Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Choosing the Correct Particulate Collector for the Job!

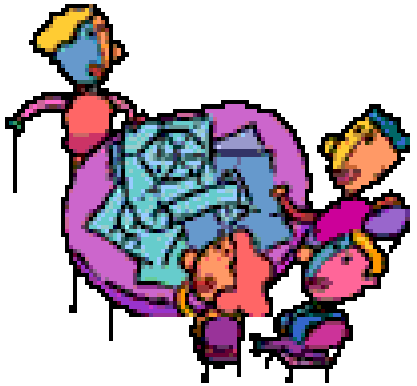
Steve Francis

July 14, 2008

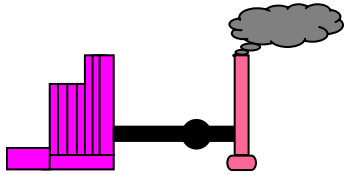
ALSTOM

Agenda

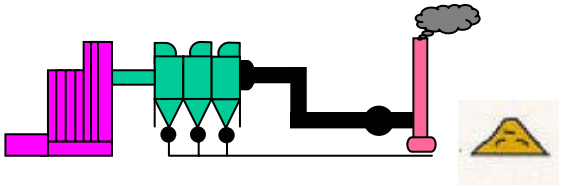
- **Emissions Limitations**
- **Product Choices & Performance Results**
- **System Combinations**
- **Recommendations**



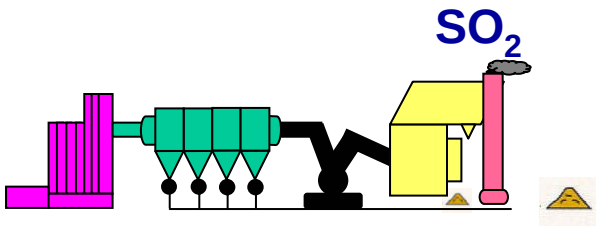
Evolution of APC Systems



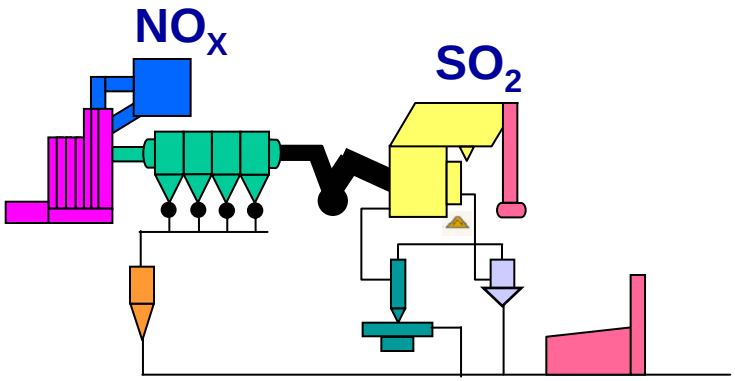
1950s



1970s

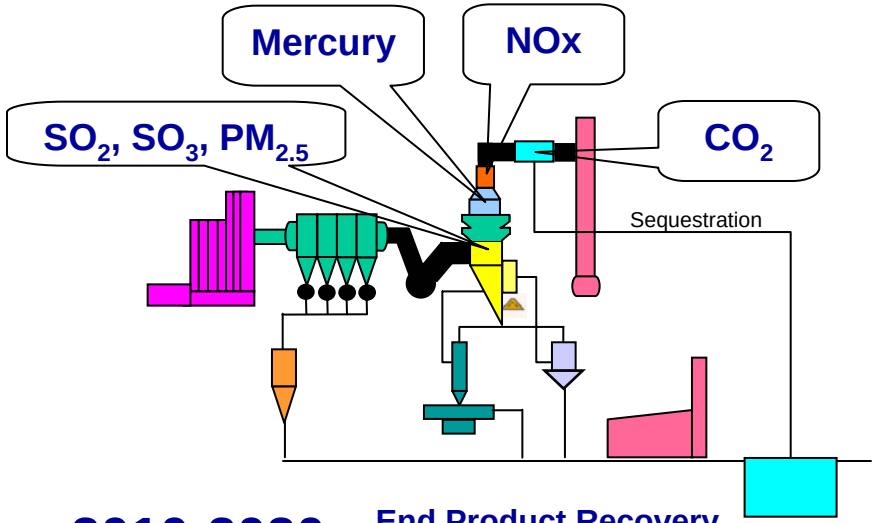


1980s



1990s

End Product Recovery and Utilization



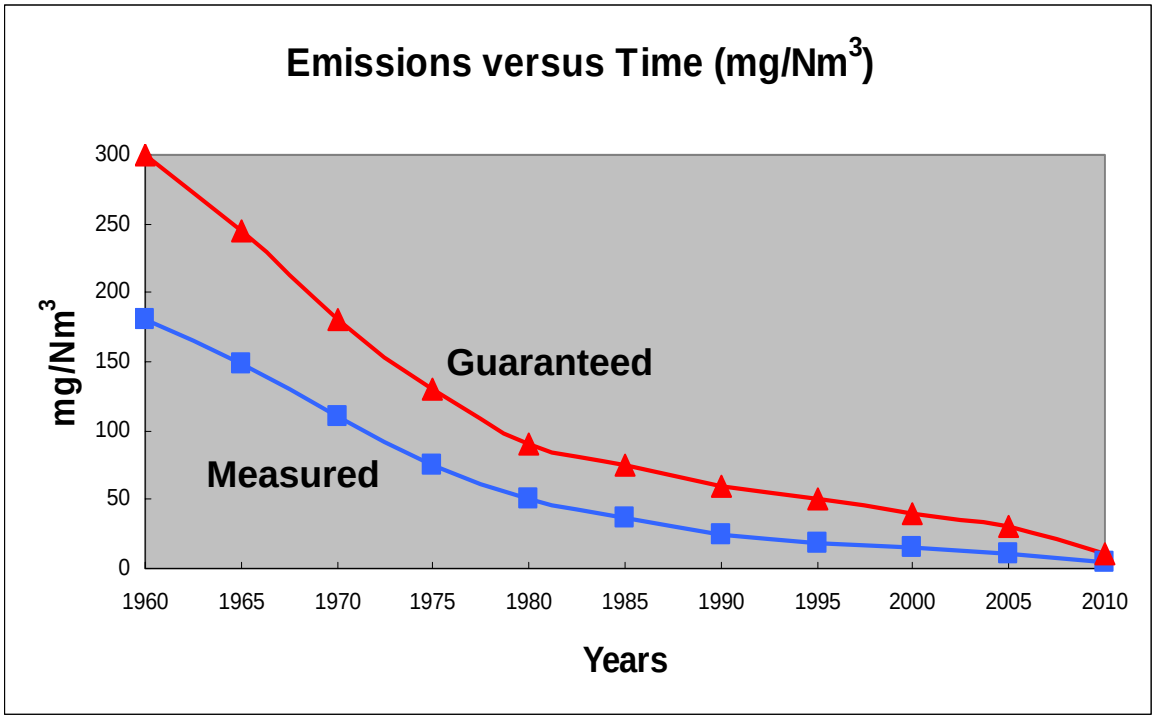
2010-2020

End Product Recovery, Utilization and CO_2 sequestration

Emissions Limitations

Trends:

- Guarantees Are Now As Low As 10 mg/Nm³ (0.005 gr/SCF)
- Trend Toward 5 mg/Nm³ (0.0025 gr/SCF)
- Increased Emphasis on Removal of Fine Particles (PM 2.5)
- Particulate Emissions Including Condensibles
- More Emphasis on Removal of Mercury and HAP's



General Note: 10 mg/Nm³ ~ 0.010 lb/MMBtu

Product Choices

Dry Electrostatic Precipitators

Wet Electrostatic Precipitators

Low Ratio Fabric Filters

High Ratio Fabric Filters

Electrostatic Precipitator (ESP)

OVER 180,000 MW OPERATING

- Meets the latest world standards for particulate removal
- Extensive ESP sizing database on world coals
- New and retrofit applications
- Tumbling hammer or Electric Impulse rapping systems
- Spiral or rigid discharge electrode
- State-of-the-art EPIC III microprocessor Automatic Voltage Controllers
- SIR High Frequency Power Supplies

ESP Performance Results

Plant	Country	Boiler capacity	Test year	Particle emission (mg/Nm^3, wet gas)
Ilo	Peru		2000	4
MP-1 (Unit 1)	Taiwan	350 t steam/h	1998	8
MP-1 (Unit 3)	Taiwan	350 t steam/h	1998	2
MP-1 (Unit 4)	Taiwan	350 t steam/h	1998	3
MP-1 (Unit 5)	Taiwan	350 t steam/h	1998	5
Jorf Lasfar	Marocco	350 MW	2000	3
FP-1	Taiwan	600 MW	2000	8
Spurlock	United States	335 MW	2003	3

Fabric Filters

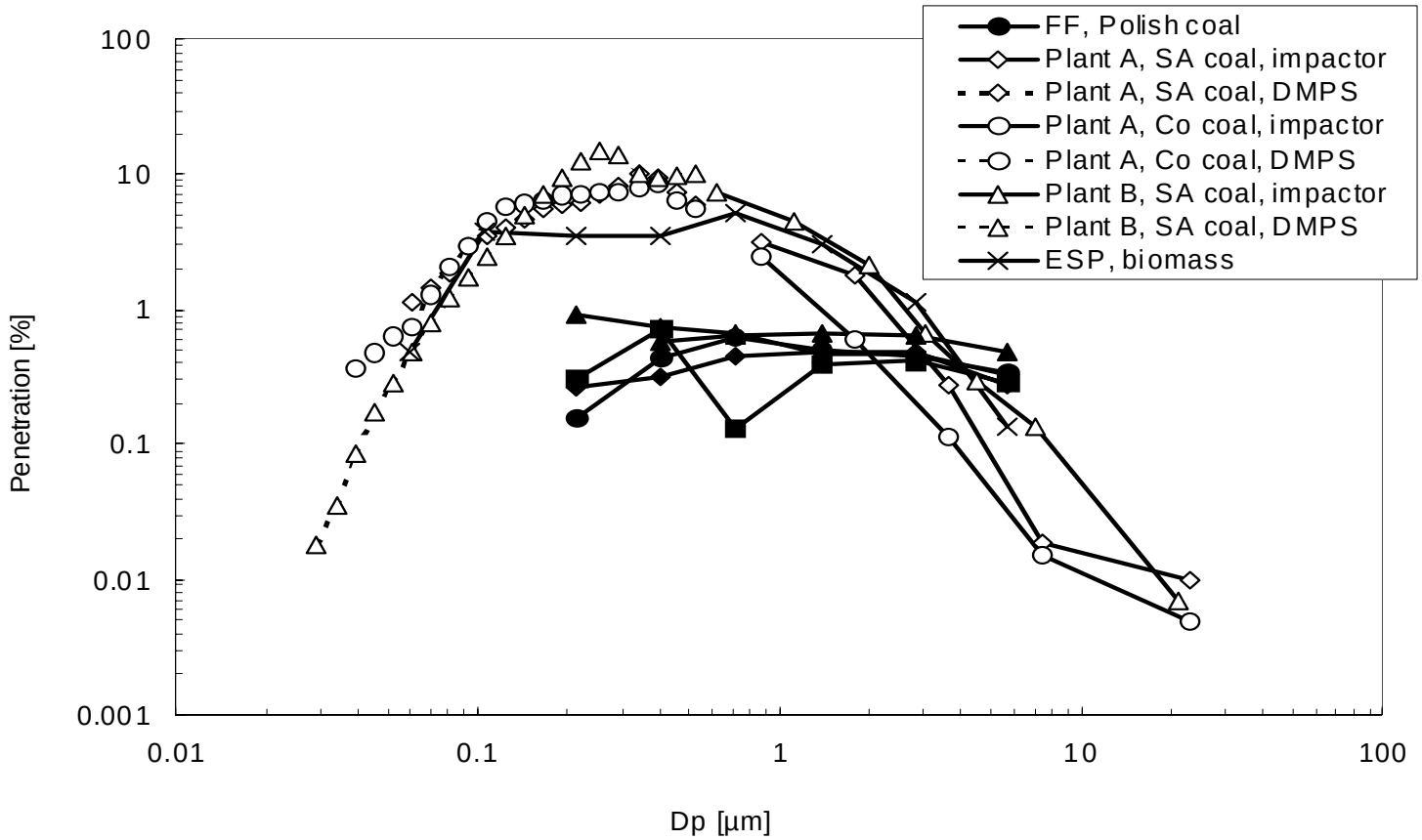
- Over 22,000 MW Operating Experience
- High & Low Ration Designs Available
- Low Ratio Cleaning Options
  - Reverse Gas
  - Reverse Gas-Sonic Assist
- High Ration Cleaning Options
  - On line via intermediate pressure, intermediate volume
  - Off line via high pressure, low volume

Xcel Energy
Unit #1 – 550 MW
Brush, CO

FF Performance Results

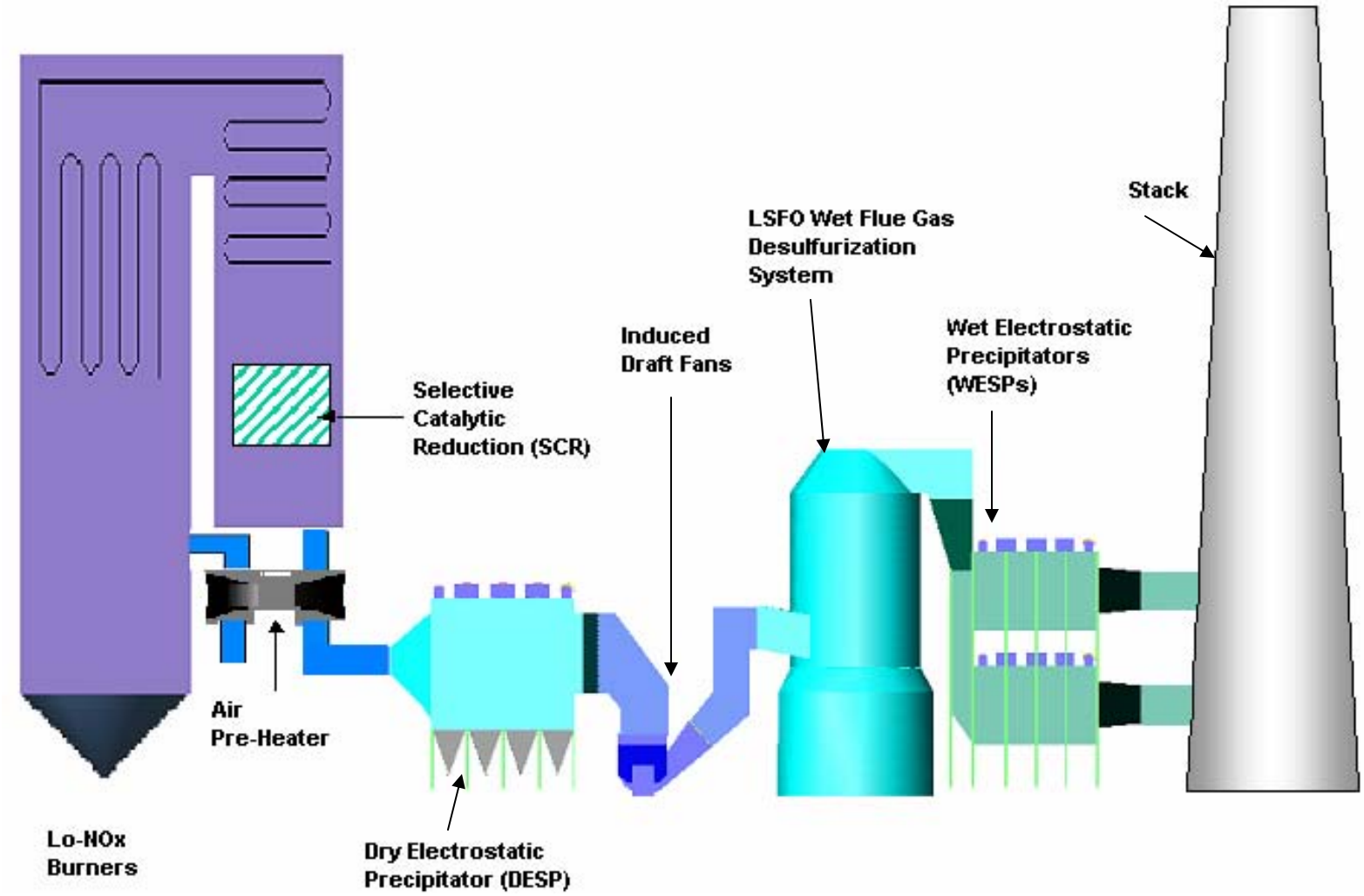
- **Power**
  - CFBC: 5 mg/Nm^3 dg
  - PC: 8 mg/Nm^3 dg
  - DFGD: 10 mg/Nm^3 dg (24 h average)
- **I&S**
  - EAF: 2 mg/Nm^3 dg(Optipulse Plus)
  - Sec. vent. : 0.4 mg/Nm^3 dg (Optipulse Plus)
  - DFGD Sinter: 10 mg/Nm^3 dg
- **Aluminium**
  - HF recovery (ABART): 2 mg/Nm^3 dg
- **WtE**
  - DFGD: 5 mg/Nm^3 dg (24 h average)
  - Filsorption II: 2 mg/Nm^3 dg

Results - Particle mass size distributions - Low pressure impactor - FF penetration vs ESP penetration

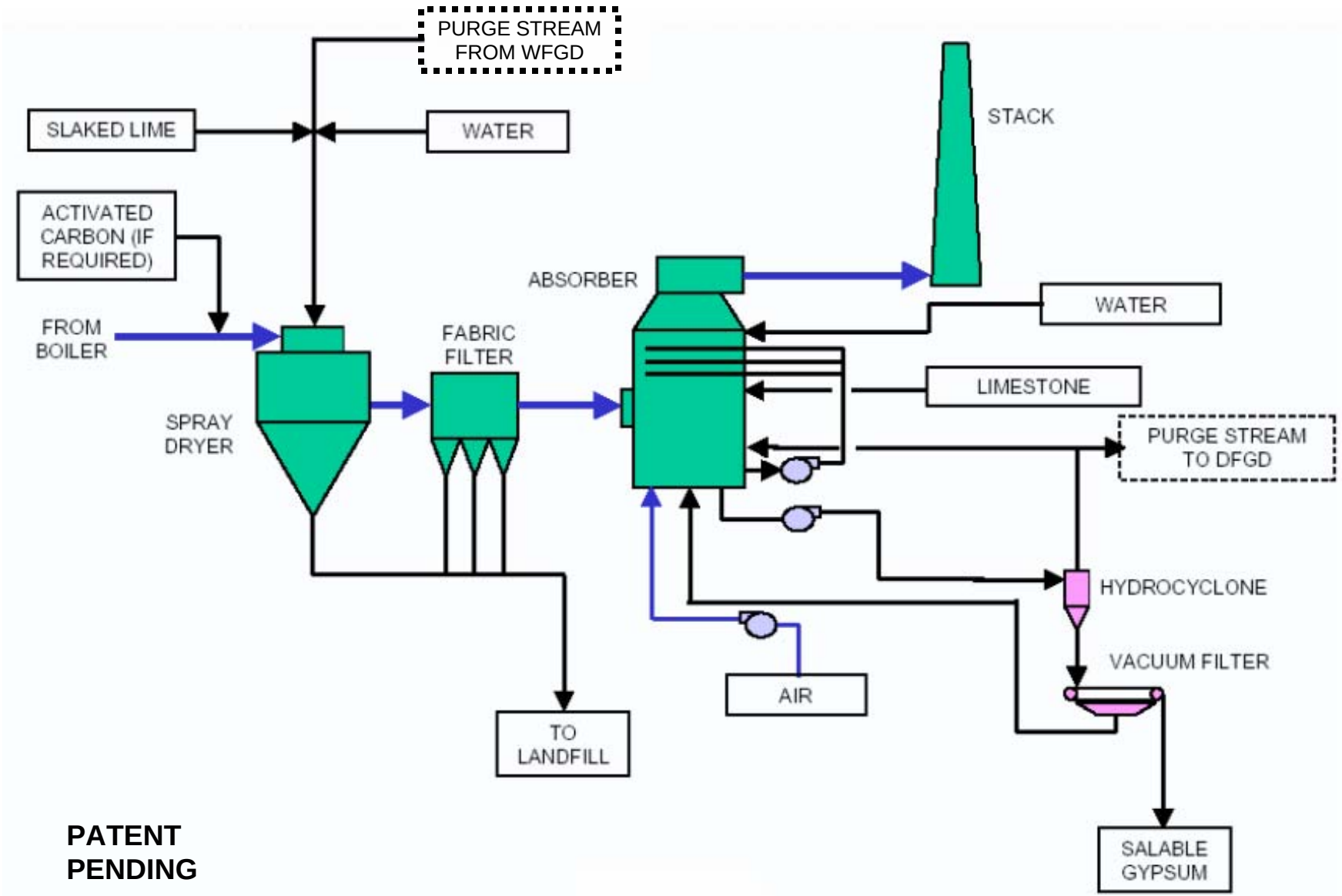


- Overall FF penetration 0.1 - 0.2% for this plant
- FF collection efficiency approx. constant at 99.5% in the size range 0.2 - 3 µm
- No decrease in collection efficiency was observed in the submicron size range

Current Back-End APC Design

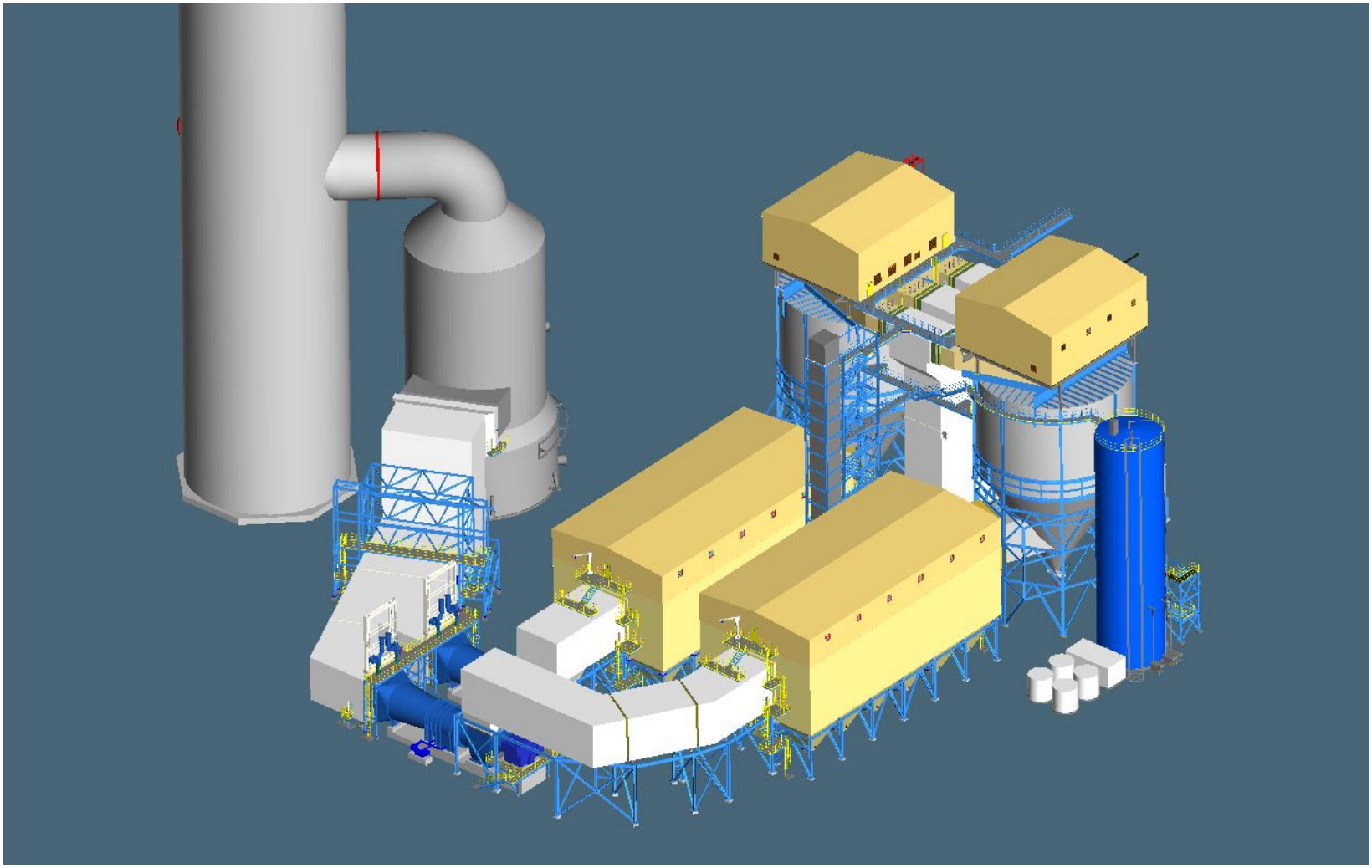


Alternative Back-End APC Design



PATENT PENDING

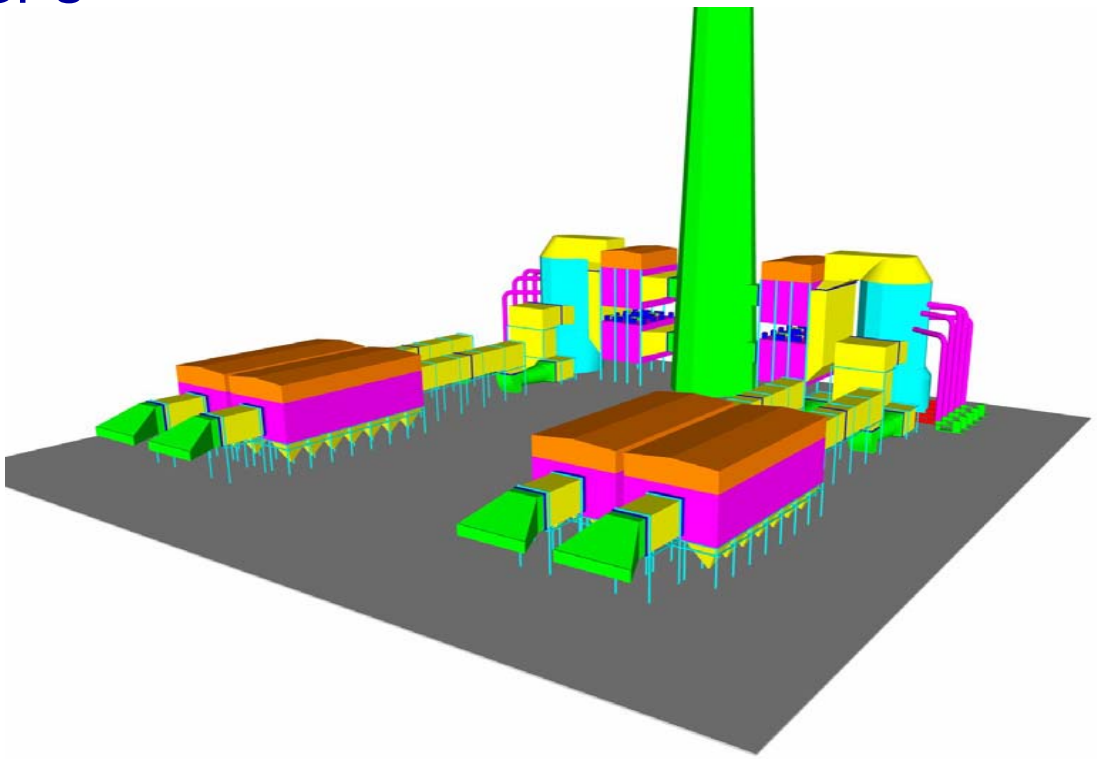
Alternative Back-End APC Design



PATENT PENDING

Contract Example

- **After coal fired boiler, ELM ROAD**
  - 650 MWe capacity system/boiler
  - Two 12 compartment FFs with 8 m long bags
  - Wet limestone FGD System
  - 4 Field, 4 Cell Wet ESPs



Contract Example

SO_2, 0.11 lb/MMBtu EPA Method 6C average of three 1-hour tests

SO_2, 820 lb/hr per CEM, 24 hour average

SO_2 , 920 lb/hr per CEM, 3 hour average

PM_{TOTAL} (Filterable + condensable), 0.015 lb/MMBtu

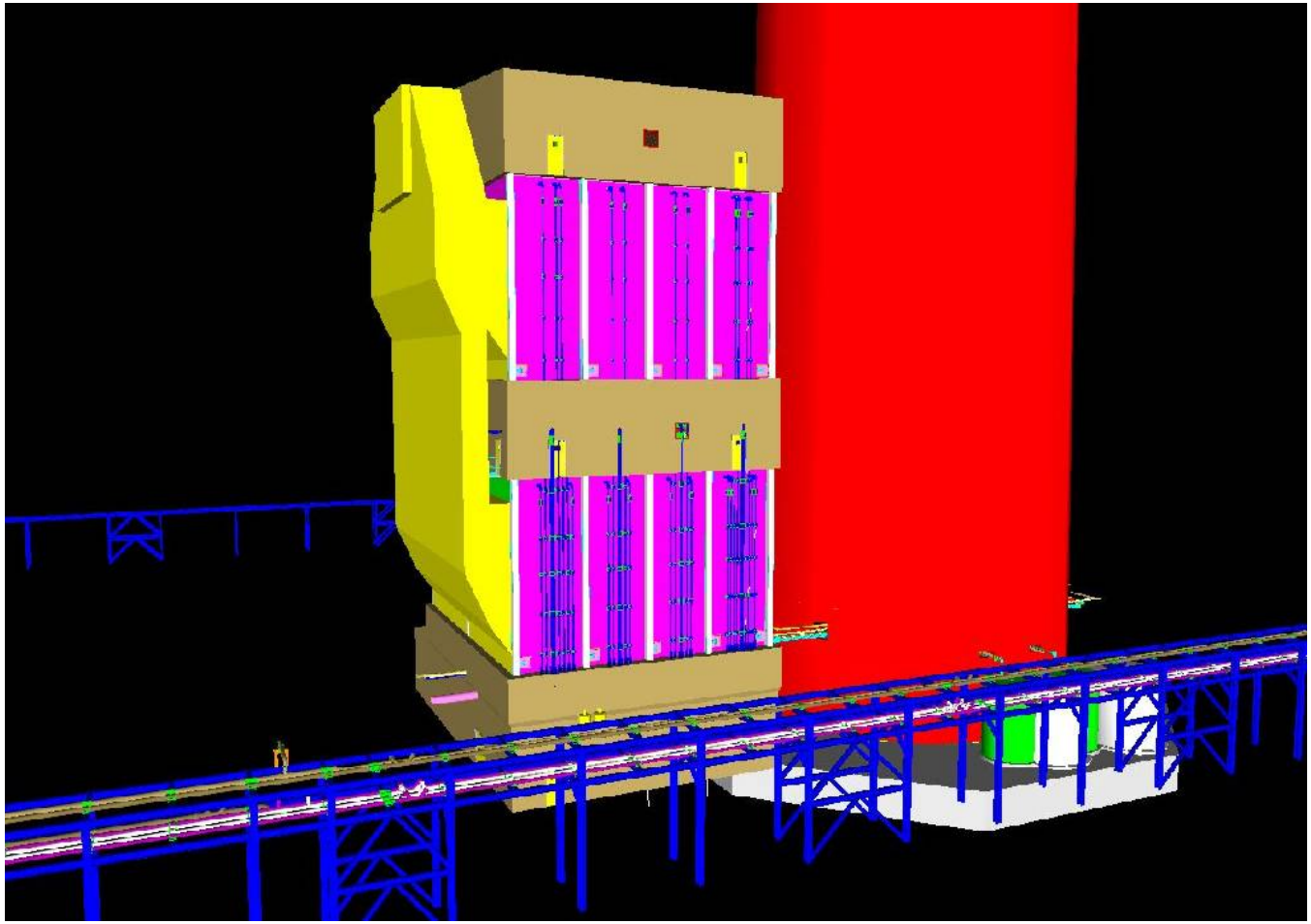
EPA Method 5B (with filter at 340 ±5°F) avg. of 3 1-hour tests

H_2SO_4, 0.009 lb/MMBtu EPA Method 8 avg. of 3 1-hour tests

Stack Opacity, 15%, EPA Method 9, 6-min. avg. in a 1-hour period

Fabric Filter Outlet Opacity, 10%, CEM, 6-min. avg. in a 3-hour period

WESPs



ELM ROAD, 2 WESPs STACKED/BOILER

Wet & Dry ESPs In Route to the Site

Recommendations

- For moderate to low resistivity dusts - DESPs
- For high resistivity dusts - FFs
- When additives are used for SO_2, SO_3 or Hg control - FFs
- For very low emissions of dust & SO_3 after WFGD
  - WESPs or
  - DFGD followed by WFGD
- For very low emissions after FFs – Use off-line cleaning

THANK YOU!

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