Alternative to Online Hardcopy of Computerized Procedure System

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1. Introduction

The Computerized Procedure System (CPS) is the main feature of the Man Machine Interface (MMI) resources of the Advanced Power Reactor 1400 (APR1400) [1-2]. CPS has much strength when operators execute the computerized procedures comparing to the paper based procedure. It has many functions such as a support for procedure flow between various procedure elements (instructions, steps, procedures, etc.), task information (step support display, plant objects, parameters, etc.), the interface between CPS and Distributed Control System (DCS). The CPS has the backup hardcopy which is paper-based and the online hardcopy in case of CPS failure. This paper describes the function of online-hardcopy of CPS and introduces negative effects about online-hardcopy. Finally, alternative methods to online hardcopy are suggested [3].

2. Online Hardcopy of CPS

CPS has the function to print execution history of Computerized Procedures (CPs) when operators execute CPs by clicking 'complete', 'postpone', 're-execute' button on step control pane Fig. 1. shows typical display of online hardcopy.
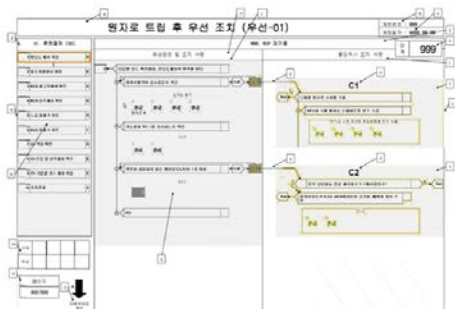

Fig. 1. The typical display of online hardcopy

These printed online hardcopies cannot be discarded because of other usage of online hardcopy. This online hardcopy is used to apply human error prevention method into CPS in Shin-Kori 3&4 units such as concurrent/independent verification. And it is also used to record shift change. Fig. 2. shows the example of concurrent verification in Shin-Kori 3&4 units.
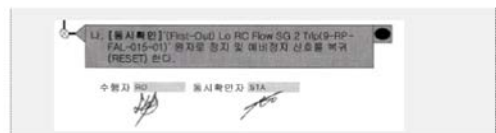

Fig. 2. The example of concurrent verification

CPS records the execution history of CPs automatically [1]. Actually except for CPS failure, online hardcopy is not needed. This makes another work to keep the online hard copy over some periods and to manage a print. And also the amount of printed online hard copy is more than the conventional paper based procedure relatively because it has task information such DCS links, pump, valve etc. as well as instructions. When an operator completes the step, one or more online hardcopies can be printed

3. Requirements on CPS Failure

The designer shall consider CPS failure because operator has to control continuously even if CPS fails. The related requirements to CPS failure are described in NUREG-0700 'Human-System Interface Design Review Guidelines' [4].

3.1 Backup Hardcopy Availability

The backup hardcopy of Computerized Procedure (CP) is created by CPS Editing System (ES) after the procedure verification and validation (V&V) process of Plant. The printed backup hardcopies are provided in Main Control Room (MCR). Fig. 3. shows the sample of backup hardcopy.
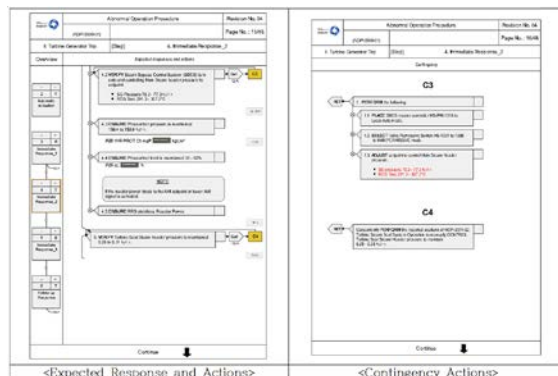

Fig. 3. The sample of the backup hardcopy of CP

3.2 Consistency of Backup Hardcopy and CBP

The format of backup hardcopy is very different from the conventional paper based procedure. It is similar to the format of computerized procedure and also has overview pane, step detail pane and its header. The operator can record the result of instruction on evaluation box of backup hard copy same as in computerized procedure.

3.3 Support for the Transfer to Backup Hardcopy

When CPS fails, operators have to keep controlling the nuclear power plant using a backup hardcopy. Therefore, it is important to provide the support for transfer computerized procedure to backup hardcopy. In APR1400 CPS provides the various supports such as execution history of CP, shift diary of IPS, online hardcopy.

4. Alternative Methods to Online Hardcopy

To remove the online hardcopy of CPS, all of CPS failures are considered. Table I describes the type of CPS failure.

Table I: Type of CPS Failure

	Type of CPS failure
4.1	Client failure
4.2	Server failure
4.3	Network failure
4.4	All workstations failure

4.1 Client Failure

An operator easily runs the other CPS client of own workstation on fixed frame of IPS if the only each client fails. If all clients fail, an operator can run again the CPS client at this time CPS client automatically load the previous computerized procedure with execution history because CPS servers are stable.

4.2 Server Failure

In case of primary server(X) failure, the backup server(Y) is promptly transferred and the related popup is provided to operators. If all servers fail, operators check the current executing CPs and keep controlling the power plant using backup hardcopy because CPS client has the execution history even if all CPS servers fail.

4.3 Network Failure

Network failure is totally same as the server failure. And all actions are same.

4.4 All Workstations Failure

This case very rarely can occur because all the hardware such as monitor cannot be unable to use caused by common cause. But if this case occurs, first operators share situation awareness such as currently executing steps, previously executed or postponed steps like key step of CPS. After sharing information, operators operate plant using backup hardcopies. In this case, online hardcopy can be needed to check the previous execution records.

5. Conclusions

This paper explained online hardcopy of CPS and burden to manage online hardcopy. Table II shows the suggested alternative methods.

Table II: Alternative methods

	Alternative Method	Online Hardcopy
4.1	Run other clients	X
4.2	Execution history of client & Backup Hardcopy	X
4.3	Execution history of client & Backup Hardcopy	X
4.4	Situation Awareness & Backup Hardcopy	△

Operators can operate a power plant using backup hardcopy and other alternative supports after removal of online hardcopy. The online hard copy, however, can be considered in emergency operating procedure(s) in case 4.4. To apply these alternatives into CPS, first CPS has to have functions related to human error prevention method for removing the unnecessary workload and V&V are performed.

REFERENCES

[1] System Specification for Computerized Procedure System in Shin-Kori 3&4 (DDS1), Korea Hydro & Nuclear Power, 2009
[2] System Specification for Computerized Procedure System in Shin-Kori 5&6 (DDS1), Korea Hydro & Nuclear Power, 2015
[3] 2017-50003339-단-TC "The removal of online hardcopy in CPS"
[4] NUREG-0700 "Human-System Interface Design Review Guidelines" Rev.2