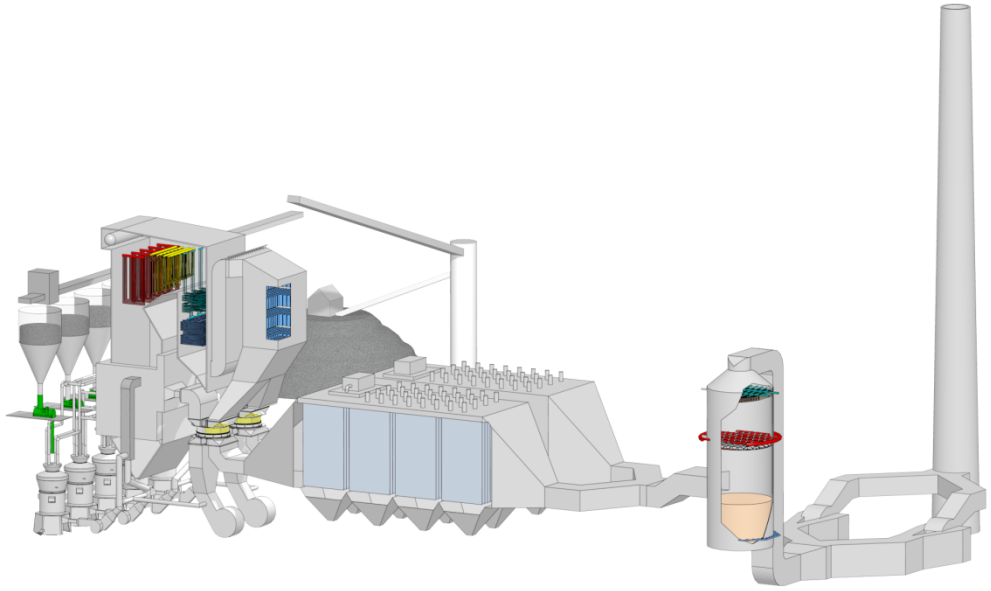
Coal Fired Boiler Optimization and the Impact on Emission Control Devices



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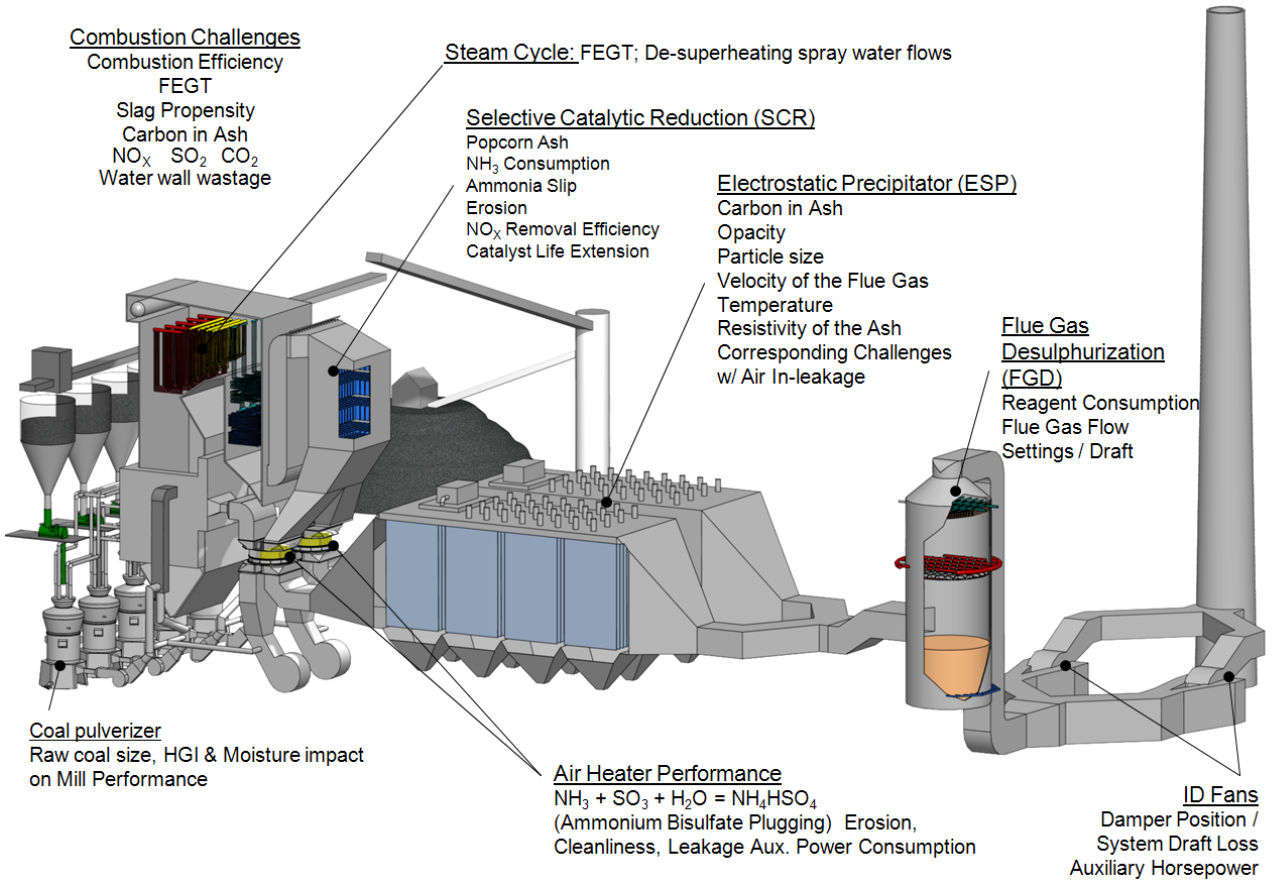
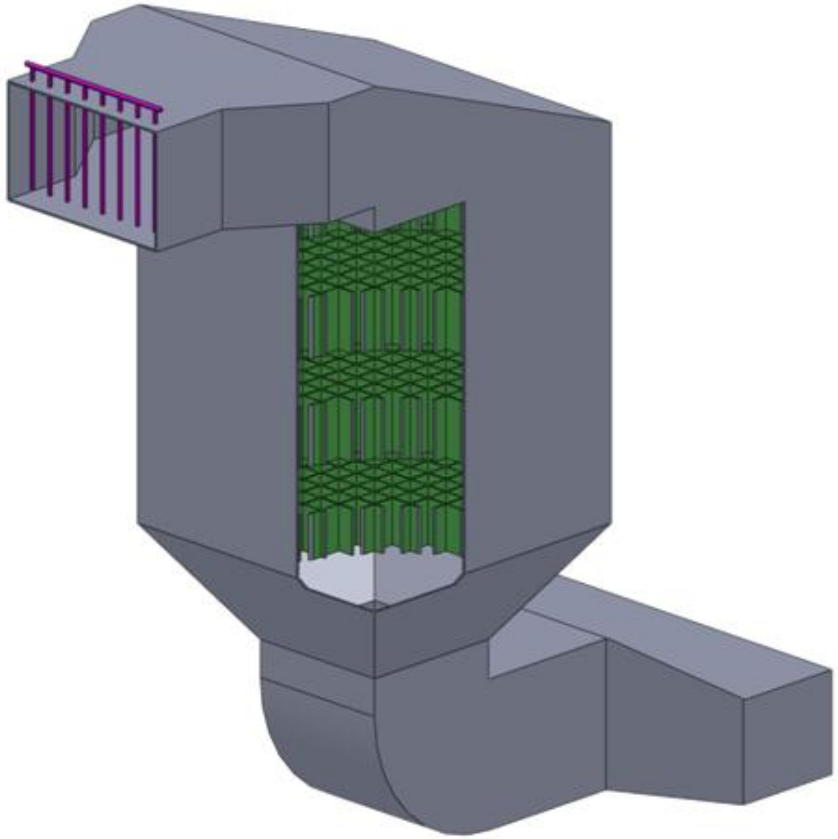
Typical Emissions Controlled via Backend Equipment

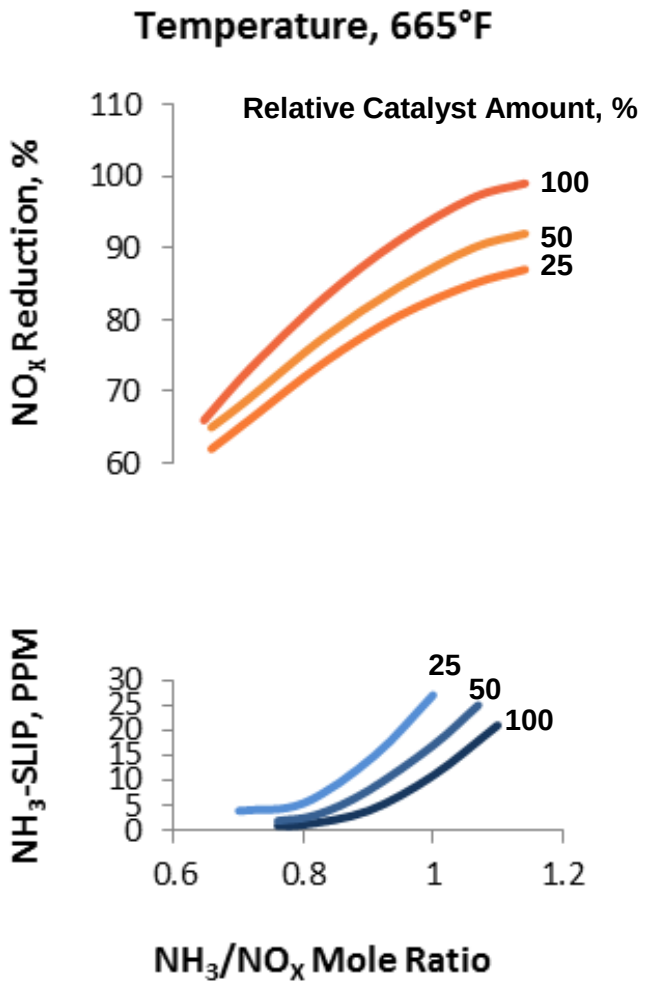
- Particulate matter
  - Electric Static Precipitator (ESP), Baghouse, Mechanical Collectors
- NO_X
  - SCR, SNCR
- SO_2
  - Scrubbers
- SO_3
  - Lime Injection



Factors Affecting Performance of SCR

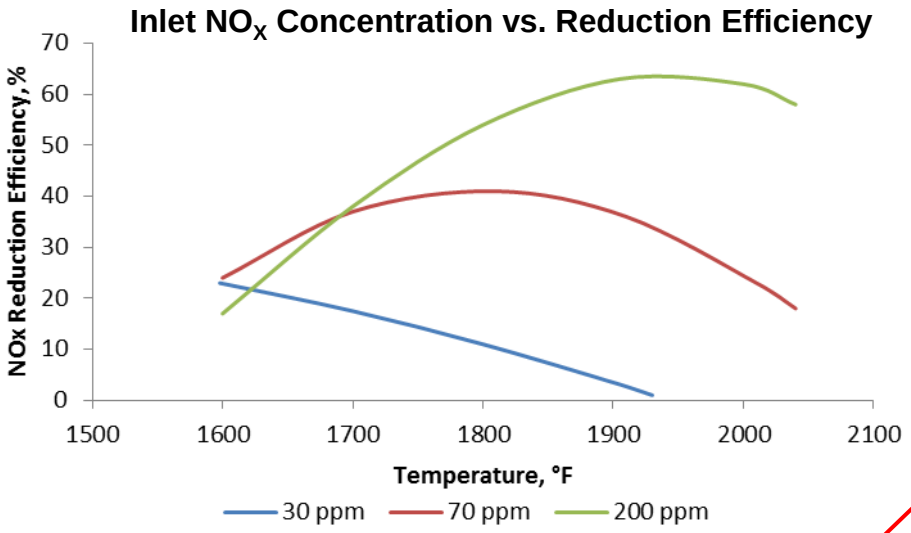
- Stoichiometric ratio of NH3 to NO_X
- Temperature
- Oxygen
- SO_X
- Ash

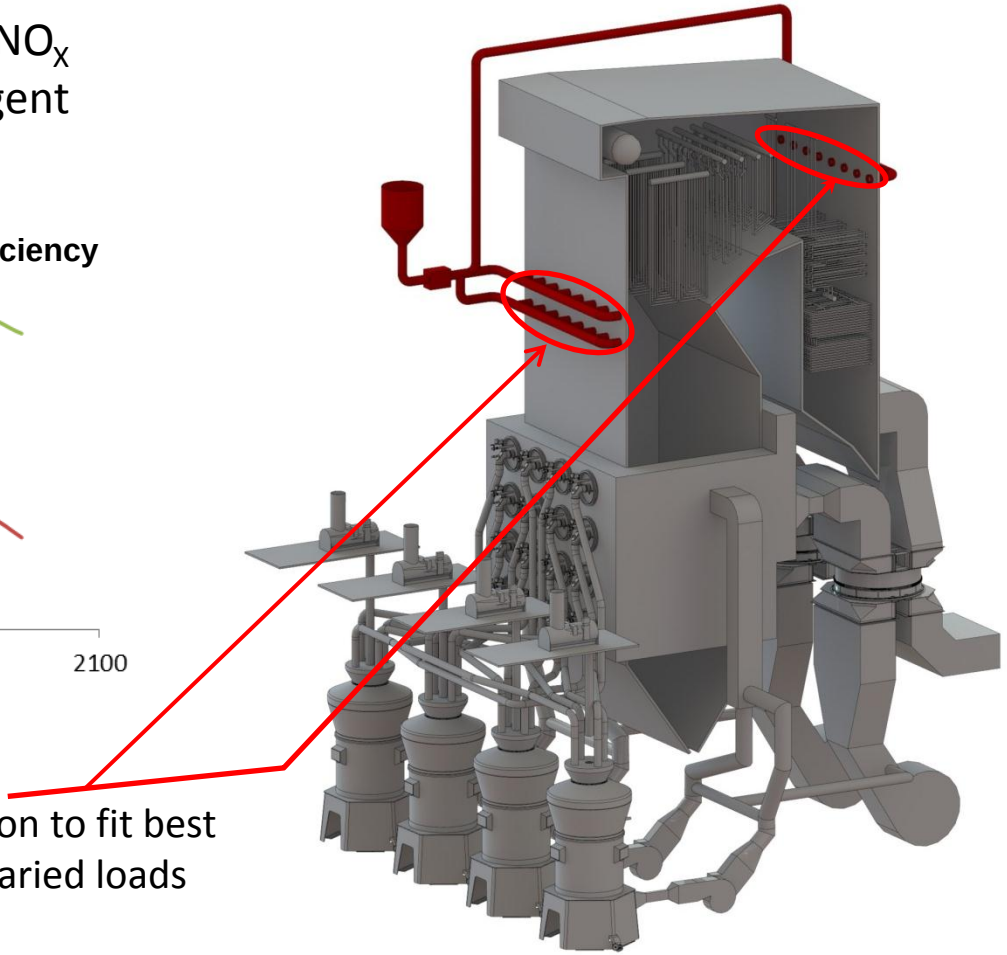




SNCR Performance Factors

- The reaction is dependent on temperature, residence time, NO_X levels and amount of reducing agent used

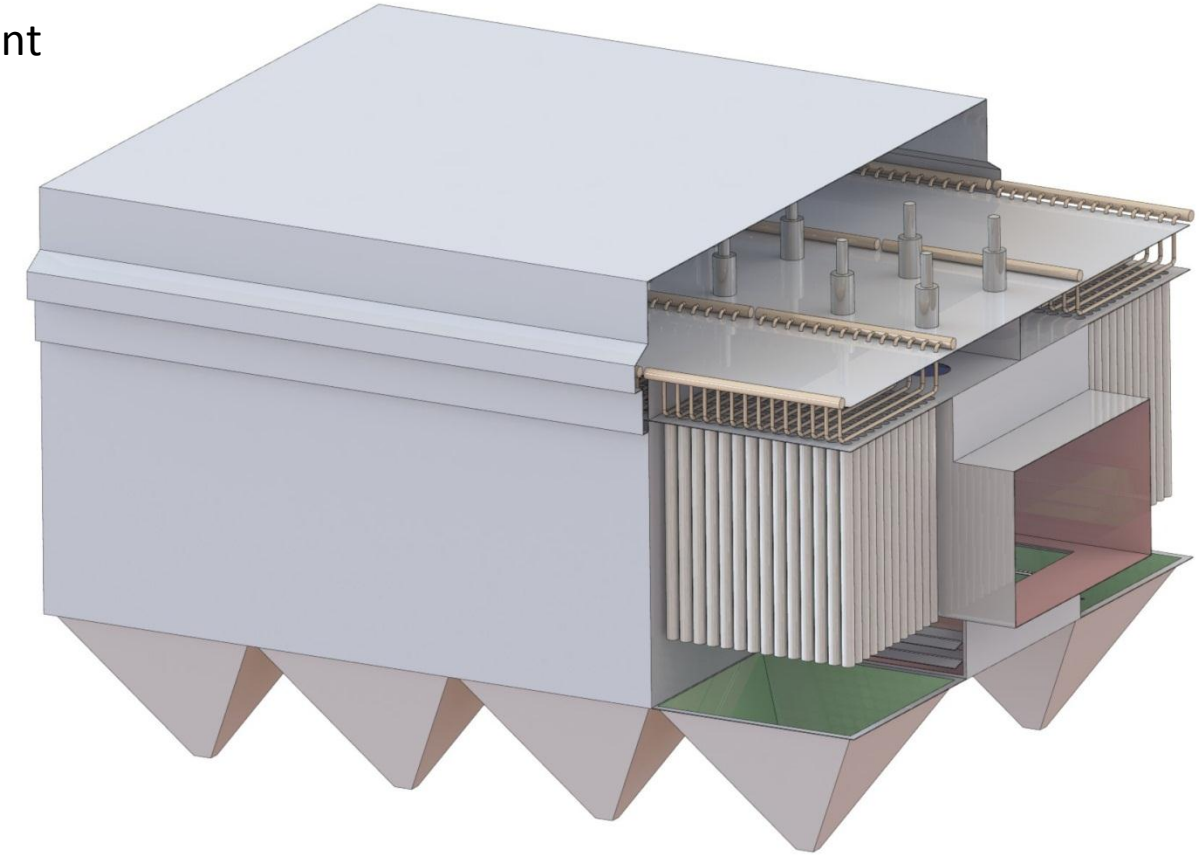




Typical three levels of injection to fit best reaction temperatures at varied loads

Particulate Collection Efficiency Factors

- Electric Static Precipitator (ESP) Performance Factors
  - Elevated temperatures
  - Carbon in ash content
  - Air In Leakage
- Fabric Filters
  - Condition of bags
- Mechanical Collectors
  - Particle Size

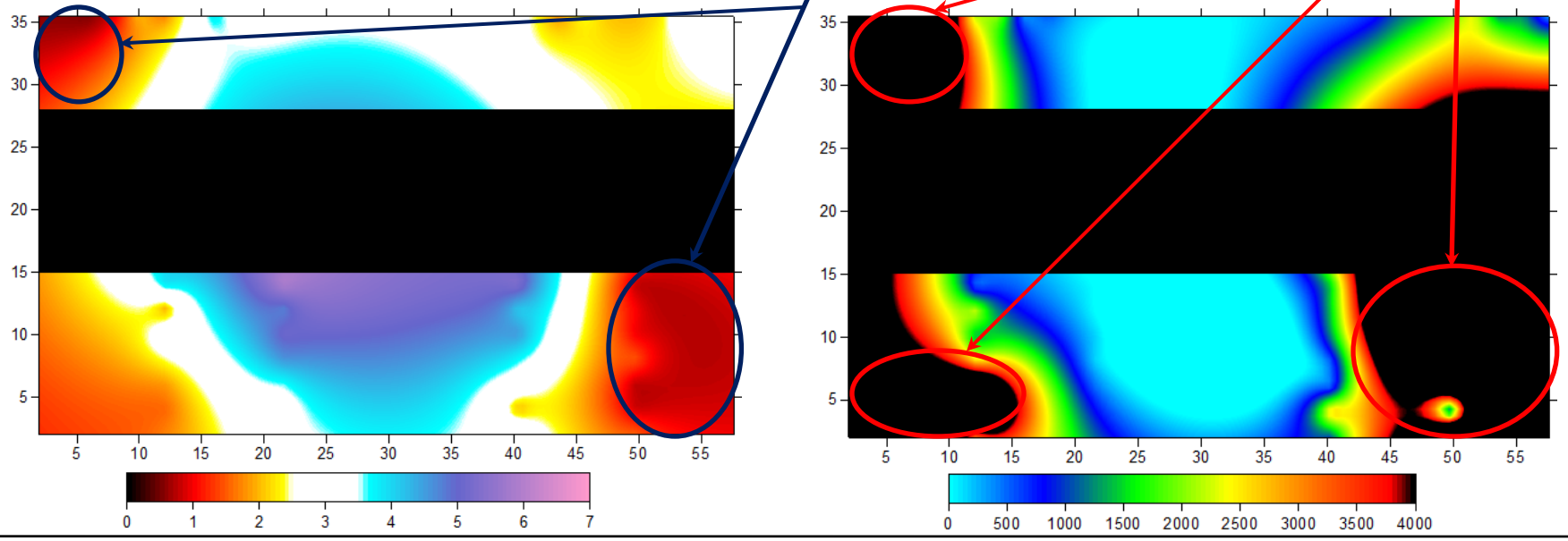


How Do We Optimize Boiler Performance?

- Need to ensure we have a balanced excess oxygen and temperature profile across the furnace exit!
- Requirements for a balanced furnace
  - Pulverizers must be optimized
  - Airflows must be staged correctly to the boiler
  - Burners must be in good condition
  - Furnace must be oxidizing

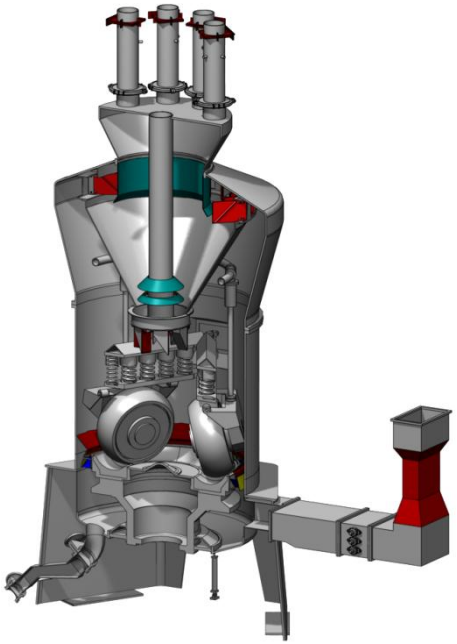
Areas where O_2 is less than 1%

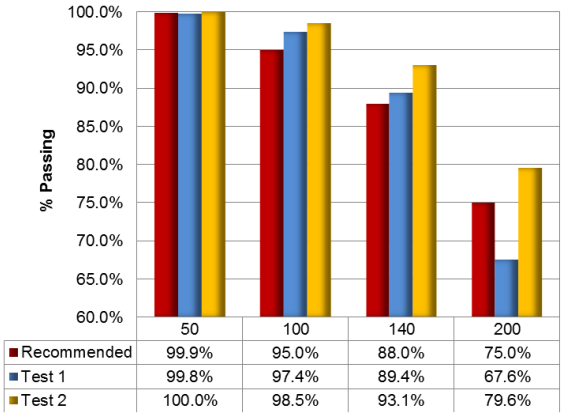
Areas of CO over 4,000 PPM



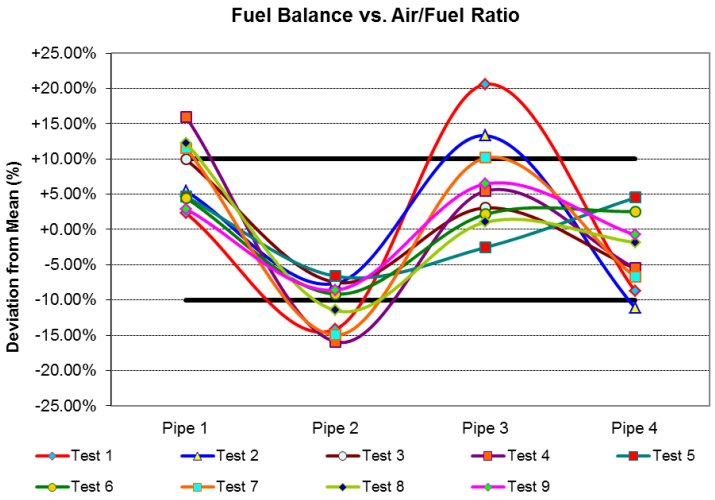
What is Optimum Pulverizer Performance?

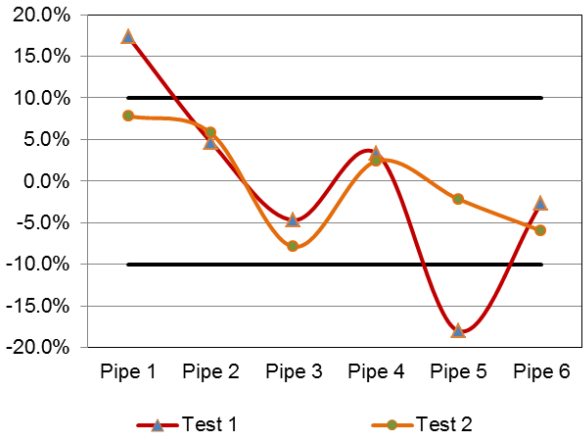
- Dirty air balance within ±5%
- Primary air flow accuracy within ±3%
- Correct primary air curve and air/fuel ratio
- Fuel fineness ≥75% passing 200 mesh and ≤0.1% retained on 50 mesh
- Fuel balance within ±10%





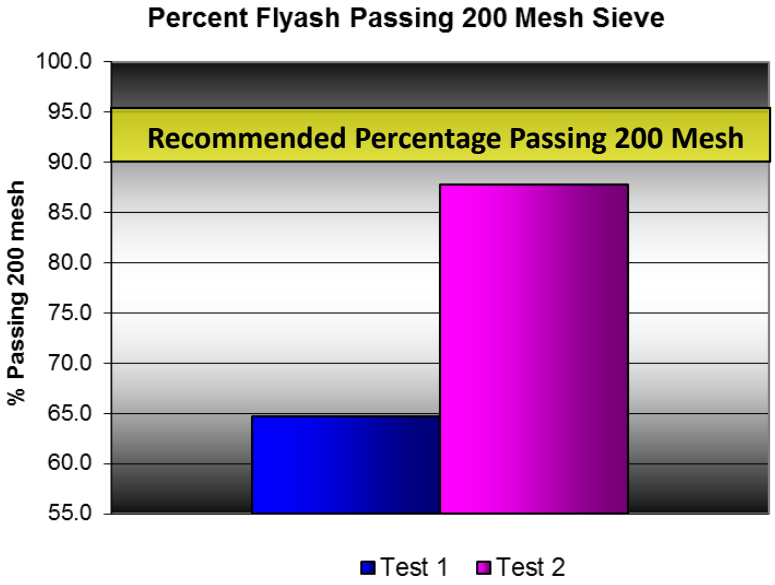
	50	100	140	200
Recommended	99.9%	95.0%	88.0%	75.0%
Test 1	99.8%	97.4%	89.4%	67.6%
Test 2	100.0%	98.5%	93.1%	79.6%





Effect of Pulverizer Performance on Carbon in Ash

- Flyash LOI is related to pulverizer performance
  - Poor pulverizer performance results in increased LOI's

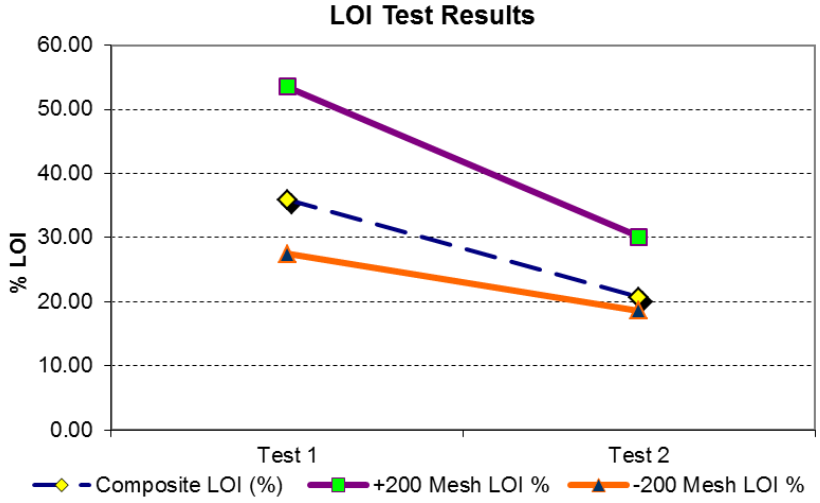


Test 1

Pulverizer	#	A	B	C	D
%Passing 50 Mesh	%	**99.96%**	**100.00%**	**99.96%**	**100.00%**
%Remaining on 50 Mesh	%	0.04%	0.00%	0.04%	0.00%
%Passing 100 Mesh	%	98.32%	98.75%	96.97%	98.27%
%Passing 140 Mesh	%	89.36%	88.64%	85.19%	86.96%
%Passing 200 Mesh	%	**73.93%**	**67.86%**	**68.76%**	**69.54%**

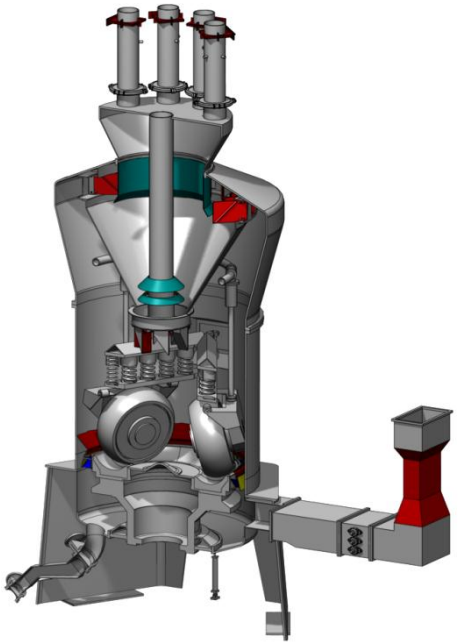
Test 2

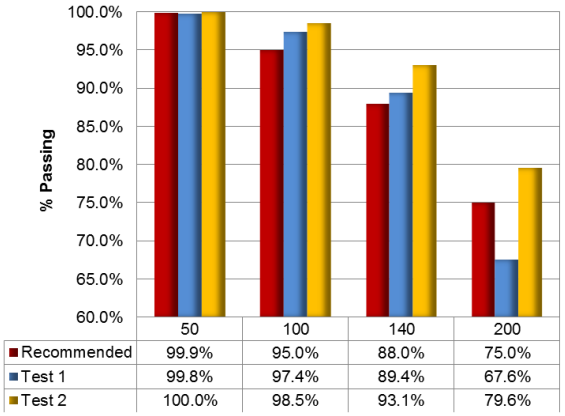
Pulverizer	#	A	B	C	D
%Passing 50 Mesh	%	**100.00%**	**100.00%**	**99.94%**	**99.80%**
%Remaining on 50 Mesh	%	0.00%	0.00%	0.06%	0.20%
%Passing 100 Mesh	%	99.01%	98.80%	97.53%	98.55%
%Passing 140 Mesh	%	91.90%	91.34%	87.22%	90.41%
%Passing 200 Mesh	%	**77.84%**	**78.52%**	**72.54%**	**76.65%**



How Do You Maintain Opitmum Pulverizer Performance?

- Quarterly performance testing programs
  - Evaluate fuel fineness, fuel balance, air/fuel ratios, dirty air balance





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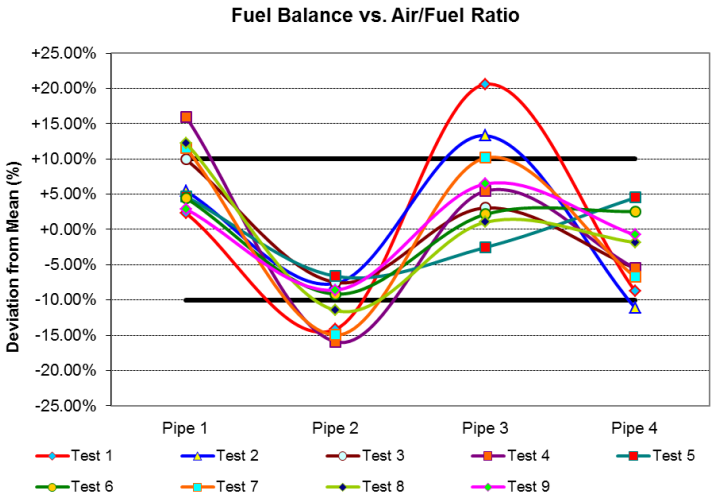
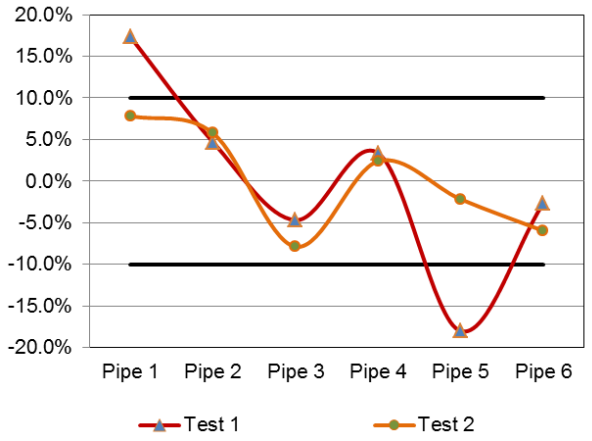
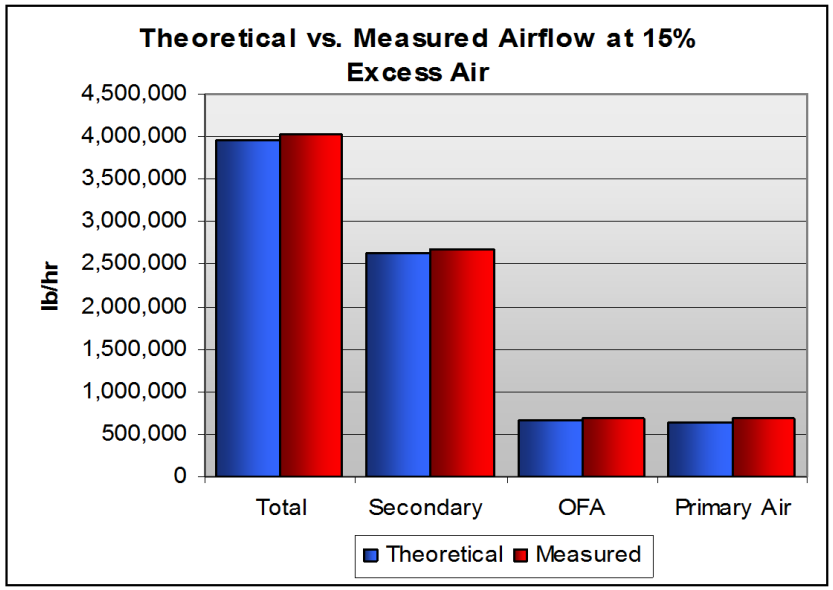
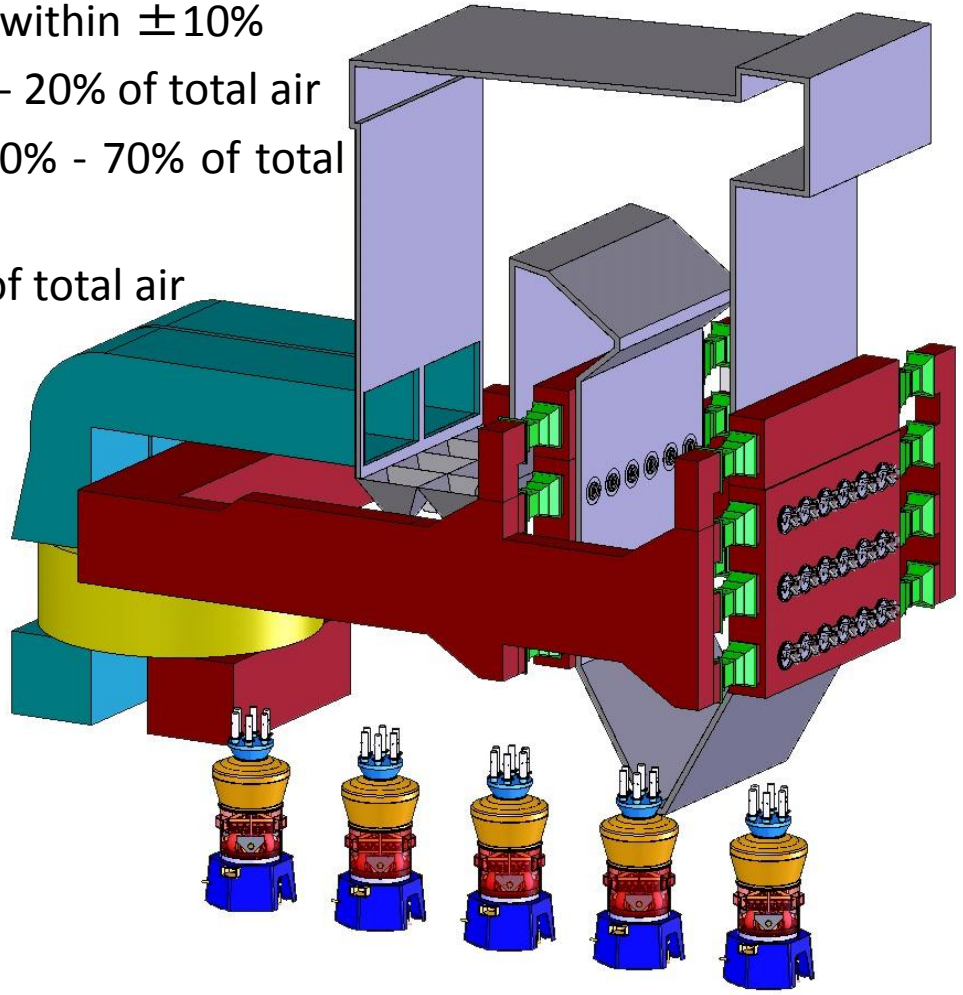




All Airflow Must Be Accurately Measured and Managed!

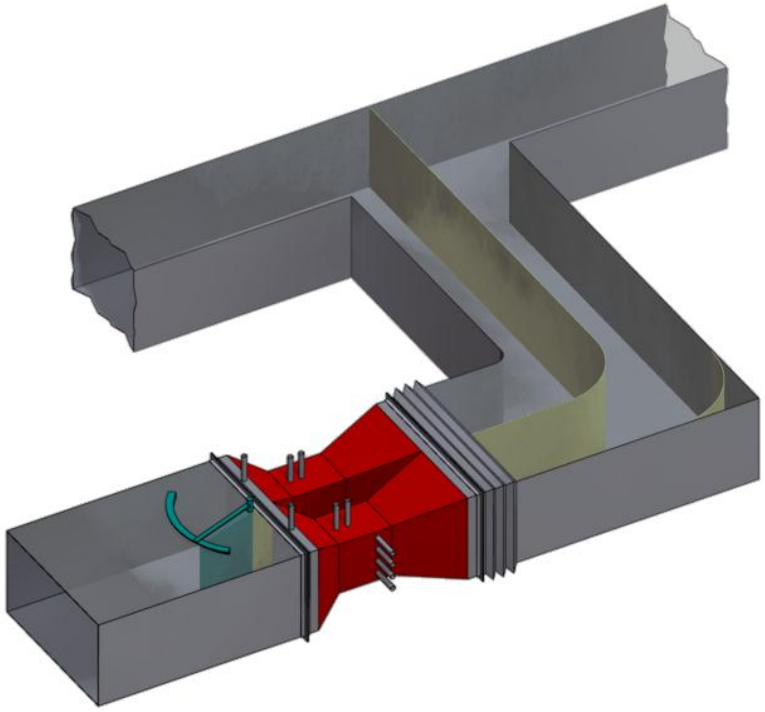
- Airflow management is key to optimizing combustion
  - Secondary airflow must be balanced within ±10%
  - Primary air should account for ~15% - 20% of total air
  - Secondary air should account for ~60% - 70% of total air
  - OFA should account for ~15% - 20% of total air

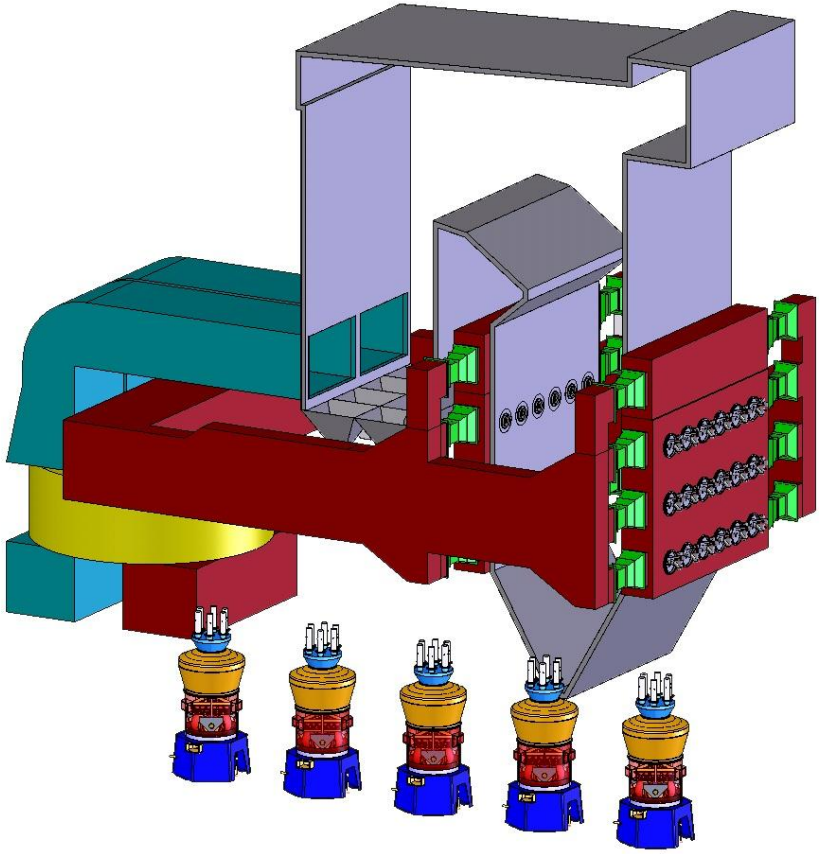




How Do We Accurately Manage the Airflow?

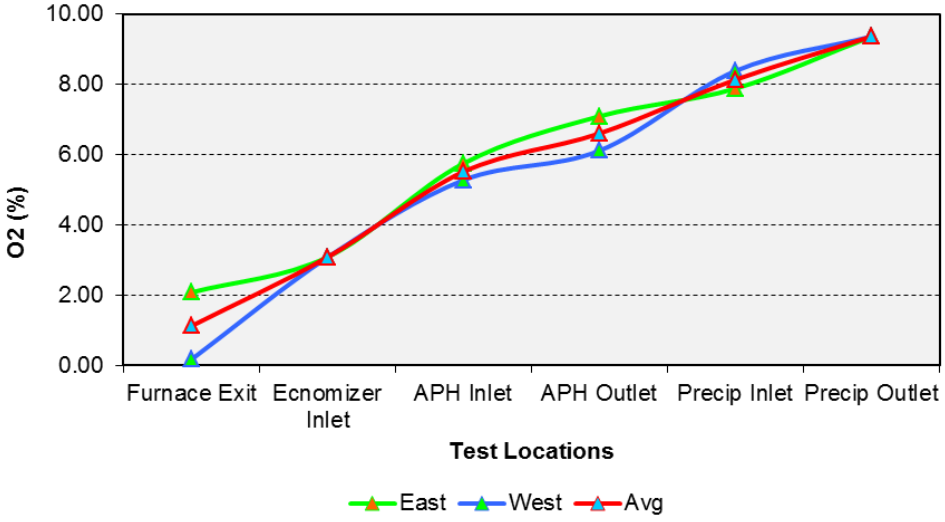
- Airflow measurement devices to each area of the boiler
  - Hot “K” calibrations of each device
  - Periodic airflow testing

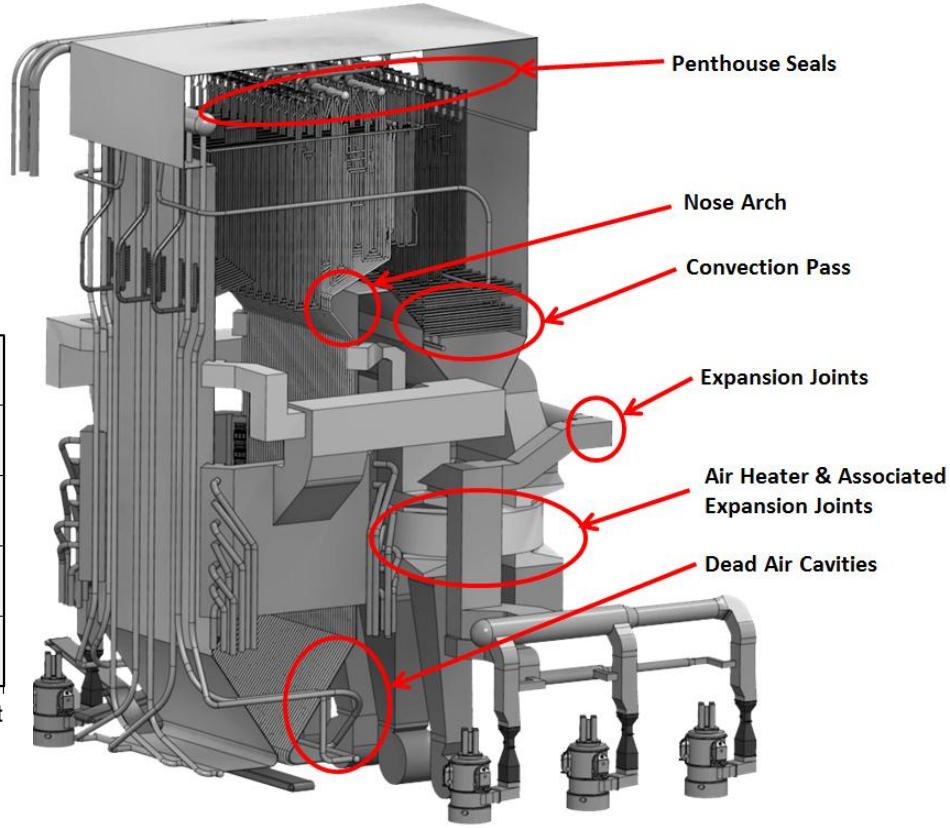




How Do We Quantify Air In Leakage?

- Oxygen rise from the furnace to the stack on balanced draft boiler
  - Point by point traverses should be conducted
- Adverse affects:
  - Heat rate penalties
  - Increased auxiliary horsepower
  - Decreased combustion efficiency
  - Increased flue gas volume
  - Fan limitations
  - Reduced generation



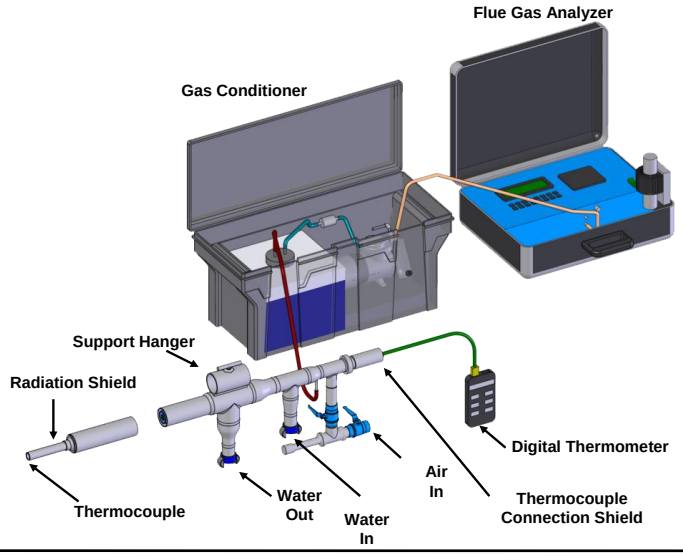


Condition of Firing Components Must be Optimized!

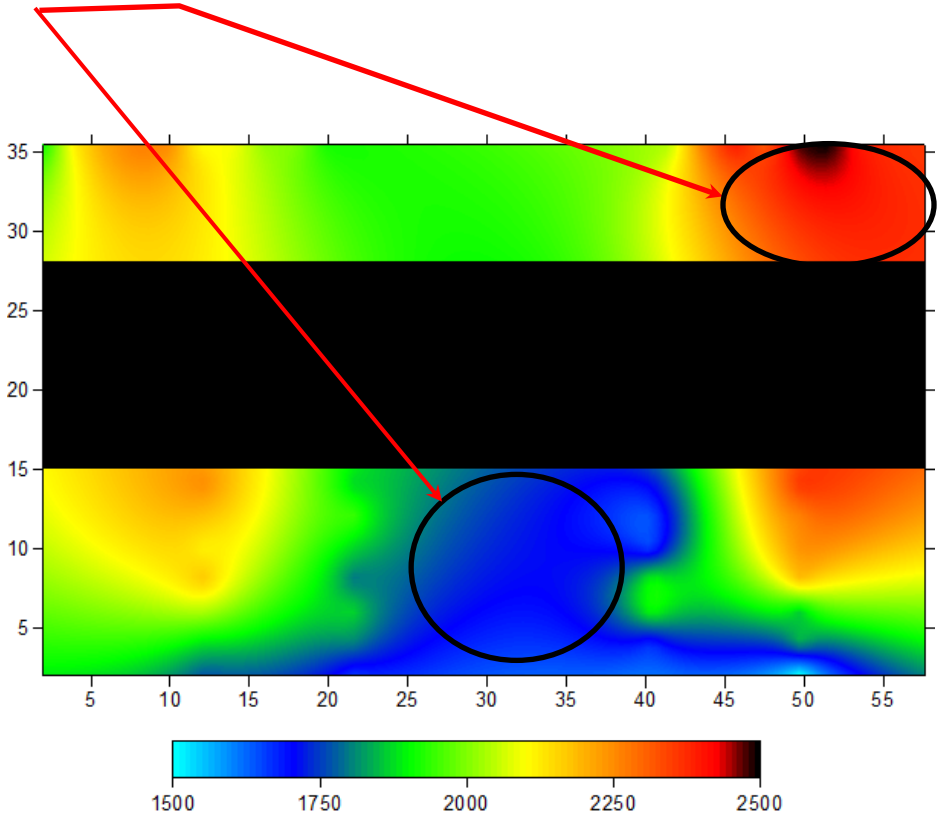
- Burners, OFA nozzles and mills must be blueprinted

How Do We Quantify Combustion Performance?

- Furnace exit traverses by a High Velocity Thermocouple (HVT) probe
  - Excess oxygen, Furnace Exit Gas Temperatures (FEGT's), CO & NO_X

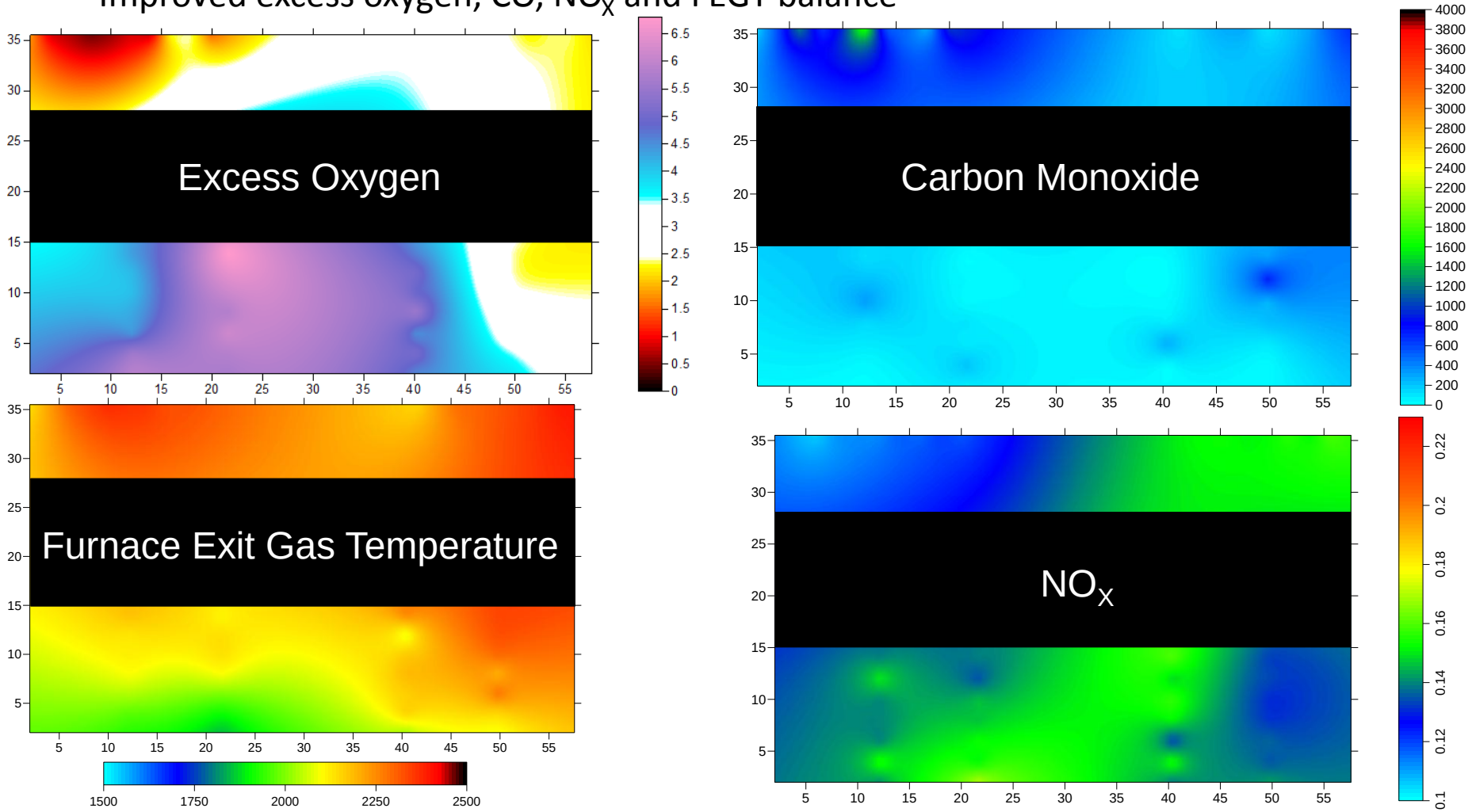


>700°F Temperature Imbalances!



Results of Boiler Tuning and Optimization

- Improved excess oxygen, CO, NO_X and FEGT balance



Neglecting Combustion Performance can Result in…

In Conclusion

•Installing backend flue gas cleanup equipment can provide instant reductions in regulated emissions

However….

•By neglecting the fundamentals of combustion, efficiencies of SCR's, FGD's and particulate control equipment will sacrificed!

Thank You

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