Maximizing Electrical Output at ComEd Nuclear Stations

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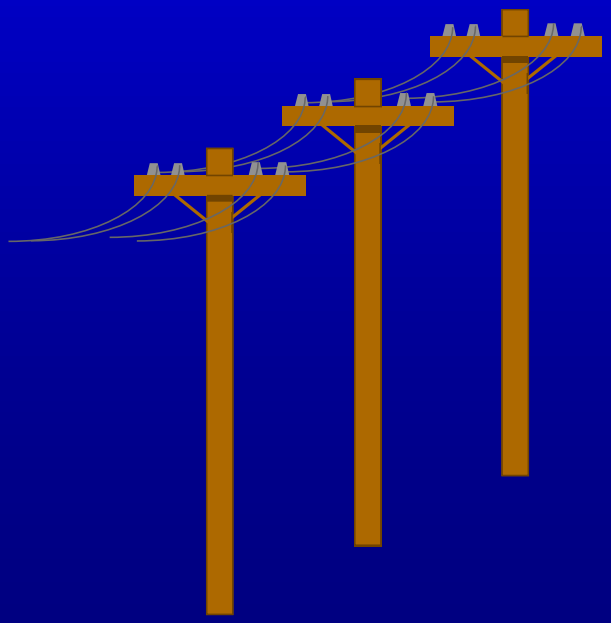


ComEd Background

- ComEd operates 5 Nuclear Stations in Northern Illinois
- All five stations contain dual units
  - Braidwood - Dual 1188 MW Units
  - Byron - Dual 1183 MW Units
  - Dresden - Dual 832 MW Units
  - LaSalle - Dual 1140 MW Units
  - Quad Cities - Dual 819 MW Units
- All units will be uprated 5 to 10%
- All units will apply for NRC license renewal

PI System Configuration

- Each site has local PI 3.2 server on NT
- 5K to 10K tags per server
- 5 years of on-line storage space available
- Main Plant Process Computers:
  - Honeywell 4010/4500
  - Re-hosted Westinghouse 2500 systems

How PI is utilized

- PI does not provide any “control”
- Most controls in a nuclear plant are analog
- Most of the protection circuitry is analog
  - hard wired, relays, bi-stable switches, etc.
- Very few digital systems actually provide “control”
- Plant Process Computers monitor plant systems
- PI provides
  - multi-user real time monitoring
  - fast retrieval of historical data

Getting Data to the End User

- Using existing company LAN/WAN for company wide connectivity
- Using standard company WIN95 desktop PCs for ProcessBook/Datalink
- 130 ProcessBook/Datalink licenses distributed throughout nuclear division
- Engineers at each site can access all sites' data

ComEd NGG PI Systems

Typical Station LAN WIN95 ProcessBook Datalink

Braidwood

Byron

Dresden

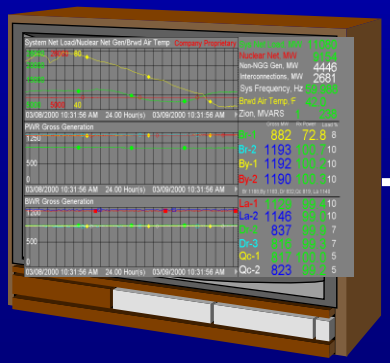
ComEd WAN

Quad Cities

LaSalle

Central

Transmission & Distribution



Nuclear Ops Center

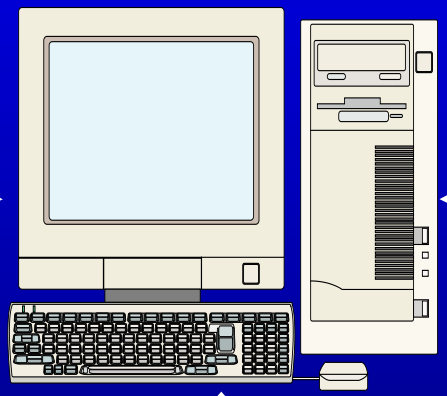
Corporate Office PCs

Data Sources for PI

Plant Process Computer

Operator Rounds

PI System



DEH System

Chemistry Data

Uses of PI

- Executive Overview of nuclear unit status
- Standard ProcessBooks for plant systems
- Electronic Operator Rounds
- Thermal Performance Optimization

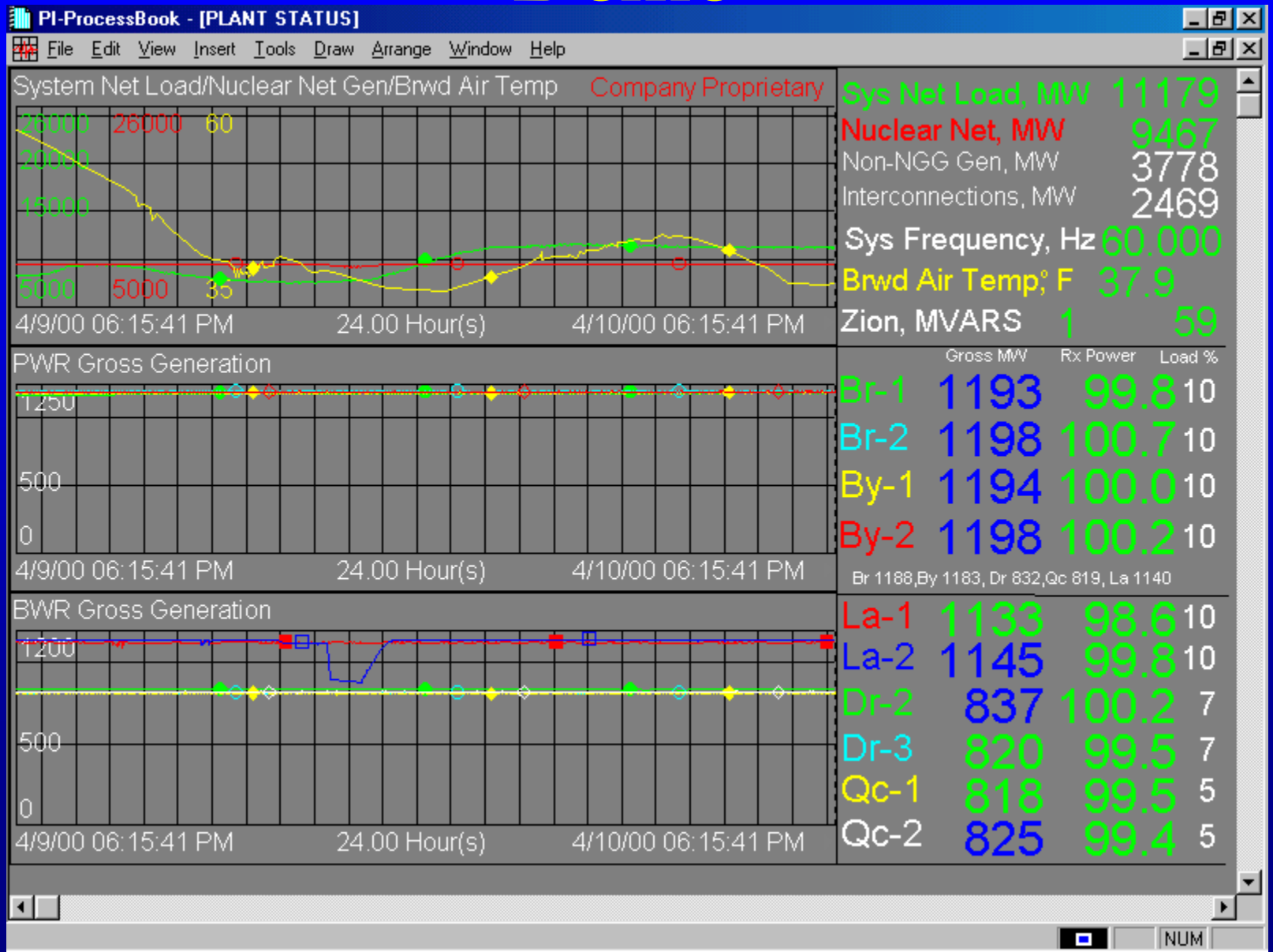
Executive Overview Display

- Central server collects data via PI to PI from all nuclear site servers
- Data consists of:
  - electrical generation (MWs)
  - and reactor power (%)
- ComEd electrical grid system information obtained from T&D PI system
- PI Performance equations calculate total nuclear contribution to system net load

Executive Overview Display (cont.)

- Provides near real-time view of all ComEd owned generation
- All nuclear personnel can access PI
- Lets each site see how they contribute to the overall power generation and load profile
- Large display in Corporate Operations Center used for quick reference
- CEO has ProcessBook and the display on his laptop

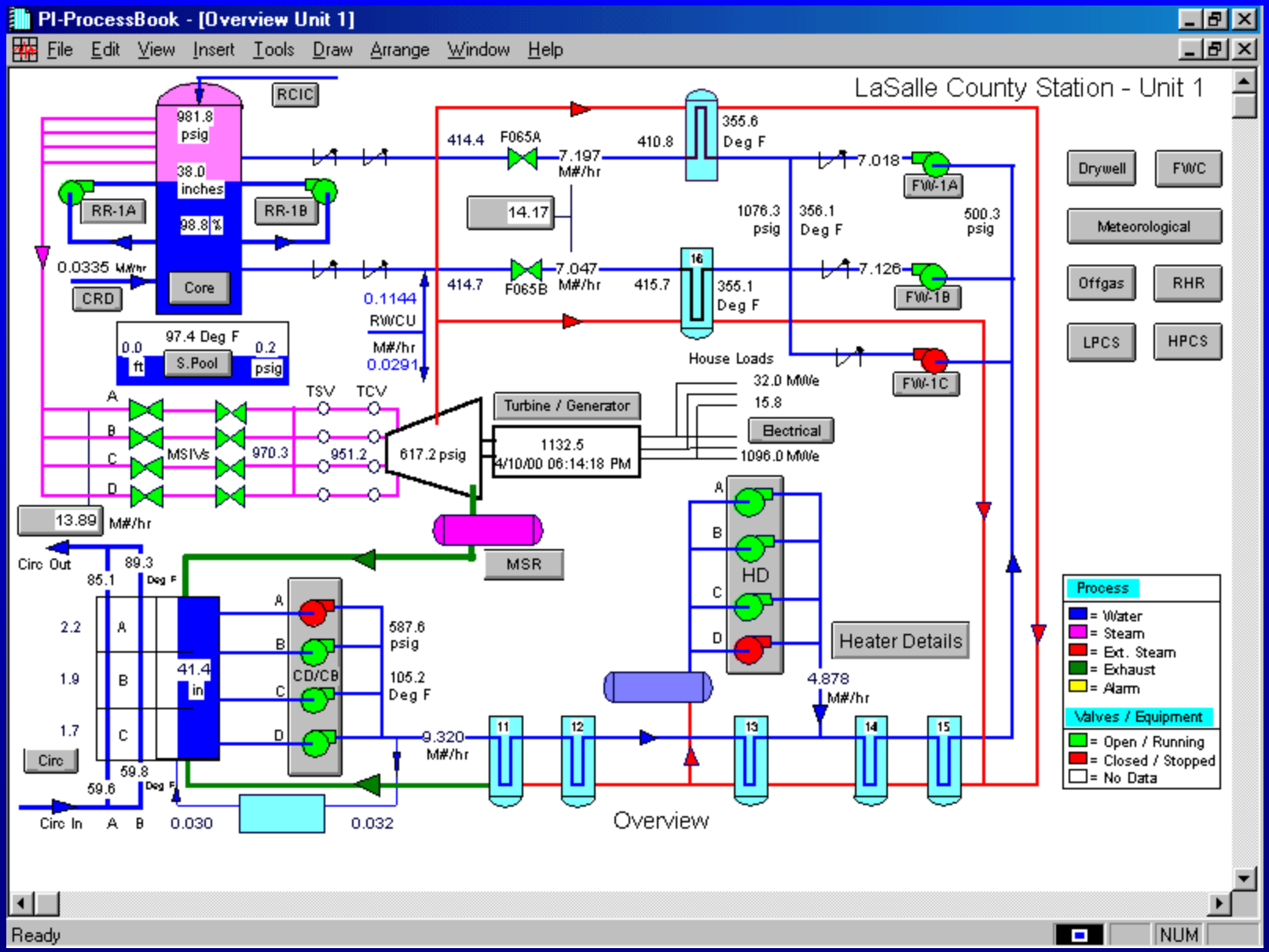
Executive Overview Display Demo



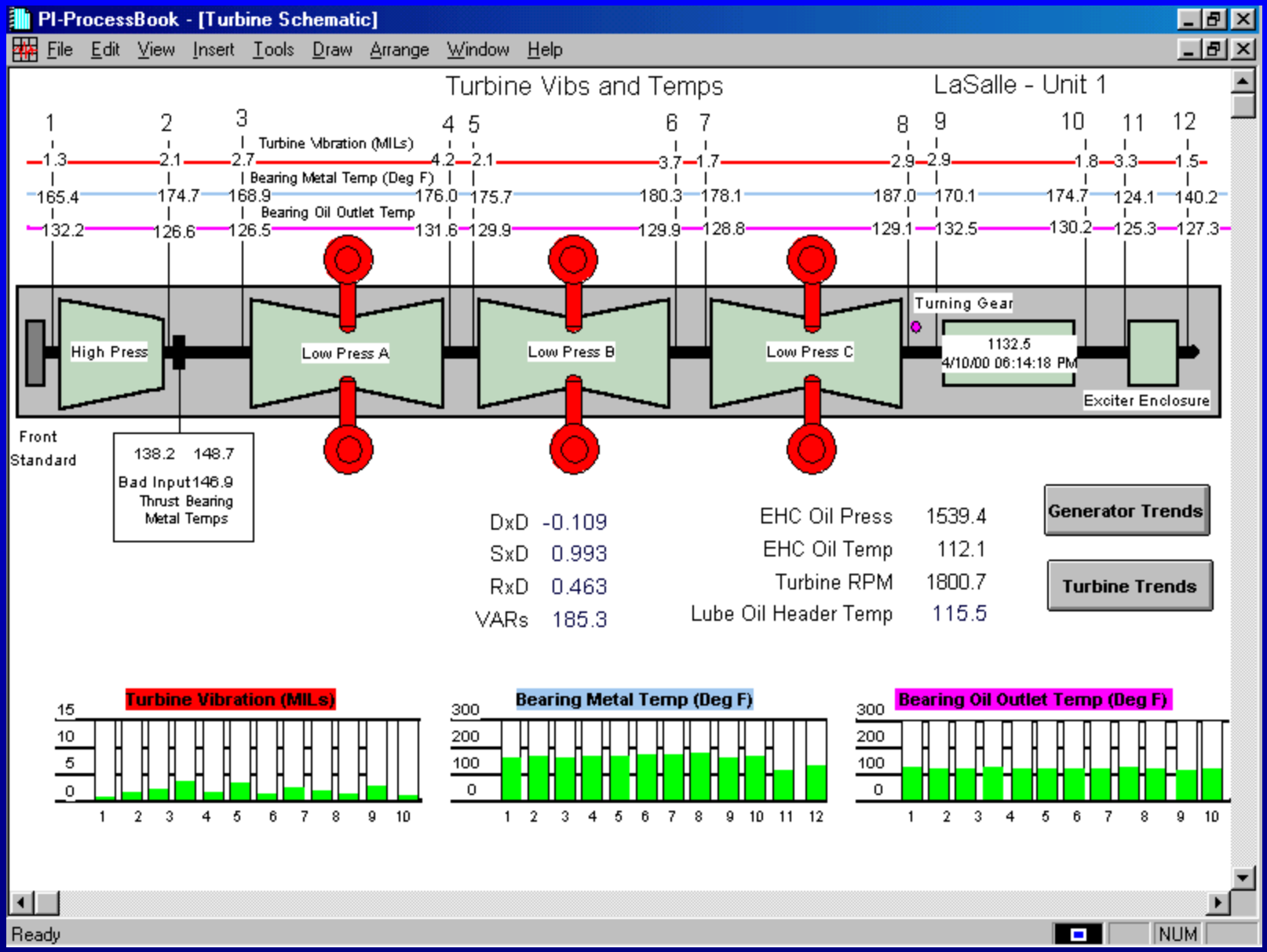
Standardized Plant ProcessBooks

- Developed standard processbooks for each unit
- Created using common active symbols and color schemes
- Consist of a simplified overview of the entire steam cycle
- Each system has its own tab (30 to 50 tabs)
- Created buttons to jump from tab to tab
- Buttons used to drill down into data
  - provide next layer of data
  - displays trends

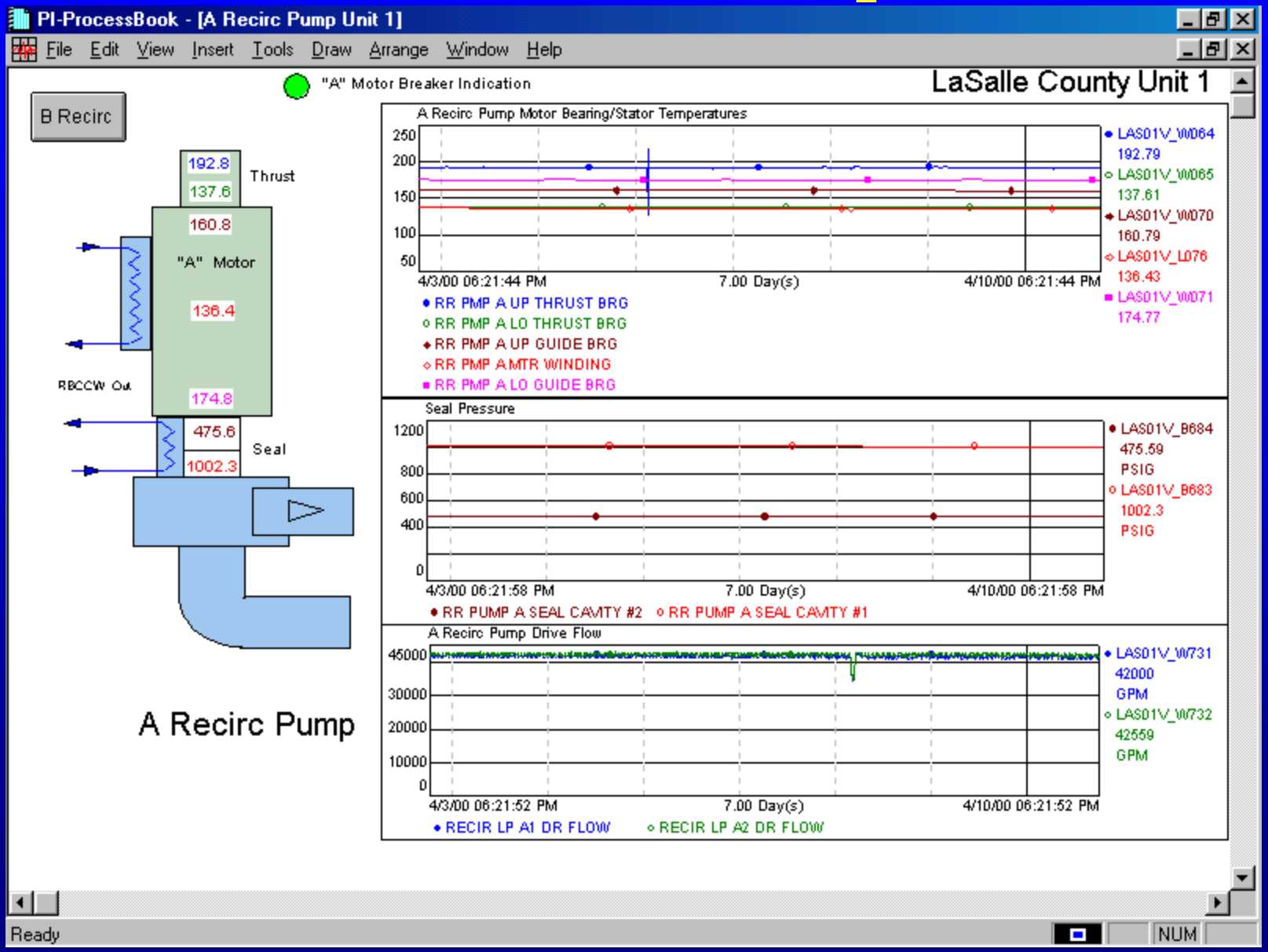
LaSalle Overview Demo



LaSalle Turbine/Generator Demo



LaSalle Recirc Pump Demo



Electronic Operator Rounds

- Operators use the NOMS software for collection and storage of data
- Data collected using hand-held Husky Data Logger
- Data is fed to an Oracle Database
- Interface Program NOMS 2 PI
  - Downloads data once per evening
  - Allows engineers to display rounds data along with process computer data

Thermal Performance Optimization

- Using DataLink to download plant data to Excel
- Common Excel spreadsheet developed for each unit
  - Specific unit selected by clicking on one button
  - Calorimetric calculations or heat balance done on live data
  - Calculation performed on demand or runs continuously

Thermal Performance Optimization
(cont.)

- Simplified for Operators
  - Displays Reactor, Turbine and Condenser parameters
  - Compares actual values to theoretical best
  - Shows off-normal values
  - Gives Operators potential equipment problems to investigate and correct
  - Calorimetric calculations are transparent to Operators

Thermal Performance Demo #1

Microsoft Excel - Loeb Report

File Edit View Insert Format Tools Data Window PI Help

Times New Roman 10 B I U 90%

H13 =

BRAIDWOOD UNIT 1 TURBINE CYCLE

THERMAL PERFORMANCE DATA

Data taken: 10-Apr-00 18:25:10

Turbine		
Gross Output:	**1190.9**	MWe
Corrected Gross Output:	**1195.3**	MWe
Expected Output:	**1199.1**	MWe
Base Comparison Output:	**1174.8**	MWe

Condenser		
CW Inlet Temp.	**57.3**	deg F
Base Comparison CWT:	**92.0**	deg F
Back Pressure:	**2.03***	in Hg
Corr. for CW Temp.:	**24.3**	MWe
CW Pumps On:	**2**	pumps

Reactor		
Core Power:	**3398.5**	MWt
Core Power:	**99.63**	%
Rated Power:	**3411.0**	MWt

*Calculated From Hotwell Temperature

Key Items That Effect MW Output

Less than Full Reactor Power

Final Feedwater Temperature Error/Problem

Feedwater Heater OOS

CW Pump Off (above 60 deg F)

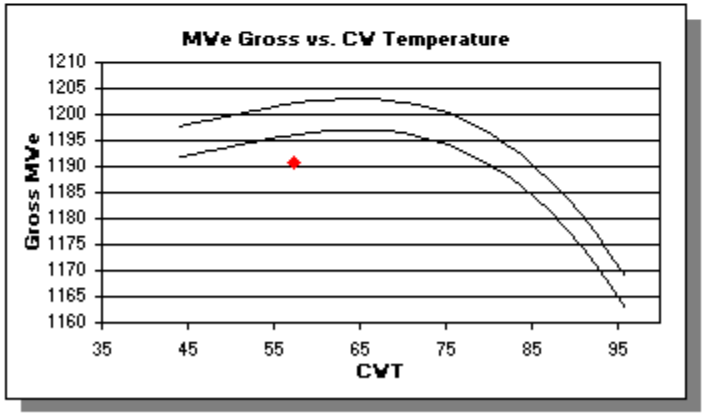
Turbine Driven Feed Pump Off

Low Steam Generator Blowdown Flow

Possible deviation areas are highlighted Red.

Start Continuous Data Update

Press **[Esc]**, *then select* "**End**" *to stop continuous data update.*



A-1
A-2
B-1
B-2
D-2
D-3
L-1
L-2
Q-1
Q-2

These buttons will NOT be in the final version.

Ready NUM

Thermal Performance Demo #2

Microsoft Excel - Loeb Report

File Edit View Insert Format Tools Data Window PI Help

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BRAIDWOOD UNIT 2 TURBINE CYCLE

THERMAL PERFORMANCE DATA

Data taken: 10-Apr-00 18:28:03

Turbine		
Gross Output:	**1198.7**	MWe
Corrected Gross Output:	**1199.0**	MWe
Expected Output:	**1200.1**	MWe
Base Comparison Output:	**1174.8**	MWe

Condenser		
CW Inlet Temp.	**56.4**	deg F
Base Comparison CWT:	**92.0**	deg F
Back Pressure:	**1.60***	in Hg
Corr. for CW Temp.:	**25.3**	MWe
CW Pumps On:	**3**	pumps

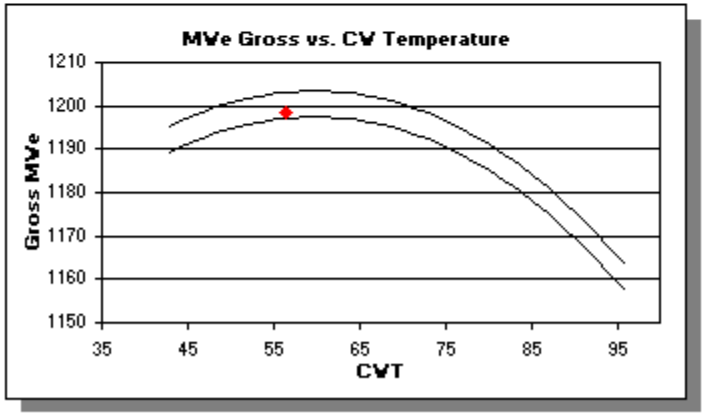
Reactor		
Core Power:	**3410.0**	MWt
Core Power:	**99.97**	%
Rated Power:	**3411.0**	MWt

*Calculated From Hotwell Temperature

Key Items That Effect MW Output
Less than Full Reactor Power
Final Feedwater Temperature Error/Problem
Feedwater Heater OOS
CW Pump Off (above 60 deg F)
Turbine Driven Feed Pump Off
Low Steam Generator Blowdown Flow
Possible deviation areas are highlighted Red.

Start Continuous Data Update

Press **[Esc]**, *then select* "**End**" *to stop continuous data update.*



A-1
A-2
B-1
B-2
D-2
D-3
L-1
L-2
Q-1
Q-2

These buttons will NOT be in the final version.

Ready NUM

Looking towards the Future

- ComEd merging with PECo
- Merger expected to occur on Aug. 1, 2000
- New company called Exelon
- Nuclear Stations will be grouped by region
- Midwest Regional Operating Group
  - will include existing ComEd Nuclear fleet
  - plus Clinton Nuclear Station

Looking towards the Future
(cont.)

- Clinton Station owned by Amergen
  - Amergen owned by PECO and British Nuclear
- Clinton located in Central Illinois
- Clinton is a single unit station
- Clinton will need a PI Server to communicate with the Midwest ROG

Mid-Atlantic ROG

- Mid-Atlantic Regional Operating Group
  - Limerick
  - Peach Bottom
  - Three Mile Island
  - Oyster Creek
- Establishing a Regional Operations Center
- Mid-Atlantic ROG installing PI to monitor units
  - 100 tag systems per station initially
  - Executive Display will be similar to one developed for ComEd Group

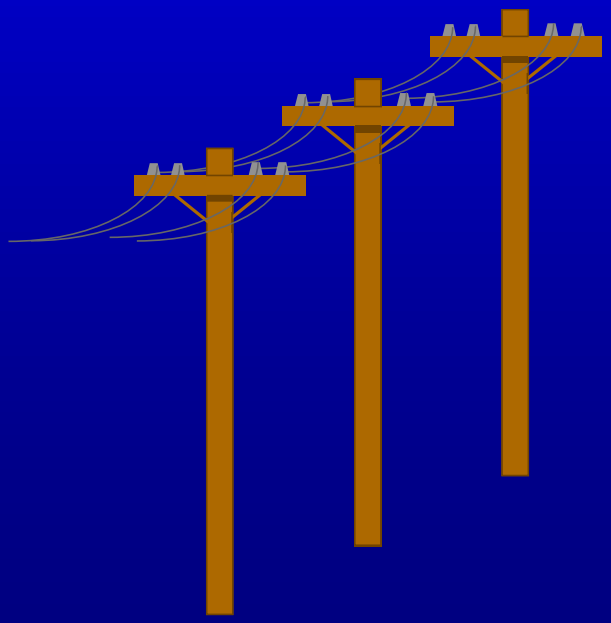
Additional Uses of PI System

- PI Historian primary repository for all time-series historical plant data
- Use PI as the backbone for System Engineer Workstation
- Chemistry Parameter Displays
- Integrate Plant Process Computer and PI; use PI as PPC's real-time database
- Increase scan rate for data
- Troubleshooting and event analysis
- Auto e-mail/pager notification when a system fails
- Take over functions of GSEP system

GSEP Point History (Old Historian vs PI)

- 1 minute resolution
- 50 MB per day
- Only 100 out of 1200 turbine points
- Each system has custom interface

- 5 second resolution
- 10 MB per day
- All 1200 points are available
- Common interface, namely Process Book

Conclusion

- End Users have to be given some examples of how PI can be used
- After that, allow creativity and innovation to flourish