## **Boiler Optimization and MATS Work Practices Requirements**

*McIlvaine Hot Topics July 10<sup>th</sup>, 2013* 





# **Mercury and Air Toxics Standard (MATS)**

- Requires all plants to reduce mercury and increase efficiency to mitigate unmeasurable air toxics
  - Requires an efficiency evaluation every 3 years starting in 2015
- Complies with a universal consent decree
  - EPA, almost all generators, states and environmental groups are parties
- Generators are investing in mercury mitigation and efficiency
- Using a neural network relaxes timing of efficiency evaluation
  - Neural combustion optimization is only technology that enables plants to defer the evaluation to 2016 and to every four years thereafter
- Substantial business driver for NeuCo
  - NeuCo is seeing 2014 budgets established to include neural networks
  - Will drive universal adoption of combustion optimization in US coal generation



- Neural network optimization is explicitly addressed by MATS in three ways
  - Neural network optimization systems qualify for the requirement in the rule for "optimizing NOx and CO."
  - Units with optimizers can defer the initial EPA "best practices" requirement by a year.
  - Units with optimizers also qualify for less frequent subsequent evaluations from every 3 years to every 4 years.
- These provisions provide further evidence that the US EPA recognizes the value of optimization with respect to regulatory objectives relating to emissions and efficiency



- Clearly demonstrate "optimization of NOx and CO"
- Defer initial boiler tune-up by one full year
  - Learn how EPA enforces rule for those not employing neural optimization
  - Better plan for initial tune-up and associated repairs
  - Avoid or defer outage associated with tune-up
- Simplify emissions performance measurement protocol
  - Single before vs. after average as opposed to hourly measurements
  - Reduce sensitive data available to state and federal regulatory agencies
- Reduce subsequent tune-ups from every 3 to every 4 years
- Better meet emissions, efficiency, and availability objectives
- Provide upgrade path for integrated boiler optimization



## Additional EPA Mandates and Enforcement Mechanisms

- Clean Air Act of 1970 and Clean Air Act Amendments of 1990
  - National Ambient Air Quality Standards, Regional Haze
  - CO<sub>2</sub> for plants triggering New Source Review
  - And now CO<sub>2</sub> standards for existing power plants
- Enforcement Mechanisms
  - New Source Review
  - Internal administrative / judicial process
  - Prescriptive standards (BART/BACT)
  - Regional / market based approaches (CAIR, CSAPR)



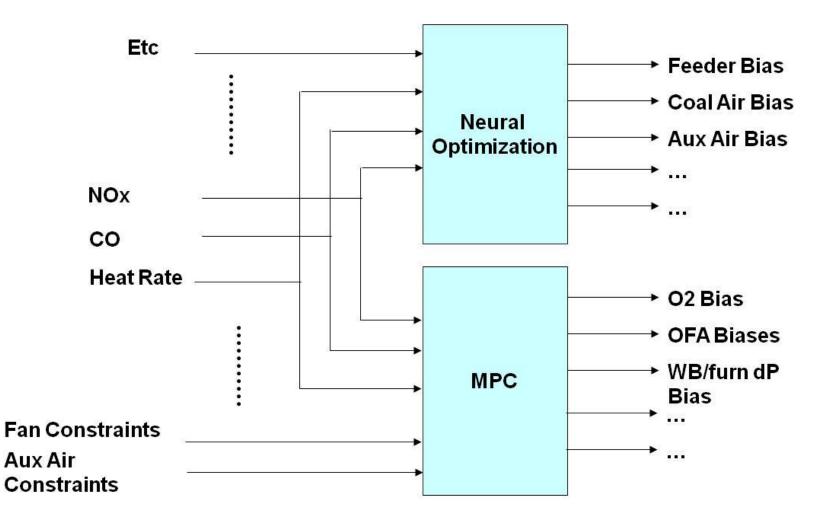
# **CombustionOpt**<sup>®</sup>

- Provides real-time closed-loop optimization of fuel and air biases
- Using:
  - Model Predictive Control (MPC)
  - Neural Networks
  - Design of Experiments (direct search)
  - Expert Rules
- To Improve:
  - NOx
  - CO
  - Heat rate
  - Steam temps
  - Opacity
  - Reagent utilization
  - Constraint performance
    (Mill Dp's, Fan Amps, O2 split)

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# **Combining Neural with MPC**





#### **Typical CombustionOpt Benefits**

- NOx reductions of 10-15%
- Boiler efficiency increase of 0.5-0.75%
- CO controlled to desired limit
- Better ramping and load-following performance
- Reduced opacity excursions
- Avoided tail-chasing behavior
- Better adherence to fan and mill amp limits
- Improved situational awareness and process insight



### **CombustionOpt at DTE Belle River**

- B&W opposed wall-fired, balanced draft boiler built in 1984
- Normal full load of 645 gross MW, Max load with over-fire of 685 gross MW (turbine limited)
- Designed for and burns 100% PRB (Decker, Spring Creek, Wyoming)
- Pulverized coal from 8 B&W MPS-89 pulverizers, 7 operate during normal operation
- 5 burners per mill, 40 total
- Originally 4 burner levels per wall, burners replaced with LNB and redistributed into 3 levels
- Top level of burners replaced with OFA ports (1/3 and 2/3 control dampers in each port)
- 6 single-point extractive type O2 probes at economizer exit



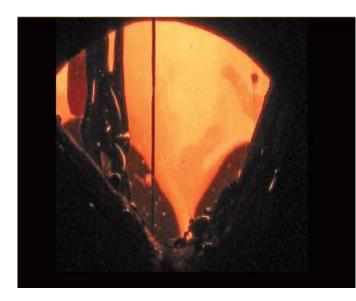


## **Unit 2 Performance Test Results**

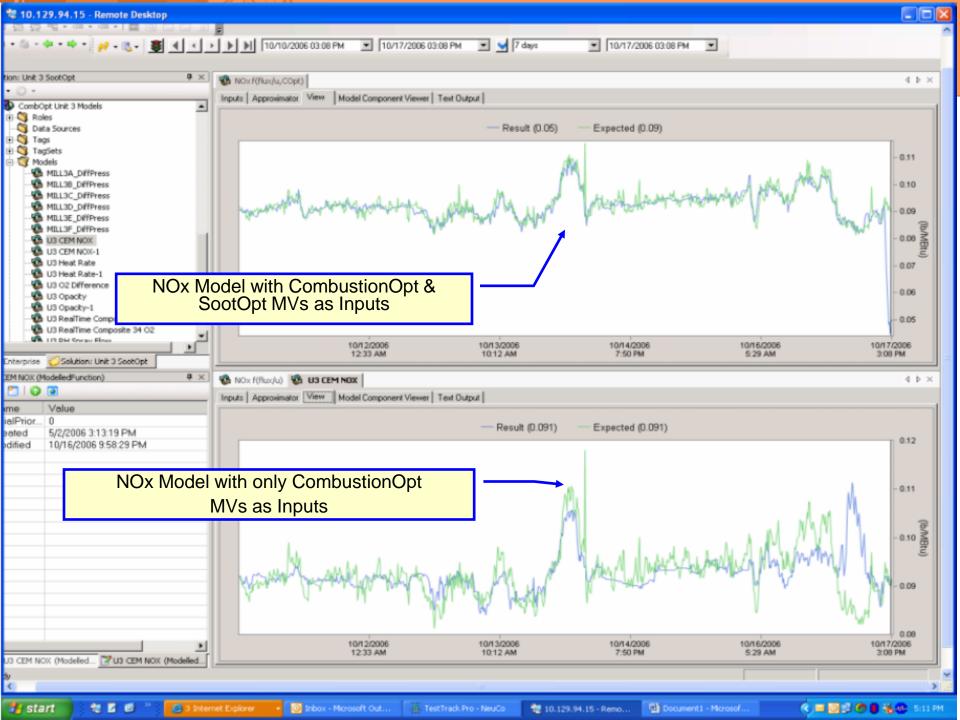
				Manua	al Tuning	Neuco	Tuning
	Baseline Heat Rate Test 07/27/10	Manual Tuning Heat Rate Test 07/28/10	Neuco Tuning Heat Rate Test 07/30/10	Manual Tuning Change (Absolute)	Manual Tuning Change (Relative, %)	Neuco Tuning Change (Absolute)	Neuco Tuning Change (Relative, %)
Gross Load, MW	647.954	647.948	645.058	-0.006	0.00%	-2.896	-0.45%
Net Load, MW	606.641	608.604	607.743	1.964	0.32%	1.102	0.18%
Auxiliary Power, MW	41.313	39.343	37.315	-1.970	-4.77%	-3.998	-9.68%
Raw Net Unit Heat Rate (Heatloss), BTU/kWhr		10402	10331	-115	-1.10%	-186.0	-1.77%
Corrected Net Unit Heat Rate (Heatloss), BTU/kWhr		10286	10224	-108	-1.0%	-169.184	-1.63%
Net Unit Heat Rate (Input/Output), BTU/kWhr		10362	Not Avail.	-131	-1.25%	Not Avail.	Not Avail.
Corrected Net Unit Heat Rate (Input/Output), BTU/kWhr		10358	Not Avail.	-100	-0.96%	Not Avail.	Not Avail.
NOx, Ib/MBTU	0.2513	0.2025	0.2010	-0.0488	-19.43%	-0.050	-20.02%
CO, PPM	88	78	157	-10	-11.18%	68.200	77.18%
CO2 Intensity, Tons CO2/MWhr		1.047	1.043	-0.02	-2.06%	-0.03	-2.43%
Total Boiler Air Flow, klb/hr		5926	5483	-387	-6.13%	-830	-13.14%
Average Excess O2, %		3.23%	2.45%	-1.15%	-26.31%	-0.019	-44.18%
Excess Air, %		20.75%	15.12%	9.75%	-31.97%	-15.38%	-50.43%



- Interrelated boiler variables must be continually managed
  - Combustion quality, fuel & air mixing, gas & steam temps, fouling, tube erosion, & emissions
  - Fluctuating constraints & changing objectives add complexity
- Independently optimizing combustion & sootblowing delivers value, but leaves benefits on the table









- Provides real-time closed-loop optimization of soot cleaning equipment
- Using:
  - Expert Rules
  - Neural Networks
- To Improve:
  - Sootblowing consistency
  - Unnecessary sootblowing
  - Steam temps
  - Sprays
  - Leverage on heat rate

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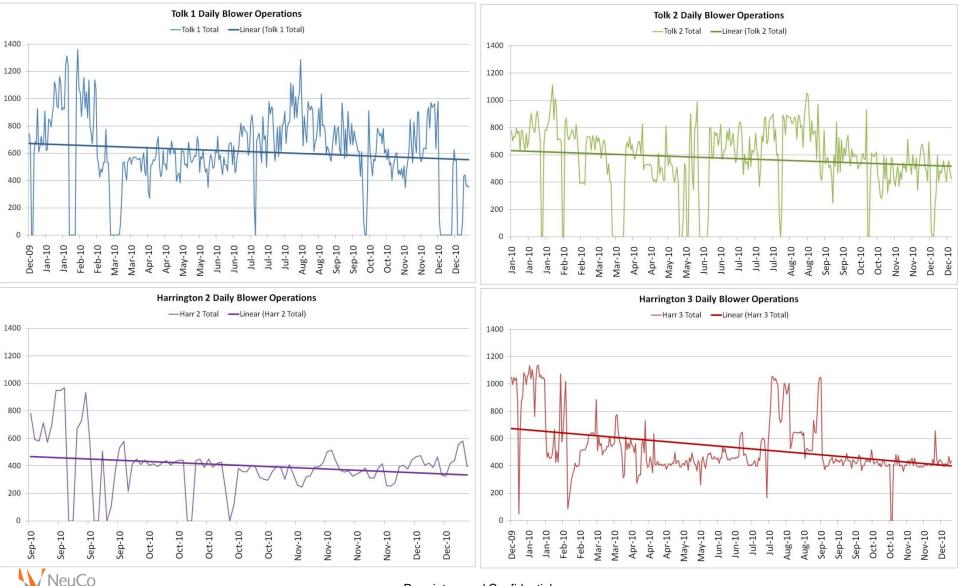


# **Typical SootOpt Benefits**

- Reduced and more tightly controlled APH inlet temps
- Improved SH and RH steam temperature control
- Reduced attemperation sprays
- Heat rate reduction of 0.75-1.00%
- Incremental NOx reduction of 2.5-5%
- Avoided opacity excursions
- Reduced blowing of 10-35%
- Avoided thermal stress from blowing clean surfaces
- Fewer tube-leak failures
- Improved situation awareness and process insight

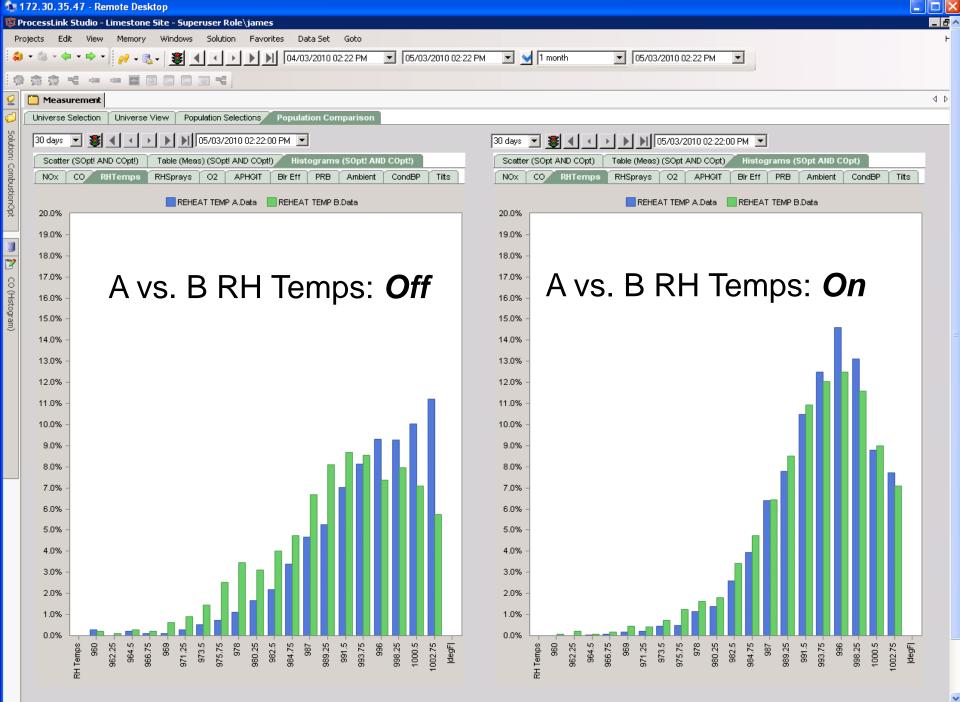


## **Blower Count Trends**

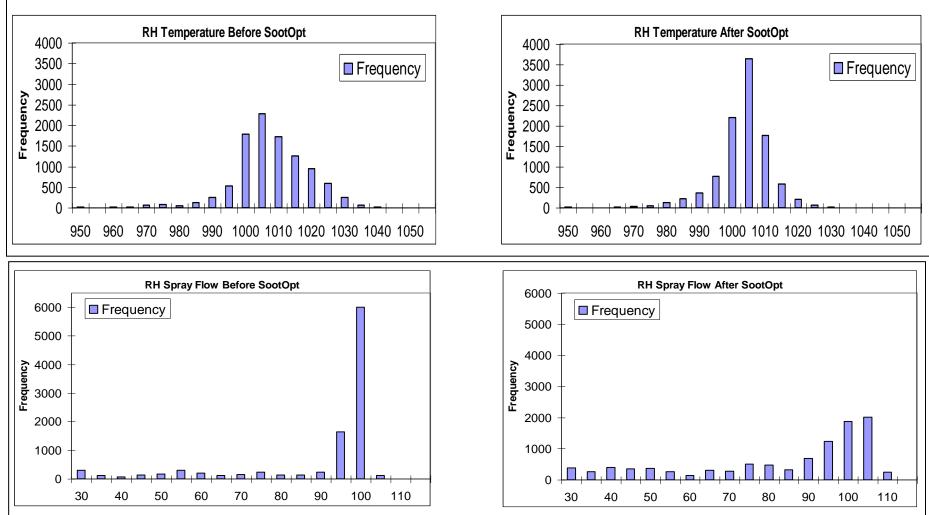


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The Optimization Standard™



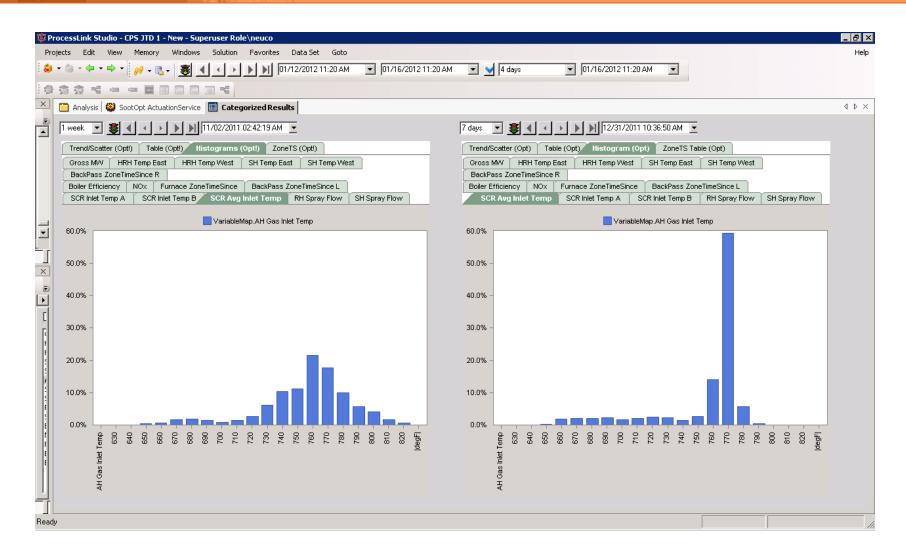
#### RH Temps & Sprays – SootOpt Before vs. After





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#### Typical Gas Inlet Temps SootOpt Off vs. On





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### **BoilerOpt Availability Mechanisms**

- Reduced Boiler Tube Leak Outages
  - Less unnecessary cleaning (SootOpt)
  - Avoided thermal stress (SootOpt & CombustionOpt)
- Avoided Slagging/Fouling De-Rates & Outages
  - Pro-active cleaning for vulnerable surfaces (SootOpt)
  - Improved stoichiometry control (CombustionOpt)
  - Tighter control of gas path temperatures (SootOpt & CombustionOpt)
  - Reduced ammonium bi-sulfate air heater pluggage (SootOpt & CombustionOpt)
- Improved Situational Awareness
  - Overtaxed mills and fans (CombustionOpt)
  - Malfunctioning sootblowers (SootOpt)



Insufficient media (SootOpt)

### **BoilerOpt Efficiency Mechanisms**

- Boiler Efficiency
  - Reduced O2 (CombustionOpt)
  - More balanced fuel and air distribution (CombustionOpt)
  - Improved heat transfer (SootOpt)
  - Better gas temperature control (SootOpt)
    - APH gas inlet temps
    - Economizer inlet and exit temps
    - Furnace exit gas temperature (FEGT)
- Additional Heat Rate Components
  - Better superheat steam temperature control (SootOpt)
  - Better reheat steam temperature control (SootOpt)
  - Reduced attemperation sprays (SootOpt)



#### **BoilerOpt Emissions Mechanisms**

#### NOx

- More balanced fuel-air distribution (CombustionOpt)
- Reduced overall O2 (CombustionOpt)
- More balanced temperature profile (SootOpt)

#### CO

- Explicitly controlling to desired limit (CombustionOpt)
- Fewer pockets of oxygen-deficient combustion (CombustionOpt)

### Opacity

- Proactive cleaning to avoid ash accumulation (SootOpt)
- Not cleaning specified zones when opacity trending high (SootOpt)
- More balanced fuel-air distribution (CombustionOpt)
- Preemptively increasing O<sub>2</sub> to manage excursions (CombustionOpt)

## • CO<sub>2</sub>

- Improved boiler efficiency (CombustionOpt)
- Tighter steam and gas temperature control (SootOpt)
- Reduced unnecessary attemperation sprays (CombustionOpt and SootOpt)



# **Questions?**

#### Peter Spinney spinney@neuco.net

