



Enabling Conditioned Based Maintenance and Improving Asset Health

Presented by **Chris Crosby** (ccrosby@osisoft.com)
21st-22nd June, 2012

Presented at: OSIsoft India Regional Seminar

Agenda

- Conditioned Based Maintenance
- Asset Health
- Use Cases

India and America – Common Values, Shared Success
op ed last September, 2011, [USINPAC Blog Network](#)

“The remarkable deepening of US-India ties over the past decade is only a start, as the relationship has still not reached its full potential. If Indians and Indian-Americans continue to contribute their ideas, their energy and their commitment, I am sure that even more exciting days lie ahead.”

Senator Richard Lugar, the Republican leader of the U.S. Senate Foreign Relations Committee

OSIsoft Receives E Award
May 17, 2012

U.S. Department of Commerce Secretary John Bryson at the White House in Washington, D.C. The “E” Awards are the highest recognition any U.S. entity may receive for making a significant contribution to the expansion of U.S. exports.

Europe represents a significant portion of the company's foreign market sales, and over the past few years the business has expanded significantly in other key markets such as Asia and Latin America.

Underlying Assumption

“Household electricity consumption is widely viewed and accepted as providing substantial standard of living (quality of life) gains. These gains come in many areas...refrigeration of food (health), lighting for reading (literacy), computers and internet access (education), productivity (income)...and suggest that observable household electricity consumption may provide useful insights into the nature of standard of living across countries and its changes over time.”

by

Roselyne Joyeux and Ronald D. Ripple in *The Evaluation of Standard of Living and the Role of Household Electricity*

4

About OSIsoft and PI System

Corporate

- Founded 1980 by Dr. J. P. Kennedy, CEO
- Privately held
- Headquarters - San Leandro, CA
- Doing business in 110 countries
- 23 offices in 13 countries with corporate presence in 10 countries

Revenue

- 2011 Revenue \$273MM; 2012 >820 employees

Installed Base

- 2,800+ Active Customers
- 10,000+ Active System licenses (excluding OEM)
- 32,000+ I/F licenses
(connection, node, server, site)
- 250,000+ Clients Licenses (individual, concurrent, enterprises)
- 250,000,000+ Data Streams



Managed PI (mPI)

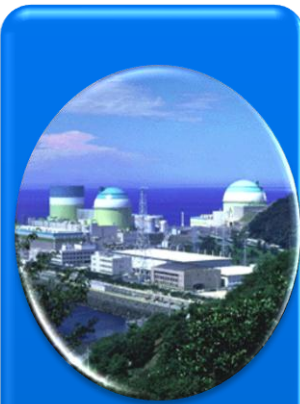
- 612 Systems
- 803 PI Servers
- 77 Enterprise Agreement Customers
- Network Operation Center (NOC)
PI Server has 1,206,080

OSIsoft Power & Utilities Industries



Power Gen Thermal

- Coal
- Gas
- Oil



Power Gen Nuclear

- Generation
- Fuel
- Regulators
- Services



Power Gen Renewables

- Wind
- Solar
- Hydro
- Marine
- Bio
- Geothermal



Water Wastewater

- Utilities
- Desalination
- Irrigation
- Industrial
- Metering
- Lifecycle



T&D - Smart Grid

- Grid Mgmt
- Phasor
- Substation
- Dist. Automation
- Dist. Generation
- Microgrids



AMI - Smart Grid

- Operational Data Manager
- Home Area Net
- Demand Response

Power & Utility Verticals



PI System -- Defacto Standard in Power and Utilities



OSIsoft Selected Power and Utilities Experience

- 55% of 475 GW average USA power generation is monitored by the PI System (coal, natural gas, renewables, hydro and nuclear)
- 85% of total 23 GW USA wind generation is monitored by the PI System
- 100% of the ISOs/RTOs in the USA use the PI System
- 17 of the top 20 wind generating producers in the world use the PI System
- Over 50% of the Concentrated Solar Plants (CSPs) in the world use the PI system
- Many of the largest solar companies in the world use the PI System (SunPower, EDF-EN, E.ON, Iberdrola, EGP, Abengoa Solar, Sempra)
- Many solar, wind, turbine and other major equipment power generation OEMs in the world use the PI System

OSIsoft Selected Nuclear Energy Experience

- 76% of operating nuclear power generators in the USA use the PI System (79 of 104), and growing
- 100% of operating nuclear power generators in Canada use the PI System (17 of 17)
- 100% of operating nuclear power generators in the United Kingdom use the PI System (18 of 18)
- 100% of operating nuclear power generators in Korea use the PI System (21 of 21)
- 66% of operating nuclear power generators in China use the PI System (10 of 15)
- 31% of under construction nuclear power generators in China have committed to use the PI System and others are considering (8 of 26)
- The PI System is widely used for emergency preparedness and response, including the US Nuclear Regulatory Commission
- Many nuclear mining, fuel conversion, fuel enrichment, fuel fabrication and waste processing companies use the PI System (over 20 companies)
- The PI System is already part of the standard design for KEPCOs advanced reactor
- The PI System is now being used as part of the testing phase for a US-based small, modular reactor and the intention is for it to become part of their standard design
- Nearly every leading advanced reactor OEMs (large and small, modular) is interested in making the PI System part of their standard design (or a standard option)

Conditioned Based Maintenance

These “Pressures” Appear to be Common

We cannot add more work than we can afford

We will always have more work than we can complete

Aging Plant
(New Failure Mechanisms and Rates)

Ever Rising Required Level of Performance

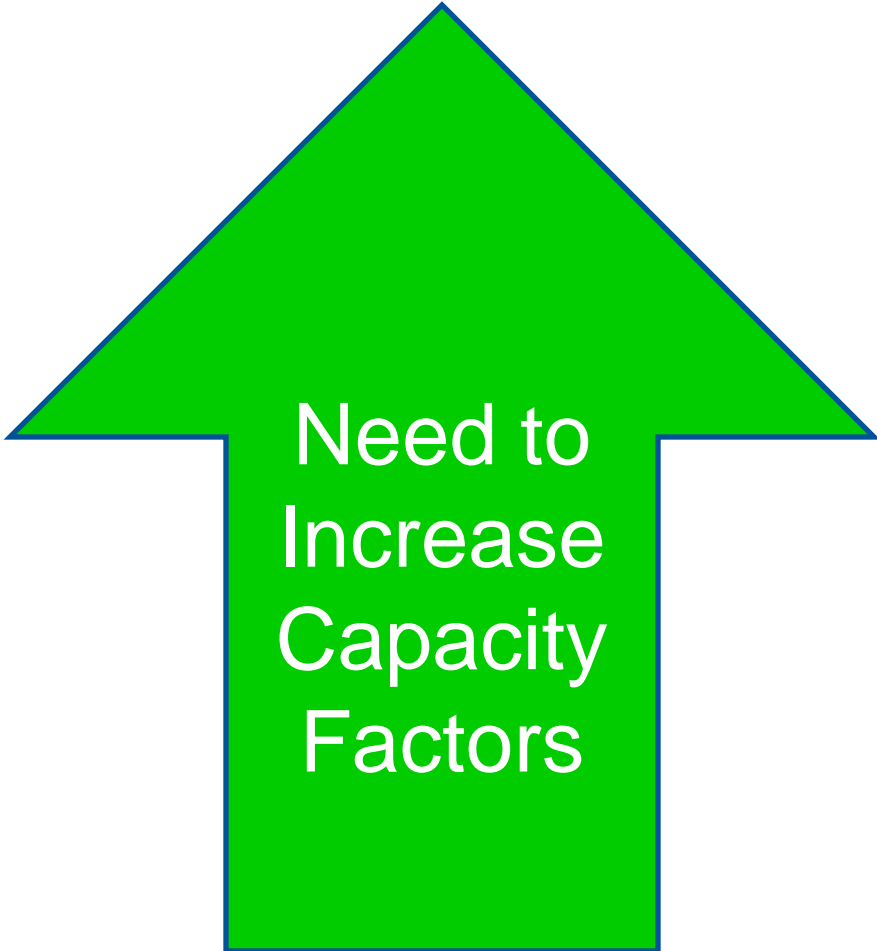
Your Organization

Experienced Personnel Leaving the Industry

Cost Reduction
(Staff, O&M and Capital Budgets)

Asset owners and managers are being squeezed by aging assets, experienced personnel leaving the industry, and continuous pressures to reduce costs and improve performance.

These “Needs” Appear to be Common



Need to
Increase
Capacity
Factors



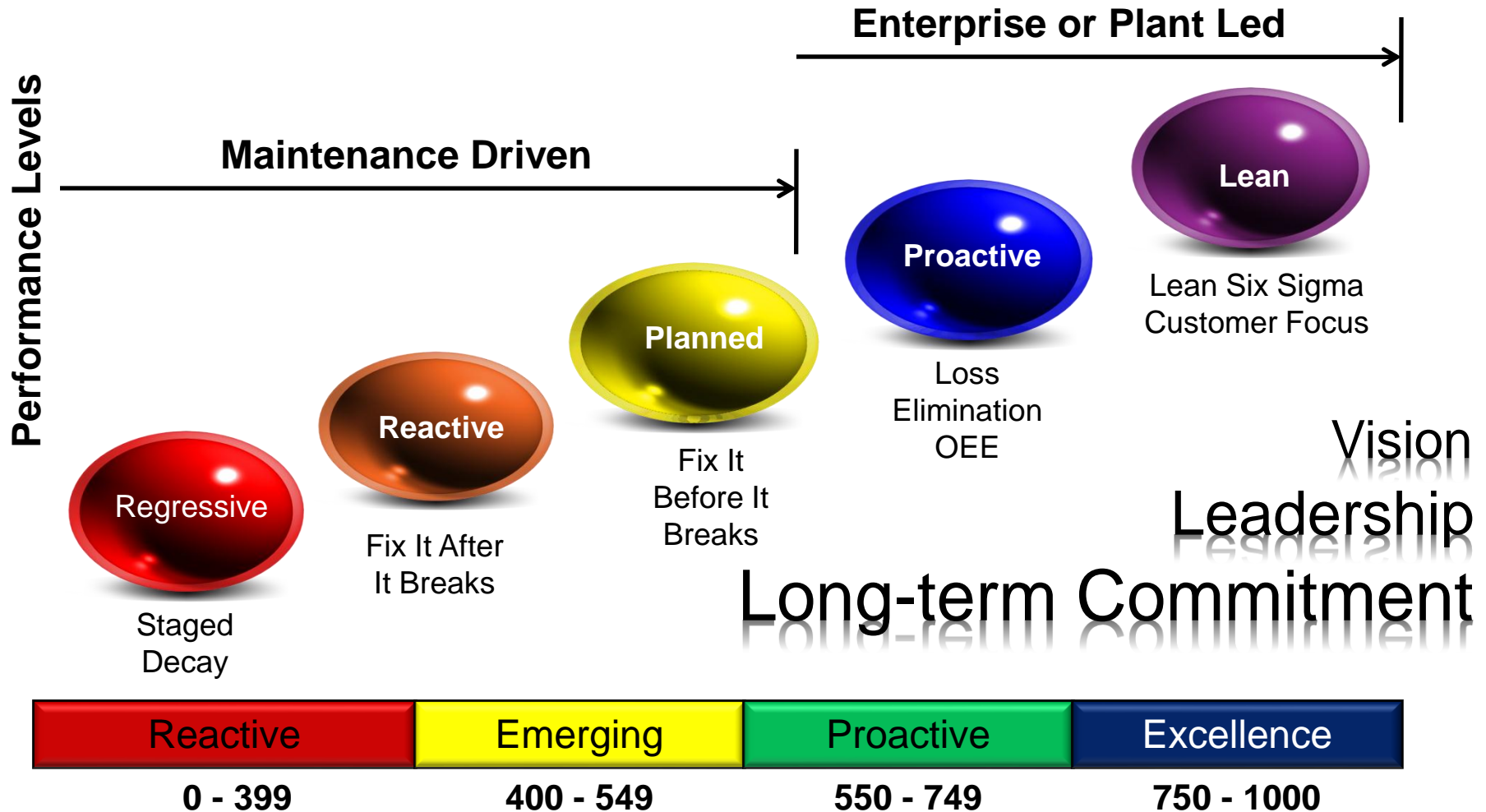
Need to
Reduce
Costs

Getting Your Feet on the Ground!



Looking for long
term
solutions...not
moving the load to
the donkey!

The Reliability Excellence Journey



Some Definitions

- Risk-based Asset Management (RBAM) - risk-based asset management strategy couples risk management, standard work, and condition-based maintenance to properly apply resources based on process criticality
- Predictive Maintenance (PdM) – using a specific asset condition indicator to estimate when an asset failure might occur.
- Condition Monitoring – determining an asset’s health (condition) based on one or more parameters. Usually visual indicators or notifications only.
- Condition-Based Maintenance (CBM) – performing maintenance activities based on the current or historical trend of an asset’s condition.
- Reliability Centered Maintenance (RCM) – A set of techniques and practices used to ensure minimal asset maintenance involving operations, monitoring, inspection, etc.
- Preventive Maintenance (PM) – scheduled activity to remove an asset from service and perform needed maintenance. May be periodic (calendar) or condition based. Planned Maintenance is usually CBM and PM.
- Corrective Maintenance – maintenance performed in response to an incipient failure of an asset (reactive).
- Enterprise Asset Management (EAM) – context, description, classification and maintenance of a site, facility, unit or other physical asset (often part of ERP).

Risk-based Asset Management



Proactive Maintenance

- Screens and information with Maintenance in mind
- A focus on critical equipment, parameters for condition
 - Vibrations (rotating equipment, motors, pumps, turbine...)
 - Temperatures (bearings, oil, metal, motors...)
 - Amps
- Transform data and use in a new, valuable way
- Use out of the box, PI System functionality
 - Totalizers for run time counters, compare/balance usage, schedule maintenance, measure accumulative damage
 - Multi-state graphics
 - Notifications
- Increase speed and accuracy of decisions

Proactive Maintenance

- Is a strategy in which Corrective, Preventive, and Predictive processes complement one another
- Average industrial plant performs **more than 55% Reactive**
- Reactive is the highest cost!
- Top industrial plants perform **less than 10% Reactive**

An industry “best practice” target goal maintenance mix

Reactive
10%



Minimize
emergent work

Preventive
35%



Optimize current PM
Practices

Predictive
55%



Expand existing PdM
Applications

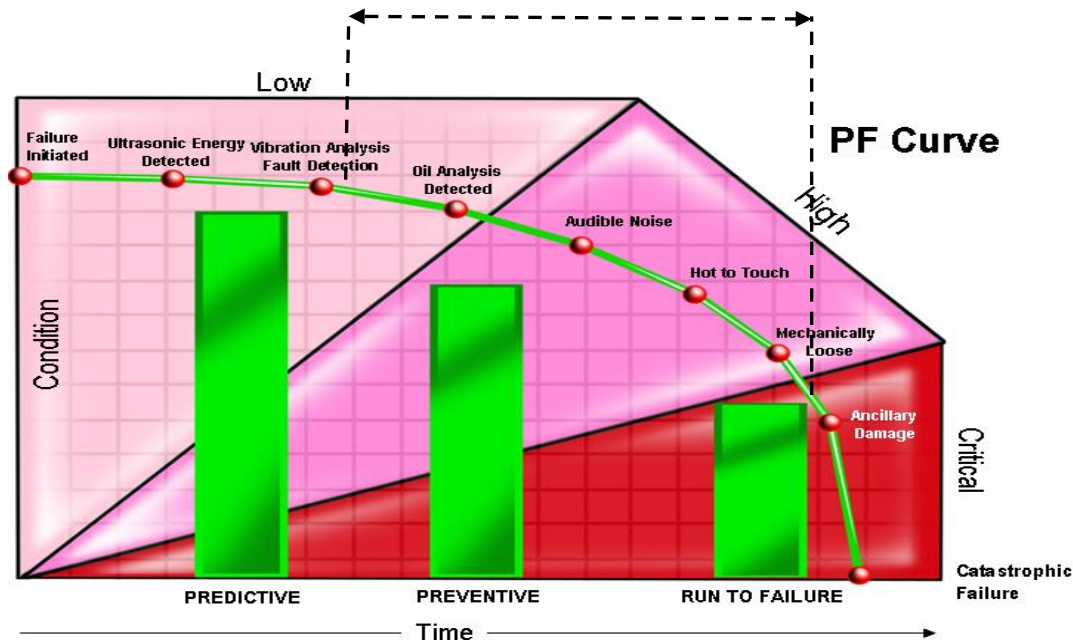


In support of this strategy, enhance & expand the effective use of data and analytical systems

Proactive Maintenance P-F Curve

P-F curve shows the behavior of equipment as it approaches failure

- “P” represents the first possible point degradation can be detected
- “F” represents the point of equipment or system failure
- The time between is your “opportunity” to avoid unplanned events



P-F Interval P-F

Time frame to rectify impending equipment failure: Planning, Scheduling, Execution Window

Earliest detection provides the greatest opportunity time

CBM Driving Factors

- Continued expectations of improvements in reliability and availability
- Lack of comprehensive asset maintenance strategy – most if not all PM work calendar-based (overly conservative)
- Aging asset profiles – asset life extensions
- No link between asset performance/health and maintenance decisions
- Complexities in data systems implemented as point solutions
- Continual staff reductions
- Aging workforce



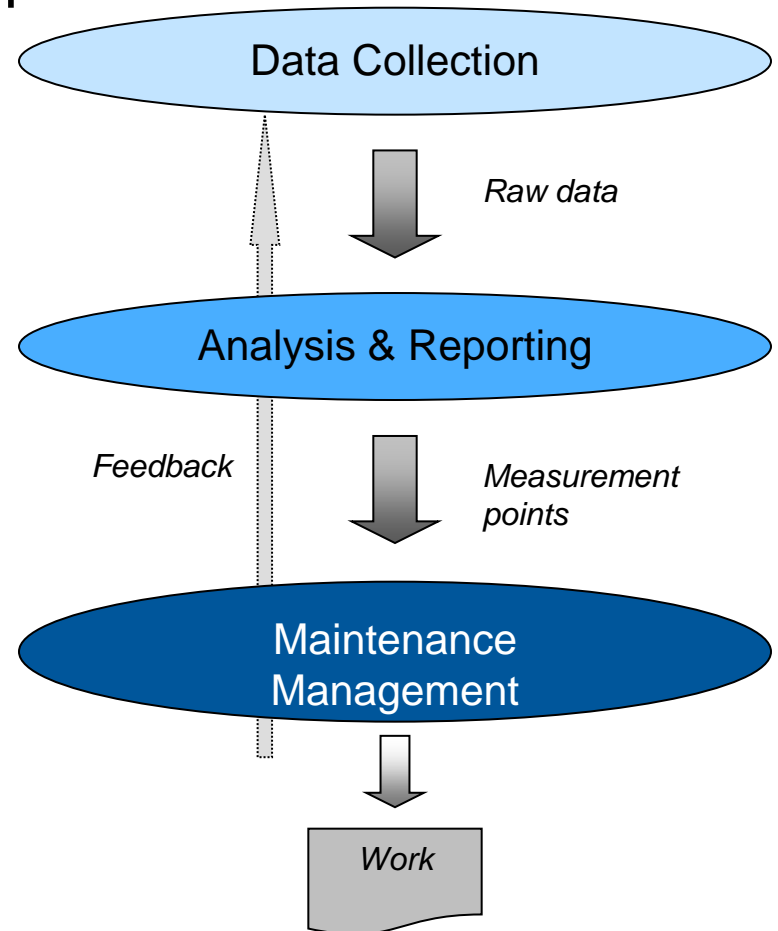
CBM Expected Benefits

- More targeted capital expenditures with eventual overall reductions
- As incipient failures are reduced, corrective maintenance costs go down and more maintenance is moved to 'planned'
- With a move to condition-based maintenance, calendar-based preventive maintenance is reduced
- Automation of condition-based notifications (emails, pages, maintenance notifications, etc.)
- Codification of organizational intelligence into condition-based algorithms
- Prioritization of maintenance, shorter downtimes, do the right work at the right time
- Improved visualization of asset health status
- Improved decision making capabilities



CBM Fundamentals

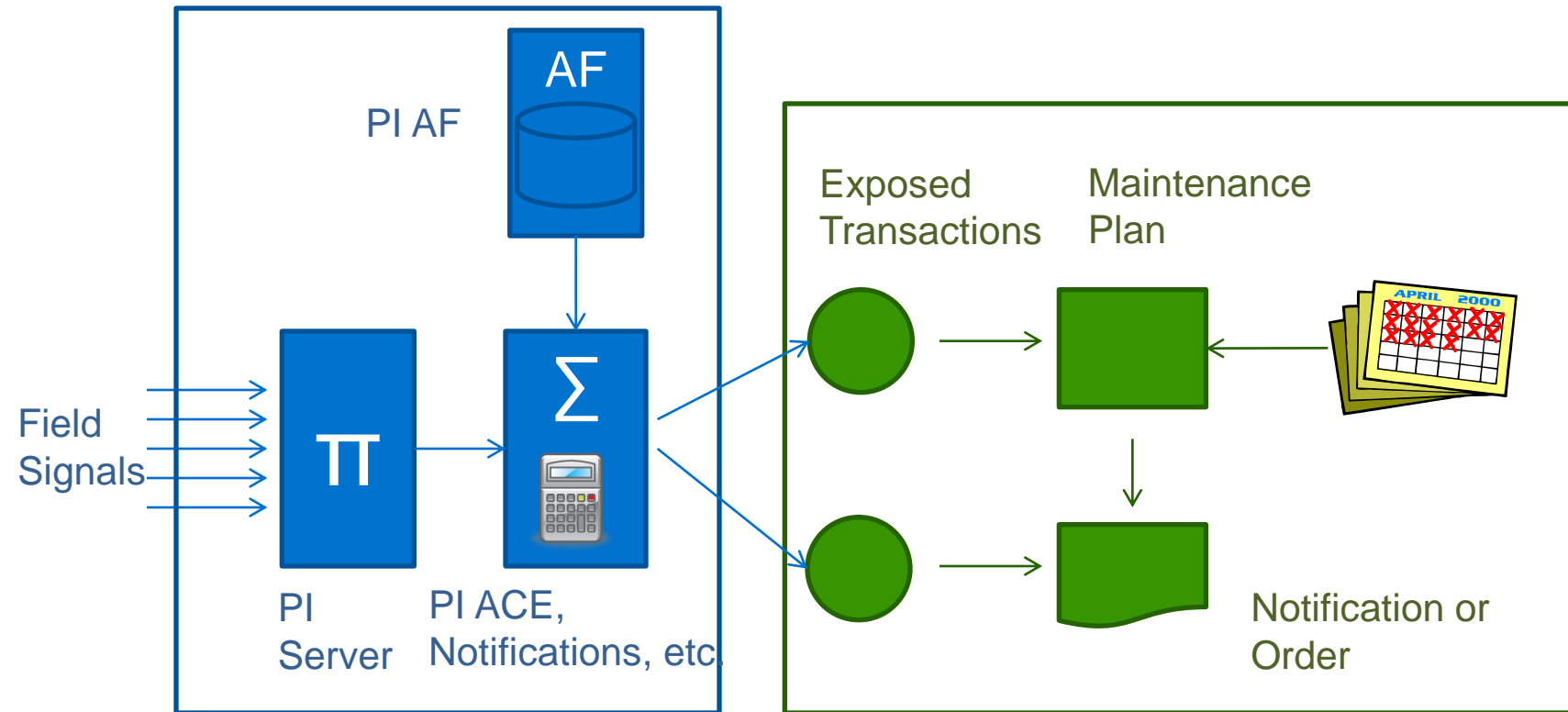
- Data Collection and Consolidation (Data)
 - Diagnostic and Inspection Data
 - Time-series Data
 - Relational Data
- Asset Analysis and Reporting (Information)
 - Condition & Criticality Assessment
 - Equipment Ranking
 - Work Prioritization
- Maintenance Management (Knowledge)
 - Meters
 - Work Order Generation
 - Maintenance Planning
 - Decision Support



Condition Monitoring

- CBM requires condition monitoring
- Condition monitoring is more than simple alarms (already done by Operations) or simple tests (usually immediately alert maintenance personnel already)
- Condition monitoring illuminates:
 - Slow moving variables (changes over many samples)
 - Multi-factor combination $CA = F1(M1) + F2(M2) + F3(M3) + \dots$
- Condition monitoring should consider performance and process data
- Condition monitoring assigns a score (e.g. 0-10, Red, Yellow, Green), detects a condition, updates a meter, etc.

CBM Integration Scenario



- PI Collects raw signal values and conditions these values via calculations and determines when to initiate transaction to EAM
- PI invokes transactions to either update measurement points (meters) or generate a notification/order, dependent on condition rules
- If meter updates, then EAM compares maintenance plan logic to current state to determine if notification/order should be generated.

Asset Health

Asset Health – The Big Opportunity

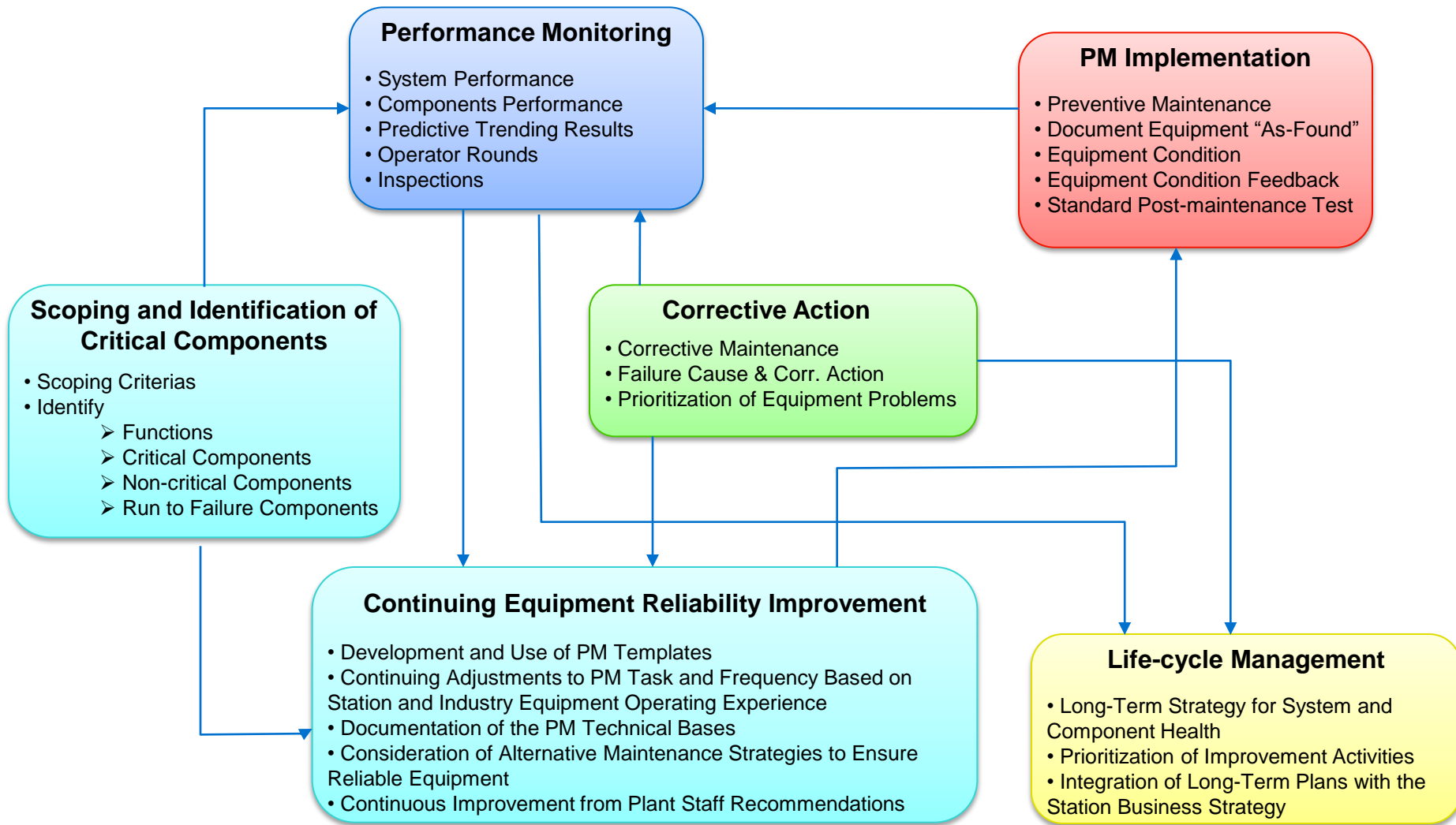
Nuclear Specific Driver - Equipment/Asset Reliability...

- Cornerstone of Operational and Reliability Excellence in NPPs
- Critical for NPP Life Extension and License Renewal
- Heavily regulated by international standards (10CFR50.65)
- INPO AP-913 (Equipment Reliability Process Description) endorses 10CFR50.65
- Requires real-time data = REAL-TIME INFRASTRUCTURE (as many other Operational and Reliability Excellence applications do)

Nuclear Specific Driver - Equipment/Asset Reliability...

- Other guides include:
 - NEI “Standard Nuclear Performance Model”
 - INPO AP-928 “Work Control Process Description”
 - INPO 01-004 “Achieving High Equipment Reliability – A Leadership Perspective”

INPO AP-913 Business Process



Specific Asset Health-related Uses for PI System Information in Power Generation

- Operations (Extend DCS Beyond the Control Room)
 - Controllable Losses – Start Up/Shut Down
- Proactive/Condition-based Maintenance
- Root Cause Analysis (RCA)
- Outage Planning (Spend \$ on the Right Things)
- Vendor Performance (Pre and Post Work Review)
- Equipment/Manufacture Performance
- Plant and System Performance/Efficiency
 - Production vs. Schedule - Heat Rate/Condenser
- Environmental (Compliance, Emissions, Limits, Reporting)
- Water Chemistry
- Fleet/Enterprise View of Core Metrics and KPIs

System Monitoring and Reporting Tool

S.M.A.R.T. - [Overall Annunciator]

File Edit View Insert Format Records Tools Window Help

S. M. A. R. T.
System Monitoring And Reporting Tool
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Manual Data
Run PI
STOP

01.00 Switch Yard	02.00 125 VDC	03.00 Start-up Transformer	04.00 4160 V Safety Related Sw.Gear	05.00 Class 1E 480 VAC Power	06.00 480V MCCs	07.00 Lighting Panel Power Supply	07.01 Emergency Lights (S/D path)	07.02 Emergency Lights
08.00 Well Water	10.00 River Water Supply	11.01 General Service Water	11.03 Pumphouse HVAC	13.02 Fire Service - Carbon Dioxide	14.00 RB Closed Cooling Water	16.00 RHR Service Water	18.00 Instrument Air	20.04 Drywell Sumps
23.00 Diesel Fuel Oil System	24.00 Standby Diesel Generators	25.00 Remote Shutdown System	30.00 CB HVAC	30.03 CB/SBGT Instrument Air Compressor	34.00 Reactor Building HVAC	35.00 Fuel Pool Cooling & Cleanup	40.00 Turbine Lube Oil	41.00 Cooling Towers
42.00 Circulating	43.00 Main	44.00 Condensate	45.01 Feedwater	46.00 Extraction Steam	49.00 RHR	50.00 Reactor Core Isolation Cooling	51.00 CORE SPRAY	52.00 High Pressure Coolant Injection
64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation	64.01: Reactor Recirculation
56.02 Reactor Manual Control	57.00 Instrument AC and UAC Cntl Pwr	58.01 Reactor Protection	58.02 Primary Containment Isolation	58.03 Steam Leak Detection	59.00 Primary Containment	64.01 Reactor Recirculation	70.00 Standby Gas Treatment	72.00 Off-Gas
64.01 Reactor Recirculation	70.00 Standby Gas Treatment	72.00 Off-Gas	73.03 Containment Atmosphere Dilution	75.00 24 VDC	78.01 Neutron Monitoring	83.01 Main Steam	83.02 Main Steam downstrm of MSIVs	83.04 Low-Low Set & ADS
95.00 Seal Oil / Hydrogen Cooling	97.00 Stator Cooling	98.00 Main Generator & Excitation	99.11 Reactor Bldg Crane & Elevator	99.27 Doors	99.28 Buildings & Structures	86.00 Stand by Transformer	87.00 Auxiliary and Main Transformers	88.00 250 VDC

S.M.A.R.T. - [Direct Monitoring Display]

File Edit View Insert Format Records Tools Window Help

64.01: Reactor Recirculation

Parameter Description: Recorder trend of MG stator temperatures - TRS4659 or MG 'B' Computer Pts. B076, B077, B078

Parameter Functions: Provide a means of adjusting reactor power and remove heat generation by varying the flow rate of the coolant through the core.

Status: GREEN

Double Click on Trend chart to activate

Legend:
 B076 V
 B077 V
 B078 V
 PI ACTION Upper
 PI ACTION Lower

Progress Energy System Engineer Desktop

Brunswick Nuclear Plant

	Unit 1	Unit 2
Plant Status		
Rx Thermal Power	100.9	35.1
Gross MWs	866	293
Net MWs	845	268

Reactor Power: 3/28/01 9:01:30 AM

- COOL HIGHFLOW POWER: 100%
- COOL REHEAT POWER: 300%

System Notebook

- Active Code
- Prevent Containment Isolation
- Reactor Trip
- Control Rod Drive Hydraulic
- Reactor Protection
- Reactor Water Chemistry
- Core Spray
- Standby Liquid Control
- Containment Atmospheric Control
- Reactor Core Loss Cooling
- High Pressure Coolant Injection
- Reactor
- Relief Valve
- Extraction Steam
- Auxiliary Boiler
- Feedwater
- Reactor Driers and Misc. Vents & D.
- Condensate
- Condensate Filter Demineralizer S.
- Condensate Densified to Out Drain
- Condensate

Equipment Issues

- PJM Concerns
- PJM Annunciator Panel
- ICCI Maintenance Rule Issues
- Key Equipment Issues
- Operator Work Alarms

System Planning

- System Review
- Core Performance
- Outage Performance
- Operability

Work Activities

- WVO Tasks
- PM Tasks (Generated only)
- Obs Log
- PMs
- ESRs

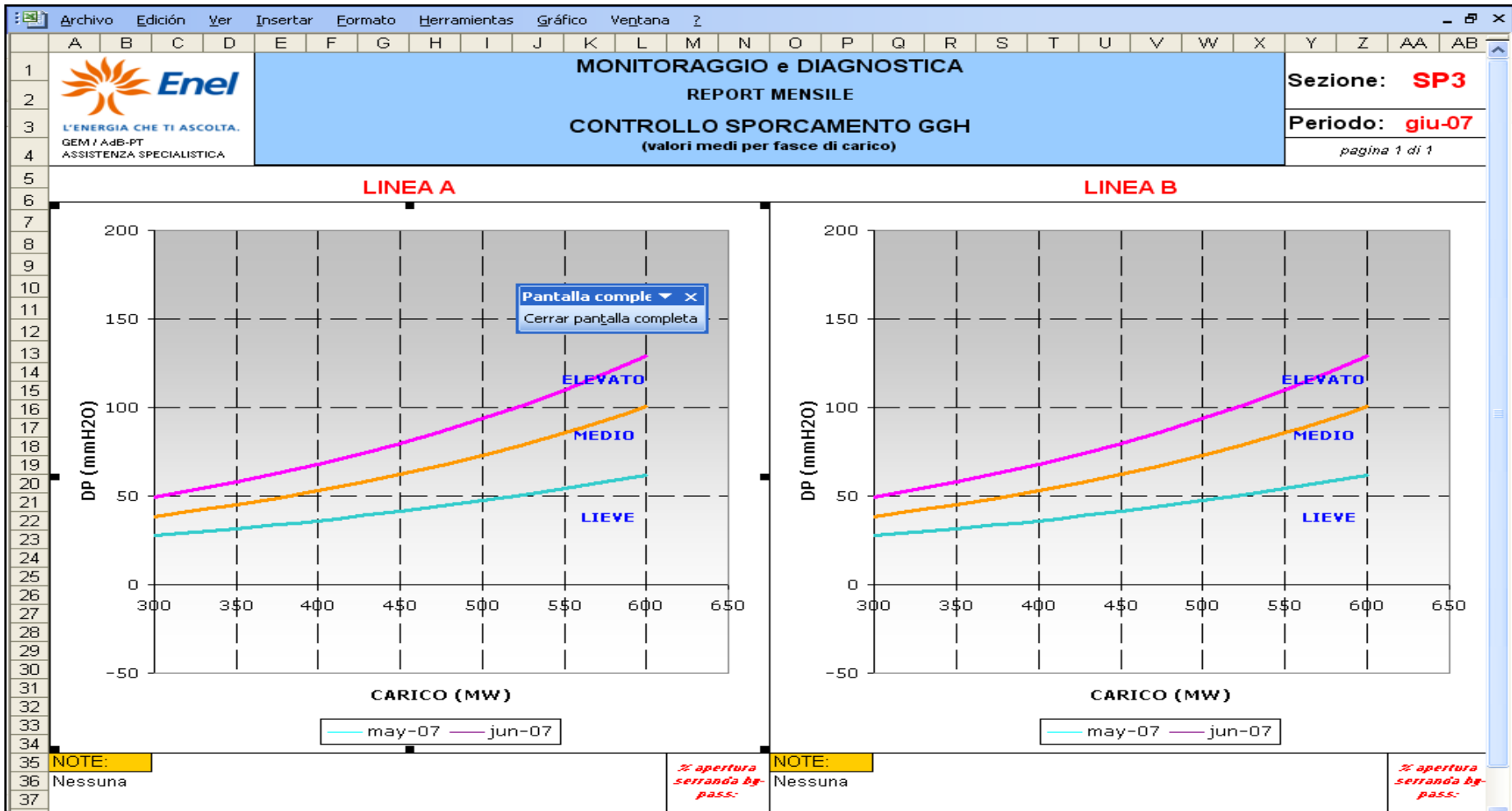
Information

- Components
- Procedures
- PMs
- ARMS WVOs

PI ProcessBook

Access

ENEL Conditioned-Based Maintenance (CBM)



Energy Performance Monitoring & Diagnostics Center (PM & DC)

Mission: Support plant objectives to achieve fleet commercial excellence through improved unit performance, equipment condition, and operational risk management



Entergy's PM & DC PI Infrastructure

- PI Servers located at 16 plants
- Operations Information Systems (OIS) implemented on 30 units:
 - Real-time performance monitoring & diagnostics thru pre-built PI-Process Book displays and General Physics EtaPro™
- Advanced Pattern Recognition (APR) implemented for 33 units:
 - Anomaly detection and alerting via advanced pattern recognition software using near real-time data from the plant PI servers



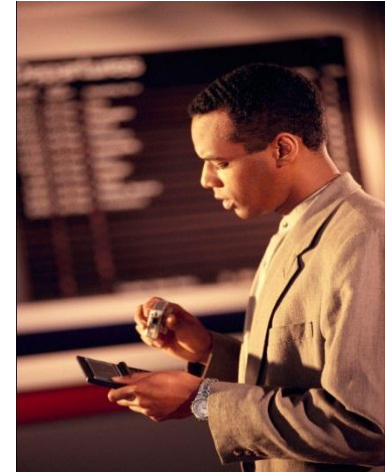
Entergy PI Use in the PM & DC

- OIS/PI is primary means of accessing plant data for routine monitoring
- Build custom ProcessBooks and DataLinks for trip analysis, unit/equipment problem diagnostics and special monitoring
- Using PI Alarm View and PI ACE for PM&DC's Alarm Management System
- All based on the foundation of the PI data collected and stored at each plant



Entergy PM & DC Monitoring Tasks

- Unit trip monitoring and diagnostics
 - Plants can use extra eyes during upsets
- Unit Start-up monitoring
 - Complex process with many opportunities for error
- Routine monitoring
 - Looking for early signs of emerging equipment problems or failed instrumentation
- Purchased Advanced Pattern Recognition (APR) software to greatly enhance anomaly detection capability and data mining
- Performs special analysis requested by plants - lost MWs, performance issues, and equipment problems



Entergy PM & DC Benefits

- Early identification of changes in equipment physical, thermal, operational & environmental performance
- Improved ability to mitigate degrading equipment condition and unit performance
- Improved ability to maximize unit value considering current market opportunities
- Leverage expertise and technology
- Enhanced teamwork

Entergy PM & DC Results

- PM&DC Benefit to cost:
 - First year: 2 to 1
 - Including initial set up cost
 - O&M dollars only
 - Ongoing after first year 3 to 1
 - O&M dollars only
 - Ongoing after first year 8 to 1
 - O&M + fuel & replacement power)
- Catches:
 - First year 252
 - Ongoing 400-500 / yr



GenOn Driving Factors for OSIsoft Solution



Problem: Many disparate plant systems and the need to turn data into actionable information

- DCS, PLC, CEMS, Analyzers...
- Various timestamps
- Data accessibility & integrity

Solution: OSIsoft, Enterprise Wide Infrastructure

- Common real-time database
- Common visualization and analytic toolset
- Common technology for development and advanced analytics
- Leverage SMEs (Central & Plant)

IPP, not a utility requires effective maintenance practices



GenOn OSIssoft Continuous Value Proposition

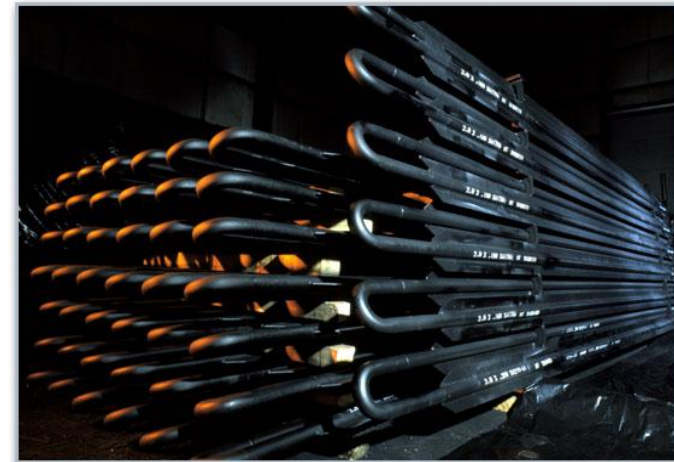
- Fleet Wide Deployment 2002
- Condition Based Maintenance on Critical Assets 2004
- Advanced Pattern Recognition Fleet-wide Rollout 2005
- Water Chemistry Automation 2007
- Automated Operator / Maintenance rounds 2008-2010
- Environmental Monitoring 2008
- Proactive Maintenance Data Gateway 2009-2011

Every phase a business value and positive ROI

GenOn Boilers Highest Lost Margin System

Boilers – “The Race Car Tire of Power Generation”

- Highest Lost Margin Opportunity
- Most outages / de-rates
- Improve Water Chemistry
 - Make visible via PI
 - Transformation of data
- Track Temperature Excursions



Highest LMO makes easy ROI with technology solution...

GenOn Water Chemistry Automation

- Improve and interface to analyzers
- Cycle Water Chemistry screens
- Response Procedure Reports (EPRI standards)
- Calculate minutes in / out of spec
- Notifications on limits



Transform and use data in a new way...



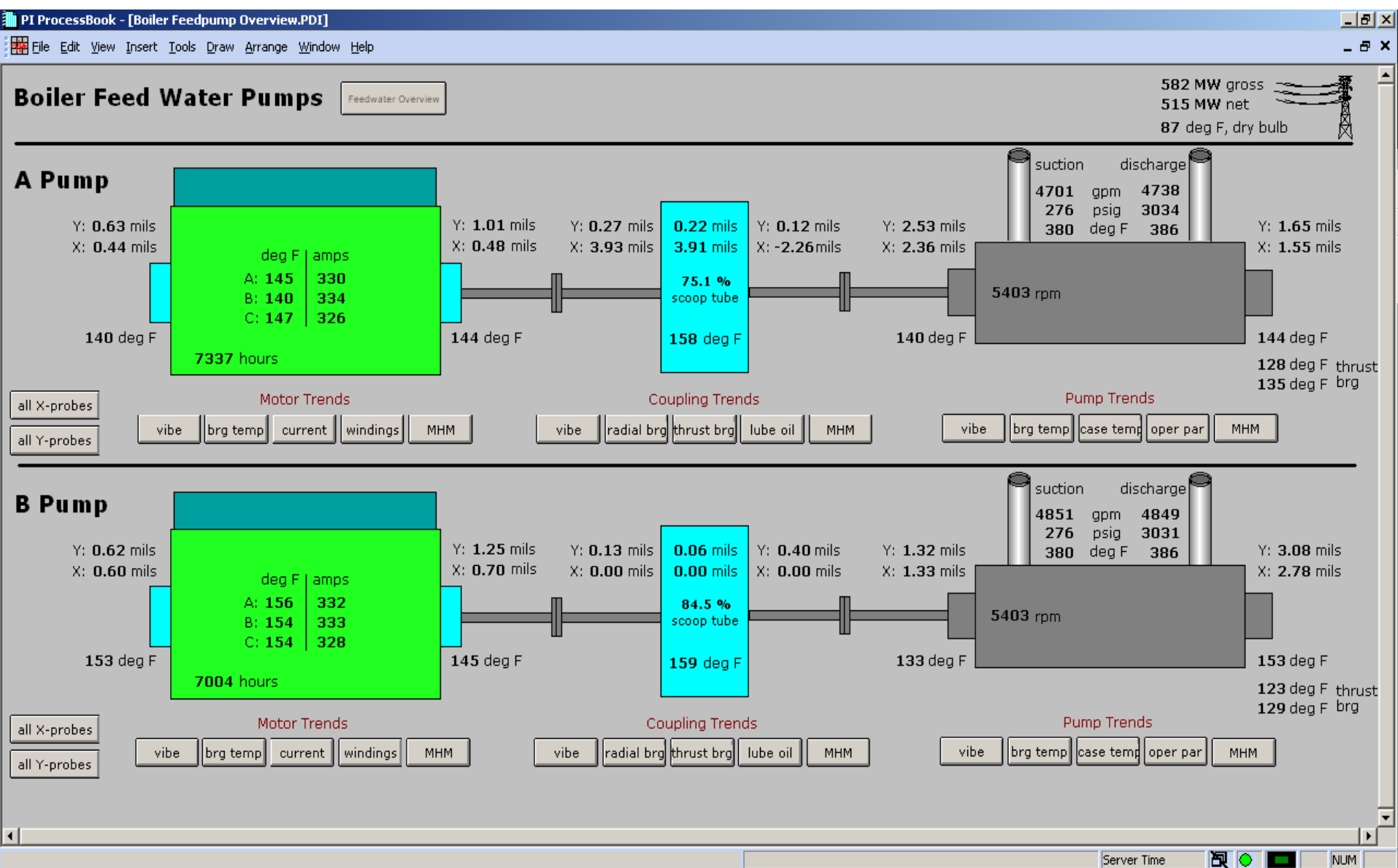
GenOn APR Modeling

Business case developed from history :

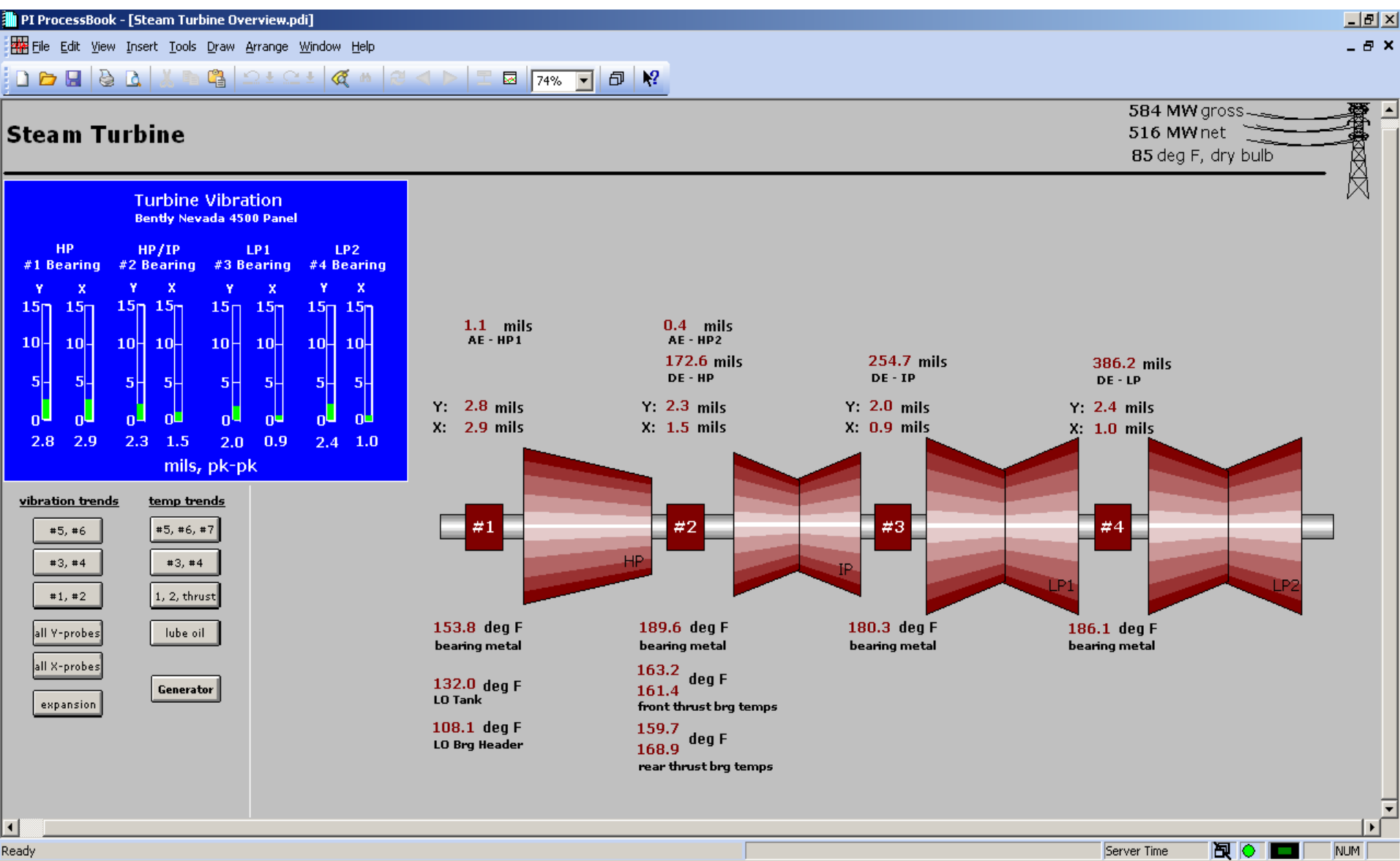
- Review equipment failures
- Outages and related lost margin
- Combined cycle plant pilot had 5 catches (~value \$948K)
- Decision to apply fleet wide
- Model critical systems and equipment

Very intelligent rules based monitoring of critical systems...

Proactive Maintenance Monitoring



Proactive Maintenance Monitoring



Condition Based Maintenance Screens

The screenshot displays a software interface for condition-based maintenance. On the left, there are two line graphs: 'Discharge Flow' and 'Total Head - 1A ='. Below the graphs is a list of equipment tags. The main area features a 'Get Runtime Tags' button, a listbox with selected items, a table with columns 'TagID', 'Tag Name', and 'Tag Descriptor', a 'Value (Hours)' input field showing '1996.35', a 'Reset Runtime Counter' button, and a large text area for comments. A red arc highlights the top right corner of the interface.

UNIT 1
149.13 MW

Get Runtime Tags yes

- 12010: BFP 1A Runtime Hours when -BFP1A.RT
- 12011: BFP 1B Runtime Hours when -BFP1B.RT
- 12012: BFP 2A Runtime Hours when -BFP2A.RT
- 12013: BFP 2B Runtime Hours when -BFP2B.RT
- 12015: Condensate Pump A Runtime -COND_A.RT
- 12019: Condensate Pump B Runtime -COND_B.RT

TagID	Tag Name	Tag Descriptor
12012	BFP2A.RT	BFP 2A Runtime Hours when

Value (Hours):

Please add comment and initials.

Reset Runtime Counter

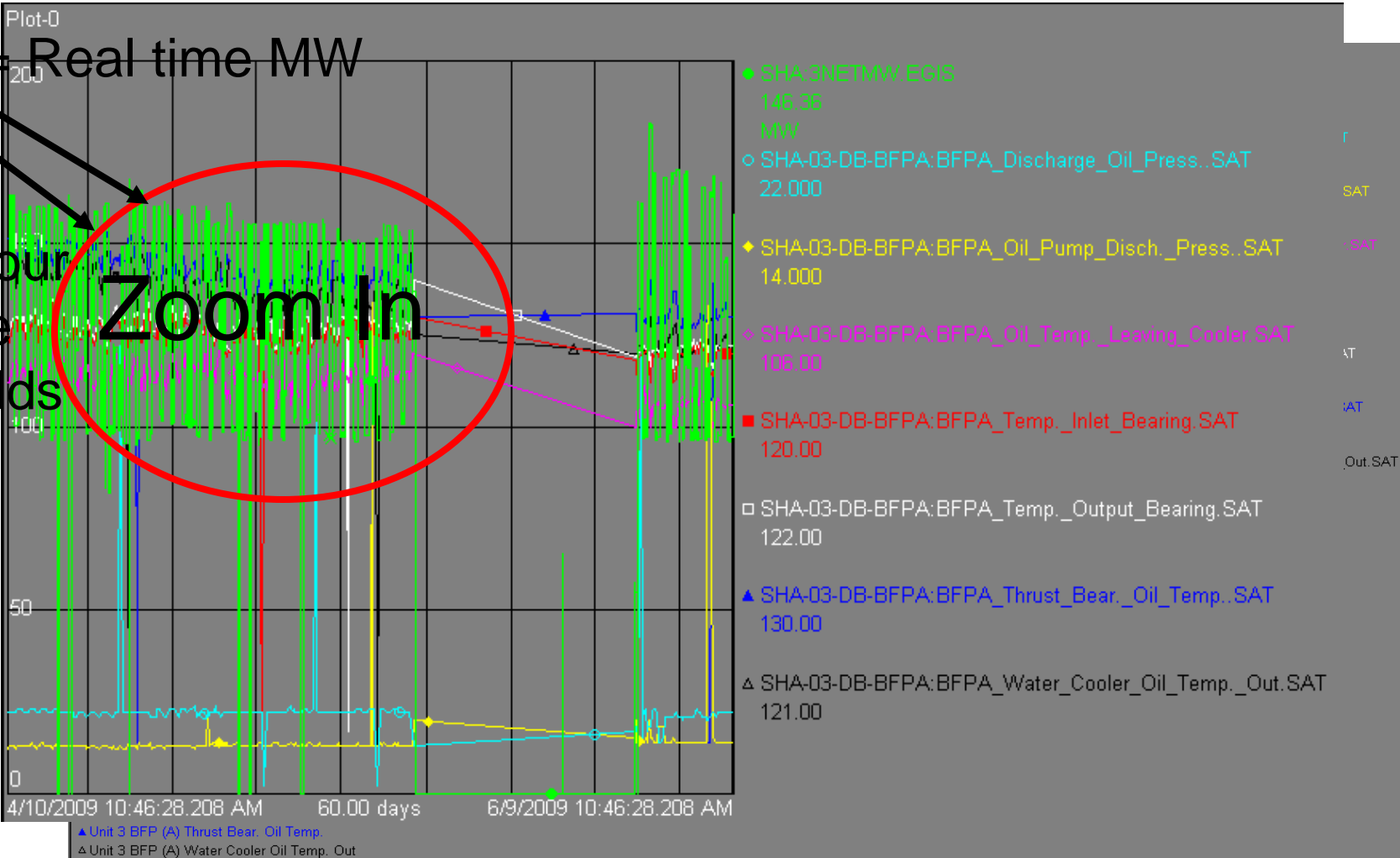
Instructions:

When the display loads it will pull back all *.RT (Runtime Counter) tags from the stations PI Server.

- Click on the runtime counter from the listbox that you would like to reset.
* - The Counter Information will be populated in the display below the listbox.
- Reset the Runtime Hours value in the text box next to the Value.
* - You can set this to any number of hours.
- Add comments and name or initials to the comments textbox.
- Click the "Reset Runtime Counter" button.

Manual Round Data Correlation

Green = Real time MW
Data Taken every hour from the handhelds



Boilers – Highest Loss Margin System

Most outages / de-rates are boiler related

- Transformation of data to useful information

Water Chemistry

Improve and interface to analyzers

- Cycle Water Chemistry screens
- Calculate minutes in / out of spec
- Notifications on limits
- Make visible via PI system



Boiler Tubes Temperatures

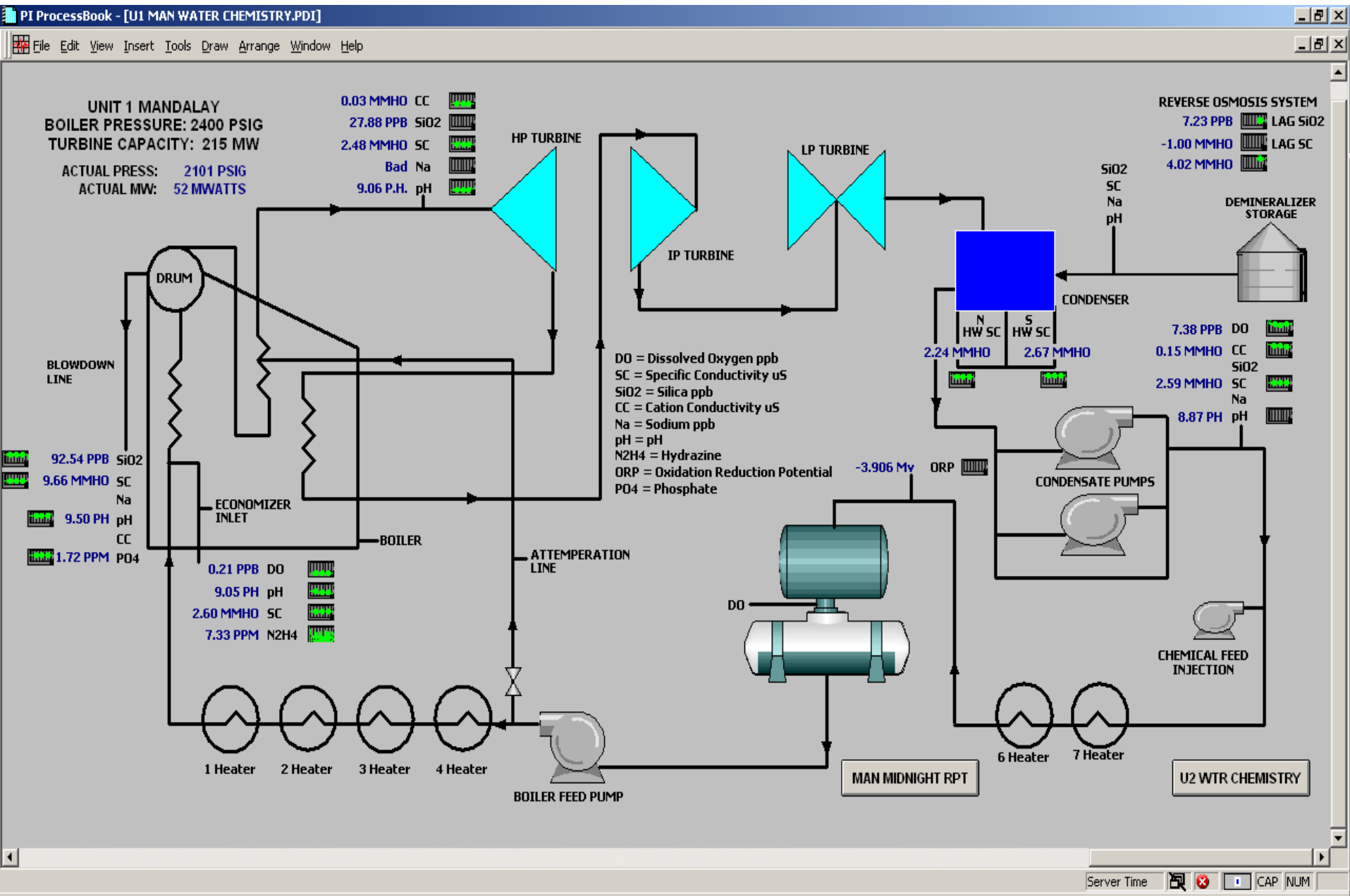
Systematically track:

- How many excursions?
- Length of excursions?
- Total time out of specification...
- Maintain instrumentation!



Transform and use data in a new way...

Water Chemistry Displays

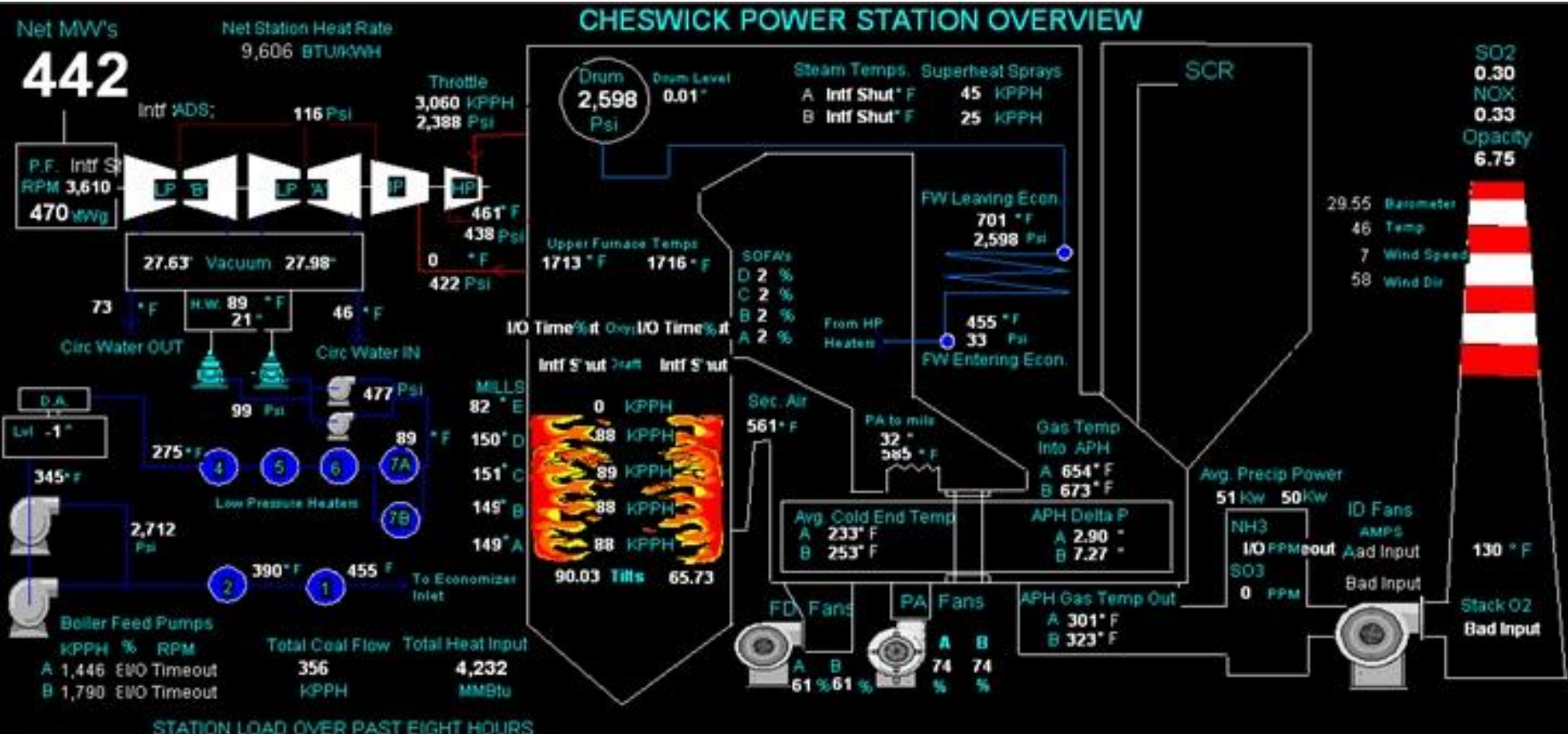


Water Chemistry - Reports

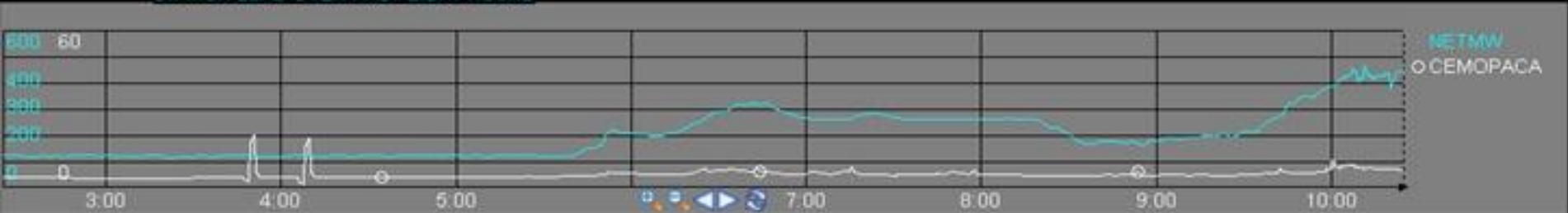
UNIT 1								
<u>MIN FOR DAY</u>	<u>AVG FOR DAY</u>	<u>MAX FOR DAY</u>	<u>MINS IN NORMAL</u>	<u>MINS IN ACTION LVL 1</u>	<u>MINS IN ACTION LVL 2</u>	<u>MINS IN ACTION LVL 3</u>	<u>MINS IN ACTION LVL 4</u>	
PARAMETERS:								
EXPECTED RANGES								
Condensate Pump Discharge								
pH	9.2 - 9.6	9.40	9.43	9.46	1440.00	0.00	0.00	0.00
CC - CPD A, $\mu\text{S/cm}$	< 0.2	0.09	0.10	0.11	1440.00	0.00	0.00	N/A
Dissolved Oxygen, ppb	< 10	2.55	3.03	3.53	1440.00	0.00	0.00	N/A
Sodium, ppb	< 3	0.09	0.09	0.10	1440.00	0.00	0.00	N/A
Boiler Feedwater								
pH	9.2 - 9.6	9.31	9.32	9.33	1440.00	0.00	0.00	0.00
Cation Conductivity, $\mu\text{S/cm}$	< 0.2	0.04	0.04	0.04	1440.00	0.00	0.00	N/A
Specific Conductivity, $\mu\text{S/cm}$	4 - 11	7.86	7.90	7.99	1440.00	0.00	N/A	N/A
Dissolved Oxygen, ppb	1- 10	8.57	8.99	9.82	1440.00	0.00	0.00	N/A
Sodium, ppb	< 3	0.12	0.13	0.15	1440.00	0.00	0.00	N/A
Boiler Water (Drum Blowdown)								
pH - T1Drum Blowdown A	9.2 - 9.6	9.13	9.16	9.21	158.35	1281.65	0.00	0.00
CC - T1 BLR 1 Water	< 1.0	0.20	0.22	0.24	1440.00	0.00	0.00	N/A
SC - T1 Drum Blowdown	4 - 11	5.26	5.30	5.38	1440.00	0.00	N/A	N/A
Silica - T1, ppb	< 60	41.69	44.11	49.17	1440.00	0.00	0.00	N/A
Sodium - T2, ppb	< 300	3.89	10.22	20.74	1440.00	0.00	0.00	N/A
Saturate Steam (Drum Steam)								
CC - T1 Drum Steam, $\mu\text{S/cm}$	< 0.2	0.13	0.14	0.15	1440.00	0.00	0.00	N/A
Degas CC - T1 Drum Steam, $\mu\text{S/cm}$	< 0.2	0.09	0.09	0.09	1440.00	0.00	0.00	N/A
SC - T1 Drum Steam, $\mu\text{S/cm}$	4 - 11	7.70	10.28	16.36	1027.47	412.53	N/A	N/A
Silica - T1, ppb	< 10	3.81	4.07	4.83	1440.00	0.00	0.00	N/A
Main Steam								
Degas Cation Conductivity, $\mu\text{S/cm}$	< 0.15	0.10	0.10	0.11	1440.00	0.00	0.00	N/A
Silica, ppb	< 10	4.99	5.51	6.39	1440.00	0.00	0.00	N/A
Sodium, ppb	< 2	0.11	0.12	0.13	1440.00	0.00	0.00	N/A

Operations

CHESWICK POWER STATION OVERVIEW



STATION LOAD OVER PAST EIGHT HOURS



Non-routine Operations : Start-Up

START UP Ramagundam U#3

PRE START CHECKS

H2 Pr: 1.85Kg/cm2	1.97473
H2 Purity:>98%	98.9995
MOT Level LO	NOT_LOW
Lube oil temp: 45 deg	46.8300
Vacuum	-693.366
Gind stm temp>280Deg	239.405
M S line charged	151.630
HP/LP charged	OUT_OF_SERVICE
Dea stm charged	8.10537
Drum Lvl	-15.5041
Dea Lvl	2423.75
Hotwell Lvl	447.221
Turning Gear :	DISENGAGED

Rolling Parameter

MS Pr : 75 Kg/cm2	151.630
MS temp: 350 deg	538.275
HRH Pr: 12 Kg/cm2	24.5788
HRH temp: 320 deg	521.469
Boiler PH	7.70544
Cond cation cond.	0.12395

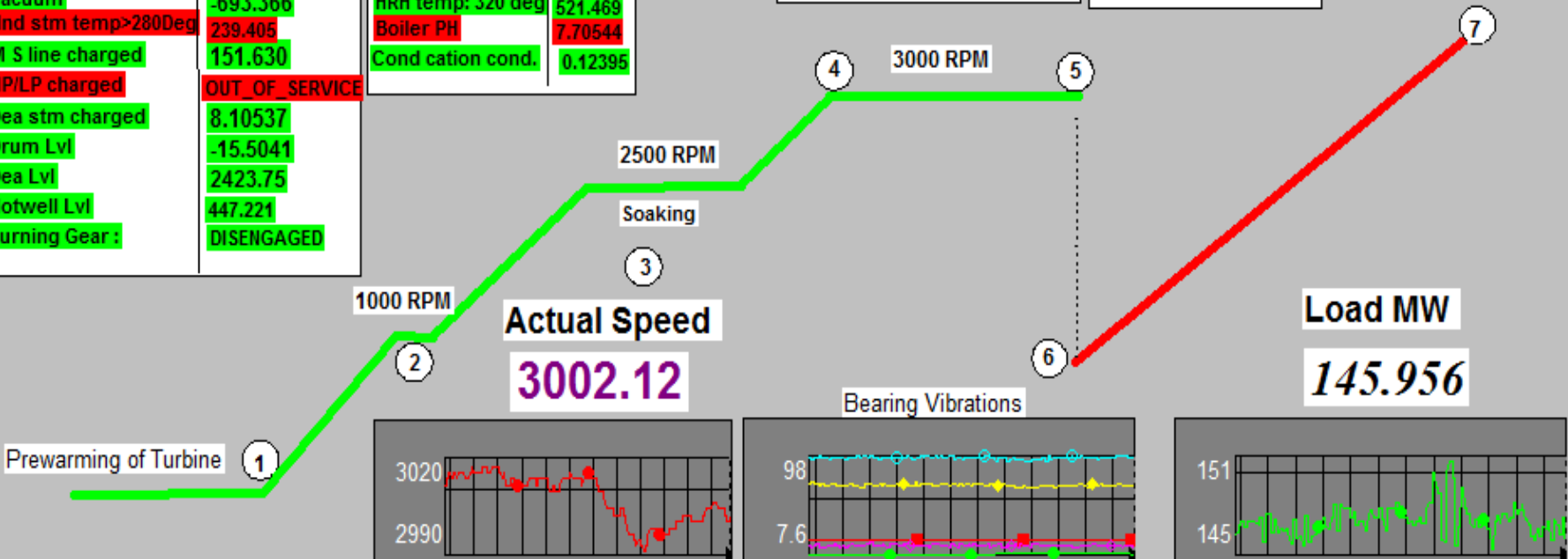
Oil Injection test
Electrical test
Total time at 3000 rpm
Time From step 4 to 5: 6 Hours

Check 5

AVR Auto	Auto
H2Cold gastemp	36.1253
Seal oil temp	35.4081

BLK 4,5 FINAL RAMP STABLISH

Raise full load: 200 MW @ 1.5 MW



Prewarming of Turbine 1

Check 1

Barring Speed: 3 to 5 RPM 3002.12
EHC in service NOT_MALFUNCTION
Criteria: ESV opening
Main Stm to CV Chest DT < 50 deg
Criteria: CV opening
HP inner Shell Metal Temp > 165
Speed raising to 1000 rpm

Check 2

Turbine Speed: 1000 RPM 3002.12
All Vibrations With in Limit
Check for all Bearing temp normal
Speed raising from 1000 to 2500 rpm

Check 3

Criteria : Speed raising 3000 rpm
- Accln rate 100 rpm 0
- HRH pr 12 kg/cm2
Block Load : 10 MW
AOP cut out 2800 rpm OFF

Check 7

Load Raising from Block load to 200 MW

Cross Over Pipe Inner Metal Temp. >= 175 Deg
For 60 Minutes

HP Heaters Charged -1.14373

ROLLING

BLOCKWISE

Non-routine Operations : Shut-Down

Check 1

All Protection in Service	
SGC oil	ON
SLC Drain	ON
LPBP	In Auto

Load MW
383.399

Check 3

Load	383.399
MS Temp	542.039
Dea Lvl	I/O Timeout
Hotwell Lvl	5.72725
TDBFP	Both in Service
Seal Stm Temp	299.279
Seal Stm Press	246.610

SHUTDOWN
RSTPS U#7

MS Press	133.784
MS Temp bef ESV-1	542.039
MS Temp bef ESV-2	533.213
HRH Press	531.397
HRH Temp bef IV-1	35.7918
HRH Temp bef IV-2	528.642
Axial Shift	-0.16543
HPT Rot Exp	16.1539
IPT Rot Exp	13.2067
HPT Diff Exp	-1.09527
IPT Diff Exp	2.20112
Cond Back Press	Bad
SH Spray	154.716
RH Spray	1.96744

Check 2

Load	383.399
MS Press	133.784
MS Temp	542.039
HP In Cas T	521.335
IP In Cas T	488.452
HPH 5&6	1

Check

Lub Oil Filter	Not Choked
Jacking Oil Filter	Not Choke
Jacking Oil Press	
H2 Cooler	
TDBFP-A	In Service
TDBFP-B	In Service
Turbine Barring Speed	80-90 rpm

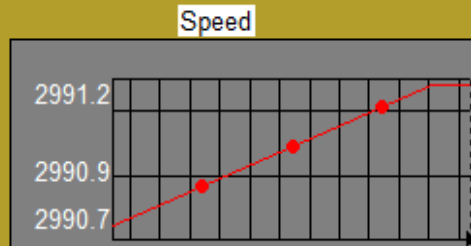
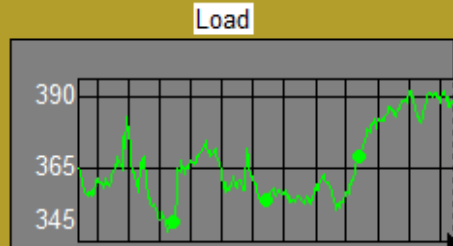
Desynco.

Overspeed Test
3000 RPM

Speed
2991.18

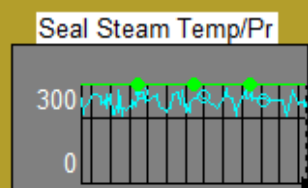
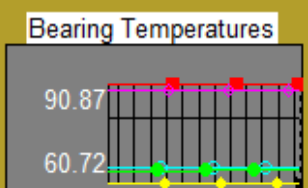
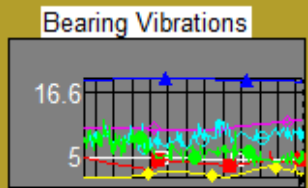
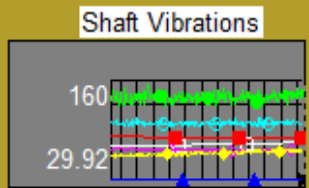
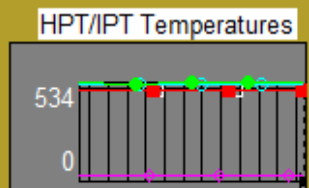
Coasting Down

Barring Speed



Check

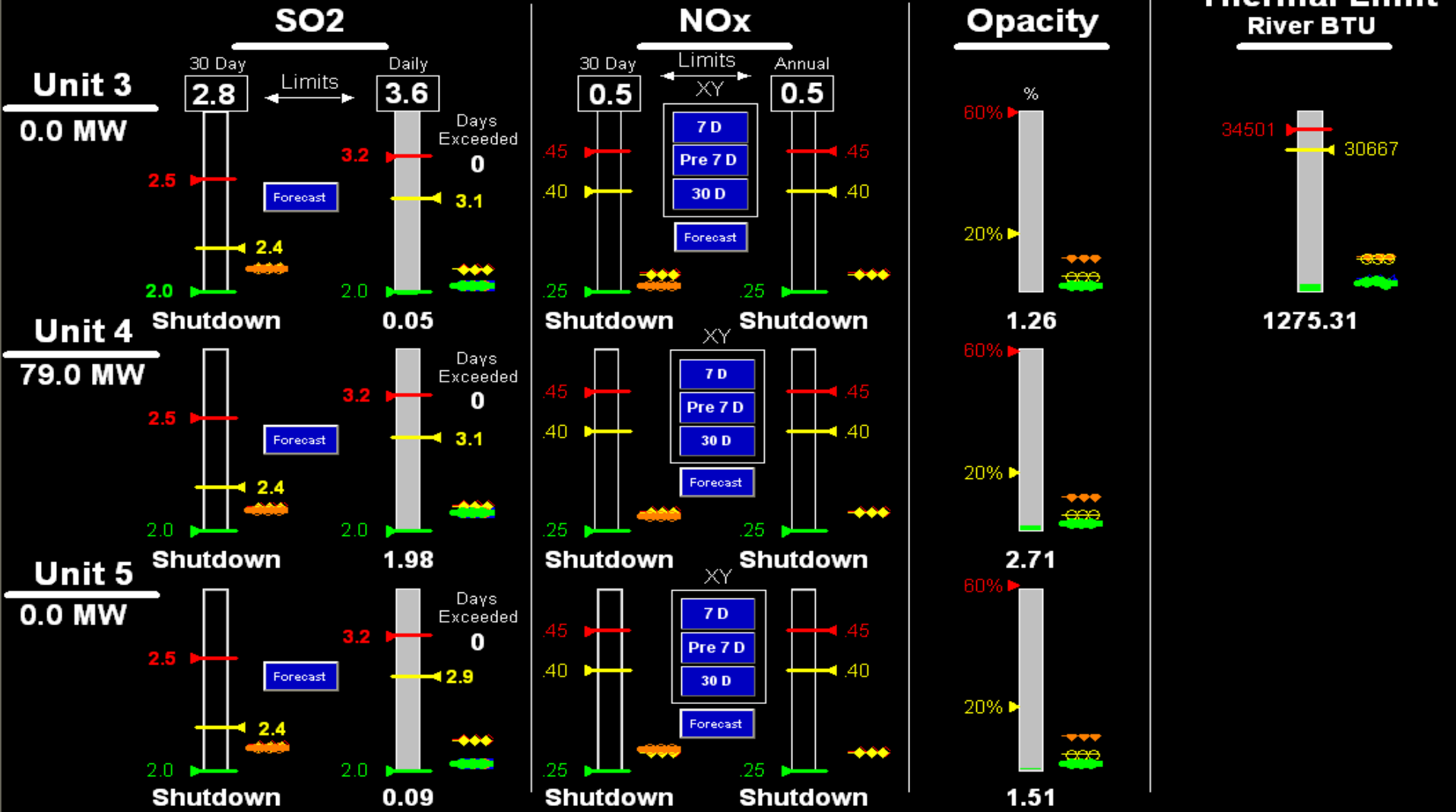
Turb Speed	
MS Temp	
AOP Status	
JOP Status	
Gate w/ Gearing	



Environmental Monitoring

Environmental Monitoring Summary

5/20/2009 8:19:13.01501 AM



Advanced Pattern Recognition (APR) Modeling

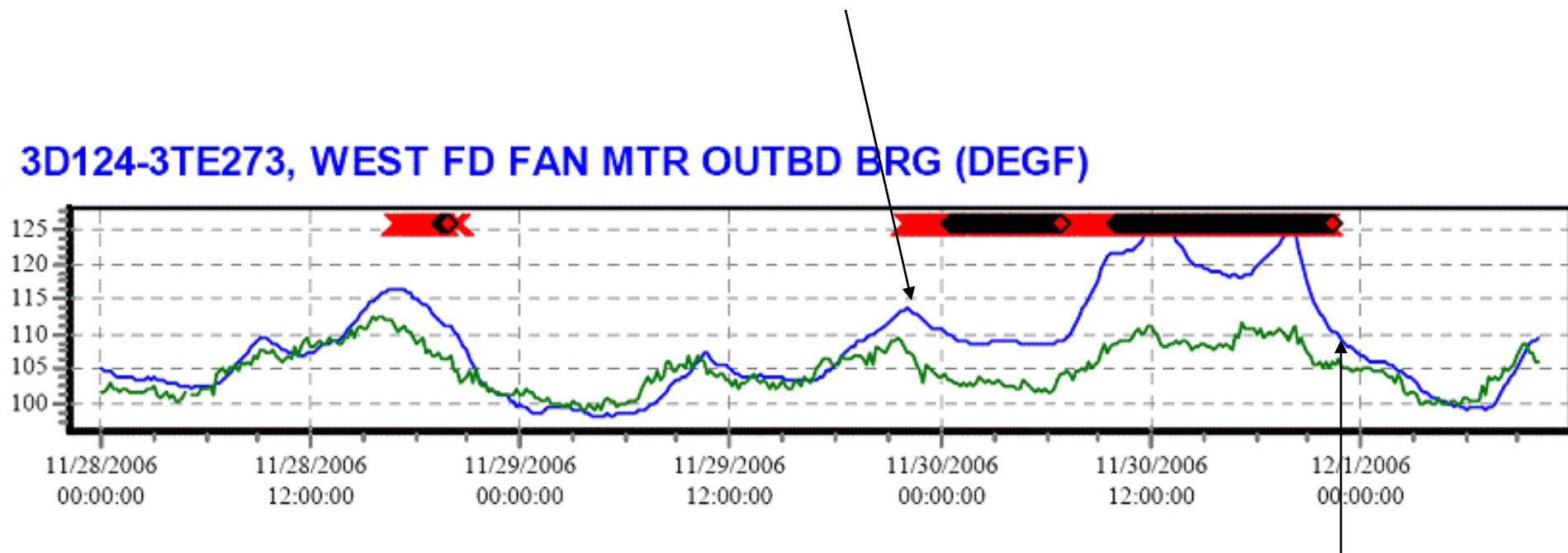
Predictive Analytics leverages the PI system

- *Computers working for you!*
- Reduces Manual Monitoring
- Detects anomalies across a fleet of assets
- Early detection of slow developing failure
- Multiple sensor models, not just a single signal
 - Avoiding failures
 - Supporting Operations
 - Optimizing Maintenance

*Rules based monitoring of critical systems.
Computer models watching the data all the time.*

Catch- Fan Motor Bearing

This is a pretty significant movement on FD Fan Motor outboard bearing (about 17 degrees above expected currently).

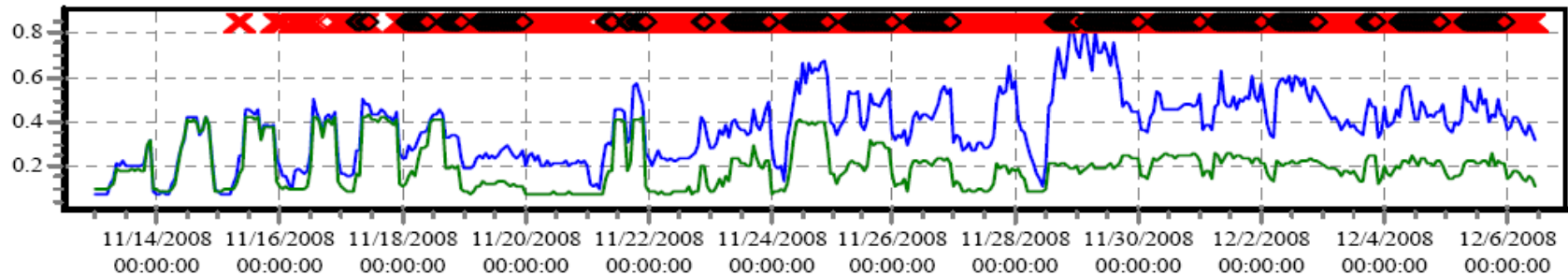


After detection, the filters were found dirty, replaced, and the oil level and temps are dropping on the motor after the change out.

Cool Catch PI & SmartSignal

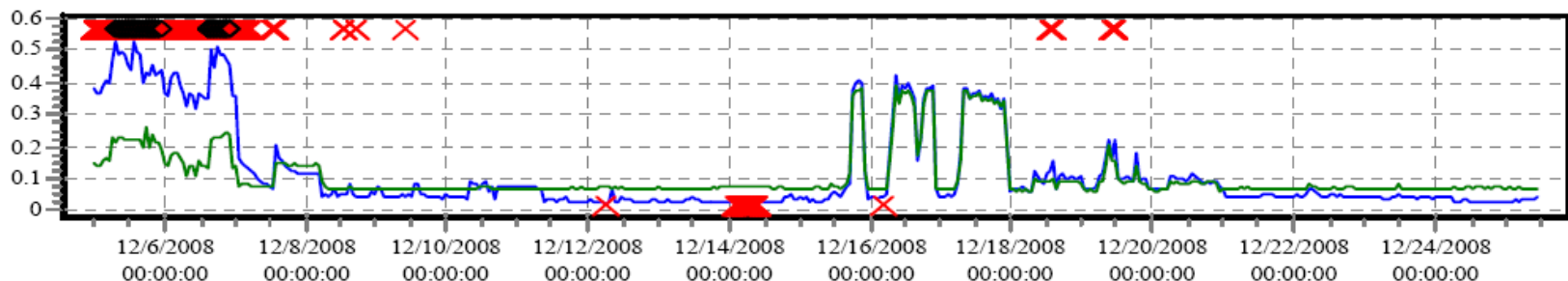
Background: A boiler acoustic detector system was installed and the data was integrated into OSI PI. A SmartSignal model was created from the statistical data. The Plant engineer noticed an increase in the Unit Penthouse Acoustic Leak Detector.

DX4_CH23, Penthouse Acoustic Leak Detector (Volts)



Resolution: The problem was looked into while the unit was offline and a small tube leak was discovered in the penthouse. The leak was repaired and the penthouse acoustic leak detector has returned to historically normal levels, avoiding a potential forced outage.

DX4_CH23, Penthouse Acoustic Leak Detector (Volts)



In Conclusion...

- PI System can support condition monitoring straight out of the box
 - The goal is to “get everything” in the operation, create a comprehensive and time synchronized correlated database (including PdM data)
 - Everything means DCS, analyzers, PdM data, CEMS (emissions), PLCs, weather, market prices, ...
 - The more dynamic the information, the better
 - Condition monitoring forms the foundation for predictive analytics where big ‘catches’ can be made
 - Condition Monitoring forms the foundation for Conditioned Based Maintenance which is core to a Proactive Maintenance culture
 - Proactive Maintenance insures a safe, available and highly reliable asset operated at the lowest life cycle cost
-

Quotes: Mahatma Gandhi

“Strength does not come from physical capacity. It comes from an indomitable will.”

“You must be the change you want to see in the world.”

“Whatever you do will be insignificant, but it is very important that you do it.”

“An ounce of practice is worth more than tons of preaching.”

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