CoalCONTROL™ – EMISSIONS REDUCTION THROUGH BURNER BALANCING

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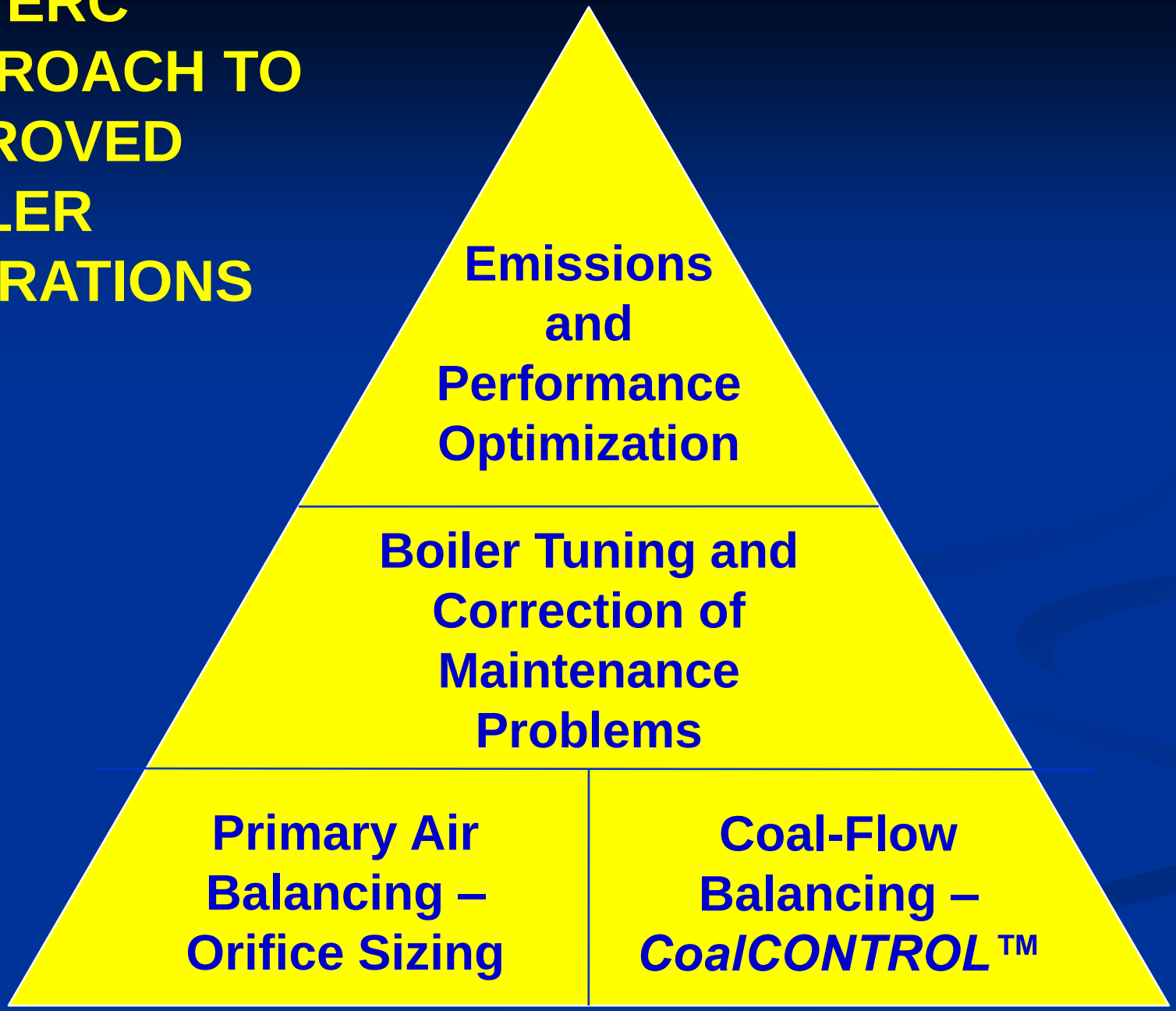
REASONS FOR COAL-FLOW BALANCING

- Improved Performance and Reduced Emissions
  - Reduced Unburned Carbon
  - Lower CO
  - Improved Steam Temperature Control
  - Lower NO_x
  - Improved ESP Performance
- Reduced Maintenance Costs
  - Lower Coal Pipe Erosion
  - Less Coal Pipe Plugging - Windbox Fires
  - Reduced Slag Buildup and Damage to Burner Tips
  - Reduced Localized Slagging and Waterwall Wastage

THE ERC APPROACH TO IMPROVED BOILER OPERATIONS



TYPICAL CoalCONTROL™ PROJECT STEPS

- Evaluate rifflers and burner lines.
- Perform unit performance and emissions baselining. Measure coal and PA flow imbalances.
  - Check measurement or collection location.
  - Review sample collection method.
  - Interpret data.
- Balance PA flow as needed.
- Design and fabricate *CoalCONTROL™* devices.
- Install and test *CoalCONTROL™.*
- Provide combustion tuning after installation.

COAL-FLOW BALANCING

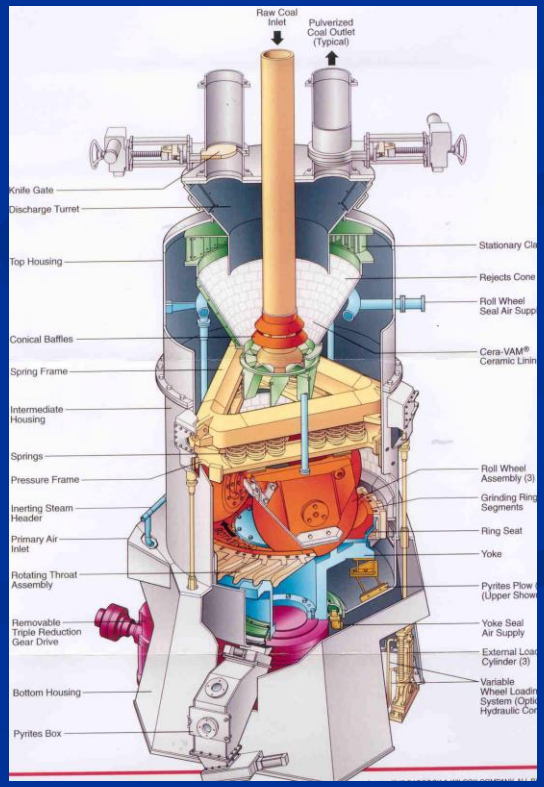
USES OF *CoalCONTROL*™ FOR COMBUSTION IMPROVEMENTS

- Balanced coal flow may not be best for optimum combustion. Optimal burner stoichiometry should be the objective.
- Adjust combustion stoichiometry at the burner tip according to:
  - Coal flow measurements.
  - Flame characteristics.
- Eliminate problems with individual burner air/fuel control:
  - Fuel Rich – High CO, LOI, and Longer Flames
  - Fuel Lean – High Flame Temperature at Burner Tip
  - High Thermal NO_x

CoalCONTROL™ DESIGNS

- Current design is for mills with 2, 3, and 4-way pipe splits.
  - Coal distribution is heavily affected by inlet maldistribution.
  - Rifflers are used to improve coal flow distribution.

- Design in progress for pressurized vertical spindle mills
  - CFD modeling completed
  - Laboratory testing completed
  - Prototype field test in 2008



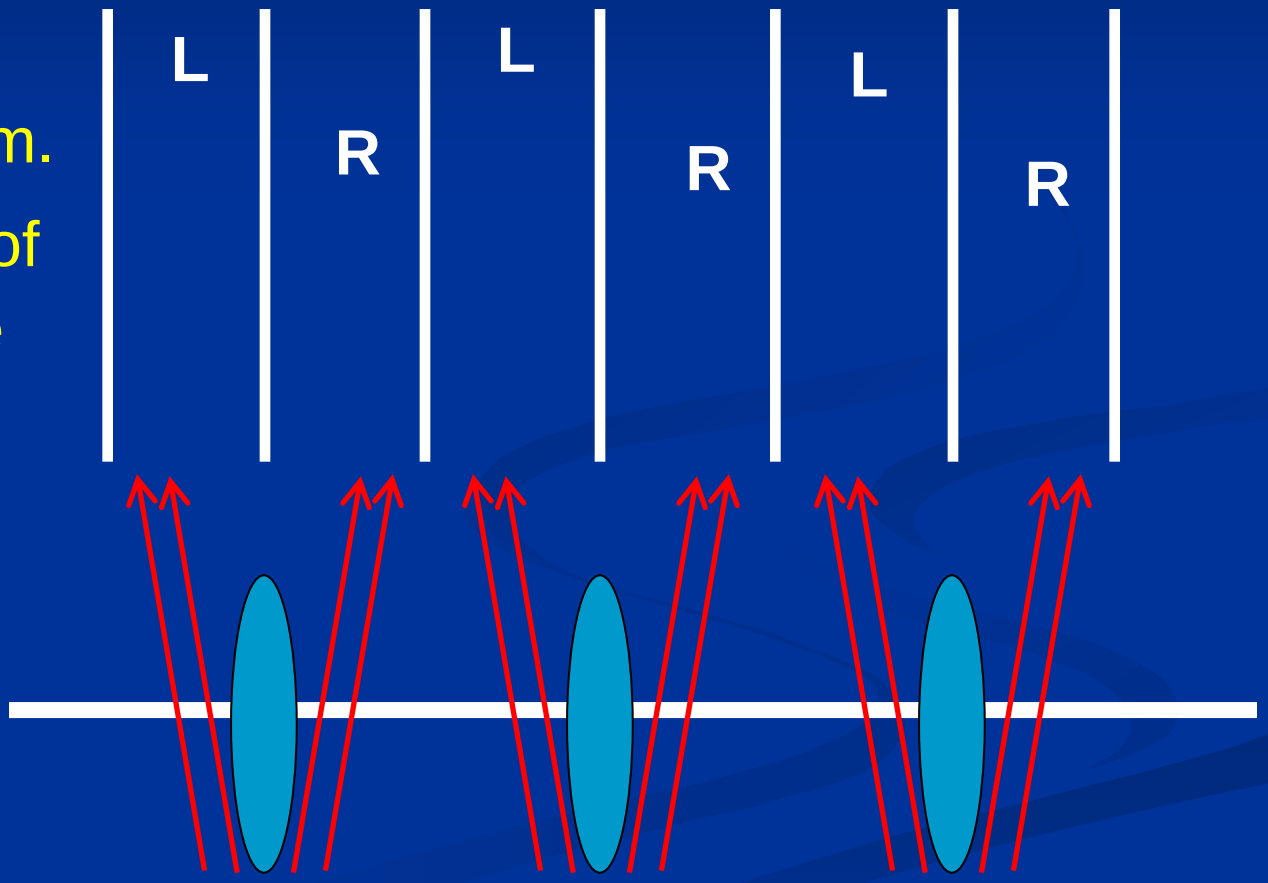
CoalCONTROL™ TECHNOLOGY FOR PIPES WITH SPLITS

- Dynamic coal flow control for two , three , and four-way splitters
- Negligible effect on Primary Air (PA) flow distribution
- Negligible additional pressure drop to existing systems
- Resistance to solid particle erosion
- Easy retrofit and cost effective
- U.S. patent Numbers: 6,789,488 and 6,966,508

CoalCONTROL™
HOW DOES IT WORK ?

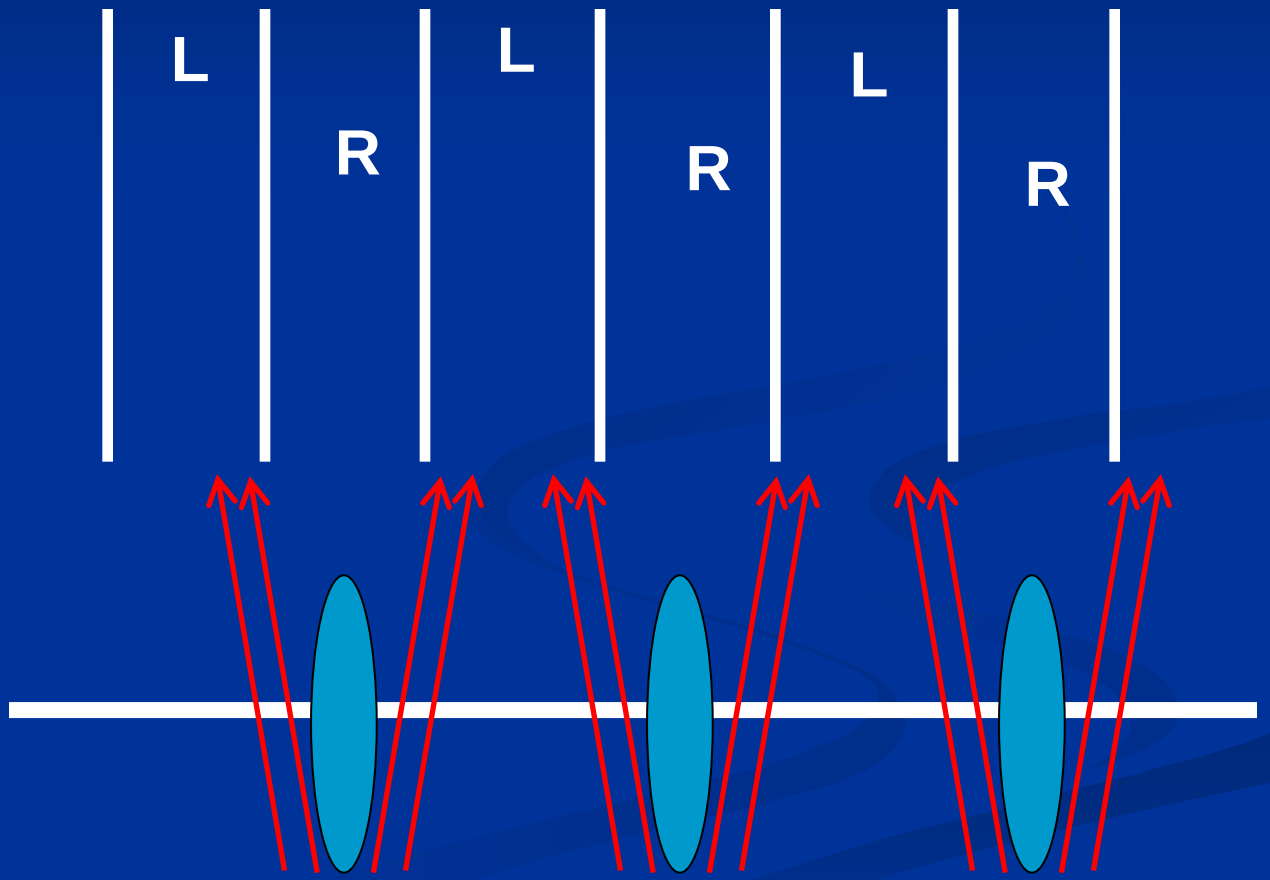
COAL FLOW BALANCING RESULTS WITH *CoalCONTROL*™ – Neutral Position

- Adds a streamline body into the coal/air flow stream.
- Takes advantage of two-phase particle flow.
  - Air phase will flow along the body without separation.
  - Coal phase will separate from the body.

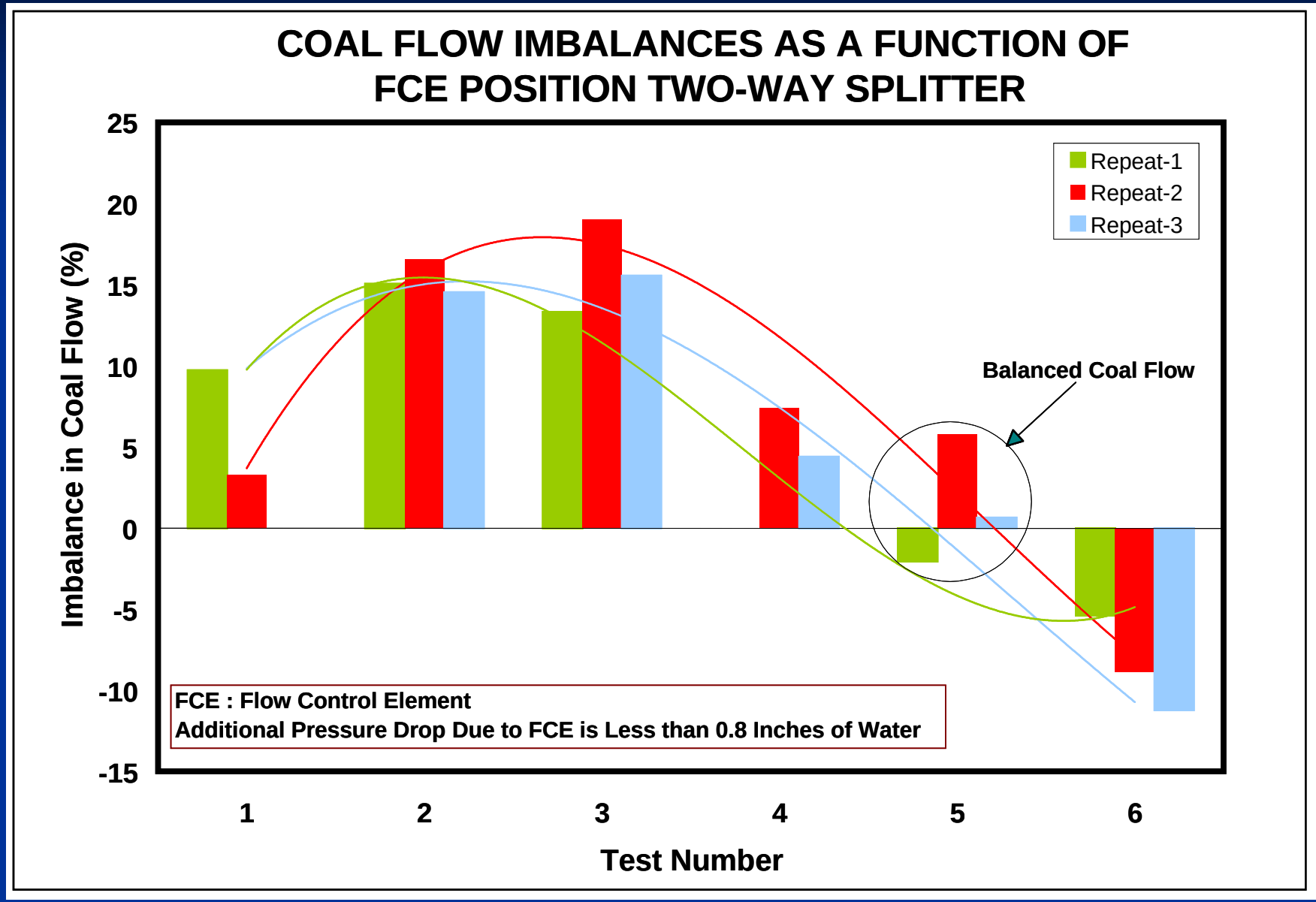


COAL FLOW BALANCING RESULTS WITH *CoalCONTROL*™ – Left Position

- Moving the streamline bodies changes the coal flow distribution.
- Changes in position doesn't affect the primary air distribution.



CONTROLABILITY OF *CoalCONTROL*™



FIELD TEST RESULTS

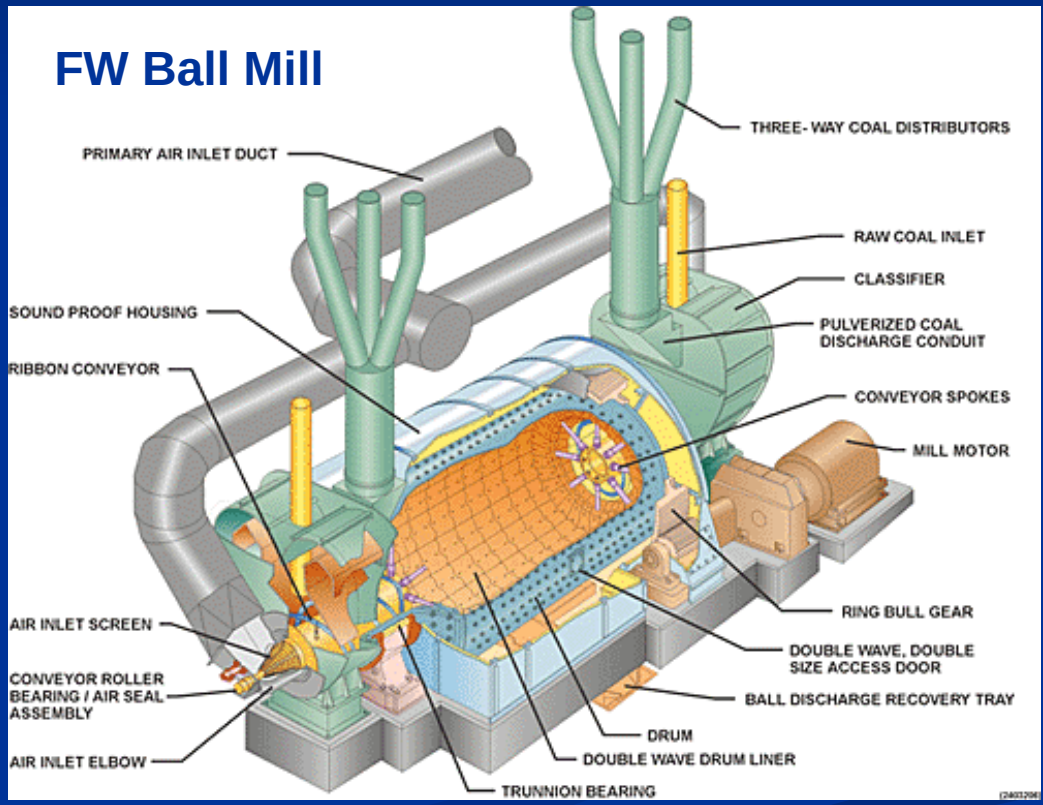
CoalCONTROL™ - 51 INSTALLATIONS

STATION	*CoalCONTROL*™ CONFIGURATION	COAL IMBALANCE, %		BOILER SPECIFICATION
		Before	After	
FirstEnergy Sammis Plant Unit 3	One 3-Way Controller	+14% to +17%	±4%	CE Raymond Mill, Wall Fired, 190 MW
Cogentrix Logan Station Unit 1	Four 3-Way Controllers and Rifflers	+50% to -30%	±5%	FW Double Ended Ball Mill, Wall Fired, 242 MW
WE Energy Presque Isle Units 5&6 (Babcock Power)	Eight 2-Way Controllers	No Data	No Data	CE Raymond Mill, Wall Fired, 90 MW
New Energy Corporation (Babcock Power)	Two 2-Way Controllers	No Data	No Data	No Data
Smurfit Stone Container (Babcock Power)	One 2-Way Controllers	No Data	No Data	No Data
PPG Industries (Babcock Power)	Three 2-Way Controllers	No Data	No Data	No Data
New Installation – Shipping in April 2008 (Babcock Power)	Sixteen 2-Way Controllers	No Data	No Data	No Data
PSEG Mercer Station Unit 2	Two 4-Way Controllers and Rifflers	25/25/25/25	Target: 20/30/30/20 Actual: 22/27/28/23	FW Double Ended Ball Mill, Wall Fired, 326 MW
AES Beaver Valley Unit 4	Two 3-Way Controllers and Rifflers	+22% to -29%	±8%	FW Exhauster, Wall Fired, Cogen
Conectiv Edge Moor Station Unit 3	Twelve 2-Way Controllers	+33% to -26%	±5%	CE Raymond Mill, T-Fired, 75 MW

LOGAN GENERATING STATION

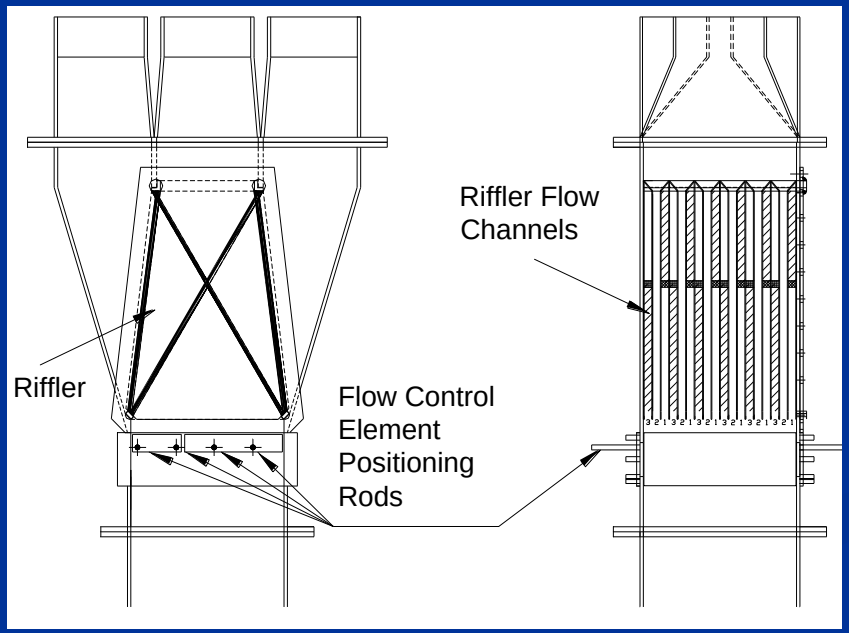
PROJECT SCOPE

- **Four 3-Way *CoalCONTROL*™** systems were designed, fabricated and installed on the Logan Generating Station's 245 MW front wall-fired unit.
- The ***CoalCONTROL*™** systems replaced the existing 3-way coal distribution splits on the Foster Wheeler (FW) horizontal ball mills.



CoalCONTROL™ DESIGN AND FABRICATION

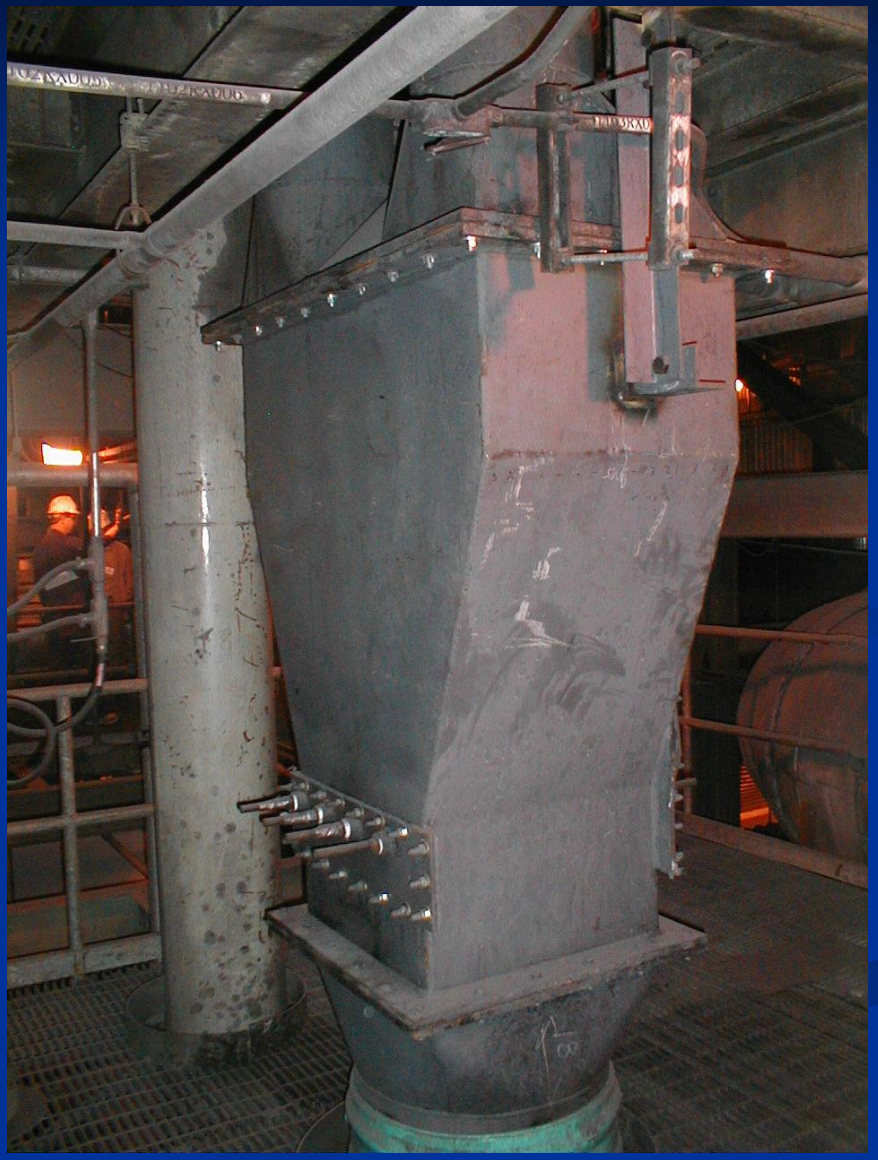
- The ERC designed a combined coal-flow controller and riffler assembly.
- Resistance to solid particle erosion was provided using Tungsten Carbide (WC) material.



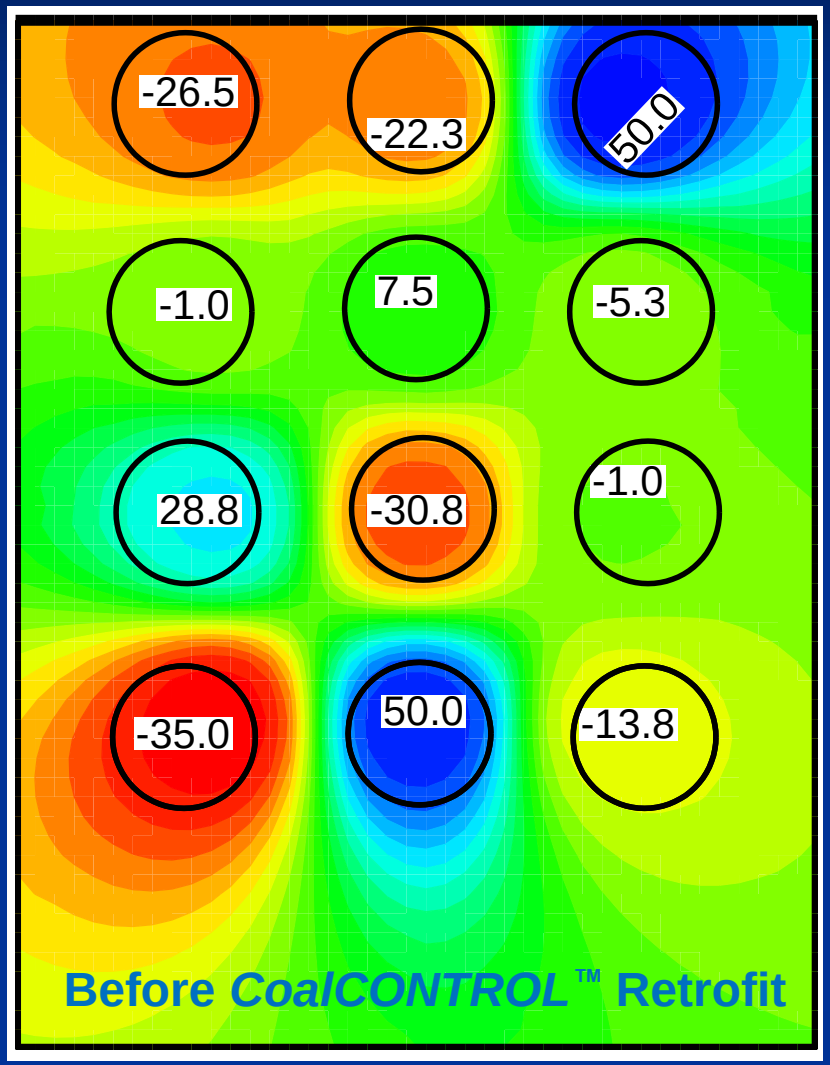
FIELD RESULTS

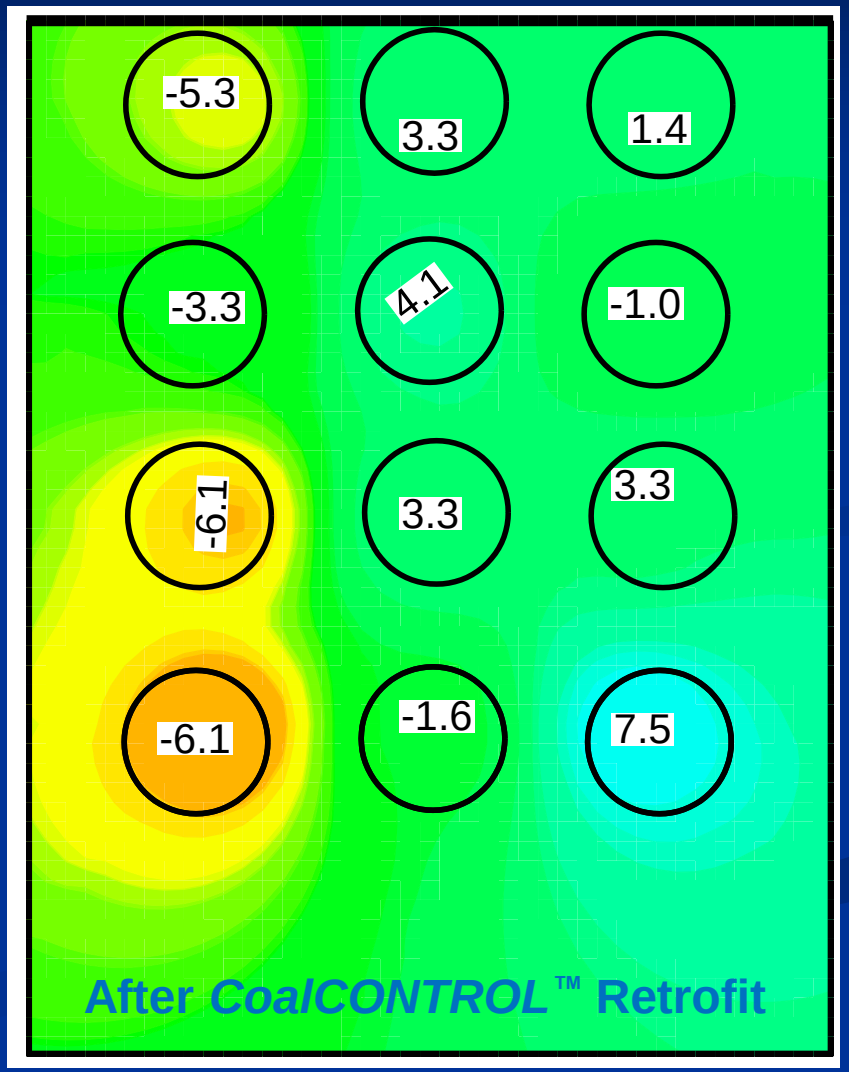
The following were observed and measured improvements:

- Reduction in Fly ash LOI
- Reduction in CO emissions
- Reduction in SCR Ammonia injection rate
- More stable unit operations

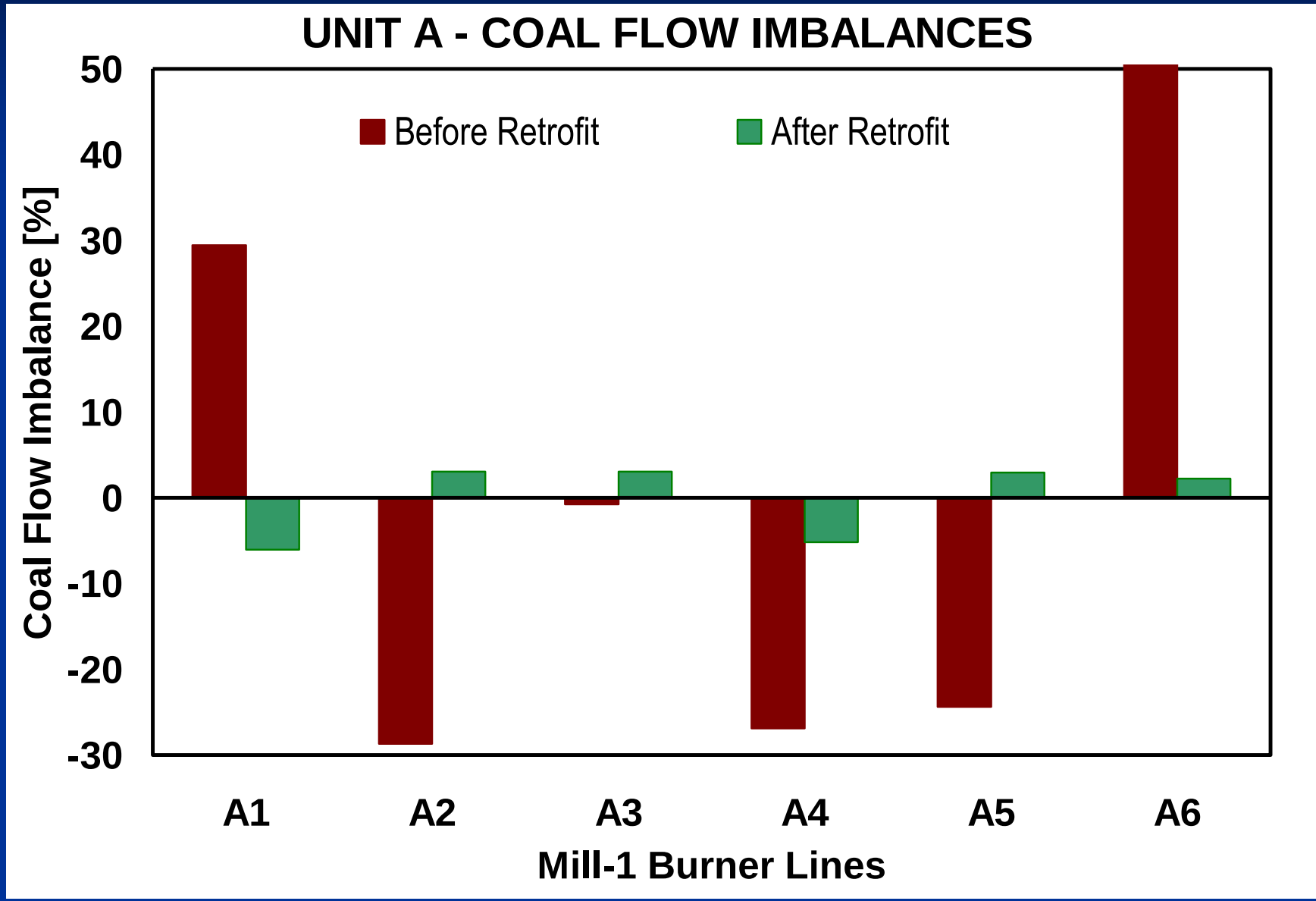


IMPROVED COAL FLOW DISTRIBUTION WITH *CoalCONTROL*™

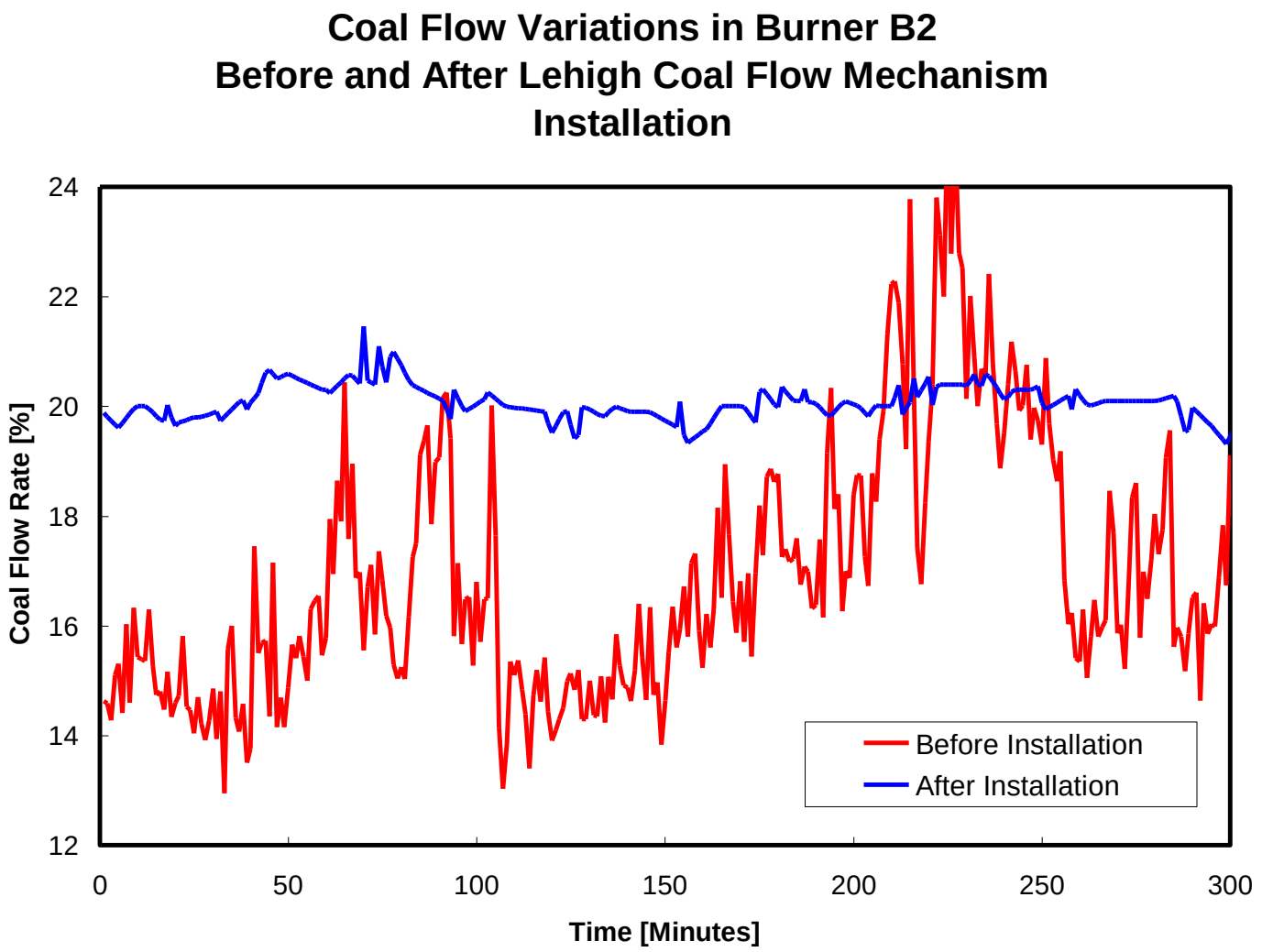




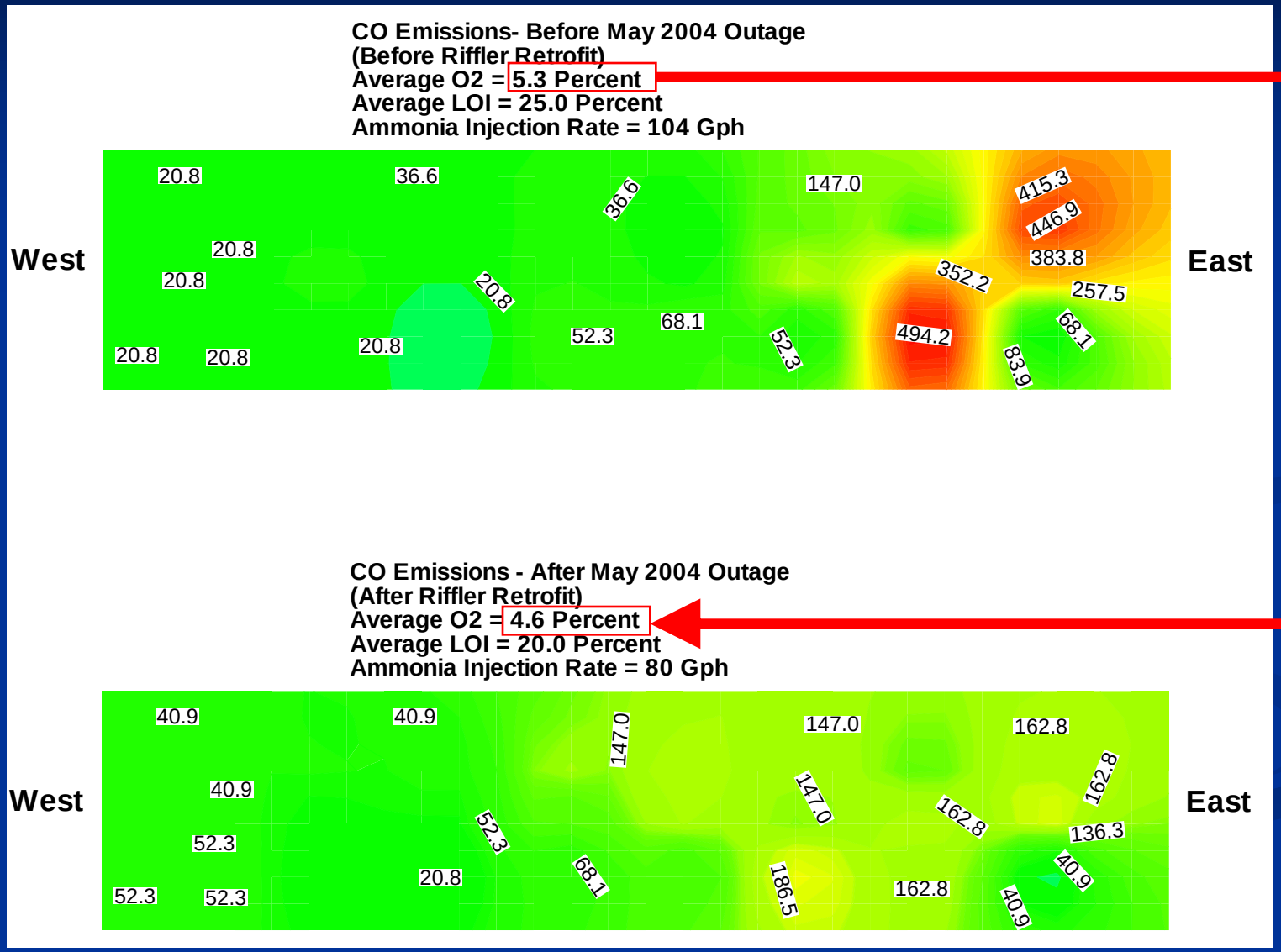
COAL BALANCE IMPROVEMENT USING *CoalCONTROL*™ – MILL 1



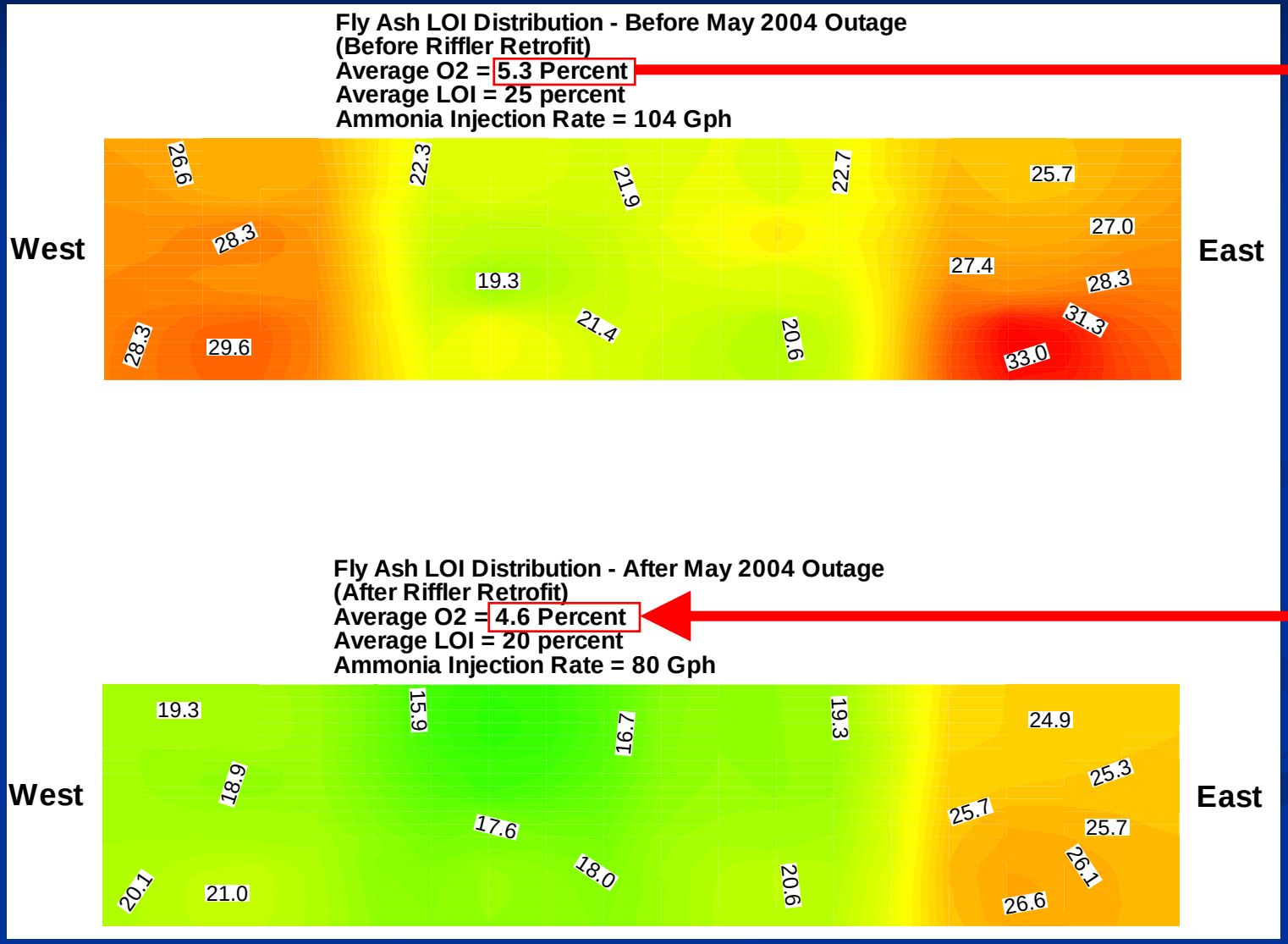
STABLE COAL FLOW CONTROL WITH *CoalCONTROL*™



REDUCTION IN CO EMISSIONS WITH *CoalCONTROL™*



REDUCTION IN LOI LEVEL IN FLY ASH WITH *CoalCONTROL™*



CoalCONTROL™ BENEFITS SUMMARY

Description	Units	Before Retrofit	After Retrofit	Difference (%)
Net Electrical Generation	MW	240.5	243.6	1.27
Average Flue Gas O_2 (Grid)	%	3.68	3.09	-0.59
Ammonia Inlet Flow	gph	106.84	88.04	-21.36
Stack NO_x	ppm	83.26	78.86	-5.58
CEMS CO Monitor	ppm	86.21	76.68	-12.43
Heat Rate	Btu/kWh	10,187	10,098	-0.88
Average LOI in Fly Ash	%	24.9	20.3	-4.56

- Savings based on lower heat rate and reduced fly ash handling cost – $ 400,000 per year
- Payback in 5 months for ***CoalCONTROL***™

MERCER GENERATING STATION

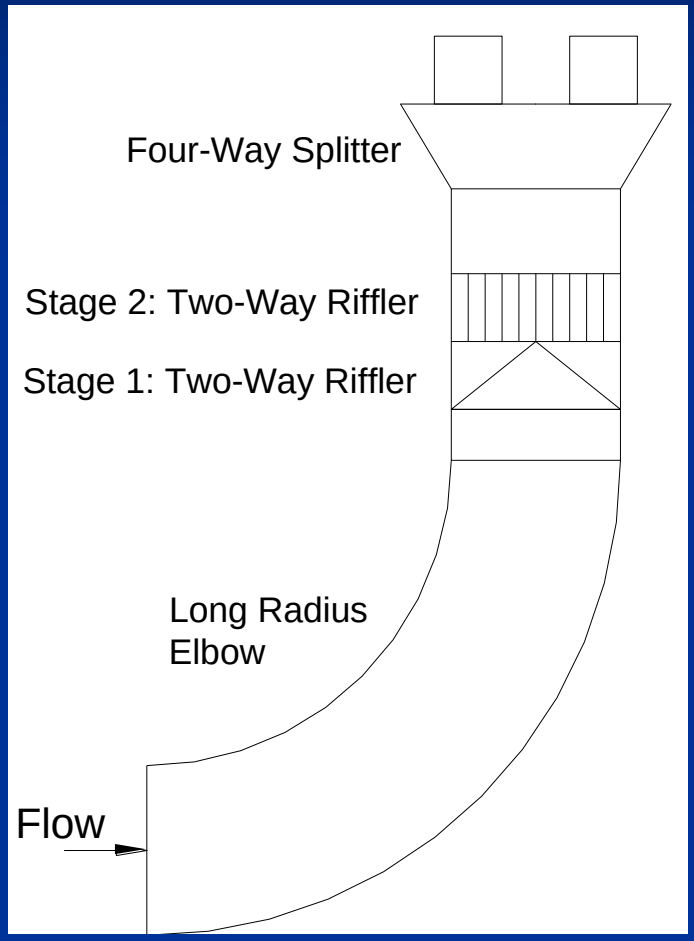
PROJECT SCOPE

- Designed and fabricated two *CoalCONTROL*™ 4-Way rifflers and flow controllers for one mill.
- Installation and coal flow adjustments – Adjusted *CoalCONTROL*™ to achieve the specified coal distribution profile of 20/30/30/20 percent of coal flow through each burner at each elevation

PROJECT APPROACH

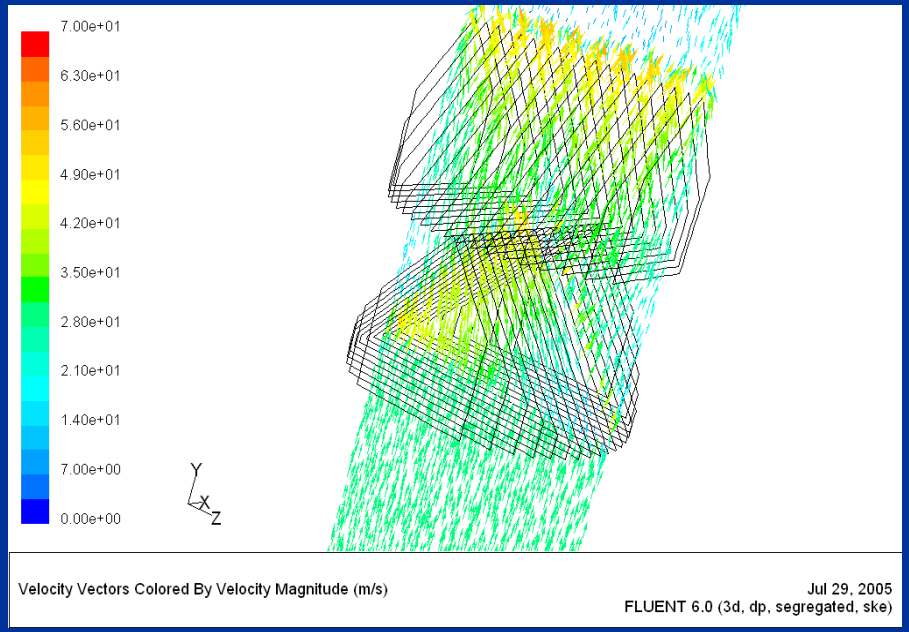
- Preliminary study was performed using the PSEG Energy Liaison Program (ELP) account.
  - CFD modeling – Pressure drop calculations and design improvement were done.
  - Contacted fabricators for cost estimates.
- Fabricated, installed and tested the ***CoalCONTROL***™ technology.
- Future work – Installation of ***CoalCONTROL***™ on the remaining mills.

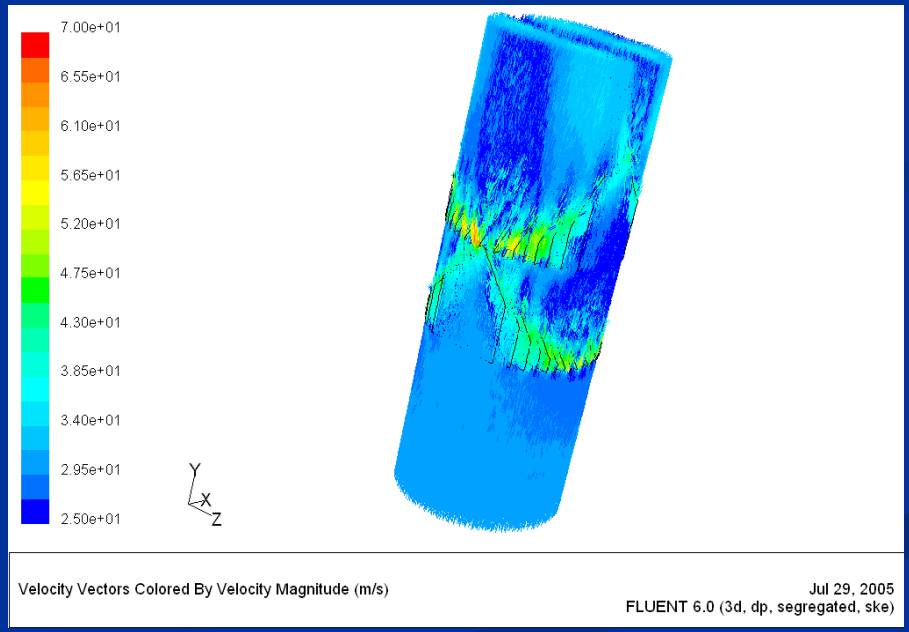
CURRENT RIFFLER DESIGN AT MERCER



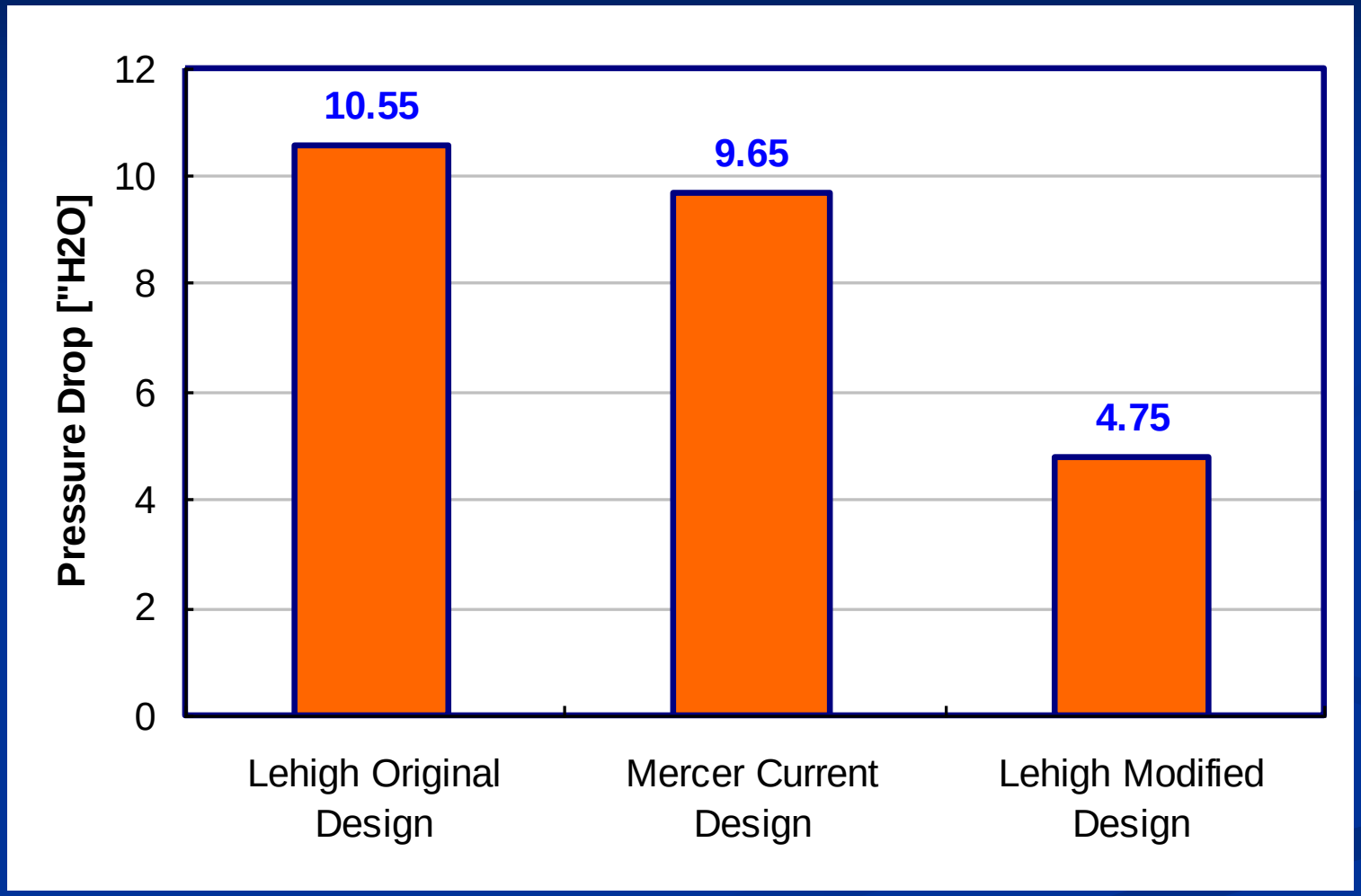
CFD MODELING OF THE EXISTING AND PROPOSED DESIGN

- Computed the pressure drop (dP) of the two designs
- Improve the proposed design to minimize dP



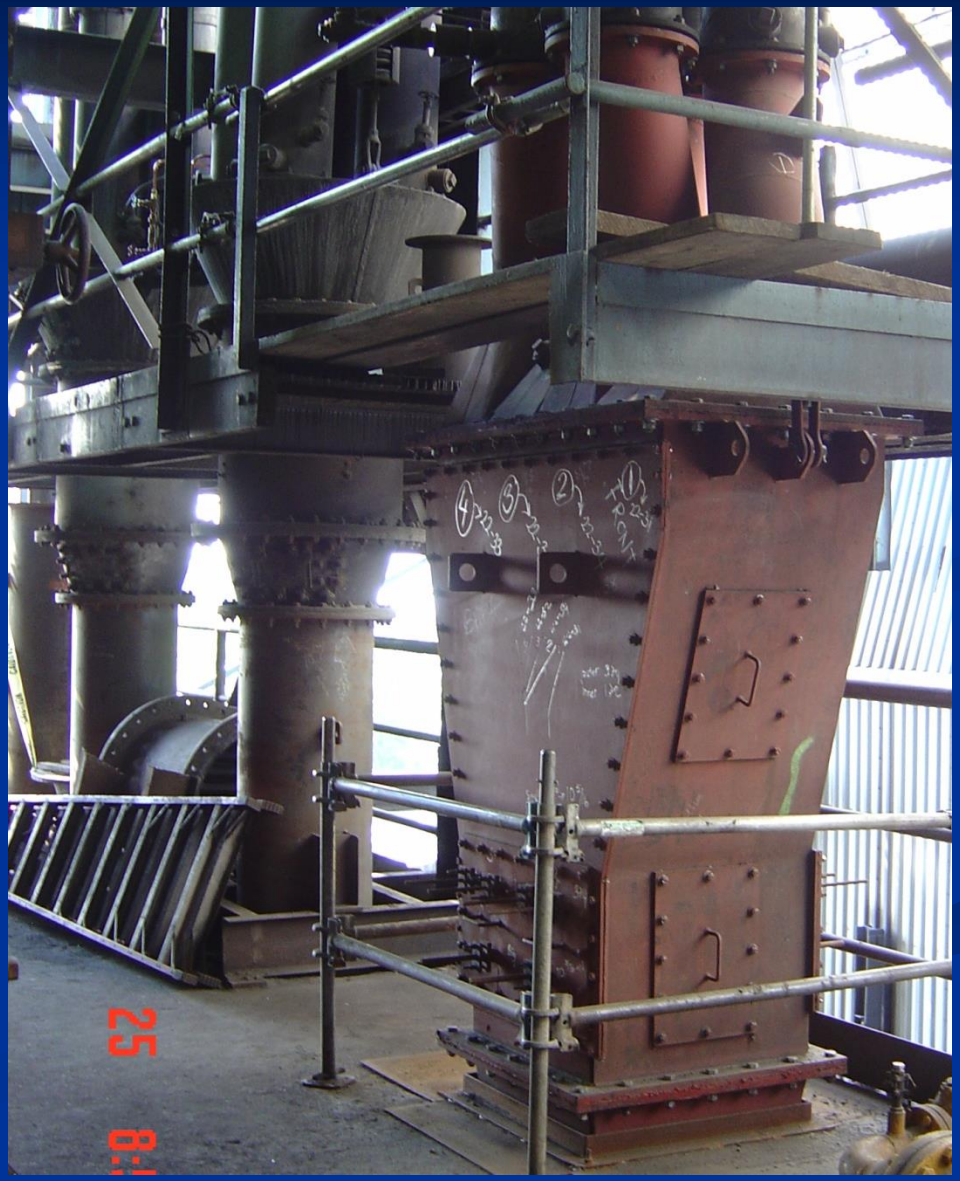


PRESSURE DROP (dP) COMPARISONS

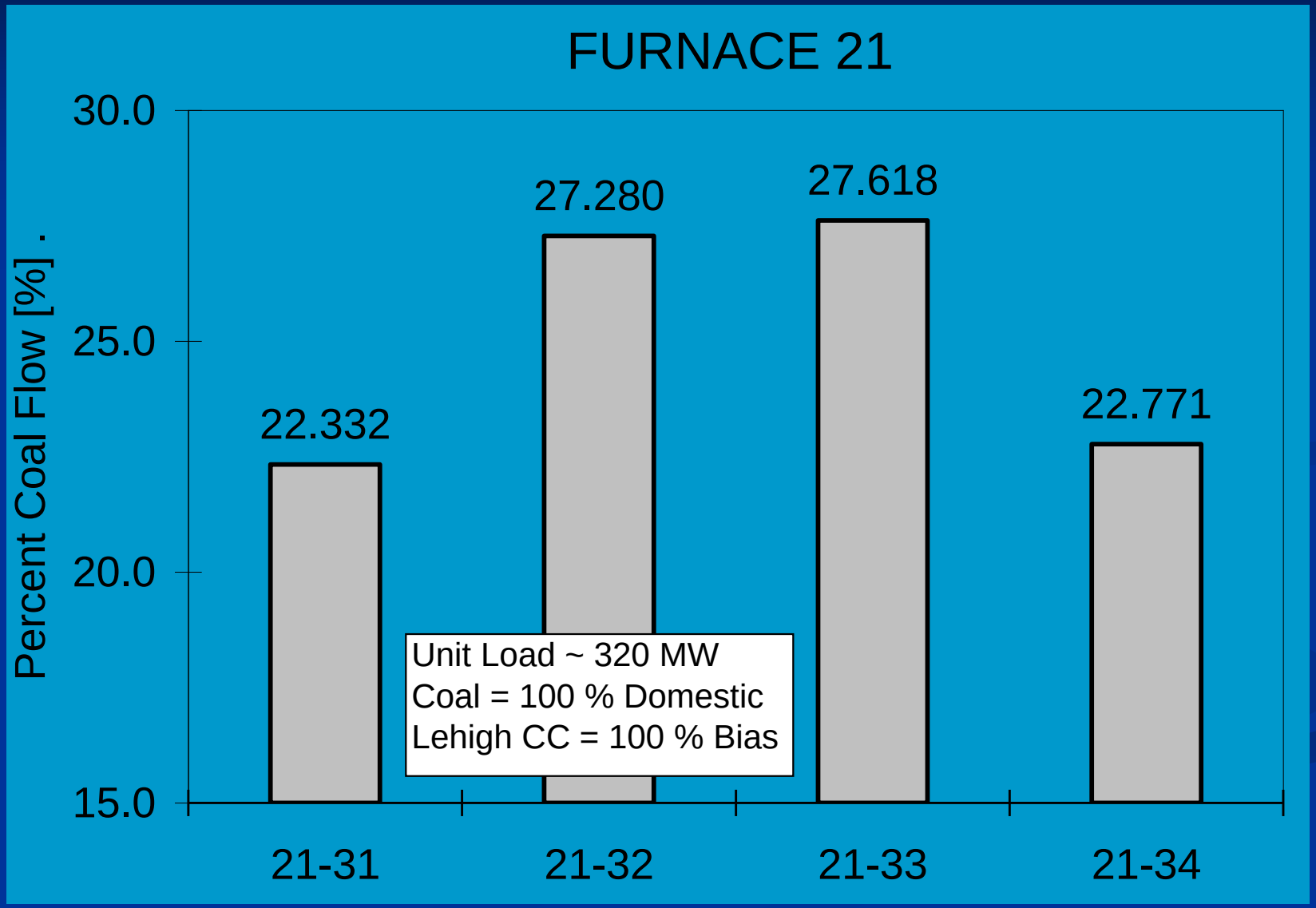


PSEG MERCER STATION – 4-WAY *CoalCONTROL™* ASSEMBLY

- Design and fabrication of two 4-Way ***CoalCONTROL™*** riffler and flow controller assemblies was done in the Winter 2006.
- Installation and adjustments of ***CoalCONTROL™*** to achieve the specified coal distribution profile was done in Spring 2007.



PSEG MERCER STATION – 4-WAY *CoalCONTROL*™ RESULTS



CONECTIV EDGE MOOR STATION

PROJECT SCOPE

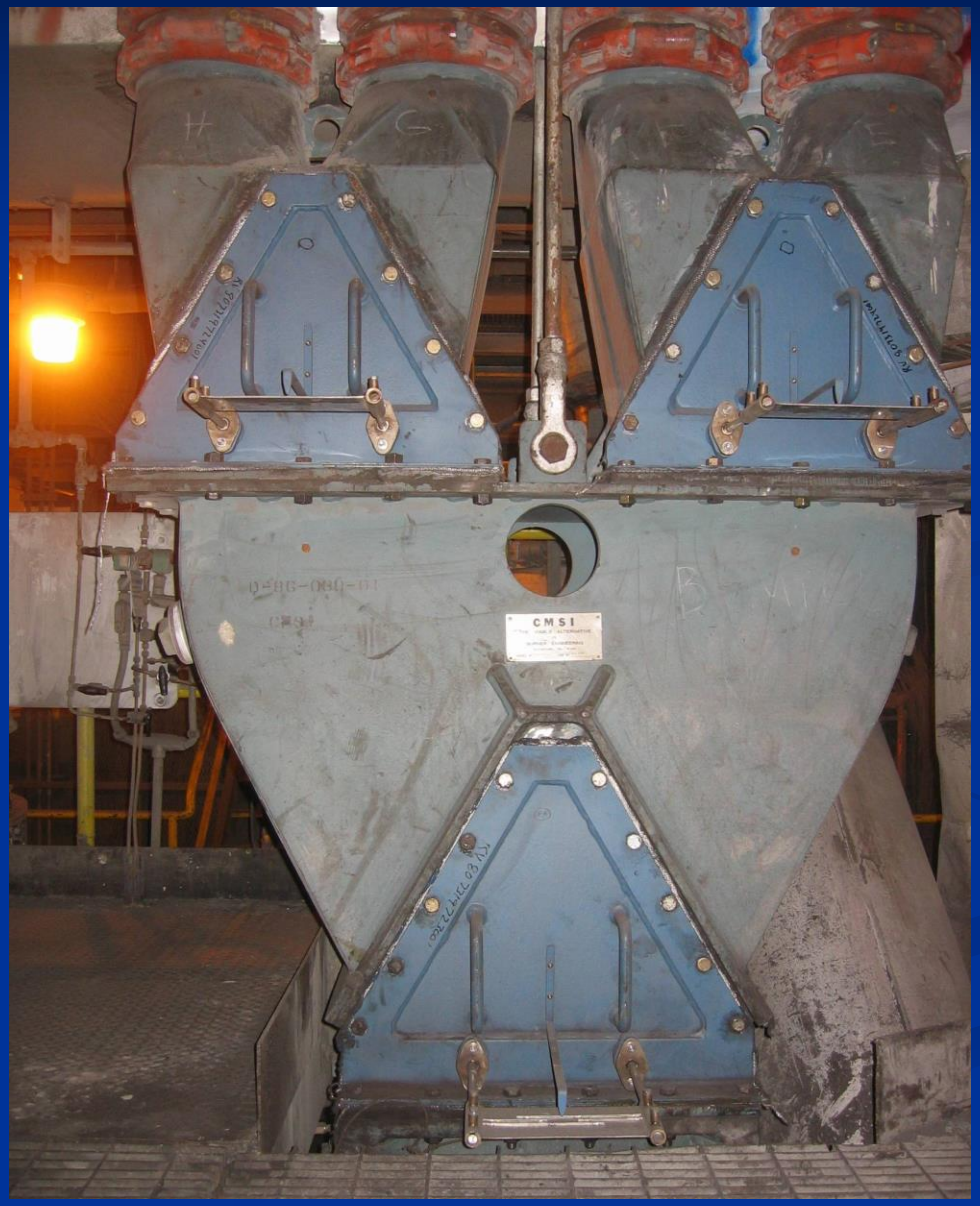
- Station retrofitted a low NO_x system. Vendor required balanced coal-flow distribution (±10%)
- Designed and fabricated twelve (four primary and eight secondary) *CoalCONTROL*™ 2-way coal-flow control elements for four mills.
- Installed and adjusted the *CoalCONTROL*™ elements to achieve the required coal-flow distribution.

PROJECT APPROACH

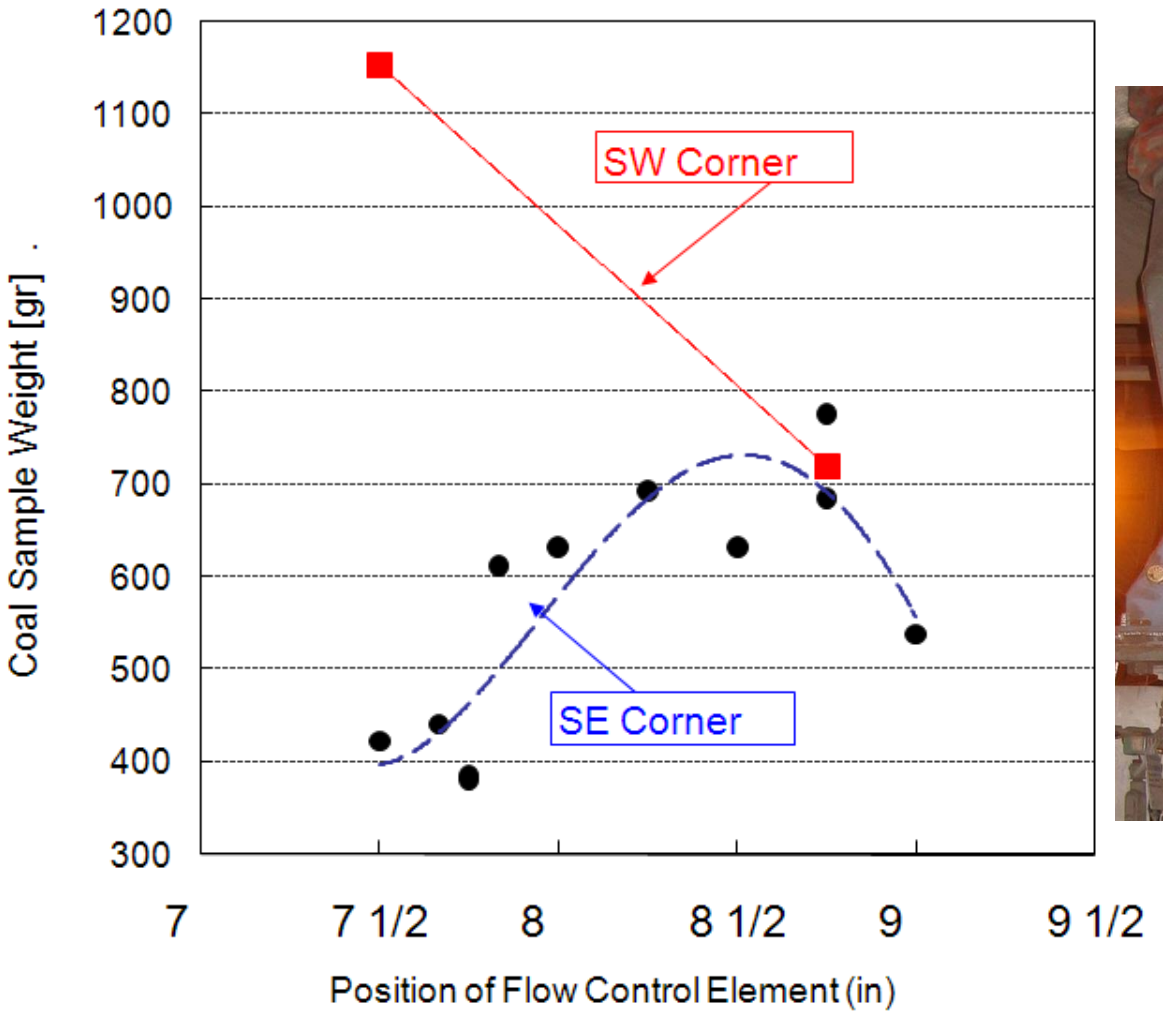
- Preliminary study used the Conectiv Energy Liaison Program (ELP) account.
  - Coal-flow element design.
  - Contacted fabricators for cost estimate
- Fabricated, installed and tested the ***CoalCONTROL™*** technology.

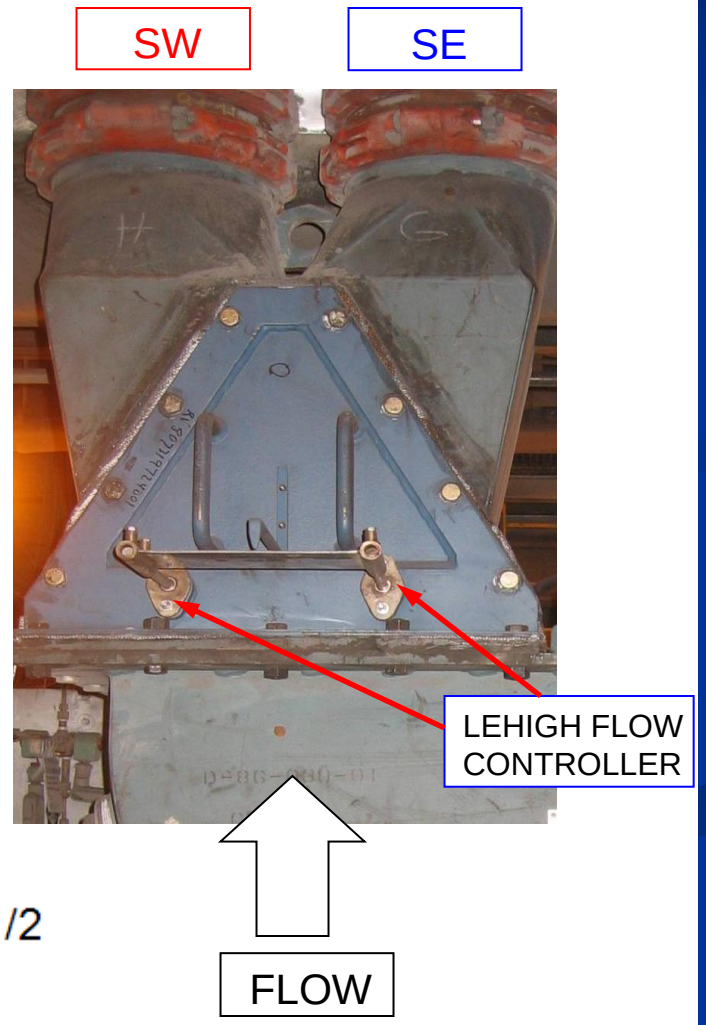
CONECTIV EDGE MOOR EXISTING RIFFLER HOUSING

LEHIGH *CoalCONTROL*™ INSTALLATION

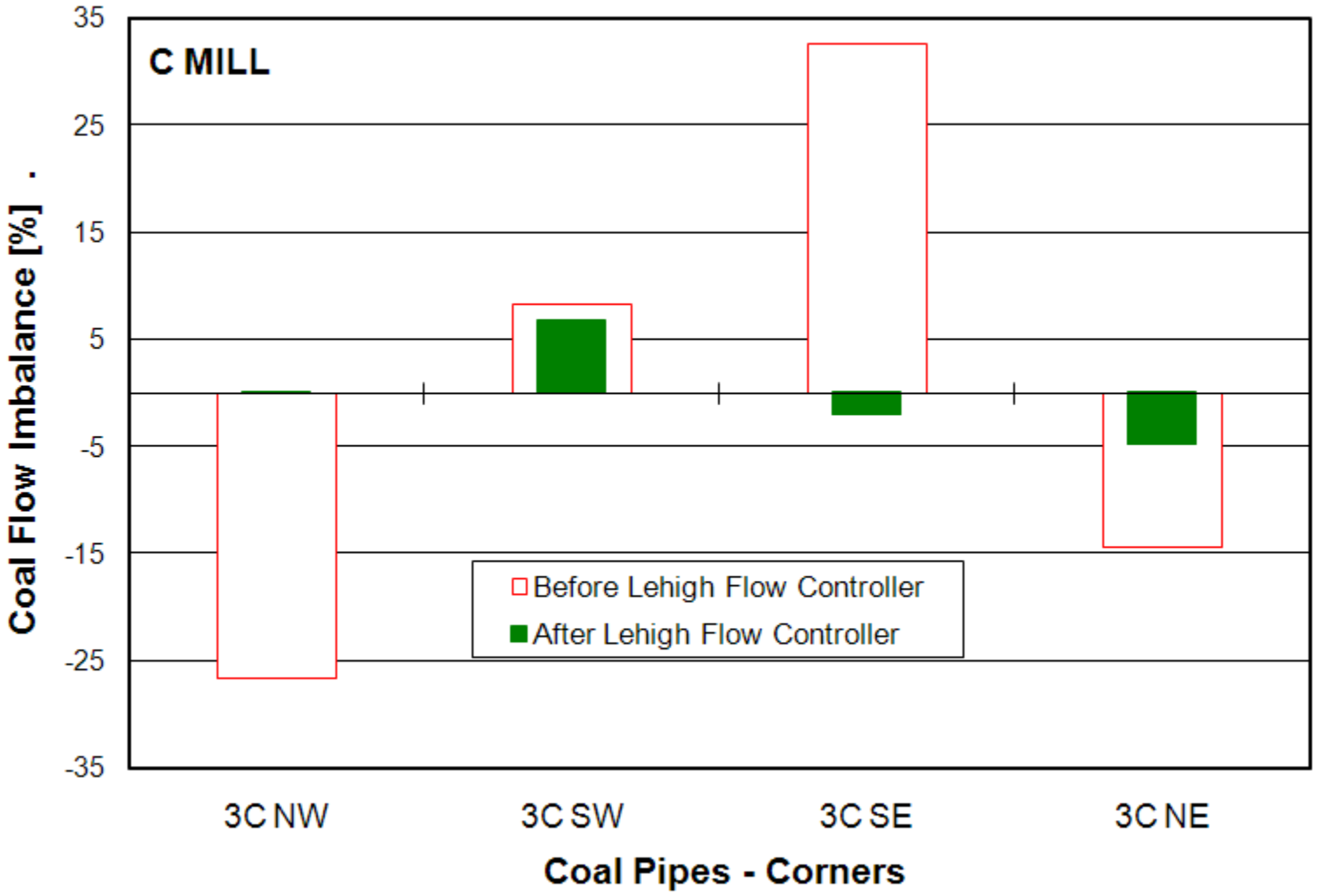


LEHIGH *CoalCONTROL*™ CONTROLIBILITY





C MILL – COAL FLOW



REAL TIME CONTROL OF COAL COMBUSTION

Specified coal flow bias between burners

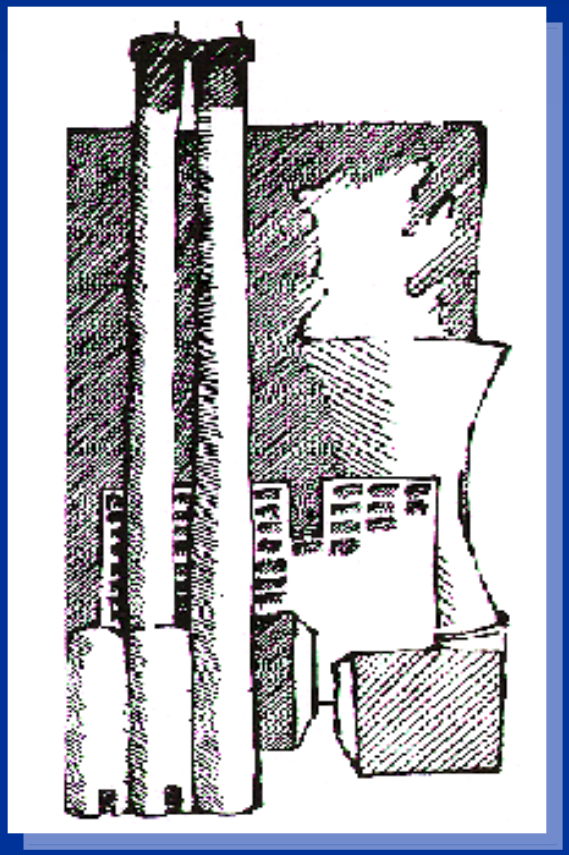
- Windbox design
- Water wall tube temperature
- Slagging
- CO emission

CONCLUSIONS

- *CoalCONTROL*™ has been tested in the field and has shown excellent results
- Primary air flow distribution was not affected by coal flow changes
- Reduced coal flow imbalances to less than ±10%
- Minimal impact on pressure drop
- Provides a useful tool for on-line combustion optimization

ENERGY RESEARCH CENTER

For more information contact –



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