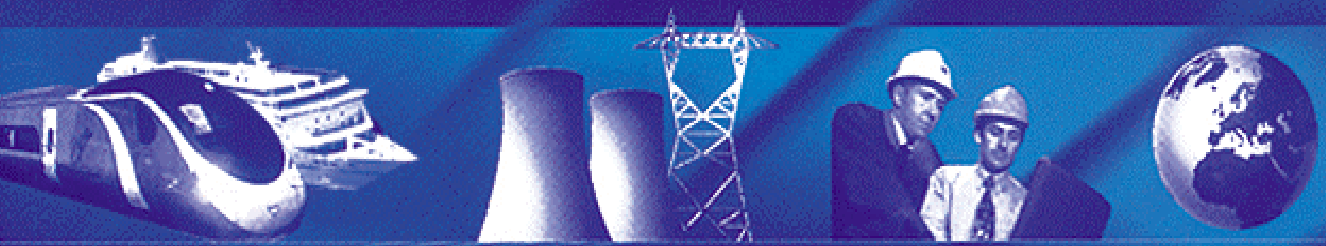

Field Demonstration of Enhanced Sorbent Injection for Mercury Control

DOE-NETL Mercury Control Program Review Meeting

July 12, 2005

Shin Kang and Srivats Srinivasachar

DOE Program Officer: Lynn Brickett

ALSTOM

Power Environment
Performance Projects

Outline

- Introduction
- Technology description - Mer-Cure™ technology
  - Pilot-scale performance
- Project description
  - Work plan
  - Host sites
  - Schedule
  - Test program
- Testing at Dave Johnston # 3
  - Equipment installation
  - Baseline data

Mer-Cure™ Technology Demonstration

Demonstration of enhanced carbon-based sorbent injection technology for mercury control at three sites burning various rank fuels

Utility:	PacifiCorp	Basin Electric	Reliant Energy
Host site:	Dave Johnston	Leland Olds 1	Portland Unit 1
Location:	Glenrock, WY	Stanton, ND	Portland, PA
Schedule:	June-Aug 2005	Sept-Nov 2005	Mar-Apr 2006

Project Team and Co-Funders

ALSTOM

- DOE NETL
- ALSTOM Power
- UND EERC
- PacifiCorp
- Basin Electric
- Reliant Energy
- North Dakota Industrial Commission (NDIC)
- Minnkota Power

Background

- **EPA specified mercury (Hg) emission reduction targets from coal-fired boilers in March '05**

- **Multiple mercury control approaches being evaluated by utilities to meet their unique needs**
  - **Activated carbon injection**
  - **Co-benefit from SCR and scrubber installation**
  - **Combustion modifications**
  - **Baghouse addition downstream of existing air pollution control - retrofit of older ESPs or spray dryers for SO_2 control**

- **Mer-Cure™ technology <u>target</u> is to be a cost-effective mercury control solution with**
  - **Low capital investment ($\$5$-$10/kW_e$)**
  - **Low operating cost (~\$0.50/MWh)**
  - **Removal efficiency greater than 70% for challenging (low-rank) coals**

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Mer-Cure™ Technology

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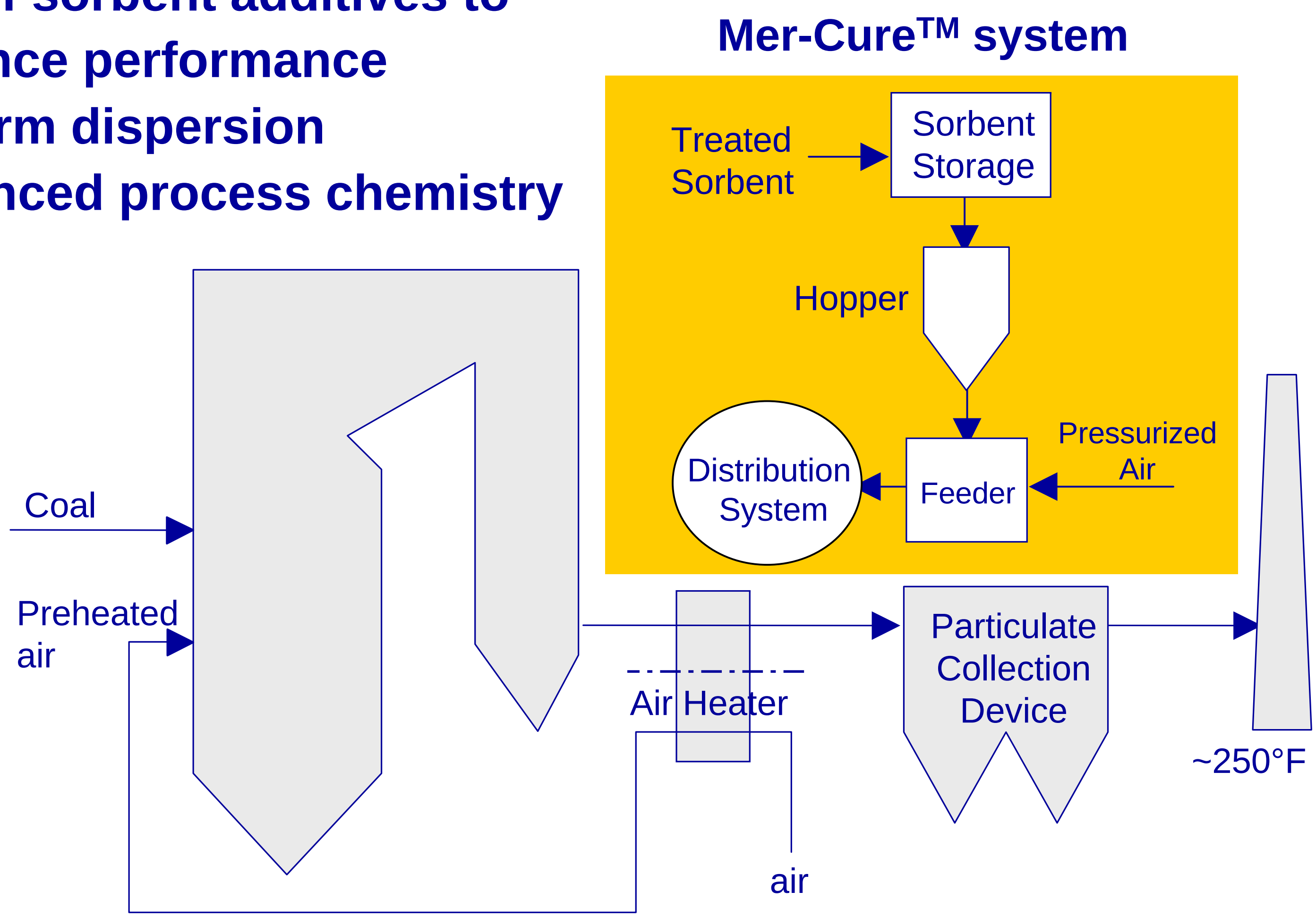
Three-pronged approach:

1. **Use of sorbent additives to enhance performance**
2. **Uniform dispersion**
3. **Enhanced process chemistry**



Mer-Cure™ Technology Verified: Pilot-Scale

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- **Testing conducted in UND-EERC's pilot-scale pulverized coal combustor system**
- **Performance compared against other technologies evaluated as part of UND-EERC program**

Pilot-Scale Test Setup

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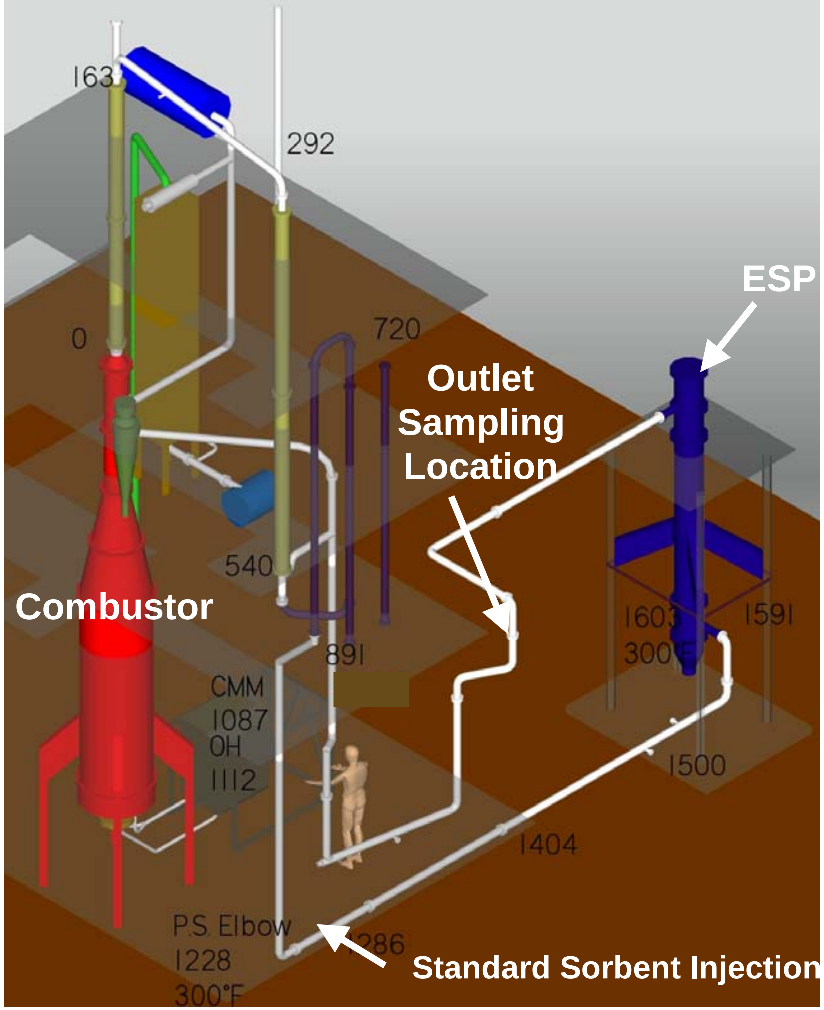
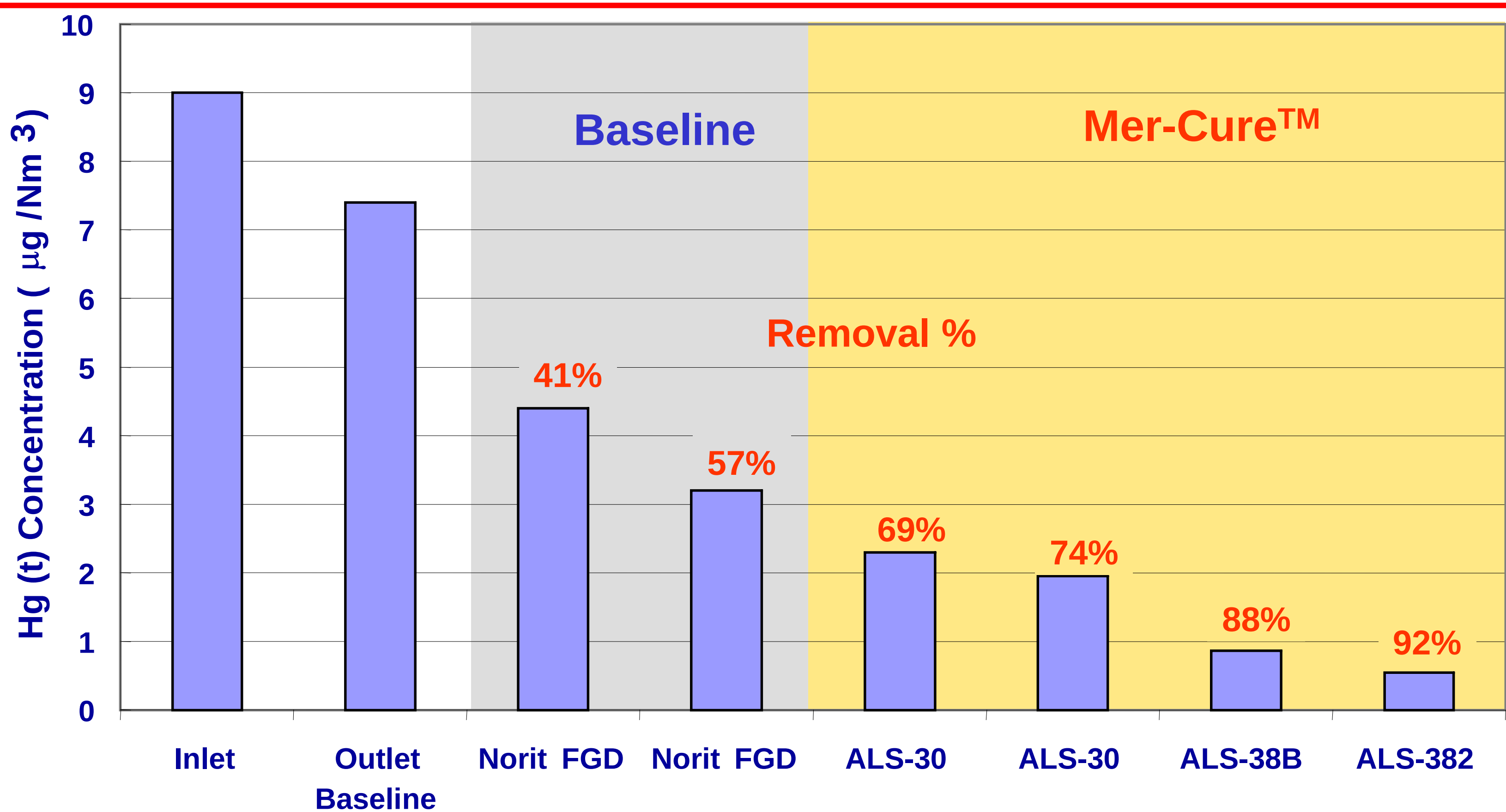


- **0.7 MMBtu/hr pulverized coal-fired combustor**
- **Tubular ESP (SCA=125)**
- **Lignite coal**

Sulfur	**0.9%**
Ash	**12.2%**
Hg	**0.077 ppm-dry**
Chlorine	**20 ppm-dry**
HHV	**9989 Btu/lb**

- **85-90% of mercury in elemental form**
- **Lignite/ESP most challenging configuration**

Pilot-Scale Test Results



Sorbent Feed Rate		X	4 X	X/3.5	X/1.5	X/2	X/2.5

- **High removal efficiency at low injection rate compared with standard PAC (Norit FGD™)**

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Project Goals

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- Demonstrate Mer-Cure^{TM} technology for mercury capture:
  - 70 -90 % capture
  - Coals of various ranks
- Obtain performance data for further development/ evaluation of technology
  - Economics
- Evaluate environmental and balance-of-plant impacts
  - Solids characterization (TCLP/SPLP)
  - Back-end component performance (e.g., ESP)

Work Breakdown Structure

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Tasks	ALSTOM	EERC	PCorp	Basin E.	Reliant
1A Design, Engineering and Fabrication	●		●		
2A Field Testing and Demonstration	●	●	●		
1B Design, Engineering and Fabrication	●			●	
2B Field Testing and Demonstration	●	●		●	
1C Design, Engineering and Fabrication	●				●
2C Field Testing and Demonstration	●	●			●
3 Technology Transfer	●	●			
4 Program Management and Reporting	●	●			

Test Program - At Each Site

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- Baseline Measurement
  - Normal operation
  - Uncontrolled mercury level
- Parametric Testing
  - Multiple sorbents at different injection rates
  - Effect of boiler operation
- Long-Term Testing
  - Four weeks of injection at selected test conditions

PacifiCorp – Dave Johnston Station

PacifiCorp – Fuel/Configuration

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Unit	Dave Johnston Unit 1	Dave Johnston Unit 3
Capacity (MW_e)	110	220
Coal Type S (%) Ash (%) Chlorine (ppm dry) Hg (ppm dry)	Cordero Rojo (PRB) 0.43 5.31 101-327 0.038-0.094	Wyodak (PRB) 0.5 6.8 < 50 0.071/0.12
Air Heaters	Two: Ljungstrom™	Two: Ljungstrom™
Flue gas temp.	280°F	315°F
Particulate control (SCA-ft^2/kacfm)	Cold-side ESP (706)	Cold-side ESP (629)

PacifiCorp – Mercury Emissions

ALSTOM

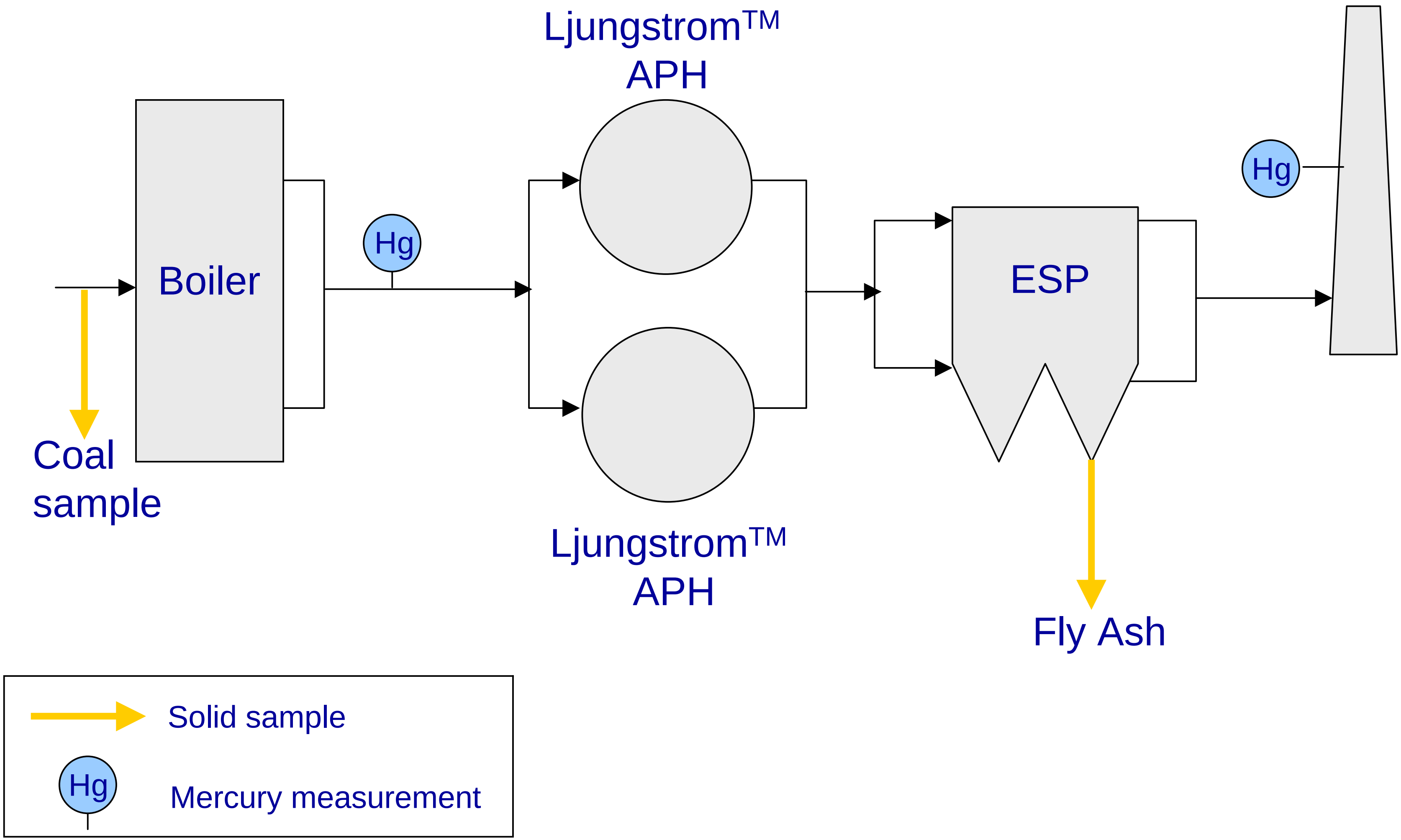
- Emissions measurements taken in late Jan 2005 using FAMS method
- DJ#1 level lower than DJ#3
- Based on results, <u>DJ3 selected for testing</u>

(in $\mu g/m^3$)	DJ1 stack	DJ3 stack
Elemental	0.4 - 0.6	2.4 - 4.35
Oxidized	0.93 - 1.21	3.1 - 4.35
Particulate	0.12 - 0.37	0.01 - 0.04
Total	1.61 - 1.93	5.55 - 8.71

PacifiCorp – Overall Sampling Layout

ALSTOM

Dave Johnston 3



PacifiCorp – Schedule

Tasks	Schedule
Host site agreement	end of Feb 2005 ✓
Port Installation	end of May 2005 ✓
Regulatory approval from local DEP	end of May 2005 ✓
Mer-Cure™ assembly/shakedown	early June 2005 ✓
→ Field Testing	mid June – mid Aug
System removal	end of Aug 2005
Reporting	end Dec 2005

* Outage for DJ3: Apr 30 – May 31 2005

Basin Electric – Leland Olds Station

Basin Electric – Fuel/Configuration

Unit	Leland Olds Unit 1
Capacity (MW_e)	~140 (~65% of 220)
Coal Type Sulfur Ash Chlorine Hg	North Dakota Lignite 0.63 % 9.86 % 20 ppm dry 0.057-0.099 ppm dry
Air Heater	One Ljungstrom and One Tubular
Flue gas temp.	350-375°F
Part. Control (SCA-ft^2/kacfm)	Cold-side ESP (320)

Basin Electric – Mercury Emissions

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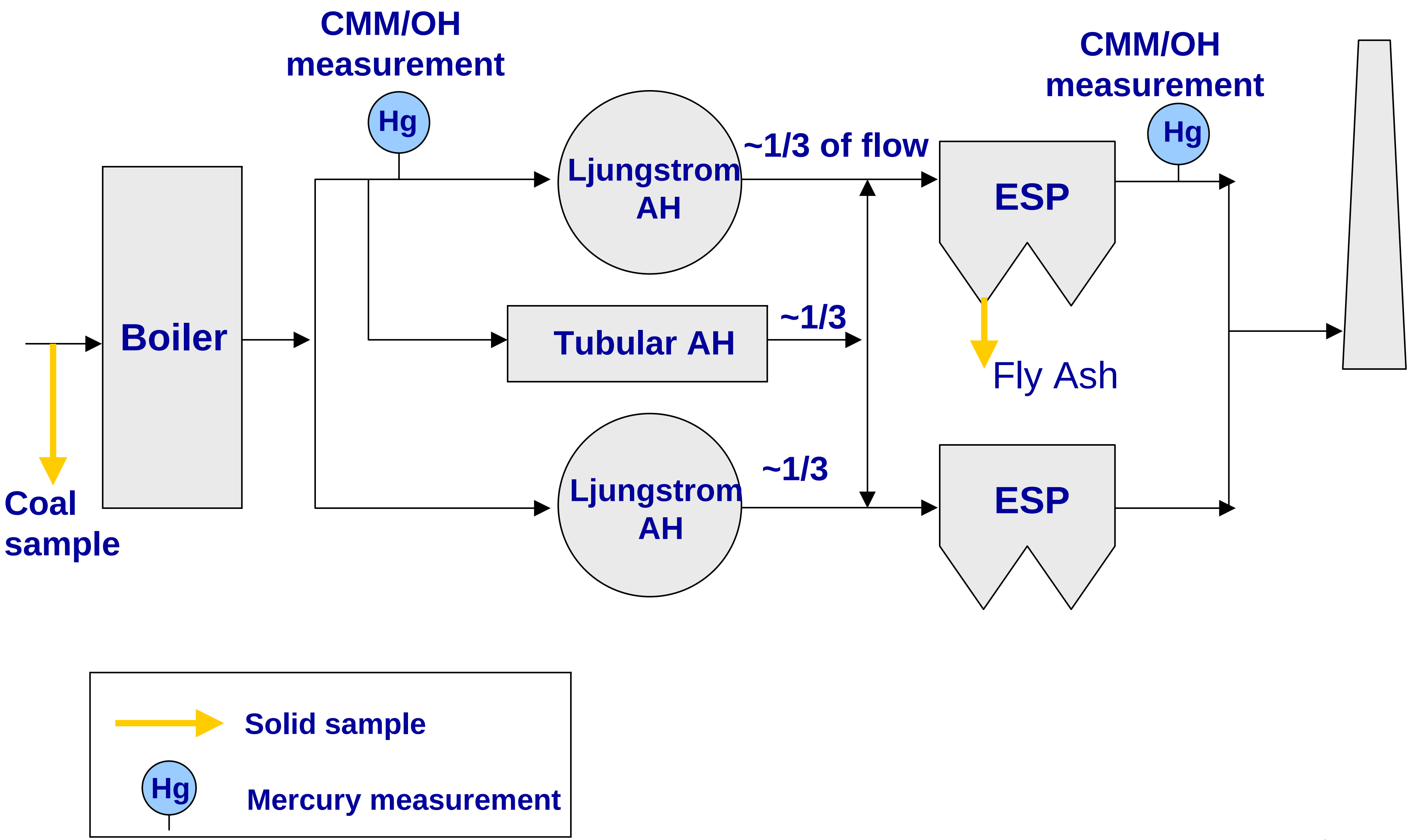
- Measurement by UND EERC in Mar 2003

	ESP Inlet	ESP Outlet
Elemental	5.8	6.4
Oxidized	0.1	1.4
Particulate	2.0	0.0
Total	7.9	7.8

Basin Electric – Overall Sampling Layout



Basin Electric – Schedule

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Tasks	Schedule
Host site agreement	December '04 ✓
Port Installation*	early Aug 2005
Regulatory approval from local DEP	early Aug 2005
Mer-Cure™ assembly/shakedown	end of Aug 2005
Field Testing	Sep – Nov 2005
System removal	early Nov 2005
Reporting	end Feb 2006

* Based on outage for Leland Olds

Reliant – Fuel/Configuration

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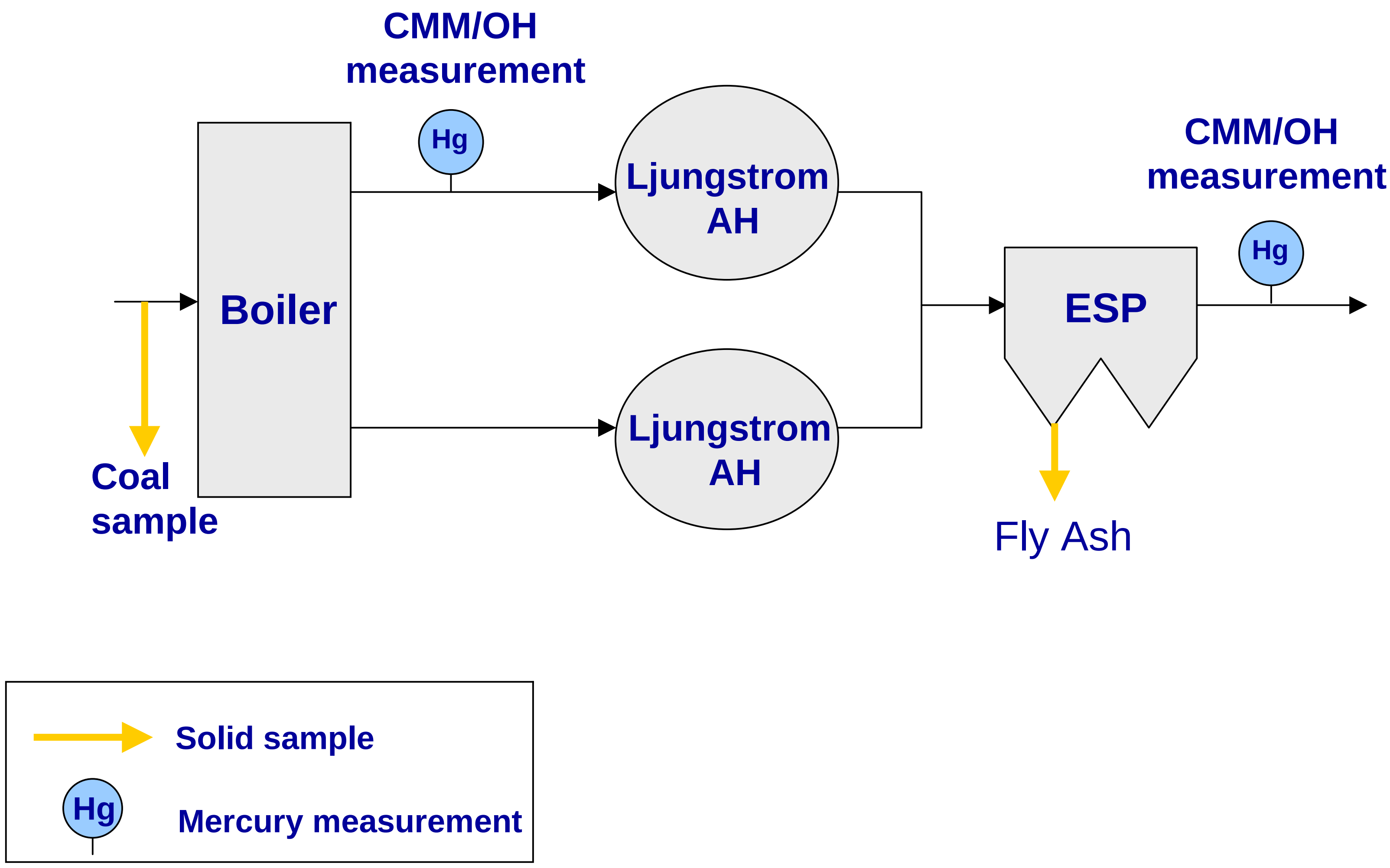
Unit	Portland Unit 1
Capacity (MW_e)	170
Coal Type Sulfur Ash Chlorine Hg	Federal #2 Pittsburgh seam 2.26 % 7.36 % 1,400 ppmw dry 0.1 - 0.16 ppmw dry
Air Heater	Two Ljungstrom™
Eco.out/ESP inlet temp.	621/277°F
Particulate control SCA(ft^2/kacfm)	cold-side ESP 284

Reliant – Overall Sampling Layout



Reliant – Schedule

Tasks	Schedule
Host site agreement	end of March 2005 ✓
Port Installation	end of March 2005 ✓
Regulatory approval from local DEP	end of Feb 2006
Mer-Cure™ assembly/shakedown	end of Feb 2006
Field Testing	Mar – Apr 2006
System removal	early May 2006
Reporting	end of Sep 2006

* Scheduled outage for Portland: March 2005

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Process Equipment Trailer

Process Equipment Trailer - Arrival at Site

Installation of Bulk Bag System

Process Trailer After Installation

DJ # 3
CFD - Velocity Contours

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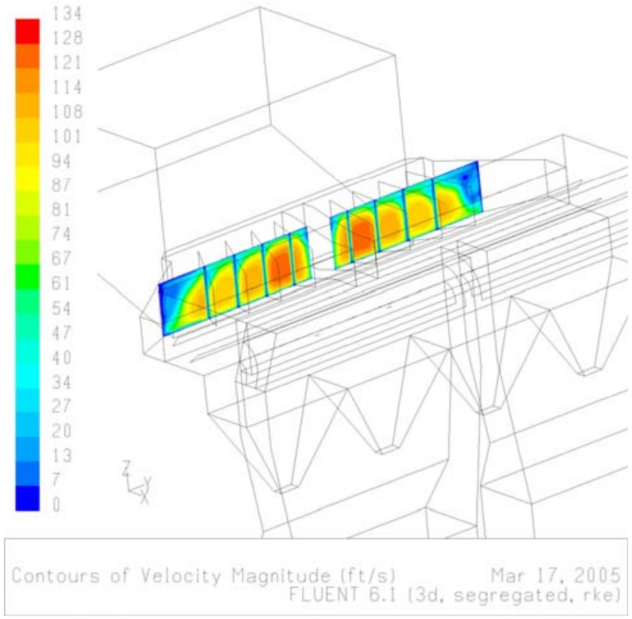
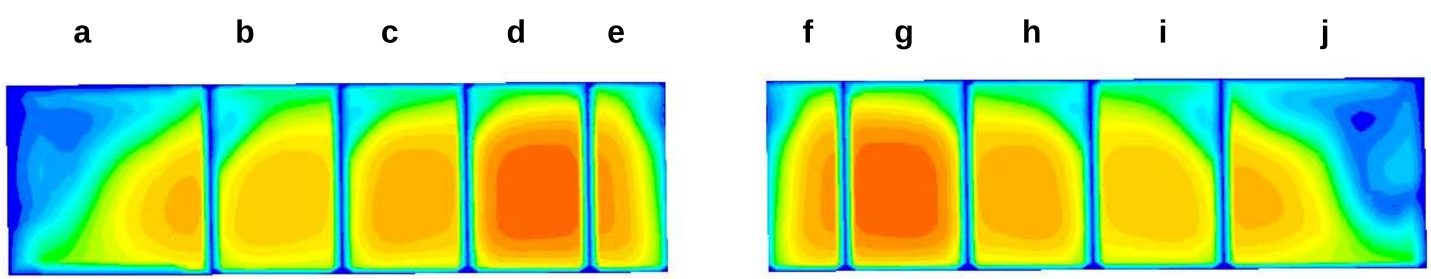


	%	Normalized to lowest flow
a	8.92%	1.31
b	10.27%	1.51
c	11.04%	1.63
d	13.01%	1.91
e	6.79%	1.00
f	6.83%	1.01
g	13.08%	1.93
h	10.86%	1.60
I	10.31%	1.52
j	8.89%	1.31



Injection Lance Location

Dave Johnston # 3 - Baseline Data

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