

Advances in Mercury Control Technology

**Pennsylvania Mercury Rule
Workgroup Meeting**

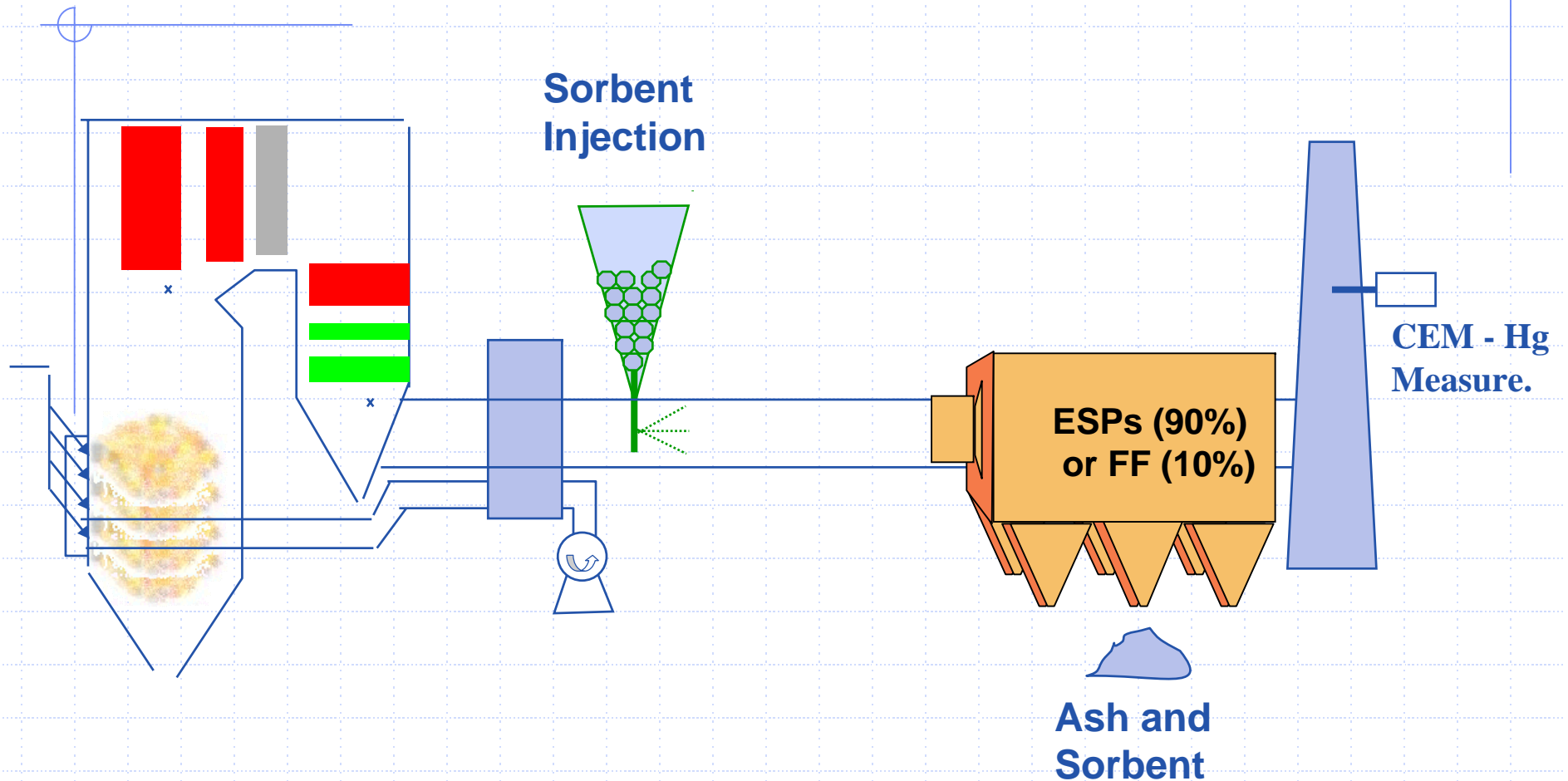
**Harrisburg, PA
November 18, 2005**

Institute of Clean Air Companies



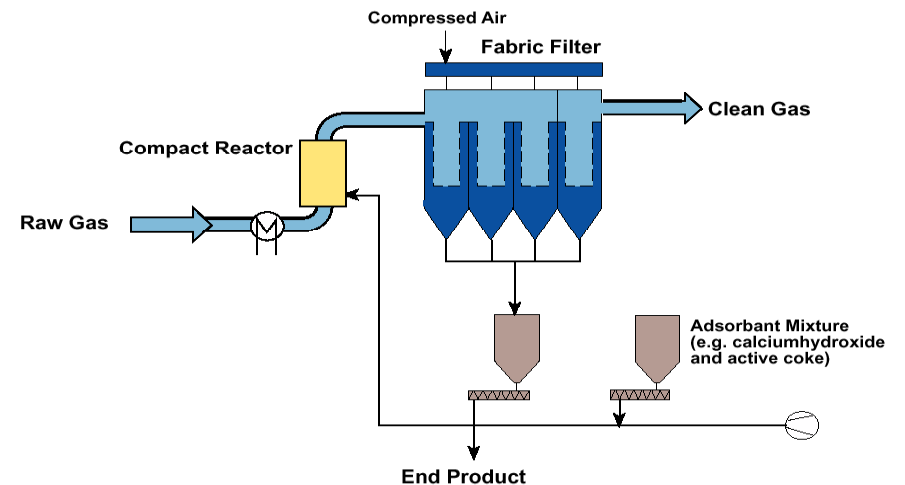
INSTITUTE OF
CLEAN
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Sorbent Injection Technology for Controlling Mercury Emissions



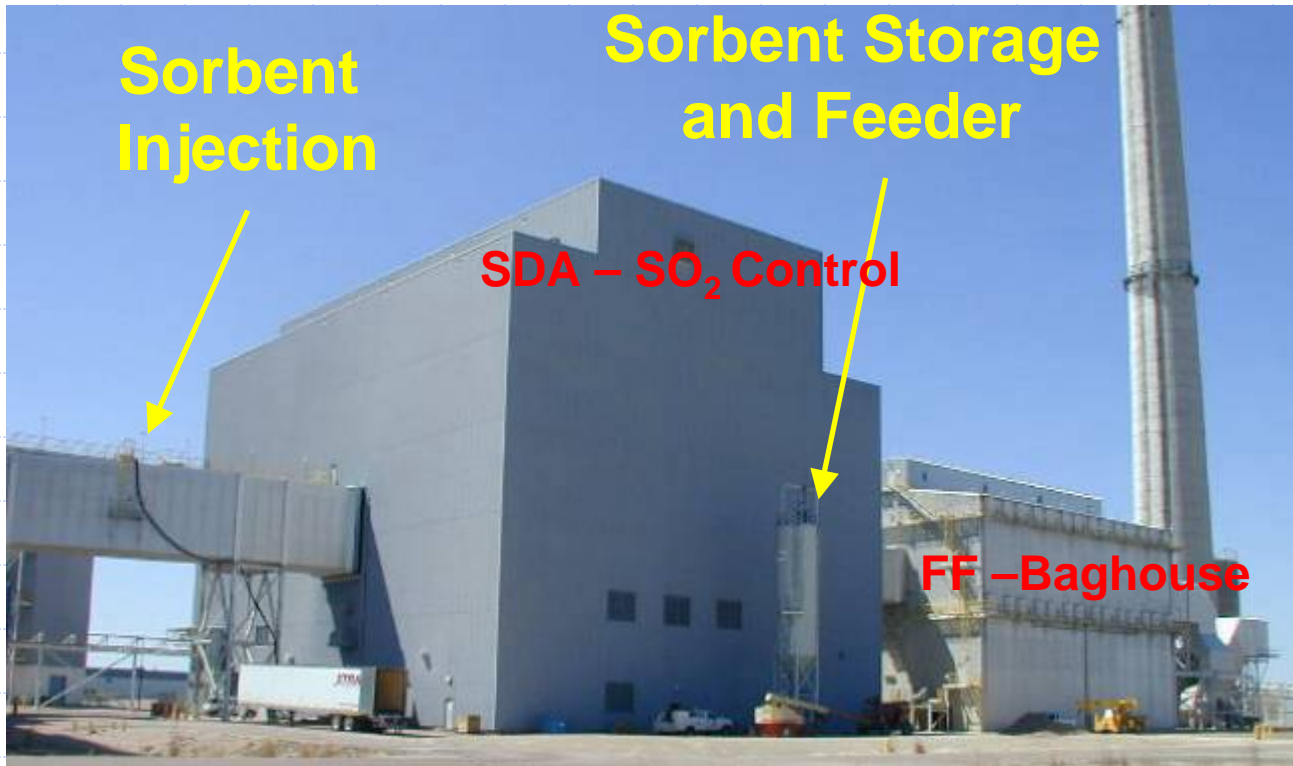
Selected European Experience With Control of Mercury Emissions

- ◆ Commercialized mercury removal technology for the European WtE industry
- ◆ Sorbent injection upstream of dedicated HRFF
 - Installed 19 systems during early 1990s
 - ✓ Utilize activated carbon/coke
 - ✓ ALL have operated reliably for more than 10 years
 - ✓ ALL achieve between 80 - 90% mercury removal
 - ✓ ALL capture both elemental and oxidized mercury
- ◆ Additional experience with sorbent injection upstream of dry FGD systems



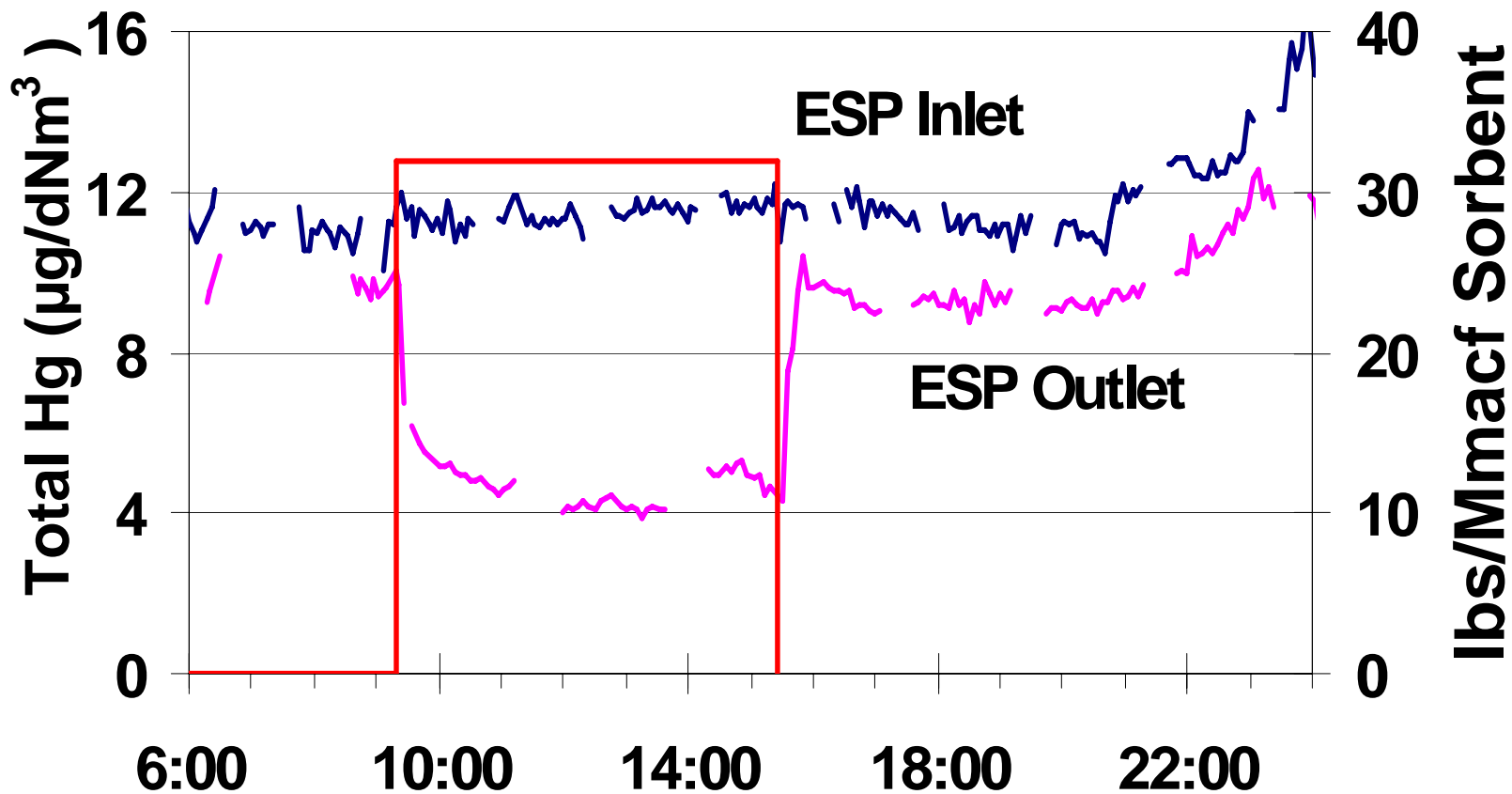
Data from US utility pilots validates performance curves from European WtE industry

Retrofit of ACI on an Existing Plant



Greater than 90% reduction in mercury emissions in less than six months!

Response Time for PAC Injection on an ESP



PAC Installations on Various Coal-Burning Power Plants



Full-Scale Tests of Sorbent Injection Completed: 2001-2004

	Site	Coal	Equipment
1.	Gaston 1 month	Low-S Bit	FF
2.	Pleasant Prairie	PRB	C-ESP
3.	Brayton Point	Low-S Bit	C-ESP
4.	Abbott	High-S Bit	C-ESP/FGD
5.	Salem Harbor	Low-S SA Bit	C-ESP
6.	Stanton 10	ND Lignite	SDA/FF
7.	Laskin	PRB	Wet P Scrbr
8.	Coal Creek	ND Lignite	C-ESP
9.	Gaston 1 year	Low-S Bit	FF
10.	Holcomb	PRB	SDA/FF
11.	Stanton 10	ND Lignite	SDA/FF
12.	Yates 1	Low-S Bit	ESP
13.	Yates 2	Low-S Bit	ESP/FGD
14.	Leland Olds	ND Lignite	C-ESP
15.	Meramec	PRB	C-ESP
16.	Brayton Point	Low-S Bit	C-ESP

Full-Scale Tests of Sorbent Injection Scheduled: 2005-2006

Site	Coal	Equipment
1-6 Commercial Tests	Low-S Bit	ESP
7. Laramie River	PRB	SDA/ESP
8. Conesville	High-S Bit	ESP/FGD
9. DTE Monroe	PRB/Bit	ESP
10. Antelope Valley	ND Lignite	SDA/FF
11. Stanton 1	ND Lignite	C-ESP
12. Council Bluffs 2	PRB	H-ESP
13. Louisa	PRB	H-ESP
14. Independence	PRB	C-ESP
15. Gavin	High-S Bit	C-ESP FGD
16. Presque Isle	PRB	HS-ESP TOXECON

Working with Potential Customers to Demonstrate Hg Control

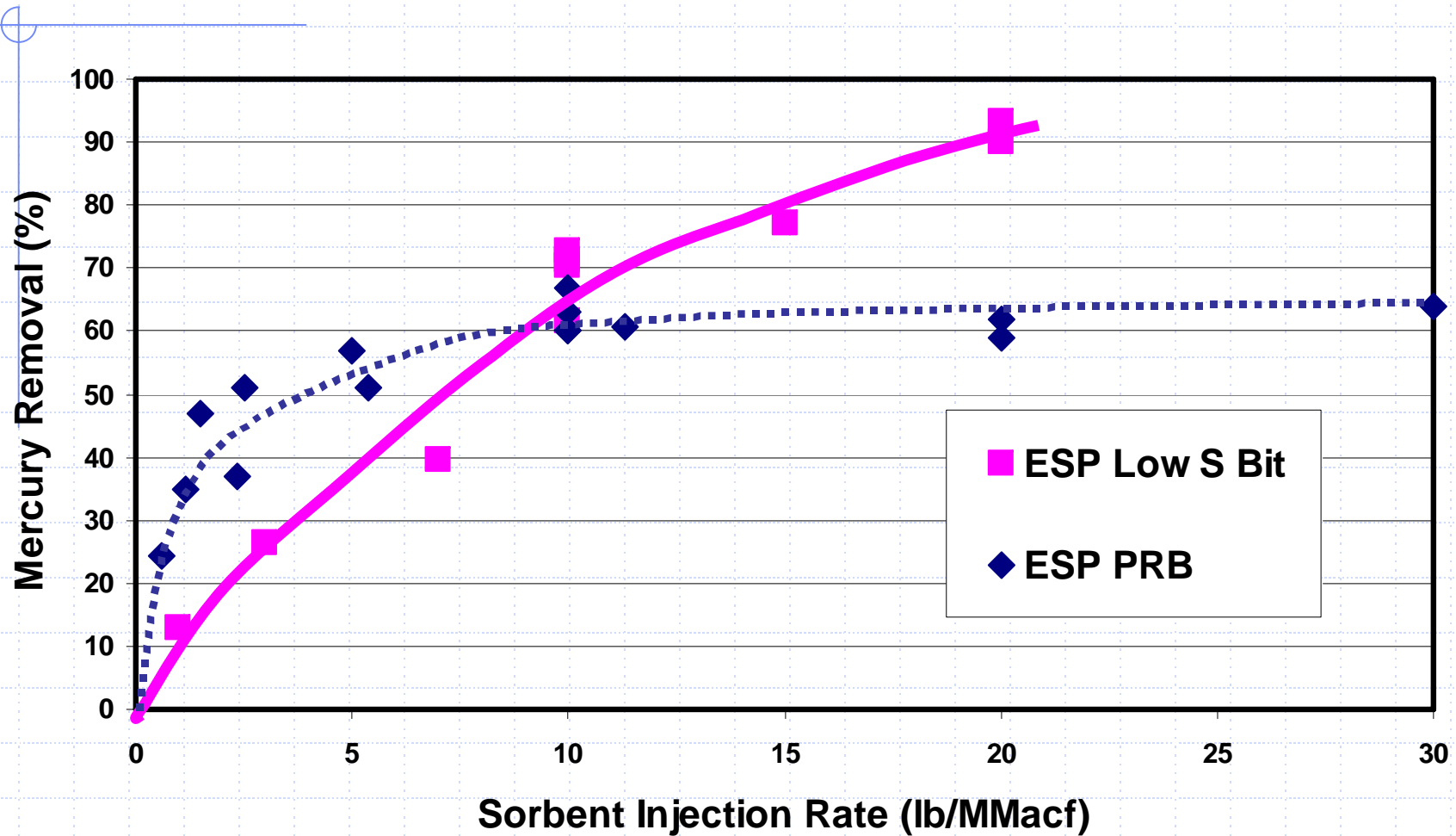
- ◆ Primary funding from DOE National Energy Technology Laboratory (NETL)
- ◆ Cofunding provided by:
 - Southern Company
 - AEP
 - TVA
 - FirstEnergy
 - DTE
 - EPRI
 - Ontario Power Generation
 - Kennecott Energy
 - Arch Coal

Extensive Data Collection and Analysis for Each Full-Scale Program

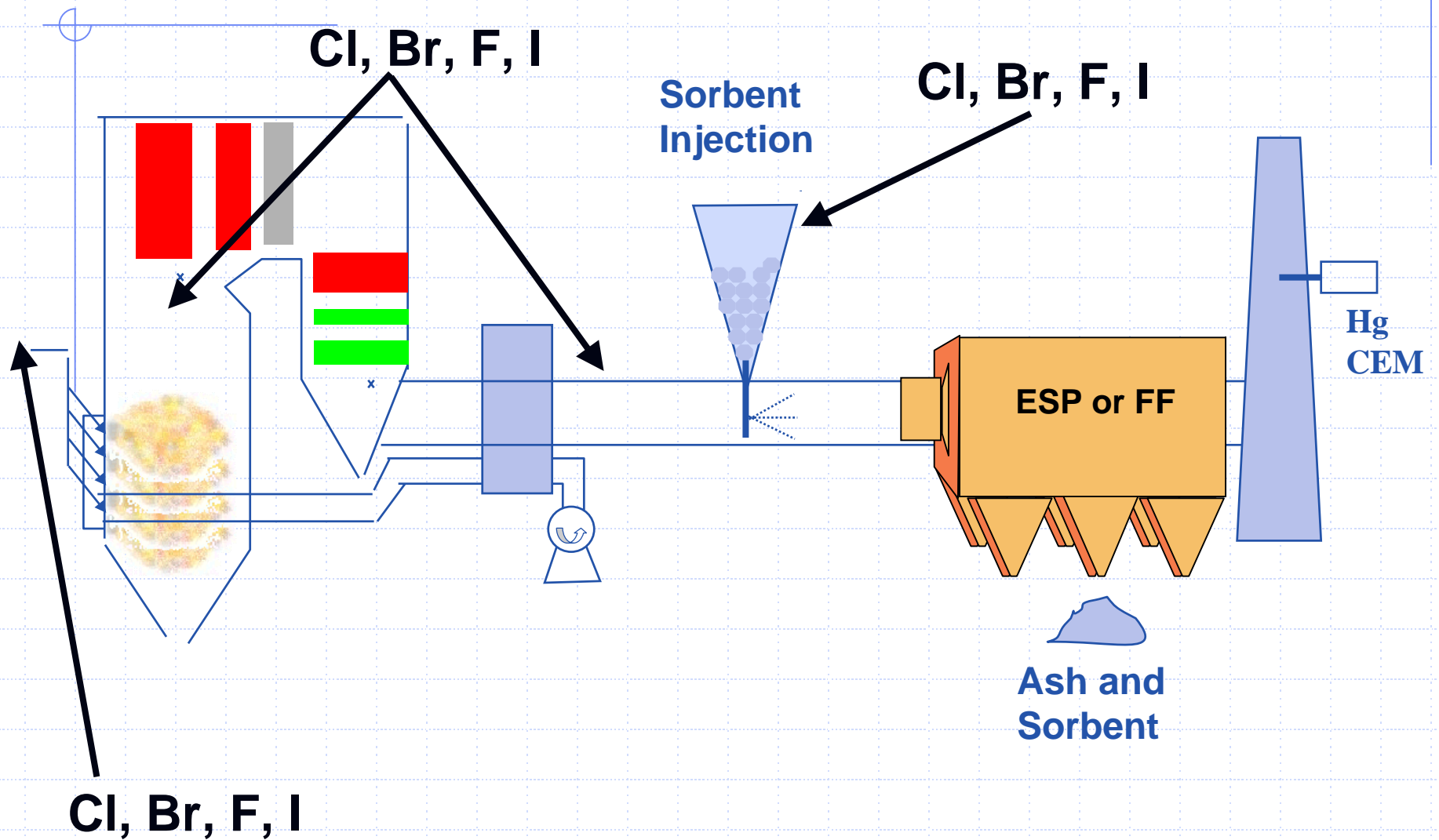
SINGLE SITE FIELD TEST REPORT TABLE OF CONTENTS

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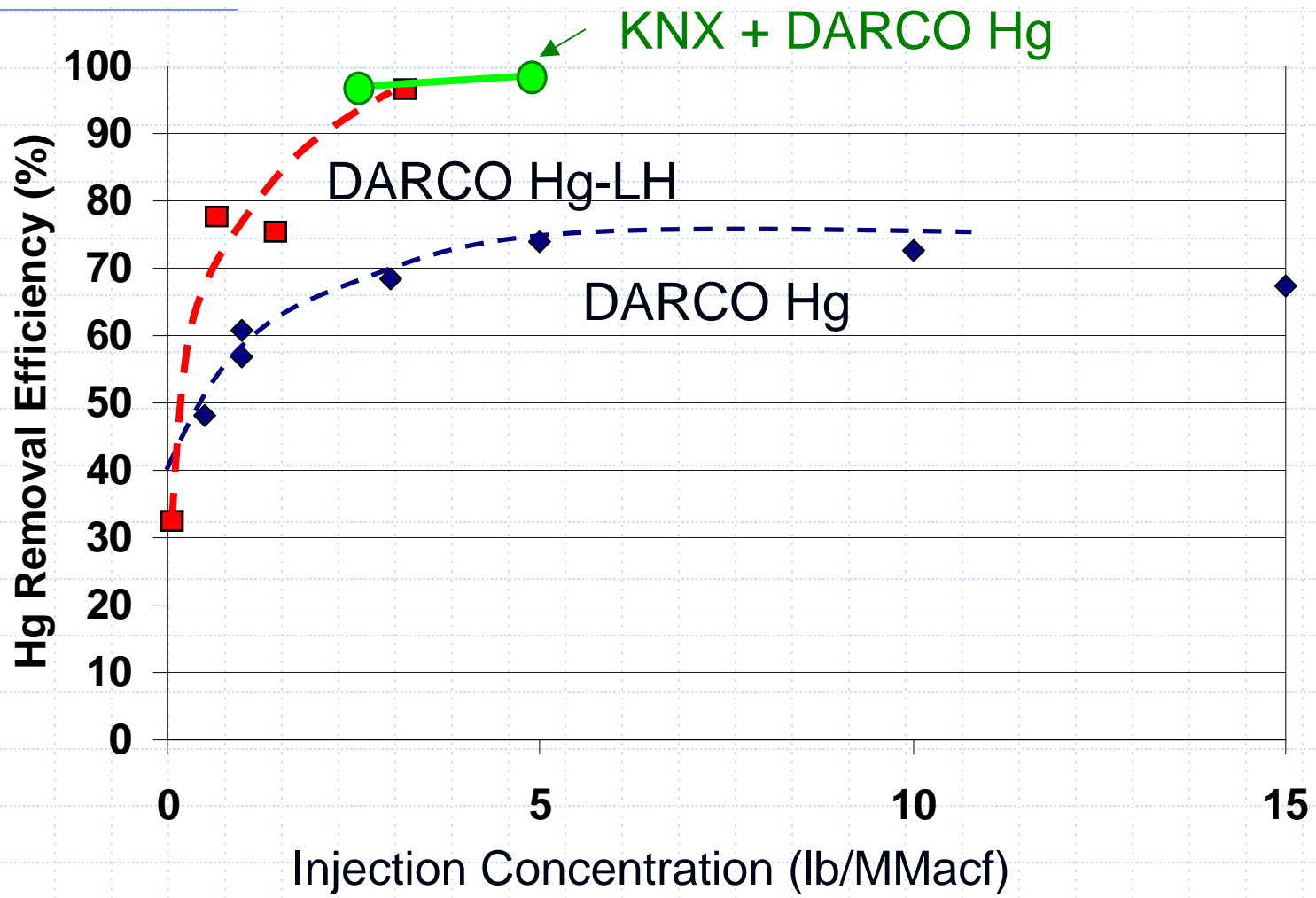
Limited Hg Capture by ACI on Western Coals



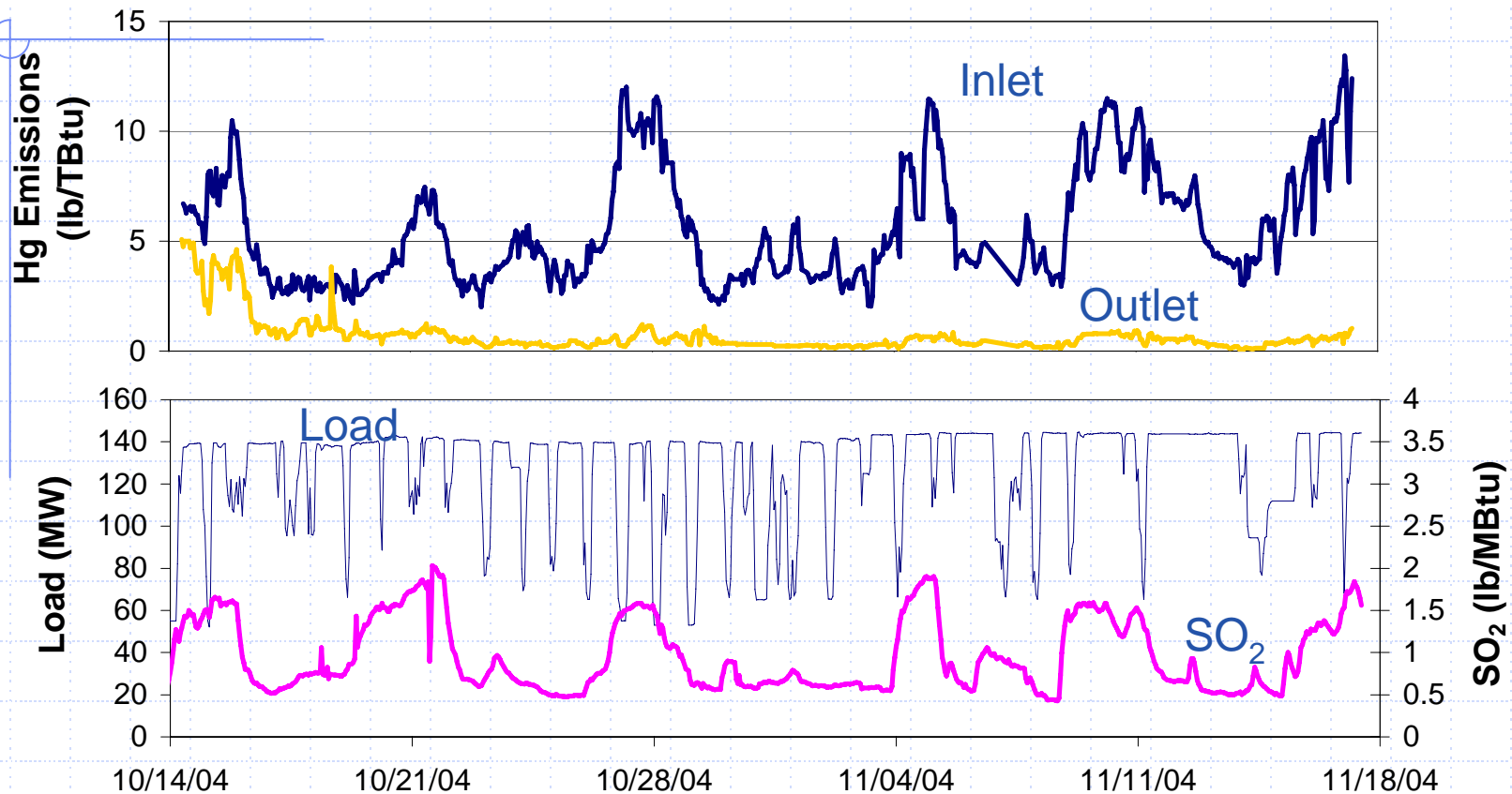
Enhancing Mercury Removal for Western Coals



Coal Additives and Brominated AC on a PRB Unit with only an ESP



Long-Term Results; PRB ESP Only Meramec, DARCO Hg-LH



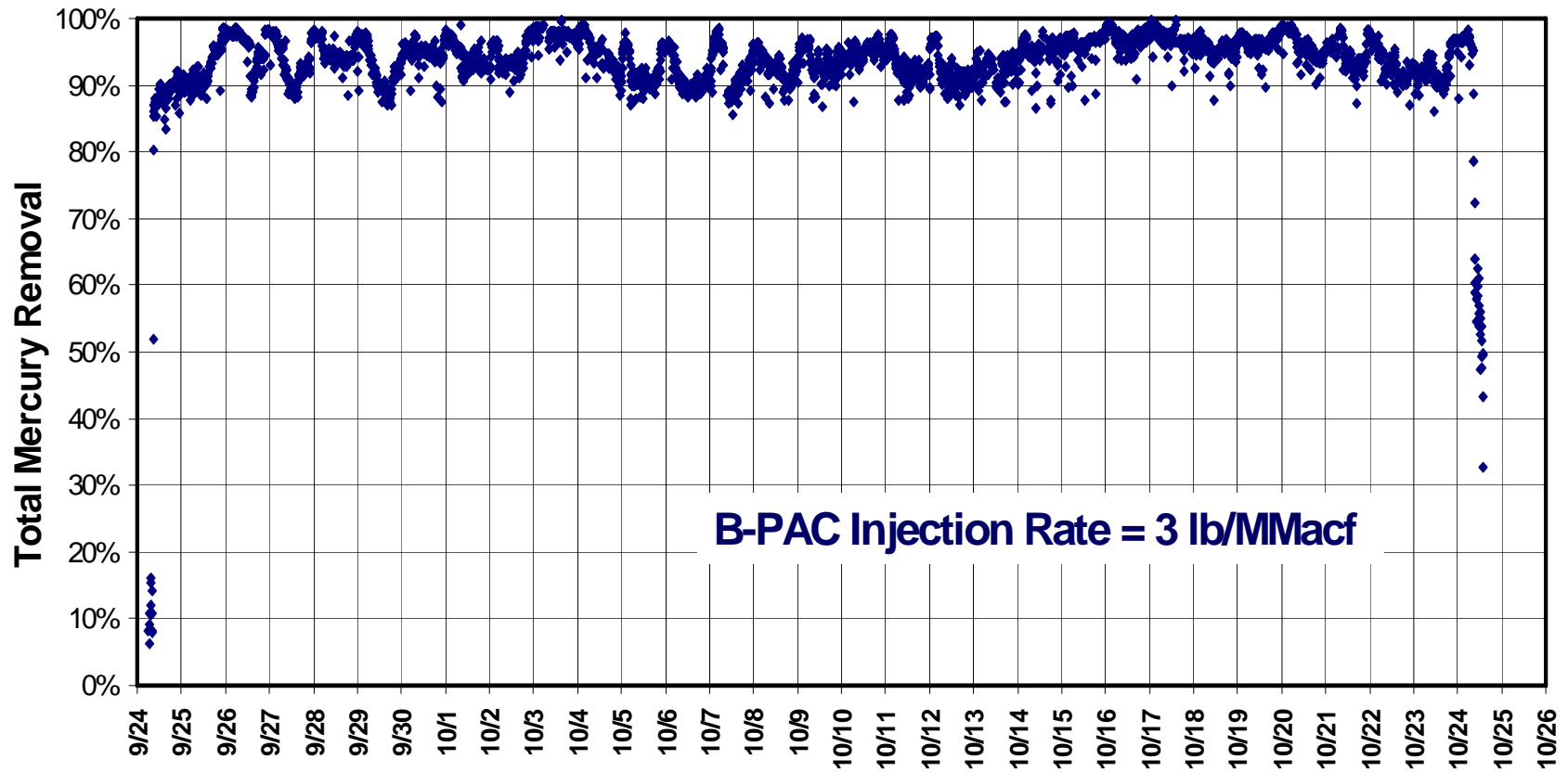
Average Hg Removal Efficiency: 93%

Sorbent Injection Concentration: 3.3 lb/MMacf

Average Hg emissions: 0.44 lb/TBTU

B-PAC Run at DTE St. Clair 85% PRB 15% Bit, ESP Only

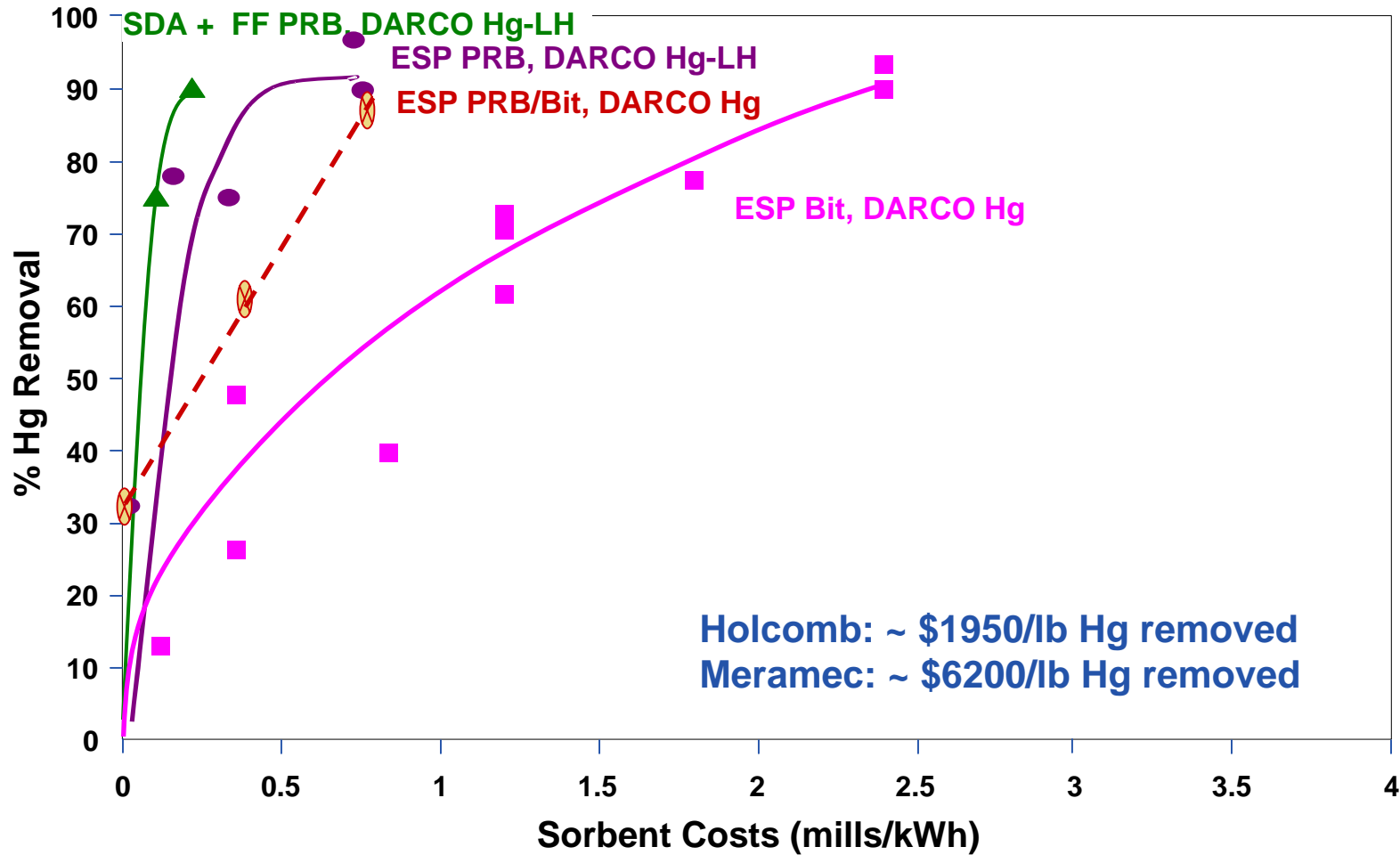
Detroit Edison St. Clair Plant - Total Hg Removal
Thirty Day Average = 94%



Commercial Suppliers of Enhancements for Western Coals

- ◆ **Brominated Carbons**
 - NORIT
 - Sorbent Technologies
- ◆ **Coal Additives**
 - Alstom Power
 - Babcock and Wilcox
- ◆ **Western Bituminous Coal**
 - Arch Coal

Sorbent Cost Comparison



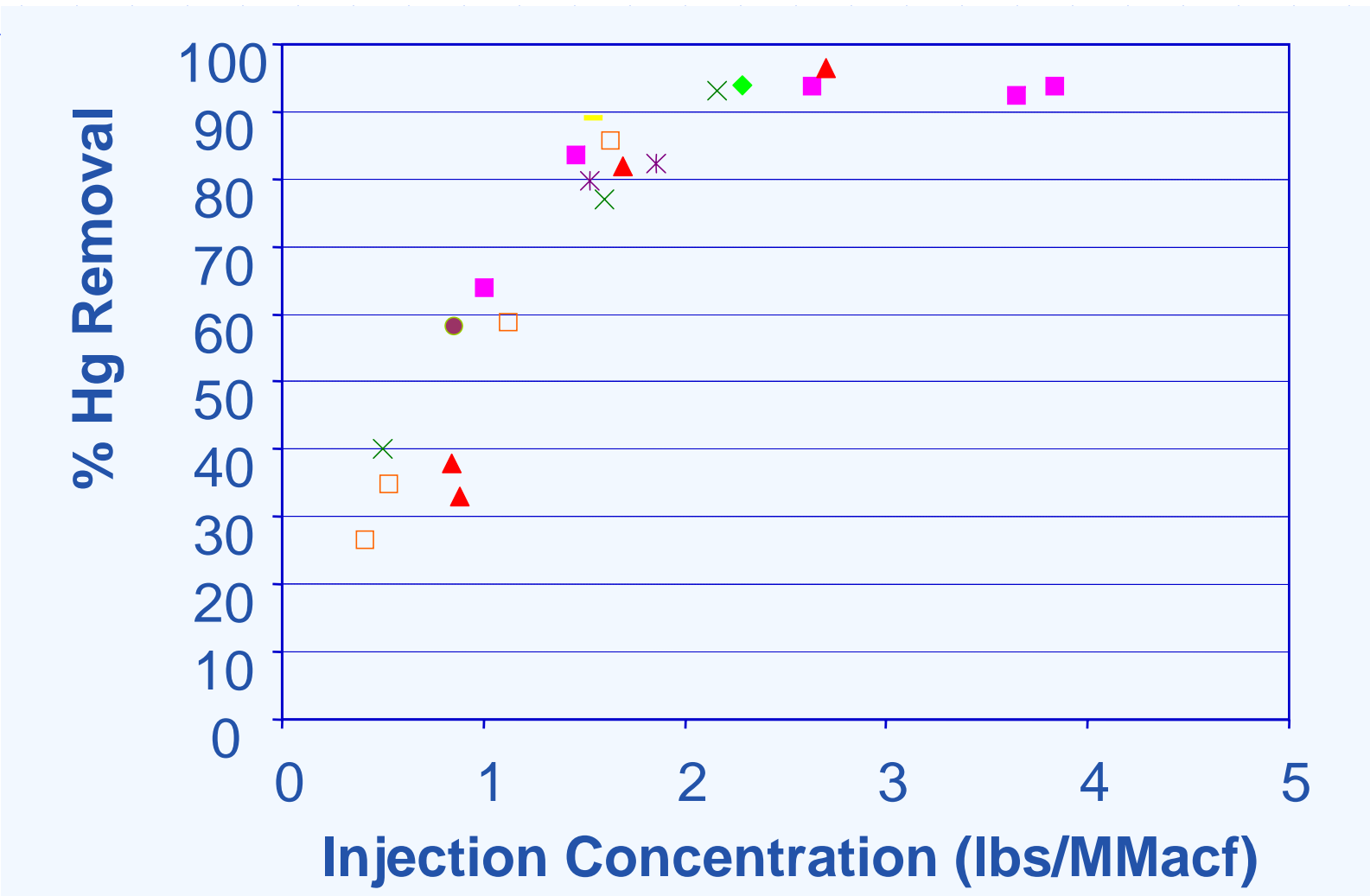
Year-Long Test of Mercury Removal in a Fabric Filter on Bituminous Coal

- ◆ 270 MW firing a variety of low-sulfur, washed eastern bituminous coals
- ◆ Particulate Collection:
 - Hot-Side ESP;
SCA = 274 ft²/kacfm
 - COHPAC™ baghouse
- ◆ Wet ash disposal to pond
- ◆ Primary funding from DOE/NETL with co-funding provided by:
 - Southern Company
 - PG&E NEG
 - Ontario Power Generation
 - TVA
 - Kennecott Energy
 - We Energies



- EPRI
- First Energy
- Hamon Research Cottrell
- Arch Coal

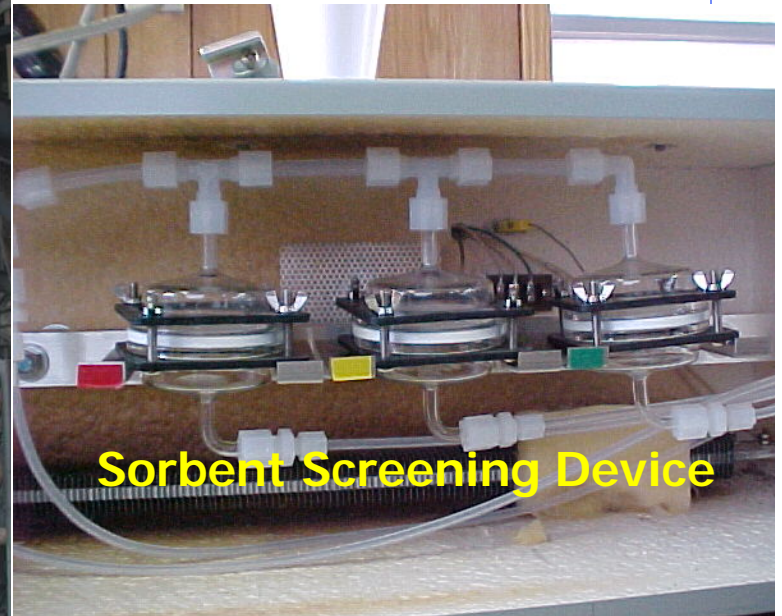
ACI with a Fabric Filter on Bituminous Coal



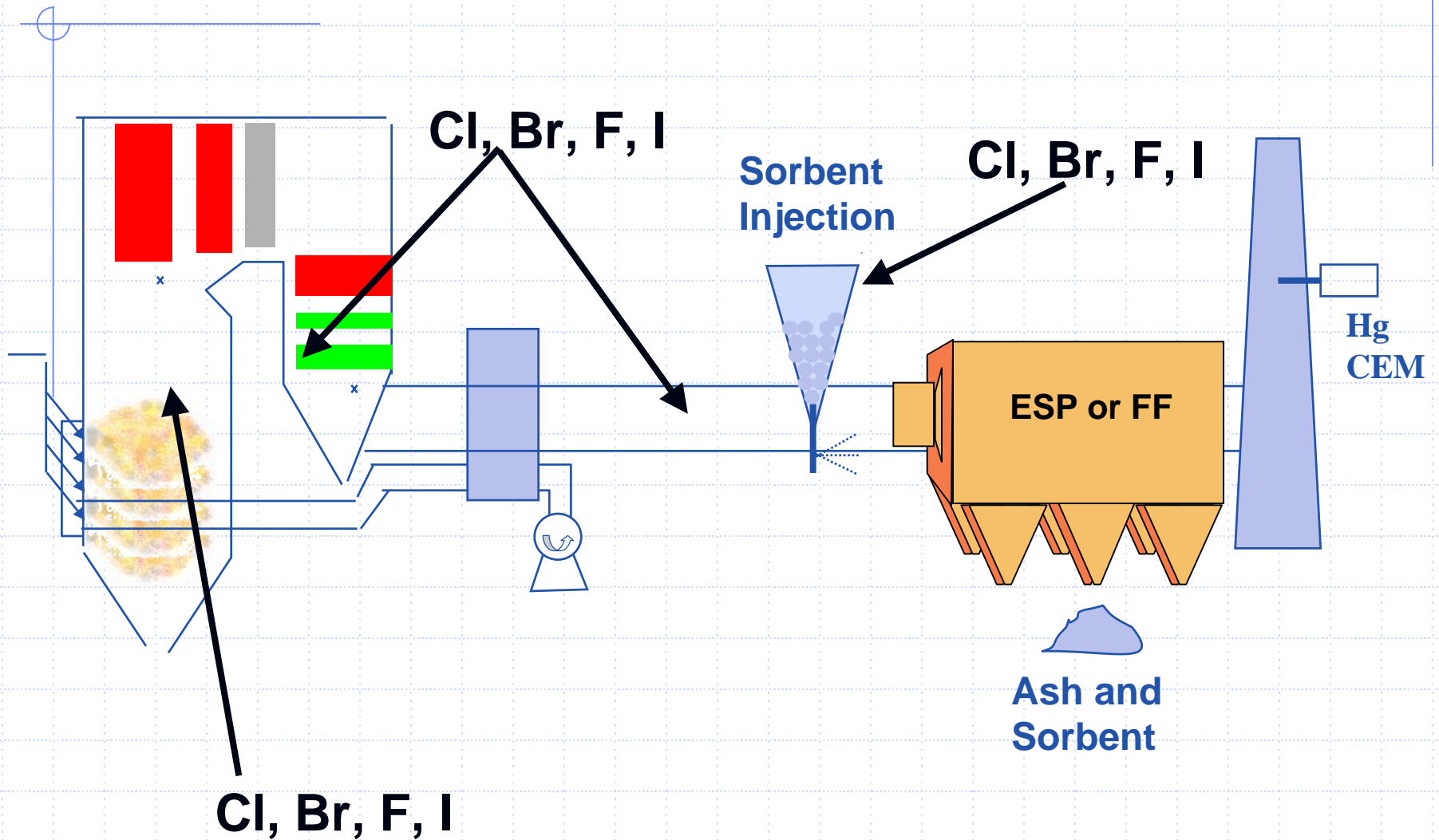


Rapid Advances in Sorbent Technology

Tools for Evaluating ACI



Phase I Diagnose Problem and Develop Potential Solutions: 2003

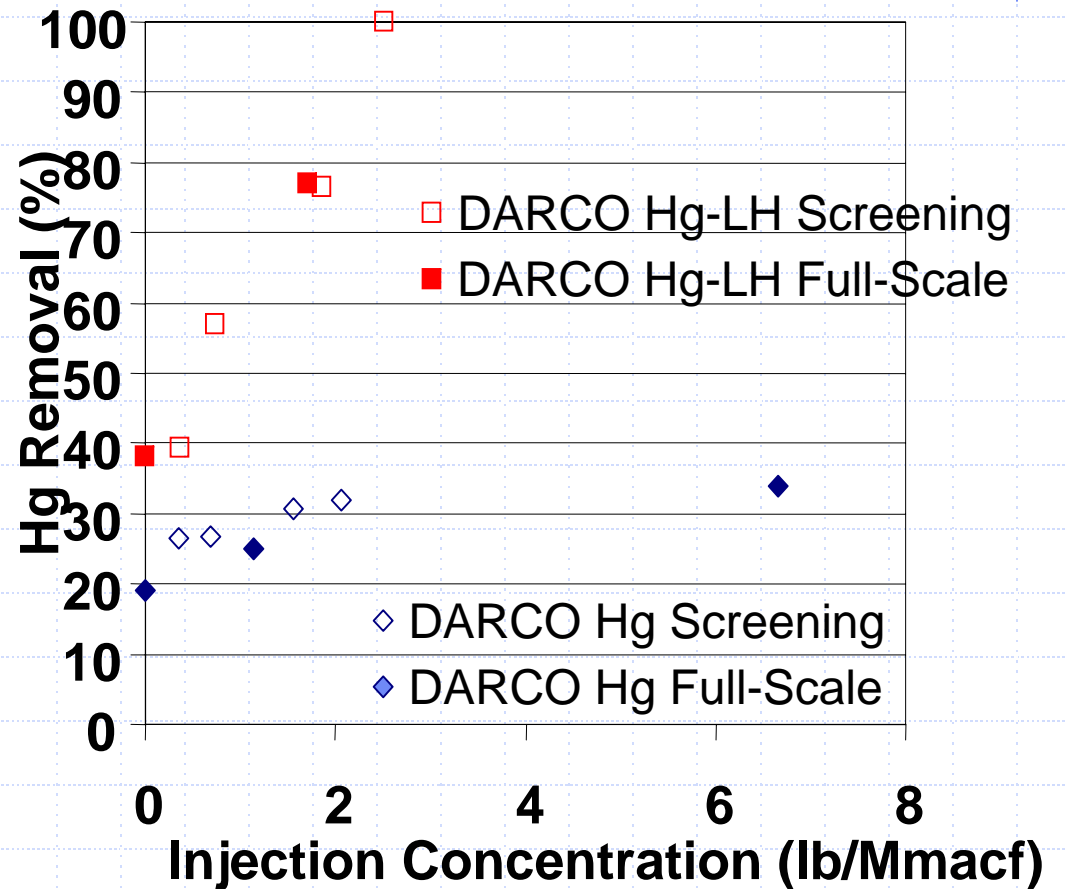
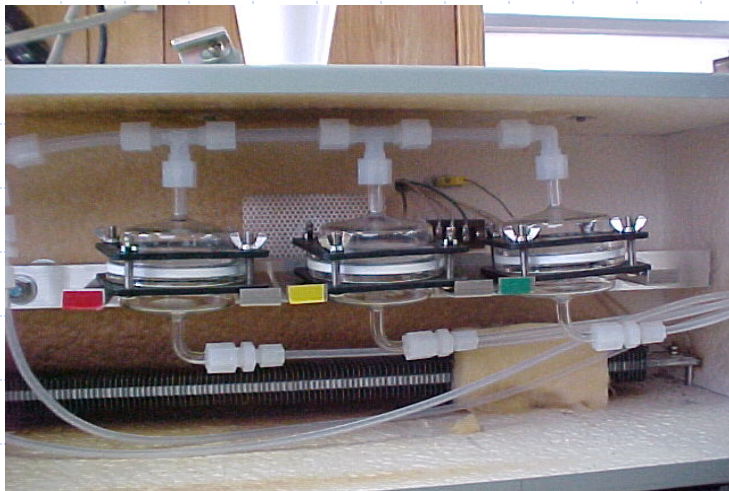


Phase II Sorbent Screening: February 2004

February 2004: Sorbent Screening Tests (100 g Samples)

Ten different sorbent vendors

Nineteen different experimental
samples



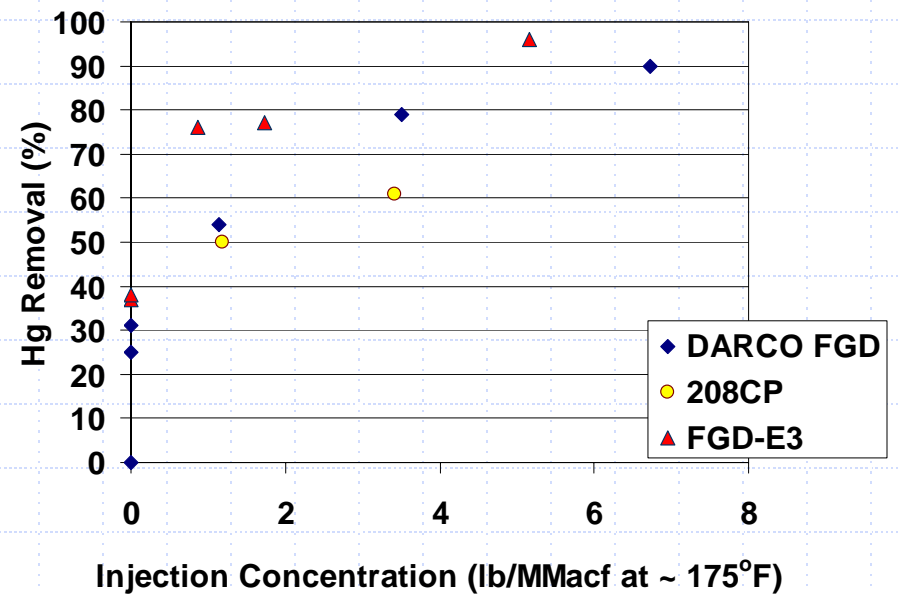
Phase III Parametric Tests: April 2004

April 2004: Parametric Tests (1000 lbs of Sorbent)



Two different sorbent vendors

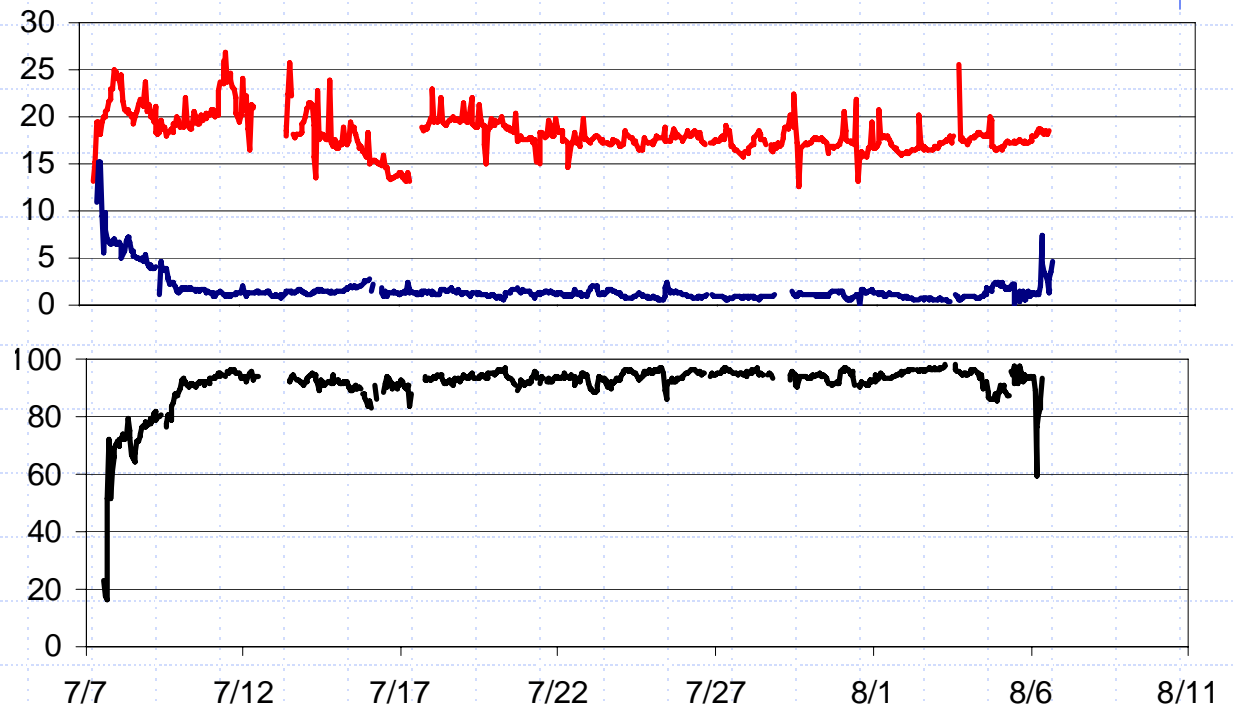
Three different experimental samples



Phase IV Long-Term Test: July 2004



July 2004: 30-Day Tests (50,000 lbs of Sorbent)



Phase V Commercial Production: December 2004

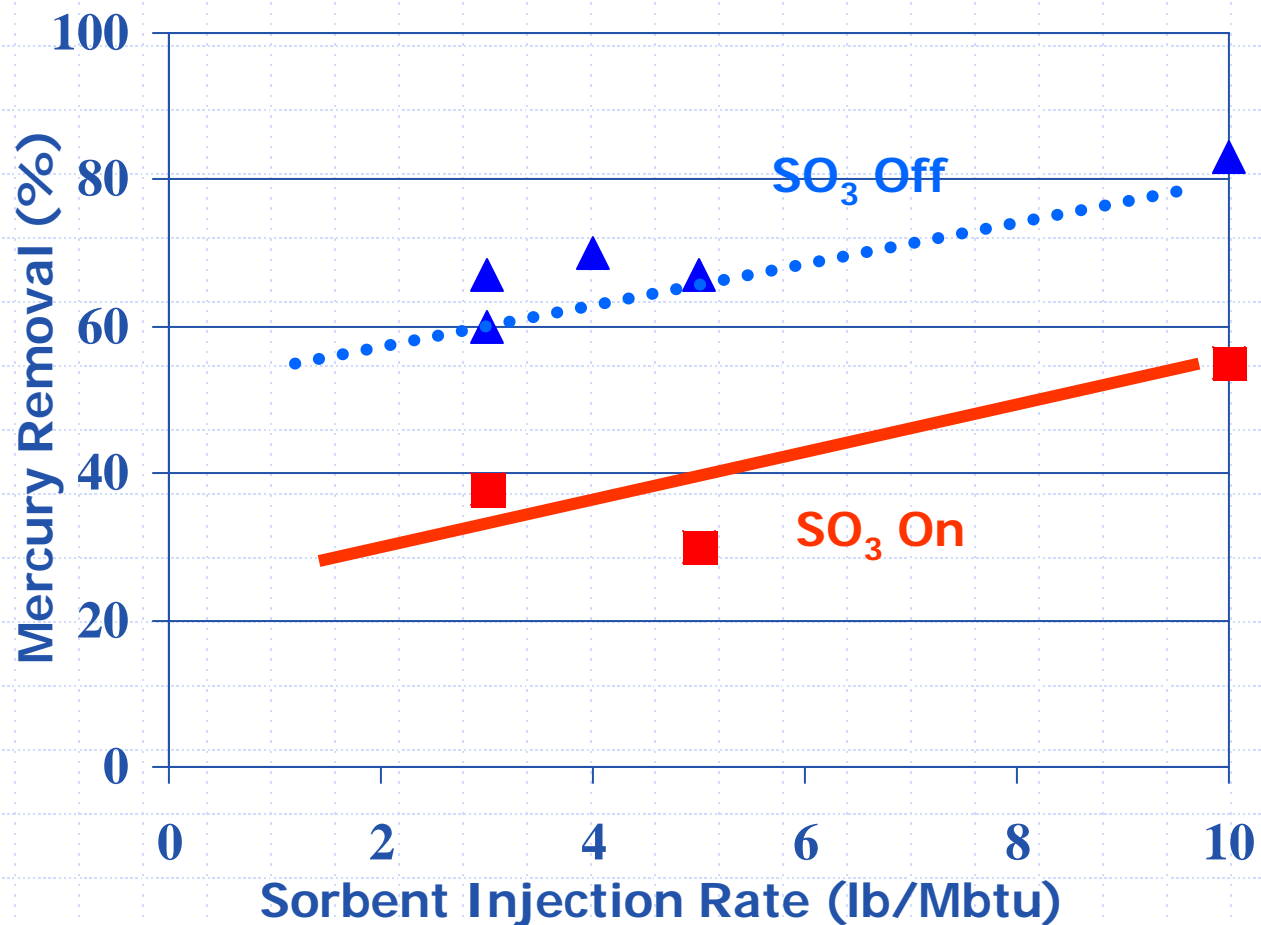




Enhancing Sorbent Technology for Bituminous Coals

Phase I Diagnose Problem and Develop Potential Solutions: 2005

Mercury Capture by Sorbent with and without SO₃



Phase II Sorbent Screening: November 2005

Overall: 34 samples, 14 vendors

- ◆ **Carbon-based**
 - 15 samples, 7 vendors
- ◆ **Non-Carbon**
 - 13 samples, 9 vendors
- ◆ **Mixtures**
 - 6 samples , 3 vendors

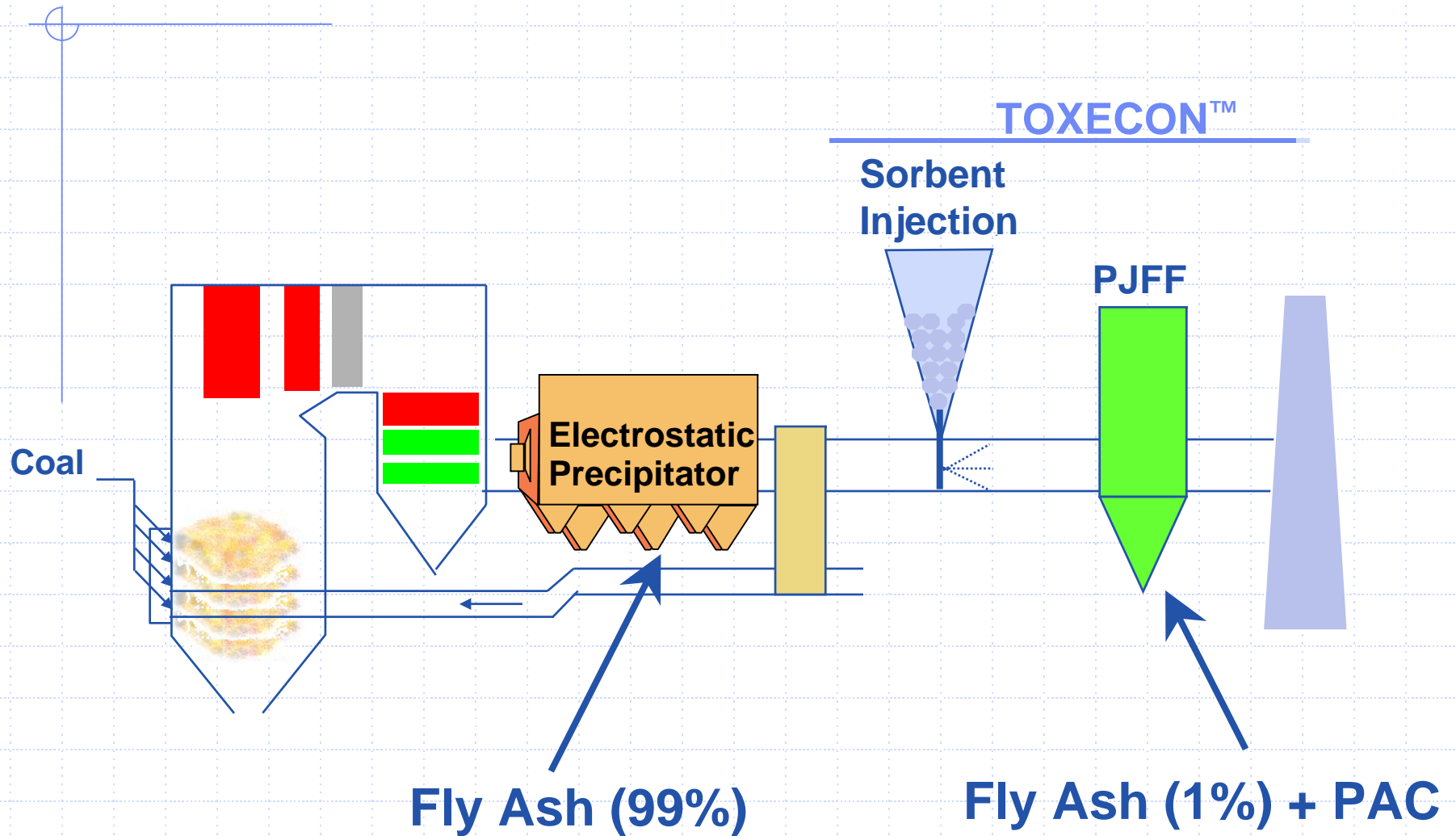
Phase III, IV, and V: 2006

- ◆ Multiple full-scale field tests planned for sites burning bituminous coals in 2006

Ash Issues

- ◆ The mercury captured by PAC, LOI, and ash appears to be very stable and unlikely to reenter the environment.
- ◆ The presence of PAC will most likely prevent the sale of ash for use in concrete
 - This will impact 30% of the units!
- ◆ Several developing technologies to address the problem:
 - Separation
 - Combustion
 - Chemical treatment
 - Non-carbon sorbents
 - Configuration solutions such as EPRI TOXECON™

EPRI TOXECON™ Configuration

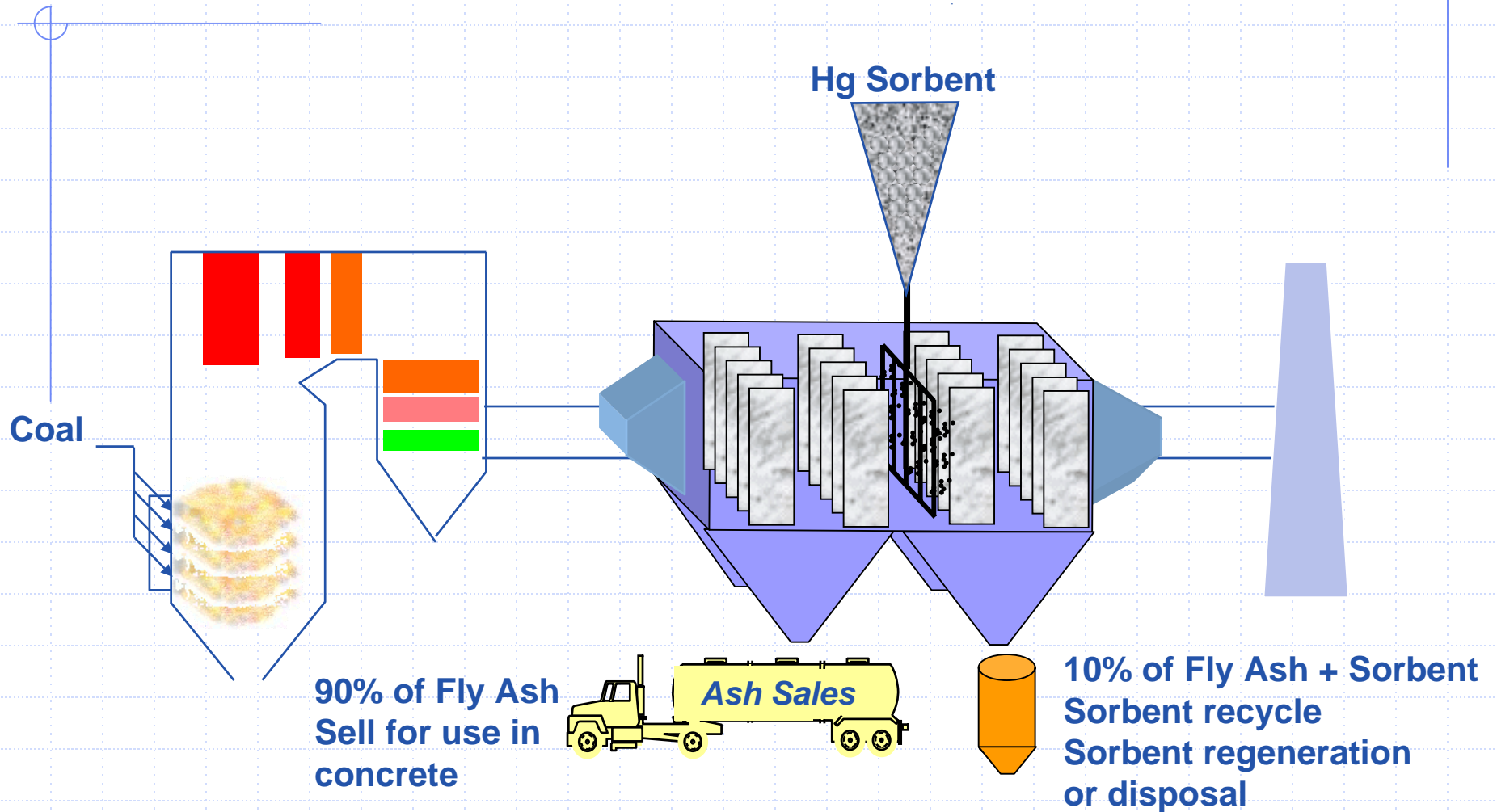


First Commercial Hg Control System Presque Isle Power Plant

- **\$50 Million** program funded by We Energies and DOE
- **Units 7 – 9 (270) MW** on PRB Coal
- **System designed for 90% Hg control**



EPRI TOXECON 2™ Configuration



TOXECON II Injection Equipment at Coal Creek and Independence



Advantages of ACI in a Rapidly Changing Regulatory Environment

- ◆ **Low Capital Cost (<\$1 Million for 100 to 500 MW plants)**
- ◆ **Operating Costs (sorbent utilization) scales directly with plant size**
- ◆ **Versatile:**
 - Can reduce mercury emissions by 10% to >90%
 - Staged emissions reductions can be achieved with no change in hardware
 - Fast implementation: 6 months for design, fabrication, and installation
 - No plant outage required for installation
- ◆ **Fuel Flexibility: Effective on both bituminous and subbituminous coals**
- ◆ **Improved sorbents result in significant reductions in costs and can be implemented with no change in hardware**
- ◆ **TOXECON™ configurations provide options for maintaining ash sales**

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