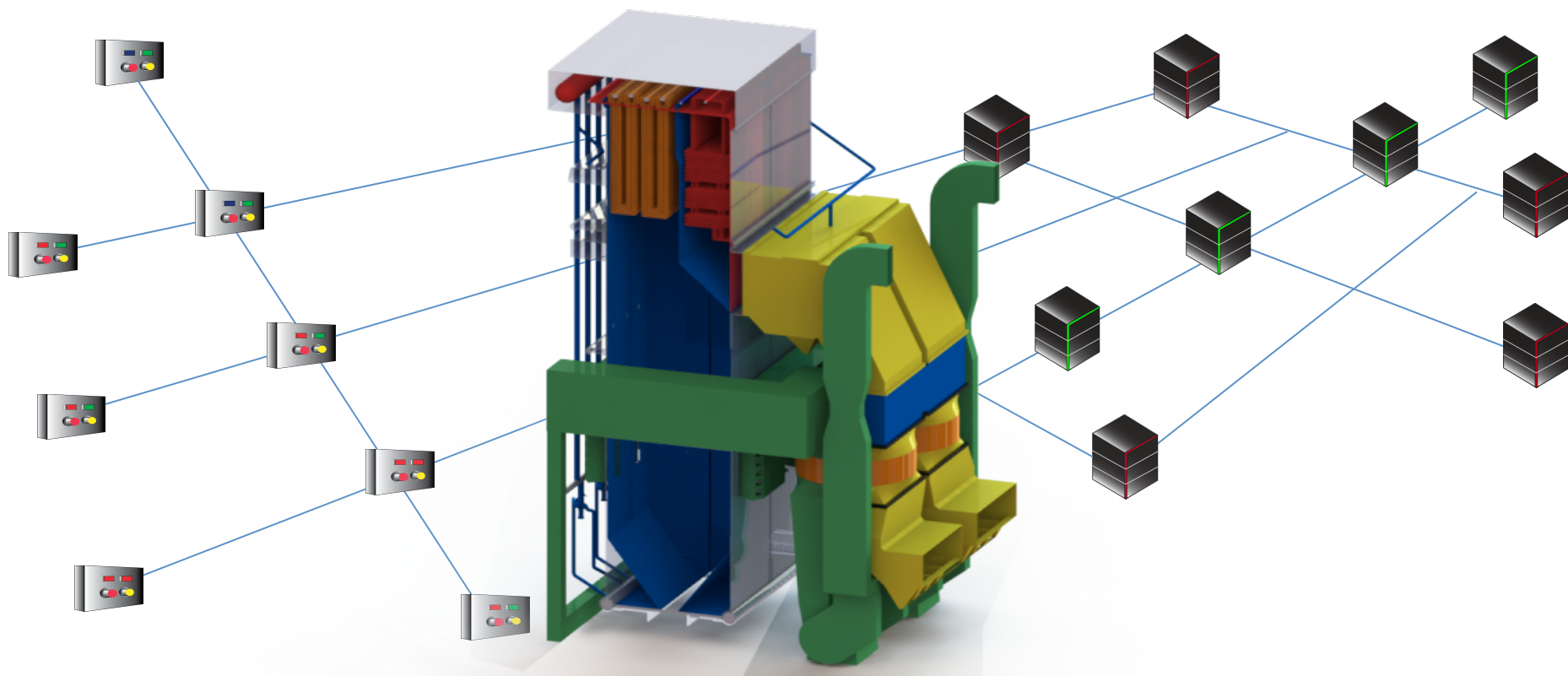


Inter-Relationships of Combustion, Efficiency, Reliability, & Air Pollution Control

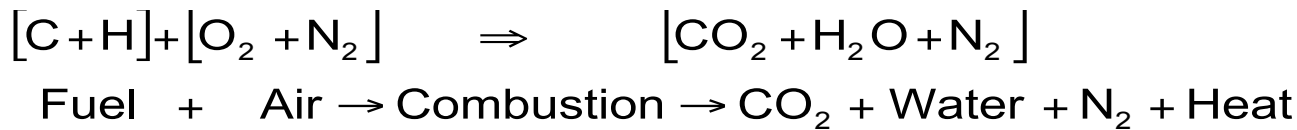
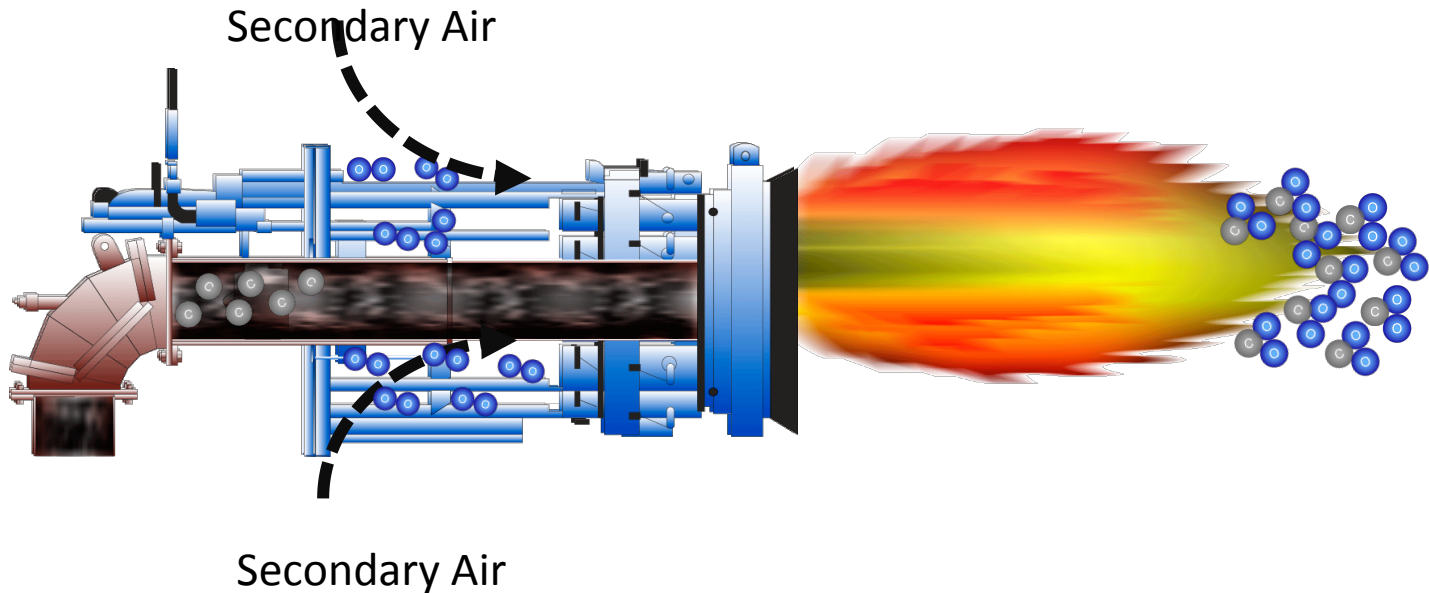
Presented by Stephen K. Storm, Stephen Storm, Inc. (SSI)



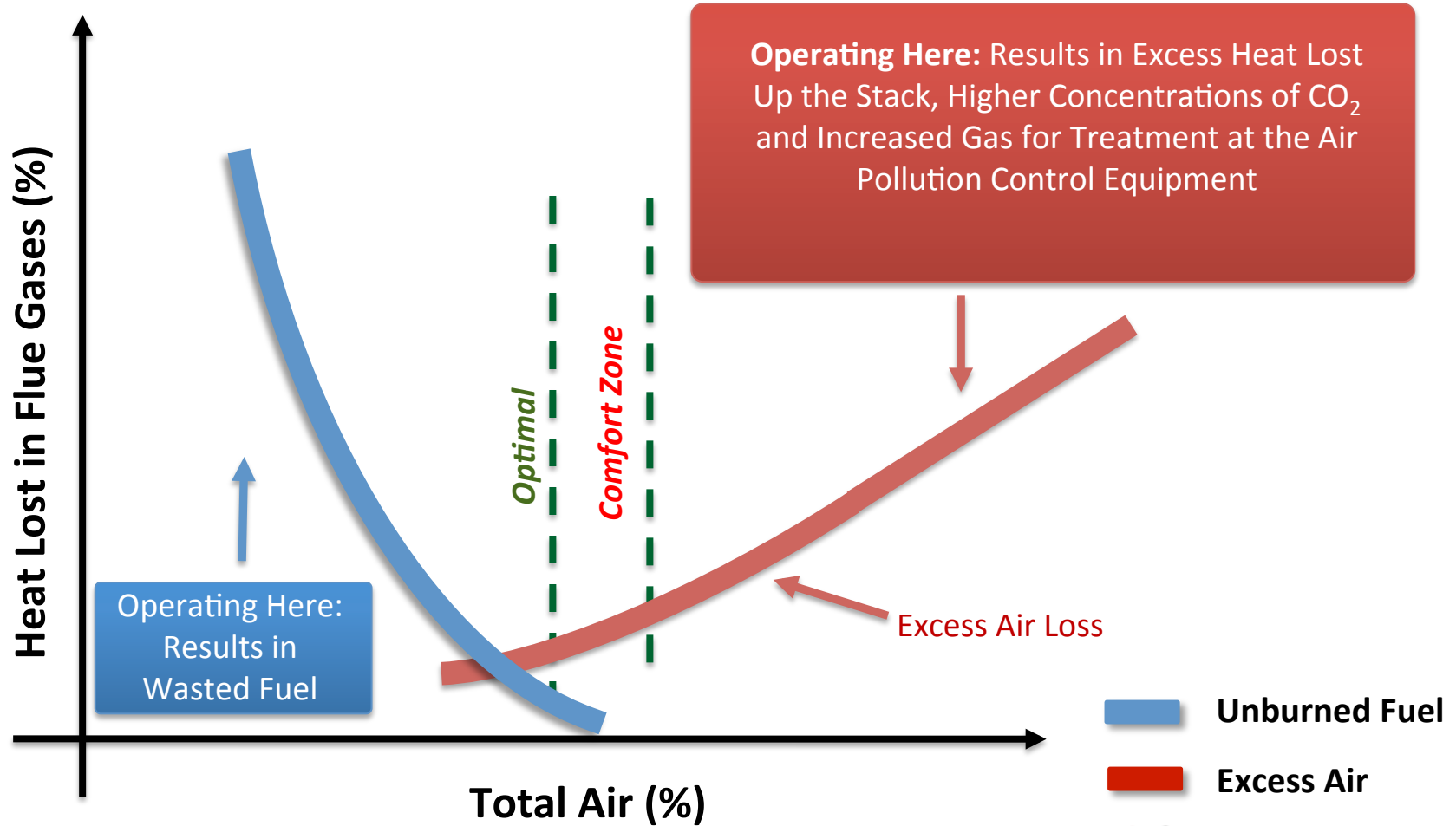
The Combustion of Carbon

Matching and mixing the air and fuel is key. Providing that the mixing takes place above the minimum combustion temperature of carbon, which is **~1,400°F**.

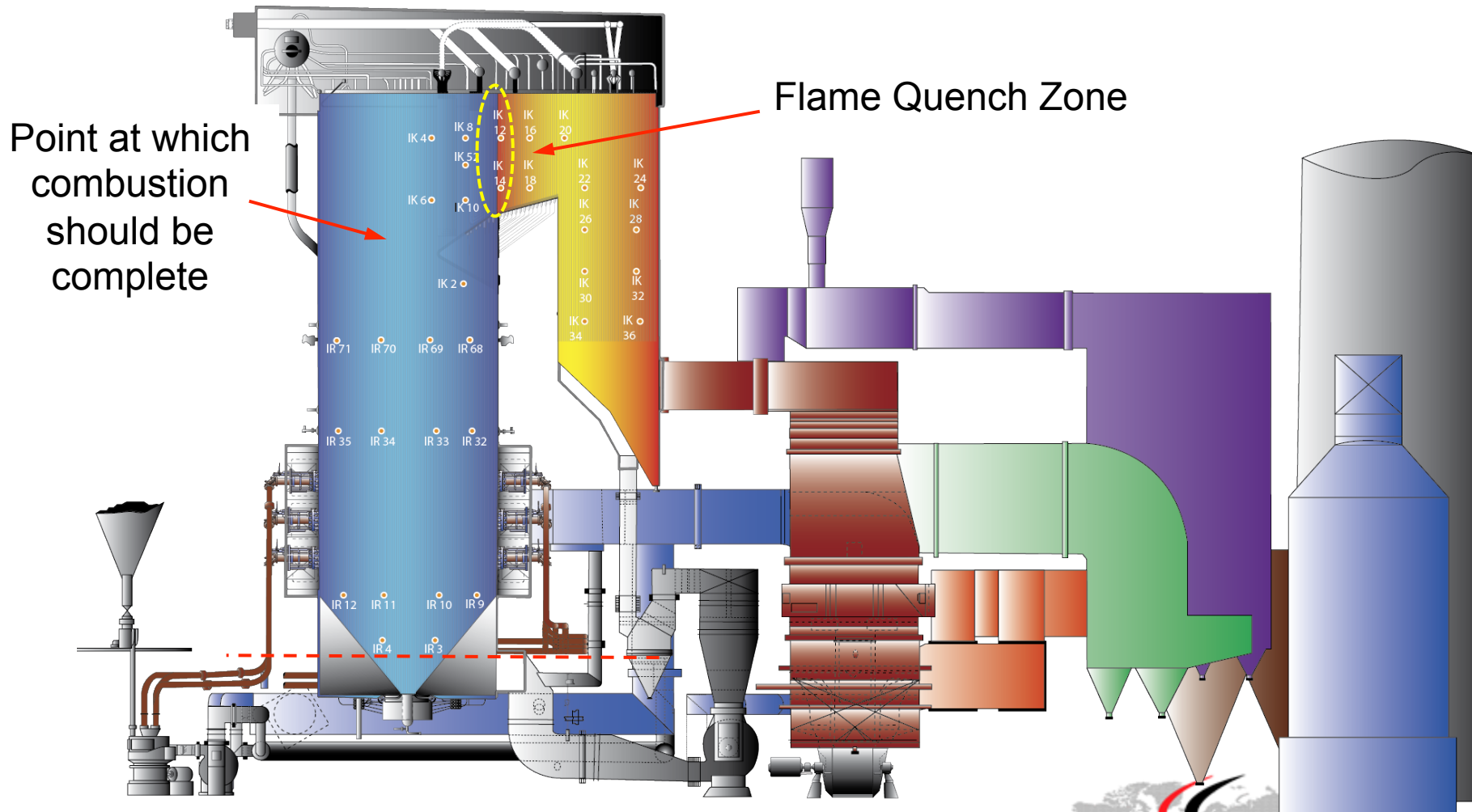
For every molecule of carbon, one molecule of CO₂ is formed (plus heat).



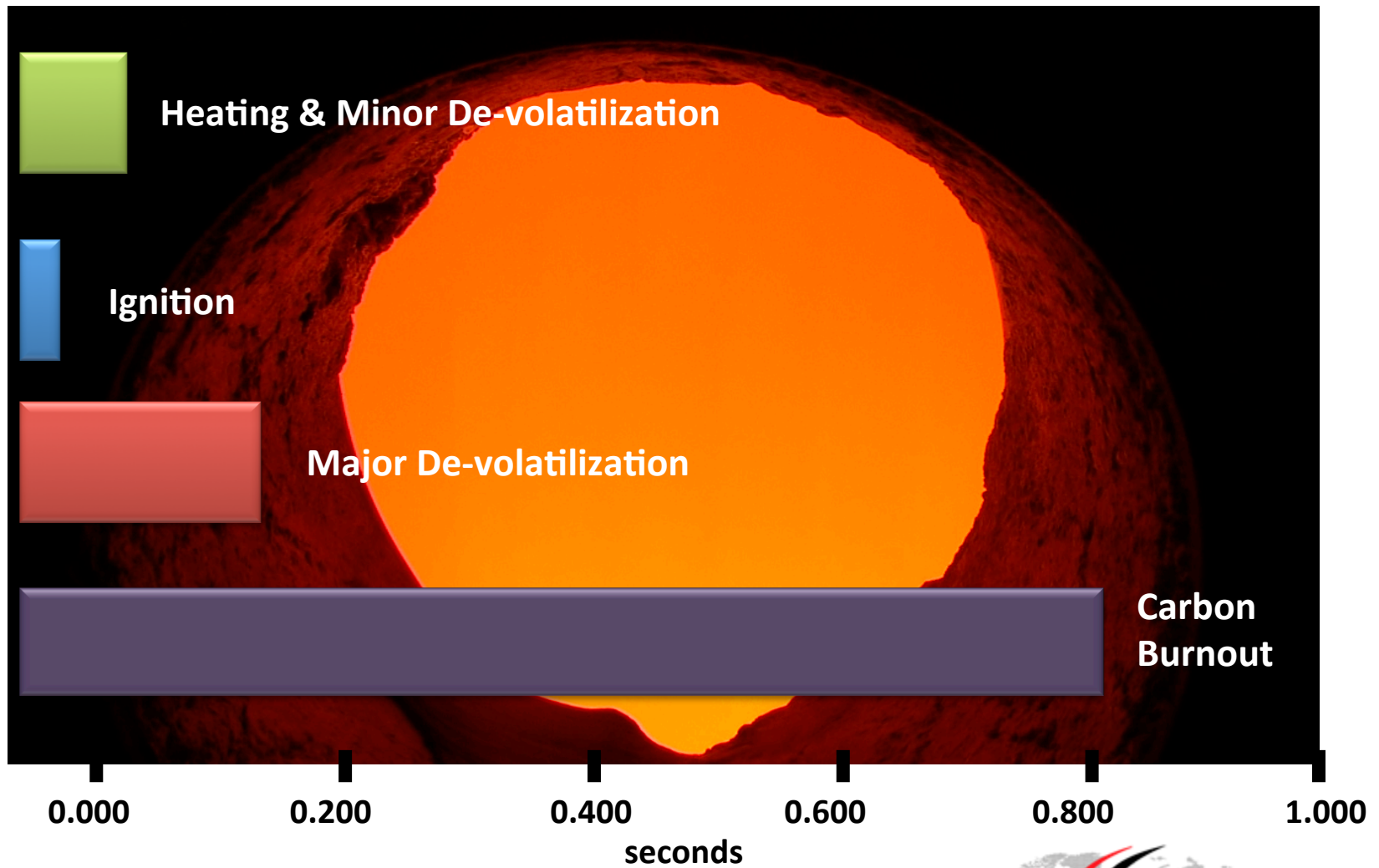
Optimizing Combustion & Boiler Efficiency



Furnace Residence Time

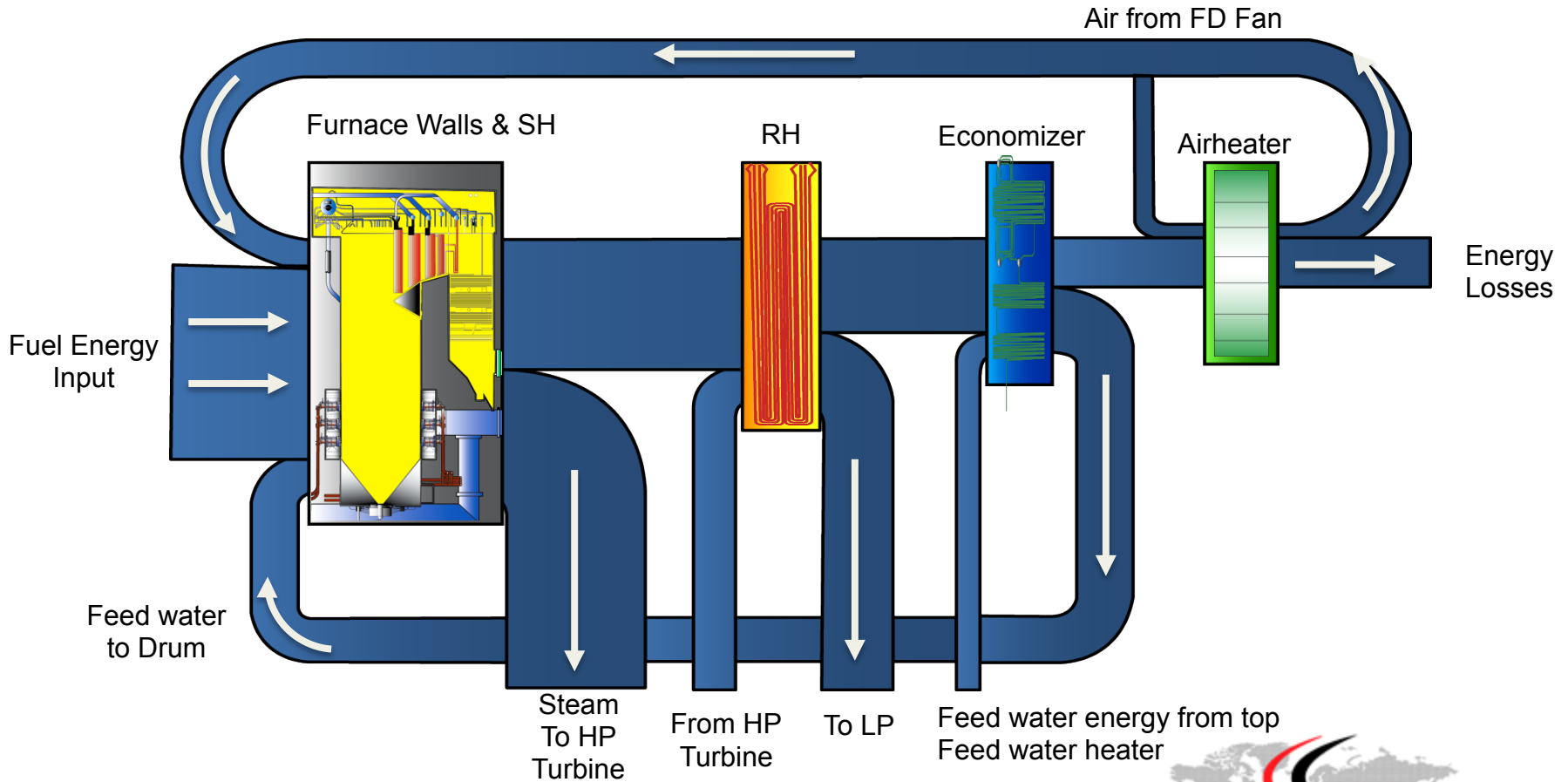


Furnace Residence Time

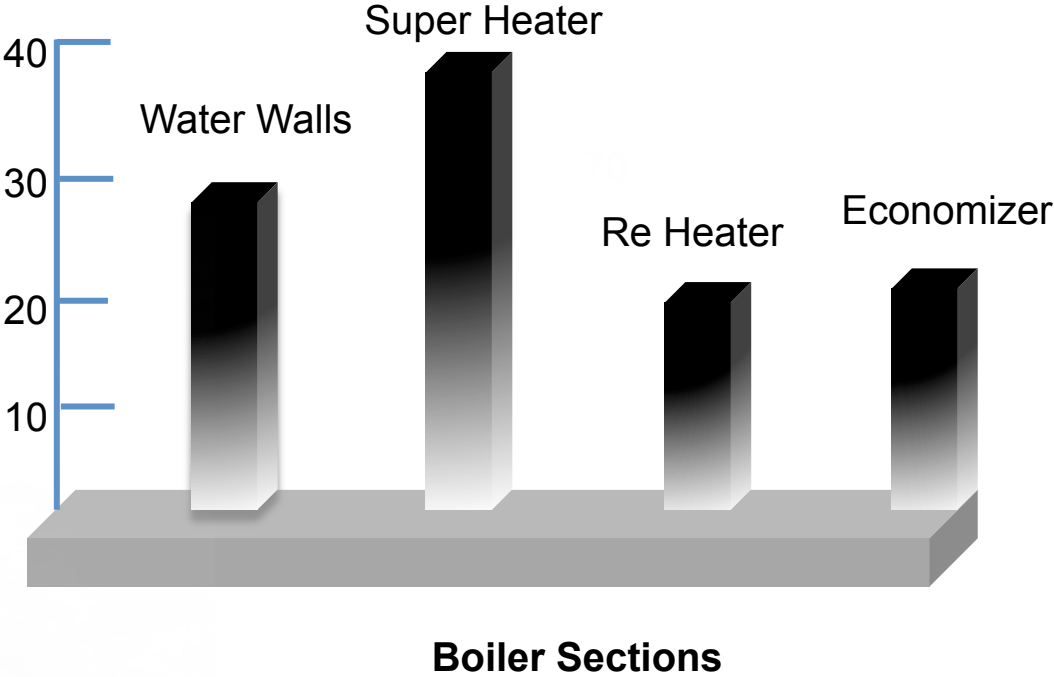
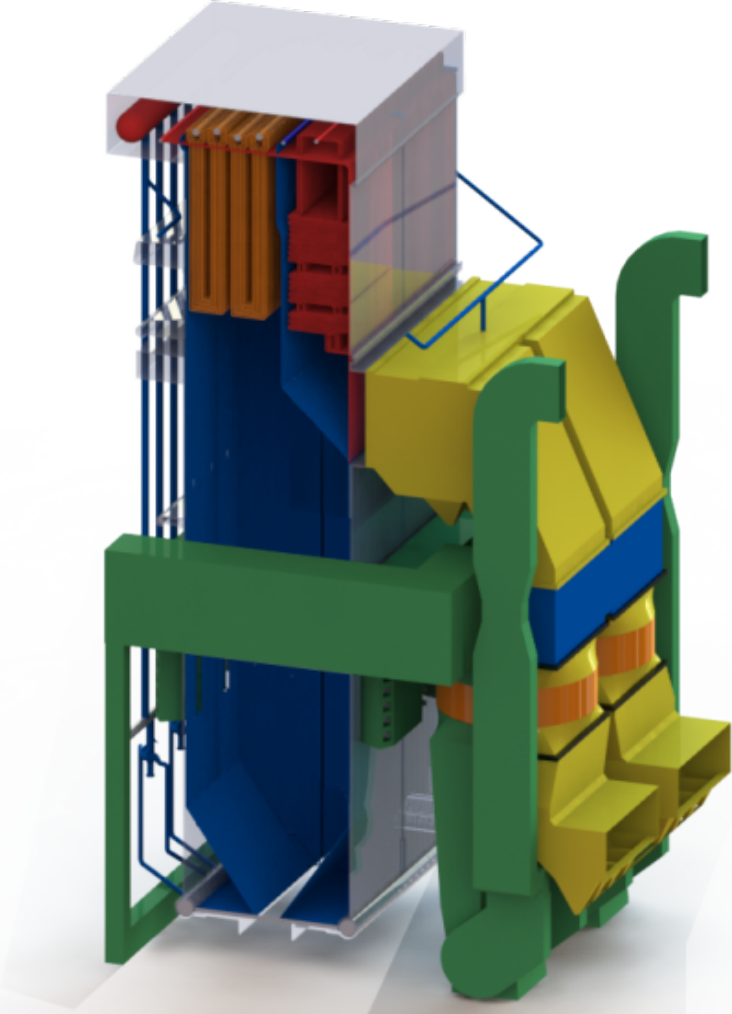


Boiler Operation & Design

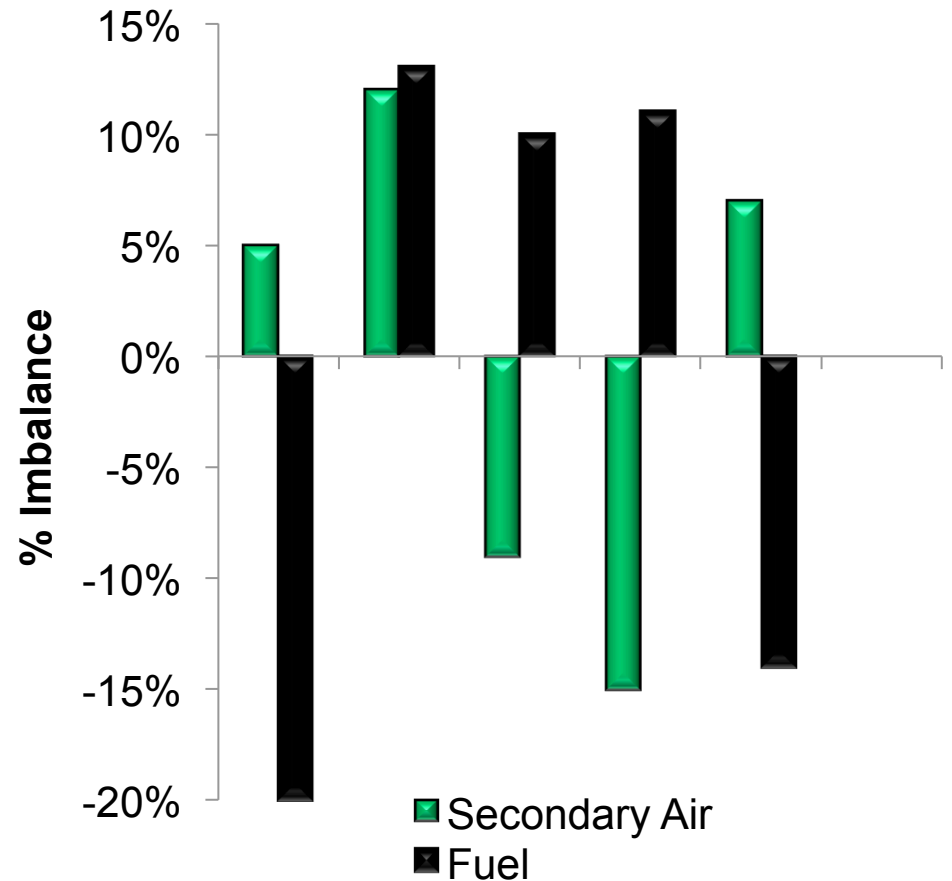
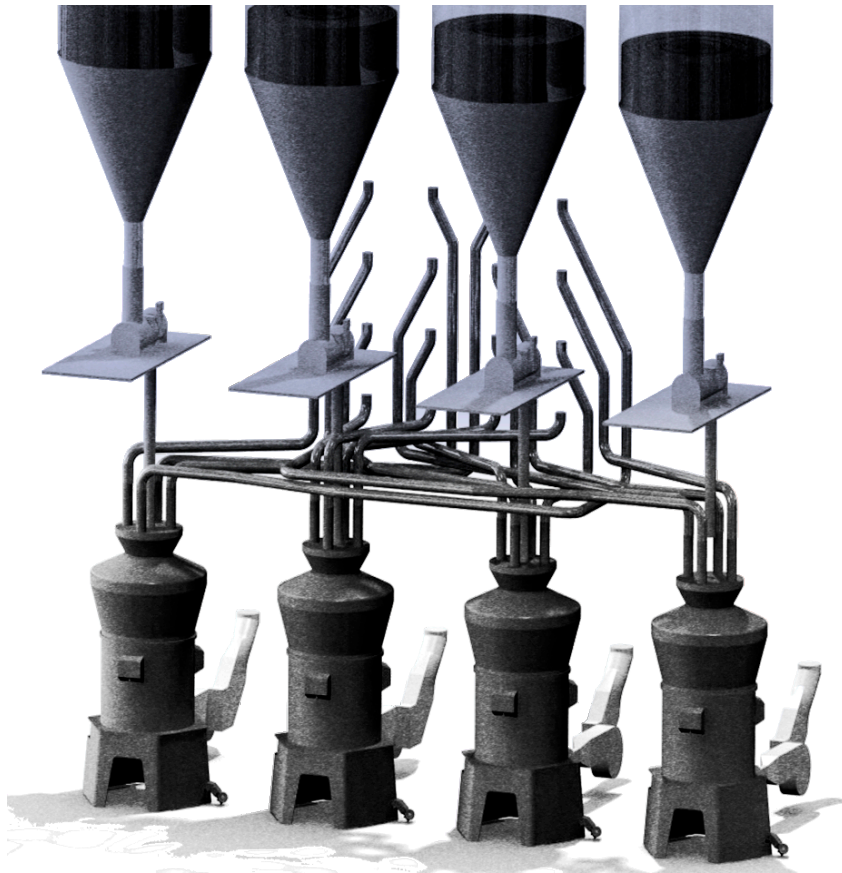
The boiler consists of a series of heat exchangers and each one of these components impacts the overall cycle performance



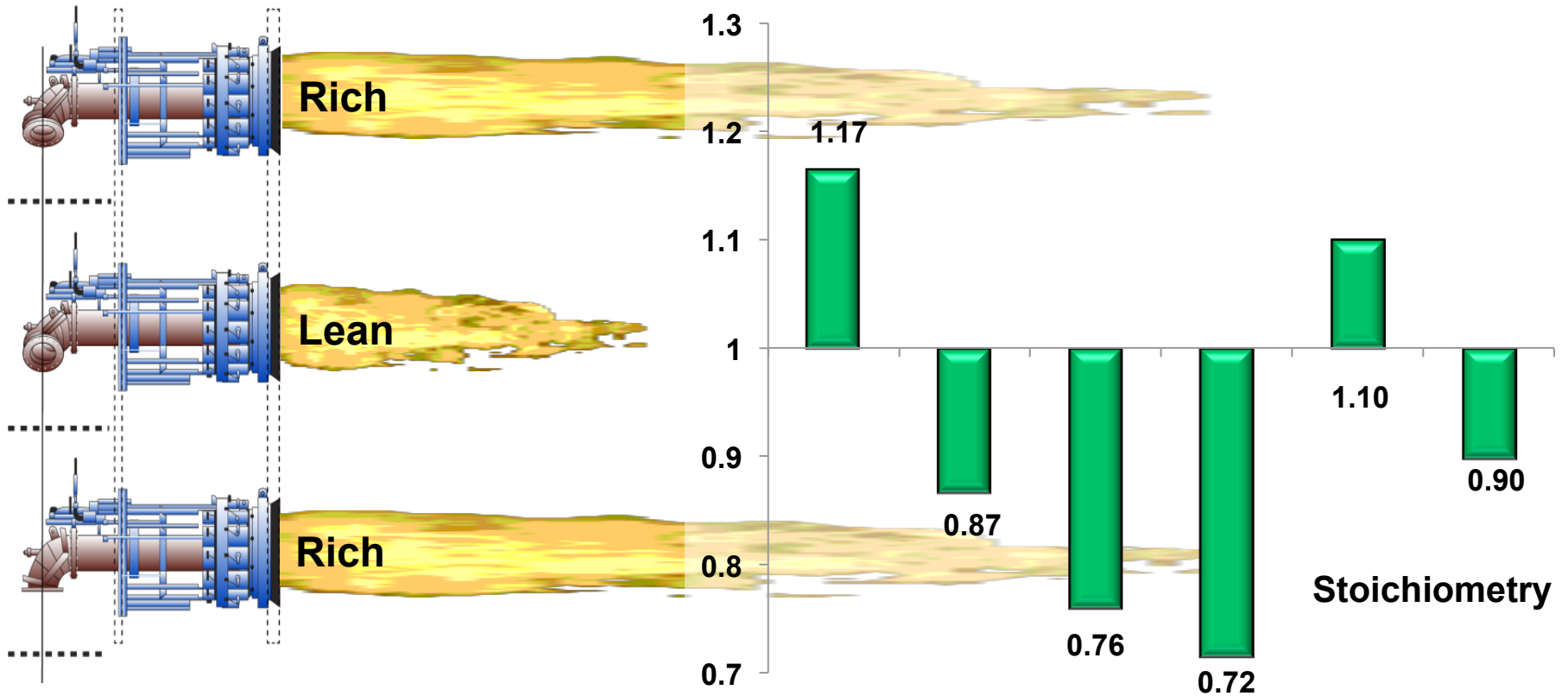
Heat Absorption Paths (typical)



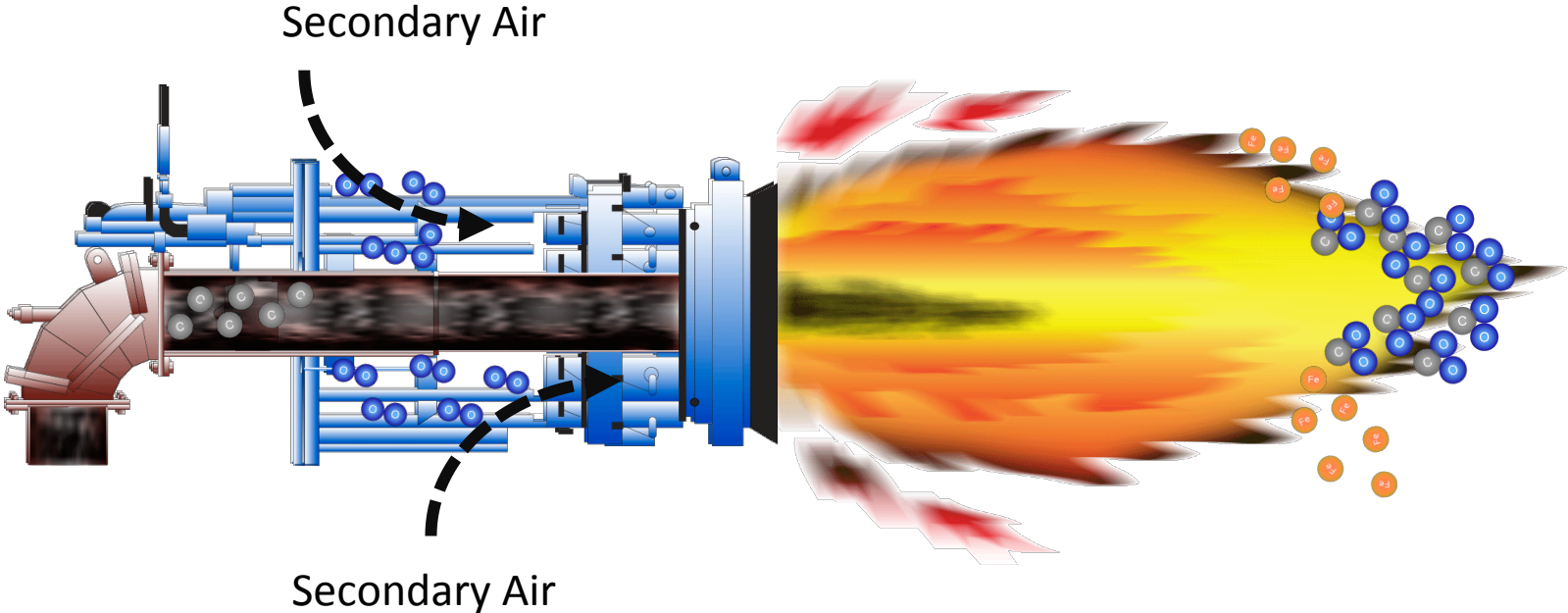
Mill Performance vs. Stoichiometry



Non Optimal Combustion



Slag Deposition on Boiler Tubes



Impact of Slag on Heat Transfer



As ash builds up on a tubes surface heat transfer is reduced...

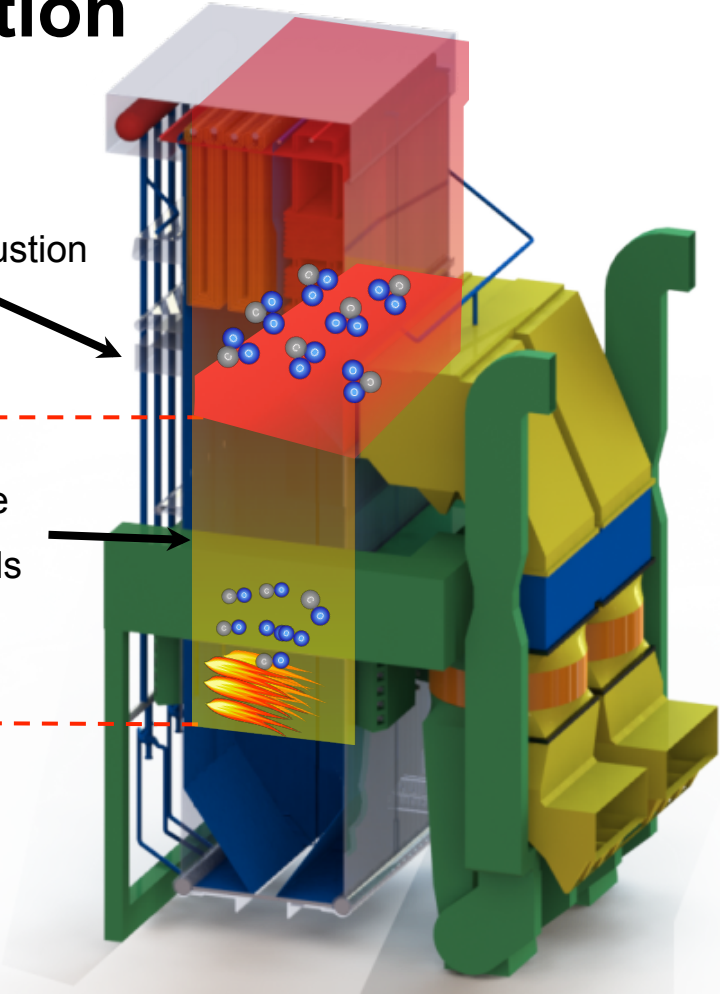


Delayed or Secondary Combustion

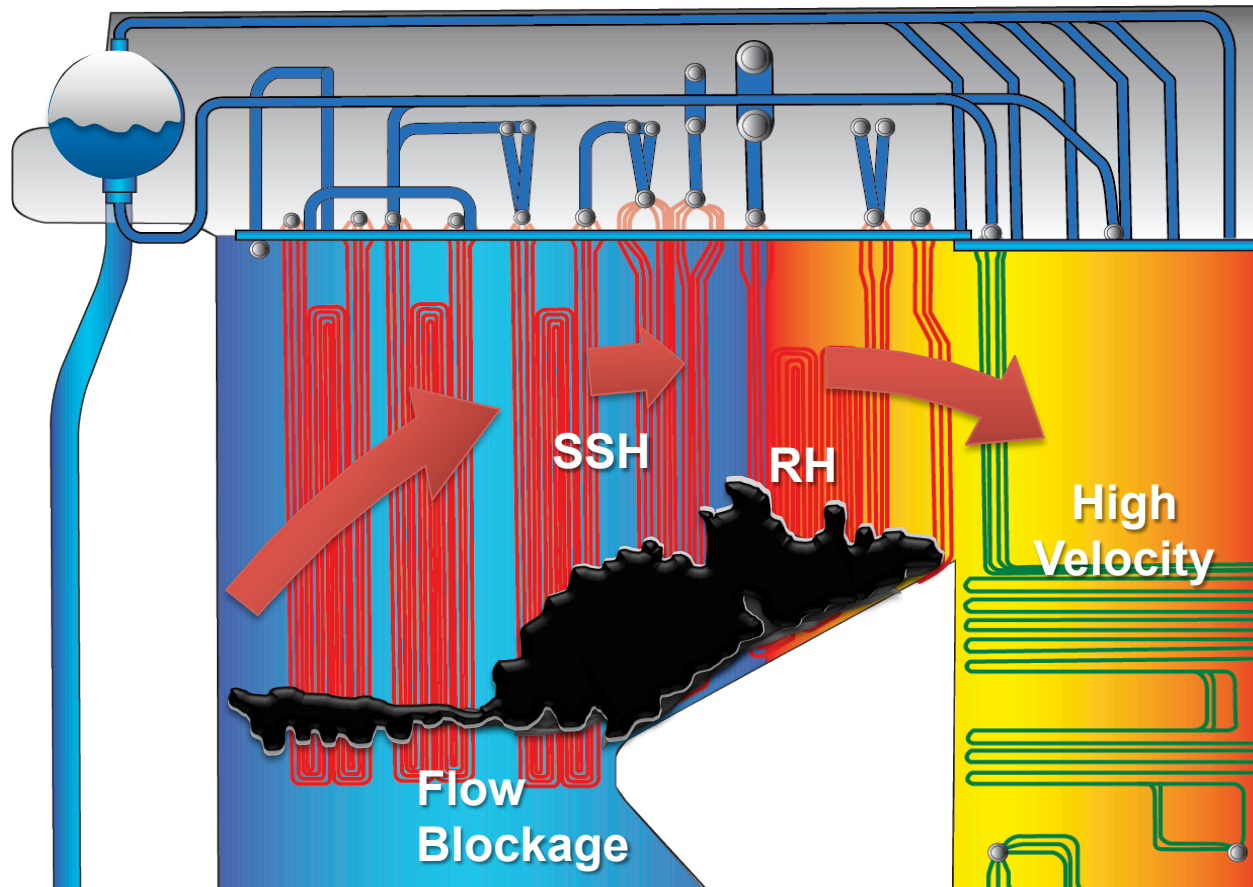


Secondary Combustion

Residence time
1 – 1.5 seconds



Slagging at Furnace



Non-Optimal furnace cleaning can significantly elevate the furnace exit gas temperature and forces heat to the convection pass .

However, slag build-up can also increase localized erosion !



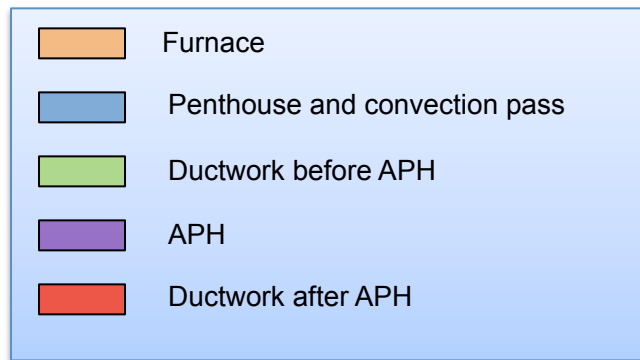
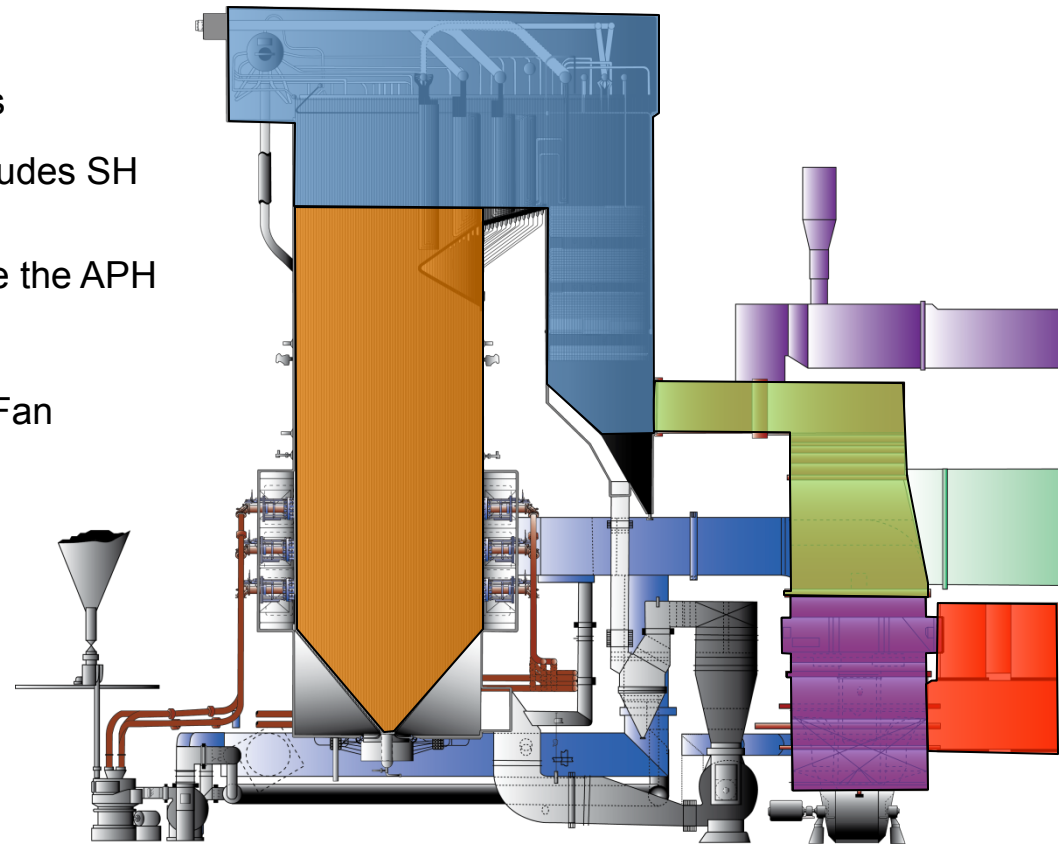
Impact of Slag on Reliability

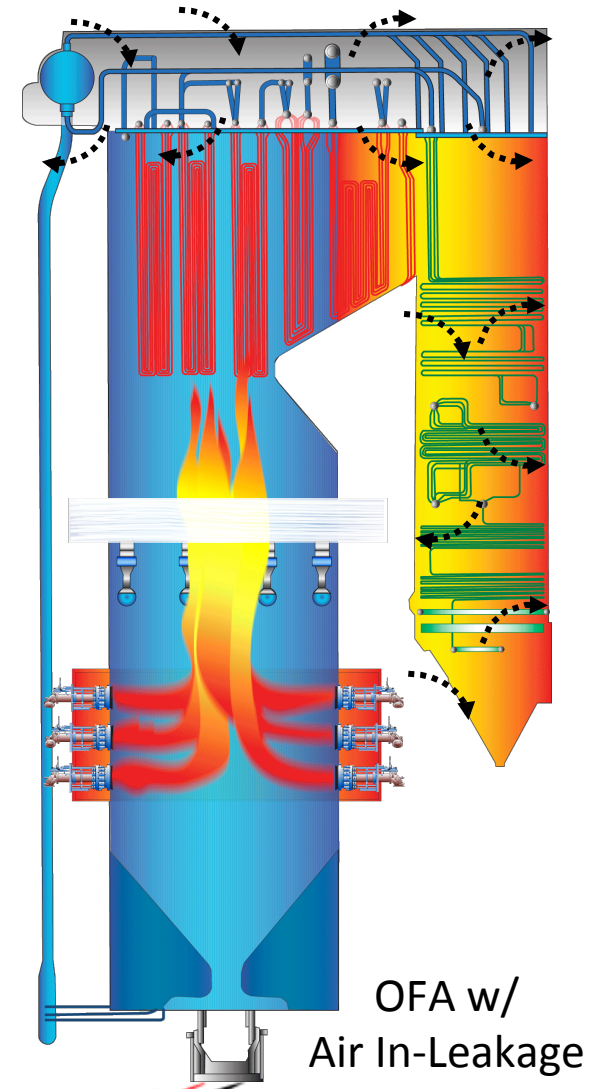
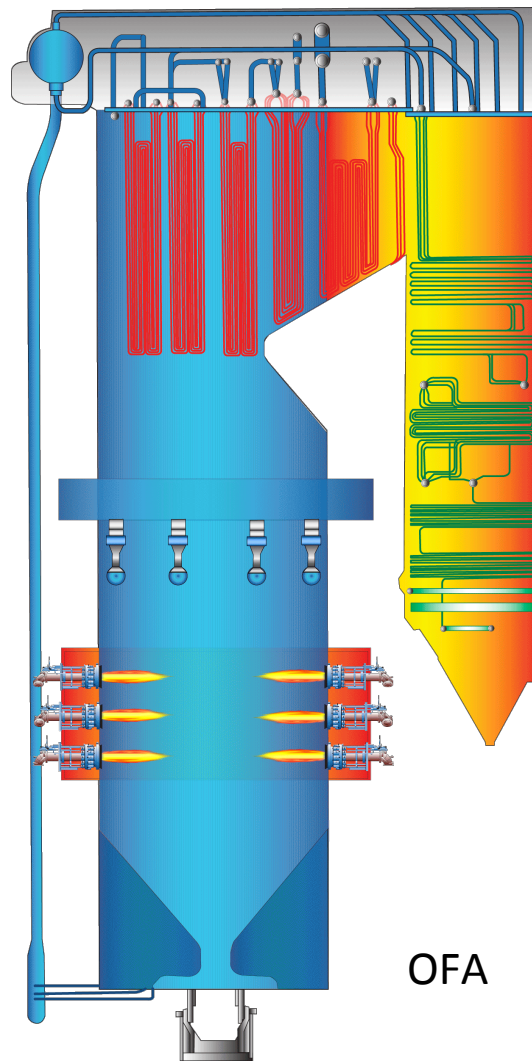
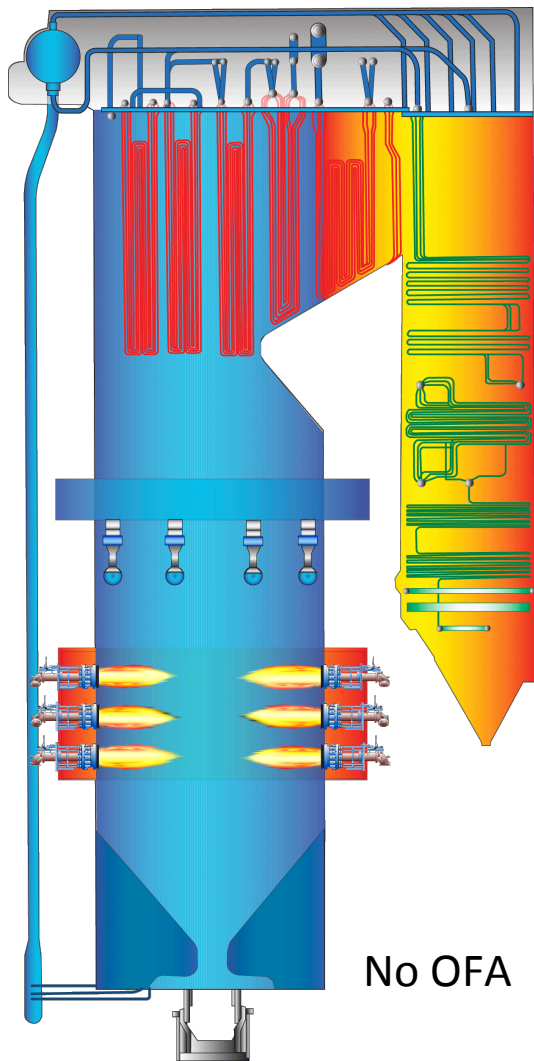


Boiler & System Air In-Leakage

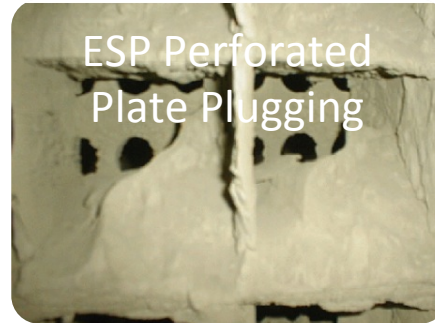
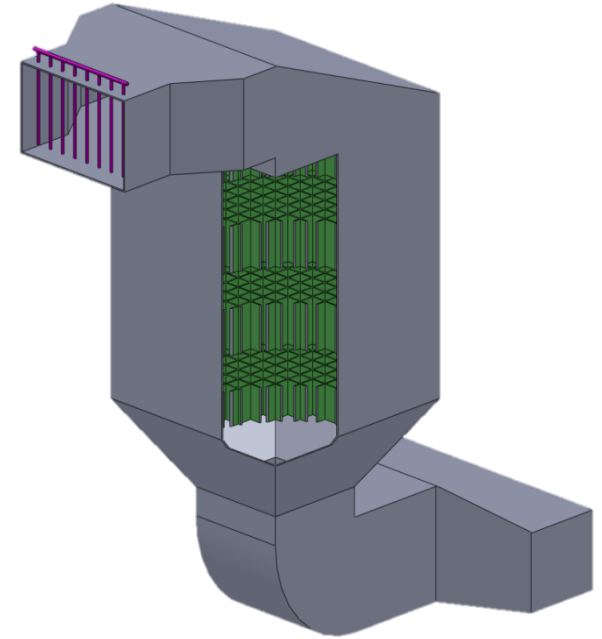
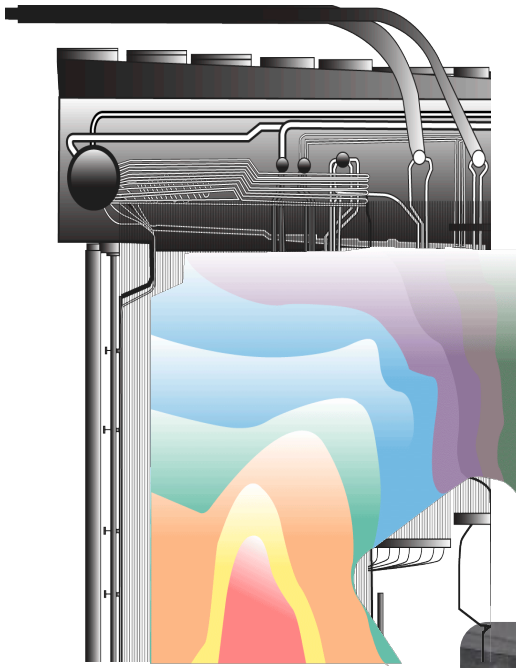
Location plays a large part of how much the leakage contributes to efficiency decreases and heat rate penalties.

- The main areas for leakage are
 - Main Furnace up to the first pendants
 - Penthouse and convection pass (includes SH and RH)
 - Ductwork after economizer but before the APH
 - Air Pre-Heater (APH)
 - Ductwork after the APH up to the ID Fan



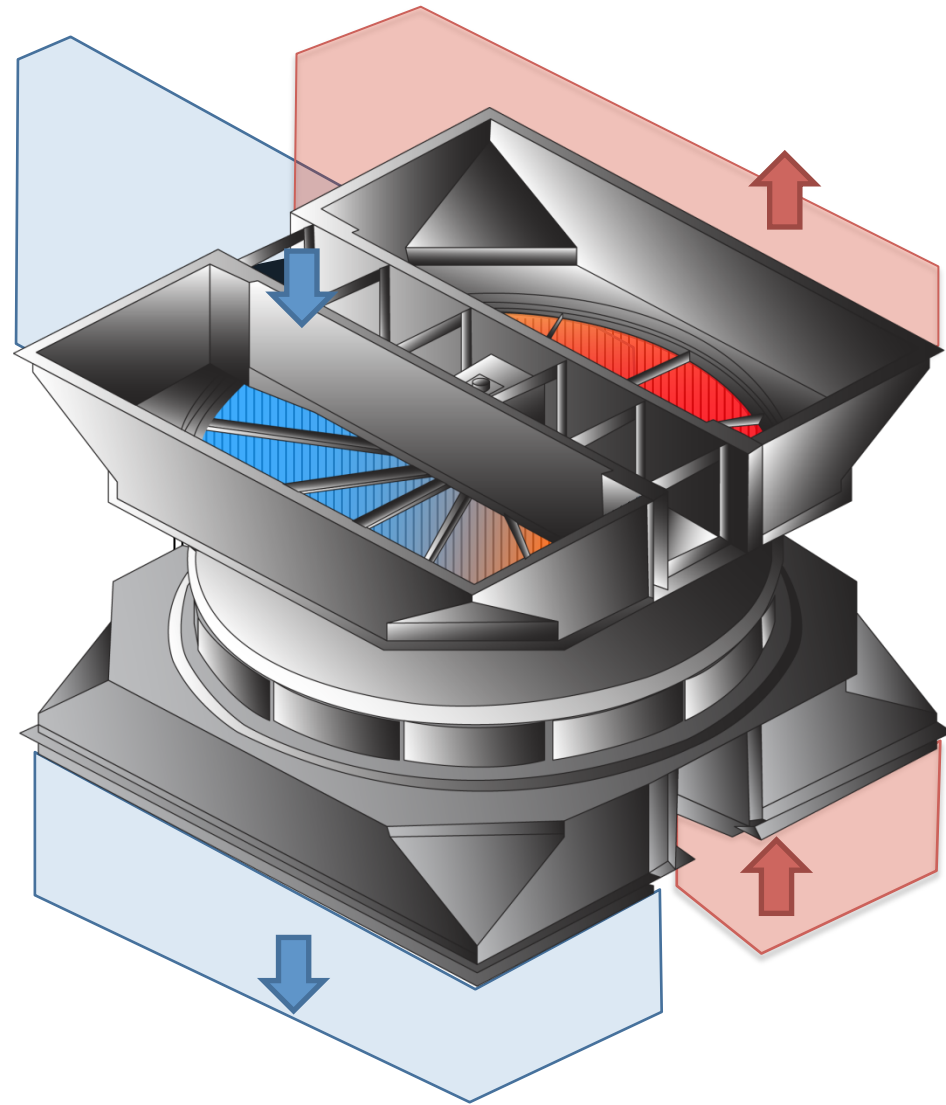


LPA and Combustion Impact APC equipment



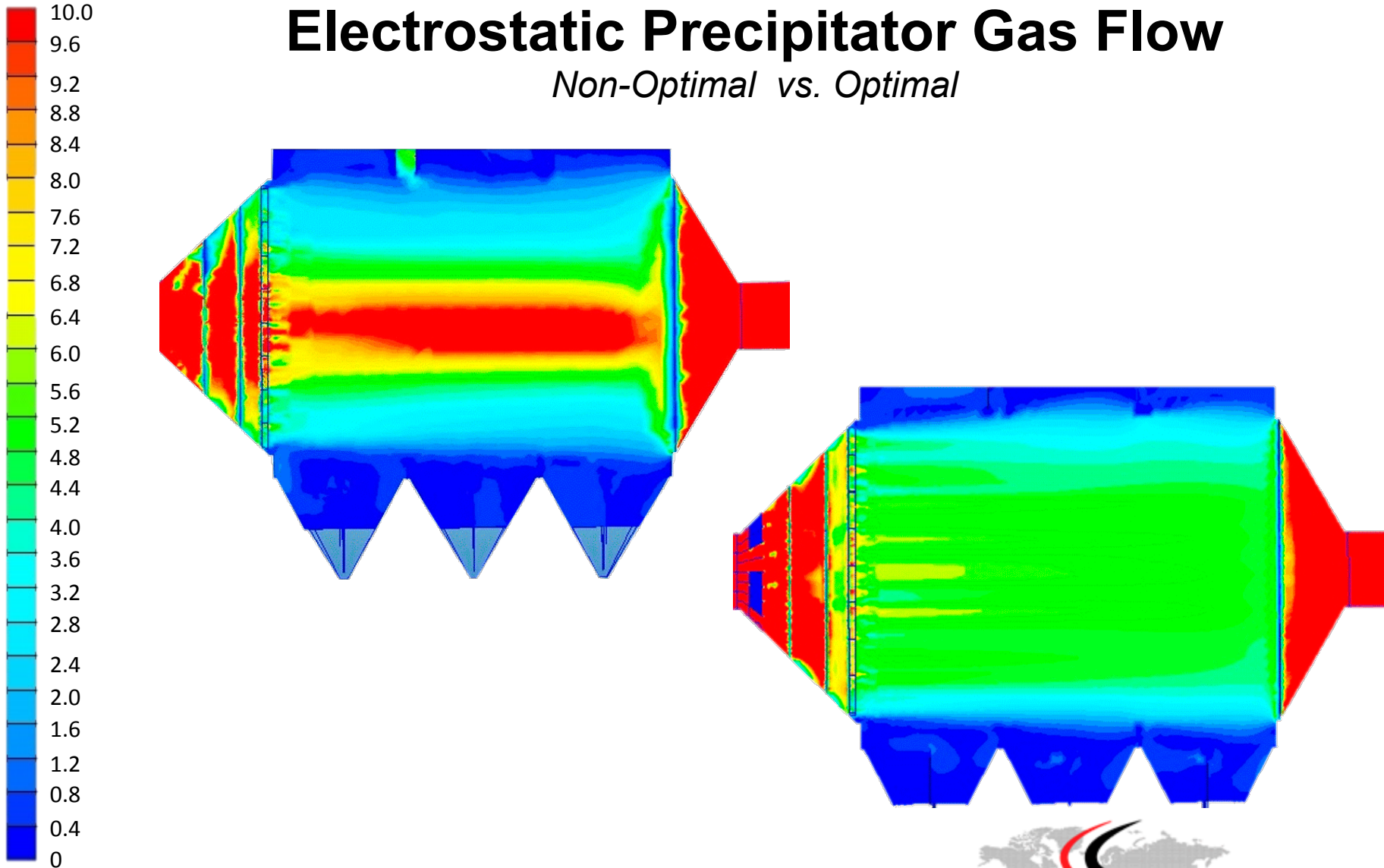
APH Considerations

- Air In-Leakage (total)
- Plant Efficiency
- Erosion / Abrasiveness
- Flue Gas Velocity
- APH Residence Time, Gas Temperatures and Turbulence
- Basket Element
- Type, Gauge, Weight(heating element)
- Fuel Analysis (S, N, H₂O)
- SNCR, SCR, NH₃ Slip, SO₃, ABS
- “Ideal vs. Actual”
- “Corrected vs. Uncorrected”
Gas Inlet & Outlet Temperatures
- Flue Gas Volume
- APC Equipment Performance
- ESP / Bag house
- Ash Resistivity
- Corrosion Control

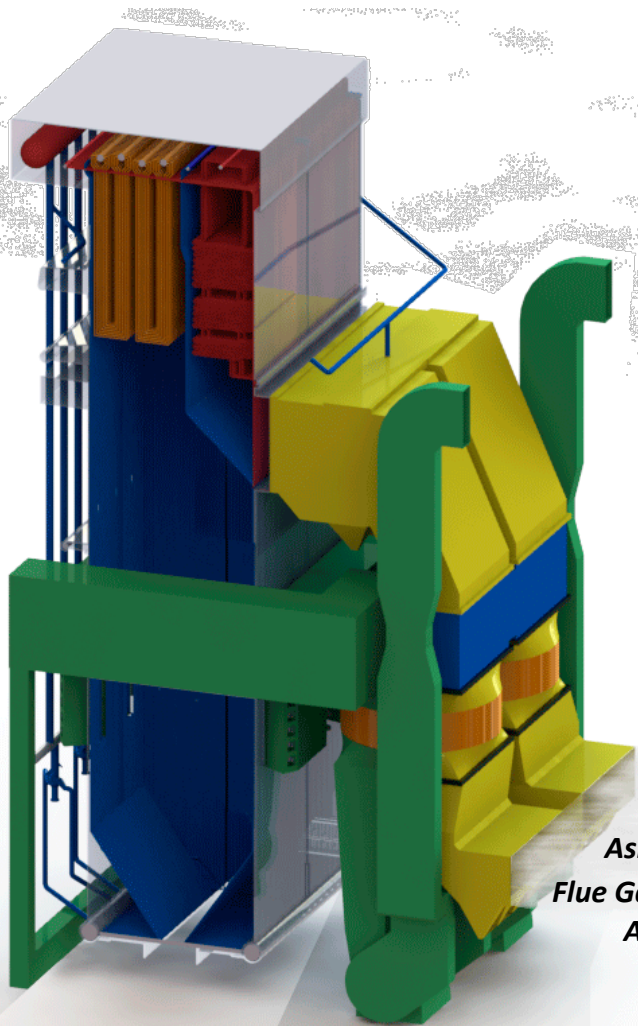


Electrostatic Precipitator Gas Flow

Non-Optimal vs. Optimal



Interrelationships with APC



Corrosiveness
Particle Resistivity
Turbulence
FGD Performance
LOI Velocity Stratifications
Temperature Gradients
Ash Particle Sizing & Density
Flue Gas Volume
Auxiliary Power
Fan Capacity

SCR plugging, “popcorn ash”

Ammonia Bisulfate (ABS) formation and air heater plugging

Oxidation of SO_2

Conversion of SO_3 to H_2SO_4

Catalyst poisoning

Ammonia slip / Poor mixing

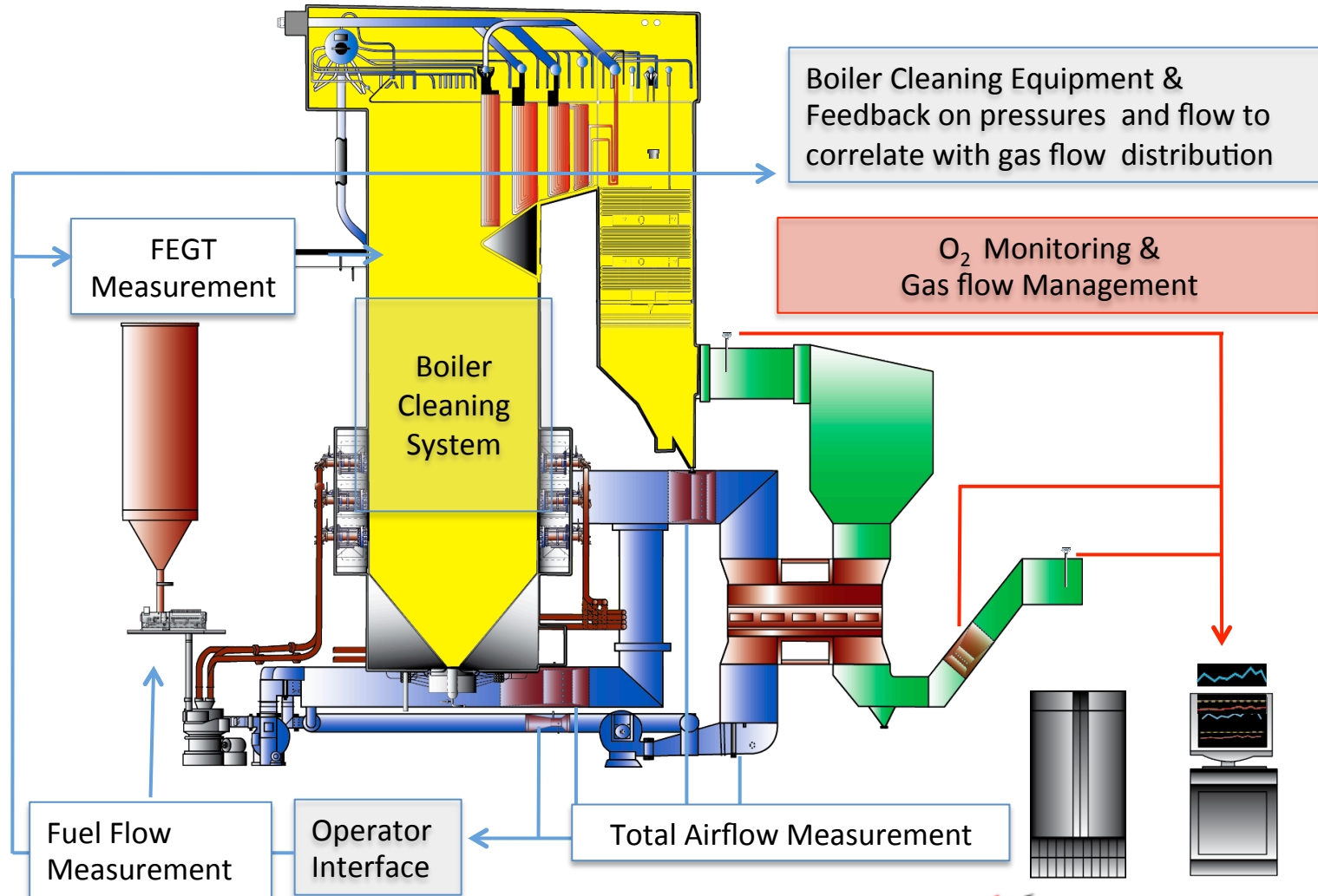
Excessive spray flows



Monitor, Control & Manage Boiler Performance !

Considerations:

- Fuels
- Fuel Line Performance
- Boiler Condition
- Ramp Rates & Responsiveness
- Total Air-Fuel Management
- Combustion Efficiency
- Performance Evaluation
 - Heat Rate
 - Efficiency
 - Emissions
 - Reliability
 - System Air In-Leakage



Closing Considerations:

- General Plant Performance Assessment
- Firing System Performance
- Total air flow measurement and control
- Boiler heat absorption assessments
(*cleanliness and heat distribution*)
- Ensuring an Oxidizing Furnace Exit w/
acceptable gas temperatures
- Management of Slagging and Erosion
- Boiler Reliability Assessment
- SNCR / SCR Performance & Reliability
- Air Heater Performance
- Large Particle Ash Management
- Acid-Gas Control
- Particulate and Emissions Control
- Auxiliary Power Consumption
- System Efficiency & Plant Heat Rate

Stephen K. Storm, C.E.M.

Stephen Storm, Inc. (SSI) | SX Powertech, LLC

P.O. Box 803

803 N. 2nd Street

Albemarle, NC 28002

Direct: (704) 796-2349

stephen@stephenstorm.com

Website: www.stephenstorm.com

www.sxpowertech.com

