Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

Necessities of the Development of a Database for the Communications Between Nuclear Power Plant Operators in Simulated Emergency Situations

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1. Introduction

Communications among main control room (MCR) operators is an important factor for understanding how and how well MCR operators manage abnormal or emergency situations in nuclear power plants (NPPs). As mentioned by many researchers, the performance of MCR operators in emergency situations in NPPs is strongly affected by not only the cognitive process of each operator, but also by communications and collaboration among operators.

Despite of the importance of correct communications among NPP operators, the possibilities of human errors in communications have not received much attention. A representative example for the lack of interests in communication-related problems is the lack of considering communication-related human errors in human reliability analysis (HRA) methods. HRA methods are used, in general, to provide human error probabilities to probabilistic safety assessment (PSA) of NPPs. In THERP (Technique for Human Error Rate Prediction) [1], which was developed by Swain and Guttmann and currently is one of the most widely used HRA method, the human errors in communications are not directly considered. The human error probability (HEP) and error factor (EF) data that we could find as the most related ones to communication-related human errors are the estimated probabilities of errors in recalling oral instruction items which are not written down, which is shown in Table 1. But, it is obvious that the failure in recalling oral instruction items and misunderstanding oral instruction items are different error types.

Number of oral instruction items or perceptual units	Failure probability to recall item "N," order of recall not important	
	HEP	EF
1	0.001	3
2	0.003	3
3	0.01	3
4	0.03	5
5	0.1	5

Table 1. Estimated probabilities of errors in recalling oral instruction items not written down (from Table 15-1 of THERP handbook [1])

The purpose of this paper is to emphasize the importance of communication-related problems in the operation of NPPs, and to assert the necessities of developing a database which includes the verbal communications of NPP MCR operators during simulated abnormal or emergency situations.

2. Necessities of Communication Database

2.1 Results from Large-Scale Investigations on Human Errors in NPPs

Strater [2] investigated 232 operational events with human errors in German NPPs and found that roughly 10% of the operational events with human errors include communication problems as being the major important contributor to the event. It is also found that the factors related to the operational side such as workload and situational pressure influence the communication process and communication failures also have an impact on the operational side. As mentioned by Strater [2], the investigation results suggest that errors in communication and errors on the operational side cannot be treated independently from each other.

Hirotsu et al.[3] investigated 193 operational events with human errors among a total of 885 operational events occurring at Japanese NPPs and found that about 13% of the operational events with human errors are caused by problems in written communications and about 5 % of the operational events with human errors are caused by problems in verbal communications. In the investigation, the written communication problem was rank as the third most frequently observed causal factor while the verbal communication problem was ranked as the eighth most frequently observed causal factor among 12 causal factors.

From the two large-scale investigations on the operational events with human errors, it becomes obvious that the communication-related problems can be a significant contributor or causal factor that should be considered in the safety analysis of NPPs.

2.2 Need of Communication-Related Human Error Data in HAMMBIT

The method developed by Kim and Seong [4] for the quantitative safety assessment of nuclear instrumentation and control (I&C) systems including human operators was recently named as HAMMBIT

(Human Action Modeling Method based on Bayesian inference and Information Theory). As the name represents, HAMMBIT is developed as an analytic method for analyzing human behavior based on Bayesian inference and the information theory.

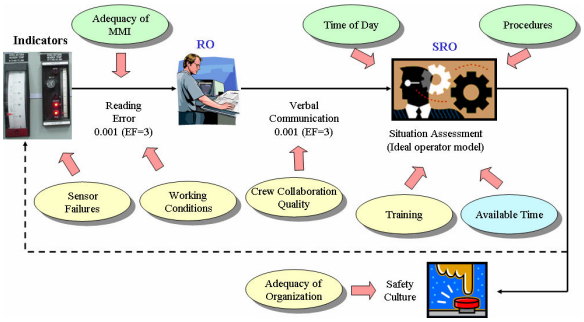

Figure 1. A brief summary of considered context factors and their assumed effects on the process of situation assessment of nuclear power plant operators (from Kim and Seong [3]).

In HAMMBIT, the data for the human error probability of a verbal communication between MCR operators is necessary. Currently, the error probability in a verbal communication between MCR operators is assumed to be 0.001 (with the error factor 3), as shown in Figure 1. For the advanced HRA methods such as HAMMBIT produce more reliable results, it is necessary for the data used in those advanced HRA methods to be based on experimental results. This can be another reason that we need to gather experimental data and develop a database for the communications between MCR operators, especially in emergency situations.

2.3 Reason for Gathering Communication Data in Simulated Situations

As Fukuda and Strater [5] mentioned, any human factors approach has limitations for investigating human factors aspects and communication problems. In incident reports, communication problems can be identified during abnormal or emergency situations, but detailed communication logs are not generally available. Considering the fact that abnormal or emergency situations do not frequently occur, observational field studies do not seem to be an efficient way due to small chances of observing MCR operators behavior in abnormal or emergency situations. Even though experimental studies with simulators can provide many experimental data, the transferability of the data gathered in simulated abnormal or emergency situations to real abnormal or emergency situations is usually brought into question, due to the lack of real threats MCR operators may be exposed in real situations.

But, if it becomes obvious that we will never be able to gather sufficient data for the communications of MCR operators in real emergency situations, the use of the communication data during simulated abnormal or emergency situations as the basis for the estimating the human error parameters related to communication problems in real abnormal or emergency situations can make sense. For this reason, the development of a database for the communications between nuclear power plant operators in simulated abnormal or emergency situations is asserted in this paper.

3. Conclusion

The importance of correct communication between MCR operators in NPPs have been mentioned by many researchers, especially in abnormal and emergency situations. But, the possibilities of communication-related problems have not been received a lot of attention in the aspect of quantitative analysis, an example of which is the lack of considering communication-related human errors in HRA used in the framework of PSA. Literature surveys on the investigations on the operational events with human errors in NPPs and a recently developed method for quantitative safety assessment of nuclear I&C systems including human operators gave us the conclusion that communication-related human errors are significant and we need data that can be used for quantitative analysis. Considering the fact that we cannot gather human error data related to communication problems during real abnormal or emergency situations, it is concluded that we need to develop a database for the communications between NPP MCR operators in simulated abnormal or emergency situations.

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