



**Report on the
Air Emissions Test Program**

**Conducted for Big Rivers Electric Corporation
At the Coleman Station Facility located in Hawesville, Kentucky**

*Report No. 3648 Coleman
August 29, 2011*

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Project Overview

General

Airtech Environmental Services Inc. (Airtech) was contracted by Big Rivers Electric Corporation (Big Rivers) to perform an air emission test program at the Coleman Station facility located in Hawesville, Kentucky. Testing was conducted to gather stack test data for an evaluation of any corrective action that may be needed to comply with the Transport Rule and Utility MACT emission limits.

Testing was conducted at the exhaust stack of Unit 1 and the three (3) exhausts of the Unit 1 Electrostatic Precipitator (ESP). These ducts are designated ESP 1, ESP 2 and ESP 3. Testing was conducted to meet the requirements of Big Rivers and Sargent & Lundy, LLC.

The specific objectives of the test program were:

- Determine the emissions of non-sulfuric acid filterable particulate matter (FPM) and condensable particulate matter (CPM) at each test location.
- Determine the emissions of hydrogen chloride (HCl) and hydrogen fluoride (HF) from each test location.
- Determine the emissions of metallic hazardous air pollutants (HAP)¹ from each test location.
- Determine the emissions of oxidized and elemental vapor-phase mercury (Hg) from each test location.

Testing was performed July 7 through July 13, 2011. Coordinating the field portion of the test program were:

Mike Galbraith – Big Rivers Electric Corporation
Brandon Check – Airtech Environmental Services Inc.

Methodology

All methods employed during the test program were performed in strict adherence with the latest published version(s). Recovery of all sample trains was performed in an on-site mobile laboratory. All sample trains were sealed with Teflon tape when not in use. All test components were sealed when transported between the laboratory and the test location. All field technicians wore polyethylene or plastic gloves while recovering field samples.

¹ Metallic HAPs are defined as: antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), manganese (Mn), nickel (Ni) and Selenium (Se).

As much as possible, testing for a given pollutant was conducted simultaneously at the ESP exhausts and stack locations.

EPA Methods 5B and 202 were used in a combined sampling train to determine the concentrations of non-sulfuric acid filterable particulate matter (FPM), condensable particulate matter (CPM) and total PM at each test location. For the EPA Methods 5B/202, a sample of the gas stream was withdrawn isokinetically from the source. Non-sulfuric acid FPM was collected in a heated probe and on a heated glass fiber filter. CPM passed through the probe and filter and was collected in a dry, glass impinger system. The amount of particulate matter collected with each sample fraction was compared to the volume of dry gas sampled to calculate a particulate concentration. Results for FPM, CPM and total PM are expressed in units of grains per dry standard cubic foot (gr/dscf), in units of pounds per hour (lb/hr) and in units of pounds per million Btu (lb/mmBtu).

Because of the relatively low moisture content and the lack of any entrained water droplets, EPA Method 26 was used to determine the concentration of HCl and HF at the ESP outlet test locations. For the EPA Method 26, a sample of the gas stream was withdrawn at a constant rate from the source through a heated, glass lined probe and a heated Teflon filter. HCl and HF in the sample stream passed through the probe and filter and were collected in a series of impingers containing a dilute sulfuric acid (H₂SO₄) solution.

EPA Method 26A was used to determine the concentration of HCl and HF at the Stack Outlet test location. For the EPA Method 26A, a sample of the stack gas was withdrawn isokinetically from the source through a glass nozzle, a heated, glass lined probe and a heated Teflon filter. HCl and HF in the sample stream passed through the probe and filter and were collected in a series of impingers containing a dilute sulfuric acid (H₂SO₄) solution.

At the conclusion of each Method 26 and 26A test run, the H₂SO₄ impinger solution was recovered from the sampling train and analyzed for HCl and HF by ion chromatography. Analysis was performed at the Airtech laboratory located in Denver, Colorado. HCl and HF results are expressed in pounds per dry standard cubic foot (lb/dscf), parts per million dry volume (ppmdv), pounds per million Btu (lb/mmBtu) and pounds per hour (lb/hr). Three (3) test runs were performed at each test location.

EPA Method 29 was used to determine the metallic HAPs concentrations at each test location. For this project, metallic HAPs were defined as antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), manganese (Mn), nickel (Ni) and selenium (Se). With the Method 29 approach, a sample of the gas stream was withdrawn isokinetically from the source and the metallic HAPs in the sample gas were collected in a sample probe, on a quartz fiber filter, and in a series of chilled, glass impingers charged with metals absorbing solutions. Analysis of the samples was performed by ElementOne Laboratories located in Wilmington, North Carolina. Metallic HAPs results are expressed in units of micrograms per dry standard cubic meter

(ug/dscm), pounds per million Btu (lb/mmBtu) and pounds per hour (lb/hr). Three (3) test runs were performed at each test location. Each test run was two (2) hours in duration.

EPA Method 30B was used to determine the concentrations of oxidized, elemental and total vapor-phase Hg at each test location. For the EPA Method 30B, a sample of the effluent was withdrawn from the source at a constant rate through paired, in-situ, sorbent media traps. One trap was spiked and the other was packed with multiple stages of media designed to separately collect total gaseous oxidized mercury (Hg^{+2}) and total gaseous elemental mercury (Hg^0). Because the speciating tubes are sensitive to sample loss and breakthrough at temperatures in excess of 210°F, air cooled probes were employed at the ESP outlet test locations. The air cooled probes used small fans to circulate ambient air through the outer sheath, thus keeping the temperature of the traps below the critical temperature. At both test locations, probe heaters were also in operation to ensure that the tubes were maintained above the dew point of the sample gas. The masses of the mercury species collected with the traps was compared to the volume of dry gas sampled to calculate the mercury concentrations. Analysis for the mercury species was performed by Airtech Environmental Services Inc. at its laboratory located in Denver, Colorado. Results for Hg are expressed in units of micro grams per dry standard cubic meter (ug/dscm), pounds per million Btu (lb/mmBtu) and pounds per hour (lb/hr). Three (3), ninety-minute test runs were performed at each test location.

Parameters

The following specific parameters were determined at the each test location:

- gas temperature
- volumetric flow rate
- carbon dioxide content
- oxygen content
- moisture content
- filterable particulate matter
- condensable particulate matter concentration
- hydrogen chloride concentration
- hydrogen fluoride concentration
- metallic hazardous air pollutants concentration
- oxidized mercury concentration
- elemental mercury concentration

Results

A summary of test results is presented in Tables 1 through 16 on Pages 6 through 25.

The F_d factors listed in the tables were calculated from coal samples collected during the testing. The F_d factor worksheets can be found in the Parameters section of the Appendix. All coal analysis can be found in the Laboratory section of the Appendix.

For the HCl and HF results, if the pollutant was not detected in the sample train, the reporting limit was used in the calculation of the total amount collected by the sample train. These pollutant results are noted with a “<”.

For the metals results, if a metal was not detected in one fraction of the sample train but detected in another fraction of the sample train, the reporting limit was used in the calculation of the total amount collected by the sample train for the non-detect fraction. These metals results are noted with a “*”.

Each Method 30B test run consisted of a spiked sample and an un-spiked sample. For this testing all spikes met the method spike recovery requirement of $85\% < R < 115\%$. All samples also met the relative deviation duplicate requirement of $RD < 10\%$. Individual spike recovery and duplicate results can be found in the parameters section of the Appendix.

All carbon dioxide data was downloaded from the installed Plant continuous emission monitoring systems (CEMS). The Coleman facility operates a CEMS in each of the three (3) ESP exhaust ducts as well as the stack. Oxygen values were calculated using the Plant CO_2 data and the F_o calculations listed in EPA Method 3B.

Submitted by:



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Summary of Results

Table 1 – Summary of ESP 1 FPM and CPM Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/8/2011	7/12/2011	7/12/2011	
Start Time	10:08	9:50	12:30	
Stop Time	11:49	11:20	14:00	
F _d (dscf/mmBtu)	9,779	9,997	9,821	
<u>Gas Conditions</u>				
Temperature (°F)	324	343	338	335
Volumetric Flow Rate (acfm)	347,200	347,000	345,600	346,600
Volumetric Flow Rate (scfm)	224,500	226,900	227,300	226,200
Volumetric Flow Rate (dscfm)	208,300	203,600	210,000	207,300
Carbon Dioxide (% dry)	12.0	11.9	12.1	12.0
Oxygen (% dry)	7.28	7.38	7.07	7.24
Moisture (%)	7.23	10.3	7.66	8.40
<u>Filterable PM Results</u>				
Concentration (grains/dscf)	0.146	0.0881	0.0859	0.107
Emission Rate (lb/mmBtu)	0.312	0.195	0.182	0.230
Emission Rate (lb/hr)	260	154	155	190
<u>Condensable PM Results</u>				
Concentration (grains/dscf)	0.0114	0.0221	0.0148	0.0161
Emission Rate (lb/mmBtu)	0.0244	0.0488	0.0314	0.0348
Emission Rate (lb/hr)	20.3	38.5	26.6	28.5
<u>Total PM Results</u>				
Concentration (grains/dscf)	0.157	0.110	0.101	0.123
Emission Rate (lb/mmBtu)	0.337	0.243	0.214	0.265
Emission Rate (lb/hr)	281	192	181	218

Table 2 – Summary of ESP 1 HCl and HF Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/8/11	7/8/11	
Start Time	8:05	6:41	13:48	
Stop Time	12:05	10:41	17:48	
F _d (dscf/mmBtu)	9,808	9,914	9,817	
<u>Gas Conditions</u>				
Temperature (°F)	348	319	332	333
Volumetric Flow Rate (acfm)	332,300	327,400	328,300	329,400
Volumetric Flow Rate (scfm)	213,700	213,200	210,300	212,400
Volumetric Flow Rate (dscfm)	193,100	196,300	188,300	192,600
Carbon Dioxide (% dry)	12.0	11.9	12.1	12.0
Oxygen (% dry)	7.28	7.38	7.07	7.24
Moisture (%)	9.67	7.95	10.5	9.38
<u>Hydrogen Chloride Results</u>				
Concentration (lb/dscf)	4.42E-06	5.09E-06	4.66E-06	4.72E-06
Concentration (ppmdv)	46.7	53.8	49.2	49.9
Emission Rate (lb/mmBtu)	0.0665	0.0780	0.0691	0.0712
Emission Rate (lb/hr)	51.2	60.0	52.6	54.6
<u>Hydrogen Fluoride Results</u>				
Concentration (lb/dscf)	1.95E-08	2.12E-08	2.01E-08	2.03E-08
Concentration (ppmdv)	0.376	0.408	0.386	0.390
Emission Rate (lb/mmBtu)	0.000294	0.000325	0.000297	0.000305
Emission Rate (lb/hr)	0.226	0.249	0.227	0.234

Table 3 – Summary of ESP 1 Metallic HAP Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:06	13:02	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Gas Conditions</u>				
Temperature (°F)	348	348	316	337
Volumetric Flow Rate (acfm)	343,100	333,500	344,800	340,500
Volumetric Flow Rate (scfm)	220,300	214,300	225,500	220,000
Volumetric Flow Rate (dscfm)	208,900	192,500	201,400	200,900
Carbon Dioxide (% dry)	12.0	11.9	12.1	12.0
Oxygen (% dry)	7.28	7.38	7.07	7.24
Moisture (%)	5.25	10.19	10.72	8.72
<u>Antimony - Sb</u>				
Concentration (ug/dscm)	4.84	5.30	8.86	6.33
Emission Rate (lb/mmBtu)	4.55E-06	5.02E-06	8.21E-06	5.93E-06
Emission Rate (lb/hr)	0.00379	0.00382	0.00668	0.00477
<u>Arsenic - As</u>				
Concentration (ug/dscm)	20.6	24.5	33.8	26.3
Emission Rate (lb/mmBtu)	1.93E-05	2.32E-05	3.13E-05	2.46E-05
Emission Rate (lb/hr)	0.0161	0.0177	0.0255	0.0198
<u>Beryllium - Be</u>				
Concentration (ug/dscm)	1.82*	2.21*	3.78*	2.60
Emission Rate (lb/mmBtu)	1.71E-06*	2.10E-06*	3.50E-06*	2.43E-06
Emission Rate (lb/hr)	0.00142*	0.00160*	0.00285*	0.00196
<u>Cadmium - Cd</u>				
Concentration (ug/dscm)	4.22	2.94	4.82	3.99
Emission Rate (lb/mmBtu)	3.96E-06	2.79E-06	4.47E-06	3.74E-06
Emission Rate (lb/hr)	0.00330	0.00212	0.00364	0.00302

* indicates that one fraction was below the detection limit.

Table 3 – Summary of ESP 1 Metallic HAP Results (continued)

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:06	13:02	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Chromium - Cr</u>				
Concentration (ug/dscm)	121	44.7	51.2	72.4
Emission Rate (lb/mmBtu)	1.14E-04	4.24E-05	4.75E-05	6.79E-05
Emission Rate (lb/hr)	0.0949	0.0323	0.0386	0.0553
<u>Cobalt- Co</u>				
Concentration (ug/dscm)	5.28	5.50	8.45	6.41
Emission Rate (lb/mmBtu)	4.96E-06	5.21E-06	7.84E-06	6.00E-06
Emission Rate (lb/hr)	0.00413	0.00396	0.00638	0.00482
<u>Lead - Pb</u>				
Concentration (ug/dscm)	15.7	32.2	29.3	25.8
Emission Rate (lb/mmBtu)	1.48E-05	3.05E-05	2.72E-05	2.42E-05
Emission Rate (lb/hr)	0.0123	0.0233	0.0221	0.0192
<u>Manganese - Mn</u>				
Concentration (ug/dscm)	46.5	46.1	70.8	54.5
Emission Rate (lb/mmBtu)	4.37E-05	4.37E-05	6.57E-05	5.10E-05
Emission Rate (lb/hr)	0.0364	0.0332	0.0534	0.0410
<u>Nickel - Ni</u>				
Concentration (ug/dscm)	108	40.6	43.0	63.9
Emission Rate (lb/mmBtu)	1.02E-04	3.85E-05	3.99E-05	6.00E-05
Emission Rate (lb/hr)	0.0846	0.0293	0.0325	0.0488
<u>Selenium - Se</u>				
Concentration (ug/dscm)	130	166	126	141
Emission Rate (lb/mmBtu)	1.22E-04	1.58E-04	1.17E-04	1.32E-04
Emission Rate (lb/hr)	0.102	0.120	0.0954	0.106

Table 4 – Summary of ESP 1 Hg Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/12/11	7/13/11	7/13/11	
Start Time	16:00	6:47	8:50	
Stop Time	17:30	8:17	10:20	
Fd (dscf/mmBtu)	9,827	9,804	9,830	
<u>Gas Conditions</u>				
Volumetric Flowrate, (dscfm)	223,200	222,200	221,700	222,400
Oxygen (% dry)	7.28	7.38	7.07	7.24
Moisture (%)	2.36	2.57	2.80	2.58
<u>Oxidized Mercury Results</u>				
Concentration Train A (µg/dscm)	0.327	0.551	0.512	0.463
Emission Rate (lb/mmBtu)	3.08E-07	5.21E-07	4.75E-07	4.35E-07
Emission Rate (lb/hr)	0.000273	0.000458	0.000426	0.000386
<u>Elemental Mercury Results</u>				
Concentration Train A (µg/dscm)	9.12	6.00	6.29	7.14
Emission Rate (lb/mmBtu)	8.58E-06	5.68E-06	5.83E-06	6.70E-06
Emission Rate (lb/hr)	0.00762	0.00500	0.00522	0.00595
<u>Total Mercury Results</u>				
Concentration Train A (µg/dscm)	9.42	6.53	6.82	7.59
Concentration Train B (µg/dscm)	9.43	6.64	6.66	7.58
Average Concentration (µg/dscm)	9.42	6.58	6.74	7.58
Emission Rate (lb/mmBtu)	8.87E-06	6.23E-06	6.25E-06	7.12E-06
Emission Rate (lb/hr)	0.00788	0.00548	0.00560	0.00632

Table 5 – Summary of ESP 2 FPM and CPM Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/8/2011	7/12/2011	7/12/2011	
Start Time	10:08	9:50	12:30	
Stop Time	11:49	11:20	14:00	
F _d (dscf/mmBtu)	9,779	9,997	9,821	
<u>Gas Conditions</u>				
Temperature (°F)	296	318	318	311
Volumetric Flow Rate (acfm)	345,700	348,300	349,500	347,800
Volumetric Flow Rate (scfm)	232,500	235,600	236,600	234,900
Volumetric Flow Rate (dscfm)	210,100	213,100	214,000	212,400
Carbon Dioxide (% dry)	11.4	11.4	11.2	11.3
Oxygen (% dry)	8.00	7.99	8.20	8.06
Moisture (%)	9.69	9.58	9.58	9.62
<u>Filterable PM Results</u>				
Concentration (grains/dscf)	0.0715	0.113	0.108	0.0974
Emission Rate (lb/mmBtu)	0.162	0.260	0.250	0.224
Emission Rate (lb/hr)	129	206	199	178
<u>Condensable PM Results</u>				
Concentration (grains/dscf)	0.0195	0.00786	0.0172	0.0148
Emission Rate (lb/mmBtu)	0.0441	0.0182	0.0396	0.0340
Emission Rate (lb/hr)	35.1	14.4	31.5	27.0
<u>Total PM Results</u>				
Concentration (grains/dscf)	0.0910	0.120	0.125	0.112
Emission Rate (lb/mmBtu)	0.206	0.279	0.289	0.258
Emission Rate (lb/hr)	164	220	230	205

Table 6 – Summary of ESP 2 HCl and HF Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/8/11	7/8/11	
Start Time	8:05	6:41	13:48	
Stop Time	12:05	10:41	17:48	
F _d (dscf/mmBtu)	9,808	9,914	9,817	
<u>Gas Conditions</u>				
Temperature (°F)	310	296	304	303
Volumetric Flow Rate (acfm)	369,900	370,200	372,600	370,900
Volumetric Flow Rate (scfm)	250,300	249,300	248,100	249,200
Volumetric Flow Rate (dscfm)	228,800	228,200	225,800	227,600
Carbon Dioxide (% dry)	11.4	11.4	11.2	11.3
Oxygen (% dry)	8.00	7.99	8.20	8.06
Moisture (%)	8.62	8.50	9.03	8.72
<u>Hydrogen Chloride Results</u>				
Concentration (lb/dscf)	5.97E-06	3.18E-06	3.57E-06	4.24E-06
Concentration (ppmdv)	63.1	33.6	37.8	44.8
Emission Rate (lb/mmBtu)	0.0949	0.0510	0.0577	0.0679
Emission Rate (lb/hr)	82.0	43.5	48.4	58.0
<u>Hydrogen Fluoride Results</u>				
Concentration (lb/dscf)	5.88E-07	3.16E-07	5.19E-07	4.74E-07
Concentration (ppmdv)	11.3	6.09	9.99	9.14
Emission Rate (lb/mmBtu)	0.00934	0.00508	0.00838	0.00760
Emission Rate (lb/hr)	8.07	4.33	7.03	6.48

Table 7 – Summary of ESP 2 Metallic HAP Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:05	13:00	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Gas Conditions</u>				
Temperature (°F)	324	327	297	316
Volumetric Flow Rate (acfm)	345,200	347,000	346,600	346,300
Volumetric Flow Rate (scfm)	229,300	229,600	232,900	230,600
Volumetric Flow Rate (dscfm)	211,400	207,500	208,600	209,200
Carbon Dioxide (% dry)	11.4	11.4	11.2	11.3
Oxygen (% dry)	8.00	7.99	8.20	8.06
Moisture (%)	7.84	9.66	10.5	9.33
<u>Antimony - Sb</u>				
Concentration (ug/dscm)	4.91	4.48	6.05	5.15
Emission Rate (lb/mmBtu)	4.87E-06	4.45E-06	6.11E-06	5.14E-06
Emission Rate (lb/hr)	0.00389	0.00348	0.00473	0.00403
<u>Arsenic - As</u>				
Concentration (ug/dscm)	21.1	19.9	22.0	21.0
Emission Rate (lb/mmBtu)	2.10E-05	1.97E-05	2.22E-05	2.10E-05
Emission Rate (lb/hr)	0.0167	0.0155	0.0172	0.0165
<u>Beryllium - Be</u>				
Concentration (ug/dscm)	2.09*	1.83*	2.75*	2.22
Emission Rate (lb/mmBtu)	2.08E-06*	1.81E-06*	2.78E-06*	2.22E-06
Emission Rate (lb/hr)	0.00166*	0.00142*	0.00215*	0.00174
<u>Cadmium - Cd</u>				
Concentration (ug/dscm)	3.09	2.69	3.09	2.96
Emission Rate (lb/mmBtu)	3.06E-06	2.67E-06	3.12E-06	2.95E-06
Emission Rate (lb/hr)	0.00245	0.00209	0.00241	0.00232

* indicates that one fraction was below the detection limit.

Table 7 – Summary of ESP 2 Metallic HAP Results (continued)

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:05	13:00	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Chromium - Cr</u>				
Concentration (ug/dscm)	30.2	63.3	95.9	63.1
Emission Rate (lb/mmBtu)	3.00E-05	6.28E-05	9.68E-05	6.32E-05
Emission Rate (lb/hr)	0.0239	0.0492	0.0749	0.0494
<u>Cobalt- Co</u>				
Concentration (ug/dscm)	5.08	5.96	7.11	6.05
Emission Rate (lb/mmBtu)	5.04E-06	5.91E-06	7.18E-06	6.04E-06
Emission Rate (lb/hr)	0.00402	0.00463	0.00555	0.00474
<u>Lead - Pb</u>				
Concentration (ug/dscm)	17.0	14.6	18.9	16.8
Emission Rate (lb/mmBtu)	1.69E-05	1.45E-05	1.91E-05	1.68E-05
Emission Rate (lb/hr)	0.0135	0.0114	0.0147	0.0132
<u>Manganese - Mn</u>				
Concentration (ug/dscm)	36.4	43.1	51.0	43.5
Emission Rate (lb/mmBtu)	3.61E-05	4.27E-05	5.15E-05	4.34E-05
Emission Rate (lb/hr)	0.0288	0.0335	0.0399	0.0340
<u>Nickel - Ni</u>				
Concentration (ug/dscm)	27.3	74.2	67.1	56.2
Emission Rate (lb/mmBtu)	2.70E-05	7.36E-05	6.77E-05	5.61E-05
Emission Rate (lb/hr)	0.0216	0.0577	0.0524	0.0439
<u>Selenium - Se</u>				
Concentration (ug/dscm)	147	167	67.3	127
Emission Rate (lb/mmBtu)	1.46E-04	1.66E-04	6.79E-05	1.27E-04
Emission Rate (lb/hr)	0.116	0.130	0.0526	0.0997

Table 8 – Summary of ESP 2 Hg Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/12/11	7/13/11	7/13/11	
Start Time	16:00	6:47	8:50	
Stop Time	17:30	8:17	10:20	
Fd (dscf/mmBtu)	9,827	9,804	9,830	
<u>Gas Conditions</u>				
M29 Volumetric Flowrate, (dscfm)	225,700	224,000	225,700	225,100
M29 Oxygen (% dry)	8.00	7.99	8.20	8.06
M29 Moisture (%)	2.21	2.36	2.26	2.28
<u>Oxidized Mercury Results</u>				
Concentration Train A (µg/dscm)	0.445	0.251	0.321	0.339
Emission Rate (lb/mmBtu)	4.42E-07	2.48E-07	3.24E-07	3.38E-07
Emission Rate (lb/hr)	0.000376	0.000210	0.000272	0.000286
<u>Elemental Mercury Results</u>				
Concentration Train A (µg/dscm)	7.13	5.32	5.81	6.09
Emission Rate (lb/mmBtu)	7.09E-06	5.27E-06	5.87E-06	6.08E-06
Emission Rate (lb/hr)	0.00603	0.00447	0.00491	0.00514
<u>Total Mercury Results</u>				
Concentration Train A (µg/dscm)	7.57	5.58	6.13	6.43
Concentration Train B (µg/dscm)	7.68	5.40	6.18	6.42
Average Concentration (µg/dscm)	7.63	5.49	6.16	6.42
Emission Rate (lb/mmBtu)	7.58E-06	5.44E-06	6.22E-06	6.41E-06
Emission Rate (lb/hr)	0.00645	0.00461	0.00521	0.00542

Table 9 – Summary of ESP 3 FPM and CPM Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/8/2011	7/12/2011	7/12/2011	
Start Time	10:08	9:50	12:30	
Stop Time	11:38	11:20	14:00	
F _d (dscf/mmBtu)	9,779	9,997	9,821	
<u>Gas Conditions</u>				
Temperature (°F)	307	318	310	312
Volumetric Flow Rate (acfm)	362,400	384,900	354,300	367,200
Volumetric Flow Rate (scfm)	239,700	260,000	241,800	247,200
Volumetric Flow Rate (dscfm)	216,800	232,800	221,100	223,600
Carbon Dioxide (% dry)	11.4	11.6	11.5	11.5
Oxygen (% dry)	8.00	7.76	7.79	7.85
Moisture (%)	9.61	10.5	8.60	9.57
<u>Filterable PM Results</u>				
Concentration (grains/dscf)	0.0947	0.0735	0.0737	0.0807
Emission Rate (lb/mmBtu)	0.214	0.167	0.165	0.182
Emission Rate (lb/hr)	176	147	140	154
<u>Condensable PM Results</u>				
Concentration (grains/dscf)	0.0318	0.00505	0.00614	0.0143
Emission Rate (lb/mmBtu)	0.0721	0.0115	0.0137	0.0324
Emission Rate (lb/hr)	59.2	10.1	11.6	27.0
<u>Total PM Results</u>				
Concentration (grains/dscf)	0.127	0.0786	0.0799	0.0950
Emission Rate (lb/mmBtu)	0.287	0.179	0.179	0.215
Emission Rate (lb/hr)	235	157	151	181

Table 10 – Summary of ESP 3 HCl and HF Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/8/11	7/8/11	
Start Time	8:05	6:41	13:48	
Stop Time	12:05	10:41	17:48	
F _d (dscf/mmBtu)	9,808	9,914	9,817	
<u>Gas Conditions</u>				
Temperature (°F)	326	301	306	311
Volumetric Flow Rate (acfm)	385,400	311,300	314,700	337,100
Volumetric Flow Rate (scfm)	254,700	207,800	208,700	223,700
Volumetric Flow Rate (dscfm)	222,600	194,300	196,000	204,300
Carbon Dioxide (% dry)	11.4	11.6	11.5	11.5
Oxygen (% dry)	8.00	7.76	7.79	7.85
Moisture (%)	12.7	6.54	6.09	8.43
<u>Hydrogen Chloride Results</u>				
Concentration (lb/dscf)	<4.62E-10	<4.59E-10	8.88E-09	3.27E-09
Concentration (ppmdv)	<0.00488	<0.00486	0.0938	0.0345
Emission Rate (lb/mmBtu)	<7.34E-06	<7.24E-06	1.39E-04	5.12E-05
Emission Rate (lb/hr)	<0.00617	<0.00536	0.104	0.0387
<u>Hydrogen Fluoride Results</u>				
Concentration (lb/dscf)	<6.95E-10	6.27E-09	5.48E-09	4.15E-09
Concentration (ppmdv)	<0.0134	0.121	0.106	0.0799
Emission Rate (lb/mmBtu)	<1.10E-05	9.88E-05	8.57E-05	6.52E-05
Emission Rate (lb/hr)	<0.00928	0.0731	0.0644	0.0489

Results preceded by “<” are below the detection limit of the method.

Table 11 – Summary of ESP 3 Metallic HAP Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:05	13:00	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Gas Conditions</u>				
Temperature (°F)	325	328	302	318
Volumetric Flow Rate (acfm)	385,000	383,300	333,500	367,300
Volumetric Flow Rate (scfm)	255,000	252,800	222,300	243,400
Volumetric Flow Rate (dscfm)	223,600	229,800	199,900	217,800
Carbon Dioxide (% dry)	11.4	11.6	11.5	11.5
Oxygen (% dry)	8.00	7.76	7.79	7.85
Moisture (%)	12.4	9.12	10.1	10.5
<u>Antimony - Sb</u>				
Concentration (ug/dscm)	4.50	7.56	5.83	5.97
Emission Rate (lb/mmBtu)	4.47E-06	7.37E-06	5.70E-06	5.85E-06
Emission Rate (lb/hr)	0.00377	0.00651	0.00437	0.00488
<u>Arsenic - As</u>				
Concentration (ug/dscm)	23.0	27.7	24.9	25.2
Emission Rate (lb/mmBtu)	2.28E-05	2.70E-05	2.44E-05	2.47E-05
Emission Rate (lb/hr)	0.0193	0.0238	0.0187	0.0206
<u>Beryllium - Be</u>				
Concentration (ug/dscm)	1.54*	2.61*	2.86*	2.33
Emission Rate (lb/mmBtu)	1.53E-06*	2.54E-06*	2.79E-06*	2.29E-06
Emission Rate (lb/hr)	0.00129*	0.00224*	0.00214*	0.00189
<u>Cadmium - Cd</u>				
Concentration (ug/dscm)	2.28	4.01	4.23	3.51
Emission Rate (lb/mmBtu)	2.26E-06	3.91E-06	4.14E-06	3.44E-06
Emission Rate (lb/hr)	0.00191	0.00345	0.00317	0.00284

* indicates that one fraction was below the detection limit.

Table 11 – Summary of ESP 3 Metallic HAP Results (continued)

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:05	13:00	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Chromium - Cr</u>				
Concentration (ug/dscm)	154	135	99.6	129
Emission Rate (lb/mmBtu)	1.53E-04	1.31E-04	9.74E-05	1.27E-04
Emission Rate (lb/hr)	0.129	0.116	0.0746	0.106
<u>Cobalt- Co</u>				
Concentration (ug/dscm)	5.48	7.23	7.52	6.74
Emission Rate (lb/mmBtu)	5.43E-06	7.04E-06	7.35E-06	6.61E-06
Emission Rate (lb/hr)	0.00459	0.00622	0.00563	0.00548
<u>Lead - Pb</u>				
Concentration (ug/dscm)	15.4	22.1	21.6	19.7
Emission Rate (lb/mmBtu)	1.53E-05	2.16E-05	2.11E-05	1.93E-05
Emission Rate (lb/hr)	0.0129	0.0190	0.0162	0.0160
<u>Manganese - Mn</u>				
Concentration (ug/dscm)	45.3	59.4	61.0	55.2
Emission Rate (lb/mmBtu)	4.49E-05	5.79E-05	5.96E-05	5.42E-05
Emission Rate (lb/hr)	0.0379	0.0511	0.0457	0.0449
<u>Nickel - Ni</u>				
Concentration (ug/dscm)	43.2	45.9	46.8	45.3
Emission Rate (lb/mmBtu)	4.28E-05	4.47E-05	4.57E-05	4.44E-05
Emission Rate (lb/hr)	0.0361	0.0395	0.0350	0.0369
<u>Selenium - Se</u>				
Concentration (ug/dscm)	140	202	127	156
Emission Rate (lb/mmBtu)	1.39E-04	1.97E-04	1.24E-04	1.53E-04
Emission Rate (lb/hr)	0.117	0.174	0.0951	0.129

Table 12 – Summary of ESP 3 Hg Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/12/11	7/13/11	7/13/11	
Start Time	16:00	6:47	8:50	
Stop Time	17:30	8:17	10:20	
Fd (dscf/mmBtu)	9,827	9,804	9,830	
<u>Gas Conditions</u>				
M5/202 Volumetric Flow, (dscfm)	217,500	212,800	216,900	215,700
M29 Oxygen (% dry)	8.00	7.76	7.79	7.85
M29 Moisture (%)	3.10	3.19	2.72	3.00
<u>Oxidized Mercury Results</u>				
Concentration Train A (µg/dscm)	0.360	0.452	0.419	0.411
Emission Rate (lb/mmBtu)	3.58E-07	4.40E-07	4.10E-07	4.03E-07
Emission Rate (lb/hr)	0.000294	0.000361	0.000341	0.000332
<u>Elemental Mercury Results</u>				
Concentration Train A (µg/dscm)	5.82	6.88	6.80	6.50
Emission Rate (lb/mmBtu)	5.79E-06	6.70E-06	6.65E-06	6.38E-06
Emission Rate (lb/hr)	0.00474	0.00549	0.00552	0.00525
<u>Total Mercury Results</u>				
Concentration Train A (µg/dscm)	6.18	7.34	7.20	6.91
Concentration Train B (µg/dscm)	6.38	7.58	7.25	7.07
Average Concentration (µg/dscm)	6.28	7.46	7.23	6.99
Emission Rate (lb/mmBtu)	6.24E-06	7.26E-06	7.07E-06	6.86E-06
Emission Rate (lb/hr)	0.00512	0.00595	0.00587	0.00565

Table 13 – Summary of the Stack Outlet FPM and CPM Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/8/2011	7/12/2011	7/12/2011	
Start Time	10:08	9:50	12:30	
Stop Time	11:53	11:42	14:15	
F _d (dscf/mmBtu)	9,779	9,997	9,821	
<u>Gas Conditions</u>				
Temperature (°F)	134	137	137	136
Volumetric Flow Rate (acfm)	1,794,000	1,809,000	1,803,000	1,802,000
Volumetric Flow Rate (scfm)	1,540,000	1,600,000	1,595,000	1,578,000
Volumetric Flow Rate (dscfm)	1,295,000	1,316,000	1,306,000	1,306,000
Carbon Dioxide (% dry)	10.3	10.6	10.4	10.4
Oxygen (% dry)	9.17	8.82	9.07	9.02
Moisture (%)	15.9	17.7	18.1	17.3
<u>Filterable PM Results</u>				
Concentration (grains/dscf)	0.0181	0.00450	0.00402	0.00887
Emission Rate (lb/mmBtu)	0.0450	0.0111	0.00996	0.0220
Emission Rate (lb/hr)	201	50.8	45.0	98.8
<u>Condensable PM Results</u>				
Concentration (grains/dscf)	0.00470	0.00957	0.00727	0.00718
Emission Rate (lb/mmBtu)	0.0117	0.0236	0.0180	0.0178
Emission Rate (lb/hr)	52.2	108	81.4	80.5
<u>Total PM Results</u>				
Concentration (grains/dscf)	0.0228	0.0141	0.0113	0.0160
Emission Rate (lb/mmBtu)	0.0567	0.0348	0.0280	0.0398
Emission Rate (lb/hr)	253	159	126	179

Table 14 – Summary of the Stack Outlet HCl and HF Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/8/11	7/8/11	
Start Time	8:05	6:41	13:48	
Stop Time	12:32	11:31	18:20	
<u>Fuel Conditions</u>				
F _d (dscf/mmBtu)	9,808	9,914	9,817	
Chlorine (mg/kg dry)	928	878	916	
Fluorine (mg/kg dry)	73	58	49	
<u>Gas Conditions</u>				
Temperature (°F)	135	133	135	134
Volumetric Flow Rate (acfm)	1,708,000	1,703,000	1,726,000	1,712,000
Volumetric Flow Rate (scfm)	1,499,000	1,463,000	1,481,000	1,481,000
Volumetric Flow Rate (dscfm)	1,259,000	1,220,000	1,226,000	1,235,000
Carbon Dioxide (% dry)	10.3	10.6	10.4	10.4
Oxygen (% dry)	9.17	8.82	9.07	9.02
Moisture (%)	16.0	16.7	17.2	16.6
<u>Hydrogen Chloride Results</u>				
Concentration (lb/dscf)	1.57E-08	1.44E-08	1.08E-08	1.36E-08
Concentration (ppmdv)	0.166	0.152	0.114	0.144
Emission Rate (lb/mmBtu)	2.75E-04	2.46E-04	1.87E-04	2.36E-04
Emission Rate (lb/hr)	1.19	1.05	0.793	1.01
<u>Hydrogen Fluoride Results</u>				
Concentration (lb/dscf)	1.03E-08	1.11E-08	1.04E-08	1.06E-08
Concentration (ppmdv)	0.199	0.214	0.200	0.205
Emission Rate (lb/mmBtu)	1.81E-04	1.91E-04	1.80E-04	1.84E-04
Emission Rate (lb/hr)	0.782	0.815	0.764	0.787

Table 15 – Summary of the Stack Outlet Metallic HAP Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:23	13:16	8:58	
<u>Fuel Conditions</u>				
F _d (dscf/mmBtu)	9,808	9,817	9,828	
Antimony (mg/kg dry)	0.01	0.05	0.01	
Arsenic (mg/kg dry)	6.70	0.59	6.35	
Beryllium (mg/kg dry)	0.38	1.09	0.87	
Cadmium (mg/kg dry)	0.25	4.69	0.94	
Chromium (mg/kg dry)	8.70	10.35	10.76	
Cobalt (mg/kg dry)	2.03	2.03	2.07	
Lead (mg/kg dry)	24.73	22.55	18.40	
Manganese (mg/kg dry)	16.72	26.85	16.70	
Nickel (mg/kg dry)	8.33	7.79	7.98	
<u>Gas Conditions</u>				
Temperature (°F)	135	134	133	134
Volumetric Flow Rate (acfm)	1,796,000	1,698,000	1,785,000	1,760,000
Volumetric Flow Rate (scfm)	1,576,000	1,492,000	1,536,000	1,535,000
Volumetric Flow Rate (dscfm)	1,308,000	1,238,000	1,284,000	1,277,000
Carbon Dioxide (% dry)	10.3	10.6	10.4	10.4
Oxygen (% dry)	9.17	8.82	9.07	9.02
Moisture (%)	17.0	17.1	16.4	16.8
<u>Antimony - Sb</u>				
Concentration (ug/dscm)	1.80	1.03	1.39	1.41
Emission Rate (lb/mmBtu)	1.96E-06	1.09E-06	1.51E-06	1.52E-06
Emission Rate (lb/hr)	0.00882	0.00476	0.00670	0.00676
<u>Arsenic - As</u>				
Concentration (ug/dscm)	5.05	4.68	4.17	4.63
Emission Rate (lb/mmBtu)	5.51E-06	4.96E-06	4.52E-06	5.00E-06
Emission Rate (lb/hr)	0.0247	0.0217	0.0201	0.0222
<u>Beryllium - Be</u>				
Concentration (ug/dscm)	0.158*	0.149*	0.166*	0.158
Emission Rate (lb/mmBtu)	1.73E-07*	1.58E-07*	1.80E-07*	1.70E-07
Emission Rate (lb/hr)	0.000776*	0.000690*	0.000799*	0.000755

Table 15 – Summary of the Stack Outlet Metallic HAP Results (continued)

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/7/11	7/7/11	7/8/11	
Start Time	8:05	11:00	6:41	
Stop Time	10:05	13:00	8:41	
F _d (dscf/mmBtu)	9,808	9,817	9,828	
<u>Cadmium - Cd</u>				
Concentration (ug/dscm)	0.461*	0.758	0.387*	0.536
Emission Rate (lb/mmBtu)	5.03E-07*	8.04E-07	4.20E-07*	5.76E-07
Emission Rate (lb/hr)	0.00226*	0.00352	0.00186*	0.00255
<u>Chromium - Cr</u>				
Concentration (ug/dscm)	4.46	5.36	4.65	4.82
Emission Rate (lb/mmBtu)	4.86E-06	5.68E-06	5.04E-06	5.19E-06
Emission Rate (lb/hr)	0.0218	0.0248	0.0224	0.0230
<u>Cobalt- Co</u>				
Concentration (ug/dscm)	0.486	0.445	0.458	0.463
Emission Rate (lb/mmBtu)	5.30E-07	4.72E-07	4.97E-07	5.00E-07
Emission Rate (lb/hr)	0.00238	0.00207	0.00221	0.00222
<u>Lead - Pb</u>				
Concentration (ug/dscm)	1.76	2.25	1.69	1.90
Emission Rate (lb/mmBtu)	1.92E-06	2.39E-06	1.83E-06	2.05E-06
Emission Rate (lb/hr)	0.00864	0.0105	0.00814	0.00908
<u>Manganese - Mn</u>				
Concentration (ug/dscm)	5.29	5.98	6.05	5.77
Emission Rate (lb/mmBtu)	5.77E-06	6.34E-06	6.55E-06	6.22E-06
Emission Rate (lb/hr)	0.0259	0.0277	0.0291	0.0276
<u>Nickel - Ni</u>				
Concentration (ug/dscm)	6.12	7.26	5.35	6.24
Emission Rate (lb/mmBtu)	6.67E-06	7.70E-06	5.80E-06	6.72E-06
Emission Rate (lb/hr)	0.0300	0.0337	0.0258	0.0298
<u>Selenium - Se</u>				
Concentration (ug/dscm)	74.6	54.0	46.5	58.4
Emission Rate (lb/mmBtu)	8.14E-05	5.73E-05	5.04E-05	6.31E-05
Emission Rate (lb/hr)	0.366	0.251	0.224	0.280

indicates that one fraction was below the detection limit.

Table 16 – Summary of the Stack Outlet Hg Results

<u>Test Parameters</u>	Run 1	Run 2	Run 3	Average
Date	7/12/11	7/13/11	7/13/11	
Start Time	16:00	6:49	8:50	
Stop Time	17:30	8:17	10:20	
<u>Fuel Conditions</u>				
Fd (dscf/mmBtu)	9,827	9,804	9,830	
Mercury (mg/kg dry)	0.096	0.112	0.113	
<u>Gas Conditions</u>				
M29 Volumetric Flowrate, (dscfm)	1,334,000	1,289,000	1,290,000	1,334,000
M29 Oxygen (% dry)	9.17	8.82	9.07	9.02
M29 Moisture (%)	16.8	17.4	17.0	17.1
<u>Oxidized Mercury Results</u>				
Concentration Train A (µg/dscm)	0.245	1.02	1.11	0.791
Emission Rate (lb/mmBtu)	2.68E-07	1.08E-06	1.20E-06	8.50E-07
Emission Rate (lb/hr)	0.00123	0.00492	0.00536	0.00384
<u>Elemental Mercury Results</u>				
Concentration Train A (µg/dscm)	2.10	2.62	2.72	2.48
Emission Rate (lb/mmBtu)	2.29E-06	2.78E-06	2.95E-06	2.67E-06
Emission Rate (lb/hr)	0.0105	0.0127	0.0131	0.0121
<u>Total Mercury Results</u>				
Concentration Train A (µg/dscm)	2.33	3.64	3.84	3.27
Concentration Train B (µg/dscm)	3.76	2.93	3.09	3.26
Average Concentration (µg/dscm)	3.05	3.29	3.46	3.27
Emission Rate (lb/mmBtu)	3.33E-06	3.48E-06	3.75E-06	3.52E-06
Emission Rate (lb/hr)	0.0152	0.0159	0.0167	0.0159

Test Procedures

Method Listing

The test methods found in 40 CFR Part 60, Appendix A and 40 CFR Part 51 Appendix M were referenced during the test program. The following individual methods were used:

EPA Method 1	Sample and Velocity Traverse for Stationary Sources
EPA Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S pitot tube)
EPA Method 3	Gas Analysis for the Determination of Dry Molecular Weight
EPA Method 4	Determination of Moisture Content in Stack Gases
EPA Method 5B	Determination of Non-Sulfuric Acid Particulate Matter Emissions from Stationary Sources
EPA Method 19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emission Rates
EPA Method 26	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources – Non-isokinetic Method
EPA Method 26A	Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources - Isokinetic Method
EPA Method 29	Determination of Metals Emissions from Stationary Sources
EPA Method 30B	Determination of Total Vapor Phase Mercury Emissions from Coal-Fired Combustion Sources Using Carbon Sorbent Traps
EPA Method 202	Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources

Method Descriptions

Method 1

Method 1 was used to determine the suitability of each test location and to determine the sample points used for the isokinetic pollutant concentration determinations. The Stack Outlet test location conformed to the minimum requirements of being located at least 2.0 diameters downstream and at least 0.5 diameters upstream from the nearest flow disturbance. The ESP test locations did not meet Method 1 requirements.

The ESP Unit 1 test location was a round, horizontal stack with a diameter of 132 inches. A single, central point was sampled for the Method 26 HCl and HF determinations.

Twelve points were sampled in one test port for the Methods 5/202 and 29 determinations. A cross section of the sampling location, showing the sample points, can be found in Figure 1 of the Appendix.

The ESP Unit 2 test location was a round, horizontal stack with a diameter of 132 inches. A single, central point was sampled for the Method 26 HCl and HF determinations. Twelve points were sampled in one test port for the Methods 5/202 and 29 determinations. A cross section of the sampling location, showing the sample points, can be found in Figure 2 of the Appendix.

The ESP Unit 3 test location was a round, horizontal stack with a diameter of 132 inches. A single, central point was sampled for the Method 26 HCl and HF determinations. Twelve points were sampled in one test port for the Methods 5/202 and 29 determinations. A cross section of the sampling location, showing the sample points, can be found in Figure 3 of the Appendix.

The Stack Outlet test location was a round, vertical stack with a diameter of 358 inches. Three points were sampled for each of the four test ports. The test location was approximately 8.4 diameters downstream and approximately 2.1 diameters upstream from the nearest flow disturbances. A cross section of the sampling location, showing the sample points, can be found in Figure 4 of the Appendix.

Method 2

Method 2 was used to determine the gas velocity through each test location using a Type-S pitot tube and an incline plane oil manometer. The values measured in Method 2, along with the measurements made in Methods 3 and 4, were used to calculate the volumetric flow rate through the test location. A diagram of the Method 2 apparatus is shown in Figure 5 and as part of the Methods 5B/202, 26, 26A and 29 sampling trains in Figure 7, 8, 9 and 10 of the Appendix.

The manometer was leveled and “zeroed” prior to each test run. The sample train was leak checked before and after each run by pressurizing the positive side, or “high” side, of the pitot tube and creating a deflection on the manometer of at least three inches H₂O. The leak check was considered valid if the manometer remained stable for 15 seconds. This procedure was repeated on the negative side by generating a vacuum of at least three inches H₂O. The velocity head pressure and gas temperature were then determined at each point specified in Method 1. The static pressure of the stack was measured using a water filled U-tube manometer. In addition, the barometric pressure was measured and recorded.

Method 3

The carbon dioxide and oxygen content of the sample gas was determined at each test location using Method 3. A gas sample was collected into a Tedlar bag from the dry gas meter exhaust of the Method 5B sampling train for the duration of each test run. Analysis was performed using an Orsat gas analyzer.

The gas analyzer was leak checked prior to analysis by raising the liquid levels in each pipette to a reference mark on the capillary tubes and then closing the pipette valves. The burette solution was then raised to bring the meniscus onto the graduated portion of the burette and the manifold valve was closed. After four minutes, the pipette meniscus did not fall below the reference mark and the burette meniscus did not fall by more than 0.2 percent, so the leak check was considered valid. The average of three gas analyses determined the carbon dioxide and oxygen contents.

The carbon dioxide content and oxygen content were used, along with the moisture content determined in Method 4, to calculate the gas stream molecular weight. The molecular weight was then used for the volumetric flow rate calculation. For these calculations, the balance of the gas stream was assumed to consist of nitrogen since other gas stream components are insignificant for the purposes of calculating molecular weight.

Method 4

The moisture content at the test location was determined using EPA Method 4 in conjunction with the Methods 5B/202, 26, 26A and 29 test runs. A known volume of sample gas was withdrawn from each source and the moisture was condensed and measured. The dry standard volume of the sample gas was then compared to the volume of moisture collected to determine the moisture content of the sample gas. A diagram of the Method 4 apparatus is shown in Figure 6 and as part of the Methods 5B/202, 26, 26A and 29 sampling trains in Figure 7, 8, 9 and 10 of the Appendix.

To condense the water vapor the gas sample passed through a series impingers. The impingers were charged as outlined in each individual method. In all trains, the last impinger contained a known weight of silica gel to absorb any residual water vapor.

After the test run the sample train was leak checked at the highest vacuum encountered during the test run. The amount of water collected in the condenser system and the silica gel weight gain was determined gravimetrically. The net weight gain of water was converted to a volume of wet gas and then compared to the amount of dry gas sampled to determine the moisture content. The moisture content was used, along with the oxygen and carbon dioxide content determined by EPA Method 3, for the calculation of the volumetric flow rate.

Method 5B/202

The total PM concentrations were determined using EPA Methods 5B/202. In EPA Methods 5B/202, a sample of the gas stream was withdrawn isokinetically from the test locations. Non-sulfuric PM was collected in the nozzle, probe, connecting glassware and filter. CPM in the sample gas passed through the filter and collected in a gas condenser system. The weight of non-sulfuric PM and CPM collected with the sample train combined with the volume of dry gas withdrawn from the stack was then used to calculate a total PM concentration. A diagram of the Method 5B/202 sampling train is shown in Figure 7 of the Appendix.

To prevent contamination, all components of the sample trains were constructed of glass or Teflon with no metal connections. Prior to testing all the components of the Method 5B sampling train were cleaned using detergent and then rinsed with tap water, deionized water and lastly with acetone. For the Method 202 sampling train all the components were cleaned using detergent and then rinsed with tap water, deionized water, acetone and lastly with hexane. After drying, all components were sealed with parafilm or Teflon tape.

The Method 5B portion of the sampling train consisted of a glass nozzle, a glass (or Teflon) lined sample probe and a glass fiber filter. The probe and filter were maintained at a temperature of 320°F (+/- 25°F).

After exiting the Method 5B portion of the sampling system, the sample gas passed through an EPA Method 23 type glass coil condenser and then through a series of four (4) glass impingers. The condenser was cooled with a water recirculation pump that was placed in a water bath. The recirculation pump and coiled condenser are used to maintain the gas temperature between 65°F and 85°F at the exit of the CPM filter. Impingers 1 and 2 were initially empty. A Teflon fiber CPM filter followed impinger 2. Impinger 3 contained 100ml of water. The fourth impinger contained a known mass of silica gel to absorb any remaining water vapor. The dry gas exiting the moisture condenser system then passed through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter the sample stream passed through an orifice which was used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane oil manometer.

Whatman 934-AH glass fiber filters were used as the substrate for the non-sulfuric PM sampling. The filter was loaded into a glass filter holder with a Teflon support screen that was cleaned and prepared in the same manner as the other components of the Method 5B sample train. Prior to the test run, the filter was baked at 320°F (+/- 25°F) for a minimum of two (2) hours then desiccated for at least 24 hours and then weighed to the nearest 0.0001gram (g) until a constant weight was achieved. The weight of the filter was considered to be constant when two consecutive weights taken at least six hours apart were within 0.0005g of each other.

The probe liner was thoroughly pre-cleaned with acetone and the probe wash was saved as a quality assurance check. The sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg. A leak test was considered valid if the leak rate was below 0.02 cfm. When not in operation or inside the stack, the nozzle was sealed with Teflon tape.

The probe tip was placed at the first of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2 by reading the velocity pressure from the oil manometer. Sample was withdrawn from the source at a rate such that the velocity in the nozzle matches the velocity of the stack gas at the sample point

(isokinetically). During the test run the train was moved to each of the Method 1 sample points. The sample time at each point was calculated based on the number of sample points and the run time. The gas velocity pressure, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure and pump vacuum were recorded for each sample point.

After the test run the sample train was leak checked at the highest vacuum encountered during the test run. The sampling train was moved to the on-site lab and purged with zero grade nitrogen at a nominal flow rate of at least 14 liters per minute for a period of 60 minutes. The nozzle, probe and front half of the filter holder were washed with acetone and the rinse saved in a 250ml glass jar equipped with a Teflon lid. The glass fiber filter was removed from the filter holder, transferred to a Petri dish and sealed.

Upon completion of the purge, the contents of impingers one and two were transferred to a pre-cleaned 950 ml sample jar equipped with a Teflon lid. The condenser coil and all connecting glassware up to and including the front half of the CPM filter were rinsed twice with deionized ultra filtered (DUIF) water and added to the sample jar. An acetone rinse of the above glassware was performed and saved in a separate pre-cleaned 500ml sample jar equipped with a Teflon lid. Finally, two (2) rinses of the above components were performed with hexane and added to the acetone container. The CPM filter was removed from the filter holder and placed in a 20ml glass vial.

Analysis of all sample fractions was performed at the Airtech laboratory located in Bensenville, Illinois. The acetone rinses from the Method 5B portion of the sampling train were transferred to tared beakers, evaporated to dryness under ambient temperature and pressure conditions, baked for six (6) hours, desiccated for 24 hours and weighed to a constant weight. A weight was considered constant when the difference between two consecutive weights, taken a minimum of six hours apart, was less than or equal to 0.0005 grams. The weight gain of the glassware rinses and glass fiber filter yield the total weight of non-sulfuric particulate collected during sampling.

Inorganic extraction of the CPM filter was performed by placing the filter into an extraction tube with DIUF water and placing it into a sonication bath for a minimum of 2 minutes. This extraction was done a total of 3 times and the water used each time was added to the impinger water container. After inorganic extraction of the CPM filter, an organic extraction of the impinger water was performed. The entire contents of the impinger water sample fraction was placed in a separatory funnel. A 30 ml aliquot of Hexane was added to the funnel and the funnel contents were thoroughly mixed. The organic layer was then allowed to separate from the water and was decanted from the funnel into the acetone and hexane sample jar. This procedure was conducted three (3) times to complete the extraction.

The inorganic contents of the separatory funnel were then transferred into a beaker and evaporated down to not less than 10 ml final volume at an elevated temperature. The

remaining liquid was evaporated to dryness at ambient temperature. The tin was desiccated for 24 hours and then weighed to a constant weight.

Organic CPM extraction of the filter was performed by placing the inorganic extracted filter into an extraction tube with hexane and placing it into a sonication bath for a minimum of 2 minutes. This extraction was done a total of 3 times and the hexane used was added to the acetone/hexane container. The contents of this container was transferred into a beaker and evaporated to dryness at ambient temperature and pressure. The tin was desiccated for 24 hours and then weighed to a constant weight.

The weight differences for the organic and inorganic fractions were combined to determine the total condensible particulate collected. All fractions of the CPM analysis were adjusted for the appropriate blank values.

EPA Method 19

The equations in EPA Method 19 were used to calculate the emission rates of various pollutants from the test location in units of pounds per million British thermal units (lb/mmBtu). The calculation was based on the oxygen content of the sample gas and an appropriate F factor, which is the ratio of combustion gas volumes to heat inputs.

Method 26

EPA Method 26 was used to determine the concentrations of HCl and HF at each ESP test location. In EPA Method 26, a sample of the stack gas was withdrawn at a constant rate from the source. HCl and HF in the sample gas was collected in a dilute sulfuric acid (H₂SO₄) solution. After each test run, the solution was recovered and analyzed using ion chromatography (IC). The total mass of each target constituent collected, combined with the volume of dry gas withdrawn from the test location was then used to calculate the in-stack concentration of each target constituent. A diagram of the sampling system may be found in Figure 8 of the Appendix.

The sample probe consisted of a heated glass liner. Sample gas passed through the probe assembly and then passed through a series of five glass midjet impingers. The first impinger was initially empty. The second and third impingers each contained 15ml of a dilute sulfuric acid (H₂SO₄) solution. The fourth impinger was initially empty. The fifth impinger contained a mass of silica gel to absorb any residual water vapor. After exiting the impinger system, the gas stream was passed through a sample pump and into a dry gas meter, where the gas volume was measured. After leaving the dry gas meter, the sample stream passed through an orifice that was used to meter the flow rate through the sample train.

The sampling train was assembled and leak checked prior to the test run. The leak check was performed by capping the probe nozzle and pulling a vacuum greater than the highest vacuum expected during the test run.

The probe tip was then placed in the duct. Sample was withdrawn from the source at a constant rate. The gas velocity pressure, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure and pump vacuum were recorded.

After the test run the train was leak checked at the highest vacuum encountered during the test run. The impinger contents were recovered and stored in a 500ml high density, polyethylene sample jar. The impingers were rinsed three (3) times each with 0.1N H₂SO₄ with the rinses added to the sample jar. The resulting samples (including all rinses) were analyzed for HCl and HF using ion chromatography. Analysis for HCl and HF was performed at the Airtech laboratory located in Denver, Colorado.

Method 26A

EPA Method 26A was used to determine the concentrations of HCl and HF at the Stack Outlet test location. A sample of the gas stream was withdrawn isokinetically from the stack through a heated probe, a Teflon mat filter and a series of glass impingers charged with a dilute sulfuric acid (H₂SO₄) solution. After each test run, the solution was recovered and analyzed using ion chromatography (IC). The total mass of each target constituent collected, combined with the volume of dry gas withdrawn from the test location was then used to calculate the in-stack concentration of each target constituent. A diagram of the sampling system may be found in Figure 9 of the Appendix.

To prevent contamination, all components of the sample train were constructed of glass with no metal connections. Prior to testing the components were cleaned using detergent and then rinsed with tap water, deionized water and lastly with acetone. After drying, all components will be sealed with parafilm or Teflon tape.

The sample probe consisted of a heated teflon liner and glass nozzle. Sample gas passed through the nozzle and probe assembly and then through a heated Teflon fiber filter. All heated components of the sampling train were maintained at a temperature of at least 248°F. After exiting the filter, the sample gas passed through a series of five glass impingers. The first impinger was initially empty. The second and third impingers each contained 100ml of a dilute H₂SO₄ solution. The fourth impinger was initially empty. The fifth impinger contained a mass of silica gel to absorb any residual water vapor. After exiting the impinger system, the gas stream passed through a sample pump and into a dry gas meter, where the gas volume was measured. After leaving the dry gas meter, the sample stream passed through an orifice that was used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline oil manometer.

The sampling train was assembled and leak checked prior to the test run. The leak check was performed by capping the probe nozzle and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check was considered valid if the leak rate was below 0.02 cubic feet per minute.

The probe tip was then placed at the first of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2 by reading the velocity pressure from the oil manometer. Sample was withdrawn from the source at a rate such that the velocity in the nozzle matched the velocity of the stack gas at the sample point (isokinetically). During the test run the train was moved to each of the Method 1 sample points. The sample time at each point was calculated based on the number of sample points and the run time. The gas velocity pressure, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure and pump vacuum were recorded for each sample point.

After the test run the train was leak checked at the highest vacuum encountered during the test run. The impinger contents were recovered and stored in a 500ml high density, polyethylene sample jar. The impingers were rinsed three (3) times each with H₂SO₄ with the rinses added to the sample jar. The resulting samples (including all rinses) were analyzed for HCl and HF using ion chromatography. Analysis for HCl and HF was performed at the Airtech laboratory located in Denver, Colorado.

Method 29

EPA Method 29 was used to determine the concentration of metallic hazardous air pollutants (HAP) at the test location. Metallic HAPs include antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), manganese (Mn), nickel (Ni) and selenium (Se). In EPA Method 29, sample gas was withdrawn isokinetically from the test location and the Metallic HAPs in the sample gas was collected in a heated probe, on a quartz fiber filter and in a series of chilled impingers charged with a metals absorbing solution. The mass of Metallic HAPs collected with the sample train, combined with the volume of dry gas withdrawn from the test location was then used to calculate the concentration of each Metallic HAPs. A diagram of the sampling system may be found in Figure 10 of the Appendix.

To prevent contamination, all components of the sample train were glass or Teflon with no metal connections. Prior to testing, the components were washed using detergent and then rinsed with tap water and rinsed again with deionized water. All glassware was soaked for a minimum of four (4) hours in a ten percent (10%) nitric acid (HNO₃) solution. After soaking, the glassware was rinsed with de-ionized, ultra filtered (DIUF) water and finally with acetone. After drying, all components were sealed with parafilm.

The sample probe consisted of a heated liner and glass nozzle. Sample gas passed through the nozzle, the probe assembly, and then through a heated quartz fiber filter. The probe and filter were maintained at 250°F (+/- 25°F). After exiting the filter, the sample gas passed through a series of five glass impingers. The first impinger was initially empty. The second and third impingers were each loaded with 100ml of a 5 percent HNO₃/10 percent H₂O₂ solution. The fourth impinger was initially empty. The fifth impinger contained a known quantity of silica gel to absorb any residual water vapor. After exiting the impingers, the gas stream passed through a sample pump and into a dry gas meter, where the gas volume was measured. After leaving the dry gas meter, the sample stream

passed through an orifice that was used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline oil manometer.

Prior to the test run, the probe was thoroughly cleaned with a 0.1 N nitric acid solution and the probe washes saved as a quality assurance check. The sampling train was then assembled and leak checked by capping the probe nozzle and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check was considered valid if the leak rate was below 0.02 cubic feet per minute.

The probe tip was then placed at the first of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2 by reading the velocity pressure from the oil manometer. Sample was withdrawn from the source at a rate such that the velocity in the nozzle matched the velocity of the stack gas at the sample point (isokinetically). During the test run the train was moved to each of the Method 1 sample points. The sample time at each point was calculated based on the number of sample points and the run time. The gas velocity pressure, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure and pump vacuum were recorded for each sample point.

After sampling, the sample train was transferred to the on-site laboratory for recovery. The filter was removed from the holder and placed in a petri dish. The front half of the sample train consisting of the nozzle, probe liner and filter holder inlet half was brushed with a non-metallic brush and rinsed with 0.1 N HNO₃. The rinse was saved in a 250ml trace clean amber glass sample jars. The contents of the first four impingers were recovered and saved in a 500ml Nalgene sample jar. The impingers and the filter outlet half were then rinsed with 0.1N HNO₃, and the rinses added to the impinger sample jar. The contents of the fifth (silica gel) impinger was weighed for moisture weight gain and discarded.

The 0.1N HNO₃ front half rinse and filter were digested with HNO₃. This fraction and the sample fraction acquired from the first three impingers were analyzed separately for all the metals listed using ICP and GFAA. Analysis of the samples was conducted by ElementOne located in Wilmington, North Carolina.

Method 30B

EPA Method 30B was used to determine the concentration of vapor-phase mercury at each test location. In EPA Method 30B, a sample of the effluent was withdrawn from the test location at a constant rate through an in-situ, glass 10 ml trap. The trap contained two stages of sorbent media designed to adsorb both Hg² and Hg⁰ forms of vapor-phase mercury. A glass wool plug preceded the sorbent media sections collected particle bound mercury. The masses of mercury species collected with the traps was compared to the volume of dry gas sampled to calculate the various mercury concentrations. A diagram of the sampling system may be found in Figure 6 of the Appendix.

The sample traps for the Method 30B apparatus were quartz in construction. Traps were fitted to the end of the probe and contained in a steel heater block assembly designed to both prevent moisture condensation in the trap as well as provide for a constant temperature during sample collection. Sample gas passed through the trap and probe assembly, then through a condenser system comprised of a series of glass impingers. After exiting the condenser system, the sample gas passed through a metering system to determine the dry volume of gas sampled.

The volume of dry gas exiting the gas condenser system was measured with a dry gas meter. After leaving the dry gas meter the sample stream passed through an orifice, which was used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane oil manometer. The gas meter reading, gas meter inlet and outlet temperatures, gas meter static pressure and pump vacuum were recorded every five minutes during each test run.

The sample train was leak checked prior to the test run by capping the trap tip and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check was considered valid if the leak rate was less than four (4) percent of the average sampling rate. Sample gas was then withdrawn from the source at a constant rate such that the predetermined sample volume was collected. After the test run the probe was removed from the stack and the sample train was leak checked at the highest vacuum encountered during the test run.

Each test run consisted of a paired set of adsorbent tubes, one spiked with a known mass of Hg and the other unspiked. The spiked tube was a standard Method 30B sampling tube packed with carbon. The unspiked tube contained proprietary sections of adsorbant media designed to collect the different species of mercury separately. A glass wool plug collected particle bound mercury. This was followed by two sections of adsorbent media designed to catch oxidized, vapor phase mercury. These sections were followed by two additional sections of adsorbent media designed to catch elemental, vapor phase mercury. All tube sections were analyzed separately using an Ohio Lumex, Model RA-915+ mercury analyzer. Quality assurance for the sample trains included spike recoveries, breakthrough checks and duplicate sample agreement. It should be noted that both spike recoveries and duplicate agreement QA is based on total mercury only.

Analysis of the samples was performed at the Airtech Laboratory located in Denver, Colorado. Results for mercury are expressed in units of pounds per million British thermal units (lbs/mmBtu) and pounds per hour (lb/hr).

