

# Compliance Strategy Options and Costs for PM<sub>2.5</sub> Control

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**McIlvaine Company Hot Topic Hour**

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# Options

## Baghouse (BH)

- Pulse Jet (PJ)\*
- Reverse Air (RA)\*

## Electrostatic Precipitator (ESP)

- Wet ESP
- Dry ESP\*
- Conversion to BH

\*Cost Comparison



# Assumptions

- Inlet Volume to Baghouse/ESP = 3,000,000 ACFM
- Normal Operating Temperature = 280 F
- Coal Sulfur Content = 3.0%
- Outlet Particulate from Baghouse/ESP = 0.0005 grains/ACFM



# Technical Comparison

<b>Cleaning Method</b>	<b>Reverse Air</b>	<b>Pulse Jet</b>	<b>ESP</b>
Air Pressure	Low	Compressed	NA
Filter Media	Woven*	Felt*	NA
Bag Diameter/Plate ga.	12 inch	6 inch	18 ga.
Bag Length/Plate Ht.	35 feet	28 feet	48 feet
Plate Spacing	NA	NA	16 in.
Collect dust	Inside tube	Outside Tube	NA
Filtration Mechanism:			NA
Without Membrane	Dust Cake	Felt + Dust	NA
With Membrane	Surface	Surface	NA
No. of Casings	2	2	2
No. of Fields	NA	NA	4
No. of Chambers	NA	NA	3
Experience:	30 years	15 years	>50 years
With ePTFE Membrane	10 years	7 years	NA



\* With and without ePTFE Membrane

# Limitations

- All numbers valid for comparison
- Not to be used for budgetary purposes
- Individual vendors quotes higher and lower
- Relative size of RA & PJ valid
- ESP and Baghouse arrangements vary
- Selection & refined design needed

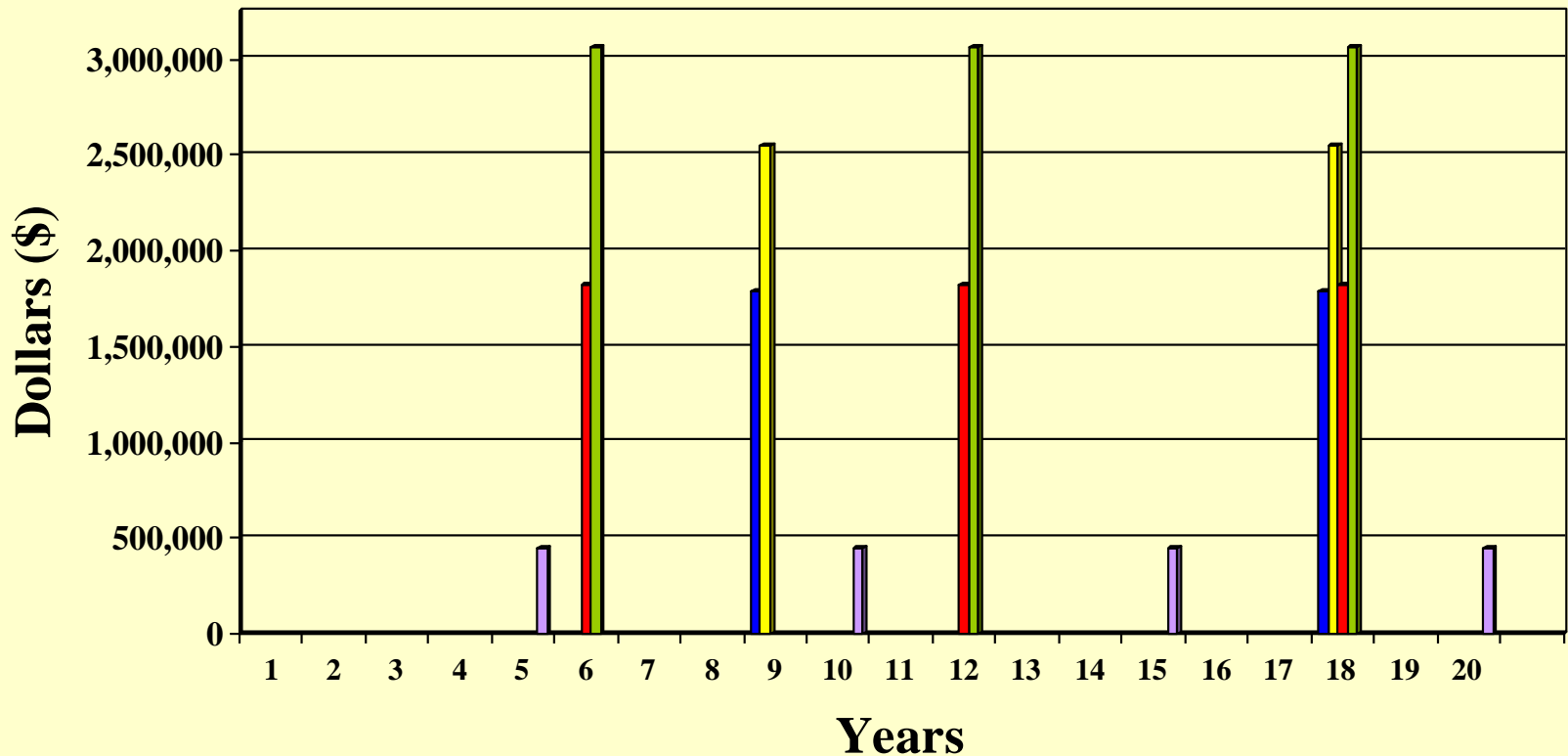


# Parts Comparison

REVERSE AIR	REVERSE AIR	PULSE JET	PULSE JET	ESP
10 oz. FG	10 oz. FG + ePTFE membrane	16 oz. PPS	16 oz. PPS + ePTFE membrane	\$368/insulator
35 ft L x 12 in D	35 ft L x 12 in D	28 ft L x 6 in D	28 ft L x 6 in D	192 insulators
\$95/bag ( $\pm 7\%$ )	\$142/bag ( $\pm 7\%$ )	\$70/bag ( $\pm 15\%$ )	\$123/bag ( $\pm 15\%$ )	\$70,656/192
16,128 bags	16,128 bags	23,296 bags	23,296 bags	\$40,250/other
\$1,525,095 / bag set	\$2,287,642 / bag set	\$1,629,132 / bag set	\$2,868,912 / bag set	\$4,600 / TR set
\$259,661 labor	\$259,661 labor	\$187,533 labor	\$187,553 labor	24 TR sets
\$1,784,756 / bag set + labor	\$2,547,303 / bag set + labor	\$1,816,665 / bag set + labor	\$3,056,445 / bag set + labor	\$110,400 / 24 sets
9 yr. life	9 yr. life	6 yr. life	6 yr. life	5 yr. life
\$198,306 / yr bags + labor	\$283,034 / yr bags + labor	\$201,852 / yr bags + labor	\$339,605 / yr bags + labor	\$88,522 / yr parts + labor



# Bag & ESP Parts Replacement Expenditure Timeline



■ Reverse Air (9 yr) \$1,784,756
 ■ Reverse Air w/Membrane (9 yr) \$2,547,303

■ Pulse Jet (6 yr) \$1,816,665
 ■ Pulse Jet w/Membrane (6 yr) \$3,056,445

■ ESP - Insulators and TR Sets (5 yr) \$442,612



# Annual Costs-ESP & Baghouse

## Fifteen Year Straight Line

Baglife: RA= 9 yr, PJ = 6 yr, ESP Insulators/TR = 5 yr

For comparison only & not for budgetary purposes

Interest charges not included

REVERSE AIR	REVERSE AIR	PULSE JET	PULSE JET	ESP
10 oz. FG	10 oz. FG + ePTFE membrane	16 oz. PPS	16 oz. PPS + ePTFE membrane	Insulators / TR
\$44,850,000 (house)	\$44,850,000 (house)	\$26,450,000 (house)	\$26,450,000 (house)	\$28,750,000 (stacked)
\$2,990,000 / yr (house)	\$2,990,000 / yr (house)	\$1,763,333/ yr (house)	\$1,763,333 / yr (house)	\$1,916,667/ yr (stacked)
\$198,306 / yr (bags)	\$283,034 / yr (bags)	\$201,852 / yr (bags)	\$339,605 / yr (bags)	\$88,522 / yr (insul./TR)
\$3,188,306 / yr	\$3,273,034 / yr	\$1,965,185 / yr	\$2,102,938 / yr	\$2,005,189 / yr





# Reliability

## Keys to trouble-free operation

- 1) Conservative G/C and/or SCA Equiv.
- 2) Vendor with direct experience
- 3) Detailed specification
- 4) QA/QC & Installation
- 5) Training, Start-up
- 6) O&M plan & implementation
- 7) Operate above the acid dew point
- 8) True for both Baghouse and ESP



# ESP Pros & Cons

## Advantages:

- 1) Low pressure drop
- 2) High experience
- 3) High temperature capability

## Disadvantages:

- 1) Very sensitive to fluctuations in gas stream conditions : flow, temperature, particulate & gas composition, dust loading
- 2) Not effective in capturing some contaminants: heavy metals, dioxins



# Baghouse Pros & Cons

## Advantages:

- 1) Extremely high efficiency on both coarse & fine particulate
- 2) Relatively insensitive to gas stream fluctuations including flow, dust loading and particulate and gas composition
- 3) Relatively simple operation
- 4) In the case of pulse jet relatively small “footprint”

## Disadvantages:

- 1) Temperature limited by bag selection (500°F max)
- 2) Relatively high flange to flange pressure drop
- 3) Bag change might require respiratory protection



# ADA-ES Long Term Evaluation ref no 8

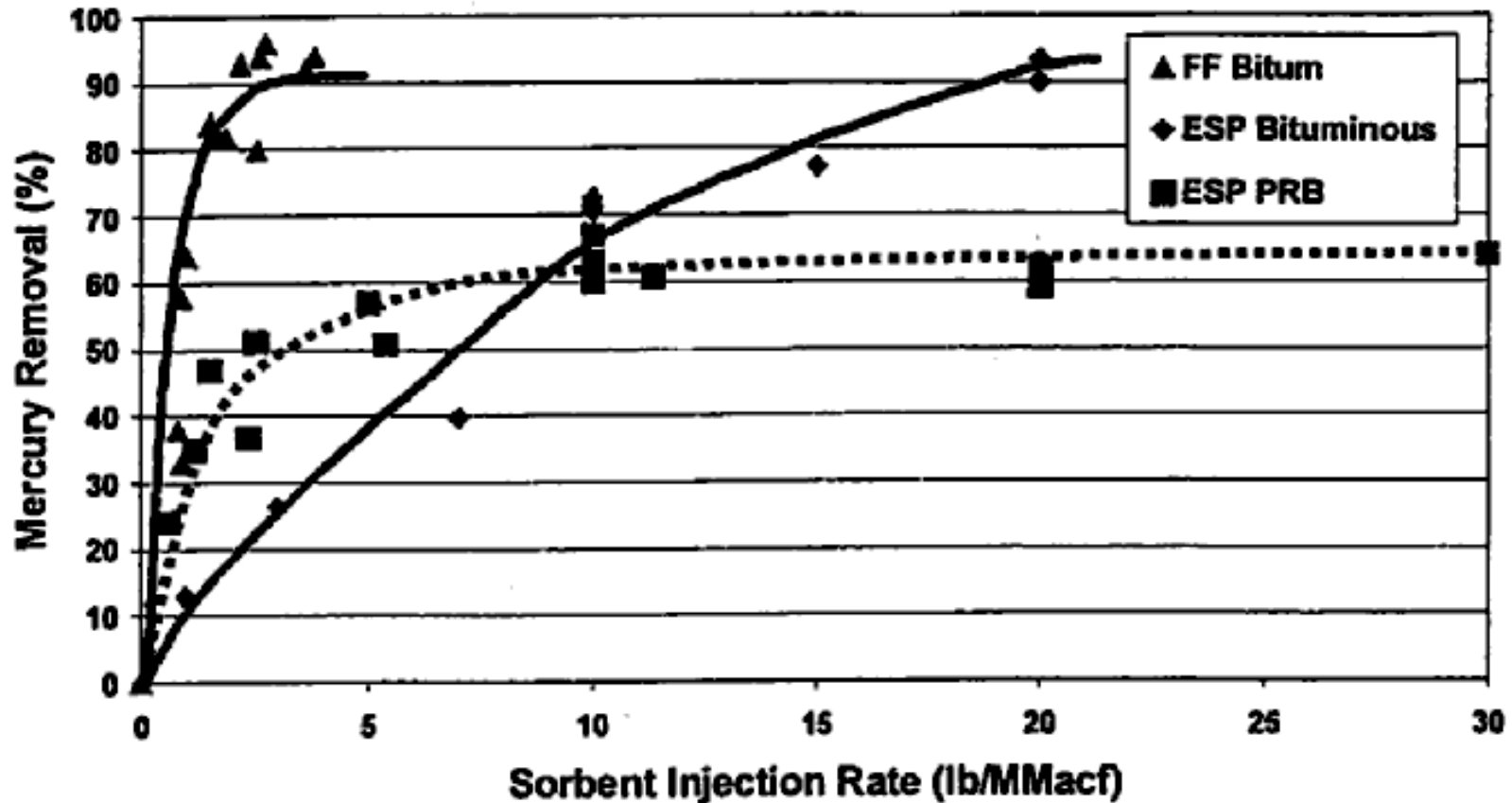


Figure 2. Mercury Removal Trends with Activated Carbon from NETL Phase I Test Program



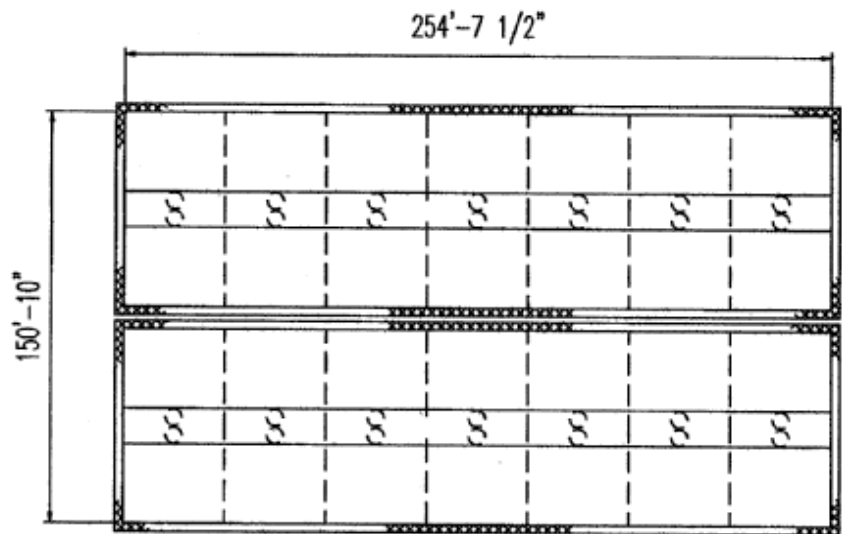
# Summary Comparison

		Reverse Air	Reverse Air w/Membrane	Pulse Jet	Pulse Jet w/Membrane	ESP
Initial House Cost		\$45 mil	\$45 mil	\$26.5 mil	\$26.5 mil	\$28.8 mil
Annual O&M Expense		\$198,306/yr	\$283,034/yr	\$201,852/yr	\$339,605/yr	\$88,522/yr
Total Annual Cost		\$3.2 mil/yr	\$3.3 mil/yr	\$2.0 mil/yr	\$2.1 mil/yr	\$2.0 mil/yr
Size (ft):	• Height	84	84	81	81	85
	• Width	151	151	111	111	326
	• Length	255	255	177	177	101
Reliability:						
• Years experience		30+	10+	15+	7+	50+
• Reported		Very Good/ Excellent	Very Good/ Excellent	Very Good	Very Good	Excellent
Flexibility:						
• Gas Volume		Very Good	Very Good	Very Good	Very Good	Fair
• Coal Characteristics		Excellent	Excellent	Excellent	Excellent	Fair/Poor
Future:						
• Fine Particle		99.99% +	99.99% +	99.99% +	99.99% +	99%+
• Mercury		90%* \$1.5 mil/yr**	90%* \$1.5 mil/yr**	90%* \$1.5 mil/yr**	90%* \$1.5 mil/yr**	60%* >\$10 mil/yr**

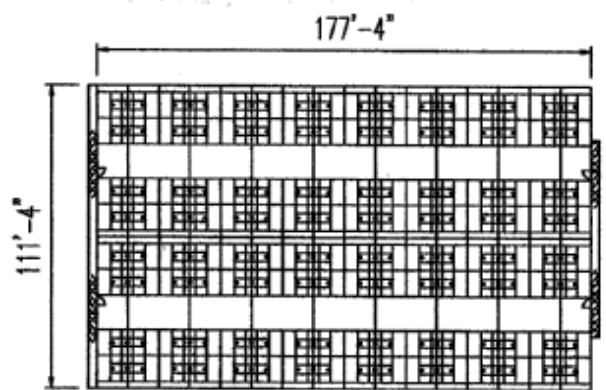


\* Sorbent efficiency    \*\*Carbon Injection comparative cost for mercury capture

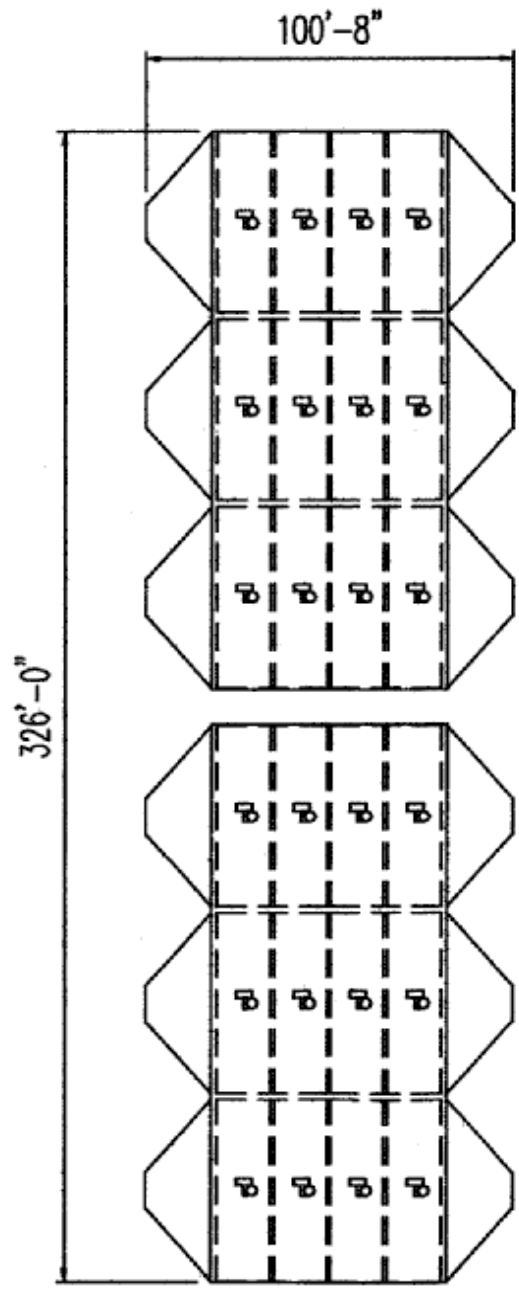
# Size Comparison



PLAN VIEW  
(Reverse Air Collector)



PLAN VIEW  
(Pulse Jet Collector)



PLAN VIEW  
(Electrostatic Precipitator)

