AAC DG를 통한 최소 1개월의 C-IE 4.16kV 전원 공급	1시간	비상-07 (SBO)	<input type="checkbox"/> 만족 <input type="checkbox"/> 불만족			시뮬레이터 구현 불가
	· CH, C & D 비필수 직류 부하 차단	2시간		N/A	N/A	N/A	
3	· RCP 운전 중 또는 운전 가능한 운전모드 4에서 정지냉각유량 상실시 SFWP 이용 SG 급수 공급(SFWP 불능시 APF 이용)	150분	비상-04 (ESDE)	<input type="checkbox"/> 만족 <input type="checkbox"/> 불만족			
	· 주급수 및 보조급수계통 운전불가능시 SFWP를 이용한 SG 급수 공급	120분	비상-01 (Rx Trip)	<input type="checkbox"/> 만족 <input type="checkbox"/> 불만족			
4	· AAC DG를 통한 최소 1개월의 C-IE 4.16kV 전원 공급	1시간	비상-07 (SBO)	<input type="checkbox"/> 만족 <input type="checkbox"/> 불만족			

Fig. 2. Assessment Sheet Example for Critical Operator Actions.

2.3 Analysis of Assessment Results & Computation of Human Performance Index

The analysis of the assessment results is conducted by statistical method which includes average and dispersion for the 4 elements such as critical operator action performance, situation awareness, task load, and cooperation & capability.

HPI (Human Performance Index) is found out using the statistical values and weights of the 4 elements respectively. Equation (1) shows the calculating method of HPI. HPI is used for analyzing the trend of operator's human performance.

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

Table I: Element weight for HPI

No.	Elements	Weight
1	Critical operator action performance	0.3
2	Situation awareness	0.2
3	Task load	0.2
4	Cooperation & capability	0.3

2.4 Corrective Action

Corrective action management is important to maintain human performance. Timely and suitable corrective action helps plant safety as well as human performance. After the assessment of human performance and the analysis of HPI trend, if there is any human factor engineering deficiency or degradation of human performance, corrective actions should be implemented and managed in a timely manner. KHNP has the corrective action program (CAP) [4], which implements and manages corrective actions.

2.5 Analysis of HPI Trend

Human performance trend analysis refers to the data of HPI. Since HPI can be acquired regularly and accumulated, through HPI trend analysis, the level of human performance can be determined. Trend analysis uses the equation (2).

$$\frac{x_0 - x_1}{\sigma} > 2 \quad (2)$$

In the equation (2), parameters are x_0 (HPI average of the previous period), x_1 (HPI average of this period), and σ (standard deviation of this period). If the calculated value from equation (2) exceeds '2' (at the

95% reliability level), it means human performance degradation. In such that case, cause analysis of degradation and corrective actions should be implemented. HPI trend is monitored and analyzed regularly, which plays an important role to maintain operator's human performance.

3. Conclusions

Managing human performance continuously is very important for plant safety operation. There are various programs and activities for monitoring human performance in KHNP. This study proposed a systematical method to manage human performance of MCR operators of APR1400 plant. That is, the strategy, the assessment method and trend analysis method for operator's human performance were described.

REFERENCES

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- [3] KHNP, Training Assessment and Recording management, Standard Administration -2082B-04
- [4] KHNP, Corrective Action Program (CAP), Standard Administration Procedure-2036, Rev.1