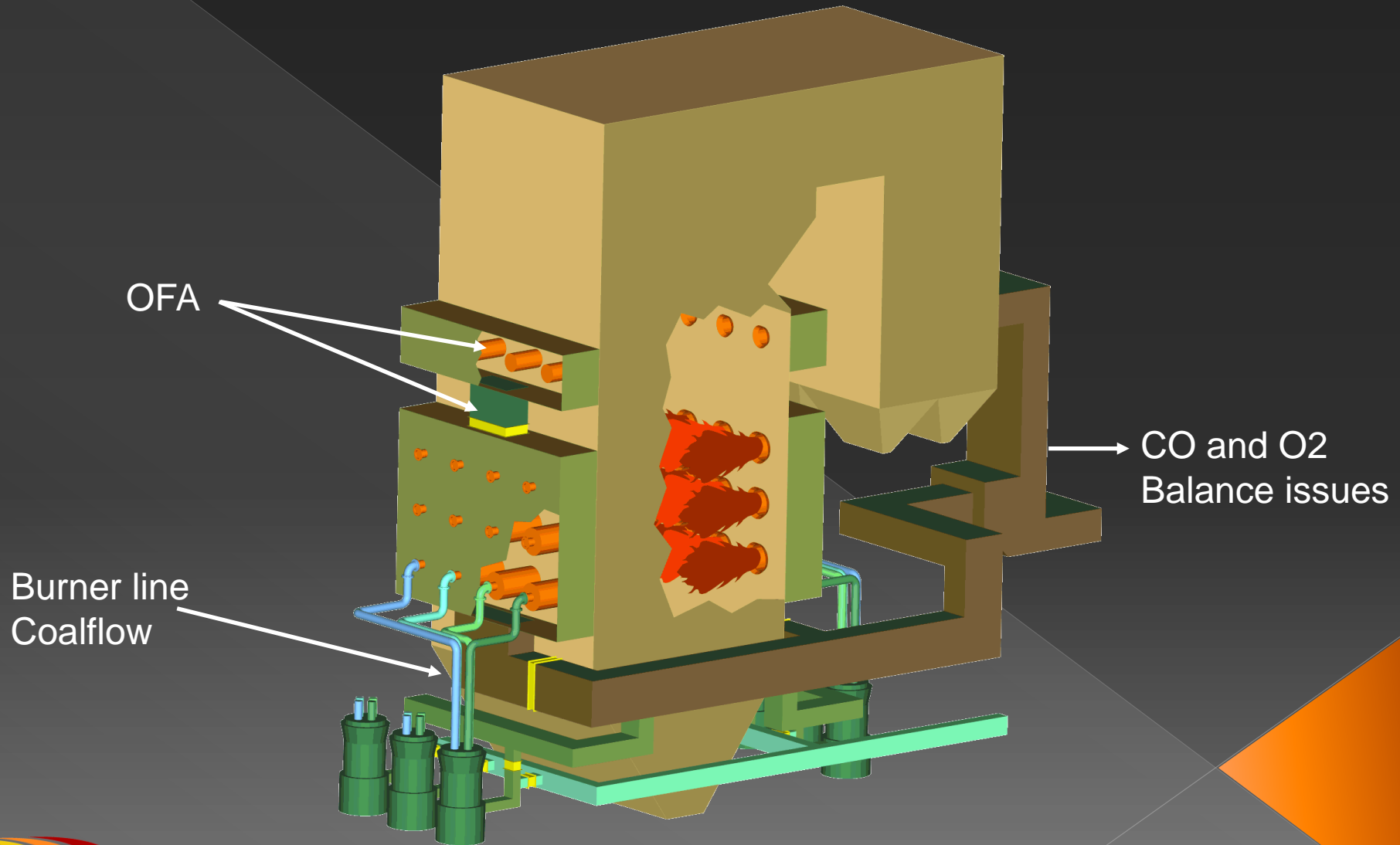




Monitoring and Optimizing Fuel Feed, Metering and Combustion in Boilers

June 13, 2013

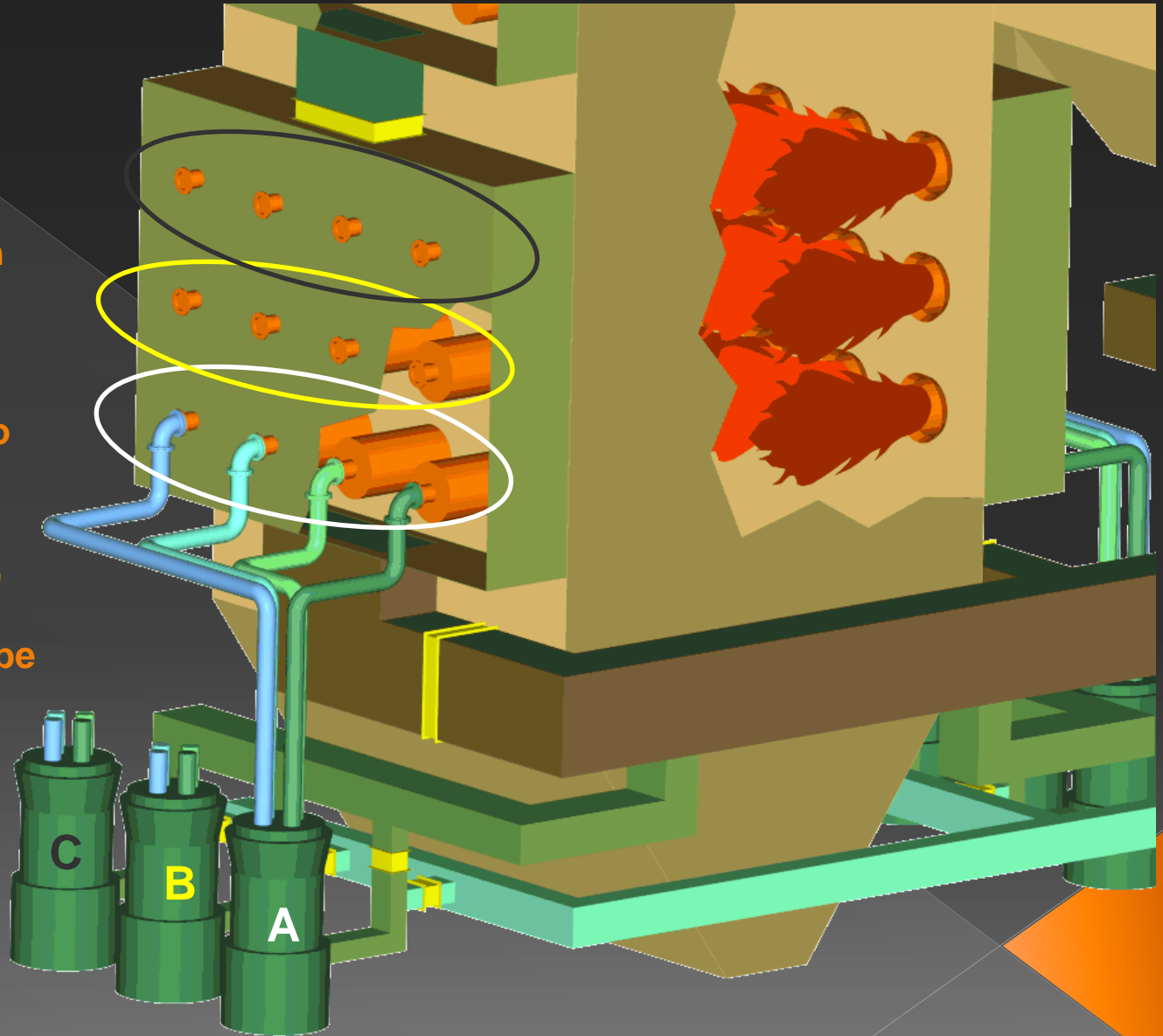
Coal Feed to the Unit is Critical to... Efficiency, LOI, Emissions, Reliability



Coal Mill Feeder Control

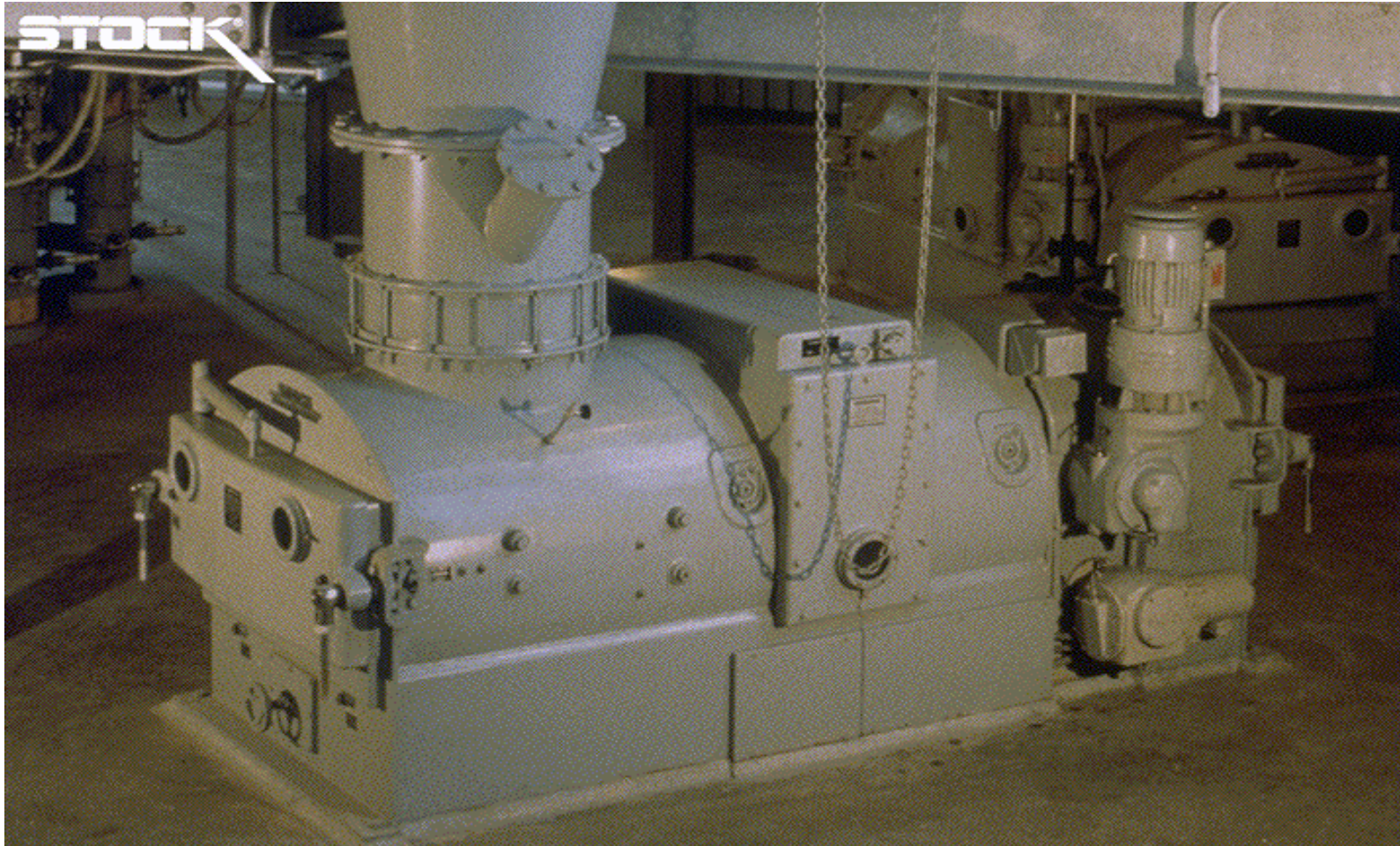
Example where each mill feeds a burner row.

Poor control leads to (undesired) heavy and light burner rows – creating Nox, high LOI, CO, slagging, fouling, tube leaks...



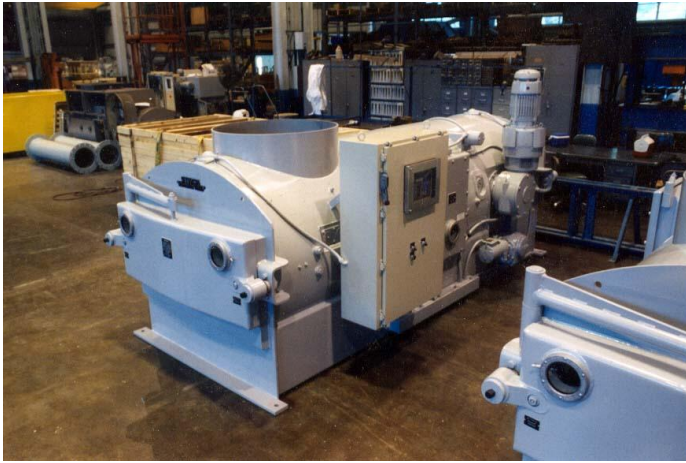
Proven solutions for a tough industry

LOAD CELL WEIGHING WITH MICROPROCESSOR CONTROL

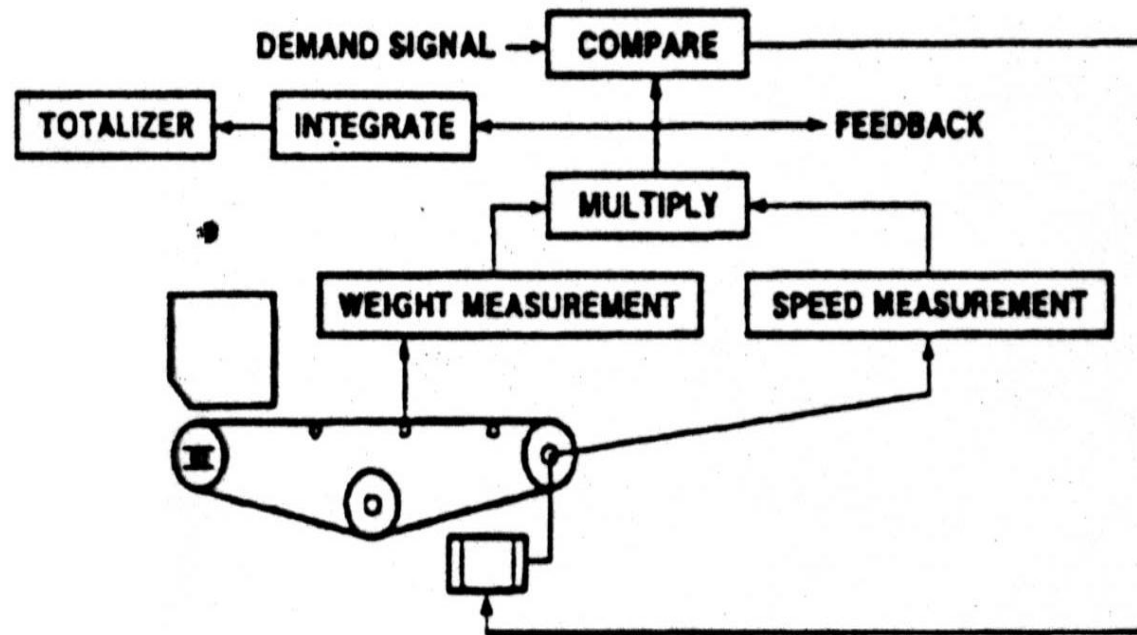


Gravimetric Feeder Functions

- Load Cell feeders
 - Fixed height leveling bar - usually high center
 - Weight on weigh span varies with material density
 - Calibration of load tare, load span and belt speed using optical probes
 - Calculation of feed rate (lbs/sec) by multiplication of belt speed (in/sec) by weight (lbs/in)
 - DCS demand signal adjusts material feed rate
 - Microprocessor controls



Stock Gravimetric feeders provide coal delivery on a weighted basis in order to more closely match the combustion control requirements for heat input into the boiler. The Gravimetric Feeder automatically compensates for density variations and feeds coal to within 1/2% of the true weight.



Benefits of Coal Pipe Metering

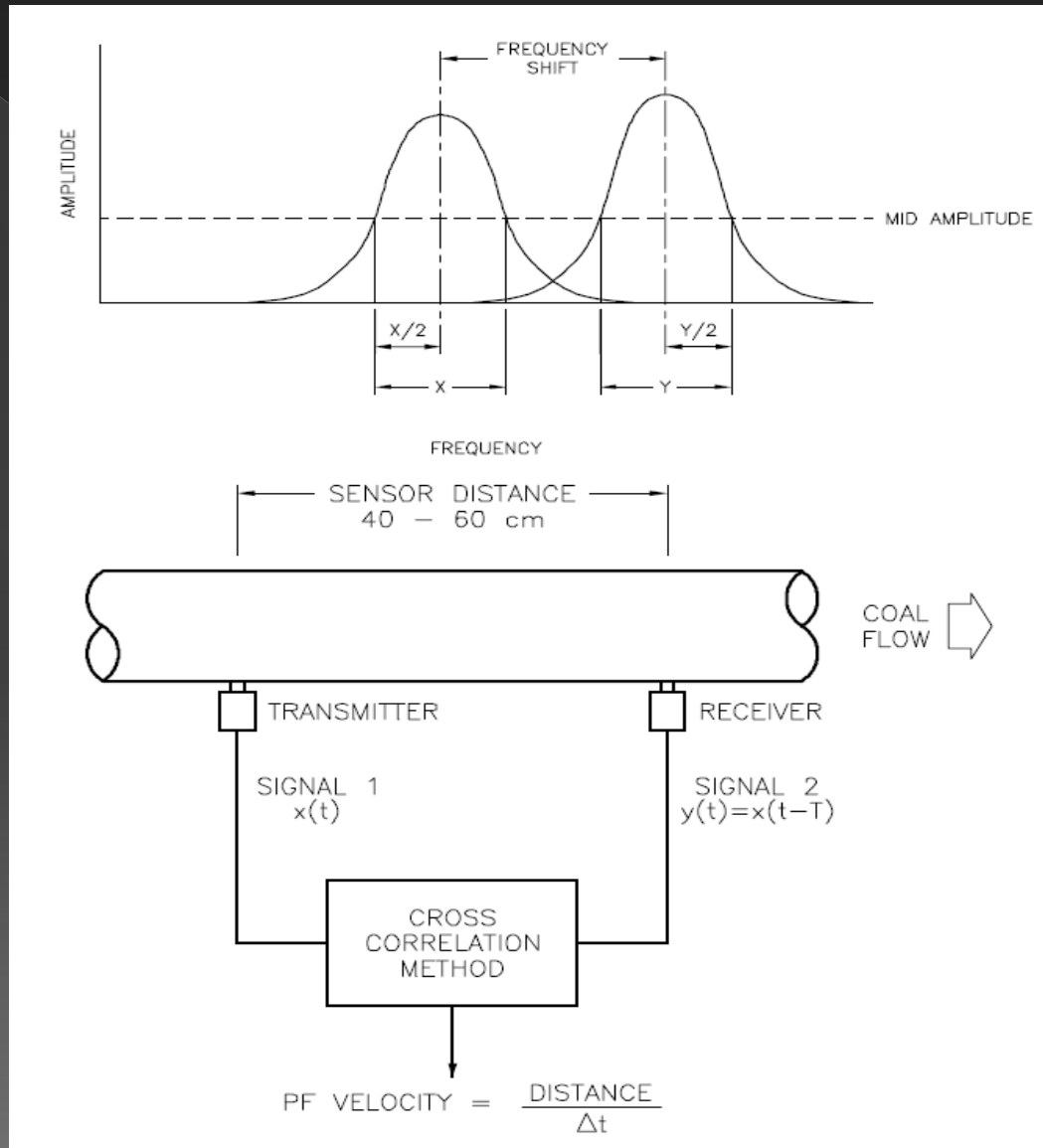
Further Improve:

- NO_x reduction
- Improve boiler efficiency
- Reduce CO and LOI
- Reduce waterwall corrosion and thus downtime (forced outages)

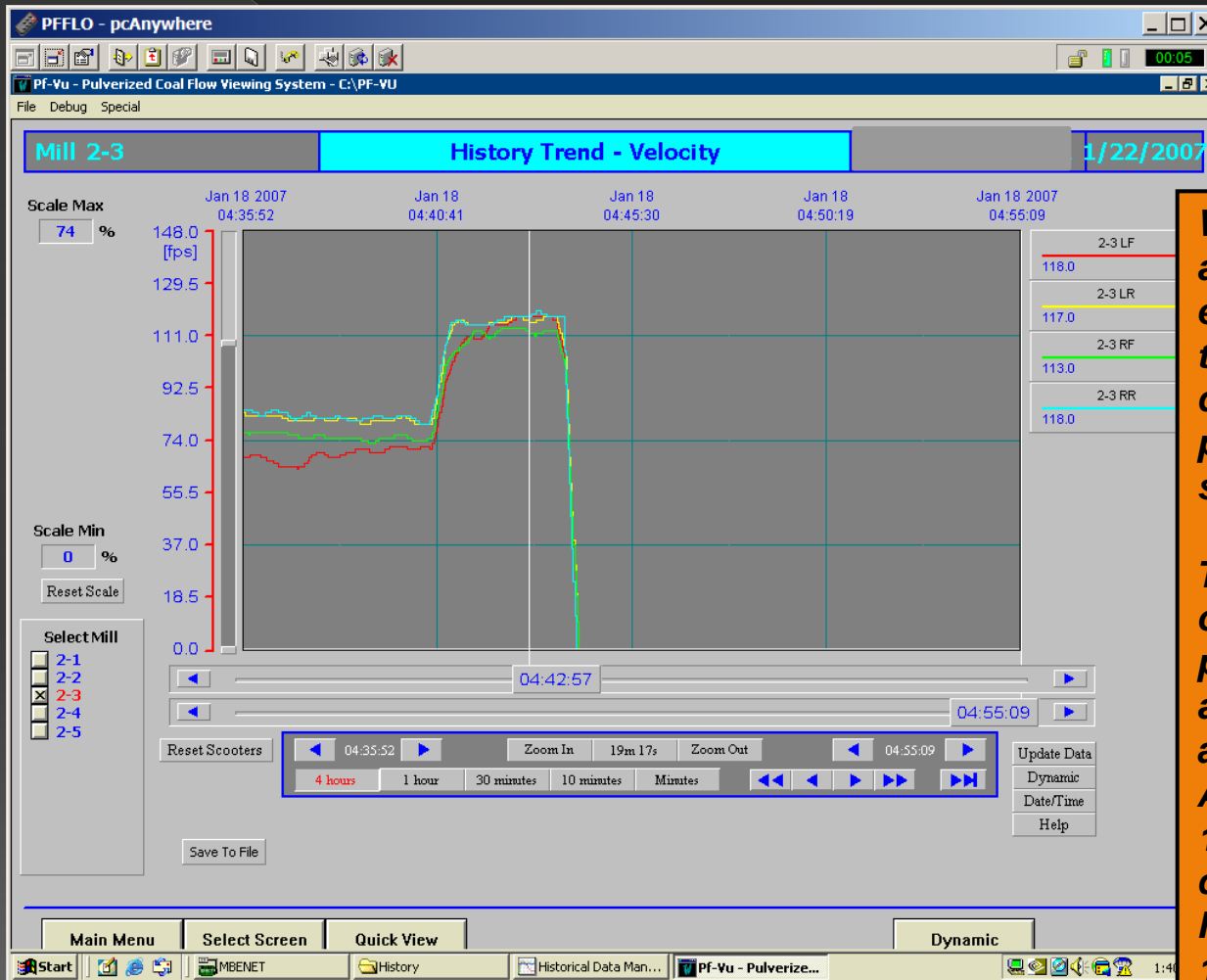
PLUS:

- ❖ Improve mill and burner performance
- ❖ Improve Primary Air Control
- ❖ Eliminate coal layout, mill pluggage, fires
- ❖ Allow operators to have more information
- ❖ Existing air and fuel (manual sampling) measurements are inaccurate

Coal Flow Measurement



Accurate Velocity Measurement

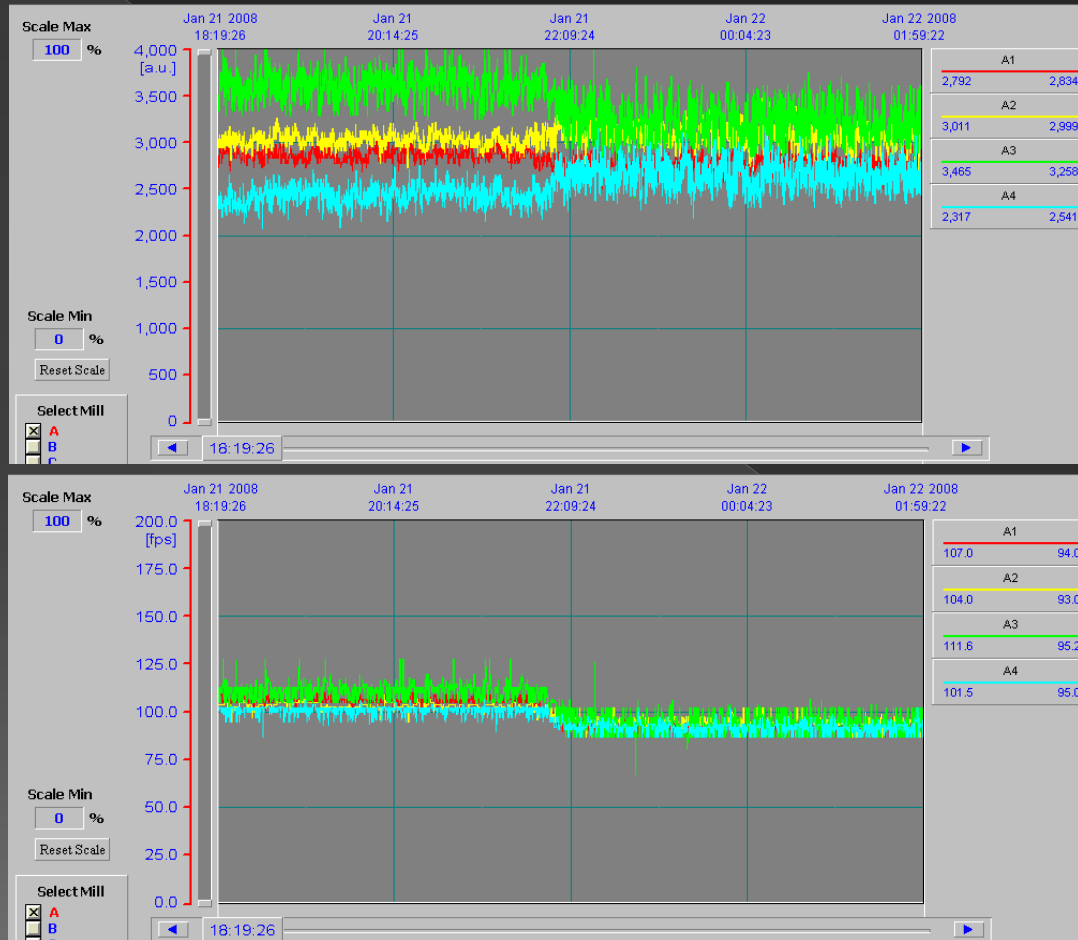


When a mill is brought down and swept with air, the mill eventually is free of coal but there is still some residual dust/ash blowing through the pipes. There is no coal density so the $MF=0$ (Density x Vel = 0).

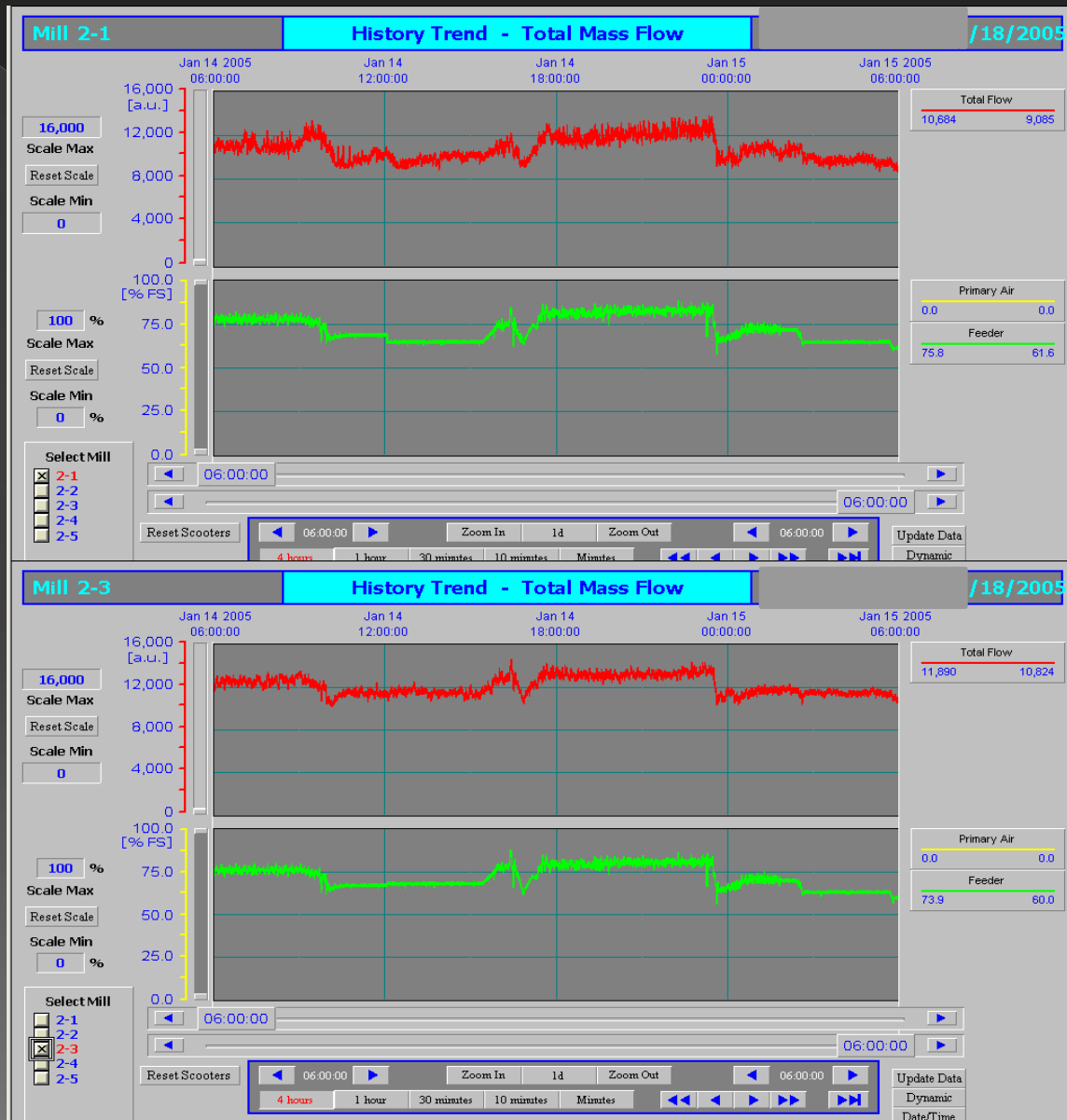
This “clean air” velocity was compared to clean air tests performed by Alstom. The accuracy of the Pf-FLO “clean air test” compared with the Alstom pitot traverse was within 1 to 4 fps. Shown is the SCADA data of the clean air test on Pf-FLO (see values on right from 113 to 118 fps). These are the values at 4:42 am on Jan. 18 after the mill was swept clean.

Primary Air and Mill Improvement

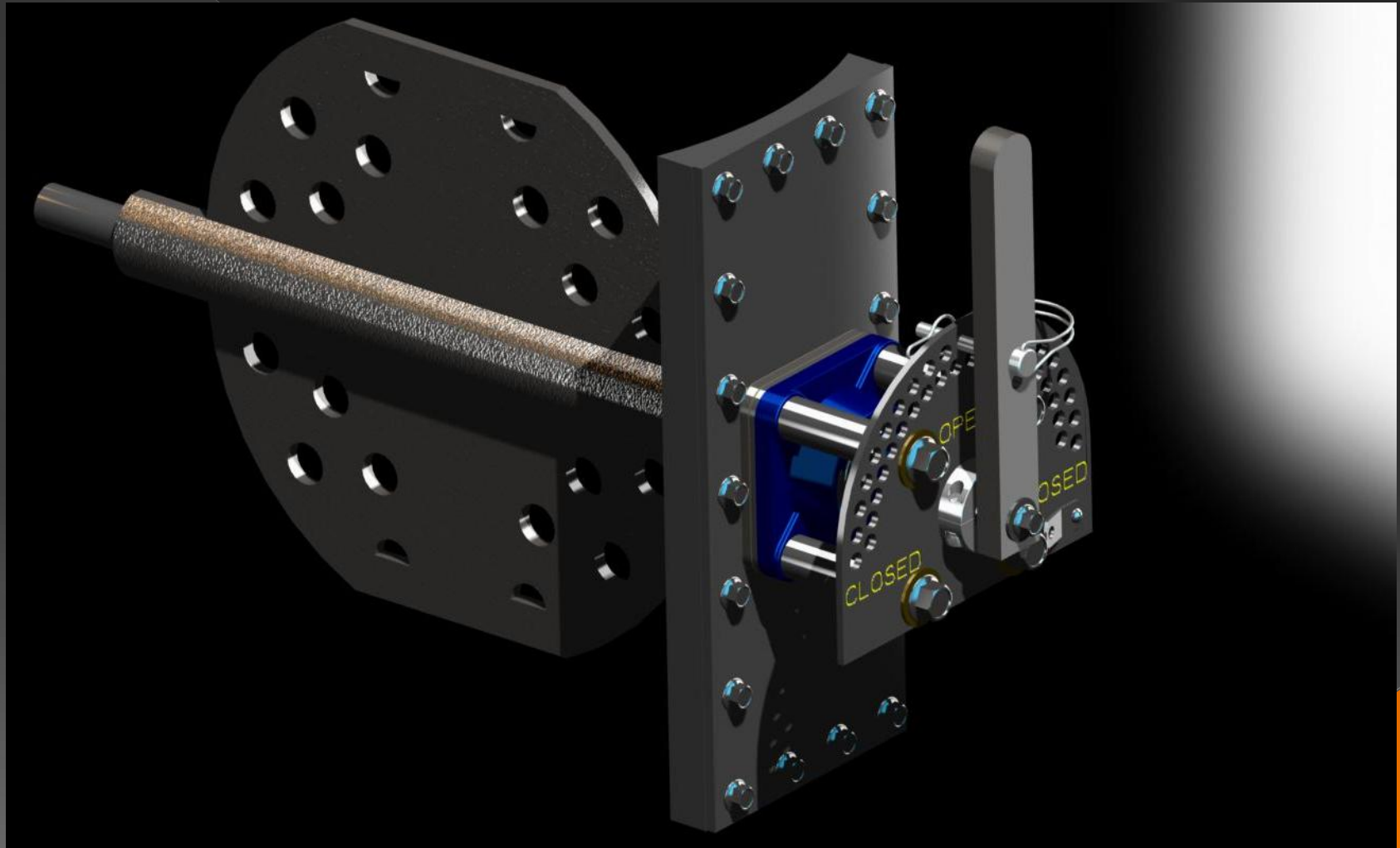
- ✘ Decreasing PA improves coal balance
- ✘ Optimum coal velocity for better combustion



Absolute Coal Flow



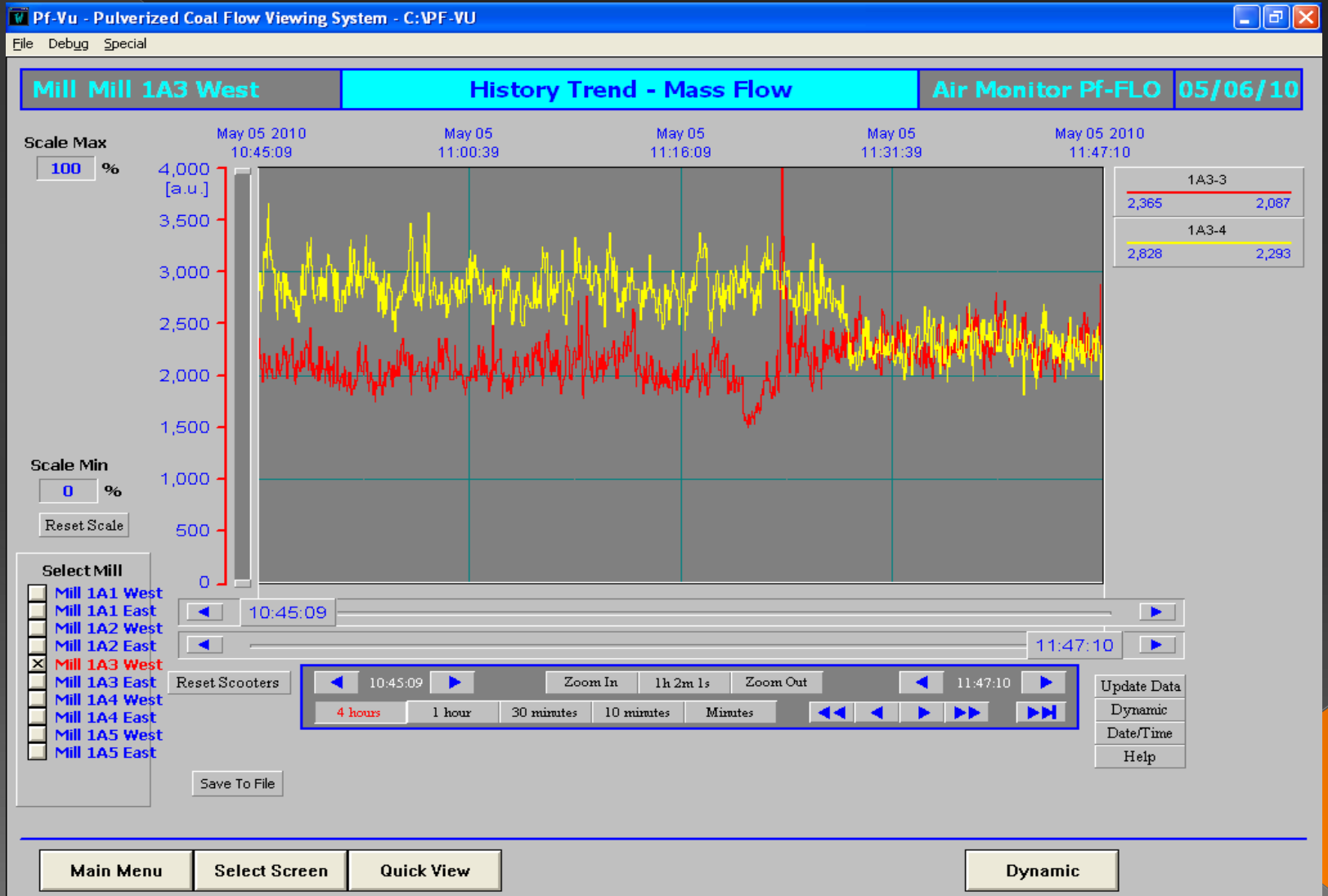
Adjustable Diffusing Coal Valves – Meter the Coal



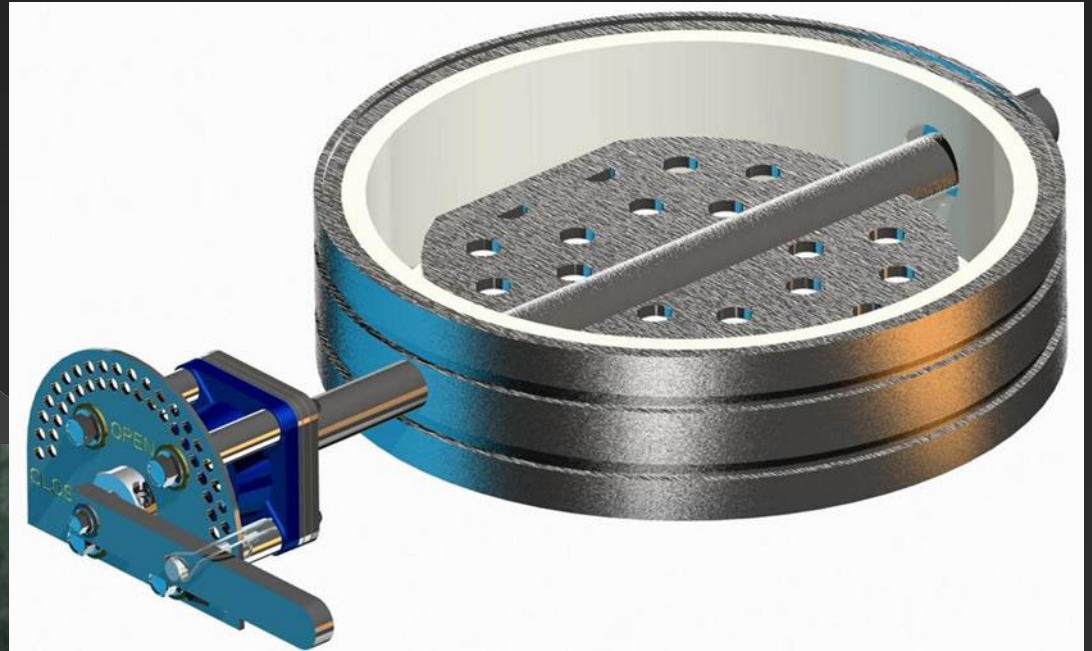
Coal Pipe Balancing



Coal Pipe Balancing

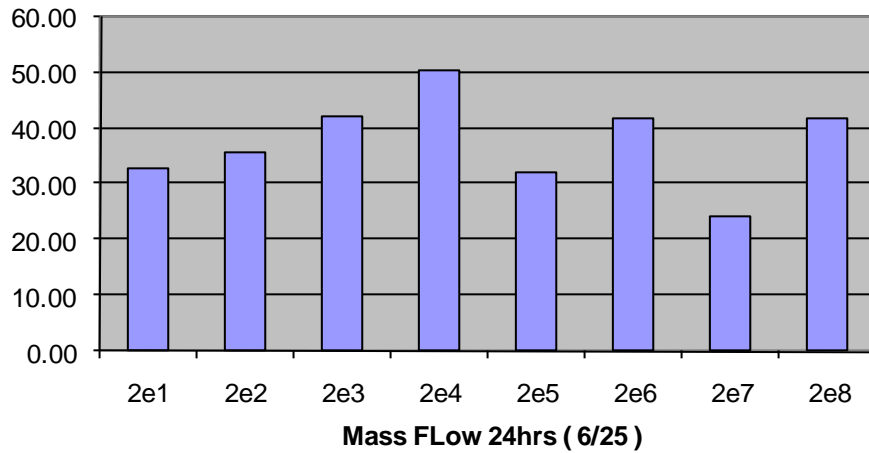


Adjustable Valves for Riffles

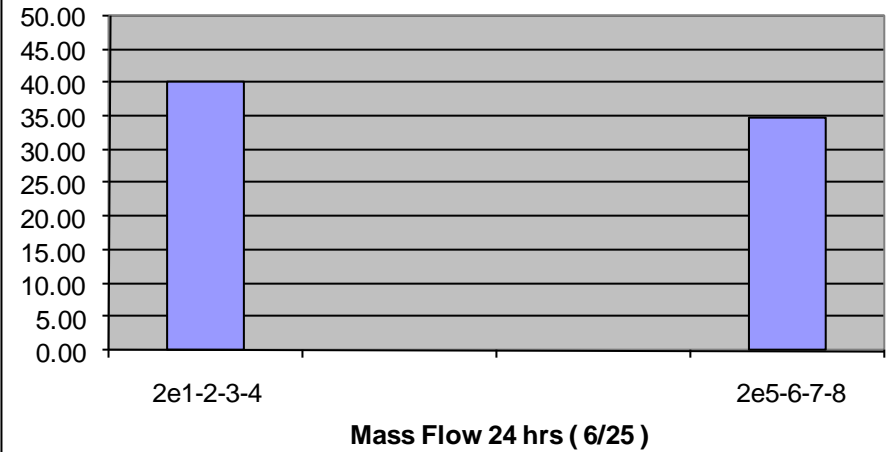


Improving Coal Distribution Improves Temperature Dist.

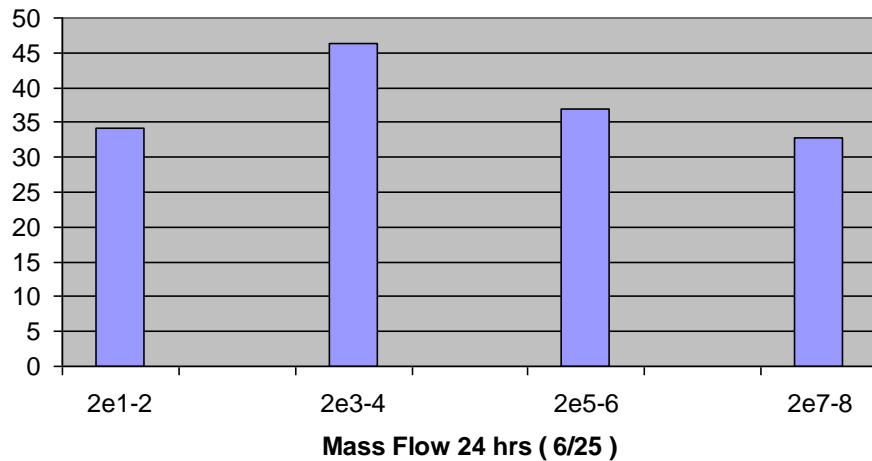
Tertiary Splits



Primary Splits

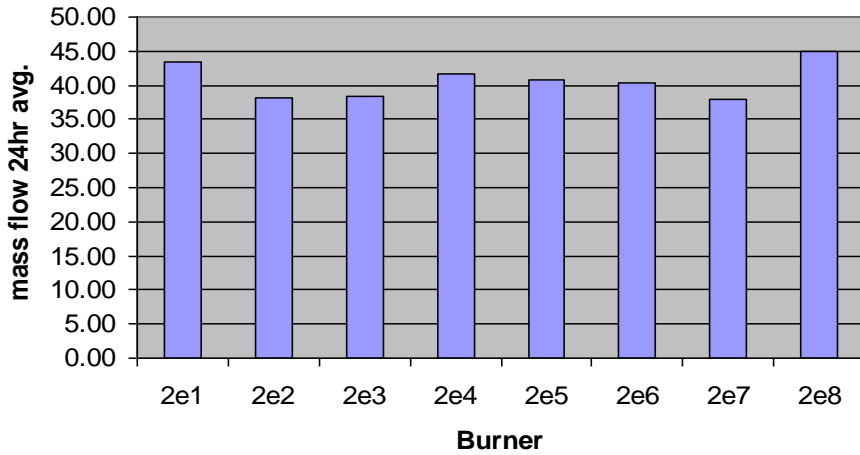


Secondary split

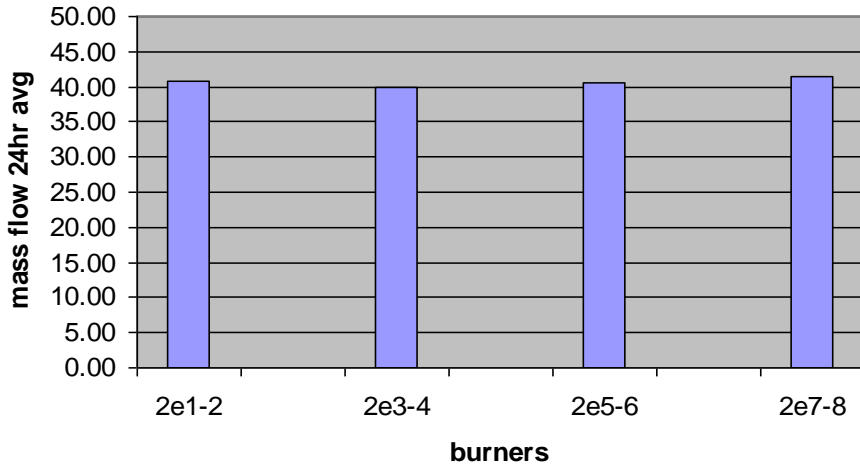


....After Balancing Pipes

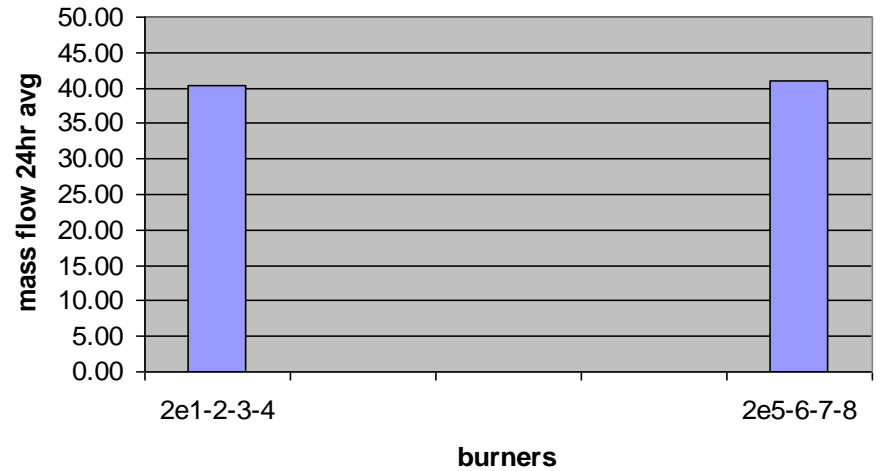
Tertiary mass flows



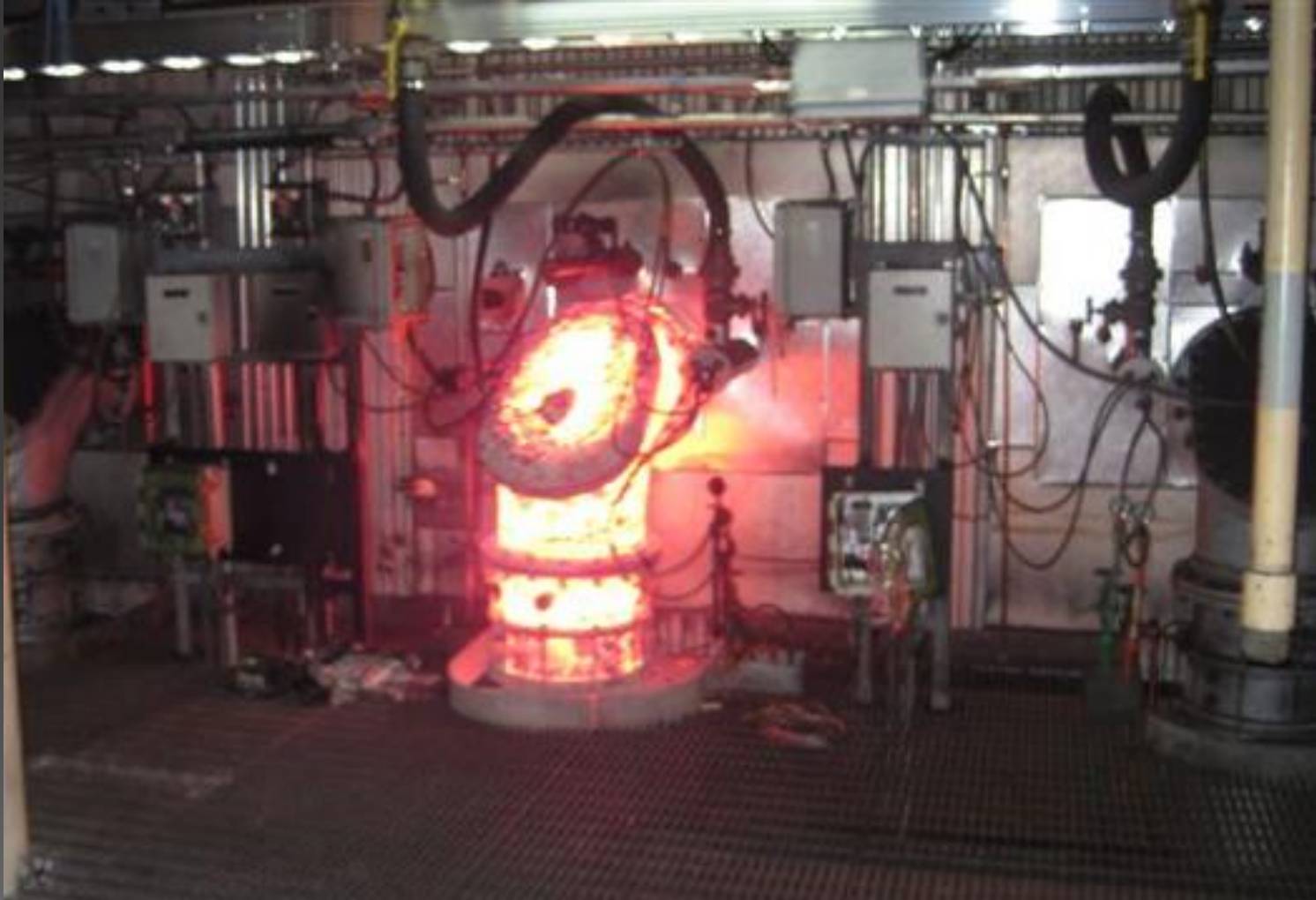
Secondary mass flows



primary Splits

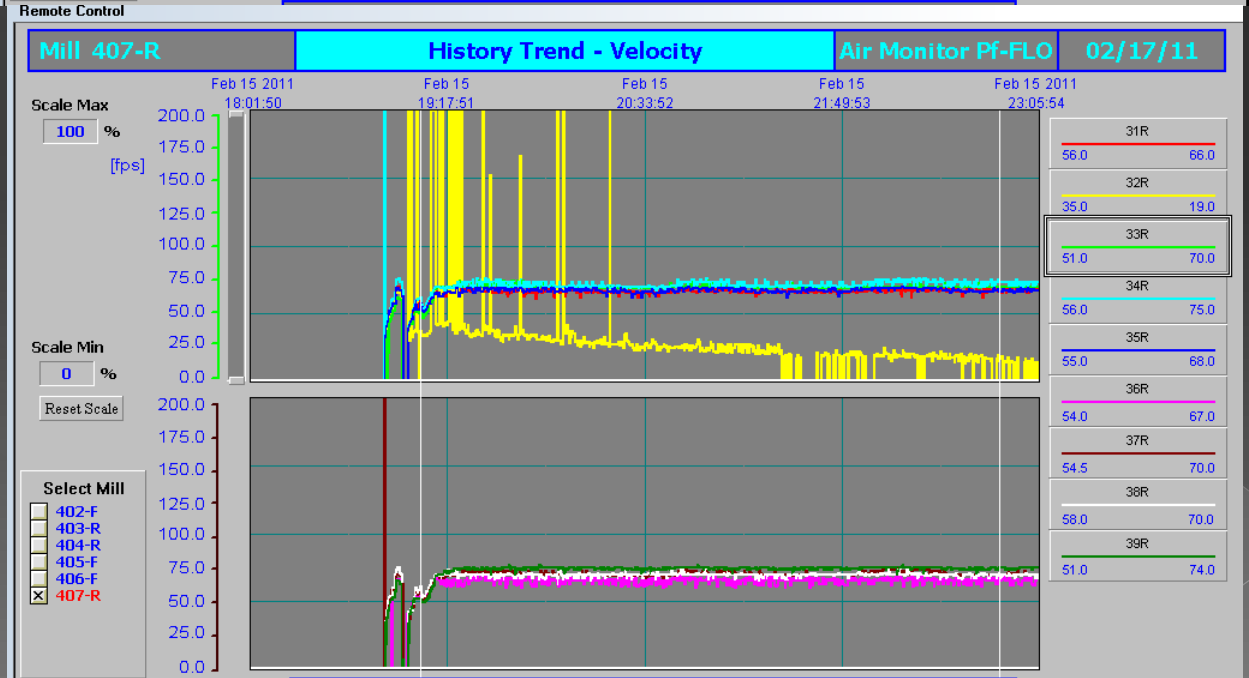
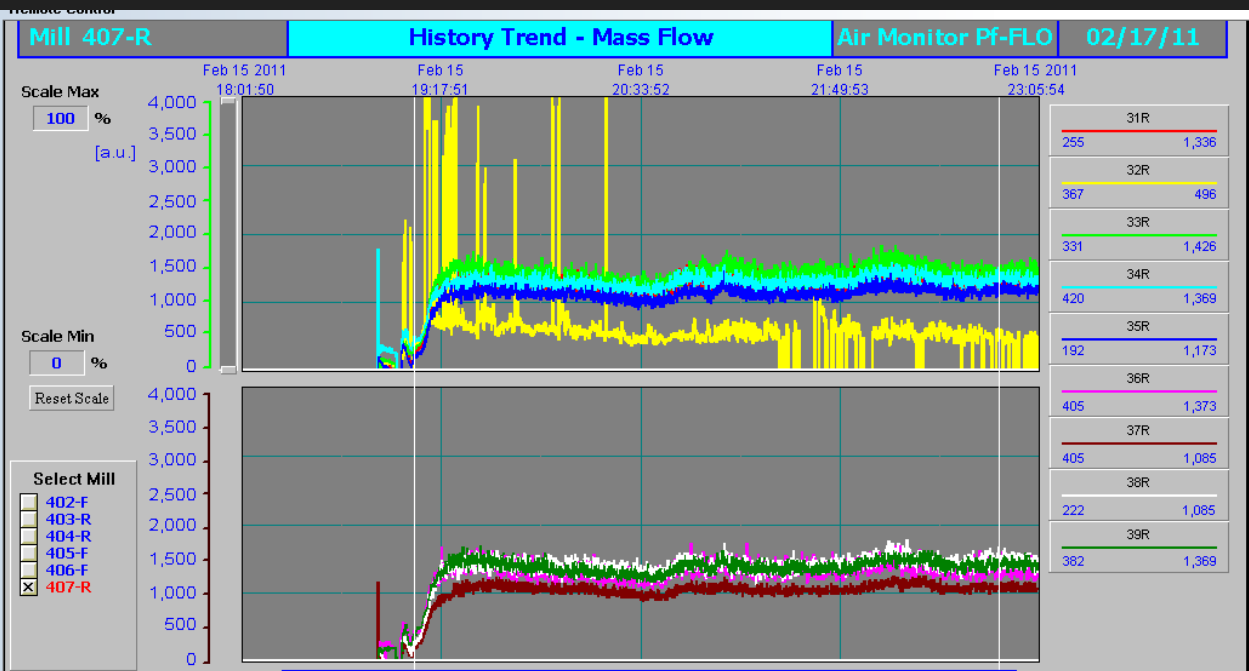


Prevent Burner/Pipe Fires



Prevent Burner/Pipe Fires





Proven solutions for a tough industry

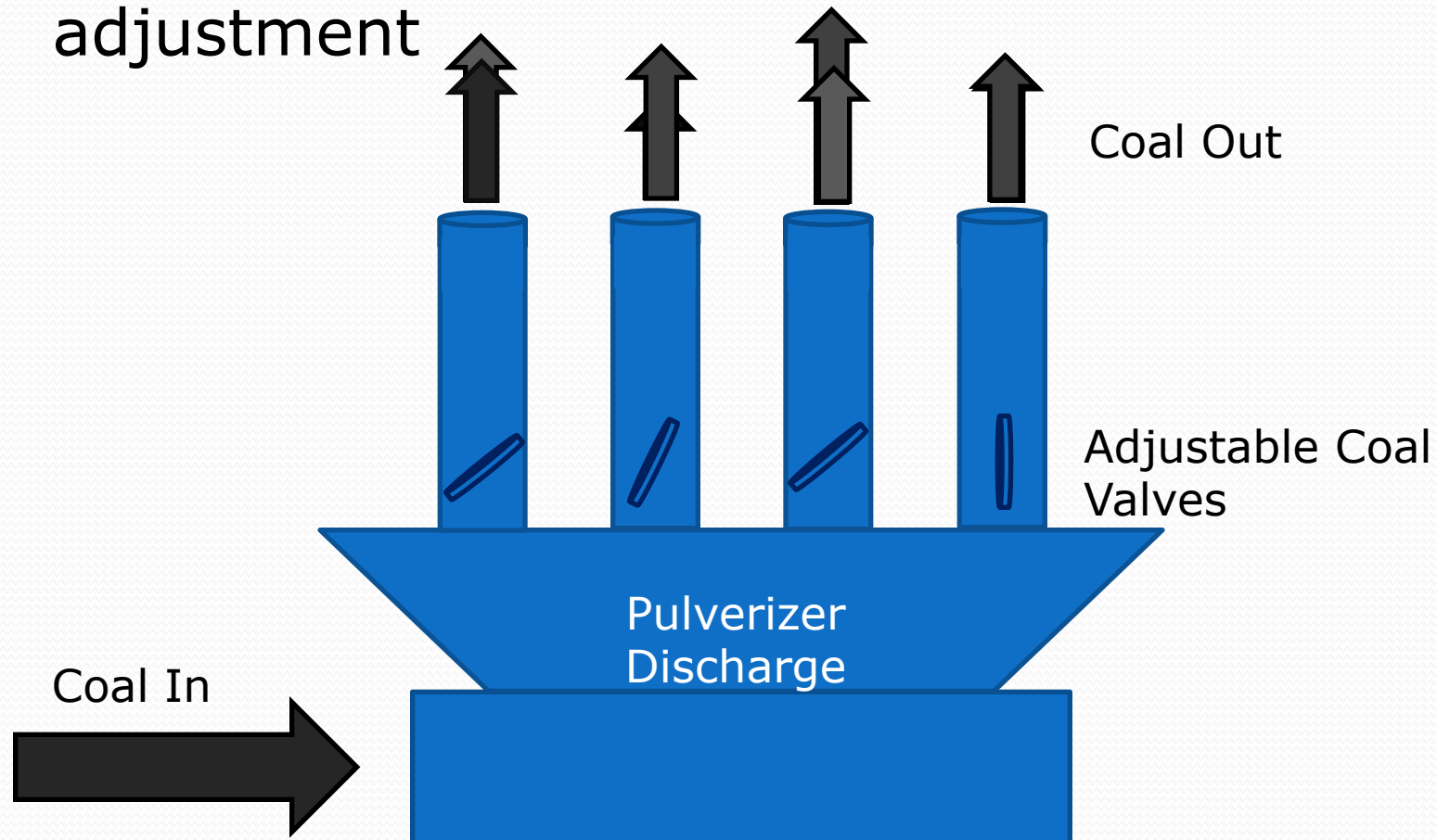
Crystal River Unit 4

- B&W Opposed Fire Pulverized Coal 770 MW
 - 6 MPS-89 Puvlerizers with Stock Gravimetric Feeders
 - 9 Coal Outlets per Mill
 - 54 B&W DRB-4Z Low NOx Burners
- 6 Compartmentalized Windboxes
 - 3 x Front, 3 X Rear
- SCR, Cold Side ESP & Wet FGD



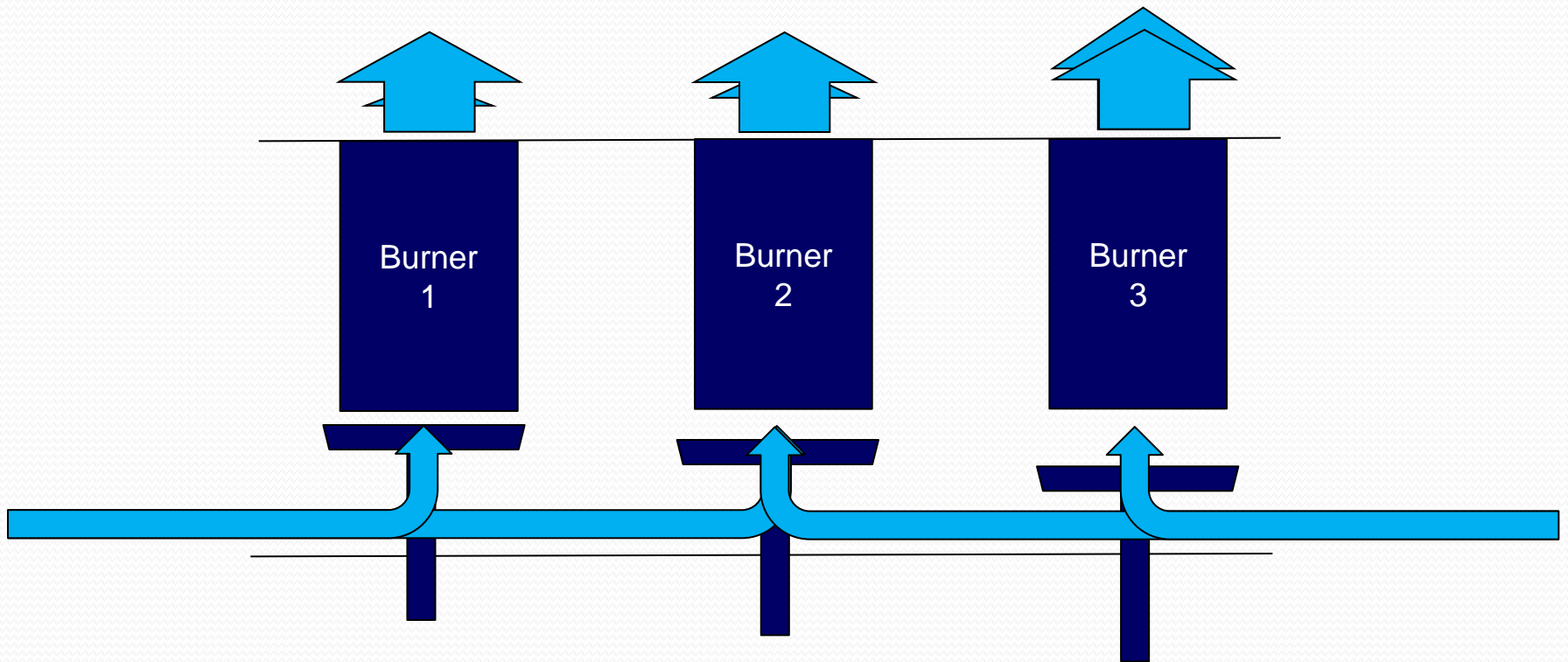
Coal Balancing

- Problem: Uneven Coal distribution
- Solution: Online coal measurement + adjustment



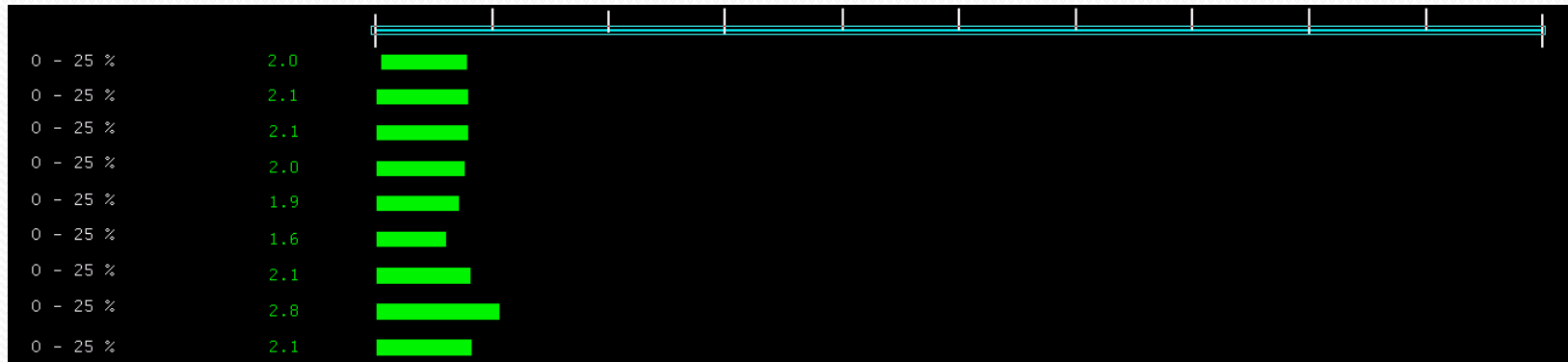
Why Automate SA Dampers?

- Dynamic windbox flow profiles
 - Fluctuating windbox pressure
 - Ash build-up

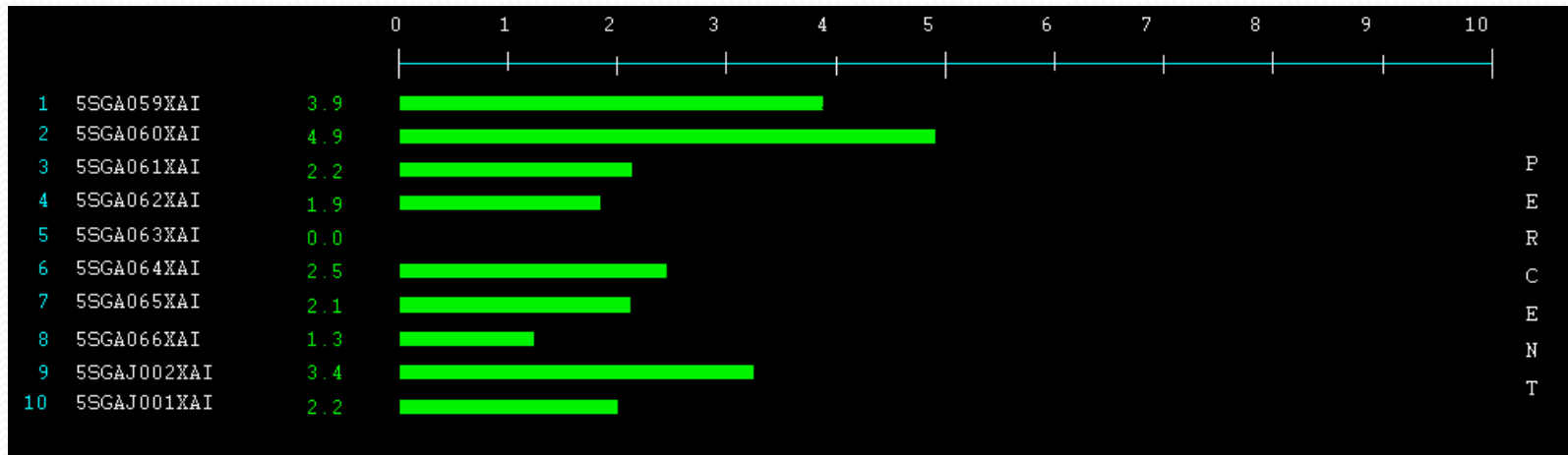


CRN O2 Distribution Comparisons

CR4 O2 Profiles



CR5 O2 Profiles



Note: Unit scales are different

New O2 Curve

- LOI benefit



Project Results

- Boiler Efficiency Increase = 0.5%
 - Annual fuel savings
- Combustion NO_x Reduction
 - 7% at full load, 15-25% at part load
 - Annual Ammonia Reagent Usage Reduction
 - SCR Catalyst Life Extension
- Fan Auxiliary Power Savings

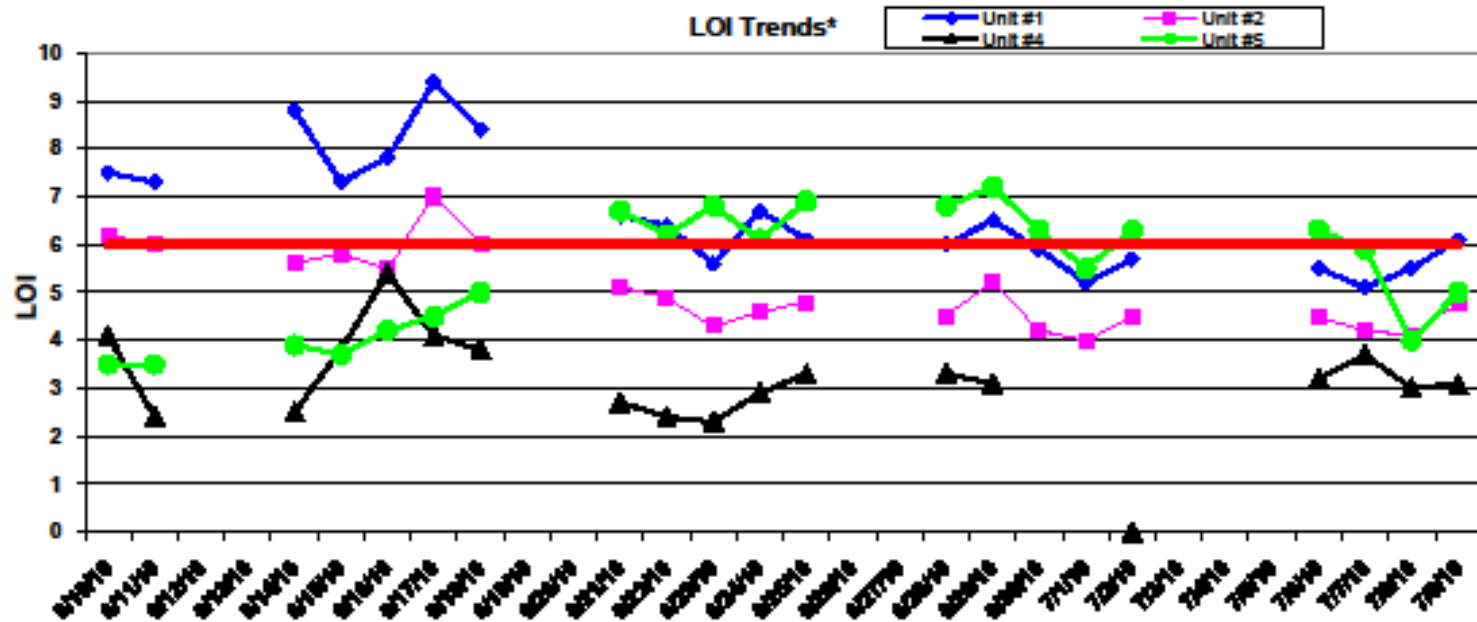
LOI Improvement

Crystal River Fly Ash Daily Report

July 9, 2010

PMI

LOI Trends (Past Rolling Month)



*Note: Above 6% LOI is Off-Spec.

Highlights

Additional “Soft” Benefits

1. Reduced emissions
2. Reduced pulverizer wear
3. Reduced wear on Coal Yard equipment.
4. Reduced boiler tube & non-pressure part erosion due to lower flue gas velocities.
5. Improved ESP performance due to lower flue gas velocities.
6. Reduced potential for slagging and fouling events
7. Improved Pressure part life due to improved temperature profile
8. Reduced ash disposal costs
9. Reduced boiler tube failures due to reducing atmospheres