Mercury Oxidation Catalysts for Enhanced Control by Wet FGD

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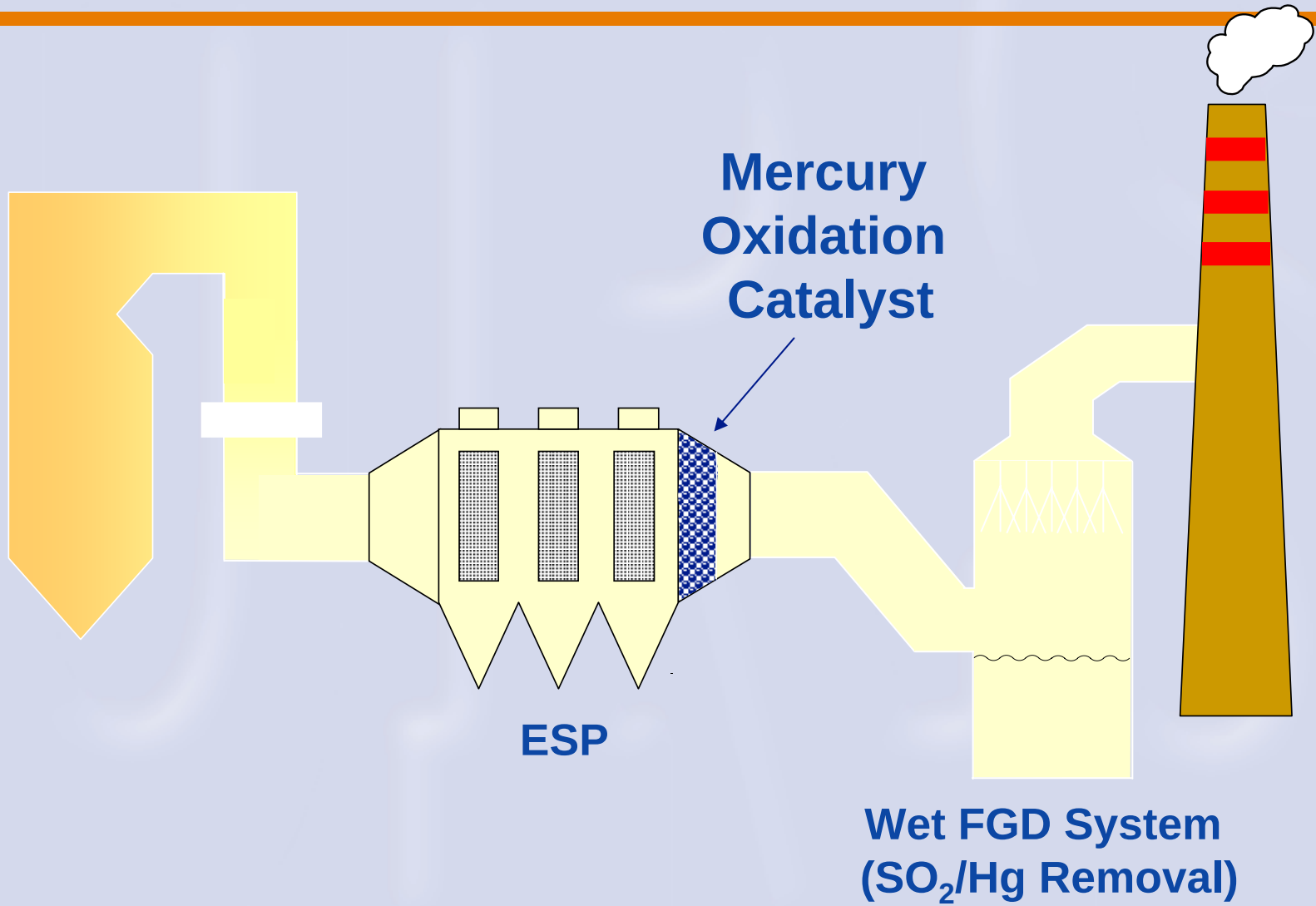
Illustration of Process Concept



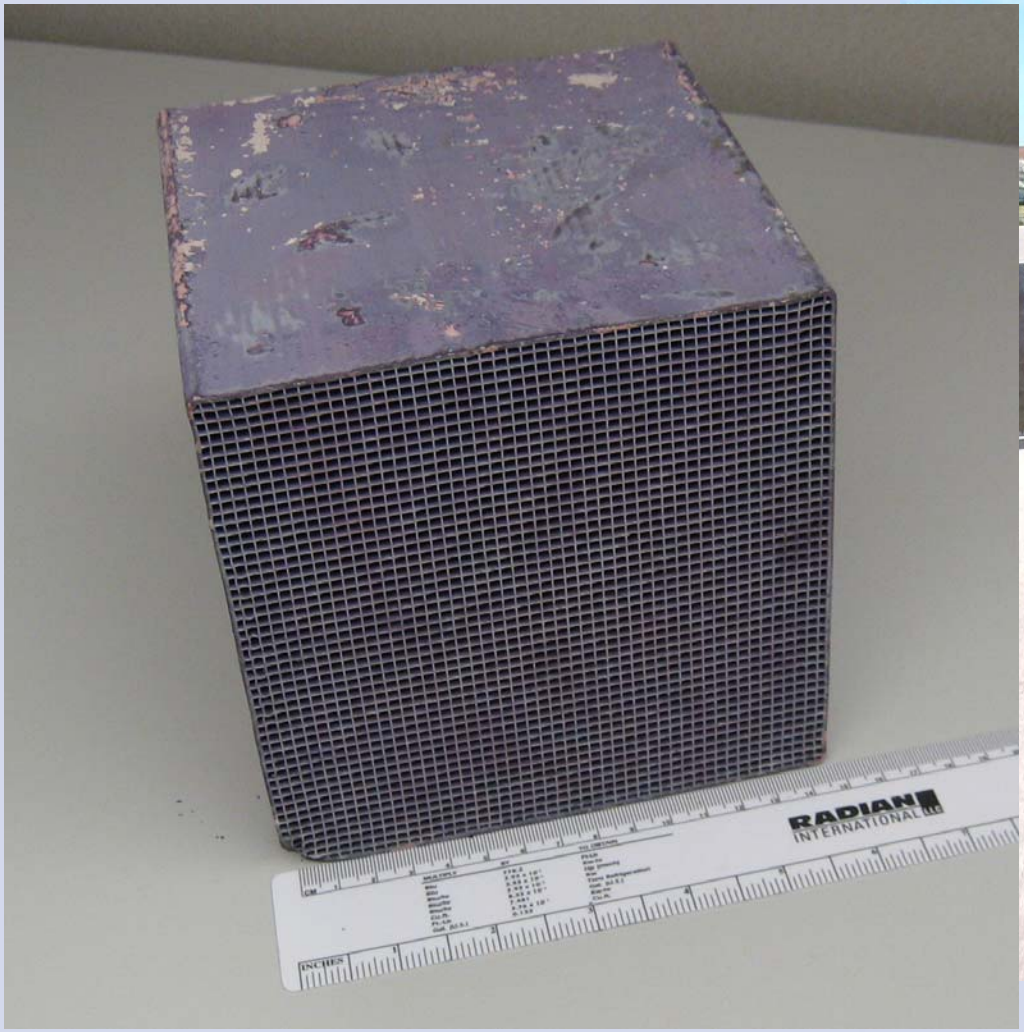
Today's Presentation

- Present and discuss results from pilot scale testing of mercury oxidation catalysts
- Describe full-scale (200 MW) demonstration to begin Spring 2008

Background

- DOE/EPRI project (DE-FC26-04NT41992) conducting pilot-scale tests of low-temp Hg^0 oxidation catalysts at three sites
  - 2 to 4 catalysts tested in parallel (~2000 acfm each)
  - 12-20 months automated operation at each site
  - ~Bimonthly catalyst activity measurements
- Pilot wet FGD (~2000 acfm – one catalyst's flow) used to measure ability to scrub catalytically oxidized Hg

Example Catalysts



Previous Project - Test Locations

- GRE's Coal Creek (ND lignite, ESP/wet FGD)
  - Pilot unit started up October 02
  - Long-term test completed June 04
- CPS' Spruce (PRB, FF/wet FGD)
  - First 2 catalysts started up August 03
  - Long-term test completed April 05

Summary from CCS Results

- Sonic horns required to prevent fly ash buildup
- Pd catalyst achieved 95% Hg^0 oxidation initially, 60-70% after 20+ months
- Pd catalyst restored to ~90% oxidation after regeneration with 600^{o}F air
- Wet FGD pilot tests showed removal of oxidized Hg across wet scrubber limited only by re-emissions (79% overall Hg removal in LSFO mode with FGD inlet Hg 84% oxidized)
- Preliminary economics showed catalytic oxidation most cost effective relative to ACI when plant sells fly ash and when catalyst can be regenerated

Summary from Spruce Results

- Sonic horns not required downstream of fabric filter (FF)
- High Hg % oxidation downstream of FF made it difficult to evaluate catalysts
- Wet FGD pilot tests showed up to 93% Hg removal when operating downstream of catalysts (FGD inlet Hg 96% oxidized)
- Preliminary economics showed catalytic oxidation not cost effective relative to ACI for PRB plant with FF

Test Locations - Current Project

- Luminant Power's Monticello Station (TX lignite/PRB, ESP, LSFO wet FGD)
  - Began January 05
  - Long-term test ended August 06
- Southern Company's Plant Yates (low S Eastern bit., ESP, CT-121 wet FGD)
  - Began December 05
  - Operated into mid-2007
  - 2007 operation limited due to host unit outages, conflicting SO_3 injection tests

Current Project (continued)

- SRP's Coronado Station (PRB, hot side ESP, fly ash sales, horizontal LS wet FGD)
  - Funded by SRP/EPRI
  - New 2-chamber catalyst pilot unit
  - Began operation March 06
  - Operated through June 07
- This presentation will focus on Monticello and Coronado results

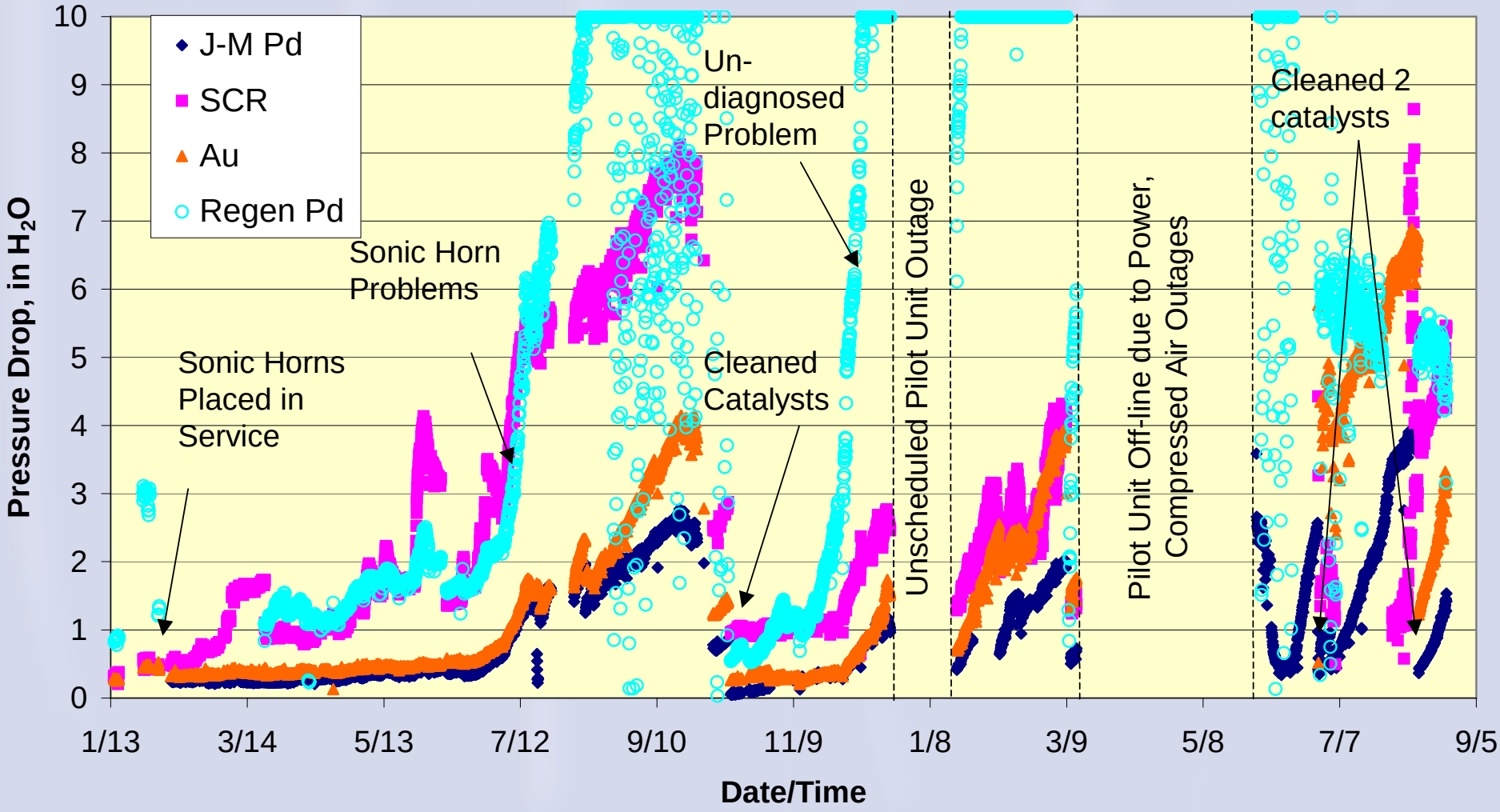
Monticello Pilot Unit (moved from CCS)

Catalyst	Cells per Sq. In. (cpsi)	Cross Section (in. x in.)	Catalyst Depth (in.)	Area Velocity (sft/hr)
Gold (Sud-Chemie Prototech)	64	29.5 x 29.5	9 (3 x 3)	50
Pd #1 (Johnson Matthey)	64	29.5 x 29.5	9	50
Pd #1 (**regenerated from CCS**)	64	29.5 x 29.5	9 (3 x 3)	50
SCR (Cormetech/MHI)	58	35.4 x 36.2	29.5	12

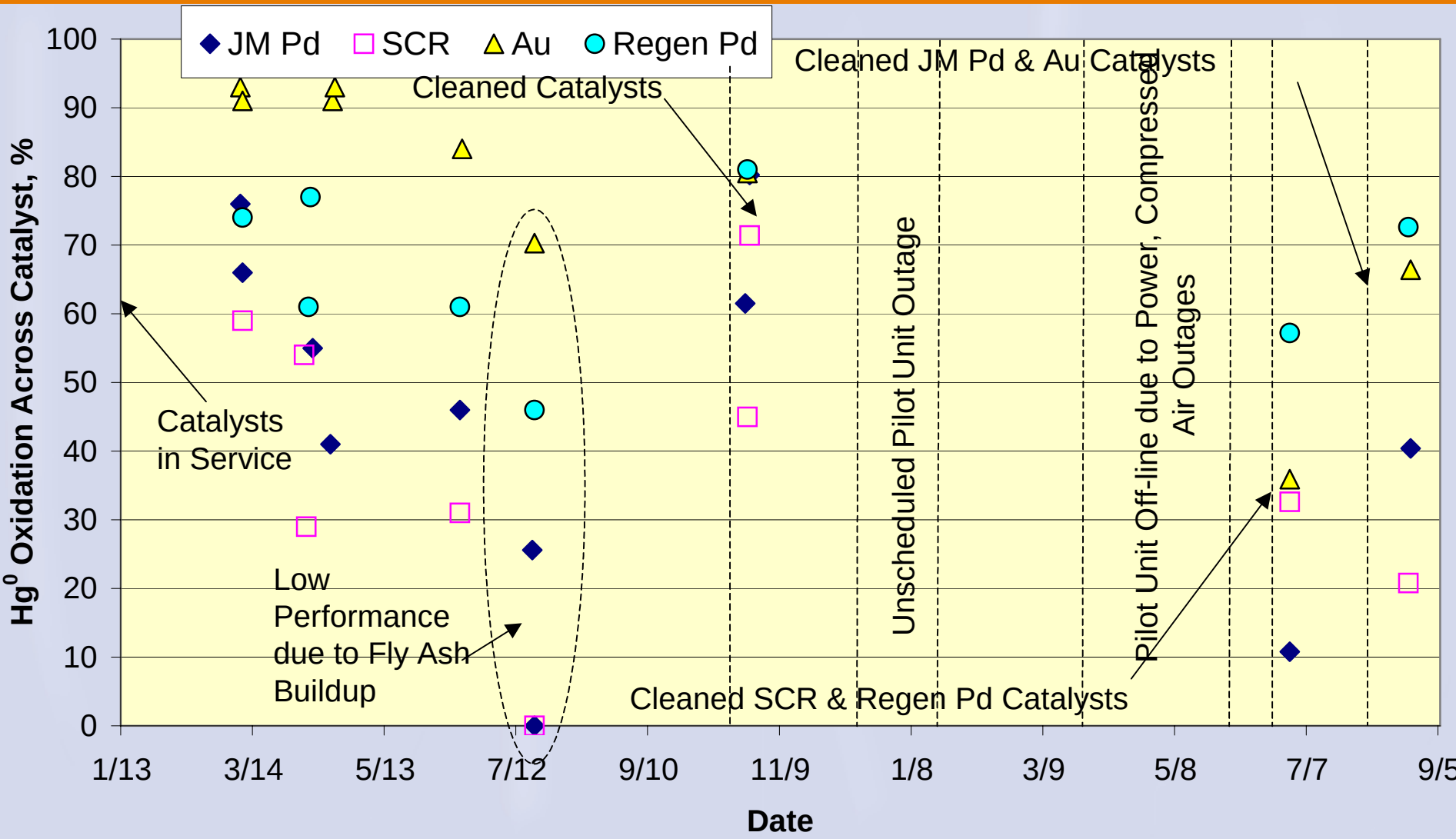
Summary of Monticello Results

- Fly ash buildup in catalysts was a problem
  - Partly due to sonic horn reliability issues
  - Unscheduled pilot unit outages (mostly due to plant construction) exacerbated buildup
    - Catalyst chambers not purged before outages
    - Flue gas moisture condensation leads to cementitious ash reactions
  - May have confounded catalyst activity results
- Lab catalyst regeneration tests completed, data analysis underway

Monticello Catalyst Pressure Drop Data



Monticello Catalyst Activity Data



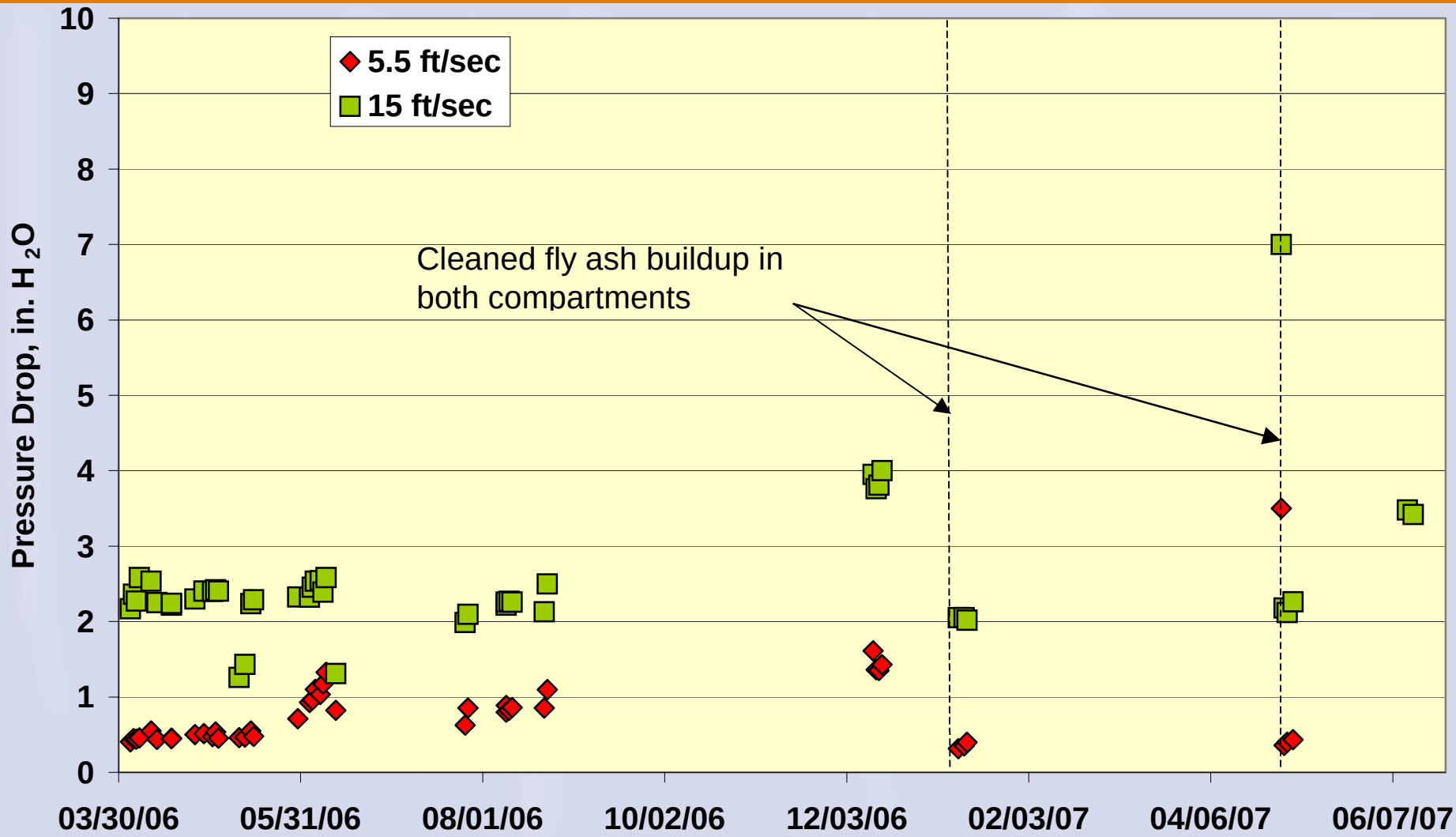
Catalyst Dimensions for Coronado Pilot

Catalyst	Cells per in.^{2} (cpsi)	Cross Section (in. x in.)	Length (in.)	Area Velocity (sft/hr)
Au (Johnson Matthey) – 5.5 ft/sec	64	30 x 30	12 (2 x 6)	38
Au (Johnson Matthey) – 15 ft/sec	64	18 x 18	24 (4 x 6)	52

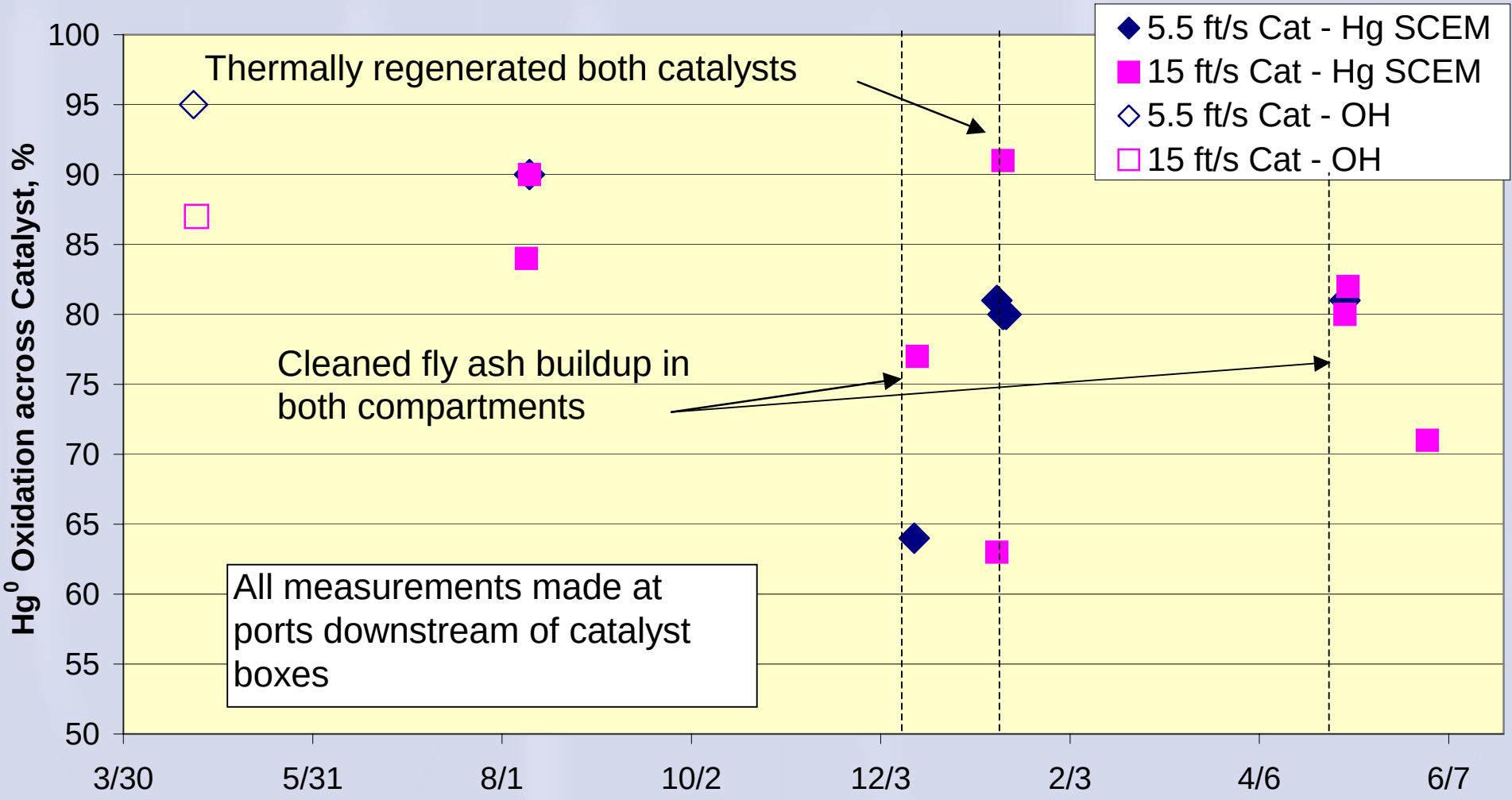
5.5 ft/sec Catalyst

15 ft/sec Catalyst

Pressure Drop Data for Coronado Pilot Unit



Activity vs. Time for Coronado Catalysts (Hg SCEM)



Wet FGD Pilot Unit at Coronado

Example Pilot Wet FGD Test Results (15 ft/sec cat., LSFO, no re-emission additive)

Date	SO_2 Removal, %	Total Hg Oxidation at FGD Inlet, %	Total Hg Removal, %	Hg^{+2} Removal, %	Hg^0 Re-emissions, % of FGD Inlet Hg^{+2}
04/23/06	95	88	**83**	97	3
05/31/07	95	75	**28**	52 (meas.) 95 (est.)	14 (meas.) 91 (est.)

- Total Hg removal appears to be limited by re-emissions in 2007 test
- May be related to change in full-scale FGD chemistry (provided makeup slurry to pilot for test)

Full-scale Testing of Hg Oxidation Catalyst

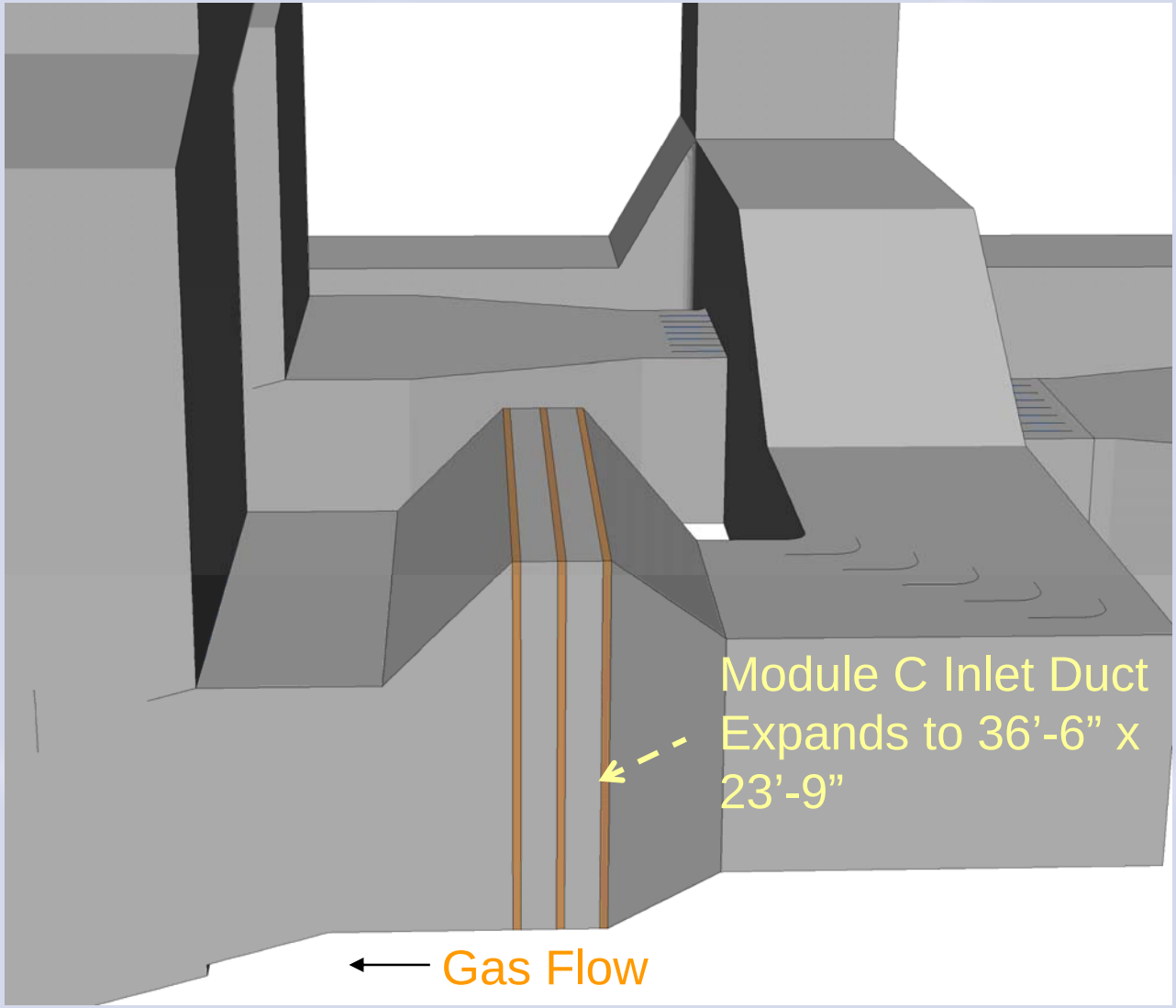
- DOE Cooperative Agreement DE-FC26-06NT42778 (award date 7/24/2006)
  - Co-funded by EPRI, LCRA, Great River Energy, Johnson Matthey (JM), Ontario Power, Southern Company, SRP, TVA, URS and Westar
- Will test JM gold catalyst at 15 ft/sec upstream of one full-scale wet FGD module (~200 MW)
- Host site is the Lower Colorado River Authority's Fayette Power Plant Unit 3 (LaGrange, TX)
  - 460 MW
  - Cold-side ESP followed by LSFO wet FGD system
  - Fires PRB

LCRA's Fayette Power Project

Full-scale Testing of Hg Oxidation Catalyst (continued)

- Partial unit treating requires duct modification upstream of FGD module
  - Limited space available leads to higher velocity catalyst (15 ft/sec), difficult retrofit
- Current project schedule:
  - Design ductwork modifications (complete)
  - Fabricate new ductwork pieces (10/07)
  - Install ductwork modifications (12/07)
  - Receive and install catalyst (03/08)
  - Begin catalyst operation (04/08)

Module C Inlet Duct Modifications



Conclusions

- Sonic horns required to keep horizontal gas flow catalysts clean downstream of ESPs
  - Important to purge catalyst on shut down
- Hg oxidized by catalysts removed by wet FGD at high efficiency, unless limited by re-emissions
- Catalysts can remain active 20+ mos. (CCS, Monticello)
- Regenerated catalyst performs similarly to fresh catalyst (Monticello)
- Economics best for plants with ESP/FGD that sell fly ash