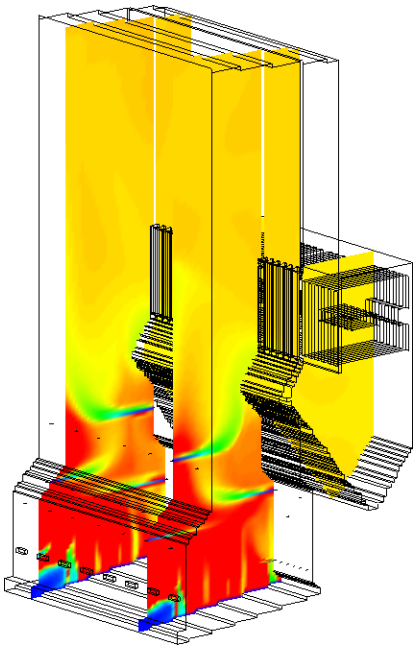
So… You're Going to Perform a Stack Test

WRBA Annual Meeting March 10-12, 2015

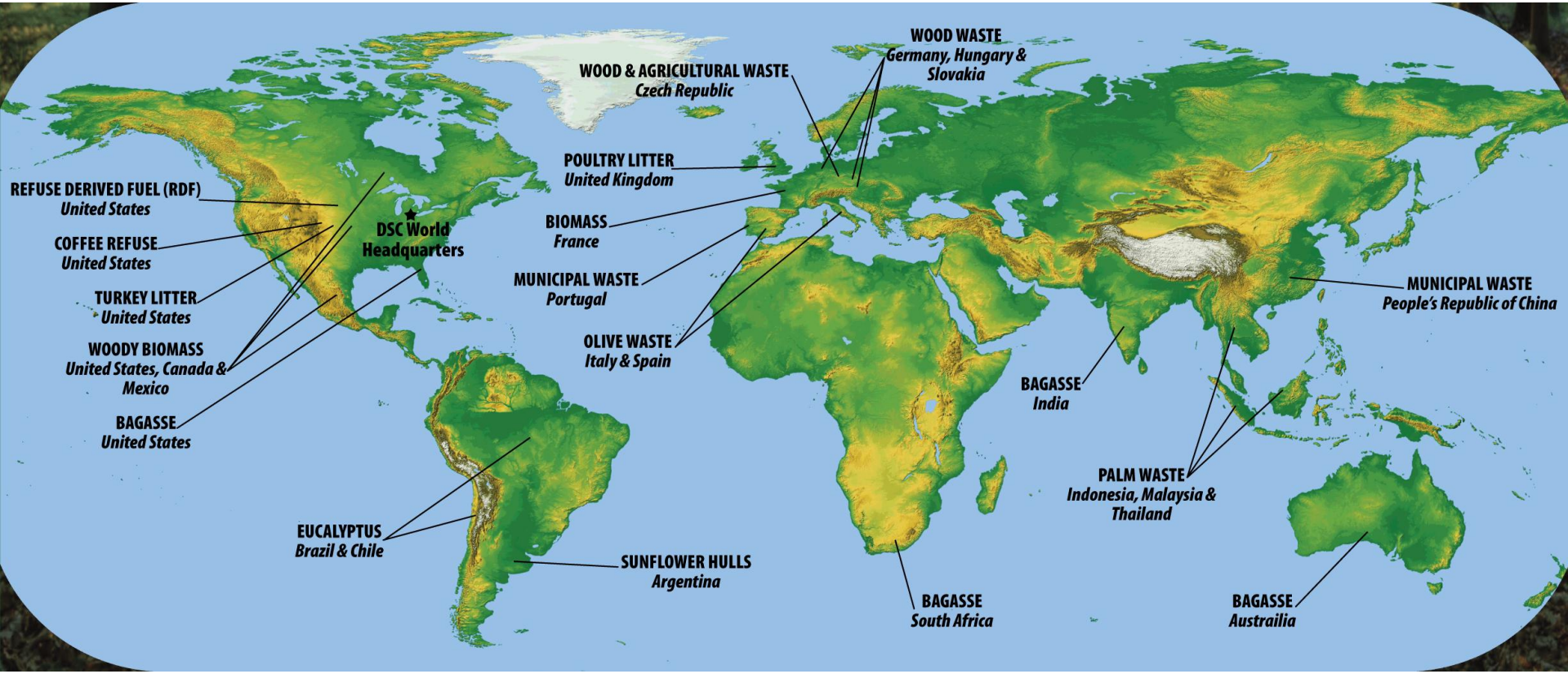
Bob Morrow – Detroit Stoker Co.

Detroit Stoker Company

- **Established 1898 – Monroe, Michigan USA**
  - **Solid Fuel Combustion Systems**
  - **Solid Fuel Feeding/Metering Systems**
  - **Rotary Seal Feeders/Double Flap Airlocks**
  - **Low NOx Gas/Oil Burners**
  - **Aftermarket Parts & Services**
  - **Engineering Studies**



Biomass/ Renewable Fuels



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Preparing For A Stack Test

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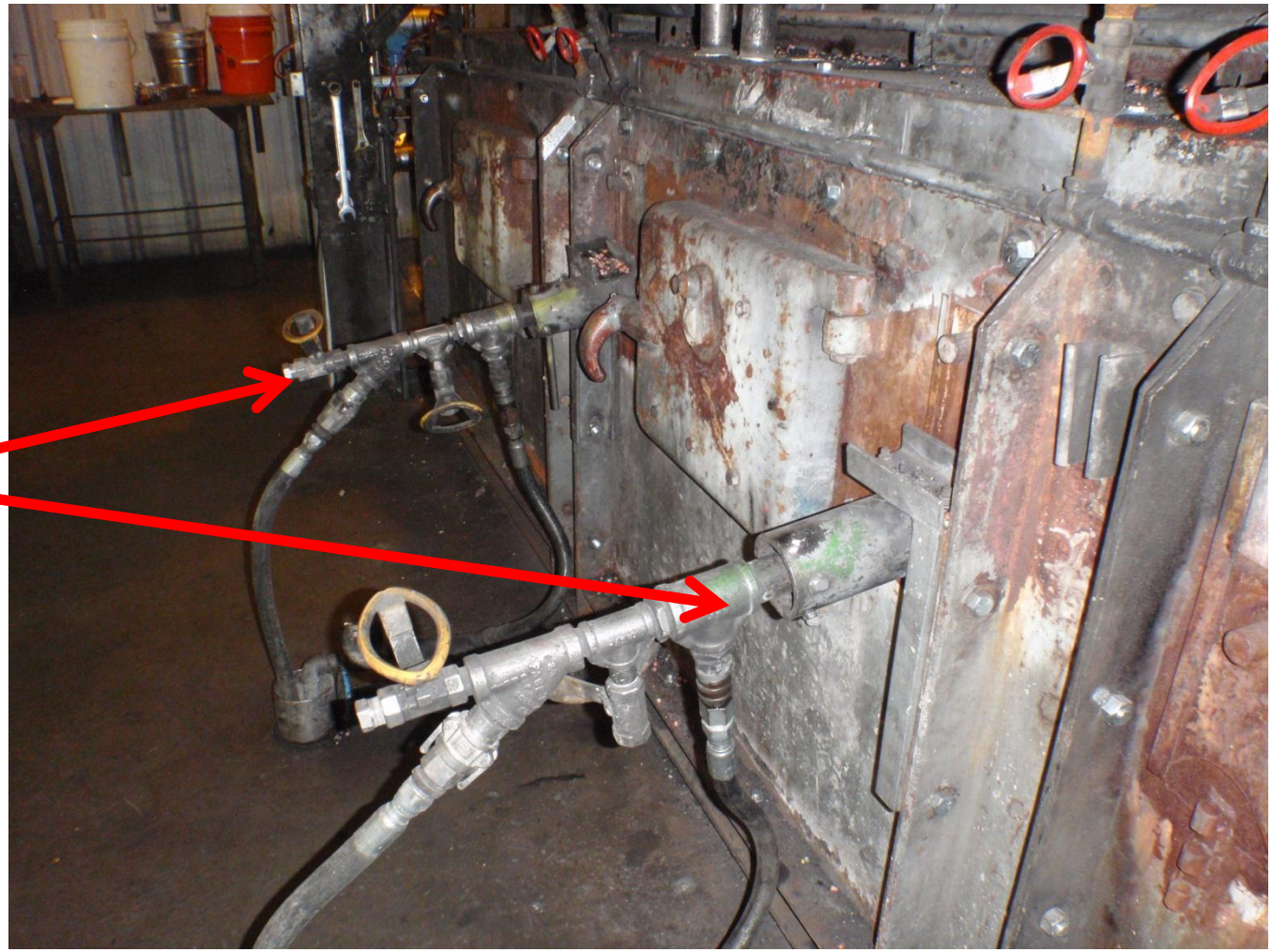
Preparation – Before Hand

- Boiler Drawings & Design Data Sheets
  - Equipment Conditions
- Reports (Inspection & Operational)
- Fuel Analysis
- Permit Requirements and Reports
- Controls & Data Acquisition

Avoiding Surprises

What's Are Those???



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Site Arrival

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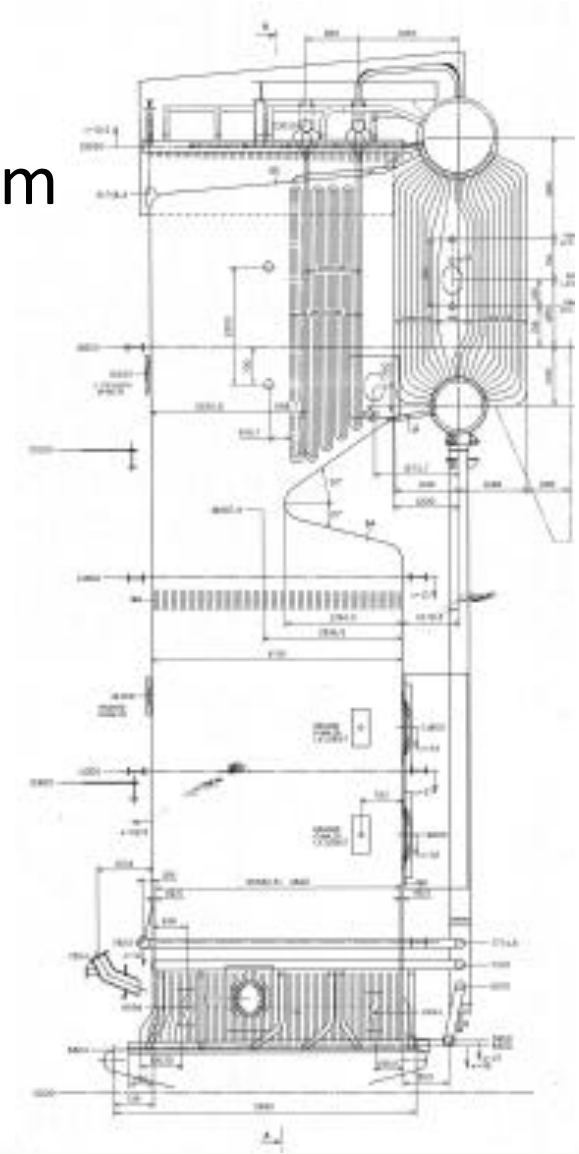
Getting Started

- Current Boiler Load and Steam Load Conditions
  - MCR or less?
  - Grate conditions & Fuel Distribution
  - Excess Oxygen
  - Secondary air conditions
  - Boiler design conditions
    - Temperatures, draft, pressure drops
- Auxiliaries
  - Post combustion SNCR, SCR, Bag Houses, ESP
- CEMS

January 2015 Example

- 1987 -174 KPPH Steam flow (MCR)
- Spreader Type Traveling Grate System
- Hogged wood and sludge
- ESP, Economizer
- Air heater – Steam Coil @ F.D. fan Discharge
- OFA, Primary air, Distribution air & Reinjection air are all preheated
- Two rear wall gas burners
- OFA modified in 2006



Goals

- Establish baseline data
- Determine capabilities of existing equipment
- Determine and prioritize steps to be taken both short term (2015) and long term (2016) and beyond

- Government requires equivalent of Boiler MACT tune up along with reduced Emissions

Emission	Current values	2016 Required Values
CO lbs/MMBtu	0.243	0.162 (200 ppm @3% O2)
NOx lbs/MMBtu	0.487	0.243

Viva La France

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Preliminary Evaluation/Considerations

- Items of Interest
  - Operational Investigation/Audit
  - Combustion Tuning
    - Fuel Handling, Metering, Distribution
    - Tramp Air Leakage
    - Combustion Air(s)

Fuel and Handling

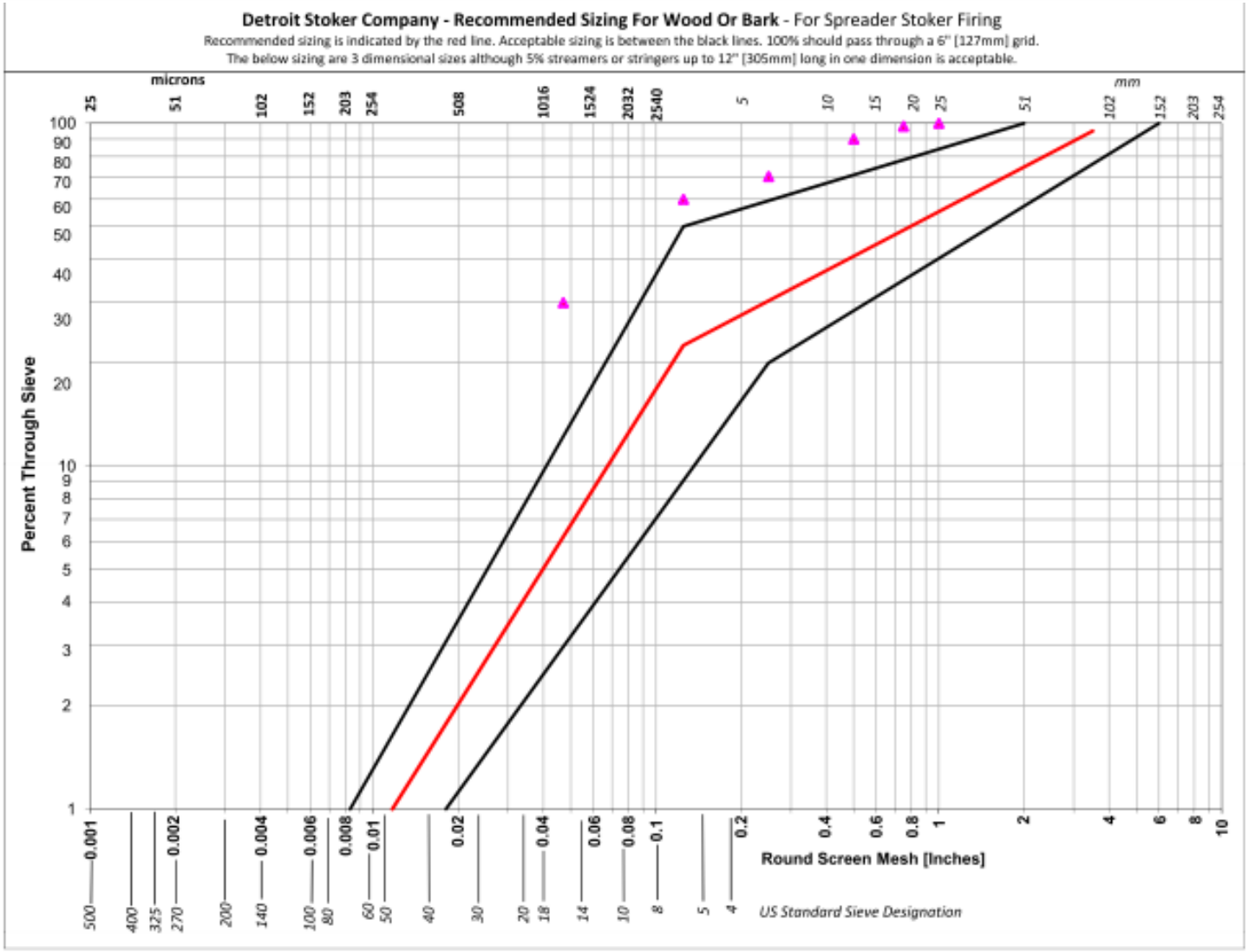
- Fuel type and mixture being fired
- Fuel preparation and sizing
  - Introduce sludge at metering bin
  - Shredder screens
- Fuel Quality
  - Ash and moisture
- Fuel Metering – Screw biases necessary?
- Fuel Mixing and Segregation

Fuel Type

Hogged/Chipped Wood Waste and Sludge

- 40 – 50% moisture Wood waste
- 2 TPH maximum input sludge
- >50% less than ¼” sizing
- 10% by heat input gas firing minimum at all times

Fuel Particle Size Distribution



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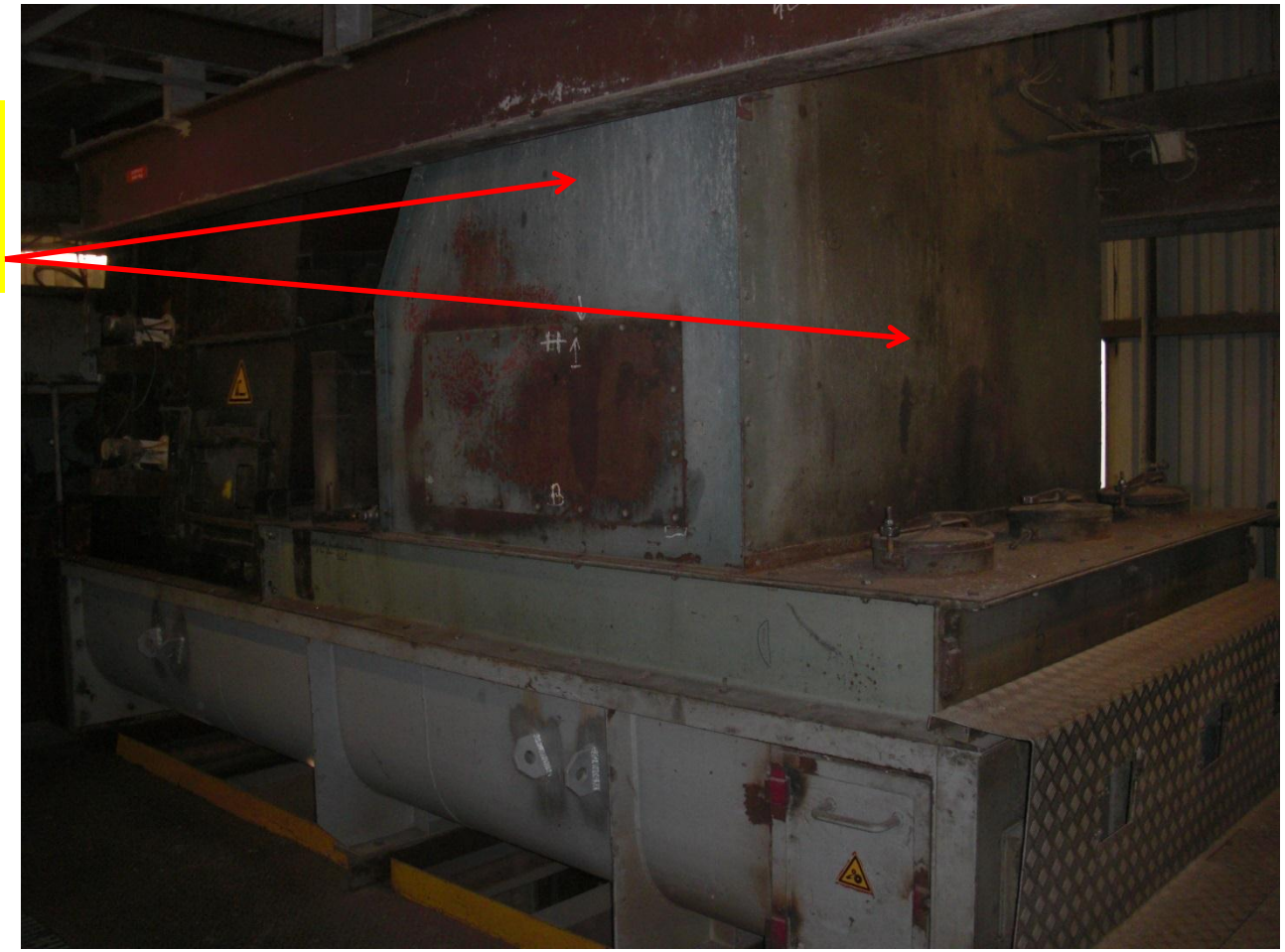
Metering Bin Arrangement

Straight side and rear walls



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Fuel Chute Arrangement

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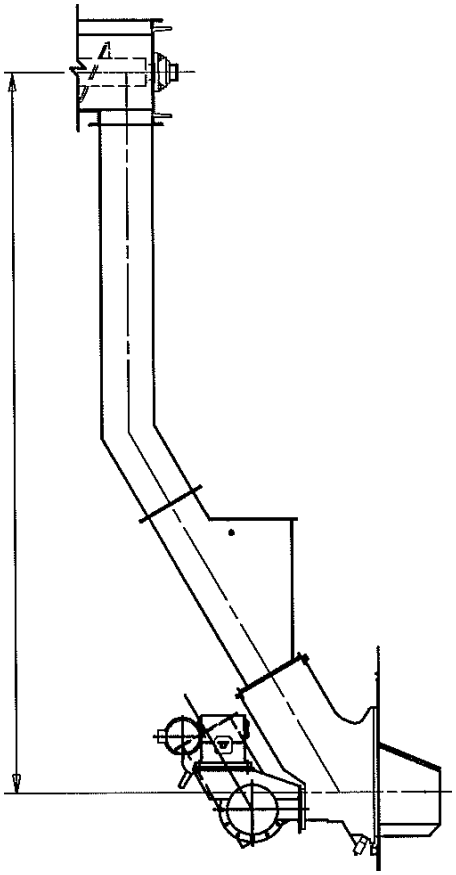
Recommendations for Fuel Chutes

12 -16 ft
recommended



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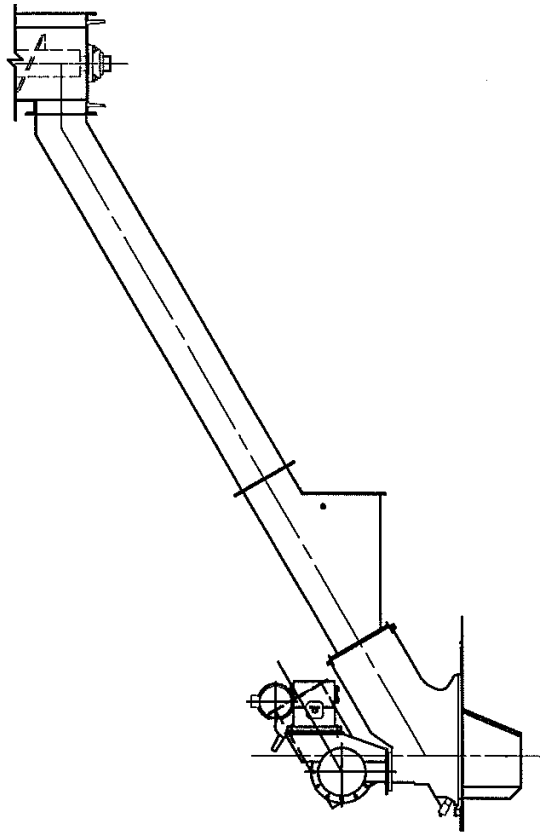

NOT ACCEPTABLE

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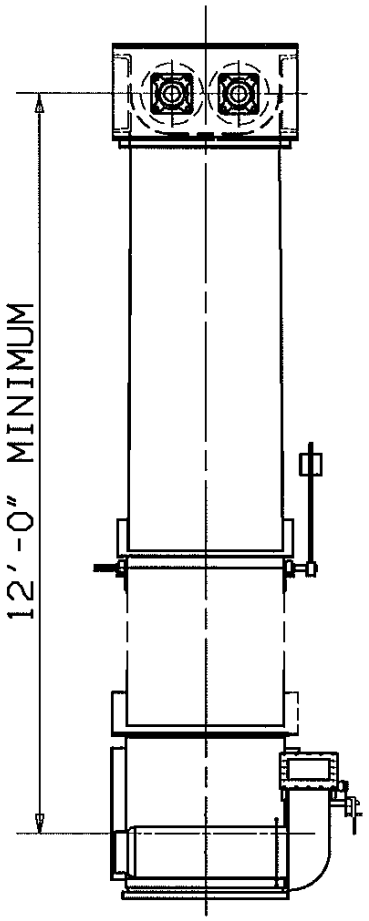
Recommendations for Fuel Chutes



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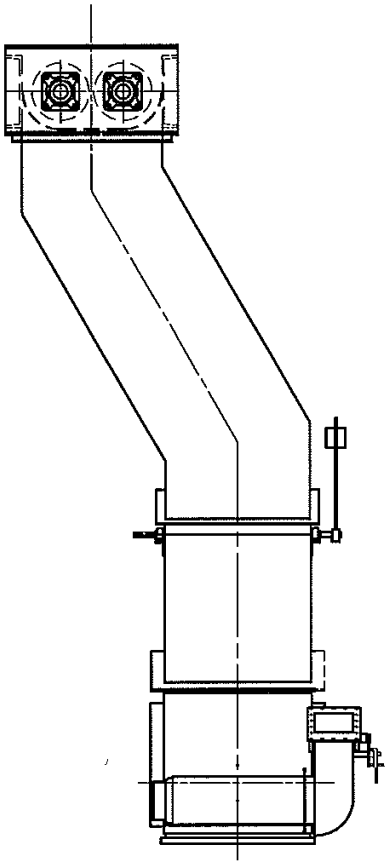

NOT ACCEPTABLE

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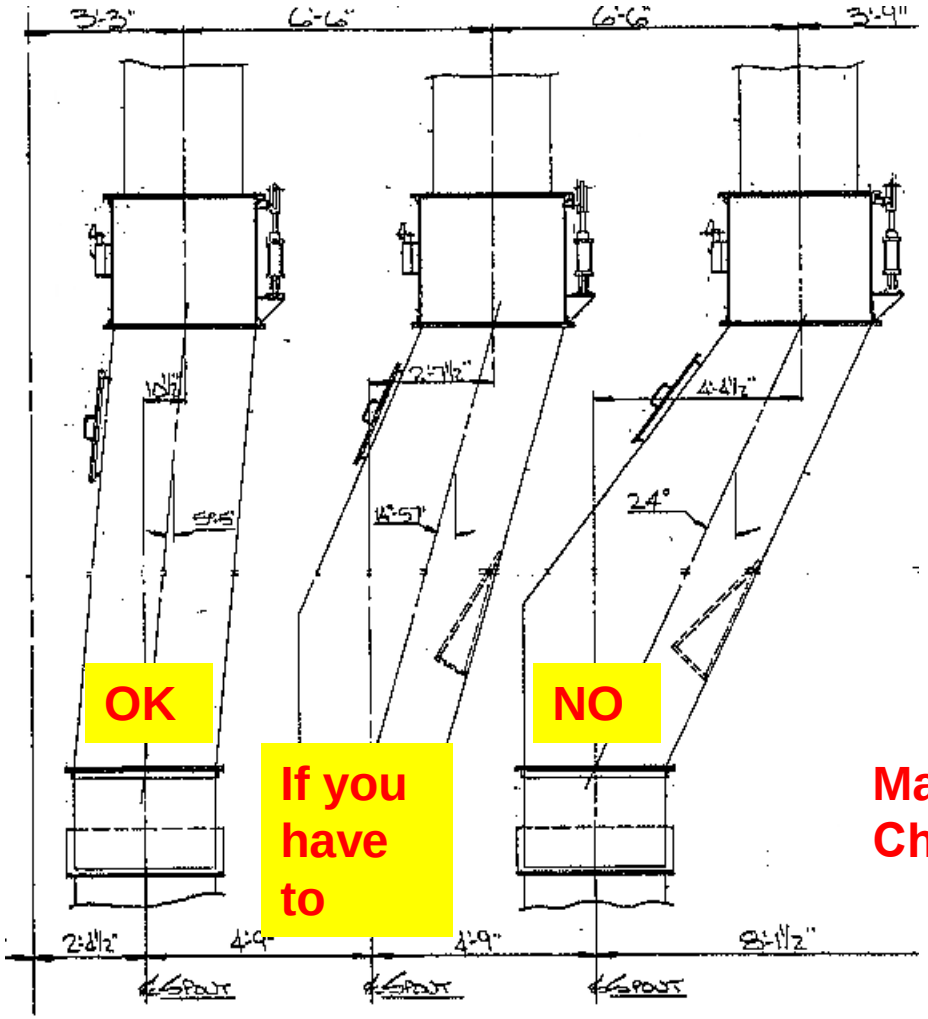
Fuel Chute Examples



Max. Recommended Chute Angle ≤15º

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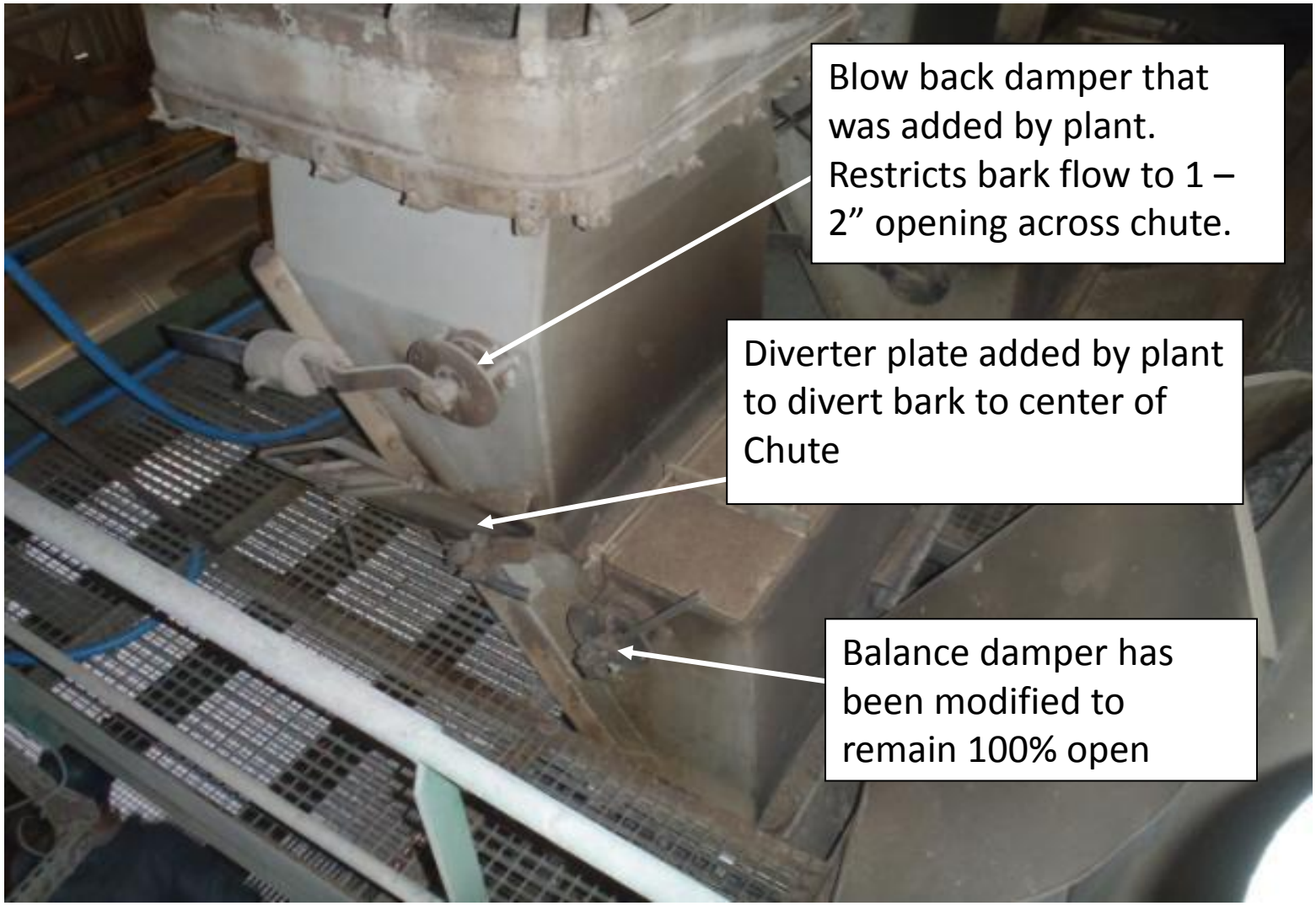
Metering Bin/Fuel Chute Design

- Large single bin design
- Single screw feeding three (3) air swept spouts
- Short vertical drop into distributor (<10’)
- Steep angles to outside distributors off of metering bin
  - Pushes fuel to side walls without necessary vertical drop to disperse across width at distribution plate

Balanced Damper Modifications



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Fuel Distribution

- Plant operating with distribution pressures from 8” w.c. – 25” w.c. as found
  - Considered high given fuel and grate length
  - Operators fighting with piling and uneven distribution
  - Adjusted distribution to 5” w.c. to 12” w.c.
  - Continued fuel distribution to rear wall with substantial reduction in piling observed

Air Seals and Leaks

- Stoker to boiler air seals in disrepair
- Leakage around distributor openings and extension fronts
- Important to seal any sources of air in-leakage

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Wet Bottom Ash Drag - Now Dry

- Originally commissioned wet bottom drag
- Been running dry to minimize moisture in ash for agricultural use of ash
- Substantial tramp air induction with negative draft

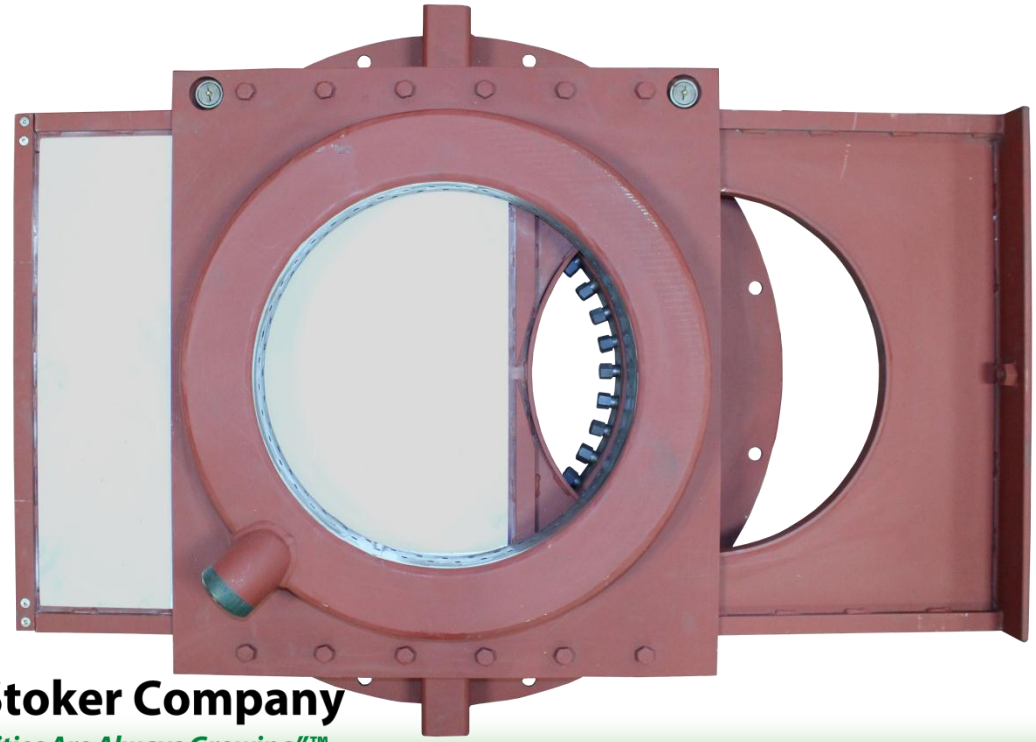
Burner Cooling Air Requirements

- Old vintage burner design
- Requires excessive cooling air
- No provision for throat gate

Burner Throat Gates

Burner Refractory Throat Shut-Off Gate Assembly:

- Minimizes Tramp/Excess Air in Furnace for Optimal Emissions when Auxiliary Burners Are Off



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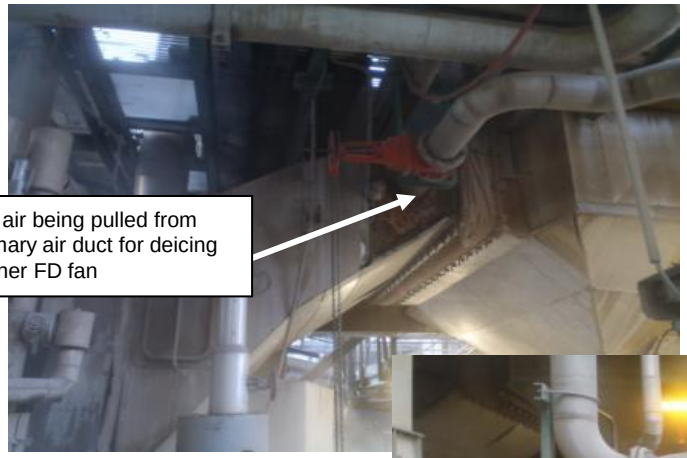
Gas Burner Fan Air Preheater?

- 10” line off of FD duct
- Blows air across open space into burner fan inlet
- Intention to keep fan from icing over



Starves left hand side of grate and creates imbalance in combustion air

Cinder Reinjection System

- Air leakage above and below lines
- Excessive air for conveying re-injected material

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Reinjection Air In-Leakage

- Slide gates in poor condition
- No rotary air locks on reinjection lines
- Tramp air leaks in reinjection box generate CO

Steam Coil Air Heater

- Typical fuel moisture of 45 – 50%
- Recommend 450 - 500°F preheated air
- Current SCAH limited to ≈400°F Max
- Steam leak detrimental to efficiency

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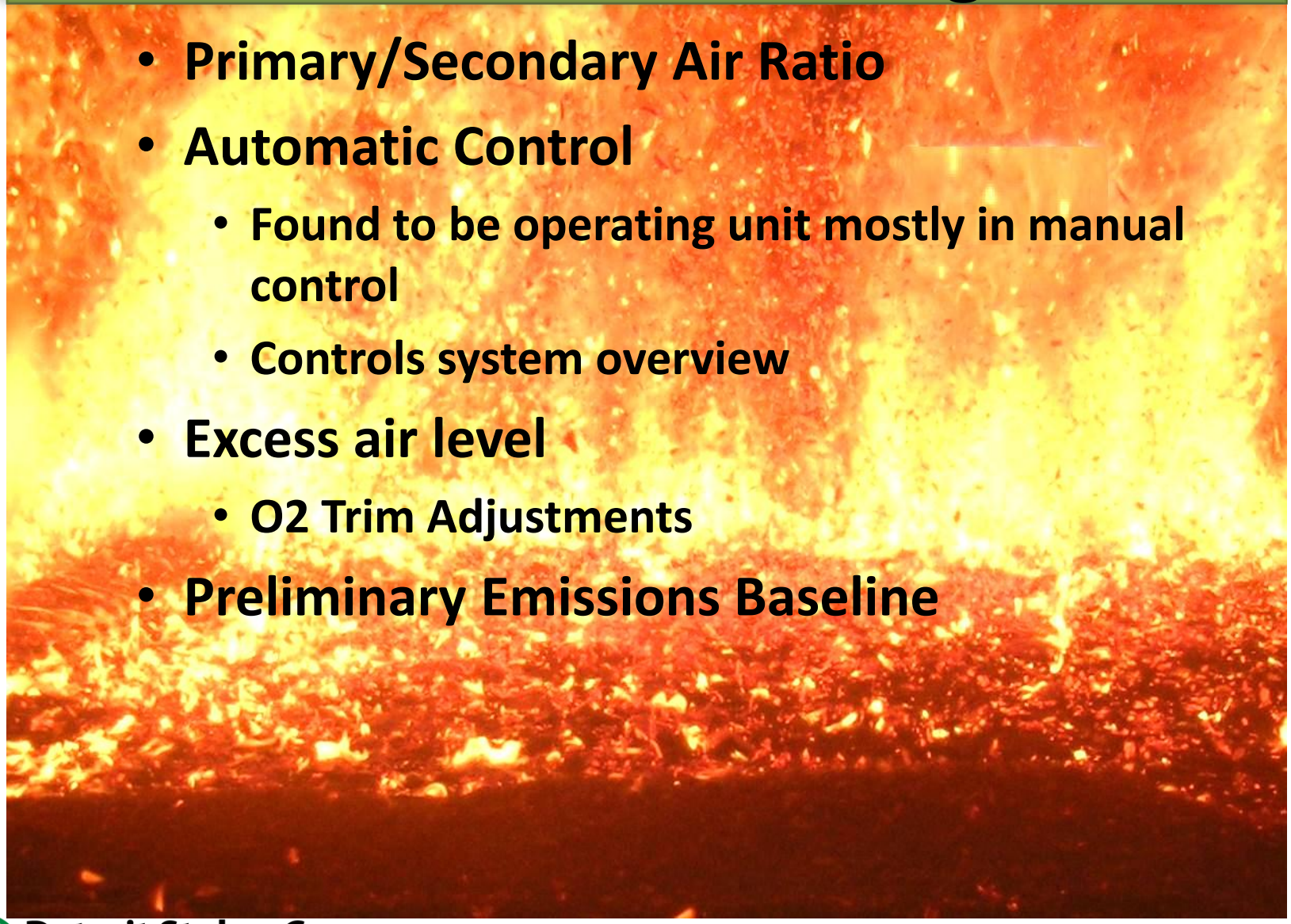
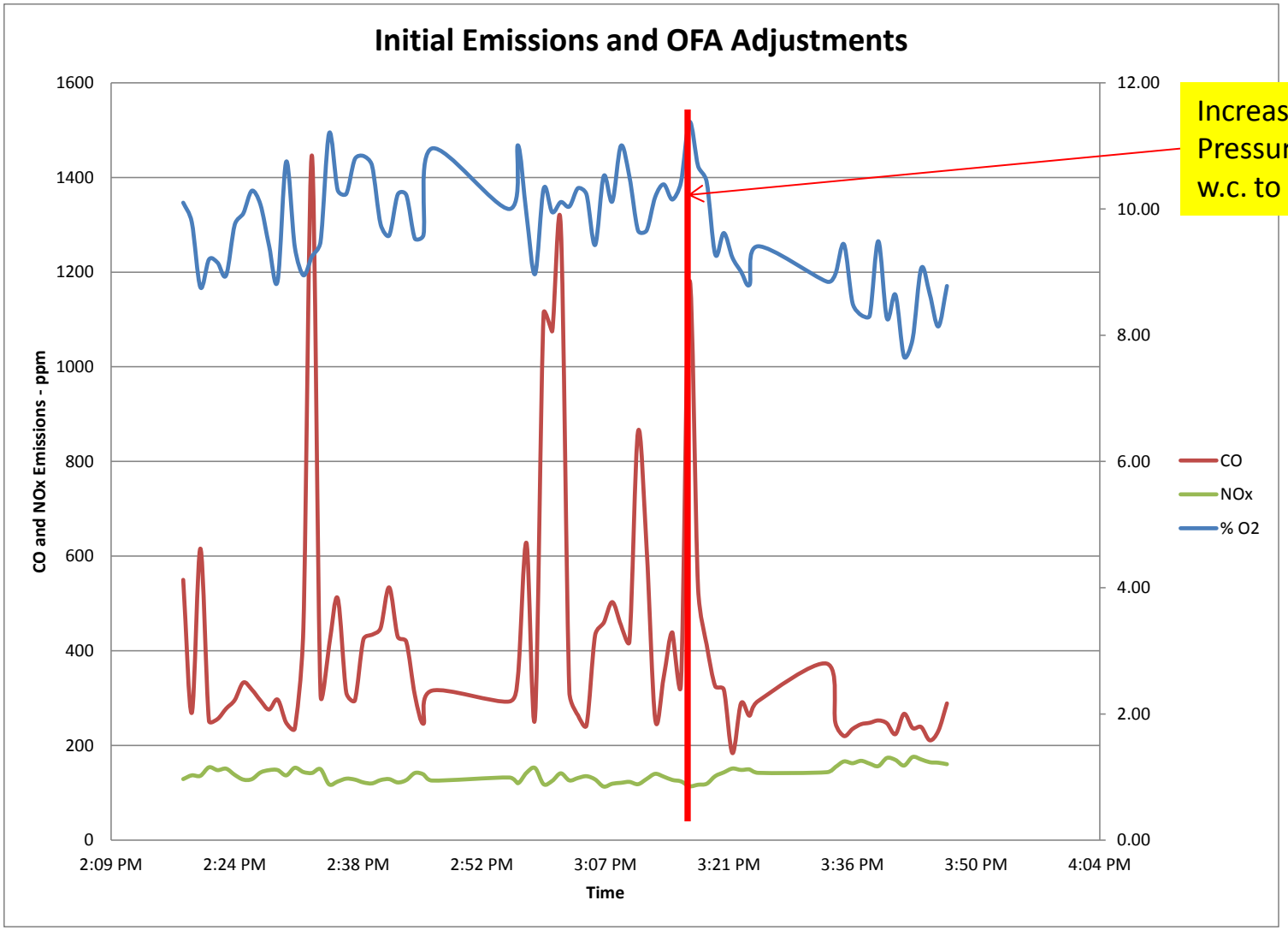
Combustion Tuning



- Primary/Secondary Air Ratio
- Automatic Control
  - Found to be operating unit mostly in manual control
  - Controls system overview
- Excess air level
  - O2 Trim Adjustments
- Preliminary Emissions Baseline

Useful OFA Pressures



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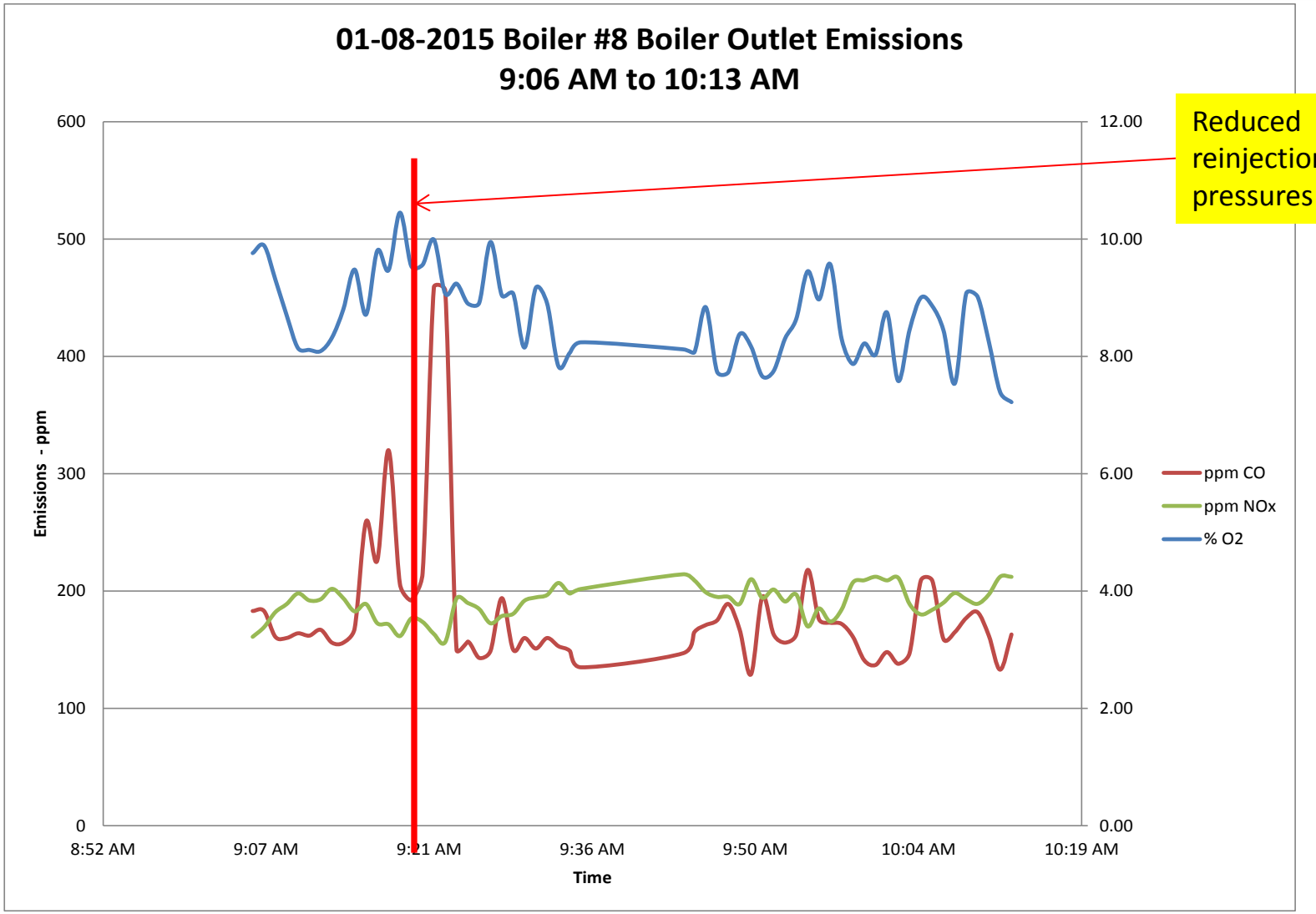
Impact of Reinjection on CO



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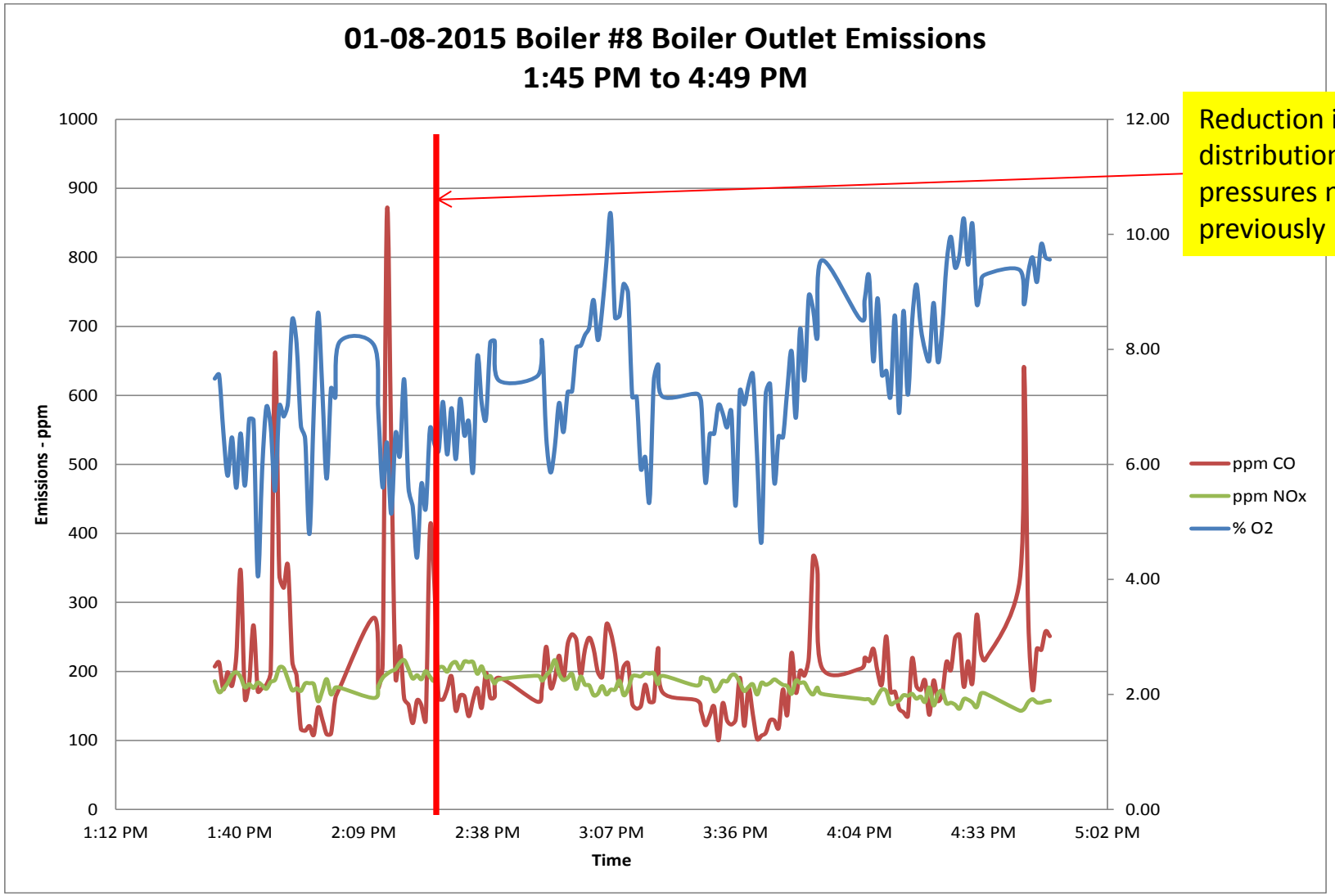
Distribution Air Adjustment



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Tuning Lessons Learned

- Increase in OFA pressure actually lowered O2
  - Primary air flow was maintained
- O2 levels unstable as O2 trim control is not tuned and operated in manual
- Reduction in distribution air and reinjection air helped stabilize firing conditions
- Observed high frequency of soot blowing
  - Operators reasoning was for controlling drum pressure

Soot Blowing and Draft

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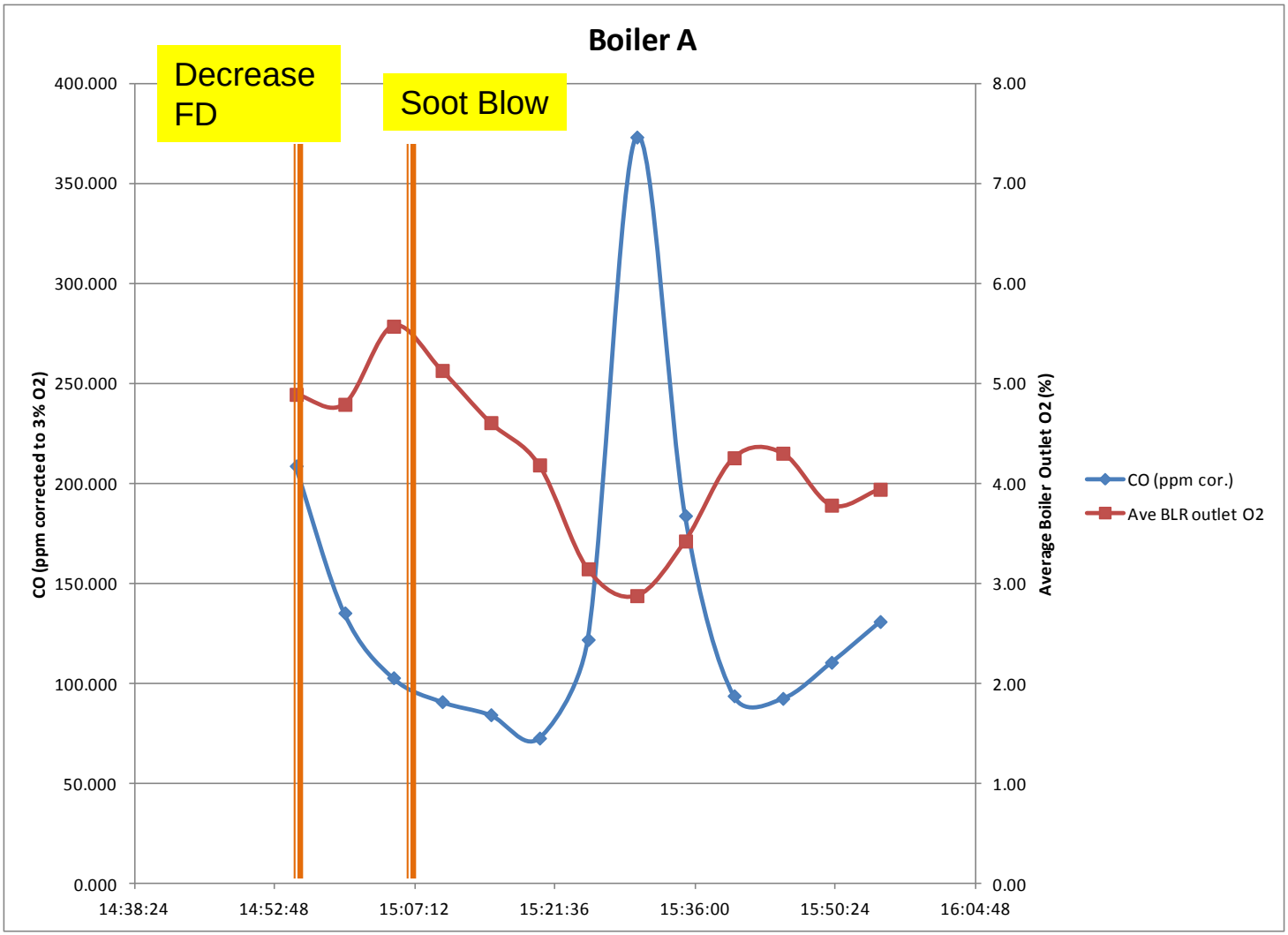
Once Upon a time Firing Coal…



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Importance of Primary Air

During Soot Blow Operators increase draft from $^{-}$0.05 “ w.c. to $^{-}$0.14 “ w.c

Ruh-Roh…

Sucked the Coal out of the Feeders !!!!!!!!!!

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Thank You

Live Long and Compliant

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