

Westinghouse Computerized Procedures System (CPS)

Background

In the mid to late 1980's Westinghouse embarked on the development of its original version of a computerized procedures system (COMPRO) to assist operators in the execution of emergency operating procedures. Although deployment was limited, COMPRO's functionality provided the foundation for combining real-time plant data into the context of procedure evaluation when executing structured procedure content.

Fast-forward 30+ years, Westinghouse has taken those early concepts that were based on the vintage technology available at the time and applied them in the redesigned Westinghouse Computerized Procedures System (CPS) product incorporating many of the most common modern interface technologies to deliver a state of the art procedure execution system for today's modern digital control room.

Originally, the concept of computerized procedures was only applied to the emergency operating procedures. Today, this concept has evolved to the extent that the Westinghouse CPS is designed for both:

- Time-critical or event-sensitive procedures like Emergency Operating Procedures (EOPs) and Abnormal Operating Procedures (AOPs)
- General Operating Procedures (GOPs) where multiple activities are led from a centralized control room in parallel, and place keeping is a critical aspect of successful process startup and/or shutdown

In addition to the application of CPS in the nuclear industry, Westinghouse is pursuing implementation of the CPS product in other industries where time critical operating procedures are used to respond to process conditions that are deviating from "normal".

Benefits

The CPS product offers the following key benefits over conventional use of paper-based central control room operating procedures:

- **Technology Expansion**
 - ✓ Incorporates widely used modern interface technologies
 - ✓ Eliminates the need for use of paper copies during and after procedure execution.
- **Procedure Execution**
 - ✓ Integrates real-time process data to enable more efficient procedure execution since step status (met/not met) can be presented at the time the step is reached
 - ✓ Integrates links to supporting process displays, incorporate process data (or calculations involving process data) to individual steps of a procedures
 - ✓ Eliminates the need for use of paper copies during and after procedure execution
 - ✓ Improvements on the order of a factor of two to three can be realized over the use of paper copies of the same procedure
- **Human Performance Improvement**
 - ✓ Reduces personnel errors associated with inadvertent skipping of a step or execution out of sequence steps by use of electronic place keeping features
 - ✓ Continuously monitors process conditions and determines the status of procedure step status thus providing an automated Peer Check during procedure performance
 - ✓ Can be used to automate operator alerts when critical procedure entry conditions are met to preclude operator missed or delayed procedure execution.
 - ✓ Enables real-time monitoring of critical continuous action conditions
- **Procedure Maintenance**
 - ✓ The "master" CPS procedure content is electronically stored, and can be maintained in a centralized location using a common procedure builder tool which produces the plant procedure in both printable and CPS compatible file formats

Description

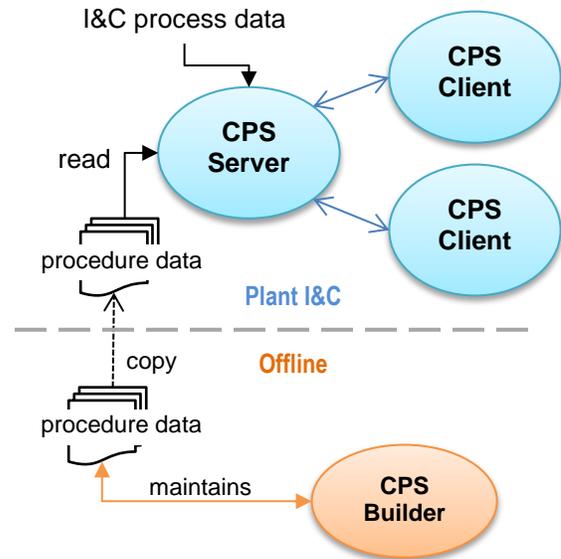
The Computerized Procedures System is designed to:

- Present electronic procedures in a user-friendly format that can be easily assimilated by the operator to accurately and efficiently assess the execution state both globally across the entire procedure set and individually at the detailed procedure content level
- Guide the user step-by-step through procedure execution by presenting the procedure state evaluation, based on real time process data, and possible navigation paths forward. CPS will recommend a path but not enforce; the operator is always in complete control of procedure execution
- Monitor and alert based on relevant information, in parallel to or in conjunction with procedure execution, including data such as procedure entry conditions, critical safety functions and parallel information (cautions, notes, foldout pages, and continuous action items)
- Maintain a chronological log of important events including entry conditions, alerts, operator actions and procedure state evaluation information during procedure execution

The Computerized Procedures System is provided as a suite of three distinct components:

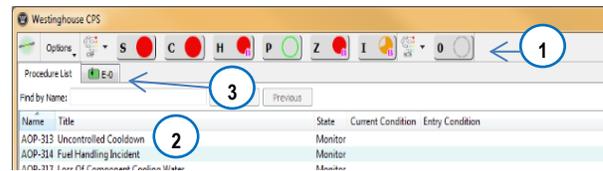
- The client application that provides the operator interface (CPS Client) on each designated central control room operator workstation that executes computerized procedures
- The server application software (CPS Server) that interfaces with process (I&C) data, monitors for procedure entry conditions, calculates procedure “state” data, performs system event logging and responds to operator requests and actions initiated from the client application(s).
- An offline procedure builder tool that is used to develop and maintain the procedure-specific files. The tool (CPS Builder) is used to produce procedure files that are used by the client and server applications.

CPS Component Block Diagram



CPS Client

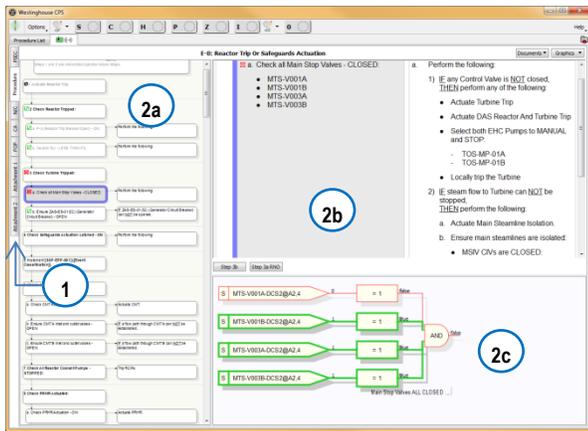
Operator interaction with CPS is through the CPS Client component module that provides the means to view and execute procedure content. The client application provides multiple ways to view the CPS data through a multi-tabbed interface.



The main interface consists of:

1. Toolbar area providing CPS health status, options menu and one of more critical safety function status trees.
2. Permanently located tab displaying the procedure list and the individual procedure's status.
3. Procedure tabs for accessing the detailed individual procedure content.

From the detailed procedure tab, the operator interacts directly with the procedure's content.

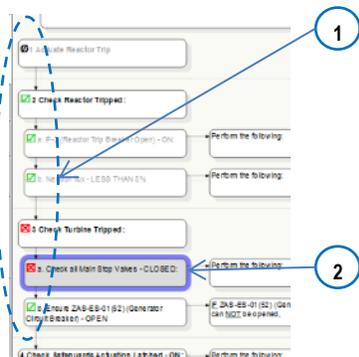


An individual procedure tab consists of:

1. Multiple sub-tabs dividing procedure content by function including entry conditions, procedure body, notes/cautions, continuous actions, foldout pages, figures and attachments
2. The procedure body itself provides multiple resizable pane views of the data:
 - a. Procedure flowchart
 - b. Current procedure step details
 - c. Current step logic expression

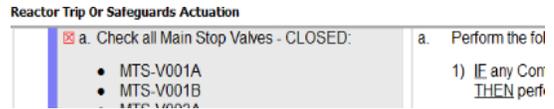
When a procedure is being executed, each of the procedure sub-tabs present dynamic evaluation state of its content, for example in the procedure body:

Flowchart View



1. Step(s)/status (met/not met)
2. Current active step

Step Detail View



Logic View (supporting process data)



Presentation of the dynamic procedure execution data in this manner provides a cognitive interface that allows the operator to assimilate current plant process state data in the context of the procedure and step being executed.

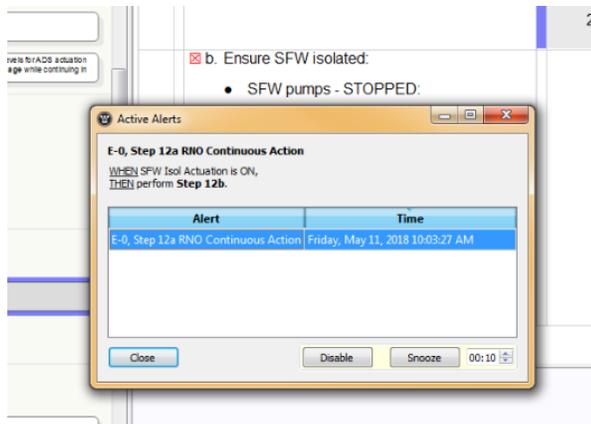
Concurrent to procedure step execution, CPS provides the capability to monitor, assess and inform the operator of other relevant procedure conditions. Procedure data included in this category are entry conditions, notes/cautions, continuous action items and foldout pages.

Procedure entry condition monitoring is performed when specific process logic can be defined for a procedure such that when the process logic evaluation is met:

Name	Title	State	Current Condition	Entry Condition
AOP-313	Uncontrolled Cooldown	Monitor		
AOP-314	Fuel Handling Incident	Monitor		
AOP-317	Loss Of Component Cooling Water	Monitor		
AOP-318	Condensate System Malfunction	Monitor		
AOP-320	Loss Of Circulating Water	Monitor		
AOP-321	Malfunction Of DDS	Monitor		
AOP-322	Main Generator Malfunctions	Monitor		
AOP-323	Loss Of AC Power	Monitor		
AOP-326	Feedwater System Malfunctions	Monitor		
AOP-327	Startup Feedwater System Malfunctions	Monitor		
AOP-328	Malfunction Of Feedwater Heaters And Extraction Steam	Monitor		
AOP-329	Loss Of Instrument Air	Monitor		
AOP-331	Loss Of DC Power Or AC Instrument Power	Monitor		
AOP-332	Loss Of Turbine Load	Monitor		
AOP-333	Main Turbine Malfunctions	Monitor		
AOP-334	Loss Of Turbine Building Closed Cooling Water System	Monitor		
AOP-336	Malfunction Of PMS	Monitor		
AOP-340	Reactor Coolant Leak	Monitor		
AOP-341	Reactor Coolant System High Activity	Monitor		
AOP-342	Reactor Coolant Pump Malfunctions	Monitor		
AOP-343	Loss Of Normal Residual Heat Removal	Monitor		
AOP-344	Loss Of Spent Fuel Pool Cooling	Monitor		
AOP-345	Loss Of Service Water	Monitor		
AOP-346	Chemistry Action Levels	Inactive		
AOP-347	Internal Flooding Response	Monitor		
AOP-348	Degraded Grid	Monitor		
AOP-354	Instrument Failure PMS Division A	Monitor		
AOP-355	Instrument Failure PMS Division B	Monitor		
AOP-356	Instrument Failure PMS Division C	Monitor		
AOP-357	Instrument Failure PMS Division D	Monitor		
AOP-358	Instrument Failure Miscellaneous Instruments	Inactive		
E-0	Reactor Trip Or Safeguards Actuation	Active	Step 1 Note 1	Any Automatic Or Manu
E-1	Loss Of Reactor Or Secondary Coolant	Inactive		

1. Procedure will auto activate and open in a new procedure tab
2. Monitoring/activation is indicated on the Procedure List tab

Similarly, parallel information monitoring for the remaining procedure data is presented through an alert mechanism which will be displayed when one or more monitored conditions are met.

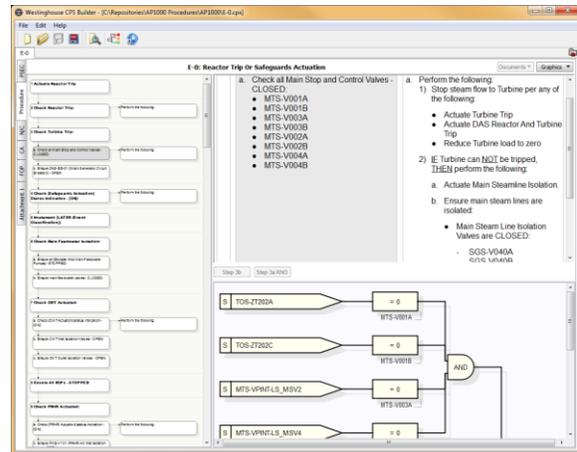


From this alert window, the operator can readily determine the alert source, condition and time and determine an appropriate action:

- Navigate directly to the indicated alert item for further investigation
- Disable the monitoring of the selected alert
- Delay addressing the alert for a period of time (snooze) at which point the alert will return if the condition is still met

CPS Builder

The maintenance of CPS procedure content is through the use of the CPS Builder component module that provides the procedure writer an interface that is virtually identical to the client interface used for procedure execution.

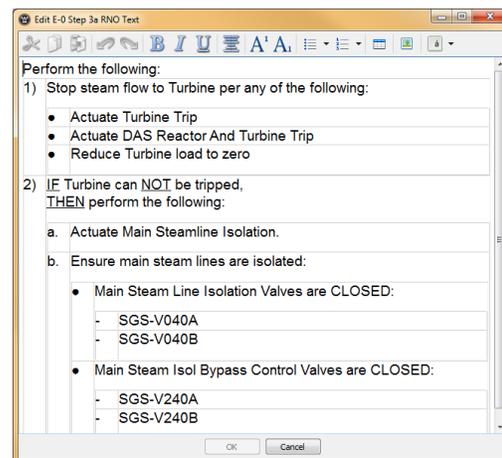


This presentation allows a procedure writer to visualize the procedure content in the same context that is presented to the operator in the CPS Client interface used in the control room.

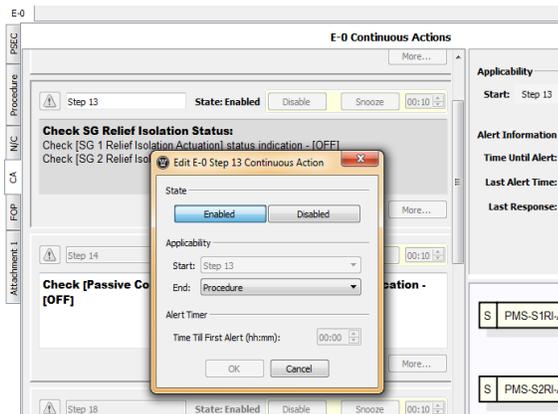
The available editing functionality is tied to the context of the procedure data by presenting only valid edit options for the currently selected procedure object thereby ensuring the integrity and structure of the CPS procedure content.

In addition to context-sensitive menu options, there are multiple editors provided for different procedure data types:

Procedure Text Editor

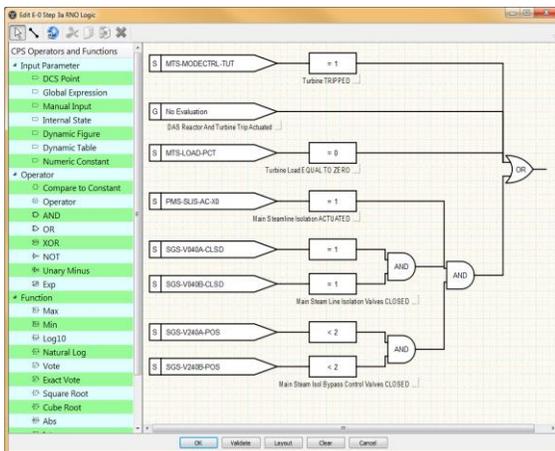


Continuous Action Editor



To incorporate process data into a procedure object, a graphical editor using “drag and drop” technology allows the writer to build a complex logic expression that is evaluated during procedure execution to determine the procedure object state (met/unmet).

Logic Expression Editor



All of the available editors provide the context of the procedure object being modified in its window frame title. Additionally, where appropriate, an editor window will validate the user’s input before exiting the editor to apply a procedure modification.

In addition to the intuitive user interface and the many user-friendly features provided in the CPS Builder, the tool can also generate electronic pdf-formatted hardcopy of both the procedure content as well as a logic report detailing the dynamic process data related to the procedure content.

Summary

The CPS provides a consistent structure within which plant operating procedures are created, maintained and utilized. It can reduce cycle time needed to implement changes in the operating procedures, because the procedures will reside within the computerized system.

The CPS is not designed to perform any plant safety protection functions, and no Category B functions rely on the CPS to perform those essential functions. The CPS is functionally categorized as Category C, or as a non-safety system, according to U.S. Nuclear Regulatory Commission (NRC) guidance.

Experience

The Westinghouse CPS is provided with its digital I&C systems being applied to new nuclear plants around the world including the AP1000 nuclear reactor.

The Westinghouse CPS can also be implemented on existing nuclear power plants and other Industrial facilities where mission-critical operating procedures are utilized.

AP1000 is a trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.