Wet FGD Additive for Enhanced Mercury Control

Gary Blythe – URS Corporation

Joe Lally – Degussa Corporation

Charles Miller – U.S. DOE-NETL

Richard Rhudy – EPRI

Project Overview

- Co-funded by DOE-NETL, EPRI, Degussa Corporation, TXU Power, Southern Company, and AES
  - DE-FC26-04NT42309 “Field Testing of a Wet FGD Additive for Enhanced Mercury Control”
- Addressing Hg^0 “re-emissions” from wet FGD systems
  - Seen as FGD outlet Hg^0 concentration > inlet Hg^0
  - Chemical reduction of Hg^{+2} removed in FGD absorber
  - Limits overall Hg removal by FGD system

Project Overview (continued)

- Field tests (pilot to full scale) of Degussa's TMT-15 additive for optimizing Hg capture by wet FGD
  - Prevent or minimize Hg^0 re-emissions
  - Lower Hg in gypsum byproduct
  - Enhance stability of Hg in gypsum used for wallboard?
- Test sites:
  - TXU Monticello 3 (pilot wet FGD) – Texas Lignite/PRB
  - Southern Co. Plant Yates 1 (pilot and full-scale JBR tests) – Low S Eastern Bituminous
  - IPL Petersburg 2 (full-scale spray tower) – High S Eastern Bituminous

Degussa TMT-15

- 15 wt% aqueous solution of trimercapto-s-triazine, tri-sodium salt ($C_3N_3S_3Na_3$)
- Primarily used to precipitate divalent heavy metals from wastewaters

  $3\ Hg^{2+} + 2\ TMTNa_3 \rightarrow Hg_3TMT_2 + 6\ Na^+$

- Currently used in 100's of incineration plants worldwide to precipitate Hg from wastewaters, and in 10's of wet scrubbers to precipitate Hg before re-emissions reactions can occur

Hg-TMT Properties

- Low toxicity
- No special PPE for handling other than gloves, goggles or glasses with close-fitting side shields
- Not considered hazardous for transportation
- The Hg-TMT precipitate is stable at low pH and high temperature
  - Unlikely to release H_2S at low pH like other sulfides
  - Less likely to release Hg during wallboard production?

Testing Completed to Date

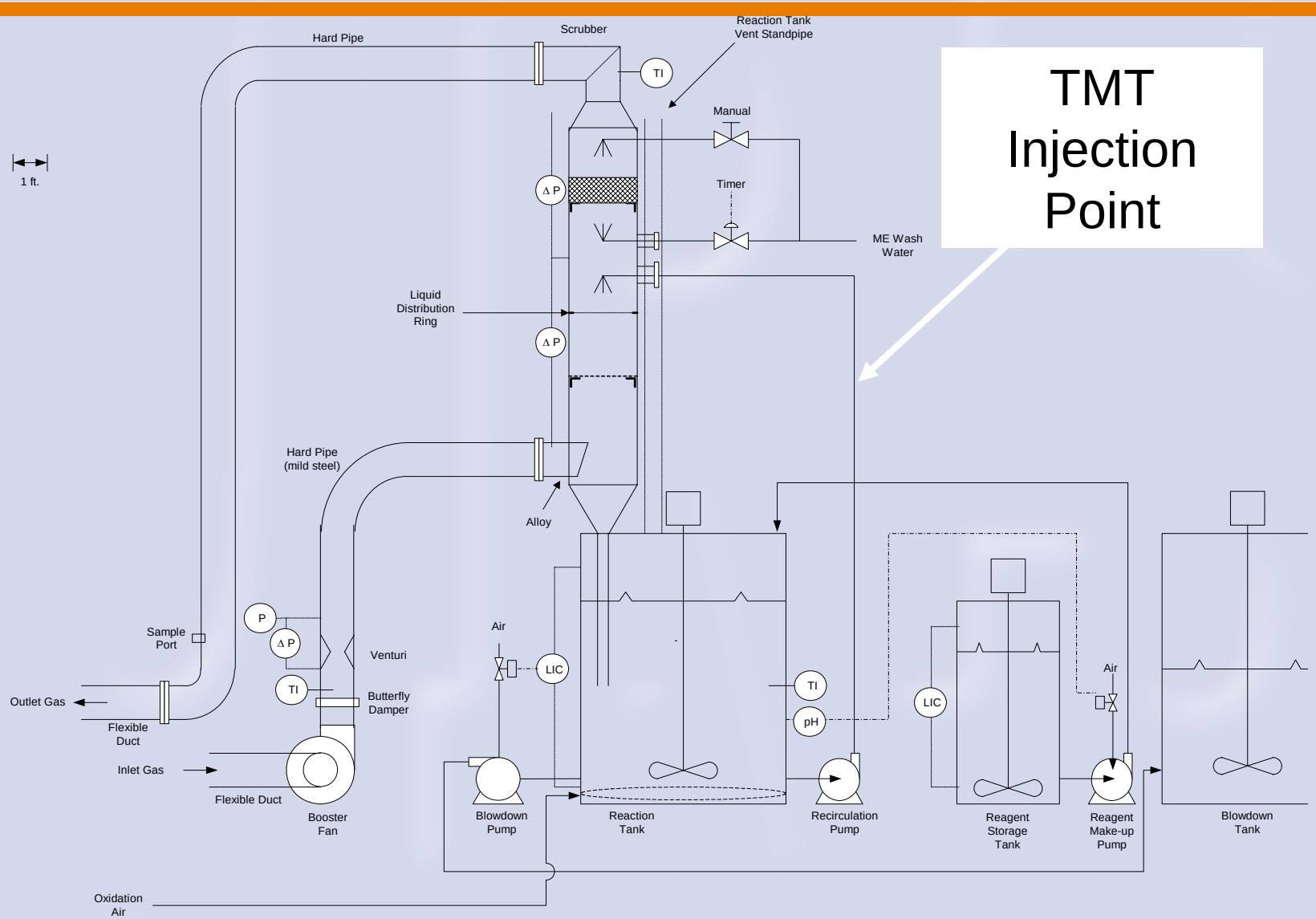
- Two weeks of testing on Monticello pilot wet FGD (limestone forced oxidation)
  - First week was screening for TMT dosage effects
  - Second week included steady-state TMT injection at selected dosage rate
    - Hydrocyclone was added to pilot FGD to allow separation of Hg-rich fines from gypsum byproduct
- One-week TMT screening effort on Yates pilot JBR (limestone forced oxidation) to screen for TMT dosage effects

Testing Completed to Date (continued)

- Two-week full-scale TMT test at IPL Petersburg 2 in July 2006
- This presentation will focus on:
  - Monticello pilot steady-state TMT effect test results
    - Also have some results from pilot TMT test downstream of Hg oxidation catalyst at PRB site
  - Petersburg full-scale TMT test results

FGD Pilot Unit at Monticello Station

FGD Pilot Unit



Review of Results of Parametric Tests at Monticello

- No apparent effect of TMT on Hg removal across FGD
  - No effect expected since re-emissions not seen at baseline
- Saw decrease in FGD liquor Hg conc. with TMT
  - No apparent TMT dosage effect
- Gravity separated gypsum from fines in the lab:
  - Moderate decrease in gypsum Hg conc. with TMT
  - Hg concentration in fines much higher than in gypsum
  - Determined need for field dewatering to measure ability to separate fine, high-Hg salts from gypsum

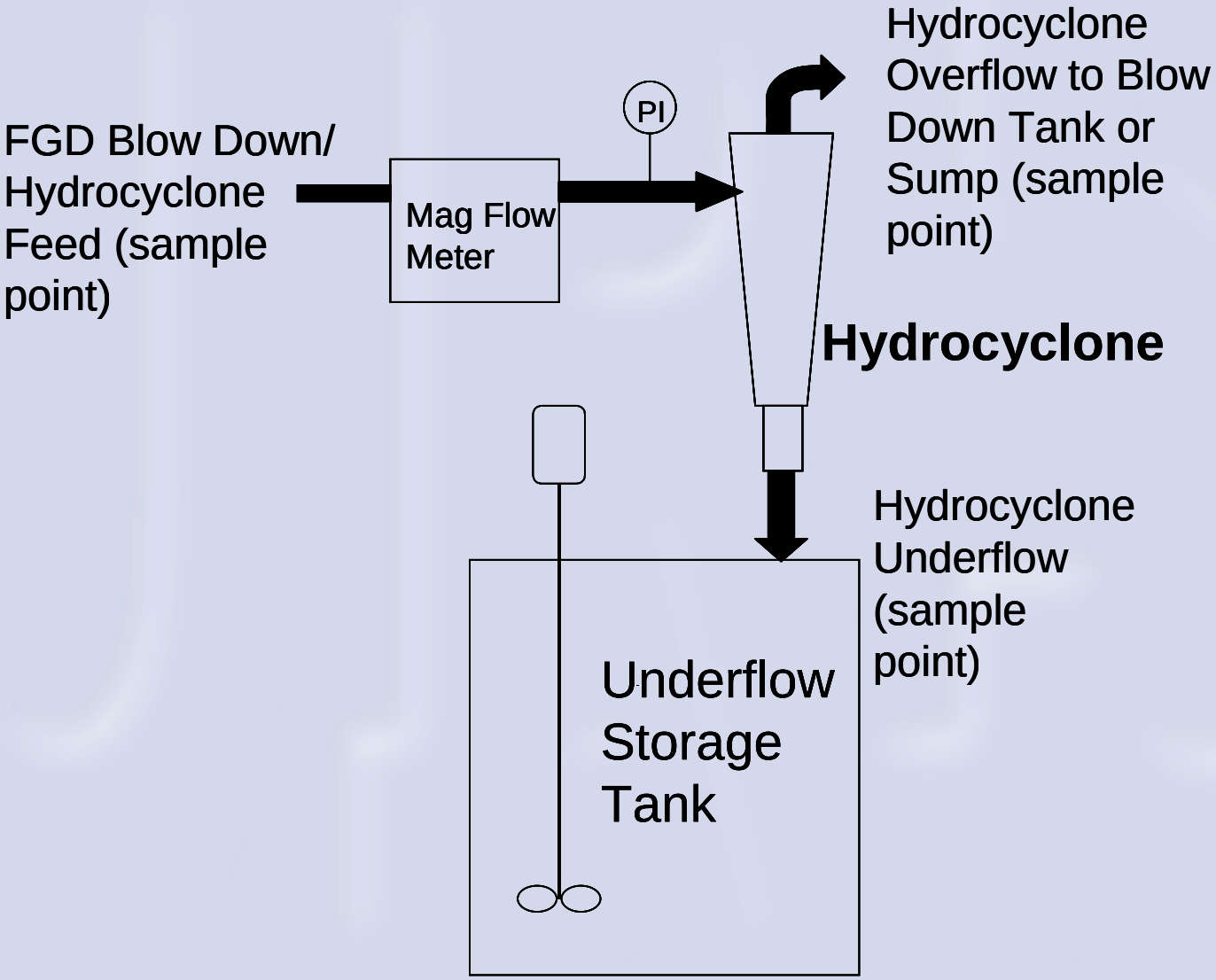
Monticello Steady-state TMT Test

- Test was conducted downstream of gold Hg oxidation catalyst
  - Had seen re-emissions during previous pilot tests on Project DE-FC26-04NT41992
- Used pilot-scale dewatering equipment to separate gypsum from Hg-rich fines
- Data collected included:
  - Hg removal across FGD (Ontario Hydro)
  - Hg in FGD byproducts
  - FGD byproduct particle size distribution data

OH Data for Monticello Pilot Steady State TMT Test Downstream of Au Catalyst

	Baseline (No TMT) – April 05	TMT-15 @ 20 mL/ton coal – Sept 05
Hg oxidation in FGD inlet gas, %	96 ± 1	67 ± 2
Total Hg removal across FGD, %	76 ± 4	61 ± 7
Hg^0 re-emission, increase across FGD, μg/Nm^3	2.1 ± 0.8	0.5 ± 0.6
Hg^0 re-emission, % of FGD inlet Hg^{+2}	7.5 ± 2.7	7.5 ± 8.4

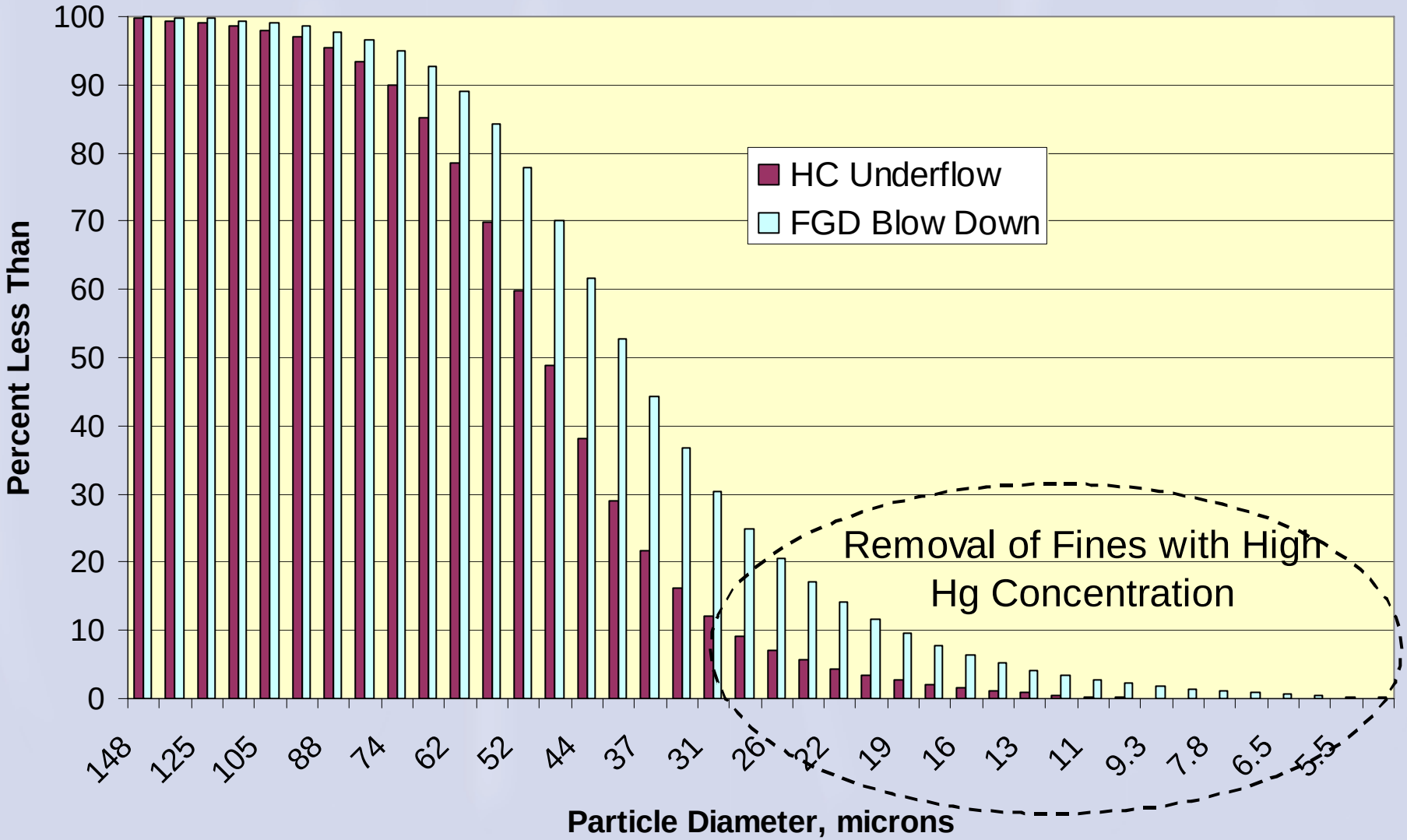
EPRI Pilot FGD Primary Dewatering Equipment



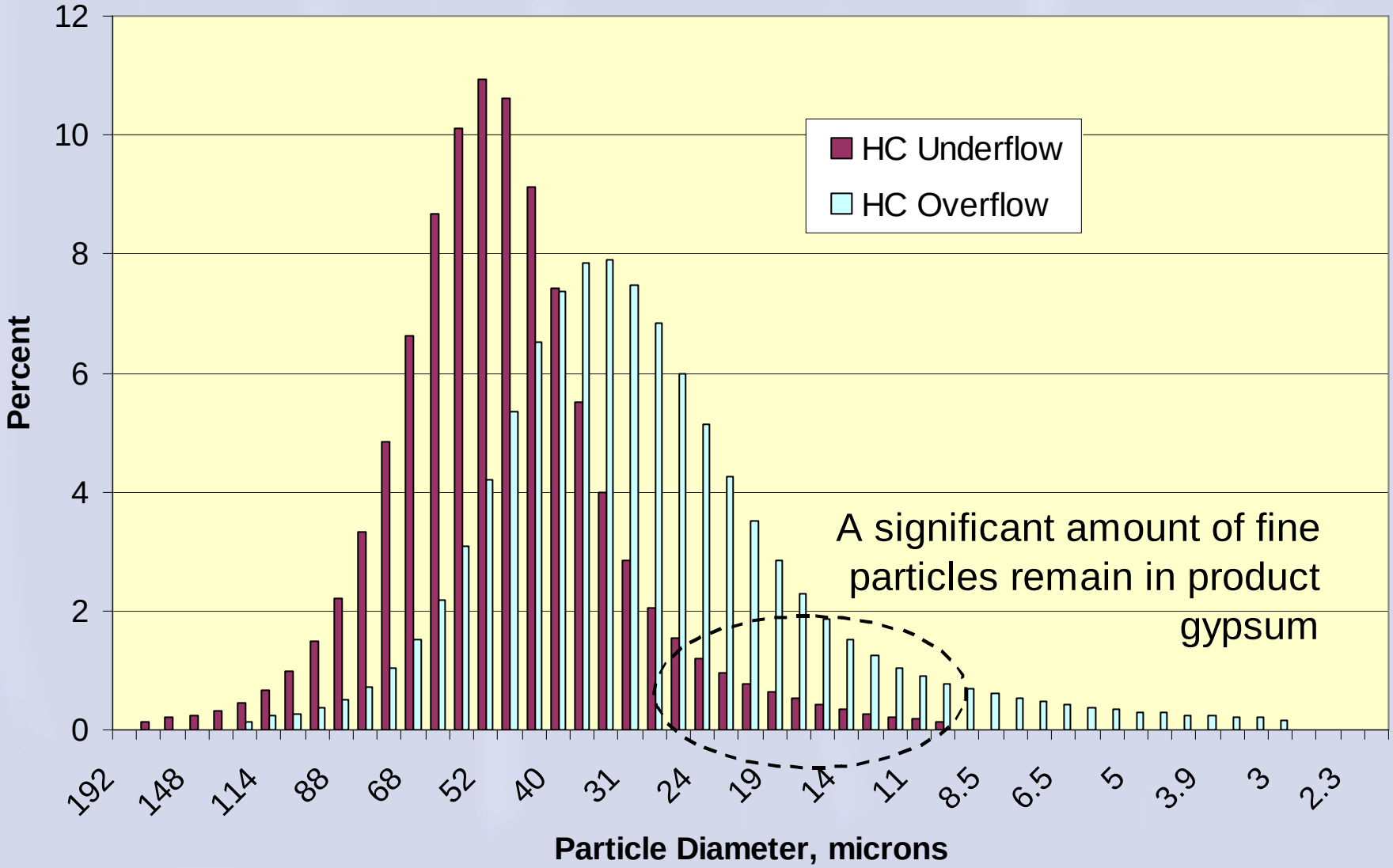
FGD Byproduct Hg Data for Monticello Pilot Steady State TMT Test

	Baseline (No TMT) – April 05	TMT-15 @ 20 mL/ton coal – Sept 05
Hg in FGD Liquor, μg/L	32	2.8
Hg in FGD Blow Down Slurry Solids, μg/g	1.4	1.9
% of Hg found in FGD Blow Down Liquor	13	1
Hydroclone Overflow Solids (Fines) Hg, μg/g	1.5	1.9
Hydroclone Underflow Solids (Gypsum) Hg, μg/g	0.6	0.5

Effect of Hydroclones in Lowering FGD Blow Down Hg Content



Limitations of Hydroclones in Lowering Blow Down Hg Content



Pilot Wet FGD Results (SRP Coronado, PRB coal, 15 ft/sec Au Catalyst)

FGD Operating Mode	SO_2 Removal, %	Total Hg Oxidation at FGD Inlet	Total Hg Removal, %	Hg^{+2} Removal, %	Hg^0 Re-emissions, % of FGD Inlet Hg^{+2}
LS Natural Oxidation	93	88	**81**	96	4
LS Natural Oxidation with TMT Addition @ 40 mL/ton coal	94	89	**87**	97	0

- Observed 4% increase in overall Hg removal equates to ~$37,000/lb of additional Hg removed, based on TMT cost

IPL Petersburg Unit 2

- 419-MW tangential-fired unit, high sulfur Indiana bituminous coal
- Emission controls include SCR, cold-side ESP, limestone forced oxidation wet FGD system (open spray absorber)
- Produces wallboard-grade gypsum as FGD byproduct

IPL Petersburg Unit 2 Test Program

- Baseline evaluation of Hg removal across wet FGD (Ontario Hydro), Hg partitioning in FGD liquor and solid byproducts
- Parametric evaluation of TMT-15 dosage (10-40 mL/ton of coal)
  - Added to reaction tank rather than directly to slurry feed to absorber
- 8-day steady-state TMT addition test at 40 mL/ton of coal TMT dosage
  - Ontario Hydro evaluation of Hg removal across FGD
  - Measure Hg partitioning in FGD byproducts

Petersburg Ontario Hydro Results

	Baseline		w/TMT@ 40 mL/ton coal	
	7/12-13/2006		7/20/2006	
	FGD Inlet	Stack	FGD Inlet	Stack
Hg^0, μg/Nm³	2.2	5.7	1.9	4.8
Hg^{+2}, μg/Nm³	6.9	0.38	7.6	1.1
Total Hg, μg/Nm³	9.2	6.1	9.5	5.8
Hg^{+2} Removal, %	-	95%	-	86%
Hg^0 re-emissions, μg/Nm³	-	3.5	-	2.9
Hg^0 re-emissions, % of inlet Hg^{+2}	-	**50%**	-	**38%**
Overall Hg Removal, %	-	**34%**	-	**39%**

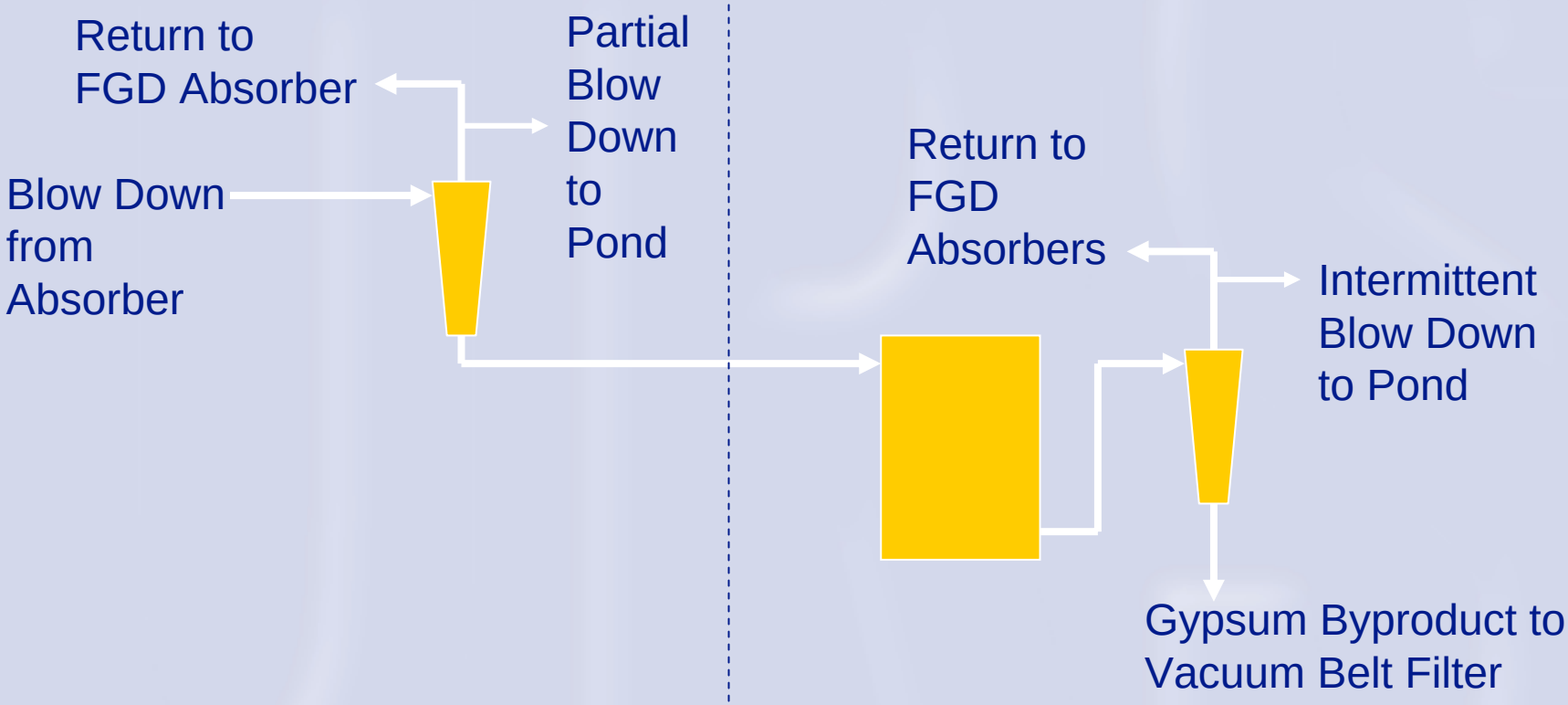
- Observed 5% increase in overall Hg removal equates to ~$25,000/lb of additional Hg removed based on TMT cost

Petersburg – Effect of TMT on Hg in FGD Liquor

	Baseline (μg/L)	W/TMT @ 40 mL/ton coal (μg/L)
Date	7/12/2006	7/20/2006
Absorber	63	60

Expected effect of lower Hg in liquor not seen with TMT addition!

Petersburg 2 Dewatering Scheme



Petersburg – Effect of TMT on Hg in FGD Byproduct Solids

	Baseline (μg/g)	W/TMT @ 40 mL/ton coal (μg/g)
Date	7/12/2006	7/20/2006
Absorber	0.41	0.33
Primary HC OF	0.95	0.74
Primary HC UF	0.13	0.12
Secondary HC Feed	0.19	0.13
Secondary HC OF	3.8	3.7
Secondary HC UF	0.14	0.13
Gypsum Byproduct	0.13	0.12

No TMT effect seen on Hg in solids!

Petersburg – Effect of TMT on Metals in FGD Absorber Liquor

	Baseline (μg/g)	W/TMT @ 40 mL/ton coal (μg/g)
Date	7/12/2006	7/20/2006
Ag	1.2	0.82
Cd	18	36
Cu	75	57
Pd	1.8	4.1
Zn	94	191

Again, no consistent effect of TMT addition seen for these metals

Summary

- Pilot-scale test results:
  - Inconclusive about effectiveness of TMT in controlling Hg^0 re-emissions
  - Show expected effects of TMT in FGD byproducts
    - Greatly reduced Hg in FGD liquor
    - Most of the Hg reports to fines in FGD solids
    - Hydroclones can remove majority, but not all of fines
- Full-scale results:
  - Modest decrease in re-emissions across absorber
  - Do not show expected effects of TMT addition in byproducts
    - No reduction in Hg in FGD liquor
    - No evidence of Hg concentration in fines in FGD solids

Future Project Plans

- Continue analysis and interpretation of IPL full-scale results
  - Possible laboratory investigation of TMT effectiveness on Petersburg FGD liquors
- Full-scale JBR steady state test planned for Plant Yates
  - Timing subject to completing review and interpretation of IPL full-scale results