ISA-106 Procedure Automation for Continuous Process Operations Technical Report 1 Summary 1 of 2

Technical Report Summary

Committee Purpose: Develop Standard for automating procedures in continuous process operations.

Scope of Technical report is to provide a common basis of understanding of the benefits, best practices application, and language including terms and definitions, that will allow for the application of procedural automation across the continuous process industries.

In agreement with the scope of the ISA106 Committee, this Technical Report focuses on automated Procedures that primarily reside on systems within the supervisory control, monitoring, and automated Process Control section of the production process. It is not the intent of the committee to have this Technical Report focus on Procedure execution at the operations management functional level.

Additionally, the focus of this Technical Report will be on continuous processes. However the contents of the technical report may be used in other types of Process Control such as batch or discrete.

The Technical Report is intended to be applicable to ProcessControl activities within the Basic Process Control System(BPCS) and Safety Instrumented Systems (SIS). RequiredSafety Instrumented Functions (SIFs) should be analyzed. and implemented in accordance with ISA-84.

Key Definitions

Basic process control system (BPCS): System which responds to input signals from the process, its associated equipment, other programmable systems and/or an operator and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any safety instrumented functions with a claimed SIL ≥ 1

Implementation method: A tool used to create a Task Example: Programming languages, BPCS configuration tools and a word processor

Operator confirmation operation: The command is performed by the control system, however the operator needs to verify.

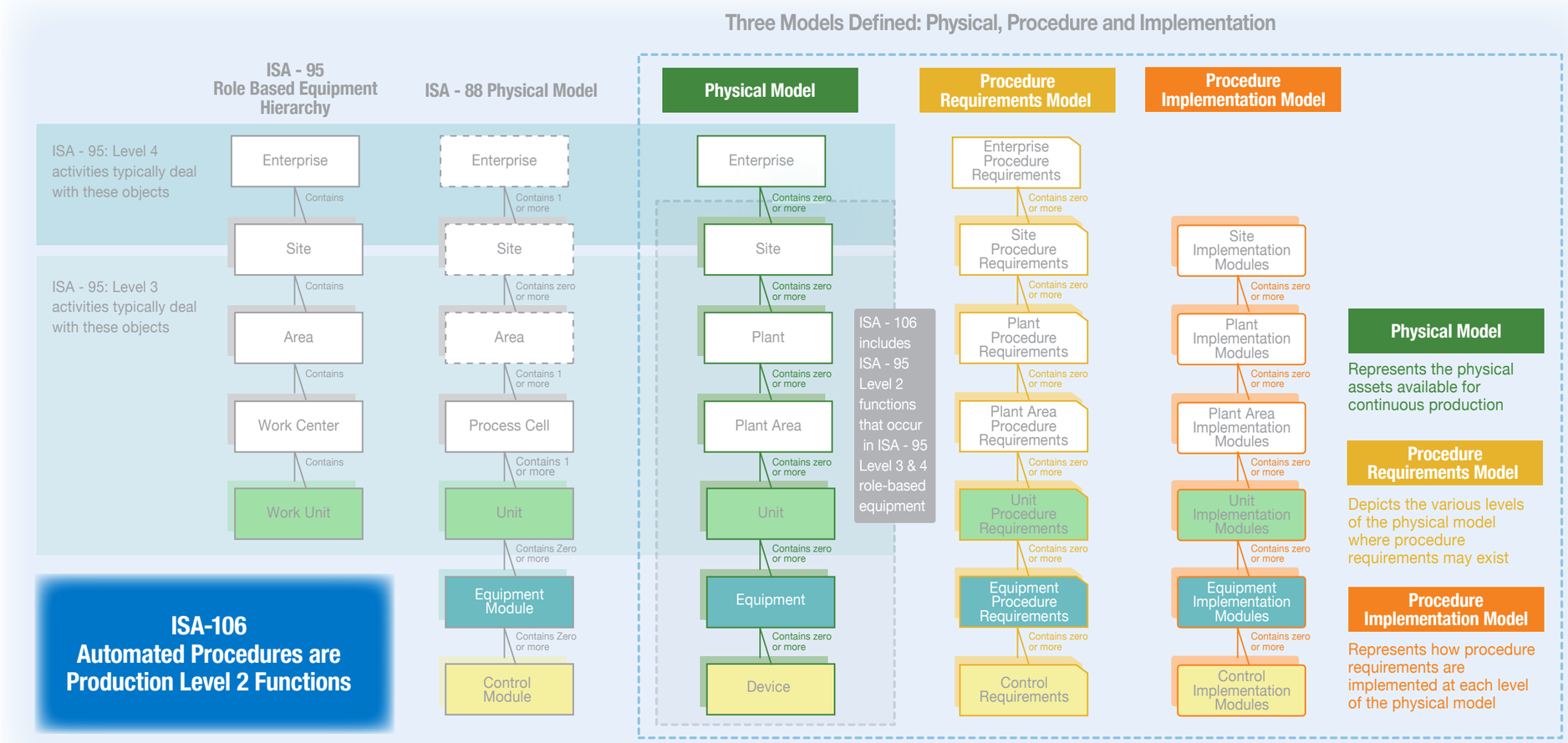
Procedural automation: Implementation of a procedure on a programmable mechanical, electric, or electronic system.

Process point of view: The view of a particular unit as a whole, not as a collection of individual loops. A control program written from the process point of view allows the operator to interact with the process as opposed to with control loops.

Process state: Distinct mode of operation that a unit moves through as it progresses from shutdown to operating and back to shutdown. Each Process State represents a unique operating regime that supports the unit's objectives of processing an input into a desired output.

State based control: A control program methodology that utilizes a framework that defines the "process states" through which equipment (general) passes during start-up, run, and shut-down conditions. These states determine the status of each controller, motor, block valve, and alarm for the unit operation.

State-based alarm (mode-based alarms): An alarm that is automatically modified or suppressed based on process state or conditions.



Value Proposition Summary

1. Improved safety performance - Automating procedures and utilizing state awareness for alarm management the workload on the operational staff is reduced during abnormal conditions. This enables more effective responses to abnormal conditions and reduces the probability of human error.

2. Improved reliability - Automated procedures can aid in maintaining maximum production rates, minimizing recovery time and avoiding shutdowns.

3. Reduced losses from operator errors - Automating procedures enables operations staffs to standardize their operating procedures. A standardized approach both reduces the likelihood for human error contributing to abnormal conditions and also lessens the time required to recover from abnormal conditions.

4. Increased Production by improving startups and shutdowns - Operations may benefit by achieving faster, safer and more consistent startup and shutdown operations of processes by automating the procedural steps.

5. Increased Production and Quality via efficient transitions - Most operational requirements staffs require process transitions from one condition to another during normal operating conditions. Automating procedures enables operations to accomplish transitions with reduced variability and in less time.

6.Reduced losses through improved responses to disturbances. Automated procedures can be prepared for potential disturbances, reducing the time to return operations to desired steady state conditions.

7. Improved Operator Effectiveness - Reduces the time an operator spends carrying out repetitive tasks and enables them to focus on process optimization and avoidance of abnormal conditions.

8. Higher Retention and Improved Dissemination of Knowledge - Automated procedures can be used to retain the knowledge of the process. This is especially important for procedures that are not executed frequently.

9. Improved Training - As knowledge & best practices is captured into automated procedures, the resulting documentation and code can be used as material for training new operators on the process.

10. Improved insight into the process - By recording system and operator actions with procedural automation, users have the opportunity to review and analyze data from every startup, shutdown, process transition, and abnormal condition recovery.

11. More efficient change control - A structured, modular approach to procedural automation minimizes production change control costs.

12. Reduced costs of enterprise adaptation - Once the overall and standard structure for sequence control has been defined and implemented, it can be modularized into libraries of code/procedure/documentation to allow easy cloning/replication from one area or site to another.

13. Common definitions and terminology - Operational staff have a common set of terms with uniform definitions to describe the requirements for improvements and changes in procedural automation. This improves communications with EPC's, system integrators, automation suppliers, and internal company departments.

Provided by YOKOGAWA

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Examples of Physical Model Level Names

Physical Model Level	Level Name Definition	Examples
Unit	An Equipment grouping to carry out one or more processing activities such as reaction, crystallization, or distillation. It combines all necessary physical processing and control process equipment required to perform those activities as an independent process equipment grouping.	-Reactor -Distillation Column -Wed End -Contactor -Dry End -Separator -Pulper -Dry/Wet Oil Tanks -Filters -LACT Unit -Compressor -Pipeline pumps -Well Head -Hydrocyclone -Reboiler -Floatation Cell
Equipment	A collection of physical devices and process hardware that performs a finite number of specific processing activities	-Pump set -Compressor -Control loop -Feed system -Analyzer and sampling system
Device	The lowest level of physical hardware in the Physical Model in a Process. Examples include control valves, instrument, and motors	-Analyzer -Pump -Control valve -Temperature transmitter

An Automation Style

is a consistent approach to designing and implementing Implementation Modules. Automation Styles provide Operators with consistency in the use of automated Procedures and can lower engineering costs by providing a framework that fosters re-use of procedural logic.

There are any number of Automation Styles that cover a spectrum of operating styles from no automation resulting in full Manual Operation to complex automation with fully automated operation.

An important aspect of an Automation Style is how much process knowledge is to reside in the Automated Procedures. More complex Automation Styles contain more process knowledge and can therefore Perform more normal and abnormal process conditions automatically thereby providing more consistent and efficient operation of the Process. Simpler Automation Styles contain less process knowledge so the Operator must Perform more Procedures and more closely monitor the Process. Three examples of Automation Styles are:

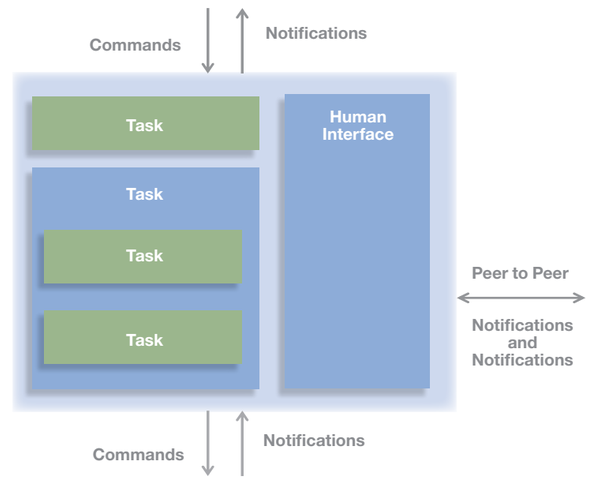
Manual Automation Style – The Operator is responsible for the Command, Perform And Verify work items. The Operator may use the BPCS console or local indicators and actuators in the field, but there is no computerized Procedural Automation involved.

Computer Assisted Automation Style - Implementation Modules are considered computer assisted when the Operator and computer share responsibility for the Command, Perform And Verify work items. The amount of automation used may vary.

Fully Automated Automation Style – Implementation Modules are considered fully automated when the computer is responsible for the bulk of the Command, Perform and Verify work items.

Implementation Modules -

Consist of a set of ordered tasks. Tasks may contain other tasks. Each task provides plant operations with step by step instructions for accomplishing the actions that are to be performed and their verification. From an operational perspective a procedure is one or more implementation modules. Figure below shows the components and inputs/outputs of an implementation module.

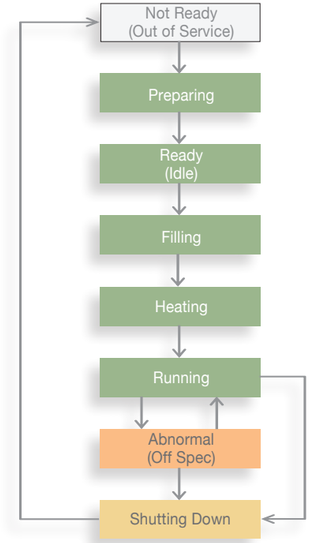


Process States-

States-Use of Process States is one method that gives a framework for organizing automated Procedures as more complex Automation Styles are used.

When using Process States, Procedural Automation is centered on a major piece of process equipment, usually a Unit. States are defined based upon the physical conditions the process equipment passes through to ensure safe and efficient operation.

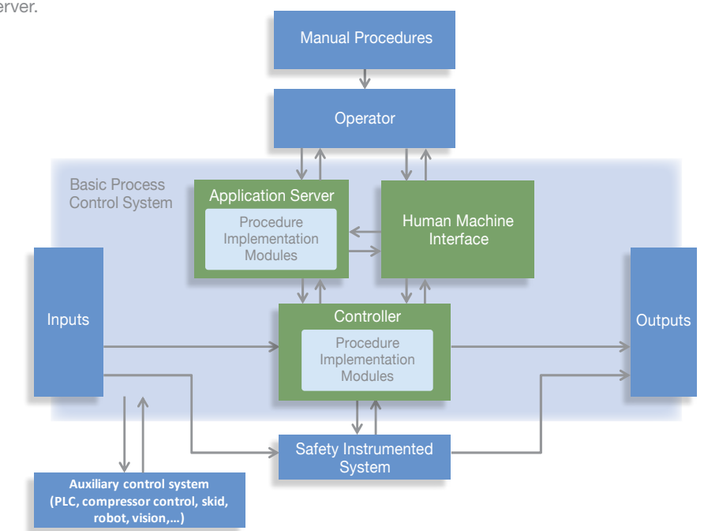
The process state concept can be expanded to implement State Based Control.



Example of State Transition Diagram

Mapping Implementation Modules to BPCS Components -

Implementation Modules are run in a BPCS controller or a BPCS application server. Figure below provides a conceptual diagram of a BPCS and shows Implementation Modules in the controller and application server.



When a Task's Implementation method results in a Task that cannot be run by a computer it is considered a manual Procedure and are beyond the scope of the BPCS. Some of these Implementation Modules may be performed by a field Operator using a printed or handheld electronic checklist. The decision to run Implementation Modules in an advisory computer or a controller is based upon safety, risk, cost and benefit.

An Implementation Module requiring fast time responses such as sequencing a set of pumps and valves with critical timing may be implemented in a real-time controller. Other Implementation Modules that do not require as high a speed response or involve more Operator interaction may be implemented in a PC/server based computer.

Criteria for deciding the appropriate location of an Implementation Module include:

- Procedure implementation cost
- Procedure lifecycle cost
- Time responses required by the Process
- Health, safety and environmental risk
- Operating philosophy for Operator interaction with Procedures
- Availability of instrumentation to perform automated tasks
- Desire for incremental implementation of automated Procedures

Three work items are required for the Implementation Module to Execute

Command – The trigger to initiate the Implementation Module. When received this causes the Implementation Module to Perform its Tasks. A Command may be issued by an Operator or another Implementation Module.

Perform – The execution of a Implementation Module's Tasks. A Task may use any type of Implementation Method, but ultimately the Task is Performed by an Operator or a computer.

Verify - Verification that the Implementation Module's Tasks were Performed successfully or failed. The verification may use any type of Implementation Method, but ultimately the verification is Performed by an Operator or a computer.