EERC Technology… Putting Research into Practice

The Use of Sorbent Traps as a Reference Method for Mercury Measurement

DOE/NETL Mercury Control Technology Conference

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Energy & Environmental Research Center

December 11–13, 2006

Acknowledgments

Work funded by:

EPRI: Agreement No. EP-P21900/C10723

Project Manager: Chuck Dene

DOE/NETL: Cooperative Agreement No. DE-FC26-98FT40321

Project Manager: Chuck Miller

Host site:

Reliant Energy's Portland Station

Project Manager: Eric Roland

Special Acknowledgement

ALSTOM

DOE-sponsored Mer-Cure demo project

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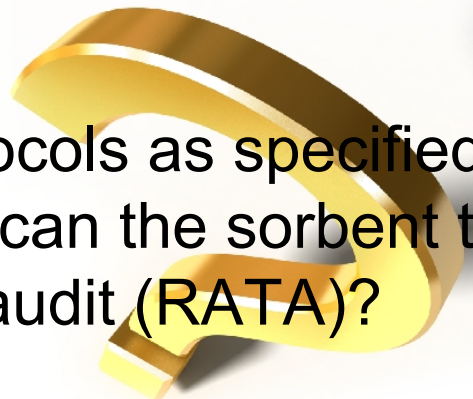
Questions

- Is there anything besides the Ontario Hydro Method that can be used as reference method?
- Can the sorbent traps be used as a reference method (RM)?
- Using the protocols as specified in the Clean Air Mercury Rule (CAMR), can the sorbent traps pass a relative accuracy test audit (RATA)?
- Can the Ohio Lumex analyzer be used to accurately and precisely measure mercury in sorbent traps?



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Approach

- All sampling was done at the electrostatic precipitator (ESP) outlet duct at Reliant Energy's Portland Station.
- Three test series were completed:
  - Test Series 1: baseline
  - Test Series 2: midlevel of mercury control
  - Test Series 3: high level of mercury control
- Sorbent traps were two section traps (no spiked section) and were obtained from Frontier Geosciences (FGS).

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Approach

- Sampling completed for each test series
  - 12 paired Ontario Hydro (OH) method trains (reference method)
  - 12 quad samples of sorbent traps
    - Two samples were analyzed in the field using the Ohio Lumex mercury analyzer.
    - Two samples were sent to FGS for analyses using U.S. Environmental Protection Agency (EPA) 1631 protocols.
    - Continuous mercury analyzer (CMM).
- Each set of sampling was 2 hours and was done simultaneously.

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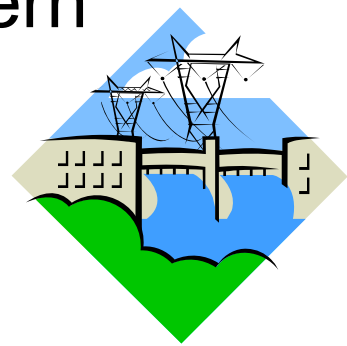
Reliant Energy's Portland Station

- 170 MW
- Fires 100% low–medium-sulfur eastern bituminous coal.
- ESP for particulate control.
- Tests were piggybacked onto ALSTOM's DOE-sponsored Mer-Cure demo project.



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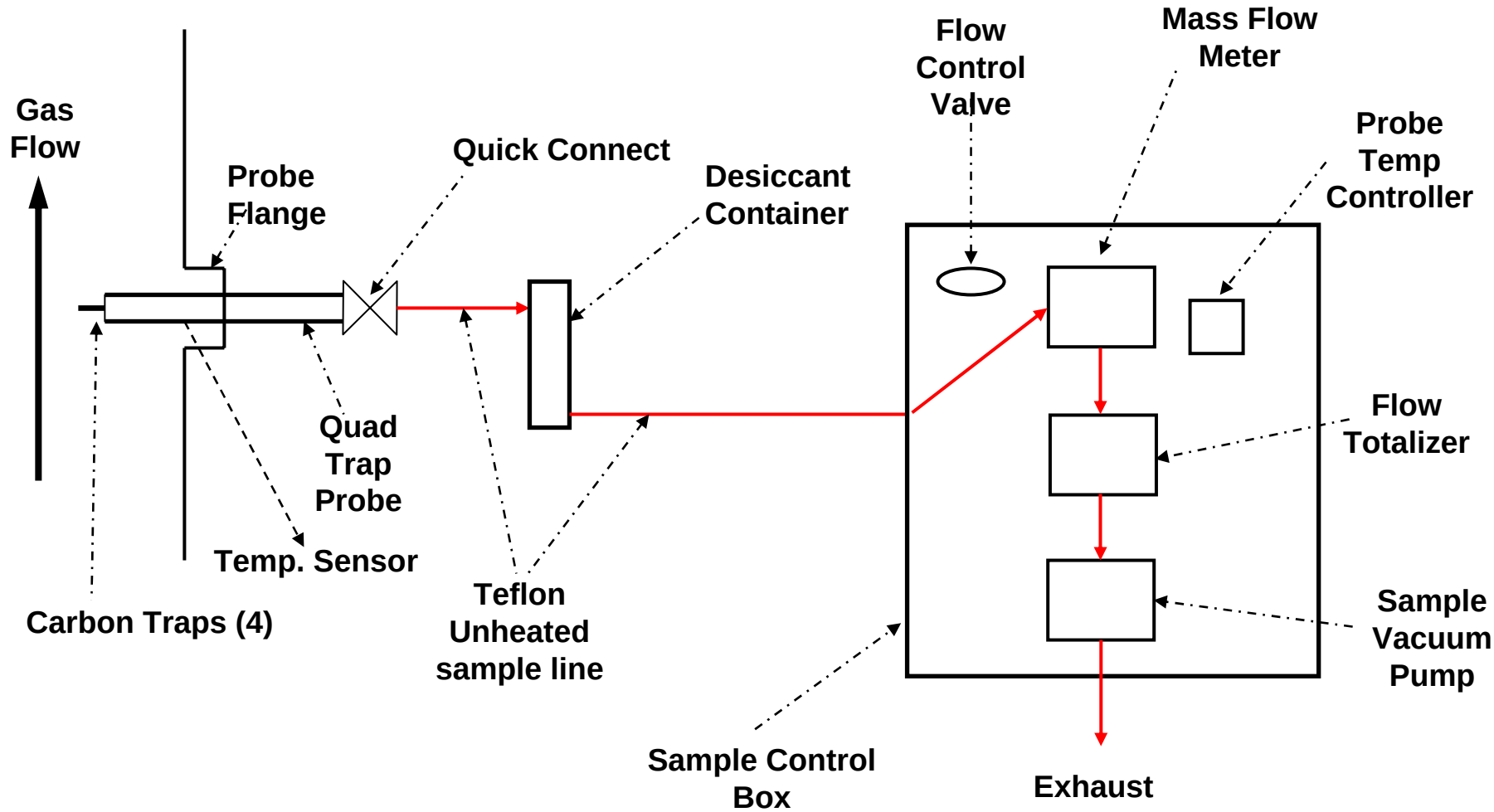
Sampling Location

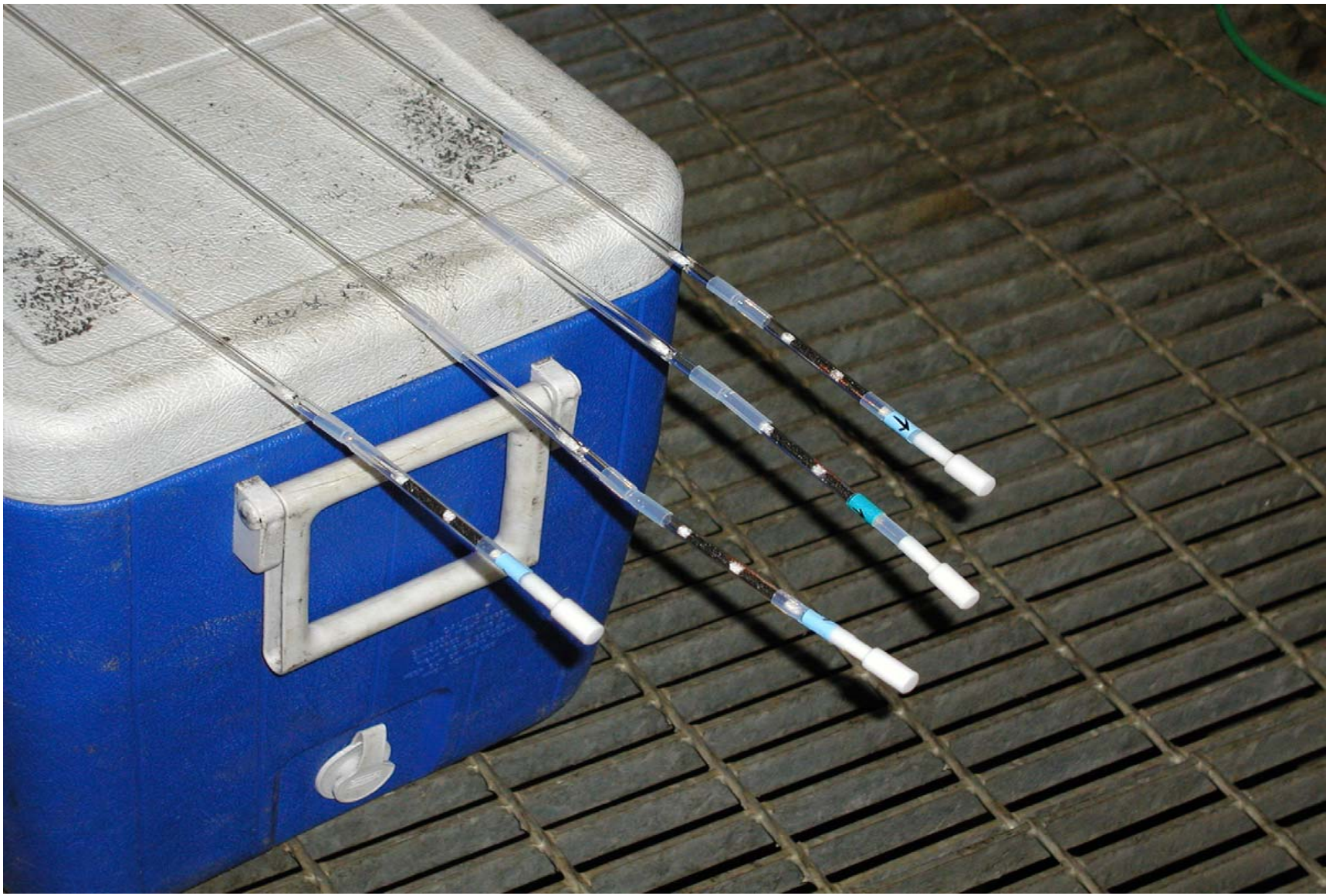
Sorbent Trap Sampling System



Used Courtesy of Eric Roland of Reliant Energy

Sampling Probe Used for the Sorbent Traps

Sorbent Traps



OH Sampling Probe

Requirements to Pass RATA

- If Hg concentration is >1 μg/m^3, relative difference (RD) for each test method must be ≤10%; if Hg concentration is ≤1 μg/m^3, RD must be ≤20%.
- To pass RATA, RA of the sorbent traps must be ≤20% of the OH method.
  - Note: For mercury concentrations <5 μg/m^3, the absolute mean difference between the RM and the test method must be <1μg/m^3.

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Test Series

Baseline (no mercury control)

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Comparison of Ohio Lumex to FGS

Test Series 1

Sample	Ohio Lumex – Sorbent Trap, µg/m^3				FGS – Sorbent Trap, µg/m^3			
	1	2	Avg	RD, %	1	2	Avg	RD, %
1	8.13	8.09	8.11	0.25	7.65	7.66	7.66	0.07
2	8.37	8.51	8.44	0.83	7.63	7.90	7.77	1.74
3	7.77	9.10	8.43	7.88	7.82	7.82	7.82	0.00
4	10.09	10.15	10.12	0.30	8.76	8.55	8.65	1.21
5	9.47	10.10	9.79	3.22	8.26	7.99	8.13	1.66
6	10.13	10.23	10.18	0.49	8.50	8.46	8.48	0.24
7	10.26	10.25	10.26	0.05	8.50	8.99	8.74	2.80
8	10.49	10.12	10.30	1.80	8.40	8.97	8.69	3.28
9	10.82	9.84	10.33	4.74	8.39	8.43	8.41	0.24
10	8.96	10.27	9.62	6.81	8.58	8.02	8.30	3.37
11	8.23	9.98	9.11	9.61	8.52	8.92	8.72	2.29
12	8.33	4.18	6.25	33.17	6.64	6.85	6.75	1.56

Comparison of Sorbent Trap and OH Data

Test Series 1

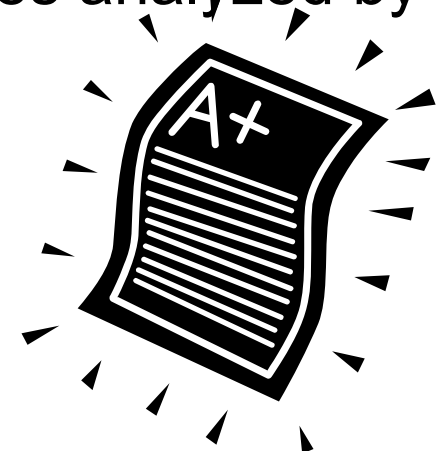
Sample	Sorbent Trap Average, µg/m^3		OH Method µg/m^3			
	Avg - OL	Avg - FGS	1	2	Avg	RD, %
1	8.11	7.66	7.62	1.60	4.61	65.29%
2	8.44	7.77	8.13	8.48	8.31	2.11%
3	8.43	7.82	8.19	8.25	8.22	0.36%
4	10.12	8.65	9.31	7.93	8.62	8.00%
5	9.79	8.13	9.23	7.91	8.57	7.70%
6	10.18	8.48	9.52	9.74	9.63	1.14%
7	10.26	8.74	8.16	7.91	8.04	1.56%
8	10.30	8.69	8.36	8.03	8.20	2.01%
9	10.33	8.41	8.22	8.83	8.52	3.58%
10	9.62	8.30	8.95	8.31	8.63	3.71%
11	9.11	8.72	9.08	9.06	9.07	0.11%
12	6.25	6.75	7.28	7.18	7.23	0.69%

Statistical Calculations
Test Series I

- Sorbent traps using FGS for analysis

RA = 5.07%

  - Number of samples = 9 (12)
  - Average OH concentration = 8.46 μg/m^3
  - Average sorbent trap (FGS) = 8.18 μg/m^3
  - Std. dev. of samples analyzed by FGS = 0.431 μg/m^3



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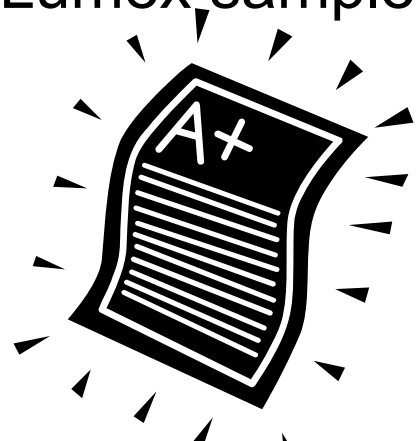
Statistical Calculations
Test Series 1

- Sorbent traps using the Ohio Lumex for analysis

  RA = 18.17%

  - Number of samples = 9 (12)
  - Average OH concentration = 8.46 µg/m^3
  - Average sorbent trap (Ohio Lumex) = 9.47 µg/m^3
  - Std. dev. of Ohio Lumex samples = 0.763 µg/m^3



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Test Series

Midlevel Mercury Control

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Comparison of Ohio Lumex to FGS

Test Series 2

Sample	Ohio Lumex – Sorbent Trap, µg/m^3				FGS – Sorbent Trap, µg/m^3			
	1	2	Avg	RD, %	1	2	Avg	RD, %
1	2.01	2.45	2.23	9.80	2.82	2.84	2.83	0.48
2	2.04	2.12	2.08	2.15	2.22	2.06	2.14	3.74
3	1.06	0.99	1.03	3.43	0.61	0.76	0.69	10.82
4	3.11	3.42	3.26	4.75	3.36	3.25	3.30	1.73
5	0.47	0.49	0.48	2.26	0.49	0.56	0.52	6.18
6	0.57	0.60	0.58	2.01	0.47	0.61	0.54	12.44
7	2.10	2.23	2.17	3.09	1.97	2.04	2.00	1.66
8	2.98	3.02	3.00	0.59	2.85	2.60	2.72	4.70
9	3.18	2.79	2.99	6.39	2.37	2.69	2.53	6.16
10	1.64	2.06	1.85	11.49	1.93	1.89	1.91	0.90
11	2.60	2.66	2.63	1.10	2.01	2.92	2.46	18.41
12	3.32	3.41	3.37	1.24	3.02	2.77	2.90	4.27

Comparison of Sampling Methods

Test Series 2

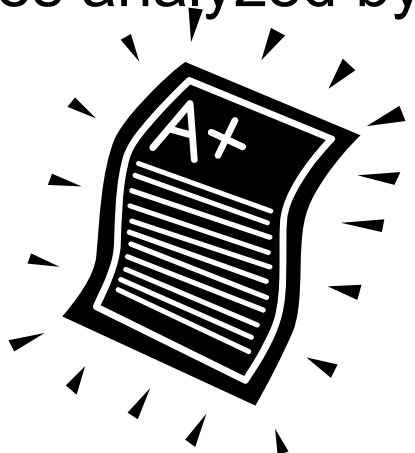
	Sorbent Traps, µg/m³		CMMs	OH Method, µg/m³			
Sample	Avg - OL	Avg - FGS	µg/m³	1	2	Avg	RD, %
1	2.23	2.83	3.82	2.84	2.93	2.89	1.57
2	2.08	2.14	2.99	2.19	2.24	2.21	1.24
3	1.03	0.69	1.57	1.13	1.13	1.13	0.19
4	3.26	3.30	3.64	2.94	3.37	3.15	6.74
5	0.48	0.52	0.69	0.47	0.57	0.52	9.71
6	0.58	0.54	0.72	0.67	0.63	0.65	3.06
7	2.17	2.00	1.96	2.04	2.29	2.17	5.80
8	3.00	2.72	2.69	2.50	3.15	2.83	11.37
9	2.99	2.53	2.64	3.05	3.19	3.12	2.20
10	1.85	1.91	2.18	1.91	2.32	2.12	9.77
11	2.63	2.46	3.07	2.85	2.90	2.88	0.95
12	3.37	2.90	3.13	3.71	3.82	3.77	1.36

Statistical Calculations
Test Series 2

- Sorbent traps using FGS for analysis

RA = 17.00%

  - Number of samples = 9 (12)
  - Average OH concentration = 2.19 μg/m^3
  - Average sorbent trap = 2.05 μg/m^3
  - Std. dev. of samples analyzed by FGS = 0.226 μg/m^3



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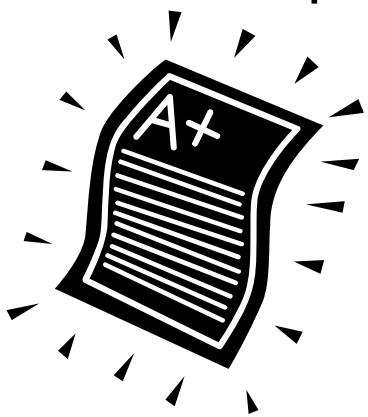
Statistical Calculations
Test Series 2

- Sorbent traps using the Ohio Lumex for analysis

  RA = 9.24%

  - Number of samples = 9 (12)
  - Average OH concentration = 2.19 µg/m^3
  - Average sorbent trap (Ohio Lumex) = 2.14 µg/m^3
  - Std. dev. of Ohio Lumex samples = 0.174 µg/m^3



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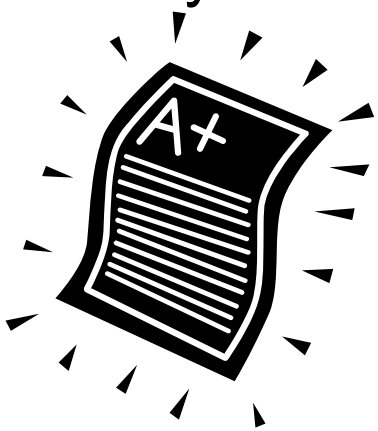
Statistical Calculations
Test Series 2

- CMM

  RA = 17.03%

  - Number of samples = 9 (12)
  - Average OH concentration = 2.19 µg/m^3
  - Average CMM = 2.43 µg/m^3
  - Std. dev. of samples analyzed CMM = 0.372 µg/m^3



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Test Series

High-Level Mercury Control

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Comparison of Ohio Lumex to FGS

Test Series 3

Sample	Ohio Lumex – Sorbent Trap, µg/m^3				FGS – Sorbent Trap, µg/m^3			
	1	2	Avg	RD, %	1	2	Avg	RD, %
1	0.22	0.23	0.22	3.72%	0.18	0.21	0.20	6.67%
2	0.17	0.14	0.15	7.79%	0.15	0.14	0.15	0.43%
3	0.06	0.17	0.12	47.33%	0.12	0.11	0.11	4.78%
4	0.54	0.59	0.57	4.08%	0.43	0.44	0.44	0.77%
5	0.35	0.30	0.32	7.96%	0.25	0.26	0.26	1.88%
6	0.11	0.11	0.11	4.18%	0.09	0.10	0.09	4.36%
7	0.17	0.11	0.14	19.83%	0.09	0.09	0.09	1.72%
8	0.13	0.16	0.15	7.74%	0.11	0.12	0.12	1.22%
9	0.13	0.12	0.12	3.23%	0.11	0.11	0.11	1.11%
10	0.02	0.09	0.06	58.73%	0.03	0.06	0.05	30.52%
11	0.19	0.29	0.24	21.33%	0.22	0.22	0.22	1.14%
12	0.20	0.27	0.23	13.80%	0.31	0.28	0.30	4.07%

Comparison of Sampling Methods

Test Series 3

	Sorbent Traps, µg/m³		CMMs	OH Method, µg/m³			
Sample	Avg - OL	Avg - FGS	µg/m³	1	2	Avg	RD, %
1	0.22	0.20	0.88	0.30	0.65	0.48	36.63%
2	0.15	0.15	0.37	0.22	0.33	0.28	19.14%
3	0.12	0.11	0.22	0.23	0.30	0.27	13.74%
4	0.57	0.44	0.47	0.52	0.41	0.47	11.93%
5	0.32	0.26	0.30	0.30	0.36	0.33	8.97%
6	0.11	0.09	0.16	0.11	0.22	0.17	31.45%
7	0.14	0.09	0.07	0.10	0.14	0.12	16.51%
8	0.15	0.12	0.09	0.15	0.26	0.21	27.24%
9	0.12	0.11	0.09	0.14	0.24	0.19	24.71%
10	0.06	0.05	0.05	0.13	0.32	0.22	43.16%
11	0.24	0.22	0.15	0.26	0.32	0.29	10.78%
12	0.23	0.30	0.21	0.37	0.48	0.42	13.08%

Statistical Calculations
Test Series 3

Measurement Method	RA, %
Sorbent Traps Using Ohio Lumex	45.71
Sorbent Traps Using FGS	52.05
CMMs	38.52

Test failed because OH sampling did not yield nine valid data points.

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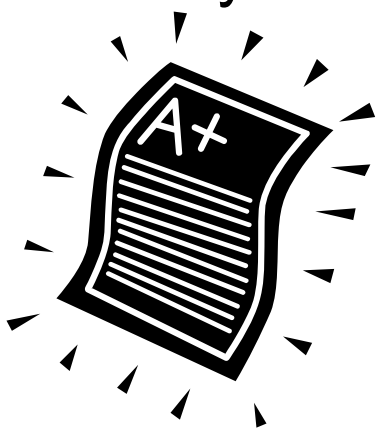
Statistical Calculations
Test Series 3

- CMM: sorbent trap (FGS) as a reference method

RA = 22.23%

  - Number of samples = 9 (12)
  - Average sorbent trap concentration = 0.19 µg/m^3
  - Average CMM = 0.21 µg/m^3
  - Std. dev. of samples analyzed CMM = 0.0504 µg/m^3



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What Next?

- Similar tests need to be completed at facilities burning other coals.
  - Texas and North Dakota lignites
  - Powder River Basin (PRB)
  - Western bituminous coal
  - High-sulfur eastern bituminous coal
  - Others?
- Quality assurance/quality control (QA/QC) protocols must be established for the Ohio Lumex or similar instruments that are in line with EPA1631.

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What Next?

- EPA must recognize the sorbent trap method as a valid RM and establish RM protocols for sorbent traps similar to OH method.
- It must be noted that in 2003 an EPA 301 validation study (proposed EPA Method 324) was submitted to EPA.

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