Improved Design of Crew Operation in Computerized Procedure System of APR1400

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1. Introduction

The Computerized Procedure System (CPS) is one of the Man Machine Interface (MMI) resources of the Advanced Power Reactor 1400 (APR1400). The CPS is a computerized operator support system that enables operating crews to execute procedures in an accurate and fast manner [1-4].

The operators perform the paper-based procedures in analog-based conventional main control room (MCR) depending on only communications between operators except a procedure controller such as a Shift Supervisor (SS), however in digital-based MCR the operators can confirm the procedures simultaneously in own console when the procedure controller of computerized procedure (CP) opens the CP. The synchronization and asynchronization function between procedure controller and other operators has to be considered to support the function of crew operation. This paper suggests the improved design of crew operation in computerized procedure system of APR1400.

2. Improved Design of Crew Operation in CPS

In this section some of the characteristics to improve the design of crew operation of CPS are described. The characteristics include Procedure Open, Starting Positon of CP, synchronization and asynchronization, User Interface.

2.1 Procedure Open

When the crew procedure is opened by procedure directory or others, the procedure is only opened at step implementer's CPS client in current design of CPS. The Procedure writers, therefore, have to consider the step implementer of CP when writing CPs and have to insert 'crew' into step implementer to open CP at every operator's CPS client. But the crew CPs will be opened at every operator's CPS client reflecting operation strategy in MCR to reduce a burden of procedure writing when procedure controller opens the crew CP in execute mode.

2.2 Starting Position of CP

When a CP opens, the first step in the gross step starts except steps without any action instructions. This way can support fast performing procedures. But the first step of the first gross step of CP starts in improved design regardless of the type of instruction when the CP opens. It can improve communications among operators in MCR by assigning operator's task. E.g. SS announces the start of CP, confirm the purpose of procedure and assign the operator's task like as Shift Technical Advisor (STA) can perform 'safety function status check' gross step.

2.3 Synchronization and Asynchronization

The Sync/Async function is complicated design concept of current CPS. A simplified Sync/Async function is suggested to solve this problem. The current Sync/Async button is enabled when the gross step controller is different from operators' CPS client. E.g. The Sync/Async button is enabled if CPS client is reactor operator and the gross step controller is other operators except RO. It means that Sync/Async function operates in gross step level. But this paper suggests that the Sync/Async function operates in procedure level. The operator does not need to navigate the gross step that he/she wants to synchronize. The CPS provides selected operator's CPS display automatically. First the CPS checks the gross step controller of the CP. If the gross step controller is only one operator then any gross step list below fig. 1 is not provided when the operator selects the Sync button. But if the gross step controller is two or more operators then the menu item (gross step controller list) below fig. 2 is provided when operator selects the Sync. This concept helps operators perform the crew operation in CPS more efficiently.
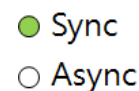

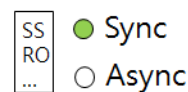Fig. 1. The Sync/Async button in only one gross step controller.

Fig. 2. The Sync/Async button in two or more gross step controllers

2.4 User Interface

The crew procedure cannot be distinguished from other normal procedure in current CPS. The identical crew procedures are needed to help operator distinguish the crew procedure on desk pane because crew procedures are opened automatically by procedure controller. Fig. 3. shows the concept of crew procedure link on desk pane.

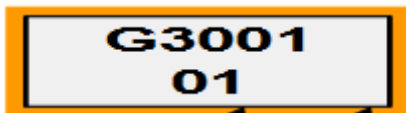Fig. 3. The user interface of crew procedure link on desk pane.

Fig. 4. The user interface of normal procedure link on desk pane.

3. Conclusions

There are improvements of crew operations in CPS below table I.

Table I: Problem Description

	Current	Improved
Procedure Open	By Implementer	All operators
Starting Position	The first step of CP with action instruction	The first step of the first gross step without action instruction.
Sync Async	Gross step level	Procedure Level
User Interface	None	Distinguished

This paper suggests the improved design of APR1400 CPS. These improvements can help operators perform the crew procedures more efficiently. And they reduce a burden of communication and misunderstanding of computerized procedures. These improvements can be applied to CPS after human factors engineering verification and validation.

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