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Canadian Boiler Society 2019 Education Days

Addressing the aging workforce problem with a few simple operator effectiveness principles

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Agenda

- **Current Industry Challenges**
- **Strategy #1: Knowledge Capture & Digitalization**
- **Strategy #2: Adopt High Performance HMI**
- **Strategy #3: Alarm Management**
- **Strategy #4: Process Simulator for Training**

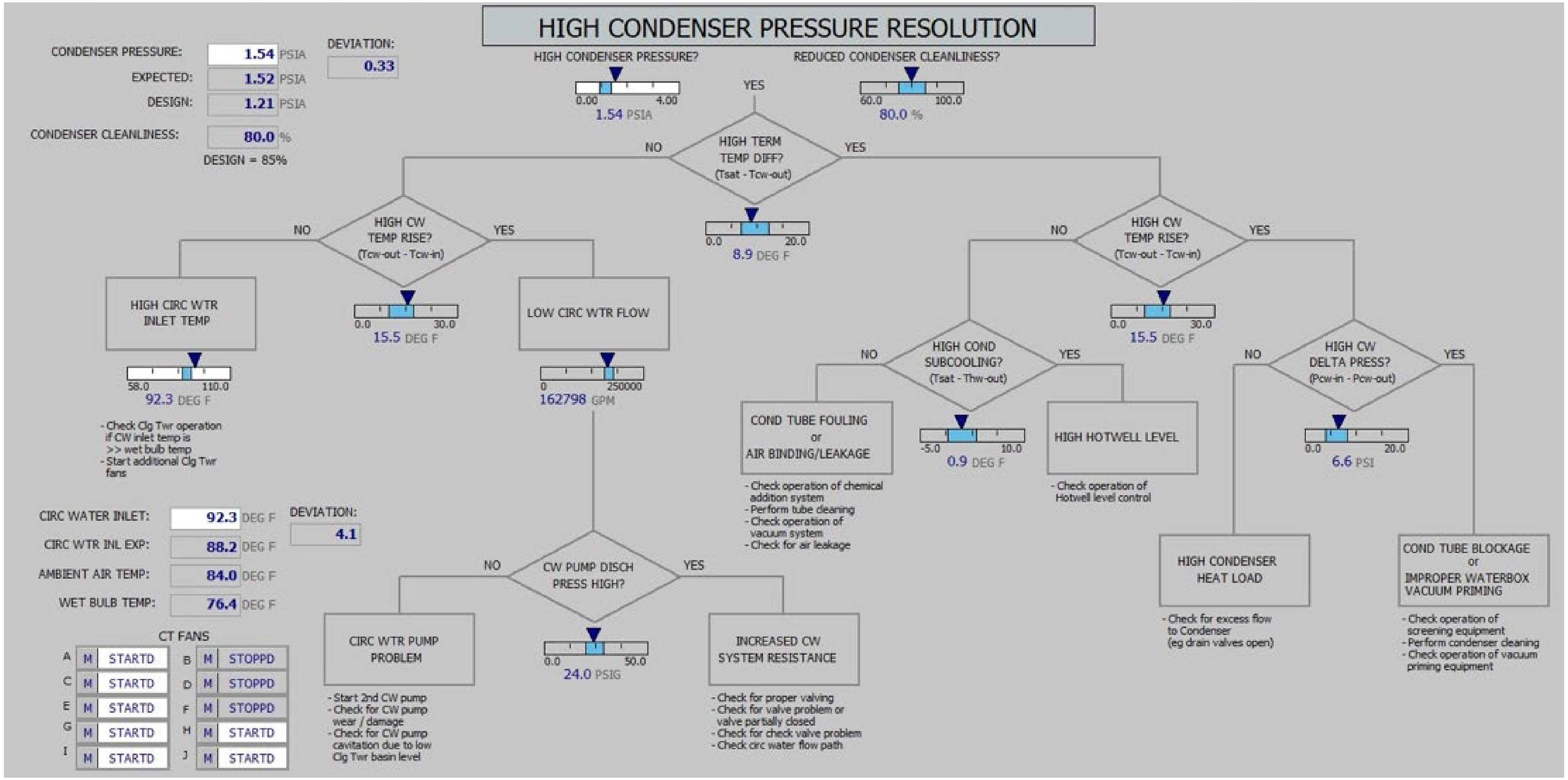
Current Industry Challenges

- 30-40 year operator veterans are retiring
- Modern day control systems introduce a disconnect with the physical process
- Operators are overloaded with Information (Training Material, SOP's, Alarm Lists, Historical data, etc.)
- "Millennials" have different expectations of their new employers

Strategy #1: Knowledge Capture & Digitalization

- Have experienced operators review existing procedures for accuracy
- Make it a culture to document ways to operate and assign a champion
- Take videos when possible
- Captured knowledge can be integrated into the control system
  - Integrated on-line documents can eliminate paper procedures
  - “Purpose built displays” allow for the integration of live process data and SOP’s
- Captured knowledge can be used in training programs
  - Can be used for training and curriculum development
  - Can be used to help define simulated conditions on process simulators

Example: Purpose Built Displays



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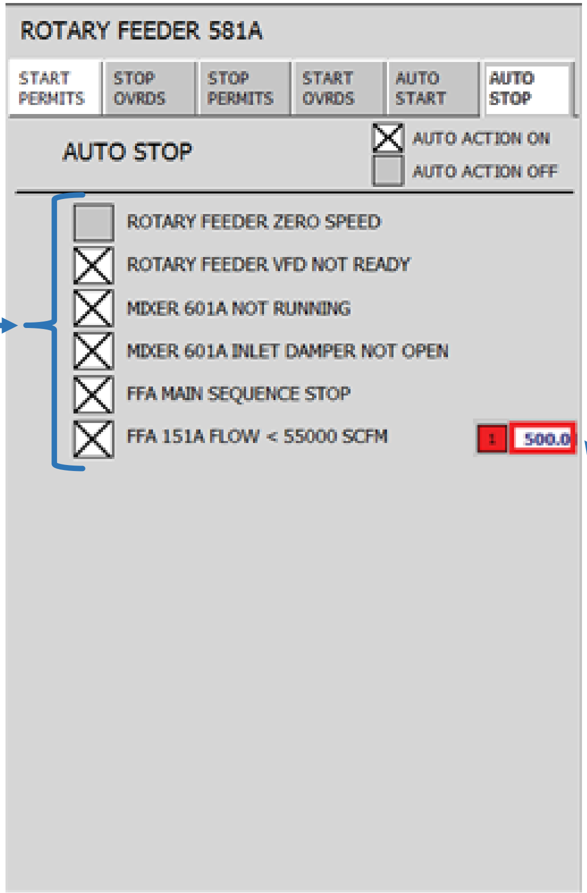
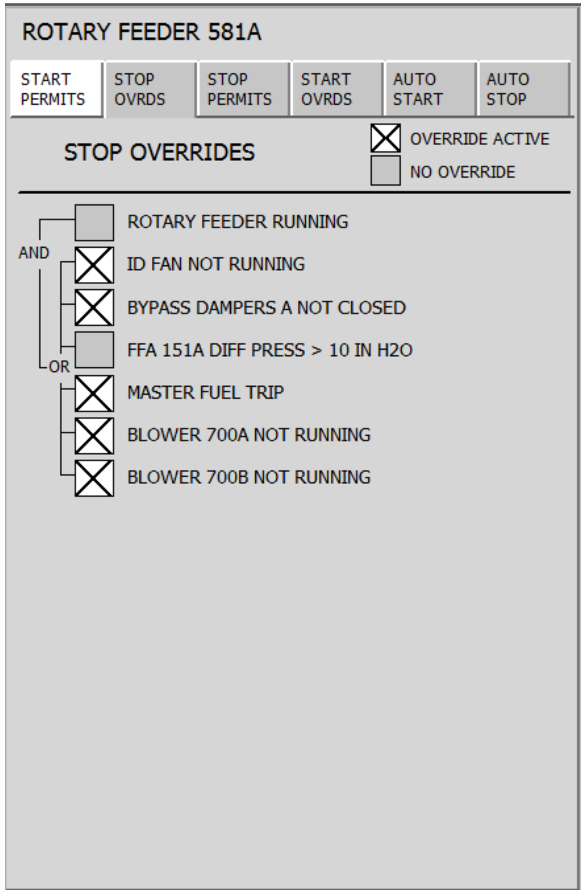
Example: Help Displays

Potential launch points for graphics or faceplate to quickly address reason preventing interaction



Live values can be added to help operations. Note: faceplates can be accessed from these

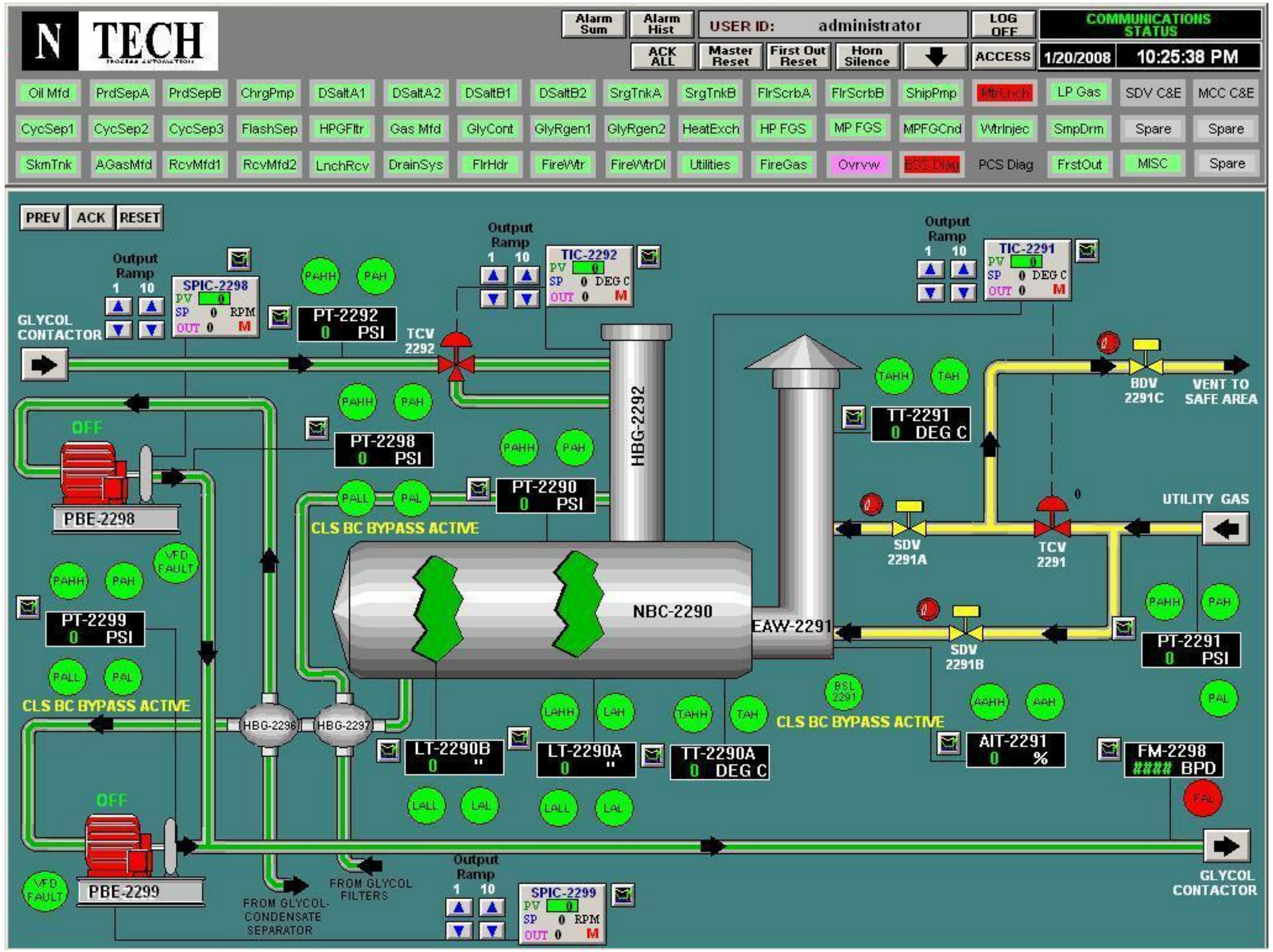


Experienced operators help define what navigation would be most helpful

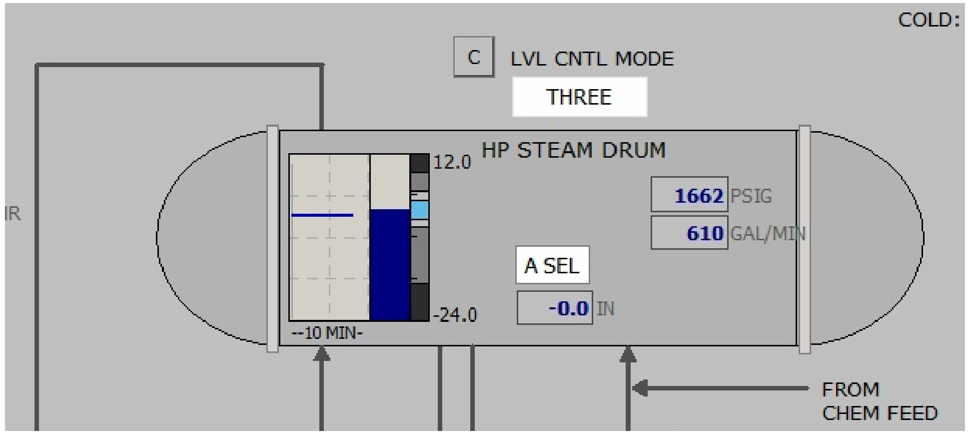
Strategy #2: Adopt High Performance HMI

- “Process graphics that maximize operator effectiveness”
- ISA101 Standard for recommended practices and technical reports pertaining to HMI
- HMI improvement projects are justified by giving operators the tools to successfully run the plant.
- Information needs to be displayed in meaningful and actionable ways rather than as "raw data.

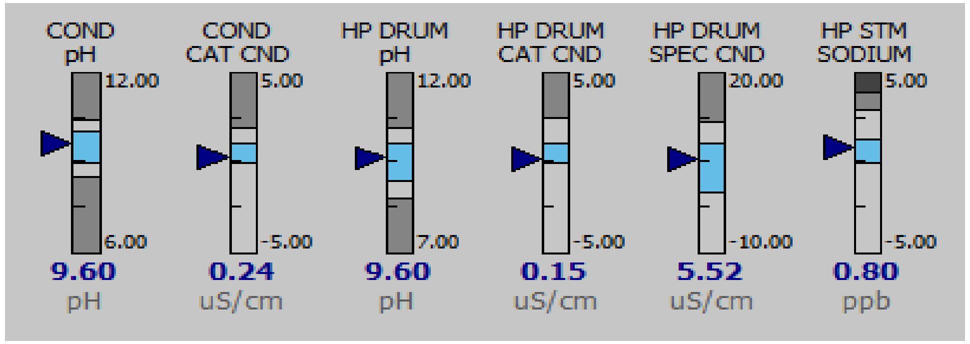
Example: Typical 1990 Graphic



Example: Graphic Enhancements

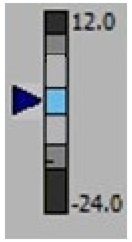


Embedded trend, every colour in use has specific purpose

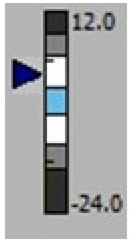


Bar graphs with individual scaling to quickly identify normal operating Conditions as defined by experienced Operators

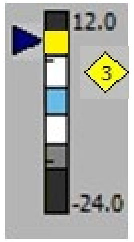
Normal Operating Range



Outside Normal Operating Range



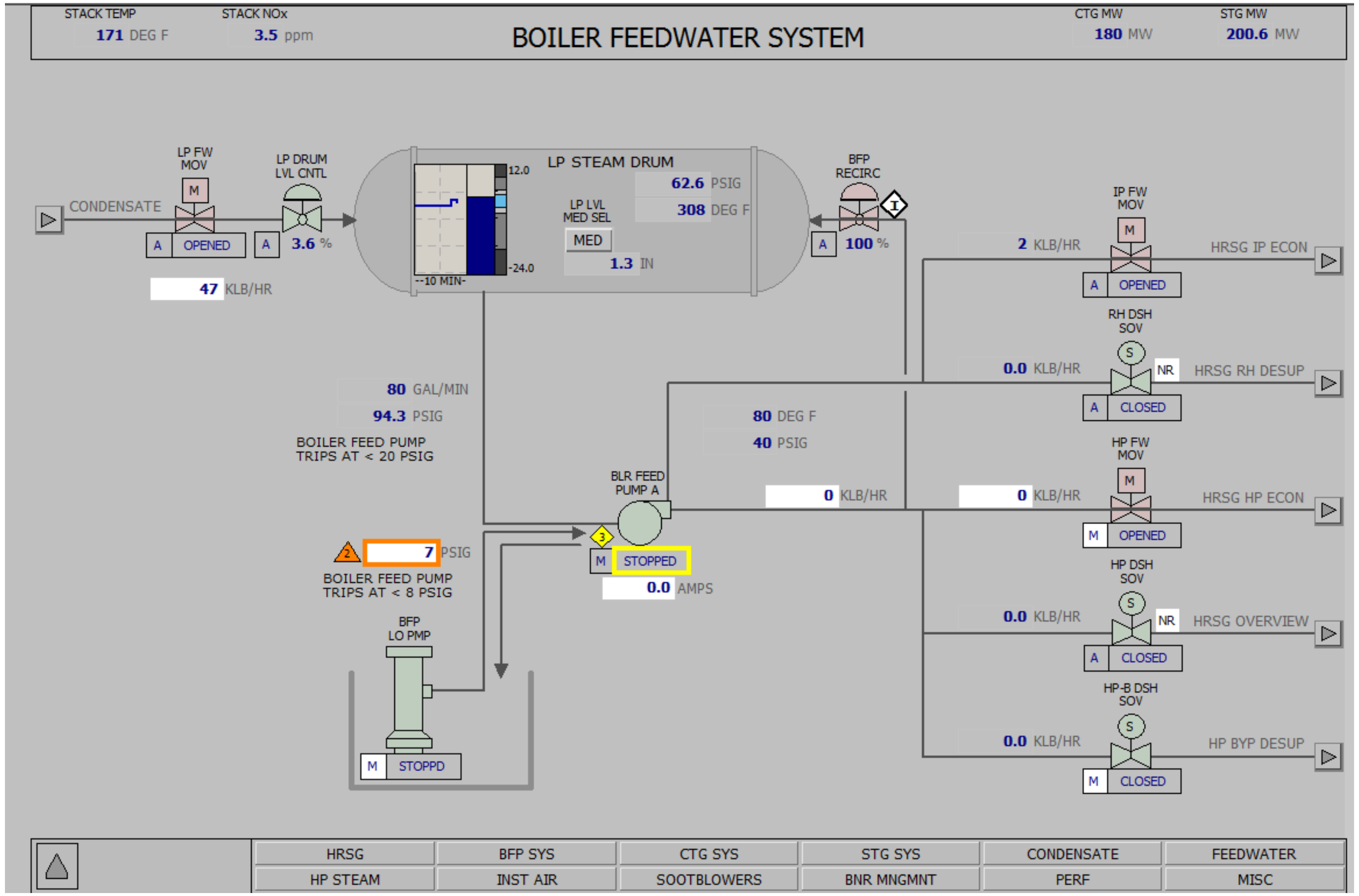
In Alarm



Alarm Priority

Example: High Performance Graphic

- Studies have found High Performance HMI has a lot to offer new operators
  - Intuitive and easy to learn
  - Maximize recognition and response, any colors that are used must be unique and meaningful
  - Graphics are consistent
  - Only information pertinent to operations is presented
  - Navigation is made consistent to facilitate route movements and eliminate guesswork



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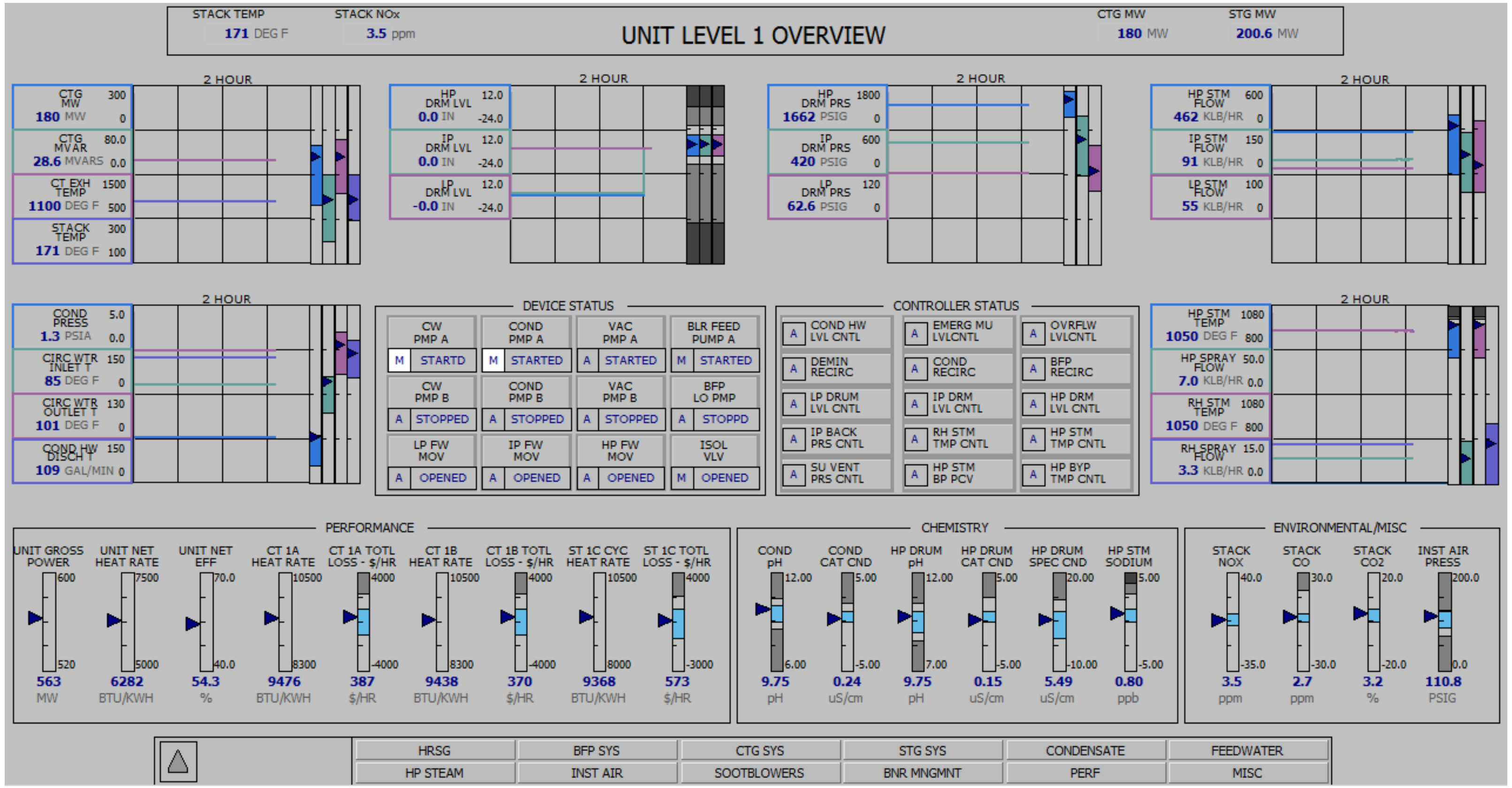
Example: Enhanced Overviews

- Allows Operators to instantly survey the entire plant or a specific area of the plant
- Displays key performance indicators at a glance
- Area level displays include the information and controls to perform most normal operator tasks



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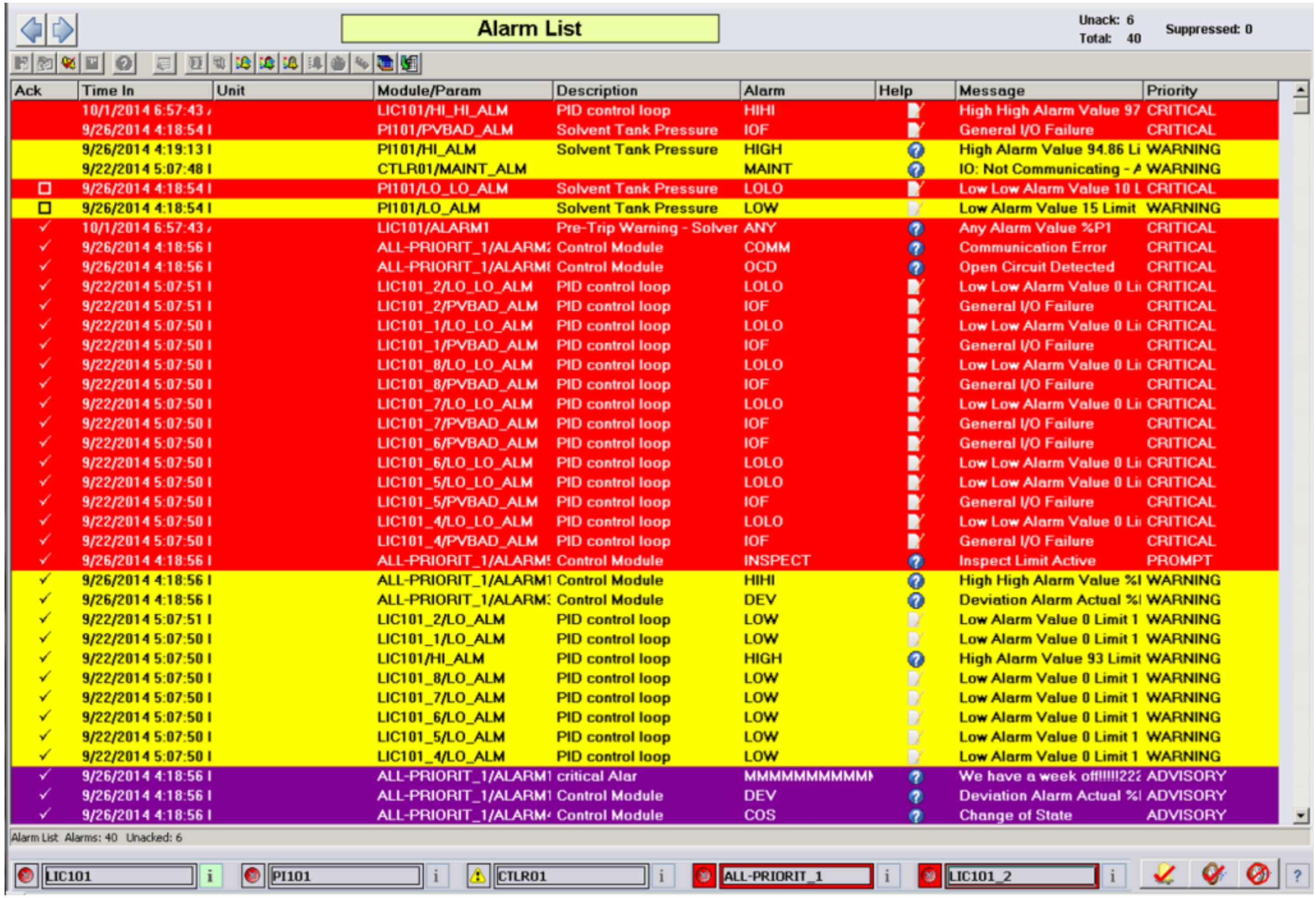
Strategy #3: Alarm Management

- The Goal:
  - Remove noise and distractions from the operator and allow for efficient recovery from plant upset
- How:
  - Reference ISA-18.2/IEC 62682 alarm management lifecycle
  - Identify and eliminate bad actors using alarm analysis tools
  - Perform alarm rationalization
    - reviewing, validating, justifying and prioritizing alarms that meet the criteria of an alarm
  - Develop and digitalize alarm response information

Example: Alarm Flood

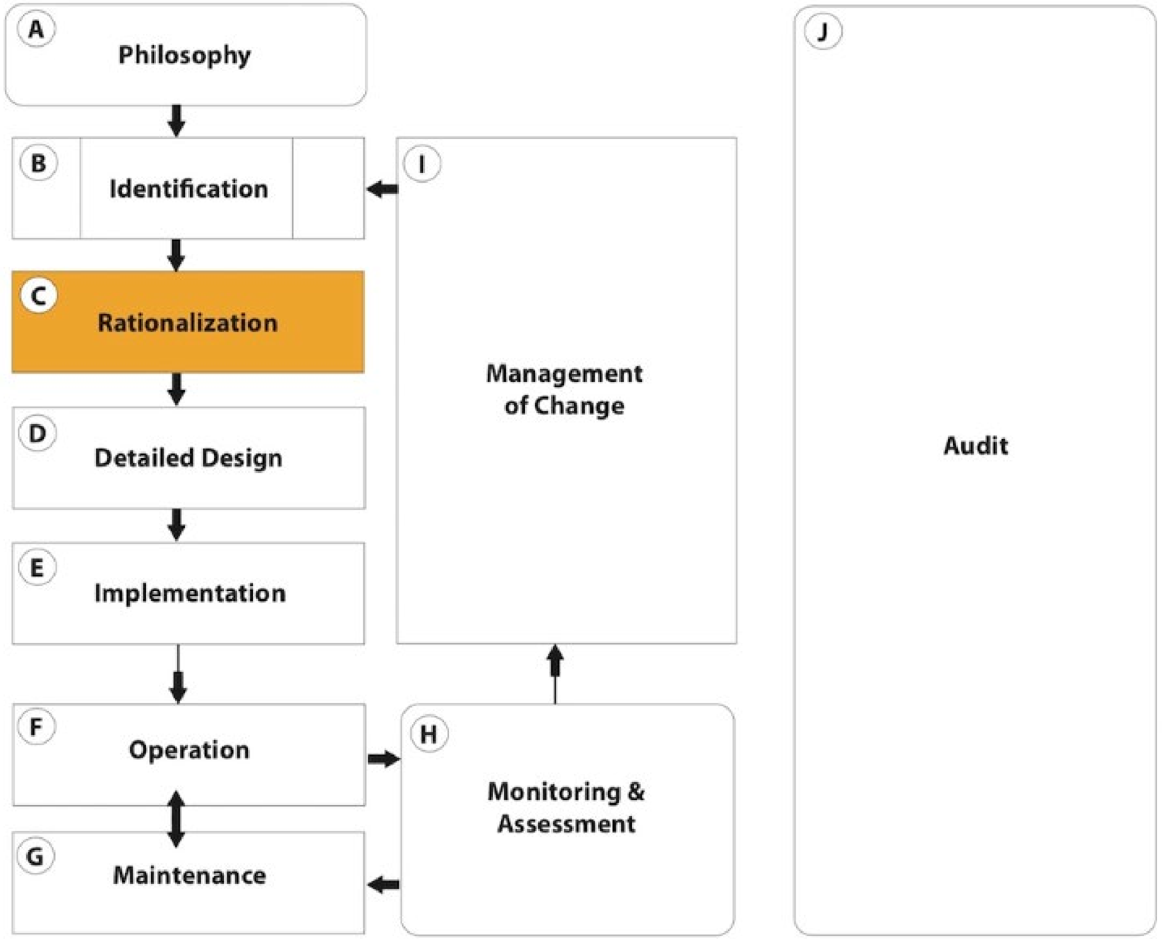


Ack	Time In	Unit	Module/Param	Description	Alarm	Help	Message	Priority
	10/1/2014 6:57:43 /		LIC101/HI_HI_ALM	PID control loop	HIHI		High High Alarm Value 97	CRITICAL
	9/26/2014 4:18:54 I		PI101/PVBAD_ALM	Solvent Tank Pressure	IOF		General I/O Failure	CRITICAL
	9/26/2014 4:19:13 I		PI101/HI_ALM	Solvent Tank Pressure	HIGH		High Alarm Value 94.86 Li	WARNING
	9/22/2014 5:07:48 I		CTLR01/MAINT_ALM		MAINT		IO: Not Communicating - A	WARNING
□	9/26/2014 4:18:54 I		PI101/LO_LO_ALM	Solvent Tank Pressure	LOLO		Low Low Alarm Value 10 L	CRITICAL
□	9/26/2014 4:18:54 I		PI101/LO_ALM	Solvent Tank Pressure	LOW		Low Alarm Value 15 Limit	WARNING
✓	10/1/2014 6:57:43 /		LIC101/ALARM1	Pre-Trip Warning - Solver	ANY		Any Alarm Value %P1	CRITICAL
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM:	Control Module	COMM		Communication Error	CRITICAL
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM	Control Module	OCD		Open Circuit Detected	CRITICAL
✓	9/22/2014 5:07:51 I		LIC101_2/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:51 I		LIC101_2/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_1/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_1/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_8/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_8/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_7/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_7/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_6/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_6/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_5/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_5/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_4/LO_LO_ALM	PID control loop	LOLO		Low Low Alarm Value 0 Li	CRITICAL
✓	9/22/2014 5:07:50 I		LIC101_4/PVBAD_ALM	PID control loop	IOF		General I/O Failure	CRITICAL
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM!	Control Module	INSPECT		Inspect Limit Active	PROMPT
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM1	Control Module	HIHI		High High Alarm Value %I	WARNING
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM:	Control Module	DEV		Deviation Alarm Actual %I	WARNING
✓	9/22/2014 5:07:51 I		LIC101_2/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101_1/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101/HI_ALM	PID control loop	HIGH		High Alarm Value 93 Limit	WARNING
✓	9/22/2014 5:07:50 I		LIC101_8/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101_7/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101_6/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101_5/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/22/2014 5:07:50 I		LIC101_4/LO_ALM	PID control loop	LOW		Low Alarm Value 0 Limit 1	WARNING
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM1	critical Alar	MMMMMMMMMMM		We have a week off!!!!!222	ADVISORY
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM1	Control Module	DEV		Deviation Alarm Actual %I	ADVISORY
✓	9/26/2014 4:18:56 I		ALL-PRIORIT_1/ALARM4	Control Module	COS		Change of State	ADVISORY

Example: Alarm Management Lifecycle

- An effective alarm management program would include an alarm philosophy that includes:
  - Criteria for an alarm
  - Alarm prioritization
  - Alarm dead band and on/off delay
  - Likely causes
  - Consequences of inaction
  - Corrective actions
  - Time to respond

All information stored in a master alarm database accessible by the HMI



ISA-18.2 Alarm Management Lifecycle

Example: Alarm Response Form

- Alarm Response Forms accessible from Alarm List or Faceplate
- Data is stored in a master alarm database which can be accessed by the HMI

Operator Alarm Response

Low | High

Tag Name	LIT06002
Description	Feed Water Heater Level
Alarm Condition	Low
Class	Safeguard
Purpose	To indicate low feed water level
Priority	
Time to Consequence	> 30 min
Time to Respond	Long
Alarm Group	0
Causes	1. Instrument malfunction 2. Normal Level CV response insuficient 3. Emergency Level CV not closed 4. Cascade CV no operating properly
Consequences	If level is too low, then damage to heater tubes (tube leaks. and drain connector) caviation can occur
Confirmatory Actions	1a. Dispatch Operator 1b. Review alarm list on corresponding faceplace 1c. Compare limit switch state with level transmitter 2. Verify normal (and dump. drain CV in automatic. 3. Verify emergency dump drain CV full closed 4. Verify position of inlet
Corrective Actions	A. Monitor level - normal drain CV should return level to setpoint B. Adjust local level controller***NOT the preferred solution*** C. Verify column valve lineup
Automatic Actions	
Escalation	
Notes	

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Strategy #4: Process Simulator for Training

- Utilize a simulator to implement a training program that matches your procedures
- Simulator utilizes the same HMI and a simulated process model for HMI feedback
- How to get started:
    - Assign a simulator champion to develop and procure simulator
    - Define a training curriculum
        - Use your updated procedures (reviewed by experienced operators) as the foundation for training scenarios
        - Add in malfunctions based on feedback from experienced operator
    - Determine initial scope of training but expect to increase overtime

Strategy #4: Simulator Payback and Benefits

- You now have the ultimate training environment
- The Simulator solution can also provide a platform for Continuous Improvement Programs
  - Support OPEX programs (e.g., alarm mgmt., high performance HMI, plant optimization)
  - Pre-validate engineering/equipment updates
  - Support security related activities (patch testing)

Strategy #4: Understanding Simulation Solutions

Things to NOT compromise on

- Virtual Controls: faithful representation of process
- Same HMI as production system
- Good instructor station
  - Ensure repeatability of the training scenarios (predefined with consistent interjection of malfunctions)
  - Make it easy for instructors to measure and track performance
- Ability to expand the simulation solution over time
  - Extend/Improve the modeling
  - Add in additional malfunctions
  - Extend the training scenarios

Things to compromise on (& then potentially expand later)

- Which Models are used & where (fidelity and scope):
  - High Fidelity models, Functional models, or Mix
  - Where are the boundary conditions
- Scope of the training scenarios
  - Basic operations, corner cases, extreme plant operating conditions
  - Turbine controls/HMI (simplified, virtual)
- Scope and complexity of malfunctions
  - Device level failures
  - Complex interactions between plant systems
- Simulation Solution Hardware
  - Physical: Exact match vs reduced set of machines
  - Cloud solution’s can help reduce cost

Thank you

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