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10 November, 1999

Mr. William Grimley
Emission Measurement Center (MD-19)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Work Order No. 12255.001.001

Re: Information Collection Request
Birchwood Power Facility Test Program Report

Dear Mr. Grimley:

Enclosed is a single copy of the test report for the mercury speciation test program performed at the Birchwood Power Facility. The test program was performed by Roy F. Weston Inc.(WESTON®) during the period of September 13 through 15, 1999.

Please contact me at (610) 701-7201 or Mr. John Lauber of Birchwood at (540) 775-6304 should you have any further questions or comments.

Very truly yours,

ROY F. WESTON INC.

Jeffrey D. O'Neill
Principal Technical Manager

JDO/cp

cc: John Lauber - BIRCHWOOD

WESTON PROJECT NO. 12255.001.001
EMISSIONS TEST REPORT
SOUTHERN ENERGY, INC.
BIRCHWOOD POWER FACILITY
KING GEORGE, VIRGINIA

NOVEMBER 1999

INFORMATION COLLECTION REQUEST
ASSESSMENT OF SPECIATED MERCURY
EMISSIONS FROM A COAL-FIRED BOILER

Prepared for:

SOUTHERN ENERGY INC.
BIRCHWOOD POWER
10900 Birchwood Drive
King George, Virginai 22485

Prepared by:

ROY F. WESTON, INC.
1400 Weston Way
P.O. Box 2653
West Chester, Pennsylvania 19380
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1. INTRODUCTION

1.1 SUMMARY OF THE TEST PROGRAM

The U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards (OAQPS) has undertaken a program to acquire information related to mercury emissions from electric utility steam generating units. As part of this Information Collection Request (ICR), EPA has selected certain utilities for emissions testing to characterize speciated mercury emissions and the effectiveness of available control measures on such emissions.

Southern Energy Inc. (SEI), Birchwood Power Facility located in King George, Virginia was selected as one of the ICR study sites. Mercury speciation sampling was performed on Unit No. 1 at the Birchwood Power facility using the Ontario Hydro method. During the ICR test program mercury speciation testing was performed on the inlet and outlet of the dry flue gas desulfurization (FGD) and baghouse of Unit No. 1.

The work was completed by Roy F. Weston, Inc., (WESTON). The mercury speciation sampling activities were performed by WESTON, the analysis of the process and Ontario Hydro method samples were performed by Philip Analytical Services. The test program was performed during the period of September 13 through 15 1999.

This test report presents the test data and test results of the mercury speciation sampling program performed on Unit No. 1 at the Birchwood Power facility and contains all test results and discussions. Appendices of the detailed test data and test results, raw test data, process data, laboratory reports, equipment calibration records and sample calculations are also provided. This report format follows EPA's Emissions Measurement Center (EMC) guideline document (GD-043) titled, Preparation and Review of Emission Test Reports which is required for ICR report submittals.

1.2 TEST PROGRAM OBJECTIVES

During the test program mercury emissions testing using the Ontario Hydro method were performed on the inlet and outlet of the FGD and baghouse serving Unit No. 1. Representative samples of the coal were sampled in conjunction with the emissions testing.

The specific objectives of this test program were as follows:

- Characterize the emissions of particulate-bound, elemental and oxidized mercury from the coal fired boiler.
- Simultaneously measure concentrations and mass rates of speciated mercury at the inlet and outlet of the FGD and baghouse on Unit No. 1.
- Obtain and analyze representative samples of the coal for the purpose of determining mercury, heating value, ash content, sulfur and chlorine levels.
- Document corresponding boiler, FGD and baghouse operations along with facility continuous emission monitoring system (CEMs) data.

A Site-Specific Sampling/Testing, Analytical and QA/QC Plan and Quality Assurance Project Plan (QAPP) dated May 1999 were developed for the ICR test program performed on Unit No. 1.

1.3 SAMPLE LOCATIONS

Representative samples from the following solid stream were collected and analyzed during the test program:

- Coal Feed.

Flue gas stream emission samples were collected at the following locations:

- Unit No. 1 FGD Inlet.
- Unit No. 1 Baghouse Outlet (stack).

1.4 POLLUTANTS MEASURED

Table 1-1 presents a summary of process solid and flue gas streams and the associated pollutants and parameters measured during the test program.

Table 1-1

Birchwood Power Facility
Unit No. 1
Process Solid and Flue Gas Streams with Pollutants/Parameters

Location/Stream Type	Pollutants or Parameters	Frequency
Unit No. 1 Coal Feed	Heating value Ash content Moisture Mercury (Hg) content Chlorine (Cl) content Sulfur content	One composite sample per run (total of 3) in conjunction with flue gas sampling on Unit No. 1
Unit No. 1 FGD Inlet and Baghouse Outlet (Stack)	Particulate bound and vapor phase mercury (including oxidized and elemental mercury speciation of vapor phase).	Inlet and outlet sampling by Ontario Hydro method on Unit No. 1.

1.5 TEST PROGRAM KEY PERSONNEL

The key personnel who coordinated and performed the test program, their project responsibilities and their phone numbers are:

Contact Name	Project Responsibility	Telephone No.	Facsimile No.
BIRCHWOOD			
Mr. John Lauber	Facility Environmental Contact	(540) 775-6304	(510) 775-2780
Mr. Mike Hogan	Facility Environmental Contact	(540) 775-6306	(510) 775-2780
EPA			
Mr. William Grimley	ICR Program Manager	(919) 541-1065	(919) 541-1039
WESTON			
Mr. Jeff O'Neill	Project Manager	(610) 701-7201	(610) 701-7401
Mr. Jack Mills	Test Team Leader	(610) 701-7245	(610) 701-7401
PHILLIP			
Mr. Vaughn O'Neill	Laboratory Analyst	(610) 921-8833	(610) 921-9667

2. PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 BIRCHWOOD POWER FACILITY UNIT NO. 1 OVERVIEW

Southern Energy, Inc. operates Unit No. 1 which is a 2200 MMBtu/hr pulverized coal-fired boiler at their Birchwood Power Facility located in King George County, Virginia. The facility operates as a cogeneration power plant. Steam generated by burning bituminous coal is used to produce electricity in a steam turbine and heat a commercial greenhouse. The Unit No. 1 is designed to operate at a full load of 222.2 megawatts (mw).

Acid gas and particulate emissions are controlled using a FGD lime spray drying system and a fabric filter baghouse. A Selective Catalytic Reduction (SCR) system is used to control oxides of nitrogen (NO_X) emissions.

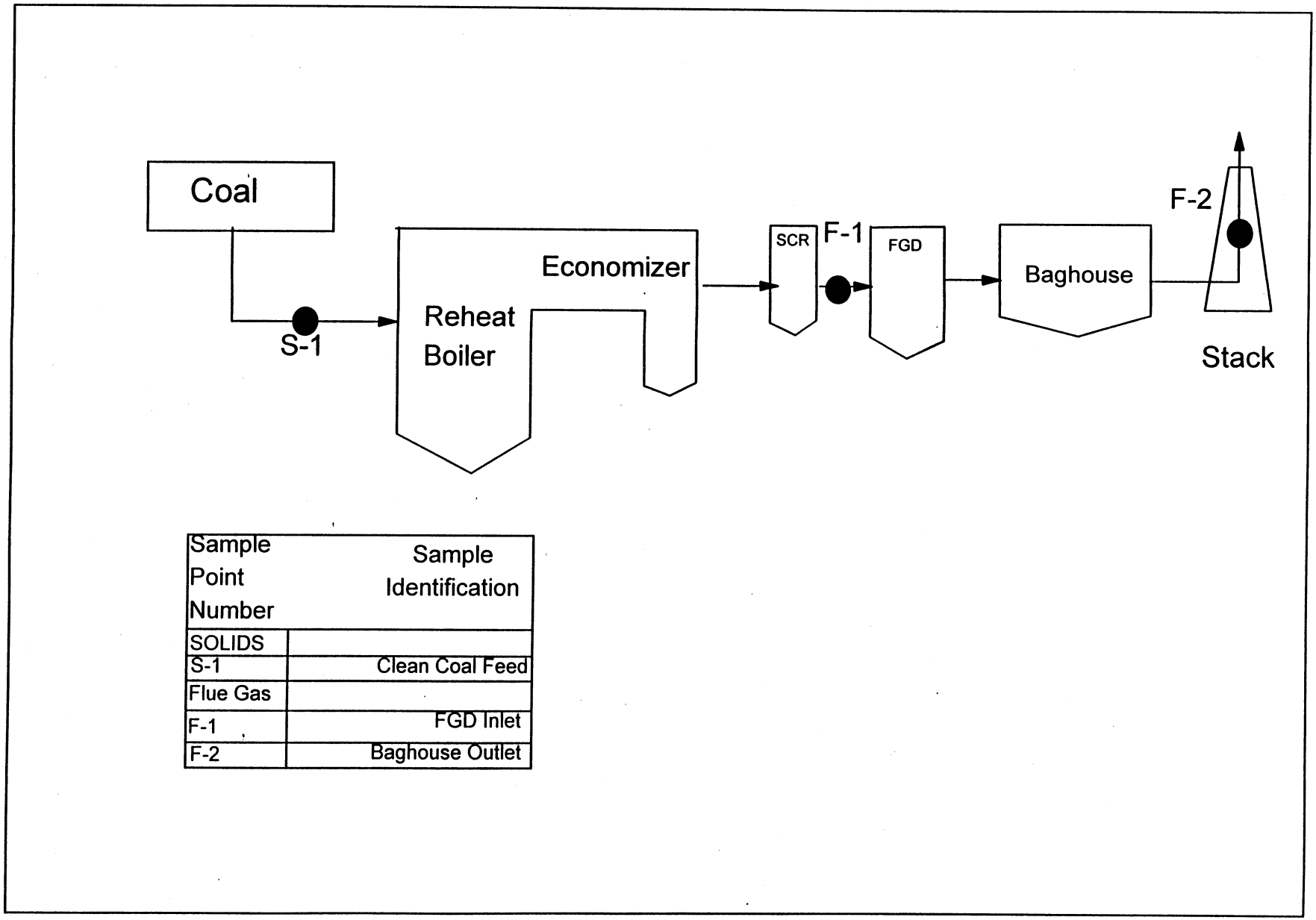
A continuous emission monitoring system (CEMS) measures the effluent concentration of NO_X, sulfur dioxide (SO_2), carbon dioxide (CO_2), volumetric flow rate and opacity in the gas stream at the outlet stack location. In addition, the inlet duct to the FGD is configured to monitor and record gaseous concentrations of SO_2, and CO_2.

Figure 2-1 presents a schematic of the Unit No. 1 boiler and pollution control equipment.

2.2 PROCESS SOLID SAMPLING LOCATIONS AND SAMPLING PROCEDURES

2.2.1 Unit No. 1 Coal Sampling

Samples of the coal feed streams were collected and composited during each test run. The coal is introduced to the boiler by four (4) coal feeders (A,B,C and D). Typically 3 of 4 feeders (normally A, B and C) are operating with the fourth as a backup. A scoop sampler was used to obtain coal samples from each operating feeder as the coal drops off the feeder belt into the pulverizer. This is the last point in the coal feed system at which representative coal samples can be obtained. Samples were collected once every 30 minutes from each of the 3 operating feeders during each of the three test periods.



Sample Point Number	Sample Identification
SOLIDS	
S-1	Clean Coal Feed
Flue Gas	
F-1	FGD Inlet
F-2	Baghouse Outlet

FIGURE 2-1
PROCESS SCHEMATIC AND SAMPLING/TESTING LOCATIONS
SEI BIRCHWOOD POWER FACILITY-UNIT NO. 1

2.3 FLUE GAS SAMPLING LOCATIONS

2.3.1 Unit No. 1 FGD Inlet

The test site at the FGD inlet is located on the vertical 6′ 0″ deep by 41′ 8″ wide rectangular duct. A total of fourteen (14) 4″ ID test ports are located horizontally across the long side of the duct. The ports are located 43′ (4.1 diameters) downstream from the SCR and air preheater outlet and 154″ (1.2 diameters) upstream of the transition duct and elbow leading to the FGD.

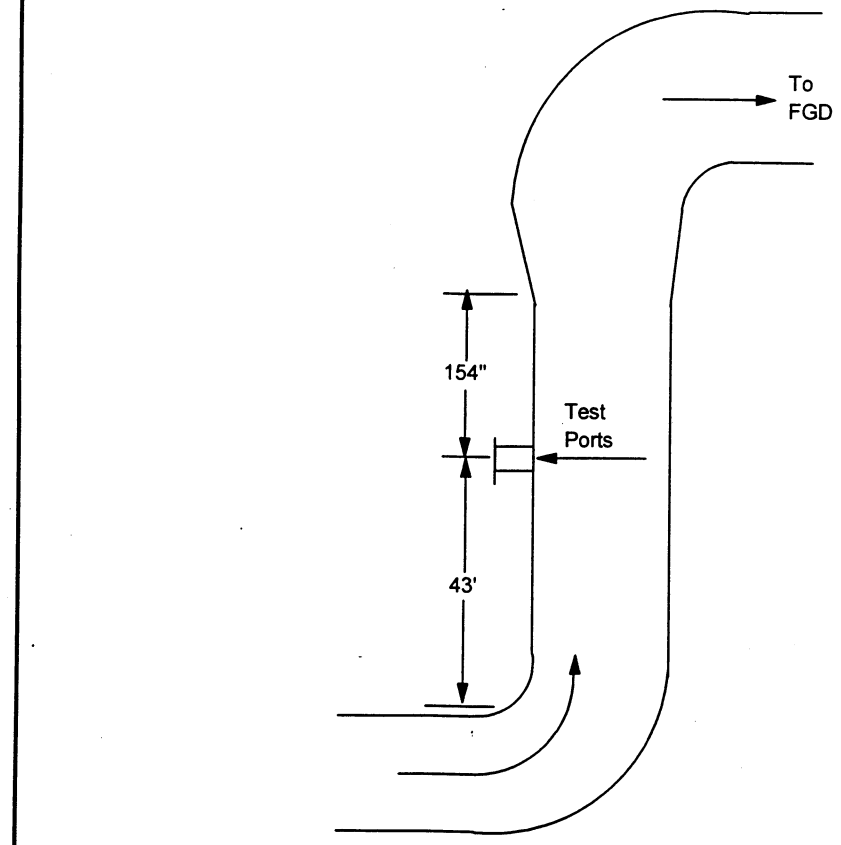
During each test run a total of five traverse points in seven of the fourteen ports (total of 35 points) were sampled. Additional explanation for port selection is provided in Section 3.3 (Testing Problems or Modifications).

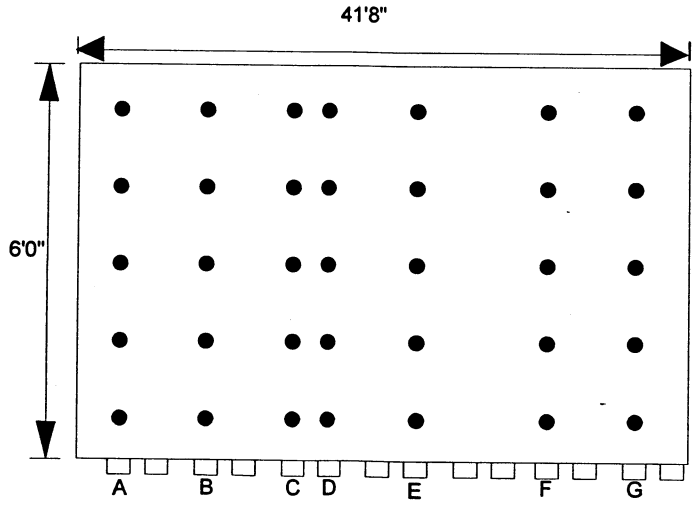
See Figure 2-2 for a schematic of the FGD inlet test site.

2.3.2 Unit No. 1 Baghouse Outlet (Stack)

A total of four (4) 6″ ID test ports are in place on the 186″ ID flue. The test ports are located ~200′ (12.9 diameters) downstream from the nearest disturbance and ~130′ (8.4 diameters) from the nearest upstream distance (stack exit).

A total of 3 points per port (12 total) were sampled. See Figure 2-3 for a schematic of the Unit No. 1 stack test location.





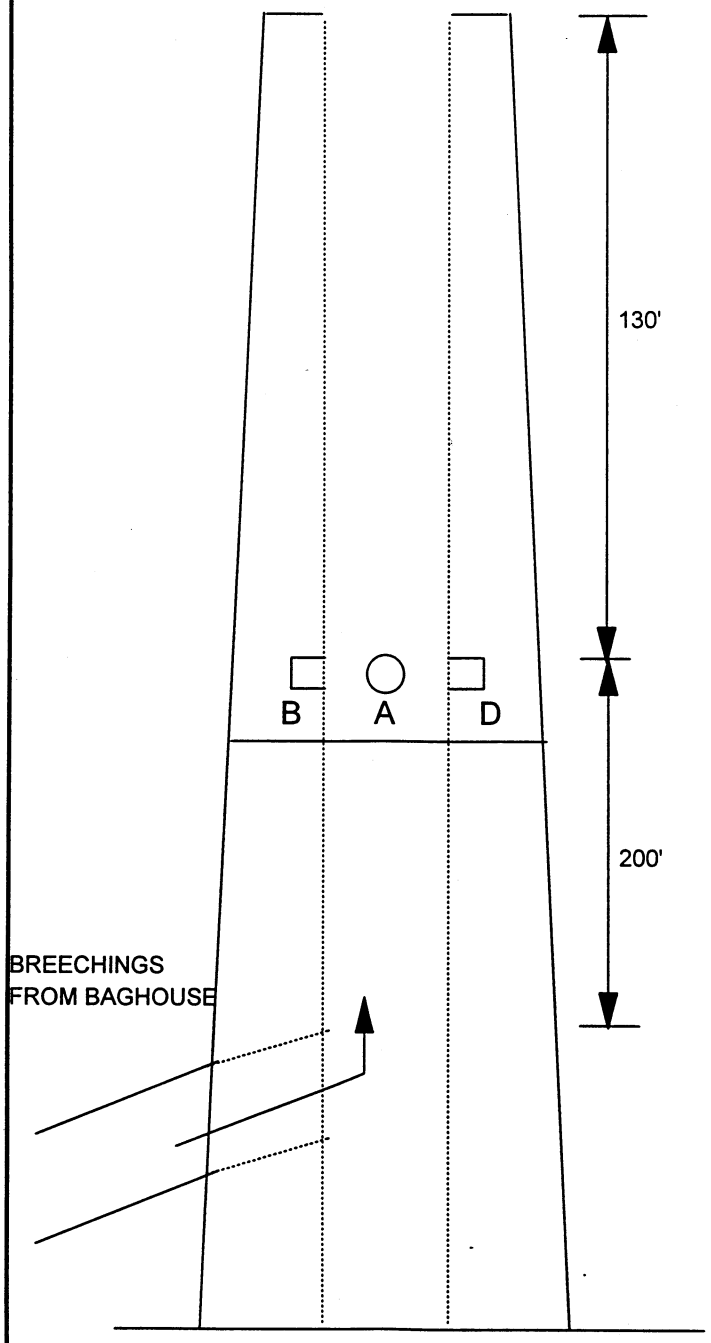
TEST PORT TRAVERSE POINT		DISTANCE FROM INSIDE NEAR WALL (INCHES)
A,B,C,D,E F.G -	1	8
	2	21 1/4
	3	35 3/8
	4	49 1/2
	5	63 5/8

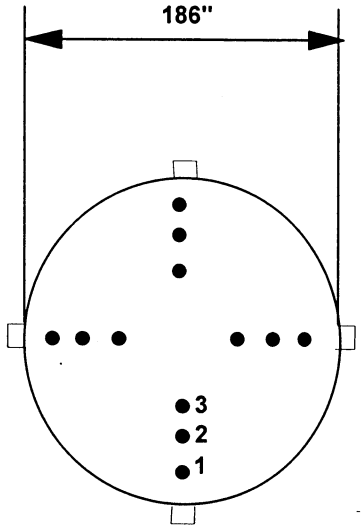
Port Length=18"

DRAWING NOT TO SCALE

FIGURE 2-2
UNIT 1 FGD INLET DUCT TEST SITE
PORT AND TRAVERSE POINT LOCATIONS

BIRCHWOOD POWER DRAWING





PLAN AT SAMPLING PORT LOCATION

Traverse Point Number	Distance From Inside Near wall
A,B,C,D - 1	8 1/8
2	27 1/8
3	55

PORT LENGTH = 12 1/2"

Drawing Not to Scale

Figure 2-3
UNIT 1 STACK TEST SITE
PORT AND TRAVERSE POINT LOCATIONS

3. SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 SAMPLING/TESTING, ANALYTICAL AND QC MATRICES

The detailed sampling/testing, analytical and QC matrices for this survey are presented on Tables 3-1 and 3-2 for the coal, and flue gas sampling locations, respectively. Each table specifies the following components:

- Sampling point identification and description.
- Test objective, number and length of test runs performed, and samples/data collected.
- Parameters measured.
- Sampling or monitoring methods employed, including sample preservation technique.
- Maximum sample holding time.
- Sample preparation/extraction and analysis methods applied.
- Sampling and analytical program design (i.e., number of samples collected/analyzed by type and method). This includes the number, or frequency and type, of QC samples analyzed for each parameter.
- Laboratory that analyzed each type of sample.

3.2 PRESENTATION OF RESULTS

3.2.1 Mercury Speciation Test Results

A summary of the Ontario Hydro method mercury speciation test results are presented on Tables 3-3, 3-4, and 3-5 for Unit No. 1.

Table 3-3 presents the measured mercury concentrations in micrograms per cubic meter (ug/m^3) for each test run and provides the percent of particulate, oxidized and elemental mercury in comparison to the total mercury.

Tables 3-4 and 3-5 presents the mercury concentrations and mass rate values for particulate, oxidized, elemental and total mercury for each individual test runs along with the measured

Table 3-1

Sampling/Testing, Analytical, and QC Plan
Unit No. 1 — Clean Coal Feed

No. of Test Runs: 3

Test Objective: Determine total mercury and chlorine content of as-fired coal.

Sampling Objective: Collect a representative sample.

Parameters to be Determined:	**Mercury**	**Chlorine**	**Heating Value**	**Ash Content**	**Sulfur Content**	**Mass Flow Rate**
Sampling or Monitoring Method:	Representative sample increments were obtained from the three (3) individual boiler coal feeders once every 30 minutes during each test period. Samples stored in air-tight, plastic-lined bucket					Gravimetric feeder readings recorded in control room
Sample Preparation/Extraction and Analysis Method(s):	ASTM D2013 and EPA Method 7471	ASTM E776 and EPA Method 300	ASTM D3286	ASTM D3174	ASTM D4239	
Maximum Holding Time (days):	28	28	28	28	28	NA
Sampling or Monitoring Design:						
Total No. of Samples	3	3	3	3	3	NA
Site Blanks	0	0	0	0	0	NA
Trip Blanks	0	0	0	0	0	NA
Lab Blanks	1	1	1	1	1	NA
Blank Spikes[2]	0	0	0	0	0	NA
Replicates[3]	1 batch	1/batch	1/batch	1/batch	1/batch	NA
QC Spikes[4]	1/batch[1]	1/batch	1/batch	1/batch	1/batch	NA
Total No. of Samples Analyzed	6	6	6	6	6	NA
Analytical Laboratory:	Philip Analytical Services					NA

Notes: [1]A batch consists of a maximum of 20 samples.

[2]A blank spike (or method spike) is a sample of reagent-grade water spiked with the analyte(s) of interest that is prepared and analyzed with the associated sample batch.

[3]This indicates that a duplicate analysis is made on one or more samples as a QC mechanism to measure analytical precision.

[4]A sample of similar matrix is spiked with a known amount of the analyte(s) of interest to determine percent recovery.

Table 3-2

Sampling/Testing, Analytical, and QC Plan
Unit No. 1 FGD Inlet and Baghouse Outlet

No. of Test Runs: 3 per unit
Test Objective: Perform mercury speciation sampling at inlet and outlet of FGD and baghouse.
Sampling Objective: Collect a representative sample.

Parameters to be Determined:	Speciated Mercury
Sampling or Monitoring and Preservation Method(s)	Ontario Hydro Method
Sample Preparation/Extraction and Analysis Method(s):	Ontario Hydro Method
Maximum Holding Time (days):	28
Sampling or Monitoring Design:	
Length of Test:	≥ 120 min
Sample Size	1 to 2.5 m^3
Total No. of Samples	3 at inlet and outlet
Site/Reagent Blanks	Minimum of 1 per sample type
Train Blanks	1 per test location (total of 2)
Lab Blanks	1 per batch[1]
Blank Spikes[2]	1 per batch
Replicates[3]	All samples
Total No. of Samples Analyzed[4]	~90
Analytical Laboratory:	Philip Analytical Services

[1]A batch consists of a maximum of 10 samples.
[2]A blank spike (or method spike) is a sample of reagent-grade water spiked with the analyte(s) of interest that is prepared and analyzed with the associated sample batch.
[3]This indicates that a duplicate analysis is made on one or more samples as a QC mechanism to measure analytical precision.
[4]Approximate number of total samples and individual fractions, duplicates and other QC samples.

Note: The facility CEMs measured sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon dioxide (CO_2), and flow on the baghouse outlet and SO_2 and CO_2 at the FGD inlet.

TABLE 3-3
COMPARISON OF MERCURY SPECIATION TO TOTAL MERCURY RESULTS
UNIT NO. 1

Mercury Species	Unit No. 1 Inlet						
	Run 2		Run 3		Run 4		Average
	(ug/m^3)	% of Total	(ug/m^3)	% of Total	(ug/m^3)	% of Total	% of Total
Particulate Bound Mercury Emissions	11.31	96.77	8.001	95.68	10.21	95.48	95.98
Oxidized Mercury Emissions	0.25	2.17	0.21	2.47	0.21	1.97	2.20
Elemental Mercury Emissions	0.12	1.06	0.15	1.85	< 0.27	2.55	1.82
Total Mercury Emissions	11.69	100.00	8.36	100.00	10.69	100.00	--

Mercury Species	Unit No. 1 Outlet						
	Run 2		Run 3		Run 4		Average
	(ug/m^3)	% of Total	(ug/m^3)	% of Total	(ug/m^3)	% of Total	% of Total
Particulate Bound Mercury Emissions	0.01	2.38	0.01	4.32	0.01	4.11	3.60
Oxidized Mercury Emissions	0.28	70.37	< 0.14	56.29	< 0.13	41.10	55.92
Elemental Mercury Emissions	0.11	27.24	0.10	39.40	< 0.18	54.79	40.48
Total Mercury Emissions	0.40	100.00	0.24	100.00	0.32	100.00	--

TABLE 3-4
BIRCHWOOD POWER
SUMMARY OF MERCURY SPECIATION TEST DATA AND TEST RESULTS
UNIT NO. 1 INLET

TEST DATA:						
Test run number	2	3		4		
Location		Unit No. 1 Inlet				
Test date	9/15/99	9/15/99		9/15/99		
Test time period	0742-1109	1218-1529		1646-1955		
PROCESS DATA:						
Unit Load, MW	236	236		236		
Coal feed rate, lb/hr.	179700	177500		177400		
Coal Btu content, Btu/lb.	11920	11810		11760		
Heat Input, 10^6 Btu/hr	2142	2096		2086		
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:						
Avg. gas stream velocity, ft./sec.	47.0	46.2		45.9		AVERAGE
Avg. gas stream volumetric flow, wacf/min.	705363	692483		688669		695505
Avg. gas stream volumetric flow, dscf/min. (1)	457124	449238		440054		448805
PARTICULATE BOUND MERCURY EMISSIONS:						
Conc., ug/m^3	11.31	8.00		10.21		9.839
Conc., ug/Nm^3 (2)	12.13	8.58		10.95		10.556
Emission rate, lbs/10^{12} Btu.	9.04	6.42		8.06		7.84
Emission rate, lbs/hr	1.94E-02	1.35E-02		1.68E-02		1.65E-02
OXIDIZED MERCURY EMISSIONS:						
Conc., ug/m^3	0.25	0.21		0.21		0.22
Conc., ug/Nm^3 (2)	0.27	0.22		0.23		0.24
Emission rate, lbs/10^{12} Btu.	0.20	0.17		0.17		0.18
Emission rate, lbs/hr	4.34E-04	3.47E-04		3.48E-04		3.76E-04
ELEMENTAL MERCURY EMISSIONS:						
Conc., ug/m^3	0.12	0.15	<	0.27	<=	0.18
Conc., ug/Nm^3 (2)	0.13	0.17	<	0.29	<=	0.20
Emission rate, lbs/10^{12} Btu.	0.10	0.12	<	0.22	<=	0.15
Emission rate, lbs/hr	2.11E-04	2.61E-04	<	4.49E-04	<=	3.07E-04
TOTAL MERCURY EMISSIONS: (3)						
Conc., ug/m^3	11.69	8.36		10.69		10.25
Conc., ug/Nm^3 (2)	12.54	8.97		11.47		10.99
Emission rate, lbs/10^{12} Btu.	9.34	6.71		8.45		8.17
Emission rate, lbs/hr	2.00E-02	1.41E-02		1.76E-02		1.72E-02

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 inches Hg (760mm Hg).
(2) Nm3 = Normal cubic meter (32 deg. F. (0 deg. C.) and 29.92 inches Hg (760mm Hg)).
(3) Non-detects included in total mercury catch value.

TABLE 3-5
BIRCHWOOD POWER
SUMMARY OF MERCURY SPECIATION TEST DATA AND TEST RESULTS
UNIT NO. 1 OUTLET

TEST DATA:							
Test run number	2		3		4		
Location			Unit No. 1 Outlet				
Test date	9/15/99		9/15/99		9/15/99		
Test time period	0742-1109		1218-1533		1645-1948		
PROCESS DATA:							
Unit Load, MW	236		236		236		
Coal feed rate, lb/hr.	179700		177500		177400		
Coal Btu content, Btu/lb.(as received)	11920		11810		11760		
Heat Input, 10^6 Btu/hr	2142		2096		2086		
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:							
Avg. gas stream velocity, ft./sec.	62.3		62.4		63.7		AVERAGE
Avg. gas stream volumetric flow, wacf/min.	705558		706902		721437		711299
Avg. gas stream volumetric flow, dscf/min. (1)	499936		498798		510592		503109
PARTICULATE BOUND MERCURY EMISSIONS:							
Conc., ug/m^3	0.009		0.010		0.013		0.011
Conc., ug/Nm^3 (2)	0.010		0.011		0.014		0.012
Emission rate, lbs/10^{12} Btu.	8.24E-03		9.29E-03		1.21E-02		9.87E-03
Emission rate, lbs/hr	1.76E-05		1.95E-05		2.52E-05		2.08E-05
OXIDIZED MERCURY EMISSIONS:							
Conc., ug/m^3	0.28	<	0.14	<	0.13	<=	0.18
Conc., ug/Nm^3 (2)	0.30	<	0.15	<	0.14	<=	0.20
Emission rate, lbs/10^{12} Btu.	0.24	<	0.12	<	0.12	<=	0.16
Emission rate, lbs/hr	5.21E-04	<	2.54E-04	<	2.52E-04	<=	3.42E-04
ELEMENTAL MERCURY EMISSIONS:							
Conc., ug/m^3	0.11		0.10	<	0.18	<=	0.13
Conc., ug/Nm^3 (2)	0.12		0.10	<	0.19	<=	0.14
Emission rate, lbs/10^{12} Btu.	0.09		0.08	<	0.16	<=	0.11
Emission rate, lbs/hr	2.02E-04		1.78E-04	<	3.36E-04	<=	2.38E-04
TOTAL MERCURY EMISSIONS: (3)							
Conc., ug/m^3	0.40		0.24		0.32		0.32
Conc., ug/Nm^3 (2)	0.42		0.26		0.34		0.34
Emission rate, lbs/10^{12} Btu.	0.35		0.22		0.29		0.28
Emission rate, lbs/hr	7.40E-04		4.51E-04		6.12E-04		6.01E-04
TOTAL MERCURY REMOVAL EFFICIENCY:	96.24%		96.73%		96.38%		96.45%

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 inches Hg (760mm Hg).
(2) Nm3 = Normal cubic meter (32 deg. F. (0 deg. C.) and 29.92 inches Hg (760mm Hg)).
(3) Non-detects included in total mercury catch value.

volumetric flow rates. Average values with the standard deviation (SDEV) and percent relative standard deviation (% RSD) have been calculated and are presented.

3.2.1.1 Unit No. 1

For Unit No. 1 FGD Inlet an average of 96% of the total mercury measured is particulate bound mercury. On average the oxidized mercury was 2.2 percent of the total and the elemental mercury was approximately 1.8 percent of the total mercury collected. At the Unit No. 1 baghouse outlet, oxidized mercury comprised the highest of the total at 56 percent. The elemental mercury was 41 percent of the total and the particulate bound mercury was three percent.

Based on the total mercury measurements the average removal efficiency for the FGD/baghouse was 96.5 percent with an average mass emission rate of 0.00060 pound per hour.

The average total mercury emission rates for Unit No. 1 are 0.32 ug/m^3, 0.28 $lbs/10^{12}$ Btu and 0.0006 lb/hr.

3.2.2 Process Solid Sample Stream Results

Table 3-6 provides a summary of the analytical results obtained on the coal feed samples collected on Unit No.1.

For each parameter measured on the Unit No. 1 coal feed stream, the concentration or percent value is presented (on or as received basis) for each individual test run along with the average values.

Detailed analytical summaries are provided in Appendix D of this report.

Based on the mercury content of the coal and the measured coal feed rate, the mass rate of mercury introduced to the boiler averaged 1.8 lb/hr.

TABLE 3-6

SUMMARY OF COAL SAMPLE RESULTS
UNIT NO. 1 COAL FEED SAMPLES

Parameter[1]	Test Run No.			
	2	3	4	Average
Mercury,ppm (mg/kg)	0.10	0.10	0.10	0.10
Chlorine, %	0.08	0.09	0.09	0.09
Heating value, Btu/lb	11920.	11810.	11760.	11830.
Ash, %	12.6	13.0	13.9	13.2
Sulfur, %	0.73	0.74	0.78	0.75
Moisture, %	5.77	6.05	5.47	5.76

(1) As received basis.

3.2.3 Unit Operation and Key Operational Parameters

This section describes the Unit No. 1 operations during the test program and provides the key operating parameters that were monitored and documented during testing.

3.2.3.1 Unit Operation During Testing

Operation of Unit No. 1 during testing was representative of normal daily operation at or near full load. Steady-state testing conditions were maintained during all test periods. The normal sootblowing activities were maintained on the boiler during testing.

3.2.3.2 Process Control Data

All key power generation process operating parameters and control data were recorded during each test period. FGD and baghouse operational indicators data were recorded by a data acquisition system. The facilities CEMS data acquisition system provided concentration values.

A summary of the key operating data is provided in Table 3-7 for Unit No. 1. All additional boiler, FGD and baghouse operations data and CEM data are provided in Appendix B.

3.3 TESTING PROBLEMS OR MODIFICATIONS

Test run one performed on September 14, 1999 was declared void at the FGD inlet test location because a number of in-stack thimble holders were broken during the test run. There was a concern that some particulate (as a result of the broken thimble holders) was lost or introduced into the vapor phase portion of the test train. Per the Site-Specific Test Plan, an out-of-stack thimble holder was utilized at the inlet test location for test runs 2, 3 and 4.

The Site-Specific Test Plan proposed sampling every other sample port across the FGD inlet duct. Due to external obstructions (stairwell support beams), the sample ports that were traversed was modified. Ports 1, 3, 5, 6, 8, 11 and 13 (from left to right) were sampled.

It should be noted that during the analysis of the Ontario Hydro samples, Philip Analytical Services noted some inconsistencies in the method equations. These inconsistencies were

brought to the attention of EPA and the Energy & Environmental Research Center (EERC) for correction. The comments provided by Philip relating to the equations are provided in the laboratory report in Appendix D.

No further sampling or analytical problems were noted during the test program. No process problems were noted during any of the test periods.

Table 3-7
Summary of Key Process Control Data
Unit No. 1

Parameter	Units	Run No.		
		2	3	4
Gross Generation	MW	236	236	236
Net Generation	MW	218	218	218
Coal Total	lbs/hr	179,700	177,500	177,400
Main Steam Flow	10^3 lb/hr	1,570	1,557	1,558
Main Stream Pressure	psig	2,396	2,397	2,395
Main Steam Temp.	°F	1,008	1,008	1,005
Lime Slurry Inj. Rate	gpm	117	122	126
Ammonia Inj. Rate	lb/hr	89	89	86
Baghouse Pressure Drop	in. H_2O	3.9	4.2	4.8
Stack gas flow (CEMs)	scfh	28,000,000	28,500,000	28,900,000
Stack opacity	%	6.2	7	7.7
Inlet CEMs (SO_2)	ppm/v	560	564	554
Stack CEMs (SO_2)	ppm/v	49	36	45
Stack CEMs (NO_x)	ppm/v	52	49	49
Inlet CEMs (CO_2)	%	13.7	13.9	13.6
Stack CEM (CO_2)	%	12.9	12.9	12.6

4. SAMPLING AND ANLAYTICAL PROCEDURES

4.1 DESCRIPTION OF SAMPLING EQUIPMENT

4.1.1 Ontario Hydro Mercury Speciation Method

The Ontario Hydro sampling train contained the following components:

- At the inlet location a calibrated borosolicate nozzle was attached to a heated borosilicate probe. The probe was attached to a thimble holder containing a high capacity quartz fiber thimble. A heated Teflon line connected the thimble holder outlet to the first impinger.

- At the inlet location the heated borosilicate probe was equipped with a calibrated thermocouple to measure flue gas temperature and a calibrated S-type pitot tube to measure flue gas velocity pressure.

- At the outlet location the heated borosilicate probe and nozzle was attached to a heated filter holder containing a 90-millimeter (mm) quartz fiber filter. The probe was equipped with a calibrated thermocouple to measure flue gas temperature and a calibrated S-type pitot tube to measure flue gas velocity pressure.

- An impinger train consisting of eight impingers. The first, second, and third impingers each contained 100 ml of 1 Normal (N) potassium chloride (KCl). The fourth impinger contained 100 ml of 5% nitric acid (HNO_3) and 10% hydrogen peroxide (H_2O_2). The fifth, sixth and seventh impingers each contained 100 ml of 4% potassium permanganate ($KMnO_4$) and 10% sulfuric acid (H_2SO_4). The eighth impinger contained 300 grams of dry preweighed silica gel. The third and seventh impingers were a Greenburg-Smith type; all other impingers were of a modified design. All impingers were maintained in a crushed ice bath.

- A vacuum line (umbilical cord) with adapter to connect the outlet of the impinger train to a control module.

- A control module containing a 3-cfm carbon vane vacuum pump (sample gas mover), a calibrated dry gas meter (sample gas volume measurement device), a calibrated orifice (sample gas flow rate monitor) and inclined manometers (orifice and gas stream pressure indicators).

- A switchable calibrated digital pyrometer to monitor flue and sample gas temperatures.

See Figures 4-1 and 4-2 for schematics of the Ontario Hydro test trains.

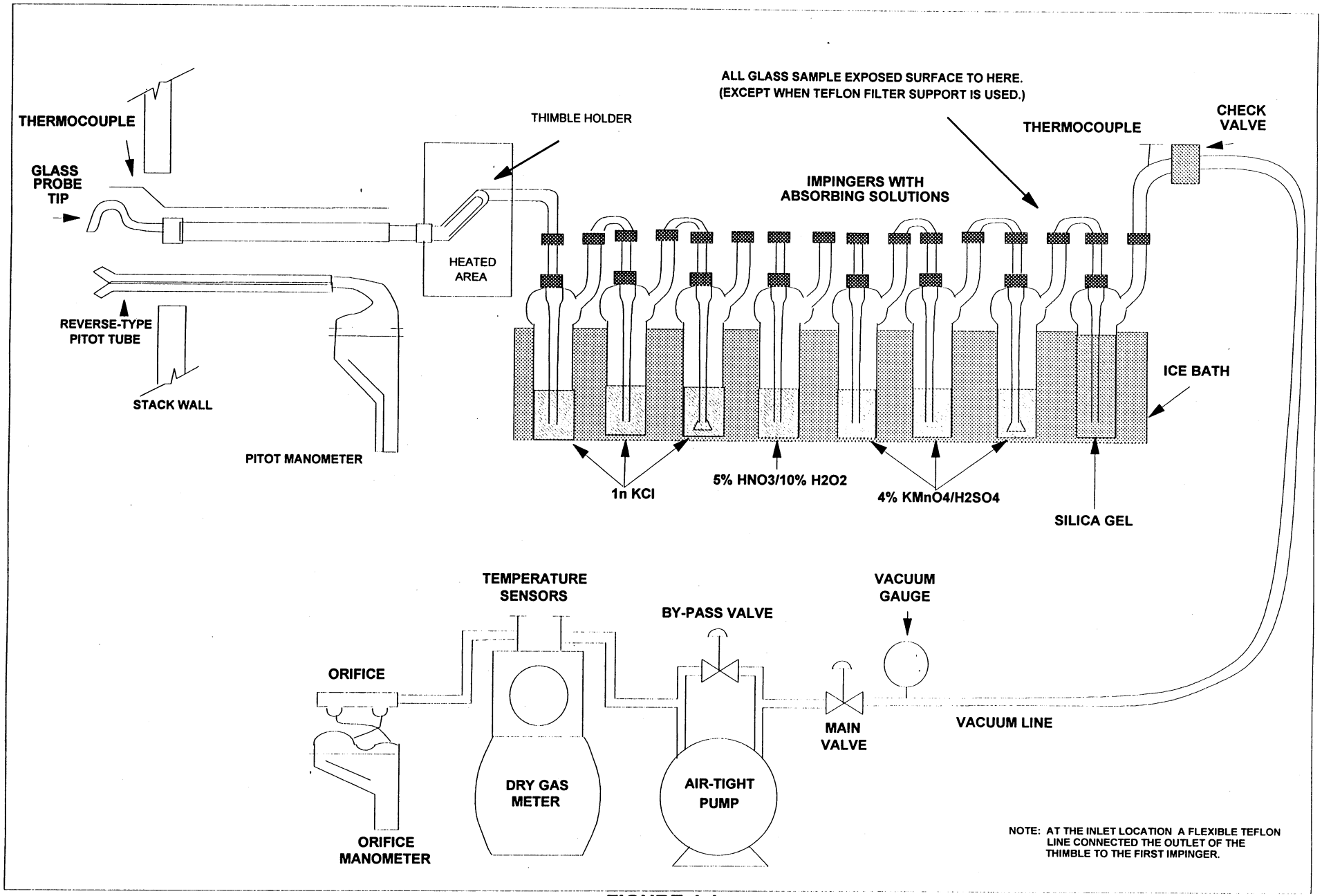


FIGURE 4-1
FGD INLET TEST LOCATION
ONTARIO HYDRO SAMPLING TRAIN

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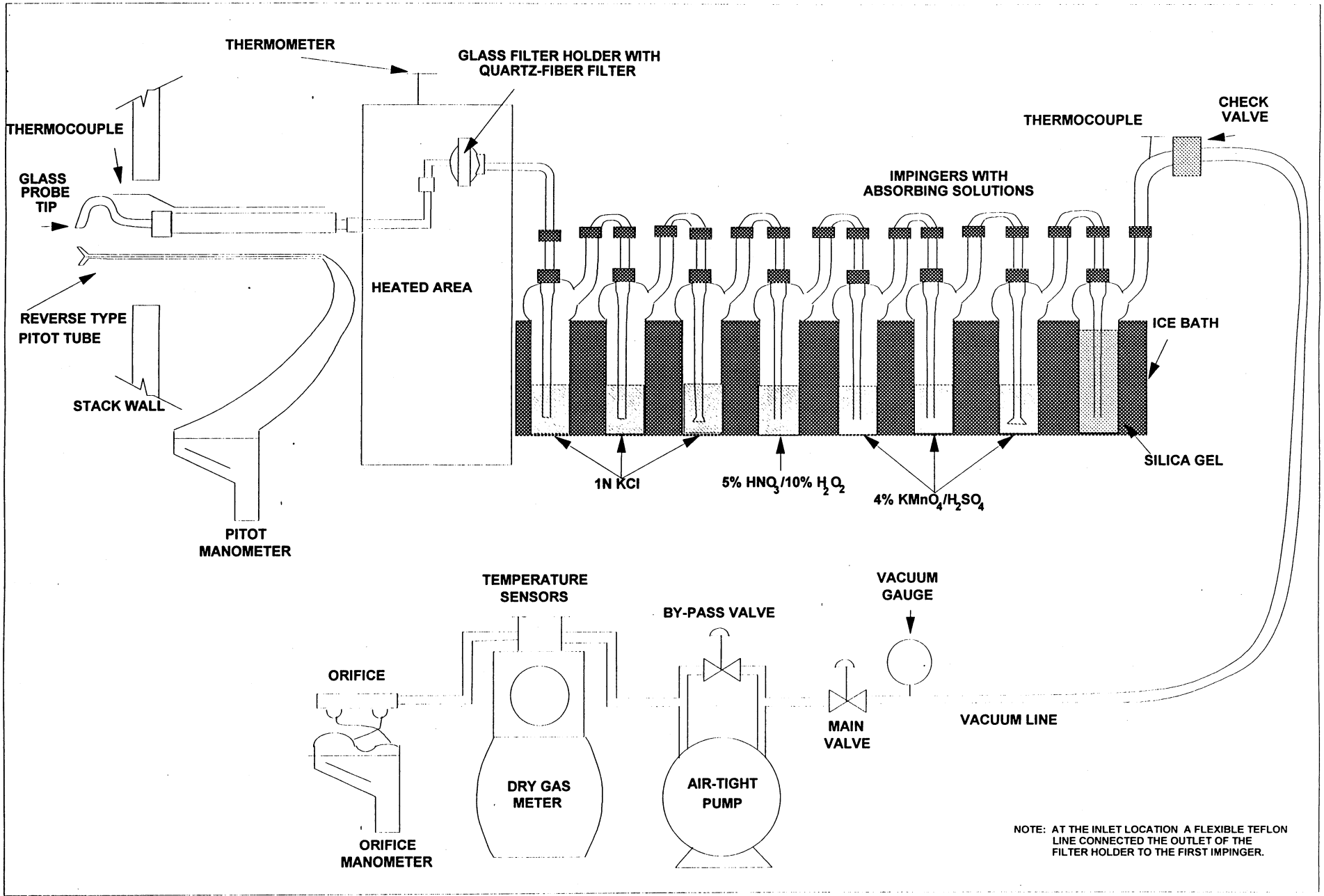

FIGURE 4-2
BAGHOUSE OUTLET TEST LOCATION
ONTARIO HYDRO SAMPLING TRAIN

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4.2 CO_2 AND O_2 SAMPLING EQUIPMENT

The fixed gases sampling train (Figure 4-3) used at the Unit No. 1 inlet and outlet test sites was assembled in accordance with EPA Method 3 and consisted of the following components:

- A stainless steel or Teflon probe (fastened to the Ontario Hydro sampling probe) with a plug of glass wool to remove particulate.
- An ice-cooled condenser to remove moisture from the sampled gases.
- A diaphragm pump to draw a sample of the gases.
- A valve and rate meter to control and monitor gas stream sampling rates, respectively.
- A Tedlar® bag to contain the sample of flue gases.

For Unit No. 1, the CO_2 and O_2 concentrations of each bag were analyzed using a Servomex 1440B CEM. The analyzers were calibrated before and after each set of analysis using EPA Protocol CO_2 and O_2 gas standards with nitrogen used as the zero gas.

4.3 SAMPLING PROCEDURES

The following paragraphs and flow charts summarize the procedures used to sample the flue gases, recovery of the resultant samples and analyze the samples.

4.3.1 Preliminary Tests

Following equipment setup, preliminary test data was compiled at each of the emission test sites to verify pretest data/assumptions, determine nozzle sizes, and compute isokinetic sampling rates.

Test site geometric measurements were measured and sampling point distances were recalculated. A pitot traverse was performed to determine velocity profiles and to check for the presence/absence of cyclonic flow at each site. The cyclonic flow checks proved negative at both locations. As appropriate, flue gas temperatures, dry gas composition, and moisture content were also determined by EPA Reference Methods 2, 3, and 4, respectively.

The preparation, sampling, and recovery procedures used to sample the emission points for speciated mercury conformed to those specified in the draft Ontario Hydro method and as described

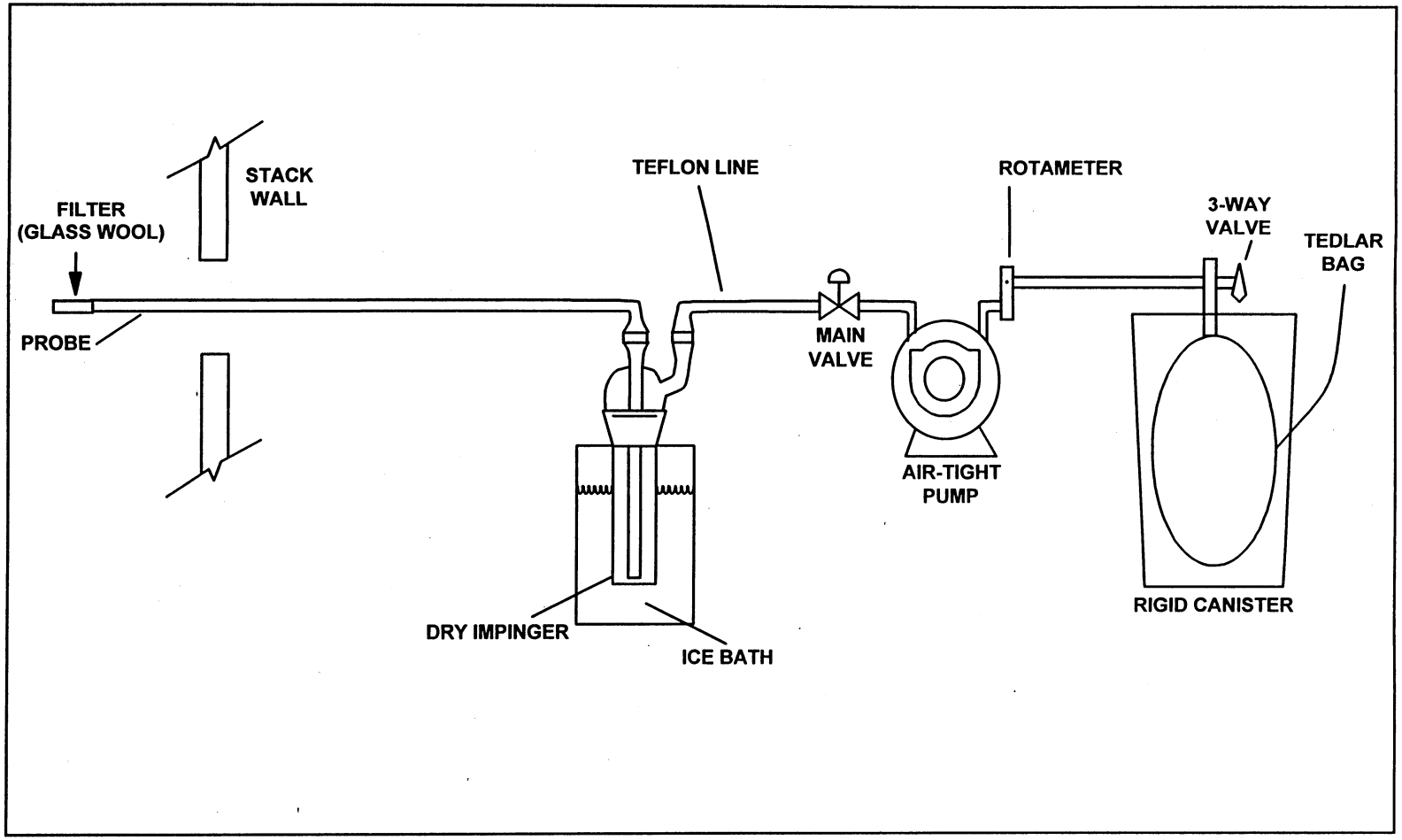

FIGURE 4-3
EPA METHOD 3 - DRY GAS STREAM COMPOSITION SAMPLING TRAIN

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in the Site-Specific Sampling/Testing, Analytical and QA/QC plan. Each inlet test run was 140 minutes in duration with readings taken at each of the 35 traverse points once every 4 minutes. The outlet tests were 144 minutes in length and each of the 12 traverse points were sampled for 12 minutes with readings taken every 4 minutes. Readings were recorded at each traverse point at all test locations. Leak checks were performed at the beginning and end of each test run and before and after test port changes. Figure 4-4 illustrates the train preparation. Figure 4-5 illustrates the sampling procedures. Figure 4-6 illustrates the sample recovery procedures.

4.4 ANALYTICAL PROCEDURES

4.4.1 Sample Analyses

4.4.1.1 Ontario hydro Sample Analyses

Figure 4-7 presents a schematic of the analytical procedures used during analysis of the Ontario Hydro samples.

4.4.1.2 Coal Sample Analyses

4.4.1.2.1 Preparation

Preparation of the coal samples followed ASTM Method D-2013. Following air drying and riffling the coal sample was pulverized until 100% of the sample passes the 60-mesh screen.

4.4.1.2.2 Chlorine

The prepared coal sample was weighed. The weighed sample was oxidized by combustion in a bomb with a bicarbonate/carbonate solution and the amount of chlorine present determined by ion-chromatography (IC) using EPA Method 300 procedures.

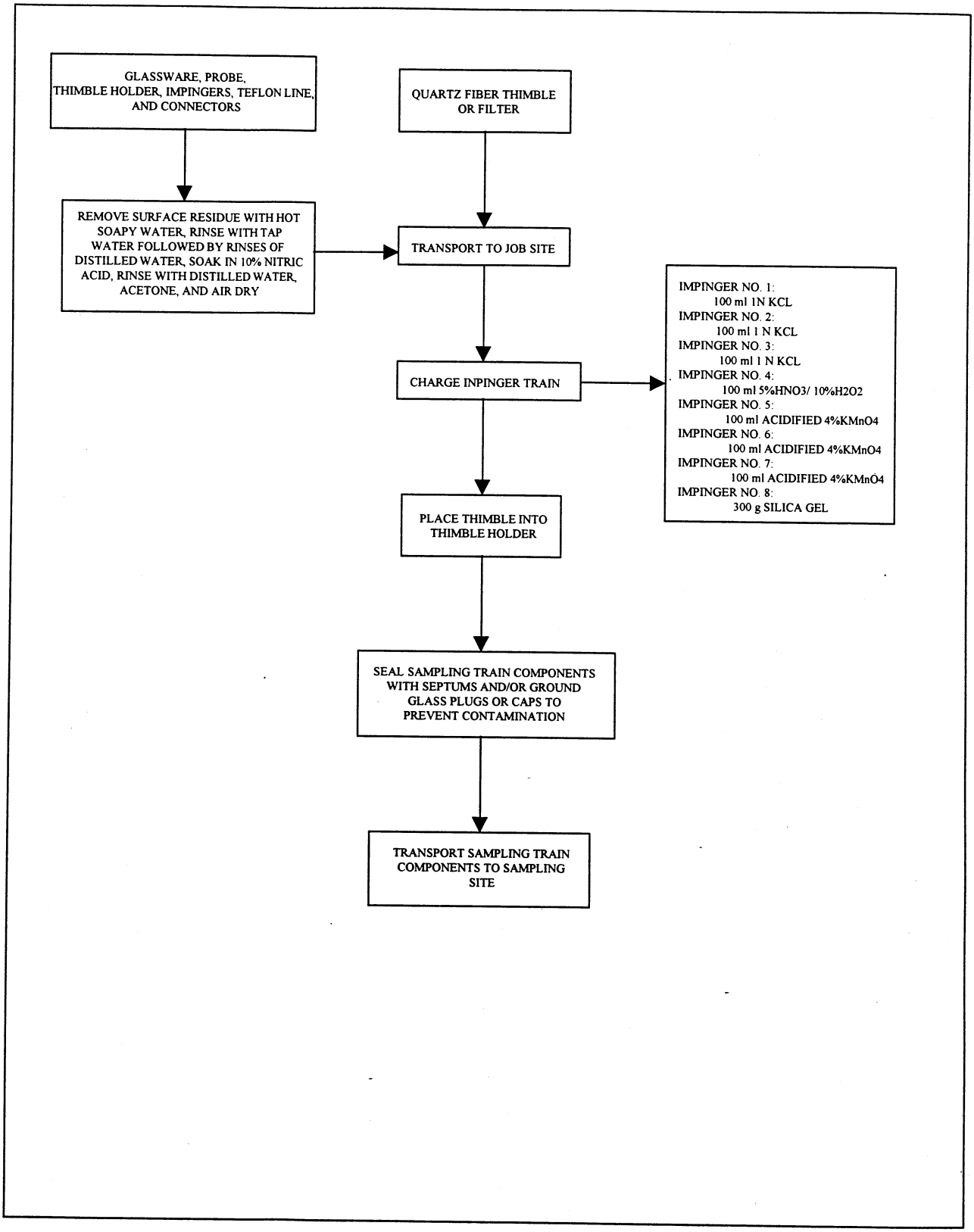

FIGURE 4-4
PREPARATION PROCEDURES FOR ONTARIO HYDRO SAMPLING TRAIN

DOE20-D20

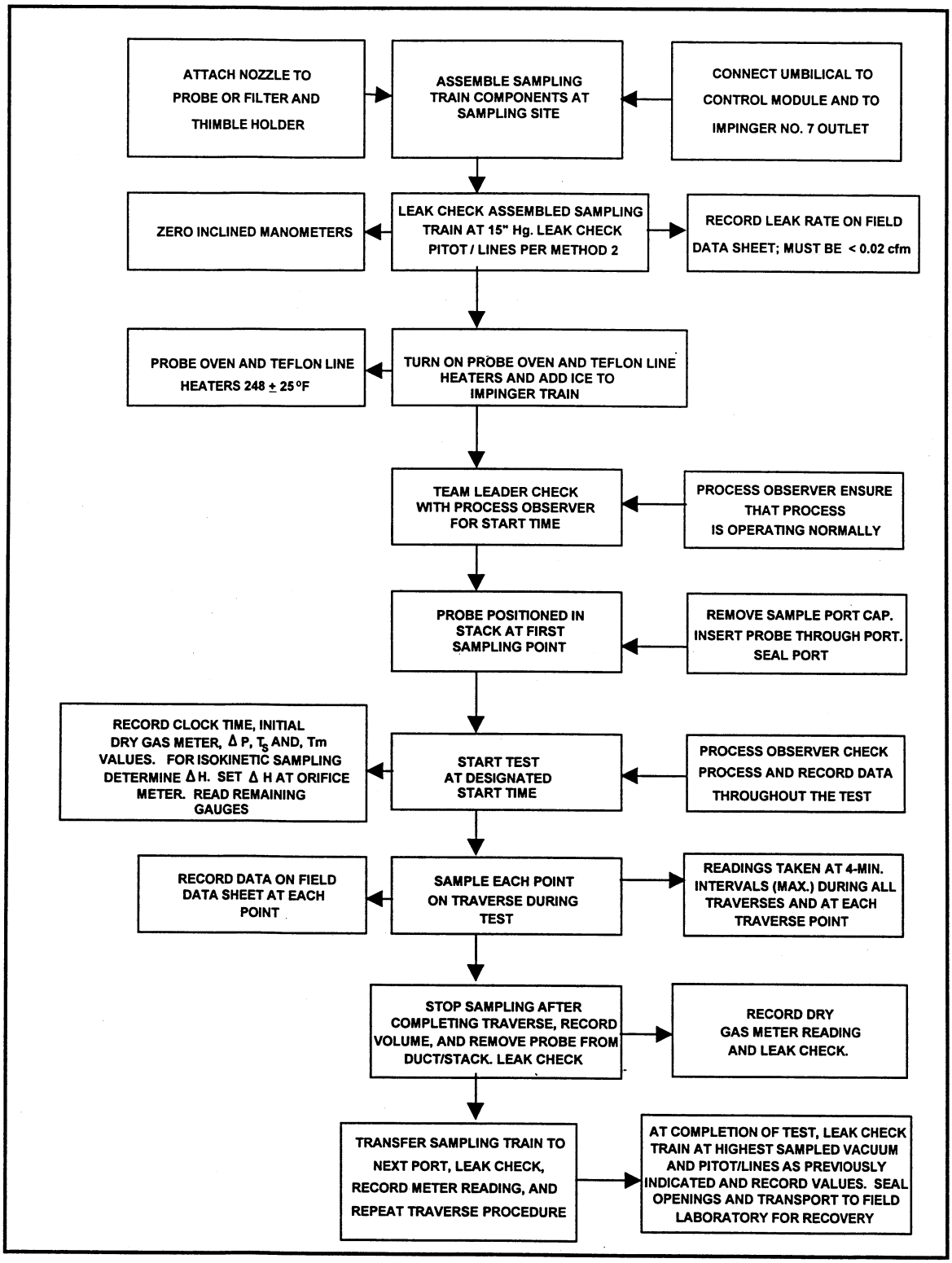

FIGURE 4 - 5
SAMPLING PROCEDURES FOR ONTARIO HYDRO TRAIN

DOE21-D20

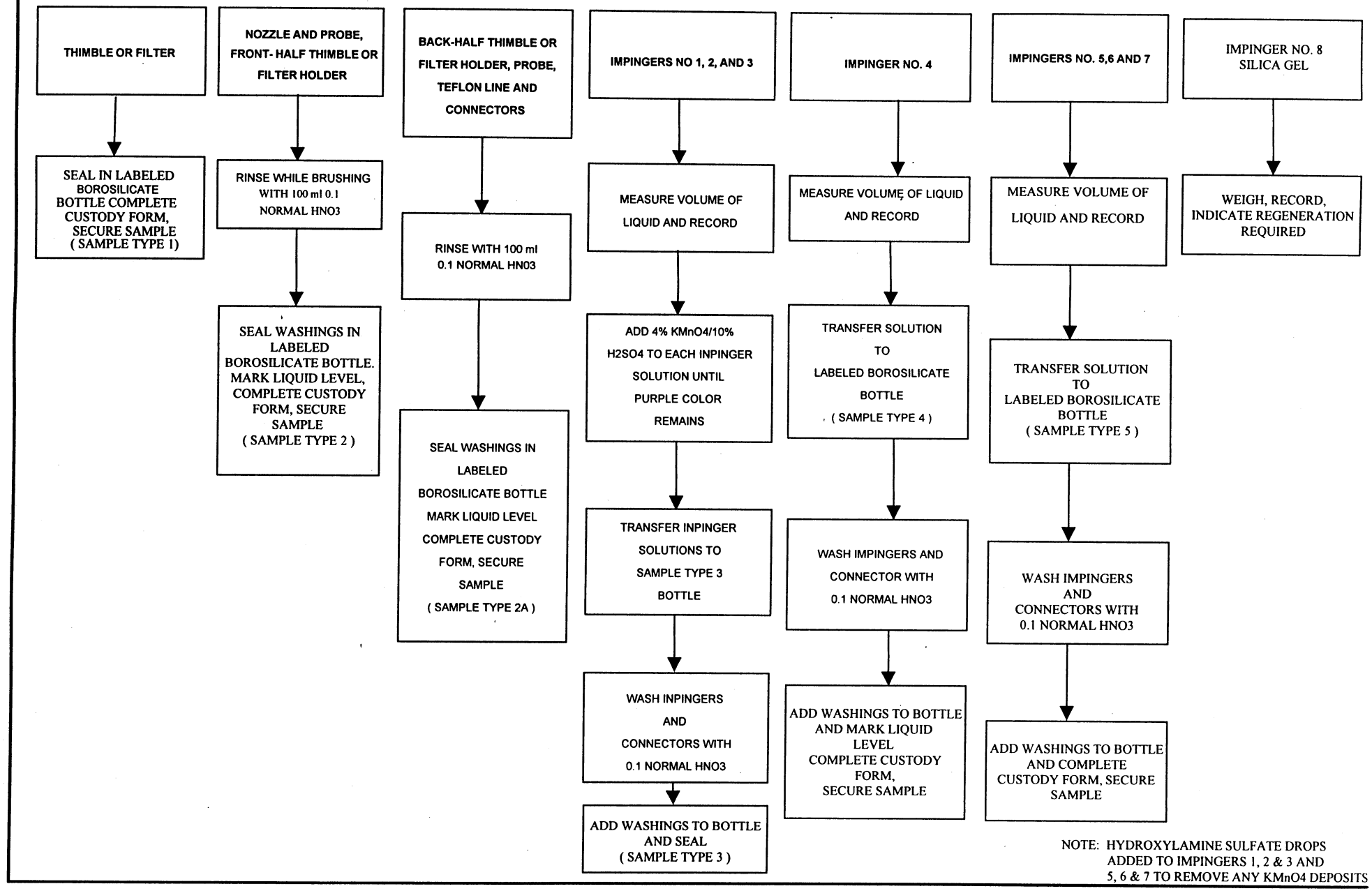

FIGURE 4 - 6
SAMPLE RECOVERY PROCEDURES FOR ONTARIO HYDRO METHOD

DOE22-D20

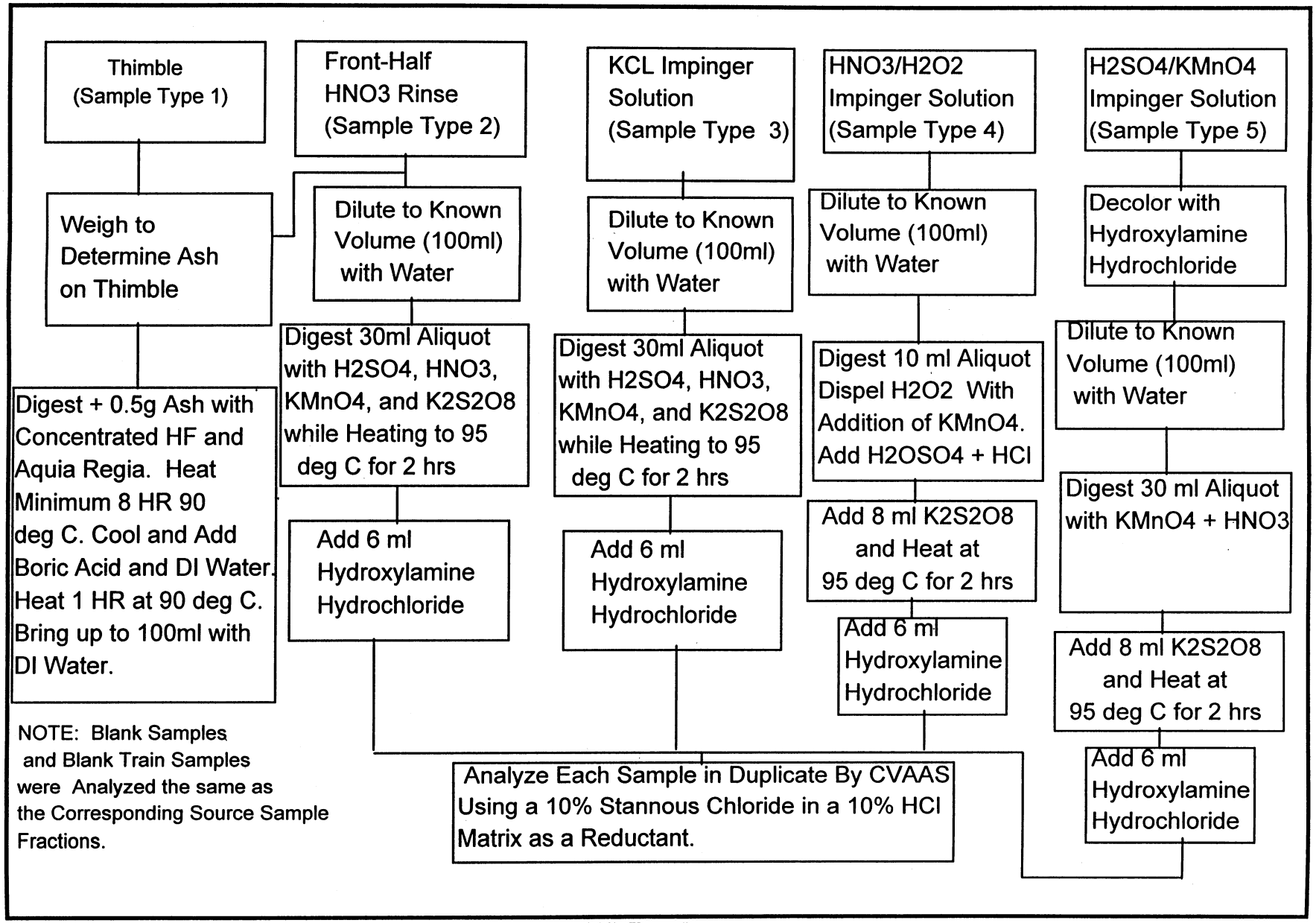

FIGURE 4 - 7

ANALYTICAL PROCEDURE FOR
ONTARIO HYDRO SAMPLING TRAIN

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4.4.1.2.3 Mercury

Following preparation the coal sample was weighed. The sample digested in sulfuric acid, nitric acid and potassium permanganate.

Following digestion the liquid sample was analyzed for total mercury content using cold vapor atomic absorption (CVAA) by EPA Method 7471 procedures.

4.4.1.2.4 Ash, Sulfur and Heating Value

The prepped coal samples were analyzed for ash and sulfur content plus heating value using ASTM Methods D3174, D4239 and D3286, respectively.

5. QUALITY ASSURANCE SUMMARY

This section discusses results for QC samples collected during the test program. Discussions are provided for stack gas samples (Subsection 5.1) and coal samples (Subsection 5.2).

5.1 STACK SAMPLE QA/QC RESULTS

This section provides detailed information regarding the QA/QC activities associated with stack sample collection, analysis, and reporting.

This summary pertains to all test data collected from sampling activities performed on Unit No. 1 during the period of 13 through 15 September 1999. Analyses were performed on these samples for speciated mercury.

Project data quality objectives, as measured by precision, accuracy and completeness, were evaluated. Additionally, holding times, spike recoveries, laboratory blanks, and calibrations were evaluated to determine overall data quality based on criteria specified in the Site-Specific Sampling/Testing, Analytical and QA/QC Plan and the Quality Assurance Project Plan.

5.1.1 Stack Sample Collection and Calculations

Field QA/QC activities associated with the collection of stack Ontario Hydro method emission samples included pre- and post-test calibrations of sampling equipment, adherence to the proper sampling method procedures, documentation of field data, recovery of samples without contamination, and collection of appropriate field train and site blank samples.

Copies of the field data sheets are contained in Appendix C. Chain of custody forms are included in each laboratory report and provide a list of all samples collected and submitted for analysis during the test program. The laboratory reports are provided in Appendix D.

Proper field sampling procedures include sampling at 100% isokinetic ±10% and maintaining sample train leakage rates at ≤ 0.02 CFM. Table 5-1 contains a summary of all isokinetic

Table 5-1

Stack Emission Sampling Field QA/QC Results

Test Location	Test Run	Isokinetic Sampling Rate[1]	Initial Leak Check Rate[2]	Final Leak Check Rate[2]	Gas Meter Calibration Values[3]	
					Pre	Post[(4)]
Unit No. 1 FGD Inlet	2	101.2	0.014	0.015	1.0098	1.0098 ± 0.05
	3	104.9	0.010	0.010	1.0098	1.0098 ± 0.05
	4	105.9	0.013	0.015	1.0098	1.0098 ± 0.05
Unit No. 1 Baghouse Outlet	2	101.5	0.012	0.008	1.0072	1.0072 ± 0.05
	3	100.8	0.008	0.012	1.0072	1.0072 ± 0.05
	4	101.7	0.009	0.006	1.00 72	1.0072 ± 0.05

1 Isokinetic rate must be 100 ± 10%. All sampling rates met isokinetic criteria.

2 Initial and final leak check value must be ≤ 0.02 CFM. All leak checks were acceptable.

3 Post-test calibration must be ± 0.05 of pre-test value. All calibration values were acceptable.

4 Based on EPA alternative post test calibration procedure.

Note:

Silica gel impinger exit temperature maintained < 68°F during all test periods.

sampling rates for all tests, initial and final leak check rates, and pre- and post-test dry gas meter calibration results. This table indicates that all test runs were within the acceptable ranges for all field measurements. Appendix F contains the stack test equipment calibration data.

5.1.2 Sample Chain of Custody

Sample custody procedures were followed per Section B-2 of the QAPP. Following collection and recovery, all samples were transferred under chain of custody to representatives of Philip Analytical Services Laboratory located in Reading, Pennsylvania. The sample storage area was locked and secured during off-hours when test representatives were not on-site.

All samples arrived in good condition to the Philip laboratory.

5.1.3 Stack Emission Blank Sample Results

Blank samples were submitted with the stack emissions samples as designated in the test method and QAPP. During each set of the three test runs, a blank sample train was setup, leak checked and recovered at each of the test locations on Unit No. 1. Site blanks of the thimbles, filters, impinger train solutions and recovery solutions were retained and analyzed. No mercury above the analytical detection limit was present in any of the site blank samples collected for Unit No. 1. A low level of mercury (0.19 μg) was detected in the FGD inlet blank train sample ($KMnO_4$ fraction). No mercury above the analytical detection limit was found in any of the other blank train fractions at the FGD inlet or baghouse outlet test location. No adjustments were made to the measured source values for the blank level detected in the one blank train inlet sample.

5.1.4 Ontario Hydro Analysis Holding Times

Holding time is the period from sample collection to sample analysis. All holding times for all Ontario Hydro sample parameters were within the maximum time period of 28 days per the Site-Specific Sampling/Testing Analytical and QA/QC Plan.

5.1.5 Internal Field Audit Procedures

During the performance of the test program, the WESTON field team leader performed an audit of the field measurement activities. A field audit checklist (Technical System Audit) was used to document the internal audit. The audit included examination of field sampling records, field instrument operating records, sample collection, recovery, handling and chain-of-custody procedures. A copy of the Technical System Audit is provided in Appendix G.

5.1.6 External Performance Evaluation Audits

No performance evaluation audits were provided to WESTON by the regulatory agencies during the test program.

The EPA's designated observers from BATTELLE and ETS were present to observe and approve the tests.

All mercury speciation stack emissions data and results are believed to be representative of the emissions encountered during the test periods and appear to be acceptable following QA/QC review.

5.1.7 Ontario Hydro Sample Analysis

Each Ontario Hydro sample was analyzed in duplicate and every 1 in 10 samples were analyzed in triplicate. The percent relative difference (RPD) for duplicate analysis is $\leq$ 20%. With the exception of a few samples which contained low levels of mercury near the detection limit, the RPD criteria was satisfied.

The accuracy criteria for spike samples and laboratory control samples is 80 to 120%. This criteria was satisfied in all cases.

5.1.8 Ontario Hydro Sample Analysis QA/QC Conclusion

All source sample data and results appear to be acceptable following QA/QC review.

5.2 PROCESS SOLID SAMPLE QA/QC RESULTS

The Site-Specific Sampling/Analytical and QA/QC Plan and the QAPP for this program identified the analytical QC objectives for the process solid sample analysis.

All QA/QC analysis results are provided in Appendix D of this report. A brief summary of the results follows.

Analytical Precision

Analytical precision was determined by RPD obtained by the duplicate sample analyses. The +RPD objective for the mercury and chlorine in coal was ≤ 20%. The RPD for ash, sulfur and heating value is ≤ 10%. The RPD objectives for duplicate analyses were met in all cases for all analytes.

Analytical Accuracy

The objectives for accuracy for spike samples and laboratory control samples were 70 to 130% for the mercury in coal and 80-120% for chlorine. The objectives for accuracy were satisfied in all cases.

5.2.1 Holding Times

All coal samples were analyzed within the required holding times as specified in the Site-Specific Sampling/Testing, Analytical and QA/QC Plan.

5.2.2 Process Sample QA/QC Conclusions

All solid sample process data and results appear to be acceptable following QA/QC review.

5.3 COMPLETENESS

Laboratory completeness is a measure of the amount of valid measurements obtained from all the laboratory measurements associated with this test program. The number of valid measurements

satisfied the laboratory completeness goal identified in the Site-Specific Sampling/Testing, Analytical and QA/QC Plan QAPP of greater than 90 percent.

Based on a review of all QA/QC results, no data has been lost or qualified as not satisfied the QC criteria for precision and accuracy. Therefore, a 100% completeness can be assigned for both sampling and analysis.