Maximizing Operating Effectiveness with Integrated Combustion and Soot Blowing Optimization

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Power-Gen International
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DYNEGY

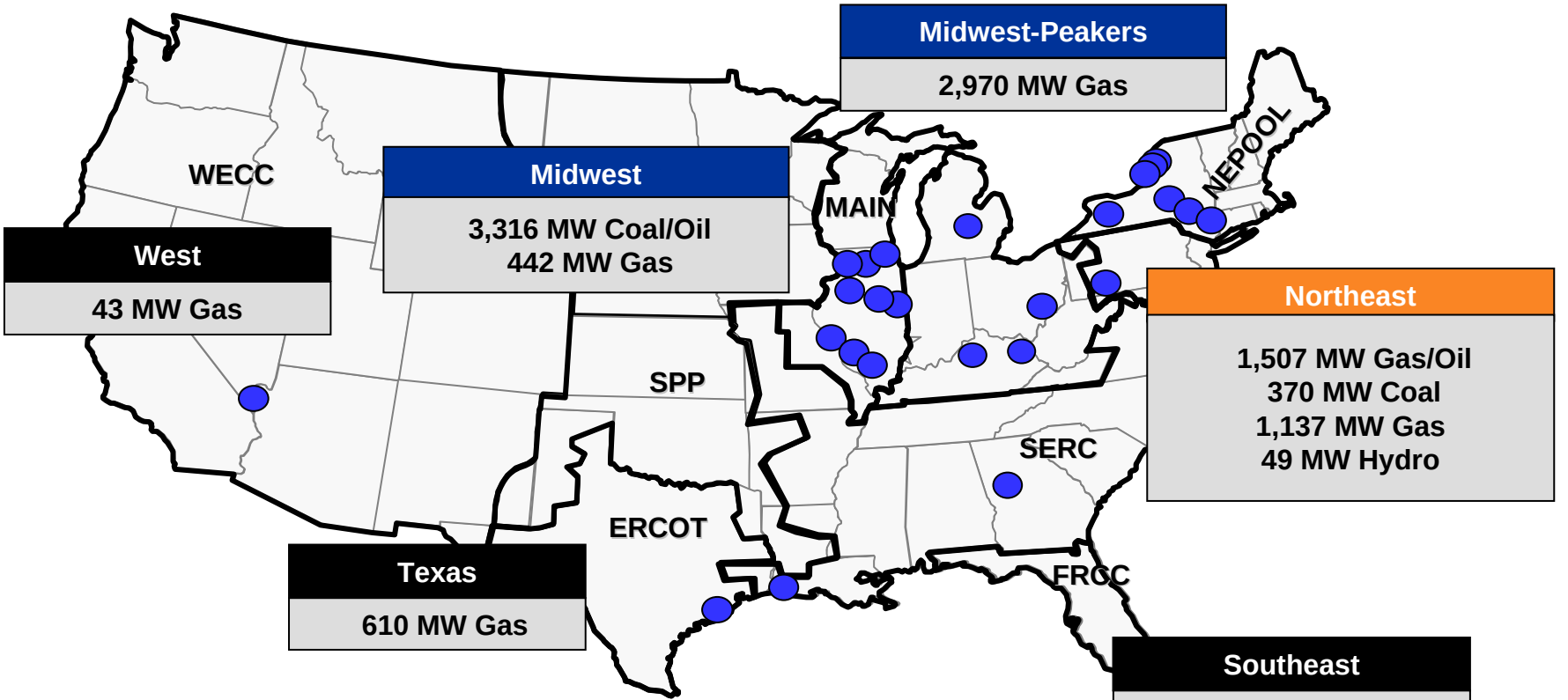
Agenda

- Dynegy Overview
- Motivations for Optimization
- CCPI Project Overview
- Soot Cleaning Optimization
- Looking Ahead

DYNEGY

About Dynegy

U.S. PORTFOLIO
11,259 net MW



Midwest-Peakers
2,970 MW Gas

Midwest
3,316 MW Coal/Oil
442 MW Gas

West
43 MW Gas

Northeast
1,507 MW Gas/Oil
370 MW Coal
1,137 MW Gas
49 MW Hydro

Texas
610 MW Gas

Southeast
815 MW Gas

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Dynegy's Baldwin Energy Complex

3 - 600 MW Units

1970-1975

Units 1 & 2 Cyclone Fired

14 Cyclones/Unit

Unit 3 T-Fired

6 Mills

PRB Coal

Conversions
1999 & 2000

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Motivations for Optimization

- **Full Load PRB operation requires tight control**
  - **Loss of spare fuel delivery capacity**
  - **Small process changes have significant effects**
  - **Seasonal impacts to heat rate**
- **Expectations**
  - **Ability to control key parameters on consistent basis**
  - **Ability to compensate for changes in coal quality**
  - **Improved understanding of available data and its use for improved operations**
  - **Ability to optimize controls to meet plant objectives.**

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NeuCo's CCPI Project @ Baldwin

- About the Clean Coal Power Initiative (CCPI)
  - $1.3 B initiative to demonstrate clean coal technologies in the field
  - Sponsored by DOE's National Energy Technology Laboratory
  - NeuCo's project at Baldwin selected as Round 1 winner in 2004
- Five integrated optimization modules, parallel development
  - SCR
  - Combustion
  - **Soot blowing**
  - Performance
  - Maintenance
- Products developed iteratively with multiple releases

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Why Optimize Soot Cleaning?

- Cleaning actions (or lack thereof) affect many plant parameters:
  - Slagging/fouling impacts heat transferability
  - Capacity: Steam and gas temperatures, spray flows, differential pressures, fan limits
  - Performance: Boiler efficiency, heat rate
  - Emissions: NOx, Opacity, LOI, CO
  - Availability/Reliability: Waterwall/tube longevity, EFOR, equipment wear-and-tear
- Operational complexities:
  - Fuel and equipment variations
  - SCR/SNCR systems
  - LOI control objectives
- Bottom line economic impact - $$$$

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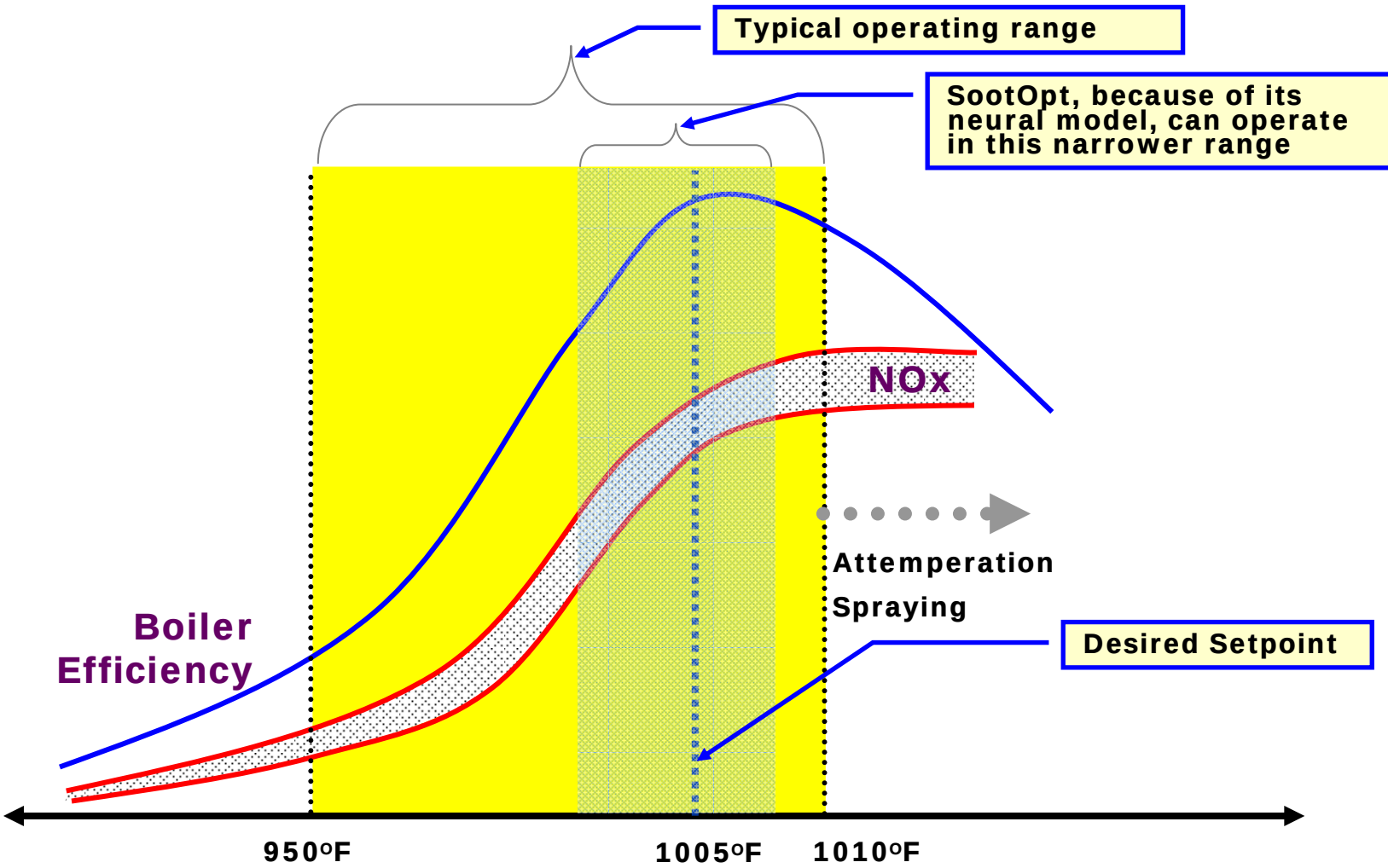
SootOpt



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What SootOpt Does

- Optimizes boiler cleaning based on unit-specific objectives:
  - Improves emissions control (NOx, opacity, CO)
  - Improves Heat Rate including Reheat & Superheat steam temperature control
  - Balances tradeoffs between furnace/backpass absorption
  - Reduces O&M costs by avoiding unnecessary boiler cleaning actions and reducing tube wear and thermal stressing
  - Compensates for off-design fuels and operations
  - Leverages existing soot cleaning instrumentation, models, equipment and control systems

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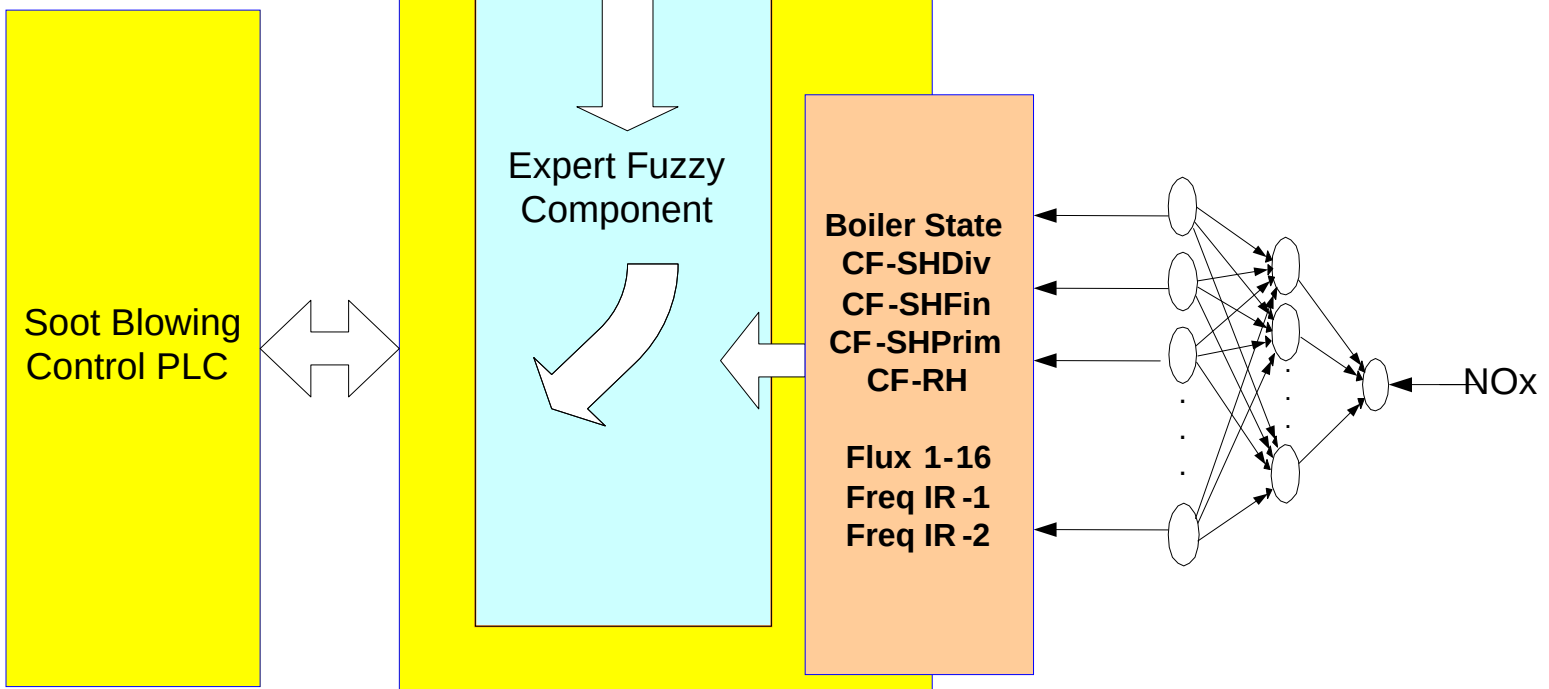
How SootOpt Works

Hybrid Expert Adaptive System

Heuristic Set 1	SH < 990	990 < SH < 995	995 < SH < Tset	SH > Tset
RH < 990	A	A	A	A
990 < RH < 995	A	B	C	C
995 < RH < Tset	A	B	B or C	C
RH > Tset	A	B	C	B or C



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SootOpt at Baldwin Unit 3

- 630 MW, Base-Loaded, T-Fired
- SOFA, Low NOx Burners
- High variability in PRB coal
- Heat Flux Sensors and Water Cannons
- Diamond SentrySeries 1500 control system with locally intelligent controls
- PrecisionClean and standard IK's in convection pass
- Also thermocouples and FEGT
- Prevailing sootblowing guidelines:
  - ISB preset flux targets in the furnace, operators intervene
  - Operator initiated in the convection pass

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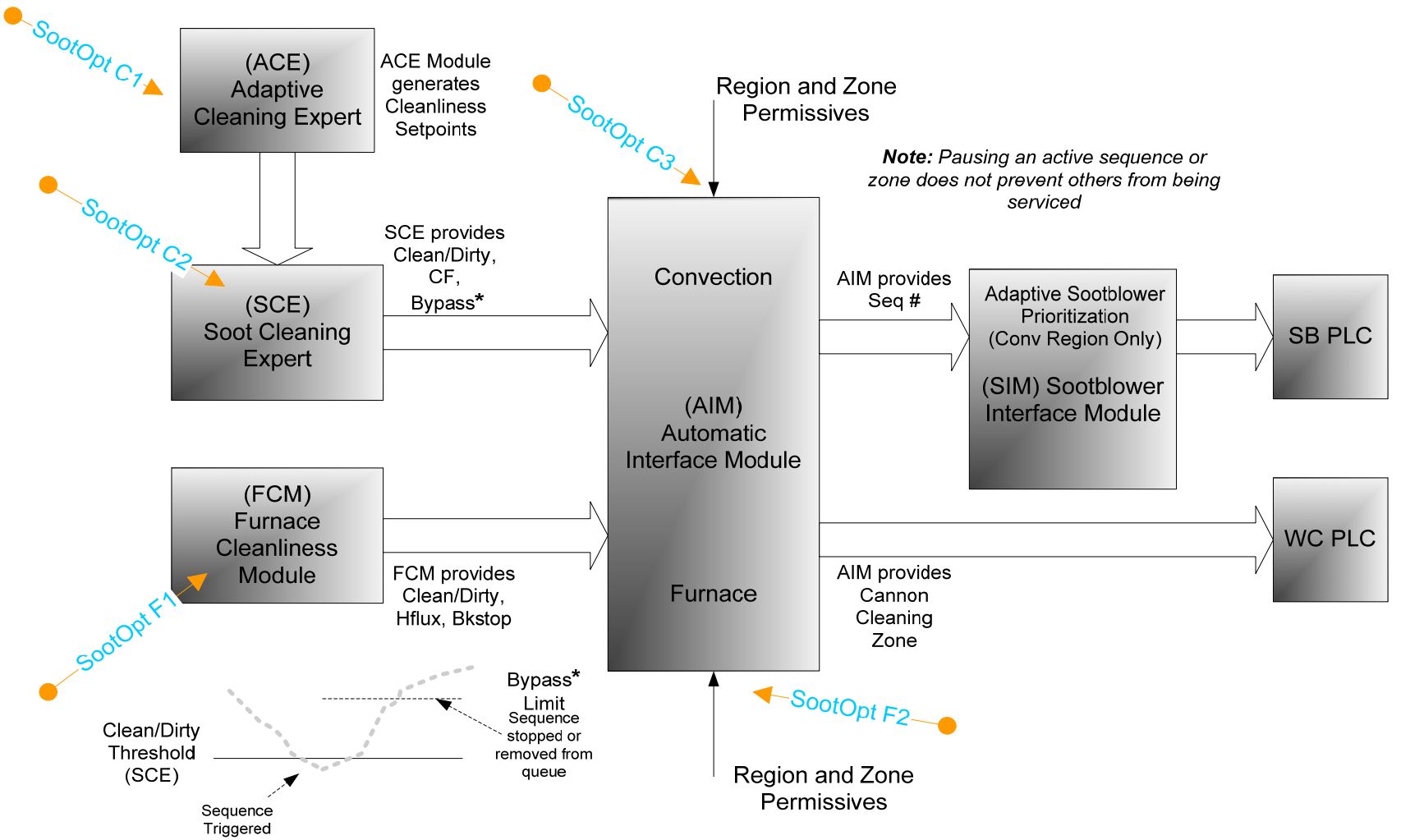
SootOpt - Diamond SentrySeries 1500 Interface



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Unit 3: SootOpt Home

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Optimization Alerts

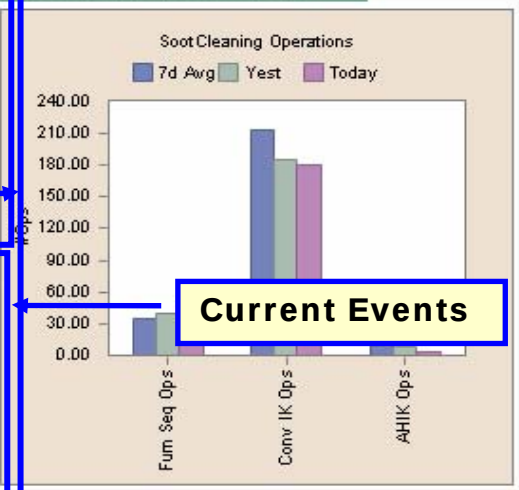
Symptom	Priority	Ranked Operational Impact
Primary SH (Seq55) auto operations < minimum		5
Economizer (Seq56) auto operations < minimum		5
Reheat SH (Seq53) auto operations < minimum		4
Secondary SH (Seq54) auto operations < minimum		
Platen SH (Seq52) auto operations < minimum		
Furn zone 7 (Seq27) auto operations < minimum		2

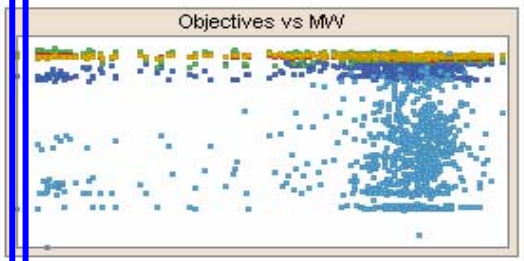
Optimization Benchmarks

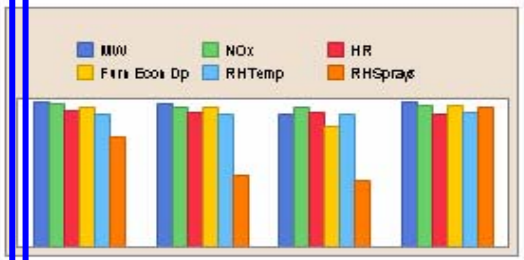
Optimization Alerts

Current Events

Optimization Benchmarks







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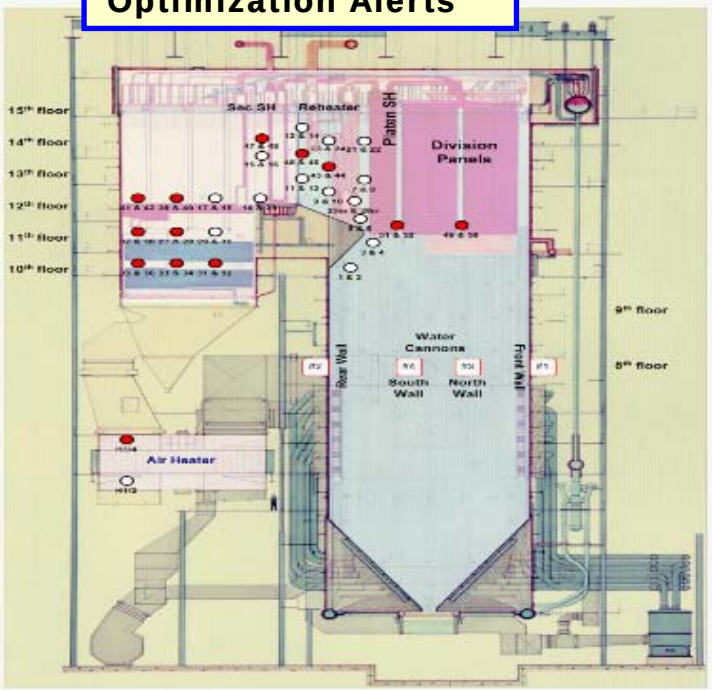
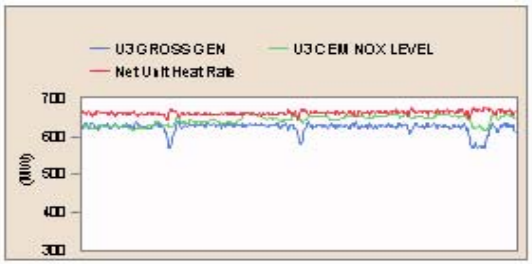


SootOpt Master En	Yes
Conv Perm All	No
Conv Auto	Yes
Conv Pause	No
Furn Auto	Yes
Cannon 12 Pause	No
Cannon 34 Pause	No

Furn Zone Running	2
Conv Seq Running	52 (PLSH)
Conv Blower Running	46
AH Blower Running	0



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Session Documents Memory Help

Unit 3: SootOpt Analysis

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Standard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

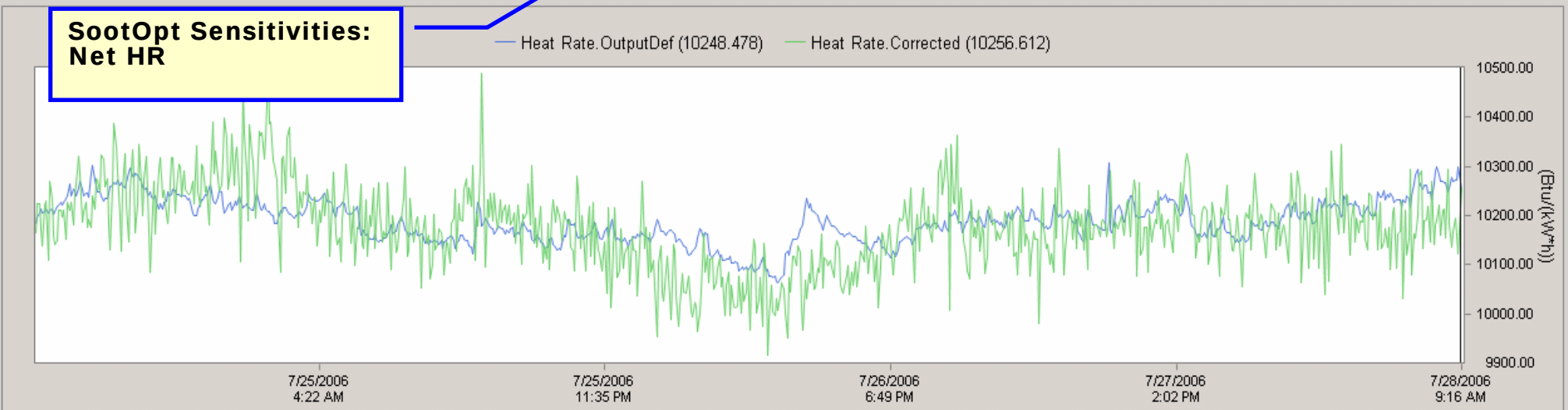
Activity/Status | Zone States | Boiler Map

Zones	IKs
Nose Arch	1, 2
Division Panels	49, 50, 51, 52
Platen SH	3, 4, 5, 6, 7, 8, 21, 22
Reheater	9, 10, 11, 12, 13, 14, 23, 24, 43, 44, 45, 46
Secondary SH	15, 16, 19, 20, 47, 48
Primary SH	17, 18, 39, 40, 41, 42
Economizer	27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38

Ready

Modelled Function: Heat Rate ☑ All Inputs

SootOpt Sensitivities: Net HR



Convection zones | Analysis Trending | **Causality RH ...(uRatio/Flux)**

Modelled Function: RH Sprays

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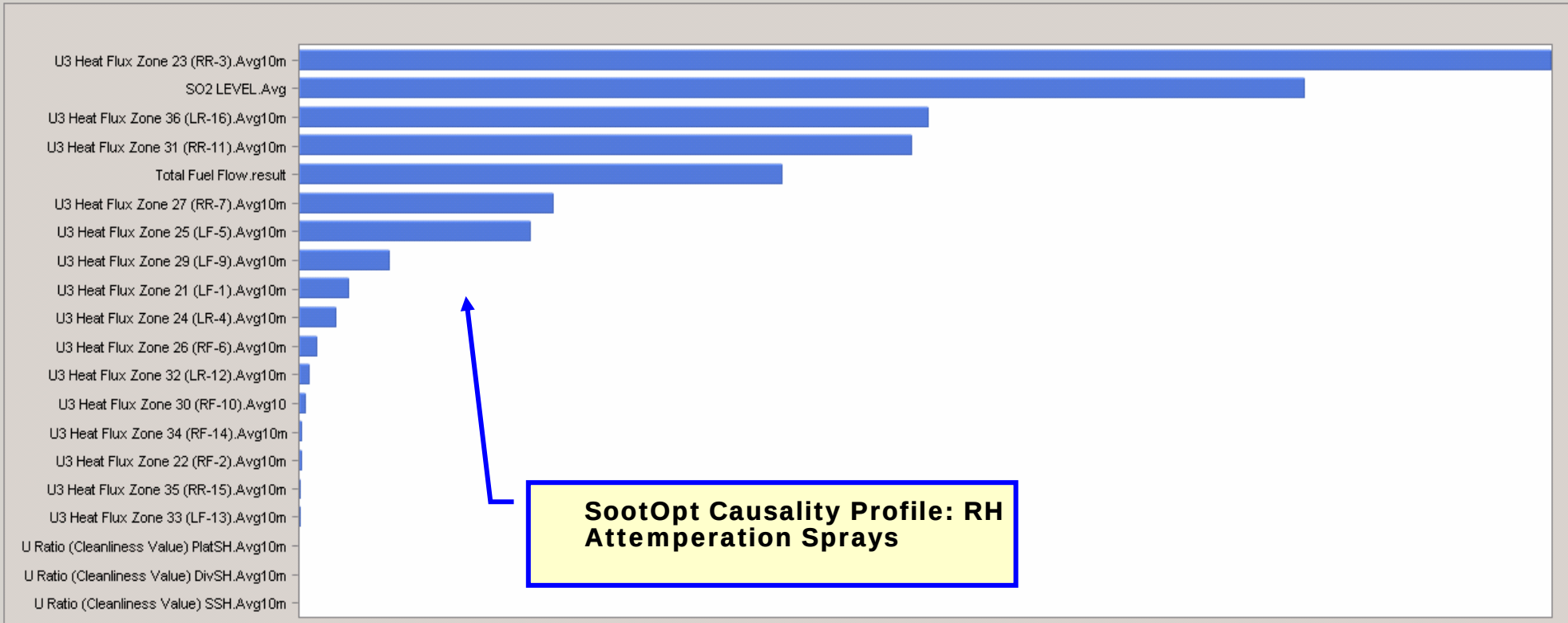

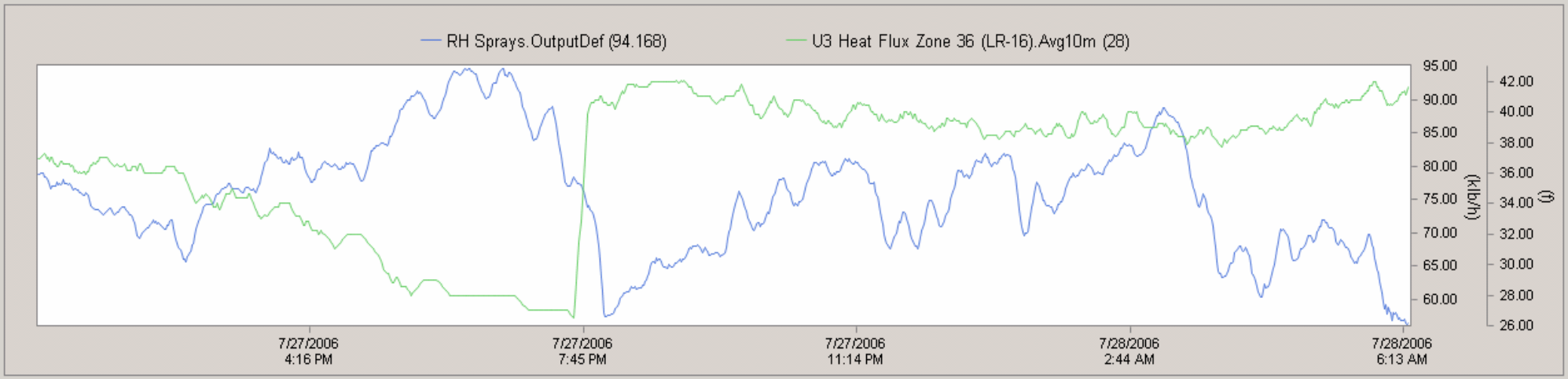

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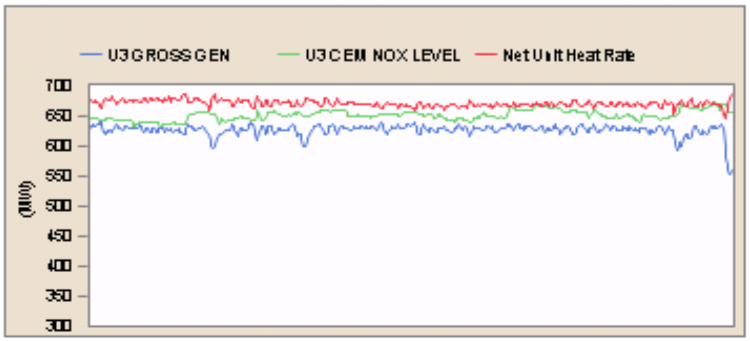
Unit 3: SootOpt Analysis

1 day | 11/02/2006 05:11:05 PM

ndard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

wity/Status | Zone States | Boiler Map

oss MW	560.36 MW
MW	533.62 MW
acity	17.39 %
nace to RH dP	0.33 inH2O
nace to Econ dP	5 inH2O
Temp	1,008.29 degF
Temp North	1,007.04 degF
Temp South	1,015.24 degF
Spray Flow	28.64 klb/h
Spray Flow	31.42 klb/h
g Furn Flux	37.96 f

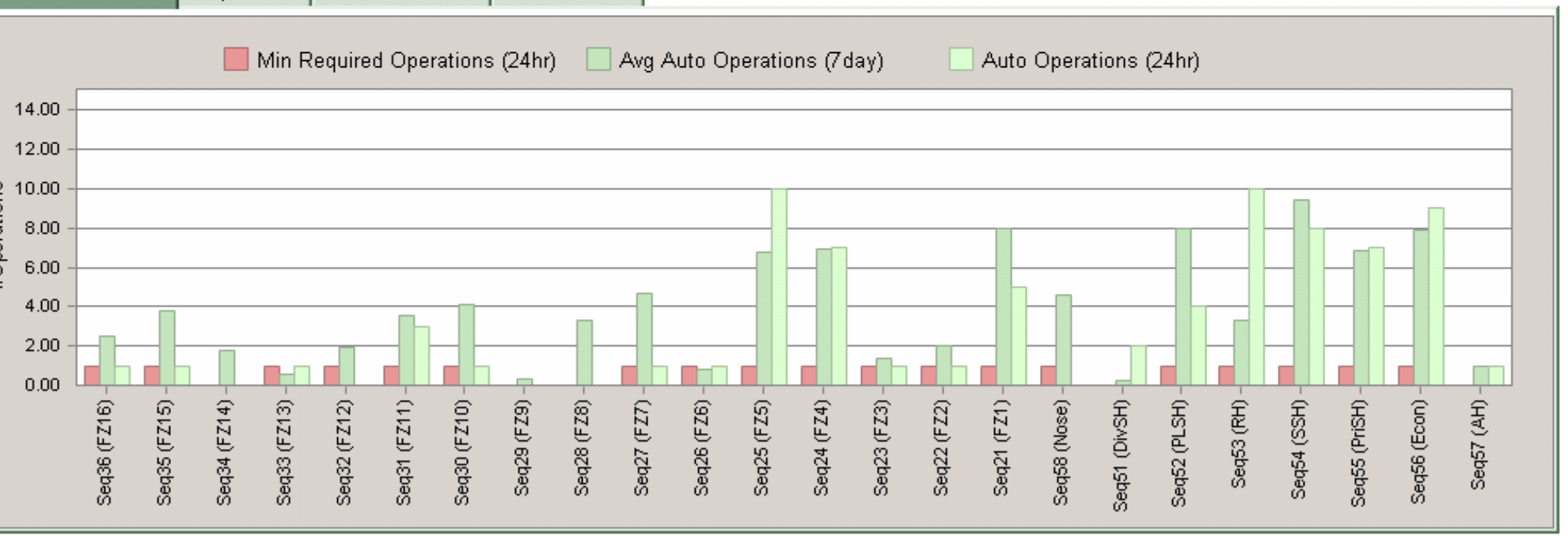


	7dAvg	Yest	Today
Seq Ops	115.97	107	73
Conv/AH Seq Ops	47.57	50	34
Furn Seq Ops	51.84	41	32
Conv IK Ops	179.9	192	145
AHIKOps	10.75	8	4

Furn Zone Running	4
Conv Seq Running	52 (PLSH)
Conv Blower Running	0
AH Blower Running	0

SootOpt Master En	Yes
Conv Perm All	No
Conv Auto	Yes
Conv Pause	No
Furn Auto	Yes
Cannon 12 Pause	No
Cannon 34 Pause	No

quence Operations | IK Operations | Convection Details | Furnace Details



ession Documents Memory Help

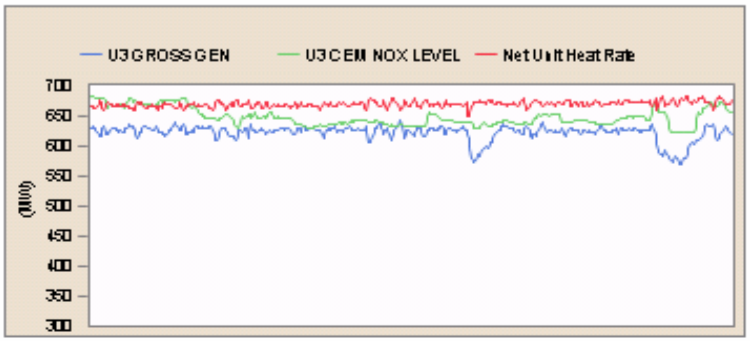
Unit 3: SootOpt Analysis

1 day | 11/04/2006 05:11:05 PM

ndard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

wity/Status | Zone States | Boiler Map

oss MW	620.12 MW
MW	592.35 MW
acity	16.46 %
nace to RH dP	0.41 inH2O
nace to Econ dP	6.2 inH2O
Temp	966.88 degF
Temp North	956.66 degF
Temp South	972.48 degF
Spray Flow	30 klb/h
Spray Flow	0 klb/h
g Furn Flux	40.65 f

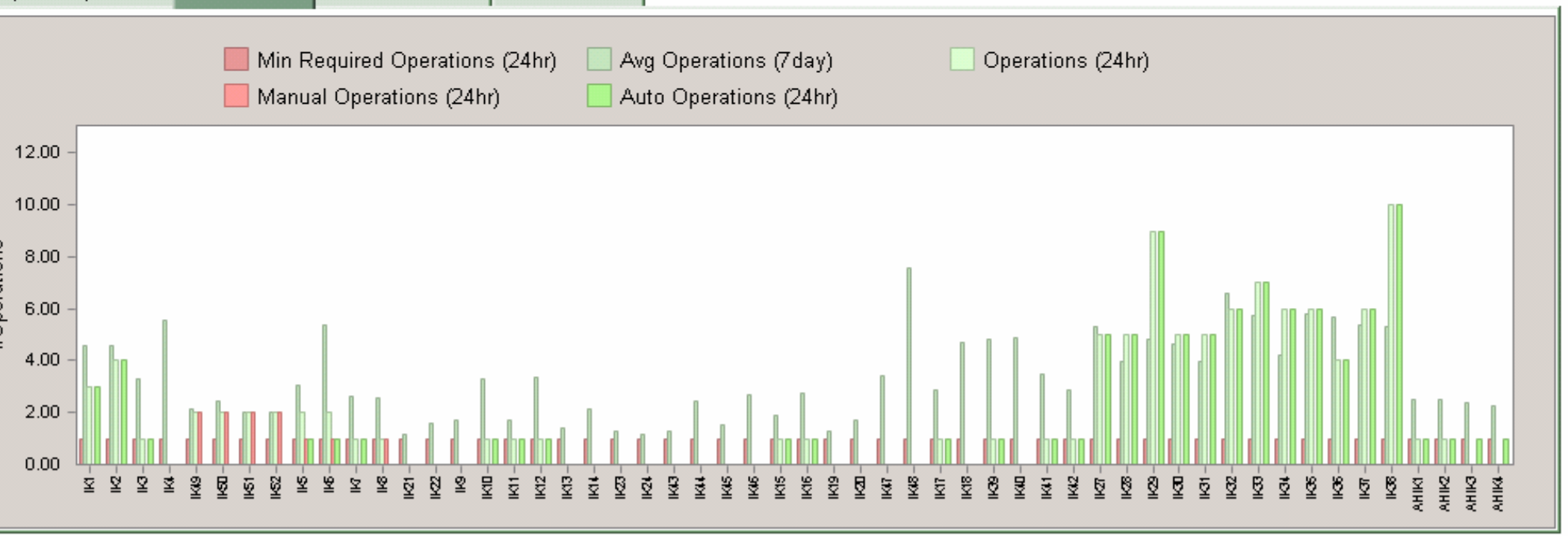


	7dAvg	Yest	Today
Seq Ops	93.96	56	43
Conv/AH Seq Ops	39.55	16	16
Furn Seq Ops	41.49	29	18
Conv IK Ops	170.54	131	83
AHIKOps	9.24	8	6

Furn Zone Running	5
Conv Seq Running	0
Conv Blower Running	0
AH Blower Running	0

SootOpt Master En	Yes
Conv Perm All	Yes
Conv Auto	Yes
Conv Pause	No
Furn Auto	Yes
Cannon 12 Pause	No
Cannon 34 Pause	No

equence Operations | IK Operations | Convection Details | Furnace Details



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Unit 3: SootOpt Analysis

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ndard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

ivity/Status | Zone States | Boiler Map

ProcessLink

Session Documents Memory Help

Unit 3: SootOpt Analysis

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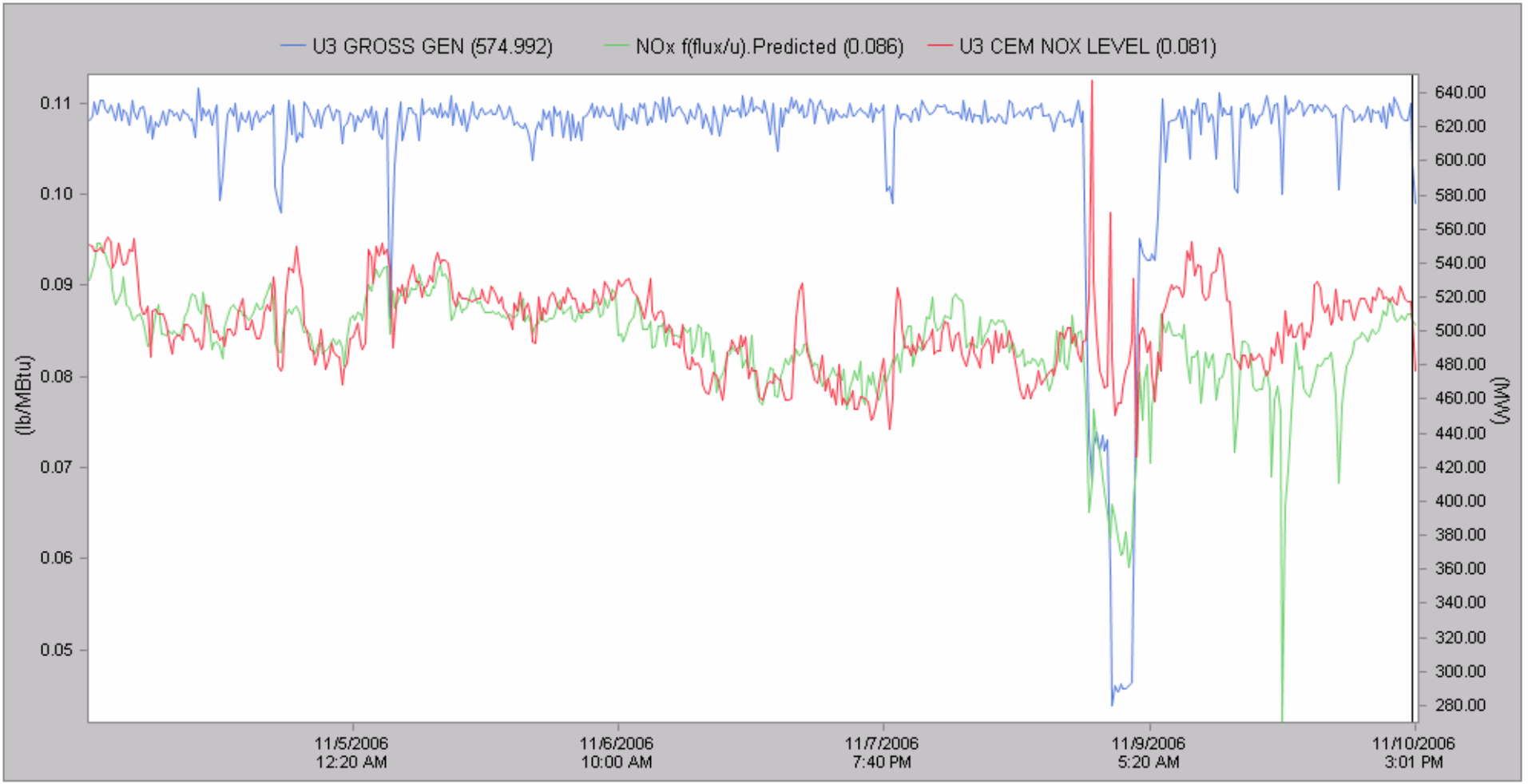
Standard | Demystifier | Trend | **Model** | Scatter | Surface | Sensitivity | Std Error | Custom

Primary: NOx f(uRatio/flux)



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Session Documents Memory Help

Unit 3: SootOpt Analysis

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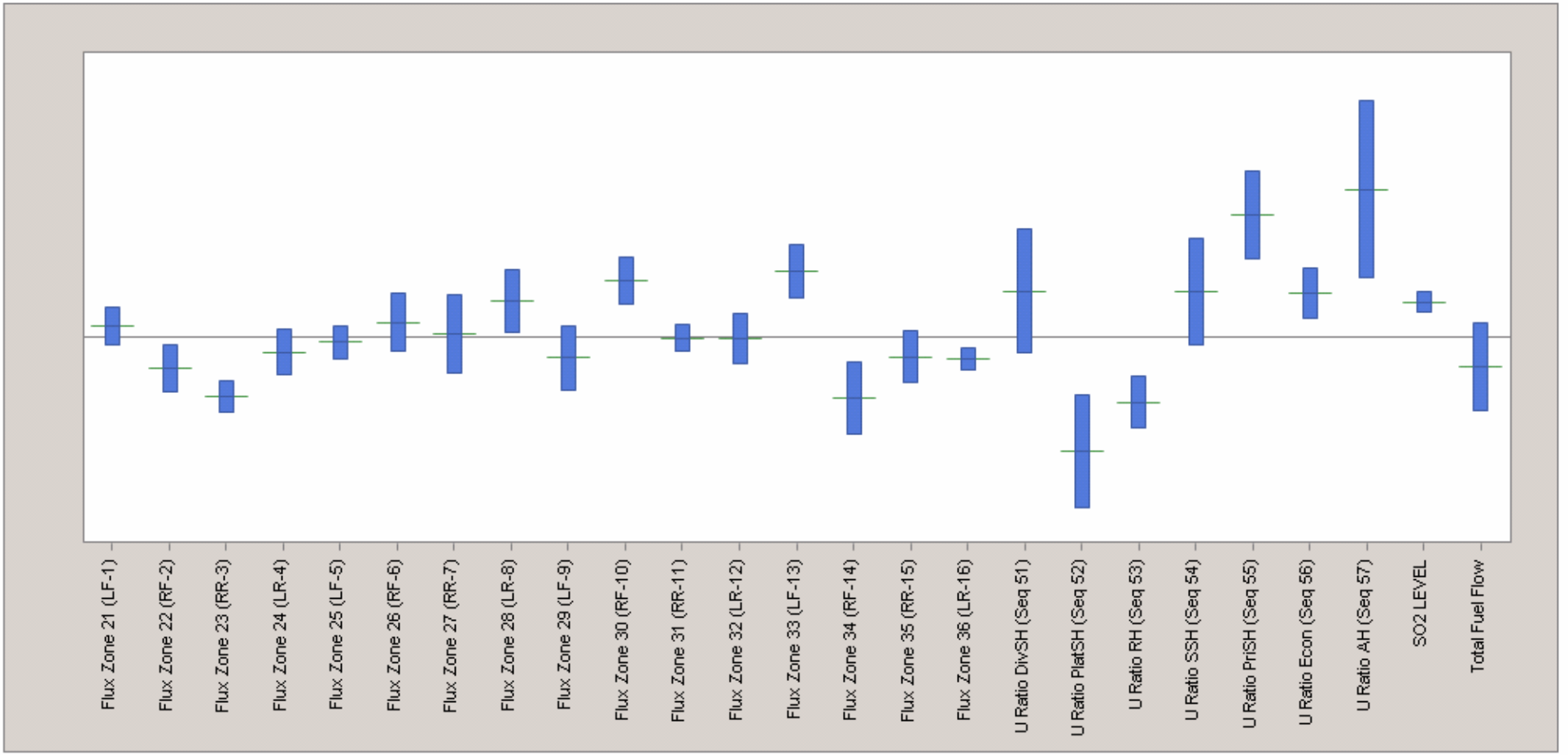
Standard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

Modelled Function: Heat Rate f(flux/u)

Inputs: flux/u,States



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SootOpt at Baldwin: Results Thus Far

- **Operating and Producing Results on Unit 3**
  - **Initially operated only on Water Cannons for furnace cleaning**
  - **Now operating on furnace and all convection pass regions**
  - **Now being integrated with CombustionOpt**
- **Being installed on Unit 2 now**
  - **Unique opportunity to quantify contributions of individual ISB control and instrumentation components**

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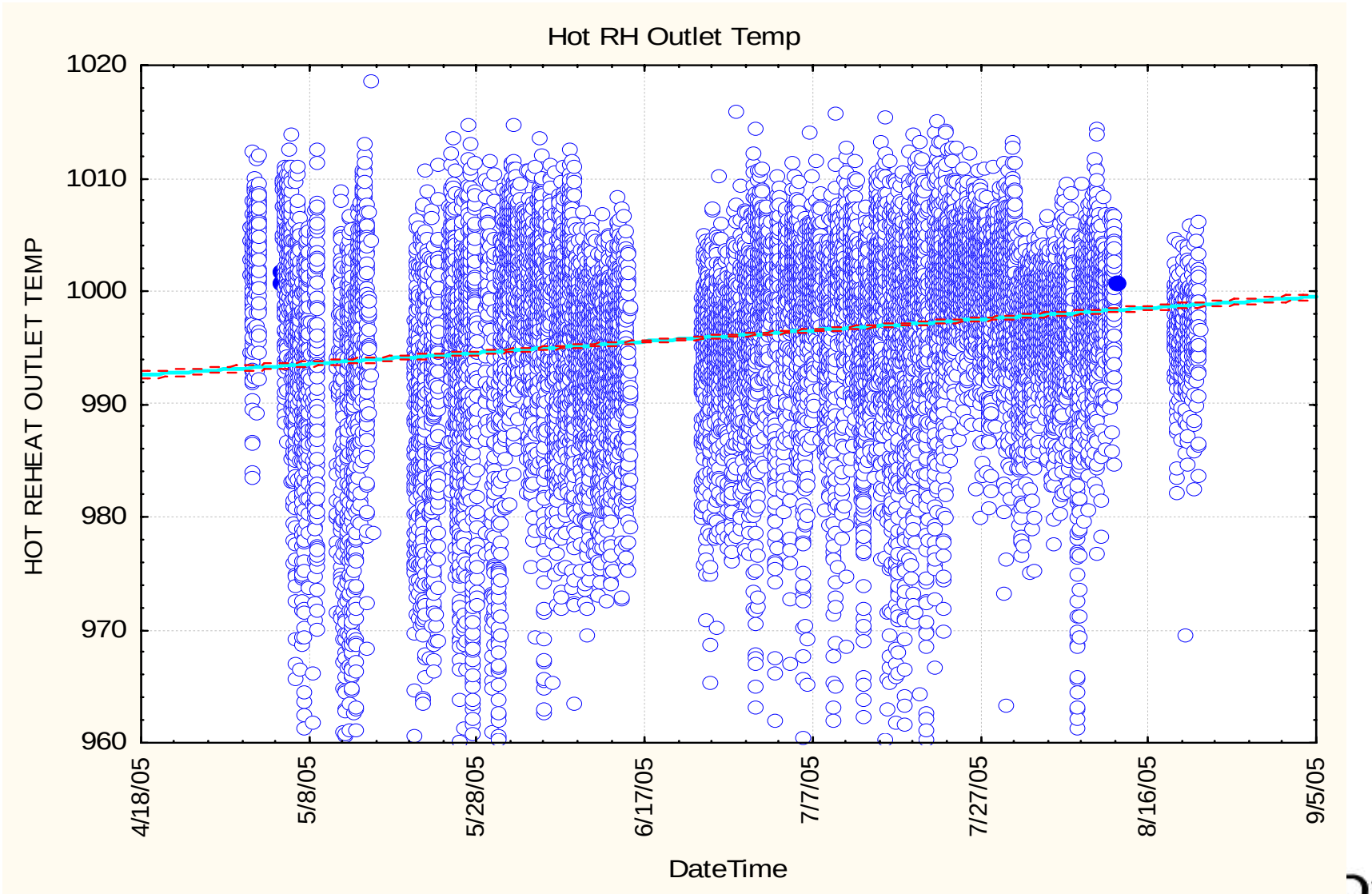
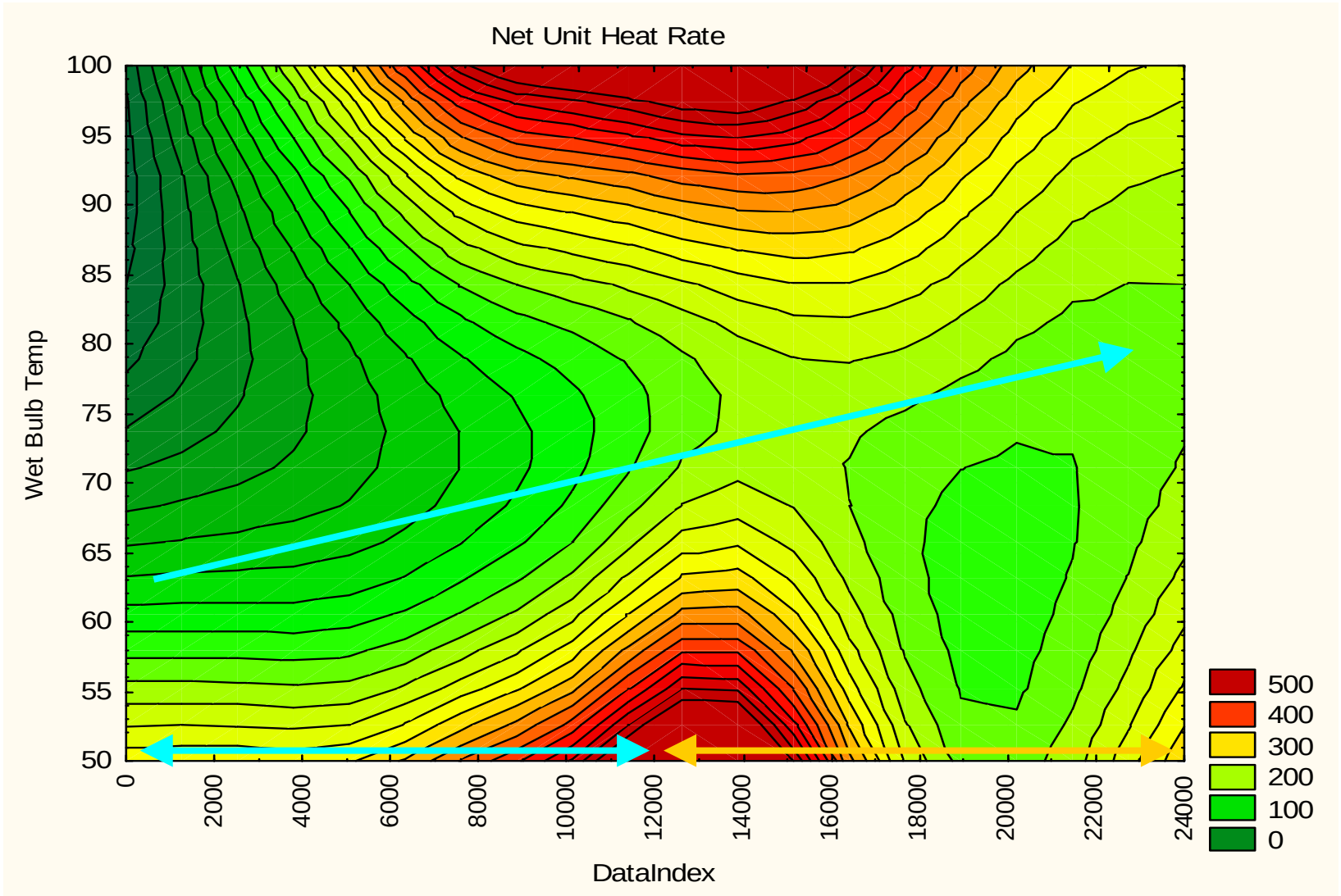
RH Temps with SootOpt (Furnace Only)



Heat Rate vs Wet Bulb over Time



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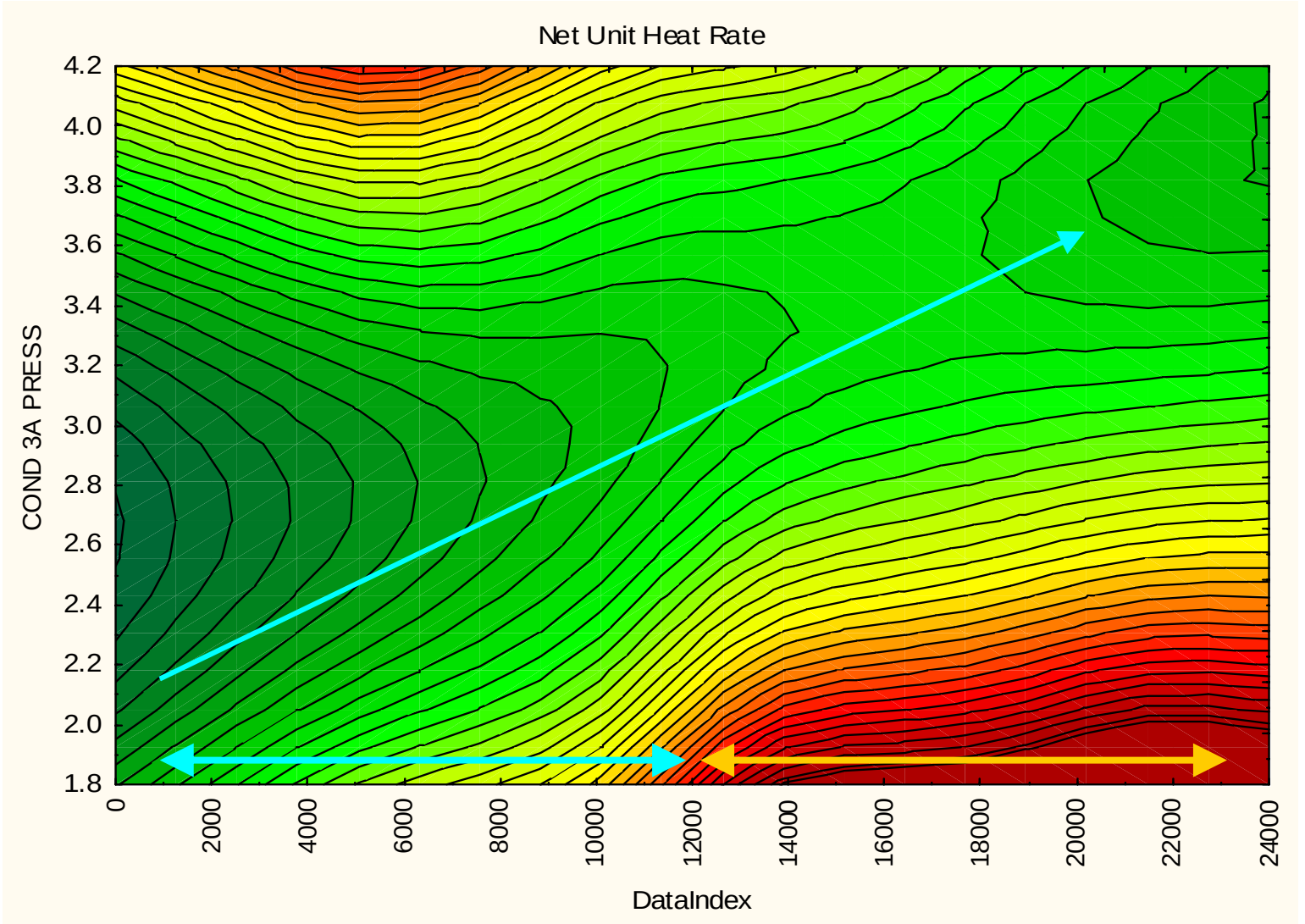
Heat Rate vs Cond Press over Time



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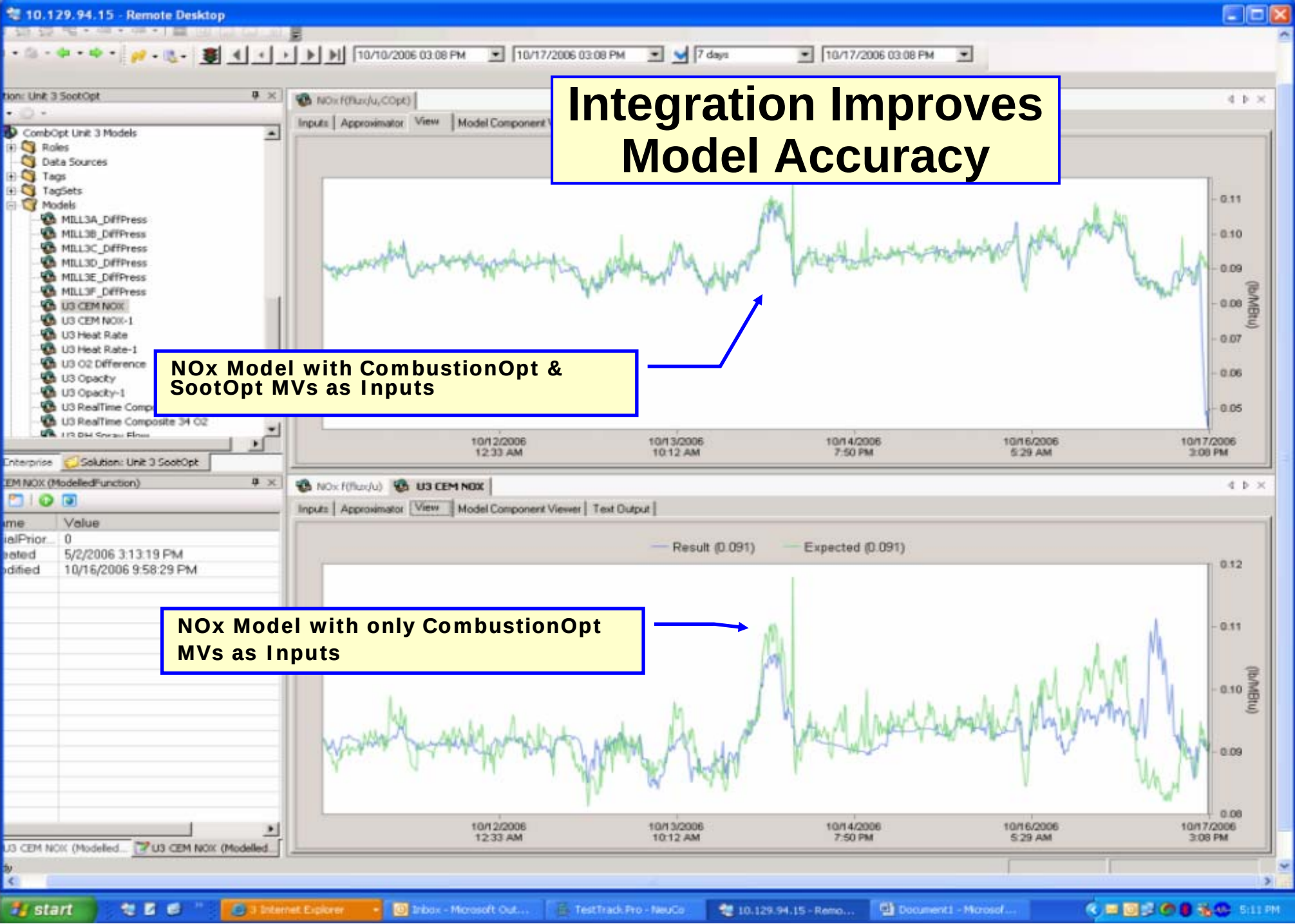
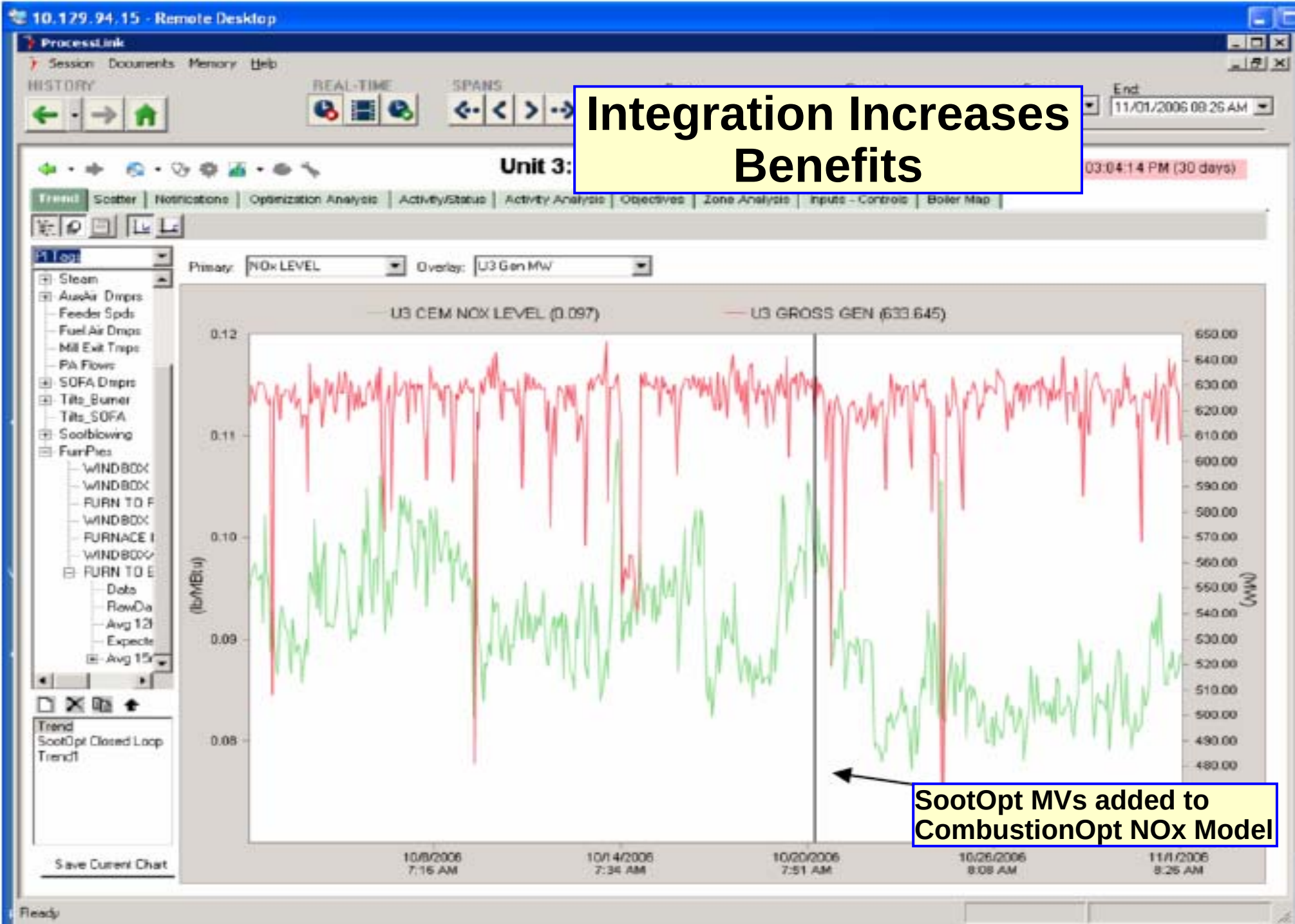
Integration Improves Model Accuracy

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ProcessLink
Session Documents Memory Help
HISTORY
REAL-TIME
SPANS
End
11/01/2006 08:26 AM
Integration Increases Benefits
Unit 3:
03:04:14 PM (30 days)
Trend Scatter Notifications Optimization Analysis Activity/Status Activity Analysis Objectives Zone Analysis Inputs - Controls Boiler Map
Plot
Steam
AuxAir Dmprs
Feeder Spds
Fuel Air Dmprs
Mill Exit Temps
PA Flows
SOFA Dmprs
Tilts_Burner
Tilts_SOFA
Sootblowing
FurnPres
Primary: NOx LEVEL
Overlay: U3 Gen MW
U3 CEM NOX LEVEL (0.097)
U3 GROSS GEN (633.645)
0.12
0.11
0.10
0.09
0.08
(lb/MBtu)
650.00
640.00
630.00
620.00
610.00
600.00
590.00
580.00
570.00
560.00
550.00
540.00
530.00
520.00
510.00
500.00
490.00
480.00
(MW)
10/8/2006 7:16 AM
10/14/2006 7:34 AM
10/20/2006 7:51 AM
10/26/2006 8:08 AM
11/1/2006 8:25 AM
SootOpt MVs added to CombustionOpt NOx Model
Trend
SootOpt Closed Loop
Trend1
Save Current Chart
Ready

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Session Documents Memory Help

Unit 3: SootOpt Analysis

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Standard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

Primary: MW Overlay: NOx

Ready

ProcessLink

Session Documents Memory Help

Unit 3: SootOpt Analysis

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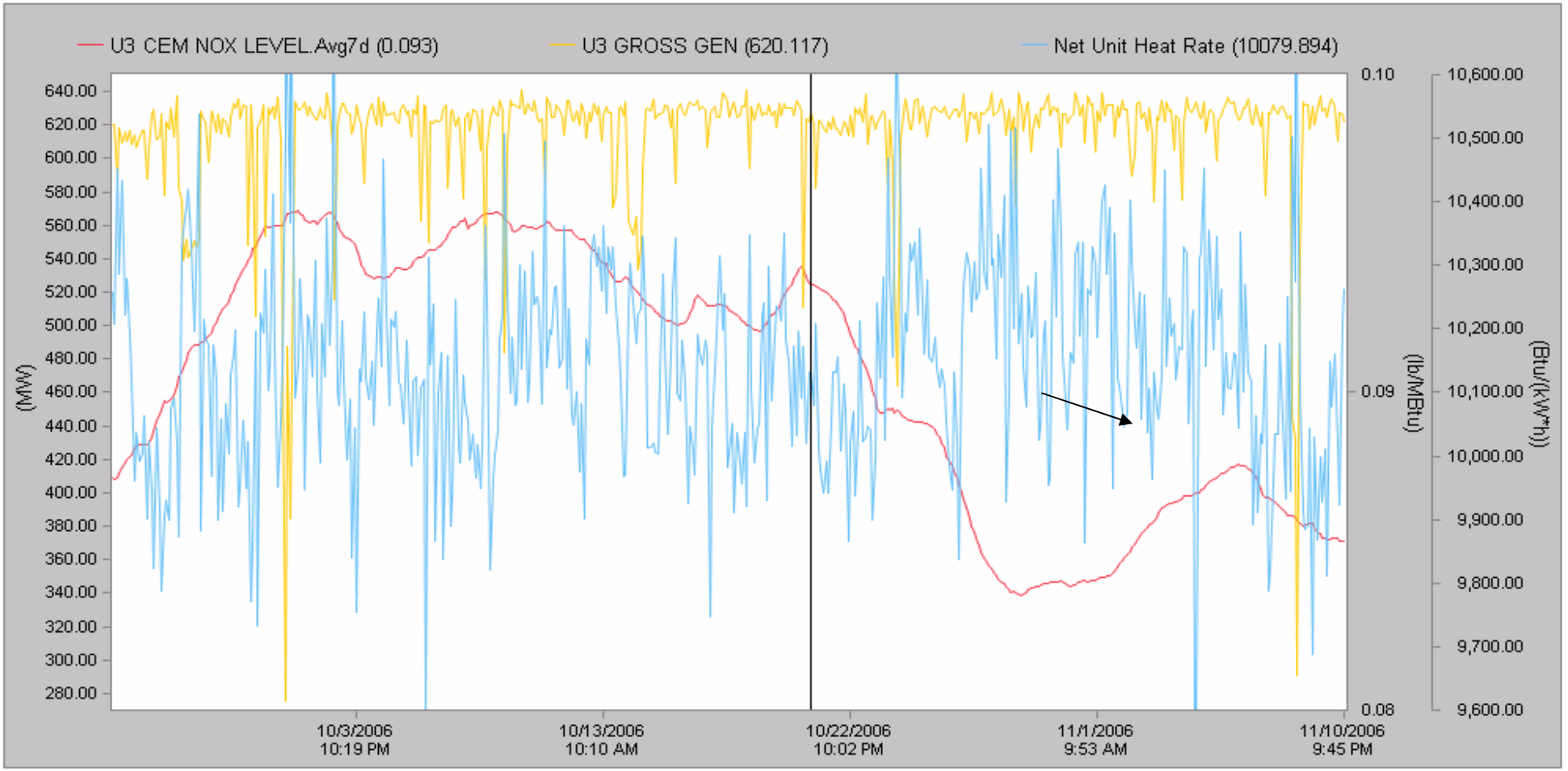
Standard | Demystifier | Trend | Model | Scatter | Surface | Sensitivity | Std Error | Custom

Primary: MW Overlay: Net Heat Rate



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SootOpt – Summary

- SootOpt improves control of heat-transfer process
- Relates impacts to global objectives. Searches for global optimum across multiple sometimes competing objectives
- SootOpt performance can be changed by changing relative priority of objectives, e.g., Steam Temperature Max vs. Heat Rate, or all can be given equal priority
- Lets user assess where priority should be given based on bottom line impact.
- The highly inter-related processes of combustion and boiler cleaning confirms the need for integration to achieve maximum benefits

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Looking Ahead

- Complete Integration of CombustionOpt and SootOpt and at Unit 3
- Complete installation of SootOpt on Unit 2
- Integrate CombustionOpt, SCR-Opt, SootOpt, PerformanceOpt and MaintenanceOpt at Unit 2
- Further refine CombustionOpt, PerformanceOpt & MaintenanceOpt at Unit 1
- Further refine Unit and Plant Advisors
- Subsequent refinement and releases based on feedback from Baldwin and other NeuCo Showcase sites

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