REINHOLD ENVIRONMENTAL Ltd.

2012 NOx-Combustion Round Table & Expo Presentation

February 13-14, 2012, in Columbus, OH / Hosted by AEP

SOUTHERN COMPANY
Energy to Serve Your World®

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BHK Babcock-Hitachi K.K.

Hitachi Power Systems America, Inc.

SCR Catalyst Co-Benefits

Presented at the
Reinhold NOx Round Table
February 13-16, 2012

Presented by
Ed Healy of Southern Company
And
Tony Favale of Hitachi Power Systems America

Outline

- MACT Compliance Strategies and SCR Co-Benefit
- Mercury Oxidation and Removal Technology
- TRAC® Performance on Bituminous Units
- TRAC® Performance on PRB Units
- TRAC® Economics
- TRAC® Record
- Summary and Conclusions

EGU MACT Hg Regulation & Compliance Strategy

- New Hg Emission Limit – 1.2 lb/TBtu (for most existing units)
- Goal… Comply with New Regulations and in the Most Cost-Effective Way
  - Retrofit unit with additional emissions control devices
  - Use additives like ACI or Ca Br to Oxidize Hg.
  - Engineer a solution to get more out of your Current Emissions Control Equipment when possible
- Evaluate – Where you are vs. where you need to be

Utilize Co-Benefit of Currently Installed Emissions Control Equipment (your SCR) to meet the Hg Emission Limit.
This is the Most Cost-Effective Compliance Strategy.

Why Oxidize Mercury in the SCR?

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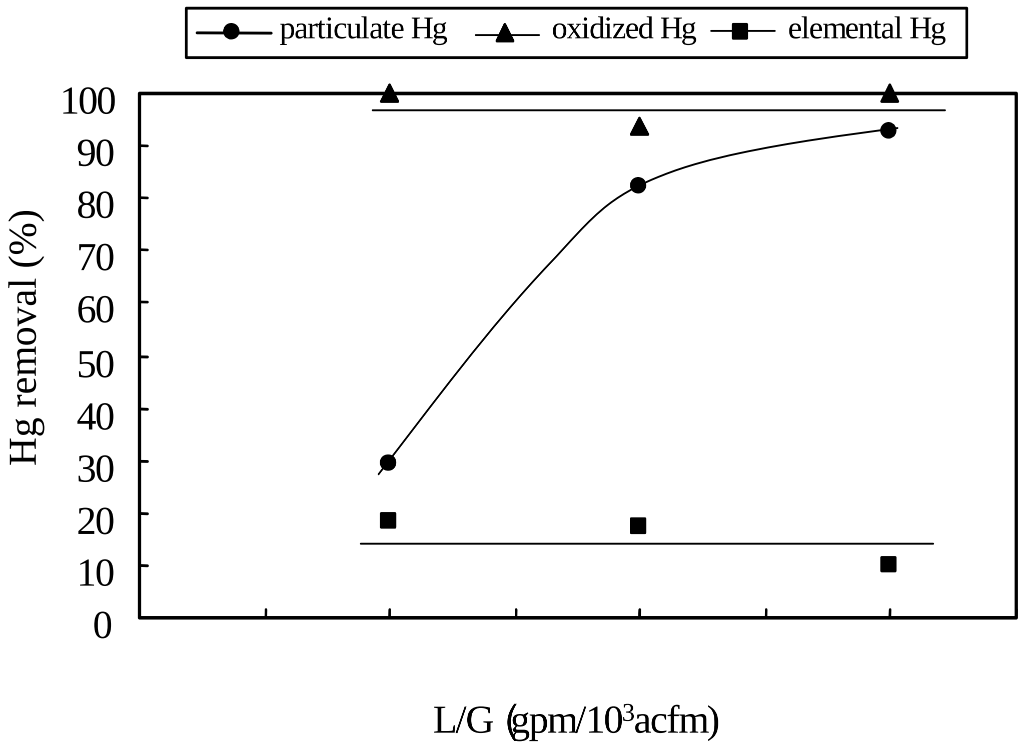
Co-Benefit…Utilization of SCR to reduce NOx and oxidize Hg

With WFGD, removal of 90+% of the oxidized mercury has be achieved

Hg Removal efficiency of Dry FGD System can be improved with more oxidized Hg

Significantly reduces or eliminates the use of additives such as ACI or Halogens



Comparison of Hg Removal Technology vs Catalyst

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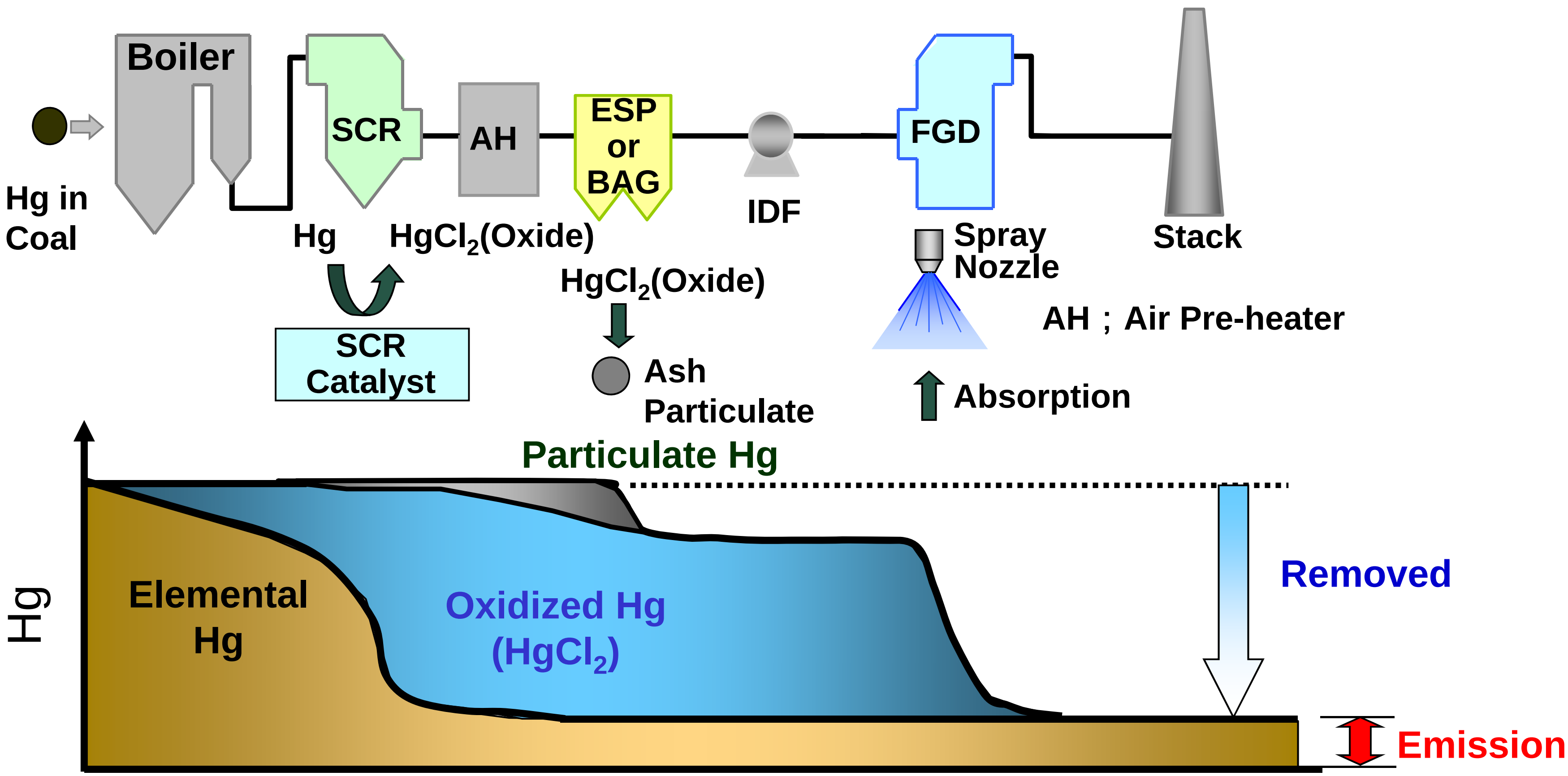
Function	Key Technology	Advantage	Disadvantage/Challenge
Adsorption	**Activated Carbon Injection (ACI)**	➢ Commercialized ➢ w/o SCR ➢ High Hg removal	➢ **High Operating Cost** ➢ ACI facility ➢ Operation and maintenance ➢ High carbon content in ash ➢ SO3 impact on removal efficiency
Oxidation	**Halogen Injection**	➢ Commercialized ➢ High Hg removal ➢ Relatively low cost	- **Balance of plant impacts** - Ineffective on bituminous coal - Separate system
	SCR Catalyst	**- Low operating cost** **- No additional facility** **- High operation reliability**	**- To improve Hg oxidation**

Process of Hg Removal by SCR + FGD



SCR Catalyst is a key component for mercury oxidation

Basic Concept of Hitachi's AQCS

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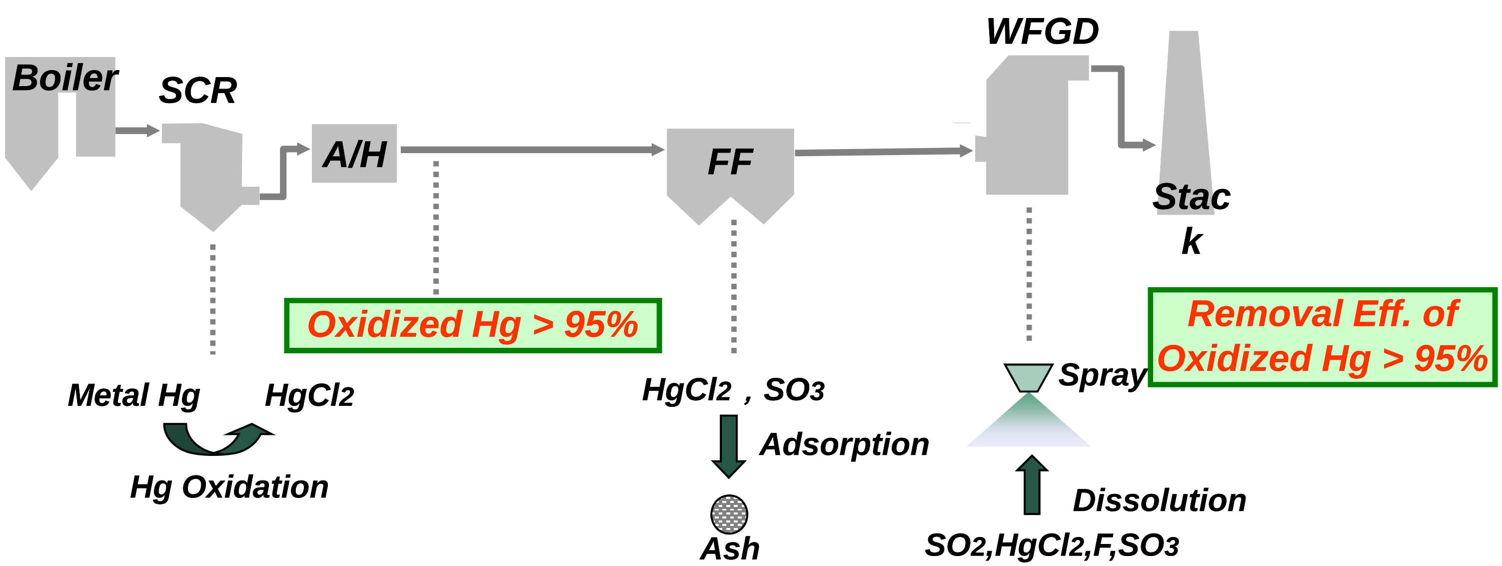
1. Hg Oxidation Catalyst with Lower SO_2 Conversion

95% Hg Oxidation at A/H Outlet

2. Less Operating Cost

- No Activated Carbon Injection

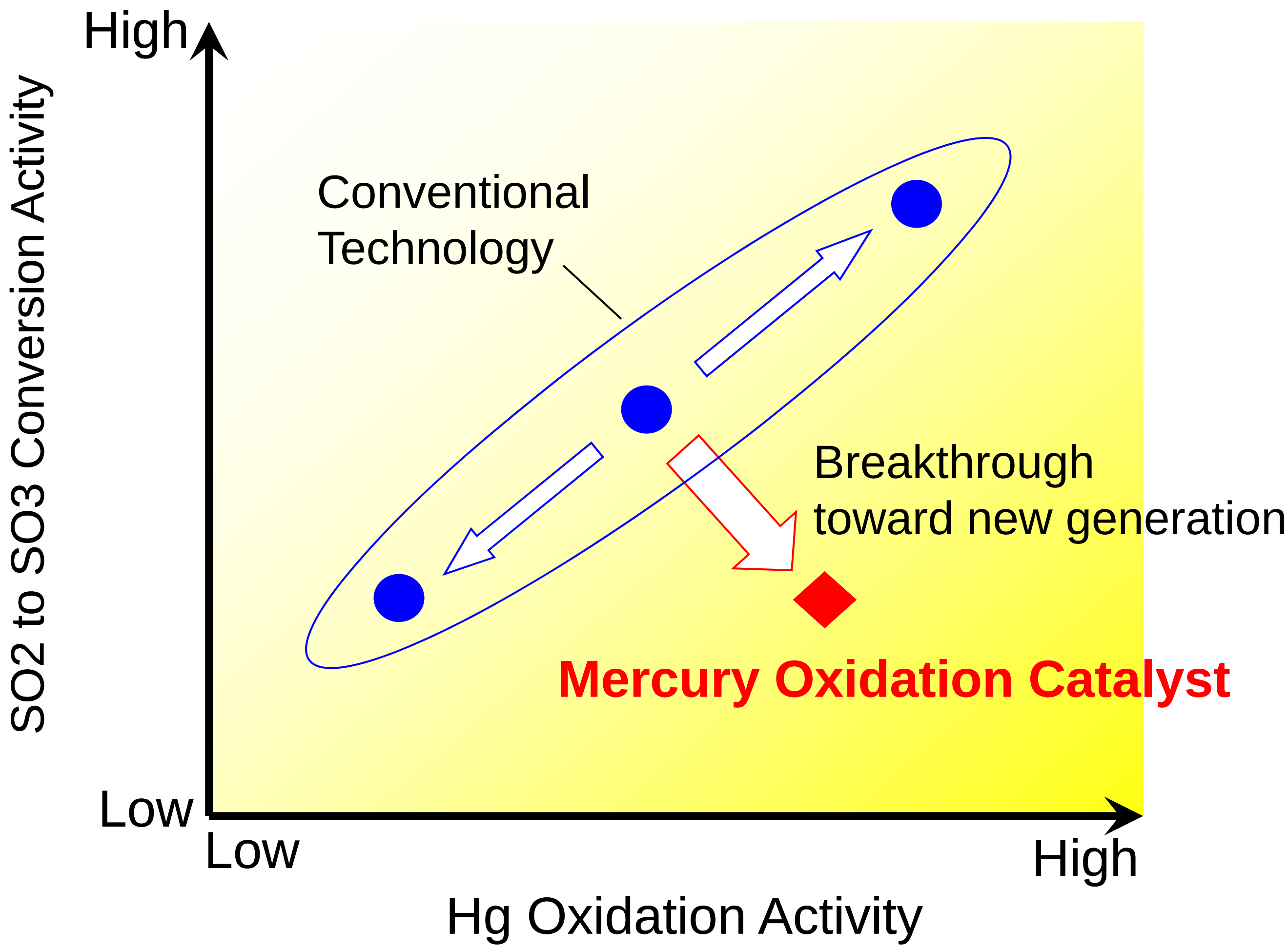
- Little or No Halogen Injection



Total Hg Removal: 95 % x 95% = 90 %

Mercury Oxidation Catalyst

Lower SO_2 conversion is required while keeping higher Hg oxidation.



TRAC® – TRiple Action Catalyst

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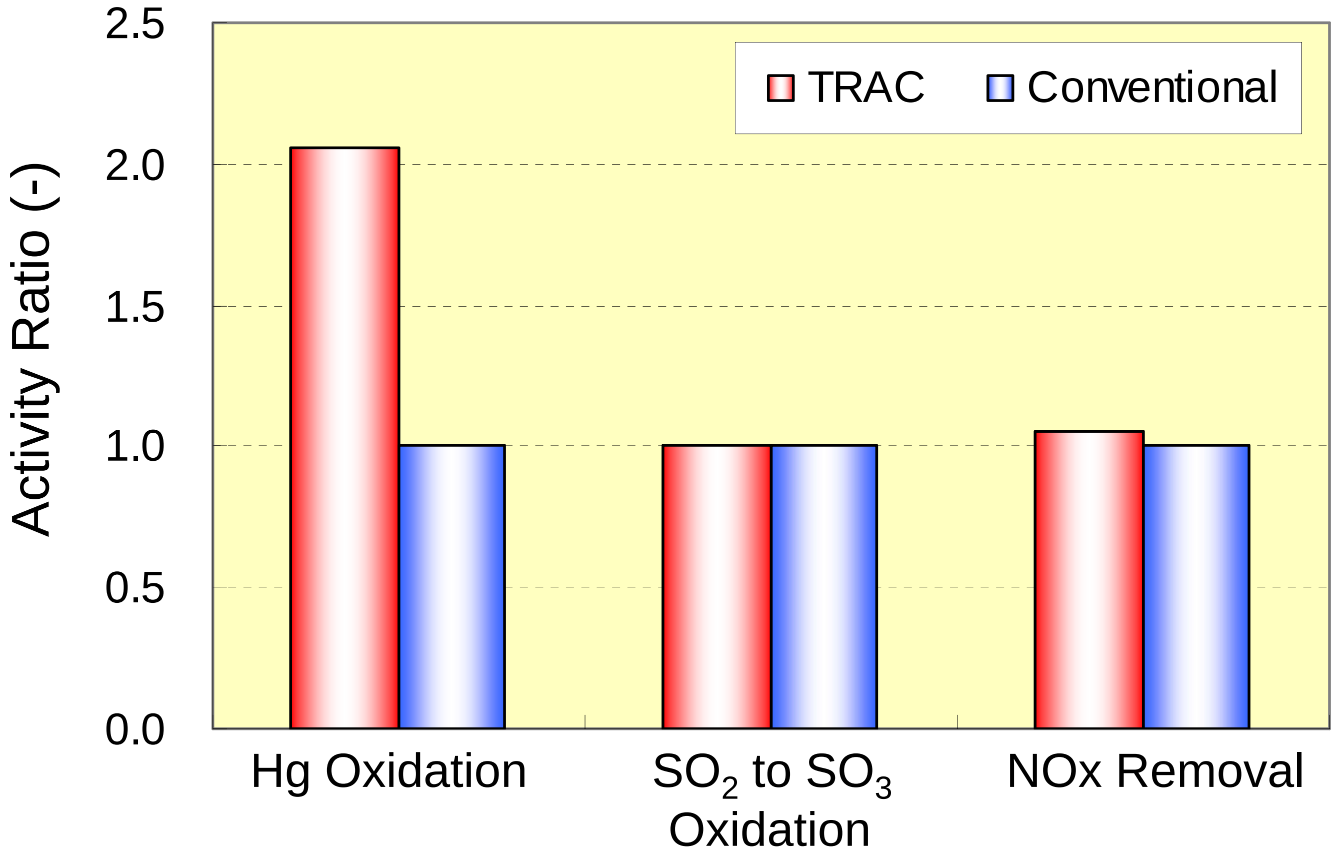
1st High Mercury Oxidation

2nd High DeNOx Performance

3rd Low SO_2 to SO_3 Oxidation



Hitachi TRAC® R&D History

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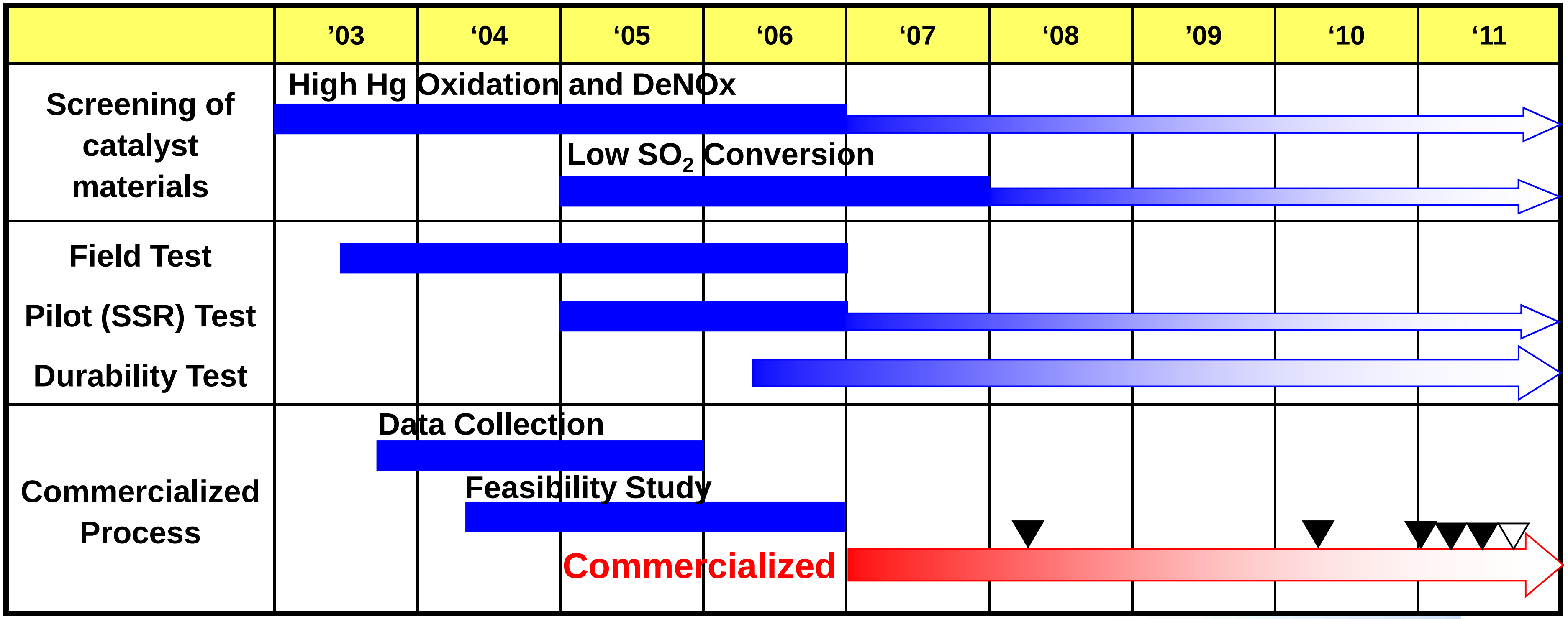
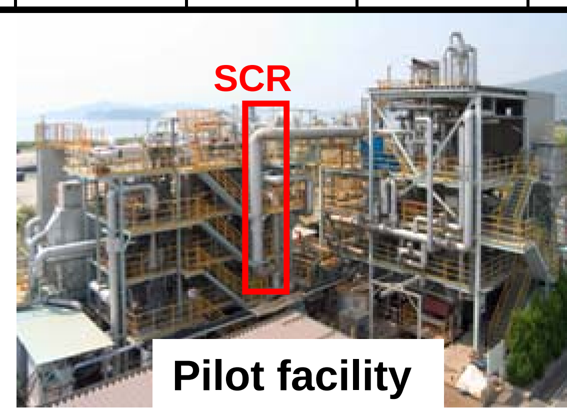



Akitsu Works



Pilot facility

Longevity Test at Mitchell Unit 1 (Bituminous)

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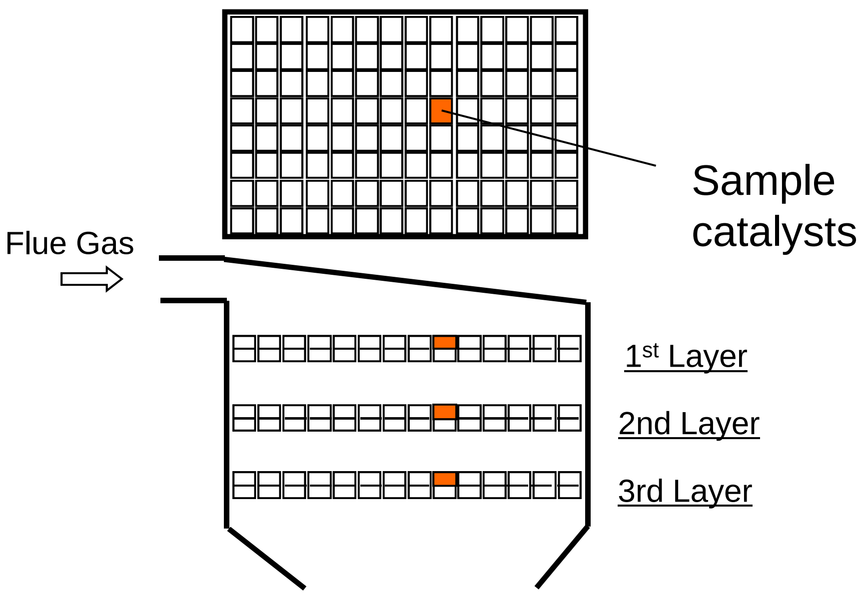
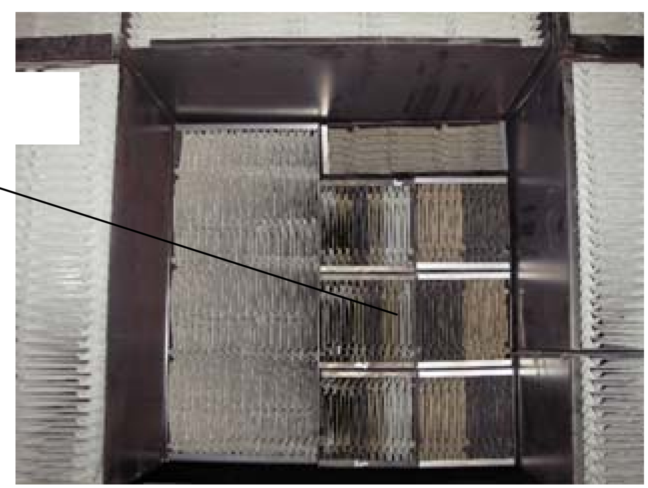
- American Electric Power
- Mitchell Unit1 (800MW)
- Coal; Eastern Bituminous
- Exposure to flue gas for over 28,000 hours
- Catalyst; TRAC® and Conventional Catalyst
- Check durability of Hg oxidation activity and NOx removal activity at BHK Lab.

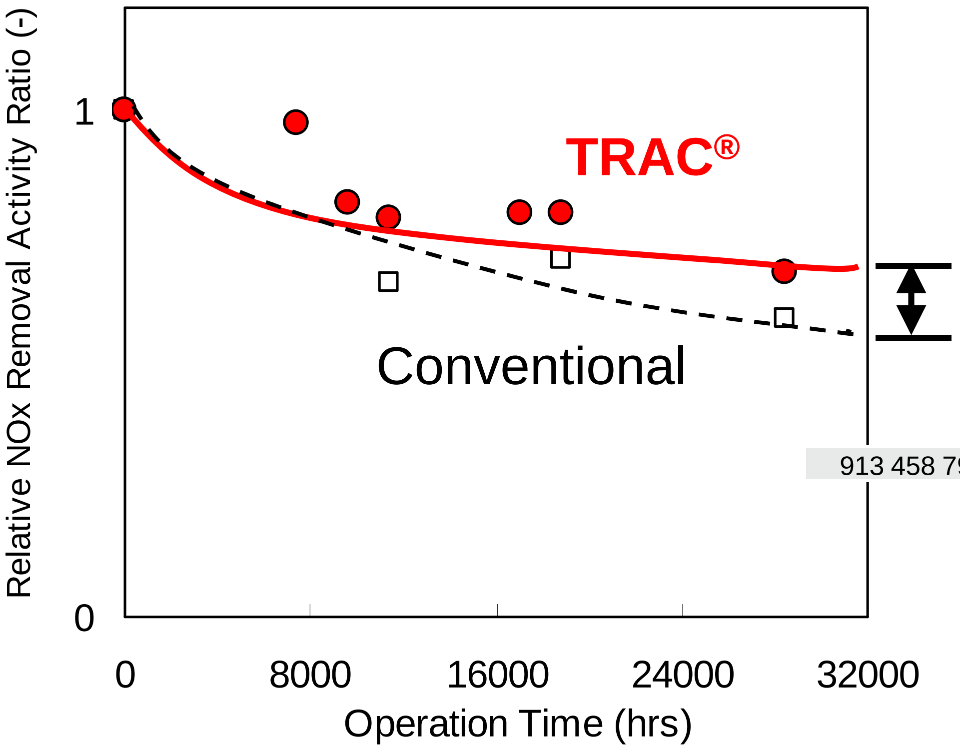
Gas Flow Rate	2,634,962 m^3N/hr
Temperature	710 F
NOx	342 ppm
SO_2	2270 ppm
HCl	90 ppm
NOx Removal	90 %
Slip NH_3	2 ppm



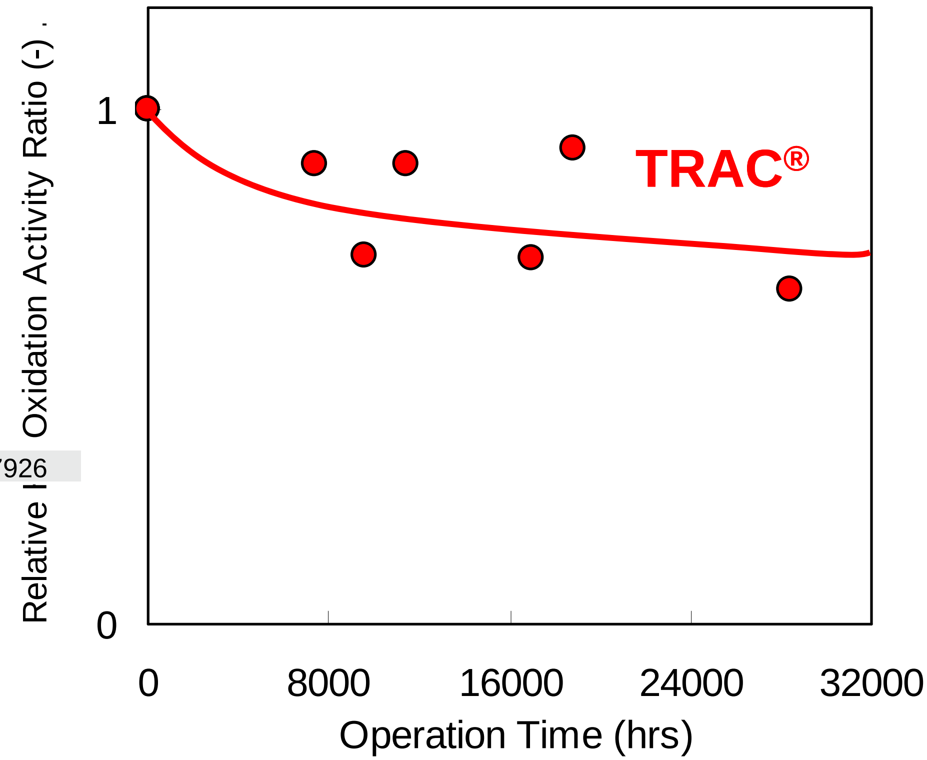


Longevity Test at Mitchell Unit1 (Bituminous)

NOx Removal



Hg Oxidation



TRAC® shows…

Higher durability of Hg oxidation as well as high durability of NOx removal.

Full Scale Test of TRAC® on PRB firing Plant

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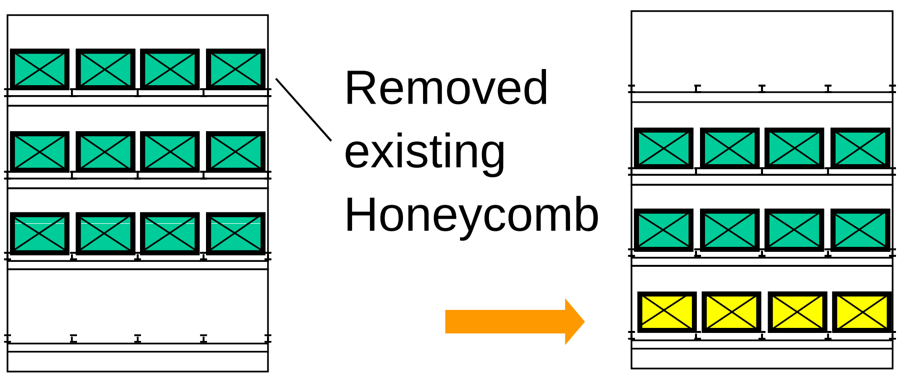
- Northern US Power Plant Unit4 (640MW)
- TRAC® Supplied in 2008 at 4th Layer
- Check durability of Hg oxidation activity and NOx removal activity at BHK Lab.

Gas Flow Rate	1,198,652 Nm^3/hr
Temperature	730 F
NOx	372 ppm
SO_2	478 ppm
HCl	**0.42 – 0.57 ppm**
NOx Removal	90 %
Slip NH_3	2 ppm

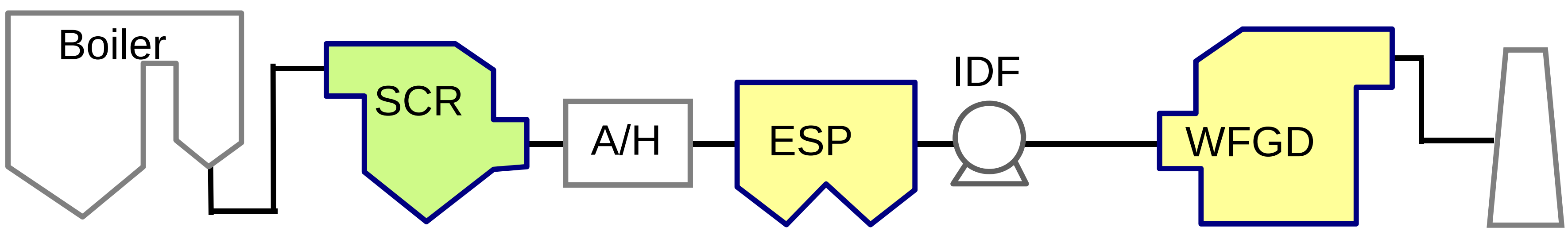
Before

After



4th layer was filled with TRAC®

35% **Hg Removal** **70%**



Longevity Test at PRB firing Plant

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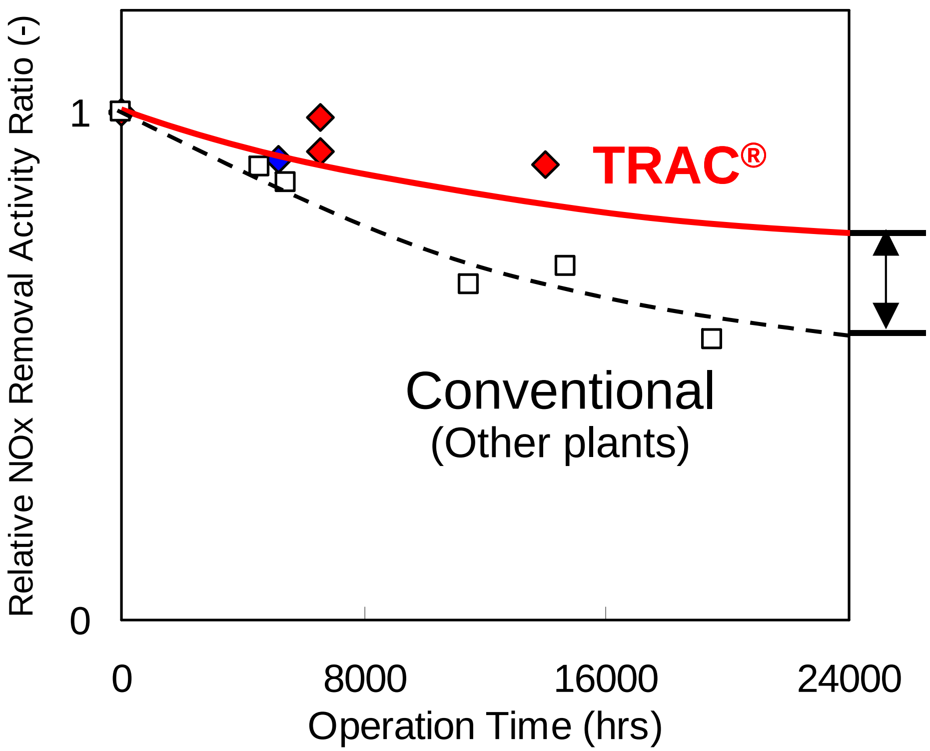
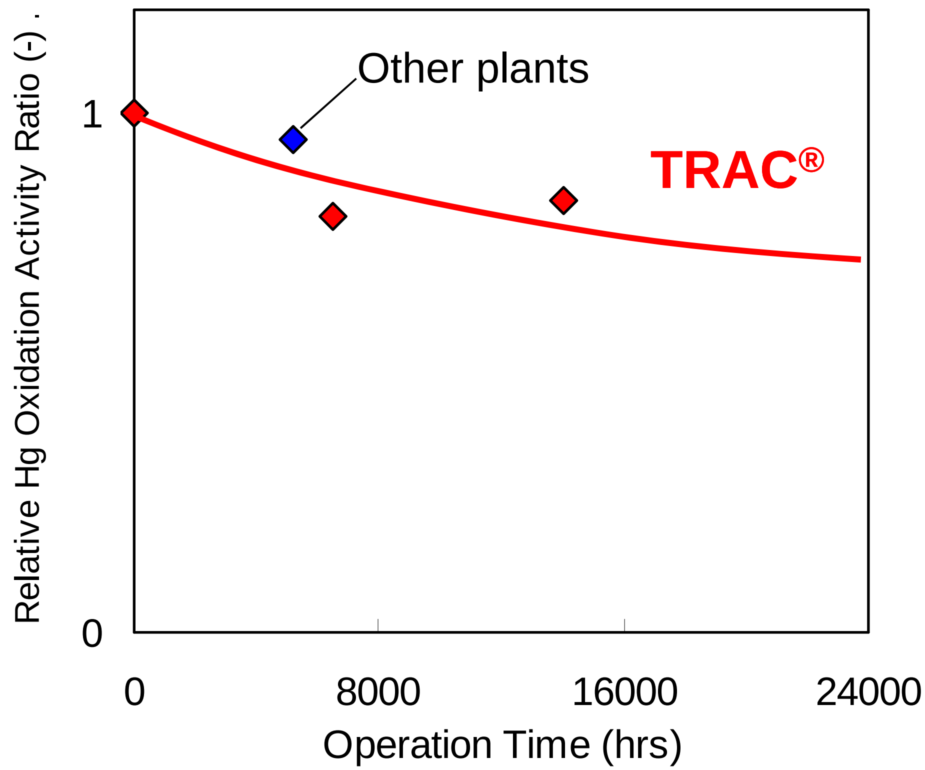
NOx Removal



Hg Oxidation



TRAC® shows…

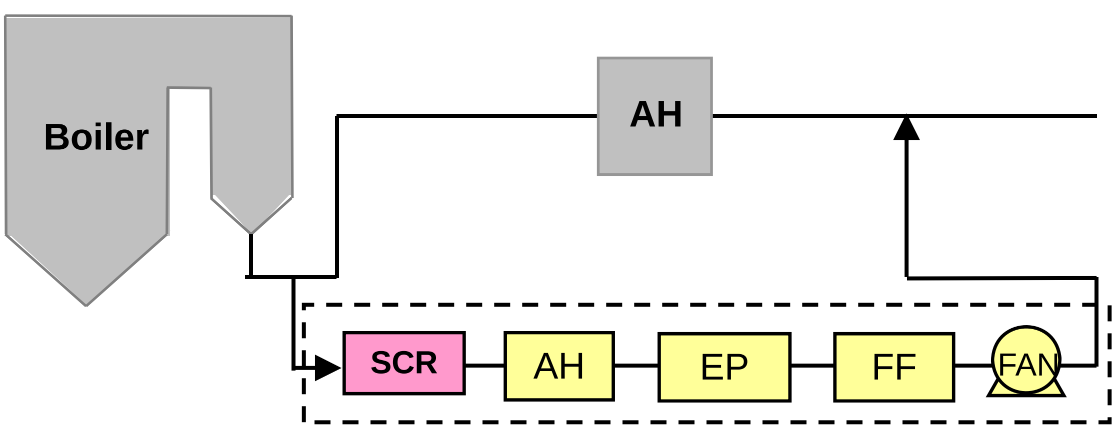
Higher Longevity of Hg oxidation as well as high Longevity of NOx removal.

Pilot Test at MRC (Bituminous)

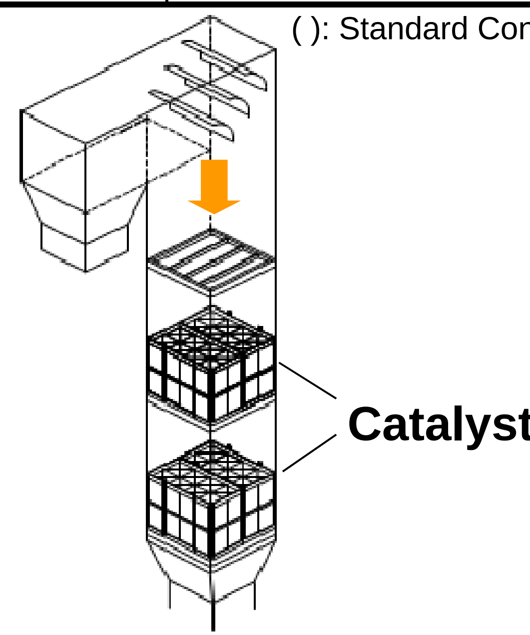
- MRC (Mercury Research Center)
- Host Unit: Gulf Power/Crist Unit5 (75MW)
- Coal; Low Sulfur Bituminous
- Slip Stream Reactor (SSR, 5MW equivalent)
  2 Layers SCR (cross section; 6.6' x 6.6')
- Parametric Testing of Hg Oxidation
  - Temperature
  - HCl
- Catalyst: TRAC® and Conventional Catalyst

Gas Flow Rate	10,705 - 17,842 m^3N/h
Temperature	626 - 752 (698) F
NOx	180 - 230 ppm
SO_2	600 - 900 ppm
HCl	110 - 350 (130) ppm
NOx Removal	90 %
Slip NH_3	2 ppm

( ): Standard Condition



Pilot Test Facility



SSR

Pilot Test at MRC (Bituminous)

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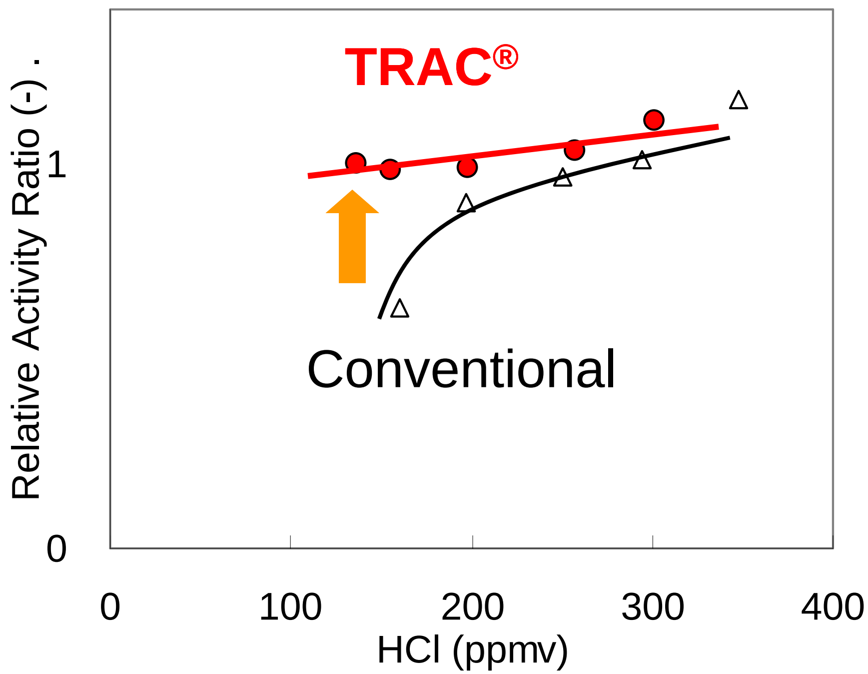
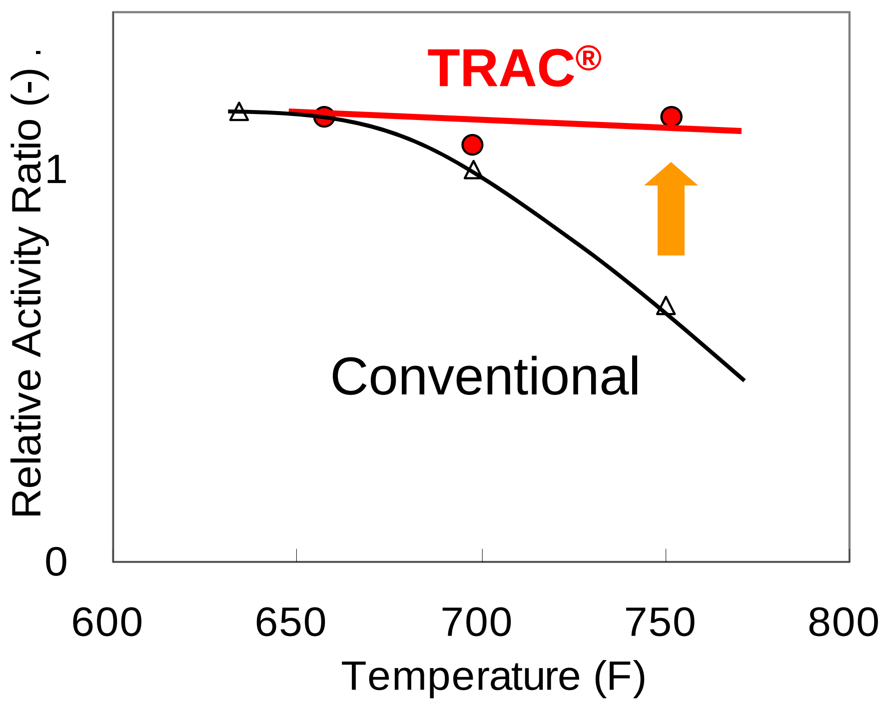
HCl Characteristics



Temperature Characteristics



TRAC® shows…

Higher Hg oxidation at lower HCl concentration

Higher Hg oxidation at higher temperature

Full-Scale Result – Plant Miller

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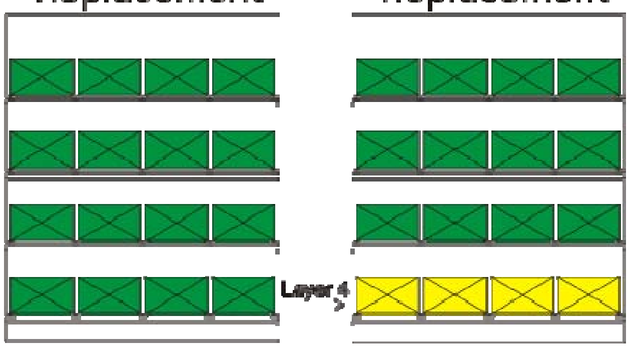
- Plant Miller Units 1 and 2 (720 MW)
- PRB Coal
- TRAC® Supplied in spring 2011

Stack Gas Flow Rate	3,397,200 m^3N/hr
Temperature	720 F
NOx	130-230 ppm
SO_2	125-325 ppm
HCl	**1-7 ppm**
NOx Removal	90 %
Slip NH_3	<2 ppm

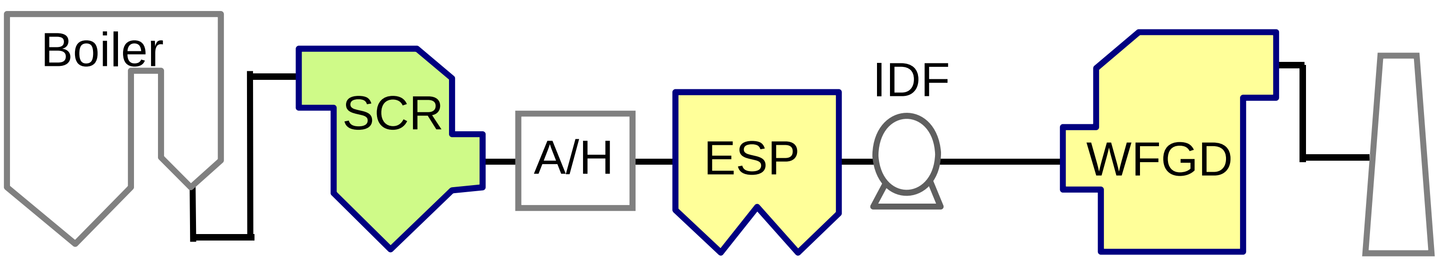
Before Catalyst Replacement

After Catalyst Replacement



Hg Removal: **30%**

Hg Removal: **60%**



Mercury SEMS Data Tree Unit Comparison

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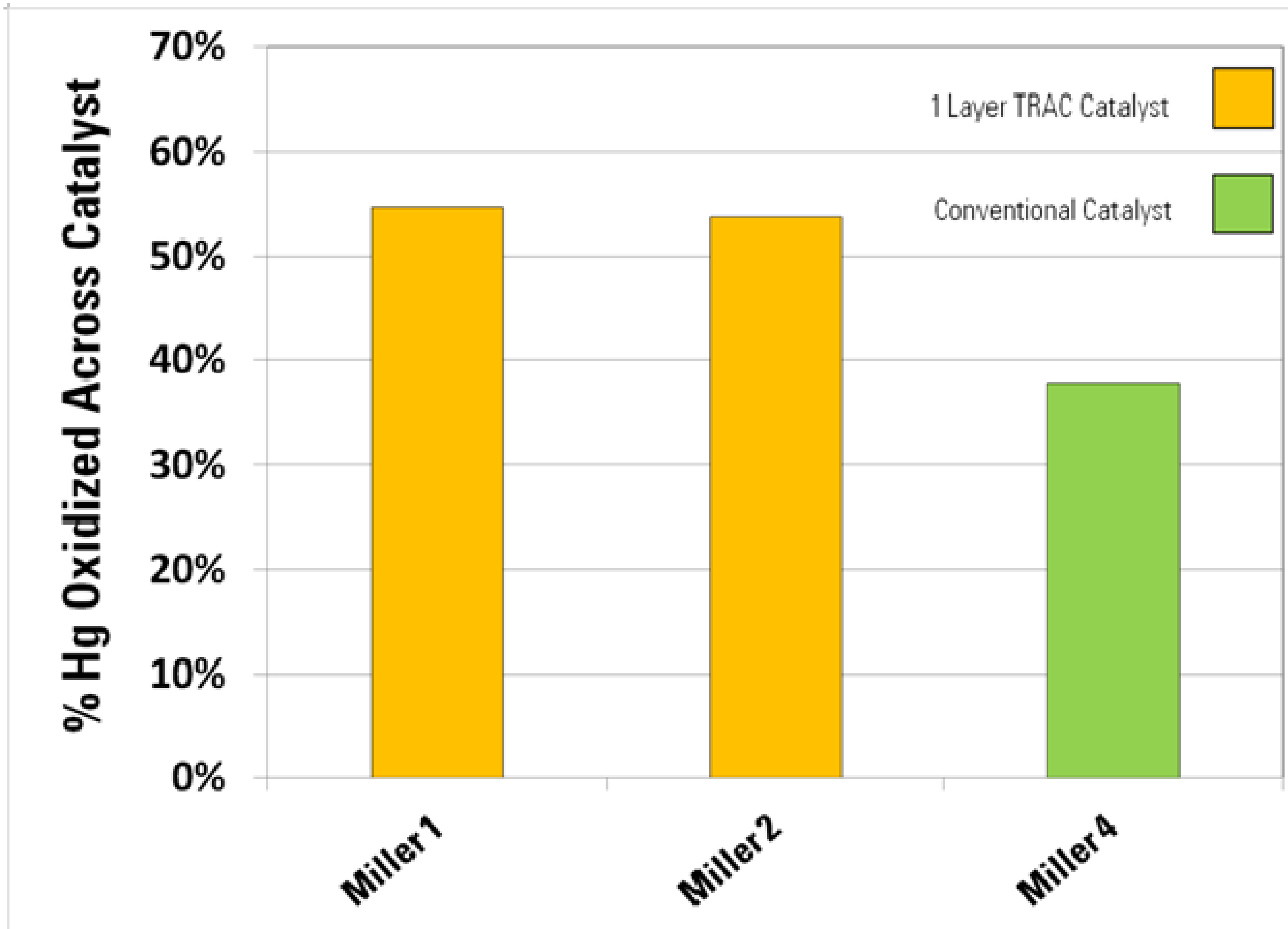

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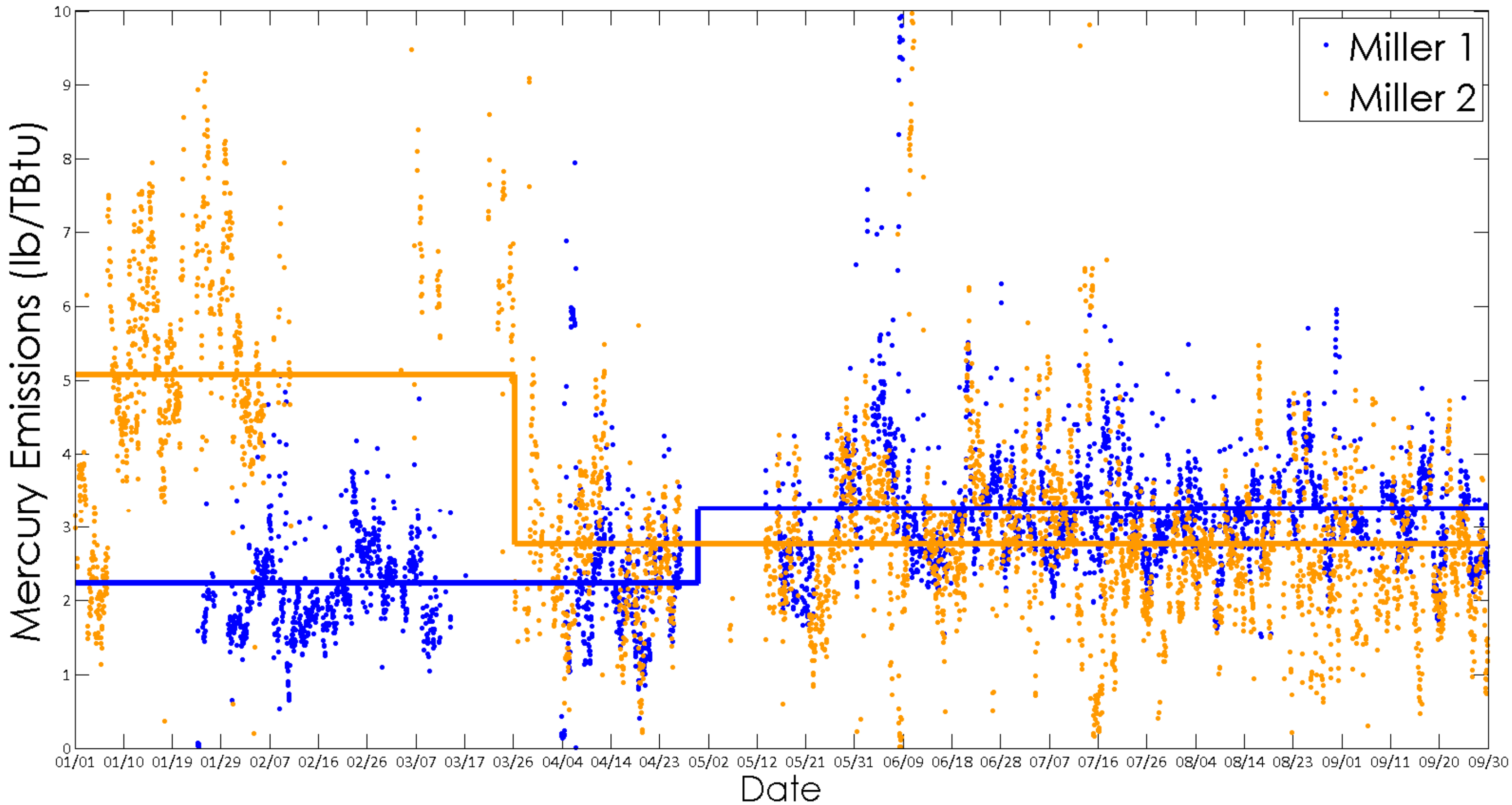
Mercury SEMS Data



Miller Unit 2 mercury emissions dropped from 5.1 lb/Tbtu to 2.8 lb/Tbtu after installing one layer of TRAC. Miller Unit 1 mercury emissions were 3.3 lb/Tbtu after installing one layer of TRAC.

TRAC® Record

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Owner	Plant	Load (MW)	Coal	Supply	Country
A	Plant A	640	PRB	2008	US
B	Plant B	550	Bituminous	2010	GR
Southern Company	Miller Unit 1	735	PRB	2011	US
Southern Company	Miller Unit 2	735	PRB	2011	US
Southern Company	Barry Unit 5	773	Bituminous	2011	US
AEP	Mountaineer Unit1	1,300	Bituminous	2011	US
Southern Company	Bowen Unit 3	950	Bituminous	2011	US
AEP	Cardinal Unit 2	600	Bituminous	2012	US

Eight Commercial Installations of TRAC® Catalyst

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Projected TRAC® Economics (Bituminous)

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Eastern Bituminous Application (with ACI)

ESP + WFGD (for 680 MW unit)	3 Layers of Conventional catalyst	2 Layers of conventional and 1 Layer of TRAC®	3 Layers of TRAC®
HG Oxidation(@ APH outlet), (%)	90	92	95
AC injection, # / MMACF	10	6	0
AC Cost / year	$7.5M	$4.5M	0
Differential Cost of TRAC / year	$0	$25,000	$75,000
Cost of using AC + TRAC over a six year period	$45M	$27.15M	$450,000

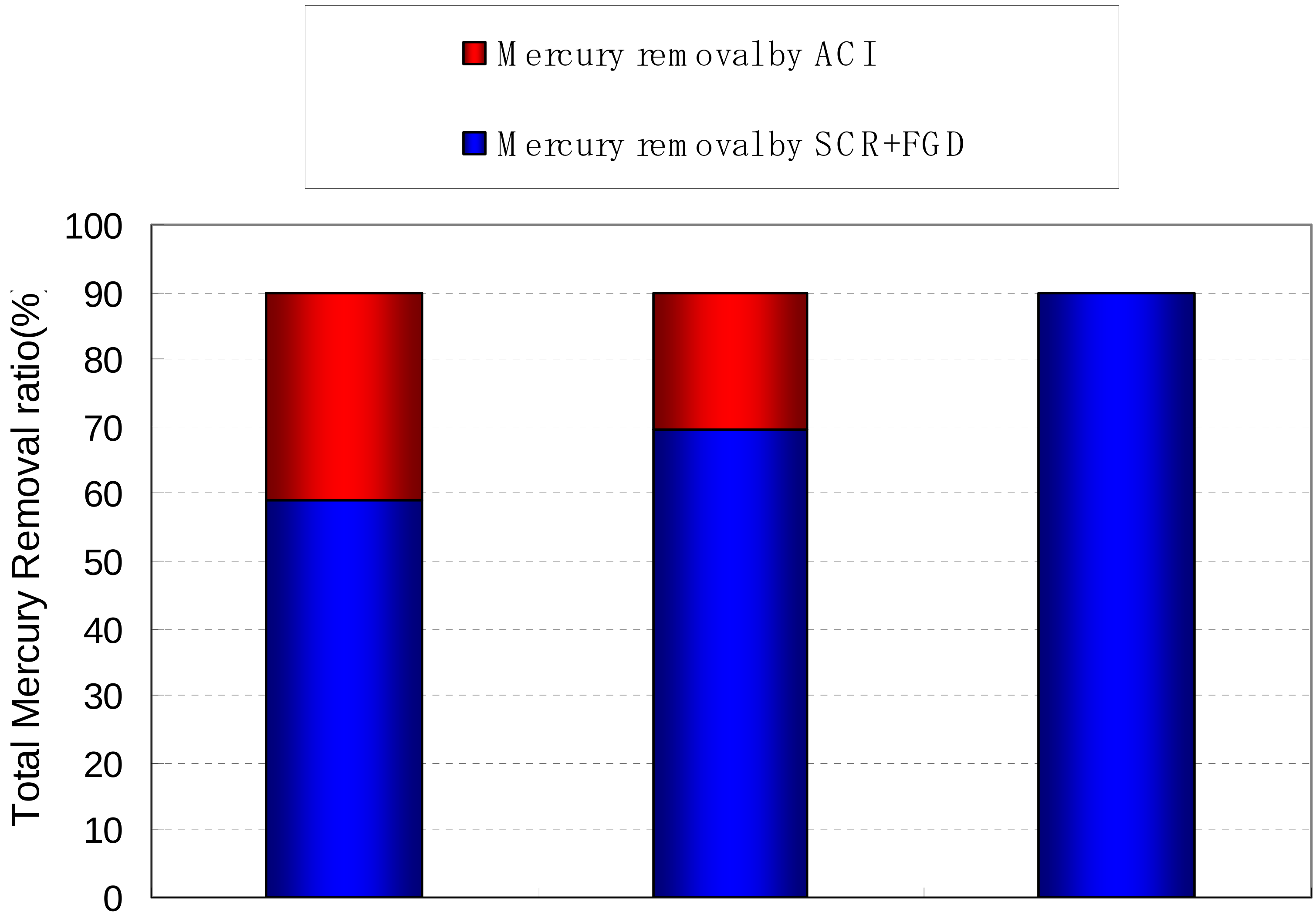
TRAC® Saves

$44,000,000

Notes: Assumes $0.75/lb for untreated AC
ACI facility initial cost is not included
Additional cost of TRAC is 10-20%

TRAC® is… **Effective to reduce operation cost by lowering or even eliminating AC injection.**

Projected TRAC® Economics (Bituminous)



Projected TRAC® Economics (PRB)

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PRB Application (with ACI)

FF + WFGD (for 680 MW unit)	3 Layers of Conventional catalyst	2 Layers of conventional and 1 Layer of TRAC®	3 Layers of TRAC®
Hg Oxidation(@ APH outlet), (%)	30	65	80
AC injection, # / MMACF	1.5	1.0	0.5
AC Cost (per year)	$1.13M	$0.75M	$0.38M
Differential Cost of TRAC / year	$0	$25,000	$75,000
Cost of using AC + TRAC over a six year period	$6.78M	$4.65M	$2.73M

TRAC® Saves

$4,000,000

Notes: Assumes $0.75/lb for untreated AC
Additional cost of TRAC is 10-20%

TRAC® is… **Effective to reduce operation cost by lowering the amount of AC injection.**

Projected TRAC® Economics (PRB)

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PRB Application (with Br Injection)

Catalyst Scenario (for 650 MW unit)	3 Layers of Conventional catalyst	2 Layers of conventional and 1 Layer of TRAC®	3 Layers of TRAC®
HG Oxidation without Br Injection (%)	41%	56%	71%
Br Required for 90% Hg Oxidation (ppm)	25 ppm	4 ppm	3 ppm
Br Cost / year ($)	$180,000	$30,000	$20,000
Differential Cost of TRAC / year ($)	$0	$25,000	$75,000
Cost of using AC + TRAC over a six year period	$1,080,000	$330,000	$570,000

Notes: Assumes $0.90/lb for 52% $CaBr_2$ solution
Additional cost of TRAC is 10-20%

TRAC® Saves

$750,000

TRAC® is… **Effective to reduce operation cost by lowering the amount of Br injection.**

Testing and Operating Summary of TRAC®

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- MRC Pilot tests indicate high Hg oxidation of TRAC® at the lower HCl concentration levels and high gas temperatures.
- Long term full-scale operation at Mitchell proves slower deactivation of TRAC® from catalyst poisons for Hg and NO_x.
- TRAC® effectively reduces operating costs by lowering the amount of AC or halogens required for both mercury control on both bituminous and PRB units.

Installation of TRAC® is a cost-effective approach to engineered co-benefit mercury control.

Summary and Conclusions

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- TRAC® and CM can be applied for all US coals
- Less than 0.15% of SO_2 / SO_3 oxidation rate per layer
- Sorbent injection for SO_3 mitigation can be reduced
- TRAC® can oxidize up to 95% of Hg. Elimination or minimization of ACI, Bromine, or other Halogen injection is achievable.
- Longer Catalyst life can be achieved by using TRAC®/CM saving millions of dollars over the life span of the SCR.

Development Continues to

Further Enhance CM and TRAC® Performance

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