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# Operator Effectiveness – The Result of a Management Process Beyond Control System Features

# Why is it important to focus on the operator?



- Over the total life cycle, most important decisions are made by the operator
- The amount of information from the process has increased dramatically
- Experience and operator skills are invaluable assets
- It is difficult and expensive to recruit and train new operators

# Performance shaping factors



Source:

David Strobhar, PE - Beville Engineering Glenn Uhack - Louisiana State University , Craig Harvey, Ph.D., PE –Louisiana State University



# Going beyond the operator workplace

## Overall control room environment is critical



- Dedicated space for control, removes distractions and focus operators on task of controlling the facility.
- Visitor area to keep non-essential personnel out of the control area
- Collaboration space. Meetings, troubleshooting, problem solving with A/V tied to control center visualization.
- Relaxation area for extended shift recharging, separate eating area to avoid noise, segregated printers to remove noise

# Introduction

## Driving effective operations



Drive effective operations with complete plant information

- Greater awareness
- Faster response
- Better decisions

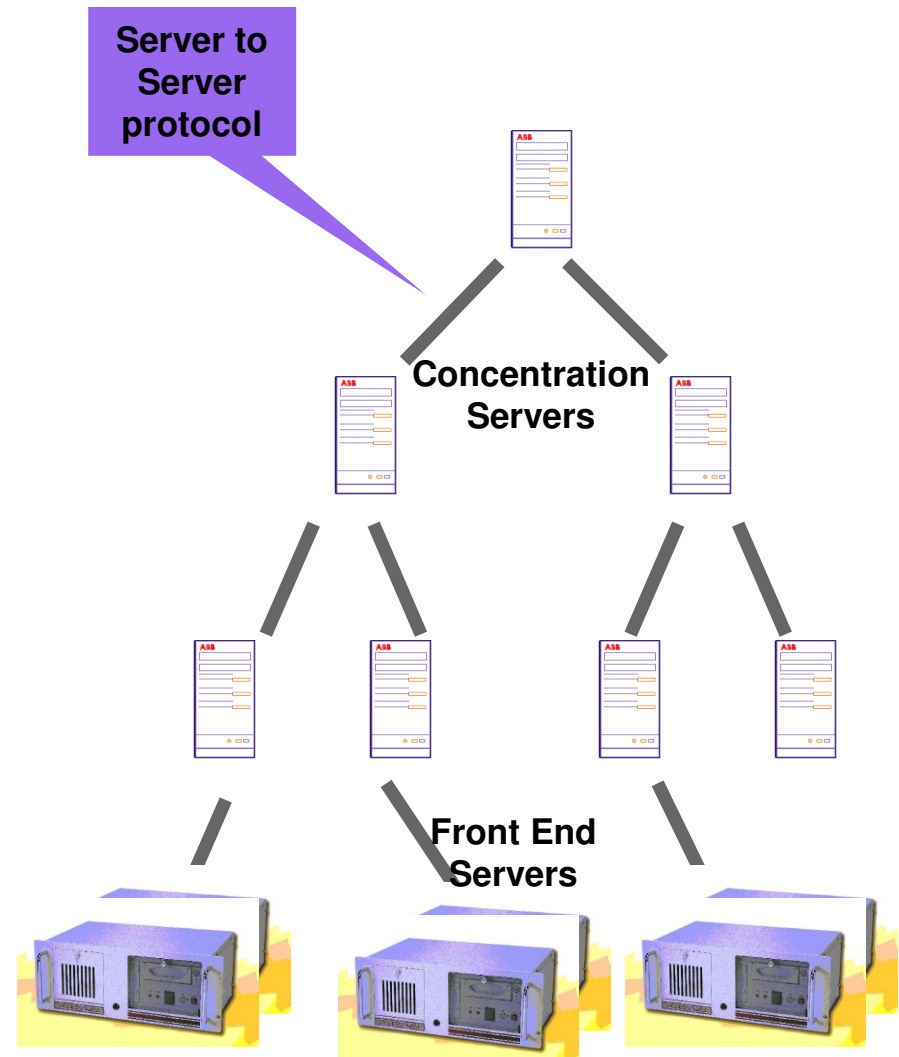
- Secure and powerful ergonomic HMI
- Industry standards based look & feel and ergonomics
- Integration of operations, information, and optimization applications
- Horizontal and vertical navigation to areas, graphics, alarms groups, etc.
- Bi-directional navigation between Operations and Engineering
- User profile recognition / user centric information presentation
- Failure analysis support (display cross navigation: graphics, trend, alarm)
- EEMUA 191 and ISA SP18.2 based alarm and event analysis and management

# Some standards for plant operation

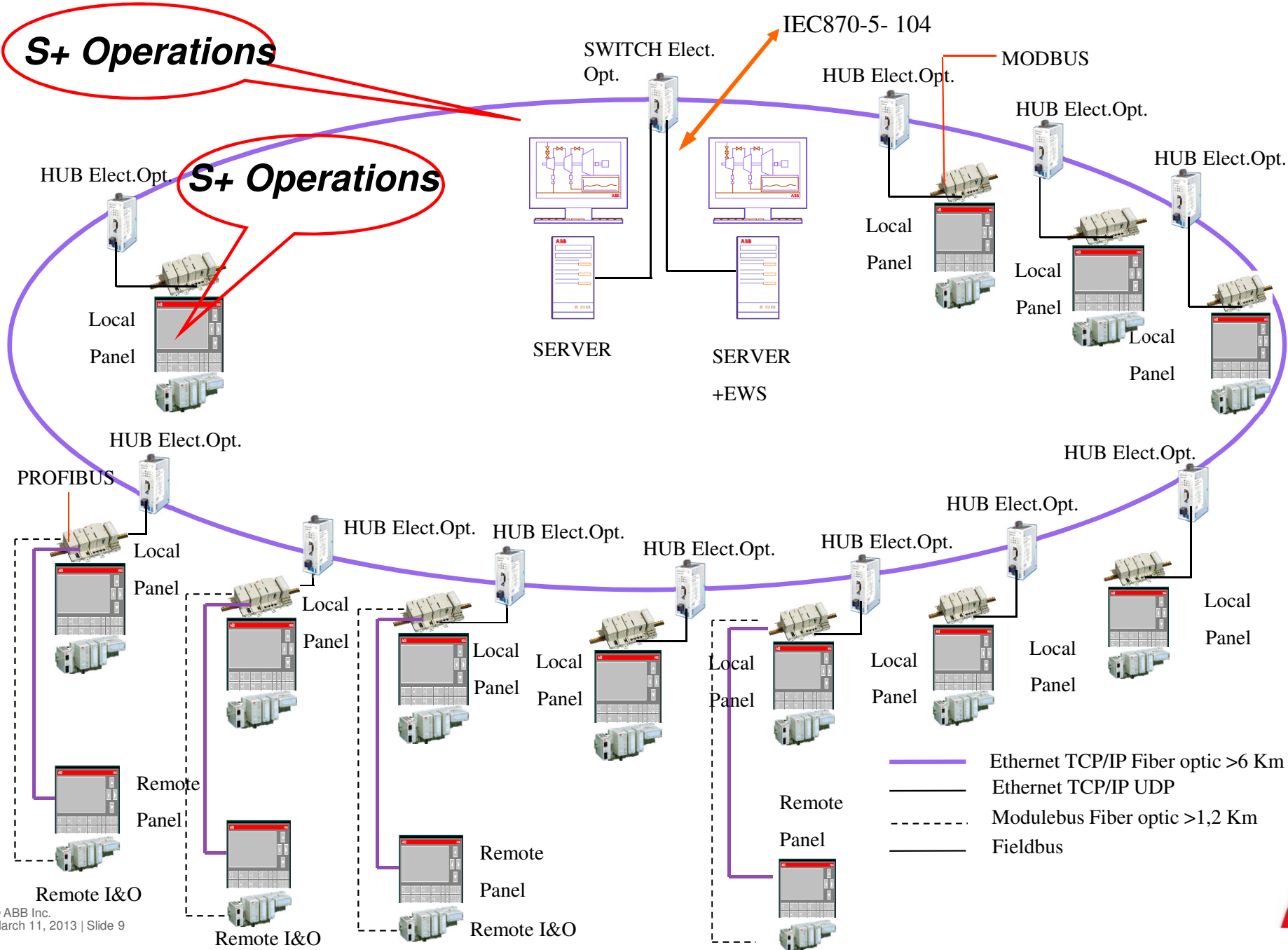
- IEC 60073: Basic and safety principles for man-machine interfaces, marking and identification
- ISO 7000: Graphical symbols
- IEC 60417-1: Graphical symbols for use on equipment
- DIN 19235: Meldung von Betriebszuständen (Annunciation of Process Conditions)
- DIN 30600: Graphische Symbole, Teil1: Bildzeichen (Graphical Symbols, Part 1:Icons)
- DIN 2481: Wärmekraftanlagen, Graphische Symbole (Power Plants, Graphical symbols)
- ANSI ISA RP.5: ON color red required
- IEC 447: MMI Actuating Principles
- ISO 9241-8: Requirements for display colors
- DIN 66234-5, Beiblatt 2: Farbkombinationen (color combinations)
- VDI/VDE 3699: Process control using display screens
  - Part 2: Basic principles
  - Part 4: Curves
  - Part 5: messages
- VGB R170 B3: Design Standards for Instrumentation and control equipment
- EEMUA P 191: Alarm Systems
- ISA SP 18.2: Management of Alarm Systems for the Process Industries
- RDS-PP: Reference Designation System for Power Plants
- ISA SP101: HMI Design
- EEMUA P201: Process plant control desks utilizing Human-Computer Interfaces

# SCADA architecture

- Scalability from very small to very large, from local to wide area networks
- Server to Server proprietary, efficient protocol (based on firewall-friendly TCP/IP sockets)
- Front end servers for Data Acquisition, a cost effective building block for hierarchical systems
- All servers support store and forward (buffering) for data and configuration changes



# SCADA architecture examples: hydro power control



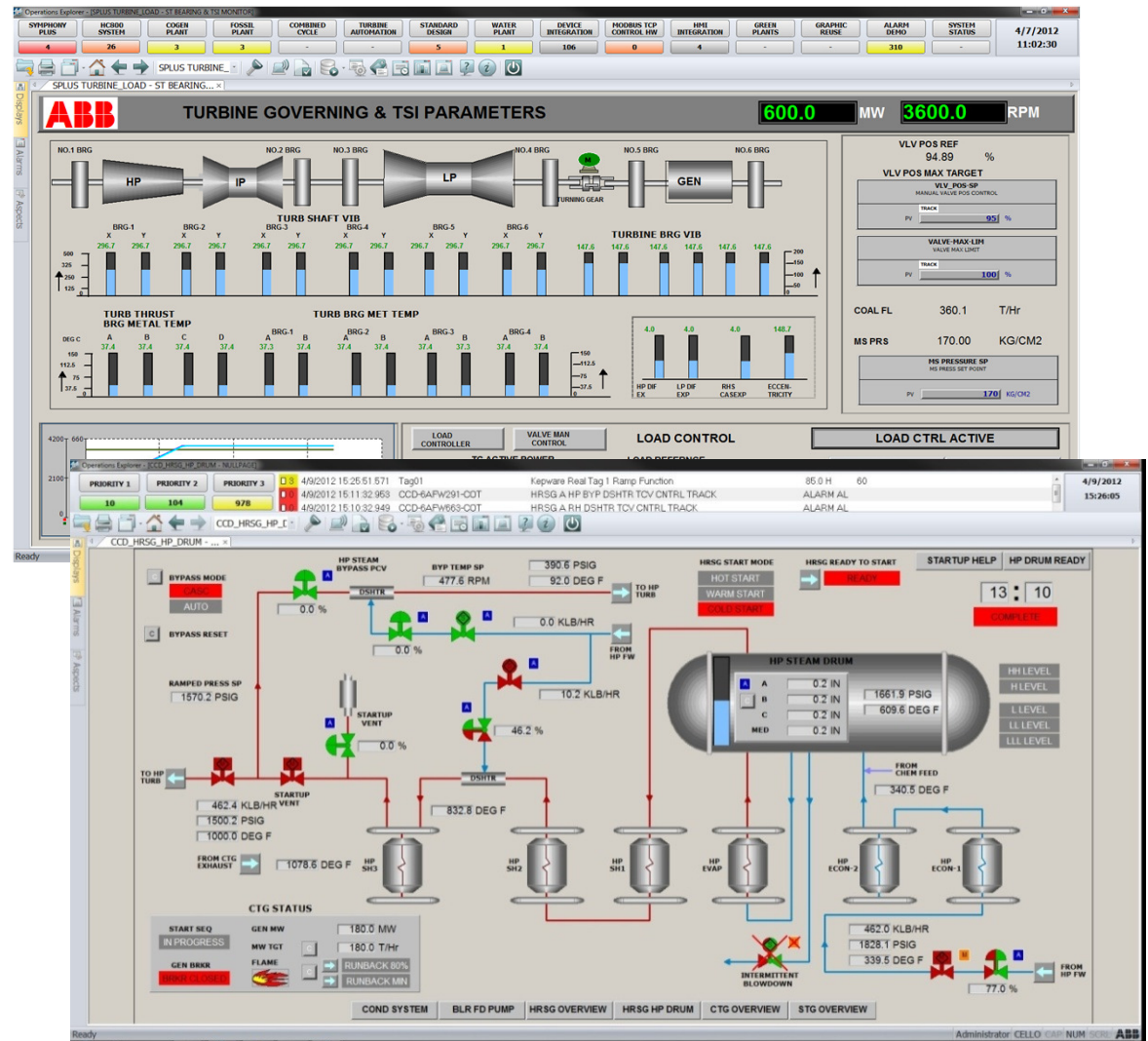


# Operation features

## High performance operator workplace

- Configurable Workplace
  - Display Framework
  - Icon Bars
  - Alarm Buttons
  - Line Alarms

- Examples
  - Alarm Group Centric
  - Alarm Window and Priority Centric



# Operation features

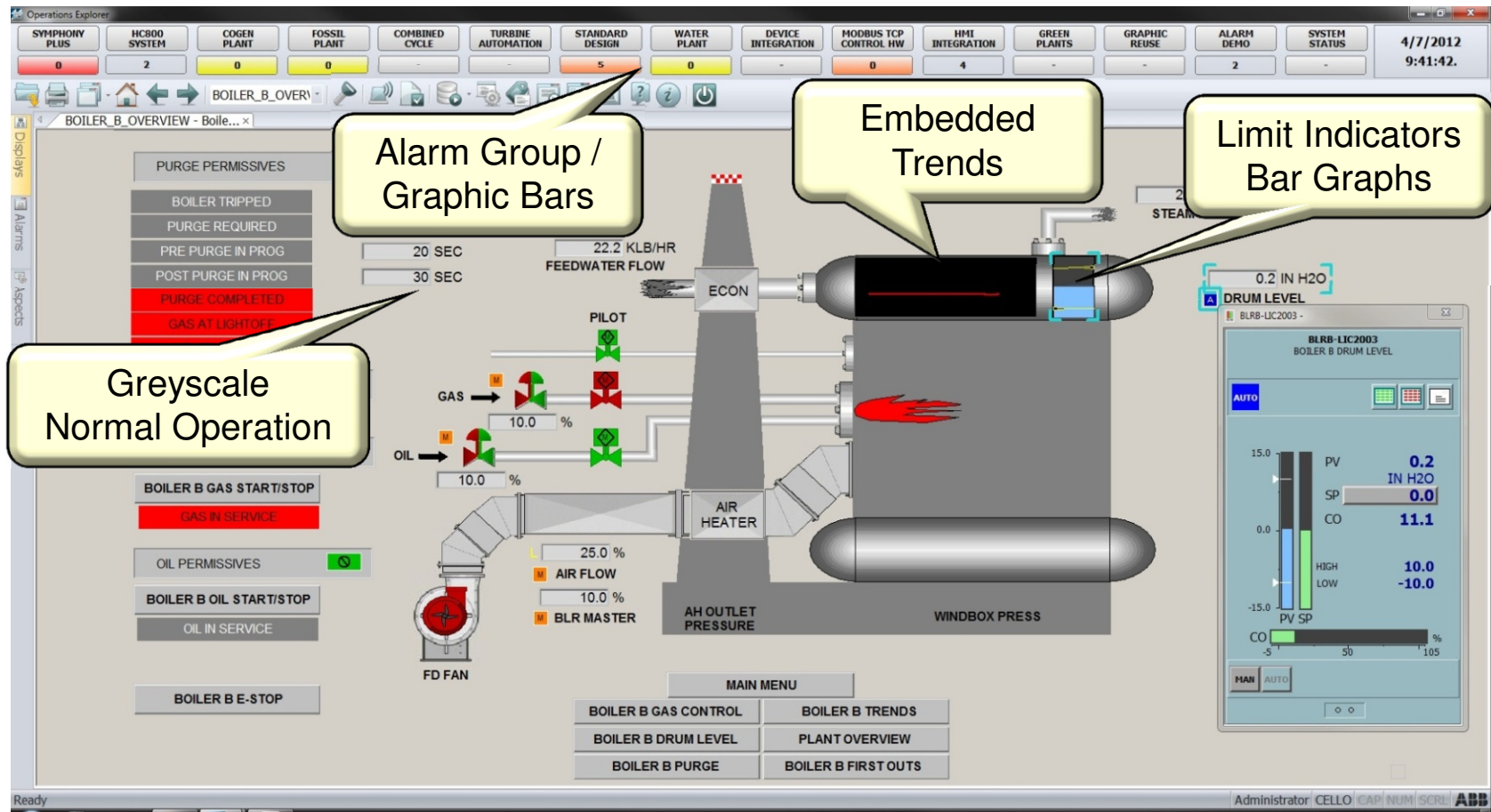
## High performance navigation

Plant operators tell us they like the quick navigation...

The screenshot shows a complex industrial control interface. On the left, a 'Displays' sidebar lists various components: BOP, GT1, GT2, CC1, CC2, CC3, CC4, CC5, and Trends. Three callout boxes point to specific features: 'Icon Bar Navigation' points to the top toolbar with various icons; 'Tab / Tile Windows' points to the 'Displays' sidebar; and 'Side Menu Flyout Navigation' points to the 'Trends' option in the sidebar. The main display area shows a detailed view of 'UNIT #1 CC STEAM OV' with various parameters and indicators, including 'AUX DRUM LEVEL TRANSMITTER 1CH96LDL3 IN H2O', 'DRUM LEVEL 1CH96LDLSEL IN', 'DRUM PRESS 1CH96PDPSEL PSI', 'SPEED 1CTSPEED', 'EXHAUST 1CTEXHAVG F', 'SPREAD 1CTSPEED F', and 'CRANKING MOTOR'. A 'WARMUP' progress bar is visible at the bottom.

# Operation features

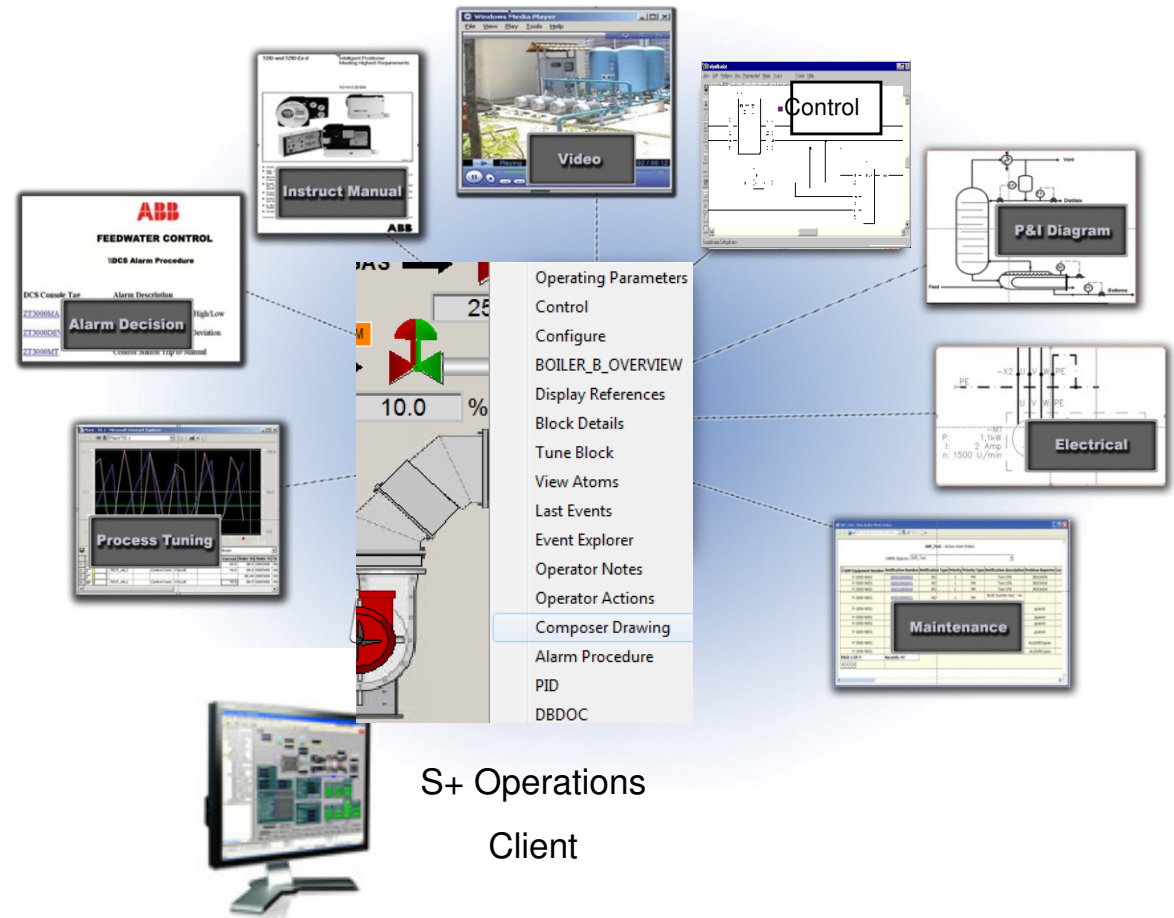
## High performance graphics



# Operation features

## High performance aspect links

- Aspect Links (Right Click)
  - Quick navigation to graphics & trends
  - Custom links per tag
  - Link to documents or launch applications:
    - Instruction manuals
    - Maintenance packages
    - Standard operating procedures
    - Web pages
    - Plant P&ID's
    - Operator notes
    - Control logic

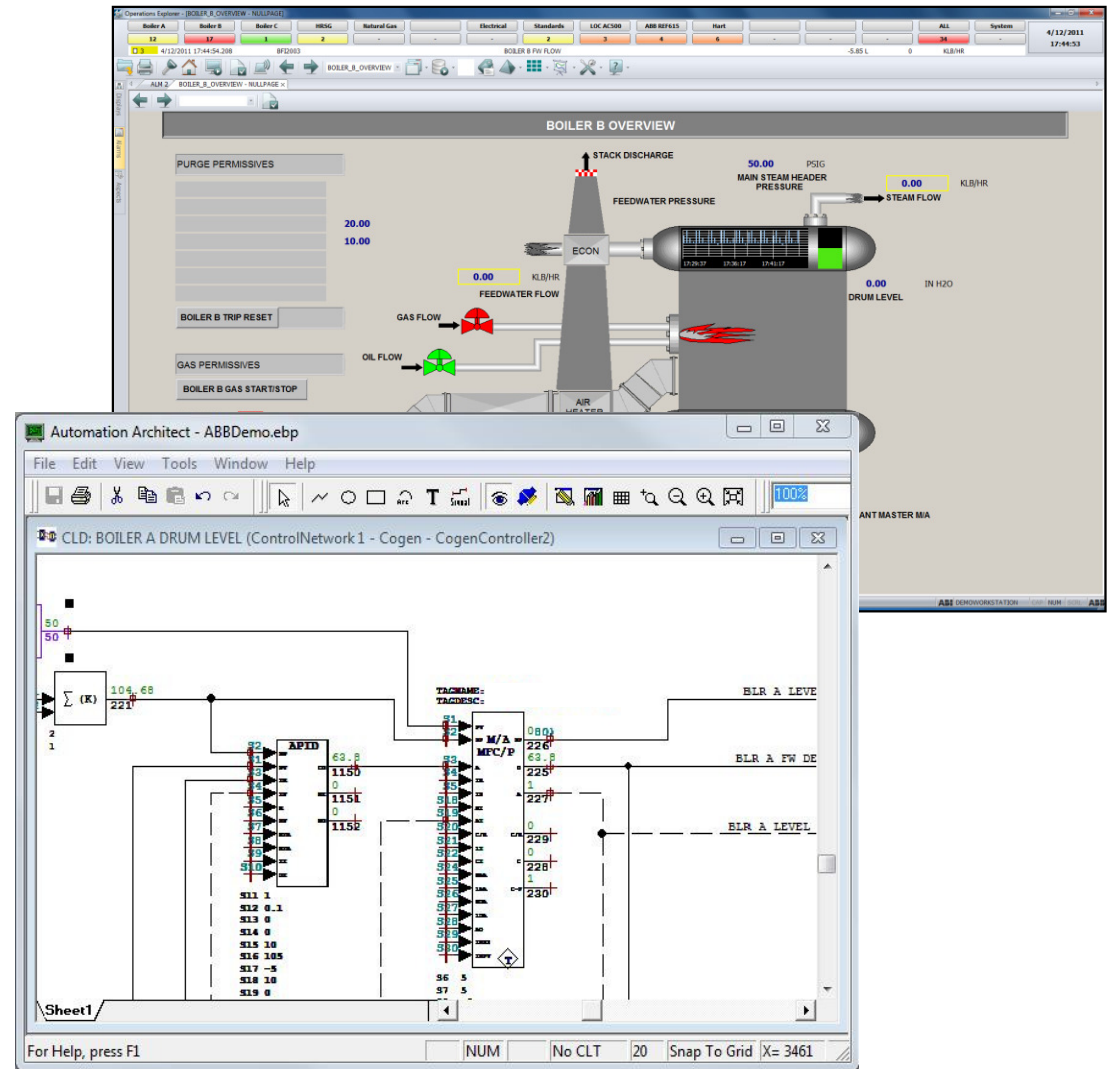




# Operation features

## View engineering tool logic (View and Monitor)

- Right click navigation
  - Graphic to engineering tool logic
  - Alarm to Composer logic
- View logic
- Monitor status in real time
- Navigate within Composer



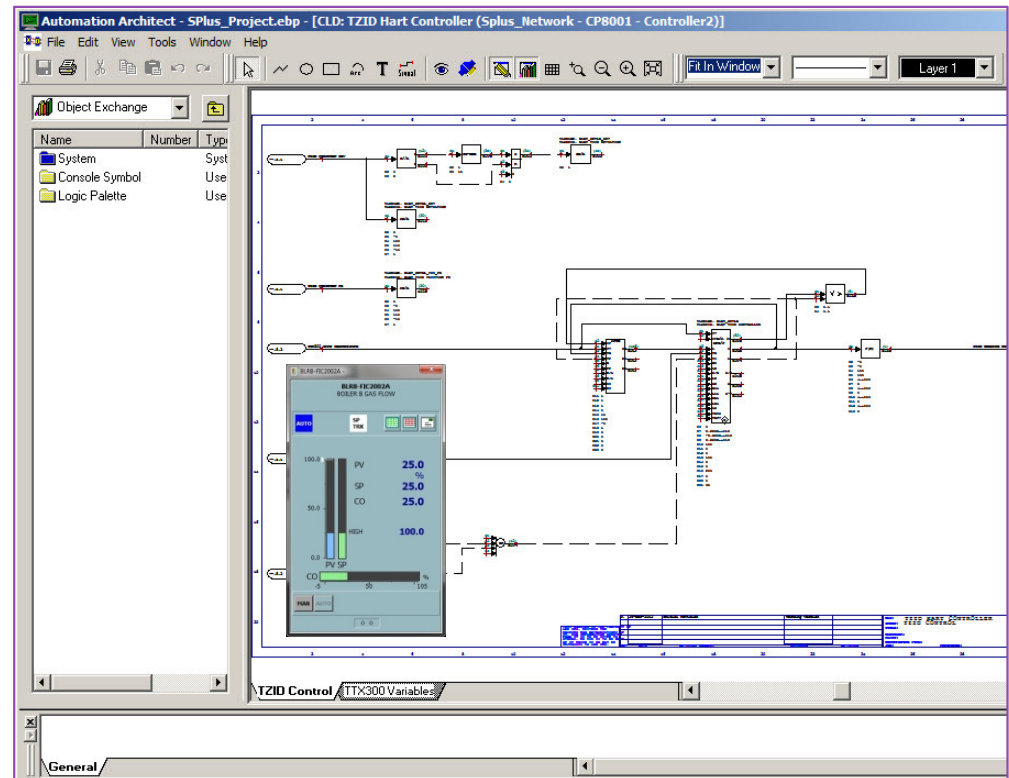
# Operation features Melody IDF and SFC Viewer

The screenshot displays the ABB Melody IDF and SFC Viewer software interface. The main window shows a process flow diagram for 'BOILER B O' with various control blocks and sensors. The interface includes a top navigation bar with buttons for 'Boiler A', 'Boiler B', 'Boiler C', 'HRS', 'Natural Gas', 'Electrical', 'Standards', 'LOC ACS00', 'ABB REF615', 'Hart', 'ALL', and 'System'. A date and time display shows '4/12/2011 17:44:53'. On the left, there are panels for 'PURGE PERMISSIVES', 'BOILER B TRIP RESET', 'GAS PERMISSIVES', 'OIL PERMISSIVES', and 'ALM 5' (alarms). On the right, there are data tables and a graph. A 'SFC Viewer' window is open in the foreground, showing a sequence of logic blocks: 'refresh', 'U280\_T058 001', 'U280\_T058 002', 'U280\_ANALOG AHY01', 'U280\_BFLAGANA 003', 'U280\_IDFO1 0E0\_01', and 'U280\_IDFO2 0E0\_01'. The SFC viewer also shows logic symbols like '>=1', '&', and 'VAR'.

# Operation features

## View HMI faceplate from engineering tool

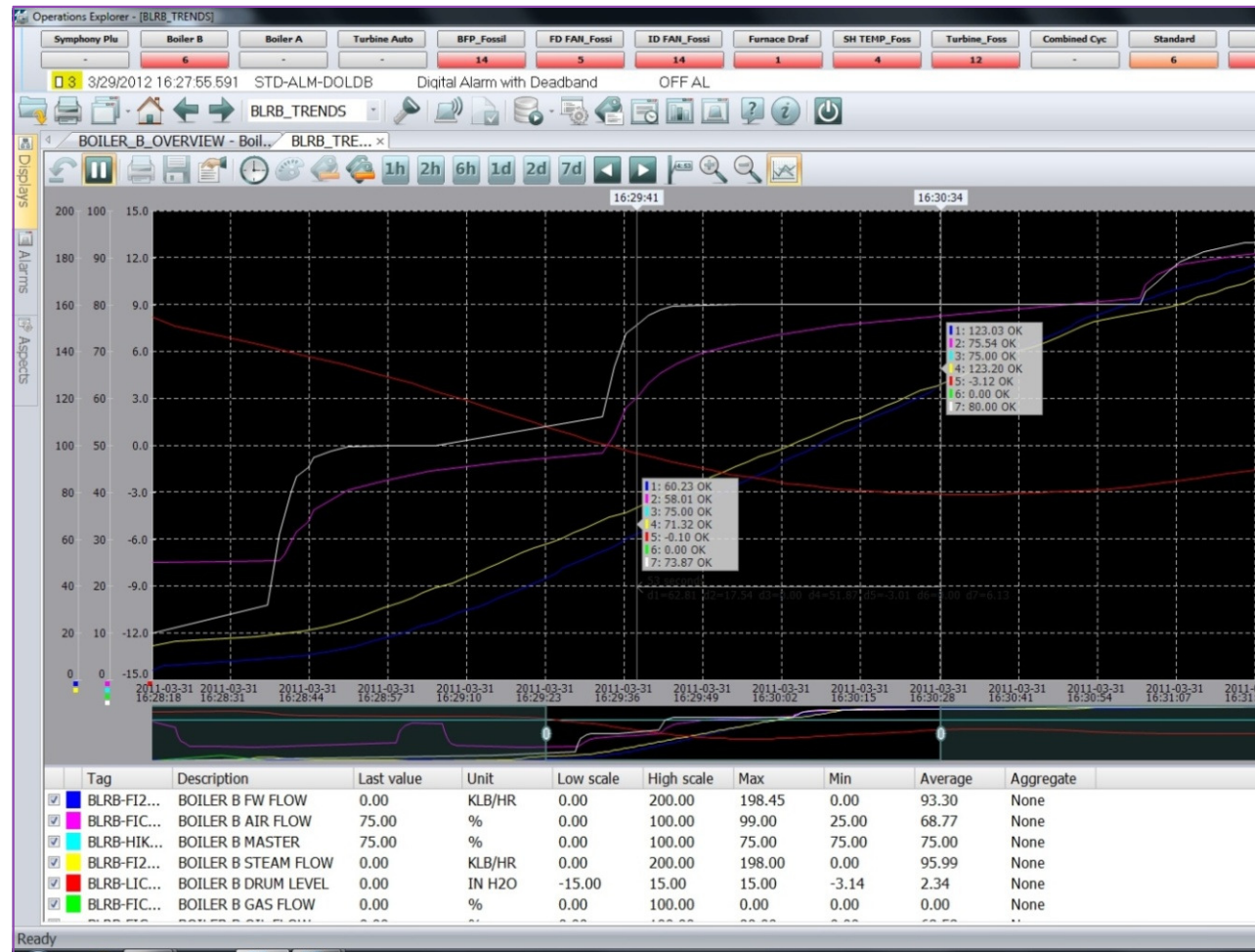
- Right click navigation
  - Exception Report block to faceplate
- Supports engineering maintenance / tuning
- Automatically configured within system



# Operation features

## High performance trend window

- Enhanced operator trend feature
- Icon selection bar
- Mouse selectable traces
- Mini preview trend
- Drag focus window
- Drag and drop PV's
- Export functions
- Ruler views (Scooter)
- User configurable
- No trace limitation
- Operator trend Integrated with history

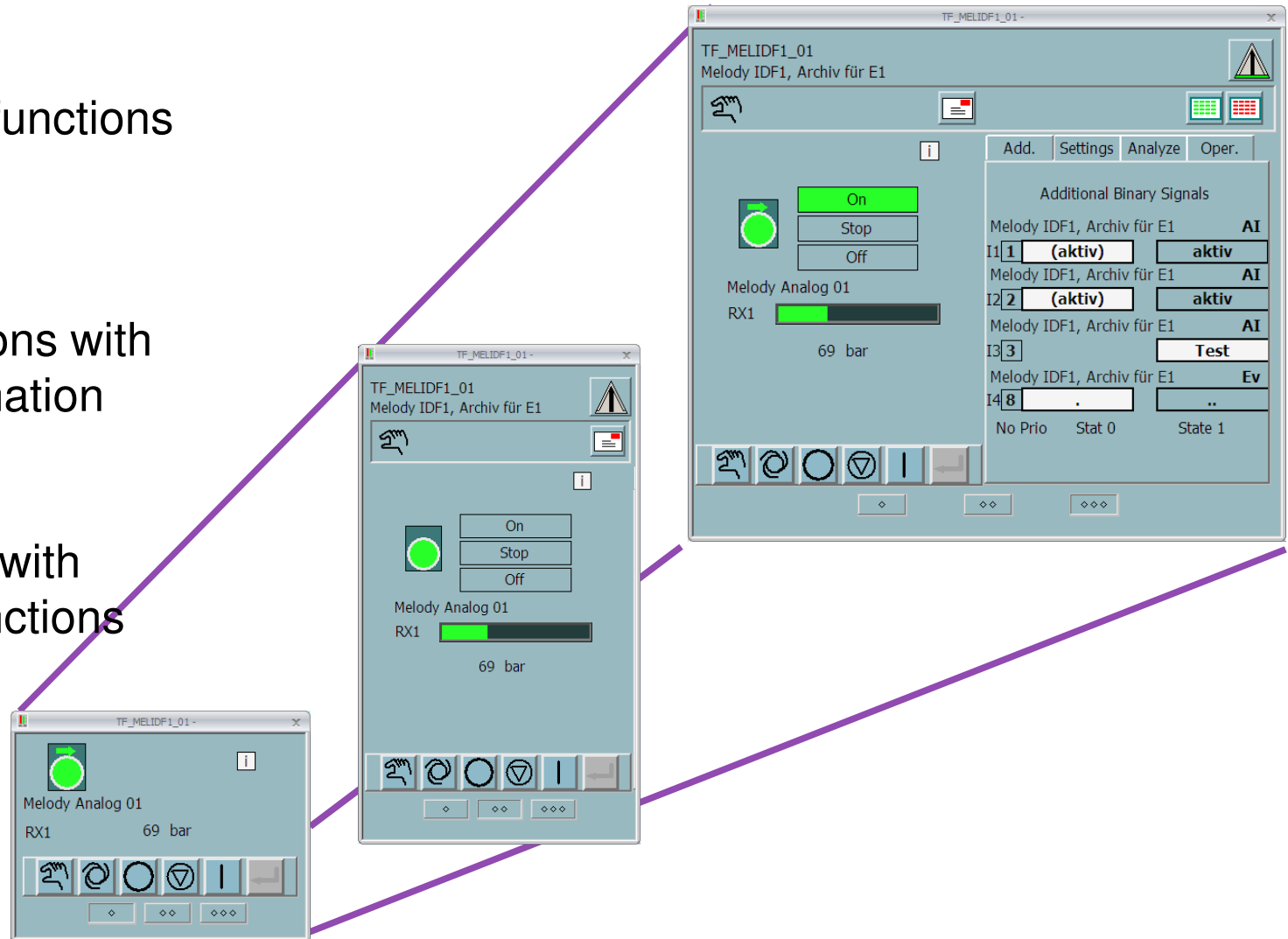




# Operation features

## Information zoom (e. g. Symphony Plus)

- Reduced faceplates:
  - Basic operations functions are present
- Standard Faceplate
  - Operations functions with some extra information
- Extended Faceplate
  - Deep information with many analysis functions



# Information Management

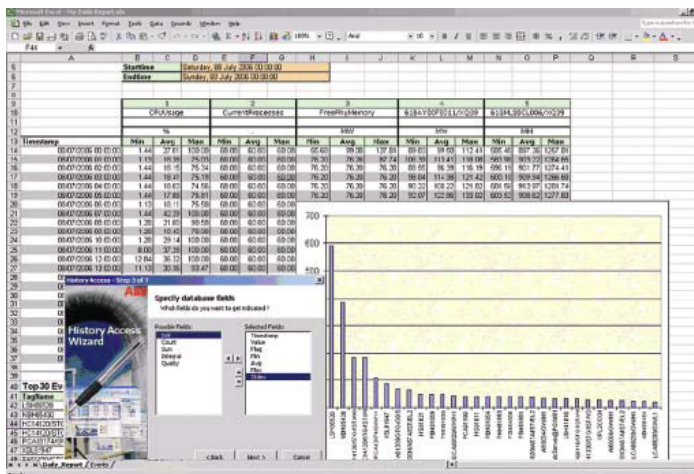
## Making real-time business decisions

Sustain profitable growth by transforming data into actionable business decisions



- Business and performance monitoring functions improve plant productivity and profitability
  - Seamless view of real-time and history
  - Discrete tag tickers / KPI reporting
  - History data from all sources
  - Flexible ready made report templates (e.g. SOE, trip, operation, status, etc.)
- Integrated applications assess plant equipment performance
  - Monitor and report equipment degradation
  - Performance displays indicate effects of current conditions on plant heat rate and fuel costs
  - Performance alarms and CMMS connectivity streamlines maintenance

# Information Management: integrated historian



- Full featured historian integrated within S+ Operations
- Best in class historian feature and performance wise
- Excel reporting and scheduled reports
- Calculation package / maintenance totalizers
- EEMUA 191 alarm management analysis
- Process optimization platform used with OPTIMAX plant performance applications
- Supports thin client (web browser based)
- Supports full client

# Information Management Logs/Reports (Excel integration)

The screenshot shows an Excel spreadsheet with a report titled "Section 3 Average Values". The report has columns for "Day", "Hour/End Time", "Generator Efficiency", "Inverter Efficiency", and "Eco Efficiency". A "History Access Wizard" dialog box is open, showing a list of possible fields (Avg, Max, Stdev, Diff, Count, Sum, Integral, Quality) and selected fields (Timestamp, Value). The wizard also allows the user to specify the order (ascending or descending) and the sort field (Timestamp).

- Balance reports
  - Typical values for operation tracking
    - Average values
    - Max/in values
    - Totals
- Trip reports
  - Presentation of process behavior with configurable:
    - Time intervals
    - Time range
- Maintenance reports
  - Informs the maintenance staff about:
    - Actual operating hours
    - Actual switching cycles
    - Identification of components to be maintained

The screenshot shows the "Signal Explorer" window with a list of signals and their sources. An "Event Access Wizard" dialog box is open, showing options for selecting the top left cell (Sheet1!\$E\$5), matrix direction (top to down), and other options like "Insert header info", "Add grid lines", "format cells", and "odd-even coloring".



# Alarm Management

## How is your alarm system performing?

- Do you recognise any of these behaviours?
  - Operators acknowledge / silence alarms without looking at or acting on them?
  - Incidents or near-incidents where operators missed alarms?
  - Acoustic alarms turned off?
  - Operators don't know what particular alarms mean?
  - Alarms disabled / suppressed for long periods without review?
- Do you measure?
  - Number of alarms / hour?
  - Number of alarms disabled / suppressed?
  - Time to silence / acknowledge?

# Alarm Management

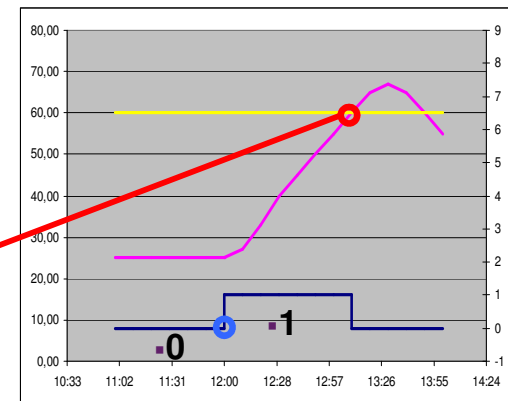
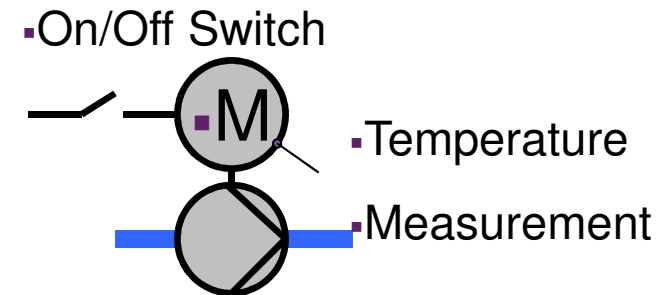
## How is your alarm system performing?

- How stressed are your operators?
- Do you have a documented alarm philosophy?
  - Have you described roles and responsibilities?
  - How do you review and implement new alarms?

# Alarm Management

## Definition: Binary value, Event, Alarm

- Binary value
  - value = 1 (Motor is on)
  - value = 0 (Motor is off)
- Event (Information)
- Motor has been switches on at 12:00 h
- Alarm (Action required)
- Temperature of Motor exceeds high limit of 60,00 at 13:10 h



# Alarm Management Principles

## Lifecycle for Alarm Management





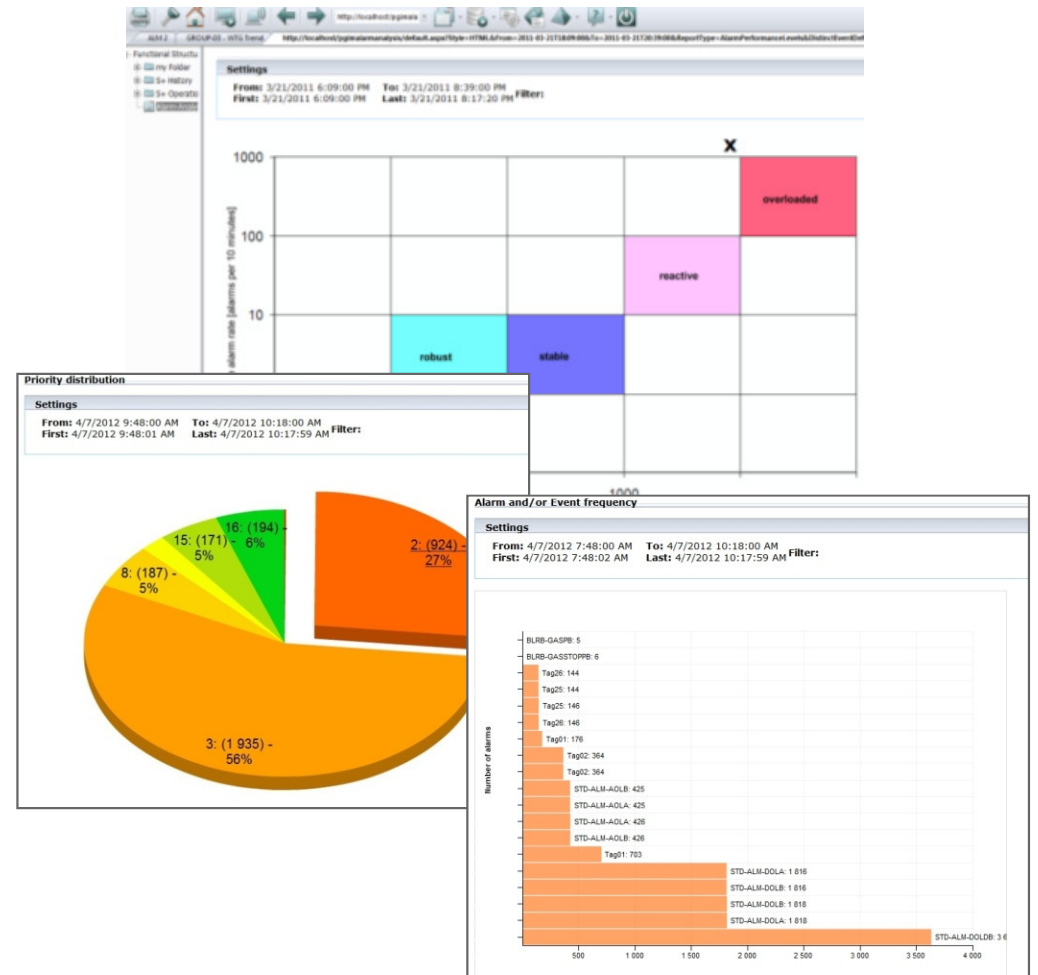
# Continuous Alarm Management

- Alarm Management as a one shot activity will not work, because alarm system quality degrades over time
- Operators have most benefit from a high quality alarm system, so they are motivated to help to maintain it
- With help of appropriate tools, operators can integrate alarm management as part of their routines, e.g. as part of
  - shift hand-over discussions
  - weekly team meetings
- From this perspective a nuisance alarm will be handled similar to a broken device

# DCS operations

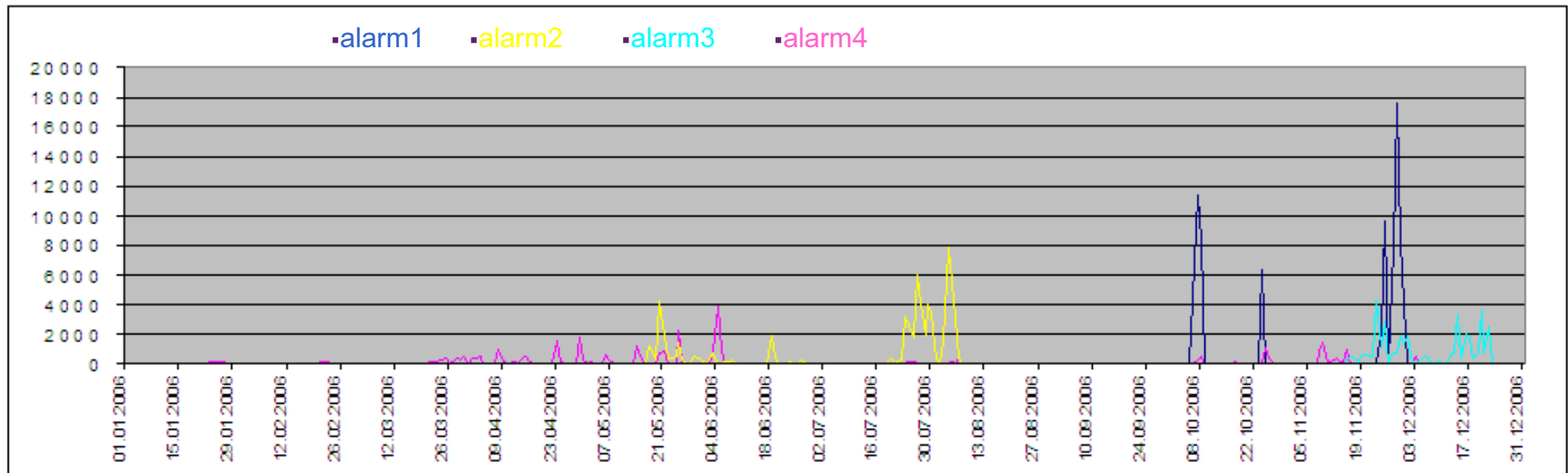
## Integrated Alarm Analysis Tools

- Supports EEMUA 191
- Integrated Alarm Analysis
  - Instantaneous Reports
  - Alarm / Event Frequency
  - Alarms over Time
  - Priority Distribution
  - Alarm Duration
  - Time to Acknowledge
  - Alarm Performance
  - Loops in Manual
  - Operator Actions
  - Exceeding Threshold
  - Standing Alarms
  - Co-Occurrences



# Alarm systems degrade over time

- Example: 2006 distribution of the top 4 alarms in a plant
- Many of the top alarms appeared in delimited episodes



- Reasons for such episodes:
  - Device broken
  - Process/automation modified

# Shift Hand Over Report

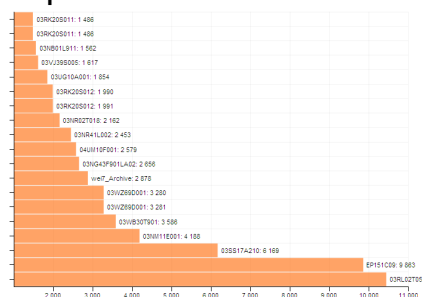
It can be used as a checklist during the hand-over discussions to pinpoint important issues during the last shift.

**PGIM Alarm Management**

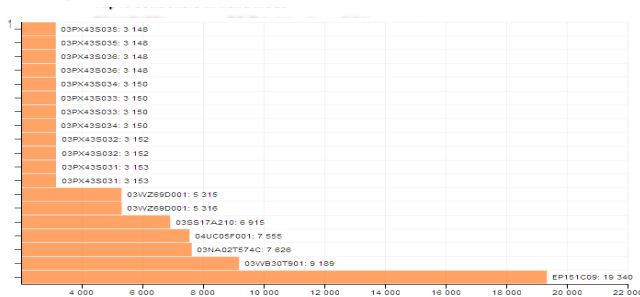
Creation Date: 10.01.2008 15:30      From: 11.10.2007 06:00:00  
 User: Hans Mustermann              To: 11.10.2007 14:00:00

**Shift Hand Over Report**

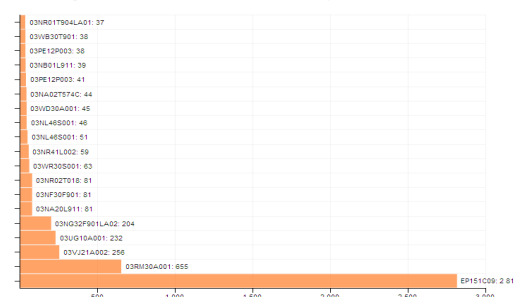
Top10 alarms



Top10 controllers in manual mode



Top10 disturbed signals



Alarms from last shift

03HA3T005	T OAK K2mer 3.4	2007-10-11T06:48:16
04UC41001	Kompl 2 B1W Entweg v Dreh	2007-10-11T08:45:57
04UC41001	Kompl 2 B1W Entweg gr Dreh	2007-10-11T08:45:57
03H05M001	P1 Schw2 in V08	2007-10-11T12:08:22
03HA2L001	L Wa H02 Errechen	2007-10-11T12:35:50

In manual mode last shift

03V6110001	VW Leerlauf/Brems Ruldrho 1	2007-10-11T12:10:21
03V6120001	R1 Ansaugvl + Multikomer 2	2007-10-11T12:12:10
03V6120008	R1 Errechen Multikomer 2	2007-10-11T12:12:19
03V6110001	R1 Ansaugvl + Multikomer 1	2007-10-11T12:13:33
03V6110008	R1 Errechen Multikomer 1	2007-10-11T12:13:42

Disturbed signals since last shift

03HA2L001	L Wa H02 Errechen	2007-10-11T12:35:50
03H05M001	T Rungas + Waecher	2007-10-11T13:56:59

Active Alarms that originated in the last shift

- Most frequent alarms during the last shift
- Control loops put in manual mode during the last shift
- Control loops most frequently put in manual mode during the last shift
- Disturbed signals during the last shift

Automatically generated at the end of each shift



# Alarm duration report

PGIM Alarm Management - Microsoft Internet Explorer provided by DECRC/K2

http://localhost/pgimalarmanalysis/default.aspx?Style=HTML&From=2007-11-01T00:00:00&To

File Edit View Favorites Tools Help

PGIM Alarm Management

AlarmDuration

Settings

From: 11/1/2007 12:00:00 AM To: 11/1/2007 12:00:00 AM

First: 11/1/2007 12:00:00 AM Last: 11/1/2007 12:00:00 AM

source	condition	name	count	total	max	min	avg	std
13WD33001L802	XG02	Schuma Znf 33						
13WD33001L802	XG02	Schuma Znf 33						
13WD33001L802	XG02	Schuma Znf 33						
13WD33002L802	XG02	Raumer Znf 33						
13WD33002L802	XG02	Raumer Znf 33						
13WD33002L802	XG02	Raumer Znf 33						
13PD14H001	XU01	Regline 1 300						
13PD14H002	XU01	Regline 2 300						
13PD14H003	XU01	Regline 3 300						
13VF980116	XB02	Air Entsch 1 WasLan						
13VF900020	XB01	Pumpe 2 WasLan						
13V125U302A	XU03	VW WasLan						
13VF900010	XB01	Air Hygig WasLan						
13NK70F001LAD1	@0001/3901/5701	Analognk 1 300						
13WD330010	XG02	Drehzahl Raue						
13WD330010	XG02	Drehzahl Schleudern	54	35681	661	3	659	669
13WD330P003	ZH52	F Oseauspension N Pumpen	75	34857	465	68	34	517
13WD190010	XG02	Drehzahl Raumen	53	34802	657	2	656	664
13NR01LAD11	XH01	CO Versuchsm. Niteln. N.	155	34756	224	396	8	3007
13PD14T001	XH03	T nach 300-Entlastpumpe	15	32832	2189	100	2003	2340
13WD13001L802	XG02	Schuma Znf 13	20	28296	1415	252	1174	1727
13WD13002L802	XG02	Raumer Znf 13	29	26685	920	581	10	1739
13WA02Q820	XU01	Q spez Wärmelast Zone 30	11	23108	2101	1521	502	5548
13WB03C300	XM01	Wind Str P H2O	23	23021	1001	1020	39	3922
13VF900010	XB02	Air Hygig WasLan	58	21951	378	954	7	5606
13VF980116	XB01	Air Entsch 1 WasLan	66	21734	329	876	0	5391
13VF900020	XB02	Pumpe 2 WasLan	62	21615	349	925	2	5602
13WD19V001	XH52	V Zentrifuge 19	70	21608	309	99	203	475

- maintaining a good alarm system quality becomes part of daily plant hygiene, just like brushing one's teeth in the morning.
- In addition to shift hand-over reports, continuous improvement should contain the standard and more long-term Alarm Management feedback loops
  - a monthly or annual review of the overall alarm system quality.



# Conclusion

- Many of today's power plants have alarm systems that overburden the operators with nuisance alarms
- Too many alarms is as bad as too little alarms, both results in unrecognized alarms by the operators
- Guidelines like EEMUA 191 or the ISA 18.2 should be used to improve the alarm system quality
- Keeping a good alarm system quality requires continuous effort and processes
- Continuous alarm management should be part of the daily operators routines

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