

EVALUATION OF SORBENT INJECTION FOR MERCURY CONTROL

**Topical Report for:
AmerenUE's Meramec Station Unit 2
Reporting Period: October 1, 2003 – September 30, 2005**

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ABSTRACT

The power industry in the U.S. is faced with meeting new regulations to reduce the emissions of mercury compounds from coal-fired plants. These regulations are directed at the existing fleet of nearly 1,100 boilers. These plants are relatively old with an average age of over 40 years. Although most of these units are capable of operating for many additional years, there is a desire to minimize large capital expenditures because of the reduced (and unknown) remaining life of the plant to amortize the project. Injecting a sorbent such as powdered activated carbon into the flue gas represents one of the simplest and most mature approaches to controlling mercury emissions from coal-fired boilers.

This is the final site report for tests conducted at AmerenUE's Meramec Station, one of five sites evaluated in this DOE/NETL program. The overall objective of the test program is to evaluate the capabilities of activated carbon injection at five plants: Sunflower Electric's Holcomb Station Unit 1, AmerenUE's Meramec Station Unit 2, Missouri Basin Power Project's Laramie River Station Unit 3, Detroit Edison's Monroe Power Plant Unit 4, and AEP's Conesville Station Unit 6. These plants have configurations that together represent 78% of the existing coal-fired generation plants.

The goals for this Phase II program established by DOE/NETL were to reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than the target established of \$60,000/lb mercury removed. The results from Meramec indicated that using DARCO[®] Hg-LH would result in higher mercury removal (90%) at a sorbent cost 90% lower than the benchmark. In addition, the estimated costs for control at Meramec are 0.74 mills/kWh compared to 1.2 mills/kWh for the maximum achievable removal at Pleasant Prairie (67% mercury removal) under the DOE Phase I program. Both units fire PRB coal and have ESPs installed for particulate control. The critical difference in the sorbent costs is the improved effectiveness of DARCO[®] Hg-LH, a bromine-treated activated carbon, over DARCO[®] Hg, a non-chemically treated carbon. These results demonstrate that the goals established by DOE/NETL were exceeded during this test program.

The increase in mercury removal over baseline conditions is defined for this program as a comparison in the outlet emissions measured using the Ontario Hydro method during the baseline and long-term test periods. The average inlet concentration was 26% higher during long-term testing compared to baseline testing. The change in outlet emissions from baseline to long-term testing was 89%.

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INTRODUCTION

On March 15, 2005, the EPA announced that it would reduce mercury emissions from coal-fired power plants through the Clean Air Mercury Rule (CAMR). Regulations will affect both new plants and the existing fleet of nearly 1100 boilers in the United States. The existing plants are relatively old with an average age of over 40 years. Most of these units are capable of operating for many additional years if the capital expenditures associated with retrofitting new pollution controls can be minimized.

ADA-ES, Inc., with support from the Department of Energy's National Energy Technology Laboratory (DOE/NETL) and industry partners, conducted a mercury control demonstration using sorbent injection into the electrostatic precipitator (ESP) at AmerenUE's 140-MW Meramec Station Unit 2. This report presents results from the demonstration including the effect on mercury emissions when 1) injecting alternative sorbents specifically designed to operate in a halogen-deficient flue gas, and 2) injecting chemical additives onto the coal.

EXECUTIVE SUMMARY

Power plants that burn PRB coals and have only cold-side ESPs for air pollution control represent a challenging configuration for controlling mercury emissions. Full-scale field tests have confirmed that the average native mercury removal at these units is low, typically less than 25%. In addition, the effectiveness of injecting standard, non-chemically treated, activated carbon is greatly diminished by the low halogen concentrations in the flue gas.

The test program at AmerenUE's Meramec Unit 2 was designed to provide a full-scale evaluation of different technologies that can overcome the limited mercury removal achievable at such sites. Each technology was based on supplementing certain halogens that are not available in sufficient quantities in these coals.

The program was very successful in that two different technologies were found that have the potential to achieve high levels (greater than 80%) of mercury removal in this difficult configuration. These technologies are:

Coal Additives

- >80% total mercury removal (coal to outlet) achieved at Meramec without carbon injection
 - Coal additive testing was conducted over a relatively short period, during which combustion conditions in the boiler may have contributed to the increased mercury removal. The tubular air preheater and the relatively long duct between the air preheater and the ESP may be other factors that contributed to increased mercury removal. These conditions may not be replicated at other boilers burning PRB coals. For example, results from tests conducted at Laramie River Station Unit 3 in this DOE program indicated that the mercury removal was limited to less than 20% with coal additives. Laramie River is a PRB site configured with a spray dryer absorber followed by an ESP. Additional longer-term tests need to be conducted to fully understand the limits of the coal additive technology.

Treated Activated Carbon Injection (DARCO[®] Hg-LH)

- High removal (>90%) achieved at Meramec during the long-term test periods
 - During 30 days of continuous injection of the DARCO[®] Hg-LH sorbent, the average inlet and outlet mercury concentrations were 8.5 and 0.6 $\mu\text{g}/\text{Nm}^3$ (5.98 and 0.44 lb/TBtu), respectively. This yields an average vapor-phase mercury capture of 93% at an average sorbent injection concentration of 3.3 lb/MMacf. Ontario Hydro measurements also confirmed that mercury removal efficiencies were greater than 90% during continuous sorbent injection.

- No adverse balance-of-plant impacts were noted
 - To help determine the balance-of-plant impacts associated with sorbent injection, sorbent was continuously injected into the Unit 2 ESP for 35 days. During this test, there were no measurable increases in stack opacity, nitrogen oxides (NO_x) or sulfur dioxide (SO₂) emissions. Sorbent injection did not appear to be detrimental to ESP electrical parameters. Fly ash samples were collected during the 35-day test and subjected to two different leaching protocols. Results from these tests indicated mercury was below detection limit in all the leachate solutions. During a 30-day leach test, 55% of the bromine measured in the ash sample containing activated carbon leached as compared to 80% from the control sample.

The goals for the program established by DOE/NETL were to reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than the target established by DOE of \$60,000/lb mercury removed. The results from Meramec indicated that using DARCO[®] Hg-LH would result in higher mercury removal (90%) at a sorbent cost 90% lower than the benchmark. In addition, the estimated costs for control at Meramec are 0.74 mills/kWh compared to 1.2 mills/kWh for the maximum achievable removal at We Energies Pleasant Prairie Power Plant (67% mercury removal) during DOE Phase I testing. Both units fire PRB coals and have ESPs installed for particulate control. The critical difference in the sorbent costs is the improved effectiveness of DARCO[®] Hg-LH over DARCO[®] Hg. These results demonstrate that the goals established by DOE/NETL were exceeded during this test program.

The increase in mercury removal over baseline conditions is defined for this program as a comparison in the outlet emissions measured using the Ontario Hydro method during the baseline and long-term test periods. The average inlet concentration was 26% higher during long-term testing compared to baseline testing. The change in outlet emissions from baseline to long-term testing was 89%.

DESCRIPTION OF OVERALL PROGRAM

This test program is part of a five-site program to obtain the necessary information to assess the feasibility and costs of controlling mercury from coal-fired utility plants. Sorbent injection for mercury control was successfully evaluated in DOE/NETL's Phase I tests at scales up to 150 MW, on plants burning subbituminous and bituminous coals, and with ESPs and fabric filters. During the Phase I project, several issues were identified that needed to be addressed, such as evaluating performance on other plant configurations, optimizing sorbent usage (costs), and gathering longer-term operating data to address concerns about the impact of activated carbon on plant equipment and operations.

The overall objective of this program is to evaluate the capabilities of activated carbon injection at five plants with configurations that, taken together, represent 78% of the existing coal-fired generation plants. A short description of the five host sites is given in Table 1. Table 2 shows the program test schedule.

The technical approach followed during this program allowed the team to 1) effectively evaluate activated carbon and other viable sorbents on a variety of coals and plant configurations, and 2) perform long-term testing at the optimum condition for at least one month. These technical objectives are accomplished by following the series of tasks, as listed below. These tasks will be repeated for each test site.

1. Host site kickoff meeting, test plan, and sorbent selection
2. Design and installation of site-specific equipment
3. Field tests
4. Data analysis
5. Sample evaluation
6. Economic analysis
7. Reporting and technology transfer

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

Table 1. Host Site Key Descriptive Information.

	Holcomb	Meramec	Laramie River	Monroe	Conesville
Test Period	3/04–8/04	8/04–11/04	2/05–3/05	3/05–6/05	2/06–5/06
Unit	1	2	3	4	5 or 6
Size (MW)	360	140	550	785	400
Coal	PRB	PRB	PRB	PRB/Bit blend	Bituminous
Particulate Control	Joy Western Fabric Filter	American Air Filter ESP	ESP	ESP	Research-Cottrell ESP
SCA (ft ² /kacfm)	NA	320	599	258	301
Sulfur Control	Spray Dryer Niro Joy Western	Compliance Coal	Spray Dryer	Coal Blending	Wet Lime DARCO [®] Hg
Ash Reuse	Disposal	Sold for concrete	Disposal	Disposal	DARCO [®] Hg Sludge Stabilization
Test Portion (MWe)	180 and 360	70	140	196	400
Typical Inlet Mercury (µg/Nm ³)	10–12	10–12	10–12	8–10	15.8
Typical Mercury Removal	0–13%	15–30%	<20%	Not Available	50%

Table 2. Field-Testing Schedule.

Site	2004				2005					
	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov
Holcomb	█									
Meramec			█							
Laramie River						█				
Monroe							█			
Conesville Spring '06										

There are more than 100 individual team members from 33 organizations participating in this five-site program. Co-funding for testing at Sunflower's Holcomb Station was provided by a subset of the participants. The organizations providing co-funding for tests at Meramec include:

- ADA-ES, Inc.
- Arch Coal
- ALSTOM
- Arch Coal
- AmerenUE
- American Electric Power
- Babcock & Wilcox
- DTE Energy
- Dynegy Generation
- EPCOR
- EPRI
- MidAmerican
- NORIT Americas
- Ontario Power Generation
- Southern Company
- TVA

Key members of the test team include:

Meramec Station

Rich Phillips

Tom Hart

ADA-ES, Inc.

Project Manager: Sharon Sjostrom

Site Manager: Travis Starns

Project Engineer: Cody Wilson

SCEM Lead: Jerry Amrhein

EPRI

Project Manager: Ramsay Chang

Reaction Engineering International

Coal and Byproduct Analysis Interpretation: Connie Senior

Others

Analytical laboratories

(SGS, Microbeam, Hawk Mountain Lab, Frontier Geosciences)

MERAMEC PROJECT OBJECTIVES AND TECHNICAL APPROACH

The primary objective for testing at AmerenUE's Meramec Station was to determine the cost and effects of sorbent injection for control of mercury in stack emissions. Meramec Station is located in St. Louis County, Missouri. During the project, the effects of coal additives and sorbent injection into an ESP were evaluated and the mercury removal performance was documented. Sorbent injection tests were conducted on one-half of the 140-MW flue gas stream. The general technical approach for the field-testing was to follow a series of tasks, as listed below.

1. Sorbent selection and screening
2. Sample and data collection coordination
3. Baseline tests
4. Parametric tests
5. Long-term tests

Importance of Testing at Meramec

Meramec Unit 2 was chosen for this evaluation because it fires subbituminous Powder River Basin (PRB) coals and is configured with a cold-side ESP (CESP). This configuration is becoming more common in the industry as many U.S. utilities are fuel-switching to lower-sulfur western coals. Previous tests at plants with this configuration (PRB/CESP) using sorbents available at the time indicated that the mercury removal was limited to about 70%.

A full-scale demonstration of carbon injection for mercury control was conducted by ADA-ES at We Energies Pleasant Prairie Power Plant, another PRB/CESP unit, during the DOE Phase I tests. At a sorbent injection concentration of 10 lb/MMacf, mercury capture across the ESP was 60–65% and showed little increase even up to an injection concentration of 30 lb/MMacf. Reducing the injection concentration to 5 lb/MMacf decreased the mercury removal to 50–55%.¹ At 1 lb/MMacf, an average mercury control efficiency of 46% was achieved over a five-day period. These data are presented in Figure 1. However, since the completion of tests at Pleasant Prairie, improved sorbents have been developed, some of which were tested at Meramec during this Phase II program.

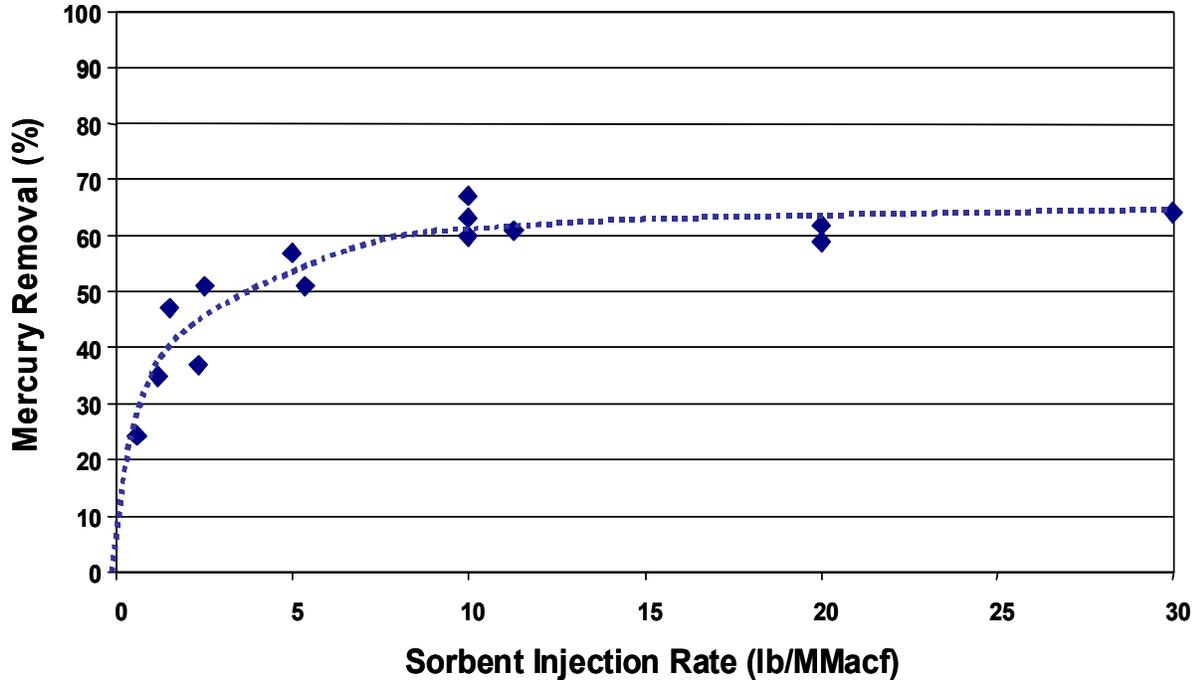


Figure 1. Data from Previous Full-Scale Evaluation at We Energies Pleasant Prairie Power Plant.

Understanding the impacts to ESP performance and other balance-of-plant issues resulting from carbon injection is the single most important step in gaining industry acceptance for this technology. Full-scale data documenting impacts to ESP performance from sorbent injection are limited. Previous mercury control demonstrations, such as the Phase I DOE tests at Pleasant Prairie, Brayton Point, and Salem Harbor were limited to a continuous injection test period of 15 days or less. The project at Meramec was designed to evaluate sorbent injection over a 30-day period to help identify balance-of-plant impacts that may not develop during a shorter test.

There are two issues related to the impact of activated carbon injection on a moderate-sized ESP. The first is the impact on the bulk properties of the ash collected on the plates. A change in the overall resistivity of the material could result in a change in the ESP performance. At all three Phase I test sites with ESPs, there were no changes observed in the fundamental operation of the ESPs. As an example, Figure 2 shows a plot of the ESP power before and during the injection of activated carbon at Dynegy's Brayton Point Station. Even at injection rates up to 20 lb/MMacf, there was no observable change in ESP operation. Similar results were also experienced at Pleasant Prairie and Salem Harbor. These data are available through DOE in the Final Report for the Phase I program.²

The second issue is whether the activated carbon can be effectively captured in the ESP. Plant operating data indicated that there were no increases in opacity during any of the test programs. Typically, the activated carbon represented an increase to the inlet particulate loading of 1–2%. In addition, the activated carbon had a mass median diameter of 17

micrometers, which is not difficult to capture for the medium to large ESPs tested (SCA >300 ft²/kacfm). Therefore, no increase in opacity was expected during these tests.

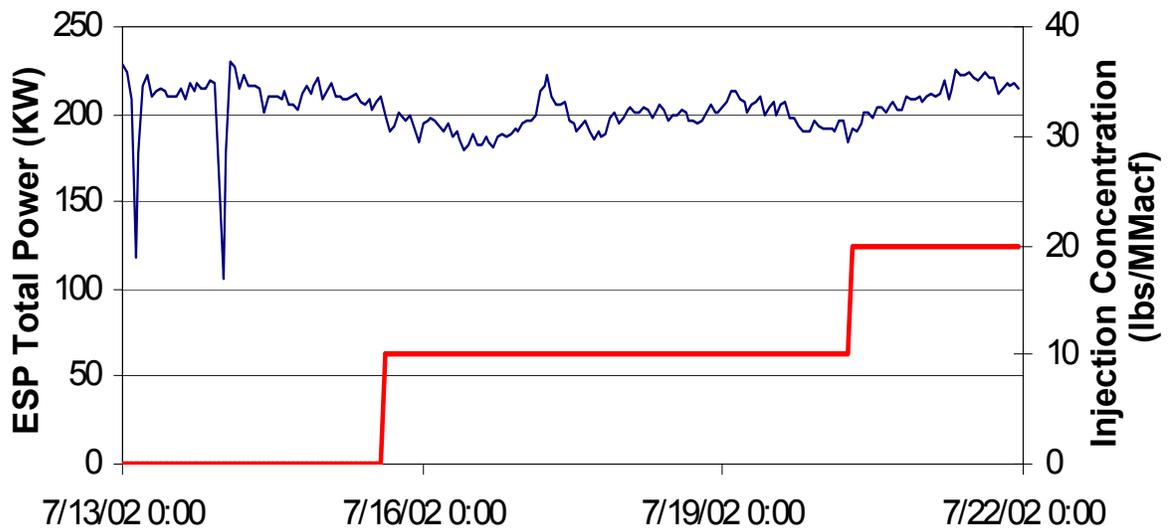


Figure 2. ESP Power during Injection of Activated Carbon at Brayton Point.

Meramec Site Description

Meramec Station is located in St. Louis County, Missouri. The test unit (Unit 2) is a load-following, sub-critical 140-MW (gross) pulverized coal, tangentially fired, electric generating unit that burns 100% PRB coals. The unit is equipped with an ESP for particulate removal. The specific collection area (SCA) of the ESP is approximately 320 ft²/kacfm. During the Spring 2004 outage, Units 1 and 2 were retrofitted with low-NO_x burners and separated overfire air for NO_x control.

The ESP on Unit 2, designed by American Air Filter Company, Inc., is comprised of two gas paths, each with five electrical fields and three mechanical fields (i.e., rows of hoppers). For the test program, sorbent was introduced upstream of the east ESP, thus treating only one-half of the 140-MW flue gas stream. A sketch of the east ESP flue gas path on Unit 2 is shown in Figure 3 and a photograph is shown in Figure 4. Key operating parameters for Meramec Unit 2 are listed in Table 3.

Tests were conducted to determine the mercury removal efficiency when injecting sorbent upstream of the ESP. Vapor-phase mercury was monitored at the inlet and outlet of the ESP with semi-continuous emissions monitors (SCEMs) throughout testing. In-situ fly ash samples were collected using a cyclone at the inlet of the ESP, and these samples were analyzed for mercury to determine the particulate-phase mercury.

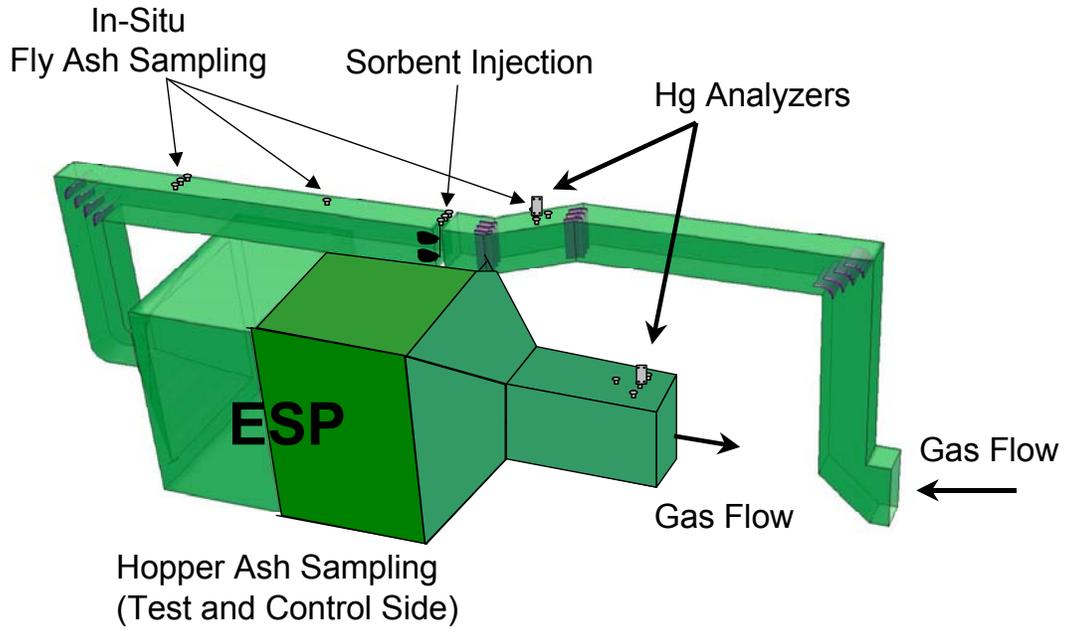


Figure 3. Sketch of East Half of Meramec Unit 2 Testing Layout.

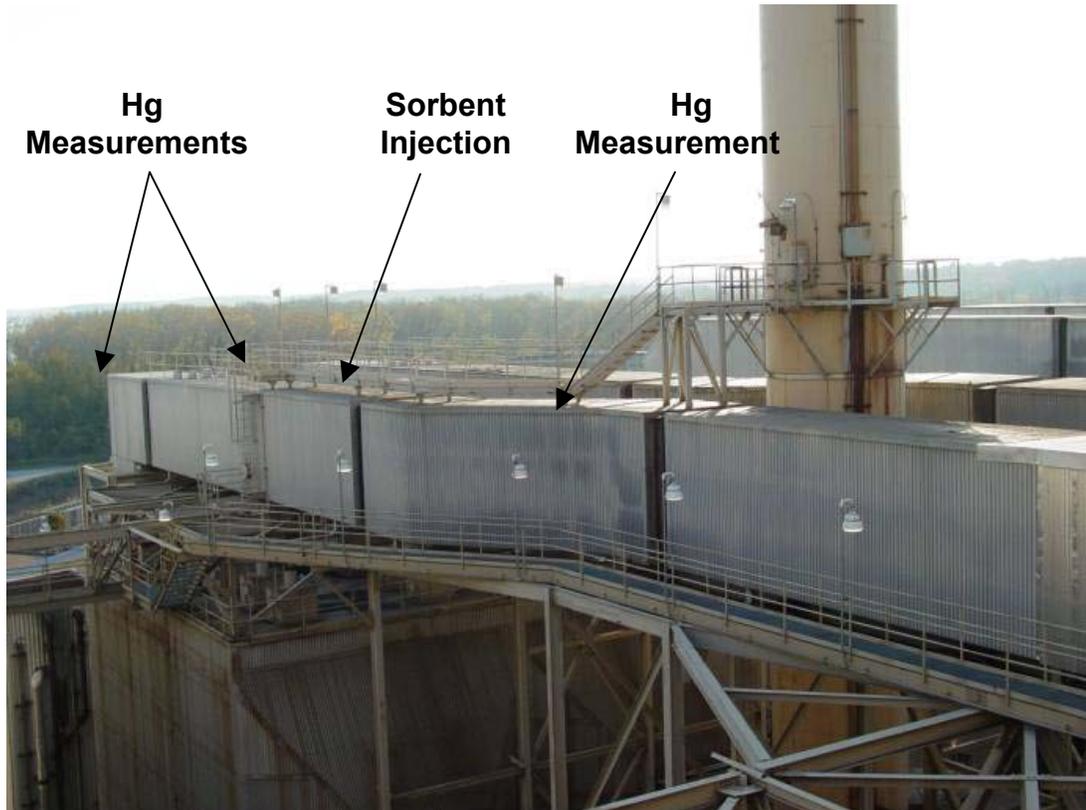


Figure 4. Photo of East ESP Inlet Duct – Unit 2.

Table 3. Meramec Key Operating Parameters.

Unit	2
Size (MW)	140
Test Portion (MWe)	70
Coal	PRB
Heating Value (lb/MMBTU, as received)	8,738
Sulfur (% by weight)	0.25
Chlorine (%)	<0.01
Mercury (µg/g)	0.052
Particulate Control	ESP (American Air Filter) SCA = ~320 ft ² /kacfm
Sulfur Control	Compliance Coal
Ash Reuse	Sold for Cement or Landfill

Equipment Descriptions

Carbon Injection and Delivery System

The carbon injection system, shown installed at Meramec in Figure 5, consists of a bulk-storage silo and twin blower/feeder trains. Powdered activated carbon (PAC) is delivered by bulk pneumatic truck and loaded into the silo, which is equipped with a bin vent bag filter. From the discharge section of the silo, the sorbent is metered by variable speed screw feeders into eductors that provide the motive force to carry the sorbent to the injection point. Regenerative blowers provide the conveying air. A programmable logic controller (PLC) system is used to control system operation and adjust injection rates. The unit is approximately 50 feet high and 10 feet in diameter with an empty weight of 10 tons. The silo can hold 20 tons of sorbent.

During testing at Meramec, flexible hose was used to transport the sorbent from the feeder to the distribution manifold located on the flue gas duct at the ESP inlet. The distribution manifold supplied sorbent to six injection lances installed in three 4-inch injection ports.

Computational Fluid Dynamics Modeling of ACI

Several Computational Fluid Dynamic (CFD) models were developed by Fluent, Inc., that were specific to Meramec Unit 2 to help determine the mixing rate and trajectory of sorbent injected into the flue gas stream via the sorbent injection lances. For the model study, the injection scheme that was simulated involved three injection ports with two lances per port placed at one-third and two-thirds of the total depth of the duct. Sorbent discharged at the end of each lance. The model predicted that the sorbent particles would remain streamlined in the flue gas stream and that dispersion was limited until approximately 20 feet after the turning vanes located in the transition section from horizontal to vertical duct. A report discussing model results is included in Appendix B.



Figure 5. Carbon Injection Storage Silo and Feeder Trains Installed at Meramec.

Mercury Analyzers

Two mercury monitors were used during this testing program to provide real-time feedback during baseline and sorbent injection testing. The system is shown in Figure 6. The mercury analyzer consisted of a cold-vapor atomic absorption spectrometer (CVAAS) coupled with a gold amalgamation system (Au-CVAAS). The system is calibrated using vapor-phase elemental mercury. The inertial separation probe shown in the figure separates the particulate matter from the sample with minimal sampling artifacts from fly ash or sorbent.

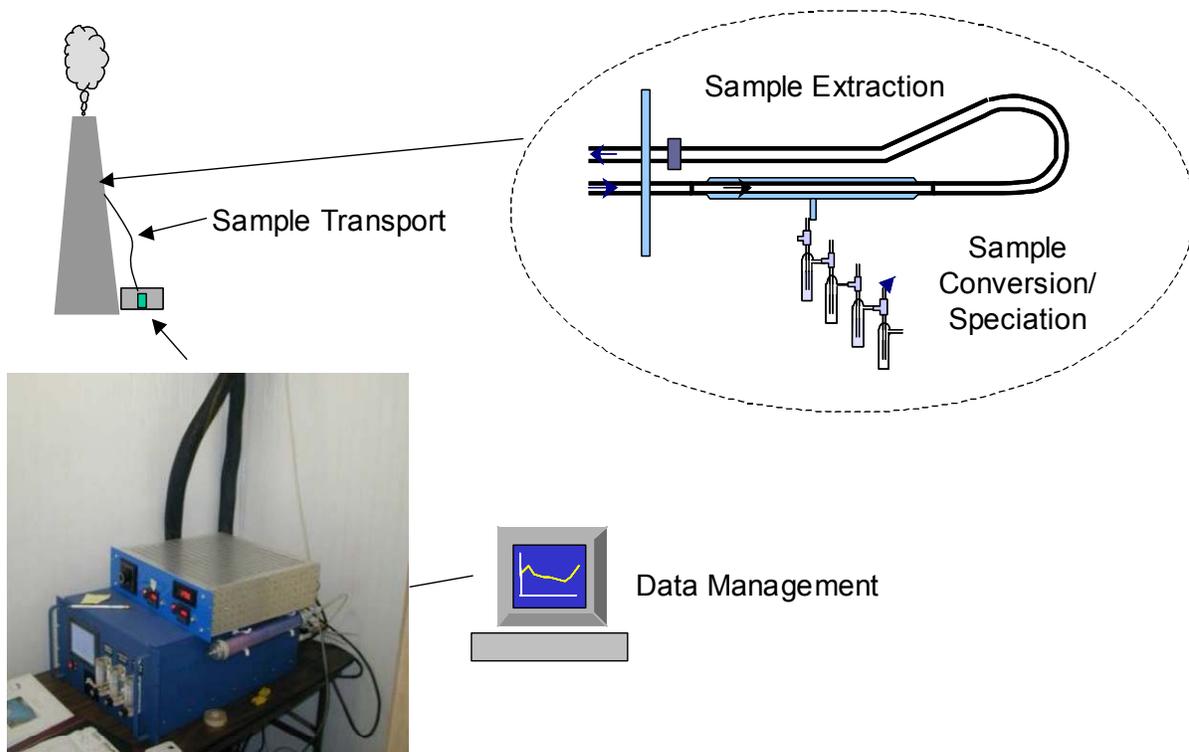


Figure 6. Sketch of Mercury Measurement System.

The analyzers are capable of measuring both 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.

In-Situ Fly Ash Sampling Device

The in-situ fly ash sampling device consists of a cyclone separator, venturi flow meter, and an eductor. The PM_{2.5} cyclone was designed to measure particulate emissions under Method 201A. Although the cyclone is designed to collect particulate 2.5 microns in diameter and greater, operating the cyclone at higher than design flow rates alters the collection efficiency to smaller diameters. A photo of the cyclone sampler is shown in Figure 7.



Figure 7. In-Situ Fly Ash Sampling Device.

Sorbent Screening Apparatus

Several groups have conducted mercury sorbent screening tests over the past few years, but sorbent performance was reported as the maximum mercury that can be collected by the sorbent, or the capacity of the sorbent.³ Although these data provide valuable information to compare the relative performances of several sorbents, they do not provide a direct indication of the injection concentration required to achieve a given level of mercury removal. To overcome these shortcomings, ADA-ES developed a sorbent screening device (SSD) that allows simultaneous comparison of several sorbents, provides an indication of the maximum mercury removal achievable with a sorbent, and provides an estimate of the amount of sorbent required to achieve various mercury removal levels in a full-scale application.

The SSD is shown in Figures 8 and 9. It consists of a heated enclosure that houses three sample filters, and was designed to simulate the mercury removal of a full-scale fabric filter, or predict mercury removal in a full-scale ESP, depending upon the SSD test configuration and operating conditions. Tests can be conducted on-site with extracted flue gas or with simulated flue gas in the laboratory. Sorbent loading can be varied to provide

data over a range of injection concentrations, nominally 1 to 10 lb/MMacf. A typical test lasts two hours or can be terminated when the outlet mercury concentration equals the inlet mercury concentration (100% breakthrough).

The important parameters that are measured and controlled are the SSD temperature, the gas flow rate through each of the filters, and the weight of the sorbent sample applied to the filter media. The inlet and outlet elemental mercury concentrations in the flue gas are carefully monitored during testing. The SCEMs are calibrated at the beginning and end of each run for quality assurance.

At Meramec, flue gas was extracted from upstream of the Unit 1 ESP. An inertial separation probe was used to remove particulate from the sample gas. The gas was then transported through a heated line to the SSD. Test samples consisted of a mixture of sorbent and Meramec ESP ash, and were evenly deposited onto glass filter paper in appropriate concentrations. Treated gas exited the heated box through chemical impingers to convert all mercury to elemental mercury, and a chiller to remove moisture. The total vapor-phase mercury concentration was measured at the inlet and outlets of the samples using CVAAS Hg SCEMs.

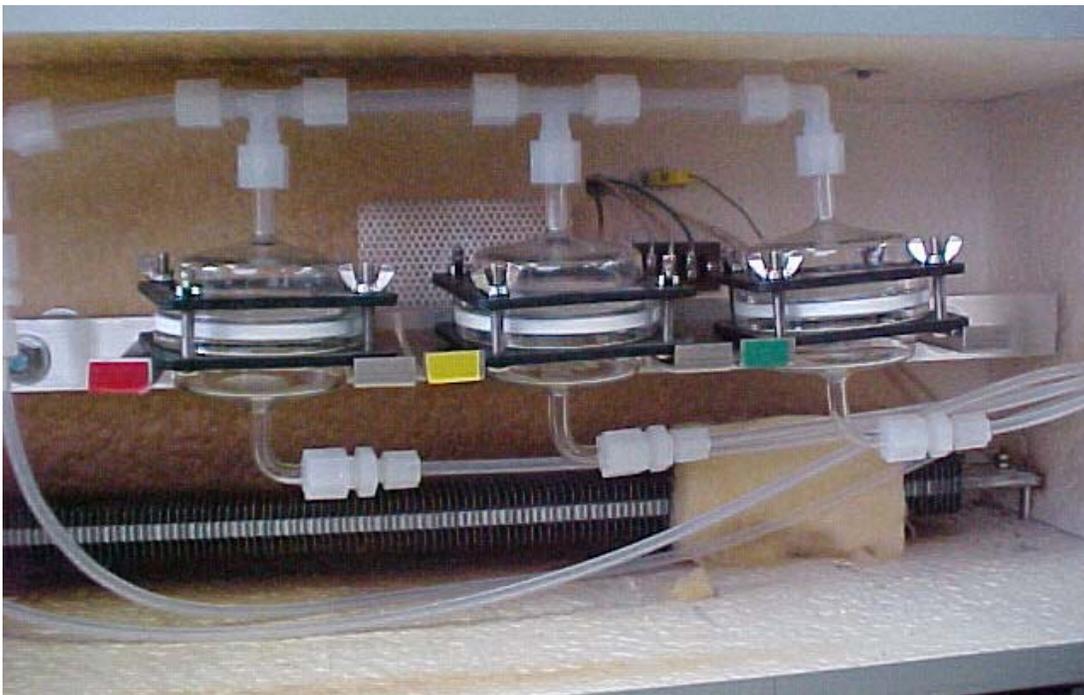


Figure 8. Sorbent Screening Device—Sample Filters.



Figure 9. Sorbent Screening Device—Heated Box and Impingers.

The SSD, as configured for tests at Meramec, was designed to estimate the sorbent injection concentrations required for various levels of mercury removal. This type of information cannot be calculated directly from the usual information provided by vendors or from laboratory tests using a fixed bed of sorbent. Fixed-bed testing can provide both capacity and reactivity (slope of the breakthrough curve) data, which can be incorporated into a model for predictions. However, the applicability of the data is limited because, in full-scale demonstrations, sorbents are typically removed from the gas stream before the equilibrium capacity has been reached.

Description of Field Testing Subtasks

The field tests were accomplished through a series of five subtasks: 1) sorbent selection and screening, 2) sample and data coordination, 3) baseline testing, 4) parametric testing, and 5) long-term testing. 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 subtask influenced the test parameters of subsequent subtasks. A summary of each subtask is presented.

Sorbent Selection and Screening

A key component of the planning process for this program is identifying potential sorbents for testing. At the onset of the testing period at Meramec, the test team determined that no sorbents were available in quantities large enough for full-scale testing that were

substantially different from materials tested at other PRB sites. Therefore, the sorbent selection process for full-scale parametric testing did not include sorbent screening. However, a series of screening tests was conducted to advance sorbent technology. ADA-ES invited sorbent developers and manufacturers to provide material designed for effective mercury removal in PRB flue gas, regardless of the availability of the material in large quantities. Ten sorbents from seven manufacturers including NORIT Americas, Cal-Pacific Carbon, Northeastern Technologies, Calgon Carbon, Zinkan Enterprises, Nonoscale Materials, and CDEM were evaluated at Meramec. Materials included bromine-treated activated carbon from lignite coal; activated carbon from bituminous coal, coconut shells, and wood; carbon nonotubes; and non-carbon mineral- and zeolite-based sorbents.

Sample and Data Coordination

Collecting, analyzing, and archiving samples and plant operating data are key aspects of any field test program. A copy of the Sample and Data Management Plan for the test program at Meramec is included in Appendix C. 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/Long-Term
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 ESP inlet/outlet	Yes	Yes
Temperature	Full traverse at ESP inlet/outlet	Yes	No
Duct gas velocity	Full traverse at ESP inlet/outlet	Yes	No
Mercury (total and speciated)	Hg Monitors at ESP inlet/outlet	Yes	Yes
Mercury (total and speciated)	ASTM M6784-02 (Ontario Hydro) at ESP inlet/outlet	Yes (1 set)	No/Yes (2 sets)
Multi-metals emissions	Method 29 at ESP inlet/outlet	Yes, outlet	No/Yes, outlet
HCl, HF, Br	EPA Method 26a at ESP inlet/outlet	Yes	Yes
Sorbent injection rate	PLC, lbs/min	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

Grab samples of ash were collected from the ESP hoppers each day of testing and analyzed for mercury. A sketch of one ESP showing how the hoppers were numbered is presented in Figure 10

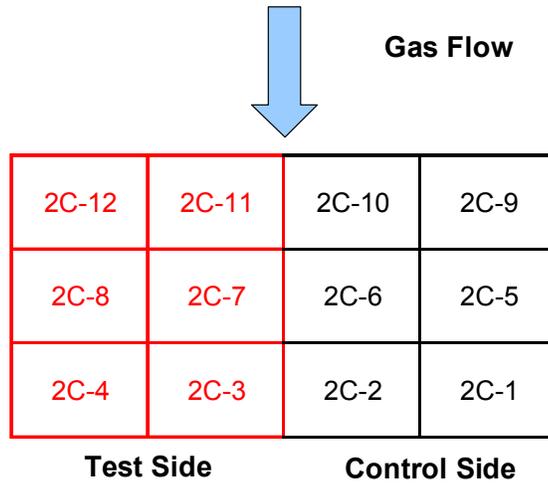


Figure 10. Sketch of ESP Hoppers showing Module Numbering.

Baseline Testing (No Sorbent Injection)

One week of baseline testing was conducted. During this period, Meramec Unit 2 fired 100% PRB coals, obtained from several different mines. At full-load, the unit operated at sub-stoichiometric oxygen levels in the combustion zone to control NO_x. The operation of the combustion zone may affect the amount of unburned carbon in the ash (loss on ignition (LOI)). The unit was maintained at standard full-load conditions, 140 MW, between the hours of 08:00 and 19:00. At night, the load was reduced to as low as 40 MW. Independent gas testing, including ASTM Method 6784-02 (Ontario Hydro) mercury measurements, M29 multi-metal measurements, and M26A, HCl, and HF measurements, were conducted in conjunction with the continuous measurements from mercury monitors during this subtask.

Parametric Testing

Following baseline testing, two weeks of parametric testing were conducted. Tests included two activated carbon sorbents and one coal additive. A second coal additive was evaluated by ADA-ES for AmerenUE and these data are included for comparison. The parametric tests are listed in the test matrix in Table 5.

Table 5. Field Testing Sequence Completed at Meramec Unit 2.

Test Description	Start Date	Parameters/Comments	Boiler Load
Baseline	08/23/04	Day 1 - Test crew set-up no restrictions on boiler load Day 2 - ASTM M6784-02, M26a Day 3 - ASTM M6784-02, M26a Day 4 - ASTM M6784-02, M26a Day 5 - No restrictions on boiler load	Full Load 24 hours per day Days 2–4
Parametric Week 1 Benchmark Testing	08/30/04	Day 1 - DARCO [®] Hg, 5 lb/MMacf Day 2 - DARCO [®] Hg, 1 & 10 lb/MMacf Day 3 - DARCO [®] Hg, 0.5 & 5 lb/MMacf Day 4 - DARCO [®] Hg, 1 lb/MMacf Day 5 - DARCO [®] Hg, 5 & 15 lb/MMacf	Full Load 6 AM–6 PM
Parametric Week 2 Enhanced Sorbent Testing	09/13/04	Day 1 - Contingency Day 2 - DARCO [®] Hg-LH, 1 lb/MMacf Day 3 - DARCO [®] Hg-LH, 0.5 lb/MMacf Day 4 - DARCO [®] Hg-LH, 3 lb/MMacf Day 5 - Contingency	Full Load 6 AM–6 PM
Parametric Week 3 KNX Coal Additive Testing	09/20/04	Day 1-3 – KNX Day 4 - KNX + DARCO [®] FGD, 1, 3, & 5 lb/MMacf Day 5 - Contingency	Full Load 6 AM–6 PM
AmerenUE Testing: SEA2 Coal Additive Testing	09/27/04	Day 1 - Baseline Day 2 - SEA2, rate 1 Day 3 - SEA2, rate 2 Day 4 - SEA2 + DARCO [®] Hg, 3 lb/MMacf Day 5 - SEA2 + DARCO [®] Hg, 1 lb/MMacf	Full Load 6 AM–6 PM
Long-Term Tests	10/15/04	Operate at consistent injection rate 24 hours a day, 4 weeks, while load following. Conduct ASTM M6784-02 during week 1 and week 4, ASTM M6784-02 and M26A tests during week 4. Sorbent and rate TBD.	Full Load only during Ontario Hydro

Parametric Week 1: DARCO[®] Hg. This sorbent, manufactured by NORIT Americas Inc, has been tested in various lab-, pilot-, and full-scale mercury control demonstrations and is considered the benchmark for performance comparisons. Properties of DARCO[®] Hg are included in Table 6. Tests were conducted during the day while the unit operated at full load.

Parametric Week 2: DARCO[®] Hg-LH. A bromine-treated lignite activated carbon product, DARCO[®] Hg-LH, was evaluated at several injection rates. Properties of DARCO[®] Hg-LH are included in Table 6. DARCO[®] Hg-LH was chosen for testing at Meramec because of its potential to achieve mercury removal levels higher than possible with non-chemically treated carbons. During the test with DARCO[®] Hg-LH, it is important to note that one of the four coal mills, Mill B, was out of service. Meramec Unit 2 is tangentially fired and Mill B feeds the second from the bottom of the four burner levels. On a tangentially-fired unit, all mills are very important to proper staging.

Table 6. Material Properties for the DARCO[®] Hg Sorbent.

Typical Properties*	DARCO[®] Hg	DARCO[®] Hg-LH
Iodine Number, mg/g	550	500
Total Sulfur, %	1.2	1.2
Bulk density, tamped, lb/ft ³	32	37
Surface Area, m ² /g	600	550
Ignition Temperature, °C	≥400	≥400

* *Data supplied by NORIT Americas Inc.*

Parametric Week 3: Coal additive. During the final week of parametric testing, a halogen-based coal additive was evaluated for its effect on mercury removal both by native fly ash and when injecting untreated activated carbon. The coal additive, KNX, was developed by ALSTOM Power. It was applied to the coal prior to entering the boiler. The same material was tested at Sunflower Electric’s Holcomb Station and demonstrated the ability to alter the mercury speciation at the air preheater (APH) exit. The KNX coal additive, combined with DARCO[®] Hg injection, demonstrated mercury removal efficiencies greater than 80% at the Holcomb Station.

Before the start of the KNX coal additive test, Mill B had been returned to service; however, the changes made to Mills A, C, and D to compensate for the loss of Mill B had not been reset for four-mill operation. This resulted in increased LOI carbon entering the ESP.

While the necessary equipment was on-site, AmerenUE sponsored the evaluation of a second coal additive, SEA2. The Energy & Environmental Research Center (EERC) developed this product. Pilot-scale testing has shown this non-carbon-based material has potential for reducing mercury emissions without affecting the resale value of the fly ash. This material was added upstream of the coal pulverizers.

Long-Term Testing

Long-term testing was conducted at the “optimum” settings as determined by the parametric tests and approved by the DOE and AmerenUE/Meramec. It was the intent of DOE that these settings represent the most cost-effective conditions for mercury removal. The long-term test period was divided into two phases. For the first phase, the goal was to determine if the sorbent injection concentration could be minimized to maintain ash sales while achieving 60–70% mercury removal. This test was conducted for 5 days. During the second phase, the mercury removal target was 85 to 95%. This phase was conducted for 30 days. The goals of the second phase were to obtain long-term (30-day) data on removal efficiency, determine the effects on the particulate control device, determine the effects on byproducts, evaluate impacts to the balance-of-plant equipment to prove viability of the process, and to determine the process economics. During this test, ASTM M6784-02, M29, and M26A measurements were conducted at the inlet and outlet of the ESP.

The long-term test of continuous sorbent injection is considered the single most important step in gaining acceptance from the utility industry as to the practical implementation of mercury removal technologies on coal-fired power plants.

RESULTS FROM MERAMEC TESTING

Results from each test series are included in this section.

Baseline Testing Results

Pre-baseline mercury measurements were made at the ESP inlet and outlet on June 22, 2004, using the Sorbent Trap Method (STM) that is based, in part, on the method described in 40 CFR Part 75 Appendix K (previously EPA draft Method 324). A description of the method is included in Appendix D. Results showed the average mercury concentrations at the ESP inlet and outlet were 6.0 lb/TBtu and 4.8 lb/TBtu respectively, yielding a native vapor-phase mercury removal efficiency of about 20%. At the beginning of baseline testing, August 24–26, 2004, the full-load mercury concentration at the ESP inlet and outlet was relatively steady. The native, daily average vapor-phase mercury removal across the ESP ranged from 15 to 18%. Both the June and August data agree well with results from other sites firing PRB coals with cold-side ESPs. The average mercury concentrations from the pre-baseline and baseline test periods are shown in Figure 11.

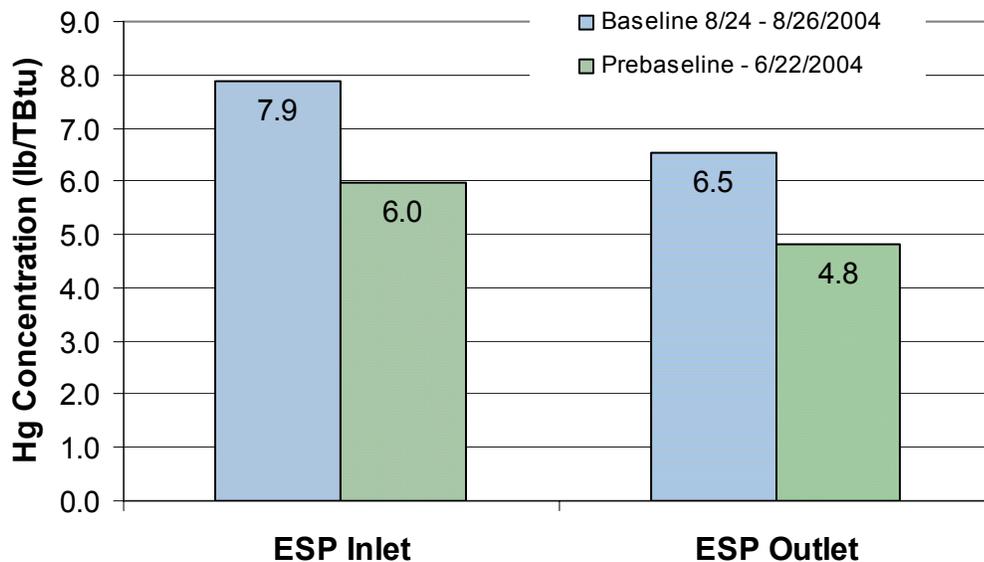


Figure 11. Pre-Baseline and Baseline Test Results at Meramec Unit 2.

Mercury, SO₂, and temperature data from the baseline period are presented in Table 7. The coals burned during this test period were obtained from more than one mine, as indicated by the change in the average SO₂ concentration measured at the stack. However, the source of PRB coals did not appear to influence the native mercury removal of the ash.

Table 7. Baseline Vapor-Phase Mercury Concentrations at Unit 2 ESP Inlet and Outlet and other Plant Data.

Date	Inlet Hg Total ($\mu\text{g}/\text{Nm}^3$)	Inlet Hg Elem. ($\mu\text{g}/\text{Nm}^3$)	Outlet Hg Total ($\mu\text{g}/\text{Nm}^3$)	Outlet Hg Elem. ($\mu\text{g}/\text{Nm}^3$)	Vapor-Phase Hg Removal (%)	SO ₂ (lb/MM BTU)	Stack Temp (F)
8/24/04 08:00–21:00	10.8	8.8	8.9	6.3	18	1.04	312
8/25/04 08:00–21:00	12.2	9.9	10.0	7.1	18	1.61	320
8/26/04 08:00–23:59	10.7	8.4	9.1	6.3	15	1.22	326

The mercury concentration in the fly ash collected in the first field ESP hoppers during baseline testing ranged from 0.374 to 0.624 ppm. This is equivalent to a particulate-phase mercury concentration of 2.88 to 4.8 $\mu\text{g}/\text{Nm}^3$ at an ash loading of 3.13 gr/dscf (based on combustion calculations). Comparing these values to the calculated mercury concentration based on the coal fired during this period suggest that the average fraction of mercury being collected on the fly ash was approximately 37%, as compared to 18% as measured with the SCEMs. This suggests that there was some particulate mercury present at the ESP inlet sample point and that in the duct between the ESP inlet and outlet sample points, a portion of the vapor-phase mercury (18%) was converted to particulate mercury. These data are presented in Table 8 below.

Table 8. Results from Samples Collected during Baseline Testing.

Date	Est Hg from Coal ($\mu\text{g}/\text{Nm}^3$)	Inlet SCEM ($\mu\text{g}/\text{Nm}^3$)	Est Outlet Vapor (Coal - Fly Ash) ($\mu\text{g}/\text{Nm}^3$)	Outlet SCEM ($\mu\text{g}/\text{Nm}^3$)	Hg Removal (Coal and Ash) (%)	Hg Removal (SCEM) (%)
8/24/04	14.27*	10.8	6.6	8.9	54	18
8/25/04	9.97*	12.2	6.5	10.0	35	18
8/26/04	8.48*	10.7	4.3	9.1	49	15

* Some variability in coal mercury concentrations within sample noted. Discussion included in section on Characterization of Process Solids.

Ontario Hydro and EPA Method 29 measurements were conducted during the baseline test. However, anomalies in the results indicated a problem with the sampling or analysis procedures. Therefore, the samples were submitted to URS Group for secondary analysis in an attempt to recover the data. URS indicated that their measurements were higher than the original analyses, but because of the handling procedures, mercury had likely

been lost between the time the solutions were analyzed by the original lab and URS. Therefore, although the URS data showed that the original results were biased low, the URS data could not be used to determine the actual flue gas mercury concentrations. The original test report and a memo from URS are included in Appendix E.

Sorbent Screening Results

A series of sorbent screening tests was conducted to evaluate the mercury removal performance of various sorbents at operating conditions designed to predict sorbent performance when injected into a full-scale ESP. This evaluation utilized the sorbent screening device described earlier in this report. Tests were completed from October 4–8, 2004. These tests were not conducted for the purpose of choosing sorbents for parametric testing at Meramec, but to evaluate potential sorbents for future applications on units firing PRB coal and configured with ESPs.

The DARCO[®] Hg and DARCO[®] Hg-LH sorbents were used as the benchmark sorbents for the sorbent screening test since they were tested at full-scale at Meramec prior to the screening tests. The best performance was obtained with the DARCO[®] Hg-LH closely followed by Sorbent A. Sorbent B also showed significant mercury capture at 76%. The best non-carbon sorbent was Sorbent C, which captured 47% of the mercury at a loading of 6 lb/MMacf. These results are included in the test summary in Table 9.

Table 9. Sorbent Screening Test Results at Meramec.

Sorbent	Equiv. Loading (lb/MMacf)	15-minute average Hg Removal %
DARCO [®] Hg	1	67
DARCO [®] Hg-LH	1	90
A	1	89
B	1	76
C*	6	47
D	1	31
E*	6	19
F*	6	9

* *Non-carbon-based materials.*

Parametric Test Results

There were inconsistencies in unit operation throughout the test program. One of the four coal mills, Mill B, was out of service during the second week of parametric testing. Because of this, Unit 2 was operated at a reduced load of about 115 MW, and higher variations were observed in the vapor-phase mercury concentration at the ESP inlet than during previous tests. These variations were likely caused by rapid changes in unburned carbon as measured by the LOI test method. Changes in the quantity and form of LOI carbon can result in different fractions of particulate and vapor-phase mercury in the flue gas. During coal blending tests, Mill B was returned to service, but the classifiers on the other three mills were not readjusted for optimal, four-mill operation.

The tubular air preheater design and long duct run between the air preheater and ESP at Meramec may have enhanced the effects of both the LOI carbon and the coal additive performance. Modeling studies of the tubular air preheater and long duct at Meramec, conducted by Reaction Engineering International, indicate this configuration was predicted to contribute to mercury oxidation in the flue gas. Oxidized mercury is predicted to be more reactive with LOI carbon than elemental mercury. The report from Reaction Engineering is included in Appendix F.

Sorbent Injection

DARCO[®] Hg Evaluations

During the first week of parametric testing, the performance of the benchmark sorbent, DARCO[®] Hg, was evaluated at various injection rates. All tests were conducted at standard, full-load conditions. The injection duration ranged from three to seven hours except for a high-injection-rate test on September 3 that was conducted for only one hour. The baseline (no sorbent injection) vapor-phase mercury removal was measured at the beginning of each test day and ranged from 13% early in the week to a high of 53% in the middle of the week. Although sorbent injection was stopped by 18:00 every day, residual sorbent in the ESP may have contributed to the variability in the baseline removal the following morning. Changes in combustion conditions may have also contributed to changes in the native mercury removal.

Table 10 presents the results with DARCO[®] Hg and shows that the hour-average mercury removal peaked at 74% at an injection concentration of 5 lb/MMacf and showed no further increase up to the maximum tested sorbent injection concentration of 20 lb/MMacf. Because of the variability in baseline removal discussed above, the mercury removal based on the change in the ESP outlet mercury concentration that resulted immediately upon the initiation of sorbent injection was also calculated. This value peaked at 72% removal at an injection concentration of 5 lb/MMacf.

The results obtained at Meramec with DARCO[®] Hg are similar to those achieved at other cold-side ESP sites burning low-rank coals (PRB and North Dakota lignite), as shown in Figure 12. In all cases, the mercury removal was limited to below 80% regardless of carbon injection concentration. It is speculated that the mercury removal is limited because there is insufficient HCl in the flue gas. Halogen species, such as HCl, are needed by activated carbon for effective mercury removal, and halogen concentrations in low rank coals (PRB) are typically relatively low. Activated carbon injection concentrations of 3 to 10 lb/MMacf are sufficient to absorb the available halogens from burning most low-rank coal, so that subsequent increases in carbon injection rates are ineffective at producing additional mercury capture.

Table 10. Mercury Concentrations at Unit 2 ESP Inlet and Outlet during DARCO® Hg Testing.

Date/Time*	Inlet Hg Total µg/Nm ³	Inlet Hg Elem. µg/Nm ³	Outlet Hg Total µg/Nm ³	Outlet Hg Elem. µg/Nm ³	Hg RE %	Injection Conc. lb/MMacf	Load MW	SO ₂ lb/MMBtu	Stack Temp °F
8/30/04 09:00–10:00	7.3	5.7	6.3	3.3	13	0	141	0.61	302
8/30/04 15:00–16:00	6.9	4.9	1.8	1.7	74	5.1	140	0.66	318
8/31/04 09:00–10:00	6.3	4.9	3.9	2.5	38	0	135	0.70	311
8/31/04 12:00–13:00	6.9	4.8	2.8	2.2	60	1.1	134	0.67	326
8/31/04 16:00–17:00	6.6	4.5	1.9	1.9	74	10.0	134	0.64	328
9/1/04 10:00–11:00	5.5	3.9	4.0	2.0	28	0	142	0.63	315
9/1/04 13:00–14:00	6.0	3.7	3.2	1.9	47	0.6	141	0.62	320
9/1/04 16:00–17:00	5.8	3.3	1.8	1.4	69	3.2	142	0.62	320
9/2/04 09:00–10:00	6.0	3.9	2.9	2.0	53	0	143	0.63	307
9/2/04 16:00–17:00	5.7	3.1	2.3	1.7	64	1.1	143	0.55	316
9/3/04 06:00–07:00	10.9	5.1	7.5	2.5	31	0	97	1.18	270
9/3/04 10:00–11:00	10.1	6.0	3.2	2.5	68	5.1	143	1.47	311
9/3/04 12:00–13:00	8.7	5.7	3.1	2.6	64	20.0	143	1.30	316

* Times shown are average periods and do not represent periods of carbon injection.

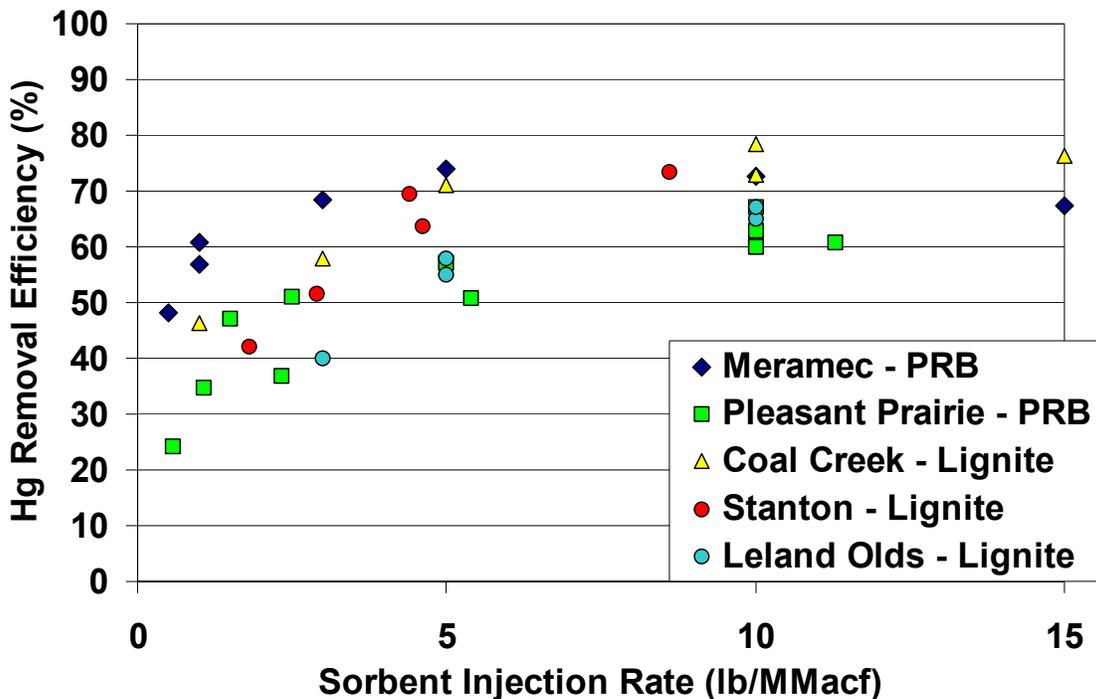


Figure 12. DARCO[®] Hg Results at Meramec and Other Low-Rank Fuel Test Sites.

DARCO[®] Hg-LH Evaluations

Because of the mercury removal limitations observed with DARCO[®] Hg at low-rank fuel sites, a series of tests was conducted with a brominated sorbent, DARCO[®] Hg-LH, that is specifically designed for use in halogen-deficient flue gas.

During the second week of parametric testing, the performance of DARCO[®] Hg-LH was evaluated at several injection rates. One of the four coal mills, Mill B, was out of service during this week. Because of the mill outage, Unit 2 was operated at a reduced load of about 115 MW, and higher variations were observed in the ESP inlet mercury concentration than during previous tests (average hourly standard deviation was 0.9 $\mu\text{g}/\text{Nm}^3$ compared to 0.6 $\mu\text{g}/\text{Nm}^3$ during earlier tests). These variations were likely caused by rapid changes in LOI carbon. Changes in LOI carbon can result in different fractions of particulate- and vapor-phase mercury in the flue gas.

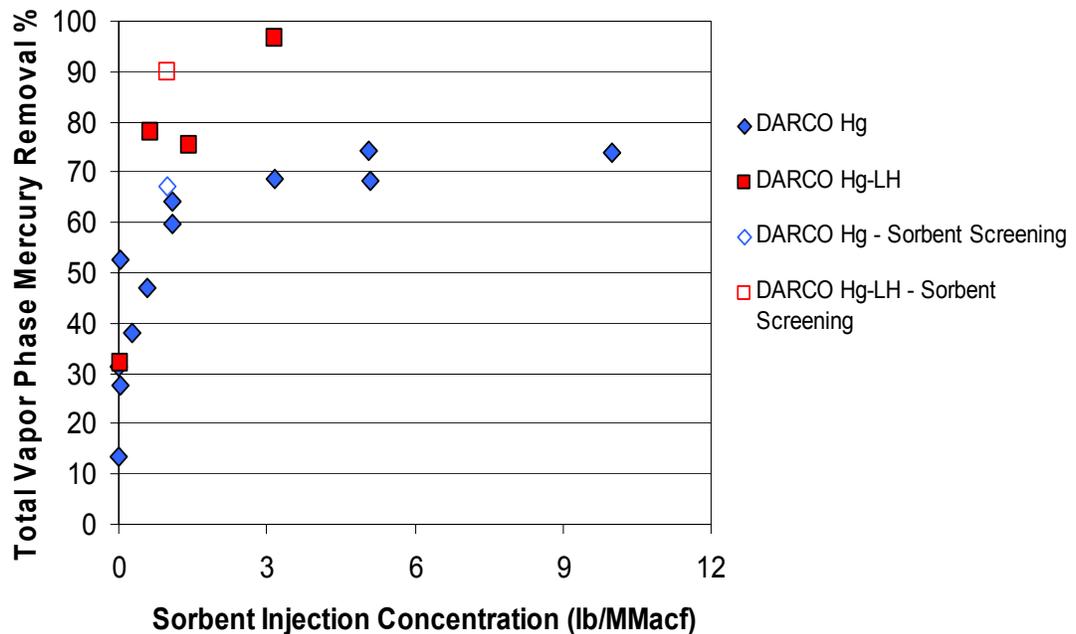
Table 11 presents the hourly average mercury concentrations measured just prior to and during DARCO[®] Hg-LH injection. At an injection concentration of 0.6 lb/MMacf, the total mercury removal was 78%. This increased to 97% removal at 3.2 lb/MMacf. The maximum mercury removal based on the change in the ESP outlet mercury concentration due to DARCO[®] Hg-LH injection was 91% at 3.2 lb/MMacf. These data clearly demonstrate that enhanced mercury removal performance can be achieved using a brominated activated carbon.

Table 11. Mercury Concentrations at the Unit 2 ESP Inlet and Outlet during DARCO[®] Hg-LH Testing.

Date/Time	Inlet Hg Total μg/Nm ³	Inlet Hg Elem. μg/Nm ³	Outlet Hg Total μg/Nm ³	Outlet Hg Elem. μg/Nm ³	Hg RE %	Injection Conc. lb/MMacf	Load MW	SO ₂ lb/MMBtu	Stack Temp °F
9/14/04 10:00–11:00	6.2	5.0	4.2	2.0	32	0	115	0.59	297
9/14/04 15:00–16:00	6.3	4.5	1.5	0.6	75	1.4	110	0.53	303
9/15/04 10:00–11:00	5.8	4.0	2.6	1.2	55	0	110	0.49	301
9/15/04 14:00–15:00	7.8	3.8	1.5	0.8	81	0.6	115	0.49	304
9/17/04 10:00–11:00	9.5	3.9	3.7	1.1	61	0	115	0.44	278
9/17/04 15:00–16:00	10.1	4.3	0.34	0.24	97	3.2	115	0.45	296

Sorbent Screening vs. Full-Scale Results

Figure 13 is a comparison of the results from the sorbent screening tests and full-scale parametric testing at Meramec for DARCO[®] Hg and DARCO[®] Hg-LH. The figure shows that the data from the SSD agree very well with full-scale results. DARCO[®] Hg-LH clearly outperforms DARCO[®] Hg as predicted by the SSD tests. These data suggest that the SSD and corresponding method of data analysis can be used to collect the data necessary to estimate the full-scale mercury removal performance of an ESP.



Coal Additives

Another option for enhancing mercury removal at sites firing PRB coals is adding chemicals to the coal. Two coal additives were tested for mercury control at Meramec. The first coal additive tested was a halogen-based coal additive, KNX, developed by ALSTOM Power. This material was evaluated during the final week of parametric testing under this DOE program. The second material tested was SEA2, an additive under development at the EERC, which was evaluated during an additional week of testing funded by AmerenUE.

Prior to the start of coal additive testing, Mill B was repaired and had been returned to service. However, the changes made to Mills A, C, and D during the outage had not been reset for four-mill operation. This may have altered the LOI concentration and form.

Some forms of LOI carbon can be effective at mercury capture. When large variations in LOI exist, large fluctuations in the fractions of vapor- and particulate-phase mercury may result. The ESP inlet vapor-phase mercury concentration, as measured by the SCSEM, was more stable than when Mill B was out of service, which suggests that large fluctuations in the LOI were no longer present. However, changes to the mill operation may have resulted in changes to the form or concentration of the LOI present in the fly ash and, consequently, a change in the stable fractions of vapor- and particulate-phase mercury.

KNX Evaluations

KNX was introduced onto the coal through the foam dust suppression system on the coal belt upstream of the tripper deck and coal bunker during each period of coal loading from Monday, September 20 through Thursday, September 23, 2004. Thus, all coal fired during this period was treated with KNX. During the final day of KNX testing, September 23, DARCO[®] Hg was injected upstream of the ESP to determine if the KNX improved the mercury removal effectiveness of the sorbent. Coal treated with KNX reached the Unit 2 boiler at nominally 8:00 a.m. on Monday, September 20, 2004.

Mill B was brought back into service shortly before KNX testing. It is expected that combustion conditions were different after the mill was returned to service and that under these conditions the “baseline” removal with no coal additive or activated carbon may have changed. Therefore, data from September 20 to 23 with KNX addition were compared to the “baseline” data from September 25 to 27 without KNX or DARCO[®] Hg injection. During September 25 to 27, the mercury removal during full-load operation ranged from 22 to 34%.

The results from KNX testing, summarized in Table 12, indicated that KNX:

- 1) Enhanced native mercury removal
- 2) Enhanced the ability of DARCO[®] Hg to remove mercury
- 3) Increased the fraction of oxidized mercury

These findings are discussed in this section.

Native Removal with KNX

The overall mercury removal based upon the mercury concentration in the coal and the vapor-phase measurements of the outlet SCEM was 88%.

Recall that the mercury SCEM only measures vapor-phase mercury. Because KNX is added with the coal, there is a potential that some additional mercury may be associated with the ash at the inlet measurement location. To account for the particulate fraction, the total mercury can be calculated using coal mercury concentrations, or measured using the in-situ ash collection device. To verify the measurements, the mercury concentration in the ash can be measured to determine the mass balance between the mercury provided by the coal, the mercury removed with the ash, and the mercury exiting the ESP as measured by the SCEM. Coal, ash, and SCEM mercury contributions are listed below:

- Inlet vapor-phase mercury: 1.7 to 3.4 $\mu\text{g}/\text{Nm}^3$ based on average SCEM measurements from daytime, full-load operation September 20 through 22. This is lower than during previous tests.
- Total inlet mercury: 4.2 to 6.5 $\mu\text{g}/\text{Nm}^3$ based upon mercury concentration in coal samples collected on September 21 and 22.
- Outlet vapor-phase mercury: 0.7 to 1.5 $\mu\text{g}/\text{Nm}^3$ based on average SCEM measurements from daytime, full-load operation September 20 through 22.
- Inlet particulate-phase mercury: The difference in the predicted total inlet mercury concentration and the measured inlet vapor-phase concentration suggests there was significant particulate-phase mercury at the inlet to the ESP during these tests. Unfortunately, in-situ ash samples were not available for most of the KNX test period to confirm the high particulate fraction of mercury.
- Ash samples collected in the first field of the ESP were available and the particulate mercury concentration based upon these samples ranged from 2.6 to 7.3 $\mu\text{g}/\text{Nm}^3$. Estimated mercury concentrations in the flue gas based on mercury in the coal and ash during coal additive testing are presented in Figure 14. The estimated particulate-phase mercury at the inlet to the ESP based upon the mercury concentration in the coal and the vapor-phase measurements of the inlet SCEM was 58%.

The change in vapor-phase mercury across the ESP can be calculated by comparing the inlet and outlet SCEM concentrations. With KNX only, the change in the vapor-phase mercury measured with the SCEMs ranged from 57 to 64%, as compared to 22 to 34% without KNX. These data also suggest that KNX alone enhanced the effectiveness of the native fly ash at Meramec.

The LOI carbon content of fly ash samples collected in the first field during KNX-only testing, September 21 through 22, ranged from 0.43 to 3.81%, with an average of 1.8%. It is believed that the LOI content of the fly ash may have contributed to the effectiveness of the KNX for mercury capture. More details on the LOI concentrations during coal additive testing are included in the section on Characterization of Process Solids.

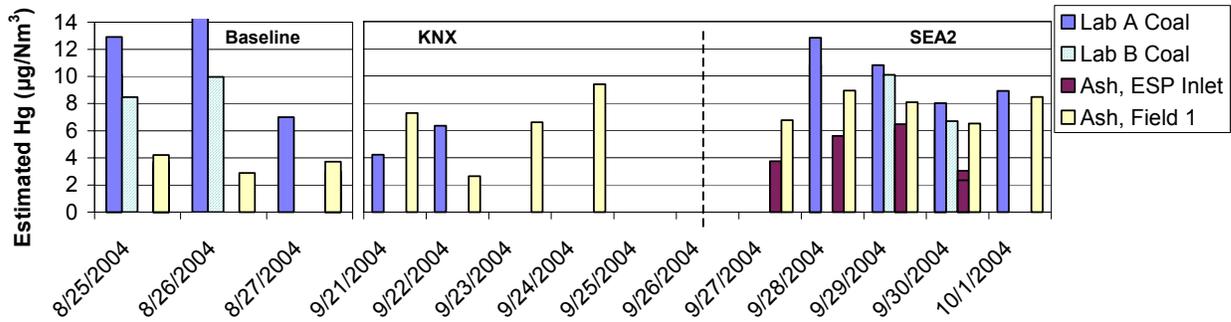


Figure 14. Flue Gas Mercury Concentrations Based upon Analyses of Ash and Coal during Coal Additive Testing.

Enhanced Effectiveness of DARCO® Hg with KNX

While injecting KNX on September 23, DARCO® Hg was injected at the ESP inlet at injection concentrations from 0.6 to 5 lb/MMacf. Sorbent was injected at 5 lb/MMacf for slightly over an hour. The average mercury removal for the hour at this injection concentration was 82%. The average vapor-phase mercury removal based upon SCSEM measurements during the final 30 minutes of testing at 5 lb/MMacf was 88%. A summary of these data is included in Table 12 and hour-average mercury removal during testing on September 23 is presented in Figure 15.

The total mercury content in the coal sample collected on September 23 was 0.108 µg/g (dry basis), which yields an equivalent total mercury concentration of 12.0 µg/Nm³ in the flue gas. Thus, the particulate-phase mercury fraction at the ESP inlet was estimated to be around 8.6 µg/g, which represented a total mercury removal of 97%. The mercury content of an ash sample collected from the first field hopper contained 0.859 µg/g mercury. This was equivalent to approximately 6.61 µg/Nm³ in the flue gas, or 55% removal based on the coal and ash. This ash sample was collected before the injection concentration was increased to 3 lb/MMacf.

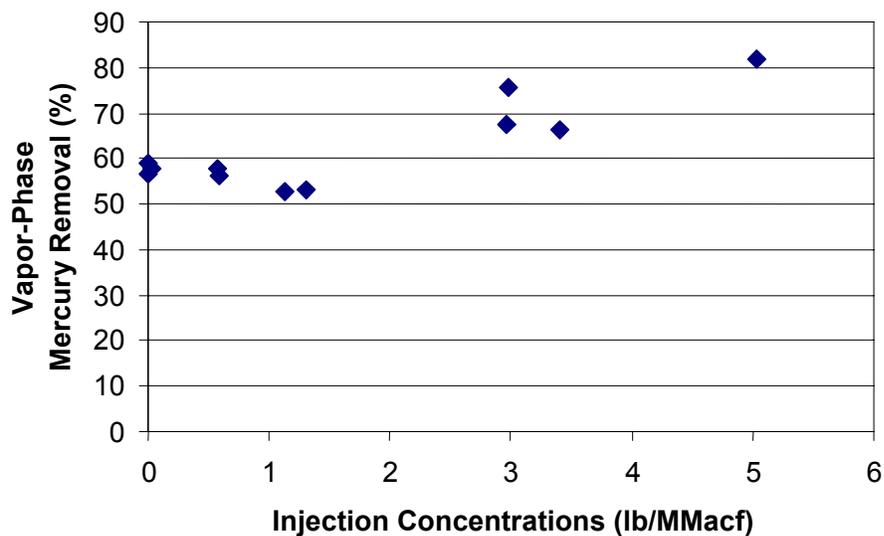


Figure 15. Hour-Average Mercury Removal during KNX + DARCO® Hg Testing.

Some coal samples were submitted to more than one laboratory for inter-laboratory comparison testing. Results rarely matched between the labs, as shown by the Lab A and Lab B data in Figure 14. This could be due to variations in the coal or inconsistencies in the laboratory analyses. These discrepancies are discussed in more detail in the section on Characterization of Process Solids.

Table 12. Vapor-Phase Mercury Concentrations at the Unit 2 ESP Inlet and Outlet During KNX and KNX+DARCO[®] Hg Testing.

Date/Time	Coal Hg µg/Nm ³	Inlet Hg Total µg/Nm ³	Inlet Hg Elem. µg/Nm ³	Outlet Hg Total µg/Nm ³	Outlet Hg Elem. µg/Nm ³	ESP Hg RE %	Total Hg RE %	DARCO [®] Hg Injection Conc. lb/MMacf
9/20/04 09:00–21:00		3.4	1.57	1.5	0.49	57		0
9/21/04 10:00–20:00	4.23	1.7	0.69	0.7	0.44	60	83	0
9/22/04 10:00–19:00	6.5	2.8	0.48	1.0	0.44	64	85	0
9/23/04 09:00–10:00		4.3	0.53	1.8	0.50	58		0
9/23/04 12:00–13:00		4.2	0.83	1.8	0.59	56		0.6
9/23/04 15:00–16:00		3.8	0.74	1.2	0.64	67		3.0
9/23/04 17:30–18:00		3.4	0.67	0.41	0.15	88		5.0
9/25/04 06:00–07:00		4.8	0.83	3.6	1.8	22		0
9/27/04 10:00–14:00		4.3	2.3	2.8	1.8	34		0

Increase Fraction of Oxidized Mercury with KNX

During KNX testing, the fraction of oxidized mercury at the ESP inlet and outlet significantly increased from baseline levels. The average fraction of oxidized mercury at the inlet to the ESP from September 21–23 was 82%. During the baseline test period, August 24–26, the average amount of oxidized mercury measured by the mercury analyzers at the ESP inlet was 20%. On September 27, following KNX testing with the adjusted mill operation, the average fraction of oxidized mercury at the inlet to the ESP was 47%. The higher fraction of oxidized mercury at the ESP inlet following KNX testing may have been a result of residual KNX in the system or a change in combustion characteristics from the mill classifier adjustments. Although coal was not treated with KNX from September 24–27, it is possible that there was still a residual effect on September 27.

SEA2 Evaluations

The second coal additive tested was SEA2, under development by the EERC. SEA2 testing was conducted from September 28 through October 1. During the final two days of testing, DARCO[®]-Hg was injected upstream of the ESP while SEA2 was present on the coal. SEA2 coal additive was introduced onto the coal at the coal feeder just upstream of coal Mill B. Unlike KNX testing, the SEA 2 could be tested in small batches rather than treating a full bunker of coal.

The average total vapor-phase mercury concentrations inlet and outlet of the ESP on September 27 prior to beginning the SEA2 tests were 4.3 $\mu\text{g}/\text{Nm}^3$ and 3.1 $\mu\text{g}/\text{Nm}^3$ respectively. This represents 27% vapor-phase mercury capture across the ESP.

During the first day of testing, SEA2 was introduced at an injection rate of 1.9 lb/hr. The total vapor-phase mercury at the inlet of the ESP decreased from 4.5 $\mu\text{g}/\text{Nm}^3$ to 2.7 $\mu\text{g}/\text{Nm}^3$ and the outlet total vapor-phase mercury decreased from 1.9 to 1.5 $\mu\text{g}/\text{Nm}^3$. Upon removal of the SEA2, the inlet and outlet mercury concentrations returned to near pre-SEA2 levels. On the following test day at an additive injection rate of 5.0 lb/hr, the effectiveness of the SEA2 was more pronounced. The average vapor-phase mercury concentrations at the inlet and outlet prior to SEA2 injection were 8.0 and 3.3 $\mu\text{g}/\text{Nm}^3$ respectively. Following introduction, the vapor-phase mercury concentrations were 2.1 $\mu\text{g}/\text{Nm}^3$ at the ESP inlet and 1.1 $\mu\text{g}/\text{Nm}^3$ (0.86 lb/TBtu) at the outlet. A summary of the results for SEA2 testing is presented in Table 13.

Table 13. Summary of Results during SEA2 Testing.

Date/Time	ESP Inlet Vapor Total $\mu\text{g}/\text{Nm}^3$	ESP Inlet Elemental $\mu\text{g}/\text{Nm}^3$	ESP Outlet Vapor Total $\mu\text{g}/\text{Nm}^3$	ESP Outlet Elemental $\mu\text{g}/\text{Nm}^3$	% Vapor-Phase Hg Removal	% Change in Inlet Vapor Hg	SEA2 Inject. Rate (lb/hr)	DARCO [®] Hg Inject. Conc. (lb/MMacf)
9/27/04 11:00–20:00	4.3	2.4	3.1	2.2	27	NA	0	0
9/28/04 10:00–15:00	2.7	1.05	1.7	0.90	33	39	1.9	0
9/29/04 08:30–12:00	4.4	1.4	2.2	1.1	29	49	1.9	0
9/29/04 12:00–14:00	3.9	0.9	2.0	0.7	50		2.4	0
9/29/04 14:00–16:00	2.2	0.8	1.3	0.4	52	73	5	0
9/30/04 10:00–15:00	3.2	0.6	1.2	0.2	49	70	5	2.9
10/1/04 9:00–12:00	2.6	0.3	1.0	NA	67	63	5	1

The SEA2 coal additive was tested with DARCO[®] Hg injection at the ESP inlet on September 30 and October 1. During the activated carbon injection tests, the SEA2 injection rate was maintained at 5 lb/hr and the sorbent injection concentrations ranged from 1.0–2.9 lb/MMacf. Without sorbent injection, SEA2 alone reduced outlet mercury emissions to nominally 1.3 $\mu\text{g}/\text{Nm}^3$ (0.95 lb/TBtu). With the co-injection of DARCO[®] Hg at the ESP inlet, average outlet mercury emissions dropped slightly to 1.0–1.2 $\mu\text{g}/\text{Nm}^3$.

Introduction of SEA2 increased the fraction of vapor-phase oxidized mercury measured by the analyzers. Prior to SEA2 testing, the oxidized mercury fraction was 45% at the inlet of the ESP and 32% at the outlet of the ESP. At an SEA2 injection rate of 5 lb/hr, the oxidized mercury fraction ranged from 62 to 90% at the ESP inlet and 72 to 83% at the ESP outlet. Recall that the fraction of oxidized mercury prior to testing SEA2 was higher

than observed at Meramec during a previous baseline test period in August 2004 and higher than typically observed by ADA-ES at PRB sites. This may be related to the higher fraction of LOI, which has been shown to promote oxidation of vapor-phase mercury,^{4,5} or residual KNX in the system from the previous test week.

Another trend noted during SEA2 testing was an increase in the vapor-phase mercury concentration at the inlet of the ESP during low-load conditions. When boiler load is reduced, less coal is being fed into the boiler. However, to maintain a minimum airflow in the duct, combustion air going to the boiler is reduced but to a lesser degree than the reduction in coal flow. Thus, the air-to-fuel ratio increases at lower boiler load conditions. Increased coal combustion completeness typically results in lower levels of LOI carbon in the fly ash at low load. Lower levels of LOI carbon in the fly ash can result in increases in vapor-phase mercury concentrations. Unfortunately, ash samples were not collected that represented high- and low-load operation to analyze for unburned carbon and mercury.

Long-Term Test (35 days)

After reviewing the parametric testing results, the test team (AmerenUE, ADA-ES, EPRI, and DOE/NETL) agreed to inject DARCO[®] Hg-LH, a brominated activated carbon, during the long-term testing period based on positive mercury removal performance and cost effectiveness from initial economic analyses. Testing objectives during the long-term test were two-fold and testing was divided into two phases:

Phase I: Determine the minimum amount of sorbent needed to maintain a mercury removal efficiency of 60–70% (October 14–18)

Phase II: Achieve 85 to 95% mercury removal across the ESP, or sustain outlet mercury emissions at nominally 0.7 lb/TBtu (1.0 $\mu\text{g}/\text{Nm}^3$) (October 18–November 17)

Phase I Testing

During the first phase of long-term testing, the target mercury removal efficiency was 60–70%. Continuous sorbent injection began on October 14 at an injection concentration of 0.5 lb/MMacf. The sorbent injection concentration was adjusted until the total vapor-phase mercury removal was in the desired range. Results from this portion of long-term testing indicate a sorbent injection concentration of 1 lb/MMacf yields of 60–70% vapor-phase mercury capture across the ESP. Daily averages of the mercury concentrations at the inlet and outlet of the ESP during the Phase I period are summarized in Table 14.

Table 14. Long-Term Vapor-Phase Mercury Concentrations and ACI Injection Rates while Targeting 60–70% Vapor-Phase Mercury Removal Efficiency.

Date	Inlet Hg (µg/Nm ³)	Inlet Hg Elem. (µg/Nm ³)	Inlet Hg (lb/TBtu)	Outlet Hg (µg/Nm ³)	Outlet Hg Elem. (µg/Nm ³)	Outlet Hg (lb/TBtu)	Hg Removal (%)	ACI Rate (lb/MMacf)
10/14/04 17:00–24:00	8.9	5.2	6.3	6.3	4.1	4.4	29.7	0.5
10/15/04 0:00–24:00	11.1	6.0	7.9	4.9	2.8	3.5	56.0	0.7
10/16/04 0:00–24:00	7.1	3.4	5.0	2.7	1.5	1.9	62.4	1.0
10/17/04 0:00–24:00	4.1	1.7	2.9	1.4	0.8	1.0	67.1	1.0
10/18/04 0:00–7:00	4.3	1.4	3.0	1.6	1.0	1.1	63.3	0.9

* Mercury concentrations shown represent only the vapor-phase species in the flue gas.

Phase II Testing

During the second phase of long-term testing, DARCO[®] Hg-LH was continuously injected over a 30-day period to achieve an average of >90% mercury capture across the ESP. The goal of this task was to prove viability of this technology and determine process economics by measuring the effects of continuous injection on:

- Balance-of-plant impacts
- ESP performance
- Byproducts (e.g., fly ash)

The sorbent feeder was configured to adjust feed rate based upon on a feed-forward signal from the plant representing the amount of coal fed into the boiler. An algorithm was developed to correlate coal feed rate to duct flow so that the sorbent injection concentration could be maintained with variations in load.

The sorbent injection concentration was increased from 2.5 lb/MMacf to 4.5 lb/MMacf over the first four days of testing in order to achieve at least 90% vapor-phase mercury capture. Following four days of Phase II testing, the injection concentration was decreased to approximately 3 lb/MMacf with no significant reduction in the mercury removal across the ESP. A trend graph of the mercury removal and sorbent injection concentration for the Phase I and Phase II test periods is presented in Figure 16.

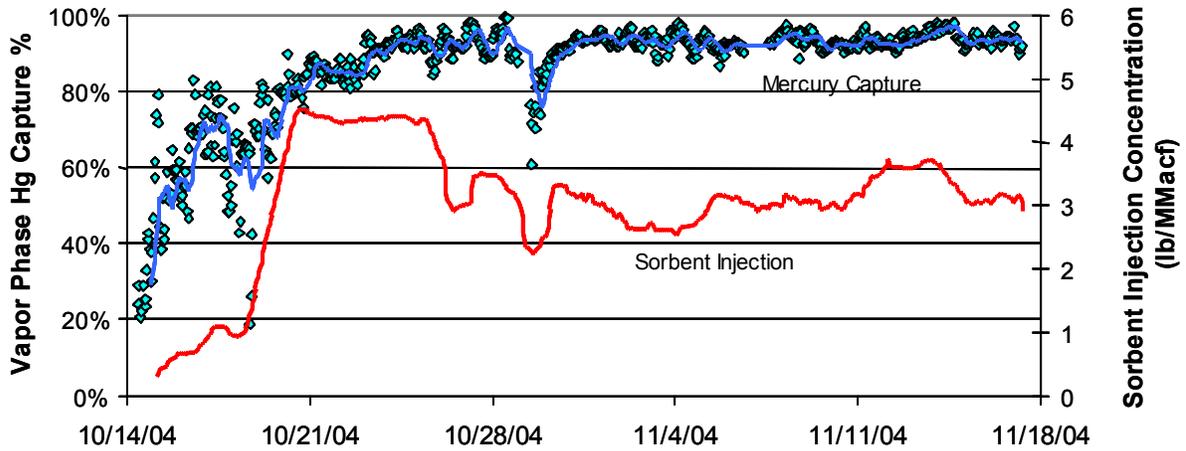


Figure 16. Mercury Removal Trends during Long-Term Testing Series.

On October 29 during the early morning hours, a module that controls the blower speed failed, causing the injection skid to go into an automatic shutdown procedure. The mercury removal decreased sharply when sorbent feed was interrupted, as shown in Figure 16. The alarm condition was repaired within a few hours and sorbent injection was resumed.

The average inlet and outlet mercury concentrations were 8.5 and 0.6 $\mu\text{g}/\text{Nm}^3$ (5.98 and 0.44 lb/TBtu) respectively for the Phase II long-term tests. This yields an average vapor-phase mercury capture of 93% at an average sorbent injection concentration of 3.3 lb/MMacf. This agrees well with the parametric testing results as shown in Figure 17. Long-term trends showing inlet and outlet mercury concentrations (lb/TBtu) are presented in Figure 18.

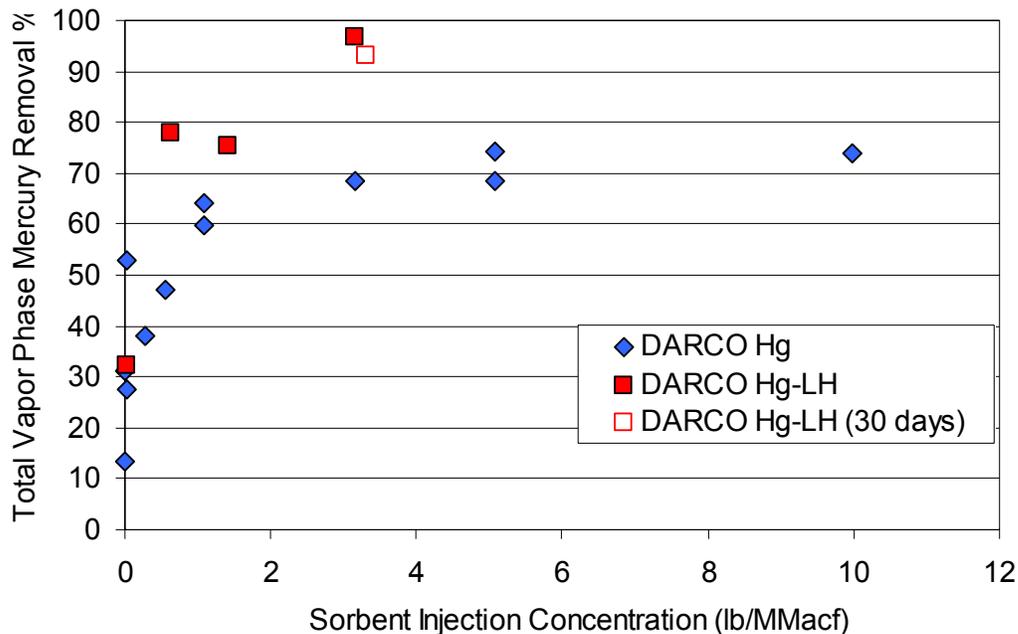


Figure 17. Comparison of DARCO® Hg-LH Results from Parametric and Long-Term Tests.

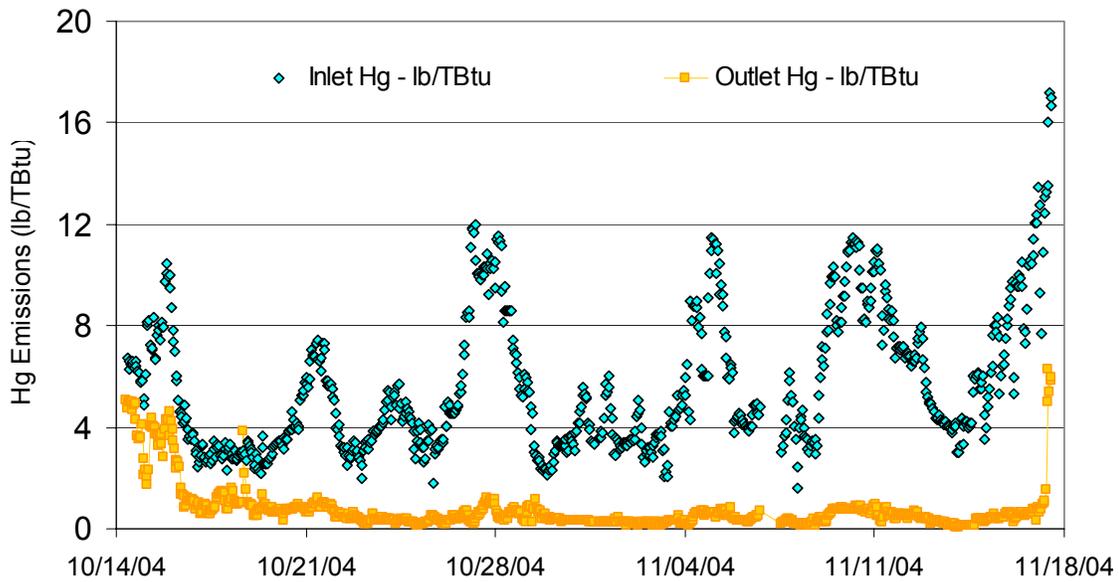


Figure 18. Mercury Concentrations (lb/TBtu) during Long-Term Testing Series.

During the 30-day continuous test (Phase II), the amount of oxidized mercury at the ESP inlet ranged from 40–60%, as shown in the trend graph in Figure 19. Due to the low total vapor-phase mercury concentrations at the outlet of the ESP, no speciation measurements were made with the SCEM at the outlet during this test period. Ontario Hydro measurements the weeks of November 2 and November 9 indicated 30 to 35% oxidized mercury at the outlet of the ESP.

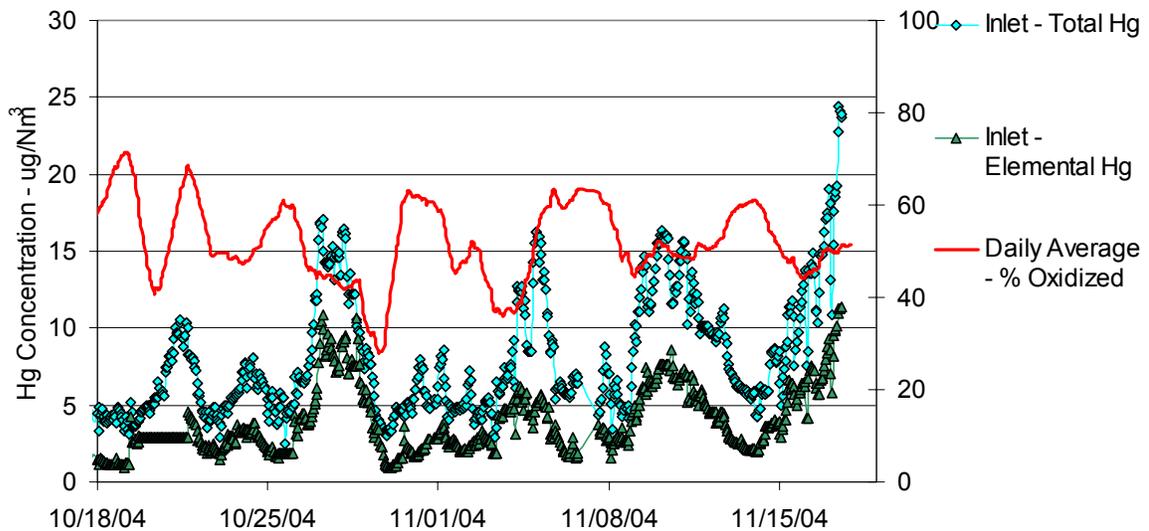


Figure 19. Speciation at the ESP Inlet during Phase II Long-Term Testing.

Mercury Concentrations Based on Several Test Methods

Several different techniques were used to measure mercury at Meramec. These included flue gas measurements using EPA Method 29, the sorbent trap method (STM) (based on the technique previously referred to as EPA draft Method 324, now 40 CFR Part 75 Appendix K), Ontario Hydro (ASTM M6784-02), mercury analyzers (SCEM), and analysis of mercury in coal and ash samples. During the long-term test period, a series of triplicate Ontario Hydro runs were conducted between November 2 and 4 and another set of triplicate runs were conducted on November 9 at both the inlet and outlet to the ESP. Data collected with these techniques during the long-term test are presented as a trend graph in Figure 20. In general, there is good correlation between the methods. The data from the coal samples are presented as the mercury concentration in the flue gas and the data from the fly ash samples are presented as amount of particulate-phase mercury captured in the first field of the ESP. Recall that the mercury analyzers measure only vapor-phase mercury, as compared to the Ontario Hydro and Method 29, which measure total mercury. The sorbent traps used at the inlet to the ESP were connected to the inertial separation probe for the analyzer, thus these values also represent only vapor-phase mercury. Data from the Ontario Hydro measurements and Method 29 mercury measurements are also included in Tables 15, 16, and 17 for reference. The full Ontario Hydro and Method 29 test reports are included in Appendix G.

The average total (vapor + particulate) mercury removal efficiencies based upon the Ontario Hydro results were 94.6 and 91.2% respectively for the two sets of measurements conducted during long-term testing. The mercury concentrations as measured by the Ontario Hydro method at the inlet to the ESP were approximately 40% higher than the concentrations measured by the inlet mercury analyzer and 60 to 90% of the mercury was reported as particulate-phase mercury. The Ontario Hydro sampling train is designed to capture particulate matter on a filter. The filters are analyzed for mercury and the numbers are reported as the particulate fraction of mercury in the flue gas. However, if the fly ash is reactive with vapor-phase mercury, additional mercury can be collected on the ash, which can bias the speciation results. The Ontario Hydro data from

Table 15 indicated a significant fraction of mercury collected on the sampling filter. This fraction is higher than predicted by coal and SCEM measurements and is likely biased high because of the reactive nature of the fly ash and not necessarily representative of the actual fraction of mercury on the fly ash at the inlet of the ESP.

Since the mercury analyzer does not have the ability to measure particulate-phase mercury, in-situ fly ash samples were collected at the ESP inlet and measured for mercury content. Mercury content from these samples suggests 30–40% of the mercury at the ESP inlet was in particulate phase. Total mercury concentrations were calculated by adding the vapor-phase concentration, as measured by the inlet mercury analyzer, and the particulate-phase fraction from the in-situ fly ash sample together. These values were within 10% of the total mercury as measured by both sets of Ontario Hydro tests.

At the ESP inlet, the average mercury concentration as measured by the EPA Method 29 was $7.175 \mu\text{g}/\text{Nm}^3$. The average mercury concentration at the ESP outlet was 0.818

$\mu\text{g}/\text{Nm}^3$, which yields an average mercury removal efficiency of approximately 89%. The total mercury concentrations measured using Method 29 agreed well with the vapor-phase mercury concentrations as measured by the mercury analyzers, but were consistently lower than the concentrations measured by the Ontario Hydro. It is unknown why there was a discrepancy between the Ontario Hydro and Method 29 results.

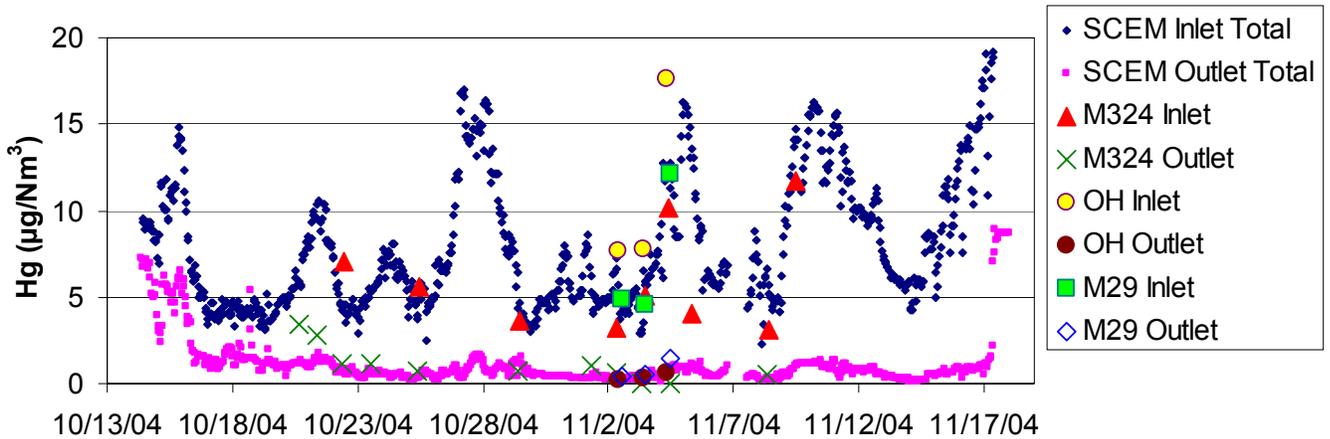


Figure 20. Long-Term Test Mercury Measurements.

Note: SCEM is vapor-phase, OH, and M29 are total mercury; M324 is vapor-phase at inlet.

Table 15. Comparison of Ontario Hydro and SCEM, November 2–4, 2004.

	ESP Inlet			ESP Outlet		
	Run 1 11/2/04 09:45 $\mu\text{g}/\text{Nm}^3$	Run 2 11/3/04 08:55 $\mu\text{g}/\text{Nm}^3$	Run 3 11/4/04 08:30 $\mu\text{g}/\text{Nm}^3$	Run 1 11/2/04 09:45 $\mu\text{g}/\text{Nm}^3$	Run 2 11/3/04 08:55 $\mu\text{g}/\text{Nm}^3$	Run 3 11/4/04 08:30 $\mu\text{g}/\text{Nm}^3$
<i>OH Particulate</i>	6.9	6.4	12.1	0.01	0.014	0.005
<i>OH Elemental</i>	0.51	0.37	1.7	0.22	0.31	0.66
<i>OH Oxidized</i>	0.33	1.0	3.8	0.10	0.08	0.37
OH Total	7.7	7.8	17.6	0.33	0.40	1.03
SCEM Vapor-Phase	4.4	5.0	12.4	0.32	0.40	0.82
In-Situ Particulate	1.7	1.6	6.3	N/A	N/A	N/A
SCEM + In-Situ Total	6.1	6.6	18.7	0.32	0.40	0.82

Table 16. Comparison of Ontario Hydro and SCEM, November 9, 2004.

	ESP Inlet			ESP Outlet		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
	11/9/04 10:45 µg/Nm ³	11/9/04 13:15 µg/Nm ³	11/9/04 15:40 µg/Nm ³	11/9/04 10:45 µg/Nm ³	11/9/04 13:15 µg/Nm ³	11/9/04 15:40 µg/Nm ³
<i>OH Particulate</i>	13.8	11.41	11.9	0.005	0.005	0.005
<i>OH Elemental</i>	2.2	2.6	2.3	1.1	2.6**	1.1
<i>OH Oxidized</i>	4.3	4.6	5.1	0.56	0.82**	0.60
OH Total	20.3	18.6	19.3	1.7	3.5**	1.7
SCEM Vapor Phase	14.4	11.5	11.3	1.1	1.1	1.1
In-Situ Particulate	7.6	7.6*	7.6*	NA	NA	NA
SCEM + In-Situ Total	22.0	19.1	18.9	1.1	1.1	1.1

Mercury concentrations are corrected to normal temperature and pressure conditions (i.e., 0° and 760 mm Hg).

** Only one in-flight sample collected on 11/9/04 during Run 1. Runs 2 and 3 are estimates based upon Run 1 values.*

*** Activated carbon was off during the second run of Ontario Hydro tests. Thus, the mercury concentrations at the ESP outlet during the second run are higher than the other two runs.*

Table 17. Comparison of EPA Method 29 and SCEM, November 2–4, 2004.

	ESP Inlet			ESP Outlet		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
	11/2/04 12:30 µg/Nm ³	11/3/04 11:28 µg/Nm ³	11/4/04 11:20 µg/Nm ³	11/2/04 12:30 µg/Nm ³	11/3/04 11:28 µg/Nm ³	11/4/04 11:20 µg/Nm ³
M 29	4.9	4.5	12.1	0.43	0.54	1.03
SCEM Vapor-Phase	4.2	5.7	11.5	0.34	0.42	0.82
In-Situ Particulate	1.7	1.6	6.3	N/A	N/A	N/A
SCEM + In-Situ Total	5.9	7.3	17.8	0.34	0.42	0.82

The increase in mercury removal over baseline conditions is defined for this program as a comparison in the outlet emissions measured using the Ontario Hydro method during the baseline and long-term test periods. During baseline testing, the average mercury concentration at the inlet was 11.2 µg/Nm³ and the average outlet concentration was 9.3 µg/Nm³. During long-term testing, the inlet concentration based upon Ontario Hydro measurements ranged from 7.7 to 20.3 µg/Nm³. The average inlet and outlet concentrations were 15.2 and 1.03 µg/Nm³. The average inlet concentration was 26% higher during long-term testing compared to baseline testing. The change in outlet emissions from baseline to long-term testing was 89%.

Effectiveness of DARCO[®] Hg-LH on Multi-Metals

To determine the trace metals emission rates, EPA Method 29 was run in triplicate at the ESP inlet and outlet during both the baseline and the long-term test periods. A summary of results from baseline testing is presented in Figure 21 and the full report is included in Appendix G. As shown in the figure, many of the species measured at the outlet of the ESP were below the detection limit of the technique, which is reported as zero on this graph. At least 50% removal was measured for several elements including arsenic, barium, cobalt, copper, manganese, and nickel. All of these should be in the particulate phase at the ESP and removed at a similar collection efficiency as the bulk fly ash.

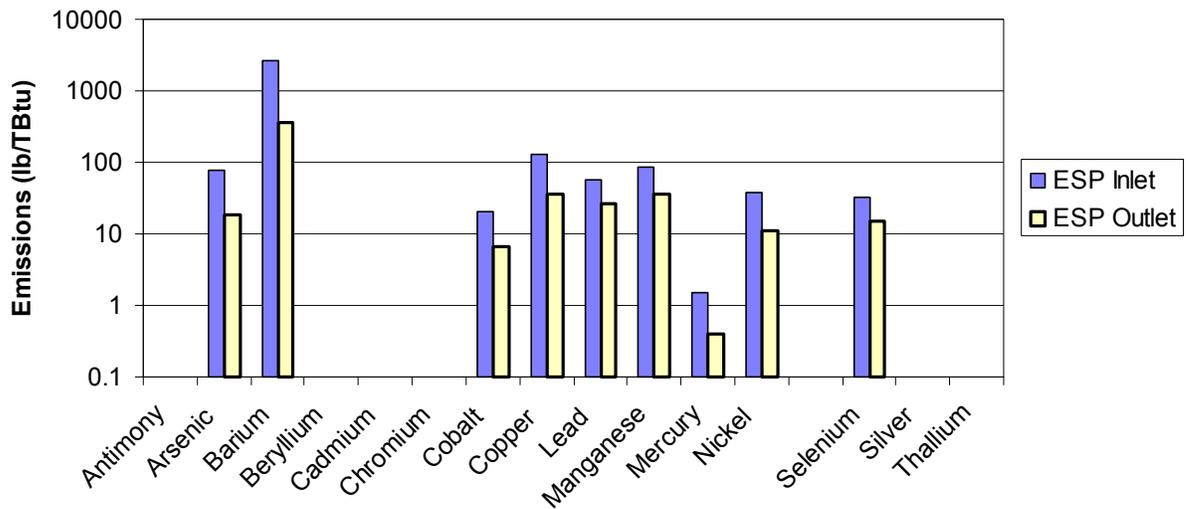


Figure 21. EPA Method 29 Measurements from Baseline Test Period.

EPA Method 29 measurements were also made during the long-term test period. The average sorbent injection concentration during these tests was approximately 2.8 lb/MMacf. The average results of the triplicate runs are included on Figure 22 and the full report is included in Appendix G. The outlet measurements for many elements, including antimony, arsenic, beryllium, cadmium, chromium, cobalt, selenium, silver, and thallium were below the detection limit for the method. These data are shown as hatched bars on the plot.

The removal efficiencies from long-term testing are compared to measurements from the baseline test period in Figure 23. As shown, the removal for most elements is higher during continuous DARCO[®] Hg-LH injection. The data are shown as hatched if the outlet value was below the detection limit, indicating that the removal efficiency is at least the level shown. No data are included on the plot for elements that were below the detection limit at the inlet of the ESP. The data are not definitive for many of the elements due to the detection limits of the method. The data from the baseline test period are suspect for some elements, especially mercury, as discussed in the section on baseline testing results. The full Method 29 test reports are included in Appendix G.

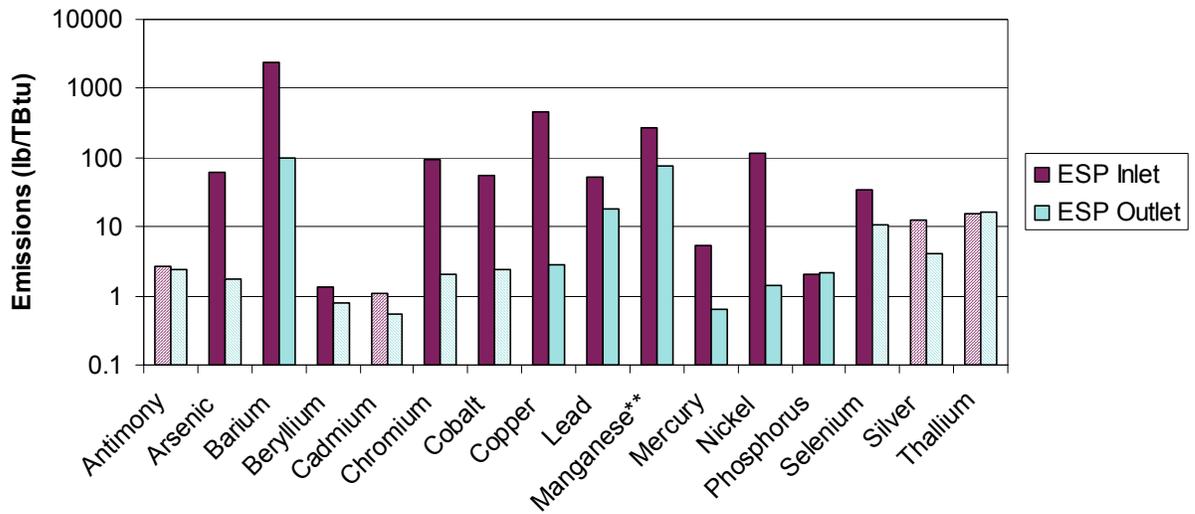


Figure 22. EPA Method 29 Measurements from Long-Term Test Period.

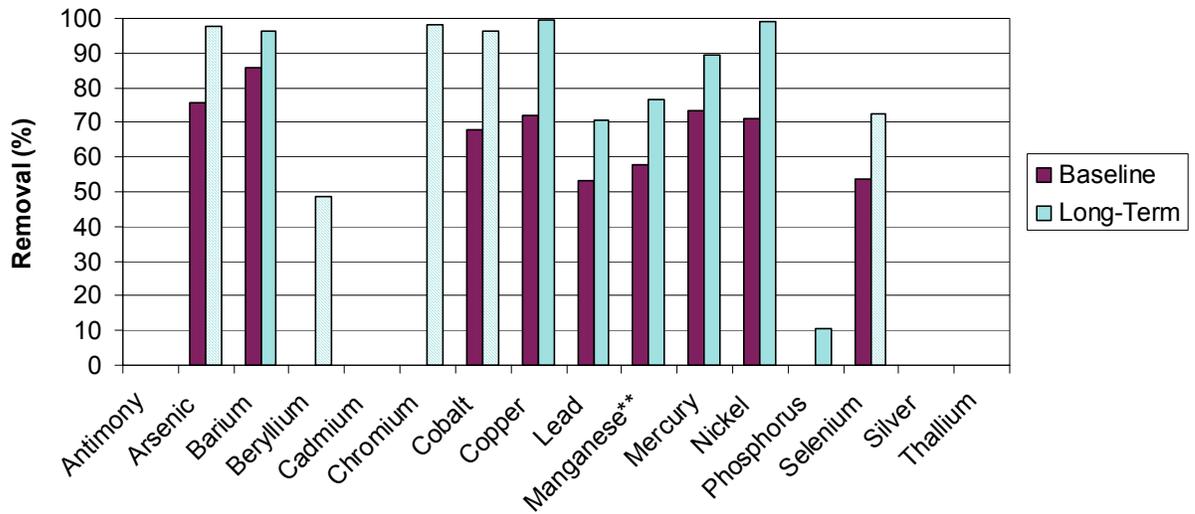


Figure 23. Multi-Metal Removal during Baseline and DARCO® Hg-LH Injection.

Effect of DARCO[®] Hg-LH on Halide Emissions

To determine the halogen and hydrogen halide concentration in the flue gas, triplicate runs of the EPA Method 26a were conducted at the inlet and outlet of the ESP during the baseline and long-term test periods. Results are summarized in Figure 24. All values are quite low, less than 1 ppm for all halides measured, which is representative of units firing PRB coals. As shown, the chlorine concentration reported during the baseline period is two to three times higher than the HCl concentration. This is an unexpected result because the system design should promote the formation of HCl over Cl₂. During the long-term test, the concentration and fractions of HCl and Cl₂ are nearly the opposite of the baseline results (baseline inlet: 294 lb/TBtu HCl, 947 lb/TBtu Cl₂; long-term inlet: 860 lb/TBtu HCl, 203 lb/TBtu Cl₂). In addition, the average HCl emissions increased from the inlet to the outlet during baseline testing.

The total chlorine (HCl + Cl₂) was almost unchanged from inlet to outlet in the baseline (1,241 to 1,276 lb/TBtu), but showed a 12% decrease during long-term testing (1,063 to 933 lb/TBtu). The total chlorine concentration measured at the inlet to the ESP translates into about 27 µg/g Cl in the coal during baseline testing and 15 µg/g Cl during long-term testing, which is in the range expected. In previous sorbent injection demonstrations, we have seen that the chlorine content of the fly ash increased when activated carbon was added.

The HBr measured at the inlet to the ESP during long-term testing was 398 lb/TBtu. This translates into about 10 µg/g Br in the coal, which is higher than expected. PRB coal samples from Jacobs Ranch and Black Thunder were analyzed for bromine during testing at Holcomb Station using Neutron Activation analysis, a low detection-limit method for bromine. These results indicated that the bromine concentration in the coal ranged from 0.5 to 1.8 µg/g.

The HBr increased 27% across the ESP during the long-term tests, from 398 lb/TBtu (0.16 ppm) at the inlet of the ESP to 685 lb/TBtu (0.26 ppm) at the outlet. The sorbent injected during the 35-day continuous test was treated with trace amounts of bromine compounds. The amount of bromine compounds used to produce the DARCO[®] Hg-LH material is unknown. The increase in HBr could be a result of a fraction of the bromine compounds released from the sorbent particle once injected into the flue gas stream. The M26a test reports are included in Appendix G.

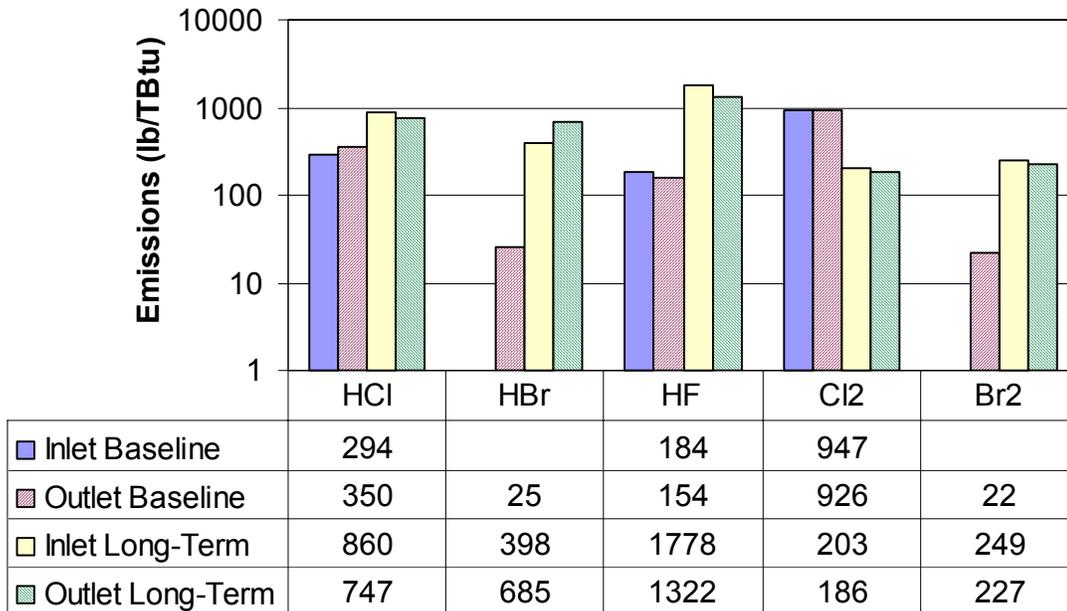


Figure 24. Results of EPA Method 26A Measurements during Baseline and Long-Term Testing.

Characterization of Process Solids and Liquids

Several types of process samples were collected during mercury control testing at Meramec. Analyses conducted included ultimate, proximate, mercury, and chlorine analyses of select coal samples, mercury analyses of most of the fly ash samples collected, and stability determinations of select fly ash samples through leaching tests and thermal desorption tests. The LOI carbon content of several ash samples was also determined.

Plant personnel collected coal samples daily throughout the evaluation. To collect a representative sample of the as-fired composition of the coal, samples were collected at the Unit 2 coal feeders just upstream of the coal pulverizers. Approximately 1-liter samples were collected and select samples were analyzed from each test period. These coal samples were typically collected during the middle of each test day.

Grab samples of coal and fly ash collected throughout testing were analyzed for mercury content. Mercury concentrations in the coal samples can be used to estimate mercury concentration in the flue gas by assuming all of the mercury in the coal volatilizes and forms vapor-phase mercury. This value can be compared to the mercury concentration measured with the mercury SCEM. Since the mercury SCEM only measures vapor-phase mercury, the two values may not compare well if there is a significant fraction of particulate-phase mercury at the inlet to the ESP. Mercury concentrations in the fly ash samples can be used to estimate the amount of mercury being collected on the fly ash and removed from the vapor-phase.

Results from ultimate, proximate, chlorine, fluorine, and mercury analyses conducted on coal samples collected on August 24 during the baseline testing series and during each set of Ontario Hydro measurements conducted during the long-term testing are presented in Table 18. Chlorine and fluorine contents from the coals from long-term testing were lower than the coal samples collected during the baseline tests.

Table 18. Results from Baseline and Long-Term Coal Analyses. (Dry Basis.)

	Baseline 8/24/04	Long-Term 11/2/04	Long-Term 11/9/04
Element			
Hg (µg/g)	0.136	0.0689	0.126
Cl ((µg/g)	16	7	6
F (µg/g)	303	54	73
Proximate			
Ash (wt%)	7.48	7.26	9
Volatile Matter (wt%)	44.16	44.71	43.16
Fixed Carbon (wt%)	48.35	48.03	47.84
Heating Value (BTU/lb)	12029	11944	12053
Total Sulfur (wt%)	0.74	0.43	1.03
Ultimate			
Ash (wt%)	7.48	7.26	9
Carbon (wt%)	72.47	72.45	71.81
Hydrogen (wt%)	5.33	4.86	5.01
Nitrogen (wt%)	0.95	1.11	1.07
Total Sulfur (wt%)	0.74	0.43	1.03
Oxygen (by difference) (wt%)	13.03	13.89	12.08

To assure the quality of the data, several coal samples were sent to more than one laboratory for redundant mercury and chlorine analyses. In most cases, the reported analyses differed from lab to lab. The results were also often different when the sample was resubmitted and analyzed by the same lab. For example, coal samples collected on August 24–26 were split and submitted to two laboratories for mercury analysis. The results were significantly different. Data are presented in Table 19 for reference. The causes of the variations in results are not clear but could be due to variations in the coal or inconsistencies in the laboratory analyses. Regardless of the reasons, the inconsistencies make it difficult to interpret the results. These discrepancies are discussed in more detail in a paper on sample quality assurance included in Appendix H.

Table 19. Variations in Coal Mercury Concentrations by Laboratory.

Sample	Lab A (µg/g)	Lab B (µg/g)
8/24/04 Sample 1 Run 1 Sample 2 Run 1 Sample 2 Run 2 Sample 2 Run 3	0.136 0.064 0.087 0.079	0.127
8/25/04 Sample 1 Sample 2	0.116 0.091	0.076
8/26/04	0.221	0.089

During the field evaluation, it was observed that changes in fuel could be identified primarily through variations in SO₂ emissions. The mercury concentrations at the inlet analyzer also trended with the SO₂ emissions throughout testing. During long-term testing when SO₂ emissions were high (>1.5 lb/MMBtu), the mercury concentrations were also at elevated levels. Several coal samples collected throughout field-testing were analyzed for mercury concentration as well as sulfur content to see the correlation between sulfur and mercury content for PRB coals. In general, the higher the sulfur content the higher the mercury content in the PRB coals. The correlation coefficient for mercury and sulfur in coal samples during this test program was 0.6, as shown in Figure 25.

Coal delivery data, provided by Meramec plant personnel, was monitored throughout long-term testing. Each coal train delivered was subjected to a short-proximate analysis. Included in the analysis was percent sulfur, which was compared to the mercury concentrations as measured by the mercury analyzers. The estimated time between the last train car being unloaded and coal from the delivery being fired in the boiler was approximately 24 hours.

Figure 26 shows the ESP inlet mercury concentration as measured by the analyzer and the sulfur concentration from short-proximate analysis for the delivery. The trend graph in

Figure 26 accounts for the 24-hour delay between the time the coal is delivered and when it is fired in the Unit 2 boiler. The trend graph in Figure 27 shows the inlet mercury concentration measured by the mercury SCSEM and the outlet SO₂ emissions measured by the plant CEM. Both the sulfur from coal proximate analyses and SO₂ emissions data indicate that sulfur can be used as a good indicator of inlet flue gas mercury concentration at this plant.

The correlation between mercury and sulfur in coal is not unexpected, since the sulfur-containing mineral pyrite (FeS₂) often contains significant amounts of mercury.

However, this relationship is highly variable and depends on the local geology of the coal. The relationship developed at Meramec should not be generalized to all PRB coals.

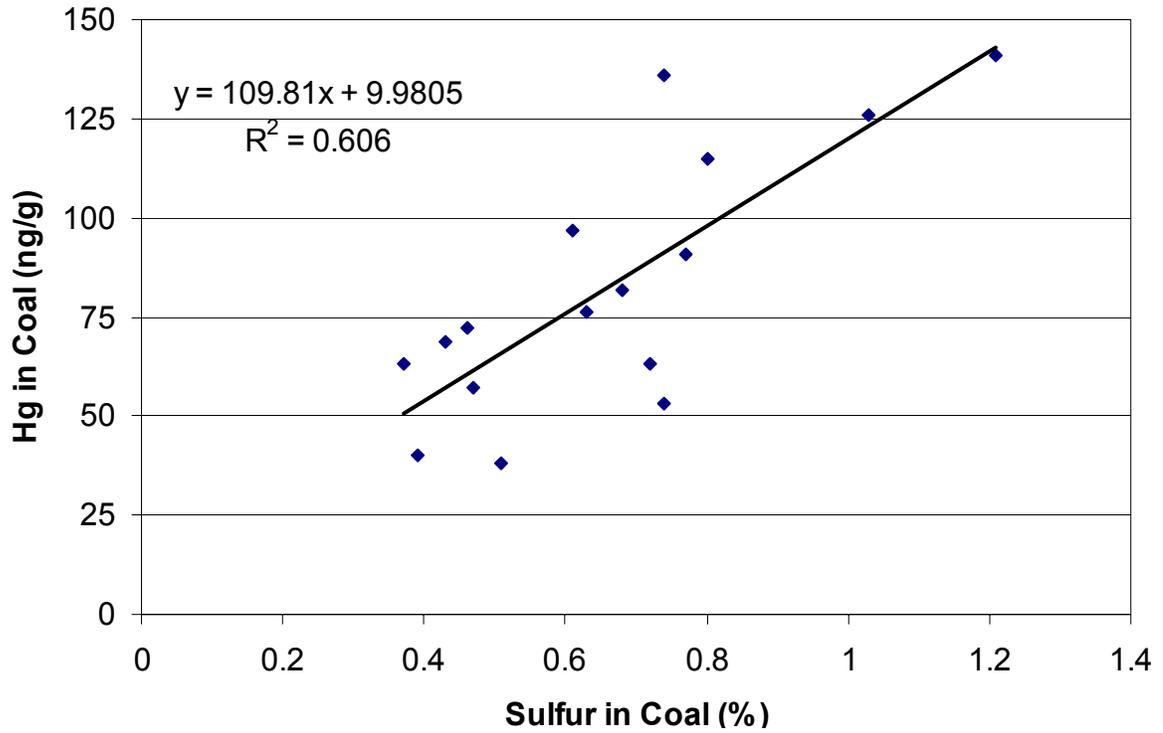


Figure 25. Mercury and Sulfur Correlation for Coals collected during Mercury Field Testing. (Values are Dry Basis.)

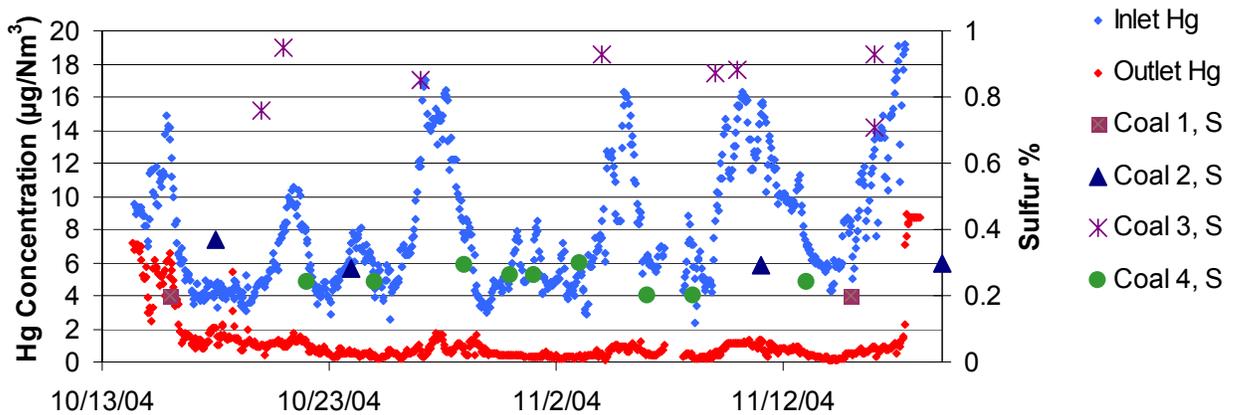


Figure 26. Sulfur in Coal and Vapor-Phase Mercury Concentrations during Long-Term Testing.

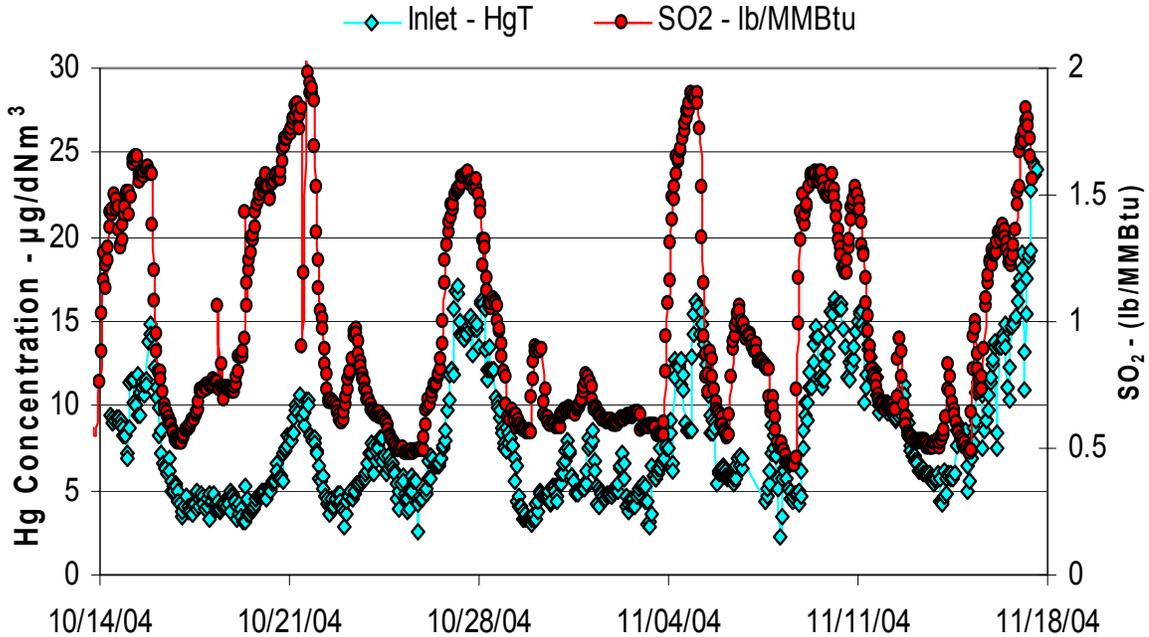


Figure 27. Mercury and Sulfur Dioxide Emissions during Long-Term Testing.

Carbon in Ash

The carbon content of several ash samples collected at Meramec was analyzed by comparing the weight difference between a dried sample and a sample heated to 800°C for two hours. This is the typical technique used to measure unburned carbon and it is reported here as LOI in reference to the analysis technique. For samples containing activated carbon, this is obviously a measure of both the unburned carbon and the activated carbon injected into the system. For very low levels of carbon, there can be a difference between the actual carbon content measured with a carbon analyzer and the change in weight from combustion using an LOI analysis. The carbon content of most samples evaluated from Meramec testing was well above this level and an LOI analysis should be a good representation of the carbon content of the ash.

Analysis of samples collected during baseline testing indicates that the carbon content in the control and test side ESP hoppers were similar and that the concentration in the inlet fields was higher than in the middle or outlet fields. The carbon content, reported as LOI, of fly ash samples collected during the baseline and first week of parametric testing is presented in Figure 28. The variation of the LOI value in the baseline samples ranged from 0.4 to 2.7 wt%. During parametric testing, the highest LOI value in the first field was 5.7%, measured on a fly ash sample collected from the ash sample collected on September 2 during the 1 lb/MMacf DARCO® Hg test. For reference, the increase in carbon content at a 1 lb/MMacf injection concentration would represent approximately 0.23% of the fly ash. This is based upon an estimated fly ash loading of 2.13 gr/acf from coal combustion calculations and roughly 30% ash in the activated carbon.

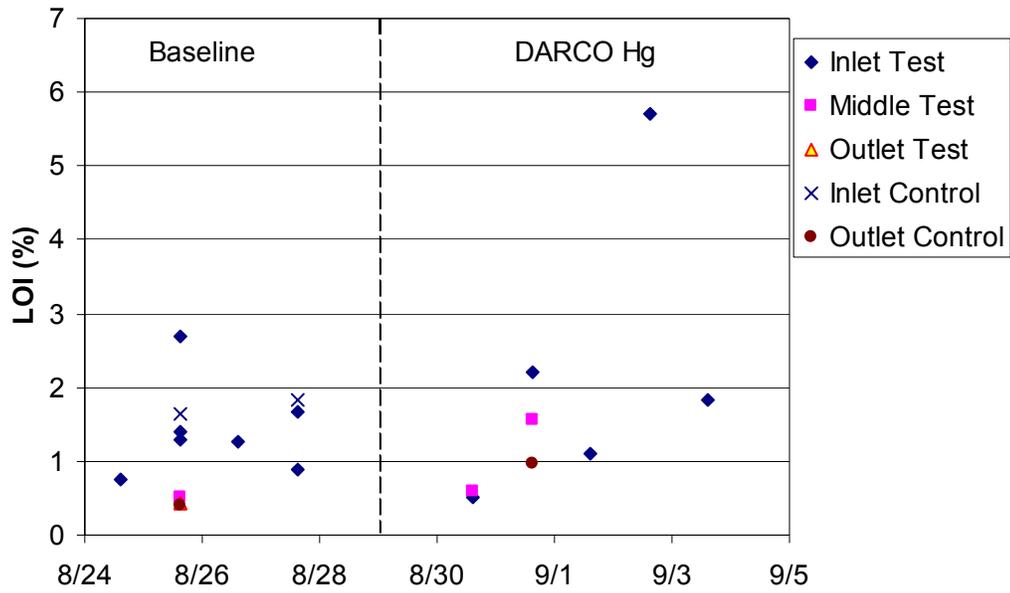


Figure 28. LOI as a Function of Time and ESP Hopper Location during Baseline and DARCO[®] Hg Parametric Testing.

LOI analyses of ash samples collected in the first ESP field indicate LOI values in excess of 1% during coal additive testing, as shown in Figure 29. It is speculated that the higher unburned carbon levels contributed to higher fractions of particulate-phase mercury. It is also speculated that the coal additives increase the effectiveness of unburned carbon for mercury capture. Therefore, due to the relatively high levels of unburned carbon present during coal additive testing, it is difficult to determine the effectiveness of the coal additives at more representative operating conditions where the unburned carbon is less than 1%.

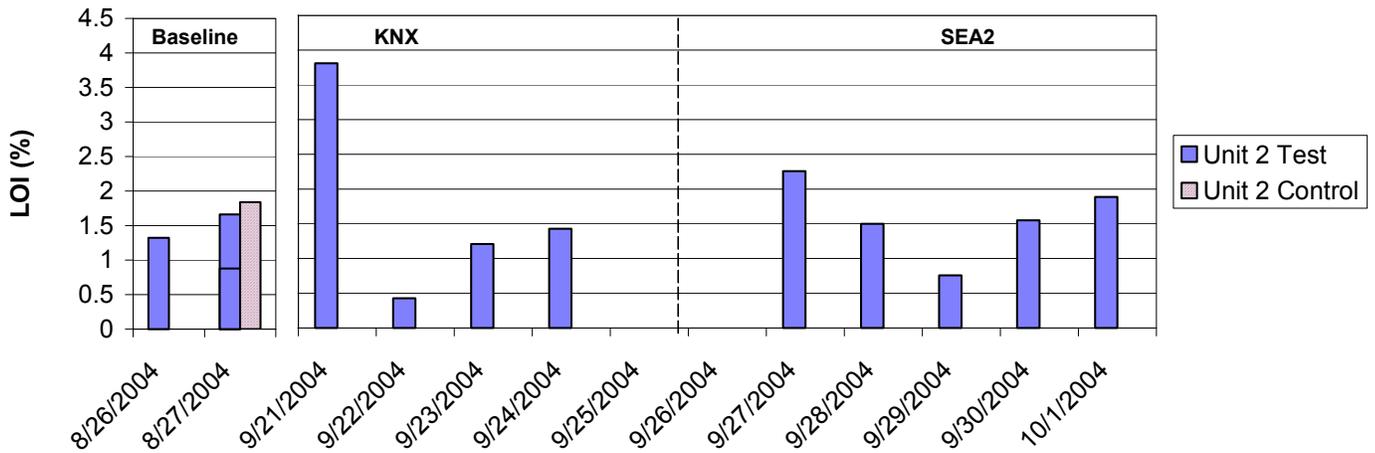


Figure 29. Carbon Content of Ash Collected in Unit 2, First Field, during Baseline and Coal Additive Tests. (Carbon Measured using an LOI Analysis).

The average carbon content for ash samples collected in the three ESP fields on the control and test sides are presented in Figure 30. The data indicate that:

1. The LOI levels from the control side decreased from the inlet to the outlet fields, indicating the ESP was more efficient at collecting unburned carbon in ash on the control side.
2. There was little change in the LOI values from inlet to outlet on the control side, indicating the collection efficiency of the ESP for the combined carbon loading (unburned carbon from the boiler and injected activated carbon) was nearly the same as the balance of the fly ash. For reference, the average activated carbon injection concentration for the long-term test was 3.3 lb/MMacf, which should result in an increase of nominally 0.75% carbon in the ash. The average LOI content (activated + unburned carbon) in the first field hopper ash was 2.6%.
3. The LOI was nearly twice as high on the control-side inlet than on the test side (4.8% compared to 2.6%).
4. The LOI level in most of the test-side samples collected were within the range of LOI measured during baseline testing (see Figure 31).

Detailed LOI results from ash collected during long-term testing are presented in Figure 31. The figure shows that there was a step change in the control-side LOI around October 28. The average LOI before October 28 was 2.6%, compared to 5.8% after October 28. This increase is probably due to combustion changes that resulted in higher unburned carbon on the control side compared to earlier in the period. During the entire test, the unburned carbon level was higher on the control side than the test side even though the average LOI was the same on the control and test sides through October 27. Because activated carbon was present on the test side, the LOI level should have been higher on the test side during any period of activated carbon injection. The different unburned carbon content from side-to-side suggests an imbalance in the combustion system, causing stratification in the unburned carbon that was preserved as the flue gas traveled from the boiler through the convective pass and air preheater.

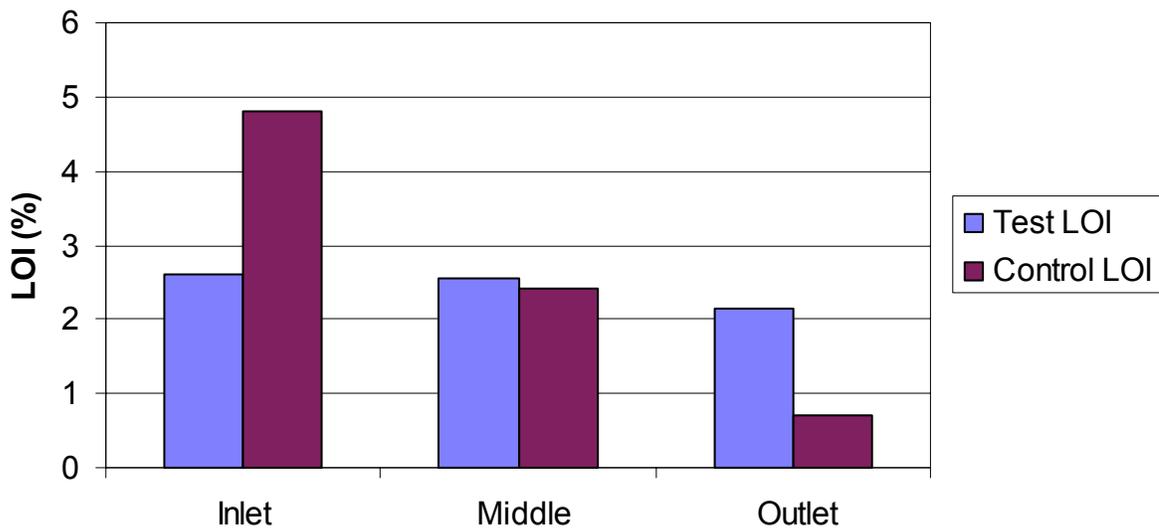


Figure 30. Average LOI during Long-Term Testing.

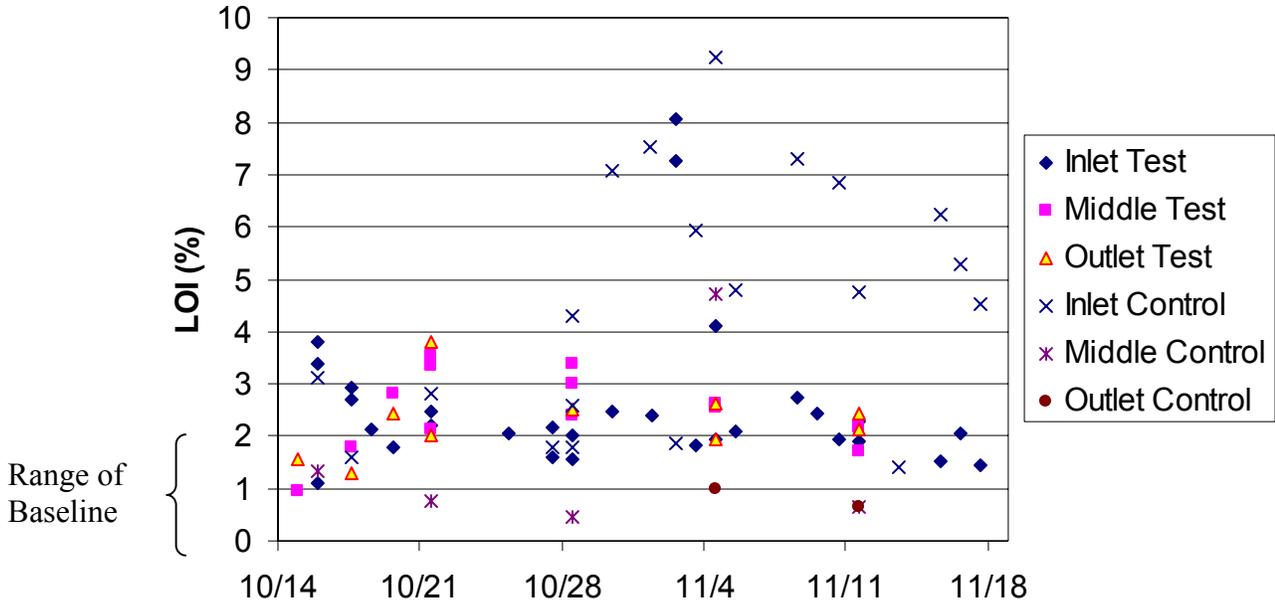


Figure 31. Carbon Content for the Inlet Field during Long-Term Testing. (Measured using LOI Procedure.)

Changes in LOI carbon can be influenced by several factors including mill settings, burner settings, and coal characteristics. No indication was given to the test crew that mill or boiler operation was changed during long-term testing. Therefore, the coal delivery schedule was reviewed to determine if there was a correlation in coal and LOI. A trend graph indicating sulfur content of the coal fired at Meramec compared to the carbon content in the ash, as measured using the LOI test procedure, is presented in Figure 32. The data indicate that, although the carbon content is changing, there does not appear to be a correlation between coal mine and carbon in the ash.

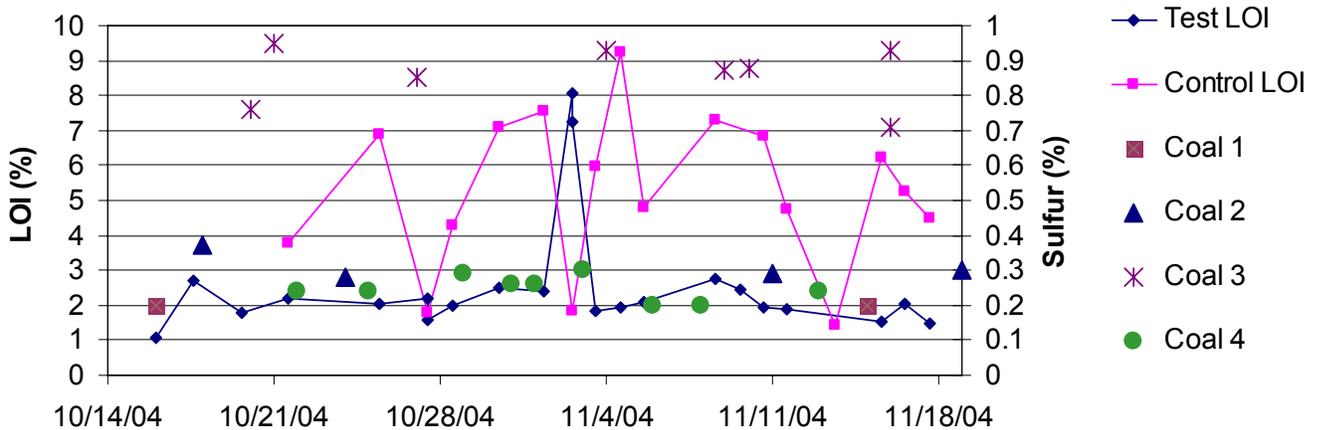


Figure 32. Comparison of Carbon in Ash from the First Field Hoppers and Sulfur in Coal.

Mercury in Fly Ash

The mercury content in the hopper ash increased from the inlet to the outlet fields during all phases of testing at Meramec. This is typically the case at units where the fly ash is effective at removing mercury, or when activated carbon is present in the ash, because the particulate collected in the ESP outlet field is exposed to flue gas much longer than fly ash collected in the inlet fields. The mercury concentrations measured in the ash collected from the ESP hoppers during baseline and DARCO[®] Hg parametric testing are presented in Figure 33. Recall that the LOI content of the ash samples varied during baseline testing. The mercury concentration in the baseline ash samples was compared to the respective LOI levels and these results are presented in Figure 34. The available data do not establish a clear trend between LOI and mercury within each collection field. As noted above, ash from the outlet fields contains higher concentrations of mercury and lower LOI contents, so there appears to be an overall trend indicating lower LOI correlates to higher mercury concentrations. However, it is expected that the higher mercury concentrations in the outlet fields are more likely a result of the exposure time of the ash to flue gas than the lower LOI content.

Results from analysis of samples collected on the control side during long-term testing indicated that samples with higher LOI contained less mercury. This trend is presented in Figure 35. It is possible that the larger carbon particles may be small pieces of unburned coal and have less surface area. Three ash samples collected during baseline and long-term testing in the first field of the control side were analyzed for size distribution. The data indicate that the material collected on October 28 was much smaller than the sample collected on November 1, as shown in the cumulative volume plot in Figure 36.

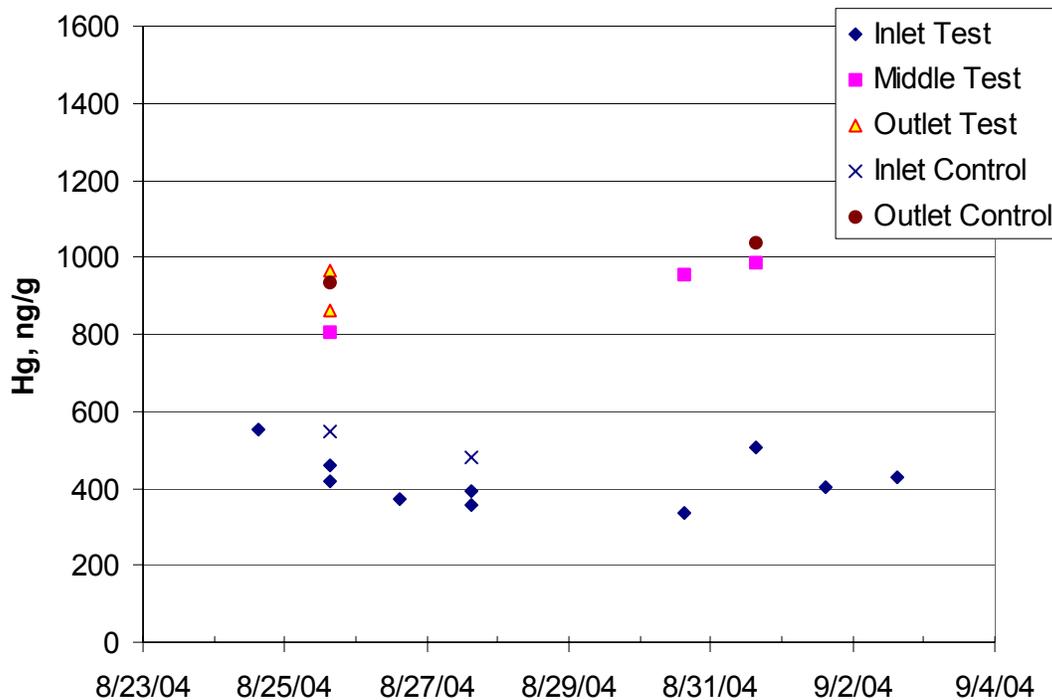


Figure 33. Mercury Content in Fly Ash Samples Collected during Baseline Testing.

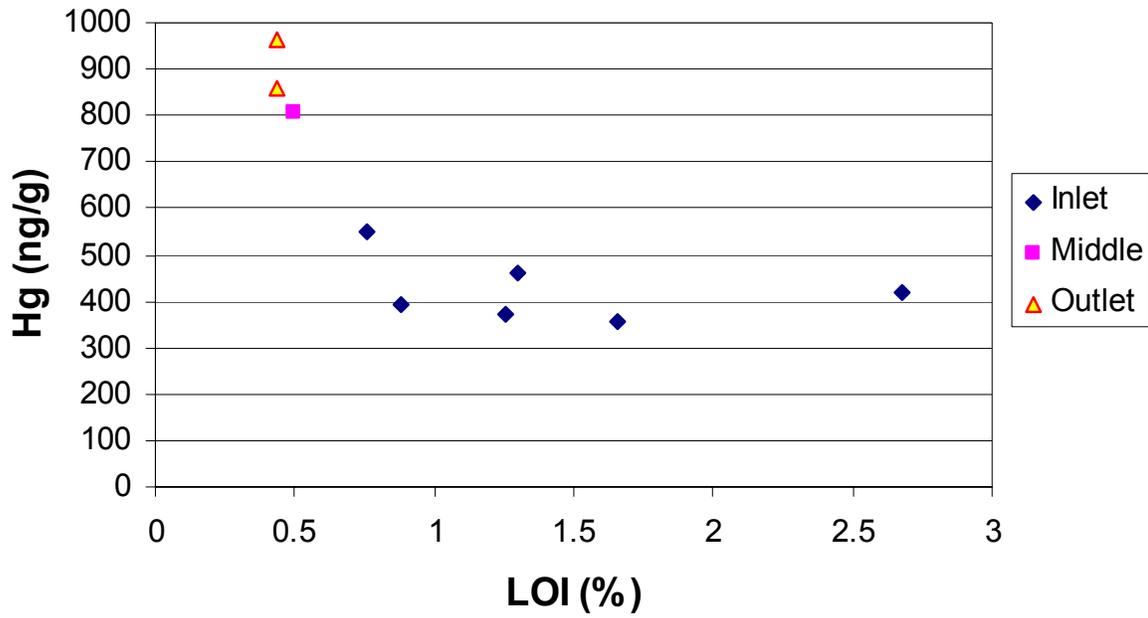


Figure 34. LOI and Mercury Comparison for Baseline Fly Ash Samples.

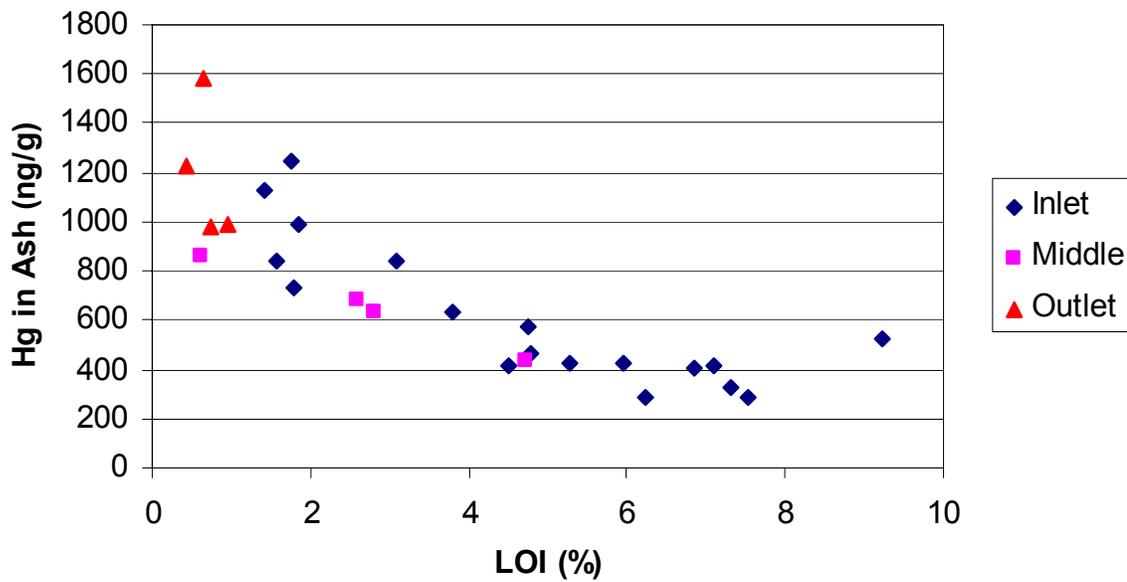


Figure 35. LOI Percentage and Mercury Content on Fly Ash from Control Side of ESP during Long-Term Testing.

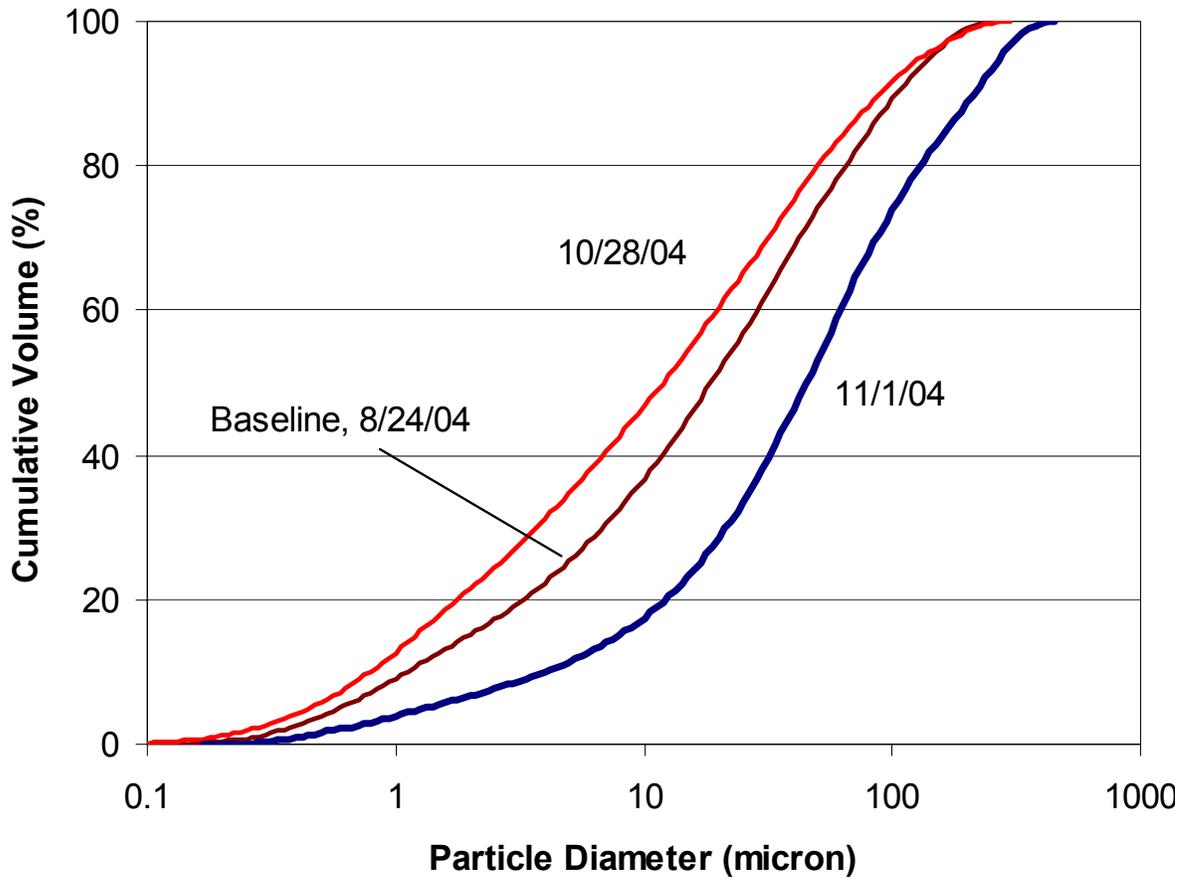


Figure 36. Size Distribution of Ash Collected in Control-Aide Hoppers, First Field.

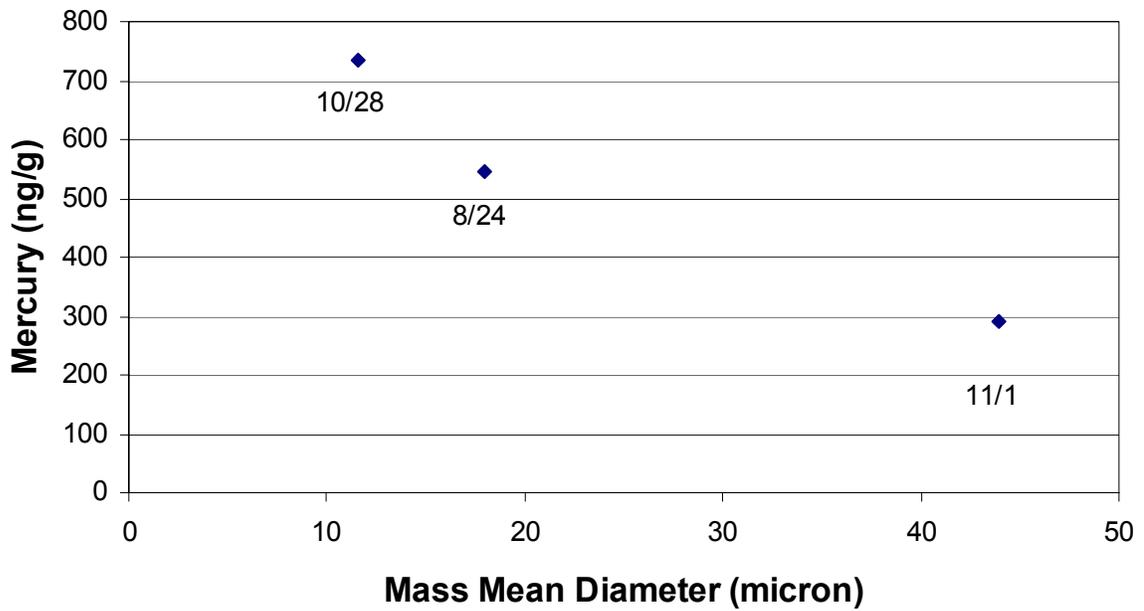


Figure 37. Mean Size of Control-Side Ash.

Five ash samples collected in the control- and test-side hoppers during baseline and long-term testing were analyzed for surface area. The LOI values of these samples can be used to estimate the specific surface area of the carbon in the sample and the mercury content per gram of carbon in the sample. These estimates are included in Table 20. The Meramec control-side samples have consistent carbon surface area in the range of 313 to 334 m²/g C. The test-side samples, which contain activated carbon, have a higher carbon surface area in the range of 397 to 412 m²/g C. Figure 38 shows the comparison among surface areas of carbon.

Table 20. Fly Ash Surface Area and Mercury Content.

Description	LOI, wt%	Surface Area		Mercury Content	
		m ² /g	m ² /g C	Hg, ng/g	Hg, ng/g C
8/24/04 2C-9 Control, Baseline	1.64	5.13	312.6	547	33,354
10/28/04 2C-11 Test	2	7.93	396.7	1,520	76,000
10/28/04 2C-9 Control	1.79	5.98	334.3	734	41,006
11/1/04 2C-11 Test	2.41	9.93	412.0	1,250	51,867
11/1/04 2C-10 Control	7.54	24.31	322.4	291	3,859

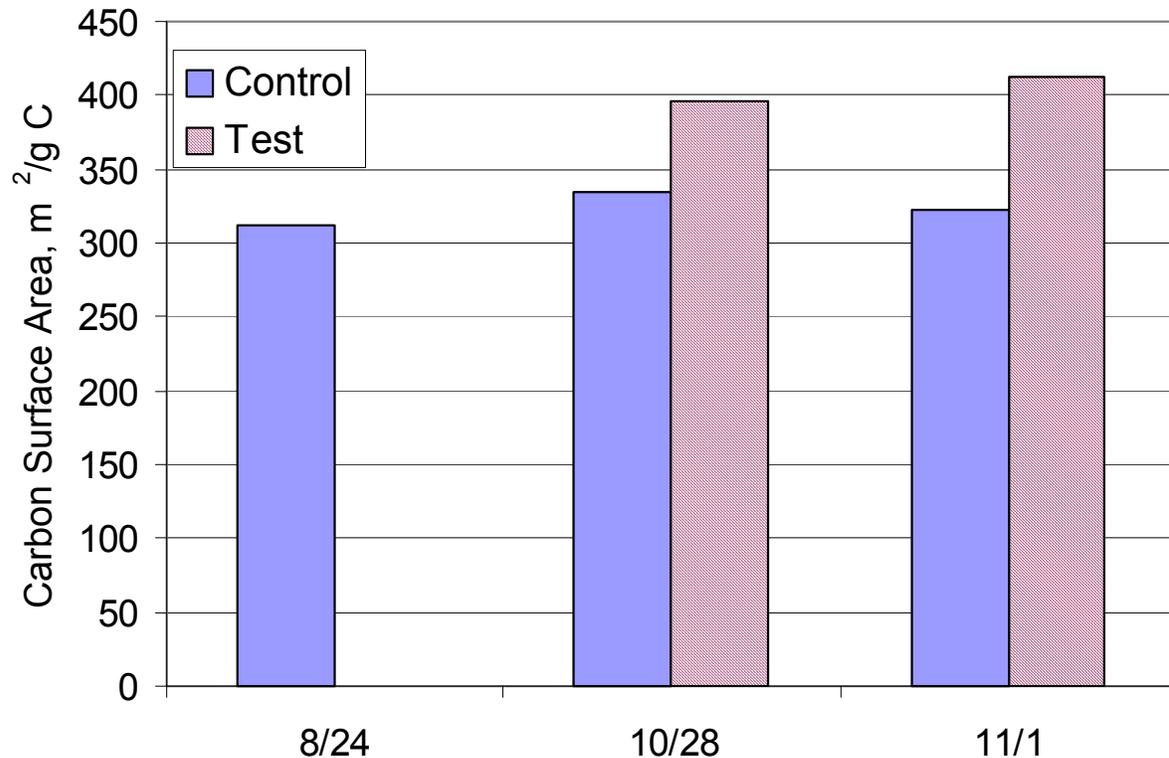


Figure 38. Surface Area of Fly Ash Per Gram of Carbon. (Estimate from LOI.)

Even though the specific surface area of the carbon is similar for all the control-side fly ash samples, the larger carbon particles in the November 1 sample may not be as efficient at adsorbing mercury from the flue gas in-flight, probably due to limitations on mass transfer to the larger unburned carbon particles. The mercury content of the three control-side ash samples is inversely proportional to the carbon size, as presented in Figure 37. In addition, these large particles are more likely to be collected in the inlet collection field of the ESP. If the large carbon particles are preferentially removed in the inlet collection fields, and the smaller particles migrate to the outlet fields, there would be a resulting increase in the mercury content of the ash from inlet to outlet as was observed at Meramec and presented in Figure 33 and Figure 39.

The average mercury concentration in the hopper ash collected during long-term testing is presented in Figure 39. The data indicate the following:

1. The mercury concentration in the fly ash increases from the inlet to the outlet ESP collection fields.
2. The samples collected from the control side of the ESP contain less mercury than the test-side samples. This indicates an increase in mercury removal across the test side of the ESP as a result of sorbent injection.

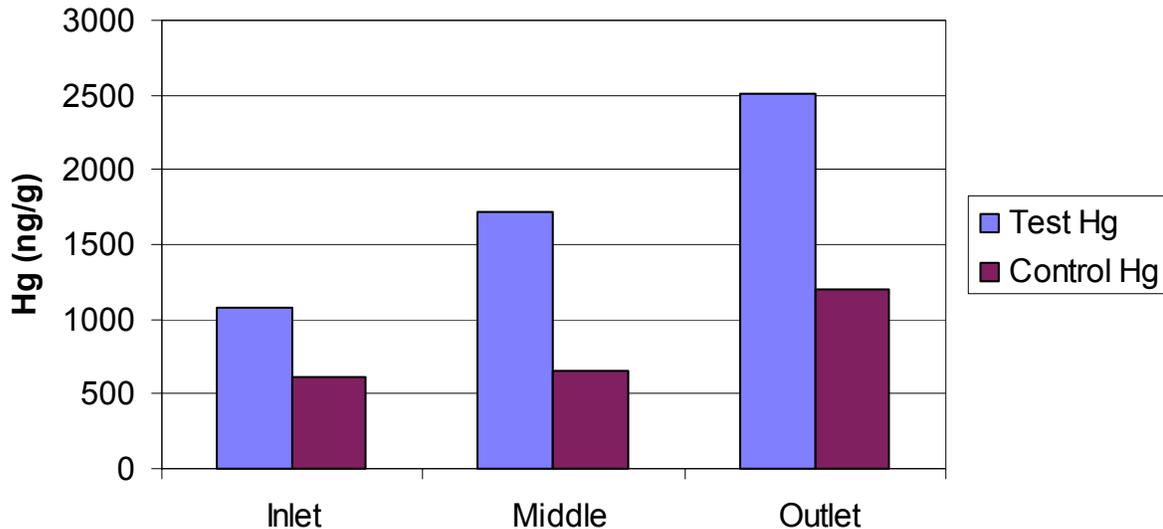


Figure 39. Mercury Variation in Fly Ash Samples Collected during Long-Term Testing. (Front to Back of ESP.)

The range of LOI was much narrower for the fly ash samples collected on the test side during long-term injection than the control side. Therefore, it is difficult to establish a clear trend of LOI and mercury content. The majority of fly ash samples collected on the test side had a range of LOI between 1.5 and 3 wt%, as shown in Figure 40. The fly ash samples collected in the middle and outlet fields generally contained higher mercury concentrations. The sample with the highest LOI, 8%, contained the lowest mercury concentration, 250 ng/g.

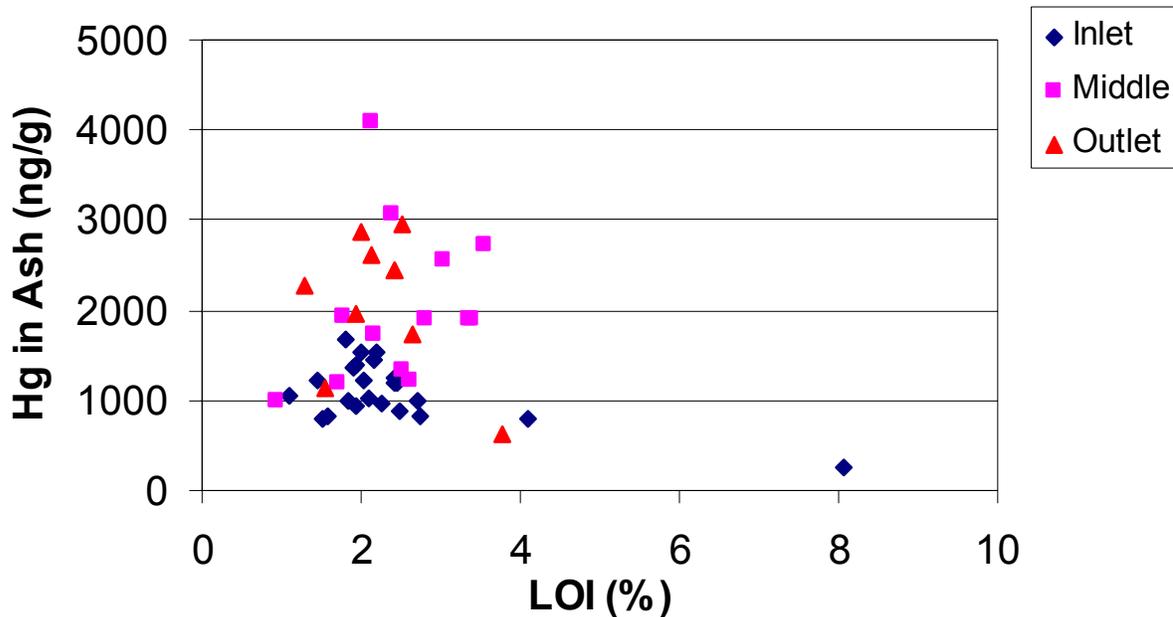


Figure 40. LOI Percentage and Mercury Content on Fly Ash from Test Side of the ESP during Long-Term Testing.

During coal additive testing, mercury content in the fly ash samples increased above baseline levels. This supports the SCEM measurements that indicated a decrease in vapor-phase mercury at the inlet and outlet of the ESP. Mercury concentrations in fly ash collected during coal additive testing are presented in Figure 41. The mercury concentration in the inlet field, identified as Field 1, more than doubled from baseline testing. The mercury concentration in coal samples collected during these tests were discussed earlier and presented in Figure 14.

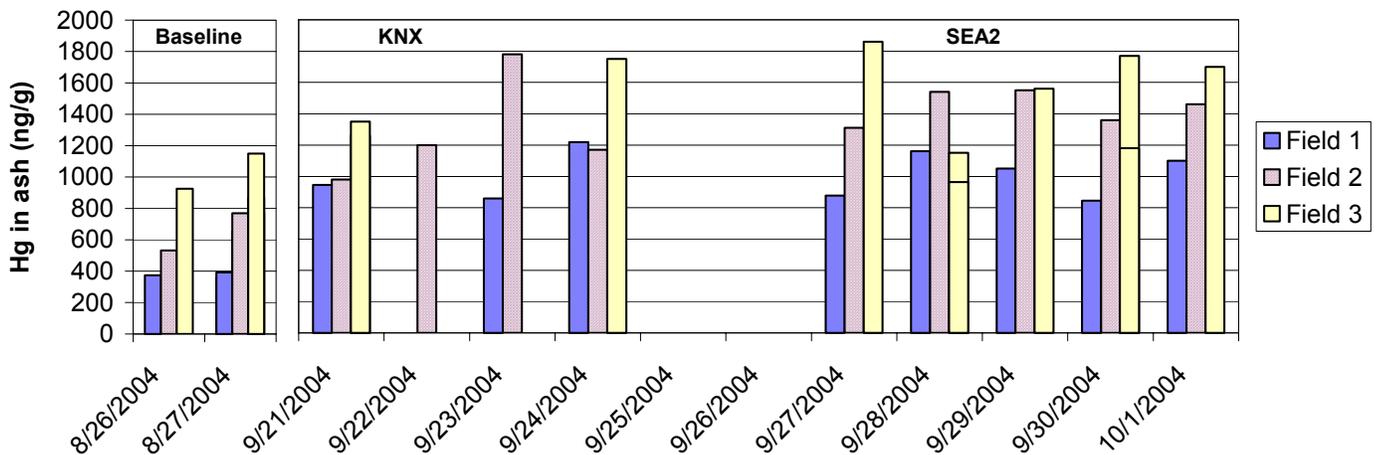


Figure 41. Mercury Content in Fly Ash Samples during Baseline, KNX, and SEA2 Testing.

Leaching Stability (Hg, Other Metals, and Halogens)

Analyses were conducted on ash samples collected during the baseline and long-term testing phases to determine the stability of mercury, bromine, arsenic, selenium, chlorine, fluorine, and iodine. Two leaching procedures were conducted: Method 1311, Toxicity Characteristic Leaching Procedure (TCLP) and the Synthetic Groundwater Leaching Procedure (SGLP). The TCLP procedure measures metal mobility, primarily As, Ba, Cd, Br, Se, and Ag, in a sanitary landfill. The TCLP extraction fluid recipes were developed by computer modeling to simulate a worst-case scenario where the waste is co-disposed with municipal solid waste. For highly alkaline samples, such as those from Meramec, a solution with a pH of 4.93, buffered using sodium hydroxide, is used. TCLP is the only leaching procedure approved for characterizing hazardous waste under RCRA. The SGLP procedure was developed by Hassett at EERC to better simulate the pH of groundwater to determine if mercury will leach from the samples under conditions designed to simulate actual field conditions. The leaching solution is synthetic groundwater.

The SGLP leaching results from baseline and KNX testing are shown in Table 21. There are no notable differences in the two sets of data.

The SGLP results from long-term testing are presented in Table 22. For both the 18-hour and 30-day leach, bromine and chlorine in the leachate were higher for the test side than the control side. Elemental analysis of the samples indicates that 67% of the bromine in the control-side ash samples leached within 18 hours and 80% within 30 days. On the test side where bromine-treated activated carbon was being injected into the system, the baseline bromine content of the ash was much higher, but only 31% of the bromine leached from the sample within the first 18 hours. The results from the 30-day leach indicated 55% of the bromine had leached from the sample.

Because of the pozzolanic characteristics of PRB ash, most plants firing 100% PRB dry landfill ash not sold for cement. Model studies estimate that it takes nominally 100 years for moisture to migrate through properly managed dry landfills. The ratio of water to ash for the SGLP test, 20:1, obviously does not represent conditions in a dry landfill. It is expected that leaching results obtained during this program represent a worst-case scenario for dry landfills that are properly managed.

If a plant that ponds their ash chose to use brominated activated carbon, bromine leaching can be important because halogens can contribute to the formation of trihalo-methanes (THM) when they react with organic matter in lakes or streams. For example, chloroform is a THM that forms when free chlorine reacts with dissolved organics. Chloroform is considered by the EPA to be a carcinogen. For reference, the primary drinking water standards indicate that the maximum contaminant level for THMs is 0.1 mg/L. According to the American National Standards Institute, the recommended residual bromine in swimming pool water is 1–2 mg/liter, and the level of bromine in seawater is 65 mg/liter. The discharge of bromine-containing water is not included in permitted limits for most power plants in Missouri. The permit requirements for the City of Springfield's Springfield Southwest Power Plant is associated to biocide use and limits the total residual chlorine and bromine outflow to 0.2 mg/liter.

Mercury was below the detection limit in the leachate solution for all samples tested. The mercury concentrations in the long-term ash samples were 97 µg/g on the control side and 1,300 µg/g on the test side.

Selenium was below detection limit in the leachate from the 18-hour leach, but concentrations increased in the 30-day leach. There was little difference between the concentration of selenium in the leachate from the test- and control-side fly ash during long-term test or baseline samples. The concentration of selenium in the ash samples collected during long-term testing were 25% higher on the test side compared to the control side (650 µg/g vs. 490 µg/g). There is not strong evidence for the activated carbon adsorbing significant additional selenium from the flue gas, as observed at Brayton Point and Salem Harbor during Phase I DOE/NETL testing.^{2,6} The ash appears to effectively prevent selenium from leaching in the SGLP test.

Table 21. Baseline SGLP Results (mg/L) from Meramec.

Condition	Baseline	Baseline	KNX	KNX
Location	2C-11	2C-11	2C-11	2C-11
Date	8/25/2004	8/25/2004	9/22/2004	9/22/2004
	18-hour	30-day	18-hour	30-day
As, mg/L	<0.005	<0.005	<0.005	<0.005
Br, mg/L	0.115	0.056	0.152	0.15
Hg, mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Se, mg/L	<0.005	0.012	<0.005	0.011
Cl, mg/L	0.17	0.24	0.17	0.22
F, mg/L	0.94	0.51	<0.02	1.89
I, mg/L	<0.05	<0.05	<0.05	<0.05

Table 22. SGLP Results (mg/L) from Meramec Long-Term Testing.

Condition	Long-Term (Control)	Long-Term (Test)	Long-Term (Control)	Long-Term (Test)
Location	2C-10	2C-11	2C-10	2C-11
Date	11/3/2004	11/3/2004	11/3/2004	11/3/2004
	18 hour	18 hour	30 day	30 day
As, mg/L	<0.010	<0.010	<0.010	<0.010
Br, mg/L	0.50	9	0.6	16
Hg, mg/L	<0.0002	<0.0002	<0.0002	<0.0002
Se, mg/L	<0.010	<0.010	0.011	0.012
Cl, mg/L	<1	6	2	11
F, mg/L	0.91	3.1	1.1	0.73
I, mg/L	<0.1	<0.1	<0.1	<0.1

The TCLP results for fly ash collected during long-term testing on the test and control side of the ESP are presented in Table 23. Mercury was below detection limit in the leachate solution for both test and control sides. Some arsenic and selenium leaching was measured, but the levels were fairly low. The amount of arsenic measured in the leachate solution from the TCLP represented 2.3% of the total arsenic contained in the control-side ash sample and 4.2% of the arsenic in the test-side ash sample. The amount of selenium in both the control- and test-side samples represented less than 0.6% of the selenium contained in the representative ash samples.

Table 23. TCLP Results from Meramec Long-Term Testing.

Condition	Long-Term (Control)	Long-Term (Test)
Location	2C-10	2C-11
Date	11/3/2004	11/3/2004
As, mg/L	0.052	0.14
Hg, mg/L	<0.00001	<0.00001
Se, mg/L	0.14	0.183

Another set of leaching tests was conducted on ash collected on November 9, 2004, during the long-term evaluation. These data, shown in Table 24, indicate that the mercury concentration in the leachate was below the detection limit for all techniques. In most cases, the arsenic in the leachate was near the detection limit. Approximately 10% leached from the test-side ash sample in the TCLP test. All other results are consistent with the analyses of samples collected on November 3, 2004.

Table 24. Leaching Results (mg/L) from Control- and Test-Side Ash Samples, November 9, 2004

	Control 2C-10 ASTM D3987-85	Control 2C-10 TCLP	Control 2C-10 18 hr SGLP	Control 2C-10 18 hr SGLP Duplicate	Test 2C-11 ASTM D3987-85	Test 2C-11 TCLP	Test 2C-11 18 hr SGLP	Test 2C-11 18 hr SGLP Duplicate
Aluminum	93				81			
Antimony	<.01				<0.01			
Arsenic	0.03	<0.01	0.03	0.02	0.02	0.25	0.04	<0.01
Barium	5.79				9.25			
Beryllium	<0.005				<0.005			
Bromine			1.8	2.5			18	16
Cadmium	<0.005				<0.005			
Chloride			2	4			10	11
Chromium	0.028				0.021			
Cobalt	<0.01				<0.01			

	Control	Control	Control	Control	Test	Test	Test	Test
	2C-10	2C-10	2C-10	2C-10	2C-11	2C-11	2C-11	2C-11
	ASTM D3987-85	TCLP	18 hr SGLP	18 hr SGLP Duplicate	ASTM D3987-85	TCLP	18 hr SGLP	18 hr SGLP Duplicate
Copper	<0.005				<0.005			
Fluoride			0.07	0.08			0.12	0.88
Lead	<0.01				<0.01			
Iodine			0.09	0.16			0.16	0.12
Iron	<0.01				<0.01			
Magnesium	0.03				0.02			
Manganese	<0.005				<0.005			
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	<0.01				<0.01			
Selenium	0.01	<0.01	0.01	0.02	0.02	0.19	0.02	0.02
Silver	<0.005				<0.005			
Thallium	<0.01				<0.01			
Zinc	<0.005				<0.005			
Boron	0.58				0.68			
Calcium	182				166			
Sodium	16.04				34.56			

In addition to the standard leaching protocols, a selective sequential extraction was conducted on ash collected from one inlet hopper from both the control- and test-side ESPs during the 30-day long-term test period. The results, presented in Table 25, indicate that the mercury is fairly stable in both the control-side and test-side ash and, until exposed to 12N nitric acid (HNO₃). This is a fairly aggressive digestion and a condition not expected to occur in an ash landfill environment.

Table 25. Selective Extraction of Mercury from Control- and Test-Side Ash.

Sample	DI Water (ng/g)	PH 2.5 HCl (ng/g)	1N KOH (ng/g)	12N HNO ₃ (ng/g)	Aqua Regia (ng/g)	Total (ng/g)
Control-Side	0.18	16.4	4.74	360	12.9	395
% of Total	0.0%	4.2%	1.2%	91.3%	3.3%	100.0%
Test-Side	0.00	15.7	4.52	866	10.2	897
% of Total	0.0%	1.8%	0.5%	96.6%	1.1%	100.0%

Thermal Desorption

The two samples collected during long-term testing and analyzed using the SGLP and TCLP leaching techniques were also analyzed to determine the mercury thermal desorption characteristics. From both the control-side and test-side samples, there was a single desorption peak, suggesting that the mercury is bound in the ash as a single compound. The addition of activated carbon to the flue gas shifted the mercury desorption peak to a higher temperature, from 358°C on the ESP control-side sample to 419°C on the ESP test-side sample.

Balance-of-Plant Impacts

Ash Sales

It is the plant's intent to sell its fly ash for use in the cement industry. It has been AmerenUE's experience that when LOI content is less than 0.7%, the fly ash has potential for cement use. As discussed in the previous section, the LOI content was typically greater than 1% on the control side during most of the test program. Therefore, comparisons between the control- and test-side hopper ash to assess the impact of carbon injection on ash sales at this site were not possible. Some laboratory tests were conducted to estimate the impact on a unit with lower LOI, however. These results are presented below.

It is estimated that the incremental carbon increase in the ash due to activated carbon injection is 0.23% at an equivalent injection concentration of 1 lb/MMacf. However, it is well known that even trace amounts of activated carbon can be detrimental to ash quality for cement use. Activated carbon will likely absorb more of the air entrainment chemicals used in the manufacture of cement than typical unburned carbon.

One method of determining the amount of air entrainment additive (AEA) needed when fly ash is used as a cement admixture is using the Foam Index test. Prior to long-term testing, Foam Index tests were conducted to help quantify the impacts of activated carbon on the Unit 2 fly ash for use as a cement admixture. Activated carbon, equivalent to the amount of carbon that would be added at injection concentrations ranging from 0.5–10 lb/MMacf, was added to fly ash samples collected from the Unit 2 ESP hoppers. Results from these tests indicated that Meramec Unit 2 fly ash mixed with activated carbon at injection rates less than or equal to 1 lb/MMacf had the potential to be used as a cement admixture. Results from these tests are shown in Table 26.

The Foam Index test is a method used for quick evaluation of the suitability of fly ash, with respect to air entrainment and pozzolanic additives for concrete. It should be noted that there is no standardized Foam Index testing protocol and results from these tests should be viewed with extreme caution. For these specific Foam Index tests, an AEA value of less than 10 drops is considered to have potential for use as a cement admixture.

Table 26. Foam Index Test Results – Meramec Ash.

% PAC, by weight	Calculated ACI Injection Rate (lb/MMacf)	# of AEA Drops
None	0	5
0.20	0.6	8
0.41	1.2	10
1.23	3.7	24
2.05	6.2	38
4.09	12.4	70

Stack Opacity and ESP Operation

The additional particulate loading to the ESP due to activated carbon injection at Meramec was nominally 0.023 gr/acf, or 1% of the ash loading. There was no measurable increase in stack opacity as a result of activated carbon injection, as shown in Figure 42.

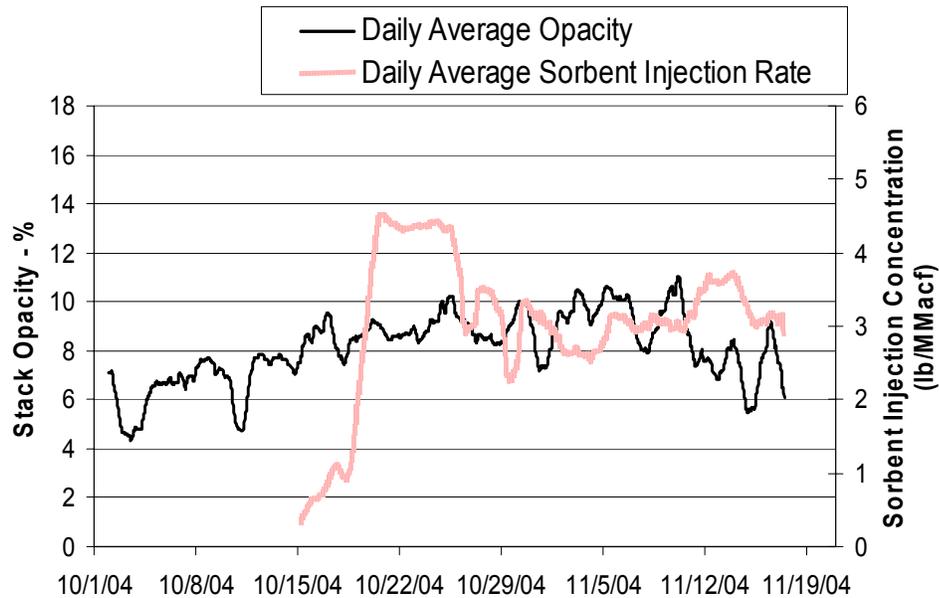


Figure 42. Meramec Unit 2 Stack Opacity during Long-Term Sorbent Injection.

An area of interest in plant operating parameters was the effect of sorbent injection on ESP electrical parameters. However, the plant experienced ESP data acquisition problems at the beginning of long-term testing and a full data set was not available for analysis. Therefore, it is difficult to quantify the impacts of ACI on ESP performance based on the ESP data available. Spark rate and total ESP power during the long-term test are presented in Figure 43. For reference, a plot showing total ESP power from the baseline, parametric, and long-term testing periods are shown in Figure 44. The ESP field power recorded during long-term testing was lower than during baseline or parametric testing, but there is no evidence that the power levels were impacted by carbon injection.

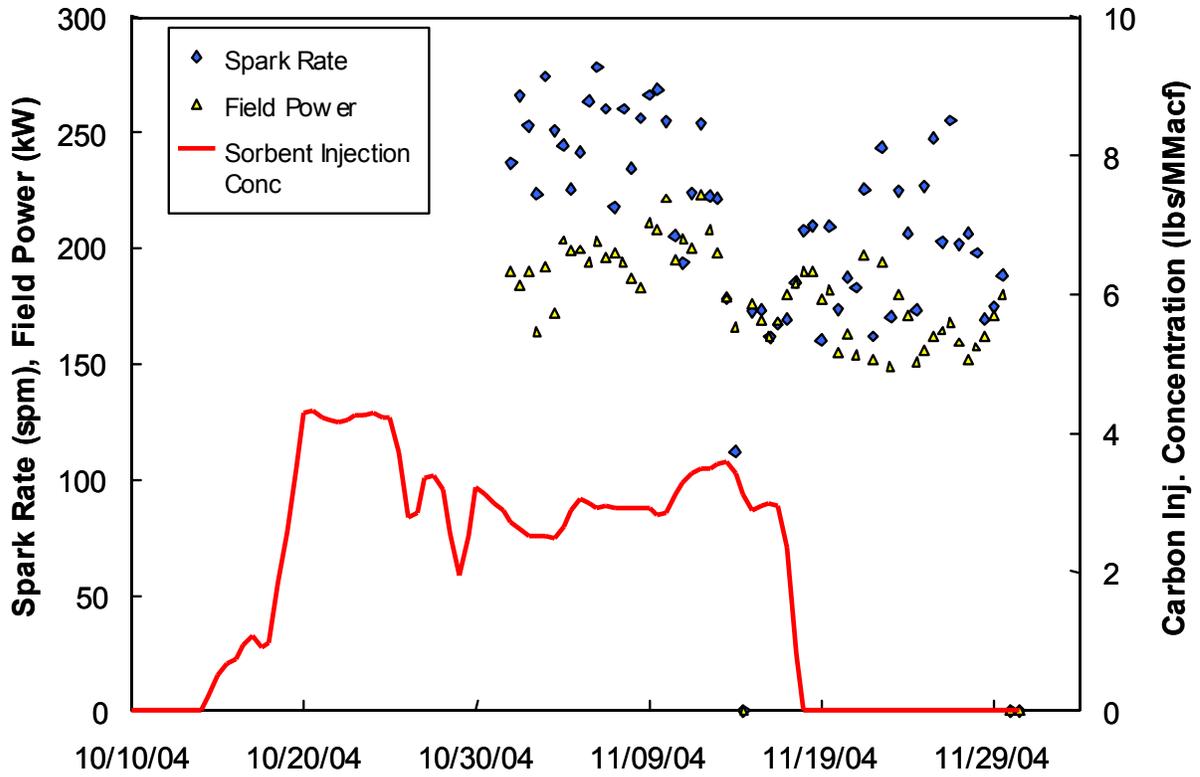


Figure 43. ESP Spark Rate and Field Power during Long-Term Testing Series.

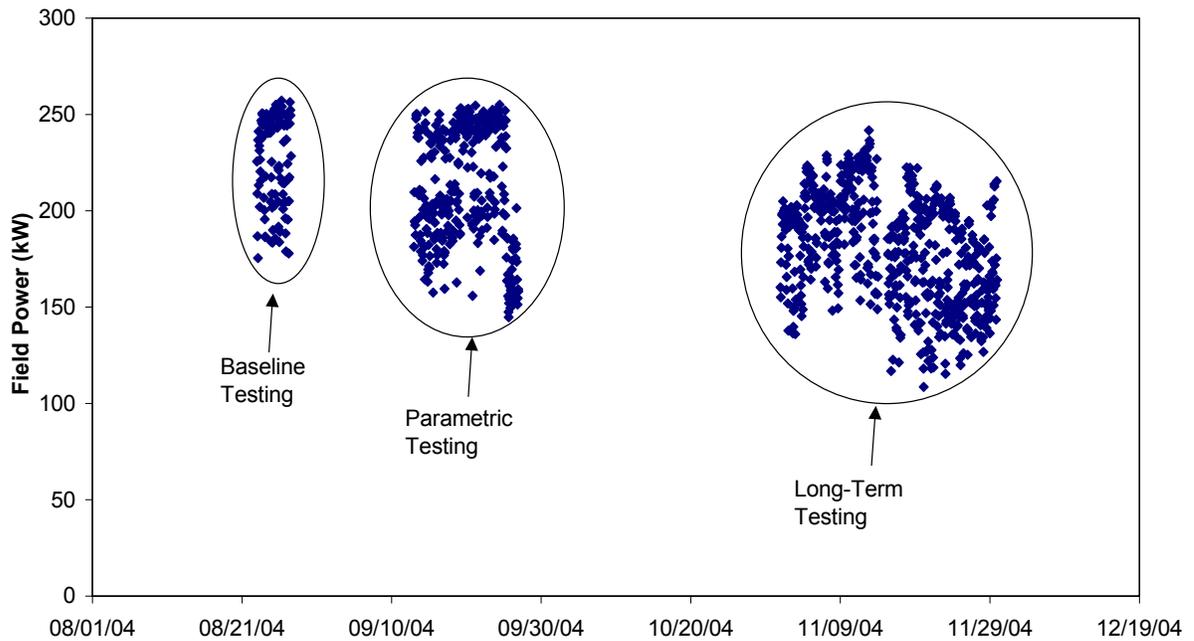


Figure 44. Total ESP Field Power during Field Testing.

ECONOMIC ANALYSIS

After completion of testing and analysis of the data, the requirements and costs for full-scale, permanent commercial implementation of the necessary equipment for mercury control using sorbent injection technology at the 140-MW Meramec Station Unit 2 were determined. The cost of process equipment sized and designed based on the long-term test results for approximately 90% mercury control, and on the plant-specific requirements (sorbent storage capacity, plant arrangement, retrofit issues, winterization, controls interface, etc.) has been estimated. The system design was based on the criteria listed in Table 27.

Table 27. System Design Criteria for Mercury Control System at Meramec Unit 2. (3.3 lb/MMacf injection, >90% Mercury Control.)

Parameter	
Number of Silos	1
Number of injection trains	2 operating, 1 spare
Design feed capacity/train (lb/hr)	600
Operating feed capacity/train (lb/hr)	55
Sorbent storage capacity (lbs)	70,000
Conveying distance (ft)	150
Sorbent	DARCO [®] Hg-LH
Aerated Density (lb/ft ³)	18
Settled Density (lb/ft ³)	28
Particle MMD (microns)	18

The estimated uninstalled cost for a sorbent injection system and storage silo for the 140-MW Unit 2 is \$694,000. Costs were estimated based on a long-term activated carbon injection concentration of 3.3 lbs/MMacf. For Meramec Unit 2, this would require an injection rate of nominally 110 lbs/hr at full load. Assuming a unit capacity factor of 85% and a delivered cost for DARCO[®] Hg-LH sorbent of \$0.95/lb, the annual sorbent cost for injecting sorbent into the existing ESP would be about \$778,200. This corresponds to a nominal sorbent cost of \$6,200 per pound of mercury removed.

Results from the field tests conducted to date indicate different levels of mercury removal can be achieved depending on the air pollution control equipment and different flue gas conditions. Data collected from the Phase I DOE tests at Gaston indicate mercury removal levels of up to 90% were obtained with COHPAC[®] (a baghouse installed downstream of an ESP) and DARCO[®] Hg sorbent injection. At Pleasant Prairie, 50–70% removal while injecting DARCO[®] Hg was the maximum achievable mercury control, with the configuration of an ESP collecting PRB ash. At Brayton Point, mercury removal levels of up to 90% were obtained with an ESP collecting bituminous ash with DARCO[®] Hg sorbent injection.^{2,7} DOE Phase II testing at Holcomb showed mercury removal levels of 90% were obtained with an SDA and FF while injecting DARCO[®] Hg-LH.⁸ Data from Meramec and the other four sites are summarized in Table 28.

Table 28. Summary of Mercury Removal Efficiencies and Costs for Different APC Configurations, Coals, and Sorbents.

Plant	APC Equipment	Coal	Sorbent	Removal %	Sorbent Cost (mills/kWh)
Gaston	COHPAC [®]	Bituminous	DARCO [®] Hg	90	0.43
Pleasant Prairie	ESP	PRB	DARCO [®] Hg	67	1.2
Brayton Point	ESP	Bituminous	DARCO [®] Hg	90	2.4
Holcomb	SDA + FF	PRB	DARCO [®] Hg-LH	90	0.44
Meramec	ESP	PRB	DARCO [®] Hg-LH	90	0.74

The results from Meramec indicate that using DARCO[®] Hg-LH would result in higher mercury removal (90%) at less than the cost of the maximum achievable removal at Pleasant Prairie (67% mercury removal). Both units fire PRB coal and have ESPs installed for particulate control. The critical difference in the sorbent costs is the improved effectiveness of DARCO[®] Hg-LH over DARCO[®] Hg. These results are presented as mills/kWh in Table 28 and as \$/kWh in Figure 45. The use of DARCO[®] Hg-LH at Meramec resulted in mercury removal at projected costs similar to what would be expected at sites using a fabric filter for particulate control collecting bituminous ash.

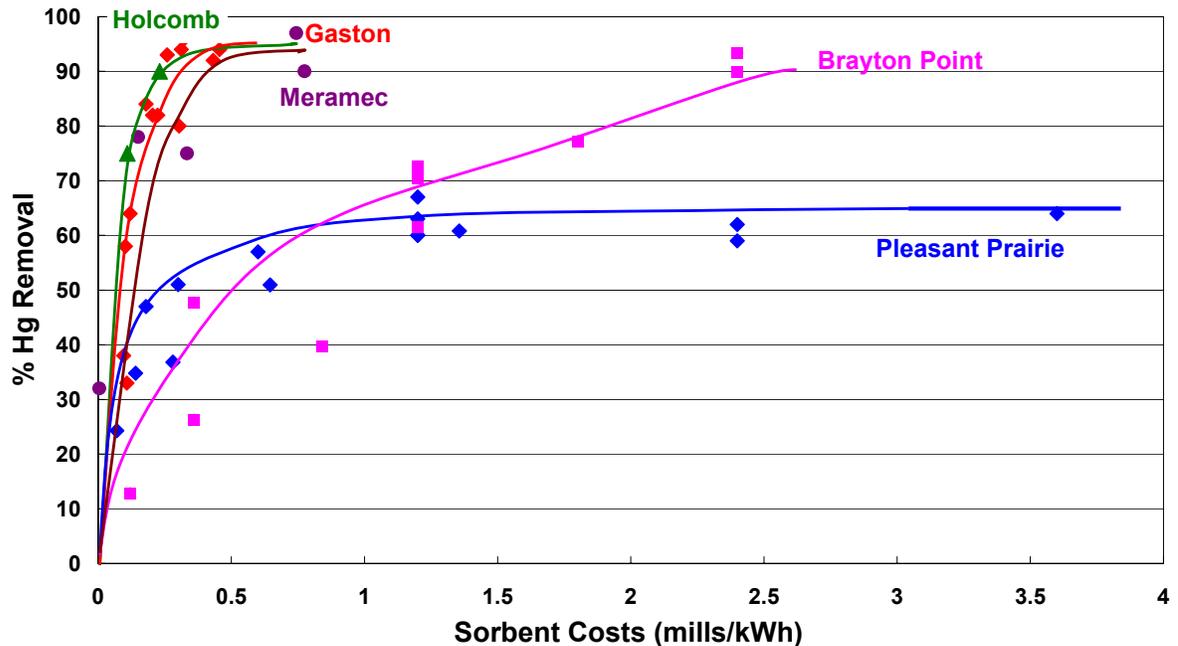


Figure 45. Comparison of Projected, Annual Sorbent Costs for ESP, COHPAC[®], and SDA + FF Configurations based on Results from NETL Full-Scale Tests.

System Description

The permanent commercial activated carbon injection system for Meramec will consist of one bulk storage silo and three dilute-phase pneumatic conveying systems. DARCO[®] Hg-LH sorbent will be received in 40,000-lb batches delivered by self-unloading pneumatic bulk tanker trucks. The silo is equipped with a pulse jet type bin vent filter to contain dust during the loading process. The silo is a shop-built, dry-welded tank with three mass flow discharge cones equipped with air fluidizing pads and nozzles to promote sorbent flow. Point level probes and weigh cells monitor sorbent level and inventory. Silo sizing was based on the capacity to hold approximately two truckloads of DARCO[®] Hg-LH sorbent, sufficient for 30 days of operation at the design injection rate.

The sorbent is fed from the discharge cones by rotary valves into feeder hoppers. From the hoppers the sorbent is metered into the conveying lines by volumetric feeders. Conveying air supplied by regenerative blowers passes through a venturi eductor, which provides suction to draw the sorbent into the conveying piping and carry it to distribution manifolds, where it splits equally to multiple injection lances. The blowers and feeder trains are contained beneath the silo within the skirted enclosure.

A Programmable Logic Controller (PLC) is used to control all aspects of system operation. The PLC and other control components will be mounted in a NEMA4 control panel. The control panel, motor control centers (MCCs), and disconnects will be housed in a prefabricated power and control building located adjacent to the silo.

Balance-of-Plant Requirements

Some modifications and upgrades to the existing plant equipment will be required to accommodate the ACI system. These include upgrades to the electrical supply at Meramec to provide new service to the ACI system. Instrument air, intercom phones, and area lighting will also be required.

It is not anticipated that ash from Meramec can be sold if activated carbon injection is implemented. No cost estimates are included to account for loss of ash sales.

Cost and Economic Methodology

Costs for the sorbent storage and injection equipment were provided by ADA-ES with input from NORIT Americas based on the design requirements in Table 27. NORIT has built and installed dozens of similar systems at waste-to-energy and incineration plants, and ADA-ES in conjunction with NORIT has provided quotes for several installations at coal-fired power plants for mercury control. Estimated costs for the distribution manifold, piping and injection lances, installation man-hour and crane-hour estimates, and an estimate for foundations including pilings are also included.

EPRI TAG methodology was used to determine the indirect costs. A project contingency of 15% was used. Since the technology is relatively simple and well proven on similar scale, the process contingency was set at 5%. ACI equipment can be installed in a

few months; therefore, no adjustment was made for interest during construction, a significant cost factor for large construction projects lasting several years.

Operating costs include sorbent costs, electric power, operating labor, maintenance (labor and materials), and spare parts. An average incremental operating labor requirement of one hour per day was estimated to cover the incremental labor to operate and monitor the ACI system. The annual maintenance costs were based on 5% of the uninstalled equipment cost. Levelized costs were developed based on a 20-year book life and are presented in constant dollars.

Capital Costs

The uninstalled ACI storage and feed equipment costs are estimated at \$964,000. The estimated cost for a sorbent injection system and storage silo installed on 140-MW Unit 2 is \$1,285,000 and includes all process equipment, foundations, support steel, plant modifications utility interfaces, engineering, taxes, overhead, and contingencies. The capital and O&M costs are summarized in Table 29.

Table 29. Capital and Operating & Maintenance Cost Estimate Summary for ACI System on Meramec Unit 2. Annual Basis 2005.

Capital Costs Summary	
Equipment, FOB Meramec	\$694,000
Site Integration (materials & labor)	\$53,000
Installation (ACI silo and process equipment,	\$124,000
Taxes	\$47,000
Indirects/Contingencies	\$367,000
Total Capital Required	\$1,285,000
\$/kW	\$9.17
Operating & Maintenance Costs Summary	
Sorbent @ \$.95/lb	\$778,000
Power, Labor, Maintenance	\$85,000
Waste Disposal	\$0
Annual O&M for 2005 (\$/kW)	\$6.17
Mills/kW-hr	0.83

If Meramec were to sell the ash from Unit 2, an additional waste disposal and loss of ash sales cost would be incurred. Assuming an ash sales loss and disposal cost of \$45/ton, the annual ash sales loss and disposal costs for Meramec Unit 2 would be \$1,070,000.

Operating and Levelized Costs

With the exception of the waste disposal costs, which are discussed below, the most significant operational cost of sorbent injection for mercury control is the DARCO[®] Hg-LH sorbent. Sorbent costs were estimated for an average of $\geq 90\%$ mercury control based on the long-term sorbent injection concentration of 3.3 lbs/MMacf. For Meramec Unit 2, this would require an injection rate of nominally 110 lbs/hr at full load. Assuming a unit capacity factor of 85% and a delivered sorbent cost of \$0.95/lb, the 20-year levelized annual cost of injecting sorbent at the ESP inlet would be \$778,000. Other annual operating levelized costs including electric power, operating labor, and maintenance were estimated to be approximately \$85,000.

Based on these test program results and assuming that sorbent injection at the ESP inlet for mercury control is sustainable, an average of $\geq 90\%$ mercury control can be attained at Meramec Unit 2 for an initial capital investment of \$1,285,000 with operating costs of \$7.85/kW, or annual constant-dollar levelized costs of \$8.92/kW. This information is summarized in Table 30.

The ash from Meramec Unit 2 is not currently sold for use in concrete due to the high LOI content; however, the plant would like to sell the ash in the future. The annual levelized cost of disposing the ash and lost ash sales revenue for Meramec Unit 2 would be \$1,362,000, increasing the levelized operating costs to \$17.57/kW. The total annual constant-dollar levelized costs would be \$18.65/kW.

Roughly 30% of the coal-fired units in the United States currently sell ash for use in concrete. For these plants, the waste disposal costs are a significant addition to the overall costs to implement the technology. Options for ACI, while minimizing lost ash sales and waste disposal costs, include: 1) TOXECON[™], installing a fabric filter downstream of an ESP and injecting carbon upstream of the fabric filter, and 2) TOXECON II[™], injecting downstream of the first or second fields in the ESP and segregating the ash collected in the front fields from the ash/carbon mix collected in the back fields. Costs associated with these two options were not included in this analysis.

The levelized costs reported in Table 30 are specific to Meramec Unit 2 and include analyses with and without lost ash sales and waste disposal costs. Because the sorbent injection equipment does not scale well between larger and smaller units, the costs of the sorbent injection equipment for mercury control at Meramec Unit 2 is relatively expensive. The initial capital cost per kW for larger units would be less than the costs reported here.

Table 30. Levelized Costs Summary.

20-Year Levelized Costs Summary—\$ Constant		
	Lost Ash Sales Revenue and Disposal Costs Included	Lost Ash Sales Revenue and Disposal Costs Not Included
Fixed Costs	\$150,000	\$150,000
Variable O&M	\$2,231,000	\$869,000
Total	\$2,610,000	\$1,249,000
Total Levelized Costs \$/kW	\$18.65	\$8.92
Operating Levelized Costs \$/kW	17.57	7.85
Operating Levelized Costs mills/kW-hr	2.36	1.05
Total Levelized Costs mills/kW-hr	2.50	1.20

CONCLUSIONS

Power plants that burn PRB coal and have cold-side ESPs for air pollution control represent a challenging configuration for controlling mercury emissions. ICR measurements and subsequent full-scale field tests have confirmed that the average native mercury removal at these units is low, typically less than 25%. In addition, the effectiveness of injecting standard, non-chemically treated, activated carbon is greatly diminished by the low halogen concentrations in the flue gas.

The test program at Meramec Unit 2 was designed to provide a full-scale evaluation of different technologies that can overcome the limited mercury removal achievable at similar sites. Each technology was based on supplementing certain halogens that are not available in sufficient quantities in these coals.

The program was very successful in that two different technologies were found that have the potential to produce high levels (>80%) of mercury removal in this difficult application. These technologies are:

- Coal Additives
 - >80% total mercury removal (coal to outlet) achieved at Meramec without carbon injection
(Plant configuration and high LOI may have contributed to removal. High removal has not been achieved at other sites firing PRB coal that have lower LOI.)
- Treated Activated Carbon Injection (DARCO[®] Hg-LH)
 - High removal (>90%) achieved at Meramec during the long-term test periods
 - No adverse balance-of-plant impacts were noted

Other Balance-of-Plant Concerns:

- Historical data suggest that no measurable mercury will leach from collected ash. Tests on the ash/sorbent mix collected during the 30-day DARCO[®] Hg-LH injection tests at Meramec indicated that mercury was below detection limit in all the leachate solutions.
- After 30-days in the SGLP leaching solution, 55% of the bromine contained on the test-side ash sample leached as compared to 80% on the control-side. The bromine concentration in the leachate solution from the test-side was higher than the control-side because of the higher baseline bromine concentrations in the ash.
(DARCO[®] Hg-LH is a bromine-treated activated carbon.)
- Flue-gas bromine measurements were made at Meramec during long-term testing of DARCO[®] Hg-LH. The HBr concentration increased from 0.16 ppm during baseline testing to 0.26 ppm during long-term testing. No levels of bromine in excess of those expected for plants firing PRB coals were measured.
- Trace amounts of activated carbon can be detrimental to ash quality for cement use. Options to protect ash for sales include TOXECON[™] and TOXECON II[™]. TOXECON II[™] tests are scheduled to begin Fall of 2005 on a separate DOE contract.

Other specific conclusions include:

- A sorbent injection concentration of approximately 1.0 lb/MMacf was needed to capture 60–70% of the vapor-phase mercury across the ESP during the preliminary 5-day continuous injection test.
- After increasing the sorbent injection rate, the average inlet and outlet vapor-phase mercury concentrations were 5.98 and 0.44 lb/TBtu respectively. This represents an approximate 93% reduction in vapor-phase mercury across the ESP and agrees well with the parametric testing results. The average sorbent injection concentration was 3.3 lb/MMacf.
- No measurable increase in stack opacity, SO₂, or NO_x emissions was observed during long-term testing.
- The two sets of Ontario Hydro measurements performed during long-term testing showed average mercury removal efficiencies of 94.6 and 91.2%. These were consistent with measurements made by the inlet and outlet mercury analyzers and in-situ fly ash samples.
- The sorbent injection system experienced no material handling problems during long-term testing.
- Data from the second half of long-term testing suggest impacts to ESP operating parameters were minimal. Data from the first half of testing are unavailable.
- There was a linear correlation between the sulfur and mercury content in the coal samples collected during this program ($r^2=0.6$).

The goals for the program established by DOE/NETL were to reduce the uncontrolled mercury emissions by 50 to 70% at a cost 25 to 50% lower than the target established by DOE of \$60,000/lb mercury removed. The results from Meramec indicated that using DARCO[®] Hg-LH would result in higher mercury removal (90%) at a sorbent cost 90% lower than the benchmark. In addition, the estimated costs for control at Meramec are 0.74 mills/kWh compared to 1.2 mills/kWh for the maximum achievable removal at Pleasant Prairie (67% mercury removal). Both units fire PRB coal and have ESPs installed for particulate control. The critical difference in the sorbent costs is the improved effectiveness of DARCO[®] Hg-LH over DARCO[®] Hg. These results demonstrate that the goals established by DOE/NETL were exceeded during this test program.

The increase in mercury removal over baseline conditions is defined for this program as a comparison in the outlet emissions measured using the Ontario Hydro method during the baseline and long-term test periods. The average inlet concentration was 26% higher during long-term testing compared to baseline testing. The change in outlet emissions from baseline to long-term testing was 89%.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACI	Activated carbon injection
AEA	Air entrainment additive
CESP	Cold-side ESP
CVAAS	Cold-vapor atomic absorption spectrometer
CVAFS	Cold-vapor atomic fluorescence spectroscopy
DARCO [®] Hg	Sorbent manufactured by NORIT Americas. Formerly known as DARCO [®] FGD
DARCO [®] Hg-LH	Sorbent manufactured by NORIT Americas. Formerly known as DARCO [®] FGD-E3
DOE	Department of Energy
EC	Equivalent sorbent injection concentration
EERC	Energy & Environmental Research Center
ESP	Electrostatic precipitator
FF	Fabric filter
FGD	Flue gas desulfurization
GRE	Great River Energy
ICR	Information Collection Request
kacfm	Thousand actual cubic feet per minute
kW	Kilowatt
MCC	Motor control center
MW	Megawatt
NETL	National Energy Technology Laboratory
O&M	Operating and Maintenance
PAC	Powdered activated carbon
PLC	Programmable Logic Controller
PRB	Powder River Basin
SCA	Specific collection area
SCEM	Semi-continuous emission monitor
SDA	Spray dryer absorber
SGLP	Synthetic groundwater leaching procedure
SSD	Sorbent screening device
TAG	Technical Assessment Guide
TCLP	Toxicity characteristic leaching procedure
µg/Nm ³	Reference to 32°F dry gas

APPENDIX A

Meramec Test Plan

DOE NATIONAL ENERGY TECHNOLOGY LABORATORY MERCURY FIELD EVALUATION

Evaluation of Sorbent Injection for Mercury Control at AmerenUE Meramec Station

Draft Test Plan – For Review Only



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Project Objectives

The objective of testing at AmerenUE’s Meramec Station is to determine the cost and effects of sorbent injection for control of mercury in stack emissions. Meramec Station is located in St. Louis County, MO. The project will evaluate the effects of sorbent injection into an electrostatic precipitator (ESP). This evaluation will be conducted on one-half of the 140 MW flue gas stream.

Project Overview

This test is part of an overall program funded by the Department of Energy’s National Energy Technology Laboratory (NETL) and industry partners to obtain the necessary information to assess the feasibility and costs of controlling mercury from coal-fired utility plants. Host sites that will be tested as part of this program are shown in Table 1. These host sites reflect a combination of coals and existing air pollution control configurations representing 78% of existing coal-fired generating plants (approximately 950 plants producing a combined 245,000 MW) and potentially a significant portion of new plants. 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 (%)*
Sunflower Electric’s Holcomb Station	PRB & Blend	SDA – Fabric Filter	360 / 180 and 360	13
Ontario Power Generation’s Nanticoke Station	PRB & Blend	ESP	500/ 250 and 500	35
AmerenUE’s Meramec Station	PRB	ESP	140 / 70	20
American Electric Power’s (AEP) Conesville Station	Bituminous & Blend	ESP + Wet FGD	400 / 400	56

* Based upon recent Ontario Hydro measurements, except Meramec which was measured via method 324.

Meramec Unit 2 was chosen for this evaluation because of its combination of firing subbituminous Powder River Basin (PRB) coal with a cold-side ESP. This combination is increasingly common as many U.S. utilities are fuel switching to lower-sulfur western coals. Approximately 25% of the electricity generated from coal-fired

power plants is derived from plants burning subbituminous fuel. However, data available through EPA’s Information Collection Request (ICR) database¹ and through other EPRI programs indicate that units burning subbituminous fuels and are configured with moderate sized ESP’s demonstrate low mercury removal². Pre-baseline mercury measurements were made on June 22, 2004, made via the Method 324 at the inlet and outlet of the ESP. During these tests, the average mercury capture across the ESP during the pre-baseline tests was ~ 20%.

Full-scale data from the DOE Phase I tests conducted at Pleasant Prairie demonstrated mercury removal efficiencies with sorbent injection were limited to ~ 70%. At a sorbent injection concentration of 10 lb/MMacf mercury capture across the ESP was 60-65%. The sorbent injection concentration was increased up to 30 lb MMacf, however increasing the injection concentration above 10 lb/MMacf showed little improvement of mercury capture across the ESP. Reducing the injection concentration to 5 lb/MMacf decreased the mercury removal to 50-55%. At 1 lb/MMacf mercury control efficiency averaging 46% over a five-day period was achieved. These data are presented in Figure 1.

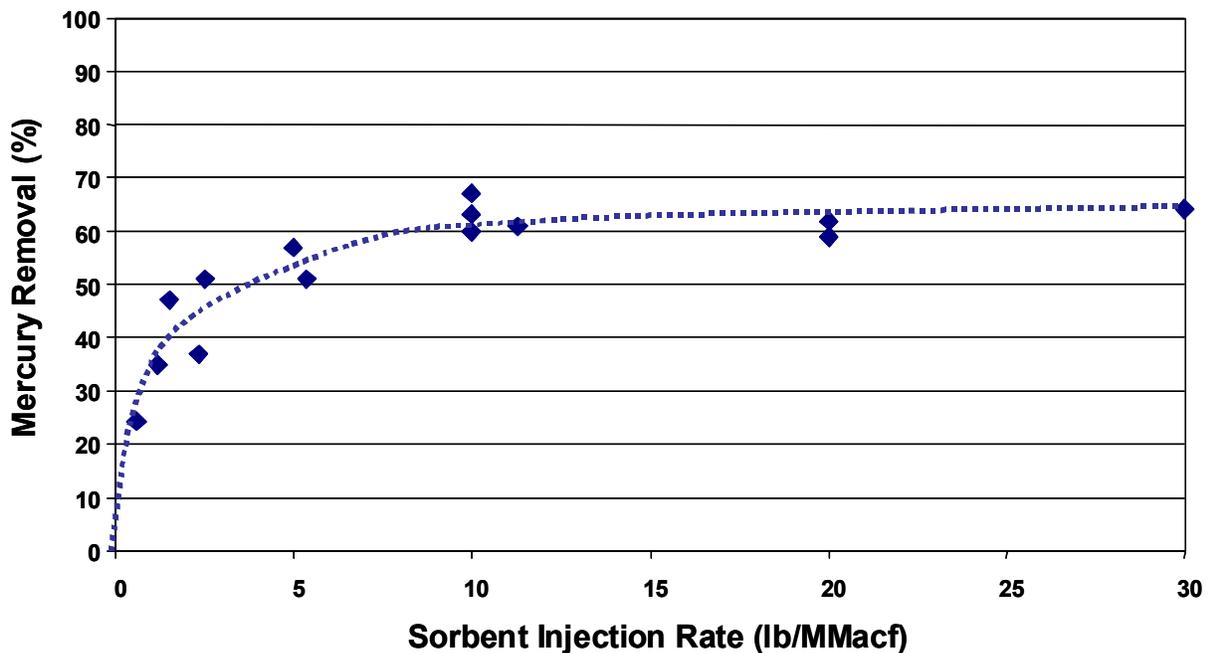


Figure 1. Data from Previous Full-Scale Evaluation at WE Energies Pleasant Prairie Power Plant

Host Site Description

Meramec Station is located in St. Louis County, Missouri. The test unit (Unit 2) is a load-following sub-critical 140-MW (gross) pulverized coal, tangentially fired, electric generating unit that burns 100% PRB coal. The unit is equipped with an ESP for particulate removal. During the 2004 spring outage, Units 1 & 2 will be retrofitted with Low NOx burners and separated overfire air for control of NOx emissions.

The ESP on Unit 2, designed by American Air Filter Company, Inc, is comprised of 5 electrical fields and 3 mechanical fields.

For sorbent injection testing with injection upstream of the ESP, only one-half of the 140 MW flue gas stream will be treated. A sketch showing one-half of the Unit 2 flue gas path is shown in Figure 2 and a photograph is shown in Figure 3. Tests will be conducted to determine the mercury removal efficiency when injecting sorbent across the ESP. Data will also be available to determine the amount of mercury captured in-flight prior to entering the ESP. Key operating parameters for Meramec Unit 2 are shown in Table 2.

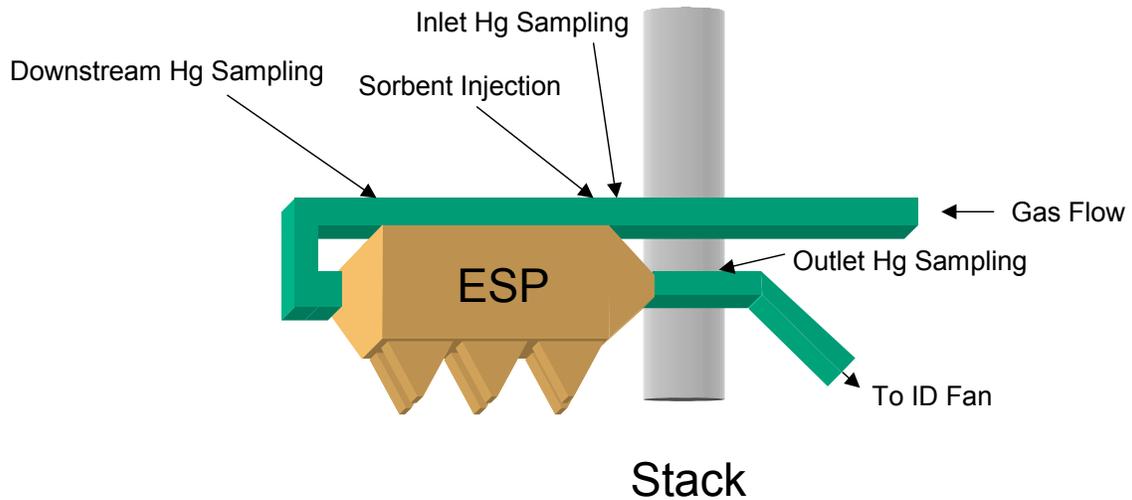


Figure 2. Sketch of East-Half of Meramec Unit 2 Testing Layout

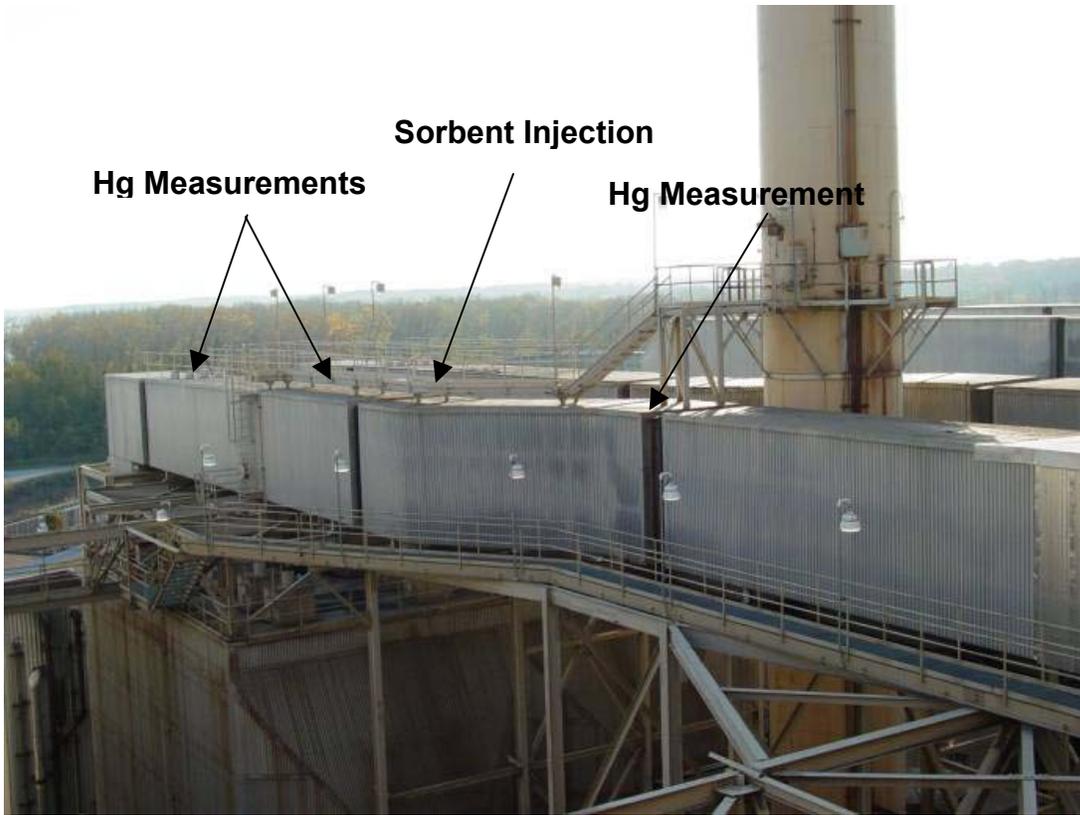


Figure 3. Photo of East ESP Inlet Duct – Unit 2.

Table 2. Meramec Key Operating Parameters

Unit	2
Size (MW)	140
Test Portion (MWe)	70
Coal	PRB
Heating Value (as received)	8738
Sulfur (% by weight)	0.25
Chlorine (%)	~0.06
Mercury ($\mu\text{g/g}$)	0.052
Particulate Control	ESP (American Air Filter) SCA = 320 ft^2/kacfm
Sulfur Control	Compliance Coal
Ash Reuse	Sold for Cement or Landfill

General Technical Approach

Activities at each test site in this program are divided into the seven tasks shown in Table 3. These tasks provide the outline for the test plan.

Table 3. Site-Specific Tasks

Task	Description
1	Host site kickoff meeting, test plan, and sorbent selection
2	Design and installation of site-specific equipment
3	Field Tests
3.1	Sorbent screening
3.2	Sample and data coordination
3.3	Baseline tests
3.4	Parametric tests
3.5	Long-term tests
4	Data analysis
5	Sample evaluation
6	Economic analysis
7	Site report

Task 1. Host Site Planning and Coordination

Efforts within this task include planning the site-specific tests with AmerenUE and Meramec Station, DOE/NETL, and contributing team members. ADA-ES met with plant personnel on February 26, 2004 to discuss the overall scope of the program, the potential impact on plant equipment and operation, and to finalize equipment and port locations. Additional communications between ADA-ES and AmerenUE personnel have been conducted to discuss the host site agreements and team member cost-sharing arrangements. These efforts will be finalized during this task. Other efforts include identifying any permit requirements, developing a quality assurance/quality control plan, finalizing the site-specific scope for each of the team members, and putting subcontracts in place for manual sampling (Ontario Hydro, M26a, etc.) sampling services. A site kickoff meeting is scheduled for April 20, 2004.

The host site will be responsible for preparing sampling and injection ports prior to testing. A document describing the new port locations and port specifications was delivered to plant personnel in February. Installation of the new test ports was completed in March 2004. The site will also be responsible for obtaining samples of coal, ash, and other solid samples during the testing program. A sample management plan describing what samples will be collected and their frequency of collection will be issued following the site kickoff meeting. Coal samples should be taken as close as possible to the feeders to represent “as-burned” or as-used samples. However, coal samples should not be collected downstream of the pulverizers because some mercury may be released as a result of heating during the grinding process. Ash samples will be required from multiple

ESP hoppers to identify variations in mercury and carbon throughout the ESP (front-to-back and side-to-side).

Sorbent Selection

A key component of the planning process for these evaluations is identifying potential sorbents for testing. The test program allows for the evaluation of different sorbents including a lignite-derived activated carbon supplied by NORIT, referred to as DARCO FGD carbon, and other alternative sorbents. DARCO FGD is considered the benchmark for these tests because of its wide use in DOE/EPRI/EPA-sponsored testing. Because of the economic impact of sorbent cost on the overall cost of mercury control, it is desirable to find less expensive sorbents. In addition, sorbents that have the potential to capture mercury at the low HCl conditions, typical of subbituminous units may be evaluated. Sorbent vendors and developers are invited to submit proposals for inclusion of their sorbents in the program. Sorbents will be selected for evaluation based upon a review of the proposals by the project team to determine potential improvements over the benchmark sorbent and the relative sorbent costs. If the team determines that information on the potential performance of sorbents in the Meramec flue gas is lacking for key candidates, select sorbents may be screened using a slipstream device at Meramec.

Task 2. Design, Fabricate, and Install Equipment

Site-specific equipment includes the sorbent distribution manifold and sorbent injectors. This must be designed and fabricated for each test site. Other equipment, such as the injection feeder/silo and mercury analyzers are used at all sites. Required site support at Meramec includes installation of required platforms and scaffolding, supplying compressed air and electrical power, wiring plant signals including boiler load to the control trailer, and balance of plant engineering. Table 4 presents a representative split of responsibilities on key equipment and activities between ADA-ES and the host plant. A foundation for the skid will also be required. ADA-ES engineers are working with plant engineers to develop an installation and contractor bid package for installation activities, and will work with the installation contractors.

Table 4. Scopes of Work for Sorbent Injection System

ADA-ES Transportable System	Provided by Host Site
Injection Silo and Feeder	Foundation and power
Sorbent Injection System	Injection ports
Sorbent Distribution Manifolds	Test ports
Conveying Hose (400 ft)	Access platforms
Sorbent Injectors	Installation labor
PLC Controls	Compressed air
Hg SCEMs	Power, Compressed Air
Office Trailer(s)	Signal Wiring / Telephones / Power

ADA-ES will oversee installation and system checkout of the mercury control equipment. If necessary, ADA-ES is capable of taking responsibility for all phases of the installation, except for final connections into plant utilities. ADA-ES will work with Meramec personnel to assure that the equipment is installed in an efficient manner, within the resources available at the site.

ADA-ES will be responsible for the final checkout of all systems and for the general maintenance of the systems during testing. At least one 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 three weeks. This includes time for checkout and troubleshooting. ADA-ES will also install the mercury monitors at Meramec.

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

Feeder and Analyzer Descriptions

The carbon injection system will consist of a bulk-storage silo and twin blower/feeder trains. PAC is delivered in bulk pneumatic trucks and loaded into the silo, which is equipped with a bin vent bag filter. From the discharge section of the silo, the sorbent is metered by variable speed screw feeders into eductors that provide the motive force to carry the sorbent to the injection point. Regenerative blowers provide the conveying air. A PLC system is used to control system operation and adjust injection rates. Figure 4 is a photograph of the sorbent silo and feeder trains designed to treat a 150-MW boiler on a unit with an ESP. The unit is approximately 50 feet high and 10 feet in diameter with an empty weight of 10 tons. The silo will hold 20 tons of sorbent. Flexible hose carries the sorbent from the feeders to distribution manifolds located on the flue gas ducts, feeding the injection probes. Each manifold supplies up to six injectors.



Figure 4. Carbon Injection Storage Silo and Feeder Trains for 150 MWe (Phase I System).

At least two mercury monitors will be used during this testing program to provide real-time feedback during baseline and sorbent injection testing. The mercury analyzer used during the Phase I program consisted of a cold vapor atomic absorption spectrometer (CVAAS) coupled with a gold amalgamation system (Au-CVAAS). The system is calibrated using vapor-phase elemental mercury. A sketch of the system is shown in Figure 5. An inertial separation probe is shown in the figure. This probe separates the particulate matter from the sample with minimal sampling artifacts from fly ash or injected sorbent.

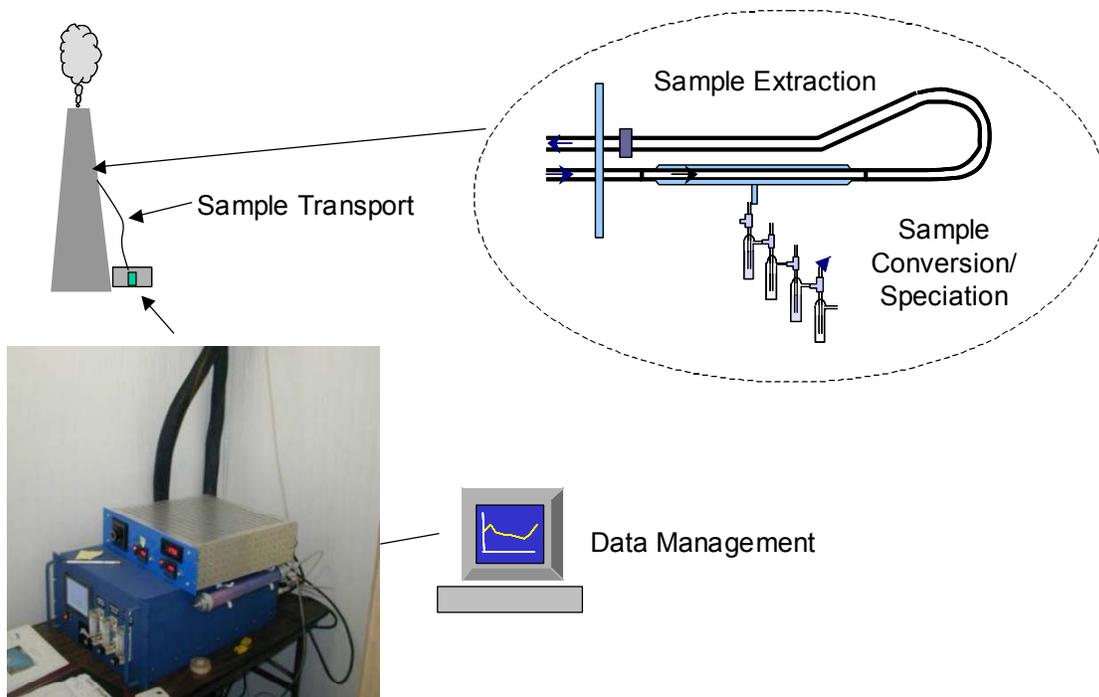


Figure 5. Sketch of Mercury Measurement System.

The analyzers are capable of measuring both 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.

Task 3. Field Testing

The field tests will be accomplished through a series of five (5) subtasks. The subtasks are independent from each other in that they each have specific goals and tests associated with them. However, they are also interdependent, as the results from each task will influence the test parameters of subsequent tasks. A summary of each task is presented.

The various tests are described below in their corresponding subtask. Exact operating conditions are subject to change based on the results from baseline and sorbent screening tests.

Subtask 3.1 Sorbent Screening

Data from other sites, similar to Meramec Unit 2 (i.e. PRB coal, similar operating temperature), will be used to determine which sorbents will be tested during the parametric and long-term testing series. Additional screening tests will be conducted between parametric and long-term testing to assess the performance of new sorbents. During these tests, a stream of flue gas will be drawn through a sorbent screening

apparatus. The mercury concentration will be measured at the inlet and outlet of the sorbent screening device to determine the performance of the sorbents being tested.

Subtask 3.2 Sample and Data Coordination

ADA-ES engineers will coordinate with plant personnel to retrieve the necessary plant operating data files. An example of the operating data is included in Table 6, along with other samples and measurements that will be collected. These data will be integrated into the sorbent injection and mercury control database. If possible, it is useful if plant operating data can be provided daily. In addition, ADA-ES site engineers will work closely with plant operators to monitor key plant operating parameters in real-time during testing. If at any time the performance of the existing pollution control equipment or outlet emissions exceed acceptable operating limits, testing will be halted. Acceptable limits will be discussed and agreed upon prior to beginning injection.

The primary extraction locations for the mercury monitors will be across the ESP. The extraction port and probe length will be identified after a full velocity and temperature traverse at the sampling locations are conducted to identify an appropriate, single-point position. The position will be at a duct average temperature and velocity. Experience has shown that this should be representative of the duct average mercury concentration. Additional extraction locations for periodic measurements will be located downstream of sorbent injection just upstream of the ESP to provide information on the in-flight mercury removal.

Triplicate manual mercury samples using ASTM M6784-02 (Ontario Hydro Method) will be collected at the ESP inlet and outlet locations. Because of the influence of HCl and HF on sorbent effectiveness, HCl and HF measurements (Method 26a) will be made at the same time the Ontario Hydro samples are collected to better characterize the flue gas.

ADA-ES engineers will also develop a sample Chain-of-Custody and coordinate with host plant personnel to assure coal, ash, and other samples are collected and tracked properly. A tentative sample collection schedule is presented in Table 7. The final schedule will be agreed upon prior to beginning baseline testing.

Table 6. Data Collected During Field Testing

Parameter	Sample/signal/test	Baseline	Parametric/ Long-Term
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 ESP inlet/outlet	Yes	Yes
Temperature	Full traverse at ESP inlet/outlet	Yes	No
Duct Gas Velocity	Full traverse at ESP inlet/outlet	Yes	No
Mercury (total and speciated)	Hg Monitors at ESP inlet/outlet	Yes	Yes
Mercury (total and speciated)	ASTM M6784-02 (Ontario Hydro) at ESP inlet/outlet	Yes (1 set)	No/Yes (2 sets)
Multi-Metals Emissions	Method 29 at ESP inlet/outlet	Yes, outlet	No/Yes, outlet
HCl, HF, Br	EPA Method 26a at ESP inlet/outlet	Yes	Yes
Sorbent Injection Rate	PLC, lbs/min	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

Table 7. Tentative Sample Collection Schedule

Test Condition	Type	Frequency	Comments
Baseline	Coal	Daily	1 liter
	ESP Ash	Daily: Middle Hopper Each Row on Test Side	1 liter
		2 samples per week: All Hoppers on Test Side	1 liter (2) 5 gallon - Samples
	Bottom Ash*	2 samples per week	1 liter
Parametric	Coal	Daily	1 liter
	ESP Ash	Daily: Middle Hopper Each Row on Test Side	1 liter
Long-Term	Coal	Daily	1 liter
	ESP Ash	Daily: Middle Hopper Each Row on Test Side	1 liter
		2 samples per week: All Hoppers on Test Side	1 liter (2) 5 gallon - Samples
	Bottom Ash*	2 samples per week	1 liter

* If sample collection is possible

Grab samples of ash will be collected from the ESP hoppers each day of testing. Samples will be segregated by the test condition (baseline, each parametric test, and long-term test). The samples will be stored in 1-liter or 5-gallon sample containers for shipping to the analytical laboratories. The schedule indicates sampling from multiple rows in the ESP. These samples will be used to determine if stratification exists throughout the system. A sketch of one of the fabric filters with the row numbers is presented in Figure 6.

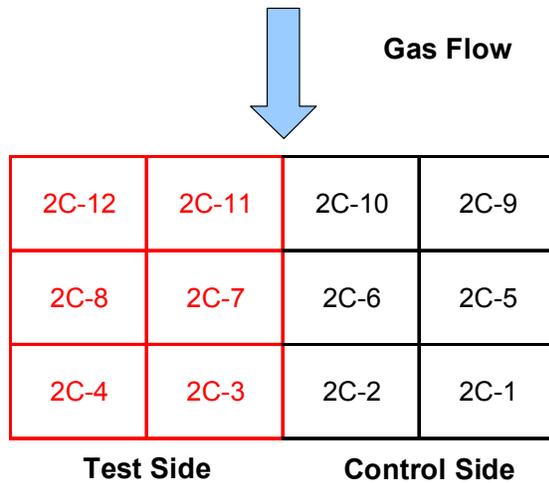


Figure 6. Sketch of Unit 2 ESP Hoppers showing Module Numbering.

Subtask 3.3 Baseline Testing

Once the equipment is installed, one week of baseline testing (no sorbent injection) is scheduled. During the baseline testing series, mercury measurements will be made at the inlet and outlet of the ESP. These data will be used to characterize native mercury capture across the ESP without sorbent injection. Unit operation will be set at conditions expected during the parametric tests. It is anticipated that boiler load will be held constant at full-load and that the air pollution equipment will be operated under standard full-load conditions. ASTM M6784-02 (mercury) measurements, and M26A (HCl and HF) measurements will be conducted in conjunction with the mercury monitors during this subtask.

Subtask 3.4 Parametric Testing

Following baseline testing, three weeks of parametric testing are planned as shown in the test matrix (Table 9).

A series of parametric tests will be conducted at full-load conditions to document sorbent injection requirements at various sorbent injection rates. Mercury measurements will be made during the parametric tests to characterize mercury capture with sorbent injection. During the parametric tests, sorbents will be injection at various rates to develop a relationship between sorbent injection rate and mercury removal efficiencies across the ESP.

The first series of parametric tests will include the DARCO FGD sorbent manufactured by NORIT Americas. This sorbent has been tested in various lab, pilot, and full-scale mercury control demonstrations and is considered the benchmark for performance comparisons. DARCO FGD is derived from a Texas-Lignite coal, and has a bulk density of 25-30 lbs/ft³.

Options for improving the mercury removal beyond that achievable with DARCO FGD will be tested at Meramec. Options include testing a chemically treated activated carbon and introducing an additive into the coal while injecting DARCO FGD. Both of these options were evaluated at Holcomb Station under this four-site DOE/NETL program. Holcomb burns a PRB coal and is configured with a spray dryer absorber and fabric filter for particulate and SO₂ control. Both options were effective at increasing mercury capture compared to the baseline results. Although the configuration is different, enhancements effective at Holcomb are likely to improve performance at Meramec. Therefore, during the second week of testing, FGD-E3, a halogenated activated carbon will be evaluated at several injection concentrations.

During the third week of parametric testing, the mercury removal performance of coal additives with and without sorbent injection will be evaluated. EPA M26a tests will also be conducted at the outlet of the ESP during weeks 2 and 3 testing to determine if there is an increase in vapor-phase halogens as a results of injecting halogenated material or coal additives. After parametric testing is completed, the project team will evaluate the data collected to determine the optimum long-term testing conditions. The best option may be DARCO FGD, the FGD-E3, or the coal additive with or without the DARCO FGD injection. The final week of testing will be used to optimize the mercury control conditions and prepare for the long-term testing series.

Subtask 3.5 Long-Term Testing

Long-term testing will be conducted at the “optimum” settings as determined in the parametric tests and approved by both DOE and AmerenUE/Meramec. It is the intent of DOE that these settings represent the maximum mercury removal. The goal of this task is to obtain sufficient operational data on removal efficiency over a 4-week period, the effects on the particulate control device, effects on byproducts, and impacts to the balance of plant equipment to prove viability of the process and determine the process economics. During this test, ASTM M6784-02 and M26A measurements will be conducted at the inlet and outlet of the pollution control device at least once, depending on results verifying mercury monitor measurements during the baseline tests.

This task is the single most important step in gaining acceptance from the utility industry as to the practical implementation of mercury removal technologies on coal-fired power plants.

Table 9. Proposed Full-Scale Test Sequence for Meramec Unit 1

Test Description	Start Date	Parameters/Comments	Boiler Load
Baseline	8/23/04	Day 1 - Test crew set-up no restrictions on boiler load Day 2 - ASTM M6784-02, M26a Day 3 - ASTM M6784-02, M26a Day 4 - ASTM M6784-02, M26a Day 5 - no restrictions on boiler load	Full Load 24 hours per day Days 2-4
Parametric Week 1 Benchmark Testing	8/30/04	Day 1 - DARCO FGD, 5 lb/MMacf Day 2 - DARCO FGD, 10 lb/MMacf Day 3 - DARCO FGD, 15 lb/MMacf Day 4 – DARCO FGD/TBD Day 5 – DARCO FGD/TBD	Full Load 6AM-6PM
Parametric Week 2 Enhanced Sorbent Testing	9/13/04	Day 1 - FGD E3, 1.0 lb/MMacf Day 2 - FGD E3, 5 lb/MMacf Day 3 - FGD E3, 10 lb/MMacf Day 4 - FGD E3, TBD Day 5 - FGD E3, TBD	Full Load 6AM-6PM
Parametric Week 3 Coal Additive Testing	9/20/04	Day 1 – Coal additive Day 2 – Coal additive Day 3 – Coal additive / DARCO FGD, 5 lb/MMacf Day 3 – Coal additive / DARCO FGD, 10 lb/MMacf Day 5 - TBD	Full Load 6AM-6PM
Long-term tests	10/18/04	Operate at consistent injection rate 24 hours a day, 4 weeks, while load following. Conduct ASTM M6784-02 during week 1 and week 4, ASTM M6784-02 and M26A tests during week 4. Sorbent and rate TBD.	Full Load only during Ontario Hydro

Task 4. Data Analysis

Data collection and analysis for this program is designed to measure the effect of sorbent injection on mercury control and the impact on the existing pollution control equipment. The mercury levels and plant operation will be characterized with and without sorbent injection and the long-term evaluation to identify effects that may not be immediate.

Many signals typically archived by the plant will be monitored to determine if any correlation exists between changes in mercury concentration with measured plant operation. A correlation is not unusual between temperature and load, for example.

Because of the apparent influence of HCl and HF on sorbent effectiveness, HCl and HF measurements will be conducted and samples analyzed to determine if a correlation exists between sorbent effectiveness and HCl and HF concentrations.

Task 5. Coal and Byproduct Evaluation

Coal and combustion byproduct samples collected throughout the field test will be analyzed in this task. During all test phases, samples of coal, fly ash, and other sample streams will be collected. Select samples will be chosen by the test team for analysis. Ultimate and proximate analyses will be performed and mercury, chlorine, and sulfur levels will be determined for the coal samples. The ash will be analyzed for mercury and LOI. Other potential tests include alkalinity, size distribution, chlorine, fluorine, and metals such as selenium and arsenic. A summary of the analyses to be performed is included in Table 10.

Although previous tests from this program and others have shown that the byproducts mixed with activated carbon are highly 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 will be collected and archived for other tests, including tests requested by EPA, DOE, and independent companies approved by DOE.

Standard leaching test methods will include the Toxicity Characteristic Leaching Procedure (TCLP, SW846-1311) and synthetic groundwater leaching procedure (SGLP). If a chemically treated sorbent is chosen for long-term tests, leaching of the chemical used in the treatment process will be reviewed.

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.

Sample and data management are needed for tracking a large quantity of samples from various process streams at Ameren UE's Meramec Station. ADA-ES is developing 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.

The SDMS will also store plant operational data and other test data during the evaluation. Pertinent plant operating parameters will be logged electronically and formatted into a common spreadsheet, which will be delivered to the test team daily. After all test data have gone through a QA/QC process, these data will be uploaded to the SDMS. The SDMS will provide a centralized access to project information and other data sets. It will provide links to previous project publications, schedules, and memos. The SDMS will have the capabilities to query certain data sets and generate plots and other necessary documents.

For data control and security, full access will be limited to the project manager and site manager at ADA-ES and the sample manager. 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.

Table 10. 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

Task 6. Design and Economics of Site-Specific Control System

After completion of testing and analysis of the data at each plant, the requirements and costs for full-scale permanent commercial implementation of the selected mercury control technology will be determined.

The ADA-ES program team will meet with the host utility plant and engineering personnel to develop plant-specific design criteria. Process equipment will be sized and designed based on test results and the plant-specific requirements (reagent storage capacity, plant arrangement, retrofit issues, winterization, controls interface, etc.). A conceptual design document will be developed. Sorbent type and sources will be evaluated to determine the most cost-effective reagent(s) for the site.

Modifications to existing plant equipment will be determined and a work scope document will be developed based on input from the plant. 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, a budget cost estimate will be developed to implement the control technology. This will include capital cost estimates for mercury control process equipment as well as projected annual operating costs. Where possible, order-of-magnitude estimates will be included for plant modifications and balance of plant items. ALSTOM will provide leveled economics for this evaluation.

Task 7. Prepare Site Report

A site report will be prepared documenting measurements, test procedures, analyses, and results obtained in Task 2. This report is intended to be a stand-alone

document providing a comprehensive review of the testing that will be submitted to the host utility.

Schedule

The tentative schedule for activities at Meramec Station is shown in Table 11.

Table 11. Tentative Schedule for Meramec

ID	Task Name	2004												2005										
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1	Planning																							
2	Design and Install Equipment																							
3	Field Testing																							
4	Baseline																							
5	Parametrics																							
6	Long Term																							
7	Data Analysis																							
8	Coal and Byproduct Evaluation																							
9	Design and Economics																							
10	Site Report																							

Key Personnel

Key personnel for the Meramec tests are identified in Table 12.

Table 12. Key Project Personnel for Meramec Mercury Field Evaluation

NAME	COMPANY	ROLE	PHONE #	E-MAIL
Richard Phillips	Ameren UE	Project Manager	314-554-3485	RPhillips@ameren.com
Sharon Sjostrom	ADA-ES	Program Manager	303-734-1727	sharons@adaes.com
Travis Starns	ADA-ES	Site Project Manager	303-734-1727	traviss@adaes.com
Tom Hart	Ameren UE	Project Engineer	314-992-7322	Thart@ameren.com
Charlie Fronick	AmerenUE	Construction Supervisor	314-992-7292	Cfronick@ameren.com
Jerry Amrhein	ADA-ES	Hg Monitors	303-734-1727	jerrya@adaes.com
Cam Martin	ADA-ES	Equipment Design	303-734-1727	Camm@adaes.com
Richard Schlager	ADA-ES	Contracts	303-734-1727	Richards@adaes.com
Connie Senior	Reaction Engineering	Coal and Byproduct Issues	801-364-6925 ext 37	senior@reaction-eng.com
Michael Durham	ADA-ES	Technical Expert	303-734-1727	miked@adaes.com
Jean Bustard	ADA-ES	Technical Expert	303-734-1727	jeanb@adaes.com
Ramsay Chang	EPRI	Technical Expert	650-855-2535	Rchang@epri.com
Leif Lindau	ALSTOM	Technical Expert	865-560-1397	Leif.lindau@power.alstom.com

APPENDIX B

Fluent CFD Modeling Presentation

CFD Modeling of Sorbent Injection at AmerenUE's Meramec plant, St.Louis (MO)

Jens I. Madsen
Fluent Inc., Morgantown, WV

February 10, 2005



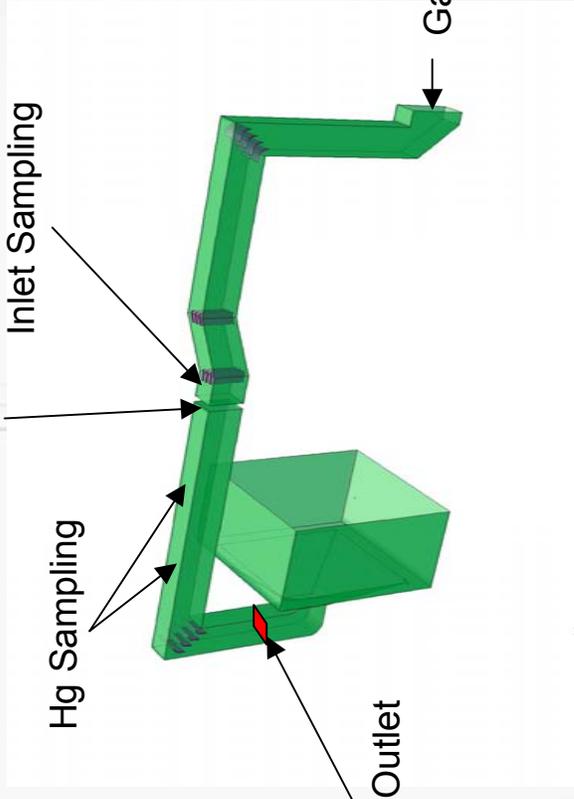
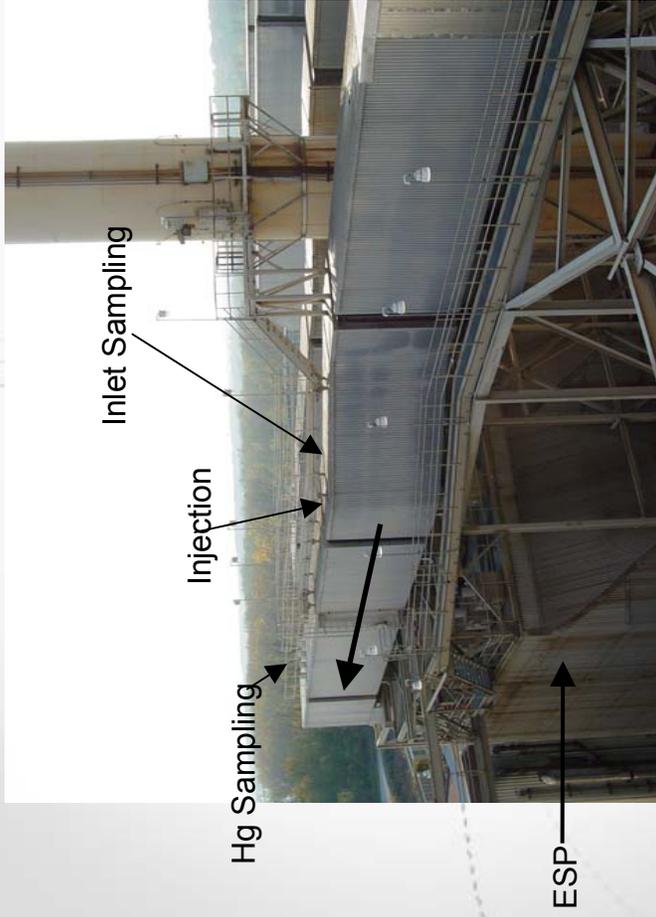
The Right Answer in CFD

Overview

- Here is a brief overview of what you will find contained in this presentation:
 - Meramec injection duct layout
 - Sorbent particle trajectory plots
 - Method for visualizing sorbent dispersion
 - Method for calculating coverage fractions
 - Meramec dispersion plots
 - Revisit of Brayton Point (for comparison)
 - Concluding Remarks
- **Your feedback is welcomed!!!**

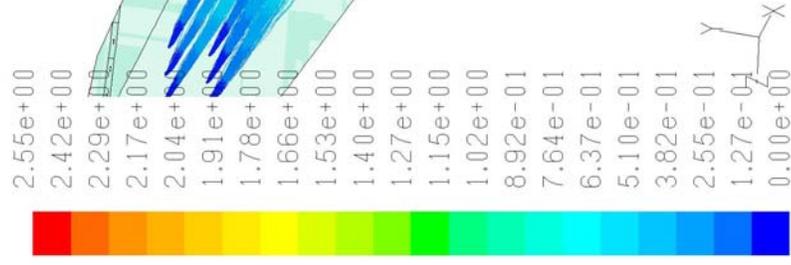
AmerenUE Meramec Plant

Sorbent Injection Duct – Reality and Model



Meramec Sorbent trajectories

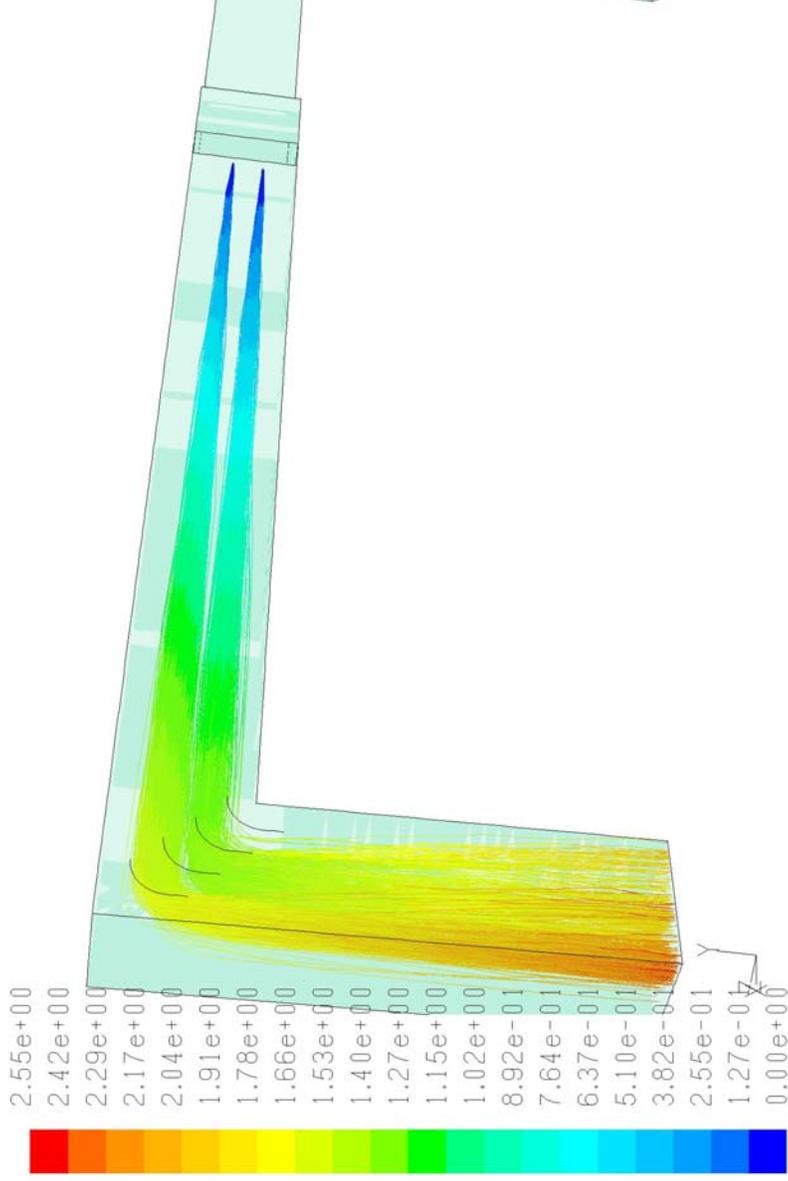
Colored by residence times



Particle Traces Colored by Particle Residence Time (s) Feb 04, 2005
FLUENT 6.1 (3d, dp, segregated, rke)

Meramec Sorbent Trajectories

Another view



Particle Traces Colored by Particle Residence Time (s) Feb 04, 2005
FLUENT 6.1 (3d, dp, segregated, rke)

Post-processing of Sorbent Injection

Some Thoughts on Trajectory Plots

- **Pros**
 - Gives a good feeling for sorbent flow patterns
 - Are particles traveling in ordered bands or is there a heavy mixing
 - Visualizes residence time
- **Cons**
 - Plots tend to get messy due to the vast number of trajectories
 - Each trajectory does not necessarily represent the same mass flow
 - Each trajectory represents a certain solids flow rate, which is scaled according to size distribution (and injection face area).
 - Plots can be misleading as some trajectories
 - **Not easy to quantify dispersion statistics**
 - Makes comparison of different injection strategies subjective

Normalized Sorbent Concentrations

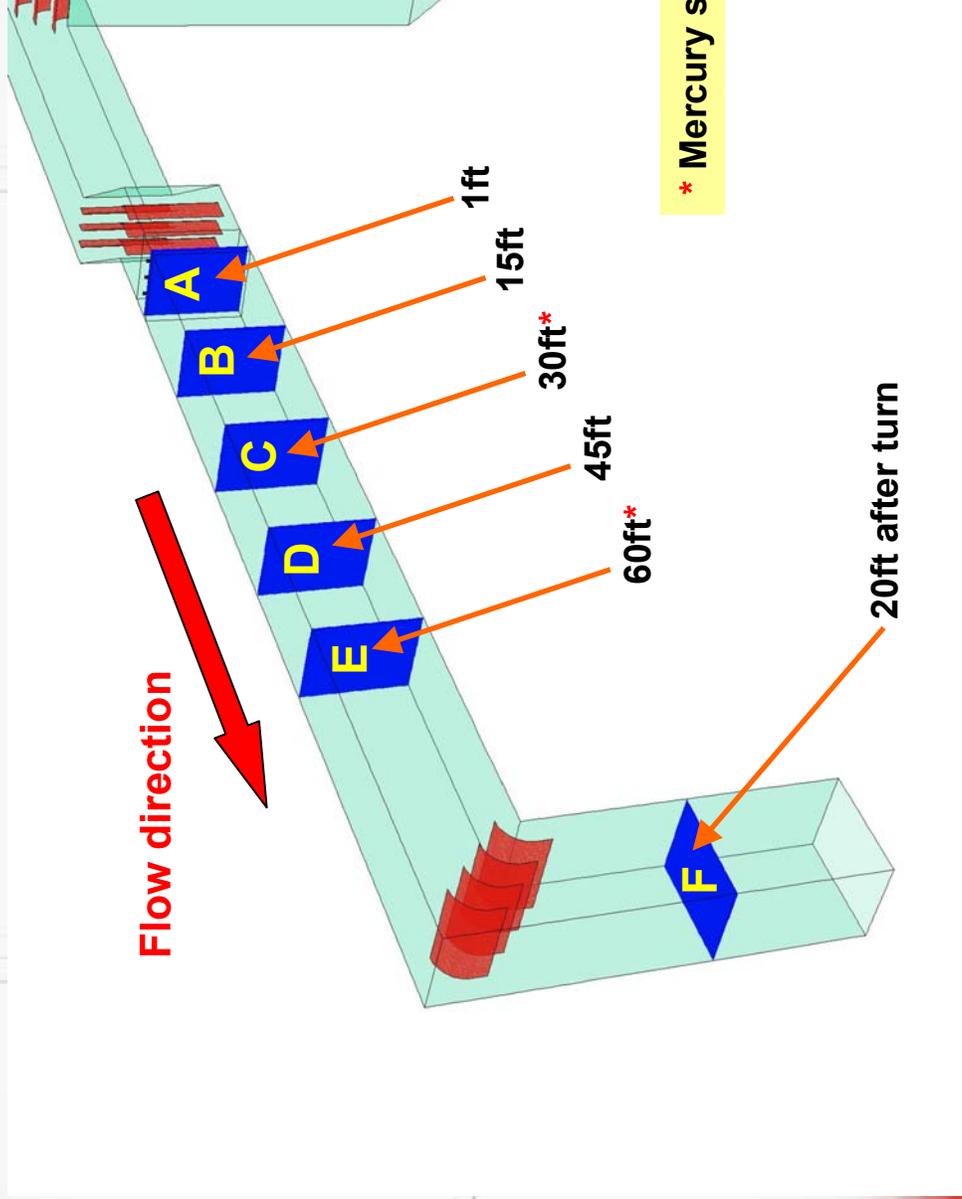
- Sorbent concentration [g/m³] have been normalized by the average concentration downstream of injection
 - This enhances visualization of dispersion patterns
 - With fully uniform dispersion (ideal case), the normalized sorbent concentration would be 1.0 throughout.
 - Normalized values of 0.0 means there is no sorbent present, etc.
 - Normalized values of 0.2 corresponds to 20% of avg. concentration etc..
 - The average sorbent concentration is calculated as:

$$\bar{c}_{sorb} = \frac{\dot{m}_{sorb}}{A_x \bar{u}_x} \approx 0.053 \text{ g} / \text{m}^3$$

- Duct cross-sectional area : $A_x = 10'3'' \times 8'2'' = 7.78 \text{m}^2$
- Mean (plug flow) gas velocity : $u_x = 16.7 \text{m/s} = 50.9 \text{fps}$
- Sorbent flow rate ($\sim 3.3 \text{lb/Macf}$) $m_{sorb} = 54.5 \text{lb/hr} = 6.87 \text{g/s}$

Meramec Simulations

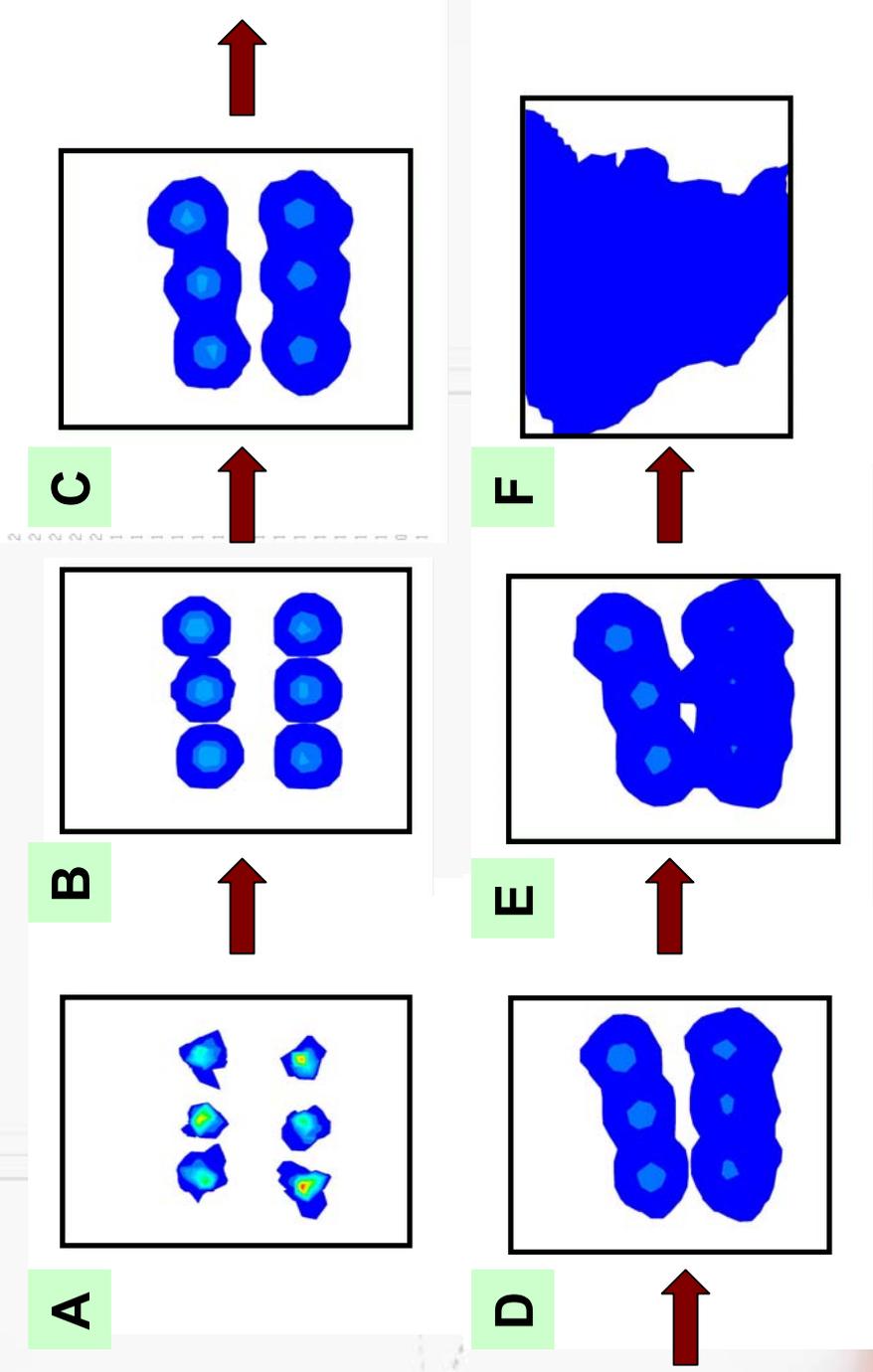
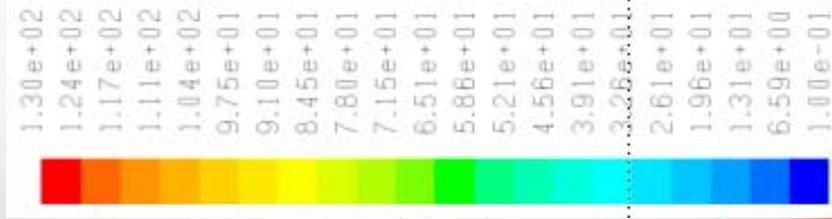
Overview of Plotting Planes



* Mercury sampling planes

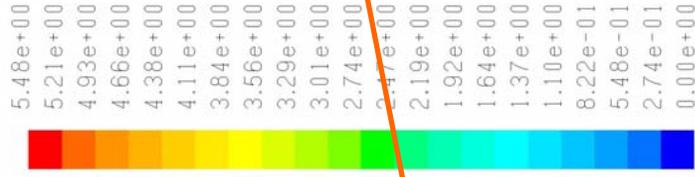
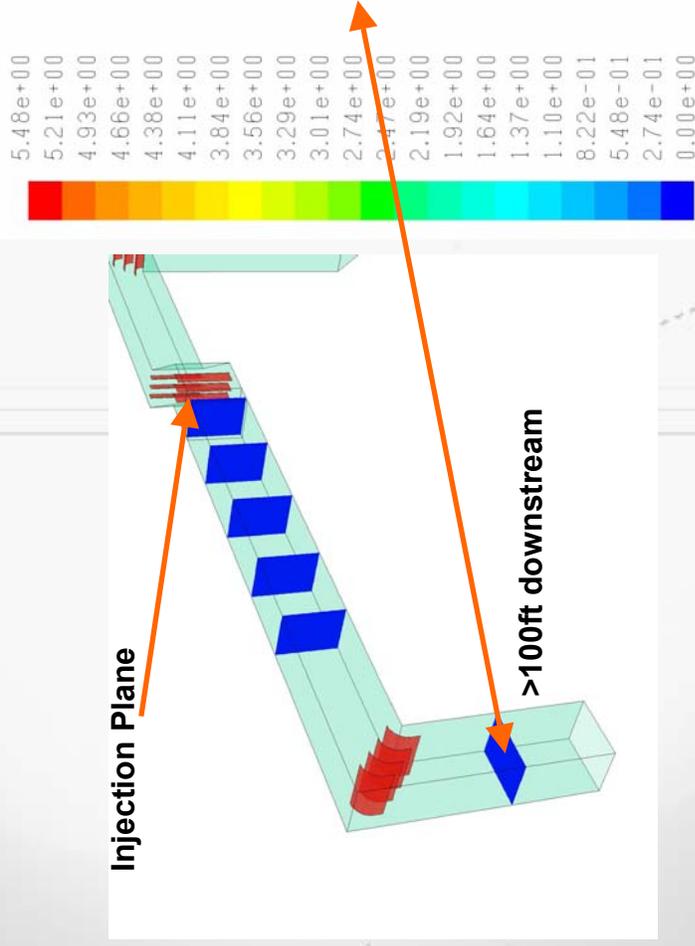
Meramec dispersion patterns

Areas covered >10% of Average Sorbent Concentration

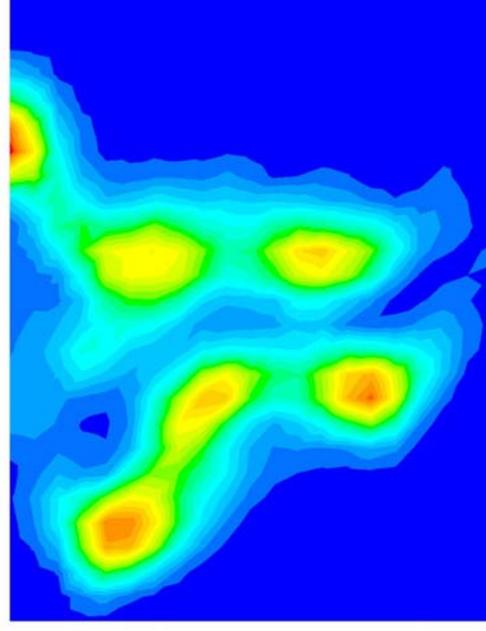


Meramec dispersion patterns

Structures prevail far downstream – six nozzles



F



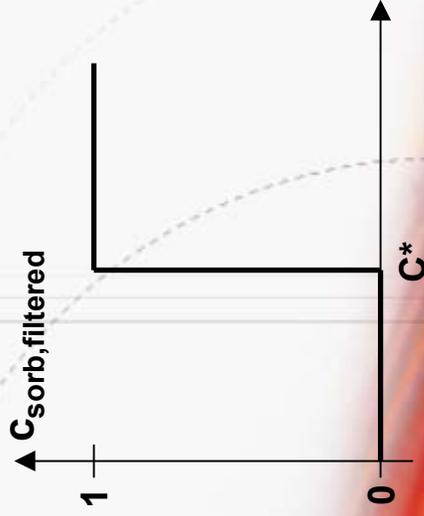
Contours of sorb-conc-norm

FLUENT 6.1 (3d, dp, segregated, rke)
Feb 04, 2005

Sorbent coverage

Methodology for determining this

- Not a standard output from Fluent simulation
- Select cut-off ratio (c^*) for normalized sorbent concentration (c_{sorb})
 - What sorbent concentrations are considered sufficient for Hg capture
- Apply filter function
 - Utilizing custom field function capability in Fluent
 - For low concentrations $c_{sorb} < c^* \rightarrow c_{sorb,filtered} = 0.0$
 - For high concentrations $c_{sorb} > c^* \rightarrow c_{sorb,filtered} = 1.0$



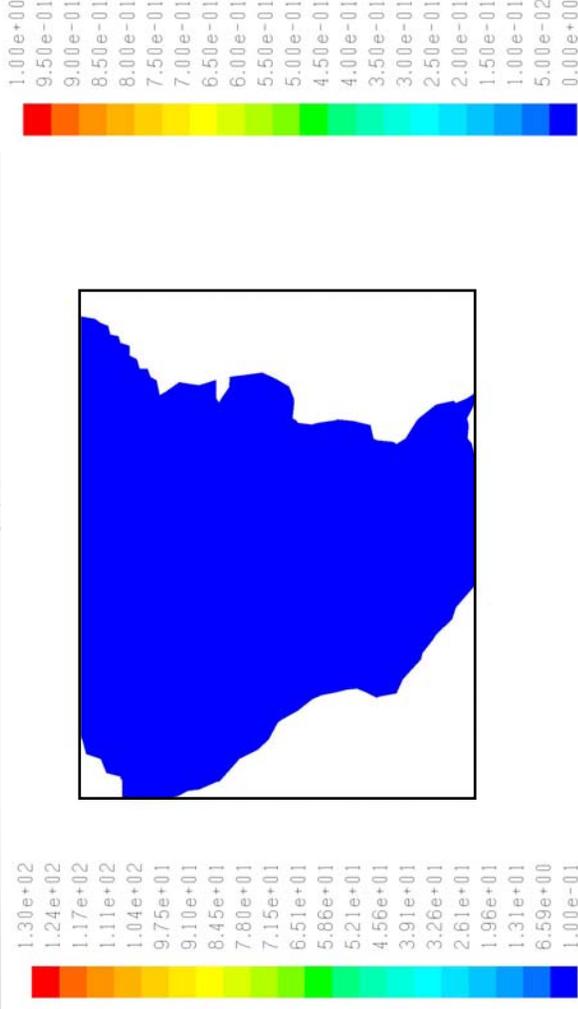
$$\frac{1}{1 + \left(\frac{c^* + \varepsilon}{c_{sorb} + \varepsilon} \right)^{100}}$$

• Area-weighted average of the filtered function is the coverage fraction

- This is a standard post-processing tool

Sorbent Concentration Filtering

Proof of concept



Contours of sorb-conc-norm Feb 04, 2005 FLUENT 6.1 (3d, dp, segregated, rke) Contours of filter-10pct Feb 08, 2005 FLUENT 6.1 (3d, dp, segregated, rke)

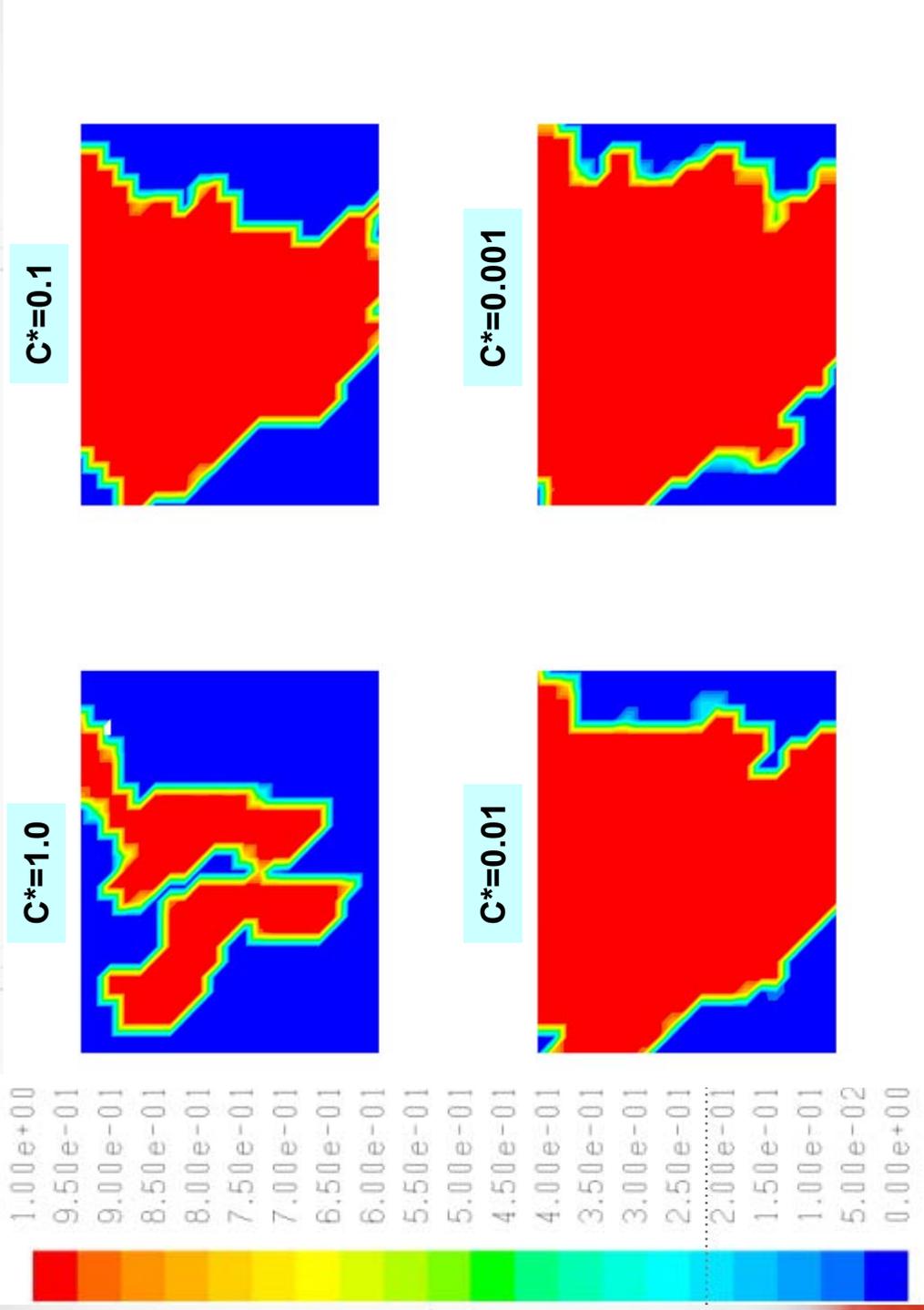
**Normalized sorbent conc.
(clipped to range $c_{sorb} > 0.1$)**

**Filtered sorbent conc.
(cut-off value $c^* = 0.1$)**



Coverage at Different Cut-off Ratios (c^*)

Plane F – 20ft downstream of duct bend

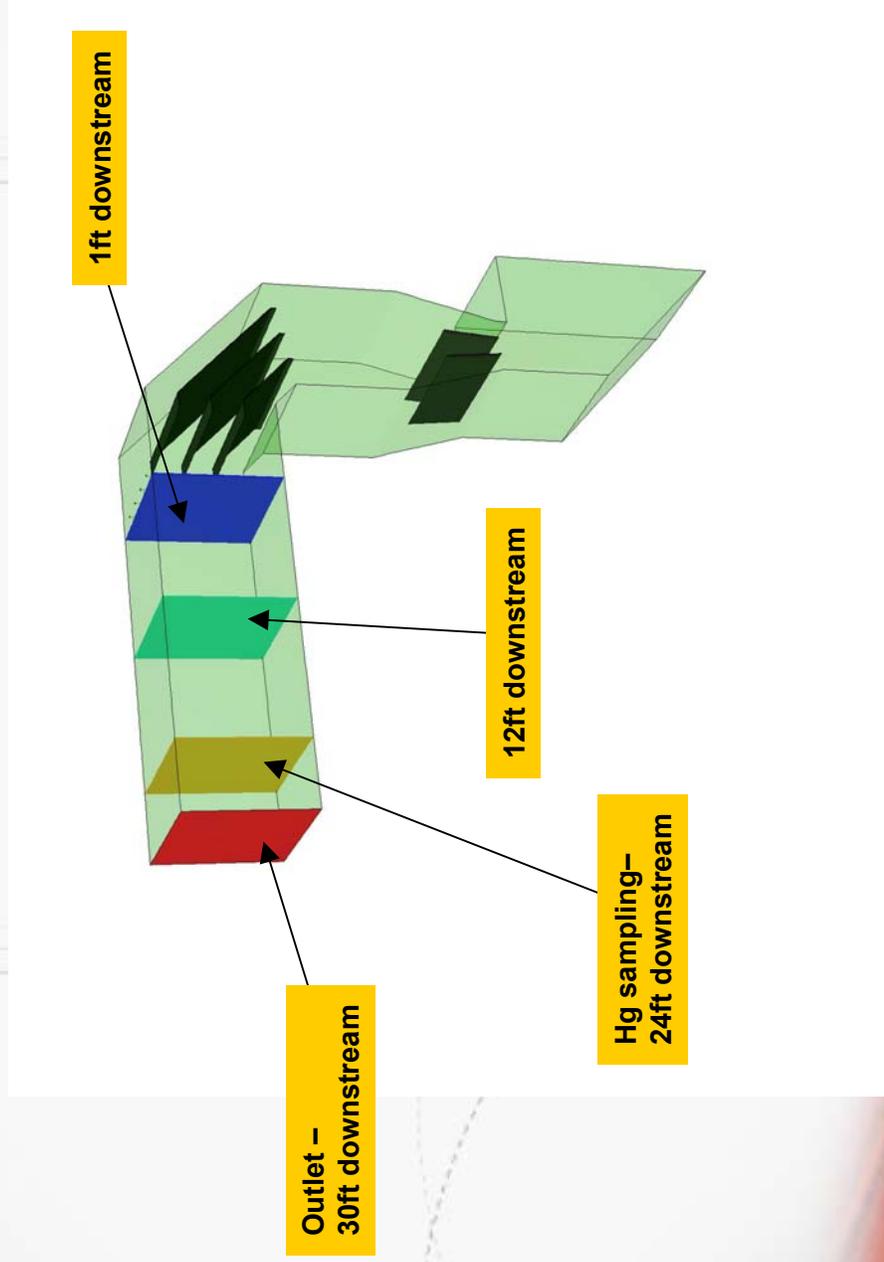


Coverage Fractions At Downstream Planes

Poor numerical integration

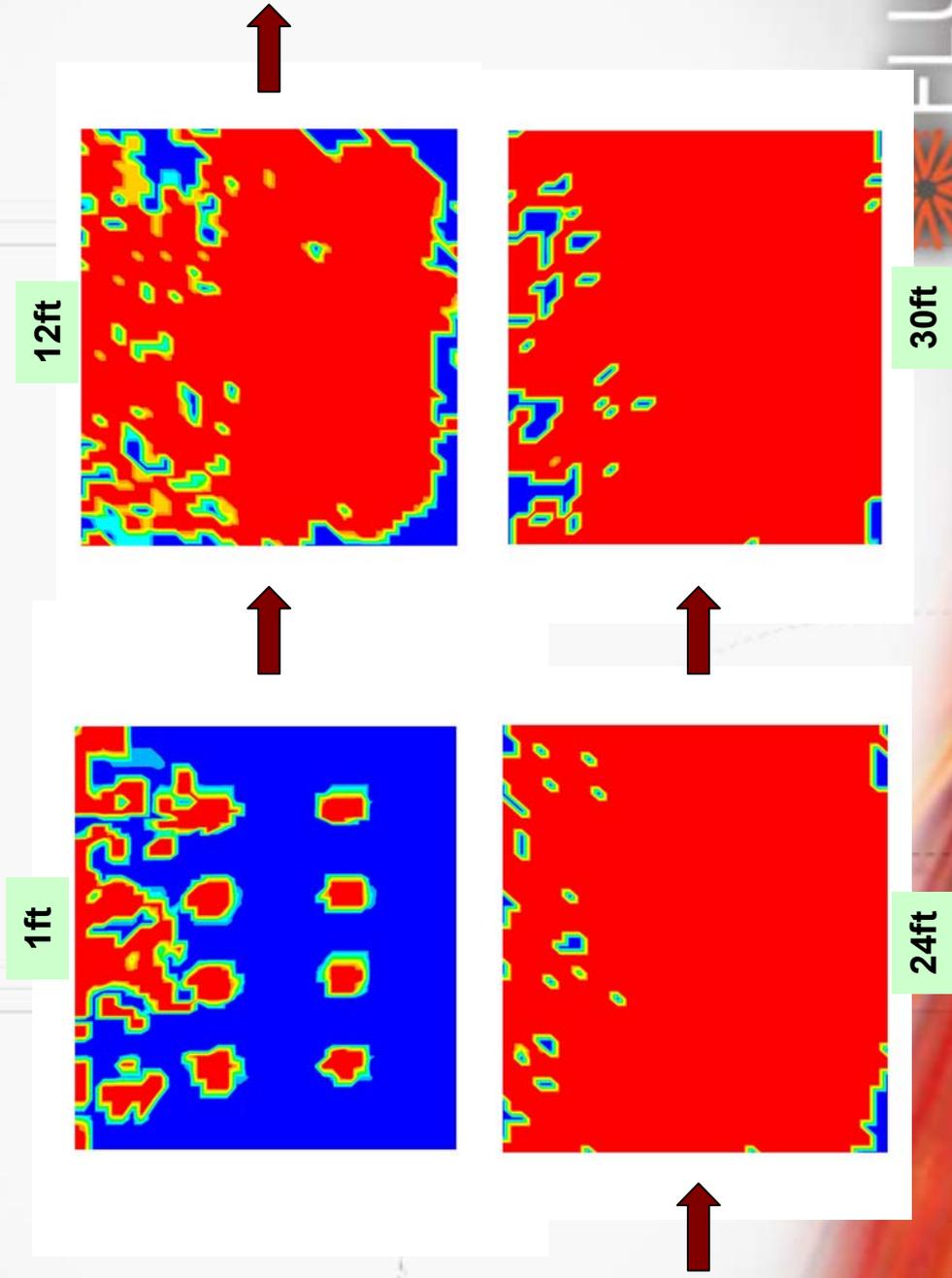
Plane	Coverage Fraction				Average Normalized C_{sorb}
	>100% avg.	>10% avg.	>1% avg.	>0.1% avg.	
A	0.049	0.056	0.066	0.070	1.486
B	0.125	0.187	0.248	0.258	1.007
C	0.164	0.296	0.390	0.406	1.002
D	0.209	0.358	0.486	0.501	1.000
E	0.227	0.424	0.528	0.564	0.999
F	0.317	0.597	0.750	0.800	0.996

Comparison with Brayton Point Computational Model with Planes Considered



Comparison with Brayton Point

Dispersion patterns – coverage with >10% of average sorbent conc.



Comparison with Brayton Point

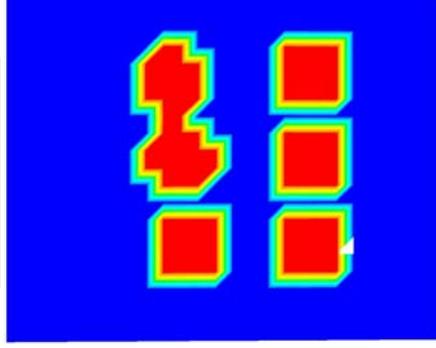
Cross-sectional Coverage Fractions

Downstream Distance from Injection	Coverage Fraction	
	>100% avg.	>10% avg.
1ft	0.069	0.221
12ft	0.224	0.840
24ft	0.282	0.970
30ft	0.307	0.944

Meramec vs. Brayton Point

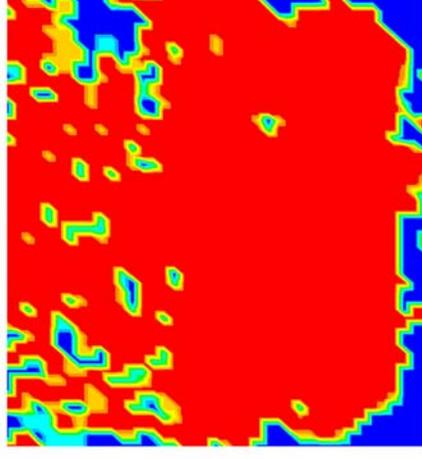
- Dispersion is remarkably better at Brayton Point than Meramec
 - Sorbent characteristics is identical (Darco FGD with 10 size bins)
 - Flow rates, velocities, and duct dimensions all in the same ballpark
 - So we have better mixing with a much shorter duct length!

MERAMEC



15ft after injection

BRAYTON PT.



12ft after injection

Meramec Simulations

Concluding Remarks

- **Methods for visualizing and quantifying sorbent coverage have been devised.**
- **What explains the remarkable contrast between dispersion patterns?**
 - Flow at Meramec is much more stratified
 - The more tumultuous flow pattern at Brayton Point provided better dispersion, probably as a result of higher turbulence intensity
 - This will be further investigated and documented in Air Quality V paper
 - **Can turbulence be induced to enhance mixing?**
 - Fortunately a substantial residence time is available at Meramec
- **Open questions:**
 - **What sorbent concentrations are sufficient to ensure capture?**
 - **Extract history statistics for a particle stream from injection to sampling**
 - It is assumed that the capture processes are very quick process, so even brief contact between carbon and flue gas entrained mercury compounds will result in some capture.
 - Highly unlikely that any gas will not pass through a well-covered portion of the duct at Brayton Point. This is less obvious at Meramec

APPENDIX C

Sample and Data Management Plan

LABORATORY MERCURY FIELD EVALUATION

Evaluation of Sorbent Injection for Mercury Control at AmerenUE Meramec Station

Sample and Data Management Plan



Prepared by:
ADA Environmental Solutions, Inc.
8100 SouthPark Way, Unit B
Littleton, CO 80120

August 20, 2004

ADA-ES, Inc., partnered with ALSTOM Power, is conducting an evaluation looking at sorbent injection for mercury control at AmerenUE's Meramec Station. The overall objective of this project is to determine the cost and effects of sorbent injection for control of mercury in stack emissions.

During the evaluation, fuel samples and certain process byproducts will be collected for determinations of mercury content, stability, and other analytes. Process byproducts of interest include but are not limited to:

- Bottom Ash
- ESP Fly Ash

Sample and data management are needed for tracking approximately 300 samples from various solid process streams at AmerenUE's Meramec Station. ADA-ES is developing 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

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 AmerenUE's Meramec Station are shown in Figure 1.

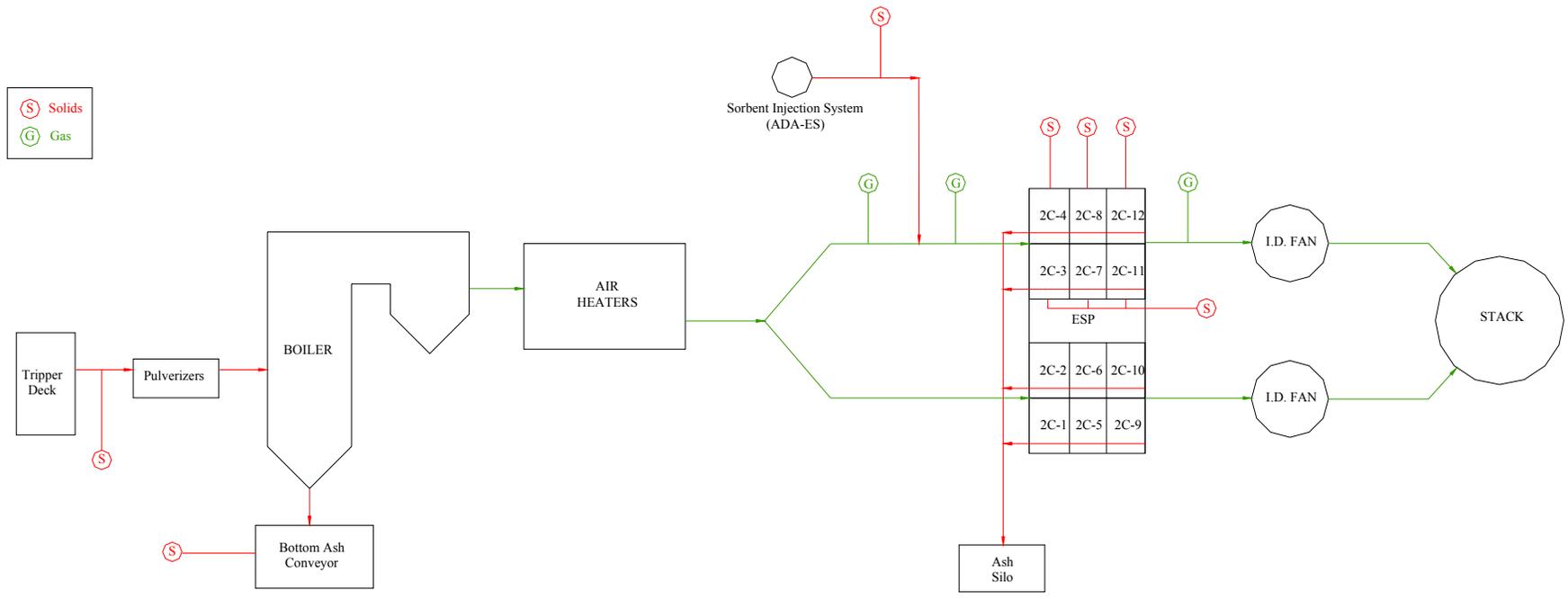


Figure 1. AmerenUE Meramec Unit 2 Configuration and Sampling Locations.

At the end of the long-term testing period, plant personnel will collect a fly ash sample inside the ESP. This sample should be collected from any surface structures (e.g., ledges, corners) that are capable of holding fly ash material in place for long periods 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.

Flyash Aspirator Sample – Samples from an in-flight flyash sampling system installed downstream of the sorbent injection ports will be collected during parametric and long-term testing periods. These samples will be used to determine the in-flight capture of mercury.

Table 1. Tentative Sampling Schedule.

Test Condition	Type	Frequency	Comments
Baseline	Coal	Daily	1 liter
	ESP Ash	Daily: Front Hopper Each Row on Test Side	1 liter
		2 samples per week: All Hoppers on Test Side	1 liter
Bottom Ash*	2 samples per week	1 liter	
Parametric	Coal	Daily	1 liter
	In-flight Flyash	TBD	1 liter
	ESP Ash	Daily: Front Hopper Each Row on Test Side	1 liter
Long-Term	Coal	Daily	1 liter
	In-flight Flyash	TBD	1 liter
	ESP Ash	Daily: Hopper 2C-10, 2C-11	1 liter
		2 sample per week: Hoppers 2C-2, 2C-3, 2C-6, 2C-7	1 liter
		1 sample per week: Hoppers 2C-4, 2C-8	1 Liter
		1 sample per week Hoppers 2C-10, 2C-11	5 gallon
As directed: Hoppers 2C-9, 2C-12	5 gallon		
Bottom Ash*	2 samples per week	1 liter	

*If sample collection is possible

Additional samples, as described in Figure 1, will be collected during long-term testing.

Sample Management Strategy

During the mercury control evaluation, Meramec plant personnel, as directed by ADA-ES, will collect the solid samples. ADA-ES will deliver a sampling schedule, which shows the sampling frequency, volume, and specific samples to collect during each testing day. A sample management flow chart is shown in Figure 3.

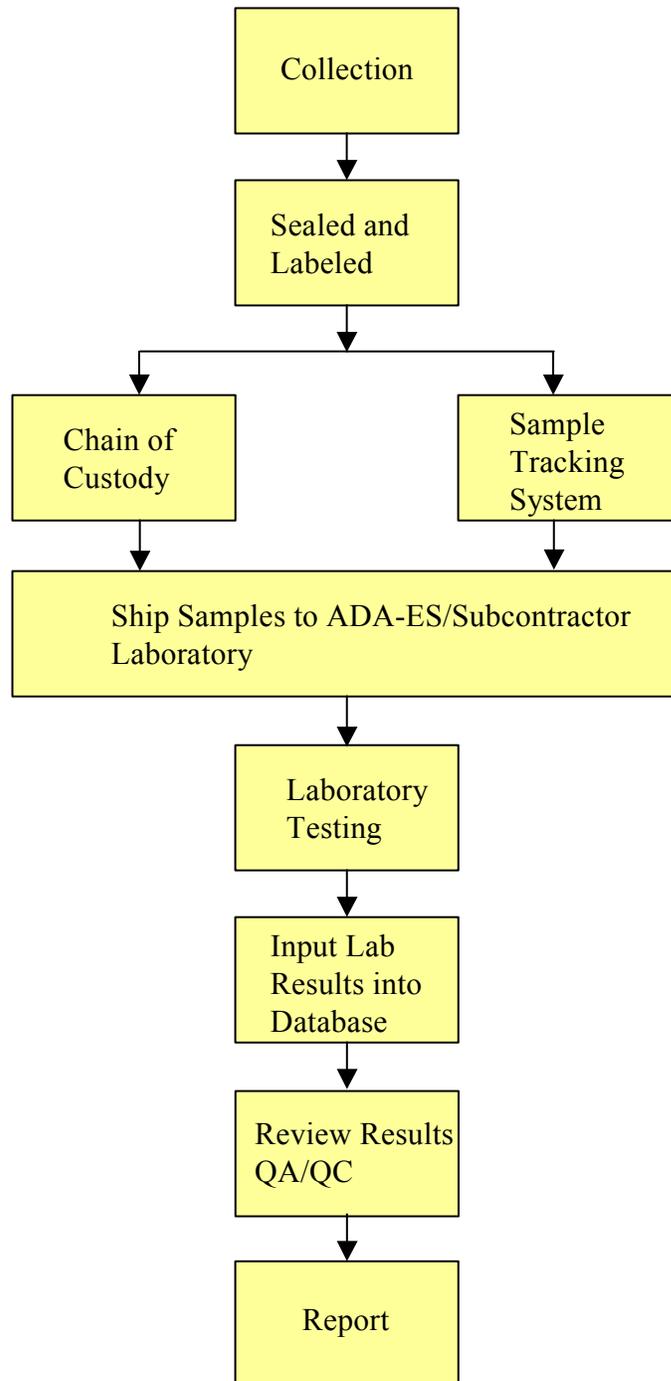


Figure 3. Sample Management Flowchart.

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, elemental analyses for coal and ash samples (including chlorine and fluorine contents), and size distribution analyses for sorbent samples.

Although previous tests from this program and others have shown that the byproducts mixed with activated carbon are highly 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 AmerenUE 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. If a chemically treated sorbent is chosen for long-term tests, leaching of the chemical used in the treatment process will be reviewed.

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 include Ontario Hydros, Method 29, and Method 26a. Hg analyzers will also be used at selected locations measuring near-real-time vapor-phase mercury concentrations in the flue gas.

Table 2. Sampling and Analytical Matrix.

Sampling Location	Sample/Type	Sampling Method	Analytical Method
ESP Inlet	Speciated Mercury	Ontario Hydro	EPA SW 846 7470 cold vapor atomic absorption spectrometry (CVAAS)
	Multi-metals	M29	TBD
	HBr, HCl, HF, BR ₂ , CL ₂ , F ₂	M26a	Ion chromatography per the promulgated EPA Method 26a
	Hg	M324	EPA Method 1631
	Total/Elemental Mercury	Continuous	AF or AA -Analysis
ESP Inlet (downstream of sorbent injection)	Total/Elemental Mercury	Continuous	AF or AA-Analysis
ESP Outlet	Speciated Mercury	Ontario Hydro	EPA SW 846 7470 cold vapor atomic absorption spectrometry (CVAAS)
	Multi-metals	M29	TBD
	HBr, HCl, HF, BR ₂ , CL ₂ , F ₂	M26a	Ion chromatography per the promulgated EPA Method 26a
	Hg	M324	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	
	Leaching	Grab Sample	TCLP, SW846-1311, SGLP
	Trace Metals	Grab Sample	

APPENDIX D

STM Procedures

2.0 DRY SORBENT TRAP METHOD – BASED ON 40 CFR PART 75, APPENDIX K

2.1 Summary of Test Method

The test method relies on the adsorption of mercury in-situ by a sorbent with a high mercury capacity, through which flue gas is drawn. All mercury is captured on the sorbent trap, which is recovered following sampling and analyzed for total mercury content in a laboratory. No chemical rinses or mercury for calibration are required on-site for this method. The method captures all vapor-phase mercury present at the measurement location, as long as the sample flue gas contact with fly ash is minimized.

This section summarizes some key variables that must be controlled for good quality application of the sorbent trap method, followed by some specific EPA requirements for QC that are currently included in the proposed method. Much of the information in this section is derived, with permission, from the proposed Test Method and from “Mercury Flue Gas Measurements, Understanding Draft Method 324 and Validation Results.”¹ EPA first proposed a sorbent trap method for mercury as Draft Method 324. It was revised and issued as 40 CFR, Part 75, Appendix K²

The method can be used for the determination of vapor-phase mercury concentrations ranging from 0.03 $\mu\text{g}/\text{dNm}^3$ to 100 $\mu\text{g}/\text{dNm}^3$ in low-dust applications. A low volume of flue gas (0.2 to 1 L/min) is sampled. The following are highlights of the method:

- The sample trap is a probe-supported dry sorbent trap that is sampled in-situ and that must be kept dry;
- The trap design includes two sections, so that breakthrough of mercury can be evaluated;
- The key field QC steps are a good leak check and accurate measurement of sample volume;
- Cleanliness is key throughout the field and laboratory handling in order to maintain low blanks, low detection limits, and reliable mercury measurement; and
- The method can be adapted to higher-dust applications, with the same speciation bias caveats that apply to wet chemistry sampling.

2.2 Sorbent Trap Design

Traps are obtained from Frontier Geosciences, Inc. This trap contains a chemically treated charcoal sorbent. The trap has been designed in two sizes, designated small and large; Figure A-2 shows the trap dimensions. These have identical sorbent type, but different size and loading capacities. In general small traps are used for short sample times (<12 hours in duration) and large traps are used for longer sample times (>12 hours in duration).

1 EPRI. “Quality Assurance/Quality Control Guidelines for Mercury Measurements Technical Report,” EPRI, Palo Alto, CA: 2005. 008267. March 2005.

2 U.S. Environmental Protection Agency. 40 CFR Part 75, Appendix K, March 2005.

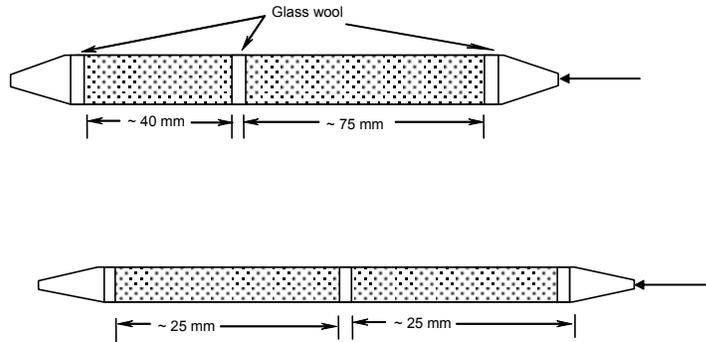


Figure A-1. Dimensions and Configuration of the Existing FSTM Sorbent Trap Used to Validate Proposed Method 324. Note: not to scale.

2.3 Sorbent trap Mercury Sampling Procedures

A simplified diagram of the field sampling train is presented in Figure A-1. These criteria are based on the FSTM trap, both in terms of temperatures and sampling rates.

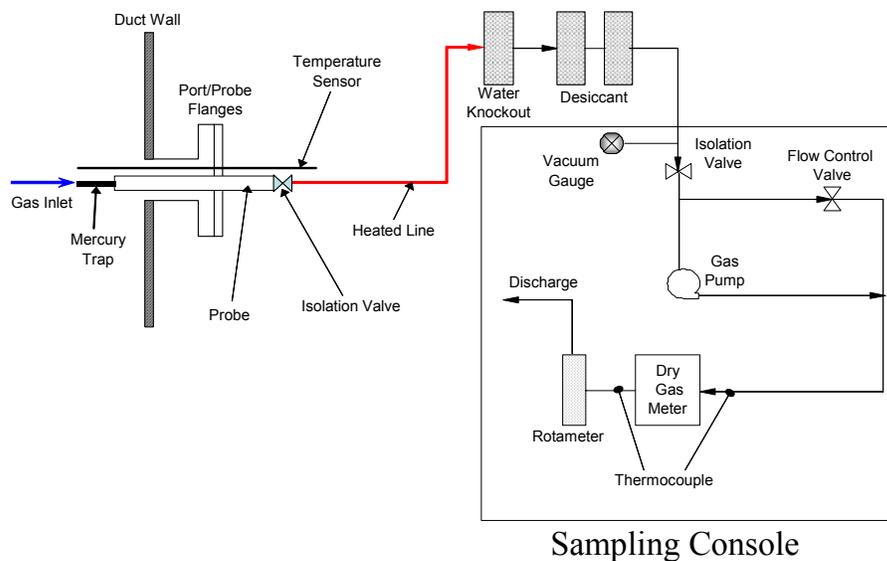


Figure A- 2. Schematic of Proposed EPA Method 324

Certain key QC measures should be emphasized during field sampling:

- When handling the sorbent traps in the field, non-talc clean laboratory gloves should be worn. This applies to installing the trap onto the probe, leak checking, and sample recovery. Cleanliness is discussed in more detail below.
- Sorbent traps need to be inserted directly in the flue gas duct when sampling, with no upstream tubing, filter, etc.
- Condensation or wetting must not occur in the sample trap, and care should be taken when handling the probe to prevent condensation from flowing back to the trap.

- For wet stack operation the trap section of the probe needs to be heated and it is recommended that a shield be incorporated in the probe to deflect entrained moisture from the trap inlets.
- Sample volume must be accurately measured (a dry gas meter calibrated as required in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source Specific Methods* as discussed in 40 CFR Part 60, Appendix A Method 5).
- The sampling train must be leak checked to assure accurate volume measurements.
- Upon sample recovery, first cover the trap ends, then wipe off any excess dirt or ash prior to storing for subsequent analysis.

2.4 Mercury Analysis Procedures

The method that has passed the Method 301 validation uses acid leaching and CVAFS analysis. The procedure is based on EPA Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. In the laboratory, each trap is acid leached, a known aliquot of the leachate is added to an acidified bubbler, the mercury is reduced by SnCl₂ and purged from solution and amalgamated on a gold trap, and finally the trap is heated and analyzed by CVAFS detection. .

APPENDIX E

URS Memo on Baseline Ontario Hydro Results



To: Sharon Sjostrom, ADA-ES
From: Mandi Richardson
Cc: Carl Richardson, Travis Starns
Date: 17 October 2005
Subject: **Ontario Hydro Results for Meramac Samples**

MEMORANDUM

At the request of ADA-ES, Ontario Hydro samples from the July 2004 flue gas sampling program at Meramac Station were shipped to URS Corporation directly from Crystal Laboratories for re-analysis of sample mercury concentration. The recovered KMnO_4 and KCl fractions of the Ontario Hydro train were received by URS Corporation in October of 2004 following digestion and sample analysis at Crystal Laboratories; the samples were thus well beyond the 28-day hold time specified in the ASTM method. The KMnO_4 fractions received included runs 1 and 2 from the inlet location, and runs 1 and 3 from the outlet locations. The samples were a dark grey in color with appreciable solids on the bottom and floating throughout the sample; this is opposed to a purple color with little or no solids for relatively fresh solutions. The KCl fractions received included runs 1-3 from the inlet location and runs 1-3 from the outlet location. These samples were clear rather than purple.

Both fractions were analyzed by M7470 in the URS laboratory on November 2, 2004. The results in ppb Hg are listed in Tables 1 and 2 below.

Table 1. KMnO_4 Data Summary – Meramac Samples

SAMPLE ID	ppb Hg
Inlet Run 1 KMnO_4	2.12
Inlet Run 2 KMnO_4	5.85
Outlet Run 1 KMnO_4	8.93
Outlet Run 3 KMnO_4	3.60

Table 2. KCl Data Summary – Meramac Samples

SAMPLE ID	ppb Hg
KCl - Inlet Run 1	0.68
KCl - Inlet Run 2	0.74
KCl - Inlet Run 3	0.73
KCl - Outlet Run 1	1.63
KCl - Outlet Run 2	1.26
KCl - Outlet Run 3	1.34

The mercury concentrations listed in the above tables were converted to total micrograms, using total sample volumes listed in the Crystal Laboratories analytical report. These calculated results were compared to the microgram Hg results listed in the Crystal Laboratories analytical report as shown in Tables 3 and 4 below.

Table 3. KMnO₄ Data Summary – Meramac Samples

SAMPLE ID	µg Hg URS	µg Hg Cryst Labs
Inlet Run 1 KMnO ₄	0.952	0.569
Inlet Run 2 KMnO ₄	2.60	0.496
Outlet Run 1 KMnO ₄	*4.02	0.539
Outlet Run 3 KMnO ₄	*1.62	0.441

*No volumes were listed in the analytical report for these samples an estimated average volume was used.

Table 4. KCl Data Summary – Meramac Samples

SAMPLE ID	µg Hg URS	µg Hg Cryst Lab
KCl - Inlet Run 1	0.426	2.80
KCl - Inlet Run 2	0.510	1.82
KCl - Inlet Run 3	0.601	2.84
KCl - Outlet Run 1	1.34	2.52
KCl - Outlet Run 2	0.859	1.19
KCl - Outlet Run 3	1.04	2.43

Table 3 shows that the KMnO₄ results from the URS laboratory were higher in mercury than the results from Crystal Laboratories. Also, because of the age and pre-treatment of the samples, it is likely that the URS laboratory results are biased low. Before being sent to URS, the test samples were digested per the Ontario Hydro Method, which likely resulted in some mercury loss over time. The Ontario Hydro method calls for the addition of hydroxylamine sulfate to the jar of KMnO₄ sample before a sample aliquot is removed and digested for mercury analysis. The addition of this solution can create a reducing environment within the sample that can subsequently result in, oxidized mercury being converted to elemental mercury. Elemental mercury is volatile and will not stay in solution. Therefore, URS received the KMnO₄ samples 4-6 weeks after the addition of the reducing solution, and mercury volatilization could have occurred during this period of time. Furthermore, the KMnO₄ results obtained by URS showed very high variability. As mentioned in the first paragraph, the KMnO₄ samples were gray and full of solids rather than purple with no solids when they were received. The degradation of the

17 October, 2005

Page 3

KMnO₄ to manganese solids creates a mal-distribution of mercury in the KMnO₄ sample, with mercury reporting to the solids. Therefore, higher variability will be observed if the aliquot taken from the sample jar for mercury analysis lacks proper homogeneity.

Table 4 shows the KCl results from the URS laboratory were lower in mercury than the results from Crystal Laboratories. Again, the Ontario Hydro method calls for the addition of hydroxylamine sulfate to the jar of KCl sample before a sample aliquot is taken and digested for mercury analysis. These KCl samples sat for weeks before URS received them for re-analysis. As explained in the above paragraph, the reducing environment created by the addition of hydroxylamine sulfate could create a low bias if the sample is not analyzed in a timely manner.

Conclusions

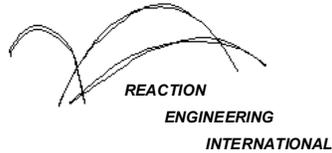
The Meramec Ontario Hydro samples analyzed by URS were outdated at the time of the analysis and likely had lost some of the original mercury (present in the sample) due to the hold time following the Ontario Hydro digestion at Crystal Laboratories. Thus, the results from the URS measurements are not likely to provide useful data for determining flue gas mercury concentrations at Meramac.

Results of the URS mercury analyses do indicate that the initial mercury measurements performed (by Crystal Laboratories) on the permanganate samples were biased low. This is based on the fact that URS measured higher mercury levels in the sample despite the likelihood that mercury-loss had occurred between the analyses by the two labs. Thus, flue gas elemental mercury concentrations, as predicted using the Crystal Laboratories results, should be biased low.

Since the URS measurements for the KCl impinger samples were lower than those at Crystal Laboratories, and mercury loss would be expected over time with the 'reduced' samples, it is not possible to draw any conclusions regarding analysis comparison with these samples.

APPENDIX F

REI Air Preheater Flow Modeling



Date: June 1, 2005

From: Connie Senior

To: Sharon Sjostrom, Travis Starns

Re: Meramec Air Preheater

Meramec Unit 2 has a tubular air preheater (APH). Most coal-fired power plants have regenerative APHs. The Salem Harbor Unit tested in the Phase I program also had a tubular APH.

I carried out calculations of the time-temperature history in the Meramec APH in order to determine the residence time and cooling rates in the APH and to compare these with estimates for regenerative APHs.

The APH at Meramec 2 is split into two sections (hot section and cold section); in between the two sections there is an ash hopper with transitional ductwork as shown in Figure 1. Information on the APH was obtained from Rich Phillips at AmerenUE. This information is summarized in Table 1.

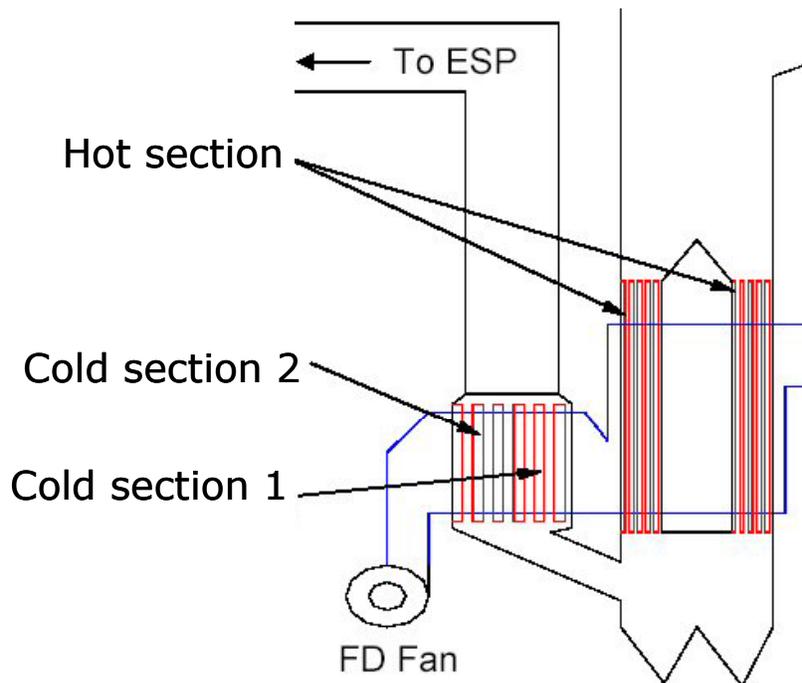


Figure 1. Meramec 2 APH layout.

PRELIMINARY

Table 1. APH dimensions.

Hot section		
Length#	ft	40.73
Tube OD***	inch	2.38
Tube ID***	inch	2.21
Tubes#		10500
External SA	ft ²	265,905
Internal SA	ft ²	247,320
Interior x-section	ft ²	279.5
Cold section 1		
Length#		25.00
Tube OD***		2.38
Tube ID***		2.21
Tubes		1954
External SA	ft ²	30,374
Internal SA	ft ²	28,251
Interior x-section	ft ²	52.0
Cold section 2		
Length#		25.00
Tube OD		3.50
Tube ID		3.33
Tubes		6798
External SA	ft ²	44,761
Internal SA	ft ²	42,638
Interior x-section	ft ²	412.1
Total cold section:		
External SA	ft ²	75,135
Internal SA	ft ²	70,889
Total area		
External SA	ft ²	341,040
Internal SA	ft ²	318,209

*From PI data

**Assumed

***Adjusted

#From drawings and other plant information

PRELIMINARY

Flow rates were calculated at full load (139 MW) and low load (80 MW). Information on temperatures at the inlet and outlet of the APH is displayed in the Appendix. The relationship between load and APH outlet temperature was estimated from data on 8/25/04 as shown in Figure 2.

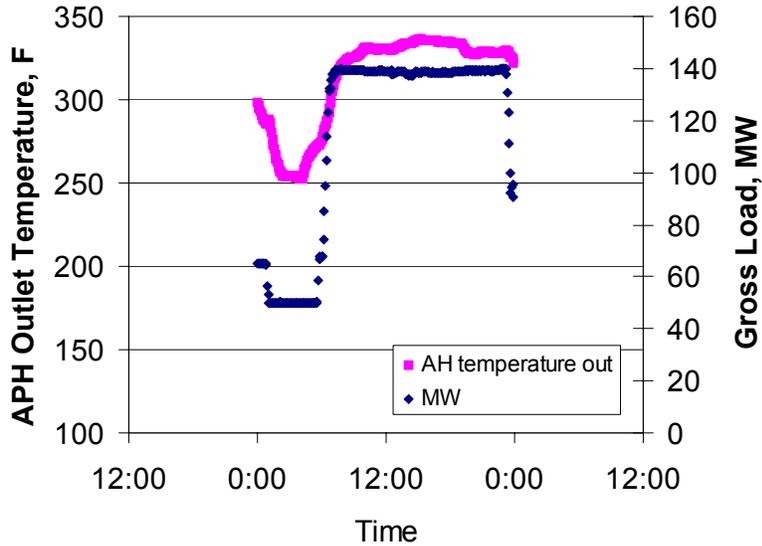


Figure 2. APH outlet temperature and load.

Reviewing the temperature data in the Appendix, the inlet/outlet temperatures were estimated to be 645/333 F at full load (140 MW). The low load temperatures varied considerably. For the purpose of this calculation, the low load temperatures were estimated at 470/280 F. The load was estimated to be 80 MW.

Table 2 shows the estimated flow rates at two load conditions. A heat rate of 10,000 BTU/kW-hr was assumed at full load and low load.

PRELIMINARY

Table 2. Calculated flow rates through the APH.

Load*	MW	140	80
Heat Rate**	Btu/kW-hr	10,000	10,000
HHV**	Btu/lb	8,740	8,740
Excess O ₂ *	%	2.3	4.5
Flue gas	scft ³ /lb coal	110.1	124.8
Flue gas	scft ³ /hr	17,605,922	11,423,341
Flue gas	lb/hr	1,320,592	856,846
Inlet T***	F	645	470
Inlet flow	acfm	611,778	334,079
Outlet T***	F	333	280
Outlet flow	acfm	439,041	265,826

*From PI data

**Assumed

***Estimated from outlet temperatures

The temperature changes in the flue gas through the hot section and cold sections of the APH were estimated from the tube surface areas in each section. The volume on the flue gas side of the APH was calculated from the length, tube dimensions and number of tubes in each section. The volume of the hopper and transitional ductwork was computed from drawings, assuming that the depth of the hopper and ductwork was the same as the depth of the air preheater sections. Table 3 gives the volumes and estimated temperatures at full load (140 MW) conditions; Table 4 gives the values at low load. The total residence time in the APH is therefore estimated to be 4 seconds at full load and 6.9 seconds at low load.

Table 3. Temperatures and residence times at 140 MW.

Gas-side volume, ft ³		T-in, F	T-out, F	T-avg, F	Volumetric flow rate at T-avg, acfm	Res. Time, sec.	Delta T, F/s
Hot section	11,381.9	645.0	401.7	515.8	541,073	1.18	-206.2
Hopper/duct	11,525.3	401.7	401.7	401.7	477,818	1.45	0.0
Cold section 1	1,300.1	401.7	333.0	366.7	51,358	1.41	-48.7
Cold section 2	10,303.4	401.7	333.0	366.7	407,007	1.41	-48.7

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Table 4. Temperatures and residence times at 80 MW.

	Gas-side volume, ft ³	T-in, F	T-out, F	T-avg, F	Volumetric flow rate at T-avg, acfm	Res. Time, sec.	Delta T, F/s
Hot section	11,381.9	470.0	321.9	392.7	306,781	2.08	-71.2
Hopper/duct	11,525.3	321.9	321.9	321.9	281,288	2.46	0
Cold section 1	1,300.1	321.9	280.0	300.6	30,662	2.36	-17.7
Cold section 2	10,303.4	321.9	280.0	300.6	242,992	2.36	-17.7

At full load, the cooling rate in the hot section was estimated to be -206 F/s (-115 K/s) and in the cold section, -49 F/s (-27 K/s). Cooling rates at load low operation are about a third of those at full load.

Estimates of the cooling rates in regenerative air preheaters were provided to George Offen by Alstom Preheater. They estimated -1200 to -6000 F/s as the range of cooling rates in regenerative air heaters. A comparison of the time temperature history for an air preheater with a cooling rate of -1300 F/s and the tubular air preheater at Meramec is shown in Figure 3. The same upstream temperature profile is assumed in both cases; *the upstream temperature profile is not necessarily that found at Meramec*. Mercury oxidation calculations were carried out using the two temperature profiles at full load to determine if the tubular air preheater would be expected to produce a higher mercury oxidation than a regenerative air preheater.

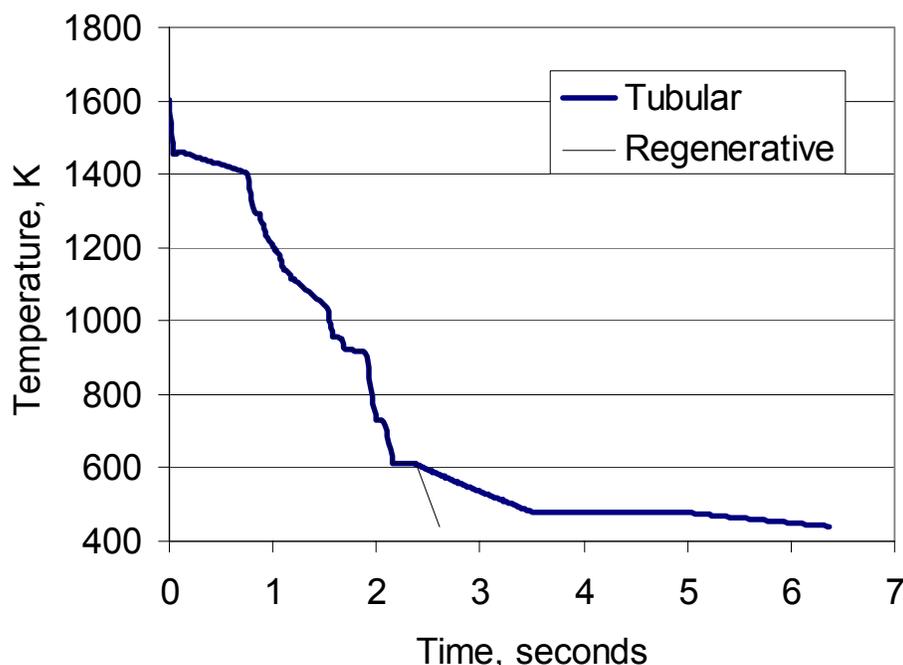


Figure 3. Time-temperature histories from furnace exit to APH exit, used for full load conditions.

PRELIMINARY

The combined homogeneous-heterogeneous kinetic model for mercury oxidation was used to look at the impact of cooling rates on mercury oxidation. In these generic calculations, the coal chlorine content was assumed to be between 7 µg/g (dry basis) and 70 µg/g (dry basis). The surface area of the fly ash was measured for a select number of samples. Table 5 gives the measured surface area and LOI for samples without activated carbon (taken from the inlet field of the ESP). The surface area of carbon in the fly ash can be estimated, assuming that the LOI is mostly due to carbon. The carbon surface area is remarkably consistent, about 320 m²/g C, which is consistent with estimates from other fly ash sources.

Table 5. Surface area and LOI of Meramec inlet field fly ash samples, without activated carbon.

Sample	Description	LOI, wt%	Surface Area		Mercury Content	
			m ² /g	m ² /g C	Hg, ng/g	Hg, ng/g C
MER024	8/24/04 2C-9 Control, Baseline	1.64	5.13	312.6	547	33,354
MER0242	10/28/04 2C-9 Control	1.79	5.98	334.3	734	41,006
MER0251	11/1/04 2C-10 Control	7.54	24.31	322.4	291	3,859

For the purpose of comparison, a cooling rate of -1300°F/s was assumed in a hypothetical regenerative air preheater. Based on the length of the ductwork from the air preheater exit to the ESP and a measured gas velocity at the inlet sample point (upstream of ACI) of 53 afps, the residence times from the APH outlet to the inlet sample point and to the ESP inlet can be calculated. The lengths from the APH outlet to the inlet sample point and the ESP inlet are 75 and 180 feet, respectively. Thus, the residence times from the APH outlet to the inlet sample point and ESP inlet are 1.41 and 3.4 seconds, respectively. Gas temperature was assumed to be constant in the duct between the APH outlet and ESP inlet.

Figure 4 shows the predicted range of oxidation of Hg⁰, assuming 2% LOI in the fly ash with coal chlorine contents ranging from 7 to 70 µg/g (dry basis). The current mercury oxidation model does not include absorption terms, so the predictions only apply to the net amount of Hg⁰ oxidation, not the partitioning between gas and particulate. The sample point is assumed to be 1.4 seconds downstream of the air preheater exit. The tubular air preheater is predicted to produce more oxidation of mercury than a hypothetical regenerative air preheater. The long residence time in the ductwork downstream of the air preheater also contributes significantly to mercury oxidation, both for tubular and regenerative air preheaters.

The unburned carbon contributes to mercury oxidation in the model, which seemed to be occurring at the plant. Figure 5 compares a calculation mercury oxidation with ash surface areas of 6.4 m²/g and 1.6 m²/g, which might correspond to about 2% carbon-in-ash and about 0.5% carbon in ash.

Thus, the tubular air preheater at Meramec and the long duct between the APH outlet and the ESP inlet are *both* expected to contribute to mercury oxidation in the flue gas.

PRELIMINARY

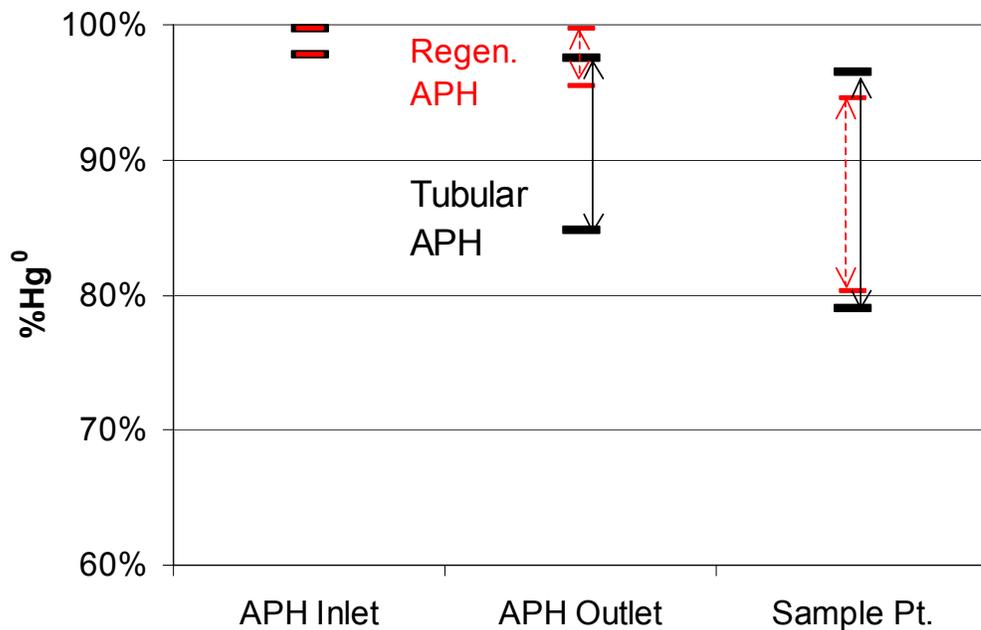


Figure 4. Predicted oxidation of Hg⁰ after tubular and regenerative APHs for a range of coal chlorine from 7 µg/g to 70 µg/g (dry basis) with 2% LOI.

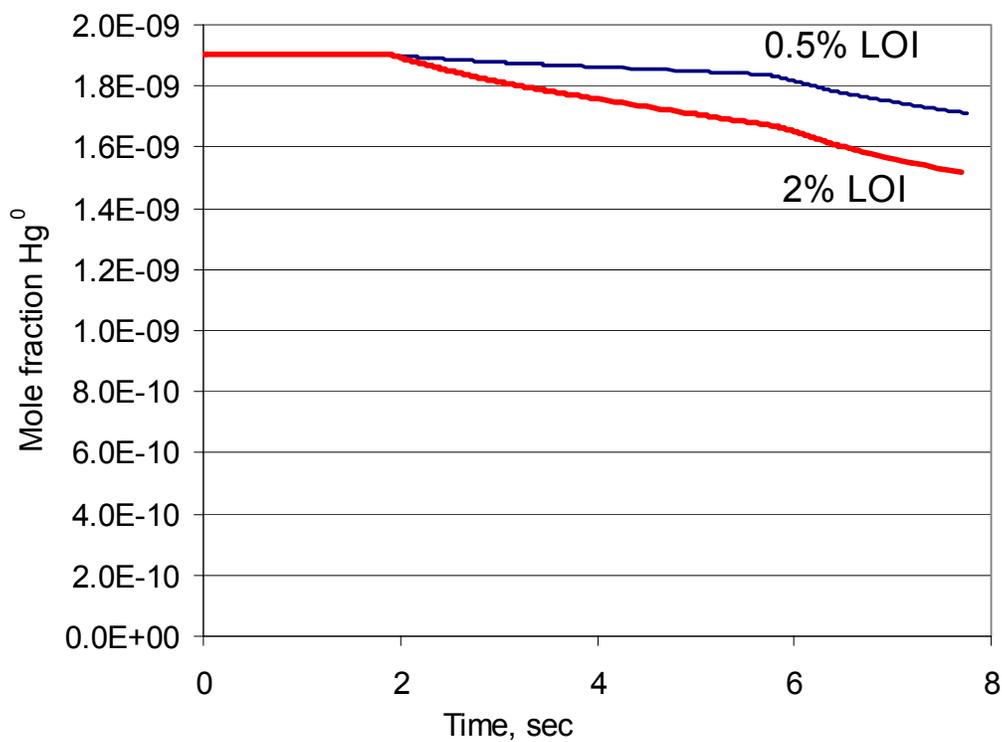
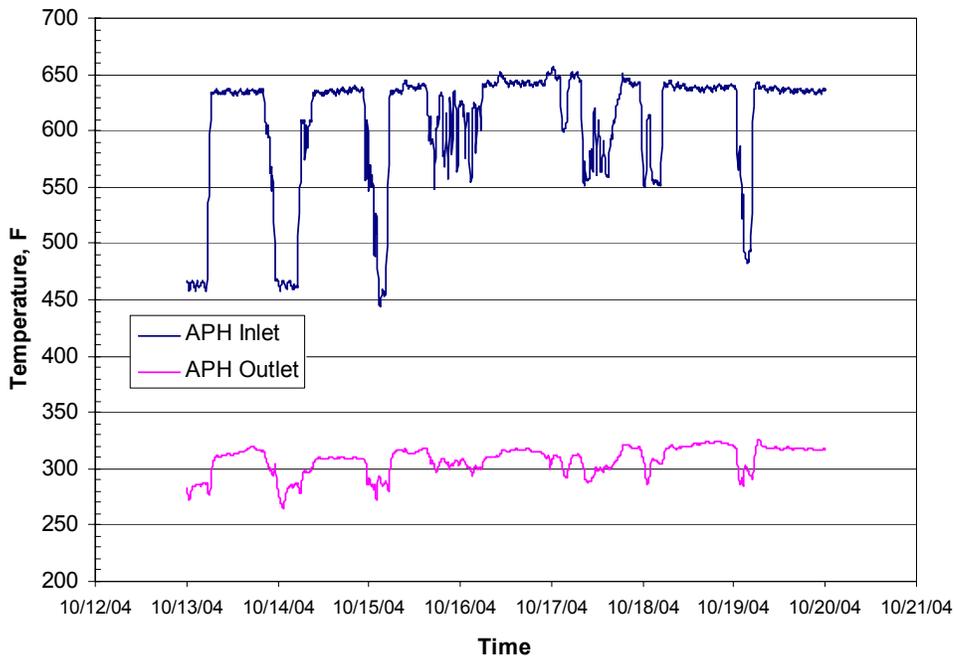
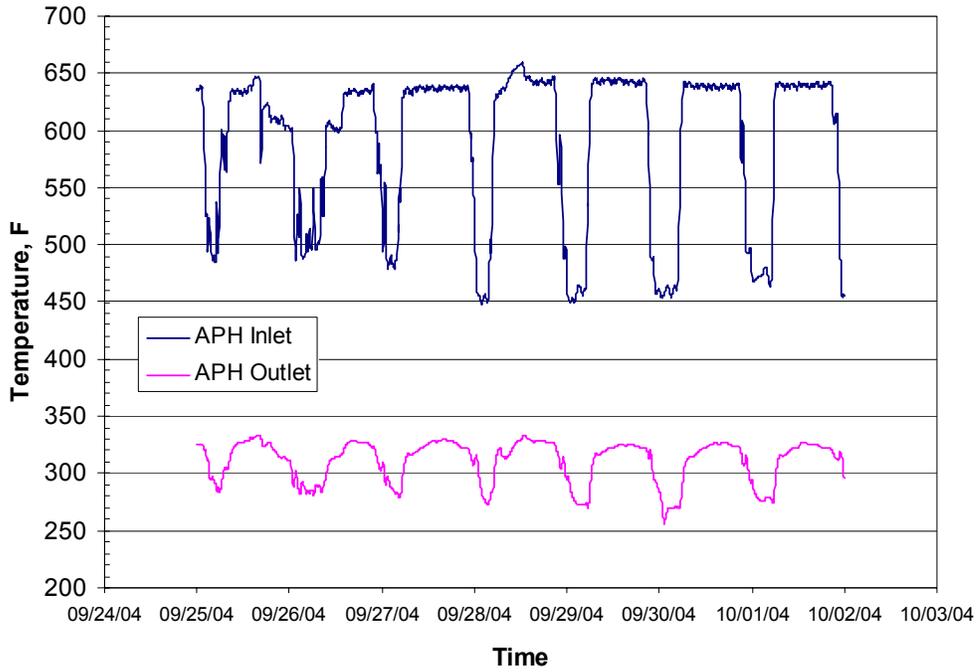


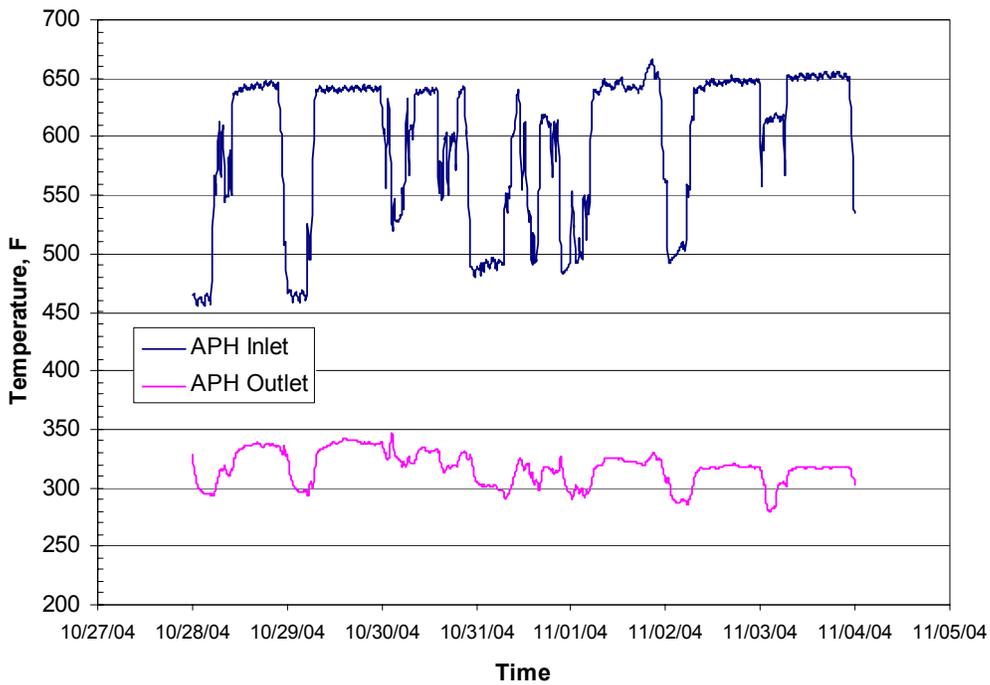
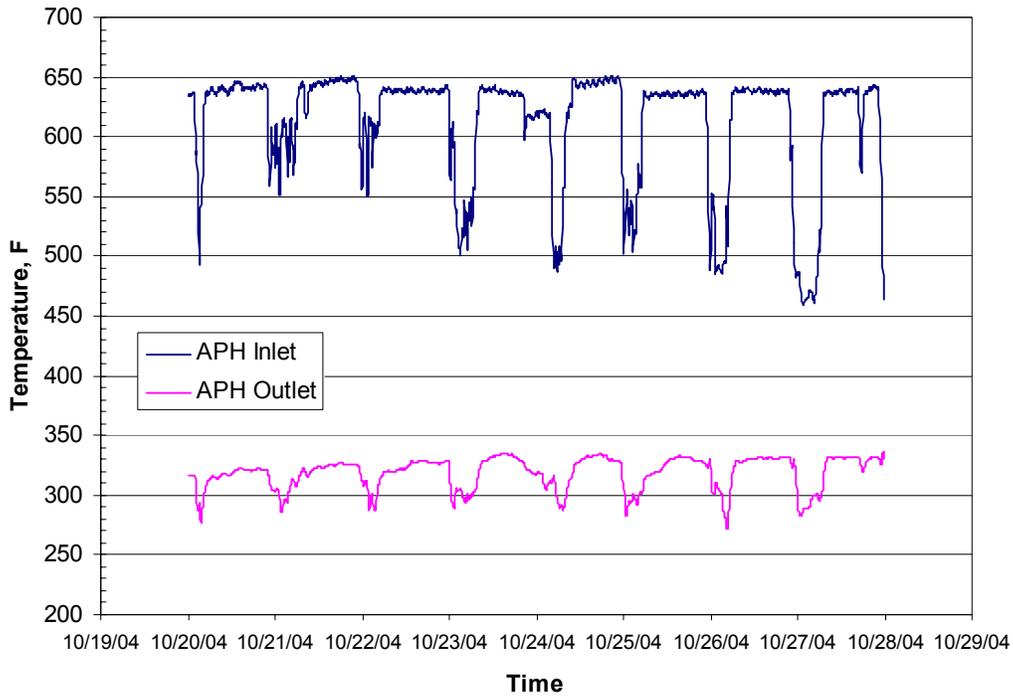
Figure 5. Mole fraction of Hg⁰ as a function of time for 2% LOI and 0.5% LOI for tubular air heater and 70 µg/g (dry basis).

PRELIMINARY

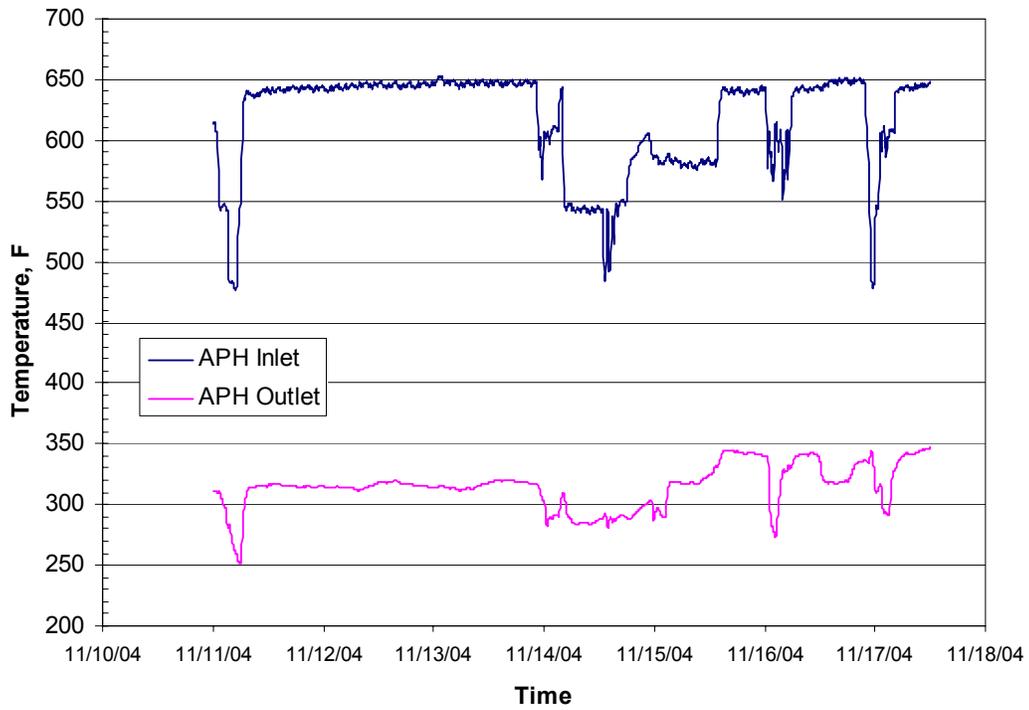
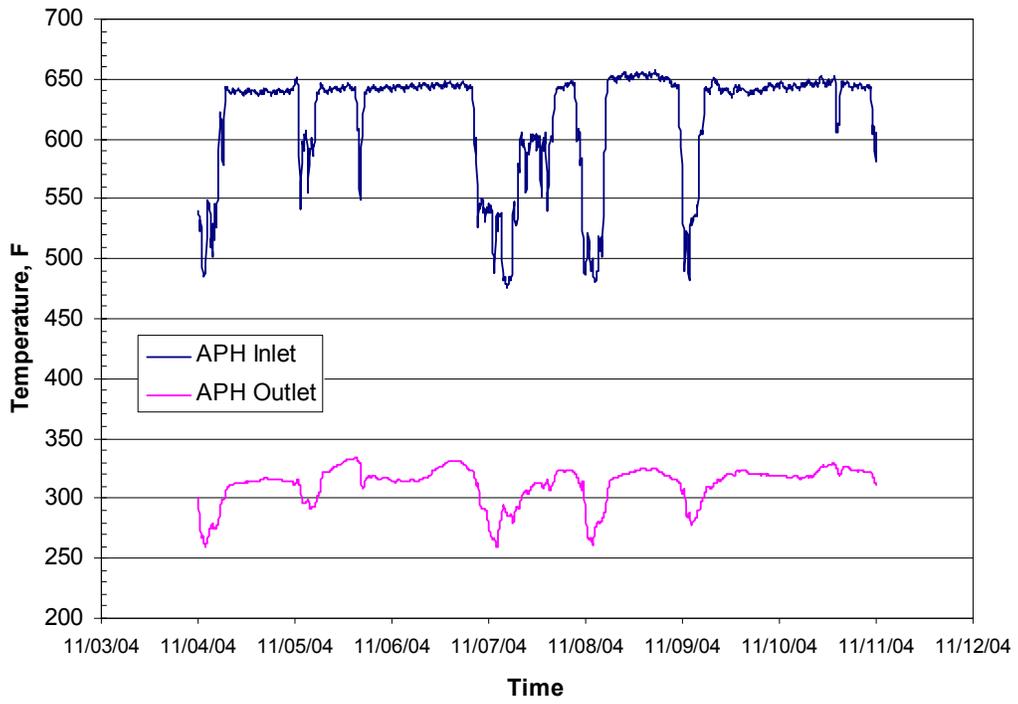
Appendix: Meramec 2 air preheater inlet and outlet temperatures during testing.



PRELIMINARY



PRELIMINARY



APPENDIX G

Speciated Mercury, Halogens, and Trace Metal Emission Test Reports

SOURCE EMISSIONS TEST REPORT
for the
ADA-ES, INC.
at the
AMERENUE MERAMEC POWER PLANT

SEPTEMBER, 2004
37314

Prepared by
Burns & McDonnell
Engineers—Architects—Consultants
Kansas City, Missouri



September 15, 2004

I, Russell D. Fowler, Jr., hereby certify that the source emissions test conducted for the ADA-ES, Inc., at the AmerenUE Meramec Power Plant, is in accordance with procedures established by the United States Environmental Protection Agency. This report accurately and faithfully represents the data obtained from this test and the results determined from analysis of this data.

Russell D. Fowler, Jr.
Source Emissions Testing
Chief of Field Operations
Energy Division

I, Joel R. Iserman - Testing Department Manager, hereby attest that the work on this project was done under my supervision and this report accurately presents the emissions from the testing performed.

Joel R. Iserman
Source Emissions Testing
Department Manager
Energy Division

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APPENDIX C - CALIBRATION OF TEST EQUIPMENT

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APPENDIX E - QUALITY ASSURANCE

*** * * * ***

PART I
INTRODUCTION

PART I
INTRODUCTION

This report presents the final results of the source emissions testing, conducted for ADA-ES, Inc.'s the AmerenUE Meramec Power Plant. The testing program consisted of sampling for mercury (Hg), metals, hydrogen halides and halogens to determine the mass emission rates. The sampling was performed August 24 - 26, 2004.

The performance testing was performed by Burns & McDonnell Engineering Company, Inc., whose main office is located at 9400 Ward Parkway, Kansas City, Missouri 64114.

The tests were performed in accordance with the United States Environmental Protection Agency Reference methods 1, 2, 26A, 29, and the Ontario Hydro Method for the mercury testing.

The results of the test are presented in Part II of this report. The testing equipment, sampling procedures, and analytical procedures are described in Part III of this report. The raw field data, plant data, equipment calibrations, lab analysis reports, and equations used in determining final results are presented in the appendices.

Burns & McDonnell's test crew consisted of Russell D. Fowler, Jr. (crew chief), Jay Beavers, Brian Heldenbrand, Nathan Linhardt and Kevin McKenna. The testing was coordinated by Mr. Travis Starns with ADA-ES, Inc.

* * * * *

PART II
SUMMARY OF TEST RESULTS

PART II

SUMMARY OF TEST RESULTS

Following are the results of the source emissions test performed for the ADA-ES, Inc. at the AmerenUE Meramec Power Plant. The testing was conducted August 24 - 26, 2004.

The testing program consisted of sampling for mercury (Hg), metals, hydrogen halides and halogens to determine the mass emission rates. The mercury sampling was performed in accordance with the Ontario Hydro method.

The following pages summarize the results of the source emissions sampling. The complete listing of the input data is also presented in the computer printouts on the following pages:

MERCURY

ADA-ES

Meramec Unit 2 - 08/24/04
Gas Flow Data DSCFH

Mercury Test - Ontario Hydro Method

Run No.	Sq Root Delta P in. H2O	Flue Temp Deg. F	Barometric Pressure in. Hg	Pitot Coefficient	Static Pressure in. H2O	Carbon Dioxide %	Oxygen %	Molecular Weight lb/lb mole	Velocity		Gas Volume
									acfm	dscfh	
Inlet											
Run 1	0.769	335.2	29.50	0.84	-13.0	15.10	3.80	29.01	266,264	54.12	8,859,588
Run 2	0.754	337.6	29.50	0.84	-13.0	15.30	3.70	29.03	261,372	53.12	8,667,490
Run 3	0.772	328.9	29.50	0.84	-13.0	15.30	3.60	29.02	266,174	54.10	8,922,286
Outlet											
Run 1	0.763	329.6	29.50	0.83	-12.0	15.00	4.00	28.97	259,965	52.84	8,707,700
Run 2	0.760	335.3	29.50	0.83	-12.0	15.10	4.00	28.99	259,782	52.80	8,644,654
Run 3	0.792	323.7	29.50	0.83	-12.0	15.00	4.10	28.97	268,827	54.64	9,071,059

Moisture Determination

Run No.	Delta H in. H2O	Meter Temp deg. F	Volume Metered cubic ft.	Meter Correction	Volume of Condensate ml	Volume Metered scf	Moisture %
Inlet							
Run 1	2.20	84.9	77.788	1.009	226.9	75.367	12.42
Run 2	2.19	95.8	77.651	1.009	222.7	73.757	12.45
Run 3	2.19	74.3	77.806	1.009	232.5	76.878	12.47
Outlet							
Run 1	2.55	85.5	79.350	0.998	234.4	76.025	12.68
Run 2	2.51	96.6	78.530	0.998	226.2	73.731	12.63
Run 3	2.72	83.7	81.900	0.998	243.1	78.761	12.69

45 3.774

ADA-ES

Meramec Unit 2 - 08/24/04

Particle-Bound Mercury Analysis - Summary of Results Mercury Test - Ontario Hydro Method

Particle-Bound Mercury

Run No.	<u>Front Half</u>		<u>Particle-Bound Mercury</u>	
	Analysis (ug)	Blank (ug)	Total (ug)	Concentration (ug/dscf) (lb/hr)
Inlet				
Run 1	3.7445	0.00	3.7445	0.049683 0.000970
Run 2	1.8040	0.00	1.8040	0.024459 0.000467
Run 3	<u>2.5339</u>	<u>0.00</u>	<u>2.5339</u>	<u>0.032960</u> <u>0.000648</u>
Average	2.6941	0.00	2.6941	0.035701 0.000695
Outlet				
Run 1	0.4621	0.00	0.4621	0.006078 0.000117
Run 2	0.1605	0.00	0.1605	0.002177 0.000041
Run 3	<u>0.4673</u>	<u>0.00</u>	<u>0.4673</u>	<u>0.005933</u> <u>0.000119</u>
Average	0.3633	0.00	0.3633	0.004729 0.000092

ADA-ES

Meramec Unit 2 - 08/24/04

Oxidized Mercury Analysis - Summary of Results

Mercury Test - Ontario Hydro Method

Oxidized Mercury

Run No.	<u>KCl Solution</u>			<u>Oxidized Mercury</u>	
	Analysis (ug)	Blank (ug)	Total (ug)	(ug/dscf)	Concentration (lb/hr)
Inlet					
Run 1	2.7990	0.00	2.7990	0.0371	0.000725
Run 2	1.8231	0.00	1.8231	0.0247	0.000472
Run 3	<u>2.8405</u>	<u>0.00</u>	<u>2.8405</u>	<u>0.0369</u>	<u>0.000727</u>
Average	2.4875	0.00	2.4875	0.0329	0.000641
Outlet					
Run 1	2.5150	0.00	2.5150	0.0331	0.000635
Run 2	1.1870	0.00	1.1870	0.0161	0.000307
Run 3	<u>2.4285</u>	<u>0.00</u>	<u>2.4285</u>	<u>0.0308</u>	<u>0.000617</u>
Average	2.0435	0.00	2.0435	0.0267	0.000520

ADA-ES
Meramec Unit 2 - 08/24/04
Elemental Mercury Analysis - Summary of Results
Mercury Test - Ontario Hydro Method

<u>Elemental Mercury</u>				<u>Elemental Mercury</u>	
Run No.	Analysis (ug)	Blank (ug)	Total (ug)	(ug/dscf)	Concentration (lb/hr)
Inlet					
Run 1	0.5690	0.00	0.5690	0.0075	0.000147
Run 2	0.4955	0.00	0.4955	0.0067	0.000128
Run 3	<u>0.4587</u>	<u>0.00</u>	0.4587	<u>0.0060</u>	<u>0.000117</u>
Average	0.5077	0.00	0.5077	0.0067	0.000131
Outlet					
Run 1	0.5392	0.00	0.5392	0.0071	0.000136
Run 2	0.2009	0.00	0.2009	0.0027	0.000052
Run 3	<u>0.4407</u>	<u>0.00</u>	0.4407	<u>0.0056</u>	<u>0.000112</u>
Average	0.3936	0.00	0.3936	0.0051	0.000100

ADA-ES
 Meramec Unit 2 - 08/24/04
 Total Mercury Analysis - Summary of Results
 Mercury Test - Ontario Hydro Method

Total Mercury

Run No.	Particle Bound			Oxidized			Elemental			Total Mercury				
	(ug/dscf)	(lb/hr)	(ug/dscf)	(lb/hr)	(ug/dscf)	(lb/hr)	(ug/dscf)	(lb/hr)	(ug/dscf)	(lb/mmBtu)	(ug/dncm)	(tons/yr)	(lb/Tbtu)	
Inlet														
Run 1	0.04968	0.00097	0.03714	0.00073	0.00755	0.00015	0.001843	0.00000248	0.0944	0.001843	3.576	0.00807	2.485	
Run 2	0.02446	0.00047	0.02472	0.00047	0.00672	0.00013	0.001068	0.00000146	0.0559	0.001068	2.118	0.00468	1.463	
Run 3	0.03296	0.00065	0.03695	0.00073	0.00597	0.00012	0.001492	0.00000197	0.0759	0.001492	2.875	0.00654	1.975	
Average	0.03570	0.00070	0.03293	0.00064	0.00674	0.00013	0.001468	0.00000197	0.0754	0.001468	2.856	0.00643	1.974	
Outlet														
Run 1	0.00608	0.00012	0.03308	0.00064	0.00709	0.00014	0.000888	0.00000123	0.0463	0.000888	1.753	0.00389	1.232	
Run 2	0.00218	0.00004	0.01610	0.00031	0.00272	0.00005	0.000400	0.00000056	0.0210	0.000400	0.796	0.00175	0.559	
Run 3	0.00593	0.00012	0.03083	0.00062	0.00560	0.00011	0.000847	0.00000114	0.0424	0.000847	1.605	0.00371	1.135	
Average	0.00473	0.00009	0.02667	0.00052	0.00514	0.00010	0.000712	0.00000098	0.0365	0.000712	1.385	0.00312	0.976	

METALS

ADA-ES

Meramec Unit 2 - 08/25/04
 Gas Flow Data DSCFH
 Metals Test - Method 29

Run No.	Sq Root Delta P in. H2O	Flue Temp Deg. F	Barometric Pressure in. Hg	Pitot Coefficient	Static Pressure in. H2O	Carbon Dioxide %	Oxygen %	Molecular Weight		Velocity	Gas Volume	
								lb/lb mole	fps		acfm	dscfh
Inlet												
Run 1	0.782	331.4	29.60	0.84	-13.0	14.20	4.80	28.77	55.04	270,773	8,959,890	
Run 2	0.775	331.8	29.60	0.84	-13.0	14.30	4.70	28.75	54.57	268,497	8,857,408	
Run 3	0.773	335.4	29.60	0.84	-13.0	14.30	4.70	28.90	54.42	267,723	8,913,104	
Outlet												
Run 1	0.801	328.4	29.60	0.83	-12.0	13.80	5.10	28.95	55.35	272,331	9,258,741	
Run 2	0.798	332.8	29.60	0.83	-12.0	13.80	5.00	28.75	55.48	272,981	9,069,132	
Run 3	0.787	336.6	29.60	0.83	-12.0	13.90	5.00	28.87	54.74	269,325	8,988,628	

Moisture Determination

Run No.	Delta H in. H2O	Meter Temp deg. F	Volume		Volume of Condensate ml	Moisture %
			Metered cubic ft.	Metered scf		
Inlet						
Run 1	2.27	80.8	85.063	1.009	279.0	13.62
Run 2	2.24	88.0	78.576	1.009	259.1	13.84
Run 3	2.29	92.5	79.433	1.009	234.3	12.65
Outlet						
Run 1	2.77	86.8	82.480	0.998	225.1	11.81
Run 2	2.74	89.9	82.070	0.998	256.0	13.34
Run 3	2.65	91.8	80.800	0.998	233.6	12.53

ADA-ES

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Inlet Test Location

Metals Test - Method 29

Run 1

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.081	0.0053	0			0.086	86
Barium	4.762	0.3889	0.5613			5.712	5712
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.033	0.0032	0.0056			0.042	42
Copper	0.219	0.0196	0.0307			0.269	269
Lead	0.112	0.0114	0.0112			0.135	135
Manganese	0.148	0.0316	0.0497			0.229	229
Mercury	0.0045	0.00022	0.0005	0	0	0.005	5
Nickel	0.077	0.0148	0.0251			0.117	117
Selenium	0.072	0	0			0.072	72
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

Run 2

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.175	0.0104	0			0.185	185
Barium	7.101	0.4443	0.0176			7.563	7563
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.063	0.0042	0.0033			0.071	71
Copper	0.402	0.0118	0.0308			0.445	445
Lead	0.149	0.0075	0.0116			0.168	168
Manganese	0.19	0.0225	0.0341			0.247	247
Mercury	0.005	0.00026	0.00039	0.00003	0	0.006	6
Nickel	0.084	0.0111	0.0077			0.103	103
Selenium	0.095	0	0			0.095	95
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

Run 3

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.315	0.0202	0.0334			0.369	369
Barium	8.131	0.0704	0.523			8.724	8724
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.057	0.005	0			0.062	62
Copper	0.333	0.0175	0.0157			0.366	366
Lead	0.174	0.0111	0			0.185	185
Manganese	0.199	0.0206	0.0235			0.243	243
Mercury	0.0014	0.00011	0.0001	0	0	0.002	2
Nickel	0.087	0.0092	0.0063			0.103	103
Selenium	0.098	0.0054	0			0.103	103
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

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Outlet Test Location

Metals Test - Method 29

Run 1

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.019	0	0			0.019	19
Barium	0.557	0.0494	0.0551			0.662	662
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.015	0.0018	0.0037			0.021	21
Copper	0.062	0.0041	0.0074			0.074	74
Lead	0.033	0.0023	0			0.035	35
Manganese	0.089	0.009	0.0089			0.107	107
Mercury	0.0008	0.00004	0	0	0	0.001	1
Nickel	0.025	0.0017	0			0.027	27
Selenium	0.039	0	0			0.039	39
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

Run 2

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.024	0.0099	0			0.034	34
Barium	1.011	0.102	0.0297			1.143	1143
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.025	0.0009	0			0.026	26
Copper	0.1	0.0074	0.0063			0.114	114
Lead	0.09	0.0069	0			0.097	97
Manganese	0.094	0.0066	0			0.101	101
Mercury	0.0012	0.00008	0	0.0000315	0	0.001	1
Nickel	0.036	0.0027	0			0.039	39
Selenium	0.044	0	0			0.044	44
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

Run 3

<u>Element</u>	<u>Filter</u> <u>(mg)</u>	<u>Imp. 1-3</u> <u>(mg)</u>	<u>Imp. 4</u> <u>(mg)</u>	<u>Imp. 5a</u> <u>(mg)</u>	<u>Imp. 5b</u> <u>(mg)</u>	<u>total</u> <u>(mg)</u>	<u>total</u> <u>(ug)</u>
Antimony	0	0	0			0.000	0
Arsenic	0.094	0.0042	0			0.098	98
Barium	1.208	0.0066	0.0069			1.222	1222
Beryllium	0	0	0			0.000	0
Cadmium	0	0	0			0.000	0
Chromium	0	0	0			0.000	0
Cobalt	0.007	0.0008	0			0.008	8
Copper	0.104	0.0053	0			0.109	109
Lead	0.088	0.0032	0			0.091	91
Manganese	0.076	0.0065	0.0074			0.090	90
Mercury	0.0007	0.00004	0	0	0	0.001	1
Nickel	0.025	0	0			0.025	25
Selenium	0.039	0	0			0.039	39
Silver	0	0	0			0.000	0
Thallium	0	0	0			0.000	0

HYDROGEN HALIDES AND HALOGENS

ADA-ES

Meramec Unit 2 - 08/26/04

Gas Flow Data DSCFH

Halogen and Halides Test - Method 26A

Run No.	Sq Root Delta P in. H2O	Flue Temp Deg. F	Barometric Pressure in. Hg	Pitot Coefficient	Static Pressure in. H2O	Carbon Dioxide %	Oxygen %	Molecular Weight lb/lb mole	Velocity fps	Gas Volume acfm	Gas Volume dscfh
Inlet											
Run 1	0.792	331.0	29.60	0.84	-13.0	14.80	4.10	28.89	55.60	273,560	9,114,258
Run 2	0.780	331.6	29.60	0.84	-13.0	14.90	4.10	28.86	54.81	269,661	8,940,834
Run 3	0.784	338.6	29.60	0.84	-13.0	14.90	4.20	28.84	55.35	272,331	8,931,372
Outlet											
Run 1	0.755	327.3	29.60	0.83	-12.0	14.60	4.30	28.77	52.30	257,317	8,549,851
Run 2	0.798	326.5	29.60	0.83	-12.0	14.50	4.40	28.75	55.27	271,912	9,038,656
Run 3	0.801	330.4	29.60	0.83	-12.0	14.60	4.30	28.76	55.60	273,561	9,048,653

Moisture Determination

Run No.	Meter Delta H in. H2O	Meter Temp deg. F	Volume Metered cubic ft.	Meter Correction	Volume of Condensate ml	Volume Metered scf	Moisture %
Inlet							
Run 1	2.33	85.4	40.136	1.009	124.5	38.995	13.07
Run 2	2.34	91.0	40.197	1.009	127.3	38.658	13.43
Run 3	2.37	96.0	40.527	1.009	129.2	38.628	13.61
Outlet							
Run 1	2.49	88.1	39.140	0.998	128.7	37.442	13.93
Run 2	2.79	96.7	41.800	0.998	136.0	39.398	13.98
Run 3	2.79	98.2	41.360	0.998	134.2	38.879	13.98

ADA-ES
 Meramec Unit 2 - 08/26/04
 Emission Rates - Summary of Results
 Halogen and Halides Test - Method 26A

Run No.	Hydrogen Chloride HCl (ug)	Hydrogen Bromide HBr (ug)	Hydrogen Fluoride HF (ug)	Chlorine Cl2 (ug)	Bromine Br2 (ug)
Inlet					
Run 1	464.4	N/D	219.3	693.9	N/D
Run 2	283.2	N/D	217.1	1831.6	N/D
Run 3	<u>523.6</u>	<u>N/D</u>	<u>359.4</u>	<u>1575.0</u>	<u>N/D</u>
Average	423.7	N/D	265.3	1366.8	N/D

Run No.	Hydrogen Chloride HCl (ug)	Hydrogen Bromide HBr (ug)	Hydrogen Fluoride HF (ug)	Chlorine Cl2 (ug)	Bromine Br2 (ug)
Outlet					
Run 1	390.0	N/D	208.0	1632.0	N/D
Run 2	416.1	30.7	269.4	1762.8	11.3
Run 3	<u>681.5</u>	<u>40.0</u>	<u>176.3</u>	<u>540.5</u>	<u>51.7</u>
Average	495.9	35.4	217.9	1311.8	31.5

Hydrogen Halides and Halogens Emission Rates

Inlet	<u>(ug/dscf)</u>	<u>(ug/dscm)</u>	<u>(ug/dncm)</u>	<u>(lb/hr)</u>	<u>(lb/mmBtu)</u>	<u>(tons/yr)</u>	<u>(lb/Tbtu)</u>
HCl	10.9	623.5	414.2	0.217	0.00029	0.95	293.6
HBr	N/D	N/D	N/D	N/D	N/D	N/D	N/D
HF	6.8	390.3	259.3	0.136	0.00018	0.59	183.8
Cl2	35.3	2011.2	1336.2	0.699	0.00095	3.06	946.9
Br2	N/D	N/D	N/D	N/D	N/D	N/D	N/D

Outlet	<u>(ug/dscf)</u>	<u>(ug/dscm)</u>	<u>(ug/dncm)</u>	<u>(lb/hr)</u>	<u>(lb/mmBtu)</u>	<u>(tons/yr)</u>	<u>(lb/Tbtu)</u>
HCl	12.9	729.6	487.1	0.252	0.00035	1.10	350.1
HBr	0.9	52.0	34.7	0.018	0.00002	0.08	25.0
HF	5.6	320.6	214.1	0.111	0.00015	0.48	153.8
Cl2	34.0	1930.2	1288.6	0.666	0.00093	2.92	926.1
Br2	0.8	46.4	30.9	0.016	0.00002	0.07	22.2

PART III
DESCRIPTION OF TESTED FACILITY

PART III
DESCRIPTION OF TESTED FACILITY

This document presents the source emissions tests conducted for ADA-ES, Inc., at the AmerenUE Meramec Power Plant. The Meramec Station is located at 8200 Fine Road, St. Louis County, Missouri. The Meramec Generating Station consists of four electric generating units. The facility tested was Unit 1.

The boiler for Unit 1 is a Combustion Engineering watertube-type, pulverized, coal-fired steam generator. Unit 1 is designed for approximately 145 megawatts of electrical generation.

The particulate emissions are controlled by an American Air Filter electrostatic precipitator. The American Air Filter precipitator, consisting of five electrical fields, has a guaranteed collection efficiency of 99 percent. The design gas volume is 600,000 cubic feet per minute at 330°F. The test ports for Unit 1 are located in the stack approximately 195 feet above grade.

The SO₂/CO₂/NO_x monitoring system was supplied by Monitor Labs. The SO₂ monitor is a Monitor Labs Model 9850. The CO₂ monitor is a Monitor Labs Model 9820. The NO_x monitor is a Monitor Labs Model 9841a. The velocity monitor is a United Science Ultra Flow Model 100. The data acquisition system consists of a computer that logs and prints out the emissions on one-minute averages during the testing program.

The system works by withdrawing and diluting the sample within the probe located in the stack. The sample then travels by Teflon® sample line to the analyzers which are located in the a heated/air-conditioned enclosure on the ground level near the base of the stack.

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PART IV
SAMPLING AND ANALYTICAL PROCEDURES

PART IV
SAMPLING AND ANALYTICAL PROCEDURES

DRAFT ONTARIO HYDRO METHOD FOLLOWS

October 27, 1999

Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method)¹

1. Scope

1.1 This method applies to the determination of elemental, oxidized, particle-bound, and total mercury emissions from coal-fired stationary sources.

1.2 This method is applicable to elemental, oxidized, particle-bound, and total mercury concentrations ranging from approximately 0.5 to 100 µg/dscm.

1.3 This method describes equipment and procedures for obtaining samples from effluent ducts and stacks, equipment and procedures for laboratory analysis, and procedures for calculating results.

1.4 This method is applicable for sampling elemental, oxidized, and particle-bound mercury at the inlet and outlet of emission control devices and for calculating control device mercury collection efficiency.

1.5 Method applicability is limited to flue gas stream temperatures within the thermal stability range of the sampling probe and filter components.

1.6 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.7 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.8 This standard assumes users are familiar with EPA stack-gas sampling procedures as stated in EPA Methods 1-4, Method 5, and Method 17.

2. Referenced Documents

- 2.1 *ASTM Standards*:
D 1193 Specification for Reagent Water²

¹ This test method is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.03 on Ambient Atmospheres and Source Emissions.

² *Annual Book of ASTM Standards*, Vol. 11.01.

D1356 Definitions of Terms Relating to Atmospheric Sampling and Analysis³
 D 2986 Evaluation of Air-Assay Media by the Monodisperse DOP (Diocetyl Phthalate) Smoke Test³
 D 3154 Test Method for Average Velocity in a Duct (Pitot Tube Method)³
 D 3685 Particulates Independently or for Particulates and Collected Residue Simultaneously in Stack Gases³
 E 1 Specification for ASTM Thermometers⁴

2.2 Other Standards:⁵

EPA Method 1 – Sample and Velocity Traverses for Stationary Sources
 EPA Method 2 – Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
 EPA Method 3 – Gas Analysis for the Determination of Dry Molecular Weight
 EPA Method 4 – Determination of Moisture Content in Stack Gases
 EPA Method 5 – Determination of Particulate Emissions from Stationary Sources
 EPA Method 12 – Determination of Inorganic Lead Emissions from Stationary Sources
 EPA Method 17– Determination of Particulate Emissions from Stationary Sources (In-Stack Filtration Method)
 EPA Method 29 – Determination of Metals Emissions from Stationary Sources
 EPA Method 101A – Determination of Particle-Bound and Gaseous Mercury Emissions from Sewage Sludge Incinerators
 EPA Method 301 – Field Validation of Pollutant Measurement Methods from Various Waste Media
 EPA SW 846 7470 – Mercury in Liquid Waste – Manual Cold Vapor Technique
 EPA Water and Waste 600/4-79-020 – Methods for Chemical Analysis of Water and Wastes

3. Terminology

3.1 Definitions other than those given below in Sections 3.2, 3.3, and 3.4 are listed in ASTM D 1356.

3.2 *Definitions of Terms specific to the standard:*

3.2.1 *elemental mercury*—mercury in its zero oxidation state, Hg⁰.

³ *Annual Book of ASTM Standards*, Vol. 11.03.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ Available from the U.S. Environmental Protection Agency's Emission Measurement Technical Information Center or Code of Federal Regulations (40 CFR Part 60, Appendix A or 40 CFR Part 61, Appendix B).

3.2.2 *oxidized mercury*—mercury in its mercurous or mercuric oxidation states: Hg_2^{2+} and Hg^{2+} , respectively.

3.2.3 *elemental mercury catch*—mercury collected in the acidified hydrogen peroxide ($\text{HNO}_3\text{-H}_2\text{O}_2$) and potassium permanganate ($\text{H}_2\text{SO}_4\text{-KMnO}_4$) impinger solutions employed in this method. This is gaseous Hg^0 .

3.2.4 *oxidized mercury catch*—mercury collected in the aqueous potassium chloride (KCl) impinger solution employed in this method. This is gaseous Hg^{2+} .

3.2.5 *particle-bound mercury catch*—mercury associated with the particulate matter collected in the front half of the sampling train.

3.2.6 *sample train*—complete setup including nozzle, probe, probe liner, filter, filter holder, impingers, and connectors.

3.2.7 *Impinger train*—setup includes only the impingers and connectors.

3.2.8 *front half of the sampling train*—all mercury collected on and upstream of the sample filter.

3.2.9 *total mercury*—all mercury (solid-bound, liquid, or gaseous) however generated or entrained in the flue gas stream (i.e., summation of elemental, oxidized, and particle-bound mercury).

3.3 Symbols:

A	=	cross-sectional area of stack, m^2 (ft^2)
B_{ws}	=	water vapor in the gas stream, proportion by volume
ΔH	=	average pressure differential across the orifice meter, kPa (in. H_2O)
Hg_{ash}	=	concentration of mercury in sample filter ash, $\mu\text{g/g}$
Hg^{tp}	=	concentration of particle-bound mercury, $\mu\text{g/dscm}$
Hg^0	=	concentration of elemental mercury, $\mu\text{g/dscm}$
Hg^{2+}	=	concentration of oxidized mercury, $\mu\text{g/dscm}$
IR	=	instrument reading from mercury analyzer, $\mu\text{g/L}$
L_p	=	leakage rate observed during the posttest leak check, m^3/min (cfm)
L_a	=	maximum acceptable leakage rate
M_s	=	molecular weight of stack gas, wet basis, g/g-mole (lb/lb-mole)
M_w	=	molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole)
N	=	Normal conditions, defined as 0°C and 1 atmosphere pressure (in the U.S. N and standard conditions are the same in SI units)
P_{bar}	=	barometric pressure at the sampling site, kPa (in. Hg)
P_s	=	absolute stack gas pressure, kPa (in. Hg)
P_{std}	=	standard absolute pressure, 101.3 kPa (29.92 in. Hg)
R	=	ideal gas constant, 0.008314 kPa-m ³ /K-g-mole (21.85 in. Hg-ft ³ /°R-lb-mole)
T_m	=	absolute average dry gas meter temperature, K (°R)

- T_s = absolute stack temperature, K ($^{\circ}$ R)
 T_{std} = standard absolute temperature, 293 K (528 $^{\circ}$ R)
 V_D = total digested volume, mL
 V_m = volume of gas sample as measured by dry gas meter, dcm (dscf)
 $V_{m(std)}$ = volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf)
 $V_{w(std)}$ = volume of water vapor in the gas sample, corrected to standard conditions, scm (scf)
 W_{ash} = total mass of ash on sample filter, g
 W_{lc} = total mass of liquid collected in impingers and silica gel, g (lb)
 Y = dry gas meter calibration factor
 θ = total sampling time, min
 θ_1 = sampling time interval, from the beginning of a run until the first component change, min

4. Summary of Test Method

4.1 A sample is withdrawn from the flue gas stream isokinetically through a probe/filter system, maintained at 120 $^{\circ}$ C or the flue gas temperature, whichever is greater, followed by a series of impingers in an ice bath. Particle-bound mercury is collected in the front half of the sampling train. Oxidized mercury is collected in impingers containing a chilled aqueous potassium chloride solution. Elemental mercury is collected in subsequent impingers (one impinger containing a chilled aqueous acidic solution of hydrogen peroxide and three impingers containing chilled aqueous acidic solutions of potassium permanganate). Samples are recovered, digested, and then analyzed for mercury using cold-vapor atomic absorption (CVAAS) or fluorescence spectroscopy (CVAFS).

5. Significance and Use

5.1 The measurement of particle-bound, oxidized, elemental, and total mercury in stationary-source flue gases provides data that can be used for dispersion modeling, deposition evaluation, human health and environmental impact assessments, emission reporting, compliance determinations, etc. Particle-bound, oxidized, and elemental mercury measurements before and after control devices may be necessary for optimizing and evaluating the mercury removal efficiency of emission control technologies.

6. Interferences

There are no known interferences, but certain biases may be encountered (See Section 16).

7. Apparatus

7.1 *Sampling Train*—similar to ASTM D 3685, EPA Method 5/EPA Method 17 and EPA Method 29 trains, as illustrated in Fig. 1.

7.1.1 *Probe Nozzle (Probe Tip)*—Glass nozzles are required unless alternate nozzles are constructed of materials that are free from contamination and will not interact with the sample. Probe fittings constructed of polytetrafluoroethylene (PTFE), polypropylene, etc., are required instead of metal fittings to prevent contamination.

7.1.2 *Probe Liner*—If the sample train is to be in EPA Method 5 configuration (out-of-stack filtration), the probe liner must be constructed of quartz or borosilicate glass. If an EPA Method 17 (in-stack filtration) sampling configuration is used, the probe/probe liner may be constructed of borosilicate glass, quartz or, depending on the flue gas temperature, PTFE.

7.1.3 *Pitot Tube*—Type S pitot tube. Refer to Section 2.2 of EPA Method 2 for a description.

7.1.4 *Differential Pressure Gauges*—inclined manometers or equivalent devices. Refer to Section 2.1 of EPA Method 2 for a description.

7.1.5 *Filter Holder*—constructed of borosilicate glass or PTFE-coated stainless steel with a PTFE filter support or other nonmetallic, noncontaminating support. Do not use a glass frit or stainless steel wire screen. A silicone rubber or PTFE gasket, designed to provide a positive seal against leakage from outside or around the filter, may be used.

7.1.6 *Connecting Umbilical Tube*—heated PTFE tubing. This tube must be heated to a minimum of 120°C to help prevent water and acid condensation. (The umbilical tube is defined as any tubing longer than 0.5 m that connects the filter holder to the impinger train).

7.1.7 *Probe and Filter Heating System*

7.1.7.1 *EPA Method 5 Configuration*—For EPA Method 5 configuration, the temperature of the flue gas, sample probe, and the exit of the sample filter must be monitored using temperature sensors capable of measuring temperature to within 3°C (5.4°F). The heating system must be capable of maintaining the sample gas temperature of the probe and exit of the sample filter to within ±15°C (±27°F) of the flue gas temperature. Regardless of the flue gas temperature, to prevent water and acid condensation, at no time must the probe temperature, sample filter exit gas temperature, or the temperature of the connecting umbilical cord be less than 120°C.

7.1.7.2 *EPA Method 17 Configuration*—For EPA Method 17 configuration, the sample filter is located in the duct and, therefore, naturally maintained at the flue gas temperature. The heating system is only required to maintain the probe and connecting umbilical cord to at least 120°C. If the flue gas temperature is less than 120°C, then EPA Method 5 configuration must be used.

7.1.8 *Condensing/Absorbing System*—consists of eight impingers immersed in an ice bath and connected in series with leak-free ground glass fittings or other noncontaminating leak-free fittings. (At no time is silicon grease or other greases to be used for this method). The first,

second, fourth, fifth, sixth, and eighth impingers are of the Greenburg–Smith design modified by replacing the standard tip with a 1.3-cm (0.5-in.)-ID straight glass tube extending to about 1.3 cm (0.5 in.) from the bottom of the flask. The third and seventh impingers are also Greenburg–Smith design, but with the standard tip including the glass impinging plate. The first, second, and third impingers contain aqueous 1 N potassium chloride (KCl) solution. The fourth impinger contains an aqueous solution of 5%^{V/V} nitric acid (HNO₃) and 10%^{V/V} hydrogen peroxide (H₂O₂). The fifth, sixth, and seventh impingers contain an aqueous solution of 4%^{W/V} potassium permanganate (KMnO₄) and 10%^{V/V} sulfuric acid (H₂SO₄). The last impinger contains silica gel or an equivalent desiccant. Refer to Note 1.

Note 1—When flue gas streams are sampled with high moisture content (>20%), additional steps must be taken to eliminate carryover of impinger contents from one sample type to the next. These steps must include use of oversized impinger(s) or use of an empty impinger between the KCl and HNO₃–H₂O₂. If a dry impinger is used, it must be rinsed as discussed in Section 13.2 of this method and the rinse added to the preceding impinger.

7.1.9 *Metering System*—vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3°C (5.4°F), and a dry gas meter or controlled orifice capable of measuring volume to within 2%.

7.1.10 *Barometer*—barometer capable of measuring atmospheric pressure to within 0.33 kPa (0.1 in. Hg). In many cases, the barometric reading may be obtained from a nearby National Weather Service station, in which case, the station value (which is the absolute barometric pressure) shall be requested. An adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of negative 0.33 kPa (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

7.1.11 *Gas Density Determination Equipment*—temperature sensor and pressure gauge, as described in Section 2.3 and 2.4 of EPA Method 2. The temperature sensor shall, preferably, be permanently attached to the pitot tube or sampling probe in a fixed configuration, such that the sensor tip extends beyond the leading edge of the probe sheath and does not touch any metal. Alternative temperature sensor configurations are described in Section 2.1.10 of EPA Method 5. If necessary, a gas analyzer can be used to determine dry molecular weight of the gas (refer to EPA Method 3).

7.2 Digestion Apparatus

7.2.1 *Dry Block Heater or Hot Water Bath*—a heater capable of maintaining a temperature of 95°C is required for digestion of samples, similar to that described in EPA SW846 Method 7470.

7.2.2 Ice Bath

7.2.3 *Digestion Flasks*—Use 50- to 70-mL tubes or flasks with screw caps that will fit a dry block heater. For a water bath, 300-mL biological oxygen demand bottles for SW846 Method

7470 are to be used. In addition, borosilicate glass test tubes, 35- to 50-mL volume, with rack are needed.

7.2.4 *Microwave or Convection Oven and PTFE Digestion Vessels*—120 mL, or equivalent digestion vessels with caps equipped with pressure relief valves for the dissolution of ash, along with a capping station or the equivalent to seal the digestion vessel caps. Use a vented microwave or convection oven for heating. In addition, polymethylpentene (PMP) or equivalent volumetric flasks are recommended for the digested ash solutions.

7.3 *Analytical Equipment*—dedicated mercury analyzer or equivalent apparatus for the analysis of mercury via CVAAS. Alternatively, CVAFS may be used. CVAAS is a method based on the absorption of radiation at 253.7 nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrometer. Absorbency is measured as a function of mercury concentration. A soda-lime trap and a magnesium perchlorate trap must be used to precondition the gas before it enters the absorption cell.

8. Reagents and Materials

8.1 *Purity of Reagents*—Reagent-grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁶ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type II in ASTM Specification D 1193.

8.3 Reagents:

8.3.1 *Boric Acid (H_3BO_3)*—purified reagent grade.

8.3.2 *Hydrochloric Acid (HCl)*—trace metal-grade concentrated hydrochloric acid, with a specific gravity of 1.18.

8.3.3 *Hydrofluoric Acid (HF)*—concentrated hydrofluoric acid, 48%–50%.

8.3.4 *Hydrogen Peroxide (H_2O_2)*—30%^{v/v} hydrogen peroxide.

8.3.5 *Hydroxylamine Sulfate ($NH_2OH \cdot H_2SO_4$)*—solid.

⁶ “Reagent Chemicals, American Chemical Society Specifications,” Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see “Reagent Chemicals and Standards,” by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY, and the “United States Pharmacopeia.”

- 8.3.6 *Hydroxylamine Hydrochloride* ($NH_2OH \cdot HCl$)—10% solution
- 8.3.6 *Sodium Chloride* ($NaCl$)—solid.
- 8.3.7 *Mercury Standard Solution*—a certified (1000 $\mu g/mL$) mercury standard.
- 8.3.7 *Nitric Acid* (HNO_3)—trace metal-grade concentrated nitric acid with a specific gravity of 1.42.
- 8.3.8 *Potassium Chloride* (KCl)—solid.
- 8.3.9 *Potassium Permanganate* ($KMnO_4$)—solid.
- 8.3.10 *Potassium Persulfate* ($K_2S_2O_8$)—solid.
- 8.3.11 *Stannous Chloride* ($SnCl_2 \cdot 2H_2O$)—solid.
- 8.3.12 *Sulfuric Acid* (H_2SO_4)—trace metal-grade concentrated sulfuric acid, with a specific gravity of 1.84.
- 8.4 *Materials:*
- 8.4.1 *Indicating Silica Gel*—with a size of 6–16 mesh.
- 8.4.2 *Crushed or Cubed Ice.*
- 8.4.3 *Sample Filters*—quartz fiber filters, without organic binders, exhibiting at least 99.95% efficiency (<0.05% penetration) for 0.3- μm dioctyl phthalate smoke particles and containing less than 0.2 $\mu g/m^2$ of mercury. Test data provided by filter manufacturers and suppliers stating filter efficiency and mercury content are acceptable. However, if no such results are available, determine filter efficiency using ASTM Test Method D 2986, and analyze filter blanks for mercury prior to emission testing. Filter material must be unreactive to sulfur dioxide (SO_2) or sulfur trioxide (SO_3).⁷
- 8.4.4 *Filter Papers*—for filtration of digested samples. The filter paper must have a particle retention of >20 μm and filtration speed of >12 sec.
- 8.4.5 *Nitrogen Gas* (N_2)—carrier gas of at least 99.998% purity. Alternatively, argon gas may be used.

⁷ Felix, L.G.; Clinard, G.I.; Lacey, G.E.; McCain, J.D. "Inertial Cascade Impactor Substrate Media for Flue Gas Sampling," U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, Publication No. EPA-600/7-77-060; June 1977, 83 p.

8.4.6 *Soda Lime*—indicating 4- to 8-mesh absorbent for trapping carbon dioxide.

8.4.7 *Sample Containers*—glass with PTFE-lined lids.

8.5 *Sampling Reagents*

8.5.1 *KCl Absorbing Solution* (1 mol/L)—Dissolve 74.56 g of KCl in 500 mL of reagent water in a 1000-mL volumetric flask, swirl to mix, and dilute to volume with water. Mix well. A new batch of solution must be made prior to each field test.

8.5.2 *HNO₃-H₂O₂ Absorbing Solution* (5%^{v/v} HNO₃, 10%^{v/v} H₂O₂)—Add slowly, with stirring, 50 mL of concentrated HNO₃ to a 1000-mL volumetric flask containing approximately 500 mL of water, and then add carefully, with stirring, 333 mL of 30%^{v/v} H₂O₂. Dilute to volume with water. Mix well. A new batch of solution must be made prior to each field test.

8.5.3 *H₂SO₄-KMnO₄ Absorbing Solution* (4%^{w/v} KMnO₄, 10%^{v/v} H₂SO₄)—Mix carefully, with stirring, 100 mL of concentrated H₂SO₄ into approximately 800 mL of water. When mixing, be sure to follow standard acid to water addition procedures and safety precautions associated with strong acids. Then add water, with stirring, to make 1 L. This solution is 10%^{v/v} H₂SO₄. Dissolve, with stirring, 40 g of KMnO₄ into 10%^{v/v} H₂SO₄, and add 10%^{v/v} H₂SO₄, with stirring, to make 1 L. (**Warning**—See 9.1.1). H₂SO₄-KMnO₄ absorbing Solution must be made daily.

8.6 *Rinse Solutions for Sample Train*

8.6.1 *0.1 N HNO₃ Solution*—A certified reagent grade 0.1 N HNO₃ solution can be purchased directly or can be made by slowly adding 12.5 mL of concentrated HNO₃ to a 2000-mL volumetric flask containing approximately 500 mL of water, then diluting with water to volume.

8.6.2 *10%^{w/v} HNO₃ Solution*—Mix carefully, with stirring, 100 mL of concentrated HNO₃ into approximately 800 mL of water. When mixing, be sure to follow standard acid to water addition procedures and safety precautions associated with strong acids. Then add water, with stirring, to make 1 L.

8.6.3 *10%^{w/v} Hydroxylamine solution*—Add 100 g Hydroxylamine sulfate and 100 grams sodium chloride to a 1000-mL volumetric flask containing approximately 500 mL of water. After the Hydroxylamine sulfate and sodium chloride has been dissolved, dilute with water to volume. As an alternative a 10% hydroxylamine hydrochloride solution can be used in all cases as a replacement for the hydroxylamine sulfate/sodium chloride solution.

8.7 *Sample Digestion Reagents:*

8.7.1 *Boric Acid Solution* (4%^{w/v})—Dissolve 4 g H₃BO₃ in water, and dilute to 100 mL.

8.7.2 *Aqua Regia (HCl:HNO₃ 3:1)*—Add 3 parts concentrated HCl to 1 part concentrated HNO₃. Note that this should be made up in advance and allowed to form a dark orange color. This mixture should be loosely capped, as pressure will build as gases form.

8.7.3 *Saturated Potassium Permanganate Solution (5%^W/_V)*—Mix 5 g KMnO₄ into water, dilute to 100 mL, and stir vigorously.

8.7.4 *Potassium Persulfate Solution (5%^W/_V)*—Dissolve 5 g K₂S₂O₈ in water, and dilute to 100 mL.

8.8 *Analytical Reagents:*

8.8.1 *Hydrochloric Acid Solution (10%^V/_V)*—Add 100 mL concentrated HCl to water, and dilute to 1 L. Be sure to follow all safety precautions for using strong acids.

8.8.2 *Stannous Chloride Solution (10%^W/_V)*—Dissolve 100 g in 10%^V/_V HCl, and dilute with 10%^V/_V HCl to 1 L. Difficulty in dissolving the stannous chloride can be overcome by dissolving in a more concentrated HCl solution (such as 100 mL of 50%^V/_V HCl) and diluting to 1 L with water. Note that care must be taken when adding water to a strong acid solution. Add a lump of mossy tin (~0.5 g) to this solution.

8.9 *Mercury Standards:*

8.9.1 *10 mg/L Hg Stock Solution*—Dilute 1 mL of 1000 mg/L Hg standard solution to 100 mL with 10%^V/_V HCl.

8.9.2 *100 µg/L Hg Stock Solution*—Dilute 1 mL of 10 mg/L Hg stock solution to 100 mL with 10%^V/_V HCl.

8.9.3 *Working Hg Standards*—Prepare working standards of 1.0, 5.0, 10.0, and 20.0 µg/L Hg from the 100-µg/L stock solution by diluting 1, 5, 10, and 20 mL each to 100 mL with 10%^V/_V HCl.

Note 1—If samples to be analyzed are less than 1.0 µg/L Hg, working standards should be prepared at 0.05, 0.1, 0.5, and 1.0 µg/L Hg from a 10-µg/L Hg standard solution.

8.9.4 *Quality Control Standard (QC)*—A quality control standard is prepared from a separate Hg standard solution. The QC standard should be prepared at a concentration of approximately one-half the calibration range.

8.10 *Glassware Cleaning Reagents*—Prior to any fieldwork, all glassware should be cleaned according to the guidelines outlined in EPA Method 29, section 5.1.1

9. Hazards

9.1 *Warning:*

9.1.1 Pressure may build up in the solution storage bottle because of a potential reaction between potassium permanganate and acid. Therefore, these bottles should not be fully filled and should be vented to relieve excess pressure and prevent explosion. Venting must be in a manner that will not allow contamination of the solution.

9.1.2 Hazards to personnel exist in the operation of the cold-vapor atomic absorption spectrophotometer. Refer to the manufacturer's instruction manual before operating the instrument.

9.1.3 Sample digestion with hot concentrated acids creates a safety problem. Observe appropriate laboratory procedures for working with concentrated acids.

9.2 *Precaution:*

9.2.1 The determination of microquantities of mercury species requires meticulous attention to detail. Good precision is generally unattainable without a high level of experience with stack-sampling procedures. Precision may be improved by knowledge of, and close adherence to, the suggestions that follow.

9.2.1.1 All glassware used in the method must be cleaned thoroughly prior to use in the field, as described in Section 8.10 of this method.

9.2.1.2 Use the same reagents and solutions in the same quantities for a group of determinations and the corresponding solution blank. When a new reagent is prepared or a new stock of filters is used, a new blank must be taken and analyzed.

10. Sampling

10.1 *Preparation for Test:*

10.1.1 *Preliminary Stack Measurements*—Select the sampling site, and determine the number of sampling points, stack pressure, temperature, moisture, dry molecular weight, and range of velocity head in accordance with procedures of ASTM Test Method D 3154 or EPA Methods 1 through 4.

10.1.2 Select the correct nozzle diameter to maintain isokinetic sampling rates based on the range of velocity heads determined in 10.1.1.

10.1.3 Ensure that the proper differential pressure gauge is selected for the range of velocity heads (refer to EPA Method 2, Section 2.2).

10.1.4 It is suggested that an EPA Method 17 configuration be used; however, if an EPA Method 5 setup is to be used, then select a suitable probe length such that all traverse points can be sampled. Consider sampling from opposite sides of the stack to minimize probe length when a large duct or stack is sampled.

10.1.5 *Sampling Time and Volume*—The total sampling time for this method should be at least 2 but not more than 3 hours. Use a nozzle size that will guarantee an isokinetic gas sample volume between 1.0 dry cubic meters corrected to standard conditions (dscm) and 2.5 dscm. If traverse sampling is done (necessary for sampling at electric utilities), use the same points for sampling that were used for the velocity traverse as stated in Section 10.1.1 of this method. Each traverse point must be sampled for a minimum of 5 minutes.

11. Preparation of Apparatus

11.1 *Pretest Preparation:*

11.1.1 Weigh several 200- to 300-g portions of silica gel in airtight containers to the nearest 0.5 g. Record the total mass of the silica gel plus container on each container. Alternatively, the silica gel can be weighed directly in the impinger immediately prior to the train being assembled.

11.1.2 Desiccate the sample filters at $20^{\circ} \pm 5.6^{\circ}\text{C}$ ($68^{\circ} \pm 10^{\circ}\text{F}$) and ambient pressure for 24 to 36 hours, weigh at intervals of at least 6 hours to a constant mass (i.e., <0.5-mg change from previous weighing), and record results to the nearest 0.1 mg. Alternatively, the filters may be oven-dried at 105°C (220°F) for 2 to 3 hours, desiccated for 2 hours, and weighed.

11.1.3 Clean all sampling train glassware as described in Section 8.10 before each series of tests at a single source. Until the sampling train is assembled for sampling, cover all glassware openings where contamination can occur.

11.2 *Preparation of Sampling Train:*

11.2.1 Assemble the sampling train as shown in Figure 1.

11.2.2 Place 100 mL of the KCl solution (see Section 8.5.1 of this method) in each of the first, second, and third impingers, as indicated in Figure 1.

11.2.3 Place 100 mL of the $\text{HNO}_3\text{-H}_2\text{O}_2$ solution (Section 8.5.2 of this method) in the fourth impinger, as indicated in Figure 1.

11.2.4 Place 100 mL of the $\text{H}_2\text{SO}_4\text{-KMnO}_4$ absorbing solution (see Section 8.5.3 of this method) in each of the fifth, sixth, and seventh impingers, as indicated in Figure 1.

11.2.5 Transfer approximately 200 to 300 g of silica gel from its container to the last impinger, as indicated in Figure 1.

11.2.6 Prior to final train assembly, weigh and record the mass of each impinger. This information is required to calculate the moisture content of the sampled flue gas.

11.2.7 To ensure leak-free sampling train connections and to prevent possible sample contamination problems, use PTFE tape, PTFE-coated O-rings, or other noncontaminating material.

11.2.8 Place a weighed filter in the filter holder using a tweezer or clean disposable surgical gloves.

11.2.9 Install the selected nozzle using a noncontaminating rubber-type O-ring or equivalent when stack temperatures are less than 260°C (500°F) and an alternative gasket material when temperatures are higher. Other connecting systems, such as PTFE ferrules or ground glass joints, may also be used on the probe and nozzle.

11.2.10 Mark the probe with heat-resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

11.2.11 Place crushed or cubed ice around the impingers.

11.2.12 *Leak-Check Procedures.* Follow the leak-check procedures given in Section 4.1.4.1 (Pretest Leak Check), Section 4.1.4.2 (Leak Checks During the Sample Run), and Section 4.1.4.3 (Posttest Leak Checks) of EPA Method 5 or 17.

Note 2—If the flue gas temperature at the sampling location is greater than 260°C (above the temperature where PTFE or rubber-type seals can be used), the posttest leak check is determined beginning at the front end of the probe (does not include nozzle or sample filter holder for EPA Method 17).

12. Calibration and Standardization

12.1 *Sampling Train Calibration:*

12.1.1 *Probe Nozzle*—Refer to Sections 2.1.1 of either EPA Method 5 or 17.

12.1.2 *Pitot Tube*—Refer to Section 4 of EPA Method 2.

12.1.3 *Metering System*—Refer to Section 5.3 of either EPA Method 5 or 17.

12.1.4 *Probe Heater*—Refer to Section 7.1.7.1 and 7.1.7.2 of this method.

12.1.5 *Temperature Gauges*—Refer to Section 4.3 of EPA Method 2.

12.1.6 *Leak Check of the Metering System*—Refer to Section 5.6 of EPA Method 5 or Section 5.5 of EPA Method 17.

12.1.7 *Barometer*—Calibrate the barometer to be used against a mercury barometer.

12.2 *Atomic Absorption or Atomic Fluorescence Spectrometer Calibration*—Perform instrument setup and optimization according to the manufacturer's specifications. Cold-vapor generation of mercury is performed via addition of stannous chloride solution to reduce oxidized mercury to its elemental state. The mercury-laden solution is then purged with a carrier gas into the atomic absorption cell. This procedure is used to calibrate the instrument using 10%^{v/v} HCl as the blank along with the standards described in Section 8.9.3. Calibration is verified by analyzing the QC standard prepared according to Section 8.9.4 of this method.

13. Procedures

13.1 *Sampling Train Operation:*

13.1.1 Maintain an isokinetic sampling rate within 10% of true isokinetic. For an EPA Method 5 configuration, maintain sample filter exit gas stream temperatures and probe within $\pm 15^{\circ}\text{C}$ of the flue gas temperature at the sampling location. However, at no time, regardless of the sample configuration, must the sample filter, probe, or connecting umbilical cord temperature be lower than 120°C .

13.1.2 Record the data, as indicated in Figure 2, at least once at each sample point but not less than once every 5 minutes.

13.1.3 Record the dry gas meter reading at the beginning of a sampling run, the beginning and end of each sampling time increment, before and after each leak check, and when sampling is halted.

13.1.4 Level and zero the manometer. Periodically check the manometer level and zero, because it may drift during the test period.

13.1.5 Clean the port holes prior to the sampling run.

13.1.6 Remove the nozzle cap. Verify that the filter and probe heating systems are up to temperature and that the pitot tube and probe are properly positioned.

Note 3—For an EPA Method 5 configuration, prior to starting the gas flow through the system, the sample filter exit gas temperature may not be at the hot box temperature. However, if the system is set up correctly, once flow is established, the sample filter exit gas temperature will quickly come to equilibrium.

13.1.7 Start the pump. Position the nozzle at the first traverse point with the nozzle tip pointing in the direction of flow. Seal the openings around the probe and port hole to prevent unrepresentative dilution of the gas stream. Read the pitot tube manometer, start the stopwatch, open and adjust the control valve until the isokinetic sampling rate is obtained (refer to Section

4.1.5 from either EPA Method 5 or 17 for information on isokinetic sampling rate computations), and maintain the isokinetic rate at all points throughout the sampling period.

13.1.8 When sampling at one traverse point has been completed, move the probe to the next traverse point as quickly as possible. Close the coarse adjust valve, and shut the pump off when transferring the probe from one sample port to another. Exclude the time required to transfer the probe from one port to another from the total sampling time.

13.1.9 Traverse the stack cross section, as required by EPA Method 1.

13.1.10 During sampling, periodically check and, if necessary, adjust the probe and filter exit sample gas temperatures, as well as the zero of the manometer.

13.1.11 Add more ice, if necessary, to maintain a temperature of $<20^{\circ}\text{C}$ (68°F) at the condenser/silica gel outlet.

13.1.12 Replace the filter assembly if the pressure drop across the filter becomes such that maintaining isokinetic sampling is no longer possible. Conduct a leak check (refer to EPA Method 5 or 17, Section 4.1.4.2) before installing a new filter assembly. The total particulate mass and determination of particle-bound mercury includes all filter assembly catches.

13.1.13 In the unlikely event depletion of KMnO_4 via reduction reactions with flue gas constituents other than elemental mercury occurs, it may render it impossible to sample for the desired minimum time. This problem is indicated by the complete bleaching of the purple color of the acidified permanganate solution. If the purple color is lost in the first two H_2SO_4 - KMnO_4 impingers, then the sample must be repeated. If the gas stream is known to contain large amounts of reducing constituents (i.e., >2500 ppm SO_2) or breakthrough has occurred in previous sampling runs, then the following modification is suggested: the amount of HNO_3 - H_2O_2 ($10\% \text{V}/\text{V}$) in the fourth impinger should be doubled, and/or a second HNO_3 - H_2O_2 impinger should be used to increase the oxidation capacity for reducing gas components prior to the H_2SO_4 - KMnO_4 impingers.

13.1.14 Use a single train for the entire sample run, except when simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct or when equipment failure necessitates a change of trains.

13.1.15 At the end of a sample run, turn off the coarse adjust valve, remove the probe and nozzle from the stack, record the final dry gas meter reading, and conduct a posttest leak check, as described in Section 4.1.4.3 of EPA Method 5. Also, leak-check the Pitot lines as described in EPA Method 2, Section 3.1. The lines must pass the leak check to validate the velocity head data.

13.1.16 Calculate percent isokinetic to determine whether the run was valid or another test run should be performed (refer to EPA Method 5 or 17).

13.2 *Sample Recovery:*

13.2.1 Allow the probe to cool before proceeding with sample recovery. When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle, and place a rinsed, noncontaminating cap over the probe nozzle to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling; a vacuum can form in the filter holder, with the undesired result of drawing liquid from the impingers onto the filter.

13.2.2 Before moving the sampling train to the cleanup site, remove the probe from the sampling train, and cap the open outlet. Be careful not to lose any condensate that may be present. Cap the filter inlet where the probe was fastened. Remove the umbilical cord from the last impinger, and cap the impinger. Cap the filter holder outlet and impinger inlet. Use noncontaminating caps, such as ground-glass stoppers, plastic caps, serum caps, or PTFE tape, to close these openings.

13.2.3 Alternatively, the following procedure may be used to disassemble the train before the probe and filter holder/oven are completely cooled. Initially disconnect the filter holder outlet/impinger inlet, and loosely cap the open ends. Then disconnect the probe from the filter holder or cyclone inlet, and loosely cap the open ends. Cap the probe tip, and remove the umbilical cord as previously described.

13.2.4 Transfer the probe and filter-impinger assembly to a clean area that is protected from the wind and other potential causes of contamination or loss of sample. Inspect the train before and during disassembly, and note any abnormal conditions.

13.2.5 The impinger train sample recovery scheme is illustrated in Figure 3.

13.2.6 *Container 1 (Sample Filter)*—Carefully remove the sample filter from the filter holder so as not to lose any ash, weigh filter and ash, and place the filter in a labeled petri dish container. To handle the filter, use either acid-washed polypropylene or PTFE-coated tweezers or clean, disposable surgical gloves rinsed with water and dried. If it is necessary to fold the filter, make certain the particulate cake is inside the fold. Transfer any particulate matter or filter fibers that adhere to the filter holder gasket to the filter in the petri dish. A dry (acid-cleaned) nonmetallic bristle brush should be used to remove any remaining particulate matter. Do not use any metal-containing materials when recovering this train. Immediately cover and seal the labeled petri dish.

13.2.7 *Container 2/2a (All Rinses in Front of the Sample Filter)*

13.2.7.1 *Case 1: Includes Gravimetric Particulate Determination in Addition to Mercury*

Quantitatively recover particulate matter and any condensate from all components prior to the sample filter. A nonmetallic brush may be used for removing particulate matter. All front-half components (all components prior to the sample filter) are then rinsed with acetone as outlined in

EPA Method 5 or 17. The acetone rinse is then placed into a container (Container 2a) for which the tare weight has been recorded. Container 2a, with a ribbed watch glass over the top, is placed in a fume hood until the acetone has completely evaporated. After the front-half components have been rinsed with acetone, then rinse these components with 0.1 N HNO₃. The 0.1 N HNO₃ rinse is placed in Container 2.

13.2.7.2 Case 2: Mercury Determination Only (No Acetone Rinse)

Quantitatively recover particulate matter and any condensate from all components prior to the sample filter. A nonmetallic brush may be used for removing particulate matter. The front-half components are then rinsed with 0.1 N HNO₃, and this rinse is placed in Container 2.

13.2.8 Container 3 (Impingers 1 through 3, KCl Impinger Contents and Rinses):

13.2.8.1 Dry the exterior surfaces of Impingers 1, 2, and 3. Then weigh and record the mass of each impinger (to the nearest 0.5 g).

13.2.8.2 Clean the filter support, the back half of the filter housing, and connecting glassware by thoroughly rinsing with 0.1 N HNO₃. Pour the rinse into a glass sample Container 3.

13.2.8.3 Carefully add small amounts of 5% w/v KMnO₄ solution very slowly to each KCl impinger and gently mix the impinger solution. Continue adding KMnO₄ solution until a purple color is obtained. Let the impingers sit for approximately 15 minutes to ensure the purple color persists.

13.2.8.4 Pour all of the liquid from the three KCl impingers into Container 3.

13.2.8.5 Rinse the impingers and connecting glassware with 10% v/v HNO₃. Although unlikely, if deposits remain on the impinger surfaces, remove them by doing another 10% v/v HNO₃ rinse that has a very small amount (several drops) of 10% w/v hydroxylamine solution added to the HNO₃ rinse solution. Rinse each of the KCl impingers with this solution until the brown stains are removed. Add these rinses to Container 3. If the solution in Container 3 becomes clear, add a small amount of the 5% w/v KMnO₄ solution until a pink or slightly purple color is obtained. Check again after 90 min to ensure the purple color remains.

13.2.8.6 Perform a final rinse of the impingers and connecting glassware with 0.1 N HNO₃, and add to Container 3.

13.2.8.7 Do a final rinse of all glass components with water which is discarded.

13.2.8.8 Mark the height of the fluid level in Container 3, seal, and clearly label the contents.

13.2.9 *Container 4 (Impinger 4, HNO₃-H₂O₂ Impinger Contents and Rinses):*

13.2.9.1 Dry the exterior surfaces of Impinger 4. Then weigh and record the mass of this impinger (to the nearest 0.5 g).

13.2.9.1 Pour the HNO₃-H₂O₂ absorbing solution into sample Container 4.

13.2.9.2 Rinse the H₂O₂-HNO₃ impinger and connecting glassware a minimum of two times with 0.1 N HNO₃, and pour the rinses into Container 4. Do a final rinse with water and discard water.

13.2.10 *Container 5 (Impingers 5 through 7, H₂SO₄-KMnO₄ Impinger Contents and Rinses):*

13.2.10.1 Dry the exterior surfaces of Impingers 5, 6, and 7. Then weigh and record the mass of each impinger (to the nearest 0.5 g).

13.2.10.2 Pour all of the liquid from the three H₂SO₄-KMnO₄ impingers into a glass sample Container 5.

13.2.10.3 Rinse the H₂SO₄-KMnO₄ impingers and connecting glassware a minimum of two times with 0.1 N HNO₃, and pour the rinses into Container 5. A third rinse must then be done (this rinse will remove any brown stains from the surface of the impingers). This rinse consists of 0.1N HNO₃ and several drops of 10% w/v hydroxylamine solution (either the NH₂OH/NaCl solution or the NH₂OH·HCl solution). This rinse must have enough 10% w/v hydroxylamine solution such that the brown stains are easily removed. If they are not easily removed add several more drops of 10% w/v hydroxylamine solution until the stains are completely gone. Add this rinse to Container 5. If the solution in Container 5 becomes clear, add small amounts of the H₂SO₄-KMnO₄ solution until a pink or slightly purple color is obtained.

13.2.10.4 Perform a final 0.1 N HNO₃ rinse of the impingers and connecting glassware follow by a water rinse. The 0.1 N HNO₃ rinse is added to Container 5, and the water rinse is discarded.

13.2.10.5 Mark the height of the fluid level, seal the container, and clearly label the contents.

Note 4—As stated earlier in the warning in Section 9.1.1, pressure can build up in the sample storage flask because of the potential reaction of KMnO₄ with acid. Do not fill the container completely, and take precautions to relieve excess pressure.

13.2.11 *Container 6 (Impinger 8, Silica Gel Impinger Contents):*

13.2.11.1 Dry the exterior surfaces of Impinger 8. Then weigh and record the mass of this impinger (to the nearest 0.5 g).

13.2.11.2 Note the color of the indicating silica gel to determine whether it has been completely spent, and make a notation of its condition. If spent, the silica gel must be either regenerated or disposed of.

13.2.12 *Solution Blanks (Containers 7–11)*

Solution blanks are taken each time new reagents are prepared. *Note:* The amount of solution collected for the blanks stated below is a suggested volume.

13.2.12.1 *Container 7 (0.1 N HNO₃ Blank)*—Place 50 mL of the 0.1 N HNO₃ solution used in the sample recovery process into a properly labeled container. Seal the container.

13.2.12.2 *Container 8 (1 N KCl Blank)*—Place 50 mL of the 1 N KCl solution used as the impinger solution into a properly labeled container. Seal the container.

13.2.12.3 *Container 9 (5%^{v/v} HNO₃–10%^{v/v} H₂O₂ Blank)*—Place 50 mL of the HNO₃–H₂O₂ solution used as the nitric acid impinger reagent into a properly labeled container. Seal the container.

13.2.12.4 *Container 10 (H₂SO₄–KMnO₄ Blank)*—Place 50 mL of the H₂SO₄–KMnO₄ solution used as the impinger solution in the sample recovery process into a properly labeled container. Refer to **Note 4** in Section 13.2.10.5 of this method.

13.2.12.5 *Container 11 (10%^{w/v} Hydroxylamine Solution)*—Place 100 mL of hydroxylamine solution into a properly labeled sample container. Seal the container.

13.2.13 *Container 12 (Sample Filter Blank)*—Once during each field test, place into a properly labeled petri dish three unused blank filters from the same lot as the sampling filters. Seal the petri dish.

13.2.14 After all of the samples have been recovered, they must be analyzed within 45 days.

13.2.15 After all impingers and connectors have been properly rinsed and the solutions recovered, the glassware should be cleaned according to the procedures in Section 8.10 or triple-rinsed with 10%^{v/v} HNO₃ followed by a rinsing with water. If a new source is to be sampled or if there are any brown stains on the glassware, then the glassware must be cleaned according to procedures in Section 8.10 of this method. If multiple sites are to be sampled during a single mobilization, an exception to this procedure will be allowed. In this case, a triple rinsing of the glassware with 10%^{v/v} HNO₃ solution followed by a water rinse prior to sampling can be used as an alternative to the procedures in Section 8.10. However, if there are any brown stains on the glassware, then the glassware must be cleaned according to procedures in Section 8.10 of this method.

13.3 *Sample Preparation:*

13.3.1 *Ash Sample (Containers 1 and 2)*

13.3.1.1 *Case 1: Includes Gravimetric Particulate Determination in Addition to Mercury*—The gravimetric particulate loading is determined from the mass of the ash on the filter (Container 1) and the residual particulate from the acetone rinse (Container 2a), as outlined in EPA Method 5 or 17. If a large amount of ash is on the filter, carefully remove the ash to create a raw ash sample from which a representative weighed aliquot can be taken for digestion. If the mass of ash collected on the filter is small (less than 0.5 g), digest the entire filter along with the ash. Dissolve the residual particulate from Container 2a using concentrated HNO₃. This solution is then added to Container 2 (0.1 N HNO₃ probe rinse). The ash material from Container 1 is then digested using the procedures described in Section 13.3.2 of this method. The same procedure is used to determine the mercury on the sample filter blank.

Use a modification of EPA SW 846 7470 to digest the sample in Container 2 prior to analysis. The main modification is that the volumes of reagents and sample have been reduced tenfold to reduce waste. This reduction in reagent volume is acceptable because modern dedicated mercury analyzers do not require the large volumes that previous manual methods required. Transfer a 10-mL aliquot of the sample to a digestion tube with a screw cap.

13.3.1.2 *Case 2: Mercury Determination Only*—The same procedures are followed as described previously in Section 13.3.1.1 with the exception that there is no Container 2a.

13.3.2 *Ash Digestion*—Accomplish the complete dissolution of ash by one of the following methods or an equivalent alternative method. The following methods are for the dissolution of inorganic samples, such as ash or sediments, when an analysis of trace elements including mercury is done.

13.3.2.1 *Microwave Digestion*—The use of this method assumes proper training in microwave digestion techniques. In addition, this method is tailored for a CEM (continuous emission monitor) microwave digestion system. A 0.5-g ash sample, accurately weighed to 0.0001 g, is placed in a PTFE microwave digestion vessel with 3 mL of concentrated HF, 3 mL of concentrated HNO₃, and 3 mL of concentrated HCl. The vessel is sealed and placed in the microwave (along with other vessels). The vessels are slowly heated to a pressure of 347 kPa (50 psi), which is held for 5 minutes, followed by heating to a pressure of 550 kPa (80 psi), which is held for 20 minutes. The vessels are allowed to cool to room temperature before venting. 15 mL of 4%^{w/v} boric acid is added to each vessel. The vessels are sealed and placed in the microwave again. The vessels are slowly heated back to a pressure of 347 kPa (50 psi) and held for 10 minutes. The vessels are again allowed to cool to room temperature before venting. The contents of each vessel are quantitatively transferred to a 50-mL PMP or polypropylene (PP) volumetric flask and diluted; note that care must be taken in adding water to a strong acid solution.

13.3.2.2 *Conventional Digestion*—The use of this method assumes proper training in PTFE bomb digestion techniques. Place a 0.5-g ash sample, accurately weighed to 0.0001 g, in a PTFE

digestion vessel with 7 mL of concentrated HF and 5 mL of aqua regia. Seal the vessel, and place it in an oven or water bath at 90°C for a minimum of 8 hours (these may be heated overnight). Cool the vessel to room temperature before venting. Add 3.5 g of boric acid and 40 mL of water to each vessel. Seal the vessels, and place them in the oven or water bath for an additional 1 hour. Cool the vessels again to room temperature before venting. Quantitatively transfer the contents of each vessel to a 100-mL PMP, PP, or glass volumetric flask and dilute. Note that care must be taken in adding water to a strong acid solution.

13.3.3 *Preparation of Aqueous KCl Impinger Solution (Containers 3 and 8)*—Dilute sample in a 500-mL volumetric flask to volume with water, and mix. Use a modification of EPA SW 846 7470 to digest the sample prior to analysis. The main modification is that the volumes of reagents and sample have been reduced tenfold to reduce waste. This reduction in reagent volume is acceptable because modern dedicated mercury analyzers do not require the large volumes that previous manual methods required. Transfer a 10-mL aliquot of the sample to a digestion tube with a screw cap. Add 0.5 mL of concentrated H₂SO₄, 0.25 mL of concentrated HNO₃, and 1.5 mL of 5%^{w/v} KMnO₄ solution. Mix the solution, and allow it to stand for 15 minutes. Add 0.75 mL of 5%^{w/v} K₂S₂O₈ solution, and loosely cap the tube. Place the tube in a dry block heater or water bath equipped with a temperature probe, and heat to 95°C. Do not allow the temperature to exceed 95°C. Hold the sample at 95°C for 2 hours before allowing it to cool to room temperature. The purple color from the added KMnO₄ solution must remain throughout the digestion. Clearing of the solution during the heating indicates the depletion of KMnO₄. If the solution goes clear add more KMnO₄ to the sample until a purple color persists. Prior to analysis, add 1 mL of 10%^{w/v} hydroxylamine sulfate solution to the sample. The sample solution should remain clear after addition of hydroxylamine sulfate. Record the volumes of the solution additions used in the preparation procedure and adjust the DF factor in equation 9 as necessary.

13.3.4 *Preparation of HNO₃-H₂O₂ Impinger Solution (Containers 4 and 9)*—Dilute sample in a 250-mL volumetric flask to volume with water, and mix. Treat the sample with a modified version of EPA SW 846 7470. Modifications to the method are necessary to properly treat the H₂O₂-containing impinger solution before the analysis with CVAAS. The modifications include the addition of HCl, the use of an ice bath during the KMnO₄ addition, and the slow addition of the KMnO₄. Transfer a 5-mL aliquot of the sample to a digestion tube with a screw cap. Add 0.25 mL of concentrated HCl, 0.25 mL of concentrated H₂SO₄, place the tube in an ice bath, and allow it to cool for 15 minutes. The destruction of H₂O₂ is accomplished by slow addition of saturated KMnO₄ solution in 0.25-mL increments along the inside of the digestion tube. The violence of this reaction requires careful, slow addition of the KMnO₄ for safety reasons and to avoid loss of analyte. Cool the sample for 15 minutes in between each addition, and mix the sample prior to each addition. After the first five additions, increase the increments to 0.5 mL. Carry out the addition of KMnO₄ until the solution remains purple, indicating complete reaction of the H₂O₂. Record the volume of saturated KMnO₄ solution added to the sample. Add 0.75 mL of 5%^{w/v} K₂S₂O₈ solution to the sample, and then cap the tube loosely. Place the tubes in a dry block heater or water bath equipped with a temperature probe, and heat to 95°C. Do not allow the temperature to exceed 95°C. Maintain the sample at 95°C for 2 hours before allowing it to cool to room temperature. Note that the purple color due to KMnO₄ must remain throughout the digestion. Clearing of the solution during the heating indicates the depletion of KMnO₄. Before

doing the analysis, add 1 mL 10%^{w/v} of hydroxylamine sulfate solution to the sample. The sample should then become clear. Record the volumes of the solution additions used in the preparation procedure and adjust the DF factor in equation 13 as necessary.

13.3.5 *Preparation of H₂SO₄-KMnO₄ Impinger Solution (Containers 5 and 10)*—Prepare the entire solution immediately prior to analysis. Dissolve by incrementally adding approximately 500 mg of solid hydroxylamine sulfate into the sample until a clear, colorless solution persists. (This is to ensure that a representative aliquot sample can be taken and that any mercury contained in the manganese dioxide that forms from the permanganate solution will be removed). Add the hydroxylamine slowly because of the violence of this reaction. Dilute the sample in a 500-mL volumetric flask to volume with water, and mix. Transfer a 10-mL aliquot of the sample to a digestion tube with a screw cap. Add 0.75 mL of 5%^{w/v} K₂S₂O₈ solution and 0.5 mL of concentrated HNO₃, and loosely cap the tube. Place the tube in a dry block heater or water bath equipped with a temperature probe, and heat to 95°C. Do not allow the temperature to exceed 95°C. Hold the sample at 95°C for 2 hours before allowing it to cool to room temperature. The purple color of the KMnO₄ solution must remain throughout the digestion. Clearing of the solution during the heating indicates the depletion of KMnO₄. Prior to analysis, add 1 mL of 10%^{w/v} of hydroxylamine sulfate solution to the sample. The sample solution should remain clear after addition of hydroxylamine sulfate. Record the volumes of the solution additions used in the preparation procedure and adjust the DF factor in equation 12 as necessary.

13.3.6 *Simplification of the Digestion*—If an acetone rinse was not used for gravimetric particulate determination or it is very clear, there is insignificant organic material present in the sampled gas stream; then the digestion procedure for the HNO₃-H₂O₂ and H₂SO₄-KMnO₄ impinger solutions may be simplified by omitting the persulfate digest. The persulfate digest is performed for the purpose of oxidizing certain organics. Because this method is specific to coal combustion systems where organic compounds are usually insignificant,⁸ this digest may be omitted because the H₂O₂ is sufficient to oxidize most compounds. The decision to omit this procedure should be made based on the gas stream being sampled and/or verification that organics resistant to H₂O₂ oxidation are not present. If unsure whether organics are present or if an acetone rinse has been used, then the total digestion procedure is required.

13.3.6.1 *Simplified Procedure for the Preparation of HNO₃-H₂O₂ Impinger Solution*—If the simplified procedure can be used for the HNO₃-H₂O₂ impinger solution, the concentrated H₂SO₄ and 5%^{w/v} K₂S₂O₈ are not added to the HNO₃-H₂O₂ aliquot sample. Also it is not necessary to heat the sample to 95°C followed by 2 hours of cooling. However, it is still necessary that the concentrated HCl be added to the solution.

⁸ “A Comprehensive Assessment of Toxic Emissions from Coal-Fired Power Plants: Phase I Results from the U.S. Department of Energy Study,” Prepared for the U.S. Department of Energy Federal Energy Technology Center, Contract No. DE-FC21-93MC30097, Energy & Environmental Research Center, University of North Dakota, Grand Forks, ND, 1996.

Just before doing the analysis, add 1mL 10%^{w/v} of hydroxylamine solution to the sample. The sample should then become clear. If the simplified procedure is used, $V(K_2S_2O_8)$ and $V(H_2SO_4)$ are zero when calculating DF in Equation 12 Section 15.

13.3.6.2 *Simplified procedure for the Preparation of H_2SO_4 - $KMnO_4$ Impinger Solution*—If the simplified procedure can be used for the H_2SO_4 - $KMnO_4$ impinger solution, the concentrated HNO_3 and 5%^{w/v} $K_2S_2O_8$ are not added to the H_2SO_4 - $KMnO_4$ aliquot sample. Also it is not necessary to heat the sample to 95°C followed by 2 hours of cooling. Just before doing the analysis, add 1mL 10%^{w/v} of hydroxylamine solution to the sample. The sample should then become clear. If the simplified procedure is used, $V(K_2S_2O_8)$ and $V(HNO_3)$ are zero when calculating DF in Equation 13 Section 15.

13.3.7 *Reagent blanks (Containers 8 through 10)*—These samples are not diluted prior to taking an aliquot. Once an aliquot is taken the preparation steps for each of the solutions (as well as the mercury concentration calculations) are the same as described above. These are Section 13.3.3 for the aqueous KCl reagent blank, Section 13.3.4 for the HNO_3 - H_2O_2 reagent blank, and Section 13.3.6.2 for the H_2SO_4 - $KMnO_4$ reagent blank.

13.3.8 *0.1 N HNO_3 and 10%^{w/v} Hydroxylamine Rinse Solutions (Containers 7 and 11)*—These solutions can be analyzed directly for mercury without any preparation steps.

13.4 *Sample Analysis*—Analyze all of the prepared solutions by CVAAS or CVAFS following the guidelines specified by the instrument manufacturer.

13.4.1 *QA/QC*—For this method, it is important that both the sampling team and analytical people be very well trained in the procedures. This is a complicated method that requires a high-level of sampling and analytical experience. For the sampling portion of the QA/QC procedure, both solution and field blanks are required. It should be noted that if high-quality reagents are used and care is taken in their preparation and in the train assembly, there should be little, if any, mercury measured in either the solution or field blanks.

As stated in Section 13.2.12 of this method, solution blanks will be taken and analyzed every time a new batch of solution is prepared. If mercury is detected in these solution blanks, the concentration is subtracted from the measured sample results. The maximum amount that can be subtracted is 10% of the measured result or 10 times the detection limit of the instrument which ever is lower. If the solution blanks are greater than 10% the data must be flagged as suspect.

A field blank is performed by assembling an impinger train, transporting it to the sampling location during the sampling period, and recovering it as a regular sample. These data are used to ensure that there is no contamination as a result of the sampling activities. A minimum of one field blank at each sampling location must be completed for each test site. Any mercury detected in the field blanks cannot be subtracted from the results. Whether or not the mercury detected in the field blanks is significant is determined based on the QA/QC procedures established prior to the testing. At a minimum, if field blanks exceed 30% of the measured value at the corresponding location, the data must be flagged as suspect.

The QA/QC for the analytical portion of this method is that every sample, after it has been prepared, is to be analyzed in duplicate with every tenth sample analyzed in triplicate. These results must be within 10% of each other. If this is not the case, then the instrument must be recalibrated and the samples reanalyzed. In addition, after every ten samples, a known spike sample must be analyzed. For the ash samples, a certified reference ash sample (may be purchased from NIST) is to be digested and analyzed at least once during the test program. It is also suggested that the QA/QC procedures developed for a test program include submitting, on occasion, spiked mercury samples to the analytical laboratory by either the prime contractor if different from the laboratory or an independent organization.

14. Flue Gas Calculations

14.1 *Dry Gas Volume*—Calculate the dry gas sample volume, $V_{m(std)}$, at standard conditions using Equation 1.

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m} \right) \left[\frac{P_{bar} + \Delta H}{P_{std}} \right] = K_1 V_m Y \frac{P_{bar} + \Delta H}{T_m} \quad [\text{Eq. 1}]$$

where:

- P_{bar} = barometric pressure at the sampling site, kPa (in. Hg)
- P_{std} = standard absolute pressure, 101.3 kPa (29.92 in. Hg)
- T_m = absolute average dry gas meter temperature (refer to Figure 2), K (°R)
- T_{std} = standard absolute temperature, 293 K (528°R)
- V_m = volume of gas sample as measured by dry gas meter, dcm (dscf)
- $V_{m(std)}$ = volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf)
- Y = dry gas meter calibration factor
- ΔH = average pressure differential across the orifice meter (refer to Figure 2), kPa (in. Hg)
- K_1 = 2.894 K/kPa (17.64°R/in. Hg)

Note 5—Equation 1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., leak checks conducted prior to component changes or following the test) exceeds the maximum acceptable leakage rate, L_a , equal to 0.00057 m³/min (0.02 cfm) or 4% of the average sampling rate, whichever is less. If the leakage rate observed during the posttest leak check, L_p , or an individual leakage rate observed during the leak check conducted prior to the “ith” component change ($i = 1, 2, 3, \dots, n$), L_i , exceeds L_a , then Equation 1 must be modified as follows:

(a) **Case I.** No component changes made during sampling run. In this case, replace V_m with the expression:

$$[V_m - (L_p - L_a)\theta]$$

where:

- L_p = leakage rate observed during the posttest leak check, m³/min (cfm)
- L_a = maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change—equal to 0.00057 m³/min (0.02 cfm) or 4% of the average sampling rate, whichever is less
- θ = total sampling time, min

(b) **Case II.** One or more component changes made during the sampling run. In this case, replace V_m with the expression:

$$\left[V_m - (L_1 - L_a)\theta_1 - \sum_{i=1}^n (L_i - L_a)\theta_i - (L_p - L_a)\theta_p \right]$$

where:

θ_i = sampling time interval, from the beginning of a run until the first component change, min

and substitute only for those leakage rates (L_i or L_p) that exceed L_a .

14.2 *Volume of Water Vapor*—Calculate the volume of water vapor of the stack gas using Equation 2.

$$V_{w(std)} = \frac{W_{lc} R T_{std}}{M_w P_{std}} = K_2 W_{lc} \quad [\text{Eq. 2}]$$

where:

- M_w = molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole)
- R = ideal gas constant, 0.008314 kPa-m³/K-g-mole (21.85 in. Hg-ft³/°R-lb-mole)
- W_{lc} = total mass of liquid collected in impingers and silica gel (refer to Figure 2), g
- $V_{w(std)}$ = volume of water vapor in the gas sample, corrected to standard conditions, scm (scf)
- K_2 = 0.001336 m³/mL (0.04707 ft³/mL)

14.3 *Volume of Moisture*—Calculate the moisture content, B_{ws} , of the stack gas using Equation 3.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}} \quad [\text{Eq. 3}]$$

where:

B_{ws} = water vapor in the gas stream, proportion by volume

15. Calculations for Particle-Bound, Oxidized, Elemental, and Total Mercury Concentrations:

15.1 Particle-Bound Mercury

15.1.1 *Case 1: Amount of Ash on the Filter is Greater Than 0.5 g*—Calculate the concentration of mercury in $\mu\text{g/g}$ in the ash sample (Hg_{ash}) using Equation 4:

$$\text{Hg}_{\text{ash}}, \mu\text{g/g} = (\text{IR})(\text{DF}) \quad [\text{Eq. 4}]$$

where:

IR = instrument reading, $\mu\text{g/L}$

DF = dilution factor = (total digested volume, L)/(mass of ash digested, g)

Calculate the amount of mercury in the probe rinse (Hg_{pr} , Container 2) in μg using Equation 5:

$$\text{Hg}_{\text{pr}}, \mu\text{g} = (\text{IR})(V_1) \quad [\text{Eq. 5}]$$

where:

IR = instrument reading, $\mu\text{g/L}$

V_1 = total volume of probe rinse sample from which sample aliquot was taken, L

Equation 5 assumes no preparation steps are needed prior to analyzing the probe rinse for mercury using CVAA. Although not required, a persulfate digest can be done on the probe rinse sample as discussed in section 13.3.3. If the persulfate digest is done equation 5 becomes $\text{Hg}_{\text{pr}}, \mu\text{g} = (\text{IR})(V_1)(\text{DF})$ where DF is the same as equation 9.

There is no filter blank subtraction when >0.5 g of ash are collected on the sample filter or thimble.

The total amount of particle-bound mercury (Hg_{p}) is then determined using Equation 6:

$$\text{Hg (particle)}, \mu\text{g} = (\text{Hg}_{\text{ash}})(W_{\text{ash}}) + \text{Hg}_{\text{pr}} \quad [\text{Eq. 6}]$$

where:

W_{ash} = the total mass of ash on filter, g

The concentration of particle-bound mercury ($\mu\text{g/dscm}$) in the gas stream is then determined using Equation 7:

$$\text{Hg}^{\text{p}}, \mu\text{g/dscm} = \text{Hg (particle)}/V_{\text{m(std)}} \quad [\text{Eq. 7}]$$

where:

$V_{\text{m(std)}}$ = is the total volume of dry gas sampled at standard (normal) conditions, dscm

15.1.2 *Case 2: Amount of Ash on the Filter is Less Than 0.5 g*—The calculation is the same as in Case 1 except the entire sample (ash and filter) is digested; therefore, DF in Equation 4 is defined only by the total digested volume. In addition a filter blank is subtracted as calculated in Equation 8.

$$\text{Hg}_{\text{fb}}, \mu\text{g} = (\text{IR})(V_2) \quad [\text{Eq. 8}]$$

where:

IR = instrument reading, $\mu\text{g/L}$

V_2 = total volume of sample filter blank digest, L

Equation 7 for Case 2 then becomes: $\text{Hg}(\text{particle}), \mu\text{g} = (\text{Hg}_{\text{ash}})(W_{\text{ash}}) - \text{Hg}_{\text{fb}} + \text{Hg}_{\text{pr}}$

15.2 Oxidized Mercury

15.2.1 *KCl Solution (Impingers 1–3)*—Calculate the concentration of mercury in $\mu\text{g/L}$ in the KCl impinger solutions using Equation 9:

$$\text{Hg}_{\text{KCl}}, \mu\text{g/L} = (\text{IR})(\text{DF}) \quad [\text{Eq. 9}]$$

where:

IR = instrument reading, $\mu\text{g/L}$

DF = dilution factor, $\frac{V_D + V(\text{H}_2\text{SO}_4) + V(\text{HNO}_3) + V(\text{KMnO}_4) + V(\text{K}_2\text{S}_2\text{O}_8) + V(\text{NH}_2\text{OH})}{V_D}$

V_D = total digested volume, 10 mL

$V(\text{H}_2\text{SO}_4)$ = volume of added concentrated H_2SO_4 , 0.5 mL

$V(\text{HNO}_3)$ = volume of added concentrated HNO_3 , 0.5 mL

$V(\text{KMnO}_4)$ = volume of added 5%^{W/V} KMnO_4 , 1.5 mL

$V(\text{K}_2\text{S}_2\text{O}_8)$ = volume of added 5%^{W/V} $\text{K}_2\text{S}_2\text{O}_8$, 0.75 mL

$V(\text{NH}_2\text{OH})$ = volume of added 10%^{W/V} hydroxylamine sulfate, 1.0 mL

The concentration of mercury in the KCl solution blank is calculated in the same way.

15.2.2 *Total Oxidized Mercury (Hg_O)*—is defined by method as the mercury measured in the KCl sample minus the mercury measured in the KCl solution blanks, as shown in Equation 10:

$$\text{Hg}_O, \mu\text{g} = (\text{Hg}_{\text{KCl}})(V_3) - (\text{Hg}_{\text{Ob}})(V_4) \quad [\text{Eq. 10}]$$

where:

Hg_{KCl} = Mercury concentration measured in KCl aliquot, $\mu\text{g/L}$

V_3 = Total volume of aqueous KCl from which sample aliquot was taken, L

Hg_{Ob} = Mercury concentration measured in KCl solution blank aliquot, $\mu\text{g/L}$

V_4 = Volume of aqueous KCl originally charged to the impingers, L

The concentration of Hg^{2+} ($\mu\text{g}/\text{dscm}$) in the gas stream is then determined using Equation 11:

$$\text{Hg}^{2+}, \mu\text{g}/\text{dscm} = \text{Hg}_0 / V_{\text{m(std)}} \quad [\text{Eq. 11}]$$

where:

$V_{\text{m(std)}}$ is the total volume of dry gas sampled at standard conditions, dscm

15.3 Elemental Mercury

15.3.1 *HNO₃-H₂O₂ Solution (Impinger 4)*—Calculate the concentration of mercury in $\mu\text{g}/\text{L}$ in the HNO_3 - H_2O_2 impinger solution using Equation 12:

$$\text{Hg}_{\text{H}_2\text{O}_2}, \mu\text{g}/\text{L} = (\text{IR})(\text{DF}) \quad [\text{Eq. 12}]$$

where:

IR = instrument reading, $\mu\text{g}/\text{L}$

DF = dilution factor, $\frac{V_{\text{D}} + \text{V}(\text{HCl}) + \text{V}(\text{H}_2\text{SO}_4) + \text{V}(\text{KMnO}_4) + \text{V}(\text{K}_2\text{S}_2\text{O}_8) + \text{V}(\text{NH}_2\text{OH})}{V_{\text{D}}}$

V_{D} = total digested volume, 5 mL

$\text{V}(\text{HCl})$ = volume of added concentrated HCl, 0.25 mL

$\text{V}(\text{H}_2\text{SO}_4)$ = volume of added concentrated H_2SO_4 , 0.5 mL

$\text{V}(\text{KMnO}_4)$ = volume of added saturated KMnO_4 , mL (volume need to turn sample to a purple color)

$\text{V}(\text{K}_2\text{S}_2\text{O}_8)$ = volume of added 5%^{W/V} $\text{K}_2\text{S}_2\text{O}_8$, 0.75 mL (if used)

$\text{V}(\text{NH}_2\text{OH})$ = volume of added 10%^{W/V} hydroxylamine sulfate, 1.0 mL

The concentration of mercury in the HNO_3 - H_2O_2 solution blank is calculated in the same way.

15.3.2 *H₂SO₄-KMnO₄ Solution (Impingers 5-7)*—Calculate the concentration of mercury in $\mu\text{g}/\text{L}$ in the H_2SO_4 - KMnO_4 impinger solutions using Equation 13:

$$\text{Mercury}, \mu\text{g}/\text{L} = (\text{IR})(\text{DF}) \quad [\text{Eq. 13}]$$

where:

DF = dilution factor, $\frac{V_{\text{D}} + \text{V}(\text{HNO}_3) + \text{V}(\text{K}_2\text{S}_2\text{O}_8) + \text{V}(\text{NH}_2\text{OH})}{V_{\text{D}}}$

IR = instrument reading, $\mu\text{g}/\text{L}$

V_{D} = total digested volume, 5 mL

$\text{V}(\text{HNO}_3)$ = volume of added concentrated HNO_3 , 0.5 mL

$\text{V}(\text{K}_2\text{S}_2\text{O}_8)$ = volume of added 5%^{W/V} $\text{K}_2\text{S}_2\text{O}_8$, 0.75 mL

The concentration of mercury in the H_2SO_4 - KMnO_4 solution blank is calculated in the same way.

15.3.3 *Total Elemental Mercury (Hg_E)*—is defined by method as the mercury measured in the H_2SO_4 - $KMnO_4$ impingers plus the mercury in the HNO_3 - H_2O_2 impingers minus the solution blanks as shown in Equation 14:

$$Hg_E, \mu g = (Hg_{H_2O_2})(V_4) - (Hg_{Eb1})(V_5) + (Hg_{KMnO_4})(V_6) - (Hg_{Eb2})(V_7) \quad [Eq. 14]$$

where:

- $Hg_{H_2O_2}$ = Mercury concentration measured in HNO_3 - H_2O_2 aliquot, $\mu g/L$
- V_4 = Total volume of aqueous HNO_3 - H_2O_2 from which sample aliquot was taken, L
- V_5 = Volume of aqueous HNO_3 - H_2O_2 originally charged to the impinger, L
- Hg_{Eb1} = Mercury concentration measured in HNO_3 - H_2O_2 solution blank aliquot, $\mu g/L$
- Hg_{KMnO_4} = Mercury concentration measured in H_2SO_4 - $KMnO_4$ aliquot, $\mu g/L$
- V_6 = Total volume of aqueous H_2SO_4 - $KMnO_4$ from which sample aliquot was taken, L
- V_7 = Volume of aqueous H_2SO_4 - $KMnO_4$ originally charged to the impingers, L
- Hg_{Eb2} = Mercury concentration measured in H_2SO_4 - $KMnO_4$ solution blank aliquot, $\mu g/L$

The concentration of Hg^{2+} ($\mu g/dscm$) in the gas stream is then determined using Equation 15:

$$Hg^0, \mu g/dscm = Hg_E/V_{m(std)} \quad [Eq. 15]$$

where:

$V_{m(std)}$ is the total volume of dry gas sampled at standard conditions, dscm

15.4 *Total Mercury*—Is defined by the method as the sum of the particulate bound mercury, oxidized mercury, and elemental mercury as shown in Equation 16:

$$Hg(\text{total}), \mu g/dscm = Hg^{\text{tp}} + Hg^{2+} + Hg^0 \quad [Eq. 16]$$

16. Precision and Bias

16.1 Precision

16.1.1 Formal evaluation of the Ontario Hydro method was completed with dynamic spiking of Hg^0 and $HgCl_2$ into a flue gas stream.⁹ The results are shown in Table 1. The relative standard deviation for gaseous elemental mercury and oxidized mercury was found to be less than 11% for mercury concentrations greater than $3 \mu g/Nm^3$ and less than 34% for mercury concentrations less than $3 \mu g/Nm^3$. In all cases, the laboratory bias for these tests based on a calculated correction factor was not statistically significant. These values were within the acceptable range, based on the criteria established in EPA Method 301 (% RSD less than 50%).

⁹ EPRI. "Evaluation of Flue Gas Mercury Speciation Methods," EPRI TR-108988, Electric Power Research Institute, Palo Alto, CA, Dec. 1997.

16.1.2 The precision of particle-bound, oxidized, and elemental mercury sampling method data is influenced by many factors: flue gas concentration, source, procedural, and equipment variables. Strict adherence to the method is necessary to reduce the effect of these variables. Failure to assure a leak-free system, failure to accurately calibrate all indicated system components, failure to select a proper sampling location, failure to thoroughly clean all glassware, and failure to follow prescribed sample recovery, preparation, and analysis procedures can seriously affect the precision of the results.

16.2 *Bias*

16.2.1 Gaseous mercury species in flue gases that are capable of interacting with fly ash particles collected in the front half of the sampling train can produce a positive particle-bound mercury bias.

16.2.2 Particle-bound mercury existing in the flue gas may vaporize after collection in the front half of the sampling train because of continued exposure to the flue gas sample stream and reduced pressures during the sampling period. Such vaporization would result in a negative particle-bound mercury bias.

Table 1

Results from Formal EPA Method 301 Evaluation Tests for the Ontario Hydro Method*

Ontario Hydro Method**	Total Vapor-Phase Mercury			Oxidized Mercury			Elemental Mercury		
	Mean, $\mu\text{g}/\text{Nm}^3$	Std. Dev.	RSD, %	Mean, $\mu\text{g}/\text{Nm}^3$	Std. Dev.	RSD, %	Mean, $\mu\text{g}/\text{Nm}^3$	Std. Dev.	RSD, %
Baseline	23.35	2.05	8.79	21.24	2.13	10.02	2.11	0.65	30.69
Hg ⁰ Spike (15.0 $\mu\text{g}/\text{Nm}^3$)	38.89	2.00	5.13	23.32	2.08	8.94	15.57	1.09	6.97
HgCl ₂ Spike (19.9 $\mu\text{g}/\text{Nm}^3$)	42.88	2.67	6.23	40.22	2.87	7.14	2.66	0.89	33.31

* For each mean result, there were 12 replicate samples (four quadrants)

** The correction factor in all cases was not statically significant and is not shown.

17. **Keywords**—Air toxics, mercury, sampling, speciation

DRAFT

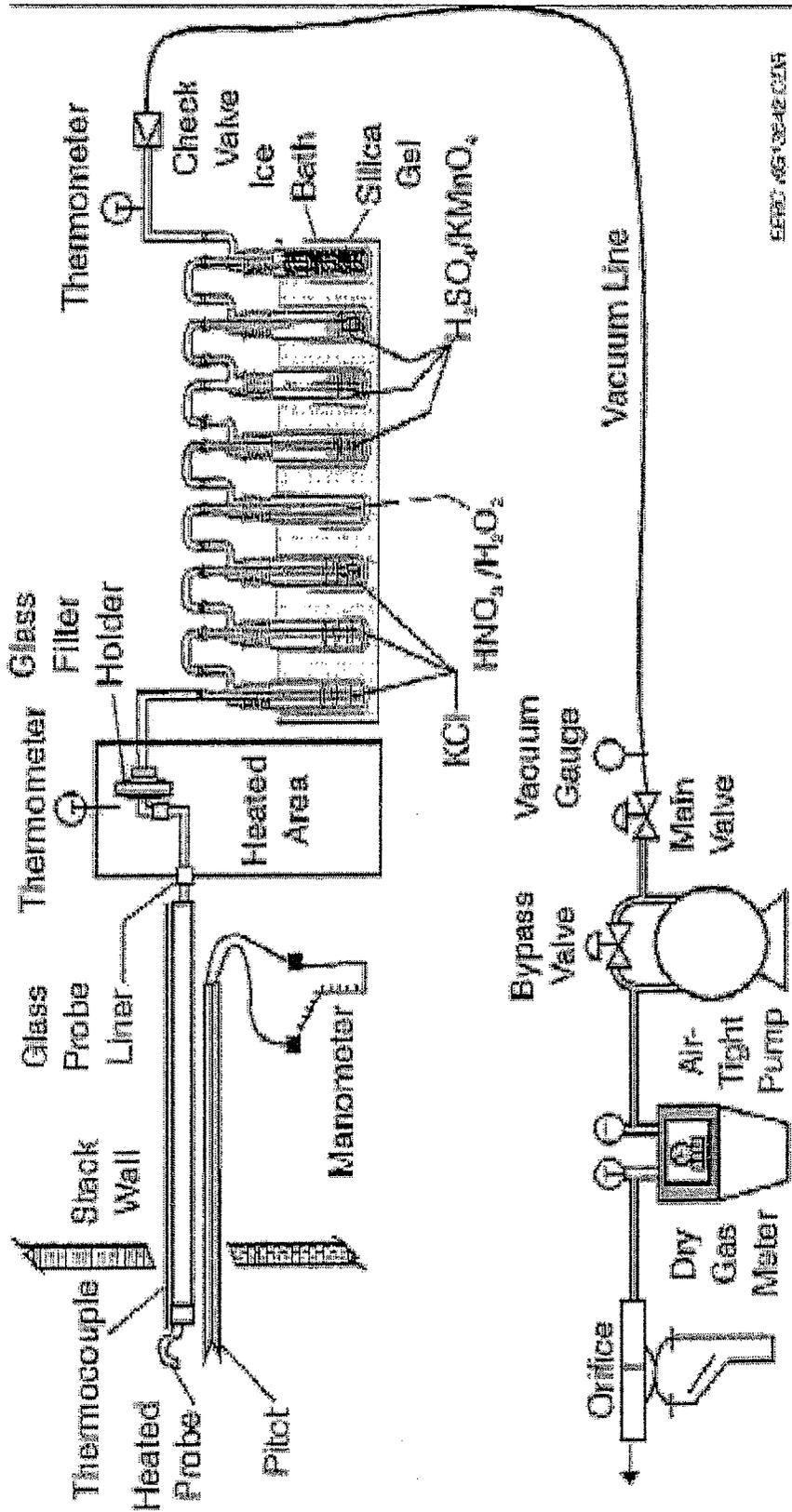


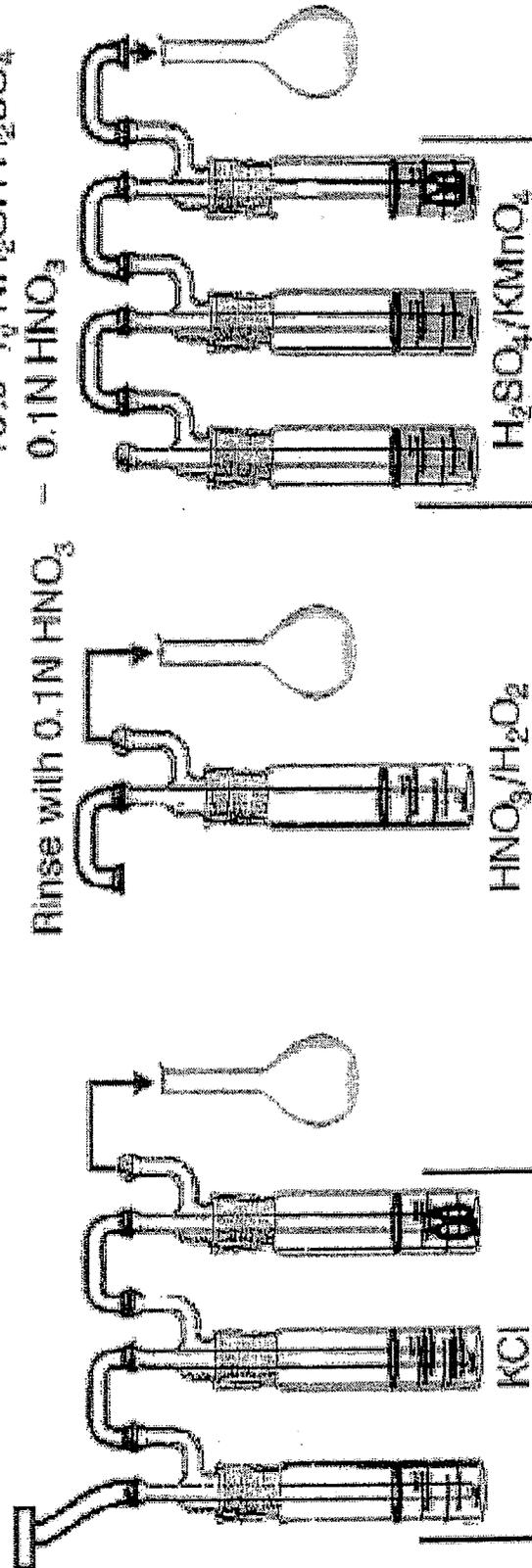
FIG. 1. Schematic of Mercury-Sampling Train in the Method 5 Configuration

DRAFT

1. Rinse filter holder and connector with 0.1N HNO_3 .
2. Add 5% $\frac{w}{v}$ KMnO_4 to each impinger bottle until purple color remains.
3. Rinse with 10% $\frac{w}{v}$ HNO_3 .
4. Rinse with a very small amount of 10% $\frac{w}{v}$ $\text{NH}_2\text{OH}\cdot\text{H}_2\text{SO}_4$ if brown residue remains.
5. Final rinse with 10% $\frac{w}{v}$ HNO_3 .

Rinse Bottles Sparingly with

- 0.1N HNO_3
- 10% $\frac{w}{v}$ $\text{NH}_2\text{OH}\cdot\text{H}_2\text{SO}_4$
- 0.1N HNO_3



Rinse All U-Tubes with 0.1N HNO_3

SEPC DL 10159.0014

FIG. 3. Sample Recovery Scheme for the Mercury-Impinger Train

BIBLIOGRAPHY OF EPA METHODS REFERENCED

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- (2) EPA Methods 6010, 6020, 7000, 7041, 7060, 7131, 7421, 7470, 7740, and 7841, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*. SW-846, Third Edition. September 1988. Office of Solid Waste and Emergency Response, U. S. Environmental Protection Agency, Washington, D.C. 20460.
- (3) EPA Methods 1 through 5, *Code of Federal Regulations*, Title 40, Part 60, Appendix A, July 1, 1991.
- (4) EPA Method 101A, *Code of Federal Regulations*, Title 40, Part 61, Appendix B, July 1, 1991.
- (5) EPA Method 29, *Emission Measurement Technical Information Center*, EMTIC TM-029, April 25, 1996.
- (6) U.S. Environmental Protection Agency "Method 301 - Field Validation of Pollutant Measurement Method from Various Waste Media," In *Code of Federal Regulations*, Title 40, Parts 61 to 80. Washington, DC, USA, Office of the Federal Register, Part 63, Appendix A, pp 324-331, July 1993.

USEPA REFERENCE METHOD 26A - HYDROGEN HALIDE AND HALOGEN EMISSIONS

Testing Equipment

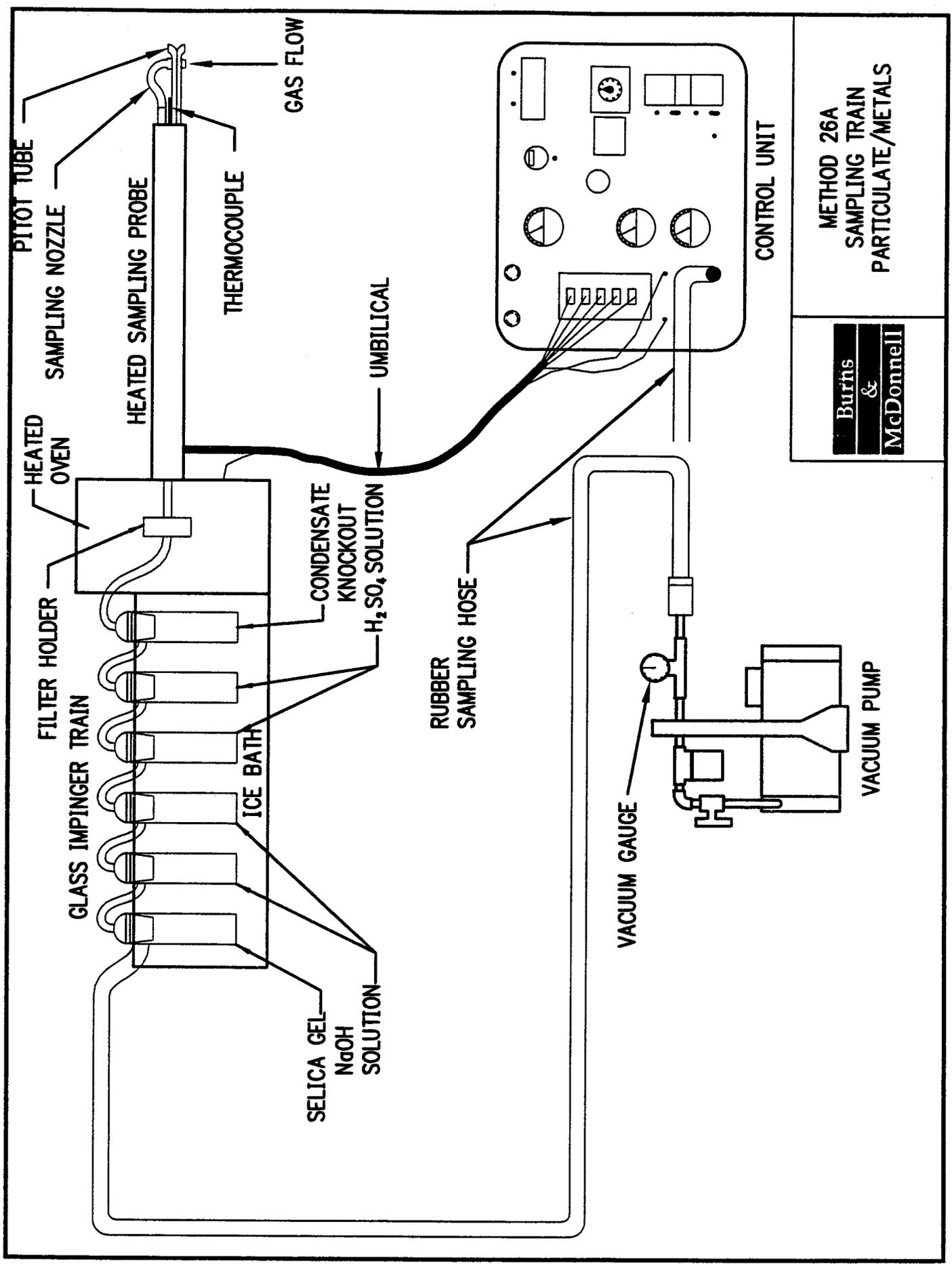
High-Volume Source Sampling Train. An Acurex Corp., arotherm high-volume stack sampler (Model HVSS-045) was used at the sampling location(s). The HVSS acids sampling train consisted basically of an effective length x one-inch diameter, glass-lined, stainless steel, probe sheath; a variable, heat-controlled filter oven with a calibrated Type K (chromel/alumel) thermocouple; a glass filter holder; a standard glass impinger assembly with a calibrated Type K (chromel/alumel) thermocouple located at the impinger outlet; a 3/4-hp, shaft-sealed, carbon vane vacuum pump assembly with a vacuum gauge; a control unit with an elapsed time indicator, a temperature selector switch, a temperature indicator (potentiometer), temperature controllers, calibrated magnehelic gauges, a calibrated dry gas meter, and a calibrated variable-diameter orifice; and umbilical and various interconnecting hoses, fittings, and valves. An appropriately sized, glass sampling nozzle, a calibrated Type K (chromel/alumel) temperature sensor, a static pressure tube, a calibrated S-type pitot tube, and a variable heat-controlled, glass liner with a calibrated Type K (chromel/alumel) thermocouple were integral parts of the probe assembly.

The vacuum pump unit was used to control gas sampling rates. The control unit was used to control probe and oven temperatures. The control unit was also used to monitor elapsed sampling times, temperatures, velocities, static pressure, gas sampling rates, and sampled gas volume.

Analyzer (Orsat). Flue gas concentrations were determined with a gas analyzer (orsat) which measure percent carbon dioxide and percent oxygen to the nearest tenth of a percent.

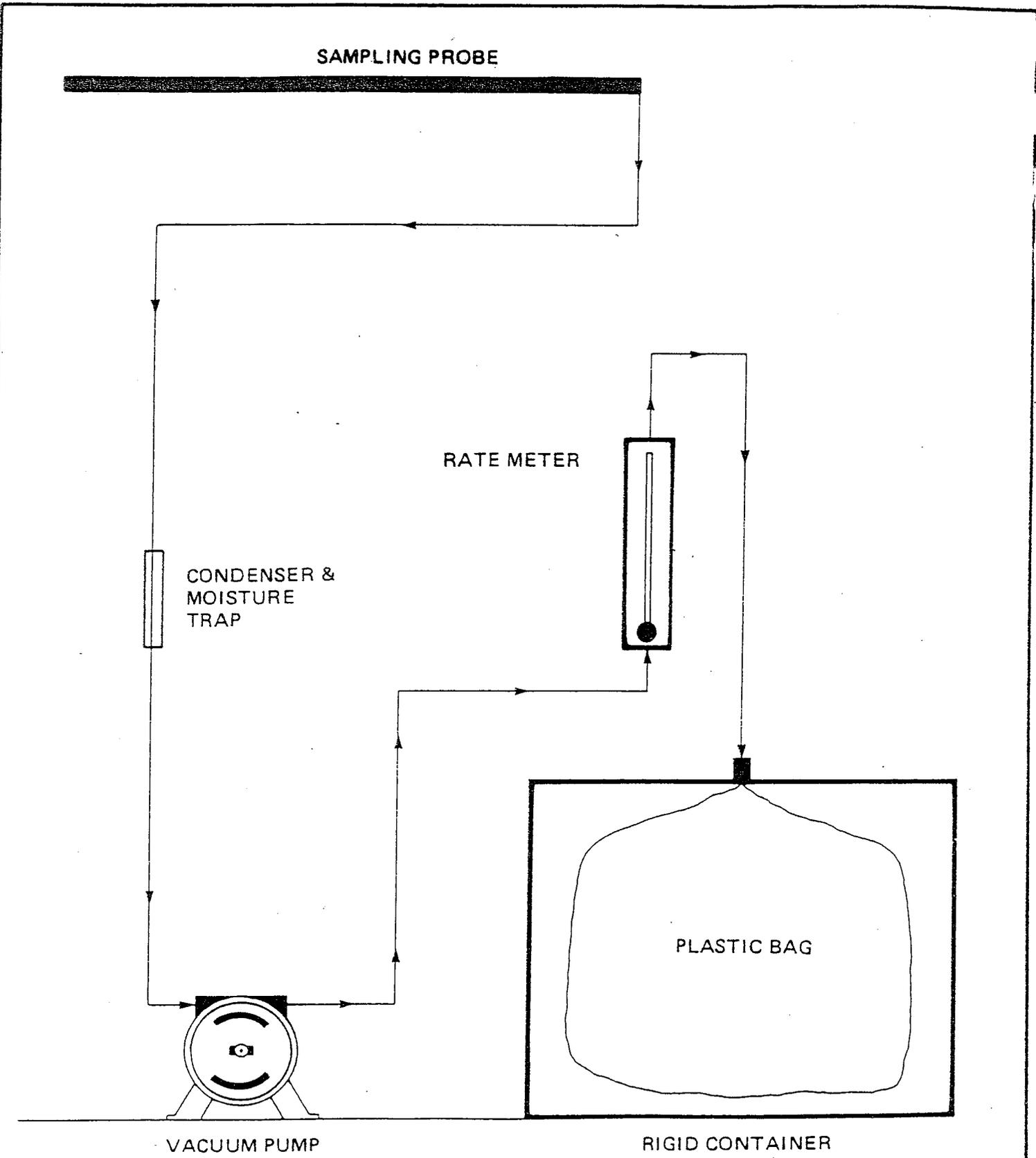
Programmable Calculator. A Texas Instruments Model TI-74 pocket computer was used to determine the isokinetic sampling rate at each sampling point.

Barometer. The barometric pressure (actual station pressure) was determined from a calibrated aneroid barometer located near the test site which read directly in inches of mercury to the nearest hundredth of an inch.



METHOD 26A
SAMPLING TRAIN
PARTICULATE/METALS

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USEPA REFERENCE METHOD 29 - PARTICULATE/METALS

Testing Equipment

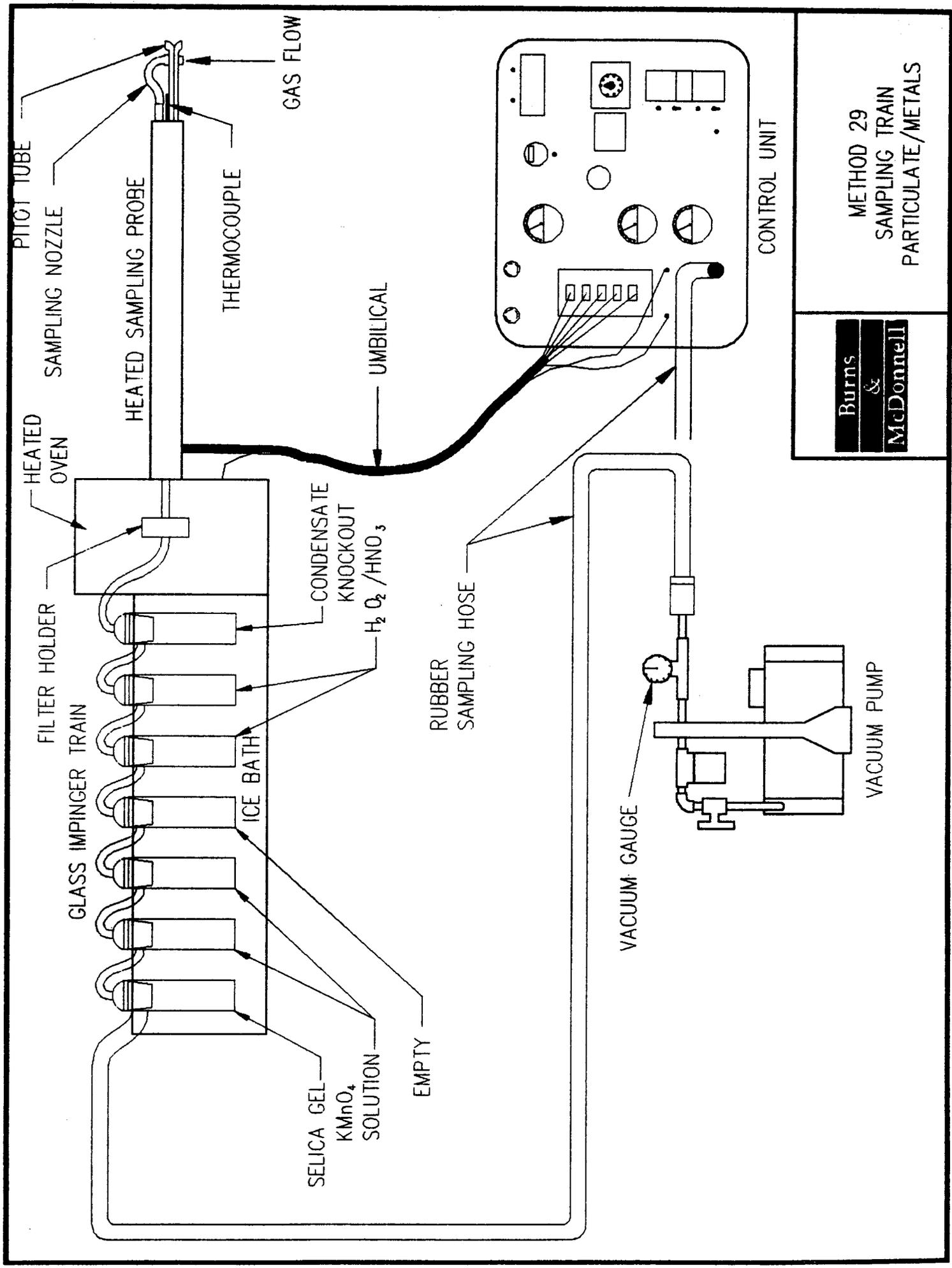
High-Volume Source Sampling Train. An Acurex Corp., aérotherm high-volume stack sampler (Model HVSS-045) was used at the sampling location(s). The HVSS particulate sampling train consisted basically of a ten (10)-foot effective length x one-inch diameter, teflon-lined, stainless steel, probe sheath; a variable, heat-controlled filter oven with a calibrated Type K (chromel/alumel) thermocouple; a glass filter holder; a standard glass impinger assembly with a calibrated Type K (chromel/alumel) thermocouple located at the impinger outlet; a 3/4-hp, shaft-sealed, carbon vane vacuum pump assembly with a vacuum gauge; a control unit with an elapsed time indicator, a temperature selector switch, a temperature indicator (potentiometer), temperature controllers, calibrated magnehelic gauges, a calibrated dry gas meter, and a calibrated variable-diameter orifice; and umbilical and various interconnecting hoses, fittings, and valves. An appropriately sized, glass sampling nozzle, a calibrated Type K (chromel/alumel) temperature sensor, a static pressure tube, a calibrated S-type pitot tube, and a variable heat-controlled, glass liner with a calibrated Type K (chromel/alumel) thermocouple are integral parts of the probe assembly.

The vacuum pump unit was used to control gas sampling rates. The control unit was used to control probe and oven temperatures. The control unit was also used to monitor elapsed sampling times, temperatures, velocities, static pressure, gas sampling rates, and sampled gas volume.

Analyzer (Orsat). Flue gas concentrations were determined with a gas analyzer (orsat) which measure percent carbon dioxide and percent oxygen to the nearest tenth of a percent.

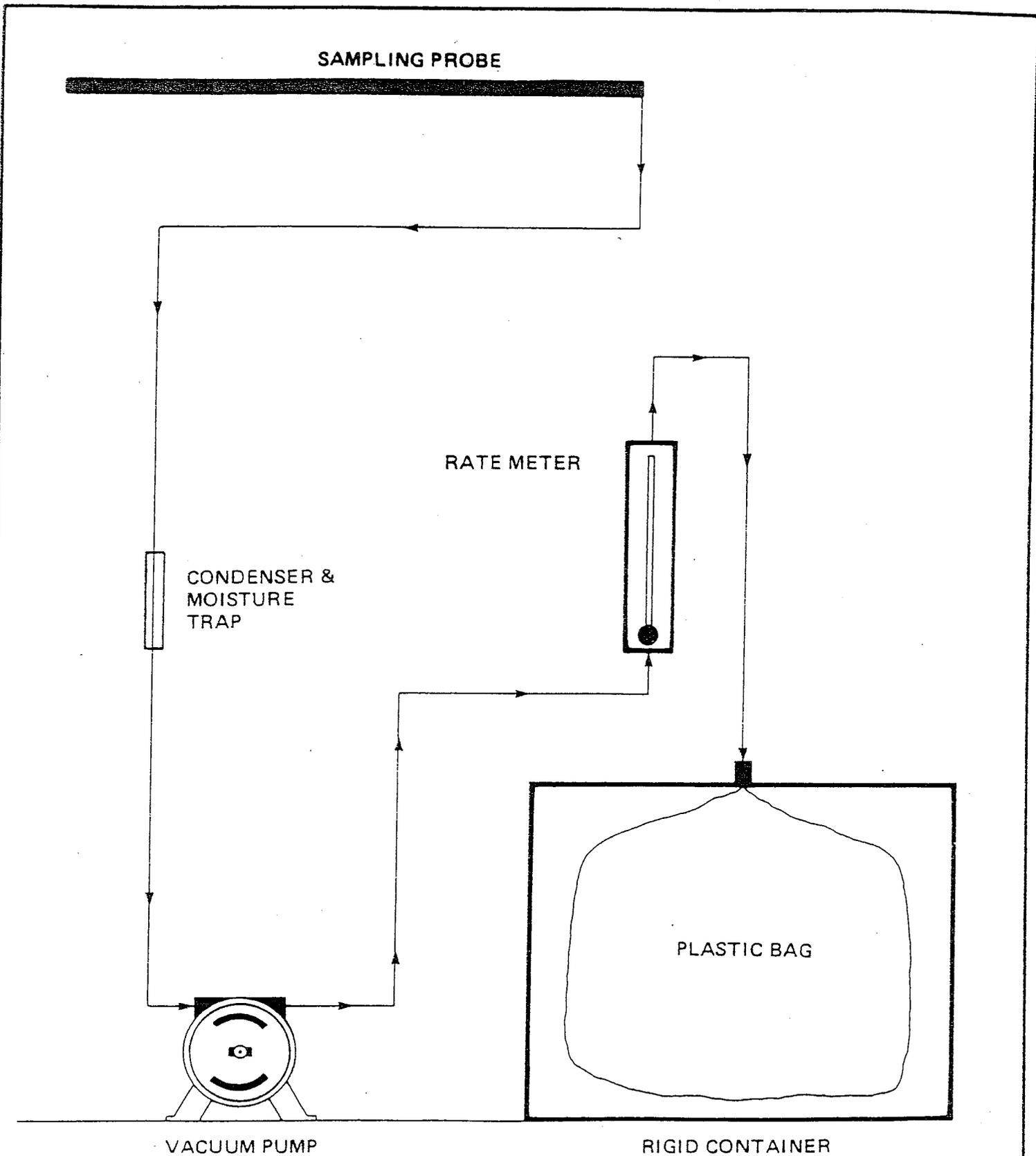
Programmable Calculator. A Texas Instruments Model TI-74 pocket computer was used to determine the isokinetic sampling rate at each sampling point.

Barometer. The barometric pressure (actual station pressure) was determined from a calibrated aneroid barometer located near the test site which read directly in inches of mercury to the nearest hundredth of an inch.



METHOD 29
 SAMPLING TRAIN
 PARTICULATE/METALS

Burns
 &
 McDonnell



Sampling Procedures

Prior to field testing, the following procedures were performed:

All instruments were checked and calibrated. Gelman Spectro Grade No. 64884, 142 millimeter, glass fiber-mat disc filters with a 99.9 percent retention of 0.3 micron particles were individually numbered, placed separately in similarly numbered glass petri dishes, oven-dried at 220°F for two to three hours, cooled in a desiccator for two hours, and individually weighed on a Sartorius analytical balance to the nearest 0.1 milligram, then weighed every six hours, minimum, until two consecutive weights within ± 0.5 milligram were obtained. Several 250 milliliter crucibles were desiccated for a minimum of 24 hours and weighed in the same manner as the filters and petri dishes. Also, several 200-gram quantities of Type 6-16 mesh indicating silica gel were weighed out on a Mettler top-loader balance and individually placed into separate airtight polypropylene storage bottles.

The number of sampling points and positions of the points in the flue at the sampling locations(s), and the sampling time at each point were determined prior to the particulate/metals testing. The sampling procedures were performed in accordance with the Environmental Protection Agency's Reference Method 29, as published in Title 40, *Code of Federal Regulations*, Part 60, Appendix A.

An HVSS sampling train was prepared in part at the sampling location(s), before each test run, in the following manner:

An appropriately sized sampling nozzle was installed onto the inlet of a sampling probe and capped. The probe was then dimensioned and marked with glass-cloth tape at increments that corresponded with the predetermined sampling point positions in the flue. A glass impinger assembly was prepared by the following procedures: The first glass impinger was left empty to collect the condensate from the particulate/metals sampling. The second and third glass impingers were prepared by adding 100 milliliters of an acidified hydrogen peroxide solution in each impinger. The fourth glass impinger was left empty in order not contaminate the acidified potassium permanganate solution with acidified hydrogen peroxide solution. The fifth and sixth glass impingers was prepared by adding 100 milliliters of the acidified potassium permanganate solution to each impinger. The seventh glass impinger was filled with 200 grams of Type 6-16 mesh indicating silica gel. This entire impinger assembly was then placed into an ice bath. A disc filter was removed from its petri dish and placed inside of a filter holder. The filter holder was then assembled to the sampling probe outlet and the impinger unit inlet. Next, an umbilical and sampling hoses were connected to the sampling probe, filter oven, impinger unit, a vacuum pump, and a control unit, accordingly. The probe and oven were then heated to and held at, temperatures between 223°F and 273°F. All magnehelic gauges were checked and zeroed. As soon as the probe and oven temperatures had stabilized, the entire sampling train assembly was leak-checked at 15 inches of mercury vacuum, minimum, for one minute and the leakage rate recorded. A leakage rate less than 0.02-cfm and no vacuum loss was considered acceptable. After the HVSS particulate/metals sampling

train had been assembled, the probe and oven heated, the entire system leak-checked, as previously described, the particulate/metals sampling was performed.

Prior to the particulate/metals sampling, a preliminary temperature and velocity traverse, orsat analysis, and calculations were performed to determine a correct nozzle and orifice size, and these factors were used in calculating the isokinetic sampling rate for each sample point. Knowing the actual pressure differential across the pitot tube used, the isokinetic sampling rate was calculated at each sample point using a Texas Instruments Model TI-74 pocket computer.

Four test runs were performed at the sampling location(s). A total of 12 points (4 points from each of the 3 sampling ports) were sampled in the flue of the stack. Each point was sampled for a period of 10 minutes at a calculated isokinetic sampling rate. The sampling data for each test run was recorded on a field test form during each of the sampling periods.

After the completion of a test run, the following procedures were performed:

A final leak-check was performed at 15 inches of mercury vacuum, minimum, for one minute and the leakage rate recorded. The sampling nozzle, sampling probe, filter holder, and impinger train were capped and taken to a clean area for sample recovery. At the recovery area, the disc filter was carefully removed from the filter holder and transferred to its petri dish for later desiccating, weighing, and analyzing. The sampling nozzle, probe, and front half of the filter holder were washed with nanograde acetone. The acetone washing and a 100 milliliter acetone blank were collected in appropriately labeled glass sample bottles and retained for later evaporation, desiccating, and weighing. The sampling nozzle, sampling probe, and the front half of

the filter holder were then rinsed thoroughly with 100 milliliters of the 0.1 N nitric acid solution and collected in an appropriately labeled glass sample bottle for later analyzing. The back half of the sample train was recovered by measuring the liquid in impinger #1 - #3, and recording the volume. This information is required to evaluate the moisture content of the sampled flue gas. The back half of the filter holder, connecting glassware and impinger #1 - #3 were rinsed with 100 milliliters of the 0.1 N nitric acid solution and collected in an appropriately labeled glass sample bottle. The content of impinger #4 (if any) was measured and recorded, then rinsed with 100 milliliters of the 0.1 N nitric acid solution and collected in an appropriately labeled glass sample bottle. The contents of impingers #5 and #6 were measured and recorded. These impingers were then rinsed out with 100 milliliters of fresh acidified potassium permanganate solutions and then rinsed with 100 milliliters of water and collected in an appropriately labeled glass sample bottle. The moisture laden silica gel in the seventh impinger was transferred to an appropriately marked, airtight polypropylene storage bottle and retained for later weighing. The weight gain of the silica gel moisture collection was added to the measured moisture condensed during the test run to determine the total moisture collected for that run.

Flue gas concentrations (percent CO₂ and percent O₂) were determined by taking, throughout each test run, by an integrated gas sampling train several orsat samples of the gas collected, simultaneously, with the particulate sampling. The integrated gas sample was collected from the discharge of the particulate control unit. The sampling train was set at a predetermined constant flow rate to obtain an adequate sample. The concentrations for each test run were recorded on a field test form.

Analytical Procedures

After the field testing was completed, the following procedures were performed:

The silica gel, disc filters, petri dishes, acetone washings, and acetone blank(s) from the test runs were analyzed by Burns & McDonnell Engineering Company, Inc., Kansas City, Missouri. The analytical procedures were performed in accordance with the Environmental Protection Agency's Reference Method 29, as published in the Title 40, *Code of Federal Regulations*, Part 60, Appendix A.

Each silica gel moisture collection was weighed directly out of its polypropylene storage bottle on a Mettler top-loader balance with a sensitivity of 0.1 gram. Each disc filter and petri dish was oven-dried at 220°F for two to three hours, cooled in a desiccator for two hours before weighing, and weighed every six hours, minimum, until two consecutive weights within ± 0.5 milligram were obtained. Each acetone washing and acetone blank was transferred from its sample bottle to a preweighed crucible for evaporation. When the acetone in a crucible had completely evaporated, the crucible was transferred to a desiccator for further drying at room temperature for a minimum of 24 hours before weighing, and weighed every six hours, minimum, until two consecutive weights within ± 0.5 milligram were obtained. Each acetone blank collected was used to determine the amount of residual weight each crucible retained due to acetone impurities. Each disc filter, petri dish, acetone washing, and acetone blank was individually weighed on a Sartorius analytical balance with a sensitivity of 0.1 milligrams.

The particulate residue in the glass crucibles were then solubilized with 10 milliliters of nitric acid and added to the probe rinse sample bottle.

All samples were packaged and delivered to Pace Laboratories for the metals analysis.

* * * * *

PART V
APPENDICES

APPENDIX A
EPA FORMULAS

NOMENCLATURE

acf	= actual cubic feet	P_f	= static pressure in flue in inches water, average
acfm	= actual cubic feet per minute	$\sqrt{\Delta P}$	= square root of velocity head in inches water, average
A	= effective area of flue in square feet	%S	= percent sulfur by weight, dry basis
acm	= actual cubic meters	scf	= standard cubic feet
acmm	= actual cubic meters per minute	scm	= standard cubic meters
A_n	= inside area of sampling nozzle in square feet	T_{std}	= absolute temperature of air in degrees Rankine at standard conditions (528 degrees)
B_{ws}	= water vapor in gas stream, proportion by volume	T_s	= absolute temperature of flue gas in degrees Rankine, average
%C	= percent carbon by weight, dry basis	T_m	= absolute temperature at meter in degrees Rankine, average
%CO	= percent carbon monoxide by volume, dry basis	V_s	= velocity of flue gas in feet (meters) per second
%CO ₂	= percent carbon dioxide by volume, dry basis	V_l	= volume of condensate through the impingers in milliliters
C_p	= pitot tube coefficient	V_{lc}	= volume of liquid collected in condenser in milliliters plus weight of liquid absorbed in silica gel in grams indicated as milliliters
D_l	= dust loading per heat input in pounds (grams) per million Btu (calories) per Fr constant	V_m	= volume of metered gas measured at meter conditions in cubic feet
D_l'	= dust loading per heat input in pounds (grams) per million Btu (calories) per Fr calculated	V_{ms}	= volume of metered gas corrected to dry standard conditions in cubic feet (meters)
dscf	= dry standard cubic feet	V_o	= volume of flue gas at actual conditions in cubic feet (meters) per minute
dscfh	= dry standard cubic feet per hour	Q_{sd}	= volume of flue gas corrected to dry standard conditions in cubic feet (meters) per hour
dscm	= dry standard cubic meters	V_t	= total volume of flue gas sampled at actual conditions in cubic feet (meters)
dscmh	= dry standard cubic meters per hour	V_w	= volume of water vapor in metered gas corrected to standard conditions in cubic feet (meters)
fps	= feet per second	V_{wc}	= volume of water condensed in impingers corrected to standard conditions
F_r	= ratio factor of dry flue gas volume to heat value of combusted fuel in dry standard cubic feet (meters) per million Btu (calories)	V_{wsg}	= volume of water collected in silica gel corrected to standard conditions
gms	= grams	W_a	= total weight of dust collected per unit volume in grains (grams) per actual cubic feet (meters)
gm-mole	= gram-mole	W_d	= total weight of dust collected per unit volume in pounds (grams) per dry standard cubic feet (meters)
grs	= grains	W_g	= total weight of dust collected in grams
ΔH	= orifice pressure drop in inches water, average	W_h	= total weight of dust collected per unit volume in pounds (grams) per hour, dry basis
%H	= percent hydrogen by weight, dry basis	W_p	= total weight of dust collected in pounds
H_c	= heat of combustion in Btu per pound, dry basis	W_s	= total weight of dust collected per unit volume in grains (grams) per dry standard cubic feet (meters)
hr	= hour	W_{sg}	= impinger silica gel weight gain in grams
%I	= percent isokinetic	Y	= metered gas volume correction factor
in. Hg	= inches mercury	Θ	= total elapsed sampling time in minutes
lbs	= pounds		
lb-mole	= pound-mole		
%M	= percent moisture by volume		
mmBtu	= million Btu		
mmcal	= million calories		
mm Hg	= millimeters mercury		
mps	= meters per second		
M_s	= molecular weight in pound (gram) per pound (gram) mole (wet basis)		
%N	= percent nitrogen by weight, dry basis		
%N ₂	= percent nitrogen by difference, dry basis		
%O	= percent oxygen by difference, dry basis		
%O ₂	= percent oxygen by volume, dry basis		
P_b	= barometric pressure in inches mercury		
P_{std}	= standard absolute pressure (29.92 in Hg)		
P_s	= absolute pressure in flue in inches (millimeters) mercury		

(1) ABSOLUTE FLUE PRESSURE (in. Hg)

$$P_s = (\pm P_f \div 13.6) + P_b$$

(2) WATER VAPOR VOLUME IN METERED GAS CORRECTED TO STANDARD CONDITIONS (scf)

$$V_{wc} = .04707 \times V_l \quad V_{wsg} = .04715 \times W_{sg}$$

$$V_w = V_{wc} + V_{wsg}$$

(3) METERED GAS VOLUME CORRECTED TO STANDARD CONDITIONS (scf)

$$V_{ms} = 17.64 \times Y \times V_m \frac{P_b + (\Delta H/13.6)}{T_m}$$

(4) PERCENT MOISTURE IN FLUE GAS

$$B_{ws} = \frac{V_w}{(V_{ms} + V_w)} \quad \%M = B_{ws} \times 100$$

(5) AVERAGE RESULTS OF FLUE GAS ANALYSIS

$$\%N_2 \text{ dry} = 100 - (\%CO_2 + \%O_2 + \%CO)$$

(6) APPROXIMATE MOLECULAR WEIGHT OF FLUE GAS (WET BASIS) (lb/lb-mole)

$$M_s = (18 \times B_{ws}) + \left((.440 (\%CO_2) + .320 (\%O_2) + .280 (\%N_2 + \%CO)) \right) \times (1 - B_{ws})$$

(7) GAS VELOCITY IN FLUE (fps)

$$V_s = 85.49 \times C_p \times (\sqrt{\Delta P}) \text{ avg.} \quad \sqrt{\frac{T_s}{P_s \times M_s}}$$

(8) FLUE GAS VOLUME AT ACTUAL CONDITIONS (acfm)

$$V_o = V_s \times A \times 60$$

(9) FLUE GAS VOLUME CORRECTED TO DRY STANDARD CONDITIONS (dscfh)

$$Q_{sd} = \frac{T_{std}}{29.92} \times \frac{P_s}{T_s} \times V_o \times (1 - B_{ws}) \times 60$$

(10) TOTAL FLUE GAS VOLUME SAMPLED AT ACTUAL CONDITIONS (acf)

$$V_t = \left[V_m \times Y \times \frac{T_s}{T_m} \times \left(\frac{P_b + (\Delta H/13.6)}{P_s} \right) \right] + \left(0.00267 \times V_{lc} \times \frac{T_s}{P_s} \right)$$

EMISSION RATE FORMULAS (lb/mmBtu)

NO_x - CO₂ Basis

$$((\text{NO}_x(\text{ppm}) \times \text{MW}) / (3.853 \times 10^8)) \times F \times (100 / \text{CO}_2(\text{percent})) = \text{NO}_x(\text{lb/mmBtu})$$

1 2 3 4 5 6

NO_x - O₂ Basis

$$((\text{NO}_x(\text{ppm}) \times \text{MW}) / (3.853 \times 10^8)) \times F \times (20.9 / (20.9 - \text{O}_2(\text{percent}))) = \text{NO}_x(\text{lb/mmBtu})$$

1 2 3 4 7 6

SO₂ - CO₂ Basis

$$((\text{SO}_2(\text{ppm}) \times \text{MW}) / (3.853 \times 10^8)) \times F \times (100 / \text{CO}_2(\text{percent})) = \text{SO}_2(\text{lb/mmBtu})$$

1 2 3 4 5 6

SO₂ - O₂ Basis

$$((\text{SO}_2(\text{ppm}) \times \text{MW}) / (3.853 \times 10^8)) \times F \times (20.9 / (20.9 - \text{O}_2(\text{percent}))) = \text{SO}_2(\text{lb/mmBtu})$$

1 2 3 4 7 6

- 1 Pollutant value in parts per million - from monitor
- 2 Molecular weight - periodic chart
- 3 Constant - Method 19 Code of Federal Regulations - derived from volume of lb-mol of ideal gas @ standard conditions x 1,000,000
- 4 F Factor - Table 19-1 Code of Federal Regulations, Method 19
- 5 Carbon dioxide value in percent - from monitor
- 6 Pollutant value calculated in pounds per million Btu
- 7 Oxygen value in percent - from monitor

APPENDIX B
TEST DATA SHEETS

Particulate Field Data Sheet

060293 Form AQD-(T-S)-5



Client: **Hg AMEREN** Date: **8/24/04** Page **1** Of **2**

Project No. **37314** Operator: **N. Linhardt**

Sampling Location: **Inlet Duct** Run No. **1**

Filter No. _____ Acetone No. _____ Condensate: **226.9**

Barometric Pressure: **29.5** Static Pressure: **-13.0** Probe Number: _____

Nozzle Diameter: **.248** Nozzle Number: **Q-250** Pitot Coefficient: **.84** Pitot Number: **X**

Meter Corr. Factor: **1.009** Meter-Orifice: **664.1**

Orsat Analysis: CO₂ **15.1** +O₂ _____ O₂ **3.8** CO _____

Sample Pt. Time: **120 min** Assumed % Moisture: **9%** Leak Test: Before **.009 @ 15 psi** After **.008 @ 14 psi**

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 0930											
A1	.70	.837	2.59	329	264	39		79	79	5	845.48
2	.80	.894	2.97	329	265	40		81	81	6	853.06
3	.60	.775	2.22	328	259	40		82	80	6	859.62
4	.43	.656	1.60	324	264	42		83	82	6	865.192
B1											
1	.65	.806	2.38	338	265	43		83	83	6	871.98
2	.75	.866	2.74	339	263	44		85	85	6	879.26
3	.80	.894	2.97	340	262	46		86	85	7	885.77
4	.90	.949	3.10	334	262	47		87	86	7	891.11
C1											
1	.60	.775	2.19	340	259	48		87	87	7	897.62
2	.70	.837	2.56	340	262	49		89	88	8	904.65
3	.55	.742	2.00	342	261	50		90	89	8	910.87
4	.40	.632	1.45	339	260	52		91	90	9	916.190
Stop @ 1142											
		.769	2.20	335.2				84.9			77.788

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Client		Date 8/29/04	Page 1 Of 2								
Project No.	Operator N. Linhardt		Orsat Analysis <table style="width:100%; border: none;"> <tr> <td style="width:25%;">CO₂</td> <td style="width:25%;">+O₂</td> <td style="width:25%;">O₂</td> <td style="width:25%;">CO</td> </tr> <tr> <td style="text-align: center;">15.3</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">3.6</td> <td style="text-align: center;">_____</td> </tr> </table>	CO ₂	+O ₂	O ₂	CO	15.3	_____	3.6	_____
CO ₂	+O ₂	O ₂		CO							
15.3	_____	3.6		_____							
Sampling Location Inlet Duct	Run No. 3										
Filter No.	Acetone No.	Condensate									
Barometric Pressure 29.5	Static Pressure -13	Probe Number									
Nozzle Diameter .248	Nozzle Number A-250	Pitot Coefficient .84	Pitot Number X								
Meter Corr. Factor 1.009	Meter-Orifice 664.1										
Sample Pt. Time 120 min	Assumed % Moisture 9	Leak Test	Before 009615ps After 00965								

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 1605											994.201
A1	.65	.806	2.36	332	262	40		74	74	4	1000.96
2	.75	.866	2.74	330	260	40		73	72	4	1008.23
3	.60	.775	2.19	329	259	41		73	72	4	1014.74
4	.44	.663	1.60	327	262	41		74	73	5	1020.324
B1	.70	.837	2.55	331	259	42		76	74	5	1027.34
2	.75	.866	2.74	330	262	43		76	74	6	1034.61
3	.60	.775	2.19	329	261	44		76	73	6	1041.12
4	.42	.648	1.53	326	258	45		77	75	7	1046.579
C1	.65	.806	2.37	330	251	46		76	75	7	1053.35
2	.70	.837	2.55	330	254	47		76	74	8	1060.38
3	.55	.742	2.00	328	255	48		74	73	8	1066.61
4	.41	.640	1.50	325	257	48		75	74	9	1072.007
Stop @											
		.772	2.19	328.9				74.3			77.806

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

060293 Form AQD-(T-S)-5



Client AMEREN			Date 8/2/04	Page 1 of 2
Project No. 37314		Operator K. ANTONIA		
Sampling Location OUTLET "24"			Run No. 2	
Filter No.	Acetone No.	Condensate 114.2		
Barometric Pressure 29.5		Static Pressure -12	Probe Number	
Nozzle Diameter .250	Nozzle Number 0.250	Pitot Coefficient .83	Pitot Number R	
Meter Corr. Factor .998		Meter-Orifice 663.1		

Orsat Analysis			
CO ₂	+O ₂	O ₂	CO
15.1		4.0	

Sample Pt. Time 10	Assumed % Moisture 10	Leak Test	Before .007 @ .12	After .006 @ .12
---------------------------	------------------------------	-----------	--------------------------	-------------------------

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 1230											
A 1	.7	.837	3.06	333	250	47		95	95	3	127.58
2	.65	.806	2.84	333	249	47		95	96	3	134.55
3	.55	.742	2.39	334	249	46		96	96	3	130.9
4	.5	.707	2.17	335	249	48		96	96	3	147.0
B											
1	.65	.806	2.83	336	250	49		96	97	3	153.9
2	.6	.775	2.6	336	250	50		96	97	3	160.58
3	.55	.742	2.38	336	250	51		97	97	3	166.98
4	.5	.707	2.16	337	249	50		97	97	3	173.1
C											
1	.6	.775	2.6	336	249	49		97	97	3	179.7
2	.6	.775	2.6	336	249	49		97	97	3	186.38
3	.55	.742	2.38	336	250	49		98	97	3	192.78
4	.5	.707	2.16	336	251	50		98	99	3	198.88
Stop @ 1435											
	.760	.872	3.35	335.3				96.6			78.53

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Burns
&
McDonnell

Client AMERON				Date 8/24/64		Page 1 Of 2	
Project No. 37314		Operator K. MCKENNA				Orsat Analysis CO ₂ +O ₂ O ₂ CO 15.0 _____ 4.1 _____	
Sampling Location OUTLET "B"			Run No. 3				
Filter No.	Acetone No.	Condensate					
Barometric Pressure 29.5	Static Pressure -12	Probe Number					
Nozzle Diameter .250	Nozzle Number 0.250	Pitot Coefficient .83	Pitot Number R				
Meter Corr. Factor .998	Meter-Orifice 663.1						
Sample Pt. Time 10	Assumed % Moisture 10		Leak Test Before .04 @ 15 After .007 @ 12				

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 1553											197.2
A 1	.65	.806	2.84	317	247	46		82	82	3	204.17
2	.65	.806	2.83	319	250	47		82	83	3	211.18
3	.6	.775	2.59	324	250	47		82	83	3	217.8
4	.55	.742	2.37	324	249	49		83	83	3	224.18
B 1	.7	.837	3.02	326	250	48		84	84	3	231.37
2	.65	.806	2.8	326	250	49		84	84	3	238.3
3	.65	.806	2.8	326	250	47		84	84	3	245.23
4	.55	.742	2.36	326	247	50		84	84	3	251.6
C 1	.7	.837	3.02	326	249	50		84	84	3	258.79
2	.65	.806	2.81	324	248	49		85	85	3	265.73
3	.65	.806	2.81	323	249	49		85	84	3	272.67
4	.55	.742	2.37	323	251	50		85	84	3	279.1
	.792	2.72	323.7					83.7			81.9

Pitot Tube Leak Check: Before After
 Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Burns
&
McDonnell

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Client				Date	8/25/04	Page	1	Of	2
Project No.		Operator			Orsat Analysis CO ₂ +O ₂ O ₂ CO 14.2 4.8 _____ _____ _____ _____				
Sampling Location			Run No.						
Filter No.		Acetone No.	Condensate						
Barometric Pressure		Static Pressure	Probe Number						
Nozzle Diameter	Nozzle Number	Pitot Coefficient	Pitot Number						
Meter Corr. Factor		Meter-Orifice							

Sample Pt. Time	120 min	Assumed % Moisture	9%	Leak Test	Before	0.11 @ 15psi	After	0.10 @ 14psi
-----------------	---------	--------------------	----	-----------	--------	--------------	-------	--------------

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start	0.95	0.97									072.54
A1	.75	.866	2.76	330	264	40	255	79	79	3	79.84
2	.80	.894	2.93	329	262	40	261	78	77	3	87.38
3	.60	.775	2.20	329	260	41	263	80	79	3	99.92
4	.46	.678	1.69	326	259	42	263	80	79	3	105.656
B1	.75	.866	2.75	331	263	43	266	80	79	3	112.95
2	.75	.866	2.75	332	262	44	267	81	80	3	120.24
3	.55	.742	2.00	335	264	45	265	81	80	4	126.47
4	.45	.671	1.64	332	263	45	263	82	81	4	132.121
C1	.70	.837	2.56	333	262	46	264	83	82	5	139.16
2	.70	.837	2.56	334	260	47	266	83	82	5	146.20
3	.50	.707	1.82	335	259	47	262	83	83	6	152.14
4	.42	.648	1.53	331	262	48	263	84	83	6	157.603
Stop											
		.782	2.27	331.4					80.8		85.063

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Client				Date	8/25/04		Page	1 Of 2									
Project No.			Operator			Orsat Analysis <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">CO₂</td> <td style="width:25%;">+O₂</td> <td style="width:25%;">O₂</td> <td style="width:25%;">CO</td> </tr> <tr> <td style="text-align: center;">14.3</td> <td></td> <td style="text-align: center;">4.7</td> <td></td> </tr> </table>				CO ₂	+O ₂	O ₂	CO	14.3		4.7	
CO ₂	+O ₂	O ₂	CO														
14.3		4.7															
Sampling Location				Run No.													
Filter No.		Acetone No.		Condensate													
Barometric Pressure			Static Pressure		Probe Number												
Nozzle Diameter		Nozzle Number		Pitot Coefficient		Pitot Number											
Meter Corr. Factor			Meter-Orifice														
Sample Pt. Time			Assumed % Moisture			Leak Test		Before		After							

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
5494	1124										157.891
A1	.70	.837	2.58	333	262	40	264	84	83	2	169.96
2	.75	.866	2.77	333	260	41	263	83	83	2	172.27
3	.55	.742	2.02	334	259	41	261	85	84	2	178.53
4	.42	.648	1.55	330	261	42	263	86	85	3	184.017
B1	.70	.837	2.58	332	259	42	262	88	87	4	191.09
2	.70	.837	2.58	332	260	43	264	89	88	5	198.16
3	.60	.775	2.21	331	259	44	262	89	88	5	204.71
4	.44	.663	1.63	327	261	44	264	90	89	6	210.337
C1	.70	.837	2.58	332	260	45	263	91	90	6	217.41
2	.75	.866	2.77	333	259	46	262	91	91	7	224.72
3	.55	.742	2.02	334	258	47	265	92	91	7	230.98
4	.42	.648	1.55	330	259	47	263	92	92	8	236.467
Stop											
		.775	2.24	331.8					88.0		78.576

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Client AMEREN				Date 8/25/04	Page 1 Of 2
Project No. 373M		Operator K. McKenna		Orsat Analysis CO ₂ +O ₂ O ₂ CO <hr/> 13.8 _____ 5.1 _____ <hr/> _____ <hr/> _____ <hr/> _____ <hr/> _____	
Sampling Location OUTLET "2"			Run No. 1		
Filter No.	Acetone No.	Condensate			
Barometric Pressure 29.6		Static Pressure -12	Probe Number		
Nozzle Diameter .250	Nozzle Number 0-250	Pitot Coefficient .83	Pitot Number R		
Meter Corr. Factor .998		Meter-Orifice 663.1			
Sample Pt. Time 10	Assumed % Moisture 10	Leak Test		Before 1007 @ 10	After 1008 @ 11

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
<i>Start @ 0850</i>											
A 1	.7	.837	3.04	325	251	47	253	85	83	3	288.10
2	.65	.806	2.82	325	250	47	250	85	83	3	295.05
3	.6	.775	2.59	326	248	48	251	86	84	3	301.72
4	.6	.775	2.59	327	250	48	250	86	85	3	308.39
<i>3.03</i>											
B 1	.7	.837	3.03	328	249	48	250	87	87	3	315.59
2	.65	.806	2.81	328	251	47	253	87	87	3	322.5
3	.6	.775	2.58	329	249	48	251	88	88	3	329.15
4	.6	.775	2.58	331	250	49	250	89	89	3	335.8
<i>C</i>											
1	.7	.837	3.02	330	251	50	253	90	89	3	342.9
2	.65	.806	2.80	331	249	51	252	91	89	3	349.82
3	.65	.806	2.80	331	250	51	250	91	90	3	356.74
4	.6	.775	2.58	331	251	51	249	91	90	3	363.38
<i>Stop @ 1055</i>											
		.801	2.77	328.4				86.8			82.48

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Client AMERON			Date 8/25/04	Page 1 Of 2								
Project No. 37314		Operator K. McKEOWN		Orsat Analysis <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">CO₂</td> <td style="width:25%;">+O₂</td> <td style="width:25%;">O₂</td> <td style="width:25%;">CO</td> </tr> <tr> <td style="text-align: center;">13.8</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">5.0</td> <td style="text-align: center;">_____</td> </tr> </table>	CO ₂	+O ₂	O ₂	CO	13.8	_____	5.0	_____
CO ₂	+O ₂	O ₂	CO									
13.8	_____	5.0	_____									
Sampling Location OUTLET "2"			Run No. 2									
Filter No.	Acetone No.	Condensate										
Barometric Pressure 29.6		Static Pressure -12	Probe Number									
Nozzle Diameter .250	Nozzle Number 0-250	Pitot Coefficient .83	Pitot Number R									
Meter Corr. Factor .998	Meter-Orifice 663.1											
Sample Pt. Time 10	Assumed % Moisture 10	Leak Test Before .004 @ 12 After _____										

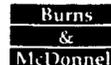
Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 1124											
A 1	.7	.837	3.02	331	250	46	251	87	87	3	364.1
2	.65	.806	2.80	331	251	47	249	88	88	3	378.2
3	.65	.806	2.79	332	249	48	251	89	89	3	385.12
4	.55	.742	2.36	332	251	47	250	90	89	3	391.48
B											
1	.7	.837	3.01	333	250	47	251	90	90	3	398.65
2	.65	.806	2.79	333	249	47	250	90	90	3	405.56
3	.6	.775	2.57	333	249	48	251	90	90	3	412.2
4	.6	.775	2.57	333	251	49	250	90	90	3	418.84
C											
1	.7	.837	3.00	334	249	50	250	90	91	3	426.
2	.65	.806	2.79	334	251	50	251	90	91	3	432.90
3	.6	.775	2.57	334	250	50	249	91	91	3	439.53
4	.6	.775	2.57	333	249	51	250	93	93	3	446.17
Stop @ 1327											
		.798	2.74	332.8					89.9		82.07

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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Client ARMEREN				Date 8/25/04	Page 1 Of 2
Project No. 37314		Operator K. McKenna		Orsat Analysis CO ₂ +O ₂ O ₂ CO 13.9 _____ 5.0 _____	
Sampling Location OUTLET "2"			Run No. 3		
Filter No.	Acetone No.	Condensate			
Barometric Pressure 29.6		Static Pressure -12	Probe Number		
Nozzle Diameter .250	Nozzle Number 0-250	Pitot Coefficient .83	Pitot Number R		
Meter Corr. Factor .998		Meter-Orifice 663.1			
Sample Pt. Time 10		Assumed % Moisture 10		Leak Test Before .05 @ 11 After .007 @ 10	

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start	1358										449.4
A 1	.65	.806	2.79	333	248	46	249	87	89	3	452.31
2	.65	.806	2.78	336	250	47	251	87	89	3	463.2
3	.6	.775	2.56	336	249	47	250	88	90	3	469.83
4	.55	.742	2.34	336	251	48	250	89	91	3	476.17
B 1	.65	.806	2.78	335	250	49	249	90	91	3	483.073
2	.65	.806	2.77	337	251	50	250	91	93	3	489.967
3	.6	.775	2.56	337	250	51	249	91	93	3	496.591
4	.55	.742	2.34	338	251	50	250	92	94	3	502.929
C 1	.7	.837	2.99	338	250	51	253	93	95	3	510.079
2	.65	.806	2.77	338	251	51	249	94	95	3	516.97
3	.65	.806	2.77	338	249	52	250	94	96	3	523.86
4	.55	.742	2.34	337	253	53	251	94	96	3	530.2
Stop	1600	.787	2.65	336.6					91.8		80.8

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

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M26A

Client ADA-ES				Date 2/26/04	Page 1 Of 2
Project No. 37314		Operator N. Linhardt		Orsat Analysis CO ₂ +O ₂ O ₂ CO 14.8 4.1	
Sampling Location Unit 2 Inlet			Run No. 1		
Filter No.	Acetone No.	Condensate			
Barometric Pressure 29.6	Static Pressure -13	Probe Number			
Nozzle Diameter 248	Nozzle Number Q-250	Pitot Coefficient .54	Pitot Number X		
Meter Corr. Factor 1.009	Meter-Orifice 664.1				
Sample Pt. Time 60 min	Assumed % Moisture 9%	Leak Test	Before .009615	After .0108162	

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 0815											316.945
A1	.65	.806	2.40	330	265	40	264	83	82	2	320.35
2	.75	.866	2.78	330	264	41	263	85	84	2	324.01
3	.65	.806	2.41	329	262	41	266	84	83	2	327.42
4	.49	.700	1.82	326	260	42	265	85	84	2	330.391
B1	.65	.806	2.40	332	261	42	264	85	85	2	333.80
2	.70	.837	2.58	334	260	43	263	86	85	2	337.33
3	.60	.775	2.21	333	259	43	260	85	85	2	340.60
4	.44	.663	1.62	328	262	44	264	86	85	2	343.411
C1	.70	.837	2.58	333	263	45	265	86	86	2	346.94
2	.80	.894	2.95	335	262	46	262	87	86	3	350.71
3	.70	.837	2.58	333	261	46	263	88	87	3	354.24
4	.45	.671	1.66	329	260	47	264	89	88	3	357.081
Stop @ 0920											
		.792	2.33	331.0					85.4		40.136

Pitot Tube Leak Check: Before ✓ After ✓
 Integrated Bag Leak Check: Before After

Particulate Field Data Sheet

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McDonnell

Client ADA-ES				Date 8/26/04	Page 1 Of 2								
Project No. 37314		Operator N. Kuhardt		Orsat Analysis <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">CO₂</td> <td style="width:25%;">+O₂</td> <td style="width:25%;">O₂</td> <td style="width:25%;">CO</td> </tr> <tr> <td style="text-align: center;">14.9</td> <td style="text-align: center;">_____</td> <td style="text-align: center;">4.1</td> <td style="text-align: center;">_____</td> </tr> </table>		CO ₂	+O ₂	O ₂	CO	14.9	_____	4.1	_____
CO ₂	+O ₂	O ₂	CO										
14.9	_____	4.1	_____										
Sampling Location Inlet Duct 2			Run No. 2										
Filter No.	Acetone No.	Condensate											
Barometric Pressure 29.6		Static Pressure -13	Probe Number _____										
Nozzle Diameter .248	Nozzle Number Q 250	Pitot Coefficient .84	Pitot Number X										
Meter Corr. Factor 1.009		Meter-Orifice 664.1											
Sample Pt. Time 60 min		Assumed % Moisture 4	Leak Test .004615psi	Before .009615psi	After .009615psi								

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start @ 0930											357.327
A1	.65	.806	2.47	333	259	42	261	89	88	2	360.79
2	.75	.866	2.86	333	264	43	256	89	88	2	364.50
3	.70	.837	2.67	333	263	43	253	89	89	2	368.09
4	.48	.693	1.83	329	262	44	254	89	88	2	371.073
B1	.65	.806	2.48	332	261	44	255	90	89	2	374.53
2	.70	.837	2.66	334	265	45	254	91	90	2	378.12
3	.60	.775	2.29	332	264	46	256	91	90	2	381.44
4	.46	.678	1.76	328	263	47	258	92	91	3	384.362
C1	.60	.775	2.28	334	262	47	261	93	92	3	387.68
2	.70	.837	2.66	334	261	48	264	94	93	3	391.27
3	.65	.806	2.48	330	264	48	263	94	94	3	394.73
4	.42	.648	1.60	327	263	49	262	95	94	4	397.524
Stop @ 1045											
		.780	2.34	331.6				91.0			40.197

Pitot Tube Leak Check: Before ✓ After ✓
 Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

060293 Form AQD-(T-S)-5



T(S)-5
1 Of 2
Burns & McDonnell

Date 8/26/04		Page 1 Of 2	
Operator K. McKeown		Orsat Analysis	
OUTLET		CO ₂	+O ₂
Run No. 1	Acetone No.	O ₂	CO
Condensate	Static Pressure 19.6	14.6	4.3
Probe Number	Probe Number -12		
Nozzle Diameter .250	Nozzle Number 0.250		
Meter Corr. Factor .998	Pitot Coefficient .83		
	Pitot Number R		
	Meter-Orifice 663.1		
Sample Pt. Time 10	Assumed % Moisture 10	Leak Test Before .007014	After .008012

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start	0715										531.3
A 1	.6	.775	2.62	326	251	47	253	85	86	3	534.65
2	.55	.742	2.4	326	249	47	251	85	86	3	537.86
3	.55	.742	2.4	326	250	48	249	85	86	3	541.05
4	.5	.707	2.18	326	249	49	250	86	88	3	544.11
B 1	.65	.806	2.85	326	250	50	249	87	87	3	547.6
2	.6	.775	2.62	326	249	50	251	87	87	3	550.95
3	.55	.742	2.4	326	253	50	249	88	88	3	554.16
4	.5	.707	2.18	326	250	51	250	89	89	3	557.22
C 1	.65	.806	2.83	330	251	50	251	89	89	3	560.701
2	.6	.775	2.61	330	250	51	250	90	90	3	564.05
3	.6	.775	2.61	330	249	52	253	91	92	3	567.39
4	.5	.707	2.17	330	250	53	250	92	93	3	570.44
Stop	0820										
		.755	2.49	327.3					88.1		39.140

Pitot Tube Leak Check: Before After

Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

060293 Form AQD-(T-S)-5



Client AMERLEN			Date 8/26/04	Page 1 Of 2
Project No. 37314		Operator K. McLEWIA		
Sampling Location 2 OUTLET			Run No. 2	
Filter No.	Acetone No.	Condensate		
Barometric Pressure 29.6		Static Pressure -12	Probe Number	
Nozzle Diameter .250	Nozzle Number 0-250	Pitot Coefficient .83	Pitot Number R	
Meter Corr. Factor .998		Meter-Orifice 663.1		
Sample Pt. Time 10 5	Assumed % Moisture 10	Leak Test Before .0070 12 After .0080 12		

Sample Point	ΔP	$\sqrt{\Delta P}$	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start 0833											
A1	.7	.837	3.09	320	252	50	249	96	94	3	571.6
2	.65	.806	2.86	322	250	49	252	96	95	3	575.23
3	.65	.806	2.84	327	251	50	250	97	94	4	579.1
4	.55	.742	2.39	328	250	51	251	97	94	4	582.59
B1	.7	.837	3.07	325	251	51	249	97	95	4	585.8
2	.65	.806	2.86	322	249	50	251	97	96	4	589.42
3	.6	.775	2.61	331	250	51	250	97	96	4	592.92
4	.55	.742	2.39	331	251	50	250	98	97	4	596.26
C1	.7	.837	3.07	325	250	51	251	98	98	5	603.1
2	.65	.806	2.84	328	250	52	250	98	98	5	606.59
3	.65	.806	2.83	330	250	52	248	98	98	5	610.05
4	.6	.775	2.61	329	251	53	250	98	98	5	613.4
Stop 0935											
		.798	2.79	326.5				96.7			41.800

Pitot Tube Leak Check: Before After
 Integrated Bag Leak Check: Before _____ After _____

Particulate Field Data Sheet

050293 Form AQD-(T-S)-5



Client AMERICA			Date 8/26/04	Page 1 Of 2
Project No. 37314		Operator K. McLENA		
Sampling Location 2 OUTLET			Run No. 3	
Filter No.	Acetone No.	Condensate		
Barometric Pressure 29.6	Static Pressure -12	Probe Number		
Nozzle Diameter .250	Nozzle Number 2-250	Pitot Coefficient .83	Pitot Number R	
Meter Corr. Factor .998	Meter-Orifice 663.1			
Sample Pt. Time 5	Assumed % Moisture 10	Leak Test Before .07014	After .008012	

Orsat Analysis			
CO ₂	+O ₂	O ₂	CO
14.6		4.3	

Sample Point	ΔP	√ΔP	ΔH	Temperature °F						Vac. Pr. (In. HG)	Dry Gas Meter Reading in Cu. Ft.
				Stack	Probe	Imp. Out	Oven	Meter In	Meter Out		
Start 0944											614.5
A 1	.7	.837	3.07	325	250	47	251	97	99	2	618.12
2	.65	.806	2.83	329	253	48	250	97	98	3	621.6
3	.6	.775	2.61	331	250	49	249	97	97	3	624.9
4	.55	.742	2.39	329	253	50	250	97	98	3	628.1
B 1	.7	.837	3.08	324	250	50	250	97	98	3	631.73
2	.65	.806	2.83	329	251	50	250	97	99	3	635.2
3	.65	.806	2.81	336	250	50	251	98	99	3	638.65
4	.55	.742	2.39	331	249	51	250	98	99	3	641.85
C 1	.7	.837	3.06	328	250	52	251	98	99	3	645.47
2	.65	.806	2.83	331	251	51	250	98	99	3	648.95
3	.65	.806	2.81	335	253	52	249	99	99	3	652.4
4	.65	.806	2.81	337	250	52	250	99	100	3	655.86
Stop 1047											
		.801	2.79	330.4					98.2		41.360

Pitot Tube Leak Check: Before After
 Integrated Bag Leak Check: Before _____ After _____

APPENDIX C
CALIBRATION OF TEST EQUIPMENT

Dry Gas Meter Calibration Sheet

Module 663
Orifice small

Run By Russell D. Fowler, Jr.
Date 07/09/04
Barometric Press 29.22

DH in H ₂ O	Vw Initial	Vw final	Vw ft. ³	Vd initial	Vd final	Vd ft. ³	tw °F	tdi °F	tdo °F	Pw in. H ₂ O	Q Min.
.5	1895	1900	5	16.988	22.052	5.064	74	76	76	-1.9	16.8
1.0	1901	1906	5	22.996	28.014	5.018	75	75	75	-2.0	11.8
2.0	1907	1912	5	28.976	33.955	4.979	75	75	75	-2.1	8.1
3.0	1913	1918	5	34.945	39.895	4.950	75	76	76	-2.2	6.4
4.0	1889	1894	5	11.083	15.998	4.915	74	76	76	-2.4	5.5

Delta H	DH 13.6	Meter Correction	Delta H@
		$Vw (P_b) (td+460)$ $Vd(P_b+(DH/13.6))(tw+460)$	$(.0319)DH(P_b+(DH/13.6))/(td+460)$ $((tw+460)Q/(Vw*P_b))^2$
0.5	0.0368	0.990	3.28
1.0	0.0735	0.994	3.26
2.0	0.1471	0.999	3.08
3.0	0.2206	1.002	2.89
4.0	0.2941	1.006	2.84
Average		0.998	3.07

DH = Orifice Setting
Vw = Volume of Gas of Wet Test Meter
Vd = Volume of Gas of Dry Gas Meter
Pw = Pressure of Wet Test Meter
tw = Temp of Fluid in Wet Test Meter
tdi = Inlet Temp of Dry Gas Meter
tdo = Outlet Temp of Dry Gas Meter
td = Average Temp of Dry Gas Meter
Q = Time in Minutes

Magnehelic Calibration

Test Location Burns & McDonnell
 Test Module 663

Run By Don Sells
 Date 06/30/04

Magnehelic Range: 0" - 6" (Delta P)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.0	0.000
2	6.00	n/a	5.70 - 6.30
3	5.00	4.9	4.75 - 5.25
4	4.00	4.0	3.80 - 4.20
5	3.00	3.0	2.85 - 3.15
6	2.00	2.0	1.90 - 2.10
7	1.00	1.0	0.95 - 1.05

Magnehelic Range: 0" - 0.5" (Delta P)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.00	0.000
2	0.50	0.50	0.475 - 0.525
3	0.40	0.40	0.380 - 0.420
4	0.30	0.30	0.285 - 0.315
5	0.20	0.19	0.190 - 0.210
6	0.10	0.10	0.095 - 0.105

Magnehelic Range: 0" - 4" (Delta H)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.0	0.000
2	4.00	3.9	3.80 - 4.20
3	3.50	3.5	3.33 - 3.68
4	3.00	3.0	2.85 - 3.15
5	2.50	2.5	2.38 - 2.63
6	2.00	2.0	1.90 - 2.10
7	1.00	1.0	0.95 - 1.05

Meter	Thermometer		
	ASTM #1928085	Trendicator	** Pass Range
IN		72.0	70.53 - 72.67
OUT	22.0	72.0	

** Trendicators are calibrated to within +/- 1.5% of the thermometer.

Note: Magnehelics are calibrated to within +/- 5% of the Inclined Draft Gauge individual reading.

Dry Gas Meter Calibration Sheet

Module 664
Orifice small

Run By Russell D. Fowler, Jr.
Date 07/08/04
Barometric Press 29.13

DH in H ₂ O	Vw Initial	Vw final	Vw ft. ³	Vd initial	Vd final	Vd ft. ³	tw °F	tdi °F	tdo °F	Pw in. H ₂ O	Q Min.
.5	1779	1784	5	130.823	135.823	5.000	76	77	76	-2.0	14.7
1.0	1785	1790	5	136.800	141.742	4.942	76	77	76	-2.2	10.5
2.0	1791	1797	6	142.710	148.622	5.912	76	77	76	-2.4	8.9
3.0	1798	1804	6	149.587	155.464	5.877	77	78	78	-2.6	7.4
4.0	1805	1810	5	156.438	161.319	4.881	77	78	78	-2.8	5.4

Delta H	DH 13.6	Meter Correction	
		Vw (Pb) (td+460) Vd(Pb+(DH/13.6))(tw+460)	Delta H@ (.0319)DH(Pb+(DH/13.6)/(td+460) ((tw+460)Q/(Vw*P _b)) ²
0.5	0.0368	1.000	2.54
1.0	0.0735	1.010	2.59
2.0	0.1471	1.011	2.59
3.0	0.2206	1.013	2.70
4.0	0.2941	1.011	2.77
Average		1.009	2.64

DH = Orifice Setting
Vw = Volume of Gas of Wet Test Meter
Vd = Volume of Gas of Dry Gas Meter
Pw = Pressure of Wet Test Meter
tw = Temp of Fluid in Wet Test Meter
tdi = Inlet Temp of Dry Gas Meter
tdo = Outlet Temp of Dry Gas Meter
td = Average Temp of Dry Gas Meter
Q = Time in Minutes

Magnehelic Calibration

Test Location Burns & McDonnell
 Test Module 664

Run By Russell D. Fowler, Jr
 Date 07/08/04

Magnehelic Range: 0" - 6" (Delta P)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.0	0.000
2	6.00	6.1	5.70 - 6.30
3	5.00	5.1	4.75 - 5.25
4	4.00	4.1	3.80 - 4.20
5	3.00	3.0	2.85 - 3.15
6	2.00	2.0	1.90 - 2.10
7	1.00	1.0	0.95 - 1.05

Magnehelic Range: 0" - 0.5" (Delta P)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.00	0.000
2	0.50	0.51	0.475 - 0.525
3	0.40	0.41	0.380 - 0.420
4	0.30	0.30	0.285 - 0.315
5	0.20	0.20	0.190 - 0.210
6	0.10	0.10	0.095 - 0.105

Magnehelic Range: 0" - 4" (Delta H)

Reading No.	Inclined Draft		
	Gauge	Magnehelic	Pass Range
1	0.00	0.0	0.000
2	4.00	3.9	3.80 - 4.20
3	3.50	3.4	3.33 - 3.68
4	3.00	3.0	2.85 - 3.15
5	2.50	2.5	2.38 - 2.63
6	2.00	2.0	1.90 - 2.10
7	1.00	1.0	0.95 - 1.05

Meter	Thermometer		
	ASTM #1928085	Trendicator	** Pass Range
IN		70.0	68.75 - 70.85
OUT	21.0	70.0	

** Trendicators are calibrated to within +/- 1.5% of the thermometer.

Note: Magnehelics are calibrated to within +/- 5% of the Inclined Draft Gauge individual reading.

PITOT CALIBRATIONS

Calibrated by: N. Linhardt

Date: 02/20/04

Pitot Tube #	1-DOT, A - Side	2-DOT, B - Side
A - 2	0.83	0.83
A - 4	0.83	0.83
A - 5	0.83	0.83
A - 6	0.83	0.83
A - 10	0.83	0.84
A - 17	0.83	0.83
A - 19	0.84	0.83
A - 21	0.83	0.83
B - 6	0.83	0.83
H - 5	0.83	0.83
H - 6	0.83	0.83
J - 1	0.83	0.83
J - 2	0.83	0.83
J - 7	0.83	0.83
J - 8	0.83	0.83
K - 1	0.83	0.83
K - 8	0.83	0.83
R	0.83	0.83
X	0.83	0.83
Y	0.83	0.83

Calibrated at Burns & McDonnell' s Testing Laboratory

NOZZLE CALIBRATION

Sized By R. Heldenbrand

Date	Nozzle	Dimensions			Difference	Avg. Diameter
		a	b	c		
2/12/2004	B - 125	0.122	0.122	0.124	0.002	0.123
2/12/2004	A - 187	0.185	0.185	0.187	0.002	0.186
2/12/2004	B - 187	0.185	0.187	0.185	0.002	0.186
2/12/2004	C - 187	0.185	0.187	0.186	0.002	0.186
2/12/2004	D - 187	0.186	0.187	0.188	0.002	0.187
2/12/2004	E - 187	0.187	0.187	0.187	0.000	0.187
2/12/2004	A - 250	0.248	0.248	0.251	0.003	0.249
2/12/2004	D - 250	0.248	0.245	0.248	0.003	0.247
2/12/2004	E - 250	0.249	0.249	0.250	0.001	0.249
2/12/2004	F - 250	0.250	0.248	0.248	0.002	0.249
2/12/2004	J - 250	0.248	0.248	0.249	0.001	0.248
2/12/2004	K - 250	0.248	0.248	0.248	0.000	0.248
2/12/2004	L - 250	0.246	0.248	0.247	0.002	0.247
2/12/2004	N - 250	0.247	0.247	0.248	0.001	0.247
2/12/2004	O - 250	0.250	0.250	0.250	0.000	0.250
2/12/2004	P - 250	0.255	0.254	0.252	0.003	0.254
2/12/2004	Q - 250	0.248	0.247	0.248	0.001	0.248
2/12/2004	R - 250	0.250	0.248	0.247	0.003	0.248
2/12/2004	S - 250	0.251	0.250	0.250	0.001	0.250
2/12/2004	A - 312	0.310	0.311	0.312	0.002	0.311
2/12/2004	B - 312	0.310	0.313	0.312	0.003	0.312
2/12/2004	C - 312	0.312	0.311	0.310	0.002	0.311
2/12/2004	D - 312	0.311	0.311	0.311	0.000	0.311
2/12/2004	E - 312	0.310	0.310	0.310	0.000	0.310
2/12/2004	F - 312	0.308	0.310	0.309	0.002	0.309
2/12/2004	G - 312	0.305	0.308	0.305	0.003	0.306
2/12/2004	I - 312	0.313	0.310	0.310	0.003	0.311
2/12/2004	J - 312	0.314	0.313	0.313	0.001	0.313
2/12/2004	K - 312	0.318	0.314	0.316	0.004	0.316
2/12/2004	A - 375	0.370	0.372	0.370	0.002	0.371
2/12/2004	C - 375	0.375	0.373	0.375	0.002	0.374
2/12/2004	E - 375	0.374	0.374	0.371	0.003	0.373
2/12/2004	F - 375	0.379	0.380	0.380	0.001	0.380
2/12/2004	G - 375	0.377	0.377	0.377	0.000	0.377
2/12/2004	H - 375	0.380	0.380	0.380	0.000	0.380
2/12/2004	J - 375	0.375	0.375	0.375	0.000	0.375
2/12/2004	K - 375	0.370	0.370	0.371	0.001	0.370
2/12/2004	M - 375	0.376	0.375	0.376	0.001	0.376
2/12/2004	N - 375	0.371	0.368	0.367	0.004	0.369
2/12/2004	R - 375	0.372	0.373	0.372	0.001	0.372
2/12/2004	A - 435	0.438	0.438	0.439	0.001	0.438
2/12/2004	B - 435	0.440	0.440	0.438	0.002	0.439
2/12/2004	C - 435	0.440	0.440	0.442	0.002	0.441
2/12/2004	E - 435	0.434	0.435	0.435	0.001	0.435
2/12/2004	F - 435	0.430	0.430	0.431	0.001	0.430
2/12/2004	G - 435	0.433	0.431	0.433	0.002	0.432

All Dimensions are in inches

NOZZLE CALIBRATION

Sized By R. Heldenbrand

Date	Nozzle	Dimensions			Difference	Avg. Diameter
		a	b	c		
2/12/2004	H - 435	0.437	0.437	0.438	0.001	0.437
2/12/2004	K - 435	0.439	0.435	0.436	0.004	0.437
2/12/2004	J - 435	0.437	0.437	0.437	0.000	0.437
2/12/2004	L - 435	0.435	0.436	0.437	0.002	0.436
2/12/2004	M - 435	0.432	0.428	0.430	0.004	0.430
2/12/2004	N - 435	0.434	0.435	0.431	0.004	0.433
2/12/2004	A - 500	0.498	0.498	0.502	0.004	0.499
2/12/2004	B - 500	0.502	0.500	0.502	0.002	0.501
2/12/2004	C - 500	0.499	0.498	0.498	0.001	0.498
2/12/2004	D - 500	0.499	0.498	0.498	0.001	0.498
2/12/2004	E - 500	0.500	0.500	0.500	0.000	0.500
2/12/2004	F - 500	0.508	0.510	0.507	0.003	0.508
2/12/2004	G - 500	0.500	0.499	0.500	0.001	0.500
2/12/2004	H - 500	0.500	0.501	0.500	0.001	0.500
2/12/2004	J - 500	0.493	0.492	0.491	0.002	0.492
2/12/2004	K - 500	0.500	0.501	0.500	0.001	0.500
2/12/2004	L - 500	0.497	0.496	0.495	0.002	0.496
2/12/2004	M - 500	0.504	0.501	0.500	0.004	0.502
2/12/2004	N - 500	0.498	0.495	0.495	0.003	0.496
2/12/2004	A - 563	0.560	0.561	0.562	0.002	0.561
2/12/2004	B - 563	0.555	0.558	0.556	0.003	0.556
2/12/2004	B - 625	0.624	0.623	0.624	0.001	0.624
2/12/2004	C - 625	0.620	0.623	0.620	0.003	0.621
2/12/2004	D - 625	0.620	0.620	0.622	0.002	0.621
2/12/2004	B - 687	0.685	0.685	0.685	0.000	0.685
2/12/2004	A - 750	0.758	0.754	0.756	0.004	0.756
2/12/2004	B - 750	0.758	0.758	0.756	0.002	0.757

All Dimensions are in inches

APPENDIX D
LABORATORY REPORTS

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 21 2004 02:19PM P2

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827106- Customer: SAMI
040827141 7314 Egypt Rd
Date Received: 08/27/04 Medina, Ohio 44256

Date Sampled: 08/24/04

Date of Analyses: 09/11/04

Time Sampled:

Project: ADA-ES

Identification: Run 1, Run 2, Run 3 Sample matrix: Filter, Liquid

Inlet

<u>Hg (ash)</u>	<u>micrograms</u>
Run 1	3.7445
Run 2	1.8040
Run 3	2.5339
<u>Hg (oxidized)</u>	<u>micrograms</u>
Run 1	2.7990
Run 2	1.8231
Run 3	2.8405
<u>Hg (elemental)</u>	<u>micrograms</u>
Run 1	0.5690
Run 2	0.4955
Run 3	0.4587

Approved By: 

Corrected report of analyses

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 21 2004 02:20PM P3

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827106- Customer: SAMI
040827141 7314 Egypt Rd
Date Received: 08/27/04 Medina, Ohio 44256

Date Sampled: 08/24/04

Date of Analyses: 09/11/04

Time Sampled:

Project: ADA-ES

Identification: Run 1, Run 2, Run 3 Sample matrix: Filter, Liquid

Outlet

<u>Hg (ash)</u>	<u>micrograms</u>
Run 1	0.4621
Run 2	0.1605
Run 3	0.4673
<u>Hg (oxidized)</u>	<u>micrograms</u>
Run 1	2.5150
Run 2	1.1870
Run 3	2.4285
<u>Hg (elemental)</u>	<u>micrograms</u>
Run 1	0.5392
Run 2	0.2009
Run 3	0.4407

Approved By: 

Corrected report of analyses

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 14 2004 10:59AM P2

Project: ADA-ES InletFilter Weight

	<u>Initial</u>	<u>After heating (80deg C-3 hrs)</u>
Run 1	14.998g	14.216g
Run 2	3.784g	3.114g
Run 3	15.588g	15.502g
Blank	3.905g	3.466g

Nitric Acid used for dissolution of each filter paper: 150ml

Weight of Ash + Filter

Run 1	14.216g
Run 2	3.114g
Run 3	15.502g

Volume of Container 2: 0.1N HNO3

Run 1	175ml
Run 2	100ml
Run 3	83ml

Container 3 Volume Volume Used

Run 1	676ml	10ml
Run 2	750ml	10ml
Run 3	884ml	10ml

Volume of solution added :

Sulfuric Acid: 0.5ml Nitric Acid: 0.5ml KMnO4: 1.5ml K2S2O4: 0.75ml NH2OH: 1.0ml

Container 4 Volume Volume Used

Run 1	150ml	5ml
Run 2	188ml	5ml
Run 3	168ml	5ml

Volume of solution added:

HCL Acid: 0.25ml Sulfuric Acid: 0.5ml KMnO4: 0.5ml K2S2O8: 0.75ml NH2OH: 1ml

Volume for KMNO4 added: container 4 and 9

<u>Time</u>	<u>Run 1</u>	<u>Run2</u>	<u>Run3</u>	<u>Cont 9</u>
4:00	0.5ml	0.5ml	0.5ml	0.5ml
4:15	0.5ml	0.5ml	0.5ml	0.5ml
4:30				0.5ml
4:45				0.5ml
5:00				0.5ml
5:15				

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 14 2004 11:00AM P3

<u>Container 5</u>	<u>Volume</u>	<u>Volume Used</u>
Run 1	449ml	5ml
Run 2	452ml	5ml
Run 3	432ml	5ml
blank	50ml	5ml

Weight of hydroxylamine sulfate added to com 5 and 10

Run 1	1ml
Run 2	1ml
Run 3	1ml
C-10 blank	1ml

	<u>Results (Hg) ppb</u>	
	<u>Replicante 1</u>	<u>Replicate 2</u>
<u>Ash</u>		
Run 1	12.660	12.678
Run 2	0.301	0.323
Run 3	11.483	11.597
<u>C-2</u>		
Run 1	10.483	10.603
Run 2	0.1431	0.1519
Run 3	9.624	9.728
<u>C-3</u>		
Run 1	2.728	3.509
Run 2	1.084	1.130
Run 3	2.212	2.282
<u>C-4</u>		
Run 1	0.5072	0.5138
Run 2	0.2094	0.2134
Run 3	0.4101	0.4181
<u>C-5</u>		
Run 1	0.7855	0.8057
Run 2	0.2348	0.2512
Run 3	0.6367	0.6499
<u>C-7</u>		
	-0.0111	-0.0004
<u>C-8</u>		
	-0.0020	-0.0032
<u>C-9</u>		
	-0.0020	0.0001
<u>C-10</u>		
	-0.0011	0.0001
<u>C-11</u>		
	-0.0025	-0.0174
<u>C-12</u>		
	-0.003	-0.004

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 14 2004 11:00AM P4

Project: ADA-ES Outlet

Filter Weight

	<u>Initial</u>	<u>After heating (80deg C-3 hrs)</u>
Run 1	3.007g	2.972g
Run 2	10.285g	10.001g
Run 3	3.333g	2.929g
Blank	3.905g	3.466g

Nitric Acid used for dissolution of each filter paper: 150ml

Weight of Ash + Filter

Run 1	2.972g
Run 2	10.001g
Run 3	2.466g

Volume of Container 2: 0.1N HNO3

Run 1	51ml
Run 2	63ml
Run 3	70ml

Container 3

	<u>Volume</u>	<u>Volume Used</u>
Run 1	862ml	10ml
Run 2	722ml	10ml
Run 3	811ml	10ml

Volume of solution added :

Sulfuric Acid: 0.5ml Nitric Acid: 0.5ml KMnO4: 1.5ml K2S2O4: 0.75ml NH2OH: 1.0ml

Container 4

	<u>Volume</u>	<u>Volume Used</u>
Run 1	151ml	5ml
Run 2	142ml	5ml
Run 3	150ml	5ml

Volume of solution added:

HCL Acid: 0.25ml Sulfuric Acid: 0.5ml KMnO4: 0.5ml K2S2O8: 0.75ml NH2OH: 1ml

Volume for KMNO4 added: container 4 and 9

<u>Time</u>	<u>Run 1</u>	<u>Run2</u>	<u>Run3</u>	<u>Cont 9</u>
4:00	0.5ml	0.5ml	0.5ml	0.5ml
4:15	0.5ml	0.5ml	0.5ml	0.5ml
4:30				0.5ml
4:45				0.5ml
5:00				0.5ml
5:15				

Results (Hg) ppb
Replicate 1 Replicate 2

Ash

Run 1	0.911	0.933
Run 2	9.309	9.379
Run 3	0.898	0.918

C-2

Run 1	0.9770	1.025
Run 2	6.275	6.503
Run 3	0.9708	0.9832

C-3

Run 1	1.937	2.143
Run 2	1.715	1.817
Run 3	2.050	2.138

C-4

Run 1	0.4795	0.4971
Run 2	0.3827	0.3971
Run 3	0.3969	0.4029

C-5

Run 1	0.3282	0.3406
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FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:15AM P2

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827142

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

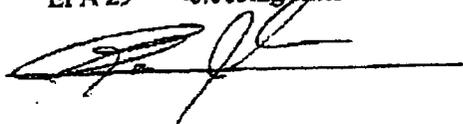
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-1-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.081mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	4.762mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.033mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.219mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.112mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.148mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0045mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.077mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.072mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827144

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

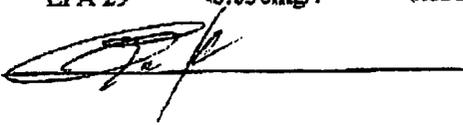
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-1-3 100ml

Sample Matrix: liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.053mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	3.889mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.032mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.196mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.114mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.316mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0022mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.148mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:17AM P1

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827145

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-1-4 558 ml

Sample Matrix: liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	1.006mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.010mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.055mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.089mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0009mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.045mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827146

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-1-5a 100~1

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:18AM P3

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827147

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

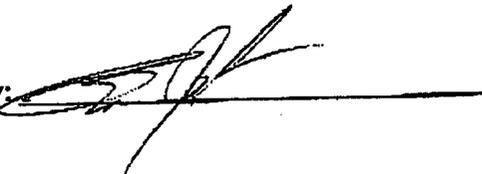
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-1-5b 348 ml

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:21AM P5

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827154

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-2-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.175mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	7.101mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.063mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.402mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.149mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.190mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0050mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.084mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.095mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827155

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-2-3 100ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.104mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	4.443mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.042mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.118mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.075mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.225mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0026mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.111mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827156

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

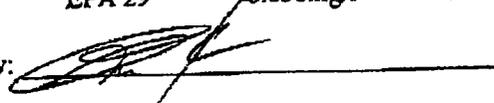
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-2-4 550 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.032mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.006mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.056mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.021mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.062mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0007mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.014mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827157

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

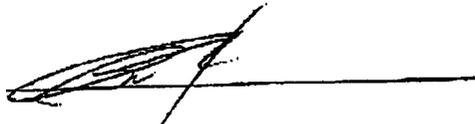
Project: ADA-ES

Identification: MI-2-5a 103-1

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	0.0003mg/l	0.0002mg/l	09/07/04

Approved By:



Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827158

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

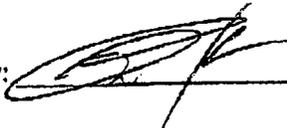
Project: ADA-ES

Identification: MI-2-5b 348 ml

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By:



FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:26AM P4

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827164

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

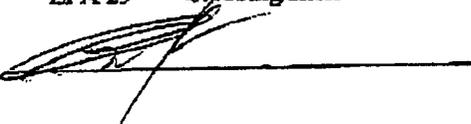
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-3-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.315mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	8.131mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.057mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.333mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.174mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.199mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0014mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.087mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.098mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:26AM P5

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827165

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-3-3 100 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.202mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	7.043mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.050mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.175mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.111mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.206mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0011mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.092mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	0.054mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

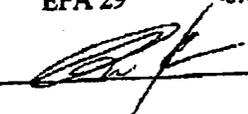
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-3-4 522m1

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.064mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	1.002mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.030mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.021mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.045mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.012mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:27AM P6

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827167

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-3-5a ¹⁰⁰
~~522~~ ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:27AM P7

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827168

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

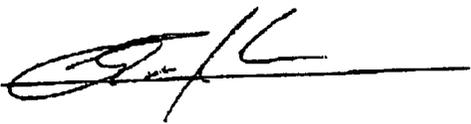
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MI-3-5b 350 ml

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827148

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

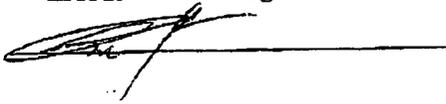
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

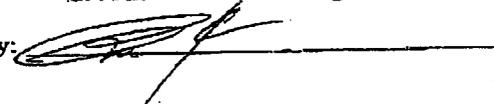
Identification: MO-1-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.019mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	0.557mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.015mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.062mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.033mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.089mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0008mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.025mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.039mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Nickel (Ni)	EPA 29	0.01 mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:19AM P1

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827150

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

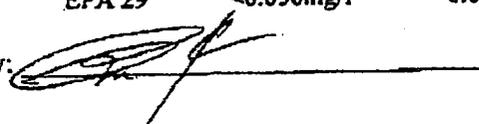
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-1-3 100m^l

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.494mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.018mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.041mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.023mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.090mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0004mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.017mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827151

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

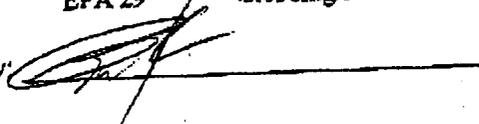
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-1-4 525 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.105mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.007mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.014mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.017mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827152

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-1-5a

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By:



FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:20AM P4

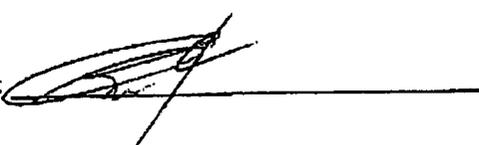
Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827153**Date Received:** 08/27/04**Date Sampled:** 08/25/04**Time Sampled:****Customer:** SAMI
7314 Egypt Rd
Medina, Ohio 44256**Project:** ADA-ES**Identification:** MO-1-5b 344**Sample Matrix:** Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:23AM P10

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827159

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-2-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.024mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	1.011mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.025mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.100mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.090mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.094mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0012mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.036mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.044mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827160

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

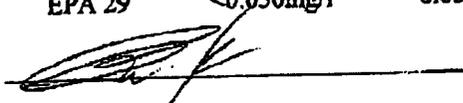
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-2-3 100~1

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.099mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	1.020mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.009mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.074mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.069mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.066mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0008mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	0.027mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:24AM P1

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827161

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-2-4 572 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.052mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.011mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	<0.014mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:25AM P2

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827162

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-5a 105 ml

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	0.0003mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:25AM P3

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827163**Date Received:** 08/27/04**Date Sampled:** 08/25/04**Time Sampled:****Customer:** SAMI
7314 Egypt Rd
Medina, Ohio 44256**Project:** ADA-ES**Identification:** MO-2-5b 350 ml**Sample Matrix:** Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:28AM PB

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827169

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

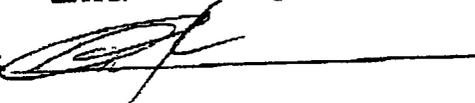
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-1

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	0.094mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	1.208mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	0.007mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	0.104mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	0.088mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	0.076mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	0.0007mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	0.025mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	0.039mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827170

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-3 99 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	0.042mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.067mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	0.008mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	0.054mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	0.032mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.066mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	0.0004mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827171

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

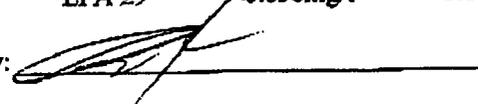
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-4 530 ml

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	0.013mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	0.014mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827172

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-5a 101 N1

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827173

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: MO-3-5b 350 ml

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By:  _____

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827174

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: M-8a

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827175

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

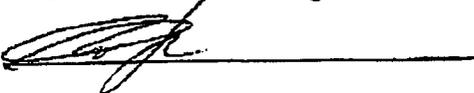
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: M-8b

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 10 2004 11:31AM P15

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827176

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

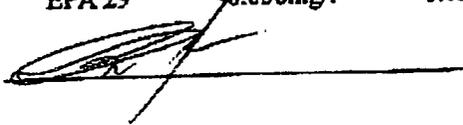
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: M-9

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Arsenic (As)	EPA 29	<0.040mg/l	0.040mg/l	09/07/04
Barium (Ba)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/l	0.0005mg/l	09/07/04
Cadmium (Cd)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Chromium (Cr)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Cobalt (Co)	EPA 29	<0.005mg/l	0.005mg/l	09/07/04
Copper (Cu)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Lead (Pb)	EPA 29	<0.020mg/l	0.020mg/l	09/07/04
Manganese (Mn)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04
Nickel (Ni)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Selenium (Se)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04
Silver (Ag)	EPA 29	<0.010mg/l	0.010mg/l	09/07/04
Thallium (Tl)	EPA 29	<0.050mg/l	0.050mg/l	09/07/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827177

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: M-10

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Mercury (Hg)	EPA 29	<0.0002mg/l	0.0002mg/l	09/07/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 10 2004 11:32AM P17

Crystal Laboratories, Inc.

1201 Camden Ave. SW * Canton, Ohio 44706

Phone No. 330-454-4222

Laboratory No. 040827178

Date Received: 08/27/04

Date Sampled: 08/25/04

Time Sampled:

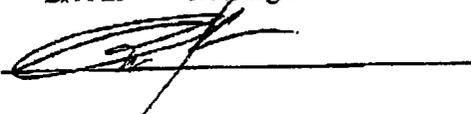
Customer: SAMI
7314 Egypt Rd
Medina, Ohio 44256

Project: ADA-ES

Identification: M-12

Sample Matrix: filter

Analysis	Method	Results	Detection Limit	Date of Analysis
Antimony (Sb)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Arsenic (As)	EPA 29	<0.004mg/filter	0.004mg/filter	09/07/04
Barium (Ba)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Beryllium (Be)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Cadmium (Cd)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Chromium (Cr)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Cobalt (Co)	EPA 29	<0.004mg/filter	0.004mg/filter	09/07/04
Copper (Cu)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Lead (Pb)	EPA 29	<0.002mg/filter	0.002mg/filter	09/07/04
Manganese (Mn)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Mercury (Hg)	EPA 29	<0.0005mg/filter	0.0005mg/filter	09/07/04
Nickel (Ni)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Selenium (Se)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04
Silver (Ag)	EPA 29	<0.001mg/filter	0.001mg/filter	09/07/04
Thallium (Tl)	EPA 29	<0.005mg/filter	0.005mg/filter	09/07/04

Approved By: 

Sample Volumes (EPA 029)

<u>Sample ID</u>	<u>Sample Volume</u>
MI-1-3	100ml
MI-1-4	558ml
MI-1-5a	100ml
MI-1-5b	348ml
MO-1-3	100ml
MO-1-4	525ml
MO-1-5a	99ml
MO-1-5b	344ml
MI-2-3	100ml
MI-2-4	550ml
MI-2-5a	103ml
MI-2-5b	348ml
MO-2-3	100ml
MO-2-4	572ml
MO-2-5a	105ml
MO-2-5b	350ml
MI-3-3	100ml
MI-3-4	522ml
MI-3-5a	100ml
MI-3-5b	350ml
MO-3-3	99ml
MO-3-4	530ml
MO-3-5a	101ml
MO-3-5b	350ml

FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 07 2004 03:41PM P2

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827092

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-1-1

Sample Matrix: Liquid

258

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
HCL	EPA 26A	1.8mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04
HF	EPA 26A	0.85mg/L	0.01mg/L	9/03/04

Approved By: 

FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 07 2004 03:42PM P3

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827093

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-1-2

Sample Matrix: Liquid

257

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	2.7mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By: _____



FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 07 2004 03:43PM P5

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827096

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-2-1

Sample Matrix: Liquid

236

Analysis	Method	Results	Detection Limit	Date of Analysis
HCL	EPA 26A	1.2mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04
HF	EPA 26A	0.92mg/L	0.01mg/L	9/03/04

Approved By: _____



FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 07 2004 03:43PM P6

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827097

Customer: SAMI

Date Received: 08/27/04

7314 Egypt Rd
Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-2-2

Sample Matrix: Liquid

241

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	7.6mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By: _____



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827100

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-3-1

Sample Matrix: Liquid

238

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
HCL	EPA 26A	2.2mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04
HF	EPA 26A	1.51mg/L	0.01mg/L	9/03/04

Approved By: _____



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827101

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26I-3-2

Sample Matrix: Liquid

250

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	6.3mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By:



FROM : CRYSTAL LAB

FAX NO. : 3304544220

Sep. 07 2004 03:42PM P4

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827094

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

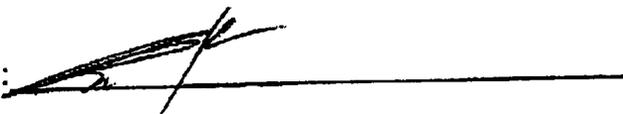
Identification: 260-1-1

Sample Matrix: Liquid

260

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
HCL	EPA 26A	1.5mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04
HF	EPA 26A	0.80mg/L	0.01mg/L	9/03/04

Approved By:



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827095

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26O-1-2

Sample Matrix: Liquid

240

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	6.8mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By:



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827098

Customer: SAMI

Date Received: 08/27/04

7314 Egypt Rd

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 260-2-1

Sample Matrix: Liquid

219

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
HCL	EPA 26A	1.9mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	0.14mg/L	0.01mg/L	9/03/04
HF	EPA 26A	1.23mg/L	0.01mg/L	9/03/04

Approved By:



FROM :CRYSTAL LAB

FAX NO. :3304544220

Sep. 07 2004 03:44PM PB

Crystal Laboratories, Inc.

1201Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827099

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26O-2-2

Sample Matrix: Liquid

226

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	7.8mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	0.05mg/L	0.01mg/L	9/03/04

Approved By: _____



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827102

Customer: SAMI

Date Received: 08/27/04

7314 Egypt Rd

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26O-3-1

Sample Matrix: Liquid

235

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
HCL	EPA 26A	2.9mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	0.17mg/L	0.01mg/L	9/03/04
HF	EPA 26A	0.75mg/L	0.01mg/L	9/03/04

Approved By: 

Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827103

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26O-3-2

Sample Matrix: Liquid

235

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	2.3mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	0.22mg/L	0.01mg/L	9/03/04

Approved By: _____



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827104

Customer: SAMI

Date Received: 08/27/04

7314 Egypt Rd
Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26H2SO4

Sample Matrix: Liquid

Analysis	Method	Results	Detection Limit	Date of Analysis
HCL	EPA 26A	<0.1mg/L	0.1mg/L	9/03/04
HBr	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04
HF	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By: _____



Crystal Laboratories, Inc.

1201 Camden Ave, Canton, Ohio 44706

Phone No: 330-454-4222

Laboratory No. 040827105

Customer: SAMI

7314 Egypt Rd

Date Received: 08/27/04

Medina, Ohio 44256

Date Sampled: 08/26/04

Time Sampled:

Project: ADA-ES

Identification: 26NaOH

Sample Matrix: Liquid

<u>Analysis</u>	<u>Method</u>	<u>Results</u>	<u>Detection Limit</u>	<u>Date of Analysis</u>
Chlorine	EPA 26A	<0.1mg/L	0.1mg/L	9/03/04
Bromine	EPA 26A	<0.01mg/L	0.01mg/L	9/03/04

Approved By: 

Sample Volumes
(EPA 026)

<u>Sample ID</u>	<u>Volume</u>
26I-1-1	258ml
26I-1-2	257ml
26O-1-1	260ml
26O-1-2	240ml
26I-2-1	236ml
26I-2-2	241ml
26O-2-1	219ml
26O-2-2	226ml
26I-3-1	238ml
26I-3-2	250ml
26O-3-1	235ml
26O-3-2	235ml

APPENDIX E
QUALITY ASSURANCE

SAMPLING EQUIPMENT PRETEST AUDIT

Plant Name Meramec Run By 8/23/04 Date RDF
 City/State St. Louis, Mo Job No. 37314
 Test Loc. Unit 2 Meter No. 6663

Dry Gas Meter Reading (Cubic Ft)	Meter Temperature (Rankine)	Lower and Upper Limits for Gamma
Initial <u>262.113</u>	In <u>84</u> <u>544</u>	.97 * Y <u>.9681</u>
Final <u>269.817</u>	Out <u>86</u> <u>546</u>	1.03 * Y <u>1.0279</u>

$V_m = \underline{7.704}$

Avg. Temp. 545 $Y_c = \frac{\text{Run Time}}{V_m} \left| \frac{(0.0319) T_d}{P_{bar}} \right| \frac{1}{2}$

$Y = \underline{0.998}$

Delta H@ 3.07 $Y_c = \frac{(10)}{(7.704)} \left| \frac{0.0319 (545)}{(29.5)} \right| \frac{1}{2}$

Pbar 29.5

Run Time 10 min $Y_c = \underline{0.9965}$

Acceptable Range for Gamma
.97 * Y < Y _c < 1.03 * Y
<u>(.9681) < 0.9965 < (1.0279)</u>

Gamma acceptable between lower and upper limits? Yes No

Thermocouples *	Allowable Deviation From Ambient	Ambient Temperature, Deg. F
Dry Gas Meter	+ - 5.4 Deg. F	<u>82</u>
Impinger Exit	+ - 2.0 Deg. F	<u>82</u>
Filter Box	+ - 5.4 Deg. F	<u>83</u>
Stack **	+ - 1.5% Deg. F	<u>83</u>

* Reference Thermometer Initial Ambient Temperature, 83°

** 1.5% of the Minimum Absolute Stack Temperature

SAMPLING EQUIPMENT PRETEST AUDIT

Plant Name Meramec Run By 8/23/04 Date RDP
 City/State St. Louis, Mo Job No. 37314
 Test Loc. Unit 2 Meter No. 604

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (Rankine)	Lower and Upper Limits for Gamma
Initial 824.412	In 85 = 545	.97 * Y 1.03 * Y (.9787) (1.0393)
Final 831.924	Out 86 = 546	

$V_m = 7.512$

Avg. Temp. 545.5 $Y_c = \frac{\text{Run Time}}{V_m} \left| \frac{(0.0319) T_d}{P_{bar}} \right| 1/2$
 $Y = \frac{1.009}{0.998}$

Delta H@ 2.64 $Y_c = \left(\frac{10}{7.512} \right) \left| \frac{0.0319 (545.5)}{(29.5)} \right| 1/2$
 Pbar 29.5

Run Time 10 min $Y_c = 1.0 \frac{23}{1000}$

Acceptable Range for Gamma
.97 * Y < Yc < 1.03 * Y
(.9787) < 1.0223 < (1.0393)

Gamma acceptable between lower and upper limits? Yes No

Thermocouples *	Allowable Deviation From Ambient	Ambient Temperature, Deg. F
Dry Gas Meter	+ - 5.4 Deg. F	83
Impinger Exit	+ - 2.0 Deg. F	84
Filter Box	+ - 5.4 Deg. F	83
Stack **	+ - 1.5% Deg. F	84

* Reference Thermometer Initial Ambient Temperature, 84°

** 1.5% of the Minimum Absolute Stack Temperature _____

WEIGHT TRACEABILITY S12-
CERTIFICATE

CUSTOMER: BURNS + MC DONNELL
9400 Ward Parkway
K.C. CITY. MO. 64114
Emission Testing Lab

*This certifies that the test weights used are traceable to the
National Institute of Standards & Technology*

Sartorius Weight set ID#: 43668; 66402

Calibrated to Class: 1

Date weight set calibrated: 08/08/03

Date weight set due: 08/08/05

N.I.S.T. Test number: 3794; 3795-0803

BALANCES/SCALES CALIBRATED

TO O.E.M. SPECIFICATIONS

**CALIBRATION
DUE DATE**

MODEL	SERIAL NUMBER	CALIBRATION DUE DATE
<u>A200S</u>	<u>3800133</u>	<u>Jan 05</u>
<u>BP210S</u>	<u>50710380</u>	<u>"</u>
<u>AccuVI-1200</u>	<u>71979</u>	<u>"</u>
<u>AccuVI-1200</u>	<u>012RBZ093</u>	<u>"</u>

Ch. Gem
Service Representative

1.20.04
Date of Issue

Analysis Request / Environmental Service: Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers Page 1 of 10

1 Company Name: Burns + McDermott
 Report Address: 9400 Wood Peakway
 Billing Address: "
 City: Kennett State: MO Zip: 64114
 Phone: 816-323-9400 Fax: 816-822-3515
 Report Attention: Russell D. Fowler, Jr.
 Project Name: ADA-ES
 P.O. #:

Indicate state where samples were collected: MO

Compliance Non-Compliance

Sample Identification 2	Date Collected	Time Collected	Grab 3	Matrix 4				Total # of Containers	Air <input type="checkbox"/> Ambient <input type="checkbox"/> IH <input type="checkbox"/>	Containers*	Analysis Requested 5	Remarks 6	Temperature of samples upon receipt (if requested)
				Soil	Water <input type="checkbox"/> NPDES <input type="checkbox"/>	Other	Hg						
HgI-1-1	8/24		X			X			X		As per Ontario Hydro Method		
HgI-1-2			X		X				X				
HgI-1-3			X		X				X				
HgI-1-4			X		X				X				
HgI-1-5			X		X				X				
H ₂ O-1-1			X		X				X				
H ₂ O-1-2			X		X				X				
H ₂ O-1-3			X		X				X				
H ₂ O-1-4			X		X				X				
H ₂ O-1-5			X		X				X				

7 Turnaround Time Requested (TAT) (please circle): Normal
 Rush (Rush TAT is subject to SAMI approval and surcharge.)
 Date results are needed: _____
 Rush results requested by (please circle): Fax Mail
 Fax # 816-822-3515

8 Notes: Ontario Hydro Method
Inlet Location
Run #
HgI - 1 - 1
1 container #
per method

Date	Time	Received by:	Date	Time	Received by:	*Canister Pressure / Vacuum 10	
						Initial	Final

Analysis Request / Environmental Service Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers

Page 5 of 10

1 Company Name: Burns + McDonnell
 Report Address: 9400 Wood Parkway
 Billing Address: "
 City: Kansas City State: MO Zip: 64114
 Phone: 816-333-9400 Fax: 816-822-3515
 Report Attention: Russell D. Fowler Sr
 Project Name: ADA-E5
 P.O. #:

Indicate state where samples were collected: MO

Compliance <input type="checkbox"/> Non-Compliance <input checked="" type="checkbox"/>	Sample Identification 2	Date Collected	Time Collected	Grid 3
	MI-1-1	8/25		X
	MI-1-2			X
	MI-1-3			X
	MI-1-4			X
	MI-1-5a			X
	MI-1-5b			X
	MI-1-6			X
	MO-1-3			X
	MO-1-4			X

7 Turnaround Time Requested (TAT) (please circle): Normal
 Rush (Rush TAT is subject to SAMI approval and surcharge.)
 Date results are needed: _____
 Rush results requested by (please circle): Fax Mail
 Fax # _____

8 Notes: Metals Sample
Inlet Location
MI-1-1 Run Container

Matrix 4	Total # of Containers			Canisters* <input type="checkbox"/> Air <input type="checkbox"/> Source <input type="checkbox"/> Ambient <input type="checkbox"/> IH	Analysis Requested 5	Remarks 6	Temperature of samples upon receipt (if requested)
	Water <input type="checkbox"/> NPDES <input type="checkbox"/> Other	Soil	Other				
Sb + As + Se + Pb + Cd + Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X		As per USEPA Method 29		
As + Se	X		X				
Br + As	X		X				
Cd + Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				
Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				
Cd + Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				
Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				
Cd + Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				
Cr + Ni + Hg + Mn + Cu + Zn + Fe + Ti + Br + As	X		X				

Date	Time	Received by:	Date	Time	Received by:	Canister Pressure / Vacuum 10	
						Initial	Final

Analysis Request / Environmental Service Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers

1 Company Name
Report Address
Billing Address
City State Zip
Phone Fax
Report Attention
Project Name
P.O. #

Indicate state where samples were collected:
Compliance Non-Compliance
2 Sample Identification
Date Collected Time Collected

Sample Identification	Date Collected	Time Collected	3	4	5	6	7	8	9	10
MO-1-5a	8/25		X	X	X	X	X	X	X	As Per USEPA Method 29
MO-1-5b			X	X	X	X	X	X	X	
MI-2-1			X	X	X	X	X	X	X	
MI-2-2			X	X	X	X	X	X	X	
MI-2-3			X	X	X	X	X	X	X	
MI-2-4			X	X	X	X	X	X	X	
MI-2-5a			X	X	X	X	X	X	X	
MI-2-5b			X	X	X	X	X	X	X	
MO-2-1			X	X	X	X	X	X	X	

Matrix	4			Total # of Containers	5		Remarks
	Water	Soil	Other		Analysis Requested	Temperature of samples	
Water	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Air	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Canisters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				

7 Turnaround Time Requested (TAT) (please circle): Normal Rush (Rush TAT is subject to SAMI approval and surcharge.) Date results are needed: Rush results requested by (please circle): Fax Mail Fax #	8 Notes:	9 Relinquished by:		10 *Canister Pressure / Vacuum	
		Date	Time	Initial	Final

Analysis Request / Environmental Service Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers

Page 8 of 10

1 Company Name
Report Address
Billing Address
City State Zip
Phone Fax
Report Attention
Project Name
P.O. #

Indicate state where samples were collected:

Compliance Non-Compliance

2 Sample Identification

3 Date Collected Time Collected

Sample Identification	Date Collected	Time Collected	Composite	Grid	Soil	Water	Other	Total # of Containers	Air	Conisters
MO-3-1	4/25		X				X		<input type="checkbox"/> Source <input type="checkbox"/> Ambient	
MO-3-2			X		X					
MO-3-3			X		X					
MO-3-4			X		X					
MO-3-5a			X		X					
MO-3-5b			X		X					
M-8a .10 HU03			X	X						
M-8b DE			X	X						
M-9 HU02/H2O2			X	X						
M-10 H2SO4/NaOH			X	X						
M-12 5-11-a			X	X						

7 Turnaround Time Requested (TAT) (please circle): Normal
Rush (Rush TAT is subject to SAMI approval and surcharge.)
Date results are needed: _____
Rush results requested by (please circle): Fax Mail
Fax # _____

8 Notes:

5 Analysis Requested

6 Remarks

As per USEPA Method 29

Temperature of samples upon receipt (if requested)

9 Relinquished by: [Signature]

10 Canister Pressure / Vacuum

Received by:	Date	Time	Initial	Final	Receipt

Analysis Request / Environmental Service Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers Page 9 of 10

1 Company Name: Buss + McDonnell
 Report Address: 7400 Wood Parkway
 Billing Address: "
 City: Kearney City State: MO Zip: 64114
 Phone: 816-333-9400 Fax: 816-822-3515
 Report Attention: Russell D. Fowler Sr.
 Project Name: ADA-ES
 P.O. #: _____

Indicate state where samples were collected: MO

Compliance Non-Compliance
3 Sample Identification **2** Date Collected Time Collected

Sample Identification	Date Collected	Time Collected	Composite	Soil	Water	Other	Total # of Containers	Canisters*	Remarks
260I-1-1 (14304)	8/26		X						As per USEPA
260I-1-2 (14304)			X						Method 260a
260O-1-1			X						
260O-1-2			X						
260I-2-1			X						
260I-2-2			X						
260O-2-1			X						
260O-2-2			X						
260I-3-1			X						
260I-3-2			X						

7 Turnaround Time Requested (TAT) (please circle): Normal
 Rush (Rush TAT is subject to SAMI approval and surcharge.)
 Date results are needed: _____
 Rush results requested by (please circle): Fax _____ Mail _____
 Fax #: _____

8 Notes: Method 260a
Inlet Location
Run #
260I-1-1

4 Matrix: Air Ambient Soil Water Other Composites
 Air Source RH

5 Analysis Requested: _____
6 Remarks: _____

9 Relinquished by: Russell D. Fowler Sr. Date: 8/27
 Relinquished by: _____ Date: _____
 Relinquished by: _____ Date: _____
 Relinquished by: _____ Date: _____

10 Canister Pressure / Vacuum
 Initial Final Receipt

Analysis Request / Environmental Service Chain of Custody

318 North Harmony St.
Medina, Ohio 44256
(330) 723-0552
FAX (330) 723-0645



Please Print. Instructions on reverse side correspond with circled numbers

1 Company Name _____
 Report Address _____
 Billing Address _____
 City _____ State _____ Zip _____
 Phone _____ Fax _____
 Report Attention _____
 Project Name _____
 P.O. # _____

Indicate state where samples were collected:
 Compliance Non-Compliance
 2 State _____
 3 Sample Identification _____
 4 Date Collected _____ Time Collected _____
 5 Composite _____
 6 Grid _____

Matrix	Matrix			Total # of Containers	Canisters*	Analysis Requested					Remarks	
	Soil	Water	Other			HCL	HBR	HF	CL	BS		Temperature of samples upon receipt (if requested)
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		As per USEPA Method 269				
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>						
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>						
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>						

7 Turnaround Time Requested (TAT) (please circle): Normal
 Rush (Rush TAT is subject to SAMI approval and surcharge.)
 Date results are needed: _____
 Rush results requested by (please circle): Fax _____ Mail _____
 Fax # _____

Relinquished by:	Date	Time	Received by:	Date	Time	Canister Pressure / Vacuum	
						Initial	Final
<i>Russell P. Folsom</i>	8/27						

8 Notes:

GE Energy

Eric Ehlers
Project Manager



ISO 9001 Accredited
Quality System

SPECIATED MERCURY, HALOGENS, AND TRACE METALS EMISSIONS LONG TERM STUDY

Prepared For
ADA-ES, Inc.

Performed At
**Ameren Energy
Meramec Power Station
Unit 2 Inlet and Outlet
St. Louis, Missouri**

Test Dates
November 2 through 4, 2004

Report No.
GE Energy Management Services, Inc. Report M22E0758A

Report Submittal Date
January 31, 2005

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

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



GE Energy

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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.



Jeffrey M. Crivlare
Senior Project Manager

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GE Energy

1.0 INTRODUCTION

GE Energy Management Services, Inc., ("GE Energy") performed a long-term speciated mercury, halogens, and trace metals emission test program on the Unit 2 ESP inlet and outlet at the Meramec Power Station of Ameren Energy in St. Louis, Missouri from November 2 through 4, 2004. The tests were authorized by Ameren Energy and performed for ADA-ES, Inc. Target metals for the test program include: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag), and thallium (Tl). The halogens that were measured are: hydrogen chloride (HCl), hydrogen fluoride (HF), Bromine (Br₂), hydrogen bromide (HBr), and chlorine (Cl₂).

The purpose of this test program was to establish long term emissions for the above parameters during normal operating conditions.

1.1 Project Contact Information

Location	Address	Contact
Test Coordinator	ADA-ES, Inc. 8100 South Park Way Unit B Littleton, Colorado, 80120	Mr. Travis Starns Project Engineer 303-734-1727 (phone) 303-734-0330 (fax) traviss@adaes.com
Testing Company Representative	GE Energy Management Services, Inc. 888 Industrial Drive Elmhurst, Illinois 60126	Eric Ehlers Project Manager 630-530-6621 (phone) 630-530-6630 (fax) eric.ehlers@ps.ge.com

The tests were conducted by Messrs. J. Robertson, P. Nemeth, D. Tuidar, A. Sakellariou, M. Anderson and E. Ehlers of GE Energy.

2.0 SUMMARY OF RESULTS

The following table summarizes test results at each of the test locations:

GE Energy

Parameter	Reference Method	Unit 2 ESP Inlet (Location 1)*	Unit 2 ESP Outlet (Location 2)*	Efficiency %
Particle Bound Mercury (lbs/hr)	Ontario Hydro	0.00854	<0.00001	99.88%
Oxidized Mercury (lbs/hr)	Ontario Hydro	0.00177	0.00019	89.26%
Elemental Mercury (lbs/hr)	Ontario Hydro	0.00087	0.00040	54.02%
Total Mercury (lbs/hr)	Ontario Hydro	0.01118	0.00060	94.63%
Antimony (lbs/hr)	Method 29	<0.00430	<0.00340	20.93%
Arsenic (lbs/hr)	Method 29	0.09866	<0.00235	97.61%
Barium (lbs/hr)	Method 29	3.86400	0.13639	96.47%
Beryllium (lbs/hr)	Method 29	0.00215	<0.0110	N/A
Cadmium (lbs/hr)	Method 29	<0.00171	<0.00075	56.14%
Chromium (lbs/hr)	Method 29	0.14603	<0.00283	98.06%
Cobalt (lbs/hr)	Method 29	0.08777	<0.00331	96.22%
Copper (lbs/hr)	Method 29	0.73091	0.00384	99.47%
Lead (lbs/hr)	Method 29	0.08525	0.02504	70.63%
Manganese (lbs/hr)	Method 29	0.44211**	0.10387***	76.51%
Mercury (lbs/hr)	Method 29	0.00832	0.00088	89.42%
Nickel (lbs/hr)	Method 29	0.18117	0.00200	98.90%
Selenium (lbs/hr)	Method 29	0.05351	<0.01471	72.51%
Silver (lbs/hr)	Method 29	<0.01945	<0.00551	71.67%
Thallium (lbs/hr)	Method 29	<0.02468	<0.02205	10.66%
HCl (lbs/hr)	Method 26A	1.2809	1.0593	17.30%
HF (lbs/hr)	Method 26A	2.6545	1.8768	29.30%
HBr (lbs/hr)	Method 26A	0.5925	0.9794	N/A
Br ₂ (lbs/hr)	Method 26A	0.3025	0.2655	12.23%
Cl ₂ (lbs/hr)	Method 26A	0.3702	0.3231	12.72%

*All emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

**Test 1 not included in average due to a small amount of the KmnO₄ solution being drawn into the HNO₃/H₂O₂ solution.

***Test 1 not included in averages (statistical outlier).

GE Energy

Complete test results for all test locations and parameters are appended in Section 6.0 of this report.

3.0 DISCUSSION OF RESULTS

Source operation appeared normal during the entire test program.

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, 26A, 29 and the Ontario Hydro Method. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/4-77-027b was used to determine the precise procedures.

4.1 Volumetric Flowrate Determination

In order to determine the emission rate on a lbs/hr basis, the gas velocities and volumetric flowrates were determined using Method 2, 40CFR60.

Velocity pressures were determined by traversing the test locations with S-type pitot tubes. Temperatures were measured using K-type thermocouples with calibrated digital temperature indicators. 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. Two sample ports were utilized at each test location due to ADA-ES Inc.'s mercury sampling equipment blocking one port.

4.2 Oxygen (O₂)/Carbon Dioxide (CO₂) Determination

Oxygen (O₂) and carbon dioxide (CO₂) 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.

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4.3 Trace Metals Determination

The Method 29 trace metals sample train is one of the comprehensive sampling systems used to sample stack gas effluent. This system is based upon the design of units which are normally employed for sampling under Method 5, 40CFR60. The inlet system consisted of a quartz thimble, a Teflon coated thimble holder, probe and five impingers.

The outlet train consisted of the following components: a glass liner wrapped with heating wire and a stainless steel jacket a high efficiency quartz filter and five impingers. Samples were collected while the probe was heated to a gas temperature of $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$. The filter holder was equipped with a Teflon® filter support. The filter medium was a Pallflex 2500 QAT-UP filter exhibiting >99.99% efficiency on 0.3 micron DOP smoke particles. The filter holder was contained in an electrically heated enclosed box that was thermostatically maintained at a temperature of $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$, which is sufficient to prevent water condensation in this portion of the train.

The first and second impingers were modified versions of the Greenburg-Smith design; initially, they were filled with 200 mls of 5% HNO_3 /10% H_2O_2 . The third and fourth impingers were also Greenburg-Smith impingers. They were each filled with 100 mls of acidic KMnO_4 . The fifth impinger was filled with silica gel to absorb any remaining moisture.

A total number of 24 points using 2 ports were utilized at both the Unit 2 ESP Inlet and Outlet test locations. Point locations were selected in accordance with Method 1, 40CFR60. Tests were performed for two hours.

All sample contact surfaces of the train were washed with 0.1 N nitric acid. The first two impingers were also washed with 0.1N nitric acid. The third and fourth impingers were rinsed with demineralized water and 8N HCl. The washes were placed in sealed and marked containers for analysis.

4.4 Speciated Mercury Determination

A total of 24 test points were sampled using two (2) ports at the Unit 2 ESP Inlet and Outlet test locations.

The speciated mercury sample train was manufactured by Nutech Corporation of Durham, North Carolina and meets all specifications required by The Ontario Hydro Method. A glass-lined probe was used at the Unit 2 ESP Outlet location while a Teflon lined probe was used at the Inlet location. Drawings depicting the sampling ports, test point locations, and sample trains are appended to this report. Velocity pressures were determined simultaneously during sampling with a calibrated S-type pitot tube and inclined manometer. All temperatures were

GE Energy

measured using K-type thermocouples with calibrated digital temperature indicators.

The outlet filter media were quartz filters exhibiting a $\geq 99.97\%$ efficiency on 0.3 micron DOP smoke particles in accordance with ASTM Standard Method D-2986-71. The inlet test employed a quartz-thimble prefilter. All sample contact surfaces of the train were washed with 0.1 N Nitric Acid. These washes were placed in sealed and marked containers for analysis. All sample recovery of impinger solutions was performed on site.

4.5 Halogen Determination

Hydrogen chloride (HCl), hydrogen fluoride (HF), hydrogen bromide (HBr), Bromine (Br₂) and chlorine (Cl₂) concentrations were determined using Method 26A, 40CFR60. An integrated sample was extracted isokinetically from each gas stream and passed through dilute (0.1 N) sulfuric acid. In the dilute acid, the HCl dissolved and formed chloride (Cl) ions. The chloride ions were then analyzed by ion chromatography. Each sample train consisted of a heated glass probe liner, a heated optional filter, and five impingers. The first and second impingers contained the dilute sulfuric acid, the third and fourth impingers contained a 0.1 N sodium hydroxide (NaOH) scrubber solution to remove any remaining chlorine, and the fourth impinger contained silica gel to absorb any remaining moisture. Each train was leak checked prior to and after each run. The samples were recovered quantitatively transferring the contents of the impingers and deionized water rinses to sample jars. The samples were mixed and labeled, and the level marked for transfer to the laboratory. The samples were then analyzed by ion chromatography.

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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 or at the jobsite 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, all reagent standardizations were performed daily by the same person performing the analysis.

Dry 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

GE Energy

HALOGEN TEST RESULTS SUMMARY

Company: Ameren
 Plant: Meramec
 Unit: Unit 2 ESP Inlet

Test Run Number	1	2	3	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	15:00	14:00	14:04	
End Time	17:02	16:05	15:56	
HCl Emissions:				
ppm:	0.77	0.61	0.87	0.75
ug/dncm	1257.25	996.16	1413.59	1222.33
lb/hr*	1.3206	1.0611	1.4611	1.2809
tons/yr*	5.7843	4.6476	6.3995	5.6105
lb/mmBtu	0.00088	0.00072	0.00098	0.00086
lb/TBtu	884.57416	717.87051	977.22568	859.89012
HF Emissions:				
ppm:	2.24	0.61	5.73	2.86
ug/dncm	1997.11	540.47	5117.97	2551.85
lb/hr*	2.0978	0.5757	5.2899	2.6545
tons/yr*	9.1883	2.5215	23.1697	11.6265
lb/mmBtu	0.00141	0.00039	0.00354	0.00178
lb/TBtu	1405.12603	389.48294	3538.09773	1777.56890
HBr Emissions:				
ppm:	0.16	0.17	0.14	0.16
ug/dncm	579.47	614.65	497.27	563.80
lb/hr*	0.6087	0.6547	0.5140	0.5925
tons/yr*	2.6660	2.8676	2.2512	2.5950
lb/mmBtu	0.00041	0.00044	0.00034	0.00040
lb/TBtu	407.70496	442.94138	343.76714	398.13783
Stack Parameters:				
Gas Volumetric Flow Rate, acfm	273,621	274,618	270,968	273,069
Gas Volumetric Flow Rate, dscfm	150,474	152,589	148,065	150,376
Average Gas Temperature, °F	326.0	325.2	323.5	324.9
Average Gas Velocity, ft/sec	55.846	56.049	55.304	55.733
Flue Gas Moisture, percent by volume	12.9	12.9	14.1	13.3
Average Flue Pressure, in. Hg	28.13	28.40	28.24	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ , by volume, dry basis	14.8	14.2	15.0	14.7
Average %O ₂ , by volume, dry basis	4.0	4.4	3.7	4.0
Dry Molecular Wt. of Gas, lb/lb-mole	30.528	30.448	30.548	
Gas Sample Volume, dscf	73.250	71.523	67.829	
Isokinetic Variance	99.6	95.9	102.3	

*Emission rates are doubled assuming equal emissions on second "pant leg" of the system.

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HALOGEN TEST RESULTS SUMMARY

Company: Ameren
Plant: Meramec
Unit: Unit 2 ESP Inlet

Test Run Number	0	0	0	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	15:00	14:00	14:04	
End Time	17:02	16:05	15:56	
Cl₂ Emissions:				
ppm:	0.10	0.09	0.08	0.09
ug/dncm	315.60	296.73	251.43	287.92
lb/hr*	0.3315	0.3161	0.2599	0.3025
tons/yr*	1.4520	1.3844	1.1382	1.3249
lb/mmBtu	0.00022	0.00021	0.00017	0.00020
lb/TBtu	222.05359	213.83377	173.81484	203.23407
Br₂ Emissions:				
ppm:	0.05	0.06	0.04	0.05
ug/dncm	346.65	402.70	307.30	352.22
lb/hr*	0.3641	0.4289	0.3176	0.3702
tons/yr*	1.5949	1.8788	1.3912	1.6216
lb/mmBtu	0.00024	0.00029	0.00021	0.00025
lb/TBtu	243.89493	290.20297	212.44037	248.84609
Stack Parameters:				
Gas Volumetric Flow Rate, acfm	273,621	274,618	270,968	273,069
Gas Volumetric Flow Rate, dscfm	150,474	152,589	148,065	150,376
Average Gas Temperature, °F	326.0	325.2	323.5	324.9
Average Gas Velocity, ft/sec	55.846	56.049	55.304	55.733
Flue Gas Moisture, percent by volume	12.9	12.9	14.1	13.3
Average Flue Pressure, in. Hg	28.13	28.40	28.24	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ , by volume, dry basis	14.8	14.2	15.0	14.7
Average %O ₂ , by volume, dry basis	4.0	4.4	3.7	4.0
Dry Molecular Wt. of Gas, lb/lb-mole	30.528	30.448	30.548	
Gas Sample Volume, dscf	73.250	71.523	67.829	
Isokinetic Variance	99.6	95.9	102.3	

*Emission rates are doubled assuming equal emissions on second "pant leg" of the system.

GE Energy

HALOGEN TEST RESULTS SUMMARY

Company: Ameren
Plant: Meramec
Unit: Unit 2 ESP Outlet

Test Run Number	1	2	3	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	15:00	14:00	14:04	
End Time	17:04	16:03	16:06	
HCl Emissions:				
ppm:	0.77	0.45	0.75	0.66
ug/dncm	1226.53	713.85	1227.84	1056.08
lb/hr*	1.2107	0.7253	1.2420	1.0593
tons/yr*	5.3028	3.1769	5.4401	4.6399
lb/mmBtu	0.00087	0.00050	0.00087	0.00075
lb/TBtu	873.30176	499.29912	869.02927	747.21005
HF Emissions:				
ppm:	1.57	0.36	4.34	2.09
ug/dncm	1404.66	321.23	3872.82	1866.24
lb/hr*	1.3865	0.3264	3.9176	1.8768
tons/yr*	6.0729	1.4296	17.1591	8.2206
lb/mmBtu	0.00100	0.00022	0.00274	0.00132
lb/TBtu	1000.12982	224.68460	2741.06314	1321.95919
HBr Emissions:				
ppm:	0.12	0.24	0.44	0.27
ug/dncm	427.51	877.02	1606.43	970.32
lb/hr*	0.4220	0.8911	1.6250	0.9794
tons/yr*	1.8483	3.9030	7.1175	4.2896
lb/mmBtu	0.00030	0.00061	0.00114	0.00068
lb/TBtu	304.38734	613.42463	1136.97996	684.93064
Stack Parameters:				
Gas Volumetric Flow Rate, acfm	261,093	259,834	258,003	259,644
Gas Volumetric Flow Rate, dscfm	141,402	145,553	144,909	143,955
Average Gas Temperature, °F	313.1	313.9	310.8	312.6
Average Gas Velocity, ft/sec	53.289	53.032	52.658	52.993
Flue Gas Moisture, percent by volume	15.1	12.9	12.6	13.5
Average Flue Pressure, in. Hg	27.94	28.22	28.06	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ by volume, dry basis	14.4	14.6	13.9	14.3
Average %O ₂ by volume, dry basis	4.2	3.9	4.1	4.1
Dry Molecular Wt. of Gas, lb/lb-mole	30.472	30.492	30.388	
Gas Sample Volume, dscf	74.466	74.325	74.078	
Isokinetic Variance	105.2	102.0	102.1	

* Emission rates are doubled assuming equal emissions on second "pant leg" of the system

GE Energy

HALOGEN TEST RESULTS SUMMARY

Company: Ameren
 Plant: Meramec
 Unit: Unit 2 ESP Outlet

Test Run Number	1	2	3	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	15:00	14:00	14:04	
End Time	17:04	16:03	16:06	
Cl₂ Emissions:				
ppm:	0.06	0.09	0.10	0.08
ug/dncm	203.57	285.54	301.84	263.65
lb/hr*	0.2009	0.2901	0.3053	0.2655
tons/yr*	0.8801	1.2708	1.3374	1.1628
lb/mmBtu	0.00014	0.00020	0.00021	0.00019
lb/TBtu	144.94635	199.71965	213.63636	186.10079
Br₂ Emissions:				
ppm:	0.04	0.05	0.04	0.05
ug/dncm	310.45	367.12	286.50	321.36
lb/hr*	0.3064	0.3730	0.2898	0.3231
tons/yr*	1.3422	1.6338	1.2694	1.4151
lb/mmBtu	0.00022	0.00026	0.00020	0.00023
lb/TBtu	221.04318	256.78240	202.77350	226.86636
Stack Parameters:				
Gas Volumetric Flow Rate, acfm	261,093	259,834	258,003	259,644
Gas Volumetric Flow Rate, dscfm	141,402	145,553	144,909	143,955
Average Gas Temperature, °F	313.1	313.9	310.8	312.6
Average Gas Velocity, ft/sec	53.289	53.032	52.658	52.993
Flue Gas Moisture, percent by volume	15.1	12.9	12.6	13.5
Average Flue Pressure, in. Hg	27.94	28.22	28.06	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ , by volume, dry basis	14.4	14.6	13.9	14.3
Average %O ₂ , by volume, dry basis	4.2	3.9	4.1	4.1
Dry Molecular Wt. of Gas, lb/lb-mole	30.472	30.492	30.388	
Gas Sample Volume, dscf	74.466	74.325	74.078	
Isokinetic Variance	105.2	102.0	102.1	

* Emission rates are doubled assuming equal emissions on second "pant leg" of the system

GE Energy

SPECIATED MERCURY TEST RESULTS SUMMARY

Company: Ameren
Plant: Meramec
Unit: Unit 2 ESP Inlet

Test Run Number	1	2	3	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	9:45	8:55	8:30	
End Time	11:50	10:57	10:40	
Particle Bound Mercury Emissions				
ppm	0.000766	0.000714	0.001348	0.000943
ug/dncm	6.86	6.39	12.08	8.44
lb/hr*	0.00671	0.00648	0.01242	0.00854
tons/yr*	0.029409	0.028377	0.054400	0.037395
lb/mmBtu	0.0000048	0.0000048	0.0000083	0.0000059
lb/Tbtu	4.76828	4.77944	8.30097	5.94956
Elemental Mercury Emissions				
ppm	0.000057	0.000042	0.000188	0.000095
ug/dncm	0.51	0.37	1.68	0.85
lb/hr*	0.00050	0.00038	0.00173	0.00087
tons/yr*	0.002194	0.001655	0.007569	0.003806
lb/mmBtu	0.0000004	0.0000003	0.0000003	0.0000003
lb/Tbtu	0.35579	0.27880	0.27880	0.30446
Oxidized Mercury Emissions				
ppm	0.000037	0.000115	0.000428	0.000193
ug/dncm	0.33	1.03	3.83	1.73
lb/hr*	0.00033	0.00105	0.00394	0.00177
tons/yr*	0.001425	0.004588	0.017266	0.007760
lb/mmBtu	0.0000002	0.0000008	0.0000026	0.0000012
lb/Tbtu	0.23108	0.77268	2.63466	1.21280
Total Mercury Emissions				
ppm	0.000860	0.000871	0.001964	0.001231
ug/dncm	7.70	7.80	17.59	11.03
lb/hr*	0.00754	0.00790	0.01809	0.01118
tons/yr*	0.033028	0.034621	0.079235	0.048961
lb/mmBtu	0.0000054	0.0000058	0.0000121	0.0000078
lb/Tbtu	5.35514	5.83092	12.09054	7.75887
Stack Parameters:				
Average Gas Temperature, °F	322.5	326.2	321.8	323.5
Average Gas Velocity, ft/sec	53.275	53.914	54.569	53.919
Flue Gas Moisture, percent by volume	15.3	13.8	13.5	14.2
Average Flue Pressure, in. Hg	28.13	28.40	28.20	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ , by volume, dry basis	14.8	14.0	14.0	14.3
Average %O ₂ , by volume, dry basis	3.8	5.0	3.6	4.1
Dry Molecular Wt. of Gas, lb/lb-mole	30.520	30.440	30.384	
Gas Sample Volume, dscf	71.846	71.158	72.173	
Isokinetic Variance	104.8	100.3	100.3	

*Emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

GE Energy

SPECIATED MERCURY TEST RESULTS SUMMARY

Company: Ameren
 Plant: Meramec
 Unit: Unit 2 ESP Outlet

Test Run Number	1	2	3	Average
Source Condition	Normal	Normal	Normal	
Date	11/2/2004	11/3/2004	11/4/2004	
Start Time	9:45	8:55	8:30	
End Time	11:50	10:58	10:32	
Particle Bound Mercury Emissions				
ppm	0.000001	0.000002	0.000001	0.000001
ug/dncm	0.01	0.01	0.01	0.01
lb/hr*	0.00001	0.00001	0.00001	0.00001
tons/yr*	0.000043	0.000063	0.000023	0.000043
lb/mmBtu	0.0000000	0.0000000	0.0000000	0.0000000
lb/Tbtu	0.00684	0.01047	0.00353	0.00695
Elemental Mercury Emissions				
ppm	0.000025	0.000034	0.000074	0.000044
ug/dncm	0.22	0.31	0.66	0.40
lb/hr*	0.00022	0.00031	0.00067	0.00040
tons/yr*	0.000968	0.001373	0.002934	0.001758
lb/mmBtu	0.0000002	0.0000002	0.0000002	0.0000002
lb/Tbtu	0.15392	0.22809	0.22809	0.20337
Oxidized Mercury Emissions				
ppm	0.000011	0.000009	0.000041	0.000021
ug/dncm	0.10	0.08	0.37	0.18
lb/hr*	0.00010	0.00008	0.00038	0.00019
tons/yr*	0.000452	0.000360	0.001647	0.000820
lb/mmBtu	0.0000001	0.0000001	0.0000003	0.0000001
lb/Tbtu	0.07183	0.05983	0.25784	0.12983
Total Mercury Emissions				
ppm	0.000037	0.000045	0.000116	0.000066
ug/dncm	0.33	0.40	1.04	0.59
lb/hr*	0.00033	0.00041	0.00105	0.00060
tons/yr*	0.001462	0.001796	0.004604	0.002621
lb/mmBtu	0.0000002	0.0000003	0.0000007	0.0000004
lb/Tbtu	0.23259	0.29839	0.72055	0.41718
Stack Parameters:				
Average Gas Temperature, °F	309.8	314.9	308.6	311.1
Average Gas Velocity, ft/sec	51.828	53.249	52.894	52.657
Flue Gas Moisture, percent by volume	11.6	12.7	13.0	12.4
Average Flue Pressure, in. Hg	27.94	28.22	28.06	
Barometric Pressure, in. Hg	29.56	29.76	29.60	
Average %CO ₂ , by volume, dry basis	14.4	13.6	13.6	13.9
Average %O ₂ , by volume, dry basis	3.9	4.9	3.8	4.2
Dry Molecular Wt. of Gas, lb/lb-mole	30.460	30.372	30.328	
Gas Sample Volume, dscf	77.497	75.322	74.609	
Isokinetic Variance	107.6	102.8	102.6	

*Emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

GE Energy

Ameren - Meramec Station
Unit 2 ESP Inlet
Trace Metals Summary
Tests 1 through 3 Averages
November 2 through 4, 2004

Parameter	Concentration (lbs/dnct)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dnctm
Antimony	< 2.3414E-10	< 0.000742	< 0.00430	< 0.01886	< 1.639E-06	< 9.328E-07	< 2.813E-06	< 2.8134	< 3.751
Arsenic	5.3026E-09	0.027291	0.09866	0.43214	3.712E-05	2.196E-05	6.35E-05	63.4970	84.939
Barium	2.1303E-07	0.598091	3.86400	16.92434	1.49E-03	8.33E-04	2.63E-03	2628.9141	3412.340
Beryllium	1.1485E-10	0.004915	0.00215	0.00940	8.04E-07	4.807E-07	1.367E-06	1.3672	1.840
Cadmium	< 9.2019E-11	< 0.000316	< 0.00171	< 0.00749	< 6.441E-07	< 3.796E-07	< 1.103E-06	< 1.1029	< 1.474
Chromium	7.9038E-09	0.058620	0.14603	0.63960	5.533E-05	3.21E-05	9.512E-05	95.1235	126.606
Cobalt	4.7641E-09	0.031173	0.08777	0.38445	3.335E-05	1.918E-05	5.74E-05	57.4014	76.314
Copper	3.9602E-08	0.240290	0.73091	3.20140	0.0002772	0.0001602	4.76E-04	476.4783	634.366
Lead	4.7213E-09	0.008787	0.08525	0.37337	3.305E-05	1.829E-05	5.862E-05	58.6206	75.628
Manganese**	2.37E-08	0.166601	0.44211	1.93642	1.66E-04	9.72E-05	2.80E-04	280.4610	380.237
Mercury	4.4792E-10	0.000861	0.00832	0.03643	3.135E-06	1.84E-06	5.358E-06	5.3579	7.175
Nickel	9.7774E-09	0.064216	0.18117	0.79352	6.844E-05	3.998E-05	0.0001173	117.2972	156.618
Selenium	2.8809E-09	0.014069	0.05351	0.23435	2.017E-05	1.186E-05	3.452E-05	34.5238	46.147
Silver	< 1.0534E-09	< 0.003765	< 0.01945	< 0.08519	< 7.374E-06	< 4.288E-06	< 1.273E-05	< 12.7284	< 16.873
Thallium	< 1.3412E-09	< 0.002530	< 0.02468	< 0.10810	< 9.388E-06	< 5.375E-06	< 1.616E-05	< 16.1598	< 21.484

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

** Test 1 not included in average due to a small amount of the KMnO₄ solution being drawn into HNO₃/H₂O₂ solution.

GE Energy

Ameren - Meramec Station
Unit 2 ESP Outlet
Trace Metals Summary
Tests 1 through 3 Averages
November 2 through 4, 2004

Parameter	Concentration (lbs/dmcf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dncm
Antimony	< 1.9573E-10	< 0.000620	< 0.00340	< 0.01489	< 1.37E-06	< 7.634E-07	< 2.485E-06	< 2.4849	< 3.135
Arsenic	< 1.3569E-10	< 0.000698	< 0.00235	< 0.01031	< 9.498E-07	< 5.29E-07	< 1.723E-06	< 1.7227	< 2.174
Barium	7.8484E-09	0.022035	0.13639	0.59739	5.49E-05	3.06E-05	9.96E-05	99.6410	125.719
Beryllium	< 6.3497E-11	< 0.002717	< 0.00110	< 0.00483	< 4.445E-07	< 2.477E-07	< 8.061E-07	< 0.8061	< 1.017
Cadmium	< 4.33E-11	< 0.000149	< 0.00075	< 0.00330	< 3.031E-07	< 1.688E-07	< 5.497E-07	< 0.5497	< 0.694
Chromium	< 1.6303E-10	< 0.001209	< 0.00283	< 0.01239	< 1.141E-06	< 6.352E-07	< 2.07E-06	< 2.0697	< 2.611
Cobalt	< 1.9049E-10	< 0.001246	< 0.00331	< 0.01449	< 1.333E-06	< 7.43E-07	< 2.418E-06	< 2.4184	< 3.051
Copper	2.2078E-10	0.001340	0.00384	0.01681	1.545E-06	8.612E-07	2.80E-06	2.8029	3.536
Lead	1.4402E-09	0.002680	0.02504	0.10968	1.008E-05	5.631E-06	1.828E-05	18.2848	23.070
Manganese**	5.99E-09	0.042031	0.10387	0.45496	4.19E-05	2.34E-05	7.60E-05	76.03055	95.92896
Mercury	5.1039E-11	0.000098	0.00088	0.00387	3.573E-07	1.987E-07	6.48E-07	0.6480	0.818
Nickel	1.1535E-10	0.000758	0.00200	0.00877	8.074E-07	4.498E-07	1.464E-06	1.4644	1.848
Selenium	< 8.4905E-10	< 0.004146	< 0.01471	< 0.06444	< 5.943E-06	< 3.307E-06	< 1.078E-05	< 10.7793	< 13.600
Silver	< 3.1748E-10	< 0.001135	< 0.00551	< 0.02415	< 2.222E-06	< 1.238E-06	< 4.031E-06	< 4.0307	< 5.086
Thallium	< 1.2699E-09	< 0.002396	< 0.02205	< 0.09658	< 8.89E-06	< 4.953E-06	< 1.612E-05	< 16.1227	< 20.342

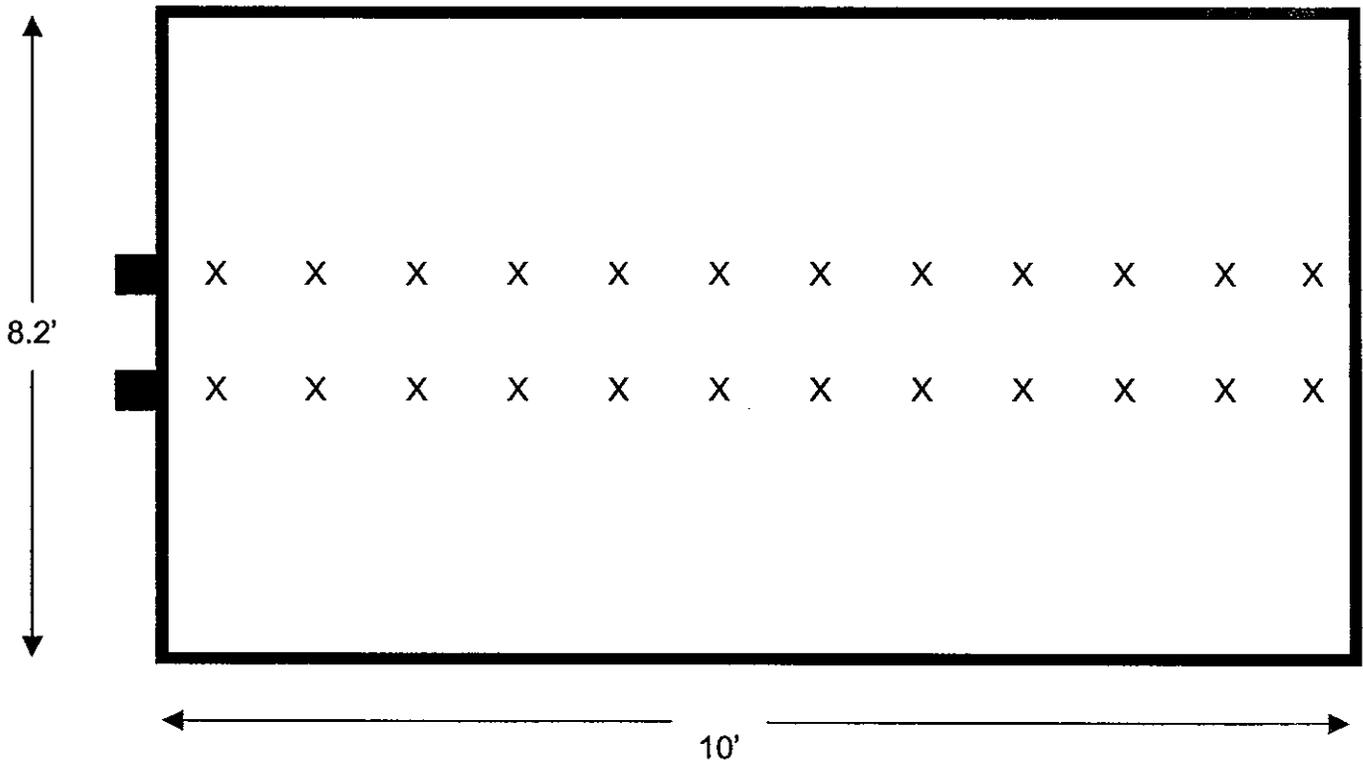
*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

** Test 1 not included in averages (statistical outlier).

GE Energy

APPENDIX

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Ameren Energy
St. Louis, Missouri

Date: November 2 through 4, 2004

Area: 81.67 Square Feet

Test Location: Unit 2 ESP Inlet

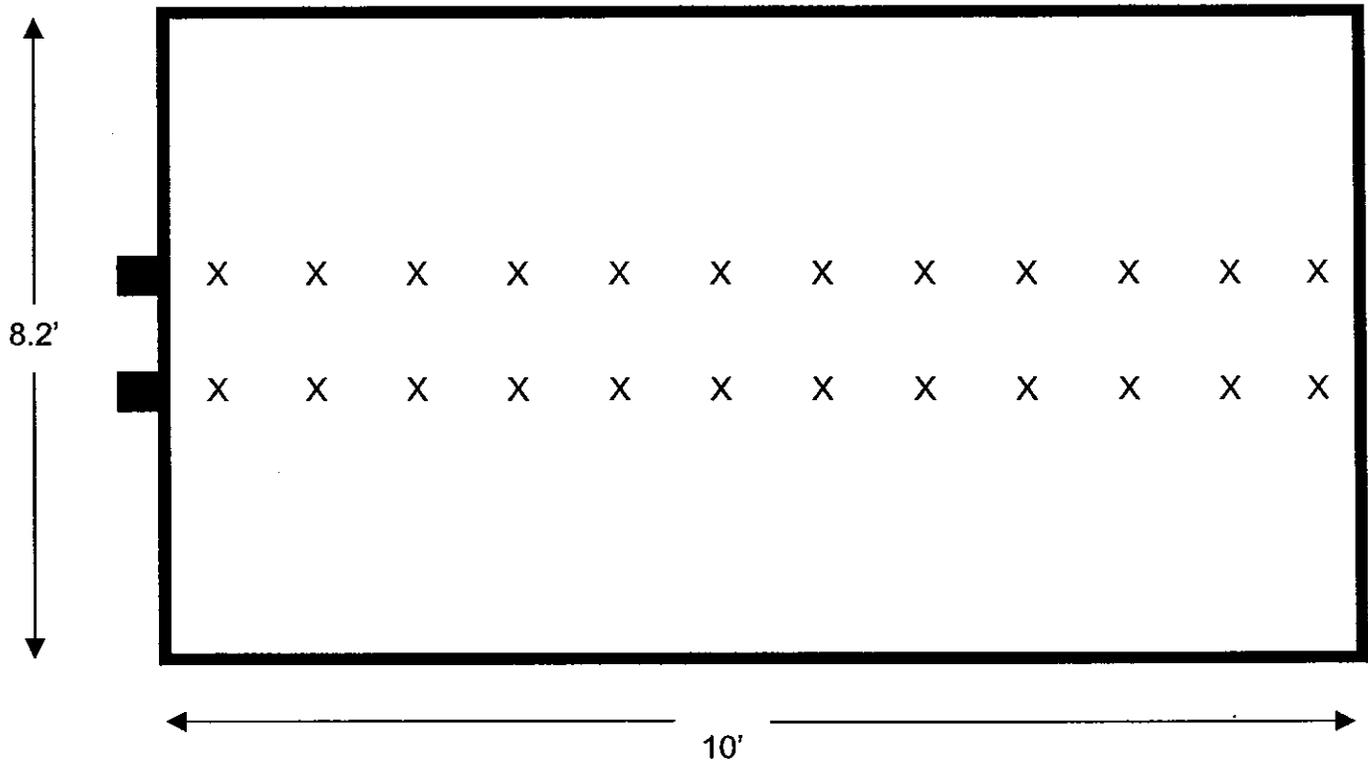
No. Test Ports: 2

Length: 10 Feet

Tests Points per Port: 12

Width: 8.2 Feet

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Ameren Energy
St. Louis, Missouri

Date: November 2 through 4, 2004

Area: 81.67 Square Feet

Test Location: Unit 2 ESP Outlet

No. Test Ports: 2

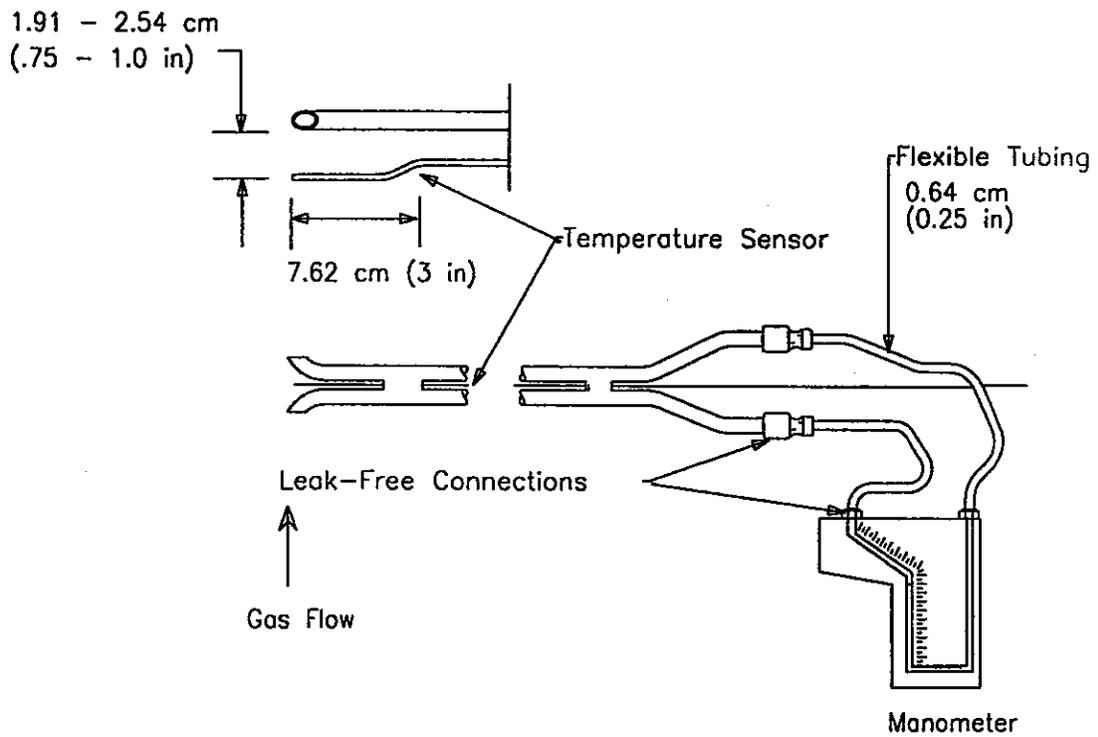
Length: 10 Feet

Tests Points per Port: 12

Width: 8.2 Feet

S-Type Pitot Tube Manometer Assembly

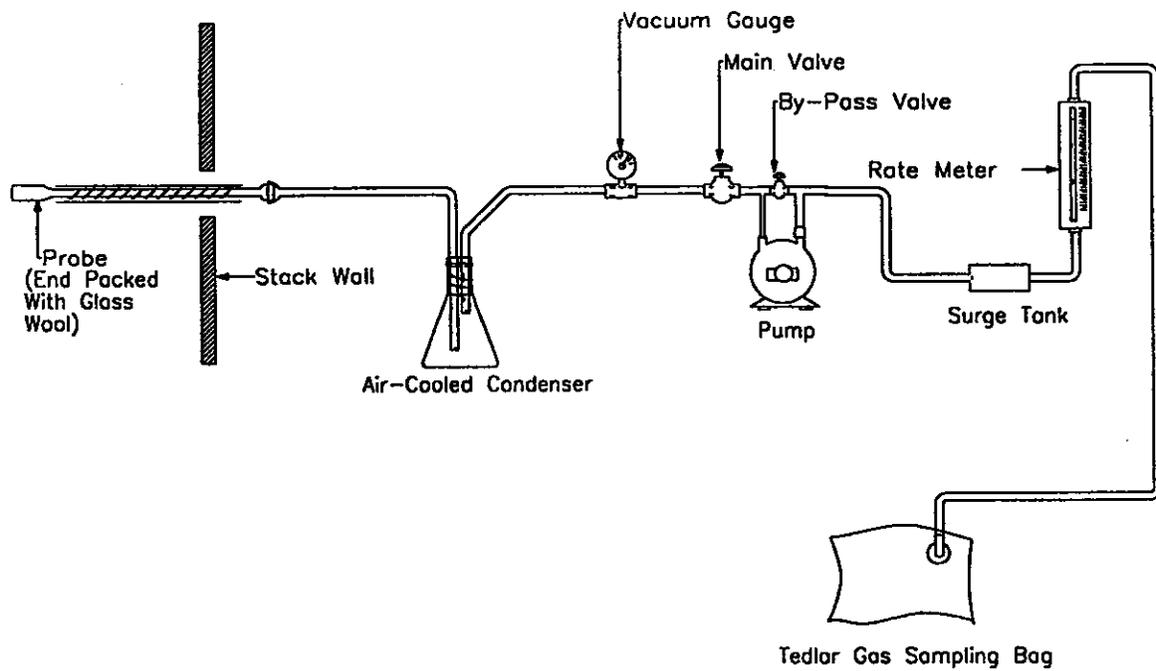
USEPA Method 2



Dwg - AD

Sampling Train for Integrated Gas Sampling

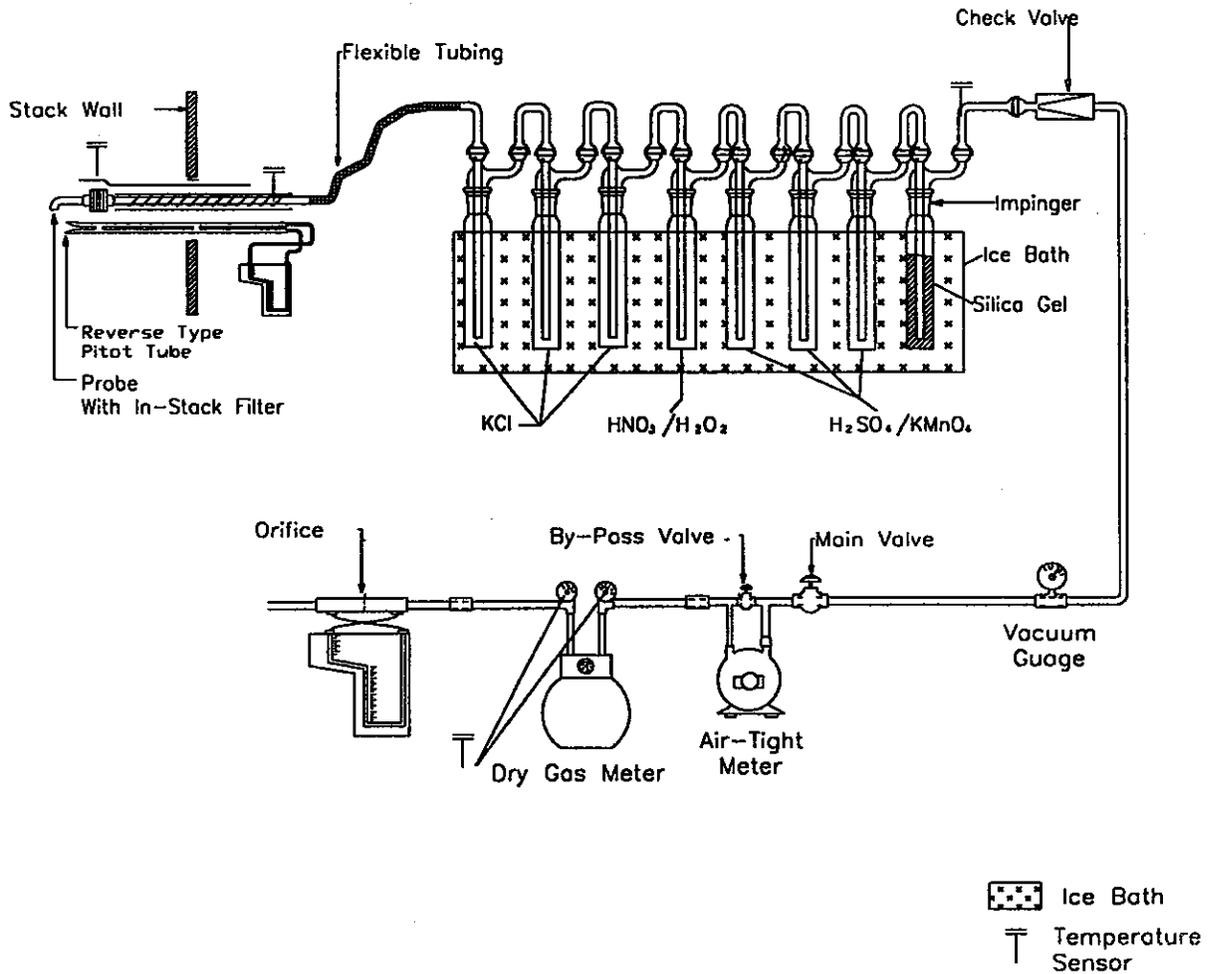
USEPA Method 3



Dwg - E

Speciated Mercury Sampling Train Equipped with In-Stack Filter

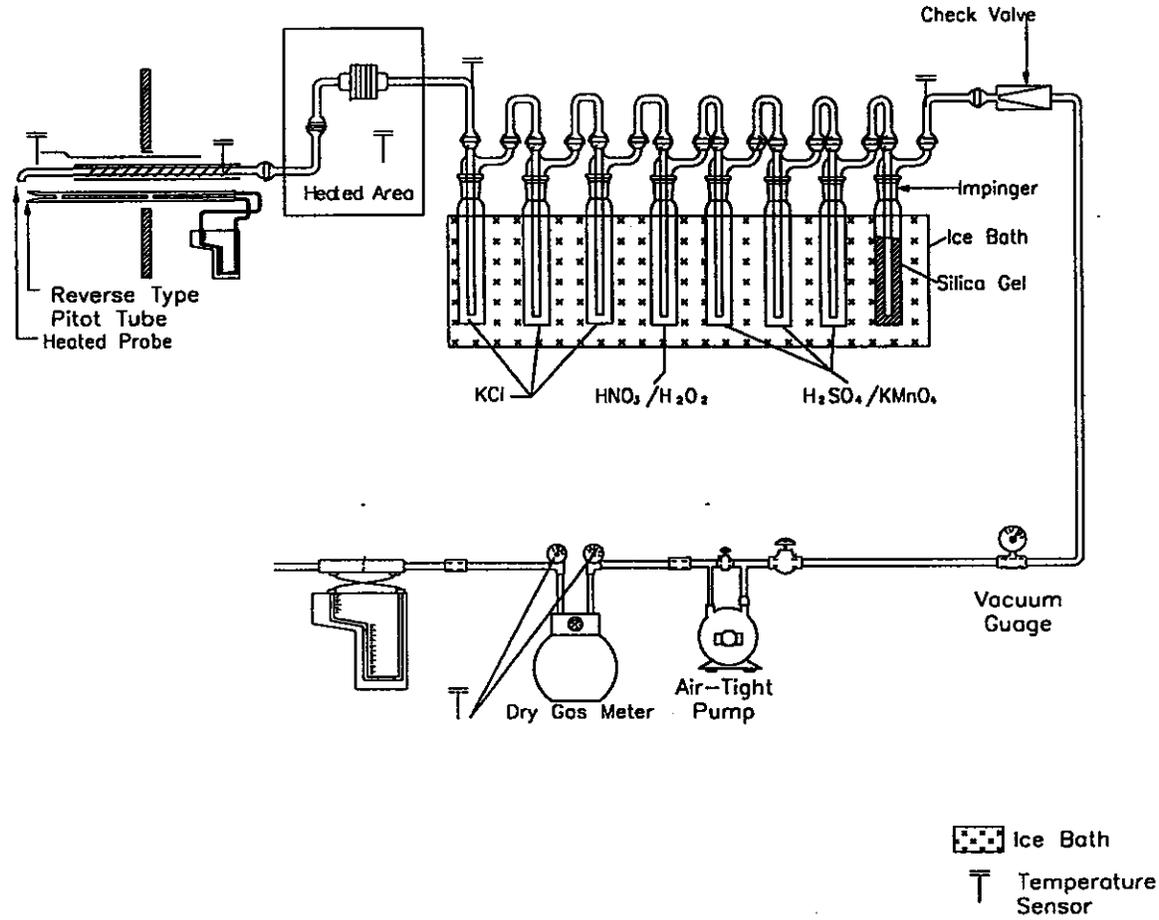
USEPA Ontario Hydro Method



Dwg - P1

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

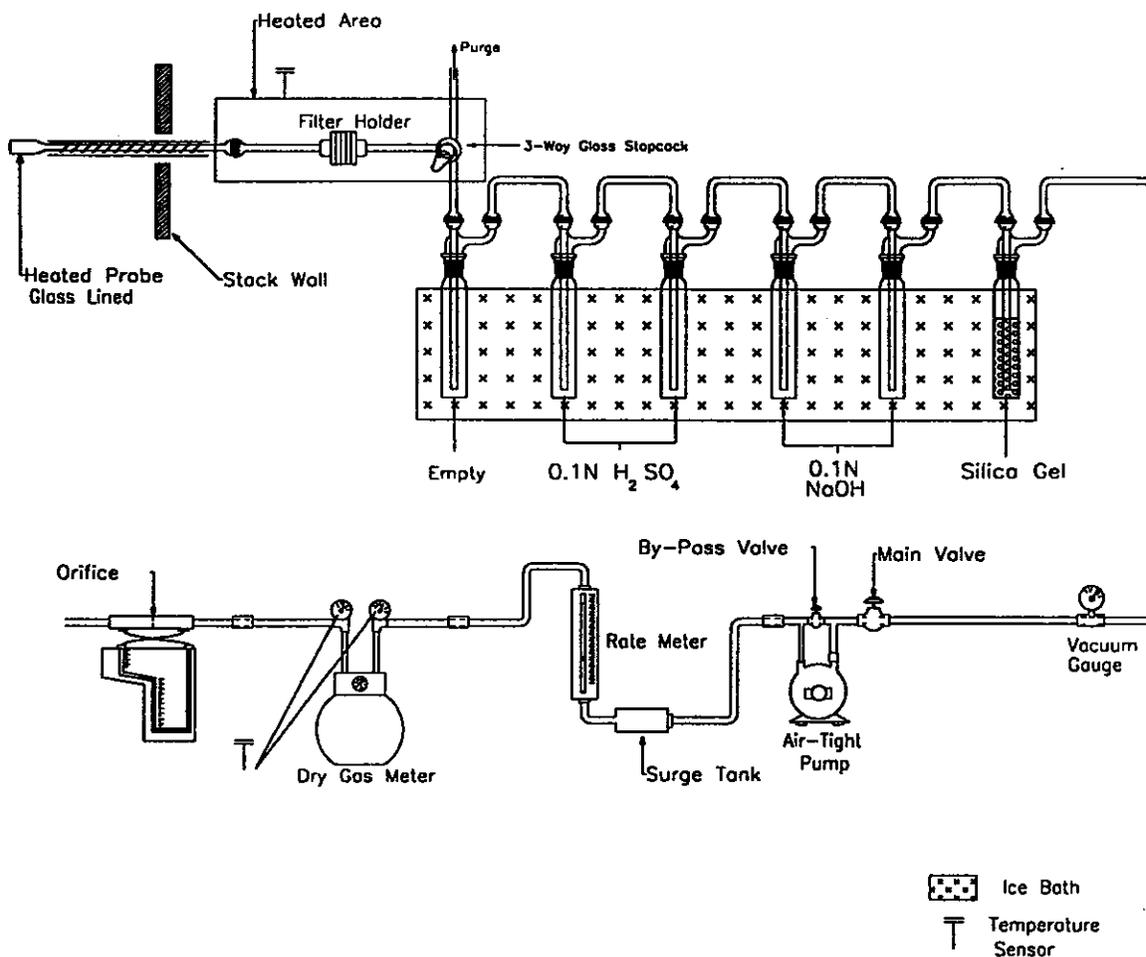
USEPA Ontario Hydro Method



Dwg - P2

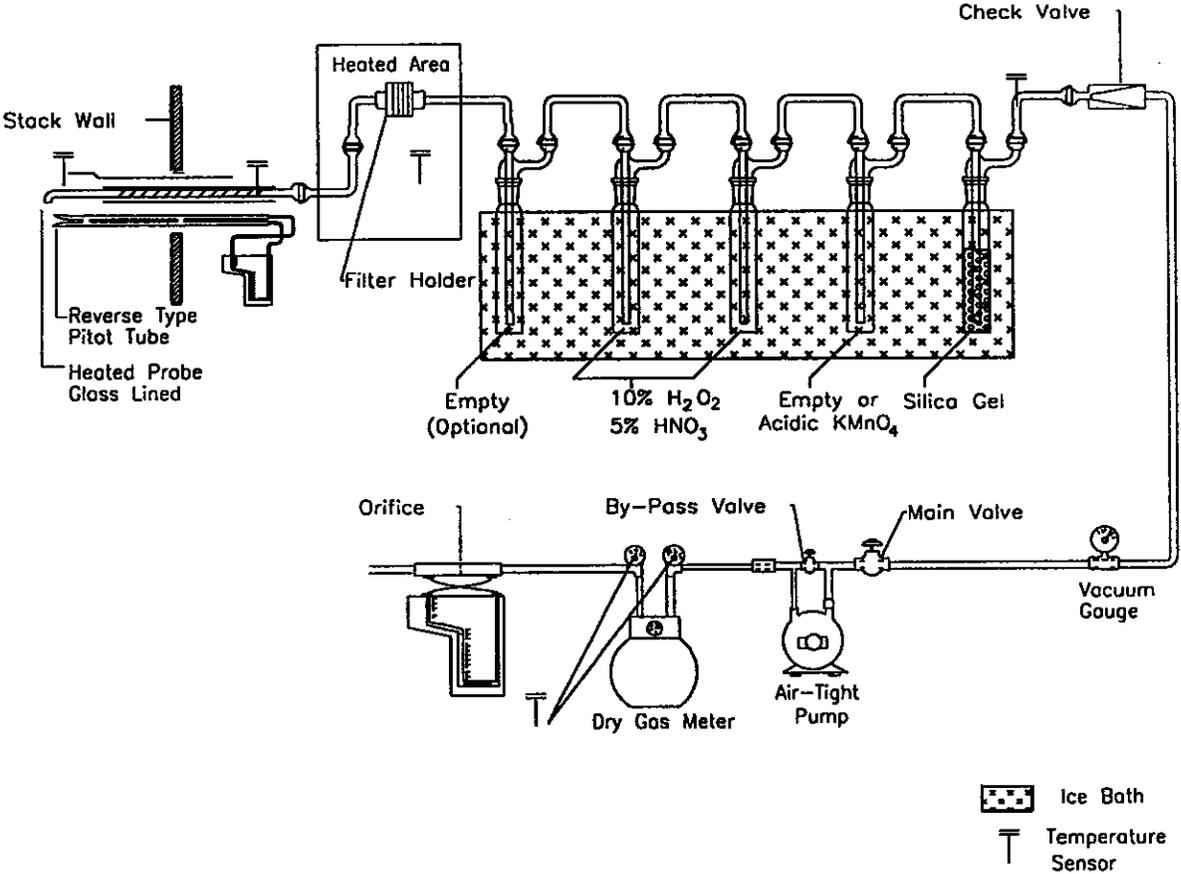
Determination of Halogen Concentrations in Stack Gases

USEPA Method 26A Sample Train



Dwg - R

Determination of Trace Metal Concentrations in Emissions From Stationary Sources



Dwg - AQ

LABORATORY REPORT

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PREPARED FOR:

PAGE 1 of 20

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number:	66527	Sample:	001	#1 Inlet	
TEST		RESULTS			DATE PERFORMED
HBr (M26A)		1.12	mg		11/9/2004
HCl (M26A)		2.43	mg		11/9/2004
HF (M26A)		3.86	mg		11/9/2004
TEI Number:	66528	Sample:	002	#2 Inlet	
TEST		RESULTS			DATE PERFORMED
HBr (M26A)		1.16	mg		11/9/2004
HCl (M26A)		1.88	mg		11/9/2004
HF (M26A)		1.02	mg		11/9/2004
TEI Number:	66529	Sample:	003	#3 Inlet	
TEST		RESULTS			DATE PERFORMED
HBr (M26A)		0.89	mg		11/10/2004
HCl (M26A)		2.53	mg		11/10/2004
HF (M26A)		9.16	mg		11/10/2004

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Report #: 66527
Report Date: 11/30/2004
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11/8/04 12:20

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TEI Number:	66530	Sample:	004 #1 outlet
TEST		RESULTS	DATE PERFORMED
HBr (M26A)		0.84 mg	11/10/2004
HCl (M26A)		2.41 mg	11/10/2004
HF (M26A)		2.76 mg	11/10/2004
TEI Number:	66531	Sample:	005 #2 outlet
TEST		RESULTS	DATE PERFORMED
HBr (M26A)		1.72 mg	11/10/2004
HCl (M26A)		1.40 mg	11/10/2004
HF (M26A)		0.63 mg	11/10/2004
TEI Number:	66532	Sample:	006 #3 outlet
TEST		RESULTS	DATE PERFORMED
HBr (M26A)		3.14 mg	11/10/2004
HCl (M26A)		2.40 mg	11/10/2004
HF (M26A)		7.57 mg	11/10/2004

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Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66533	Sample: 007 <i>H₂O₂ Blank</i>		
TEST	RESULTS		DATE PERFORMED
HBr (M26A)	<0.01 mg		11/10/2004
HCl (M26A)	<0.01 mg		11/10/2004
HF (M26A)	<0.01 mg		11/10/2004
TEI Number: 66534	Sample: 008 <i>#1 Inlet</i>		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.67 mg		11/10/2004
Chlorine (M26A)	0.73 mg		11/10/2004
TEI Number: 66535	Sample: 009 <i>#2 Inlet</i>		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.76 mg		11/10/2004
Chlorine (M26A)	0.68 mg		11/10/2004
TEI Number: 66536	Sample: 010 <i>#3 Inlet</i>		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.55 mg		11/10/2004
Chlorine (M26A)	0.57 mg		11/10/2004

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 Elmhurst, IL 60120

Report #: 66527
 Report Date: 11/30/2004
 Sample Received:
 11/8/04 12:20

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TEI Number: 66537	Sample: 011 #1 outlet		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.61 mg		11/10/2004
Chlorine (M26A)	0.52 mg		11/10/2004
TEI Number: 66538	Sample: 012 #2 outlet		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.72 mg		11/10/2004
Chlorine (M26A)	0.68 mg		11/10/2004
TEI Number: 66539	Sample: 013 #3 outlet		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	0.56 mg		11/10/2004
Chlorine (M26A)	0.71 mg		11/10/2004
TEI Number: 66540	Sample: 014 Blank		
TEST	RESULTS		DATE PERFORMED
Bromine (M26A)	<0.01 mg		11/10/2004
Chlorine (M26A)	0.12 mg		11/10/2004

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

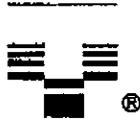
M22E0758-01

TEI Number: 66541

Sample: 015 *PI Inlet Filter*

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	108 ug	11/19/2004
Barium (6010)	14300 ug	11/24/2004
Beryllium (6010)	1.3 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	226 ug	11/19/2004
Cobalt (6010)	142 ug	11/19/2004
Copper (6010)	1090 ug	11/19/2004
Lead (6010)	<3 ug	11/19/2004
Manganese (6010)	762 ug	11/19/2004
Mercury (245.2)	5.82 ug	11/23/2004
Nickel (6010)	223 ug	11/19/2004
Selenium (7740)	62 ug	11/23/2004
Silver (6010)	36.1 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66542

Sample: 016 #2 Inlet Filter

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	9.5 ug	11/19/2004
Arsenic (7060)	52 ug	11/19/2004
Barium (6010)	1620 ug	11/24/2004
Beryllium (6010)	1.2 ug	11/19/2004
Cadmium (6010)	1.1 ug	11/19/2004
Chromium (6010)	157 ug	11/19/2004
Cobalt (6010)	122 ug	11/19/2004
Copper (6010)	942 ug	11/19/2004
Lead (6010)	18.5 ug	11/19/2004
Manganese (6010)	48.9 ug	11/19/2004
Mercury (245.2)	5.07 ug	11/23/2004
Nickel (6010)	183 ug	11/19/2004
Selenium (7740)	40 ug	11/23/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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

Report #: 66527
 Report Date: 11/30/2004
 Sample Received:
 11/8/04 12:20

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TEI Number: 66543 Sample: 017 #3 Inlet Filter

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	5.6 ug	11/19/2004
Arsenic (7060)	319 ug	11/19/2004
Barium (6010)	2150 ug	11/24/2004
Beryllium (6010)	8.0 ug	11/19/2004
Cadmium (6010)	5.2 ug	11/19/2004
Chromium (6010)	330 ug	11/19/2004
Cobalt (6010)	162 ug	11/19/2004
Copper (6010)	1500 ug	11/19/2004
Lead (6010)	15.9 ug	11/19/2004
Manganese (6010)	708 ug	11/19/2004
Mercury (245.2)	11.6 ug	11/24/2004
Nickel (6010)	460 ug	11/19/2004
Selenium (7740)	127 ug	11/23/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66544

Sample: 018 #1 Outlet Filter

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	6.5 ug	11/19/2004
Arsenic (7060)	3.4 ug	11/19/2004
Barium (6010)	241 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	5.7 ug	11/19/2004
Lead (6010)	6.4 ug	11/19/2004
Manganese (6010)	4.6 ug	11/19/2004
Mercury (245.2)	<0.02 ug	11/23/2004
Nickel (6010)	3.8 ug	11/19/2004
Selenium (7740)	<10 ug	11/23/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66545

Sample: 019 #2 outld filter

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/19/2004
Barium (6010)	327 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	1.0 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	6.3 ug	11/19/2004
Lead (6010)	78 ug	11/19/2004
Manganese (6010)	4.1 ug	11/19/2004
Mercury (245.2)	<0.02 ug	11/23/2004
Nickel (6010)	3.4 ug	11/19/2004
Selenium (7740)	<10 ug	11/23/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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LABORATORY REPORT

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66546

Sample: 020 #3 outlet filter

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	5.4 ug	11/19/2004
Barium (6010)	187 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	1.1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	5.4 ug	11/19/2004
Lead (6010)	9.0 ug	11/19/2004
Manganese (6010)	4.5 ug	11/19/2004
Mercury (245.2)	<0.02 ug	11/23/2004
Nickel (6010)	3.7 ug	11/19/2004
Selenium (7740)	<10 ug	11/23/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

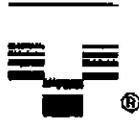
TEI Number: 66547

Sample: 021 *Outlet Blank R-He*

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/19/2004
Barium (6010)	4.2 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	<3 ug	11/19/2004
Lead (6010)	3.6 ug	11/19/2004
Manganese (6010)	<3 ug	11/19/2004
Mercury (245.2)	<0.02 ug	11/23/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	<10 ug	11/23/2004
Silver (6010)	31.4 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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LABORATORY REPORT



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Frank Jarke
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888 Industrial Dr.
Elmhurst, IL 60126

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66548

Sample: 022 #1 Inlet Imps 1x2

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	40.7 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	4.1 ug	11/19/2004
Lead (6010)	367 ug	11/19/2004
Manganese (6010)	351000 ug	11/30/2004
Mercury (245.2)	2.21 ug	11/17/2004
Nickel (6010)	3.7 ug	11/19/2004
Selenium (7740)	<10 ug	11/23/2004
Silver (6010)	<3 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

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LABORATORY REPORT

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66549

Sample: 023 #2 Inlet Imps 1+2

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	2.7 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	<3 ug	11/19/2004
Lead (6010)	20.2 ug	11/19/2004
Manganese (6010)	668 ug	11/19/2004
Mercury (245.2)	2.80 ug	11/17/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	<10 ug	11/24/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

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

PREPARED FOR:

PAGE 14 of 20

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66550

Sample: 024 #3 Inlet Imps (22)

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<3 ug	11/18/2004
Barium (6010)	72.4 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	6.7 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	14.4 ug	11/19/2004
Lead (6010)	10.8 ug	11/19/2004
Manganese (6010)	56.8 ug	11/19/2004
Mercury (245.2)	9.96 ug	11/17/2004
Nickel (6010)	11.4 ug	11/19/2004
Selenium (7740)	31 ug	11/24/2004
Silver (6010)	47.3 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
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PREPARED FOR:

PAGE 15 of 20

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

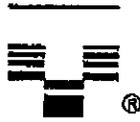
M22E0758-01

TEI Number: 66551

Sample: 025 #1 outlet Imps (2)

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	1.4 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	3.5 ug	11/19/2004
Lead (6010)	34.5 ug	11/19/2004
Manganese (6010)	3160 ug	11/24/2004
Mercury (245.2)	0.58 ug	11/17/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	<10 ug	11/24/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

 Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-1617
847-647-1345

PREPARED FOR:

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66552

Sample: 026 #2 D.H.H. Jmp 1=2

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	<1 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	3.4 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	<3 ug	11/19/2004
Lead (6010)	11.8 ug	11/19/2004
Manganese (6010)	258 ug	11/19/2004
Mercury (245.2)	0.56 ug	11/17/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	<10 ug	11/24/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

 Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-1617
847-647-1345

PREPARED FOR:

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66553

Sample: 027 #3 with Imp 122

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	<1 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	<3 ug	11/19/2004
Lead (6010)	21.8 ug	11/19/2004
Manganese (6010)	116 ug	11/19/2004
Mercury (245.2)	1.81 ug	11/17/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	40 ug	11/24/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

 Gayle F. O'Neill, Ph.D.

LABORATORY REPORT

TEI Analytical, Inc.
7177 N. Austin
Niles, IL 60714-1617
847-647-1345

PREPARED FOR:

PAGE 18 of 20

Frank Jarke
GC Energy Management Services, Inc.
888 Industrial Dr.
Firmhurst, IL 60126

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66554

Sample: 028 HNO_3/H_2O_2 Blank

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/11/2004
Antimony (6010)	<3 ug	11/19/2004
Arsenic (7060)	<2 ug	11/18/2004
Barium (6010)	568 ug	11/19/2004
Beryllium (6010)	<1 ug	11/19/2004
Cadmium (6010)	<1 ug	11/19/2004
Chromium (6010)	<3 ug	11/19/2004
Cobalt (6010)	<3 ug	11/19/2004
Copper (6010)	<3 ug	11/19/2004
Lead (6010)	4.8 ug	11/19/2004
Manganese (6010)	3.1 ug	11/19/2004
Mercury (245.2)	0.25 ug	11/17/2004
Nickel (6010)	<3 ug	11/19/2004
Selenium (7740)	<10 ug	11/24/2004
Silver (6010)	<5 ug	11/19/2004
Thallium (7841)	<20 ug	11/29/2004

 Gayle E. O'Neill, Ph.D.

LABORATORY REPORT

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

PREPARED FOR:

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66555	Sample: 029 #1 Inlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	0.60 ug		11/17/2004
TEI Number: 66556	Sample: 030 #2 Inlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	1.21 ug		11/17/2004
TEI Number: 66557	Sample: 031 #3 Inlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	2.09 ug		11/17/2004
TEI Number: 66558	Sample: 032 #1 outlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	0.53 ug		11/17/2004

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LABORATORY REPORT



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

PREPARED FOR:

PAGE 20 of 20

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

Report #: 66527
Report Date: 11/30/2004
Sample Received:
11/8/04 12:20

M22E0758-01

TEI Number: 66559	Sample: 033 #2 outlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	0.75 ug		11/17/2004
TEI Number: 66560	Sample: 034 #3 outlet Hg		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	1.32 ug		11/17/2004
TEI Number: 66561	Sample: 035 Hg Blank		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	<0.06 ug		11/17/2004
TEI Number: 66562	Sample: 082		
TEST	RESULTS		DATE PERFORMED
Preparation (M-29)			11/10/2004
Mercury (245.2)	<0.06 ug		11/23/2004

Gayle E. O'Neill, Ph.D.

LABORATORY REPORT



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

PREPARED FOR:

PAGE 1 of 1

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

Report #: 66562
 Report Date: 12/1/2004
 Sample Received:
 11/8/01 12:20

M22E0758-01

TEI Number: 66562

Sample: 082 Inlet Filter Blank

TEST	RESULTS	DATE PERFORMED
Preparation (M-29)		11/15/2004
Antimony (6010)	<5 ug	11/30/2004
Arsenic (7060)	<2 ug	12/1/2004
Barium (6010)	7.2 ug	11/30/2004
Beryllium (6010)	<1 ug	12/1/2004
Cadmium (6010)	<1 ug	11/30/2004
Chromium (6010)	4.0 ug	11/30/2004
Cobalt (6010)	<3 ug	11/30/2004
Copper (6010)	<3 ug	11/30/2004
Lead (6010)	11.8 ug	11/30/2004
Manganese (6010)	<3 ug	11/30/2004
Mercury (245.2)	<0.06 ug	11/23/2004
Nickel (6010)	<3 ug	11/30/2004
Selenium (7740)	<10 ug	12/1/2004
Silver (6010)	<5 ug	11/30/2004
Thallium (7841)	<20 ug	12/1/2004

Gayle E. O'Neill, Ph.D.

PASC - Certificate of Analysis

Component	Method	Blank		MS % Rec.	MDL	Units	Blank		MS % Rec.	OHHG	OHHG	OHHG
		Spike#1	Spike#1				Spike#2	Spike#2				
	Blank	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	0758-01-RB	0758-01-Out-FB	0758-01-In-FB
	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081607 04	081608 04	081609 04
	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	081606 04	04-Nov-2004	04-Nov-2004	04-Nov-2004
Final volume measured - ash	100	-	-	-	0	ml	-	-	-	-	-	-
Final volume measured - bulk	100	-	-	-	0	"	-	-	100	-	-	-
Final volume measured - probe	100	-	-	-	0	"	-	-	-	-	-	-
Filter weight	-	-	-	-	1.0	mg	-	-	700	-	-	-
Filter weight	-	-	-	-	1.0	"	-	-	2900	-	-	-
Impinger volume - hydroxylamine	-	-	-	-	-	ml	-	-	100	-	-	-
Impinger volume - KCl - combined	-	-	-	-	-	"	-	-	52	1000	1000	1000
Impinger volume - KMnO4 - combined	-	-	-	-	-	"	-	-	110	500	500	500
Weight of sample	-	-	-	-	0.0001	g	-	-	-	-	-	-
Mercury - filter	<	0.10	100	0.10	0.010	ug	0.10	100	<	(1)	(1)	(1)
Mercury - filter - ash	<	0.11	110	0.11	0.010	"	0.11	110	<	-	-	-
Mercury - hydroxylamine	-	-	-	-	0.010	"	-	-	<0.10	-	-	-
Mercury - KCl	<	0.49	98	0.50	0.050	"	0.50	99	<	<0.10	<0.10	<0.10
Mercury - KMnO4	<	0.51	100	0.49	0.050	"	0.49	99	<	<	<	<
Mercury - H2O2	<	0.27	110	0.27	0.025	"	0.27	110	<0.057	<0.25	<0.25	<0.25
Mercury - probe rinse	<	0.10	100	0.10	0.010	"	0.10	100	-	-	-	-

PASC - Certificate of Analysis

Component	MDL	Units	OHHG		OHHG		OHHG		OHHG	
			0758-01-Out-R1 081610 04							
Final volume measured - ash	0	ml	-	-	-	-	-	-	-	-
Final volume measured - bulk	0	"	100	-	-	-	-	-	-	-
Final volume measured - probe	0	"	-	-	-	-	-	-	-	-
Filter weight	1.0	mg	710	-	-	-	-	-	-	-
Filter weight	1.0	"	-	-	-	-	-	-	-	-
Impinger volume - hydroxylamine		ml	-	-	-	-	-	-	-	-
Impinger volume - KCl - combined		"	1000	-	-	-	-	-	-	-
Impinger volume - KMnO4 - combined		"	500	-	-	-	-	-	-	-
Weight of sample	0.0001	g	-	-	-	-	-	-	-	-
Mercury - filter	0.010	ug	(1) 0.020	0.020	0.12	98	0.12	0.12	100	-
Mercury - filter - ash	0.010	"	-	-	-	-	-	-	-	-
Mercury - hydroxylamine	0.010	"	-	-	-	-	-	-	-	-
Mercury - KCl	0.050	"	0.21	0.21	1.1	92	1.1	1.2	96	-
Mercury - KMnO4	0.050	"	0.45	0.44	0.92	96	0.90	0.90	92	-
Mercury - H2O2	0.025	"	<0.25	<0.25	2.5	98	2.5	2.5	97	-
Mercury - probe rinse	0.010	"	-	-	-	-	-	-	-	-

Client ID:

Lab No.:

Date Sampled:

MDL Units

PASC - Certificate of Analysis

Client ID: 0758-01-Out-R2
Lab No.: 081611 04
Date Sampled: 03-Nov-2004
MDL **Units**

Component	MDL	Units	0758-01-Out-R2 081611 04 03-Nov-2004	0758-01-Out-R3 081612 04 04-Nov-2004	0758-01-In-R1 081613 04 02-Nov-2004	0758-01-In-R1 081613 04 02-Nov-2004 Duplicate	0758-01-In-R1 081613 04 02-Nov-2004 M. Spike	0758-01-In-R1 081613 04 02-Nov-2004 MS % Rec.	0758-01-In-R1 081613 04 02-Nov-2004 MS Dup
Final volume measured - ash	0	ml	-	-	100	-	-	-	-
Final volume measured - bulk	0	"	100	100	-	-	-	-	-
Final volume measured - probe	0	"	-	-	100	-	-	-	-
Filter weight	1.0	mg	700	680	-	-	-	-	-
Filter weight	1.0	"	-	-	16000	-	-	-	-
Impinger volume - hydroxylamine		ml	-	-	-	-	-	-	-
Impinger volume - KCl - combined		"	1000	1000	1000	-	-	-	-
Impinger volume - KMnO4 - combined		"	500	500	500	-	-	-	-
Weight of sample	0.0001	g	-	-	16	-	-	-	-
			(1)	(1)	(1)	-	-	-	-
Mercury - filter	0.010	ug	0.028	<	-	-	-	-	-
Mercury - filter - ash	0.010	"	-	-	13	13	16	110	16
Mercury - hydroxylamine	0.010	"	-	-	-	-	-	-	-
Mercury - KCl	0.050	"	0.16	0.73	0.53	-	-	-	-
Mercury - KMnO4	0.050	"	0.61	1.3	0.97	-	-	-	-
Mercury - H2O2	0.025	"	<0.25	<0.25	<0.25	-	-	-	-
Mercury - probe rinse	0.010	"	-	-	0.10	-	-	-	-

PASC - Certificate of Analysis

Client ID: 0758-01-In-R1 OHHG 0758-01-In-R2 OHHG 0758-01-In-R3

Lab No.: 081613 04 081614 04 081615 04

Date Sampled: 02-Nov-2004 03-Nov-2004 04-Nov-2004

MDL **Units** **MSD % Rec.**

Component	MDL	Units	MSD % Rec.	OHHG	OHHG	OHHG
Final volume measured - ash	0	ml	-	100	100	100
Final volume measured - bulk	0	"	-	-	-	-
Final volume measured - probe	0	"	-	100	100	100
Filter weight	1.0	mg	-	-	-	-
Filter weight	1.0	"	-	14000	19000	19000
Impinger volume - hydroxylamine		ml	-	-	-	-
Impinger volume - KCl - combined		"	-	1000	1000	1000
Impinger volume - KMnO4 - combined		"	-	500	500	500
Weight of sample	0.0001	g	-	14	19	19
				(1)	(1)	(1)
Mercury - filter	0.010	ug	-	-	-	-
Mercury - filter - ash	0.010	"	100	12	23	23
Mercury - hydroxylamine	0.010	"	-	-	-	-
Mercury - KCl	0.050	"	-	1.6	6.9	6.9
Mercury - KMnO4	0.050	"	-	0.70	3.2	3.2
Mercury - H2O2	0.025	"	-	<0.25	<0.25	<0.25
Mercury - probe rinse	0.010	"	-	0.34	0.40	0.40

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Read Instructions on Reverse Side Before Completing Form!

CHAIN OF CUSTODY RECORD						
Project Number: <i>M22E0758 - 01</i>			Date Results Required:			
Client: <i>ADA-ES (American - Paramar)</i>			TAT Required:			
Plant/Location: <i>Paramar Plant</i> <i>Unit 2 Inlet & Outlet (ESP)</i>			LAB ONLY	PO Number: <i>M86001465 - PSC</i> <i>M86001444 - TEI</i>		
Project Supervisor: <i>ELE</i>				LIMS Entry: <i>E.V.</i>		
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
001	11/2/04	Unit 2 ESP Inlet Test #1 ^{H₂SO₄}	4	H ₂ SO ₄ fraction	HCl, HF, HBr, M26A	
002	11/3/04	↓ ↓ 2	↓			
003	11/4/04	↓ ↓ 3	↓			
004	11/2/04	Unit 2 ESP Outlet Test 1	↓			
005	11/3/04	↓ ↓ 2	↓			
006	11/4/04	↓ ↓ 3	↓			
007	11/4/04	H ₂ SO ₄ Blank	↓			
008	11/2/04	Unit 2 ESP Inlet #1 ^{Exlet NaOH}	1	NaOH fraction	Br ₂ , Cl ₂ , M26A	
009	11/3/04	↓ ↓ 2	↓			
010	11/4/04	↓ ↓ 3	↓			
011	11/2/04	Unit 2 outlet T# 1	↓			
012	11/3/04	↓ ↓ T# 2	↓			
013	11/4/04	↓ ↓ T# 3	↓			
014	11/4/04	NaOH Blank	↓			
015	11/2/04	Unit 2 ESP Inlet #1 ^{Filter + H₂SO₄ wash}	2		M29 Full Scan (see M22E0758-7)	
016	11/3/04	↓ ↓ #2	2			
Delivered by: <i>ELE</i>		Date/Time: <i>11/5/04 12:00a.m.</i>	Processed by: <i>DJS 11/5/04 E.V. J.W.</i>		Date/Time:	Received by Laboratory:

Special Instructions:

M26A 4 ~~sample~~ containers Inlet - Nucle Rinse
Thimble
Line Rinse
H₂SO₄ Imps & Rinse

Outlet - Probe Rinse
Filter
Line Rinse
H₂SO₄ Imps & Rinse

Read Instructions on Reverse Side Before Completing Form!

CHAIN OF CUSTODY RECORD							
Project Number: <i>MARE0758-01</i>				Date Results Required:			
Client: <i>ADA-ES (Amgen)</i>				TAT Required:			
Plant/Location: <i>Meromec Unit 2 ESP Inlet 2 outlet</i>				LAB	PO Number:		
Project Supervisor: <i>ELC</i>					LIMS Entry:		
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab	
017	11/4/04	Unit 2 ESP Inlet Test 3 ^{Filter} + HNO_3 (2)			M29 - Metals (see below)		
018	11/2/04	Unit 2 ESP Outlet T1	3				
019	11/3/04	↓ ↓ T2					
020	11/4/04	↓ ↓ T3					
021	11/4/04	Outlet BLANK: Filter + 0.1N HNO_3 (2)					
022	11/2/04	Unit 2 ESP Inlet Test 1, React. II					
023	11/3/04	↓ ↓ Test 2					
024	11/4/04	↓ ↓ Test 3					
025	11/2/04	Unit 2 ESP Outlet Test 1, React. II					
026	11/3/04	↓ ↓ Test 2					
027	11/4/04	↓ ↓ Test 3					
028	11/4/04	BLANK: $\text{HNO}_3/\text{H}_2\text{O}_2$ (2)				✓	
029	11/2/04	Unit 2 ESP Inlet Test 1, React. III				M29 - Mercury	
030	11/3/04	↓ ↓ Test 2				↓	
031	11/4/04	↓ ↓ Test 3			↓		
032	11/2/04	Unit 2 ESP Outlet Test 1, Fr. III			M29 - Mercury		
Delivered by:		Date/Time	Processed by:		Date/Time	Received by Laboratory:	

Special Instructions:

M29: Fraction I - Filter + 0.1N HNO_3 wash
 Fraction II - $\text{HNO}_3/\text{H}_2\text{O}_2$ imp. content + nitric line rinse
 Fraction III - KMnO_4 imp + HCl rinse

M29 Metals: Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Thallium

Read Instructions on Reverse Side Before Completing Form!

CUSTODY RECORD						
Project Number: M22E0958-01				Date Results Required:		
Client: ADA-ES (Ameren)				TAT Required:		
Plant/Location: Meramec - Unit 2 ESP Inlet & Outlet					PO Number:	
Project Supervisor: ELE					LIMS Entry:	
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
033	11/3/04	Unit 2 ESP Outl. Test 2	Fe III		M29 - Mercury	
034	11/4/04	↓ ↓ Test 3	↓		↓	
* 035	11/4/04	BLANK: KMnO ₄ + DM water + HCl			↓	
036	11/2/04	Unit 2 ESP Inlet Test 1 ^{Trimbler}	1		Hg by Out. Hydro	
037	11/3/04	↓ 2 ↓	1			
038	11/4/04	↓ 3 ↓	2			
039	11/2/04	Unit 2 ESP Inlet + 1 Nitric ^{Front 1/2}	1			
040	11/3/04	↓ 2 ↓	↓			
041	11/4/04	↓ 3 ↓	↓			
042	11/2/04	Unit 2 1 ^{Probed Line} _{Kel Imp} ^{reverse}	1			
043	11/3/04	↓ 2 ↓	↓			
044	11/4/04	↓ 3 ↓	↓			
045	11/2/04	↓ 1 Hg ₂ /H ₂ O Imp	1			
046	11/3/04	↓ 2 ↓	↓			
047	11/4/04	↓ 3 ↓	↓			
048	11/2/04	↓ 1 H ₂ S ₄ /KMnO ₄ Imp	1			
Delivered by: ELE		Date/Time 11/5/04 12:00 a.m.	Processed by: BJS 11/5/04 E-V 11/8/04 JW		Date/Time	Received by Laboratory:

Special Instructions:

* S.035 - BLANK for Mercury: KMnO₄ + DM water blank: + HCl

Read Instructions on Reverse Side Before Completing Form!

Project Number: <i>M22E075X-01</i>		Date Results Required:				
Client: <i>ADA-ES (Ameren)</i>		TAT Required:				
Plant/Location: <i>Meramec Unit 2 ESP Inlet 2 Outlet</i>		PO Number:				
Project Supervisor: <i>ELC</i>		LIMS Entry:				
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
<i>049</i>	<i>11/3/04</i>	<i>Unit 2 ESP Inlet #2 H₂SO₄/K₂Cr₂O₇ Imps.</i>	<i>1</i>		<i>Hy by Hydro</i>	
<i>050</i>	<i>11/4/04</i>	<i>↓ #3</i>	<i>1</i>			
<i>051</i>	<i>11/2/04</i>	<i>Unit 2 ESP outlet #1 Filter</i>	<i>1</i>			
<i>052</i>	<i>11/3/04</i>	<i>2 ↓</i>	<i>1</i>			
<i>053</i>	<i>11/4/04</i>	<i>3 ↓</i>	<i>1</i>			
<i>054</i>	<i>11/2/04</i>	<i>1 nitric Probe Rinse</i>	<i>1</i>			
<i>055</i>	<i>11/3/04</i>	<i>2 ↓</i>	<i>1</i>			
<i>056</i>	<i>11/4/04</i>	<i>3 ↓</i>	<i>1</i>			
<i>057</i>	<i>11/2/04</i>	<i>#1 { HNO₃ Probe Line Rinse K₂Cr₂O₇ Imps</i>	<i>2</i>			
<i>058</i>	<i>11/3/04</i>	<i>2 ↓</i>	<i>1</i>			
<i>059</i>	<i>11/4/04</i>	<i>3 ↓</i>	<i>1</i>			
<i>060</i>	<i>11/2/04</i>	<i>1 HNO₃/H₂O Imp</i>	<i>1</i>			
<i>061</i>	<i>11/3/04</i>	<i>2 ↓</i>	<i>1</i>			
<i>062</i>	<i>11/4/04</i>	<i>3 ↓</i>	<i>1</i>			
<i>063</i>	<i>11/2/04</i>	<i>1 H₂SO₄/K₂Cr₂O₇ Imp</i>	<i>1</i>			
<i>064</i>	<i>11/3/04</i>	<i>2 ↓</i>	<i>1</i>			
Delivered by:		Date/Time	Processed by:		Date/Time	Received by Laboratory:

Special Instructions:

Read Instructions on Reverse Side Before Completing Form!

Project Number: <i>M22E0757-01</i>		Date Results Required:	
Client: <i>ADA-ES (Ameren)</i>		TAT Required:	
Plant/Location: <i>Meramec - Unit 2 ESP Inlet Outlet</i>		PO Number:	
Project Supervisor: <i>ELF</i>		LIMS Entry:	

Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
<i>065</i>	<i>11/4/04</i>	<i>Unit 2 ESP outlet #3 ^{H₂SO₄/K₂MnO₄ sup}</i>	<i>1</i>		<i>Hg by Hydro</i>	
<i>066</i>	<i>11/4/04</i>	<i>Filter Reagent Blank #1123</i>	<i>1</i>			
<i>067</i>		<i>#1121</i>				
<i>068</i>		<i>#1122</i>				
<i>069</i>		<i>Thimble Reagent Blank #266</i>				
<i>070</i>		<i>#283</i>				
<i>071</i>		<i>#286</i>				
<i>072</i>		<i>0.1 N HNO₃ Reagent Blank</i>				
<i>073</i>		<i>Hydroxamine Reagent Blank</i>				
<i>074</i>		<i>KCl Reagent Blank</i>				
<i>075</i>		<i>HNO₃/H₂O Reagent Blank</i>				
<i>076</i>		<i>Field Blank ^{Inlet} KCl sup</i>				
<i>077</i>		<i>HNO₃/H₂O sup</i>				
<i>078</i>		<i>H₂SO₄/K₂MnO₄</i>				
<i>079</i>		<i>Outlet KCl sup</i>				
<i>080</i>		<i>HNO₃/H₂O sup</i>				

Delivered by:	Date/Time	Processed by:	Date/Time	Received by Laboratory:
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Special Instructions:

Read Instructions on Reverse Side Before Completing Form!

Project Number: <i>M2280758-01</i>			Date Results Required:			
Client: <i>ADA-ES (Apprentice)</i>			TAT Required:			
Plant/Location: <i>Maramba - Unit 2 ESP Inlet outlet</i>			PO Number:			
Project Supervisor: <i>ELF</i>			LIMS Entry:			
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/ Comp	Analysis Requested	Sub Lab
<i>081</i>	<i>11/4/04</i>	<i>Field Blank Outlet ^{H₂O₂/K₂O₄}</i>	<i>1</i>		<i>Hg by Hydro</i>	
<i>082</i>	<i>11/4/04</i>	<i>M29-Inlet BL/w/with Qtz Thimble + H₂O₂</i>			<i>M29</i>	
<i>083</i>	<i>11/4/04</i>	<i>KMnO₄/H₂SO₄ Reagent blank</i>			<i>Ontario Hydro</i>	
Delivered by:		Date/Time	Processed by:		Date/Time	Received by Laboratory:

Special Instructions:

CALCULATIONS FOR HYDROGEN CHLORIDE (HCl)

Concentration of Hydrogen Chloride:

$$\frac{\text{lbs HCl}}{\text{dscf}} = \frac{\mu\text{g HCl in sample}}{4.536 \times 10^8 \times \text{dscf}}$$

where:

$$4.536 \times 10^8 = \mu\text{g/lb}$$

dscf = Volume of gas sampled

$$\mu\text{g/lb HCl} = \mu\text{g Cl} \times \frac{36.453}{35.453}$$

Parts Per Million v/v- Hydrogen Chloride

$$\text{ppm HCl} = \frac{\text{lbs HCl}}{\text{dscf}} \div \frac{36.453}{385 \times 10^6}$$

where:

385 = Volume of 1 lb mole of gas at 68F and 29.92 in. Hg

10^6 = Conversion of ppm v/v

METAL SAMPLE CALCULATION

Concentration

$$\frac{\mu\text{g}}{\text{m}^3} = \frac{\mu\text{g of sample}}{\text{dscf volume sampled} \times 0.02832 \frac{\text{m}^3}{\text{ft}^3}}$$

Emission Rate

$$\frac{\mu\text{g of sample} \times \frac{1 \times 10^{-6} \text{ grams}}{\mu\text{g}}}{453.6 \text{ gr/lb}} = \text{lbs of sample}$$

$$\frac{\text{lbs/sample}}{V_m (\text{std}) \text{ sample}} \times \text{dscfm} \times 60 \frac{\text{min}}{\text{hr}} = \text{lbs/hr}$$

EMISSION RATE CALCULATIONS

A pollutant emission rate (E), expressed as pounds of pollutant per million Btu heat input from the fuel combusted can be calculated by several methods as follows:

1. $C = C_s/7000$ where, C = pollutant concentration, lb/dscf
 c_s = pollutant concentration, grains/dscf
2. If fuel flow is monitored and the fuel combusted during the test is sampled and analyzed for gross calorific value, then:

$$E = \frac{Q_{sd}C}{\text{fuel flow rate (lb / hr) GCV}} \times 10^6$$

where, E = lbs per million Btu

GCV = gross calorific value, Btu / lb

Q_{sd} = dry volumetric gas flow at standard conditions, dscf / hr

3. If an integrated gas sample is taken during the test and analyzed for %CO₂ or %O₂, dry basis by volume, with an Orsat gas analyzer, then

$$E = C F_c \frac{100}{(\%CO_2)} \text{ or, } E = C F \frac{20.9}{(20.9 - \%O_2)} \text{ where,}$$

%CO₂ and %O₂ are expressed as percent; and, for example, for subbituminous and bituminous coals:

F_c = a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted, 1800 scf CO₂/million Btu.

F = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted, 9780 dscf/million Btu.

4. If fuel sample increments are taken and composited during the test and an ultimate analysis is performed and the GCV is determined, then

$$F_c = \frac{321 \times 10^3 (\%C)}{GCV} \text{ where, \%C = carbon content by weight expressed as percent}$$

$$F = \frac{[3.64 (\%H) + 1.53 (\%C) + 0.57 (\%S) + 0.14 (\%N) - 0.46 (\%O_2)]}{GVC} \times 10^6$$

where, H, C, S, N, and O are content by weight of hydrogen, carbon, sulfur, nitrogen, and oxygen (expressed as percent) respectively.

5. If fuels other than subbituminous and bituminous coals are fired, other F-factors than those above will apply; and, if combinations of different fuels are fired, the F-factors must be prorated according to the fraction of the total heat input derived from each type of fuel.

VOLUMETRIC AIR FLOW CALCULATIONS

$$V_m(\text{std}) = 17.647 \times V_m \times \left[\frac{P_{\text{bar}} + \frac{DH}{13.6}}{(460 + T_m)} \right] \times Y$$

$$V_w(\text{std}) = 0.0471 \times V_{lc}$$

$V_{lc} = \text{water} + \text{silica net}$

$$B_{ws} = \left[\frac{V_w(\text{std})}{V_w(\text{std}) + V_m(\text{std})} \right]$$

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

$$M_S = M_d \times (1 - B_{ws}) + (18 \times B_{ws})$$

$$V_s = \sqrt{\frac{(T_s + 460)}{M_s \times P_s}} \times \sqrt{DP} \times C_p \times 85.49$$

- C_p = pitot tube correction factor
- P_s = absolute flue gas pressure
- M_s = molecular weight of gas (lb/lb mole)
- M_d = dry molecular weight of gas (lb/lb mole)
- B_{ws} = water vapor in gas stream proportion by volume

$$A_{cfm} = V_s \times \text{Area (of stack or duct)} \times 60$$

$$D_{scfm} = A_{cfm} \times 17.647 \times \left[\frac{P_s}{(460 + T_s)} \right] \times (1 - B_{ws})$$

$$S_{cfm} = A_{cfm} \times 17.647 \times \left[\frac{P_s}{(460 + T_s)} \right]$$

$$S_{cfh} = S_{cfm} \times 60 \frac{\text{min}}{\text{hr}}$$

NOMENCLATURE – ISOKINETIC SAMPLING

- A = Cross-sectional area of stack or duct, ft^2
 A_n = Cross-sectional area of nozzle, ft^2
 B_{ws} = Water vapor in gas stream, proportion by volume
 C_a = Acetone blank residue concentration, g/g
 C_{acf} = Concentration of particulate matter in gas stream at actual conditions, gr/acf
 C_p = Pitot tube coefficient, dimensionless
 C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, gr/dscf
 IKV = Isokinetic sampling variance, must be $.90 \leq \text{IKV} \leq 1.10$
 M_d = Dry molecular weight of gas, $\text{lb}/\text{lb-mole}$
 m_n = Total amount of particulate matter collected, grams
 M_s = Molecular weight of gas, wet basis, $\text{lb}/\text{lb-mole}$
 M_w = Molecular weight of water, $18.0 \text{ lb}/\text{lb-mole}$
 m_a = Mass of residue of acetone after evaporation, grams
 P_{bar} = Barometric pressure at testing site, in. Hg
 P_g = Static pressure of gas, in. Hg (in. $\text{H}_2\text{O}/13.6$)
 P_s = Absolute pressure of gas, in. Hg = $P_{\text{bar}} + P_g$
 P_{std} = Standard absolute pressure, 29.92 in. Hg
 Q_{acfm} = Actual volumetric gas flow rate, acfm
 Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, dscf/hr
 R = Ideal gas constant, $21.85 \text{ in. Hg-ft}^3/^\circ\text{R-lb-mole}$
 T_m = Absolute dry gas meter temperature, $^\circ\text{R}$
 T_s = Absolute gas temperature, $^\circ\text{R}$
 T_{std} = Standard absolute temperature, 528°R
 V_a = Volume of acetone blank, ml
 V_{aw} = Volume of acetone used in wash, ml
 V_{lc} = Total volume of liquid collected in impingers and silica gel, ml
 V_m = Volume of gas sample as measured by dry gas meter, dcf
 $V_{\text{m(std)}}$ = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscf
 v_s = Gas velocity, ft/sec
 $V_{\text{w(std)}}$ = Volume of water vapor in gas sample, corrected to standard conditions, scf
 W_a = Weight of residue in acetone wash, grams
 Y = Dry gas meter calibration factor
 ΔH = Average pressure differential across the orifice meter, in. H_2O
 Δp = Velocity head of gas, in. H_2O
 ρ_a = Density of acetone, $0.7855 \text{ g}/\text{ml}$ (average)
 ρ_w = Density of water, $0.002201 \text{ lb}/\text{ml}$
 θ = Total sampling time, minutes
 K_1 = $17.64 \text{ }^\circ\text{R}/\text{in. Hg}$
 K_2 = $0.04707 \text{ ft}^3/\text{ml}$
 K_4 = $0.09450/100 = 0.000945$
 K_p = Pitot tube constant, $85.49 \frac{\text{ft}}{\text{sec}} \left[\frac{(\text{lb}/\text{lb - mole})(\text{in. Hg})}{(^\circ\text{R})(\text{in. H}_2\text{O})} \right]^{1/2}$
 $\%EA$ = Percent excess air
 $\%\text{CO}_2$ = Percent carbon dioxide by volume, dry basis
 $\%\text{O}_2$ = Percent oxygen by volume, dry basis
 $\%\text{CO}$ = Percent carbon monoxide by volume, dry basis
 $\%\text{N}_2$ = Percent nitrogen by volume, dry basis
 0.264 = Ratio of O_2 to N_2 in air, v/v
 0.28 = Molecular weight of N_2 or CO , divided by 100
 0.32 = Molecular weight of O_2 divided by 100
 0.44 = Molecular weight of CO_2 divided by 100
 13.6 = Specific gravity of mercury (Hg)

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, $0.048137 \text{ (in. Hg)(ft}^3\text{)/(g-mole)(}^\circ\text{R)} =$
 $[21.8348 \text{ (in. Hg)(ft}^3\text{)/(lb-mole)(}^\circ\text{R)}] / 453.592 \text{ g-mole/lb-mole}$

T_m = Absolute average dry gas meter temperature, $^\circ\text{R}$

T_{std} = Standard absolute temperature, 528 $^\circ\text{R}$

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

CALCULATION FORMULAS ISOKINETIC SAMPLING

$$1. V_{m(\text{std})} = V_m Y \left(\frac{T_{\text{std}}}{T_m} \right) \left(\frac{P_{\text{bar}} + \frac{\Delta H}{13.6}}{P_{\text{std}}} \right) = K_1 V_m Y \frac{P_{\text{bar}} + \frac{\Delta H}{13.6}}{T_m}$$

$$2. V_{w(\text{std})} = V_{lc} \left(\frac{\rho_w}{M_w} \right) \left(\frac{RT_{\text{std}}}{P_{\text{std}}} \right) = K_2 V_{lc}$$

$$3. B_{ws} = \frac{V_{w(\text{std})}}{V_{m(\text{std})} + V_{w(\text{std})}}$$

$$4a. C_a = \frac{m_a}{V_a \rho_a}$$

$$4b. W_a = C_a V_{aw} \rho_a$$

$$5. C_s = (15.43 \text{ grains/gram}) (m_n / V_{m(\text{std})})$$

$$6. C_{acf} = 15.43 K_i \left(\frac{m_n P_s}{V_{w(\text{std})} + V_{m(\text{std})} T_s} \right)$$

$$7. \%EA = \left(\frac{\%O_2 - (0.5 \%CO)}{0.264 \%N_2 - (\%O_2 - 0.5 \%CO)} \right) \times 100$$

$$8. M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$$

$$9. M_s = M_d(1 - B_{ws}) + 18.0 B_{ws}$$

$$10. v_s = K_p C_p \sqrt{\frac{\Delta P T_s}{P_s M_s}}$$

$$11. Q_{acfm} = v_s A (60 \frac{\text{sec}}{\text{min}})$$

$$12. Q_{sd} = (3600 \frac{\text{sec}}{\text{hr}}) (1 - B_{ws}) v_s \left(\frac{T_{\text{std}} P_s}{T_s P_{\text{std}}} \right) A$$

$$13. E \text{ (emission rate, lbs/hr)} = Q_{sd} (C_s / 7000 \text{ grains/lb})$$

$$14. IKV = \frac{T_s V_{m(\text{std})} P_{\text{std}}}{T_{\text{std}} v_s \theta A_n P_s 60 (1 - B_{ws})} = K_4 \frac{T_s V_{m(\text{std})}}{P_s v_s A_n \theta (1 - B_{ws})}$$

TEST DATA

- Method 26A

Run No.: 1

Project Number: M22E0758

Test Date: 11/2/2004

TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	24
Nozzle Diameter:	0.247 in.	Test Length:	120 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.
Static Pressure:	-19.50	In. H ₂ O
Flue Pressure (Ps):	28.13	In. Hg. abs.
Sample Train	Pre: 0.002	
Leak Check	Post: 0.000	
	@ 15/15	In. Hg.
Carbon Dioxide:	14.8	%
Oxygen:	4.0	%
Nitrogen:	81.2	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	230.60	mls.
Difference:	230.60	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	230.60	

STACK PARAMETERS

Delta H:	1.07	Inches H ₂ O	Gas Weight dry, Md:	30.528	lb/lb mole
Meter Temperature, Tm:	72.1	°F	Gas Weight wet, Ms:	28.910	lb/lb mole
Sqrt ΔP:	0.791	Inches H ₂ O	Excess Air:	22.940	%
Stack Temperature, Ts:	326.0	°F	Gas Velocity, Vs:	55.846	
Meter Volume, Vm:	75.121	Cubic Feet	Volumetric Flow, ACFM:	273,621	
Meter Volume, Vmstd:	73.250	dscf	Volumetric Flow, DSCFM:	150,474	
Meter Volume, Vwstd:	10.861	wscf	Volumetric Flow, SCFM:	172,786	
Moisture, Bws:	0.129		Isokinetic Variance, %I:	99.6	
Meter Volume, Normal	68.256				

EMISSION DATA

Type of Fuel Firing: Coal
 Fuel Factor F_d (dscf/mmBtu): 9780
 List Mol. Wt. of Analyte if ppm needed: 36.461

	Filterable	Condensable			
			36.461		
HCl				HBr	
mg (net) collected:	2.43	---		mg (net) collected:	1.12
ppm:	0.77	---		ppm:	0.16
ug/dncm:	1257.25	---		ug/dncm:	579.47
lb/hr:	0.6603	---		lb/hr:	0.3043
lb/mmBtu (based on Fd):	0.00088	---		lb/mmBtu (based on Fd):	0.00041
			20.006		
HF					70.906
mg (net) collected:	3.86	---		Cl ₂	
ppm:	2.24	---		mg (net) collected:	0.61
ug/dncm:	1997.11	---		ppm:	0.10
lb/hr:	1.0489	---		ug/dncm:	315.60
lb/mmBtu (based on Fd):	0.00141	---		lb/hr:	0.1658
			159.818	lb/mmBtu (based on Fd):	0.00022
Br ₂					
mg (net) collected:	0.67	---			
ppm:	0.05	---			
ug/dncm:	346.65	---			
lb/hr:	0.1821	---			
lb/mmBtu (based on Fd):	0.00024	---			

TEST DATA	Method 26A	Run No.: 2
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Project Number: M22E0758	Test Date: 11/3/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	24
Nozzle Diameter:	0.247 in.	Test Length:	120 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.76	in. Hg.	
Static Pressure:	-18.50	in. H ₂ O	
Flue Pressure (Ps):	28.40	in. Hg. abs.	
Sample Train	Pre: 0.004		
Leak Check	Post: 0.005		
	@ 15/13	in. Hg.	
Carbon Dioxide:	14.2	%	
Oxygen:	4.4	%	
Nitrogen:	81.4	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	225.80	mls.	
Difference:	225.80		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	225.80		

STACK PARAMETERS

Delta H:	1.07	Inches H ₂ O	
Meter Temperature, Tm:	63.7	°F	
Sqrt ΔP:	0.797	Inches H ₂ O	
Stack Temperature, Ts:	325.2	°F	
Meter Volume, Vm:	71.703	Cubic Feet	
Meter Volume, Vmstd:	71.523	dscf	
Meter Volume, Vwstd:	10.635	wscf	
Moisture, Bws:	0.129		
Meter Volume, Normal	66.647		
Gas Weight dry, Md:	30.448	lb/lb mole	
Gas Weight wet, Ms:	28.837	lb/lb mole	
Excess Air:	25.747	%	
Gas Velocity, Vs:	56.049		
Volumetric Flow, ACFM:	274,618		
Volumetric Flow, DSCFM:	152,589		
Volumetric Flow, SCFM:	175,279		
Isokinetic Variance, %I:	95.9		

EMISSION DATA

Type of Fuel Firing: Coal
 Fuel Factor F_d (dscf/mmBtu): 9780
 List Mol. Wt. of Analyte if ppm needed: 36.461

	<u>Filterable</u>	<u>Condensable</u>			
HCl			36.461		80.917
mg (net) collected:	1.88	---		HBr	
ppm:	0.61	---		mg (net) collected:	1.16
ug/dncm:	996.16	---		ppm:	0.17
lb/hr:	0.5305	---		ug/dncm:	614.65
lb/mmBtu (based on Fd):	0.00072	---		lb/hr:	0.3274
			20.0060	lb/mmBtu (based on Fd):	0.00044
HF					70.906
mg (net) collected:	1.02	---		Cl₂	
ppm:	0.61	---		mg (net) collected:	0.56
ug/dncm:	540.47	---		ppm:	0.09
lb/hr:	0.2878	---		ug/dncm:	296.73
lb/mmBtu (based on Fd):	0.00039	---		lb/hr:	0.1580
			80.917	lb/mmBtu (based on Fd):	0.00021
			159.818		
Br₂					
mg (net) collected:	0.76	---			
ppm:	0.06	---			
ug/dncm:	402.70	---			
lb/hr:	0.2145	---			
lb/mmBtu (based on Fd):	0.00029	---			

TEST DATA	Method 26A	Run No.: 3
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Project Number:	M22E0758	Test Date: 11/4/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	11
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	22
Nozzle Diameter:	0.247 in.	Test Length:	110 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.	
Static Pressure:	-18.50	in. H ₂ O	
Flue Pressure (Ps):	28.24	in. Hg. abs.	
Sample Train Pre:	0.001		
Leak Check Post:	0.004		
	@ 15/20	in. Hg.	
Carbon Dioxide:	15.0	%	
Oxygen:	3.7	%	
Nitrogen:	81.3	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	236.30	mls.	
Difference:	236.30		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	236.30		

STACK PARAMETERS

Delta H:	1.09	Inches H ₂ O	Gas Weight dry, Md:	30.548	lb/lb mole
Meter Temperature, Tm:	76.1	°F	Gas Weight wet, Ms:	28.779	lb/lb mole
Sqrt ΔP:	0.784	Inches H ₂ O	Excess Air:	20.830	%
Stack Temperature, Ts:	323.5	°F	Gas Velocity, Vs:	55.304	
Meter Volume, Vm:	69.985	Cubic Feet	Volumetric Flow, ACFM:	270,968	
Meter Volume, Vmstd:	67.829	dscf	Volumetric Flow, DSCFM:	148,065	
Meter Volume, Vwstd:	11.130	wscf	Volumetric Flow, SCFM:	172,360	
Moisture, Bws:	0.141		Isokinetic Variance, %I:	102.3	
Meter Volume, Normal	63.205				

EMISSION DATA

Type of Fuel Firing: Coal
 Fuel Factor F_d (dscf/mmBtu): 9780
 List Mol. Wt. of Analyte if ppm needed: 36.461

	<u>Filterable</u>	<u>Condensible</u>			
HCl			36.461		20.006
mg (net) collected:	2.53	---		HF	
ppm:	0.87	---		mg (net) collected:	9.16
ug/dncm:	1413.59	---		ppm:	5.73
lb/hr:	0.7305	---		ug/dncm:	5117.97
lb/mmBtu (based on Fd):	0.00098	---		lb/hr:	2.6449
			20.006	lb/mmBtu (based on Fd):	0.00354
HF					
mg (net) collected:	9.16	---		HBr	80.917
ppm:	5.73	---		mg (net) collected:	0.89
ug/dncm:	5117.97	---		ppm:	0.14
lb/hr:	2.6449	---		ug/dncm:	497.27
lb/mmBtu (based on Fd):	0.00354	---		lb/hr:	0.2570
			80.917	lb/mmBtu (based on Fd):	0.00034
			159.818		
Br₂					
mg (net) collected:	0.55	---			
ppm:	0.04	---			
ug/dncm:	307.30	---			
lb/hr:	0.1588	---			
lb/mmBtu (based on Fd):	0.00021	---			

TEST DATA	Method 26A	Run No.: 1
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Project Number:	M22E0758	Test Date: 11/2/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.	
Static Pressure:	-22.00	in. H ₂ O	
Flue Pressure (Ps):	27.94	in. Hg. abs.	
Sample Train	Pre: 0.002		
Leak Check	Post: 0.000		
	@ 10/6	in. Hg.	
Carbon Dioxide:	14.4	%	
Oxygen:	4.2	%	
Nitrogen:	81.4	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	280.90	mls.	
Difference:	280.90		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	280.90		

STACK PARAMETERS

Delta H:	1.29	Inches H ₂ O	Gas Weight dry, Md:	30.472	lb/lb mole
Meter Temperature, Tm:	75.0	°F	Gas Weight wet, Ms:	28.590	lb/lb mole
Sqrt ΔP:	0.758	Inches H ₂ O	Excess Air:	24.292	%
Stack Temperature, Ts:	313.1	°F	Gas Velocity, Vs:	53.289	
Meter Volume, Vm:	76.127	Cubic Feet	Volumetric Flow, ACFM:	261,093	
Meter Volume, Vmstd:	74.466	dscf	Volumetric Flow, DSCFM:	141,402	
Meter Volume, Vwstd:	13.230	wscf	Volumetric Flow, SCFM:	166,525	
Moisture, Bws:	0.151		Isokinetic Variance, %I:	105.2	
Meter Volume, Normal	69.389				

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F ₂ (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	35.461

	<u>Filterable</u>	<u>Condensible</u>			
			36.461		80.917
HCl				HBr	
mg (net) collected:	2.41	---		mg (net) collected:	0.84
ppm:	0.77	---		ppm:	0.12
ug/dncm:	1226.53	---		ug/dncm:	427.51
lb/hr:	0.6053	---		lb/hr:	0.2110
lb/mmBtu (based on Fd):	0.00087	---		lb/mmBtu (based on Fd):	0.00030
			20.006		
HF				Cl ₂	
mg (net) collected:	2.76	---		mg (net) collected:	0.40
ppm:	1.57	---		ppm:	0.06
ug/dncm:	1404.66	---		ug/dncm:	203.57
lb/hr:	0.6933	---		lb/hr:	0.1005
lb/mmBtu (based on Fd):	0.00100	---		lb/mmBtu (based on Fd):	0.00014
			80.917		
			159.818		
Br ₂					
mg (net) collected:	0.61	---			
ppm:	0.04	---			
ug/dncm:	310.45	---			
lb/hr:	0.1532	---			
lb/mmBtu (based on Fd):	0.00022	---			

TEST DATA - Method 26A Run No.: 2

Project Number: M22E0758 Test Date: 11/3/2004

TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.76	in. Hg.
Static Pressure:	-21.00	in. H ₂ O
Flue Pressure (Ps):	28.22	in. Hg. abs.
Sample Train Pre:	0.000	
Leak Check Post:	0.000	
	@ 10/6	in. Hg.
Carbon Dioxide:	14.6	%
Oxygen:	3.9	%
Nitrogen:	81.5	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	234.50	mls.
Difference:	234.50	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	234.50	

STACK PARAMETERS

Delta H:	1.22	Inches H ₂ O	Gas Weight dry, Md:	30.492	lb/lb mole
Meter Temperature, Tm:	65.8	°F	Gas Weight wet, Ms:	28.876	lb/lb mole
Sqrt ΔP:	0.761	Inches H ₂ O	Excess Air:	22.139	%
Stack Temperature, Ts:	313.9	°F	Gas Velocity, Vs:	53.032	
Meter Volume, Vm:	74.190	Cubic Feet	Volumetric Flow, ACFM:	259,834	
Meter Volume, Vmstd:	74.325	dscf	Volumetric Flow, DSCFM:	145,553	
Meter Volume, Vwstd:	11.045	wscf	Volumetric Flow, SCFM:	167,182	
Moisture, Bws:	0.129		Isokinetic Variance, %I:	102.0	
Meter Volume, Normal	69.259				

EMISSION DATA

Type of Fuel Firing: Coal
 Fuel Factor F_d (dscf/mmBtu): 9780
 List Mol. Wt. of Analyte if ppm needed: 35.461

	<u>Filterable</u>	<u>Condensable</u>		
			36.461	80.917
HCl				
mg (net) collected:	1.40	---		
ppm:	0.45	---		
ug/dncm:	713.85	---		
lb/hr:	0.3627	---		
lb/mmBtu (based on Fd):	0.00050	---		
			20.006	
HF				70.906
mg (net) collected:	0.63	---		
ppm:	0.36	---		
ug/dncm:	321.23	---		
lb/hr:	0.1632	---		
lb/mmBtu (based on Fd):	0.00022	---		
			80.917	
			159.818	
Br₂				
mg (net) collected:	0.72	---		
ppm:	0.05	---		
ug/dncm:	367.12	---		
lb/hr:	0.1865	---		
lb/mmBtu (based on Fd):	0.00026	---		

TEST DATA

- **Method 26A**

Run No.: 3

Project Number: M22E0758

Test Date: 11/4/2004

TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.
Static Pressure:	-21.00	in. H₂O
Flue Pressure (Ps):	28.06	in. Hg. abs.
Sample Train Leak Check	Pre: 0.001 Post: 0.000 @ 10/6	in. Hg.
Carbon Dioxide:	13.9	%
Oxygen:	4.1	%
Nitrogen:	82.0	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	225.90	mls.
Difference:	225.90	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	225.90	

STACK PARAMETERS

Delta H:	1.22	Inches H₂O	Gas Weight dry, Md:	30.388	lb/lb mole
Meter Temperature, Tm:	65.9	°F	Gas Weight wet, Ms:	28.832	lb/lb mole
Sqrt ΔP:	0.755	Inches H₂O	Excess Air:	23.364	%
Stack Temperature, Ts:	310.8	°F	Gas Velocity, Vs:	52.658	
Meter Volume, Vm:	74.360	Cubic Feet	Volumetric Flow, ACFM:	258,003	
Meter Volume, Vmstd:	74.078	dscf	Volumetric Flow, DSCFM:	144,909	
Meter Volume, Vwstd:	10.640	wscf	Volumetric Flow, SCFM:	165,723	
Moisture, Bws:	0.126		Isokinetic Variance, %I:	102.1	
Meter Volume, Normal	69.028				

EMISSION DATA

Type of Fuel Firing: Coal
Fuel Factor F_d (dscf/mmBtu): 9780
List Mol. Wt. of Analyte if ppm needed: 36.461

	<u>Filterable</u>	<u>Condensable</u>			
			36.461		
HCl				HBr	
mg (net) collected:	2.40	---		mg (net) collected:	3.14
ppm:	0.75	---		ppm:	0.44
ug/dncm:	1227.84	---		ug/dncm:	1606.43
lb/hr:	0.6210	---		lb/hr:	0.8125
lb/mmBtu (based on Fd):	0.00087	---		lb/mmBtu (based on Fd):	0.00114
			20.006		

Ameren - Meramec Station

Trace Metals Emissions

Unit 2 ESP Inlet

Test #1

November 2, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dncf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dncm
Antimony	< 6.0	< 2.18E-10	< 0.000689	< 0.00392	< 0.01717	< 1.52E-06	< 8.40E-07	< 2.71E-06	< 2.7110	< 3.484
Arsenic	108	3.92E-09	0.020151	0.07055	0.30900	2.74E-05	1.51E-05	4.88E-05	48.7981	62.717
Barium	14292.8	5.18E-07	1.454758	9.33644	40.89361	3.63E-03	2.00E-03	6.46E-03	6457.98	8299.960
Beryllium	1.3	4.71E-11	0.002017	0.00085	0.00372	3.30E-07	1.82E-07	5.87E-07	0.5874	0.755
Cadmium	< 2.0	< 7.25E-11	< 0.000249	< 0.00131	< 0.00572	< 5.08E-07	< 2.80E-07	< 9.04E-07	< 0.9037	< 1.161
Chromium	222.0	8.05E-09	0.059690	0.14502	0.63517	5.63E-05	3.11E-05	1.00E-04	100.3072	128.917
Cobalt	142.0	5.15E-09	0.033684	0.09276	0.40628	3.60E-05	1.99E-05	6.42E-05	64.1605	82.461
Copper	1094.1	3.97E-08	0.240664	0.71470	3.13037	2.78E-04	1.53E-04	4.94E-04	494.3518	635.354
Lead	362.2	1.31E-08	0.024437	0.23660	1.03630	9.19E-05	5.07E-05	1.64E-04	163.6544	210.333
Manganese**	351758.9	1.28E-05	89.500784	229.77836	1006.42923	8.93E-02	4.92E-02	1.59E-01	158936.71	204269.6
Mercury	8.38	3.04E-10	0.000584	0.00547	0.02398	2.13E-06	1.17E-06	3.79E-06	3.7864	4.866
Nickel	226.7	8.22E-09	0.053977	0.14809	0.64862	5.75E-05	3.17E-05	1.02E-04	102.4308	131.647
Selenium	62.0	2.25E-09	0.010976	0.04050	0.17739	1.57E-05	8.68E-06	2.80E-05	28.0137	36.004
Silver	36.1	1.31E-09	0.004678	0.02358	0.10329	9.16E-06	5.05E-06	1.63E-05	16.3112	20.964
Thallium	< 40.0	< 1.45E-09	< 0.002736	< 0.02613	< 0.11445	< 1.02E-05	< 5.60E-06	< 1.81E-05	< 18.0734	< 23.228

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

** Not included in average due to a small amount of the KMnO₄ solution being drawn into HNO₃/H₂O₂ solution.

Test Support Data	
Sample Volume (Vm, normal)	60.813
Volumetric Flowrate (acfm)	272,168
Volumetric Flowrate (dscfm)	150,156
%O ₂	4.5
%CO ₂	14.2
Fuel Factor	9,780

TEST DATA	- Method 29	Run No.: 1
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Project Number:	M22E0758	Test Date: 11/2/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	1
Pitot Tube Coefficient:	0.840	Number of Points per Port:	21
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	21
Nozzle Diameter:	0.247 in.	Test Length:	105 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.	
Static Pressure:	-19.50	in. H₂O	
Flue Pressure (Ps):	28.13	in. Hg. abs.	
Sample Train	Pre: 0.004		
Leak Check	Post: 0.001		
	@ 20/20	in. Hg.	
Carbon Dioxide:	14.2	%	
Oxygen:	4.5	%	
Nitrogen:	81.3	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	201.90	mls.	
Difference:	201.90		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	201.90		

STACK PARAMETERS

Delta H:	1.11	Inches H₂O	Gas Weight dry, Md:	30.452	lb/lb mole
Meter Temperature, Tm:	69.0	°F	Gas Weight wet, Ms:	28.868	lb/lb mole
Sqrt ΔP:	0.787	Inches H₂O	Excess Air:	26.528	%
Stack Temperature, Ts:	325.2	°F	Gas Velocity, Vs:	55.549	
Meter Volume, Vm:	66.536	Cubic Feet	Volumetric Flow, ACFM:	272,168	
Meter Volume, Vmstd:	65.262	dscf	Volumetric Flow, DSCFM:	150,156	
Meter Volume, Vwstd:	9.509	wscf	Volumetric Flow, SCFM:	172,035	
Moisture, Bws:	0.127		Isokinetic Variance, %I:	101.6	
Volume, Normal:	60.813				

Ameren - Meramec Station

Trace Metals Emissions

Unit 2 ESP Inlet

Test #2

November 3, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dscf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dncm
Antimony	9.5	3.04E-10	0.000961	0.00557	0.02441	2.12E-06	1.18E-06	3.59E-06	3.5863	4.862
Arsenic	52.0	1.66E-09	0.008551	0.03051	0.13362	1.16E-05	6.46E-06	1.96E-05	19.6303	26.614
Barium	1612.8	5.15E-08	0.144678	0.94617	4.14422	3.61E-04	2.00E-04	6.09E-04	608.8422	825.442
Beryllium	1.2	3.83E-11	0.001641	0.00070	0.00308	2.68E-07	1.49E-07	4.53E-07	0.4530	0.614
Cadmium	1.1	3.51E-11	0.000121	0.00065	0.00283	2.46E-07	1.37E-07	4.15E-07	0.4153	0.563
Chromium	153.0	4.89E-09	0.036257	0.08976	0.39315	3.42E-05	1.90E-05	5.78E-05	57.7585	78.306
Cobalt	122.0	3.90E-09	0.025506	0.07157	0.31349	2.73E-05	1.52E-05	4.61E-05	46.0558	62.440
Copper	942.0	3.01E-08	0.182622	0.55264	2.42055	2.11E-04	1.17E-04	3.56E-04	355.6109	482.122
Lead	22.1	7.06E-10	0.001314	0.01297	0.05679	4.94E-06	2.75E-06	8.34E-06	8.3429	11.311
Manganese	713.8	2.28E-08	0.160068	0.41876	1.83417	1.60E-04	8.87E-05	2.69E-04	269.4640	365.328
Mercury	8.83	2.82E-10	0.000542	0.00518	0.02269	1.97E-06	1.10E-06	3.33E-06	3.3334	4.519
Nickel	183.0	5.85E-09	0.038402	0.10736	0.47023	4.09E-05	2.27E-05	6.91E-05	69.0837	93.661
Selenium	40.0	1.28E-09	0.006241	0.02347	0.10278	8.95E-06	4.97E-06	1.51E-05	15.1003	20.472
Silver	< 10.0	< 3.20E-10	< 0.001142	< 0.00587	< 0.02570	< 2.24E-06	< 1.24E-06	< 3.78E-06	< 3.7751	< 5.118
Thallium	< 40.0	< 1.28E-09	< 0.002411	< 0.02347	< 0.10278	< 8.95E-06	< 4.97E-06	< 1.51E-05	< 15.1003	< 20.472

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

Test Support Data	
sample Volume (Vm, normal)	69,000
Volumetric Flowrate (acfm)	275,328
Volumetric Flowrate (dscfm)	153,010
%O2	3.6
%CO2	14.4
Fuel Factor	9,780

TEST DATA	- Method 29	Run No.: 2
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Project Number:	M22E0758	Test Date: 11/3/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	24
Nozzle Diameter:	0.247 in.	Test Length:	120 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.76		in. Hg.
Static Pressure:	-18.50		in. H₂O
Flue Pressure (Ps):	28.40		in. Hg. abs.
Sample Train	Pre: 0.004		
Leak Check	Post: 0.002		
	@ 15/15		in. Hg.
Carbon Dioxide:	14.4		%
Oxygen:	3.6		%
Nitrogen:	82.0		%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00		mls.
Final Impinger Content:	234.70		mls.
Difference:	234.70		
Silica Initial Wt.	0.00		grams
Silica Final Wt.	0.00		grams
Difference:	0.00		
Total Water Gain:	234.70		

STACK PARAMETERS

Delta H:	1.06	Inches H₂O	Gas Weight dry, Md:	30.448	lb/lb mole
Meter Temperature, Tm:	64.5	°F	Gas Weight wet, Ms:	28.831	lb/lb mole
Sqrt ΔP:	0.799	Inches H₂O	Excess Air:	19.947	%
Stack Temperature, Ts:	324.7	°F	Gas Velocity, Vs:	56.194	
Meter Volume, Vm:	74.348	Cubic Feet	Volumetric Flow, ACFM:	275,328	
Meter Volume, Vmstd:	74.048	dscf	Volumetric Flow, DSCFM:	153,010	
Meter Volume, Vwstd:	11.054	wscf	Volumetric Flow, SCFM:	175,853	
Moisture, Bws:	0.130		Isokinetic Variance, %I:	99.0	
Volume, Normal:	69.000				

Ameren - Meramec Station
Trace Metals Emissions
Unit 2 ESP Inlet
Test #3
November 4, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dncf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dncm
Antimony	5.6	1.81E-10	0.000574	0.00342	0.01499	1.27E-06	7.78E-07	2.14E-06	2.1428	2.905
Arsenic	319.0	1.03E-08	0.053171	0.19493	0.85380	7.23E-05	4.43E-05	1.22E-04	122.0626	165.487
Barium	2142.8	6.94E-08	0.194836	1.30940	5.73518	4.86E-04	2.98E-04	8.20E-04	819.92	1111.618
Beryllium	8.0	2.59E-10	0.011088	0.00489	0.02141	1.81E-06	1.11E-06	3.06E-06	3.0611	4.150
Cadmium	5.2	1.68E-10	0.000578	0.00318	0.01392	1.18E-06	7.22E-07	1.99E-06	1.9897	2.698
Chromium	332.7	1.08E-08	0.079913	0.20330	0.89047	7.54E-05	4.62E-05	1.27E-04	127.3048	172.594
Cobalt	162.0	5.25E-09	0.034329	0.09899	0.43359	3.67E-05	2.25E-05	6.20E-05	61.9879	84.041
Copper	1514.4	4.90E-08	0.297585	0.92541	4.05327	3.43E-04	2.10E-04	5.79E-04	579.4722	785.623
Lead	10.1	3.27E-10	0.000609	0.00617	0.02703	2.29E-06	1.40E-06	3.86E-06	3.8647	5.240
Manganese	761.7	2.47E-08	0.173133	0.46545	2.03868	1.73E-04	1.06E-04	2.91E-04	291.4580	395.146
Mercury	23.40	7.58E-10	0.001457	0.01430	0.06263	5.30E-06	3.25E-06	8.95E-06	8.9538	12.139
Nickel	471.4	1.53E-08	0.100268	0.28806	1.26170	1.07E-04	6.55E-05	1.80E-04	180.3772	244.548
Selenium	158.0	5.12E-09	0.024988	0.09655	0.42289	3.58E-05	2.19E-05	6.05E-05	60.4574	81.965
Silver	47.3	0.153E-09	0.005476	0.02890	0.12660	1.07E-05	6.57E-06	1.81E-05	18.0989	24.538
Thallium	< 40.0	< 1.30E-09	< 0.002444	< 0.02444	< 0.10706	< 9.07E-06	< 5.55E-06	< 1.53E-05	< 15.3057	< 20.751

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

Test Support Data	
Sample Volume (Vm, normal)	68.074
Volumetric Flowrate (acfm)	256,701
Volumetric Flowrate (dscfm)	157,237
%O2	3.6
%CO2	14.6
Fuel Factor	9,780

TEST DATA**- Method 29****Run No.: 3****Project Number:** M22E0758**Test Date:** 11/4/2004**TEST PARAMETERS**

Company:	Ameren	Duct Shape:	Rectangular	
Plant:	Meramec	Length:	8.17	Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00	Feet
Source Condition:	Normal	Duct Area:	81.660	Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical	
Temp ID:	E-68	Port Length:	18.00	in.
Meter ID:	E-68	Port Size (diameter):	4.00	in.
Meter Calibration Factor:	0.992	Port Type:	Flange	
Pitot ID:	835A	Number of Ports Sampled:	2	
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12	
Probe Length:	10.0	Minutes per Point:	5.0	
Probe Liner Material:	Teflon	Total Number of Traverse Points:	24	
Nozzle Diameter:	0.247	Test Length:	120	min.
Train Type:	Other			

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.
Static Pressure:	18.50	in. H₂O
Flue Pressure (Ps):	30.96	in. Hg. abs.
Sample Train	Pre: 0.003	
Leak Check	Post: 0.005	
	@ 15/15	in. Hg.
Carbon Dioxide:	14.6	%
Oxygen:	3.6	%
Nitrogen:	81.8	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	215.00	mls.
Difference:	215.00	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	215.00	

STACK PARAMETERS

Delta H:	1.07	Inches H₂O	Gas Weight dry, Md:	30.480	lb/lb mole
Meter Temperature, Tm:	75.1	°F	Gas Weight wet, Ms:	28.961	lb/lb mole
Sqrt ΔP:	0.781	Inches H₂O	Excess Air:	20.005	%
Stack Temperature, Ts:	323.4	°F	Gas Velocity, Vs:	52.392	
Meter Volume, Vm:	75.242	Cubic Feet	Volumetric Flow, ACFM:	256,701	
Meter Volume, Vmstd:	73.054	dscf	Volumetric Flow, DSCFM:	157,237	
Meter Volume, Vwstd:	10.127	wscf	Volumetric Flow, SCFM:	179,033	
Moisture, Bws:	0.122		Isokinetic Variance, %I:	95.1	
Volume, Normal:	68.074				

Ameren - Meramec Station
Trace Metals Emissions
Unit 2 ESP Outlet
Test #1
November 2, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dscf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dscm
Antimony	6.5	2.04E-10	0.000647	0.00357	0.01564	1.43E-06	7.96E-07	2.59E-06	2.5948	3.274
Arsenic	3.4	1.07E-10	0.000550	0.00187	0.00818	7.48E-07	4.17E-07	1.36E-06	1.3573	1.713
Barium	236.8	7.45E-09	0.020905	0.13007	0.56971	5.21E-05	2.90E-05	9.45E-05	94.53	119.272
Beryllium	< 2.0	< 6.29E-11	< 0.002691	< 0.00110	< 0.00481	< 4.40E-07	< 2.45E-07	< 7.98E-07	< 0.7984	< 1.007
Cadmium	< 2.0	< 6.29E-11	< 0.000216	< 0.00110	< 0.00481	< 4.40E-07	< 2.45E-07	< 7.98E-07	< 0.7984	< 1.007
Chromium	< 6.0	1.89E-10	0.001399	0.00330	0.01444	1.32E-06	7.35E-07	2.40E-06	2.3952	3.022
Cobalt	< 6.0	< 1.89E-10	< 0.001234	< 0.00330	< 0.01444	< 1.32E-06	< 7.35E-07	< 2.40E-06	< 2.3952	< 3.022
Copper	9.2	2.89E-10	0.001755	0.00505	0.02213	2.02E-06	1.13E-06	3.67E-06	3.6727	4.634
Lead	32.5	1.02E-09	0.001902	0.01785	0.07819	7.15E-06	3.98E-06	1.30E-05	12.9741	16.370
Manganese	3161.5	9.94E-08	0.697707	1.73656	7.60614	6.96E-04	3.87E-04	1.26E-03	1262.0837	1592.391
Mercury	0.86	2.70E-11	0.000052	0.00047	0.00207	1.89E-07	1.05E-07	3.43E-07	0.3433	0.433
Nickel	3.8	1.19E-10	0.000785	0.00209	0.00914	8.36E-07	4.66E-07	1.52E-06	1.5170	1.914
Selenium	< 20.0	< 6.29E-10	< 0.003071	< 0.01099	< 0.04812	< 4.40E-06	< 2.45E-06	< 7.98E-06	< 7.9841	< 10.074
Silver	< 10.0	< 3.14E-10	< 0.001124	< 0.00549	< 0.02406	< 2.20E-06	< 1.23E-06	< 3.99E-06	< 3.9920	< 5.037
Thallium	< 40.0	< 1.26E-09	< 0.002373	< 0.02197	< 0.09623	< 8.80E-06	< 4.90E-06	< 1.60E-05	< 15.9682	< 20.147

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

Test Support Data	
Sample Volume (V _m , normal)	70.113
Volumetric Flowrate (acfm)	261,495
Volumetric Flowrate (dscfm)	145,572
%O ₂	4.8
%CO ₂	14.0
Fuel Factor	9,780

TEST DATA- **Method 29****Run No.: 1****Project Number:** M22E0758**Test Date:** 11/2/2004**TEST PARAMETERS**

Company:	Ameren	Duct Shape:	Rectangular	
Plant:	Meramec	Length:	8.17	Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00	Feet
Source Condition:	Normal	Duct Area:	81.660	Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical	
Temp ID:	E-22	Port Length:	18.00	in.
Meter ID:	E-22	Port Size (diameter):	4.00	in.
Meter Calibration Factor:	1.000	Port Type:	Flange	
Pitot ID:	643A	Number of Ports Sampled:	2	
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12	
Probe Length:	10.0	Minutes per Point:	5.0	
Probe Liner Material:	Glass	Total Number of Traverse Points:	24	
Nozzle Diameter:	0.250	Test Length:	120	min.
Train Type:	Hot Box			

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.
Static Pressure:	-22.00	in. H₂O
Flue Pressure (Ps):	27.94	in. Hg. abs.
Sample Train	Pre: 0.001	
Leak Check	Post: 0.000	
	@ 10/6	in. Hg.
Carbon Dioxide:	14.0	%
Oxygen:	4.8	%
Nitrogen:	81.2	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	237.60	mls.
Difference:	237.60	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	237.60	

STACK PARAMETERS

Delta H:	1.29	Inches H₂O	Gas Weight dry, Md:	30.432	lb/lb mole
Meter Temperature, Tm:	73.6	°F	Gas Weight wet, Ms:	28.822	lb/lb mole
Sqrt ΔP:	0.763	Inches H₂O	Excess Air:	28.852	%
Stack Temperature, Ts:	311.1	°F	Gas Velocity, Vs:	53.371	
Meter Volume, Vm:	76.723	Cubic Feet	Volumetric Flow, ACFM:	261,495	
Meter Volume, Vmstd:	75.242	dscf	Volumetric Flow, DSCFM:	145,572	
Meter Volume, Vwstd:	11.191	wscf	Volumetric Flow, SCFM:	167,223	
Moisture, Bws:	0.129		Isokinetic Variance, %I:	103.2	
Meter Volume, Normal:	70.113				

Ameren - Meramec Station

Trace Metals Emissions

Unit 2 ESP Outlet

Test #2

November 3, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dscf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dncm
Antimony	< 6.0	< 1.90E-10	< 0.000602	< 0.00331	< 0.01449	< 1.33E-06	< 7.46E-07	< 2.41E-06	< 2.4139	< 3.046
Arsenic	< 4.0	< 1.27E-10	< 0.000652	< 0.00221	< 0.00966	< 8.87E-07	< 4.97E-07	< 1.61E-06	< 1.6092	< 2.030
Barium	322.8	1.02E-08	0.028719	0.17798	0.77954	7.16E-05	4.01E-05	1.30E-04	129.8651	163.853
Beryllium	< 2.0	< 6.34E-11	< 0.002712	< 0.00110	< 0.00483	< 4.44E-07	< 2.49E-07	< 8.05E-07	< 0.8046	< 1.015
Cadmium	1.0	3.17E-11	0.000109	0.00055	0.00241	2.22E-07	1.24E-07	4.02E-07	0.4023	0.508
Chromium	3.4	1.08E-10	0.000799	0.00187	0.00821	7.54E-07	4.23E-07	1.37E-06	1.3678	1.726
Cobalt	< 6.0	< 1.90E-10	< 0.001244	< 0.00331	< 0.01449	< 1.33E-06	< 7.46E-07	< 2.41E-06	< 2.4139	< 3.046
Copper	6.3	2.00E-10	0.001211	0.00347	0.01521	1.40E-06	7.83E-07	2.53E-06	2.5345	3.198
Lead	81.4	2.58E-09	0.004801	0.04488	0.19658	1.81E-05	1.01E-05	3.27E-05	32.7479	41.319
Manganese	259.0	8.21E-09	0.057603	0.14280	0.62547	5.75E-05	3.22E-05	1.04E-04	104.1979	131.468
Mercury	1.06	3.36E-11	0.000065	0.00058	0.00256	2.35E-07	1.32E-07	4.26E-07	0.4264	0.538
Nickel	3.4	1.08E-10	0.000708	0.00187	0.00821	7.54E-07	4.23E-07	1.37E-06	1.3678	1.726
Selenium	< 20.0	< 6.34E-10	< 0.003095	< 0.01103	< 0.04830	< 4.44E-06	< 2.49E-06	< 8.05E-06	< 8.0462	< 10.152
Silver	< 10.0	< 3.17E-10	< 0.001133	< 0.00551	< 0.02415	< 2.22E-06	< 1.24E-06	< 4.02E-06	< 4.0231	< 5.076
Thallium	< 40.0	< 1.27E-09	< 0.002392	< 0.02205	< 0.09660	< 8.87E-06	< 4.97E-06	< 1.61E-05	< 16.0923	< 20.304

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

Test Support Data	
Sample Volume (Vm, normal)	69,572
Volumetric Flowrate (acfm)	258,717
Volumetric Flowrate (dscfm)	144,994
%O2	4.8
%CO2	14.1
Fuel Factor	9,780

TEST DATA	- Method 29	Run No.: 2
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Project Number:	M22E0758	Test Date: 11/3/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS			MOISTURE DETERMINATION		
Barometric Pressure (Pb):	29.76	in. Hg.	Initial Impinger Content:	0.00	mls.
Static Pressure:	-21.00	in. H₂O	Final Impinger Content:	231.00	mls.
Flue Pressure (Ps):	28.22	in. Hg. abs.	Difference:	231.00	
Sample Train	Pre: 0.000		Silica Initial Wt.	0.00	grams
Leak Check	Post: 0.000		Silica Final Wt.	0.00	grams
	@ 10/6	in. Hg.	Difference:	0.00	
Carbon Dioxide:	14.1	%	Total Water Gain:	231.00	
Oxygen:	4.8	%			
Nitrogen:	81.1	%			

STACK PARAMETERS					
Delta H:	1.21	Inches H₂O	Gas Weight dry, Md:	30.448	lb/lb mole
Meter Temperature, Tm:	60.5	°F	Gas Weight wet, Ms:	28.865	lb/lb mole
Sqrt ΔP:	0.757	Inches H₂O	Excess Air:	28.898	%
Stack Temperature, Ts:	315.5	°F	Gas Velocity, Vs:	52.804	
Meter Volume, Vm:	73.780	Cubic Feet	Volumetric Flow, ACFM:	258,717	
Meter Volume, Vmstd:	74.662	dscf	Volumetric Flow, DSCFM:	144,994	
Meter Volume, Vwstd:	10.880	wscf	Volumetric Flow, SCFM:	166,124	
Moisture, Bws:	0.127		Isokinetic Variance, %I:	102.9	
Meter Volume, Normal:	69.572				

Ameren - Meramec Station

Trace Metals Emissions

Unit 2 ESP Outlet

Test #3

November 4, 2004

Parameter	Sample Results (ug)	Concentration (lbs/dscf)	Concentration (ppm)	Emissions Rate (lbs/hr)*	Emissions Rate (tons/yr)*	gr/dscf	gr/acf	lbs/10 ⁶ Btu	lbs/10 ¹² Btu	ug/dscm
Antimony	< 6.0	< 1.93E-10	< 0.000610	< 0.00332	< 0.01454	< 1.35E-06	< 7.48E-07	< 2.45E-06	< 2.4462	< 3.086
Arsenic	5.4	1.73E-10	0.000892	0.00299	0.01308	1.21E-06	6.73E-07	2.20E-06	2.2015	2.778
Barium	182.8	5.87E-09	0.016481	0.10112	0.44291	4.11E-05	2.28E-05	7.45E-05	74.53	94.031
Beryllium	< 2.0	< 6.42E-11	< 0.002749	< 0.00111	< 0.00485	< 4.50E-07	< 2.49E-07	< 8.15E-07	< 0.8154	< 1.029
Cadmium	1.1	3.53E-11	0.000121	0.00061	0.00267	2.47E-07	1.37E-07	4.48E-07	0.4485	0.566
Chromium	< 6.0	< 1.93E-10	< 0.001429	< 0.00332	< 0.01454	< 1.35E-06	< 7.48E-07	< 2.45E-06	< 2.4462	< 3.086
Cobalt	< 6.0	< 1.93E-10	< 0.001261	< 0.00332	< 0.01454	< 1.35E-06	< 7.48E-07	< 2.45E-06	< 2.4462	< 3.086
Copper	5.4	1.73E-10	0.001052	0.00299	0.01308	1.21E-06	6.73E-07	2.20E-06	2.2015	2.778
Lead	22.4	7.19E-10	0.001339	0.01239	0.05427	5.04E-06	2.79E-06	9.13E-06	9.1323	11.522
Manganese	117.4	3.77E-09	0.026460	0.06494	0.28445	2.64E-05	1.46E-05	4.79E-05	47.8632	60.390
Mercury	2.88	9.25E-11	0.000178	0.00159	0.00698	6.47E-07	3.59E-07	1.17E-06	1.1742	1.481
Nickel	3.7	1.19E-10	0.000780	0.00205	0.00896	8.32E-07	4.61E-07	1.51E-06	1.5085	1.903
Selenium	40.0	1.28E-09	0.006273	0.02213	0.09692	8.99E-06	4.99E-06	1.63E-05	16.3077	20.576
Silver	< 10.0	< 3.21E-10	< 0.001148	< 0.00553	< 0.02423	2.25E-06	1.25E-06	4.08E-06	4.0769	5.144
Thallium	< 40.0	< 1.28E-09	< 0.002424	< 0.02213	< 0.09692	< 8.99E-06	< 4.99E-06	< 1.63E-05	< 16.3077	< 20.576

*Emissions rates are doubled assuming equal emissions on second "pant leg" of the system.

Test Support Data	
Sample Volume (Vm, normal)	68.653
Volumetric Flowrate (acfin)	258,905
Volumetric Flowrate (dscfin)	143,551
%O2	4.8
%CO2	13.8
Fuel Factor	9,780

TEST DATA- **Method 29****Run No.: 3****Project Number:** M22E0758**Test Date:** 11/4/2004**TEST PARAMETERS**

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.
Static Pressure:	-21.00	in. H₂O
Flue Pressure (Ps):	28.06	in. Hg. abs.
Sample Train	Pre: 0.002	
Leak Check	Post: 0.001	
	@ 10/6	in. Hg.
Carbon Dioxide:	13.8	%
Oxygen:	4.8	%
Nitrogen:	81.4	%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	248.90	mls.
Difference:	248.90	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	248.90	

STACK PARAMETERS

Delta H:	1.23	Inches H₂O	Gas Weight dry, Md:	30.400	lb/lb mole
Meter Temperature, Tm:	69.6	°F	Gas Weight wet, Ms:	28.698	lb/lb mole
Sqrt ΔP:	0.756	Inches H₂O	Excess Air:	28.760	%
Stack Temperature, Ts:	310.4	°F	Gas Velocity, Vs:	52.842	
Meter Volume, Vm:	74.464	Cubic Feet	Volumetric Flow, ACFM:	258,905	
Meter Volume, Vmstd:	73.675	dscf	Volumetric Flow, DSCFM:	143,551	
Meter Volume, Vwstd:	11.723	wscf	Volumetric Flow, SCFM:	166,392	
Moisture, Bws:	0.137		Isokinetic Variance, %I:	102.5	
Meter Volume, Normal:	68.653				

TEST DATA	- Ontario Hydro	Run No.: 1
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Project Number:	M22E0758	Test Date: 11/2/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Teflon	Total Number of Traverse Points:	24
Nozzle Diameter:	0.247 in.	Test Length:	120 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.	
Static Pressure:	-19.50	in. H₂O	
Flue Pressure (Ps):	28.13	in. Hg. abs.	
Sample Train Pre:	0.002		
Leak Check Post:	0.004		
	@ 15/20	in. Hg.	
Carbon Dioxide:	14.8	%	
Oxygen:	3.8	%	
Nitrogen:	81.4	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	275.20	mls.	
Difference:	275.20		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	275.20		

STACK PARAMETERS

Delta H:	1.04	Inches H₂O	
Meter Temperature, Tm:	68.4	°F	
Sqrt ΔP:	0.752	Inches H₂O	
Stack Temperature, Ts:	322.5	°F	
Meter Volume, Vm:	73.174	Cubic Feet	
Meter Volume, Vmstd:	71.846	dscf	
Meter Volume, Vwstd:	12.962	wscf	
Moisture, Bws:	0.153		
Meter Volume, Normal	66.949		
Gas Weight dry, Md:	30.520	lb/lb mole	
Gas Weight wet, Ms:	28.606	lb/lb mole	
Excess Air:	21.482	%	
Gas Velocity, Vs:	53.275		
Volumetric Flow, ACFM:	261,026		
Volumetric Flow, DSCFM:	140,264		
Volumetric Flow, SCFM:	165,570		
Isokinetic Variance, %I:	104.8		

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F_d (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	200.590
Speciated Mercury	
Particle Bound Mercury	0.00
mg (net) collected:	0.013000
ppm:	0.000766
ug/dncm:	6.86
lb/hr:	0.003357
lb/mmBtu (based on Fd):	0.00000477
Elemental Mercury	
mg (net) collected:	0.00097
ppm:	0.000057
ug/dncm:	0.51
lb/hr:	0.000250
lb/mmBtu (based on Fd):	0.00000036
Oxidized Mercury	
mg (net) collected:	0.00063
ppm:	0.000037
ug/dncm:	0.33
lb/hr:	0.000163
lb/mmBtu (based on Fd):	0.00000023
Total Mercury	
mg (net) collected:	0.01460
ppm:	0.000860
ug/dncm:	7.70
lb/hr:	0.003770
lb/mmBtu (based on Fd):	0.00000536

TEST DATA	- Ontario Hydro	Run No.: 2
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Project Number:	M22E0758	Test Date: 11/3/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Inlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	PJN	Sample Plane:	Vertical
Temp ID:	E-68	Port Length:	18.00 in.
Meter ID:	E-68	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	0.992	Port Type:	Flange
Pitot ID:	835A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.840	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe LIner Material:	Teflon	Total Number of Traverse Points:	24
Nozzle Diameter:	0.247 in.	Test Length:	120 min.
Train Type:	Other		

STACK CONDITIONS

Barometric Pressure (Pb):	29.76	in. Hg.	
Static Pressure:	-18.50	in. H ₂ O	
Flue Pressure (Ps):	28.40	in. Hg. abs.	
Sample Train Pre:	0.010		
Leak Check Post:	0.001		
	@ 20/20	in. Hg.	
Carbon Dioxide:	14.0	%	
Oxygen:	5.0	%	
Nitrogen:	81.0	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	241.10	mls.	
Difference:	241.10		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	241.10		

STACK PARAMETERS

Delta H:	0.97	Inches H ₂ O		30.440	lb/lb mole
Meter Temperature, Tm:	62.2	°F	Gas Weight dry, Md:		
Sqrt ΔP:	0.765	Inches H ₂ O	Gas Weight wet, Ms:	28.728	lb/lb mole
Stack Temperature, Ts:	326.2	°F	Excess Air:	30.518	%
Meter Volume, Vm:	71.159	Cubic Feet	Gas Velocity, Vs:	53.914	
Meter Volume, Vmstd:	71.158	dscf	Volumetric Flow, ACFM:	264,157	
Meter Volume, Vwstd:	11.356	wscf	Volumetric Flow, DSCFM:	145,221	
Moisture, Bws:	0.138		Volumetric Flow, SCFM:	168,396	
Meter Volume, Normal	66.308		Isokinetic Variance, %I:	100.3	

EMISSION DATA

Type of Fuel Firing:	Coal	
Fuel Factor F_d (dscf/mmBtu):	9780	
List Mol. Wt. of Analyte if ppm needed:	200.590	
Speciated Mercury		
Particle Bound Mercury		0.00
mg (net) collected:	0.012000	---
ppm:	0.000714	---
ug/dncm:	6.39	---
lb/hr:	0.003239	---
lb/mmBtu (based on Fd):	0.00000478	---
Elemental Mercury		
mg (net) collected:	0.0007	---
ppm:	0.000042	---
ug/dncm:	0.37	---
lb/hr:	0.000189	---
lb/mmBtu (based on Fd):	0.00000028	---
Oxidized Mercury		
mg (net) collected:	0.00194	---
ppm:	0.000115	---
ug/dncm:	1.03	---
lb/hr:	0.000524	---
lb/mmBtu (based on Fd):	0.00000077	---
Total Mercury		
mg (net) collected:	0.01464	
ppm:	0.000871	
ug/dncm:	7.80	
lb/hr:	0.003952	
lb/mmBtu (based on Fd):	0.00000583	

TEST DATA	- Ontario Hydro	Run No.: 3
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Project Number: M22E0758		Test Date: 11/4/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Inlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: P/JN		Sample Plane: Vertical	
Temp ID: E-68		Port Length: 18.00	In.
Meter ID: E-68		Port Size (diameter): 4.00	In.
Meter Calibration Factor: 0.992		Port Type: Flange	
Pitot ID: 835A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.840		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Teflon		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.247	In.	Test Length: 120	min.
Train Type: Other			

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.	
Static Pressure:	-19.00	In. H ₂ O	
Flue Pressure (Ps):	28.20	in. Hg. abs.	
Sample Train	Pre: 0.005		
Leak Check	Post: 0.004		
	@ 15/15	in. Hg.	
Carbon Dioxide:	14.0	%	
Oxygen:	3.6	%	
Nitrogen:	82.4	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	238.20	mls.	
Difference:	238.20		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	238.20		

STACK PARAMETERS

Delta H:	1.03	Inches H ₂ O	
Meter Temperature, Tm:	65.0	°F	
Sqrt ΔP:	0.773	Inches H ₂ O	
Stack Temperature, Ts:	321.8	°F	
Meter Volume, Vm:	72.931	Cubic Feet	
Meter Volume, Vmstd:	72.173	dscf	
Meter Volume, Vwstd:	11.219	wscf	
Moisture, Bws:	0.135		
Meter Volume, Normal	67.253		
Gas Weight dry, Md:	30.384	lb/lb mole	
Gas Weight wet, Ms:	28.718	lb/lb mole	
Excess Air:	19.831	%	
Gas Velocity, Vs:	54.569		
Volumetric Flow, ACFM:	267,367		
Volumetric Flow, DSCFM:	147,318		
Volumetric Flow, SCFM:	170,218		
Isokinetic Variance, %I:	100.3		

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F _a (dscf/mmBtu):	9780
List Mol. Wt. of Analyte If ppm needed:	200.590

Speciated Mercury	
Particle Bound Mercury	0.00
mg (net) collected:	0.023000 ---
ppm:	0.001348 ---
ug/dncm:	12.08 ---
lb/hr:	0.006210 ---
lb/mmBtu (based on Fd):	0.00000830 ---
Elemental Mercury	
mg (net) collected:	0.0032 ---
ppm:	0.000188 ---
ug/dncm:	1.68 ---
lb/hr:	0.000864 ---
lb/mmBtu (based on Fd):	0.00000115 ---
Oxidized Mercury	
mg (net) collected:	0.00730 ---
ppm:	0.000428 ---
ug/dncm:	3.83 ---
lb/hr:	0.001971 ---
lb/mmBtu (based on Fd):	0.00000263 ---
Total Mercury	
mg (net) collected:	0.03350
ppm:	0.001964
ug/dncm:	17.59
lb/hr:	0.009045
lb/mmBtu (based on Fd):	0.00001209

TEST DATA	- Ontario Hydro	Run No.: 1
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Project Number:	M22E0758	Test Date: 11/2/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.56	in. Hg.	
Static Pressure:	-22.00	in. H ₂ O	
Flue Pressure (Ps):	27.94	in. Hg. abs.	
Sample Train Pre:	0.005		
Leak Check Post:	0.003		
	@ 10/6	in. Hg.	
Carbon Dioxide:	14.4	%	
Oxygen:	3.9	%	
Nitrogen:	81.7	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	215.60	mls.	
Difference:	215.60		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	215.60		

STACK PARAMETERS

Delta H:	1.23	Inches H ₂ O	Gas Weight dry, Md:	30.460	lb/lb mole
Meter Temperature, Tm:	72.6	°F	Gas Weight wet, Ms:	29.016	lb/lb mole
Sqrt ΔP:	0.744	Inches H ₂ O	Excess Air:	22.073	%
Stack Temperature, Ts:	309.8	°F	Gas Velocity, Vs:	51.828	
Meter Volume, Vm:	78.880	Cubic Feet	Volumetric Flow, ACFM:	253,939	
Meter Volume, Vmstd:	77.497	dscf	Volumetric Flow, DSCFM:	143,818	
Meter Volume, Vwstd:	10.155	wscf	Volumetric Flow, SCFM:	162,663	
Moisture, Bws:	0.116		Isokinetic Variance, %I:	107.6	
Meter Volume, Normal	72.214				

EMISSION DATA

Type of Fuel Firing:	Coal	
Fuel Factor F_d (dscf/mmBtu):	9780	
List Mol. Wt. of Analyte if ppm needed:	200.590	
Spectated Mercury		
Particle Bound Mercury		0.00
mg (net) collected:	0.000020	---
ppm:	0.000001	---
ug/dncm:	0.01	---
lb/hr:	0.000005	---
lb/mmBtu (based on Fd):	0.00000001	---
Elemental Mercury		No
mg (net) collected:	0.0005	---
ppm:	0.000025	---
ug/dncm:	0.22	---
lb/hr:	0.000110	---
lb/mmBtu (based on Fd):	0.00000015	---
Oxidized Mercury		
mg (net) collected:	0.00021	---
ppm:	0.000011	---
ug/dncm:	0.10	---
lb/hr:	0.000052	---
lb/mmBtu (based on Fd):	0.00000007	---
Total Mercury		
mg (net) collected:	0.00068	---
ppm:	0.000037	---
ug/dncm:	0.33	---
lb/hr:	0.000167	---
lb/mmBtu (based on Fd):	0.00000023	---

TEST DATA	- Ontario Hydro	Run No.: 2
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Project Number: M22E0758		Test Date: 11/3/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Outlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: AS		Sample Plane: Vertical	
Temp ID: E-22		Port Length: 18.00	in.
Meter ID: E-22		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 1.000		Port Type: Flange	
Pitot ID: 643A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.836		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Glass		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.250	in.	Test Length: 120	min.
Train Type: Hot Box			

STACK CONDITIONS

Barometric Pressure (Pb): 29.76		in. Hg.	
Static Pressure: -21.00		in. H₂O	
Flue Pressure (Ps): 28.22		in. Hg. abs.	
Sample Train Pre: 0.000			
Leak Check Post: 0.000			
	@ 10/6	in. Hg.	
Carbon Dioxide: 13.6		%	
Oxygen: 4.9		%	
Nitrogen: 81.5		%	

MOISTURE DETERMINATION

Initial Impinger Content:		0.00	mls.
Final Impinger Content:		233.00	mls.
Difference:		233.00	
Silica Initial Wt.		0.00	grams
Silica Final Wt.		0.00	grams
Difference:		0.00	
Total Water Gain:		233.00	

STACK PARAMETERS

Delta H: 1.22		Inches H₂O	
Meter Temperature, Tm: 59.9		°F	
Sqrt ΔP: 0.763		Inches H₂O	
Stack Temperature, Ts: 314.9		°F	
Meter Volume, Vm: 74.346		Cubic Feet	
Meter Volume, Vmstd: 75.322		dscf	
Meter Volume, Vwstd: 10.974		wscf	
Moisture, Bws: 0.127			
Meter Volume, Normal: 70.187			
Gas Weight dry, Md:		30.372	lb/lb mole
Gas Weight wet, Ms:		28.799	lb/lb mole
Excess Air:		29.490	%
Gas Velocity, Vs:		53.249	
Volumetric Flow, ACFM:		260,900	
Volumetric Flow, DSCFM:		146,331	
Volumetric Flow, SCFM:		167,651	
Isokinetic Variance, %I:		102.8	

EMISSION DATA

Type of Fuel Firing: Coal	
Fuel Factor F_d (dscf/mmBtu): 9780	
List Mol. Wt. of Analyte if ppm needed: 200.590	

Speciated Mercury			
Particle Bound Mercury			0.00
mg (net) collected:	0.000028		
ppm:	0.000002		
ug/dncm:	0.01		
lb/hr:	0.000007		
lb/mmBtu (based on Fd):	0.00000001		
Elemental Mercury			
mg (net) collected:	0.00061		
ppm:	0.000034		
ug/dncm:	0.31		
lb/hr:	0.000157		
lb/mmBtu (based on Fd):	0.00000023		
Oxidized Mercury			
mg (net) collected:	0.00016		
ppm:	0.000009		
ug/dncm:	0.08		
lb/hr:	0.000041		
lb/mmBtu (based on Fd):	0.00000006		
Total Mercury			
mg (net) collected:	0.00080		
ppm:	0.000045		
ug/dncm:	0.40		
lb/hr:	0.000205		
lb/mmBtu (based on Fd):	0.00000030		

TEST DATA	- Ontario Hydro	Run No.: 3
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Project Number:	M22E0758	Test Date: 11/4/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.60	in. Hg.	
Static Pressure:	-21.00	in. H ₂ O	
Flue Pressure (Ps):	28.06	in. Hg. abs.	
Sample Train Leak Check	Pre: 0.000		
	Post: 0.002		
	@ 10/6	in. Hg.	
Carbon Dioxide:	13.6	%	
Oxygen:	3.8	%	
Nitrogen:	82.6	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	235.90	mls.	
Difference:	235.90		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	235.90		

STACK PARAMETERS

Delta H:	1.23	Inches H ₂ O	Gas Weight dry, Md:	30.328	lb/lb mole
Meter Temperature, Tm:	64.4	°F	Gas Weight wet, Ms:	28.730	lb/lb mole
Sqrt ΔP:	0.758	Inches H ₂ O	Excess Air:	21.104	%
Stack Temperature, Ts:	308.6	°F	Gas Velocity, Vs:	52.894	
Meter Volume, Vm:	74.667	Cubic Feet	Volumetric Flow, ACFM:	259,159	
Meter Volume, Vmstd:	74.609	dscf	Volumetric Flow, DSCFM:	145,304	
Meter Volume, Vwstd:	11.111	wscf	Volumetric Flow, SCFM:	166,943	
Moisture, Bws:	0.130		Isokinetic Variance, %I:	102.6	
Meter Volume, Normal	69.522				

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F_a (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	200.590

Speciated Mercury			0.00
Particle Bound Mercury			
mg (net) collected:	0.000010	---	
ppm:	0.000001	---	
ug/dncm:	0.01	---	
lb/hr:	0.000003	---	
lb/mmBtu (based on Fd):	0.00000000	---	
Elemental Mercury			
mg (net) collected:	0.0013	---	
ppm:	0.000074	---	
ug/dncm:	0.66	---	
lb/hr:	0.000335	---	
lb/mmBtu (based on Fd):	0.00000046	---	
Oxidized Mercury			
mg (net) collected:	0.00073	---	
ppm:	0.000041	---	
ug/dncm:	0.37	---	
lb/hr:	0.000188	---	
lb/mmBtu (based on Fd):	0.00000026	---	
Total Mercury			
mg (net) collected:	0.00204	---	
ppm:	0.000116	---	
ug/dncm:	1.04	---	
lb/hr:	0.000526	---	
lb/mmBtu (based on Fd):	0.00000072	---	

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.

NOZZLES

The nozzles are measured according to Method 5, Section 5.1.

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

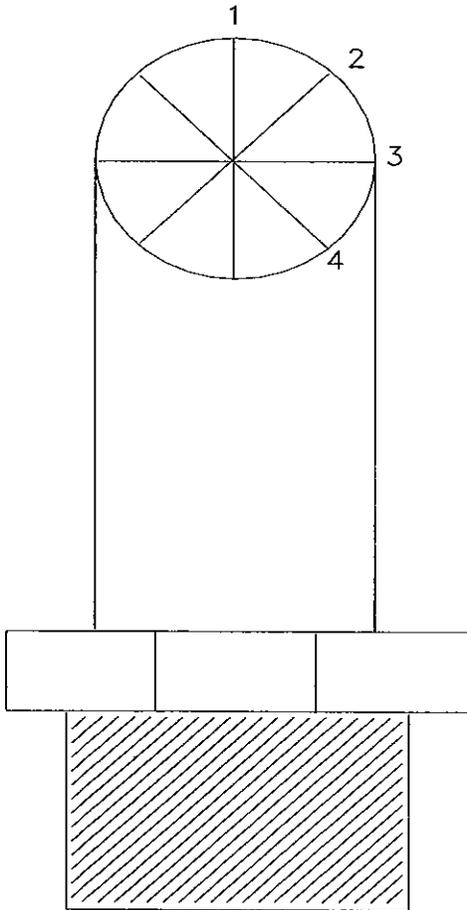
The accuracy of the analytical balance is checked with Class S, Stainless Steel Type 303 weights manufactured by F. Hopken and Son, Jersey City, New Jersey.

Nozzle Calibration

Date: 10/20/2004

Nozzle ID No.: N/A

Analyst: JPH



0.247 1

0.246 2

0.246 3

0.248 4

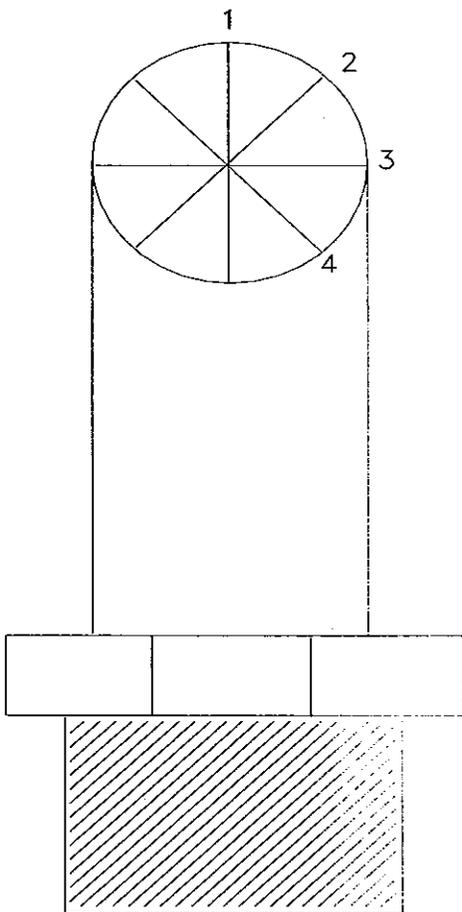
Average
<u>0.247</u>

Nozzle Calibration

Date: 10/20/2004

Nozzle ID No.: N/A

Analyst: JPH



0.250 1

0.250 2

0.249 3

0.250 4

Average
<u>0.250</u>

METER BOX CALIBRATION

Dry Gas Meter No. E22 Date: 10-18-04
 Standard Meter No. 2547159 Calibrated By: PSH
 Standard Meter (Yr) 1.0008 Barometric Pressure: 29.26

Formula Protection Password: MPA

Run Number	Orifice Setting in H2O 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.	Chg (H@)
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Final		75.932	55.062	64	71	71				
Initial		70.927	50.000	64	71	71				
Difference	1	0.20	5.005	64	71	71	69	19	17	0.997
Final		81.668	60.869	64	73	73				1.669
Initial		75.999	55.132	64	71	71				
Difference	2	0.50	5.669	64	72	72	70	13	58	0.998
Final		65.743	44.834	63	70	70				1.703
Initial		60.347	39.617	63	68	68				
Difference	3	0.70	5.196	63	69	69	67	11	1	1.001
Final		86.806	66.072	64	75	75				1.770
Initial		81.732	60.931	64	73	73				
Difference	4	0.90	5.074	64	74	74	71	9	35	0.998
Final		99.228	79.650	64	78	78				
Initial		94.227	74.584	64	75	75				
Difference	5	1.20	5.001	64	77	77	73	8	22	1.002
Final		70.865	49.947	64	72	72				1.872
Initial		65.856	44.946	64	70	70				
Difference	6	2.00	5.009	64	71	71	68	6	29	1.005
Average										1.783

VOLUME METERING SYSTEM FIELD AUDIT

Date: 10-18-04

Name: PSH

EPA Control Module No.: E22

Ambient Temperature: 63 °F

Calibration (Y): 1.000

Barometric Pressure: 29.26 "Hg

Delta H: 1.783

Run No.	Time	Gas Meter Reading/Gas Meter Temperature			Yc (Calculated)
	(Minutes)	(Cubic Feet)	Inlet (°F)	Outlet (°F)	
1	0	78.833	77	71	1.010
	10	86.392	79	72	
	Vm=	7.559	Avg.= 75	534.75	
2	0	86.392	79	72	1.011
	10	93.952	81	73	
	Vm=	7.560	Avg.= 76	536.25	
3	0	93.952	81	73	1.010
	10	101.517	73	74	
	Vm=	7.565	Avg.= 75	535.25	

$$Y_c = \frac{10}{V_m} \sqrt{\frac{0.319 T_m}{P_{bar}}}$$

Limit: 0.97Y <Yc< 1.03Y

Limit: 0.970 <Yc< 1.030

METER BOX CALIBRATION

Dry Gas Meter No. E68 Date: 10-25-04
 Standard Meter No. 2547159 Calibrated By: PSH
 Standard Meter (Yr) 1.0008 Barometric Pressure: 29.36

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		103.379	25.858	65	76	74					
Initial		98.378	20.720	65	76	73					
Difference	1	5.001	5.138	65	76	74	75	18	9	0.991	1.465
Final		108.442	31.084	65	80	75					
Initial		103.441	25.928	65	77	74					
Difference	2	5.001	5.156	65	79	75	77	11	47	0.990	1.539
Final		93.188	15.422	65	75	72					
Initial		88.187	10.322	65	72	70					
Difference	3	5.001	5.100	65	74	71	72	10	5	0.992	1.590
Final		113.583	36.374	66	83	76					
Initial		108.582	31.226	65	80	75					
Difference	4	5.001	5.148	66	82	76	79	8	57	0.993	1.595
Final		118.760	41.642	66	86	77					
Initial		113.687	36.391	66	83	76					
Difference	5	5.073	5.251	66	85	77	81	7	53	0.990	1.601
Final		98.330	20.670	65	77	73					
Initial		93.329	15.569	65	75	72					
Difference	6	5.001	5.101	65	76	73	74	6	6	0.993	1.656

Average 0.992 1.574

VOLUME METERING SYSTEM FIELD AUDIT

Date: 10-25-04

Name: PSH

EPA Control Module No.: E68

Ambient Temperature: 65 °F

Calibration (Y): 0.992

Barometric Pressure: 29.36 "Hg

Delta H: 1.574

Run No.	Time	Gas Meter Reading/Gas Meter Temperature			Yc (Calculated)
	(Minutes)	(Cubic Feet)	Inlet (°F)	Outlet (°F)	
1	0	41.804	75	69	1.014
	10	49.304	77	70	
	Vm=	7.500	Avg.= 73	532.75	
2	0	49.304	77	70	1.017
	10	56.799	79	71	
	Vm=	7.495	Avg.= 74	534.25	
3	0	56.799	79	71	1.019
	10	64.287	81	72	
	Vm=	7.488	Avg.= 76	535.75	

$$Y_c = \frac{10}{V_m} \sqrt{\frac{0.319 T_m}{P_{bar}}}$$

Limit: 0.97Y <Yc< 1.03Y

Limit: 0.962 <Yc< 1.021

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? yes no

Pitot tube openings damaged? yes (explain below) no

$\alpha_1 = 0^\circ (<10^\circ)$, $\alpha_2 = 0^\circ (<10^\circ)$

$z = A \sin \gamma = 0.000$ (in.); (<0.125 in.)

$\beta_1 = 0^\circ (<5^\circ)$, $\beta_2 = 0^\circ (<5^\circ)$

$w = A \sin \theta = 0.000$ (in.); (<0.03125 in.)

$\gamma = 0^\circ$, $\theta = 0^\circ$, $A = 0.750$ (in.)

$P_A = 0.376$ (in.), $P_B = 0.374$ (in.), $D_t = 0.250$ (in.)

Comments:

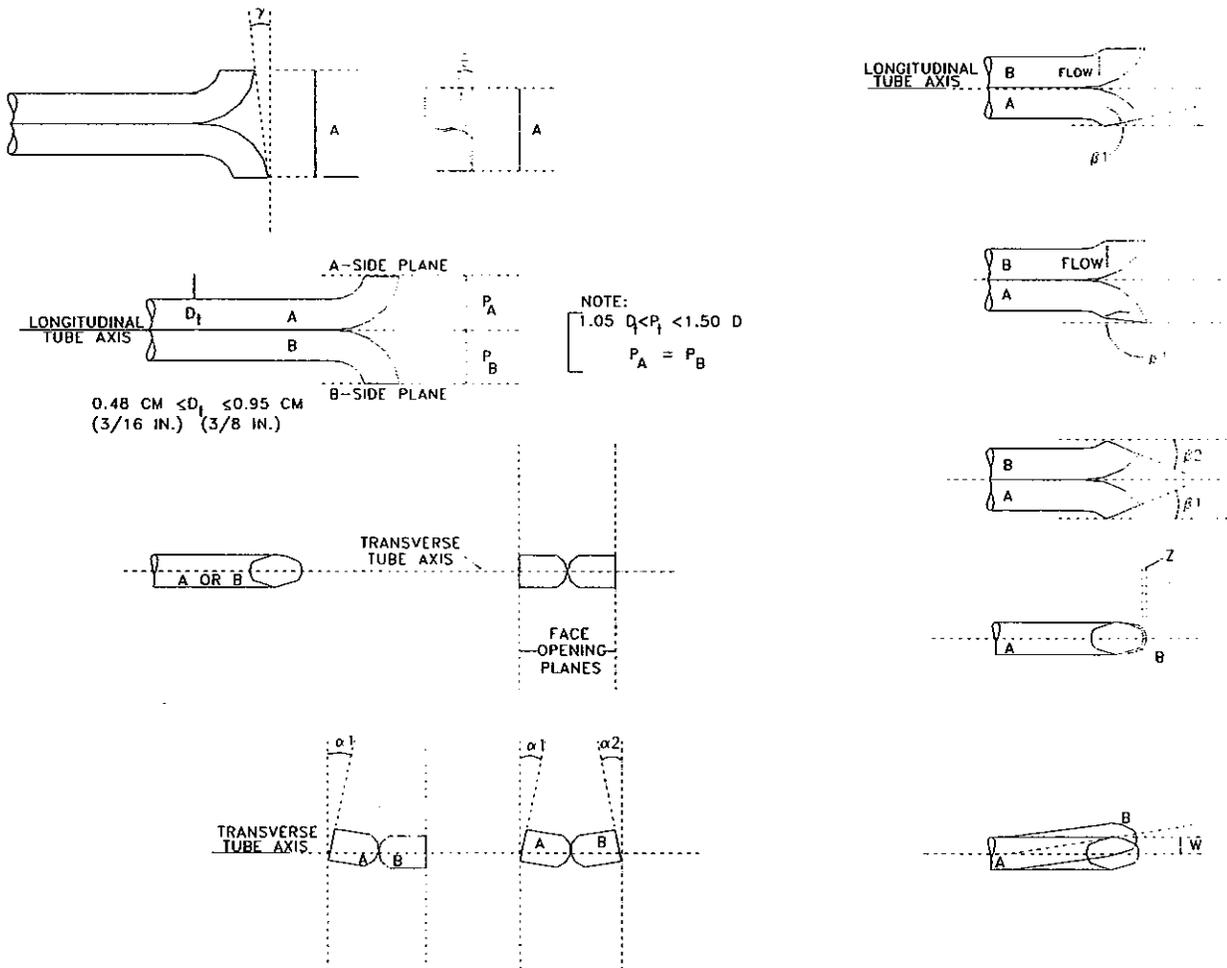
Assign baseline coefficient, 0.840

Calibration required? yes no

Pitot Tube No.: 835

Date: 10/5/2004

Name: L. Campo



TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? yes no

Pitot tube openings damaged? yes (explain below) no

$\alpha_1 = 4^\circ (<10^\circ)$, $\alpha_2 = 5^\circ (<10^\circ)$ $z = A \sin \gamma = 0.025$ (in.); (<0.125 in.)

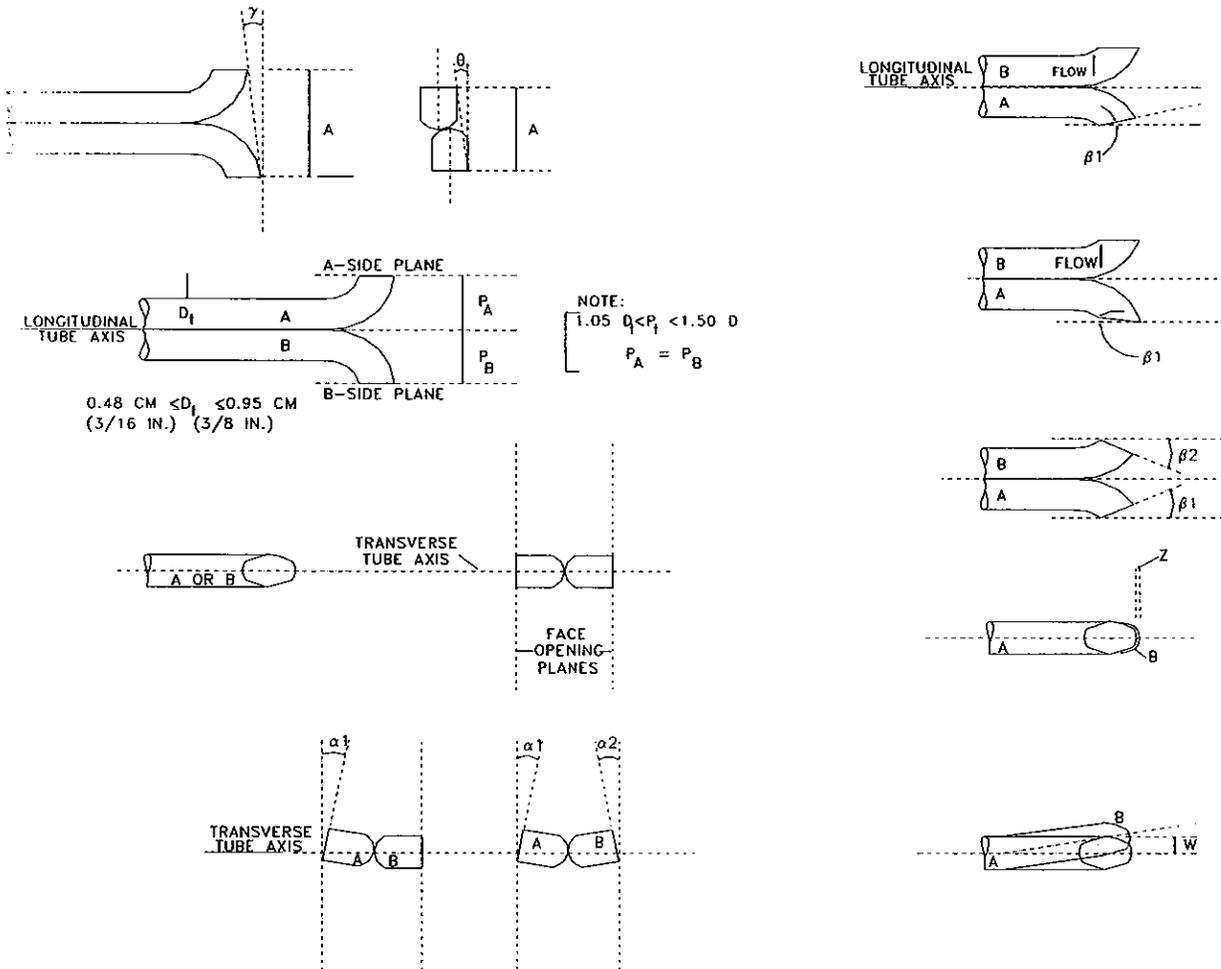
$\beta_1 = 2^\circ (<5^\circ)$, $\beta_2 = 1^\circ (<5^\circ)$ $w = A \sin \theta = 0.013$ (in.); (<0.03125 in.)

$\gamma = 2^\circ$, $\theta = 1^\circ$, $A = 0.730$ (in.) $P_A = #####$ (in.), $P_B = 0.340$ (in.), $D_t = 0.250$ (in.)

Comments: _____

Calibration required? yes no

Pitot Tube No.: P643 Date: 10/5/2004 Name: TAM



PITOT TUBE CALIBRATION DATA

Type "S" Pitot Tube ID Number: 643 Size (OD): 1/4" Leak Check: Pass

Calibration Pitot Tube

Type: Hemispherical (std) Size (OD): 1/4" Cp(std) = 1.00 ID #: Dwyer 160-8

Calibration Date: 11/30/00 Performed By: Rich Russ

P _{std} , (in.) H ₂ O		A-Side Calibration		
Set Value	Read Value	P _s , (in.) H ₂ O	C _{p(S)} ^a	DEV. ^b
0.25	0.25	0.36	0.833	0.002
0.55	0.55	0.79	0.834	0.001
0.85	0.85	1.22	0.835	0.001
1.00	1.00	1.43	0.836	0.001
2.00	2.00	2.86	0.836	0.001
3.00	3.00	4.27	0.838	0.003
Average			0.836	0.001

P _{std} , (in.) H ₂ O		B-Side Calibration		
Set Value	Read Value	P _s , (in.) H ₂ O	C _{p(S)} ^a	DEV. ^b
0.25	0.25	0.36	0.833	0.002
0.55	0.55	0.79	0.834	0.001
0.85	0.85	1.22	0.835	0.001
1.00	1.00	1.43	0.836	0.001
2.00	2.00	2.86	0.836	0.001
3.00	3.00	4.27	0.838	0.003
Average			0.836	0.001

$$\overline{C_p}(A) - \overline{C_p}(B) = 0.000$$

(must be ≤ 0.01)

$${}^a C_{p(S)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_s}}$$

$${}^b DEV = C_{p(S)} - \overline{C_p}$$

(must be ≤ 0.01)

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M-36A Test Run No. #1-1265 Run Date: 1/2/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Averett - Mesomer
 Plant: St. Louis, Mo
 Test Location: # 2 Inlet
 Source Condition: Normal
 Test Engineer: P. S. ...
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.56
 Static Pressure (in. H₂O): -19.5"
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.002 Post: 0.000 @ 15/15 in. Hg
 Pitot Leak Check: Pre √3 Post √3
 Carbon Dioxide (%): 4.8
 Oxygen (%): 4.9

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 238 Tare Wt (g) 2.8106
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other - _____

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: American - Worcester
 Plant: St. Louis, Mo
 Test Location: # 2 inlet

List Test Method Used: M-26A
 Test Run No. #1 - Inlet
 Date: 11/2/04

Traverse Sheet 1 of 3

Port-Point No.	Clock Time 24-hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (G) F	Probe Temp F	Filter Holder Temp F	Impinger Outlet Temp F	Meter Temp (t _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	15 ⁰⁰	.55	.94	12.133	.742	.59	2.93	—	322	257	258	68SF	68	67	2
2	15 ⁰⁵	.55	.94	15.12	.742	.59	2.93	15.062	323	260	267	F _{2.00}	71	67	2
3	15 ¹⁰	.52	.88	17.93	.721	.57	2.85	17.991	325	263	265	F _{2.00}	73	67	2
4	15 ¹⁵	.52	.88	20.92	.721	.57	2.85	20.840	323	263	265		73	67	2
5	15 ²⁰	.58	.99	23.72	.762	.60	3.01	23.69	324	270	271		73	68	2
6	15 ²⁵	.58	.99	26.71	.762	.60	3.01	26.698	324	270	271		75	68	3
7	15 ³⁰	.73	1.24	29.73	.854	.675	3.37	29.699	327	270	273		78	68	3
8	15 ³⁵	.75	1.28	33.12	.866	.684	3.42	33.073	323	268	267		78	68	3
9	15 ⁴⁰	.75	1.28	36.42	.866	.684	3.42	36.493	323	270	270		79	68	4
10	15 ⁴⁵	.68	1.16	40.01	.825	.651	3.26	39.914	322	271	271		79	68	4
11	15 ⁵⁰	.69	1.17	43.18	.831	.656	3.28	43.171	320	272	271		79	68	4
12	15 ⁵⁵	.68	1.16	46.52	.825	.651	3.26	46.432	320	271	273		79	68	5
	16 ⁰⁰		1.00	49.75	.793			49.709	323					71.51	
2-1	16 ⁰²	.60	1.02	49.833	.775	.612	3.06	—	329	261	263		79	68	6
2	16 ⁰⁷	.60	1.02	52.73	.775	.612	3.06	52.693	331	262	265		79	68	6
3	16 ¹²	.57	.969	56.02	.755	.596	2.98	55.953	331	270	268		79	68	6
4	16 ¹⁷	.57	.969	58.97	.755	.596	2.98	58.935	331	272	273		79	68	6
5	16 ²²	.60	1.02	61.93	.775	.612	3.06	61.915	329	270	271		78	68	7
6	16 ²⁷	.58	.986	65.02	.762	.601	3.01	64.975	322	271	273		78	68	7
7	16 ³²	.67	1.13	67.95	.819	.650	3.23	67.983	329	271	273		77	68	8
8	16 ³⁷	.67	1.13	71.23	.819	.650	3.23	71.217	330	272	273		77	68	8
9	16 ⁴²	.69	1.17	74.52	.831	.656	3.281	74.446	331	271	273		78	68	8
10	16 ⁴⁷	.68	1.16	77.74	.825	.651	3.257	77.727	328	272	273		77	67	10
11	16 ⁵²	.65	1.10	80.92	.806	.637	3.185	80.984	328	271	273		76	66	10
12	16 ⁵⁷	.60	1.02	84.13	.775	.612	3.059	84.168	329	272	273		76	66	11
	17 ⁰²			87.372				87.228							

= Data does not get entered in Excel

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M-26A Test Run No. #2-1247 Run Date: 1/23/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Andersen - Anderson
 Plant: St. Louis, Mo
 Test Location: #2 ESP inlet duct
 Source Condition: Normal
 Test Engineer: P. N. Numb
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): _____ Diameter (ft.): _____
 Width (ft.): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.72
 Static Pressure (in. H₂O): -18.5
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: √0.004 Post: √0.000 @ 15/13 in. Hg
 Pitot Leak Check: Pre √3 Post √3
 Carbon Dioxide (%): 14.7
 Oxygen (%): 11.4
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other: _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 235 Tare Wt (g) 2.0828
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: Amesbury - Newbury
 Plant: St Louis Mo
 Test Location: #2 Inlet

List Test Method Used: M26
 Test Run No. #2 - Inlet
 Date: 11/03/04

Traverse Sheet 1 of 1

Port Point No.	Clock Time 24 hr.	Velocity Head (V) in H ₂ O	Office (VH) in H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. VP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (°C) F	Probe Temp (°C) F	Filter Holder Temp (°C) F	Impinger Outlet Temp (°C) F	Meter Temp (°C)	
													Inlet	Outlet
1-1	1400	.68	1.14	40.460	.825	.635	3.174	—	324	250	253	62	59	2
2	1405	.67	1.20	40.700	.819	.630	3.151	43.635	325	250	250	66	59	2
3	1410	.68	1.14	46.785	.825	.635	3.174	46.786	324	252	252	68	59	3
4	1415	.67	1.20	44.98	.819	.630	3.151	44.960	325	251	253	69	60	3
5	1420	.58	.97	51.32	.73	.586	2.932	51.101	325	257	254	69	60	3
6	1425	.58	.97	54.21	.762	.586	2.932	54.033	322	251	255	69	60	3
7	1430	.62	1.03	56.97	.787	.606	3.032	56.965	321	251	257	69	60	3
8	1435	.61	1.02	60.13	.781	.601	3.007	59.996	322	252	251	69	60	3
9	1440	.76	1.26	63.25	.87	.671	3.356	63.007	321	257	253	69	60	4
10	1445	.65	1.09	66.29	.81	.621	2.104	66.359	320	251	255	69	60	4
11	1450	.66	1.10	69.39	.81	.624	3.128	69.463	320	257	255	69	60	4
12	1455	.70	1.16	72.55	.84	.644	3.22	72.591	320	251	255	68	60	4
13	1500			75.832				75.812						
2-1	1505	.58	.97	75.984	.76	.586	2.82	—	330	251	257	68	60	4
2	1510	.57	.95	79.02	.75	.581	2.907	78.916	329	255	253	68	60	4
3	1515	.65	1.09	81.75	.81	.620	3.104	81.823	329	255	251	68	60	4
4	1520	.65	1.09	85.23	.81	.620	3.104	84.927	329	257	251	68	60	5
5	1525	.53	.89	88.21	.73	.541	2.803	88.031	329	251	251	69	60	5
6	1530	.53	.89	90.92	.73	.541	2.803	90.834	330	261	263	68	59	7
7	1535	.64	1.07	93.65	.80	.614	3.080	93.637	328	270	265	67	58	8
8	1540	.63	1.05	96.72	.79	.611	3.056	96.717	328	270	265	67	58	9
9	1545	.67	1.12	99.92	.82	.63	3.152	99.772	325	271	266	67	58	9
10	1550	.75	1.25	102.94	.86	.667	3.334	102.923	328	271	265	67	58	10
11	1555	.61	1.02	106.53	.78	.60	3.007	106.257	325	270	261	68	59	10
12	1600	.61	1.02	109.49	.78	.60	3.007	109.261	326	270	261	68	60	10
13	1605			112.315				112.271						

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M 26A Test Run No. #3- West Run Date: 11/4/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Andersen - Newcastle
 Plant: St. Louis Mo
 Test Location: #2 ESP Inlet Duct
 Source Condition: Normal
 Test Engineer: P. Newell
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.6
 Static Pressure (in. H₂O): -18.5
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.001 Post: 0.004 @ 15720 in. Hg
 Pitot Leak Check: Pre: 3 Post: 3
 Carbon Dioxide (%): 15.0
 Oxygen (%): 2.7
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780-Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

COMMENTS & NOTES:

SAMPLE COLLECTION:
 Thimble No. 267 Tare Wt (g) 2.8287
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: American - Mechanical List Test Method Used: MZCA
 Plant: St Louis Mo Test Run No. # 3 - 11/16/11
 Test Location: #2 ESP Inlet Duct Date: 11/14/11 Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet °F	Outlet °F	
1-1	1404	.68	1.20	83.30	.824	.668	3.339	—	321	251	260	568	74	68	4
2	1409	.63	1.11	86.73	.794	.643	3.215	86.725	321	259	267	560	77	69	5
3	1414	.60	1.06	90.04	.775	.627	3.137	89.939	322	260	260	560	78	69	5
4	1419	.55	.97	93.24	.742	.601	3.004	93.076	322	261	260	560	78	69	5
5	1424	.55	.97	96.15	.742	.601	3.004	96.079	323	262	261	560	79	69	5
6	1429	.60	1.06	99.32	.775	.627	3.137	99.084	320	261	261	560	80	70	6
7	1434	.60	1.06	102.27	.775	.627	3.137	102.221	321	265	262	560	80	70	6
8	1439	.65	1.14	105.42	.806	.653	3.265	105.358	320	264	264	560	80	70	7
9	1444	.60	1.06	108.74	.775	.627	3.137	108.623	320	261	264	560	81	71	7
10	1449	.65	1.14	111.82	.806	.653	3.265	111.76	322	261	264	560	82	71	7
11	1454	.57	1.00	115.21	.755	.611	3.054	115.028	321	263	264	560	82	71	7
12	1459	.55	.97	118.07	.742	.601	3.004	118.083	319	264	264	560	82	71	8
13	1504	.64	1.13	121.097	.806	.653	3.265	121.086	327	262	263	560	82	70	10
2-1	1506	.64	1.13	121.119	.806	.653	3.265	121.119	327	262	263	560	82	70	10
2	1511	.62	1.09	124.33	.787	.64	3.19	124.357	328	261	264	560	82	72	10
3	1516	.68	1.19	127.58	.825	.666	3.339	127.540	327	261	265	560	82	73	10
4	1521	.67	1.18	130.88	.819	.66	3.315	130.879	327	260	264	560	82	73	10
5	1526	.68	1.19	134.21	.825	.666	3.339	134.194	326	261	259	560	82	73	11
6	1531	.64	1.07	137.54	.781	.63	3.163	137.533	326	261	257	560	82	73	11
7	1536	.61	1.07	140.70	.781	.63	3.163	140.696	326	261	258	560	83	74	12
8	1541	.60	1.06	143.72	.775	.63	3.187	143.859	325	262	259	560	84	74	12
9	1546	.59	1.03	147.00	.768	.622	3.111	146.996	326	262	261	560	84	74	13
10	1551	.62	1.09	150.11	.787	.638	3.189	150.107	326	261	263	560	84	74	13
11	1556	.62	1.09	153.32	.787	.638	3.189	153.296	326	261	263	560	84	74	13

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M26A Test Run No. 1 Run Date: 11/2/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MGRAMAL
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: .936
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): .750
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): 10.00 Diameter (ft.): _____
 Width (ft.): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (In.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.56
 Static Pressure (in. H₂O): -22
 Flue Pressure (in. Hg Abs): 27.94
 Sample Train Leak Check: Pre: .002 Post: .000 @ 10 1/6" in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 17.4
 Oxygen (%): 4.2
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1116 Tare Wt (g) 0.6880
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMERGEN-ADA
 Plant: MERAMAC

List Test Method Used: M26A
 Test Run No. 1
 Date: 11/2/04

Test Location: UNIT 2 ESP-OUTLET DUCT

305
843
2.22

1 of 1
 Traverse Sheet

Port-Point No.	Clock Time 24 hr	Velocity Head (ΔP) in. H ₂ O	Velocity (ft/s)	Actual Meter Volume (V _a) ft ³	Theoretical Meter Rate (Q _t) gpm	Theoretical Meter Volume (V _t) ft ³	Theoretical Meter Volume per-point (V _p) ft ³	Stack Temp (C) F	Probe Temp F	Filter Holder Temp F	Impinger Outlet Temp F	Meter Temp (T _m)		Pump Vacuum in. Hg
												Inlet F	Outlet F	
1-1	1500	.66	1.45	865.115	.680	3.400	—	310	302	304	568	74	71	2
2	1505	.62	1.38	868.520	.664	3.322	868.515	312	305	315	641	75	71	2
3	1510	.62	1.36	871.840	.659	3.295	871.837	313	310	321	1400	75	71	2
4	1515	.58	1.27	825.130	.637	3.187	825.122	314	312	318		76	72	2
5	1520	.60	1.31	878.320	.648	3.242	878.319	314	313	316		76	72	2
6	1525	.65	1.42	881.560	.675	3.394	881.561	315	312	316		77	72	2
7	1530	.70	1.53	884.940	.700	3.501	884.935	315	310	315		77	72	2
8	1535	.67	1.47	888.450	.685	3.426	888.436	315	310	316		77	72	2
9	1540	.64	1.40	891.860	.670	3.348	891.862	314	309	317		77	72	2
10	1545	.58	1.27	895.210	.637	3.187	895.210	313	309	317		78	72	2
11	1550	.53	1.16	898.400	.609	3.047	898.397	311	308	318		78	72	2
12	1555	.50	1.10	901.445	.592	2.959	901.444	310	308	318		78	72	2
13	1600			904.403			904.403							
2-1	1604	.59	1.29	905.200	.643	3.215	—	310	303	316		78	72	2
2	1609	.62	1.36	908.415	.659	3.295	908.415	311	307	318		78	72	2
3	1614	.58	1.27	911.710	.637	3.187	911.710	310	308	318		78	72	2
4	1619	.62	1.36	914.900	.659	3.295	914.897	313	310	320		78	72	2
5	1624	.61	1.34	918.190	.654	3.269	918.192	314	312	320		79	72	2
6	1629	.59	1.29	921.460	.643	3.215	921.461	314	312	320		79	73	2
7	1634	.58	1.27	924.680	.637	3.187	924.676	314	312	318		79	73	2
8	1639	.58	1.27	927.860	.637	3.187	927.863	315	312	318		80	73	2
9	1644	.52	1.14	931.050	.604	3.018	931.050	315	310	316		80	73	2
10	1649	.43	.94	934.070	.549	2.744	934.068	314	310	316		80	73	2
11	1654	.40	.88	936.815	.529	2.647	936.812	314	310	314		80	73	2
12	1659	.38	.83	939.460	.516	2.580	939.459	313	310	312		81	73	2
13	1704			942.039			942.039							

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M26A Test Run No. 2 Run Date: 11/3/64

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MEMPHIS
 Test Location: UNIT 2 EXP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 647A
 Pitot Tube Coefficient: 0.36
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): 0.250
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): 10.00 Diameter (ft.):
 Width (ft.): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.76
 Static Pressure (in. H₂O): -21
 Flue Pressure (in. Hg Abs): 28.22
 Sample Train Leak Check: Pre: 000 Post: 000 @ 10.76 in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 14.6
 Oxygen (%): 3.9
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 -Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1120 Tare Wt (g) .6907
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN - ADA
 Plant: MERAMAS
 Test Location: UNIT 2 ESP - OUTLET DUCT

List Test Method Used: M26A
 Test Run No: 2
 Date: 11/3/04

1 of 1
 Traverse Sheet

Port-Point No.	Clock Time 24 hr.	Velocity Head (AP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqr. AP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (C) F	Probe Temp F	Filter Holder Temp F	Impinger Outlet Temp F	Meter Temp (t _m) F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	1400	.63	1.32	101.263	.794	.645	3.223	—	311	258	253	≤ 680	64	58	3	
2	1405	.63	1.32	104.490	.794	.645	3.223	104.486	312	260	254	64/14	65	59	3	
3	1410	.61	1.28	107.710	.781	.634	3.171	107.709	313	260	254	iced	65	59	3	
4	1415	.58	1.22	110.880	.762	.618	3.092	110.880	314	262	258		67	60	3	
5	1420	.61	1.28	113.930	.781	.634	3.171	117.972	315	263	259		68	61	3	
6	1425	.68	1.43	121.145	.825	.670	3.348	119.143	315	263	261		69	61	3	
7	1430	.68	1.43	120.500	.825	.670	3.348	120.491	314	262	260		69	61	3	
8	1435	.64	1.34	123.840	.800	.650	3.248	123.839	313	262	260		69	61	3	
9	1440	.62	1.30	127.095	.787	.639	3.193	127.087	313	261	260		70	61	3	
10	1445	.59	1.24	130.290	.768	.622	3.119	130.284	312	261	262		70	62	3	
11	1450	.56	1.18	133.400	.748	.608	3.038	133.403	312	260	260		70	62	3	
12	1455	.52	1.09	136.440	.721	.586	2.928	136.441	311	261	261		71	62	3	
1500				139.369				139.369								
2-1	1503	.64	1.34	139.669	.800	.650	3.248	—	310	260	262		68	62	3	
2	1508	.64	1.34	142.920	.800	.650	3.248	142.917	312	260	260		68	62	3	
3	1513	.59	1.24	146.170	.768	.624	3.119	146.165	313	261	260		68	62	3	
4	1518	.59	1.24	149.285	.768	.624	3.119	149.284	313	261	261		69	63	3	
5	1523	.56	1.18	152.400	.748	.608	3.038	152.403	315	262	262		69	63	3	
6	1528	.60	1.26	155.440	.775	.629	3.145	155.441	316	262	264		70	64	3	
7	1533	.57	1.20	158.590	.755	.613	3.065	158.586	318	263	264		71	64	3	
8	1538	.60	1.26	161.650	.775	.629	3.145	161.651	318	263	264		71	65	3	
9	1543	.56	1.18	164.800	.748	.608	3.038	164.796	318	261	265		72	65	3	
10	1549	.46	.97	167.840	.678	.551	2.754	167.834	318	261	263		72	66	3	
11	1553	.43	.90	170.590	.656	.532	2.662	170.588	315	260	267		73	66	3	
12	1558	.38	.80	173.250	.616	.501	2.503	173.250	312	258	262		74	67	3	
1603				175.753				175.753								

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 (74.190)

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M26A Test Run No. 3 Run Date: 11/4/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MERAMAC
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AJ
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: .836
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): .250
 Tail Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): 10.00 Diameter (ft.): _____
 Width (ft.): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.6
 Static Pressure (in. H₂O): -2.1
 Flue Pressure (in. Hg Abs): 28.06
 Sample Train Leak Check: Pre: .001 Post: .000 @ 6" / 6" in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 13.9
 Oxygen (%): 4.1
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1118 Tare Wt (g) 0.6949 HCL
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMC-RFN-ADA
 Plant: MERAMAC
 Test Location: UNIT 2 ESP-OUTLET DUCT

List Test Method Used: M26A
 Test Run No. 3
 Date: 11/4/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24-hr.	Velocity Head (ΔP) in. H ₂ O	Velocity Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _a) ft ³	X Sqrt. AP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (°C) F	Probe Temp °F	Filter Holder Temp °F	Impinger Outlet Temp °F	Meter Temp (t _m) °F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	1404	.64	1.36	330.778	.800	.657	3.284	—	309	262	260	≤ 68°	64	61	2	
2	1407	.66	1.40	334.060	.812	.667	3.335	374.062	310	263	261	fully	65	61	2	
3	1414	.63	1.34	337.400	.794	.652	3.258	337.397	311	263	261	1001	66	63	2	
4	1419	.60	1.28	340.660	.775	.636	3.180	340.655	311	263	263		66	62	2	
5	1424	.61	1.30	343.840	.781	.641	3.206	343.835	312	264	262		67	63	2	
6	1429	.68	1.45	347.040	.825	.677	3.385	347.041	312	264	262		68	63	2	
7	1434	.70	1.49	350.725	.837	.687	3.434	350.726	312	263	262		69	63	2	
8	1439	.66	1.41	353.860	.812	.667	3.335	353.860	312	263	262		70	63	2	
9	1444	.61	1.30	357.195	.781	.641	3.206	357.195	311	262	261		70	63	2	
10	1449	.56	1.19	360.400	.748	.614	3.072	360.401	311	262	260		70	63	2	
11	1454	.56	1.19	363.475	.748	.614	3.072	363.477	310	263	260		70	63	2	
12	1459	.57	.79	366.545	.608	.499	2.497	366.545	309	263	260		70	63	2	
	1504			369.042				369.042								
2-1	1506	.63	1.34	369.800	.794	.652	3.258	—	309	263	262		68	63	2	
2	1511	.63	1.34	372.060	.794	.652	3.258	372.058	309	263	262		69	63	2	
3	1516	.60	1.28	376.370	.775	.636	3.180	376.376	310	263	263		69	63	2	
4	1521	.60	1.28	379.500	.775	.636	3.180	379.496	310	262	263		69	63	2	
5	1526	.59	1.26	382.680	.769	.621	3.153	382.676	311	262	263		70	67	2	
6	1531	.59	1.26	385.820	.768	.631	3.153	385.829	311	263	263		70	64	2	
7	1536	.58	1.24	388.980	.762	.625	3.126	388.982	312	263	263		70	64	2	
8	1541	.58	1.24	392.110	.762	.625	3.126	392.108	312	261	262		70	64	2	
9	1546	.47	1.00	395.240	.686	.563	2.814	395.234	312	261	262		70	64	2	
10	1551	.44	.94	398.050	.663	.545	2.723	398.048	312	260	260		71	64	2	
11	1556	.41	.87	400.725	.640	.526	2.628	400.731	311	260	258		71	64	2	
12	1601	.37	.79	403.160	.608	.499	2.497	403.199	310	258	256		71	64	2	
	1606			405.896				405.896								

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74.36

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: ONT. HYDRO Test Run No. # 1-1245 Run Date: 1/2/07

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Amesco
 Plant: St Louis, Mo
 Test Location: Itz Inlet
 Source Condition: Normal
 Test Engineer: P. New
 Temp ID: E68
 Meter ID: E68
 Meter Calibration Factor: 992
 Pitot ID: 835A
 Pitot Tube Coefficient: _____
 Probe Length (ft.): 10'
 Probe Liner Material: Teflon
 Nozzle Diameter (in.): .247
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): 10' Diameter (ft): _____
 Width (ft): 8'2"
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream 16 Downstream 51
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18"
 Port Size (diameter in.): 4"
 Port Type: Flange
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.56
 Static Pressure (in. H₂O): -14.5"
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: √ 6.002 Post: √ 6.004 @ 15/20 in. Hg
 Pitot Leak Check: Pre √ 3" Post _____
 Carbon Dioxide (%): 14.8
 Oxygen (%): 3.8
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 -Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 24 Tare Wt (g) 2.8874
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: American List Test Method Used: Ont Hydro
 Plant: St. Louis, Mo Test Run No. # 1 - Inlet
 Test Location: Unit #2 Inlet Date: 11/2/04 Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24-hr	Velocity Head (ΔP) in H ₂ O	Office (ΔH) in H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _t) ft ³	Theoretical Meter Volume (V _t) ft ³	Stack Temp (C) F	Probe Temp. F	Filter Holder Temp. F	Impinger Outlet Temp. F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	9:45	.58	1.05	68.762	.762	.62	3.084	—	322	256	255	68 F	63	61	4
2	9:50	.60	1.08	71.82	.77	.63	3.137	71.846	322	257	255	68 F	66	61	4
3	9:55	.57	.92	74.90	.71	.58	2.892	74.983	322	258	256	70 F	70	62	3
4	10:00	.53	.96	77.73	.73	.59	2.95	77.875	322	257	257	71 F	71	63	3
5	10:05	.56	1.01	80.71	.75	.61	3.03	80.823	322	251	253	72 F	72	63	4
6	10:10	.49	.89	83.92	.70	.57	2.84	83.853	318	256	256	72 F	72	63	4
7	10:15	.57	.92	86.67	.71	.58	2.89	86.688	318	258	258	73 F	73	64	9
8	10:20	.61	1.10	89.53	.78	.63	3.16	89.580	295	261	257	74 F	74	65	7
9	10:25	.62	1.12	92.73	.79	.64	3.19	92.743	309	263	259	74 F	74	65	7
10	10:30	.45	.81	96.00	.67	.54	2.72	95.93	317	260	257	75 F	75	66	7
11	10:35	.49	.88	98.72	.70	.57	2.84	98.65	321	260	257	75 F	75	66	7
12	10:40	.48	.87	101.39	.69	.56	2.81	101.485	323	260	257	74 F	74	66	7
10:45			.97	104.374	.731			104.295	317.58						
2-1	10:50	.62	1.12	104.723	.787	.637	3.189	—	328	260	257	71 F	71	68	6
2	10:55	.61	1.10	108.20	.781	.633	3.163	107.912	329	260	257	72 F	72	66	6
3	11:00	.58	1.05	111.03	.762	.620	3.084	111.075	329	261	258	72 F	72	66	7
4	11:05	.58	1.05	114.32	.762	.617	3.084	114.159	325	263	260	72 F	72	66	7
5	11:10	.59	1.07	117.32	.768	.622	3.111	117.243	329	261	261	72 F	72	66	8
6	11:15	.60	1.09	120.00	.775	.627	3.137	120.354	328	262	257	73 F	73	66	9
7	11:20	.56	1.02	123.02	.748	.606	3.031	123.491	328	262	258	73 F	73	66	10
8	11:25	.69	1.25	126.54	.831	.673	3.364	126.522	327	265	260	72 F	72	66	11
9	11:30	.64	1.16	129.35	.80	.648	3.240	129.886	327	261	260	72 F	72	66	11
10	11:35	.63	1.14	133.04	.79	.643	3.22	133.126	324	262	261	72 F	72	66	11
11	11:40	.60	1.09	136.22	.77	.627	3.137	136.255	325	261	263	72 F	72	66	11
12	11:45	.49	.88	139.22	.70	.567	2.835	139.48	326	260	260	72 F	72	66	12
11:50			1.00	142.885	.773			142.315	327.42						

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322.50

68.3

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: DNT Hydro Test Run No. #2-1-1-1-1 Run Date: 11/27/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Aveston - Americas
 Plant: 1st. Louis No
 Test Location: #2 ESP Inlet duct
 Source Condition: Normal
 Test Engineer: P. N. N. N. N.
 Temp ID: E-68
 Meter ID: E-68
 Meter Calibration Factor: .992
 Pitot ID: 835A
 Pitot Tube Coefficient: _____
 Probe Length (ft.): 10'
 Probe Liner Material: Teflon
 Nozzle Diameter (in.): .247
 T/F in Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): 82" Diameter (ft): _____
 Width (ft): 10'
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18"
 Port Size (diameter in.): 4"
 Port Type: Flange
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.71
 Static Pressure (in. H₂O): -18.5
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.010 Post: 0.001 @ 20/20 in. Hg
 Pitot Leak Check: Pre √3" Post _____
 Carbon Dioxide (%): 14.4
 Oxygen (%): 8.6
 Gas Values by (select one): Method 3 Oxyg/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9870 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

COMMENTS & NOTES:

SAMPLE COLLECTION:
 Thimble No. _____ Tare Wt (g) _____
 Filter No. 245 Tare Wt (g) 2.9046
 Fuel Samples collected for analysis? Yes No

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: Amesha - Knechtel
 Plant: 5th Level
 Test Location: #2 Inlet Duct

List Test Method Used: DRT-Hygd
 Test Run No. #2 - Inlet
 Date: 11/3/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Velocity Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp °F	Filter Holder Temp °F	Impinger Outlet Temp °F	Meter Temp (t _m) °F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	8:55	.60	1.00	31.290	.77	.586	2.982	—	322	259	267	63°F	59	55	4	
2	9:00	.59	.99	34.31	.76	.591	2.957	94.272	322	260	267	Endlog	63	55	4	
3	9:05	.59	.99	37.32	.76	.591	2.957	97.229	322	261	265	Endlog	63	55	4	
4	9:10	.50	.84	100.13	.71	.54	2.722	100.186	322	261	260		65	57	4	
5	9:15	.51	.85	102.93	.71	.55	2.749	102.908	322	260	269		65	57	4	
6	9:20	.62	1.04	105.62	.78	.606	3.031	105.657	320	262	265		65	57	4	
7	9:25	.62	1.04	108.76	.78	.61	3.031	108.688	320	263	266		65	57	4	
8	9:30	.52	.87	111.82	.72	.55	2.776	111.779	321	262	268		67	59	5	
9	9:35	.54	.90	114.63	.73	.57	2.829	114.495	322	261	263		67	58	5	
10	9:40	.67	1.11	117.42	.82	.63	3.151	117.324	320	263	264		67	58	5	
11	9:45	.66	1.10	120.43	.81	.63	3.128	120.475	323	264	261		67	57	5	
12	9:50	.66	1.10	123.61	.81	.63	3.128	123.608	324	261	263		67	57	5	
	9:55			126.745				126.731								
2-1	9:57	.61	1.02	127.021	.78	.60	3.000	—	333	262	261		67	57	6	
2	10:02	.60	1.00	130.03	.775	.59	2.98	130.021	332	261	262		67	57	6	
3	10:07	.58	.97	133.21	.762	.586	2.932	133.003	333	262	268		68	59	6	
4	10:12	.55	.92	135.92	.742	.571	2.855	135.935	333	262	268		69	59	6	
5	10:17	.54	.90	138.39	.735	.566	2.829	138.790	331	261	269		68	59	6	
6	10:22	.53	.89	141.62	.728	.561	2.863	141.619	331	262	267		68	59	8	
7	10:27	.60	1.00	144.43	.775	.596	2.982	144.422	329	263	265		68	59	9	
8	10:32	.57	.95	147.52	.755	.581	2.907	147.004	329	264	265		68	59	10	
9	10:37	.58	.97	150.31	.762	.586	2.932	150.31	330	262	265		68			
10	10:42	.60	1.00	153.77	.775	.596	2.982	153.243	330	265	265		69			
11	10:47	.61	1.01	156.23	.781	.601	3.007	156.025	329	261	265		69			
12	10:52	.61	1.01	159.27	.781	.601	3.007	159.232	328	261	266		69			
	10:57			162.725				162.739								

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: Orsat

Test Run No. # 3-1067

Run Date: 11/7/69

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Amesbury - Amesbury
 Plant: Spokane Mo
 Test Location: #2 BSL INLET DUCT
 Source Condition: Normal
 Test Engineer: P. Newell
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.60
 Static Pressure (in. H₂O): _____
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.005 Post: 0.004 @ 1515 in. Hg
 Pitot Leak Check: Pre √3 Post _____
 Carbon Dioxide (%): 14.2
 Oxygen (%): 3.6
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

COMMENTS & NOTES:

SAMPLE COLLECTION:
 Thimble No. 240/246 Tare Wt (g) 2.8240 / 2.786
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: American - Mechanics
 Plant: St. Louis Mo
 Test Location: #2 Inlet Duct

List Test Method Used: ASTM D160
 Test Run No. # 3 Inlet
 Date: 11/4/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg
												Inlet °F	Outlet °F	
1-1	8:30	.61	1.05	13.827	.781	.617	3.085	—	324	252	68°F	62	55	5
2	8:35	.60	1.03	11.72	.775	.612	3.059	16.912	325	251	Fullly Read	62	55	5
3	8:41	.61	1.05	19.95	.781	.617	3.09	19.972	325	250	Read	65	56	6
4	8:45	.61	1.05	23.04	.781	.617	3.09	23.057	325	251		66	56	6
5	8:50	.55	.95	26.21	.742	.586	2.929	26.147	325	251		68	57	6
6	8:55	.55	.95	29.05	.742	.586	2.929	29.076	324	252		68	57	6
7	9:00	.77	1.32	31.97	.88	.693	3.464	32.005	323	251		68	57	6
8	9:05	.63	1.08	35.52	.794	.627	3.135	35.471	323	252		68	57	6
9	9:10	.67	1.15	38.52	.819	.647	3.233	38.606	323	252		69	58	8
10	9:15	.55	.95	41.82	.742	.59	2.929	41.839	323	251		69	58	12
11	9:20	.60	1.03	44.75	.775	.612	3.059	44.768	324	251		69	58	8
12	9:25	.60	1.03	47.81	.775	.612	3.059	47.828	324	251		69	58	8
	9:30			52.921				50.887						
2-1	9:40	.64	1.10	51.320	.80	.632	3.160	—	320	251		69	58	5
2	9:45	.58	1.00	54.97	.76	.602	3.008	54.047	320	260		70	59	6
3	9:50	.60	1.03	57.05	.77	.612	3.059	57.055	321	261		71	60	6
4	9:55	.60	1.03	60.23	.78	.613	3.059	60.115	319	260		72	61	6
5	10:00	.62	1.06	63.21	.78	.622	3.110	63.110	320	261		73	62	7
6	10:05	.55	.95	66.25	.74	.586	2.929	66.280	320	251		74	64	8
7	10:10	.53	.91	69.21	.72	.575	2.876	69.209	318	251		75	65	8
8	10:15	.55	.95	72.11	.74	.586	2.929	72.085	320	251		75	65	8
9	10:20	.58	.99	75.11	.762	.601	3.008	75.014	319	251		75	65	8
10	10:25	.58	.99	78.11	.762	.602	3.008	78.022	319	251		75	65	8
11	10:30	.60	1.03	80.92	.775	.612	3.059	81.030	319	251		75	65	9
12	10:35	.60	1.03	84.12	.775	.612	3.061	84.089	319	251		75	65	9
	10:40			87.157				87.150						

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: ONT. HYDRO Test Run No. 1 Run Date: 11/2/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MGRAMAL
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: 0.836
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): 0.250
 T₁ Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): 17.00 Diameter (ft.):
 Width (ft.): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.56
 Static Pressure (in. H₂O): -22
 Flue Pressure (in. Hg Abs): 27.94
 Sample Train Leak Check: Pre: 005 Post: 003 @ 10 1/6" in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 14.4
 Oxygen (%): 3.9

MOISTURE DETERMINATION:

Impinger Final Wt (mL):
 Impinger Initial Wt (mL):
 Impinger Wt Gain (mL):
 Total Water Gain (mL/g):
 Description of Impinger H₂O:
 Silica Gel Exhausted?:
 Impingers Recovered by:
 Silica Gel Weighed by:
 Sample Removed from Site by:

Silica Final Wt (g):
 Silica Initial Wt (g):
 Silica Wt Gain (g):

Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)

Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other -

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1096 Tare Wt (g) 0.6950
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMERGEN-ADA
 Plant: MERAMAC
 Test Location: UNIT 2 ESP-OUTLET DUCT

List Test Method Used: DMT-HYDRO
 Test Run No. 1
 Date: 11/2/04

Traverse Sheet 1 of 1

Port Point No.	Clock Time 24-hr	Velocity Head (ΔP) in. H ₂ O	2-79 Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _a) ft ³	Sqrt ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _t) ft ³	Theoretical Meter Volume (V _t) ft ³	Stack Temp (°C) F	Probe Temp °F	Filter Holder Temp °F	Impinger Outlet Temp °F	Meter Temp. (°F)		Pump Vacuum in. Hg
													Inlet	Outlet	
1-1	945	.57	1.27	707.359	.755	.636	2.182	—	301	308	309	680	73	68	5
2	950	.59	1.31	710.540	.768	.648	3.238	710.541	302	308	309	64/4	74	69	5
3	955	.56	1.24	713.780	.748	.631	3.154	713.779	304	309	312	iced	74	69	5
4	1000	.60	1.31	716.940	.775	.648	3.242	716.933	313	310	312		75	68	5
5	1005	.60	1.31	720.180	.775	.648	3.242	720.175	313	310	318		75	68	5
6	1010	.55	1.20	723.420	.742	.621	2.104	723.417	313	309	319		75	68	5
7	1015	.54	1.18	726.520	.735	.615	3.075	726.521	313	309	319		75	68	5
8	1020	.55	1.20	729.600	.742	.621	3.104	729.596	312	310	320		75	68	5
9	1025	.46	1.01	732.700	.678	.568	2.878	732.700	312	309	319		76	68	4
10	1030	.45	.99	735.540	.671	.561	2.807	735.538	312	308	319		76	69	4
11	1035	.38	.84	738.345	.616	.520	2.598	738.345	304	308	316		77	70	4
12	1040	.26	.58	740.945	.510	.470	2.149	740.945	302	307	315		77	70	4
	1045			743.092				743.092							
2-1	1050	.66	1.47	744.300	.812	.685	3.424	—	307	312	312		76	70	5
2	1055	.64	1.40	747.785	.800	.670	3.348	747.724	311	313	311		76	70	5
3	1100	.64	1.40	757.070	.800	.670	3.348	757.072	311	315	311		76	70	5
4	1105	.58	1.27	757.420	.762	.637	3.187	757.420	312	315	310		76	70	5
5	1110	.60	1.31	757.600	.775	.648	3.242	757.607	313	315	309		76	70	5
6	1115	.73	1.60	762.850	.854	.715	3.576	760.849	313	315	309		77	70	5
7	1120	.73	1.60	764.425	.854	.715	3.576	764.425	312	312	309		77	70	5
8	1125	.66	1.45	768.000	.812	.680	3.400	768.001	312	312	309		77	70	5
9	1130	.64	1.40	771.400	.800	.670	3.348	771.401	312	310	308		77	70	4
10	1135	.55	1.20	774.750	.742	.621	3.104	774.749	311	310	308		77	70	4
11	1140	.57	1.16	777.825	.728	.609	3.047	777.825	310	309	308		77	70	4
12	1145	.37	.81	780.900	.608	.509	2.546	780.900	310	309	307		77	70	4
	1150			783.446				783.446							

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74.879

ISOKINETIC TEST DATA

TEST PARAMETERS:

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

List Method Used: OMT HYDRO Test Run No. 2 Run Date: 11/3/04

Company: AMEREN-ADA Duct Shape (select): Rectangular or Round Diameter (ft): _____
 Plant: MERAMAC Length (ft): 10.00
 Test Location: UNIT 2 ESP-OUTLET DUCT Width (ft): 8.167 Duct Area (Sq. Ft.): _____
 Source Condition: NORMAL Disturbance (in diameters) Upstream — Downstream —
 Test Engineer: AS Sample Plane (select): Horizontal or Vertical
 Temp ID: E-22 Port Length (in.): 18
 Meter ID: E-22 Port Size (diameter in.): 4
 Meter Calibration Factor: 1.000 Port Type: FLANGES
 Pitot ID: 643A Number of Ports Sampled: 2
 Pitot Tube Coefficient: .836 Number of Points per Port: 12
 Probe Length (ft.): 10 Minutes per Point: 5
 Probe Liner Material: GLASS Total Number of Traverse Points: 24
 Nozzle Diameter (in.): .250 Test Length (min): 120
 Train Setup (select): Anderson Box Hot Box Other _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.76 Silica Final Wt (g): _____
 Static Pressure (in. H₂O): -2.1 Silica Initial Wt (g): _____
 Flue Pressure (in. Hg Abs): 28.72 Impinger Wt Gain (mL): _____
 Sample Train Leak Check: Pre: 100 Post: 000 @ 10" / 6" in. Hg
 Pitot Leak Check: Pre ✓ Post ✓
 Carbon Dioxide (%): 13.6
 Oxygen (%): 4.9
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 117 Tare Wt (g) 0.6228
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN-ADA
 Plant: MGRAMAC

List Test Method Used: OMT HYDRO
 Test Run No. 2

Test Location: UNIT 2 ESP-OUTLET DUCT

Date: 11/3/04 Traverse Sheet 1 of 1

Part-Point No.	Clock Time 24 hr.	Velocity Head (V/P) in. H ₂ O	2.1 Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. V/P	Dry Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (S) F	Probe Temp. F	Filter Holder Temp. F	Impinger Outlet Temp. F	Meter Temp. (F _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	855	.63	1.32	945.128	.797	.645	3.223	—	312	312	318	≤68°	57	54	4
2	900	.64	1.34	948.350	.800	.650	3.248	948.351	314	312	318	fully	58	54	4
3	905	.62	1.30	951.600	.787	.639	3.197	951.599	315	313	318	iced	58	55	4
4	910	.58	1.22	954.800	.762	.618	3.092	954.796	315	314	320		59	55	4
5	915	.58	1.22	957.890	.762	.618	3.092	957.882	315	314	321		60	56	4
6	920	.65	1.37	960.980	.806	.655	3.273	960.980	316	313	321		61	56	4
7	925	.66	1.39	964.250	.812	.660	3.298	964.253	315	313	322		61	57	4
8	930	.64	1.34	967.550	.800	.650	3.248	967.551	314	313	325		62	57	4
9	935	.60	1.26	970.800	.775	.629	3.145	970.799	314	313	325		63	57	4
10	940	.52	1.09	973.940	.721	.586	2.928	973.944	314	312	324		63	58	4
11	945	.54	1.13	976.870	.735	.597	2.983	976.872	314	312	323		64	58	4
12	950	.44	.92	979.855	.663	.559	2.693	979.855	314	311	320		64	58	4
13	955			982.548				982.548							
2-1	958	.58	1.22	983.208	.762	.618	3.092	—	312	312	320		63	58	4
2	1003	.61	1.28	986.300	.781	.634	3.171	986.300	312	312	321		63	58	4
3	1008	.60	1.26	989.500	.775	.629	3.145	989.471	313	312	320		64	58	4
4	1013	.60	1.26	992.600	.775	.629	3.145	992.616	314	313	316		64	58	4
5	1019	.61	1.28	995.760	.781	.634	3.171	995.761	316	314	318		64	58	4
6	1023	.61	1.28	998.930	.781	.634	3.171	998.932	318	314	318		64	58	4
7	1028	.63	1.32	1002.100	.794	.645	3.223	1002.103	318	313	316		64	58	4
8	1033	.63	1.32	1005.330	.794	.645	3.223	1005.326	318	313	315		65	58	4
9	1038	.58	1.22	1008.550	.762	.618	3.092	1008.549	318	312	312		65	58	4
10	1043	.53	1.11	1011.640	.728	.591	2.956	1011.641	316	312	315		66	58	4
11	1048	.48	1.00	1014.600	.693	.563	2.813	1014.597	316	311	318		66	59	4
12	1053	.45	.95	1017.410	.671	.545	2.724	1017.410	314	311	318		66	59	4
13	1058			1020.134				1020.134							

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74.346

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: DMT. HYDRO Test Run No. 3 Run Date: 11/11/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA Duct Shape (select): Rectangular or Round
 Plant: MERAMAL Length (ft): 10.00 Diameter (ft):
 Test Location: UNIT 2 ESP-OUTLET DUCT Width (ft): 8.167
 Source Condition: NORMAL Duct Area (Sq. Ft.): 81.67 Upstream Downstream
 Test Engineer: AS Disturbance (in diameters) Horizontal or Vertical
 Temp ID: E-22 Sample Plane (select): 18 or
 Meter ID: E-22 Port Length (in.): 4
 Meter Calibration Factor: 1.000 Port Size (diameter in.): FLANGE
 Pitot ID: 641A Port Type:
 Pitot Tube Coefficient: .836 Number of Ports Sampled: 2
 Probe Length (ft.): 10 Number of Points per Port: 5
 Probe Liner Material: GLASS Minutes per Point:
 Nozzle Diameter (in.): .250 Total Number of Traverse Points: 24
 Train Setup (select): Anderson Box Hot Box Other 120 Test Length (min):

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.6 Silica Final Wt (g):
 Static Pressure (in. H₂O): -21. Silica Initial Wt (g):
 Flue Pressure (in. Hg Abs): 28.06 Silica Wt Gain (g):
 Sample Train Leak Check: Pre: 000 Post: 002 @ 10 1/6 in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 13.6
 Oxygen (%): 3.8
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780-Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other

MOISTURE DETERMINATION:

Impinger Final Wt (mL): Silica Final Wt (g):
 Impinger Initial Wt (mL): Silica Initial Wt (g):
 Impinger Wt Gain (mL): Silica Wt Gain (g):
 Total Water Gain (mL/g):
 Description of Impinger H₂O:
 Silica Gel Exhausted?:
 Impingers Recovered by:
 Silica Gel Weighed by:
 Sample Removed from Site by:

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1099 Tare Wt (g) 0.6785
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMERGEN - ADA
 Plant: MERAMAL
 Test Location: UNIT 2 ESP - OUTLET DUCT

List Test Method Used: OMT. HYDRO
 Test Run No. 3
 Date: 11/4/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (Vp) in. H ₂ O	Orifice (AO) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqr. VP	Meter Rate cfm	Theoretical Meter Volume per Point (V _t) ft ³	Theoretical Meter Volume (V _t) ft ³	Stack Temp (S) F	Probe Temp F	Filter Holder Temp F	Impinger Outlet Temp F	Meter Temp (t _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	830	.62	1.32	178.145	.787	.646	3.232	—	306	312	308	568°	62	58	4
2	835	.64	1.36	181.380	.800	.657	3.284	181.377	307	312	309	Full	63	58	4
3	840	.66	1.41	184.660	.812	.667	3.335	184.661	308	312	309	iced	63	58	4
4	845	.56	1.19	187.995	.748	.614	3.072	187.996	309	315	310		64	58	4
5	850	.62	1.32	191.070	.787	.646	3.232	191.068	309	313	312		65	58	4
6	855	.69	1.47	194.300	.831	.682	3.410	194.300	309	313	318		65	59	4
7	900	.71	1.51	197.710	.843	.692	3.459	197.710	309	313	319		66	59	4
8	905	.66	1.41	201.170	.812	.667	3.335	201.169	309	313	320		66	59	4
9	910	.62	1.32	204.500	.787	.646	3.272	204.504	308	313	320		67	59	4
10	915	.58	1.24	207.785	.762	.625	3.126	207.726	308	313	321		67	60	4
11	920	.58	1.24	210.865	.762	.625	3.126	210.862	307	312	321		68	60	4
12	925	.50	1.07	213.990	.707	.581	2.903	213.988	307	311	320		68	60	4
	930			216.891				216.891							
2-1	932	.62	1.32	217.105	.787	.646	3.232	—	307	312	328		69	61	4
2	937	.62	1.32	220.370	.787	.646	3.232	220.357	308	312	328		70	62	4
3	942	.60	1.28	223.590	.775	.616	3.180	223.569	308	313	327		70	62	4
4	947	.62	1.32	226.780	.787	.646	3.232	226.749	308	313	326		71	63	4
5	952	.57	1.21	229.985	.755	.620	3.099	229.981	309	313	326		71	63	4
6	957	.57	1.21	233.080	.755	.620	3.099	233.080	310	313	326		70	63	4
7	1002	.55	1.17	236.170	.742	.609	3.044	236.179	311	312	326		70	63	4
8	1007	.54	1.15	239.220	.735	.603	3.017	239.227	311	312	326		70	63	4
9	1012	.53	1.13	242.265	.728	.598	2.988	242.240	311	313	326		70	63	4
10	1017	.48	1.02	245.230	.693	.569	2.844	245.228	310	312	324		71	64	4
11	1022	.40	.85	248.035	.632	.519	2.596	248.072	309	310	323		71	64	4
12	1027	.33	.70	250.670	.574	.472	2.358	250.668	308	308	320		71	64	4
	1032			253.026				253.026							

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ISOKINETIC TEST DATA

List Method Used: M2A Test Run No. #1-1-121 Run Date: 1/12/69

TEST PARAMETERS:

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Ames
 Plant: St. Louis Mo
 Test Location: #2 Inlet
 Source Condition: Normal
 Test Engineer: P. M. ...
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Test Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.86
 Static Pressure (in. H₂O): -14.5"
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.004 Post: 0.001 @ 20/20 in. Hg
 Pitot Leak Check: Pre 3 Post 3
 Carbon Dioxide (%): 14.2
 Oxygen (%): 9.5
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 237 Tare Wt (g) 2.9434
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: Ameren List Test Method Used: M29
 Plant: St. Louis #16 Test Run No. #1 - Inlet
 Test Location: #2 Inlet Date: 1/2/04 Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. (V)	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp °F	Filter Holder Temp °F	Impinger Outlet Temp °F	Meter Temp (t _m) °F		Pump Vacuum in. Hg
													Inlet	Outlet	
1-1	1230	.57	1.03	43.967	.75	.611	3.058	—	330	262	257	±68°F	65	63	3
2	1235	.55	1.00	47.12	.74	.601	3.004	47.025	330	262	257	Full	66	63	3
3	1240	.55	1.00	50.13	.74	.601	3.004	50.628	329	263	254	Full	68	63	3
4	1245	.57	1.03	53.04	.75	.611	3.058	53.033	329	262	260	~	72	63	3
5	1250	.62	1.12	56.22	.787	.640	3.188	56.091	327	263	260	~	72	64	3
6	1255	.63	1.14	59.30	.794	.643	3.215	59.279	326	261	262	~	72	64	3
7	1300	.66	1.19	62.43	.812	.658	3.290	62.494	327	262	258	~	73	65	3
8	1305	.62	1.12	65.73	.787	.638	3.188	65.784	327	261	260	~	74	65	3
9	1310	.63	1.14	68.87	.794	.643	3.214	68.973	327	263	261	~	74	65	3
10	1315	.66	1.19	72.20	.812	.658	3.290	72.188	326	263	261	~	74	65	3
11	1320	.63	1.14	75.53	.794	.643	3.215	75.478	324	263	263	~	74	65	5
12	1325	.63	1.14	78.72	.794	.643	3.215	78.693	320	270	263	~	74	65	5
1-1	1330	.58	1.05	81.932	.781	.617	3.084	81.908	326.8	—	—	~	74	65	6
2-1	1333	.58	1.05	82.402	.762	.617	3.084	—	321	271	273	~	74	65	6
2	1338	.57	1.03	84.97	.755	.612	3.058	84.992	325	271	273	~	74	65	6
3	1343	.53	.96	88.04	.728	.589	2.95	88.050	325	271	272	~	74	65	6
4	1348	.57	1.03	90.95	.755	.612	3.058	90.998	325	272	273	~	74	66	6
5	1353	.64	1.16	94.03	.80	.648	3.24	94.057	323	270	269	~	75	67	6
6	1358	.63	1.14	97.25	.794	.643	3.21	97.297	324	266	268	~	75	67	7
7	1403	.72	1.30	100.53	.849	.687	3.44	100.512	322	267	267	~	76	68	11
8	1408	.73	1.32	103.92	.854	.692	3.460	103.948	321	261	263	~	76	68	15
9	1413	.73	1.32	107.43	.854	.692	3.460	107.468	322	262	263	~	76	68	20
1-1	1415	.73	1.32	110.973	.854	.692	3.460	110.968	—	—	—	~	—	—	—
1-1	1420	.73	1.32	110.973	.854	.692	3.460	110.968	—	—	—	~	—	—	—
1-1	1425	.73	1.32	110.973	.854	.692	3.460	110.968	—	—	—	~	—	—	—

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M29 Test Run No. #2-1264 Run Date: 11/3/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Amesbury - Massachusetts
 Plant: St Louis No
 Test Location: #2 300 Inlet Duct
 Source Condition: Pinpoint
 Test Engineer: _____
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.72
 Static Pressure (in. H₂O): -18.5
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.004 Post: 0.012 @ 15 in. Hg
 Pitot Leak Check: Pre √3 Post _____
 Carbon Dioxide (%): 14.4
 Oxygen (%): 3.6
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 244 Tare Wt (g) 2.7608
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M29 Test Run No. #3-1N1 Run Date: 4/16/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Arcen - Nevada
 Plant: St. Louis
 Test Location: #2 OP Inlet Duct
 Source Condition: Natural
 Test Engineer: P. New
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other _____

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.60
 Static Pressure (in. H₂O): -18.5"
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.003 Post: 0.005 @ 15/5 in. Hg
 Pitot Leak Check: Pre 3 Post _____
 Carbon Dioxide (%): 14.6
 Oxygen (%): 3.6

Moisture Determination:
 Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No.: 236 Tare Wt (g) 2.8510
 Filter No.: _____ Tare Wt (g) _____
 Fuel Samples collected for analysis: Yes No

COMMENTS & NOTES:

10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: Amercon - Morencie
 Plant: St. Louis, Mo

List Test Method Used: M-29
 Test Run No. #3 Inlet
 Date: 11/4/04

Test Location: #2 ESP Inlet Duct Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24-hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m) °F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	1120	.62	1.10	96.801	.787	.622	3.110	—	318	260	270	±68°F	73	68	2	
2	1125	.63	1.08	100.02	.794	.627	3.135	99.911	318	271	265	Fully	77	68	2	
3	1130	.61	1.05	103.05	.781	.617	3.085	103.046	318	265	265	Fed	77	68	2	
4	1135	.63	1.08	106.22	.794	.627	3.135	106.131	320	265	265		77	68	3	
5	1140	.63	1.08	109.30	.794	.627	3.135	109.266	320	261	263		78	70	3	
6	1145	.57	.98	112.52	.755	.596	2.982	112.461	322	262	263		79	71	4	
7	1150	.58	1.00	115.39	.761	.602	3.008	115.383	320	261	260		80	71	4	
8	1155	.55	.95	118.72	.742	.586	2.929	118.391	320	261	260		80	71	4	
9	1200	.62	1.06	121.35	.787	.622	3.110	121.320	319	260	261		80	71	4	
10	1205	.61	1.05	124.49	.781	.617	3.085	124.430	320	260	261		80	71	4	
11	1210	.57	1.00	127.38	.755	.612	3.058	127.615	319	261	260		80	71	5	
12	1215	.56	.99	130.53	.75	.606	3.031	130.572	318	260	261		80	71	5	
	1220			133.721				133.602								
2-1	1222	.64	1.12	133.897	.80	.648	3.24	—	328	261	265		82	72	6	
2	1227	.65	1.14	137.15	.81	.653	3.265	137.132	328	261	265		83	72	6	
3	1232	.60	1.05	140.24	.77	.627	3.137	140.402	328	261	260		83	72	6	
4	1237	.63	1.11	143.59	.79	.64	3.215	143.539	327	261	264		83	72	7	
5	1242	.65	1.14	146.52	.81	.65	3.265	146.753	329	262	265		80	72	8	
6	1247	.58	1.02	150.00	.76	.62	3.084	150.018	329	263	264		80	72	9	
7	1252	.58	1.02	153.11	.76	.62	3.084	153.102	329	261	264		80	72	10	
8	1257	.60	1.06	156.02	.77	.62	3.137	156.186	326	260	261		80	72	10	
9	1302	.63	1.10	159.04	.79	.64	3.215	159.323	326	260	260		79	72	10	
10	1307	.63	1.10	162.59	.79	.64	3.215	162.537	328	261	260		78	71	10	
11	1312	.62	1.09	165.80	.79	.64	3.189	165.752	327	261	261		78	71	11	
12	1317	.64	1.12	168.90	.80	.65	3.240	168.941	326	259	261		78	71	11	
	1322			172.219				172.181								

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M29

Test Run No. 1

Run Date: 11/2/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ABA

Plant: MEMPHIS

Test Location: UNIT 2 ESP-OUTLET DUCT

Source Condition: NORMAL

Test Engineer: AS

Temp ID: E-22

Meter ID: E-22

Meter Calibration Factor: 1.000

Pitot ID: 643A

Pitot Tube Coefficient: .836

Probe Length (ft.): 10

Probe Liner Material: GLASS

Nozzle Diameter (in.): .250

Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round

Length (ft): 10.00 Diameter (ft): _____

Width (ft): 8.167

Duct Area (Sq. Ft.): 81.67

Disturbance (in diameters) Upstream _____ Downstream _____

Sample Plane (select): Horizontal or Vertical

Port Length (in.): 18

Port Size (diameter in.): 4

Port Type: FLANGE

Number of Ports Sampled: 2

Number of Points per Port: 12

Minutes per Point: 5

Total Number of Traverse Points: 24

Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.56

Static Pressure (in. H₂O): -22

Flue Pressure (in. Hg Abs): 27.94

Sample Train Leak Check: Pre: .001 Post: .000 @ 10"/6" in. Hg

Pitot Leak Check: Pre Post

Carbon Dioxide (%): 14.0

Oxygen (%): 4.8

Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)

Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal

10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

COMMENTS & NOTES:

SAMPLE COLLECTION:

Thimble No. _____

Filter No. 1098

Fuel Samples collected for analysis? Yes No

Tare Wt (g) _____

Tare Wt (g) 0.6772

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____

Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____

Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____

Total Water Gain (mL/g): _____

Description of Impinger H₂O: _____

Silica Gel Exhausted?: _____

Impingers Recovered by: _____

Silica Gel Weighed by: _____

Sample Removed from Site by: _____

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMGEN-ADA
 Plant: MERAMAC

List Test Method Used: M29
 Test Run No. 2
 Date: 11/2/64

Test Location: UNIT 2 ESP-OUTLET DUCT

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr	Velocity Head (ΔP) in. H ₂ O	2.19 Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _a) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) F	Probe Temp F	Filter Holder Temp F	Impinger Outlet Temp F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	1230	.64	1.40	786.239	.800	.670	3.348	—	310	303	304	680	71	68	2
2	1235	.64	1.40	789.590	.800	.670	3.348	789.587	312	310	314	680	72	68	2
3	1240	.62	1.36	792.940	.789	.659	3.295	792.935	312	311	315	680	72	69	2
4	1245	.56	1.23	796.230	.748	.626	3.132	796.220	312	311	316	680	73	69	2
5	1250	.58	1.27	799.360	.762	.637	3.187	799.362	312	310	317	680	74	69	2
6	1255	.67	1.47	802.500	.819	.685	3.426	802.549	312	310	317	680	74	70	2
7	1300	.69	1.51	805.985	.831	.695	3.476	805.975	312	308	318	680	75	70	2
8	1305	.63	1.38	809.450	.794	.664	3.322	809.451	312	308	318	680	76	70	2
9	1310	.59	1.29	812.780	.768	.643	3.215	812.773	311	309	316	680	77	70	2
10	1315	.56	1.23	815.985	.748	.626	3.132	815.988	311	310	315	680	77	70	2
11	1320	.54	1.18	819.120	.735	.615	2.075	819.120	310	310	315	680	77	70	2
12	1325	.51	1.12	822.195	.714	.598	2.989	822.195	310	310	315	680	77	70	2
13	1330			825.184				825.184							
2-1	1332	.61	1.35	825.900	.781	.658	3.292	—	303	309	318	680	77	71	2
2	1337	.59	1.31	829.190	.762	.643	3.237	829.192	305	309	316	680	78	71	2
3	1342	.57	1.27	832.430	.755	.636	3.182	832.429	308	309	315	680	78	71	2
4	1347	.57	1.25	835.610	.755	.632	3.160	835.617	311	310	313	680	78	71	2
5	1352	.58	1.27	838.770	.762	.637	3.187	838.771	312	310	312	680	78	72	2
6	1357	.63	1.38	841.960	.794	.664	3.322	841.958	313	310	312	680	79	72	2
7	1402	.64	1.40	845.280	.800	.670	3.348	845.280	313	310	317	680	79	72	2
8	1407	.62	1.36	848.600	.787	.659	3.295	848.628	314	309	313	680	79	72	2
9	1412	.59	1.29	851.925	.768	.643	3.215	851.923	314	309	312	680	79	73	2
10	1417	.51	1.12	855.140	.714	.598	2.989	855.138	313	308	312	680	79	73	2
11	1422	.45	.99	858.130	.671	.561	2.807	858.127	312	308	312	680	79	73	2
12	1427	.43	.94	860.935	.656	.549	2.744	860.934	312	308	317	680	79	73	2
13	1432			863.678				863.678							

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76.723

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: MA9 Test Run No. 2 Run Date: 11/3/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MERAMAL
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: .836
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): .750
 T₉₀In Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): 10.00 Diameter (ft):
 Width (ft): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.76
 Static Pressure (in. H₂O): -21
 Flue Pressure (in. Hg Abs): 28.22
 Sample Train Leak Check: Pre: 0.00 Post: 0.00 @ 10' / 6" in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 14.1
 Oxygen (%): 4.8
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 -Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1119 Tare Wt (g) 0.6887
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN-AOA

Plant: MERAMAC

Test Location: UNIT 2 ESP-OUTLET DUCT

List Test Method Used: M29

Test Run No: 2

Date: 11/3/04

Traverse Sheet 1 of 1

Port Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate (V _m) gpm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) F	Probe Temp. F	Filter Holder Temp. F	Impinger Outlet Temp. F	Meter Temp. (t _m) F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	1128	.63	1.32	21.455	.794	.645	3.223	—	312	262	261	5680	57	55	2	
2	1133	.63	1.32	24.690	.794	.645	3.223	24.678	314	264	262	Fully	58	56	2	
3	1138	.61	1.28	27.900	.781	.634	3.171	27.901	316	265	262	iced	59	56	2	
4	1143	.57	1.20	31.090	.755	.613	3.065	31.072	317	262	260		61	57	2	
5	1148	.59	1.24	34.150	.768	.624	3.119	34.137	317	260	257		62	57	2	
6	1153	.67	1.41	37.260	.819	.665	3.323	37.256	317	258	257		63	57	2	
7	1158	.70	1.47	40.580	.837	.679	3.397	40.579	317	256	260		67	57	2	
8	1203	.64	1.34	43.980	.800	.650	3.248	43.976	317	256	260		64	57	2	
9	1208	.60	1.26	47.230	.775	.629	3.145	47.224	316	254	258		64	58	2	
10	1213	.58	1.22	50.370	.762	.618	3.092	50.369	316	254	258		65	58	2	
11	1218	.54	1.13	53.470	.735	.597	2.983	53.461	315	251	254		65	58	2	
12	1223	.45	.95	56.445	.671	.545	2.724	56.444	313	251	252		66	58	2	
	1228			59.168				59.168								
2-1	1230	.63	1.32	60.115	.794	.645	3.223	—	311	254	261		65	58	2	
2	1235	.65	1.37	63.340	.806	.655	3.273	63.338	313	255	264		65	58	2	
3	1240	.62	1.30	66.610	.787	.639	3.197	66.611	315	256	264		65	58	2	
4	1245	.58	1.22	69.810	.762	.618	3.092	69.808	316	259	264		64	58	2	
5	1250	.58	1.22	72.960	.762	.618	3.092	72.960	316	257	262		64	57	2	
6	1255	.60	1.26	75.980	.775	.629	3.145	75.992	317	257	262		64	57	2	
7	1300	.58	1.22	79.145	.762	.618	3.092	79.137	317	256	261		65	58	2	
8	1305	.58	1.22	82.240	.762	.618	3.092	82.229	318	256	260		65	58	2	
9	1310	.55	1.22	85.330	.742	.602	3.011	85.321	317	255	260		65	58	2	
10	1315	.47	.99	88.335	.686	.557	2.723	88.332	316	255	258		66	58	2	
11	1320	.42	.88	91.115	.648	.526	2.631	91.115	315	253	258		66	58	2	
12	1325	.36	.76	97.745	.600	.487	2.436	97.746	313	252	258		66	58	2	
	1330			96.182				96.182								

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73.78

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: M29 Test Run No. 3 Run Date: 11/4/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MERAMAL
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-22
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: .836
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): .250
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft.): 10.00 Diameter (ft.):
 Width (ft.): 8.167
 Duct Area (Sq. Ft.): 81.67
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.6
 Static Pressure (in. H₂O): -21
 Flue Pressure (in. Hg Abs): 28.06
 Sample Train Leak Check: Pre: .002 Post: .001 @ 10 1/8 in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 13.8
 Oxygen (%): 4.8

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1101 Tare Wt (g) 0.7084
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 -Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other _____

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN-ADA
 Plant: PERAMAC
 Test Location: UNIT 2 ESP-OUTLET DUCT

List Test Method Used: M29
 Test: Run No. 3
 Date: 11/4/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (in. H ₂ O) (VAP)	Velocity Orifice (in. H ₂ O) (ΔH)	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate (cfm)	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (°C) F	Probe Temp. F	Filter Holder Temp. F	Impinger Outlet Temp. F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet F	Outlet F	
1-1	11:20	.64	1.36	254.402	.800	.657	3.284	—	309	308	310	68	64	2	
2	11:25	.64	1.36	257.690	.800	.657	3.284	257.686	309	308	312	69	64	2	
3	11:30	.64	1.36	260.970	.800	.657	3.284	260.970	310	309	313	71	65	2	
4	11:35	.59	1.26	264.255	.762	.631	3.153	264.254	311	309	315	72	65	2	
5	11:40	.61	1.30	267.410	.781	.641	3.206	267.407	310	309	315	72	65	2	
6	11:45	.70	1.49	270.620	.837	.687	3.434	270.613	310	310	316	72	65	2	
7	11:50	.68	1.45	274.050	.825	.677	3.385	274.047	310	311	317	73	65	2	
8	11:55	.64	1.36	277.475	.800	.657	3.284	277.472	310	311	317	73	65	2	
9	12:00	.60	1.28	280.720	.775	.636	3.180	280.716	310	313	318	73	66	2	
10	12:05	.58	1.24	283.960	.762	.625	3.126	283.996	310	313	317	74	66	2	
11	12:10	.58	1.24	287.205	.762	.625	3.126	287.272	309	312	315	74	66	2	
12	12:15	.55	1.17	290.150	.742	.609	3.044	290.149	308	312	315	74	66	2	
12:20				293.192				293.192							
2-1	12:22	.60	1.28	293.770	.775	.636	3.180	—	308	310	318	74	66	2	
2	12:27	.60	1.28	296.970	.775	.636	3.180	296.915	309	312	319	74	66	2	
3	12:32	.58	1.24	300.095	.762	.625	3.126	300.095	310	312	319	75	66	2	
4	12:37	.62	1.32	303.220	.787	.646	3.232	303.221	310	313	320	75	66	2	
5	12:42	.58	1.24	306.455	.762	.625	3.126	306.453	312	313	320	75	66	2	
6	12:47	.59	1.26	309.583	.768	.631	3.153	309.579	311	312	319	75	66	2	
7	12:52	.57	1.21	312.739	.755	.620	3.099	312.732	313	312	318	75	67	2	
8	12:57	.55	1.17	315.836	.742	.609	3.044	315.831	313	311	318	75	67	2	
9	13:02	.53	1.13	318.815	.728	.598	2.988	318.875	313	311	317	74	67	2	
10	13:07	.47	.87	321.865	.640	.526	2.628	321.863	312	311	317	74	67	2	
11	13:12	.40	.85	324.490	.632	.519	2.596	324.491	312	310	318	74	67	2	
12	13:17	.32	.68	327.090	.566	.464	2.322	327.087	310	310	318	74	67	2	
13:22				329.409				329.409							

= Data does not get entered in Excel

74.464

Test 1 – Ontario Hydro - Outlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	685.0	811.1	126.1
2	683.3	734.6	51.3
3	660.3	676.4	16.1
4	718.8	722.8	4.0
5	717.7	715.5	-2.2
6	720.9	719.1	-1.8
7	698.5	694.7	-3.8
8	763.8	789.7	25.9
Total			215.6

Test 1 – Ontario Hydro - Inlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	672.0	858.8	186.8
2	667.6	717.1	49.5
3	674.5	682.5	8.0
4	682.4	689.3	6.9
5	710.6	714.8	4.2
6	630.6	631.5	0.9
7	692.6	693.9	1.3
8	765.2	782.8	17.6
Total			275.2

Test 2 – Ontario Hydro - Outlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	688.8	838.3	149.5
2	685.6	732.1	46.5
3	661.0	680.2	19.2
4	724.2	731.6	7.4
5	723.0	725.4	2.4
6	722.0	723.1	1.1
7	692.9	692.5	-0.4
8	797.9	805.2	7.3
Total			233.0

Test 2 – Ontario Hydro - Inlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	669.6	820.3	150.7
2	674.4	724.4	50.0
3	674.2	689.3	15.1
4	682.8	690.5	7.7
5	709.9	712.2	2.3
6	634.0	632.6	-1.4
7	693.4	694.2	0.8
8	778.9	794.8	15.9
Total			241.1

Test 3 – Ontario Hydro - Outlet – November 4, 2004

Impinger No.	Pre	Post	Difference
1	675.5	831.3	155.8
2	668.2	713.0	44.8
3	675.7	686.7	11.0
4	684.6	694.2	9.6
5	640.2	638.1	-2.1
6	636.1	638.6	2.5
7	695.7	697.8	2.1
8	778.5	793.0	14.5
Total			238.2

Thimble ripped, some particulate matter got into impingers 1-3

Test 3 – Ontario Hydro - Inlet – November 4, 2004

Impinger No.	Pre	Post	Difference
1	686.3	848.1	161.8
2	683.8	722.5	38.7
3	659.3	671.2	11.9
4	721.2	730.7	9.5
5	718.8	719.7	0.9
6	721.2	728.1	6.9
7	691.8	692.6	0.8
8	774.7	788.1	13.4
Total			243.9

Test 1 – Method 29 Trace Metals - Outlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	683.7	842.0	158.3
2	671.0	724.1	53.1
3	711.7	718.8	7.1
4	746.6	747.6	1.0
5	767.3	784.4	17.1
Total			237.6

Test 1 – Method 29 Trace Metals - Inlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	709.3	839.8	130.5
2	631.9	706.2	74.3
3	688.3	753.9	65.6
4	712.5	620.0	-86.5
5	751.4	769.4	18.0
Total			201.9

KmnO₄ impinger carried over to the nitric/peroxide impinger (inlet only).

Test 2 – Method 29 Trace Metals - Outlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	680.2	845.5	165.3
2	678.7	724.3	45.6
3	713.5	720.9	7.4
4	744.8	748.4	3.6
5	784.8	793.9	9.1
Total			231.0

Test 2 – Method 29 Trace Metals - Inlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	710.4	860.7	150.3
2	631.0	682.0	51.0
3	601.3	612.2	10.9
4	691.4	700.8	9.4
5	714.1	716.0	1.9
6	769.1	780.3	11.2
Total			234.7

Test 3 – Method 29 Trace Metals - Outlet – November 4, 2004

Impinger No.	Pre	Post	Difference
1	679.8	856.3	176.5
2	679.5	728.5	49.0
3	711.8	722.0	10.2
4	743.7	747.8	4.1
5	779.3	788.4	9.1
Total			248.9

Test 3 – Method 29 Trace Metals - Inlet – November 4, 2004

Impinger No.	Pre	Post	Difference
1	710.4	849.7	139.3
2	632.3	682.6	50.3
3	604.0	614.3	10.3
4	690.4	697.2	6.8
5	714.7	713.9	-0.8
6	793.2	802.3	9.1
Total			215.0

Test 1 – Method 26A HCl, HF and BR⁺ - Outlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	674.1	898.1	224.0
2	634.1	664.0	29.9
3	673.6	682.7	9.1
4	687.7	689.0	1.3
5	789.5	806.1	16.6
Total			280.9

Test 1 – Method 26A HCl, HF and BR⁺ - Inlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	703.0	836.0	133.0
2	697.9	753.4	55.5
3	700.0	718.4	18.4
4	698.1	706.2	8.1
5	782.3	797.9	15.6
Total			230.6

Test 2 – Method 26A HCl, HF and BR⁺ - Outlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	677.7	860.5	182.8
2	634.5	659.8	25.3
3	679.3	687.2	7.9
4	687.1	688.8	1.7
5	762.2	779.0	16.8
Total			234.5

Test 2 – Method 26A HCl, HF and BR⁺ - Inlet – November 3, 2004

Impinger No.	Pre	Post	Difference
1	707.7	850.0	142.3
2	698.6	745.8	47.2
3	700.5	712.9	12.4
4	700.1	706.3	6.2
5	757.2	774.9	17.7
Total			225.8

Test 3 – Method 26A HCl, HF and BR⁺ - Outlet – November 4, 2004

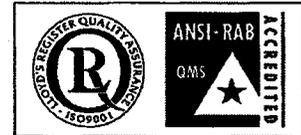
Impinger No.	Pre	Post	Difference
1	680.2	851.4	171.2
2	633.4	659.3	25.9
3	676.2	684.2	8.0
4	690.1	691.8	1.7
5	759.2	778.3	19.1
Total			225.9

Test 3 – Method 26A HCl, HF and BR⁺ - Inlet – November 4, 2004

Impinger No.	Pre	Post	Difference
1	708.4	855.3	146.9
2	698.2	743.1	44.9
3	701.4	717.1	15.7
4	699.9	706.5	6.6
5	760.4	782.6	22.2
Total			236.3

GE Energy

Eric L. Ehlers
Project Manager



ISO 9001 Accredited
Quality System

SPECIATED MERCURY EMISSIONS LONG TERM STUDY

Prepared For
ADA-ES, Inc.

Performed At
**Ameren Energy
Meramec Power Station
Unit 2
St. Louis, Missouri**

Test Date
November 9, 2004

Report No.
GE Energy Management Services, Inc. Report M22E0758B

Report Submittal Date
January 31, 2005

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

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



GE Energy

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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.



Jeffrey M. Crivlare
Senior Project Manager

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GE Energy

1.0 INTRODUCTION

GE Energy Management Services, Inc., ("GE Energy") performed a long term speciated mercury emission test program on the Unit 2 ESP inlet and outlet at the Meramec Power Station of Ameren Energy in St. Louis, Missouri on November 9, 2004. The tests were authorized by Ameren Energy and performed for ADA-ES, Inc.

The purpose of this test program was to establish long term emissions for the above parameters during normal operating conditions.

1.1 Project Contact Information

Location	Address	Contact
Test Coordinator	ADA-ES, Inc. 8100 South Park Way Unit B Littleton, Colorado, 80120	Mr. Travis Starns Project Engineer 303-734-1727 (phone) 303-734-0330 (fax) traviss@adaes.com
Testing Company Representative	GE Energy Management Services, Inc. 888 Industrial Drive Elmhurst, Illinois 60126	Eric Ehlers Project Manager 630-530-6621 (phone) 630-530-6630 (fax) eric.ehlers@ps.ge.com

The tests were conducted by Messrs. J. Robertson, P. Nemeth, D. Tuidier, A. Sakellariou, M. Anderson and E. Ehlers of GE Energy.

2.0 SUMMARY OF RESULTS

The following table summarizes test results at each of the test locations:

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Parameter	Reference Method	Unit 2 ESP Inlet (Location 1)*	Unit 2 ESP Outlet (Location 2)*	Efficiency %
Particle Bound Mercury (lbs/hr)	Ontario Hydro	0.01213	<0.00001	99.92%
Oxidized Mercury (lbs/hr)	Ontario Hydro	0.00457	0.00067	85.34%
Elemental Mercury (lbs/hr)	Ontario Hydro	0.00234	0.00164	29.91%
Total Mercury (lbs/hr)	Ontario Hydro	0.01904	0.00231	87.86%

*All emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

Complete test results for all test locations and parameters are appended in Section 6.0 of this report.

3.0 DISCUSSION OF RESULTS

Source operation appeared normal during the entire test program. The activated carbon injection system shut down for approximately one hour during the second test run. Testing continued throughout this time period.

4.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed as described in the Ontario Hydro Method. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/4-77-027b was used to determine the precise procedures.

4.1 Volumetric Flowrate Determination

In order to determine the emission rate on a lbs/hr basis, the gas velocities and volumetric flowrates were determined using Method 2, 40CFR60.

Velocity pressures were determined by traversing the test locations with S-type pitot tubes. Temperatures were measured using K-type thermocouples with calibrated digital temperature indicators. 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.

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Two test ports were used at both locations due to ADA-ES, Inc. mercury measurement equipment blocking access to one test port.

4.2 Oxygen (O₂)/Carbon Dioxide (CO₂) Determination

Oxygen (O₂) and carbon dioxide (CO₂) 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 Speciated Mercury Determination

A total of 24 test points were sampled using two (2) ports at the Unit 2 ESP Inlet and Outlet test locations.

The speciated mercury sample train was manufactured by Nutech Corporation of Durham, North Carolina and meets all specifications required by The Ontario Hydro Method. A glass-lined probe was used at the Unit 2 ESP Outlet location, while a teflon-lined probe was used at the Inlet location. Drawings depicting the sampling ports, test point locations, and sample trains are appended to this report. Velocity pressures were determined simultaneously during sampling with a calibrated S-type pitot tube and inclined manometer. All temperatures were measured using K-type thermocouples with calibrated digital temperature indicators.

The outlet filter media were quartz filters exhibiting a $\geq 99.97\%$ efficiency on 0.3 micron DOP smoke particles in accordance with ASTM Standard Method D-2986-71. The inlet test employed a quartz-thimble prefilter. All sample contact surfaces of the train were washed with 0.1 N Nitric Acid. These washes were placed in sealed and marked containers for analysis. All sample recovery of impinger solutions was performed on site.

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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 or at the jobsite 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, all reagent standardizations were performed daily by the same person performing the analysis.

Dry 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

GE Energy

SPECIATED MERCURY TEST RESULTS SUMMARY

Company: Ameren
 Plant: Meramec
 Unit: Unit 2 ESP Inlet

Test Run Number	4	5	6	Average
Source Condition	Normal	Normal	Normal	
Date	11/9/2004	11/9/2004	11/9/2004	
Start Time	10:45	13:15	15:40	
End Time	12:55	15:22	17:46	
Particle Bound Mercury Emissions				
ppm	0.001540	0.001275	0.001330	0.001382
ug/dncm	13.80	11.42	11.91	12.37
lb/hr*	0.01309	0.01145	0.01186	0.01213
tons/yr*	0.057322	0.050131	0.051964	0.053139
lb/mmBtu	0.0000096	0.0000079	0.0000083	0.0000086
lb/Tbtu	9.59346	7.93789	8.28093	8.60409
Elemental Mercury Emissions				
ppm	0.000248	0.000295	0.000254	0.000266
ug/dncm	2.22	2.64	2.27	2.38
lb/hr*	0.00211	0.00265	0.00226	0.00234
tons/yr*	0.009240	0.011602	0.009920	0.010254
lb/mmBtu	0.0000015	0.0000018	0.0000018	0.0000017
lb/Tbtu	1.54646	1.83705	1.83705	1.74019
Oxidized Mercury Emissions				
ppm	0.000476	0.000510	0.000571	0.000519
ug/dncm	4.26	4.57	5.11	4.65
lb/hr*	0.00404	0.00458	0.00509	0.00457
tons/yr*	0.017701	0.020053	0.022300	0.020018
lb/mmBtu	0.0000030	0.0000032	0.0000036	0.0000032
lb/Tbtu	2.96246	3.17516	3.55365	3.23042
Total Mercury Emissions				
ppm	0.002264	0.002079	0.002154	0.002166
ug/dncm	20.28	18.62	19.29	19.40
lb/hr*	0.01924	0.01867	0.01922	0.01904
tons/yr*	0.084263	0.081786	0.084184	0.083411
lb/mmBtu	0.0000141	0.0000130	0.0000134	0.0000135
lb/Tbtu	14.10238	12.95010	13.41548	13.48932
Stack Parameters:				
Average Gas Temperature, °F	325.7	330.4	329.6	328.6
Average Gas Velocity, ft/sec	52.979	53.921	53.813	53.571
Flue Gas Moisture, percent by volume	16.7	12.9	13.4	14.2
Average Flue Pressure, in. Hg	27.97	27.97	27.97	
Barometric Pressure, in. Hg	29.33	29.33	29.33	
Average %CO ₂ by volume, dry basis	15.0	14.8	14.6	14.8
Average %O ₂ by volume, dry basis	3.8	3.8	3.8	3.8
Dry Molecular Wt. of Gas, lb/lb-mole	30.552	30.520	30.488	
Gas Sample Volume, dscf	68.673	69.717	70.011	
Isokinetic Variance	103.4	99.3	100.4	

*Emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

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SPECIATED MERCURY TEST RESULTS SUMMARY

Company: Ameren
Plant: Meramec
Unit: Unit 2 ESP Outlet

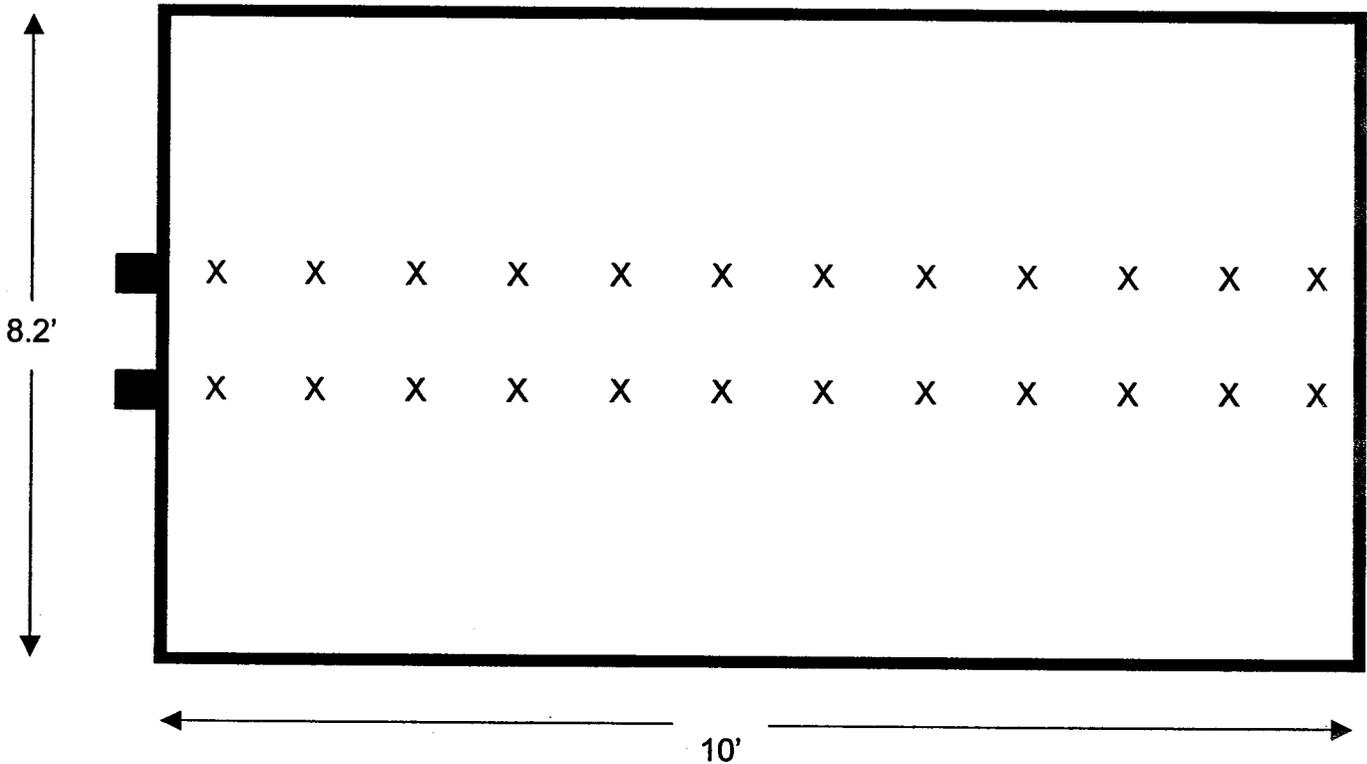
Test Run Number	4	5	6	Average
Source Condition	Normal	Normal	Normal	
Date	11/9/04	11/9/2004	11/9/2004	
Start Time	10:45	13:15	15:40	
End Time	12:48	15:17	17:44	
Particle Bound Mercury Emissions				
ppm	0.000001	0.000001	0.000001	0.000001
ug/dncm	0.01	0.01	0.01	0.01
lb/hr*	0.00001	0.00001	0.00001	0.00001
tons/yr*	0.000023	0.000023	0.000023	0.000023
lb/mmBtu	0.0000000	0.0000000	0.0000000	0.0000000
lb/Tbtu	0.00367	0.00379	0.00372	0.00373
Elemental Mercury Emissions				
ppm	0.000126	0.000293	0.000124	0.000181
ug/dncm	1.13	2.63	1.11	1.62
lb/hr*	0.00113	0.00264	0.00114	0.00164
tons/yr*	0.004964	0.011565	0.004979	0.007169
lb/mmBtu	0.0000008	0.0000019	0.0000019	0.0000016
lb/Tbtu	0.80811	1.94024	1.94024	1.56286
Oxidized Mercury Emissions				
ppm	0.000063	0.000092	0.000068	0.000074
ug/dncm	0.56	0.82	0.60	0.66
lb/hr*	0.00057	0.00083	0.00062	0.00067
tons/yr*	0.002482	0.003614	0.002716	0.002937
lb/mmBtu	0.0000004	0.0000006	0.0000004	0.0000005
lb/Tbtu	0.40405	0.60632	0.44668	0.48569
Total Mercury Emissions				
ppm	0.000190	0.000386	0.000192	0.000256
ug/dncm	1.70	3.45	1.72	2.29
lb/hr*	0.00171	0.00347	0.00176	0.00231
tons/yr*	0.007469	0.015202	0.007717	0.010129
lb/mmBtu	0.0000012	0.0000026	0.0000013	0.0000017
lb/Tbtu	1.21583	2.55035	1.26933	1.67850
Stack Parameters:				
Average Gas Temperature, °F	314.3	316.3	316.3	315.6
Average Gas Velocity, ft/sec	52.739	53.921	54.250	53.637
Flue Gas Moisture, percent by volume	12.1	13.7	12.5	12.4
Average Flue Pressure, in. Hg	27.79	27.79	27.79	
Barometric Pressure, in. Hg	29.33	29.33	29.33	
Average %CO ₂ , by volume, dry basis	14.7	14.2	14.0	14.3
Average %O ₂ , by volume, dry basis	4.3	4.8	4.8	4.6
Dry Molecular Wt. of Gas, lb/lb-mole	30.524	30.464	30.432	
Gas Sample Volume, dscf	73.904	73.860	75.193	
Isokinetic Variance	102.6	102.5	102.3	

*Emission rates are doubled assuming equal emissions on the second "pant leg" of the system.

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APPENDIX

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Ameren Energy
St. Louis, Missouri

Date: November 9, 2004

Area: 81.67 Square Feet

Test Location: Unit 2 ESP Inlet

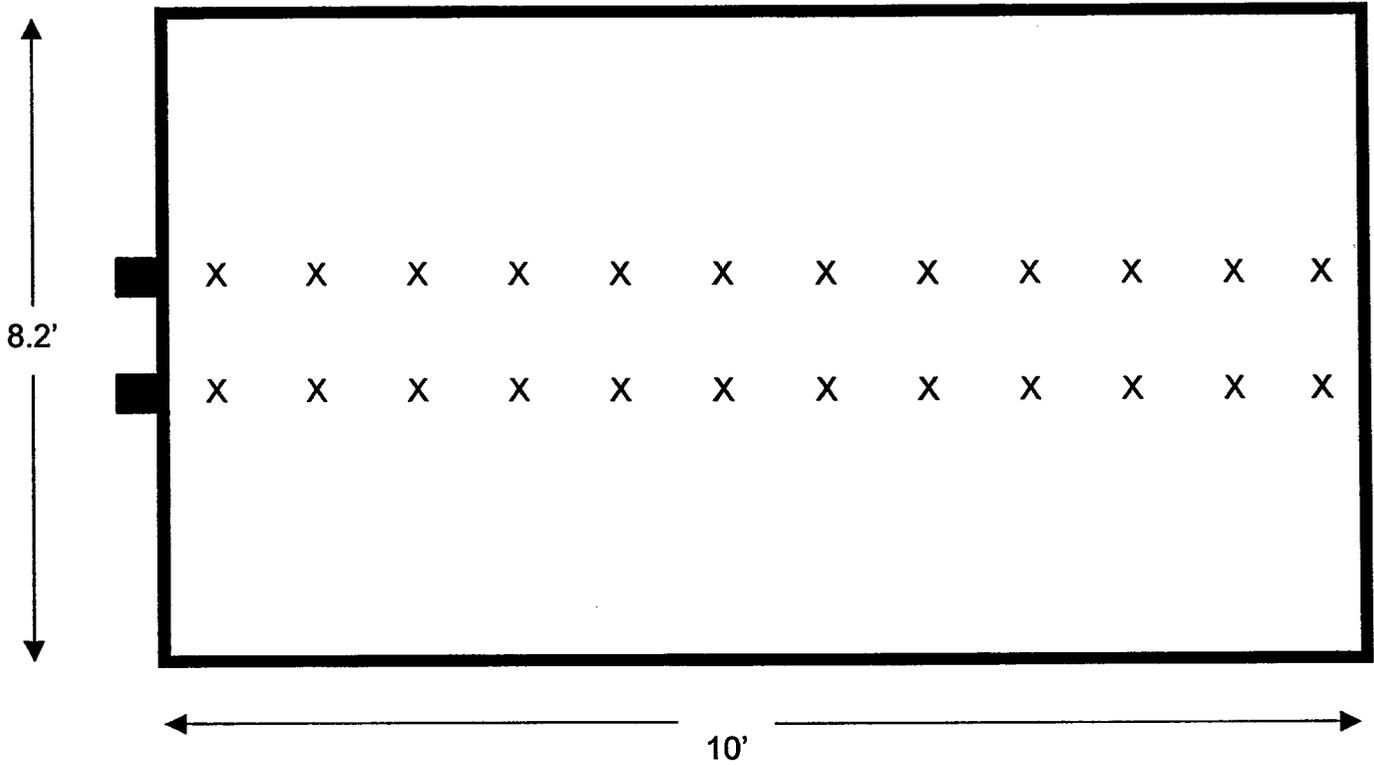
No. Test Ports: 2

Length: 10 Feet

Tests Points per Port: 12

Width: 8.2 Feet

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Ameren Energy
St. Louis, Missouri

Date: November 9, 2004

Area: 81.67 Square Feet

Test Location: Unit 2 ESP Outlet

No. Test Ports: 2

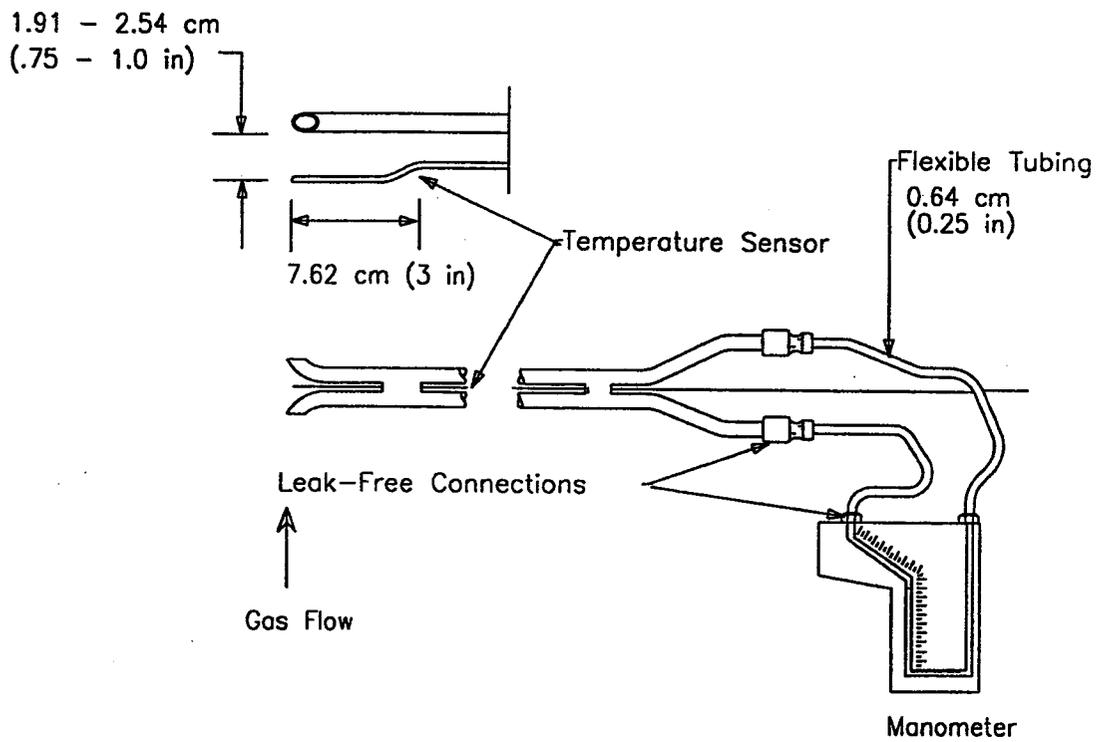
Length: 10 Feet

Tests Points per Port: 12

Width: 8.2 Feet

S-Type Pitot Tube Manometer Assembly

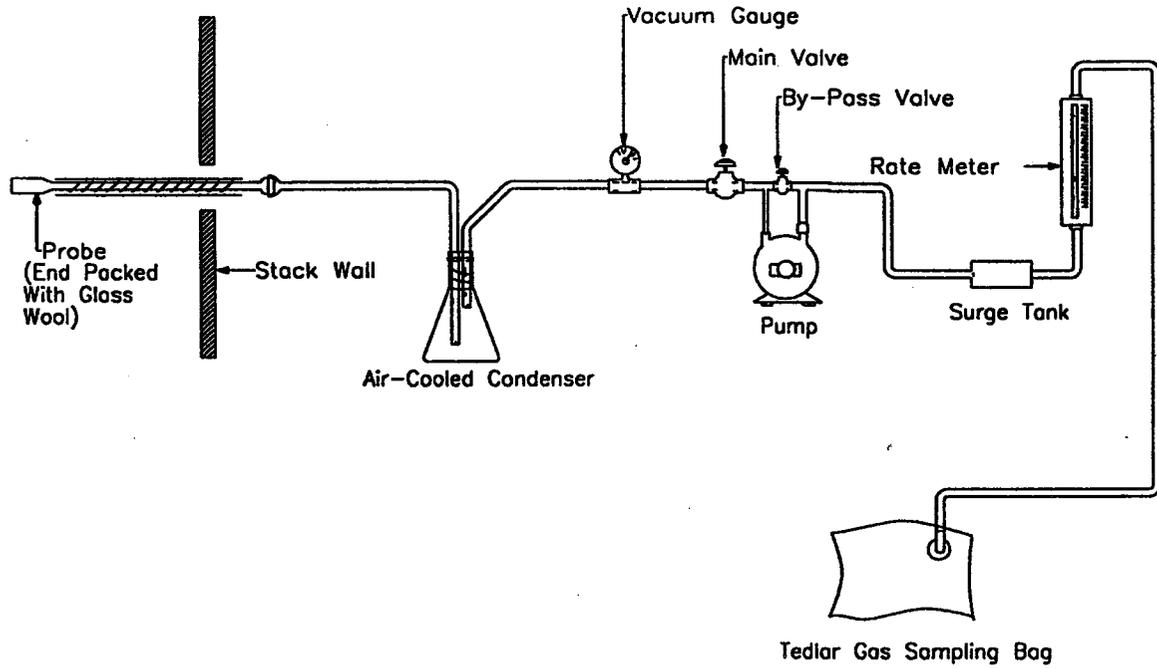
USEPA Method 2



Dwg - AD

Sampling Train for Integrated Gas Sampling

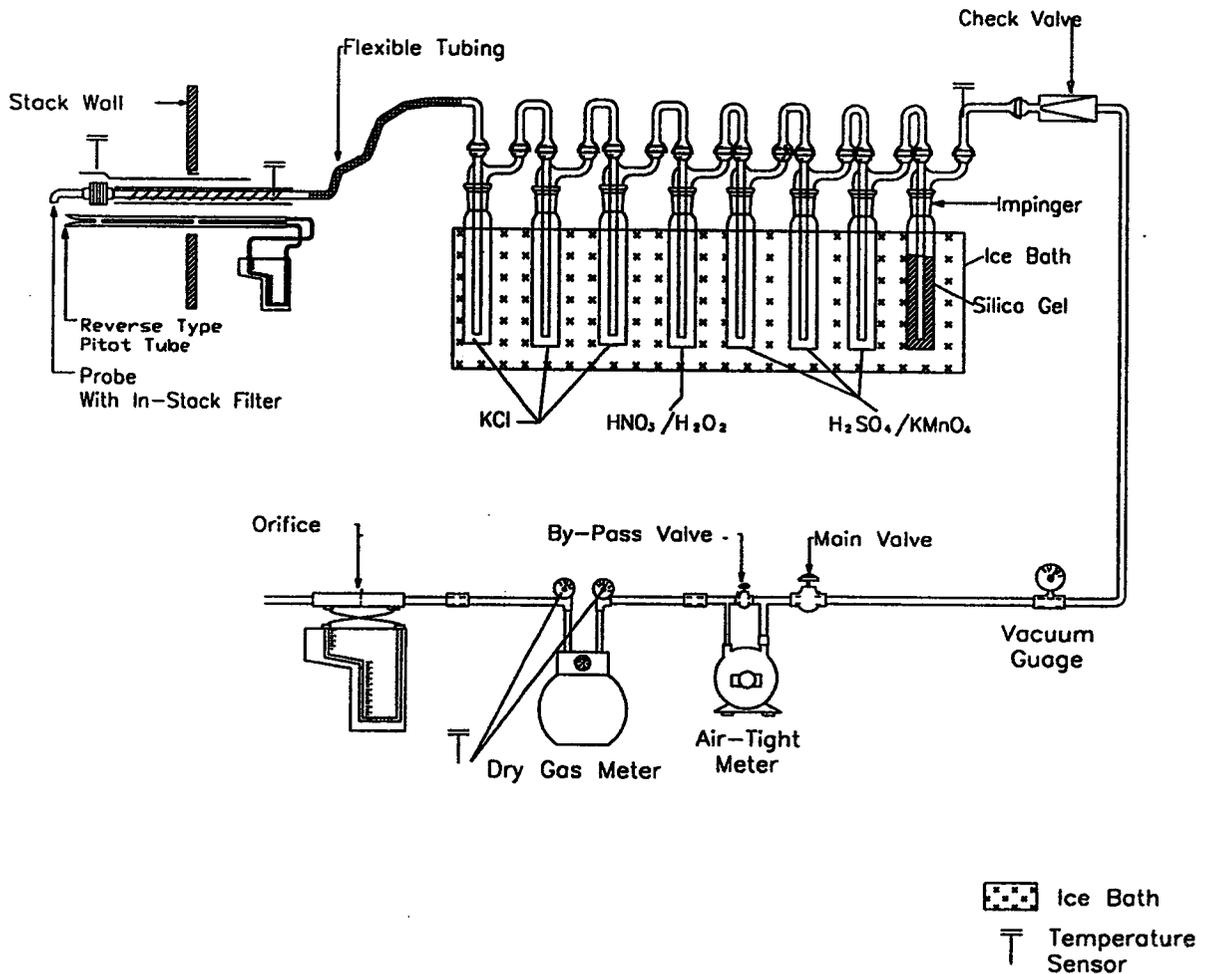
USEPA Method 3



Dwg - E

Speciated Mercury Sampling Train Equipped with In-Stack Filter

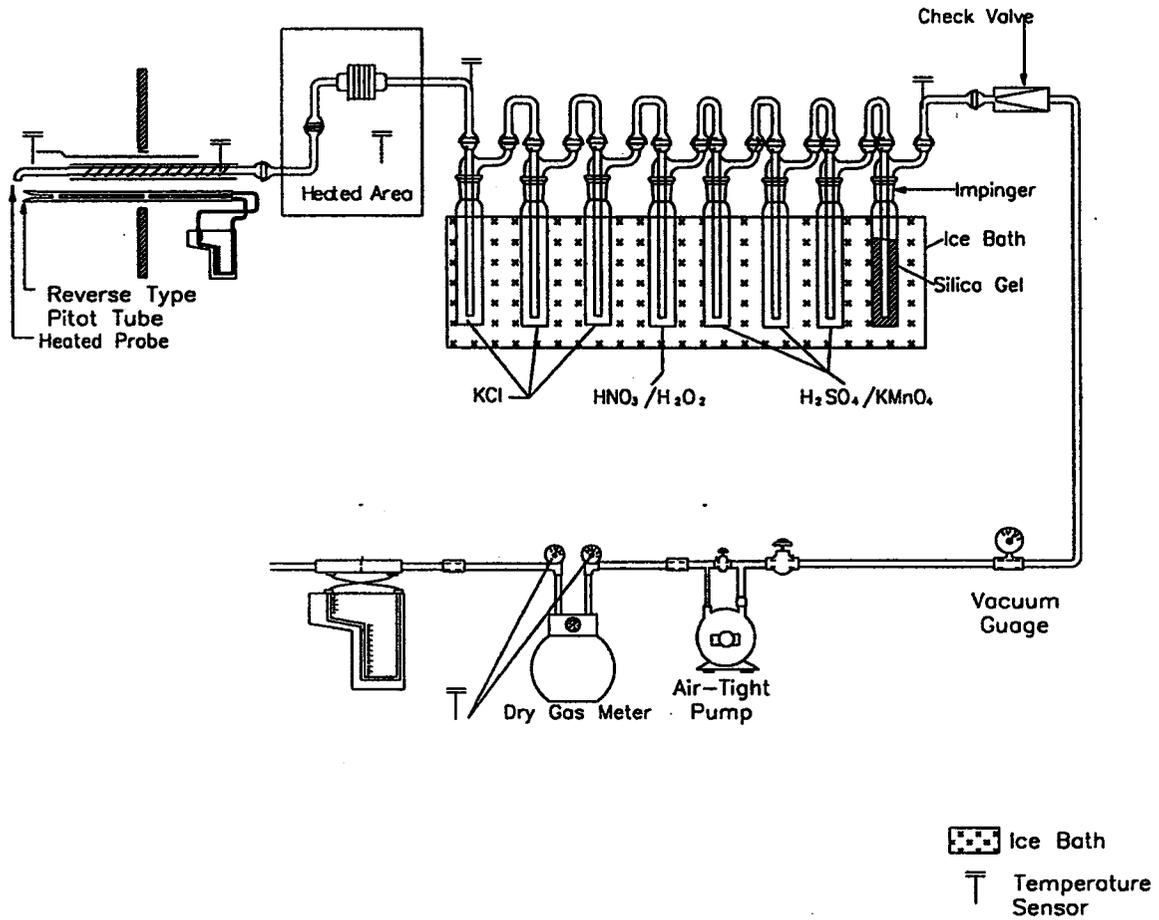
USEPA Ontario Hydro Method



Dwg - P1

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

USEPA Ontario Hydro Method



Dwg - P2

PASC - Certificate of Analysis

Component	Method	Client ID:		MDL	Units	Blank		Spike #2	OHHG		OHHG
		081626 04	081626 04			Spike #1	Spike #2		0758-02-RB	0758-02-Out-FB	
Lab No.:	081626 04	081626 04	081626 04	081626 04	081626 04	081626 04	081626 04	081626 04	081628 04	081629 04	081629 04
Date Sampled:	-	-	-	-	-	-	-	-	09-Nov-2004	09-Nov-2004	09-Nov-2004
		% Recoveries			% Recoveries						
Final volume measured - ash	100	-	-	0	ml	-	-	-	-	-	-
Final volume measured - bulk	100	-	-	0	"	-	-	-	-	-	-
Final volume measured - probe	100	-	-	0	"	-	-	-	-	-	-
Filter weight	-	-	-	1.0	mg	-	-	-	-	-	-
Filter weight	-	-	-	1.0	"	-	-	-	-	-	-
Impinger volume - KCl - combined	-	-	-		ml	-	-	-	1000	1000	1000
Impinger volume - KMnO4 - combined	-	-	-		"	-	-	-	1000	1000	1000
Weight of sample	-	-	-	0.0001	g	-	-	-	-	-	-
Mercury - filter	<	0.10	100	0.010	ug	0.10	100	0.10	(1)	(1)	(1)
Mercury - filter - ash	<	0.11	110	0.010	"	0.11	110	0.11	-	-	-
Mercury - KCl	<	0.49	98	0.050	"	0.50	99	0.50	<	<	<0.10
Mercury - KMnO4	<	0.51	100	0.050	"	0.49	99	0.49	0.37	0.37	4.9
Mercury - H2O2	<	0.26	100	0.025	"	0.26	100	0.26	<0.25	<0.25	<0.25
Mercury - probe rinse	<	0.10	100	0.010	"	0.10	100	0.10	-	-	-

PASC - Certificate of Analysis

Component	MDL	Units	OHHG 0758-02-Out-R4 081630 04 09-Nov-2004					
Final volume measured - ash	0	ml	-	-	-	-	-	-
Final volume measured - bulk	0	"	100	-	-	-	-	-
Final volume measured - probe	0	"	-	-	-	-	-	-
Filter weight	1.0	mg	690	-	-	-	-	-
Filter weight	1.0	"	-	-	-	-	-	-
Impinger volume - KCl - combined		ml	1000	-	-	-	-	-
Impinger volume - KMnO4 - combined		"	1000	-	-	-	-	-
Weight of sample	0.0001	g	-	-	-	-	-	-
Mercury - filter	0.010	ug	(1)	0.11	100	0.11	100	100
Mercury - filter - ash	0.010	"	<	-	-	-	-	-
Mercury - KCl	0.050	"	1.1	1.1	95	2.0	2.0	93
Mercury - KMnO4	0.050	"	2.2	2.1	95	3.1	3.1	100
Mercury - H2O2	0.025	"	<0.25	<0.25	100	2.7	2.7	100
Mercury - probe rinse	0.010	"	-	-	-	-	-	-

PASC - Certificate of Analysis

Component	Client ID:	OHHG	OHHG	OHHG	OHHG	OHHG	OHHG	OHHG	OHHG	OHHG
	Lab No.:	0758-02-Out-R5	0758-02-Out-R6	0758-02-In-R4						
	Date Sampled:	081631 04	081632 04	081633 04	081633 04	081633 04	081633 04	081633 04	081633 04	081633 04
	MDL	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004	09-Nov-2004
	Units									MS % Rec.
Final volume measured - ash	0	-	-	100	-	-	-	-	-	-
Final volume measured - bulk	0	100	100	-	-	-	-	-	-	-
Final volume measured - probe	0	-	-	100	-	-	-	-	-	-
Filter weight	1.0	700	710	-	-	-	-	-	-	-
Filter weight	1.0	-	-	22000	-	-	-	-	-	-
Impinger volume - KCl - combined		1000	1000	1000	-	-	-	-	-	-
Impinger volume - KMnO4 - combined		1000	1000	1000	-	-	-	-	-	-
Weight of sample	0.0001	-	-	22	-	-	-	-	-	-
Mercury - filter	0.010	0.010	(1)	-	-	-	-	-	-	-
Mercury - filter - ash	0.010	-	<	25	25	30	100	-	-	-
Mercury - KCl	0.050	1.6	1.2	7.5	-	-	-	-	-	-
Mercury - KMnO4	0.050	4.7	2.2	3.7	-	-	-	-	-	-
Mercury - H2O2	0.025	0.42	<0.25	0.33	-	-	-	-	-	-
Mercury - probe rinse	0.010	-	-	0.22	-	-	-	-	-	-

PASC - Certificate of Analysis

Component	MDL	Units	OHHG		OHHG		OHHG	
			0758-02-In-R4	081633 04	0758-02-In-R4	081633 04	0758-02-In-R5	081635 04
Final volume measured - ash	0	ml	-	-	-	-	100	100
Final volume measured - bulk	0	"	-	-	-	-	-	-
Final volume measured - probe	0	"	-	-	-	100	100	100
Filter weight	1.0	mg	-	-	-	-	-	-
Filter weight	1.0	"	-	-	-	17000	18000	18000
Impinger volume - KCl - combined		ml	-	-	-	1000	1000	1000
Impinger volume - KMnO4 - combined		"	-	-	-	1000	1000	1000
Weight of sample	0.0001	g	-	-	-	17	18	(1)
Mercury - filter	0.010	ug	-	-	-	-	-	-
Mercury - filter - ash	0.010	"	29	92	-	21	22	22
Mercury - KCl	0.050	"	-	-	-	7.4	9.4	9.4
Mercury - KMnO4	0.050	"	-	-	-	4.5	4.2	4.2
Mercury - H2O2	0.025	"	-	-	-	0.36	<0.25	<0.25
Mercury - probe rinse	0.010	"	-	-	-	1.0	0.041	0.041

Read Instructions on Reverse Side Before Completing Form!

CHAIN OF CUSTODY RECORD						
Project Number: M22E0758-02			Date Results Required:			
Client: ADA-ES (Ameren)			TAT Required:			
Plant/Location: Meramec Unit 2 ESP Inlet & Outlet			LAB USE ONLY	PO Number: M 86001465-PSC		
Project Supervisor: ELS				LIMS Entry: E.V.		
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
001	11/9/04	Unit 2 ESP Inlet Test ^{7hr imble}	2		Hg by Hydro	
002			5	↓		
003			6	↓		
004			4 ^{HNO₃} Front's	1		
005			5	↓		
006			6	↓		
007			4 ^{Pulse of line Rspic} KCl Imp	2		
008			5	↓		
009			6	↓		
010			4 ^{HNO₃/H₂O₂} Imp	1		
011			5	↓		
012			6	↓		
013			4 ^{H₂O₂/HNO₃} Imp	1		
014			5	↓		
015			6	↓		
016		Unit 2 ESP outlet	4 Filter	1		

Delivered by: 	Date/Time 11/9/04 15:00	Processed by: DJS E.V. 11/9/04	Date/Time	Received by Laboratory:
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Special Instructions:

Read Instructions on Reverse Side Before Completing Form!

CHAIN-OF-CUSTODY RECORD						
Project Number: <i>M226088-02</i>				Date Results Required:		
Client: <i>ADN-ES (Ameren)</i>				TAT Required:		
Plant/Location: <i>Meramec Unit 2 ESP</i> <i>Inlet & outlet</i>				LAB Use Only	PO Number:	
Project Supervisor: <i>ELC</i>					LIMS Entry:	
Sample Number	Date Sampled	Sample Point Identification	# of Conts	Grab/Comp	Analysis Requested	Sub Lab
017	11/9/04	Unit 2 ESP outlet 5 Filter	1		Hg by Hydro	
018		6 ↓	1			
019		4 Nitro- Probe Rinse	1			
020		5 ↓	1			
021		6 ↓	1			
022		4 Hang Line Rinse KCl Imp	1			
023		5 ↓	1			
024		6 ↓	1			
025		4 HNO ₃ /H ₂ O Imp	1			
026		5 ↓	1			
027		6 ↓	1			
028		4 H ₂ SO ₄ /KMnO ₄ Imp	1			
029		5 ↓	1			
030		6 ↓	1			
031		8 KCl Reagent Blank	1			
032		Field Blank Inlet KCl Imp	1			
Delivered by:		Date/Time	Processed by:		Date/Time	Received by Laboratory:
		11/9/04 15:00				

Special Instructions:

Read Instructions on Reverse Side Before Completing Form!

CHAIN OF CUSTODY RECORD

Project Number: <i>m22E0158-02</i>	Date Results Required:
Client: <i>ADA-LS (Ameren)</i>	TAT Required:
Plant/Location: <i>Marion Unit 2 ESP</i> <i>Inlet & Outlet</i>	PO Number:
Project Supervisor: <i>LEK</i>	LIMS Entry:

Sample Number	Date Sampled	Sample Point Identification	# of Concs	Grab/Comp	Analysis Requested	Sub Lab
033	11/9/04	Field Blank Inlet <i>Hg_g/H₂O Imp</i>	1		<i>Hg by Hyd</i>	
034	↓	↓ <i>H₂SO₄/K₂Cr₂O₇ Imp</i>	1		↓	
035	↓	Outlet <i>K₂Cr₂O₇ Imp</i>	↓		↓	
036	↓	↓ <i>H₂SO₄/H₂O Imp</i>	↓		↓	
037	↓	↓ <i>H₂SO₄/K₂Cr₂O₇ Imp</i>	↓		↓	
038						
039						
040						
041						
042						
043						
044						
045						
046						
047						
048						

Delivered by: 	Date/Time <i>11/9/04</i> <i>15:00</i>	Processed by:	Date/Time	Received by Laboratory:
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Special Instructions:

METAL SAMPLE CALCULATION

Concentration

$$\frac{\mu\text{g}}{\text{m}^3} = \frac{\mu\text{g of sample}}{\text{dscf volume sampled} \times 0.02832 \frac{\text{m}^3}{\text{ft}^3}}$$

Emission Rate

$$\frac{\mu\text{g of sample} \times \frac{1 \times 10^{-6} \text{ grams}}{\mu\text{g}}}{453.6 \text{ gr/lb}} = \text{lbs of sample}$$

$$\frac{\text{lbs/sample}}{\text{Vm (std) sample}} \times \text{dscfm} \times 60 \frac{\text{min}}{\text{hr}} = \text{lbs/hr}$$

EMISSION RATE CALCULATIONS

A pollutant emission rate (E), expressed as pounds of pollutant per million Btu heat input from the fuel combusted can be calculated by several methods as follows:

1. $C = C_s/7000$ where, C = pollutant concentration, lb/dscf
 c_s = pollutant concentration, grains/dscf
2. If fuel flow is monitored and the fuel combusted during the test is sampled and analyzed for gross calorific value, then:

$$E = \frac{Q_{sd} C}{\text{fuel flow rate (lb / hr) GCV}} \times 10^6$$

where, E = lbs per million Btu

GCV = gross calorific value, Btu / lb

Q_{sd} = dry volumetric gas flow at standard conditions, dscf / hr

3. If an integrated gas sample is taken during the test and analyzed for %CO₂ or %O₂, dry basis by volume, with an Orsat gas analyzer, then

$$E = C F_c \frac{100}{(\%CO_2)} \text{ or, } E = C F \frac{20.9}{(20.9 - \%O_2)} \text{ where,}$$

%CO₂ and %O₂ are expressed as percent; and, for example, for subbituminous and bituminous coals:

F_c = a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted, 1800 scf CO₂/million Btu.

F = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted, 9780 dscf/million Btu.

4. If fuel sample increments are taken and composited during the test and an ultimate analysis is performed and the GCV is determined, then

$$F_c = \frac{321 \times 10^3 (\%C)}{GCV} \text{ where, \%C = carbon content by weight expressed as percent}$$

$$F = \frac{[3.64 (\%H) + 1.53 (\%C) + 0.57 (\%S) + 0.14 (\%N) - 0.46 (\%O_2)]}{GVC} \times 10^6$$

where, H, C, S, N, and O are content by weight of hydrogen, carbon, sulfur, nitrogen, and oxygen (expressed as percent) respectively.

5. If fuels other than subbituminous and bituminous coals are fired, other F-factors than those above will apply; and, if combinations of different fuels are fired, the F-factors must be prorated according to the fraction of the total heat input derived from each type of fuel.

VOLUMETRIC AIR FLOW CALCULATIONS

$$V_m (\text{std}) = 17.647 \times V_m \times \left[\frac{P_{\text{bar}} + \frac{DH}{13.6}}{(460 + T_m)} \right] \times Y$$

$$V_w (\text{std}) = 0.0471 \times V_{lc}$$

$V_{lc} = \text{water} + \text{silica net}$

$$B_{ws} = \left[\frac{V_w (\text{std})}{V_w (\text{std}) + V_m (\text{std})} \right]$$

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

$$M_S = M_d \times (1 - B_{ws}) + (18 \times B_{ws})$$

$$V_s = \sqrt{\frac{(T_s + 460)}{M_s \times P_s}} \times \sqrt{DP} \times C_p \times 85.49$$

- C_p = pitot tube correction factor
- P_s = absolute flue gas pressure
- M_s = molecular weight of gas (lb/lb mole)
- M_d = dry molecular weight of gas (lb/lb mole)
- B_{ws} = water vapor in gas stream proportion by volume

$$A_{cfm} = V_s \times \text{Area (of stack or duct)} \times 60$$

$$D_{scfm} = A_{cfm} \times 17.647 \times \left[\frac{P_s}{(460 + T_s)} \right] \times (1 - B_{ws})$$

$$S_{cfm} = A_{cfm} \times 17.647 \times \left[\frac{P_s}{(460 + T_s)} \right]$$

$$S_{cfh} = S_{cfm} \times 60 \frac{\text{min}}{\text{hr}}$$

NOMENCLATURE – ISOKINETIC SAMPLING

- A = Cross-sectional area of stack or duct, ft^2
 A_n = Cross-sectional area of nozzle, ft^2
 B_{ws} = Water vapor in gas stream, proportion by volume
 C_a = Acetone blank residue concentration, g/g
 C_{acf} = Concentration of particulate matter in gas stream at actual conditions, gr/acf
 C_p = Pitot tube coefficient, dimensionless
 C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, gr/dscf
 IKV = Isokinetic sampling variance, must be $.90 \leq \text{IKV} \leq 1.10$
 M_d = Dry molecular weight of gas, $\text{lb}/\text{lb-mole}$
 m_n = Total amount of particulate matter collected, grams
 M_s = Molecular weight of gas, wet basis, $\text{lb}/\text{lb-mole}$
 M_w = Molecular weight of water, $18.0 \text{ lb}/\text{lb-mole}$
 m_a = Mass of residue of acetone after evaporation, grams
 P_{bar} = Barometric pressure at testing site, in. Hg
 P_g = Static pressure of gas, in. Hg (in. $\text{H}_2\text{O}/13.6$)
 P_s = Absolute pressure of gas, in. Hg = $P_{\text{bar}} + P_g$
 P_{std} = Standard absolute pressure, 29.92 in. Hg
 Q_{acfm} = Actual volumetric gas flow rate, acfm
 Q_{std} = Dry volumetric gas flow rate corrected to standard conditions, dscf/hr
 R = Ideal gas constant, $21.85 \text{ in. Hg}\cdot\text{ft}^3/\text{°R}\cdot\text{lb-mole}$
 T_m = Absolute dry gas meter temperature, °R
 T_s = Absolute gas temperature, °R
 T_{std} = Standard absolute temperature, 528°R
 V_a = Volume of acetone blank, ml
 V_{aw} = Volume of acetone used in wash, ml
 V_{ic} = Total volume of liquid collected in impingers and silica gel, ml
 V_m = Volume of gas sample as measured by dry gas meter, dcf
 $V_{m(\text{std})}$ = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscf
 v_s = Gas velocity, ft/sec
 $V_{w(\text{std})}$ = Volume of water vapor in gas sample, corrected to standard conditions, scf
 W_a = Weight of residue in acetone wash, grams
 Y = Dry gas meter calibration factor
 ΔH = Average pressure differential across the orifice meter, in. H_2O
 Δp = Velocity head of gas, in. H_2O
 ρ_a = Density of acetone, $0.7855 \text{ g}/\text{ml}$ (average)
 ρ_w = Density of water, $0.002201 \text{ lb}/\text{ml}$
 θ = Total sampling time, minutes
 K_1 = $17.64 \text{ °R}/\text{in. Hg}$
 K_2 = $0.04707 \text{ ft}^3/\text{ml}$
 K_4 = $0.09450/100 = 0.000945$
 K_p = Pitot tube constant, $85.49 \frac{\text{ft}}{\text{sec}} \left[\frac{(\text{lb}/\text{lb-mole})(\text{in. Hg})}{(\text{°R})(\text{in. H}_2\text{O})} \right]^{1/2}$
 $\%EA$ = Percent excess air
 $\%\text{CO}_2$ = Percent carbon dioxide by volume, dry basis
 $\%\text{O}_2$ = Percent oxygen by volume, dry basis
 $\%\text{CO}$ = Percent carbon monoxide by volume, dry basis
 $\%\text{N}_2$ = Percent nitrogen by volume, dry basis
 0.264 = Ratio of O_2 to N_2 in air, v/v
 0.28 = Molecular weight of N_2 or CO , divided by 100
 0.32 = Molecular weight of O_2 divided by 100
 0.44 = Molecular weight of CO_2 divided by 100
 13.6 = Specific gravity of mercury (Hg)

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, $0.048137 \text{ (in. Hg)(ft}^3\text{)/(g-mole)(}^\circ\text{R)} =$
 $[21.8348 \text{ (in. Hg)(ft}^3\text{)/(lb-mole)(}^\circ\text{R)}] / 453.592 \text{ g-mole/lb-mole}$

T_m = Absolute average dry gas meter temperature, $^\circ\text{R}$

T_{std} = Standard absolute temperature, 528 $^\circ\text{R}$

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

CALCULATION FORMULAS ISOKINETIC SAMPLING

$$1. V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m} \right) \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}} \right) = K_1 V_m Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$2. V_{w(std)} = V_{lc} \left(\frac{\rho_w}{M_w} \right) \left(\frac{RT_{std}}{P_{std}} \right) = K_2 V_{lc}$$

$$3. B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

$$4a. C_a = \frac{m_a}{V_a \rho_a}$$

$$4b. W_a = C_a V_{aw} \rho_a$$

$$5. C_s = (15.43 \text{ grains/gram}) (m_n / V_{m(std)})$$

$$6. C_{acf} = 15.43 K_i \left(\frac{m_n P_s}{V_{w(std)} + V_{m(std)} T_s} \right)$$

$$7. \%EA = \left(\frac{\%O_2 - (0.5 \%CO)}{0.264 \%N_2 - (\%O_2 - 0.5 \%CO)} \right) \times 100$$

$$8. M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$$

$$9. M_s = M_d(1 - B_{ws}) + 18.0 B_{ws}$$

$$10. v_s = K_p C_p \sqrt{\frac{\Delta P T_s}{P_s M_s}}$$

$$11. Q_{acfm} = v_s A (60 \frac{sec}{min})$$

$$12. Q_{sd} = (3600 \frac{sec}{hr}) (1 - B_{ws}) v_s \left(\frac{T_{std} P_s}{T_s P_{std}} \right) A$$

$$13. E \text{ (emission rate, lbs/hr)} = Q_{sd} (C_s / 7000 \text{ grains/lb})$$

$$14. IKV = \frac{T_s V_{m(std)} P_{std}}{T_{std} v_s \theta A_n P_s 60 (1 - B_{ws})} = K_4 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$$

TEST DATA	- Ontario Hydro	Run No.: 4
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Project Number: M22E0758		Test Date: 11/9/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Inlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: PJN		Sample Plane: Vertical	
Temp ID: E-68		Port Length: 18.00	in.
Meter ID: E-68		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 0.992		Port Type: Flange	
Pitot ID: 835A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.840		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Teflon		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.247	in.	Test Length: 120	min.
Train Type: Other			

STACK CONDITIONS

Barometric Pressure (Pb): 29.33		in. Hg.
Static Pressure: -18.50		in. H₂O
Flue Pressure (Ps): 27.97		in. Hg. abs.
Sample Train Pre: 0.002		
Leak Check Post: 0.004		
	@ 15/15	in. Hg.
Carbon Dioxide: 15.0		%
Oxygen: 3.8		%
Nitrogen: 81.2		%

MOISTURE DETERMINATION

Initial Impinger Content: 0.00		mls.
Final Impinger Content: 291.70		mls.
Difference: 291.70		
Silica Initial Wt. 0.00		grams
Silica Final Wt. 0.00		grams
Difference: 0.00		
Total Water Gain: 291.70		

STACK PARAMETERS

Delta H: 1.01		Inches H₂O	
Meter Temperature, Tm: 81.9		°F	
Sqrt ΔP: 0.743		Inches H₂O	
Stack Temperature, Ts: 325.7		°F	
Meter Volume, Vm: 72.290		Cubic Feet	
Meter Volume, Vmstd: 68.673		dscf	
Meter Volume, Vwstd: 13.739		wscf	
Moisture, Bws: 0.167			
Gas Weight dry, Md: 30.552		lb/lb mole	
Gas Weight wet, Ms: 28.459		lb/lb mole	
Excess Air: 21.546		%	
Gas Velocity, Vs: 52.979			
Volumetric Flow, ACFM: 259,574			
Volumetric Flow, DSCFM: 135,887			
Volumetric Flow, SCFM: 163,073			
Isokinetic Variance, %I: 103.4			

Meter Volume, Normal	63.992
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EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F_d (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	200.590

Speciated Mercury

Particle Bound Mercury

mg (net) collected: 0.025000

ppm: 0.001540

ug/dncm: 13.80

lb/hr: 0.006544

lb/mmBtu (based on Fd): 0.00000959

Elemental Mercury

mg (net) collected: 0.00403

ppm: 0.000248

ug/dncm: 2.22

lb/hr: 0.001055

lb/mmBtu (based on Fd): 0.00000155

Oxidized Mercury

mg (net) collected: 0.00772

ppm: 0.000476

ug/dncm: 4.26

lb/hr: 0.002021

lb/mmBtu (based on Fd): 0.00000296

Total Mercury

mg (net) collected: 0.03675

ppm: 0.002264

ug/dncm: 20.28

lb/hr: 0.009619

lb/mmBtu (based on Fd): 0.00001410

TEST DATA	- Ontario Hydro	Run No.: 5
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Project Number: M22E0758		Test Date: 11/9/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Inlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: PJN		Sample Plane: Vertical	
Temp ID: E-68		Port Length: 18.00	in.
Meter ID: E-68		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 0.992		Port Type: Flange	
Pitot ID: 835A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.840		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Teflon		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.247	in.	Test Length: 120	min.
Train Type: Other			

STACK CONDITIONS

Barometric Pressure (Pb): 29.33		in. Hg.
Static Pressure: -18.50		in. H₂O
Flue Pressure (Ps): 27.97		in. Hg. abs.
Sample Train Pre: 0.004		
Leak Check Post: 0.005		
	@ 15/15	in. Hg.
Carbon Dioxide: 14.8		%
Oxygen: 3.8		%
Nitrogen: 81.4		%

MOISTURE DETERMINATION

Initial Impinger Content: 0.00		mls.
Final Impinger Content: 220.00		mls.
Difference: 220.00		
Silica Initial Wt. 0.00		grams
Silica Final Wt. 0.00		grams
Difference: 0.00		
Total Water Gain: 220.00		

STACK PARAMETERS

Delta H: 1.02		Inches H₂O	
Meter Temperature, Tm: 86.4		°F	
Sqrt ΔP: 0.759		Inches H₂O	
Stack Temperature, Ts: 330.4		°F	
Meter Volume, Vm: 74.002		Cubic Feet	
Meter Volume, Vmstd: 69.717		dscf	
Meter Volume, Vwstd: 10.362		wscf	
Moisture, Bws: 0.129			
Gas Weight dry, Md: 30.520		lb/lb mole	
Gas Weight wet, Ms: 28.900		lb/lb mole	
Excess Air: 21.482		%	
Gas Velocity, Vs: 53.921			
Volumetric Flow, ACFM: 264,190			
Volumetric Flow, DSCFM: 143,628			
Volumetric Flow, SCFM: 164,975			
Isokinetic Variance, %I: 99.3			

Meter Volume, Normal 64.964

EMISSION DATA

Type of Fuel Firing: Coal
Fuel Factor F_d (dscf/mmBtu): 9780
List Mol. Wt. of Analyte if ppm needed: 200.590

Speciated Mercury
Particle Bound Mercury
mg (net) collected: 0.021000
ppm: 0.001275
ug/dncm: 11.42
lb/hr: 0.005723
lb/mmBtu (based on Fd): 0.00000794

Elemental Mercury
mg (net) collected: 0.00486
ppm: 0.000295
ug/dncm: 2.64
lb/hr: 0.001324
lb/mmBtu (based on Fd): 0.00000184

Oxidized Mercury
mg (net) collected: 0.00840
ppm: 0.000510
ug/dncm: 4.57
lb/hr: 0.002289
lb/mmBtu (based on Fd): 0.00000318

Total Mercury
mg (net) collected: 0.03426
ppm: 0.002079
ug/dncm: 18.62
lb/hr: 0.009336
lb/mmBtu (based on Fd): 0.00001295

TEST DATA	Ontario Hydro	Run No.: 6
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Project Number: M22E0758		Test Date: 11/9/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Inlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: PJN		Sample Plane: Vertical	
Temp ID: E-68		Port Length: 18.00	in.
Meter ID: E-68		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 0.992		Port Type: Flange	
Pitot ID: 835A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.840		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Teflon		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.247	in.	Test Length: 120	min.
Train Type: Other			

STACK CONDITIONS

Barometric Pressure (Pb): 29.33		in. Hg.	
Static Pressure: -18.50		in. H₂O	
Flue Pressure (Ps): 27.97		in. Hg. abs.	
Sample Train Leak Check	Pre: 0.005		
	Post: 0.004		
	@ 15/15	in. Hg.	
Carbon Dioxide: 14.6		%	
Oxygen: 3.8		%	
Nitrogen: 81.6		%	

MOISTURE DETERMINATION

Initial Impinger Content: 0.00		mls.	
Final Impinger Content: 230.20		mls.	
Difference: 230.20			
Silica Initial Wt. 0.00		grams	
Silica Final Wt. 0.00		grams	
Difference: 0.00			
Total Water Gain: 230.20			

STACK PARAMETERS

Delta H: 1.01		Inches H₂O	
Meter Temperature, Tm: 78.9		°F	
Sqrt ΔP: 0.757		Inches H₂O	
Stack Temperature, Ts: 329.6		°F	
Meter Volume, Vm: 73.299		Cubic Feet	
Meter Volume, Vmstd: 70.011		dscf	
Meter Volume, Vwstd: 10.842		wscf	
Moisture, Bws: 0.134			
Meter Volume, Normal 65.238			
Gas Weight dry, Md: 30.488		lb/lb mole	
Gas Weight wet, Ms: 28.813		lb/lb mole	
Excess Air: 21.418		%	
Gas Velocity, Vs: 53.813			
Volumetric Flow, ACFM: 263,664			
Volumetric Flow, DSCFM: 142,711			
Volumetric Flow, SCFM: 164,812			
Isokinetic Variance, %I: 100.4			

EMISSION DATA

Type of Fuel Firing: Coal	
Fuel Factor F_d (dscf/mmBtu): 9780	
List Mol. Wt. of Analyte if ppm needed: 200.590	

	<u>Filterable</u>	<u>Condensible</u>
Speciated Mercury		
Particle Bound Mercury		
mg (net) collected:	0.022000	
ppm:	0.001330	
ug/dncm:	11.91	
lb/hr:	0.005932	
lb/mmBtu (based on Fd):	0.00000828	
Elemental Mercury		
mg (net) collected:	0.00420	
ppm:	0.000254	
ug/dncm:	2.27	
lb/hr:	0.001132	
lb/mmBtu (based on Fd):	0.00000158	
Oxidized Mercury		
mg (net) collected:	0.009441	
ppm:	0.000571	
ug/dncm:	5.11	
lb/hr:	0.002546	
lb/mmBtu (based on Fd):	0.00000355	
Total Mercury		
mg (net) collected:	0.03564	
ppm:	0.002154	
ug/dncm:	19.29	
lb/hr:	0.009610	
lb/mmBtu (based on Fd):	0.00001342	

TEST DATA	- Ontario Hydro	Run No.: 4
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Project Number: M22E0758		Test Date: 11/9/04
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Outlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: AS		Sample Plane: Vertical	
Temp ID: E-22		Port Length: 18.00	in.
Meter ID: E-22		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 1.000		Port Type: Flange	
Pitot ID: 643A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.836		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Glass		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.250	in.	Test Length: 120	min.
Train Type: Hot Box			

STACK CONDITIONS

Barometric Pressure (Pb): 29.33		in. Hg.
Static Pressure: -21.00		in. H₂O
Flue Pressure (Ps): 27.79		in. Hg. abs.
Sample Train Pre: 0.002		
Leak Check Post: 0.001		
	@	in. Hg.
Carbon Dioxide: 14.7		%
Oxygen: 4.3		%
Nitrogen: 81.0		%

MOISTURE DETERMINATION

Initial Impinger Content: 0.00		mls.
Final Impinger Content: 215.10		mls.
Difference: 215.10		
Silica Initial Wt. 0.00		grams
Silica Final Wt. 0.00		grams
Difference: 0.00		
Total Water Gain: 215.10		

STACK PARAMETERS

Delta H: 1.28		Inches H₂O	
Meter Temperature, Tm: 94.2		°F	
Sqrt ΔP: 0.753		Inches H₂O	
Stack Temperature, Ts: 314.3		°F	
Meter Volume, Vm: 78.880		Cubic Feet	
Meter Volume, Vmstd: 73.904		dscf	
Meter Volume, Vwstd: 10.131		wscf	
Moisture, Bws: 0.121			
Meter Volume, Normal 68.866			
Gas Weight dry, Md: 30.524		lb/lb mole	
Gas Weight wet, Ms: 29.014		lb/lb mole	
Excess Air: 25.170		%	
Gas Velocity, Vs: 52.739			
Volumetric Flow, ACFM: 258,401			
Volumetric Flow, DSCFM: 143,918			
Volumetric Flow, SCFM: 163,647			
Isokinetic Variance, %I: 102.6			

EMISSION DATA

Type of Fuel Firing: Coal
Fuel Factor F_d (dscf/mmBtu): 9780
List Mol. Wt. of Analyte if ppm needed: 200.590

Speciated Mercury

Particle Bound Mercury

mg (net) collected: 0.000010

ppm: 0.000001

ug/dncm: 0.01

lb/hr: 0.000003

lb/mmBtu (based on Fd): 0.00000000

Elemental Mercury

mg (net) collected: 0.0022

ppm: 0.000126

ug/dncm: 1.13

lb/hr: 0.000567

lb/mmBtu (based on Fd): 0.00000081

Oxidized Mercury

mg (net) collected: 0.00110

ppm: 0.000063

ug/dncm: 0.56

lb/hr: 0.000283

lb/mmBtu (based on Fd): 0.00000040

Total Mercury

mg (net) collected: 0.00331

ppm: 0.000190

ug/dncm: 1.70

lb/hr: 0.000853

lb/mmBtu (based on Fd): 0.00000122

TEST DATA	- Ontario Hydro	Run No.: 5
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Project Number: M22E0758	Test Date: 11/9/2004
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TEST PARAMETERS

Company:	Ameren	Duct Shape:	Rectangular
Plant:	Meramec	Length:	8.17 Feet
Test Location:	Unit 2 ESP Outlet	Width:	10.00 Feet
Source Condition:	Normal	Duct Area:	81.660 Sq. Ft.
Test Engineer:	AS	Sample Plane:	Vertical
Temp ID:	E-22	Port Length:	18.00 in.
Meter ID:	E-22	Port Size (diameter):	4.00 in.
Meter Calibration Factor:	1.000	Port Type:	Flange
Pitot ID:	643A	Number of Ports Sampled:	2
Pitot Tube Coefficient:	0.836	Number of Points per Port:	12
Probe Length:	10.0 ft.	Minutes per Point:	5.0
Probe Liner Material:	Glass	Total Number of Traverse Points:	24
Nozzle Diameter:	0.250 in.	Test Length:	120 min.
Train Type:	Hot Box		

STACK CONDITIONS

Barometric Pressure (Pb):	29.33	in. Hg.	
Static Pressure:	-21.00	in. H₂O	
Flue Pressure (Ps):	27.79	in. Hg. abs.	
Sample Train	Pre: 0.003		
Leak Check	Post: 0.001		
	@ 10/6	in. Hg.	
Carbon Dioxide:	14.2	%	
Oxygen:	4.8	%	
Nitrogen:	81.0	%	

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.	
Final Impinger Content:	249.30	mls.	
Difference:	249.30		
Silica Initial Wt.	0.00	grams	
Silica Final Wt.	0.00	grams	
Difference:	0.00		
Total Water Gain:	249.30		

STACK PARAMETERS

Delta H:	1.31	Inches H₂O	
Meter Temperature, Tm:	99.9	°F	
Sqrt ΔP:	0.765	Inches H₂O	
Stack Temperature, Ts:	316.3	°F	
Meter Volume, Vm:	79.641	Cubic Feet	
Meter Volume, Vmstd:	73.860	dscf	
Meter Volume, Vwstd:	11.742	wscf	
Moisture, Bws:	0.137		
Gas Weight dry, Md:	30.464	lb/lb mole	
Gas Weight wet, Ms:	28.754	lb/lb mole	
Excess Air:	28.944	%	
Gas Velocity, Vs:	53.921		
Volumetric Flow, ACFM:	264,193		
Volumetric Flow, DSCFM:	143,977		
Volumetric Flow, SCFM:	166,866		
Isokinetic Variance, %I:	102.5		

Meter Volume, Normal 68.825

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F_d (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	200.590

Speciated Mercury
Particle Bound Mercury
mg (net) collected: 0.000010
ppm: 0.000001
ug/dncm: 0.01
lb/hr: 0.000003
lb/mmBtu (based on Fd): 0.00000000

Elemental Mercury
mg (net) collected: 0.0051
ppm: 0.000293
ug/dncm: 2.63
lb/hr: 0.001320
lb/mmBtu (based on Fd): 0.00000194

Oxidized Mercury
mg (net) collected: 0.00160
ppm: 0.000092
ug/dncm: 0.82
lb/hr: 0.000413
lb/mmBtu (based on Fd): 0.00000061

Total Mercury
mg (net) collected: 0.00673
ppm: 0.000386
ug/dncm: 3.45
lb/hr: 0.001735
lb/mmBtu (based on Fd): 0.00000255

TEST DATA	- Ontario Hydro	Run No.: 6
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Project Number: M22E0758		Test Date: 11/9/2004
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TEST PARAMETERS

Company: Ameren		Duct Shape: Rectangular	
Plant: Meramec		Length: 8.17	Feet
Test Location: Unit 2 ESP Outlet		Width: 10.00	Feet
Source Condition: Normal		Duct Area: 81.660	Sq. Ft.
Test Engineer: AS		Sample Plane: Vertical	
Temp ID: E-22		Port Length: 18.00	in.
Meter ID: E-22		Port Size (diameter): 4.00	in.
Meter Calibration Factor: 1.000		Port Type: Flange	
Pitot ID: 643A		Number of Ports Sampled: 2	
Pitot Tube Coefficient: 0.836		Number of Points per Port: 12	
Probe Length: 10.0	ft.	Minutes per Point: 5.0	
Probe Liner Material: Glass		Total Number of Traverse Points: 24	
Nozzle Diameter: 0.250	in.	Test Length: 120	min.
Train Type: Hot Box			

STACK CONDITIONS

Barometric Pressure (Pb): 29.33		in. Hg.
Static Pressure: -21.00		in. H₂O
Flue Pressure (Ps): 27.79		in. Hg. abs.
Sample Train Pre: 0.001		
Leak Check Post: 0.001		
	@ 9/6	in. Hg.
Carbon Dioxide: 14.0		%
Oxygen: 4.8		%
Nitrogen: 81.2		%

MOISTURE DETERMINATION

Initial Impinger Content:	0.00	mls.
Final Impinger Content:	228.80	mls.
Difference:	228.80	
Silica Initial Wt.	0.00	grams
Silica Final Wt.	0.00	grams
Difference:	0.00	
Total Water Gain:	228.80	

STACK PARAMETERS

Delta H: 1.33		Inches H₂O	
Meter Temperature, Tm: 94.5		°F	
Sqrt ΔP: 0.772		Inches H₂O	
Stack Temperature, Ts: 316.3		°F	
Meter Volume, Vm: 80.285		Cubic Feet	
Meter Volume, Vmstd: 75.193		dscf	
Meter Volume, Vwstd: 10.776		wscf	
Moisture, Bws: 0.125			
Meter Volume, Normal	70.067		
Gas Weight dry, Md:	30.432		lb/lb mole
Gas Weight wet, Ms:	28.874		lb/lb mole
Excess Air:	28.852		%
Gas Velocity, Vs:	54.250		
Volumetric Flow, ACFM:	265,805		
Volumetric Flow, DSCFM:	146,847		
Volumetric Flow, SCFM:	167,893		
Isokinetic Variance, %I:	102.3		

EMISSION DATA

Type of Fuel Firing:	Coal
Fuel Factor F_d (dscf/mmBtu):	9780
List Mol. Wt. of Analyte if ppm needed:	200.590
Speciated Mercury	
Particle Bound Mercury	
mg (net) collected:	0.000010
ppm:	0.000001
ug/dncm:	0.01
lb/hr:	0.000003
lb/mmBtu (based on Fd):	0.00000000
Elemental Mercury	
mg (net) collected:	0.0022
ppm:	0.000124
ug/dncm:	1.11
lb/hr:	0.000568
lb/mmBtu (based on Fd):	0.00000082
Oxidized Mercury	
mg (net) collected:	0.00120
ppm:	0.000068
ug/dncm:	0.60
lb/hr:	0.000310
lb/mmBtu (based on Fd):	0.00000045
Total Mercury	
mg (net) collected:	0.00341
ppm:	0.000192
ug/dncm:	1.72
lb/hr:	0.000881
lb/mmBtu (based on Fd):	0.00000127

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.

NOZZLES

The nozzles are measured according to Method 5, Section 5.1.

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

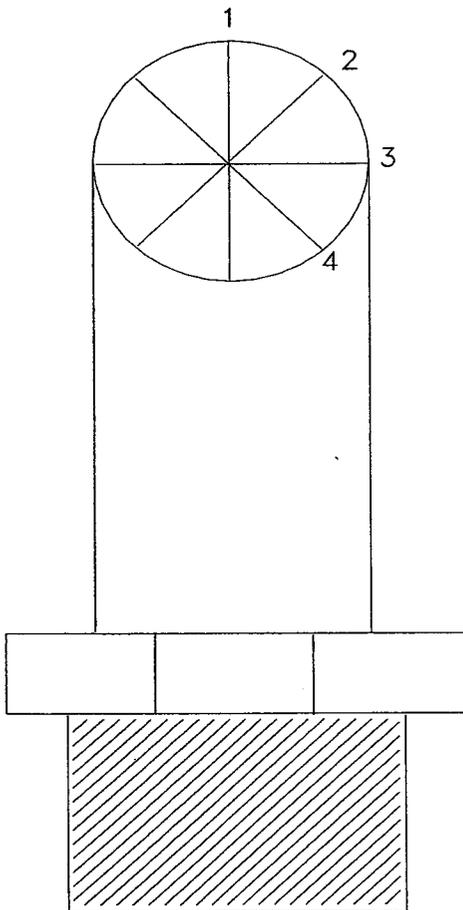
The accuracy of the analytical balance is checked with Class S, Stainless Steel Type 303 weights manufactured by F. Hopken and Son, Jersey City, New Jersey.

Nozzle Calibration

Date: 10/20/2004

Nozzle ID No.: N/A

Analyst: JPH



0.247 1

0.246 2

0.246 3

0.248 4

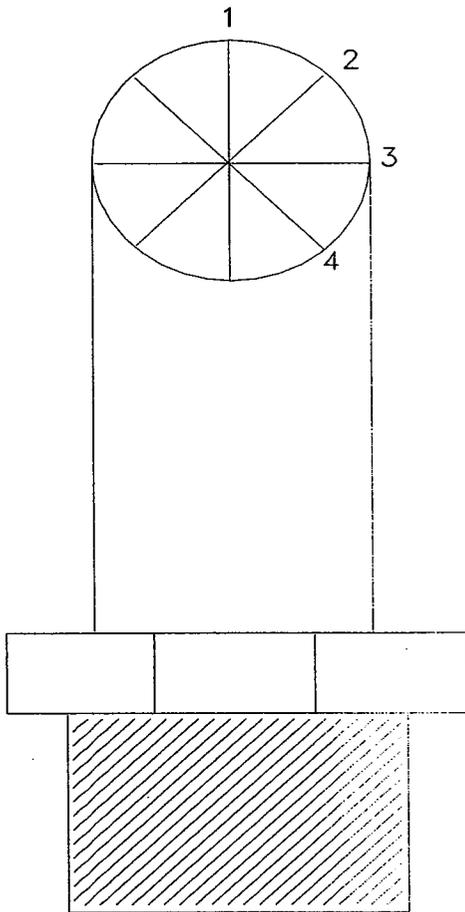
Average
<u>0.247</u>

Nozzle Calibration

Date: 10/20/2004

Nozzle ID No.: N/A

Analyst: JPH



0.250 1

0.250 2

0.249 3

0.250 4

Average
<u>0.250</u>

METER BOX CALIBRATION

Dry Gas Meter No. E22
 Standard Meter No. 2547159
 Standard Meter (Yr) 1.0008

Date: 10-18-04
 Calibrated By: PSH
 Barometric Pressure: 29.26

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@)
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Final		75.932	55.062	64	71	67					
Initial		70.927	50.000	64	71	66					
Difference	1	5.005	5.062	64	71	67	69	19	17	0.997	1.669
Final		81.668	60.869	64	73	68					
Initial		75.999	55.132	64	71	67					
Difference	2	5.669	5.737	64	72	68	70	13	58	0.998	1.703
Final		65.743	44.834	63	70	65					
Initial		60.547	39.617	63	68	63	67	11	1	1.001	1.770
Difference	3	5.196	5.217	63	69	64					
Final		86.806	66.072	64	75	69					
Initial		81.732	60.931	64	73	68					
Difference	4	5.074	5.141	64	74	69	71	9	35	0.998	1.797
Final		99.228	79.650	64	78	71					
Initial		94.227	74.584	64	75	69					
Difference	5	5.001	5.066	64	77	70	73	8	22	1.002	1.872
Final		70.865	49.947	64	72	66					
Initial		65.856	44.946	64	70	65	68	6	29	1.005	1.886
Difference	6	5.009	5.001	64	71	66					

Average 1.000 1.783

VOLUME METERING SYSTEM FIELD AUDIT

Date: 10-18-04

Name: PSH

EPA Control Module No.: E22

Ambient Temperature: 63 °F

Calibration (Y): 1.000

Barometric Pressure: 29.26 "Hg

Delta H: 1.783

Run No.	Time	Gas Meter Reading/Gas Meter Temperature			Yc (Calculated)
	(Minutes)	(Cubic Feet)	Inlet (°F)	Outlet (°F)	
1	0	78.833	77	71	1.010
	10	86.392	79	72	
	Vm=	7.559	Avg.= 75	534.75	
2	0	86.392	79	72	1.011
	10	93.952	81	73	
	Vm=	7.560	Avg.= 76	536.25	
3	0	93.952	81	73	1.010
	10	101.517	73	74	
	Vm=	7.565	Avg.= 75	535.25	

$$Y_c = \frac{10}{V_m} \sqrt{\frac{0.319 T_m}{P_{bar}}}$$

Limit: 0.97Y <Yc< 1.03Y

Limit: 0.970 <Yc< 1.030

METER BOX CALIBRATION

Dry Gas Meter No. E68 Date: 10-25-04
 Standard Meter No. 2547159 Calibrated By: PSH
 Standard Meter (Yr) 1.0008 Barometric Pressure: 29.36

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.	Chg (H@)
1	0.20	103.379	25.858	65	76	74				
Final		103.379	25.858	65	76	74				
Initial		98.378	20.720	65	76	73				
Difference		5.001	5.138	65	76	74	75	18	9	0.991
1.465		108.442	31.084	65	80	75				
Final		103.441	25.928	65	77	74				
Initial		5.001	5.156	65	79	75	77	11	47	0.990
Difference	0.50	93.188	15.422	65	75	72				
Final		88.187	10.322	65	72	70				
Initial		5.001	5.100	65	74	71	72	10	5	0.992
Difference	0.70	113.583	36.374	66	83	76				
Final		108.582	31.226	65	80	75				
Initial		5.001	5.148	66	82	76	79	8	57	0.993
Difference	0.90	118.760	41.642	66	86	77				
Final		113.687	36.391	66	83	76				
Initial		5.073	5.251	66	85	77	81	7	53	0.990
Difference	1.20	98.330	20.670	65	77	73				
Final		93.329	15.569	65	75	72				
Initial		5.001	5.101	65	76	73	74	6	6	0.993
Difference	2.00									

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.	Chg (H@)
1	0.20	103.379	25.858	65	76	74				
Final		103.379	25.858	65	76	74				
Initial		98.378	20.720	65	76	73				
Difference		5.001	5.138	65	76	74	75	18	9	0.991
1.465		108.442	31.084	65	80	75				
Final		103.441	25.928	65	77	74				
Initial		5.001	5.156	65	79	75	77	11	47	0.990
Difference	0.50	93.188	15.422	65	75	72				
Final		88.187	10.322	65	72	70				
Initial		5.001	5.100	65	74	71	72	10	5	0.992
Difference	0.70	113.583	36.374	66	83	76				
Final		108.582	31.226	65	80	75				
Initial		5.001	5.148	66	82	76	79	8	57	0.993
Difference	0.90	118.760	41.642	66	86	77				
Final		113.687	36.391	66	83	76				
Initial		5.073	5.251	66	85	77	81	7	53	0.990
Difference	1.20	98.330	20.670	65	77	73				
Final		93.329	15.569	65	75	72				
Initial		5.001	5.101	65	76	73	74	6	6	0.993
Difference	2.00									

Average 0.992 1.574

VOLUME METERING SYSTEM FIELD AUDIT

Date: 10-25-04

Name: PSH

EPA Control Module No.: E68

Ambient Temperature: 65 °F

Calibration (Y): 0.992

Barometric Pressure: 29.36 "Hg

Delta H: 1.574

Run No.	Time	Gas Meter Reading/Gas Meter Temperature			Yc (Calculated)
	(Minutes)	(Cubic Feet)	Inlet (°F)	Outlet (°F)	
1	0	41.804	75	69	1.014
	10	49.304	77	70	
	Vm=	7.500	Avg.= 73	532.75	
2	0	49.304	77	70	1.017
	10	56.799	79	71	
	Vm=	7.495	Avg.= 74	534.25	
3	0	56.799	79	71	1.019
	10	64.287	81	72	
	Vm=	7.488	Avg.= 76	535.75	

$$Y_c = \frac{10}{V_m} \sqrt{\frac{0.319 T_m}{P_{bar}}}$$

Limit: 0.97Y <Yc< 1.03Y

Limit: 0.962 <Yc< 1.021

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? * yes no

Pitot tube openings damaged? yes (explain below) * no

$\alpha_1 = \underline{0}^\circ (<10^\circ)$, $\alpha_2 = \underline{0}^\circ (<10^\circ)$

$z = A \sin \gamma = \underline{0.000}$ (in.); (<0.125 in.)

$\beta_1 = \underline{0}^\circ (<5^\circ)$, $\beta_2 = \underline{0}^\circ (<5^\circ)$

$w = A \sin \theta = \underline{0.000}$ (in.); (<0.03125 in.)

$\gamma = \underline{0}^\circ$, $\theta = \underline{0}^\circ$, $A = \underline{0.750}$ (in.)

$P_A = \underline{0.376}$ (in.), $P_B = \underline{0.374}$ (in.), $D_t = \underline{0.250}$ (in.)

Comments:

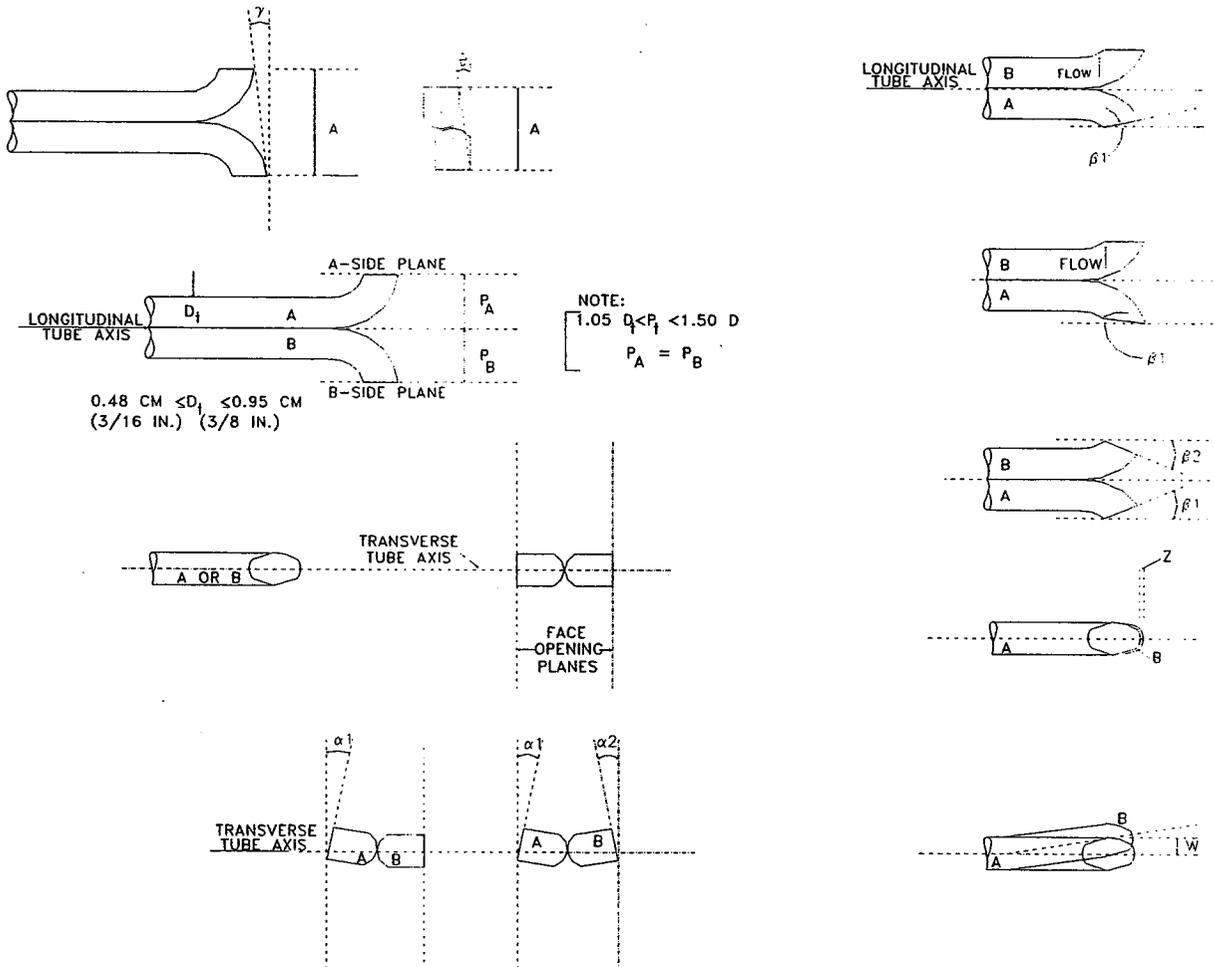
Assign baseline coefficient, 0.840

Calibration required? yes * no

Pitot Tube No.: 835

Date: 10/5/2004

Name: L. Campo



TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? yes no

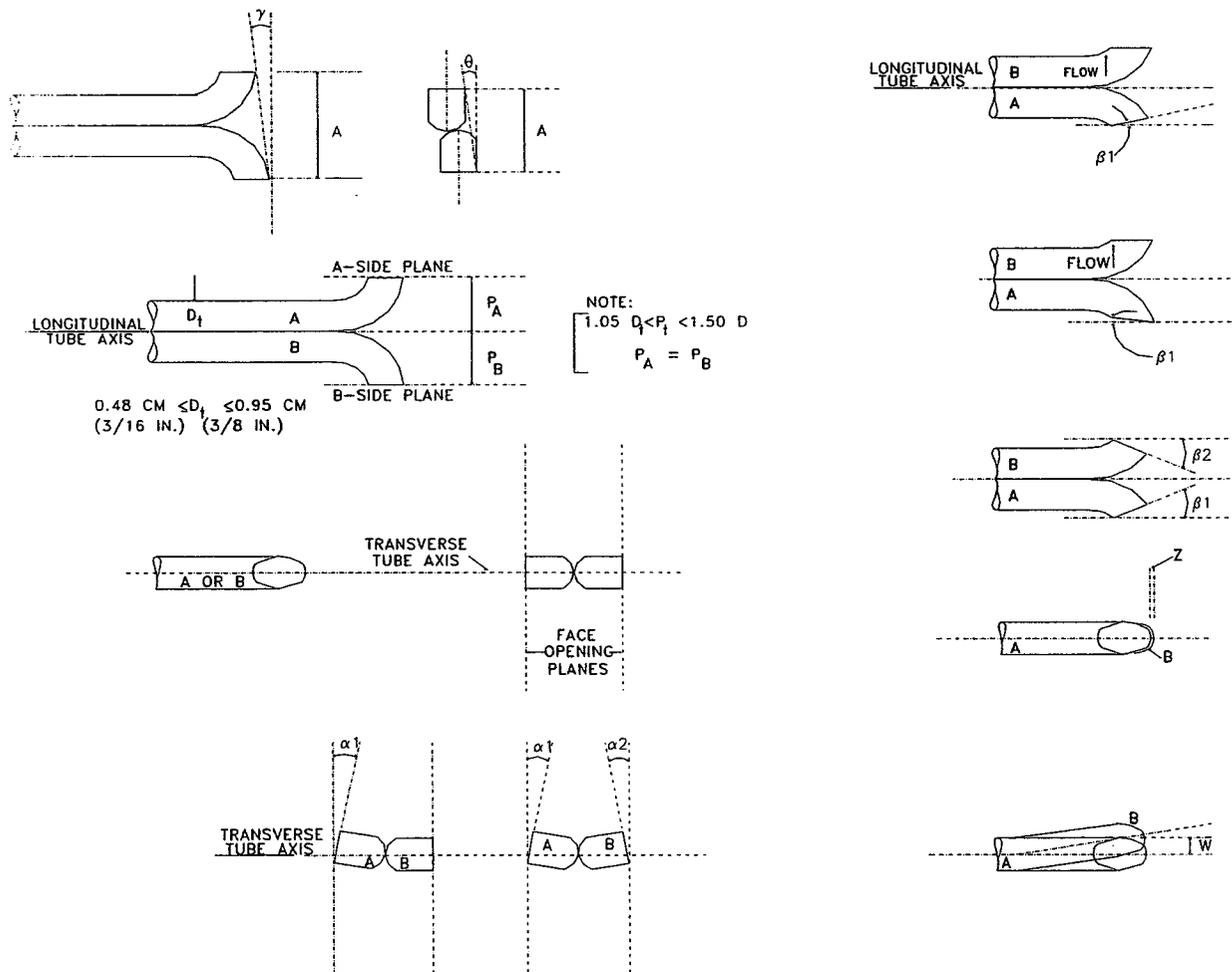
Pitot tube openings damaged? yes (explain below) no

$\alpha_1 = 4^\circ (<10^\circ)$, $\alpha_2 = 5^\circ (<10^\circ)$ $z = A \sin \gamma = 0.025$ (in.); (<0.125 in.)
 $\beta_1 = 2^\circ (<5^\circ)$, $\beta_2 = 1^\circ (<5^\circ)$ $w = A \sin \theta = 0.013$ (in.); (<0.03125 in.)
 $\gamma = 2^\circ$, $\theta = 1^\circ$, $A = 0.730$ (in.) $P_A = #####$ (in.), $P_B = 0.340$ (in.), $D_t = 0.250$ (in.)

Comments: _____

Calibration required? yes no

Pitot Tube No.: P643 Date: 10/5/2004 Name: TAM



PITOT TUBE CALIBRATION DATA

Type "S" Pitot Tube ID Number: 643 Size (OD): 1/4" Leak Check: Pass

Calibration Pitot Tube

Type: Hemispherical (std) Size (OD): 1/4" Cp(std) = 1.00 ID #: Dwyer 160-8

Calibration Date: 11/30/00 Performed By: Rich Russ

P_{std} , (in.) H ₂ O		A-Side Calibration		
Set Value	Read Value	P_s , (in.) H ₂ O	$C_{p(S)}$ ^a	DEV. ^b
0.25	0.25	0.36	0.833	0.002
0.55	0.55	0.79	0.834	0.001
0.85	0.85	1.22	0.835	0.001
1.00	1.00	1.43	0.836	0.001
2.00	2.00	2.86	0.836	0.001
3.00	3.00	4.27	0.838	0.003
Average			0.836	0.001

P_{std} , (in.) H ₂ O		B-Side Calibration		
Set Value	Read Value	P_s , (in.) H ₂ O	$C_{p(S)}$ ^a	DEV. ^b
0.25	0.25	0.36	0.833	0.002
0.55	0.55	0.79	0.834	0.001
0.85	0.85	1.22	0.835	0.001
1.00	1.00	1.43	0.836	0.001
2.00	2.00	2.86	0.836	0.001
3.00	3.00	4.27	0.838	0.003
Average			0.836	0.001

$$\overline{C_p}(A) - \overline{C_p}(B) = 0.000$$

(must be ≤ 0.01)

$${}^a C_{p(S)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_s}}$$

$${}^b DEV = C_{p(S)} - \overline{C_p}$$

(must be ≤ 0.01)

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: Ort. Hydro.

Test Run No. #14-1367

Run Date: 11/9/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Ameren - Noremco

Plant: St. Louis, MO

Test Location: #2 ESP Inlet Duct

Source Condition: Normal

Test Engineer: P. N. Smith

Temp ID: E68

Meter ID: E68

Meter Calibration Factor: .992

Pitot ID: 835A

Pitot Tube Coefficient: 10

Probe Length (ft.): 16.8

Probe Liner Material: Teklon

Nozzle Diameter (in.): .247

Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round

Length (ft.): 10' Diameter (ft.): _____

Width (ft.): 8 1/2"

Duct Area (Sq. Ft.): _____

Disturbance (in diameters) Upstream _____ Downstream _____

Sample Plane (select): Horizontal or Vertical

Port Length (in.): 18

Port Size (diameter in.): 4"

Port Type: Flange

Number of Ports Sampled: 2

Number of Points per Port: 12

Minutes per Point: 24

Total Number of Traverse Points: 5

Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33"

Static Pressure (in. H₂O): -18.5"

Flue Pressure (in. Hg Abs): _____

Sample Train Leak Check: Pre: 0.002 Post: 0.004 @ 15/15 in. Hg

Pitot Leak Check: Pre √3" Post √34

Carbon Dioxide (%): 15.0

Oxygen (%): 3.8

Gas Values by (select one): Method 3 Orsat Fyrite Method 3A (analyzer)

Fuel Type Firing (Select): 9860 - Bituminous Coal 9860 - Lignite Coal

10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other - _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____

Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____

Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____

Total Water Gain (mL/g): _____

Description of Impinger H₂O: _____

Silica Gel Exhausted?: _____

Impingers Recovered by: _____

Silica Gel Weighed by: _____

Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 262 / 282

Filter No. _____

Fuel Samples collected for analysis? Yes No

Tare Wt (g) 2,9165 / 2,7813

Tare Wt (g) _____

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN - MERAMEC
 Plant: St. Louis, MO

List Test Method Used: Ont Hydro
 Test Run No. 44-1161
 Date: 11/10/04

Test Location: #2 ESP Inlet Duct Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Heated Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg	
													Inlet °F	Outlet °F		
1-1	1045	.56	.99	58.744	.746	.606	3.031	—	323	257	255	568F	75	71	4	
2	1050	.52	.92	61.72	.721	.584	2.920	61.775	321	258	259	Feed	82	74	5	
3	1055	.52	.92	64.70	.721	.584	2.920	64.695	321	255	259	Feed	83	75	5	
4	1100	.53	.93	67.25	.728	.590	2.948	67.615	323	257	255		83	75	5	
5	1105	.50	.88	70.22	.707	.573	2.864	70.563	324	255	256		83	75	6	
6	1110	.50	.88	73.00	.707	.573	2.864	73.426	323	251	255		85	76	6	
7	1115	.53	.93	76.02	.728	.589	2.948	76.290	322	254	255		86	77	6	
8	1120	.53	.93	79.24	.728	.589	2.948	79.238	322	255	251		86	77	8	
9	1125	.53	.93	82.21	.728	.589	2.948	82.186	322	251	255		86	77	10	
10	1130	.56	.99	85.15	.748	.606	3.031	85.134	322	255	256		87	78	10	
11	1135	.50	.88	88.07	.707	.573	2.864	88.165	322	255	254		87	78	10	
12	1140	.50	.88	91.04	.707	.573	2.864	91.029	322	255	251		87	78	12	
	1145			93.901				93.893								
2-1	1155	.63	1.10	94.572	.794	.643	3.215	—	325	257	253		83	78	4	
2	1200	.62	1.09	97.75	.787	.638	3.189	97.787	330	252	253		85	78	4	
3	1205	.57	1.00	100.95	.755	.612	3.058	100.976	330	260	257		86	78	5	
4	1210	.54	.95	104.11	.735	.595	2.976	104.034	331	261	260		87	78	6	
5	1215	.54	.95	107.04	.735	.595	2.976	107.010	331	258	255		88	79	7	
6	1220	.57	1.00	109.97	.755	.612	3.058	109.986	330	258	255		90	80	7	
7	1225	.57	1.00	113.05	.755	.612	3.058	113.044	330	257	255		90	80	7	
8	1230	.55	.97	116.11	.742	.601	3.004	116.108	329	255	255		90	80	8	
9	1235	.62	1.09	119.07	.787	.640	3.189	119.106	328	254	255		90	80	8	
10	1240	.58	1.02	122.31	.762	.617	3.084	122.295	328	251	255		89	80	8	
11	1245	.59	1.04	125.40	.768	.622	3.111	125.380	328	250	255		89	80	9	
12	1250	.59	1.04	128.52	.768	.622	3.111	128.490	327	252	255		88	81	9	
	1255			131.707				131.602								

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: outlet Test Run No. 15-121 Run Date: 11/2/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Anderson-Meridian
 Plant: St. Louis MO
 Test Location: #2 Outlet Pit
 Source Condition: Noise
 Test Engineer: P. N. ...
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Gain Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): _____ Diameter (ft): _____
 Width (ft): _____
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33
 Static Pressure (in. H₂O): -18.5"
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: √ 0.004 Post: √ 0.005 @ 15/15 in. Hg
 Pitot Leak Check: Pre √ 3" Post √ 3
 Carbon Dioxide (%): 14.8
 Oxygen (%): 3.8

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

COMMENTS & NOTES:

10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
SAMPLE COLLECTION:
 Thimble No. 284/285 Tare Wt (g) 2.8869/28690
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: American - Mechanical
 Plant: St. Louis NU
 Test Location: #2 Bldg in West Duct

List Test Method Used: OM - Hydro.
 Test Run No. # 5 - Inlet
 Date: 11/04/04

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet °F	Outlet °F	
1-1	13 15	.69	1.21	33.425	.831	.673	3.364	—	332	257	251	±68°F	87	82	5
2	13 20	.68	1.20	36.72	.824	.668	3.339	36.789	333	256	258	Fr. 007	88	82	5
3	13 25	.58	1.02	40.15	.762	.617	3.084	40.129	334	257	258	Fr. 007	88	82	5
4	13 30	.57	1.00	43.22	.755	.612	3.058	43.213	335	254	255	—	88	82	6
5	13 35	.55	.97	46.30	.742	.601	3.004	46.271	334	257	255	—	89	83	7
6	13 40	.60	1.11	49.33	.794	.643	3.215	49.275	334	257	255	—	89	83	7
7	13 45	.63	1.11	52.37	.794	.643	3.215	52.490	334	258	257	—	90	84	7
8	13 50	.60	1.06	55.70	.77	.627	3.137	55.705	333	257	257	—	90	84	8
9	13 55	.60	1.06	58.87	.77	.627	3.137	58.842	333	255	257	—	91	85	10
10	14 00	.60	1.06	62.05	.77	.627	3.137	61.979	333	255	258	—	91	85	11
11	14 05	.58	1.02	65.12	.76	.617	3.084	65.116	333	257	258	—	91	84	11
12	14 10	.58	1.02	68.04	.76	.617	3.084	68.200	334	257	256	—	90	83	11
	14 15			71.433				71.284				—			
2-1	14 22	.57	1.00	71.804	.75	.62	3.058	—	329	251	255	—	89	83	6
2	14 27	.56	.99	74.85	.75	.61	3.031	74.862	329	251	255	—	89	83	6
3	14 32	.52	.91	77.90	.72	.58	2.920	77.893	329	251	257	—	89	83	6
4	14 37	.48	.85	81.02	.69	.56	2.806	80.813	329	253	255	—	89	84	6
5	14 42	.50	.88	83.65	.70	.57	2.864	83.620	330	255	257	—	89	84	6
6	14 47	.57	1.00	86.49	.75	.61	3.058	86.484	327	255	257	—	90	84	6
7	14 52	.55	.97	89.55	.74	.60	3.004	89.542	327	251	254	—	91	84	7
8	14 57	.55	.97	92.53	.74	.60	3.004	92.545	326	254	255	—	90	83	7
9	15 02	.56	.99	95.72	.75	.61	3.031	95.55	327	251	255	—	90	84	8
10	15 07	.57	1.00	98.75	.75	.61	3.058	98.58	325	255	255	—	89	83	9
11	15 12	.57	1.00	101.0	.75	.61	3.058	101.64	325	255	256	—	89	83	11
12	15 17	.57	1.00	104.72	.75	.61	3.058	104.698	325	257	255	—	90	84	11
	15 22			107.798				107.756				—			

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ISOKINETIC TEST DATA

List Method Used: _____ Test Run No. _____ Run Date: _____

TEST PARAMETERS:

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: Aspen - Merrow
 Plant: St. Louis, Mo
 Test Location: #2 Exp Safety Duct
 Source Condition: Normal
 Test Engineer: P. N. N...
 Temp ID: _____
 Meter ID: _____
 Meter Calibration Factor: _____
 Pitot ID: _____
 Pitot Tube Coefficient: _____
 Probe Length (ft.): _____
 Probe Liner Material: _____
 Nozzle Diameter (in.): _____
 Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): 10' Diameter (ft): _____
 Width (ft): 8'2"
 Duct Area (Sq. Ft.): _____
 Disturbance (in diameters) Upstream _____ Downstream _____
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): _____
 Port Size (diameter in.): _____
 Port Type: _____
 Number of Ports Sampled: _____
 Number of Points per Port: _____
 Minutes per Point: _____
 Total Number of Traverse Points: _____
 Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33
 Static Pressure (in. H₂O): -18.5
 Flue Pressure (in. Hg Abs): _____
 Sample Train Leak Check: Pre: 0.004 Post: 0.004 @ 15/15 in. Hg
 Pitot Leak Check: Pre 3 Post 3
 Carbon Dioxide (%): 14.6
 Oxygen (%): 3.8

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. 276/281 Tare Wt (g) 2.7947/2.9960
 Filter No. _____ Tare Wt (g) _____
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

Gas Values by (select one): Method 3 Orsat Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: Ameren-Meramec
 Plant: St. Louis M6

List Test Method Used: ASTM Hydro.
 Test Run No.: #6 inlet
 Date: 11/9/04

Test Location: #2 Inlet Dist

Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet °F	Outlet °F	
1-1	1540	.53	.93	8.457	.73	.590	2.948	—	335	260	261	568°F	82	82	4
2	1545	.54	.95	11.42	.73	.595	2.976	11.405	335	260	255	Fr. 022	85	82	4
3	1550	.55	.97	14.37	.74	.60	3.00	14.381	334	260	257	Fr. 022	85	81	5
4	1555	.56	.99	17.40	.75	.61	3.031	17.381	334	260	257	Fr. 022	86	81	5
5	1600	.55	.97	20.43	.74	.60	3.00	20.412	334	261	260	Fr. 022	86	81	7
6	1605	.52	.92	23.41	.72	.58	2.92	23.412	334	260	260	Fr. 022	86	82	7
7	1610	.57	1.00	26.27	.75	.61	3.05	26.332	334	260	260	Fr. 022	86	82	7
8	1615	.57	1.00	29.42	.75	.61	3.05	29.387	333	261	260	Fr. 022	86	82	7
9	1620	.59	1.04	32.51	.77	.62	3.111	32.439	332	261	261	Fr. 022	85	80	8
10	1625	.61	1.07	35.70	.78	.63	3.163	35.580	332	260	261	Fr. 022	83	78	8
11	1630	.60	1.06	38.72	.77	.63	3.137	38.712	332	261	261	Fr. 022	83	78	8
12	1635	.59	1.04	41.82	.77	.62	3.111	41.850	332	259	257	Fr. 022	81	77	8
12	1640			44.982				44.961							
2-1	1646	.62	1.09	45.901	.787	.64	3.189	—	325	254	254	Fr. 022	78	74	5
2	1651	.65	1.14	48.12	.81	.65	3.265	48.150	326	256	254	Fr. 022	78	74	5
3	1656	.65	1.14	51.43	.81	.65	3.265	51.415	327	256	257	Fr. 022	79	73	6
4	1701	.62	1.09	54.71	.78	.63	3.189	54.680	327	255	258	Fr. 022	79	73	7
5	1706	.61	1.07	57.89	.78	.63	3.163	57.869	324	256	255	Fr. 022	79	73	8
6	1711	.53	.93	61.11	.73	.59	2.948	61.032	328	257	255	Fr. 022	79	73	9
7	1716	.51	.90	63.92	.71	.58	2.892	63.980	327	255	258	Fr. 022	79	73	9
8	1721	.54	.95	66.87	.73	.59	2.976	66.872	328	255	251	Fr. 022	78	72	9
9	1726	.56	.99	69.75	.748	.61	3.030	69.848	325	256	254	Fr. 022	77	72	9
10	1731	.56	.99	72.84	.748	.61	3.030	72.878	325	256	258	Fr. 022	77	72	9
11	1736	.54	1.00	75.80	.755	.61	3.058	75.908	324	255	257	Fr. 022	77	72	9
12	1741	.57	1.00	78.92	.755	.61	3.058	78.966	324	255	255	Fr. 022	76	71	9
12	1746			82.175				82.027							

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ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: QNT, HYDRO Test Run No. 4 Run Date: 11/9/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
Plant: MERAMAC
Test Location: UNIT 2 ESP-OUTLET DUCT
Source Condition: NORMAL
Test Engineer: AS
Temp ID: E-22
Meter ID: E-22
Meter Calibration Factor: 1.000
Pitot ID: 643A
Pitot Tube Coefficient: .836
Probe Length (ft.): 10
Probe Liner Material: GLASS
Nozzle Diameter (in.): .250
Train Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
Length (ft): 12.00 Diameter (ft): _____
Width (ft): 8.67
Duct Area (Sq. Ft.): 81.67
Disturbance (in diameters) Upstream Downstream
Sample Plane (select): Horizontal or Vertical
Port Length (in.): 18
Port Size (diameter in.): 4
Port Type: FLANGE
Number of Ports Sampled: 2
Number of Points per Port: 12
Minutes per Point: 54
Total Number of Traverse Points: 120
Test Length (min): _____

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33
Static Pressure (in. H₂O): 21
Flue Pressure (in. Hg Abs): 27.786
Sample Train Leak Check: Pre: 002 Post: 001 @ 10 1/6" in. Hg
Pitot Leak Check: Pre Post
Carbon Dioxide (%): 17.7
Oxygen (%): 4.3

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
Total Water Gain (mL/g): _____
Description of Impinger H₂O: _____
Silica Gel Exhausted?: _____
Impingers Recovered by: _____
Silica Gel Weighed by: _____
Sample Removed from Site by: _____

Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)

Fuel Type Firing (Select): 9780-Bituminous Coal 9860 - Lignite Coal
10100 - Anthracite Coal 9190 -Fuel Oil 8710 -Natural Gas Other: _____

COMMENTS & NOTES:

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
Filter No. 1097 Tare Wt (g) 20740
Fuel Samples collected for analysis? Yes No

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMEREN-ADA
 Plant: MEDANMAC
 Test Location: UNIT 2 ESP - OUTLET DUCT

List Test Method Used: OMT, NYDRD
 Test Run No. 4
 Date: 11/9/04 Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Velocity Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m) °F		Pump Vacuum in. Hg	
													Inlet	Outlet		
1-1	1045	.60	1.34	406.642	.775	.674	3.369	—	310	304	314	≤68°	92	87	4	
2	1050	.62	1.38	410.015	.782	.683	3.413	410.012	315	306	313	54/11	93	88	5	
3	1055	.62	1.38	413.420	.787	.683	3.413	413.425	315	308	312	100d	95	89	5	
4	1100	.56	1.25	416.840	.748	.649	3.244	416.838	315	309	310		96	89	5	
5	1105	.56	1.25	420.090	.748	.649	3.244	420.082	315	310	310		97	90	5	
6	1110	.62	1.38	423.325	.787	.687	3.413	423.322	315	309	309		97	90	5	
7	1115	.66	1.47	426.740	.812	.704	3.522	426.739	315	309	308		98	91	5	
8	1120	.64	1.43	430.260	.800	.694	3.468	430.261	314	308	308		99	91	5	
9	1125	.63	1.41	433.730	.794	.688	3.441	433.729	314	308	307		99	91	5	
10	1130	.59	1.32	437.170	.768	.666	3.330	437.170	314	307	306		100	92	5	
11	1135	.56	1.25	440.500	.748	.649	3.244	440.500	313	307	306		100	92	5	
12	1140	.43	.960	443.745	.656	.569	2.847	443.744	317	307	306		100	92	4	
	1145			446.587				446.587								
2-1	1148	.59	1.32	449.017	.768	.666	3.330	—	312	307	306		97	91	5	
2	1153	.58	1.29	450.350	.762	.660	3.301	450.343	314	307	306		97	91	5	
3	1158	.58	1.29	453.650	.762	.660	3.301	453.648	315	307	306		98	91	5	
4	1203	.60	1.34	456.955	.775	.672	3.358	456.949	315	307	306		98	91	5	
5	1208	.62	1.38	460.310	.787	.683	3.413	460.307	315	307	306		98	91	5	
6	1213	.59	1.32	463.720	.768	.666	3.330	463.720	315	307	306		98	91	5	
7	1218	.56	1.25	467.050	.748	.649	3.244	467.050	315	307	306		98	91	5	
8	1223	.56	1.25	470.295	.748	.649	3.244	470.294	315	307	306		98	91	5	
9	1228	.54	1.20	473.540	.735	.639	3.186	473.538	315	307	306		99	91	5	
10	1233	.54	1.20	476.725	.735	.639	3.186	476.724	315	306	307		99	92	5	
11	1238	.43	.96	479.910	.656	.569	2.847	479.910	314	306	307		100	92	4	
12	1243	.38	.85	482.755	.616	.534	2.672	482.753	314	306	308		100	92	4	
	1248			485.425				485.425								

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78.352

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: ONT. HYDRO Test Run No. 5 Run Date: 11/9/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-AQA Duct Shape (select): Rectangular or Round
 Plant: MERAMAC Length (ft): 10.00 Diameter (ft): _____
 Test Location: UNIT 2 ESP - OUTLET DUCT Width (ft): 8.167
 Source Condition: NORMAL Duct Area (Sq. Ft.): 81.67 Upstream _____ Downstream _____
 Test Engineer: AS Disturbance (in diameters) _____ Horizontal or Vertical
 Temp ID: E-22 Sample Plane (select): _____ or _____
 Meter ID: E-22 Port Length (in.): 18
 Meter Calibration Factor: 1.000 Port Size (diameter in.): _____
 Pitot ID: 643A Port Type: FLANGE
 Pitot Tube Coefficient: .836 Number of Ports Sampled: 2
 Probe Length (ft.): 10 Number of Points per Port: 12
 Probe Liner Material: GLASS Minutes per Point: 5
 Nozzle Diameter (in.): .250 Total Number of Traverse Points: 24
 Gain Setup (select): Anderson Box Hot Box Other _____ Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33 Silica Final Wt (g): _____
 Static Pressure (in. H₂O): 21 Silica Initial Wt (g): _____
 Flue Pressure (in. Hg Abs): 27.786 Impinger Wt Gain (mL): _____
 Sample Train Leak Check: Pre: .003 Post: .001 @ 10" / 5" Total Water Gain (mL/g): _____
 Pitot Leak Check: Pre ✓ Post ✓ Description of Impinger H₂O: _____
 Carbon Dioxide (%): 14.2 Silica Gel Exhausted?: _____
 Oxygen (%): 4.8 Impingers Recovered by: _____
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1103 Tare Wt (g) 0.6794
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMERIN-ADA
 Plant: MERAMAC

List Test Method Used: OMT, HTDPO
 Test Run No.: 5

Test Location: UNIT 2 ESP-DWILET DUCT

Date: 11/9/04 Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	2.23 Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	X Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg	
													Inlet °F	Outlet °F		
1-1	1315	.66	1.47	486.782	.812	.704	3.522	—	311	308	312	568.0	98	94	5	
2	1320	.66	1.47	490.300	.812	.704	3.522	490.304	313	308	315	561.4	99	94	5	
3	1325	.63	1.41	493.800	.794	.688	3.441	493.826	315	307	320	lead	100	95	5	
4	1330	.59	1.32	497.300	.768	.666	3.330	497.267	316	307	320		101	95	5	
5	1335	.60	1.34	500.600	.775	.672	3.358	500.597	317	307	318		101	95	5	
6	1340	.73	1.63	502.980	.854	.741	3.704	502.955	317	307	316		102	95	5	
7	1345	.68	1.52	507.660	.825	.715	3.575	507.659	318	306	321		102	96	5	
8	1350	.68	1.52	511.235	.825	.715	3.575	511.234	318	306	322		103	96	5	
9	1355	.63	1.41	514.810	.794	.688	3.441	514.809	318	306	322		104	97	5	
10	1400	.61	1.36	518.220	.781	.677	3.386	518.250	317	305	323		104	97	5	
11	1405	.57	1.27	521.625	.755	.655	3.273	521.636	315	305	323		105	97	5	
12	1410	.48	1.07	524.900	.693	.601	3.003	524.909	313	305	320		105	97	4	
1415				527.912				527.912								
2-1	1417	.61	1.36	528.320	.781	.677	3.386	—	314	305	323		104	97	5	
2	1422	.60	1.34	531.705	.775	.672	3.358	531.706	316	306	324		105	98	5	
3	1427	.60	1.34	535.065	.775	.672	3.358	535.064	317	306	324		105	98	5	
4	1432	.61	1.36	538.425	.781	.677	3.386	538.422	318	307	325		105	98	5	
5	1437	.61	1.36	541.810	.781	.677	3.386	541.808	319	307	325		105	98	5	
6	1442	.63	1.41	545.200	.794	.688	3.441	545.194	319	308	325		105	98	5	
7	1447	.58	1.29	548.640	.762	.660	3.301	548.635	320	307	324		104	97	5	
8	1452	.58	1.29	551.945	.762	.660	3.301	551.936	320	306	324		104	97	5	
9	1457	.51	1.14	555.240	.714	.619	3.096	555.237	318	306	322		104	97	5	
10	1502	.46	1.03	558.340	.678	.588	2.940	558.333	316	305	322		105	97	4	
11	1507	.43	.96	561.280	.656	.569	2.843	561.273	314	305	322		105	97	4	
12	1512	.39	.87	564.120	.624	.541	2.707	564.116	313	305	323		105	97	4	
1517				566.823				566.823								

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79.633

ISOKINETIC TEST DATA

TEST PARAMETERS:

List Method Used: ONT, HYDR Test Run No. 6 Run Date: 11/9/04

Check here if same Test Parameters as previous run (and if necessary, indicate new pitot, nozzle, etc.); Test Location must be filled out on each sheet.

Company: AMEREN-ADA
 Plant: MEMPHIS
 Test Location: UNIT 2 ESP-OUTLET DUCT
 Source Condition: NORMAL
 Test Engineer: AS
 Temp ID: E-23
 Meter ID: E-22
 Meter Calibration Factor: 1.000
 Pitot ID: 643A
 Pitot Tube Coefficient: .836
 Probe Length (ft.): 10
 Probe Liner Material: GLASS
 Nozzle Diameter (in.): .250
 Gain Setup (select): Anderson Box Hot Box Other

Duct Shape (select): Rectangular or Round
 Length (ft): 10.00 Diameter (ft): _____
 Width (ft): 8.163
 Duct Area (Sq. Ft.): 81.63
 Disturbance (in diameters) Upstream Downstream
 Sample Plane (select): Horizontal or Vertical
 Port Length (in.): 18
 Port Size (diameter in.): 4
 Port Type: FLANGE
 Number of Ports Sampled: 2
 Number of Points per Port: 12
 Minutes per Point: 5
 Total Number of Traverse Points: 24
 Test Length (min): 120

STACK CONDITIONS:

Barometric Pressure (in. Hg): 29.33
 Static Pressure (in. H₂O): -21
 Flue Pressure (in. Hg Abs): 27.786
 Sample Train Leak Check: Pre: .001 Post: .916 in. Hg
 Pitot Leak Check: Pre Post
 Carbon Dioxide (%): 14
 Oxygen (%): 4.8
 Gas Values by (select one): Method 3 Orsat/Fyrite Method 3A (analyzer)
 Fuel Type Firing (Select): 9780 - Bituminous Coal 9860 - Lignite Coal
 10100 - Anthracite Coal 9190 - Fuel Oil 8710 - Natural Gas Other _____

MOISTURE DETERMINATION:

Impinger Final Wt (mL): _____ Silica Final Wt (g): _____
 Impinger Initial Wt (mL): _____ Silica Initial Wt (g): _____
 Impinger Wt Gain (mL): _____ Silica Wt Gain (g): _____
 Total Water Gain (mL/g): _____
 Description of Impinger H₂O: _____
 Silica Gel Exhausted?: _____
 Impingers Recovered by: _____
 Silica Gel Weighed by: _____
 Sample Removed from Site by: _____

SAMPLE COLLECTION:

Thimble No. _____ Tare Wt (g) _____
 Filter No. 1104 Tare Wt (g) 0.6928
 Fuel Samples collected for analysis? Yes No

COMMENTS & NOTES:

FIELD TEST DATA SHEET - ISOKINETIC SAMPLING

Company: AMERON-ADA
 Plant: NERAMAC

List Test Method Used: ONT HYDR O
 Test Run No: 6
 Date: 11/9/04

Test Location: UNIT 2 ESP - OUTLET DUCT Traverse Sheet 1 of 1

Port-Point No.	Clock Time 24 hr.	Velocity Head (ΔP) in. H ₂ O	Velocity Orifice (ΔH) in. H ₂ O	Actual Meter Volume (V _m) ft ³	X Sqrt. ΔP	Meter Rate cfm	Theoretical Meter Volume per Point (V _m) ft ³	Theoretical Meter Volume (V _m) ft ³	Stack Temp (t _s) °F	Probe Temp. °F	Filter Holder Temp. °F	Impinger Outlet Temp. °F	Meter Temp. (t _m)		Pump Vacuum in. Hg
													Inlet °F	Outlet °F	
1-1	1540	.68	1.52	568.175	.825	.715	3.575	—	313	304	312	≤68°	94	90	5
2	1545	.68	1.52	571.350	.825	.715	3.575	571.350	315	308	312	54/14	95	90	5
3	1550	.68	1.52	575.325	.825	.715	3.575	575.325	317	308	312	1600	96	90	5
4	1555	.67	1.27	578.900	.755	.655	3.273	578.900	318	310	313	—	96	91	5
5	1600	.64	1.43	582.175	.800	.694	3.468	582.175	319	310	316	—	97	91	5
6	1605	.72	1.61	585.640	.849	.736	3.628	585.640	319	310	318	—	97	91	5
7	1610	.72	1.61	589.320	.849	.736	3.628	589.319	319	312	321	—	98	91	5
8	1615	.68	1.52	592.995	.825	.715	3.575	592.997	318	315	322	—	98	92	5
9	1620	.64	1.43	596.570	.800	.694	3.468	596.572	317	315	324	—	98	92	5
10	1625	.61	1.36	600.040	.781	.677	3.386	600.040	317	317	324	—	99	92	5
11	1630	.57	1.27	603.425	.755	.655	3.273	603.426	316	317	323	—	99	92	5
12	1635	.42	.94	606.700	.648	.562	2.809	606.699	314	317	322	—	99	92	4
	1640			609.508				609.508							
2-1	1644	.60	1.34	610.027	.775	.672	3.358	—	312	313	318	—	96	91	5
2	1649	.60	1.34	613.390	.775	.672	3.358	613.385	313	314	320	—	97	91	5
3	1654	.60	1.34	616.750	.775	.672	3.358	616.745	315	316	322	—	97	91	5
4	1659	.62	1.38	620.100	.787	.683	3.413	620.101	316	316	322	—	98	91	5
5	1704	.63	1.41	623.520	.794	.688	3.441	623.514	318	318	323	—	98	91	5
6	1709	.63	1.41	626.960	.794	.688	3.441	626.955	318	318	323	—	98	91	5
7	1714	.60	1.34	630.420	.775	.672	3.358	630.396	318	320	324	—	98	91	5
8	1719	.62	1.38	633.750	.787	.683	3.413	633.754	318	320	324	—	99	91	5
9	1724	.53	1.18	637.170	.728	.631	3.156	637.167	317	321	323	—	99	92	5
10	1729	.46	1.03	640.325	.678	.588	2.940	640.323	316	322	320	—	99	92	4
11	1734	.46	1.03	643.265	.678	.588	2.940	643.263	315	321	320	—	100	92	4
12	1739	.41	.91	646.205	.640	.555	2.776	646.203	313	318	317	—	100	92	4
13	1744			648.970				648.979							

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80.285

Test 4 – Ontario Hydro - Outlet – November 9, 2004

Impinger No.	Pre	Post	Difference
1	686.8	817.5	130.7
2	686.5	723.5	37.0
3	664.9	685.2	20.3
4	721.6	732.0	10.4
5	719.0	720.1	1.1
6	719.6	718.1	-1.5
7	694.4	692.3	-2.1
8	751.9	771.1	19.2
Total			215.1

Test 4 – Ontario Hydro - Inlet – November 2, 2004

Impinger No.	Pre	Post	Difference
1	672.0	858.8	186.8
2	667.6	717.1	49.5
3	674.5	682.5	8.0
4	682.4	689.3	6.9
5	710.6	714.8	4.2
6	630.6	631.5	0.9
7	692.6	693.9	1.3
8	765.2	782.8	17.6
Total			275.2

Test 5 – Ontario Hydro - Outlet – November 9, 2004

Impinger No.	Pre	Post	Difference
1	689.8	865.5	175.7
2	672.2	713.0	40.8
3	692.9	702.7	9.8
4	687.0	693.6	6.6
5	706.4	707.0	0.6
6	689.7	687.3	-2.4
7	695.7	696.5	0.8
8	798.2	815.6	17.4
Total			249.3

Test 5 – Ontario Hydro - Inlet – November 9, 2004

Impinger No.	Pre	Post	Difference
1	678.8	820.4	141.6
2	676.9	716.9	40.0
3	685.0	690.7	5.7
4	689.2	695.2	6.0
5	702.8	706.3	3.5
6	697.1	698.7	1.6
7	686.7	687.1	0.4
8	779.3	800.5	21.2
Total			220.0

Test 6 – Ontario Hydro - Outlet – November 9, 2004

Impinger No.	Pre	Post	Difference
1	681.6	832.8	151.2
2	687.0	732.3	45.3
3	661.3	672.5	11.2
4	722.0	728.2	6.2
5	722.2	724.9	2.7
6	719.9	721.8	1.9
7	693.4	693.7	0.3
8	770.9	780.9	10.0
Total			228.8

Test 6 – Ontario Hydro - Inlet – November 9, 2004

Impinger No.	Pre	Post	Difference
1	676.1	846.0	169.9
2	671.2	699.6	28.4
3	685.8	696.9	11.1
4	686.4	691.3	4.9
5	634.9	636.3	1.4
6	630.7	631.9	1.2
7	693.7	693.0	-0.7
8	793.5	807.5	14.0
Total			230.2

APPENDIX H

Fuel and Byproducts Paper

EVALUATION OF FUEL SAMPLES AND PROCESS BYPRODUCTS FROM FULL-SCALE MERCURY CONTROL EVALUATIONS CONDUCTED ON COAL-FIRED BOILERS BURNING PRB FUEL

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ABSTRACT

With impending regulation of mercury from coal-fired power plants, several mercury control evaluations have been conducted targeting the most mature retrofit technologies. Plant configuration, fly ash composition, flue gas chemistry, and other parameters are pivotal in the complex issue of mercury control. During these evaluations, fuel samples and certain process byproducts were collected and tested for mercury content, stability, and other site-specific variables. These data were used to provide further information on the impacts of mercury control technologies on process by-products.

This paper will present data from plants where halogen-enhanced sorbents and coal additives were used for mercury control. Fly ash samples were subjected to various leaching protocols, looking for trace amounts of halogens and select analytes (e.g., mercury, arsenic, selenium) being leached from the sample. This paper also documents results from foam index testing, surface area measurements, and unburned carbon tests from various fly ash samples.

INTRODUCTION

ADA-ES, Inc., is conducting a test program to obtain the necessary information to assess the feasibility and costs of controlling mercury from five plants with configurations that, together, represent over 80% of the existing coal-fired generation plants and potentially a significant portion of new plants. This program is being conducted under a cooperative agreement with the Department of Energy's National Energy Technology Laboratory (NETL), and is co-funded by EPRI and several industry partners. To date, testing has been completed on four plants that fire western subbituminous Powder River Basin (PRB) coal or a blend of PRB and bituminous coals. The fifth test site, scheduled for testing in the spring of 2006, fires a high-sulfur bituminous coal. Host sites for this program are shown in Table 1.

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

	Sunflower Electric	Ameren UE	Missouri Basin Power Project	DTE Energy	AEP
	Holcomb	Meramec	Laramie River	Monroe	Conesville
Test Period	3/04–8/04	8/04–11/04	2/05–3/05	3/05–6/05	2/06–5/06
Unit	1	2	3	4	5 or 6
Size (MW)	360	140	550	785	400
Coal	PRB	PRB	PRB	PRB/Bit blend	Bituminous
Particulate Control	Fabric Filter	ESP	ESP	ESP	ESP
SCA (ft ² /kacfm)	NA	419	599	258	301
NO _x Control				SCR	
Sulfur Control	Spray Dryer	Compliance Coal	Spray Dryer	Coal Blending	Wet Lime FGD
Ash Reuse	Disposal	Sold for concrete	Disposal	Disposal	FGD Sludge Stabilization
Test Portion (MWe)	180 and 360	70	140	196	400
Typical Inlet Mercury (µg/dNm ³)	10–12	10–12	10–12	8–10	15.8
Typical Native Mercury Removal*	0–13%	15–30%	<20%	Not Available	50%
Average Hg Removal during 30-day ACI test	93%	93%	NA	Pending	Spring 2006

* Hg removal from existing APCD.

Field testing at each site included a baseline test period to determine the native mercury removal and parametric testing to evaluate several mercury control options such as coal blending, coal-additive introduction, and activated carbon injection (both non-chemically treated and bromine-treated). A 30-day continuous evaluation of the most promising option was conducted at all sites except Laramie River. Testing at Monroe Station has been completed, and the results will be presented at the meeting.

Coal and combustion byproducts were collected during all test phases. To assure an accurate representation of the bulk coal and ash properties and to ensure overall data quality, multiple samples were collected. The number of samples collected at each test site is summarized in Table 2. Over 200 samples were collected during long-term testing at each site. All ash samples were analyzed for mercury. For the sites with ESPs, all inlet hopper samples were analyzed for LOI. Several coal samples were characterized and analyzed for mercury and chlorine. Other analyses were also included, as discussed below.

Table 2. Summary of Samples Collected at each Test Site.

Plant	Coal	Bottom Ash	In-Situ Ash	Hopper Ash	Other	Totals
Holcomb	53	10	44	306	109	522
Meramec	56	9	47	224	2	338
Laramie River	23	none	21	28	4	76
Monroe	40*	none	40	135	2	217*

* Approximately 30 coal samples were collected but have not been received by ADA-ES from the laboratory at Monroe.

Although previous analyses from this and other programs have shown that the byproducts mixed with activated carbon are highly stable, standard leaching test methods, including the Toxicity Characteristic Leaching Procedure (TCLP, SW846-1311) and Synthetic Groundwater Leaching Procedure (SGLP), were conducted to assure that activated carbon containing bromine behaved the same as carbon without bromine. Thermal desorption tests were also conducted to determine if the mercury was thermally stable in the fly ash. When a chemically treated sorbent was used for long-term tests, leaching of the specific chemical used to treat the sorbent was carried out.

Quality Assurance

Obtaining an accurate representation of the actual coal and ash properties is critical. Problems can occur through improper sampling and through inadequate analyses. Improper sampling encompasses both contamination of the samples during sample handling, and collecting samples that are not representative of the bulk coal or ash. To assure the quality of the data, multiple samples were collected.

Mercury in Coal

Several coal samples were sent to more than one laboratory for redundant mercury analyses. In many cases, the reported mercury contents of the same coal sample differed from lab to lab. The results were also often different when the sample was re submitted and analyzed by the same lab or when the lab conducted several analyses of the same sample. For example, coal samples collected during baseline testing at Meramec were split and submitted to two laboratories, A and C, for mercury analysis. The results were often significantly different, as shown in Figure 1.

Data presented in Table 3 shows the variability within a single lab for multiple analyses of the same sample and for separate analyses of samples sent to the lab from the same batch of coal. The causes of the variations in results are not clear but could be due to non-homogeneous samples that can cause actual variations in the coal analysis, or inconsistencies in the laboratory analyses. Procedures have been put into place to prepare and homogenize larger coal samples to minimize actual variations in the coal. In addition, as part of their quality assurance program, both labs participate in externally organized round robin programs for mercury in coal.

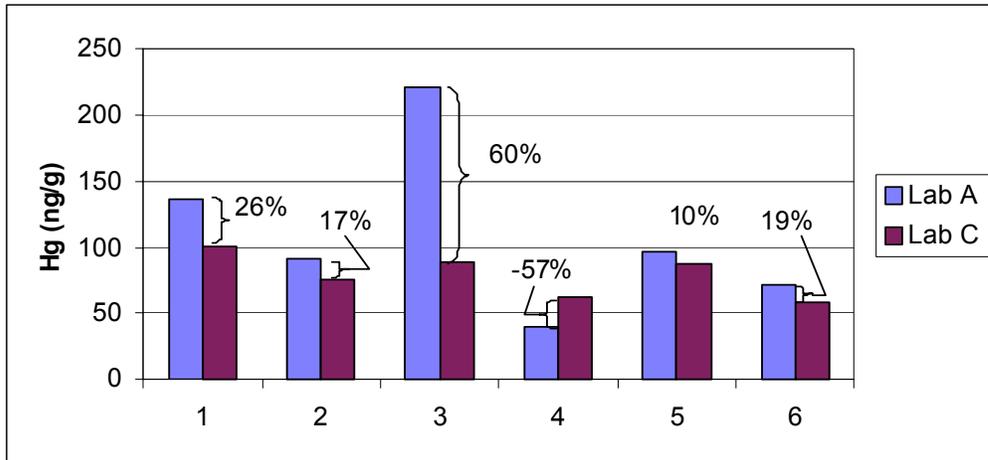


Figure 1. Inter-laboratory Variability in Coal Mercury Concentrations.

Table 3. Variations in Coal Mercury Concentrations by Laboratory.

Sample	LabA (ng/g)	Lab C (ng/g)
8/24/05		
Sample 1 Run 1	136	127
Sample 2 Run 1	64	
Sample 2 Run 2	87	
Sample 2 Run 3	79	
8/25/04		
Sample 1	116	76
Sample 2	91	

Chlorine in Coal

PRB coal contains relatively low concentrations of chlorine, typically less than 50 µg/g. Specialized techniques are required to obtain accurate measurement of chlorine in coal. In addition, extra care must be taken while handling the samples as they can be readily contaminated by touching (sweat contains NaCl) or if HCl is used in the lab. Figure 2 shows the results of chlorine analyses conducted by Lab A on one set of coal samples from Meramec. The first three results were higher than expected for PRB coal, and the concentration quickly decreased from the first to the third sample. A fraction of prepared sample number 17 was reanalyzed by another lab and the result was consistent with the original analysis. This suggests contamination in the laboratory, probably while the samples were ground prior to analysis. Fresh portions of samples 17, 18, and 31 were resubmitted to Lab A for processing and analysis and new analyses produced results less than 30 µg/g chlorine.

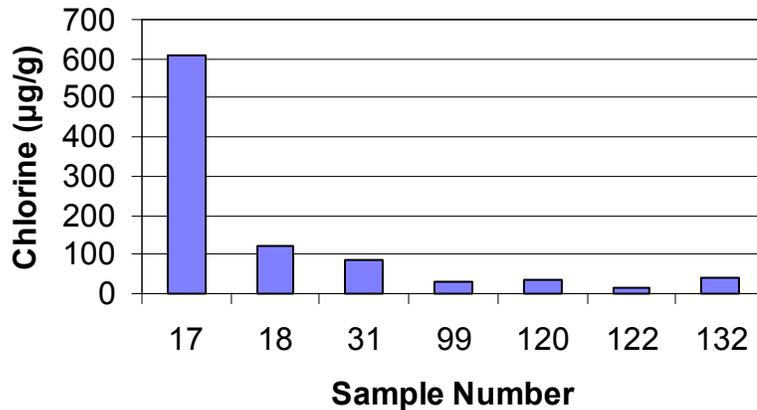


Figure 2. Chlorine Results from Coal collected at Meramec.

Mercury in Ash

During testing at Holcomb, ADA-ES acquired an Ohio Lumex analyzer that determines mercury in fly ash using direct combustion. Initial tests with the Ohio Lumex produced results that were consistently higher than those from Lab A. Therefore, three ash samples were submitted to two additional labs for comparison (ADA-ES is Lab B). The results, presented in Figure 3, indicate that Labs B, C, and D produced results within 6% of each other, while Lab A was consistently lower by at least 30%. These results show that the results from the Ohio Lumex compare favorably with the standard techniques used by most labs. Therefore, most of the subsequent ash mercury analyses were conducted by ADA-ES with the Ohio Lumex. Lab A later indicated that the spray dryer solids contained in the fly ash may have interfered with the digestion technique used at the lab.

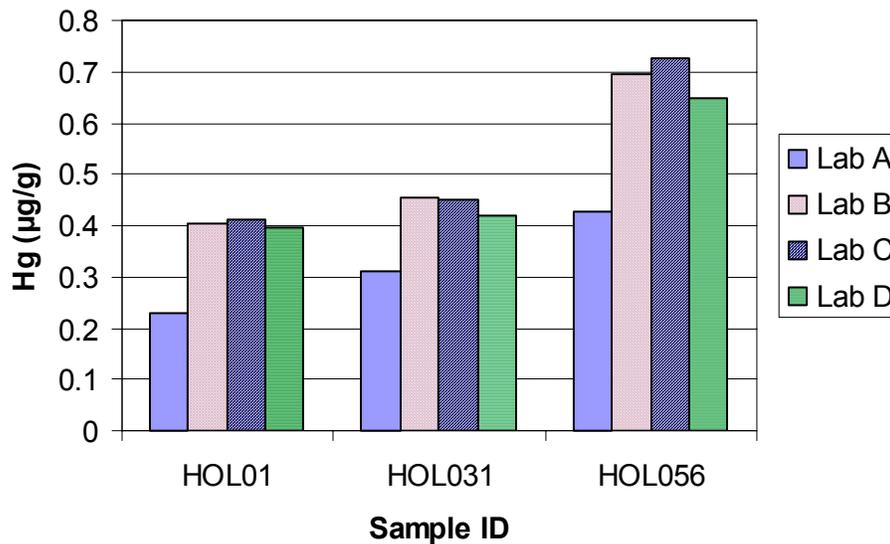


Figure 3. Inter-Laboratory Variability in Fly Ash Mercury Concentrations.

The data above demonstrate the difficulty in obtaining consistent and accurate results for mercury and chlorine in coal and ash samples. As part of the sample management procedure followed by ADA-ES during this ongoing program, NIST standard coal and ash samples are regularly submitted with other samples.

RESULTS

Process Variability

Mercury in Coal at Meramec

During the Meramec field evaluation, it was observed that changes in fuel could be identified primarily through variations in SO₂ emissions. Several coal samples were analyzed for mercury and sulfur content to determine if there was a correlation for these PRB coals. Figure 4 shows that, in general, the higher the sulfur content the higher the mercury content in the PRB coals from Meramec. The correlation coefficient was calculated to be 0.64. Results from sulfur and mercury analyses from two coals from Holcomb are also included.

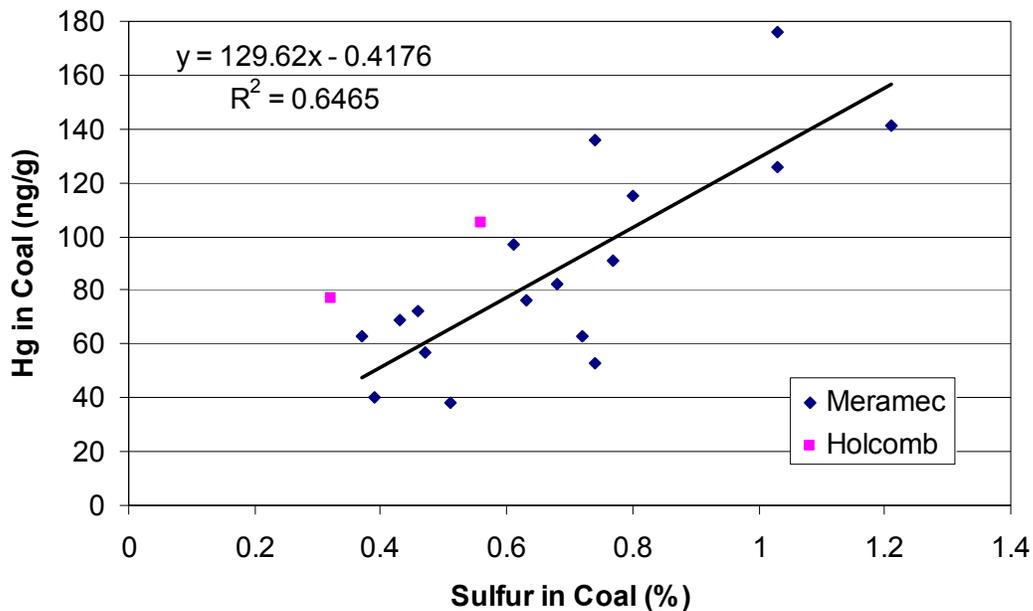


Figure 4. Correlation between Sulfur and Mercury in PRB Coals.

Coal delivery data, provided by Meramec plant personnel, was monitored throughout long-term testing. Each coal train delivered was subjected to a short-proximate analysis. Included in the analysis was percent sulfur, which was compared to the mercury concentrations as measured by the mercury analyzers. The estimated time between the last train car being unloaded and coal from the delivery being fired in the boiler was approximately 24 hours. Figure 5 shows the ESP inlet mercury concentration as measured by the analyzer and the sulfur concentration from short proximate analysis for the delivery (corrected by approximately 24 hours to account for the delay between the time the coal is delivered and when it is fired in the Unit 2 boiler). The figure includes the outlet SO₂ emissions measured by the plant CEM. Both the coal sulfur and SO₂ emissions show a strong correlation to the SCEM mercury data at the Meramec Station.

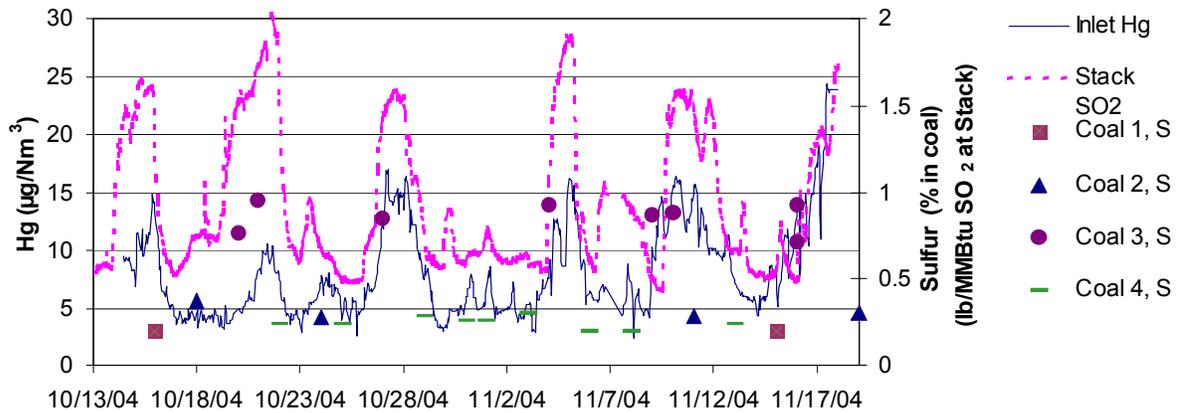


Figure 5. Sulfur in Coal and Vapor-Phase Mercury Concentrations during Long-Term Testing.

The correlation between mercury and sulfur in coal is not unexpected, since the sulfur-containing mineral pyrite (FeS_2) often contains significant amounts of mercury. However, this relationship is highly variable and depends on the local geology of the coal. The relationship developed at Meramec and Holcomb should not be generalized to all PRB coals.

Variations of Mercury in Fly Ash by Location

During long-term testing, ash was collected from several hoppers in the fabric filter at Holcomb and the ESP at Meramec and analyzed for mercury to determine if mercury variations occur. More than 100 hopper ash samples were collected during long-term testing at Holcomb and analyzed for mercury. A sketch of the hopper layout at Holcomb is shown in Figure 6. The front-to-back variation in the mercury concentration is presented in Figure 7, and the side-to-side variation is presented in Figure 8. Note that the mercury concentration is low at the beginning of the test period during the transition from baseline testing to activated carbon injection testing. For reference, the average mercury removal across the SDA + FF was 93% during activated carbon injection.

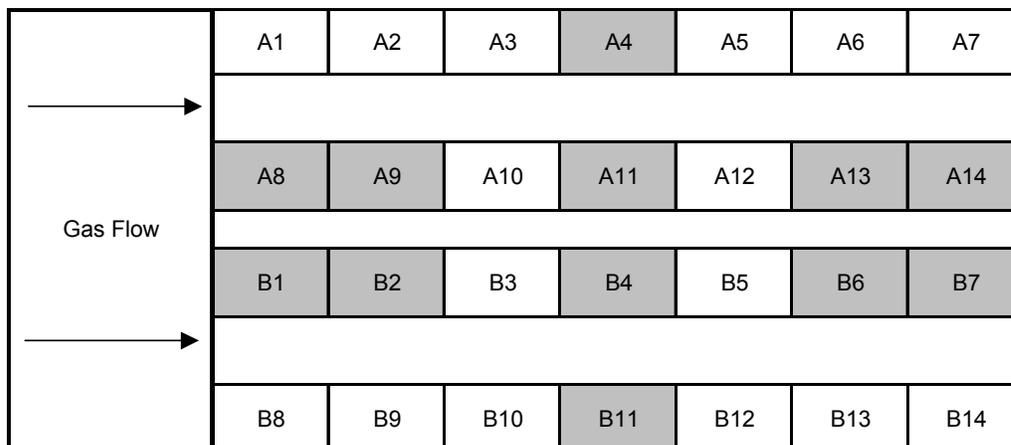


Figure 6. Sketch of Fabric Filter showing Module Numbering.

In general, the mercury concentration is relatively consistent during the long-term test. It does appear that the mercury concentrations in the front hopper, A8, were slightly lower than in the other hoppers, and the concentration in the back hoppers, A13 and A14, were somewhat higher than average (Figure 7). The variation from side-to-side by row (Figure 8) shows there are a few low values in the outer rows (A1–7 and B8–14), but in general there was little difference throughout the hoppers.

An in-situ ash sample was also collected upstream of the SDA using a cyclone. The mercury concentration in these samples is also included in Figure 5 and indicates that only about 20% of the total mercury eventually collected by the fly ash and activated carbon mix occurred by the time the ash reached the SDA. There was approximately 2 seconds of residence time between the injection location and the in-situ ash sampling location. This suggests that most of the mercury capture occurs in the SDA and fabric filter.

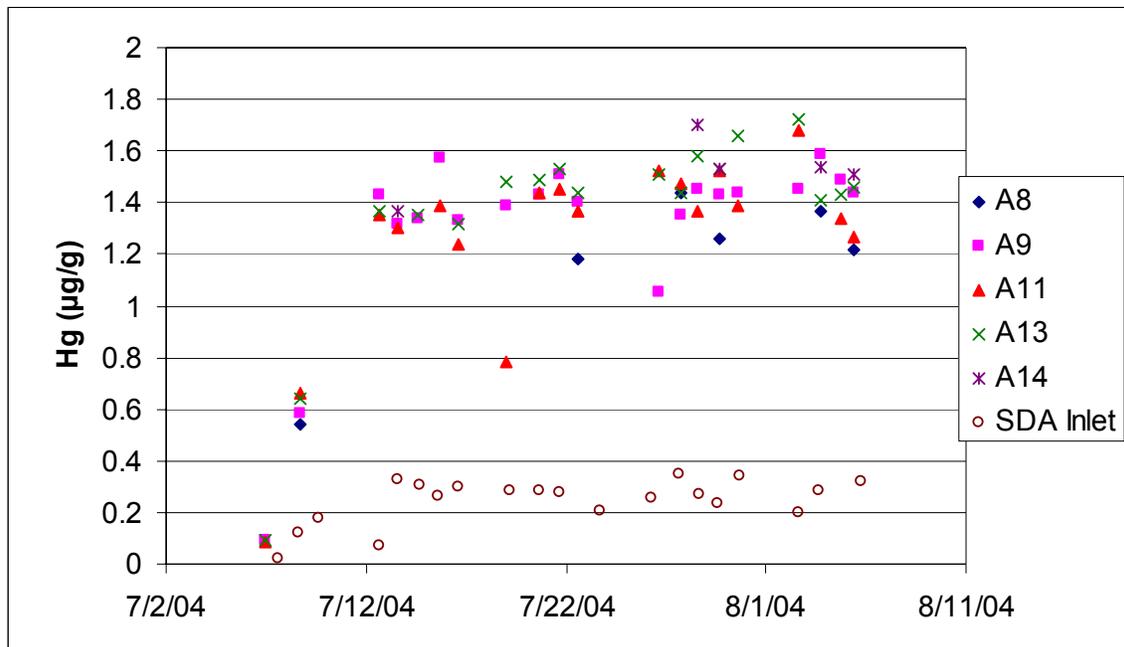


Figure 7. Mercury in Ash Samples Collected during Long-Term Testing—Variation Front to Back in the Fabric Filter.

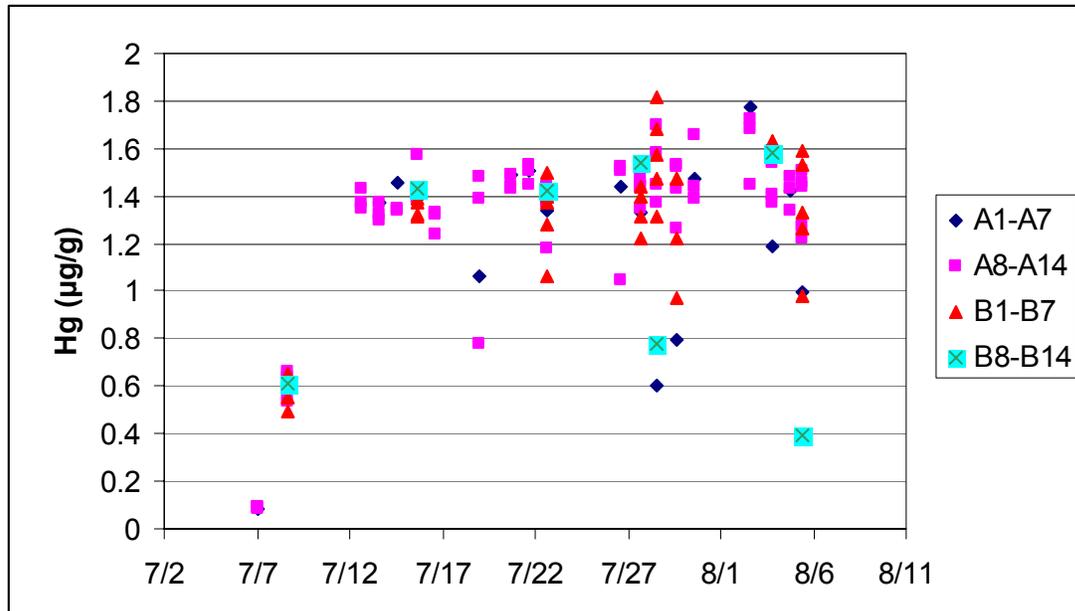


Figure 8. Mercury in Ash Samples Collected at Holcomb during Long-Term Testing—Variation by Fabric Filter Module.

The estimated mercury concentration in the flue gas due to mercury in the coal and the fraction of mercury removed from the gas based on ash analyses can be calculated. For the long-term test at Holcomb, these values are shown in Figure 9 along with the results from the SCEMs and three other sampling methods: Ontario Hydro, EPA M29, and sorbent traps (M324). The figure shows good agreement between all methods. Holcomb fired Jacob’s Ranch coal throughout long-term testing and little variation in the inlet mercury concentration was noted. Several other process streams were also sampled during the Holcomb long-term test to assure that no other sources or sinks of mercury were being neglected. Additional samples included coal, ash, and lime feed, coal dust suppression agent and SDA recycle water. No significant mercury was found in these other feed streams. For Holcomb, this study indicates that mercury concentrations in the coal and ash can be used to estimate the mercury removal across the unit. For plants that fire coal from several different mines, like Meramec, the use of coal samples to estimate mercury removal performance is more challenging.

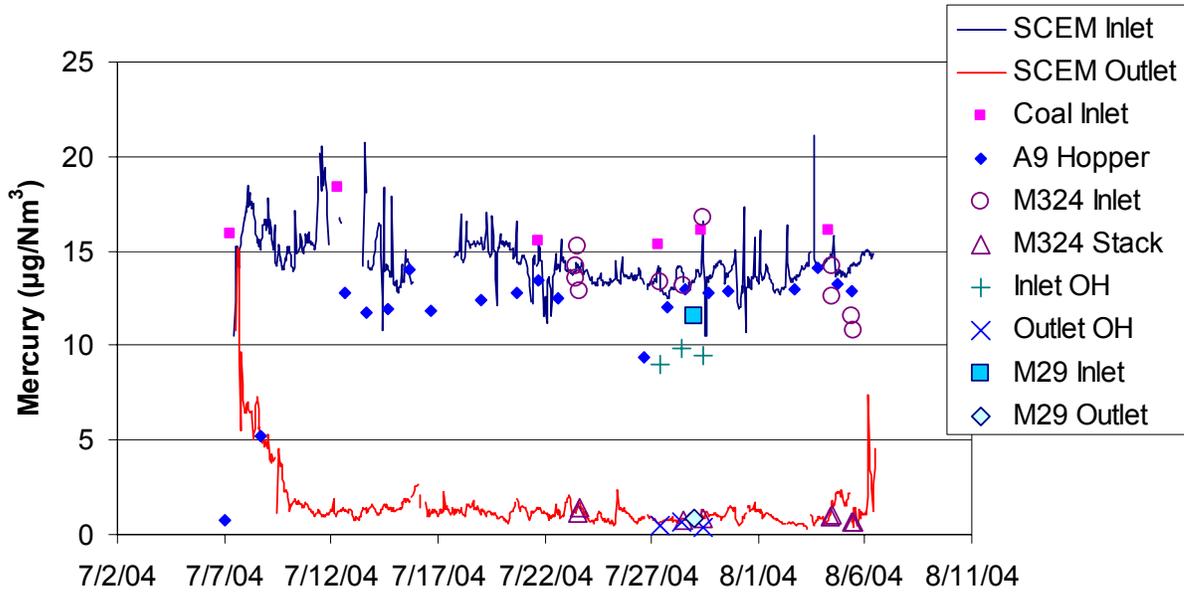


Figure 9. Comparison of Vapor and Solid Mercury Measurements at Holcomb Station.

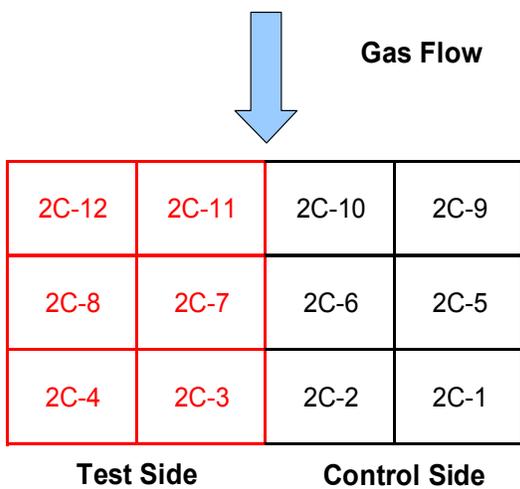


Figure 10. Sketch of ESP Hopper Layout at the Meramec Station.

ESP ash samples were also collected at Meramec during the long-term (30-day) continuous activated carbon injection test. A sketch of the ESP hopper arrangement at Meramec is shown in Figure 10. Activated carbon was injected into only one of two ESPs in the divided gas path, which provided an opportunity to collect control samples (i.e., ash containing no activated carbon) to compare with the test samples.

The average mercury concentration during long-term testing in the test-side is presented in Figure 11 and the control-side is presented in Figure 12. The average mercury removal across the test-side ESP during the 30-day period was 93%.

The test-side data indicate that, in general, the mercury concentration in the ash increased from the inlet collection fields to the outlet fields. This is typically the case at units where the fly ash is effective at removing mercury, or when activated carbon is present in the ash, because the particulate collected in the ESP outlet field is exposed to flue gas much longer than fly ash collected in the inlet fields. The data also show significant difference in the mercury concentration between the test- and control-sides. The ash mercury concentration in the control-side was about 50% lower than the test-side. This indicates significant mercury removal across the control-side even in the absence of activated carbon.

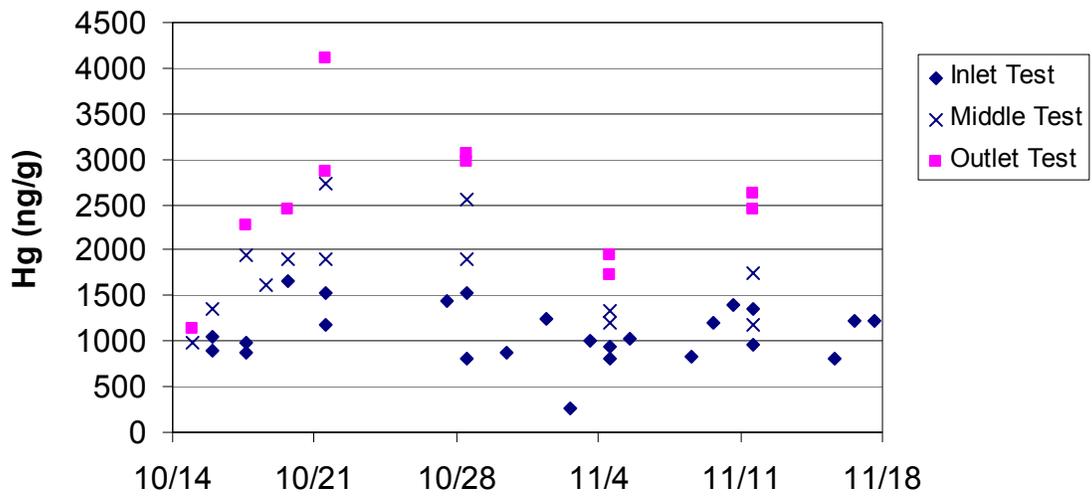


Figure 11. Mercury in Test-Side Ash Samples Collected at Meramec during Long-Term Testing.

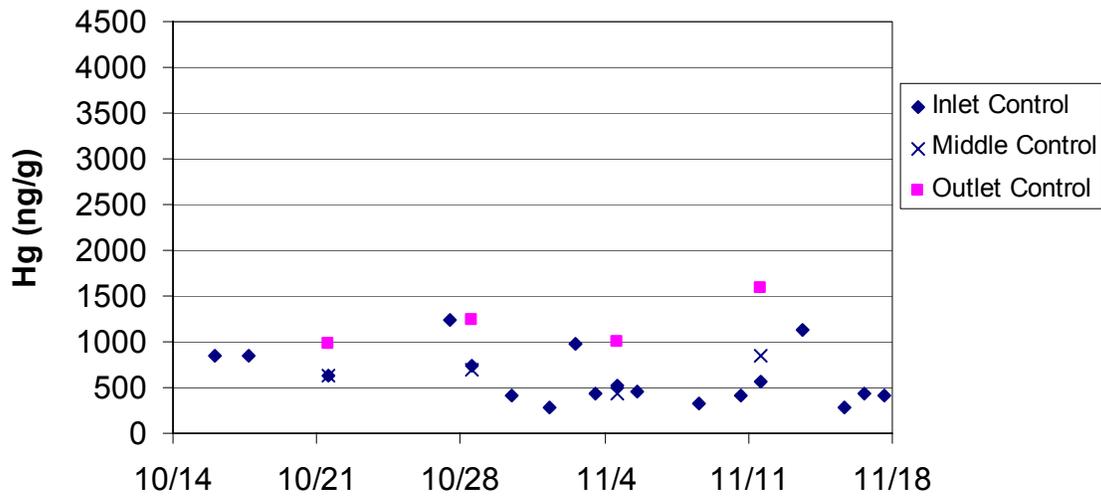
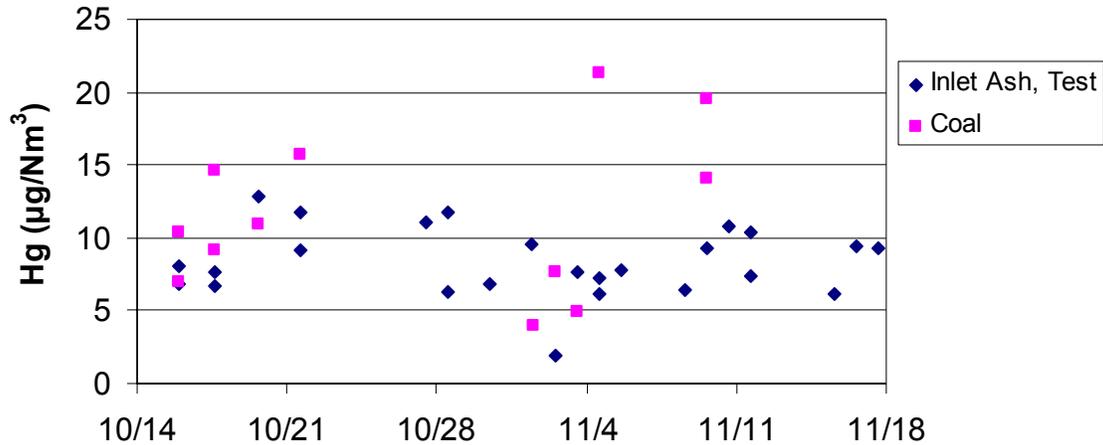


Figure 12. Mercury in Control-Side Ash Samples Collected at Meramec during Long-Term Testing.

Figure 13 is a comparison of coal mercury and the ash mercury in the inlet-field, test-side. There is a wide variation in the coal mercury concentration and, for some samples, the coal mercury was lower than that measured in the ash. Meramec burns coal from at least four different mines and it is dumped into a single pile for all units at Meramec Station. Discrepancies in mercury concentrations calculated from coal and ash samples are likely due to the difficulty in obtaining representative grab samples.



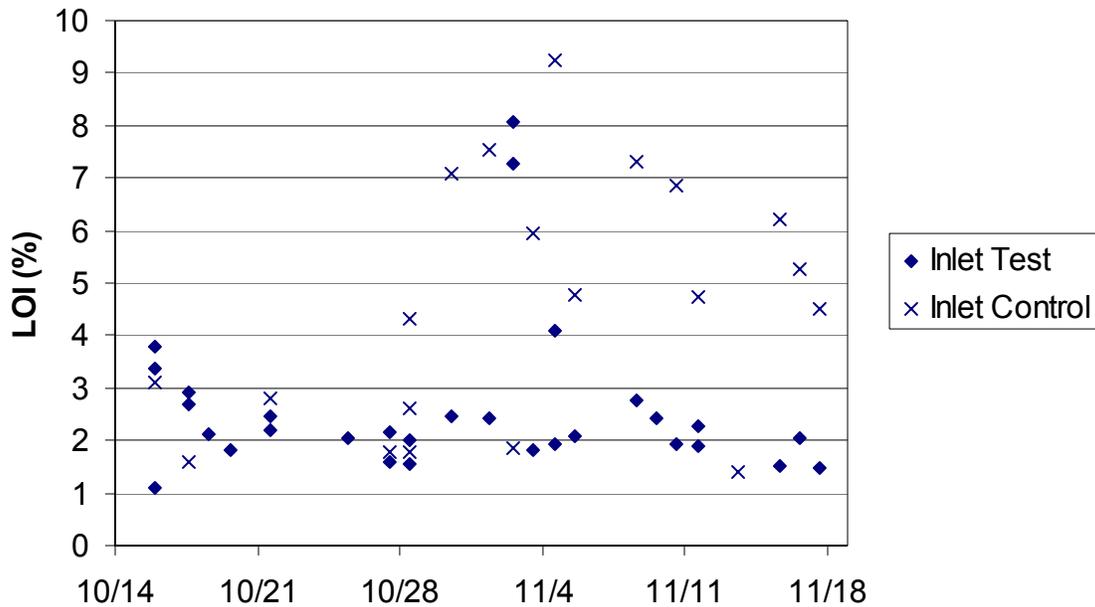


Figure 14. Carbon Content for the Inlet Field during Long-Term Testing (Measured using LOI Procedure).

Figure 15 depicts another apparent anomaly in that the control-side ash samples with high LOI contained less mercury. To better understand the causes of this trend, five ash samples from the control-side and test-side ESPs were further analyzed for size distribution and surface area, in addition to the standard LOI and mercury analyses. The results are given in Table 4 and show that:

- Mercury was inversely proportional to LOI.
- The mercury content of the three control-side ash samples was inversely proportional to the carbon size.
- The Meramec control-side samples had consistent carbon surface area in the range of 313 to 334 m²/g C. The test-side samples, which contain activated carbon, had slightly higher carbon surface area, in the range of 397 to 412 m²/g C.

The table shows that the sample with the highest LOI also contained the largest particles (sample from 11/1/04), and this is the key to understanding the unexpected trend. The high LOI samples from these Meramec samples contain large carbon particles that may not be as efficient at adsorbing mercury from the flue gas in-flight, probably due to limitations on mass transfer to the relatively few larger unburned carbon particles.

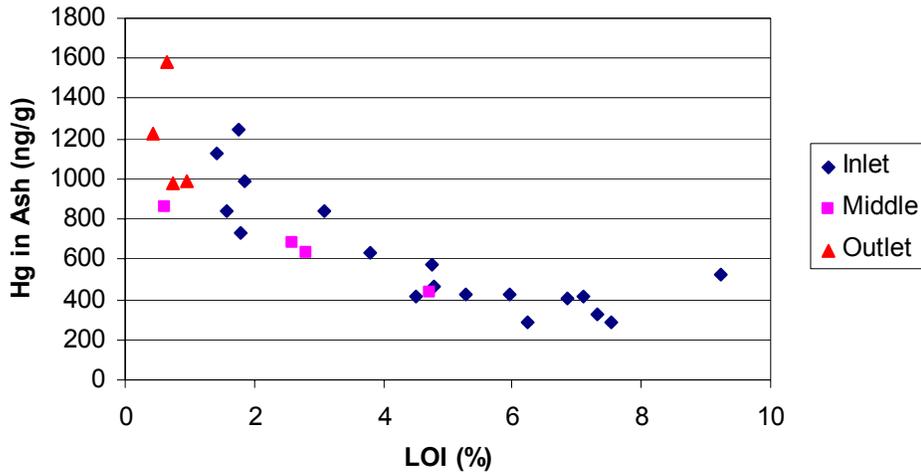


Figure 15. LOI% and Mercury Content on Fly Ash from Control-side of ESP during Long-Term Testing at Meramec.

Table 4. Fly Ash Surface Area and Mercury Content.

Description	LOI, wt%	Mean particle size, micron	Surface Area		Mercury Content	
			m ² /g	m ² /g C*	Hg, ng/g	Hg, ng/g C
8/24/04 2C-9 Control, Baseline	1.64	18	5.13	312.6	547	33,354
10/28/04 2C-9 Control	1.79	11.53	5.98	334.3	734	41,006
11/1/04 2C-10 Control	7.54	43.9	24.31	322.4	291	3,859
10/28/04 2C-11 Test	2	12.16	7.93	396.7	1,520	76,000
11/1/04 2C-11 Test	2.41	11.64	9.93	412.0	1,250	51,867

* The LOI values of these samples were used to estimate the specific surface area of the carbon in the sample and the mercury content per gram of carbon in the sample.

Byproduct End-Use

Impact of Carbon on Ash Sales

Activated carbon will likely absorb more of the air entrainment agent (AEA) used in the manufacture of cement than typical unburned carbon. One method of determining the amount of air entrainment additive needed for fly ash used as a cement admixture is the foam index test. Prior to long-term testing at Meramec, foam index tests were conducted to help quantify the impacts of activated carbon on Unit 2 fly ash. According to the contractor that conducted the foam index tests, ash that required less than 10 drops of AEA is usually acceptable for sale. Activated carbon was added to fly ash samples in amounts simulating injection concentrations ranging from 0.5 to 10 lb/MMacf and foam index tests were conducted on the combined product. The results shown in Table 5 indicate Meramec Unit 2

ash had the potential for use as a cement admixture mixed at activated carbon injection concentrations of less than 1.2 lb/MMacf. The level of unburned carbon will also affect the required AEA, and ash collected during long-term testing contained significantly higher unburned carbon than the samples used in the foam index study.

Table 5. Foam Index Test Results—Meramec Ash

% Activated Carbon by weight	Calculated ACI Injection Concentration (lb/MMacf)	Number of AEA Drops
None	0	5
0.20	0.6	8
0.41	1.2	10
1.23	3.7	24
2.05	6.2	38
4.09	12.4	70

Stability of Mercury and Bromine—Leaching Results

Leaching analyses were performed on ash samples from baseline and long-term testing phases at each test site to determine the stability of mercury and bromine using SGLP and TCLP leaching protocols. SGLP results are presented in Table 6 and show that mercury levels are below the detection limit for both the baseline and long-term tests. The TCLP mercury results for Meramec were also below detection limits for the method. For the Holcomb sample, 0.032 µg/L mercury leached from the sample (RCRA limit = 200 µg/L). The levels of bromine leached from long-term samples are much higher than from the baseline samples.

Table 6. SGLP Results for Holcomb and Meramec Samples.

		Baseline (mg/L)		Long-Term Testing (mg/L)	
		SGLP 18-hr	SGLP 30-day	SGLP 18-hr	SGLP 30-day
Holcomb	Br*	1.48	1.55	10.10	10.40
Meramec	Br	0.115	0.056	9	16
Holcomb	Hg	<0.0002	<0.0002	<0.0002	<0.0002
Meramec	Hg	<0.0002	<0.0002	<0.0002	<0.0002

** A bromine-based water treatment chemical is used for the spray dryer feed water and may have influenced the leaching results.*

Stability of Mercury and Bromine—Thermal Desorption Results

In addition to leaching studies, mercury thermal desorption analyses were carried out on samples collected during the baseline and long-term tests. In these experiments, the samples were heated from a temperature of 22°C, at a rate of 25°C/minute, to 750°C. The mass of mercury desorbed was measured as a function of temperature. The results indicated that the baseline ash sample from Holcomb was stable to 240°C (464°F) and the long-term ash

sample was stable to 315°C (599°F). The addition of activated carbon at Meramec also caused a shift of the first mercury desorption peak to a higher temperature, from 358°C (676°F) on the ESP control-side sample to 419°C (786°F) on the ESP test-side sample.

The thermal stability of bromine in ash collected during long-term testing at Holcomb was also evaluated. Analysis consisted of measuring the bromine concentration in the baseline sample, heating portions of the sample to various temperatures from 65 to 204°C (150 to 400°F), and measuring the bromine remaining on each heated sample. The amount of bromine retained on the sample after heating up to 204°C (400°F) remained relatively unchanged, indicating the bromine collected on the sample is thermally stable within this temperature range.

CONCLUSIONS

Power plants burning PRB coal have been the sites of a number of evaluations of control technologies for control of mercury emissions. It has been demonstrated on these units, that increasing the halogen concentration in the flue gas stream coupled with activated carbon injection can yield mercury removal efficiencies greater than >80%. Coal samples collected during these evaluations were analyzed for mercury content and other analytes. Results from these tests suggest the mercury content varied by mine and there was a correlation between mercury and sulfur in the coal. Fly ash samples collected during these evaluations were subjected to several tests to help quantify the amount of mercury collected on the ash and the stability of the bound mercury. Below are a few of the major conclusions derived from these tests:

- Careful sample collection, handling, and analysis are critical to obtaining quality results. Samples should be homogenized prior to analysis and quality control procedures should be in place in the field and lab.
- Historical data suggest that mercury leaching from collected ash samples is near the detection limit for most methods. SGLP tests on the ash and sorbent/ash mix collected from DARCO[®] Hg-LH injection tests at Holcomb and Meramec indicated that mercury was below detection limit in all the leachate solutions.
- After 30 days in the SGLP leaching solution, some bromine leached from the ash/DARCO[®] Hg-LH sorbent mixtures. Additional testing and analysis should be conducted to quantify the impact of bromine leaching from fly ash/sorbent mixtures.
- Mercury in the native ash at Meramec was inversely proportional to LOI. The mercury concentration was inversely proportional to the carbon size.
- The thermal stability of mercury in ash increases when DARCO[®] Hg-LH activated carbon is present. The first desorption peak was at 315°C in a PRB-derived fly ash with SDA solids (Holcomb), and 419°C in a PRB-derived fly ash from an ESP application (Meramec).

ACKNOWLEDGMENTS

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