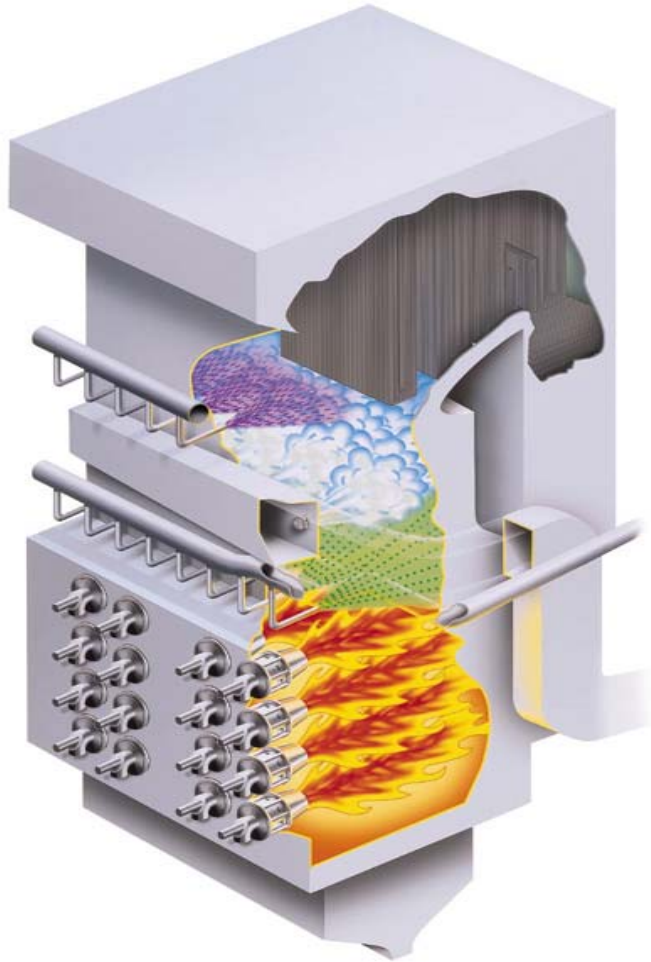
Combustion Optimization for Coal-Fired Boilers



James Tobin
Neil Widmer

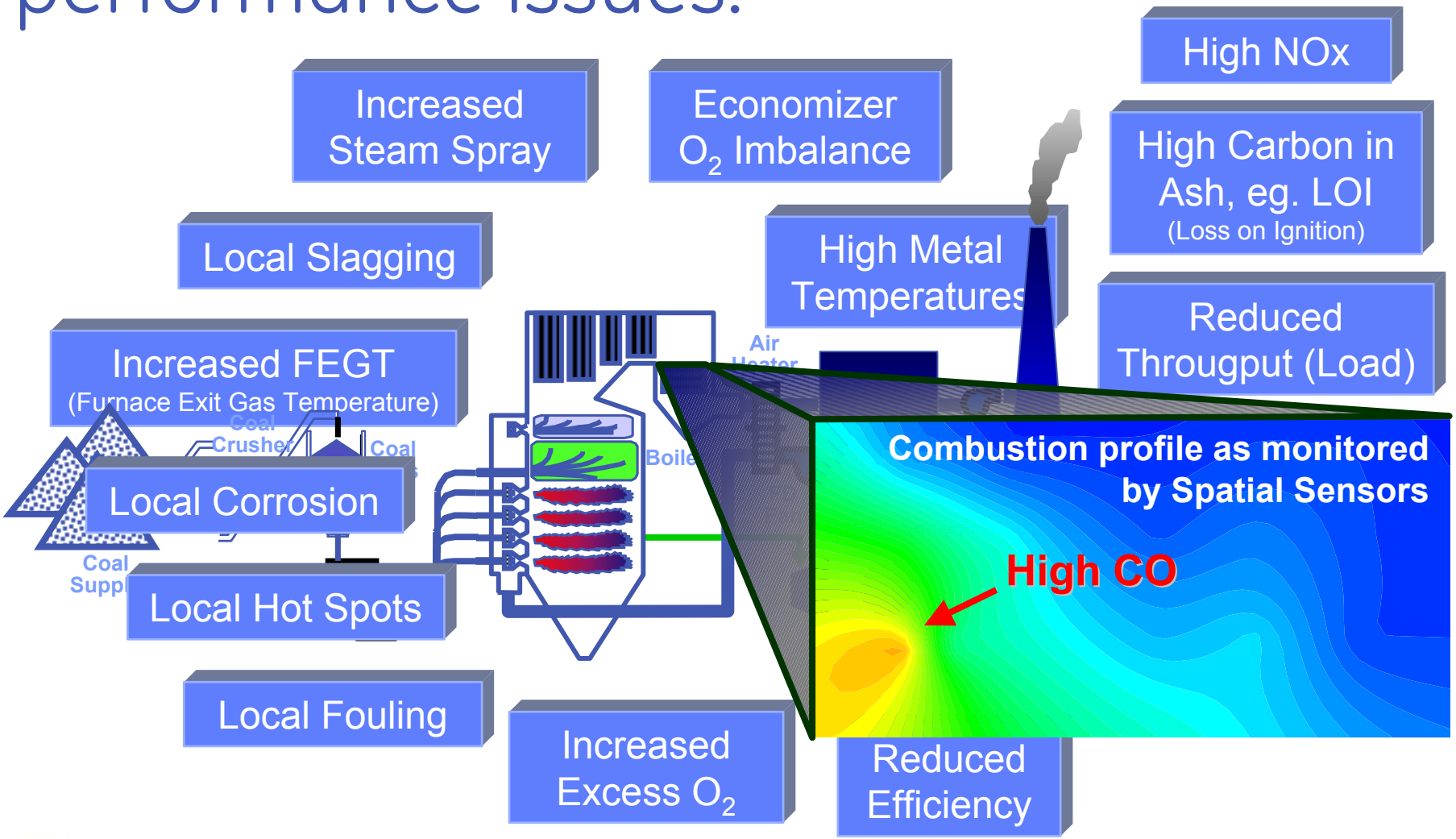
GE Energy

2nd U.S.-China NOx Workshop
Dalian, China
August 2005

imagination at work

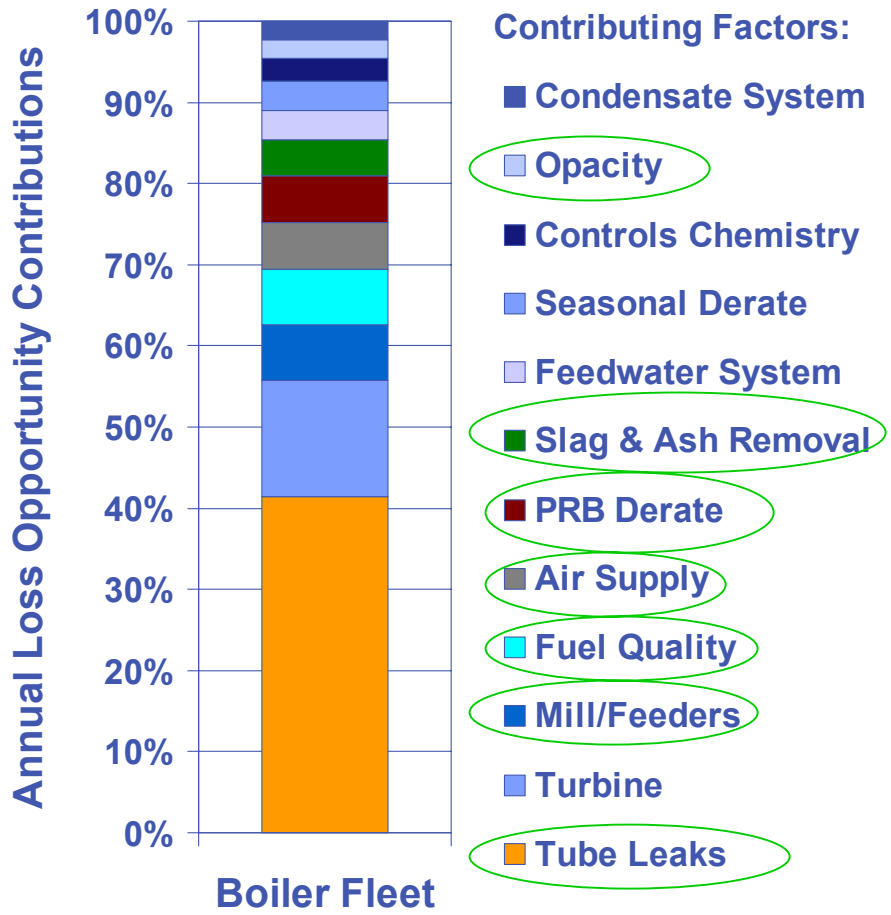
The problem …

Poor combustion result in many performance issues.

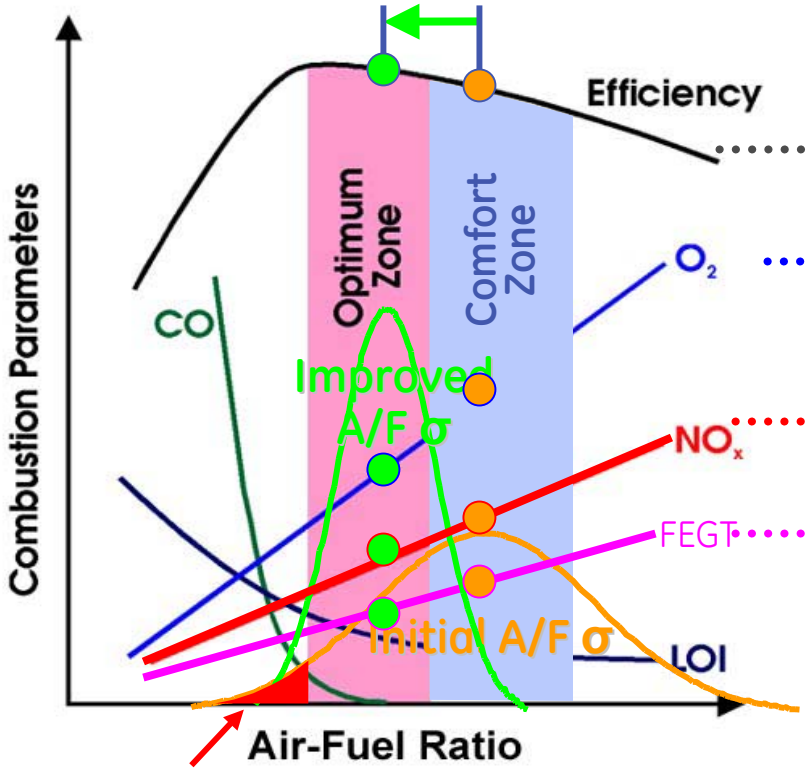


The major lost opportunities result from poor combustion.

Fleet-wide lost opportunity cost can be over $80 MM per year.



Improved burner operation drives performance gains.



High CO Burners Limit Performance

Fuel Savings

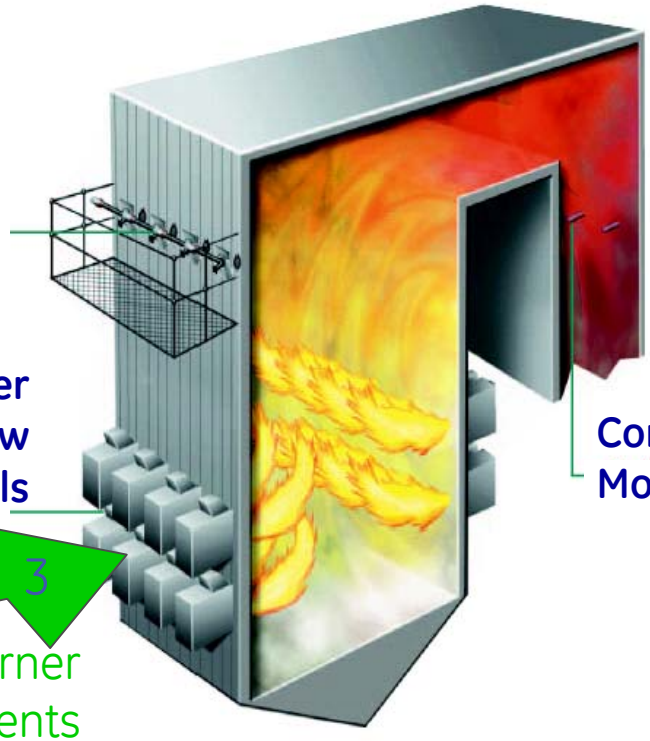
Output (Throughput)

Emissions Credits

Availability & Peak Power

Solutions …

Zonal™ combustion control system



object

Output ↑

NOx ↓

Availability ↑

Efficiency ↑

Burner Airflow Controls

Combustion (O_2/CO) Monitors

3 Burner Adjustments

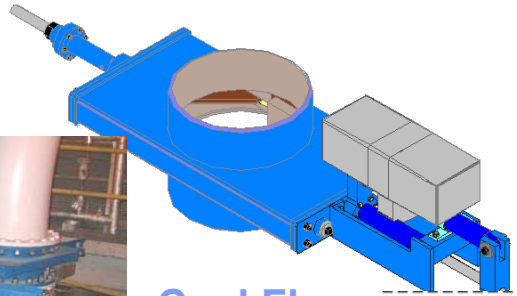
Combustion Diagnostic 1

Burner Coal Flow Controls

Combustion Tuning Controls

2 Zonal Fuel and Air Optimization

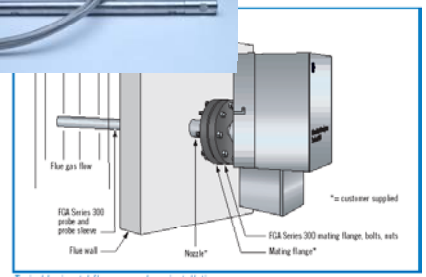
Components …

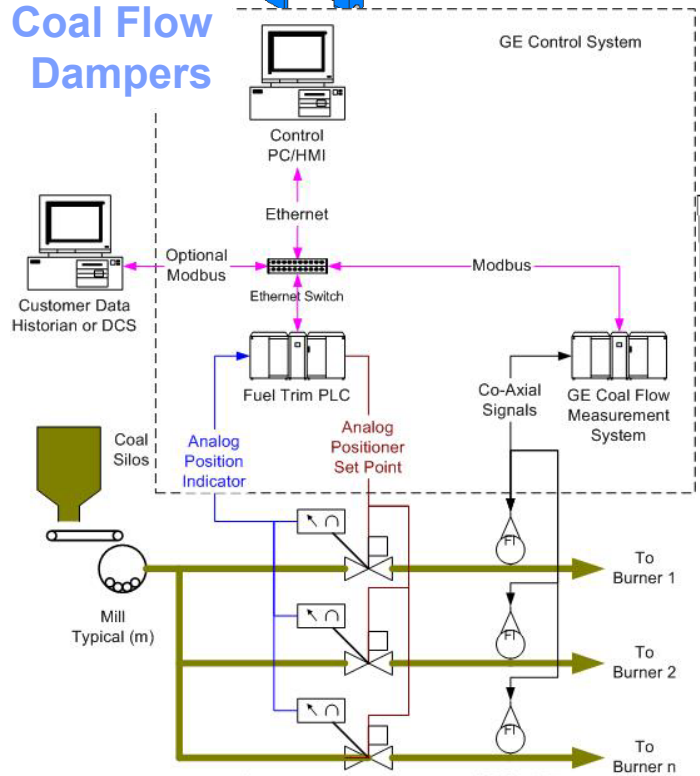


Coal Flow Dampers

Coal Flow Sensors

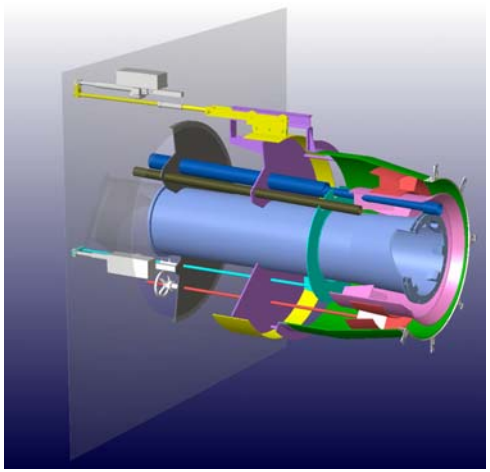
Combustion Sensors

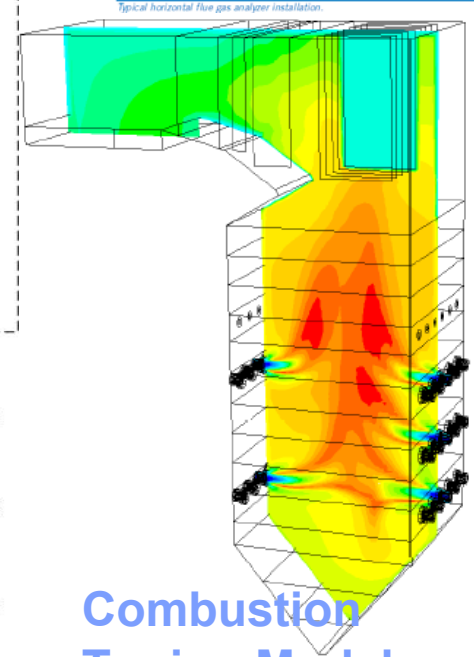




Zonal™ Combustion Controls

Burner Airflow Controls





Combustion Tuning Model

Zonal™ combustion control system … how fuel & air controls work together.

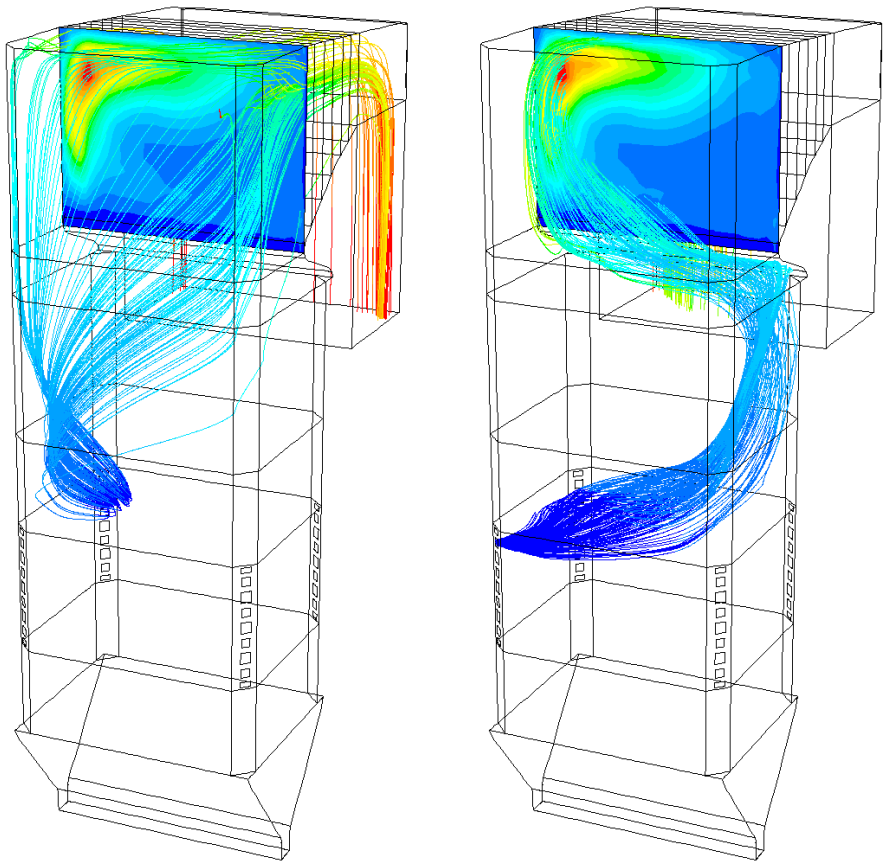
Zonal Fuel Trim - coarse controls for combustion shaping :

- Optimize wall-burner firing
  - Reduce impingement
- Reshape tangential fireball
  - Centered and round
- Tune furnace fuel distribution
  - Balance economizer O_2
  - Divert heat loading from peak FEGT & slag regions

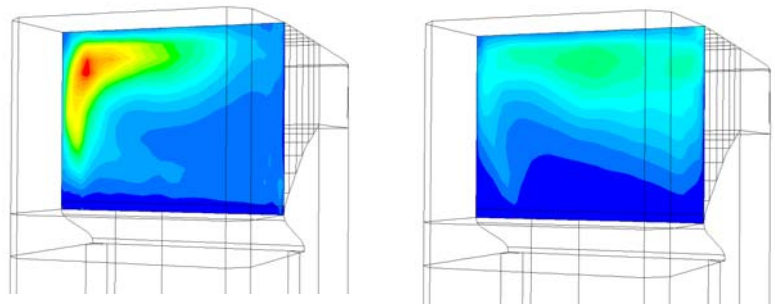
Zonal CO Trim - fine controls for combustion balancing :

- Trim furnace zonal air/fuel ratios based on sensor grid
  - Balance CO
  - Reduce hot spots
  - Reduce delayed combustion
  - Maintain burner flame
  - Reduce LOI
  - Reduce excess O_2

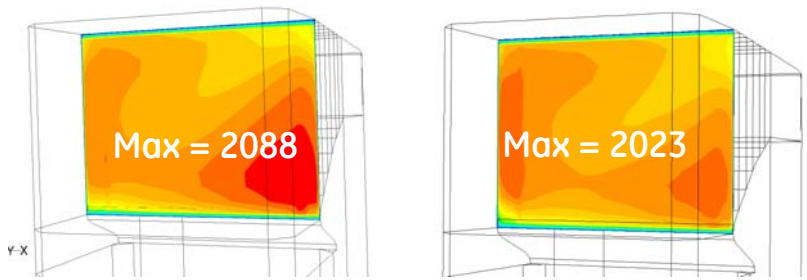
Fuel control can reduce temperature and CO zones … the precursors to slag.



Before **After**

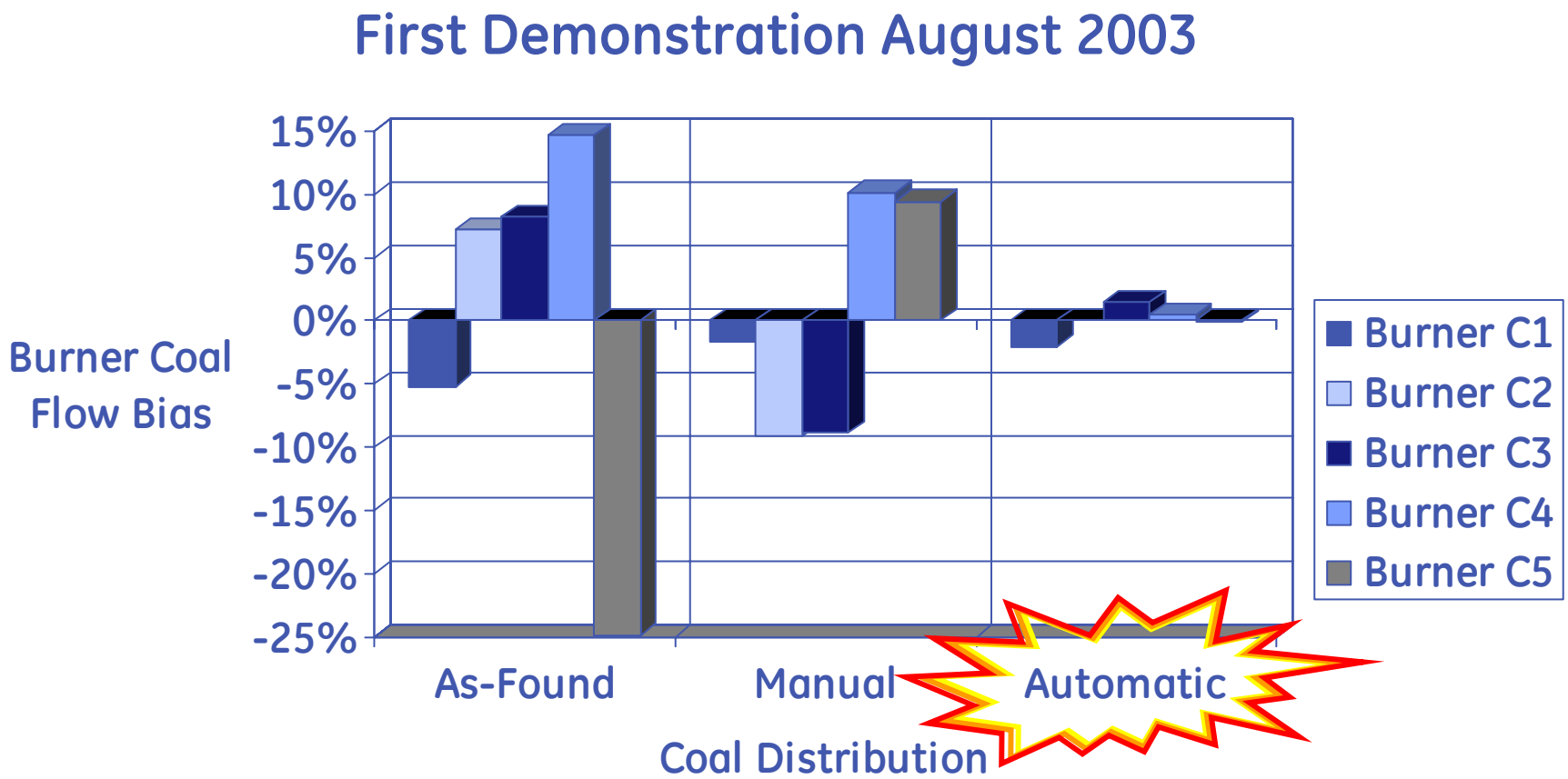


CO Profile

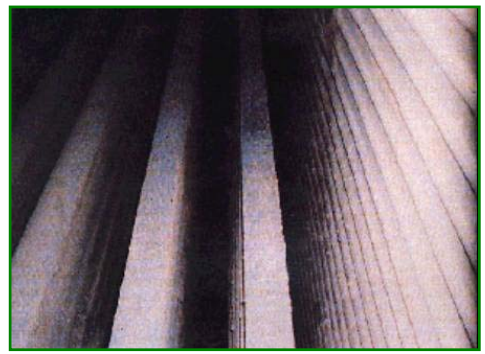


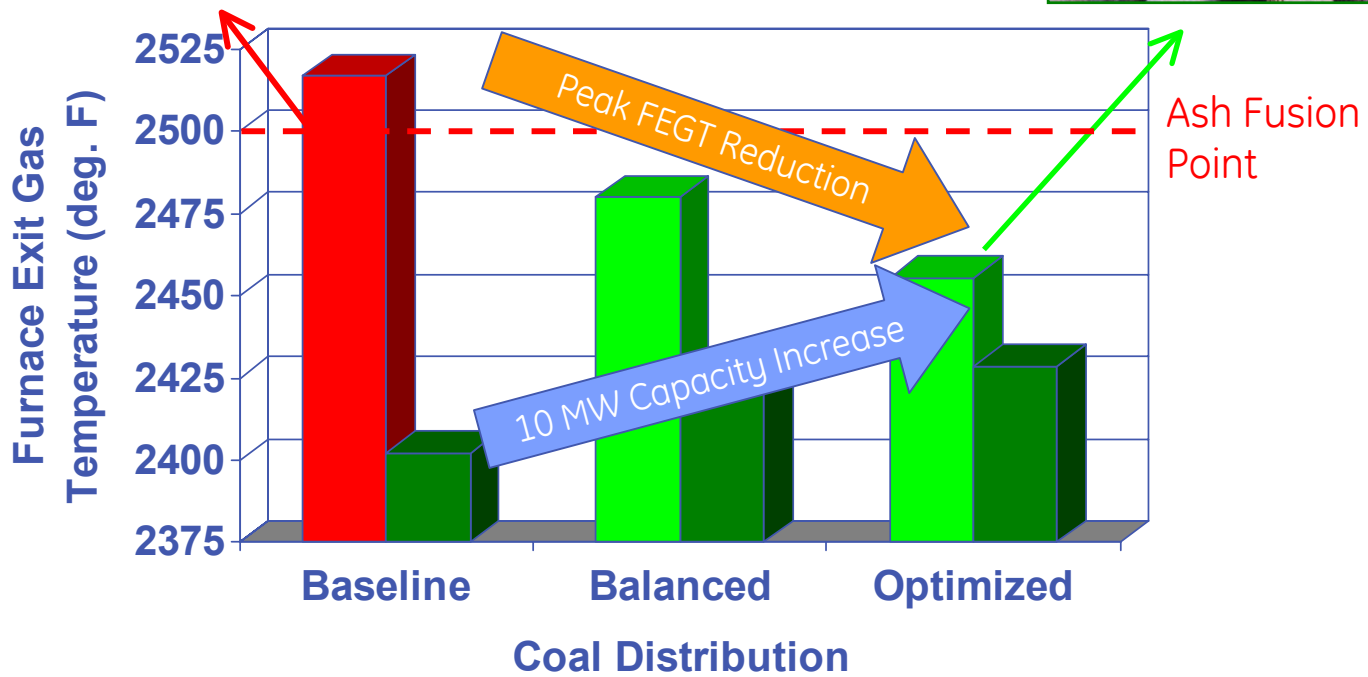
Gas Temp. Profile

Automatic Fuel Trim controls are successful at tightening distribution.

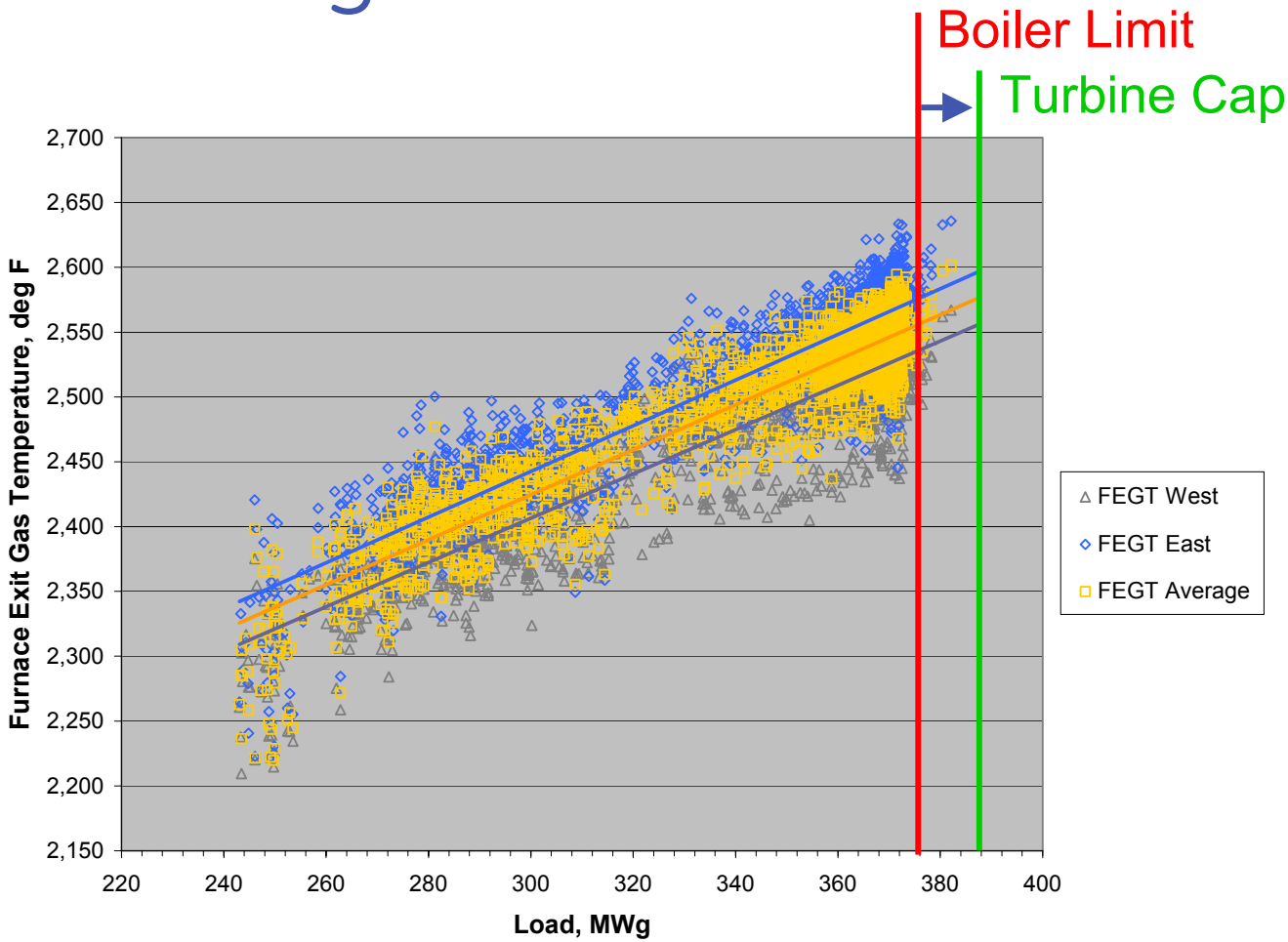


Balanced and optimized coal flow distribution reduced peak FEGT 60°F.



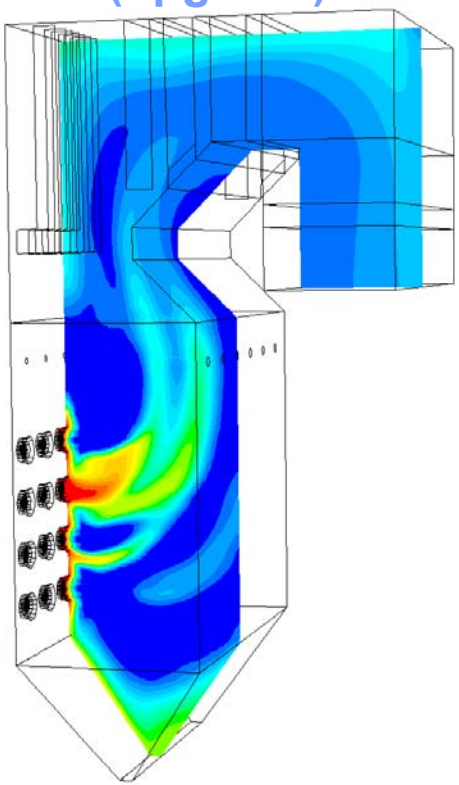


20°F Peak FEGT limited boiler capacity approximately 10MW.

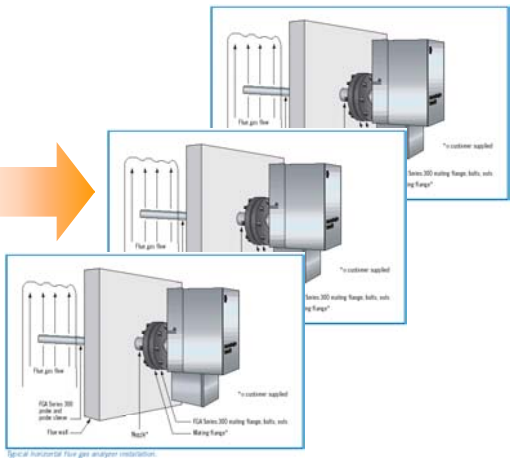


Zonal™ combustion monitoring system

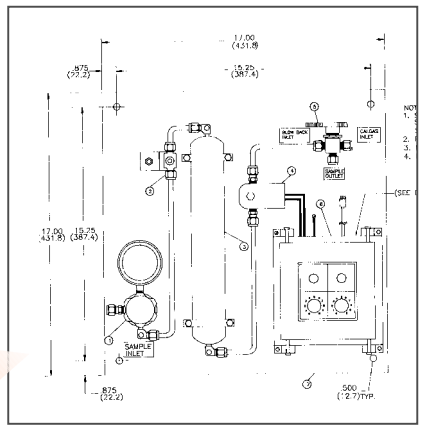
Modeling (upgrade)



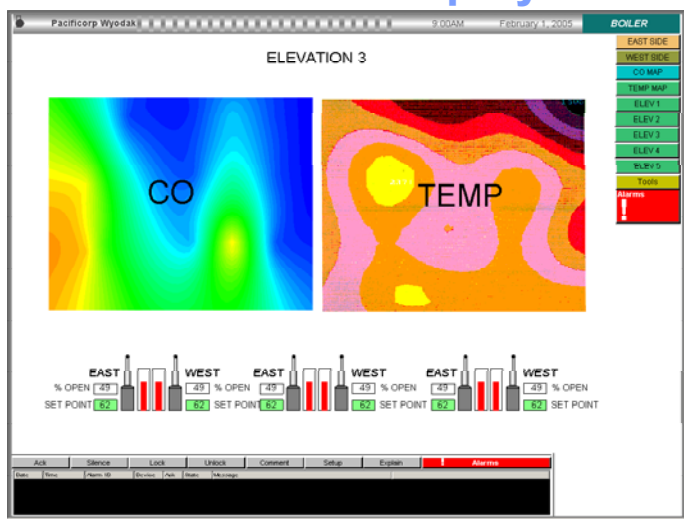
Sensor Array



Flow and Control Panel

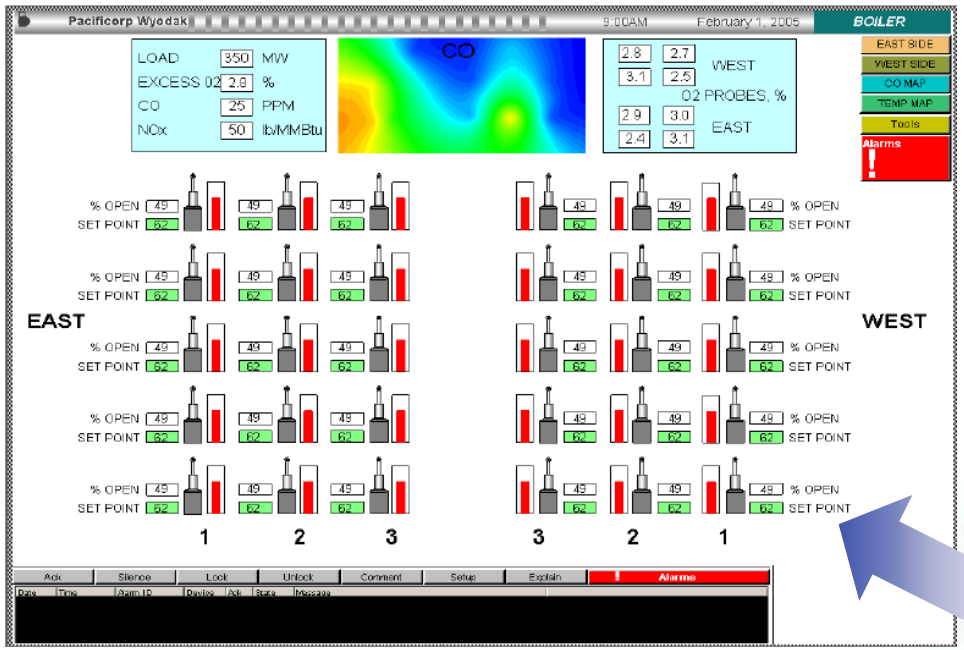


Interface Display

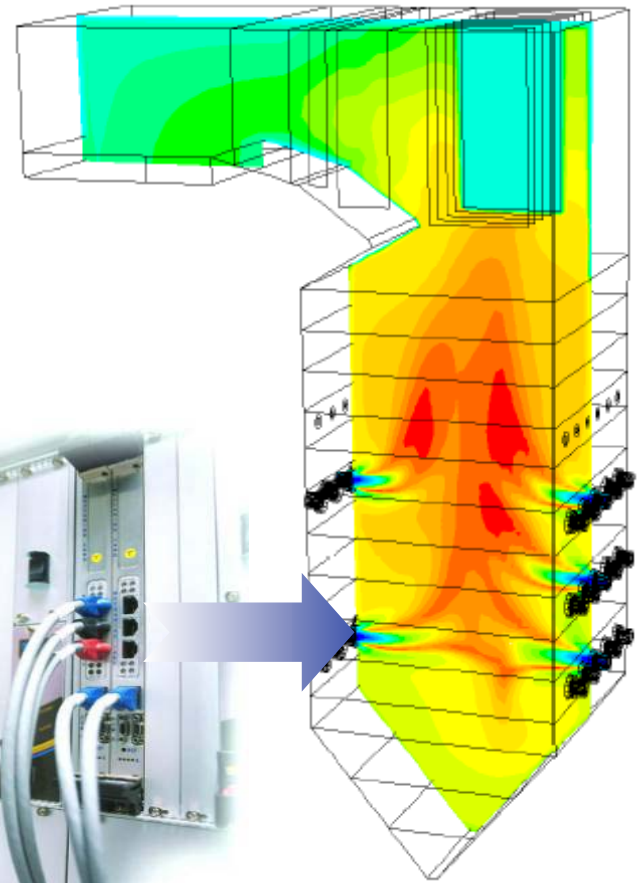


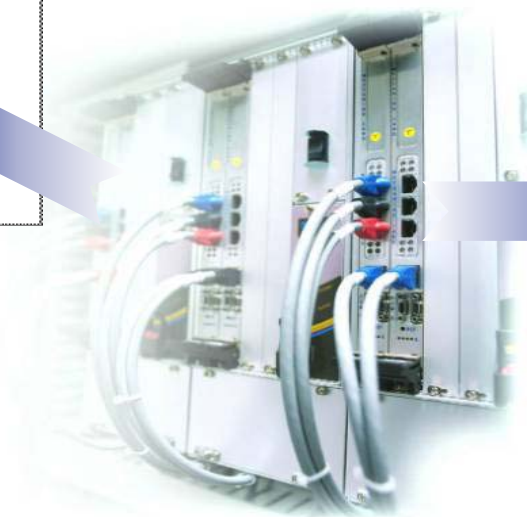
Zonal™ combustion model-based control system.

Monitoring & Control Interface

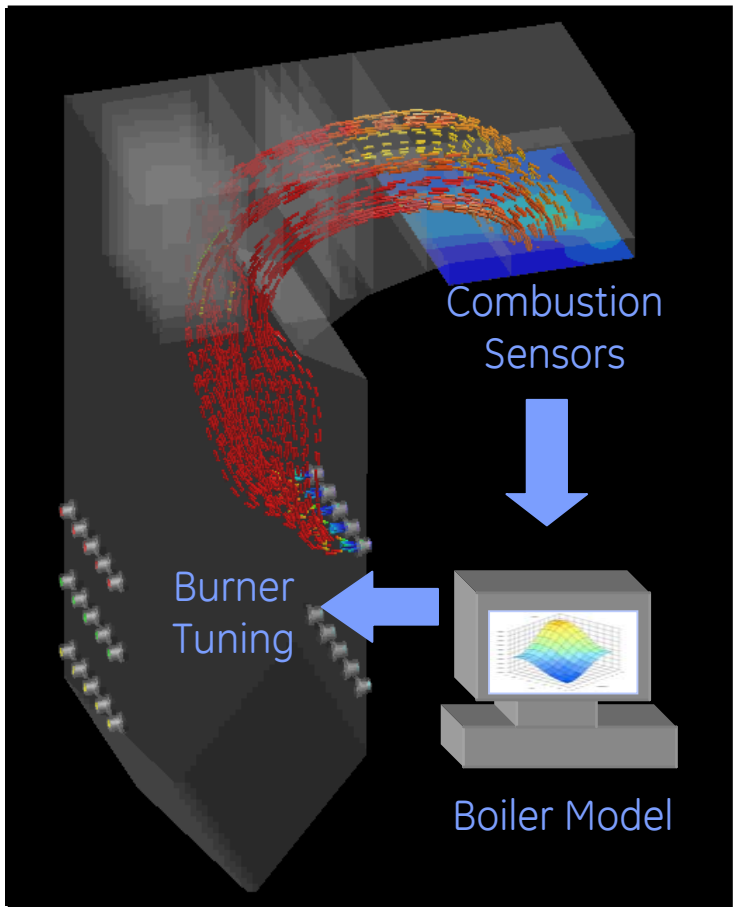


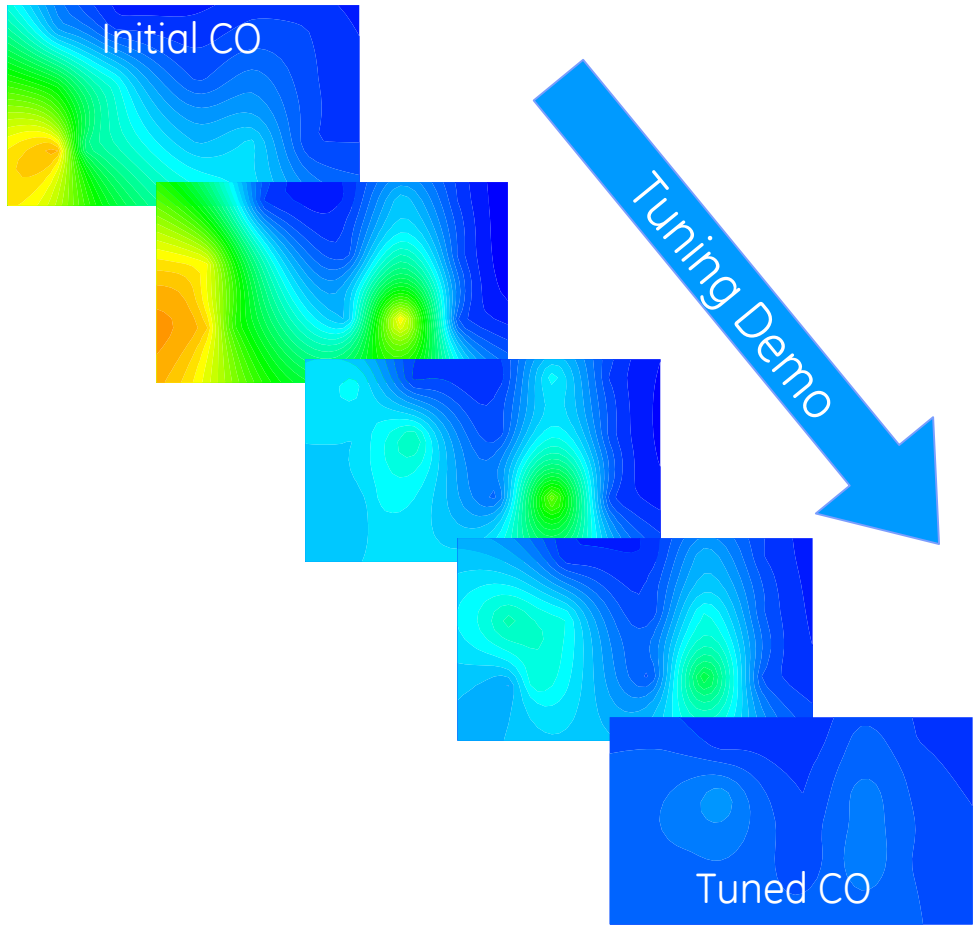
Combustion Trim Model



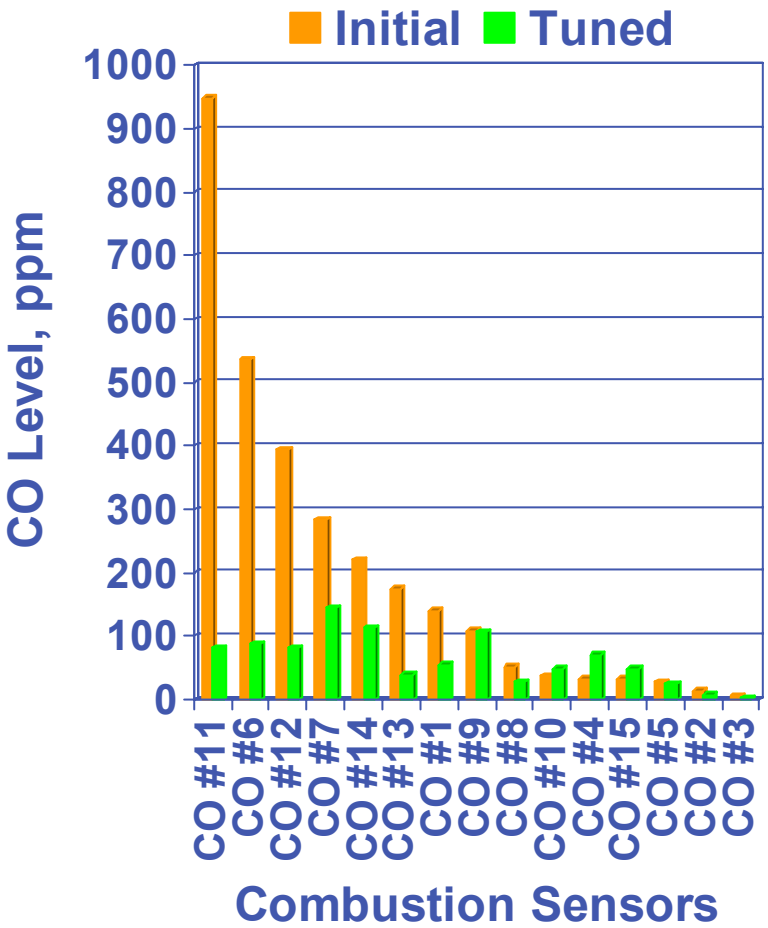


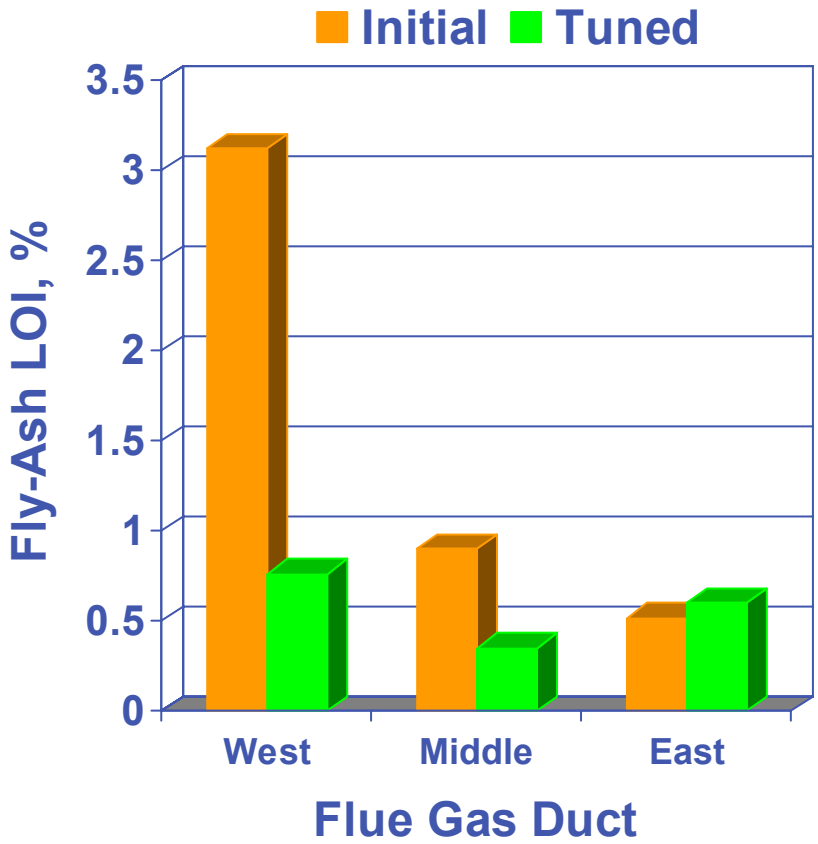
Zonal™ combustion tuning system demonstration.





Systematic tuning balanced CO and fly-ash LOI … synergistic with Hg control.





Zonal™ combustion control system features:

- Faster tuning experience
- One system for managing Zonal™ combustion
- Improves quality through systematic methods
- Advises burner adjustments
- Stores preferred burner setting by operating mode
- Diagnoses combustion performance

Benefits …

Combustion Optimization – Case Study

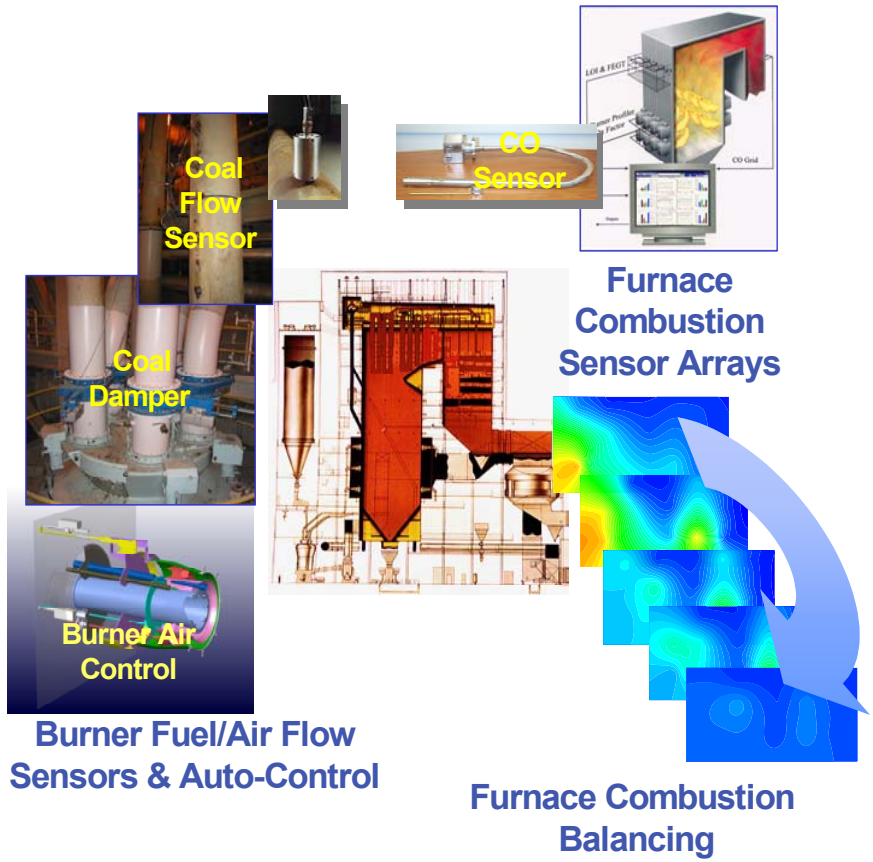
Sunflower Electric 380 MW Boiler

Scope:

- GE coal flow monitors & control
- GE combustion sensors
- GE boiler tuning services
- GE control software

System Benefits:

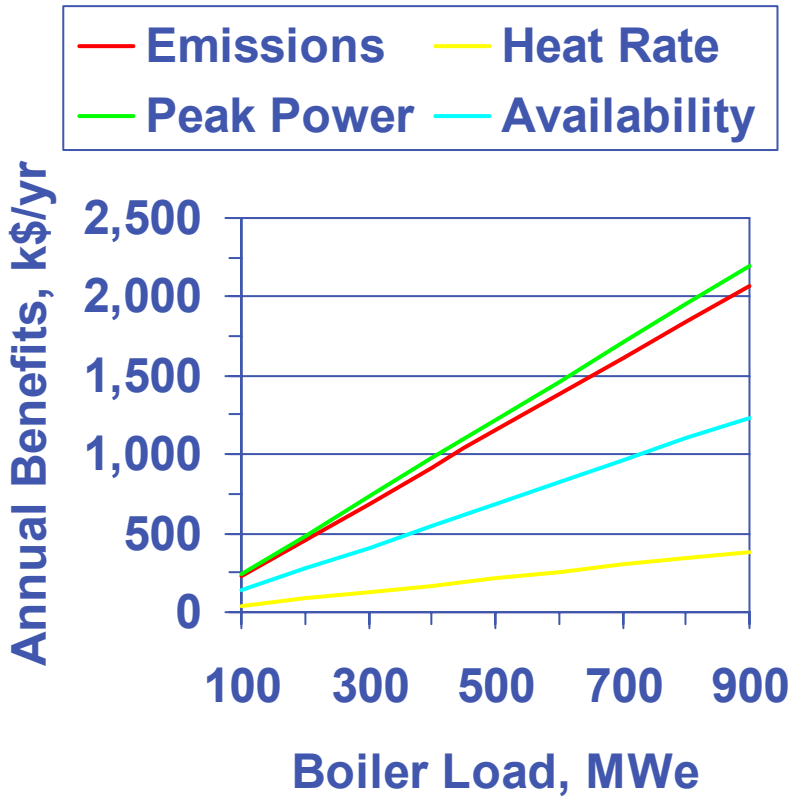
- Reduced peak FEGT 60°F
  - Eliminated barrier to increasing output 10 MW worth $1M/yr
- Reduced high CO and temperature zones
  - Avoid future slag outage 1 weeks worth ~ $2.5M/yr
- Reduced NOx and Heat Rate



Zonal™ combustion controls benefits:

- ✓ Reduce average and peak FEGT
- ✓ Reduce fuel rich (CO) zones
- ✓ Reduce corrosion
- ✓ Reduce slagging
- ✓ Reduce LOI
- ✓ Reduced NOx

Good combustion provides significant benefits.



Improvements :

- Excess O_2: 0.5% reduction
- Emissions (NOx): 15% reduction
- Heat Rate: 0.4% improvement
- Peak Power: 2.3% increase
- Availability: 1 week avoided outage

Economic assumptions provided in notes

Economic benefits are site-specific. Your plants benefits may vary.