Setting the Standard for Automation™

ISA-106: Using Procedural Automation to Improve Operational Efficiency

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Standards

Certification

Education & Training

Publishing

Conferences & Exhibits

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Presenter

- **Marcus Tennant, MS** has been with Yokogawa Corporation since December 2008 as a Principal Systems Architect. Prior to Yokogawa, Marcus was employed at Rockwell Automation for 10 years as a Product Manager and Application Engineer. Prior to that, he was with Morton International for 10 years holding various positions in Process Development, Project Engineering, and Q.A. and with Jones-Blair Company for 5 years as an R&D Chemist and Process Engineer.
- Marcus has a B.S. in Chemical Engineering from Michigan State University and an M.S. in Operations and Technology Management from the Stuart School of Business at Illinois Institute of Technology.

YOKOGAWA

Presentation Outline

- Issues of procedures in process industries
- Efforts in the automation of procedures
- Formation of the ISA-106 standards committee
- Overview of standards committee work
- Applicability of procedural automation to Water/Wastewater operations
- Summary

ISSUES OF PROCEDURES IN PROCESS INDUSTRIES

Industry Issues

- Many industry incidents can be traced back to errors in the execution of plant procedures
- Continuous process units must be able to respond to changing conditions safely and efficiently
  - Raw material feedstock source switch
  - Adjusting to product mix to meet market demands
  - Adjust different operating conditions and running times
  - May require more frequent start-ups and shutdowns
- Many experienced process operators that have the knowledge to safely and efficiently execute procedures are retiring.
- To address the issues above, several companies have invested in automating operational procedures but often do not achieve operational or safety improvement goals.

Water treatment operator errors

- **Crews with the City of Amarillo dealt with an accidental release of waste water**

  AMARILLO, TEXAS --, released contents from the aeration basin at the River Road Wastewater Plant. **The cause of the release was due to operator error while draining the tank for maintenance work. It consis**ted of aeration basin contents from the domestic wastewater treatment plant. The area affected by the release is along east Amarillo Creek north of the plant. The following actions were taken, appropriate government officials and affected property owners were notified. Along with notifying the Texas Commission on Environmental Quality.

- **Staff Error Blamed For Sewage Spill**

  WETHERSFIELD — Staff error at the Metropolitan District Commission caused an estimated 3 1/2 to 4 million gallons of raw sewage and rainwater to pour into Wethersfield Cove last week, commission officials said. **Sewage treatment plant operators closed the wrong sewer main gates during the heavy rains last week, causing sewage to back up and flow into the cove**.

- **Operator error sends sewage-tainted storm water into Lake Champlain**

  About 2.5 million gallons of storm water and untreated sewage flowed from the Perkins Pier wastewater treatment plant Wednesday morning due to an "**operator-induced equipment failure**," according to the Burlington Public Works Department. Pumps that normally would inject chlorine into raw sewage during storm water surges did not deploy at about 6 a.m. **because a plant employee failed to follow correct operating procedures**

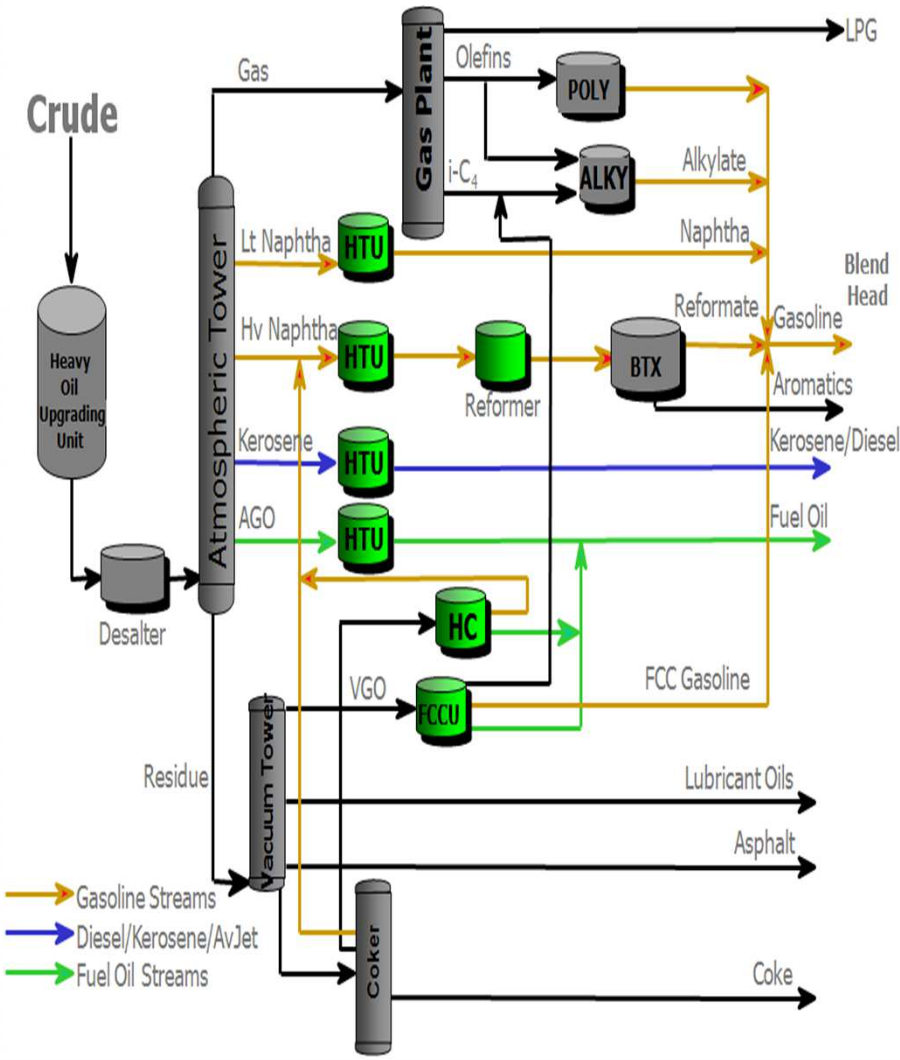
Industry Incidents

- Kern Oil Refinery in Bakersfield, California on January 19, 2005
  - Incident killed one employee and caused multiple injuries to other employees
  - Crude unit start-up
  - Workers over pressurized a pump casing which catastrophically ruptured, releasing and igniting hot oil that immediately exploded

- Giant Industries Ciniza Refinery, Gallup, New Mexico, April 8, 2004
  - 6 employees were injured, 4 requiring hospitalization with serious burn injuries
  - During hydrofluoric acid (HF) alkylation unit maintenance a shut-off valve was not closed as required, caused release of flammable liquids and vapors which caused subsequent explosions

*(FAT/CAT) fatality/catastrophe

Flexibly in operations - Distillation Unit example

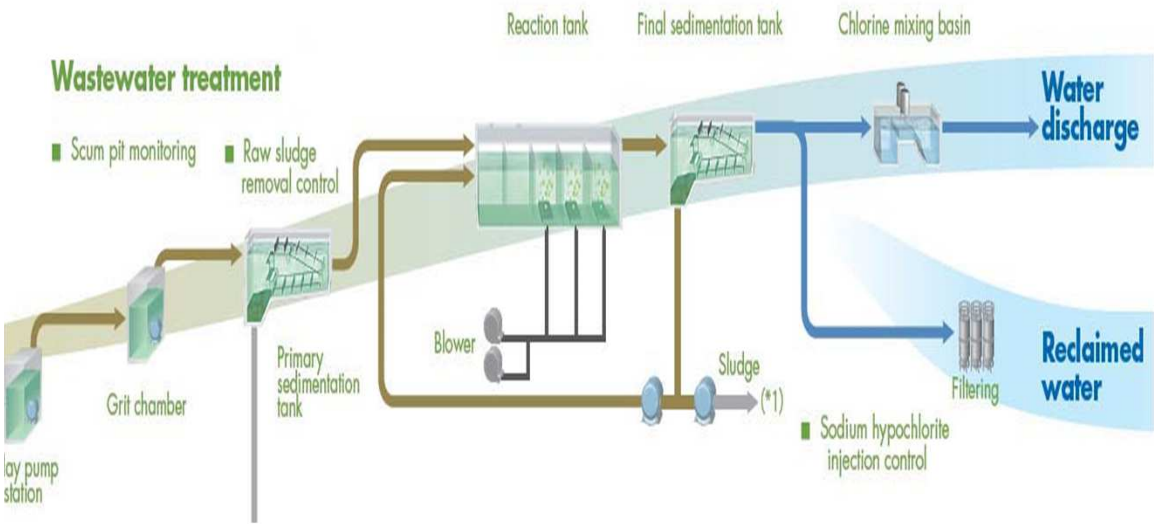


- Startup -
  - frequency may vary, from once every day to once every five years.
  - Operator skill impacts the efficiency of the startup.
  - May not have experienced personnel available for the start up.

Shutdown –
- Might not be scheduled.
- “On shift” operators might not be the best operators.

Feedstock and product output transitions
- Many refiners purchase crude oil of different types in tankers. & must adjust operation to process correctly the next type of oil.
- Chemical plants often make a variety of products in a campaign fashion by changing operation to meet the new product specs.

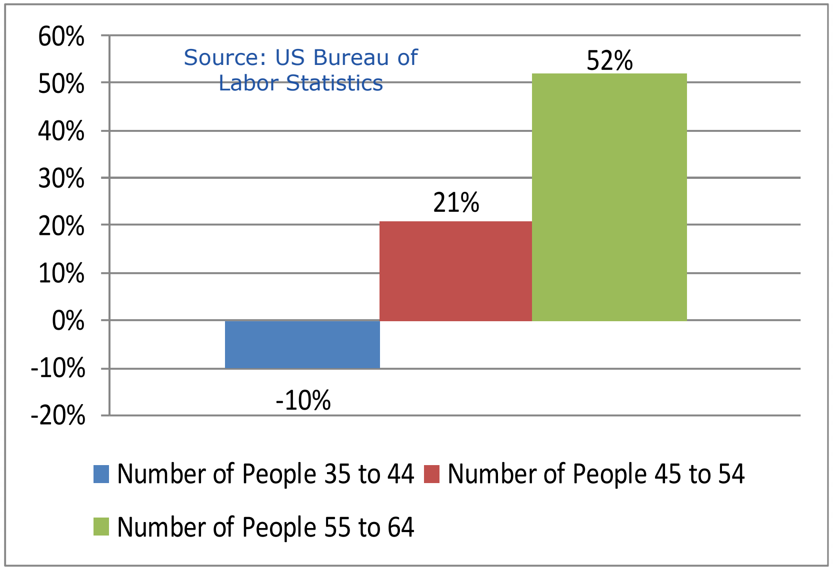
Flexibly in operations – Water Treatment



- Startup -
  - frequency may vary, from once every day to once every five years.
  - Often more at a Unit level than complete plant
  - May not have experienced personnel available for the start up.
- Shutdown –
  - Might not be scheduled.
  - "On shift" operators might not be the best operators to shut down unit
- Feedstock and product output transitions
  - Storm surges
  - Composition input changes
  - Process upset recovery

Skills Leaving the Workforce

Changing Workforce Demographics from 2000 to 2010



- Around the developed world the skilled workforce is aging
- Major Refining Company
  - Lost 2500 years of experience recently when 100 operators retired at one site, each with an average of 25 years experience
- Major Chemical Company
  - Analyzed plant demographics
  - Found one of their largest plants would lose 75 percent of its operating staff to retirement in the next 3 years.

EFFORTS IN THE AUTOMATION OF PROCEDURES

Issues automation of procedures

- Several companies have built automated procedures but have found that they are complex and difficult to maintain
  - Often use programming tools in a legacy control system that are difficult to use, require very specialized programming knowledge, and are very costly.
  - Programmed procedures are often written with minimal structure and documentation.
  - Engineers who built the procedures may not be available to implement updates and modifications. Difficult for another engineer to understand the code and make changes.
  - Not integrated with the SOP's
  - Often the operational staff of the process unit will revert back to manual procedures out of frustration and inflexibly.

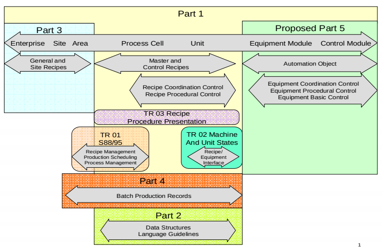
FORMATION OF THE ISA-106 STANDARDS COMMITTEE

Committee Status

- Formed in 2010
- Recently completed the first of three Technical Reports
  - Procedure Automation for Continuous Process Operations - Models and Terminology
  - TR #2 – Automated Procedure Life-cycle
  - TR #3 – Examples
- Standard will be produced based upon the Technical Reports and industry feedback

ISA106 Input

ISA-88



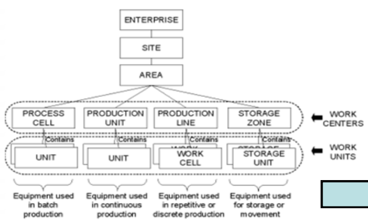
Center for Operator Performance
An Industry/University Center for Excellence

ASM

NAMUR

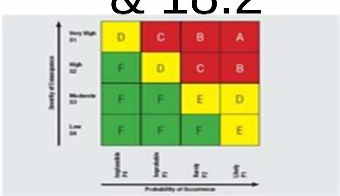
Company Practices

ISA-95



ISA-84,101

& 18.2



Literature

Industry Analysts

Vendor Input

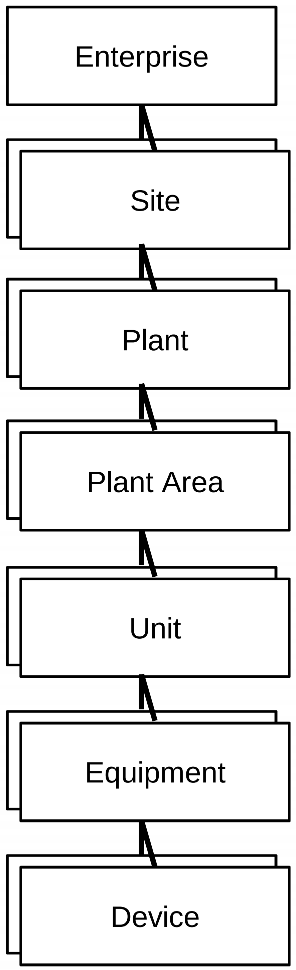
OVERVIEW OF STANDARDS COMMITTEE WORK

Models and Terminology

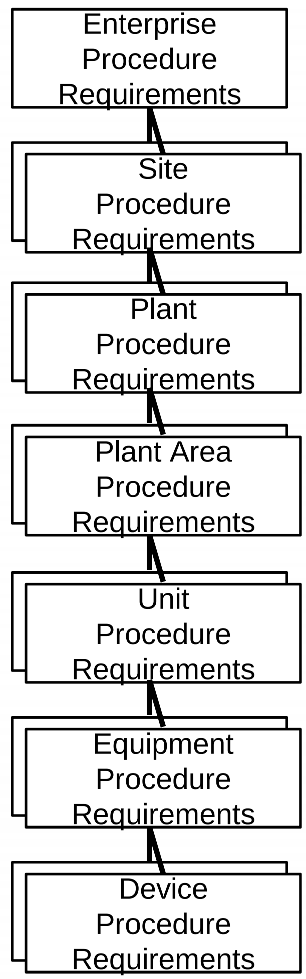
- 1st Technical Report
  - States committee's current thinking on how to organize and approach procedure automation
- Models
  - Concepts to give the industry a common mental model for automated procedures
- Terminology
  - Definitions to give the industry a common language for automated procedures

ISA-106 Key Models

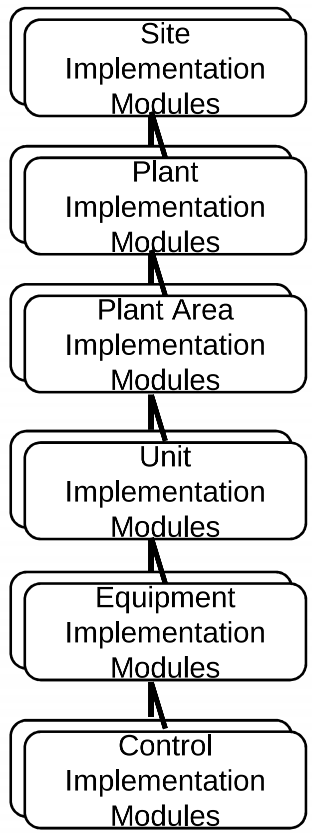
Physical Model



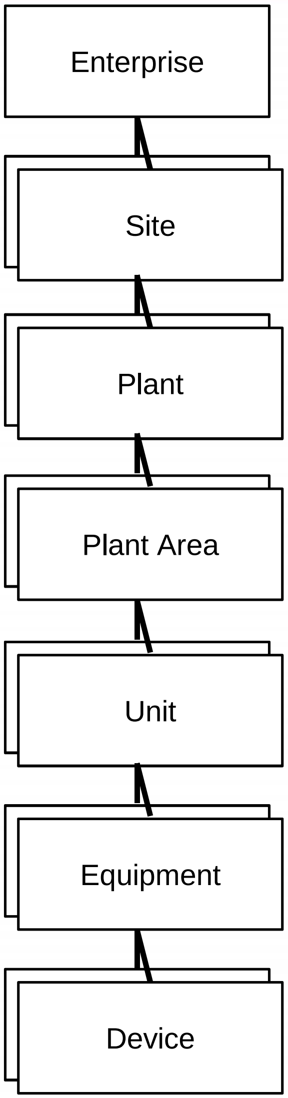
Procedure Requirements Model



Procedure Implementation Model

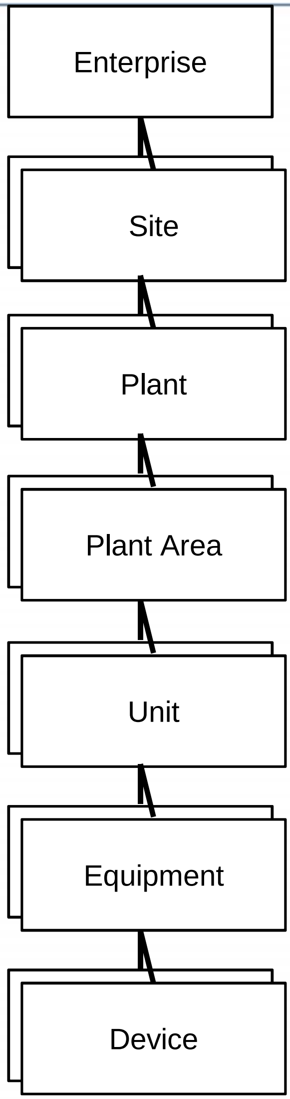


Physical Model



- Organizes physical equipment into a hierarchy
- Provides a common set of terms and equipment levels for companies & industries to map their terms to
  - Common terms enable products and people to work more efficiently with different owner/operators.
- Physical model is the foundation of the ISA-106 work
  - Each item in the model can have procedures

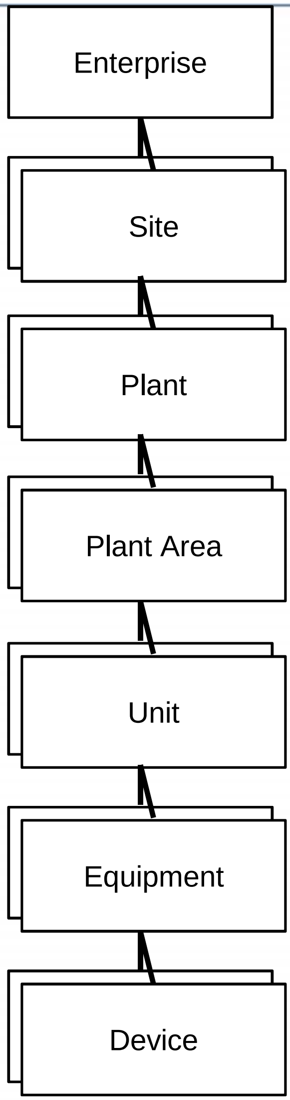
Physical Model – Industry examples of generic names



Results of committee owner/operator terminology

ISA-106	Chemical Company	Oil Refinery	Paper	Offshore Oil Platform	Water Treatment
Enterprise	Enterprise			Field	District
Site	Site	Site		Platform	Faculty
Plant	Plant	Complex	Mill	Package	Plant
Plant Area	Area	Plant			Treatment Area
Unit	Unit	Unit			Unit
Equipment	Equipment				
Device	Device	Device			

Physical Model - Examples

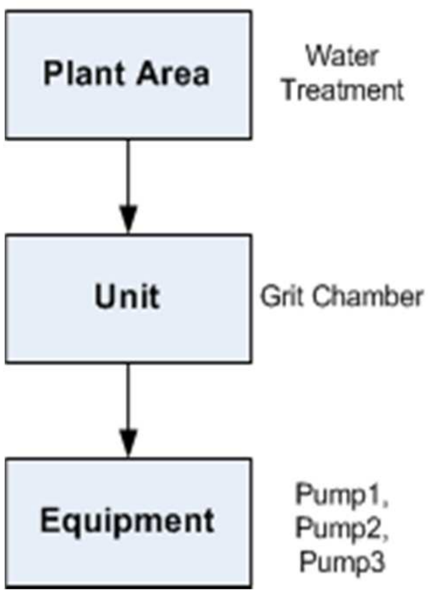


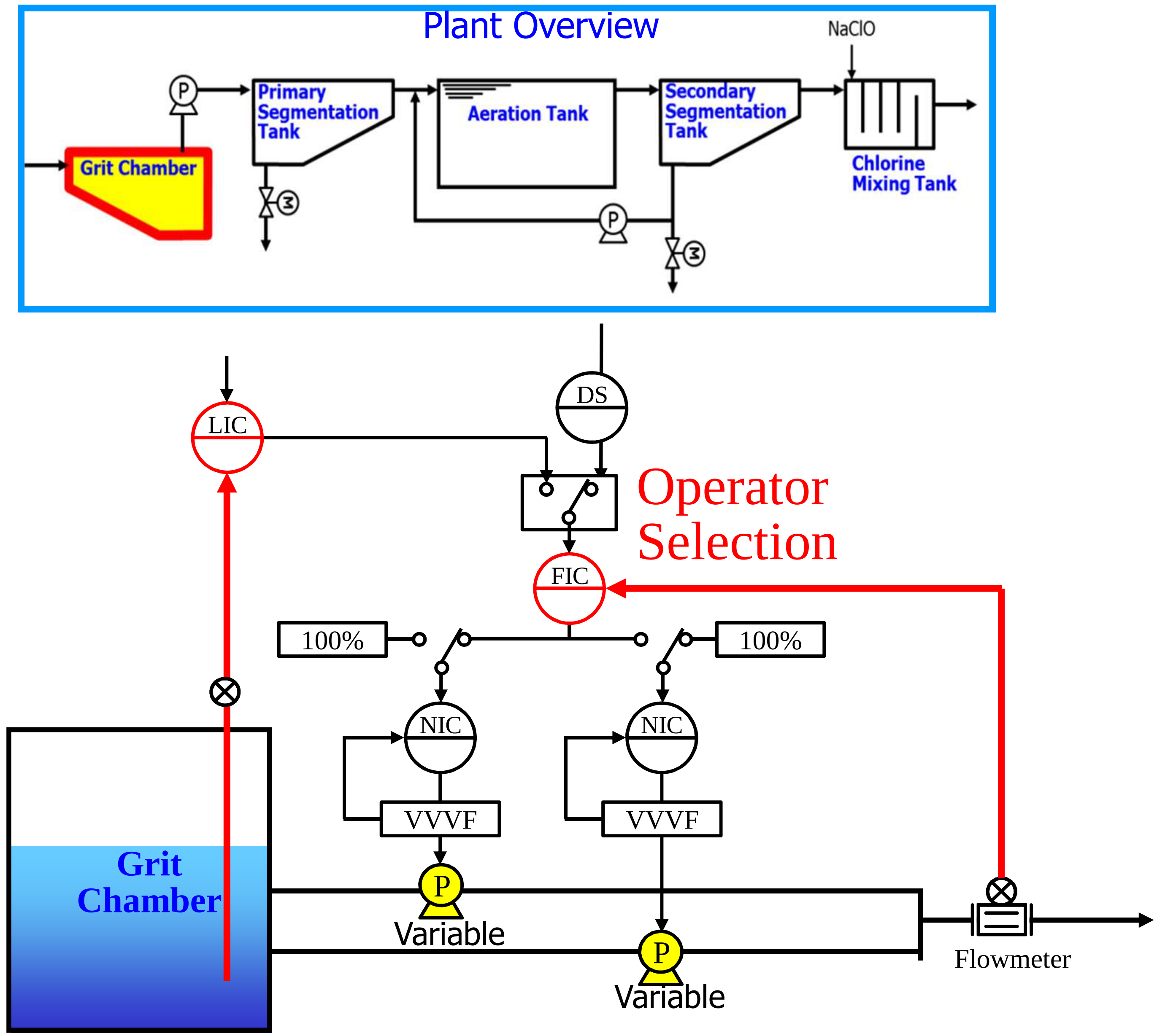
Results of committee owner/operator terminology

Enterprise	Corporate	Division	Business Unit		
Site	Complex	Train	Facility	Verbund	Field
Plant	Platform	Train			
Plant Area	Separation Injection	Train Utilities	Sub-sea **Water Treating**	Gas Compression Production Manifold	Dehydration Wells
Unit	**Separator**	Dry/Wet Oil Tanks	Pipeline Pumps	Hydrocyclone	Compressor
Equipment	Pump Set	**Feed System**	Reboiler	Sampling System	Compressor
Device	Control Valve	Transmitter	Pump	**Analyzer**	

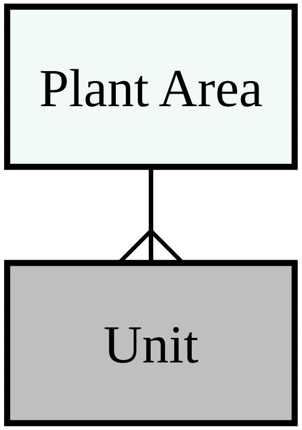
Wastewater Application Example

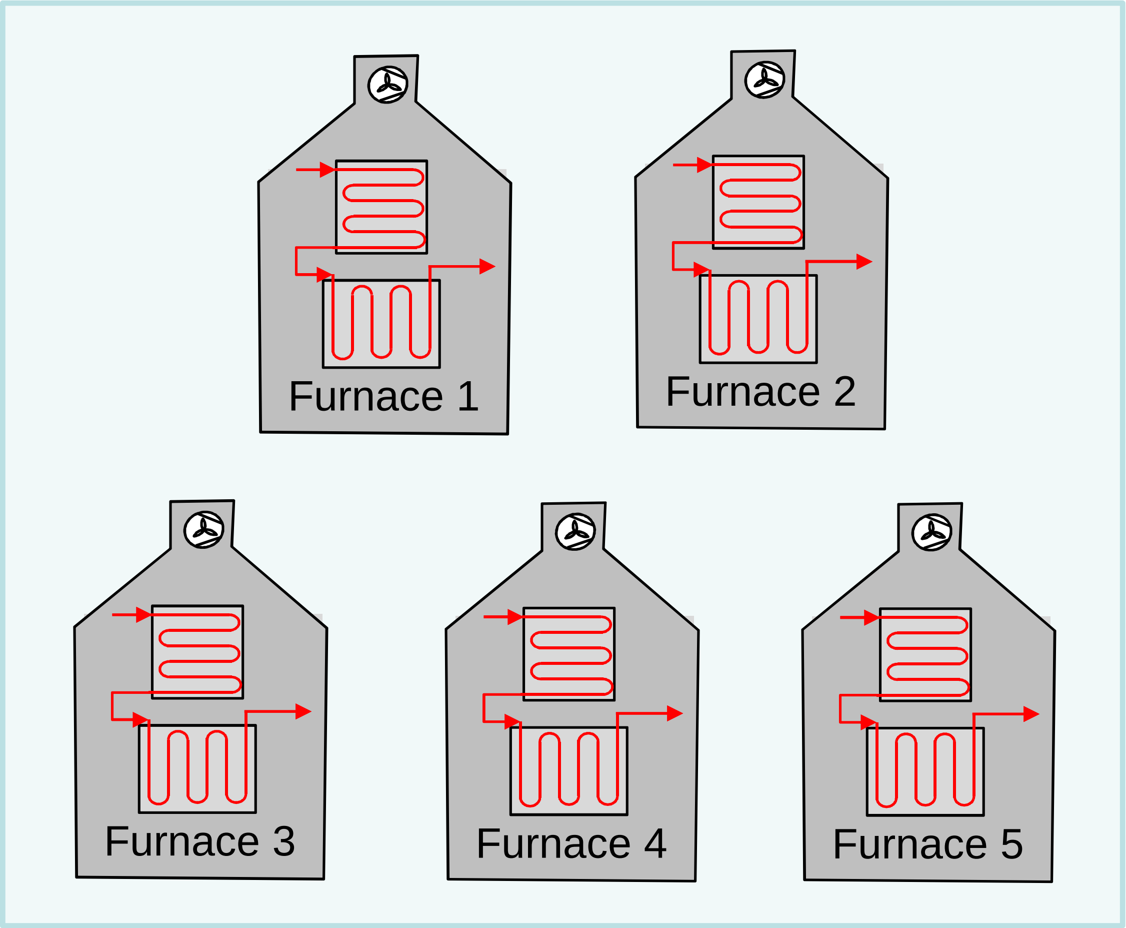
Physical Model



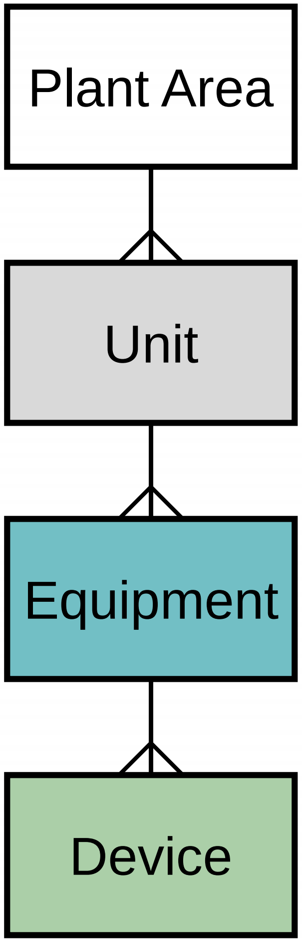


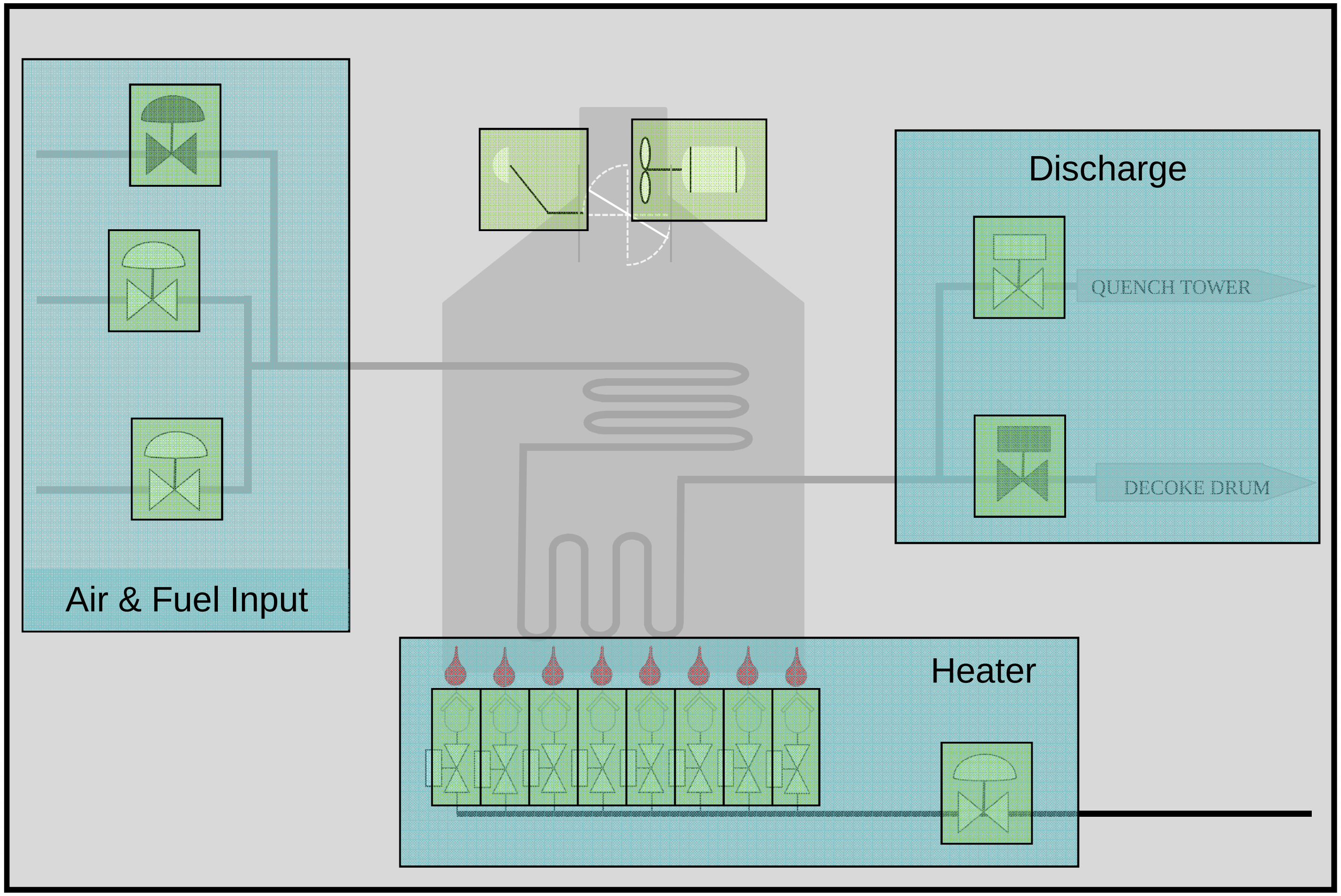
Ethylene Furnace Example



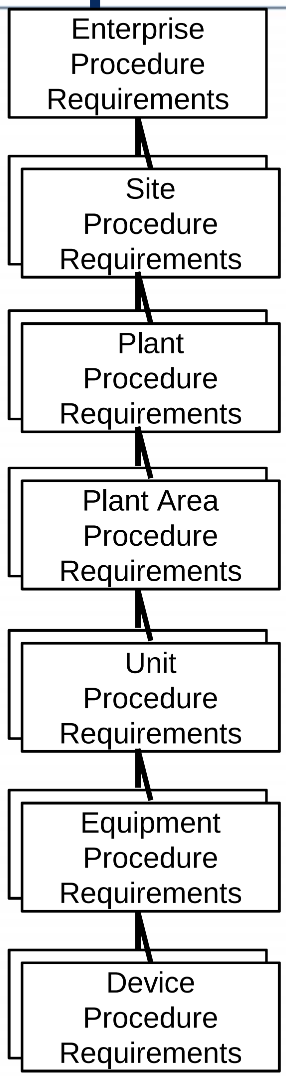


Ethylene Furnace Example



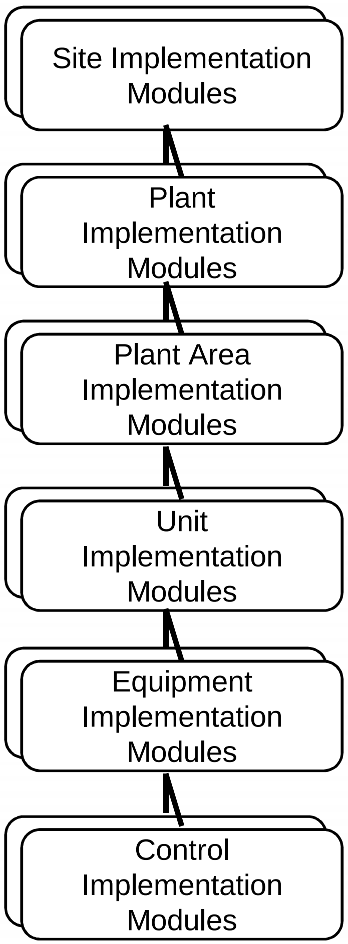


Procedure Requirements Model



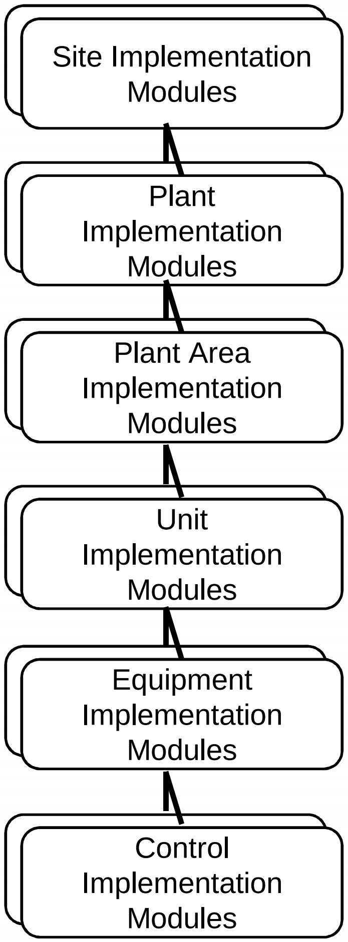
- Definition of the procedure
  - What must be done to accomplish it's objective
  - Functional requirement for the automated procedure
- Procedures are associated with objects in the physical model
  - Most common for units, equipment and devices

Procedure Implementation Model

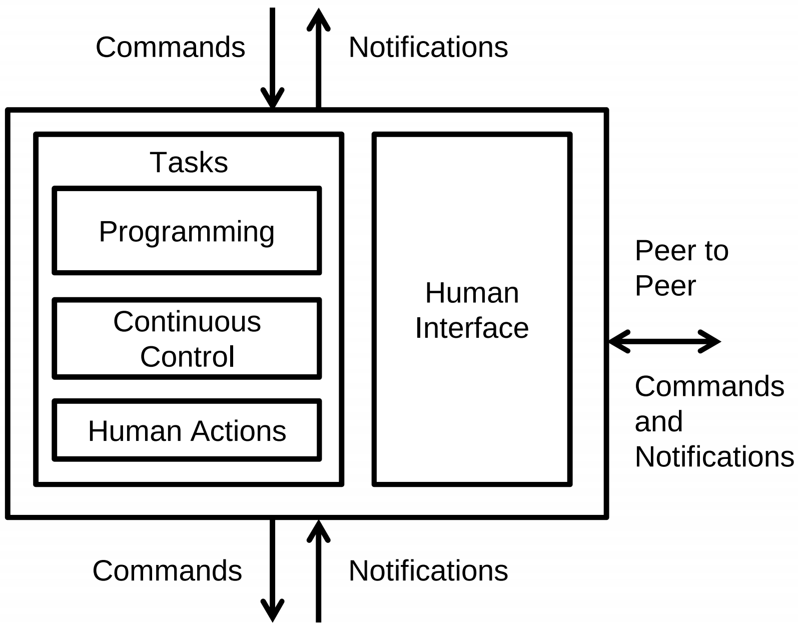


- The actual automated procedure
  - Program, function block, sequential function chart, flowchart,…
- The design of implementation modules is an engineering process
  - Procedure requirements are the specification
  - Not always a 1:1 mapping with procedure requirements

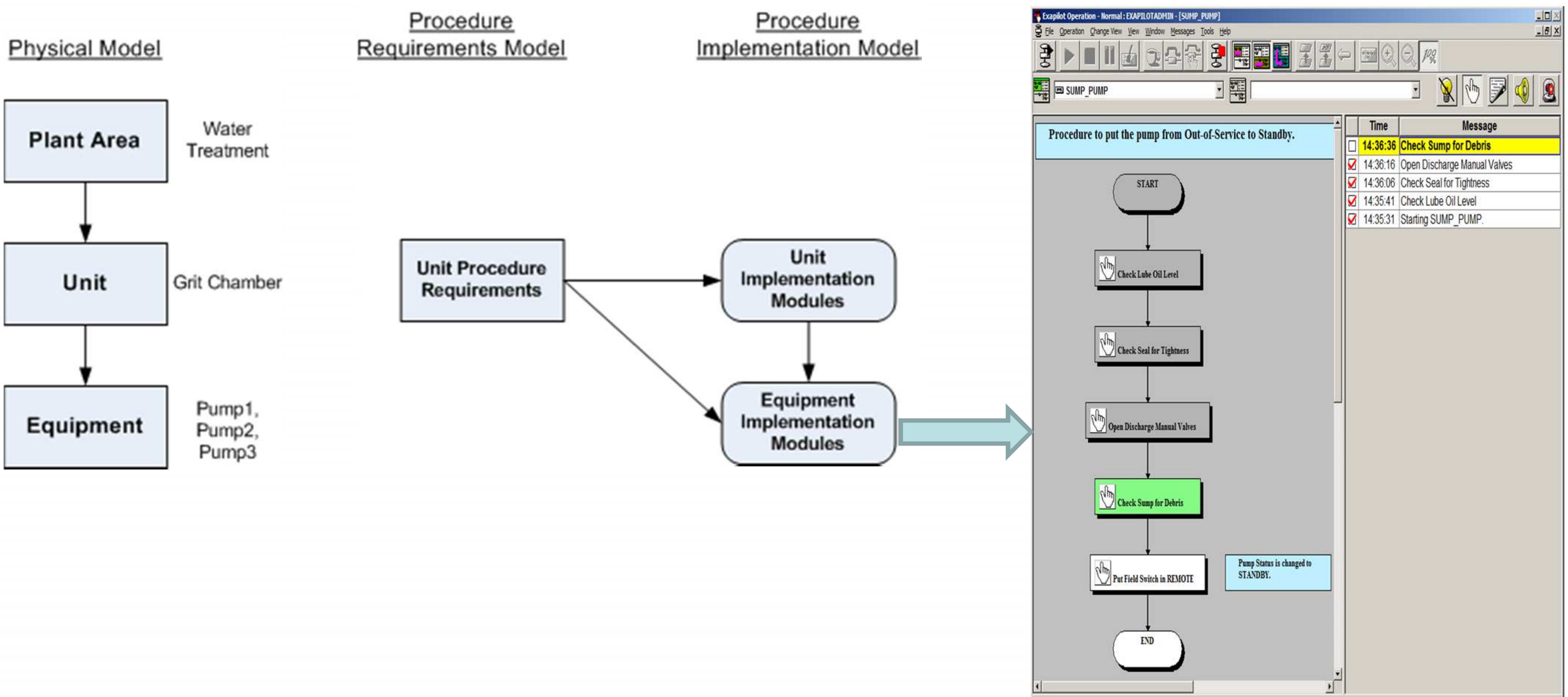
Implementation Modules



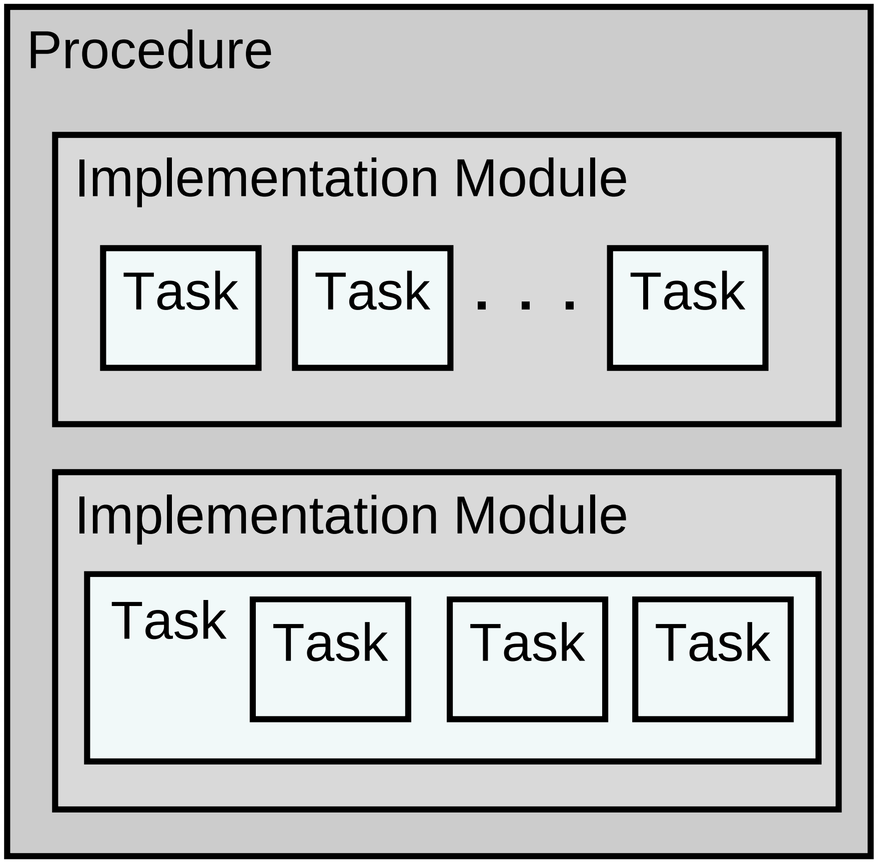
- Consist of a set of ordered tasks
  - Tasks may contain tasks
- Tasks perform step by step actions



ISA 106 Model example



Procedure Execution



- Each Procedure, Implementation Module & Task has 3 execution work items
  - **Command** – Trigger
  - **Perform** – Actions
  - **Verify** – Success/Failure
- Computer/Human Mix
  - C-P-V work items can be done by a computer or human

Command ›››› Perform ›››› Verify

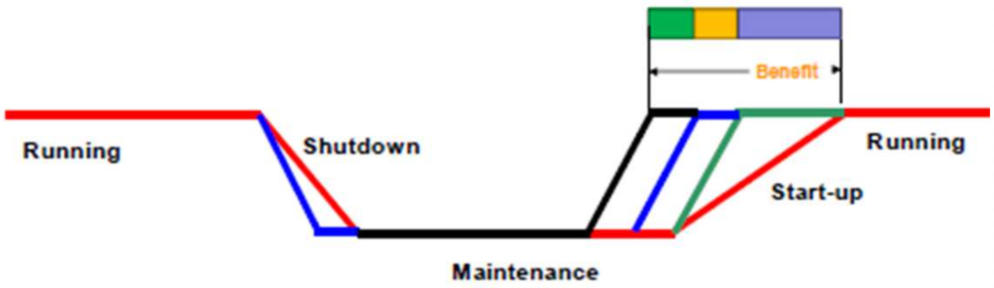
Operator Notifications

Operator Notification Types	Operator is expected to take an action	Operator might need to be aware but is not required to take action
Arises from an abnormal process or equipment situation (ISA-18.2)	**Alarm**	**Alert**
Arises from a normal situation (ISA-106)	**Prompt**	**Status Notification**

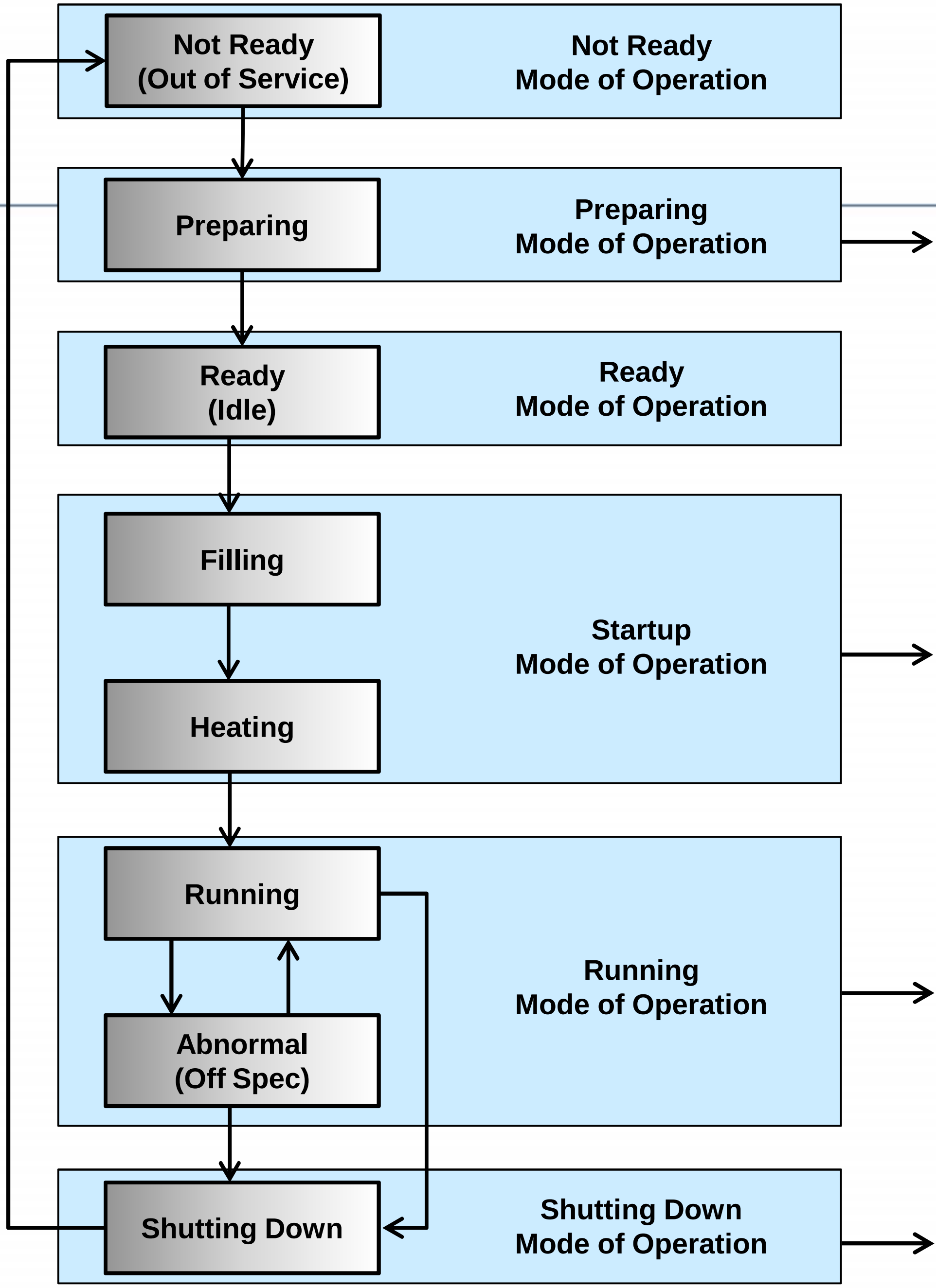
ISA-106 complements the
ISA-18.2 Alarm Management Standard

State-based Control

- A plant automation control design technique that assigns process states and defined transition procedures
  - Most effective at the unit level
  - Provides a high degree of automation
    - Startup, Shutdown, Transitions, Abnormal Condition Responses

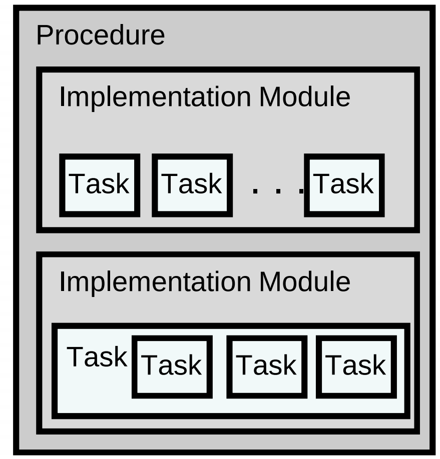


State-based Control Example



Prepare Procedure

Startup Procedure

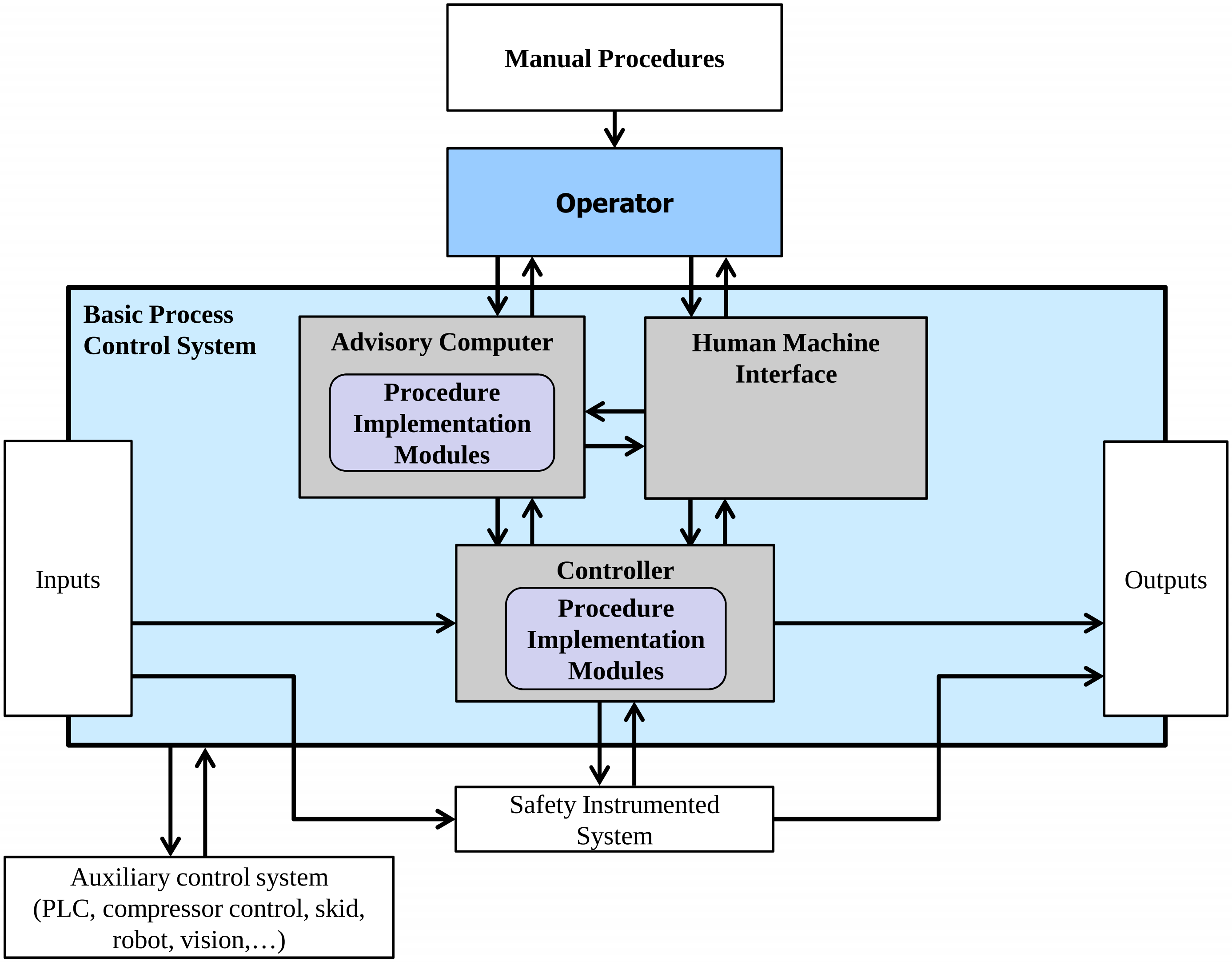


Production Rate of Change Procedure

Abnormal Condition Handling Procedure

Controlled Shutdown Procedure

Control System Architecture



SUMMARY

Summary

- Successful execution and management of procedures is important to safe and efficient operation of continuous process operations
- ISA 106 committee has released a technical report to document best practices in continuous process applications
- Concepts of ISA 106 can be applied to automating procedures in Water/Waste Water applications