Reinhold Environmental Ltd.

2006 APC Round Table & Expo Presentation

July 16-18, 2006, Columbus, OH

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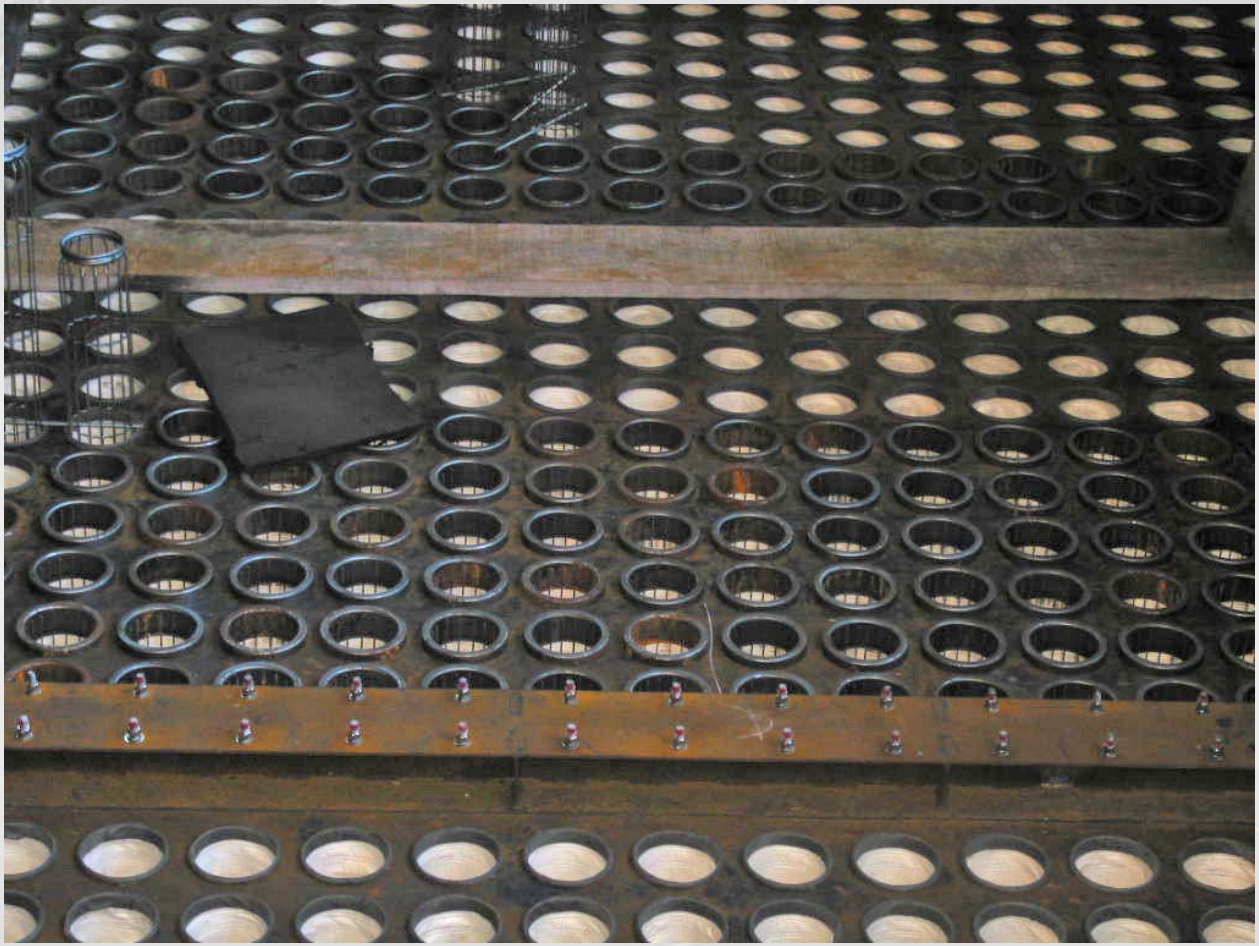
Fabric Filter Fundamentals
&
Mercury Control Capability

Rich Miller
ADA-ES, INC.

2006 APC/PCUG Conference
Columbus, Ohio
July 17-18, 2006

Fabric Filter Control Technologies



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Common Types of Fabric Filters

	Reverse Gas	Pulse Jet	TOXECON	COHPAC
Pressure Drop	6-8" W.C.	SAME	SAME	SAME
Bag Life	3 yr. Guar., 7+ Expected	3 yr. Guar., 5+ Expected	3 yr. Guar., 4-5 yrs. Expected	2-3 Yr. Guar., 4 yrs. + Expected
A/C Ratio's	2:1 Net	4:1 Net	5.5 to 6:1 Gross	> 8:1 Gross
Type Cleaning	Off-Line Cleaning	On-Line Cleaning	On-Line Cleaning	On-Line Cleaning
Fabric Type	Woven Fiberglass	PPS Felt	PPS Felt	PPS Felt
Max. Bag Length	36'-0"	27'-0"	27'-0"	27'-0"

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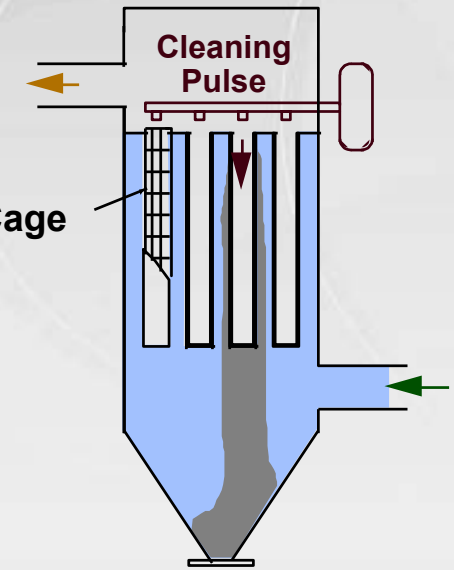
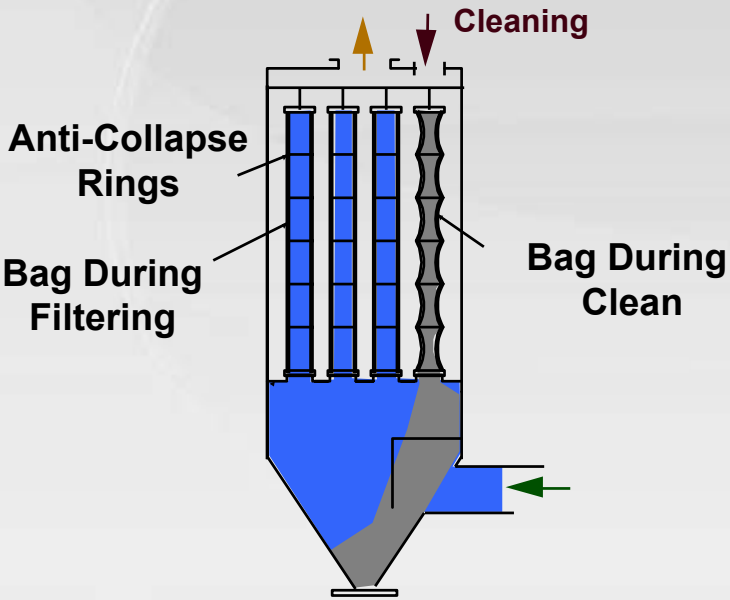
Reverse Gas vs. Pulse Jet

CONVENTIONAL PULSE-JET

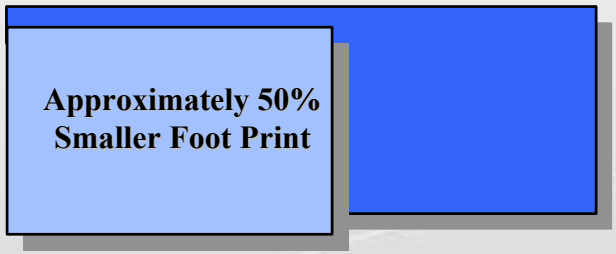


REVERSE-GAS



Reverse-Gas 250 MW @ 11648 ft²

Low & MP PJ
250 MW @ 6419 ft²



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Reverse Gas Fabric Filters

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Benefits of Reverse Gas Technology

- Conservative design approach
- Reduced filtration velocities
- Use of higher temperature fabrics
- Sonic Assist common approach
- Longer filtration life anticipated
- Proven design for large flue gas volumes
- Can meet required particulate control levels
- But greater real estate & capital cost than PJ technology

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Typical Reverse Gas Fabric Filter Installations

Utility Pulse Jet Technology

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Utility Pulse Jet Baghouse Experience Base

- Large Number of Pulse Jet Type Fabric Filters Installed Worldwide
- Largest Individual PJFF Installation (700 MW+) In South Africa
- Majority of Installations Located Off-Shore
  - Most in South Africa & Australia
- Wide Variety of coals
- New and Retrofit Utility Installations
- Many large DFGD/PJFF Installations being developed in U.S. > 800 MW in total capacity
- Many ESP/PJFF Conversions

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Pulse Jet Design Experience

- Bag sizes: 5-6” diameter x 20’-27’ long
- Typical cloth: 16 to 18 oz/sq.Yd. Synthetic Felt Fabric
  - Fabric selections typically PPS or combination of other fibers
  - Use of lower temperature Acrylic Felt also possible with strict temperature control systems
- Split, two or three piece cage assemblies
- Diaphragm valves anywhere from 1.5” up to 12” diameter depending upon pulse pressures utilized
- Air to cloth = Typically 3.5 to 4:1 (4 fpm) gross, higher with COHPAC (8 fpm) or TOXECON (6 fpm) type systems

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Pulse Cleaning Systems

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Low Pressure Pulse Jet Fabric Filters

- Uses low pressure (7-15 psi) positive displacement blowers in lieu of compressors.
- Uses 8 to 15” Dia. diaphragm valve sizes
- Does not require the use of air dryers.
- Compressed air required only for damper operation
- Uses rotating cleaning manifold in lieu of stationary blow pipes and diaphragms

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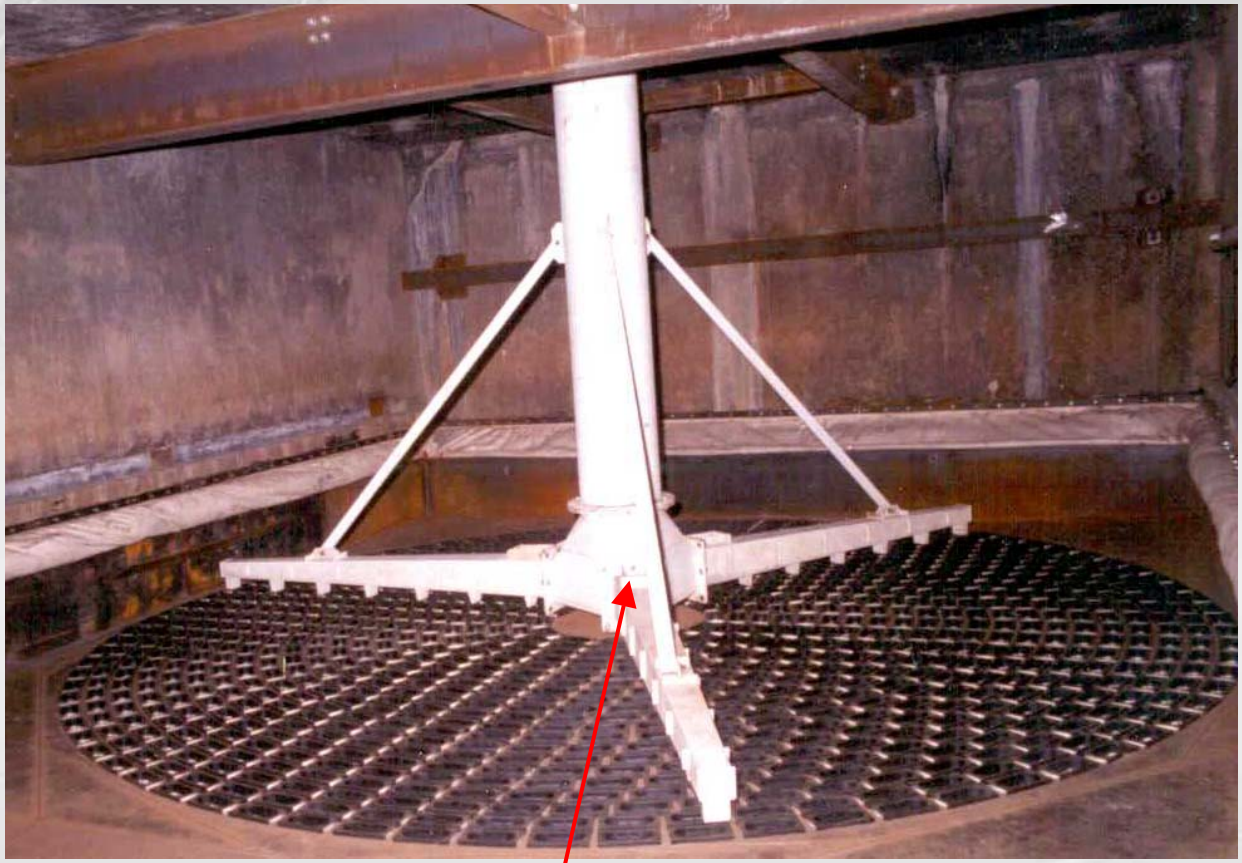
Typical Low Pressure PJ Cell Plate



Cleaning Air Manifold Arms

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High & Medium Pressure Pulse Jet Technologies

- Individual blow pipes located over each row of bags
  - Blow Pipe/Diaphragm valves sized from 1-4” diameter
- High Pressure pulse jets (HPPJ) require use of venturies to introduce secondary cleaning air into bags
  - Low and Medium pressure designs have sufficient secondary air delivered into filter bags to avoid need for venturies
- HPPJ typically uses off-line cleaning while Low & MPPJ primarily use on-line cleaning technologies
- Pulse pressures typically at 30-50 psi (MPPJ) or 70-90 psi (HPPJ)

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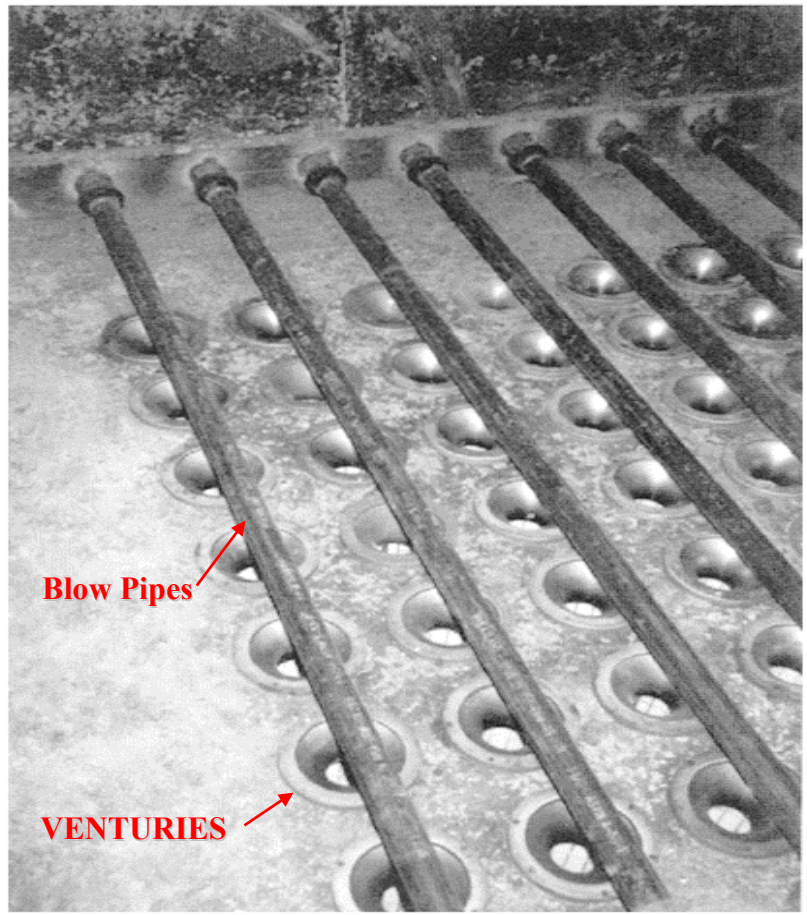
Typical High Pressure Pulse Jet Cell Plate & Pulse Pipe Arrangement



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Medium Pressure Pulse Jet Cell Plate and Pulse Pipe Arrangement

Pulse Pipes

No Venturies

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ESP to Pulse Jet Conversions

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ESP-to-FF Conversions

- Both Low & Medium Pressure pulse jet designs have been successfully utilized for conversion of Electric Utility ESP casings into fabric filters
- Significant amount of conversion experience around the world
- Majority of units located in either South Africa or Australia
- Minimum ESP SCA of 250 to 300 is typically required for full conversion of casing with some degree of sectionalization
- Largest current project in US is PacifiCorp's Huntington Station at 450 MW

ESP Conversions Continued

- Required outage time and overall cost is impacted by:
  - Condition of Existing ESP Casing
  - Ability to utilize existing side walls and hoppers
  - Degree of compartment sectionalization desired
  - Un-restricted crane access to ESP casing
  - Ability to pre-assemble and store large built-up sections adjacent to casing being converted
  - Additional pressure drop capacity of existing I.D. fans
  - Outage time can range from 6 to 18 weeks depending upon the condition of the ESP, degree of sectionalization required and available crane access to the site

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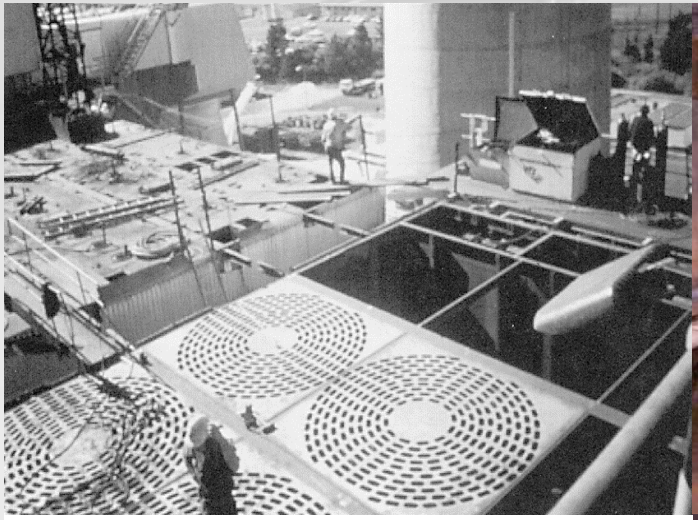
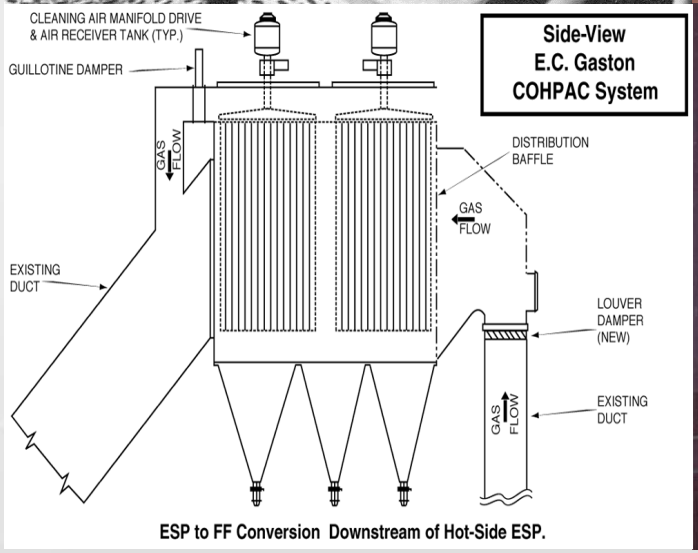
ESP Conversion Examples

(Photos courtesy of Hamon Research-Cottrell)





ESP to FF Conversion Downstream of Hot-Side ESP.

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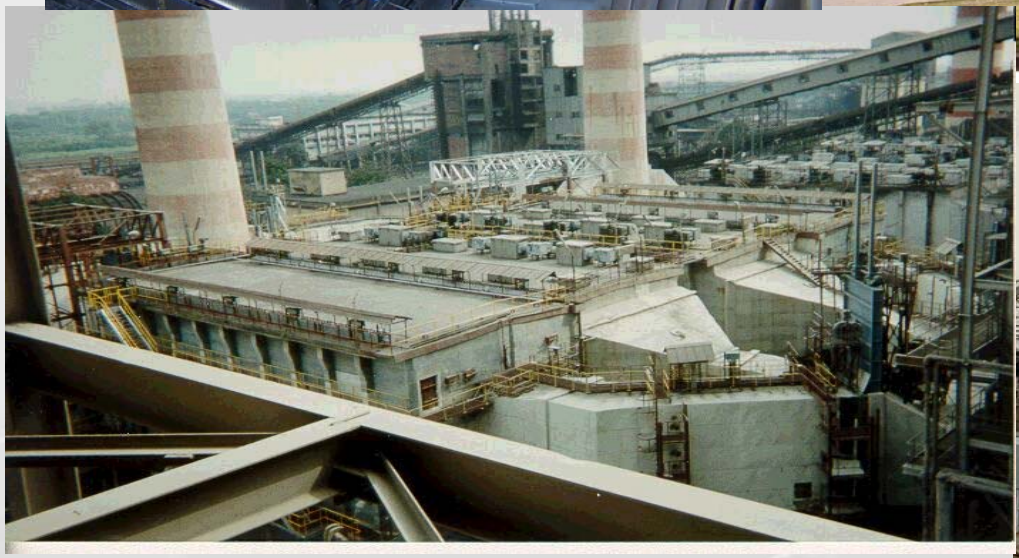
Additional ESP Conversion Photos

(Installation Photos Courtesy of Alstom)



COHPAC/TOXECON ™
Fabric Filters

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COHPAC™ Fabric Filter Technology
COmpact Hybrid PArticulate Collector

- EPRI developed, patented & licensed technology
- Pulse jet fabric filter in series with ESP
- Higher gross filtration rates (> 8.0 fpm) than conventional pulse jets

  Therefore:
  - Smaller amount of filter bags
  - Highly compact footprint
- Meets tough emission standards
  - Particulates, opacity, PM-10/2.5 and air toxins with the appropriate dry additives

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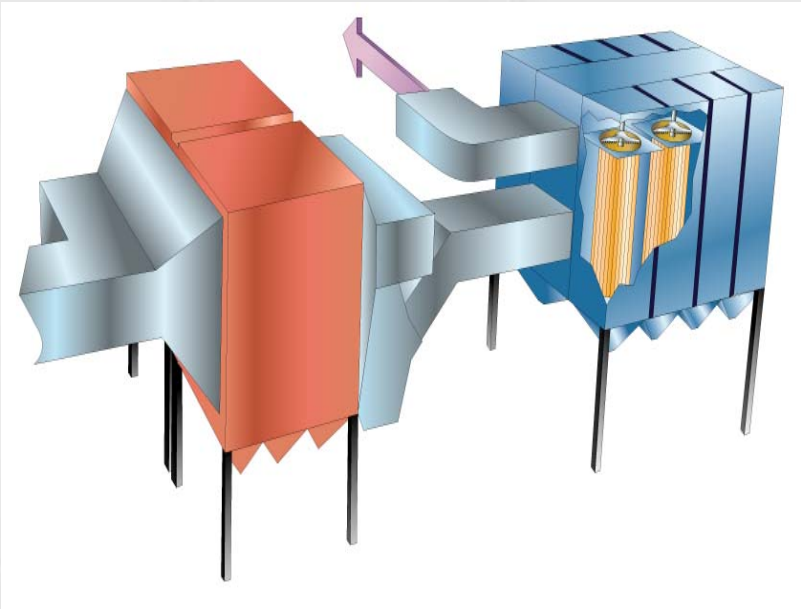
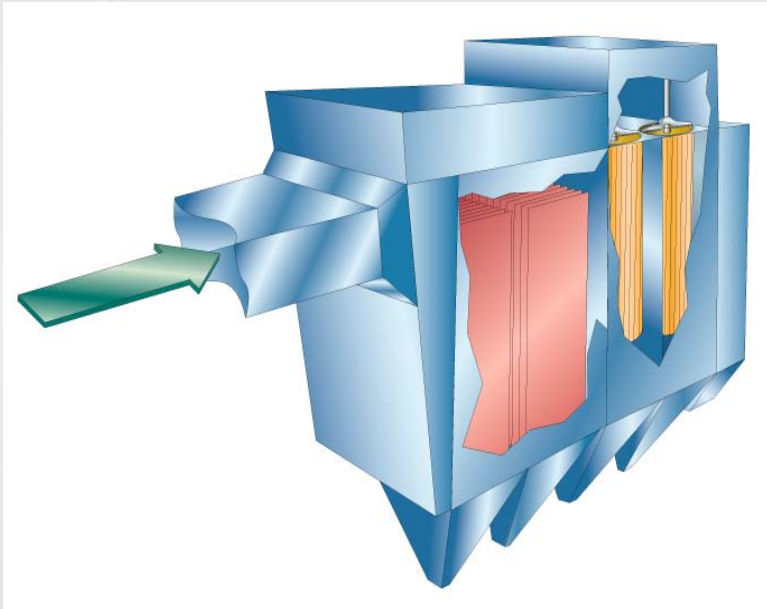
COHPAC System Types

COHPAC I Arrangement



COHPAC II Arrangement



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COHPAC Fabric Filter

- ESP removes most of the fly ash (primary)
  - Therefore low ash/dust loading to FF
- ESP leaves electric charge on particulate
  - Therefore reduced ash cake packing density
  - Therefore lower fabric filter pressure drop
- Fabric filter section becomes final collection (polishing) device
  - Therefore emissions <0.012 lb/Mbtu **(Clear Stack)**
  - Ability to add additional dry sorbent (TOXECON) for mercury & other pollutants with separate ash collection stream
  - Ash is collected on traditional PPS or composite fabrics available from large number of fabric suppliers

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COHPAC Experience:

- A large number of Commercial Operating COHPAC Units To Date (More in development stages)
- Units Currently In Operation:
  - TXU Big Brown Station Units #1 & #2
    - 2 x 600 MW Lignite Coal Fired Boilers
  - Alabama Power, E.C. Gaston Station, Unit #2 & #3
    - 2 x 272 MW Eastern Bituminous Coal Fired Boilers
    - TOXECON demonstration site
  - American Ref-Fuel, SEMASS Waste-to-Energy Combustors
    - 2 x 25MW Boilers
    - First Full-Scale TOXECON Demonstration
  - WE Energies, Presque Isle

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COHPAC/TOXECON Photos

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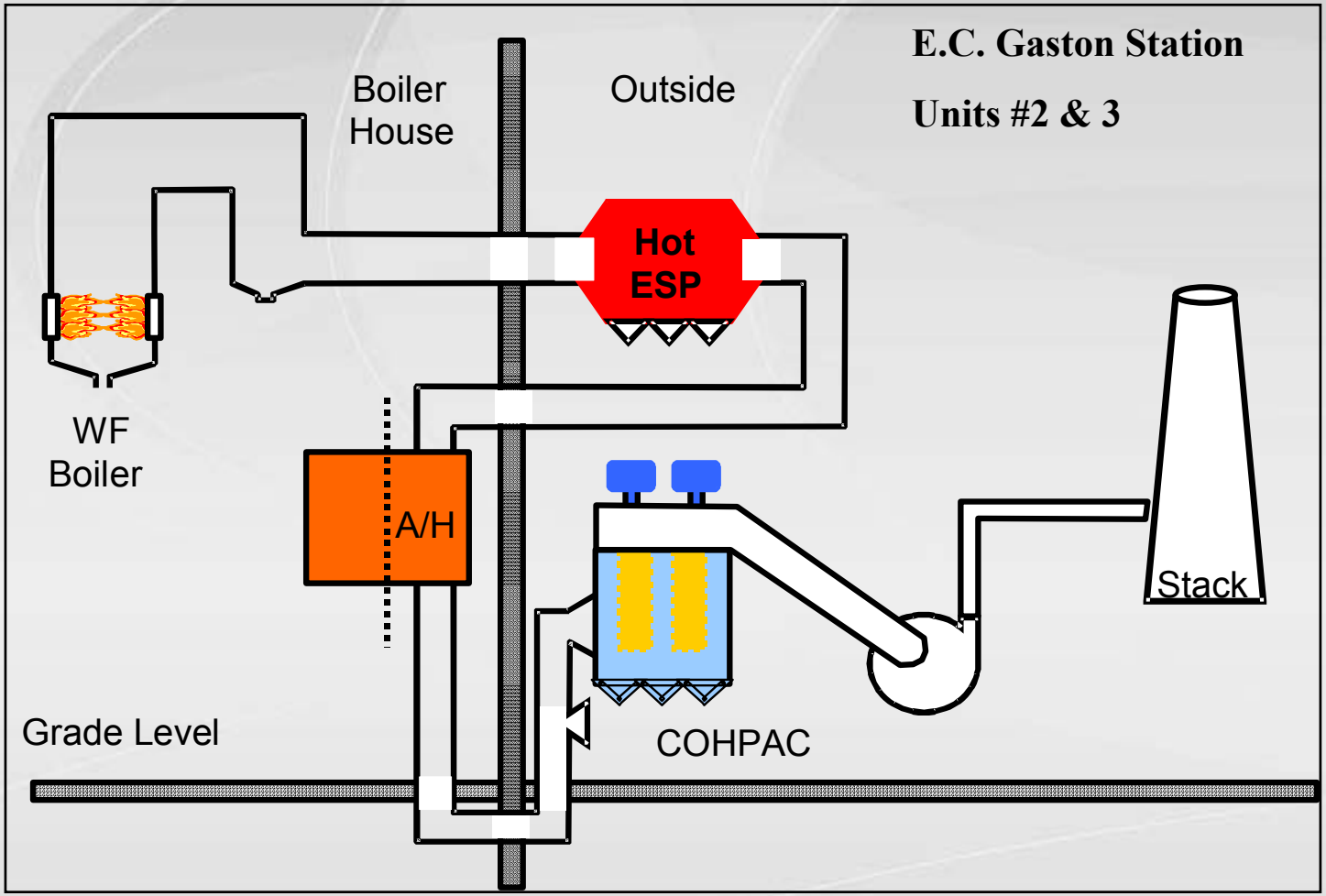
Alabama Power Installations



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Typical Utility Pulse Jet Installation Photos

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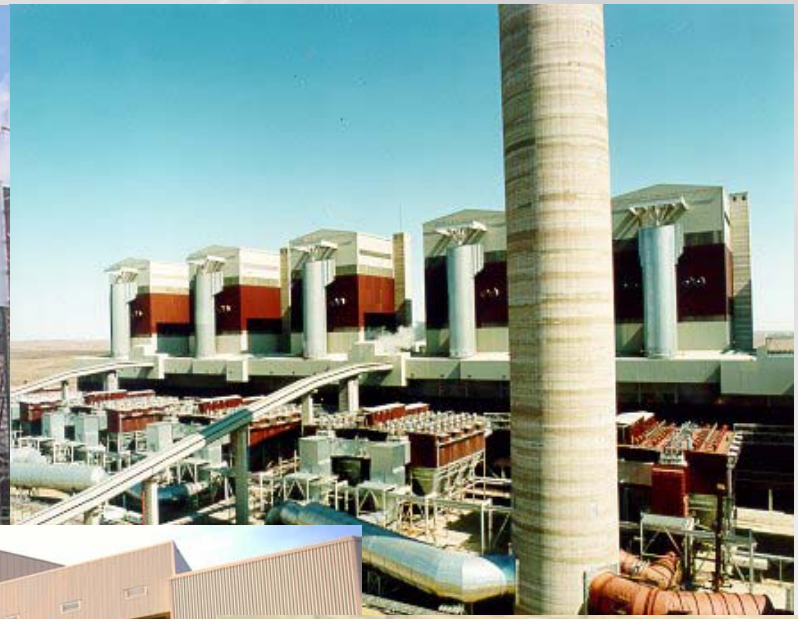
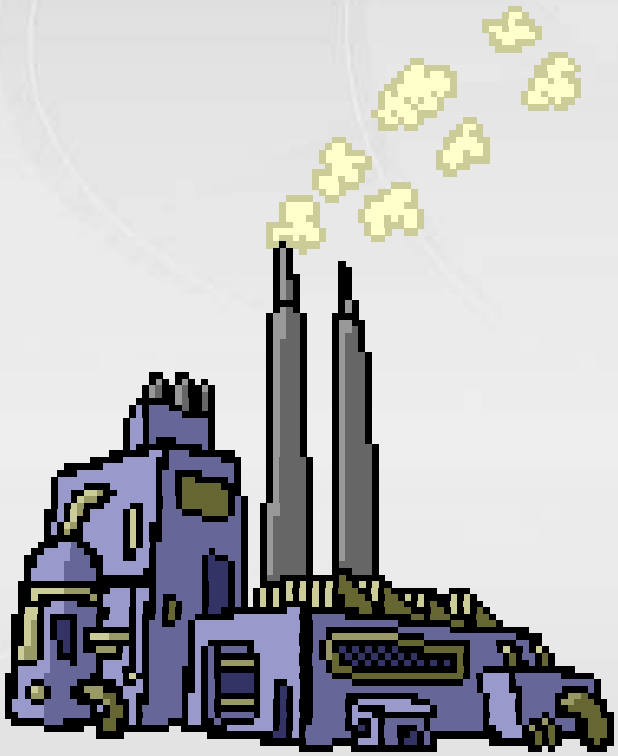
Typical Utility Pulse Jet Installations



Mercury Abatement & TOXECON™



Some Potential FF Control Methods

Retrofits

- COHPAC or other polishing fabric filter technology incorporated with dry pulverized activated carbon becomes TOXECON™
- Carbon can be added to existing ESP's or full-size fabric filters
- Humidification may be required based upon flue gas temperatures at exit to air heaters or use of alternate carbons
- Installation of Dry or Wet FGD technologies using fabric filter technologies

NOTE: Both COHPAC & TOXECON™ technologies are EPRI patented and licensed technologies and are subject to specific royalty payments.

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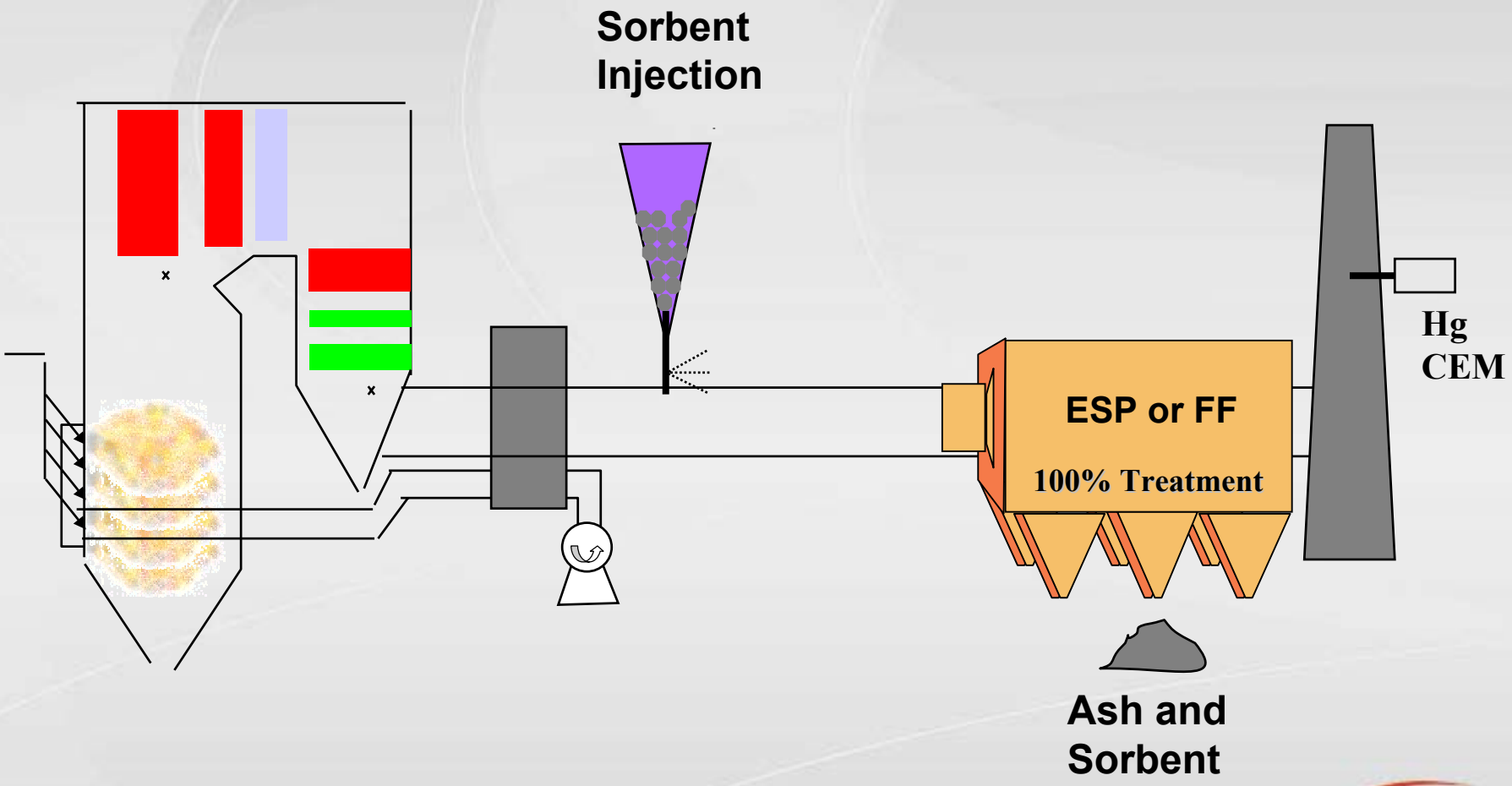
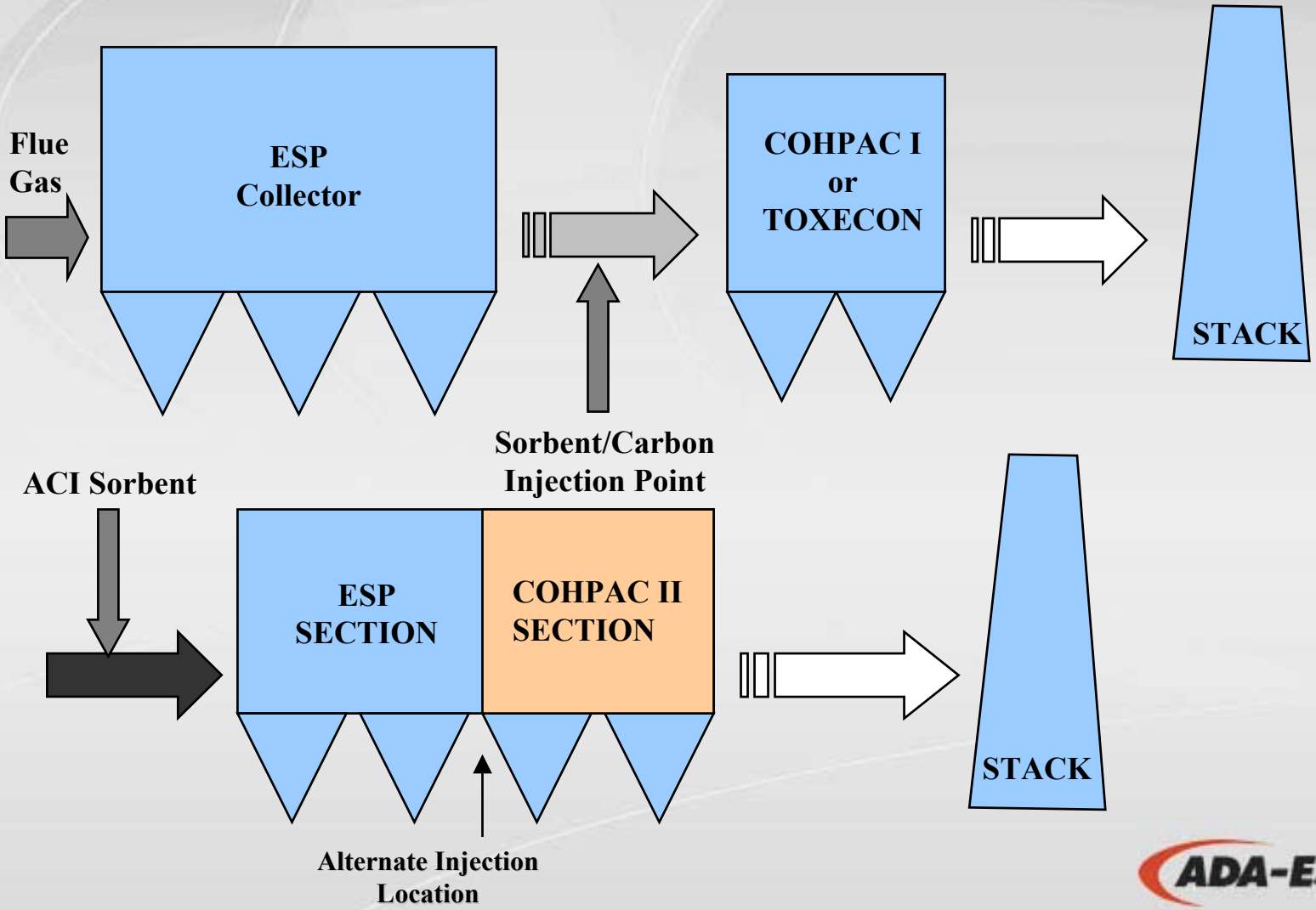
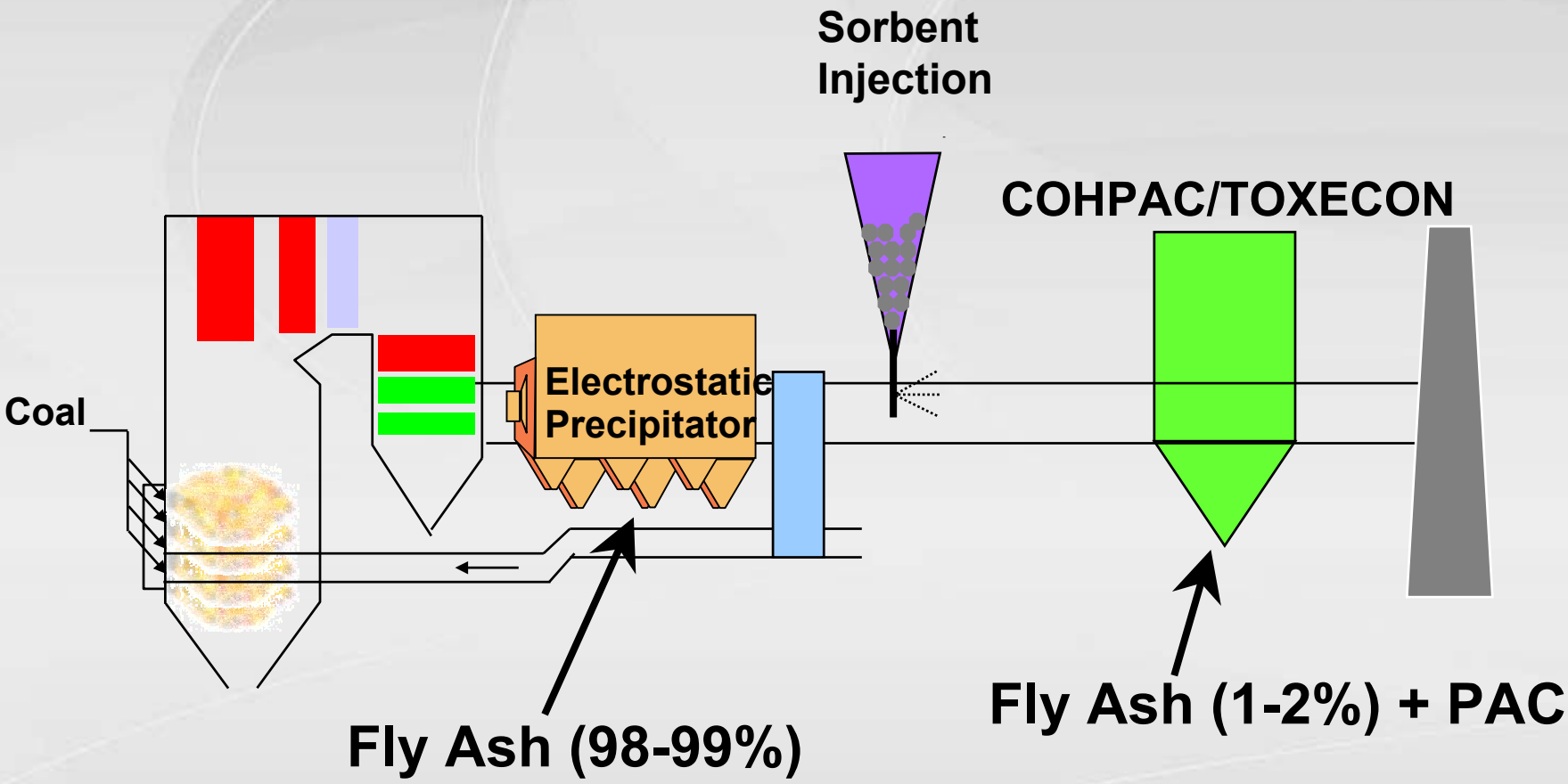
Typical Coal-Fired Boiler with Sorbent Injection



Potential COHPAC/TOXECON Solutions



Site Test Configuration at both Gaston & Presque Isle Stations



TOXECON™ – 270 MW Demonstration

- **A Mercury and Multi-Pollutant Control Technology**
- **Presque Isle Power Plant, Marquette MI**
  - **Units 7-9 (90 MW ea)**
  - **PRB Coal**
- **$49.8M**
  - **$24.9M DOE**
  - **$24.9M We Energies**
- **90% Hg Control**
  - ∗ **$SO_2 \Rightarrow 70\%$**
  - ∗ **$NO_X \Rightarrow 30\%$**

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ADA-ES ACI System at We Energies Presque Isle (270MW) TOXECON™

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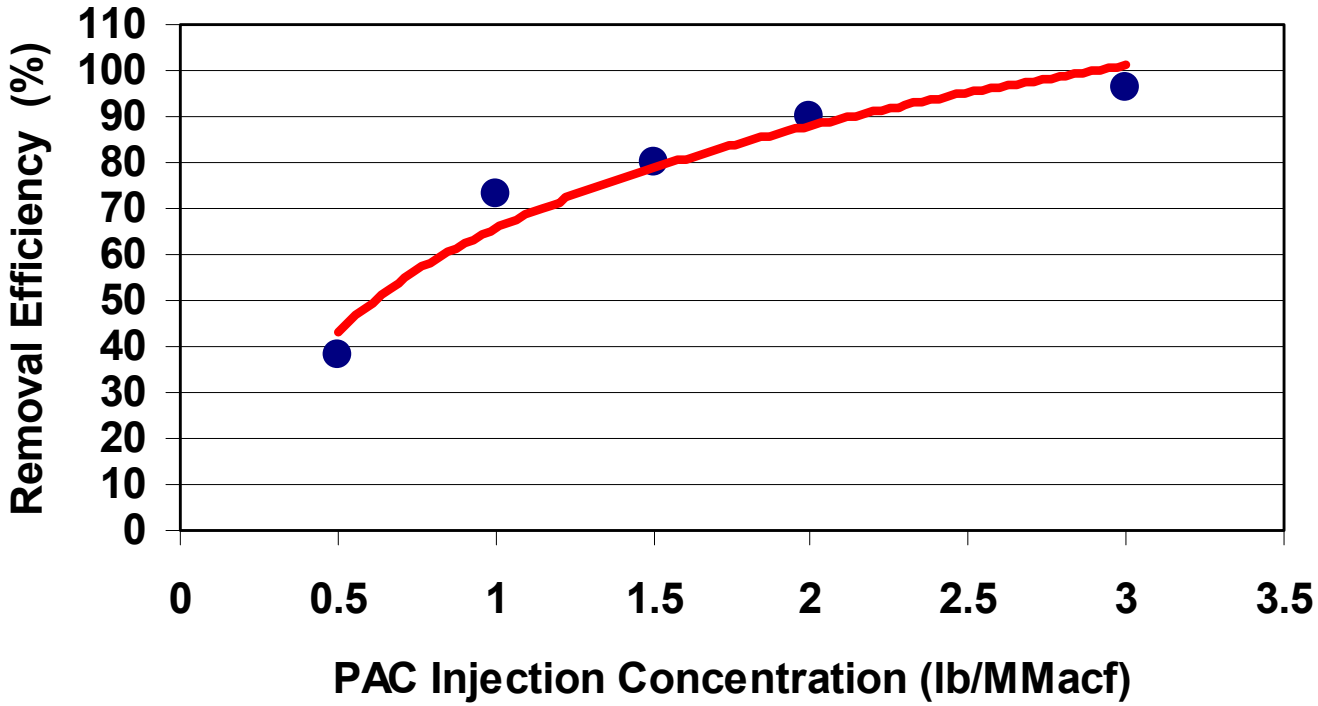
Presque Isle Hg Reduction Curve (TOXECON/PJFF – PRB)



First Quarter 2006 Test Data

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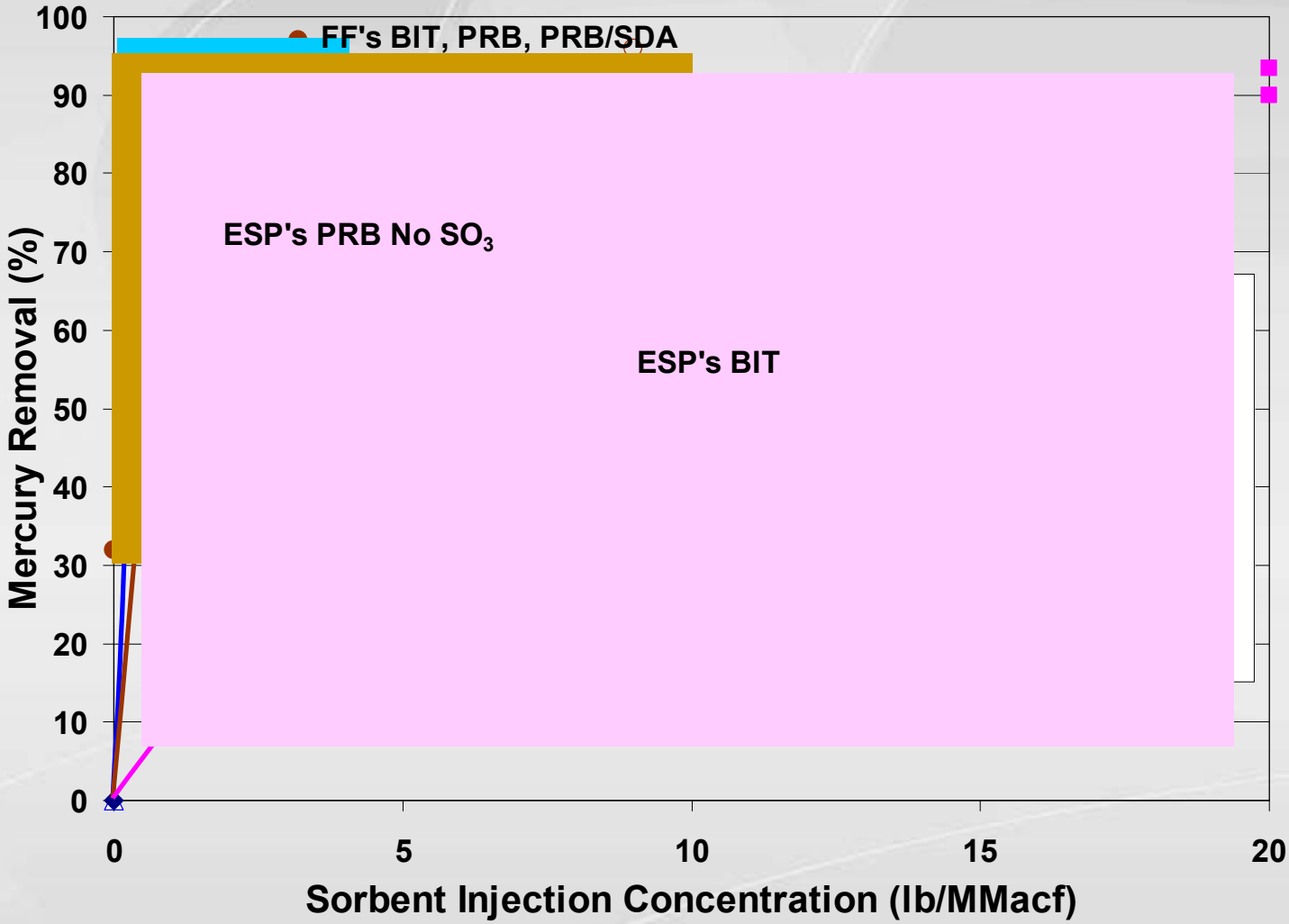
ESP vs FF Mercury Reduction ACI Performance Comparisons



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Conclusions

- Fabric filters provide better contact and residence time between the sorbent and mercury than ESPs alone, thus resulting in higher removal levels at lower sorbent costs.
  - Sorbent injection can effectively capture elemental and oxidized mercury from both bituminous and subbituminous (PRB) coals
- New COHPAC FF's (TOXECON) are being designed to accommodate higher loadings of PAC to insure high (>90%) mercury removal.
- Coal characteristics (PRB vs. Bit) appear to affect ACI performance with an ESP but not significantly with FF
- COHPAC/TOXECON provides a multi-pollutant control device able to consistently achieve low stack opacity levels, reduction of fine particulates (PM 2.5 & 10) and mercury reduction at a reasonable cost utilizing commercially available dry additives

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Conclusions

- Use of COHPAC/TOXECON preserves fly ash sales as ash/carbon can be separated from ESP ash

- On TOXECON type installations with carbon enriched ash, it is strongly recommended that fabric filter hoppers NOT be used and storage of ash be kept to a minimum, <4 hours storage times suggested. These operating procedures minimize potential for carbon enriched ash to smolder and burn.

- Hopper heaters should only be used for start-up, when PAC injection is not being utilized. If utilized during operation with PAC, hopper heaters should only be operated to maintain skin temperatures above the dew point and operated in a narrow temperature range of say 50F. (ie. 250-300F)

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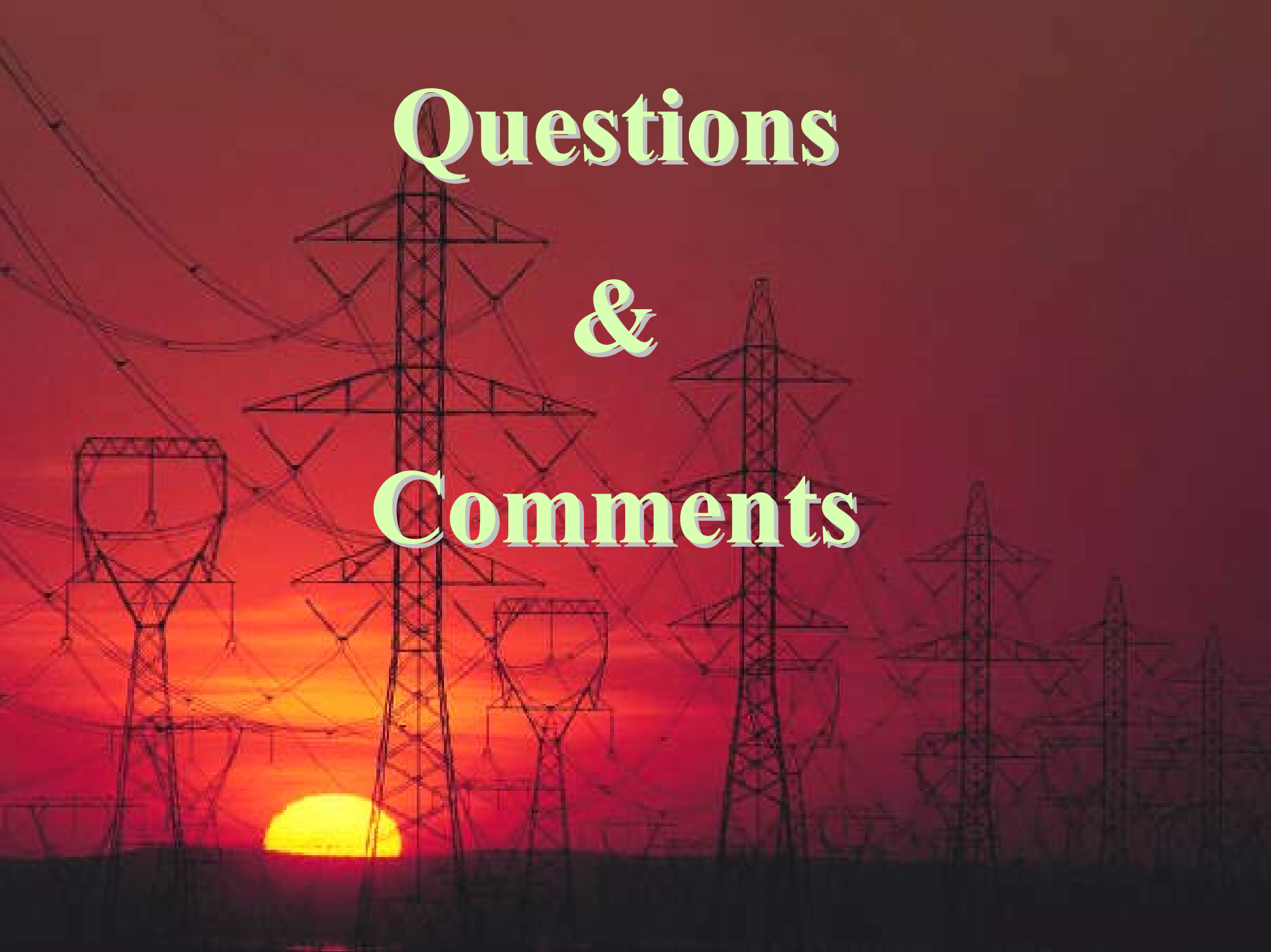
Questions
&
Comments