

Sorbent Injection for Small ESP Mercury Control in Bituminous Coal Flue Gas

DOE/NETL Mercury Program Review Meeting
July 14th, 2004

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Presentation Outline

■ Project Background

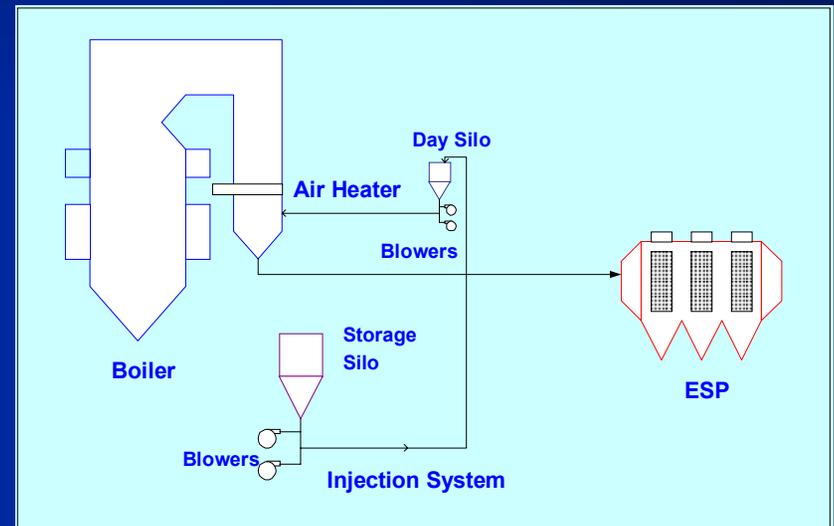
■ Test Objectives

- Host Site
- Planned tests

■ Project Status

- Completed tests
- Results

■ Future Plans



Project Background

- Financial Assistance Program DE-FC26-03NT41987
- Full-scale activated carbon injection tests at Southern Company's Georgia Power Plant Yates
 - **Units 1 and 2**
 - **ESPs with SCA <200 ft²/1000 acfm**

Project Team



**Dawn Chapman
(COR)**



**Mark Berry
Nick Irvin
Ken McBee**



Carl Richardson



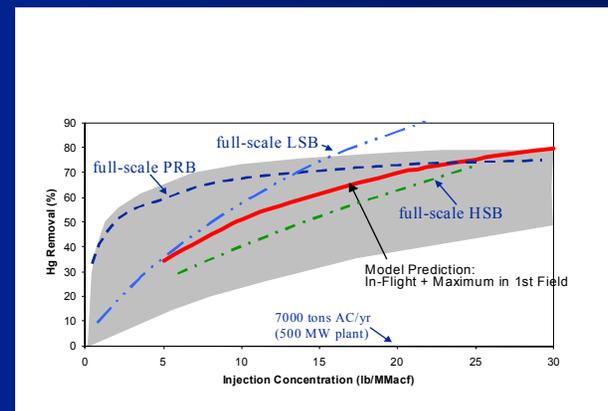
Ramsay Chang



**Sharon Sjostrom
Dave Muggli**

Project Background

- Most previous ACI testing with ESPs performed on relatively large units
 - High levels of Hg removal possible
 - No apparent detrimental effects on ESP performance
- 70% of utility ESPs have SCA <math>< 300 \text{ ft}^2/1000 \text{ acfm}</math>
 - Sorbent injection performance in this size range not currently known
 - Effects on ESP performance?



Project Background

- **38,000 MW capacity from bituminous plants**
 - **Many scrubbed bituminous units**
 - **Many units with small ESPs**
- **Emission limits may require many bituminous plants to increase Hg removal**
 - **Will depend on existing configuration, Hg speciation**
- **Is important to evaluate ACI with low SCAs, bituminous flue gas**

Project Objectives

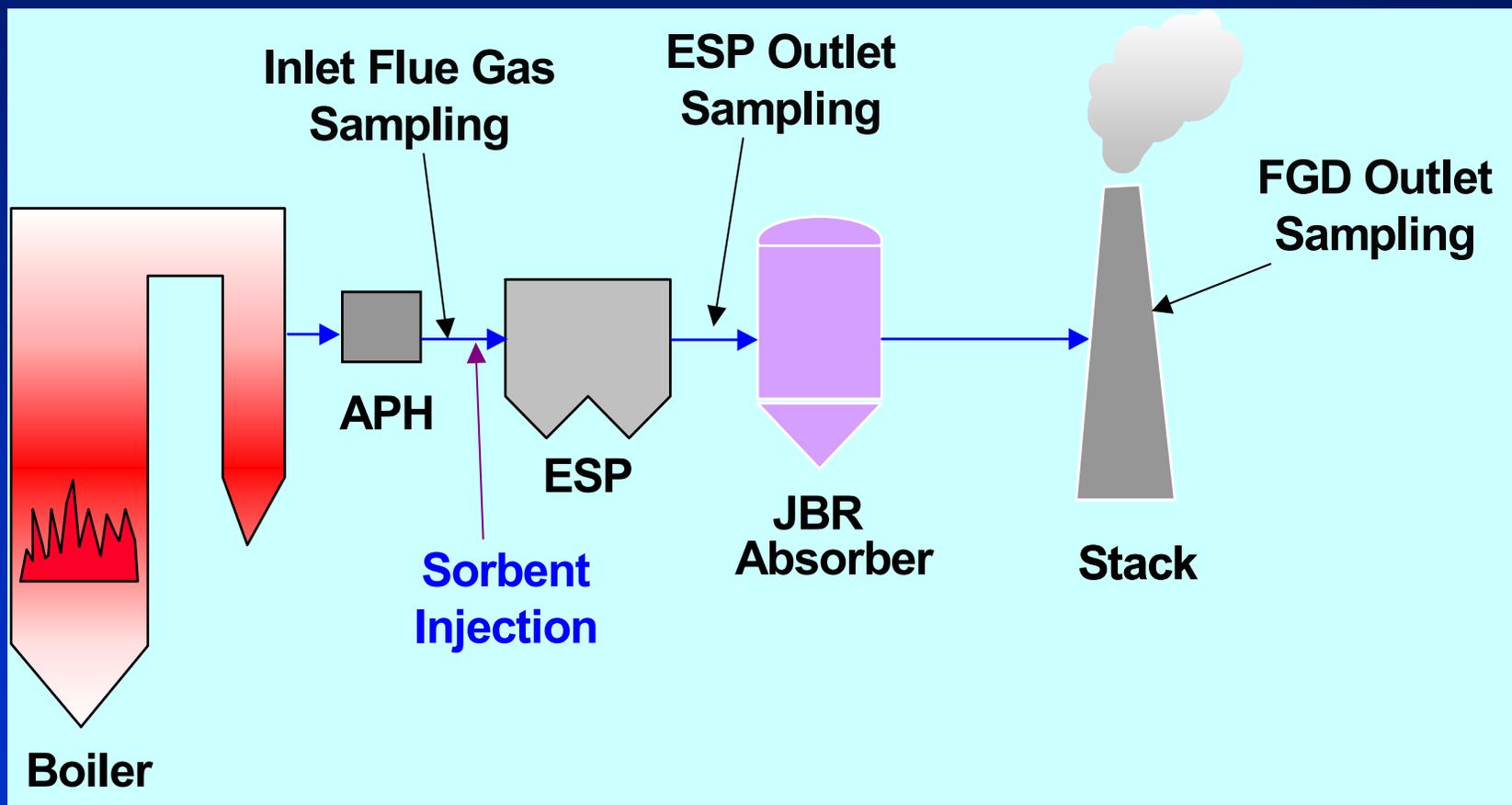
**Evaluate sorbent injection for Hg control
in bituminous flue gas across small-
sized ESPs and ESP/FGD**

- **Removal performance & variability**
 - **Optimal process conditions**
- **Balance of plant effects**
 - **ESP, FGD operation**
 - **Effects on byproduct ash, gypsum**

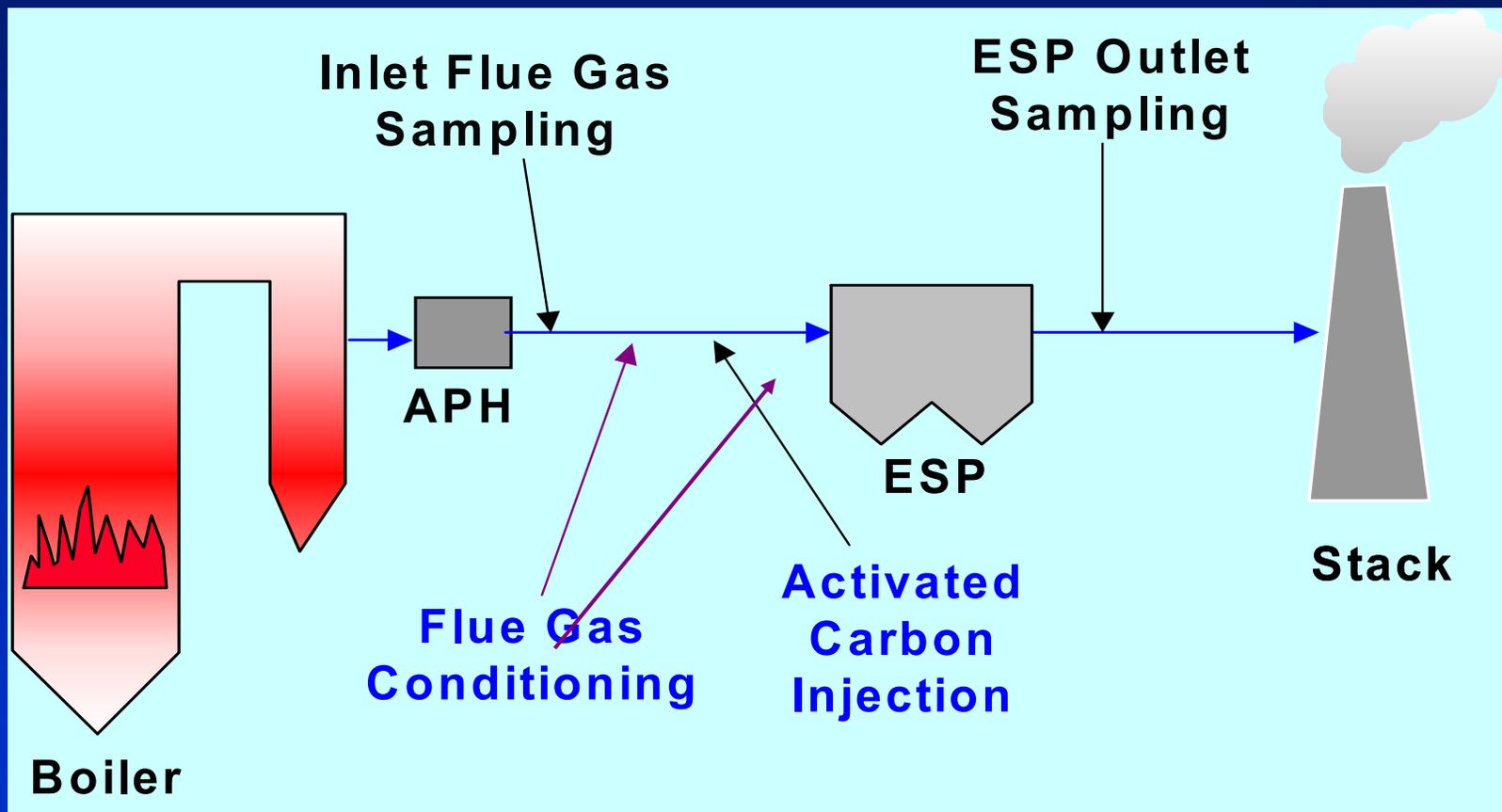
Georgia Power Plant Yates

	Yates Unit 1	Yates Unit 2
Boiler		
Type	CE Tangential Fired	
Nameplate (MW)	100	
Coal		
Type	Eastern Bituminous	
Sulfur (wt %, day)	1.0	
Mercury (mg/kg, dry)	0.10	
Chloride (mg/kg, dry)	300-1400	
ESP		
Type	Cold-Side	
ESP Manufacturer	Buell	
Specific Collection Area (ft ² /1000afcm)	173	144
Flue Gas Conditioning	None	SO₃/NH₃
ESP Inlet Temp. (°F)	310	300
NO_x Controls	Low NOx Burners	None
SO₂ Controls	Chiyoda CT-121 wet scrubber	None

Plant Yates Unit 1 Configuration

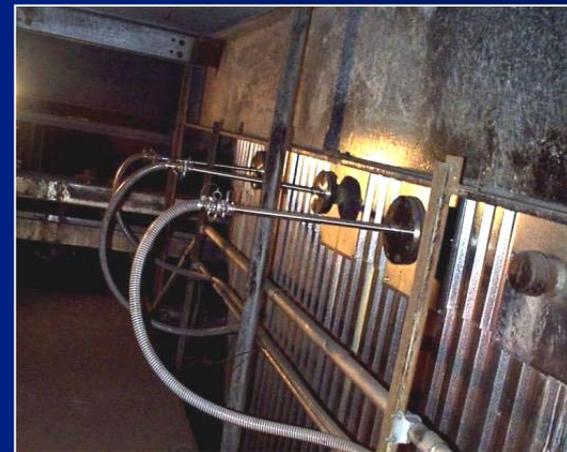


Plant Yates Unit 2 Configuration



Planned Tests

- Short-term parametric tests (Units 1 & 2)
 - Effect of sorbent type
 - 2 - 3 activated carbon sorbents
 - Effect of sorbent injection rate
 - 1-20 lb/MM acf
 - Effect of flue gas conditioning (Unit 2)
- Long-term sorbent injection test
 - Unit 1 test
 - 30 day test
 - Process variability
 - Effects on ESP, FGD operation



Project Status

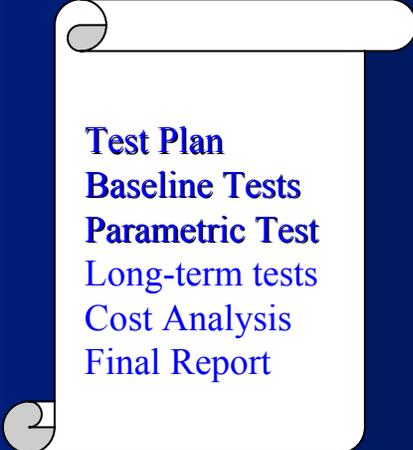
Completed Tests

■ Baseline Testing

- **Units 1 and 2 (March-04)**
 - Flue gas characterization
 - Ontario Hydro testing

■ Parametric Testing

- **Unit 1 (April-04)**
 - 3 sorbents
- **Unit 2 (March-04)**
 - Effect of FGC with Norit FGD™
 - Effect of injection rate



Test Plan
Baseline Tests
Parametric Test
Long-term tests
Cost Analysis
Final Report

Baseline Results

Test Parameter	Unit 1	Unit 2
Coal Hg (ppm)	0.06 - 0.09	0.07 – 0.14
Coal Chloride (ppm)	230 - 360	280 - 440
Coal Sulfur (%)	0.7 - 1.3	1.0 – 1.4
Flue Gas Hg at ESP Inlet ($\mu\text{g}/\text{Nm}^3$)	3.5 - 5.0	5.0 – 7.0
Mercury Oxidation at ESP Inlet (% of Total)	30 - 40	30 - 40
Fly Ash Hg (ppm)	0.30	0.25

Baseline Results

- Observed 'natural' Hg removal across ESPs
 - Unit 1: 20% – 50%
 - Unit 2: 20% – 60%
 - Results supported by fly ash Hg levels
- Fly Ash LOI: 8-12%
- Ontario Hydro bias in high-dust gas
 - Hg oxidation across filter
 - Supported by lab tests with Yates fly ash

Parametric Tests – Units 1 and 2

- Short-term ACI tests performed
 - 2 – 8 hrs per test condition
- Carbon injection carried out by ADA-ES
 - Porta-Pac injection skid
 - ~1000 lb carbon super sacks
- Unit 1
 - 20 tests over 2-wk period
- Unit 2
 - 10 tests over 1-wk period

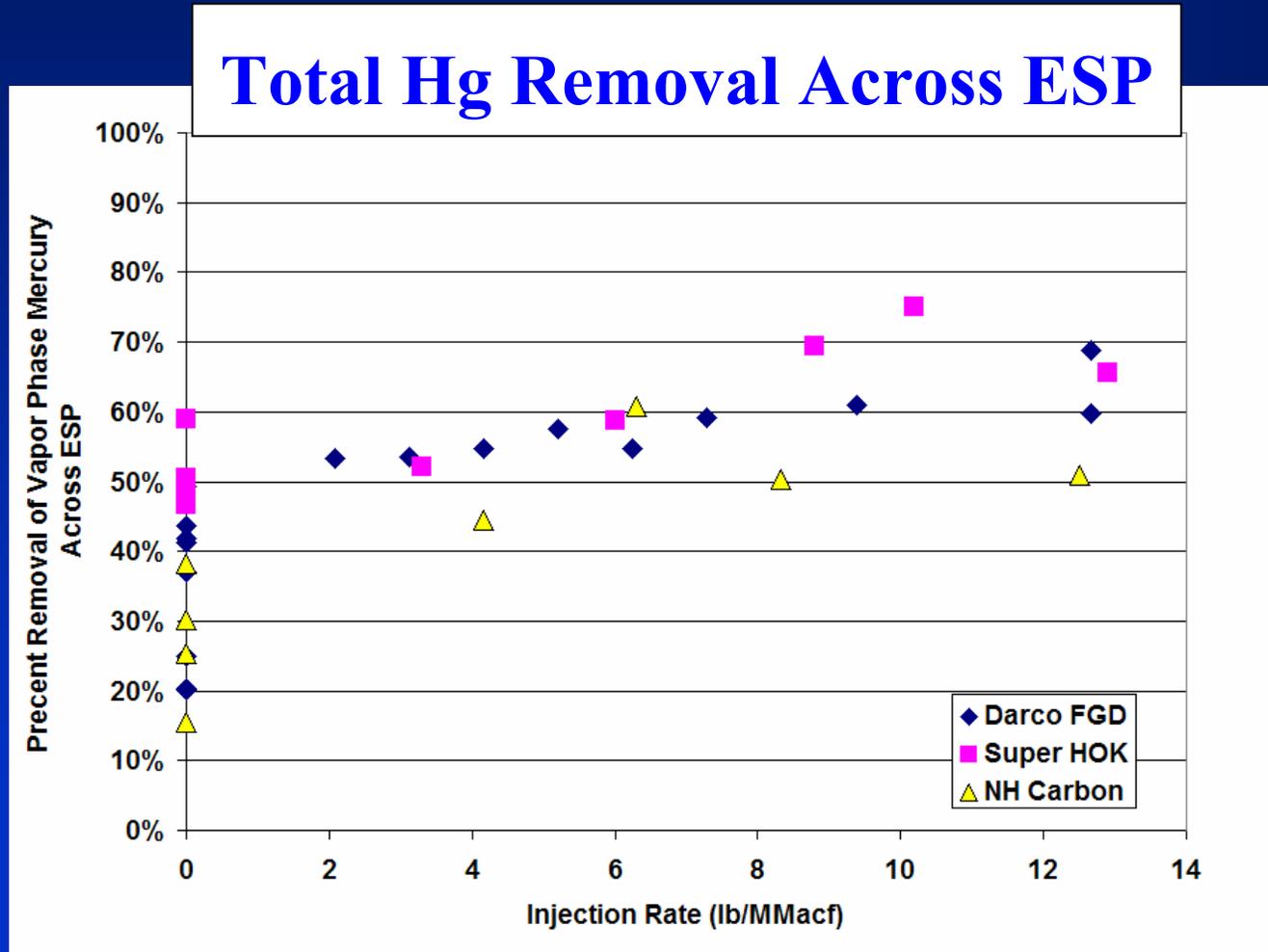


Carbon Sorbents Tested

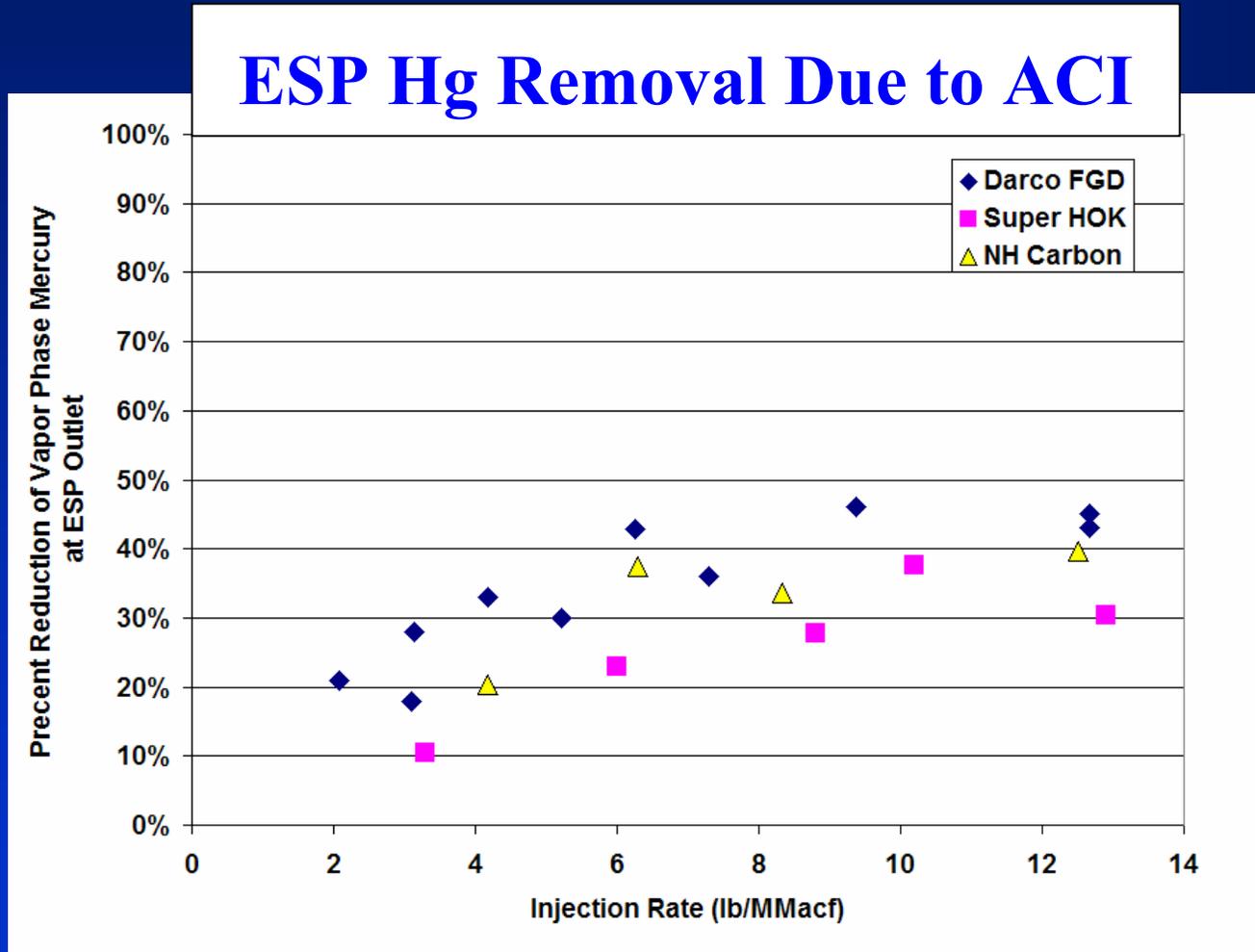
Carbon Name	Manufacturer	Carbon Description	Cost (\$/lb)
Darco FGD™	Norit Americas	Tx lignite-derived activated carbon; baseline carbon; 19 µm mean particle size	0.50
Super HOK	RWE Rheinbraun	German lignite-derived activated carbon; 23 µm mean particle size	0.35*
NH Carbon	Ningxia Huahui Activated Carbon Co.	Chinese chemically treated bituminous-derived activated carbon; 24 µm mean particle size	0.88

* - F.O.B. Pennsylvania

Parametric Test Results – Unit 1



Parametric Test Results – Unit 1



Parametric Test Results – Unit 1

■ ESP Operation

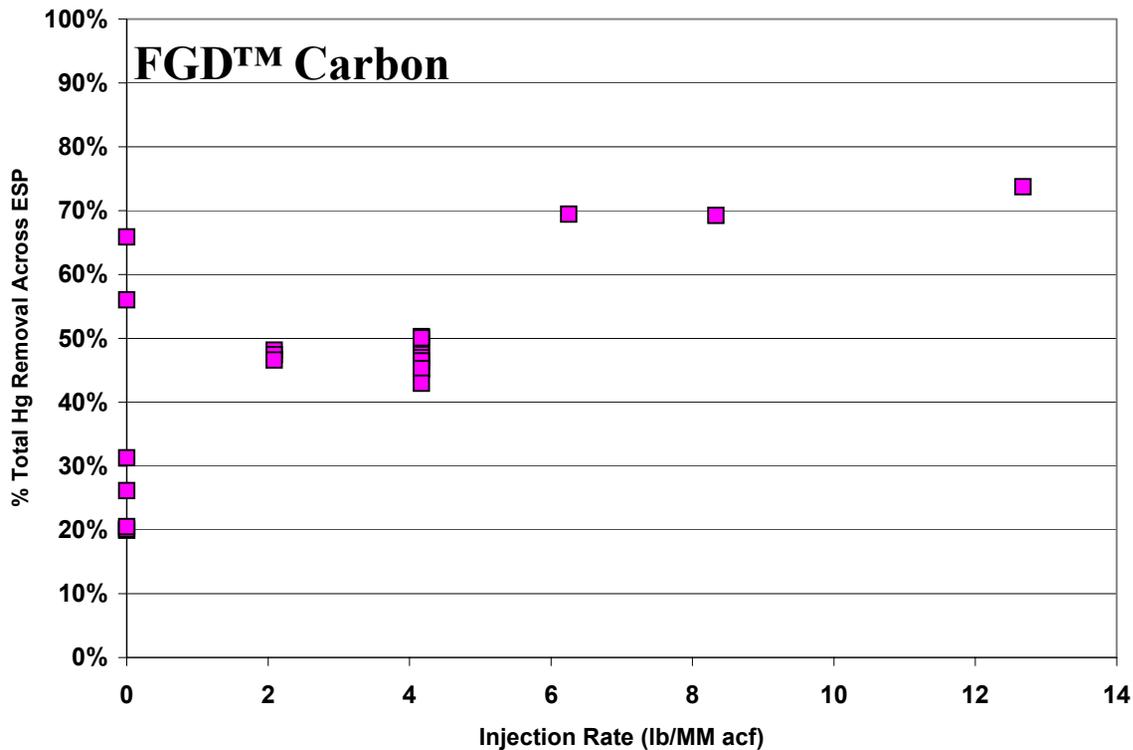
- **Flue gas particulate levels at outlet**
 - Measured by EPA Method17
 - Variable results, within range observed at baseline conditions
- **Increased arc rate in all ESP fields**

■ Fly Ash properties

- **LOI content ranged from 7 – 13% during ACI**
- **Hg levels ranged from 0.18 – 0.52 ppm**

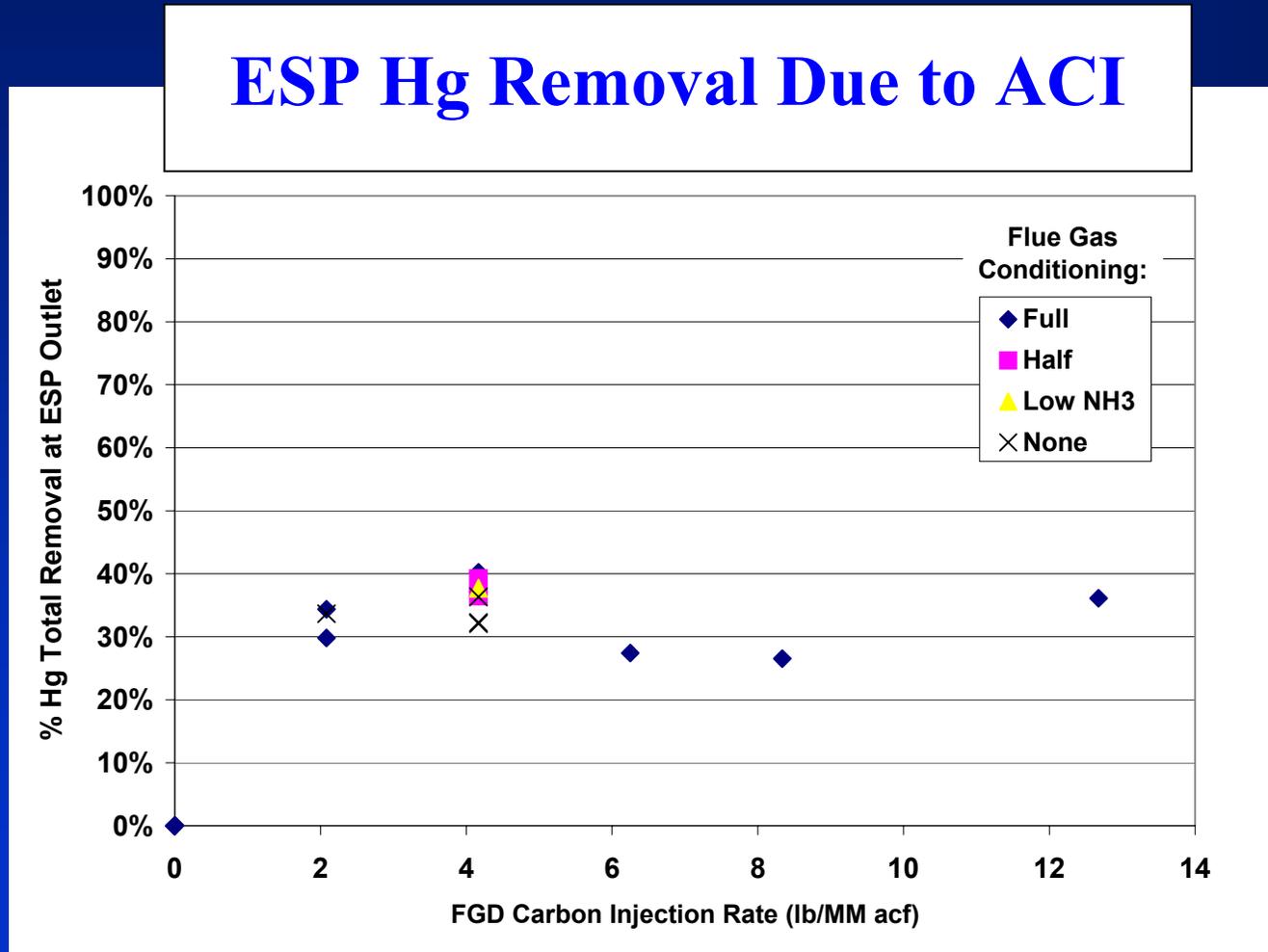
Parametric Test Results – Unit 2

Total Hg Removal across ESP



Parametric Test Results – Unit 2

ESP Hg Removal Due to ACI



Parametric Test Results – Unit 2

■ ESP Operation

- Flue gas particulate levels at outlet
 - No observed increases with ACI
- Increased arc rate in all ESP fields

■ Fly Ash properties

- LOI content ranged from 7 – 22% during ACI
- Hg levels ranged from 0.18 – 0.53 ppm

Summary

- **Baseline, Parametric tests completed**
- **Similar results obtained with 3 tested carbons on Unit 1**
 - **Chemically modified sorbent similar to FGD, HOK**
- **Increased removal with injection rate up to 6 lb/MM acf**
 - **Curve flat upon reaching 70% total removal (30-40% ACI removal)**
 - **Carbon performance may be affected by 'natural' removal**
- **Dual FGC did not impact ACI Hg removal**
- **No appreciable change in Hg oxidation across ESP**

Summary

ESP Performance

- Performance not impacted during short-term tests
- Increased arc rate observed with both ESPs
 - **Small ESPs may be challenged by ACI process**
 - **Long-term test data needed**

Future Plans

- Long-term test planned for Fall-04
 - Nov. test likely
 - 30-day test (Unit 1)
 - Long-term ESP performance
 - Effect on wet FGD system
 - Carbon TBD

