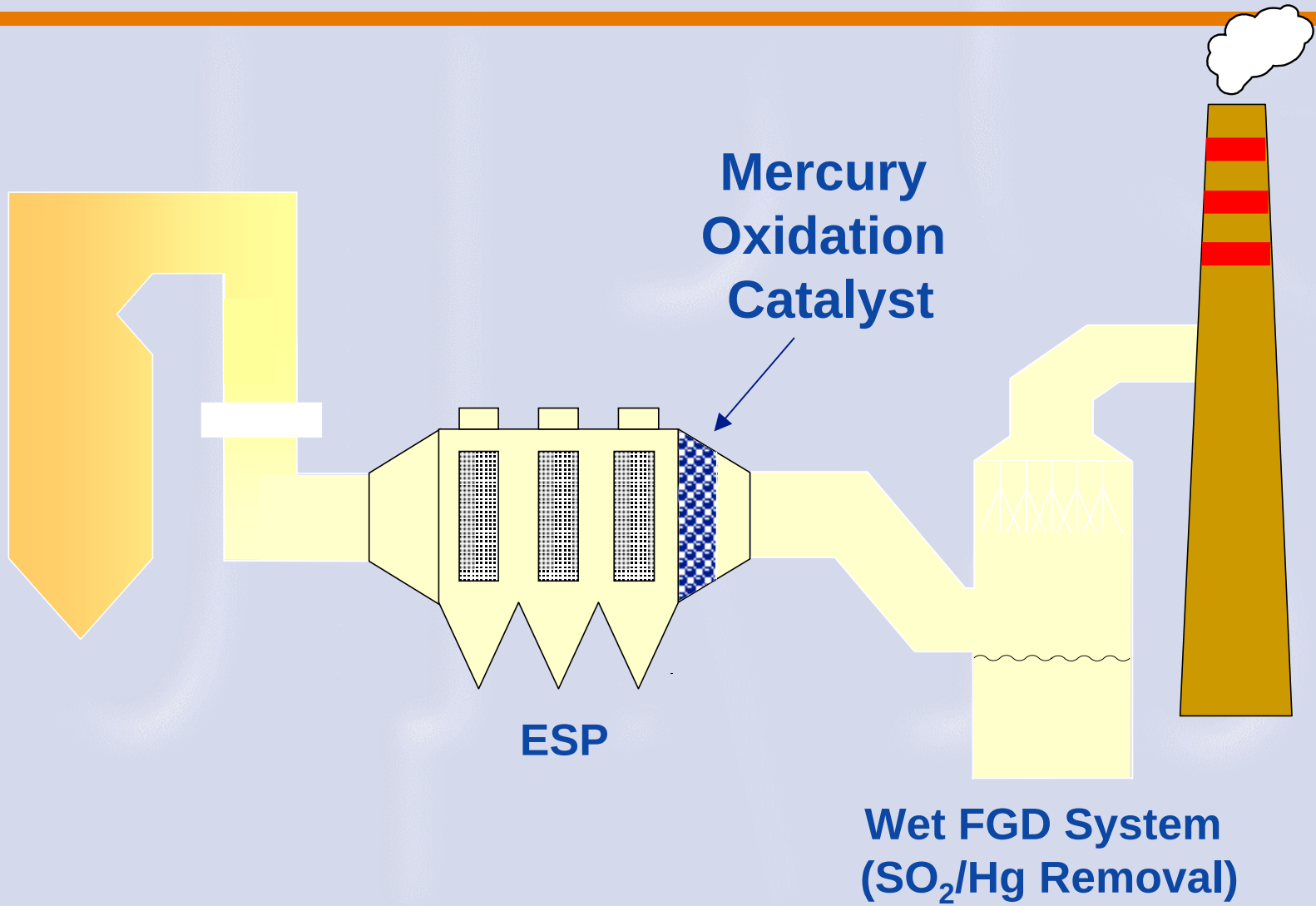
Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems

Gary Blythe
URS Corporation

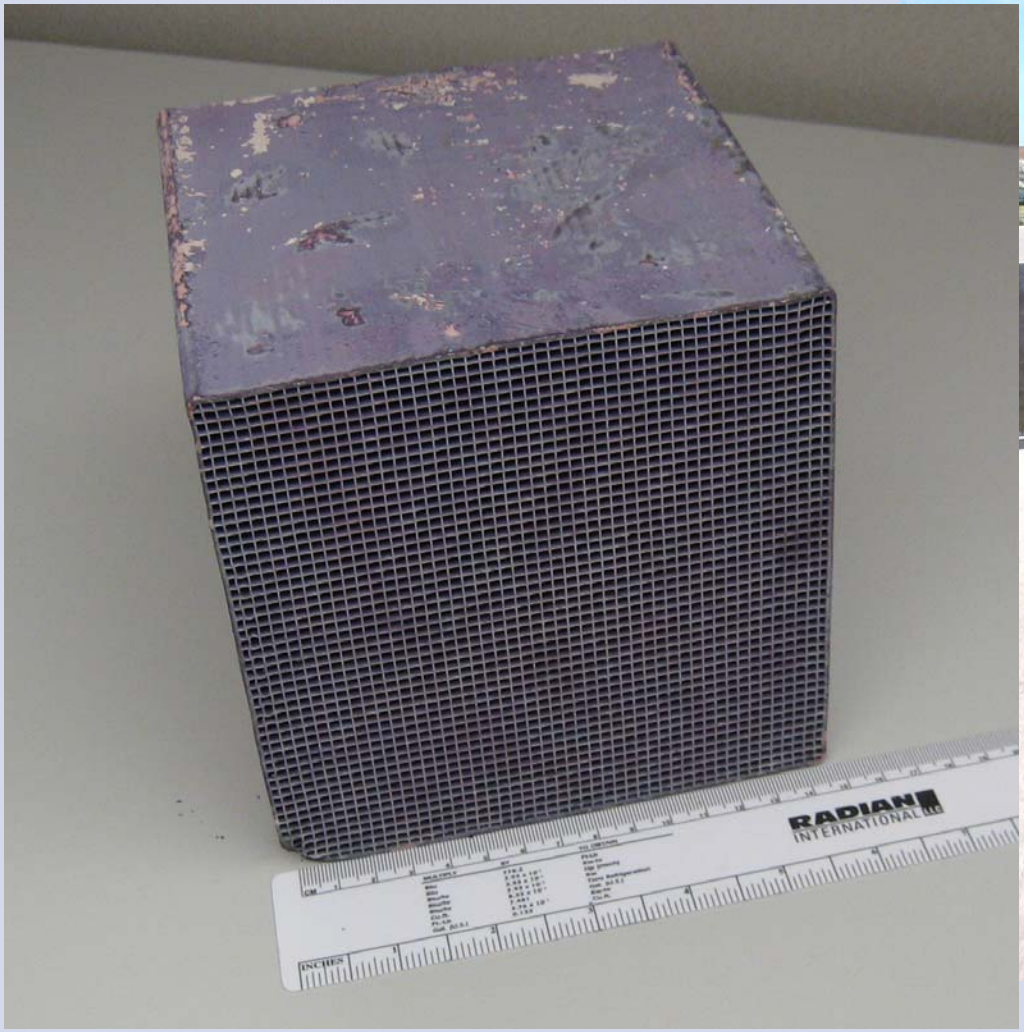
Illustration of Process Concept



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 60-70% Hg^0 oxidation 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
  - Pd and Au catalysts achieved ~50% Hg^0 oxidation after ~17 months
  - Pd and Au catalysts restored to ~80% oxidation after regeneration with 600^{o}F air
- 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

- TXU'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
  - Will operate into early 2007

Current Project (continued)

- SRP's Coronado Station (PRB, hot side ESP, fly ash sales, horizontal LS wet FGD)
  - Added to project in 2006
  - Funded by SRP/EPRI tailored collaboration project
  - New 2-chamber catalyst pilot unit
  - Began operation March 06
  - Will operate through March 07

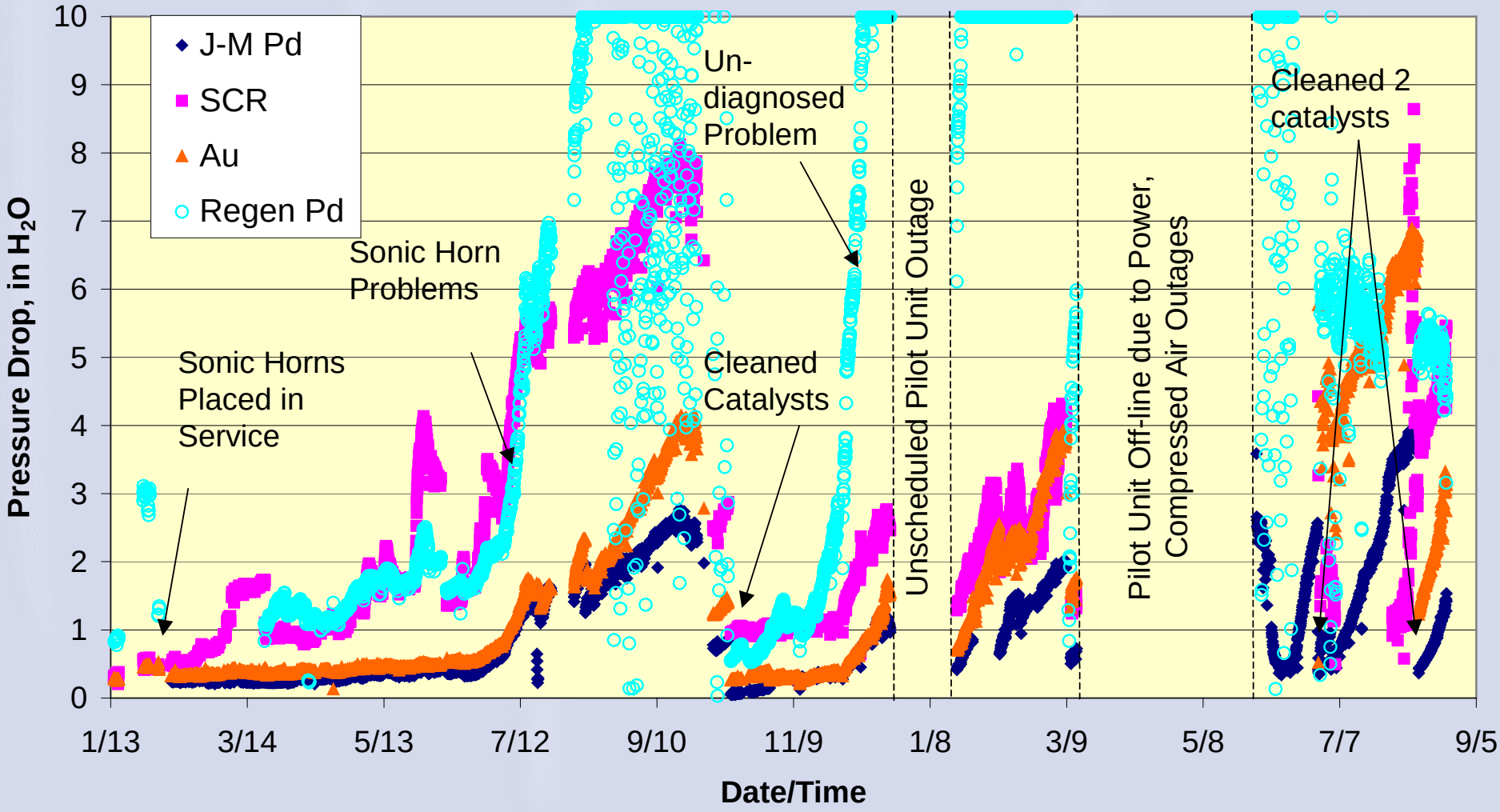
Monticello Pilot Unit (moved from CCS)

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

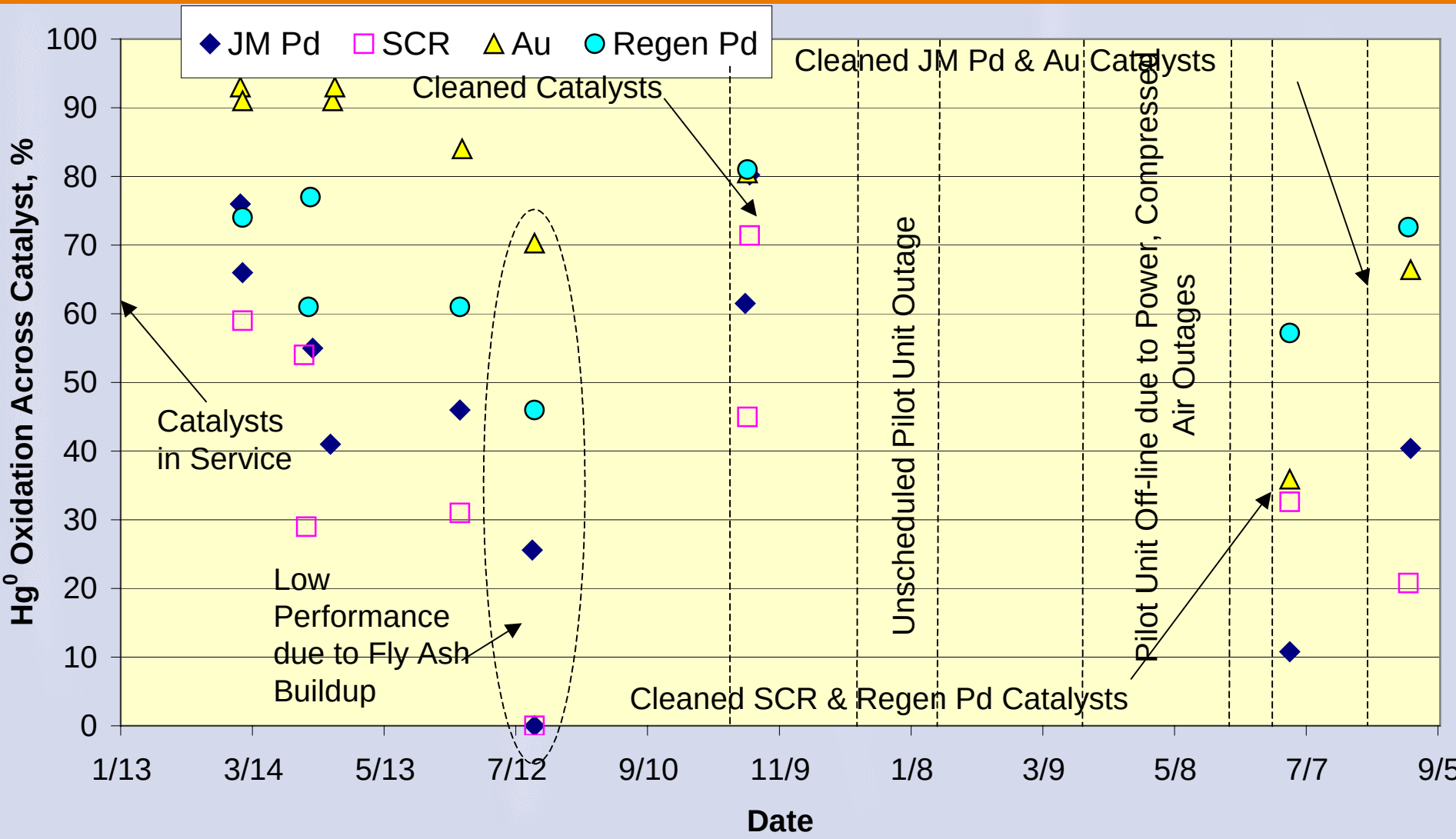
Summary of Monticello Results

- Fly ash buildup in catalysts has been a problem
  - Partly due to sonic horn reliability issues (same horns and controls used at CCS)
  - Unscheduled pilot unit outages (mostly due to plant construction) appear to have exacerbated buildup
    - Catalyst chambers not purged before outages
    - Flue gas moisture condensation leads to cementitious reactions with ash
- May have confounded catalyst activity results

Monticello Catalyst Pressure Drop Data



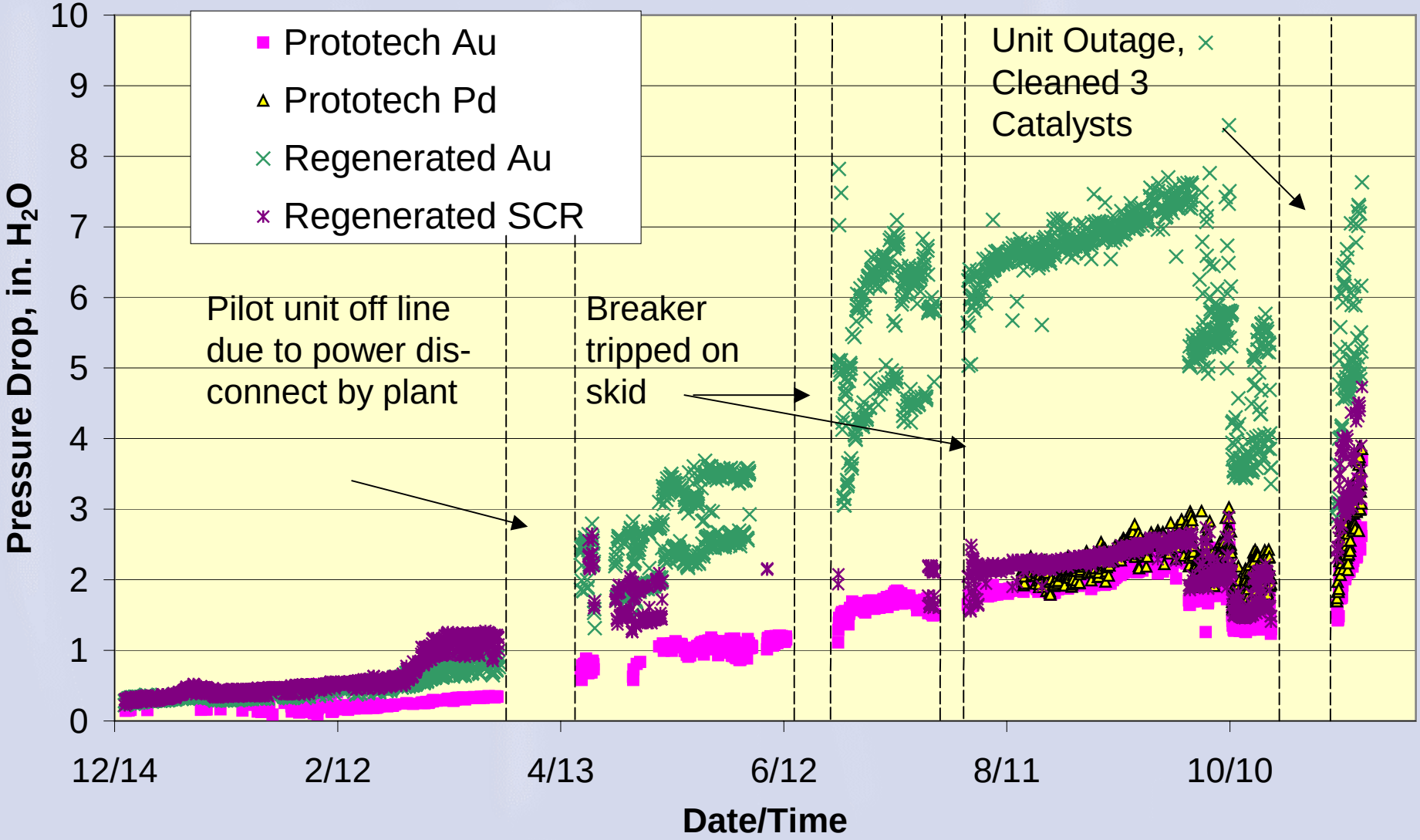
Monticello Catalyst Activity Data



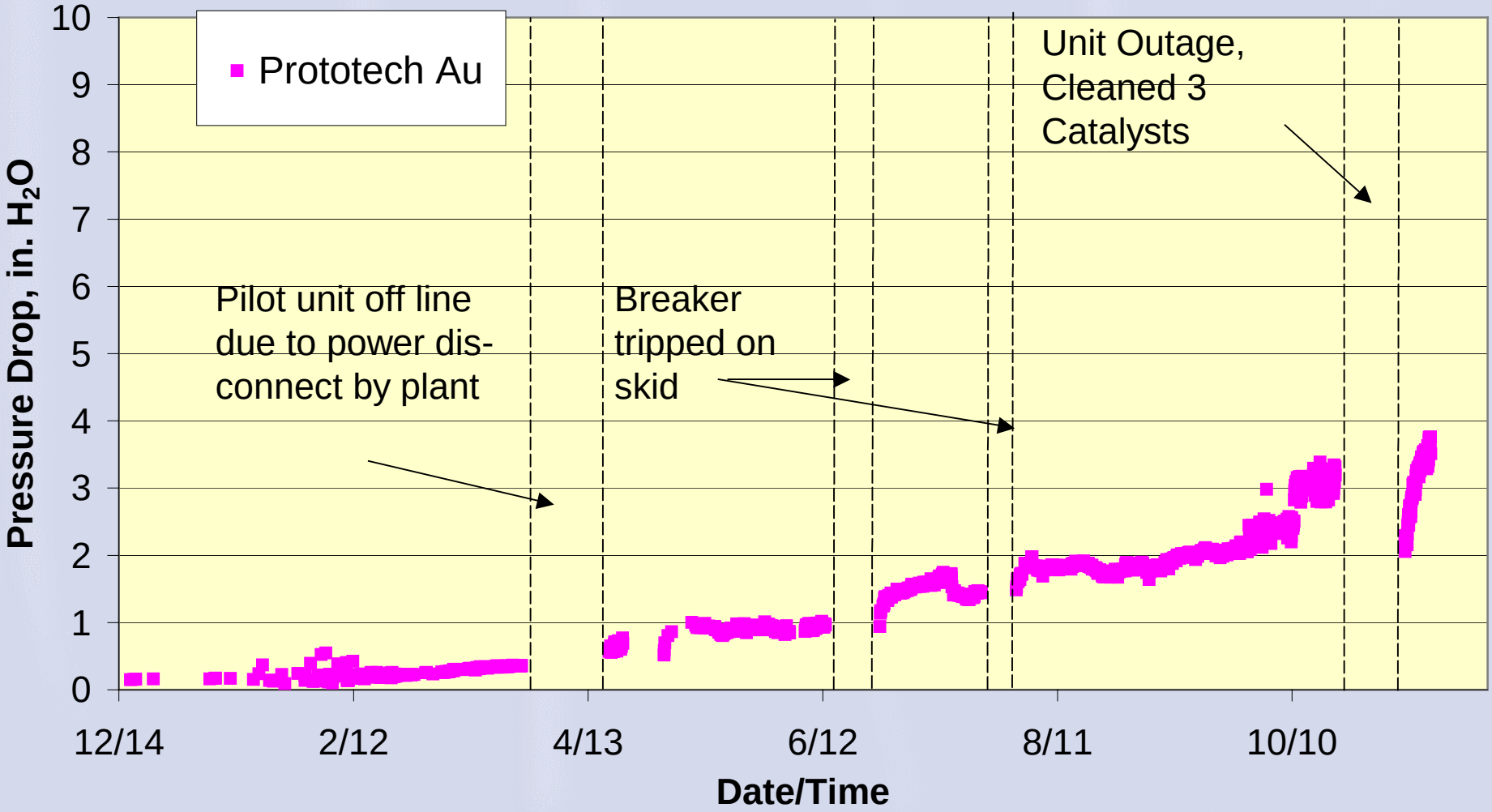
Yates Pilot Unit (moved from Spruce)

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 (Sud-Chemie Prototech)	64	29.5 x 29.5	9 (3 x 3)	50
Au (Prototech - regenerated from Spruce)	64	29.5 x 29.5	9 (3 x 3)	50
SCR (Argillon – regenerated from Spruce)	46	35.4 x 35.4	29.5	13

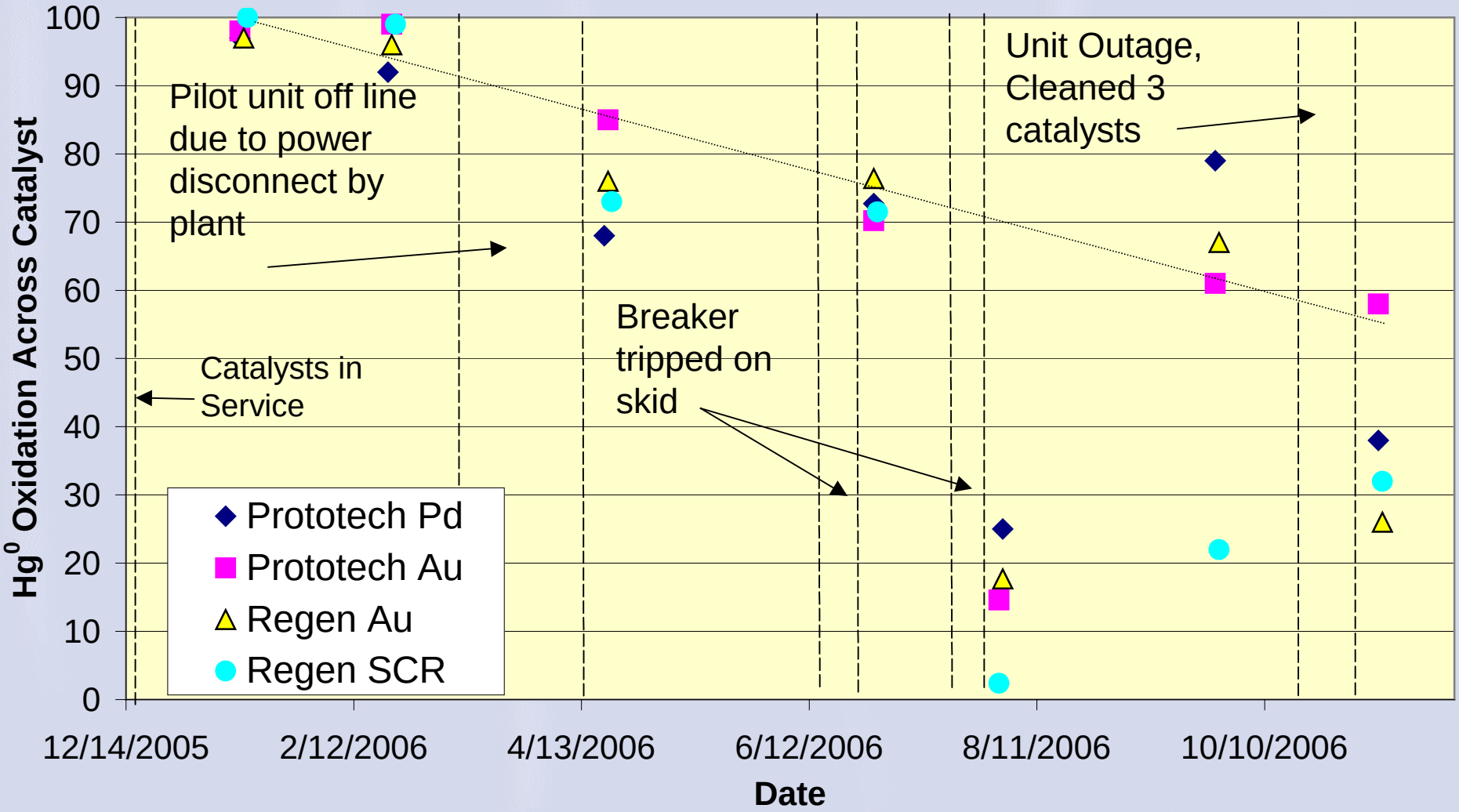
Yates Catalyst Pressure Drop Data



Yates Catalyst Pressure Drop Data (normalized to 1800 acfm)



Yates Catalyst Activity Data



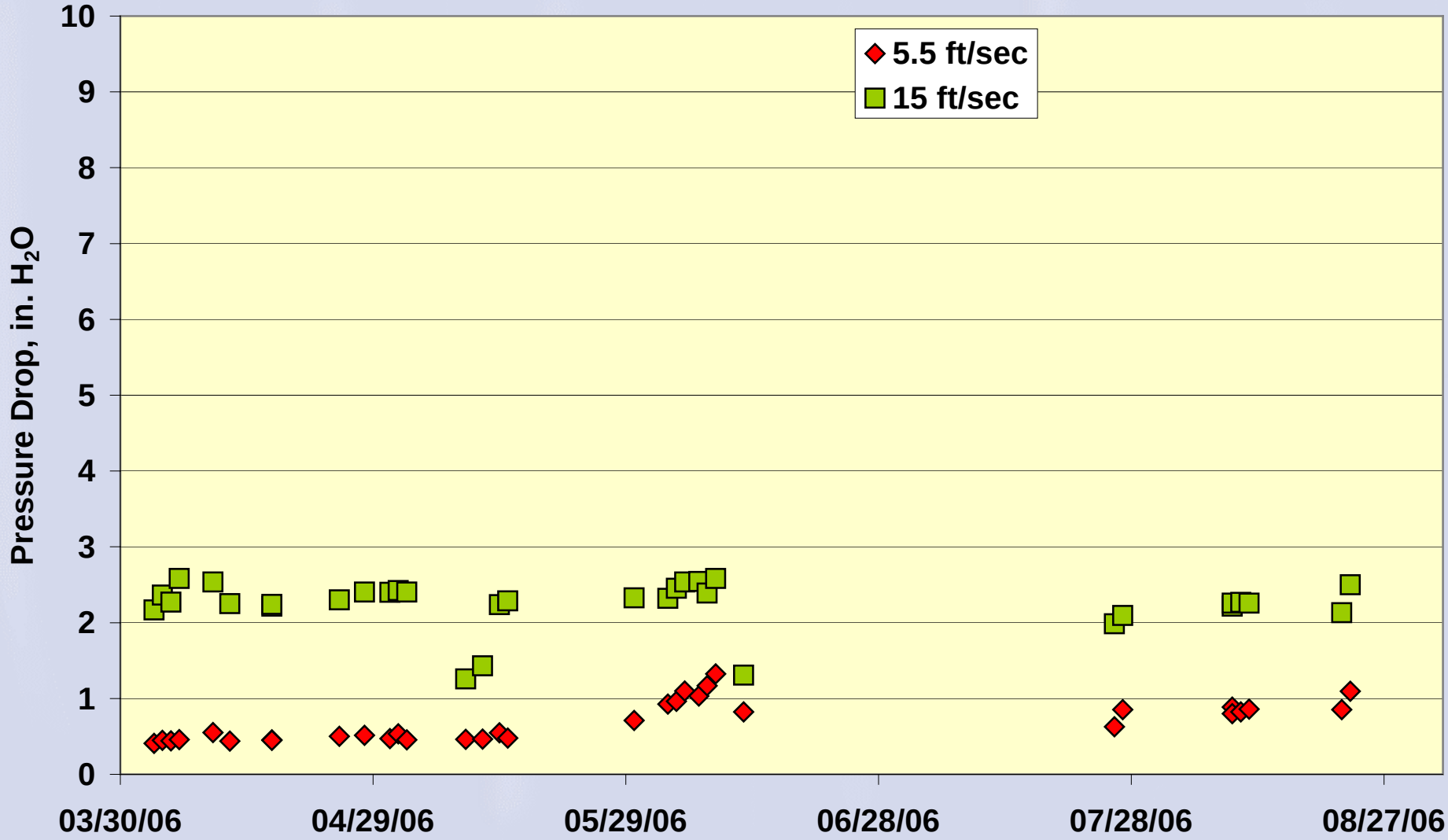
Catalyst Dimensions for Coronado Pilot

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

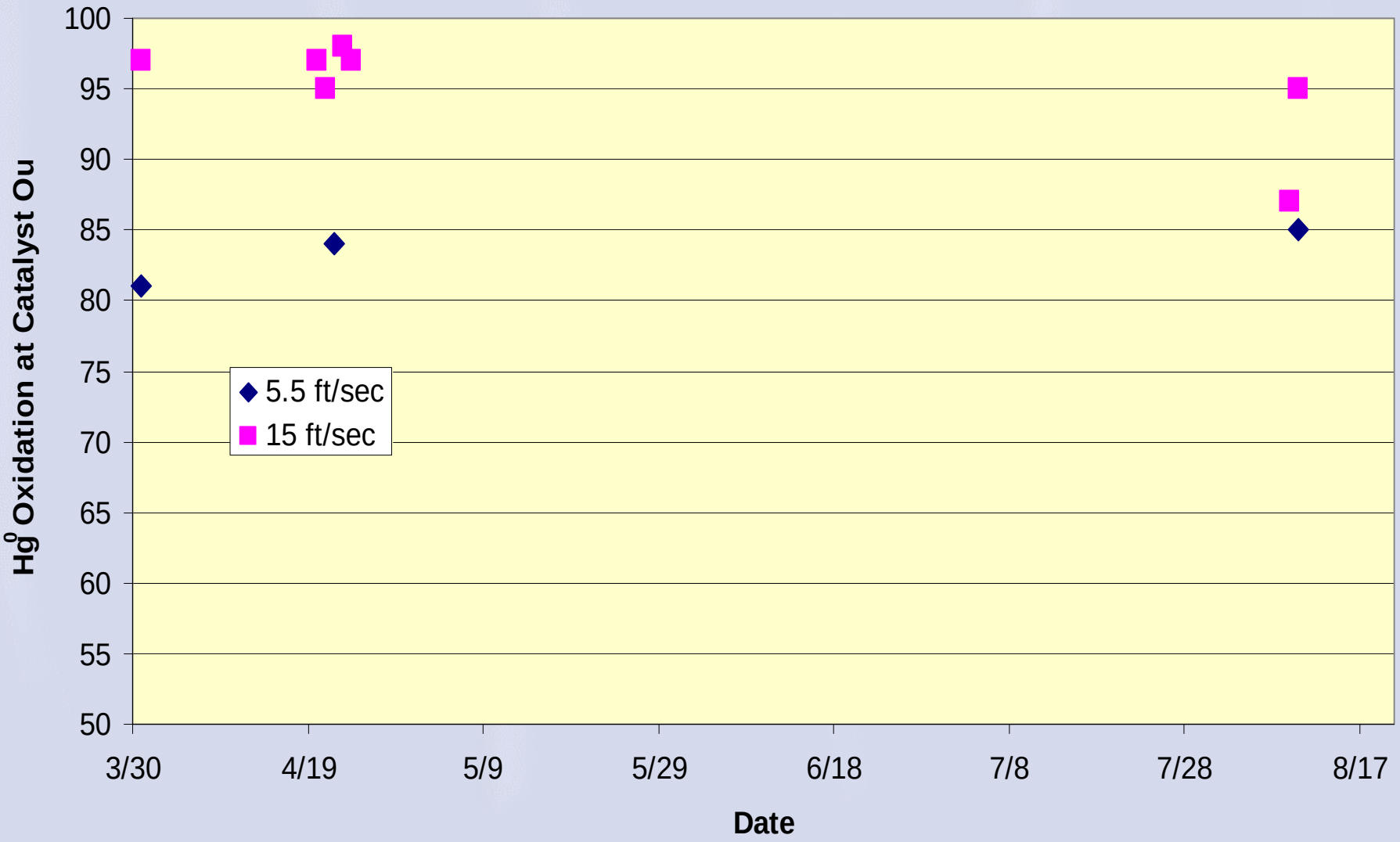
5.5 ft/sec Catalyst

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 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	94	89	**87**	97	0

Total Hg Oxidation at Catalyst Inlet – 8%

Expected Total Hg Removal Across FGD (w/o catalyst) - **<10%**

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, Southern Company, SRP, TVA, URS and Westar
- Will test 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
  - 460 MW
  - Cold-side ESP followed by LSFO wet FGD system
  - Fires PRB

Conclusions

- Sonic horns are required to keep horizontal gas flow catalysts clean downstream of ESPs
  - May not be adequate downstream of small ESPs
- Hg oxidized by catalysts removed by wet FGD at high efficiency, unless limited by re-emissions
- Catalysts can remain active 20+ mos. (Coal Creek)
- Regenerated catalyst performs similarly to fresh catalyst (Monticello)
- Economics show possible lower cost than ACI
  - Economics best for plants with ESP/FGD that sell ash
  - Catalyst regeneration greatly improves economics
    - Current EPRI project will optimize regeneration conditions