In-House Research on Mercury Measurement and Control at NETL

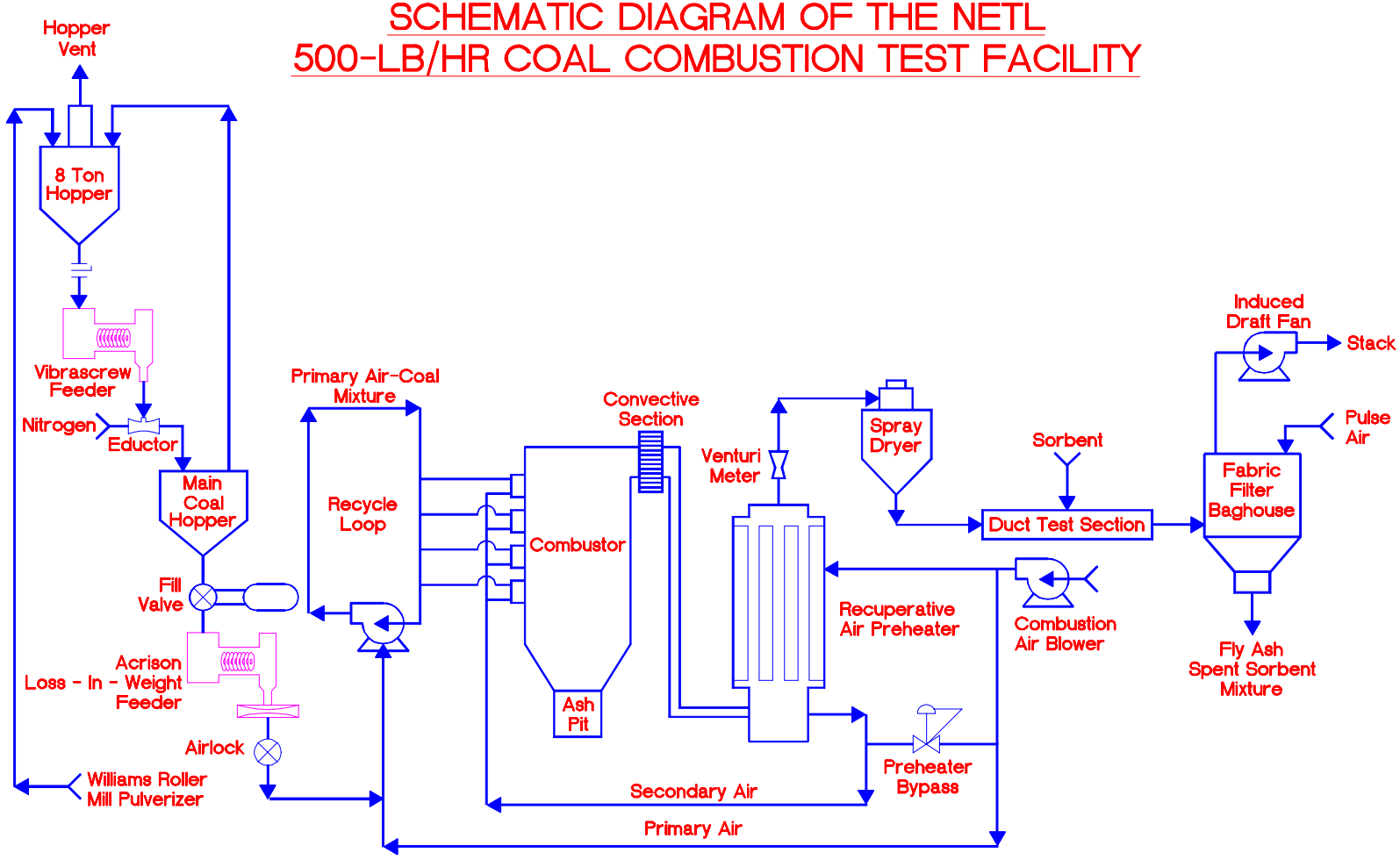
BACKGROUND

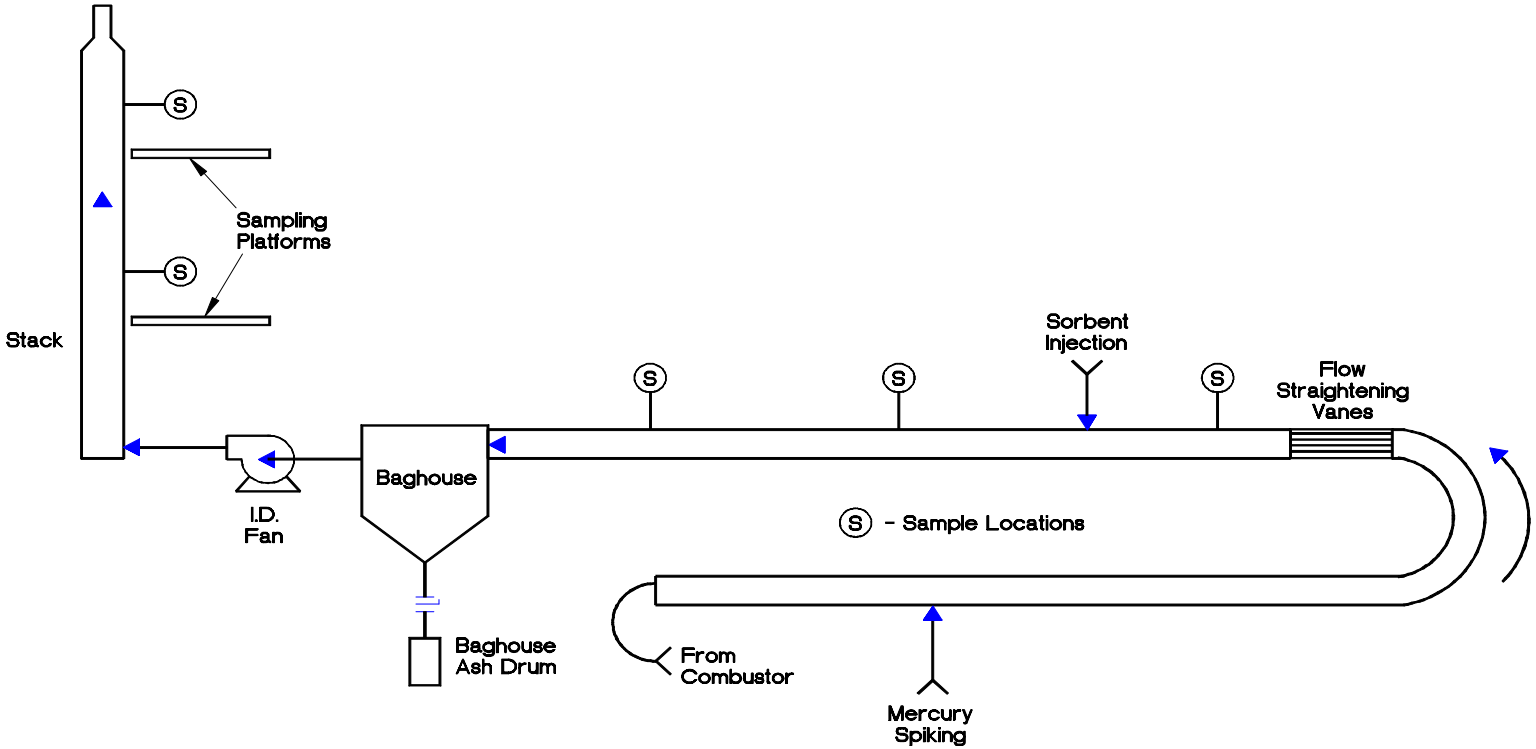
- Over 32% of man-made emissions of Hg in U.S. are from coal-fired utilities.
- Future regulation of utility emissions has been proposed by EPA.
- Control of Hg emissions is complicated by low concentrations (~1 ppbv) and speciation variability.
- EPA report suggests sorbent injection as a low-cost technique for mercury removal.
- NETL's in-house research effort is conducted at both pilot and lab scales.

PILOT RESEARCH OBJECTIVES

- **Evaluate methods for measurement of mercury concentration and speciation.**
- **Assess the technical performance of sorbent-based control technology by developing engineering databases.**

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





DUCT TEST SECTION

PILOT WORK TESTING GOALS

- Determine mass balances around pilot unit and baghouse efficiency.
- Quantify mercury concentration, vapor/solid distribution, and speciation in flue gas.
- Measure mercury concentration in coal and ash.
- Assess sorbent removal capability.

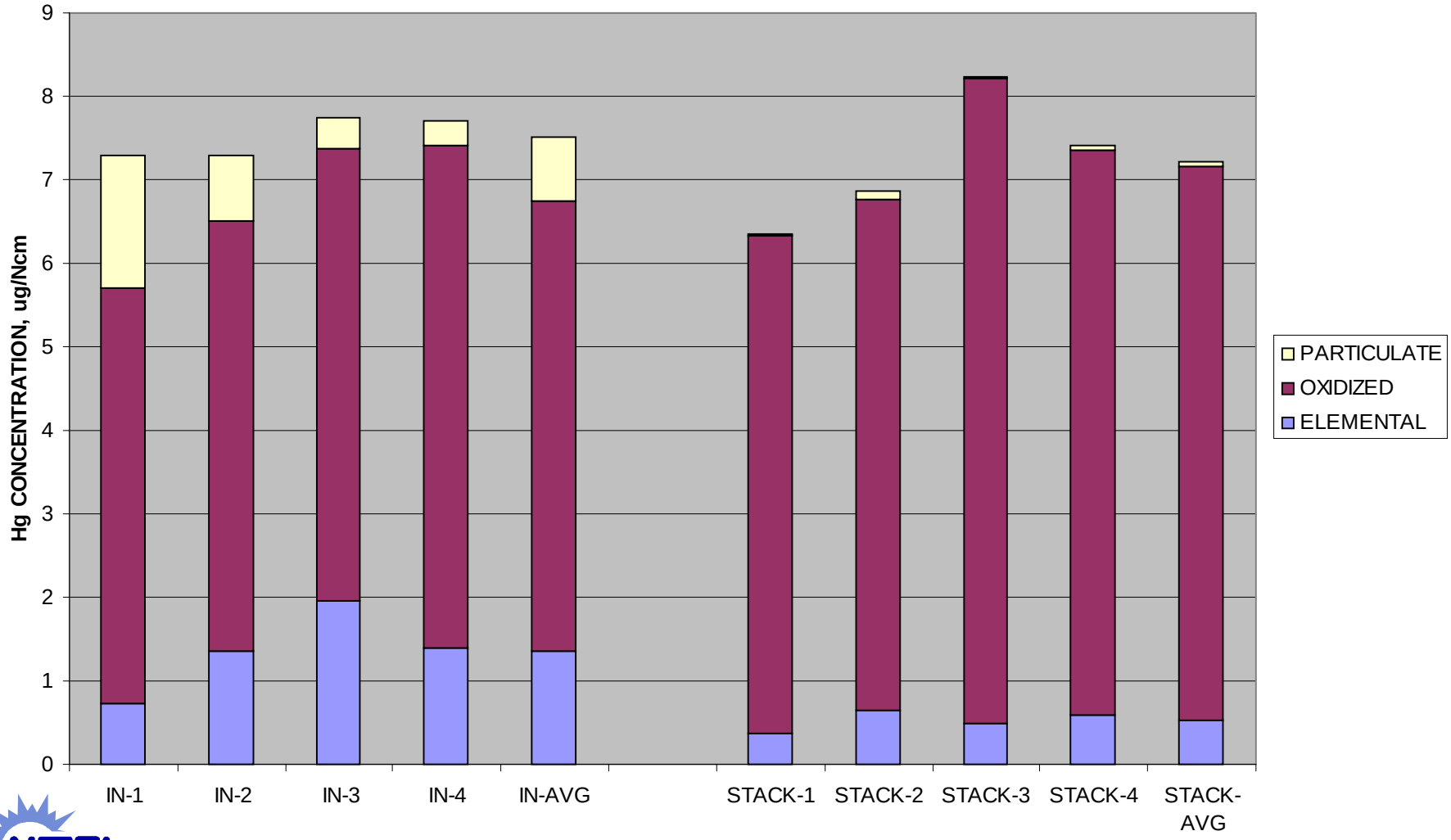
RESULTS OF PREVIOUS TESTING

- Characterization tests completed using various bituminous coals
- Collaborative research efforts with ATS, Inc., and ADA, Inc.
- Training for DOE Air Toxics Team in EPA/ASTM methods
- Shakedown of sorbent injection system

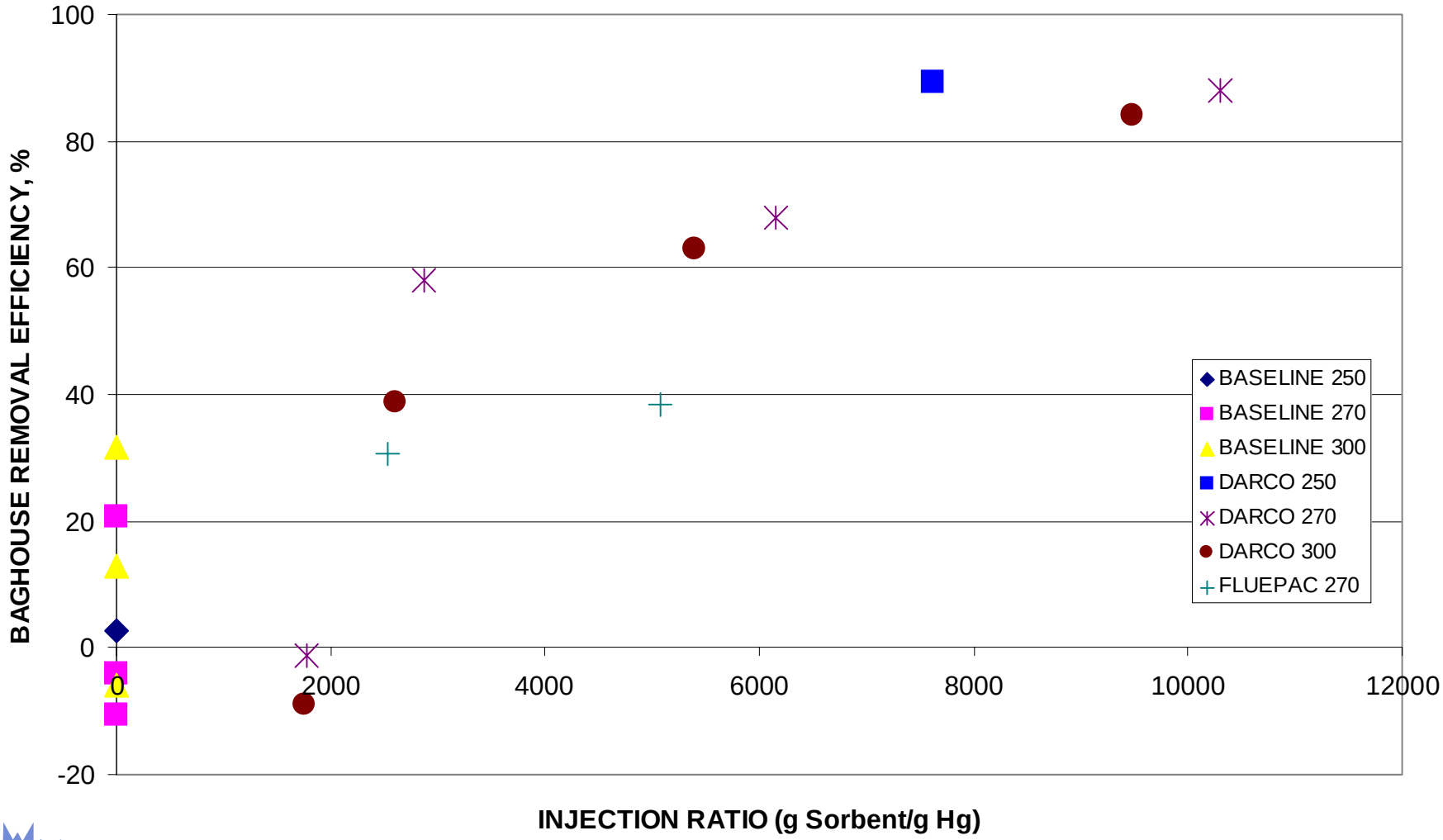
RECENT GOALS

- **Establish mercury speciation and removals with baseline low-sulfur coal.**
- **Compare mercury speciation techniques: Ontario-Hydro, continuous emissions monitor, and Sorbent Ontario-Hydro.**
- **Test commercial sorbents.**
  - Calgon FluePac and Darco Norit FGD
  - Various injection rates and baghouse conditions

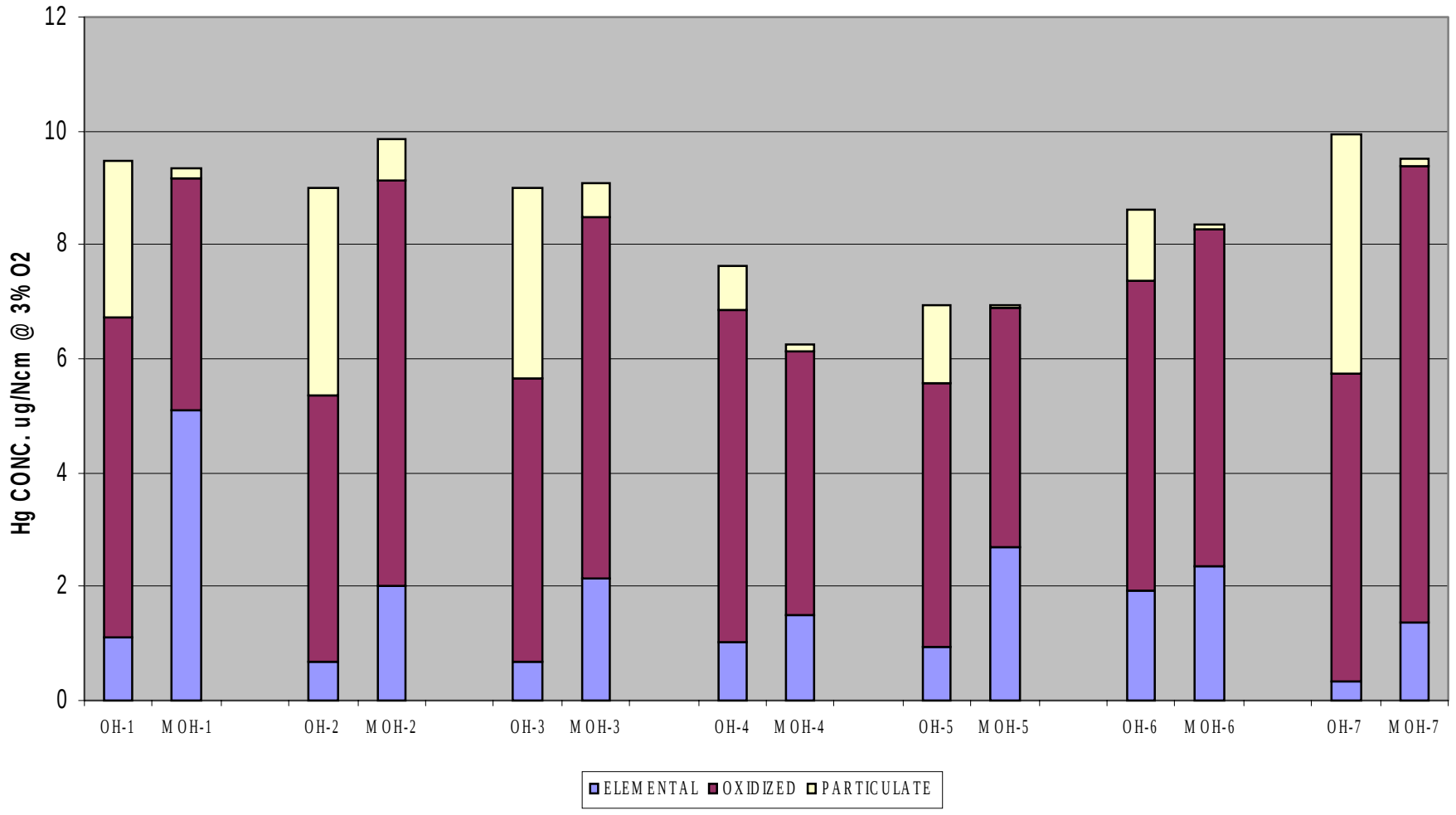
EVERGREEN COAL NO SORBENT INJECTION
ONTARIO-HYDRO METHOD



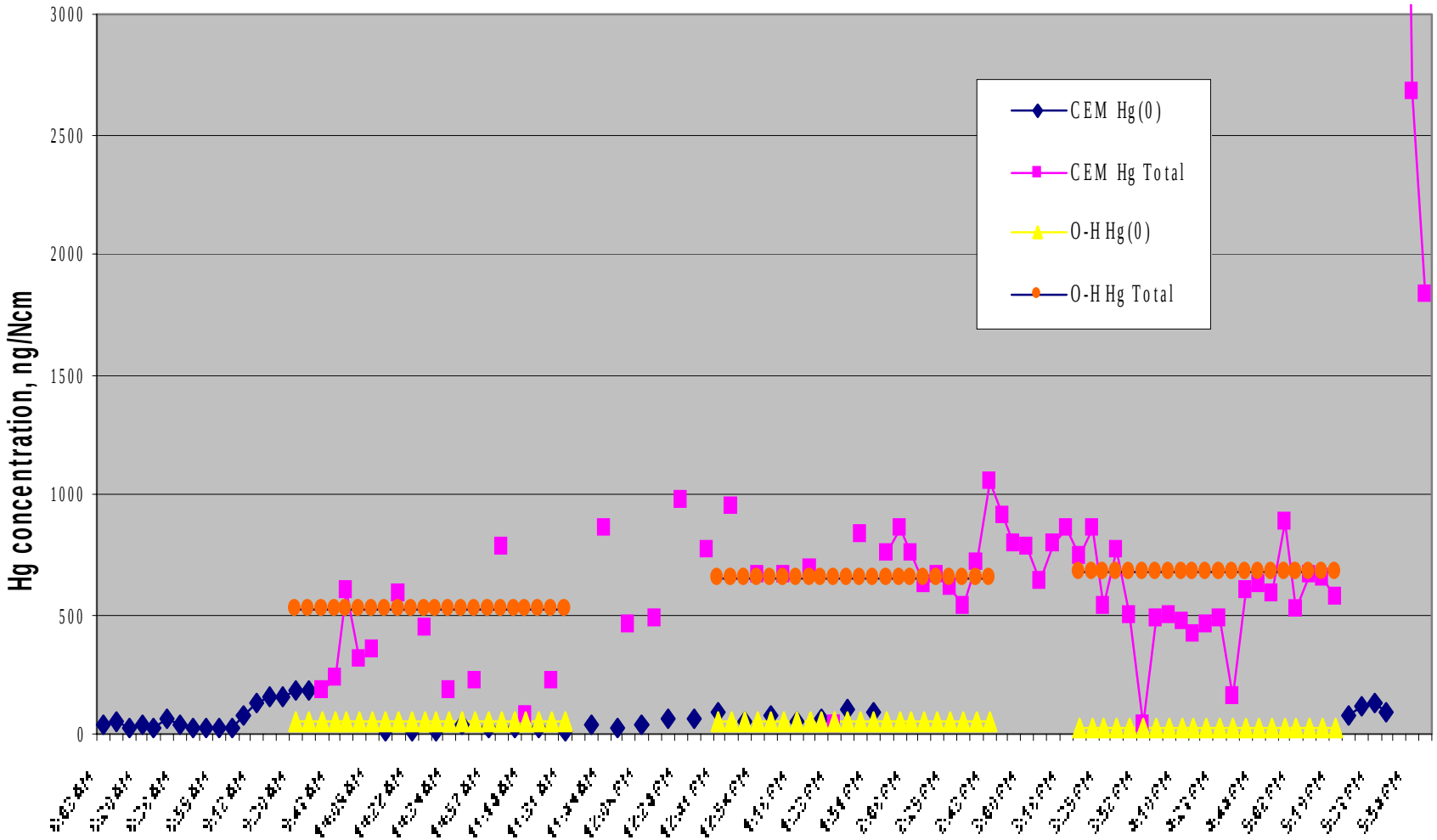
MERCURY REMOVAL VS. SORBENT INJECTION RATE



EFFECT OF FILTERED SOLIDS ON SPECIATION



COMPARISON OF PSA CEM VS O-H METHOD 03/28/00



CONCLUSIONS

- **Hg removals of 40 to 90% achieved at injection ratios of 2,600:1 to 10,300:1 with Norit DARCO activated carbon.**
- **Hg removals of 30% to 40% achieved with Calgon FluePac at injection ratios of 2,500:1 to 5,100:1.**
- **In-duct removals were not significant under the conditions tested.**
- **Elemental mercury appears to be oxidized by filter cake.**

CONCLUSIONS

- **Initial results indicate that, although humidification can significantly lower flue gas temperature, higher moisture may have an adverse affect on mercury removal with activated carbon.**

- **There was good agreement among the three techniques for used to measure mercury speciation.**

CURRENT PLANS FOR PILOT WORK

- Continue testing with activated carbon and quantify effects of humidification and baghouse pressure drop on mercury removal.
- Evaluate novel sorbents.
- Determine sorbent effectiveness downstream of baghouse with and without recycle.
- Compare removals using sorbent injection with ESP and baghouse.

Lab-Scale Research Objectives

- Develop cost-effective novel sorbents.
- Elucidate mercury-sorbent interactions.
- Explore innovative techniques for mercury removal, for example, photochemical oxidation

Parametric Scan In Packed-Bed Reactor

Sorbents/Promoters

- **AC, Metal oxides, Halides, Sulfur/Sulfides**

  Flyash (unburned carbon)

Supports

- **AC, Alumina, Silicates**

Temperatures: 140°F, 280°F, 350°F

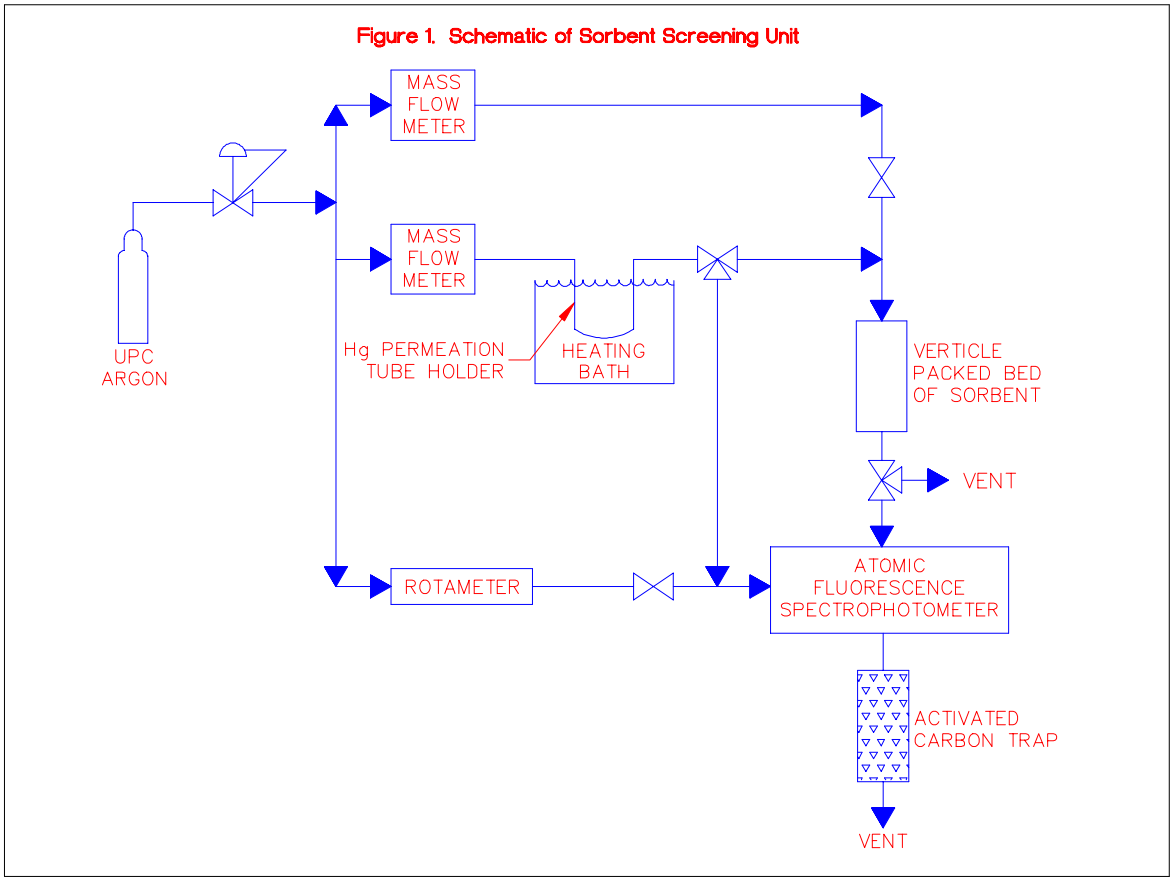
Carrier Gases: Ar, Air, 4% O_2, SFG

Elemental Mercury Concentration: 585 ppb

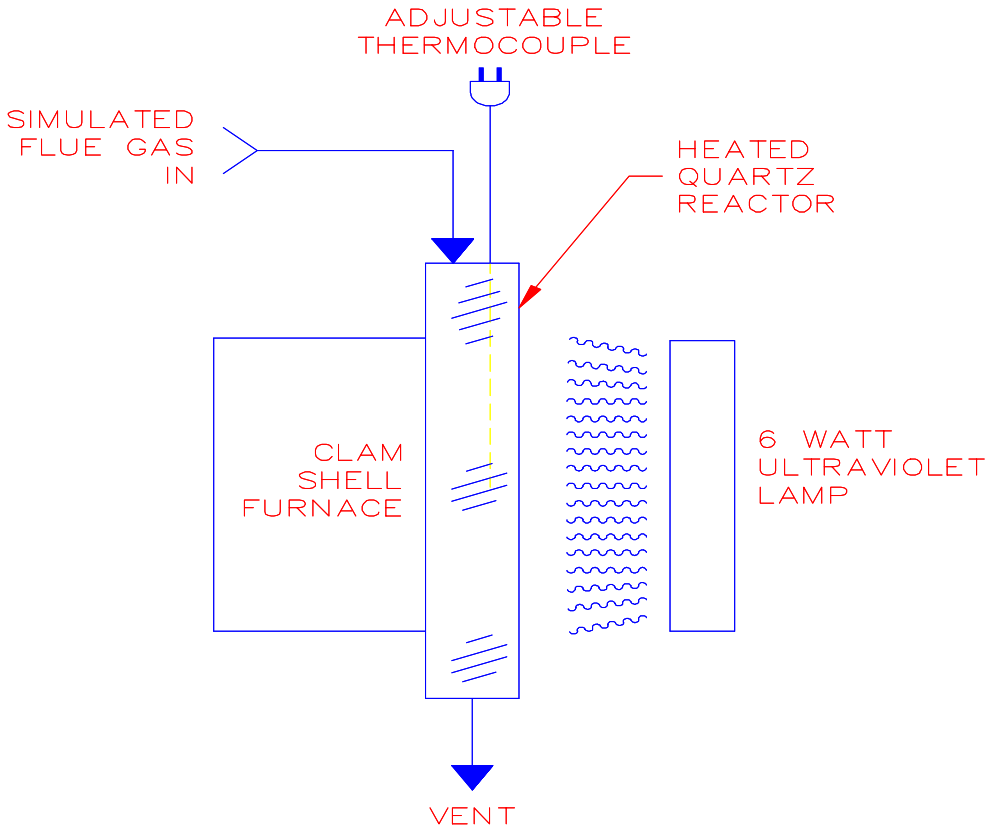
Mass of Sorbent: 10 mg

Mercury Measurement: AFS, CVAAS

LAB-SCALE SORBENT SCREENING UNIT



LAB-SCALE PHOTOREACTOR



Lab-Scale Conclusions: Sorbents

- **Packed-bed system can screen potential sorbents using AFS continuous Hg detector.**

- **In general, sorbents perform better:**
  - **When chemically promoted**
  - **At lower temperatures**

- **Future sorbent work will investigate:**
  - **Impact of simulated flue gas**
  - **Sequestration of the mercury**
  - **Pilot plant testing**

Lab-Scale Conclusions: Irradiation

- **Irradiation with 253.7 nm ultraviolet light will remove elemental mercury from flue gas.**
- **Capture as oxide or sulfate.**
- **Larger removals at lower temperature.**
- **Future work will optimize process.**