Improvement on Procedure Directory of APR1400 Computerized Procedure System

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1. Introduction

Computer based procedures are being applied to digitalized nuclear power plants (NPPs) in the world [1]. The Computerized Procedure System (CPS) of Advanced Power Reactor 1400 had applied at Shin-Kori unit 3 in 2012 and recently Shin Kori unit 3 has achieved one cycle trouble free using CPS. This CPS has been improved continually since first applied at Shin Kori unit 3 and many functions and features have been added to CPS of Shin Hanul units 1&2 and Shin Kori units 5&6 [2-3]. Korea Hydro Nuclear Power Central Research Institute (KHNP CRI) had found the improvements on CPS by verification & validation of CPS own process, interviewing operators and reviewing Operating Experience Review (OER) [4].

In this paper, we describe the layout and improvements on 'Procedure Directory' of CPS. The procedure directory is one of important functions and operators can open the Computerized Procedures (CP) through the procedure directory.

2. User Interface of Procedure Directory

The procedure directory is the dialog to search and open the CP. The design of procedure directory should be compact because it has much information of all CP. The procedure directory consists of total 7 detailed bar & panes in Figure 1.

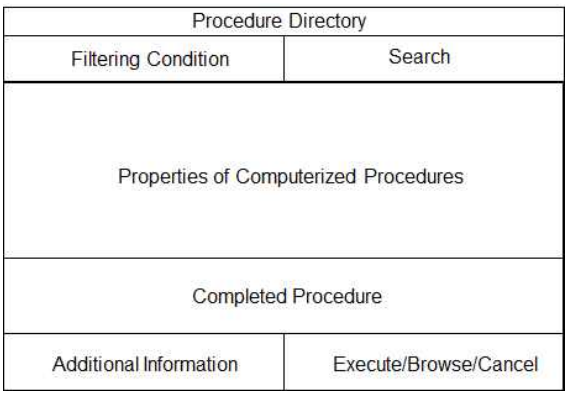

Fig. 1. The user interface of procedure directory of CPS

In CPS of Shin Kori units 5&6, completed procedure pane and additional information panes have been added.

3. Features and Improvements

The procedure directory of Shin Kori 5&6 has several features compared to previous reference CPS. The main features are as follows:

- Removal of less used information
- Optimization to lending states of CP considering task analysis
- Enhancement to the management of completed procedure
- Minimization of intervention to operator
- Improvement on updating speed of the procedure directory
- Addition to important information

3.1. Removal of less used information

Procedure information is optimized in limited size of procedure directory. For example, some conditions of filtering have been removed such as train, date, priority and etc.

3.2. Optimization to lending states of CP

The CPS provides the lending states of CP such as 'New', 'Desk', 'Logged' and 'Completed'. In Shin Kori units 5&6, if 'Logged' state is created, operator cannot open the CP in 'New' state. The amount of procedure list has decreased and the potential human error has been removed through this optimization. Figure 2 shows lending states of CP [5].

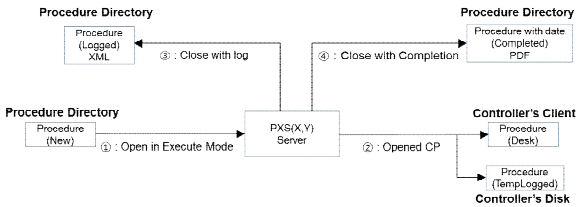

Fig. 2. Lending states of CP

3.3. Enhancement to the management of completed procedure

The management of the completed procedures is important for the maintenance of the plant. In previous reference CPS, operator can check only one completed procedure, if he or she needs to check the previous completed procedure then he or she cannot directly

check the CP and only can check the CP at the office after gathering the CP from CPS servers. In Shin-Kori units 5&6, operators can access the previous whole completed procedures on procedure directory because the format of completed procedure has been changed into portable document format in Figure 1.

Completed procedures are automatically enrolled with time stamp in completed procedure pane on procedure directory when the procedure is completed.

3.4. Minimization of intervention to operators

The CPS provides the 'Browse' and 'Execute' selection dialog when an operator open the CP in previous CPS. This dialog has been removed through the 'Execute Open' and 'Browse Open' buttons. This minimization of intervention to operator can help operators execute the CP fast and precisely.

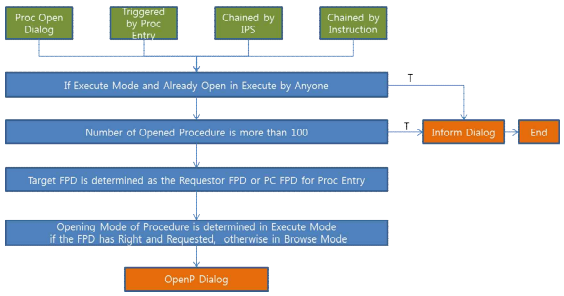

Fig. 3. Procedure Open Flow Chart

3.5. Improvement on updating speed of the procedure directory

The number of computerized procedure in nuclear power plant is about 9,000 ~ 10,000. Because there are corresponding procedures for each alarm ID, operators can directly access the ARP through alarm ID on alarm list. But many procedures might be burden of network and process of CPS execution. The information of procedure directory in CPS server is zipped and sent to all clients to overcome this drawback. This improvement decreases the 20~30% time to open the procedure directory.

3.6. Addition to important information

The property of CP has been added to procedure information column such as crew, browser, executer, controller (Primary/Secondary) and etc. This information has been collected through interviewing operators and V&V debriefing.

4. Conclusions

This paper describes the features and improvements on procedure directory of CPS in Shin-Kori units 5&6. These improvements can help operators perform the computerized procedure efficiently. These features and improvements remove the human error and enhance the understating of procedure. These improvements can be applied to CPS after human factors engineering verification and validation.

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