Northern States Power Company

414 Nicollet Mall
Minneapolis, Minnesota 55401-1927
Telephone (612) 330-5500

May 30, 2000

Mr. Bill Grimley
U.S. Environmental Protection Agency
Emissions, Measurement Center
Office of Air Quality Planning & Standards
Research Triangle Park
North Carolina 27711

Re: Sherburne County Generating Plant Unit 3, Becker, Minnesota
Submittal of Stack Test Reports for EPA Information Collection Request (ICR) for Mercury (Hg)

Dear Mr. Grimley

NSP is submitting the stack test reports for Hg testing that was completed at Sherburne County unit 3.

Please find enclosed three stack test reports, # 000403B, for the completed testing utilizing the Ontario Hydro Method.

If you have any questions concerning this submittal, please contact me at 330-6083.

Sincerely,

Rick Karpinske

Rick Karpinske
Senior Environmental Analyst

Enclosure:

cc: Lee Eberley (w/o encl)
Patti Leaf (w/o encl)
Alma Webb-Allen (w/o encl)
Chris Olson (w/o encl)
Bob Catron
Paul Chu EPRI
ERAD Record Center

j:\cems\Hg testing\Sherco\Sh3 ICR Hg test report submittal letter

SPECIATED MERCURY EMISSIONS TESTING

Performed For
NORTHERN STATES POWER COMPANY

At The
Sherburne County Generating Plant
Unit 3
Inlet and Stack
Becker, Minnesota

January 25 and 26, 2000

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

945 Oaklawn Avenue
Elmhurst, Illinois 60126-1012
Phone 630-993-9000
Facsimile 630-993-9017

Mostardi Platt

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January 25 and 26, 2000

MOSTARDI PLATT PROJECT 000403B
DATE SUBMITTED: MAY 25, 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 all 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 Unit 3 of Northern States Power Company in Becker, Minnesota to be one of seventy-eight coal-fired utility steam generating units to conduct mercury emissions measurements. Testing was performed at Unit 3 on January 25 and 26, 2000. Simultaneous measurements were conducted at the Inlet and Stack. 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
- Northern States Power
  Project Coordinator, Rick Karpinske 612-330-6083

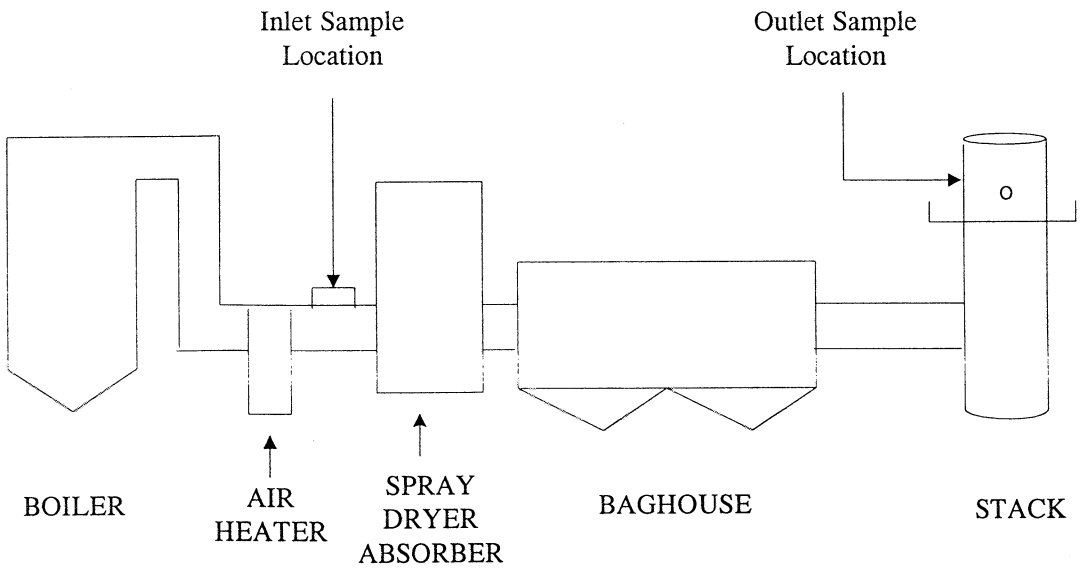
2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

Sherburne County Unit 3 is a pulverized coal fired balanced draft steam boiler with a name plate rating of 900 MW. Figure 2-1 shows a schematic of the boiler and pollution control equipment, including sample points.

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:

- Babcock & Wilcox wall fired balanced draft boiler
- 900 MW gross capacity

- Fuel:
- Subbituminous Coal (0.6% sulfur)

- SO_2 control: Spray Dryer Absorber (SDA)

- NO_X control: Dual Register Burners

- Joy Baghouse (Design Efficiency 99.8%)

2.2 Control Equipment Description

Particulate emissions from the boiler are controlled by a Joy Baghouse with an estimated collection efficiency of 99.8%. Sulfur dioxide emissions are controlled by a Joy/Niro Spray Dryer Absorber (SDA) with rotary atomizers. The SDA has a design efficiency of 73% SO_2 removal.

The flue gas at the inlet was approximately 295 °F. At the outlet, the gas temperature was approximately 175 °F and contained approximately 15 percent (15%) moisture.

2.3 Flue Gas Sampling Locations

2.3.1 Inlet Location

Inlet samples were collected at the SDA inlet. A schematic and cross section of the inlet location are shown in Figure 2-2. This location does not meet the requirements of USEPA Method 1. Oxygen (O_2) and carbon dioxide (CO_2) concentrations were determined at each test using Method 3 (integrated sampling).

A preliminary oxygen traverse was performed prior to the mercury tests in order to determine if there was any stratification in the duct. The traverse was taken from the ports at the top, middle and bottom. The in-stack filtration per Method 17 was used.

2.3.2 Outlet Location

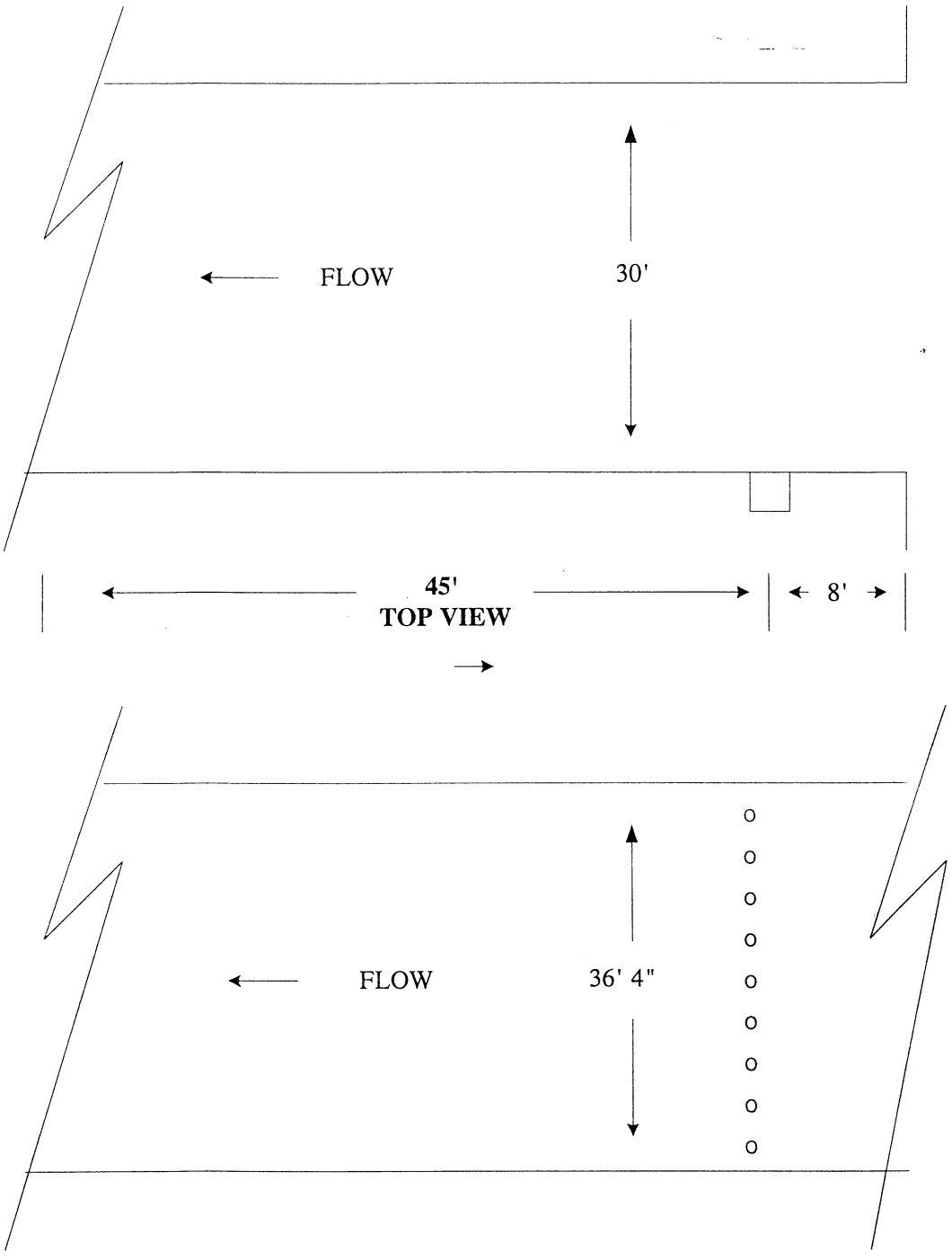
Outlet samples were collected at the outlet (stack) sample ports. A schematic and cross section of the stack location is shown in Figure 2-3. This location meets the requirements of USEPA Method 1. Twelve (12) points were sampled.

The flue gas at the outlet was below the method specification of a minimum filtration temperature of 120°C. Therefore, out of stack filtration per Method 5 was used.

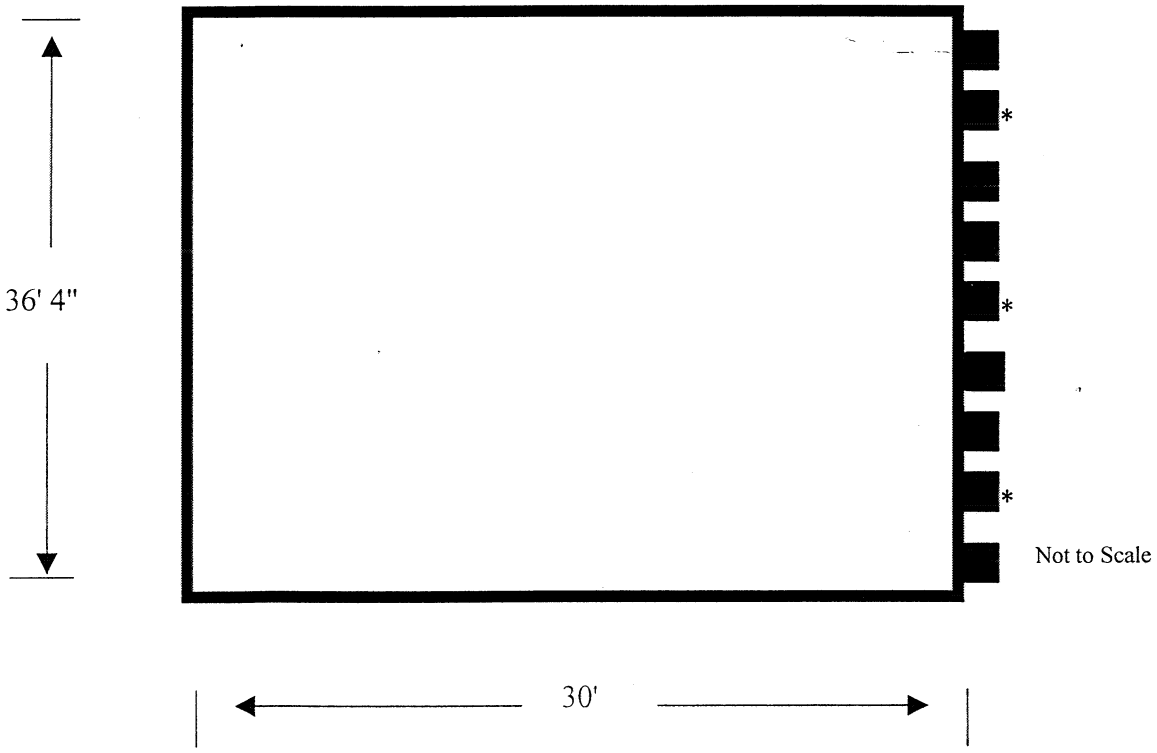
2.4 Fuel Sampling Location

Fuel samples were collected utilizing the existing Ramsey Automatic Coal Sampling System eight (8) hours prior to each test. A coal sample of approximately thirty (30) pounds was taken from the head end of the 7A and 7B conveyor at the top of transfer tower 4. The sample was riffled down on site to approximately a two quart size. The samples were marked with the appropriate time and date.

Figure 2-2 Schematic of the Sherburne County Generating Plant Inlet Sampling Location



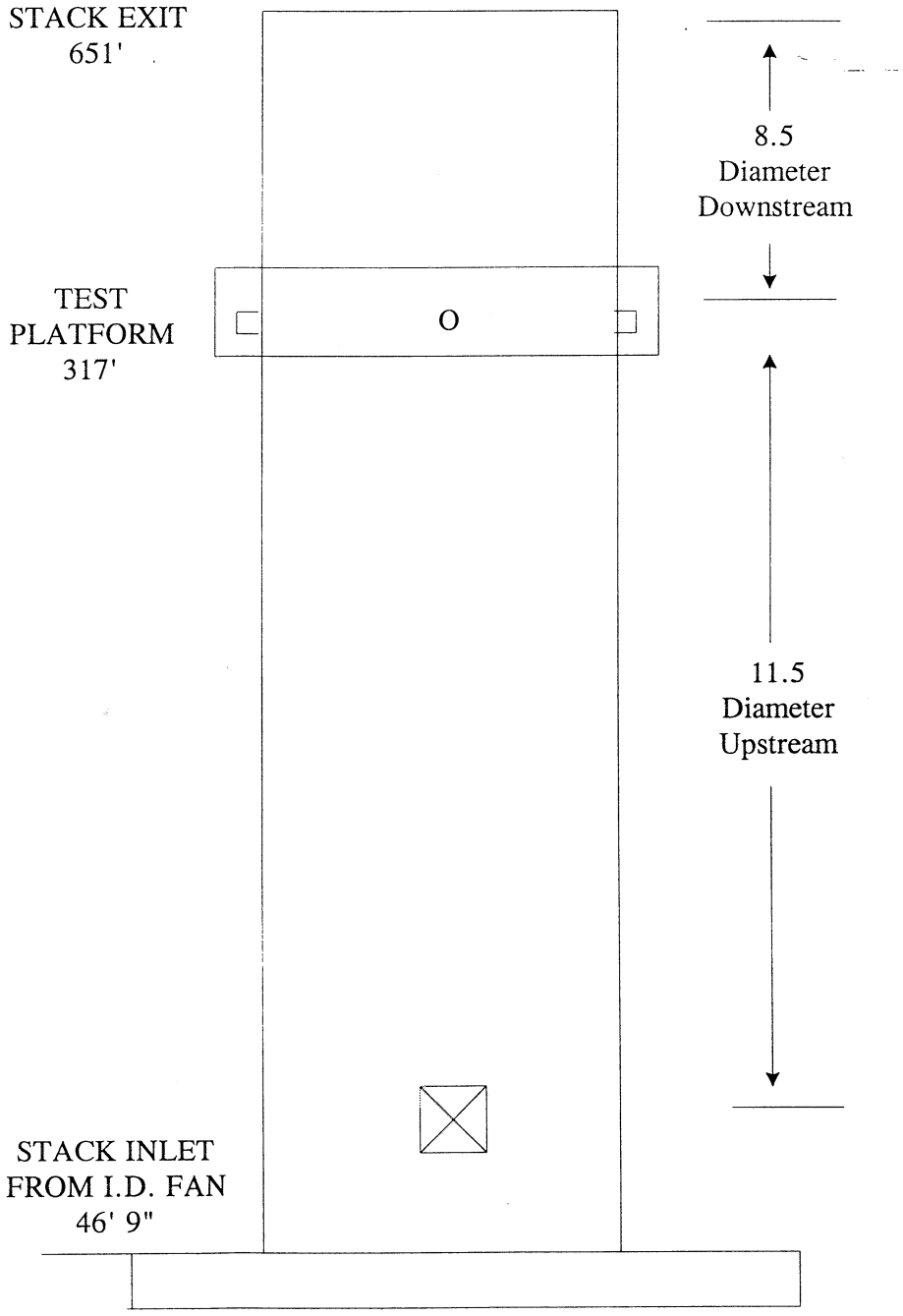
Equal Area Traverse For Rectangular Ducts (Inlet)



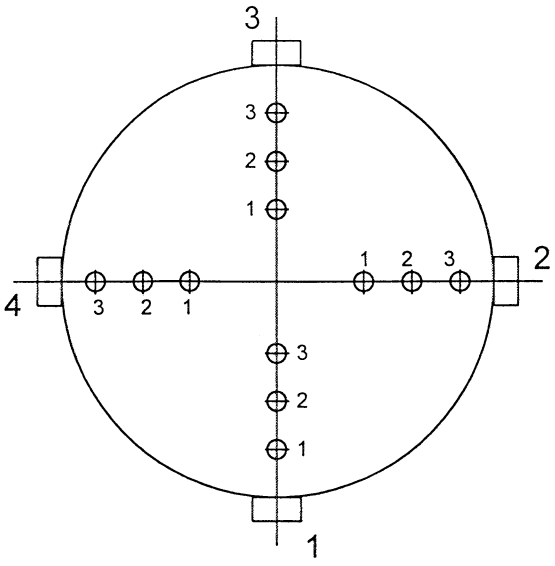
Job:	Northern States Power Company Sherburne County Generating Plant		
Date:	TBA	Area:	1090.00 ft^2
Unit No:	3	No. Test Ports:	9*
Length:	36 Feet 4 Inches	Tests Points per Port:	4
Width:	30 Feet	Distance Between Ports:	4.05 Feet
Duct No:	SDA Inlet		

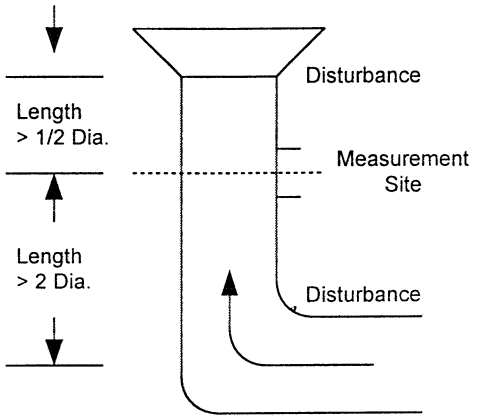
* Three (3) ports were traversed for O_2 stratification. The middle port was sampled because no stratification existed.

Figure 2-3 Schematic of the Sherburne County Generating Plant Outlet Sampling Location



Equal Area Traverse For Round Ducts (Outlet)





Job: Northern States Power Company
Sherburne County Generating Plant

Date: January 25 and 26, 2000

Unit No: 3

Duct No: Stack

Duct Diameter: 29.5 Feet

Duct Area: 683.49 Square Feet

No. Points Across Diameter: 6

No. of Ports: 4

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, and stack).
- 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 NSP - SHERBURNE COUNTY GENERATING PLANT, UNIT 3

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	Philip Services
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	Philip Services
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

The QAPP indicated that the mercury would be analyzed by TEI, Inc. The mercury samples from this test program were sent to the Philip Services for analysis. There were no other 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				0.05842
Run 1				0.05927
Run 2				0.05271
Run 3				0.05680
Average				
Inlet	0.07691	0.00377	0.00000	0.08068
Run 1	0.07830	0.00164	0.00000	0.07995
Run 2	0.06987	0.00132	0.00000	0.07119
Run 3	0.07503	0.00224	0.00000	0.07727
Average				
Stack	0.05237	0.00122*	0.00074	0.05434
Run 1	0.06869	0.00101*	0.00081	0.07051
Run 2	0.05871	0.00143*	0.00164	0.06177
Run 3	0.05992	0.00122*	0.00106	0.06221
Average				

* Qualified data per QAPP

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 inlet and stack locations on a thousand standard cubic foot per minute basis (KSCFM) were in agreement.

Table 3-3 COMPARISON OF VOLUMETRIC FLOW RATE DATA						
	Inlet			Stack		
Run No.	KACFM	KSCFM	KDSCFM	KACFM	KSCFM	KDSCFM
Run 1	3328.9	2228.4	1968.3	2837.0	2295.5	2031.8
Run 2	3376.5	2249.6	1979.2	2852.3	2309.3	1896.9
Run 3	3346.1	2218.5	1951.6	2860.0	2326.8	1977.3
Average	3350.5	2232.2	1966.4	2850.0	2310.5	1968.7

3.3.3 Individual Run Results

A detailed summary of results for each sample run at the inlet and stack test locations 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 are 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	9844	9885	9868	
Date	1/25/2000	1/25/2000	1/26/2000	
Start Time	11:32	14:40	8:35	
End Time	13:54	16:56	10:46	
Elemental Mercury:				
HNO_3-H_2O_2, ug detected	ND <0.25	ND <0.25	ND <0.25	ND <0.25
H_2SO_4-$KMnO_4$, ug detected	20.000	20.000	18.000	19.333
Reported, ug	20.000	20.000	18.000	19.333
ug/dscm	10.43	10.56	9.56	10.19
lb/hr	0.07691	0.07830	0.06987	0.07503
lb/10^{12} Btu	7.84	7.87	7.37	7.69
Oxidized Mercury:				
KCl, ug detected	0.980	0.420	0.340	0.580
Reported, ug	0.980	0.420	0.340	0.580
ug/dscm	0.51	0.22	0.18	0.30
lb/hr	0.00377	0.00164	0.00132	0.00224
lb/10^{12} Btu	0.38	0.17	0.14	0.23
Particle-bound Mercury:				
Filter, ug detected	ND <0.010	ND <0.010	ND <0.010	ND <0.010
HNO_3, ug detected	ND <0.010	ND <0.010	ND <0.010	ND <0.010
Reported, ug	0.000	0.000	0.000	0.000
ug/dscm	0.00	0.00	0.00	0.00
lb/hr	0.00000	0.00000	0.00000	0.00000
lb/10^{12} Btu	0.00	0.00	0.00	0.00
Total Inlet Speciated Mercury:				
ug/dscm	10.94	10.79	9.74	10.49
lb/hr	0.08068	0.07995	0.07119	0.07727
lb/10^{12} Btu	8.22	8.04	7.51	7.92
Average Gas Volumetric Flow Rate:				
@ Flue Conditions, acfm	3,328,858	3,376,452	3,346,102	3,350,471
@ Standard Conditions, dscfm	1,968,310	1,979,160	1,951,580	1,966,350
Average Gas Temperature, °F	292.2	295.8	301.2	296.4
Average Gas Velocity, ft/sec	50.90	51.63	51.16	51.23
Flue Gas Moisture, percent by volume	11.67	12.02	12.03	11.91
Average Flue Pressure, in. Hg	28.53	28.53	28.60	
Barometric Pressure, in. Hg	29.60	29.60	29.70	
Average %CO_2 by volume, dry basis	15.2	15.4	14.7	15.1
Average %O_2 by volume, dry basis	3.8	3.6	4.2	3.9
% Excess Air	21.61	20.24	24.40	22.09
Dry Molecular Wt. of Gas, lb/lb-mole	30.584	30.608	30.520	
Gas Sample Volume, dscf	67.695	66.856	66.498	
Isokinetic Variance	99.5	97.7	98.6	

Table 3-5
STACK INDIVIDUAL RUN RESULTS

Test Run Number:	**1**	**2**	**3**	**Average**
Source Condition		Normal		
Fuel Factor, dscf/10^6 Btu	9844	9885	9868	
Date	01/25/2000	1/25/2000	1/26/2000	
Start Time	11:30	14:40	8:37	
End Time	13:48	16:55	11:00	
Elemental Mercury:				
HNO_3-H_2O_2, ug detected	ND <0.025	ND <0.025	ND <0.025	ND <0.025
H_2SO_4-$KMnO_4$, ug detected	12.000	17.000	14.000	14.333
Reported, ug	12.000	17.000	14.000	14.333
ug/dscm	6.88	9.67	7.93	8.16
lb/hr	0.05237	0.06869	0.05871	0.05992
lb/10^{12} Btu	6.05	8.72	7.09	7.29
Oxidized Mercury:				
KCl, ug detected	0.280	0.250	0.340	0.290
Reported, ug	0.280	0.250	0.340	0.290
ug/dscm	0.16	0.14	0.19	0.17
lb/hr	0.00122	0.00101	0.00143	0.00122
lb/10^{12} Btu	0.14	0.13	0.17	0.15
Particle-bound Mercury:				
Filter/HNO_3, ug detected	0.170	0.200	0.390	0.253
Reported, ug	0.170	0.200	0.390	0.253
ug/dscm	0.10	0.11	0.22	0.14
lb/hr	0.00074	0.00081	0.00164	0.00106
lb/10^{12} Btu	0.09	0.10	0.20	0.13
Total Outlet Speciated Mercury:				
ug/dscm	7.14	9.93	8.34	8.47
lb/hr	0.05434	0.07051	0.06177	0.06221
lb/10^{12} Btu	6.28	8.95	7.46	7.56
Average Gas Volumetric Flow Rate:				
@ Flue Conditions, acfm	2,836,976	2,852,314	2,860,005	2,849,765
@ Standard Conditions, dscfm	2,031,752	1,896,884	1,977,343	1,968,659
Average Gas Temperature, °F	176.8	176.4	177.7	177.0
Average Gas Velocity, ft/sec	69.18	69.55	69.74	69.49
Flue Gas Moisture, percent by volume	11.49	17.86	15.02	14.79
Average Flue Pressure, in. Hg	29.20	29.20	29.40	
Barometric Pressure, in. Hg	29.31	29.31	29.51	
Average %CO_2 by volume, dry basis	12.5	12.2	12.7	12.5
Average %O_2 by volume, dry basis	6.3	6.6	6.5	6.5
% Excess Air	41.62	44.48	43.83	43.31
Dry Molecular Wt. of Gas, lb/lb-mole	30.252	30.216	30.292	
Gas Sample Volume, dscf	61.570	62.089	62.363	
Isokinetic Variance	97.7	105.6	101.7	

Table 3-6
COAL USAGE RESULTS

Test Run Number:	1	2	3	Average
Source Condition		Normal		
Date	01/25/2000	1/25/2000	1/26/2000	
Start Time	11:30	14:40	8:37	
End Time	13:48	16:55	11:00	
Coal Properties:				
Carbon, % dry	68.57	68.52	67.61	68.23
Hydrogen, % dry	4.60	4.57	4.49	4.55
Nitrogen, % dry	0.86	0.85	0.85	0.85
Sulfur, % dry	0.81	0.68	0.78	0.76
Ash, % dry	11.31	10.99	12.23	11.51
Oxygen, % dry (by difference)	13.85	14.39	14.04	14.09
Volatile, % dry	41.50	42.48	41.55	41.84
Moisture, %	26.67	25.50	25.46	25.88
Heat Content, Btu/lb dry basis	11770	11670	11541	11660
F_d Factor O_2 basis, dscf/10^6 Btu	9844	9885	9868	9866
F_c Factor CO_2 basis, scf/10^6 Btu	1870	1885	1880	1878
Chloride, ug/g dry	85.0	93.0	128.0	102.0
Mercury, ug/g dry	0.08	0.08	0.07	0.08
Coal Consumption:				
Total Raw Coal Input, tons/hr	497.94	497.26	505.10	500.10
Total Coal Input, lbs/hr dry	730279	740917	753003	741400
Total Mercury Available in Coal:				
Mercury, lbs/hr	0.05842	0.05927	0.05271	0.05680
Mercury, lbs/10^{12} Btu	6.80	6.86	6.07	6.57

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Test Methods

4.1.1 Speciated mercury emissions

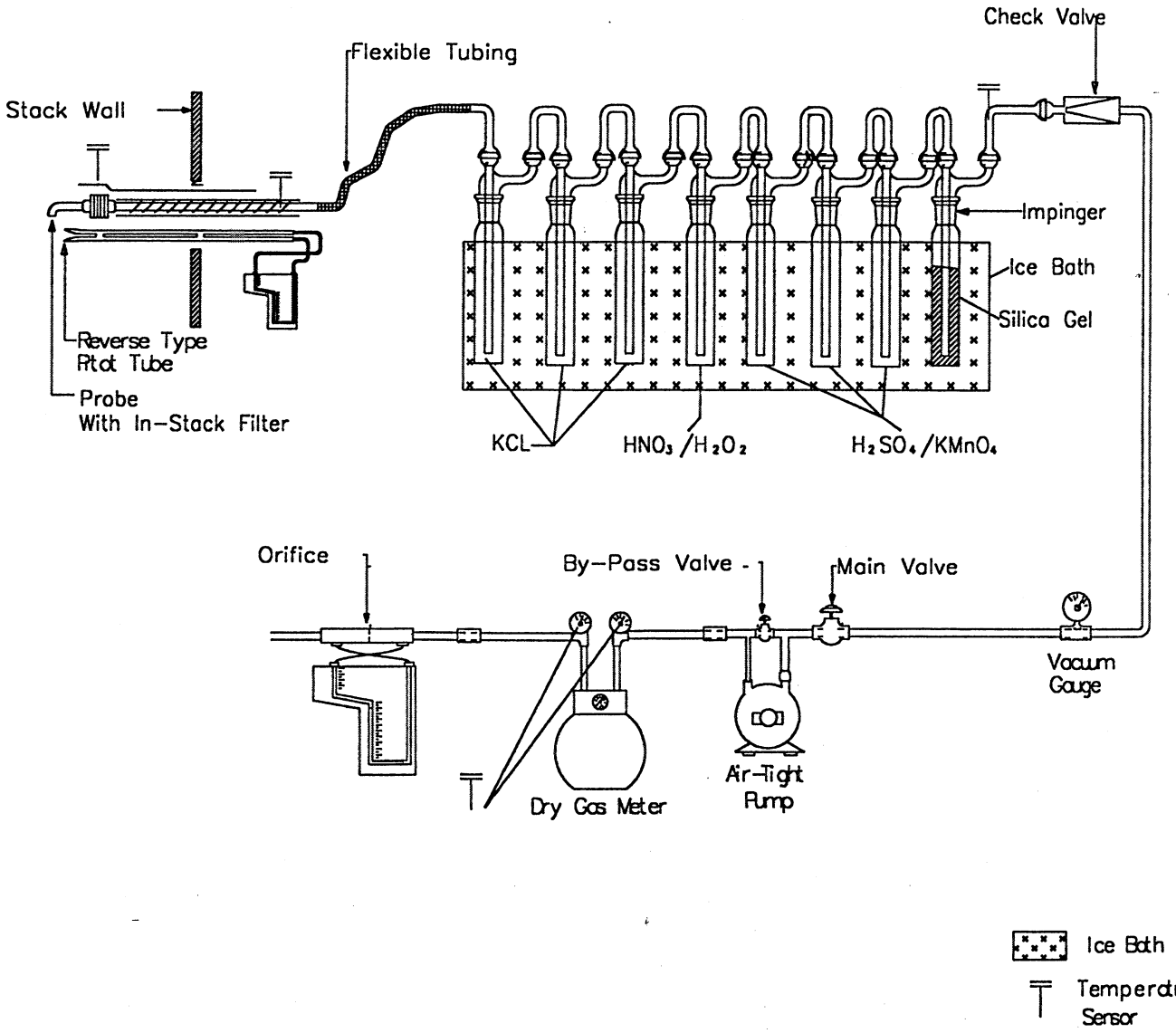
Speciated mercury emissions were determined via the draft "Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario-Hydro Method)", dated July 7, 1999.

The in-stack filtration (Method 17) configuration was utilized at the inlet location and the out-of-stack filtration (Method 5) configuration was utilized at the stack. Figures 4-1 and 4-2 are schematics of the Ontario-Hydro sampling trains.

Figure 4-3 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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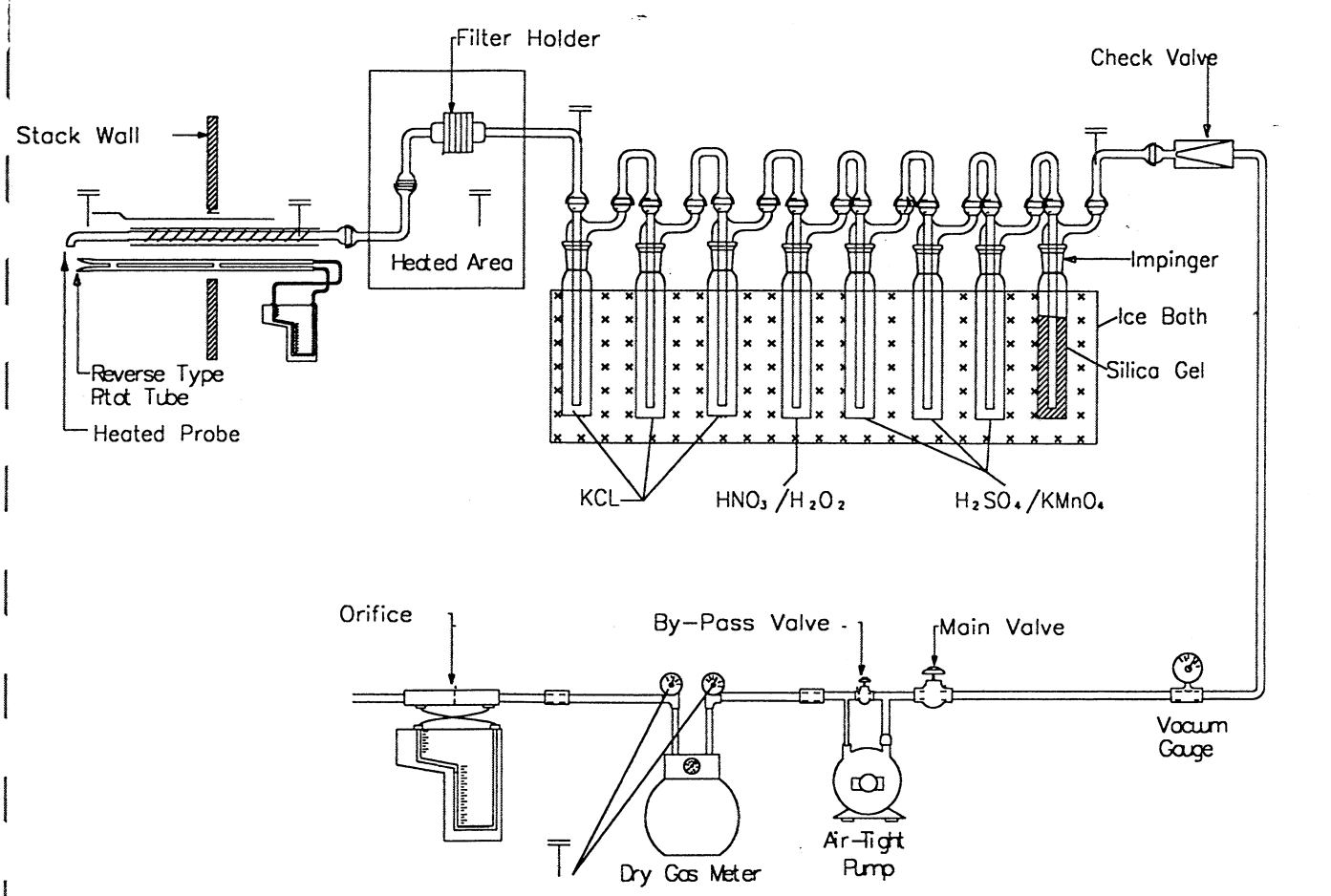
A Full Service Environmental Consulting Company

Speciated Mercury Sampling Train Equipped with Out-of-Stack Filter

Ontario Hydro Method



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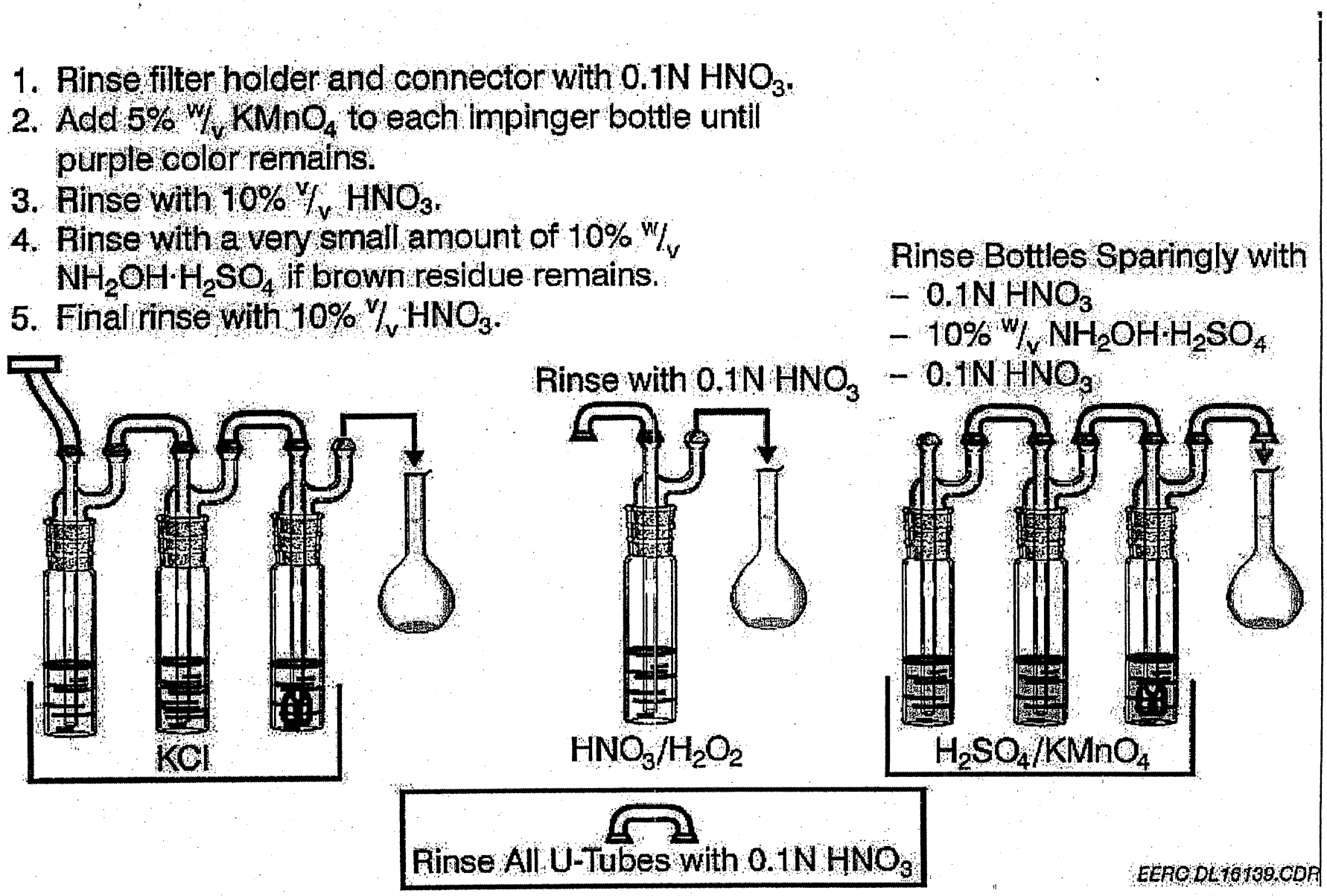

Figure 4-3 Sample Recovery Scheme for Ontario-Hydro Method Samples

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 presented in Table 3-6 was continuously monitored by the facility. Process data was averaged over the course of each sample run.

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.

5.1 QA/QC Problems

The blank train analysis for the stack sample #076 was more than 30% of the three values obtained at the stack for the KCl impinger. The data for the stack from the KCl impinger is therefore qualified.

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)**
091, 092, 093	Front-half	Filter (Method 17)	< 0.063	0.010
094, 095, 096	Front-half	Filter (Method 5)	< 0.010	0.010
098	1 N KCl	1 N KCl	< 0.050	0.030
097	HNO_3/H_2O_2	HNO_3/H_2O_2	< 0.25	0.010
101-104	$KMnO_4/H_2SO_4$	$KMnO_4/H_2SO_4$	< 0.030	0.030

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 January 25, 2000. 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)**
076	KCl impingers	Impingers/rinse	0.29	0.030
079	KCl impingers	Impingers/rinse	0.13	0.030
077	HNO_3-H_2O_2 impingers	Impingers/rinse	< 0.25	0.010
080	HNO_3-H_2O_2 impingers	Impingers/rinse	< 0.25	0.010
078	$KMnO_4/H_2SO_4$ impingers	Impingers/rinse	< 0.10	0.030
081	$KMnO_4/H_2SO_4$ impingers	Impingers/rinse	< 0.10	0.030

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.

