POWER-GEN EUROPE

RENEWABLE ENERGY WORLD CONFERENCE & EXPO EUROPE

T6S2

Retrofit, Conversion from Solid to Gas Fuel for Circulating Fluidised Bed Utility Boiler

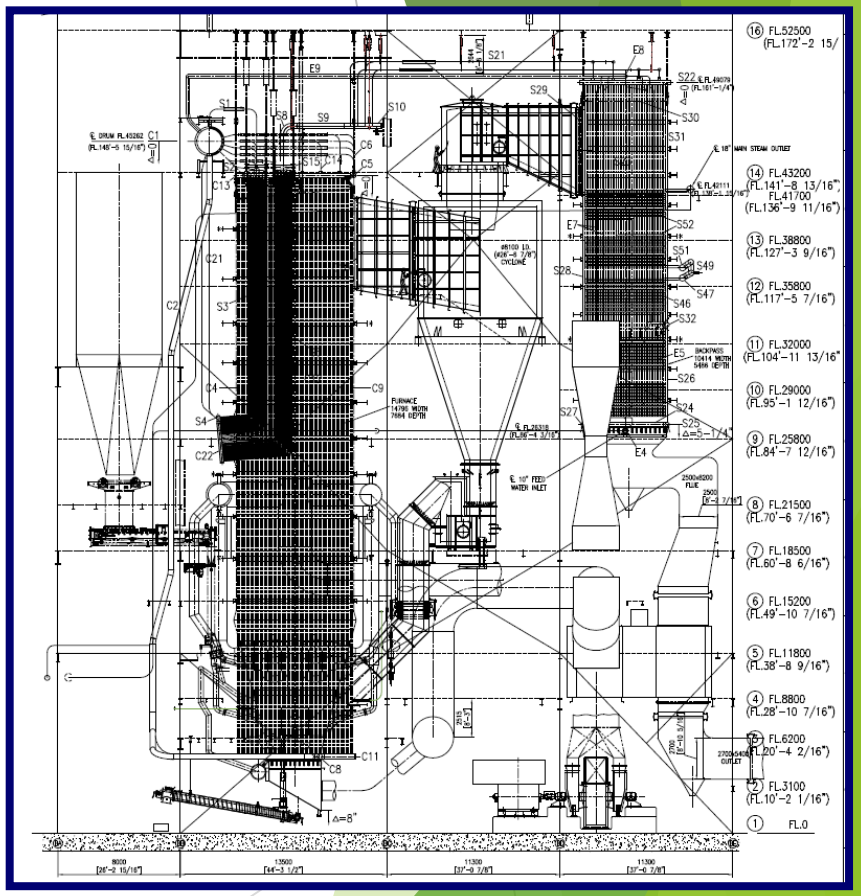
Jay Richardson – Combustion Engineer
Zeeco, Inc.

Overview:

- Circulating Fluidised Bed (CFB) Utility Boiler
- 550 tph steam at 127 barg and 541°C
- Operating on solid fuel for 1.5 years
- Full conversion from Petroleum Coke (Pet Coke)
- Meet NOx requirements and capacity
- Minimal or no impact on waterside

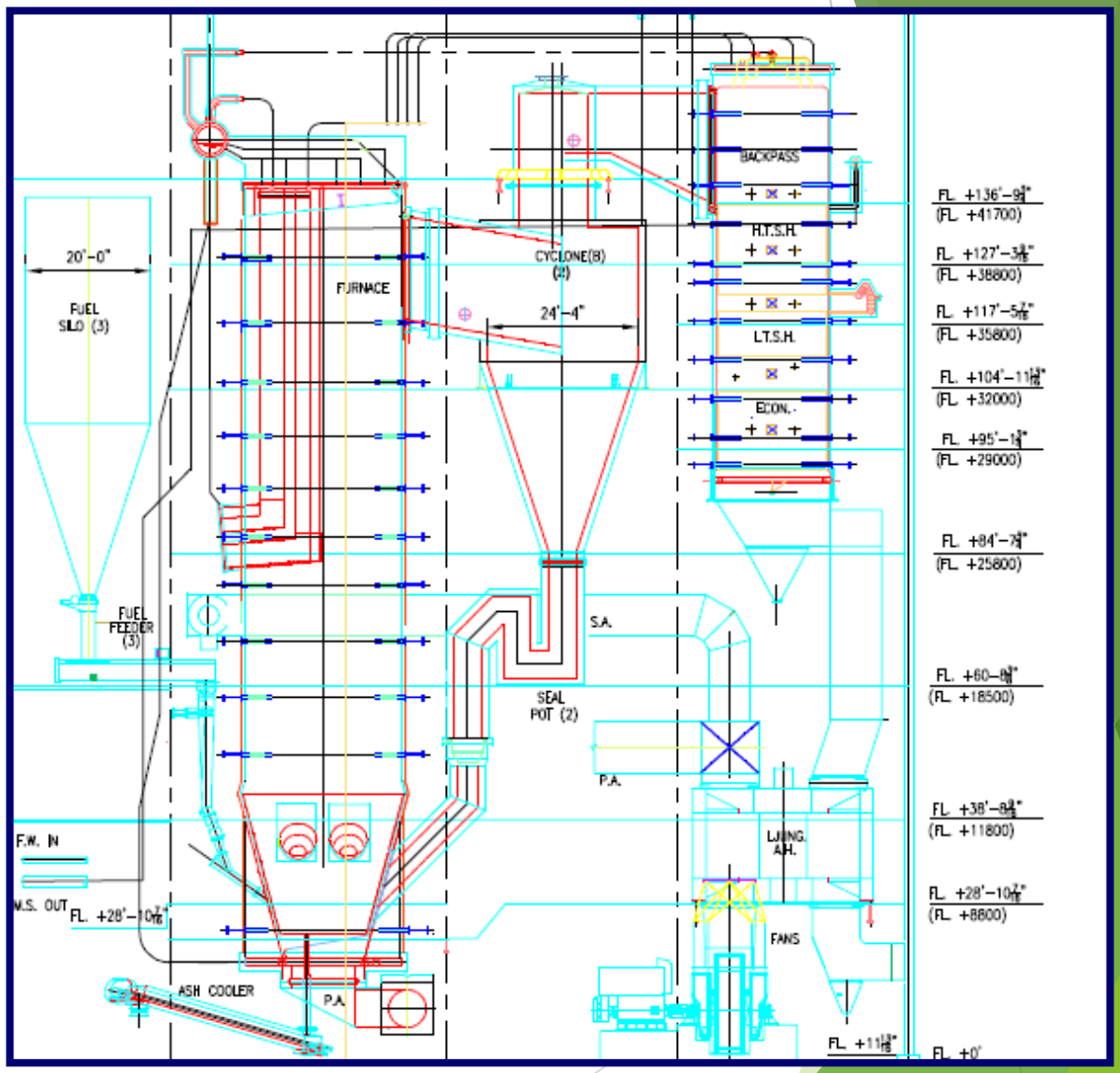
Challenges to Overcome:

- Meet current permit NOx limits – 0.07lbs/mmbtu (118 mg/Nm3)
- No E-FGR (convective impacts).
- Ensure no degradation / derate on steam production.
- Solids return systems – cyclone
- Ancillary equipment
- Fluidization system
- Maintain original design ramp rates
- Maintain 10-1 turndown of steam flow
- No design changes on existing water or steam circuit metallurgy



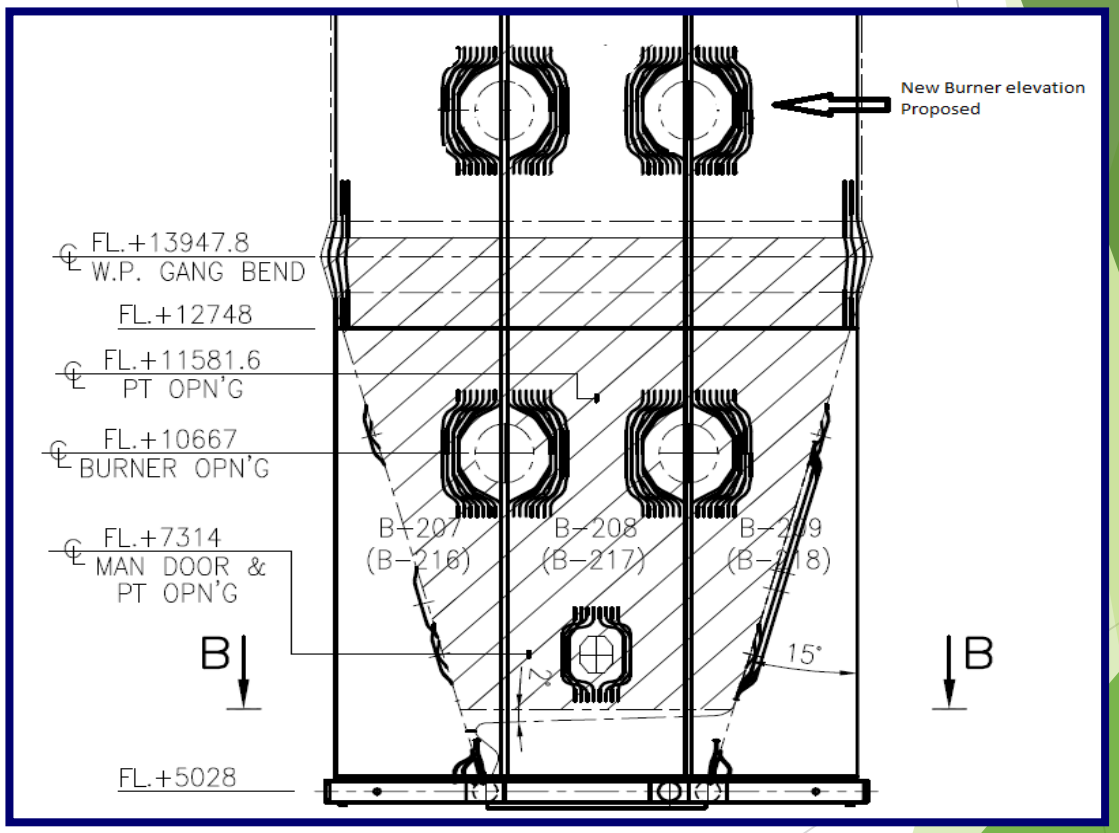
Options:

1. Remove Fluidised bed bottom and fire vertically.
    - Removes Coal Firing capability
2. Remove Start-Up Burners and Increase Firing Capacity
    - Heat Absorption issues
3. Replace Start-Up Burners and add second level of burners to achieve capacity.
    - Ideal Solution
- Performance runs are critical for waterwall protection system (circulation ratio) and reliable steam production post-retrofit.



Option 3:

- Replace 4 Start-Up burners with new burners
- Add second elevation of burners
  - (existing tube panel)
- ~80% of equipment remained available for future pet coke firing
- Complete redesign of combustion air system
- Integration of new redundant BMS and controls logic
- New gas fuel skids
- Refractory removal
- Structural support modifications for new equipment

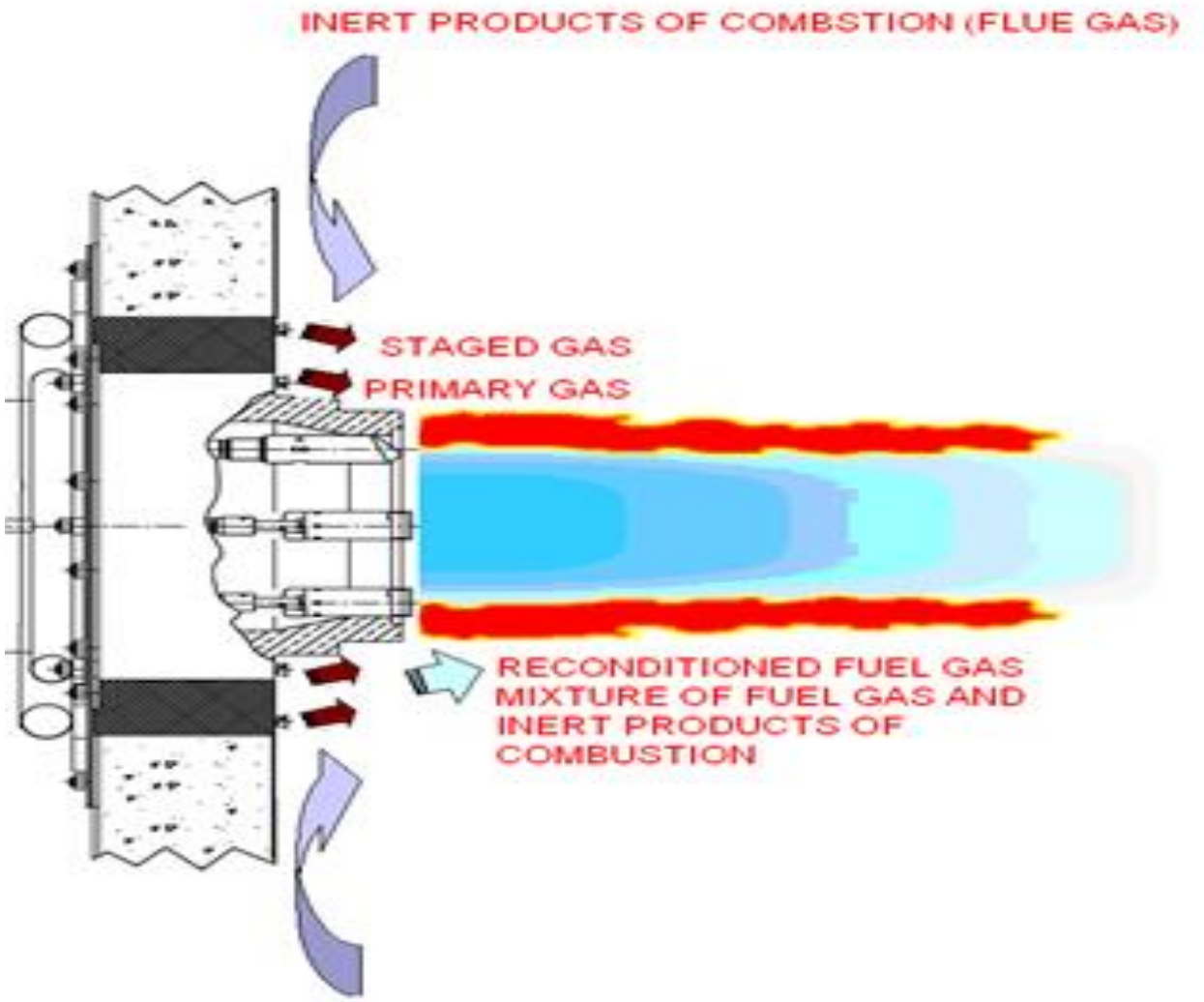


Fluid Bed Bottom – Refractory to be Removed:

Ultra-Low NOx Free Jet Burners:

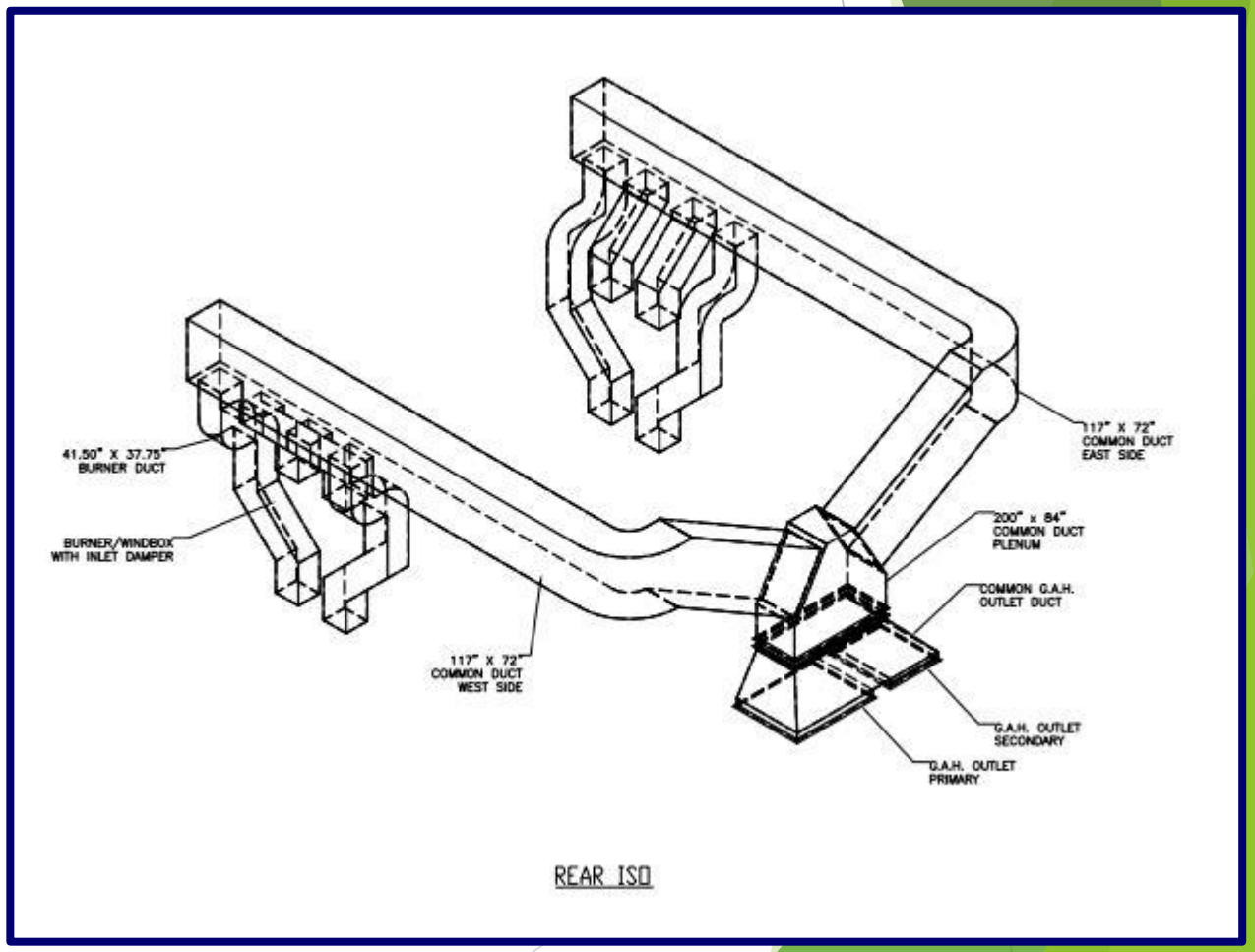
- Natural Gas firing
- 52 MW HHV (capacity)
- Two Fuel Connections for improved turndown/operation
- Exmo auxiliaries and refractory tile for stability
- Steam lance for NOx reduction
  - never commissioned
- Individual windboxes with dampers

Burner Design Theory:



Combustion Air System Redesign:

- Originally airflow is split between bed lances and start up burners
- All airflow redirected to existing and new burner elevation.
- Physical Air Flow Modeling



Physical Air Flow Modeling:

- Plexiglass Model
- 1/8 Scale

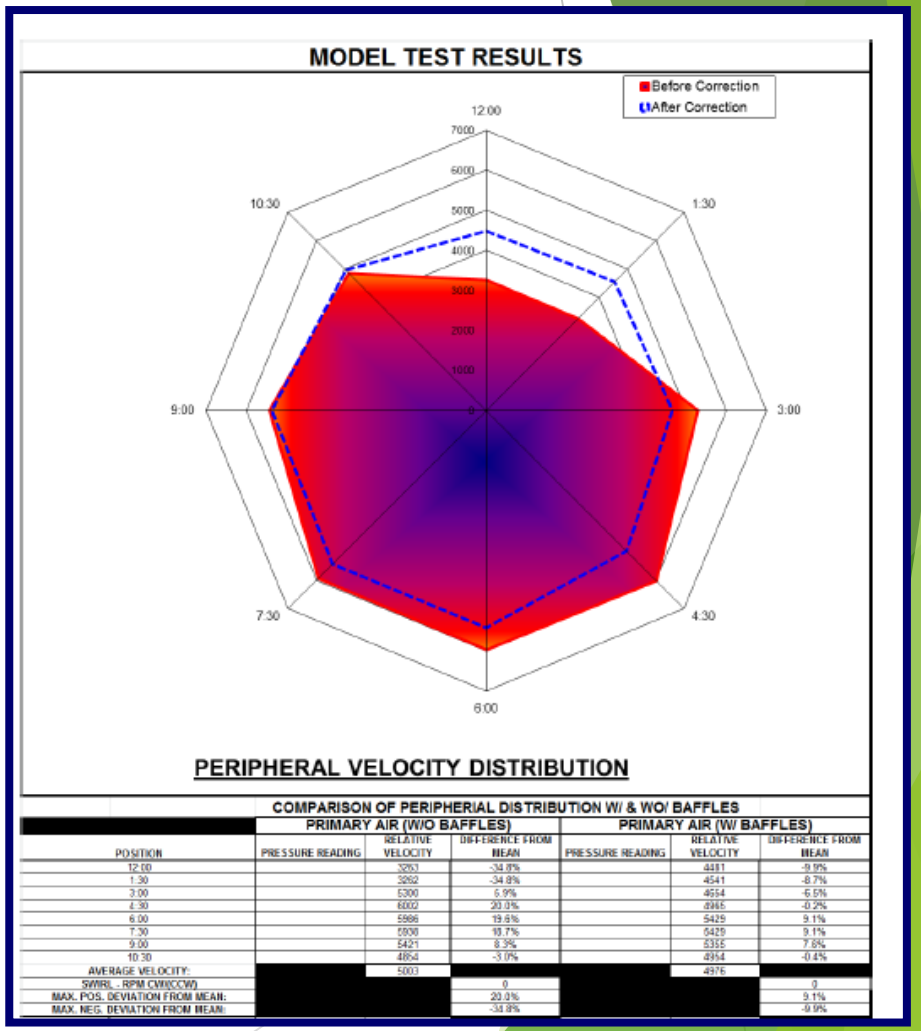
Pressure Coefficient:

C_p= static Pressure/dynamic pressure = 1/[Euler No.]^2

- Accurate
- Efficient
- Flexible
- Inexpensive

Physical Air Flow Modeling Cont.:

- Airflow Distribution +/-2% to each burner is key.
- Fuel should be “balanced” to each burner
- Flame fit equalized for each burner
- Temperature distribution equalized with firing rate
- System design assistance for balance and pressure drop optimization



PERIPHERAL VELOCITY DISTRIBUTION

COMPARISON OF PERIPHERIAL DISTRIBUTION W/ & WO/ BAFFLES

	PRIMARY AIR (W/O BAFFLES)			PRIMARY AIR (W/ BAFFLES)		
POSITION	PRESSURE READING	RELATIVE VELOCITY	DIFFERENCE FROM MEAN	PRESSURE READING	RELATIVE VELOCITY	DIFFERENCE FROM MEAN
12:00		3263	-34.8%		4481	-9.9%
1:30		3262	-34.8%		4541	-8.7%
3:00		5300	6.9%		4664	-6.5%
4:30		6002	20.0%		4965	-0.2%
6:00		5986	19.6%		5429	9.1%
7:30		5938	18.7%		5429	9.1%
9:00		5421	8.3%		5355	7.6%
10:30		4854	-3.0%		4954	-0.4%
AVERAGE VELOCITY:		5003			4976	
SWIRL - RPM CW/(CCW)			0			0
MAX. POS. DEVIATION FROM MEAN:			20.0%			9.1%
MAX. NEG. DEVIATION FROM MEAN:			-34.8%			-9.9%

Results:

- Unit re-commissioned in less than two weeks.
- <100 mg/Nm3 NOx emissions
  - No FGR or Steam Injection
- 550 tph production achieved
- Sister unit conversion the following year (2014)

Questions?