REINHOLD ENVIRONMENTAL Ltd.

2013 NOx-Combustion Round Table & Expo Presentations

February 18 & 19, 2013, in Salt Lake City, UT / Hosted by PacifiCorp

Fixed-structure Sorbent Mercury Control

Paul Barilla
W.L. Gore & Associates, Inc.

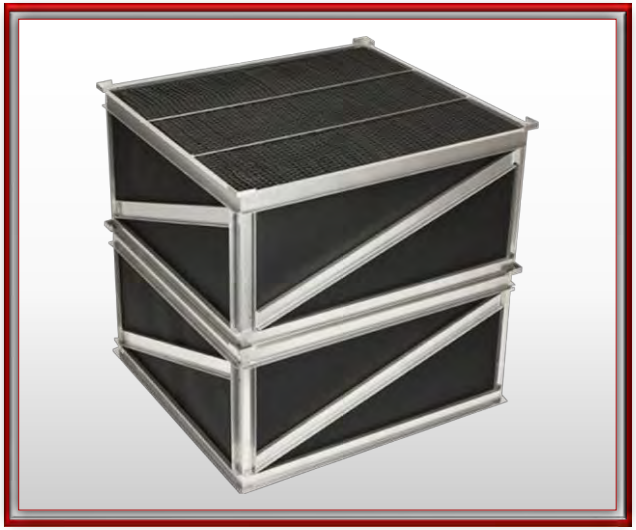
Blake Stapper
URS Corporation

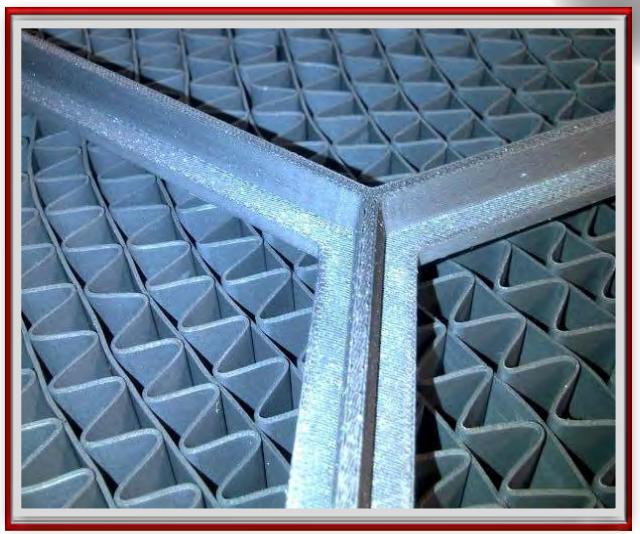
Reinhold NOx-Combustion Round Table
February 19, 2013

Traditional Strategies for Mercury Control

Sorbent Injection	Mercury oxidation chemistry →capture Hg in scrubber liquor
Fly ash contamination – Loss of sales/disposal costs	Additives (i.e., Br) can cause corrosion
Additional PM burden on collector	Waste water treatment concerns (i.e., Br, Se)
Sensitivity (SO_3, Hg species)	Potential Hg Re-emissions from scrubber

Fixed-structure Sorbent Mercury Control System





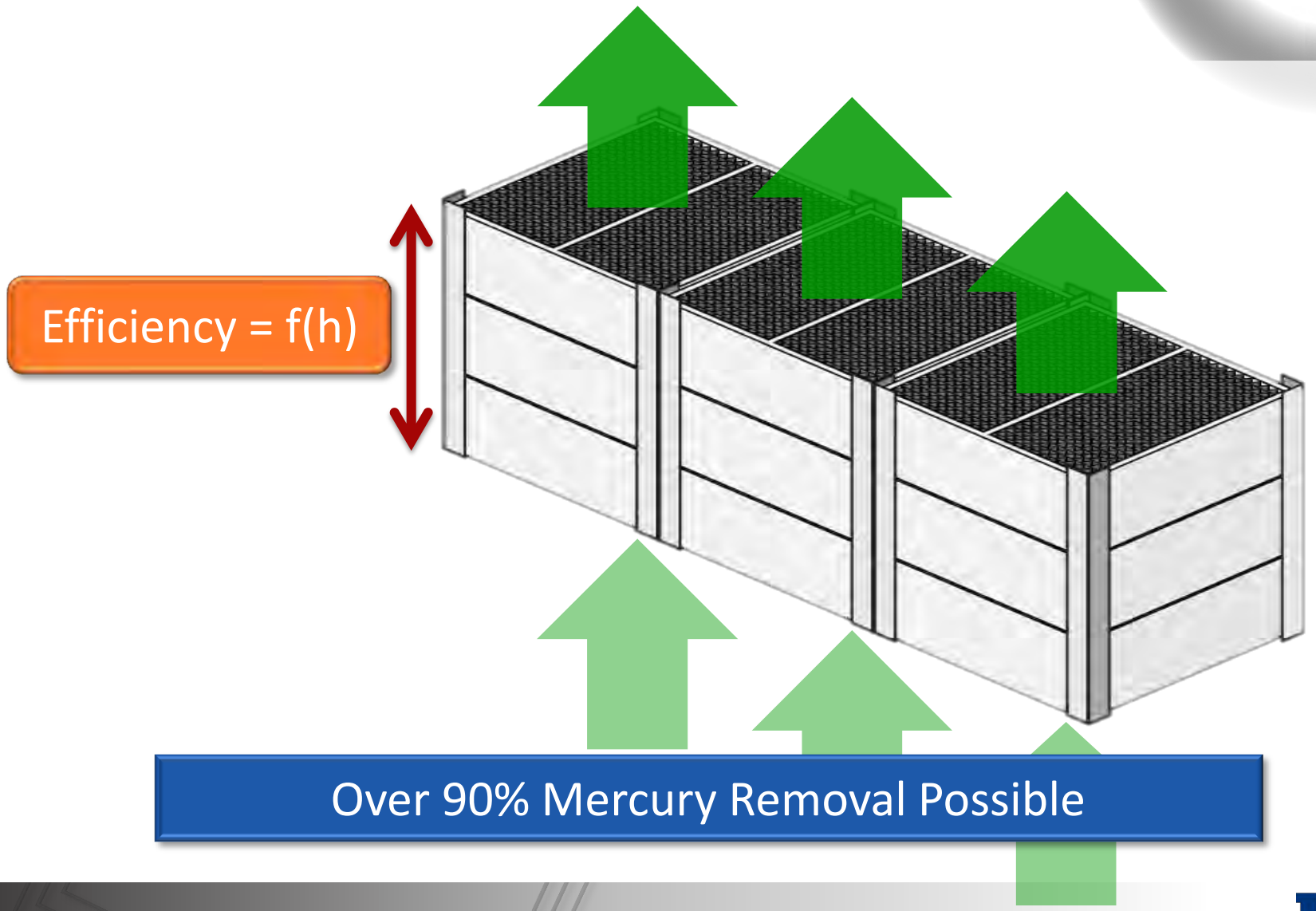
Fixed-structure Sorbent Mercury Control

EPRI-Patented Concept for wFGD Applications

No Injection of Sorbents or Chemicals

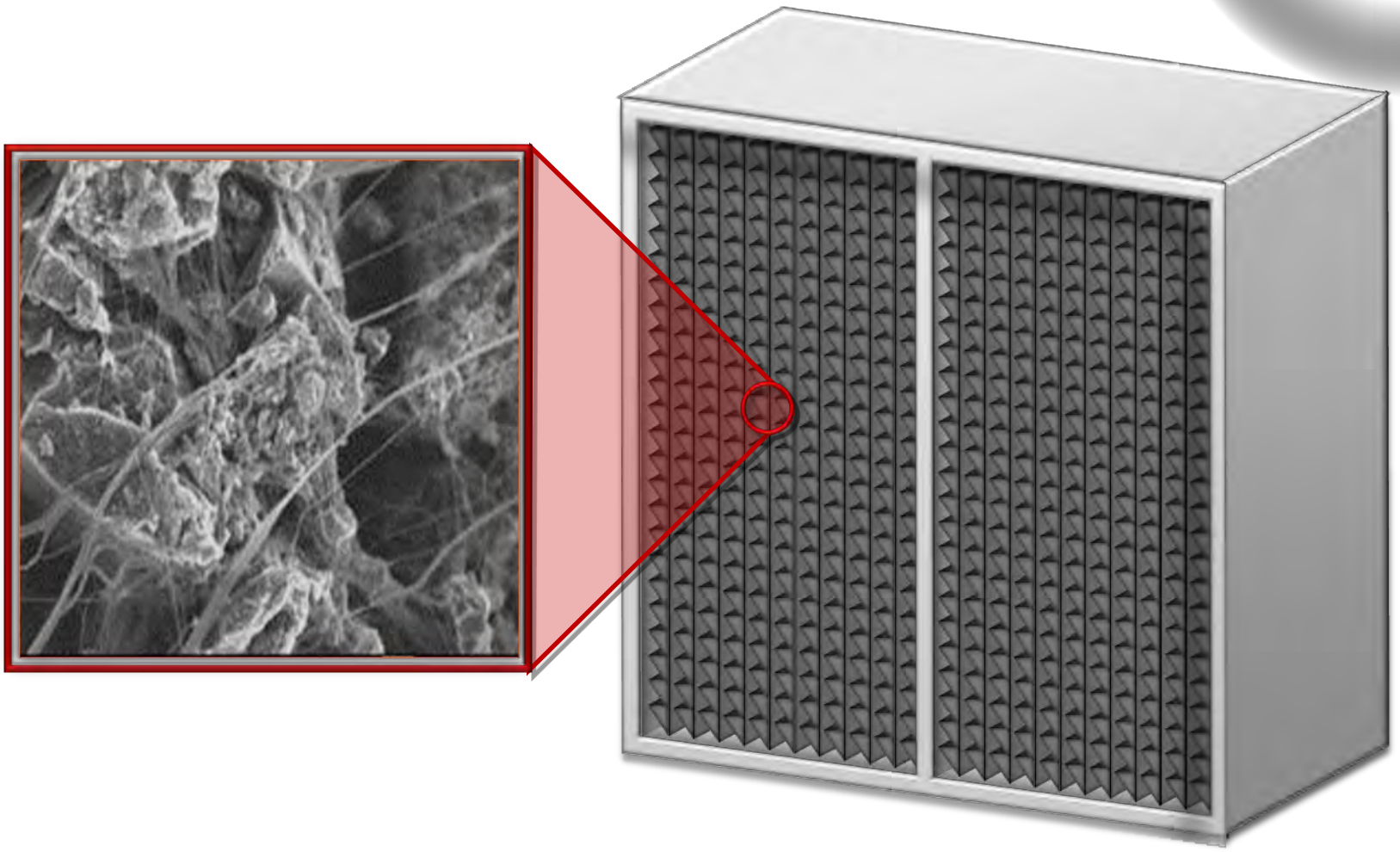
Passive Operation – No moving parts

Discrete Modules



Over 90% Mercury Removal Possible

W. L. Gore Sorbent Polymer Composite (SPC)



Captures Elemental & Oxidized Mercury

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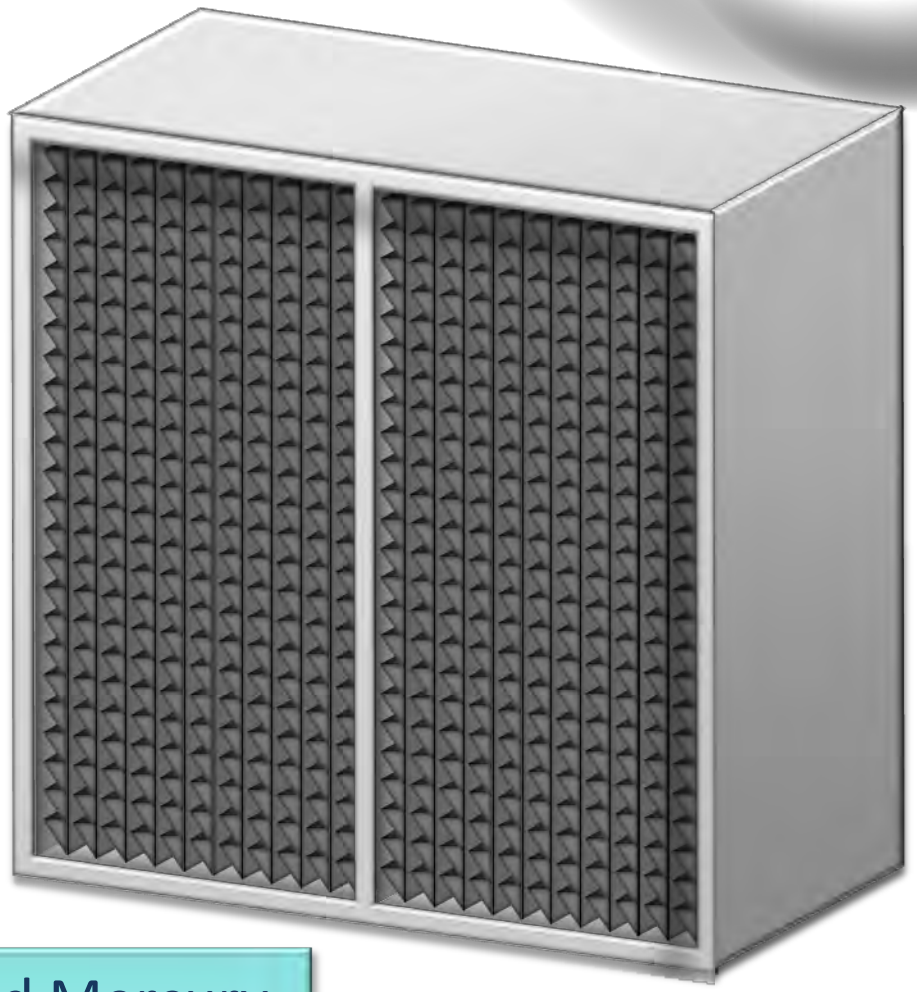
- Mercury is strongly bound within SPC
- High capacity for mercury storage
- Operates even in very wet gas streams



Elemental Mercury

Oxidized Mercury

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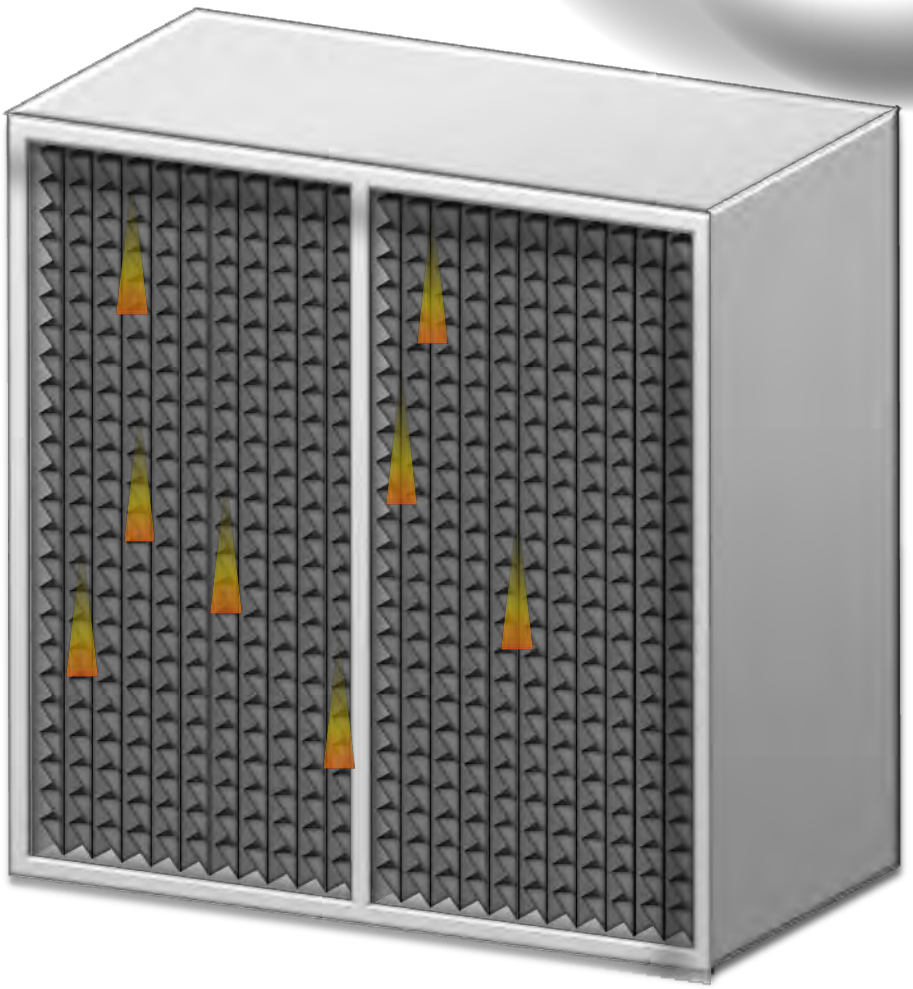
SO_2 Removal Co-Benefit

SO_2 converted to liquid sulfuric acid

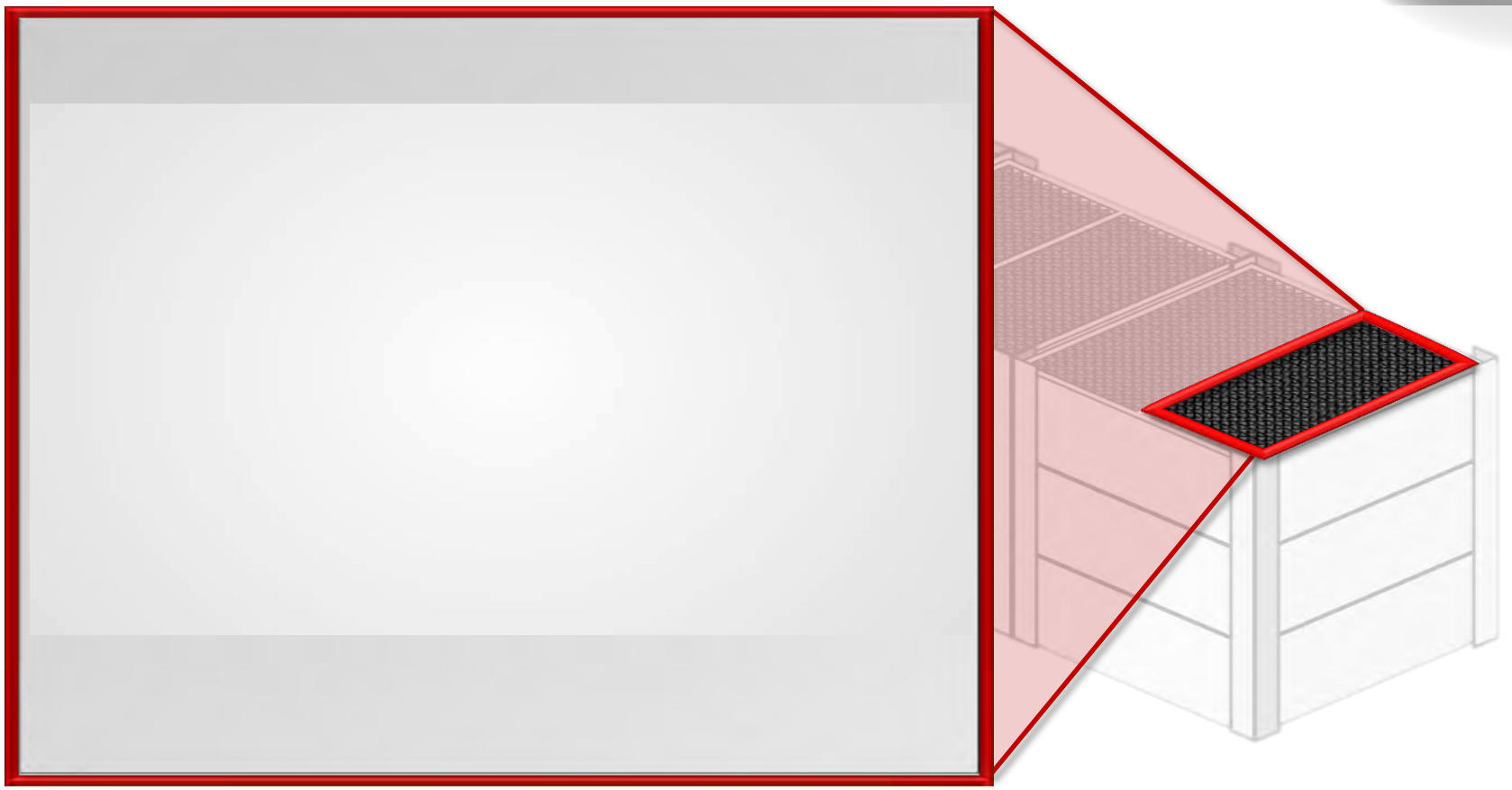
SO_2 removal is a co-benefit

SO_3 does not inhibit mercury capture

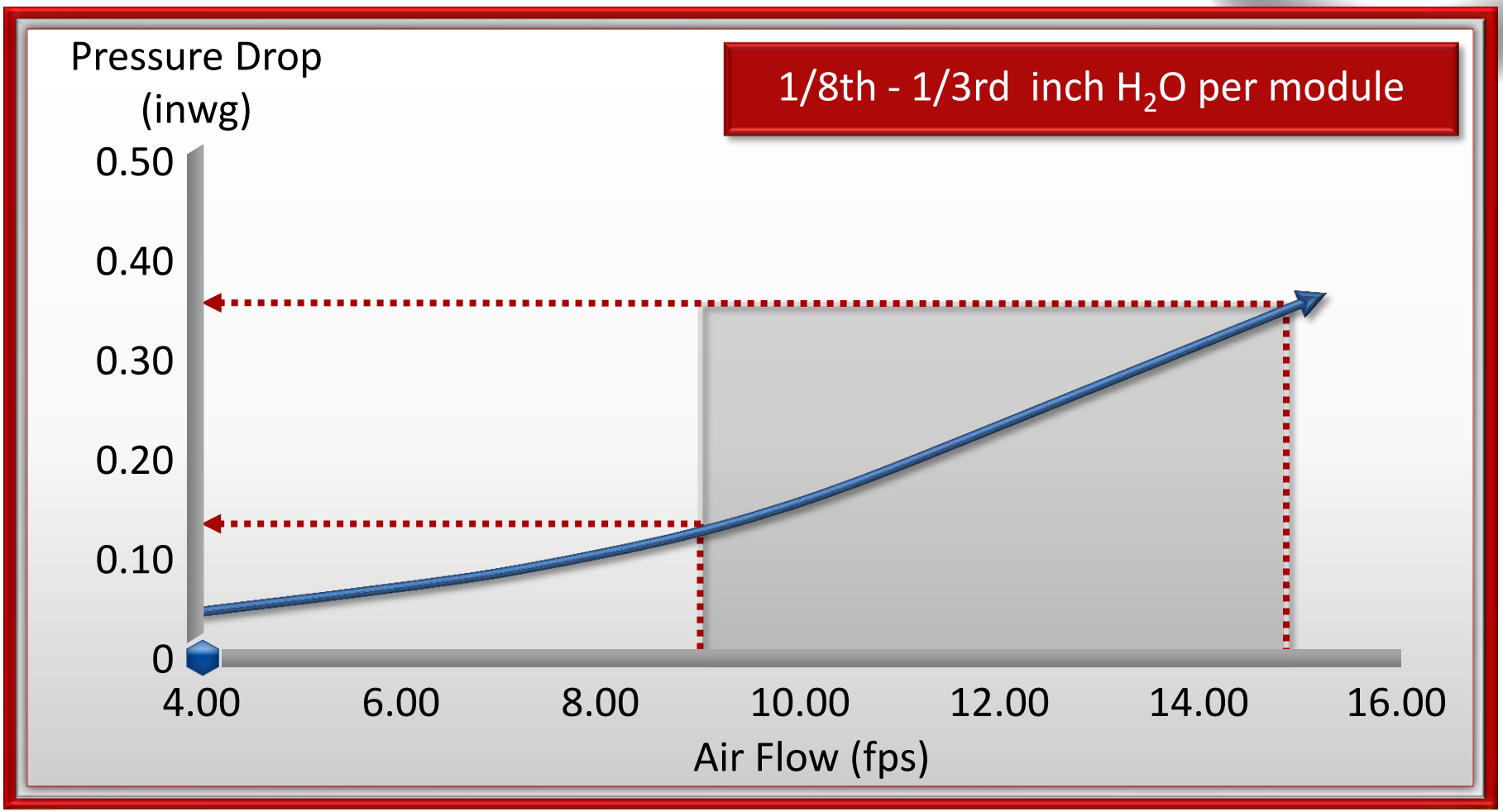


SO_2

Low Pressure Drop



Pressure Drop



Fixed-structure Sorbent Mercury Control System

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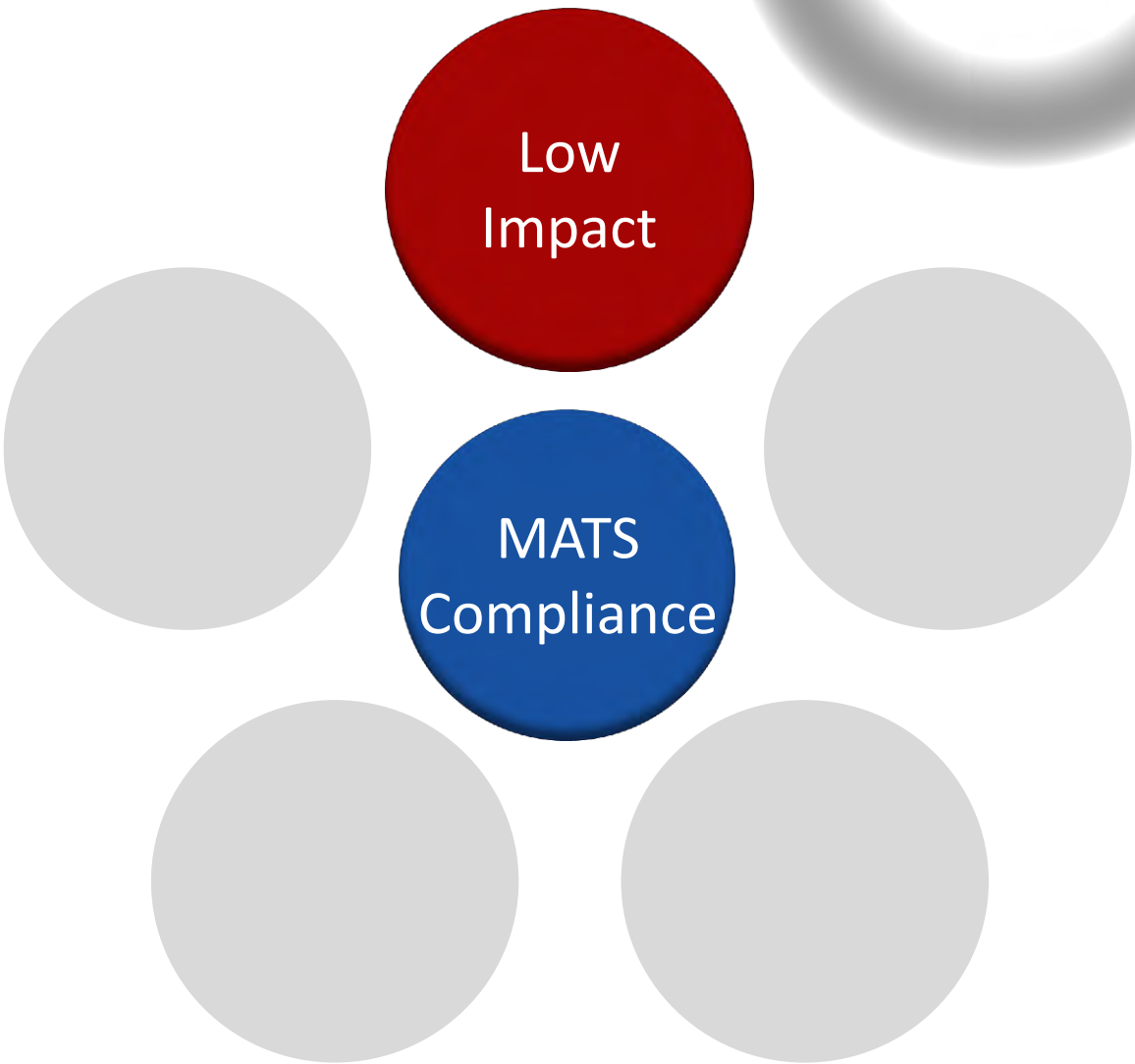
- No Carbon Injection
- No Fly Ash Contamination
- No Additional PM
- No Bromine Injection
- No Corrosion Concerns
- No Wastewater Treatment System Impact



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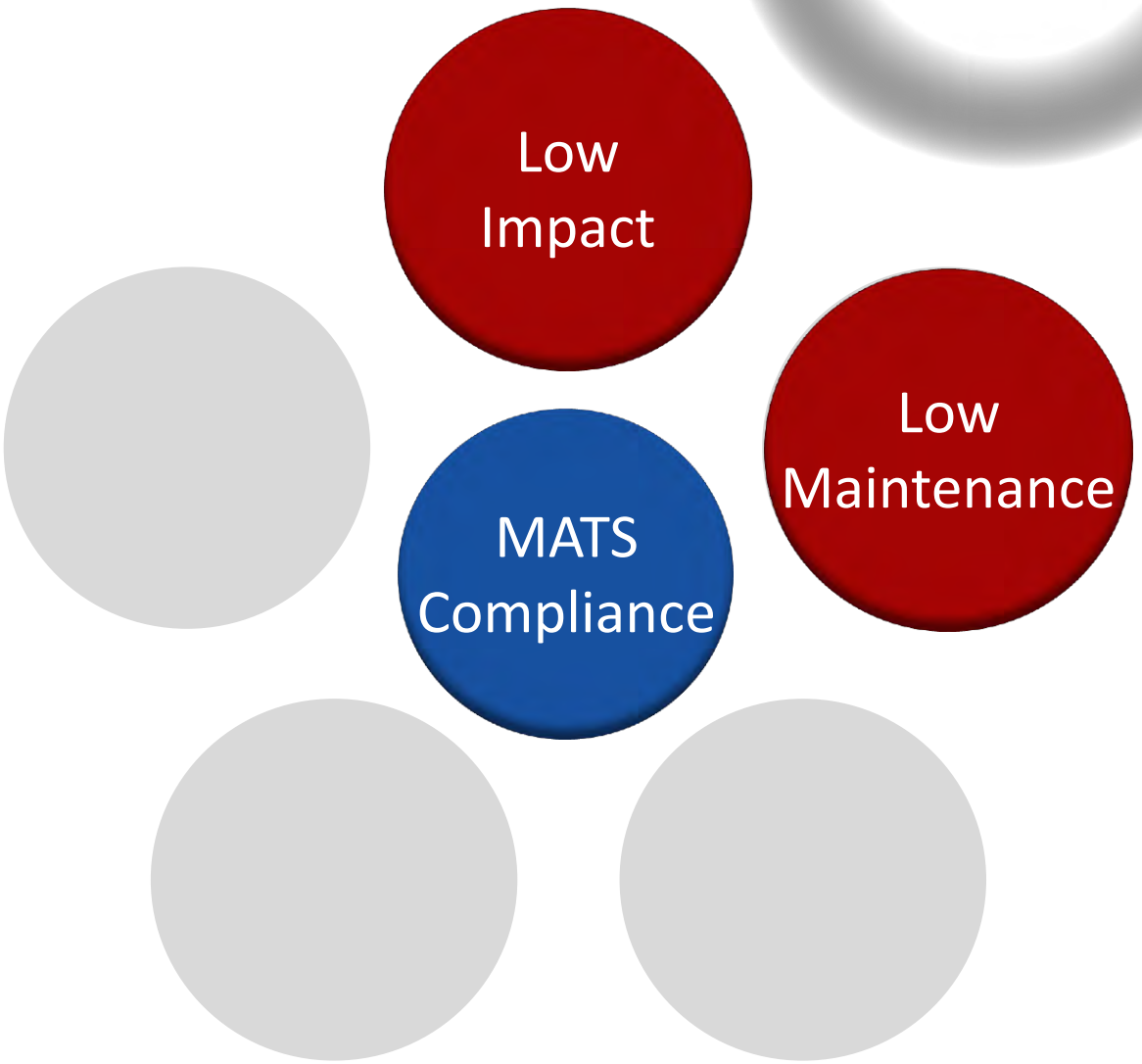
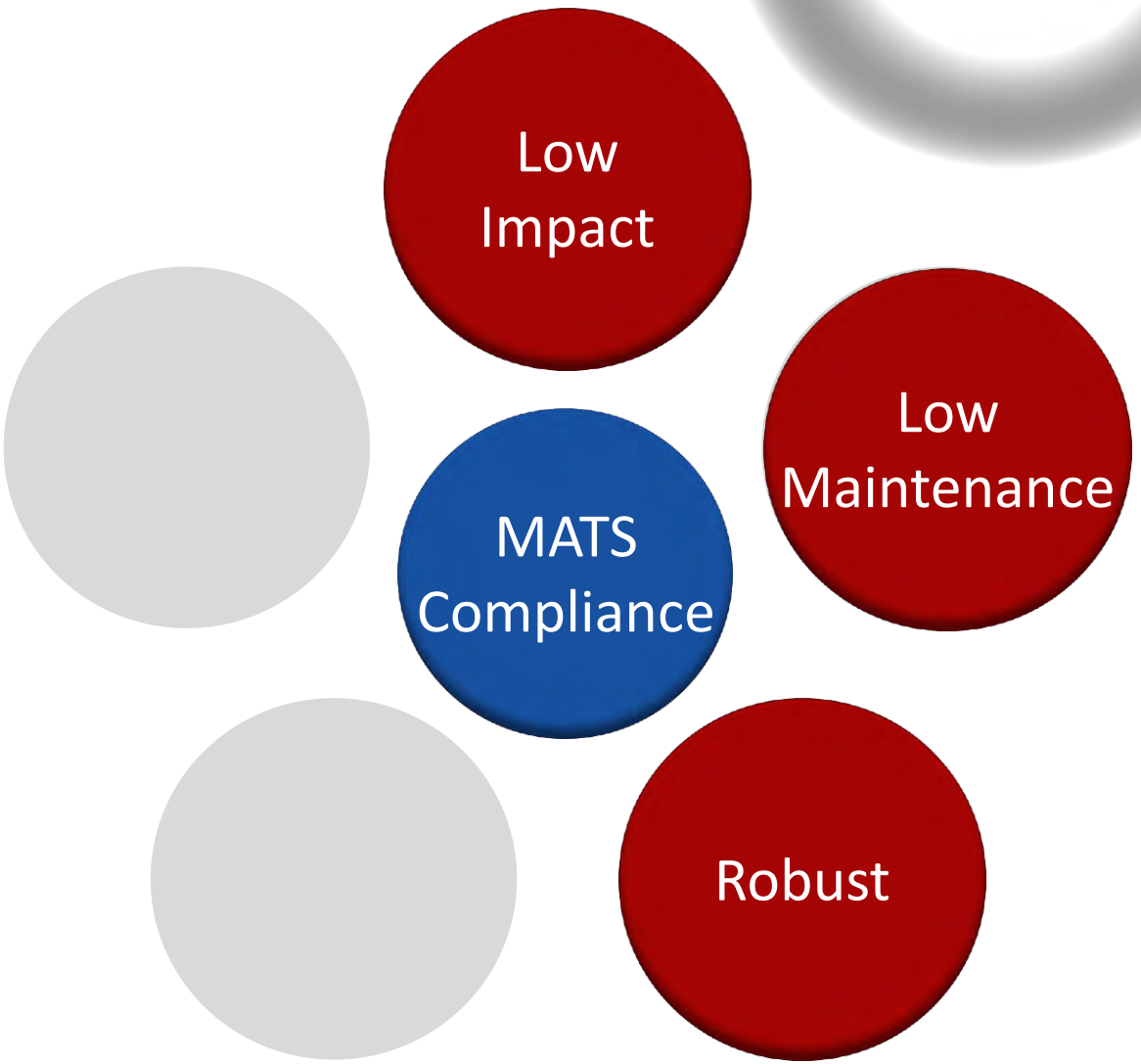
Fixed-structure Sorbent Mercury Control System

- No Moving Parts
- No Adjustments In Use
- No Regeneration Required



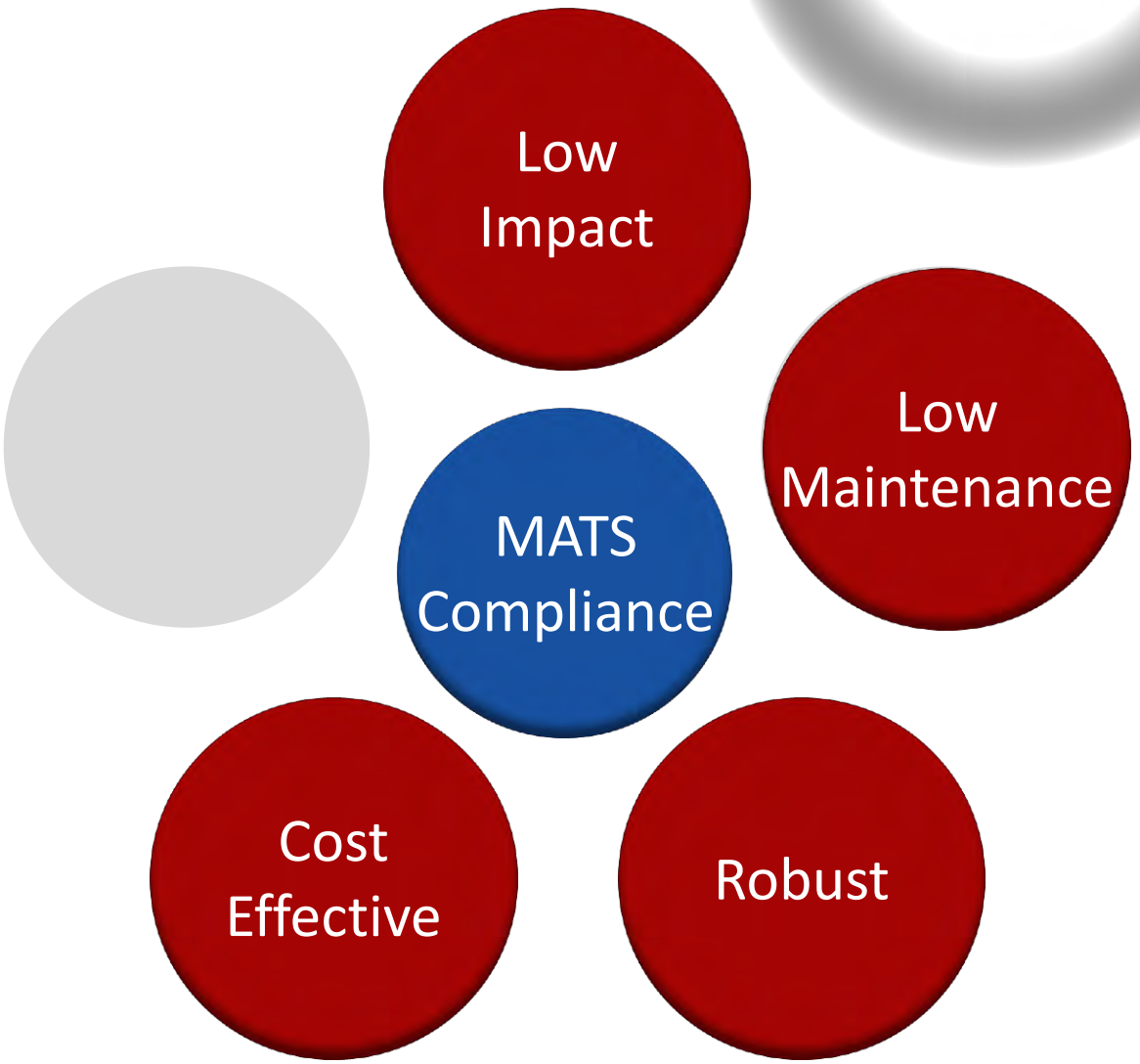
Fixed-structure Sorbent Mercury Control System

- Insensitive to SO_3
- Insensitive to Hg Species (Hg^0, Hg^{2+})
- Fuel Flexibility
- Re-emissions Barrier



Fixed-structure Sorbent Mercury Control System

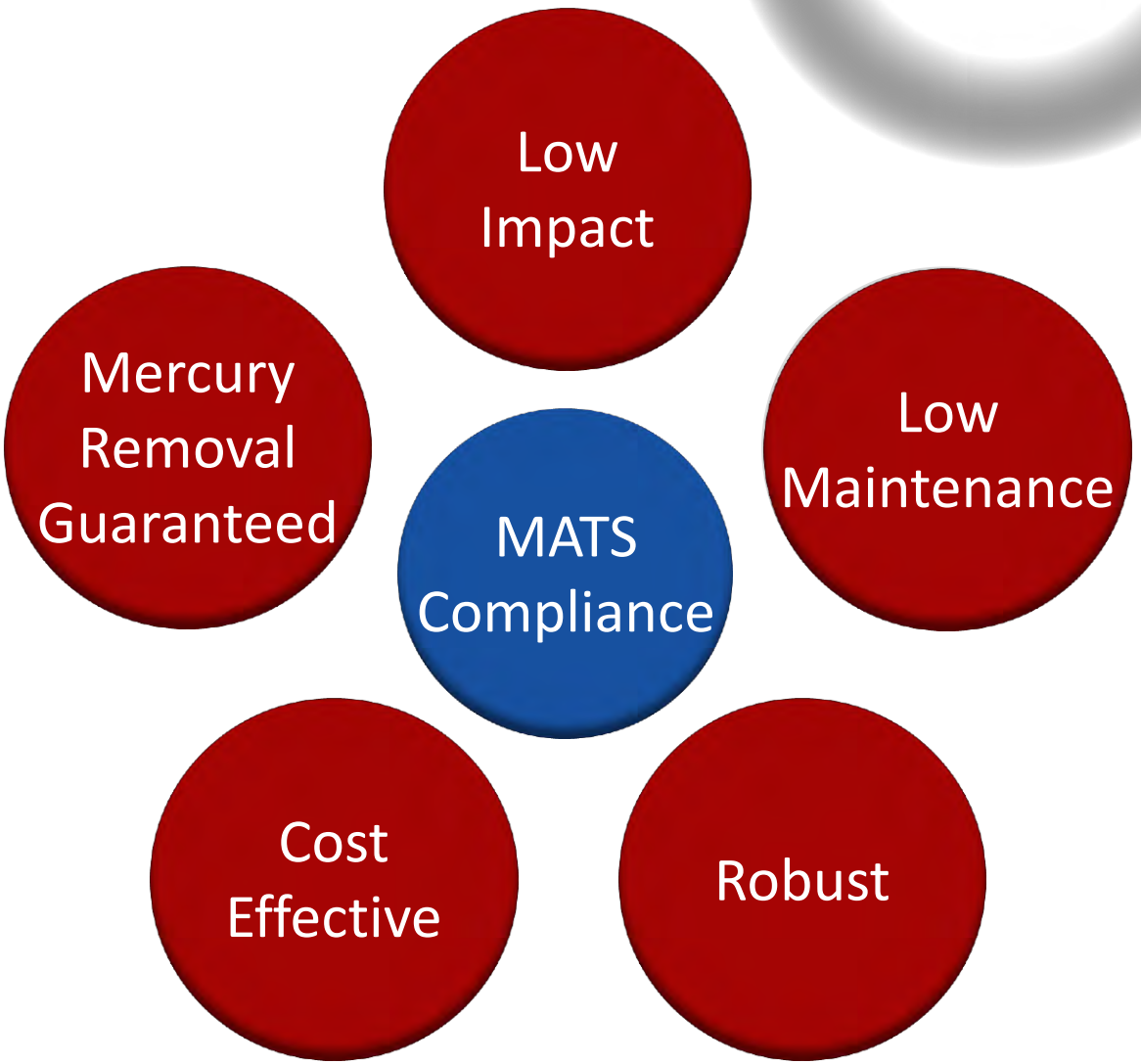
- Long Module Lifetime
- Low Operating Cost
- Zero Footprint
- SO_2 Removal Co-benefit



Fixed-structure Sorbent Mercury Control System

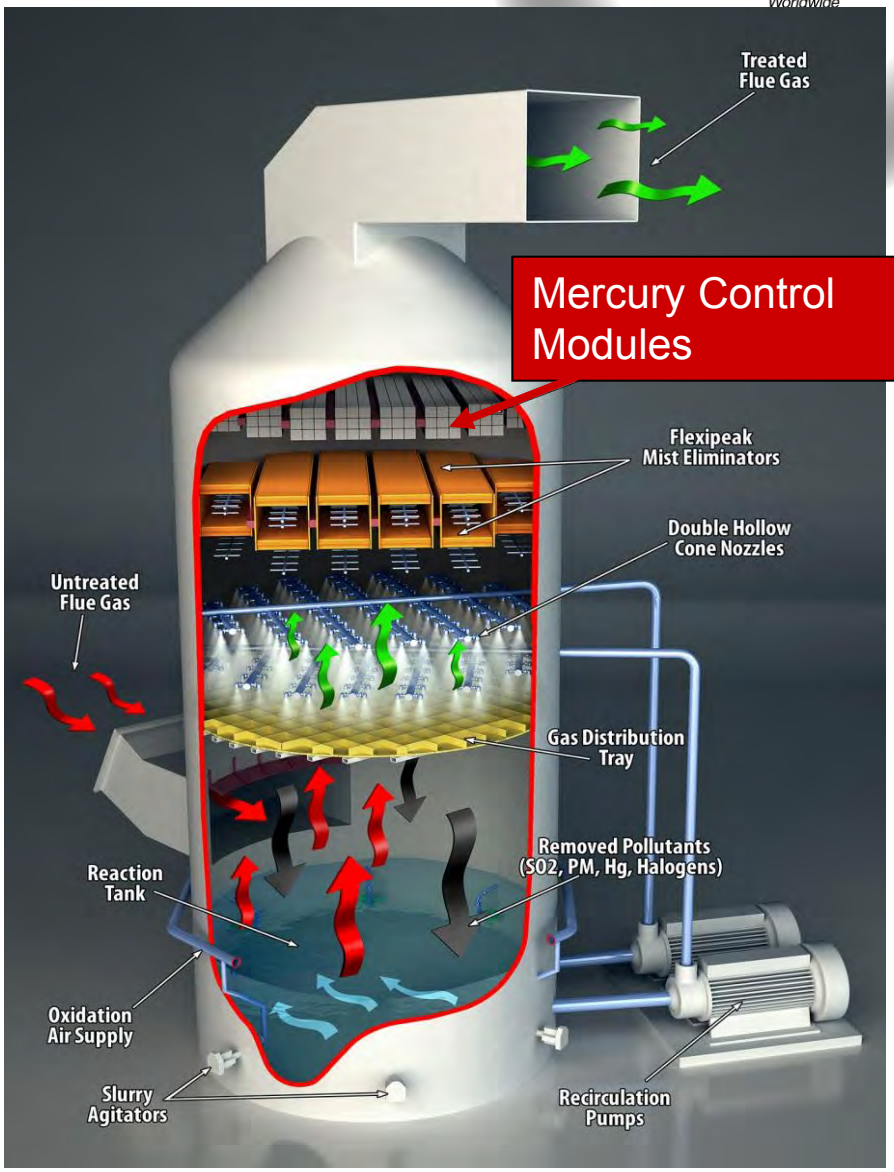
"Tailpipe" solution

Commitment to Fitness-for-Use



Installation in Wet FGD

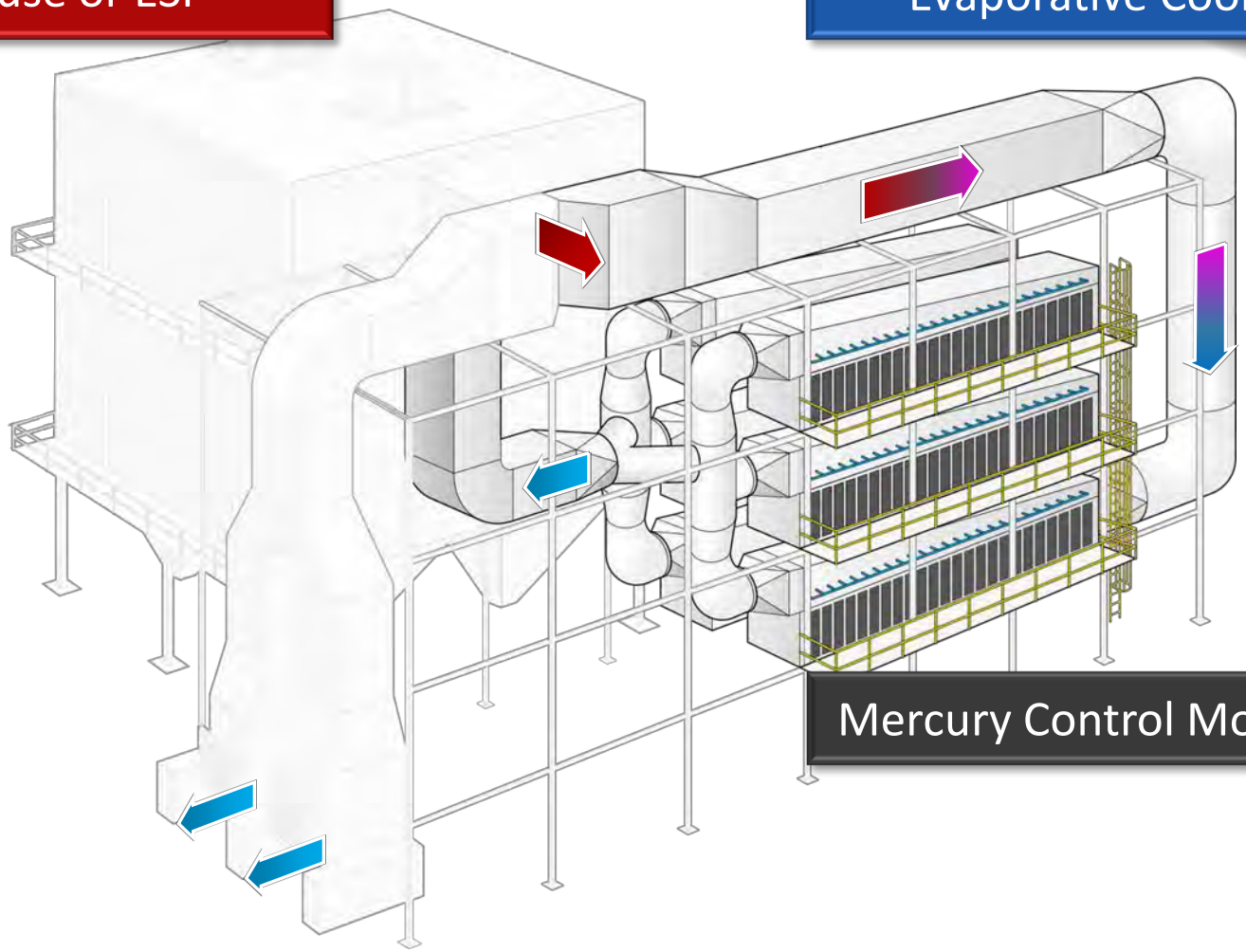
- Modules located downstream of MEs
- Relocation of MEs to create space
- Structural analysis to support load
- Proper selection of materials



Installation without Scrubber

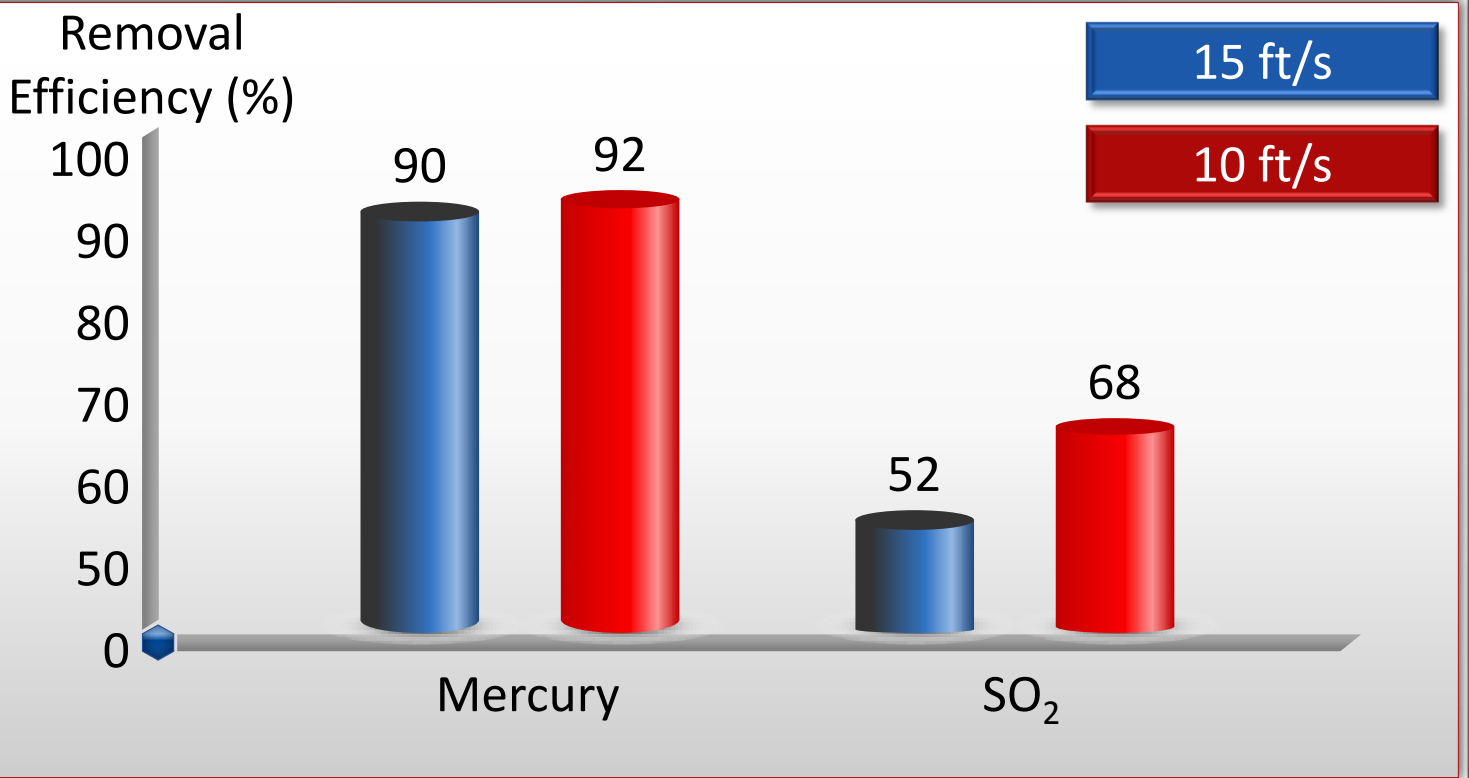
Baghouse or ESP

Evaporative Cooler

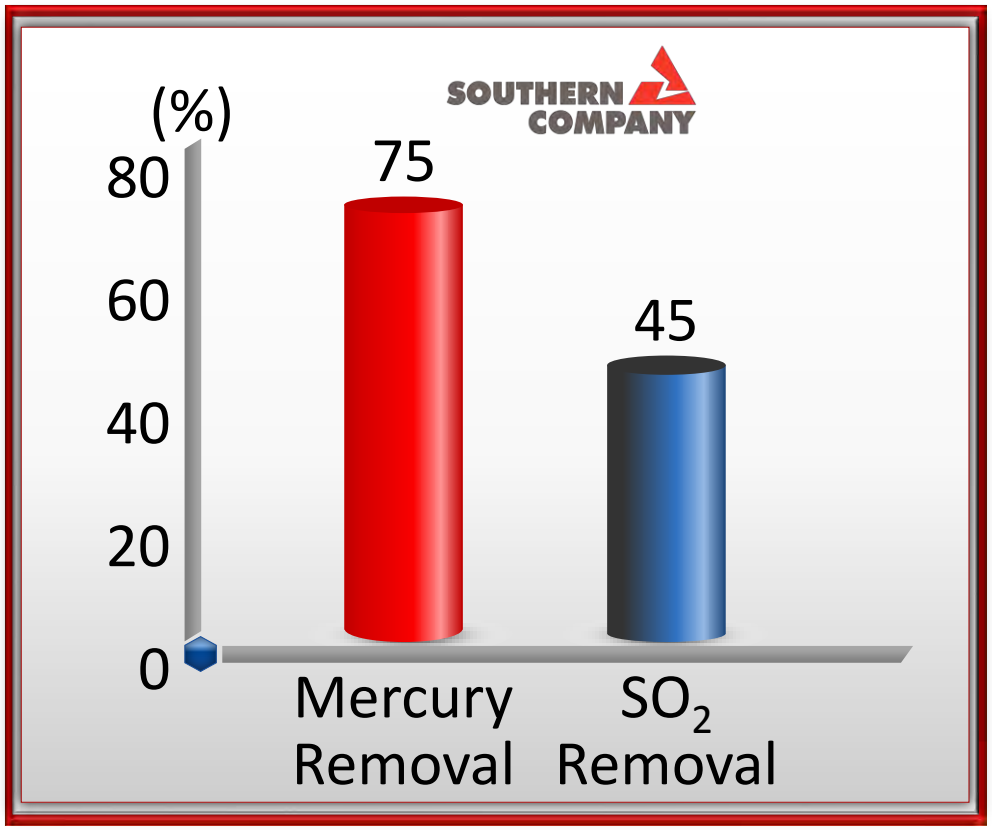


Mercury Control Modules

180 Day Test Pilot - Yates



Additional Pilot Testing Underway - Gorgas



Post-scrubber slip-stream (3000 cfm)

4 module stack (4’ high)

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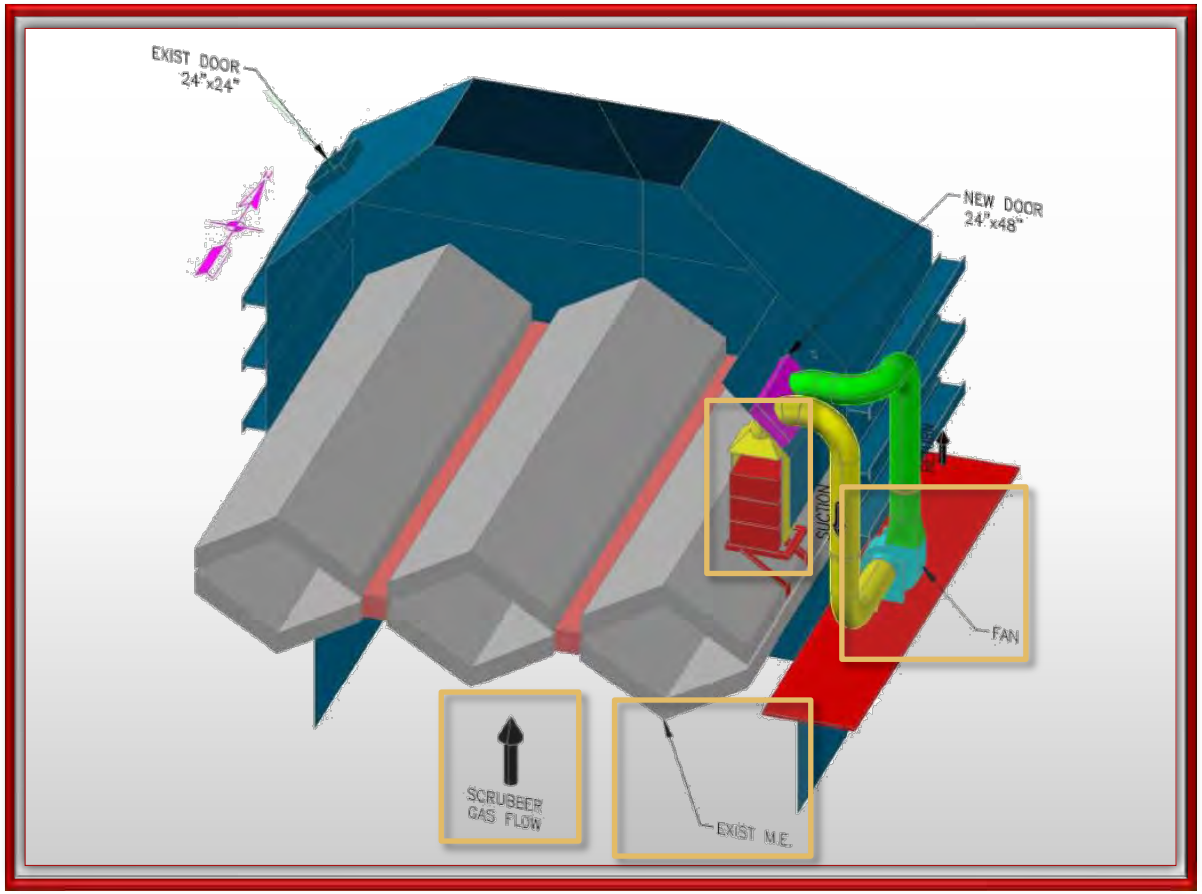
Coal Creek Pilot



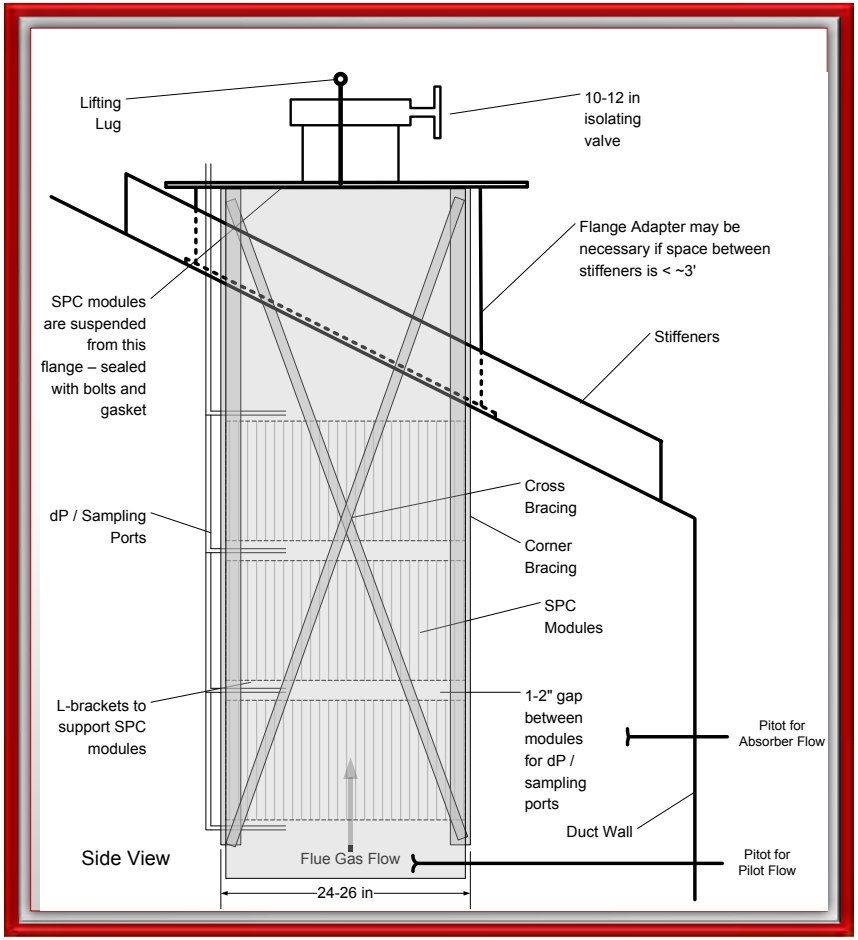
Experience full scrubber carry-over

Hg, SOx, & ΔP measurements

Coal Creek Pilot

Three Module Stack

Coal Creek Pilot Location Operational Impact



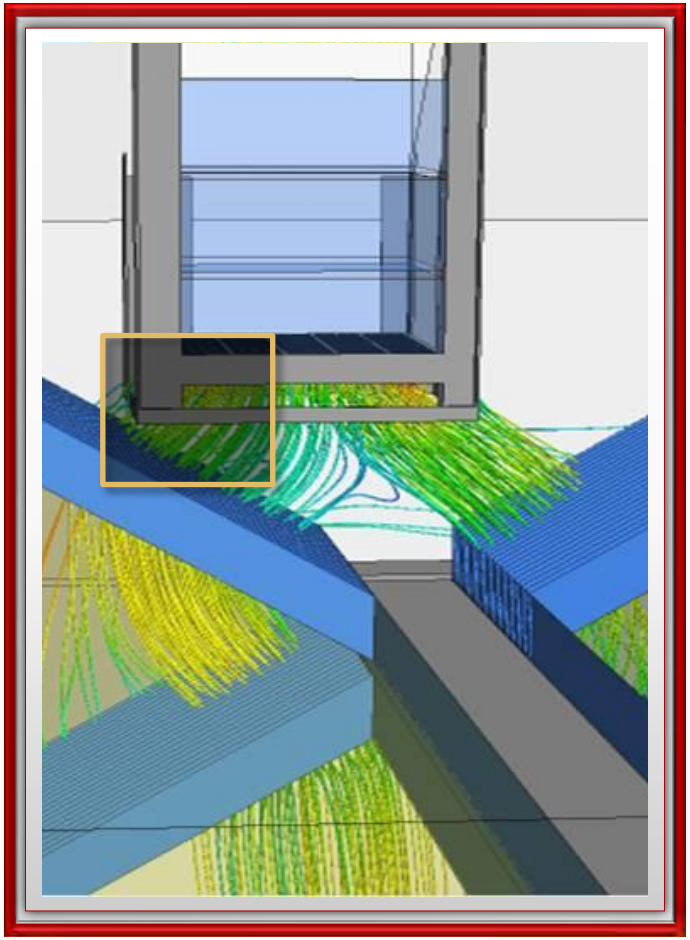
Limited flexibility for locating pilot due to structural beams

Proximity to ME (8in) & uneven flow distribution

Some solids accumulation on one side of leading edge of 1st module

No impact on pressure drop or Hg removal performance

Coal Creek Pilot Modifications



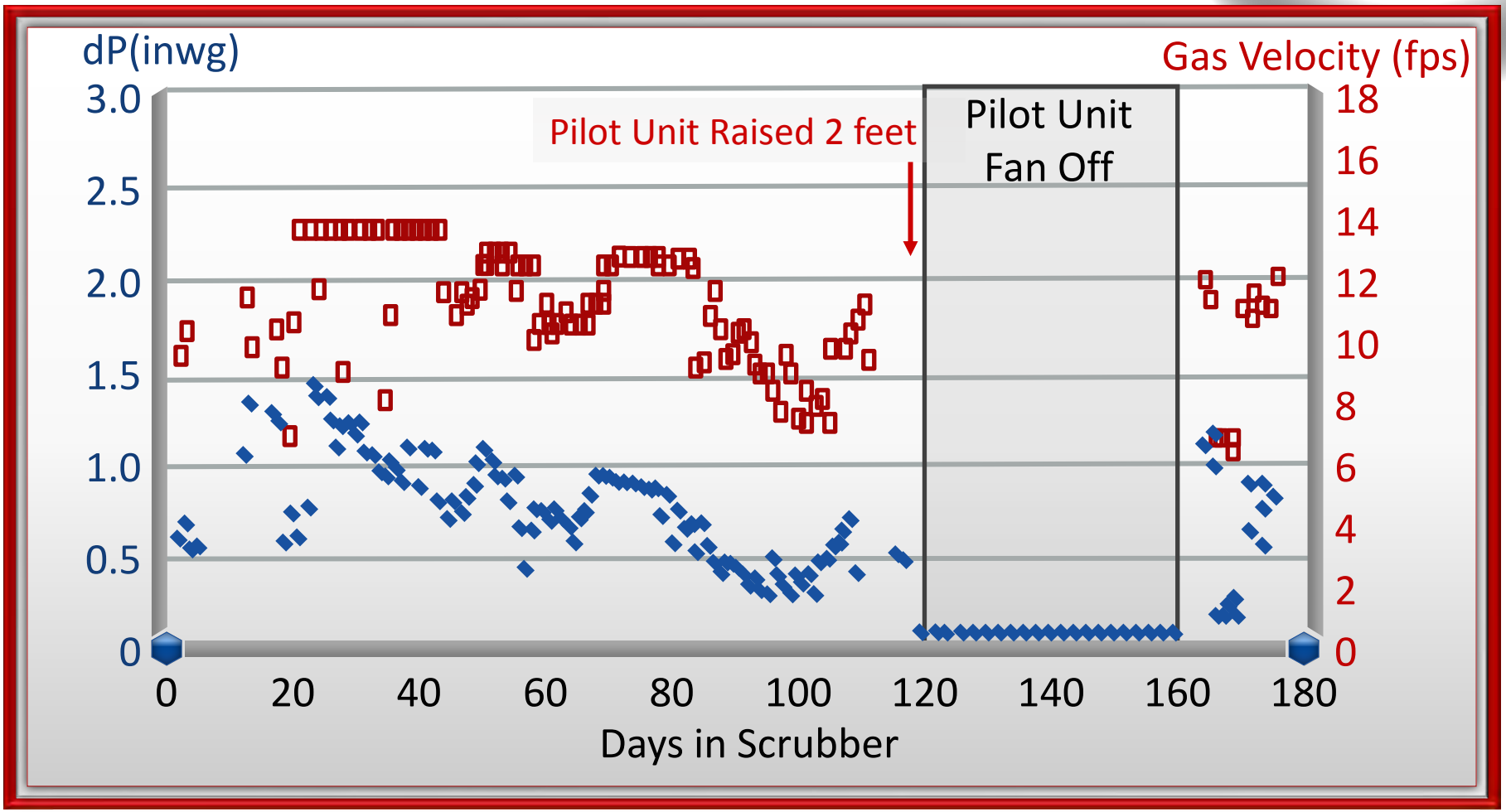
- CFD modeling suggests liquid deposition from high velocity
- Module surface retracted by two feet to increase distance from ME
- Wash system installed for periodic (15sec/6hr) wetting of upstream face
- Subsequent operation demonstrated no evidence of accumulation

Modules in Operation

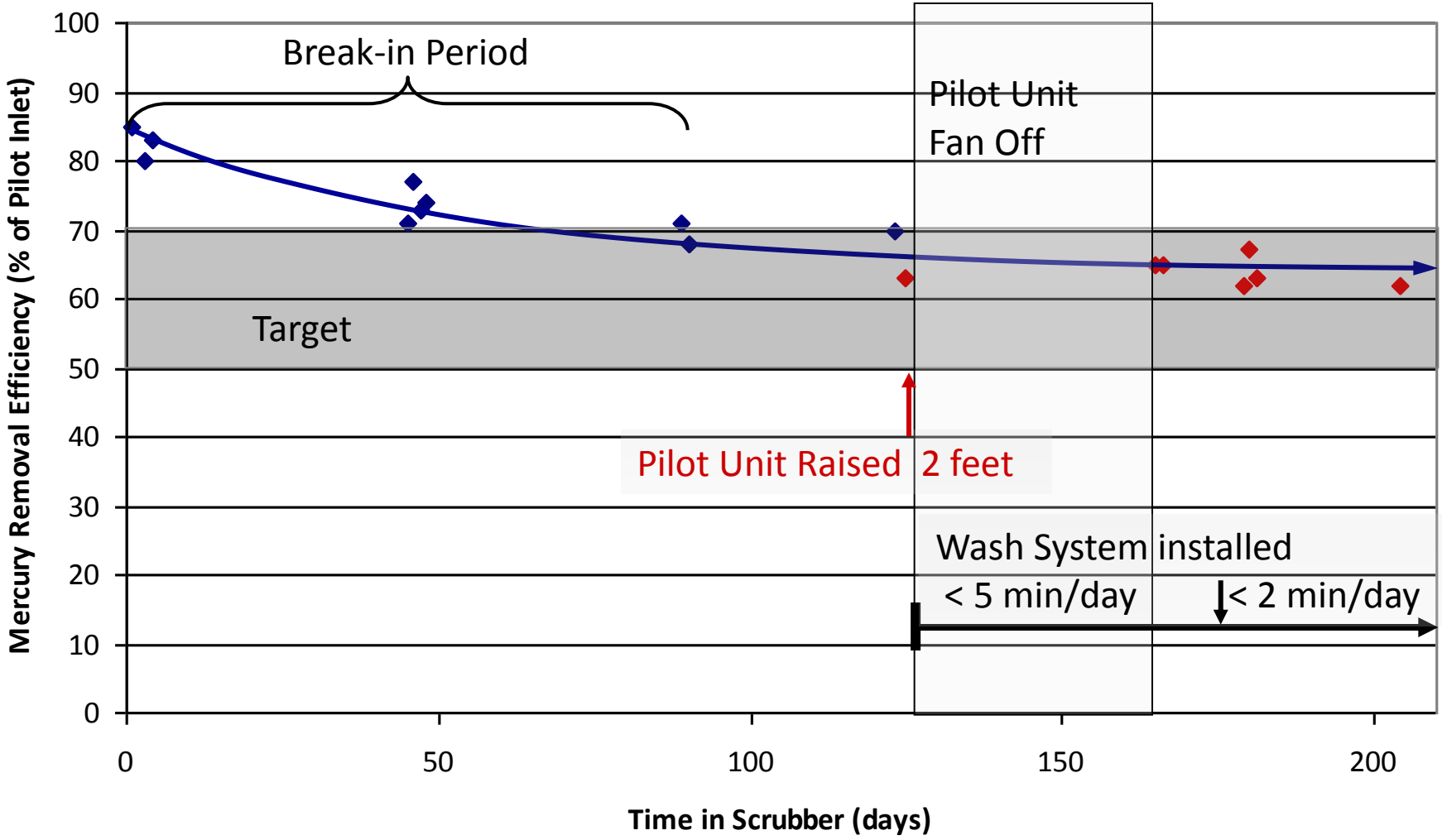
Jan 22: Leading Edge of Modules Viewed through scrubber window

Top View of Module Removed for inspection

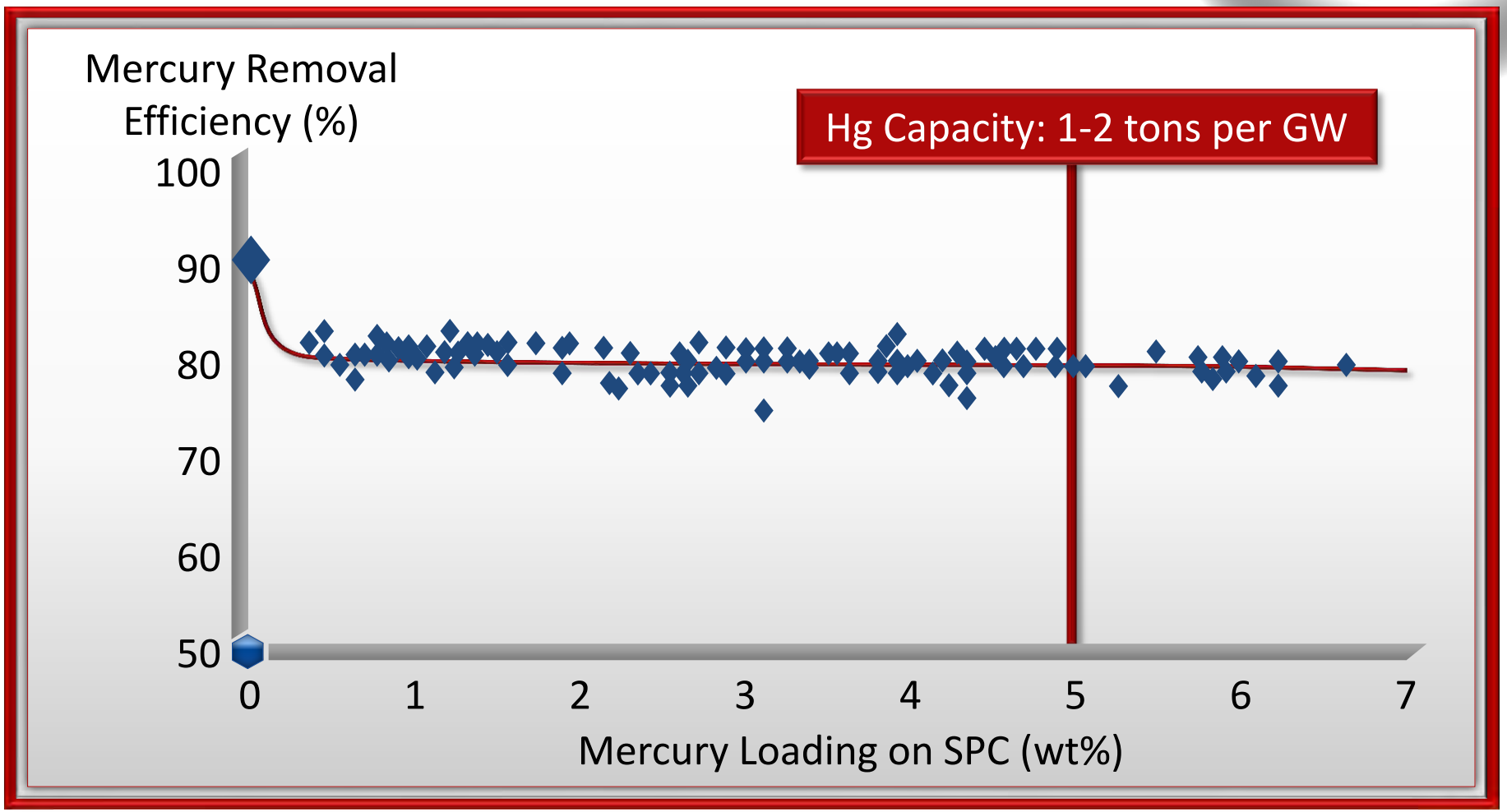
Pressure Drop Across the Coal Creek Pilot



Mercury Removal – Coal Creek Pilot

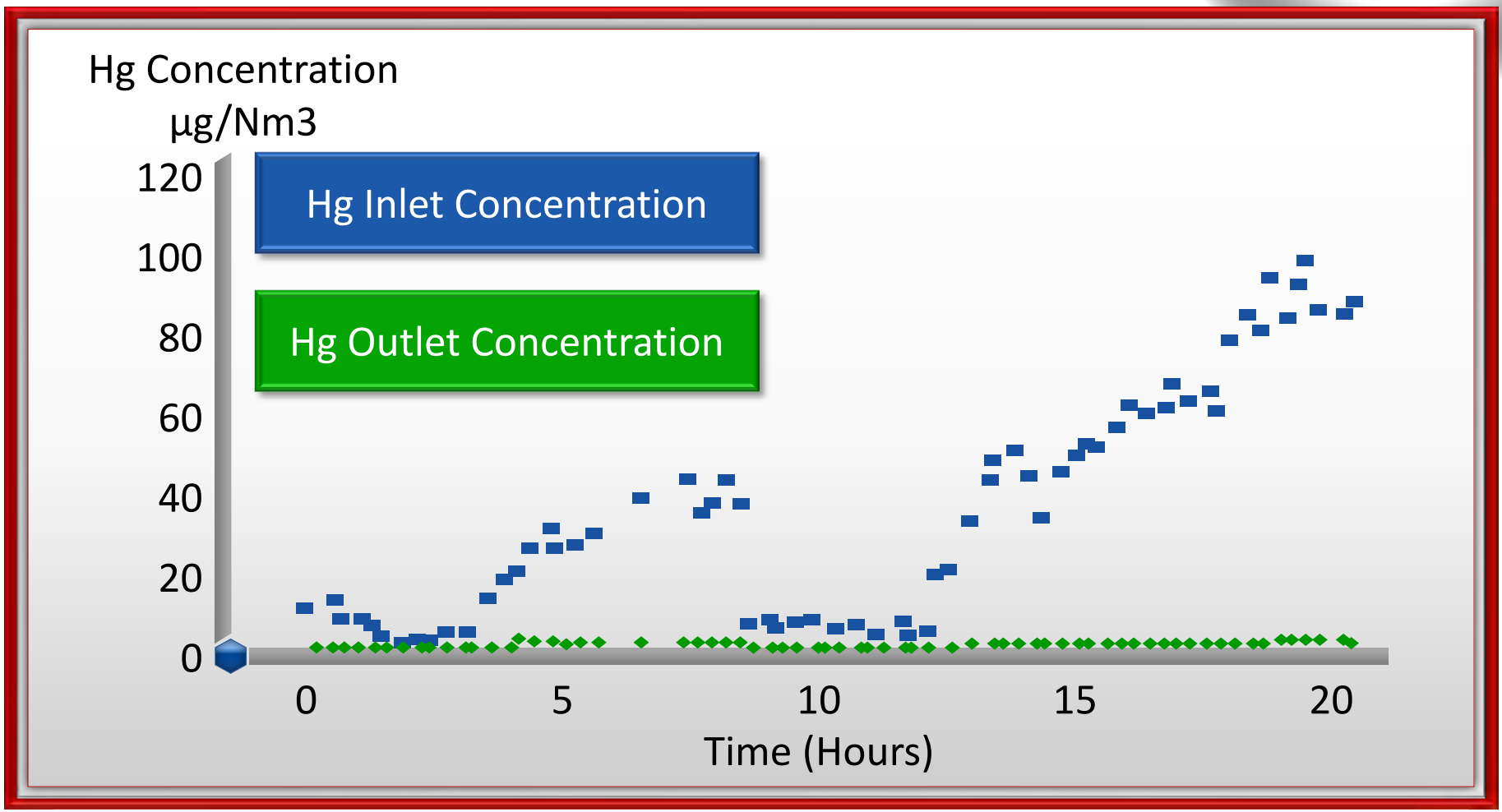


Module Lifetime Projection

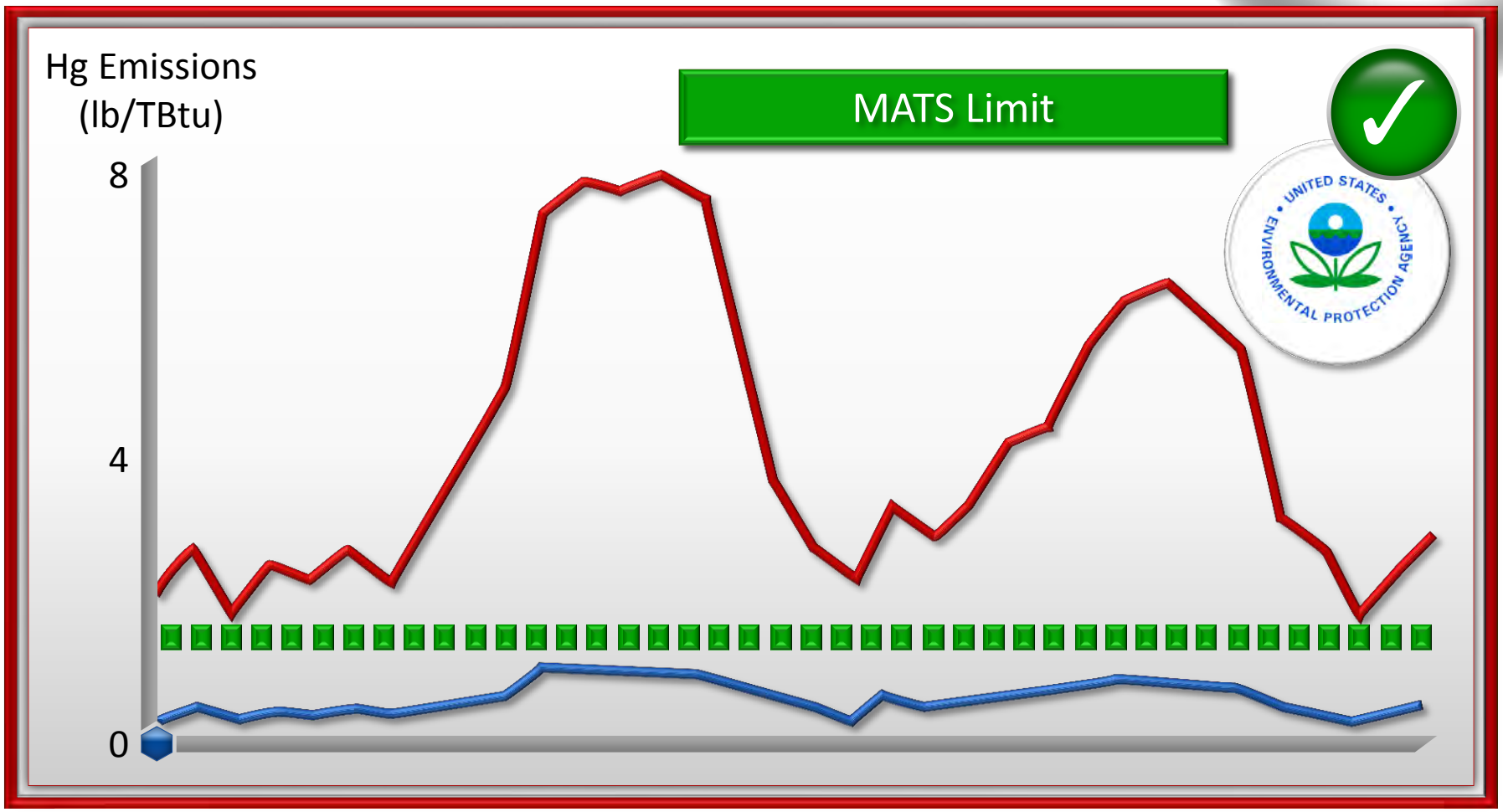


Measured removal on 6” SPC length scaled to 48” removal efficiency

Variable Mercury Emissions – No Adjustments



Simple Solution for Scrubber Re-emissions



Cost Model: Key Assumptions

Hg control option	Assumption	Bituminous	Lignite
Fixed-structure Sorbent	Module Life	5 yrs (range 3 – 9)	5 yrs (range 3 – 9)
ACI	PAC Inj. Rate (#/MMacf)	3 (range 1 – 5)	
ACI plus DSI	DSI Inj. Rate (#/hr)	700 (range 525 – 1050)	
	PAC Inj. Rate (#/MMacf)	1 (range 0.5 – 3)	
Brominated ACI	Br-PAC Inj. Rate (#/MMacf)		3 (range 1 – 5)
Calcium Bromide	Concentration on Coal (ppm)		100 (range 50 -150)
Unbrominated ACI plus CaBr	PAC Inj. Rate (#MMacf)		3 (range 1 – 5)
	$CaBr_2$ Inj. Rate (ppm)		25 (range 15-50)

General Assumptions: 500 MW Unit size

70% Hg reduction needed for MATS Compliance

15% capitalization factor

Fly ash value: $7/ton (range 1-18)

Fly ash disposal: $10/ton (range 5-20)

Fly ash sale lost $\geq$ 3lb/MMacf

PAC costs: $0.75.lb (range $0.50-1.00)

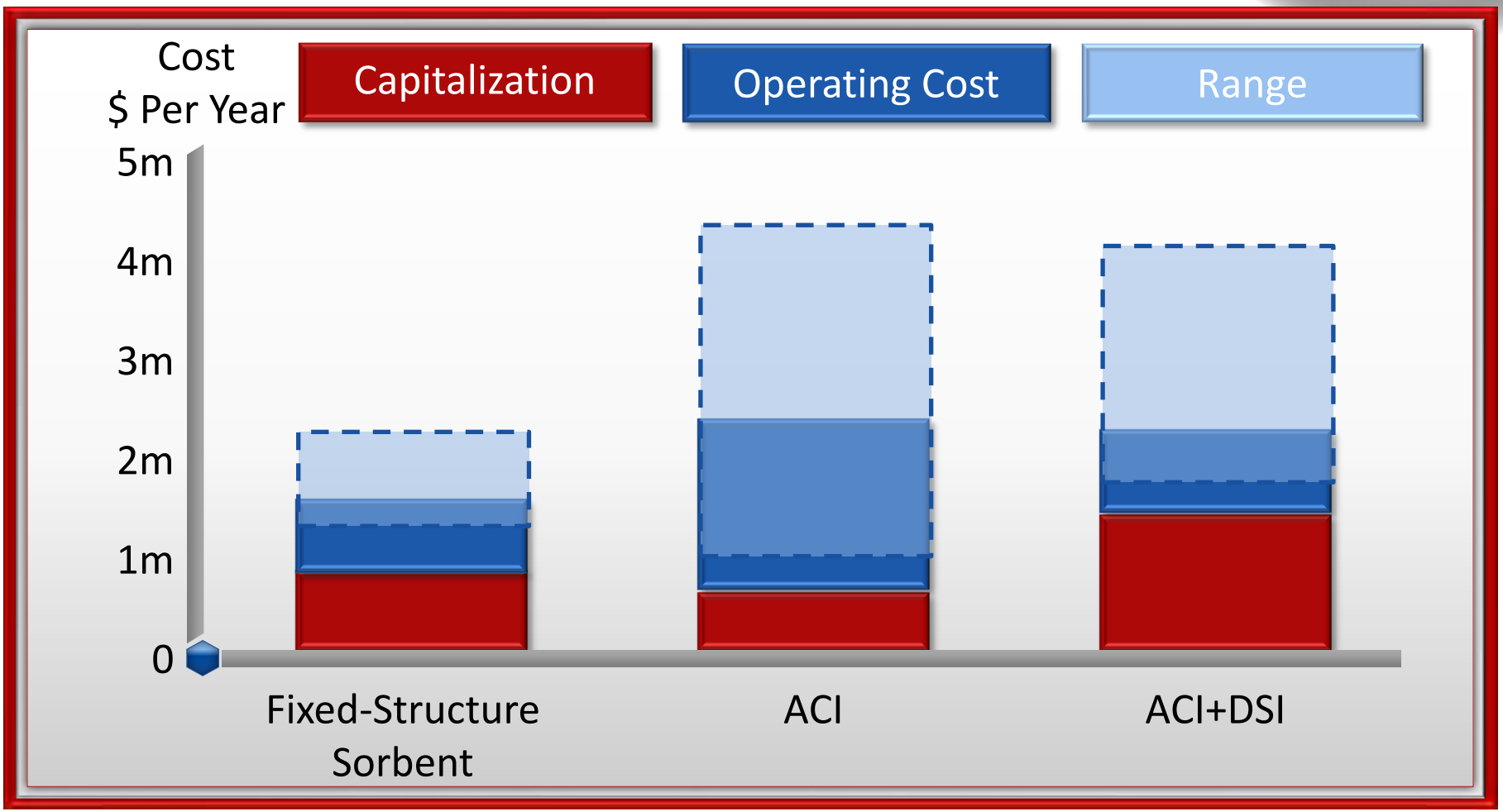
Br-PAC costs: $1.25/lb (range $1.00-1.50)

$CaBr_2$ costs: $1.25/lb (range $1.00-1.50)

$Ca(OH)_2$ costs: $100/ton (range $75-130)

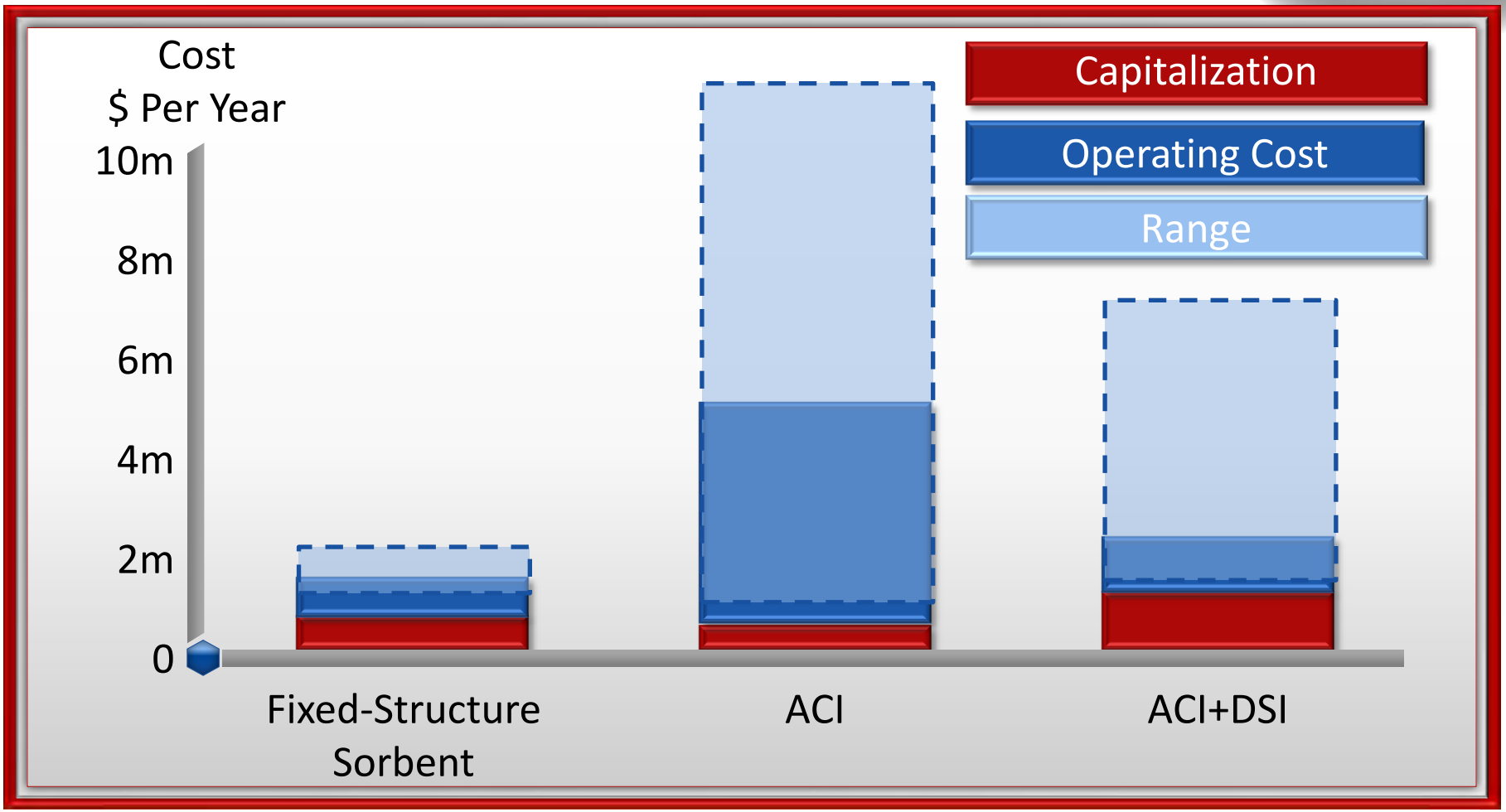
Protected Cost of Mercury Reduction Technologies

Bituminous Coal, 500MW – No Impact on Fly Ash Sales



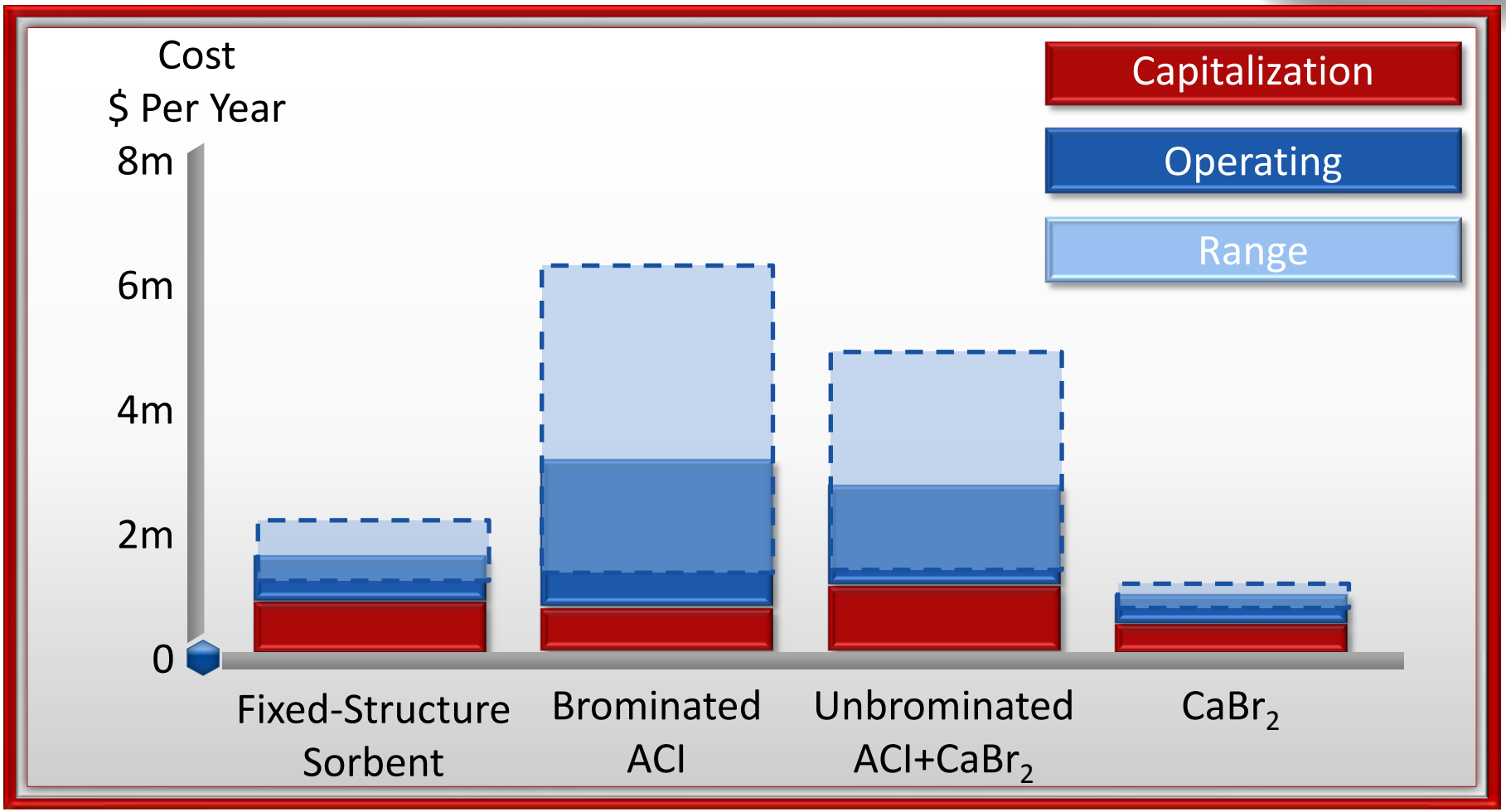
Protected Cost of Mercury Reduction Technologies

Bituminous Coal, 500MW – with Fly Ash Impact



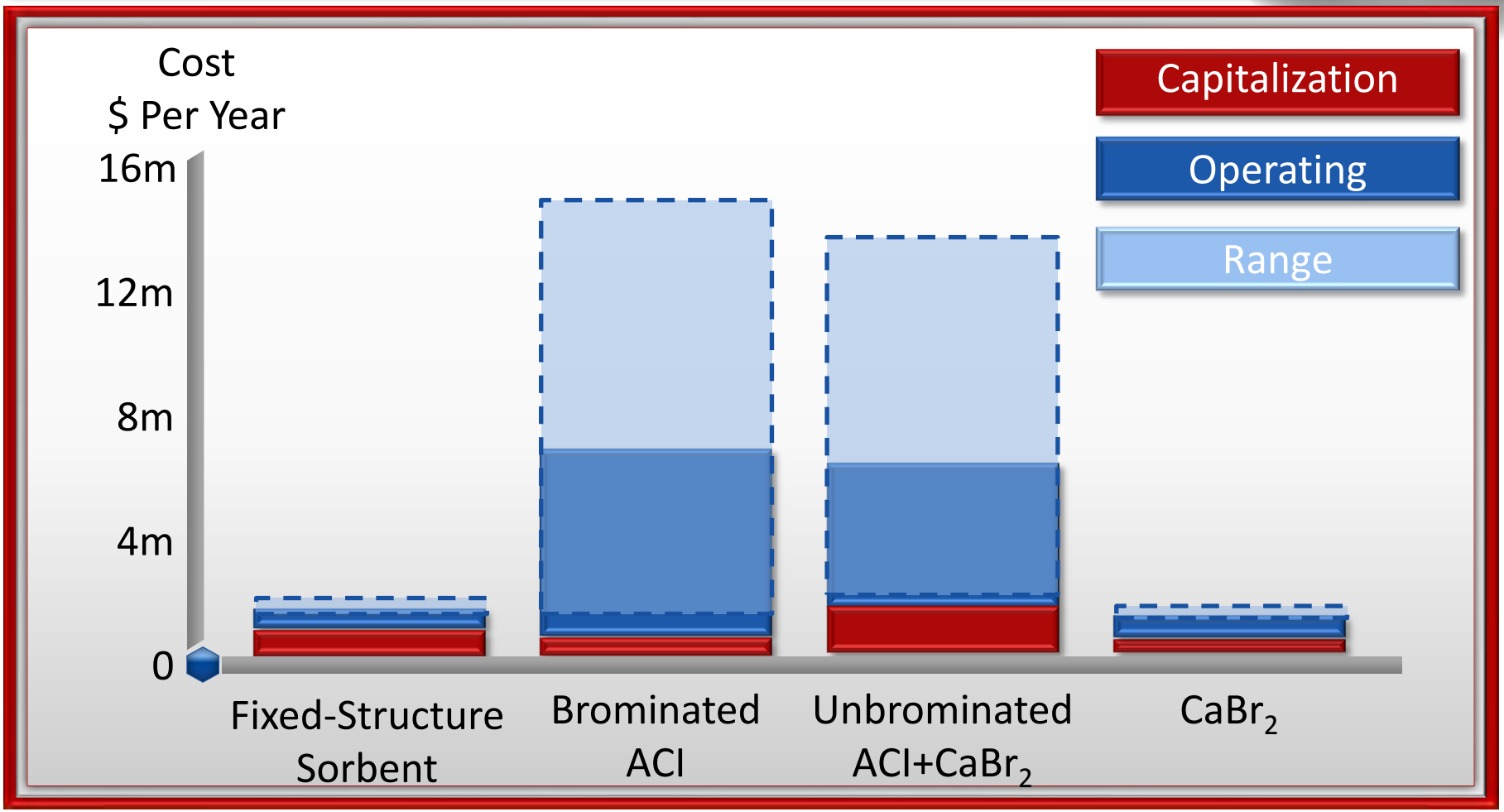
Protected Cost of Mercury Reduction Technologies

Lignite coal, 500MW – No Impact on Fly Ash Sales



Protected Cost of Mercury Reduction Technologies

Lignite coal, 500MW – with Fly Ash Impact



Future Activities

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Pilot Testing

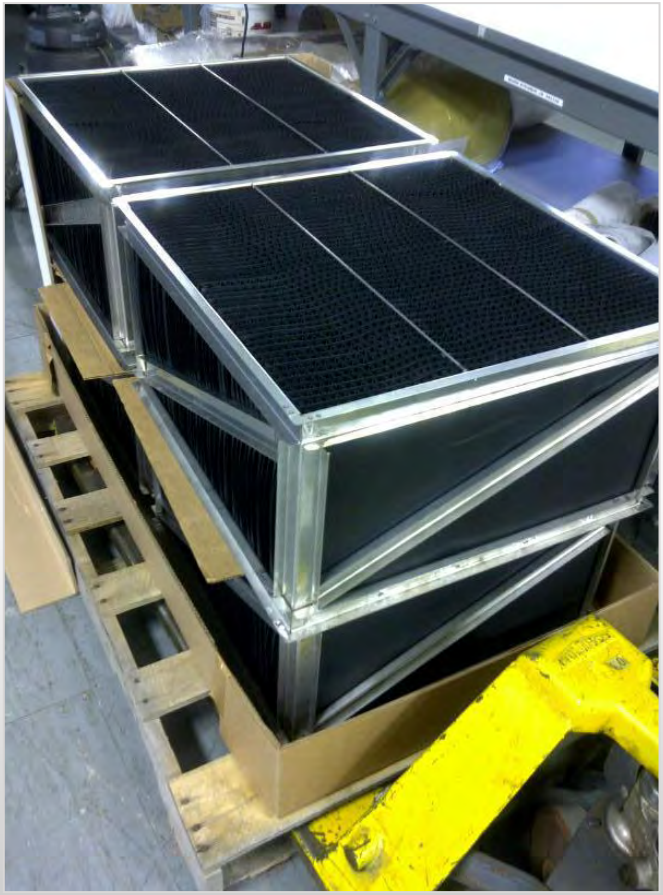
- Continue existing pilot tests
- New applications (i.e., unscrubbed sites)

Multiple full-scale installations in 2013

- 2-3 in power applications (in-scrubber)
- 2-3 in non power (cement, incinerator)

High volume manufacturing

- Available Fall 2013



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