

May 30, 2000

Mr. William Grimley
Emissions Measurement Center
Interstate 40 and Page Road
4930 Old Page Road
Room Number E-108
Durham, North Carolina 27709



Dear Mr. Grimley,

This report describes a second mercury speciation stack test conducted at our Gibson Station Unit #3. As we had discussed with the Agency in our March 2000 correspondence, we had identified some variability in the results from our original test. We conducted that test in October 1999. In that time we had seen particulate mercury levels in one run notably higher than the other two. By re-testing we had hoped to improve our knowledge of mercury levels in the flue gas of this unit and explain some of this variability. What we have learned is that changes in at least one operating parameter can apparently cause significant changes in flue gas concentrations of mercury.

Our review of the March retest results indicate that the mercury measurements in the flue gas – for both the ESP inlet and at the stack – are about 3 times the mercury levels in the coal. Specifically, the flue gas measurements were in the order of 30 lb Hg/trillion Btu, compared with 11 lb Hg/trillion Btu as analyzed in the coal. Most of the mercury was oxidized, and represented nearly 90% of the total mercury. Obviously it is not possible to “create” mercury in a boiler. We have reviewed the data and plant operating conditions attempting to explain this discrepancy.

Coal analyses: During each test run, multiple samples were taken from each operating coal feeder. The samples were then composited prior to analysis. We have repeated the coal analyses using a 2nd laboratory, and the results are generally consistent. Reviewing Gibson coal data from part II of the Mercury ICR indicates that the plant burned 5 different coals. During both the October and March stack tests, the plant burned the same Cyprus Amax coal. The coal analyses for sulfur, heating value, ash and chlorine were also consistent between the two sets of tests, indicating that the coal source did not vary. The Cyprus Amax coal contained the highest mercury levels of the 5 coals that the Gibson plant burns. The mercury concentration in the Cyprus Amax coal ranged from 10-16 lb/trillion Btu. Even at the highest mercury levels, this would not adequately account for all the mercury in the flue gas. We concluded that coal analysis was representative of the mercury inputs to the boiler, and thus the inconsistencies were in the measurement of the flue gas.

Flue gas measurements and laboratory analysis. Because both the ESP inlet and stack results both show high levels of oxidized mercury, any sampling and/or analysis discrepancies or errors would have to be systematic. We have re-analyzed the impinger solutions and the results are relatively consistent. The reagent and field blanks, while showing notably high indications, are a small fraction (about 10%) of the total mercury recovered in the sample. These indications do however correspond to the oxidized mercury fraction, which is the most variable fraction. The reagent blank values were subtracted from the actual field samples values. Therefore the level of the oxidized mercury measured in the flue gas can not be attributed to the high reagent blank values. After an extensive review of the sampling and laboratory work, we believe that these results do represent the amount of mercury recovered by the sampling train.

Operating Conditions. Gibson unit #3 returned from a one-day outage 9 days before the March retest. During the 1st stack test run, the plant was required to blow soot and clean the air heaters. The station had not cleaned the air heaters for several days previously. Soot blowing is a periodic operation for coal fired boilers. It is not uncommon to operate the air heater soot blowers daily for approximately 45 minutes. At Gibson unit #3, high-pressure steam is blown directly into the heat transfer surfaces of the air heater. The accumulated ash and other materials are dislodged by the steam and are carried out of the air heater by the flue gas. These materials are later removed in the precipitators.

During the original test conducted in October of 1999, we identified one run with a higher level of particulate bound mercury. We suspected it was caused by air heater soot blowing. We decided to allow continued soot blowing throughout the 2nd and 3rd tests to maintain consistency between the 3 runs. It is possible that there could have been mercury in the air heater ash. The mercury in the ash could have volatilized and converted to oxidized mercury (since most of the mercury was oxidized and not particulate). Under this scenario, we would believe that the mercury evolution would be greatest at the beginning, i.e. the first tests. However, the results are quite consistent between the 3 runs.

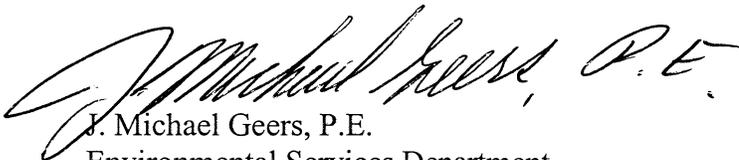
In addition, Gibson Unit#3 utilizes sulfur trioxide injection for flue gas conditioning. We investigated this system to determine if additional mercury entering the flue gas through this system could explain the higher mercury numbers. On a mass balance basis, we determined that because of the relatively low mass flow that is injected, the mercury concentration of the sulfur would have to be extremely high. Conversations with our vendor indicated this would be very unlikely.

Conclusions Because we have high confidence in the mercury in coal analyses, we are concerned that the flue gas mercury measurements are not representative of normal operations. Based on our current understanding, the leading explanation is that mercury in some form accumulates on the air heater surfaces. Then, the process of steam cleaning the air heaters removes that mercury and causes an increase in oxidized mercury. Because air heater soot blowing is an infrequent and intermittent operation, a test taken under these circumstances is not characteristic of normal operation. In addition, because we have noted high levels of mercury in the reagent and field blanks, we can not rule out the sampling and laboratory analysis as a possible explanation.

We conclude the results from the March re-tests are not be representative of normal plant emissions of mercury. In fact we feel they demonstrate that mercury emissions from a coal fired generating unit can fluctuate greatly over a short period of time. **We, therefore, recommend to the Agency that the original October test results be used to represent the Gibson power plants. We do not recommend that the Agency use the March retest results.** In addition, we feel this potential variability needs to be further investigated as part of EPA's process of understanding mercury emissions from coal fired power plants.

The attached report documents the March 2000 retest run. The October 1999 report is described in a separate report. If you would like to discuss these results, please call me at 513-287-3839 or Paul Chu at 650 855 2812. We would also be happy to review the results in a conference call if this would be more convenient.

Very truly your,


J. Michael Geers, P.E.
Environmental Services Department

JMG

Enclosures



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SOURCE EMISSIONS SURVEY
OF
GIBSON GENERATING STATION
UNIT NUMBER 3 PRECIPITATOR INLET DUCT
AND STACK
OWENSVILLE, INDIANA
FOR
CINERGY CORPORATION
AND
THE ELECTRIC POWER RESEARCH INSTITUTE

MARCH 2000

FILE NUMBER 99-95GIB3A

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1 INTRODUCTION

1.1 Summary of Test Program

METCO Environmental, Dallas, Texas, conducted a source emissions survey of the Gibson Generating Station, Unit Number 3, located in Owensville, Indiana, for Cinergy Corporation and the Electric Power Research Institute, on March 28, 29, and 30, 2000. The purpose of these tests was to meet the requirements of the EPA Mercury Information Collection Request (ICR). Speciated mercury concentrations at the Unit Number 3 Precipitator Inlet Duct, speciated mercury emissions at the Unit Number 3 Stack, and mercury and chlorine content of the fuel were determined. The sulfur, ash, and Btu content of the fuel were also determined.

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999; and ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286. The test was also conducted in accordance with the Sampling and Analytical Test Plan and the Quality Assurance Project Plan previously submitted to, and approved by the US EPA.

1.2 Key personnel

Mr. Bill Hefley of METCO Environmental was the onsite project manager. Mr. Shane Lee, Mr. Mike Bass, Mr. Scott Hart, Mr. Jason Brown, and Mr. Chris Breitling of METCO Environmental performed the testing.

Mr. J. Michael Geers of Cinergy Corporation was the utility representative. Mr. Jeffrey S. Snow of Cinergy Corporation performed process monitoring and sampling.

Mr. Paul Chu was the Electric Power Research Institute project manager.

Table 1-1 Test Program Organization

Organization	Individual	Responsibility	Phone Number
<i>Project Team</i>			
METCO	Bill Hefley	Project Manager	(972) 931-7127
<i>Utility</i>			
Cinergy Corp.	J. Michael Geers	Utility Representative	(513) 287-3839
Cinergy Corp.	Jeffrey S. Snow	Process Monitoring & Sampling	(812) 386-4202
<i>QA/QC</i>			
EPRI	Paul Chu	Project Manager	(650) 855-2812

2 SOURCE AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

Gibson Unit Number 3 is a Foster Wheeler opposed wall fired, supercritical, once through, balanced draft unit. The boiler is designed to operate at 4,588,000 pounds of steam per hour at 1,005 °F and 3,850 psig. Steam is supplied to a GE turbine-generator. The design gross capacity of the unit is 676 megawatts.

Gibson Generating Station receives Coal from train and truck deliveries. Coal is also stored on-site to provide a reliable supply during delivery disruptions. Coal is conveyed via conveyor belts to a coal storage bunker inside the plant. During the conveyance to the bunker, the coal is sampled by a mechanical sampling system. From the bunkers, the coal is fed into the pulverizers by variable speed belt feeders that control coal flow rate. The pulverizers crush the coal the fineness necessary for combustion in the boiler.

Combustion air is drawn from the atmosphere by forced draft fans. At the pulverizers, a portion of the combustion air is used to transport the finely crushed coal to the burners in the boiler. The remainder of the air is introduced directly at the boiler. The heat released during combustion is used to create steam that flows to a turbine-generator to produce electricity.

After combustion, the gasses generated (flue gas) are drawn from the boiler by induced draft fans. The combination of forced and induced draft fans is balanced to produce a neutral gas pressure in the boiler. As the flue gas exits the boiler, an air heater removes a portion of the waste heat. The air heater transfers the captured waste heat to the incoming combustion air.

2.2 Control Equipment Description

Flue gas flows into the electrostatic precipitators to remove particulate matter. The electrostatic precipitator (ESP) electrically charges the ash particles in the flue gas to collect and remove them. The unit is comprised of a series of parallel vertical plates through which the flue gas passes. Centered between the plates are charging electrodes, which provide the electric field. As flue gas passes through the electric field, the particulate material takes on a negative charge. The ash particles are then attracted to the grounded collection plates. The particles form a layer of ash on the collection plates. Periodically the collection plates are mechanically rapped causing the accumulated ash to fall into collection hoppers below. The collected ash is then evacuated from the hopper by the fly ash transport system.

2.3 Flue Gas and Process Sampling Locations

2.3.1 *Inlet Sampling Locations*

The sampling location on the Unit Number 3 Precipitator Inlet Duct is approximately 83 feet above the ground. The sampling location is located 24 feet 11 inches (1.88 equivalent duct diameters) downstream from a bend in the duct and 21 feet 7 inches (1.63 equivalent duct diameters) upstream from a bend in the duct.

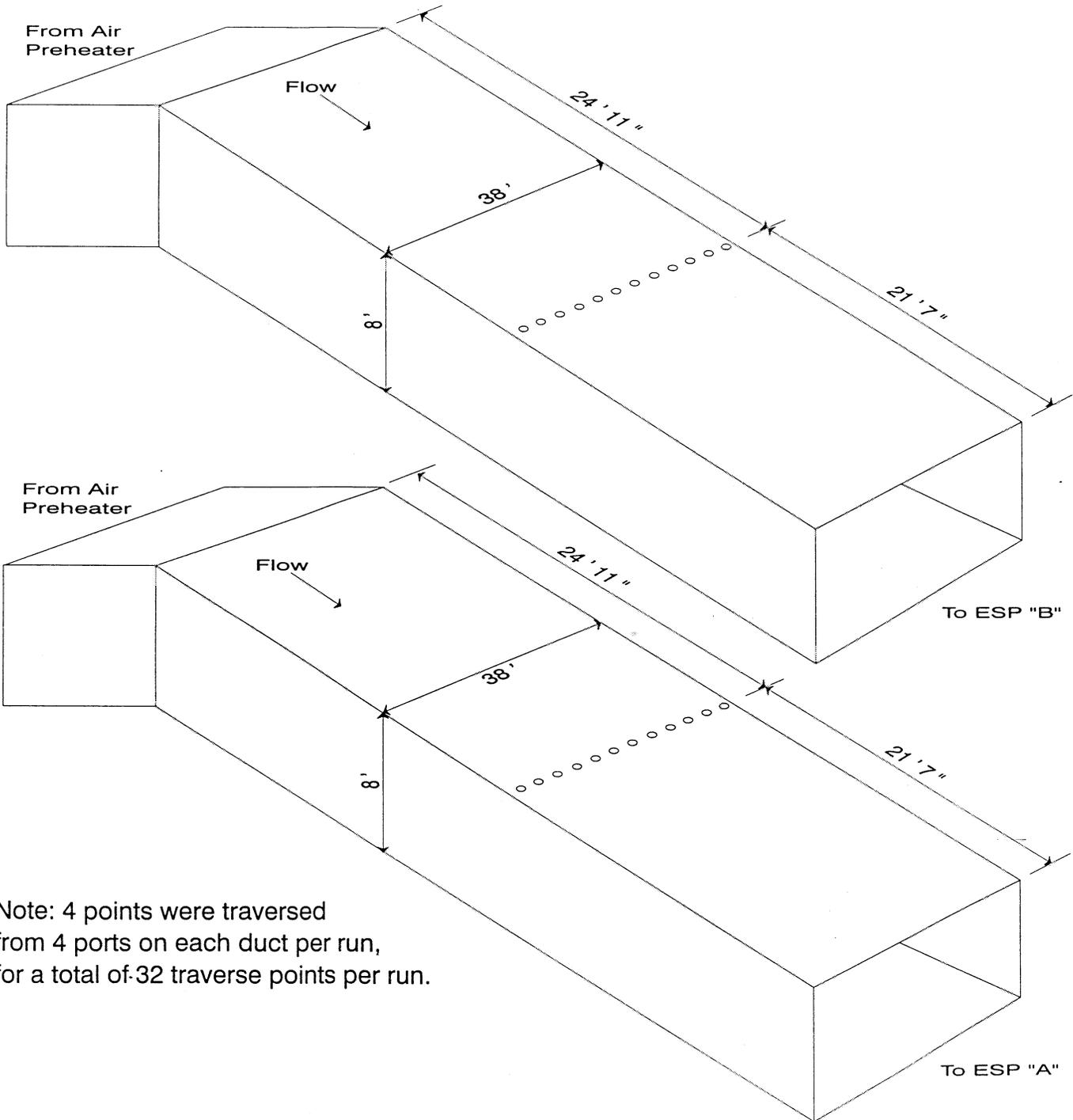
2.3.2 *Stack Sampling Locations*

The sampling location on the Unit Number 3 Stack is 252 feet 6 ½ inches above the ground. The sampling location is located 155 feet 8 inches (4.88 stack diameters) downstream from the inlet to the stack and 252 feet 5 inches (7.91 stack diameters) upstream from the outlet to the stack.

2.3.3 Coal Sampling Location

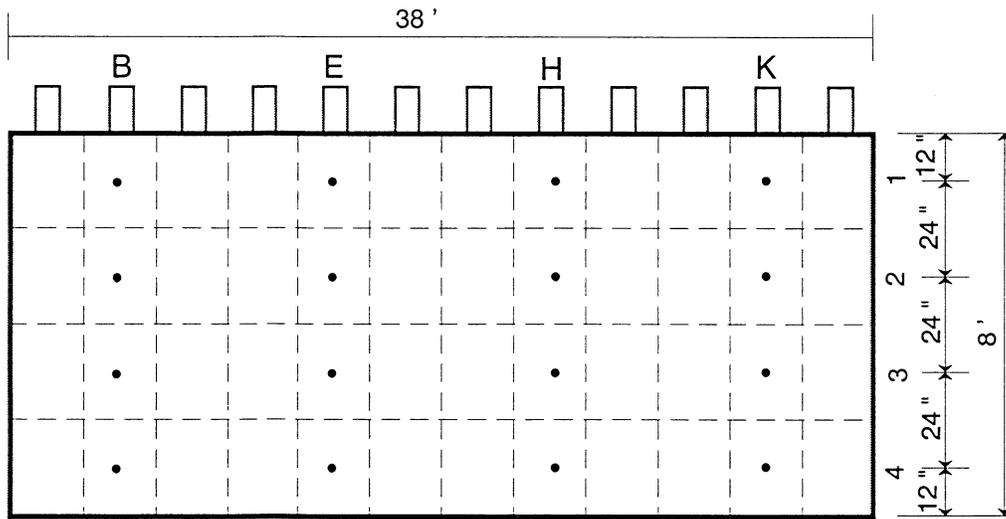
The coal sampling locations are located at the coal feeders and immediately downstream of the coal bunkers (B).

Figure 2-1
Description of sampling locations at Gibson Unit Number 3 Precipitator Inlet Duct

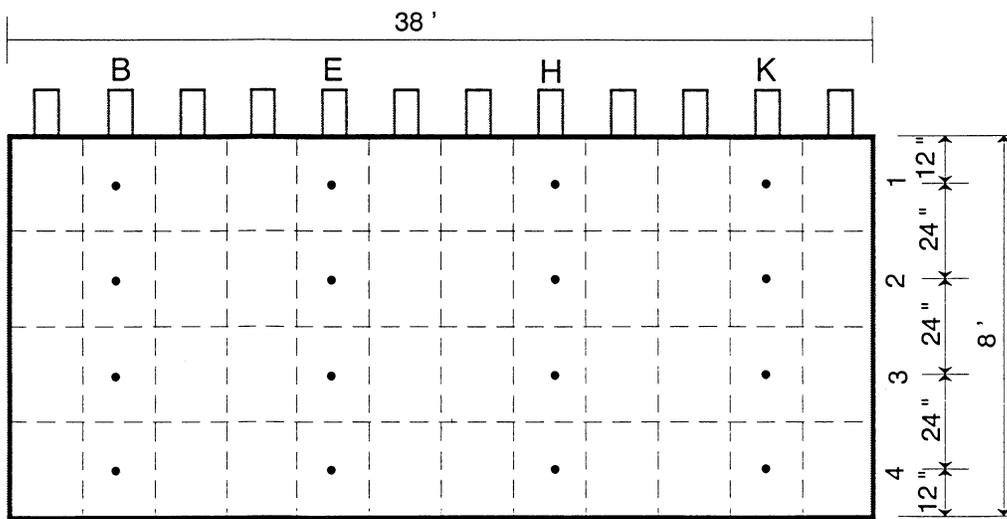


Note: 4 points were traversed from 4 ports on each duct per run, for a total of 32 traverse points per run.

Figure 2-2
Description of sampling points at Gibson Unit Number 3 Precipitator Inlet Duct



Inlet Duct B



Inlet Duct A

Figure 2-3
Description of sampling locations at Gibson Unit Number 3 Stack

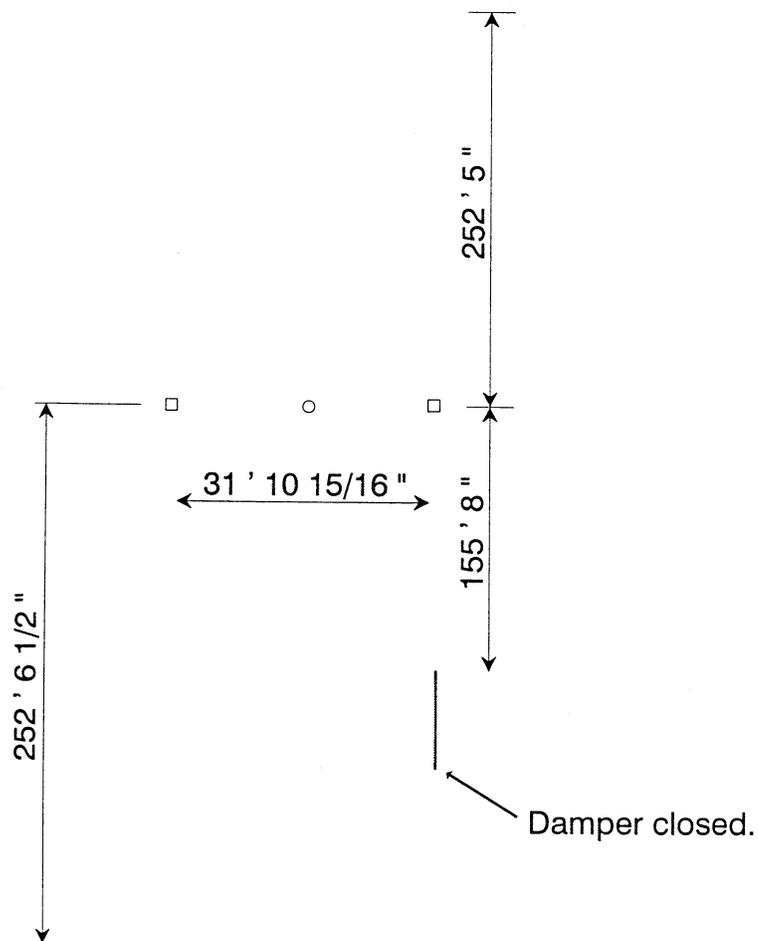
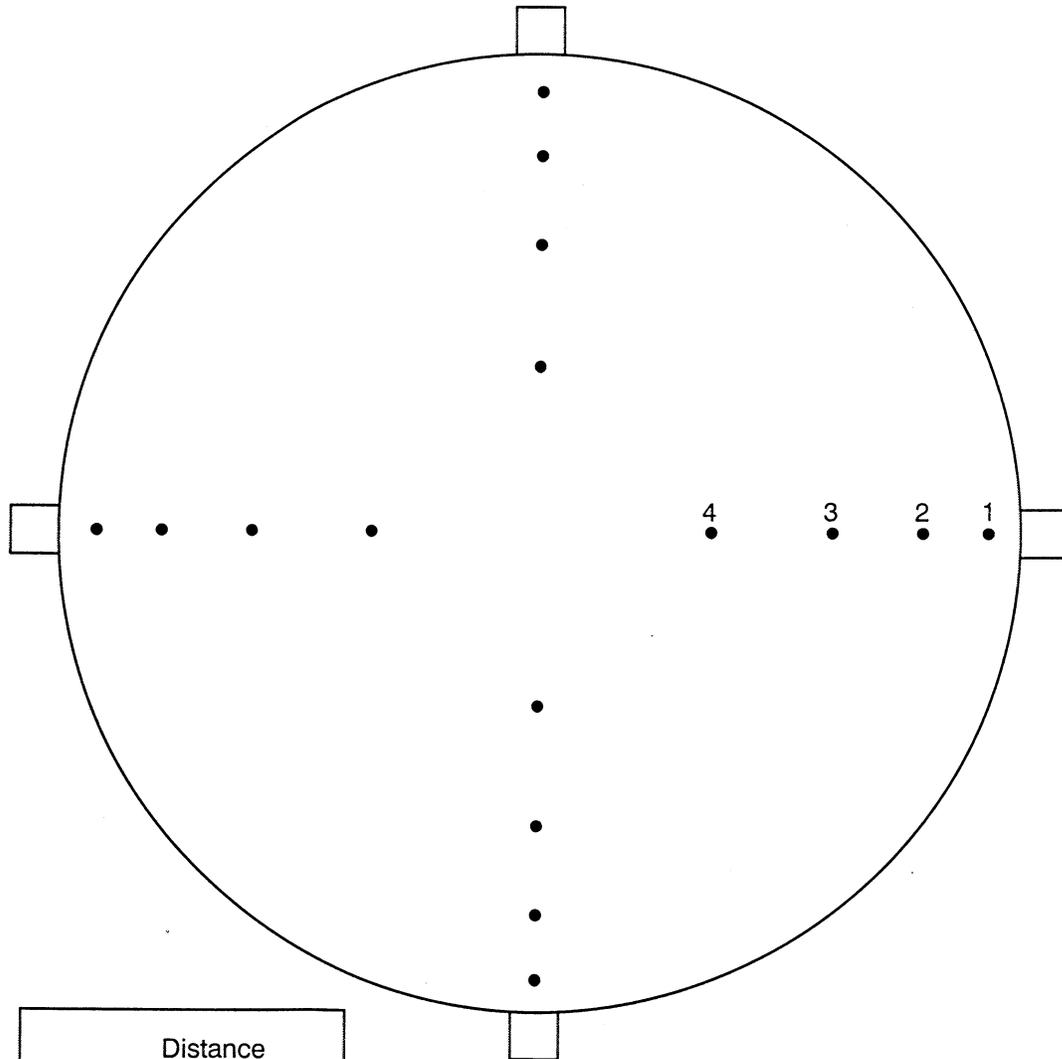


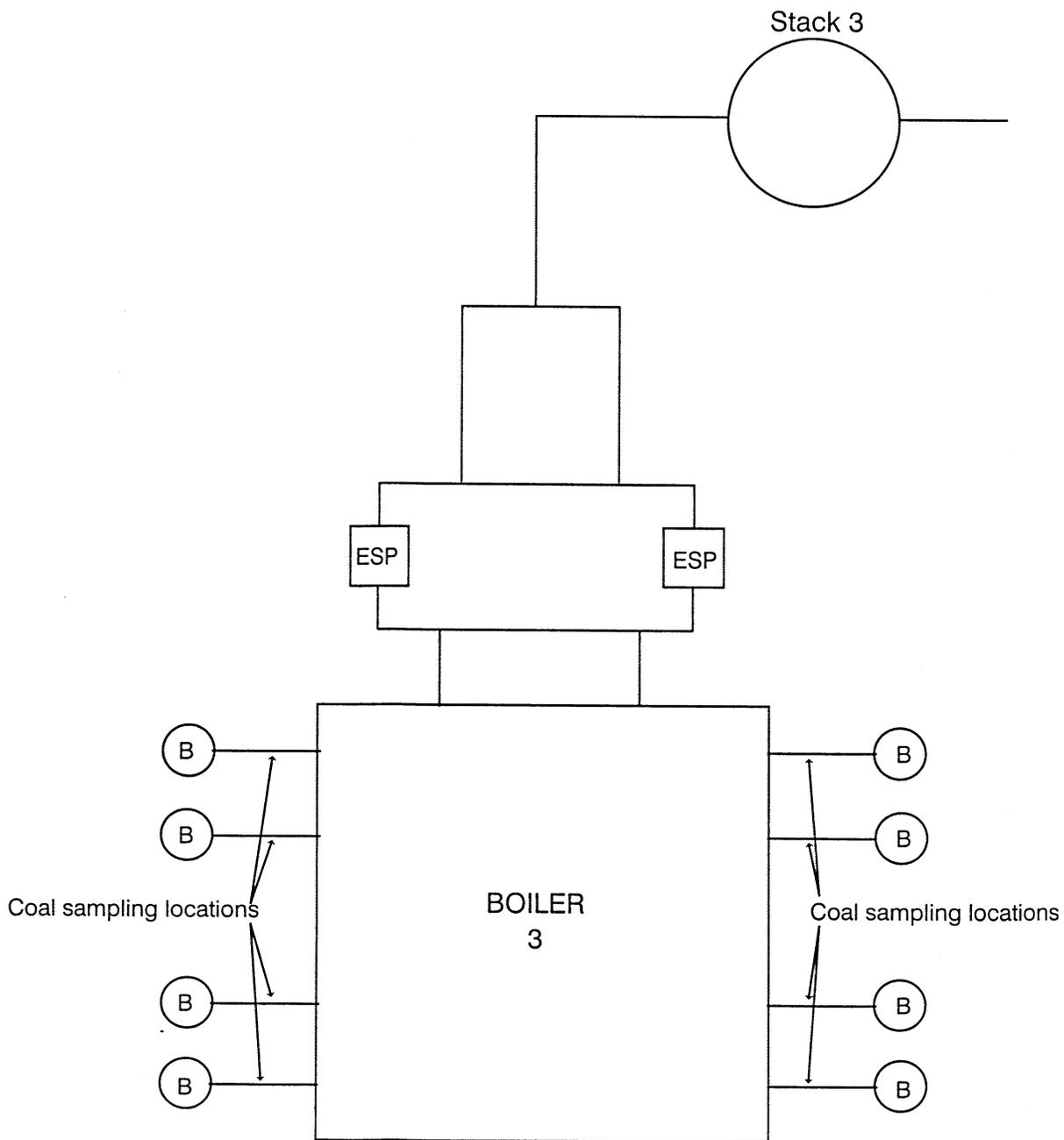
Figure 2-4
Description of sampling points at Gibson Unit Number 3 Stack



<u>Point*</u>	<u>Distance from Wall</u>
1	12 1/4 "
2	40 3/16 "
3	74 5/16 "
4	123 11/16 "

*Calculated as one-half of an eight point traverse.

Figure 2-5
Description of coal sampling locations at Gibson Unit Number 3



3 SUMMARY AND DISCUSSION OF RESULTS

3.1 Objectives and Test Matrix

3.1.1 *Objective*

The objective of the tests was to collect the information and measurements required by the EPA Mercury ICR. Specific objectives listed in order of priority are:

1. Quantify speciated mercury emissions at the stack.
2. Quantify speciated mercury concentrations in the flue gas at the inlet.
3. Quantify fuel mercury and chlorine content during the stack and inlet tests.
4. Provide the above information for use in developing boiler, fuel, and specific control device mercury emission factors.

3.1.2 *Test Matrix*

The test matrix is presented in Table 1. The table includes a list of test methods to be used. In addition to speciated mercury, the flue gas measurements include moisture, flue gas flow rates, carbon dioxide, and oxygen.

**Table 3-1
Test Matrix for Mercury ICR Tests at Gibson Unit Number 3**

Sampling Location	No. of Runs	Species Measured	Sampling Method	Sample Run Time	Analytical Method	Analytical Laboratory
Stack	3	Speciated Hg	Ontario Hydro	160 min	Ontario Hydro	TestAmerica
Stack	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Stack	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Stack	3	O ₂ & CO ₂	EPA 3B	Concurrent	Orsat	METCO
Inlet	3	Speciated Hg	Ontario Hydro	160 min	Ontario Hydro	TestAmerica
Inlet	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
Inlet	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
Inlet	3	O ₂ & CO ₂	EPA 3B	Concurrent	Orsat	METCO
Coal Feeders	3	Hg, Cl, Sulfur, Ash, and Btu/lb in coal	ASTM D2234	1 grab sample every 30-minutes per feeder per run	ASTM D6414-99 (Hg), ASTM E776/300.0 (Cl), ASTM D-4239 (S), ASTM D-3174 (Ash), and ASTM D-3286 (Btu/lb)	TestAmerica and Philip Services

3.2 Field Test Changes and Problems

A fourteen foot probe was implemented after previous attempts to reach the required sample points with a twenty foot probe. The weight of the twenty foot probe caused significant deflection. The fourteen foot probe eliminated the problem with deflection and the need for a probe extension to reach all of the sample points. Sixteen traverse points were sampled at the stack sampling location.

Run Number 1 was aborted due to reference method sampling equipment problems.

3.3 Handling of Non-Detects

This section addresses how data will be handled in cases where no mercury is detected in an analytical fraction. It should be noted that the analytical method specified in the Ontario Hydro Method has a very low detection limit, which is expected to be well below flue gas levels for most cases if the laboratory uses normal care and state of the art analytical equipment. However, there were cases where certain fractions of a test did not show detectable mercury levels. This section addresses how non-detects were handled in calculating and reporting mercury levels.

3.3.1 *A single analytical fraction representing a subset of a mercury species is not detected.*

When more than one sample component is analyzed to determine a mercury species (such as analyzing the probe rinse and filter catch separately to determine total particulate mercury) and one fraction is not detected, it will be counted as zero. Total mercury for that species will be the sum of the detected values of the remaining fraction(s). For example, if the probe rinse had ND < 0.05 µg and the filter had 1.5 µg, total particulate mercury would be reported as 1.5 micrograms.

3.3.2 All fractions representing a mercury species are not detected.

If all fractions used to determine a mercury species are not detected, the total mercury for that species will be reported as not detected, at the sum of the detection limits of the individual species.

For example, if the probe rinses were not detected at 0.003 μg and the filter catch were not detected at 0.004 μg , the reported particulate mercury would be reported as ND < 0.007 μg . This is expected to represent a small fraction (<1%) of the total mercury, even under worse case scenario of 1 $\mu\text{g}/\text{Nm}^3$.

3.3.3 No mercury is detected for a species on all three test runs.

When all three test runs show no detectable levels of mercury for a mercury species, that mercury species will be reported as not detected at less than the average detection limit. For example, if three results for elemental mercury are ND < 0.10, ND < 0.13, and ND < 0.10, the results would be reported as ND < 0.13 (the highest of the three detection levels).

In calculating total mercury, a value of zero will be used for that species. For example, if particulate mercury were ND < 0.11 μg , oxidized mercury were 2.0 μg , and elemental mercury were 3.0 μg , total mercury would be reported as 5.0 μg .

In calculating the percentage of mercury in the other two species, a value of zero will be used. For the example listed in the preceding paragraph, the results would be reported as 0% particulate mercury, 40% oxidized mercury, and 60% elemental mercury.

3.3.4 *Mercury is detected on one or two of three runs.*

If mercury is detected on one or two of three runs, average mercury will be calculated as the average of the detected value(s) and half of the detection limits for the non-detect(s).

Example 1: The results for three runs are 0.20, 0.20, and ND < 0.10. The reported value would be calculated as the average of 0.20, 0.20, and 0.05, which is 0.15 μg .

Example 2: The results for three runs are 0.14, ND < 0.1, and ND < 0.1. The average of 0.14, 0.05, and 0.05 is calculated to be 0.08. Since this is below the detection limit of 0.1, the reported value is ND < 0.1.

3.4 Summary of Results

The results of the tests performed at Gibson Unit Number 3 are listed in the following tables.

Table 3-2

Gibson Unit Number 3 Source Emissions Results

Run Number	2	3	4
Test Date	03/29/00	03/29/00	03/29/00
Test Time	1015-1312	1345-1642	1710-2052
Inlet Gas Properties			
Flow Rate – ACFM	2,487,043	2,493,355	2,504,050
Flow Rate – DSCFM*	1,497,668	1,486,340	1,501,576
% Water Vapor - % Vol.	7.21	7.92	7.48
CO ₂ - %	13.4	13.4	13.4
O ₂ - %	6.0	6.2	6.2
% Excess Air @ Sampling Point	39	41	41
Temperature - °F	313	314	311
Pressure – “Hg	28.32	28.29	28.21
Percent Isokinetic	93.1	100.3	100.3
Volume Dry Gas Sampled – DSCF*	62.478	66.812	67.453
Stack Gas Properties			
Flow Rate – ACFM	2,980,247	2,977,256	2,995,056
Flow Rate – DSCFM*	1,880,553	1,855,424	1,877,564
% Water Vapor - % Vol.	6.30	7.11	5.90
CO ₂ - %	10.6	10.8	10.5
O ₂ - %	9.2	8.8	9.1
% Excess Air @ Sampling Point	76	70	75
Temperature - °F	309	310	314
Pressure – “Hg	29.24	29.17	29.11
Percent Isokinetic	104.1	103.0	100.6
Volume Dry Gas Sampled – DSCF*	64.405	62.920	62.176

* 29.92 “Hg, 68 °F (760 mm Hg, 20 °C)

Note: Run Number 1 was aborted due to reference method sampling equipment problems.

**Table 3-3
Gibson Unit Number 3 Mercury Removal Efficiency**

Run Number	2	3	4	Average
Test Date	03/29/00	03/29/00	03/29/00	
Test Time	1015-1312	1345-1642	1710-2052	
Total mercury				
Inlet - lb/10 ¹² Btu	27.16	30.15	34.18	30.50
Stack - lb/10 ¹² Btu	28.29	27.17	33.66	29.71
Removal efficiency - %	-----	9.9	1.5	2.6
Particulate mercury				
Inlet - lb/10 ¹² Btu	1.38	0.89	1.25	1.17
Stack - lb/10 ¹² Btu	3.59E-3	4.74E-3	6.76E-3	5.03E-3
Removal efficiency - %	99.7	99.5	99.5	99.6
Oxidized mercury				
Inlet - lb/10 ¹² Btu	22.66	27.17	31.73	27.19
Stack - lb/10 ¹² Btu	22.91	23.03	30.65	25.53
Removal efficiency - %	-----	15.2	3.4	6.1
Elemental mercury				
Inlet - lb/10 ¹² Btu	3.14	2.09	1.18	2.14
Stack - lb/10 ¹² Btu	5.37	4.15	2.99	4.17
Removal efficiency - %	-----	-----	-----	-----

**Table 3-4
Gibson Unit Number 3 Mercury Speciation Results**

Run Number	2	3	4	Average
Test Date	03/29/00	03/29/00	03/29/00	
Test Time	1015-1312	1345-1642	1710-2052	
Inlet Mercury Speciation				
Particulate mercury – µg	2.86	1.95	2.76	-----
µg/dscm	1.62	1.03	1.44	1.36
lb/10 ¹² Btu	1.38	0.89	1.25	1.17
% of total Hg	5.1	3.0	3.7	3.9
Oxidized mercury – µg	46.8	59.2	69.8	-----
µg/dscm	26.45	31.29	36.54	31.43
lb/10 ¹² Btu	22.66	27.17	31.73	27.19
% of total Hg	83.4	90.1	92.8	88.8
Elemental mercury - µg	6.48	4.55	2.59	-----
µg/dscm	3.66	2.40	1.36	2.47
lb/10 ¹² Btu	3.14	2.09	1.18	2.14
% of total Hg	11.6	6.9	3.5	7.3
Total mercury – µg	56.1	65.7	75.2	-----
µg/dscm	31.71	34.73	39.37	35.27
lb/10 ¹² Btu	27.16	30.15	34.18	30.50
Stack Mercury Speciation				
Particulate mercury – µg	0.006	0.008	0.011	-----
µg/dscm	3.29E-3	4.49E-3	6.25E-3	4.68E-3
lb/10 ¹² Btu	3.59E-3	4.74E-3	6.76E-3	5.03E-3
% of total Hg	0.01	0.02	0.02	0.02
Oxidized mercury – µg	38.3	38.9	49.9	-----
µg/dscm	21.00	21.83	28.34	23.72
lb/10 ¹² Btu	22.91	23.03	30.65	25.53
% of total Hg	81.0	84.8	91.1	85.6
Elemental mercury – µg	8.98	7.01	4.86	-----
µg/dscm	4.92	3.93	2.76	3.87
lb/10 ¹² Btu	5.37	4.15	2.99	4.17
% of total Hg	19.0	15.3	8.9	14.4
Total mercury – µg	47.3	45.9	54.8	-----
µg/dscm	25.94	25.76	31.13	27.61
lb/10 ¹² Btu	28.29	27.17	33.66	29.71
Coal Analysis				
Mercury – ppm dry	0.117	0.115	0.123	0.118
Mercury - lb/10 ¹² Btu	10.99	11.34	11.91	11.41
Chlorine - ppm dry	1,700	1,700	2,200	1,867
Moisture - %	7.38	7.81	8.19	7.79
Sulfur - % dry	1.45	1.45	1.57	1.49
Ash - % dry	12.2	12.9	13.9	13.0
HHV - Btu/lb as fired	10,780	10,720	10,610	10,703
Coal flow - lb/hr as fired	590,617	575,617	554,075	573,436
Total Heat Input – 10 ⁶ Btu/hr	6,366.9	6,170.6	5,878.7	6,138.7
Total Mercury Mass Rates				
lb/hr input in coal	0.07	0.07	0.07	0.07
lb/hr at Precipitator inlet	0.17	0.19	0.20	0.19
lb/hr emitted	0.18	0.17	0.20	0.18

**Table 3-5
Gibson Unit Number 3 Process Data**

Run Number	2	3	4
Test Date	03/29/00	03/29/00	03/29/00
Test Time	1015-1312	1345-1642	1710-2052
Unit Operation			
Unit Load - MW net	662	658	638
Coal Mills in Service	6	6	5
Coal Flow - tons/hr	295	271	256
Steam Flow - klb/hr	4,572	4,544	4,393
Furnace Exit Gas Temp. - °F	785	785	782
CEM data			
CO ₂ - % wet	9.44	9.36	9.24
SO ₂ - lbs/10 ⁶ Btu	2.35	2.35	2.19
NO _x - lbs/10 ⁶ Btu	0.517	0.483	0.473
Opacity - %	18.75	17.61	15.98
Flow - scf/hr	126,521,923	126,147,790	124,857,376
Precipitator data			
Opacity - %	18.46	17.87	15.08
Gas Inlet Temp. A - °F	331	332	328
Gas Inlet Temp. B - °F	306	308	303
Gas Outlet Temp. - °F	274	278	275

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Emission Test Methods

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999; ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286.

A preliminary velocity traverse was made at eight ports at the inlet sampling location, in order to determine the uniformity and magnitude of the flow prior to testing. Several traverse points were checked for cyclonic flow and none was found to be present. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Four traverse points were sampled from each of the eight ports, for a total of thirty-two traverse points at both sampling locations.

A preliminary velocity traverse was made at each of the four ports at the stack sampling locations, in order to determine the uniformity and magnitude of the flow prior to testing. Several traverse points were checked for cyclonic flow and none was found to be present. Alternate procedures would be required if the angle of cyclonic flow was greater than 20 degrees. Four traverse points were sampled from each of the four ports, for a total of sixteen traverse points.

The sampling trains were leak-checked at the end of the nozzle at 15 inches of mercury vacuum before each test, and again after each test at the highest vacuum reading recorded during each test. This was done to predetermine the possibility of a diluted sample.

The pitot tube lines were checked for leaks before and after each test under both a vacuum and a pressure. The lines were also checked for clearance and the manometer was zeroed before each test.

Integrated orsat samples were collected and analyzed according to EPA Method 3B during each test.

4.1.1 Mercury

Triplicate samples for mercury were collected. The samples were taken according to EPA Methods 1, 2, 3B, 4, 5, and 17; and the Ontario Hydro Method, Revised July 7, 1999. For each run at the inlet sampling location, samples of five-minute duration were taken isokinetically at each of the thirty-two traverse points for a total sampling time of 160 minutes. For each run at the stack sampling location, samples of ten-minute duration were taken at each of the sixteen traverse points for a total sampling time of 160 minutes. Data was recorded at five-minute intervals. Blank train samples and reagent blanks were submitted.

The "front-half" of the sampling train at the inlet sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Thimble and Backup Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "front-half" of the sampling train at the stack sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "back-half" of the sampling train contained the following components:

<u>Impinger Number</u>	<u>Impinger Type</u>	<u>Impinger Contents</u>	<u>Amount</u>	<u>Parameter Collected</u>
1	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
2	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
3	Greenburg-Smith Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
4	Modified Design	5% HNO ₃ and 10% H ₂ O ₂	100 ml	Elemental Mercury and Moisture
5	Modified Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
6	Modified Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
7	Greenburg-Smith Design	4% KMnO ₄ and 10% H ₂ SO ₄	100 ml	Elemental Mercury and Moisture
8	Modified Design	Silica	200 g	Moisture

All glassware was cleaned prior to use according to the guidelines outlined in EPA Method 29, Section 5.1.1 and the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.15. All glassware connections were sealed with Teflon tape.

At the conclusion of each test, the filter and impinger contents were recovered according to procedures outlined in the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.

Mercury samples were analyzed by Cold Vapor Atomic Absorption and Fluorescence Spectroscopy.

4.2 Process Test Methods

ASTM D2234 method of coal sampling was followed. For each test run, a grab sample of coal was collected every 30 minutes from each coal scale immediately downstream of the coal bunkers. One composite sample was prepared for analysis from the individual feeder samples. Each sample was analyzed for mercury, chlorine, sulfur, ash, and Btu content by ASTM Methods D6414-99, E766/300.0, D-4239, D-3174, and D-3286, respectively.

4.3 Sample Tracking and Custody

Samples and reagents were maintained in limited access, locked storage at all times prior to the test dates. While on site, they were at an attended location or in an area with limited access. Off site, METCO and TestAmerica provided limited access, locked storage areas for maintaining custody.

Chain of custody forms are located in Appendix F. The chain of custody forms provide a detailed record of custody during sampling, with the initials noted of the individuals who loaded and recovered impinger contents and filters, and performed probe rinses.

All samples were packed and shipped in accordance with regulations for hazardous substances.

5 QA/QC ACTIVITIES

The major project quality control checks are listed in Table 5-1. Matrix Spike Summaries are listed in Table 5-2. Duplicate and Triplicate Analyses Summaries are listed in Table 5-3. Additional method-specific QC checks are presented in Table 5-4 (Methods 1 and 2), Table 5-5 (Method 5/17 sampling), and Table 5-6 (Ontario Hydro sample recovery and analysis). These tables also include calibration frequency and specifications.

**Table 5-1
Major Project Quality Control Checks**

<i>QC Check</i>	<i>Information Provided</i>	<i>Results</i>
<i>Blanks</i>		
Reagent blank	Bias from contaminated reagent	Mercury was detected
Field blank	Bias from handling and glassware	Mercury was detected
<i>Spikes</i>		
Matrix spike	Analytical bias	Sample results were between 75% - 125% recovery
<i>Replicates</i>		
Duplicate analyses	Analytical precision	Results were < 10% RPD
Triplicate analyses	Analytical precision	Results were < 10% RPD

**Table 5-2
Gibson Unit Number 3 Matrix Spike Summary**

<i>Sampling Location</i>	<i>Run Number</i>	<i>Container</i>	<i>Results (µg)</i>	<i>True Value (µg)</i>	<i>Recovery (%)</i>
Inlet Duct	2	3	47.0	44.2	106
Inlet Duct	2	4	0.582	0.564	103
Inlet Duct	2	5	2.80	2.35	119
Inlet Duct	3	1	0.0516	0.0500	103
Reagent Blank	-----	8	14.07	14.00	100
Reagent Blank	-----	12	0.0505	0.050	101

**Table 5-3
Gibson Unit Number 3 Duplicate and Triplicate Analyses Summary**

<i>Sampling Location</i>	<i>Run Number</i>	<i>Container</i>	<i>Results (µg)</i>	<i>Duplicate Results (µg)</i>	<i>RPD</i>	<i>Triplicate Results (µg)</i>	<i>RPD</i>	
Inlet	2	1A	2.83	2.83	<1.0	-----	-----	
		1B	0.0062	0.0060	4.1	0.0065	4.7	
		2	0.025	0.026	1.3	0.024	5.0	
		3	46.8	47.3	<1.0	-----	-----	
		4	0.287	0.284	1.1	-----	-----	
	5	6.19	6.27	1.1	-----	-----		
	3	1A	1.95	1.95	<1.0	-----	-----	
		1B	0.0039	0.0042	8.7	-----	-----	
		2	<0.0055	<0.0055	<1.0	-----	-----	
		3	59.2	60.6	2.0	57.5	2.8	
		4	0.190	0.194	2.0	0.179	6.4	
	5	4.36	4.36	<1.0	4.26	2.3		
	4	1A	2.74	2.73	<1.0	-----	-----	
		1B	0.0042	0.0045	5.8	-----	-----	
		2	0.019	0.020	4.8	-----	-----	
		3	69.8	68.9	1.1	-----	-----	
		4	0.102	0.095	7.1	-----	-----	
	5	2.49	2.49	<1.0	-----	-----		
	Stack	2	1A	0.0062	0.0059	5.0	-----	-----
			2	<0.0086	<0.0086	<1.0	-----	-----
3			38.3	39.0	1.5	-----	-----	
4			0.322	0.314	2.6	-----	-----	
5			8.66	8.57	1.1	-----	-----	
3		1A	0.0076	0.0077	1.3	-----	-----	
		2	<0.0095	<0.0095	<1.0	-----	-----	
		3	38.9	38.7	<1.0	-----	-----	
		4	0.178	0.171	4.0	-----	-----	
		5	6.83	6.85	<1.0	-----	-----	
4		1A	0.0089	0.0086	4.0	-----	-----	
		2	0.0023	0.0023	1.7	-----	-----	
		3	49.9	51.3	2.4	-----	-----	
		4	0.075	0.069	7.9	-----	-----	
		5	4.78	4.76	<1.0	-----	-----	

**Table 5-4
QC Checklist and Limits for Methods 1 and 2**

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Measurement site evaluation	>2 diameters downstream and 0.5 diameters upstream of disturbances*	Method 1, Section 2.1
Pitot tube inspection	Inspect each use for damage, once per program for design tolerances	Method 2, Figures 2-2 and 2-3
Thermocouple	+/- 1.5% (°R) of ASTM thermometer, before and after each test mobilization	Method 2, Section 4.3
Barometer	Calibrate each program vs. mercury barometer or vs. weather station with altitude correction	Method 2, Section 4.4

* Although the inlet sampling location does not meet the requirements of EPA Method 1, three-dimensional flow testing as described in EPA Method 1 was not performed. Several traverse points were checked for cyclonic flow and none was found to be present.

**Table 5-5
QC Checklist and Limits for Method 5/17 Sampling**

Quality Control Activity	Acceptance Criteria and Frequency	Reference
<i>Pre-mobilization checks</i>		
Gas meter/orifice check	Before test series, $Y_D \pm 5\%$ (of original Y_D)	Method 5, Section 5.3
Probe heating system	Continuity and resistance check on element	
Nozzles	Note number, size, material	
Glassware	Inspect for cleanliness, compatibility	
Thermocouples	Same as Method 2	
<i>On-site pre-test checks</i>		
Nozzle	Measure inner diameter before first run	Method 5, Section 5.1
Probe heater	Confirm ability to reach temperature	
Pitot tube leak check	No leakage	Method 2, Section 3.1
Visible inspection of train	Confirm cleanliness, proper assembly	
Sample train leak check	≤ 0.02 cf at 15" Hg vacuum	Method 5, Section 4.1.4
<i>During testing</i>		
Probe and filter temperature	Monitor and confirm proper operation	
Manometer	Check level and zero periodically	
Nozzle	Inspect for damage or contamination after each traverse	Method 5, Section 5.1
Probe/nozzle orientation	Confirm at each point	
<i>Post test checks</i>		
Sample train leak check	≤ 0.02 cf at highest vacuum achieved during test	Method 5, Section 4.1.4
Pitot tube leak check	No leakage	Method 2, Section 3.1
Isokinetic ratio	Calculate, must be 90-110%	Method 5, Section 6
Dry gas meter calibration check	After test series, $Y_D \pm 5\%$	Method 5, Section 5.3
Thermocouples	Same as Method 2	
Barometer	Compare w/ standard, ± 0.1 " Hg	

Table 5-6 QC Checklist and Limits for Ontario Hydro Mercury Speciation

Quality Control Activity	Acceptance Criteria and Frequency	Reference
<i>Pre-mobilization activities</i>		
Reagent grade	ACS reagent grade	Ontario Hydro Section 8.1
Water purity	ASTM Type II, Specification D 1193	Ontario Hydro Section 8.2
Sample filters	Quartz; analyze blank for Hg before test	Ontario Hydro Section 8.4.3
Glassware cleaning	As described in Method	Ontario Hydro Section 8.10
<i>On-site pre-test activities</i>		
Determine SO ₂ concentration	If >2500 ppm, add more HNO ₃ -H ₂ O ₂ solution	Ontario Hydro Section 13.1.13
Prepare KCl solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare HNO ₃ -H ₂ O ₂ solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare H ₂ SO ₄ -KMnO ₄ solution	Prepare daily	Ontario Hydro Section 8.5
Prepare HNO ₃ rinse solution	Prepare batch as needed; can be purchased premixed	Ontario Hydro Section 8.6
Prepare hydroxylamine solution	Prepare batch as needed	Ontario Hydro Section 8.6
<i>Sample recovery activities</i>		
Brushes and recovery materials	No metallic material allowed	Ontario Hydro Section 13.2.6
Check for KMnO ₄ Depletion	If purple color lost in first two impingers, repeat test with more HNO ₃ -H ₂ O ₂ solution	Ontario Hydro Section 13.1.13
Probe cleaning	Move probe to clean area before cleaning	Ontario Hydro Section 13.2.1
Impinger 1,2,3 recovery.	After rinsing, add permanganate until purple color remains to assure Hg retention	Ontario Hydro Section 13.2.8
Impinger 5,6,7 recovery.	If deposits remain after HNO ₃ rinse, rinse with hydroxylamine sulfate. If purple color disappears after hydroxylamine sulfate rinse, add more permanganate until color returns	Ontario Hydro Section 13.2.10
Impinger 8	Note color of silica gel; if spent, regenerate or dispose.	Ontario Hydro Section 13.2.11
<i>Blank samples</i>		
0.1 N HNO ₃ rinse solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
KCl solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
HNO ₃ -H ₂ O ₂ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
H ₂ SO ₄ -KMnO ₄ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Hydroxylamine sulfate solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Unused filters	Three from same lot.	Ontario Hydro Section 13.2.12
Field blanks	One per set of tests at each test location.	Ontario Hydro Section 13.4.1
<i>Laboratory activities</i>		
Assess reagent blank levels	Target <10% of sample value or <10x instrument detection limit. Subtract as allowed.	Ontario Hydro Section 13.4.1
Assess field blank levels	Compare to sample results. If greater than reagent blanks or greater than 30% of sample values, investigate. Subtraction of field blanks not allowed.	Ontario Hydro Section 13.4.1
Duplicate/triplicate samples	All CVAAS runs in duplicate; every tenth run in triplicate. All samples must be within 10% of each other; if not, recalibrate and reanalyze.	Ontario Hydro Section 13.4.1

6 DESCRIPTION OF TESTS

Personnel from METCO Environmental arrived at the plant at 7:30 a.m. on Tuesday, March 28, 2000. After meeting with plant personnel and attending a brief safety meeting, the equipment was moved onto the Unit Number 3 Precipitator Inlet Duct and Stack. The preliminary data was collected. The equipment was secured for the night. All work was completed at 5:00 p.m.

On Wednesday, March 29, work began at 6:30 a.m. The equipment was prepared for testing. The first set of tests for mercury began at 7:35 a.m. Testing continued until the completion of the fourth set of tests at 8:52 p.m. The samples were recovered. The equipment was secured for the night. All work was completed at 10:15 p.m. Run Number 1 was aborted due to reference method sampling equipment problems.

On Thursday, March 30, work began at 7:30 a.m. The equipment was moved off of the sampling locations and loaded into the sampling van. The samples and the data were transported to METCO Environmental's laboratory in Dallas, Texas, for analysis and evaluation.

Operations at the Cinergy Corporation, Gibson Generating Station, Unit Number 3 Precipitator Inlet Duct and Stack, located in Owensville, Indiana, for the Electric Power Research Institute, were completed at 9:00 a.m. on Thursday, March 30, 2000.


Billy J. Mullins, Jr. P.E.
President