Feb. 11, 2004

Biomass Utilization in Main Stream Power Systems

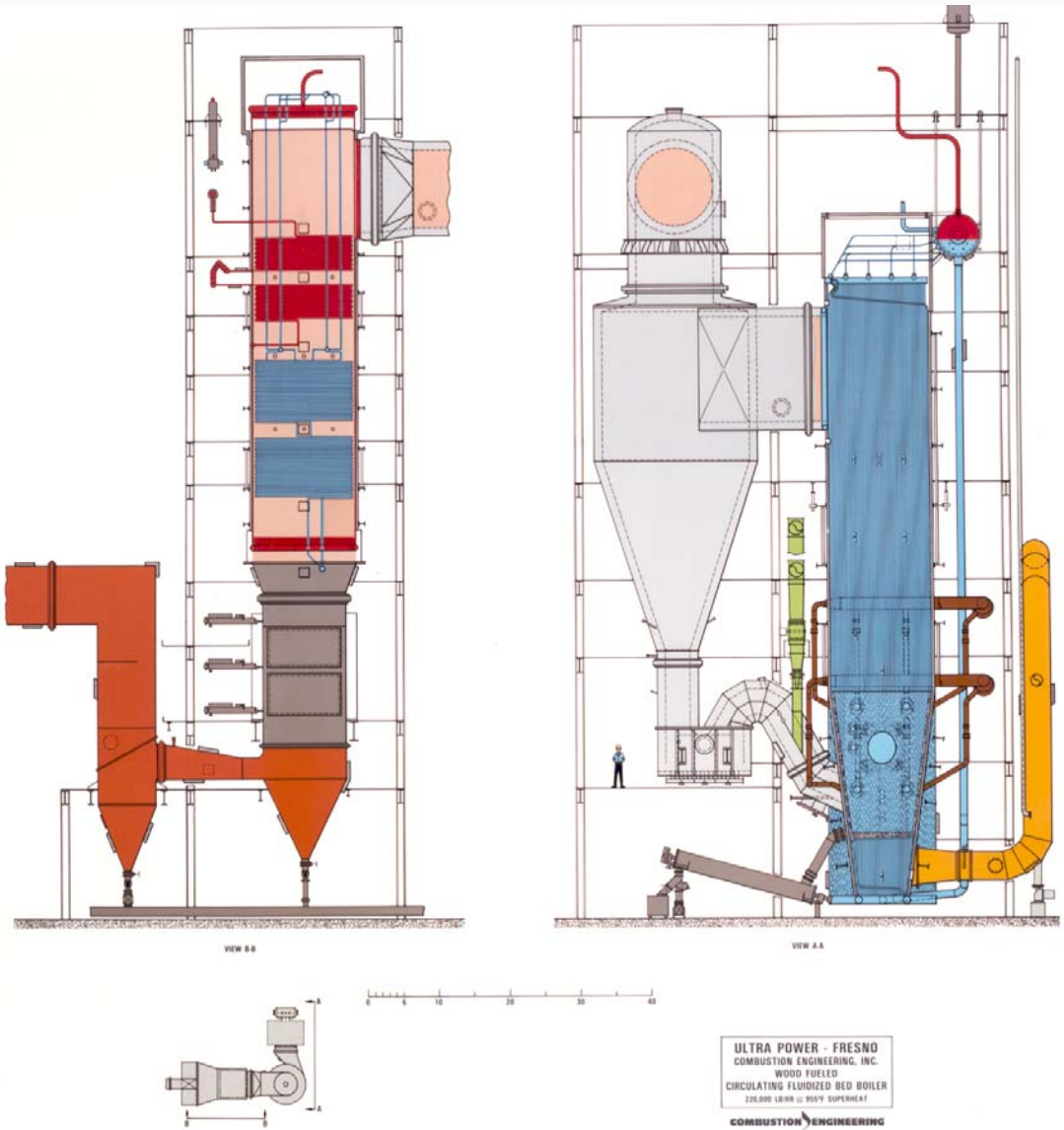
Galen Richards

ALSTOM

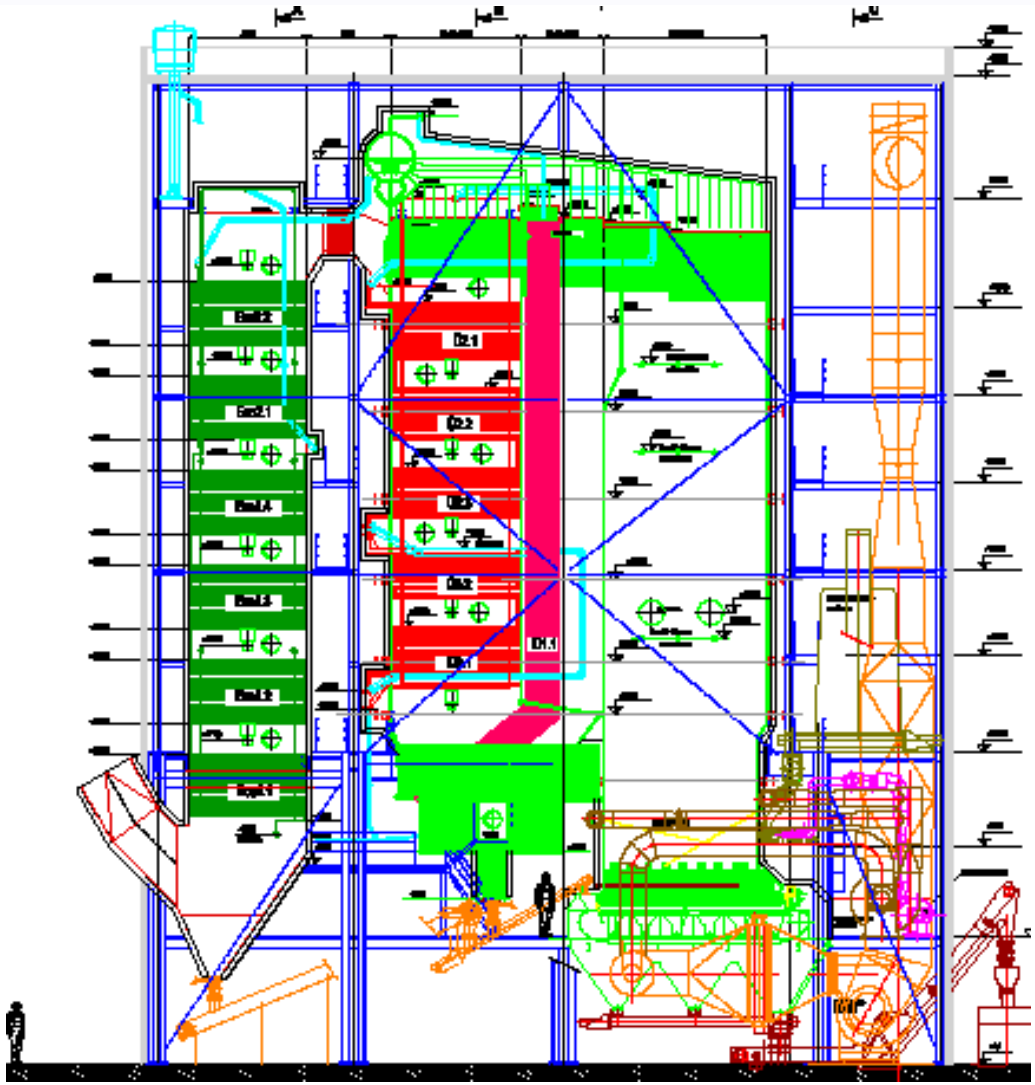
Outline

- Overview of biomass experience at ALSTOM Power Inc.
- Retrofit of a bark-fired stoker boiler

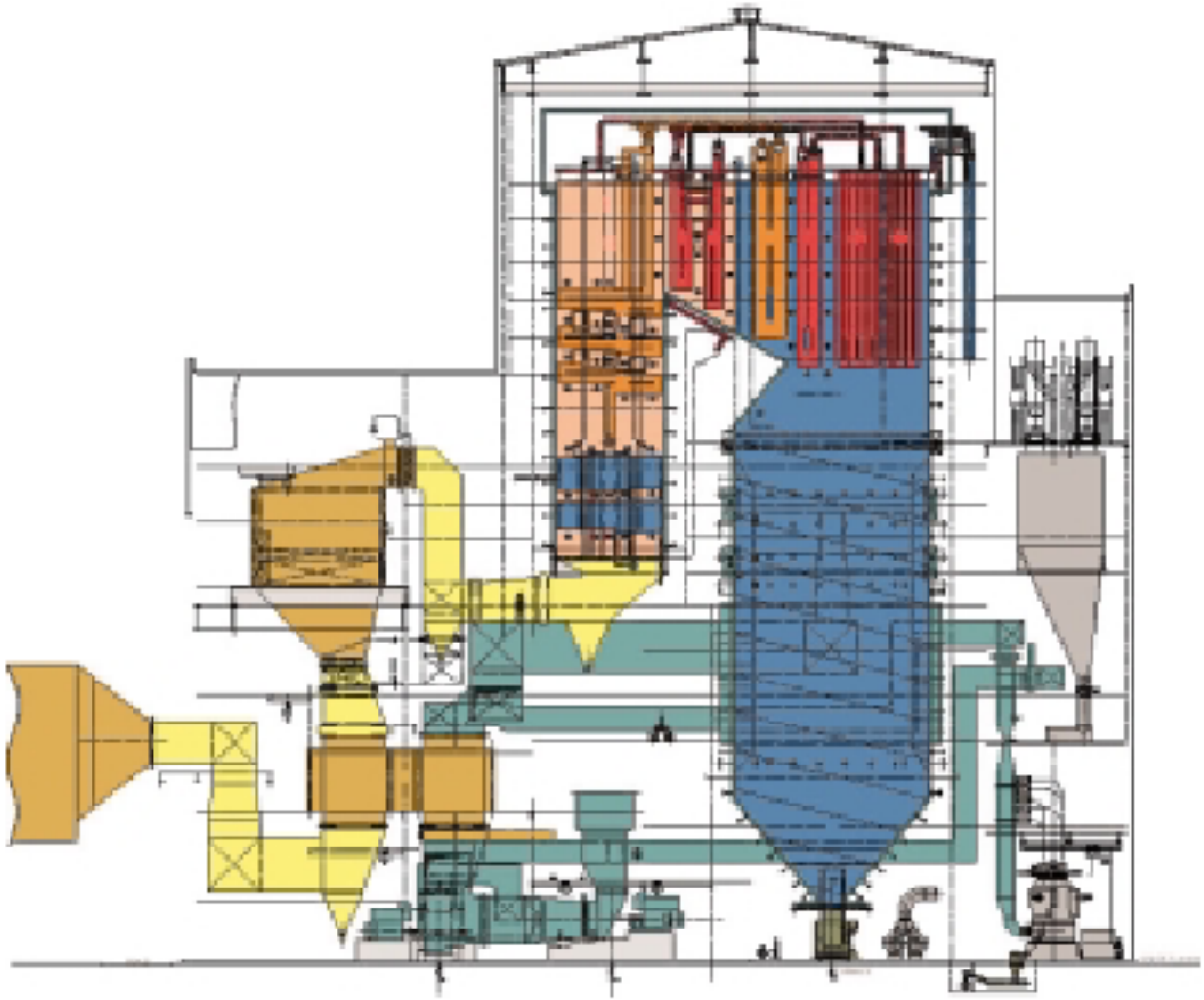
Biomass-Fired CFB



Biomass-Fired Stoker



Pulverized Coal-Fired Boiler



ALSTOM Biomass Experience

* ALSTOM has over 100 boilers firing or cofiring biomass

Country	Customer Name	Station Name	Type	Primary Fuels	Steam Flow k_lb/h
USA	S.D. Warren	Skowhegan	Suspension	Wood Waste, #6 Oil	660
USA	Stratton Energy	Stratton	Stoker	Bark	400
USA	Ultrapower	Rocklin	CFB	Biomass	220
USA	Ultrapower	Fresno	CFB	Biomass	220
USA	Temple Eastex Inc.	Evadale 2	Stoker	Bark	400
USA	Union Camp	Eastover	Suspension	Coal, #6 FO & Bark	400
USA	Union Camp	Savannah	Suspension	Coal, #6 FO & Bark	800

ALSTOM Biomass Experience

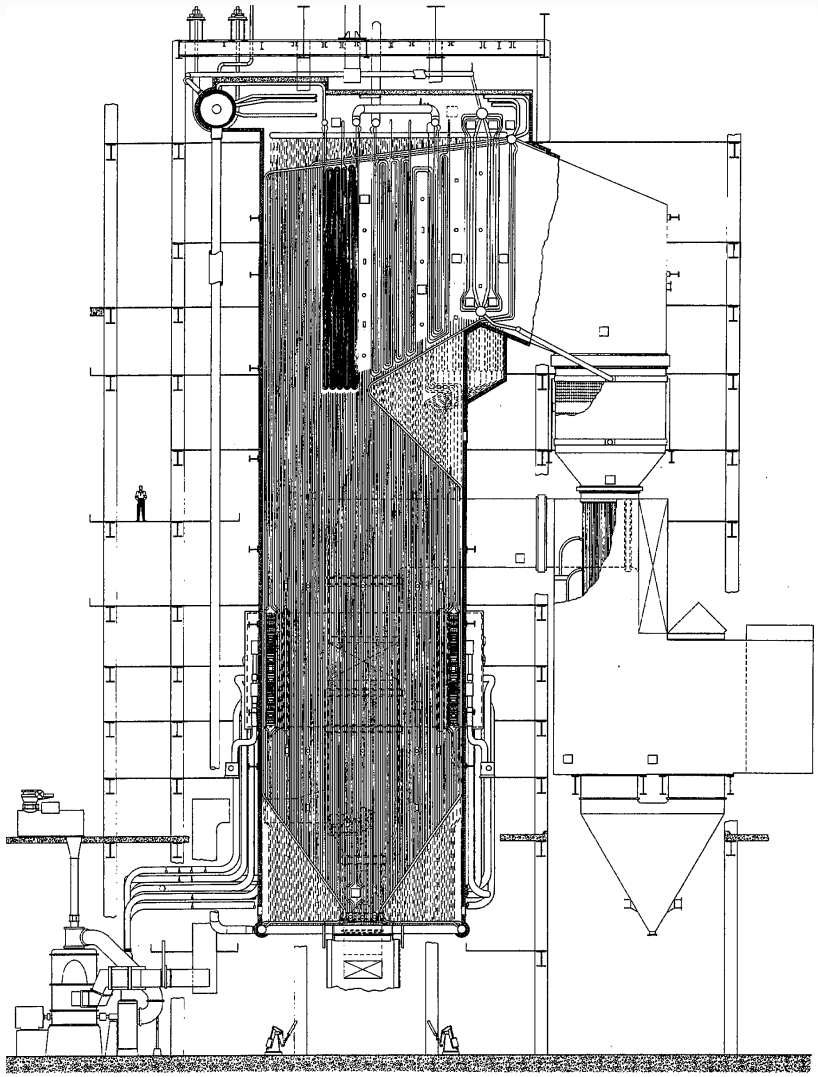
Country	Customer Name	Station Name	Type	Primary Fuels	Steam Flow k_lb/h
Australia	Stanwell	Rocky Point	Stoker	Biomass, wood	130
Australia	Macquaire	Liddell	Suspension	Coal & sawdust	500 MWe
Vietnam	Tate & Lyle Sugar	Nghe An Tate	Stoker	Bagasse	320
Canada	MacKenzie	Finlay Forest	BFB	Wood & sawdust	228
Austria	Oesterreichische Draukraftwerke	St. Andra	Suspension	Coal & Wood	728
USA	Genessee	Flint	Stoker	Wood	330
USA	Osceola	Pahokee 1 & 2	Stoker	Bagasse	440
USA	Okeelanta	South Bay 1, 2 & 3	Stoker	Bagasse	440
USA	Colmac Mecca	Mecca 1 & 2	CFB	Biomass	232
USA	Scott Paper	Somerset 3	Stoker	Wood	700

Recent ALSTOM Biomass Boiler Sales

Plant	Fuel	Capacity	Commissioning (planned)
Landesbergen	Wood	20 MW + District Heating Option	April 2004
Zolling	Wood	20 MW + District Heating	April 2004
Emden	Wood	20 MW + District Heating Option	April 2005
Stapelfeld	Wood	20 MW + District Heating	April 2005
Delitzsch	Wood	20 MW	September 2004

Bark Cofiring with Coal

- Union Camp, Savannah Station
- 190 MWe
- Originally designed to cofire bark with coal

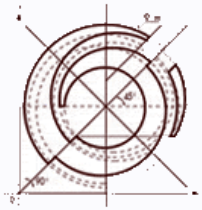


Wood Cofiring with Coal

- St. Andra power station, Austria
- 100 MWe lignite-fired unit
- Retrofit to fire bituminous coal and 10% wood on hopper grate

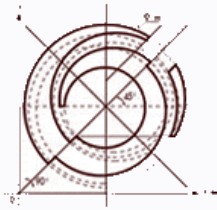
Wood Cofiring with Coal

- Liddell Power Station, Australia
- 4-500 MWe coal-fired units
- Fire up to 5% sawdust through the mills



Other Current ALSTOM Biomass Projects

- European unit cofiring pelletized straw with coal
- Recent RFP for unit that will fire 100% coal - 100% straw
- Coal-fired CFB wants to cofire biomass



Issues with Biomass Utilization

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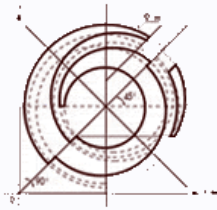
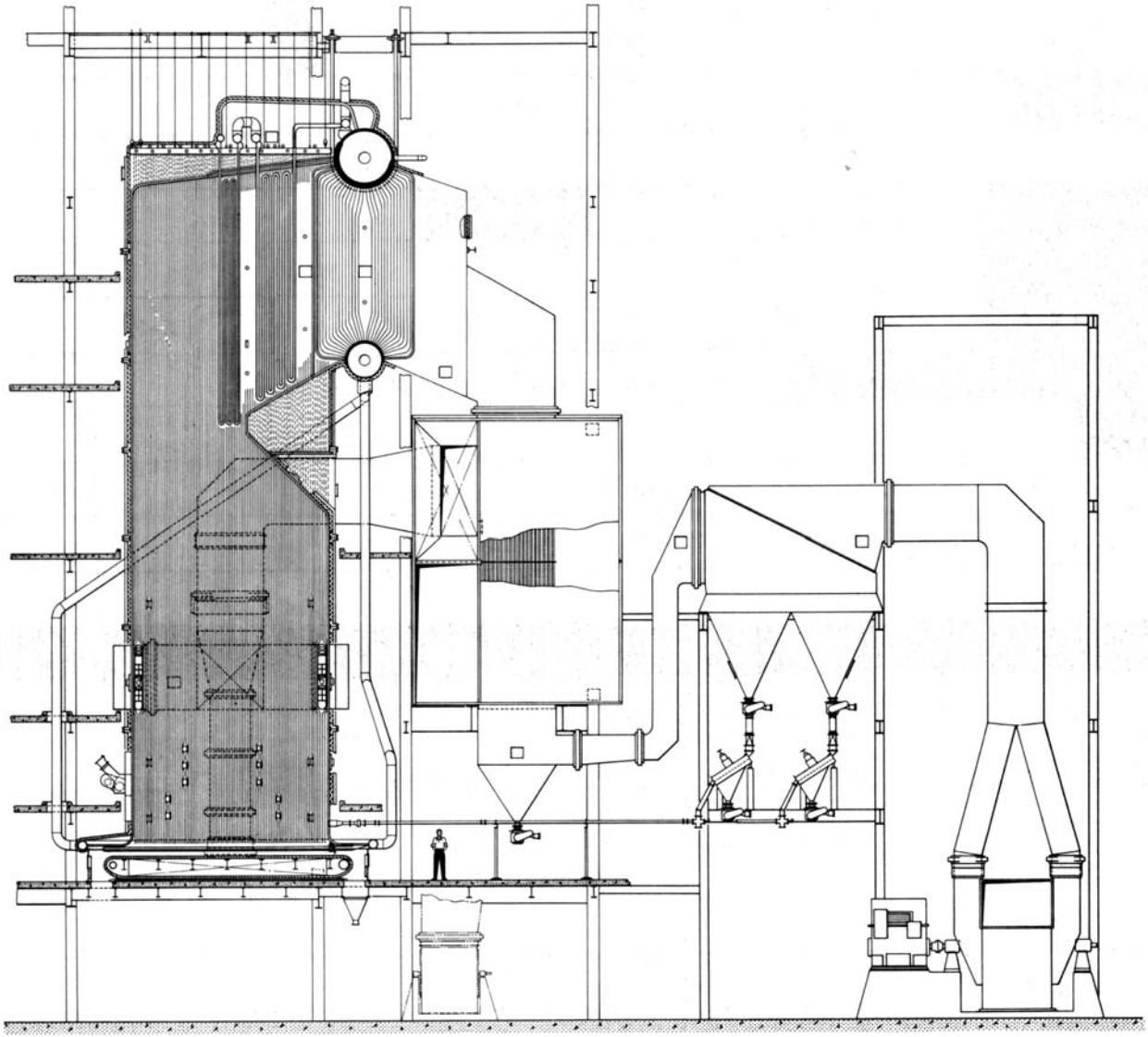
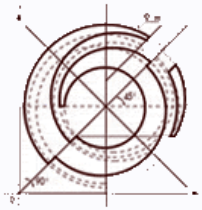
- Fuel preparation
- Fuel feeding
- Fuel variability
- Ash deposition
- Fly ash utilization
- Corrosion
- Erosion



VU-40 Stoker
CFD Modeling & Retrofit

VU-40 Stoker





Project Objectives

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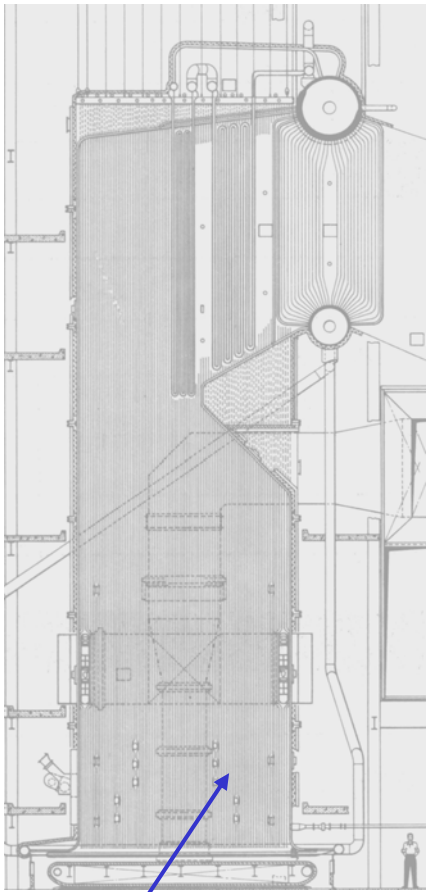
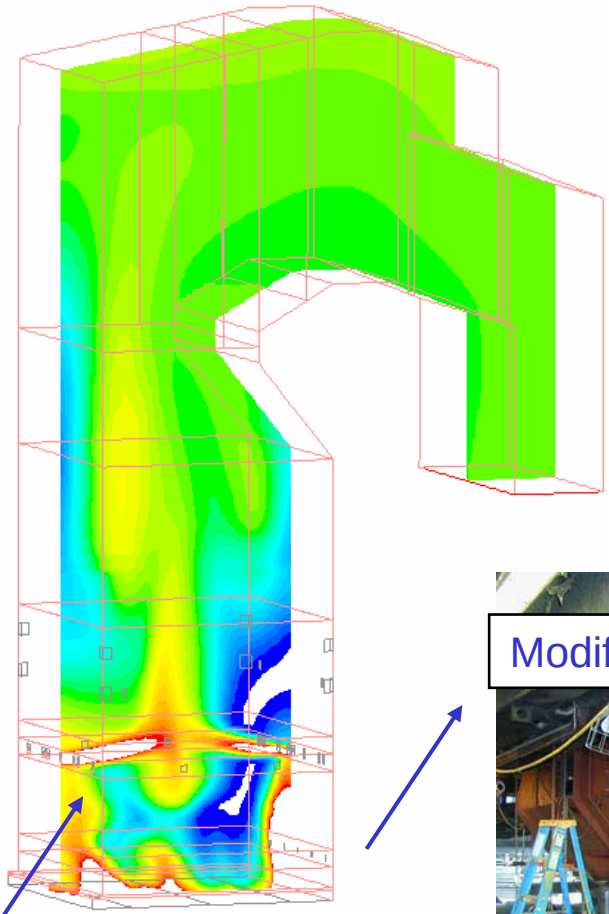
- Reduce the Unburned Carbon Levels
- Reduce NOx & CO Emissions
- Increase Efficiency/Capacity
- Measure Pre and Post Conditions
- Minimize unit outage duration

Project Scope



Stoker
Pre-tests



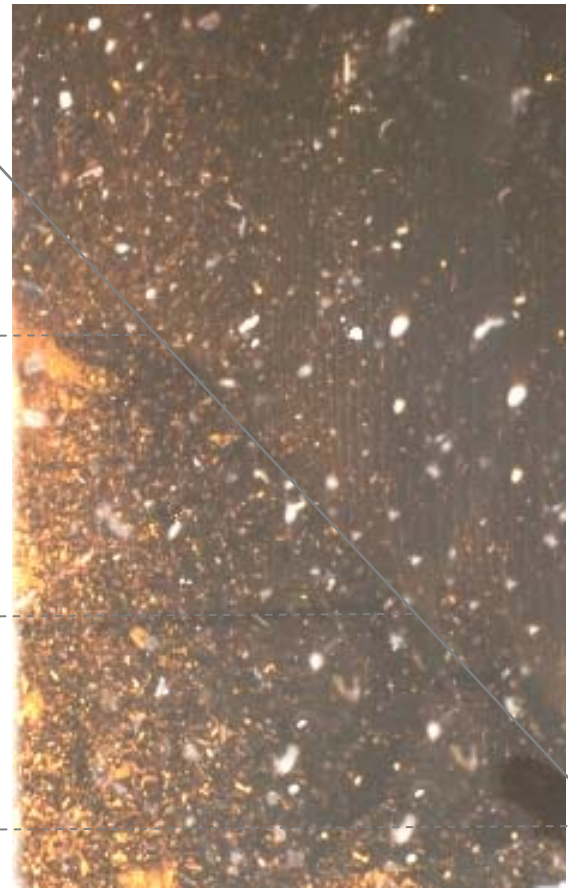
CFD Modeling...

Back on line….

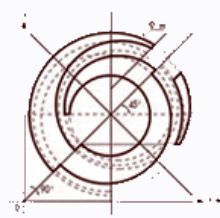
Modifications….

Assessment: Pre-Retrofit

- Operation:
  - Limited Capacity
  - High Unburned Fines
  - Opacity during start-up
  - Erosion of ID fan & ductwork
  - Needed cinder reinjection
  - Difficulty burning wet bark
- Combustion System:
  - Ineffective air system
  - Leakage around stoker
  - Air heater leakage



Carryover
(near rear wall)



CFD Model Description

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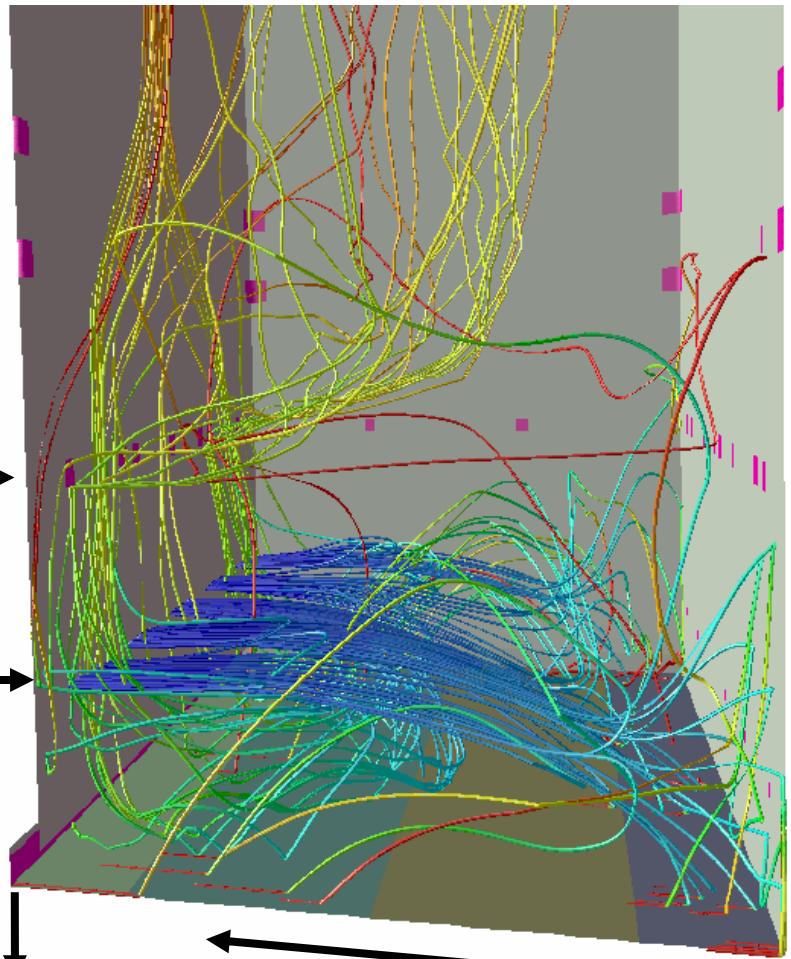
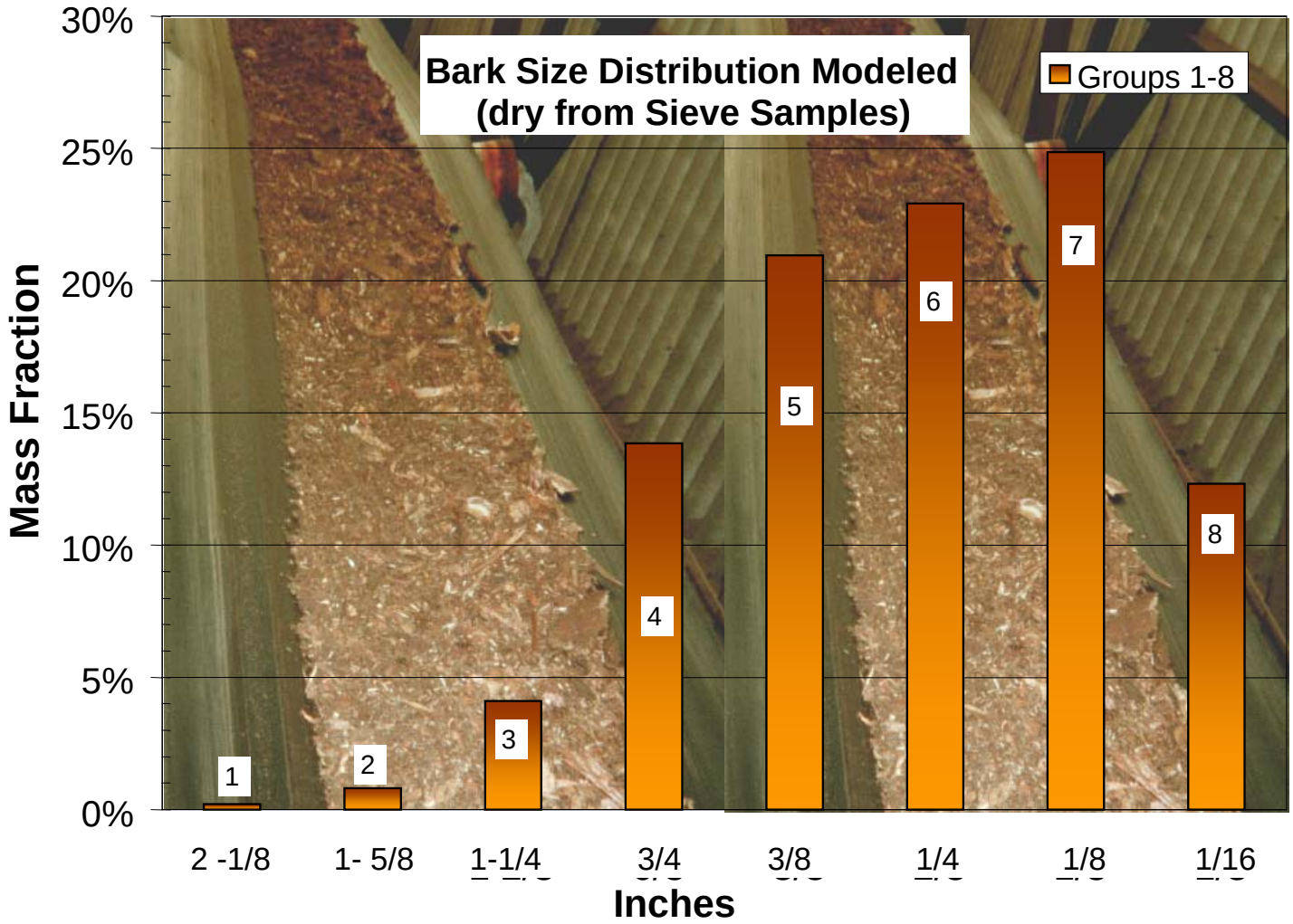
- Coupled Gas/Particle Steady-state solutions
- κ–ε turbulence model
- 2-step gas reaction chemistry
- Particles:
  - Bark and Char Reinjection groups
  - Prescribed non-spherical drag coefficients
- Heat extraction from walls, superheater & boiler banks
- FLUENT - UDF for grate combustion

Grate Combustion Model

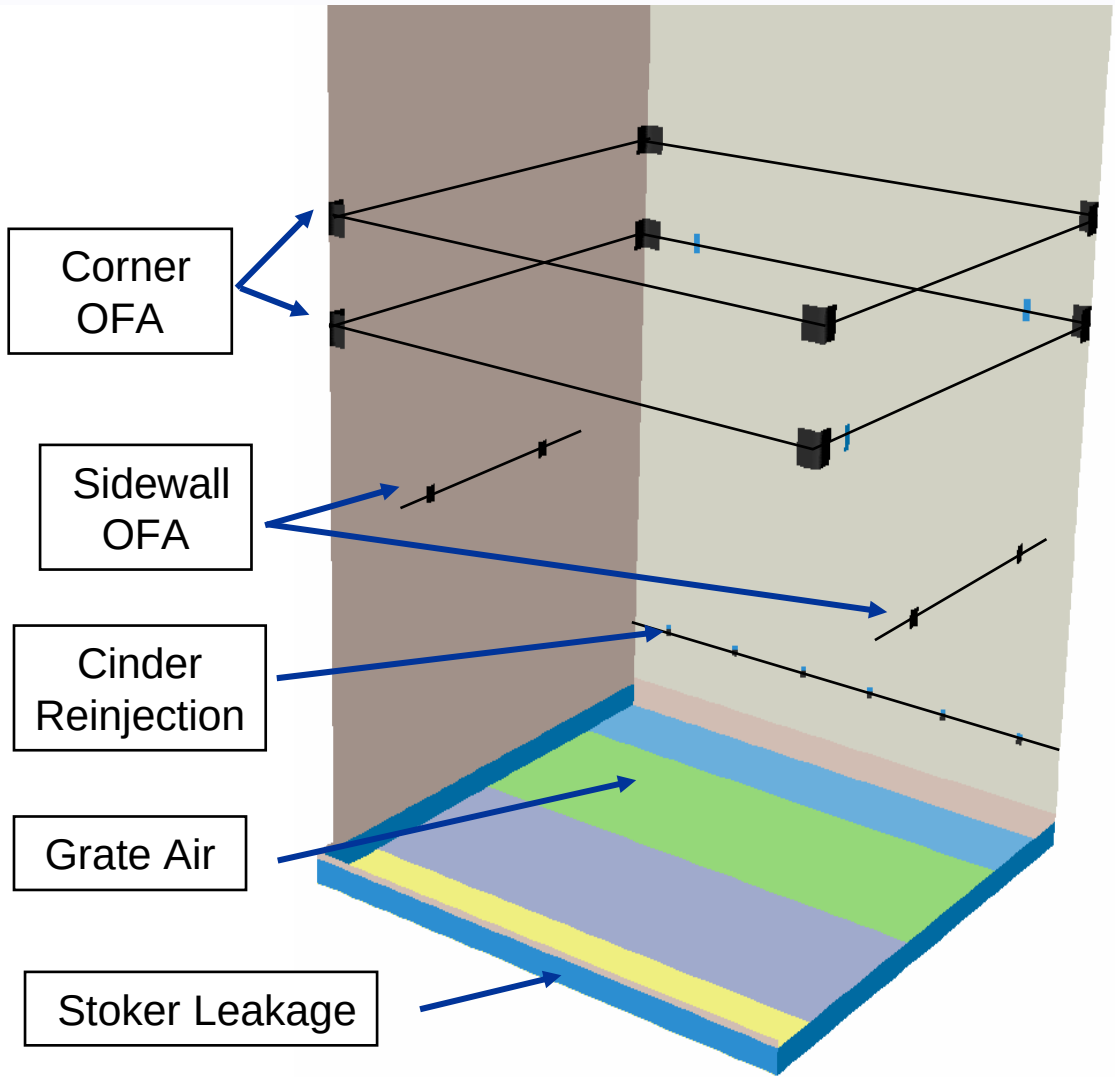


Bark Particle Size Distribution

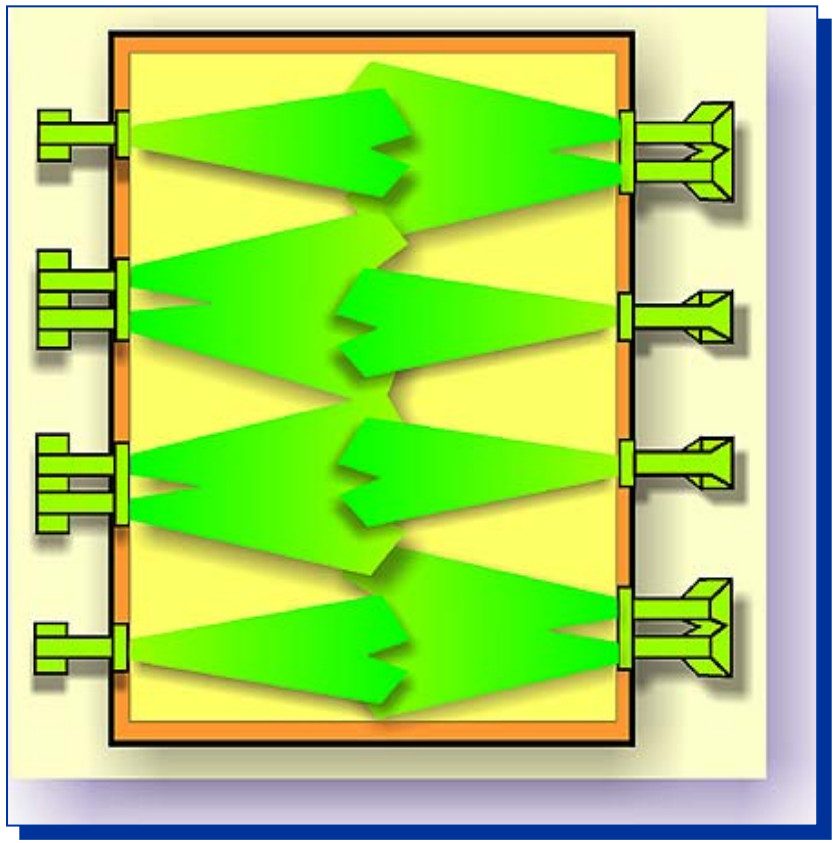
Bark Heating Value: 4,347 Btu/lb
Moisture Content: 49%

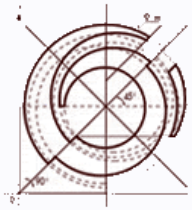


Baseline Air Sources



HMZ™ Nozzle Arrangement





Scope of Upgrade

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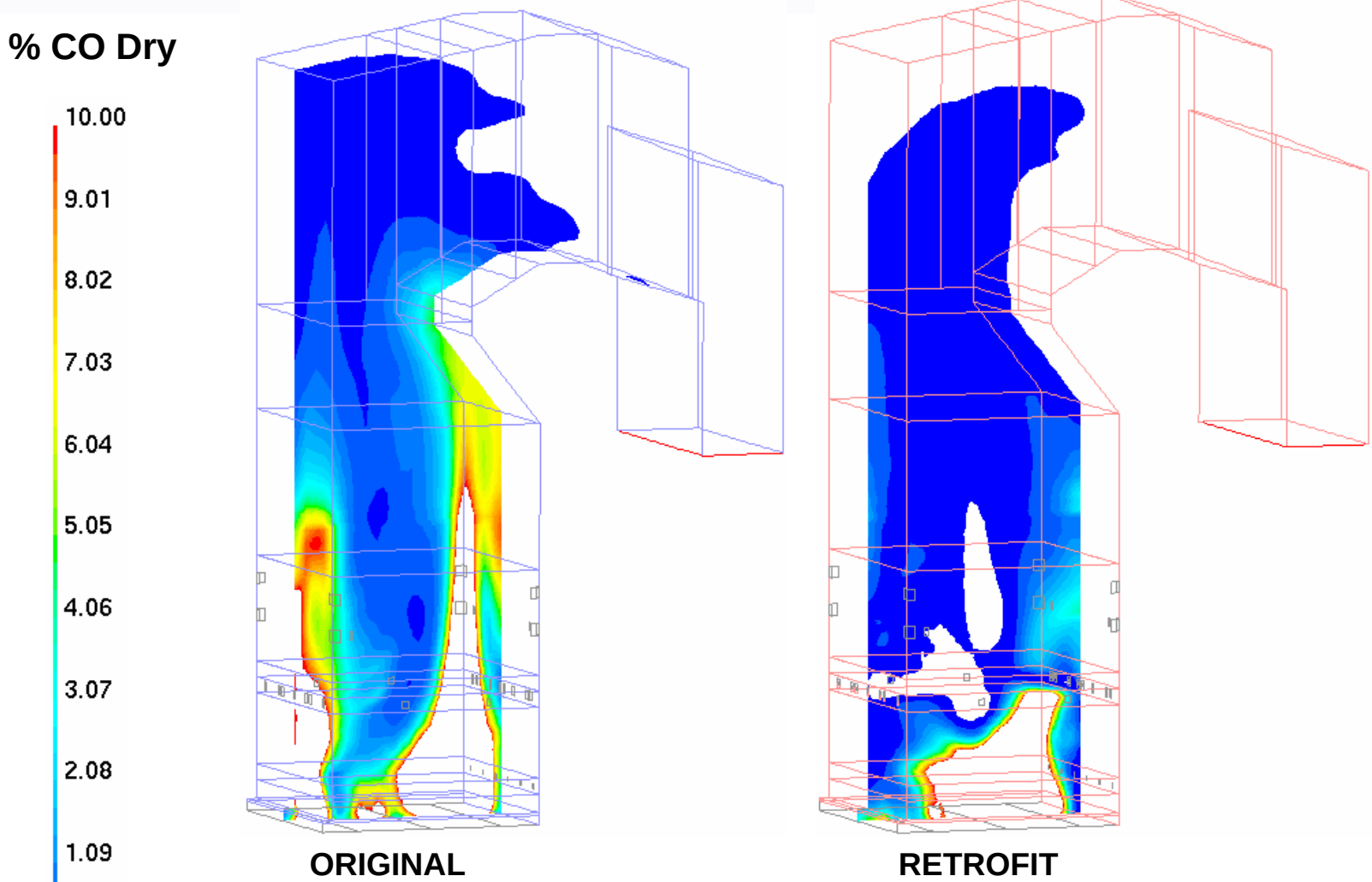
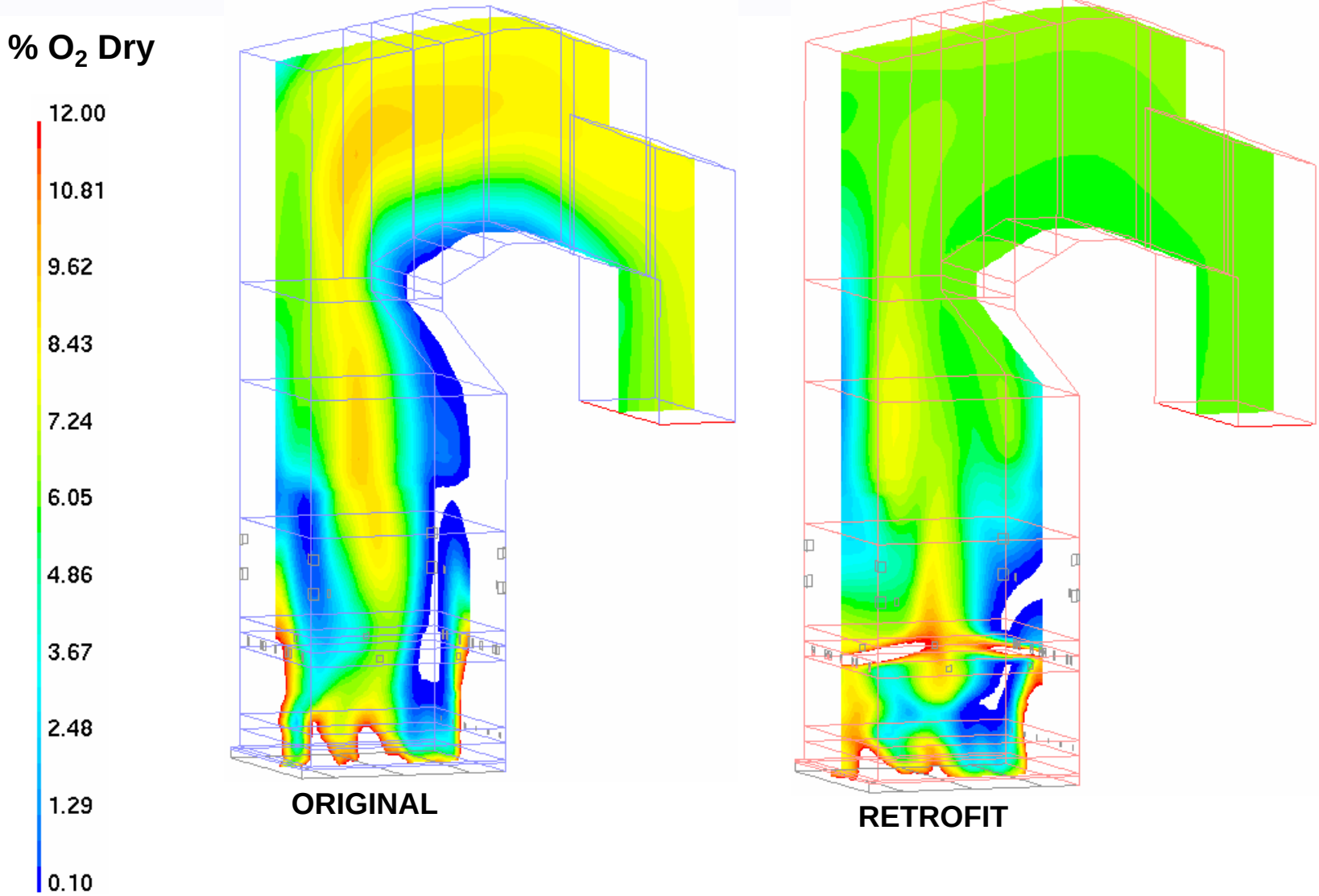
- New ductwork
- HMZ™ nozzles & flow dampers and seal boxes
- Pressure part modifications
- Air flow measuring devices
- Fabric stoker seal
- Air heater repairs

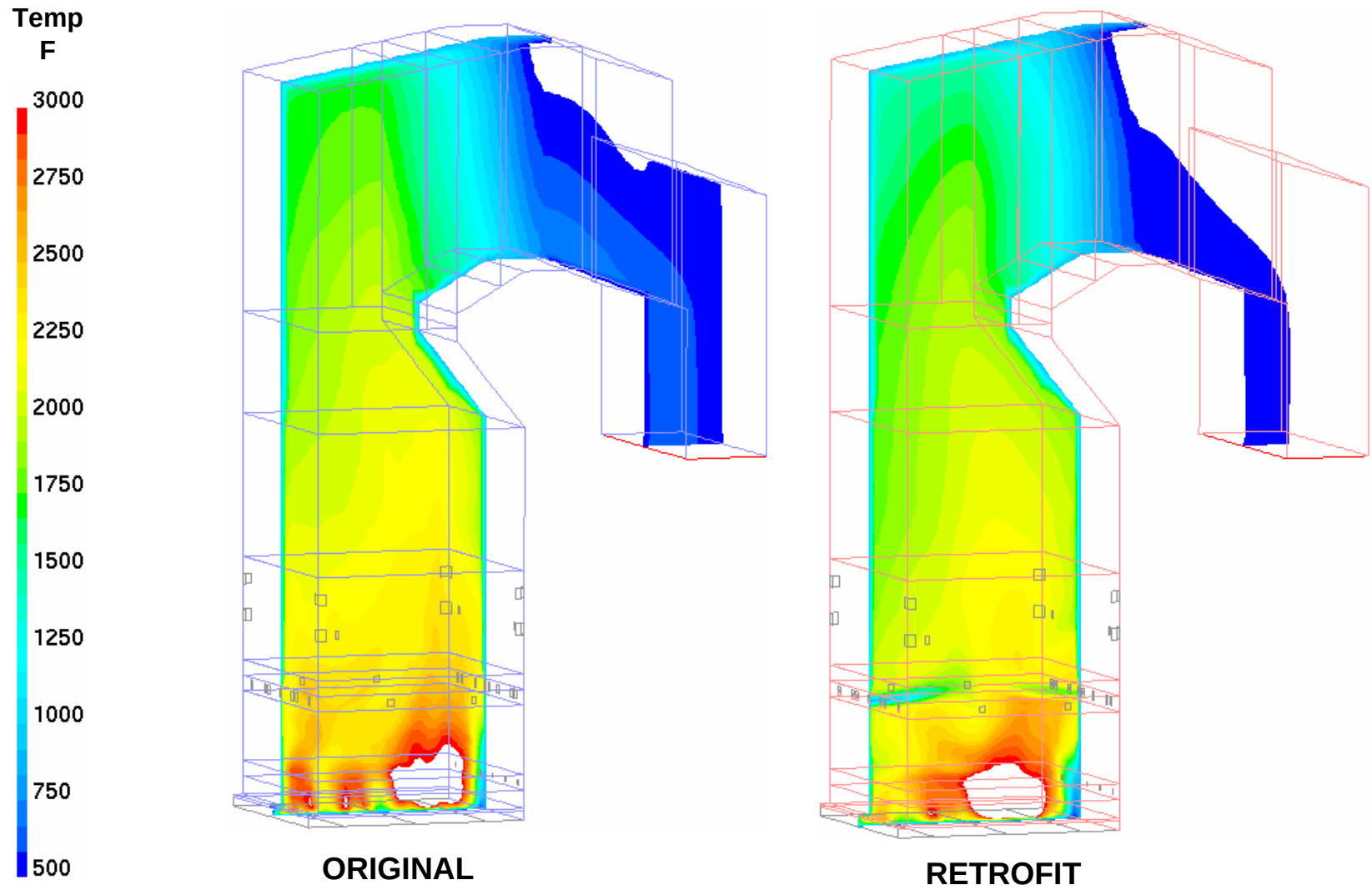
Predicted CO



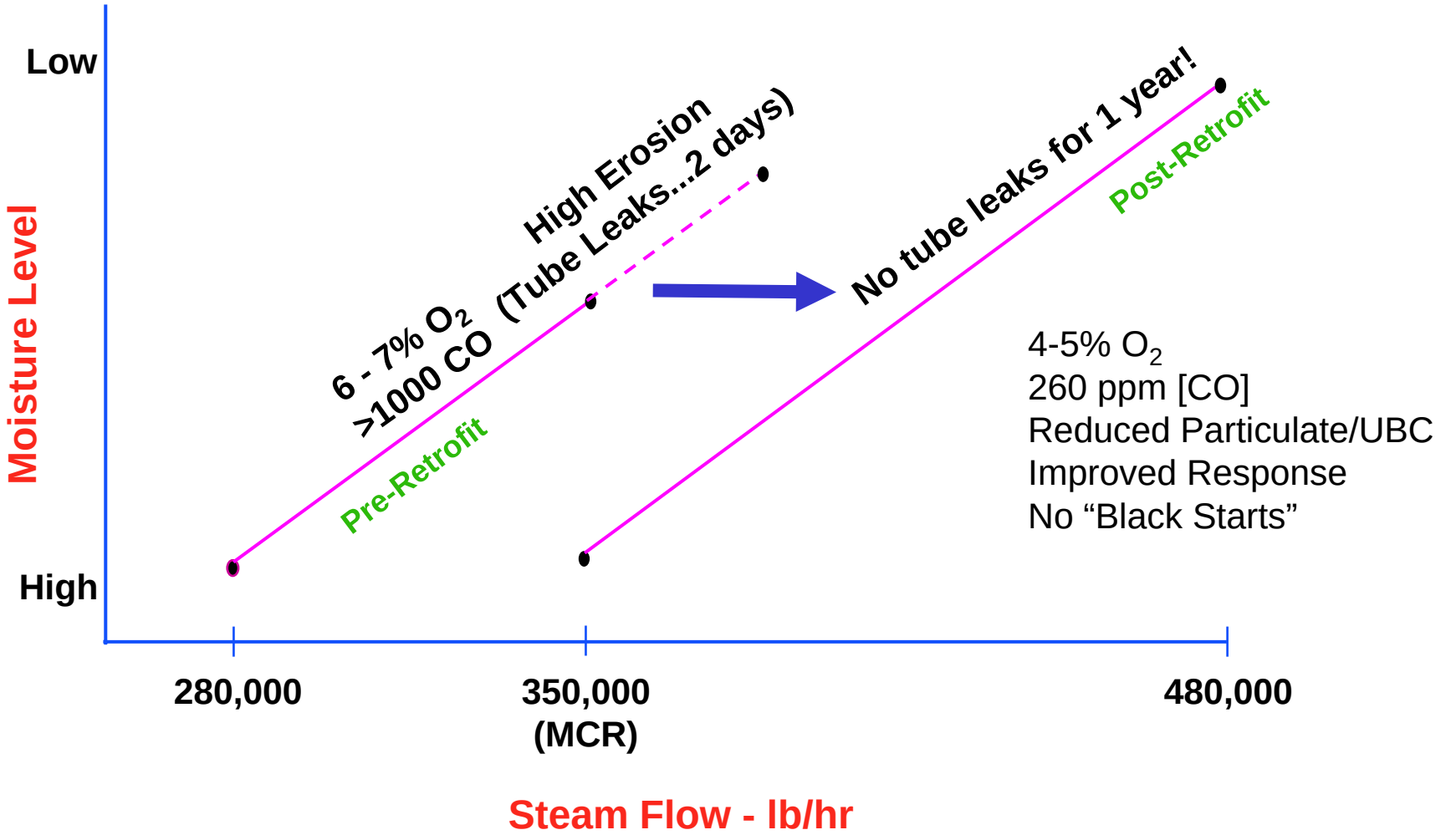
Predicted O_2

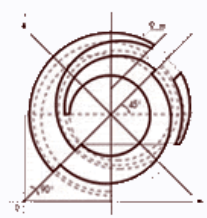


Predicted Gas Temperature



Performance Improvement

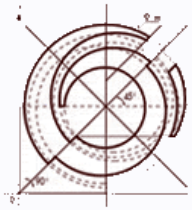




Boiler Performance Summary

ALSTOM

CONDITION	Units	Original Design	Original Operation	Upgrade Design	Upgrade Operation
Steam Flow	K lb/hr	350	365	400	430-480
Steam Temp	F	825	844	825	865
Steam Press	psig	850	850	850	850
Feedwater	F	295	266	295	265
Exit Gas Temp	F	400	?	495	575
Air to Furnace	F	495	470	495	575
Grate HHRR	MMBtu/hr-ft^2	1.080	1.100	1.234	1.330
Increase in Duty	%	-	7.5	15	29
Excess Air @TAH	%	33	45	25	25-30
Fuel Moisture	%	55	48.3	55	48.3
Overfire Air	%	40	20	45-50	50
Undergrate Air	%	60	80	50-55	50



Conclusions

- CFD modeling adequately simulates observed trends for stoker boilers
- Stoker retrofit decreased CO emissions and carbon in the fly ash while while operating at increased boiler load and lower excess air
- Many older stoker boilers may benefit from a retrofit

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