Install Boiler 10 Natural Gas Burners

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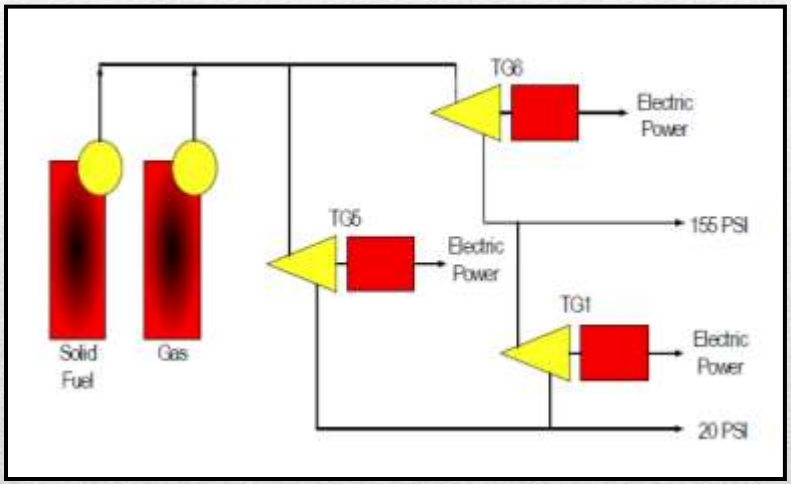
Agenda

- Introductions
- Plant Overview and Gas Burner Need
- Permitting Strategy
- Project Design
- Project Construction
- Startup and Lessons Learned
- Conclusion
- Questions

Overview

- University of Iowa – Main Power Plant
  - ✓ 4 Boilers: 600+ klb/hr, 3 Turbine Generators - 24.7 MW

Boiler	Installed	Fuel	Capacity	Emissions Control
7	1991	Gas	100,000 lbs/hour	Low Nox Burners
8	1991	Gas	100,000 lbs/hour	Low Nox Burners
10	1975	Coal	170,000 lbs/hour	Electrostatic Precipitator
11	1987: modified in 1996	Coal & Biomass	170,000 lbs/hour	Baghouse and SO_2 Emissions Control



  - ✓ 6 offsite natural gas and 1 biomass boilers

Project Scope

- Install two (2) new low Nox gas burners with individual air plenums in the existing pressure part openings.
- Install a new FD fan to support full-load natural gas firing.
- Install an FGR system for:
  - ✓ lowering natural gas burner NOx emissions.
  - ✓ Cooling the natural gas burners during stoker firing
  - ✓ Cooling the stoker grate during natural gas firing
- Install an airflow measurement device to measure combustion airflow to the natural gas burners.

Project Scope (Cont.)

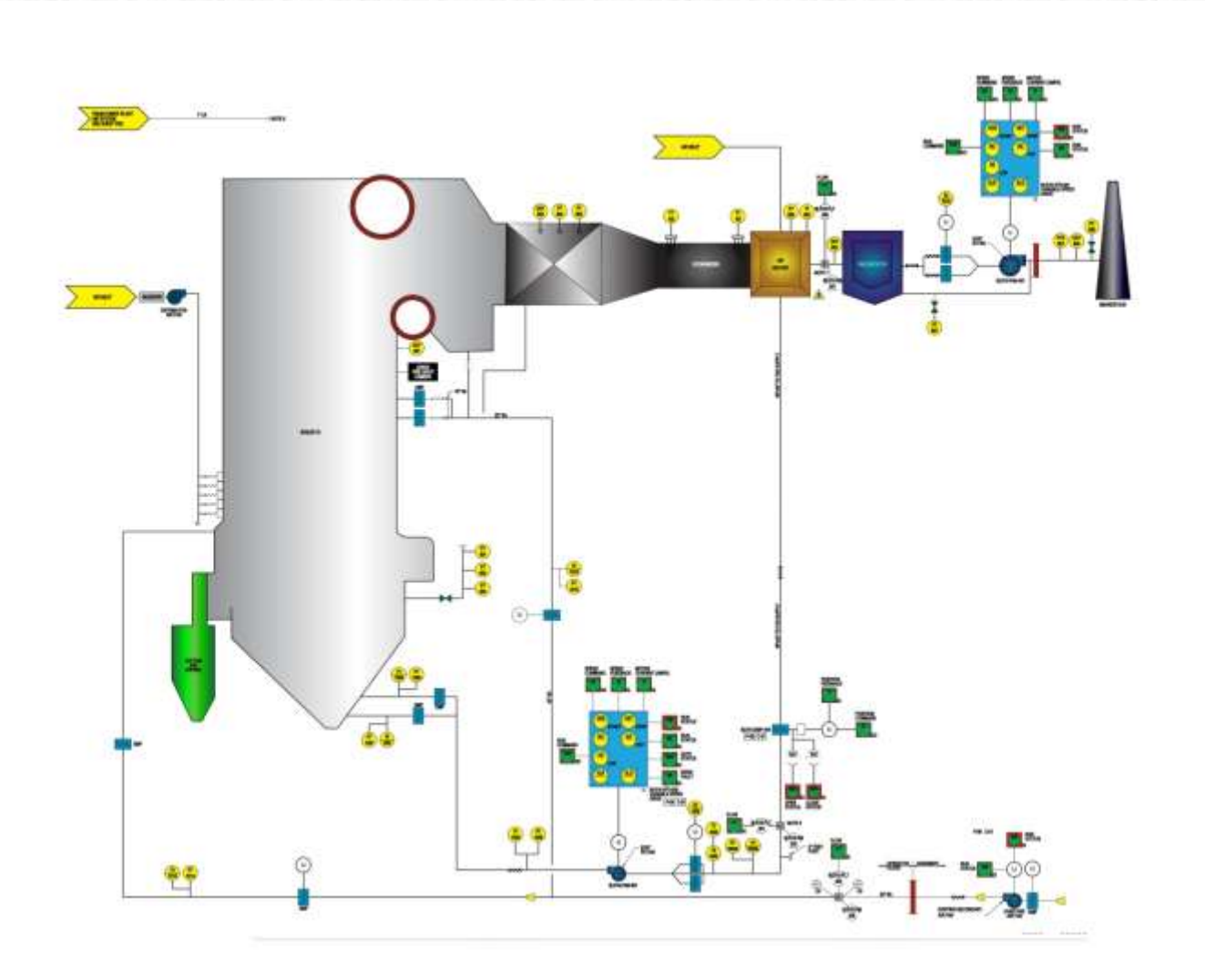
- Remove two (2) of the five (5) existing boiler ash hoppers and associated reinjection lines.
- Monitor the SH steam and metal temperatures during natural gas firing to prevent overheating of the superheater outlet header and superheater tubes.
- Protect the grate via gravel or by being bricked over if the University plans to fire solely natural gas. If stoker-firing capability is to be retained at all times, cooling air or cooling FGR can be passed through the stoker.

Boiler 10 Performance

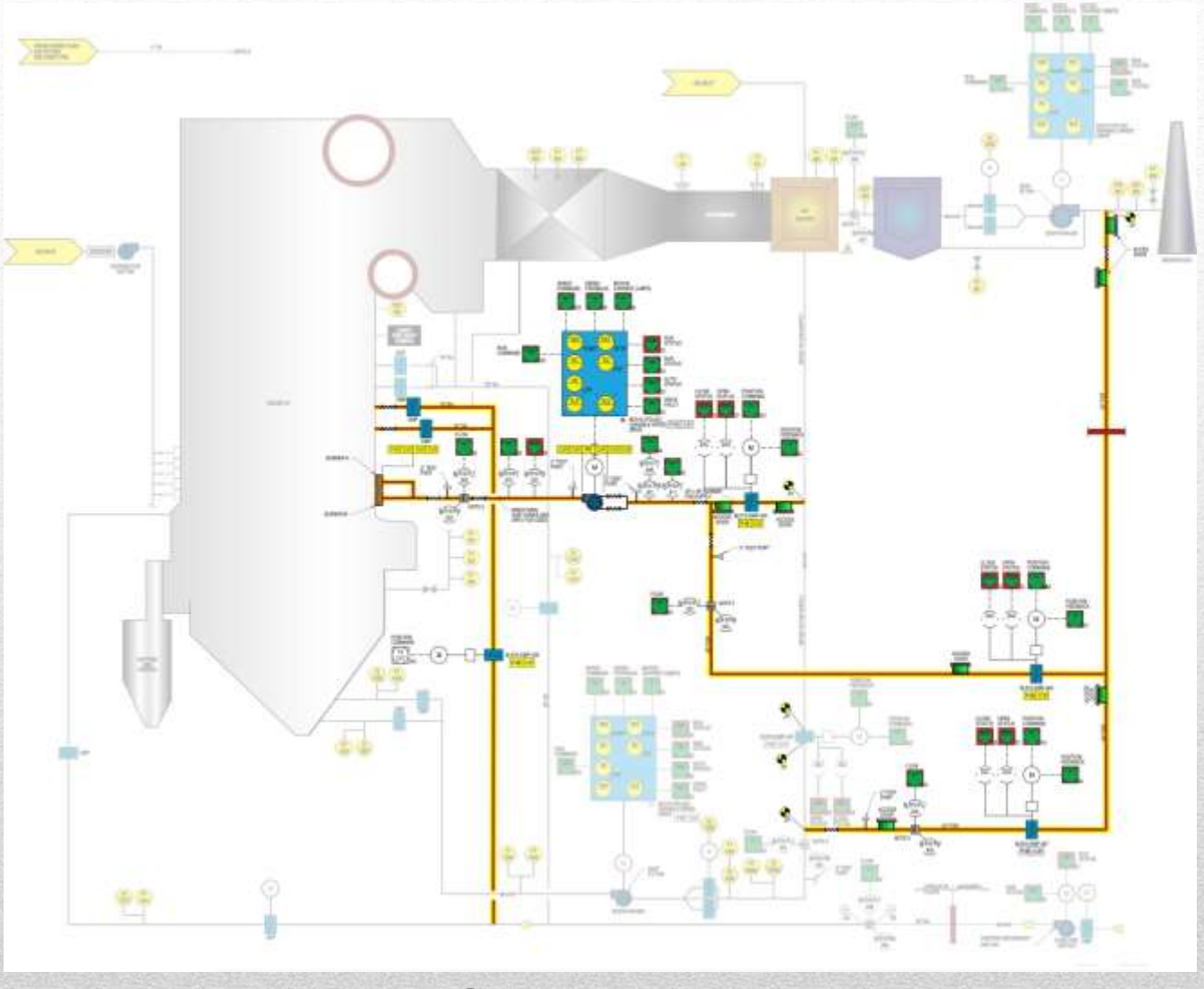
Parameter	Boiler 3
Steam flow (lb/hr)	170,000
Steam temperature (°F)	760
Steam pressure (psia)	490
Feedwater temperature (°F)	360
Drum pressure (psia)	---
Superheat Attemperation	Yes
Original fuel	Coal
Firing arrangement	Traveling grate Spreader stoker
Superheat	Yes
Air heater type	Tubular

Burner Operating Data

Fuel type	Natural gas
Fuel flow per burner	108,000 schf
Design heat release per burner	108 MM Btu/hr
Minimum heat release per burner	9 MM Btu/hr
Total boiler heat release	218 MM Btu/hr
Burner turndown required	12:1
Excess air at design heat release	10%
Combustion airflow per burner	25,314 ACFM



P&ID of Boiler 10 Prework



P&ID of Boiler 10 Post Work

New FD Fan

- The existing FD fan does not have sufficient static pressure capability for full-load natural gas firing.
- A new FD fan is required for full-load natural gas firing.

Natural Gas FD Fan Sizing Criteria

Design Criteria	Units	Test Block +10% Flowrate, +21% Static, +25°F	100% Boiler MCR 0% FGR Included
Combustion airflow rate	lb/hr	189,200	172,000
Combustion air temperature	°F	275	250
Volumetric flow rate	ACFM	59,800	52,500
Total static pressure	iwc	14.5	11.9

One of Two New Gas Burners

Natural Gas FD Fan Performance

Flow	ACFM	59,800
Static Pressure	in. WG	15
Speed	RPM	1,780
Power	BHP	176
Temperature	°F	275
Elevation	feet	650
Density	lb/ft^3	.0.527
Outlet velocity	ft/min	3,902

Breeching to the Burners was Modeled

Parameter	Units	Boiler 3	
		Coal	Natural Gas
Flue gas inlet temp	°F	1,650	1,916
Flue gas outlet temp	°F	1,240	1,337
Steam inlet temp	°F	472	470
Steam outlet temp	°F	775	820
Calculated tube midwall temp	°F	827	902
Tube midwall temp limit	°F	1,017	1,017
Calculated tube outer wall temp	°F	829	**904**
Tube outer wall temp limit	°F	900	900

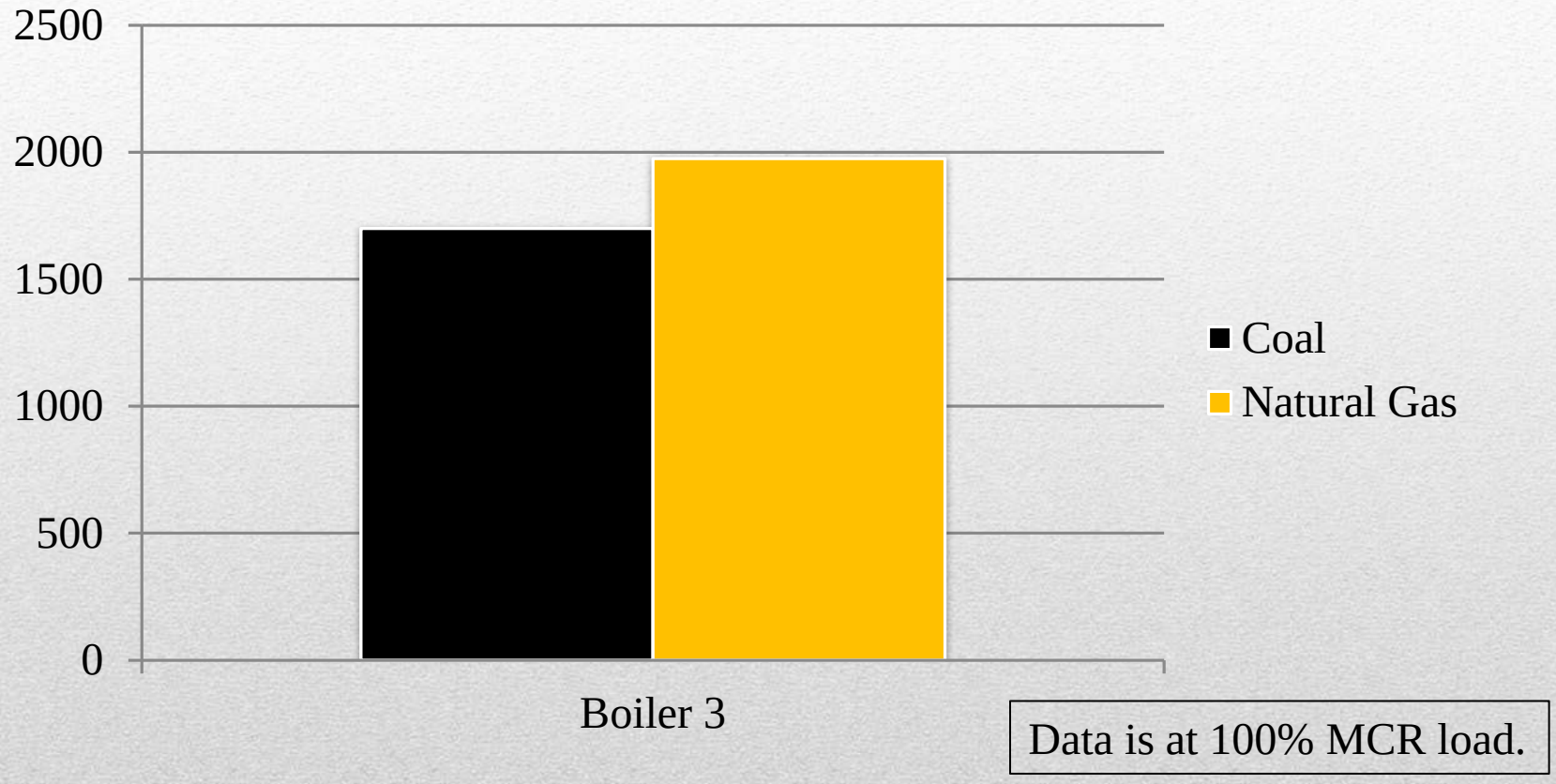
Changing FEGT, absorption effectiveness, and flue gas flow cause some pressure part temps to rise and some to fall.

Tube Metal Temps & Pressure Part Mods

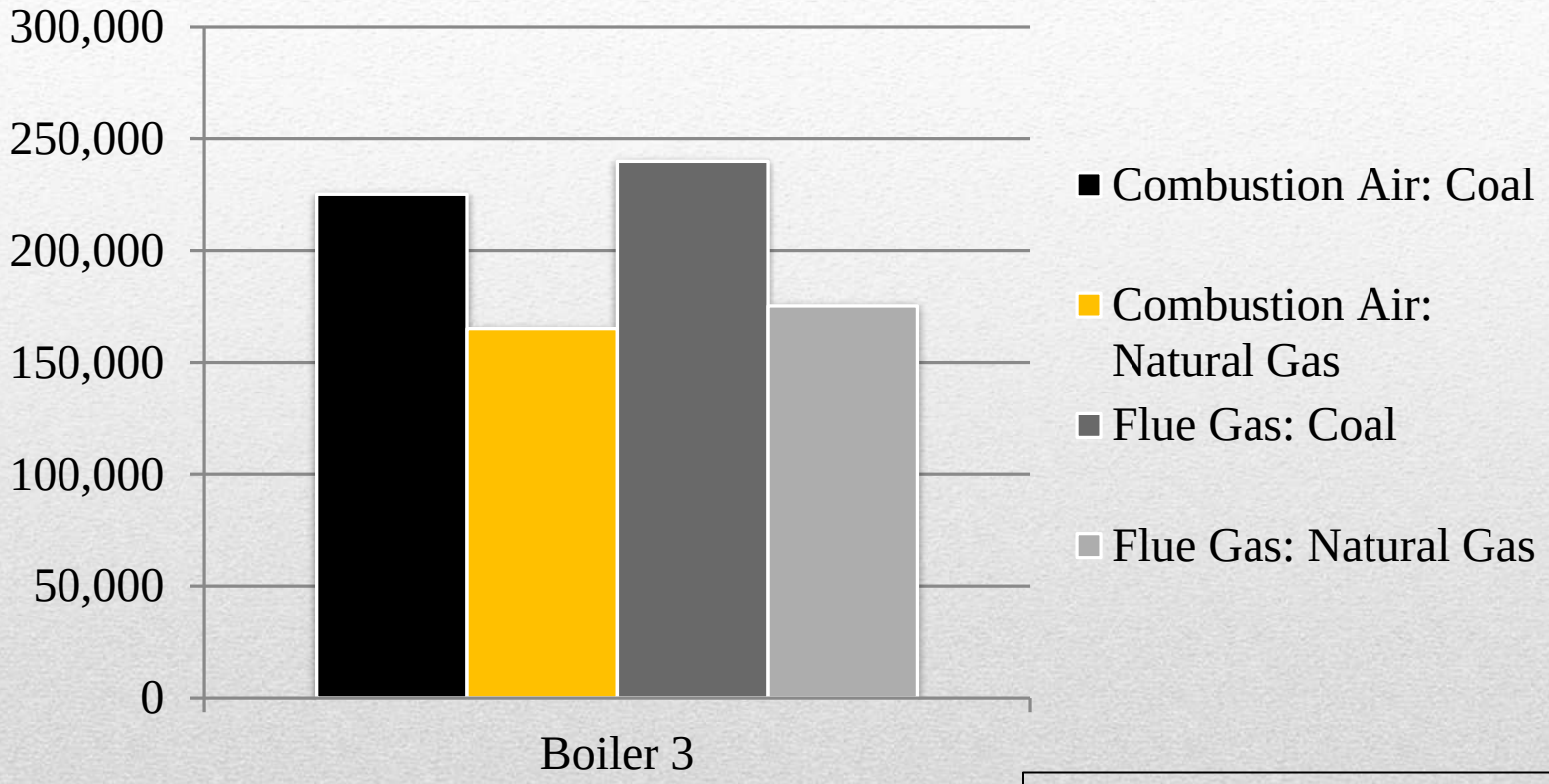
Parameter	Units	Boiler 3	
		Coal	Natural Gas
Load	%MCR	100	100
Type of attemperator station		Spray	
SH temp before spray	°F	779	815
SH temp after spray	°F	755	760
Total superheat steam flow	lb/hr	159,485	170,000
Spray water temp	°F	352	352
Spray water flow	lb/hr	1,897	**4,671**

Attemperator Flow

Superheater Tube Temperature Transmitters

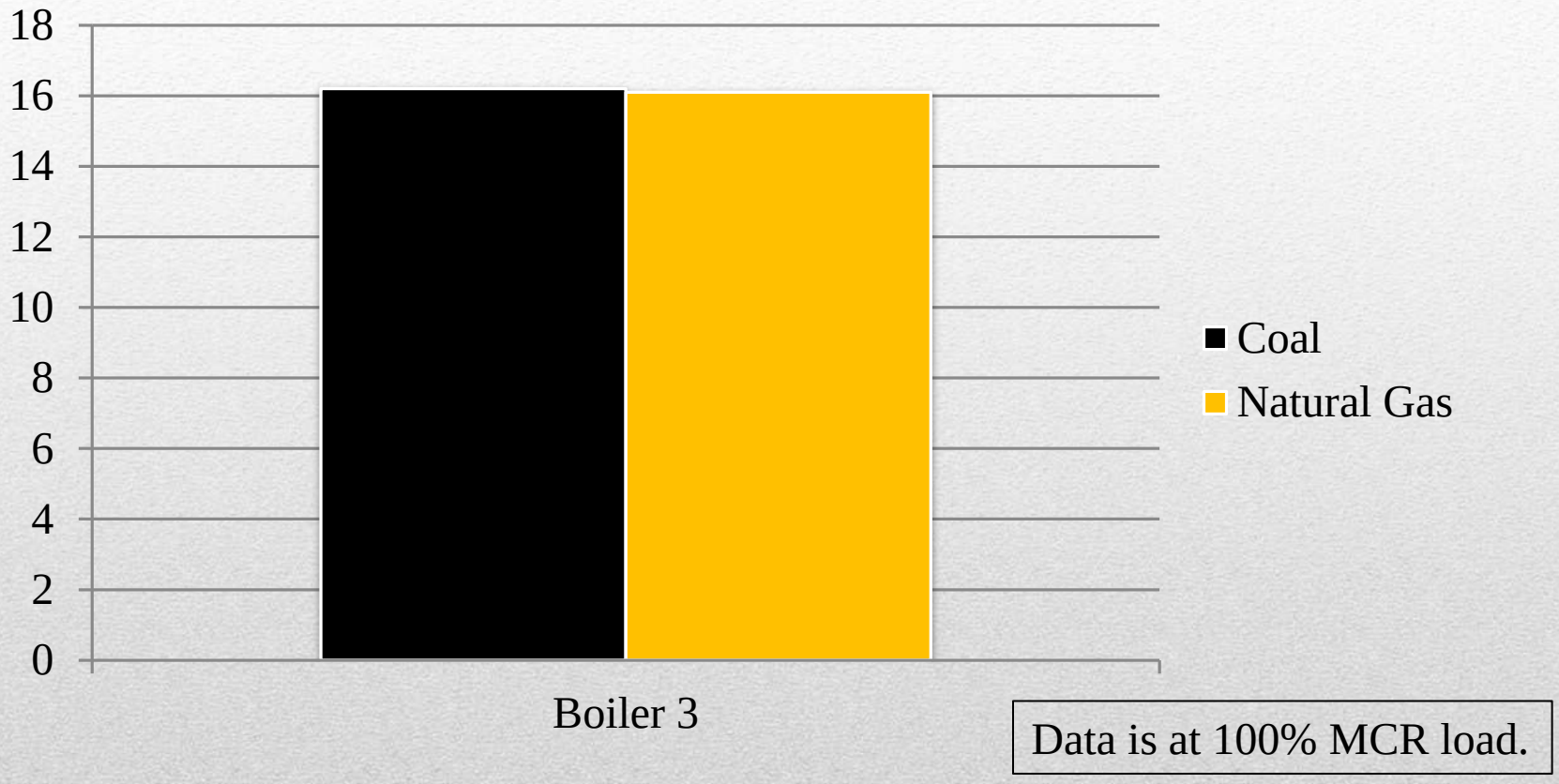


Furnace Exit Gas Temperature (°F)



Data is at 100% MCR load.

Combustion Air & Flue Gas Flow Rates (lb/hr)



Total Boiler Losses on Efficiency (%)

New Breeching and Damper

New Burner Fan

New Breeching

New Flow Meter

New Gas Train