Low-Cost Options for Moderate Levels of Mercury Control

Topical Report for
MidAmerican's Louisa Generating Station
Reporting Period: January 1–March 31, 2006

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DISCLAIMER

ABSTRACT

On March 15, 2005, EPA issued the Clean Air Mercury Rule, requiring phased-in reductions of mercury emissions from electric power generators. ADA-ES, Inc., with support from DOE/NETL and industry partners, is conducting evaluations of EPRI's TOXECON II™ process and of high-temperature reagents and sorbents to determine the capabilities of sorbent/reagent injection, including activated carbon, for mercury control on different coals and air emissions control equipment configurations.

DOE/NETL targets for total mercury removal are ≥55% (lignite), ≥65% (subbituminous), and ≥80% (bituminous). Based on work done to date at various scales, meeting the removal targets appears feasible. However, work needs to progress to more thoroughly document and test these promising technologies at full scale.

This is the final site report for tests conducted at MidAmerican's Louisa Station, one of three sites evaluated in this DOE/NETL program. The other two sites in the program are MidAmerican's Council Bluff Station and Entergy's Independence Station.

MidAmerican's Louisa Station burns Powder River Basin (PRB) coal and employs hot-side electrostatic precipitators with flue gas conditioning for particulate control. This part of the testing program evaluated the effect of reagents used in the existing flue gas conditioning on mercury removal.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Power plants that burn Powder River Basin (PRB) coal and have only hot-side electrostatic precipitators (ESPs) for air pollution control represent a challenging configuration for controlling mercury emissions. Limited testing on hot-side ESP configurations with injecting conventional powdered activated carbons just upstream of the ESP has indicated these sorbents perform very poorly at the elevated temperatures associated with hot-side ESP installations.

In order to further the understanding of potential mercury control systems for power plants burning PRB coals and using hot-side ESPs for air pollution control, DOE selected ADA-ES, Inc., to conduct a test program at MidAmerican's Louisa Generating Station to evaluate the mercury removal effectiveness of the hot-side flue gas conditioning agent, ADA-37, currently in use at Louisa and any synergistic effects of ALSTOM's coal additive, KNX. Testing was conducted from January 28 to February 13, 2006. The plant burned the normal subbituminous PRB fuel during the test program. This report provides the results from the test program.

The effect of both ADA-37 and KNX was tested during the parametric test period. Although ADA-37 is typically on at Louisa, data were collected without ADA-37 and at three different injection rates (6, 12, and 18 gallons per hour). KNX was injected at two different rates (3 and 8 gallons per hour). Results indicate that ADA-37 is not effective at removing mercury across a hot-side ESP. KNX appeared to increase the fraction of oxidized mercury, but no net increase in mercury removal was noted with KNX.

INTRODUCTION

Description of Overall Program

The test program at MidAmerican's Louisa Generating Station is part of a three-site program funded by the Department of Energy's National Energy Technology Laboratory (DOE/NETL) and industry partners to obtain the necessary information to assess the feasibility and costs of controlling mercury from coal-fired utility plants using either high-temperature sorbents or EPRI's TOXECON II™ process. High-temperature sorbents are included in the test programs at MidAmerican's Louisa Station and Council Bluffs Station. Sorbent injection into an electrostatic precipitator (ESP), or TOXECON II™, is the focus of testing at Entergy's Independence Station. All of these sites fire Powder River Basin (PRB) coal and currently achieve less than 20% mercury removal. Key descriptive information about these plants is included in Table 1. Table 2 shows the test schedule for the overall program.

The technical approach followed during this program allowed the team to evaluate the potential of ADA-37 and ALSTOM's coal additive KNX. These technical objectives were accomplished by following a series of tasks, as listed below. These tasks are repeated for each test site.

Task 1. Site Coordination, Kickoff Meeting, Test Plan and QA/QC Plan

Task 2. Design and Install Site-Specific Equipment

Task 3. Sorbent Selection

Task 4. Field-Tests – Baseline Tests

Task 5. Field-Tests – Parametric Tests

Task 6. Field-Tests – Long-Term Tests (not included at Louisa)

Task 7. Data Analysis

Task 8. Sample Evaluation

Task 9. Site Report

Task 10. Technology Transfer

Task 11. Management and Reporting

A detailed description of each task is given in the Test Plan for Louisa included in Appendix A.

Table 1. Host Site Key Descriptive Information.

	Entergy Independence	MidAmerican Council Bluffs	MidAmerican Louisa
	TOXECON II™	**High-Temperature Sorbents**	
Unit No.	1	2	1
Size (MW)	842	88	700
Test Portion (MW)	210	88	700
Coal	PRB	PRB	PRB
Heating Value (as rec'd.)	8,870	8,425	8,500
Sulfur (% by weight)	0.32	0.32	0.32
Chlorine (ppm)	50	50–100	50–100
Mercury (µg/g)	0.04	0.08	0.08
Particulate Control	Cold-Side ESP	Hot-Side ESP	Hot-Side ESP
SCA/fields (ft^2/kacfm)	542/8	224/4	459/5
Sulfur Control	Compliance Coal	Compliance Coal	Compliance Coal
Disposition of Ash	Sold	Some Sold	Sold
Typical Inlet Mercury (µg/dncm)	6–7	11.1–13.5	11.1–13.4
Typical Mercury Removal	10%–20%	0%–10%	0%–10%

Table 2. Field-Testing Schedule.

Site	2005		2006				2007		
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Louisa									
Independence									
Council Bluffs									

The primary funding for testing at Louisa is through U.S. DOE Cooperative Agreement No. DE-FC26-05NT42307. Almost twenty-eight percent of the funding is through industry participants including:

- EPRI
- ADA-ES, Inc.
- SCS
- DTE Energy
- MidAmerican – Louisa Generating Station (host site)

Key members of the test team include:

ADA-ES, Inc.
EPRI
Others
Stack test firms
Analytical laboratories

Site Testing Overview

Louisa Generating Station is configured with a hot-side ESP. It was identified as one of the high-temperature sorbent test sites because it currently uses a flue gas conditioning agent, ADA-37, to enhance particulate removal in the ESP. Results of testing for the EPA's most recent mercury Information Collection Request (ICR) at the Alliant Columbia Generating Station show mercury removal of up to 32% while conditioning the ESP with ADA-37. This is higher native mercury removal than for any of the other hot-side plants in the ICR database. Tests were planned at Louisa to determine the potential of ADA-37 for mercury trim control.

The site set-up activities started on January 25, 2006, with equipment setup, and concluded on February 13, 2006. ADA-37 flue gas conditioning reagent was injected using the existing injection grid throughout the test program. The injection lances were cleaned several weeks prior to this testing during a routine plant outage. During a portion of the test program, ALSTOM's KNX material, a bromine-based coal additive, was applied to the coal through a temporary injection system at the coal gravimetric feeders.

Mercury measurements were made using a semi-continuous emission monitor (SCEM) at the ESP inlet, a mercury continuous emissions monitor (Hg CEM) at the stack, the dry sorbent trap method (STM) at the stack, and analysis of coal and ash samples.

PROJECT OBJECTIVES AND TECHNICAL APPROACH

The general approach for the field-testing at Louisa was to follow a series of three tasks: 1) Sample and Data Collection Coordination, 2) Baseline Tests, and 3) Parametric Tests.

The objectives of these tests were to evaluate the following:

- Baseline, native mercury capture.
- Potential of the existing flue gas conditioning reagent, ADA-37, to increase mercury removal across the ESP.
- Mercury speciation change when applying an additive, ALSTOM KNX, to the coal prior to entering the pulverizers and furnace.

Importance of Testing at Louisa

Available data indicate that mercury removal across a hot-side ESP is limited. Some data suggest that the flue-gas conditioning agent ADA-37 may increase mercury in these units. This test program fills a data gap for the industry.

LOUISA GENERATING STATION SITE DESCRIPTION

General Description of Unit 2

The test unit (Unit 2) is a single 700-MW PRB coal-fired electric generating unit. The unit typically fires PRB coal in a balanced draft Babcock & Wilcox opposed wall fired boiler. The Research-Cottrell hot-side ESP is followed by two Ljungström regenerative air heaters. Key operating parameters for Louisa Unit 2 are shown in Table 3. A general sketch of the flue gas flow is shown in Figure 1.

The ESP configuration for Louisa Unit 2 has four boxes in a split wedge arrangement, with each box consisting of 27 transformer/rectifier (TR) sets, 3 chambers, 51 gas passages, 5 electrical fields and 8 bus sections. A sketch of the ESP showing the TR sets and electrical fields is shown in Figure 2.

Table 3. Louisa Key Operating Parameters.

Unit	1
Size (MWnet)	700
Test Portion (MWe)	700
Coal	PRB
Heating Value (as received)	8500
Sulfur (% by weight)	0.32
Chlorine (%)	~0.01
Mercury (µg/g))	0.08
Particulate Control	Hot-Side ESP; SCA = 459 ft^2/kacfm
Sulfur Control	Compliance Coal
Air Preheater	Regenerative
Ash Reuse	Sold

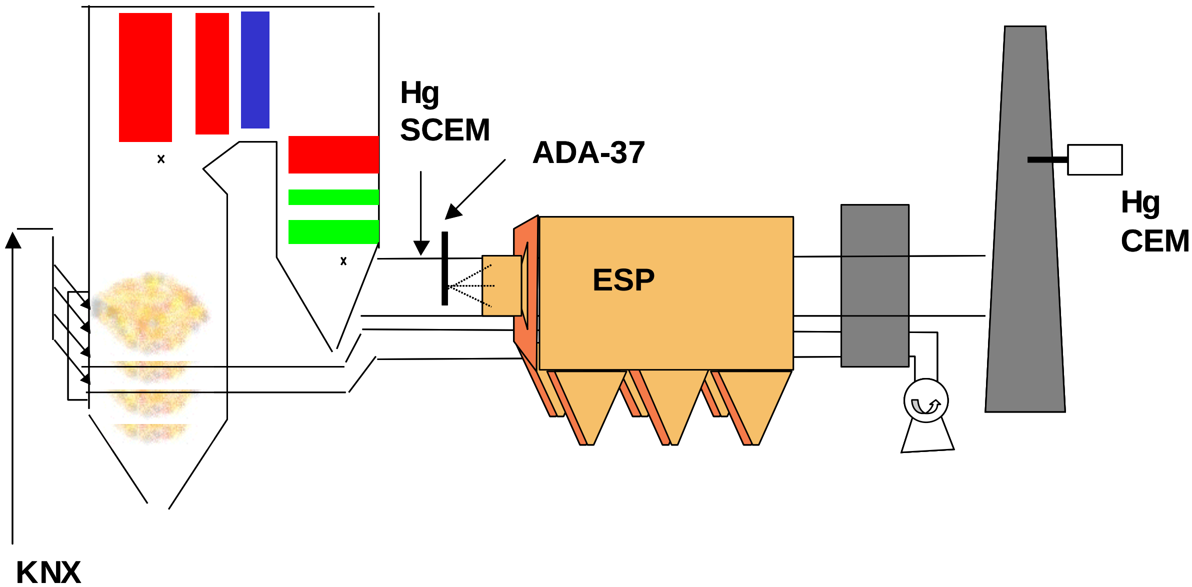


Figure 1. Sketch of Louisa Unit 2 General Configuration.

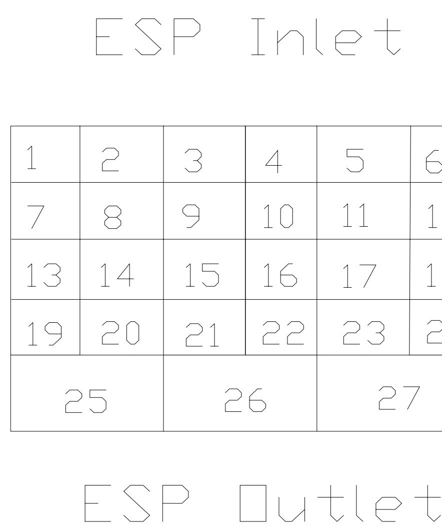


Figure 2. Single ESP Box Electrical Field Configuration.

Because Louisa sells its fly ash, it was important that the reagents used during testing would not impact the marketability of the fly ash. The reagents tested at Louisa should have no impact on ash sales.

For collection of plant operating data, the plant installed a workstation in the ADA-ES testing office trailer that was connected to the plant control and information system.

Description of Sorbent Injection and Mercury Monitoring Locations

During the test program, the liquid reagent ADA-37 was injected upstream of the ESP using existing injection lances. One hundred percent of the Unit 1 flue gas flow was treated. For a portion of the tests, ALSTOM's KNX coal additive was added to the coal prior to combustion. The unit has seven pulverizers. KNX was injected into the feeders on four of the mills (mills 101, 102, 103, and 104). KNX-treated coal was delivered to four burner elevations—two on the front wall and two on the rear wall—which should have provided relatively uniform distribution within the furnace. A diagram of the boiler showing the burner arrangement and the associated coal mill for each burner level is shown in Figure 3.

Two mercury monitors were installed for this program. An SCEM was installed in a port upstream of one pair of ESP boxes. An Hg CEM was installed at the 400-foot test elevation in the Unit 1 stack.

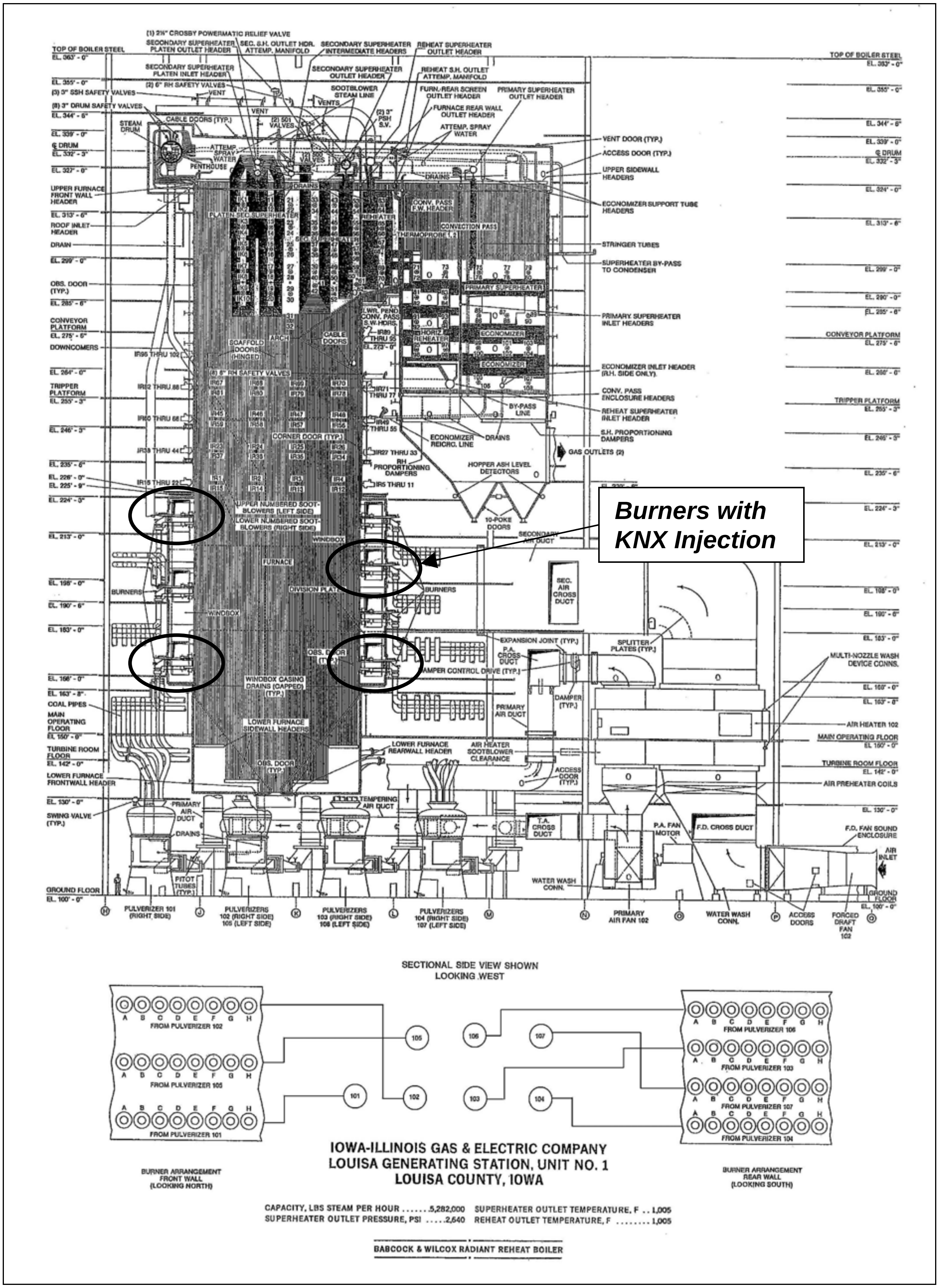


Figure 3. Louisa Boiler Arrangement Indicating Burners with KNX-Treated Coal.

EQUIPMENT DESCRIPTIONS

ADA-37 Injection System

The reagent injection system currently in use at Louisa consists of a bulk-storage vessel and a single feeder/metering train. A photo of the ADA-37 injection skid is shown in Figure 4.

Figure 4. ADA-37 Injection Skid Installed at Louisa Generating Station.

Two sets of injection grids, one for each ESP path, are installed on Unit 1. Each grid consists of six injection lances connected by a common header located upstream of the ESPs. A programmable logic controller (PLC) system controls the system operation. The sorbent injection system allows controlling the reagent feed rate either manually through a Human-Machine Interface (HMI), or automatically through a load-following signal from the plant such as unit MW load or flue gas flow rate.

Bulk delivery trucks deliver and unload the ADA-37 flue gas conditioning reagent into a storage vessel near the skid. The reagent is delivered from the bottom of the storage vessel through a metering system and then into the feed system. The reagent is mixed with dilution water, which is then transported to the injection grid. Atomizing air is used to create the maximum efficiency droplet size for distribution.

ALSTOM KNX Injection System

The ALSTOM KNX liquid delivery system consists of a 55-gallon drum with a feed line to a variable speed positive displacement pump. KNX was delivered to the coal at the gravimetric feeders via flex tubing.

Mercury Monitoring System

Two mercury monitors were used during testing at Louisa. One was an SCEM built and operated by Apogee Scientific, Inc. One was a continuous emissions monitor (CEM) built by Thermo Electron Corporation and operated by ADA-ES. The SCEM was installed at the inlet to the ESP upstream of sorbent injection. The CEM was installed at the stack. The SCEM consisted of a cold-vapor atomic absorption spectrometer (CVAAS) coupled with a gold amalgamation system (Au-CVAAS). A similar SCEM is shown in Figure 5. The CEM uses a dilution probe followed by a cold-vapor atomic fluorescence spectrometer (CVAFS). Both systems used inertial separation probes to separate the particulate-free sample gas from the bulk flue gas.

Both analyzers are capable of measuring total vapor-phase mercury and elemental vapor-phase mercury. The analyzer determines total vapor-phase mercury concentrations by reducing all of the oxidized mercury to the elemental form near the extraction location. To measure elemental mercury, the oxidized mercury is removed while allowing elemental mercury to pass through without being altered.

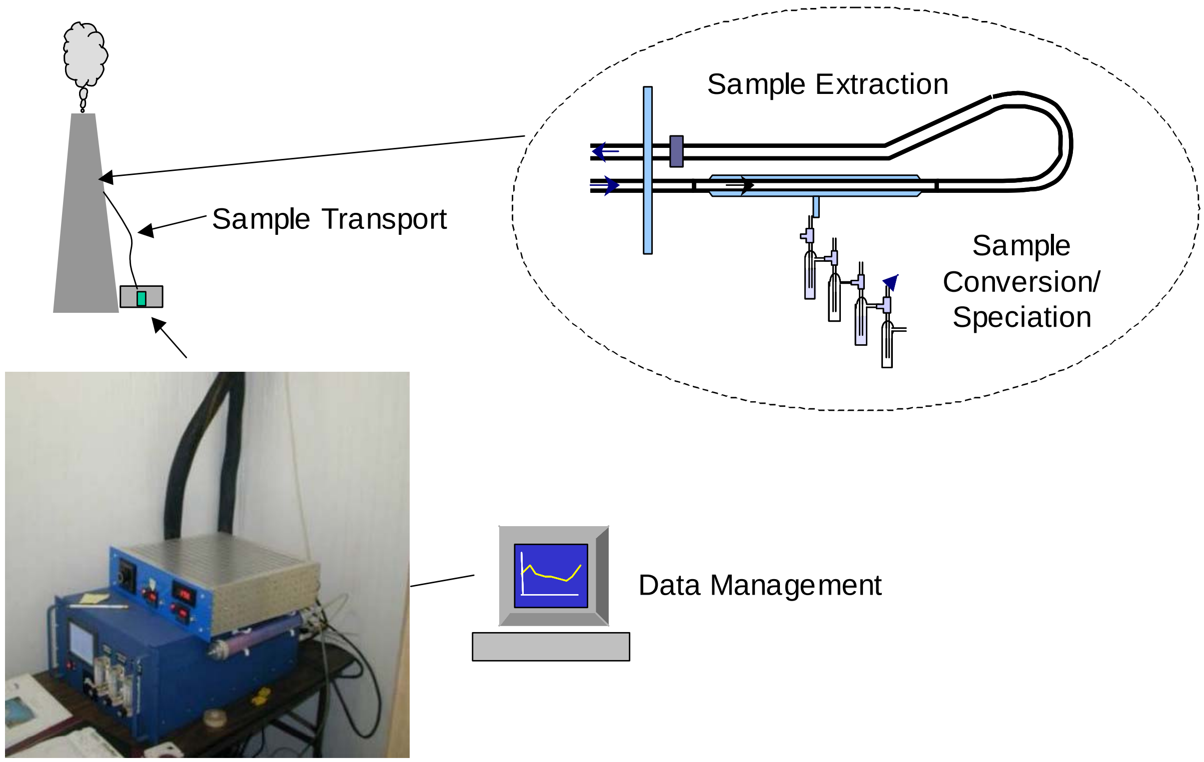


Figure 5. Sketch of SCEM Mercury Measurement System.

TEST PROGRAM DESCRIPTION

Description of Field-Testing Tasks

The field tests were accomplished through a series of three subtasks:

1. Sample and Data Collection Coordination
2. Baseline Tests
3. Parametric Tests

The subtasks are independent from each other in that they each have specific goals and tests. However, they are also interdependent, as the results from each task influenced the test parameters of subsequent tasks. A summary of each subtask is presented in the following sections.

Sample and Data Collection Coordination

Collecting, analyzing, and archiving samples and plant operating data are key aspects of any field test program. A copy of the Sample Collection and Management Plan for the test program at Louisa is included in Appendix B. An example of samples and data collected during testing is presented in Table 4.

Table 4. Data Collected during Field Testing.

Parameter	Sample/Signal/Test	Baseline	Parametric
Coal	Batch sample	Yes	Yes
Coal	Plant signals: burn rate (lb/hr) quality (lb/MMBTU, % ash)	Yes	Yes
Fly ash	Batch sample	Yes	Yes
Unit operation	Plant signals: boiler load, etc.	Yes	Yes
Temperature	Plant signal at AH inlet and stack	Yes	Yes
Mercury (total and speciated)	Hg monitors at ESP inlet/outlet	Yes	Yes
Mercury (total)	STM (modified 40 CFR, Part 75, Appendix K)	Yes	Yes
HCl, HF, Br	EPA Method 26a at ESP outlet	Yes	Yes
Sorbent Injection Rate	ADA-37 and KNX injection pumps, gph	No	Yes
Plant CEM data (NO_x, O_2, SO_2, CO)	Plant data – stack	Yes	Yes
Stack Opacity	Plant data – stack	Yes	Yes
Pollution Control Equipment	Plant data (Sec mA, Sec. Voltage, Sparks, etc.)	Yes	Yes

Coal samples were collected daily and provided for analysis. Grab samples of ash were collected from the ESP hoppers each day of testing.

Overview of Test Program Sequence

Equipment installation began on January 25, 2006. During the following four days, mercury SCEM and CEM analyzers were installed and operationally tested in preparation for the testing program.

Hg CEM measurements started as planned on January 28, 2006. The location of the Thermo Hg CEM was in the annular space between the chimney and the liner at the 400-foot emissions monitoring elevation on the stack. Due to the varying ambient conditions at that location, the first readings from the Thermo Hg analyzer were erratic. Subsequent modifications to this area stabilized the temperatures, which resulted in more stable operation and data from the analyzer. Stable data collection started on February 1, 2006.

Baseline and Parametric Testing (No Sorbent Injection)

Approximately 92 hours of baseline data were collected during this test program. During the baseline period, ADA-37 injection was turned off to evaluate the impact on native mercury removal. Mercury measurements were made upstream of the reagent injection location and at the main stack. The unit was operated at conditions expected during the parametric tests. This included operating the boiler at full-load and load-following conditions, and operating the ESP equipment under standard operating conditions.

Parametric Testing

Eleven days of parametric testing were conducted. The goal of the parametric test sequence was to develop a relationship between reagent injection concentration and mercury removal efficiencies across the ESP. During the first six days of parametric testing, the ADA-37 injection rate was adjusted for 6, 12, and 18 gallons per hour with two days at each injection concentration. During three days of parametric testing, the effect of KNX injection on mercury removal and speciation was evaluated with and without ADA-37 injection. In addition to mercury concentrations, the correlation between reagent injection rate and ESP operation (power, spark rate, etc., and particulate emissions from the ESP) was also evaluated.

EPA M26A measurements were made during the KNX injection sequence to compare the halogens in the flue gas during normal ADA-37 injection and when adding bromine to the coal in the form of KNX.

RESULTS FROM LOUISA TESTING

Mercury Removal Results

Baseline testing (no ADA-37 or KNX injection) was conducted January 31 through February 2 and February 12 through 13, 2006. ADA-37 testing was conducted February 3 through 8, 2006, and KNX evaluations were conducted February 9 through 11, 2006.

ADA-37 Tests

The ADA-37 testing consisted of injecting the flue gas conditioning reagent at rates of 6, 12, and 18 gallons per hour for two days per rate and observing the change in mercury levels across the ESP. Mercury removal trends are presented in Figure 6. The data suggest that there was no change in mercury removal with varying ADA-37 injection rates, including periods with no injection. The flue gas temperature at the inlet to the air preheater was typically between 780 and 800ºF during full-load conditions. There was fairly good correlation between the analyzer and STM measurements.

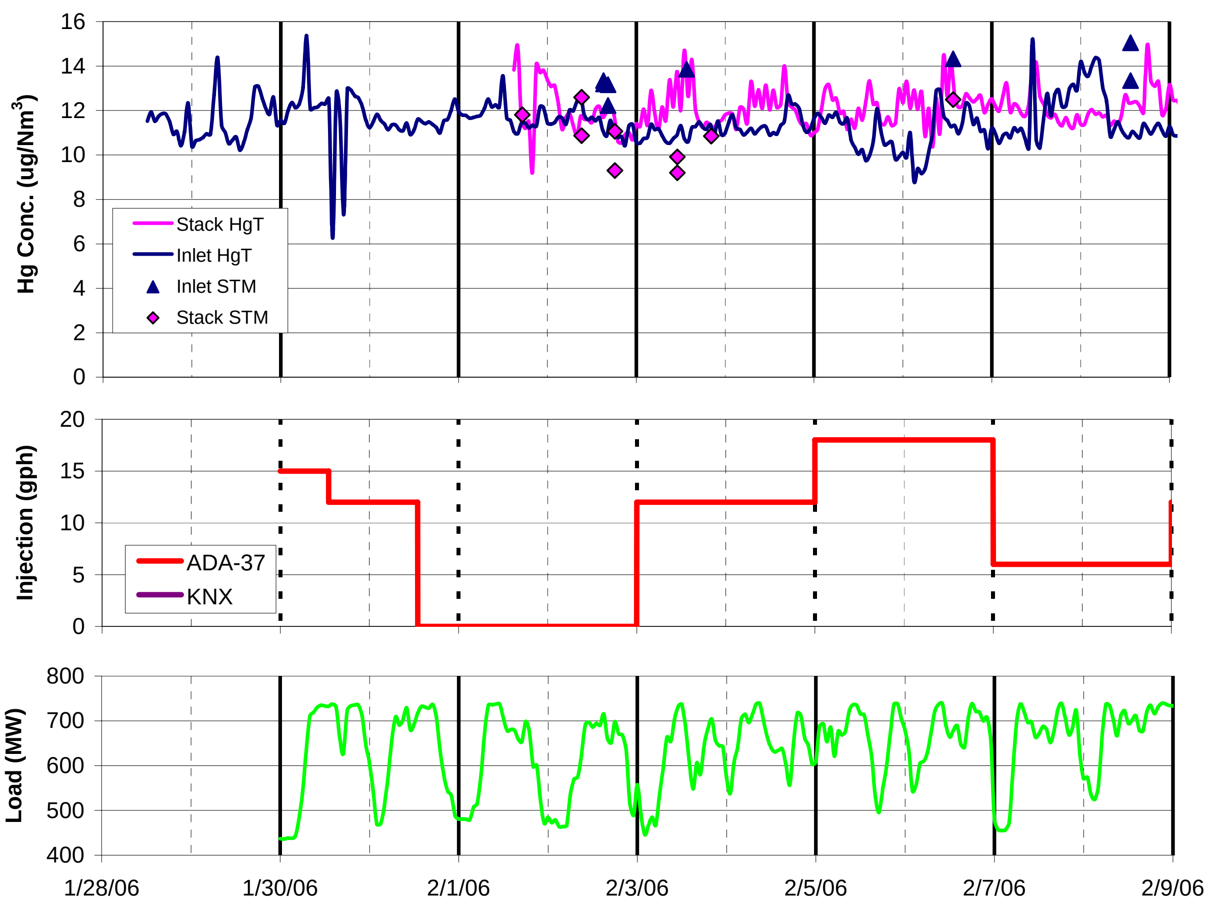


Figure 6. Mercury Removal Trends during Baseline and ADA-37 Testing.

ALSTOM KNX Tests

The addition of KNX to the coal appeared to increase the fraction of oxidized mercury at both the inlet to the ESP and the stack. At an injection rate of 3 gallons per hour, the fraction of oxidized mercury at the inlet to the ESP increased from less than 15% to between 30 and 45%. At 8 gallons per hour KNX, the fraction of oxidized mercury at the inlet to the ESP was nearly 50%. At the stack, the fraction of oxidized mercury was between 30 and 50% without KNX, 68 to 77% at 3 gallons per hour, and over 80% at 8 gallons per hour. These trends are shown in Figure 7.

The addition of KNX did not change the mercury removal across the ESP. The increased fraction of oxidized mercury may be beneficial if Louisa were configured with a wet scrubber. In this case, a portion of the oxidized mercury may be removed in the scrubber.

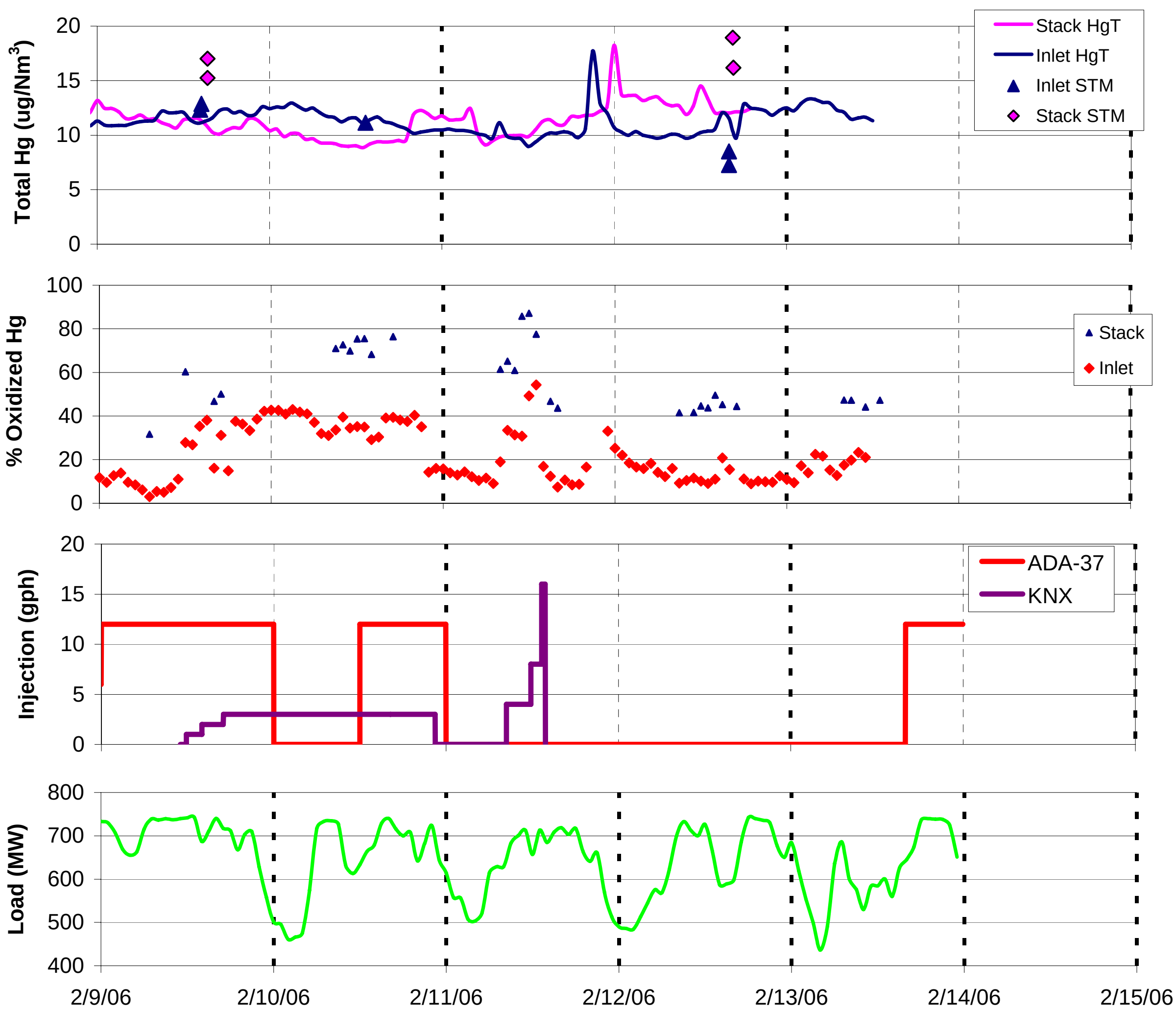


Figure 7. Mercury Speciation and KNX Injection Rate.

Coal and Ash Analyses

Results from as-fired coal samples collected on February 4 and 9, 2006, are shown in Tables 5 and 6. These data indicate that the coal fired at Louisa during testing was fairly typical for PRB coal.

Table 5. Louisa Unit 2 Coal Analysis, Dry Basis.

	2/4/06	2/9/06
Ultimate		
Carbon		70.29
Hydrogen		5.03
Nitrogen		1.02
Sulfur		0.48
Ash		6.95
Oxygen		16.23
Proximate		
Ash	7.83	6.95
Volatile	41.46	41.63
Fixed Carbon	50.71	51.42
HHV (BTU/lb)	11975	11996
Hg (ppb)	118	130
Hg (lb/TBtu)	9.85	10.8

Table 6. Mineral Analysis of Ashed Coal, 2/9/06 Sample.

Mineral	Concentration (µg/g)
Ag	<0.2
As	1.00
Ba	110.00
Be	0.40
Cd	<0.2
Co	3.00
Cr	4.00
Cu	12.00
Mn	10.00
Ni	4.00
Pb	<2
Sb	<1
Se	1.00
Tl	<1
V	15.00
Zn	3.00

Fifteen ash samples were collected from the Row 1 hoppers on ESP 101 and 104 (thirty samples total). The highest fraction of LOI measured during the program was 0.18%. The average LOI was 0.11%. The mercury concentrations measured in the ash samples were all below 10 ng/g. This confirms that there was no mercury removal in the hot-side ESP.

ESP Performance

The normal flue gas conditioning injection rate is 12 gallons per hour, which the plant injects at a constant rate independent of unit load. During this program, ADA-37 was shut off for periods up to 56 hours and injection rates of 6, 12, and 18 gallons per hour were tested for 48-hour increments. The ESP had come offline for a cleaning just prior to the DOE test program and there was sufficient ESP preconditioning so that the plant did not see any change in ESP performance or plant opacity when operating with no reagent injection. A trend of stack opacity is shown with ADA-37 and KNX injection rates in Figure 8 for reference.

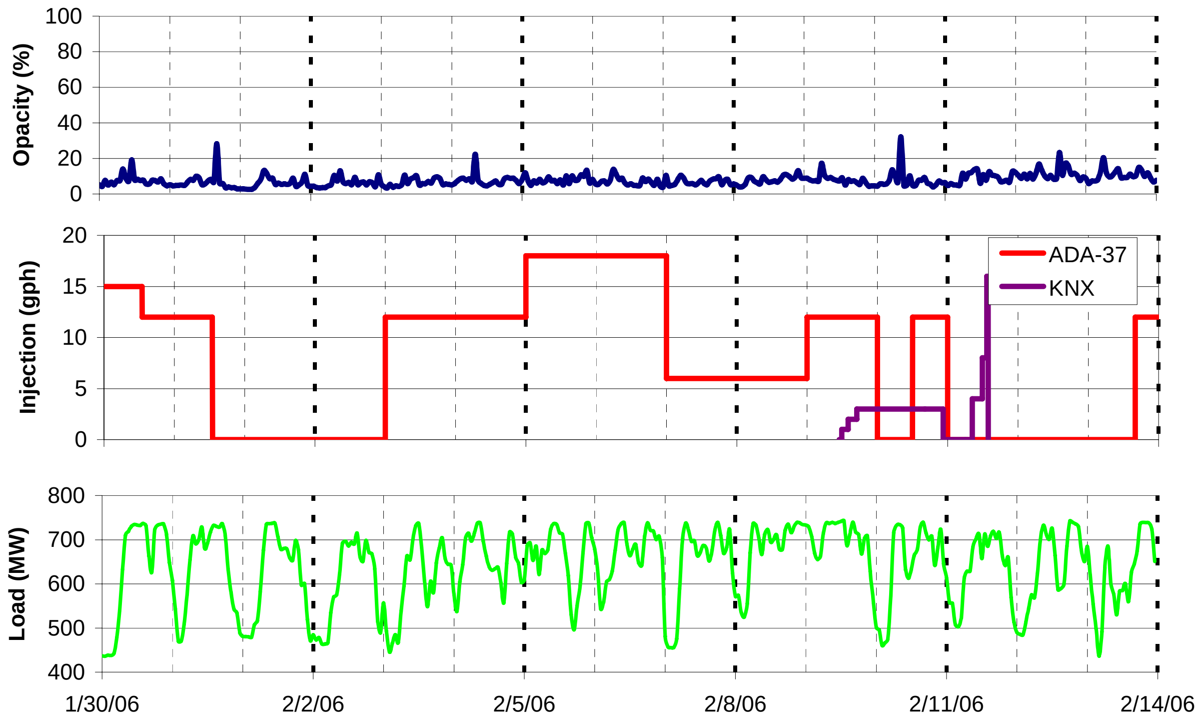
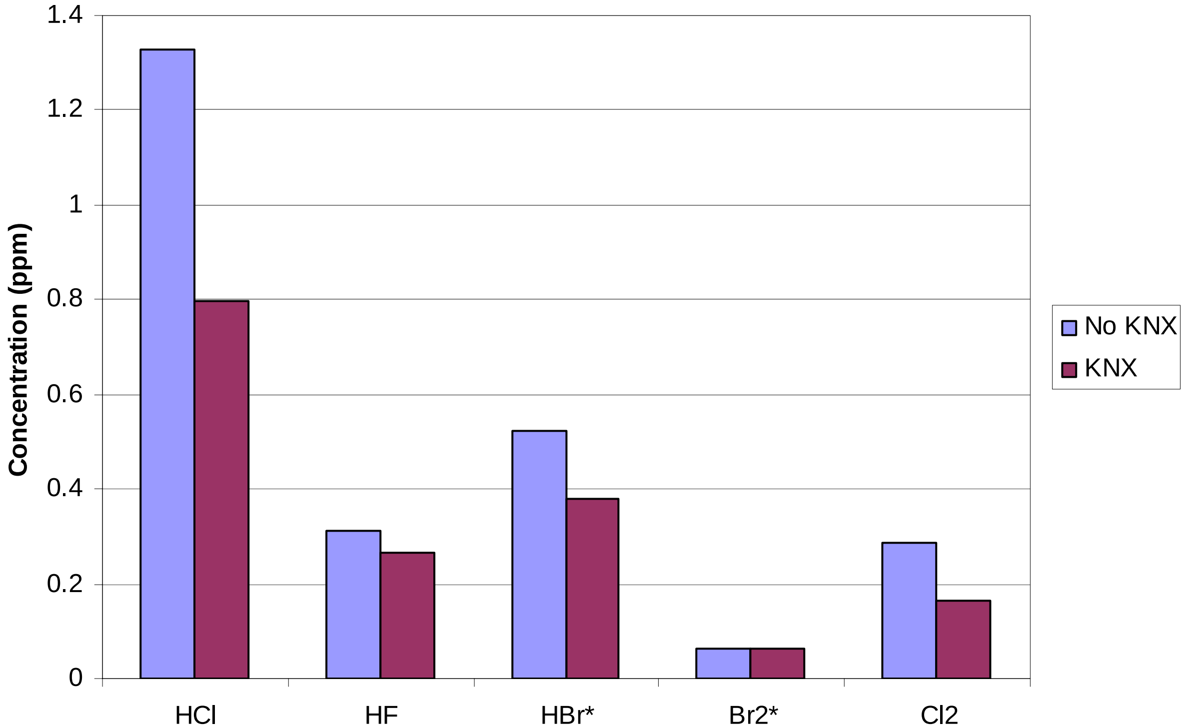


Figure 8. Opacity Trends during Parametric Testing.

Results of EPA M26A Testing

EPA M26A measurements were made on February 8 and 9, 2006, to determine whether the introduction of KNX onto the coal resulted in an increase in bromine emissions at the stack. Results from these tests indicate that there was no measurable increase in bromine emissions during KNX testing. These results are shown in Figure 9. The full M26A report is included in Appendix C.



** HBr and Br_2 concentrations were below the detection limit for testing without KNX. Br_2 concentrations were below the detection limit for the KNX test period.*

Figure 9. Results from EPA M26A Measurements at Louisa.

CONCLUSIONS

Testing was conducted from January 28 to February 13, 2006, to evaluate the mercury removal effectiveness of the hot-side ESP flue gas conditioning agent, ADA-37, currently in use at Louisa and any synergistic effects of ALSTOM's coal additive, KNX.

Results indicate that ADA-37 is not effective at removing mercury across the hot-side ESP at Louisa at injection rates up to 18 gallons per hour. KNX appeared to increase the fraction of oxidized mercury, but no net increase in mercury removal was noted with KNX. The plant burned the normal subbituminous PRB fuel during the test program.

No impacts on ESP performance were noted as a result of changing the ADA-37 injection concentration. However, the ESP had come offline for a cleaning just prior to the DOE test program and there was sufficient ESP preconditioning so that the plant did not see any change in plant opacity when operating with no reagent injection during the relatively short parametric test period.

APPENDIX A

Louisa Test Plan

DOE NATIONAL ENERGY TECHNOLOGY LABORATORY MERCURY FIELD EVALUATION

Evaluation of High Temperature Liquid Sorbent Injection for Mercury Control at MidAmerican's Louisa Generating Station

Test Plan

For:
MidAmerican Energy Company
DOE NETL
EPRI

By:
ADA Environmental Solutions, Inc.
8100 SouthPark Way, Unit B
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December 14, 2005

Table of Contents

List of Figures

List of Tables

Project Objectives

The objective of testing at MidAmerican Energy Company's Louisa Generating Station is to determine the cost and effects of reagent injection using ADA-ES's high temperature liquid injection process for control of mercury in stack emissions.

The benefit of the high temperature liquid injection process, shown in Figure 1, *High Temperature Liquid Injection Process Diagram*, is that the existing ESP collects the majority of ash and mercury while the flue gas is hot, potentially minimizing or eliminating the need for adding a particulate collection device downstream of the air pre-heater when the flue gas is cooler and existing technologies are available to control mercury emissions. With high temperature liquid injection, the reagent/sorbent injection is upstream of the existing hot side electrostatic precipitator (ESP). This process, not involving activated carbon, allows the ash collected in the ESP fields to continue to be sold for use in concrete.

Even though this evaluation will inject reagent into the entire hot-side ESP, mercury measurements will be sampled from one-half of the 700 MW flue gas stream from Unit 1. The inlet will be sampled upstream of one of the two hot side ESP units, the outlet will be sampled at the stack. Some consideration is being given to sampling downstream of the ESP to evaluate speciation changes caused by the reagent injection.

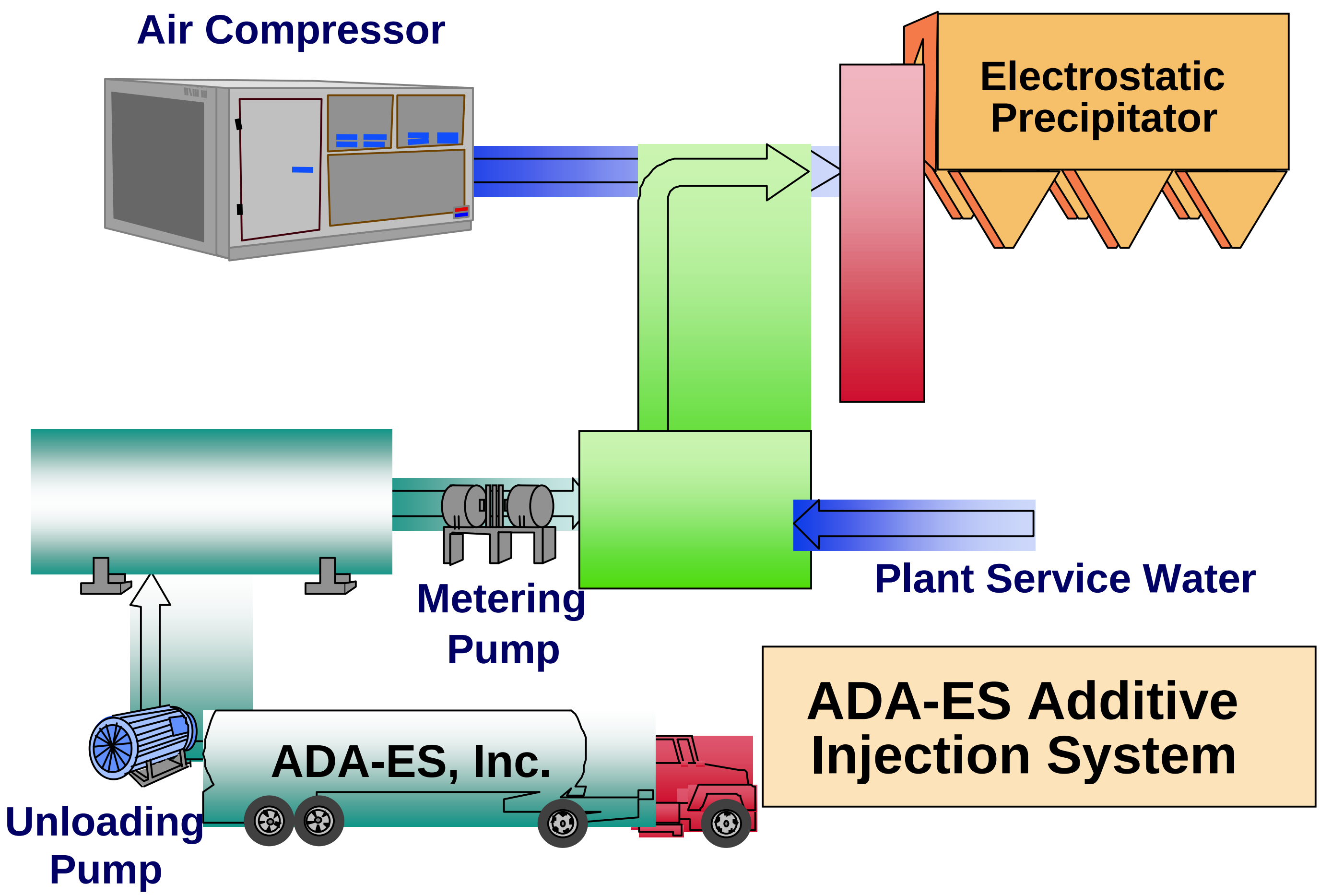


Figure 1. High Temperature Liquid Injection Process Diagram.

Project Overview

The Louisa test program is part of a four-site program funded by the Department of Energy's National Energy Technology Laboratory (DOE/NETL) and industry partners to obtain the necessary information to assess the feasibility and costs of controlling mercury from coal-fired utility plants using either high temperature sorbents or EPRI's TOXECON II^{TM} process. Table 1*, Host Sites Participating in the Sorbent Injection Demonstration Project*, shows the host sites for this program's testing. Testing at these four host sites will allow documentation of sorbent performance on the following configurations:

Table 1. Host Sites Participating in the Sorbent Injection Demonstration Project.

	Coal / Options	**APC**	**Capacity (MW) / Test Portion**	**Current Hg Removal (%)**
Entergy's **Independence Plant Unit 2**	PRB	Cold-Side ESP	842/106	10-20%
MidAmerican's **Louisa Generating Station Unit 1**	PRB	Hot-Side ESP	700/700	<10% (Estimated)
MidAmerican's **Council Bluffs Energy Center Unit 2**	PRB	Hot-Side ESP	88/88	<10% (Estimated)
AEP's **Gavin Station Unit 1 or 2**	Bit	Cold-Side ESP / FGD	1,200/200	40% ESP (Est), 70%+ in FGD

The test program selected Louisa Unit 1 as one of the test sites because it's flue gas conditioning system injects a high temperature reagent which has been shown to remove 30% of the mercury in flue gas at a cost of $700K per year for a 500-MW PRB plant. This cost is 20% of what DOE and EPA projections indicated for a cold-side electrostatic precipitator (ESP) plant this size. This combination will allow an evaluation of the high temperature liquid injection process to take advantage as much as possible of existing equipment and minimize the need for installing new major capital equipment.

Host Site Description

The Louisa Generating Station is located in Louisa County, Iowa near Muscatine, Iowa. Unit 1 is a 700-MW (net) pulverized coal electric generating unit with Lungstrum regenerative air preheaters that burns PRB coal. Table 2*, Louisa Key Operating Parameters*, shows the key operating parameters for Louisa Unit 1.

Table 2. Louisa Key Operating Parameters.

Unit	1
Size (MWnet)	700
Test Portion (MWe)	700
Coal	PRB
Heating Value (as received)	8,500
Sulfur (% by weight)	0.32
Chlorine (%)	~0.01
Mercury (μg/g)	0.08
Particulate Control	Hot-Side ESP SCA = 459 ft^2/kacfm
Sulfur Control	Compliance Coal
Air Pre-Heater	Regenerative
Ash Reuse	Sold

Louisa Unit 1 is equipped with four ESP units operating in a split wedge arrangement for particulate removal. Figure 2, *Sketch of the Plant Process at Louisa Unit 1*, shows a sketch of the Unit 1 flue gas path. The figure shows the planned injection location with respective sampling locations. The reagent will be injected into the entire flue gas stream to allow the plant to continue treating all of its fly ash to maintain ESP performance.

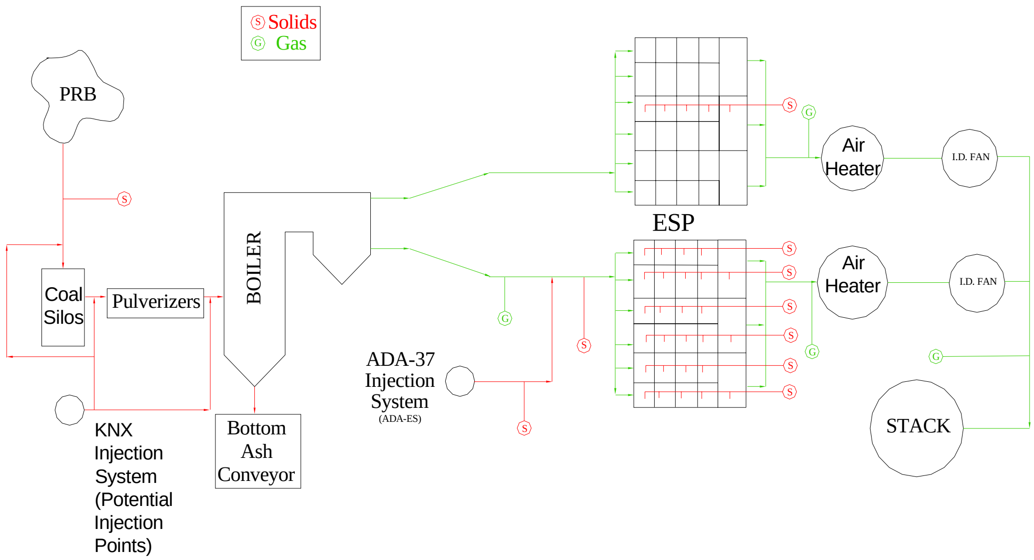


Figure 2. Sketch of Plant Process at Louisa Unit 1.

The ESP configuration for Louisa Unit 1 has four boxes in a split wedge arrangement, with each box consisting of 27 transformer/rectifier sets, 3 chambers, 51 gas passages, five electrical fields and eight bus sections. See Figure 3, *ESP Electrical Field Configuration*.

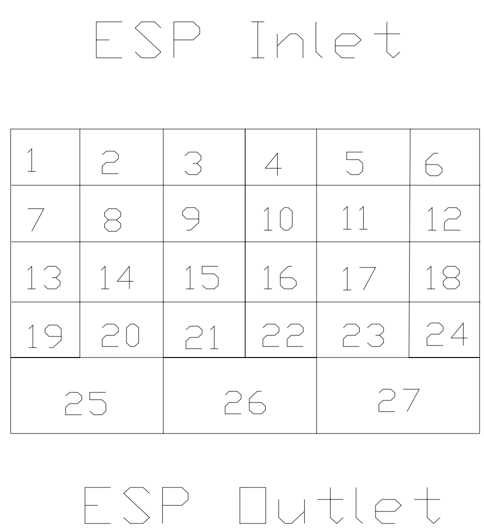


Figure 3: ESP Electrical Field Configuration.

During the test program, liquid reagent will be injected upstream of the ESP for the full system, and mercury monitoring will occur in the main stack on 100% of the 700 MW flue gas stream. In addition, Alstom's KNX coal additive will be used during part of the test sequence to determine the benefits of halogen additives for mercury removal.

General Technical Approach

The test program activities for each test site consist of the eleven tasks shown in Table 3, *Site-Specific Tasks.* These tasks provide the outline for the test plan.

Table 3. Site-Specific Tasks.

Task	Description
1.	Site Coordination, Kickoff Meeting, Test Plan, and QA/QC Plan
2.	Design and Install Site-Specific Equipment
3.	Field-Tests – Sorbent Selection
4.	Field-Tests – Baseline Tests
5.	Field-Tests – Parametric Tests
6.	Field-Tests – Long-Term Tests
7.	Data Analysis
8.	Sample Evaluation
9.	Site Report
10.	Technology Transfer
11.	Management and Reporting

Following are the task descriptions for the MidAmerican Louisa testing:

Task 1. Site Coordination, Kickoff Meeting, Test Plan, and QA/QC Plan

Efforts within this task include planning the site-specific tests with MidAmerican, the Louisa Generating Station, DOE/NETL, and the contributing team members. ADA-ES will meet with MidAmerican and Louisa plant personnel to discuss the overall scope of the program, the potential impact on plant equipment and operation, and identify potential equipment and port locations. ADA-ES will conduct additional communications with MidAmerican to discuss the host site agreements and team member cost-sharing arrangements. ADA-ES and MidAmerican will finalize these efforts during this task. Other efforts include identifying any permit requirements, developing a quality assurance/quality control plan, developing a site specific installation document, finalizing the site-specific scope for each of the team members, and putting subcontracts in place for manual (Particulate, Halogen, etc.) sampling services.

Test Plan

This document is the Test Plan for the project testing at MidAmerican's Louisa Generating Station.

QA/QC Plan

ADA-ES personnel and subcontractors will be performing the various sampling and analytical functions required to evaluate the effectiveness of the mercury controls. All testing personnel will be required to adhere to written QA/QC procedures. QA/QC procedures will be prepared as part of separate detailed QA/QC plan that will be submitted for approvals prior to the testing dates by MidAmerican/Louisa and DOE. The plans will include the necessary QA/QC activities that are required to assure the validity of collected data. At a minimum, the QA/QC Plan will include a description of the test methods to be used: instrument/equipment testing; maintenance and inspection procedures; instrument calibration and frequency; inspection/acceptance requirements for supplies and consumables; procedures for checking data reduction and validation; and sample handling and chain of custody requirements. Standard methodologies and procedures have been established for all the methods to be used in the testing, therefore any new or unproven techniques will be noted as such when presenting information to the project.

Initial Sorbent/Reagent Selection

A key component of the test planning process for these evaluations is identifying potential sorbents/reagents for testing. The test program originally anticipated the full-scale evaluation of two different reagents. Potential alternate reagents included those that may achieve higher mercury removal or reagents that are equally as effective but lower cost. The program decided that the testing would include using the present flue-gas conditioning reagent (ADA-37), injecting it at various injection rates and under various operating conditions. Following the ADA-37 tests, the program will introduced the KNX reagent onto the coal delivery system to evaluate the effect of halogen additives used in conjunction with the flue-gas conditioning reagent.

Task 2. Design and Install Site-Specific Equipment

Site-specific equipment includes the existing flue gas conditioning distribution header and injection grid installed in the ESP inlet ducts. These are in place as part of an operational flue gas conditioning system. The Alstom KNX delivery equipment is easily portable and scalable and will be delivered during the testing phase at Louisa.

Table 4, *Scope of Work for Reagent Injection System*, presents a representative split of responsibilities on key equipment and activities between ADA-ES and the host plant.

Table 4. Scopes of Work for Reagent System.

ADA-ES	Host Site*
Hg SCEMs, including installation	Access platforms, if necessary
Office Trailer	Installation labor, if necessary
Coordination of Reagent Ordering and Delivery	Compressed air
Coordination of Sub-Contractor Duties and Activities	Electrical power
	Signal Wiring / Telephones / Power
	Collection of Coal and Ash Samples
	PI System Information Trend Database
	PI Data Collection
	EMO Testing Unit Load Coordination
	Coordinate Test Program Technical Needs from MidAmerican

* MidAmerican will be reimbursed per DOE/Host Site Agreements for expenses to facilitate the testing.

ADA-ES will oversee installation and system checkout of the overall reagent injection system equipment and mercury measurement equipment and will be responsible for general maintenance of the systems during testing. At least one ADA-ES engineer or technician who is solely dedicated to the operation of the equipment will be on-site or on-call for all tests. The actual equipment installation, not including preparation tasks, is estimated to take one week. This includes time for checkout and troubleshooting. ADA-ES personnel and/or sub-contractors will operate all testing/reagent equipment for the testing. While the host site is invited to monitor the operation of the equipment, the presence (or lack thereof) of this monitor will not delay the testing sequence unless it is a matter concerning plant reliability or safety, in which case the test crew will defer to the direction of the plant personnel.

MidAmerican Energy Company will be responsible for all permitting and any regulatory variance requirements. ADA-ES can assist by providing information to, or meeting with, regulatory agencies as required.

The site-specific equipment for this test includes the following:

Reagent Injection System

The existing reagent injection system (Figure 4, *Flue Gas Conditioning System Injection Skid and Feeder System Installed at MidAmerican's Louisa Generating Station*) consists of a bulk-storage vessel and a single feeder/metering train.

Figure 4: Flue Gas Conditioning System Injection Skid and Feeder System Installed at MidAmerican's Louisa Generating Station.

Bulk delivery trucks deliver and unload the ADA-37 flue gas conditioning reagent into the storage vessel. The reagent feeds from the bottom of the storage vessel through a metering system and then into the feed system.

The reagent injection system for this testing has one delivery train. The train includes a pump with a meter, which measures the chemical reagent and injects the reagent into the dilution water, which is then transported to the injection point. To prevent condensation, atomizing air is used to create the maximum efficiency droplet size for distribution.

Louisa Unit 1 has two sets of injection grids, one for each ESP path. Each grid consists of six injection lances connected by a common header located upstream of the ESPs. A PLC system controls the system operation. The sorbent injection system allows controlling the reagent feed rate either manually through an HMI interface, or automatically through a load following signal from the plant such as unit MW load or flue gas flow rate.

The Alstom KNX liquid delivery system consists of a 55-gal drum with a feed line to a positive displacement pump capable of delivery 5gph. The system delivers the KNX reagent to the coal via flex tubing. The point of application to the coal can be anywhere that ensures good mixing within the furnace. Typical delivery points include the main coal feeder conveyor belt and the lowest burner feed mill. The injection pump has the capability to manually vary the injection rate.

Mercury Monitoring System

The test program will use at least two mercury monitoring systems to provide real-time feedback of the mercury levels in the flue gas during baseline and reagent injection testing. Each monitoring system consists of a sample extraction and conditioning system and the analyzer system, connected with a heated sample transport umbilical bundle. The ADA-ES analyzers consist of a cold vapor atomic absorption spectrometer (CVAAS) coupled with a gold amalgamation system (Au-CVAAS). Figure 5, *Sketch of Mercury Measurement System*, shows a sketch of the system.

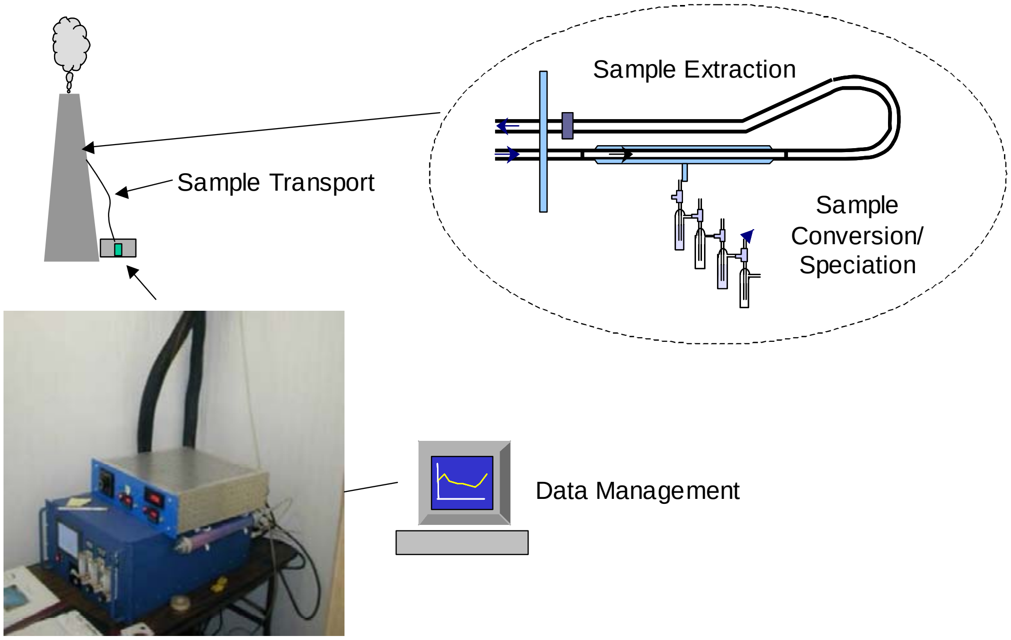


Figure 5: Sketch of Mercury Measurement System.

The figure shows an inertial separation probe. This probe separates the particulate matter from the sample with minimal sampling artifacts from fly ash or injected sorbent.

The system uses vapor-phase elemental mercury for analyzer calibration.

The monitoring system measures both *total* vapor-phase mercury and *elemental* vapor-phase mercury. The system determines *total* vapor-phase mercury concentrations by chemically reducing all of the oxidized mercury to the elemental form near the extraction location. To measure *elemental* mercury, the system removes the oxidized mercury from the sample gas while allowing elemental mercury to pass through without alteration. The oxidized mercury is then the difference between the *total* mercury measurement and the *elemental* mercury measurement.

As an alternate to the system described above, ADA-ES will use its best efforts to use Thermo's newly released I-series mercury monitoring systems for this test, dependent upon availability.

Task 3. Field-Tests – Sorbent Selection

The test program will test, at a minimum, the present flue gas conditioning reagent (ADA-37), injecting it at various injection rates and under various operating conditions. In addition, the test program will test Alstom KNX reagent as a halogen additive, adding it to the coal delivery system (TBD) prior to the coal entering the burners.

Task 4, 5, and 6.

Tasks 4, 5, and 6 are the actual field testing efforts to collect data to quantify the mercury removal. Table 5*, Full-Scale Test Sequence*, below, outlines the testing sequence plan.

Table 5. Full-Scale Test Sequence.

Test Description	Test Week	Parameters/Comments	Boiler Load
Set Up		Install Monitoring Equipment Inspect and Clean all Reagent Injectors	No Load Restrictions
Baseline	Week 0	Day 6 and 7 – No ADA-37 Injection (if possible)	No Load Restrictions
Parametric Testing	Week 1	Day 1 – ADA-37, NIR (Normal Injecting Rate) Day 2 – ADA-37, NIR, test crew set-up for M26A Day 3 – ADA-37, NIR, M26A Sorbent Screening	Full Load 6AM-6PM
Parametric Testing	Week 1	Day 4 – ADA-37 Reduced Injection Rate (RIR) Day 5 – ADA-37, RIR Day 6 – ADA-37, RIR Day 7 – ADA-37, Increased Injection Rate (IIR)	Full Load 6AM-6PM, Sat – Sunday: Low Load
Parametric Testing	Week 2	Day 1 – ADA-37, IIR Day 2 – ADA-37, IIR Day 3 – Transition to Alstom KNX, ADA-37 - NIR Day 4 – KNX, ADA-37 - NIR Day 5 – KNX, ADA-37 - NIR, M26A Day 6 – KNX, ADA-37 - NIR Day 7 – Transition to ADA-37, NIR	Full Load 6AM-6PM, Sat – Sunday: Low Load
Baseline	Week 3	Day 1 and 2 – No ADA-37 Injection (if possible)	Full Load 6AM-6PM
Decommission	Week 3	Remove all monitoring equipment Inspect and Clean all Reagent Injectors	No Load Restrictions

Notes: Monitor Hg and ESP performance during all tests.

Minimum Normal Injection Rate defined at 12 gallons per hour.

Certain tests may be cancelled or modified if opacity levels approach 20% limit.

Table 6, *Test Matrix for Baseline and Parametric Test Series*, details the testing during each day. See the description of project Tasks 4, 5, and 6 below for further detail of the scope of each of these tasks.

Table 6: Test Matrix for Baseline and Parametric Test Series

	Testing Day	Fuel: PRB	Set Up/ Demobilize	Baseline	Parametric	ADA-37 Injection Rate	Full Load 0600-1800	Load Following 0600-1800	ADA-ES Traverse	SCEM	STM inlet	STM Outlet	Method 26A	Sorbent Screening
		X	x											
		X	x											
		X	x						x		1	1		
		X	x						x					
SA		X		x		None				x				
SU		X		x		None				x				
M	1	X			x	NIR	x		x	x				x
TU	2	X			x	NIR	x			x	2	2	x	x
W	3	X			x	NIR	x			x			x	x
TH	4	X			x	RIR	x			x	1	1		
F	5	X			x	RIR	x			x	1	1		
SA	6	X			x	RIR		x		x				
SU	7	X			x	IIR		x		x				
M	8	X			x	IIR	x			x	1	1		
TU	9	X			x	IIR	x			x	1	1		
W	10	X			x	_	x			x				
TH	11	X			x	KNX/NIR	x			x	2	2		
F	12	X			x	KNX/NIR	x			x	1	1	x	
SA	13	X			x	KNX/NIR		x		x				
SU	14	X			x	NIR				x				
M	15	X		x		None				x				
TU	16	X		x		None				x				
W	17	X	x											
TH	18	X	x											
		X												
											2=dual sample, 1=single sample	2=dual sample, 1=single sample		

Task 4. Field-Tests – Baseline Tests

The test program desires to conduct up to four days of baseline testing, two days prior to and two days after the parametric testing, as shown in Table 5 and Table 6. During this baseline testing, the test program will evaluate the native mercury removal with no flue gas conditioning reagent injection. These tests must necessarily depend on being able to run the unit without increasing the likelihood of incurring an opacity increase. The test program will coordinate very closely with the plant operations during these anticipated tests.

The first part of baseline testing will commence shortly after installation of the mercury monitors and testing equipment and the second part will take place after the parametric test sequence. During the baseline testing, the test program will perform mercury measurements upstream of the reagent injection location and at the main stack and will use this data to characterize native mercury capture as well as mercury speciation across the ESP at the aforementioned test conditions. The Unit will operate at conditions expected during the parametric tests. This includes operating the boiler at full-load and load- following conditions and operating the ESP equipment under standard operating parameters.

Task 5. Field-Tests – Parametric Tests

The test program will conduct two weeks of parametric testing, as shown in Table 5 and Table 6. During the two weeks of parametric testing, the test program will evaluate the performance of the reagent(s) at several injection concentrations.

The goal of the parametric test sequence is to develop a relationship between reagent injection concentration and mercury removal efficiencies across the ESP. The test program will develop a correlation between reagent injection concentration and ESP operation (power, spark rate, etc., and particulate emissions from the ESP) during this task.

The test program will conduct the parametric tests at plant full-load operating conditions and at plant load following conditions. The test program will perform mercury measurements with the mercury monitors.

During this Task, the test program will perform a M26A (HCl and HF) test in conjunction with performing continuous mercury measurements using the mercury monitors and dry sorbent trap method (STM). The use of Ontario Hydro and Abbreviated Method 5 (17) measurements are being evaluated in the context of funding. If funding is available, the test program will perform these measurements as well.

The test program will also perform an M26A measurement during the KNX injection sequence to compare the halogens in the flue gas during normal ADA-37 injection and when adding the halogenated reagents.

Sorbent Screening

The test program will include sorbent screening to evaluate the effectiveness of various solid reagents in removing mercury at the Louisa station. This testing will be in addition to the parametric tests and are a precursor to testing solid high temperature reagents at Council Bluffs Unit No 2, a site designated for testing later in this DOE program.

Upon completion of the parametric testing, the test team (MidAmerican, ADA-ES, DOE, EPRI) will review the parametric testing results to determine if any follow on testing is necessary.

Task 6. Field-Tests – Long-Term Tests

This test program is not currently scheduled to include long term testing.

Task 7. Data Analysis

The goal of the data collection and analysis for this program is to measure the effect of reagent injection on mercury control and speciation, and the impact on the existing ESP. The test program will characterize mercury levels and plant operation.

Task 8. Sample Evaluation

The test program will collect coal and combustion byproduct samples throughout the testing period. The program will analyze selected samples to better characterize mercury removal performance and factors that may influence this performance. Coal analyses will include ultimate and proximate analyses, as well as mercury and chlorine content. The ash analysis will include mercury and other possible tests such as alkalinity, size distribution, chlorine, fluorine, and metals such as selenium and arsenic.

Ash testing will also include standard leaching test methods such as the Toxicity Characteristic Leaching Procedure (TCLP, SW846-1311) and synthetic groundwater leaching procedure (SGLP). Further analysis can be performed per specific request of the team participants.

It is important to continue evaluating these byproducts for each condition using well-established and documented techniques, and new techniques designed to perform even more robust analyses of the byproducts.

DOE has a test program planned to evaluate the stability of mercury on coal combustion byproducts. The Louisa test program will provide ash samples to the DOE contractor for analysis. The program will also collect and archive additional ash for other tests, including EPA, DOE, and EPRI requested tests, and independent DOE and MidAmerican approved companies.

The test program requires a sample and data management process for tracking a large quantity of samples from various process streams during the testing efforts. ADA-ES has developed a Sample and Data Management System (SDMS) that will store test data from the evaluation. The SDMS data can generate reports, track sample history, and input results from laboratory analyses.

For data control and security, the system limits full access to the project manager and site manager at ADA-ES and the sample manager. Operators collecting samples will upload information to the database and print sample labels and Chain-of-Custody forms. ADA-ES will include testing results with regularly issued reports to the test team.

Task 9. Site Report

The test program will prepare a site report documenting measurements, test procedures, analyses, and results obtained in Tasks 4, 5, and 6. This report is a stand-alone document providing a comprehensive review of the testing. The test program will submit this report to MidAmerican. The report will also include a section on the initial economics for full-scale permanent commercial implementation of the control scheme.

Based on input from the plant, the report will address modifications to existing plant equipment and develop a work scope document for the HIGH TEMPERATURE LIQUID INJECTION process. This may include modifications to the particulate collector, ash handling system, compressed air supply, electric power capacity, other plant auxiliary equipment, utilities, and other balance of plant engineering requirements.

Finally, the test program will develop a budget level cost estimate to implement/modify the HIGH TEMPERATURE LIQUID INJECTION control technology. This will include capital cost estimates for mercury control process equipment as well as projected annual operating costs. Where possible, the report will include order-of-magnitude estimates for plant modifications and balance of plant items.

Task 10. Technology Transfer

The ultimate goal of technology transfer efforts is to make the program testing results available to the public as quickly, comprehensively and accurately as possible. To accomplish this goal, ADA-ES will work with DOE/NETL to determine and support efforts for key meetings, presentations and publications at selected conferences to increase exposure of the test results and receive comments on the applicability of the technology to the industry.

Transferring the information generated during this program to the coal-fired utility industry is an important part of the program. Dr. Durham, who has led the technology transfer activities during the DOE Phase I and II programs, will lead this important activity. Technology transfer activities in the previous testing programs included participating in DOE/NETL-sponsored meetings, EPA Hg MACT Stakeholder meetings, presentations at more than 50 events or companies, hosting a project Web site for project team members and for presentation of project information, and publication of more than 100 technical papers.

ADA-ES will work with DOE/NETL to determine and support efforts for key meetings, presentations and publications. ADA-ES will also establish a Web site for the project and participants. ADA-ES has done this on other NETL projects with excellent results.

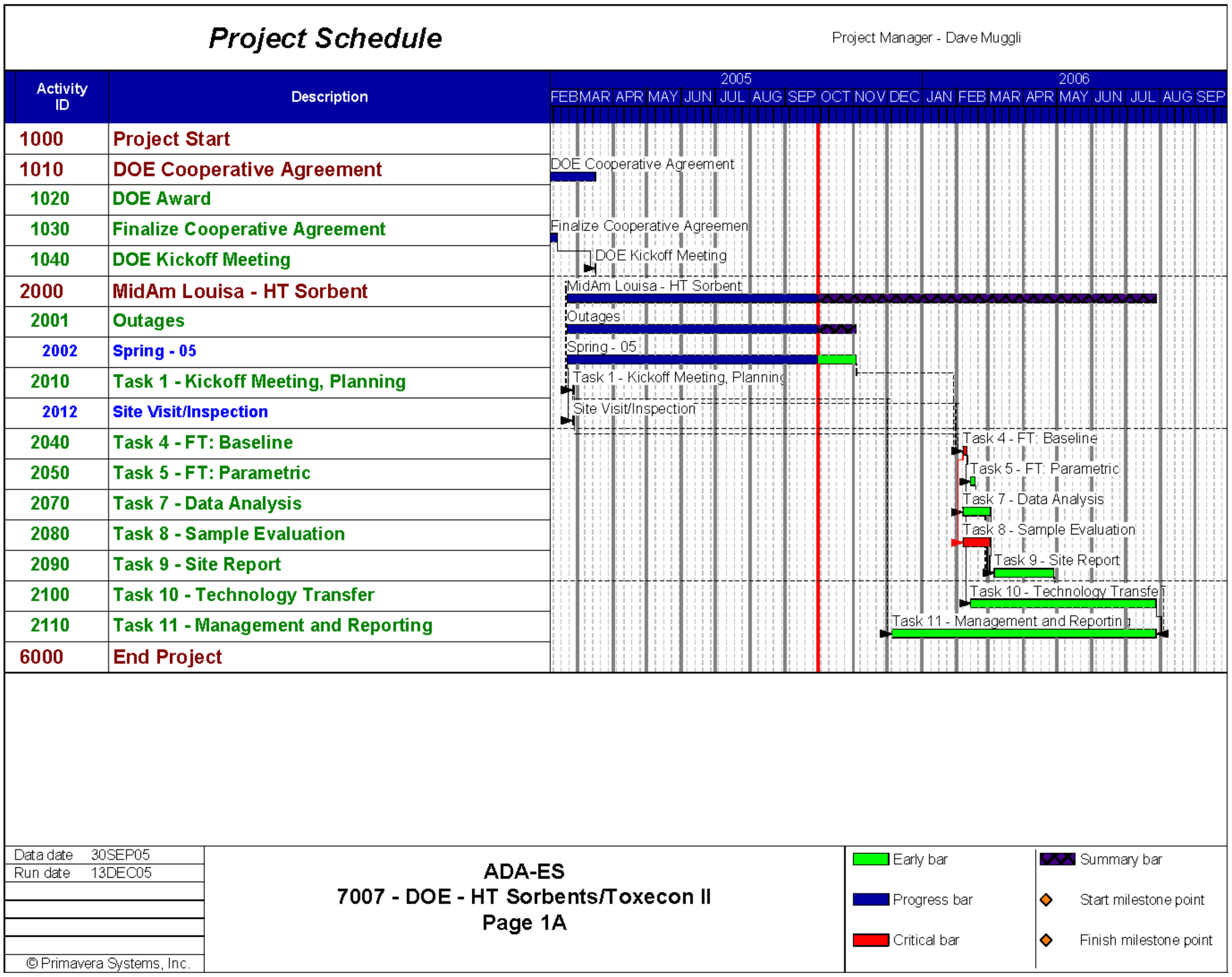
Task 11. Management and Reporting

This task includes the overall program management, and preparation of financial and administrative reports. This task will also include periodic meetings with DOE to discuss progress and obtain overall direction of the program from the DOE project manager.

Schedule

The current schedule for activities at Louisa Generating Station is shown in Figure 6.

Figure 6: Current Schedule for the Louisa Test Program.



Key Personnel

Key personnel for the Louisa tests are identified in Table 7.

Table 7: Key Project Personnel for Louisa Mercury Field Evaluation.

Name	Company	Role	Phone #	E-Mail
Andrew O'Palko	DOE/NETL	Project Manager	304-285-4715	andrew.opalko@netl.doe.gov
Kevin Dodson	MidAmerican	MidAmerican Technical Support	563-333-8184	kddodson@midamerican.com
Dave Muggli	ADA-ES	Program Manager	303-339-8853	davem@adaes.com
Tom Campbell	ADA-ES	Site Project Manager	303-339-8864	tomc@adaes.com
Cody Wilson	ADA-ES	Site Project Engineer	303-339-8860	codyw@adaes.com
Ron Unser	MidAmerican	Unit Manager	563-262-2861	reunser@midamerican.com
Jerry Amrhein	ADA-ES	Hg Monitors	303-339-8841	jerrya@adaes.com
Ken Baldrey	ADA-ES	Technical Expert	303-734-1727	kenb@adaes.com
Jean Bustard	ADA-ES	Technical Expert	303-734-1727	jeanb@adaes.com
Michael Durham	ADA-ES	Technical Expert	303-734-1727	miked@adaes.com
Cam Martin	ADA-ES	Equipment Design	303-339-8849	camm@adaes.com
Richard Schlager	ADA-ES	Contracts	303-339-8855	Richards@adaes.com
Sharon Sjostrom	ADA-ES	Technical Expert	303-734-1727	sharons@adaes.com
Connie Senior	Reaction Engineering	Coal and Byproduct Issues	801-364-6925 ext 37	senior@reaction-eng.com
Ramsay Chang	EPRI	Technical Expert	650-855-2535	rchang@epri.com

APPENDIX B

Sample Collection and Management Plan

LABORATORY MERCURY FIELD EVALUATION

Evaluation of Sorbent Injection for Mercury Control at MidAmerican Louisa Station

Sample Collection and Management Plan

Prepared by:

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8100 SouthPark Way, Unit B
Littleton, CO 80120

January 4, 2006

ADA-ES, Inc. is conducting an evaluation looking at sorbent injection for mercury control at MidAmerican's Louisa Station. The overall objective of this project is to determine the cost and effects of reagent injection for control of mercury in stack emissions using a flue gas conditioning (FGC) injection configuration.

During the evaluation, fuel samples and certain process byproducts will be collected for determination of mercury content, stability, and other analytes. Process byproduct of primary interest is fly ash; however, other process byproducts may also be collected.

Sample and data management are needed for tracking approximately 100 samples from various solid process streams at Louisa Station. ADA-ES has developed a Sample and Data Management System (SDMS) that will store test data from the evaluation. These data can be used to generate reports, track sample history, and input results from laboratory analyses.

ADA-ES will also store plant operational data and other test data during the evaluation. Pertinent plant operating parameters will be logged electronically. For data control and security, full access will be limited to the project, site, and sample manager at ADA-ES as well as the MidAMerican designated representative. Operators collecting samples will be able to upload information to the database and print sample labels and Chain-of-Custody forms. ADA-ES will include results with regularly issued reports to the test team.

Sampling Locations

Samples of various gaseous and solid process streams will be collected during the evaluation. Specific flue gas samples are not included in this document. Sampling locations for Louisa Station Unit 1 are shown in Figure 1.

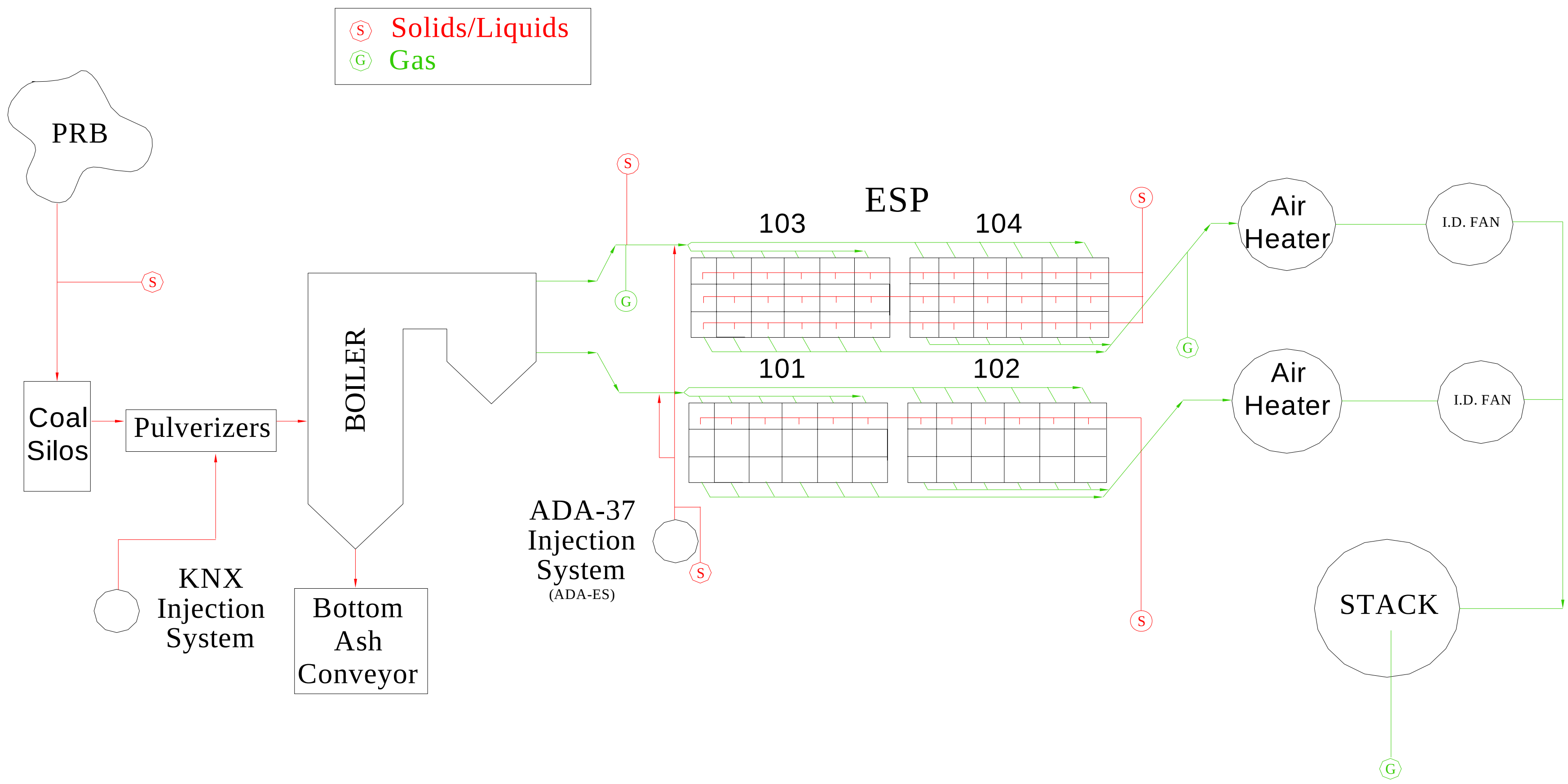


Figure 1. Louisa Station Unit 1 Configuration and Sampling Locations.

Sample Collection

Coal and combustion byproducts will be collected during the mercury control evaluation. Samples will be segregated by the test condition (baseline and each parametric test). Collecting a representative sample is the primary objective of the sampling strategy. Representative samples will be collected only under stable and normal operating conditions unless otherwise directed by ADA-ES personnel.

Sample Streams

Coal Samples – Daily grab samples will be collected from the coal conveyor that feeds the unit 1 coal silos. Louisa plant personnel will collect the sample between 5:00 am and 11:00 am, thus representing the coal fired between 10:00am and 4:00pm. ADA-ES will provide the sample schedule and sample bottles.

ESP Fly Ash – Grab samples of ash will be collected from each row of ESP hoppers each day of testing. Samples will be segregated by the test condition (baseline and each parametric test). The samples will be stored in 1-quart sample containers for shipping to the analytical laboratories.

The schedule indicates sampling from multiple rows on both sides of the ESP. These samples will be used to determine if stratification exists throughout the system and to compare ash properties of the two sides. A sketch showing the collection fields from the ESP is shown in Figure 2. The shaded hoppers indicate the collection fields from which fly ash samples will be collected.

During testing, the rows of ESP hoppers, with the exception of the inlet row of hoppers, to be sampled should be isolated around 10:00am with ash samples being collected at 3:00 pm. This will ensure the sample collected represents the ash collected by the ESP during the test period, which typically starts at 10am and ends around 5:00pm. ADA will coordinate ash sampling and hopper emptying activities with plant operations.

Flue Gas Flow – ESP 103					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

Flue Gas Flow – ESP 104					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

Flue Gas Flow – ESP 101					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

Flue Gas Flow – ESP 102					
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

*Sampled Collection Fields

Figure 2. ESP Hopper Layout and Sampling Locations.

If possible, plant personnel may collect a fly ash sample inside the ESP at the end of the testing period. This sample should be collected from any surface structures (e.g., ledges, corners) that are capable of holding fly ash material in place for a long period of time. This sample should be exposed to coal-derived flue gas for long periods of time. This sample will be analyzed for metals content (e.g., Hg, As, Se) to help determine if these toxics accumulate over time and surpass any recommended exposure limits.

Table 1. Tentative Sampling Schedule.

Test Condition	Type	Frequency	Volume Collected
Baseline	Coal	Daily	2 liters/5lbs
	ESP Ash	Daily: Each Row on Sample Side 1 sample: All Rows on Sample Side, Inlet Row on Non-Sample Side	1 Quart 1 Quart
Parametric	Coal	Daily	2 liters/5lbs
	ESP Ash	Daily: Each Row on Sample Side 1 sample per test sequence: All Rows on Sample Side, Inlet Row on Non-Sample Side	1 Quart 1 Quart

Sample Management Strategy

During the mercury control evaluation, Louisa plant personnel, as directed by ADA-ES, will collect the coal samples. ADA-ES personnel will collect the in-situ fly ash samples. The ADA-ES site manager will deliver a sampling schedule, which shows the sampling times, volume, and specific samples to collect during each testing day. A sample management flow chart is shown in Figure 3.

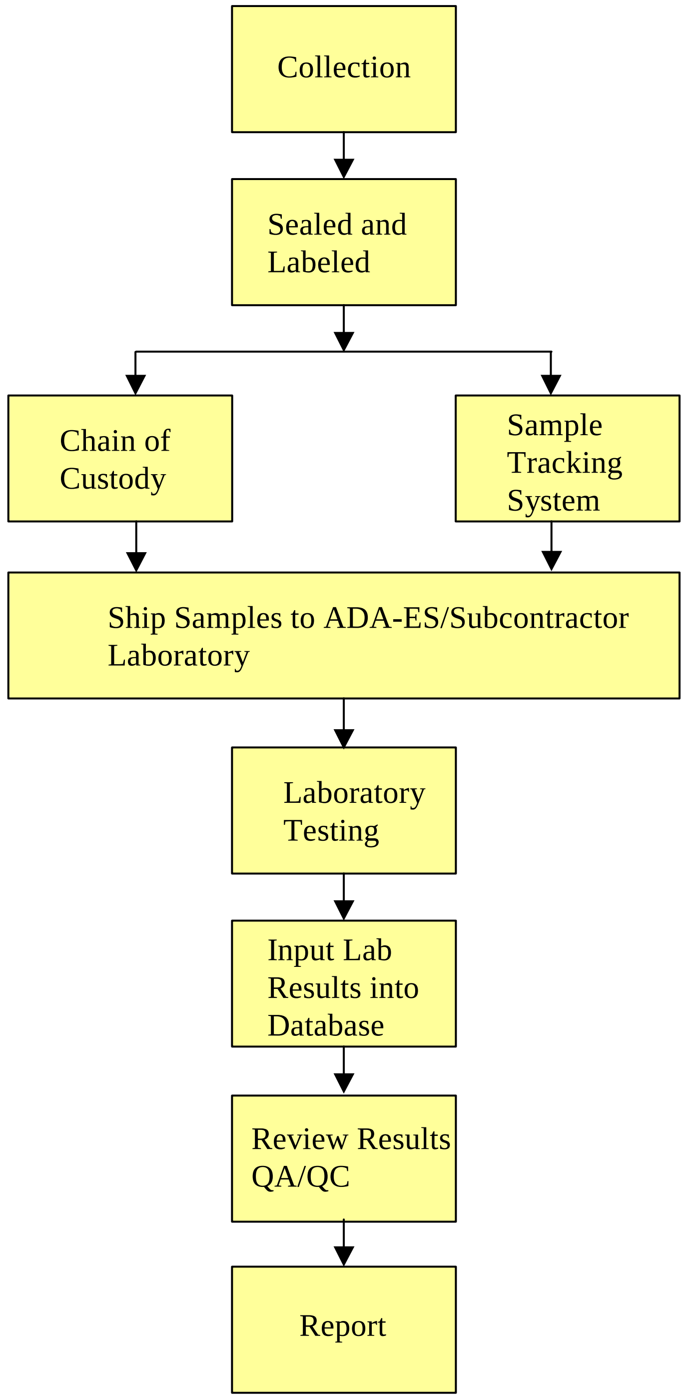


Figure 3. Sample Management Flowchart.

Once the samples have been collected, they will be delivered to ADA-ES personnel to be sealed and labeled. The samples will be logged into a database and given a sample identification number. Authorized project team members will have access to the database to see which samples have been collected and are available for testing.

Once the samples have been sealed and labeled, ADA-ES personnel will generate a Chain-of Custody (COC) form to be delivered with each shipment of samples. The COC will be used for sample tracking and identification. Although ADA-ES will not enforce the strict COC procedures (e.g., signatures to release sample custody, controlled access), all pertinent information will be recorded.

The samples, along with a COC, will be shipped to the ADA-ES laboratory for storage. Once received, ADA-ES will identify samples for mercury, and other, analyses. Other analyses will include ultimate and proximate analyses for coal and elemental analyses for coal and ash samples (including chlorine and fluorine contents).

Sample Analysis

Although previous tests from other programs have shown that the byproducts are extremely stable, it is important to continue evaluating these byproducts for each condition using well-established and documented techniques, and new techniques designed to perform even more robust analyses of the byproducts. Additional ash samples will be collected and archived for other tests, including tests requested by EPA, DOE, and independent companies approved by DOE. No samples will be shipped to outside firms without prior approval of MidAmerican and DOE.

Standard leaching test methods conducted on the fly ash samples will include the Toxicity Characteristic Leaching Procedure (TCLP, SW846-1311) and the synthetic groundwater leaching procedure (SGLP). Solid and liquid samples will be collected and analyzed according to the methods as prescribed in Table 2.

The final series of tests are optional, based on whether a determination is made that additional analyses are needed for purposes of troubleshooting or for gaining additional insight into control options. For example, it may be desirable to determine the size and composition of the ash for certain applications. These analyses will provide information on the impacts of mercury control on ash properties. The properties have a significant impact on the performance of combustion and environmental control systems.

Table 2. Summary of Byproduct and Waste Characterization Testing

Series	Test Purpose	Test Method	Comments
1	Ash Disposal	TCLP (SW846-1311)	Measures leachable Hg, As, Ba, Cd, Cr, Pb, Se, Ag
2	Environmental Stability – Leaching	EERC SGLP	Measures leachable Hg at 18 hours, 2 weeks, and 4 weeks
3	Special Testing	Various	As needed for troubleshooting or site-specific information needs

Once the laboratory testing is complete, results will be logged into the SDMS. Authorized project team members will have access to the database to view the results. A report will be generated summarizing results from the sample analyses.

Flue Gas Samples

Flue gas measurements will be made at the locations indicated on Figure 1. Flue gas analyses will include the EPA Method 26A. Hg analyzers and sorbent trap method tests (STM) will also be used at selected locations measuring near-real-time vapor-phase mercury concentrations in the flue gas.

Table 3. Sampling and Analytical Matrix.

Sampling Location	Sample/Type	Sampling Method	Analytical Method
Economizer Outlet/ESP Inlet	Hg – Vapor Phase	STM	EPA Method 1631
	Total/Elemental Mercury – Vapor Phase	Semi-Continuous	AF or AA -Analysis
	Particulate Hg	Modified $PM_{2.5}$	Modified Ohio Lumix ASTM 6722D-01
ESP Outlet and/or Stack	HBr, HCl, HF, BR_2, CL_2	M26A	Ion chromatography per the promulgated EPA Method 26a
	Hg	STM	EPA Method 1631
	Total/Elemental Mercury	Continuous	AF or AA-Analysis
Coal Fuel to Boiler	Hg	Grab Sample	ASTM D6414-99 or 01
	Cl	Grab Sample	Modified ASTM D5808 (Oxidative Hydrolysis Microcoulometry)
	F	Grab Sample	TBD
	Ultimate Analysis	Grab Sample	
	Proximate Analysis	Grab Sample	
	Trace Metals	Grab Sample	
Bottom Ash, Fly Ash	Hg	Grab Sample	ASTM D6414-99 or 01
	Cl	Grab Sample	Modified ASTM D5808 (Oxidative Hydrolysis Microcoulometry)
	LOI / Carbon Content	Grab Sample	ASTM C311-04
	Leaching	Grab Sample	TCLP, SW846-1311, SGLP
	Trace Metals	Grab Sample	

APPENDIX C

Gaseous Emissions Test, GE Energy

GE Energy

Christopher F. Miller
Project Supervisor

ISO 9001 Accredited
Quality System

GASEOUS EMISSIONS TEST

Performed For
ADA-ES, Inc.

At The
MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
Muscatine, Iowa

Test Dates
February 8 and 9, 2006

Report No.
GE Energy Management Services, Inc. Report M22E1180A

Report Submittal Date
March 10, 2006

GE Energy Management Services, Inc.
888 Industrial Drive
Elmhurst, Illinois 60126
USA

T 630-530-6600
F 630-530-6630

GE Energy

TABLE OF CONTENTS

GE Energy

CERTIFICATION SHEET

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

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

GE ENERGY MANAGEMENT SERVICES, INC.

Harry Hanson
Senior Project Manager

GE Energy

GASEOUS EMISSIONS TEST
Performed For
ADA-ES, INC.
At the
MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
Muscatine, Iowa
February 8 and 9, 2006

1.0 INTRODUCTION

GE Energy Management Services, Inc. ("GE Energy") performed a gaseous emission test program on the Unit 1 Stack at the Louisa Generating Station of MidAmerican Energy in Muscatine, Iowa on February 8 and 9, 2006. The tests were authorized by MidAmerican Energy and performed for ADA-ES, Inc.

The purpose of this test program was to determine hydrogen chloride (HCl), hydrogen fluoride (HF), hydrogen bromide (HBr), bromine (Br_2) and chlorine (Cl_2) concentrations and emission rates during normal operating conditions.

1.1 Project Contact Information

Location	Address	Contact
Test Facility	MidAmerican Energy Louisa Generating Station 8602 172nd Street Muscatine, Iowa 52761	Mr. Jim Haack (563) 262-2860 (phone) (563) 262-2892 (fax)
Testing Coordinator	ADA-ES, Inc. 8100 SouthPark Way, Unit B Littleton, Colorado 80120	Mr. Eric Zipp Field Engineer (303) 734-1727 (phone) (303) 734-0330 (fax) ericz@adaes.com
Testing Company Representative	GE Energy Management Services, Inc. 888 Industrial Drive Elmhurst, Illinois 60126	Mr. Christopher F. Miller Project Supervisor 630-530-6616 (phone) 630-530-6630 (fax) christopher.miller@ge.com

Messrs. M. Kielanowicz and C. Miller of GE Energy conducted the testing.

2.0 SUMMARY OF RESULTS

During this test program, three (3) sixty-minute HCl, HF, HBr, Br_2 and Cl_2 test runs were conducted on the Unit 1 Stack test location. The average test results were as follows:

Parameter		February 8, 2006	February 9, 2006
HCl	ppm	1.326	0.799
	lb/hr	12.697	7.912
HF	ppm	0.312	0.265
	lb/hr	1.639	1.440
HBr	ppm	0.129	0.380
	lb/hr	2.733	8.324
Br_2	ppm	0.065	0.063
	lb/hr	2.733	2.724
Cl_2	ppm	0.289	0.163
	lb/hr	5.376	3.129

Complete test results summaries are tabulated and can be found in Section 6.0.

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program. Unit operating data was recorded and retained by plant personnel.

4.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed as described in the Title 40, Code of Federal Regulations, Part 60 (40CFR60), Appendix A, Methods 1, 2, 3, 4, 26A and the latest revisions thereof. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Volumetric Flowrate Determination
In order to determine the emission rate on a lbs/hr basis, the gas velocity and volumetric flowrate were determined using Method 2, 40CFR60.

Velocity pressures were determined by traversing the test location with an S-type pitot tube. Temperatures were measured using a K-type thermocouple with a calibrated digital temperature indicator. The molecular weight and moisture content of the gases were determined to permit the calculation of the volumetric flowrate. Sampling points utilized were determined using Method 1, 40CFR60.

4.2 Oxygen (O_2)/Carbon Dioxide (CO_2) Determination
Oxygen (O_2) and carbon dioxide (CO_2) gas contents were determined in accordance with Method 3, 40CFR60. This method collected samples in an integrated manner and analyzed the samples using a Hays Orsat gas analyzer. Several gas extractions were performed during each test run to ensure a stable reading. Mandatory leak checks were performed prior to and following each use. Chemicals are changed frequently and inspected for reactivity prior to each use.

4.3 Hydrogen Halides (HCl, HBr, HF) and Halogens (Cl_2, Br_2) Determination
Hydrogen chloride (HCl), hydrogen fluoride (HF), Hydrogen bromide (HBr), bromine (Br_2) and chlorine (Cl_2) concentrations were determined using Method 26A, 40CFR60. An integrated twenty-four-point sample was extracted from the gas stream and passed through 0.1 N sulfuric acid (H_2SO_4) and 0.1 N sodium hydroxide (NaOH). The samples were then analyzed by ion chromatography. The sample train consisted of a heated glass probe liner, a heated optional filter, and six impingers. The first impinger was short stemmed and empty to knock out heavy moisture, the second and third impingers contained the dilute sulfuric acid, the fourth and fifth impingers contained a 0.1 N sodium hydroxide (NaOH) scrubber solution to remove any remaining chlorine, and the sixth impinger contained silica gel to absorb any remaining moisture. The train was leak checked prior to and after each run. The sample was then extracted isokinetically. The samples were recovered by quantitatively transferring the contents of the first three impingers (the knock out and the two acidic absorbing solution impingers) and deionized water rinses to a glass sample jar. Impingers 4 and 5 (alkaline absorbing solution) and deionized water rinses are transferred to a separate glass sample jar. The samples were labeled, and the level marked for transfer to the laboratory. The samples were then analyzed by ion chromatography.

The test trains were weighed before and after each test for moisture determination.

The test crew performed sample recovery at the test site and initial analysis was performed on site. Samples were transported to an approved lab for final analysis. Copies of all sample analysis sheets are appended to this report.

Calculations were performed on the computer. An explanation of the nomenclature and calculations along with the complete test results are appended. Also appended are the calibration data and copies of the raw field data sheets.

Raw data are kept on file at the GE Energy office in Elmhurst, Illinois. All samples from this test program (not already used in analysis) will be retained for 60 days after the submittal of the report, after which they will be discarded unless GE Energy is advised otherwise.

5.0 QUALITY ASSURANCE PROCEDURES

GE Energy recognizes the previously described reference methods to be very technique oriented and attempts to minimize all factors which can increase error by implementing its Quality Assurance Program into every segment of its testing activities.

Shelf life of chemical reagents prepared at the GE Energy laboratory did not exceed those specified in the above mentioned methods; and those reagents having a shelf life of one week were prepared daily at the jobsite. When on-site analyses were required, the same person performing the analysis performed all reagent standardizations daily.

Dry test meters and wet test meters were calibrated according to methods described in the Quality Assurance Handbook, Sections 3.3.2, 3.4.2 and 3.5.2. Percent error for the wet test meter according to the methods was less than the allowable error of 1.0 percent. The dry test meters measured the test sample volumes to within 2 percent at the flowrate and conditions encountered during sampling.

6.0 TEST RESULTS SUMMARY

GASEOUS TEST RESULTS SUMMARY

MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
February 8, 2006

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HCl	
					ppm	lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.705	6.743
2	13:15-14:15	13.5	6.5	1,685,823	2.602	24.922
3	14:45-15:45	13.3	6.8	1,682,868	0.672	6.428
Average		13.4	6.6	1,683,903	1.326	12.697

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HF	
					ppm	lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.350	1.834
2	13:15-14:15	13.5	6.5	1,685,823	0.291	1.530
3	14:45-15:45	13.3	6.8	1,682,868	0.296	1.552
Average		13.4	6.6	1,683,903	0.312	1.639

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HBr *	
					ppm	lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.127	2.697
2	13:15-14:15	13.5	6.5	1,685,823	0.129	2.733
3	14:45-15:45	13.3	6.8	1,682,868	0.131	2.771
Average		13.4	6.6	1,683,903	0.129	2.733

* HBr laboratory results are below the detection limit of 0.05 mg.

Note: Test 1 flow value is the average flow runs pre 1.and post 1.
Test 2 flow value is the average flow runs post 1 and post 2.
Test 3 flow value is the average flow runs post 2 and post 3.

GE Energy

GASEOUS TEST RESULTS SUMMARY

MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
February 8, 2006

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	Br_2 *	
					ppm	lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.064	2.697
2	13:15-14:15	13.5	6.5	1,685,823	0.065	2.733
3	14:45-15:45	13.3	6.8	1,682,868	0.066	2.771
Average		13.4	6.6	1,683,903	0.065	2.733

* Br_2 laboratory results are below the detection limit of 0.05 mg.

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	Cl_2	
					ppm	lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.339	6.311
2	13:15-14:15	13.5	6.5	1,685,823	0.390	7.269
3	14:45-15:45	13.3	6.8	1,682,868	0.137	2.549
Average		13.4	6.6	1,683,903	0.289	5.376

Note: Test 1 flow value is the average flow runs pre 1.and post 1.
Test 2 flow value is the average flow runs post 1 and post 2.
Test 3 flow value is the average flow runs post 2 and post 3.

GASEOUS TEST RESULTS SUMMARY

MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
February 9, 2006

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HCl	
					ppm	lb/hr
1	12:25-13:25	13.9	5.6	1,737,321	0.898	8.868
2	14:05-15:05	14.1	5.7	1,714,553	0.651	6.345
3	15:39-16:39	14.0	5.6	1,769,099	0.848	8.523
Average		14.0	5.6	1,740,324	0.799	7.912

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HF	
					ppm	lb/hr
1	12:25-13:25	13.9	5.6	1,737,321	0.221	1.197
2	14:05-15:05	14.1	5.7	1,714,553	0.219	1.173
3	15:39-16:39	14.0	5.6	1,769,099	0353	1.950
Average		14.0	5.6	1,740,324	0.265	1.440

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	HBr	
					ppm	lb/hr
1	12:25-13:25	13.9	5.6	1,737,321	0.338	7.399
2	14:05-15:05	14.1	5.7	1,714,553	0.434	9.384
3	15:39-16:39	14.0	5.6	1,769,099	0.367	8.189
Average		14.0	5.6	1,740,324	0.380	8.324

Note: Test 1 flow value is the average flow runs pre 1.and post 1.
Test 2 flow value is the average flow runs post 1 and post 2.
Test 3 flow value is the average flow runs post 2 and post 3.

GASEOUS TEST RESULTS SUMMARY

MidAmerican Energy
Louisa Generating Station
Unit 1 Stack
February 9, 2006

RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	Br_2 * ppm	Br_2 * lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.063	2.720
2	13:15-14:15	13.5	6.5	1,685,823	0.062	2.666
3	14:45-15:45	13.3	6.8	1,682,868	0.063	2.785
Average		13.4	6.6	1,683,903	0.063	2.724

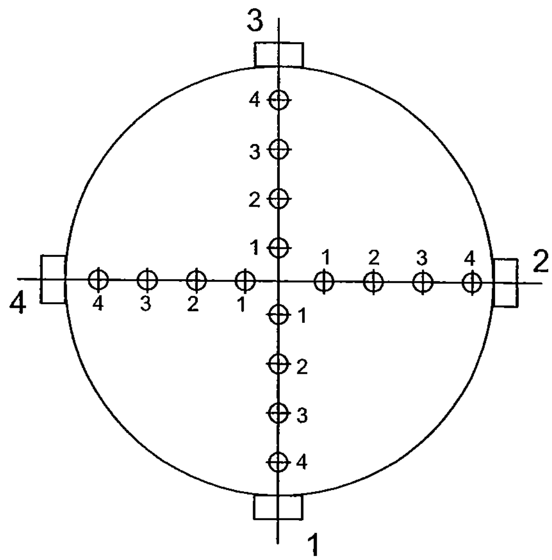
* Br_2 laboratory results are below the detection limit of 0.05 mg.

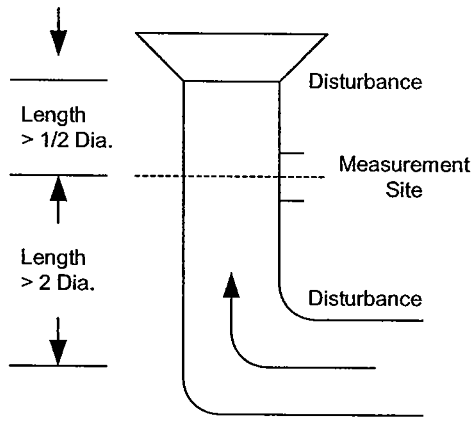
RUN #	Time	CO_2 % dry	O_2 % dry	Flow dscfm	Cl_2 ppm	Cl_2 lb/hr
1	11:25-12:25	13.5	6.5	1,683,018	0.306	5.875
2	13:15-14:15	13.5	6.5	1,685,823	0.065	1.226
3	14:45-15:45	13.3	6.8	1,682,868	0.117	2.284
Average		13.4	6.6	1,683,903	0.163	3.129

Note: Test 1 flow value is the average flow runs pre 1.and post 1.
Test 2 flow value is the average flow runs post 1 and post 2.
Test 3 flow value is the average flow runs post 2 and post 3.

APPENDIX

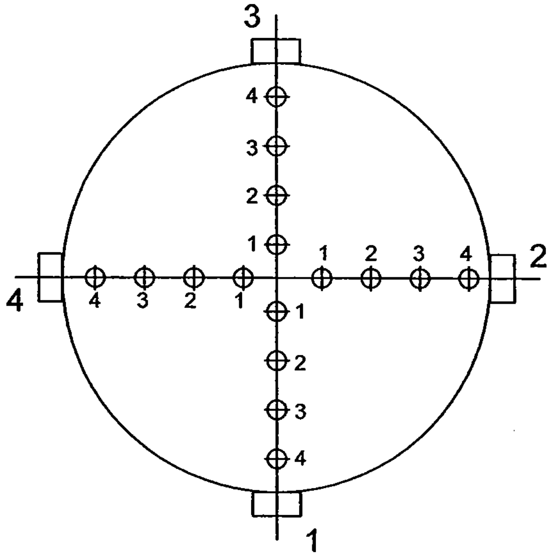
EQUAL AREA TRAVERSE FOR ROUND DUCTS

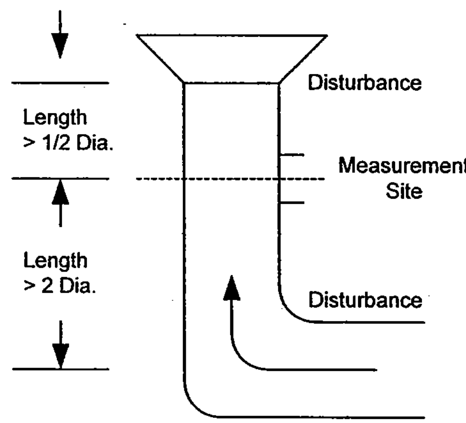




Job:	MidAmerican Energy Louisa Generating Station Muscatine, Iowa
Date:	February 8 and 9, 2006
Test Location:	Unit 1 Stack
Diameter:	32.15 Feet
Area:	811.81 Square Feet
No. Points Across Diameter:	8
No. of Ports:	4

EQUAL AREA TRAVERSE FOR ROUND DUCTS

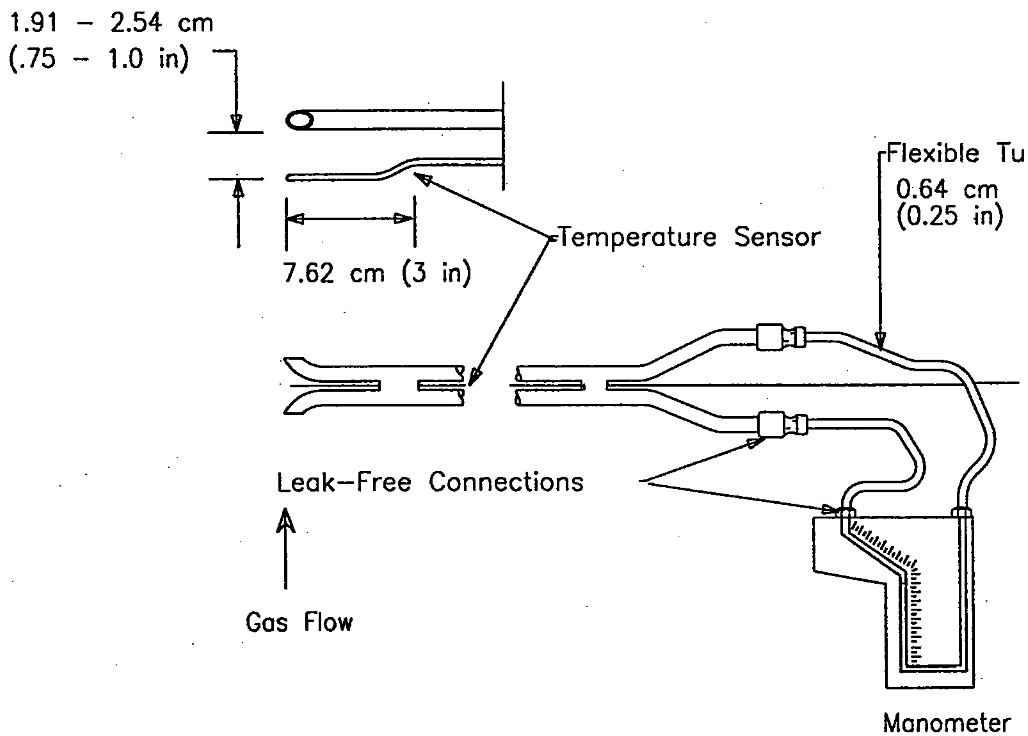




Job:	MidAmerican Energy Louisa Generating Station Muscatine, Iowa
Date:	February 8 and 9, 2006
Test Location:	Unit 1 Stack
Diameter:	32.15 Feet
Area:	811.81 Square Feet
No. Points Across Diameter:	8
No. of Ports:	4

S-Type Pitot Tube Manometer Assembly

USEPA Method 2

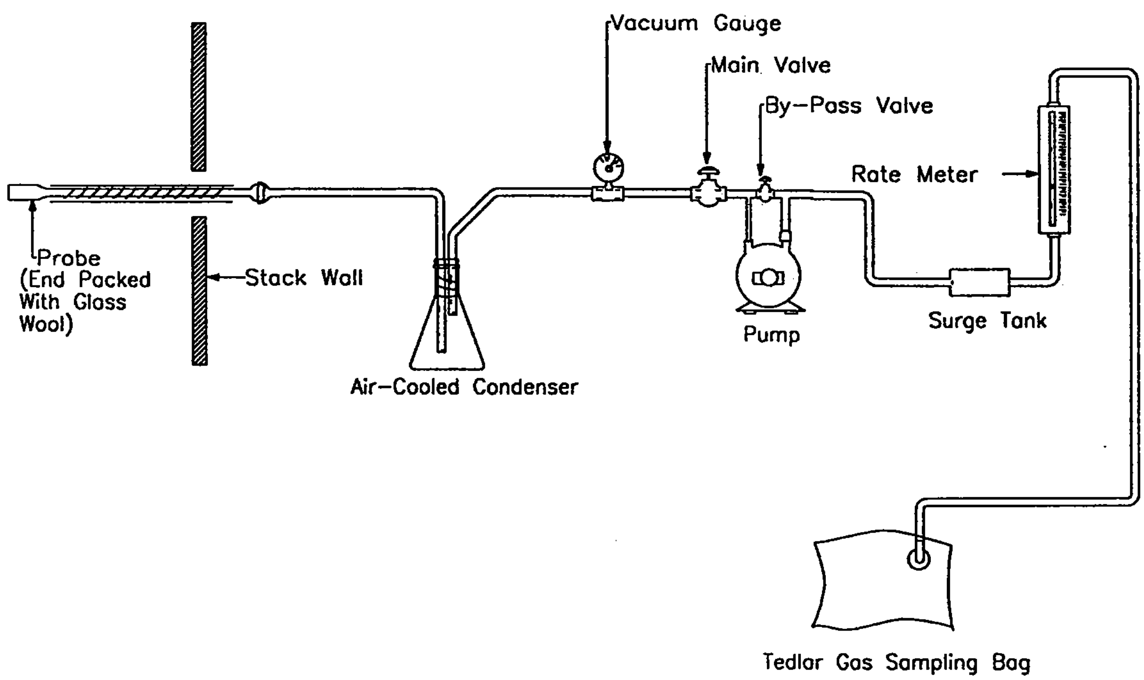


Dwg - AD

GE Energy

Sampling Train for Integrated Gas Sampling

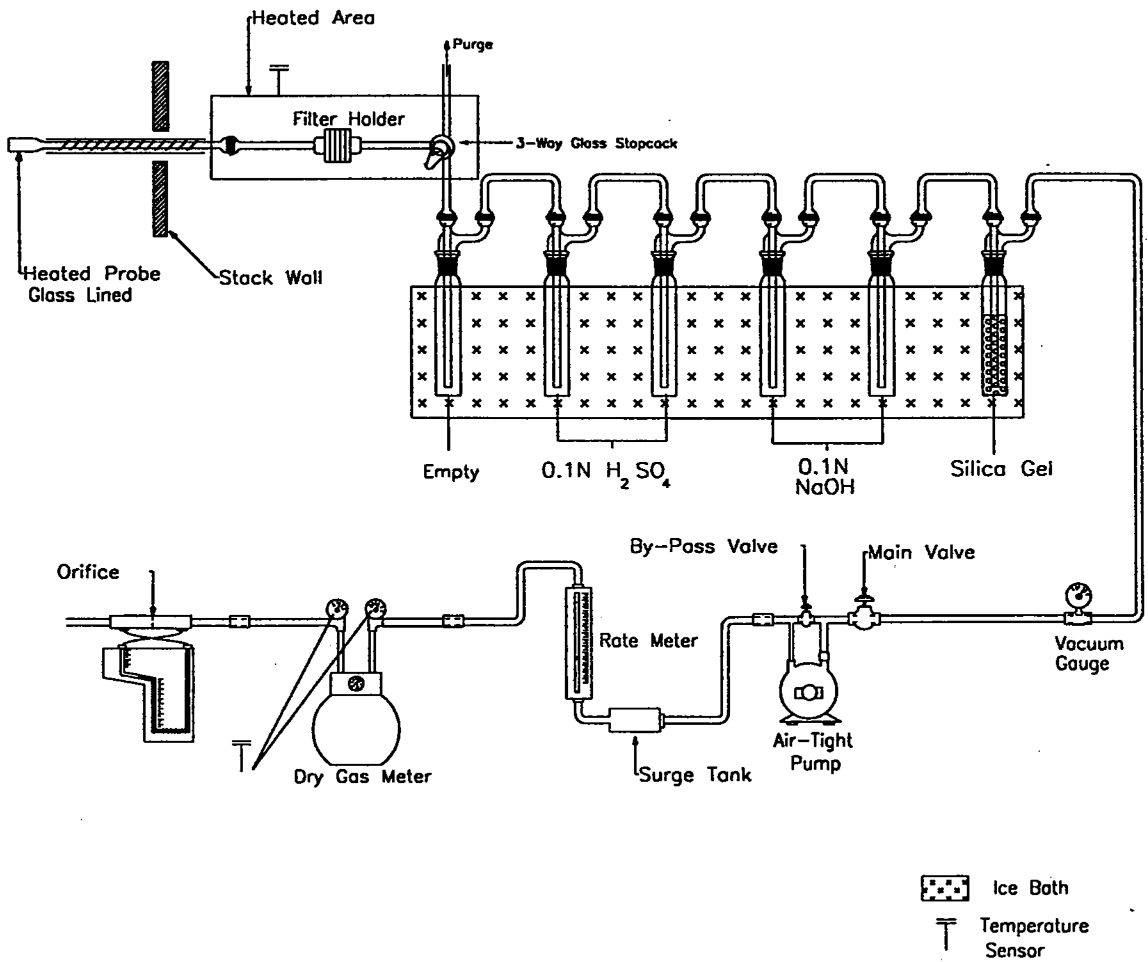
USEPA Method 3



Dwg - E

Determination of HCl, HF, HBr, Br_2 and Cl_2 Concentrations in Stack Gases

USEPA Method 26A Sample Train



Dwg - R

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-4617
847-647-1345

PREPARED FOR:

Frank Jarke
GE Energy Management Services, Inc.
888 Industrial Dr.
Elmhurst, IL 60126

Report #: 70899
Report Date: 2/22/2006
Sample Received:
2/13/06 12:19

M22E1180-02

2/18 TEI Number: 70899 Sample: 001 T1

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	<0.05	mg	2/15/2006
HCl (M26A)	0.125	mg	2/15/2006
HF (M26A)	0.034	mg	2/15/2006

2/18 TEI Number: 70900 Sample: 002 T2

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	<0.05	mg	2/15/2006
HCl (M26A)	0.456	mg	2/15/2006
HF (M26A)	0.028	mg	2/15/2006

2/18 TEI Number: 70901 Sample: 003 T3

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	<0.05	mg	2/15/2006
HCl (M26A)	0.116	mg	2/15/2006
HF (M26A)	0.028	mg	2/15/2006

g. e. O'Neill
Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-4617
847-647-1345

PREPARED FOR:

Frank Jarke
GE Energy Management Services, Inc.
888 Industrial Dr.
Elmhurst, IL 60126

Report #: 70899
Report Date: 2/22/2006
Sample Received:
2/13/06 12:19

M22E1180-02

2/9 TEI Number: 70902 Sample: 004 T1

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	0.136	mg	2/15/2006
HCl (M26A)	0.163	mg	2/15/2006
HF (M26A)	0.022	mg	2/15/2006

2/9 TEI Number: 70903 Sample: 005 T2

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	0.176	mg	2/15/2006
HCl (M26A)	0.119	mg	2/15/2006
HF (M26A)	0.022	mg	2/15/2006

2/9 TEI Number: 70904 Sample: 006 T3

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	0.147	mg	2/15/2006
HCl (M26A)	0.153	mg	2/15/2006
HF (M26A)	0.035	mg	2/15/2006

g. e. O'Neill
Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-4617
847-647-1345

PREPARED FOR:

Frank Jarke
GE Energy Management Services, Inc.
888 Industrial Dr.
Elmhurst, IL 60126

Report #: 70899
Report Date: 2/22/2006
Sample Received:
2/13/06 12:19

M22E1180-02

TEI Number: 70905 Sample: 007 blank

TEST	RESULTS		DATE PERFORMED
HBr (M26A)	<0.05	mg	2/15/2006
HCl (M26A)	<0.01	mg	2/15/2006
HF (M26A)	<0.01	mg	2/15/2006

2/8 TEI Number: 70906 Sample: 008 T1

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/15/2006
Chlorine (M26A)	0.117	mg	2/15/2006

2/8 TEI Number: 70907 Sample: 009 T2

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/15/2006
Chlorine (M26A)	0.133	mg	2/15/2006

2/8 TEI Number: 70908 Sample: 010 T3

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/15/2006
Chlorine (M26A)	0.046	mg	2/15/2006

G. E. O'Neill

Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-4617
847-647-1345

PREPARED FOR:

Frank Jarke
GE Energy Management Services, Inc.
888 Industrial Dr.
Elmhurst, IL 60126

Report #: 70899
Report Date: 2/22/2006
Sample Received:
2/13/06 12:19

M22E1180-02

2/9 TEI Number: 70909 Sample: 011 T1

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/16/2006
Chlorine (M26A)	0.108	mg	2/16/2006

2/9 TEI Number: 70910 Sample: 012 T2

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/16/2006
Chlorine (M26A)	0.023	mg	2/16/2006

2/9 TEI Number: 70911 Sample: 013 T3

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/16/2006
Chlorine (M26A)	0.041	mg	2/16/2006

TEI Number: 70912 Sample: 014 blank

TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.05	mg	2/16/2006
Chlorine (M26A)	<0.01	mg	2/16/2006

G. E. O'Neill
Gayle E. O'Neill, Ph.D.

GE Energy

Read Instructions on Reverse Side Before Completing Form!

CHAIN OF CUSTODY RECORD

Project Number: M22E1180 – 02	Date Results Required: NORMAL
Client: ADA-ES (MIDAMERICAN ENERGY)	TAT Required:
Plant/Location: MIDAMERICAN ENERGY – LOUISA GENERATING STATION MUSCATINE, IOWA	PO Number:
Project Supervisor: C. MILLER	LIMS Entry:

Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/ Comp	Analysis Requested	Sub Lab
001	2/8/06	TEST 1 → UNIT 1 STACK NORMAL (COND 1)	2 (1)	H_2SO_4 fraction	M26 – HCL, HBr, HF, Cl2	
002	2/8/06	TEST 2 → UNIT 1 STACK NORMAL (COND 1)	2			
003	2/8/06	TEST 3 → UNIT 1 STACK NORMAL (COND 1)	2			
004	2/9/06	TEST 1 → UNIT 1 STACK NORMAL (COND 2 KNX INJECTION)	2			
005	2/9/06	TEST 2 → UNIT 1 STACK NORMAL (COND 2 KNX INJECTION)	2			
006	2/9/06	TEST 3 → UNIT 1 STACK NORMAL (COND 2 KNX INJECTION)	2			
007		BLANK, 0.1N H_2SO_4	1		M26 – HCl, HBr, HF	
008	2/8/06	Test 1 – Unit 1 Stack	1	NaOH fraction	M26 – Cl_2, Br_2	
009		Test 2 normal cond 1	1			
010		Test 3	1			
011	2/9/06	Test 1 Unit 1 Stack Condit. 2	1			
012		Test 2	1			
013		Test 3	1			
014		BLANK, 0.1N NaOH	1			
015						
016						

Delivered by:	Date/Time	Processed by:	Date/Time	Received by Laboratory:
[signature]	1400 ON 2/10/06	E. R. 02/13/06	2/13/06 12:19 pm	EJ-J

Special Instructions:

G:\Lab\LAB Data\Current Manual Forms\CUSTODY.FRM.doc

GL Energy Volume Record Sheet		
Description	Initial Volume	Analyst/Date
	M22E1180-02	E. V. 02/13/06
	Volumes, M26	
S. 001	58 mL	
002	52	
003	43	
004	40	
005	39	
006	66	
007	50	
008	50	
009	40	
010	42	
011	28	
012	33	
013	51	
014	50	

Example Calculations - Volumetric Flow

Company: MidAmerican
Plant: Louisa Generating Station
Source: Unit 1 Stack
Run: Normal Load, Run Pre 1
Date: 02/08/06

Moisture Content

$$Vm(std) = 17.647 \times Vm \times \frac{Pb + \frac{\Delta H}{13.6}}{(460 + Tm)} \times Yd$$

$$Vw(std) = (0.04707 \times Vlc\ silica\ net\ H_2O) + (0.04715 \times Vlc\ net\ H_2O)$$

$$Bws = \frac{Vw(std)}{Vw(std) + Vm(std)}$$

Vw(std) = 0.528 Vm(std) = 4.093

Bws = 0.114

Dry Molecular Weight

$$Md = 0.44 \times (\%CO_2) + 0.32 \times (\%O_2) + 0.28 \times \%N_2$$

$\%CO_2$ = 13.5 $\%O_2$ = 6.5 $\%N_2$ = 80.0

Md = 30.42

Wet Molecular Weight

$$Ms = Md \times (1\text{-}Bws) + (18.0 \times Bws)$$

Md = 30.42 Bws = 0.114

Ms = 29.00

Average Duct Velocity

$$Vs = 85.49 \times Cp \times Sqrt\ \Delta P\ (avg) \times ((Ts\ (avg) + 460)/ (Ps \times Ms))^{1/2}$$

Cp = 0.840 Ts (avg) = 297.7 Sqrt ΔP avg: 0.846
Ps = 29.84 Ms = 29.00

Vs = 56.83

Volumetric Flow Rate

Q (Actual Basis)= Vs x A x 60

Vs = 56.83 A = 811.805

Q = 2768157 acfm

$$Qs\ (Standard\ Basis) = 17.647 \times Q \times \frac{Ps}{460 + Ts\ (avg)}$$

Q = 2768157 Ps = 29.84 Ts (avg) = 297.7

Qs = 1923795 scfm

Qs (Standard Basis)= scfm x 60 min/hr

Qs = 115427720 scfh

Example Calculations

MidAmerican Energy
Louisa Generating Station - Unit 1 Stack
February 8, 2006 - Test 1

Hydrogen Chloride (HCl) ppm

Test 1:

= mg HCl x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x ((385 x 10^6)/(36.461 (MW of HCl)))

Note: 385 = Volume of l lb mole of gas at 68°F and 29.92 inches of Hg
10^6 = Conversion of ppm v/v

= 0.125 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x ((385 x 10^6)/(36.461 (MW of HCl)))

= 0.705

Hydrogen Chloride (HCl) lb/hr

Test 1:

= mg HCl x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x dscfm x 60 min/hr

= 0.125 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x 1,683,018 dscfm x 60 min/hr

= 6.743

Hydrogen Fluoride (HF) ppm

Test 1:

= mg HF x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x ((385 x 10^6)/(20.006 (MW of HF)))

= 0.034 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x ((385 x 10^6)/(20.006 (MW of HF))

= 0.350

Hydrogen Fluoride (HF) lb/hr

Test 1:

= mg HF x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x dscfm x 60 min/hr

= 0.034 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x 1,683,018 dscfm x 60 min/hr

= 1.834

Hydrogen Bromide (HBr) ppm

Test 1:

= mg HBr x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x ((385 x 10^6)/(80.917 (MW of HBr)))

= 0.050 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x ((385 x 10^6)/(80.917 (MW of HBr)))

Note: Laboratory results are below the detection limit of 0.05 mg.

= 0.127

Hydrogen Bromide (HBr) lb/hr

Test 1:

= mg HBr x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x dscfm x 60 min/hr

= 0.050 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x 1,683,018 dscfm x 60 min/hr

= 2.697

Example Calculations

MidAmerican Energy
Louisa Generating Station - Unit 1 Stack
February 8, 2006 - Test 1

Chlorine (Cl_2) ppm
Test 1:

= mg Cl_2 x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x ((385 x 10^6)/(70.906 (MW of Cl_2)))

= 0.117 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x ((385 x 10^6)/(70.906 (MW of Cl_2)))

= 0.339

Chlorine (Cl_2) lb/hr
Test 1:

= mg Cl_2 x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x dscfm x 60 min/hr

= 0.117 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x 1,683,018 dscfm x 60 min/hr

= 6.311

Bromine (Br_2) ppm
Test 1:

= mg Br_2 x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x ((385 x 10^6)/(159.818 (MW of Br_2)))

= 0.050 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x ((385 x 10^6)/(159.818 (MW of Br_2)))

Note: Laboratory results are below the detection limit of 0.05 mg.

= 0.064

Bromine (Br_2) lb/hr
Test 1:

= mg Br_2 x 10^-3 x ((2.2046 x 10^-3) / (Vmstd dscf)) x dscfm x 60 min/hr

= 0.050 mg x 10^-3 x ((2.2046 x 10^-3) / (4.127 dscf)) x 1,683,018 dscfm x 60 min/hr

= 2.697

VOLUMETRIC AIR FLOW CALCULATIONS

$$Vm\,(std) = 17.647 \times Vm \times \left[\frac{P_{bar} + \frac{DH}{13.6}}{(460 + Tm)} \right] \times Y$$

$$Vw\,(std) = 0.0471 \times Vlc$$

Vlc = water + silica net

$$Bws = \left[\frac{Vw\,(std)}{Vw\,(std) + Vm\,(std)} \right]$$

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + \left[0.28 \times (100 - \%CO_2 - \%O_2)\right]$$

$$MS = Md \times (1 - Bws) + (18 \times Bws)$$

$$Vs = \sqrt{\frac{(Ts + 460)}{Ms \times Ps}} \times \sqrt{DP} \times Cp \times 85.49$$

Cp	=	pitot tube correction factor
Ps	=	absolute flue gas pressure
Ms	=	molecular weight of gas (lb/lb mole)
Md	=	dry molecular weight of gas (lb/lb mole)
Bws	=	water vapor in gas stream proportion by volume

$$Acfm = Vs \times Area\ (of\ stack\ or\ duct) \times 60$$

$$Dscfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right] \times (1 - Bws)$$

$$Scfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right]$$

$$Scfh = Scfm \times 60 \frac{min}{hr}$$

MOISTURE CALCULATIONS

$$V_{wc(std)} = \frac{(V_f - V_i)\,\rho_w\, R\, T_{std}}{P_{std} M_w} = 0.04707(V_f - V_i)$$

$$V_{wsg(std)} = \frac{(W_f - W_i)\, R\, T_{std}}{P_{std}\, M_w} = 0.04715\,(W_f - W_i)$$

$$V_{m(std)} = 17.64\ V_m\ Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

Where:

B_{ws} =	Water vapor in gas stream, proportion by volume
M_w =	Molecular weight of water, 18.015 lb/lb-mole
P_{bar} =	Barometric pressure at the testing site, in. Hg
P_{std} =	Standard absolute pressure, 29.92 in. Hg
R =	Ideal gas constant, 0.048137 (in. Hg)(ft^3)/(g-mole)(°R) = [21.8348(in. Hg)(ft^3)/(lb-mole)(°R)]/453.592 g-mole/lb-mole
T_m =	Absolute average dry gas meter temperature, °R
T_{std} =	Standard absolute temperature, 528 °R
V_f =	Final volume of condenser water, ml
V_i =	Initial volume of condenser water, ml
V_m =	Dry gas volume measured by dry gas meter, dcf
$V_{m(std)}$ =	Dry gas volume measured by dry gas meter, corrected to standard conditions, scf
$V_{wc(std)}$ =	Volume of condensed water vapor, corrected to standard conditions, scf
$V_{wsg(std)}$ =	Volume of water vapor collected in silica gel, corrected to standard conditions, scf
W_f =	Final weight of silica gel, g
W_i =	Initial weight of silica gel, g
Y =	Dry gas meter calibration factor
ΔH =	Average pressure exerted on dry gas meter outlet by gas sample bag, in. H_2O
ρ_w =	Density of water, 0.9982 g/ml
13.6 =	Specific gravity of mercury (Hg)
17.64 =	T_{std}/P_{std}
0.04707 =	ft^3/ml 0.04715 = ft^3/g

METHOD 26 TEST RESULTS

Date:	2/8/2006	Condition:	Normal
Project:	MidAmerican	Data Taken By:	CFM/MJK
Location:	Louisa Generating Station	Fuel Factor:	N/A
Source:	Unit 1 Stack		

Test Number:	1	Time:	11:25-12:25
Pressure, Barometric(Hg"):....................	29.920	Carbon Dioxide Content(%):................................	13.50
Pressure, Static(H_2O"):..........................	-1.10	Oxygen Content(%):..	6.50
Pressure, Stack(Hg"):.............................	29.839	Nitrogen Content(%):...	80.00
Initial Volume (liters)...............................	6737.29	HF (mg)..	0.034
Final Volume (liters)................................	6857.49	HCl (mg)...	0.125
Meter Temperature (°F)..........................	90.23	Water Vapor in Flue Gas (Bws):............................	0.113
Meter Volume (dscf)................................	4.127	HF (ppm):..	0.350
Meter Calibration (Y)...............................	1.007	HCl (ppm):...	0.705
Initial Wt. (grms or mls)...........................	826.6	HF (lbs/hr):...	1.834
Final Wt. (grms or mls)............................	837.8	HCl (lbs/hr):..	6.743
Average Delta H (ΔH).............................	2.500	HF (lbs/MMBtu):..	N/A
Dry Standard Flow Rate (dscfm): *........	1,683,018	HCl (lbs/MMBtu):...	N/A

* Test 1 flow value is the average flow runs pre 1 and post 1.

Test Number:	2	Time:	13:15-14:15
Pressure, Barometric(Hg"):....................	29.920	Carbon Dioxide Content(%):................................	13.50
Pressure, Static(H_2O"):..........................	-1.10	Oxygen Content(%):..	6.50
Pressure, Stack(Hg"):.............................	29.839	Nitrogen Content(%):...	80.00
Initial Volume (liters)...............................	6858.12	HF (mg)..	0.028
Final Volume (liters)................................	6978.37	HCl (mg)...	0.456
Meter Temperature (°F)..........................	96.77	Water Vapor in Flue Gas (Bws):............................	0.096
Meter Volume (dscf)................................	4.080	HF (ppm):..	0.291
Meter Calibration (Y)...............................	1.007	HCl (ppm):...	2.602
Initial Wt. (grms or mls)...........................	670.5	HF (lbs/hr):...	1.530
Final Wt. (grms or mls)............................	679.7	HCl (lbs/hr):..	24.922
Average Delta H (ΔH).............................	2.500	HF (lbs/MMBtu):..	N/A
Dry Standard Flow Rate (dscfm): *............	1,685,823	HCl (lbs/MMBtu):...	N/A

* Test 2 flow value is the average flow runs post 1 and post 2.

Test Number:	3	Time:	14:45-15:45
Pressure, Barometric(Hg"):....................	29.920	Carbon Dioxide Content(%):................................	13.30
Pressure, Static(H_2O"):..........................	-1.10	Oxygen Content(%):..	6.80
Pressure, Stack(Hg"):.............................	29.839	Nitrogen Content(%):...	79.90
Initial Volume (liters)...............................	6983.680	HF (mg)..	0.028
Final Volume (liters)................................	7103.940	HCl (mg)...	0.116
Meter Temperature (°F)..........................	105.54	Water Vapor in Flue Gas (Bws):............................	0.110
Meter Volume (dscf)................................	4.017	HF (ppm):..	0.296
Meter Calibration (Y)...............................	1.007	HCl (ppm):...	0.672
Initial Wt. (grms or mls)...........................	714.0	HF (lbs/hr):...	1.552
Final Wt. (grms or mls)............................	724.5	HCl (lbs/hr):..	6.428
Average Delta H (ΔH).............................	2.500	HF (lbs/MMBtu):..	N/A
Dry Standard Flow Rate (dscfm): *............	1,682,868	HCl (lbs/MMBtu):...	N/A

* Test 3 flow value is the average flow runs post 2 and post 3.

Average HCl lbs/hr:	12.697	Average HF lbs/hr:	1.639
Average HCl ppm:	1.326	Average HF ppm:	0.312
Average Flow Rate (dscfm)	1683903		

METHOD 26 TEST RESULTS

Date:	2/8/2006	Condition:	Normal
Project:	MidAmerican	Data Taken By:	CFM/MJK
Location:	Louisa Generating Station	Fuel Factor:	N/A
Source:	Unit 1 Stack		

Test Number:	1	Time:	11:25-12:25
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.50
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.50
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	80.00
Initial Volume (liters)	6737.29	HBr (mg)	0.050
Final Volume (liters)	6857.49	HCl (mg)	N/A
Meter Temperature (°F)	90.23	Water Vapor in Flue Gas (Bws):	0.113
Meter Volume (dscf)	4.127	HBr (ppm):	0.127
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	826.6	HBr (lbs/hr):	2.697
Final Wt. (grms or mls)	837.8	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HF (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,683,018	HCl (lbs/MMBtu):	N/A

* Test 1 flow value is the average flow runs pre 1 and post 1.

Test Number:	2	Time:	13:15-14:15
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.50
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.50
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	80.00
Initial Volume (liters)	6858.12	HBr (mg)	0.050
Final Volume (liters)	6978.37	HCl (mg)	N/A
Meter Temperature (°F)	96.77	Water Vapor in Flue Gas (Bws):	0.096
Meter Volume (dscf)	4.080	HBr (ppm):	0.129
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	670.5	HBr (lbs/hr):	2.733
Final Wt. (grms or mls)	679.7	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HF (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,685,823	HCl (lbs/MMBtu):	N/A

* Test 2 flow value is the average flow runs post 1 and post 2.

Test Number:	3	Time:	14:45-15:45
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.30
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.80
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	79.90
Initial Volume (liters)	6983.680	HBr (mg)	0.050
Final Volume (liters)	7103.940	HCl (mg)	N/A
Meter Temperature (°F)	105.54	Water Vapor in Flue Gas (Bws):	0.110
Meter Volume (dscf)	4.017	HBr (ppm):	0.131
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	714.0	HBr (lbs/hr):	2.771
Final Wt. (grms or mls)	724.5	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HF (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,682,868	HCl (lbs/MMBtu):	N/A

* Test 3 flow value is the average flow runs post 2 and post 3.

Note: HBr laboratory results are below the detection limit of 0.05 mg.

Average HBr lbs/hr:	2.733
Average HBr ppm:	0.129
Average Flow Rate (dscfm)	1683903

METHOD 26 TEST RESULTS

Date:	2/8/2006	Condition:	Normal
Project:	MidAmerican	Data Taken By:	CFM/MJK
Location:	Louisa Generating Station	Fuel Factor:	N/A
Source:	Unit 1 Stack		

Test Number:	1	Time:	11:25-12:25
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.50
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.50
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	80.00
Initial Volume (liters)	6737.29	Br_2 (mg)	0.050
Final Volume (liters)	6857.49	Cl_2 (mg)	0.117
Meter Temperature (°F)	90.23	Water Vapor in Flue Gas (Bws):	0.113
Meter Volume (dscf)	4.127	Br_2 (ppm):	0.064
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.339
Initial Wt. (grms or mls)	826.6	Br_2 (lbs/hr):	2.697
Final Wt. (grms or mls)	837.8	Cl_2 (lbs/hr):	6.311
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,683,018	Cl_2 (lbs/MMBtu):	N/A

* Test 1 flow value is the average flow runs pre 1 and post 1.

Test Number:	2	Time:	13:15-14:15
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.50
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.50
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	80.00
Initial Volume (liters)	6858.12	Br_2 (mg)	0.050
Final Volume (liters)	6978.37	Cl_2 (mg)	0.133
Meter Temperature (°F)	96.77	Water Vapor in Flue Gas (Bws):	0.096
Meter Volume (dscf)	4.080	Br_2 (ppm):	0.065
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.390
Initial Wt. (grms or mls)	670.5	Br_2 (lbs/hr):	2.733
Final Wt. (grms or mls)	679.7	Cl_2 (lbs/hr):	7.269
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,685,823	Cl_2 (lbs/MMBtu):	N/A

* Test 2 flow value is the average flow runs post 1 and post 2.

Test Number:	3	Time:	14:45-15:45
Pressure, Barometric(Hg"):	29.920	Carbon Dioxide Content(%):	13.30
Pressure, Static(H_2O"):	-1.10	Oxygen Content(%):	6.80
Pressure, Stack(Hg"):	29.839	Nitrogen Content(%):	79.90
Initial Volume (liters)	6983.680	Br_2 (mg)	0.050
Final Volume (liters)	7103.940	Cl_2 (mg)	0.046
Meter Temperature (°F)	105.54	Water Vapor in Flue Gas (Bws):	0.110
Meter Volume (dscf)	4.017	Br_2 (ppm):	0.066
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.137
Initial Wt. (grms or mls)	714.0	Br_2 (lbs/hr):	2.771
Final Wt. (grms or mls)	724.5	Cl_2 (lbs/hr):	2.549
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,682,868	Cl_2 (lbs/MMBtu):	N/A

* Test 3 flow value is the average flow runs post 2 and post 3.

Note: Br_2 laboratory results are below the detection limit of 0.05 mg.

Average Cl_2 lbs/hr:	5.376	Average Br_2 lbs/hr:	2.733
Average Cl_2 ppm:	0.289	Average Br_2 ppm:	0.065
Average Flow Rate (dscfm)	1683903		

METHOD 26 TEST RESULTS

Date:	**2/9/2006**	**Condition:**	**Normal**
Project:	**MidAmerican**	**Data Taken By:**	**CFM/MJK**
Location:	**Louisa Generating Station**	**Fuel Factor:**	**N/A**
Source:	**Unit 1 Stack**		

Test Number:	1	**Time:**	12:25-13:25
Pressure, Barometric(Hg"):	29.960	**Carbon Dioxide Content(%):**	13.90
Pressure, Static(H_2O"):	-1.00	**Oxygen Content(%):**	5.60
Pressure, Stack(Hg"):	29.886	**Nitrogen Content(%):**	80.50
Initial Volume (liters)	7127.26	**HF (mg)**	0.022
Final Volume (liters)	7247.5	**HCl (mg)**	0.163
Meter Temperature (°F)	78.46	**Water Vapor in Flue Gas (Bws):**	0.110
Meter Volume (dscf)	4.224	**HF (ppm):**	0.221
Meter Calibration (Y)	1.007	**HCl (ppm):**	0.898
Initial Wt. (grms or mls)	698.9	**HF (lbs/hr):**	1.197
Final Wt. (grms or mls)	710.0	**HCl (lbs/hr):**	8.868
Average Delta H (ΔH)	2.500	**HF (lbs/MMBtu):**	N/A
Dry Standard Flow Rate (dscfm): *	1,737,321	**HCl (lbs/MMBtu):**	N/A

*** Test 1 flow value is the average flow runs pre 1 and post 1.**

Test Number:	2	**Time:**	14:05-15:05
Pressure, Barometric(Hg"):	29.960	**Carbon Dioxide Content(%):**	14.10
Pressure, Static(H_2O"):	-1.00	**Oxygen Content(%):**	5.70
Pressure, Stack(Hg"):	29.886	**Nitrogen Content(%):**	80.20
Initial Volume (liters)	7252.31	**HF (mg)**	0.022
Final Volume (liters)	7372.52	**HCl (mg)**	0.119
Meter Temperature (°F)	74.62	**Water Vapor in Flue Gas (Bws):**	0.123
Meter Volume (dscf)	4.254	**HF (ppm):**	0.219
Meter Calibration (Y)	1.007	**HCl (ppm):**	0.651
Initial Wt. (grms or mls)	698.9	**HF (lbs/hr):**	1.173
Final Wt. (grms or mls)	711.5	**HCl (lbs/hr):**	6.345
Average Delta H (ΔH)	2.500	**HF (lbs/MMBtu):**	N/A
Dry Standard Flow Rate (dscfm): *	1,714,553	**HCl (lbs/MMBtu):**	N/A

*** Test 2 flow value is the average flow runs post 1 and post 2.**

Test Number:	3	**Time:**	15:39-16:39
Pressure, Barometric(Hg"):	29.960	**Carbon Dioxide Content(%):**	14.00
Pressure, Static(H_2O"):	-1.00	**Oxygen Content(%):**	5.60
Pressure, Stack(Hg"):	29.886	**Nitrogen Content(%):**	80.40
Initial Volume (liters)	7375.450	**HF (mg)**	0.035
Final Volume (liters)	7495.640	**HCl (mg)**	0.153
Meter Temperature (°F)	81.23	**Water Vapor in Flue Gas (Bws):**	0.097
Meter Volume (dscf)	4.201	**HF (ppm):**	0.353
Meter Calibration (Y)	1.007	**HCl (ppm):**	0.848
Initial Wt. (grms or mls)	715.6	**HF (lbs/hr):**	1.950
Final Wt. (grms or mls)	725.2	**HCl (lbs/hr):**	8.523
Average Delta H (ΔH)	2.500	**HF (lbs/MMBtu):**	N/A
Dry Standard Flow Rate (dscfm): *	1,769,099	**HCl (lbs/MMBtu):**	N/A

*** Test 3 flow value is the average flow runs post 2 and post 3.**

Average HCl lbs/hr:	7.912	**Average HF lbs/hr:**	1.440
Average HCl ppm:	0.799	**Average HF ppm:**	0.265
Average Flow Rate (dscfm)	1740324		

METHOD 26 TEST RESULTS

Date:	2/9/2006	Condition:	Normal
Project:	MidAmerican	Data Taken By:	CFM/MJK
Location:	Louisa Generating Station	Fuel Factor:	N/A
Source:	Unit 1 Stack		

Test Number:	1	Time:	12:25-13:25
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	13.90
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.60
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.50
Initial Volume (liters)	7127.26	HBr (mg)	0.136
Final Volume (liters)	7247.5	HCl (mg)	N/A
Meter Temperature (°F)	78.46	Water Vapor in Flue Gas (Bws):	0.110
Meter Volume (dscf)	4.224	HBr (ppm):	0.338
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	698.9	HBr (lbs/hr):	7.399
Final Wt. (grms or mls)	710.0	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HBr (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,737,321	HCl (lbs/MMBtu):	N/A

* Test 1 flow value is the average flow runs pre 1 and post 1.

Test Number:	2	Time:	14:05-15:05
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	14.10
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.70
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.20
Initial Volume (liters)	7252.31	HBr (mg)	0.176
Final Volume (liters)	7372.52	HCl (mg)	N/A
Meter Temperature (°F)	74.62	Water Vapor in Flue Gas (Bws):	0.123
Meter Volume (dscf)	4.254	HBr (ppm):	0.434
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	698.9	HBr (lbs/hr):	9.384
Final Wt. (grms or mls)	711.5	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HBr (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,714,553	HCl (lbs/MMBtu):	N/A

* Test 2 flow value is the average flow runs post 1 and post 2.

Test Number:	3	Time:	15:39-16:39
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	14.00
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.60
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.40
Initial Volume (liters)	7375.450	HBr (mg)	0.147
Final Volume (liters)	7495.640	HCl (mg)	N/A
Meter Temperature (°F)	81.23	Water Vapor in Flue Gas (Bws):	0.097
Meter Volume (dscf)	4.201	HBr (ppm):	0.367
Meter Calibration (Y)	1.007	HCl (ppm):	N/A
Initial Wt. (grms or mls)	715.6	HBr (lbs/hr):	8.189
Final Wt. (grms or mls)	725.2	HCl (lbs/hr):	N/A
Average Delta H (ΔH)	2.500	HBr (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,769,099	HCl (lbs/MMBtu):	N/A

* Test 3 flow value is the average flow runs post 2 and post 3.

Average HBr lbs/hr:	8.324
Average HBr ppm:	0.380
Average Flow Rate (dscfm)	1740324

METHOD 26 TEST RESULTS

Date:	2/9/2006	Condition:	Normal
Project:	MidAmerican	Data Taken By:	CFM/MJK
Location:	Louisa Generating Station	Fuel Factor:	N/A
Source:	Unit 1 Stack		

Test Number:	1	Time:	12:25-13:25
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	13.90
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.60
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.50
Initial Volume (liters)	7127.26	Br_2 (mg)	0.050
Final Volume (liters)	7247.5	Cl_2 (mg)	0.108
Meter Temperature (°F)	78.46	Water Vapor in Flue Gas (Bws):	0.110
Meter Volume (dscf)	4.224	Br_2 (ppm):	0.063
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.306
Initial Wt. (grms or mls)	698.9	Br_2 (lbs/hr):	2.720
Final Wt. (grms or mls)	710.0	Cl_2 (lbs/hr):	5.875
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,737,321	Cl_2 (lbs/MMBtu):	N/A

* Test 1 flow value is the average flow runs pre 1 and post 1.

Test Number:	2	Time:	14:05-15:05
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	14.10
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.70
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.20
Initial Volume (liters)	7252.31	Br_2 (mg)	0.050
Final Volume (liters)	7372.52	Cl_2 (mg)	0.023
Meter Temperature (°F)	74.62	Water Vapor in Flue Gas (Bws):	0.123
Meter Volume (dscf)	4.254	Br_2 (ppm):	0.062
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.065
Initial Wt. (grms or mls)	698.9	Br_2 (lbs/hr):	2.666
Final Wt. (grms or mls)	711.5	Cl_2 (lbs/hr):	1.226
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,714,553	Cl_2 (lbs/MMBtu):	N/A

* Test 2 flow value is the average flow runs post 1 and post 2.

Test Number:	3	Time:	15:39-16:39
Pressure, Barometric(Hg"):	29.960	Carbon Dioxide Content(%):	14.00
Pressure, Static(H_2O"):	-1.00	Oxygen Content(%):	5.60
Pressure, Stack(Hg"):	29.886	Nitrogen Content(%):	80.40
Initial Volume (liters)	7375.450	Br_2 (mg)	0.050
Final Volume (liters)	7495.640	Cl_2 (mg)	0.041
Meter Temperature (°F)	81.23	Water Vapor in Flue Gas (Bws):	0.097
Meter Volume (dscf)	4.201	Br_2 (ppm):	0.063
Meter Calibration (Y)	1.007	Cl_2 (ppm):	0.117
Initial Wt. (grms or mls)	715.6	Br_2 (lbs/hr):	2.785
Final Wt. (grms or mls)	725.2	Cl_2 (lbs/hr):	2.284
Average Delta H (ΔH)	2.500	Br_2 (lbs/MMBtu):	N/A
Dry Standard Flow Rate (dscfm): *	1,769,099	Cl_2 (lbs/MMBtu):	N/A

* Test 3 flow value is the average flow runs post 2 and post 3.

Note: Br_2 laboratory results are below the detection limit of 0.05 mg.

Average Cl_2 lbs/hr:	3.129	Average Br_2 lbs/hr:	2.724
Average Cl_2 ppm:	0.163	Average Br_2 ppm:	0.063
Average Flow Rate (dscfm)	1740324		

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Pre 1
Plant:	Louisa Generating Station	**Date:**	2/8/2006
Source:	Unit 1 Stack	**Start Time:**	10:45
Pitot ID:	789A	**End Time:**	11:05
Pitot Coefficient:	0.840	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.92
P_g - Stack Pressure, inches of H_2O	-1.10
P_s - Absolute stack pressure, inches Hg	29.84
t_s - Average stack temperature, °F	297.7
% CO_2	13.5
% O_2	6.5
% N_2	80.0
Md - dry basis lb/lb mole	30.42
Ms - wet basis lb/lb mole	29.00
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	237.925
Final Meter Volume:	242.170
Meter Temperature:	90.23
Meter Volume Vm(std):	4.093
Meter Volume Vw(std):	0.528
Delta H:	2.50
Train Initial Wt:	826.600
Train Final Wt:	837.800
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.114**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.75	0.8660	299	58.24
A 02	0.70	0.8367	298	56.23
A 03	0.69	0.8307	297	55.79
A 04	0.52	0.7211	296	48.40
B 01	0.76	0.8718	298	58.59
B 02	0.78	0.8832	298	59.35
B 03	0.78	0.8832	296	59.28
B 04	0.61	0.7810	296	52.42

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.76	0.8718	297	58.55
C 02	0.77	0.8775	298	58.97
C 03	0.76	0.8718	298	58.59
C 04	0.61	0.7810	297	52.45
D 01	0.80	0.8944	298	60.11
D 02	0.78	0.8832	299	59.39
D 03	0.79	0.8888	299	59.77
D 04	0.63	0.7937	299	53.38

Method 2 Results	
Average ΔP	0.7181
Average Sqrt ΔP	0.8460
Average Velocity Vs (ft/sec)	56.831
No WAF Applied to this Test	
Q - ACFM	2,768,157
Qsd - DSCFM	1,704,483
Qs - SCFM	1,923,795
Qs - SCFH	115,427,720

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 1/Pre 2
Plant:	Louisa Generating Station	**Date:**	2/8/2006
Source:	Unit 1 Stack	**Start Time:**	12:44
Pitot ID:	789A	**End Time:**	12:59
Pitot Coefficient:	0.840	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.92
P_g - Stack Pressure, inches of H_2O	-1.10
P_s - Absolute stack pressure, inches Hg	29.84
t_s - Average stack temperature, °F	296.6
% CO_2	13.1
% O_2	6.7
% N_2	80.2
Md - dry basis lb/lb mole	30.36
Ms - wet basis lb/lb mole	28.95
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	237.925
Final Meter Volume:	242.170
Meter Temperature:	90.23
Meter Volume Vm(std):	4.093
Meter Volume Vw(std):	0.528
Delta H:	2.50
Train Initial Wt:	826.600
Train Final Wt:	837.800
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.114**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.80	0.8944	297	60.12
A 02	0.71	0.8426	297	56.64
A 03	0.73	0.8544	297	57.43
A 04	0.51	0.7141	297	48.00
B 01	0.79	0.8888	297	59.75
B 02	0.71	0.8426	297	56.64
B 03	0.69	0.8307	296	55.80
B 04	0.55	0.7416	296	49.82

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.77	0.8775	297	58.98
C 02	0.72	0.8485	297	57.04
C 03	0.71	0.8426	296	56.60
C 04	0.58	0.7616	296	51.16
D 01	0.72	0.8485	298	57.07
D 02	0.67	0.8185	298	55.06
D 03	0.65	0.8062	295	54.12
D 04	0.58	0.7616	295	51.12

Method 2 Results	
Average ΔP	0.6806
Average Sqrt ΔP	0.8234
Average Velocity Vs (ft/sec)	55.322
No WAF Applied to this Test	
Q - ACFM	2,694,652
Qsd - DSCFM	1,661,552
Qs - SCFM	1,875,341
Qs - SCFH	112,520,462

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 2/Pre 3
Plant:	Louisa Generating Station	**Date:**	2/8/2006
Source:	Unit 1 Stack	**Start Time:**	14:24
Pitot ID:	789A	**End Time:**	14:35
Pitot Coefficient:	0.84	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.92
P_g - Stack Pressure, inches of H_2O	-1.10
P_s - Absolute stack pressure, inches Hg	29.84
t_s - Average stack temperature, °F	298.3
% CO_2	13.5
% O_2	6.5
% N_2	80.0
Md - dry basis lb/lb mole	30.42
Ms - wet basis lb/lb mole	29.19
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	242.192
Final Meter Volume:	246.439
Meter Temperature:	96.77
Meter Volume Vm(std):	4.046
Meter Volume Vw(std):	0.443
Delta H:	2.50
Train Initial Wt:	670.500
Train Final Wt:	679.900
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.099**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.77	0.8775	298	58.78
A 02	0.75	0.8660	298	58.02
A 03	0.71	0.8426	298	56.45
A 04	0.56	0.7483	297	50.10
B 01	0.79	0.8888	298	59.54
B 02	0.78	0.8832	298	59.16
B 03	0.70	0.8367	299	56.09
B 04	0.60	0.7746	298	51.89

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.78	0.8832	299	59.20
C 02	0.77	0.8775	299	58.82
C 03	0.71	0.8426	299	56.48
C 04	0.59	0.7681	298	51.46
D 01	0.74	0.8602	298	57.63
D 02	0.70	0.8367	299	56.09
D 03	0.72	0.8485	299	56.88
D 04	0.59	0.7681	298	51.46

Method 2 Results	
Average ΔP	0.7038
Average Sqrt ΔP	0.8377
Average Velocity Vs (ft/sec)	56.115
No WAF Applied to this Test	
Q - ACFM	2,733,286
Qsd - DSCFM	1,710,094
Qs - SCFM	1,897,995
Qs - SCFH	113,879,726

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 3
Plant:	Louisa Generating Station	**Date:**	2/8/2006
Source:	Unit 1 Stack	**Start Time:**	15:45
Pitot ID:	789A	**End Time:**	15:58
Pitot Coefficient:	0.84	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.92
P_g - Stack Pressure, inches of H_2O	-1.10
P_s - Absolute stack pressure, inches Hg	29.84
t_s - Average stack temperature, °F	296.1
% CO_2	13.3
% O_2	6.8
% N_2	79.9
Md - dry basis lb/lb mole	30.40
Ms - wet basis lb/lb mole	29.02
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	246.626
Final Meter Volume:	250.873
Meter Temperature:	105.54
Meter Volume Vm(std):	3.984
Meter Volume Vw(std):	0.495
Delta H:	2.50
Train Initial Wt:	714.000
Train Final Wt:	724.500
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.111**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)	Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.70	0.8367	297	56.17	**C 01**	0.72	0.8485	297	56.97
A 02	0.69	0.8307	297	55.77	**C 02**	0.72	0.8485	296	56.93
A 03	0.63	0.7937	296	53.25	**C 03**	0.71	0.8426	296	56.53
A 04	0.52	0.7211	296	48.38	**C 04**	0.60	0.7746	295	51.94
B 01	0.71	0.8426	297	56.57	**D 01**	0.69	0.8307	296	55.73
B 02	0.72	0.8485	296	56.93	**D 02**	0.70	0.8367	296	56.14
B 03	0.74	0.8602	296	57.72	**D 03**	0.69	0.8307	296	55.73
B 04	0.57	0.7550	296	50.66	**D 04**	0.63	0.7937	295	53.22

Method 2 Results	
Average ΔP	0.6713
Average Sqrt ΔP	0.8184
Average Velocity Vs (ft/sec)	54.903
No WAF Applied to this Test	
Q - ACFM	2,674,237
Qsd - DSCFM	1,655,642
Qs - SCFM	1,862,364
Qs - SCFH	111,741,838

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Pre 1
Plant:	Louisa Generating Station	**Date:**	2/9/2006
Source:	Unit 1 Stack	**Start Time:**	11:46
Pitot ID:	789A	**End Time:**	12:05
Pitot Coefficient:	0.840	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.96
P_g - Stack Pressure, inches of H_2O	-1.00
P_s - Absolute stack pressure, inches Hg	29.89
t_s - Average stack temperature, °F	304.1
% CO_2	13.9
% O_2	5.6
% N_2	80.5
Md - dry basis lb/lb mole	30.45
Ms - wet basis lb/lb mole	29.07
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	251.697
Final Meter Volume:	255.943
Meter Temperature:	78.46
Meter Volume Vm(std):	4.189
Meter Volume Vw(std):	0.523
Delta H:	2.50
Train Initial Wt:	698.900
Train Final Wt:	710.000
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.111**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.84	0.9165	304	61.72
A 02	0.86	0.9274	304	62.45
A 03	0.78	0.8832	304	59.48
A 04	0.65	0.8062	303	54.26
B 01	0.84	0.9165	304	61.72
B 02	0.83	0.9110	304	61.35
B 03	0.80	0.8944	304	60.24
B 04	0.66	0.8124	304	54.71

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.84	0.9165	304	61.72
C 02	0.83	0.9110	305	61.39
C 03	0.76	0.8718	304	58.71
C 04	0.63	0.7937	303	53.42
D 01	0.86	0.9274	304	62.45
D 02	0.87	0.9327	305	62.86
D 03	0.83	0.9110	305	61.39
D 04	0.69	0.8307	305	55.98

Method 2 Results	
Average ΔP	0.7856
Average Sqrt ΔP	0.8852
Average Velocity Vs (ft/sec)	59.604
No WAF Applied to this Test	
Q - ACFM	2,903,188
Qsd - DSCFM	1,781,392
Qs - SCFM	2,003,816
Qs - SCFH	120,228,938

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 1/Pre 2
Plant:	Louisa Generating Station	**Date:**	2/9/2006
Source:	Unit 1 Stack	**Start Time:**	12:38
Pitot ID:	789A	**End Time:**	13:55
Pitot Coefficient:	0.840	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.96
P_g - Stack Pressure, inches of H_2O	-1.00
P_s - Absolute stack pressure, inches Hg	29.89
t_s - Average stack temperature, °F	303.6
% CO_2	13.4
% O_2	6.2
% N_2	80.4
Md - dry basis lb/lb mole	30.39
Ms - wet basis lb/lb mole	29.02
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	251.697
Final Meter Volume:	255.943
Meter Temperature:	78.46
Meter Volume Vm(std):	4.189
Meter Volume Vw(std):	0.523
Delta H:	2.50
Train Initial Wt:	698.900
Train Final Wt:	710.000
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.111**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.81	0.9000	306	60.74
A 02	0.79	0.8888	306	59.99
A 03	0.74	0.8602	305	58.02
A 04	0.57	0.7550	304	50.89
B 01	0.75	0.8660	304	58.37
B 02	0.73	0.8544	303	57.55
B 03	0.70	0.8367	303	56.36
B 04	0.59	0.7681	303	51.74

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.78	0.8832	303	59.49
C 02	0.75	0.8660	304	58.37
C 03	0.72	0.8485	303	57.16
C 04	0.60	0.7746	303	52.18
D 01	0.75	0.8660	303	58.33
D 02	0.75	0.8660	303	58.33
D 03	0.69	0.8307	302	55.92
D 04	0.61	0.7810	302	52.57

Method 2 Results	
Average ΔP	0.7081
Average Sqrt ΔP	0.8403
Average Velocity Vs (ft/sec)	56.613
No WAF Applied to this Test	
Q - ACFM	2,757,509
Qsd - DSCFM	1,693,250
Qs - SCFM	1,904,668
Qs - SCFH	114,280,077

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 2/Pre 3
Plant:	Louisa Generating Station	**Date:**	2/9/2006
Source:	Unit 1 Stack	**Start Time:**	15:20
Pitot ID:	789A	**End Time:**	15:35
Pitot Coefficient:	0.84	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.96
P_g - Stack Pressure, inches of H_2O	-1.00
P_s - Absolute stack pressure, inches Hg	29.89
t_s - Average stack temperature, °F	299.8
% CO_2	14.1
% O_2	5.7
% N_2	80.2
Md - dry basis lb/lb mole	30.48
Ms - wet basis lb/lb mole	28.95
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	256.113
Final Meter Volume:	260.358
Meter Temperature:	74.62
Meter Volume Vm(std):	4.218
Meter Volume Vw(std):	0.594
Delta H:	2.50
Train Initial Wt:	698.900
Train Final Wt:	711.500
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.123**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.84	0.9165	299	61.65
A 02	0.80	0.8944	299	60.16
A 03	0.77	0.8775	299	59.02
A 04	0.61	0.7810	298	52.50
B 01	0.81	0.9000	300	60.58
B 02	0.80	0.8944	300	60.20
B 03	0.78	0.8832	300	59.44
B 04	0.66	0.8124	299	54.64

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.80	0.8944	301	60.24
C 02	0.81	0.9000	300	60.58
C 03	0.77	0.8775	301	59.10
C 04	0.65	0.8062	299	54.23
D 01	0.84	0.9165	301	61.73
D 02	0.79	0.8888	301	59.86
D 03	0.76	0.8718	300	58.68
D 04	0.65	0.8062	299	54.23

Method 2 Results	
Average ΔP	0.7588
Average Sqrt ΔP	0.8701
Average Velocity Vs (ft/sec)	58.538
No WAF Applied to this Test	
Q - ACFM	2,851,267
Qsd - DSCFM	1,735,856
Qs - SCFM	1,979,311
Qs - SCFH	118,758,668

METHOD 2 VOLUMETRIC FLOW DATA

Project No:	M22E1180	**Source Condition:**	Normal
Company:	MidAmerican	**Run No.:**	Post 3
Plant:	Louisa Generating Station	**Date:**	2/9/2006
Source:	Unit 1 Stack	**Start Time:**	16:32
Pitot ID:	789A	**End Time:**	16:51
Pitot Coefficient:	0.84	**RM Testers:**	CFM/MJK

Test Parameters	
P_{bar} - Barometric pressure, inches Hg	29.96
P_g - Stack Pressure, inches of H_2O	-1.00
P_s - Absolute stack pressure, inches Hg	29.89
t_s - Average stack temperature, °F	303.1
% CO_2	14.0
% O_2	5.6
% N_2	80.4
Md - dry basis lb/lb mole	30.46
Ms - wet basis lb/lb mole	29.24
Stack Diameter, Feet	32.15
Cross Sectional Area of Stack, Ft^2	811.81

Moisture Determination	
Meter Calibration:	0.998
Initial Meter Volume:	260.462
Final Meter Volume:	264.706
Meter Temperature:	81.23
Meter Volume Vm(std):	4.166
Meter Volume Vw(std):	0.453
Delta H:	2.50
Train Initial Wt:	715.600
Train Final Wt:	725.200
Condensate Initial Vol:	0.000
Condensate Final Vol:	0.000
Bws - Moisture content fraction	**0.098**

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
A 01	0.83	0.9110	303	61.13
A 02	0.82	0.9055	303	60.76
A 03	0.82	0.9055	303	60.76
A 04	0.67	0.8185	302	54.89
B 01	0.86	0.9274	303	62.22
B 02	0.85	0.9220	304	61.90
B 03	0.80	0.8944	304	60.05
B 04	0.69	0.8307	303	55.74

Port Point	ΔP (in. H_2O)	Sqrt. ΔP	Temp (°F)	Velocity (V)
C 01	0.84	0.9165	305	61.58
C 02	0.82	0.9055	304	60.80
C 03	0.79	0.8888	304	59.68
C 04	0.64	0.8000	303	53.68
D 01	0.82	0.9055	303	60.76
D 02	0.80	0.8944	303	60.01
D 03	0.82	0.9055	302	60.72
D 04	0.68	0.8246	301	55.26

Method 2 Results	
Average ΔP	0.7844
Average Sqrt ΔP	0.8848
Average Velocity Vs (ft/sec)	59.358
No WAF Applied to this Test	
Q - ACFM	2,891,207
Qsd - DSCFM	1,802,341
Qs - SCFM	1,998,161
Qs - SCFH	119,889,674

CALIBRATION PROCEDURES

PITOT TUBES

The pitot tubes used during this test program are fabricated according to the specification described and illustrated in the *Code of Federal Regulations*, Title 40, Part 60, Appendix A, Methods 1 through 5 as published in the *Federal Register*, Volume 42, No. 160; hereafter referred to by the appropriate method number. The pitot tubes comply with the alignment specifications in Method 2, Section 4; and the pitot tube assemblies are in compliance with specifications in the same section.

Pitot tube assemblies are calibrated in accordance with Method 2, Section 4, against a standard hemispherical pitot utilizing a wind tunnel meeting the specification in Method 2, Section 4.1.2.

TEMPERATURE SENSING DEVICES

The potentiometer and thermocouples are calibrated against a mercury thermometer in a calibration well. Alternatively, readings are checked utilizing a NBS traceable millivolt source.

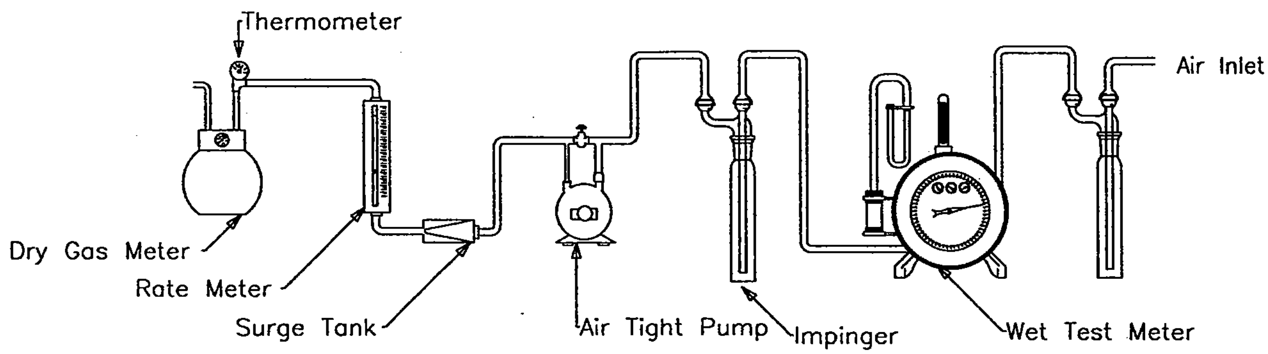
DRY GAS METERS

The test meters are calibrated according to Method 5, Section 5.3 and "Procedures for Calibrating and Using Dry Gas Volume Meters as Calibration Standards" by P.R. Westlin and R.T. Shigehara, March 10, 1978.

ANALYTICAL BALANCE

The accuracy of the analytical balance is checked with Class S, Stainless Steel Type 303 weights manufactured by F. Hopken and Son, Jersey City, New Jersey.

Gas Meter Calibration Train



Dwg - AF

METER BOX CALIBRATION

Dry Gas Meter No.	N3	Date:	01-11-06
Standard Meter No.	2547157	Calibrated By:	PSH
Standard Meter (Yr)	1.0051	Barometric Pressure :	29.19

Formula Protection Password: MPA

Run Number		Orifice Setting in H20 Chg (H)	Standard Meter Gas Volume Vr	Dry Meter Gas Volume Vd	Standard Meter Temp. F tr	Dry Gas Meter Inlet Temp. F tdi	Dry Gas Meter Outlet Temp. F tdo	Dry Gas Meter Avg. Temp. F td	Time Min.	Time Sec.	Y	Chg (H@)
Final			41.726	45.431	66	85	79					
Inital			36.710	40.300	66	84	79					
Difference	1	0.20	5.016	5.131	66	85	79	82	18	15	1.006	1.467
Final			46.927	50.785	66	85	79					
Inital			41.905	45.618	66	85	79					
Difference	2	0.50	5.022	5.167	66	85	79	82	11	45	1.000	1.516
Final			31.207	34.638	66	82	79					
Inital			26.134	29.418	66	80	79					
Difference	3	0.70	5.073	5.220	66	81	79	80	10	3	0.996	1.528
Final			53.038	57.078	66	86	80					
Inital			47.210	51.060	66	85	79					
Difference	4	0.90	5.828	6.018	66	86	80	83	10	17	0.997	1.551
Final			58.427	62.670	66	86	80					
Inital			53.212	57.265	66	85	80					
Difference	5	1.20	5.215	5.405	66	86	80	83	8	4	0.993	1.588
Final			36.623	40.209	66	84	79					
Inital			31.417	34.850	66	82	79					
Difference	6	2.00	5.206	5.359	66	83	79	81	6	20	0.994	1.643
									Average		0.998	1.549

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

EPA Control Module Number: N3 Name: PSH

Ambient Temperature: 61 °F Date: 02-13-06

Omega Engineering Calibrator Model No. CL23A Serial # T-124947

Date Of Calibration Verification: May 11, 2005

Primary Standards Directly Traceable to National Institute of Standards and Technology (NIST)

Reference[a] Source Temperature, (°F)	**Test Thermometer Temperature, (°F)**	**Temperature Difference, %**
0	-1	0.2
600	600	0.0
1200	1200	0.0

$$\frac{(\text{Ref. Temp., °F} + 460) - (\text{Test Therm. Temp., °F} + 460)}{\text{Ref. Temp., °F} + 460} * 100 <= 1.5\ \%$$

METER BOX CALIBRATION

Dry Gas Meter No.	HCL3	Date:	01-11-06
Standard Meter No.	3470249	Calibrated By:	PSH
Standard Meter (Yr)	1.0053	Barometric Pressure :	29.19

Run Number		Orifice Setting in H20 Chg (H)	Standard Meter Gas Volume Vr	Dry Meter Gas Volume Vd	Standard Meter Temp. F tr	Dry Gas Meter Inlet Temp. F tdi	Dry Gas Meter Outlet Temp. F tdo	Dry Gas Meter Avg. Temp. F td	Time Min.	Time Sec.	Y
Final			54.302	144.47	68	72	72				
Inital			52.800	101.81	68	70	70				
Difference	1	1.80	1.502	1.51	68	71	71	71	20	0	0.999
Final			55.807	186.83	69	74	74				
Inital			54.302	144.47	69	72	72				
Difference	2	1.80	1.505	1.50	69	73	73	73	20	0	1.010
Final			57.317	229.30	69	76	76				
Inital			55.807	186.83	69	74	74				
Difference	3	1.80	1.510	1.50	69	75	75	75	20	0	1.014

Average 1.007

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

EPA Control Module Number: HCL3 Name: PSH

Ambient Temperature: 68 °F Date: 01-11-06

Omega Engineering Calibrator Model No. CL23A Serial # T-124947

Date Of Calibration Verification: May 11, 2005

Primary Standards Directly Traceable to National Institute of Standards and Technology (NIST)

Reference Source Temperature, (°F)	Test Thermometer Temperature, (°F)	Temperature Difference, %
0	-1	0.2
600	599	0.1
1200	1200	0.0

$$\frac{(\text{Ref. Temp., °F} + 460) - (\text{Test Therm. Temp., °F} + 460)}{\text{Ref. Temp., °F} + 460} * 100 <= 1.5\ \%$$

METER BOX CALIBRATION

Dry Gas Meter No.	HCL3	Date:	02-17-06
Standard Meter No.	2962156	Calibrated By:	PSH
Standard Meter (Yr)	1.0036	Barometric Pressure :	29.89

Run Number		Orifice Setting in H20 Chg (H)	Standard Meter Gas Volume Vr	Dry Meter Gas Volume Vd	Standard Meter Temp. F tr	Dry Gas Meter Inlet Temp. F tdi	Dry Gas Meter Outlet Temp. F tdo	Dry Gas Meter Avg. Temp. F td	Time Min.	Time Sec.	Y
Final			96.081	876.05	68	73	73				
Inital			94.610	834.50	68	68	68				
Difference	1	1.80	1.471	1.47	68	71	71	71	20	0	1.003
Final			97.544	917.39	69	76	76				
Inital			96.081	876.05	68	73	73				
Difference	2	1.80	1.463	1.46	69	75	75	75	20	0	1.009
Final			98.986	958.62	69	80	80				
Inital			97.544	917.39	69	76	76				
Difference	3	1.80	1.442	1.46	69	78	78	78	20	0	1.003
									Average		1.005

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

EPA Control Module Number: HCL3 Name: PSH

Ambient Temperature: 68 °F Date: 01-11-06

Omega Engineering Calibrator Model No. CL23A Serial # T-124947

Date Of Calibration Verification: May 11, 2005

Primary Standards Directly Traceable to National Institute of Standards and Technology (NIST)

Reference[a] Source Temperature, (°F)	Test Thermometer Temperature, (°F)	Temperature Difference, %
0	-1	0.2
600	599	0.1
1200	1200	0.0

$$\frac{(\text{Ref. Temp., °F} + 460) - (\text{Test Therm. Temp., °F} + 460)}{\text{Ref. Temp., °F} + 460} * 100 <= 1.5\ \%$$

METER BOX CALIBRATION

Dry Gas Meter No.	HCL3	Date:	02-17-06
Standard Meter No.	2962156	Calibrated By:	PSH
Standard Meter (Yr)	1.0036	Barometric Pressure :	29.89

Run Number		Orifice Setting in H20 Chg (H)	Standard Meter Gas Volume Vr	Dry Meter Gas Volume Vd	Standard Meter Temp. F tr	Dry Gas Meter Inlet Temp. F tdi	Dry Gas Meter Outlet Temp. F tdo	Dry Gas Meter Avg. Temp. F td	Time Min.	Time Sec.	Y
Final			96.081	876.05	68	73	73				
Inital			94.610	834.50	68	68	68				
Difference	1	1.80	1.471	1.47	68	71	71	71	20	0	1.003
Final			97.544	917.39	69	76	76				
Inital			96.081	876.05	68	73	73				
Difference	2	1.80	1.463	1.46	69	75	75	75	20	0	1.009
Final			98.986	958.62	69	80	80				
Inital			97.544	917.39	69	76	76				
Difference	3	1.80	1.442	1.46	69	78	78	78	20	0	1.003

Average 1.005

GE Energy

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

EPA Control Module Number: HCL3 Name: PSH

Ambient Temperature: 68 °F Date: 02-17-06

Omega Engineering Calibrator Model No. CL23A Serial # T-124947

Date Of Calibration Verification: May 11, 2005

Primary Standards Directly Traceable to National Institute of Standards and Technology (NIST)

Reference[a] Source Temperature, (°F)	Test Thermometer Temperature, (°F)	Temperature Difference, %
0	0	0.0
600	600	0.0
1200	1200	0.0

$$\frac{(\text{Ref. Temp., °F} + 460) - (\text{Test Therm. Temp., °F} + 460)}{\text{Ref. Temp., °F} + 460} * 100 <= 1.5\ \%$$

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN POWER)

Location: UNIT 1 STACK

Date: 2/8/06 Test No: PRE #1 Time: 1045-1105

NLY 3 PORTS SSIBLE

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1-1	.75		299						
2	.70		298						
3	.69		297						
4	.52		296						
2-1	.76		298						
2	.78		298						
3	.78		296						
4	.61		296						
2-1	.76		297						
2	.77		298						
3	.76		298						
4	.61		297						
3-1	.80		298						
2	.78		299						
3	.79		299						
4	.63		299						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.12 "Hg Static -1.1 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID N3

0.44 × 13.5 %CO_2 = ____ √ΔP ____ t_s ____ °F T ____ °R Flue Area 811.81 ft^2

0.32 × 6.5 %O_2 = + ____ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ____ B_{ws} .115 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ ft/sec(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = 3,292,980 acfm Port Length 18 Inches

$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R}$ = 2,288,534 SCFM

$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws)$ = 2,025,352 DSCFM

Pre-test leak check 0.0 "H_2O 4 3"

Post-test leak check 0.0 "H_2O 3"

SCFH 137,312,030

Data Taken By: CFM/MJK

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN POWER)

Location: UNIT 1 STACK

Date: 2/8/06 Test No: POST 1/PRE 2 Time: 1244 - 1259

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1 - 1	.80		297						
2	.71		297						
3	.73		297						
4	.51		297						
2 - 1	.79		298						
2	.71		297						
3	.69		296						
4	.55		296						
2 - 1	.77		297						
2	.72		297						
3	.71		296						
4	.58		296						
3 - 1	.72		298						
2	.67		298						
3	.65		295						
4	.58		295						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.92 "Hg Static -1.1 "H_2O P_g ______ "Hg P_s ______ "Hg Pitot ID 789A C_p .840 Temp. ID NJ

0.44 × 13.1 %CO_2 = ______ √ΔP ______ t_s ______ °F T ______ °R Flue Area 811.81 ft^2

0.32 × 6.7 %O_2 = + ______ Duct Dimensions 32.151' diameter

0.28 × ______ %N_2 = + ______ B_{ws} .115 1 - B_{ws} ______ Disturbance: Upstream ______

(______ Md × ______ 1-Bws) + (18 × ______ Bws) = ______ (Ms) Downstream ______

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ ft/sec(Vs)$$

Q_{acfm} = ______ Vs × ______ Flue Area × 60 = 3,208,343 acfm Port Length 18 Inches

$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R}$ = 2,232,844 SCFM

$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws)$ = 1,976,067 DSCFM

Pre-test leak check 0.0 "H_2O @ 3"

SCFH 133,970,630

Post-test leak check 0.0 "H_2O @ 3" Data Taken By: CFM/MJK

PITOT TRAVERSE DATA

Project: ADA-ES/MIDAMERICAN POWER

Location: UNIT 1 STACK

Date: 2/8/06 Test No: POST 2/PRE3 Time: 1424-1438

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1-1	.77		298						
2	.75		298						
3	.71		298						
4	.56		297						
2-1	.79		298						
2	.78		298						
3	.70		299						
4	.60		298						
2-1	.78		299						
2	.77		299						
3	.71		299						
4	.59		298						
3-1	.74		298						
2	.70		299						
3	.72		299						
4	.59		298						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.92 "Hg Static -1.1 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID N3

0.44 × 13.5 %CO_2 = ______ √ΔP ______ t_s ____ °F T ____ °R Flue Area 811.81 ft^2

0.32 × 6.5 %O_2 = + ______ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ______ B_{ws} .097 1 - B_{ws} ____ Disturbance: Upstream ______

(______ Md × ______ 1-Bws) + (18 × ______ Bws) = ______ (Ms) Downstream ______

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ ft/sec(Vs)$$

Q_{acfm} = ______ Vs × ______ Flue Area × 60 = 3,257,892 acfm Port Length 18 Inches

$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R}$ = 2,262,282 SCFM

$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws)$ = 2,042,841 DSCFM

Pre-test leak check 0.0 "H_2O @ 3" SCFH 135,736,948

Post-test leak check 0.0 "H_2O @ 3" Data Taken By: CFM/MJK

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN POWER)

Location: UNIT 1 STACK

Date: 2/8/06 Test No: POST 3 Time: 1545-1558

Point No.	ΔP	$\sqrt{\Delta P}$	t_s	α	Point No.	ΔP	$\sqrt{\Delta P}$	t_s	α
1-1	.70		297						
2	.69		297						
3	.63		296						
4	.52		296						
2-1	.71		297						
2	.72		296						
3	.74		296						
4	.57		296						
2-1	.72		297						
2	.72		296						
3	.71		296						
4	.60		295						
3-1	.69		296						
2	.70		296						
3	.69		296						
4	.63		295						

Y= 0.998
ΔH= 1.549

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.92 "Hg Static -1.1 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID N3

0.44 × 13.3 %CO_2 = ____ $\sqrt{\Delta P}$ ____ t_s ____ °F T ____ °R Flue Area 811.81 ft^2

0.32 × 6.8 %O_2 = + ____ Duct Dimensions 32.151' diamete

0.28 × ____ %N_2 = + ____ B_{ws} .111 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ \text{ ft/sec}(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = 3,181,998 acfm Port Length 18 Inches

$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R}$ = 2,215,974 SCFM

$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws)$ = 1,970,001 DSCFM

Pre-test leak check 0.0 "H_2O @ 3"

Post-test leak check 0.0 "H_2O @ 3"

SCFH 132,958,442

Data Taken By: CFM/MJK

NORMAL - COND 1

METHOD 26 FIELD DATA SHEET

Project: ADA-ES (MIDAMERICAN POWER) Date: 2/8/06
Sampling Location: UNIT 1 STACK
Source Condition: COND 1. Monitor: Model HCL-3
Dry Gas Meter No. HCL-3 Y = 1.007 Serial No. HCL-3

Test (Run) No. 1 Barometric Pressure (P_{bar}) ______ in. Hg
Gas Temperature ______ °F Static Pressure ______ in. Hg
Orsat Analysis %CO_2 %O_2

IMPS 1-3 38 mL
IMPS 4-5 30 mL

	Clock Time 24 hour	Meter Volume (V_m) ~~ft³~~ L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
.81 ft³	1125	6737.29	2 L/MIN	82	≤ 68°F
	1130	6747.31		83	FULLY
	1135	6757.32		85	ICED
	1140	6767.34		85	
	1145	6777.35		86	
	1150	6787.37		88	
	1155	6797.40		90	
	1200	6807.42		93	
	1205	6817.45		95	
	1210	6827.46		97	
	1215	6837.49		97	
	1220	6847.50		96	
7.01 ft³	1225	6857.49		96	
	Avg.	120.20		90.23	(T_m) °R

Impingers / Silica Gel or Train

1–Knockout 837.8 grams (W_f)
2–0.1N H_2SO_4/5mL - 826.6 grams (W_i)
3– " /15mL 11.2 grams
× 0.04715 =
4–0.1N NaOH/5mL
5– " /15mL ______ ft³[V_w (std)]
6–Silica 109.5/110.9
$V_{m(std)}$ = ______ ft³

Leak Check: 0.0 @ 10" 0.0 @ 10"

Water Vapor, proportion by volume" B_{ws} = 0.115 / 9.8 w/mL
Moisture Correction factor: $1 - B_{ws}$ = ______

Comments: Sampling rate = 2 liters/min or 0.07 cu.ft./min
60 min. test = 4.2 cu.ft.

261.1
+ 565.5
826.6

262.7
+ 575.1
837.8

Test (Run) No. 2 Barometric Pressure (P_{bar}) ______ in. Hg
Gas Temperature ______ °F Static Pressure ______ in. Hg
Orsat Analysis %CO_2 %O_2

IMP 1-2 42 mL
IMPS 2-4 28 mL

	Clock Time 24 hour	Meter Volume (V_m) ~~ft³~~ L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
7.03 ft³	1315	6858.12	2 L/MIN	96	≤ 68°F
	1320	6868.15		95	FULLY
	1325	6878.18		95	ICED
	1330	6888.21		95	
	1335	6898.24		94	
	1340	6908.27		93	
	1345	6918.26		93	
	1350	6928.28		95	
	1355	6938.30		97	
	1400	6948.31		98	
	1405	6958.34		100	
	1410	6968.32		103	
7.24 ft³	1415	6978.37		104	
	Avg.	120.25		96.77	(T_m) °R

Glass Sample Containers / Silica Gel or Train

No. 1–impingers 1,2+3 679.7 grams (W_f)
No. 2–impingers 4+5 - 670.5 grams (W_i)
9.2 grams
* unless discussed prior to testing, other modes of recovery × 0.04715 =
______ ft³[V_w (std)]
$V_{m(std)}$ = ______ ft³

Leak Check: 0.0 @ 10" 0.0 @ 10"

Water Vapor, proportion by volume" B_{ws} = 0.097
Moisture Correction factor: $1 - B_{ws}$ = ______

Comments: If using ¼" Teflon as probe, rinse with D.I. into containers No. 1.*

249.7
420.8
+
670.5

SILICA
105.7/107.0

242.2
437.5
679.7

$$V_{m(std)} = 17.647\, V_m\, Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \qquad B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

Operator: CFM/MJK

137,151,923 w/9.8%
137,212,030 w/11.5%

Form 1000 GE Energy

METHOD 26 FIELD DATA SHEET

Project: ADA-ES (MIDAMERICAN POWER) Date: 2/8/06
Sampling Location: UNIT 1 STACK
Source Condition: COND 1 Monitor: Model HCL-3
Dry Gas Meter No. HCL-3 Y = 1.007 Serial No. HCL-3

Test (Run) No. 3 Barometric Pressure (P_{bar}) ______ in. Hg
Gas Temperature °F Static Pressure in. Hg
Orsat Analysis %CO_2 %O_2

IMPS 1-2 34 mL
IMPS 3-4 36

Clock Time 24 hour	Meter Volume (V_m) ~~ft³~~ L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
1445	6983.68	2 L/MIN	100	≤ 68°F
1450	6993.70		99	FULLY
1455	7003.72		99	ICED
1500	7013.74		99	
1505	7023.77		101	
1510	7033.80		103	
1515	7043.81		104	
1520	7053.83		106	
1525	7063.86		109	
1530	7073.89		112	
1535	7083.90		113	
1540	7093.92		114	
1545	7103.94		113	
Avg.	120.26		105.54	(T_m) °R

44.43 ft³
78.64 ft³

Impingers
1–Knockout
2–0.1N H_2SO_4
3– "
4–0.1N NaOH
5– "
6–Silica

Silica Gel or Train
724.5 grams (W_f)
- 714.0 grams (W_i)
10.5 grams
× 0.04715 =
______ ft³[V_w (std)]

$V_{m(std)}$ = ______ ft³

Leak Check: 0.0 @ 10" 0.0 @ 10"

Water Vapor, proportion by volume"
B_{ws} = 0.111
Moisture Correction factor:
1 - B_{ws} = ______

456
+ 258
714

464.5
+ 260.0
724.5

Comments: Sampling rate = 2 liters/min or 0.07 cu.ft./min
60 min. test = 4.2 cu.ft.

Test (Run) No. ______ Barometric Pressure (P_{bar}) ______ in. Hg
Gas Temperature °F Static Pressure in. Hg
Orsat Analysis %CO_2 %O_2

Clock Time 24 hour	Meter Volume (V_m) ~~ft³~~ L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
Avg.				(T_m) °R

Glass Sample Containers
No. 1–impingers 1,2+3
No. 2–impingers 4+5
* unless discussed prior to testing, other modes of recovery

Silica Gel or Train
______ grams (W_f)
- ______ grams (W_i)
______ grams
× 0.04715 =
______ ft³[V_w (std)]

$V_{m(std)}$ = ______ ft³

Leak Check:

Water Vapor, proportion by volume"
B_{ws} = ______
Moisture Correction factor:
1 - B_{ws} = ______

Comments: If using ¼" Teflon as probe, rinse with D.I. into containers No. 1. *

$$V_{m(std)} = 17.647\, V_m\, Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \qquad B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

Operator: CFM/MJK

Form 1000 GE Energy

PITOT TRAVERSE DATA

Project: HDA-ES (MIDAMERICAN ENERGY)

Location: UNIT 1 STACK

Date: 2/9/06 Test No: PRE 1 Time: 11:46-1205

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1-1	.84		304						
2	.86		304						
3	.78		304						
4	.65		303						
2-1	.84		304						
2	.83		304						
3	.80		304						
4	.66		304						
2-1	.84		304						
2	.83		305						
3	.76		304						
4	.63		303						
3-1	.86		304						
2	.87		305						
3	.83		305						
4	.69		305						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.96 "Hg Static -1.0 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID U3

0.44 × 13.9 %CO_2 = ____ √ΔP ____ t_s ____ °F T ____ °R Flue Area ____ ft^2

0.32 × 5.6 %O_2 = + ____ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ____ B_{ws} ____ 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ \text{ ft/sec}(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = ____ acfm Port Length 18 Inches

$$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} = \_\_\_\_ \text{ SCFM}$$

$$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws) = \_\_\_\_ \text{ DSCFM}$$

Pre-test leak check 0.0 "H_2O @ 3"

Post-test leak check 0.0 "H_2O @ 3"

Data Taken By: CFM/MJK

Form 1012

GE Energy

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN ENERGY)

Location: UNIT 1 STACK

Date: 2/9/06 Test No: POST 1/PRE 2 Time: 1238-1355

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1-1	.81		306						
2	.79		306						
3	.74		305						
4	.57		304						
2-1	.75		304						
2	.73		303						
3	.70		303						
4	.59		303						
2-1	.78		303						
2	.75		304						
3	.72		303						
4	.60		303						
3-1	.75		303						
2	.75		303						
3	.69		302						
4	.61		302						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.96 "Hg Static -1.0 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID N3

0.44 × 13.4 %CO_2 = ____ √ΔP ____ t_s ____ °F T ____ °R Flue Area ____ ft^2

0.32 × 6.2 %O_2 = + ____ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ____ B_{ws} ____ 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ \text{ft/sec}(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = ____ acfm Port Length 18 Inches

$$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} = \_\_\_\_ \text{ SCFM}$$

$$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws) = \_\_\_\_ \text{ DSCFM}$$

Pre-test leak check 0.0 "H_2O @ 3"

Post-test leak check 0.0 "H_2O @ 3" Data Taken By: CFM/MJK

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN ENERGY)

Location: UNIT 1 STACK

Date: 2/9/06 Test No: ~~POST 2~~/ PRE 3 Time: 1520-1535

Point No.	ΔP	√ΔP	t_s	α	Point No.	ΔP	√ΔP	t_s	α
1-1	.84		299						
2	.80		299						
3	.77		299						
4	.61		298						
2-1	.81		300						
2	.80		300						
3	.78		300						
4	.66		299						
2-1	.80		301						
2	.81		300						
3	.77		301						
4	.65		299						
3-1	.84		301						
2	.79		301						
3	.76		300						
4	.65		299						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.96 "Hg Static -1.0 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789A C_p .840 Temp. ID N3

0.44 × 14.1 %CO_2 = ____ √ΔP ____ t_s ____ °F T ____ °R Flue Area ____ ft^2

0.32 × 5.7 %O_2 = + ____ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ____ B_{ws} ____ 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ ft/sec(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = ____ acfm Port Length 18 Inches

$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R}$ = ____ SCFM

$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws)$ = ____ DSCFM

Pre-test leak check 0.0 "H_2O @ 3"

Post-test leak check 0.0 "H_2O @

Data Taken By: CFM/MJK

PITOT TRAVERSE DATA

Project: ADA-ES (MIDAMERICAN ENERGY)

Location: UNIT 1 STACK

Date: 2/9/06 Test No: POST 3 Time: 1632-1651

Point No.	ΔP	$\sqrt{\Delta P}$	t_s	α	Point No.	ΔP	$\sqrt{\Delta P}$	t_s	α
1-1	.83		303						
2	.82		303						
3	.82		303						
4	.67		302						
2-1	.86		303						
2	.85		304						
3	.80		304						
4	.69		303						
2-1	.84		305						
2	.82		304						
3	.79		304						
4	.64		303						
3-1	.82		303						
2	.80		303						
3	.82		302						
4	.68		301						

Preliminary Velocity Calculation (This data has not been peer reviewed and may not be accurate)

P_{bar} 29.96 "Hg Static -1.0 "H_2O P_g ____ "Hg P_s ____ "Hg Pitot ID 789 A C_p .840 Temp. ID N3

0.44 × 14.0 %CO_2 = ____ $\sqrt{\Delta P}$ ____ t_s ____ °F T ____ °R Flue Area ____ ft^2

0.32 × 5.6 %O_2 = + ____ Duct Dimensions 32.151' diameter

0.28 × ____ %N_2 = + ____ B_{ws} ____ 1 - B_{ws} ____ Disturbance: Upstream ____

(____ Md × ____ 1-Bws) + (18 × ____ Bws) = ____ (Ms) Downstream ____

$$v_s = 85.49 \times \_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_ Ms \times \_\_\_\_ Ps}} \times \_\_\_\_ \sqrt{\Delta P} = \_\_\_\_ ft/sec(Vs)$$

Q_{acfm} = ____ Vs × ____ Flue Area × 60 = ____ acfm Port Length 18 Inches

$$Q_{scfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} = \_\_\_\_ SCFM$$

$$Q_{dscfm} = 17.647 \times ACFM \times \frac{Ps}{Ts\ °R} \times (1\text{-}Bws) = \_\_\_\_ DSCFM$$

Pre-test leak check 0.0 "H_2O @ 3"

Post-test leak check 0.0 "H_2O @ 3" Data Taken By: CFM/MJK

NORMAL - COND 2
KNX INJECTION

METHOD 26 FIELD DATA SHEET

Project: ADA-ES (MIDAMERICAN ENERGY) Date: 2/9/06
Sampling Location: UNIT 1 STACK
Source Condition: COND 2 Monitor: Model #HCL-3
Dry Gas Meter No. #HCL-3 Y = 1.007 Serial No. #HCL-3

Test (Run) No. 1 Barometric Pressure (P_{bar}) ______ in. Hg Orsat Analysis
Gas Temperature °F Static Pressure in. Hg %CO_2 %O_2

	Clock Time 24 hour	Meter Volume (V_m) L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
1.45 ft³ →	1225	7127.26	2 L/MIN	79	≤ 68°F
	1230	7137.29		77	FULLY
	1235	7147.31		77	ICED
	1240	7157.34		77	
	1245	7167.35		76	
	1250	7177.38		76	
	1255	7187.43		77	
	1300	7197.45		77	
	1305	7207.45		78	
	1310	7217.48		80	
	1315	7227.50		81	
	1320	7237.51		82	
13.66 ft³ →	1325	7247.50		83	
	Avg.	120.24		78.46	(T_m) °R

IMPS 1-2 36
IMPS 3-4 28

Impingers / Silica Gel or Train
1–Knockout 710.0 grams (W_f)
2–0.1N H_2SO_4 - 698.9 grams (W_i)
3– " 11.1 grams
× 0.04715 =
4–0.1N NaOH
5– " ______ ft³[V_w (std)]
6–Silica
$V_{m(std)}$ = ______ ft³
Leak Check: 0.00 @ 10" 0.0 @ 10"
Water Vapor, proportion by volume" B_{ws} = ______
Moisture Correction factor: 1 - B_{ws} = ______
Comments: Sampling rate = 2 liters/min or 0.07 cu.ft./min
60 min. test = 4.2 cu.ft.

253.9
+ 445.0
698.9

455
+255
710

Silica
108.6/110.2

Test (Run) No. 2 Barometric Pressure (P_{bar}) ______ in. Hg Orsat Analysis
Gas Temperature °F Static Pressure in. Hg %CO_2 %O_2

	Clock Time 24 hour	Meter Volume (V_m) L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
53.83 ft³ →	1405	7252.31	2 L/MIN	72	≤ 68°F
	1410	7262.34		72	FULLY
	1415	7272.37		73	ICED
	1420	7282.39		74	
	1425	7292.40		75	
	1430	7302.42		76	
	1435	7312.44		76	
	1440	7322.45		76	
	1445	7332.48		76	
	1450	7342.47		75	
	1455	7352.49		75	
	1500	7362.53		75	
58.04 ft³ →	1505	7372.52		75	
	Avg.	120.21		74.62	(T_m) °R

IMP 1-2 38 mL
IMP 3-4 30 mL

Glass Sample Containers / Silica Gel or Train
No. 1–impingers 1,2+3 711.5 grams (W_f)
No. 2–impingers 4+5 - 698.9 grams (W_i)
12.6 grams
× 0.04715 =
* unless discussed prior to testing, other modes of recovery
______ ft³[V_w (std)]
$V_{m(std)}$ = ______ ft³
Leak Check: 0.0 @ 10" 0.0 @ 10"
Water Vapor, proportion by volume" B_{ws} = ______
Moisture Correction factor: 1 - B_{ws} = ______
Comments: If using ¼" Teflon as probe, rinse with D.I. into containers No. 1. *

446.2
+ 252.7
698.9

254.7
+ 456.8

Silica
104.0/104.7

$$V_{m(std)} = 17.647\ V_m\ Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \qquad B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

Operator: CFM/MJK

Form 1000 GE Energy

METHOD 26 FIELD DATA SHEET

Project: ADA-ES/MIDAMERICAN ENERGY Date: 2/9/06
Sampling Location: UNIT 1 STACK
Source Condition: COND 2 Monitor: Model #HCL-3
Dry Gas Meter No. #HCL-3 Y = 1.007 Serial No. #HCL-3

Test (Run) No. 3 Barometric Pressure (P_{bar}) ______ in. Hg Orsat Analysis
Gas Temperature °F Static Pressure in. Hg %CO_2 %O_2

Clock Time 24 hour	Meter Volume (V_m) ~~ft³~~ L	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
1539	7375.45	2 L/MIN	73	≤68°F
1544	7385.46	↓	74	FULLY
1549	7395.49		75	ICED
1554	7405.51		77	↓
1559	7415.53		78	
1604	7425.52		79	
1609	7435.54		80	
1614	7445.56		82	
1619	7455.57		82	
1624	7465.59		85	
1629	7475.62		88	
1634	7485.61		90	
1639	7495.64		93	
Avg.			(T_m) °R	

58.14 ft³ (beside 1539)
162.35 ft³ (beside 1639)

Impingers / Silica Gel or Train
1–Knockout 725.2 grams (W_f)
2–0.1N H_2SO_4 - 715.6 grams (W_i)
3– " 9.6 grams
× 0.04715 =
4–0.1N NaOH
5– " ______ ft³[V_w (std)]
6–Silica
$V_{m(std)}$ = ______ ft³
Leak Check: 0.0 @ 10" 0.0 @ 10"
Water Vapor, proportion by volume"
B_{ws} = ______
Moisture Correction factor:
1 - B_{ws} = ______

Comments: Sampling rate = 2 liters/min or 0.07 cu.ft./min
60 min. test = 4.2 cu.ft.

252.8
462.8
715.6

471.0
254.2

Silica
108.2/109.0

Test (Run) No. ______ Barometric Pressure (P_{bar}) ______ in. Hg Orsat Analysis
Gas Temperature °F Static Pressure in. Hg %CO_2 %O_2

Clock Time 24 hour	Meter Volume (V_m) ft³	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (T_m) °F	Impinger Outlet Temp. °F
Avg.			(T_m) °R	

Glass Sample Containers / Silica Gel or Train
No. 1–impingers 1,2+3 ______ grams (W_f)
No. 2–impingers 4+5 -______ grams (W_i)
______ grams
* unless discussed prior to testing, other modes of recovery × 0.04715 =
______ ft³[V_w (std)]
$V_{m(std)}$ = ______ ft³
Leak Check:
Water Vapor, proportion by volume"
B_{ws} = ______
Moisture Correction factor:
1 - B_{ws} = ______

Comments: If using ¼" Teflon as probe, rinse with D.I. into containers No. 1. *

$$V_{m(std)} = 17.647\, V_m\, Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \qquad B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

Operator: CFM/MJK

Form 1000 GE Energy