



VIRGINIA POWER

February 23, 2000

Mr. William Grimley/Ms. Lara Autry
Emissions Measurement Center (MD-19)
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

Attn: Electric Utility Steam Generating Unit Mercury Test Program

Dear Mr. Grimley and Ms. Autry:

In response to EPA's "Clean Air Act Section 114" letter from Ms. Sally L. Shaver, dated March 11, 1999, requiring Virginia Power to submit all final emission test results of speciated mercury at the inlet and outlet of the last emissions control device on one unit at the Virginia Power/Old Dominion Electric Cooperative Clover Power Station, we are submitting this letter with an attached report that meets this requirement.

The actual mercury emissions tests were conducted by ETS, Inc. on Unit 2 during November 30 and December 1, 1999, and were in compliance with EPA's approved protocols described in Clover's Site-Specific Plan and Clover's Quality Assurance Program Plan. In addition, this submittal is in compliance with the requirement to submit the test results within 90 days of completion but no later than May 31, 2000.

If you have any questions or comments, please contact Mr. Joe Leslie at (804) 550-5825 or Mr. Russ Wood at (804) 273-3015.

Very truly yours,

Pamela F. Faggert
Vice President and
Chief Environmental Officer

cc with attachment:

- Mr. William Maxwell, Emissions Standards Division (MD-13),
U. S. Environmental Protection Agency, Office of Air Quality Planning
and Standards, Research Triangle Park, North Carolina 27711
- Ms. Judith Katz, Region III, Director, Air Protection Division, U. S.
Environmental Protection Agency, MD-3AP00, 1650 Arch Street,
Philadelphia, PA 19103
- Mr. John M. Daniel, Jr., Director, Virginia DEQ, Air Division, Richmond, VA
- Mr. David J. Brown, Compliance Manager, Virginia DEQ, Lynchburg, VA

**Site-Specific Test Report for Mercury
Information Collection Request (ICR) Test
Required by the EPA**

**Test Program Conducted at
Virginia Power
Clover Power Station - Unit 2
Clover, Virginia**

**Test Date: December 1, 1999
Report Date: February 18, 2000**



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In Toxic Emission Measurement and Control***

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1.0 Introduction

1.1 Summary of Test Program

1.1.1 General Information

An air emissions test program was performed on Unit 2 at Clover Power Station in Clover, Virginia. The test program was conducted on November 30 and December 1, 1999 by ETS, Incorporated (ETS) of Roanoke, Virginia.

1.1.2 Objective

The purpose of the testing was to satisfy an Information Collection Request (ICR) issued to Virginia Power by the Environmental Protection Agency (EPA). By means of the ICR, the EPA notified Virginia Power that stack testing for mercury emissions was to be conducted at Clover Power Station. Specifically, mercury emissions testing was required at the inlet and outlet to the wet scrubber serving one of the two identical units at the station. Station personnel selected Unit 2 for the testing.

1.1.3 Process of Interest

Virginia Power and Old Dominion Electric Cooperative equally own the Clover Power Station, while Virginia Power is responsible for electricity generation. Unit 2 consists of a pulverized coal-fired utility boiler coupled with a steam turbine and electric generator capable of generating 424 MW (for "description" purposes only) of electricity. The boiler is equipped with Pollution Minimum burners to control nitrogen oxide emissions, a

baghouse for particulate removal, and a wet-limestone scrubber for sulfur dioxide control.

1.1.4 Test Program

Mercury emissions were determined using the “Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method).”

Three measurements were made for mercury at the Unit 2 A baghouse outlet/wet scrubber inlet and the Unit 2 stack. These measurements were accompanied by testing for the average temperature, moisture content, molecular weight, velocity, and volumetric flow rate of the flue gas. Three measurements for average gas temperature, moisture content, molecular weight, velocity, and volumetric flow rate of the flue gas were also made at the Unit 2 B baghouse outlet/wet scrubber inlet.

Reduction efficiency across the wet scrubber was determined by simultaneous testing for mercury concentration at one of two scrubber inlet ducts (the A duct) and the Unit 2 exhaust stack. Reduction efficiency was calculated by assuming similar mercury concentrations at each of the two inlet ducts and pro-rating the inlet mass loading of mercury based on flow measurements taken in both inlet ducts.

1.2 Key Personnel

The following personnel participated in the test program:

Name	Affiliation	Position	Telephone No.
Joe Leslie	Va Power	Team Leader - Emissions Support Group	(804) 550-5825
Tim Hamlet	Va Power	Environmental Compliance Coordinator	(804) 454-2105
Andy Hetz	ETS	Manager - Field Services	(804) 265-0004
Tony Underwood	ETS	Project Manager	(804) 265-0004
Dave Vecellio	ETS	Field Specialist	(804) 265-0004
Sean Warden	ETS	Field Specialist	(804) 265-0004
Jeremy McKenna	ETS	Field Technician	(804) 265-0004
Frank Craighead	ETS	Field Technician	(804) 265-0004
Chawn Duty	ETS	Field Technician	(804) 265-0004
Rusty Caton	ETS	Field Technician	(804) 265-0004

Margaret Wagner of the Virginia Department of Environmental Quality (VDEQ)

witnessed voided test run 1 on November 30, 1990.

2.0 Plant and Sampling Location Descriptions

2.1 Process Description and Operation

Figure 2-1 illustrates a general layout of the equipment of Clover Power Station Unit 2.

Unit 2 is one of two identical tangentially-fired pulverized coal boilers at Clover Power Station. Each unit generates steam for use in a turbine-generator having the capacity to generate 424 MW_{net} of electrical power.

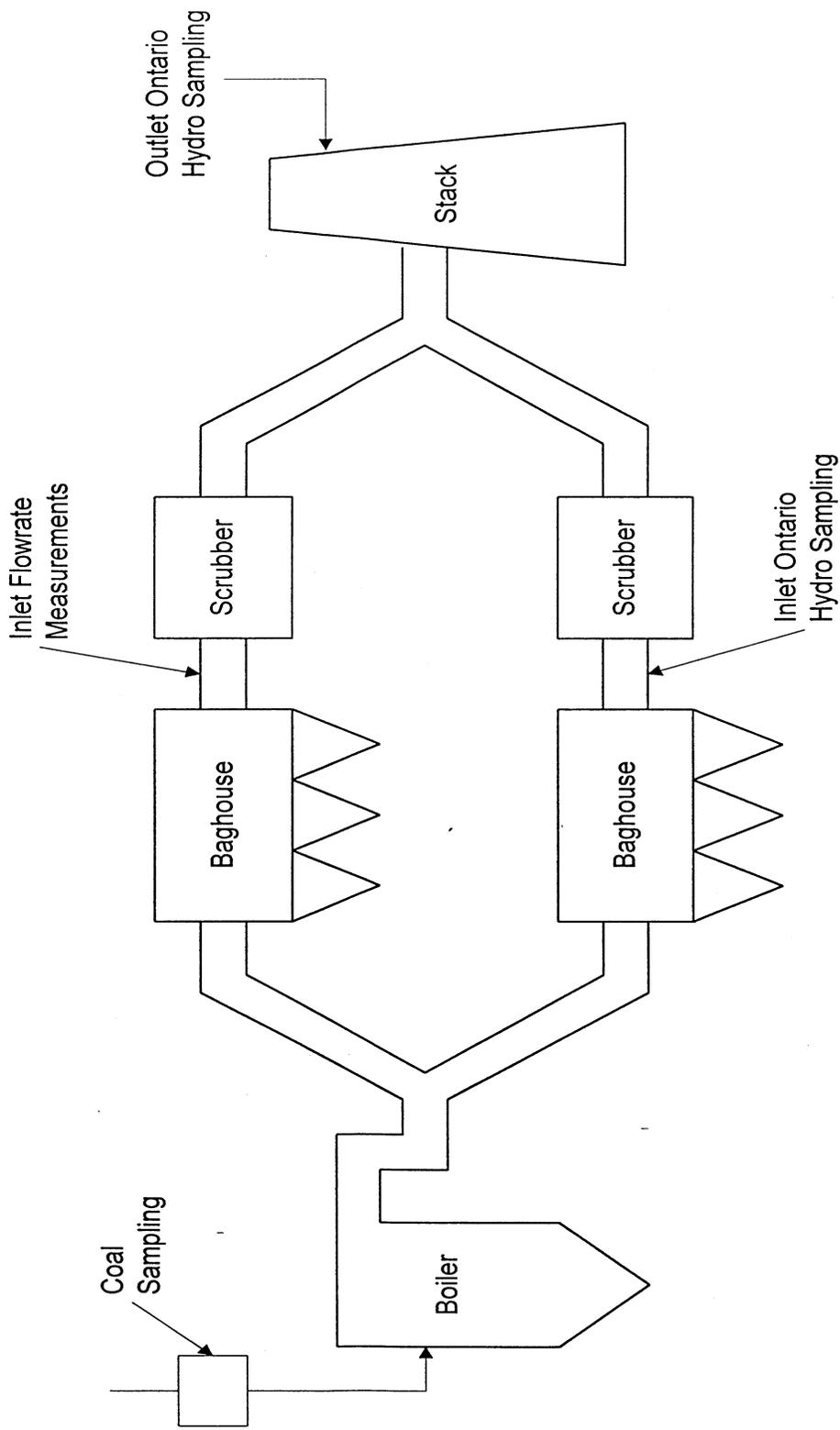


Figure 2-1: General Layout - Clover Power Station Unit 2.

2.2 Control Equipment Description

Pollution controls include Pollution Minimum burners for reduction of nitrogen oxides, a baghouse to remove particulate, and a wet-limestone scrubber for control of sulfur dioxide.

2.3 Flue Gas and Process Sampling Locations

2.3.1 Flue Gas Sampling Locations

Flue gas sampling was performed at the Unit 2 A and B scrubber inlet ducts and the Unit 2 exhaust stack.

2.3.1.1 Unit 2 Exhaust Stack

Figure 2-2 provides a schematic of the Unit 2 exhaust stack sampling location. The exhaust stack had a 267-inch inside diameter at the sampling location and had four test ports (4 inches in diameter and 8 inches in length) located at 90° angles. The test ports were located 84.34 feet (3.79 diameters) downstream from the nearest flow disturbance and 223.5 feet (10.0 diameters) upstream from the nearest flow disturbance.

2.3.1.2 Unit 2 A and B Scrubber Inlet

A diagram of the identical A and B scrubber inlet sampling locations is provided in Figure 2-3. The test ports were located 9.67 feet (0.69 diameters) downstream from the nearest disturbance and 17.33 feet (1.23 diameters) upstream from the nearest disturbance. The scrubber inlet locations measured 14 feet by 14 feet, resulting in an equivalent diameter of

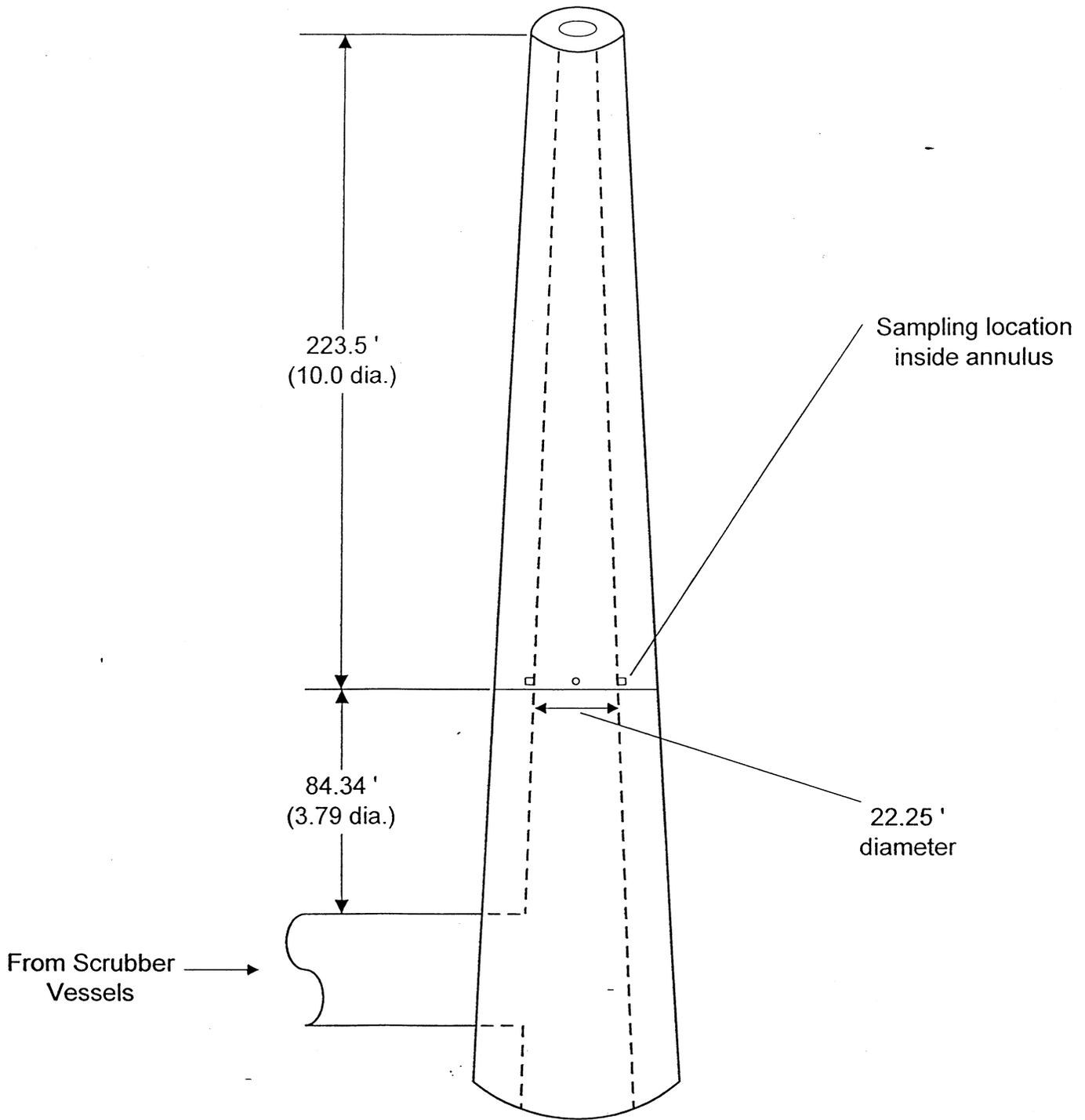


Figure 2-2. Schematic of Unit 2 Stack Sampling Location

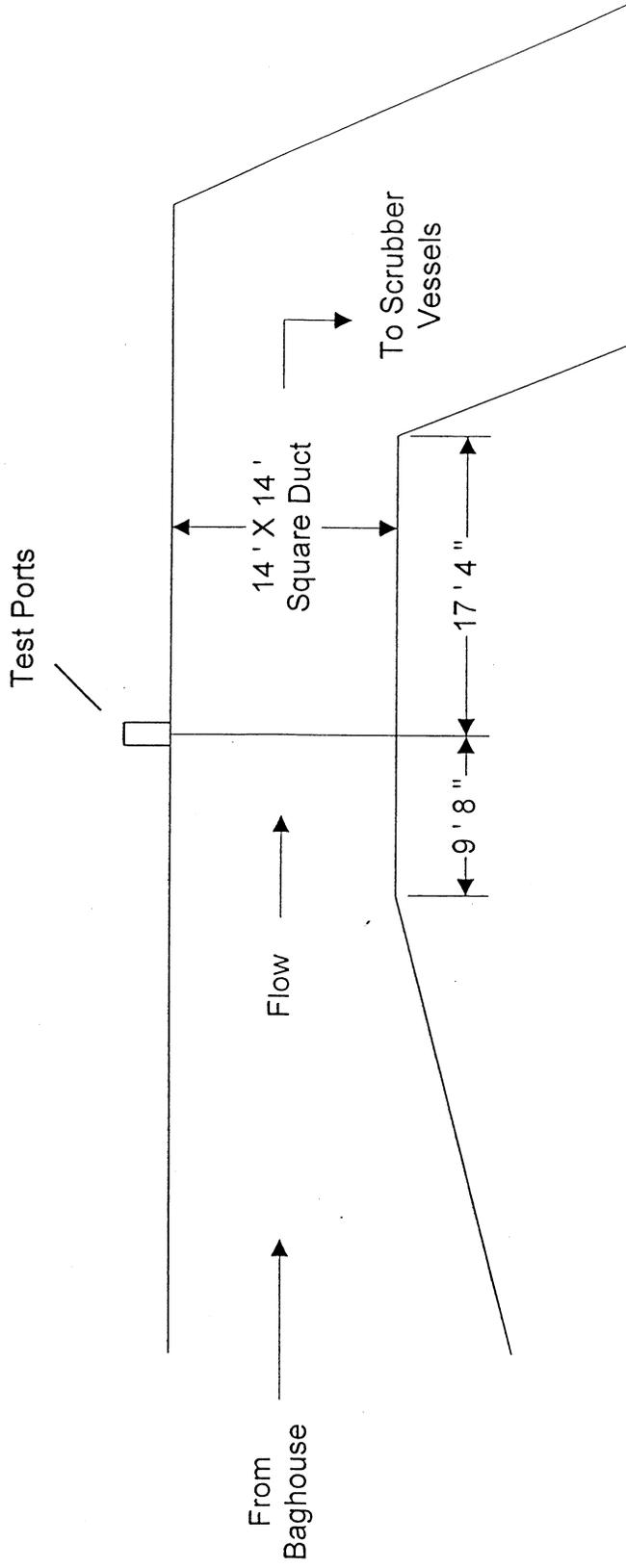


Figure 2-3. Schematic of Unit 2 A and B Scrubber Inlet Sampling Location

14 feet. Five test ports were located on the top of each ductwork. These ports were approximately four inches in diameter and 36 inches in length.

2.3.2 Coal Sampling Locations

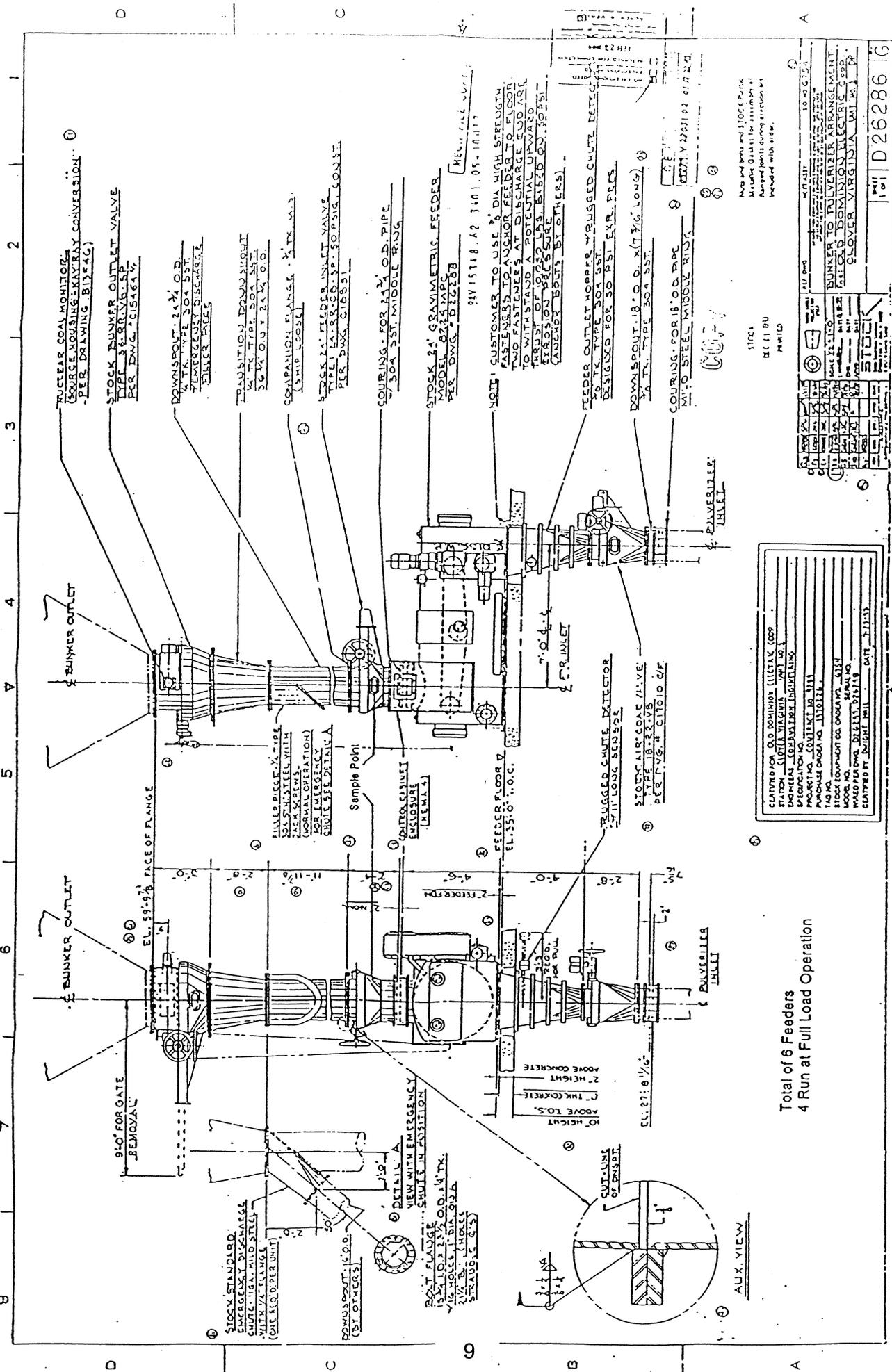
Coal samples were taken at the sampling ports at the inlet valves to the gravimetric feeders beneath the coal bunkers. Figure 2-4 is a diagram of the coal sampling locations (coal was granular at this stage, and not yet pulverized). Virginia Power had six feeder systems for each Unit at Clover Power Station. Four of these systems were in operation at any one time. Coal was sampled from all coal feed systems in operation during the test.

3.0 Summary and Discussion of Test Results

3.1 Objectives and Test Log

As stated Section 1.1.2, the objective of the testing was to determine mercury emissions and reduction efficiency across the Unit 2 wet scrubber as required by the ICR.

A detailed test log of the dates and times of the individual testing is provided in Table 3-1.



NUCLEAR COAL MONITOR
COVERING HOUSING-KRAYAY CONVERSION
- PER DRAWING B134G

STOCK BUNKER OUTLET VALVE
TYPE 18-22-25
PER DWG. 20154647

DOWNSPOUT - 24" O.D.
4" TX. TYPE 304 SS.
EMERGENCY DISCHARGE
VALVE

TRANSITION DOWNMOUTH
4" TX. TYPE 304 SS.
EMERGENCY DISCHARGE
VALVE

COMPANION FLANGE - 4" TX. S.S.
(SMP. 2005)

FEEDER 24" FEEDER INLET VALVE
TYPE 18-22-25
PER DWG. 20154647

COURING - FOR 24" O.D. PIPE
304 SS. MIDDLE RING

STOCK 24' GRAVIMETRIC FEEDER
MODEL 82141APC
PER DWG. B132288

NOTE: CUSTOMER TO USE 3" DIA HIGH STRENGTH
FASTENERS TO ANCHOR FEEDER TO FLOOR
TWO FASTENERS AT DISCHARGE END AS
TO WITHSTAND A POTENTIAL UPWARD
FORCE OF 2000 LBS. BASED ON 2075-
CAPACITOR BOLT BY OTHERS.

FEEDER OUTLET HORROR WYRUSSED CHUTE NETWORK
DESIGNED FOR 30 PSI. S.V.P. PRESS.

DOWNSPOUT - 18" O.D. X 1 1/4" LONG
4" TX. PIPE 304 SS.

COURING - FOR 18" O.D. PIPE
MIL. STEEL MIDDLE RING

STOCK
B131180
PART 10

NOTES AND BLOCK PARTS
LISTING. QUALITY NUMBER OF
ANGED PARTS DURING PRODUCTION
INCLUDED WITH THIS.

DATE	BY	CHKD	APP'D	REV
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	1
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	2
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	3
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	4
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	5
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	6
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	7
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	8
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	9
10-10-72	J. H. HARRIS	J. H. HARRIS	J. H. HARRIS	10

CLAYTON FOR O.D. DOMINION (LITTE) COP
PART NO. 20154647
PURCHASE FROM O.D. DOMINION
PROJECT NO. 20154647
TAG NO.
STOCK EQUIPMENT CO. O.D. DOMINION
O.D. DOMINION PART NO.
WAS PER DWG. B131180 PART 10
CLAYTON BY BRIGHT HILL PART 10

Total of 6 Feeders
4 Run at Full Load Operation

Figure 2-4. Coal Feeder Sampling Location

Table 3-1. Test Log for Virginia Power Clover Power Station – Unit 2					
Test Location	Run I.D.	Test Parameter(s)	Date	Start Time	End Time
Unit 2 Stack	U2SO-MOH-R2	Flow by EPA Methods 1-4	12/1/99	0835	1110
	U2SO-MOH-R3	Speciated Mercury by Draft Ontario Hydro		1225	1439
	U2SO-MOH-R4	Method		1546	1802
Unit 2 A Scrubber Inlet	U2SIA-MOH-R2	Flow by EPA Methods 1-4	12/1/99	0835	1112
	U2SIA-MOH-R3	Speciated Mercury by Draft Ontario Hydro		1225	1443
	U2SIA-MOH-R4	Method		1546	1806
Unit 2 B Scrubber Inlet	U2SIB-M1-4-R2	Flow by EPA Methods 1-4	12/1/99	0835	1112
	U2SIB-M1-4-R3			1225	1443
	U2SIB-M1-4-R4			1546	1806

3.2 Field Test Changes and Problems

Test run 1 (conducted on November 30, 1999) was voided because of delays caused by damage to the sampling probe during port changes, including a separation in the sample line. The I-beams supporting the sampling probe at the scrubber inlet were

approximately 20 feet above the opening of the sample ports. On November 30, 1999, ETS attempted to sample at that location using a probe of over 21 feet in length. This resulted in several problems caused by contact between the probe and the I-beam during port changes. These problems included a short in the power supply to the probe heater, a damaged thermocouple connection, and separation of the sampling line. Because of delays caused by these problems and because separation of the sampling line occurred before a leak check could be conducted, the test runs at all sampling locations were voided. Sampling was completed successfully on the following day after the probe was cut to a length of 19 feet and the connections at the end of the probe were reworked.

The sample recovery procedures employed on site differed slightly from those proposed in the Site Specific Test Plan (SSTP). The SSTP proposed that all sampling components be transferred to a remote location for recovery. The filters and impinger trains were transferred to a laboratory for recovery, but the nozzles and sampling probes were recovered at the sampling locations. This was done because of the difficulty and delays caused by removing the probes from the sampling locations, particularly the 19-foot probe used at the scrubber inlet.

3.3 Presentation of Results

Table 3-2 is an overall summary of test program results. Results for testing at the Unit 2 stack are provided in Table 3-3. Table 3-4 provides a summary of the testing conducted at the Unit 2 A scrubber inlet. Table 3-5 summarizes the flow measurements conducted at the B scrubber inlet. Process data are summarized in Table 3-6. More detailed data and results can be found in Appendix A. Detailed process data are provided in Appendix F.

4.0 Sampling and Analytical Procedures

4.1 Flue Gas Sampling Procedures

All sampling and analytical procedures followed the recommendations of the U.S. Environmental Protection Agency (EPA) in Appendix A to Title 40, Part 60 of the *Code of Federal Regulations* (40 CFR 60), or other methods accepted by the EPA and the Virginia Department of Environmental Quality (VDEQ). The following specific methods were used:

- EPA Method 1 for determination of sampling and traverse points;
- EPA Method 2 for determination of flue gas velocity and volumetric flow rate;
- EPA Method 3 (sampling procedure) and 3A analytical procedure) for determination of flue gas composition and molecular weight;
- EPA Method 4 for determination of flue gas moisture content; and
- ASTM October 21, 1999 draft "Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method) for determination of mercury emissions

Raw field data for the testing are contained in Appendix C.

TABLE 3-2

OVERALL SUMMARY OF TEST RESULTS

RUN ID.	TEST RUN 2	TEST RUN 3	TEST RUN 4	AVERAGE
DATE	12/01/99	12/01/99	12/01/99	
TIME STARTED	08:35	12:25	15:46	
TIME ENDED	11:12	14:43	18:06	

A SCRUBBER INLET MASS LOADING

Particle-Bound Mercury - lbs/hr	0.00006	0.00003	0.00007	0.00005
Oxidized Mercury - lbs/hr	0.00094	0.00103	0.00109	0.00102
Elemental Mercury -lbs/hr	0.00104	0.00186	0.00058	0.00116
Total Mercury - lbs/hr	0.00203	0.00293	0.00174	0.00223

A AND B SCRUBBER INLET MASS LOADING (COMBINED)

Particle-Bound Mercury - lbs/hr	0.00014	0.00008	0.00018	0.00013
Oxidized Mercury - lbs/hr	0.00232	0.00263	0.00267	0.00254
Elemental Mercury -lbs/hr	0.00257	0.00473	0.00142	0.00291
Total Mercury - lbs/hr	0.00503	0.00744	0.00427	0.00558

STACK EMISSIONS

Particle-Bound Mercury - lbs/hr	0.00008	<	0.00006	0.00010	<	0.00006	
Oxidized Mercury - lbs/hr	0.00069		0.00057	<	0.00017	<	0.00036
Elemental Mercury -lbs/hr	0.00068		0.00029		0.00023		0.00040
Total Mercury - lbs/hr	0.00145		0.00086		0.00033		0.00088

SCRUBBER REDUCTION EFFICIENCY

Particle-Bound Mercury - %	43.01	>	24.74	41.71	>	54.11	
Oxidized Mercury - %	70.33		78.29	>	93.61	>	85.92
Elemental Mercury - %	73.34		93.89		83.83		86.20
Total Mercury - %	71.11		88.44		92.21		84.20

TABLE 3-3

SUMMARY OF SPECIATED MERCURY EMISSIONS

UNIT 2 STACK

RUN I.D.	U2SO-MOH-R2	U2SO-MOH-R3	U2SO-MOH-R4	- AVERAGE
DATE	12/01/99	12/01/99	12/01/99	
TIME STARTED	08:35	12:25	15:46	
TIME ENDED	11:10	14:39	18:02	
<u>SAMPLING PARAMETERS</u>				
Metered Volume - dcf	58.840	59.524	60.308	59.557
Corrected Volume - dscf	60.846	61.139	61.228	61.071
Total Test Time - min	120	120	120	120
% Isokinetics	104.0	103.6	103.2	103.6
<u>GAS PARAMETERS</u>				
Gas Temperature - ° F	123	122	122	122
Oxygen - %	6.7	6.5	6.4	6.5
Carbon Dioxide - %	12.2	12.4	12.6	12.4
Moisture - %	11.9	12.3	12.1	12.1
<u>GAS FLOWRATE</u>				
Velocity - ft/sec	51.74	52.34	52.49	52.19
Actual Volume - acfm	1207137	1220961	1224525	1217541
Standard Volume - dscfm	963345	971801	976982	970709
<u>PARTICLE-BOUND MERCURY</u>				
Conc. - actual ug/dscm	0.04	< 0.03	0.05	< 0.03
Conc. - ug/dscm @7% O2	0.04	< 0.03	0.05	< 0.03
Mass Rate - lbs/hr	0.00008	< 0.00006	0.00010	< 0.00006
<u>OXIDIZED MERCURY</u>				
Conc. - actual ug/dscm	0.33	0.27	< 0.08	< 0.17
Conc. - ug/dscm @7% O2	0.32	0.26	< 0.08	< 0.17
Mass Rate - lbs/hr	0.00069	0.00057	< 0.00017	< 0.00036
<u>ELEMENTAL MERCURY</u>				
Conc. - actual ug/dscm	0.33	0.14	0.11	0.19
Conc. - ug/dscm @7% O2	0.32	0.13	0.10	0.19
Mass Rate - lbs/hr	0.00068	0.00029	0.00023	0.00040
<u>TOTAL MERCURY</u>				
Conc. - actual ug/dscm	0.69	0.41	0.16	0.42
Conc. - ug/dscm @7% O2	0.68	0.39	0.15	0.41
Mass Rate - lbs/hr	0.00145	0.00086	0.00033	0.00088

Notes:

"<" denotes a non-detectable quantity or a non-detectable quantity included in a 3-run average.

A non-detectable quantity is assumed zero when adding fractions.

TABLE 3-4

SUMMARY OF SPECIATED MERCURY LOADINGS

A SCRUBBER INLET

RUN I.D.	U2SIA-MOH-R2	U2SIA-MOH-R3	U2SIA-MOH-R4	- AVERAGE
DATE	12/01/99	12/01/99	12/01/99	
TIME STARTED	08:35	12:25	15:46	
TIME ENDED	11:12	14:43	18:06	
<u>SAMPLING PARAMETERS</u>				
Metered Volume - dcf	48.398	47.296	49.523	48.406
Corrected Volume - dscf	50.628	48.507	51.722	50.286
Total Test Time - min	125	125	125	125
% Isokinetics	101.2	99.9	102.8	101.3
<u>GAS PARAMETERS</u>				
Gas Temperature - ° F	275	275	274	275
Oxygen - %	5.0	5.2	5.0	5.1
Carbon Dioxide - %	14.1	13.9	14.0	14.0
Moisture - %	6.5	6.4	6.5	6.4
<u>GAS FLOWRATE</u>				
Velocity - ft/sec	54.71	53.12	55.08	54.31
Actual Volume - acfm	643432	624707	647792	638644
Standard Volume - dscfm	415869	403708	418462	412680
<u>PARTICLE-BOUND MERCURY</u>				
Conc. - actual ug/dscm	0.05	0.03	0.07	0.05
Conc. - ug/dscm @7% O2	0.05	0.02	0.06	0.04
Mass Rate - lbs/hr	0.00006	0.00003	0.00007	0.00005
<u>OXIDIZED MERCURY</u>				
Conc. - actual ug/dscm	0.86	0.94	1.02	0.94
Conc. - ug/dscm @7% O2	0.76	0.83	0.89	0.83
Mass Rate - lbs/hr	0.00094	0.00103	0.00109	0.00102
<u>ELEMENTAL MERCURY</u>				
Conc. - actual ug/dscm	0.96	1.69	0.54	1.06
Conc. - ug/dscm @7% O2	0.84	1.50	0.47	0.94
Mass Rate - lbs/hr	0.00104	0.00186	0.00058	0.00116
<u>TOTAL MERCURY</u>				
Conc. - actual ug/dscm	1.87	2.66	1.63	2.05
Conc. - ug/dscm @7% O2	1.64	2.35	1.42	1.80
Mass Rate - lbs/hr	0.00203	0.00293	0.00174	0.00223

TABLE 3-5

SUMMARY OF FLOW MEASUREMENTS AND CALCULATED MERCURY LOADINGS

B SCRUBBER INLET

RUN I.D.	U2SIB-M1-4-R2	U2SIB-M1-4-R3	U2SIB-M1-4-R4	AVERAGE
DATE	12/01/99	12/01/99	12/01/99	
TIME STARTED	08:35	12:25	15:46	
TIME ENDED	11:12	14:43	18:06	
<u>SAMPLING PARAMETERS</u>				
Metered Volume - dcf	86.088	92.550	90.534	89.724
Corrected Volume - dscf	88.067	92.196	91.762	90.675
Total Test Time - min	125	125	125	125
<u>GAS PARAMETERS</u>				
Gas Temperature - ° F	290	289	290	290
Oxygen - %	4.0	4.2	4.5	4.2
Carbon Dioxide - %	14.8	14.5	14.6	14.6
Moisture - %	5.5	5.9	5.8	5.8
<u>GAS FLOWRATE</u>				
Velocity - ft/sec	53.49	56.85	53.61	54.65
Actual Volume - acfm	629038	668526	630404	642656
Standard Volume - dscfm	401732	426348	401663	409914
<u>CALCULATED PARTICLE-BOUND MERCURY*</u>				
Conc. - actual ug/dscm	0.05	0.03	0.07	0.05
Conc. - ug/dscm @7% O2	0.05	0.02	0.06	0.04
Mass Rate - lbs/hr	0.00008	0.00005	0.00010	0.00008
<u>CALCULATED OXIDIZED MERCURY*</u>				
Conc. - actual ug/dscm	0.92	1.00	1.05	0.99
Conc. - ug/dscm @7% O2	0.76	0.83	0.89	0.83
Mass Rate - lbs/hr	0.00138	0.00160	0.00158	0.00152
<u>CALCULATED ELEMENTAL MERCURY*</u>				
Conc. - actual ug/dscm	1.02	1.80	0.56	1.12
Conc. - ug/dscm @7% O2	0.84	1.50	0.47	0.94
Mass Rate - lbs/hr	0.00153	0.00287	0.00084	0.00175
<u>CALCULATED TOTAL MERCURY*</u>				
Conc. - actual ug/dscm	1.99	2.83	1.68	2.16
Conc. - ug/dscm @7% O2	1.64	2.35	1.42	1.80
Mass Rate - lbs/hr	0.00299	0.00451	0.00252	0.00334

* Based on the mercury concentration measured at the A Scrubber Inlet corrected for oxygen inleakage by the following equation:

$$\text{Hg, ug/dscm @ B Scrubber Inlet} = \frac{(\text{Hg, ug/dscm @ A Scrubber Inlet}) \times (20.9 - \%O_2 \text{ @B Scrubber Inlet})}{(20.9 - \%O_2 \text{ @A Scrubber Inlet})}$$

TABLE 3-6

SUMMARY OF PROCESS DATA

RUN I.D.	TEST RUN 2	TEST RUN 3	TEST RUN 4	AVERAGE
DATE	12/01/99	12/01/99	12/01/99	
TIME STARTED	08:35	12:25	15:46	
TIME ENDED	11:12	14:43	18:06	
COAL FEEDERS				
Coal Feed Rate - Feeder A - tons/hr	33.09	32.76	32.57	32.81
Coal Feed Rate - Feeder B - tons/hr	33.12	32.82	32.63	32.86
Coal Feed Rate - Feeder C - tons/hr	33.14	32.83	32.63	32.87
Coal Feed Rate - Feeder D - tons/hr	32.98	32.70	32.53	32.74
Coal Feed Rate - Feeder E - tons/hr	33.02	32.73	32.55	32.77
Total Coal Feed Rate - tons/hr	165.35	163.84	162.91	164.03
COAL QUALITY (AS RECEIVED)				
Mercury Content - mg/kg	0.11	0.16	0.19	0.15
Chlorine Content - %w/w	0.04	0.05	0.06	0.05
Gross Caloric Value - Btu/lb	12520	13140	13050	12903
SCRUBBERS				
Slurry Feed - A Vessel- gal/min	43.23	44.33	39.90	42.49
Slurry Feed - C Vessel- gal/min	43.94	47.22	69.32	53.49
Reagent pH - A Vessel	5.31	5.30	5.28	5.30
Reagent pH - C Vessel	5.40	5.40	5.47	5.42
Inlet Temperature - A Vessel - F	298.02	297.24	297.61	297.62
Inlet Temperature - C Vessel - F	279.90	280.20	280.62	280.24
Outlet Temperature - A Vessel - F	121.75	121.73	121.94	121.81
Outlet Temperature - C Vessel - F	118.13	116.89	118.91	117.98
Pressure Drop - A Vessel - in. W. C.	2.47	2.67	2.86	2.67
Pressure Drop - C Vessel - in. W. C.	3.38	3.45	3.53	3.45
GENERATOR				
Electrical Generation - MWgross	460.98	462.48	461.88	461.78
BOILER				
Main Steam Flow - klb/hr	3292.13	3322.20	3322.02	3312.12
Main Steam Temperature - F	975.88	986.58	985.56	982.67
Main Steam Pressure - psig	2519.66	2518.47	2518.85	2518.99
CEMS DATA				
Exhaust Gas Flow - scfh	68510633	68843484	68177717	68510611
SO2 Inlet - lbs/MMBtu	1.77	1.78	1.77	1.77
SO2 Inlet - ppmwv	840.90	860.14	858.31	853.12
SO2 Outlet - lbs/MMBtu	0.06	0.07	0.07	0.07
SO2 Outlet - ppmwv	19.75	23.41	22.91	22.02
CO2 Inlet - %wv	14.21	14.42	14.45	14.36
CO2 Outlet - %wv	10.54	10.54	10.51	10.53

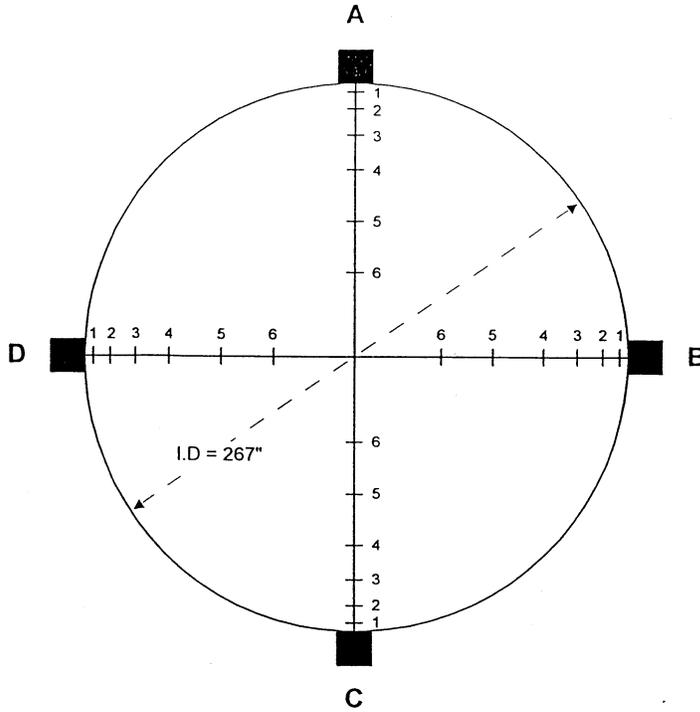
4.1.1 Sampling Point Determination

4.1.1.1 Unit 2 Stack

The procedures of EPA Method 1 were used to determine the number and location of traverse points at the Unit 2 stack. Twenty-four traverse points (six in each of four ports, see Figure 4-1) were used for gas flow rate determination, and for mercury sampling. A cyclonic flow check was performed in accordance with Section 2.4 of EPA Method 1 to verify the absence of cyclonic flow at the stack location. Results of the cyclonic flow check indicated the absence of cyclonic flow and are presented in Appendix C.4.

4.1.1.2 Unit 2 A and B Scrubber Inlet

The test ports at the two identical scrubber inlet ducts were located 9.67 feet (0.69 diameters) downstream from the nearest flow disturbance, and 17.33 feet (1.23 diameters) upstream from the nearest flow disturbance. The scrubber inlet locations measure 14 feet by 14 feet, resulting in an equivalent diameter of 14 feet. This did not meet the EPA Method 1 requirement for the minimum distance of two diameters downstream from the nearest flow disturbance. Therefore, 25 sampling and traverse points (the maximum number required by EPA Method 1) were used. The sampling points were selected in accordance with EPA Method 1. Five points were sampled in each of five test ports (see Figure 4-2). The test ports were located on the top of each ductwork, and were approximately four inches in diameter and 36 inches in length.



Port depth is approximately 8 inches

Point	% of ID	Distance from Inside of Port (inches)
1	2.1	5.6
2	6.7	17.9
3	11.8	31.5
4	17.7	47.3
5	25	66.8
6	35.6	95.1

Inside Diameter	267 in.	22.3 ft.
Distance Upstream from Disturbance	84.34 ft.	10.0 dia.
Distance Downstream from Disturbance	223.5 ft.	3.79 dia.
Distances upstream and downstream from flow disturbances will be measured on site and documented in the final report.		

Figure 4-1 - Sampling and Traverse Points for the Unit 2 Stack

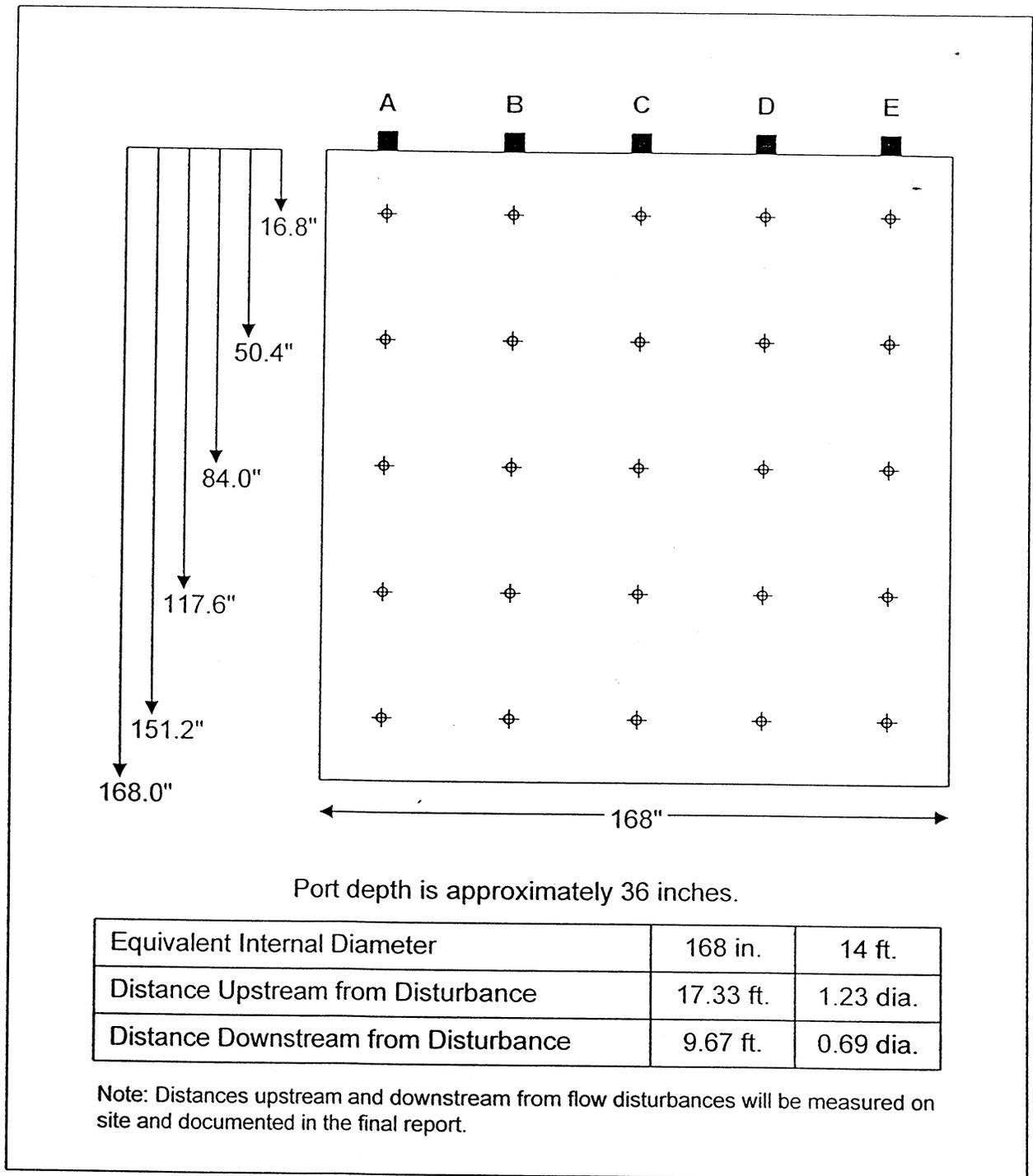


Figure 4-2 - Sampling and Traverse Points for the A and B Scrubber Inlets

Although these sampling locations did not meet the requirement of EPA Method 1, cyclonic flow checks performed on both scrubber inlets demonstrated the absence of cyclonic flow. These measurements are included in Appendix C.4 and may indicate that the flow measurements taken at these locations were valid.

4.1.2 Volumetric Measurements - EPA Method 2

EPA Reference Method 2 was used to determine the velocity and volumetric flow rates of the stack gases. Stainless steel type-S pitot tubes were used to measure the gas velocity. The pitot tubes were calibrated against a NIST-traceable pitot tube in accordance with Method 2. Calibrated type-K thermocouples were used to determine gas temperatures.

Velocity and temperature measurements were made at each of the points shown in Figures 4-1 and 4-2. These measurements were performed separately at the B scrubber inlet and in conjunction with the Ontario Hydro Method testing at all other test locations.

4.1.3 Molecular Weight Determination - EPA Method 3

Sampling for gas compositional measurements (O_2 and CO_2), for determining the average molecular weight of the stack gases, was conducted in accordance with EPA Reference Method 3.

Single-point, integrated sampling was used to obtain a constant-rate sample of the flue gas concurrent with each set of pollutant and flow test runs. A peristaltic pump was used to fill a Tedlar bag, and moisture was removed from the sample gas by an air-cooled condenser located prior to the pump. Figure 4-3 shows a schematic of the Method 3 sampling train.

4.1.4 Flue Gas Moisture Content - EPA Method 4

Flue gas moisture was measured in accordance with the sampling and analytical procedures outlined in EPA Method 4. The EPA Method 4 testing was conducted using a separate sampling train at the B scrubber inlet and in conjunction with the Ontario Hydro Method testing at all other locations. Figure 4-4 shows a diagram of the EPA Method 4 sampling train used at the B scrubber inlet. The flue gas moisture for each test was determined by gravimetric analysis of the water collected in the impinger condensers of the sampling trains. All impingers were contained in an ice bath throughout the testing to ensure complete condensation of the moisture in the flue gas stream. Any moisture not condensed in the impingers was captured in the silica gel in the final impinger.

4.1.5 Mercury Speciation - Ontario Hydro Method

Sampling for elemental, oxidized, particle-bound and total mercury at the Unit 2 stack was performed in accordance with EPA Method 5 in conjunction with the Ontario Hydro Method. Mercury was sampled at the A scrubber inlet in accordance with EPA Method 17 in conjunction with the Ontario Hydro Method.

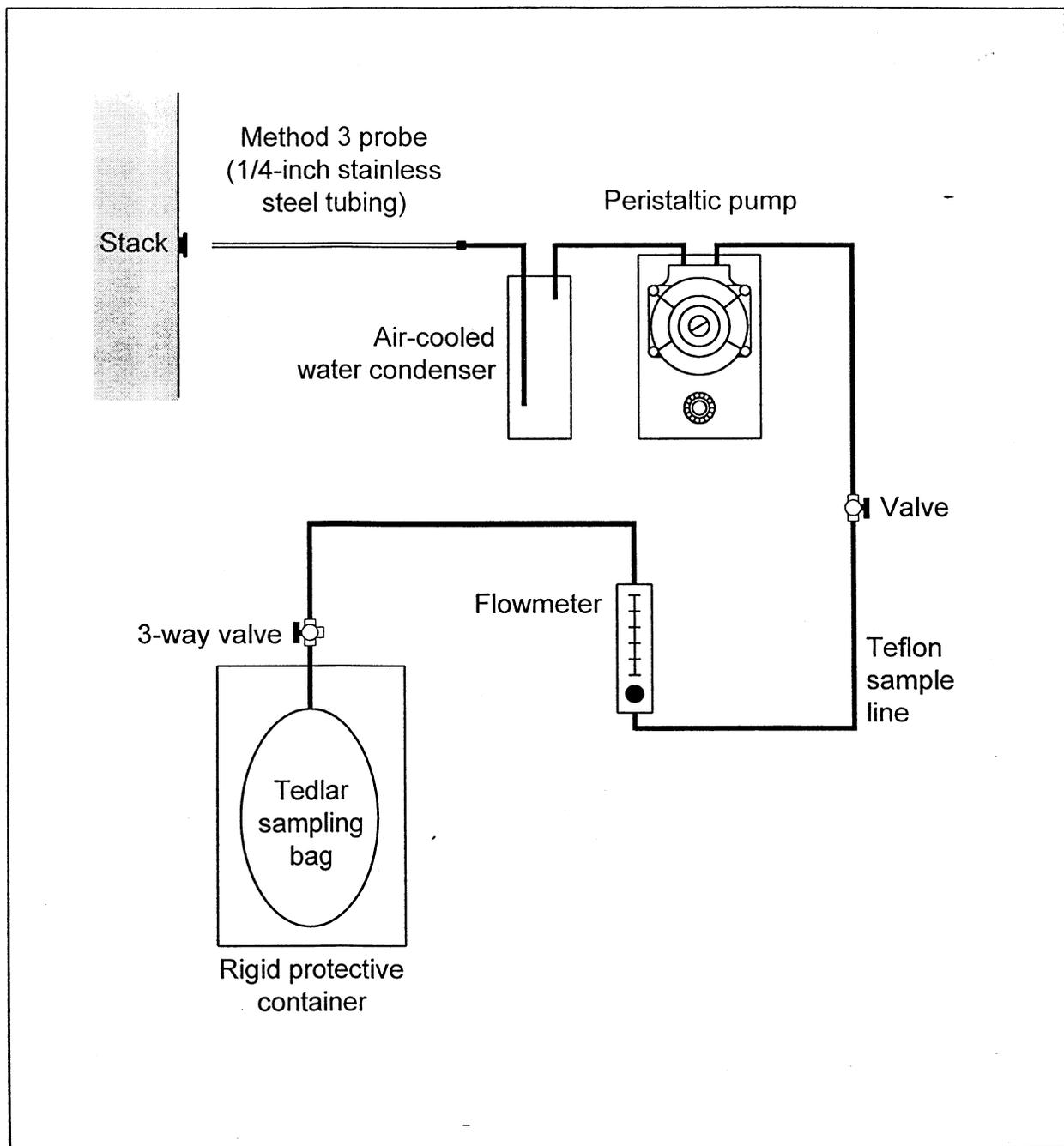


Figure 4-3 - EPA Method 3 Sampling Train

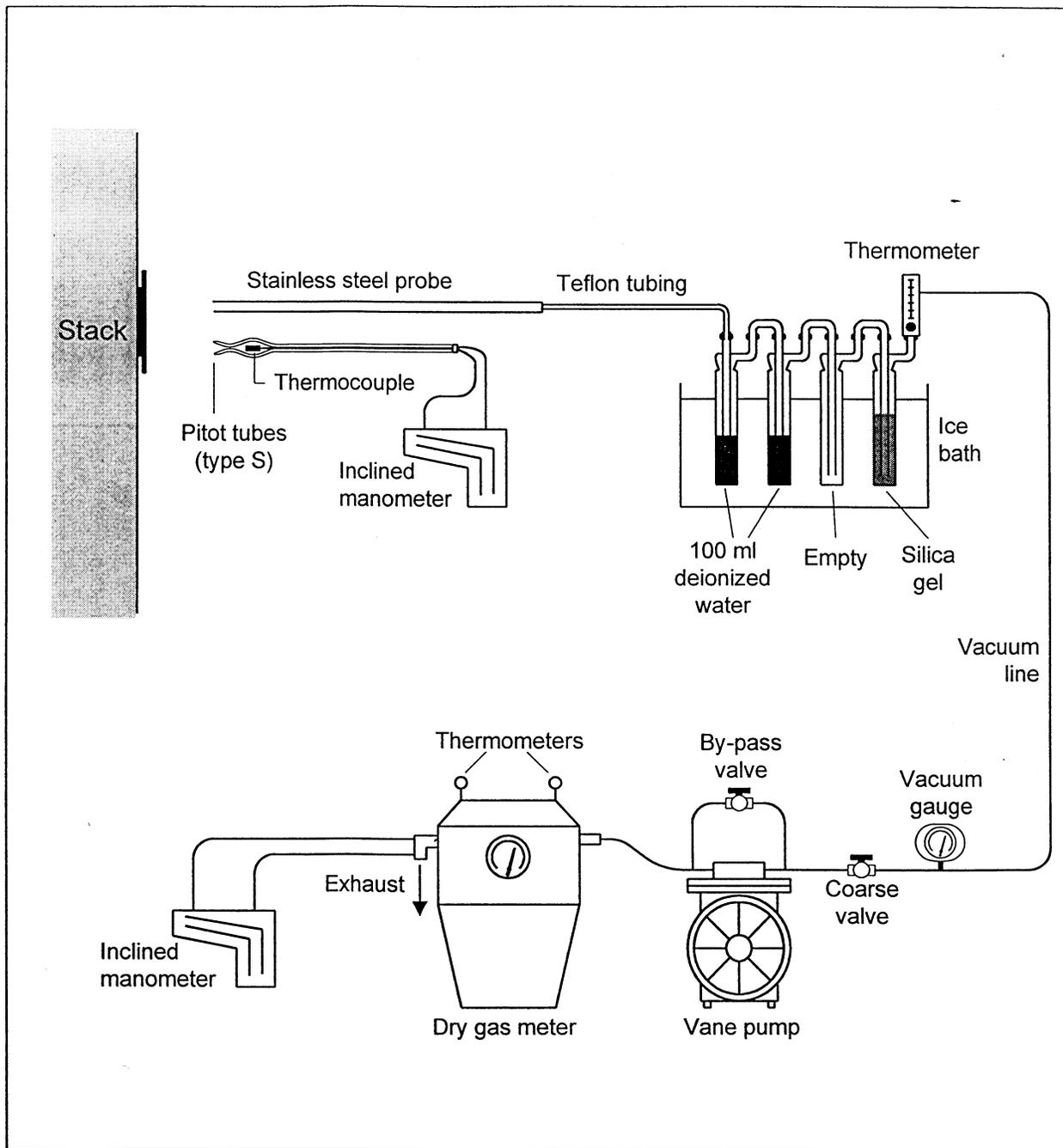


Figure 4-4 - EPA Method 4 Sampling Train

4.1.5.1 Sampling Train Description at the Exhaust Stack

The testing at the exhaust stack was conducted using the sampling train illustrated in Figure 4-5. A heated stainless steel probe with a borosilicate glass liner was used to withdraw the gas sample. For isokinetic gas withdrawal, the probe was equipped with an appropriately sized glass nozzle connected to the probe by a Teflon union and ferrules.

From the nozzle and probe, sample gas was pulled through a heated glass filter holder containing a tared Pallflex ultra-pure 2500 QUAT-UP quartz filter supported on a Teflon frit. Due to the low effluent temperatures (< 248°F), the probe and filter were maintained at a minimum of 248°F, as required by the Ontario Hydro Method. Sample gas subsequently passed through an impinger train consisting of eight glass impingers immersed in an ice bath. The first three impingers each initially contained 100 milliliters of 1 normal potassium chloride (1.0 N KCl). The fourth impinger initially contained 100 milliliters of 5% v/v nitric acid/10% v/v hydrogen peroxide (HNO₃/H₂O₂) solution. The fifth, sixth and seventh impingers each initially contained 100 milliliters of 4% w/v potassium permanganate and 10% v/v sulfuric acid (H₂SO₄/KMnO₄) solution. The eighth impinger initially contained approximately 200 grams of silica gel.

4.1.5.2 Sampling Train Description at the A Scrubber Inlet

Figure 4-6 illustrates the major components of the Ontario Hydro sampling train using the Method 17 configuration. A heated stainless steel probe with a Teflon liner was used to withdraw the gas sample. For isokinetic gas withdrawal, the probe was

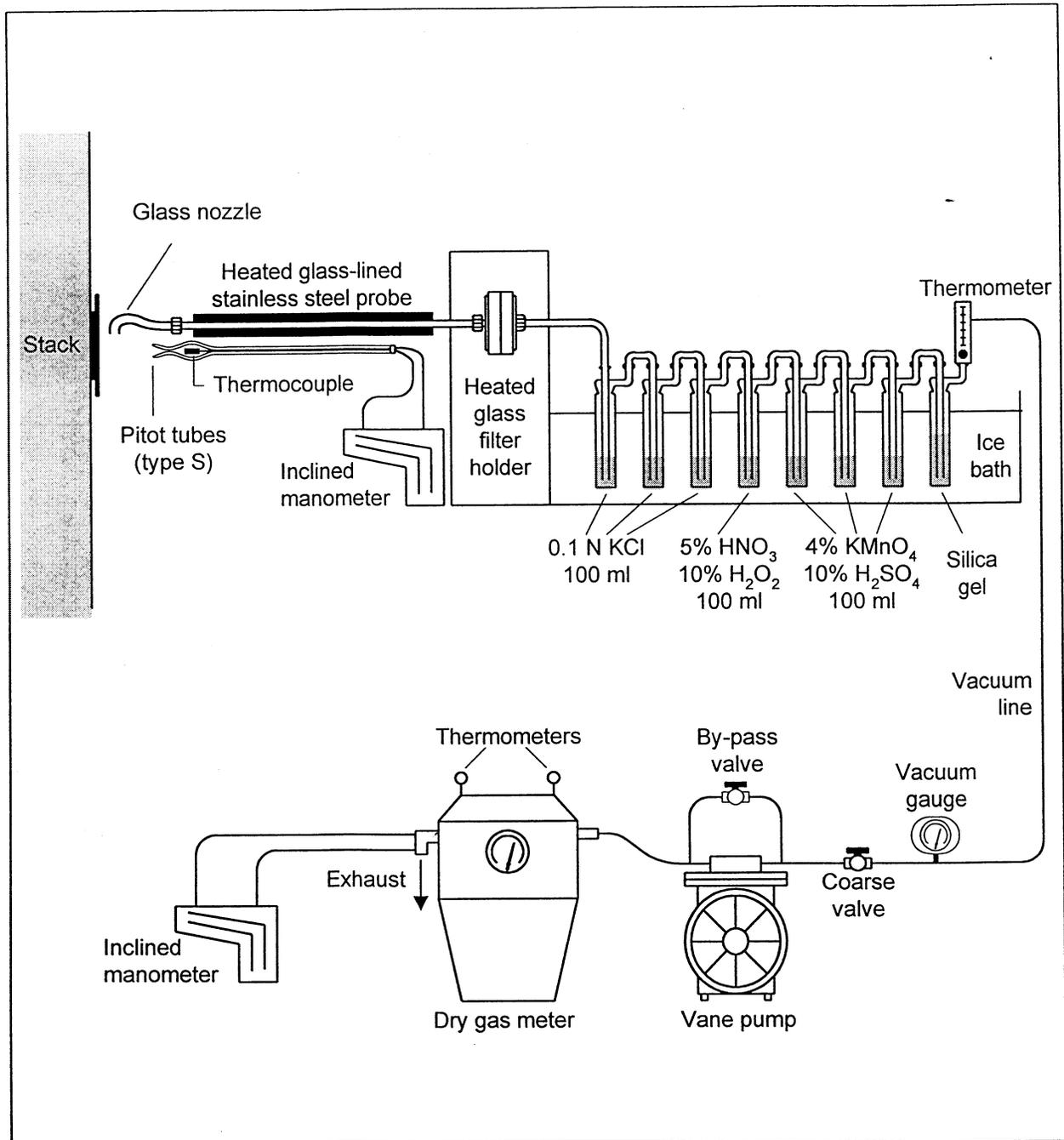


Figure 4-5 - Ontario Hydro Method Sampling Train (EPA Method 5 Configuration)

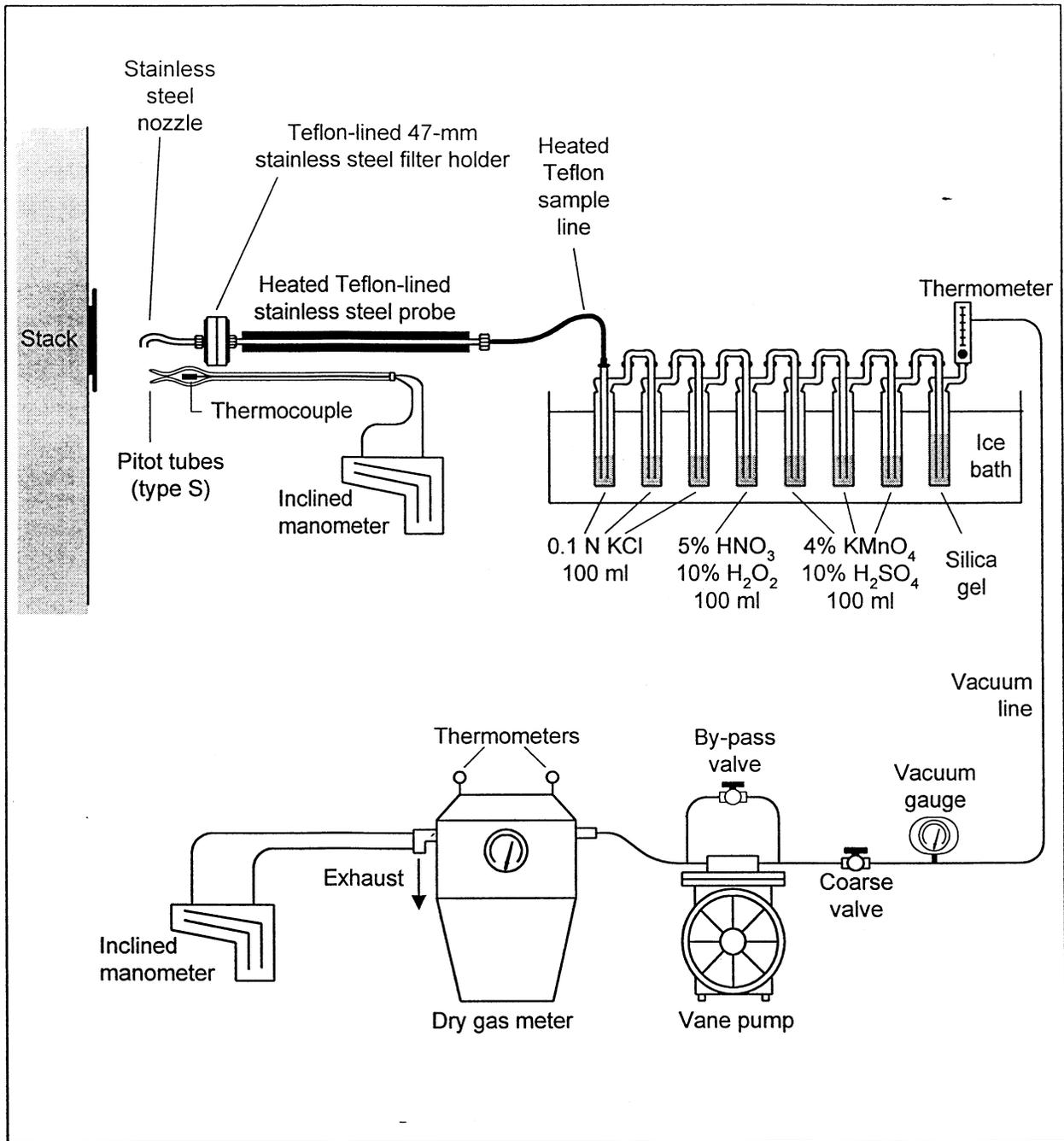


Figure 4-6 - Ontario Hydro Method Sampling Train (EPA Method 17 Configuration)

equipped with an appropriately sized Teflon-lined stainless steel nozzle connected by a Teflon-lined stainless steel nozzle union and ferrules.

From the nozzle, the sample gas passed through a 47-mm diameter Teflon-lined stainless steel filter holder containing a quartz filter. Since the filtering system is in-situ, the temperature of the filtering system was maintained at the effluent temperature, as required by the Ontario Hydro method. Following the filtering system, the sample gas passed through a heated Teflon liner and probe extension, maintained at a minimum of 248°F, as required by the Ontario Hydro Method. Sample gas subsequently passed through an impinger train consisting of eight glass impingers immersed in an ice bath, identical to the impinger train used at the stack outlet described in Section 4.1.5.1.

4.1.5.3 Sampling Train Pretest Preparation

All glassware components of the sampling train were precleaned before use. The following cleaning procedure was used:

- 1) Wash with hot water and detergent.
- 2) Rinse with tap water three times.
- 3) Rinse with deionized, distilled water three times.
- 4) Soak in a 10% nitric acid solution for four hours.
- 5) Rinse three times with deionized water.
- 6) Rinse with acetone, and allow to air dry.
- 7) Cover all openings with Teflon tape.

The filters were tared to a constant weight before use. The filters were oven-dried at 220°F for 2-3 hours, desiccated for at least two hours, and weighed to a constant weight (< 0.5 mg change between consecutive weighings), with weighings at intervals of at least six hours.

4.1.5.4 Sampling Train Operation

Sampling was conducted in accordance with EPA Method 5 procedures and specifications, including leak checking, isokinetic sampling rate, and stack traversing. The sampling nozzle was selected and the sampling train operated such that the final sample volume during each test run was between 35.3 and 88.3 dry standard cubic feet (1.0 and 2.5 dry standard cubic meters). At the exhaust stack, sampling was conducted for five minutes at each of the 24 traverse points, resulting in a 120-minute test per run, excluding the time required to change ports.

The Ontario Hydro Method required a minimum sampling time at each traverse point of five minutes. Thus, at the scrubber inlet, sampling was conducted for five minutes at each of the 25 traverse points, resulting in a 125-minute test per run, excluding the time required to change ports. Due to the high negative pressure at the scrubber inlet, the sampling pump remained on as the probe was inserted and removed from each sampling port to prevent loss of particulate matter. Extreme care was be taken to minimize this transition time and consequent effects on the sample.

4.1.5.5 Sample Recovery and Clean-up

At the completion of each test, the particulate filters were removed from the impinger trains and all open ends capped with Teflon Tape. The sample recovery procedures employed on site differed from those in the Site Specific Test Plan (SSTP). The SSTP

proposed that all sampling components be transferred to a remote location for recovery. The filters and impinger trains were transferred to a laboratory for recovery, but the nozzles and sampling probes were recovered at the sampling locations. Detailed sample recovery procedures are provided in Figure 4-7.

4.1.5.6 Field Blanks

As an additional quality control measure, two field blank were collected during the test program. The field blank consist of charging a complete impinger train, which were then taken to the stack and scrubber inlet test locations. The trains were left at the test locations for the duration of a test run, then recovered using the same procedures as for actual sample trains.

4.1.5.7 Reagent Blanks

One set of reagent blanks were collected from the stock of reagent used during the test program. The reagent blanks consisted of:

Container 7	50 ml of 0.1N HNO ₃
Container 8	50 ml of 1.0 N KCl
Container 9	50 ml of HNO ₃ - H ₂ O ₂ solution
Container 10	50 ml of H ₂ SO ₄ - KMnO ₄ solution
Container 11	100 ml of 10 w/v% hydroxylamine sulfate
Container 12A	1 unused blank Method 5 filter
Container 12B	1 unused blank Method 17 filter

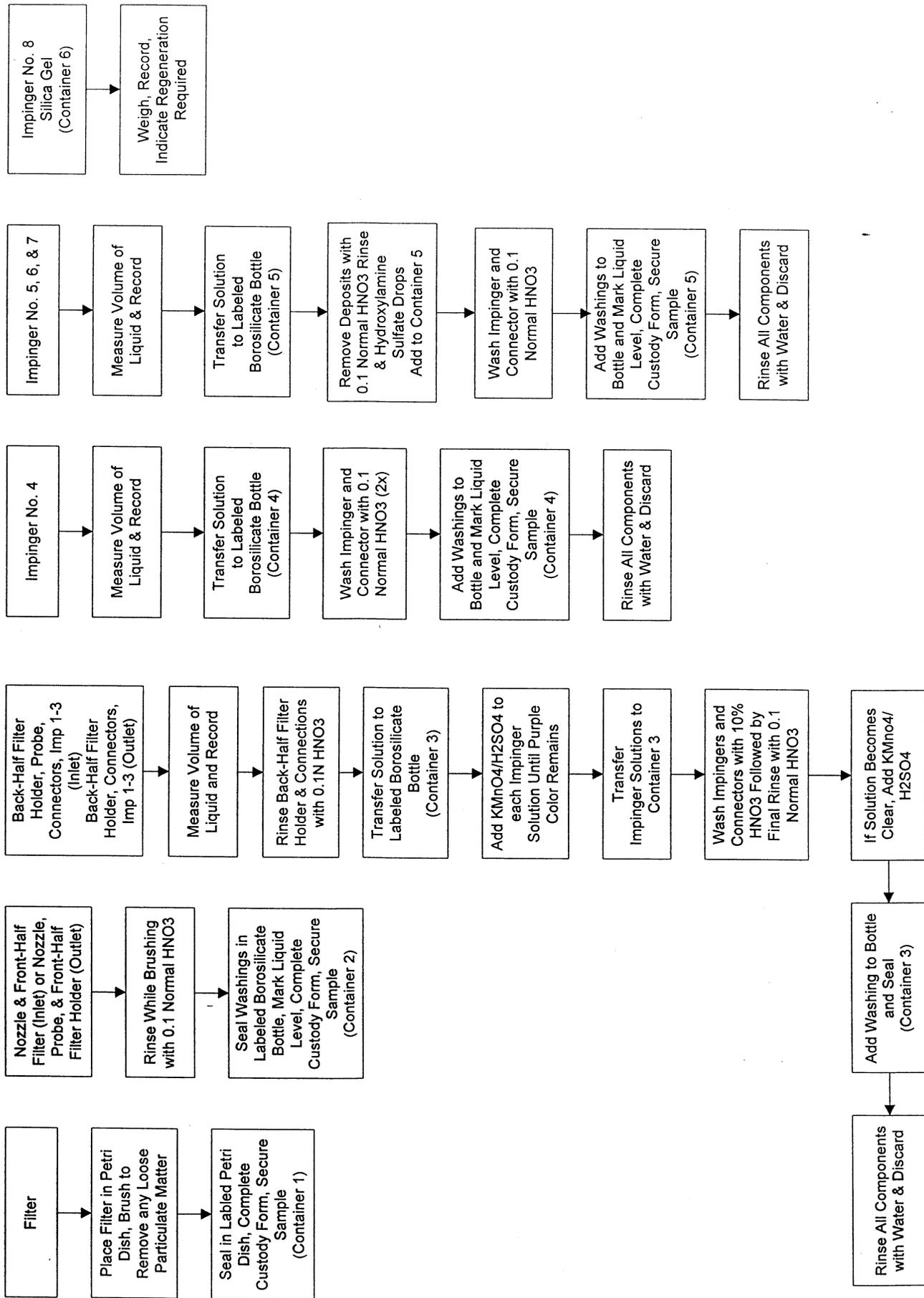


FIGURE 4-7
SAMPLE RECOVERY PROCEDURES FOR ONTARIO HYDRO METHOD SAMPLING TRAIN

4.2 Process Test Methods

4.2.1 Coal Sampling Procedures

One scoop coal sample was collected from each of the operating coal feeders every thirty minutes during each test run. All samples taken from separate locations during the same test run were composited on site and a representative one-liter sample was taken from the composite.

4.2.2 Procedures for Obtaining Process Data

Process data were taken using remote sensors and continuously logged into Virginia Power's continuous data recording system. At the conclusion of the sampling program, the data were given to ETS personnel in a Microsoft Excel spreadsheet format.

Detailed printouts of these data are provided in Appendix F.

4.3 Analytical Procedures

4.3.1 Molecular Weight Determination - EPA Method 3A

Oxygen and carbon dioxide concentrations of the Method 3 gas samples were measured instrumentally using continuous gas analyzers. A Teledyne model 320A chemical cell portable O₂ analyzer and a HORIBA model PIR-2000 NDIR CO₂ analyzer were used for the analyses. Each instrument conformed to the design specifications of EPA Method 3A. Before each series of analyses, each analyzer was zeroed using zero nitrogen, and spanned using a certified calibration gas with a concentration of 80-100% of the instrument span. After calibration, a mid-range gas (40-60% of the instrument

span) was introduced to each monitor. The mid range response error never exceeded two percent of the instrument span. Data for the O₂ and CO₂ analyses are included in Appendix D

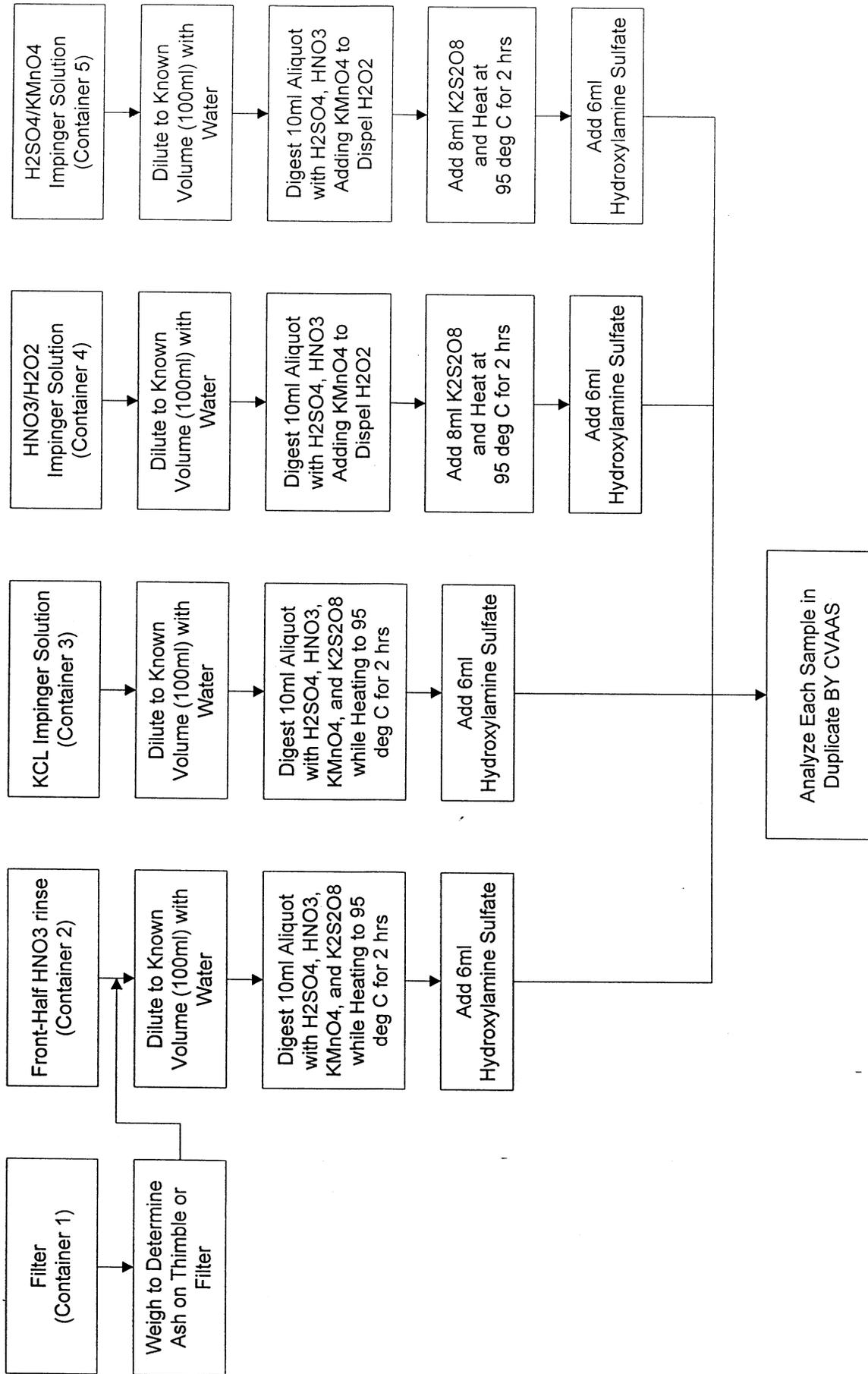
4.3.2 Moisture Content - EPA Method 4

Moisture contents were determined gravimetrically in accordance with Method 4 by measuring the volume and/or mass gain of each impinger in the pollutant sampling trains. Moisture analytical results are contained in Appendix D.

4.3.3 Speciated Mercury Analysis - Ontario Hydro Method

Figure 4-8 presents a schematic of the analytical procedures used during the analyses of the Ontario-Hydro sampling trains. These procedures were followed with one exception: visual inspection of the particulate samples from the scrubber inlet and Unit 2 stack revealed little appreciable particulate catch. From this inspection, the determination was made that significantly less than 0.5 grams of particulate was captured, and that post-test sample weights were not necessary. Thus, the entire sample filters were digested for analyses.

Analyses for particle-bound mercury was performed on the nozzle, probe and front-half filter housing rinses, and filter (stack), or on the filter and nozzle rinses (scrubber inlet). The contents and rinses of impingers 1 through 3 of the sampling train, as well as the rinses from the filter support, back filter housing, and any connecting glassware, were



NOTE: Blank samples (types 7, 8, 9, 10, 11, & 12) and blank train samples were analyzed the same as the corresponding source sample fraction.

FIGURE 4-8
ANALYTICAL PROCEDURE FOR ONTARIO
HYDRO METHOD SAMPLING TRAIN

analyzed for oxidized mercury. Elemental mercury was determined by the analysis of the contents and rinses of impingers 4 through 7.

4.3.4 Coal Sample Analyses

4.3.4.1 Preparation

The coal samples were prepared in accordance with ASTM Method D-2013. The samples were air dried, riffled and pulverized until 100% of the sample passed through a 60-mesh screen.

4.3.4.2 Coal Analyses for Chlorine

A portion of the prepared coal sample was weighed, then oxidized by combustion in a bomb calorimeter with a bicarbonate/carbonate solution. The resulting chlorides were captured in distillate water for analysis using ion chromatography (IC) according to the procedures of EPA Method 300.

4.3.4.3 Coal Analyses for Mercury

Following preparation, a portion of the coal sample was weighed. The sample was then 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 the procedures of EPA SW-846, Method 7471.

4.4.4.4 Coal Analysis for Gross Calorific Value

The calorific value of the prepared coal sample was determined by burning a weighed sample, in oxygen, in a calibrated bomb calorimeter under controlled conditions. The calorimeter was standardized by burning benzoic acid. The calorific value of the sample was computed from temperature observations made before, during, and after combustion, and making proper allowances for heat contributed by other processes, and for thermometer and thermochemical corrections.

4.4 Data Analysis

All calculations related to testing, including gas flow rates, temperatures, percent isokinetics, moisture contents, and pollutant emissions, are shown in Appendix B.

4.5 Equipment Calibration

Field equipment was calibrated in accordance with the requirements of the applicable EPA Methods, and with recommendations contained in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III* (EPA-600/4-77-027b, August 1977). Field equipment calibrations are include in Appendix E.

A