SPECIATED MERCURY EMISSIONS TESTING

Performed For
CITY OF GRAND ISLAND

At The
Platte Generating Station
Unit 1
Precipitator Inlet and Outlet
Grand Island, Nebraska

August 18 and 19, 1999

Mostardi Platt

Utilities Department

CITY OF GRAND ISLAND

Working Together for a Better Tomorrow. Today.

March 23, 2000

U.S. Environmental Protection Agency
Emissions, Measurement Center
Office of Air Quality Planning & Standards
Research Triangle Park, NC 27711

ATTN: Mr. Bill Grimley

Dear Mr. Grimley:

Please find enclosed three (3) copies of the Speciated Mercury Emissions Testing that was performed at the Precipitator Inlet and Outlet of City of Grand Island in Grand Island, Nebraska on August 18 and 19, 1999.

Should you have any questions, do not hesitate to contact Mr. Timothy Luchsinger at 308-385-5494.

Sincerely,

Shelly Schnakenberg

Shelly Schnakenberg
Utilities Secretary

Encls.

Cc: Mr. Paul Chu, Electric Power Research Institute w/one (1) copy

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Mostardi-Platt Associates, Inc.
A Full-Service
Environmental Consulting
Company

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Grand Island, Nebraska
August 18 and 19, 1999

MOSTARDI PLATT PROJECT 93305
DATE SUBMITTED: MARCH 16, 2000

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CERTIFICATION SHEET

Having supervised and worked on the test program described in this report, and having written this report, I hereby certify the data, information, and results in this report to be accurate and true according to the methods and procedures used.

Data collected under the supervision of others is included in this report and is presumed to have been gathered in accordance with recognized standards.

MOSTARDI-PLATT ASSOCIATES, INC.

James R. Platt
Vice President, Emissions Services

Reviewed by:

Frank H. Jarke
Manager, Analytical and Quality Assurance

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1.0 INTRODUCTION

1.1 Summary of Test Program

The United States Environmental Protection Agency (USEPA), is using its authority under section 114 of the Clean Air Act, as amended, to require that selected coal-fired utility steam generating units provide certain information that will allow the USEPA to calculate the annual mercury emissions from each unit. This information will assist the USEPA Administrator in determining whether it is appropriate and necessary to regulate emissions of Hazardous Air Pollutants (HAPs) from electric utility steam generating units. The Emission Measurement Branch (EMB) of the Office of Air Quality Planning and Standards (OAQPS) oversees the emission measurement activities. MOSTARDI-PLATT ASSOCIATES, INC. (Mostardi Platt) conducted the mercury emission measurements.

The USEPA selected the Platte Generating Station of the City of Grand Island in Grand Island, Nebraska to be one of seventy-eight coal-fired utility steam-generating units to conduct mercury emissions measurements. Testing was performed at Unit 1 on August 18 and 19, 1999, and was the only tested unit at this facility. Simultaneous measurements were conducted at the inlet and outlet of the precipitator. Mercury emissions were speciated into elemental, oxidized and particle-bound mercury using the Ontario-Hydro test method. Fuel samples were also collected concurrently with Ontario-Hydro samples in order to determine fuel mercury content.

1.2 Key Personnel

The key personnel who coordinated the test program and their telephone numbers are:

- Mostardi Platt Vice President, James Platt 630-993-9000
- City of Grand Island, Andrew Cofas 308-385-5497

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

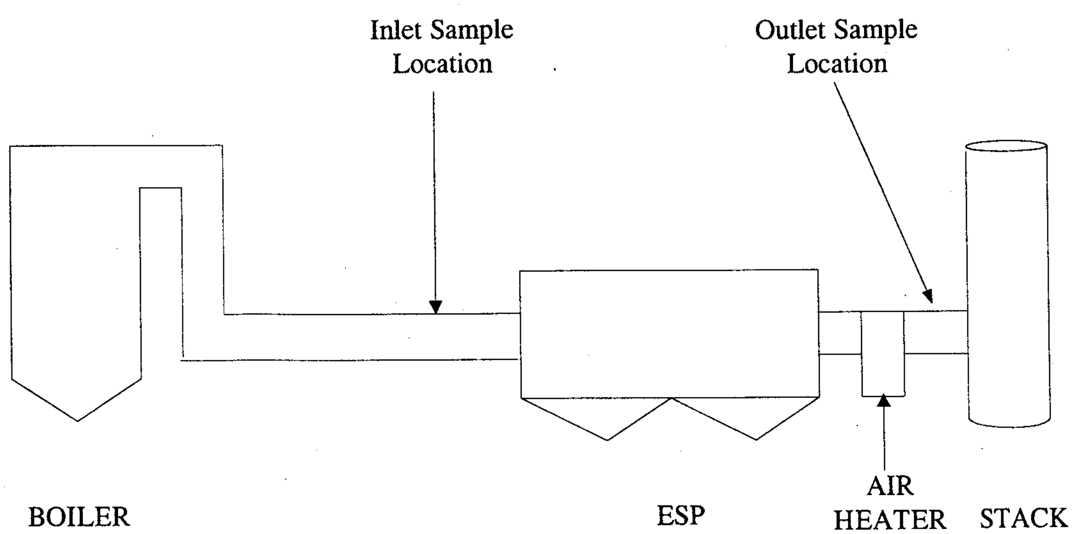
2.1 Process Description

Figure 2-1 illustrates the basic operational steps for this coal-fired steam generator. The steps are:

Grand Island Unit 1 is a pulverized coal fired, balanced draft boiler with a nameplate rating of 108 MW (gross). Figure 2-1 shows a schematic of the boiler and pollution control equipment, including sample points.

Unit 1 is a coal burning steam boiler. The steam is converted into mechanical energy by flowing through a turbine (generator) which produces electrical power. The unit was operating at or near full load during the tests. Fuel type, boiler operation and control device operation were maintained at normal operating conditions.

Figure 2- 1: Schematic of the Boiler and Pollution Control Equipment.



The following is a list of operating components for this unit:

- ABB Combustion Engineering pulverized coal fired, balanced draft boiler
- 108 MW gross capacity (Name plate rating)
- Fuel:
  - Subbituminous coal, 0.44% sulfur
- SO_2 control: None
- NO_X control: None
- Joy-Western Hot Side Electrostatic Precipitator

2.2 Control Equipment Description

Particulate emissions from the boiler are controlled by a Joy-Western hot side electrostatic precipitator with an estimated collection efficiency of 99.6%.

The flue gas at the inlet is approximately 750°F. At the outlet, the gas temperature is approximately 300°F and contains approximately 10 percent (10%) moisture.

2.3 Flue Gas Sampling Locations

2.3.1 Inlet Location

Inlet samples were collected at the precipitator inlet. A schematic and cross section of the inlet location are shown in Figures 2-3. This location does not meet the requirements of USEPA Method 1.

Nine (9) test ports exist at the inlet location. Four (4) of the nine (9) are not available for mercury testing. Monitors have been installed for unit operating control. Inlet sampling was for mercury concentration and gas flow determination. The outlet flow was utilized to calculate the inlet emission rates.

2.3.2 Outlet Location

Outlet samples were collected at the precipitator outlet duct sample ports. A schematic and cross section of the stack location is shown in Figures 2-4. This location does meet the requirements of USEPA Method 1.

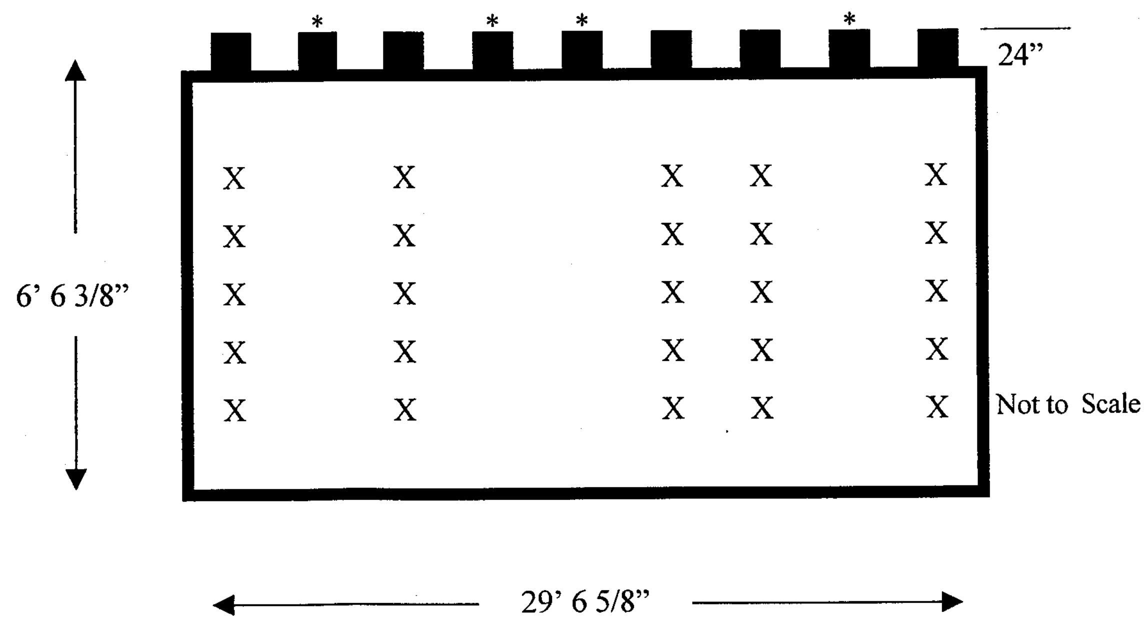
The flue gas at the outlet is above the method specification of a minimum filtration temperature of 120°C. Therefore, in stack filtration per Method 17 will be used.

2.4 Fuel Sampling Location

Fuel samples were collected at the fuel feeders to each individual pulverizing mill. One sample was collected from each feeder during each test run, and the feeder samples collected during a test run were composited prior to analysis. The Mostardi-Platt Associates, Inc. test crew supervisor assisted plant personnel with the collection of fuel samples.

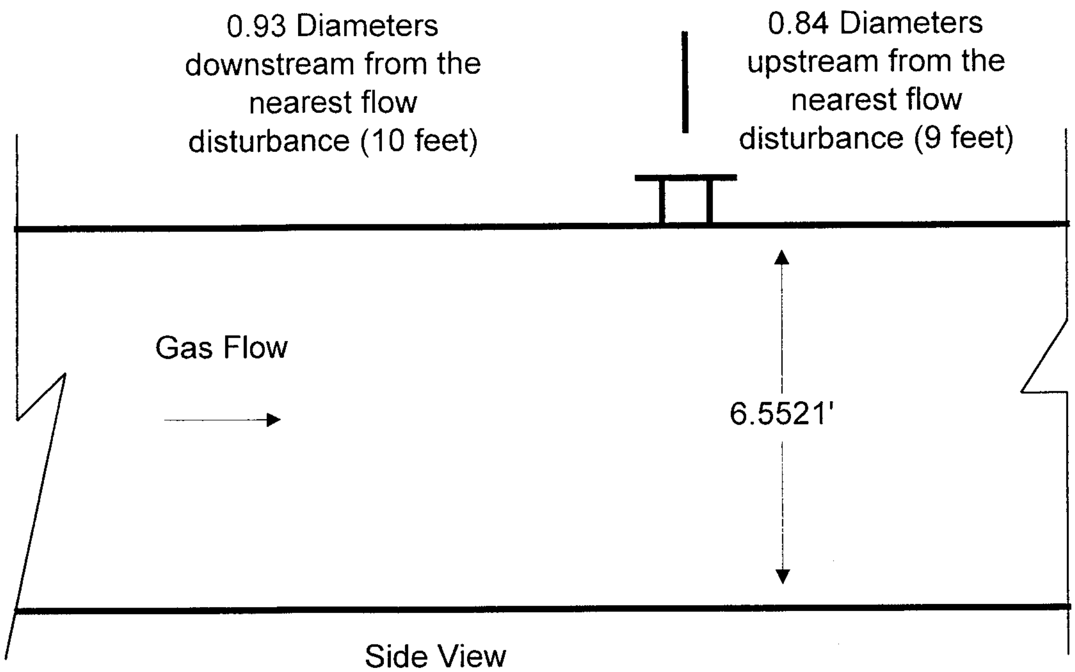
Figure 2- 2: Schematic of the Unit 1 Precipitator Inlet Sampling Location

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job:	City of Grand Island Platte Generating Station		
Date:	August 18 and 19, 1999	Area:	193.012 ft^2
Unit No:	1	No. Test Ports:	9*
Length:	6 Feet, 6.375 Inches	Tests Points per Port:	5
Width:	29 Feet, 6.625 Inches	Distance Between Ports:	3 Feet
Duct No:	Inlet	Distance Between Points:	1.31 Feet

*Four (4) of the test ports were not available for mercury testing. Oxygen (O_2) and carbon monoxide (CO) monitors have been installed for unit operating control.



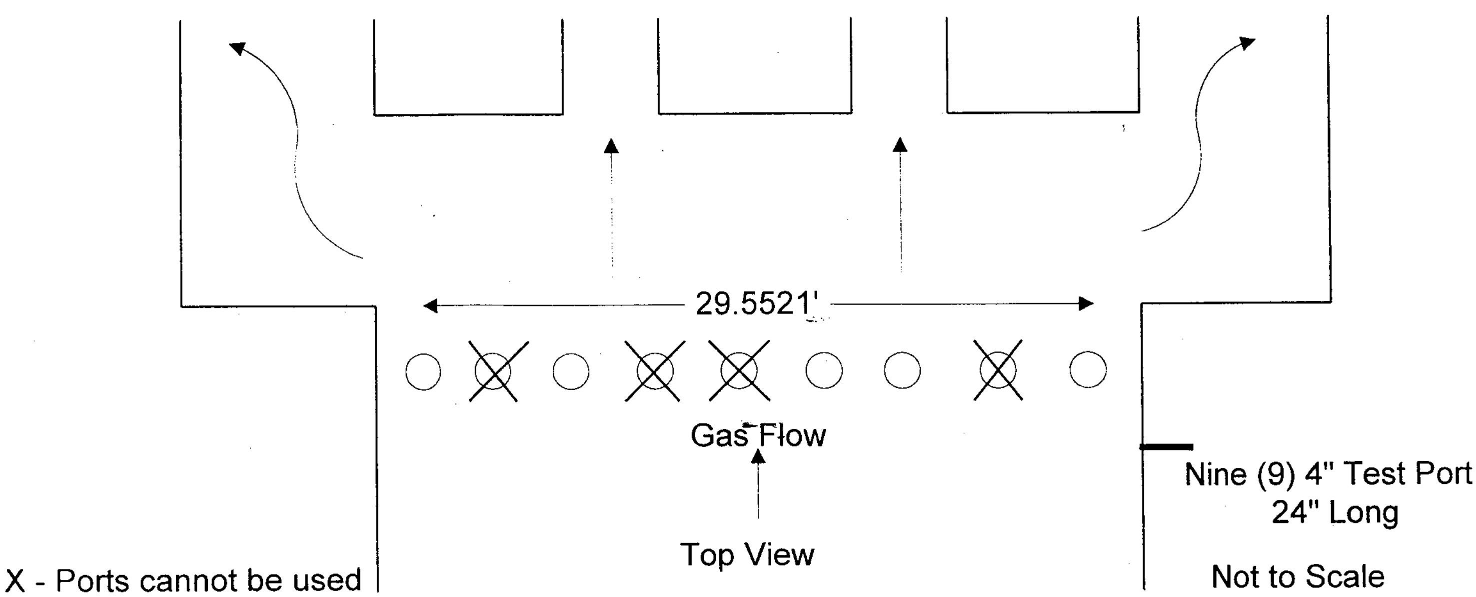
Side View

D = Equivalent Diameter

$$D = \frac{2 \times L \times W}{L + W}$$

$$D = \frac{2 \times 6.5313 \times 29.5521}{6.5313 + 29.5521}$$

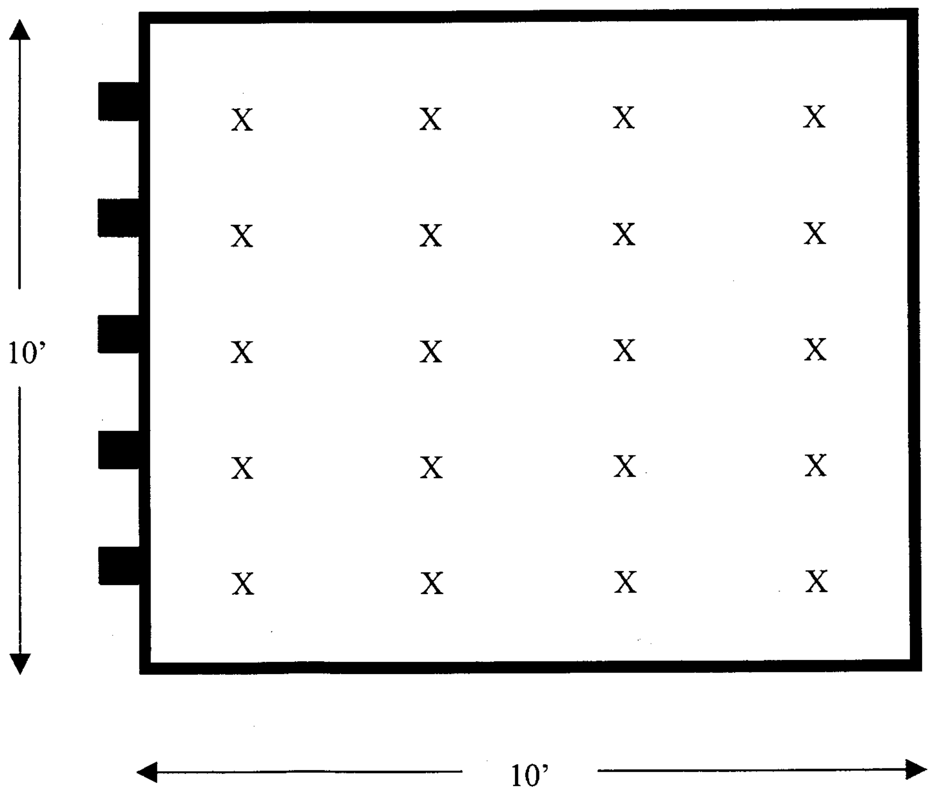
D = 10.7



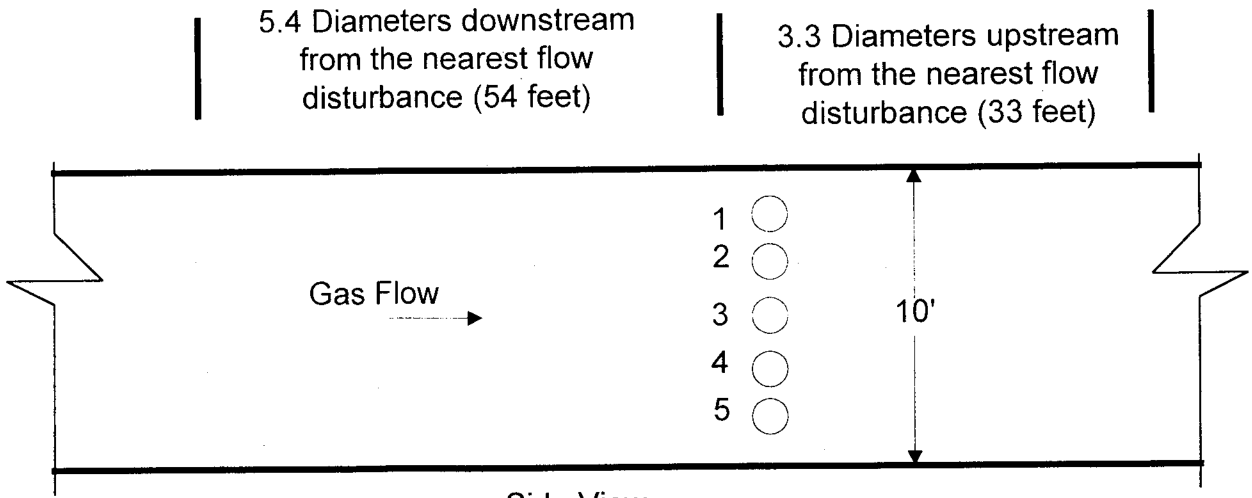
Top View

Figure 2- 3: Schematic of the Unit 1 Precipitator Outlet Sampling Location

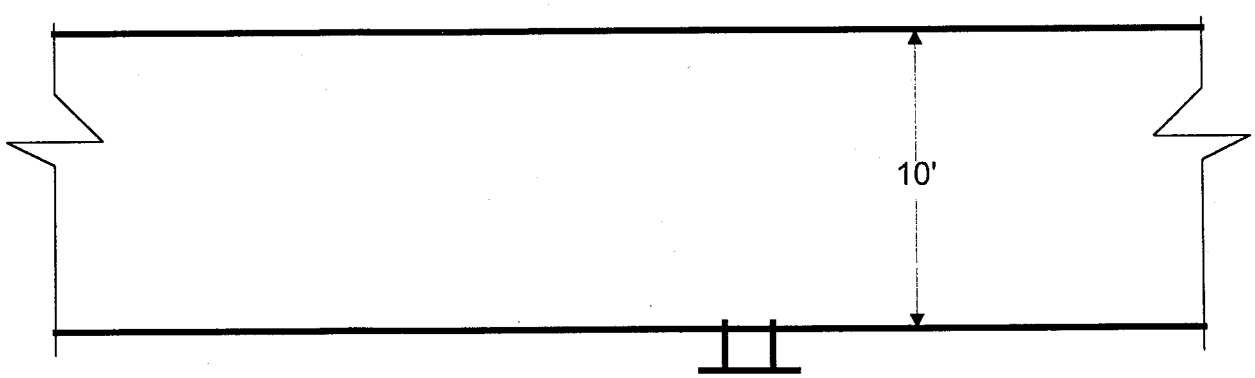
EQUAL AREA TRAVERSE
FOR RECTANGULAR DUCTS



Job:	City of Grand Island Platte Generating Station		
Date:	August 18 and 19, 1999	Area:	100.00 ft^2
Unit No:	1	No. Test Ports:	5
Length:	10 Feet	Tests Points per Port:	4
Width:	10 Feet	Distance Between Ports:	2 Feet
Duct No:	Outlet	Distance Between Points:	2.5 Feet



Side View



Five (5), 4" Test Ports
17" Long

Top View

D = Equivalent Diameter

$$D = \frac{2 \times L \times W}{L + W}$$

$$D = \frac{2 \times 10 \times 10}{10 + 10}$$

$$D = 10$$

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 Objectives and Test Matrix

The purpose of the test program was to quantify mercury emissions from this unit. This information will assist the USEPA Administrator in determining whether it is appropriate and necessary to regulate emissions of Hazardous Air Pollutants (HAPs) from electric utility steam generating units. The specific objectives, in order of priority were:

- Compare mass flow rates of mercury at the three sampling locations (fuel, inlet to and outlet from the precipitator).
- Measure speciated mercury emissions at the outlet.
- Measure speciated mercury concentrations at the inlet of the last air pollution control device.
- Measure mercury and chlorine content from the fuel being used during the testing.
- Measure the oxygen and carbon dioxide concentrations at the inlet and the outlet.
- Measure the volumetric gas flow at the inlet and the outlet.
- Measure the moisture content of the flue gas at the inlet and the outlet.
- Provide the above information to the USEPA for use in establishing mercury emission factors for this type of unit.

The test matrix is presented in Table 3-1. The table shows the testing performed at each location, methodologies employed and responsible organization.

Table 3-1
TEST MATRIX FOR THE PLATTE GENERATING STATION UNIT 1

Sampling Location	No. of Runs	Parameters	Sampling Method	Sample Run Time (min)	Analytical Method	Analytical Laboratory
Outlet	3	Speciated Hg	Ontario Hydro	120	EPA SW846 7470	TEI
Outlet	3	Moisture	EPA 4	120	Gravimetric	Mostardi Platt
Outlet	3	Flow	EPA 1 & 2	120	Pitot Traverse	Mostardi Platt
Outlet	3	O_2/CO_2	EPA 3	120	Orsat	Mostardi Platt
Inlet	3	Speciated Hg	Ontario Hydro	120	EPA SW846 7470	TEI
Inlet	3	Moisture	EPA 4	120	Gravimetric	Mostardi Platt
Inlet	3	Flow	EPA 1 & 2	120	Pitot Traverse	Mostardi Platt
Inlet	3	O_2/CO_2	EPA 3	120	Orsat	Mostardi Platt
Fuel Feeders	3	Hg, Cl in Fuel	Grab	1 Sample Per Feeder Per Run	ASTM D3684 (Hg) ASTM D4208 (Cl)	CTE

3.2 Field Test Changes and Problems

There were no field test changes or problems encountered during this test program.

3.3 Presentation of Results

3.3.1 Mercury Mass Flow Rates

The mass flow rates of mercury determined at each sample location are presented in Table 3-2.

Table 3-2
SUMMARY OF RESULTS

Sample Location	Elemental Mercury (lb/hr)	Oxidized Mercury (lb/hr)	Particle-Bound Mercury (lb/hr)	Total Mercury (lb/hr)
Fuel				
Run 1				0.00859
Run 2				0.00750
Run 3				0.00509
Average				**0.00706**
Inlet				
Run 1	0.00802	0.00338	0.00002	0.01142
Run 2	0.00913	0.00155	0.00003	0.01070
Run 3	0.01038	0.00391	0.00003	0.01432
Average	**0.00917**	**0.00295**	**0.00003**	**0.01215**
Outlet				
Run 1	0.00654	0.00108	0.00002	0.00764
Run 2	0.01239	0.00057	0.00002	0.01298
Run 3	0.01110	0.00113	0.00002	0.01224
Average	**0.01001**	**0.00093**	**0.00002**	**0.01096**

3.3.2 Comparison of Volumetric Flow Rate

Volumetric flow rate is a critical factor in calculating mass flow rates. Ideally, the volumetric flow rate (corrected to standard pressure and temperature) measured at the inlet to the control device should be the same as that measured at the stack, which should be the same as that measured by the CEMS. As can be seen in Table 3-3, the flow rates of the three locations on a thousand standard cubic foot per minute basis (KSCFM) were in agreement.

Table 3-3 COMPARISON OF VOLUMETRIC FLOW RATE DATA			
Run No.	**Inlet KACFM/KSCFM/KDSCFM**	**Stack KACFM/KSCFM/KDSCFM**	**CEMS KSCFM**
Run 1	649.169/257.200/225.307	420.351/270.823/237.783	263.000
Run 2	648.964/257.163//222.189	422.823/269.067/230.859	256.895
Run 3	653.592//263.380/223.610	416.363/273.721/237.042	254.061
Average	**650.575/259.248/223.702**	**419.846/271.204/235.228**	**257.985**

3.3.3 Individual Run Results

A detailed summary of results for each sample run at the precipitator inlet and outlet are presented in Tables 3-4 and 3-5, respectively.

3.3.4 Process Operating Data

The process operating data collected during the tests is included in Appendix A. A summary of the coal usage and mass emission rate of mercury available from coal is presented in Table 3-6.

Table 3-4
INLET INDIVIDUAL RUN RESULTS

Test Run Number:	1	2	3	Average
Source Condition		Normal		
Fuel Factor, dscf/10^6 Btu	9748	9795	9709	
Date	8/18/99	8/18/99	8/19/99	
Start Time	10:00	15:00	9:30	
End Time	12:55	17:15	11:44	
Elemental Mercury:				
ug detected	12.333	13.400	14.932	13.555
ug/dscm	9.00	10.56	11.69	10.42
lb/hr	0.00760	0.00878	0.00979	0.00872
lb/hr (based on outlet dscfm)	0.00802	0.00913	0.01038	0.00917
lb/10^{12} Btu	6.98	8.08	8.21	7.76
Oxidized Mercury:				
ug detected	5.201	2.271	5.631	4.368
ug/dscm	3.80	1.79	4.41	3.33
lb/hr	0.00320	0.00149	0.00369	0.00280
lb/hr (based on outlet dscfm)	0.00338	0.00155	0.00391	0.00295
lb/10^{12} Btu	2.94	1.37	3.10	2.47
Particle-bound Mercury:				
ug detected	0.037	<0.039	0.037	<0.038
ug/dscm	0.03	0.03	0.03	0.03
lb/hr	0.00002	0.00002	0.00002	0.00002
lb/hr (based on outlet dscfm)	0.00002	0.00003	0.00003	0.00003
lb/10^{12} Btu	0.02	0.02	0.02	0.02
Total Inlet Speciated Mercury:				
ug/dscm	12.83	12.37	16.13	13.78
lb/hr	0.01082	0.01030	0.01351	0.01154
lb/hr (based on outlet dscfm)	0.01142	0.01070	0.01432	0.01215
lb/10^{12} Btu	9.95	9.47	11.33	10.25
Average Gas Volumetric Flow Rate:				
@ Flue Conditions, acfm	649,169	648,964	653,592	650,575
@ Standard Conditions, dscfm	225,307	222,189	223,610	223,702
Average Gas Temperature, °F	773.3	775.8	780.6	776.6
Average Gas Velocity, ft/sec	56.06	56.04	56.44	56.18
Flue Gas Moisture, percent by volume	12.38	13.61	15.08	13.69
Average Flue Pressure, in. Hg	27.68	27.75	28.32	
Barometric Pressure, in. Hg	28.00	28.10	28.63	
Average %CO_2 by volume, dry basis	14.5	14.9	16.0	15.1
Average %O_2 by volume, dry basis	4.5	4.2	2.9	3.9
% Excess Air	26.65	24.48	15.45	22.19
Dry Molecular Wt. of Gas, lb/lb-mole	30.500	30.552	30.675	
Gas Sample Volume, dscf	48.371	44.833	45.097	
Isokinetic Variance	109.2	102.6	103.5	

Table 3-5
OUTLET INDIVIDUAL RUN RESULTS

Test Run Number:	1	2	3	**Average**
Source Condition	Normal			
Fuel Factor, dscf/10^6 Btu	9748	9795	9709	
Date	8/18/99	8/18/99	8/19/99	
Start Time	10:01	15:00	9:30	
End Time	12:42	17:15	11:43	
Elemental Mercury:				
ug detected	11.406	21.009	18.157	16.857
ug/dscm	7.35	14.33	12.50	11.39
lb/hr	0.00654	0.01239	0.01110	0.01001
lb/10^{12} Btu	6.24	12.07	10.53	9.61
Oxidized Mercury:				
ug detected	1.891	0.973	1.851	1.572
ug/dscm	1.22	0.66	1.27	1.05
lb/hr	0.00108	0.00057	0.00113	0.00093
lb/10^{12} Btu	1.03	0.56	1.07	0.89
Particle-bound Mercury:				
ug detected	<0.036	<0.035	<0.029	<0.033
ug/dscm	0.02	0.02	0.02	0.02
lb/hr	0.00002	0.00002	0.00002	0.00002
lb/10^{12} Btu	0.02	0.02	0.02	0.02
Total Outlet Speciated Mercury:				
ug/dscm	8.58	15.02	13.79	12.46
lb/hr	0.00764	0.01298	0.01224	0.01096
lb/10^{12} Btu	7.29	12.65	11.62	10.52
Average Gas Volumetric Flow Rate:				
@ Flue Conditions, acfm	420,351	422,823	416,363	419,846
@ Standard Conditions, dscfm	237,783	230,859	237,042	235,228
Average Gas Temperature, °F	308.1	316.4	307.2	310.5
Average Gas Velocity, ft/sec	70.06	70.47	69.39	69.97
Flue Gas Moisture, percent by volume	12.15	14.24	13.42	13.27
Average Flue Pressure, in. Hg	28.03	28.01	28.58	
Barometric Pressure, in. Hg	28.10	28.10	28.64	
Average %CO_2 by volume, dry basis	13.3	13.3	13.2	13.3
Average %O_2 by volume, dry basis	5.9	5.7	5.9	5.8
% Excess Air	38.58	36.60	37.85	37.68
Dry Molecular Wt. of Gas, lb/lb-mole	30.371	30.352	30.347	
Gas Sample Volume, dscf	54.839	51.773	51.300	
Isokinetic Variance	108.8	105.8	102.1	

Table 3-6
COAL USAGE RESULTS

Test Run Number:	1	2	3	Average
Source Condition		Normal		
Date	8/18/99	8/18/99	8/19/99	
Start Time	10:01	15:00	9:30	
End Time	12:55	17:15	11:44	
Coal Properties:				
Carbon, % dry	70.44	70.95	70.60	70.66
Hydrogen, % dry	4.97	4.90	4.97	4.95
Nitrogen, % dry	1.16	1.15	1.15	1.15
Sulfur, % dry	0.45	0.43	0.42	0.43
Ash, % dry	7.63	6.94	7.11	7.23
Oxygen, % dry (by difference)	15.35	15.63	15.75	15.58
Volatile, % dry	43.64	43.64	43.59	43.62
Moisture, %	31.68	29.14	31.22	30.68
Heat Content, Btu/lb dry basis	12230	12211	12284	12242
F_d Factor O_2 basis, dscf/10^6 Btu	9748	9795	9709	9751
F_c Factor CO_2 basis, scf/10^6 Btu	1849	1865	1845	1853
Chloride, ug/g dry	177.0	174.0	191.0	180.7
Mercury, ug/g dry	0.11	0.09	0.07	0.09
Coal Consumption:				
Feeder A, Klbs/hr	38.15	40.02	38.45	
Feeder B, Klbs/hr	38.43	40.39	38.90	
Feeder C, Klbs/hr	---	---	28.46	
Feeder D, Klbs/hr	37.71	37.14	---	
Total Raw Coal Input, Klbs/hr	114.29	117.55	105.81	112.55
Total Coal Input, lbs/hr dry	78083	83296	72777	78052
Total Mercury Available in Coal:				
Mercury, lbs/hr	0.00859	0.00750	0.00509	0.00706
Mercury, lbs/10^{12} Btu	8.99	7.37	5.70	7.35

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Test Methods

4.1.1 Speciated mercury emissions

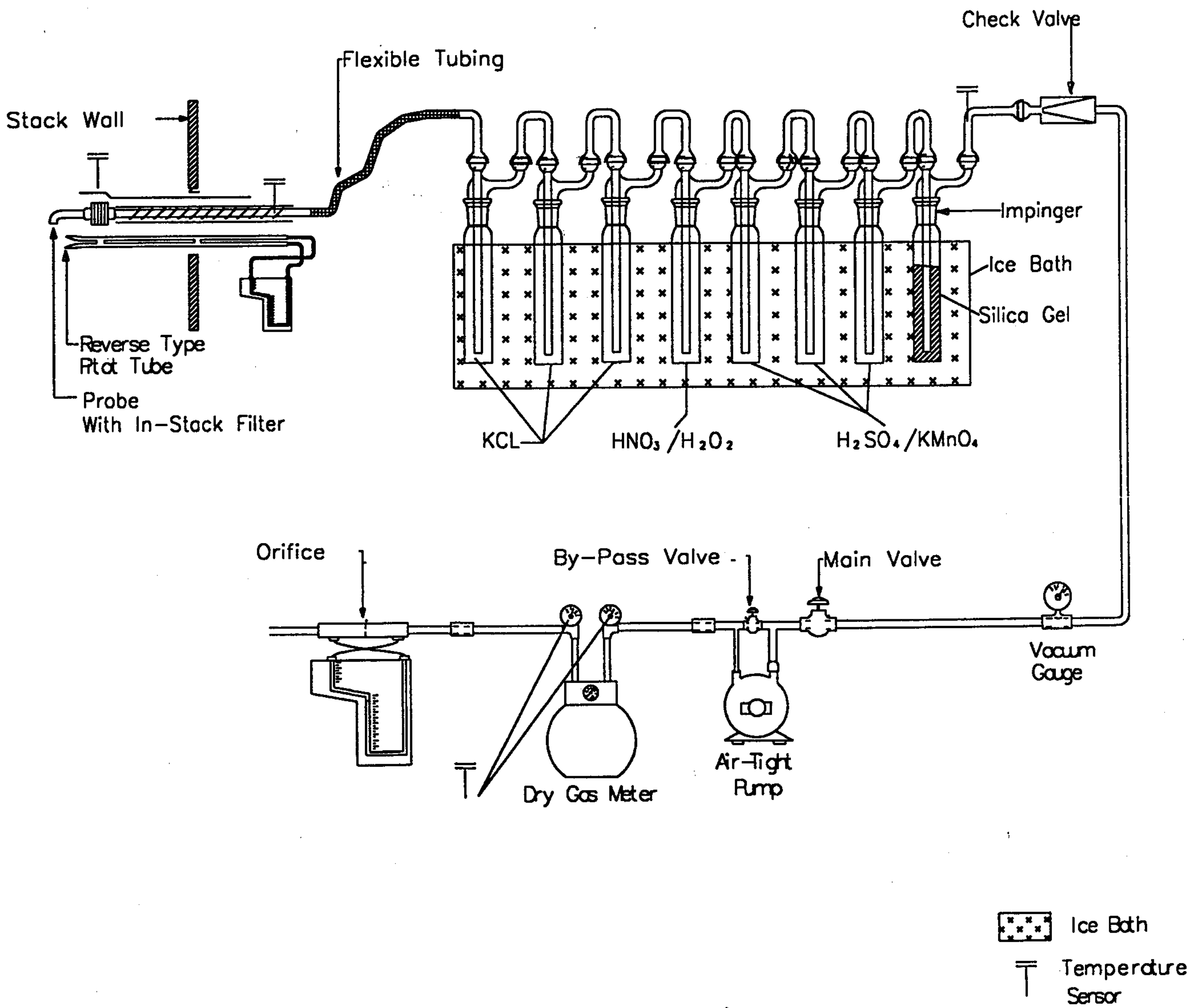
Speciated mercury emissions were determined via the draft "Standard Test Method for Elemental, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario-Hydro Method)", dated April 8, 1999. Any revisions to this test method issued after April 8, 1999, but before July 1, 1999, were incorporated.

The in-stack filtration (Method 17) configuration was utilized at the inlet and outlet test locations. Figure 4-1 is the schematic of the Ontario-Hydro sampling train.

Figure 4-2 illustrates the sample recovery procedure. The analytical scheme was per Section 13.3 of the Ontario-Hydro Method.

Speciated Mercury Sampling Train Equipped with In-Stack Filter

Ontario Hydro Method



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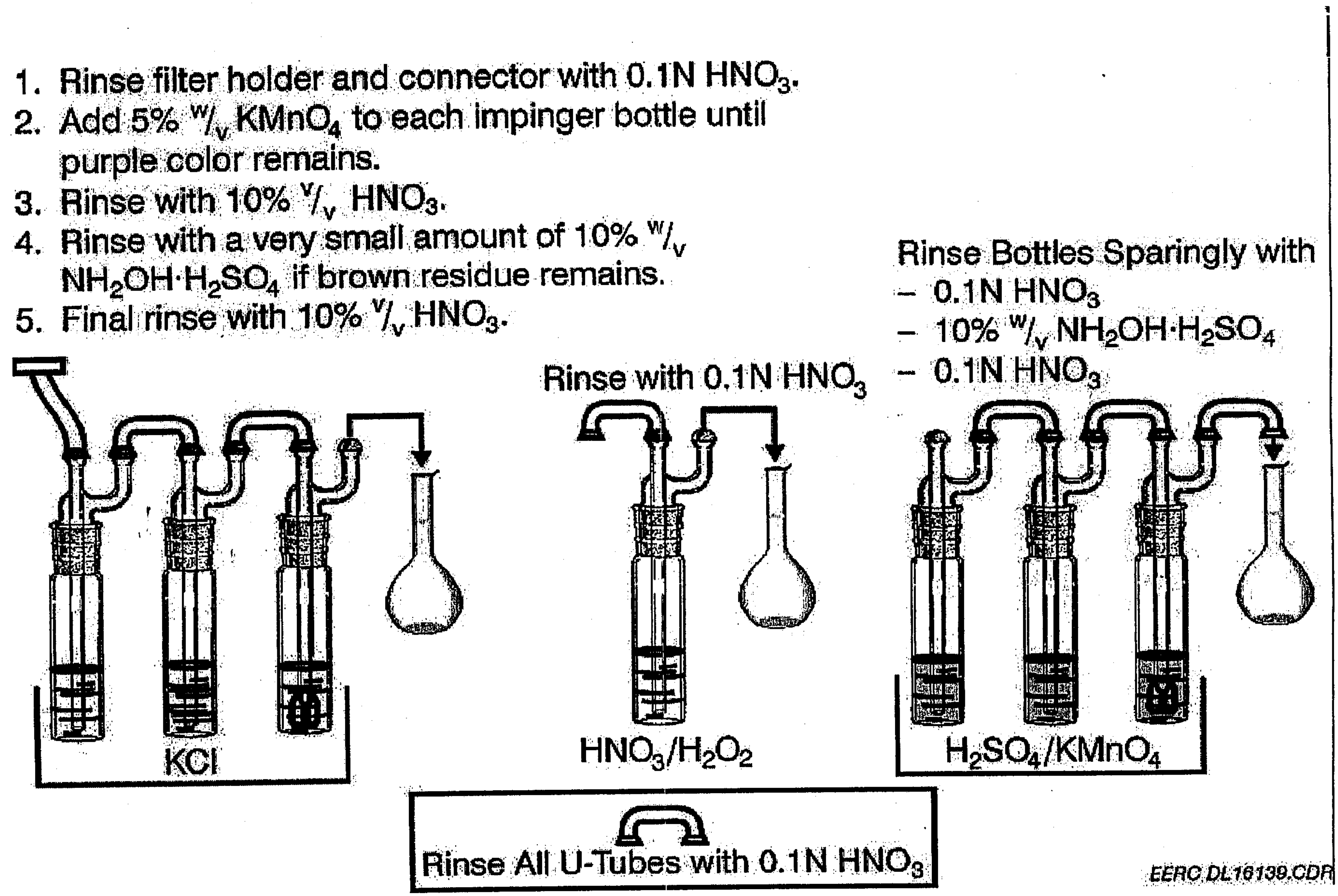

Figure 4-1: Sample Recovery Scheme for Ontario-Hydro Method Samples

4.1.2 Fuel samples

Fuel samples were collected by composite sampling. Three samples were collected at equally spaced intervals during each speciated mercury sampling run. Each set of three samples was composited into a single sample for each sample run. Sample analysis was conducted according to the procedures of ASTM D3684 and ASTM D4208.

4.2 Procedures for Obtaining Process Data

Plant personnel were responsible for obtaining process operating data. The process data, which can be found in Appendix A, was continuously monitored by the facility.

4.3 Sample Identification and Custody

The chain-of-custody for all samples obtained for analysis can be found in Appendix E.

5.0 INTERNAL QA/QC ACTIVITIES

All sampling, recovery and analytical procedures conform to those described in the site specific test plan. All resultant data was reviewed by the laboratory and Mostardi Platt per the requirements listed in the QAPP and were determined to be valid except where noted below.

5.1 QA/QC Problems

Reagent blanks are required to be less than ten times the detection limit or ten percent of the sample values found.

The reagent blank, Sample ID #042, for $KMNO_4/H_2SO_4$ was found to be 0.068 μg which is more than ten times the detection limit of 0.003 μg. This value was however, less than ten percent of the results for the $KMNO_4/H_2SO_4$ impingers and therefore the data does not need to be qualified.

The train blank value for the KC1 impinger at the outlet, Sample ID #032, was more than 30% of the values obtained at this location for the KC1 fraction. Procedural problems are outlined by the laboratory (see Appendix F) resulted in incorrect values being obtained initially for the KC1 fraction. These samples were reprepped and rerun with similar results being obtained.

The matrix spike and matrix spike duplicate for the analysis of the filter blanks do not agree within ten percent of each other. This set of samples is being rerun.

5.2 QA Audits

5.2.1 Reagent Blanks

As required by the method, blanks were collected for all reagents utilized. The results of reagent blank analysis are presented in Table 5-1.

Table 5-1
REAGENT BLANK ANALYSIS

Sample ID #	Sample Fraction	Contents	Mercury (µg)	Detection Limit (µg)
038	Front-half	0.1N HNO_3/Filter	< 0.002	0.002
039	1 N KCl	1 N KCl	0.009	0.003
040	HNO_3/H_2O_2	HNO_3/H_2O_2	< 0.008	0.008
042	$KMnO_4/H_2SO_4$	$KMnO_4/H_2SO_4$	0.068	0.003
043	$KMnO_4/H_2SO_4$	$KMnO_4/H_2SO_4$	0.019	0.003

5.2.2 Blank Trains

As required by the method, blank trains were collected at both the inlet and stack sampling locations. These trains were collected on August 18 and 19, 1999. The results of blank train analysis are presented in Table 5-2.

Table 5-2
BLANK TRAIN ANALYSIS

Sample ID#	Sample Fraction	Contents	Mercury (µg)	Detection Limit (µg)
035, 036, 037	Front-half	Filter	0.036	0.002
029	KCl impingers	Impingers/rinse	0.454	0.03
032	KCl impingers	Impingers/rinse	0.908	0.03
030	HNO_3-H_2O_2 impingers	Impingers/rinse	0.060	0.04
033	HNO_3-H_2O_2 impingers	Impingers/rinse	0.077	0.04
031	$KMnO_4/H_2SO_4$ impingers	Impingers/rinse	0.18	0.03
034	$KMnO_4/H_2SO_4$ impingers	Impingers/rinse	0.25	0.03

5.2.3 Field Dry Test Meter Audit

The field dry test meter audit described in Section 4.4.1 of Method 5 was completed prior to the test. The results of the audit are presented in Appendix C.

