Reducing Unburned Carbon using Coal Flow Distribution Analysis

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Why should we balance coal flow to each burner?

- Optimize combustion
- Reduce excess air requirements
- Lower NO_X emissions
- Lower unburned carbon
- Lessen performance impacts on other equipment
- Large potential savings

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Objectives for a coal flow measurement system

- Simple to install and operate
- Accurate, repeatable and reliable
- Safer, cleaner, more flexible and less labor intensive than extractive methods
- Easily up-gradable

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The basis of our technology

- Non-intrusive microwave sensors containing a transmitter and receiver (transceiver) are mounted flush with the inside of the coal pipe
- The microwave energy is reflected only by moving coal particles
- Heavy swirls and roping are still a challenge to accurate measurement

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The basis of our technology

Signal	particles passing the sensor
Concentration	normal and half
Velocity	normal and half
Concentration vs. Velocity	double concentration at half velocity vs. half concentration at double velocity
Particle size	normal concentration and size versus normal concentration and half size

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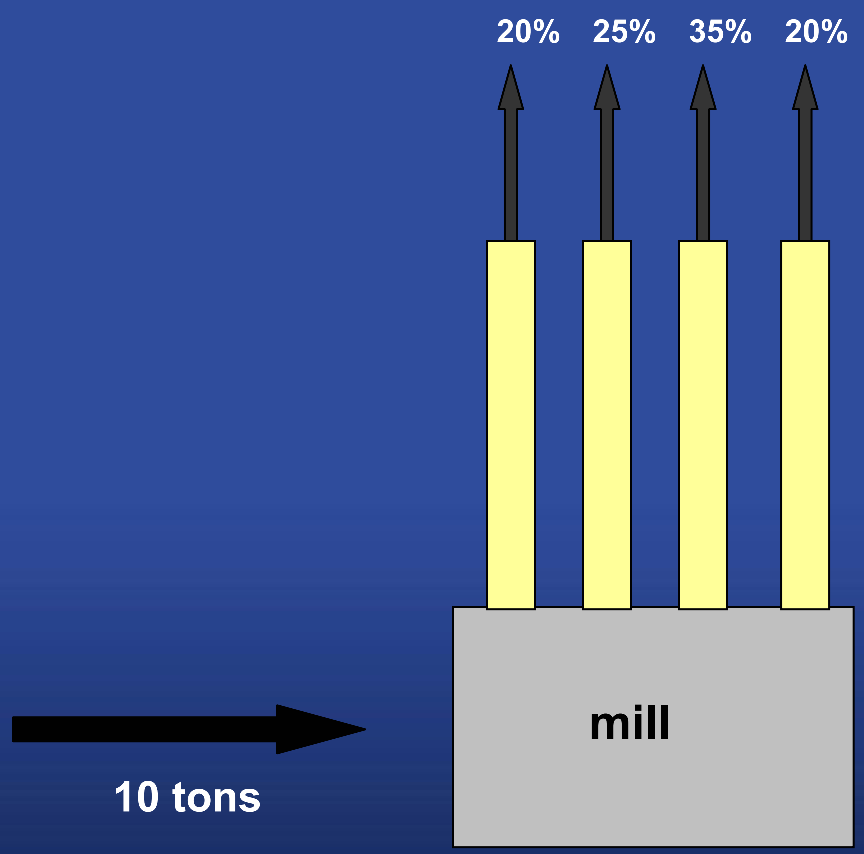

relative values

multiplied with the feeder information

= absolute values

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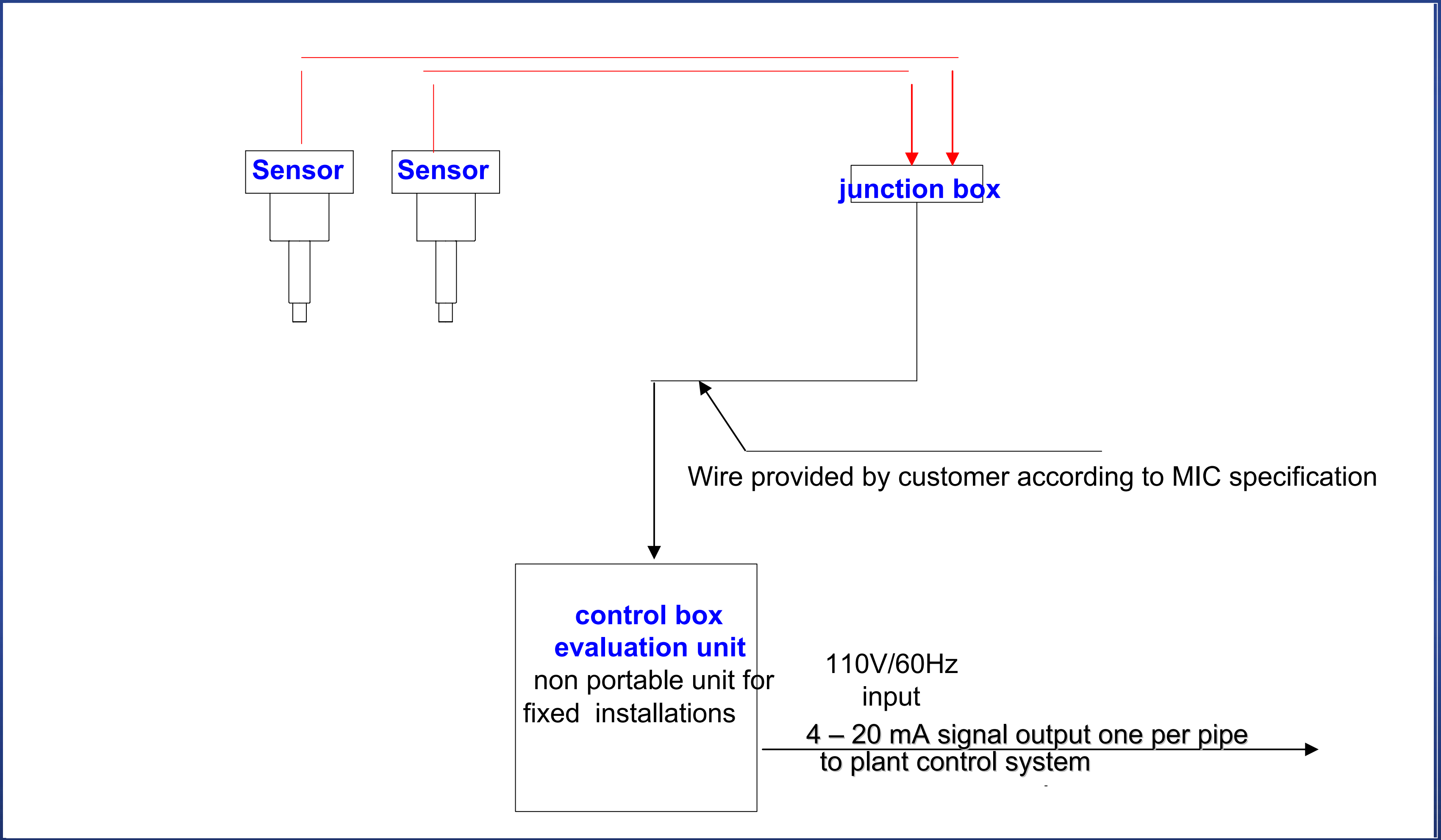
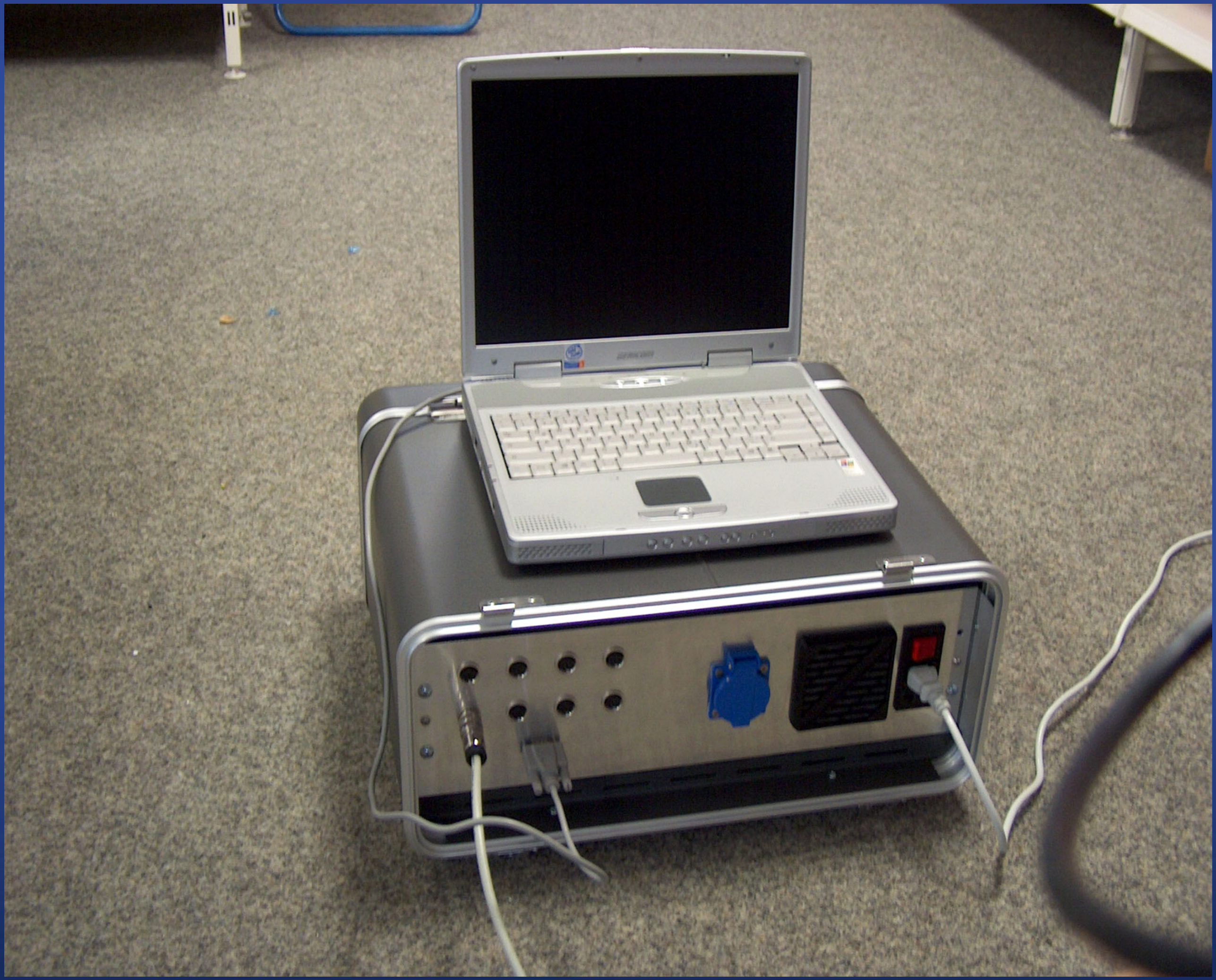
Principle Arrangement Diagram



Mobile System



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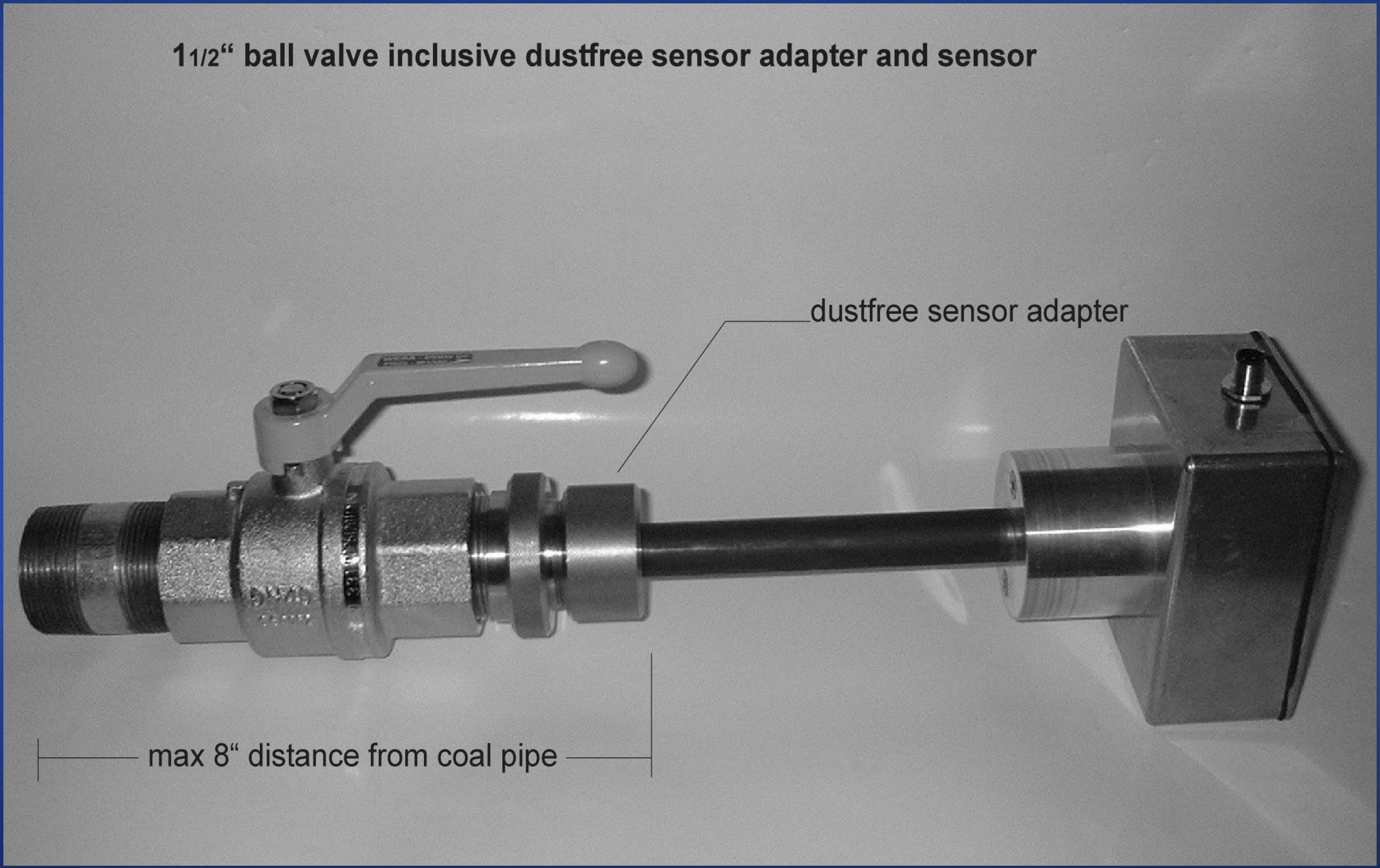
1 1/2“ ball valve inclusive dustfree sensor adapter and sensor
dustfree sensor adapter
max 8“ distance from coal pipe

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Mobile System Sensor Setup

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Permanent Installation

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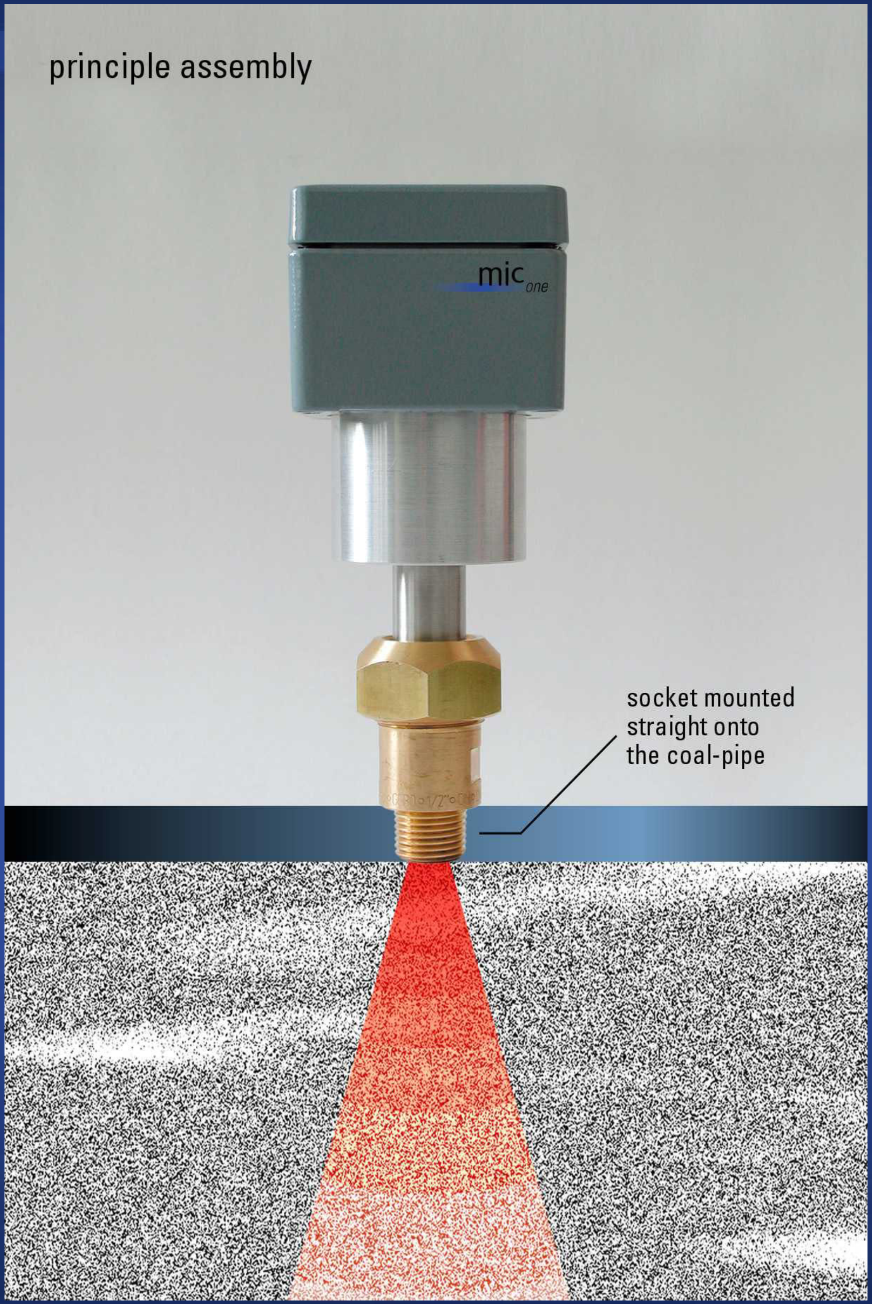
principle assembly
mic one
socket mounted
straight onto
the coal-pipe

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Permanent Installation

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Sensors installed in horizontal pipes

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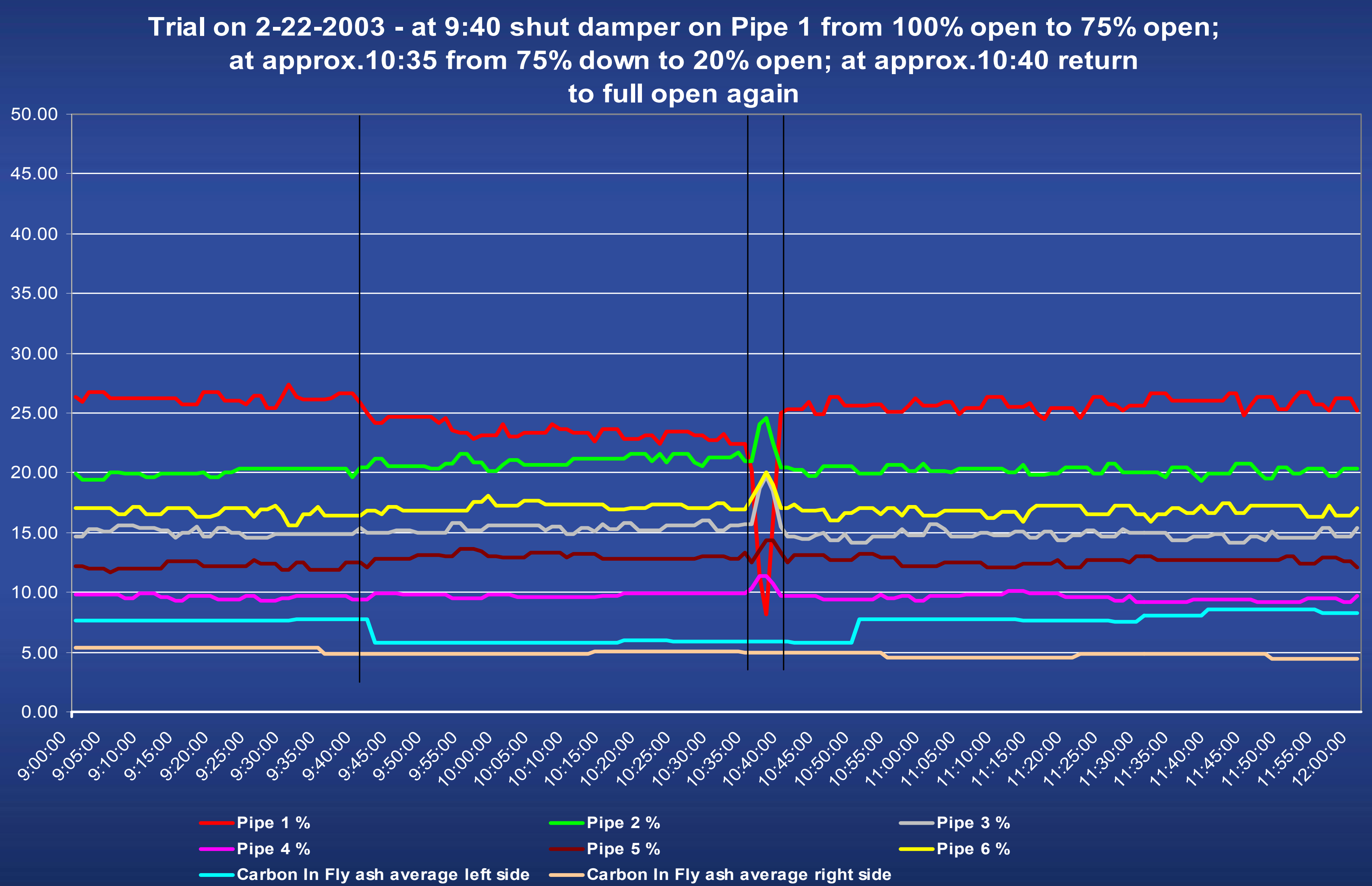

Trial on 2-22-2003 - at 9:40 shut damper on Pipe 1 from 100% open to 75% open; at approx.10:35 from 75% down to 20% open; at approx.10:40 return to full open again
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
9:00:00
9:05:00
9:10:00
9:15:00
9:20:00
9:25:00
9:30:00
9:35:00
9:40:00
9:45:00
9:50:00
9:55:00
10:00:00
10:05:00
10:10:00
10:15:00
10:20:00
10:25:00
10:30:00
10:35:00
10:40:00
10:45:00
10:50:00
10:55:00
11:00:00
11:05:00
11:10:00
11:15:00
11:20:00
11:25:00
11:30:00
11:35:00
11:40:00
11:45:00
11:50:00
11:55:00
12:00:00
Pipe 1 %
Pipe 2 %
Pipe 3 %
Pipe 4 %
Pipe 5 %
Pipe 6 %
Carbon In Fly ash average left side
Carbon In Fly ash average right side

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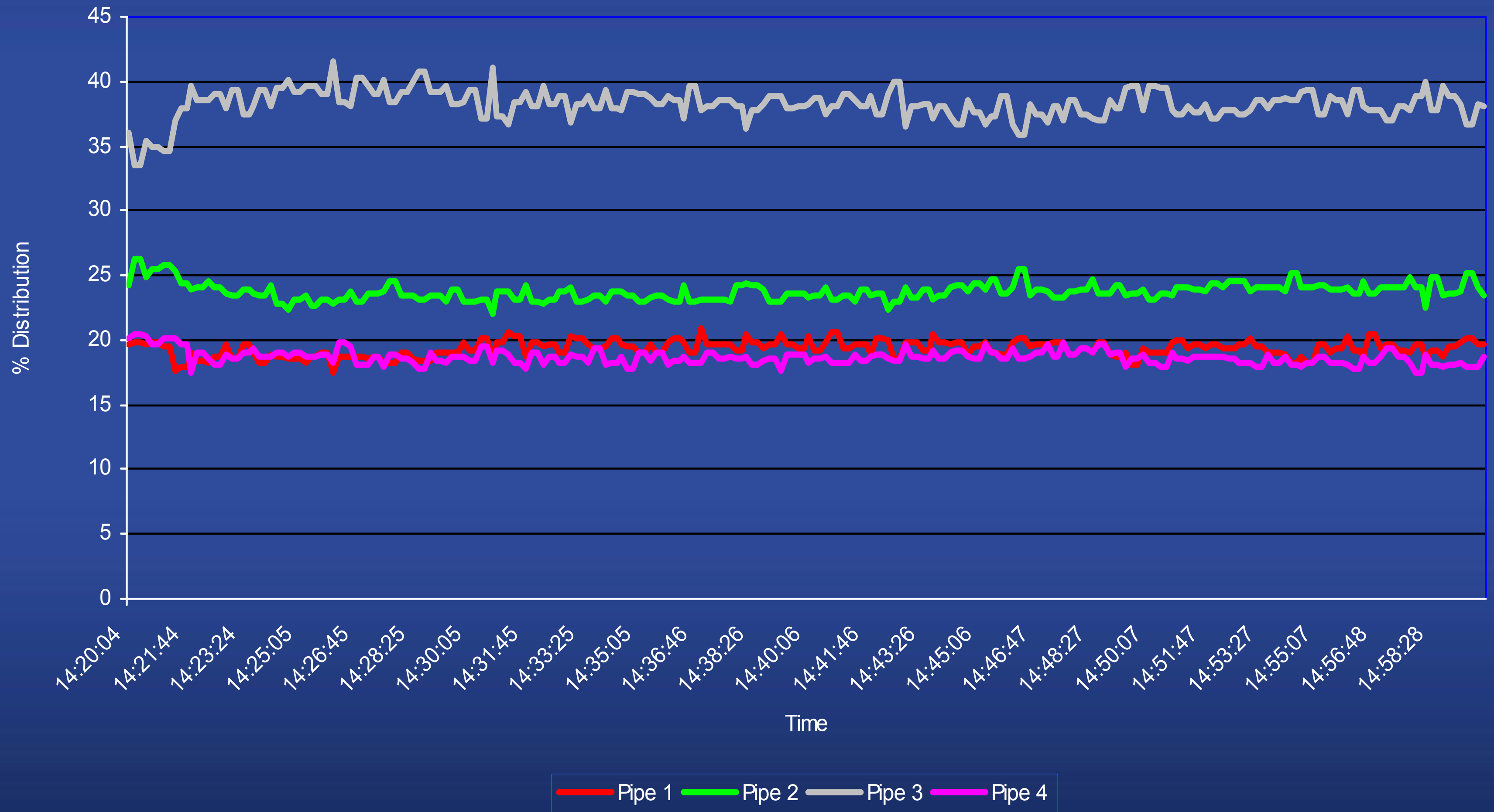
Midwest Utility Experiencing High Carbon in Ash



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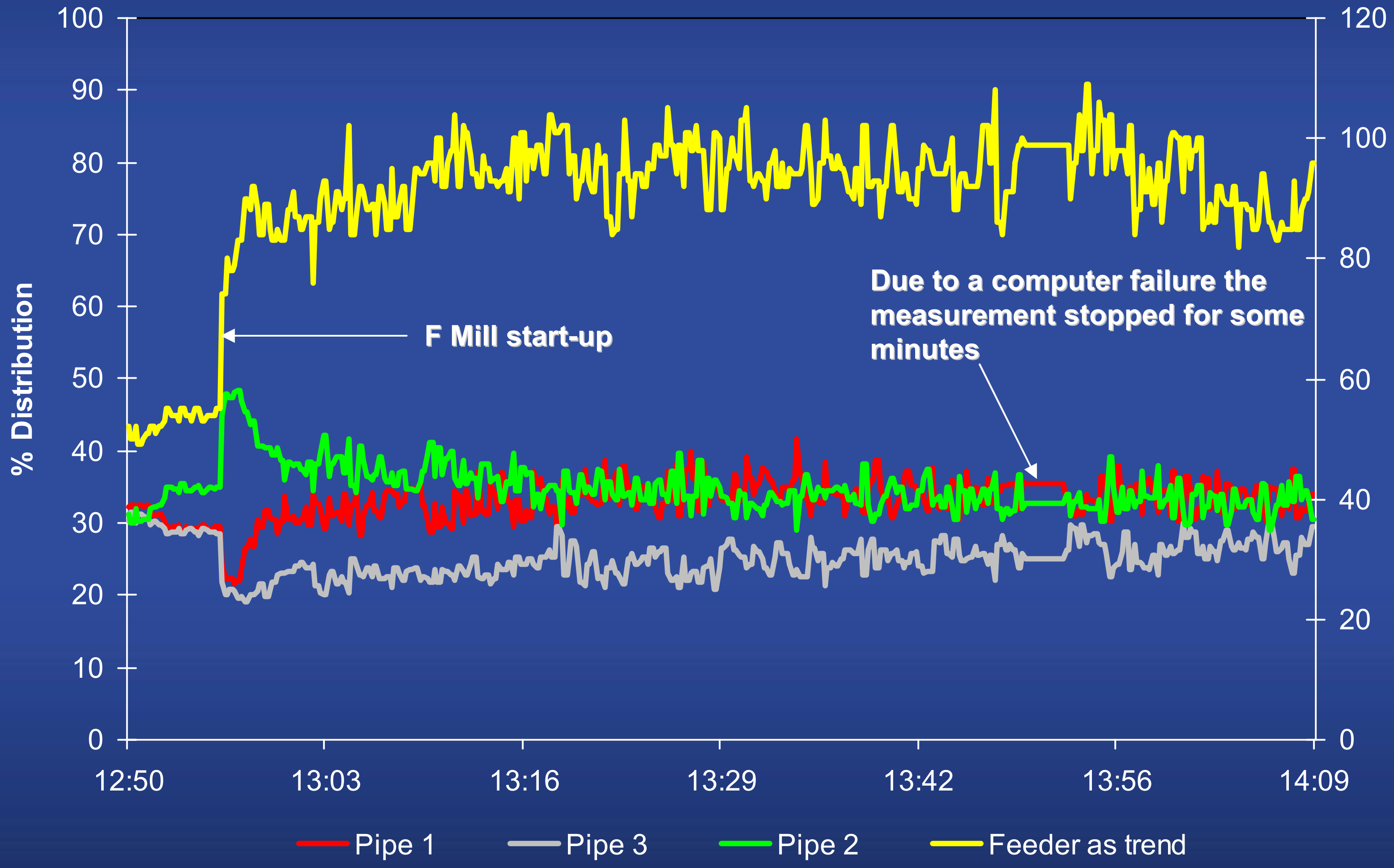
Testing during a mill start



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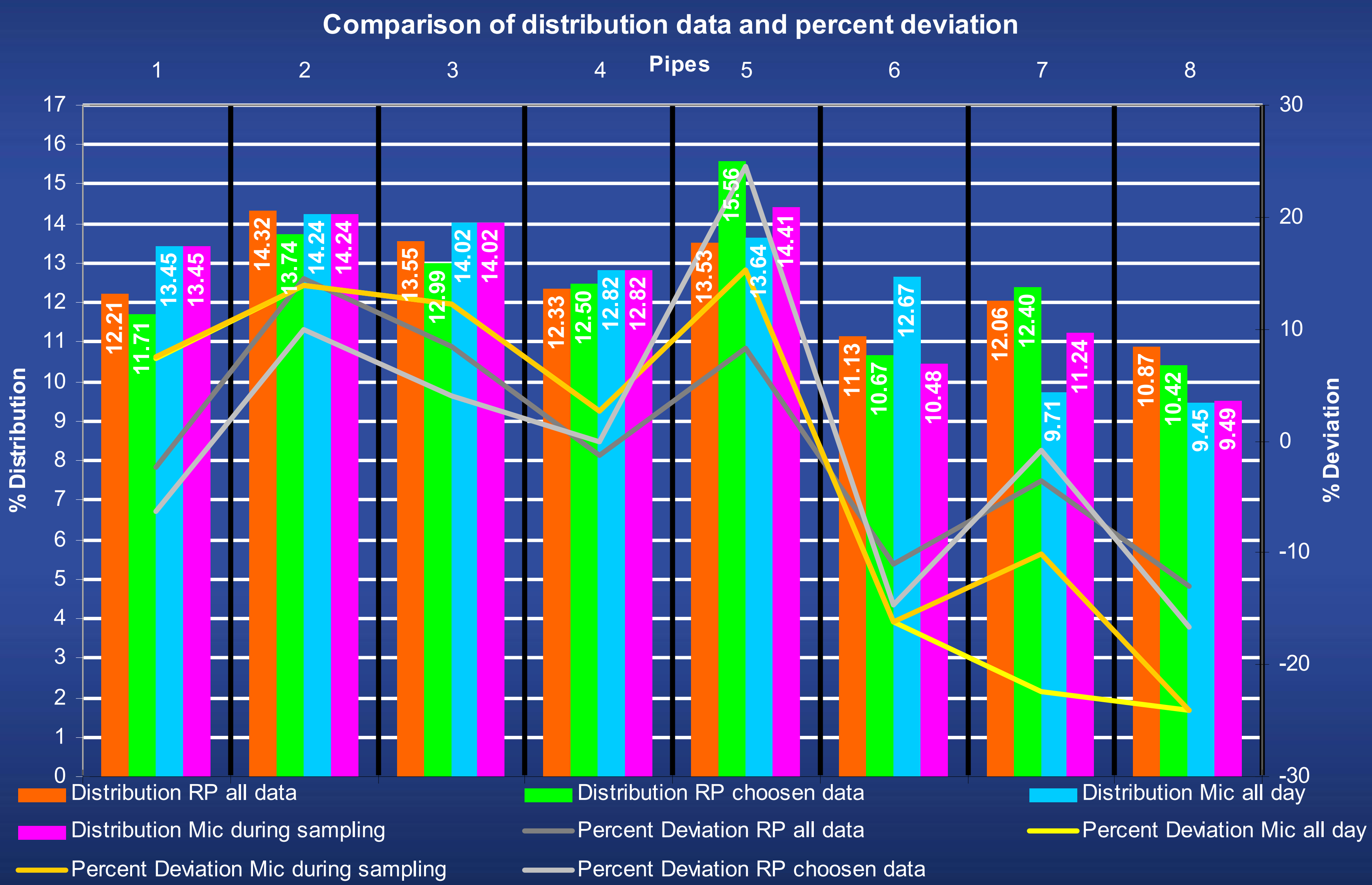

Comparison of distribution data and percent deviation
Pipes
1 2 3 4 5 6 7 8
% Distribution
% Deviation
12.21 11.71 13.45 13.45
14.32 13.74 14.24 14.24
13.55 12.99 14.02 14.02
12.33 12.50 12.82 12.82
13.53 15.56 13.64 14.41
11.13 10.67 12.67 10.48
12.06 12.40 9.71 11.24
10.87 10.42 9.45 9.49
Distribution RP all data
Distribution RP choosen data
Distribution Mic all day
Distribution Mic during sampling
Percent Deviation RP all data
Percent Deviation Mic all day
Percent Deviation Mic during sampling
Percent Deviation RP choosen data

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Calculations for the economics of coal flow balancing

General factors	units	Example 1		Example 2
Unit Rating	MWe	125.00		600.00
Capacity Factor	%	0.50		0.80
Heat Rate	Btu/kWh	11,000.00		9,600.00
Coal Heating Value	Btu/lb	12,000.00		10,000.00
Coal Costs	$/ton	35.00		25.00
Carbon/Coal	%	65.00%		45.00%
Ash/Coal	%	15.00%		8.00%
Carbon/Ash Reduction [UBC]	%	5.00%		2.00%
Conversion factor lb/ton	2,000.00	2,000.00		2,000.00
Annual heat input	MMBtu	6,022,500.00		40,366,080.00
NOx	lb/MMBtu	0.45		0.25
NOx reduction	%	10.00%		5.00%
NOx credits	$/ton	1,500.00		1,500.00
Annual Fuel costs	$	8,782,812.50		50,457,600.00
Fuel savings	%	0.01154		0.00356
Annual fuel savings	$	101,340.14		179,404.80
Annual NOx reduction	tons	135.51		252.29
Annual Savings due to NOx	$	203,259.38		378,432.00
Total savings in US$		**304,599.52**		**557,836.80**