Pilot-Scale Research at NETL on Mercury Measurement and Control

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NETL

Mercury Control Technology R&D Program Review Meeting

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Project Objectives

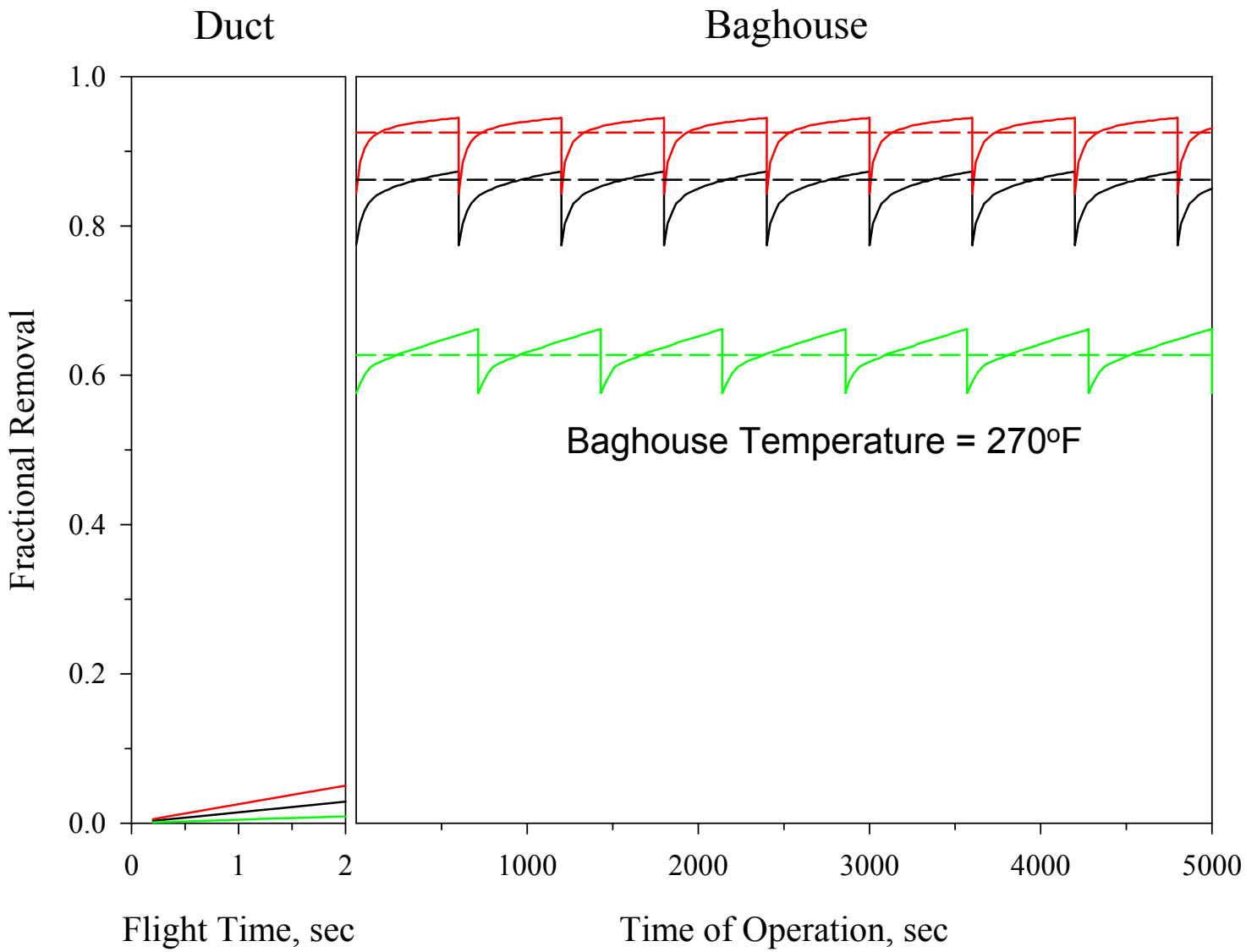
- Conduct parametric testing to assess the Hg removal performance of activated carbon and novel sorbents for a range of coals and blends
- Evaluate methods for measurement of mercury concentration and speciation
- Provide for testing of novel Hg removal methods (e.g. GP-254, Thief)
- Use test data for model development and validation

Modeling of Sorbent Injection Upstream of a Baghouse

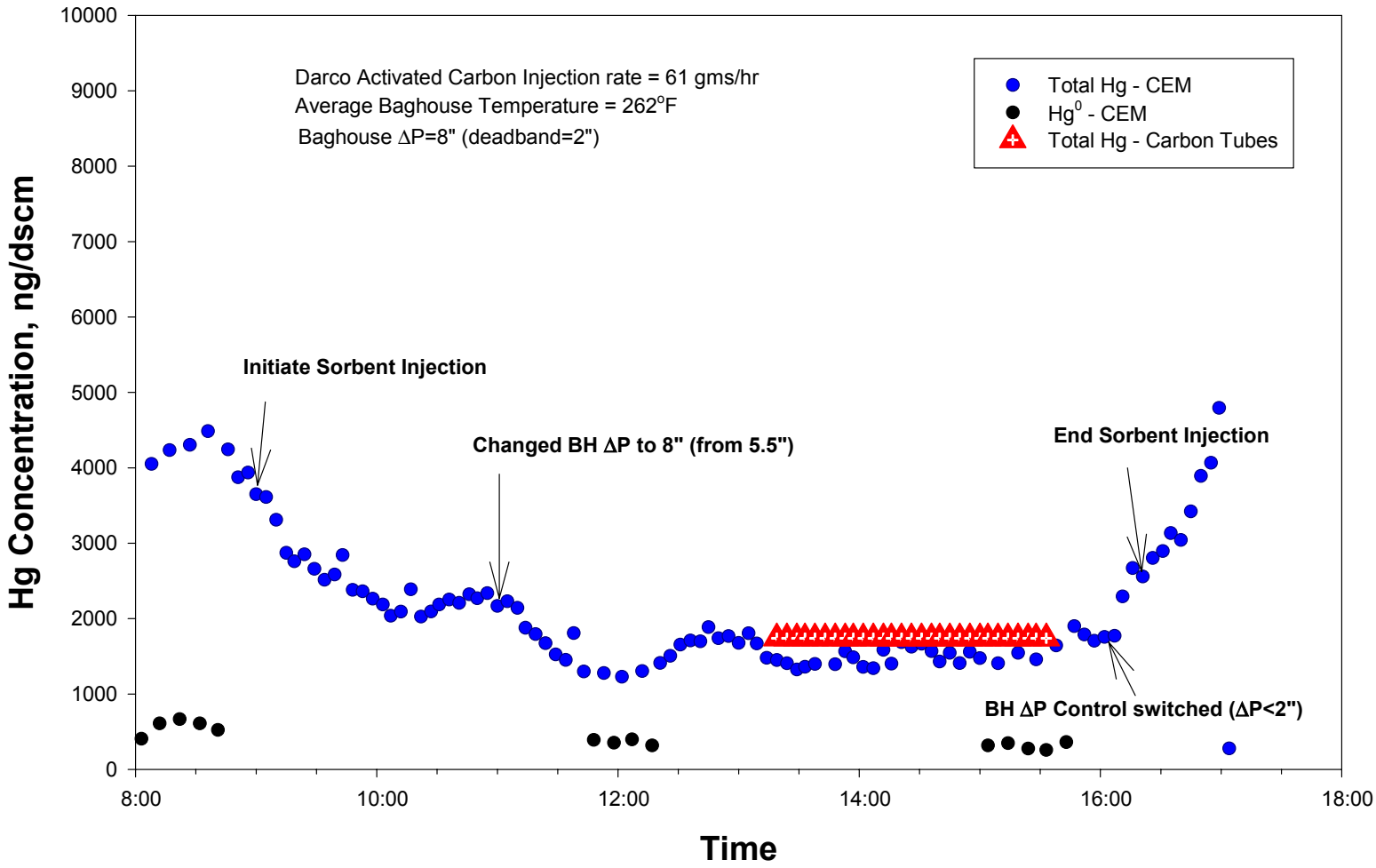
Model developed by Dr. Radisav D. Vidic, University of Pittsburgh, and Joseph Flora, University of South Carolina.

- **Two-Stage Mathematical Model**
  - Mercury removal in duct modeled using a plug flow system.
    - Accounts for presence of an external mass transfer boundary layer.
  - Mercury removal in the fabric filter modeled using a growing-bed packed-bed approach.
    - Accounts for presence of an external mass transfer boundary layer, dispersion, and a periodic cleaning interval.
- **Mercury removal in the activated carbon particle is modeled using a pore diffusion model with the Langmuir isotherm describing equilibrium between the gas phase and the carbon particle surface.**

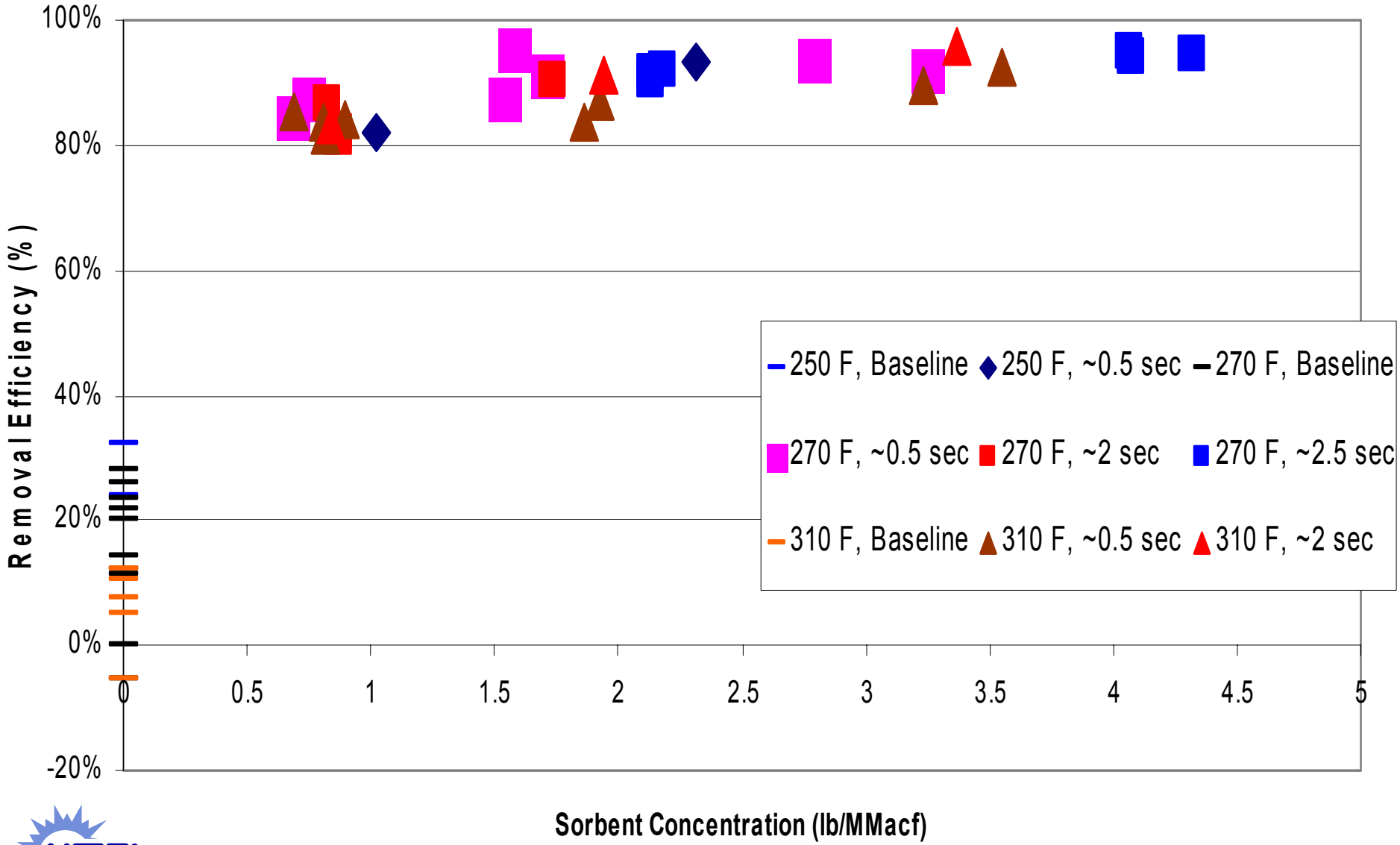
Mercury Removal Data and Model Fit



Influence of Baghouse Pressure Drop on Hg Removal

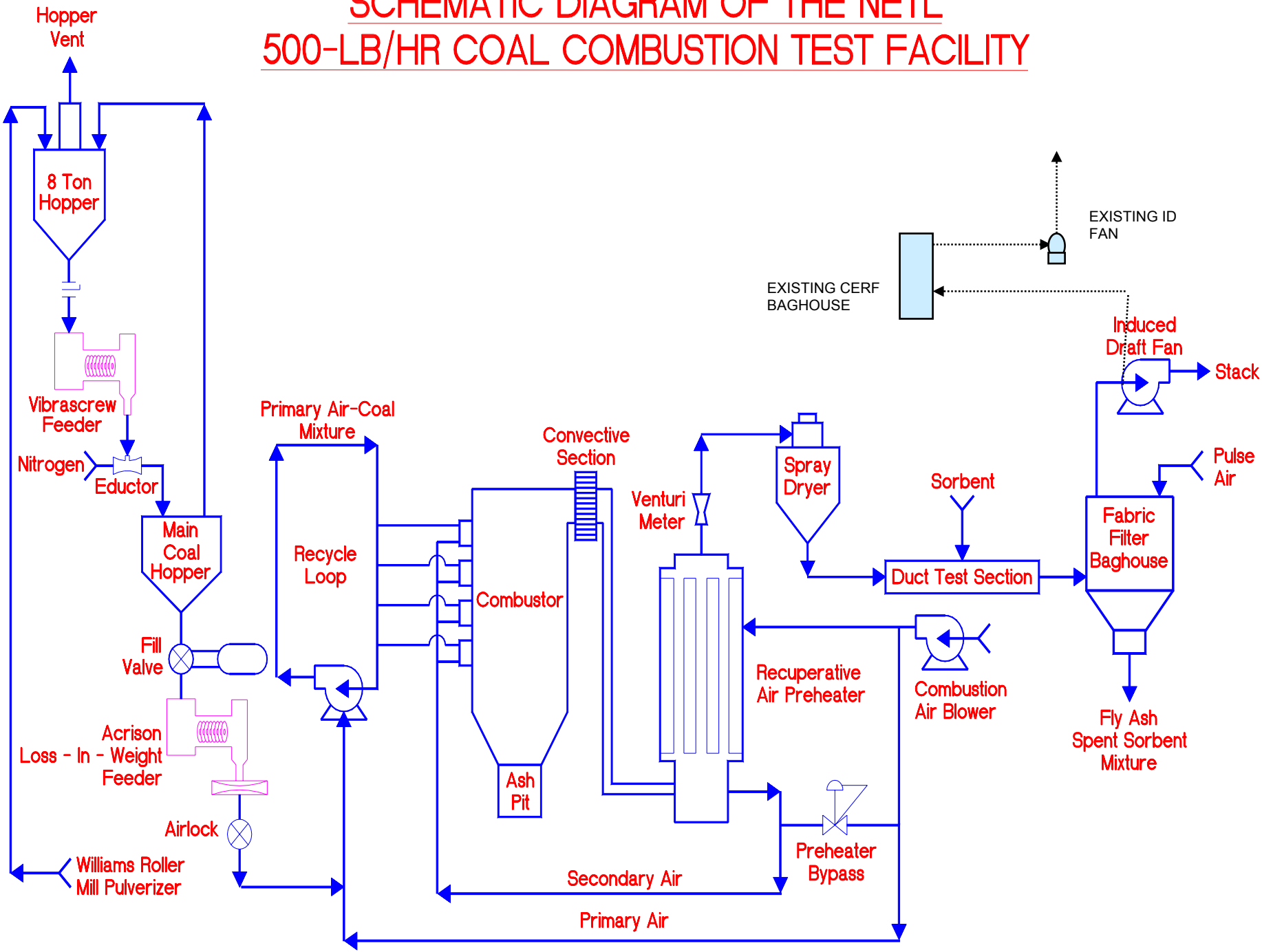


Baghouse Hg Removal Efficiency – PRB

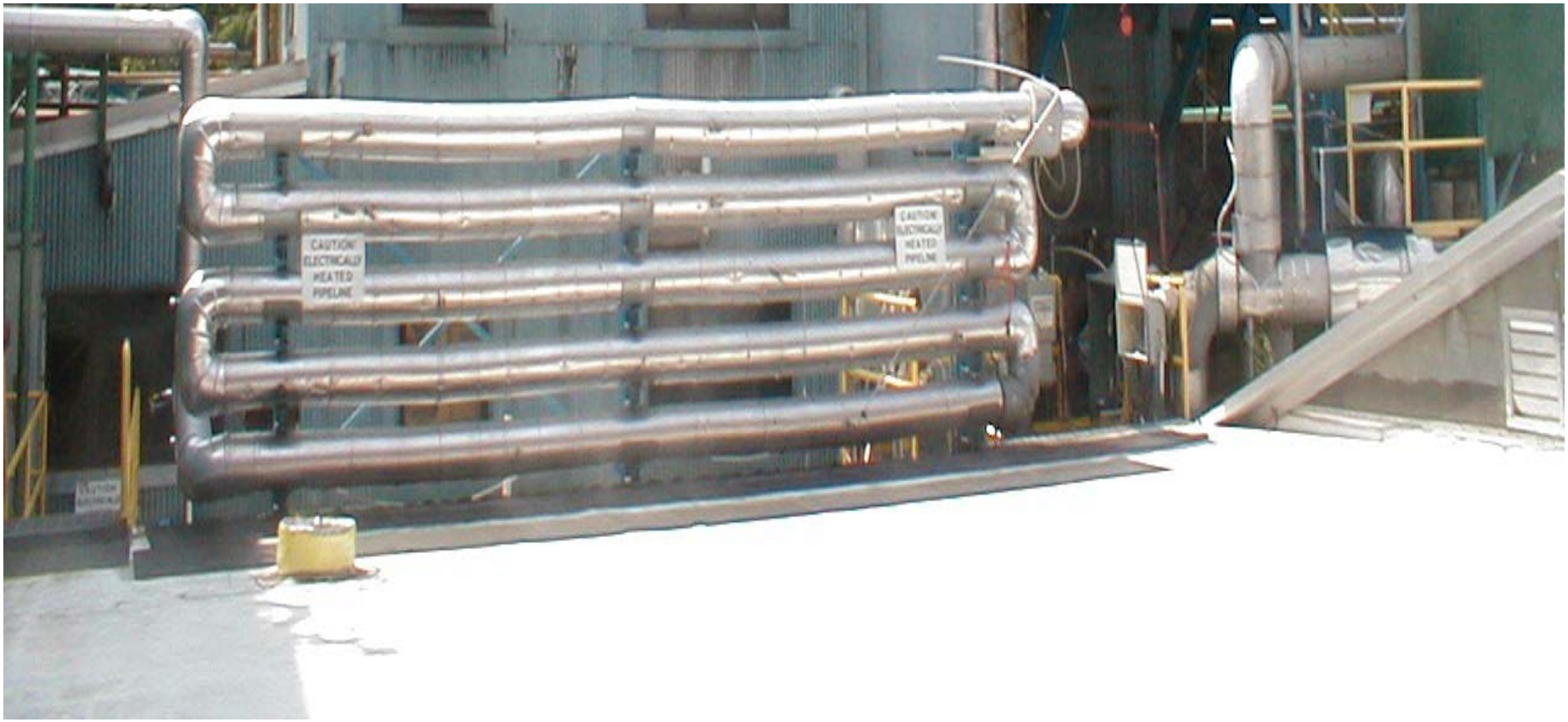


In-Duct Hg Removal Performance of Norit Darco FGD

SCHEMATIC DIAGRAM OF THE NETL 500-LB/HR COAL COMBUSTION TEST FACILITY



Slipstream



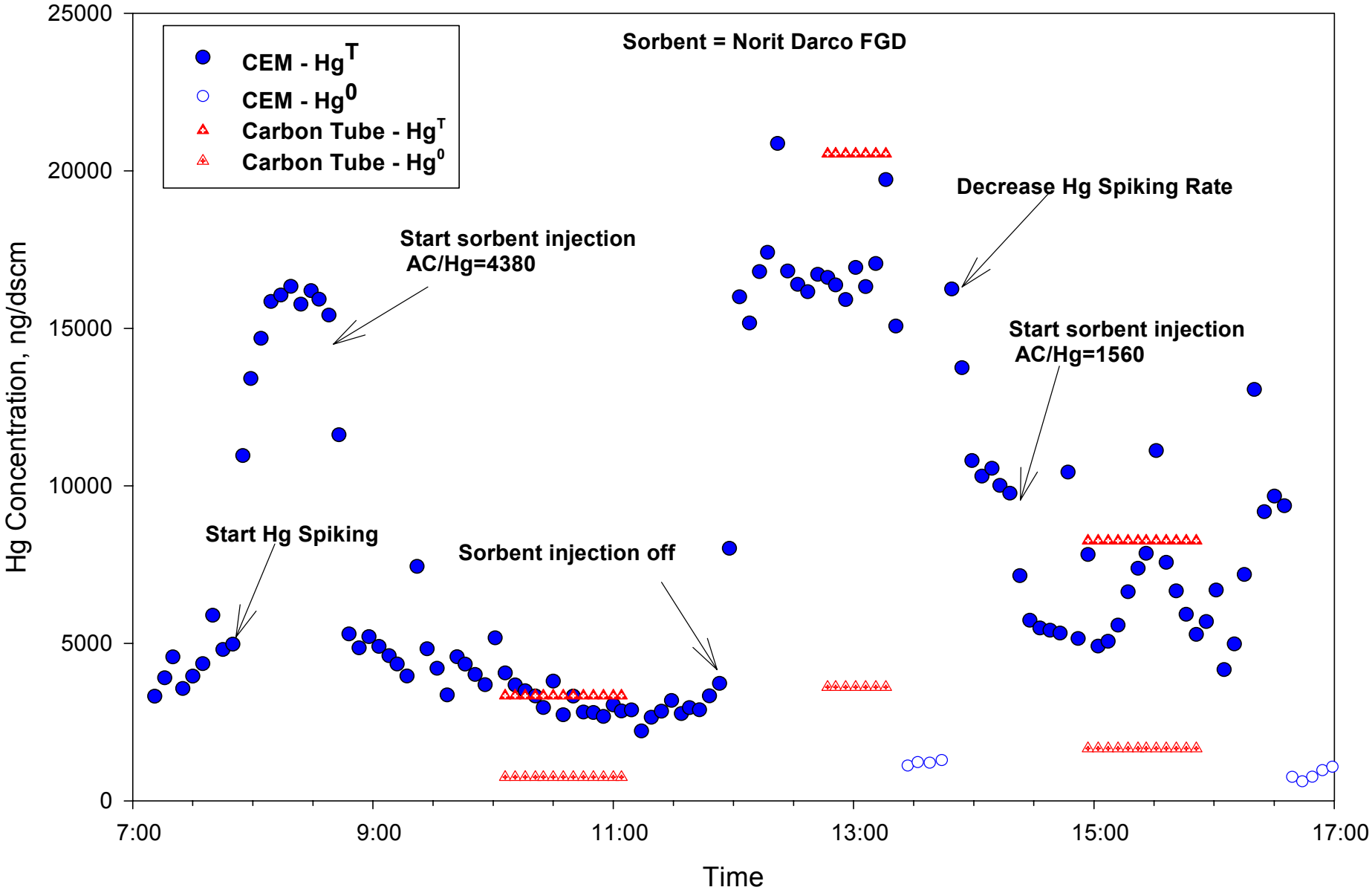
QSIS Probe Installed at Slipstream

Developed by Apogee Scientific

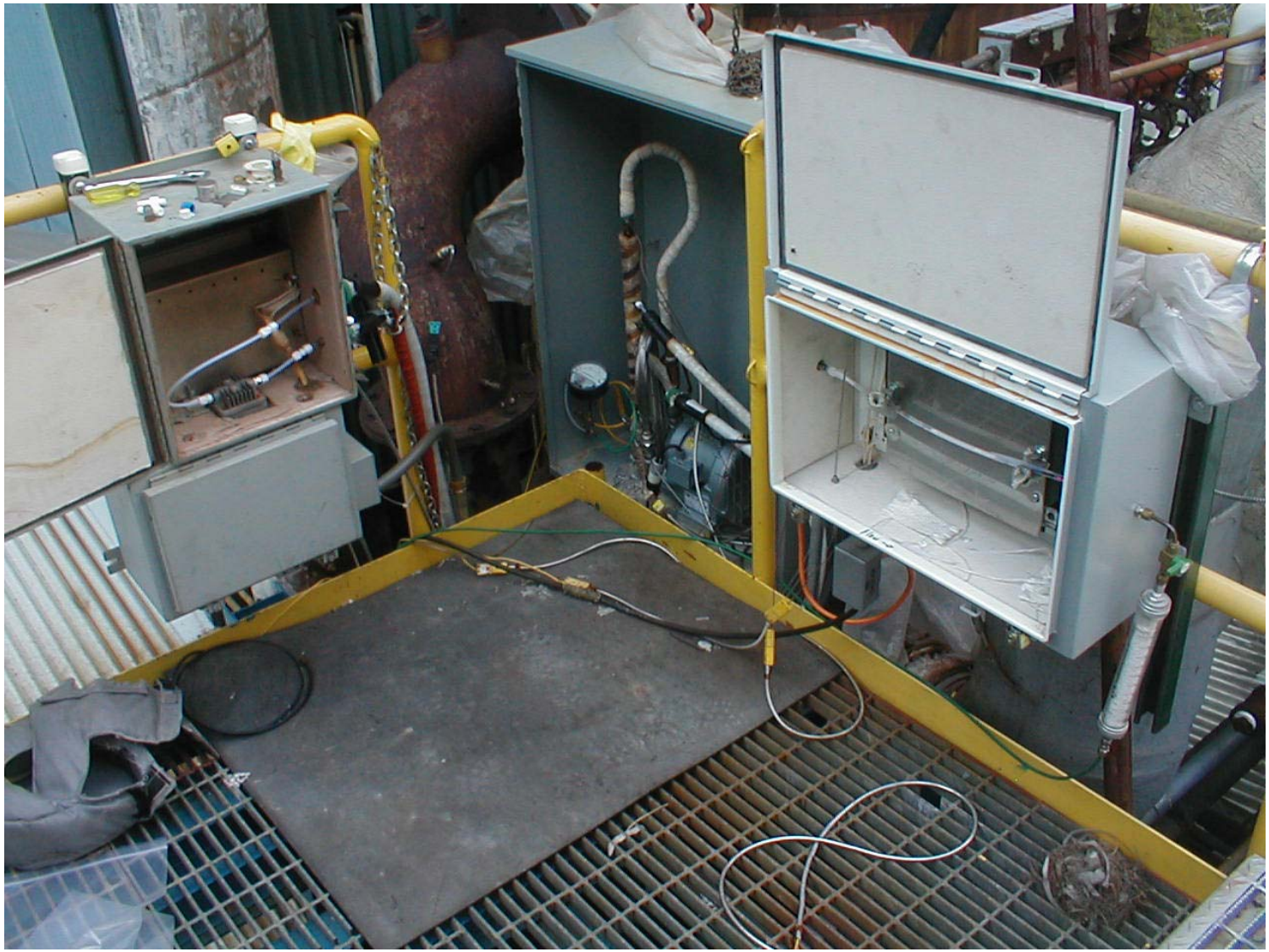
In-Duct Removals in Slipstream

- **Slipstream allows testing in a flyash free flue gas where a wide range of variables can be altered**
  - **Residence times of 0.5 to over 4.0 seconds**
  - **Temperatures from under 200°F to over 350°F**
  - **Varying Hg concentration and speciation**
- **Various sampling techniques to quantify in-duct removals in the slipstream evaluated**
  - **Cyclone**
  - **$PM_{2.5}$ Sampling Head**
  - **Virtual Impactor developed by MSP Corporation**
  - **Quicksilver Inertial Separation (QSIS) Probe**
- **Best results achieved with QSIS probe combined with Hg CEM and solid sorbent sampling method**

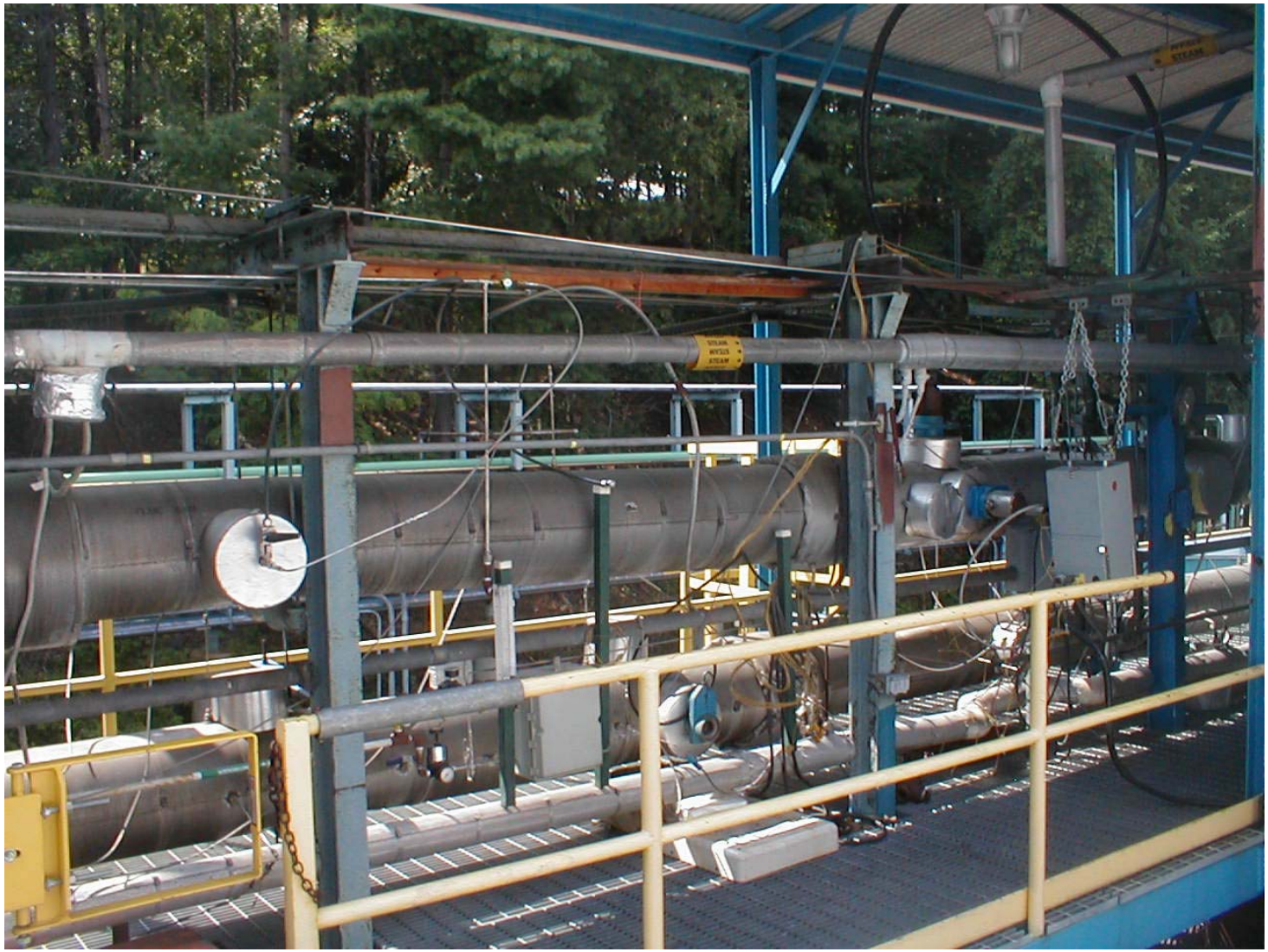
Slipstream Hg Measurements – QSIS Probe



Baghouse Inlet Sampling Configuration

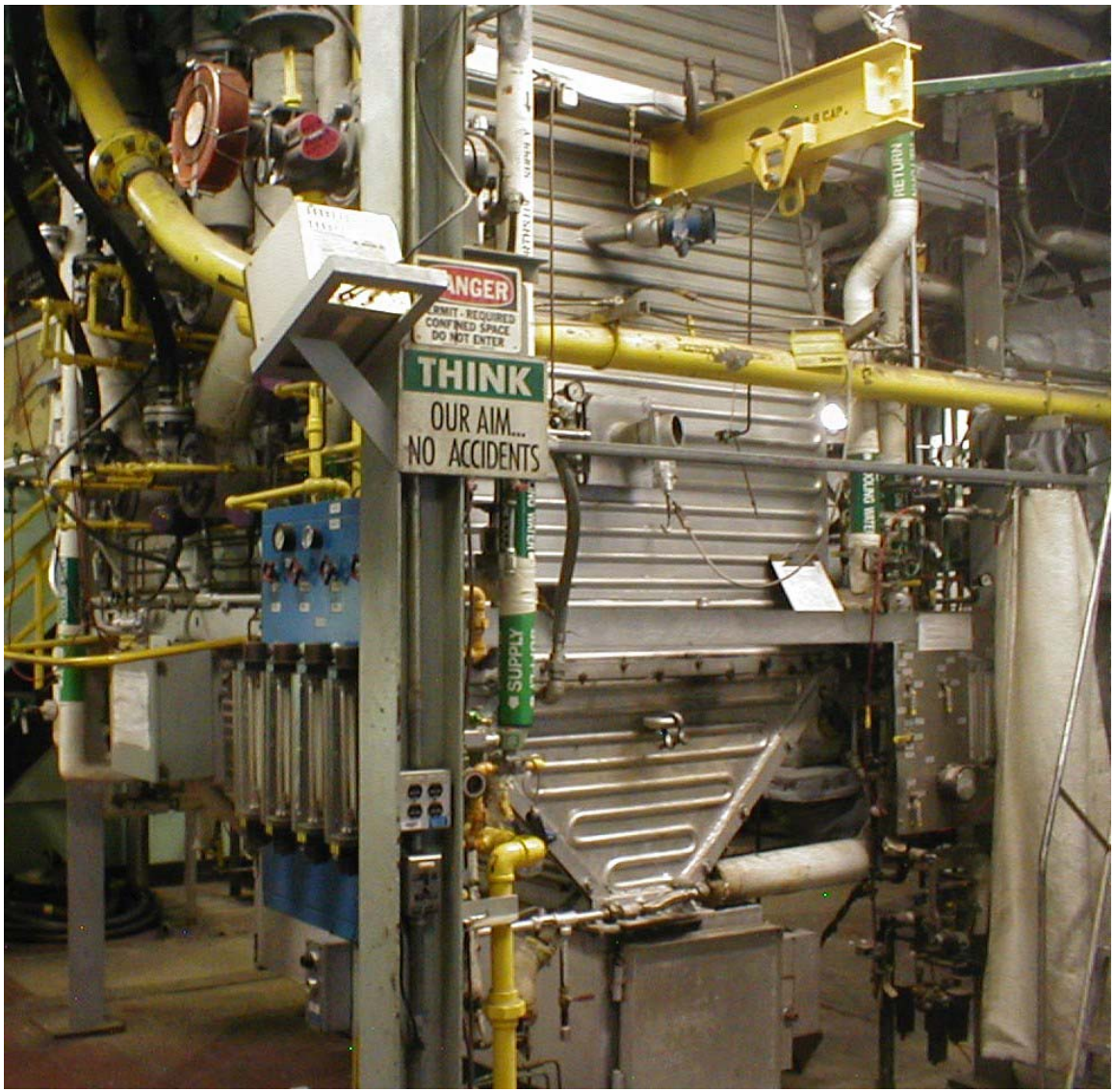


Spray Injection Duct Sampling Location

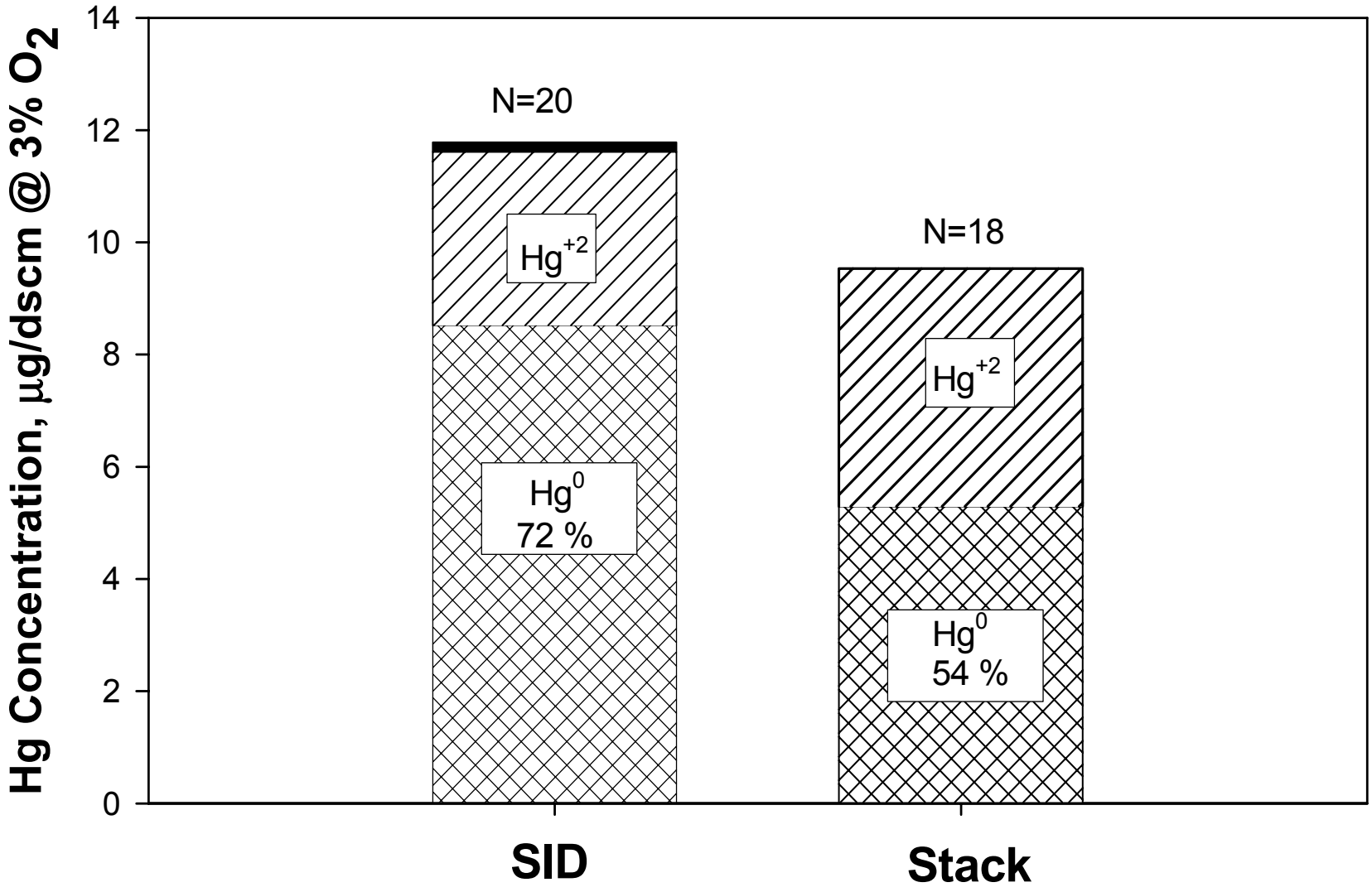


Spray Injection Duct

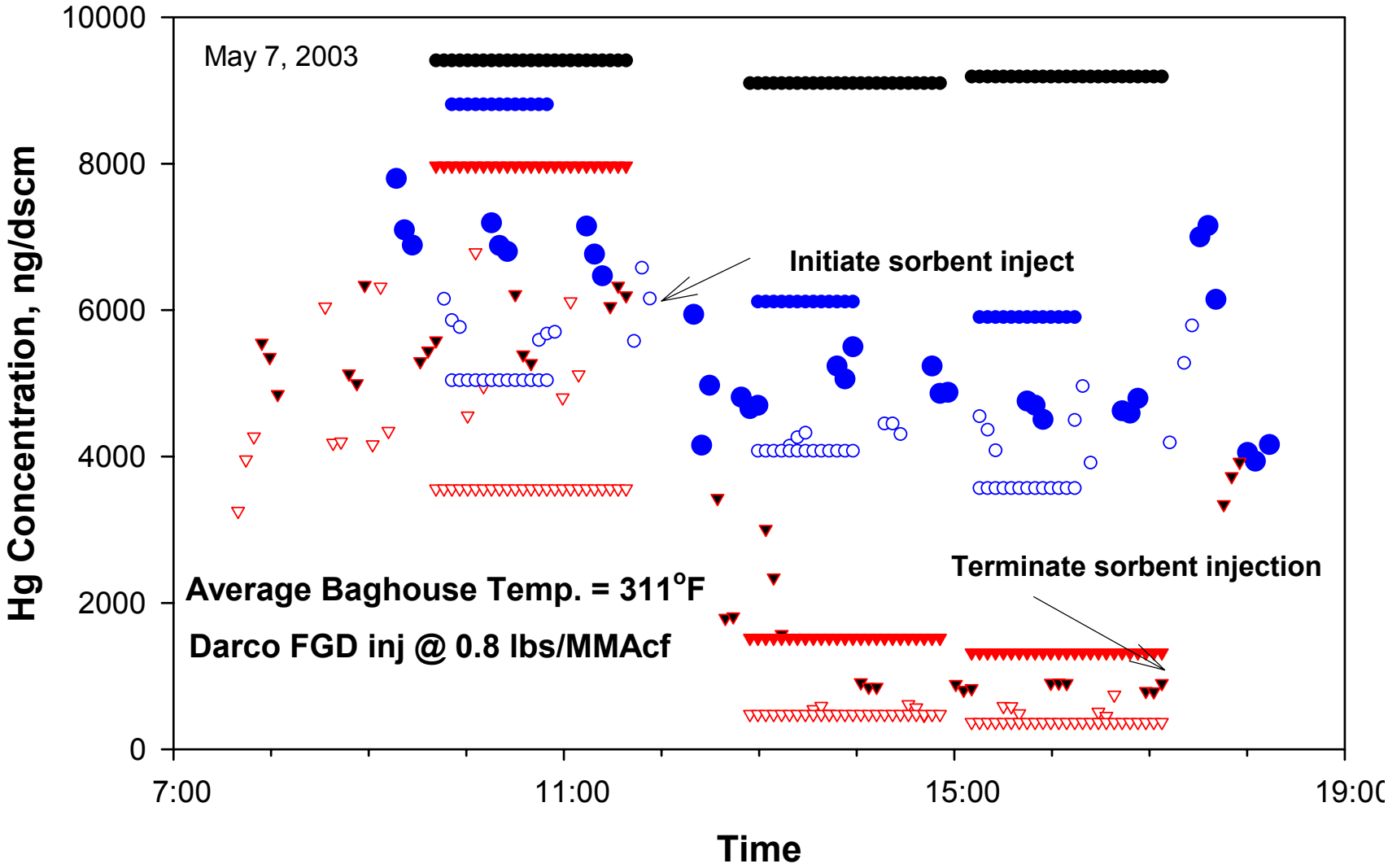
500 lb/hr Combustor



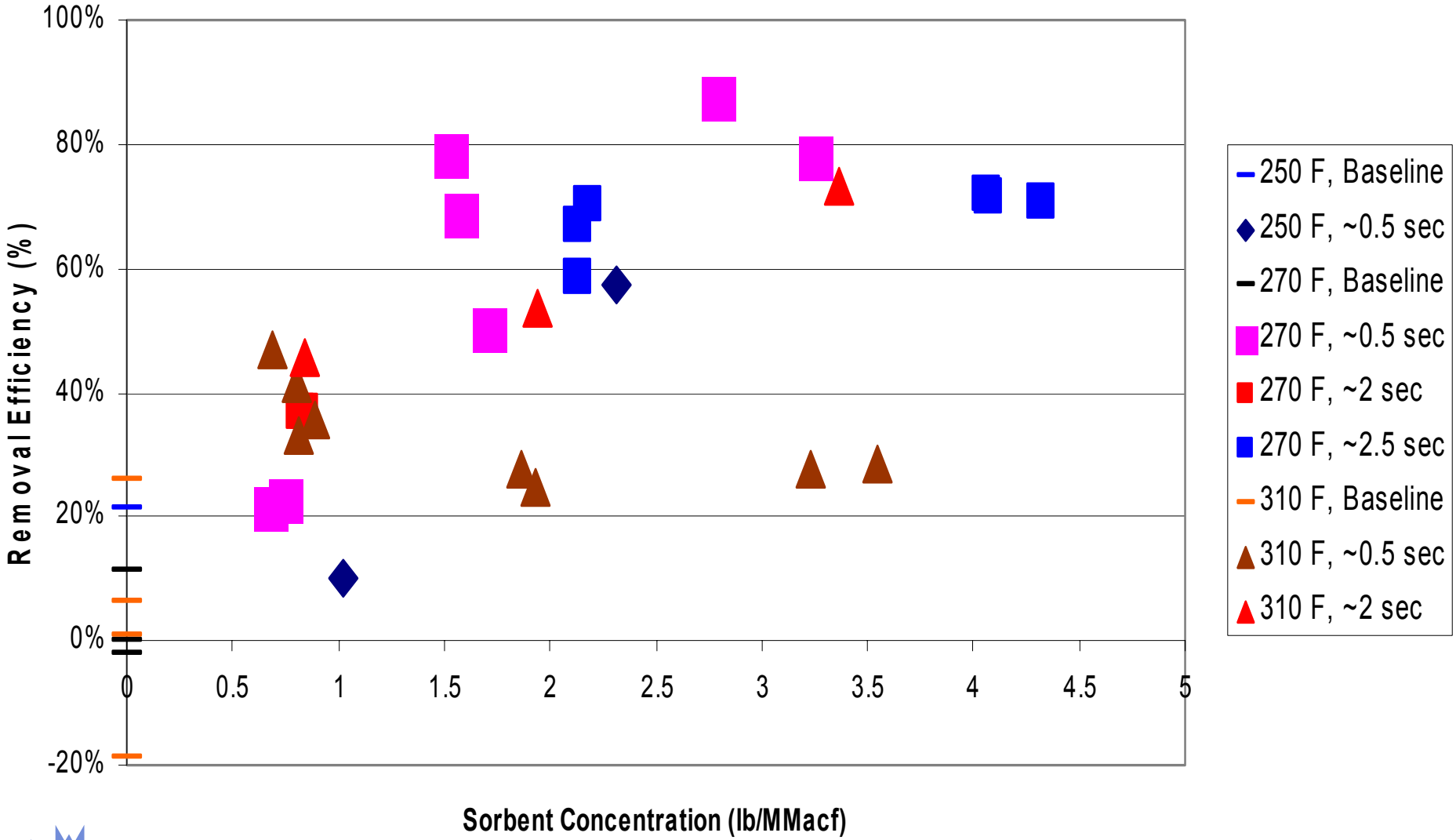
Hg Speciation-PRB Coal w/o Sorbent Injection



Typical Hg Sampling Day - PRB Coal



In-Duct Hg Removal Efficiency



Conclusions from Parametric Testing

- 500 lb/hr pilot combustor baseline speciation and activated carbon removal efficiency are very similar to full-scale testing results
- Impact of residence time on in-duct removal efficiency greater at higher temperatures
- Increase in Hg removal efficiency with sorbent feed rate up to about 3 lb/MMacf

Conclusions from Parametric Testing cont.

- Increase in removal minimal above 3 lb/MMacf
- Above 3 lb/MMacf best strategy to increase Hg removal may be to decrease duct temperature or increase residence time
- Total system removals 85-95 percent

Conclusions from Parametic Testing cont.

- **Slipstream measurements useful for evaluation of various in-duct measurement methods**
  - Slipstream Hg removals with Evergreen coal were not representative of pilot-scale testing
  - Conversion of elemental to oxidized mercury in the slipstream

Work in Progress

- GP-254
- Thief process
- Hg control in SD/FF configuration
- Enhancements to numerical model using PRB data from full flow testing on 500 lb/hr unit
- Effects of coal blends on Hg removal