

**Air Permit Review**

**Permit Issue Date:**

**Region:** Asheville Regional Office  
**County:** Rutherford  
**NC Facility ID:** 8100028  
**Inspector's Name:** Mike Parkin  
**Date of Last Inspection:** 09/18/2008  
**Compliance Code:** C/In Compliance With  
 Procedural Reqr

<b>Facility Data</b>			<b>Permit Applicability (this application only)</b>
<p><b>Applicant (Facility's Name):</b> Duke Energy Carolinas, LLC - Cliffside Steam Station</p> <p><b>Facility Address:</b>                  Duke Energy Carolinas, LLC - Cliffside Steam Station                  573 Duke Power Road (SR 1002)                  Cliffside, NC 28024</p> <p><b>SIC:</b> 4911 / Electric Services  <b>NAICS:</b> 221112 / Fossil Fuel Electric Power Generation</p> <p><b>Facility Classification: Before:</b> Title V <b>After:</b> Title V  <b>Fee Classification: Before:</b> Title V <b>After:</b> Title V</p>			<p><b>SIP:</b>  <b>NSPS:</b>  <b>NESHAP:</b>  <b>PSD:</b>  <b>PSD Avoidance:</b>  <b>NC Toxics:</b>  <b>112(r):</b>  <b>Other:</b></p>
<b>Contact Data</b>			<b>Application Data</b>
<b>Facility Contact</b>	<b>Authorized Contact</b>	<b>Technical Contact</b>	<p><b>Application Number:</b> 8100028.08B  <b>Date Received:</b> 10/27/2008  <b>Application Type:</b> Modification  <b>Application Schedule:</b> TV-Significant  <b>Existing Permit Data</b>  <b>Existing Permit Number:</b> 04044/T28  <b>Existing Permit Issue Date:</b> 01/29/2008  <b>Existing Permit Expiration Date:</b> 10/31/2008</p>
Steve Hodges Environmental Coordinator (828) 657-2339 573 Duke Power Road Mooresboro NC, 28114	Rick Roper Manager Cliffside Steam Station 573 Duke Power Road Mooresboro NC, 28114	William Horton Senior Environmental Specialist (980) 373-3226 526 South Church Street Charlotte NC, 28202	
<p><b>Review Engineer:</b> Ed Martin</p> <p><b>Review Engineer's Signature:</b> _____ <b>Date:</b> _____</p>		<p style="text-align: center;"><b>Comments / Recommendations:</b></p> <p><b>Issue</b> 04044/T29  <b>Permit Issue Date:</b>  <b>Permit Expiration Date:</b></p>	

Attachments

1. Unit 6 New Generation Design Basis Coal Specification Parent Coals Table
2. Marshall Unit 4 FGD Clean Air Engineering test report, dated May 29, 2007
3. Alstom letter dated October 14, 2008

**I. Purpose of Application:**

Duke Energy has submitted an application (8100028.08B) to request that its existing permit be amended to require that Hazardous Air Pollutants (HAPs) emissions from the Unit 6 boiler be less than 25 tons per year and that emissions of any single HAP be less than 10 tons per year. Duke has furnished calculations showing the HAP emissions it projects from Unit 6 and the Division of Air Quality (DAQ) has reviewed those calculations and made a preliminary assessment of the accuracy of Duke's calculations as described below. In summary, the DAQ has tentatively concluded that Duke's estimate of Unit 6's potential HAP emissions are accurate.

By definition, actual emissions are always less than potential emissions. The DAQ has calculated expected actual emissions of HAPs based on the data supplied by Duke and tentatively confirmed that they are expected to be considerably less than potential emissions.

Based on this review, the DAQ is proposing to approve Duke's request and issue a revised air quality permit containing enforceable permit conditions restricting HAP emissions from Cliffside Unit 6 to less than 10 tons per year for any single HAP and less than 25 tons per year for all HAPs.

This change is a significant permit modification being made in accordance with 15A NCAC 2Q .0501(c)(2).

**II. Permit Changes:**

The following changes are proposed to be made to the Duke Energy Carolinas LLC Cliffside Air Permit No. 04044T28:

Page	Part, Section	Description of Changes
<b>Part I</b>		
Cover	--	Amended permit numbers and dates.
51	Part I, Section 2.1 J.13	Added requirement for emissions of hazardous air pollutants (HAPs) from Unit 6.

**III. Facility Description**

See existing Air Quality Permit

**IV. Summary of Changes to Emission Sources and Control Devices:**

There are no changes to emission sources or control devices.

**V. Emission and Regulatory Evaluation**

In the application requesting the HAP permit conditions, Duke provided calculations indicating that the potential HAP emissions from Unit 6 are less than 10 tons per year of any single HAP and less than 25 tons per year for all HAPs combined. In addition to reviewing Duke's calculations for appropriateness and accuracy, the DAQ calculated expected actual emissions from Cliffside Unit 6 based on assumptions described below to understand how close their actual emissions would be to their potential emissions.

**Duke's HAP Calculations**

**Acid Gases (HCl and HF)**

Potential estimates of emissions are based on the foreseeable worst-case concentrations (maximum) of chlorides and fluorides in coal for Cliffside Unit 6 fuel supply. This information is presented in the Unit 6 New Generation Design Basis Coal Specification Parent Coals table (Attachment 1). The Parent Coals include all fuel supply regions that may foreseeably provide coal to Cliffside. These coals may be burned either individually (100% of fuel) or blended with the other fuels.

The calculations assume, as an upper bound, that all of the chloride and fluoride will exit the boiler as hydrochloric acid (HCl) or hydrofluoric acid (HF). HCl and HF will be removed by the pollution control equipment, including the spray dry adsorber (SDA), fabric filter, and wet fuel gas desulfurization system (FGD). This combination of controls is expected to be highly effective at capture of these acid gases. Capture efficiency used by the applicant is based on actual stack test data obtained by Duke's vendor at a similarly designed FGD system at Duke Energy's Marshall Station, which reported 99.9% removal efficiency. (Clean Air Engineering test report, dated May 29, 2007, Attachment 2) The vendor for the control system for Cliffside Unit 6 reported that the system is expected to achieve a similar reduction efficiency. (Alstom letter dated October 14, 2008, Attachment 3).

The calculations are based on the following:

Chlorine in Coal:	3209 ppm (maximum of all coals)
Fluorine in Coal:	177 ppm (maximum of all coals)
Heat Input Rate:	7850 mmBtu/hr
Heat Content of Coal:	12,777 Btu/lb (mean of all coals)
Removal Efficiency	99.9%

Annual Capacity Factor 100% (8760 hr/yr)

Uncontrolled HCl lb/mmBtu = Chlorine Content x 36.5/35.5 HCl/Cl Molar Ratio / Heat Content  
= 3209 x 36.5/35.5 / 12,777 Btu/lb  
= 0.2582 lb/mmBtu

Controlled HCl lb/mmBtu = Uncontrolled HCl x (1 - Removal Efficiency)  
= 0.2582 lb/mmBtu x (1 - 0.999)  
= 0.00026 lb/mmBtu

HCl Hourly Emissions = Controlled HCl Emissions Rate (lb/mmBtu) x Heat Input Rate (mmBtu/hr)  
= 0.00026 lb/mmBtu x 7850 mmBtu/hr  
= 2.03 lb/hr

HCl Annual Emissions = HCl Hourly Emissions x 8760 hr/year/2000 lb/ton  
= 2.03 lb/hr x 8760 hr/yr / 2000 lb/ton  
= **8.88 tons/yr**

Uncontrolled HF lb/mmBtu = Fluorine Content x 20/19 HF/F Molar Ratio / Heat Content  
= 177 x (20/19) / 12,777 Btu/lb  
= 0.0145 lb/mmBtu

Controlled HF lb/mmBtu = Uncontrolled HF x (1 - Removal Efficiency)  
= 0.0145 lb/mmBtu x (1 - 0.999)  
= 0.000015 lb/mmBtu

HF Hourly Emissions = Controlled HF Emissions Rate (lb/mmBtu) x Heat Input Rate (mmBtu/hr)  
= 0.000015 lb/mmBtu x 7850 mmBtu/hr  
= 0.114 lb/hr

HF Annual Emissions = HF Hourly Emissions x 8760 hr/year/2000 lb/ton  
= 0.114 lb/hr x 8760 hr/yr / 2000 lb/ton  
= **0.50 tons/yr**

#### Metal HAPs (except mercury and selenium)

Calculations for non-mercury metal HAPs are based on AP-42 emission factor methodology for metals (AP-42 Section 1.1 Table 1.1-16), which uses the following equation:

$$E = a \times \left( \frac{C}{A} \times PM \right)^b$$

where: E = emissions in lb/10<sup>12</sup> Btu  
C = concentration of metal in the coal, parts per million by weight (ppmwt).  
A = weight fraction of ash in the coal. For example, 10% ash is 0.1 ash fraction.  
PM = site-specific emission factor for total particulate matter, lb/10<sup>6</sup> Btu.  
a and b = pollutant-specific factors (from AP-42 Section 1.1 Table 1.1-16).

The site-specific particulate factor is based on the current BACT limit for Unit 6 established in the existing permit. Ash and trace element concentration are based on typical fuel analyses from actual fuel deliveries to Duke Energy plants in NC and SC, using last 5-year average actual coal constituents. Emissions are calculated at 800 MW and operation at 8760 hours per year. Note: mercury emissions were based on the current permit mercury limit of 0.019 lb/GWh. Information obtained by DAQ since the issuance of the permit has confirmed that Unit 6 will have no difficulty meeting this limit. Also, selenium emissions are based on EPRI's emission factor.

#### Non-Metal HAPs

Calculations are based on emission factors from AP-42 or from emission factors from the EPRI Emission Factor Handbook - 1995, revised 2002. These factors (shown in the application) are used to determine the emissions rate in pounds per hour. Emissions are calculated by multiplying the emissions factor (pounds per ton of coal) times the fuel firing rate (maximum coal consumption).

Short Term Emissions Rate (lb/hr) = Emission Factor (lb/ton coal) x Fuel Firing Rate (tons/hour).

Tons per Year = Short Term Emissions Rate (lb/hr) x 8760 hours per year / 2000 lb/ton.

Example: Acetaldehyde Emissions

Emission Factor: 8.18 E-05 lb/ton coal

Fuel Firing Rate: 307.2 tons/hr (maximum coal consumption)

Short Term Acetaldehyde Emissions:  $8.25 \text{ E-}06 \text{ lb/ton} \times 307.2 \text{ tons/hr} = 2.51 \text{ E-}02 \text{ lb/hr}$

Annual Acetaldehyde Emissions:  $2.51 \text{ E-}02 \text{ lb/hr} \times 8760 \text{ hours per year} / 2000 \text{ lb/ton} = 0.11 \text{ tpy}$

**Table 1**  
**Summary of HAP Emissions - Duke's Calculations**

TRI Chemical	Annual Emissions (ton/yr)
<b>Acid Gases</b>	
Hydrogen Chloride	8.88
Hydrogen Fluoride	0.50
<b>Total Acid Gases</b>	<b>9.38</b>
<b>Metal HAPs</b>	
Antimony	0.006
Arsenic	0.089
Beryllium	0.008
Cadmium	0.015
Chromium	0.196
Cobalt	0.050
Lead	0.108
Manganese	0.237
Mercury	0.067
Nickel	0.186
Selenium	1.31
<b>Total Metal HAPs</b>	<b>2.276</b>
<b>Non-Metal HAPs</b>	
Acetaldehyde	0.11
Acetophenone	0.04
Acrolein	0.07
Anthracene	0.00
Benzene	0.13
Benzo(g,h,i)perylene	0.00
Benzyl Chloride	0.01
Biphenyl	0.01
Bis(2-ethylhexyl)phthalate	0.12
Bromoform	0.00
Carbon Disulfide	0.04
2-Chloroacetophenone	0.01
Chlorobenzene	0.01
Chloroform	0.03
Cumene	0.01
Cyanide*	3.36
2,4-Dinitrotoluene	0.01
Dimethyl Sulfate	0.06
Ethyl benzene	0.03

Ethyl Chloride (Chloroethane)	0.02
Ethylene Dichloride	0.05
Ethylene Dibromide	0.00
Formaldehyde	0.09
Hexane	0.09
Isophorone	0.04
Methyl Bromide (Bromomethane)	0.03
Methyl Chloride (Chloromethane)	0.04
Methyl Ethyl Ketone	0.52
Methyl Hydrazine	0.23
Methyl Methacrylate	0.04
Methyl tert-butyl ether	0.05
Methylene Chloride	0.12
Naphthalene	0.02
Phenanthrene	0.01
Phenol	0.11
Propionaldehyde	0.07
Styrene	0.02
Tetrachloroethylene	0.01
Toluene	0.06
1,1,1-Trichloroethane	0.03
Vinyl Acetate	0.01
Xylene	0.02
PAC category	0.00
<b>Total Non-Metal HAPs</b>	<b>5.73</b>
<b>Dioxans and Furans</b>	
PCDD/PCDF	0.00000237
<b>Total all HAPS</b>	<b>17.39</b>

DAQ tentatively concurs with Duke's calculation methodology and its conclusion that Unit 6's potential HAP emissions do not exceed 10 tpy for any single HAP and do not exceed 25 tpy for all HAPs. DAQ will take into account all comments received as part of the upcoming public process before reaching its final conclusions.

#### Expected Actual Emissions

As noted above the calculations of potential emissions are based on worst-case conditions. The DAQ has tentatively concluded that actual HAP emissions in this case are likely to be considerably lower than the potential emission calculations. Because HCl and HF represent a large fraction of the overall HAP emission rate, the DAQ only estimated expected actual emissions for these pollutants and added the potential emissions for all other HAPs.

#### Acid Gases (HCl and HF)

DAQ's initial estimate of expected (actual) HCl and HF emissions are based on actual average values of chlorine and fluorine content of the coal, an estimate of the actual expected annual capacity factor, and the recognition that the spray dry absorber (SDA), installed before the FGD system, will remove some of the acid gases. The capture efficiency Duke used in its calculations is based on actual stack test data obtained from the vendor of a similarly designed FGD system (without SDA) at Duke Energy's Marshall Station, which reported 99.9% removal efficiency. This was the removal across the FGD, using a series of EPA method 26 sampling trains at the FGD inlet and stack. For the purposes of this estimate, the DAQ assumes the effect of the spray dry absorber will be to remove approximately 50% of the acid gases prior to the FGD; therefore, increasing the total removal efficiency for acid gases to 99.95%. Assumptions used to calculate expected actual emissions are shown below.

Chlorine in Coal:	1102 ppm (mean of all coals burned by Duke)
Fluorine in Coal:	94.7 ppm (mean of all coals burned by Duke)
Heat Input Rate:	7850 mmBtu/hr
Heat Content of Coal:	12,777 Btu/lb
Removal Efficiency	99.95%
Estimated Capacity Factor	80%

Uncontrolled HCl lb/mmBtu = Chlorine Content x 36.5/35.5 HCl/Cl Molar Ratio / Heat Content  
= 1102 x 36.5/35.5 / 12,777 Btu/lb  
= 0.0887 lb/mmBtu

Controlled HCl lb/mmBtu = Uncontrolled HCl x (1 - Removal Efficiency)  
= 0.0887 lb/mmBtu x (1 - 0.9995)  
= 0.0000443 lb/mmBtu

HCl Hourly Emissions = Controlled HCl Emissions Rate (lb/mmBtu) x Heat Input Rate (mmBtu/hr)  
= 0.0000443 lb/mmBtu x 7850 mmBtu/hr  
= 0.348 lb/hr

HCl Annual Emissions = HCl Hourly Emissions x 8760 hr/year/2000 b/ton x Annual Capacity Factor  
= 0.348 lb/hr x 8760 hr/year / 2000 lb/ton x 0.80  
= **1.22 tons/yr**

Uncontrolled HF lb/mmBtu = Fluorine Content x 20/19 HF/F Molar Ratio / Heat Content  
= 94.7 x (20/19) / 12,777 Btu/lb  
= 0.0078 lb/mmBtu

Controlled HF = Uncontrolled HF x (1 - Removal Efficiency)  
= 0.078 lb/mmBtu x (1 - 0.9995)  
= 0.0000039 lb/mmBtu

HF Hourly Emissions = Controlled HF Emissions Rate (lb/mmBtu) x Heat Input Rate (mmBtu/hr)  
= 0.0000039 lb/mmBtu x 7850 mmBtu/hr  
= 0.0306 lb/hr

HF Annual Emissions = HF Hourly Emissions x 8760 hr/year/2000 lb/ton x Annual Capacity Factor  
= 0.0306 lb/hr x 8760 hr/year / 2000 lb/ton x 0.80  
= **0.107 tons/yr**

**Table 2  
Summary of Expected Actual HAP Emissions**

<b>TRI Chemical</b>	<b>Annual Emissions (ton/yr)</b>
Hydrogen Chloride	1.22
Hydrogen Fluoride	0.107
<b>Total Acid Gases</b>	<b>1.327</b>
<b>Total HAP Metals</b>	<b>2.276</b>
<b>Total Non-Metal HAPs</b>	<b>5.73</b>
PCDD/PCDF	<b>0.00000237</b>
<b>Total all HAPS</b>	<b>9.33</b>

**Compliance Assurance**

As noted above, DAQ has tentatively concluded that Cliffside Unit 6 does not have the potential to exceed the 10/25 tpy HAP thresholds. However, because HCl is the HAP with the highest potential emission rate (8.88 tpy using Duke's calculations and 1.22 tpy using DAQ's calculations) the NCDAQ is proposing to include an annual stack test requirement in order to confirm HCl removal efficiency is being achieved consistent with the assumptions used in calculations.

**VI. Public Notice**

This proposed approval of Duke's request for 10/25 tpy HAP limitations to be placed in their existing Cliffside permit will be taken to notice pursuant to rule 15A NCAC 2Q .0307, and a public hearing will be held to take comment on the proposed approval of this request.

**VII. Other Requirements**

PE Seal

The application was sealed Mr. Daniel A. Markley of Duke Energy in accordance with 15A NCAC 2Q .0112 requirements. The PE number for Mr. Markley is 13751. The NCBELS website indicate that the status of his PE license is "current".

Zoning

Not applicable since there is no expansion of the facility.

Fee Classification

The facility fee classification before and after this modification will remain as "Title V".

Increment Tracking

NA

**VIII. Recommendations**

The DAQ proposes approval of Duke's request subject to public notice and evaluation of all information received as part of the public process.

# ATTACHMENT 1

Duke Energy - Carolina  
 New Generation Design Basis Coal Specification - Parent Coals  
 By: B.T. Nguyen  
 Date: 4/20/2005

Revised Date: 3/10/2008 (by Kris Knudsen)  
 Notes:

Parent Coals are individual coals that may be received at Cliffside Station for use in Unit 6. With the exception of the sub-bituminous coals (PRE\_3 and PRE\_6), each coal may be burned directly in the boiler or may be blended with other coals. The sub-bituminous coals will not be burned individually but must be blended with other bituminous coals as a ratio of no more than 50% sub-bituminous. Actual fuel burned in Unit 6 will depend on fuel supply market conditions.

STATISTICAL ANALYSIS:

Description	HHV Dry (Btu/lb)	Mercury Dry (ppm)	Chlorine Dry (ppm)	Mercury in coal (lbm Hg/Tbu)	Flourine Dry (ppm)
Measure =	12,777	1,102	8,092	94.7	
Maximum =	13,905	3,209	177.0		
Minimum =	10,484	0.940	3.024		

SUMMARY AND CALCULATED COAL QUALITY DATA:

HHV Dry (Btu/lb)	Mercury Dry (ppm)	Chlorine Dry (ppm)	Mercury in coal (lbm Hg/Tbu)	Flourine Dry (ppm)	PRE 1	PRE 2	PRE 3	PRE 4	PRE 5	PRE 6	PRE 7	PRE 8	PRE 9	PRE 10
13,905	13,061	12,746	12,648	13,000	10,484	10,523	12,155	12,322	13,255	13,467	13,483	13,660	12,807	13,635
0.980	0.100	0.130	0.130	0.180	0.070	0.080	0.080	0.080	0.100	0.080	0.110	0.070	0.201	0.193
921	500	1,316	1,040	563	563	180	180	180	3,100	1,400	1,800	3,000	697	1,050
89.0	132.5	82.0	84.0	75.0	177.0	54.8	54.8	54.8	107.0	47.0	64.5	72.0	697	1,050
5,754	7,650	4,705	10,270	13,643	9,437	6,837	6,583	4,185	7,465	5,940	8,193	5,117	15,597	14,195

Note: Dry Heat Value (HHV) is equal to the wet basis heat value from the Proximate Analysis divided by 1 minus the Recessional Moisture Content (% RBM)

COAL QUALITY DATA:

Coal Case	Blacksburg	MA New	ILBS 3	CA1	CA2	CA3	CA4	COL	PRE 3	PRE 4	ILBS 5	ILBS 6	ILBS 8	ILBS 9	OH-ICR	PA-ICR
Proximate Analysis (As Received)																
Moisture (%)	13.62	12.175	11.132	11.676	12.289	10.648	9.772	11.517	8.661	8.610	12.026	12.339	12.339	12.722		
Ash (%)	5.34	6.80	12.66	7.65	5.40	4.57	6.78	12.91	27.09	27.32	10.72	8.75	5.35	7.00		
Sulfur (%)	2.47	3.29	3.06	1.76	0.80	0.67	0.81	0.52	0.30	0.17	2.45	2.82	2.83	2.48		
Volatile Matter (%)	36.93	36.89	35.30	32.67	32.15	25.7	25.64	35.90	31.45	31.17	24.28	35.12	36.48	34.40		
Fixed Carbon (%)	51.45	49.66	42.59	47.03	49.62	42.37	40.81	45.22	37.06	37.06	47.53	48.17	46.55	44.00		
Ash Loading (lbm/Tbu)	5.53	10.40	7.59	10.30	10.37	27.33	27.38	4.52	5.01	5.05	6.53	9.43	6.78	6.78		
Calculated SO2	3.15	5.41	5.50	1.93	1.30	1.33	1.25	0.97	0.68	0.33	4.09	4.26	4.59	3.90		
Ultimate Analysis (DD)																
Carbon (%)	79.58	71.34	71.03	73.39	73.39	62.62	60.72	73.87	69.28	69.96	74.13	74.23	74.42	75.63		
Hydrogen (%)	5.02	4.71	5.65	4.77	4.16	3.78	4.96	4.96	4.95	5.09	5.03	5.29	5.29	5.30		
Nitrogen (%)	1.41	1.50	1.29	1.39	1.04	1.04	1.09	1.53	0.94	0.92	1.52	1.55	1.57	1.60		
Ash Mineral Analysis																
Silica (SiO2) - %	44.22	49.09	51.88	58.33	56.19	62.98	61.84	56.4	37.8	35.43	48.42	49.47	47.97	48.00		
Alumina (Al2O3) - %	21.85	19.75	19.3	26.54	30.78	28.43	24.62	22.17	15.83	17.49	20.48	20.59	18.83	20.60		
Titania (TiO2) - %	0.97	0.84	0.96	1.54	1.82	1.59	1.67	0.90	1.25	1.38	1.06	1.11	1.00	1.10		
Iron Oxide (Fe2O3) - %	19.97	19.07	16.33	6.83	4.36	2.57	2.76	8.94	5.64	5.28	19.64	18.66	21.98	20.30		
Magnesia (MgO) - %	0.82	1.23	0.91	0.83	0.77	0.84	0.93	1.61	3.74	5.09	0.92	1.22	0.90	1.30		
Lime (CaO) - %	4.8	4.23	3.93	1.17	0.87	0.36	0.4	3.85	19.38	21.11	3.54	4.19	3.63	2.70		
Potassium Oxide (K2O) - %	1.46	2.37	2.06	2.2	2.2	2.78	3.03	1.37	0.53	0.42	2.26	2.28	2.29	2.30		
Sodium Oxide (Na2O) - %	0.96	0.91	1.37	0.23	0.25	0.18	0.17	1.53	1.21	1.85	1.00	0.88	0.55	0.60		
Phosphorous Pentoxide (P2O5) - %	0.47	0.38	0.11	0.23	0.18	0.14	0.11	0.19	0.07	1.00	0.12	0.28	0.09	0.20		
Sulfur Trioxide (SO3) - %	4.53	3.53	2.65	0.76	0.53	0.2	0.34	5.07	13.58	10.48	2.43	1.70	2.54	2.10		
Ash Fusion Temperature																
ID @ Oxidizing - F	2,409	2,240	2,293	2,700	2,700	2,800	2,700	2,647	2,173	2,135	2,410	1,990	2,345	2,430		
Sulfating @ Oxidizing - F	2,481	2,699	2,381	2,700	2,700	2,800	2,700	2,700	2,188	2,188	2,510	2,040	2,410	2,470		
Unfused @ Oxidizing - F	2,480	2,698	2,447	2,700	2,700	2,800	2,700	2,700	2,188	2,188	2,500	2,110	2,490	2,500		
Fluid @ Oxidizing - F	2,531	2,543	2,547	2,700	2,700	2,800	2,700	2,700	2,188	2,188	2,500	2,110	2,490	2,500		
ID @ Reducing - F	2,017	2,067	1,984	2,689	2,700	2,800	2,700	2,700	2,077	2,077	2,020	1,980	1,995	2,045		
Sulfating @ Reducing - F	2,146	2,145	2,097	2,700	2,700	2,800	2,700	2,700	2,140	2,105	2,070	2,040	2,035	2,130		
Unfused @ Reducing - F	2,178	2,231	2,178	2,700	2,700	2,800	2,700	2,700	2,113	2,113	2,100	2,320	2,105	2,220		
Fluid @ Reducing - F	2,352	2,344	2,309	2,700	2,700	2,800	2,700	2,700	2,173	2,152	2,420	2,390	2,345	2,390		
Miscellaneous:																
Gross (HCl)	56	55	52	39	41	42	42	45	51	52	56	54	60	57		
Equivalent Moisture (%)	8.5	7	3.00	3.80	4.30	2.50	1.50	1.50	1.00	1.00	7.50	5.30	4.50	3.50		
Free Swelling Index	5.75	7.66	4.71	10.20	13.84	9.50	6.50	3.02	6.88	4.12	7.47	5.64	8.15	5.12		
Calculated Hg (lbm/Tbu)																
Trace Metals - dry whole coal basis																
Chlor Ppm	921	500	1,316	1,040	1,152	503	583	183.4	100	100	1,400	1,800	1,800	3,209		
Fluorine Ppm	80	177	158	84	107	29.5	64	107	29.5	64	107	107	54.3	72		
Mercury Ppm	0.98	0.1	0.98	0.13	0.18	0.1	0.07	0.14	0.08	0.09	0.1	0.08	0.11	0.07		

## ATTACHMENT 2

CleanAir

CleanAir Engineering  
1601 Parkway View Drive  
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800-632-1619  
www.cleanair.com



ALSTOM Power, Inc.  
1409 Centerpoint Blvd.  
Knoxville, Tennessee 37932-1962

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**REPORT ON FGD FEEDBACK TEST PROGRAM**

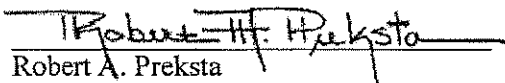
Performed for:  
**ALSTOM POWER, INC.**  
AT THE  
**UNIT 4 FGD ABSORBER INLET AND STACK**  
**DUKE ENERGY**  
**MARSHALL STEAM STATION**

Client Reference No: 96004005  
CleanAir Project No: 10171  
Revision 0: May 29, 2007

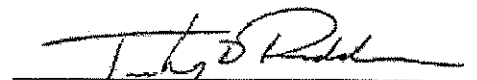
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To the best of our knowledge, the data presented in this report are accurate, complete, error free, legible and representative of the actual emissions during the test program.

Submitted by,

  
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*CleanAir*

ALSTOM POWER, INC.  
MARSHALL STEAM STATION

Client Reference No: 96004005  
CleanAir Project No: 10171

**REVISION HISTORY**

ii

**REPORT ON FGD FEEDBACK TEST PROGRAM**

Revision History

Revision No:	Date	Pages	Comments
R0	05/29/2007	All	Final version of original document.

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*CleanAir*

ALSTOM POWER, INC.  
MARSHALL STEAM STATION

Client Reference No: 96004005  
CleanAir Project No: 10171

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**PROJECT OVERVIEW**

1-1

ALSTOM Power Inc. (ALSTOM) contracted Clean Air Engineering (CleanAir) to perform air emission testing at the Duke Energy Marshall Steam Station located in Terrell, North Carolina.

The test parameters included the following emissions measurements:

- sulfur dioxide (SO<sub>2</sub>)
- sulfur trioxide (SO<sub>3</sub>)
- hydrogen chloride (HCl)
- hydrogen fluoride (HF)
- mercury (Hg)
- trace metals:
  - antimony (Sb)
  - arsenic (As)
  - barium (Ba)
  - beryllium (Be)
  - cadmium (Cd)
  - chromium (Cr)
  - cobalt (Co)
  - copper (Cu)
  - lead (Pb)
  - manganese (Mn)
  - nickel (Ni)
  - phosphorus (P)
  - selenium (Se)
  - silver (Ag)
  - thallium (Tl)
  - zinc (Zn)

The testing took place at the Unit 4 Flue Gas Desulfurization (FGD) Inlet and FGD Stack locations on March 27 through March 30, 2007. Coordinating the field testing were:

D. Laslo – ALSTOM Power Inc.  
G. English – Duke Energy  
B. Delatte – Clean Air Engineering

Table 1-1 outlines the schedule adhered to during the test program. Table 1-2 summarizes the results of the test program. A more detailed presentation of the test conditions and results of analysis are shown in Tables 2-1 through 2-24 on pages 2-1 through 2-23.

**PROJECT OVERVIEW**

**Table 1-1:  
Schedule of Activities**

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Unit 4 FGD Inlet	CleanAir Method 8B	SO2/SO3	03/27/07	11:48	12:48
2	Unit 4 FGD Inlet	CleanAir Method 8B	SO2/SO3	03/27/07	15:01	16:01
1	Unit 4 FGD Stack	CleanAir Method 8C	SO2/SO3	03/27/07	11:48	13:57
2	Unit 4 FGD Stack	CleanAir Method 8C	SO2/SO3	03/27/07	15:01	16:47
1	Unit 4 FGD Inlet	USEPA Method 29	Trace Metals	03/27/07	11:48	13:36
2	Unit 4 FGD Inlet	USEPA Method 29	Trace Metals	03/27/07	15:01	16:49
1	Unit 4 FGD Stack	USEPA Method 29	Trace Metals	03/27/07	11:48	13:57
2	Unit 4 FGD Stack	USEPA Method 29	Trace Metals	03/27/07	15:01	16:47
1	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/28/07	09:35	11:11
2	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/28/07	11:59	13:35
3	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/28/07	14:03	15:39
4	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/29/07	08:41	10:17
5	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/29/07	10:51	12:27
6	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/29/07	12:58	14:34
7	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/30/07	08:26	10:02
8	Unit 4 FGD Inlet	USEPA Method 26 - Glass	HCl and HF	03/30/07	11:23	12:59
1	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/28/07	09:35	11:11
2	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/28/07	11:59	13:35
3	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/28/07	14:03	15:39
4	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/29/07	08:41	10:17
5	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/29/07	10:51	12:27
6	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/29/07	12:58	14:34
7	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/30/07	08:26	10:02
8	Unit 4 FGD Inlet	USEPA Method 26 - Teflon	HCl and HF	03/30/07	11:23	12:59
1	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/28/07	09:35	11:11
2	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/28/07	11:59	13:35
3	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/28/07	14:03	15:39
4	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/29/07	08:41	10:17
5	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/29/07	10:51	12:27
6	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/29/07	12:58	14:34
7	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/30/07	08:26	10:02
8	Unit 4 FGD Stack	USEPA Method 26 - Glass	HCl and HF	03/30/07	11:23	12:59
1	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/28/07	09:35	11:11
2	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/28/07	11:59	13:35
3	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/28/07	14:03	15:39
4	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/29/07	08:41	10:17
5	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/29/07	10:51	12:27
6	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/29/07	12:58	14:34
7	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/30/07	08:26	10:02
8	Unit 4 FGD Stack	USEPA Method 26 - Teflon	HCl and HF	03/30/07	11:23	12:59

Note: FTIR samples collected at FGD Inlet on March 27 and 28 and FGD Stack on March 29 and 30, 2007.

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**PROJECT OVERVIEW**

1-3

**Table 1-2:  
Summary of Test Results**

<u>Source</u>			
Method	Constituent	FGD Inlet	FGD Stack
<b>Unit 4</b>			
<b>CleanAir Method 8B/8C</b>			
	SO <sub>2</sub> (ppmdv @ 3% O <sub>2</sub> )	0.86	0.74
	SO <sub>2</sub> (ppmdv)	753	38.1
	SO <sub>2</sub> (ppmdv @ 3% O <sub>2</sub> )	1,063	48.2
<b>Plant CEMS</b>			
	SO <sub>2</sub> (ppmdv)	N/A	39.0
<b>EPA Method 320 - FTIR</b>			
	SO <sub>2</sub> (ppmdv)	878	38.6
<b>EPA Method 29</b>			
	Mercury (lb/hr)	1.28E-02	4.21E-03
	Antimony (lb/hr)	5.00E-03	1.95E-03
	Arsenic (lb/hr)	5.86E-02	6.30E-03
	Barium (lb/hr)	1.34E-01	4.92E-03
	Beryllium (lb/hr)	1.94E-03	<1.99E-04
	Cadmium (lb/hr)	1.49E-03	<9.49E-04
	Chromium (lb/hr)	2.13E-02	3.29E-03
	Cobalt (lb/hr)	2.54E-02	<9.33E-04
	Copper (lb/hr)	2.17E-02	3.28E-03
	Lead (lb/hr)	1.46E-02	4.59E-03
	Manganese (lb/hr)	2.87E-02	6.92E-03
	Nickel (lb/hr)	2.56E-02	1.81E-02
	Phosphorus (lb/hr)	1.51E-01	<7.98E-03
	Selenium (lb/hr)	2.26E-01	8.15E-02
	Silver (lb/hr)	4.49E-03	1.64E-03
	Thallium (lb/hr)	<7.86E-04	<7.98E-04
	Zinc (lb/hr)	2.26E-01	9.47E-02
<b>EPA Method 26 - Glass</b>			
	HCl (ppmdv @ 3% O <sub>2</sub> )	70.7	0.07
	HF (ppmdv @ 3% O <sub>2</sub> )	9.9	<0.01
	HCl Reduction Efficiency (% Removal)		99.9
	HF Reduction Efficiency (% Removal)		99.9
<b>EPA Method 26 - Teflon</b>			
	HCl (ppmdv @ 3% O <sub>2</sub> )	68.3	0.09
	HF (ppmdv @ 3% O <sub>2</sub> )	8.7	<0.01
	HCl Reduction Efficiency (% Removal)		99.9
	HF Reduction Efficiency (% Removal)		99.9
<b>EPA Method 320 - FTIR</b>			
	HCl (ppmdv @ 3% O <sub>2</sub> )	69.1	0.04
	HF (ppmdv @ 3% O <sub>2</sub> )	9.9	0.10

**PROJECT OVERVIEW**

1-4

**DISCUSSION OF TEST PROGRAM**

***Project Objectives***

The objectives of the test program were as follows:

1. Determine the concentration of trace metals and SO<sub>3</sub> at the Flue Gas Desulphurization (FGD) Inlet and FGD Stack.
2. Collect more precise data on the HF and HCl emission rates and removal effectiveness of the various ALSTOM scrubber configurations.
3. Explore the potential reaction between HF with the glass probe liner used in the EPA Method 26 sampling train and the possible positive bias of silicon tetra fluoride, if present in the flue gas stream, on the test results.
4. Compare the results from instrumental (Fourier Transform Infrared (FTIR)) and the wet chemistry (EPA Reference Method 26) in the measurement of HCl and HF.

***Sulfur Trioxide/Sulfur Dioxide***

The concentration of SO<sub>3</sub> and SO<sub>2</sub> at the FGD Inlet was determined using CleanAir Method 8B, "Determination of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide, and Sulfuric Acid Vapor and Mist from Stationary Sources Using a Controlled Condensation Sampling Apparatus."

The FGD Stack used CleanAir Method 8C, "Determination of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide, and Sulfuric Acid Vapor and Mist from Stationary Sources Using an EPA Method 8 Sampling Apparatus Modified to Mitigate the Effects of Moisture and Other Potential Interferents." This methodology was performed at the FGD Stack due to elevated moisture content of the flue gas.

***Trace Metals***

EPA Method 29 sampling runs were performed concurrently at the FGD Inlet and FGD Stack locations for the specified trace metals including mercury.

**PROJECT OVERVIEW**

1-5

**DISCUSSION OF TEST PROGRAM (CONTINUED)**

***Hydrogen Chloride and Hydrogen Fluoride***

The test program consisted of performing a series of EPA Method 26 sampling trains at the Unit 4 FGD Inlet and FGD Stack. At each location two (2) EPA Method 26 (HCl and HF) sampling trains were run concurrently. The first train designated "Method 26 – Glass" consisted of a standard EPA Method 26 sampling train including a glass probe liner and a quartz glass fiber filter. The second train designated as "Method 26 – Teflon" consisted of modifications to the standard EPA Method 26 sampling train; the probe liner and filter medium were both Teflon.

***FTIR Spectroscopy***

FTIR was performed at the FGD Inlet on March 27 and 28. The FTIR was then relocated to the FGD Stack and measured stack concentrations on March 29 and 30.

Data presented in results section has been edited to correspond with EPA Method 26 run times. A complete set of FTIR data is included in appendix of this report.

In order to assess the validity of the FTIR data a comparison was made between the FTIR data and data recorded by the plant CEMS, Reference Method CEMS\* and results from the EPA Method 26 sampling trains. The comparison of the following parameters (SO<sub>2</sub>, NO<sub>x</sub>, CO<sub>2</sub> and Moisture) demonstrated the validity of FTIR spectra data. These comparisons are contained in the results section of this test report.

\*CleanAir operated the reference method CEMS using the exhaust stream of the FTIR as a QA/QC check of the FTIR sampling system.

# CleanAir

ALSTOM POWER, INC.  
MARSHALL STEAM STATION

Client Reference No: 96004005  
CleanAir Project No: 10171

## RESULTS

2-1

**Table 2-1:**  
**Unit 4 FGD Inlet – CleanAir Method 8B – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		12:48	16:01	
<b>Process Conditions</b>				
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	261	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	6.63	7.02
<b>Gas Flow Rate<sup>1</sup></b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,488,716	1,497,298
<b>Sulfuric Acid Vapor (SO<sub>3</sub>) Results</b>				
C <sub>sd</sub>	SO <sub>3</sub> Concentration (ppmdv)	0.50	0.72	0.61
C <sub>sd7</sub>	SO <sub>3</sub> Concentration @3% O <sub>2</sub> (ppmdv)	0.72	1.00	0.86
C <sub>sd12</sub>	SO <sub>3</sub> Concentration @12% CO <sub>2</sub> (ppmdv)	0.57	0.77	0.67
E <sub>lb/hr</sub>	SO <sub>3</sub> Rate (lb/hr)	9.44	13.3	11.4
E <sub>kg/hr</sub>	SO <sub>3</sub> Rate (kg/hr)	4.28	6.05	5.17
E <sub>Fd</sub>	SO <sub>3</sub> Rate - F <sub>d</sub> -based (lb/MMBtu)	0.0017	0.0024	0.0020
E <sub>Fc</sub>	SO <sub>3</sub> Rate - F <sub>c</sub> -based (lb/MMBtu)	0.0018	0.0024	0.0021
<b>Sulfur Dioxide (SO<sub>2</sub>) Results</b>				
C <sub>sd</sub>	SO <sub>2</sub> Concentration (ppmdv)	634	872	753
C <sub>sd7</sub>	SO <sub>2</sub> Concentration @3% O <sub>2</sub> (ppmdv)	911	1215	1063
C <sub>sd12</sub>	SO <sub>2</sub> Concentration @12% CO <sub>2</sub> (ppmdv)	721	935	828
E <sub>lb/hr</sub>	SO <sub>2</sub> Rate (lb/hr)	9,521	12,951	11,236
E <sub>kg/hr</sub>	SO <sub>2</sub> Rate (kg/hr)	4,318	5,873	5,096
E <sub>Fd</sub>	SO <sub>2</sub> Rate - F <sub>d</sub> -based (lb/MMBtu)	1.73	2.30	2.02
E <sub>Fc</sub>	SO <sub>2</sub> Rate - F <sub>c</sub> -based (lb/MMBtu)	1.80	2.33	2.06

<sup>1</sup> Volumetric flow rates obtained from EPA Method 29 sampling train.

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**RESULTS**

2-2

**Table 2-2:  
Unit 4 FGD Stack – CleanAir Method 8C – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:57	16:47	
<b>Process Conditions</b>				
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	6.7	6.9	6.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	12.3	12.0	12.2
T <sub>s</sub>	Sample temperature (°F)	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.82	12.89	12.86
<b>Gas Flow Rate<sup>1</sup></b>				
Q <sub>a</sub>	Volumetric flow rate; actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,951,831	1,930,456	1,941,144
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,701,608	1,681,609	1,691,608
<b>Sulfuric Acid Vapor (SO<sub>3</sub>) Results</b>				
C <sub>sd</sub>	SO <sub>3</sub> Concentration (ppmdv)	0.53	0.63	0.58
C <sub>sd7</sub>	SO <sub>3</sub> Concentration @3% O <sub>2</sub> (ppmdv)	0.66	0.81	0.74
C <sub>sd12</sub>	SO <sub>3</sub> Concentration @12% CO <sub>2</sub> (ppmdv)	0.52	0.63	0.57
E <sub>lb/hr</sub>	SO <sub>3</sub> Rate (lb/hr)	11.2	13.3	12.3
E <sub>kg/hr</sub>	SO <sub>3</sub> Rate (kg/hr)	5.09	6.03	5.56
E <sub>Fd</sub>	SO <sub>3</sub> Rate - F <sub>d</sub> -based (lb/MMBtu)	0.0016	0.0019	0.0017
E <sub>Fc</sub>	SO <sub>3</sub> Rate - F <sub>c</sub> -based (lb/MMBtu)	0.0016	0.0020	0.0018
RE	Reduction Efficiency (% Removal) <sup>2</sup>	7.98%	19.2%	13.6%
<b>Sulfur Dioxide (SO<sub>2</sub>) Results</b>				
C <sub>sd</sub>	SO <sub>2</sub> Concentration (ppmdv)	39.2	36.9	38.1
C <sub>sd7</sub>	SO <sub>2</sub> Concentration @3% O <sub>2</sub> (ppmdv)	49.3	47.1	48.2
C <sub>sd12</sub>	SO <sub>2</sub> Concentration @12% CO <sub>2</sub> (ppmdv)	38.3	36.9	37.6
E <sub>lb/hr</sub>	SO <sub>2</sub> Rate (lb/hr)	665	619	642
E <sub>kg/hr</sub>	SO <sub>2</sub> Rate (kg/hr)	302	281	291
E <sub>Fd</sub>	SO <sub>2</sub> Rate - F <sub>d</sub> -based (lb/MMBtu)	0.094	0.089	0.091
E <sub>Fc</sub>	SO <sub>2</sub> Rate - F <sub>c</sub> -based (lb/MMBtu)	0.095	0.092	0.094
RE	Reduction Efficiency (% Removal) <sup>2</sup>	94.6%	96.1%	95.4%

<sup>1</sup> Volumetric flow rates obtained from EPA Method 29 sampling train.

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<sup>2</sup> Reduction efficiency determined using ppm @ 3% O<sub>2</sub>.

**RESULTS**

2-3

**Table 2-3:  
Unit 4 FGD Inlet – Method 29 (Hg) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:36	16:49	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	261	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	5.63	7.02
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,488,716	1,497,298
<b>Mercury Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.41E-10	1.44E-10	1.42E-10
C <sub>a</sub>	Concentration (lb/acf)	9.46E-11	9.73E-11	9.60E-11
C <sub>sd</sub>	Concentration (µg/dscm)	2.25E+00	2.31E+00	2.28E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	3.24E+00	3.21E+00	3.22E+00
C <sub>sd</sub>	Concentration (mg/dscm)	2.25E-03	2.31E-03	2.28E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	2.42E+00	2.48E+00	2.45E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	1.27E-02	1.29E-02	1.28E-02
E <sub>g/s</sub>	Rate (g/s)	1.60E-03	1.62E-03	1.61E-03

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**RESULTS**

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**Table 2-4:  
Unit 4 FGD Inlet – Method 29 (Sb, As, Ba, Be) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:36	16:49	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	281	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	6.63	7.02
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,488,716	1,497,298
<b>Antimony Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	8.18E-11	2.91E-11	5.55E-11
C <sub>a</sub>	Concentration (lb/acf)	5.50E-11	1.97E-11	3.73E-11
C <sub>sd</sub>	Concentration (µg/dscm)	1.31E+00	4.66E-01	8.88E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.88E+00	6.49E-01	1.26E+00
C <sub>sd</sub>	Concentration (mg/dscm)	1.31E-03	4.66E-04	8.88E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.41E+00	5.00E-01	9.53E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	7.39E-03	2.60E-03	5.00E-03
E <sub>g/s</sub>	Rate (g/s)	9.31E-04	3.27E-04	6.29E-04
<b>Arsenic Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	6.88E-10	6.16E-10	6.52E-10
C <sub>a</sub>	Concentration (lb/acf)	4.62E-10	4.16E-10	4.39E-10
C <sub>sd</sub>	Concentration (µg/dscm)	1.10E+01	9.87E+00	1.04E+01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.58E+01	1.37E+01	1.48E+01
C <sub>sd</sub>	Concentration (mg/dscm)	1.10E-02	9.87E-03	1.04E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.18E+01	1.06E+01	1.12E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	6.21E-02	5.50E-02	5.86E-02
E <sub>g/s</sub>	Rate (g/s)	7.83E-03	6.93E-03	7.38E-03
<b>Barium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.60E-09	1.38E-09	1.49E-09
C <sub>a</sub>	Concentration (lb/acf)	1.08E-09	9.30E-10	1.00E-09
C <sub>sd</sub>	Concentration (µg/dscm)	2.57E+01	2.20E+01	2.39E+01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	3.69E+01	3.07E+01	3.38E+01
C <sub>sd</sub>	Concentration (mg/dscm)	2.57E-02	2.20E-02	2.39E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	2.76E+01	2.36E+01	2.56E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	1.45E-01	1.23E-01	1.34E-01
E <sub>g/s</sub>	Rate (g/s)	1.83E-02	1.55E-02	1.69E-02
<b>Beryllium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.30E-11	2.02E-11	2.16E-11
C <sub>a</sub>	Concentration (lb/acf)	1.54E-11	1.37E-11	1.46E-11
C <sub>sd</sub>	Concentration (µg/dscm)	3.68E-01	3.24E-01	3.46E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	5.28E-01	4.51E-01	4.90E-01
C <sub>sd</sub>	Concentration (mg/dscm)	3.68E-04	3.24E-04	3.46E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	3.95E-01	3.48E-01	3.71E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	2.08E-03	1.81E-03	1.94E-03
E <sub>g/s</sub>	Rate (g/s)	2.62E-04	2.28E-04	2.45E-04

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**RESULTS**

**Table 2-5:  
Unit 4 FGD Inlet – Method 29 (Cd, Cr, Co, Cu) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:36	16:49	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	261	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	6.63	7.02
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,488,716	1,497,298
<b>Cadmium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.74E-11	1.59E-11	1.66E-11
C <sub>a</sub>	Concentration (lb/acf)	1.17E-11	1.07E-11	1.12E-11
C <sub>sd</sub>	Concentration (µg/dscm)	2.78E-01	2.54E-01	2.66E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	3.99E-01	3.54E-01	3.77E-01
C <sub>sd</sub>	Concentration (mg/dscm)	2.78E-04	2.54E-04	2.66E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	2.98E-01	2.73E-01	2.86E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	1.57E-03	1.42E-03	1.49E-03
E <sub>g/s</sub>	Rate (g/s)	1.98E-04	1.79E-04	1.88E-04
<b>Chromium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.43E-10	2.31E-10	2.37E-10
C <sub>a</sub>	Concentration (lb/acf)	1.63E-10	1.56E-10	1.60E-10
C <sub>sd</sub>	Concentration (µg/dscm)	3.89E+00	3.70E+00	3.79E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	5.58E+00	5.15E+00	5.37E+00
C <sub>sd</sub>	Concentration (mg/dscm)	3.89E-03	3.70E-03	3.79E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	4.17E+00	3.97E+00	4.07E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	2.19E-02	2.06E-02	2.13E-02
E <sub>g/s</sub>	Rate (g/s)	2.76E-03	2.60E-03	2.68E-03
<b>Cobalt Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	9.14E-11	4.75E-10	2.83E-10
C <sub>a</sub>	Concentration (lb/acf)	6.14E-11	3.21E-10	1.91E-10
C <sub>sd</sub>	Concentration (µg/dscm)	1.46E+00	7.61E+00	4.54E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	2.10E+00	1.06E+01	6.35E+00
C <sub>sd</sub>	Concentration (mg/dscm)	1.46E-03	7.61E-03	4.54E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.57E+00	8.17E+00	4.87E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	8.26E-03	4.25E-02	2.54E-02
E <sub>g/s</sub>	Rate (g/s)	1.04E-03	5.35E-03	3.19E-03
<b>Copper Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.76E-10	2.06E-10	2.41E-10
C <sub>a</sub>	Concentration (lb/acf)	1.86E-10	1.39E-10	1.62E-10
C <sub>sd</sub>	Concentration (µg/dscm)	4.43E+00	3.29E+00	3.86E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	6.36E+00	4.59E+00	5.47E+00
C <sub>sd</sub>	Concentration (mg/dscm)	4.43E-03	3.29E-03	3.86E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	4.75E+00	3.54E+00	4.14E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	2.50E-02	1.84E-02	2.17E-02
E <sub>g/s</sub>	Rate (g/s)	3.15E-03	2.31E-03	2.73E-03

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**RESULTS**

**Table 2-6:  
Unit 4 FGD Inlet – Method 29 (Pb, Mn, Ni, P) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:36	16:49	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	261	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	6.63	7.02
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,488,716	1,497,298
<b>Lead Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.83E-10	1.42E-10	1.63E-10
C <sub>a</sub>	Concentration (lb/acf)	1.23E-10	9.63E-11	1.10E-10
C <sub>sd</sub>	Concentration (µg/dscm)	2.92E+00	2.28E+00	2.60E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	4.20E+00	3.18E+00	3.69E+00
C <sub>sd</sub>	Concentration (mg/dscm)	2.92E-03	2.28E-03	2.60E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	3.14E+00	2.45E+00	2.79E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	1.65E-02	1.27E-02	1.46E-02
E <sub>g/s</sub>	Rate (g/s)	2.08E-03	1.60E-03	1.84E-03
<b>Manganese Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	3.38E-10	3.01E-10	3.19E-10
C <sub>a</sub>	Concentration (lb/acf)	2.27E-10	2.04E-10	2.15E-10
C <sub>sd</sub>	Concentration (µg/dscm)	5.40E+00	4.83E+00	5.12E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	7.76E+00	6.72E+00	7.24E+00
C <sub>sd</sub>	Concentration (mg/dscm)	5.40E-03	4.83E-03	5.12E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	5.80E+00	5.18E+00	5.49E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	3.05E-02	2.69E-02	2.87E-02
E <sub>g/s</sub>	Rate (g/s)	3.84E-03	3.39E-03	3.62E-03
<b>Nickel Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	3.38E-10	2.30E-10	2.84E-10
C <sub>a</sub>	Concentration (lb/acf)	2.27E-10	1.56E-10	1.91E-10
C <sub>sd</sub>	Concentration (µg/dscm)	5.41E+00	3.69E+00	4.55E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	7.77E+00	5.13E+00	6.45E+00
C <sub>sd</sub>	Concentration (mg/dscm)	5.41E-03	3.69E-03	4.55E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	5.81E+00	3.96E+00	4.88E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	3.05E-02	2.06E-02	2.56E-02
E <sub>g/s</sub>	Rate (g/s)	3.85E-03	2.59E-03	3.22E-03
<b>Phosphorus Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.73E-09	1.63E-09	1.68E-09
C <sub>a</sub>	Concentration (lb/acf)	1.17E-09	1.10E-09	1.14E-09
C <sub>sd</sub>	Concentration (µg/dscm)	2.78E+01	2.62E+01	2.70E+01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	3.99E+01	3.64E+01	3.82E+01
C <sub>sd</sub>	Concentration (mg/dscm)	2.78E-02	2.62E-02	2.70E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	2.98E+01	2.81E+01	2.89E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	1.57E-01	1.46E-01	1.51E-01
E <sub>g/s</sub>	Rate (g/s)	1.97E-02	1.84E-02	1.91E-02

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**RESULTS**

**Table 2-7:  
Unit 4 FGD Inlet – Method 29 (Se, Ag, Tl, Zn) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:36	16:49	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	8.4	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	259	261	260
B <sub>w</sub>	Actual water vapor in gas (% by volume)	7.41	6.63	7.02
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,239,913	2,203,593	2,221,753
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,626,462	1,594,475	1,610,469
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,505,880	1,486,716	1,497,298
<b>Selenium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.56E-09	2.48E-09	2.52E-09
C <sub>a</sub>	Concentration (lb/acf)	1.72E-09	1.67E-09	1.70E-09
C <sub>sd</sub>	Concentration (µg/dscm)	4.10E+01	3.97E+01	4.04E+01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	5.89E+01	5.52E+01	5.71E+01
C <sub>sd</sub>	Concentration (mg/dscm)	4.10E-02	3.97E-02	4.04E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	4.40E+01	4.26E+01	4.33E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	2.32E-01	2.21E-01	2.26E-01
E <sub>g/s</sub>	Rate (g/s)	2.92E-02	2.79E-02	2.86E-02
<b>Silver Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	5.98E-11	4.02E-11	4.99E-11
C <sub>a</sub>	Concentration (lb/acf)	4.01E-11	2.72E-11	3.36E-11
C <sub>sd</sub>	Concentration (µg/dscm)	9.55E-01	6.44E-01	7.99E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.37E+00	8.96E-01	1.13E+00
C <sub>sd</sub>	Concentration (mg/dscm)	9.55E-04	6.44E-04	7.99E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.02E+00	6.91E-01	8.58E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	5.39E-03	3.59E-03	4.49E-03
E <sub>g/s</sub>	Rate (g/s)	6.79E-04	4.52E-04	5.65E-04
<b>Thallium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	<8.70E-12	<8.80E-12	<8.75E-12
C <sub>a</sub>	Concentration (lb/acf)	<5.85E-12	<5.95E-12	<5.90E-12
C <sub>sd</sub>	Concentration (µg/dscm)	<1.39E-01	<1.41E-01	<1.40E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	<2.00E-01	<1.96E-01	<1.98E-01
C <sub>sd</sub>	Concentration (mg/dscm)	<1.39E-04	<1.41E-04	<1.40E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	<1.50E-01	<1.51E-01	<1.50E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	<7.86E-04	<7.86E-04	<7.86E-04
E <sub>g/s</sub>	Rate (g/s)	<9.91E-05	<9.91E-05	<9.91E-05
<b>Zinc Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.44E-09	2.60E-09	2.52E-09
C <sub>a</sub>	Concentration (lb/acf)	1.64E-09	1.76E-09	1.70E-09
C <sub>sd</sub>	Concentration (µg/dscm)	3.91E+01	4.16E+01	4.03E+01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	5.61E+01	5.79E+01	5.70E+01
C <sub>sd</sub>	Concentration (mg/dscm)	3.91E-02	4.16E-02	4.03E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	4.19E+01	4.47E+01	4.33E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	2.20E-01	2.32E-01	2.26E-01
E <sub>g/s</sub>	Rate (g/s)	2.78E-02	2.92E-02	2.86E-02

**RESULTS**

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**Table 2-8:  
Unit 4 FGD Stack – Method 29 (Hg) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:57	16:47	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	7.4	8.2	7.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.7	11.0	11.3
T <sub>s</sub>	Sample temperature (°F)	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.82	12.89	12.86
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,951,831	1,930,456	1,941,144
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,701,608	1,681,609	1,691,608
<b>Mercury Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	3.97E-11	4.32E-11	4.15E-11
C <sub>a</sub>	Concentration (lb/acf)	3.10E-11	3.37E-11	3.23E-11
C <sub>sd</sub>	Concentration (µg/dscm)	6.36E-01	6.92E-01	6.64E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	8.42E-01	9.73E-01	9.08E-01
C <sub>sd</sub>	Concentration (mg/dscm)	6.36E-04	6.92E-04	6.64E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	6.83E-01	7.42E-01	7.13E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	4.06E-03	4.36E-03	4.21E-03
E <sub>g/s</sub>	Rate (g/s)	5.11E-04	5.49E-04	5.30E-04

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**RESULTS**

**Table 2-9:  
Unit 4 FGD Stack – Method 29 (Sb, As, Ba, Be) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:57	16:47	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	7.4	8.2	7.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.7	11.0	11.3
T <sub>s</sub>	Sample temperature (°F)	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.62	12.89	12.66
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,951,831	1,930,456	1,941,144
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,701,808	1,681,609	1,691,608
<b>Antimony Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.31E-11	1.53E-11	1.92E-11
C <sub>a</sub>	Concentration (lb/acf)	1.80E-11	1.19E-11	1.49E-11
C <sub>sd</sub>	Concentration (µg/dscm)	3.69E-01	2.44E-01	3.07E-01
C <sub>sd7</sub>	Concentration @7% O <sub>2</sub> (µg/dscm)	3.80E-01	2.67E-01	3.23E-01
C <sub>sd</sub>	Concentration (mg/dscm)	3.69E-04	2.44E-04	3.07E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	3.96E-01	2.62E-01	3.29E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	2.35E-03	1.54E-03	1.95E-03
E <sub>g/s</sub>	Rate (g/s)	2.97E-04	1.94E-04	2.45E-04
<b>Arsenic Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	6.08E-11	6.34E-11	6.21E-11
C <sub>a</sub>	Concentration (lb/acf)	4.74E-11	4.94E-11	4.84E-11
C <sub>sd</sub>	Concentration (µg/dscm)	9.73E-01	1.02E+00	9.94E-01
C <sub>sd7</sub>	Concentration @7% O <sub>2</sub> (µg/dscm)	1.00E+00	1.11E+00	1.05E+00
C <sub>sd</sub>	Concentration (mg/dscm)	9.73E-04	1.02E-03	9.94E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.04E+00	1.09E+00	1.07E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	6.21E-03	6.40E-03	6.30E-03
E <sub>g/s</sub>	Rate (g/s)	7.82E-04	8.06E-04	7.94E-04
<b>Barium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	5.42E-11	4.28E-11	4.85E-11
C <sub>a</sub>	Concentration (lb/acf)	4.22E-11	3.34E-11	3.78E-11
C <sub>sd</sub>	Concentration (µg/dscm)	8.67E-01	6.85E-01	7.76E-01
C <sub>sd7</sub>	Concentration @7% O <sub>2</sub> (µg/dscm)	8.92E-01	7.48E-01	8.20E-01
C <sub>sd</sub>	Concentration (mg/dscm)	8.67E-04	6.85E-04	7.76E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	9.31E-01	7.36E-01	8.33E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	5.53E-03	4.32E-03	4.92E-03
E <sub>g/s</sub>	Rate (g/s)	6.97E-04	5.44E-04	6.20E-04
<b>Beryllium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	<1.95E-12	<1.98E-12	<1.96E-12
C <sub>a</sub>	Concentration (lb/acf)	<1.52E-12	<1.54E-12	<1.53E-12
C <sub>sd</sub>	Concentration (µg/dscm)	<3.12E-02	<3.17E-02	<3.15E-02
C <sub>sd7</sub>	Concentration @7% O <sub>2</sub> (µg/dscm)	<3.21E-02	<3.46E-02	<3.34E-02
C <sub>sd</sub>	Concentration (mg/dscm)	<3.12E-05	<3.17E-05	<3.15E-05
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	<3.35E-02	<3.41E-02	<3.38E-02
E <sub>lb/hr</sub>	Rate (lb/hr)	<1.99E-04	<2.00E-04	<1.99E-04
E <sub>g/s</sub>	Rate (g/s)	<2.51E-05	<2.52E-05	<2.51E-05

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**RESULTS**

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**Table 2-10:  
Unit 4 FGD Stack – Method 29 (Cd, Cr, Co, Cu) – Runs 1-2**

Run No.	1	2	Average
Date (2007)	Mar 27	Mar 27	
Start Time (approx.)	11:48	15:01	
Stop Time (approx.)	13:57	16:47	
<b>Gas Conditions</b>			
O <sub>2</sub> Oxygen (dry volume %)	7.4	8.2	7.8
CO <sub>2</sub> Carbon dioxide (dry volume %)	11.7	11.0	11.3
T <sub>s</sub> Sample temperature (°F)	125	125	125
B <sub>w</sub> Actual water vapor in gas (% by volume)	12.82	12.89	12.86
<b>Gas Flow Rate</b>			
Q <sub>a</sub> Volumetric flow rate, actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>s</sub> Volumetric flow rate, standard (scfm)	1,951,831	1,930,456	1,941,144
Q <sub>std</sub> Volumetric flow rate, dry standard (dscfm)	1,701,608	1,681,609	1,691,608
<b>Cadmium Results - Total</b>			
C <sub>sd</sub> Concentration (lb/dscf)	1.08E-11	<7.93E-12	<9.34E-12
C <sub>a</sub> Concentration (lb/acf)	8.39E-12	<6.18E-12	<7.28E-12
C <sub>sd</sub> Concentration (µg/dscm)	1.72E-01	<1.27E-01	<1.50E-01
C <sub>sd7</sub> Concentration @3% O <sub>2</sub> (µg/dscm)	1.77E-01	<1.39E-01	<1.58E-01
C <sub>sd</sub> Concentration (mg/dscm)	1.72E-04	<1.27E-04	<1.50E-04
C <sub>sd</sub> Concentration (µg/Nm <sup>3</sup> dry)	1.85E-01	<1.36E-01	<1.61E-01
E <sub>lb/hr</sub> Rate (lb/hr)	1.10E-03	<8.00E-04	<9.49E-04
E <sub>g/s</sub> Rate (g/s)	1.38E-04	<1.01E-04	<1.20E-04
<b>Chromium Results - Total</b>			
C <sub>sd</sub> Concentration (lb/dscf)	3.19E-11	3.29E-11	3.24E-11
C <sub>a</sub> Concentration (lb/acf)	2.49E-11	2.56E-11	2.53E-11
C <sub>sd</sub> Concentration (µg/dscm)	5.12E-01	5.27E-01	5.19E-01
C <sub>sd7</sub> Concentration @3% O <sub>2</sub> (µg/dscm)	5.26E-01	5.75E-01	5.51E-01
C <sub>sd</sub> Concentration (mg/dscm)	5.12E-04	5.27E-04	5.19E-04
C <sub>sd</sub> Concentration (µg/Nm <sup>3</sup> dry)	5.49E-01	5.65E-01	5.57E-01
E <sub>lb/hr</sub> Rate (lb/hr)	3.26E-03	3.32E-03	3.29E-03
E <sub>g/s</sub> Rate (g/s)	4.11E-04	4.18E-04	4.15E-04
<b>Cobalt Results - Total</b>			
C <sub>sd</sub> Concentration (lb/dscf)	1.04E-11	<7.93E-12	<9.18E-12
C <sub>a</sub> Concentration (lb/acf)	8.14E-12	<6.18E-12	<7.16E-12
C <sub>sd</sub> Concentration (µg/dscm)	1.67E-01	<1.27E-01	<1.47E-01
C <sub>sd7</sub> Concentration @3% O <sub>2</sub> (µg/dscm)	1.72E-01	<1.39E-01	<1.55E-01
C <sub>sd</sub> Concentration (mg/dscm)	1.67E-04	<1.27E-04	<1.47E-04
C <sub>sd</sub> Concentration (µg/Nm <sup>3</sup> dry)	1.79E-01	<1.36E-01	<1.58E-01
E <sub>lb/hr</sub> Rate (lb/hr)	1.07E-03	<8.00E-04	<9.33E-04
E <sub>g/s</sub> Rate (g/s)	1.34E-04	<1.01E-04	<1.18E-04
<b>Copper Results - Total</b>			
C <sub>sd</sub> Concentration (lb/dscf)	4.10E-11	2.35E-11	3.23E-11
C <sub>a</sub> Concentration (lb/acf)	3.20E-11	1.83E-11	2.52E-11
C <sub>sd</sub> Concentration (µg/dscm)	6.57E-01	3.76E-01	5.17E-01
C <sub>sd7</sub> Concentration @3% O <sub>2</sub> (µg/dscm)	6.75E-01	4.11E-01	5.43E-01
C <sub>sd</sub> Concentration (mg/dscm)	6.57E-04	3.76E-04	5.17E-04
C <sub>sd</sub> Concentration (µg/Nm <sup>3</sup> dry)	7.05E-01	4.04E-01	5.54E-01
E <sub>lb/hr</sub> Rate (lb/hr)	4.19E-03	2.37E-03	3.28E-03
E <sub>g/s</sub> Rate (g/s)	5.28E-04	2.99E-04	4.13E-04

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**RESULTS**

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**Table 2-11:  
Unit 4 FGD Stack – Method 29 (Pb, Mn, Ni, P) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:57	16:47	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	7.4	8.2	7.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.7	11.0	11.3
T <sub>s</sub>	Sample temperature (°F)	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.82	12.89	12.86
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>s</sub>	Volumetric flow rate, standard (scfm)	1,951,831	1,930,456	1,941,144
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,701,608	1,681,609	1,691,608
<b>Lead Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	4.90E-11	4.15E-11	4.52E-11
C <sub>a</sub>	Concentration (lb/acf)	3.82E-11	3.23E-11	3.53E-11
C <sub>sd7</sub>	Concentration (µg/dscm)	7.84E-01	6.65E-01	7.24E-01
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	8.06E-01	7.25E-01	7.66E-01
C <sub>sd</sub>	Concentration (mg/dscm)	7.84E-04	6.65E-04	7.24E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	8.42E-01	7.13E-01	7.77E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	5.00E-03	4.19E-03	4.59E-03
E <sub>g/s</sub>	Rate (g/s)	6.30E-04	5.27E-04	5.79E-04
<b>Manganese Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	9.76E-11	3.83E-11	6.80E-11
C <sub>a</sub>	Concentration (lb/acf)	7.62E-11	2.98E-11	5.30E-11
C <sub>sd7</sub>	Concentration (µg/dscm)	1.56E+00	6.13E-01	1.09E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.61E+00	6.69E-01	1.14E+00
C <sub>sd</sub>	Concentration (mg/dscm)	1.56E-03	6.13E-04	1.09E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.68E+00	6.58E-01	1.17E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	9.97E-03	3.66E-03	6.92E-03
E <sub>g/s</sub>	Rate (g/s)	1.26E-03	4.87E-04	8.71E-04
<b>Nickel Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	2.47E-10	1.10E-10	1.78E-10
C <sub>a</sub>	Concentration (lb/acf)	1.93E-10	8.55E-11	1.39E-10
C <sub>sd7</sub>	Concentration (µg/dscm)	3.96E+00	1.76E+00	2.86E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	4.07E+00	1.92E+00	2.99E+00
C <sub>sd</sub>	Concentration (mg/dscm)	3.96E-03	1.76E-03	2.86E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	4.24E+00	1.89E+00	3.07E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	2.52E-02	1.11E-02	1.81E-02
E <sub>g/s</sub>	Rate (g/s)	3.18E-03	1.39E-03	2.29E-03
<b>Phosphorus Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	<7.79E-11	<7.93E-11	<7.86E-11
C <sub>a</sub>	Concentration (lb/acf)	<6.08E-11	<6.18E-11	<6.13E-11
C <sub>sd7</sub>	Concentration (µg/dscm)	<1.25E+00	<1.27E+00	<1.26E+00
C <sub>sd7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	<1.28E+00	<1.39E+00	<1.33E+00
C <sub>sd</sub>	Concentration (mg/dscm)	<1.25E-03	<1.27E-03	<1.26E-03
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	<1.34E+00	<1.36E+00	<1.35E+00
E <sub>lb/hr</sub>	Rate (lb/hr)	<7.96E-03	<8.00E-03	<7.98E-03
E <sub>g/s</sub>	Rate (g/s)	<1.00E-03	<1.01E-03	<1.00E-03

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**RESULTS**

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**Table 2-12:  
Unit 4 FGD Stack – Method 29 (Se, Ag, Tl, Zn) – Runs 1-2**

Run No.		1	2	Average
Date (2007)		Mar 27	Mar 27	
Start Time (approx.)		11:48	15:01	
Stop Time (approx.)		13:57	16:47	
<b>Gas Conditions</b>				
O <sub>2</sub>	Oxygen (dry volume %)	7.4	8.2	7.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.7	11.0	11.3
T <sub>s</sub>	Sample temperature (°F)	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.82	12.89	12.86
<b>Gas Flow Rate</b>				
Q <sub>a</sub>	Volumetric flow rate, actual (acfm)	2,181,522	2,157,786	2,169,654
Q <sub>std</sub>	Volumetric flow rate, dry standard (dscfm)	1,701,608	1,681,609	1,691,608
<b>Selenium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	8.65E-10	7.41E-10	8.03E-10
C <sub>a</sub>	Concentration (lb/acf)	6.75E-10	5.78E-10	6.26E-10
C <sub>std</sub>	Concentration (µg/dscm)	1.39E+01	1.19E+01	1.29E+01
C <sub>std7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.42E+01	1.30E+01	1.36E+01
C <sub>sd</sub>	Concentration (mg/dscm)	1.39E-02	1.19E-02	1.29E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.49E+01	1.27E+01	1.38E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	8.83E-02	7.48E-02	8.15E-02
E <sub>g/s</sub>	Rate (g/s)	1.11E-02	9.42E-03	1.03E-02
<b>Silver Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.96E-11	1.26E-11	1.61E-11
C <sub>a</sub>	Concentration (lb/acf)	1.53E-11	9.85E-12	1.26E-11
C <sub>std</sub>	Concentration (µg/dscm)	3.14E-01	2.02E-01	2.58E-01
C <sub>std7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	3.23E-01	2.21E-01	2.72E-01
C <sub>sd</sub>	Concentration (mg/dscm)	3.14E-04	2.02E-04	2.58E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	3.37E-01	2.17E-01	2.77E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	2.00E-03	1.28E-03	1.64E-03
E <sub>g/s</sub>	Rate (g/s)	2.53E-04	1.61E-04	2.07E-04
<b>Thallium Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	<7.79E-12	<7.99E-12	<7.86E-12
C <sub>a</sub>	Concentration (lb/acf)	<6.09E-12	<6.18E-12	<6.13E-12
C <sub>std</sub>	Concentration (µg/dscm)	<1.25E-01	<1.27E-01	<1.26E-01
C <sub>std7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	<1.28E-01	<1.38E-01	<1.33E-01
C <sub>sd</sub>	Concentration (mg/dscm)	<1.25E-04	<1.27E-04	<1.26E-04
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	<1.34E-01	<1.36E-01	<1.35E-01
E <sub>lb/hr</sub>	Rate (lb/hr)	<7.96E-04	<8.00E-04	<7.98E-04
E <sub>g/s</sub>	Rate (g/s)	<1.00E-04	<1.01E-04	<1.00E-04
<b>Zinc Results - Total</b>				
C <sub>sd</sub>	Concentration (lb/dscf)	1.12E-09	7.47E-10	9.32E-10
C <sub>a</sub>	Concentration (lb/acf)	8.71E-10	5.82E-10	7.26E-10
C <sub>std</sub>	Concentration (µg/dscm)	1.79E+01	1.20E+01	1.49E+01
C <sub>std7</sub>	Concentration @3% O <sub>2</sub> (µg/dscm)	1.84E+01	1.31E+01	1.57E+01
C <sub>sd</sub>	Concentration (mg/dscm)	1.79E-02	1.20E-02	1.49E-02
C <sub>sd</sub>	Concentration (µg/Nm <sup>3</sup> dry)	1.92E+01	1.28E+01	1.60E+01
E <sub>lb/hr</sub>	Rate (lb/hr)	1.14E-01	7.54E-02	9.47E-02
E <sub>g/s</sub>	Rate (g/s)	1.44E-02	9.50E-03	1.19E-02

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**RESULTS**

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**Table 2-13:  
Unit 4 FGD Inlet – Method 26 – Glass, Runs 1-4**

Run No.		1	2	3	4	Average
Date (2007)		Mar 28	Mar 28	Mar 28	Mar 29	
Start Time (approx.)		09:35	11:59	14:03	08:41	
Stop Time (approx.)		11:11	13:35	15:39	10:17	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	8.8	8.7	7.5	8.0	8.2
CO <sub>2</sub>	Carbon dioxide (dry volume %)	10.6	9.9	11.8	11.2	10.9
T <sub>s</sub>	Sample temperature (°F)	255	259	262	250	257
B <sub>w</sub>	Actual water vapor in gas (% by volume)	10.50	10.61	9.84	9.69	10.16
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	58.7	49.8	54.0	45.0	51.9
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	86.6	73.1	72.1	62.5	73.6
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	9.35E-02	7.89E-02	7.79E-02	6.75E-02	7.95E-02
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	9.44E-02	8.57E-02	7.79E-02	6.85E-02	8.16E-02
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	11.7	7.40	5.58	6.71	7.84
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	17.2	10.9	7.46	9.31	11.2
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	1.02E-02	6.43E-03	4.42E-03	5.52E-03	6.64E-03
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	1.03E-02	6.98E-03	4.42E-03	5.60E-03	6.82E-03

052607 111959

**RESULTS**

2-14

**Table 2-14:  
Unit 4 FGD Inlet – Method 26 – Glass, Runs 5-8**

Run No.		5	6	7	8	Average
Date (2007)		Mar 29	Mar 29	Mar 30	Mar 30	
Start Time (approx.)		10:51	12:58	08:26	11:23	
Stop Time (approx.)		12:27	14:34	10:02	12:59	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	9.5	7.6	8.2	8.1	8.4
CO <sub>2</sub>	Carbon dioxide (dry volume %)	9.9	11.6	11.0	11.1	10.9
T <sub>s</sub>	Sample temperature (°F)	246	244	241	244	244
B <sub>w</sub>	Actual water vapor in gas (% by volume)	10.13	10.01	9.58	9.67	9.85
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppm dv)	42.42	42.17	50.02	55.43	47.51
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	66.61	56.75	70.50	77.52	67.85
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MM Btu)	7.19E-02	6.13E-02	7.61E-02	8.37E-02	7.33E-02
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MM Btu)	7.30E-02	6.19E-02	7.74E-02	8.50E-02	7.43E-02
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppm dv)	5.42	8.25	5.61	6.71	6.00
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	8.51	8.41	7.90	9.38	8.55
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MM Btu)	5.04E-03	4.99E-03	4.68E-03	5.56E-03	5.07E-03
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MM Btu)	5.11E-03	5.03E-03	4.76E-03	5.64E-03	5.14E-03

052907 112604

**RESULTS**

2-15

**Table 2-15:  
Unit 4 FGD Inlet – Method 26 – Teflon, Runs 1-4**

Run No.		1	2	3	4	Average
Date (2007)		Mar 28	Mar 28	Mar 28	Mar 29	
Start Time (approx.)		09:35	11:59	14:03	08:41	
Stop Time (approx.)		11:11	13:35	15:39	10:17	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	8.1	8.5	9.5	8.0	8.5
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.2	10.6	9.9	11.2	10.7
T <sub>s</sub>	Sample temperature (°F)	255	257	257	247	254
B <sub>w</sub>	Actual water vapor in gas (% by volume)	11.18	10.88	10.47	10.27	10.65
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	43.82	51.03	56.60	42.69	48.54
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	61.28	73.67	88.87	59.24	70.76
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	6.62E-02	7.96E-02	9.60E-02	6.40E-02	7.64E-02
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	6.66E-02	8.20E-02	9.73E-02	6.49E-02	7.77E-02
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	8.34	6.53	5.31	5.50	5.92
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	8.86	9.43	8.33	7.63	8.56
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	5.25E-03	5.59E-03	4.94E-03	4.52E-03	5.07E-03
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	5.29E-03	5.75E-03	5.01E-03	4.58E-03	5.16E-03

Removal efficiency based on ppmdv @ 3% O<sub>2</sub>

052807 112007

**RESULTS**

2-16

**Table 2-16:  
Unit 4 FGD Inlet – Method 26 – Teflon, Runs 5-8**

Run No.		5	6	7	8	Average
Date (2007)		Mar 29	Mar 29	Mar 30	Mar 30	
Start Time (approx.)		10:51	12:58	08:26	11:23	
Stop Time (approx.)		12:27	14:34	10:02	12:59	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	8.0	7.7	8.5	7.9	8.0
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.6	11.6	10.6	11.4	11.3
T <sub>s</sub>	Sample temperature (°F)	243	242	239	242	242
B <sub>w</sub>	Actual water vapor in gas (% by volume)	11.13	9.97	10.01	9.98	10.27
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	44.61	43.45	47.85	53.22	47.28
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	61.90	58.92	69.08	73.28	65.79
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	6.69E-02	6.36E-02	7.46E-02	7.91E-02	7.11E-02
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	6.55E-02	6.38E-02	7.69E-02	7.95E-02	7.14E-02
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	7.53	6.17	5.71	5.74	6.29
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	10.45	8.37	8.24	7.90	8.74
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	6.19E-03	4.96E-03	4.88E-03	4.68E-03	5.18E-03
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	6.06E-03	4.97E-03	5.03E-03	4.70E-03	5.19E-03

Removal efficiency based on ppmdv @ 3% O<sub>2</sub>

052907 112010

**RESULTS**

2-17

**Table 2-17:  
Unit 4 FGD Stack – Method 26 – Glass, Runs 1-4**

Run No.		1	2	3	4	Average
Date (2007)		Mar 28	Mar 28	Mar 28	Mar 29	
Start Time (approx.)		09:35	11:59	14:03	08:41	
Stop Time (approx.)		11:11	13:35	15:39	10:17	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	7.9	8.2	7.3	7.0	7.6
CO <sub>2</sub>	Carbon dioxide (dry volume %)	11.4	11.0	11.9	12.1	11.6
T <sub>s</sub>	Sample temperature (°F)	124	124	125	125	125
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.80	11.74	13.24	12.43	12.55
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	0.052	0.102	0.061	0.052	0.067
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	0.072	0.144	0.080	0.067	0.091
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	7.76E-05	1.56E-04	8.69E-05	7.24E-05	9.81E-05
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	7.79E-05	1.58E-04	8.74E-05	7.32E-05	9.92E-05
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.8%	99.9%	99.9%	99.9%
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	<0.0077	<0.011	<0.011	<0.011	<0.010
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	<0.011	<0.015	<0.014	<0.015	<0.014
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	<6.26E-06	<9.02E-06	<8.57E-06	<8.76E-06	<8.16E-06
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	<6.29E-06	<8.17E-06	<8.62E-06	<8.86E-06	<8.24E-06
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.9%	99.9%	99.9%	99.9%

<sup>1</sup> Reduction efficiency determined using ppmdv @ 3% O<sub>2</sub>.

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**RESULTS**

2-18

**Table 2-18:  
Unit 4 FGD Stack – Method 26 – Glass, Runs 5-8**

Run No.		5	6	7	8	Average
Date (2007)		Mar 29	Mar 29	Mar 30	Mar 30	
Start Time (approx.)		10:51	12:58	08:26	11:23	
Stop Time (approx.)		12:27	14:34	10:02	12:59	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	7.0	7.1	6.9	7.0	7.0
CO <sub>2</sub>	Carbon dioxide (dry volume %)	12.2	12.2	12.1	12.2	12.2
T <sub>s</sub>	Sample temperature (°F)	123	123	123	122	123
B <sub>w</sub>	Actual water vapor in gas (% by volume)	11.68	11.65	11.78	11.81	11.73
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	0.033	0.050	0.033	0.038	0.038
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	0.043	0.065	0.043	0.046	0.049
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	4.61E-05	7.07E-05	4.60E-05	5.01E-05	5.32E-05
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	4.62E-05	7.04E-05	4.69E-05	5.03E-05	5.35E-05
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.9%	100.0%	100.0%	99.9%
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	<0.011	<0.011	<0.012	<0.012	<0.011
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	<0.015	<0.014	<0.015	<0.015	<0.015
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	<8.77E-06	<8.55E-06	<8.76E-06	<8.90E-06	<8.76E-06
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	<8.80E-06	<8.52E-06	<8.93E-06	<8.93E-06	<8.79E-06
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.8%	99.9%	99.9%	99.9%	99.9%

<sup>1</sup> Reduction efficiency determined using ppmdv @ 3% O<sub>2</sub>.

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**RESULTS**

2-19

**Table 2-19:  
Unit 4 FGD Stack – Method 26 – Teflon, Runs 1-4**

Run No.		1	2	3	4	Average
Date (2007)		Mar 28	Mar 28	Mar 28	Mar 29	
Start Time (approx.)		09:35	11:59	14:03	08:41	
Stop Time (approx.)		11:11	13:35	15:39	10:17	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	7.0	6.9	6.9	7.1	7.0
CO <sub>2</sub>	Carbon dioxide (dry volume %)	12.3	12.3	12.1	12.2	12.2
T <sub>s</sub>	Sample temperature (°F)	126	126	126	126	126
B <sub>w</sub>	Actual water vapor in gas (% by volume)	12.45	12.98	12.22	12.07	12.43
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	0.045	0.089	0.036	0.080	0.062
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	0.058	0.113	0.046	0.103	0.080
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	6.23E-05	1.22E-04	5.01E-05	1.11E-04	8.66E-05
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	6.20E-05	1.23E-04	5.10E-05	1.11E-04	8.67E-05
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.8%	99.9%	99.8%	99.9%
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	<7.49E-03	<7.55E-03	<9.27E-03	<1.10E-02	<8.84E-03
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	<0.010	<0.010	<0.012	<0.014	<0.011
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	<5.72E-06	<5.72E-06	<7.02E-06	<8.48E-06	<6.74E-06
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	<5.69E-06	<5.74E-06	<7.15E-06	<8.45E-06	<6.76E-06
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.9%	99.9%	99.8%	99.9%

<sup>1</sup> Reduction efficiency determined using ppmdv @ 3% O<sub>2</sub>.

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**RESULTS**

2-20

**Table 2-20:  
Unit 4 FGD Stack – Method 26 – Teflon, Runs 5-8**

Run No.		5	6	7	8	Average
Date (2007)		Mar 29	Mar 29	Mar 30	Mar 30	
Start Time (approx.)		10:51	12:58	08:26	11:23	
Stop Time (approx.)		12:27	14:34	10:02	12:59	
<b>Process Conditions</b>						
F <sub>d</sub>	Oxygen-based F-factor (dscf/MMBtu)	9,780	9,780	9,780	9,780	
F <sub>c</sub>	Carbon dioxide-based F-factor (dscf/MMBtu)	1,800	1,800	1,800	1,800	
<b>Gas Conditions</b>						
O <sub>2</sub>	Oxygen (dry volume %)	6.8	6.8	6.8	6.8	6.8
CO <sub>2</sub>	Carbon dioxide (dry volume %)	12.3	12.5	12.2	12.3	12.3
T <sub>s</sub>	Sample temperature (°F)	124	124	124	123	124
B <sub>w</sub>	Actual water vapor in gas (% by volume)	11.75	11.30	11.49	11.87	11.60
<b>Hydrogen Chloride (HCl) Results</b>						
C <sub>sd</sub>	HCl Concentration (ppmdv)	0.058	0.053	0.027	0.13	0.068
C <sub>sd7</sub>	HCl Concentration @3% O <sub>2</sub> (ppmdv)	0.074	0.067	0.034	0.17	0.086
E <sub>Fd</sub>	HCl Rate - Fd-based (lb/MMBtu)	7.97E-05	7.20E-05	3.71E-05	1.82E-04	9.27E-05
E <sub>Fc</sub>	HCl Rate - Fc-based (lb/MMBtu)	8.05E-05	7.15E-05	3.78E-05	1.84E-04	9.34E-05
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.9%	100.0%	99.8%	99.9%
<b>Hydrogen Fluoride (HF) Results</b>						
C <sub>sd</sub>	HF Concentration (ppmdv)	<0.011	<0.011	<0.010	<0.011	<0.011
C <sub>sd7</sub>	HF Concentration @3% O <sub>2</sub> (ppmdv)	<0.014	<0.014	<0.013	<0.014	<0.014
E <sub>Fd</sub>	HF Rate - Fd-based (lb/MMBtu)	<8.50E-06	<8.34E-06	<7.61E-06	<8.07E-06	<8.13E-06
E <sub>Fc</sub>	HF Rate - Fc-based (lb/MMBtu)	<8.58E-06	<8.28E-06	<7.74E-06	<8.15E-06	<8.19E-06
RE	Reduction Efficiency (% Removal) <sup>1</sup>	99.9%	99.8%	99.9%	99.9%	99.9%

<sup>1</sup> Reduction efficiency determined using ppmdv @ 3% O<sub>2</sub>.

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**RESULTS**

2-21

Table 2-21:  
Unit 4 FGD Inlet – FTIR – March 27, 2007

Time (HH:MM)	MKS (FTIR)									Servomex (Paramagnetic/UV)	
	HC	HF	CO	NO	NO <sub>2</sub>	SO <sub>2</sub>	NH <sub>3</sub>	H <sub>2</sub> O	CO <sub>2</sub>	O <sub>2</sub>	CO <sub>2</sub>
	(ppmdv)	(ppmdv)	(ppmdv)	(ppmdv)	(ppmdv)	(ppmdv)	(ppmdv)	(%dv)	(%dv)	(%dv)	(%dv)
12:30	48.1	0.16	389.5	106.0	0.10	861.0	0.41	7.28	11.6	8.1	11.4
12:45	54.7	0.54	414.5	103.0	0.13	868.3	0.31	7.35	11.7	6.5	11.2
13:00	55.4	3.38	212.0	108.9	0.11	868.7	0.18	7.29	11.8	8.0	11.5
13:15	56.2	5.38	220.5	108.3	0.11	866.4	0.09	7.35	11.9	8.0	11.6
13:30	56.3	6.43	161.6	103.9	0.08	861.9	0.10	7.30	11.8	7.9	11.6
13:45	56.4	7.15	162.7	104.4	0.05	852.3	0.03	7.27	11.7	7.8	11.7
14:00	56.6	7.49	269.6	104.9	0.08	855.5	0.06	7.11	11.6	8.0	11.5
14:15	57.4	8.01	202.6	105.8	0.13	869.8	0.03	7.24	11.8	7.9	11.6
14:30	56.2	8.01	155.4	102.4	0.21	849.8	0.03	7.06	11.6	8.2	11.3
14:45	57.1	8.32	157.2	109.2	0.12	865.9	0.02	7.11	11.7	8.0	11.5
15:00	57.4	8.30	431.4	101.8	0.20	870.4	0.01	7.04	11.5	8.0	11.5
15:15	56.4	8.45	171.9	102.9	0.21	863.7	0.00	7.06	11.6	8.2	11.3
15:30	56.9	8.58	296.6	102.5	0.22	866.7	0.01	7.07	11.6	8.0	11.5
15:45	55.6	8.55	75.4	107.3	0.21	859.4	0.00	7.19	11.9	8.1	11.3
16:00	56.5	8.58	246.0	100.4	0.21	876.5	-0.03	7.09	11.6	8.0	11.4
16:15	54.2	7.98	238.2	95.0	0.29	843.0	-0.05	6.78	11.0	9.0	10.6
16:30	54.2	8.05	30.4	99.6	0.39	834.7	0.05	6.83	10.9	8.6	10.9
<b>Average</b>	<b>55.9</b>	<b>6.86</b>	<b>209.1</b>	<b>104.5</b>	<b>0.17</b>	<b>859.0</b>	<b>0.07</b>	<b>7.14</b>	<b>11.6</b>	<b>8.0</b>	<b>11.4</b>
<b>(±)</b>	<b>0.4</b>	<b>0.22</b>	<b>1.0</b>	<b>0.4</b>	<b>0.03</b>	<b>0.7</b>	<b>0.09</b>				

**RESULTS**

2-22

**Table 2-22:  
Unit 4 FGD Inlet – FTIR – March 28, 2007**

Time (HH:MM)	MKS (FTIR)									Servomex (Paramagnetic/OVI)	
	HCl (ppmdv)	HF (ppmdv)	CO (ppmdv)	NO (ppmdv)	NO <sub>2</sub> (ppmdv)	SO <sub>2</sub> (ppmdv)	NH <sub>3</sub> (ppmdv)	H <sub>2</sub> O (%dv)	CO <sub>2</sub> (%dv)	O <sub>2</sub> (%dv)	CO <sub>2</sub> (%dv)
9:30	47.6	7.51	462.2	104.8	1.23	895.8	-0.13	7.61	12.3	6.7	12.6
9:45	47.9	8.15	126.5	116.3	1.24	895.7	-0.11	7.64	12.6	6.6	12.7
10:00	47.7	8.11	219.0	109.4	1.18	894.3	-0.15	7.59	12.4	6.8	12.8
10:15	48.1	8.13	322.5	105.9	1.21	899.3	-0.16	7.63	12.4	6.7	12.6
10:30	47.2	8.01	81.7	117.1	1.22	881.6	-0.15	7.48	12.3	6.8	12.5
10:45	47.9	8.12	306.0	105.5	1.18	899.2	-0.22	7.74	12.3	6.4	12.1
11:00	48.1	8.31	260.0	106.8	1.23	899.1	-0.16	7.79	12.4	6.8	12.5
11:15	49.2	8.29	243.1	110.6	1.18	894.1	-0.17	7.80	12.4	6.8	12.5
11:30	51.6	8.51	594.1	108.2	1.23	922.7	-0.20	7.93	12.7	6.4	12.9
11:45	50.8	8.40	213.7	108.4	1.16	898.6	-0.18	7.78	12.5	6.6	12.7
12:00	51.5	8.53	124.1	120.4	1.28	903.8	-0.17	7.83	12.7	6.6	12.7
12:15	52.5	8.59	159.2	112.8	1.20	886.8	-0.16	7.77	12.6	6.7	12.6
<b>Average</b>	<b>49.1</b>	<b>8.19</b>	<b>249.6</b>	<b>110.3</b>	<b>1.23</b>	<b>896.34</b>	<b>-0.16</b>	<b>7.70</b>	<b>12.4</b>	<b>6.6</b>	<b>12.3</b>
<b>(+/-)</b>	<b>0.15</b>	<b>0.33</b>	<b>1.30</b>	<b>0.30</b>	<b>0.03</b>	<b>0.70</b>	<b>0.09</b>	<b>0.04</b>	<b>0.03</b>		

**RESULTS**

**Table 2-23:  
Unit 4 FGD Stack – FTIR – March 29, 2007**

Time (HR:MM)	MKS (FTIR)									Servomex (Paramagnetic UV)		Plant CEMS	
	HC (ppmdv)	HF (ppmdv)	CO (ppmdv)	NO (ppmdv)	NO <sub>2</sub> (ppmdv)	SO <sub>2</sub> (ppmdv)	NH <sub>3</sub> (ppmdv)	H <sub>2</sub> O (%)	CO <sub>2</sub> (%dv)	O <sub>2</sub> (%dv)	CO <sub>2</sub> (%dv)	SO <sub>2</sub> (ppmdv)	CO <sub>2</sub> (%dv)
12:15	0.07	0.17	311.5	112.1	1.49	36.4	0.78	11.60	12.7	6.6	12.7		
12:30	0.05	0.10	294.3	116.0	1.65	35.4	0.72	11.19	12.7	6.4	12.9	35.1	12.6
12:45	0.15	0.18	235.1	115.0	1.54	35.1	0.73	11.49	12.7	6.4	12.9		
13:00	-0.05	0.15	638.0	111.5	1.55	36.3	0.74	11.42	12.8	6.3	12.8	33.9	12.6
13:15	0.02	0.06	204.1	115.3	1.59	34.6	0.67	11.40	12.7	6.7	12.7		
13:30	0.11	0.11	480.8	113.6	1.54	37.0	0.70	11.47	12.8	6.4	12.9	35.8	12.6
13:45	-0.03	0.13	319.4	114.6	1.54	36.1	0.77	11.05	12.7	0.0	0.0		
14:00	-0.04	0.16	458.8	115.5	1.60	38.1	0.76	11.54	12.8	6.4	12.9	36.2	12.5
14:15	0.15	0.09	488.6	113.1	1.53	34.9	0.63	11.45	12.7	0.0	0.0		
14:30	0.14	0.11	584.9	112.8	1.59	35.8	0.81	11.56	12.8	6.3	13.0	33.3	12.5
14:45	0.21	0.11	233.1	115.3	1.62	32.9	0.82	11.61	12.6	6.6	12.7		
<b>Average</b>	<b>0.07</b>	<b>0.12</b>	<b>335.1</b>	<b>114.6</b>	<b>1.56</b>	<b>35.3</b>	<b>0.74</b>	<b>11.32</b>	<b>12.7</b>	<b>6.5</b>	<b>12.9</b>	<b>34.9</b>	<b>12.6</b>
(stdev)	0.07	0.08	1.50	0.90	0.09	0.34	0.17	0.08	0.05				

Plant CEMS corrected to ppmvd using measured moisture content of flue gas.

**Table 2-24:  
Unit 4 FGD Stack – FTIR – March 30, 2007**

Time (HR:MM)	MKS (FTIR)									Servomex (Paramagnetic UV)		Plant CEMS	
	HC (ppmdv)	HF (ppmdv)	CO (ppmdv)	NO (ppmdv)	NO <sub>2</sub> (ppmdv)	SO <sub>2</sub> (ppmdv)	NH <sub>3</sub> (ppmdv)	H <sub>2</sub> O (%)	CO <sub>2</sub> (%dv)	O <sub>2</sub> (%dv)	CO <sub>2</sub> (%dv)	SO <sub>2</sub> (ppmdv)	CO <sub>2</sub> (%dv)
8:15	0.00	-0.01	624.3	108.8	1.56	38.8	0.75	11.37	12.3				
8:30	-0.03	-0.01	406.3	112.5	1.46	39.0	0.72	11.20	12.5	6.6	12.7	39.5	12.5
8:45	-0.14	0.02	225.6	113.1	1.63	40.1	0.76	11.74	12.5	6.6	12.7		
9:00	0.03	0.00	572.9	111.6	1.60	44.5	0.74	11.71	12.6	6.5	12.7	43.2	12.4
9:15	-0.06	0.03	400.7	114.4	1.60	42.7	0.73	11.63	12.6	6.5	12.7		
9:30	0.09	0.04	459.7	113.7	1.62	43.3	0.72	11.48	12.6	6.5	12.7	44.3	12.4
9:45	0.11	0.07	500.0	113.0	1.60	41.3	0.74	10.83	12.5	6.6	12.7		
10:00	-0.08	0.00	385.8	114.5	1.58	45.7	0.72	11.25	12.6	6.5	12.7	44.3	12.5
10:15	0.03	0.05	390.1	116.0	1.54	45.4	0.79	11.19	12.6	6.6	12.6		
10:30	0.08	0.07	143.2	116.5	1.53	39.9	0.79	10.85	12.5	6.6	12.7	43.9	12.7
10:45	0.06	0.06	322.2	115.3	1.57	40.3	0.73	11.28	12.6	6.6	12.6		
11:00	-0.14	0.02	643.8	115.5	1.65	45.3	0.76	11.33	12.7	6.5	12.7	42.6	12.4
11:15	-0.06	-0.04	220.4	116.5	1.67	45.2	0.72	11.23	12.6	6.6	12.7		
11:30	-0.03	0.06	219.9	115.9	1.57	42.0	0.77	11.24	12.6	6.6	12.7	42.6	12.5
11:45	-0.01	0.00	371.0	113.9	1.45	39.7	0.73	10.81	12.6	6.6	12.6		
12:00	0.06	0.08	220.6	115.7	1.54	38.8	0.79	11.41	12.6	6.7	12.6	40.6	12.5
12:15	0.03	0.04	217.0	118.1	1.60	38.3	0.74	11.48	12.6	6.6	12.7		
12:30	0.05	0.11	243.0	117.5	1.58	39.5	0.79	11.51	12.6	6.5	12.7	38.2	12.6
12:45	-0.07	0.00	370.8	116.3	1.47	39.3	0.74	11.55	12.7	6.3	12.9		
13:00	-0.08	0.01	463.6	114.8	1.54	39.9	0.81	11.14	12.6	6.4	12.8	39.7	12.4
<b>Average</b>	<b>0.00</b>	<b>0.04</b>	<b>382.7</b>	<b>114.8</b>	<b>1.58</b>	<b>41.6</b>	<b>0.76</b>	<b>11.33</b>	<b>12.6</b>	<b>6.6</b>	<b>12.7</b>	<b>43.0</b>	<b>12.5</b>
(stdev)	0.07	0.08	0.90	0.90	0.08	0.34	0.15	0.08	0.04				

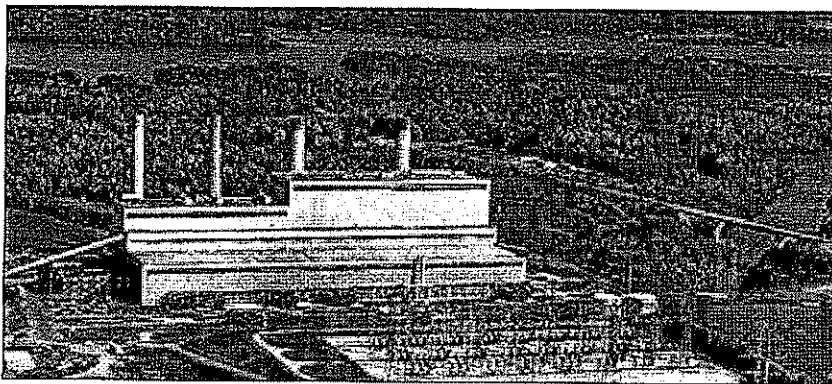
Plant CEMS corrected to ppmvd using measured moisture content of flue gas.

**DESCRIPTION OF INSTALLATION**

3-1

**MARSHALL STEAM STATION**

Capacity: 2,090 megawatts  
Location: Catawba County, North Carolina  
Commercial Date: 1965



Marshall Steam Station is a four-unit, coal-fired generating facility located in Catawba County, North Carolina. Named for former Duke Power president E.C. Marshall, the station is located on Lake Norman.

The second largest coal facility owned by Duke Energy in the Carolinas, Marshall generates enough electricity to power approximately two million homes. Since it began commercial operation in 1965, Marshall Steam Station has been among the most efficient power plants in the nation.

Duke Energy has made significant improvements to reduce emissions from the company's coal-fired plants. A unique type of burner arrangement in the boilers keeps the nitrogen oxide emissions from the Marshall facility well below regulatory limits.

In 2004, the company began installing flue gas desulfurization equipment – commonly known as scrubbers. This equipment will lower the station's sulfur dioxide emissions by approximately 95 percent. The project is scheduled for completion in 2007

A schematic of the process indicating sampling locations is shown in Figure 3-1.

**DESCRIPTION OF INSTALLATION**  
**MARSHALL STEAM STATION (CONTINUED)**

3-2

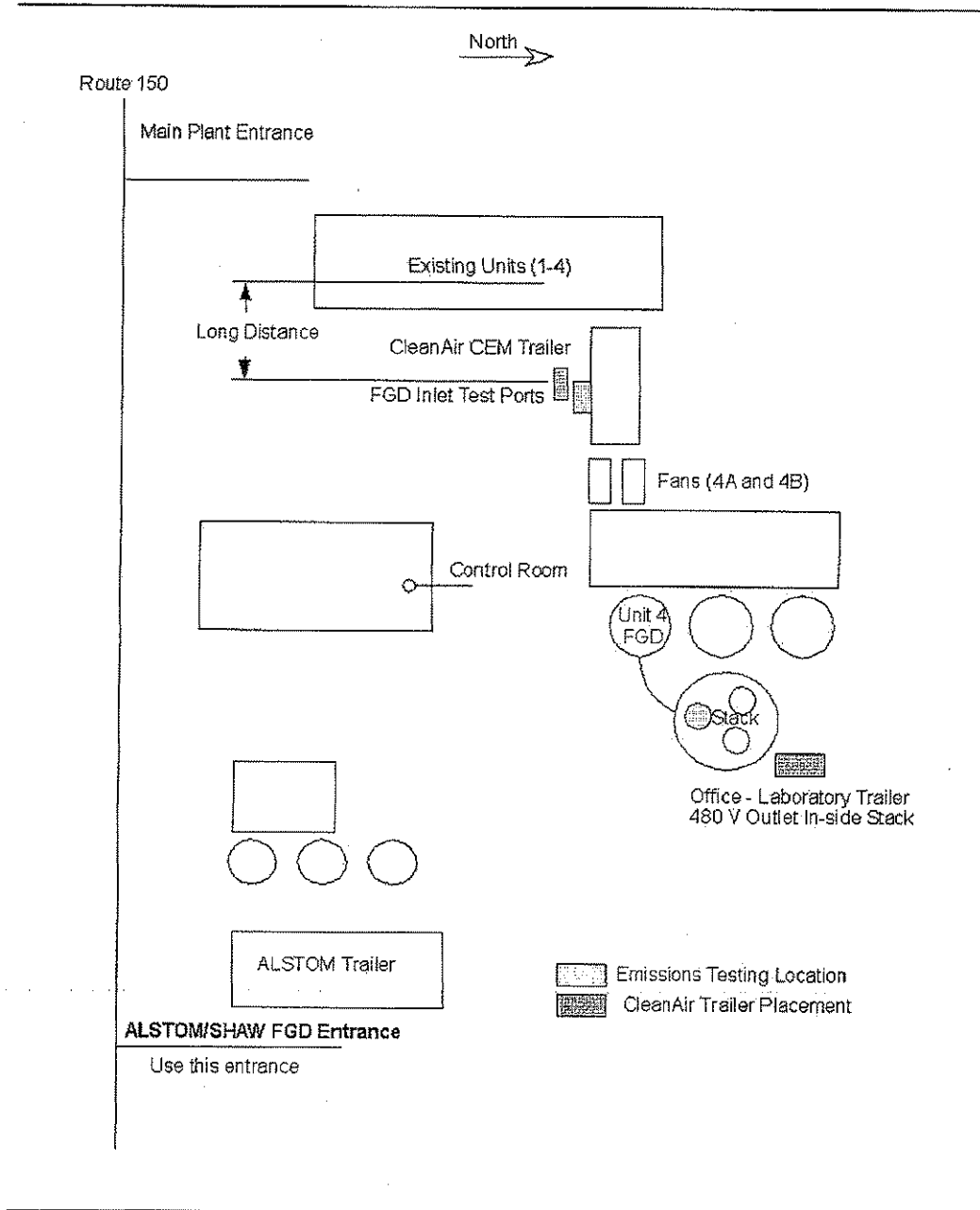


Figure 3-1: Process Schematic

**DESCRIPTION OF INSTALLATION**

3-3

**DESCRIPTION OF SAMPLING LOCATIONS**

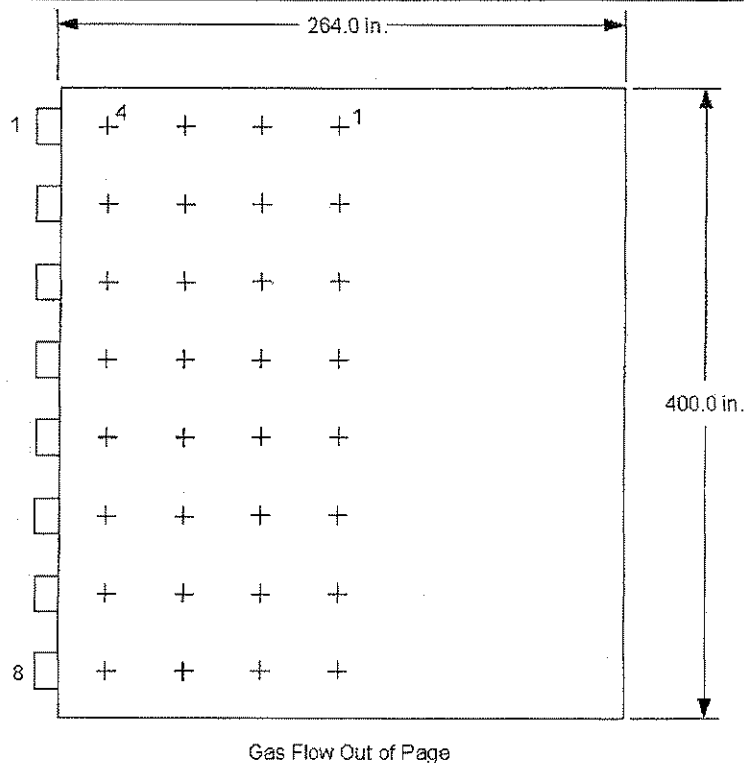
Table 3-1 outlines the sampling point configurations. Figure 3-2 through Figure 3-3 illustrates the sampling points and orientation of sampling ports for each of the sources tested in the program.

**Table 3-1:  
Sampling Points**

Location	Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
FGD Inlet	SO <sub>3</sub> /SO <sub>2</sub>	8B	1-2	1	1	60	60	N/A
FGD Inlet	Trace Metals	29	1-2	8	4	3	96	3-2
FGD Inlet	HCl/HF	26	1-8	1	1	96	96	N/A
FGD Stack	SO <sub>3</sub> /SO <sub>2</sub>	8C	1-2	1	1	60	90	N/A
FGD Stack	Trace Metals	29	1-2	3	4	18	96	3-3
FGD Stack	HCl/HF	26	1-8	1	1	96	96	N/A

**DESCRIPTION OF INSTALLATION**  
**DESCRIPTION OF SAMPLING LOCATIONS (CONTINUED)**

3-4

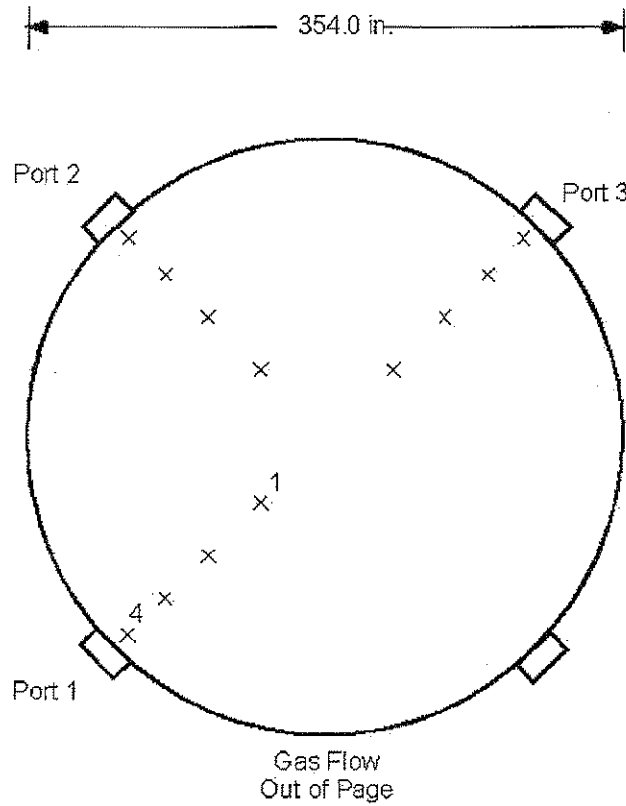


<u>Sampling Point</u>	<u>Port to Point Distance (in.)</u>
1	92.4
2	66.0
3	39.6
4	13.2

**Figure 3-2: FGD Inlet Sampling Point Determination (EPA Method 1)**

**DESCRIPTION OF INSTALLATION**  
**DESCRIPTION OF SAMPLING LOCATIONS (CONTINUED)**

3-5



<u>Sampling Point</u>	<u>Port to Point Distance (in.)</u>
1	114.3
2	68.7
3	37.2
4	11.3

Figure 3-3: FGD Stack Sampling Point Determination (EPA Method 1)

**METHODOLOGY**

Clean Air Engineering followed procedures as detailed in U.S. Environmental Protection Agency (USEPA) Methods 1, 2, 3A, 26, 29 320 and CleanAir Methods 8B and 8C. The following table summarizes the methods and their respective sources.

**Table 4-1:  
Summary of Sampling Procedures**

Title 40 CFR Part 60 Appendix A

Method 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 26	"Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources Non-Isokinetic Method"
Method 29	"Determination of Metals Emissions from Stationary Sources"

Miscellaneous Methods

CleanAir Method 8B	"Determination Of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide, And Sulfuric Acid Vapor And Mist From Stationary Sources Using A Controlled Condensation Sampling Apparatus"
CleanAir Method 8C	"Determination Of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide, And Sulfuric Acid Vapor And Mist From Stationary Sources Using An EPA Method 8 Sampling Apparatus Modified To Mitigate The Effects Of Moisture And Other Potential Interferents"

Title 40 CFR Part 63 Appendix A

Method 320	"Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy"
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These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR) and on the World Wide Web at <http://www.cleanair.com>.

Diagrams of the sampling apparatus and major specifications of the sampling, recovery and analytical procedures are summarized for each method in Appendix A.

CleanAir followed specific quality assurance and quality control (QA/QC) procedures as outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods", EPA/600/R-94/038C. Additional QA/QC methods as prescribed in CleanAir's internal Quality Manual were also followed. Results of all QA/QC activities performed by CleanAir are summarized in Appendix D.

*CleanAir*

ALSTOM POWER, INC.  
MARSHALL STEAM STATION

Client Reference No: 96004005  
CleanAir Project No: 10171

**APPENDIX**

**5-1**

TEST METHOD SPECIFICATIONS .....	A
SAMPLE CALCULATIONS .....	B
PARAMETERS .....	C
QA/QC DATA .....	D
FIELD DATA .....	E
FIELD DATA PRINTOUTS .....	F
LABORATORY DATA .....	G
PLANT DATA .....	H

# ATTACHMENT 3

**POWER**  
ENVIRONMENTAL CONTROL SYSTEMS  
North America

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Fax: +1 865 694 5203  
[www.environment.power.alstom.com](http://www.environment.power.alstom.com)

**ALSTOM**

October 14, 2008

Subject: Cliffside 6 Acid Gas Removal

**Duke Energy**  
526 South Church Street  
Charlotte, NC 28202

Attn:  
Sam Alexander  
General Manager  
Cliffside Modernization Project

Dear Sam,

In response to your inquiry concerning the expected emissions of hydrogen chloride (HCl) and hydrogen fluoride (HF) from Cliffside Unit 6, Alstom offers the following:

Performance predictions for HCl and HF emissions at Cliffside Unit 6 were originally based on the assumption that these species are removed in the same percentage as SO<sub>2</sub>. Thus, if the SO<sub>2</sub> removal efficiency is 99%, it is assumed that HCl and HF removal efficiencies are also 99%. The above assumption is known to be conservative as both HCl and HF are stronger acids and more reactive than SO<sub>2</sub>, which would tend to produce higher removal efficiencies than SO<sub>2</sub>, all other parameters being equal.

There is now reason to believe that the actual performance at Cliffside 6 will be significantly better than originally predicted as demonstrated by data from recent testing of WFGD systems.

	Duke Energy Marshall Unit 4	Plant A
SO <sub>2</sub> Removal (%)	95-96	95-96
HCl Inlet (lb/MMBtu)	0.096	0.087
HCl Emissions (lb/MMBtu)	Avg. 0.000128	Avg. 0.000214
HCl Removal (%)	99.7-99.9 (Avg. 99.87)	99.7-99.8 (Avg. 99.75)
HF Inlet (lb/MMBtu)	Avg. 0.0070	Avg. 0.0093
HF Emissions (lb/MMBtu)	Avg. 0.0000125	Avg. 0.0000463
HF Removal (%)	99.8-99.9	99.7-99.8

It is evident from the data that (1) the HCl and HF removal efficiencies are higher than SO<sub>2</sub> in all cases and (2) very high removal efficiencies/low emissions are achievable.

Marshall Unit 4 incorporates Alstom's most current design features – dual orifice nozzles and performance enhancement plates (wall rings). Dual orifice nozzles provide extremely good contact between the flue gas and scrubbing slurry, and increase liquid residence time in the absorber. Performance enhancement plates ensure that no unscrubbed flue gas

**ALSTOM**

bypasses the spray zone along the vessel walls. These two features are responsible for the extremely low emissions at Marshall.

Plant A is a utility grade coal fired plant with two large scale units firing bituminous coal. The Alstom WFGD system, put in service in the mid-1990's, is of similar design, but lacks performance enhancement plates and has been only partially retrofitted with dual orifice nozzles.

The advanced Integrated Air Quality Control System planned for Cliffside Unit 6 further enhances the potential for extremely low acid gas emissions. In this process, a high-efficiency WFGD system is preceded by DFGD system comprised of a Spray Dryer Absorber (SDA) and Pulse Jet Fabric Filter (PJFF). Lime slurry is injected in the SDA primarily for acid mist ( $H_2SO_4$ ) control. Pilot testing at Cliffside Unit 5 has indicated that 50-70% of the HCl is collected in the SDA; HF was not measured.

The high efficiency Cliffside WFGD is an advanced version of the Marshall WFGD with an additional spray level and design  $SO_2$  removal efficiency of 99% compared with the Marshall design efficiency of 95%. With two stages (i.e. DFGD and WFGD) of acid gas control, HCl and HF removal performance at Cliffside Unit 6 is expected to be better than the single stage scrubber (i.e. WFGD) systems at Marshall.

This information is provided for information purposes only and reflects what Alstom reasonably expects the emissions to be based on the data above and the particular equipment to be provided at Cliffside Unit 6, but it does not constitute a specific performance guarantee or warranty by Alstom for HCl or HF removal.

Sincerely,



Phil Rader  
Business Sales Manager

cc: Eileen Windham, Alstom  
Dave Borsare, Alstom