

Mercury Control Technologies for Electric Utilities Burning Lignite Coals

Introduction to Project Presentation for Conference Call

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Agenda – 12/04/01

- Introductory Statements 10 A.M.
- Background
- Project Organization
- Presentation/Discussion
of Initial Project Plans
- Group Discussions
- Identification of Key Issues
and Test Parameters
- Next Step
- Wrap-up 12 Noon

Multi-Client Project

Potential Sponsors/Participants

Canada

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

United States

- Basin Electric Power Cooperative
- BNI Coal Ltd. & Minnkota Power Cooperative, Inc.
- Great River Energy
- Minnesota Power, Inc.
- Otter Tail Power Company
- EPRI
- North Dakota Industrial Commission
- U.S. Department of Energy
- B&W / McDermott

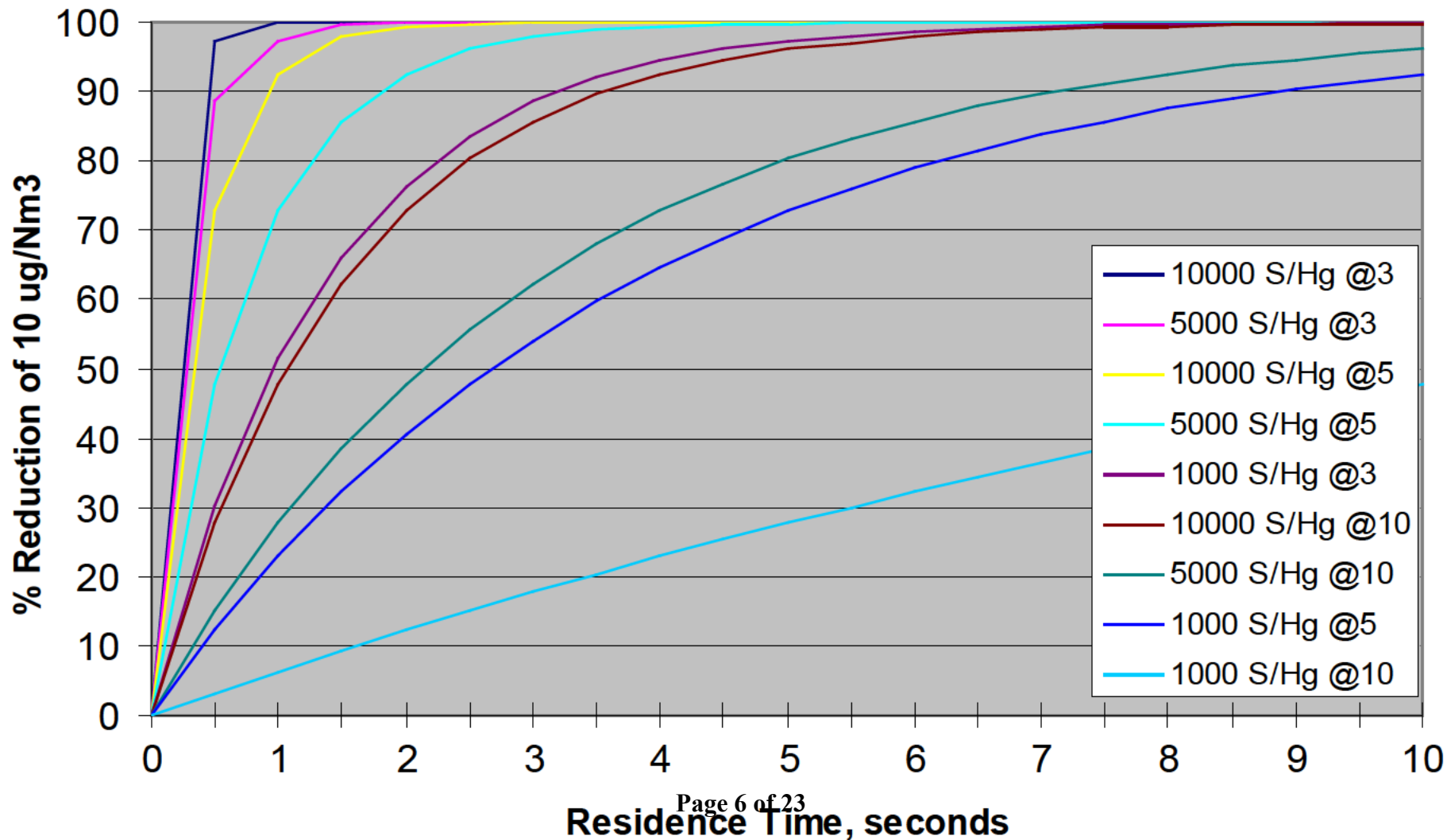
Background

- Mercury is an Immediate Issue
 - December 2000 EPA decides regulation will be required
 - Regulations to be proposed by December 2003
 - Promulgation of regulations by December 2004
 - Compliance by 2007
 - MACT discussions (EPA) and 3P discussions (Congress)
 - Canadian consultative process for “Canadawide Standards” for mercury emissions from coal-fired electricity generation
- Mercury Emissions from Lignite Coals, More Challenging
 - Higher fraction of elemental mercury
 - Potentially less reactive toward catalysts and sorbents
 - Different flue gas and fly ash characteristics

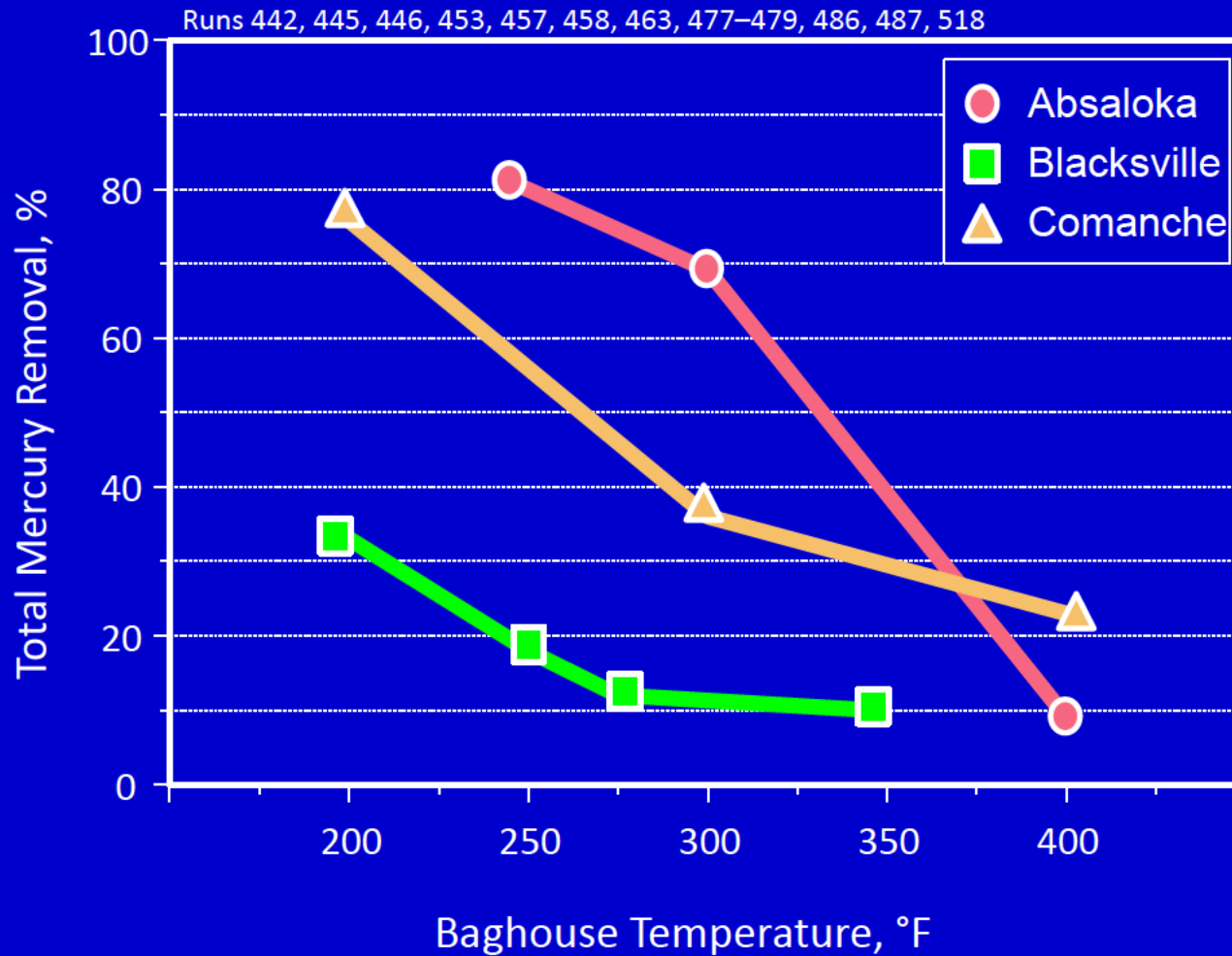
Focus on Sorbent-Based Technology

- Most plants are equipped with particulate control devices
- Sorbent injection can be easily added to these plants at relatively low cost as compared to other mercury control options
- Preliminary bench- and pilot-scale tests indicate that carbon-based sorbents may be effective for mercury capture under certain conditions. More data needed under different conditions
- For units equipped with scrubbers, catalytic oxidation may be an option. Some sorbents have the potential to facilitate oxidation.

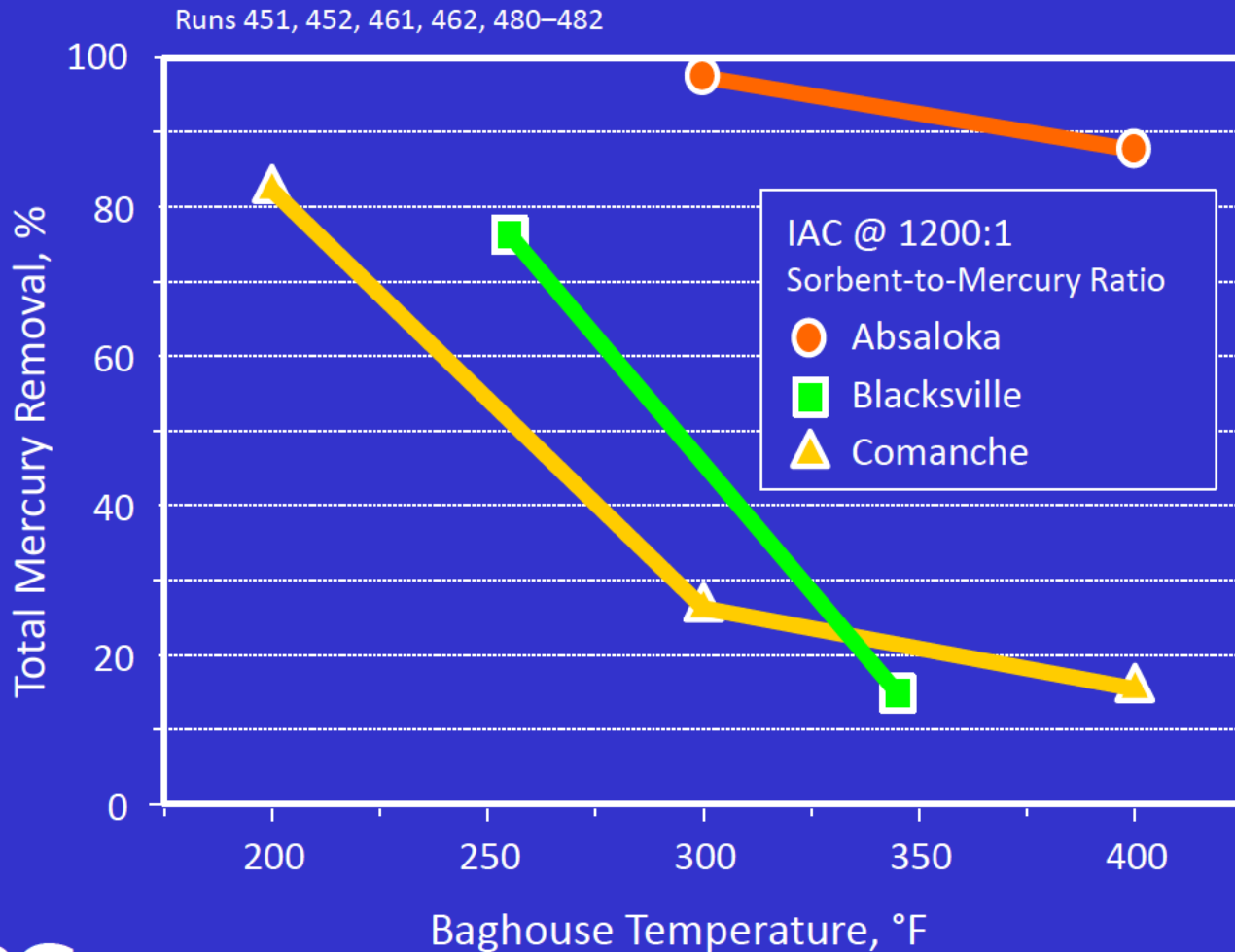
Theoretical Capture of Mercury by Sorbents Based on Diffusional Limit 300 F, 10 ug/Nm³ of Hg



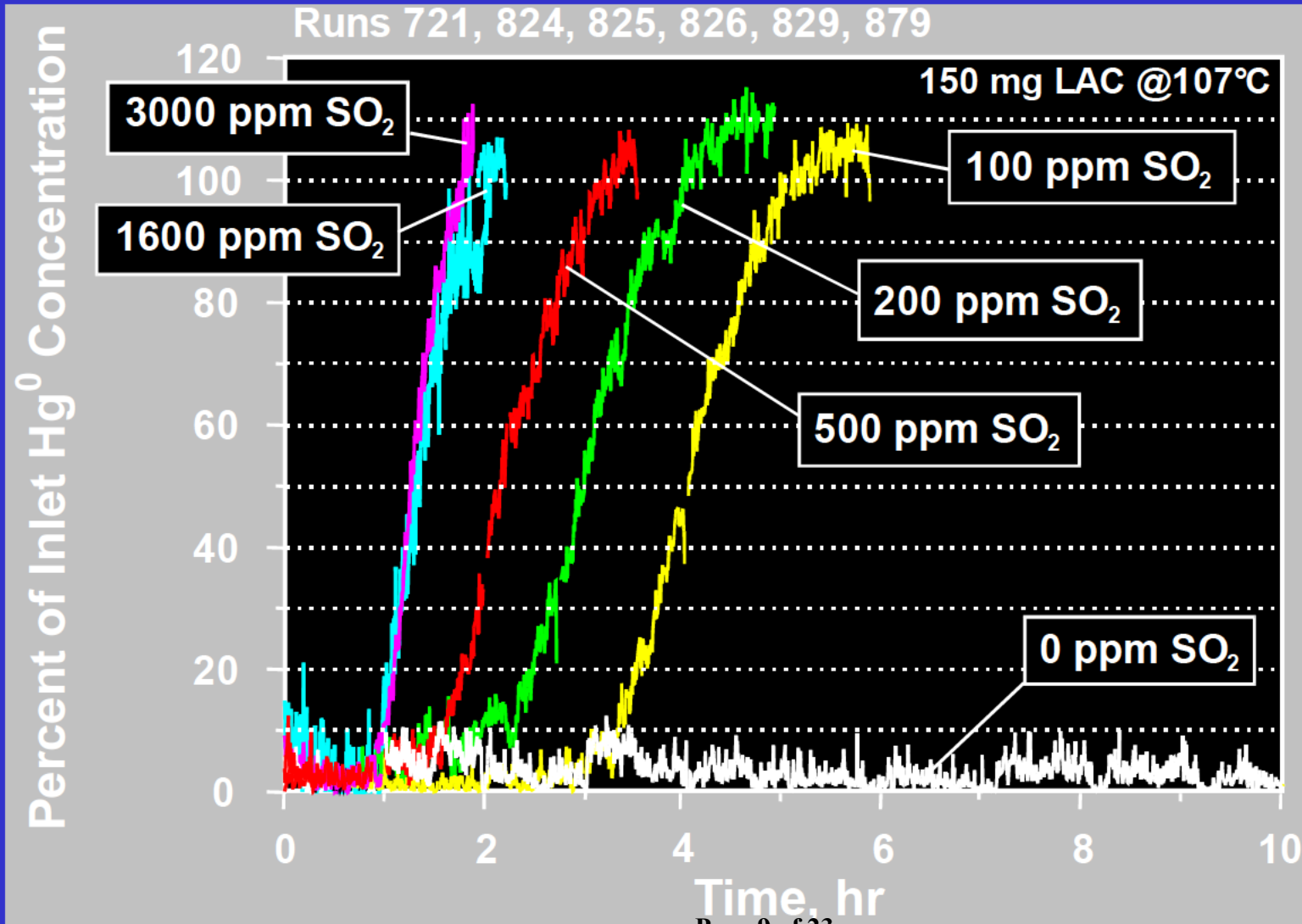
Total Mercury Removal Across Baghouse for Baseline Tests



Total Mercury Removal Across Baghouse for Iodine-Impregnated Activated Carbon Tests

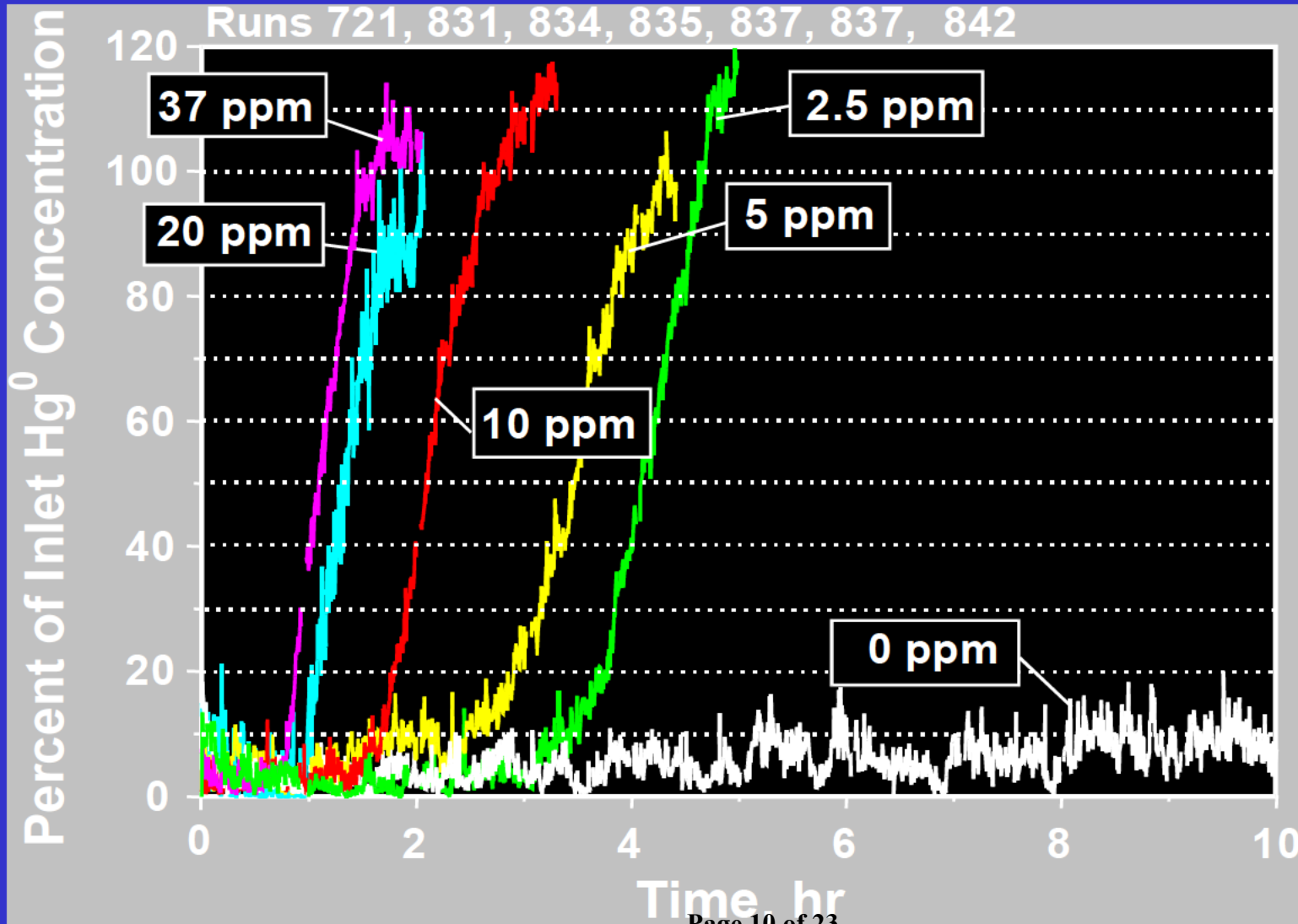


Effect of SO₂ Concentration on Hg⁰ Capture with Activated Carbon



Hg⁰–15 µg/m³
O₂–6%
CO₂–12%
H₂O–8%
N₂–Balance
HCl–50 ppm
SO₂–0 to 3000 pp
NO–400 ppm
NO₂–20 ppm

Effect of NO_2 Concentration on Hg^0 Capture with Activated Carbon



Hg^0 —15 $\mu\text{g}/\text{m}^3$
 O_2 —6%
 CO_2 —12%
 H_2O —8%
 N_2 —Balance
 HCl —50 ppm
 SO_2 —1600 ppm
 NO —400 ppm
 NO_2 —0 to 37 ppm

Project Goals

Develop, Test, and Demonstrate Sorbent-Based Technologies for 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 and sorbents for Hg capture in pilot facility
- Field demonstrate sorbent-based technology to prove and quantify effectiveness, performance, and cost

Approach

Building on Previous Efforts

Phase I Bench/Pilot-Scale Testing

- Flue Gas Characterizations
- Bench Scale Screening
- Fixed Bed Evaluations
- Pilot-Scale Testing
- Byproduct Analyses

Phase II Full-Scale Testing/Demonstration

- Field Demonstration
 - Select sorbent and system configuration
 - Set up hardware
 - Evaluate sorbent impacts
 - Evaluate impact of operation variables
 - Byproduct analyses
 - Quantify effectiveness and cost

Phase I - Sorbent Preparation and Selection

Possible Sorbent Candidates

- Carbons
 - FGD Norit
 - ND lignite activated carbon
 - Saskatchewan lignite activated carbon
 - Enhancements/Modifications to these and other carbons
- Calcium based sorbents
 - Traditional lime based sorbents
 - Lime / Carbon sorbent mixture
 - Reactive flyash
 - Calcium Silicates and Oxidant doping of lime based sorbents
- Other possibilities (Na_2S_4 , Iron Oxides, et al)

Phase I - Bench Scale Fixed Bed Testing

- Bench-scale screening
 - Evaluate a number of different sorbents, sorbent enhancements/modifications, gas species interactions, oxidation potential, sorbent size, temperature, etc
 - Fixed bed using simulated gas similar to that produced from burning lignite coal
 - Initial screening of sorbents to evaluate capture effectiveness, oxidation potential, and capacity
 - Provide relative ranking to determine most promising sorbent for pilot and full scale testing

Phase I – Pilot-Scale Testing

Preliminary Test Matrix

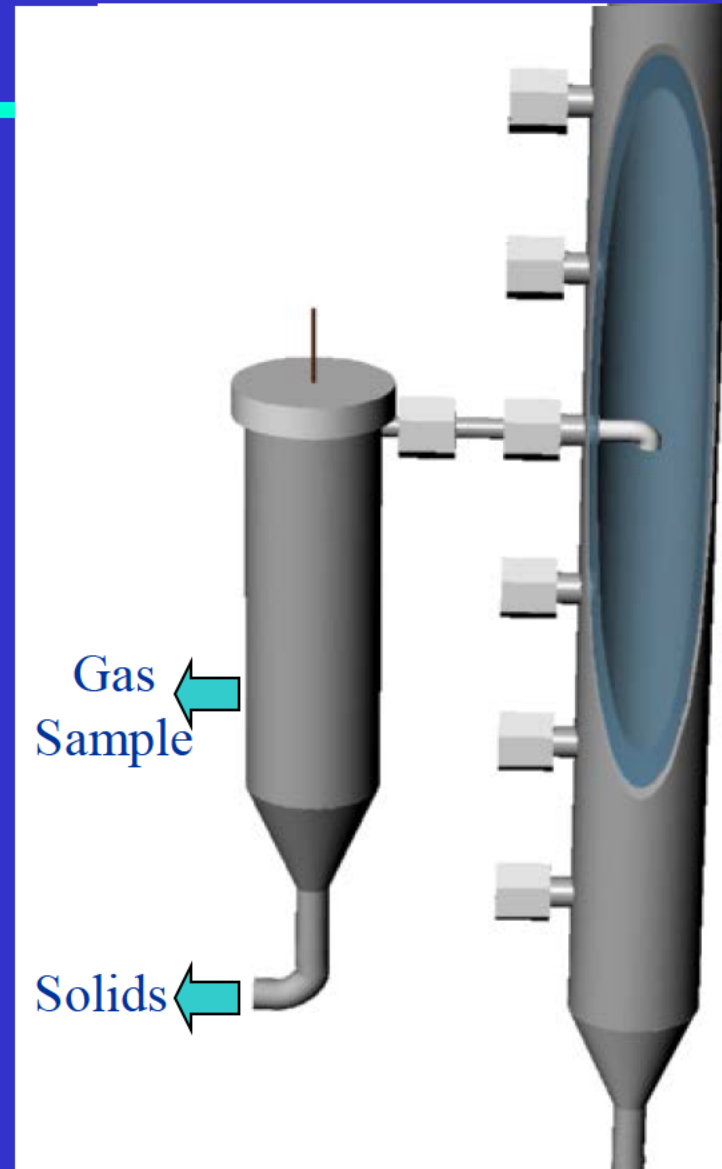
Test	Coal	Sorbent	Temperature (F)	Particulate Control	Sorbent Size	Sorbent Ratio
Baseline (T1)	Canada Coal 1 (C1)	Sorbent 1 (S1)	300	ESP	As Rec'd	10,000
Test 2 (T2)	C1	S1	400	ESP	As Rec'd	10,000
T3	C1	S1	300	ESP	Fine	10,000
T4*	C1	S1	300	ESP	Fine	5,000
T5	C1	S1	300	Baghouse	As Rec'd	10,000
T6	C1	S1	400	Baghouse	As Rec'd	10,000
T7	C1	S1	300	Baghouse	Fine	10,000
T8*	C1	S1	300	Baghouse	Fine	5,000
T9-34	C1	S2 – S4	Repeat for Remaining Three Sorbents			
Downselect to Two Sorbents						
T35 – 50	US Coal C2	Best 2	Repeat for Coal 2			

*Use entrained flow reactor module at 1 and 5 sec residence time

Entrained Flow Reactor

System & Testing Objectives

- Simulates the flue gas duct
- Allows in flight performance
 - Varied, low sorbent res. times (0 to 10 S)
 - Use for ESP performance evaluations.
 - Minimize the solids/gas interaction during sampling



Phase II, Field Demonstration

Proposed Site – Poplar River Power Station (SaskPower)

- Two Units, Commissioned in 1981 and 1983
- Unit 1 = 298 MW & Unit 2 = 294 MW
- Electrostatic Precipitators for particulate control



Poplar River Power Station

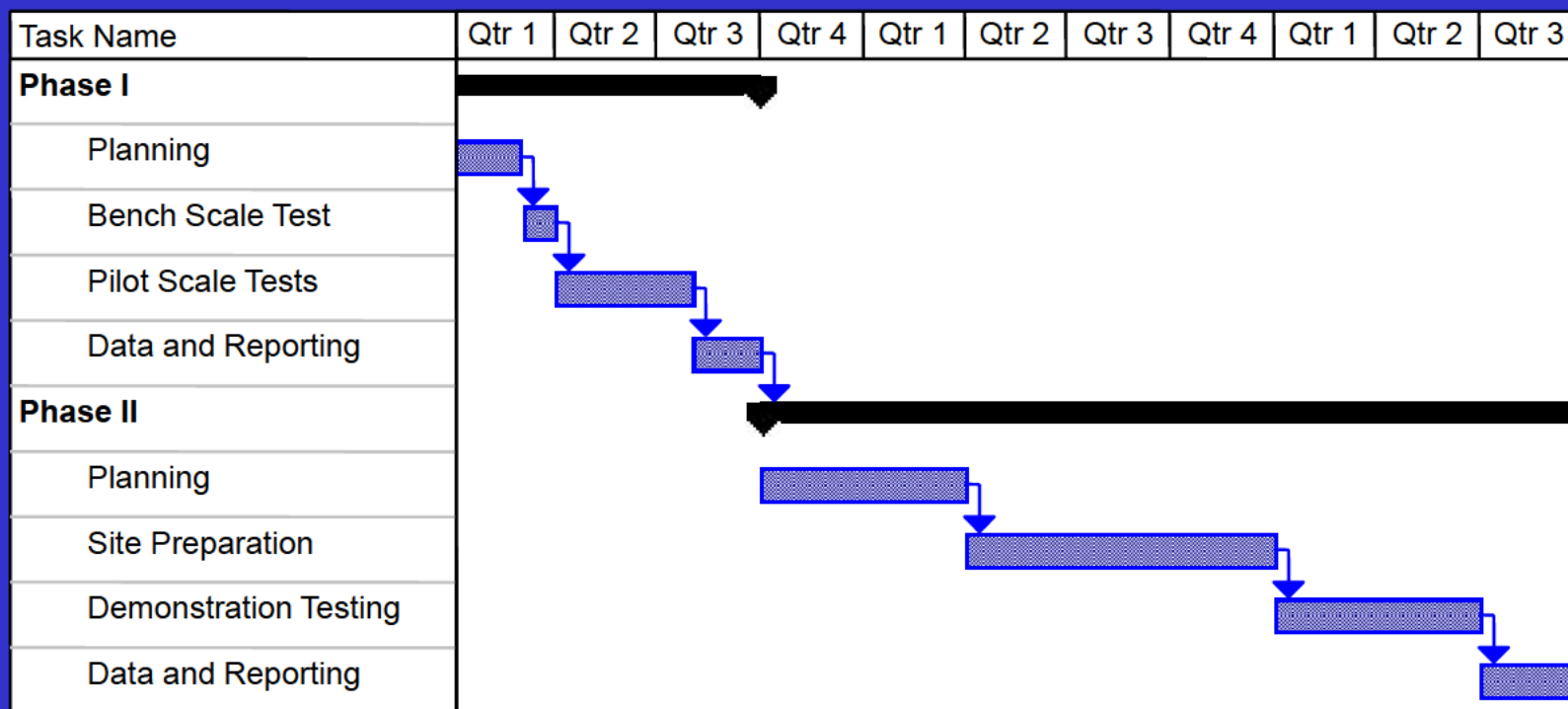
- South-central Saskatchewan
- 10 km SE of Coronach

Phase II Testing

Field Demonstration

- Define control technology, based on Phase I
 - Select most promising sorbent
 - Identify the process requirements
 - Sorbent injection upstream of a polishing filter, or
 - Highly reactive sorbent upstream of the ESP
 - Possible flue gas conditioning
- Perform demonstration on about $\frac{1}{4}$ of the flue gas from one unit
- Evaluate effectiveness as a function of process variables (Temperatures, sorbent size, sorbent characteristics, particulate control system operation, etc)
- Quantify performance, effectiveness, and cost

Project Timeline



Initial Funding Scenario

Phase	Phase Description	Cost
1	Development and Testing of Sorbents at EERC Bench-Pilot-Scale Facilities	\$600,000 -to- \$1,000,000
2	Demonstration of Sorbent Technology at Saskatchewan Power Plant	\$1,500,000 -to- \$5,000,000

Phase I:

- ~\$350K from industry: Saskatchewan Power, ND utilities, EPRI, and NDIC
- ~\$350K from Environment Canada and the U.S. DOE

Phase II:

- \$2 to 4 million from Saskatchewan Power and Environment Canada
- \$100K from ND utilities and EPRI
- \$200K from NDIC
- \$350K from the U.S. DOE

Project Management Plan

DRAFT --

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SaskPower, Environment Canada, Luscar Ltd., SRC
Basin Electric, B&W, BNI Coal Ltd. & Minnkota, GRE, Minnesota Power, Ottertail, EPRI
North Dakota Industrial Commission, U.S. Department of Energy

Ontario Ministry of the Environment

EERC

John Pavlish, Project Manager

Steve Benson
Sorbent Characterization

Mike Holmes
Pilot and Field Testing

Role of Sponsors

- Multi-sponsor project
- All sponsors participate in meetings, phone calls, etc
- All sponsors have access to data, reports, etc
- Project representative will work as team to develop project direction and plans (final decisions will be consensus and could consider equitable contribution)
- What needs to be included in agreement???

Next Steps

- Finalize project participants and sponsors
- Finalize funding details
- Firm up Phase I approach / scope
- Submit proposal to project sponsors
- Establish appropriate contracts
- Begin project Spring 2002