# Long-Term Operation of a COHPAC™ System for Removing Mercury from Coal-Fired Flue Gas

**DOE/NETL's Mercury Control Technology R&D Program Review**

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# Outline

- Review of Results from Full-Scale Short-Term Tests (2001)
- Overview of Long-Term Test Program
- Recent Results from Long-Term Test Program
- Next Steps

# NETL Phase I Mercury Control Tests

- Perform short-term, full-scale evaluations of sorbent-based mercury control on coal-fired boilers (up to 150 MW equivalent).
- Test conducted 2001 – 2002 at four sites.
- Primary funding from DOE National Energy Technology Laboratory (NETL) with co-funding provided by:
  - Southern Company
  - PG&E NEG
  - Ontario Power Generation
  - TVA
  - Kennecott Energy
  - We Energies
  - EPRI
  - First Energy
  - Hamon Research-Cottrell
  - Arch Coal

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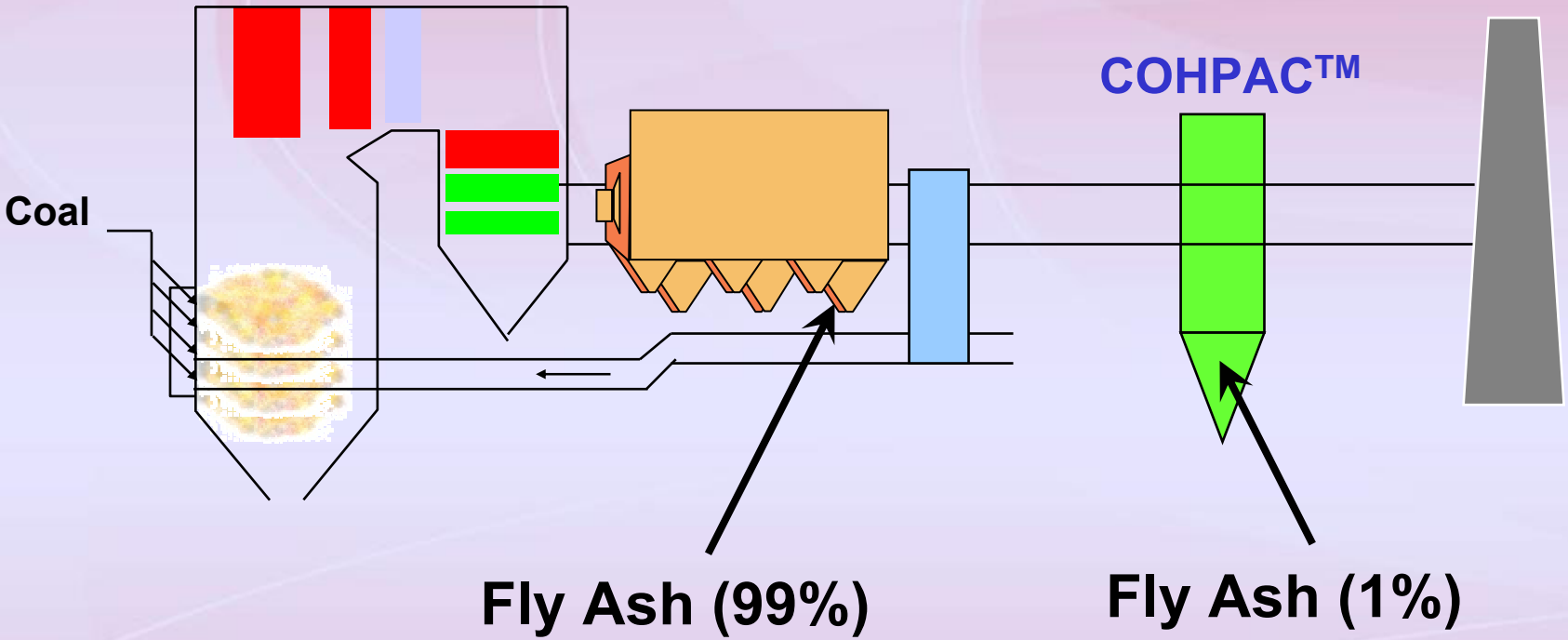
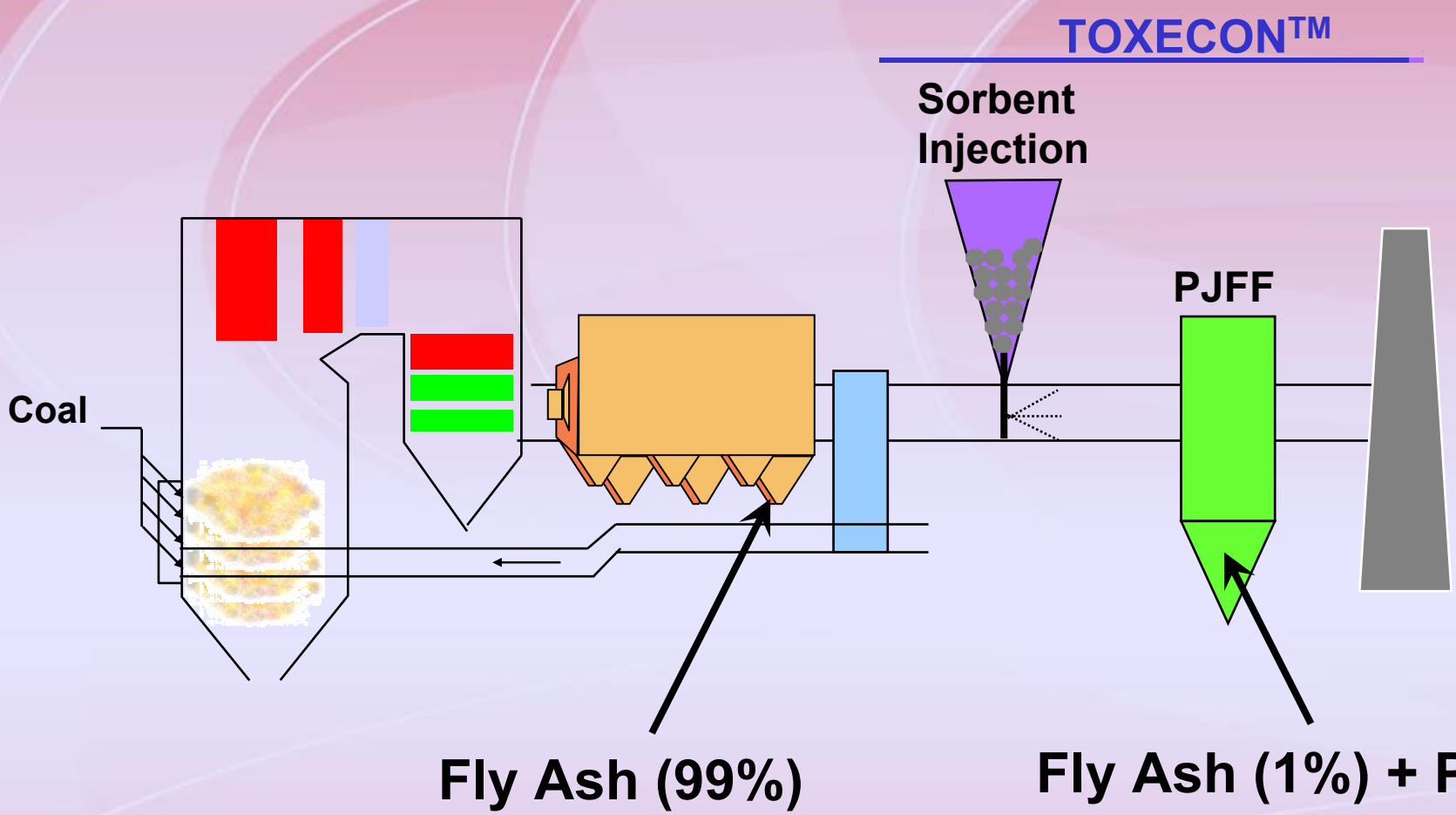
# Alabama Power E.C. Gaston Unit 3

- 270 MW firing a variety of low-sulfur, washed eastern bituminous coals.
- Particulate Collection:
  - Hot-side ESP, SCA = 274 $ft^2$/1000 acfm; and
  - COHPAC™ baghouse
- Wet ash disposal to pond.

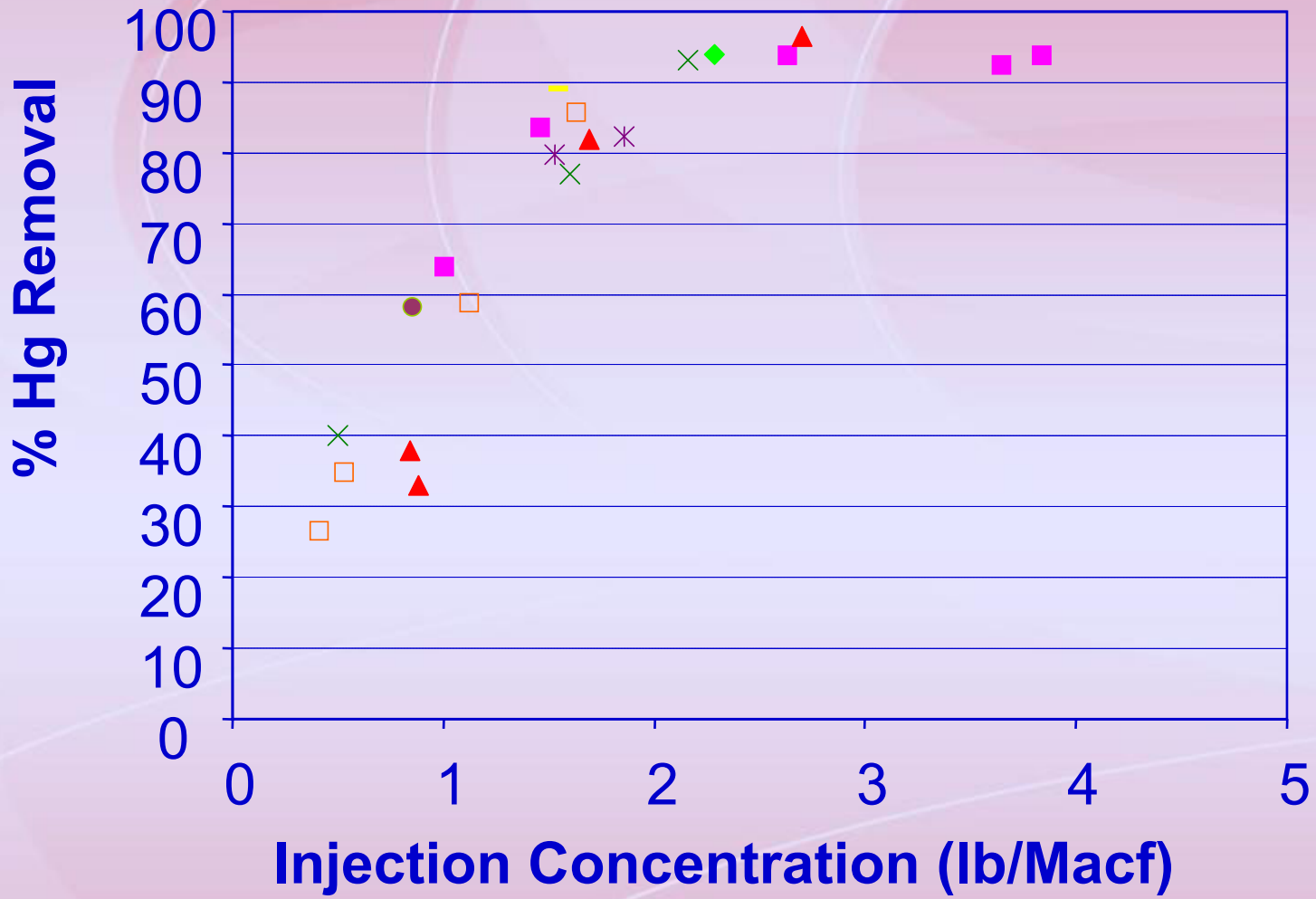
# COHPAC™ Configuration



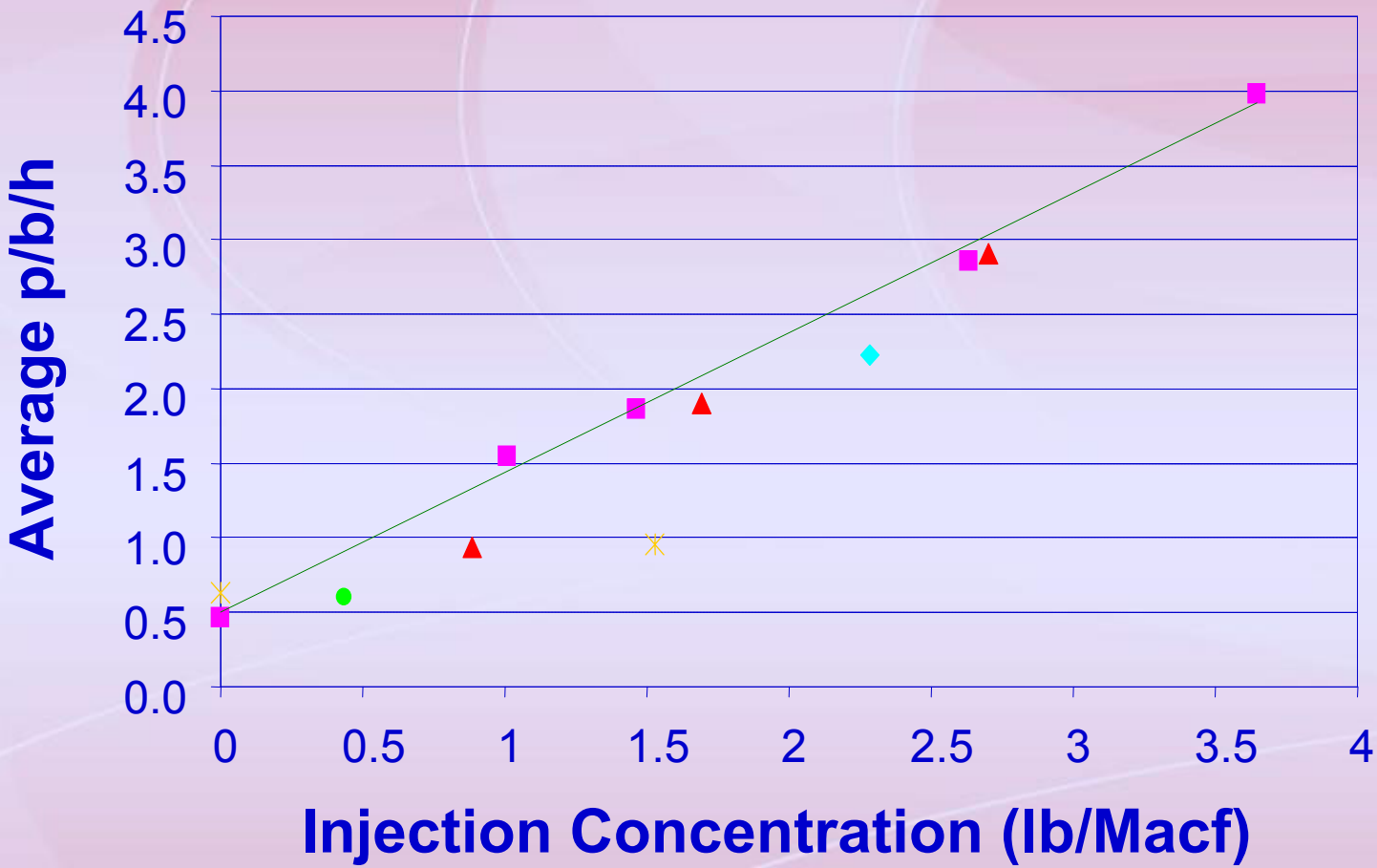
# TOXECON™ Configuration



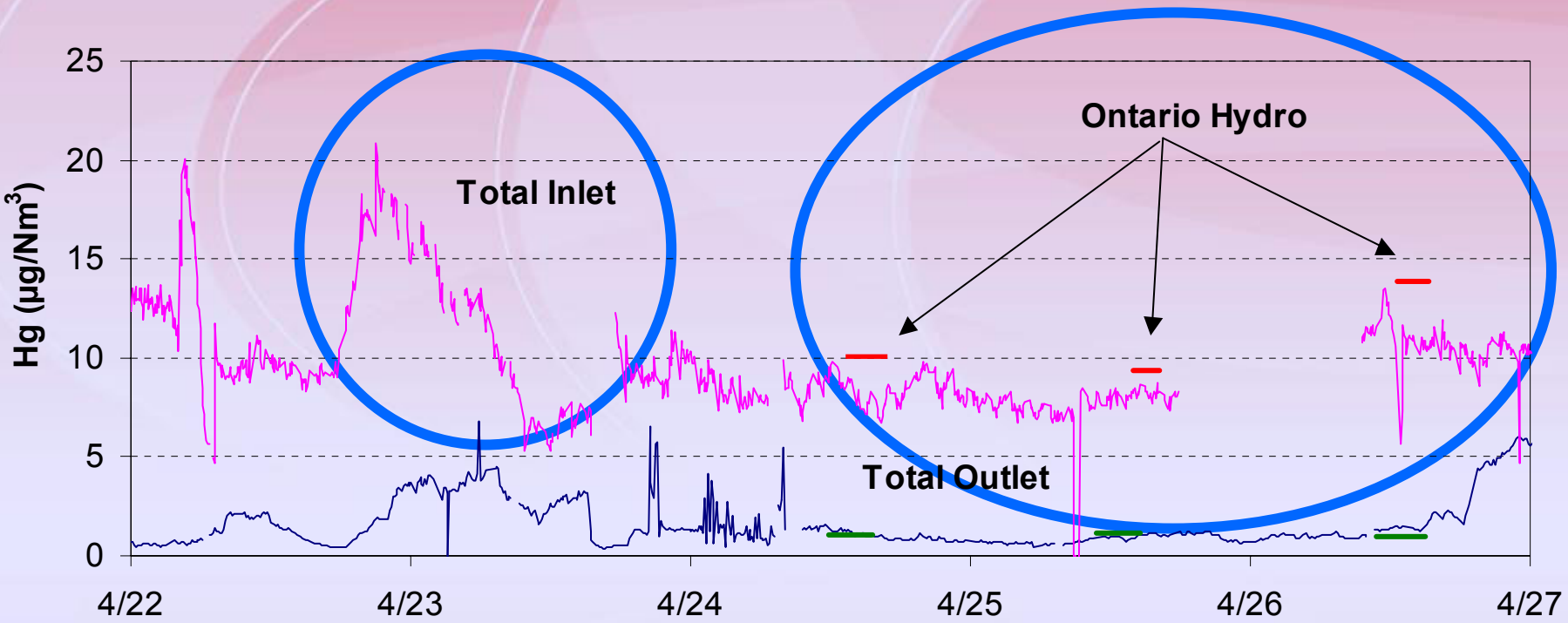
# Phase I Test Results



# Impact of Injection on Performance



# 5-Day Continuous Injection




**(Injection Concentration = 1.5 lbs/Macf)**

# Unanswered Questions

- Long-term test removal efficiency varied between ~40 and 90%. What injection rate is necessary to tighten this range?
- Can advanced, high-permeability fabrics reduce impact of carbon on cleaning frequency?
- What are the long-term impacts on bag life?

# Long-Term TOXECON™ Test

- Follow-on program to Phase I field tests
- Alabama Power Gaston Unit 3 COHPAC™
  - Sorbent injection in one-half of Unit 3 COHPAC™
  - 135 MW, ~ 500,000 acfm
- Funding provided by
  - NETL
  - Southern Company
  - Ontario Power Generation
  - Alleghany Power
  - Hamon Research-Cottrell
  - EPRI
  - TVA
  - First Energy
  - Duke Power
  - Arch Coal

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# Test Program Major Tasks

- Evaluate long-term performance of activated carbon injection into COHPAC™
  - 6 months on original bags
  - 6 months on new, high-perm bags
- Perform short-term tests of alternate sorbents
- Design and install a sorbent injection system capable of continuous, unattended operation
- Install a mercury analyzer capable of continuous, long-term operation

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# Actual Schedule

| | 1Q03 | 2Q03 | 3Q03 | 4Q03 | Status |
|---|---|---|---|---|---|
| Installation & Start-Up | | | | | ✓ |
| Baseline Period 1 | | | | | ✓ |
| Optimization Period 1 | | | | | ✓ |
| Baseline Period 2 | | | | | ✓ |
| Optimization Period 2 | | | | | ✓ |
| Original Bag Test | | | | | In Progress |

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# Silo Installation

# Lances

# Mercury Detector

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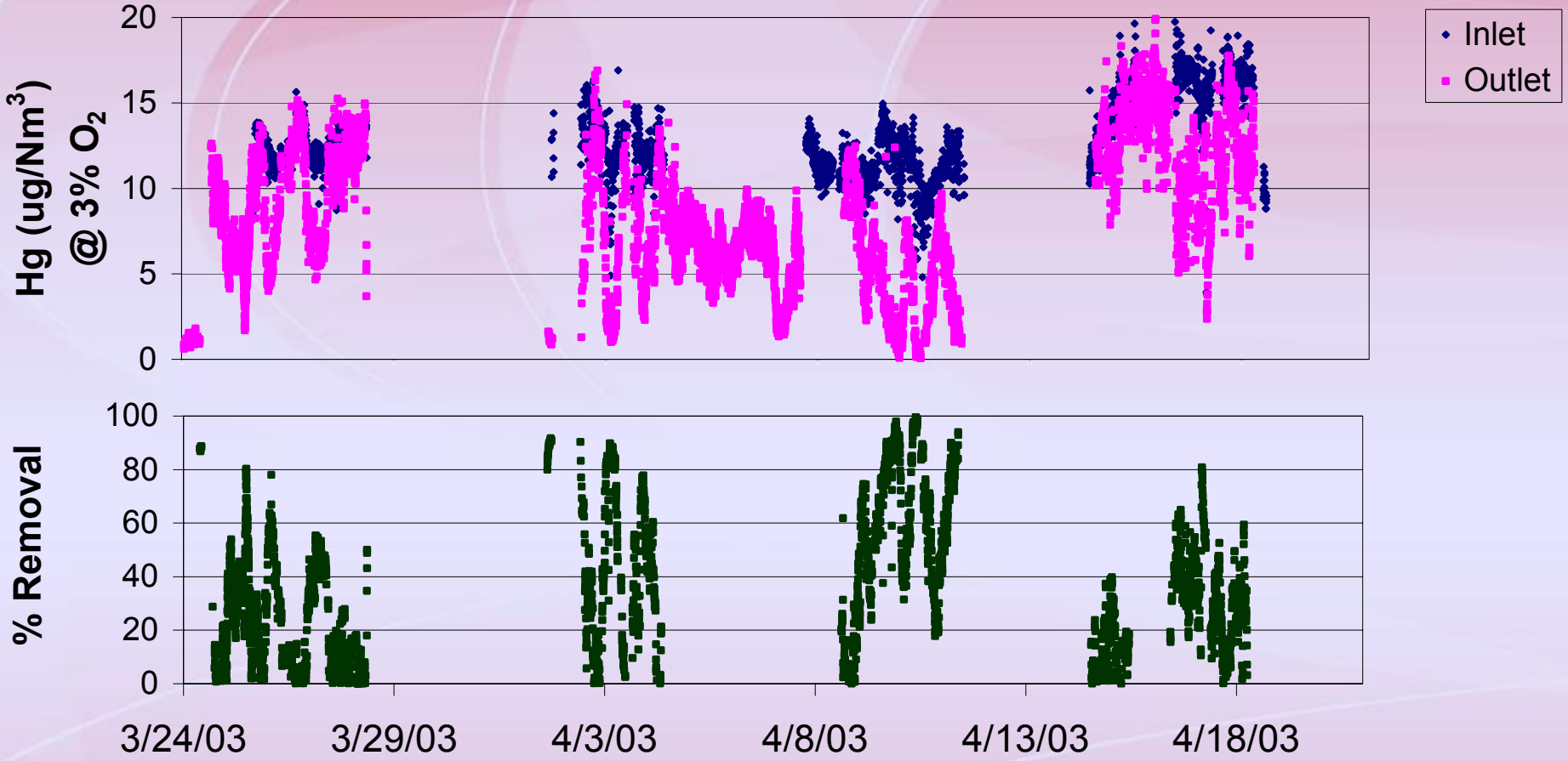
# Current Operation

- Full-time, on-site staff of three people
- Carbon injected 24 hours a day, 7 days a week
  - Norit Darco FGD activated carbon
- Hg S-CEM operation
  - 24/7 operation began week of July 21
  - Previous operation was Monday through Friday only

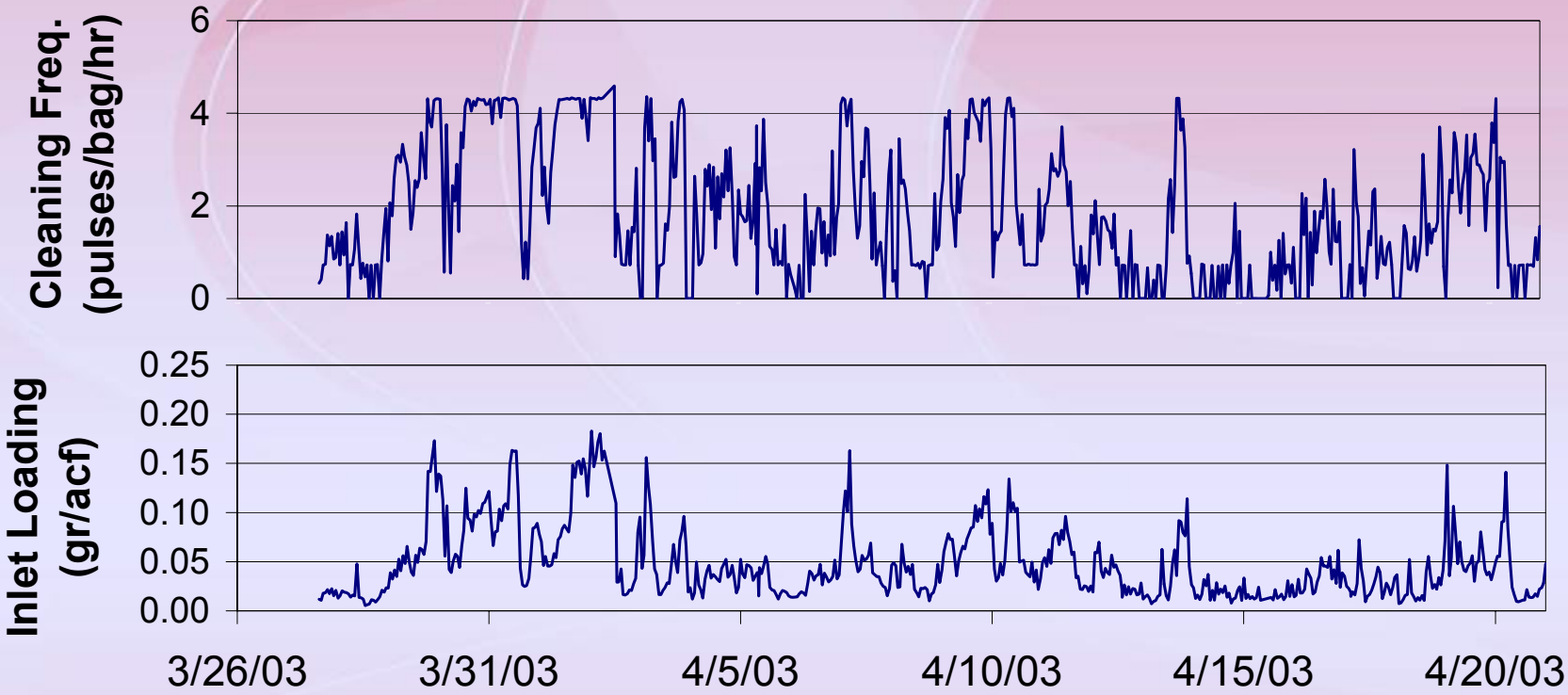
# Baseline Period 1 (No ACI)

- Goals
  - Inspect bags and test for bag strength
  - Measure mercury with Ontario Hydro tests and SCEM
  - Monitor COHPAC™ performance
  - Collect ash and coal samples

# Hg CEM Measurements Baseline 1



# COHPAC™ Performance Baseline 1

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# Results from Baseline OH Tests (No ACI)

| | PARTICULATE | OXIDIZED | ELEMENTAL | TOTAL |
|---|---|---|---|---|
| | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| COHPAC Inlet | 1.4 | 11.3 | 4.8 | 17.6 |
| COHPAC Outlet | 0.05 | 11.9 | 0.99 | 13.0 |
| Removal Efficiency | 96.3% | -5.4% | 79.6% | 26.3% |

# Baseline Period 1 Results (No ACI)

- COHPAC™ cleaning frequency significantly higher than historical averages
- Baseline mercury removal varies between 0 and 90%
  - Higher mercury removal during periods with higher inlet loading
  - Average from OH tests was 26.3%
- LOI of COHPAC™ hopper ash higher than previous tests (17% vs 11%)
- Baseline bag measurements completed
  - Bags in good condition

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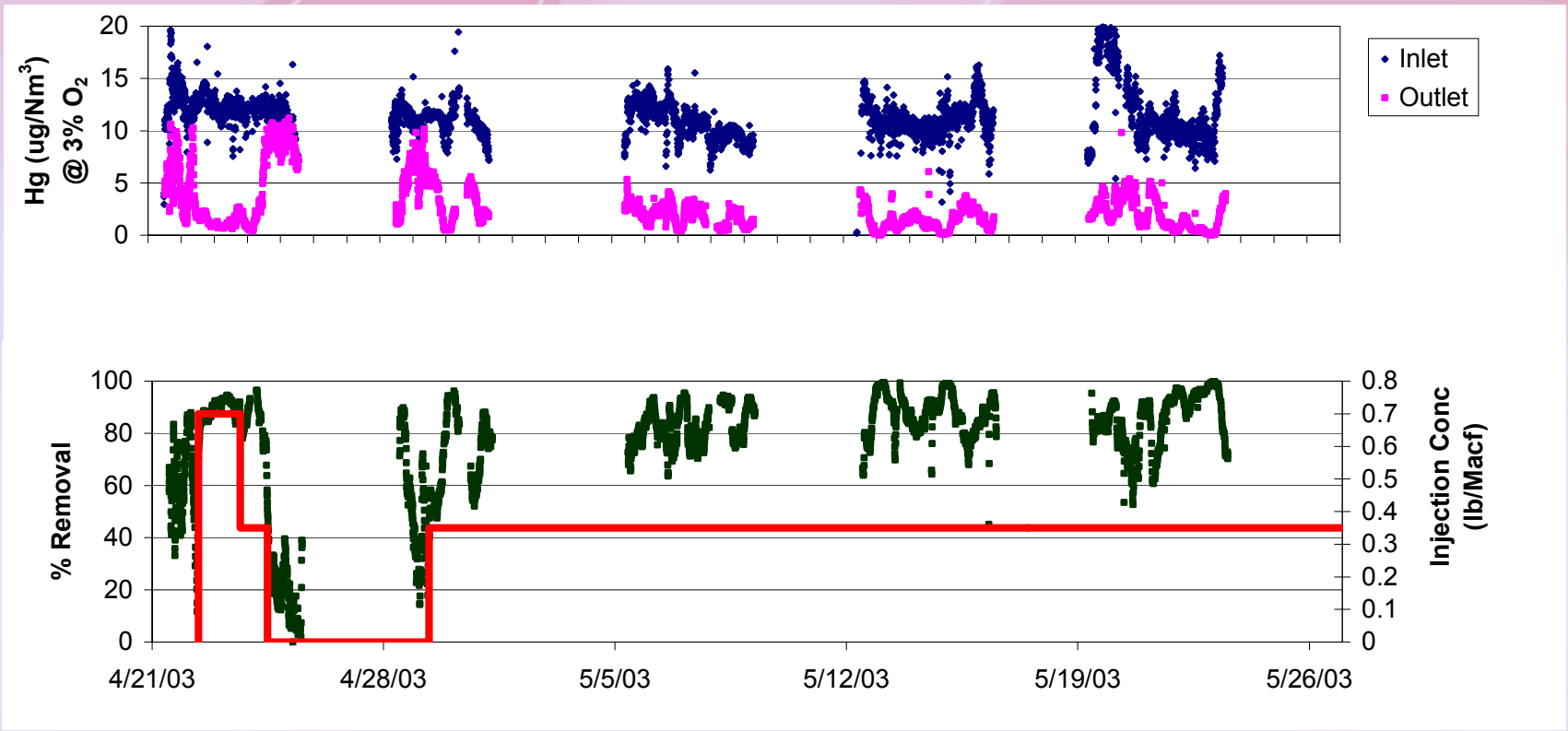
# Hg CEM Measurements Optimization 1

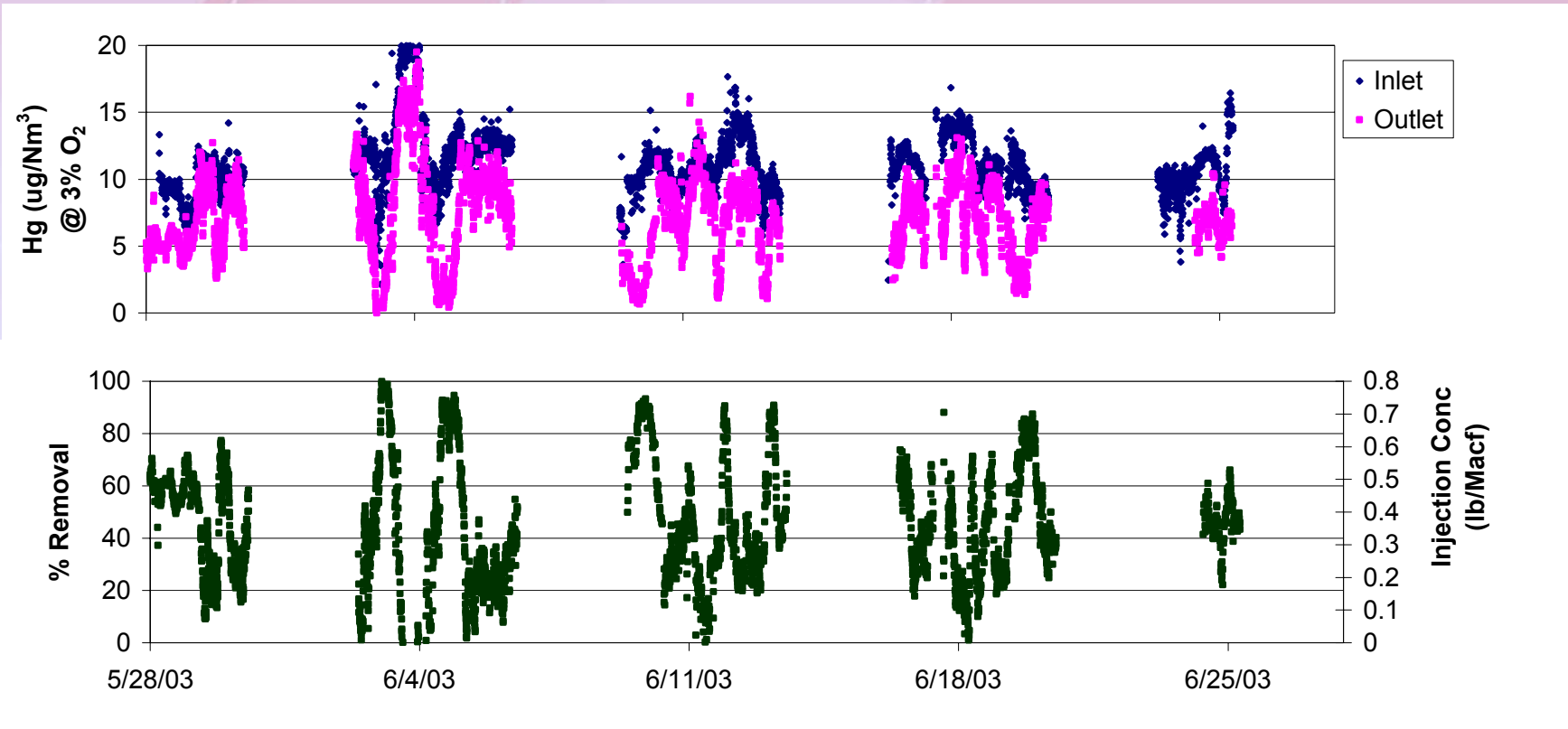


# COHPAC™ Hopper Ash Comparison

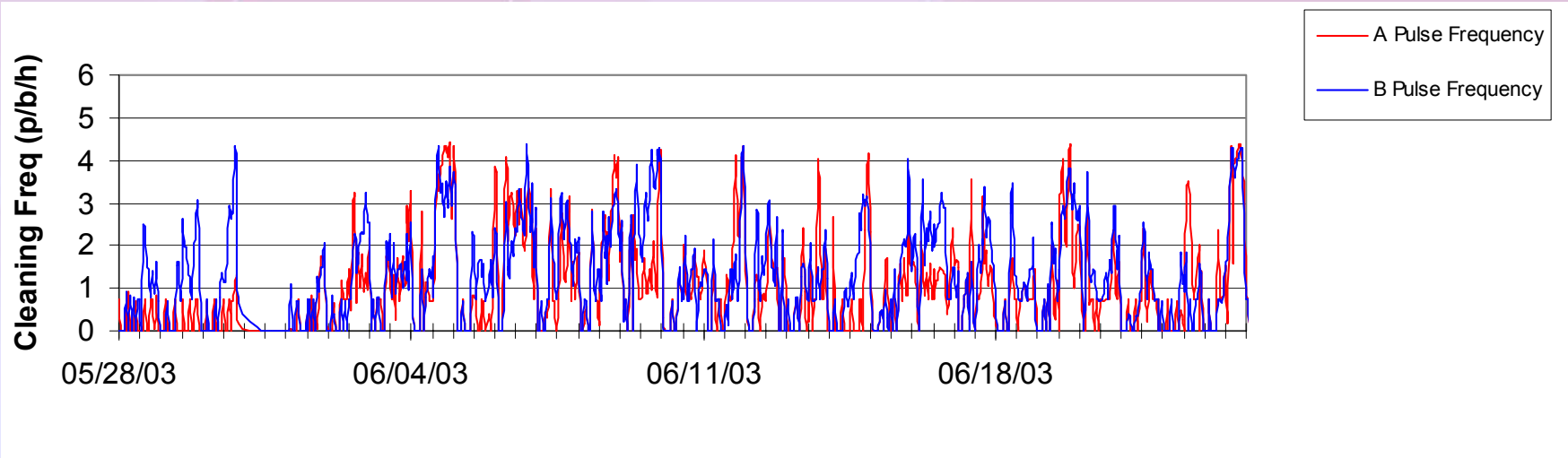
# Test Plan Redirection

- Goals
  - Obtain better understanding of “new” baseline conditions and cause(s)
  - Is COHPAC™ performance unique to B-side?
  - Would switching sides help meet test objectives?
  - Develop recommendations on how to proceed.

# Hg CEM Measurements Baseline 2 (No ACI)



# COHPAC Performance
# Baseline Period 2 (no ACI)



# Recommendations - Baseline Period 2

- Do not change sides
  - Still working on understanding operational changes
- Implement a new carbon injection control logic based on feedback from inlet mass loading.

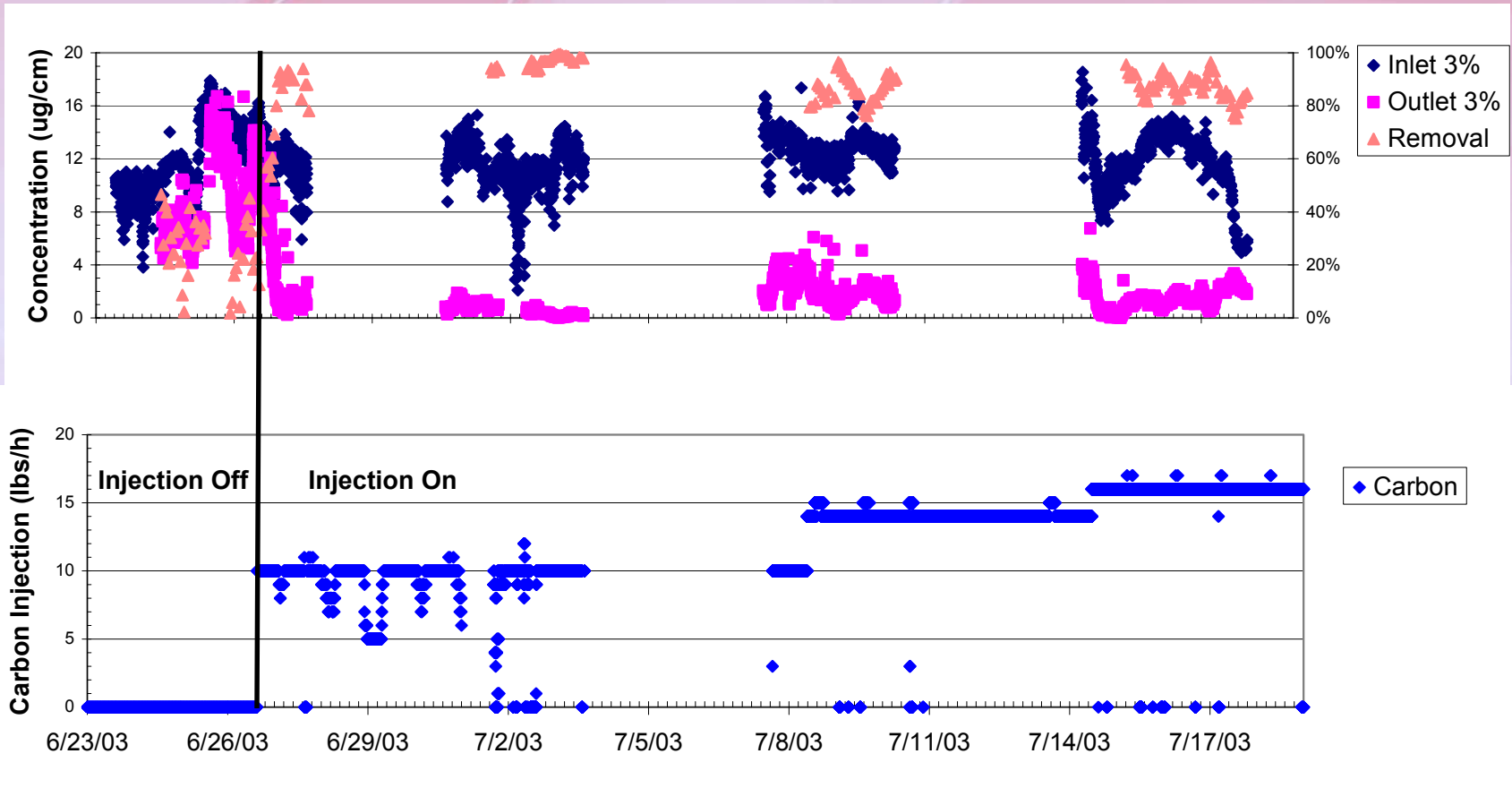
# Optimization Period 2 (with ACI)

- Goal – Inject activated carbon to obtain greater than 80% mercury removal
- Implement new carbon injection control logic
  - Injection rate varies based on inlet mass loading
  - During periods of high inlet mass loading, injection turned off

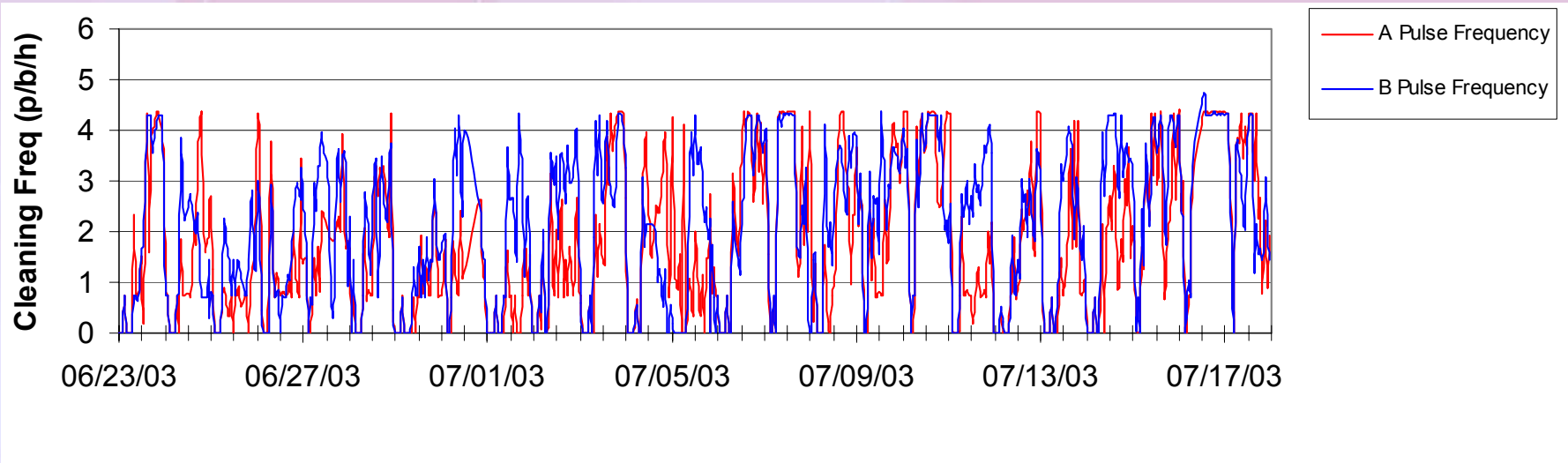
# New Injection Control Logic

| Inlet Loading (gr/scf) | Injection Concentration (lbs/Macf) | Injection Rate (lbs/h) |
|---|---|---|
| <0.1 | 0.52 | 15 |
| <0.2 | 0.35 | 10 |
| >0.2 | 0 | 0 |

# Optimization Period 2 (with ACI) Mercury Removal Trends



# COHPAC Performance Optimization Period 2 (with ACI)



# Performance Comparison 2001 vs 2003

| | 2001 | 2003 |
|---|---|---|
| **With ACI** | | |
| Carbon Injection Concentration | 1.5 lbs/Macf | 0.52 lbs/Macf |
| Average Hg Removal | 78% | 89%[a] |
| Variation | 36 – 90% | 76 – 98% |
| Average Cleaning Frequency | 0.74 p/b/h | 2.3 p/b/h |
| **Baseline with no ACI** | | |
| Average Baseline LOI | 11% | 17% |
| Average Baseline Hg Removal[b] | 0% | 26% |
| Average Baseline Inlet Mass Loading[c] | <0.01 gr/acf | 0.054 gr/acf |

a. *Calculated from hourly averages. Mercury measurements only made Monday through Friday.*
b. *Average from Ontario Hydro tests.*
c. *Baseline inlet loading during long-term tests.*
*Note: In Phase I, inlet loading was lower during long-term tests than during baseline tests.*

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# Results Summary (Preliminary)

- Baseline cleaning frequency is high
  - Inlet loading is higher than Phase I
  - Appears to be coal related
- Baseline Hg removal is higher
  - LOI in COHPAC™ ash is higher than Phase I
- Carbon injection rate is limited by cleaning frequency
  - Maximum injection concentration = 0.52 lbs/Macf compared to 1.5 lbs/Macf in Phase I

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# Results Summary (Preliminary), con't.

- Obtaining higher mercury removal at lower carbon injection rates than Phase I
  - Variation in removal efficiency is still larger than desired (76% - 90+%)
- Mercury S-CEM is now being operated 24/7
  - Calibrated every working day
  - Must change impingers about every 3 days
- Injection equipment is reliable and easily modified
  - Installed new program to control carbon injection

# Next Steps

- Continue injecting activated carbon using current control scheme
  - Unless forced to shut-down because of COHPAC™ performance
- Perform second set of Ontario Hydro measurements
  - Scheduled for week of August 25
- Evaluate alternate carbons
  - Difficult under current conditions
- Continue investigating cause of higher inlet COHPAC™ mass loading
- Install new high-perm bags in fall

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# Acknowledgements


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