

A Method for Analyzing the Communications among Nuclear Power Plant Operators in Emergency Situations

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1. Introduction

Communications among MCR operators is an important factor for understanding how and how well MCR operators manage abnormal situations in NPPs. As mentioned by Ujita et al.[1,2], the performance of MCR operators in emergency situations in NPPs is strongly affected by not only the cognitive process for each operator, but also by communications and collaboration among operators. Many researches have been conducted to find out the relation between the communication of human operators and the performance of them. But, it seems that few researches have been conducted on in what way the communication among MCR operators should be performed to enhance the performance of them.

In this paper, we propose an analysis method for evaluating the quality of communications among MCR operators in nuclear power plants (NPPs).

2. The Proposed Method

2.1 Background

As mentioned above, few researches have been conducted on the development of measures for communication quality. Intuitively speaking, one of the most important aspects of high quality communication will be less chance of confusion or misunderstanding. In this sense, we first focused on the completeness of sentences.

2.2 Assumption of Top-Down Type Communication

In emergency situations in NPPs, the senior reactor operator (SRO) and other operators have to manage the emergency situations by following the steps in the emergency operation procedures (EOPs). In such situations, most communications are commenced by the SRO, which are the request of necessary information to be used to make decisions specified in the EOPs. Normally other operators receive request of information or command of control actions and respond correspondingly. In this sense, the communications in MCRs of NPPs in emergency situations can be considered to be the top-down type among the four communication types defined in Ujita et al.[1]. In the development of the proposed method, this type of communications is basically assumed.

2.3 Three Components of a Sentence

After analyzing various communication logs of MCR operators' training in simulated emergency situations, three important components of sentences in the communication among MCR operators were identified, which are:

- (1) Subject : the operator who have to take necessary actions
- (2) Object : the system or component in the plant
- (3) Verb : the property or operational state of the object

For example, when the SRO in a shift asks the reactor operator about the value and the trend of the reactor coolant system (RCS) average temperature (T_{avg}), RO becomes the subject, the RCS T_{avg} becomes the object, and the value and the trend become the verb.

2.4 Three Categories for Evaluating How Clearly Each Component is Expressed

For the evaluation of how well each component of a sentence is clearly expressed, we defined the following three categories:

- (1) A: clearly expressed or explicitly mentioned
- (2) B: ambiguously expressed
- (3) C: not expressed / possible to confusion or misunderstand

For example, consider a situation when an SRO asks other operators "what is the RCS T_{avg} value?" In this situation, even though the subject is not clearly expressed in the sentence, the SRO and other operators would expect that the RO will answer the question. Therefore, the subject in the sentence is ambiguously expressed and therefore, the subject in the sentence is evaluated to belong to the category B. The object (RCS T_{avg}) and the verb (the value) are clearly expressed in the sentence, and therefore they are evaluated to belong to the category A. Thus, the sentence is evaluated to be BAA.

3. An Example Application

As an example application, we analyzed the communication logs of two MCR operator teams experiencing two simulated emergency situations,

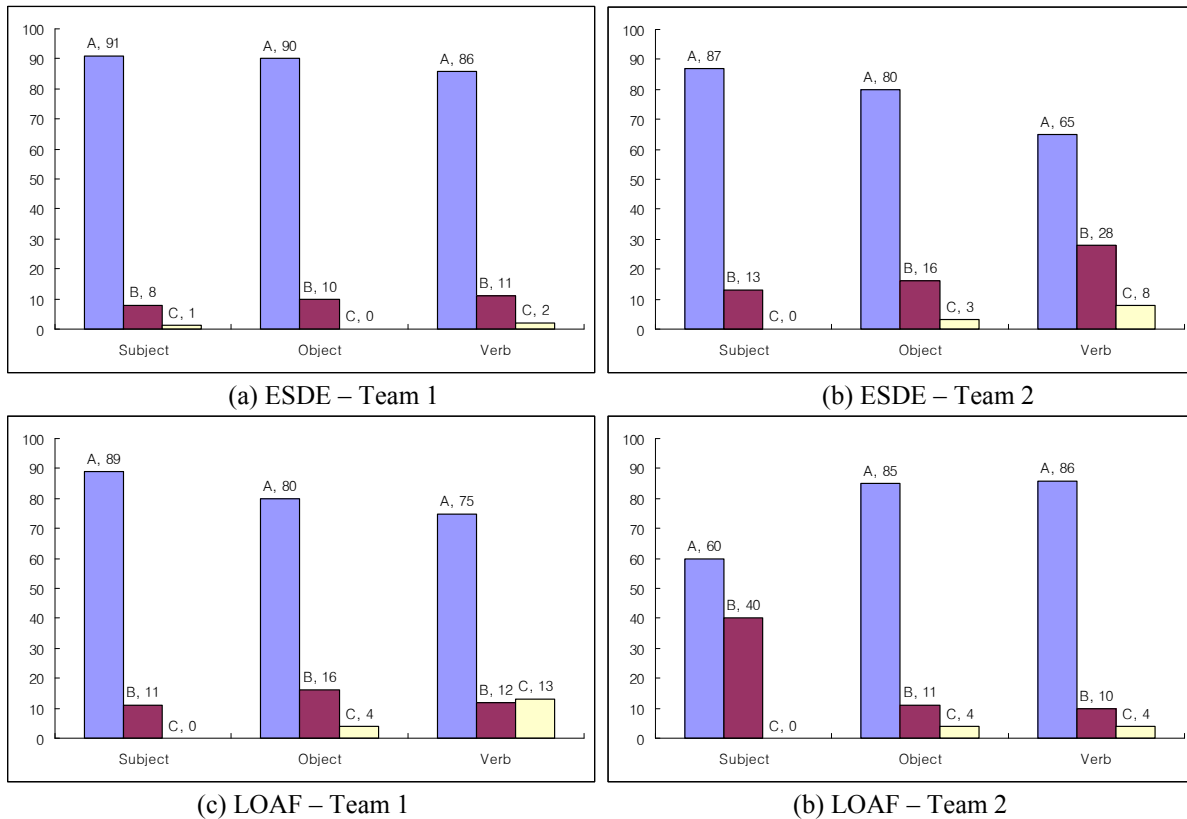


Figure 1 Category ratios of subjects, objects, and verbs

excess steam dump event (ESDE) and loss of all feedwater (LOAF). Each communication log contains the conversations among the operators for about 25 to 30 minutes after the reactor trip. The steps in EOPs become the basis for the division of the basic elements of a conversation. Repeated request of information or conversations for simple confirmation are included in the original segment.

Figure 1 shows the category ratios of subjects, objects, and verbs of the two teams in the two simulated emergency situations. It can be seen from Figure 1 that the two teams in general clearly specify the subjects, objects, and verbs in their conversations. When we compare the two teams, sentence completeness of Team 1 is somewhat higher than that of Team 2. In case of Team 2, the SRO often omitted to specify whether he requested the value of a parameter or the trend of the parameter, even though operators give proper information to the SRO based on their knowledge, experience, and the ongoing situation. Subjective evaluations on the two teams gave the impression that the performance of Team 1 is better than that of Team 2.

4. Conclusions

To evaluate the quality of communications among MCR operators in NPPs, we developed a method for analyzing the communications of NPP operators in emergency situations. In the proposed method, the

completeness of a sentence is defined as how clearly the three important components of a sentence, which are the subject, object, and verb, are expressed in the sentence. Each of the subject, object, and verb is evaluated to be one of the three categories, which are A (clearly expressed), B (ambiguously expressed), and C (not expressed / possible to confuse). As an example, the sentence completeness method is applied to the communication logs of two teams under two simulated emergency situations. It was found that MCR operators in general clearly specify the subjects, objects, and verbs in their conversations. From the comparison of sentence completeness and subjective evaluation results, it is expected that the proposed method can be used to evaluate and improve the quality of communications among MCR operators.

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