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A Study on Large Display Panel Design for the Countermeasures against Team Errors within the Main Control Room of APR-1400

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1. Introduction

In nuclear industry, human errors have been recently highlighted again after the recognition of the importance of the personal aspect as well as the system aspect in Fukushima accident [1]. The system side of the human errors still reveals the rooms to improve further not only the working environment, but also the management such as policy, personnel organization, reward and punishment, and education and training system, etc. The personal aspect of human errors has been mainly overcome by virtue of the education and training. However, in the system aspect, the education and training system needs to be reconsidered for more effective reduction of human errors affected from various systems hazards. Traditionally the education and training systems are mainly not focused on team skills such as communication, situational awareness, and coordination, etc. but individual knowledge, skill, and attitude. However, the team factor is one of the crucial issues to reduce the human errors in most industries [2].

In this study, we identify the emerging types of team errors, especially, in digitalized control room of nuclear power plants such as the APR-1400 main control room. Most works in nuclear industry are to be performed by a team of more than two persons. Even though the individual errors can be detected and recovered by the qualified others and/or the well trained team, it is rather seldom that the errors by team could be easily detected and properly recovered by the team itself. Note that the team is defined as two or more people who are appropriately interacting with each other, and the team is a dependent aggregate, which accomplishes a valuable goal [3]. Team error is one of the typical organizational errors that may occur during performing operations in nuclear power plants. In other words, team error is defined as human error made in team process [3]. Organizational errors sometimes increase the likelihood of operator errors through the active failure pathway and, at the same time, enhance the possibility of adverse outcomes through defensive weaknesses [4].

We incorporate the crew resource management as a representative approach to deal with the team factors of the human errors. We suggest a set of crew resource management training procedures under the unsafe environments where human errors can have devastating effects. Additionally, contingency guides and supporting tools are proposed for recovering the team errors in control room of nuclear power plants.

Especially, in this conference, as one of the supporting tools against human errors in digitalized control room, we'll introduce the follow four types of alternative interfaces as barriers against team errors in the large display panel of the APR-1400 main control room.

- Pointing and marking interface
- Numeric directing interface
- Control state popup interface
- Control history popup interface

The large display panel provides overview information to main control room operators. To only provide the overview function, the large display panel was designed just passive display. However, passive display is likely to reduce operators' attention during normal operational phase generally. The mentioned four alternatives as active functions will support them in terms of focused or divided attention for more effective team performance in main control room.

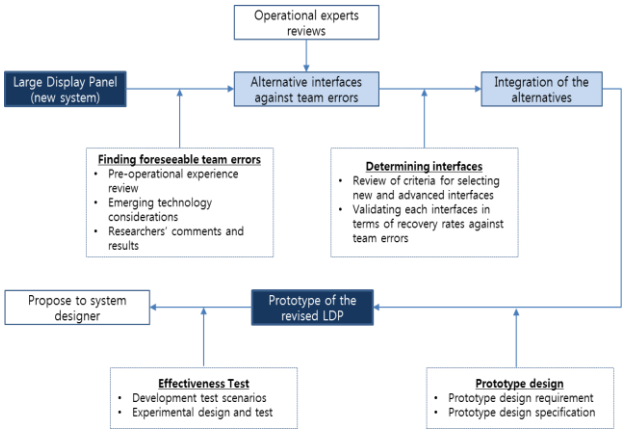

Figure 1. Process for developing a revised LDP

Firstly the pointing and marking interface provides more clear communication between shift supervisor and reactor operator, turbine operator or electric operator. The pointing and marking interface will be realized by using the air writing technology. Secondly, the numeric directing interface provides more clearly dynamic directions of each operational variable such as temperature, pressure, flow etc. Only digitalized numeric information provides the current quantity of each variable so that operators are likely to miss the

directions and trend of the variables. Thirdly, the control state popup interface provide supports operators to share more clear situational awareness among them. For example, when reactor operator is controlling a safety valve, the control state popup will be display on the large display panel concurrently to share the control situation with other operators. Lastly, the control history popup interface provides operators with context information whether the intended action is correct or not. The history popup is provided only by operators' options using mouth input device.

2. Methods and Results

The process for developing a revised large display panel described in Figure 1. We reviewed pre-operational experience through interviewing current operators who are working for the KHNP in Kori site. Also we reviewed literatures relevant to emerging technology in advanced control room. To find foreseeable team errors in a condition of using large display panel in main control room, we analyzed team error mechanism with operational experts using the team error process model [3] of Figure 2.

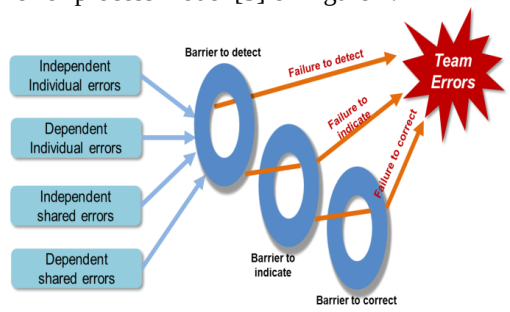

Figure 2. Team error process model by Sasou & Reason

We also analyzed feasible scenarios related with team errors in a condition of using the large display panel. The analysis was performed based on the team error process model as an example of Figure 3.

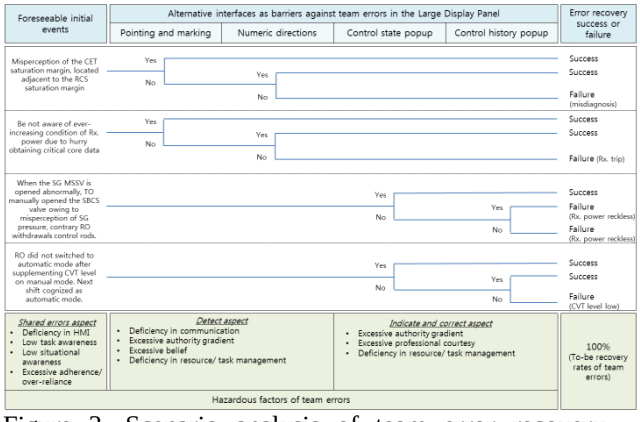

Figure 3. Scenario analysis of team error recovery success or failure

3. Conclusions

We are on the way to develop alternative interfaces against team error in a condition of using large display panel in main control room of APR-1400. The APR-1400 is a new plant adapted to advanced digital technology in main control room. The large display panel is a representative feature of digitalized control room. As a group-view display, the large display panel provides plant overview to the operators. However, in terms of team performance and team errors, the large display panel is on a discussion board still because the large display panel was designed just a concept of passive display. In this study, we will propose revised large display panel which is integrated with several alternative interfaces against feasible team errors. We are on the phase of analyzing foreseeable team errors and feasible scenarios. After validating the effectiveness through the experimental way, we will propose a revised large display panel. Of cause, the adoption and application are the other business.

Acknowledgements

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