EERC Technology – Putting Research into Practice

Mercury Control Technologies for Electric Utilities Burning Lignite Coal – Phase II Field Testing of Slipstream Technology

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DOE NETL Mercury Control Technology R&D Program Review

Project Officer: Lynn Brickett

Pittsburgh Airport Hyatt Hotel
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International Participation

Canada

- Saskatchewan Power
- Environment Canada
- Ontario Ministry of the Environment
- Luscar Ltd.

United States

- Basin Electric Power Cooperative
- Minnkota Power Cooperative, Inc.
- Otter Tail Power Company
- EPRI
  - Great River Energy
  - Xcel Energy
  - Minnesota Power, Inc.
- North Dakota Industrial Commission
- U.S. Department of Energy, National Energy Technology Laboratory (NETL)

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Project Goals

Develop, Test, and Demonstrate Sorbent-Based Technologies for Electric Utilities Burning Lignite Coal

- Increase the scientific understanding of mercury–flue gas interactions leading to more effective design of sorbents
- Test a range of sorbent-based technology options
- Determine and demonstrate optimum conditions for Hg capture using sorbents
- Field-demonstrate sorbent-based technology to prove and quantify effectiveness, performance, and cost

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Approach

Phase I – Bench-/Pilot-Scale Testing

- Lignite flue gas characterization
- Bench-scale sorbent-screening tests
- Pilot-scale control technology-screening tests
- By-product analyses

Phase II – Field Testing of Slipstream Technology

- Field demonstration
  - Select sorbent and technology option
  - Prepare site and install technology hardware
  - Evaluate sorbent effectiveness and impacts
  - Evaluate impact of design and process variables
  - By-product analyses
  - Quantify effectiveness and cost

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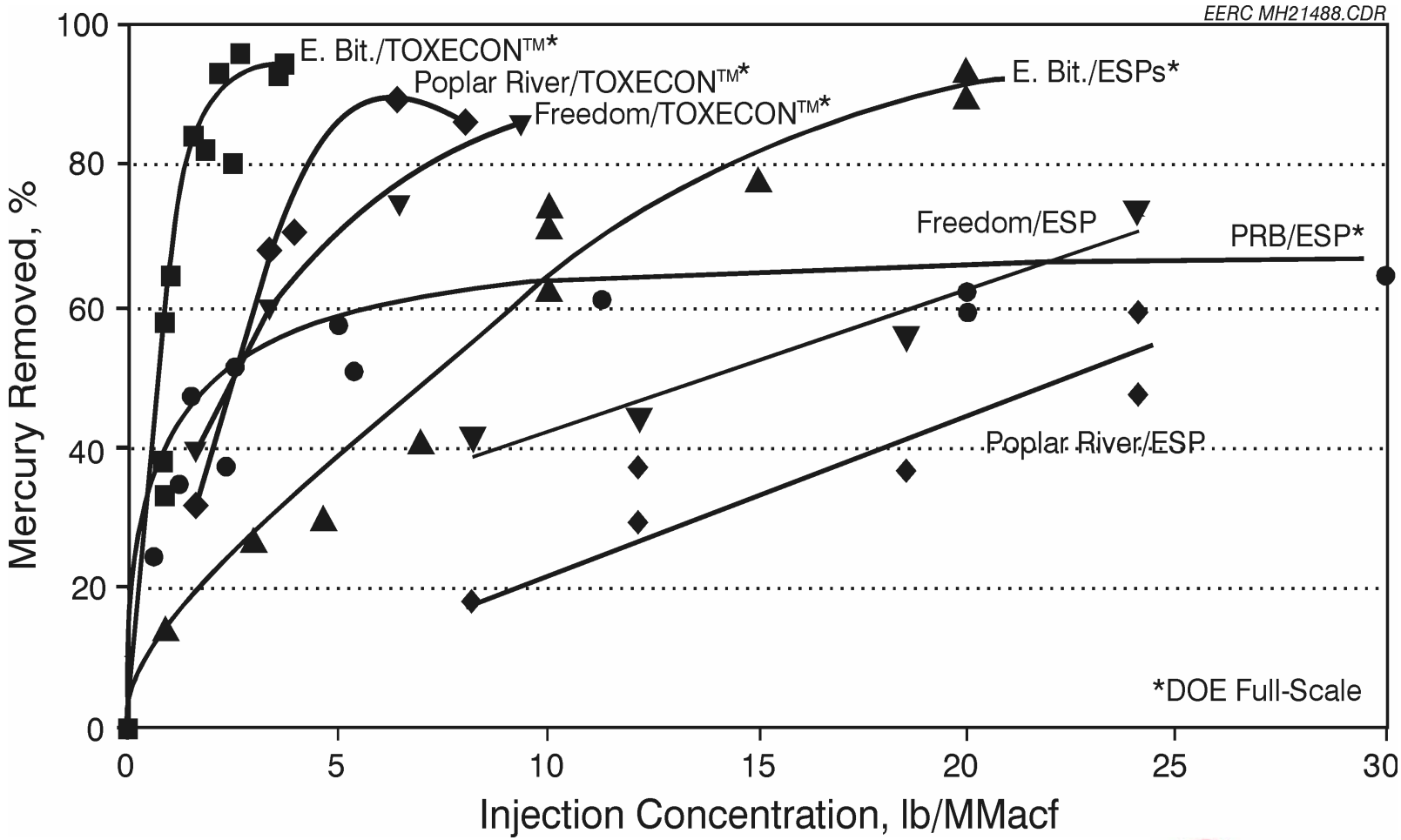
Phase I: Observed Trends in Hg Removal Using Activated Carbon Injection (ACI)



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Phase II – Field Testing of Slipstream Technology

Proposed Site – Poplar River Power Station (SaskPower)

- Two units, commissioned in 1981 and 1983
- Unit 1 = 298 MW and Unit 2 = 294 MW
- ESPs for particulate control

Poplar River Power Station

- South-central Saskatchewan
- 10 km SE of Coronach
- 1- to 10-MWe slipstream (varies with air-to-cloth ratio)

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Phase II – Field Testing of Slipstream Technology

Phase II Activities

- Assist in design of slipstream technology
- Develop test plan and test technology at Poplar River Plant
- Evaluate mercury impact on ash
- Summarize technology performance and cost
- Reporting and management

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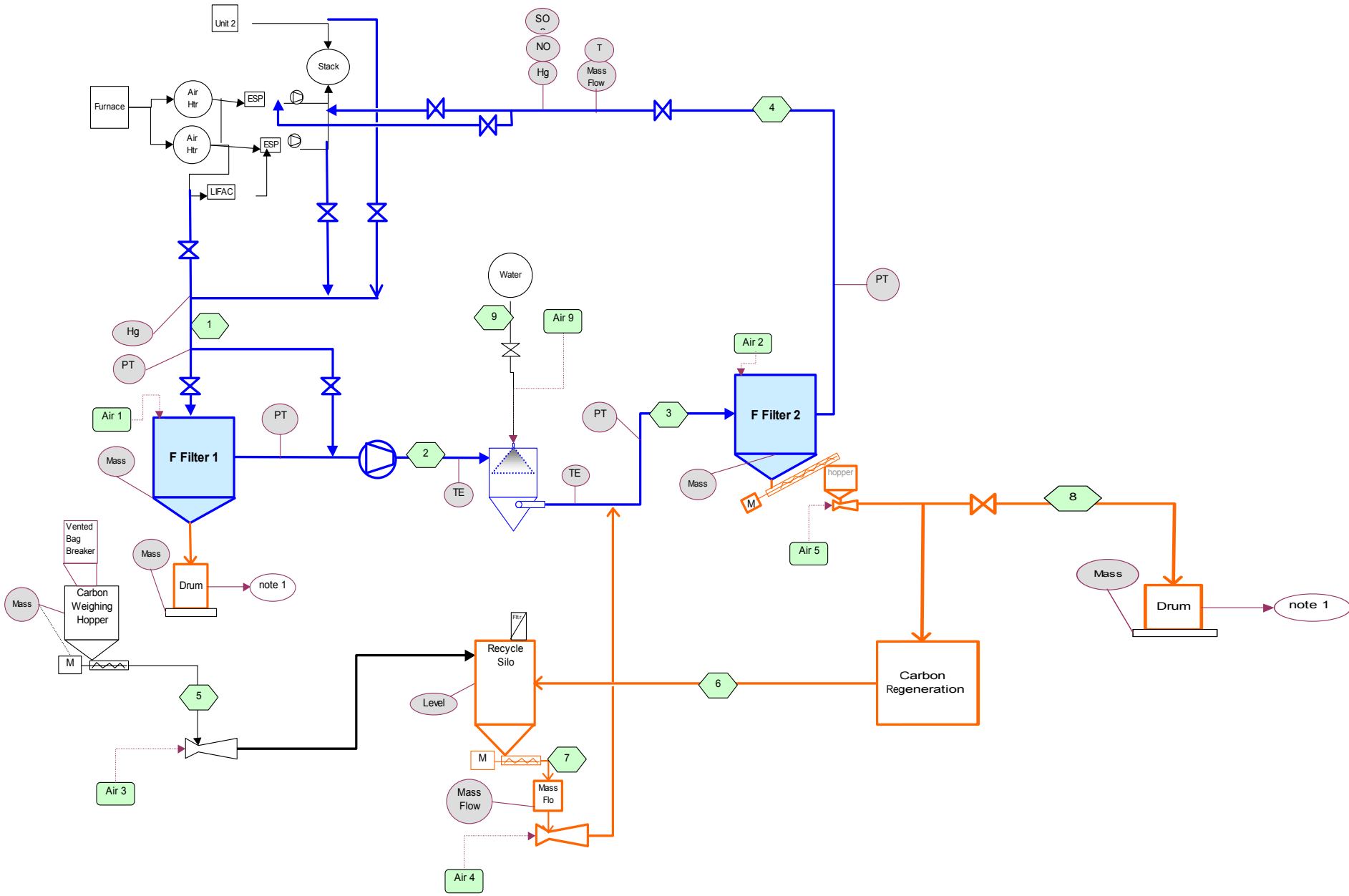
Phase II Field Testing
Design and Installation of Slipstream Technology

Progress: design of system complete, construction has begun, and shakedown testing scheduled for August.

- Factory acceptance tests for control system complete.
- CEM (NO_x/SO_2/CO/CO_2/O_2) system built, and system testing occurring at factory.
- Continuous Hg monitors ordered and received, and testing scheduled in July.
- Construction – all tie-ins complete, duct manufacturing complete, and fabric filter manufacturing in progress.
- Construction planned to be complete in August.
- First testing planned for early September.

Emission Control Research Facility



Building to House Slipstream Technology

Flue Gas Piping from Plant to Building

Installation of Prefabricated Technology Components

Simplified Test Plan Details (tentative)

Test Condition	Test Duration, days
Shakedown Testing	2–5
Screening Tests, 1-2 weeks	
Sorbent 1, Luscar	1
Sorbent 2, NORIT FGD	1
Sorbent 3-?, TBD*	2–5
Parametric Tests	
Sorbent 1 or 2 or 3 or 4	20–30
Long-Term (3–6 month) Tests	
Sorbent 1, Luscar	90–180

* To be determined based on sponsor input.

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Screening and Parametric Test Parameters

Sorbents

- Commercially Available AC (Norit FGD, etc.)
- Luscar Prepared AC
- Treated Carbons
- Amended Silicates?
- Recycled/Regenerated Sorbents

Test Parameters

- Injection Rate
- Batch/Continuous Injection
- Gas Temperature
- Gas Flow (a/c of 4, 6, 8)
- Bag Material
- Bag Cleaning
- Low/High Dust Loading

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Phase II – Field Testing
Bench-Scale Testing

- Twelve Luscar-prepared sorbents were tested.
- Approximately 1-gram sample size.
- Bench-scale screening was conducted using low-acid-gas conditions and elemental mercury (Hg^0) injection.

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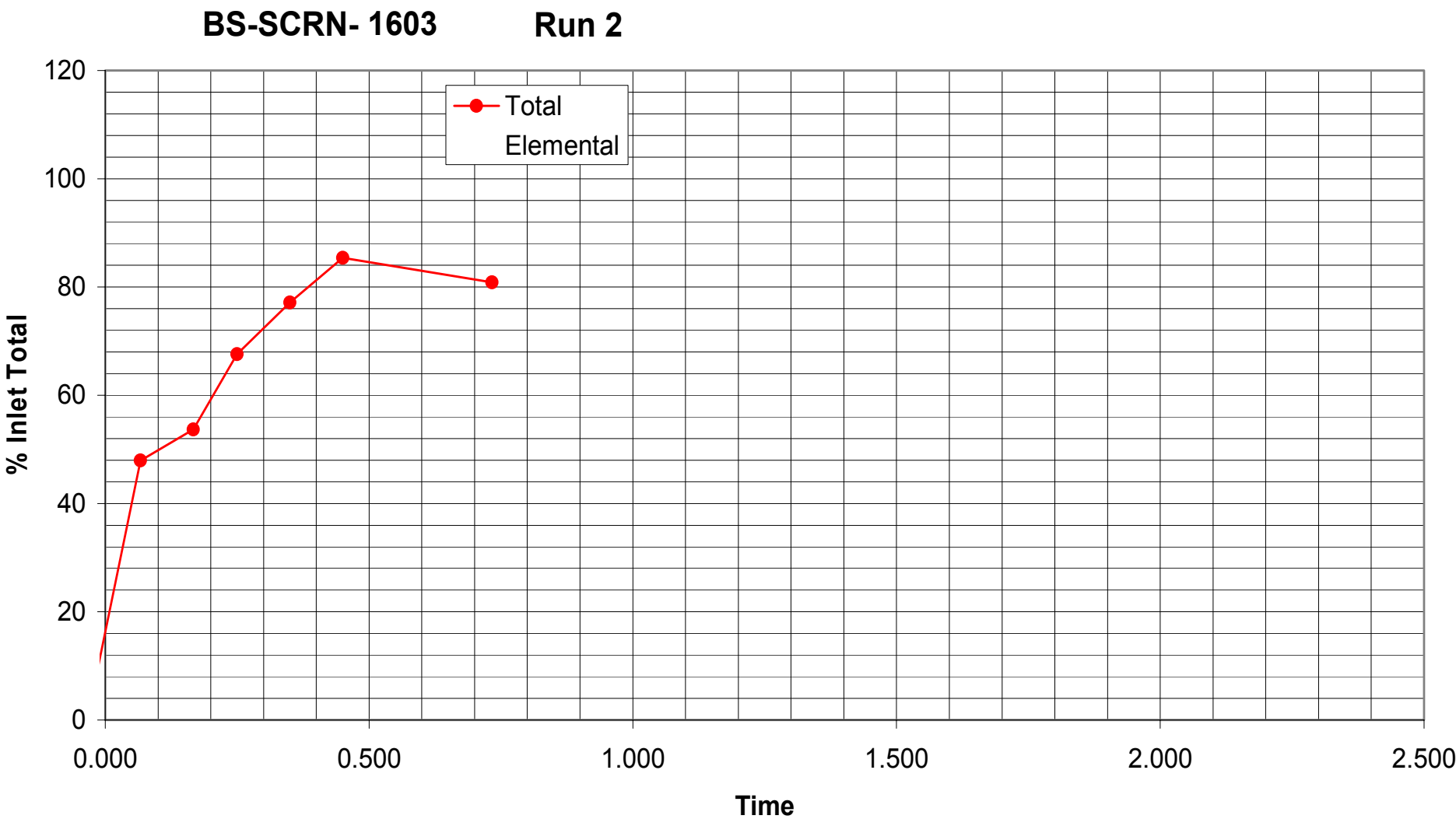
Bench-Scale Tests
Low-Acid-Gas Conditions

	Target Conditions	Actual Conditions
Total Flow:	29.9 scfh	31.9 scfh
O_2	6%	5.62%
CO_2	12%	11.25%
H_2O	15%	14.06%
SO_2	600 ppm	562 ppm
NO	120 ppm	110 ppm
HCl	1 ppm	0.93 ppm
NO_2	6 ppm	5.6 ppm

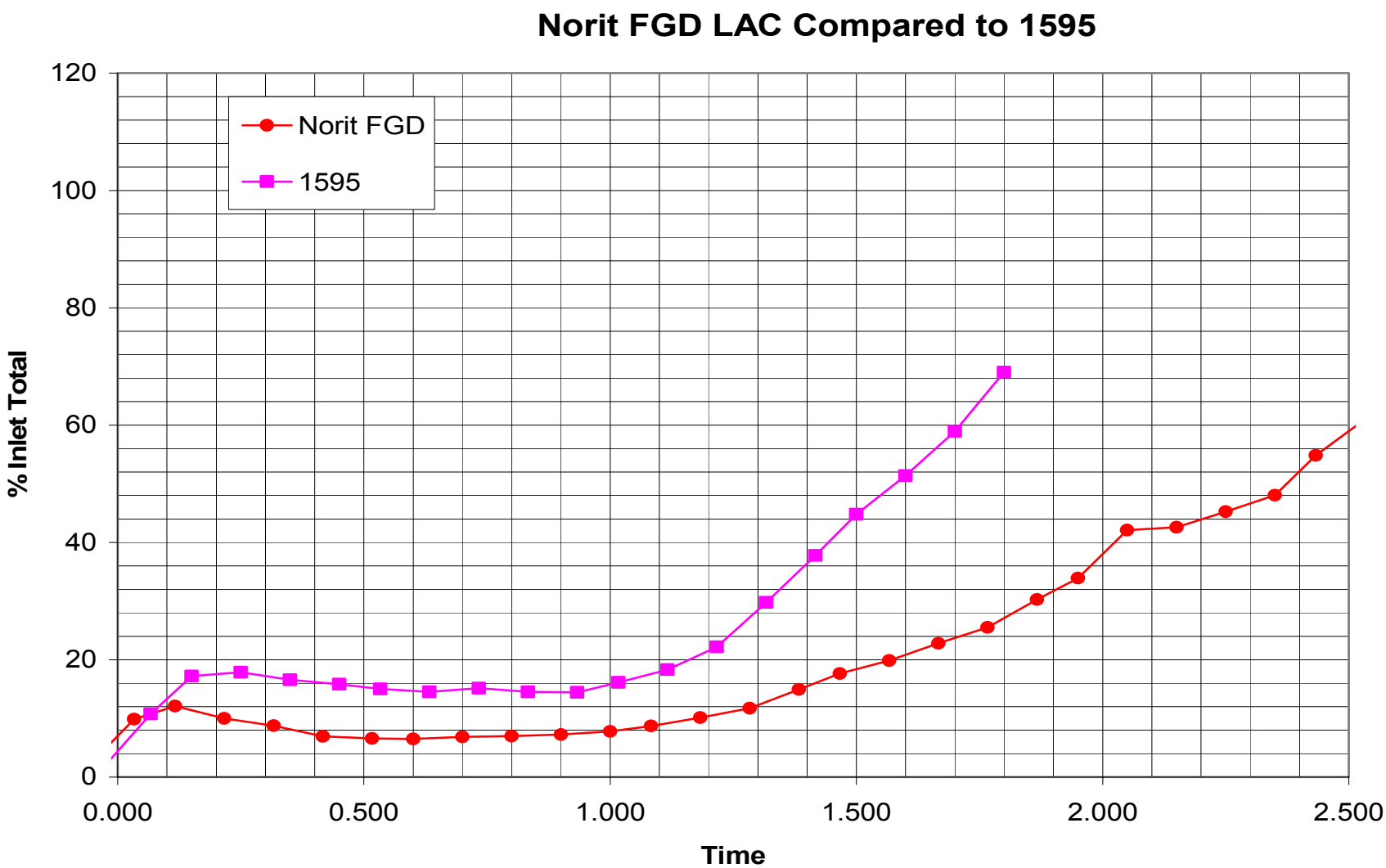
Bench-Scale Results
1603, MaxWell Run 2

O2=6%...CO2=12%...H2O=15%...SO2=600ppm…NO=120ppm…HCl=1ppm…NO2=6ppm…



Bench-Scale Results
Norit FGD and 1595, MaxWell Run 1

O2=6%...CO2=12%...H2O=15%...SO2=600ppm…NO=120ppm…HCl=1ppm…NO2=6ppm…



Phase II – Field Testing
Summary Results of Bench-Scale Tests

Bench-Scale ID	Maxwell ID	Total Capacity, µg of Hg	Time to BT, hr	Corresponding Figure
1603	NA	54.2	2.5	1
1595	1	45.8	2.5	6
1599	3	35.5	2.2	10
1594	11a	34.6	2.3	5
1602	NA	34.4	2.1	13
1593	9	32.3	1.8	4
1601	5	27.7	2	12
1591	8	26.4	2	2
1597	10	25.7	2.1	8
1600	6	25.6	2.2	11
1596	4	22.5	1.8	7
1598	11b	22.5	1.8	9
1592	7	4.7	1.1	3
1603	2	2	0.8	14

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Phase II – Field Testing
Recommendations Bench-Scale Testing

Based on bench-scale testing, the two best candidates for pilot-scale testing are:

- **1595 (Run1).**
- **1599 (Run 3).**

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Phase II – Field Testing
Preliminary Results Pilot-Scale Testing

Preliminary Results of Luscar Activated Carbon Sorbents

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Poplar River Coal Analysis
Test Coal

- As received, wt%
  - Moisture 36.10
  - Volatile matter 27.76
  - Fixed carbon 21.81
  - Ash 14.33

- As fired, wt%
  - Moisture 30.20
  - Volatile matter 32.01
  - Fixed carbon 24.09
  - Ash 13.7

  - Btu/lb 6253
- Mercury and chlorine, dry basis
  - Hg 0.124 µg/g
  - Cl 19.4 µg/g

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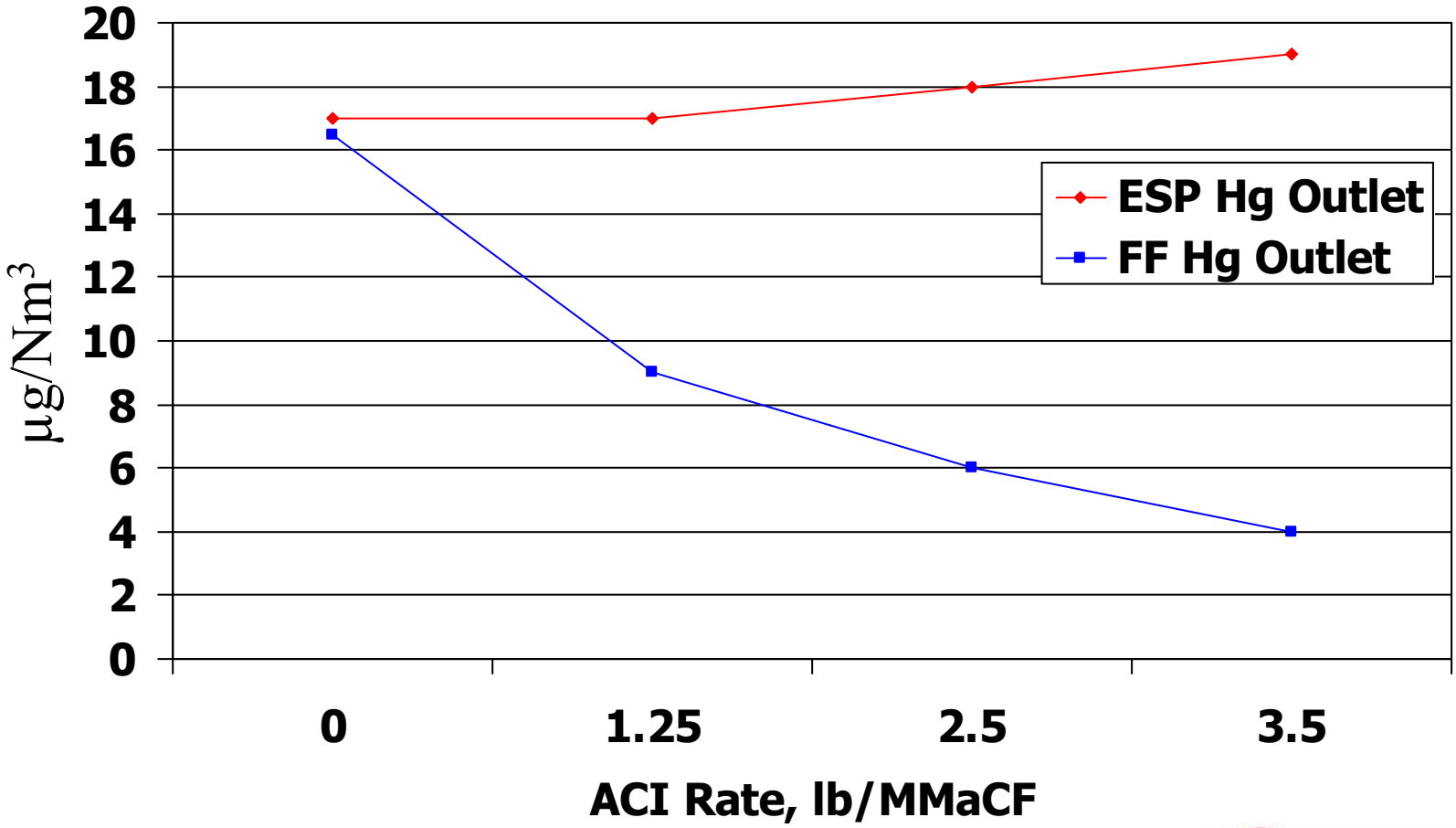
Pilot-Scale Test Results
Luscar 2 – Effect of Injection Rate



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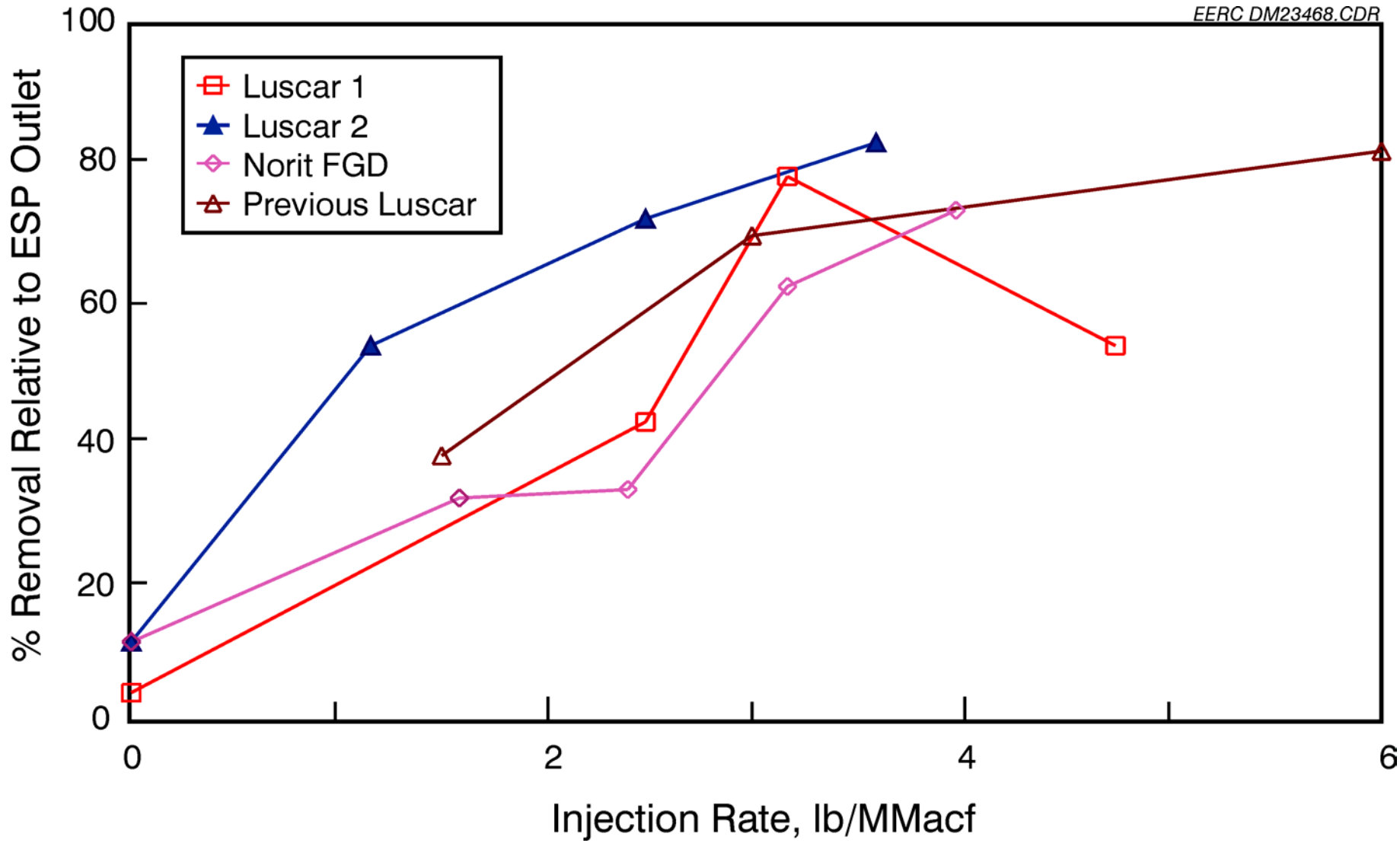
Pilot-Scale Test Results
Summary of Mercury Removal



Phase II Schedule

Date	Milestones
June 1, 2003	Phase II activities start
December 2003 – July 2004	Design and construct
August 2004	Shakedown testing of equipment and instruments
September 2004	Begin field testing
September– October 2004	Perform screening and parametric testing
October–February 2005	Perform long-term testing
October–February 2005	Evaluate ash impacts
December–March 2005	Summarize technology performance
December–March 2005	Estimate sorbent technology costs
March 2005	Draft report
April 31, 2005	Report review, address comments, and issue final report

*Exact schedule will be based on plant outages and other plant considerations.

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