Design for Procedure Editor to integrate procedure administration tasks in nuclear power plants

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1. Introduction

Korean procedures of nuclear power plants have been computerized since SKN34. The computerized procedures cover types of EOP, AOP, ARP, and GOP. The other procedures were still based on paper.

Whenever procedures are revised periodically, they are checked and verified by other engineers or operators. There are administration procedures for these activities. They are called procedure generation package.

CPSES(Computerized Procedure System Editing System) has been developed to write computerized procedures. CPSES has been revised several times to be user friendly. In the paper, CPSES improved in verification and validation area is explained.

2. Flowlogic Diagram for Computerized Procedure System

There are no standard formats for CPS comparing to monitoring and control system. Lots of CPS have been developed with different formats. Dual column format in text is popular. Dual column format in the paper based procedure has advantage because of reduced reading burden. Dual column format with CPS is utilized as paper format. An example of dual column is AP1000 CPS developed by Westinghouse. Another format is flowchart format introduced by EDF. Flowchart is preferred format because workflow is clearly directed. APR1400 CPS has developed Flowlogic diagram. Flowlogic diagram is made by combing Flowchart and Logic Diagram [1,4]. Nodes in procedures are directed by arrows in Flowchart. All instructions within a node is combined by Logic operator. The frequently encountered logic operators in the procedure are AND/OR/Sequence.

APR1400 CPS has been evaluated to be helpful for procedure execution during human factor evaluation. Dynamic behaviors of Flowlogic diagram has been upgraded by analyzing operation experiences. The Flowlogic diagram becomes more powerful.

APR1400 CPS consists of PXS(Procedure eXecution System) and CPSES. PXS can view CP (Computerized Procedure) written by CPSES. PXS[3] is shown in Fig. 1. The middle pane of PXS shows overview of focal procedure, and the right pane shows details of focal step rendered in Flowlogic Diagram.
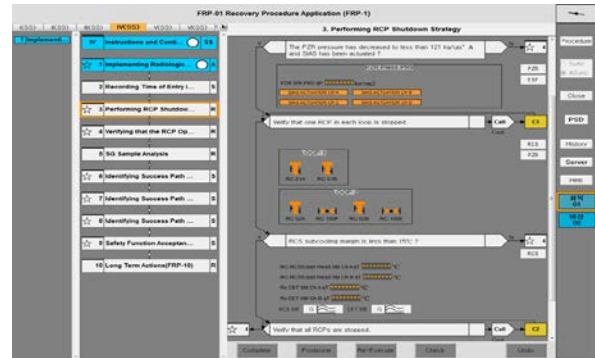

Fig. 1 PXS User Interface.

CPSES is shown in Fig.2 which have similar overview and Flowlogic diagram. The similar view is useful to check latent errors while editing procedures. There are additional pane called project pane.
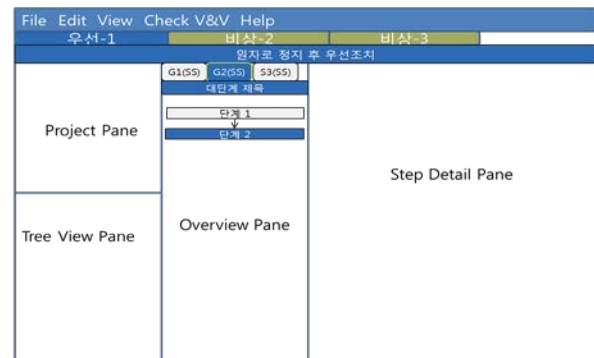

Fig. 2 CPSES User Interface.

CP has a well defined data structure. Its hierarchical structure is depicted in Fig.3. CP is decomposed from procedure to instruction via Gross step and step. the instruction is end node. There are one to one correspondent a book and a procedure. Node procedure is corresponding to book, node gross step to chapter, node step to paragraph, and node instruction to sentence.

A step can be divided differently by normal step or contingency step. When normal step cannot be performed due to any reason, the corresponding contingency step should be performed. The hierarchical tree in Fig.3 shows contingency step in yellow called and returned buttons.

This hierarchical data is stored in file of which data is defined by XML schema. Initial schema was defined for SKN34.The improved Flowlogic diagram requires version of XML. Furthermore redundant properties of that XML schema shall be version upped. On the other

hand, revision of XML makes CP incompatible with the previous CP. Therefore XML revision needs careful consideration [2].
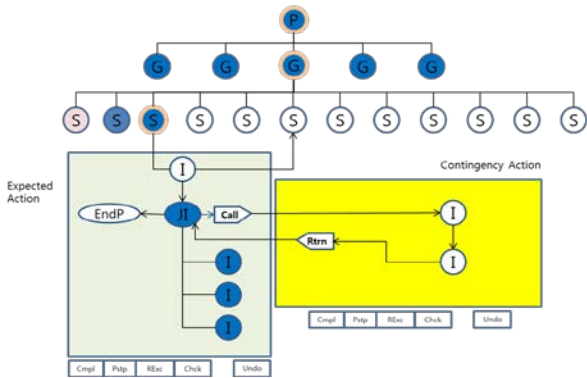

Fig. 3 Hierarchy of CP

3. High version of CPSES

User cases of CPSES were analyzed to find area for improvement. Once CP is written, it is saved in SAP. CP should be validated and verified. And it should be approved and dispatched to PXS server in Fig.4.
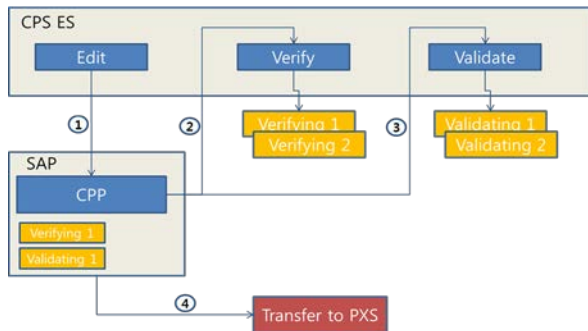

Fig. 4 Administration procedures to revise CP

CPSES should support all these activities. Common patterns as follows are derived after task analysis.

- There cover sheet, should be a package to hold CP, V&V report, and images
- CPSES should handle package rather than file
- CP or pdf should be imported or exported from package
- CPSES should provide pane for package
- CPSES should render CP in tree view which is primarily based on XML. But meaningless nodes of the tree should be hidden.
- Attributes or contents of nodes are merged in properties dialog.in Fig.5. Even though XML distinguishes attributes and contents of specific node, its interface should be combined to be user friendly.
- CPSES shall support batch operation to replace specific properties or print out backup hardcopy.

- CPSES shall check syntax errors of CP based on XML schema
- CPSES shall check reference errors of CP based on nodes of CP and CPSDB. CPSDB is a database holding process variables to insert to procedures. CPSDB shall be managed in SAP to provide recent and consistent database.
- CPSES shall provide manual checking dialog to review a step with procedure writer's guidelines.
- CPSES provides capability add nodes and remove nodes efficiently.
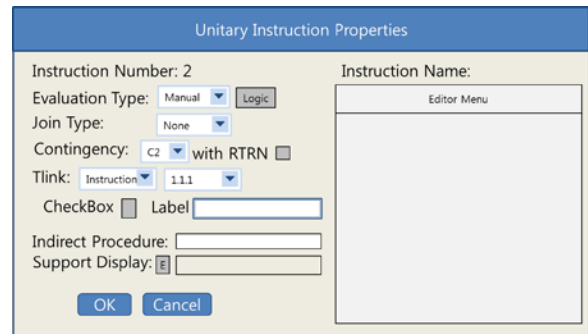- CPSES provide a logic dialog to edit mathematical expressions[5]

Fig. 5 Instruction Property Dialog

4. Conclusions

PXS has been upgraded continuously because PXS is used for procedure execution. On the other hand, CPSES has not upgraded frequently because CPSES is used to edit procedure. PXS has been evaluated useful due to continuous upgrade, but CPSES is said to difficult to use. During SKN56 CPS, CPSES is supposed to be upgraded, and its design features are explained in this paper.

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