Human performance data obtained from simulated emergencies

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1. Introduction

The importance of human performance related problems (i.e., human factors) has been demonstrated over the past decades through well publicized events. Accordingly, a lot of effort has been spent on eliciting a feasible reason why human performance deviates from a certain expected level. However, a lack of available data is one of the main obstacles in scrutinizing human performance related problems [1]. Thus, in this study, human performance data under simulated emergencies have been extracted using a full scope simulator located in the reference NPP.

2. Data collection and analysis

The main purpose of this study is to provide plant-specific and domain-specific human performance data that can be used to premeditate human performance related problems under emergencies. To accomplish this goal, over 100 audio-visual records that were collected from re-training sessions for licensed MCR operators have been analyzed by the time-line and protocol analysis techniques.

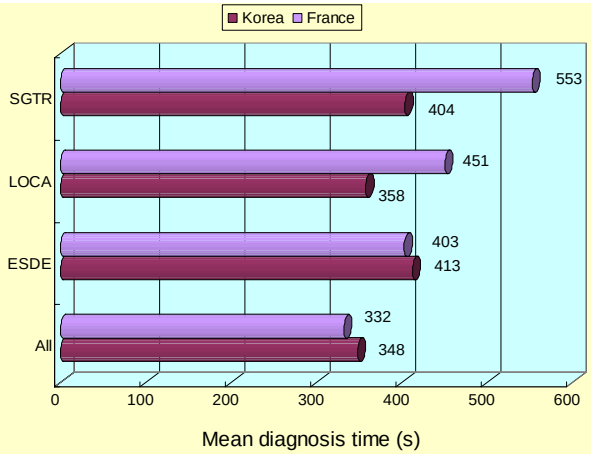
As a result, many kinds of useful information that could have a crucial role in scrutinizing human performance related problems have been extracted. These raw data were stored in Operators Performance for Reliability Analysis (OPERA) database [2]. The following shows typical operators' performance data that are available from OPERA database.

- Event diagnosis time data
- Step performance time data
- Task completion time data

3. The meaning of the extracted performance data

In securing operators' performance data under emergencies, the use of simulators has been regarded as one of the most effort-effective ways in scrutinizing human performance related problems. In other words, the simulator is a very useful tool for understanding human behaviors that can result in human performance related problems, since it allows researchers to systematically observe human behaviors in coping with a hypothetical accident. However, several discrepancies from a real situation (such as the level of stress or fidelity, etc.) could give rise to dispute the use of operators' performance data extracted from the simulator. Thus, to unravel this concern, it is meaningful to compare operators' performance data obtained from this study those from other researches and/or studies. In other words, if operators' performance data of this study are congruent with other performance data that were extracted from diverse simulation conditions or from real accidents, then it is strongly anticipated that the collected data could be properly used to scrutinize human performance related problems.

Firstly, operators' performance data of simulation studies that were conducted in France were compared with those of this study. Fig. 1 shows the comparison results for event diagnosis time data [2, 3].



< Figure 1. Comparing event diagnosis time data >

As shown in Fig. 1, except steam generator tube rupture (SGTR), operators' performance data of France seem to be reasonably comparable to those of this study (i.e., Korea). For example, on average, French operators spent 451 seconds in diagnosing the occurrence of loss of coolant accident (LOCA), while Korean operators spent 358 seconds to accomplish it. In the case of excess steam demand event (ESDE), operators' performance data were more homogeneous because both French and Korean operators spent a very similar time to diagnose what event had occurred. Based on the results of these comparisons, it is positive to expect that operators' performance data of

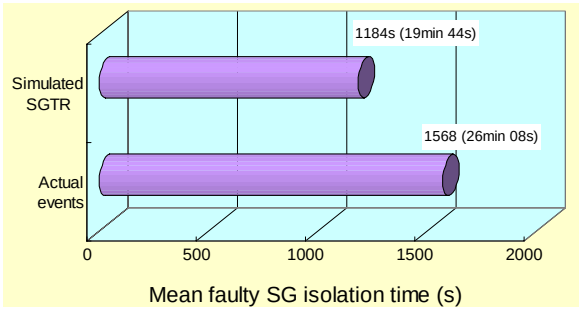
this study are meaningful for scrutinizing human performance related problems. This expectation can become more conclusive if we compare operators' performance data that were obtained from simulated emergencies with those from real events.

Although it is very difficult (or sometimes impossible) to acquire human performance data under a real situation, some operators' performance data are available for when SGTR had actually occurred [4]. Table 1 shows a brief summary of operators' response time data in isolating a faulty steam generator (SG).

< Table 1. Operators' response time when SGTR has actually occurred >

Plant	Year	Leak rate	Faulty SG isolation
Point Beach 1	1975	470 LPM	58min
Surry 2	1976	1250 LPM	18min
Prairie Is. 1	1979	1270 LPM	27min
Ginna	1982	2900 LPM	15min
North Anna 1	1987	2410 LPM	18min
McGuire 1	1989	1900 LPM	11min
Mihama 2	1991	2600 LPM	22min
Fort Calhourn	1984	425 LPM	40min
			Mean: 26min 08s

As can be seen in Table 1, operators isolated a faulty SG within about 26 minutes (in average) after SGTR has initiated. Interestingly, this response time can be compared with the mean value of the task completion time of "Identifying and isolating a faulty SG", which has been measured by 19min. 44s (See Fig. 2).



< Figure 2. Comparing operators' response time for "faulty SG isolation" task >

This strongly alludes to the fact that operators' performance data obtained from simulated emergencies can be used as an useful yardstick for estimating or understanding their performance under real situations.

4. Conclusion

In this study, records of re-training sessions for licensed MCR operators have been collected. Based on these records, detailed analyses have been conducted in order to extract operators' performance data under simulated emergencies. As a result, invaluable operators' performance data that seem to be meaningful in scrutinizing human performance related problems have been secured, and they are stored in OPERA database.

Although it is still not easy to conjecture operators' behaviors under a real situation on the basis of those under a simulated situation. However, it was found that operators' performance data of this study are congruent with performance data that were extracted from diverse simulation conditions as well as from real accidents. Thus, it is strongly believed that operators' performance data that are available from OPERA database will provide a concrete foundation for scrutinizing the changes of human performance under emergencies.

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