MONTANA-DAKOTA
UTILITIES CO.
A Division of MDU Resources Group, Inc.

400 North Fourth Street
Bismarck, ND 58501
(701) 222-7900

May 18, 2000

Mr. William Grimley/Ms. Lara Autry
Emission Measurement Center (MD-19)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

RE: Lewis & Clark Station Speciated Mercury Test Report

Dear Mr. Grimley/Ms. Autry:

Enclosed is the Speciated Mercury Emissions Testing Report for the Lewis & Clark Station Unit 1 conducted on April 11, 2000. I have included three copies, one being unbound as requested.

During 1999, Mostardi Platt acquired Braun Intertec testing services. Personnel responsible for sampling and reporting remained unchanged from the start of the project to completion.

If you have any questions pertaining to the report, please contact me at 701-222-7689.

Sincerely,

Rick Patzman

Rick Patzman
Senior Environmental Scientist

cc: Gary Gress, Andrea Stomberg\File, Office
Craig Herbert, Lewis & Clark Station

File: Air/Hazardous Air Pollutants/Mercury

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SPECIATED MERCURY EMISSIONS TESTING

Performed For
MONTANA-DAKOTA UTILITIES CO.

At The
Lewis and Clark Station
Unit B1
Wet Scrubber Inlet and Main Stack
Sidney, Montana

April 11, 2000

Mostardi Platt

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

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MOSTARDI PLATT PROJECT M001501
DATE SUBMITTED: MAY 16, 2000

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CERTIFICATION SHEET

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

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

MOSTARDI-PLATT ASSOCIATES, INC.

Bruce Randall
Regional Manager

Reviewed by:

Frank H. Jarke
Manager, Analytical and Quality Assurance

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1.0 INTRODUCTION

1.1 Summary of Test Program

The U.S. Environmental Protection Agency (EPA), 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 EPA to calculate the annual mercury emissions from each unit. This information will assist the EPA 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 emission measurements.

EPA selected the Montana-Dakota Utilities Co. (M-DU), Lewis and Clark Station (L&C) in Sidney, Montana to be one of seventy-eight coal-fired utility steam generating units to conduct emissions measurements. The test performed at L&C Unit B1 was the only test at this facility, and it was conducted on April 11, 2000. Simultaneous measurements were conducted at the inlet and outlet of the wet scrubber. 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:

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- Mostardi-Platt Project Manager - Bruce Randall (651) 686-0700
- M-DU L&C Plant Manager - Craig Herbert (406) 482-1614
- M-DU L&C Plant Contact/Process Monitor – George Gasper (406) 482-1614

2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

Unit B1 at the Lewis and Clark Station is a Combustion Engineering tangentially fired boiler rated at 600 million British Thermal Units per hour (MMBtu/hr). The boiler is capable of burning approximately 50 tons of lignite coal or 600,000 cubic feet of natural gas per hour at maximum capacity. As the flue gas exits the boiler, it passes through a multicyclone collector prior to a wet limestone scrubber. From the wet scrubber, flue gas exits through a 250-foot stack.

The boiler is capable of generating 425,000 pounds of steam per hour at 955°F and 1275 psig. Normal full load is between 46 and 56 megawatts (MW). During the test, Unit B1 was operated at maximum achievable normal full load condition firing coal without any supplemental gas fuel.

A process flow diagram is presented in Figure 2-1.

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Attachment #1 (Revised 12/6/99)

Lewis & Clark Station   Process Flow Diagram

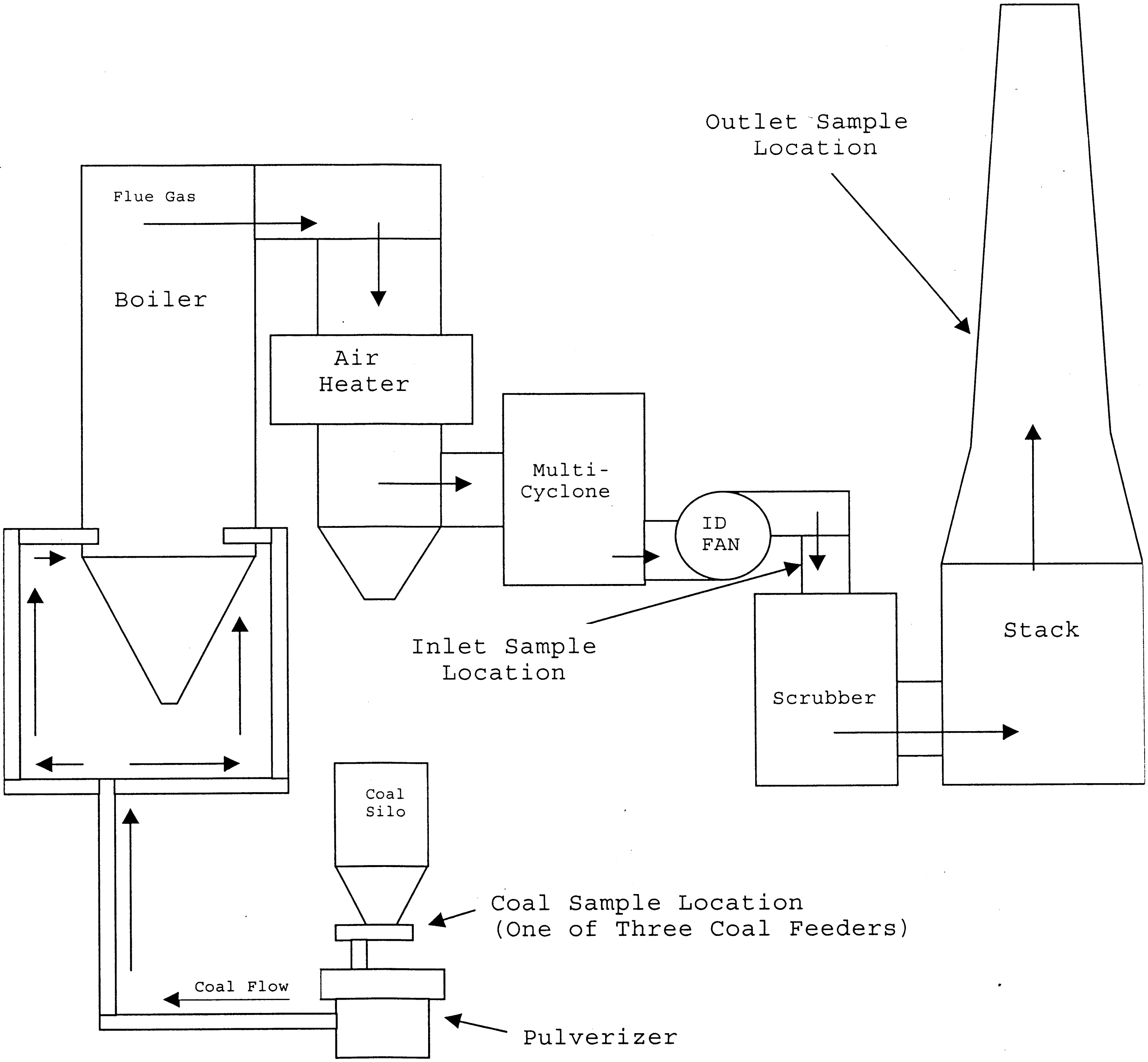

Figure 2-1: Schematic of the Boiler and Pollution Control Equipment

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2.2 Control Equipment Description

Particulate matter emissions from the boiler are controlled by a multicyclone and a Research Cottrell flooded disc wet scrubber. The multicyclone collector is capable of achieving 75 to 80% removal of large particles, and is in service when the boiler is in operation. The cyclone consists of four compartments. During normal operation, the two center compartments are in operation at low load. As the boiler increased load, the third and fourth compartments are placed in service as needed. The normal operating range of differential pressure across the multi-cyclone is 2-7"H_2O, with a set point of 2.5"H_2O.

The flooded disc wet scrubber consists of one cell, which is in operation whenever the boiler is on, and is capable of achieving 98% control efficiency. The scrubber disc position will vary between 2 and 17.5 inches to control the pressure drop across the disc at 12"H_2O. Normal operating condition for the scrubber differential pressure is 10 to 13"H_2O at full load.

2.3 Flue Gas Sampling Locations

Emissions sampling was conducted at: (1) the inlet to the wet scrubber, and (2) the main stack. Figures 2-2 and 2-3 are schematics of these sampling locations.

2.3.1 Wet Scrubber Inlet

As can be seen in Figure 2-2, the wet scrubber inlet location consists of a single duct. The duct is circular, ten feet six inches in diameter. The duct is equipped with four sample ports, consisting of four inch threaded pipe nipples (with caps), approximately one foot long. Gas temperature at this location was approximately 400°F. Duct static pressure was approximately 14 " H_2O. The direction of flue gas flow at this location is downward.

The sample ports were installed 2.4 duct diameters downstream of the nearest disturbance in flow, and 0.4 duct diameters upstream of the nearest disturbance in flow. Sampling was conducted at six traverse points in each of four ports (twenty-four total points). Sample duration was five minutes per traverse point, for a total sample time of one hundred and twenty (120) minutes. The traverse point locations utilized are presented below.

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Traverse Point Number	Distance From Inside Wall (inches)
6	44.9
5	31.5
4	22.3
3	14.9
2	8.4
1	2.6

The wet scrubber inlet location did not meet Method 1 criteria for distances upstream and downstream of the sample ports to the nearest disturbance. A preliminary traverse indicated an average flow angle of less than ten degrees from vertical. Thus, it is anticipated that cyclonic flow effects will be minimal and the inlet volumetric flow will be used in the emission rate calculations. This was verified by a comparison of the inlet, outlet and CEM volumetric flow.

2.3.2 Main Stack

See Figure 2-3. The diameter of the main stack at the sample location was 174 inches. The main stack was equipped with four three-inch sample ports, approximately four inches long. Gas temperature at this location was approximately 140°F, with a static pressure of approximately –0.5"H_2O.

Sampling was conducted at a total of twenty traverse points, five in each of the four ports. Sample duration was six minutes per traverse point, for a total sample duration of one hundred and twenty (120) minutes. Proposed traverse point locations are presented below.

Traverse Point Number	Distance From Inside Wall (inches)
5	59.5
4	39.3
3	25.4
2	14.3
1	4.5

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Figure 2-2: Wet Scrubber Inlet Location

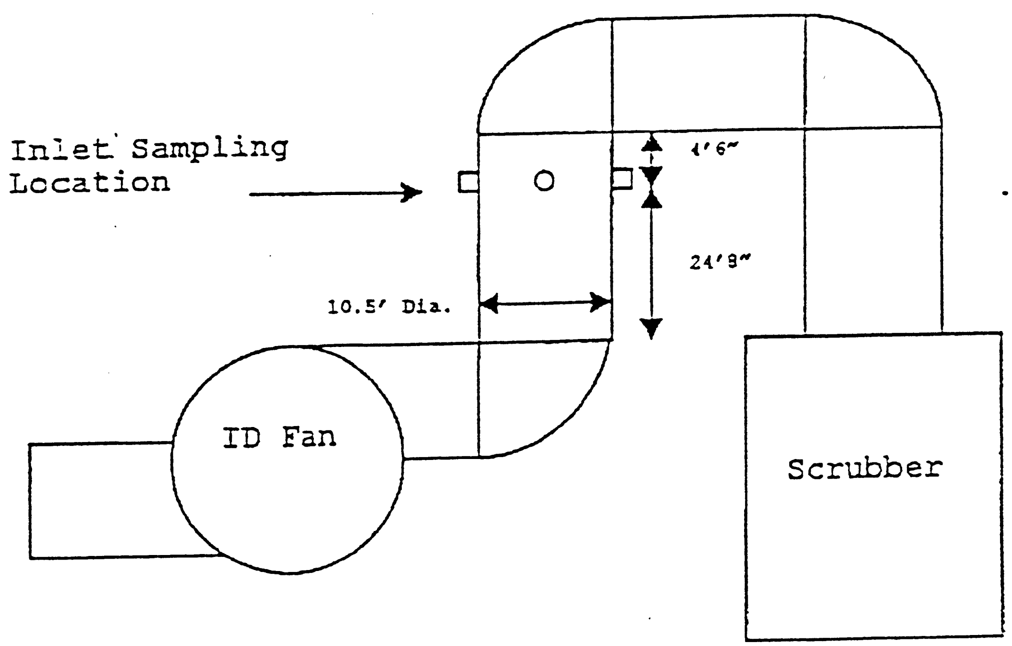

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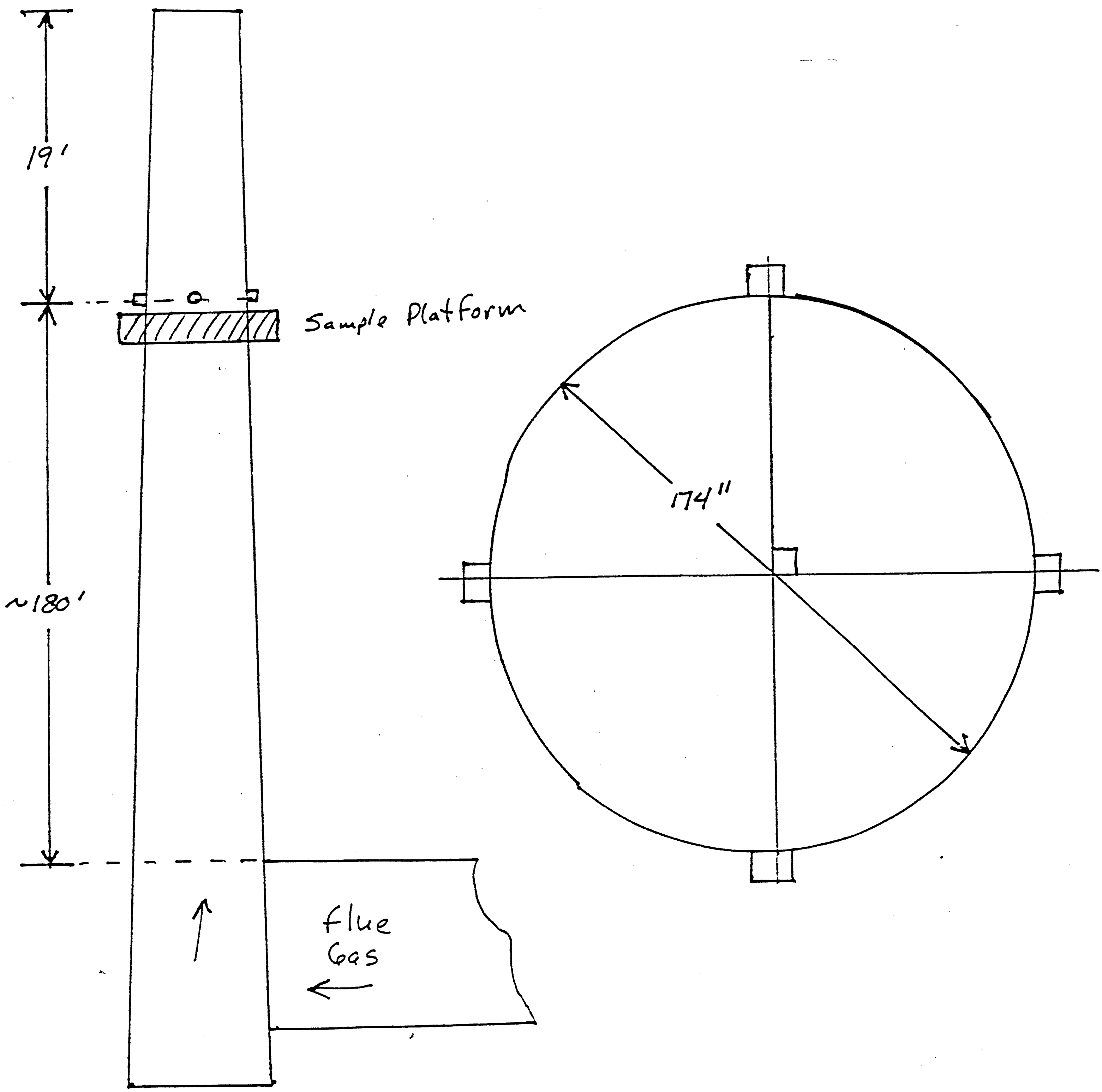
Figure 2-3: Main Stack Location



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2.4 Fuel Sampling Location

Fuel samples were collected using a simple grab sample technique. Samples were collected at approximately fifteen-minute intervals during each of the three test periods. Samples were collected from three locations located below the coal storage silos at the coal feeder to the pulverizer. The grab samples collected during each test period were composited into one sample for analysis. This was repeated during each of the three test periods. A total of three samples were analyzed for a proximate analysis including mercury and chlorine representing the coal combusted during the test.

Samples were collected at the coal feeder to the pulverizer. From the pulverizer, the coal is injected directly into the boiler. To assure that the coal samples taken represented coal burned during the test period; samples were collected at approximately 15, 30, 45, 60, 75 and 90 minutes into the test period.

The Lewis & Clark Station does not have a way to mechanically determine the quantity of coal burned during the testing periods. The quantity of coal burned during the test was determined as follows:

$$\text{Total Tons of Coal Burned} = \frac{\text{Total Heat Input determined by CEMS}}{\text{Btu/lb} \times 2000}$$

The Btu/lb was obtained from the proximate analysis of the composite sample taken during each test run.

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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 EPA Administrator in determining whether it is appropriate and necessary to regulate emissions of Hazardous Air Pollutants (HAPs) from electric utility steam generating units. The specific objectives, in order of priority were:

- Compare mass flow rates of mercury at the three sampling locations (fuel, inlet to and outlet of the wet scrubber)
- Monitor coal feed rate and control equipment operating parameters

Table 3-1 presents the sampling and analytical matrix and sampling log.

Table 3-1: Sampling Matrix

Run No.	Date	Sample Type	Test Method	Clock Time Sampling Time Inlet	Clock Time Sampling Time Outlet
1	4/11/00	Speciated Mercury	Ontario Hydro	08:39-11:43 120	08:39-11:34 120
2	4/11/00	Speciated Mercury	Ontario Hydro	12:48-15:25 120	12:48-15:21 120
3	4/11/00	Speciated Mercury	Ontario Hydro	16:00-18:32 120	15:58-18:26 120

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3.2 Field Test Changes and Problems

Inlet Sample Location. The sample percentage of isokinetic for the first sample run (87.1%) was slightly below the minimum recommended percentage of 90. This was likely caused by build-up of particulate matter on the filter. A smaller nozzle was used for the second and third sample runs, and no further problems were experienced.

Hydroxylamine Sulfate Solution. On July 9, 1999, Bruce Randall received a telephone call from the Energy and Environmental Research Center. The caller informed Mr. Randall that the recipe for this solution was to be revised such that equal amounts of Hydroxylamine Sulfate and Sodium Chloride were utilized. Mr. Randall verbally confirmed this change with Mr. Bill Grimley of EPA. This change was incorporated and utilized.

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 (gram/hr)	Oxidized Mercury (gram/hr)	Particle-Bound Mercury (gram/hr)	Total Mercury (gram/hr)
Fuel				
Run 1				2.92
Run 2				3.09
Run 3				3.77
Average				**3.26**
Wet Scrubber Inlet				
Run 1	2.22	3.13	0.22	5.57
Run 2	1.67	2.70	0.33	4.71
Run 3	2.02	1.24	0.28	3.55
Average	**1.97**	**2.36**	**0.28**	**4.61**
Main Stack				
Run 1	2.46	0.088	0.011	2.56
Run 2	2.40	0.059	0.001	2.46
Run 3	2.66	0.084	0.001	2.74
Average All Runs	**2.51**	**0.077**	**0.004**	**2.59**

3.3.2 Comparison of Volumetric Flow Rate

Volumetric flow rate is a critical factor in calculating mass flow rates. As can be seen in Table 3-3 on the following page, there was agreement between the volumetric flow rate

(standard basis) measured at the wet scrubber inlet, the main stack, and via the CEMS. The average inlet volumetric measured at the wet scrubber inlet was within 3.8% of that measured at the main stack; the flow measured via the CEMS was within 8.2% of that measured at the main stack.

Table 3-3: Comparison of Volumetric Flow Rate Data

	Inlet KACFM/KSCFM/KDSCFM	Stack KACFM/KSCFM/KDSCFM	CEMS KSCFM
Run 1	233.4/143.1/122.1	175.7/145.7/116.0	151.97
Run 2	242.9/147.9/126.5	167.6/139.1/110.0	152.93
Run 3	245.2/147.9/126.5	166.7/138.3/109.2	152.58
Average	240.5/146.3/125.0	170.0/141.0/111.7	152.49

3.3.3 Individual Run Results

A detailed summary of results for each sample run at the wet scrubber inlet and main stack 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 presented in Table 3-6.

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Table 3-4
UNIT 1B WET SCRUBBER INLET INDIVIDUAL RUN RESULTS

Parameter	Run 1	Run 2	Run 3	Average
Sample Date	04/11/00	04/11/00	04/11/00	
Clock Time	0839-1137	1248-1525	1600-1832	
Sample Time	120	120	120	120
Average Duct Temperature (°F)	383	388	397	389
Average Duct Velocity (ft/s)	44.9	46.8	47.2	46.3
Moisture Content (%vol)	14.6	14.5	14.5	14.5
CO_2 Content (%vol dry)	15.7	15.8	15.8	15.8
O_2 Content (%vol dry)	4.5	4.4	4.4	4.4
Fo	1.045	1.044	1.044	1.044
Wet Molecular Weight (g/g-mole)	28.83	28.86	28.86	28.85
Volume Flow Rate (ACFM)	233400	242900	245200	240500
Volume Flow Rate (SCFM)	143100	147900	147900	146300
Volume Flow Rate (DSCFM)	122100	126500	126500	125033
Coal Feed Rate (ton/hr)	48.0	44.8	50.6	47.8
Coal Hg Content (mg/kg, as received)	0.067	0.076	0.082	0.075
Coal Total Mercury (gram/hr)	2.92	3.09	3.77	3.26
Sample Volume (dscf)	60.824	47.727	48.795	52.449
Net Elemental Hg (µg)	18.4	10.5	13.0	14.0
Net Oxidized Hg (µg)	26.0	17.0	8.0	17.0
Net Particle-Bound Hg (µg)	1.8	2.1	1.8	1.9
Total Hg (µg)	46.20	29.62	22.80	32.87
Elemental Hg ER (gram/hr)	2.22	1.67	2.02	1.97
Oxidized Hg ER (gram/hr)	3.13	2.70	1.24	2.36
Particle-Bound Hg (gram/hr)	0.22	0.33	0.28	0.28
Total Hg (gram/hr)	5.57	4.71	3.55	4.61
Sample Percentage of Isokinetic (%)	87.1	102.2	104.5	97.9

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Table 3-5
UNIT 1B MAIN STACK INDIVIDUAL RUN RESULTS

Parameter	Run 1	Run 2	Run 3	Average
Sample Date	04/11/00	04/11/00	04/11/00	
Clock Time	0839-1134	1248-1521	1558-1826	
Sample Time	120	120	120	120
Average Duct Temperature (°F)	140	140	140	140
Average Duct Velocity (ft/s)	17.7	16.9	16.8	17.1
Moisture Content (%vol)	20.4	20.9	21.0	20.8
CO_2 Content (%vol dry)	15.4	15.6	15.6	15.5
O_2 Content (%vol dry)	4.8	4.7	4.7	4.7
Fo	1.045	1.038	1.038	1.040
Wet Molecular Weight (g/g-mole)	28.08	28.03	28.01	28.04
Volume Flow Rate (ACFM)	175700	167600	166700	170000
Volume Flow Rate (SCFM)	145700	139100	138300	141033
Volume Flow Rate (DSCFM)	116000	110000	109200	111733
Coal Feed Rate (ton/hr)	48.0	44.8	50.6	47.8
Coal Hg Content (mg/kg, as received)	0.067	0.076	0.082	0.075
Coal Total Mercury (gram/hr)	2.92	3.09	3.77	3.26
Sample Volume (dscf)	43.375	40.138	40.781	41.431
Net Elemental Hg (µg)	15.31	14.61	16.54	15.49
Net Oxidized Hg (µg)	0.55	0.36	0.52	0.48
Net Particle-Bound Hg (µg)	0.066	0.005	0.005	0.025
Total Hg (µg)	15.93	14.98	17.07	15.99
Elemental Hg ER (gram/hr)	2.46	2.40	2.66	2.51
Oxidized Hg ER (gram/hr)	0.088	0.059	0.084	0.077
Particle-Bound Hg (gram/hr)	0.011	0.001	0.001	0.004
Total Hg (gram/hr)	2.56	2.46	2.74	2.59
Sample Percentage of Isokinetic (%)	96.3	94.0	96.2	95.5

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Table 3-6
PROCESS OPERATING DATA

Parameter	Run 1	Run 2	Run 3	Average
Date	04/11/00	04/11/00	04/11/00	
Start-End Time	0839-1133	1248-1600	1558-1834	
Volume Flow Rate (KSCFH)	9118.13	9176.04	9155.08	9149.75
Stack SO2 (lb/hr)	354	346	342	347
Stack NOx (lb/MMBtu)	0.358	0.363	0.365	0.362
Scrubber ΔP ("H2O)	12.0	11.9	11.9	11.9
Slurry Density (SGU)	1.09	1.09	1.09	1.09
Slurry pH	5.00	5.00	5.02	5.01
Total Slurry Flow (gal/min)	3639	3644	3626	3636
Gross Load (MW)	47.55	47.39	47.15	47.36
Coal Feed Rate (ton/hr)	50.6	44.8	48.0	47.8
Heat Input - CO_2 based MMBtu	1828.274	1687.763	1634.275	1716.771

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4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Test Methods

4.1.1 Speciated Mercury Emissions

Speciated mercury emissions were determined via the draft "Standard Test Method for Elemental, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario-Hydro Method)", dated April 8, 1999. Any revisions to this test method issued after April 8, 1999 but before July 1, 1999 were incorporated. The change in formula for the Hydroxylamine Sulfate recovery solution described in Section 3.2.2 of this report was the only change from the procedures proposed in the Site Specific Test Plan for this project.

The out-of-stack filtration (Method 5) configuration was utilized at both the wet scrubber inlet and the main stack. Figure 4-1 is a schematic of the Ontario-Hydro sampling trains.

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

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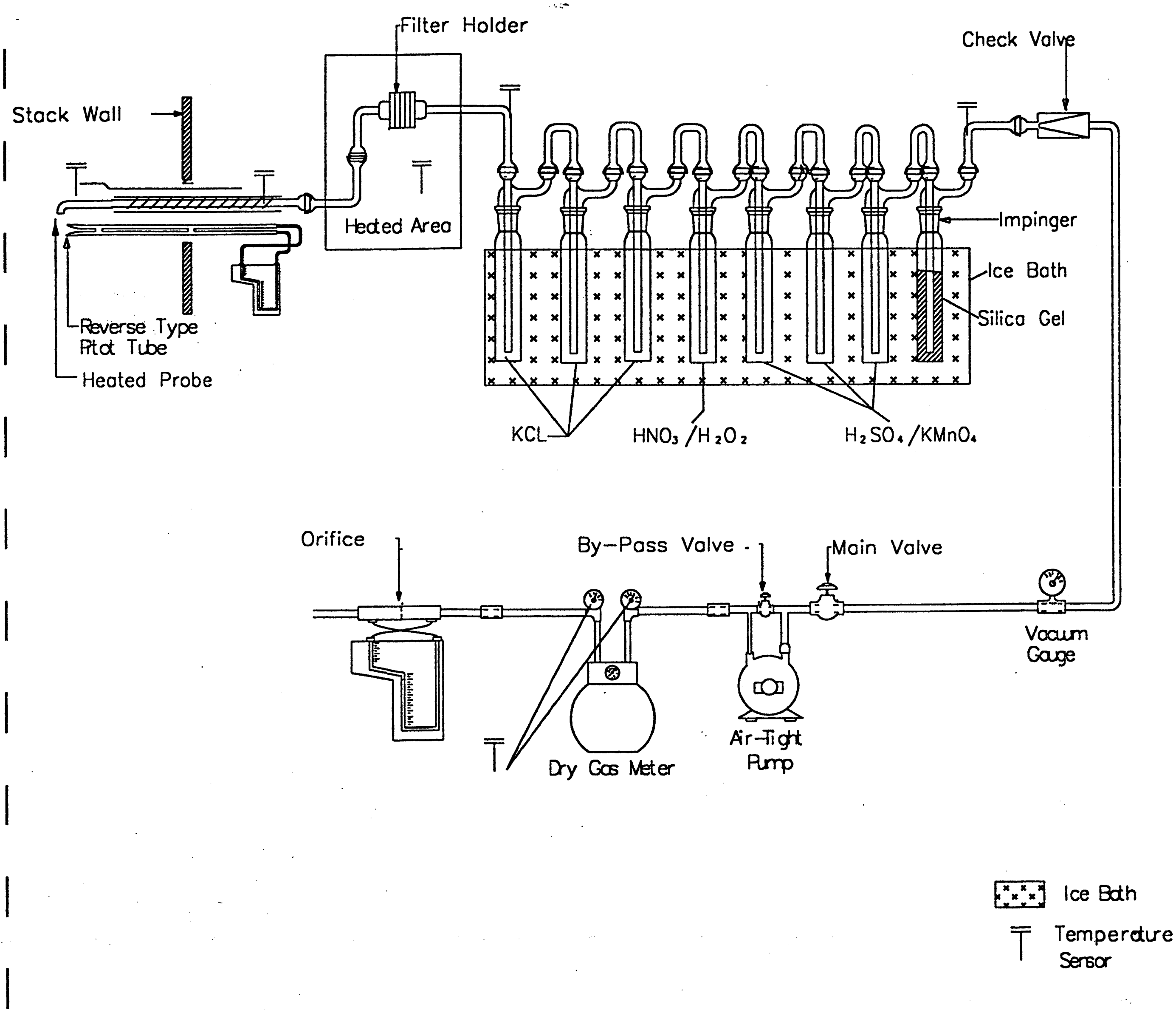
Speciated Mercury Sampling Train Equipped with Out-of-Stack Filter

Ontario Hydro Method



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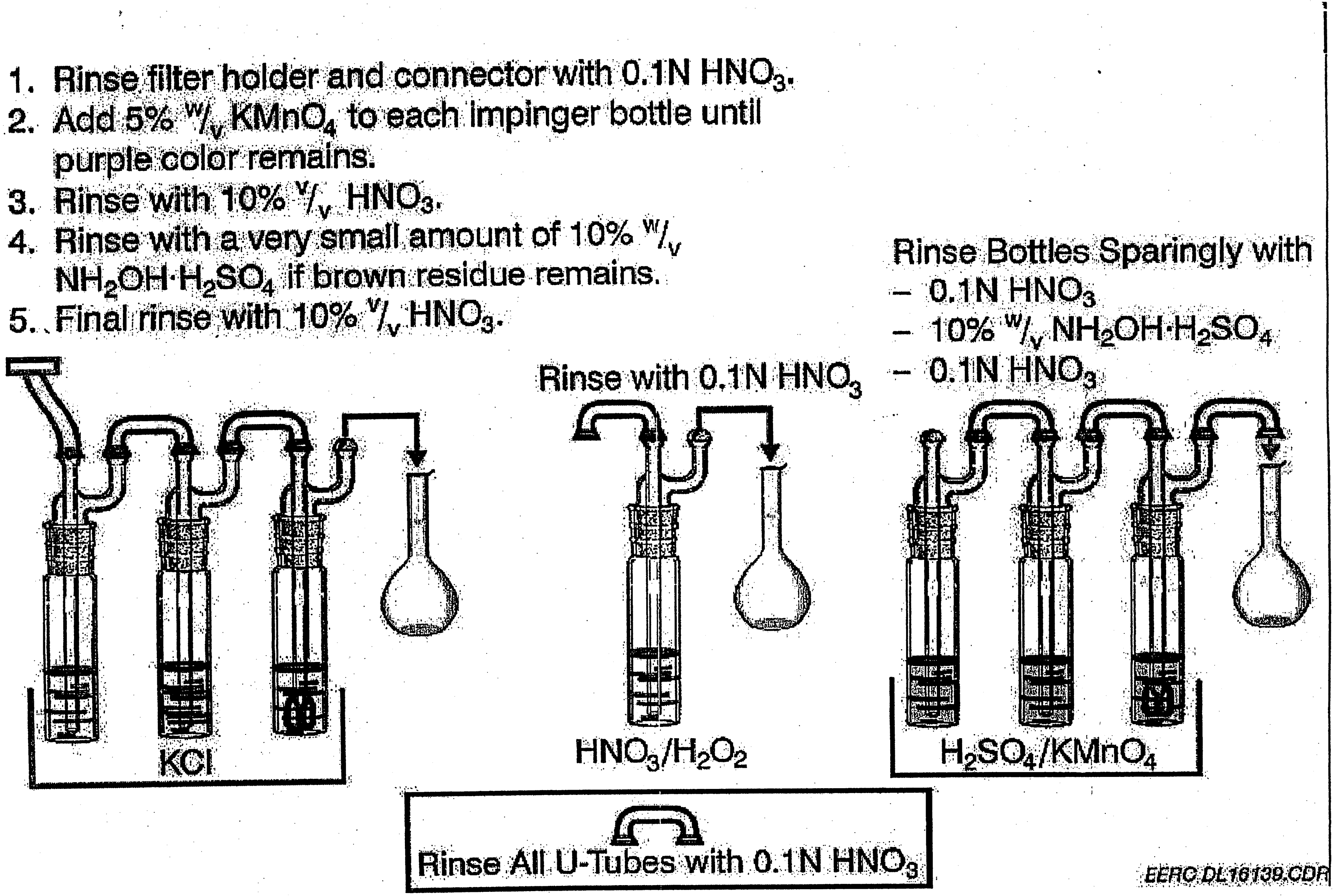

Figure 4- 2: Sample Recovery Scheme for Ontario-Hydro Method Samples

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 Method 7471A.

4.2 Procedures for Obtaining Process Data

Mr. George Gasper was responsible for obtaining process operating data. The process data presented in Table 3-6 was continuously monitored via the facility computerized control system and/or the Unit B1 CEMS. Process data was averaged over the course of each sample run. All instruments used to collect process data are routinely calibrated according to M-DU L&C procedures.

Coal feed rates were determined as described in Section 2.4.

5.0 INTERNAL QA/QC ACTIVITIES

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

5.1 QA/QC Problems

One QA/QC problem occurred during these tests. A detectable amount of Mercury was found in three blank train fractions:

- The acidified potassium permanganate portion of blank train from the wet scrubber inlet contained 1.0 micrograms of mercury. This corresponds to approximately 7.1% of the average amount of mercury found in the acidified potassium permanganate impingers from the sample runs.
- The acidified potassium permanganate portion of the blank train from the main stack contained 0.55 micrograms of mercury. This corresponds to approximately 3.6% of the average amount of mercury found in the acidified potassium permanganate impingers from the sample runs.
- The KCl portion of the blank train from the wet scrubber inlet contained 0.15 micrograms of mercury. This corresponds to approximately 0.9% of the average amount of mercury found in the KCl impingers from the sample runs.

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The cause of these issues is not known. However, since the amount of mercury found in the blank trains is relatively small compared to that found in the sample runs, no significant bias in results is expected.

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 is presented in Table 5-1.

Table 5-1: Reagent Blank Analysis

Container #	Sample Fraction	Contents	Mercury (µg)	Detection Limit (µg)
C7/C12	Front-half	0.1N HNO3/Filter	<0.010	0.010
C8	1 N KCl	1 N KCl	<0.030	0.030
C9	HNO_3/H_2O_2	HNO_3/H_2O_2	<0.050	0.010
C10	$KMnO_4/H_2SO_4$	$KMnO_4/H_2SO_4$	<0.030	0.030
C11	Hydroxylamine	Hydroxylamine	<0.090	0.010

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 04/12/00. The results of blank train analysis are presented in Table 5-2.

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Table 5-2: Blank Train Analysis

Container #	Sample Fraction	Contents	Mercury (µg)	Detection Limit (µg)
IB C01/C02	Front-half	Filter/front-half rinse	<0.010	0.010
SB C01/C02	Front-half	Filter/front-half rinse	<0.010	0.010
IB C03	KCl impingers	Impingers/rinse	0.15	0.030
SB C03	KCl impingers	Impingers/rinse	<0.010	0.030
IB C04	HNO_3-H_2O_2 impingers	Impingers/rinse	<0.25	0.010
SB C04	HNO_3-H_2O_2 impingers	Impingers/rinse	<0.25	0.010
IB C05	$KMnO_4$/H_2SO_4 impingers	Impingers/rinse	1.0	0.030
SB C05	$KMnO_4$/H_2SO_4 impingers	Impingers/rinse	0.55	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 Table 5-3.

Table 5-3: Field Meter Audit

Meter Box Number	Pre-Audit Value	Allowable Error	Calculated Yc	Acceptable
80573	0.998	0.9681<Yc<1.0279	0.9853	Yes
38758	1.002	0.9720<Yc<1.0320	0.9989	Yes

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