



**DEPARTMENT OF ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY**

**Field Test Program to Develop Comprehensive Design,  
Operating, and Cost Data for Mercury Control Systems**

**Final Site Report for:  
E.C. Gaston Unit 3  
Sorbent Injection into COHPAC for Mercury Control**

**U.S. DOE Cooperative Agreement No. DE-FC26-00NT41005  
Topical Report No. 41005R11**

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**May 2003**

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## **ABSTRACT**

With the Nation's coal-burning utilities facing the possibility of tighter controls on mercury pollutants, the U.S. Department of Energy is funding projects that could offer power plant operators better ways to reduce these emissions at much lower costs.

Mercury is known to have toxic effects on the nervous system of humans and wildlife. Although it exists only in trace amounts in coal, mercury is released when coal burns and can accumulate on land and in water. In water, bacteria transform the metal into methylmercury, the most hazardous form of the metal. Methylmercury can collect in fish and marine mammals in concentrations hundreds of thousands times higher than the levels in surrounding waters.

One of the goals of DOE is to develop technologies by 2005 that will be capable of cutting mercury emissions 50 to 70 percent at well under one-half of today's costs. ADA Environmental Solutions (ADA-ES) is managing a project to test mercury control technologies at full scale at four different power plants from 2000 – 2003. The ADA-ES project is focused on those power plants that are not equipped with wet flue gas desulfurization systems.

ADA-ES has developed a portable system that will be tested at four different utility power plants. Each of the plants is equipped with either electrostatic precipitators or fabric filters to remove solid particles from the plant's flue gas.

ADA-ES's technology will inject a dry sorbent, such as activated carbon, which removes the mercury and makes it more susceptible to capture by the particulate control devices. A fine water mist may be sprayed into the flue gas to cool its temperature to the range where the dry sorbent is most effective.

PG&E National Energy Group is providing two test sites that fire bituminous coals and both are equipped with electrostatic precipitators and carbon/ash separation systems. Wisconsin Electric Power Company is providing a third test site that burns Powder River Basin (PRB) coal and has an electrostatic precipitator for particulate control. Alabama Power Company will host a fourth test at its Plant Gaston, which is equipped with a hot-side electrostatic precipitator and a downstream fabric filter.

## **EXPERIMENTAL**

All field-testing has been completed at E.C. Gaston and all data and samples have been analyzed.

## **RESULTS AND DISCUSSIONS**

This Topical Report is issued as complete detailed results of data and sample analysis. These results are for tests that were conducted at Alabama Power Company's E.C. Gaston Plant Unit 3.

# MAIN REPORT

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## EXECUTIVE SUMMARY

Gaston Unit 3 was successfully tested for applicability of activated carbon injection as a mercury control technology. Test results from this site have enabled a thorough evaluation of the impacts of future mercury regulations to Gaston Unit 3, including performance, estimated cost, and operation data. Directly as a result of this work, further study to obtain an optimized design can be defined and conducted.

The team responsible for executing this program included plant and Alabama Power headquarters personnel, Southern Company personnel, EPRI and several of its member companies, DOE, ADA-ES, Norit America, Hamon Research Cottrell, Apogee Scientific, Southern Research Institute, URS Corporation, Reaction Engineering, as well as other laboratories. The technical support of all of these entities came together to make this program work on a short schedule and achieve its goals.

Overall the objectives of this four-month laboratory and field test program were to determine the mercury control and balance-of-plant impacts resulting from activated carbon injection into a full-scale COHPAC baghouse on Gaston Unit 3, a bituminous-coal-fired 270 MW unit. Ten different sorbents were tested in a laboratory apparatus for mercury adsorption. These sorbents included ash-derived, carbon-based, and proprietary clay-based sorbents. Seven of these sorbents were then tested in a slipstream of flue gas from Gaston Unit 3. Five sorbents were tested full-scale by injection into one-half of the Unit 3 flue gas stream (135 MW nominal). Sorbents were injected in the duct downstream of the hot-side electrostatic precipitator and upstream of COHPAC.

The sorbent required for a given mercury removal, targeted at 50%, 75%, and 90% removal, was slightly less than predicted. In long-term testing (over a period of one week) almost 80% removal was achieved using 1.5 lb/MMacf of Darco FGD injection. This resulted in the maximum acceptable bag-cleaning frequency of about 1.5 pulses/bag/hour.

Ash analysis showed that the ash/sorbent byproduct of mercury control passed a standard TCLP test, enabling the routine disposal method for Unit 3, consisting of sending the ash to on-site ash ponds for future landfilling. Economics for a permanent full-scale system on Unit 3 were developed. These costs are contingent on factors such as bag life, which can be evaluated further with a longer term test covering several months.

## INTRODUCTION

In December 2000 EPA announced the intent to regulate mercury emissions from the nation's coal-fired power plants. In anticipation of these regulations, a great deal of research has been conducted during the past decade to characterize the emission and control of mercury compounds from the combustion of coal. Much of this research was funded by the Department of Energy, EPA, and EPRI. The results are summarized in the comprehensive AWMA Critical Review Article<sup>1</sup>. As a result of these efforts, the following was determined:

1. Trace concentrations of mercury in flue gas can be measured relatively accurately;
2. Mercury is emitted in a variety of forms;
3. Mercury species vary with fuel source and combustion conditions; and
4. Control of mercury from utility boilers can be both difficult and expensive.

This latter point is one of the most important and dramatic findings from the research conducted to date. Because of the large volumes of gas to be treated, low concentrations of mercury, and presence of difficult to capture species such as elemental mercury, some estimates show that 90% mercury reduction for utilities could cost the industry as much as \$5 billion per year<sup>1</sup>. Most of these costs will be borne by power plants that burn low-sulfur coal and do not have wet scrubbers as part of the air pollution equipment.

With regulations rapidly approaching, it is important to concentrate efforts on the most mature retrofit control technologies. Injection of dry sorbents such as powdered activated carbon (PAC) into the flue gas and further collection of the sorbent by ESPs and fabric filters represents the most mature and potentially most cost-effective control technology for power plants. However, all of the work to date has been conducted using bench-scale and pilot experiments. Although these reduced-scale programs provide valuable insight into many important issues, they cannot fully account for impacts of additional control technology on plant-wide equipment.

Therefore, it is necessary to scale-up the technology and perform full-scale field tests to document actual performance levels and determine accurate cost information. Under a DOE/NETL cooperative agreement, ADA-ES is working in partnership with PG&E National Energy Group (NEG), We-Energies, a subsidiary of Wisconsin Energy Corp., Alabama Power Company, a subsidiary of Southern Company, and EPRI on a field evaluation program of sorbent injection upstream of existing particulate control devices for mercury control<sup>2-4</sup>. Other organizations providing cost share to this program are Ontario Power Generation, First Energy, Cinergy, Duke Power, Northern Indiana Public Service Company, MidAmerican Energy Company, LG&E Corporation, Hamon-Research Cottrell, TVA, Kennecott Energy, and Arch Coal. Team members include EPRI, Apogee Scientific, URS Corporation, Energy & Environmental Strategies, Reaction Engineering, Southern Research Institute, Hamon Research-Cottrell, Environmental Elements Corporation, Norit Americas, and EnviroCare International.

This report is the Final Report presenting results from the first of these field test programs, conducted at Alabama Power Company's E.C. Gaston Electric Generating Plant.

## DESCRIPTION OF OVERALL PROGRAM

The Department of Energy’s National Energy Technology Laboratory (NETL) is the primary funding agency on an industry cost-shared test program to obtain the necessary information to assess the costs of controlling mercury from coal-fired utility plants that do not have scrubbers for SO<sub>2</sub> control. The method for mercury control evaluated in this program is the injection of dry sorbents, such as activated carbon, upstream of the existing particulate control device on a full-scale system. The economics are developed based on various levels of mercury control at four different host sites. The four sites, shown below, fire a coal type and have particulate control equipment that are representative of 75% of the coal-fired generation in the United States.

Test Site	Coal	Particulate Control
PG&E NEG Salem Harbor	Low S. Bituminous	Cold-Side ESP
PG&E NEG Brayton Point	Low S. Bituminous	Cold-Side ESP
We-Energies Pleasant Prairie	PRB (Subbituminous)	Cold-Side ESP
Alabama Power Gaston	Low S. Bituminous	Hot-Side ESP COHPAC FF

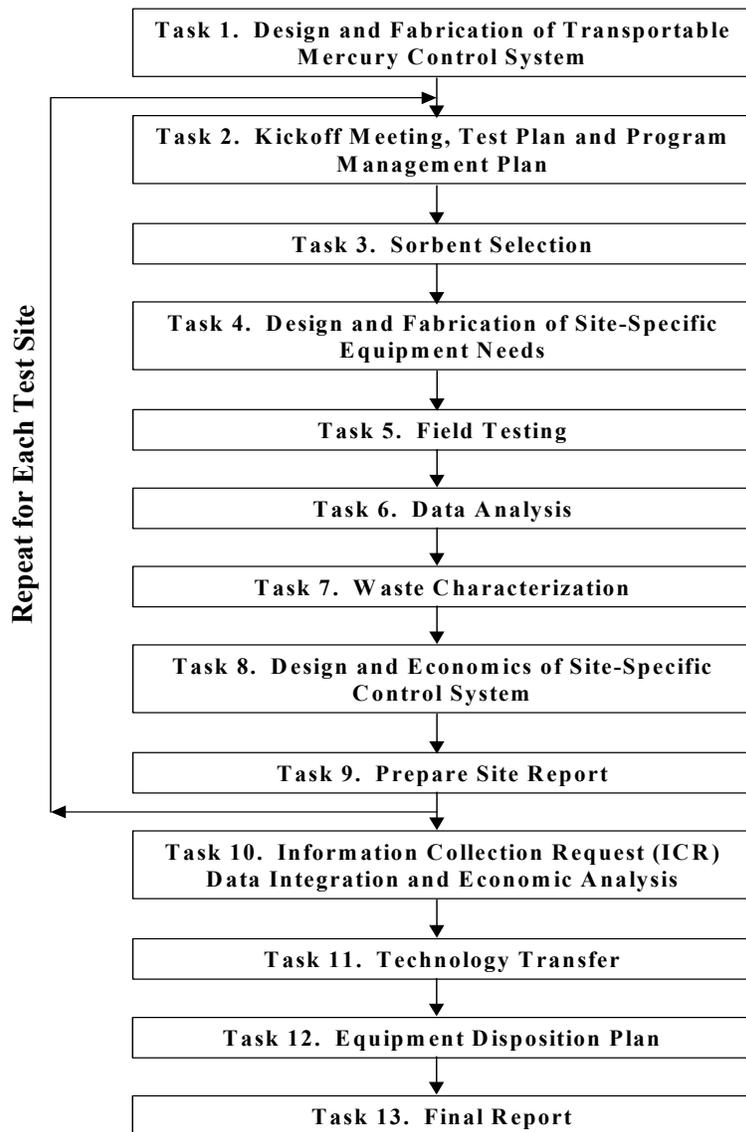
Gaston Unit 3 was chosen as one of the test sites because COHPAC represents a cost-effective retrofit option for utilities with electrostatic precipitators (ESPs). COHPAC is an EPRI-patented design<sup>5</sup> that places a high air-to-cloth ratio baghouse downstream of an existing ESP to improve overall particulate collection efficiency. Building on the COHPAC invention, EPRI has also patented TOXECON<sup>6</sup>, which adds sorbent injection upstream of COHPAC, for control of air toxics. The advantages of this configuration are:

1. Sorbents are mixed with a small fraction of the ash (nominally 1%), reducing the impact on ash reuse and waste disposal.
2. Pilot plant studies and theory<sup>7</sup> indicate that compared to ESPs, baghouses require one-tenth the sorbent to achieve similar removal efficiencies.
3. Capital costs for COHPAC/TOXECON are less than other options such as replacing the ESP with a baghouse or larger ESP.
4. COHPAC requires much less physical space than either a larger ESP or full-size baghouse system.
5. Outage time can be significantly reduced with COHPAC systems in comparison to major ESP rebuilds/upgrades.

In addition Gaston Unit 1, which has a similar configuration to Unit 3, showed in EPA ICR testing that marginal mercury removal is realized across the particulate control system in a baseline condition.<sup>8</sup> This makes TOXECON a practical solution.

The overall program has 12 technical tasks. Tasks 2 through 9 are specific for each of the field evaluations and Tasks 1, 10, 11 and 12 are common tasks in support of all the test sites. The technical tasks are shown on Figure 1.

**Figure 1:** Outline of Overall Program Technical Tasks



This program is funded through a cooperative agreement between the Department of Energy National Energy Technology Laboratory (NETL) and ADA Environmental Solutions, LLC (ADA-ES). The agreement includes a requirement that industry cost share this program at a minimum of 33%. The primary industry cost share partners for the Gaston tests were:

<b>Alabama Power Company</b>	<b>EPRI</b>
<b>Hamon Research-Cottrell</b>	<b>ADA-ES</b>
<b>Norit Americas, Inc.</b>	<b>Ontario Power</b>

As well as a consortium of EPRI TC members:

<b>Cinergy Corp.</b>	<b>Duke Energy Corp.</b>	<b>MidAmerican Energy Company</b>
<b>First Energy Corp.</b>	<b>LG&amp;E Energy Corp.</b>	<b>Northern Indiana Public Service Company</b>

# GASTON PROJECT OBJECTIVE AND TECHNICAL APPROACH

The overall objectives of testing at Alabama Power's Gaston Unit 3 were to determine the achievable mercury control level, cost and impacts of sorbent injection into the COHPAC baghouse for mercury control. The evaluation was conducted on one-half of the gas stream, nominally 135 MW. The side chosen for testing was B-side. A-side was monitored as the control unit.

To achieve the overall objective, the program was designed with an extensive field evaluation, laboratory testing, and analysis effort. This report presents the results of these efforts.

## SITE DESCRIPTION

Alabama Power Company, a subsidiary of Southern Company, owns and operates the E.C. Gaston Electric Generating Plant located in Wilsonville, Alabama. The plant has four 270 MW balanced draft and one 880 MW forced draft coal fired boilers. All units fire a variety of low-sulfur, washed, eastern bituminous coals.

The primary particulate control equipment on all units are hot-side ESPs. Units #1 & #2 and Units #3 & #4 share common stacks. In 1996 Alabama Power contracted with Hamon Research-Cottrell to install COHPAC downstream of the hot-side ESP on Unit 3. This COHPAC system was designed to maintain Unit #3 & #4's stack opacity levels below 5% on a six-minute average<sup>9</sup>.

The COHPAC system is a hybrid pulse-jet cleaned baghouse designed to treat flue gas volumes of 1,070,000 acfm at 290°F (gross air-to-cloth ratio of 8.5 ft/min with on-line cleaning). The COHPAC baghouse consists of four (4) isolatable compartments, two compartments per air-preheater identified as either A- or B-Side. Each compartment consists of two bag bundles, each having a total of 544, 23-foot long, polyphenylene sulfide (PPS) felt filter bags, 18 oz/yd<sup>2</sup> nominal weight. This results in a total of 1,088 bags per compartment, or 2,176 bags per casing<sup>9</sup>. The evaluation was conducted on one-half of the gas stream, nominally 135 MW. The side chosen for testing was B-side. A-side was monitored as the control unit for operational comparisons.

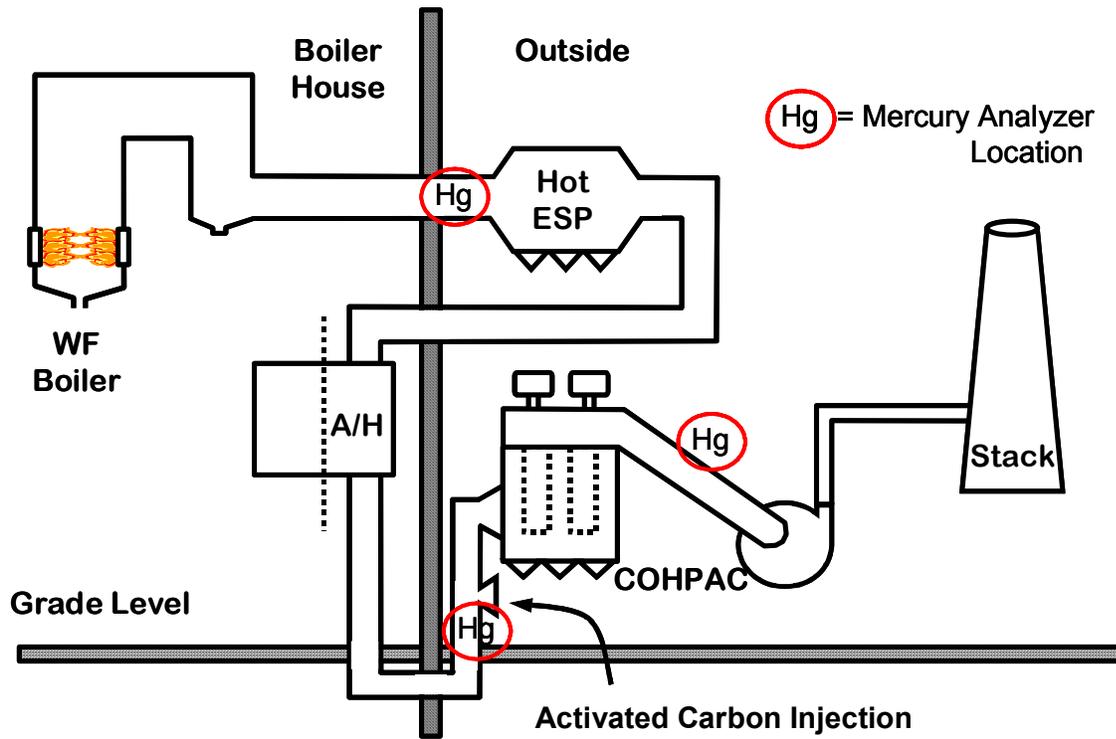
The hot-side ESP is a Research-Cottrell weighted wire design. The specific collection area (SCA) is 274 ft<sup>2</sup>/1000 acfm. Depending on the operating condition of the hot-side ESP, nominally 97 to 99+% of the flyash is collected in the ESP. The remaining flyash is collected in the COHPAC system. The average inlet particulate mass concentration into COHPAC between 1/97 and 4/99 was 0.0413 gr/act<sup>9</sup>. Hopper ash from both the ESP and the baghouse is sent to a wet ash pond for disposal. A hydrovactor system delivers the flyash to the pond.

Figure 2 shows a diagram of the location of the various components of the air pollution control train. Alabama Power's design parameters for Gaston Unit 3 are presented in Table 1. For the

mercury control program, carbon-based dry sorbents were injected upstream of COHPAC, downstream of the ESP over an eight week period. This amounts to a TOXECON configuration.

**Figure 2.** Flow Schematic of Gaston Unit 3, Showing Injection and Measurement Locations

## E. C. Gaston Unit 3



**Table 1.** Site Description Summary, Gaston Unit 3.

<b>Parameter Identification</b>	<b>Description</b>
<b>Boiler Manufacturer</b>	<b>B&amp;W wall-fired</b>
Burner Type	B&W XCL
Low NOx Burners	Yes
NOx Control (Post Combustion)	None
Temperature (APH Outlet)	290°F
<b>Coal (Typical – this unit fires a variety of coals)</b>	
Type	Eastern Bituminous
Heating Value (Btu/lb)	13,744
Moisture (%)	6.9
Sulfur (%)	0.9
Ash (%)	13.1
Hg (µg/g)	0.06
Cl (%)	0.03
<b>Control Device</b>	
Type	Hot-Site ESP with COHPAC
ESP Manufacturer	Research Cottrell
Design	Weighted Wire
Specific Collection Area (ft <sup>2</sup> /1000acfm)	274
Flue Gas Conditioning	None
Baghouse Manufacturer	Hamon Research-Cottrell
Design	Pulse-Jet, Low Pressure – High Volume
Air-to-Cloth Ratio (acfm/ft <sup>2</sup> )	8.5:1 (gross), On-Line Cleaning

## FIELD AND LABORATORY EVALUATION

The critical elements of the site evaluation were the actual field tests and measurements, which relied upon accurate, rapid measurements of mercury concentration and an injection system that realistically represented commercially-available technology.

Near real-time, vapor-phase mercury measurements were made using a Semi-Continuous Emissions Monitors (S-CEM) designed and operated by Apogee Scientific. This instrument was developed with EPRI funding to facilitate EPRI research and development efforts<sup>10</sup>. Multiple S-CEMs were used. The locations of the analyzers are shown on Figure 2. The S-CEMs operated continuously for over seven weeks, providing speciated, vapor-phase mercury concentrations at the inlet and outlet of COHPAC.

Norit Americas supplied a portable, dilute-phase pneumatic injection system that is typical of those used at Municipal Solid Waste (MSW) facilities for mercury control with activated carbon. ADA-ES designed the distribution and injection components of the system.

A Test Plan for this program at Plant Gaston was developed prior to commencing testing.<sup>11</sup> Meetings were held with plant, project and environmental personnel to finalize the scope and logistics of the test program. The program was initiated on an unusually short schedule, with the decision to go forward occurring in December 2000 and initial tests taking place in January 2001. In spite of this short schedule, ten sorbents were laboratory-screened, eight sorbents were field-screened, and five sorbents were tested full-scale. This project came together in the short time frame because of the extraordinary efforts of the team, particularly support from Alabama Power and from Apogee.

The overall schedule for equipment installation and tests conducted for the Gaston Unit 3 evaluation is shown in Table 2.

**Table 2.** Schedule of Gaston Unit 3 Mercury Control Evaluation

<b>Test Description</b>	<b>Dates (2001)</b>
Pre-Baseline Measurements	January 18 - 26
Sorbent Screening Tests (lab)	January 1 - 20
Sorbent Screening Tests (field)	January 25 - 29
Equipment Installation	February 19 – March 1
Leaching Test	March 1 -3
Baseline Tests	March 5 - 7
Parametric Test Week 1	March 12 - 16
Parametric Test Week 2	March 19 – 23
Parametric Test Week 3	March 26 - 30
Long Term Test (Darco FGD)	April 17 – 27
Re-Test of Insul and Fine FGD	April 28 and 29
Ash / sample and data analyses	March 2001 – June 2002

The following sections describe each component of the program; laboratory and field test results are presented under the appropriate subsections below.

### **Site-Specific Equipment Description**

Sorbent requirements for various levels of mercury control were predicted based on empirical models developed through EPRI funding<sup>7</sup>. The values used were based on a uniform sorbent size of 15 microns (this corresponds well to the size of commercially-available PAC) and a bag cleaning frequency of 2 pulses/bag/hr (also assumed all bags were cleaned at the same time when in practice, the bags are cleaned in sections or rows). Rates used to design equipment for the Gaston test are presented in Table 3. The system was sized for a maximum injection rate of 100 lb/h. Equipment was installed the weeks of February 19 and 26.

**Table 3.** Predicted Injection Rates for FGD Carbon on B-Side of COHPAC<sup>4</sup>

<b>Target Hg Removal Efficiency (%)</b>	<b>Predicted Injection Concentration (lb/MMacf)</b>	<b>Predicted Injection Rate<sup>a</sup> (lb/h)</b>
50	0.5	<30
75	1.5	45
90	3.0	90

*a. Injection rate based on nominal flow at full load of 500,000 acfm.*

Figure 3 is a picture of the portable injection skid supplied by Norit Americas and installed for injection into Plant Gaston Unit 3B. Activated carbon delivered to the plant in 900 lb supersacks was loaded onto the skid by a hoist. The sorbent was metered by a variable-speed screw feeder into the conveying line. A blower/eductor provided the motive force to carry the sorbent ~100 ft to the injection point.

Sorbent was pneumatically conveyed via flexible hose from the feeder to a distribution manifold at the injection level and injected into the flue gas through six injection probes (three/duct). Figure 4 is a photograph of the distribution manifold. The injection system operated without plugging while injecting carbon based products with D50 particle size of 15 micron. The distribution system plugged once while feeding a finer material with a D50 of 6-7 microns.

**Figure 3.** Carbon Injection Skid Installed at Plant Gaston



**Figure 4.** Distribution Manifold for Injection Lances at Plant Gaston



### **Sorbent Selection and Screening**

Because of the economic impact of sorbent cost on the overall cost of mercury control, it is desirable to find less expensive sorbents. Many groups, including team members EPRI, URS Corporation (URS), and Apogee, have conducted extensive studies on this issue and have developed methods to quickly and economically screen potential sorbents.

The test plan included time to evaluate several sorbents. It was expected that alternative sorbents would be chosen from several different potential sorbent types and suppliers. In some cases it is of interest to consider using ash with high LOI from plants within the host sites' system. In other cases it is of interest to consider sorbents that provide site specific benefits. The procedure for sorbent screening is first to assess whether a sorbent meets the economic and availability criteria below, then to include the sorbent in laboratory screening to determine its capacity. Following these tests, promising sorbents can then be included in the field test program. If initial screening shows good results and the sorbent is available, more extensive field testing, including duct injection, may be performed.

### ***Sorbent Selection Criteria***

The future market for mercury sorbents is potentially very large and this program provides the first opportunity for suppliers to have sorbents evaluated full-scale. To follow the intent of NETL in choosing sorbents (to test commercially- or near commercially-available products), a sorbent selection criteria was developed so that sorbent vendors/developers could clearly understand the needs and requirements of this program. A draft of the sorbent selection criteria

is included in the Gaston Test Plan<sup>11</sup>. In summary an alternative sorbent supplier must show that the sorbent will:

1. Cost at least 25% less to use than FGD carbon;
2. Be available in quantities of at least 15,000 lb and 250,000 lb for site tests;
3. Be available in sufficient quantities to supply at least 1000 tons per year by 2007; and
4. Have a capacity of at least 100 µg/g as measured in the laboratory by URS Corporation.

### ***Sorbents Selected for Laboratory Screening Tests***

Fixed bed mercury capacity tests were conducted by URS on 10 different sorbents that were considered potential sorbents for full-scale testing at Gaston. A list of the sorbents tested prior to the start of the full-scale field tests and a brief description of each are presented in Table 4. The table also shows which of these sorbents were then included in field screening. Both Laboratory and Field sorbent test results are presented below under the “Results” section. The three categories of sorbents tested are described below.

Norit-supplied PACs: Norit America’s Darco FGD powdered activated carbon was considered the benchmark sorbent because of its wide use in DOE/EPRI/EPA sponsored studies. Three alternate Norit sorbents were also selected for the laboratory screening tests. These sorbents were a lower activity FGD (FGL), a bituminous-based activated carbon, and a subbituminous activated carbon.

Gaston ash: Fly ash collected in the hot-side ESP upstream of the COHPAC baghouse has an average carbon content (as indicated by loss-on-ignition, or LOI testing) between 10 and 20%. Because of the high LOI, this ash was also considered a potential sorbent. Tests were conducted to determine if this ash could be collected, processed (size segregated) and reinjected as a sorbent.

Ash collected from the COHPAC baghouse was tested to help understand the low baseline mercury collection efficiency of the baghouse.

TDA-supplied sorbents: TDA Research, a company developing clay based sorbents through DOE funding, made arrangements to have three of their sorbents tested.

**Table 4.** Sorbents Selected for Laboratory Fixed Bed Testing and for Slipstream Tests

NAME	SUPPLIER	DESCRIPTION	PRIMARY BENEFIT	LAB	SLIP-STREAM
Darco FGD	Norit Americas Inc.	Lignite derived activated carbon	Benchmark Sorbent, high capacity	X	X
FGL Carbon M-1182	Norit Americas Inc.	Lower activity, lignite derived activated carbon	Lower cost	X	X
GAC 1240	Norit Americas Inc.	Bituminous coal derived activated carbon	Alternate carbon based product	X	Combined sample tested in field (PAC 2B)
GAC 830	Norit Americas Inc.	Subbituminous coal derived activated carbon	Alternate carbon based product	X	
ESP Flyash	Gaston	Hot-side ESP hopper sample	Reuse of site ash, lower cost	X	X
ESP Flyash +200	Gaston	Hot-side ESP hopper sample separated to +200 mesh	Reuse of site ash, lower cost	X	X
COHPAC Flyash	Gaston	COHPAC Hopper Ash	Measure capacity	X	
TDA421-A	TDA Research	Non-carbon based	Lower cost, non-carbon	X	
TDA421-B	TDA Research	Non-carbon based	Lower cost, non-carbon	X	X
TDA421-C	TDA Research	Non-carbon based	Lower cost, non-carbon	X	

The laboratory mercury adsorption tests were carried out by URS using similar, simulated gas conditions. Gas conditions were chosen based on coal and operating conditions at Gaston. Test conditions were:

SO <sub>2</sub> (ppm)	600	NO <sub>x</sub> (ppm)	200
HCl (ppm)	5	H <sub>2</sub> O (%)	7
CO <sub>2</sub> (%)	12	O <sub>2</sub> (%)	5
Hg* (µg/Nm <sup>3</sup> )	50	Temperature (°F)	275

\* Target concentration

## **Field Tests**

The field tests were separated into four different test phases:

1. Pre-baseline and Sorbent Screening;
2. Baseline and Leaching;
3. Parametric Tests; and
4. Long-Term Tests.

Test methods are described first, and then each of these phases of testing is described in the subsections below.

### ***1. Test Methods used in Field Testing at Gaston***

For testing at Gaston Unit 3 the team generated a document entitled “Quality Assurance Project Plan for Performance Evaluation,” (QAPP) which is included as Appendix A. This document includes the test methodology and quality control procedures used. Detailed descriptions of the Ontario-Hydro method field sampling and laboratory analyses are included. Also included in the QAPP is a detailed description of the S-CEM method used for continuous mercury monitoring. These were the two methods used to measure mercury during the field tests.

EPA Method 17 was used to determine particulate loading at the inlet to COHPAC during baseline testing. Standard EPA methods 2, 3, and 4 were also followed as described in the QAPP.

Three measurement locations were used as depicted on Figure 2. These are the inlet to the hot-side ESP and the inlet and outlet of COHPAC.

### ***2. Pre-baseline Measurements and Sorbent Screening***

The first field measurements were made prior to installing the injection equipment. The objectives for the pre-baseline and sorbent screening tests were to:

1. Measure vapor-phase mercury concentrations at three locations using the S-CEM (supplied and operated by Apogee) to compare results with Ontario Hydro measurements made in 1999 under the EPA’s information collection request (ICR) (the ICR measurements were made across the hot-side ESP on Unit1);
2. Document mercury emissions across COHPAC; and
3. Perform screening tests for mercury adsorption characteristics of several sorbents that had been screened in the laboratory and were candidate sorbents for the full-scale tests.

For pre-baseline tests vapor-phase mercury measurements were made with the S-CEMs upstream of the hot-side ESP, upstream of the COHPAC baghouse (downstream of the hot-side ESP and airpreheater) and downstream of COHPAC, as shown on Figure 2. Measurements across the hot-side ESP were compared to measurements made as part of Phase III of the ICR on Gaston Unit 1. Since no previous measurements of mercury removal across the COHPAC baghouse had

been made, these tests provided important insight for planning of the actual injection tests. All of these tests were done under normal unit operating conditions with no duct sorbent injection.

Five carbon-based sorbents (including two Darco FGD samples), three variations of ash from Gaston, and three non-carbon based sorbents were screened by URS in a laboratory mercury adsorption test fixture. Eight of these sorbents were then evaluated in a similar test device on a slip stream of flue gas at Gaston. Table 4, above, includes information on each tested sorbent. A description of the slipstream screening device is included in the Gaston Test Plan.<sup>11</sup>

### ***3. Leaching Test and Baseline Testing***

Leaching tests, in which activated carbon was injected to ascertain how ash would be impacted during testing, were conducted the week prior to baseline testing. The procedures are described here. The S-CEMs were used to monitor mercury levels and removal during leaching tests.

To ensure that there would be no environmental impact on the ash pond from activated carbon-enriched ash being transported into the pond during testing, a short test was conducted to measure leaching properties of an ash/activated carbon sample. After equipment installation and checkout but before any carbon was fed into the duct, arrangements were made to isolate the B-side hoppers so carbon could be injected and not carried to the ash pond. For this test carbon was injected for several hours on two different days. Hopper samples were removed after several hours of operation on the second day. A composite sample was taken to Alabama Power Company (APC) Environmental Affairs for testing. The mercury S-CEMs were operating during this test. Appendix B (February 5 and 22 memos) contains test/schedule memos that provide more detail on daily planning and requests for assistance from APC.

Ontario Hydro and S-CEM measurements were both used to quantify mercury removal and emissions during baseline testing. Southern Research Institute conducted all Ontario Hydro testing. Apogee performed all S-CEM testing. Baseline measurement locations included the inlet and outlet of COHPAC.

Baseline tests to document current operating conditions were conducted the week before the start of the parametric test series. During this test boiler load was held steady at “full-load” conditions during testing hours, nominally 7:00 am to 7:00 pm. Mercury across B-Side of COHPAC was measured using the two separate methods as described in the QAPP:

1. S-CEM (run continuously); and
2. Draft Ontario Hydro Method (triplicate runs).

In addition to monitoring mercury removal, it was also important to document the performance of COHPAC with and without sorbent injection. This is critical to the success of sorbent injection for mercury control in a TOXECON configuration. All tests, including baseline, parametric, and long-term tests, included monitoring of COHPAC performance. The primary performance indicators are:

**Pressure Drop/Drag:** Pressure drop and drag are both used to monitor the permeability of the filter and dustcake. Pressure drop is a direct measurement of pressure loss across

the fabric filters. Drag is a calculated number that normalizes pressure drop to flow by dividing pressure drop by the air-to-cloth ratio. These values are a function of inlet grain loading, filtering characteristics of the particulate matter, and flow and time between cleaning. Of particular interest is the change in rate of pressure drop increase with sorbent injection and whether pressure drop/drag returns to baseline levels when injection is stopped.

**Cleaning Frequency:** Pressure drop/drag is controlled in a baghouse by the cleaning frequency. It is expected that cleaning frequency will increase with the increased particulate loading from sorbent injection. Cleaning frequency was monitored before, during and after sorbent injection.

**Opacity/Emissions:** Cleaning frequency and particulate matter characteristics can affect collection efficiency across the baghouse. Most emissions occur immediately following a clean, so increasing the cleaning frequency can increase outlet emissions. The emissions could also increase if the particulate does not form a high efficiency filter cake, but tends to work through the fabrics.

**Bag Strength:** The filter bags in COHPAC are made from Ryton™ felt. The Ryton bags at Gaston have experienced very little loss in fabric strength, as measured by Mullen Burst tests, in the four years of operation. To assure that carbon injection will not adversely affect fabric strength, samples of both old and new bags were pulled periodically throughout the test. On February 26 three new bags were installed into bundle A20 and B20, row 14, bag numbers 25, 26, and 27. One bag from each side was removed after the parametric tests and the remaining bags were removed after the long term tests. Bags were sent to Grubb Filtration Testing Services to measure bag strength, by the Mullen Burst test method, and pH.

During the baseline tests, daily samples of coal, COHPAC ash and ESP ash were collected. Triplicate EPA Method 17 particulate measurements were also made at the COHPAC inlet.

#### ***4. Parametric Testing***

A series of parametric tests was conducted to determine the optimum operating conditions for several levels of mercury control up to 90% mercury removal, via duct injection of several sorbents, as screened by prior tests. To minimize permitting issues, only coal-based sorbents were considered for duct injection at this site, although as described previously, some non-coal sorbents were screened. Norit Americas lignite-based PAC, Darco FGD, was chosen as the benchmark sorbent. Darco FGD is Norit's standard product for mercury removal at MSW and incineration sites. Once the parametric tests were completed, sorbent type and injection concentration for the long term tests were chosen based on the results.

A major influence on sorbent effectiveness and performance is the size of the sorbent. There was interest from the mercury team in testing sorbents of various sizes during the parametric test series, and these were pursued even after parametric testing had begun. Norit was able to provide some alternately-sized sorbents, which were included in the parametric testing although

they had not been included in the screening tests. Two sorbents were added to the parametric testing in this manner, one was Darco Insul (a smaller sorbent) and one was HydroDarco-C (a larger sorbent).

Darco Insul was provided after the parametric tests were already underway and was tested briefly during the parametric series, and again after the end of the long-term test series. It is a fine carbon of limited availability, which is used in another industry. It is based on Darco FGD but is chemically treated and size-separated for a smaller average size of 6-8 micrometers MMD. Smaller sizes are of interest in sorbent testing because of typically higher capacity, reactivity, and the potential for increased utilization predicted by mass transfer theory. The team was interested in determining whether the chemical treatment impacted this sorbent's effectiveness. In response to this, Norit provided "FGD Fines," which is similar to Insul but not treated. The tests comparing Insul to FGD Fines was conducted following completion of the long-term test series.

HydroDarco-C is also used in another industry and is based on Darco FGD. It is size-separated for a larger average size of about 30 micrometers MMD. This sorbent was of interest because of the possibility that pressure-drop impacts across the fabric filter would be reduced. It was tested during the main parametric tests series.

During the parametric tests, the S-CEMs were used to quantify mercury control effectiveness of each tested condition.

In all, 15 different parametric conditions were tested. The primary variables were sorbent type and target mercury removal level (which enabled calculation of injection concentration and injection rate, per the model previously referenced<sup>7</sup>). Other variables included COHPAC cleaning settings and flow through the baghouse. Although lower flue gas temperatures have been correlated with increased mercury removal, temperature was not a variable during these tests because normal operating temperatures at this plant were between 250°F and 270°F, which is cool enough for acceptable removal.

A summary of the parametric tests is presented in Table 5. Unless noted, all tests were conducted with the boiler at full load conditions and COHPAC cleaning at a drag-initiate setpoint of 0.6 inches w.c./ft/min. A description of the different carbon sorbents used in these tests is presented in Table 6. Detailed test plans for each week of parametric tests can be found in Appendix C in memo's dated March 7, March 15 and March 25.

**Table 5.** Summary of Parametric Test Conditions.

Test Series	Carbon Name	Target Hg Removal Efficiency (%)	Non Standard Conditions
1-5	Darco FGD	50, 75 and 90	Standard
6-9	Norit PAC2B	50, 75, 90	Standard
10	None	Baseline	Standard
11	Darco Insul	90	Standard
12	HydroDarco-C	90	Standard
13 a-c	Darco FGD	75	Change to pressure drop initiate clean
14	Darco FGD	50	Lower A/C to 4 ft/min
15	Darco FGD	50	Compare to test 14 with A/C = 7 ft/min

**Table 6.** Description of Norit Carbons Used in Parametric Tests.

Name	Description	Particle Size Distribution <sup>a</sup>		
		D95	D50	D5
Darco FGD	Lignite AC	52	15-20	<3
Norit PAC2B	Subbit/Bit Blend of GACs	52	15-20	<3
Darco Insul	Fine chemically treated specialty product	25	6-7	<2
Fine FGD	Ground FGD	D90: 16	6-7	<1
HydroDarco-C	Coarser FGD	100	30	3

*a. Percent of particles less than size in microns*

## 5. Long-Term Performance Tests

Continuous, 24-hour per day testing for five days at “optimum” plant operating conditions (most cost-effective mercury removal), as determined from the parametric tests, was conducted to gather data on:

1. Mercury removal efficiency over time;
2. The effects on COHPAC and balance of plant equipment of sorbent injection; and
3. Operation of the injection equipment to determine the viability and economics of the process.

Darco FGD activated carbon was the sorbent for these tests. Carbon was injected continuously 24 hours per day, for nine days. Injection rate was set by taking into consideration both mercury removal and the projected increase in COHPAC cleaning frequency. A detailed test plan can be found in Appendix D dated April 9.

Similar to the baseline test series, mercury was measured by both the S-CEMs and manual methods (Ontario Hydro). These measurements were made at three locations: upstream of the hot side ESP, and the inlet and outlet of COHPAC. COHPAC performance, coal and ash samples, and plant CEM data were collected. During these tests an EPA audit of the manual measurements was performed.

## GASTON TEST RESULTS

Field testing on Gaston Unit 3 was concluded on April 29, 2001. The test series and dates of testing are summarized below:

**Table 7.** Schedule of Gaston Field Tests

<b>Test Description</b>	<b>Dates (2001)</b>
Pre-Baseline Measurements	January 18 - 26
Sorbent Screening Tests (field)	January 25 - 29
Leaching Test	March 1 -3
Baseline Tests	March 5 - 7
Parametric Test Week 1	March 12 - 16
Parametric Test Week 2	March 19 – 23
Parametric Test Week 3	March 26 - 30
Long Term Test (Darco FGD)	April 17 – 27
Re-Test of Insul and Fine FGD	April 28 and 29

Results are presented separately for each of the series of tests in the subsections below. Results from coal and ash analyses for all test series are presented and discussed together under “Coal and Ash Characterization.” Cost data is provided in the final subsection “Economic Analysis.”

## Laboratory and Field Sorbent Screening Test Results

Laboratory sorbent screening results are presented in Table 8. Gaston sieved ash showed effective capacity for both elemental and oxidized mercury. Gaston COHPAC and ESP ash showed effective capacity for oxidized mercury. Norit GAC sorbents (bituminous and subbituminous based) showed very high capacities for both elemental and oxidized mercury. Capacities for the TDA samples for mercuric chloride were between 40 to 99  $\mu\text{g/g}$  and for elemental mercury between 8 and 64. Sample TDA421-B showed the best results for TDA products.

Results from fixed bed screening tests, conducted by Apogee, on a slip stream of flue gas were similar to the laboratory results, showing that the activated carbons had adsorption capacities 100 times greater than ash or a non-carbon-based sorbent. Figure 5 presents these results compared to results from the laboratory tests. The TDA sample showed very low adsorption capacity when exposed to flue gas.

In choosing sorbents for a baghouse, it is generally believed that sorbents with capacities greater than 100  $\mu\text{g}/\text{Nm}^3$  will provide mercury control. However, it is also believed for baghouse configurations that higher adsorption capacity sorbents will be more effective at similar injection rates than lower ones because of the relatively long exposure time and good contact as flue gas passes through the dustcake. What is not known is at what point there are diminishing returns with higher capacities. Therefore it was of interest to consider ash, a lower capacity sorbent, from the ESP as a potential sorbent. But because of the accelerated schedule at this site and the safety issues involved with removing large quantities of hot ash ( $> 600^\circ\text{F}$ ) from the hoppers, it was not possible to use Gaston ash as a candidate for duct injection testing.

**Table 8.** Laboratory Fixed Bed Mercury Adsorption Capacity Test Results

<b>Sample ID</b>	<b>Mercuric Chloride Equilib Capacity @ 50 µg/Nm<sup>3</sup> (µ Hg/g)</b>	<b>Elemental Mercury Equilib Capacity @ 50 µg/Nm<sup>3</sup> (µ Hg/g)</b>
<b>Screening Tests Performed Prior to Field ACI or PAC Tests</b>		
Gaston ESP Flyash	35	96
Gaston ESP +200 mesh	139	39
Gaston COHPAC ash	41	2
GAC-830	2441	2976
GAC-1240	2251	3011
FGL M-1182	1931	2278
Darco FGD M-1161	2179	1870
TDA421-A	61	N/A
TDA421-B	99	64
TDA421-C	40	8
Darco FGD (reference sample)	2852	1826
<b>Capacity Tests Requested During Field ACI Evaluation</b>		
<b>COHPAC Ash Samples – Parametric Tests</b>		
GAS00037 A-Side (no carbon)	18	27
GAS00038 B-Side (with Darco FGD)	50	86
<b>Sorbents Tested in Parametric Tests (samples taken from feed hopper)</b>		
Darco Insul		2282
Norit PAC 2B		1833
HydroDarco-C		1042
Darco FGD (reference)		1519

**Figure 5:** Results from Screening Tests on Sorbents Tested in the Laboratory and on a Slip Stream of Flue Gas from Gaston Unit 3.

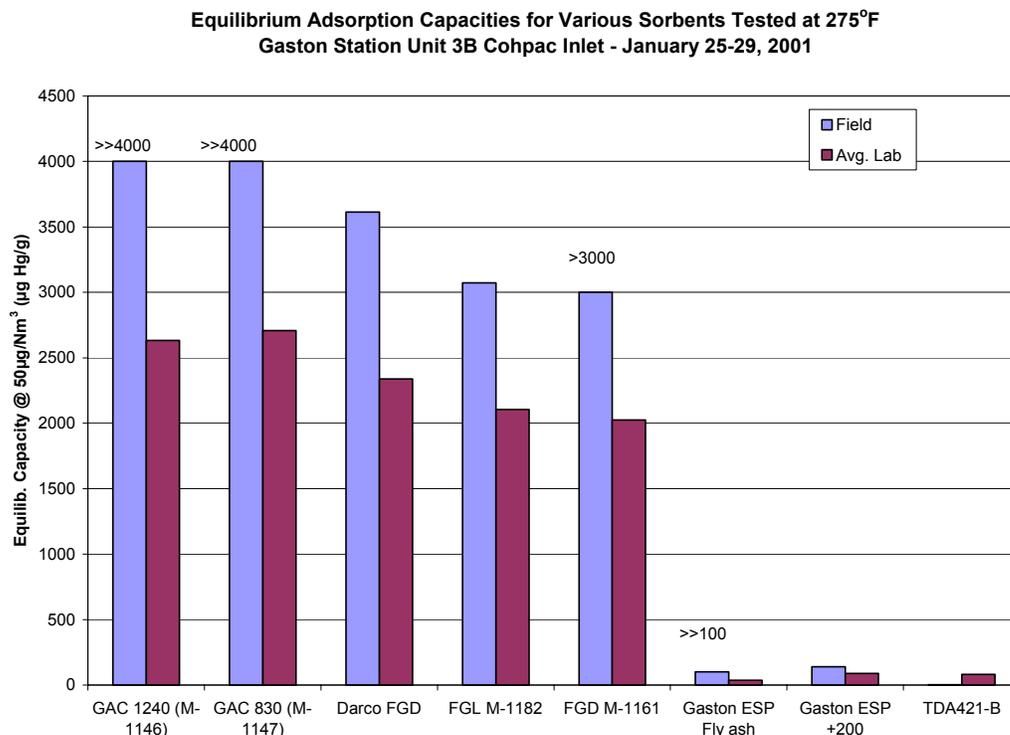


Figure 5 shows the comparison between laboratory and field (slipstream) fixed-bed test results. Eight sorbents were tested in the field in total. Major conclusions from these results are:

- The capacities of the activated carbon sorbents were higher in the field than in laboratory tests.
- The capacity of sieved, ground ESP fly ash was high enough to be an interesting candidate for in-duct sorbent injection tests. Unfortunately, this was not found to be practical for these tests because of the difficulty in extracting and handling the high-temperature ash.

### Pre-Baseline Test Results

Table 9 presents vapor-phase mercury measurements during the pre-baseline tests in January. These results and the preliminary fixed-bed laboratory screening results were presented in a memo dated January 24, 2001, included in Appendix B. Two S-CEM analyzers were used for these tests. The analyzers were set-up to measure simultaneously either across the hot-side ESP or COHPAC. Flue gas temperatures were nominally 650°F at the inlet to the hot-side ESP and between 240 – 270°F at COHPAC inlet and outlet.

The results show that vapor-phase mercury varied between 7 and 10  $\mu\text{g}/\text{dNm}^3$  at all three locations. There was no measurable removal of vapor-phase mercury across either the hot-side ESP or COHPAC.

These results are comparable to those made during ICR measurements on Unit 1 for total mercury concentrations and removal efficiencies. ICR measurements showed total mercury concentrations between 6.0 and 7.5  $\mu\text{g}/\text{dNm}^3$  and no mercury removal across the hot-side ESP<sup>8</sup>. A coal sample taken in December 2000 was analyzed for mercury by URS and showed 0.0906 ppm (about 8  $\mu\text{g}/\text{Nm}^3$ ) of mercury. The coal sample also confirmed that measured mercury levels were in an expected range.

It was somewhat surprising that there was no measured mercury removal across COHPAC, especially at operating temperatures below 270°F. Review of data collected through the ICR at other plants shows that there was significant natural mercury capture on units with baghouses when firing bituminous coals<sup>12</sup>. This natural collection is assumed to occur because of exposure of the flue gas to ash on the bag dustcake. The ash at Gaston was tested for loss on ignition (LOI) and mercury adsorption capacity by URS. Analysis of the ash showed high carbon content throughout the total size distribution (LOI around 7% in the HESP ash and about 11% in COHPAC ash) and an adsorption capacity that was comparable to other bituminous ashes. However, since COHPAC is downstream of the hot-side ESP and the ESP was in excellent condition at the time of the tests, the inlet loading was very low (0.04 gr/acf on average and less than 0.01 during the tests, according to the BHA particulate monitors in the COHPAC inlet duct) and there was a relatively small amount of ash present to react with mercury.

**Table 9.** Pre-Baseline Mercury Measurement Results (S-CEM).

Location	Total Mercury $\mu\text{g}/\text{dNm}^3 @ 3\% \text{O}_2$	Oxidized Mercury %
ESP Inlet	7 – 10	5 - 33
ESP Outlet/COHPAC Inlet	7 – 10	29 – 51
COHPAC Outlet	7 – 10	52 - 76
Mercury Removal Across ESP		0%
Mercury Removal Across COHPAC		0%

The portion of vapor-phase mercury in the oxidized state increased in the direction of flow. There was a greater percentage of elemental mercury at the hot-side inlet (economizer outlet) than there was at either the COHPAC inlet or outlet. The most significant oxidation occurred across the COHPAC baghouse. Similar phenomena have been documented across baghouses with PPS fabric bags.<sup>12</sup>

These tests confirmed that no mercury removal is seen in the native configuration at Gaston Unit 3, making it an interesting candidate for sorbent injection.

### Leaching and Baseline Test Results

Activated carbon was injected for a short period during “leaching tests” in order to determine the impacts on ash disposal during the full test series. These leaching tests were conducted on March 1-3, 2001, and results are presented with graphs in the March 8, 2001 memo in Appendix C. The S-CEMs were used to obtain mercury removal across COHPAC initially and with carbon injection. Significant results and observations from this short-term test include:

- Inlet mercury concentration ranged from 5.8 to 10.6 ug/Nm<sup>3</sup>, consistent with pre-baseline measurements.
- Removal of mercury across COHPAC without sorbent injection was nominal to zero.
- At a carbon injection feedrate of 100 lb/hr, the grain loading to COHPAC was approximately doubled. Within 30 minutes of starting injection, 88% mercury removal was measured.
- When carbon injection was turned off, outlet mercury removal returned to pre-test values after 6 hours.
- COHPAC cleaned more frequently during sorbent injection (increase approximately from once per three hours to once per hour) but returned to normal pre-test rates two hours after sorbent injection was stopped.

The leaching test was performed in order to determine the impact of sorbent injection on ash disposal. This was determined by TCLP tests performed by Alabama Power’s test lab. TCLP results showed that mercury was not detected and that all measured metals were well below their threshold limits. LOI measurements showed 10.46% LOI in the COHPAC/sorbent injection samples. These leaching test results confirmed that the ash/sorbent mixture generated during injection tests could be sent to the ash pond. This made ash disposal routine, rather than having to isolate and separately dispose of the ash during sorbent injection tests.

For Baseline tests both S-CEMs and Ontario-Hydro were used to make mercury measurements. In addition coal and ash analyses for mercury were made. These results are tabulated and discussed in the Section below entitled “Coal and Ash Characterization.” Triplicate COHPAC inlet particulate measurements via Method 17 were made by SRI. It appears there was a sampling problem during the first run. Taking the average of the other two runs shows that the COHPAC inlet particulate loading was 0.08 gr/acf during baseline tests. This is higher than average for the site.

Results from the Ontario Hydro tests conducted by Southern Research Institute are presented in Table 10. Similar to pre-baseline measurements, there was no measurable mercury removal across COHPAC. The average of the inlet and outlet total mercury measurements was about 14 µg/Nm<sup>3</sup>. S-CEM measurements showed vapor phase mercury varied between 8 to 12.5 µg/Nm<sup>3</sup>. Detailed Ontario-Hydro test results are reported by SRI in a separate report.<sup>13</sup>

In addition to monitoring mercury removal, it was also important to document the performance of COHPAC during sorbent injection. The primary COHPAC performance indicator at this site was cleaning frequency. Pressure drop/drag is controlled by the cleaning frequency. It was expected that cleaning frequency would increase with the increased particulate loading from sorbent injection. Cleaning frequency was monitored before, during and after sorbent injection, beginning during this baseline test series.

Coal analyses showed mercury levels in the three coal samples varied between 0.06 and 0.17 µg/g. Since Gaston burns coals from several different coal sources each day it is difficult to correlate mercury level in the coal to a specific flue gas measurement; however, the higher coal mercury values correlate well with mercury measured in the flue gas. For example, a coal mercury level of 0.17 µg/g is equivalent to a mercury concentration of 15.0 µg/dncm in the flue gas.

The Ontario Hydro measurements showed oxidation across COHPAC. At the inlet the average fraction of oxidized mercury was 61%, and increased to 77% at the outlet. Flue gas temperatures during these tests were nominally 255°F.

**Table 10:** Baseline Ontario Hydro Measurements at COHPAC Inlet and Outlet

Date/Location	Particulate (µg/dncm <sup>1</sup> )	Oxidized (µg/dncm <sup>1</sup> )	Elemental (µg/dncm <sup>1</sup> )	Total (µg/dncm <sup>1</sup> )	Percent Oxidized
3/6/01 Inlet	0.0	10.7	6.1	16.9	63
3/6/01 Inlet	0.0	7.4	6.5	13.9	53
3/7/01 Inlet	0.2	8.4	4.0	12.5	67
Average Inlet	0.1	8.8	5.5	14.4	61
3/6/01 Outlet	0.0	9.4	4.3	13.7	69
3/6/01 Outlet	0.0	11.5	2.8	14.3	81
3/7/01 Outlet	0.0	10.1	2.3	12.4	82
Average Outlet	0.0	10.4	3.1	13.5	77

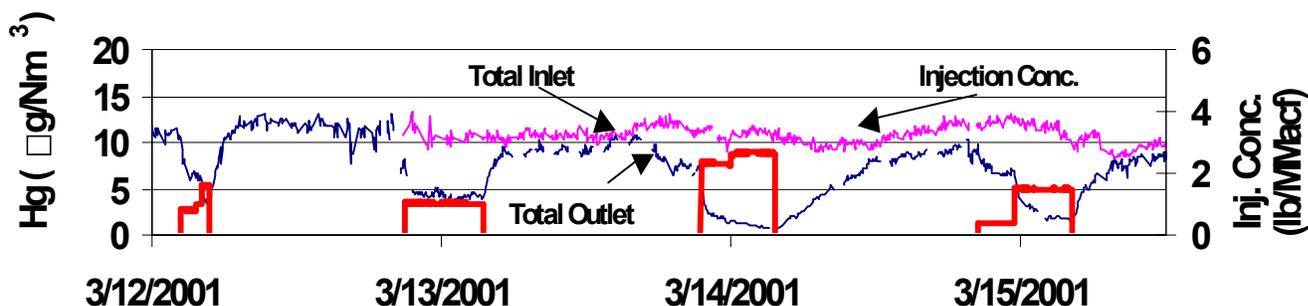
*1. Normal: T = 32°F*

### Parametric Tests

Parametric testing showed mercury removal as a function of injection concentration and sorbent type, and the impact of sorbent injection on COHPAC performance. The parametric test conditions are presented above in Table 5, and the carbons described in Table 6. Feedback from the S-CEMs was invaluable in making real-time decisions on test conditions. Examples of the data provided from the S-CEMs are presented in Figure 6. These data are from the first week of parametric tests, test numbers 1 – 4, with Darco FGD. Reduction in outlet mercury concentration can be seen to correlate with relative injection rates. Each test condition was held constant for 6-8 hours when possible.

Preliminary results from each of the three weeks of parametric tests have been presented in memos dated March 15, March 25, and May 9, 2001, which can be found in Appendix C. The most significant of these results are summarized here.

**Figure 6.** S-CEM Mercury Measurements During the First Week of Parametric Tests with Norit Darco FGD PAC



Results with Darco FGD showed mercury removal efficiencies as high as 90% at injection concentrations about 2.0 lbs/MMacf. This is less carbon than the theoretically predicted rate of 3.0 lbs/MMacf<sup>7</sup>. The predicted and actual injection rates for target removals of 50, 75, and 90% are summarized in Table 11.

**Table 11.** Predicted and Measured Injection Rates for Target Mercury Removals. Darco FGD Injection.

Target Removal %	Predicted Injection* lb/MMacf	Parametric Test Results lb/MMacf
50	1.0	0.65
75	2.0	1.4
90	3.0	2.2

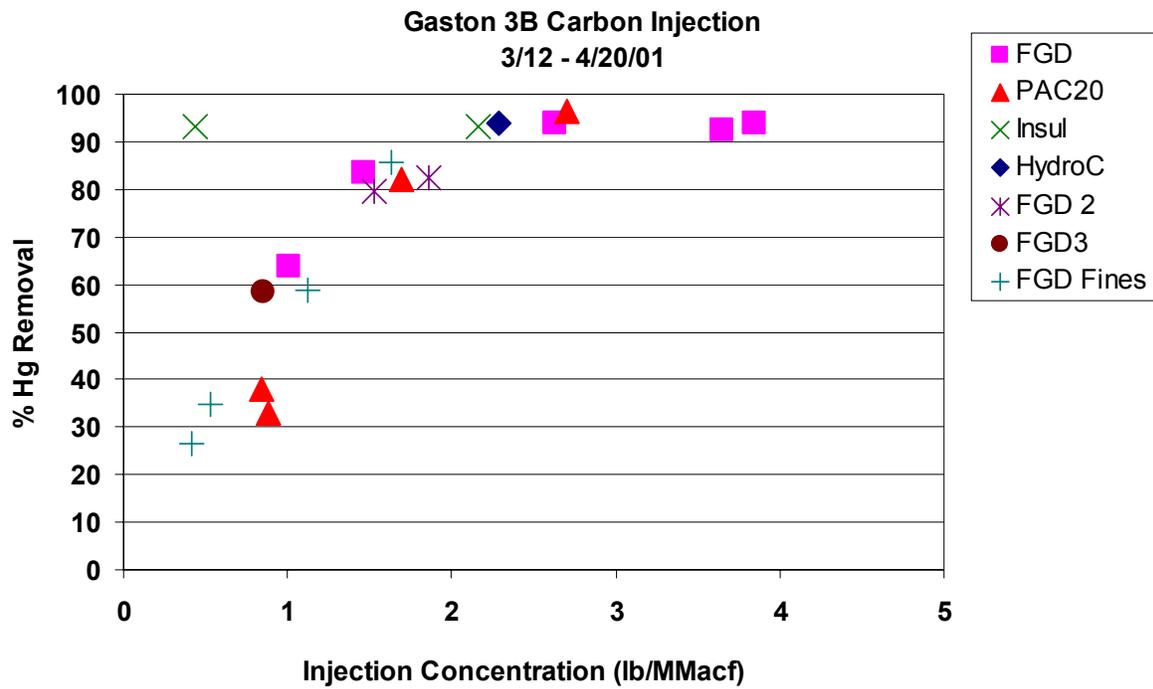
\* Based on uniform sorbent size of 15 microns.

Other carbon-based products tested and described in Table 6, showed similar performance to Darco FGD. Increasing the amount of sorbent above 2.0 lb/MMacf did not improve removal efficiency. Figure 7 presents mercury removal efficiencies as activated carbon injection concentrations were varied during the parametric tests for several activated carbons. This figure shows that mercury removal increased nearly linearly with injection rate up to 2 lbs/MMacf and then leveled off at about 90% removal with higher injection providing no additional benefit.

As shown on Figure 7, a single test result obtained during the parametric testing showed Insul carbon to remove 93% mercury at an injection rate of only 0.44 lb/MMacf. Follow-up testing was conducted after the long term test series was complete to confirm this result and to test “Fine FGD,” which is ground FGD provided by Norit. The retest of Insul did not confirm the unusually high removal at low injection rate. Rather, the tests of both Insul and Fine FGD fall in line with the balance of data from other carbons. They both provided about 40% mercury removal at an injection rate of 0.5-.6 lb/MMacf. The detailed data from these parametric tests are provided in Appendix E.

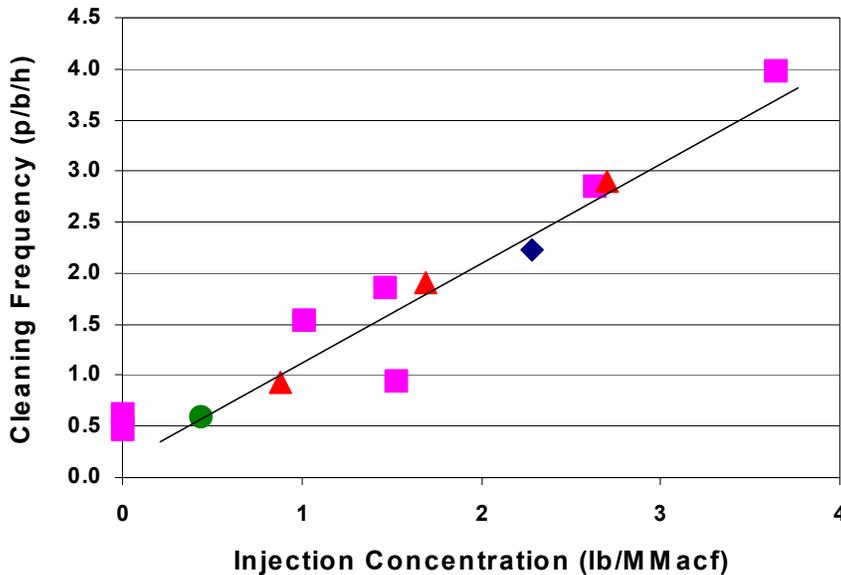
Thus there was no measurable performance difference between the different PAC’s.

**Figure 7.** Mercury Removal Trends Across COHPAC as a Function of PAC Injection Concentrations. Measurements Made During Parametric Tests, March – April 2001.



Carbon injection significantly increased the cleaning frequency of the COHPAC baghouse. At an injection concentration of 2.0 lbs/MMacf the cleaning frequency increased from 0.5 to 2 pulses/bag/hour, or a factor of 4. An acceptable cleaning frequency at this site, per Alabama Power, is 1.5 pulses/bag/hour, to maintain good bag life. Figure 8 shows the impact of sorbent injection on cleaning frequency.

**Figure 8.** COHPAC Cleaning Frequency in Pulses/Bag/Hour as a Function of PAC Injection Concentration. Measurements Made During Parametric Tests, March 2001



Parametric tests were performed to vary both injection rate and sorbent type. The main effects that were evaluated were mercury removal and baghouse cleaning frequency. The main conclusions and observations are summarized as:

- Each of the five sorbents tested (see Table 6) performed similarly in terms of both mercury control and bag cleaning rate.
- The quantity of sorbent required for a given removal was somewhat less than expected.
- Mercury removal leveled off at about 90%, which corresponded to 2 lb/MMacf of sorbent injection.
- At this “maximum” mercury control condition, bags were cleaning at 2 pulses/bag/hour, which is an unacceptably high cleaning rate for this site.
- At an acceptable cleaning rate of 1.5 pulses/bag/hour, about 1.0 to 1.5 lb/MMacf can be injected. This corresponded to about 60-80% mercury removal during these short-term tests.

## Long-Term Tests

During these tests, carbon was injected continuously 24 hours per day, for 9 days. Based on results from the parametric tests, Darco FGD was chosen as the sorbent and a target injection rate of 1.5 lbs/MMacf was chosen to maintain COHPAC cleaning frequency below 1.5 pulses/bag/hour. Injection rate was determined by taking into consideration both mercury removal and the projected increase in COHPAC cleaning frequency. An injection concentration of 1.5 lbs/MMacf was targeted to maintain COHPAC cleaning frequency below 1.5 pulses/bag/hour.

Similar to the baseline test series, mercury was measured by both the S-CEMs and manual methods (Ontario Hydro). COHPAC performance, coal and ash samples, and plant CEM data were collected. During these tests an EPA audit of the manual measurements was performed.

The long-term tests started on April 18 and carbon was injection continuously until April 26. Full load boiler conditions were held between the times of 0700 and 2000, with load under dispatch control at other times for the first 5 days. During the three days when the Ontario Hydro tests were conducted, full load was maintained 24 hours/day. At the beginning of this test series time was needed to work out a COHPAC cleaning logic issue and there was a short period when load was lowered to fix a mill problem. The final 7 days of the test were conducted at the optimized PAC feedrate and COHPAC cleaning logic.

Three sets of Ontario Hydro measurements were made at three locations: 1) inlet of the hot-side ESP, 2) COHPAC inlet and 3) COHPAC outlet. SRI coordinated all tests and reported the results. Arcadis G&M Inc. conducted the hot-side measurements using an experimental in-duct, quartz thimble to minimize sampling artifacts often seen with this method. Artifacts have been known to occur when the particulate collected on the filter captures vapor phase mercury, resulting in higher particulate phase mercury than is really present. Sampling artifacts from particulate on the filter were not as much of a concern at the other two locations because most of the particulate was already removed by either the hot-side ESP or COHPAC.

Preliminary results from these tests were presented in a memo dated May 2, 2001, included in Appendix D. This section presents more complete final data.

Table 12 presents the results from each of the Ontario Hydro measurements. These data show that the inlet to the hot-side ESP and the inlet to COHPAC have similar, average mercury concentrations and speciation. The outlet mercury concentrations show the effect of carbon injection with overall low mercury emissions for all species. Table 13 presents average, speciated mercury removal across COHPAC. The overall average reduction in total mercury is 90%. At the outlet the predominant species of mercury is the oxidized form; however, it is still 85% less than upstream of PAC injection. Detailed results, including data sheets, from Ontario-Hydro tests are reported separately<sup>13</sup>.

Table 14 compares the Ontario-Hydro mercury measurements to those using the S-CEM. This table shows that the S-CEM agrees well with the Ontario-Hydro method. Comparing the tabulated results and the graphs of S-CEM data, it is clear that the S-CEM tool is key for tracking

mercury performance in real time as boiler and fuel changes result in variations in mercury concentrations, as discussed below.

Figure 9 presents inlet and outlet mercury concentrations as measured by the S-CEMs, boiler load, and PAC injection concentration during the last 5 days of the long-term test. Periods when Ontario Hydro measurements were made are also identified. The S-CEMs indicate that mercury removal was nominally 87, 90, and 88% during the Ontario Hydro tests. This correlates well with the manual measurements. However, it is important to note that the S-CEMs showed that the average mercury removal efficiency over the multi-day time period was 78%, with variations between 36% to over 90%. This difference is probably due to varying coal and operating conditions over time. Figure 9 also shows that during this 5-day period inlet mercury concentration varied by nearly a factor of five. Outlet concentrations can be seen to follow the inlet and there are times during these transitional periods when removal efficiencies are fairly low. During the period when the Ontario Hydro tests were run, inlet mercury levels were low and fairly steady. These tests were conducted under ideal conditions and may show the best case condition for mercury control at this injection rate.

During the test program sorbent was injected at a constant rate with no attempt to increase sorbent when the inlet mercury concentration increased. However, the data in Figure 9 highlight the importance of having CEMs to use as process control for a permanent mercury control system.

**Table 12:** Ontario Hydro Measurements at Hot-Side ESP Inlet, COHPAC Inlet and COHPAC Outlet during Long-Term Carbon Injection Test.

Date/Location	Particulate ( $\mu\text{g}/\text{dnm}^3$ )	Oxidized ( $\mu\text{g}/\text{dnm}^3$ )	Elemental ( $\mu\text{g}/\text{dnm}^3$ )	Total ( $\mu\text{g}/\text{dnm}^3$ )	Percent Oxidized
4/24/01 ESP Inlet <sup>2</sup>	0.5	2.7	5.2	8.3	32
4/25/01 ESP Inlet <sup>2</sup>	0.0	6.8	3.4	10.2	66
4/26/01 ESP Inlet <sup>2</sup>	0.1	6.2	2.8	8.6	66
Average ESP Inlet	0.2	5.1	3.8	9.0	55
4/24/01 COHPAC In	0.1	4.6	4.9	9.5	48
4/25/01 COHPAC In	0.4	5.2	3.1	8.7	60
4/26/01 COHPAC In	0.2	7.9	4.8	12.8	62
Average COHPAC Inlet	0.2	5.9	4.2	10.3	57
4/24/01 COHPAC Out	0.1	0.9	0.1	1.1	91
4/25/01 COHPAC Out	0.2	0.8	0.1	1.0	78
4/26/01 COHPAC Out	0.1	0.9	< 0.1	0.9	93
Average COHPAC Outlet	0.1	0.8	$\leq 0.1$	1.0	87

1. Normal:  $T = 32^\circ\text{F}$

2. Tests conducted by Arcadis using an in-stack (heated) quartz thimble.

**Table 13:** Average Mercury Removal Efficiencies Across COHPAC as Measured with Ontario Hydro Method

Sampling Location	Particulate ( $\mu\text{g}/\text{dncm}^1$ )	Oxidized ( $\mu\text{g}/\text{dncm}^1$ )	Elemental ( $\mu\text{g}/\text{dncm}^1$ )	Total ( $\mu\text{g}/\text{dncm}^1$ )
COHPAC Inlet	0.2	5.9	4.2	10.3
COHPAC Outlet	0.1	0.8	$\leq 0.1$	1.0
Removal Efficiency (%)	50	86	$\geq 98$	90

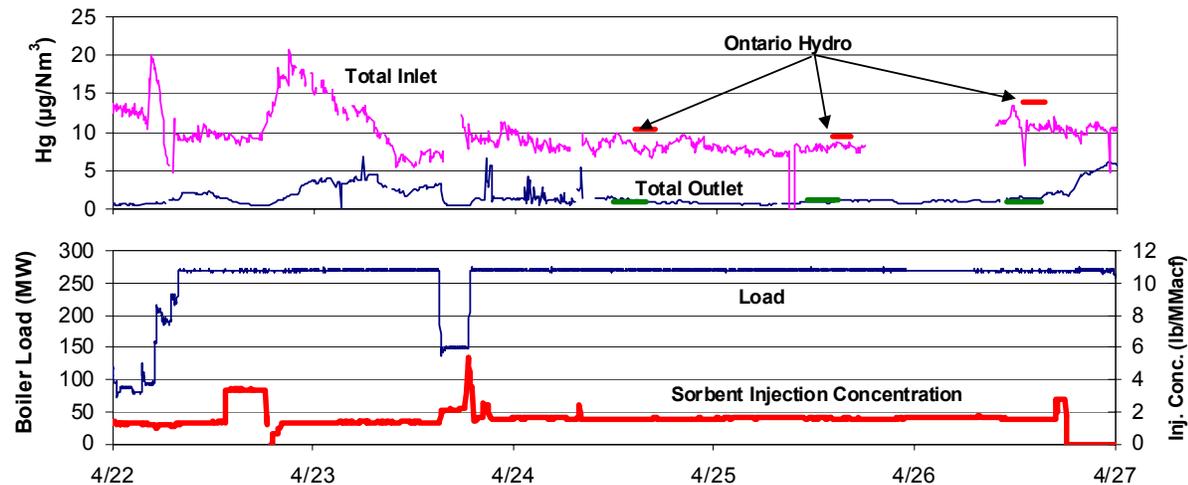
1. Normal:  $T = 32^\circ\text{F}$

**Table 14.** Comparison of coal-based calculations with flue gas measurements. Simultaneous S-CEM and Ontario-Hydro measurements were taken during Long-Term sorbent injection test. Total Hg,  $\mu\text{g}/\text{Nm}^3 @ 3\% \text{O}_2$ .

	4/22/01	4/23/01	4/24/01	4/25/01	4/26/01	4/27/01	4/28/01
Coal	23.8		12.3	17.7	9.5	15.6	
OH <sup>1</sup>			9.5	8.7	12.8		
S-CEM	10-18	7-16	7-10	5-8	10	8-12	10-14

1. Ontario Hydro Measurements at COHPAC Inlet.

**Figure 9.** Inlet and Outlet COHPAC Mercury Concentrations, Boiler Load and PAC Injection Concentration During Long-Term Tests, April 2001



The most challenging time for COHPAC performance was during the period with continuous full-load operation and PAC injection. The cumulative cleaning frequency increased to a high of 1.3 pulses/bag/hour, but was mostly maintained at levels less than 1.0 pulses/bag/hour.

A few new Ryton bags that were installed into both A and B side on 2/26/01 were strength-tested following the long-term tests. They had been in place for the entire sorbent injection test program. The results of these tests are detailed in a memo from Grubb Filtration in Appendix F. No significant differences between the control side A and injection side B were seen in appearance or in measurements of fabric strength or pH.

### **Coal and Ash Characterization**

Coal and ash samples were collected daily during the baseline, parametric and long-term tests. Gaston fires a variety of washed, low sulfur eastern bituminous coals. Because several coals can be fired in a day, the daily coal samples will provide relative mercury concentrations, but may not be representative of specific test periods. Since the parametric tests covered such short periods of time, analyses of samples from this period was kept to a minimum. The main samples analyzed were from baseline and long-term tests, for comparison of normal operation to low-mercury operation. Selected samples were analyzed for Hg, LOI, and/or leaching characteristics.

Ash generated from the E.C. Gaston Plant is impounded using a wet ash handling system. The ash is not currently beneficially reused, therefore the waste characterization testing was aimed at assessing the stability of the mercury contained on the COHPAC collected materials.

The standard testing technique used for assessing hazardous waste characteristics is the Toxicity Characteristic Leaching Procedure (TCLP, SW846-1311). The test protocol involves exposing a 100-gram sample of ash to 1-liter of acidic solution (acetic acid-or acetate based) for 24 hours. The solution is then analyzed for several metals (including mercury) to determine how much of each target metal was leached from the solid sample. This is an EPA test protocol.<sup>14</sup> Results are compared against limits established by regulation. In the case of mercury, a maximum leachable level of 0.2 mg/liter has been established. These tests and analyses were performed during the initial “Leaching Tests” on site. The test found that the ash / sorbent combination passed TCLP for all regulated substances.

The synthetic ground water leaching procedure (SGLP) was developed at the University of North Dakota Energy and Environmental Research Center (EERC) and was designed to simulate the leaching of CUBs under important environmental conditions.<sup>15</sup> It was initially used to characterize highly alkaline CUBs, primarily fly ash produced from the combustion of low rank coals. The procedure was modeled after the TCLP, but allowing for disposal conditions other than those of a sanitary landfill. Deionized water is used as the leaching solution instead of the acidic solutions used in the TCLP. The SGLP was designed primarily for use with materials such as low-rank coal ash that undergo hydration reactions upon contact with water. Test conditions are end-over-end agitation, a 20:1 liquid to solid ratio and a thirteen-hour equilibration time.

The results of analysis of the solid samples from both Baseline and Long-Term sorbent injection tests at Gaston Unit 3 are presented here. Highlights of the results are summarized as follows:

## General Results of Coal and Ash Analyses

- Characterization of the ash at Gaston Unit 3 consisted of preliminary TCLP testing for acceptability to the plant, followed by comparative analyses for mercury, particle size distribution and LOI on samples collected during testing. Since the ash at this site is significantly smaller in quantity (COHPAC ash only) than ash from a full unit, and is disposed of on-site in ash ponds for eventual landfill, analyses to determine the impacts on byproduct use were not applicable and were not pursued. Leaching tests showed that the ash/sorbent combination was below regulatory maximums.
- The configuration of Gaston Unit 3 is such that the majority of ash is collected in the Hot-Side Electrostatic Precipitator (HESP), while a small fraction is collected in COHPAC. This splitting of the ash makes a mass balance (mercury in coal=mercury in ash + mercury emitted) virtually impossible. No mass balance is attempted here, but trends of LOI content, mercury content, and size of ash are noted. The variation in coals fired at Gaston adds to the unpredictability of mercury concentrations in the ash.
- Coal mercury levels correspond reasonably well with mercury levels measured at the inlet to the HESP and the inlet to COHPAC. Results from analyses of coal grab samples are used to project mercury emissions in the duct, and these are correlated with gaseous sampling results. Those correlations are better in some cases than others. These discrepancies may be caused by the difficulty of obtaining a time-representative coal sample in a unit that fires a variety of coals. The time lag between coal sampling and firing that coal may not correspond to the test period exactly, and as seen in S-CEM data throughout this report, inlet mercury levels vary significantly with time. Samples were taken from the coal bunkers as they were being filled, rather than from the feeders. This means the time lag could be 18-24 hours between the sample time and furnace.

## Baseline Testing

- Significant variation in the coal properties (volatile matter, Hg content) occurred during the baseline-testing period.
- The total mercury at the COHPAC inlet as measured by the Ontario Hydro method averaged  $14.5 \mu\text{g}/\text{Nm}^3$  during a two-day period when the coal mercury as sampled corresponded to  $6.5 \mu\text{g}/\text{Nm}^3$ . The prior day's coal mercury corresponded to  $16.4 \mu\text{g}/\text{Nm}^3$ . During this same period the measurements taken by the S-CEMs showed 8 to  $12.5 \mu\text{g}/\text{Nm}^3$  of vapor-phase mercury. These results correspond reasonably well, but point to the difficulty in obtaining representative coal samples for more-precise mercury calculations.
- The COHPAC A-side (control side) ash had 0.7-0.8 ppm mercury in comparison with 0.005-0.03 ppm mercury in the HESP ash during the baseline tests, indicating that mercury is concentrated in the ash that is captured in COHPAC. The main characteristics that may affect this difference in mercury capture are: temperature (about 255 F in COHPAC compared with about 690 F in the HESP) and residence time.

## Long-Term Sorbent Injection Testing

- The coal for the sorbent injection tests appeared to be similar to that burned during the baseline testing.
- LOI was higher during these tests than the baseline series, with 11.8% average LOI in the HESP and 14.5% average LOI in COHPAC A-side (control side). These values are both several percentage points higher than LOI during baseline tests.
- The B-side (injection side) sorbent-ash mixture showed about 30 wt% LOI as compared to ~15 wt% LOI in the A-side (control side) ash.
- Ash samples show significant data scatter between individual mercury analyses, reflecting the difficulty of obtaining representative ash samples. Based on an average of five samples, the sorbent-ash mixture from the B-side (injection side) hopper contains 50 times the mercury of the A-side (control side) hopper ash, indicating removal of mercury by sorbent across the COHPAC. A-side ash averaged 0.8 ppm mercury, compared with 0.75 ppm during baseline tests. B-side ash averaged 41.8 ppm mercury.
- Gaston Station burns different coals and changes coal frequently. The coal mercury content varied in the long-term testing from 0.08 to 0.2 µg/g. If the plant continues to operate with such a wide range of mercury contents, then effective mercury control can either be achieved by adding enough sorbent for the *maximum expected mercury content* or by using a continuous mercury monitor to determine the level of mercury in the flue gas and the amount of sorbent needed.

Appendix G contains the full writeup of coal and ash characterization results provided by Connie Senior of Reaction Engineering, with all samples listed. Selected results are presented here. LOI measurements of ash were carried out at PSI, while Microbeam Technologies carried out all other analyses.

### Detailed Results Discussion: Baseline Testing

Table 15 gives the results of coal analyses for the baseline testing. The plant burns more than one coal, switching coals frequently. This may account for the large variation in the coal properties. The coal is bituminous with about 14 wt% ash (as-received basis). The chlorine content is very low for a bituminous coal (100-160 ppmw, dry basis). The mercury content varied between 0.06 and 0.16 ppmw (dry basis). The notable aspect of the coal data is that the coal properties (volatile matter, moisture, mercury content) changed markedly between 3/5 and 3/6. As mentioned above, each coal sample is a single grab sample taken from the coal bunkers, and do not reflect a well-blended average of fired coal.

**Table 15.** Baseline coal sample results (as-received basis).

ADA Sample	GAS00010	GAS00014	GAS00019
MTI Sample	01-057	01-058	01-059
Date/Time	3/5/2001 0:00	3/6/2001 0:00	3/7/2001 0:00
<b>ULTIMATE ANALYSIS (As Received):</b>			
Carbon	65.31	71.54	73.21
Hydrogen	4.07	3.58	3.66
Oxygen	5.44	1.87	0.94
Nitrogen	1.70	1.56	1.58
Sulfur	1.49	1.05	0.88
Ash	13.64	13.71	14.22
Moisture	8.35	6.69	5.51
Hg, µg/g	0.163	0.077	0.056
Cl, µg/g	148.47	88.64	133.68
HHV, Btu/lb	11,709	12,443	11,990
SO <sub>2</sub> , lb/MBtu	2.55	1.69	1.47
Ash, lb/MBtu	11.65	11.02	11.86
Hg, lb/TBtu	13.93	6.19	4.65
Hg, µg/dnm <sup>3</sup> (3%O <sub>2</sub> )	19.09	8.38	5.91
<b>PROXIMATE ANALYSIS (As Received):</b>			
Fixed Carbon	49.71	62.2	61.83
Volatile matter	28.3	17.4	18.44
Ash	13.64	13.71	14.22
Moisture	8.35	6.69	5.51

As shown in Table 16, the Ontario Hydro measurements of total mercury at the inlet to the COHPAC on 3/6 and 3/7 were from 13 to 17 µg/dscm. For 3/6 and 3/7, the coal analysis indicated a total mercury concentration in the flue gas of 5-7 µg/dscm (calculated at 3% O<sub>2</sub>), or half of the Ontario Hydro measurement. On 3/5, the coal mercury was equivalent to 16 µg/dscm, which was commensurate with the Ontario Hydro measurements (although one was not made on that day). The lag time of firing bunker (sampled) coal may contribute to the difference between coal and flue gas samples. S-CEM measurements showed total gaseous mercury concentrations in the range of 8-12.5 µg/dscm at the inlet to the HESP. Since this range of gaseous mercury concentration is similar to the total mercury based on the coal composition, there is reason to believe that the total mercury at the HESP inlet was representative of the total mercury input to the boiler.

**Table 16.** Total mercury in flue gas at COHPAC inlet: comparison of Ontario Hydro measurement and calculation from coal composition

ADA Sample	GAS00010	GAS00014	GAS00019
MTI Sample	01-057	01-058	01-059
Date/Time	5-Mar	6-Mar	7-Mar
<b>Coal measurements</b>			
Hg, $\mu\text{g}/\text{dnm}^3$ (3%O <sub>2</sub> )	16.35	7.55	5.45
<b>Ontario Hydro measurements</b>			
Hg, $\mu\text{g}/\text{dnm}^3$ (3%O <sub>2</sub> )		16.92	12.56
		13.98	

The LOI was measured for the HESP hopper samples and for the COHPAC hopper samples (A-side). The HESP ash has a moderate carbon level (~7 wt% LOI) and the carbon content of the ash increases to ~11 wt% LOI in the COHPAC ash. The apparent increase in LOI could indicate that the carbon is concentrated in finer ash particles that are likely to escape the HESP but be captured by the baghouse.

The mercury content of the HESP ash was generally low and this is supported by previous measurements that showed almost no mercury in the particulate phase at the inlet to the HESP. In contrast, the COHPAC ash had 40 to 100 times as much mercury as the HESP ash, reflecting the effect of lower temperatures and longer residence times in the COHPAC unit as compared to the HESP. Table 17 shows these results in detail.

**Table 17.** Ash analyses from baseline testing at Gaston Unit 3.

Sample ID	MTI ID	Date/Time	Sample Location	Hg, $\mu\text{g}/\text{g}$ (AR)	LOI, wt%
GAS00011	01-060	3/6/2001 15:00	ESP Ash	0.00546	7.1
GAS00012	01-061	3/6/2001 15:20	COHPAC, A-side	0.672	11.8
GAS00016	01-062	3/7/2001 13:30	ESP Ash	0.0262	7.58
GAS00017	01-063	3/7/2001 14:00	COHPAC, A-side	0.83	11.2

### Detailed Results: Long-Term Sorbent Injection Testing

The coal analyses during Long-Term tests (Table 18) suggest a lot of variability in the coal mercury content from sample to sample. The S-CEM and Ontario Hydro measurements also show considerable variation in the gaseous mercury in the flue gas (Table 19). Taken together, these data suggest that there is considerable variability in the mercury content of the coal, and that the gas phase mercury varies significantly from day to day. This has implications for implementation of a future sorbent injection system with this particular mix of coals.

**Table 18.** Sorbent injection campaign coal sample results (as-received basis).

ADA Sample	GAS00125	GAS00144	GAS00150	GAS00156	GAS00158
MTI Sample	01-112	01-116	01-120	01-124	01-125
		4/24/2001			
Date/Time	4/22/2001 12:00	12:00	4/25/2001 12:00	4/26/2001 12:00	4/27/2001 12:00
<b>ULTIMATE ANALYSIS (As Received):</b>					
Carbon	66.23	63.49	72.17	70.78	68.44
Hydrogen	3.30	3.21	3.43	3.23	3.61
Oxygen	4.93	4.63	3.40	3.77	4.03
Nitrogen	1.38	1.26	1.51	1.46	1.45
Sulfur	1.34	1.12	1.24	1.11	1.36
Ash	15.43	18.80	12.14	13.24	14.30
Moisture	7.40	7.49	6.12	6.41	6.82
Hg, µg/g	0.199	0.099	0.161	0.084	0.137
Cl, µg/g	211.42	248.45	132.81	111.65	140.77
HHV, BTU/lb	11,650	11,174	12,389	12,332	11,963
SO <sub>2</sub> , lb/MBtu	2.31	2.00	2.00	1.81	2.27
Ash, lb/MBtu	13.24	16.82	9.80	10.74	11.96
Hg, lb/TBtu	17.09	8.86	13.03	6.82	11.45
Hg, µg/dnm <sup>3</sup> (3%O <sub>2</sub> )	23.80	12.32	17.68	9.46	15.61
<b>PROXIMATE ANALYSIS (As Received):</b>					
Fixed Carbon	50.57	49.85	56.95	56.52	51.94
Volatile matter	26.6	23.86	24.79	23.83	26.94
Ash	15.43	18.8	12.14	13.24	14.3
Moisture	7.4	7.49	6.12	6.41	6.82

**Table 19.** Mercury in flue gas at COHPAC inlet: comparison of S-CEM gaseous measurement and total mercury calculation from coal composition and from Ontario Hydro measurement

ADA	Coal				GAS0012		GAS0015	GAS0015	
Sample					5	GAS00144	0	6	
MTI	Coal							GAS00158	
Sample					01-112	01-116	01-120	01-124	01-125
Date	19-Apr-01	20-Apr-01	21-Apr-01	22-Apr-01	24-Apr-01	25-Apr-01	26-Apr-01	27-Apr-01	
Coal Analysis					23.80	12.32	17.68	9.46	15.61
OH (COHPAC In)						9.57	8.69	12.88	
S-CEM	14.5	18	12	12	8	7	8		

The analyses of the ash samples are summarized in Tables 20 and on Figure 10. As with the baseline samples, there was a slight increase in LOI between the HESP ash and the COHPAC A-side ash, although the increase was not as large as that seen in the baseline testing. The B-side ash, of course, was mixed with sorbent and showed an average of about 30 wt% LOI. It is not surprising, that the sorbent-ash mixtures from the B-side hopper contain 10 to 100 times the mercury of the A-side hopper ash. The data scatter between individual tests is large and is shown in the Appendix G data.

**Table 20.** Summary of Ash Analyses.

Location	Average LOI (%)		Average Hg, µg/g	
	Sorbent Injection	Baseline	Sorbent Injection	Baseline
COHPAC A-side (control side) ash	14.5	11.5	0.81	0.75
COHPAC B-side (injection side) ash + sorbent	29.9	N/A	41.8	N/A
HESP ash	11.8	7.3	0.94	0.016

**Figure 10.** Mercury content of ash as a function of LOI for Unit 3 sorbent testing.

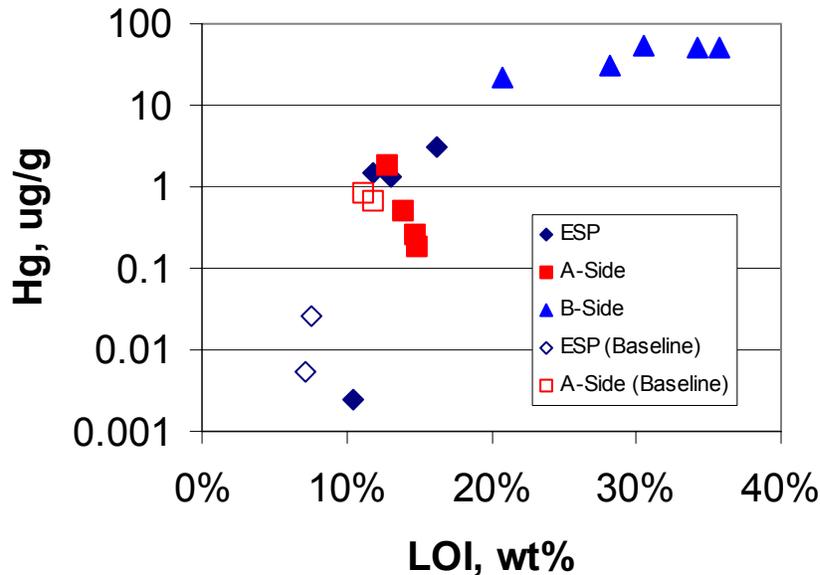


Figure 10 shows the correlation between LOI and mercury content of the ash for all samples. The high values of the mercury content of the HESP ash for the samples taken on 4/25 and 4/26 seemed inconsistent with the baseline (March) measurements of mercury in the HESP ash. The April mercury measurements average an order of magnitude higher than the March measurements. However, further analysis determined that these were accurate, and that the discrepancy is probably caused by the inaccuracies of collecting ash samples in the harsh, high-temperature, HESP hopper environment.

The conclusion is that measuring the mercury content of the hopper ash does not give a realistic picture of the amount of mercury adsorption that takes place in the flue gas. The HESP is a particularly challenging sample environment, with ash at hundreds of degrees and a sample location available only at the bottom of the hopper. This limited sampling access results in a grab sample that does not represent an average of the captured ash.

Leaching tests were also performed. Samples from Gaston's COHPAC B hoppers were leached at EERC using the standard TCLP procedure and also the synthetic groundwater leaching procedure (SGLP). They were also subjected to sulfuric acid leaching (SAL) at a pH of 2, following procedures similar to TCLP and SGLP. This is an extreme condition that might simulate acid mine drainage. One duplicate measurement was made for the TCLP procedure and one for the SGLP procedure. Table 21 gives the leaching results from EERC. With one exception, all of the results (in terms of Hg in leachate) were below the detection limit of 0.01 mg/L. Compare this with the total mercury in ash, Table 20, which averaged almost 42  $\mu\text{g/g}$ .

**Table 21. Leaching results (EERC).**

Plant	Sample Type	Location	Inj.Rate lb/MMacf	Hg in Leachate (mg/L or ppbw)		
				TCLP	SGLP	SAL
Gaston	COHPAC Ash	B-Side	1.5	0.01	<0.01	<0.01
Gaston	COHPAC Ash	B-Side	1.5		<0.01	
Gaston	COHPAC Ash	B-Side	1.5	<0.01	<0.01	<0.01

### 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 have been determined. The cost of process equipment that is sized and designed based on long-term test results for approximately 65-90% 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 22.

**Table 22. System Design Criteria for Mercury Control System at Gaston Unit 3.**

Parameter	
Number of Silos	1
Number of injection trains	2
Design feed capacity/train	100
Operating feed capacity/train (lb/hr)	40
Sorbent storage capacity (lbs)	50,000
Conveying distance (ft)	250
Sorbent	Powdered Activated Carbon
Aerated Density (lb/ft <sup>3</sup> )	18
Settled Density (lb/ft <sup>3</sup> )	34
Particle MMD (microns)	18

### System Description

The permanent commercial Activated Carbon Injection (ACI) system will consist of a bulk storage silo and a dilute phase pneumatic conveying system. Figure 11 is a process diagram of the ACI system. Norit Americas, Inc. provided a detailed quote for this equipment, the quote is included in Appendix H.

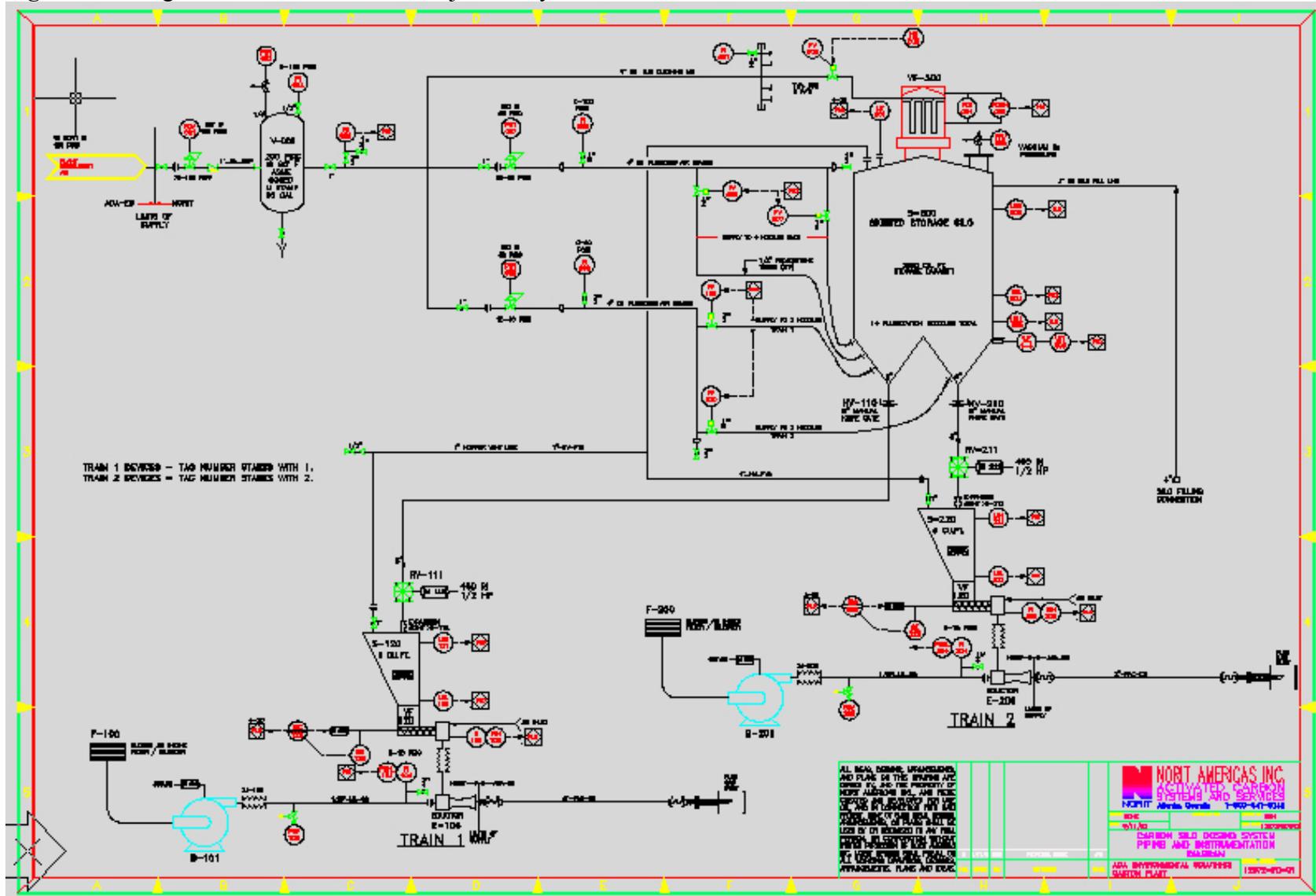
PAC sorbent will be received in 40,000 lb batches delivered by self-unloading pneumatic bulk tanker trucks. The silo is equipped with a pulse jet type bin vent filter to contain dusting during the loading process. The silo is a shop-built, dry-welded tank with twin mass flow discharge cones equipped with air fluidizing pads and nozzles to promote powder flow. Point level probes and weigh cells monitor sorbent level and inventory. Silo sizing was based on the capacity to hold 1.25 truckloads of PAC. This will allow one week operation after the refill level has been reached.

The PAC is fed from the discharge cones by rotary valves into feeder hoppers. From the hoppers the PAC is metered into the conveying lines by volumetric feeders. Conveying air supplied by regenerative blowers passes thru a venturi eductor which provides suction to draw the PAC 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, MCCs and disconnects will be housed in a pre-fabricated Power and control building located adjacent to the silo.

Figure 11. Diagram of Activated Carbon Injection System for Gaston Unit 3.



## **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 Gaston to provide new service to the ACI system. Instrument air, intercom phones and area lighting will also be required.

## **Cost and Economic Methodology**

Costs for the Sorbent storage and injection equipment were provided by Norit-Americas (Norit) based on the design data in Table 22. Norit has built and installed dozens of these systems at waste-to-energy and incineration plants. ADA-ES provided costs for the distribution manifold, piping and injection lances. Norit also provided an installation man-hour estimate and crane-hour estimate that were used to develop the installation costs for the Norit Equipment along with an estimate for foundations including pilings.

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 operating labor requirement of 4 hours 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.

More detailed cost information in all categories, including labor rate assumptions, etc., are included in Appendix H.

## **Capital Costs**

The uninstalled ACI storage and feed equipment costs for a sorbent concentration of 1.5 lb/MMacf (shown to provide between 65 and 90% control in parametric and long-term tests) are estimated at \$345,000± 10%. The estimated cost for a sorbent injection system and storage silo installed on 270 MW Unit 3 is \$816,000 and includes all process equipment, foundations, support steel, plant modifications utility interfaces, engineering, taxes, overhead and contingencies. Table 23 briefly summarizes the capital and O&M costs.

**Table 23.** Capital and Operating & Maintenance Cost Estimate Summary for ACI System on Gaston Unit 3. Annual Basis 2003.

<b>CAPITAL COSTS SUMMARY</b>	
Equipment	\$345,000
Site Integration (materials & labor)	\$120,000
Installation (ACI silo and process equipment)	\$ 90,000
Taxes/Freight	\$ 27,900
Indirects/Contingencies	\$233,160
<b>Total Capital Required</b>	<b>\$816,060</b>
<b>OPERATING &amp; MAINTENANCE COSTS SUMMARY</b>	
Sorbent @ \$.50/lb	\$245,280
COHPAC Bag Replacement: 2-yr rather than 4-yr basis (incremental cost)	\$ 53,600
Other Misc. Costs	\$100,615
Waste Disposal	None Assumed
<b>Annual O&amp;M for 2003</b>	<b>\$399,495</b>

### Operating and Levelized Costs

The most significant operational cost of ACI is the PAC sorbent. Sorbent costs were estimated for nominally 65-90% mercury control based on the removals during parametric and long-term PAC injection concentration of 1.5 lbs/MMacf. For Gaston Unit 3, this would require an injection rate of nominally 80 lbs/h. Assuming a unit capacity factor of 70% and a delivered cost of \$0.50/lb for PAC, the annual sorbent cost for injecting PAC into the existing COHPAC baghouse would be about \$250,000. Other annual operating costs including electric power, operating labor, and maintenance were estimated to be approximately \$100,000.

No additional costs were included for waste disposal. This is based on the continued acceptance of the spent PAC sorbent in Gaston's ash pond disposal operation. Waste solids from the COHPAC baghouse (flyash escaping the ESP + injected PAC) are estimated at between 500 and 1200 tons/year depending on the collection efficiency of the ESP.

### Baghouse Impacts

The test program showed that ACI significantly changes the required baghouse cleaning frequency. This will have a negative impact on baglife. Under normal operation, the bags at Gaston are projected to have a 4-year bag life. The increased wear and tear from the more frequent bag cleaning could reduce the life expectancy to 2 years, doubling the bag replacement budget. A second option is to install higher permeability bags which should reduce pressure drop and decrease cleaning frequency. Numerous risks are associated with the high permeability bags including increased particulate emissions and fabric strength. A test program is recommended to evaluate high permeability bags with PAC injection at Gaston.

For the operating & maintenance cost estimate above, an installed cost of \$100/bag was used, and a two-year rather than four-year life was assumed.

Because of the uncertainty in quantifying the incremental bag replacement cost, and the uniqueness of this factor to Gaston, the bag replacement cost is not included in the levelized costs presented here. With the balance of the above factors taken into account, and with assumptions for labor rates, power cost, and escalation factors as shown in Appendix H, levelized costs were calculated. The first-year costs including fixed capital are \$474,000. Annual 20-yr levelized costs on a current-dollar basis are \$536,000.

Based on these test program results and assuming that the operation mode of ACI into COHPAC is sustainable, between 65 and 90% mercury control can be attained at Gaston Unit 3 for a capital investment of \$816,000 and annual current-dollar levelized costs of \$536,000 (1.5 lb/MMacf sorbent concentration is assumed). Bag replacement costs are additional, but have yet to be accurately determined.

## CONCLUSIONS and RECOMMENDATIONS

A full-scale evaluation of mercury control using activated carbon injection upstream of a COHPAC baghouse was conducted at Alabama Power Company's Plant Gaston Unit 3. This comprehensive test program answered many questions about the potential for mercury control on Gaston Unit 3, and also pointed to several areas in which more information is needed. This section summarizes the test results and conclusions first, followed by recommendations for implementation of a permanent mercury control system for the unit, should this be deemed necessary.

- Gaston Unit 3's HESP / COHPAC combination does not remove mercury from the flue gas stream without sorbent injection.
- Effective mercury removal, up to 90% efficiency, was obtained for short operating periods (8 hrs) by injecting powdered activated carbon upstream of COHPAC.
- Various carbon-based sorbents that were injected upstream of COHPAC performed nominally the same as Darco FGD, the benchmark sorbent. Some variations of sorbents that were tested included smaller particle size, larger particle size, and sorbents derived from both subbituminous and bituminous coals.
- A significant increase in the cleaning frequency of the COHPAC baghouse occurred with the injection of activated carbons. At this site, the maximum acceptable cleaning frequency and pressure drop limited the amount of sorbent that could be injected and therefore the maximum mercury removal actually achievable. Based on these results, it will be necessary to take into consideration the sorbent injection rate in the design of future COHPAC baghouses and perhaps design the baghouses more conservatively.
- On average, around 78% mercury removal was obtained when PAC was injected into COHPAC 24 hr/day during long-term tests. Mercury removal varied throughout the period and ranged from 36% to 90%.
- To verify S-CEM measurements during the long-term tests, mercury removal across COHPAC was measured following the draft Ontario Hydro method. Results show an average 90% removal for the three tests periods. These results confirm the high mercury removal measured with the S-CEMs. Agreement during test periods between the S-CEMs and Ontario-Hydro methods was very good.
- Actual mercury removals were slightly higher (or amount of sorbent required is slightly lower) than, but in reasonably close agreement with, theoretical model predictions for 80 to 90% removal (1.5 to 2 vs 3 lbs/MMacf), considering that the model is based on a uniform PAC particle size of 15 microns when in fact the actual FGD carbon used has a wide size distribution with significant numbers of particles below 15 microns<sup>7</sup>. The model also assumed a cleaning frequency of 2 pulses/bag/hr (all bags cleaned at the same time) whereas the bags were actually cleaned at ~ 1 to 2 pulses/bag/hr (bags cleaned 15 (one row) at a time) during the tests.

- Sieved, ground HESP flyash showed a high enough mercury adsorption capacity in laboratory tests to be of interest for further testing. Managing the extraction and processing of this high-temperature product was beyond the scope of this testing.
- TCLP testing of the ash with sorbent injection showed that it passed all regulatory limits, and could be sent to Gaston's ash pond for future landfill.
- Bag strength and pH were unaffected in these short-term tests.
- Capital cost for the equipment to control mercury at the 270 MW Gaston Unit 3 is estimated at \$816,000 installed. Major operating and maintenance costs in addition to the cost of sorbent include bag replacement (shorter bag life is expected). The capital cost of this system is scalable upwards but not significantly scalable downwards, since this system represents a relatively low sorbent consumption and storage. The basic components of the system do not decrease in number as the sorbent demand decreases.
- Total O&M cost including sorbent and bag replacement is estimated to be \$400k for 2003 for 65-90% mercury control.
- More-frequent, blended coal and ash samples need to be obtained if a mass balance for mercury is to be attempted.
- Additional testing over longer periods (up to a year) need to occur to determine the impact of carbon injection on bag life (pressure drop and bag strength) and outlet particulate emissions. This could provide the opportunity to evaluate high-permeability bags as an alternative to extend bag life with sorbent injection.

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## **APPENDIX A**

# **Quality Assurance Project Plan**

## PART A. PROJECT MANAGEMENT

### A1.0 Title and Approval Sheet

#### A1.1 Title

E.C. Gaston Unit 3 Sorbent Injection into COHPAC for Mercury Control: Quality Assurance Project Plan For Performance Evaluation

NOTE: This Test/QA Plan has been structured to conform with the format of the EPA document *EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5)*.

#### A1.2 Approval

This Test/QA Plan has been reviewed and approved by the following program participants:

ADA-ES Project Manager    C.J. Bustard    \_\_\_\_\_    Date: \_\_\_\_\_

ADA-ES QA Manager        K. Baldrey     \_\_\_\_\_    Date: \_\_\_\_\_

SRI QA Manager            J.D. McCain    \_\_\_\_\_    Date: \_\_\_\_\_

Southern Co Project Eng.    Larry Monroe    \_\_\_\_\_    Date: \_\_\_\_\_

EPA Project Representative    \_\_\_\_\_        Date: \_\_\_\_\_

# QUALITY ASSURANCE PROJECT PLAN

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- Summary of the Ontario Hydro Test Method (sampling-specific sections)
- Ontario Hydro Mercury Train Recovery Procedures
- Procedure for the Analysis of Ontario Hydro Method Trains

**ATTACHMENT B**

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- B1 Baseline Field Test Data
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- B2 Carbon Injection Tests – Field Data
- B3 Galbraith Laboratory Analytical Reports
  - B3a – Baseline Tests
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- Description of Semi-Continuous Emissions Monitor for Mercury

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### **A3.0 Distribution List**

The following is a list of individuals who will receive copies of the approved Test/QA Plan and any subsequent revisions.

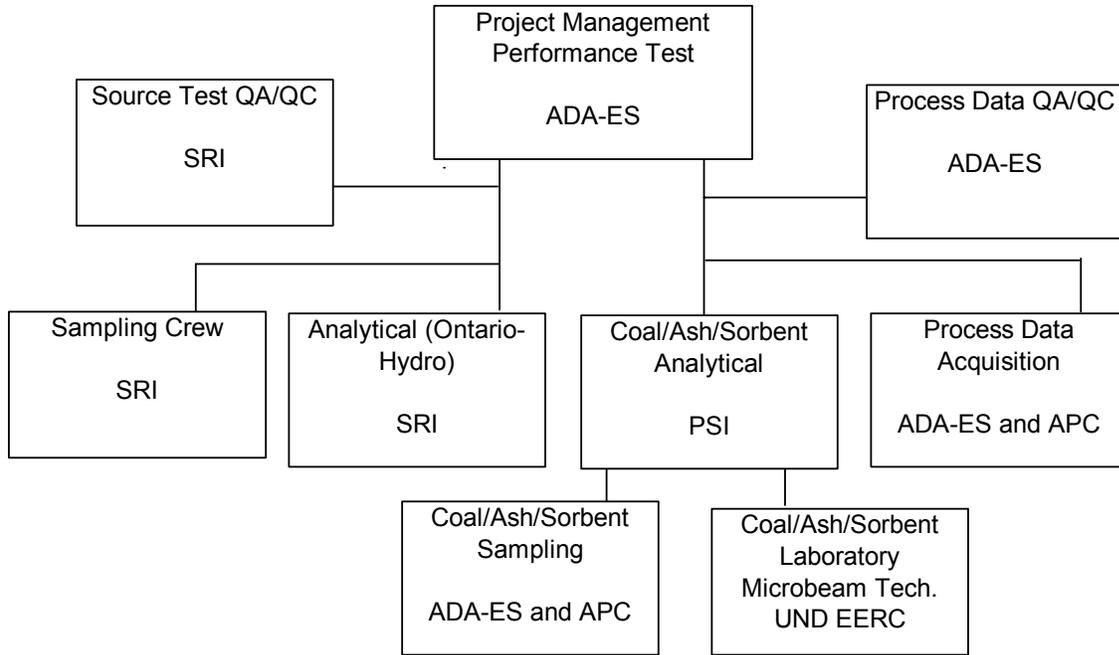
### **A4.0 Task Organization**

This Quality Assurance Project Plan is specific to the activities of the final Performance Evaluation, including emissions sampling, process sample analysis, and process data analysis.

The overall project organizational structure is outlined in the Project Test Plan<sup>1</sup>. For the Performance Evaluation, the following organizational breakdown is provided.

- ADA-ES is the managing organization for the Performance Evaluation. Ms. Jean Bustard is the Project Manager for the Gaston demonstration.
- Alabama Power Company and parent Southern Company are the host utility. Mr. David Prater is the APC engineer assigned to this project. Mr. Larry Monroe is the project manager for Southern Company.
- ADA-ES will coordinate the activities of the Performance Evaluation with the host utility, Alabama Power and Southern Company. Mr. Ken Baldrey will act as Test Coordinator and oversee quality assurance activities.
- Southern Research Institute will oversee all emissions sampling and associated laboratory analysis, including quality assurance activities. Mr. Joseph D. McCain is the Task Manager and QA manager for SRI.
- Analysis of Ontario Hydro samples will be supervised by SRI and performed by Galbraith Laboratories, Knoxville, Tennessee.
- ADA-ES will coordinate gathering of process data and samples with the host utility, Alabama Power Company. Mr. Charles Lindsey, the ADA-ES Site Project Leader, will be in charge of this task.
- Physical Sciences, Inc. (PSI) of Andover Massachusetts will oversee analysis of all process samples including coal, fly ash, and sorbent. Dr. Constance Senior is the Task Manager for Gaston, as well as the other sites in the overall program.
- Analysis of process samples will be supervised by PSI and performed through subcontract laboratories Microbeam Technologies, of Grand Forks, North Dakota, EERC of University of North Dakota, and Hawk Mountain Labs.

Figure 1 shows the organizations and responsibilities specific to the Performance Evaluation. Table 1 provides a list of the key personnel who will be involved.



**Figure 1: Performance Evaluation Organizational Chart**

**Table 1**  
**Key Project Personnel for Gaston Performance Evaluation**

<b>NAME</b>	<b>COMPANY</b>	<b>ROLE</b>	<b>PHONE #</b>	<b>CELL OR PAGER #</b>
Larry Monroe	Southern Company	Southern Company Project Engineer	205 257 5367	
David Prater	Alabama Power	Alabama Power Project Engineer	205 669 8036	334 350 6145
Jean Bustard	ADA-ES	Project Manager	303 734 1727	303 898 5762
Charles Lindsey	ADA-ES	On-site Project Lead	205 655 6832	303 618 4860
Ken Baldrey	ADA-ES	Test Coordinator and ADA-ES QA Manager	303 734 1727	
Dr. Constance L. Senior	PSI, Inc.	Task Manager: Process Sampling and Analysis	978 738 8233	
Joseph D. McCain	Southern Research Institute	SRI Task Manager and QA Manager	205 581 2381	

## **A5.0 Problem Definition**

### **A5.1 Background**

This test is part of an overall program funded by the Department of Energy's National Energy Technology Laboratory (NETL) to obtain the necessary information to assess the costs of controlling mercury from coal-fired utility plants that do not have scrubbers for SO<sub>2</sub> control. The economics will be developed based on various levels of mercury control (at different temperatures) at four different host sites.

The overall objective of this project is to determine the cost and impacts of sorbent injection into the COHPAC baghouse for mercury control at Alabama Power's Gaston Unit 3. The evaluation will be conducted on ½ of the gas stream, nominally 125 MW.

Testing at Gaston is part of a field evaluation program that will implement mercury control technologies on portions of full-scale particulate control equipment to obtain performance and operational data, and gather samples to determine the impact of these technologies on waste disposal and byproduct reuse.

The method for controlling mercury at Gaston will be sorbent injection. If required, mercury removal will be enhanced by temperature control. At Gaston, it is possible to lower temperature by opening dilution dampers located on the baghouse inlet plenums. It is desirable to evaluate mercury removal at temperatures as low as 250°F.

A series of parametric sorbent injection tests will be conducted to determine the optimum operating conditions for several levels of mercury control up to 90% mercury removal. Based on results from these tests, a two-week test with one sorbent at optimized conditions will be conducted to assess longer-term impact to COHPAC and auxiliary equipment. At this optimized control condition, a Performance Evaluation will be conducted to assess mercury removal efficiency.

This Quality Assurance Project Plan is specific to the activities of the final Performance Evaluation, including emissions sampling, process sample analysis, and process data analysis.

### **A5.2 Process Description**

Alabama Power Company, a subsidiary of Southern Company, owns and operates the E.C. Gaston Electric Generating Plant located in Wilsonville, Alabama. The plant has four (4) 270 MW balanced draft and one (1) forced draft coal fired boilers. All units fire a variety of low sulfur, washed, Eastern bituminous coals.

A summary of important descriptive parameters for Gaston Unit 3 is presented in Table 2. Figure 2 is a schematic layout of the boiler and pollution control equipment.

**Table 2**  
**Site Description Summary, Gaston Unit 3**

<b>PARAMETER IDENTIFICATION</b>	<b>DESCRIPTION</b>
<i><b>Process</b></i>	
<b>Boiler Manufacturer</b>	B&W wall-fired
Burner Type	B&W CXL
Low NO <sub>x</sub> Burners	Yes
Steam Coils	No
Over Fire Air	No
NO <sub>x</sub> Control (Post Combustion)	None
Temperature (APH Outlet)	290°F
<i><b>Coal</b></i>	
<b>Type</b>	Eastern Bituminous
Heating Value (Btu/lb)	13,744
Moisture (%)	6.9
Sulfur (%)	0.9
Ash (%)	13.1
Hg (µg/g)	0.06
Cl (%)	0.03
<i><b>Control Device</b></i>	
<b>Type</b>	Hot-Site ESP with COHPAC
ESP Manufacturer	Research Cottrell
Design	Weighted Wire
Specific Collection Area (ft <sup>2</sup> /1000acfm)	274
Flue Gas Conditioning	None
Baghouse Manufacturer	Hamon Research-Cottrell
Design	Pulse-Jet, Low Pressure – High Volume
Air-to-Cloth Ratio (acfm/ft <sup>2</sup> )	8.5:1 (gross)

## E. C. Gaston Unit 3

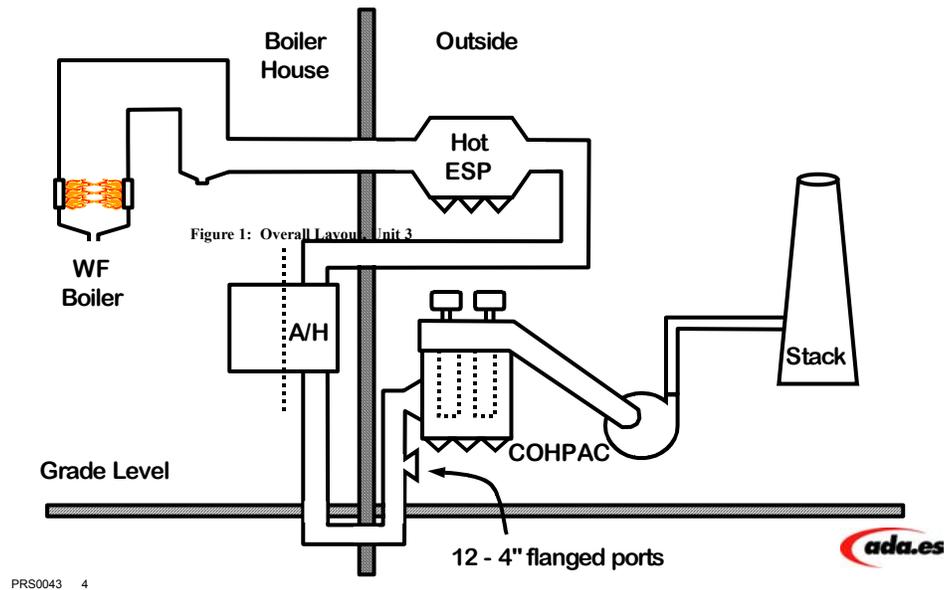


Figure 2: Process Layout

### A5.2.1 Control Equipment

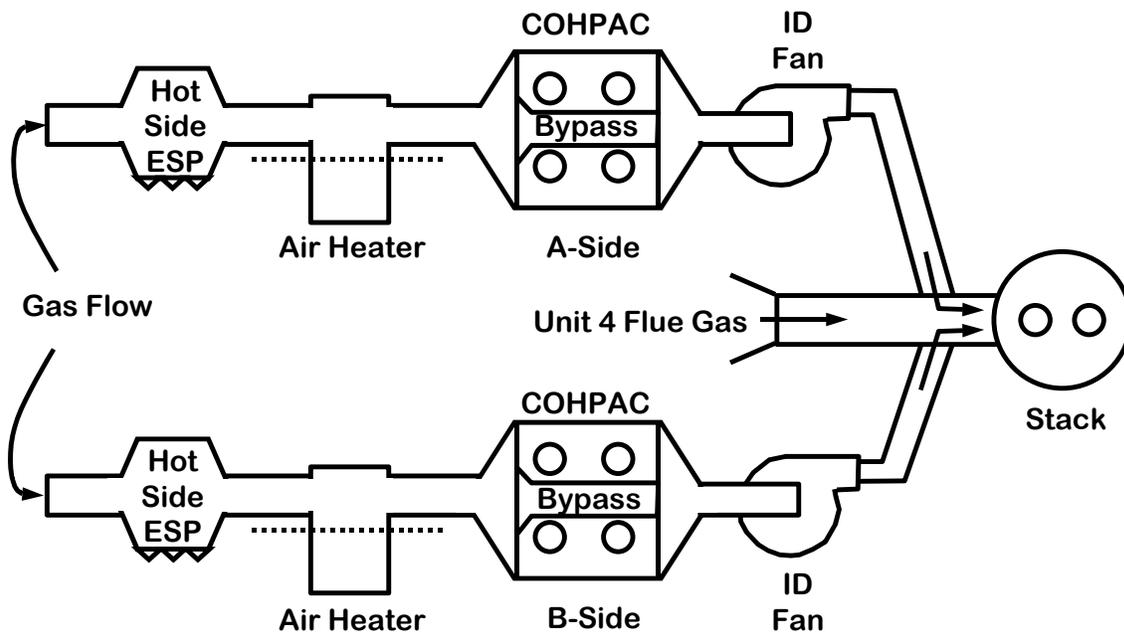
Figure 3 shows the particulate control layout for Gaston Unit 3. The primary particulate control equipment on all units at Gaston are hot-side ESPs. The Unit #3 hot-side ESP is a Research-Cottrell weighted wire design. The Specific Collection Area is 274 ft<sup>2</sup>/1000 acfm.

In 1996 Alabama Power contracted with Hamon Research-Cottrell to install COHPAC<sup>2</sup> downstream of the hot-side ESP on Unit 3. Gaston Unit 3 was chosen for this evaluation because COHPAC represents a cost-effective retrofit option for utilities with electrostatic precipitators (ESPs). COHPAC is an EPRI patented concept that places a high air-to-cloth ratio baghouse downstream of an existing ESP to improve overall particulate collection efficiency. In this evaluation dry sorbents will be injected upstream of COHPAC, downstream of the ESP. The advantages of this configuration are:

1. Sorbents are mixed with a small fraction of the ash (nominally 1%), which reduces the impact on ash reuse and waste disposal;
2. Pilot plant studies and theory indicate that compared to ESPs, baghouses require 1/10 the sorbent to achieve similar removal efficiencies; and
3. Capital costs for COHPAC are less than other options such as replacing the ESP with a baghouse or larger ESP.

The COHPAC system is a pulse-jet cleaned baghouse designed to treat flue gas volumes of 1,070,000 acfm at 290°F (gross air-to-cloth ratio of 8.5 ft/min with on-line cleaning). The COHPAC baghouse consists of four (4) isolatable compartments, two compartments per air-preheater identified as either A- or B-Side. Each compartment consists of two bag bundles, each having a total of 544, 23-foot long, Ryton™ felt filter bags, 18 oz/yd<sup>2</sup> nominal weight. This results in a total of 1,088 bags per compartment, or 2,176 bags per casing.

Depending on the operating condition of the hot-side ESP, nominally 97 to 99+% of the fly ash is collected in the ESP. The remaining fly ash is collected in the COHPAC system. Hopper ash is sent to a wet ash pond for disposal. A hoveyvor system delivers the fly ash to the pond.



**Figure 3: Elevation View of Gaston #3**

### A5.3 Objective

The purpose of the Performance Evaluation is to collect the necessary information to determine control efficiency for speciated mercury during sorbent injection upstream of the COHPAC baghouse. Data collected, once validated, will be used to evaluate the feasibility, costs, and performance of mercury control from coal-fired boilers by sorbent injection with the ESP/COHPAC control equipment configuration. Costing data will be expected to be of sufficient accuracy for non-site-specific estimates (typically a +/-25% margin of error built into the estimates).

## A6.0 Project/Task Description and Schedule

### A6.1 Description of the Work to be Performed

The test methodology will be similar in scope to the EPA's 1999 Information Collection Request (ICR) for mercury emissions measurements at selected coal-fired power plants. Measurements will be made for elemental, oxidized, particle-bound and total mercury (collectively referred to as speciated mercury) to assess mercury control performance. Measurements will be conducted upstream of the COHPAC baghouse and at the COHPAC baghouse outlet. Supporting data will also be collected for gas flow, moisture content, oxygen (O<sub>2</sub>) and carbon dioxide (CO<sub>2</sub>) as well as data establishing the operating condition of the unit during the test. The primary test matrix is presented in Table 3 and summarized below. Other supporting engineering data will be gathered simultaneously that is outside the scope of this QAPP.

Triplicate measurements will be performed concurrently at the inlet and the outlet of one half (B-side) of the COHPAC. The tests will include the following:

- The Ontario Hydro Mercury speciation method<sup>3</sup> will be used to collect elemental, oxidized, particulate-bound, and total mercury emissions at the inlet of the COHPAC baghouse;
- The Ontario Hydro Mercury speciation method will be used to collect elemental, oxidized, particulate-bound, and total mercury emissions at the outlet of the COHPAC baghouse;
- The collected samples will be digested according to the Ontario-Hydro method and analyzed for speciated mercury using cold vapor atomic absorption spectrometry (CVAAS);
- Fuel samples will be collected by the routine plant composite sampling method. Refer to Section B.2.3 for more detail on coal sampling. An ultimate and proximate analysis will be performed on the coal along with mercury and chlorine; and
- Hopper fly ash samples will be collected from the ESP and COHPAC hoppers. Ash samples will be analyzed for Loss on Ignition, and total mercury. COHPAC B-side ash (w/spent sorbent) will be tested for mercury stability by the SGLP leach test and by thermal desorption.

Supporting measurements will also be taken including:

- Measurement of oxygen and carbon dioxide concentration in the flue gas at the COHPAC inlet and outlet using EPA Reference Method 3 (modified);
- Measurement of volumetric gas flow at the COHPAC inlet and outlet using EPA Reference Methods 1 and 2;
- Measurement of moisture content of the flue gas at the COHPAC inlet and outlet using EPA Reference Method 4;
- Measurement of sorbent injection rate by gravimetric calibration; and
- Process data including unit load, COHPAC process data, flue gas temperature, and stack opacity.

**Table 3**  
**Test Matrix for Performance Evaluation**

<b>Sampling Location</b>	<b>No. of Runs</b>	<b>Parameters</b>	<b>Sampling Method</b>	<b>Sample Run Time</b>	<b>Analytical Method</b>	<b>Analytical Laboratory</b>
COHPAC Inlet B-side	3	Speciated Hg	Ontario Hydro	120 min.	EPA SW846 7470 (CVAAS), modified	Galbraith Laboratories
Inlet, B-side	3	Moisture	EPA 4	120	Gravimetric	SRI
Inlet, B-side	3	Flow	EPA 1 & 2	120	Pitot Traverse	SRI
Inlet, B-side	3	O <sub>2</sub> /CO <sub>2</sub>	EPA 3 (modified)	120	Teledyne Hastings meter O <sub>2</sub> / Fyrite CO <sub>2</sub>	SRI
COHPAC Outlet B-side	3	Speciated Hg	Ontario Hydro	145 min.	EPA SW846 7470 (CVAAS), modified	Galbraith Laboratories
Outlet, B-side	3	Moisture	EPA 4	145	Gravimetric	SRI
Outlet, B-side	3	Flow	EPA 1 & 2	145	Pitot Traverse	SRI
Outlet, B-side	3	O <sub>2</sub> /CO <sub>2</sub>	EPA 3 (modified)	145	Teledyne Hastings meter O <sub>2</sub> / Fyrite CO <sub>2</sub>	SRI
Coal Belt Unit 3	Daily composite	Ultimate/Proximate Hg, Cl in Coal	Grab, composite	Sample daily	ASTM D3684 (Hg) Oxidative Hydrolysis Microcoulometry (Cl)	EERC Hawk Mountain Labs
ESP Hoppers	Daily	Hg, LOI in Ash	Grab	Sample daily	ASTM D6414-99	EERC
COHPAC Hoppers B-side	Daily	Hg, LOI in Ash, Hg leachability, Hg Thermal Stability	Grab	Sample daily	ASTM D6414-99, SGLP leach test, Thermal Desorption	EERC
COHPAC Hoppers A-side	Daily	Hg, LOI in Ash	Grab	Sample daily	ASTM D6414-99	EERC
Plant Process	Continuous	Unit Load, Stack opacity, flue gas temperature	logged data	Continuous throughout test	Plant Instrumentation	APC
COHPAC Process	Continuous	Flue gas temperature(s), gas flow to B-side	1 minute logged data	Continuous throughout test	Plant Instrumentation	APC & SRI

ADA-ES Sorbent Injection Skid	3	Sorbent injection rate	Grab	Once per OH run	Calibrated screw feed rotation	ADA-ES
COHPAC Inlet Mercury Monitor	Semi-continuous	Vapor phase speciated mercury	Extractive, impinger-based	Semi-continuous	CVAAS	Apogee Scientific
COHPAC Outlet Mercury Monitor	Semi-continuous	Vapor phase speciated mercury	Extractive, impinger-based	Semi-continuous	CVAAS	Apogee Scientific
ESP Inlet (per EPA/SRI, outside scope of QAPP)	3	Speciated Hg	Ontario Hydro, EPA/SRI protocol and equipment		EPA SW846 7470 (CVAAS), modified	Galbraith Laboratories

## **A6.2 Quality Assessment Techniques**

Quality assessment techniques for the Ontario Hydro tests are as prescribed in the method and include the analysis of field blanks, reagent blanks, and spiked samples. The Task Manager continually audits the performance of sampling team members during field-testing, and ensures that proper equipment is being utilized according to specified protocols. In addition, EPA will conduct a performance audit of the sampling methods.

## **A6.3 Work Schedule**

The emissions sampling and all other plant activities at Gaston are scheduled for the week of April 23, 2001. The subsequent laboratory analysis will be completed within the critical holding periods, according to the individual methods. A report of the Performance Evaluation results will be issued within 60 days of completion of sampling. The data developed will be incorporated into the technical and economic Objectives of the project for which further reports will be issued outside the scope of the Performance Evaluation.

## **A6.4 Records and Reports**

A test report will be issued for the source emissions portion of the Performance Evaluation. All data obtained will be incorporated into the overall project site report. For further information on records and documentation management refer to Section A9.0.

## **A7.0 Quality Objectives and Criteria for Measurement Data**

### **A7.1 Data Quality Objectives for Measurement Data**

The overall objective for this project is to quantitatively characterize the performance of sorbent injection for mercury control for Gaston Unit 3 under optimized control conditions. Measurements will be conducted on ½ of the gas stream, nominally 125 MW. The critical measurements in this program are those associated with determination of speciated mercury concentration at the inlet and outlet of the control device (COHPAC baghouse). The data quality objectives (DQOs) are to:

- Determine speciated mercury concentration in the flue gas at inlet and outlet of the COHPAC baghouse with sufficient accuracy to verify the target control efficiency during representative long-term process operation; and
- Gather representative supporting process information.

The DQOs to meet project objectives are believed to be within the capabilities of the measurement methods selected. The test procedures selected are standardized test methods. A high level of quality control is inherent to these same procedures. The data quality indicator (DQI) goals for the intended measurements are presented in Section A7.2. The QA approach for this project will emphasize achieving these DQI goals, but will be flexible enough to draw conclusions from data that may not meet the stringent DQI levels.

One potential issue, inherent in the project objective, is the lower detection limit of the Ontario Hydro method. The target goal for mercury control may be as high as 90% removal. It is expected that the total mercury concentration in the flue gas at the inlet location will be in the range of 7 - 12  $\mu\text{g}/\text{Nm}^3$ . Therefore, the outlet total mercury may be as low as 0.5  $\mu\text{g}/\text{Nm}^3$ . Sampling times will be extended at the outlet location to increase the measurable concentrations in solution. In addition, the analytical procedures have been modified somewhat from the draft method to improve detection, as detailed in Appendix A.

## **A7.2 Measurement Performance Criteria**

The DQI goals for bias and precision for the critical measurements associated with this project are identical to those found in the test methodology. The inability to meet the presented DQI goals should not adversely impact project objectives. There are no indications at this time that these objectives will not be met.

### Bias

Gaseous mercury may be adsorbed on fly ash collected on the sampling filters. Elemental mercury may be oxidized by the fly ash on the filters.

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.

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.

For this test the particulate concentration, in particular at the COHPAC baghouse outlet, will be very light, minimizing any potential interferences or bias due to particulate interaction.

### Sampling and Analytical Precision

Per the draft method specification<sup>3</sup>, formal evaluation of the Ontario Hydro method was completed with dynamic spiking of  $\text{Hg}^0$  and  $\text{HgCl}_2$  into a flue gas stream. The relative standard deviation for gaseous elemental mercury and oxidized mercury was found to be less than 11% for mercury concentrations greater than  $3 \mu\text{g}/\text{Nm}^3$  and less than 34% for mercury concentrations less than  $3 \mu\text{g}/\text{Nm}^3$ . 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%).

### Sampling Precision

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.

Sampling methodology will meet specific QC standards, with corrective actions, as detailed in Table 4. Field blanks will be taken to identify any problems with reagent solutions or contaminants.

### Completeness

The target goal for completeness of critical data is 100%. All replicate runs will be verified for acceptability of the field testing procedures. Any runs not found acceptable will be repeated. Once collected, sample handling and holding time procedures will be adhered to such that all samples will be delivered to the analytical laboratory in good order. Laboratory quality control procedures will be completed to validate the sample analysis. In the event of an unacceptable result of a QC control or blank sample, the analysis will be repeated.

### Representativeness

The representativeness of each sample collected is ensured through the sampling approach. Samples are collected isokinetically in a full traverse of the duct for each run according to standard EPA methods. Process variables such as fuel characteristics, unit operation, and flue gas constituents are expected to be fully representative of the overall process. Steady, full load operation will be verified prior to each sampling run.

## Comparability

All test data will be reported in a manner consistent with the referenced methods used and using standard units. Thus, the test data generated in the planned test program will be comparable to data produced by both the EPA and other organizations using comparable EPA-approved methods. Results from the Ontario Hydro tests will be directly comparable to the EPA mercury ICR results, although somewhat more supporting information will be obtained in this project.

## **A8.0 Special Training Requirements/Certification**

Special certification is not required for the methods to be applied in the Performance Evaluation. However, the Ontario Hydro test protocol is a rigorous, complex sampling method that demands experienced operators and appropriate equipment. All sampling and analytical personnel involved have performed the identical procedures for the baseline testing in March 2001.

## **A9.0 Documentation and Records**

All data including deliverable reports, original data sheets, and computer-generated spreadsheets, with the exception of restricted computer software, will be available for inspection by the DOE, EPA, and others as authorized by ADA-ES. Original data will be archived and stored for a period of five years.

### Test Operation Records

The following test operations records will be an integral part of the Performance Evaluation:

- Chain-of Custody Records;
- Daily Test Log will be kept by Test Coordinator;
- Individual runs sheets will be completed for each sampling method;
- Coal, sorbent, and ash samples will be logged into a sample tracking database; and
- Plant process data will be logged on 1-minute intervals into an archival spreadsheet.

## Reports

The following reports will be issued for the Performance Evaluation:

- **Preliminary Test Report to Project Management.** A preliminary report of test completeness, process information, and summary of pending work to complete the Performance Evaluation will be issued to Project Management within one week of completion of field testing.
- **Emissions Test Report, SRI.** A separate report will be issued for the source testing portion of the Performance Evaluation. Report format will follow EPA's Emission Measurement Center (EMC) guidelines<sup>8</sup>.
- **Project Site Report.** The source testing report and other data from the Performance Evaluation will be incorporated into the overall site report of all of the technical and economic activities of the project.

## **PART B. MEASUREMENT/DATA ACQUISITION**

### **B1.0 Sampling Process Design**

The Performance Evaluation will be conducted after approximately six weeks of parametric studies of mercury control at Gaston Unit 3. The parametric tests will evaluate the effects of different sorbents and process conditions on mercury removal efficiency. A final, optimized test condition for a target mercury removal efficiency will be determined for the Performance Evaluation. Unit operation will be conducted at the optimized condition 24 hours/day for at least five days prior to the Performance Evaluation testing.

The Ontario Hydro test method will be the primary quantitative proof of mercury removal. It is an established sampling method for mercury from coal-fired boilers and was used for all of EPA's mercury ICR testing. Therefore, the results obtained can be directly compared to previously collected data from the ICR. In addition to the manual OH trains, certain semi-continuous mercury monitors (Mercury S-CEM) will be operating at the inlet and outlet to the COHPAC. These instruments have been developed by and are utilized extensively by EPRI contractors. However, the sampling protocol has not been extensively verified as yet, therefore the results from these instruments will be used as a secondary research and engineering aid. Refer to Appendix C for further details of the instrument and sampling methodology.

A total of three concurrent Ontario-Hydro runs will be conducted at inlet and outlet to the B-side COHPAC baghouse. Inlet sampling time will be approximately 120 minutes while the outlet will be approximately 145 minutes. Additional sample time at the outlet is desirable in order to improve the method's lower detection limits. Inlet tests will not be extended beyond 120 minutes in order to ensure that the impinger solutions are not overloaded.

Each of these runs will be conducted during full Unit load (250 MW or greater) with sorbent injected at the optimized rate. The target control efficiency for total Mercury will be at least 70%, but may be as high as 90%.

Coal samples will be tested for mercury and chlorine content in order to characterize the fuel source and resulting mercury speciation. Composite coal samples will be collected and analyzed for each sample day. Due to the configuration of coal transfer and limited access points at Gaston, coal samples will be taken from the coal feed belt at the inlet to the storage bunkers. A variety of coals are fired on any given day, however, the primary variable qualities (chlorine and mercury content) are relatively constant within the normal range of coals.

Ash samples will be collected from the ESP hoppers, and each of: 1) COHPAC baghouse A-side hoppers; and 2) COHPAC Baghouse B-side hoppers. The B-side fly ash will be analyzed for stability of captured mercury by leaching tests and thermal desorption. A-side ash samples will be available as a control for comparison if necessary.

## **B2.0 Sampling Methods**

### **B2.1 Ontario Hydro Mercury Speciation**

Measurement of speciated mercury in the flue gas will be by the Ontario Hydro Method. This method is an ASTM specification and is currently a draft EPA method<sup>3</sup>. There are several specific exceptions to the sampling procedures of the draft method that will be implemented to improve overall accuracy and to accommodate site-specific needs. Procedures to be employed are included in Appendix A as the sampling-specific sections of the published ASTM method. The exceptions to the method are highlighted by boldfaced print.

The Ontario-Hydro trains will utilize an EPA Method 17 configuration with a flexible Teflon umbilical from probe to impinger ice bath. This configuration is a necessity at the sampling locations on Gaston Unit 3 COHPAC due to the constricted access to the sampling ports.

Recovery of the sampling trains will be performed in a contaminant-free portable laboratory trailer located at the site. SRI has prepared a written Standard Operating Procedure for the mercury train recovery, included in Appendix A.

### **B2.2 Sampling Locations**

#### Inlet

Sampling points at the COHPAC inlet have been selected in accordance with EPA Methods 1 and 2. A full traverse will be made across the seven inlet sampling ports with five points per port. Sampling time at each point will be four minutes for a total run time of 120 minutes. If mechanical interferences prevent a port from being used, the adjacent port most likely to have similar gas flows will be substituted.

#### Outlet

Sampling points at the COHPAC outlet have been selected in accordance with EPA Methods 1 and 2. A traverse will be made across the sixteen outlet sampling ports with three points per port. Sampling time will be three minutes per point for a total of 144 minutes. The traverse may be adjusted by eliminating one port dedicated to use by a semi-continuous mercury analyzer. In the latter event, the adjacent port most likely to have similar gas flows will be substituted.

#### ESP Inlet

At the request of EPA, triplicate Ontario-Hydro tests will be conducted at the Unit 3 ESP inlet, B-side duct, using existing sampling ports. At this location there are three available sampling ports spaced across roughly  $\frac{1}{4}$  of the duct area each. This test is outside of the scope of this QAPP, but will be conducted simultaneously with tests at the other OH locations.

## **B2.3 Coal and Ash Sampling**

Coal samples will be collected at the final access into the feeder system, the coal belt inlet to bunker for Unit 3. This is the last available sample access in the coal feed system at Gaston. Coal off the belt at this location will be fired approximately 10 - 12 hours after entering the bunker. Due to this limitation in coal sample availability, a composite sample will be collected for each sample day of the Performance Evaluation, beginning one full day prior to the first test. Plant personnel collect composite coal samples by taking a grab sample (coal scoop) from the rotary tram over the coal bunkers every 15 minutes during each fill cycle during the day. The fill cycle schedule is on an as-needed basis at various times throughout the day. The collected sample of approximately five gallons will be thoroughly mixed prior to collection of smaller laboratory coal samples. These raw, washed coal samples will then be prepared at the laboratory according to the standard ASTM D2013 method.

Hopper ash samples will be collected from the ESP and from the COHPAC baghouse for each test day. Sample collection will be coordinated with plant operations in order to ensure a fresh ash sample. ESP ash will be taken from an available access port in the ESP front field hoppers prior to entry to the wet ash handling system. Separate ash samples will be taken for A-side COHPAC (untreated) and for B-side (sorbent injection). There are four compartment hoppers on each side. Fresh ash samples will be extracted from each of the four (4) compartment hoppers for each side prior to the wet ash handling system. These samples will be composited to produce a single integrated sample.

## **B2.4 Sorbent Feed Rate**

A material feeder and Programmable Logic Controller automatically control sorbent injection rate at the ADA-ES injection skid. The calibration of the solid sorbent feed rate will be verified prior to each of the Ontario Hydro test runs. This will be verified by a tachometer reading of screw feeder rotation. The automatic feed rate will be adjusted, if necessary, to maintain the target rate.

## **B3.0 Sample Handling and Custody Requirements**

A key issue in the Performance Evaluation is the integrity of the samples tested. Sample management and tracking procedures will be implemented to ensure proper sample control, handling, transfer, and custody. Chain-of-custody will be utilized in order to ensure the traceability of the handling and possession of each sample from the time of collection through the completion of analysis. Samples will be uniquely labeled upon collection and stored as appropriate for the method.

## **B4.0 Analytical Methods**

### **B4.1 Ontario Hydro Mercury Speciation**

A Standard Operating Procedure for the analysis of the Ontario Hydro samples is included in Appendix A. There are some specific exceptions to the prescribed EPA Method 7470 (CVAAS) analytical method, as detailed in Appendix A. These exceptions are designed to improve detection limits for the method. For this test program, the level of mercury control will be as high as 90% and total mercury concentrations of  $0.5 \mu\text{g}/\text{Nm}^3$  may be achieved, making low detection limits for the outlet samples a necessity.

### **B4.2 Coal Analysis**

Dr. Constance Senior of PSI, Inc. will supervise analysis of all coal and ash samples. Coal samples will be analyzed by standard ASTM methods with the requisite quality control procedures. The raw, washed coal sample will be prepared at the laboratory according to the standard ASTM D2013 method. Ultimate/proximate analysis and particle-bound mercury will be tested at the Energy and Environmental Research Center (EERC) of the University of North Dakota

Coal analysis for chlorine will be performed by an advanced procedure, Oxidative Hydrolysis Microcoulometry, as recently investigated in a recent EPRI sponsored round-robin study of analytical techniques for chlorine in coal<sup>4</sup>. Since this is a non-standard analytical technique, one of the study participants, Hawk Mountain Labs, will be contracted to do this work. The method yields significantly better precision and a much lower quantitative limit than any of the commonly applied ASTM test methods such as D4208 Oxygen Bomb/Ion Selective Electrode Method.

### **B4.3 Ash Analysis**

Collected ESP hopper ash samples, COHPAC B-side ash samples, and COHPAC A-side ash samples will be analyzed for volatile fraction (Loss-On-Ignition) and for total mercury content. Analysis for particle-bound mercury will be by ASTM Test Method D6414-99 (CVAAS). In addition, ash samples from the COHPAC B-side will be further tested for stability of the collected mercury using two techniques, leaching and thermal desorption. The Energy and Environmental Research Center (EERC) will conduct these tests. Leaching tests are done using a method known as the synthetic groundwater leaching procedure (SGLP)<sup>5</sup>. This test is modeled after the TCLP, but modified to allow for disposal scenarios. A shake extraction technique is used to mix the solid sample with an aqueous solution. Aliquots of the liquid are then analyzed after 18 hours, two weeks, and four weeks.

Thermal desorption tests will be performed using a special test fixture that is heated using a programmable temperature controller<sup>6</sup>. The temperature of the ash sample is ramped to 500°C at a rate of 20°C per minute. Mercury that is released by the sample is swept to a spectrophotometer for mercury measurement as a function of time and temperature.

## **B5.0 Quality Control Requirements**

Specific quality control requirements are listed by method in Table 4. For each item there is a criteria for acceptance and an associated corrective response if necessary. In addition to these specific QC activities, the Reference test methods stipulate further routine QC that will be adhered to.

**Table 4**  
**Quality Control Requirements**

<b>Method</b>	<b>QC Item</b>	<b>Requirement</b>	<b>Acceptance Criteria</b>	<b>Corrective Action</b>
EPA 2	Pitot Tube Inspection	Inspect for damage periodically during test	Pitot is free from obvious damage	Replace
EPA 2	Pitot Tube Leak Check	Check pitot and lines for leaks pre-test and post-test	Pitot and lines to manometer must be leak free	Replace or repair and recheck
EPA 3/CO <sub>2</sub>	Minimum 3 runs per OH test	Verify fresh fyrite fluid, sample pre-test in open air through sample train	Fyrite CO <sub>2</sub> zero in open atmosphere test	Change fluid, check Fyrite seals and sample train integrity
EPA 3 (modified)/O <sub>2</sub>	Pre-test check	Sample pre-test in open air through sample train	Oxygen reading between 20 – 22%	Repair or replace meter, retest
EPA 3 (modified)/O <sub>2</sub>	Point by point sample	Test at each traverse point	Oxygen reading consistent from point to point	If leaks are indicated, halt OH test, check sample train integrity
EPA 4	Ice Bath	Ice must be present during test	Ice is present	Add ice
EPA 17/OH	Isokinetic Rate	Check at each run	90 – 110%, avg. all points	Repeat test
EPA 17/OH	Sample Train Leak Check	Check leak rate pre and post test and after any component change.	0.02 cfm maximum leak.	Check all connections, tighten and re-check
EPA 17/OH	Nozzle	Inspect for damage after each traverse	Free of damage	Replace nozzle,
EPA 17/OH	Probe/Nozzle orientation	Check at each traverse	Alignment into flow	Adjust
EPA 17/OH	Manometer	Check level periodically throughout test	Level	Adjust
Ontario Hydro	Impinger Solutions	Check of KmnO <sub>4</sub> Depletion	Purple color remains in Impingers 7, 8, 9	Increase solution in Impinger 7 and repeat test
Ontario Hydro	Impinger solution integrity	Check pre and post test	No carryover of impinger solution from one type solution to next	Repeat test
Ontario Hydro	Train Recovery	Recover train in a contamination free environment	Recovery area must be free from potential contaminants	Move recovery to cleaner area
EPA 17/OH	Probe Thermocouple	Accuracy must be checked	Check calibration with ASTM thermometer pre-test (+-1.5% maximum deviation)	Replace
EPA 17/OH	Barometer	Calibrate field instrument against a mercury barometer once per project	Agreement within 0.1 in Hg	Recalibrate
EPA 17/OH	Gas Meter	Pre-test and post-test calibration against standard	Agreement within method specification	Repair and recalibrate or replace

EPA 17/OH	Thimbles or Filters	Clean and free of contamination	Analysis of unused thimble must not contain mercury	Replace
EPA 17/OH	Brushes and Recovery Materials	Clean and metal free	No metal parts for any equipment used in recovery	Replace
Ontario Hydro	Glassware	Cleaned prior to project	Glassware clean and contamination free	Reclean
Ontario Hydro	Reagents free from contamination	Metals analytical grade reagents	Verify reagent quality from supplier	Obtain metals analytical grade reagents
Ontario Hydro	Purity of Water	Water must be free of impurities	Reagent grade, low metals, ASTM Type II or equivalent	Obtain new source for water
Ontario Hydro	Field Blanks	Analyze one field blank per test	Field blanks must be less than 30% of sample values or less than reagent blank values	Investigate source of contamination
Ontario Hydro	Reagent Blanks	Analyze one reagent blank for each reagent used per test	Reagent blanks must be less than 10X the instrument detection limit or less than 10% of the measured sample values	Determine source of contamination
Ontario Hydro Analytical	CVAAS	Instrument is working properly	Calibrations, blanks and standards all perform as expected	Repair instrument
COHPAC Process Data	Flue gas temperature(s), partial flow to B-side	Data is representative of process operation	Compare temperatures and flow rates to manual traverses obtained via Method 17	Investigate any significant differences
Sorbent injection rate	Calibrated feed screw rotation	Sorbent feed is +/-10% of target rate	Check prior to each OH run	Adjust feed rate and repeat check

## **B6.0 Instrumentation/Equipment Testing, Inspection, Maintenance**

Sampling equipment is routinely inspected prior to a field test in conjunction with pre-test calibration and checkout procedures. Maintenance is routinely performed on all critical components. In addition, backups to critical components will be available at the site in the event of equipment malfunction during the Performance Evaluation.

## **B7.0 Instrument Calibration and Frequency**

### Sampling Equipment

Calibration of emissions sampling equipment including gas meters, manometers, pitot, nozzles will be as prescribed in the reference EPA Methods<sup>7</sup>. The dry gas meters of the Ontario Hydro trains will be calibrated per Federal Register Method utilizing a NIST traceable laminar flow element or critical flow orifices. The nozzles will also undergo a pre-test and post-test calibration. Pitot tubes and thermocouples will be calibrated pre-test only.

### Analytical Balances

The accuracy of analytical balances will be checked at least once each day of use using Class S calibration weights.

### CVAAS

Calibration and maintenance of this equipment follows procedures provided by the manufacturer and specified in the methods used in this project. Results of these calibrations will be supplied as part of the final report documentation.

### COHPAC Process Sensors

The thermocouples and flow measuring devices installed in the B-Side COHPAC compartment will be checked against manual traverse data taken during baseline testing (Method 17 and Ontario Hydro) in March, 2001. Any major deviations or inconsistencies will be investigated prior to commencement of the Performance Evaluation.

## **B8.0 Inspection/Acceptance Requirements for Supplies and Consumables**

All reagents and solutions utilized for the Performance Evaluation will be freshly obtained, metals analytical grade. The Ontario Hydro method specifies that field blanks of all solutions shall be taken and analyzed concurrently with other samples. Any abnormally high background mercury in the sampling train or impinger solutions will be identified by this procedure. Laboratory analytical supplies will also be metals grade and blanks of prepared solutions will be tested concurrently with actual samples.

## **B9.0 Data Acquisition Requirements (Non-Direct Measurements)**

Any data or reference source that is required for the Performance Evaluation that is not a measured value will be disclosed in the overall Project Site Report. The reference will include all pertinent information including the reference title, section, and important information taken.

## **B10.0 Data Management**

### Sampling Data

Test data will be collected and evaluated by the SRI Task Manager at the conclusion of each Ontario Hydro run to determine acceptability of field procedures. The SRI Task Manager will review all data for completeness, and perform selected calculation audits to ensure that the data are valid.

### COHPAC and Process Data

Process data from a dedicated data acquisition computer for the COHPAC baghouse will be downloaded each test day. This data will be formatted into a spreadsheet log and archived for later use. A copy of the final spreadsheet log covering the full Performance Evaluation period will be made available to the Task Managers for incorporation into or reference for subsequent analysis and reporting.

Other plant process data may be required from unit operators on a non-standard basis. The ADA-ES Site Leader will be responsible for ensuring that all necessary data is collected. Log sheets will be maintained in the Unit control room and will be collected daily by the ADA-ES Site Leader. These will be entered into the process data spreadsheet log and made available to the Task Managers for incorporation into or reference for subsequent analysis and reporting.

### Process Samples

After collection, samples will be assigned a unique tracking number and logged into a tracking database. Sample location and time of collection will be logged. The sample tracking database will include all samples taken during the project and will be used in conjunction with the chain-of-custody to organize shipments to each of the subcontract laboratories.

All electronic stored data will be posted to the ADA-ES corporate computer network under a unique project subdirectory. The data will then be backed up as a routine function of the entire network. In addition, an archival hard disk (zip disk) will be made. The Test Coordinator will be responsible for all distribution and update to the archival test data.

## **PART C. ASSESSMENT/OVERSIGHT**

### **C1.0 Assessments and Response Actions**

Assessment and response activities for the most part will be confined to the QA/QC procedures required in the Test Methods. Refer to Table 4 for the expected corrective response for any problems encountered with the critical data for this project. For the Ontario Hydro method, a complete field blank will be taken by assembling a train at the test location, then disassembling and recovering in the same manner as for actual samples. The recovered samples will be analyzed along with the actual sample to document that the sampling procedures do not introduce any mercury contamination. In addition to the field blank, a reagent (solution) blank will be analyzed to determine if there are any potential contaminated reagents.

These blanks will isolate any mercury contamination problems in the sampling method, however, if a problem were to be identified the response would depend on the severity of the interference. Responses could include correcting or adjusting results for a background interference or, if the problem was severe enough, a complete retest might be required. The Project Manager based on the recommendations of the Test Coordinator and Task Manager will determine corrective response for such a situation.

Laboratory quality assurance for routine ASTM coal and ash analysis will follow the methods and recommendations of the respective laboratories.

### **C2.0 Reports to Management**

A preliminary report of test completeness, process information, and summary of pending work to complete the Performance Evaluation will be issued to Project Management within one week of completion of field testing. The Project Manager will be responsible for distribution of this to the various project participants.

## **PART D. DATA VALIDATION AND USABILITY**

### **D1.0 Data Review, Validation, and Verification Requirements**

In general, all measurement data will be validated based on the following criteria:

- Process conditions are at the required conditions during testing;
- Sample collection procedures are performed as required by the Test Method and SOP;
- Data are consistent with expected results; and
- Sampling and analytical procedures adhere to prescribed QC procedures.

Any suspect data will be flagged and identified according to the specific deviation from prescribed criteria and their potential effect on the data quality.

### **D2.0 Data Transformation and Reduction**

Standardized forms will be used to record data for each test method. These forms are provided in Appendix B. All run sheets are to be reviewed daily by the Task Manager for evaluation of progress, completeness, and non-conforming items. Standardized computer spreadsheets or data reduction programs will be used to reduce and analyze data. At the end of each test day, test data will be input to these spreadsheets. Laboratory analytical results will not be available at the end of each test day; however, results will be entered as they become available. Final data reduction for emissions testing will follow the standardized summary format specified by the EPA OAQPS Emission Measurement Center<sup>7</sup>.

Once the Ontario Hydro analytical results are completed and the data is reduced to final form, a spot check of the calculations for one complete run will be performed independently to verify agreement of data reduction procedures and units of measurement.

### **D3.0 Validation and Verification Methods**

Critical data will be validated internally by QC personnel prior to incorporation into final reports. All measurement data will be validated against the standards of the Test Method, adherence to QC procedures, consistency with expected and/or other results, and the specific acceptance criteria. Data will be coded as either valid or invalid based on their adherence to these criteria. It is the responsibility of ADA-ES and SRI Task Managers to determine the usability of data that does not meet DQI goals and to identify any data limitations in the project's final report.

### **D4.0 Reconciliation with Data Quality Objectives**

ADA-ES will complete a Reconciliation of Performance Evaluation results with Data Quality Objectives to determine if the DQOs have been met. ADA-ES and SRI quality assurance staff will have the final evaluation as to whether or not the project met the objectives of the sampling design, and whether or not departures, if any, from QA/QC guidelines are significant and are acceptable. The conclusions will be presented in the final Site Report for the project.

## LIST OF ACRONYMS AND ABBREVIATIONS

ADA-ES – ADA Environmental Solutions  
APC – Alabama Power Company  
ASTM – American Society for Testing and Materials  
A/C – Air-to-Cloth Ratio  
COHPAC - Compact Hybrid Particulate Collector  
CVAAS – Cold vapor atomic absorption spectrometry  
DQI – Data Quality Indicators  
DQO - Data Quality Objectives  
DOE – U.S. Department of Energy  
EERC – Energy and Environmental Research Center  
EPA – Environmental Protection Agency  
EPRI – Electric Power Research Institute  
ESP – Electrostatic Precipitator  
ICR – EPA’s Information Collection Request to evaluate speciated mercury emissions from selected coal-fired boilers  
NETL – DOE National Energy Technology Laboratory  
PSI – Physical Sciences, Inc.  
OH – Ontario Hydro mercury test method  
QAPP – Quality Assurance Project Plan  
SCA – Specific Collection Area  
SGLP – Synthetic Groundwater Leaching Procedure  
SOP – Standard Operating Procedures  
SRI – Southern Research Institute  
TCLP – Toxicity Characteristic Leaching Procedure

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# **ATTACHMENT A**

**SUMMARY OF THE ONTARIO HYDRO TEST METHOD  
(Sampling-Specific Sections, Exceptions to published ASTM Method  
highlighted)**

**ONTARIO HYDRO MERCURY TRAIN RECOVERY PROCEDURES  
PROCEDURE FOR THE ANALYSIS OF ONTARIO HYDRO METHOD  
TRAINS**

## **Summary of the Ontario Hydro Test Method (Sampling-Specific Sections, Exceptions to published ASTM Method boldfaced)**

### **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°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. 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). **Exception taken here: SRI uses an unheated PTFE tube, draining any condensate from it into the first impinger and recovering any remaining residue with multiple rinses using 0.1 N HNO<sub>3</sub>.**
- 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.
- 7.1.8 *Condensing/Absorbing System*—consists of ~~eight~~ **eleven** 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). **Exception: SRI uses Dupont Krytox, a PTFE based grease, on the ground glass fittings to improve sealing of the joints. The latter has proven to be non-contaminating and non-interfering in similar test programs in the past.** The first, second, fifth, seventh, eighth, ninth and eleventh 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 eighth impingers are also Greenburg–Smith design, but with the standard tip including the glass impinging plate. **The fourth, sixth and tenth impingers use cut-off stems to provide isolation of solutions.** The first, second, and third impingers contain aqueous 1 N potassium chloride (KCl) solution. The fourth impinger is empty while the fifth contains an aqueous solution of 5%  $\text{v/v}$  nitric acid (HNO<sub>3</sub>) and 10%  $\text{v/v}$  hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>). The sixth impinger is empty, and seventh, eighth and ninth impingers contain an aqueous solution of 4%  $\text{w/v}$  potassium permanganate (KMnO<sub>4</sub>) and 10%  $\text{v/v}$  sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). The last impinger contains silica gel or an equivalent desiccant. (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 HNO<sub>3</sub> –H<sub>2</sub>O<sub>2</sub>. 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). **Exception: SRI uses Teledyne Hastings O<sub>2</sub> meters at the exit of the gas metering system to obtain point by point oxygen concentrations and provide a QA check against leaks developing in the sampling system. Spot checks using Fyrite devices are used to measure CO<sub>2</sub> for gas density determinations in conjunction with the Teledyne Hastings O<sub>2</sub> meters.**

## 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 two, but not more than three 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 five minutes. **Exception: Because of the geometry of the outlet ducts and the number of sampling points required to obtain suitable traverses of them, the sampling time at each traverse point at the outlet is set at three minutes.**

## 11. Preparation of Apparatus

### 11.1 *Pre-test 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 six 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  $105^{\circ}\text{C}$  ( $220^{\circ}\text{F}$ ) for two to three hours, desiccated for two 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 fifth 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 seventh, eighth and ninth 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 non-contaminating material (SRI uses Dupont Krytox grease).
- 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 (Pre-test Leak Check), Section 4.1.4.2 (Leak Checks During the Sample Run), and Section 4.1.4.3 (Post test Leak Checks) of EPA Method 5 or 17. [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 1)].

## 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.

### 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  $120^{\circ}\text{C}$ .
- 13.1.2 Record the data, as indicated in Figure 2, at least once at each sample point but not less than once every five 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. (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  $<20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ) 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  $\text{KMnO}_4$  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  $\text{H}_2\text{SO}_4$ – $\text{KMnO}_4$  impingers, then the sample must be repeated. If the gas stream is known to contain large amounts of reducing constituents (i.e.,  $>2500$  ppm  $\text{SO}_2$ ) or breakthrough has occurred in previous sampling runs, then the following modification is suggested: the amount of  $\text{HNO}_3$ – $\text{H}_2\text{O}_2$  (10%  $\text{v/v}$ ) in the fourth impinger should be doubled, and/or a second  $\text{HNO}_3$ – $\text{H}_2\text{O}_2$  impinger should be used to increase the oxidation capacity for reducing gas components prior to the  $\text{H}_2\text{SO}_4$ – $\text{KMnO}_4$  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, non-contaminating 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 non-contaminating 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 HNO<sub>3</sub>. The 0.1 N HNO<sub>3</sub> 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 HNO<sub>3</sub>, 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 HNO<sub>3</sub>, Pour the rinse into a glass sample Container 3.

3.2.8.3 Carefully add small amounts of 5% w/v KMnO<sub>4</sub> solution very slowly to each KCl impinger and gently mix the impinger solution. Continue adding KMnO<sub>4</sub> 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 HNO<sub>3</sub>. Although unlikely, if deposits remain on the impinger surfaces, remove them by doing another 10% v/v HNO<sub>3</sub> rinse that has a very small amount (several drops) of 10% w/v hydroxylamine solution added to the HNO<sub>3</sub> 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 KMnO<sub>4</sub> 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 HNO<sub>3</sub> 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 5 (Impinger 4, HNO<sub>3</sub>–H<sub>2</sub>O<sub>2</sub> 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 HNO<sub>3</sub>–H<sub>2</sub>O<sub>2</sub> absorbing solution into sample Container 4.

13.2.9.2 Rinse the HNO<sub>3</sub>–H<sub>2</sub>O<sub>2</sub> impinger and connecting glassware a minimum of two times with 0.1 N HNO<sub>3</sub>, and pour the rinses into Container 4. Do a final rinse with water and discard water.

- 13.2.10 *Container 5 (Impingers 7 through 9, H<sub>2</sub>SO<sub>4</sub>–KMnO<sub>4</sub> 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 H<sub>2</sub>SO<sub>4</sub>–KMnO<sub>4</sub> impingers into a glass sample Container 5.
- 13.2.10.3 Rinse the H<sub>2</sub>SO<sub>4</sub>–KMnO<sub>4</sub> impingers and connecting glassware a minimum of two times with 0.1 N HNO<sub>3</sub>, 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 0.1 N HNO<sub>3</sub> and several drops of 10% w/v hydroxylamine solution (either the NH<sub>2</sub>OH/NaCl solution or the NH<sub>2</sub>OH/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 H<sub>2</sub>SO<sub>4</sub>–KMnO<sub>4</sub> solution until a pink or slightly purple color is obtained.
- 13.2.10.4 Perform a final 0.1 N HNO<sub>3</sub> rinse of the impingers and connecting glassware follow by a water rinse. The 0.1 N HNO<sub>3</sub> 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. (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 KMnO<sub>4</sub> 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 HNO<sub>3</sub> Blank)*—Place 50 mL of the 0.1 N HNO<sub>3</sub> 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%  $v/v$  HNO<sub>3</sub> – 10%  $v/v$  H<sub>2</sub>O<sub>2</sub> Blank)*—Place 50 mL of the HNO<sub>3</sub> –H<sub>2</sub>O<sub>2</sub> solution used as the nitric acid impinger reagent into a properly labeled container. Seal the container.
- 13.2.12.4 *Container 10 (H<sub>2</sub>SO<sub>4</sub> –KmnO<sub>4</sub> Blank)*—Place 50 mL of the H<sub>2</sub>SO<sub>4</sub> –KMnO<sub>4</sub> 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%  $v/v$  HNO<sub>3</sub> 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%  $v/v$  HNO<sub>3</sub> 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.

## Ontario Hydro Mercury Train Recovery Procedures

### Bottles needed:

100 mL glass bottle for filter

2 or 3, as needed, 500 mL glass bottles for Teflon umbilical rinse, KCl impinger contents and rinses

1 500 mL glass bottle for HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> impinger contents and rinses

2 500 mL amber vented glass or Nalgene bottles for H<sub>2</sub>SO<sub>4</sub>/KMnO<sub>4</sub> impinger contents and rinses

4 100 mL glass bottles for solution blanks of 0.1 N HNO<sub>3</sub>, HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub>, KCl, and H<sub>2</sub>SO<sub>4</sub>/KMnO<sub>4</sub> solutions

### Rinse Bottles needed:

0.1 N HNO<sub>3</sub>

10% hydroxylamine sulfate/sodium chloride solution

H<sub>2</sub>SO<sub>4</sub>/KMnO<sub>4</sub> solution

DI water

- 1.0 Remove U-connecting unions.
- 2.0 Weigh each impinger and record weight on recovery form.
- 3.0 Pour contents of impingers 1, 2 and 3 into sample bottle used for Teflon umbilical rinse and more clean sample bottles as needed.
- 4.0 Pour contents of impinger 4 (if any) and impinger 5 into a clean sample bottle.
- 5.0 Pour contents of impingers 6, 7, 8 and 9 into clean, vented sample bottle.
- 6.0 Rinse impingers 1,2,&3 with 0.1 N HNO<sub>3</sub> and pour into the bottle with impinger 3.
- 7.0 Rinse U-connecting unions from impingers 1,2, & 3 with 0.1 N HNO<sub>3</sub> and pour into bottle with impinger 3.

- 8.0 Rinse impingers 4 and 5 and connecting U-tubes with 0.1 N HNO<sub>3</sub> into bottle with impinger contents.
- 9.0 Pour contents of impingers 4, 5, & 6 into the same Nalgene bottle.
- 10.0 Rinse impingers 6, 7, 8, and 9 and connecting U-tubes with 0.1 N HNO<sub>3</sub> followed by additional HNO<sub>3</sub> with several drops of hydroxylamine-NaCl added and pour into the same Nalgene bottle.
- 11.0 Mark the height of the fluid level in each of the bottles, label appropriately, assigning sample numbers to each and seal bottles and add custody seals.

## Procedure for the Analysis of Ontario Hydro Method Trains

Upon receipt of the samples at the laboratory, confirm that all samples are accounted for and that all custody seals are intact.

Each train will consist of six containers, as follows:

Front Half Sample:

Filter

Acetone Rinse

0.1 N HNO<sub>3</sub> Rinse

Back Half Samples:

KCl Impingers

HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> Impinger

H<sub>2</sub>SO<sub>4</sub>/KMnO<sub>4</sub> Impingers

Additional containers will consist of reagent blanks and blind QA/QC samples.

All glassware and Teflon digestion vessels used in the analysis must be EPA cleaned for metals to insure the integrity of the samples. Graduated cylinders used in volume measurements must be tap rinsed, 1:1 HNO<sub>3</sub> rinsed, and DI H<sub>2</sub>O rinsed between samples. Weights required should be recorded accurately to within 0.1 mg. The calibration of analytical balances used must be checked daily.

All concentration and digestion procedures should be performed in an adequately functioning fume hood. Personnel performing the procedures should be trained in safe handling procedures for hydrofluoric acid and in proper bomb digestion techniques, and should be familiar with the analytical methods used throughout this procedure.

### *Reagents Required*

Note: All reagents should contain low mercury content or be of trace metal grade.

Deionized water

Boric Acid (H<sub>3</sub>BO<sub>3</sub>)

Hydrochloric acid (HCl)

Hydrofluoric acid (HF)

Hydroxylamine sulfate (NH<sub>2</sub>OH · H<sub>2</sub>SO<sub>4</sub>)

Or Hydroxylamine hydrochloride (NH<sub>2</sub>OH · HCl)

Sodium Chloride

1000 µg/mL Hg stock standard solution

Nitric Acid (HNO<sub>3</sub>)

Potassium permanganate (KMnO<sub>4</sub>)

Potassium persulfate (K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>)

Ice

## Front Half Sample Digestion

1. Note the fluid levels marked in the field and note if any leakage occurred during transit.
2. Record the volume of the acetone rinse accurately to within 1 mL, then quantitatively transfer all ash from the sample container and the graduated cylinder with acetone into a tared 250 mL beaker. Evaporate to dryness at ambient temperature and pressure, protecting the sample from access to contamination. Once dry, desiccate for 24 hours and weigh to a constant weight. Record the weight of ash collected. Save for use in step (3).
3. Record the volume of the 0.1 N HNO<sub>3</sub> rinse accurately to within 1 mL, then quantitatively transfer to a 250 mL beaker with DI H<sub>2</sub>O. Thoroughly rinse the sample container with DI H<sub>2</sub>O and collect in the beaker. Note if any particulate matter is present.
4. Reconstitute the residue from step (1) with 10 mL of concentrated HNO<sub>3</sub> and combine with the 0.1 N HNO<sub>3</sub> rinse.
5. Cover the beaker with a ribbed watch glass and concentrate at just below boiling to approximately 10 mL. **CRITICAL:** Do not allow the sample to boil or go to dryness as quantitative loss of mercury will result.
6. Using Teflon tweezers (or tweezers covered with Teflon tape), carefully weigh the filter, using care not to dislodge any particulate matter. Record the weight.
7. Carefully place the filter into the Teflon digestion vessel, using the Teflon tweezers to fold it as far down into the vessel as possible. Quantitatively transfer the concentrated sample from step (4) into the vessel with as little DI H<sub>2</sub>O as possible, wetting the filter in the process. Add 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 eight hours (these may be heated overnight). Cool the vessel to room temperature; vent slowly.
8. Add 3.5 g of boric acid and 40 mL of DI H<sub>2</sub>O to the vessel. Seal the vessel and return to the oven or water bath for 1 hour. Cool the vessel to room temperature; vent slowly.
9. Quantitatively transfer the contents of the vessel into a 100 mL PMP or PP volumetric flask and dilute to volume (glass is not recommended for use with HF). Use extreme care during this process.

Label the digestate above as the Front Half sample for the particular train.

## Sample Preparation for Analysis by CVAAS

Preservation of detection limits is critical in the analysis of these samples. Modify SW-846 Method 7470A as detailed below for the analysis of these samples. Procedures detailed below assume the use of an automated Hg analyzer, which requires only small sample volumes for analysis.

QA/QC: For each matrix set of samples of 10 or less, choose one sample on which to perform a duplicate digestion, a matrix spike and matrix spike duplicate. Spike at a known concentration similar to the expected concentration of mercury in the samples prior to adding any reagents. Each sample is to be analyzed with two replicate measurements with each tenth sample (or the last sample in the matrix set) analyzed with triplicate measurements. For each analysis batch the receiving laboratory should prepare and analyze an independent quality control standard to verify the calibration of the instrument. A digestion blank should be analyzed with each digestion batch. The results of the digestion duplicate and the percent recovery of the matrix spike and matrix spike duplicate are to be reported with the results.

### *Front Half Preparation*

Transfer 20 mL of digestate to a 50-mL digestion tube or an appropriate digestion vessel. Add 1.00 mL of concentrated  $\text{H}_2\text{SO}_4$  and 0.500 mL of concentrated  $\text{HNO}_3$ , mixing after each addition. Add 3.00 mL of 5%  $\text{KMnO}_4$  ( $^w/v$ ) to each sample and mix. If the solution does not remain purple, add a small amount of solid  $\text{KMnO}_4$  and mix. Repeat until the solution remains purple for at least 15 minutes. Add 1.60 mL of  $\text{K}_2\text{S}_2\text{O}_8$ . Loosely cap the tube or vessel. Heat at  $95^\circ\text{C}$  in a water bath or oven for two hours. The sample solution must remain purple throughout the digestion period to insure that all mercury present is reduced. Cool and add 1.20 mL of 12% hydroxylamine sulfate/ sodium chloride solution. The solution should become clear. If not, add additional hydroxylamine reagent in 0.25-mL increments until the solution becomes clear. Record the exact volume of all reagents added. Analyze per the guidelines specified by the CVAAS instrument's manufacturer.

### *Preparation of KCl Impingers Solution*

Note the fluid level marked in the field and note if any leakage occurred. Thoroughly mix the container before recording the volume of the solution accurately to within 1 mL, and note if the solution remained purple since recovery. Transfer 20 mL of sample to a 50-mL digestion tube or an appropriate digestion vessel. Add 1.00 mL of concentrated  $\text{H}_2\text{SO}_4$  and 0.500 mL of concentrated  $\text{HNO}_3$ , mixing after each addition. Add 3.00 mL of 5%  $\text{KMnO}_4$  ( $^w/v$ ) to each sample and mix. If the solution does not remain purple, add a small amount of solid  $\text{KMnO}_4$  and mix. Repeat until the solution remains purple for at least 15 minutes. Add 1.60 mL of  $\text{K}_2\text{S}_2\text{O}_8$ . Loosely cap the tube or vessel. Heat at  $95^\circ\text{C}$  in a water bath or oven for two hours. The sample solution must remain purple throughout the digestion period to insure that all mercury present is reduced. Cool and add 1.20 mL of 12% hydroxylamine sulfate/ sodium chloride solution. The solution should become clear. If not, add additional hydroxylamine reagent in 0.25-mL increments until the solution becomes clear. Record the exact volume of all reagents added. Analyze per the guidelines specified by the CVAAS instrument's manufacturer.

### *Preparation of HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> Impinger Solution*

Note the fluid level marked in the field and note if any leakage occurred. Record the volume of the solution accurately to within 1 mL. Transfer 10 mL of sample to a 50-mL digestion tube or an appropriate digestion vessel. Add 0.500 mL of concentrated HCl and 0.500 mL of concentrated H<sub>2</sub>SO<sub>4</sub>, mixing after each addition. Place the tubes or digestion vessels into an ice bath and add 1.00 mL of 5% KMnO<sub>4</sub> (<sup>w/v</sup>) in 0.250-mL increments to each sample and mix, allowing the solution to cool between additions. Use care in these additions, as the reaction may be violent. Continue to add 5% KMnO<sub>4</sub> in 0.500 mL increments, with mixing and cooling between additions, until a total of 3.00 mL have been added. If the solution does not remain purple, add a small amount of solid KMnO<sub>4</sub> and mix. Use care in these additions, as the reaction may be violent. Repeat until the solution remains purple for at least 15 minutes. Add 1.60 mL of K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>. Loosely cap the tube or vessel. Heat at 95°C in a water bath or oven for two hours. The sample solution must remain purple throughout the digestion period to insure that all mercury present is reduced. Cool and add 1.20 mL of 12% hydroxylamine sulfate/ sodium chloride solution and mix. The solution should become clear. If not, add additional hydroxylamine reagent in 0.25-mL increments until the solution becomes clear. Record the exact volume of all reagents added. Analyze per the guidelines specified by the CVAAS instrument's manufacturer.

### *Preparation of the KMnO<sub>4</sub>/H<sub>2</sub>SO<sub>4</sub> Impingers Solution*

Note the fluid level marked in the field and note if any leakage occurred. Thoroughly mix the container before recording the volume of the solution accurately to within 1 mL, and note if the solution remained purple since recovery. Transfer 20 mL of sample to a 50-mL digestion tube or an appropriate digestion vessel using appropriate representative sampling technique. Add 1.00 mL of concentrated H<sub>2</sub>SO<sub>4</sub> and 0.500 mL of concentrated HNO<sub>3</sub>, mixing after each addition. Add 3.00 mL of 5% KMnO<sub>4</sub> (<sup>w/v</sup>) to each sample and mix. Add 1.60 mL of K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>. Loosely cap the tube or vessel. Heat at 95°C in a water bath or oven for two hours. The sample solution must remain purple throughout the digestion period to insure that all mercury present is reduced. Cool and add 1.20 mL of 12% hydroxylamine sulfate/ sodium chloride solution. The solution should become clear. If not, add additional hydroxylamine reagent in 0.25-mL increments until the solution becomes clear. Record the exact volume of all reagents added. Analyze per the guidelines specified by the CVAAS instrument's manufacturer.

### *Preparation of Reagent Blanks and Laboratory Blind QA/QC Samples*

These solutions should be prepared like the impinger solutions they represent:

1 M KCl

5% <sup>v/v</sup> HNO<sub>3</sub> / 10% <sup>v/v</sup> H<sub>2</sub>O<sub>2</sub> solution

4% <sup>w/v</sup> KMnO<sub>4</sub> / 10% <sup>v/v</sup> H<sub>2</sub>SO<sub>4</sub> solution

The acetone solution(s) should be evaporated to dryness as described in steps (1) and (2) of the Front Half Sample Digestion Procedure above. Reconstitute the residue with 10 mL of concentrated HNO<sub>3</sub> and dilute to volume in a 100-mL volumetric flask. Analyze as described for the KCl Impinger solutions.

The filter samples should be digested in a Teflon bomb as described in steps (6) – (9) of the Front Half Sample Digestion Procedure above. Since there will be no rinse solutions for combination with the filter, wet the filter after it is placed into the Teflon digestion bomb with 5-10 mL of deionized water prior to adding the HF, the proceed as described above.

Analyze the 0.1 N HNO<sub>3</sub> solution(s) and the 10% <sup>v/v</sup> HNO<sub>3</sub> solution(s) as described for the KCl Impinger solutions.

### *Instrument Calibration*

Prepare standards in a matrix-matched solution by performing serial dilutions from a 1000 µg/mL mercury stock solution, available commercially. First, dilute 1 mL of 1000 µg/mL mercury stock solution to 100 mL in 10% <sup>v/v</sup> HCl for a 10 µg/mL stock solution. Then, dilute 1 mL of the 10 µg/mL stock solution to 100 mL in 10% <sup>v/v</sup> HCl for a 100 µg/L working stock solution. Front half digestates and HNO<sub>3</sub>/ H<sub>2</sub>O<sub>2</sub> impinger solutions should be analyzed with a low curve ranging from 0.1 µg/L to 1.0 µg/L. Prepare the calibration curve by diluting 0.100 mL, 0.200 mL, 0.500 mL and 1.000 mL of 100 µg/L working stock solution to 100 mL in matrix-matched blank solution. KCl impinger solutions and KMnO<sub>4</sub>/ H<sub>2</sub>SO<sub>4</sub> solutions should be analyzed with a high curve ranging from 1.0 µg/L to 20.0 µg/L. Prepare the calibration curve by diluting 1.00 mL, 5.00 mL, 10.0 mL and 20.0 mL of 100 µg/L working stock solution to 100 mL in matrix-matched blank solution. If the actual concentrations found are too high for the front half digestates or the HNO<sub>3</sub>/ H<sub>2</sub>O<sub>2</sub> impinger solutions, reanalyze with the higher curve. Similarly, if the actual concentrations found in the KCl impinger solutions and KMnO<sub>4</sub>/ H<sub>2</sub>SO<sub>4</sub> solutions are below the concentration range, reanalyze with the lower curve.

### *Calculations*

$$Hg_{\text{sample}}, \mu\text{g/L} = (\text{IR})(\text{DF})$$

Where:

IR = raw concentration, calculated from the calibration curve

DF = dilution factor,  $\frac{V_D + V_{\text{reagents}}}{V_D}$

V<sub>D</sub> = total digested sample volume

V<sub>reagents</sub> = total volume of added reagents for digestion

### *Reporting Requirements*

For each sample, the following parameters must appear in the report:

The total volume of the sample as received at the laboratory (as applicable)

Any leakages observed or degradations of sample preservatives

The calculated mercury results

Duplicate results and RPDs

Matrix Spike and Matrix Spike Duplicate results and RPDs

Independent QA/QC sample recovery(s)

# **ATTACHMENT B**

**Data sheets, all Methods**

**Hg Train Weight sheets**

**Custody forms**

**Sample Labels**

# Measurement of Mercury Species Around a COHPAC System at Alabama Power Company's E.C. Gaston Generating Station

## ***Introduction***

The measurements reported here were made to assist ADA-ES (ADA) as part of a Department of Energy mercury control technology evaluation project. The work was carried out around the Gaston Unit 3 COHPAC baghouse installation. Two series of tests were carried out to quantify mercury emissions at the inlet and outlet of the COHPAC unit. The first test series, carried out in early March 2001, was done on a COHPAC module operating without the mercury control system to establish a baseline condition for comparison with later tests with the mercury control system in operation. The second set of tests, during which the mercury control system was in use, was conducted in late April 2001. Measurements at the inlet to the hotside ESP inlet were added to the April test program at the behest of the US EPA. Sampling at all locations was done concurrently, insofar as possible, with triplicate pairs of samples being collected. The sampling method used was developed by Dr. Keith Curtis of Ontario Hydro Technologies (now listed as a Draft Method by EPA entitled "Standard Test Method for Elemental, Oxidized, Particle-Bound, and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method).") The sampling and analysis were conducted in accordance with the site specific QA/QC plan developed jointly by ADA-ES and Southern Research. The sampling was performed by Southern Research (with assistance from Arcadis G&M, Inc. for hotside ESP location) with the laboratory analyses for the collected samples being performed by Galbraith Laboratories, Inc.

## ***Sampling***

In the Ontario Hydro Method, mercury in particulate phase in the flue gas is collected on Method 5-type filters while vapor phase mercury and mercury compounds are collected in impinger solutions. Ionized mercury is captured in a series of three impingers containing KCl solution, and elemental mercury is captured in a series of three impingers containing a solution of  $\text{KMnO}_4$  and  $\text{H}_2\text{SO}_4$ . Between the KCl and  $\text{KMnO}_4$  impingers is a single impinger with a solution of  $\text{H}_2\text{O}_2$  and  $\text{HNO}_3$ . This intermediate impinger is used to preclude depletion of the  $\text{KMnO}_4$  by acid gases ( $\text{SO}_2$ , in particular). The  $\text{KMnO}_4/\text{H}_2\text{SO}_4$  and  $\text{H}_2\text{O}_2/\text{HNO}_3$  solutions were made up fresh daily per the method requirements.

The COHPAC inlet duct dimensions were 6 feet by 31.5 feet with six evenly-spaced ports along the long dimension of the duct. One of the inlet ports was inaccessible during the baseline test series and two inlet ports were inaccessible during the second test series.

The outlet duct dimensions were 4 feet by (effectively) 33.56 feet with 16 evenly-spaced ports along the long dimension. Three of the outlet ports were inaccessible during the baseline test series and four of the outlet ports were inaccessible during the second test series. The hot-side ESP inlet duct dimensions were 5 feet by 30 feet with five ports along the long dimension, only two of which were accessible for sampling. In each case, when a port was inaccessible for sampling the adjacent port deemed most likely representative of the inaccessible port was sampled in its place.

The layouts of the sampling ports and platforms at both the inlet and outlet of the COHPAC made it impractical to use the normal, close-coupled filter-oven/impinger sampling. Rather, a glass-lined probe and small oven containing the filter was employed that was connected to the impingers by a teflon umbilical line with the impingers located at a convenient, fixed position. Because of the relatively high negative differential pressures in the ducts, teflon check-valves were employed immediately following the filters to ensure that back-flows did not create problems as the probes were inserted and withdrawn from the ducts.

In addition to the mercury sampling, three EPA Method 17 sampling runs were made at the COHPAC inlet during the baseline test.

### ***Analysis***

Analysis of mercury from the flue gas samples was done in three fractions:

- particulate phase mercury is determined by analysis of the solids trapped on the filter and in the sampling probe of the OHT,
- ionized mercury is determined from the combined quantity of mercury captured in the KCl impingers, and
- elemental mercury is determined from the combined quantity of mercury captured in the  $\text{H}_2\text{O}_2/\text{HNO}_3$  and the  $\text{KMnO}_4/\text{H}_2\text{SO}_4$  impingers.

Mercury in the impinger solutions was stabilized by a hydroxylamine and  $\text{KMnO}_4$  addition after sample recovery each day. For each sampling train the KCl impingers were combined into a single sample for analysis. The  $\text{H}_2\text{O}_2/\text{HNO}_3$  impinger was analyzed separately to avoid matrix problems, and the  $\text{KMnO}_4/\text{H}_2\text{SO}_4$  impingers from each train were also combined for analysis.

Quality assurance procedures included the analysis of blanks and standard reference materials and laboratory spiked solutions and filters. In addition to the three OHT samples from each location, a 'blank train' (a complete OHT train prepared for sampling, leak-checked, and then immediately recovered as if used for flue gas sampling) sample

was “run”, permitting a quality assurance check on the sampling equipment, assembly, and handling. ‘Reagent blanks’ (samples of each of the reagents used in the sampling and sample recovery operation) from each batch of chemicals prepared were retained and analyzed together with the actual samples. The US EPA provided a ‘blind’ sample of fly ash certified by NIST to contain known concentrations of mercury which was used to spike two filters to be analyzed with the flue gas samples as a quality assurance check of the analytical protocols and instrumentation.

### **Results**

Measurement results from the baseline tests are summarized in Tables 1 and 2. Table 1 provides speciated and total mercury concentrations, emission rates for total mercury, COHPAC gas flow rates and isokinetic sampling ratios for both the COPAC inlet and outlet sampling locations. Table 2 provides a summary of the results for the COHPAC inlet Method 17 sampling. Copies of field data sheets, meter-box and probe calibrations, detailed results for each sampling run, custody sheets, and the Galbraith Laboratories report on their analyses are included in appendices to this report.

Measurement results from the carbon injection tests are summarized in Table 3 which provides speciated and total mercury concentrations, emission rates for total mercury, COHPAC gas flow rates and isokinetic sampling ratios for the hotside ESP inlet, the COPAC inlet and the COHPAC outlet sampling locations. Again, copies of field data sheets, meter-box and probe calibrations, detailed results for each sampling run, custody sheets, and the Galbraith Laboratories report on their analyses are included in appendices to this report.

Table 1. Baseline Test Mercury Concentrations from the Ontario Hydro Method, µg/dncm

Date and Location	Time	Particulate	Oxidized Vapor	Elemental Vapor	Total	Conc. Ratio	Fraction Oxidized	Emission Rate, lb/hr	Gas Flow dscfm	Percent Isokinetic
3/6/2001										
COHPAC Inlet	12:49-15:00	0.02	10.69	6.14	16.86		0.63	0.0193	305850	94.6
COHPAC Outlet	11:10-15:01	0.01	9.43	4.25	13.68	0.81	0.69	0.0143	280620	96.7
3/6/2001										
COHPAC Inlet	16:37-18:54	0.03	7.41	6.49	13.93		0.53	0.0170	326676	108.3
COHPAC Outlet	16:55-21:15	0.02	11.54	2.76	14.32	1.03	0.81	0.0160	300345	100.7
3/7/2001										
COHPAC Inlet	12:38-15:18	0.20	8.37	3.95	12.52		0.67	0.0157	335759	105.1
COHPAC Outlet	12:05-15:02	0.01	10.09	2.26	12.35	0.99	0.82	0.0158	341973	98.0

Table 2. Baseline Test COHPAC Inlet M17 Results

Date	Time	Particulate Concentration, mg/dncm	Emission Rate, lb/hr	Gas Flow dscfm	Percent Isokinetic
3/6/2001	9:02-11:13	13.4	22.1	305935	99.7
3/7/2001	8:10-9:52	272	350	345024	99.1
3/7/2001	10:34-12:10	263	333	338452	108.9

Table 3. Results of Mercury Emissions Tests from the Ontario Hydro Method with Carbon Injection into COHPAC Inlet, µg/dncm

Date and Location	Time	Particulate	Oxidized Vapor	Elemental Vapor	Total	Outlet/Inlet	Fraction Oxidized	Emission Rate, lb/hr	Gas Flow dscfm	Percent Isokinetic
4/24/01										
ESP Inlet	10:39-13:55	0.47	2.69	5.17	8.33	0.11	0.32	0.00885	284241	100.4
COHPAC Inlet	14:20-16:43	0.11	4.58	4.85	9.54	0.10	0.48	0.0106	297975	102.6
COHPAC Outlet	11:48-15:38	0.10	0.86	0.09	1.05		0.91	0.0012	312087	105.4
4/25/01										
ESP Inlet	11:17-14:08	0.02	6.76	3.41	10.19	0.10	0.66	0.0104	272998	104.7
COHPAC Inlet	13:57-16:10	0.38	5.18	3.11	8.66	0.12	0.60	0.00934	288329	102.6
COHPAC Outlet	10:51-14:37	0.18	0.81	0.05	1.04		0.78	0.0013	322275	99.1
4/26/01										
ESP Inlet	11:55-14:10	0.06	5.70	2.81	8.58	0.11	0.66	0.0091	282255	104.5
COHPAC Inlet	12:38-15:18	0.15	7.91	4.78	12.84	0.07	0.62	0.0134	279995	104.0
COHPAC Outlet	10:52-14:59	0.07	0.86	<0.05	0.93		0.93	0.0011	316659	102.4

Table C1 provides a summary of Galbraith Laboratories' internal QA/QC checks related to the sample analyses. Table C2 provides a summary of Galbraith Laboratories' internal QA/QC checks related to the sample analyses. Table C3 provides a summary of the results for a set of 'blind' spiked samples that were submitted to Galbraith Laboratories for analysis with the actual field samples. The latter include results for two filter samples loaded as indicated with NIST certified flyash provided by the US EPA.

Pre-test and post-test leak checks of the sampling trains were all satisfactory with the exception of the hotside ESP inlet run on 4/26. In the latter case, the post-test leak check showed a leakage rate of 0.09 cfm at the highest vacuum obtained during the test. Ioskinetic ratios for all sampling runs were within the allowable ranges of 90 to 110 percent. Recovery of laboratory matrix spikes performed by Galbraith were acceptable in all cases, falling in the range of 84 to 122 percent with excellent reproducibility in duplicate analyses. Similarly, the results of duplicate analyses of actual samples were good, with deviations of less than 5 percent in most cases and maximum deviations of less than 10 percent.

Recoveries of blind spikes submitted by Southern Research Institute with the samples were mixed. Recoveries of spiked  $\text{HNO}_3/\text{H}_2\text{O}_2$  solutions fell in the range of 85 to 122 percent as did the results for the two higher level spikes in KCl solutions. However, the recovery for the low level spike in the KCl solution was only 31 percent and the recoveries for all of the spiked  $\text{KMnO}_4$  solutions were all low, ranging from 22 to 64 percent. The cause of the latter results are not known; however, given the good recoveries of spikes performed at Galbraith, they may indicate a problem with the preparation of the spikes rather than in the analyses. Unfortunately, by the time the results were obtained the holding times for the samples had long been exceeded and re-analysis of suspect samples were not believed to be worthwhile.



Table C2. Summary of Galbraith Laboratories, Inc. Matrix Spike and Duplicate Analysis Results for Carbon Injection Test.

Sample ID	Matrix	% Recovery	Sample ID	Matrix	µg/L
ADA-2-EI1-9	H2SO4/KMnO4 sol'n blank	95.2	ADA-2-EI1-13	10% hydroxylamineHCl blank	<.2
ADA-2-EI1-10	1N KCl sol'n blank	110	ADA-2-EI3-8	H2SO4/KMnO4	10.91
ADA-2-EI1-13	10% hydroxylamineHCl blank	99.2	ADA-2-EI3-9	HNO3/H2O2 blank	<.186
ADA-2-CO4-7	10% HNO3 blank	97.8	ADA-2-EI4-10	H2SO4/KMnO4 blank	<.146
ADA-2-CI3-1,2,3	Front half	116.9	ADA-2-CO4-7	10% HNO3 blank	0.16
ADA-2-CO3-1,2,3	Front half	107.7	ADA-2-CI4-1,2,3	Front half	0.201
ADA-2-CO3-7	H2SO4/KMnO4 blank	88.4	ADA-2-CI4-4	1N KCl	14.4
ADA-2-L-9	HNO3/H2O2 blank	84	ADA-2-CI4-5	HNO3/H2O2	0.623
ADA-2-L-13	1N KCl sol'n blank	114.5	ADA-2-CI3-1,2,3	Front half	0.53
ADA-2-L18	NIST ash on filter	87.6	ADA-2-CO3-1,2,3	Front half	0.45
			ADA-2-CO3-5	HNO3/H2O2	<.186
			ADA-2-L-14	Filter	0.393
			ADA-2-L18	NIST ash on filter	0.0454
					0.372
					0.0389

Duplicate Analyses:

Table C3. Mercury Spike Results

Sample ID	Matrix	Ash, g	SPIKE, µg	Reported µg	% RECOVERY
ADA-2-L-2	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		0.737	0.164	22.25
ADA-2-L-3	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		5.99	2.29	38.23
ADA-2-L-4	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		1.0	0.637	63.70
ADA-2-L-6	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		1.0	0.9095	90.95
ADA-2-L-7	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		5.5	4.65	84.55
ADA-2-L-8	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		0.400	0.486	121.50
ADA-2-L-10	KCl		6.00	5.459	90.98
ADA-2-L-11	KCl		1.00	1.094	109.40
ADA-2-L-12	KCl		0.400	0.124	31.00
ADA-2-L-14	Filter		1.00	0.394	39.40
ADA-2-L-15	Filter		0.40	0.192	48.00
ADA-2-L-17	NIST Ash	0.0792		<0.0154	
ADA-2-L-18	NIST Ash	0.600		0.0422	

# **ATTACHMENT B1**

## **Baseline Field Test Data**

## **B1a-Method 17**



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	2/3	21	5.2	254	0.43	1.15	616.8					52	45	5.2
	2/4	24	6.0	261	0.50	1.34	618.3					53	46	5.0
	2/5	27	6.3	263	0.5	1.37	620.1					55	47	5.0
	END	30					621.876							
					0.									
	3/1	30	2.5	227	0.08	0.25	621.876					50	49	6.4
	3/2	33	—	235	0.18	0.49	622.0					52	49	6.5
	3/3	36	5.3	244	0.34	0.91	623.7					54	50	6.3
	3/4	39	5.8	250	0.45	1.22	625.3					55	50	5.6
	3/5	42	5.8	255	0.45	1.22	627.1					56	51	5.2
	END	45					628.606							
	4/1	45	2.2	226	0.05	0.18	628.6					54	55	6.6
	4/2	48	2.6	231	0.15	0.40	630.4					58	56	7.0
	4/3	51	5.5	236	0.34	0.91	—					56	56	6.6
	4/4	54	6.7	240	0.50	1.34	632					59	56	6.5
	4/5	57	6.8	247	0.54	1.45	634.79					61	57	5.8
	END	60												
	5/1	60	4.2	222	0.25	0.67	634.79					62	57	7.4
	5/2	63	5.4	225	0.38	1.04	636.2					64	57	7.7
	5/3	66	5.5	224	0.40	1.09	637.7					64	57	7.4
	5/4	69	5.5	230	0.40	1.09	639.3					65	58	7.6
	5/5	72	6.2	231	0.50	1.34	641.1					66	58	7.5



1M17

3/6/01

MASS TRAIN OPERATION		dp PITOT	dP ORI	dp PITOT	dP ORI
GAS ANALYSIS - O2	: 6.5	0.200	0.54	0.560	1.50
CO2	: 11.0	0.220	0.59	0.580	1.56
H2O	: 8.0	0.240	0.64	0.600	1.61
AVG dP	: 0.4761	0.260	0.70	0.620	1.67
AMB PRESS, in Hg	: 30.21	0.280	0.75	0.640	1.72
STACK dP, in H2O	: -13.5	0.300	0.81	0.660	1.77
AVG SQR ROOT dP	: 0.69	0.320	0.86	0.680	1.83
MINIMUM PITOT dP	: 0.20	0.340	0.91	0.700	1.88
dP INCREMENT	: 0.020	0.360	0.97	0.720	1.93
		0.380	1.02	0.740	1.99
STACK GAS TEMP, F	: 260	0.400	1.07	0.760	2.04
GAS METER TEMP, F	: 80	0.420	1.13	0.780	2.10
		0.440	1.18	0.800	2.15
PITOT CONSTANT	: 0.83	0.460	1.24	0.820	2.20
ORIFICE CONSTANT	: 1.85	0.480	1.29	0.840	2.26
		0.500	1.34	0.860	2.31
NOZZLE DIA, in	: 0.250	0.520	1.40	0.880	2.36
SYSTEM FLOW, acfm	: 0.922	0.540	1.45	0.900	2.42
FLOW, scfm	: 0.62832				

0.1 = 30

3/6/01

Inlet M11  
LOW Range Pitot dp.

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	6.5	0.000	0.00	0.360	0.98
CO2 :	11.0	0.020	0.05	0.380	1.04
H2O :	8.0	0.040	0.11	0.400	1.09
AVG dp :	0.4761	0.060	0.16	0.420	1.14
AMB PRESS, in Hg :	30.21	0.080	0.22	0.440	1.20
STACK dp, in H2O :	-13.5	0.100	0.27	0.460	1.25
AVG SQR ROOT dp :	0.69	0.120	0.33	0.480	1.31
MINIMUM PITOT dp :	0.00	0.140	0.38	0.500	1.36
dp INCREMENT :	0.020	0.160	0.44	0.520	1.42
		0.180	0.49	0.540	1.47
STACK GAS TEMP, F :	250	0.200	0.55	0.560	1.53
GAS METER TEMP, F :	80	0.220	0.60	0.580	1.58
		0.240	0.65	0.600	1.64
PITOT CONSTANT :	0.83	0.260	0.71	0.620	1.69
ORIFICE CONSTANT :	1.85	0.280	0.76	0.640	1.74
		0.300	0.82	0.660	1.80
NOZZLE DIA, in :	0.250	0.320	0.87	0.680	1.85
SYSTEM FLOW, acfm :	0.916	0.340	0.93	0.700	1.91
FLOW, scfm :	0.63273				



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	2/3	21	8.2	244	0.55	1.53	354.6					49	44	5.0
	2/4	24	10.0	248	0.62	1.73	356.3					51	45	4.6
	2/5	27	12.0	251	0.66	1.84	358.2					52	45	4.5
	END	30					360.174							
	3/1	30	5.0	234	0.14	0.39	360.174	LEAK CHECK				50	46	13.0
	3/2	33	5.2	231	0.25	0.69	361.63	STOP RESAMPLE				50	47	8.0
	3/3	36	7.0	236	0.43	1.20	362.4					63	47	6.1
	3/4	39	7.3	237	0.57	1.59	—					<del>53</del>	<del>47</del>	5.1
	3/5	42	11.8	242	0.62	1.73	366.4					54	48	4.6
	END	45					368.0							
	4/1	45	2.8	223	0.05	0.14	368.0					52	48	6.4
	4/2	48	4.0	225	0.18	0.50	368.7					52	48	7.5
	4/3	51	6.0	225	0.37	1.03	369.7					53	48	7.0
	4/4	54	8.5	231	0.60	1.52	371.4					54	48	5.8
	4/5	57	11.3	234	0.65	1.81	—					55	49	5.3
	END	60					375.07							
	5/1	60	5.3	217	0.30	0.84	375.07					54	49	6.2
	5/2	63	6.0	213	0.37	1.03	376.5					54	50	7.6
	5/3	66	7.0	216	0.46	1.28	378.1					55	50	7.4
	5/4	69	7.0	219	0.46	1.28	379.0					55	50	7.0
	5/5	72	9.5	221	0.65	1.81	381.6					56	51	6.6



3/7/01 ME #17 Inlet,

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	6.5	0.000	0.00	0.360	1.00
CO2 :	11.0	0.020	0.06	0.380	1.06
H2O :	8.0	0.040	0.11	0.400	1.11
AVG dp :	0.4761	0.060	0.17	0.420	1.17
AMB PRESS, in Hg :	30.33	0.080	0.22	0.440	1.23
STACK dp, in H2O :	-13.5	0.100	0.28	0.460	1.28
AVG SQR ROOT dp :	0.69	0.120	0.33	0.480	1.34
MINIMUM PITOT dp :	0.00	0.140	0.39	0.500	1.39
dp INCREMENT :	0.020	0.160	0.45	0.520	1.45
		0.180	0.50	0.540	1.50
STACK GAS TEMP, F :	235	0.200	0.56	0.560	1.56
GAS METER TEMP, F :	80	0.220	0.61	0.580	1.62
		0.240	0.67	0.600	1.67
PITOT CONSTANT :	0.83	0.260	0.72	0.620	1.73
ORIFICE CONSTANT :	1.85	0.280	0.78	0.640	1.78
		0.300	0.84	0.660	1.84
NOZZLE DIA, in :	0.250	0.320	0.89	0.680	1.89
SYSTEM FLOW, acfm :	0.904	0.340	0.95	0.700	1.95
FLOW, scfm :	0.64074				

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI	
-----		-----	-----	-----	-----	
GAS ANALYSIS - O2	:	6.5	0.000	0.00	0.720	2.00
CO2	:	11.0	0.040	0.11	0.760	2.12
H2O	:	8.0	0.080	0.22	0.800	2.23
AVG dP	:	0.4761	0.120	0.33	0.840	2.34
AMB PRESS, in Hg	:	30.33	0.160	0.45	0.880	2.45
STACK dP, in H2O	:	-13.5	0.200	0.56	0.920	2.56
AVG SQR ROOT dP	:	0.69	0.240	0.67	0.960	2.67
MINIMUM PITOT dP	:	0.00	0.280	0.78	1.000	2.78
dP INCREMENT	:	0.040	0.320	0.89	1.040	2.90
			0.360	1.00	1.080	3.01
STACK GAS TEMP, F	:	235	0.400	1.11	1.120	3.12
GAS METER TEMP, F	:	80	0.440	1.23	1.160	3.23
			0.480	1.34	1.200	3.34
PITOT CONSTANT	:	0.83	0.520	1.45	1.240	3.45
ORIFICE CONSTANT	:	1.85	0.560	1.56	1.280	3.56
			0.600	1.67	1.320	3.68
NOZZLE DIA, in	:	0.250	0.640	1.78	1.360	3.79
SYSTEM FLOW, acfm	:	0.904	0.680	1.89	1.400	3.90
FLOW, scfm	:	0.64074				



MI 7-3

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	5/3	21	5.5	219	0.42	1.17	408.6					58	53	8.3
	5/4	24	6.3	222	0.46	1.28	410.3					59	53	7.8
	5/5	27	8.0	223	0.60	1.67	412.0					59	53	<del>8.0</del>
	END	30					413.95							
	4/1	30	2.0	228	0.05	0.14	413.95					58	54	9.8
	4/2	33	3.2	228	0.16	0.45	414.6					58	54	9.2
	4/3	34	5.3	232	0.38	1.06	415.7					59	54	8.2
	4/4	39	8.5	235	0.58	1.62	417.2					60	55	6.8
	4/5	42	9.0	237	0.64	1.78	419.2					61	55	5.9
	END	45					421.225							
	3/1	45	2.9	235	0.110	0.28	421.225					60	55	9.2
	3/2	48	4.5	236	0.24	0.67	422.1					61	56	8.5
	3/3	51	6.0	240	0.49	0.23	423.6					61	56	7.6
	3/4	54	7.3	244	0.58	1.52	425.3					62	56	6.7
	3/5	57	8.8	245	0.58	1.52	426.9					62	56	5.6
	END	60					428.76							
	2/1	60	4.7	245	0.28	0.78	430.2					61	57	8.0
	2/2	63	6.0	248	0.45	1.26	—					62	57	6.4
	2/3	66	7.2	252	0.55	1.53	432.1					63	57	5.7
	2/4	69	10.0	257	0.62	1.73	—					64	57	5.0
	2/5	72	15.0	259	0.65	1.81	435.7					63	58	4.6



prelim final wgs 3/14/01  
 JH

## WEIGHT SHEET

		Substrate		Nozzle Wash	
Date:	ID #	Final		Final	
Run #	OMT-1W	386.9		251.3	
		Initial	350	Initial	250
		10.13		0.43	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-2W	768.2		274.9	
		Initial	350	Initial	200
		12.78		49.94	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-3W	746.1		265.3	
		Initial	350	Initial	200
		6.39		58.39	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-4W				
		Initial	350	Initial	250
		140.24		128.32	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT				
		Initial		Initial	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-1W				
		Initial	300	Initial	200
		60.07		50.40	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-2W				
		Initial	300	Initial	200
		62.71		49.94	
		Net		Net	
Date:	ID #	Final		Final	
Run #	OMT-3W				
		Initial	300	Initial	200
		56.34		58.40	
		Net		Net	
Date:	ID #	Final		Final	
Run #					
		Initial		Initial	
		Net		Net	
Date:	ID #	Final		Final	
Run #					
		Initial		Initial	
		Net		Net	
Date:	ID #	Final		Final	
Run #					
		Initial		Initial	
		Net		Net	

2/27

✓

2/28

RUN IDENTIFICATION: M17-1  
 RUN DATE : 3/6/01  
 GAS ANALYSIS - O2 : 6.8  
 (Dry Basis) - CO2: 13.5  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.20  
 STACK dP, in H2O : -13.5  
 NOZZLE DIA, in : 0.253  
 PITOT CONSTANT : 0.81  
 GAS METER CALIB : 1.025  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 68.8  
 PARTICLE MASS, mg : 27.7  
 TIME SAMPLED, min : 90  
 GAS METER VOL, ft3: 47.596  
 AVG SQRT PITOT dp : 0.625  
 AVG ORI dP, in H2O: 1.100  
 AVG STACK TEMP, F : 236  
 GAS METER TEMP, F : 54

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 99.7  
 CALCULATED % H2O : 6.0  
 AVG GAS VELOCITY, ft/s : 38.8  
 AVG GAS TEMPERATURE, F : 236  
 GAS VOLUME FLOW, acfm : 439,807  
 dscfm : 305,935  
 wscfm : 325,512  
 Dry Gas lb/hr: 1447183  
 Moisture lb/hr: 54775  
 Total lb/hr: 1501958  
 MASS LOADING, gr/acf : 5.85E-03  
 gr/dscf : 8.41E-03  
 mg/acm : 1.34E+01  
 mg/dscm : 1.93E+01  
 gr/dscf @7% O2 : 8.30E-03  
 gr/dscf @12% CO2 : 7.48E-03  
  
 EMISSION RATE, lb/hr : 2.21E+01  
 EMISSION RATE, #/E6-Btu: 1.75E-02

RUN IDENTIFICATION: M17-2  
 RUN DATE : 3/7/01  
 GAS ANALYSIS - O2 : 6.5  
 (Dry Basis) - CO2: 13.0  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.33  
 STACK dP, in H2O : -13.5  
 NOZZLE DIA, in : 0.251  
 PITOT CONSTANT : 0.81  
 GAS METER CALIB : 1.002  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 78.3  
 PARTICLE MASS, mg : 430.4  
 TIME SAMPLED, min : 90  
 GAS METER VOL, ft3: 53.035  
 AVG SQRT PITOT dp : 0.700  
 AVG ORI dP, in H2O: 1.400  
 AVG STACK TEMP, F : 230  
 GAS METER TEMP, F : 50

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 99.1  
 CALCULATED % H2O : 6.2  
 AVG GAS VELOCITY, ft/s : 43.2  
 AVG GAS TEMPERATURE, F : 230  
 GAS VOLUME FLOW, acfm : 490,053  
 dscfm : 345,024  
 wscfm : 367,800  
 Dry Gas lb/hr: 1627155  
 Moisture lb/hr: 63726  
 Total lb/hr: 1690881  
 MASS LOADING, gr/acf : 8.34E-02  
 gr/dscf : 1.19E-01  
 mg/acm : 1.91E+02  
 mg/dscm : 2.72E+02  
 gr/dscf @7% O2 : 1.14E-01  
 gr/dscf @12% CO2 : 1.09E-01  
  
 EMISSION RATE, lb/hr : 3.50E+02  
 EMISSION RATE, #/E6-Btu: 2.41E-01

RUN IDENTIFICATION:	M17-3	REDUCED MASS TRAIN DATA	
RUN DATE	: 3/7/01	-----	
GAS ANALYSIS - O2 :	7.3	ISOKINETIC AGREEMENT, %:	108.9
(Dry Basis) - CO2:	12.5		
Setup value - H2O:	8	CALCULATED % H2O :	6.4
AMB PRESS, in Hg :	30.33	AVG GAS VELOCITY, ft/s :	42.8
STACK dP, in H2O :	-13.5	AVG GAS TEMPERATURE, F :	235
NOZZLE DIA, in :	0.236	GAS VOLUME FLOW, acfm :	485,325
PITOT CONSTANT :	0.81	dscfm :	338,452
GAS METER CALIB :	1.002	wscfm :	361,786
DUCT AREA, ft2 :	189	Dry Gas lb/hr:	1593633
		Moisture lb/hr:	65288
H2O COLLECTED, ml :	77.9	Total lb/hr:	1658922
PARTICLE MASS, mg :	396.6	MASS LOADING, gr/acf :	7.99E-02
TIME SAMPLED, min :	90	gr/dscf :	1.15E-01
GAS METER VOL, ft3:	51.243	mg/acm :	1.83E+02
AVG SQRT PITOT dp :	0.690	mg/dscm :	2.63E+02
AVG ORI dP, in H2O:	1.400	gr/dscf @7% O2 :	1.17E-01
AVG STACK TEMP, F :	235	gr/dscf @12% CO2 :	1.10E-01
GAS METER TEMP, F :	57		
		EMISSION RATE, lb/hr :	3.33E+02
		EMISSION RATE, #/E6-Btu:	2.47E-01

## **B1b-Ontario Hydro**



# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/05/01

Project: \_\_\_\_\_

Train ID: Outlet Run 1

Run No.: ADA-1-01

Filter ID: AIZ VOID

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>669.8</u>	_____	_____	_____
Impinger 2 - 100 ml KCl Solution	<u>581.2</u>	_____	_____	_____
Impinger 3 - 100 ml KCl Solution	<u>589.2</u> <sup>603.6</sup>	_____	_____	_____
Impinger 4 - empty	<u>463.8</u> <sup>494.0</sup>	_____	_____	_____
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>600.8</u>	_____	_____	_____
Impinger 6 - empty	<u>416.5</u>	_____	_____	_____
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>590.4</u>	_____	_____	_____
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>567.6</u>	_____	_____	_____
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>604.0</u>	_____	_____	_____
Impinger 10 - empty	<u>524.7</u>	_____	_____	_____
Impinger 11 - silica gel	<u>811.2</u>	_____	_____	_____

Net Total: \_\_\_\_\_

Additional Comments:

VOID

Prepared by: <u>Wijema D. K. [Signature]</u>	Date	Time
Received for sampling by: <u>[Signature]</u>	03/05/01	1408
Received for recovery by: _____	03/05/01	1409



## Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/05/01

Project: A251.2

Train ID: Inlet Run 1

Run No.: ADA-1E1

Filter ID: QF1

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>580.9</u>	<u>581.2</u>		
Impinger 2 - 100 ml KCl Solution	<u>604.1</u>	<u>604.1</u>		
Impinger 3 - 100 ml KCl Solution	<u>659.8</u>	<u>659.8</u>		
Impinger 4 - empty	<u>453.0</u>	<u>453.1</u>		
Impinger 5 - 100 ml HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Solution	<u>650.7</u>	<u>650.8</u>		
Impinger 6 - empty	<u>431.0</u>	<u>431.2</u>		
Impinger 7 - 100 ml H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Solution	<u>595.0</u>	<u>595.0</u>		
Impinger 8 - 100 ml H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Solution	<u>571.8</u>	<u>571.9</u>		
Impinger 9 - 100 ml H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Solution	<u>602.4</u>	<u>602.5</u>		
Impinger 10 - empty	<u>478.2</u>	<u>478.3</u>		
Impinger 11 - silica gel	<u><del>754.0</del> 753.7</u>	<u>754.5</u>		<u>Orange</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynema D. Kimberrough</u>	<u>03/05/01</u>	<u>1310</u>
Received for sampling by: <u>SOP</u>	<u>03/05/01</u>	<u>1407</u>
Received for recovery by: <u>Wynema D. Kimberrough</u>	<u>03/05/01</u>	<u>1407</u>

Inlet 3/5/01 Run sheet

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
-----		-----	-----	-----	-----
GAS ANALYSIS - O2 :	6.5	0.200	0.40	0.560	1.12
CO2 :	11.0	0.220	0.44	0.580	1.16
H2O :	8.0	0.240	0.48	0.600	1.20
AVG dP :	0.4761	0.260	0.52	0.620	1.24
AMB PRESS, in Hg :	30.21	0.280	0.56	0.640	1.28
STACK dP, in H2O :	-13.5	0.300	0.60	0.660	1.32
AVG SQR ROOT dP :	0.69	0.320	0.64	0.680	1.36
MINIMUM PITOT dP :	0.20	0.340	0.68	0.700	1.40
dP INCREMENT :	0.020	0.360	0.72	0.720	1.44
		0.380	0.76	0.740	1.48
STACK GAS TEMP, F :	260	0.400	0.80	0.760	1.52
GAS METER TEMP, F :	80	0.420	0.84	0.780	1.56
		0.440	0.88	0.800	1.60
PITOT CONSTANT :	0.83	0.460	0.92	0.820	1.64
ORIFICE CONSTANT :	1.87	0.480	0.96	0.840	1.68
		0.500	1.00	0.860	1.72
NOZZLE DIA, in :	0.232	0.520	1.04	0.880	1.76
SYSTEM FLOW, acfm :	0.793	0.540	1.08	0.900	1.80
FLOW, scfm :	0.54016				

nozzle  $T\phi$



248.54

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	2/3	28	4.0	261	0.41	0.70	251.6	260	237	<del>38</del>	38	57	53	5.0
	2/4	32	4.5	263	0.48	0.82	253.3	254	243		38	58	54	4.8
	2/5	36	4.5	246	0.43	0.73	255.2	235	242		37	57	54	4.8
	END	40					257.052							
					NET 2 =		8.512							
1335	3/1	40	3.2	226	0.09	0.15	257.13	220	236		38	57	54	7.4
	3/2	44	3.8	246	0.18	0.31	258.3	223	234		38	57	55	6.6
	3/3	48	4.0	251	0.33	0.56	259.5	236	237		37	57	55	6.0
	3/4	52	4.3	257	0.45	0.77	261.0	246	240		37	58	55	5.6
	3/5	56	4.5	241	0.43	0.73	263.0	260	241		37	60	56	5.3
	END	60					264.764							
					NET 3 =		7.634							
	5/1	60	4.0	224	0.22	0.38	264.85	231	238		38	60	56	8.0
	5/2	64	4.3	232	0.34	0.58	266.24	260	236		37	60	56	8.0
	5/3	68	4.5	233	0.39	0.66	267.8	252	237		37	60	57	8.1
	5/4	72	4.5	233	0.39	0.66	269.6	253	239		37	60	57	7.8
	5/5	76	4.7	189	0.53	0.90	271.3	250	239		37	62	57	7.7
	END	80					273.45							
	TO													
	5/1	80	4.0	223	0.20	0.35	273.45	235	237		38	61	58	8.2
1423	5/2	84	4.2	229	0.34	0.58	274.8	227	237		38	62	57	8.0
	5/3	88	4.3	230	0.40	0.68	276.4	261	240		38	61	58	8.4
	5/4	92	4.3	226	0.38	0.65	278.1	244	240		39	63	59	8.0
	5/5	96	4.5	202	0.52	0.89	280.0	250	239		39	63	58	7.7



## Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 3/6/01

Project: A251-2

Train ID: Inlet Run 2

Run No.: ADA1-I2

Filter ID: QF17

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>587.1</u>	<u>655.0</u>		
Impinger 2 - 100 ml KCl Solution	<u>608.9</u>	<u>610.3</u>		
Impinger 3 - 100 ml KCl Solution	<u>661.7</u>	<u>662.8</u>		
Impinger 4 - empty	<u>454.2</u>	<u>454.6</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>652.6</u>	<u>655.6</u>		
Impinger 6 - empty	<u>432.2</u>	<u>433.1</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>596.5</u>	<u>598.0</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>574.6</u>	<u>575.6</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>604.3</u>	<u>604.3</u>		
Impinger 10 - empty	<u>479.8</u>	<u>480.0</u>		
Impinger 11 - silica gel	<u>754.5</u>	<u>766.4</u>		<u>1/3 spent</u>

Net Total: \_\_\_\_\_

Additional Comments:

Prepared by: <u>Wynema D. Embrough</u>	Date	Time
Received for sampling by: <u>JMCO</u> <u>3/6/01 0945</u> <u>ASCO</u>	<u>03/06/01</u>	<u>0945</u>
Received for recovery by: <u>Wynema D. Embrough</u>	<u>03/06/01</u>	<u>1530</u>

Inlet 3/06/01

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	8.0	0.100	0.17	1.000	1.66
CO2 :	12.5	0.150	0.25	1.050	1.74
H2O :	8.0	0.200	0.33	1.100	1.82
AVG dP :	0.4761	0.250	0.41	1.150	1.90
AMB PRESS, in Hg :	30.30	0.300	0.50	1.200	1.99
STACK dP, in H2O :	-13.5	0.350	0.58	1.250	2.07
AVG SQR ROOT dP :	0.69	0.400	0.66	1.300	2.15
MINIMUM PITOT dP :	0.10	0.450	0.74	1.350	2.23
dP INCREMENT :	0.050	0.500	0.83	1.400	2.32
		0.550	0.91	1.450	2.40
STACK GAS TEMP, F :	260	0.600	0.99	1.500	2.48
GAS METER TEMP, F :	75	0.650	1.08	1.550	2.57
		0.700	1.16	1.600	2.65
PITOT CONSTANT :	0.83	0.750	1.24	1.650	2.73
ORIFICE CONSTANT :	1.87	0.800	1.32	1.700	2.81
		0.850	1.41	1.750	2.90
NOZZLE DIA, in :	0.222	0.900	1.49	1.800	2.98
SYSTEM FLOW, acfm :	0.720	0.950	1.57	1.850	3.06
FLOW, scfm :	0.49161				

T67

INLET 3/6/01 AM

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 8.0	0.000	0.00	0.540	0.92
CO2	: 12.5	0.030	0.05	0.570	0.97
H2O	: 8.0	0.060	0.10	0.600	1.02
AVG dP	: 0.4761	0.090	0.15	0.630	1.07
AMB PRESS, in Hg	: 30.30	0.120	0.20	0.660	1.12
STACK dP, in H2O	: -13.5	0.150	0.26	0.690	1.17
AVG SQR ROOT dP	: 0.69	0.180	0.31	0.720	1.23
MINIMUM PITOT dP	: 0.00	0.210	0.36	0.750	1.28
dP INCREMENT	: 0.030	0.240	0.41	0.780	1.33
		0.270	0.46	0.810	1.38
STACK GAS TEMP, F	: 240	0.300	0.51	0.840	1.43
GAS METER TEMP, F	: 75	0.330	0.56	0.870	1.48
		0.360	0.61	0.900	1.53
PITOT CONSTANT	: 0.83	0.390	0.66	0.930	1.58
ORIFICE CONSTANT	: 1.87	0.420	0.71	0.960	1.63
		0.450	0.77	0.990	1.69
NOZZLE DIA, in	: 0.222	0.480	0.82	1.020	1.74
SYSTEM FLOW, acfm	: 0.709	0.510	0.87	1.050	1.79
FLOW, scfm	: 0.49858				



12.5% O<sub>2</sub>

306.32

Run No. 43 Page 2 of 3

Test No. 3

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H <sub>2</sub> O	Orifice DH in. H <sub>2</sub> O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	Den. Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	5/3	28	4.3	227	0.45	0.44	308.8	241	233	7	40	60	59	8.1
	5/4	32	4.5	224	0.45	0.44	310.2	229	245		39	60	59	8.2
	5/5	36	4.8	166	0.63	0.62	311.8	243	246		38	61	59	7.4
	END TO 5	40					313.4							
	5/1	40	4.3	223	0.25	0.25	313.4	246	238		38	61	59	8.1
	5/2	44	4.3	226	0.36	0.35	314.6	257	237		38	61	59	8.2
	5/3	48	4.3	226	0.45	0.44	315.8	234	237		38	61	59	8.1
	5/4	52	4.3	224	0.45	0.44	317.2	255	238		38	61	59	8.0
	5/5	56	4.5	174	0.60	0.59	318.7	239	242		38	61	59	7.5
	END	60					320.347							
					NETS I		14.027							
	3/1	60	3.7	229	0.09	0.09	320.42	223	235		39	61	59	9.2
	3/2	64	4.0	242	0.18	0.18	321.2	241	235		38	60	59	7.6
	3/3	68	4.3	247	0.39	0.38	322.1	243	241		37	61	59	7.0
	3/4	72	4.5	245	0.51	0.50	323.5	234	242		36	60	58	6.4
	3/5	76	4.5	129	0.51	0.50	325.1	244	240		35	60	58	6.3
	END	80					326.495							
					NET 3 =		6.075							
	2/1	80	4.0	228	0.21	0.21	326.55	230	238		37	60	60	7.3
	2/2	84	4.3	256	0.38	0.37	327.7	258	238		37	60	58	6.1
	2/3	88	4.5	258	0.49	0.48	328.8	248	239		36	60	58	5.5
	2/4	92	4.7	252	0.52	0.51	330.35	255	240		36	60	58	5.3



# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/06/01 Project: A251.2 3  
 Train ID: Inlet Run 3 Run No.: ADA-1-~~5~~

Filter ID: QF4

Weight, grams

	<u>Initial</u>	<u>Final</u>	<u>Net</u>	<u>Color</u>
Impinger 1 - 100 ml KCl Solution	<u>596.1</u>	<u>646.4</u>		
Impinger 2 - 100 ml KCl Solution	<u>552.0</u>	<u>552.7</u>		
Impinger 3 - 100 ml KCl Solution	<u>583.7</u>	<u>584.6</u>		
Impinger 4 - empty	<u>421.9</u>	<u>422.6</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>616.6</u>	<u>620.0</u>		
Impinger 6 - empty	<u>415.3</u>	<u>415.9</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>608.0</u>	<u>609.1</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>594.5</u>	<u>594.9</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>585.5</u>	<u>586.2</u>		
Impinger 10 - empty	<u>561.0</u>	<u>561.8</u>		
Impinger 11 - silica gel	<u>710.3</u>	<u>720.8</u>		

Net Total: \_\_\_\_\_

Additional Comments:

Prepared by: <u>Wynema D. Kinborough</u>	<u>03/06/01</u>	<u>1500</u>
Received for sampling by: <u>[Signature]</u>	<u>3/6/01</u>	<u>1535</u>
Received for recovery by: <u>Wynema D. Kinborough</u>	<u>03/06/01</u>	<u>1800</u>

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	8.0	0.000	0.00	0.540	0.53
CO2 :	12.5	0.030	0.03	0.570	0.56
H2O :	8.0	0.060	0.06	0.600	0.59
AVG dP :	0.4761	0.090	0.09	0.630	0.62
AMB PRESS, in Hg :	30.30	0.120	0.12	0.660	0.65
STACK dP, in H2O :	-13.5	0.150	0.15	0.690	0.68
AVG SQR ROOT dP :	0.69	0.180	0.18	0.720	0.71
MINIMUM PITOT dP :	0.00	0.210	0.21	0.750	0.74
dP INCREMENT :	0.030	0.240	0.24	0.780	0.77
		0.270	0.27	0.810	0.80
STACK GAS TEMP, F :	240	0.300	0.30	0.840	0.83
GAS METER TEMP, F :	75	0.330	0.33	0.870	0.86
		0.360	0.35	0.900	0.89
PITOT CONSTANT :	0.83	0.390	0.38	0.930	0.92
ORIFICE CONSTANT :	1.87	0.420	0.41	0.960	0.95
		0.450	0.44	0.990	0.98
NOZZLE DIA, in :	0.193	0.480	0.47	1.020	1.01
SYSTEM FLOW, acfm :	0.540	0.510	0.50	1.050	1.03
FLOW, scfm :	0.37932				

T80

INLET RUN 3 3/6/01 PM

MASS TRAIN OPERATION		dp PITOT	dP ORI	dp PITOT	dP ORI
GAS ANALYSIS - O2 :	8.0	0.000	0.00	0.540	0.60
CO2 :	12.5	0.030	0.03	0.570	0.63
H2O :	8.0	0.060	0.07	0.600	0.67
AVG dP :	0.4761	0.090	0.10	0.630	0.70
AMB PRESS, in Hg :	30.30	0.120	0.13	0.660	0.73
STACK dP, in H2O :	-13.5	0.150	0.17	0.690	0.77
AVG SQR ROOT dP :	0.69	0.180	0.20	0.720	0.80
MINIMUM PITOT dP :	0.00	0.210	0.23	0.750	0.84
dP INCREMENT :	0.030	0.240	0.27	0.780	0.87
		0.270	0.30	0.810	0.90
STACK GAS TEMP, F :	240	0.300	0.33	0.840	0.94
GAS METER TEMP, F :	75	0.330	0.37	0.870	0.97
		0.360	0.40	0.900	1.00
PITOT CONSTANT :	0.83	0.390	0.43	0.930	1.04
ORIFICE CONSTANT :	1.87	0.420	0.47	0.960	1.07
		0.450	0.50	0.990	1.10
T22 NOZZLE DIA, in :	0.199	0.480	0.53	1.020	1.14
SYSTEM FLOW, acfm :	0.574	0.510	0.57	1.050	1.17
FLOW, scfm :	0.40324				



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1151	3-1	0	-4.5	201	.80	.77	529.45	243	244	-	51	65	60	
1154	3-2	3	-4.5	207	.64	.63	530.48	250	246	-	51	66	61	
1157	3-3	6	-4.5	226	.50	.48	531.82	247	249	-	52	68	60	
End		9					532.954							
1205	2-1	0	-4.0	225	.36	.34	533.675	255	258	-	51	66	59	
1208	2-2	3	-4.0	224	.55	.53	534.68	269	260	-	51	67	62	
1211	2-3	6	-4.0	215	.75	.72	535.83	265	242	-	51	68	62	
End		9					537.20							
1230	5-1	0	-4.0	221	.58	.58	537.75	243	252	-	51	69	61	
	5-2	3	-4.0	228	.48	.48	538.99	246	263	-	51	70	62	
	5-3	6	-4.0	220	.52	.48	540.18	244	245	-	50	70	62	
End		9					541.295							
1230	5-1	0	-4.0	212	.58	.58	541.44	248	243	-	50	70	63	
	5-2	3	-4.0	230	.54	.53	542.76	247	245	-	50	70	63	
	5-3	6	-4.0	216	.55	.53	543.93	244	245	-	50	70	64	
		9					545.131							
1249	7-1	0	-4.0	230	.45	.43	546.190	248	246	-	50	71	69	
1252	7-2	3	-4.0	227	.38	.39	547.44	242	253	-	50	71	66	
1255	7-3	6	-4.0	211	.66	.63	548.42	243	253	-	50	71	67	
		9					549.67							

2

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1300	8-1	0	-4.0	222	.47	.48	550.02	245	257	-	50	71	68	
1303	8-2	3	-4.0	231	.35	.34	550.91	247	250	-	50	71	68	
1306	8-3	6	-4.0	228	.60	.58	552.05	243	259	-	50	71	69	
End		9					553.042							
1320	10-1	0	-4.0	252	.45	.43	555.22	245	255	-	50	71	69	
1323	10-2	3	-4.0	252	.55	.53	556.32	246	253	-	50	72	68	
1326	10-3	6	-4.0	237	.50	.48	557.64	245	253	-	50	72	69	
End		9	-4.0											
1335	9-1	0	-4.0	245	.70	.68	559.155	248	250	-	50	72	69	
1338	9-2	3	-4.0	247	.45	.43	560.51	246	226	-	50	72	69	
1341	9-3	6	-4.0	2	.40	.39	561.53	245	248	-	46	73	70	
End		9					562.496							
*1348	12-1	0	-4.0	243	.35	.34	564.398	250	250	-	47	73	70	
1348	12-2	3	-4.0	253	.70	.68	565.42	250	271	-	47	74	70	
1348	12-3	6	-4.0	235	.60	.58	566.666	252	277	-	46	74	70	
End		9					567.926							
*1359	12-1	0	-4.0	244	.40	.39	567.952	246	251	-	46	74	70	
1359	12-2	3	-4.0	252	.70	.68	569.11	250	233	-	47	75	70	
1408	12-3	6	-4.0	251	.65	.63	570.41	251	247	-	47	74	71	
End		9					571.638							

\* WSP  
SOP  
11/20

1410	12-1	0	-4.0	245	.40	.39	571.664	246	243	50	72	70
1413	12-2	3	-4.0	252	.70	.68	572.77	249	265	50	72	71
1416	12-3	6	-4.0	251	.65	.63	574.04	249	265	50	73	71
	END	9					575.300					
1420	14-1	0	-4.0	259	.50	.48	576.73	266	247	46	74	71
1423	14-2	3	-4.0	252	.55	.53	577.89	261	250	46	74	71
1426	14-3	6	-4.0	242	.65	.63	578.99	267	252	46	74	71
	END	9					579.573					

1430	14-1	0	-4.0	254	.50	.48	579.684	243	234	46	74	71
1433	14-2	3	-4.0	252	.55	.53	580.81	245	240	46	74	71
1436	14-3	6	-4.0	243	.65	.63	581.99	251	252	46	74	71
	END	9					583.415					

1452	16-1	0	-4.0	249	.85	.92	583.621	247	251	48	74	71
1455	16-2	3	-4.0	251	.70	.68	585.11	256	277	48	74	71
1458	16-3	6	-4.0	243	.70	.68	586.42	247	274	48	74	71
	END	9					587.755					

OUTLET

3/5/01

3/6/01

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 6.5	0.400	0.38	1.300	1.25
CO2	: 11.0	0.450	0.43	1.350	1.30
H2O	: 8.0	0.500	0.48	1.400	1.34
AVG dP	: 1.06916	0.550	0.53	1.450	1.39
AMB PRESS, in Hg	: 30.21	0.600	0.58	1.500	1.44
STACK dP, in H2O	: -19.0	0.650	0.62	1.550	1.49
AVG SQR ROOT dP	: 1.03	0.700	0.67	1.600	1.54
MINIMUM PITOT dP	: 0.40	0.750	0.72	1.650	1.58
dP INCREMENT	: 0.050	0.800	0.77	1.700	1.63
		0.850	0.82	1.750	1.68
STACK GAS TEMP, F	: 240	0.900	0.86	1.800	1.73
GAS METER TEMP, F	: 80	0.950	0.91	1.850	1.78
		1.000	0.96	1.900	1.82
PITOT CONSTANT	: 0.87	1.050	1.01	1.950	1.87
ORIFICE CONSTANT	: 1.87	1.100	1.06	2.000	1.92
		1.150	1.10	2.050	1.97
NOZZLE DIA, in	: 0.187	1.200	1.15	2.100	2.02
SYSTEM FLOW, acfm	: 0.811	1.250	1.20	2.150	2.06
FLOW, scfm	: 0.56836				

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NOZZLE  
OUTLET

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/06/01 Project: A251-2  
 Train ID: Outlet Run 2 Run No.: ADA-1-02  
 Filter ID: QFZ

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>670.1</u>	<u>727.9</u>		
Impinger 2 - 100 ml KCl Solution	<u>587.1</u>	<u>585.4</u>		
Impinger 3 - 100 ml KCl Solution	<u>605.3</u>	<u>606.0</u>		
Impinger 4 - empty	<u>463.9</u>	<u>464.0</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>602.4</u>	<u>605.4</u>		
Impinger 6 - empty	<u>415.7</u>	<u>417.0</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>597.7</u>	<u>597.9</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>571.3</u>	<u>596.5</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>608.7</u>	<u>582.6</u>		
Impinger 10 - empty	<u>524.8</u>	<u>525.1</u>		
Impinger 11 - silica gel	<u>811.9</u>	<u>825.7</u>		<u>1/3 spent</u>

Net Total: \_\_\_\_\_

**Additional Comments:**

*KMnO4 was present in the U-TUBE that connected impingers 8 & 9. used 03/06/01.*

Prepared by: <u>Wynema D. Kintorugh</u>	Date	Time
Received for sampling by: <u>William R. G. King</u>	<u>03/06/01</u>	<u>0930</u>
Received for recovery by: <u>Wynema D. Kintorugh</u>	<u>03/06/01</u>	<u>1530</u>

OUTLET 8/6/01

MASS TRAIN OPERATION			dp PITOT	dp ORI	dp PITOT	dp ORI
-----			-----	-----	-----	-----
GAS ANALYSIS - O2	:	6.5	0.200	0.19	1.100	1.06
CO2	:	12.5	0.250	0.24	1.150	1.11
H2O	:	8.0	0.300	0.29	1.200	1.16
AVG dP	:	1.06916	0.350	0.34	1.250	1.21
AMB PRESS, in Hg	:	30.21	0.400	0.39	1.300	1.25
STACK dP, in H2O	:	-19.0	0.450	0.43	1.350	1.30
AVG SQR ROOT dP	:	1.03	0.500	0.48	1.400	1.35
MINIMUM PITOT dP	:	0.20	0.550	0.53	1.450	1.40
dP INCREMENT	:	0.050	0.600	0.58	1.500	1.45
			0.650	0.63	1.550	1.50
STACK GAS TEMP, F	:	230	0.700	0.68	1.600	1.54
GAS METER TEMP, F	:	75	0.750	0.72	1.650	1.59
			0.800	0.77	1.700	1.64
PITOT CONSTANT	:	0.87	0.850	0.82	1.750	1.69
ORIFICE CONSTANT	:	1.87	0.900	0.87	1.800	1.74
			0.950	0.92	1.850	1.79
NOZZLE DIA, in	:	0.187	1.000	0.97	1.900	1.83
SYSTEM FLOW, acfm	:	0.802	1.050	1.01	1.950	1.88
FLOW, scfm	:	0.5703				

742



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1727	14-1	0	-4.0	222	.80	.79	599.855	250	242	-	49	71	68	
1730	14-2	3	-4.0	252	.70	.69	601.30	246	241	-	50	72	69	
1733	14-3	6	-4.0	251	.55	.54	602.78	248	253	-	50	72	69	
1736	End	9					603.87							
1740	12-1	0	-4.0	245	.55	.54	605.172	249	254	-	50	71	69	
43	12-2	3	-4.0	249	.85	.84	606.62	252	251	-	50	70	69	
46	12-3	6	-4.0	235	.75	.74	607.53	251	247	-	50	70	69	
49	End	9					608.741							
1752	12-1	0	-4.0	247	.55	.54	608.741	250	251	-	49	70	69	
	12-2	3	-4.0	249	.85	.84	610.66	252	251	-	49	70	69	
	12-3	6	-4.0	239	.75	.74	611.65	247	250	-	49	70	69	
	End	9					613.457							
1801	12-1	0	-4.0	245	.55	.54	613.457	243	253	-	48	69	68	
04	12-2	3	-4.0	250	.85	.84	614.62	247	249	-	48	69	68	
07	12-3	6	-4.0	235	.75	.74	615.89	252	251	-	48	69	68	
10	End	9					617.369							
1813	10-1	0	-4.0	249	.60	.59	617.665	247	239	-	48	70	67	
16	10-2	3	-4.0	249	.60	.59	619.22	250	241	-	48	71	66	
19	10-3	6	-4.0	243	.50	.50	620.05	249	247	-	48	71	66	
22	End	9					621.32							
1840	10-1	0	-4.0	247	.65	.64	621.32	244	257	-	48	71	65	

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1:43	<del>7</del> <sup>9</sup> -2	3	-4.0	232	.55	.54	622.71	247	263	-	48	71	66	
1:46	<del>10</del> <sup>9</sup> -3	6	-4.0	237	.50	.50	623.93	249	258	-	48	71	66	
	44	9					625.09							
1:40	<del>7</del> -1	0	-4.0	223	.65	.64	626.20	243	247	-	48	70	65	
4:3	<del>8</del> -2	3	-4.0	228	.50	.50	627.59	244	251	-	49	69	66	
4:6	<del>8</del> -3	6	-4.0	216	.60	.59	628.81	246	242	-	49	69	66	
4:9		9					630.01							
1:52	8-1	0	-4.0	221	.50	.50	630.13	243	251	-	48	69	66	
5:5	8-2	3	-4.0	226	.35	.35	631.31	248	252	-	48	69	66	
5:8	8-3	6	-4.0	218	.66	.59	632.30	249	252	-	48	69	66	
2:01		9					633.29							
2:17	6-1	0	-4.0	234	.60	.59	637.91	250	244	-	48	68	65	
2:20	6-2	3	-4.0	221	.70	.69	639.17	244	254	-	48	68	65	
2:23	6-3	6	-4.0	209	.80	.79	640.54	247	261	-	47	68	65	
2:26		9					641.94							
2:07	5-1	0	-4.0	237	.50	.50	633.89	244	247	-	48	68	64	
2:10	5-2	3	-4.0	240	.55	.54	635.18	243	253	-	48	68	64	
2:17	5-3	6	-4.0	220	.65	.64	636.98	248	243	-	47	68	64	
2:16		9					637.550							



# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/06/01

Project: A251.2

Train ID: Outlet Run 3

Run No.: ADA-1-02  
ADA-1-03

Filter ID: QF3

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>597.6</u>	<u>607.1</u>	_____	_____
Impinger 2 - 100 ml KCl Solution	<u>580.1</u>	<u>582.1</u>	_____	_____
Impinger 3 - 100 ml KCl Solution	<u>584.5</u>	<u>585.4</u>	_____	_____
Impinger 4 - empty	<del>409.7</del> <del>467.8</del>	<u>410.2</u>	_____	_____
Impinger 5 - 100 ml HNO3/H2O2 Solution	<del>613.9</del> <del>611.8</del>	<u>615.2</u>	_____	_____
Impinger 6 - empty	<del>451.5</del> <del>448.4</del>	<u>451.8</u>	_____	_____
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<del>579.4</del> <u>569.8</u>	<u>579.5</u>	_____	_____
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<del>582.2</del> <del>575.5</del>	<u>576.5</u>	_____	_____
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<del>608.1</del> <del>602.5</del>	<u>602.7</u>	_____	_____
Impinger 10 - empty	<u>502.7</u>	<u>503.3</u>	_____	_____
Impinger 11 - silica gel	<u>681.7</u>	<u>645.6</u>	_____	<u>1/3 ppt</u>
	Net Total:		_____	_____

Additional Comments:

Prepared by: <u>Wyreana D. Kimbrough</u>	Date	Time
Received for sampling by: <u>WJact</u>	<u>03/06/01</u>	<u>1500</u>
Received for recovery by: <u>Wyreana D. Kimbrough</u>	<u>3/6/01</u>	<u>1512</u>
	<u>03/06/01</u>	<u>2040</u>

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI	
GAS ANALYSIS - O2	:	6.5	0.200	0.20	1.100	1.09
CO2	:	12.5	0.250	0.25	1.150	1.14
H2O	:	8.0	0.300	0.30	1.200	1.19
AVG dP	:	1.06916	0.350	0.35	1.250	1.24
AMB PRESS, in Hg	:	30.21	0.400	0.40	1.300	1.29
STACK dP, in H2O	:	-19.0	0.450	0.45	1.350	1.34
AVG SQR ROOT dP	:	1.03	0.500	0.50	1.400	1.39
MINIMUM PITOT dP	:	0.20	0.550	0.54	1.450	1.44
dp INCREMENT	:	0.050	0.600	0.59	1.500	1.49
			0.650	0.64	1.550	1.53
STACK GAS TEMP, F	:	230	0.700	0.69	1.600	1.58
GAS METER TEMP, F	:	75	0.750	0.74	1.650	1.63
			0.800	0.79	1.700	1.68
PITOT CONSTANT	:	0.87	0.850	0.84	1.750	1.73
ORIFICE CONSTANT	:	1.87	0.900	0.89	1.800	1.78
			0.950	0.94	1.850	1.83
NOZZLE DIA, in	:	0.189	1.000	0.99	1.900	1.88
SYSTEM FLOW, acfm	:	0.813	1.050	1.04	1.950	1.93
FLOW, scfm	:	0.57763				

OUTLET # 3 3/6/01 PM.

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	6.5	0.200	0.19	1.100	1.06
CO2 :	12.5	0.250	0.24	1.150	1.11
H2O :	8.0	0.300	0.29	1.200	1.16
AVG dP :	1.06916	0.350	0.34	1.250	1.21
AMB PRESS, in Hg :	30.21	0.400	0.39	1.300	1.25
STACK dP, in H2O :	-19.0	0.450	0.43	1.350	1.30
AVG SQR ROOT dP :	1.03	0.500	0.48	1.400	1.35
MINIMUM PITOT dP :	0.20	0.550	0.53	1.450	1.40
dP INCREMENT :	0.050	0.600	0.58	1.500	1.45
		0.650	0.63	1.550	1.50
STACK GAS TEMP, F :	230	0.700	0.68	1.600	1.54
GAS METER TEMP, F :	75	0.750	0.72	1.650	1.59
		0.800	0.77	1.700	1.64
PITOT CONSTANT :	0.87	0.850	0.82	1.750	1.69
ORIFICE CONSTANT :	1.87	0.900	0.87	1.800	1.74
		0.950	0.92	1.850	1.79
NOZZLE DIA, in :	0.187	1.000	0.97	1.900	1.83
SYSTEM FLOW, acfm :	0.802	1.050	1.01	1.950	1.88
FLOW, scfm :	0.5703				



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	2/3	35	4.0	254	0.49	0.51	466.0	257	240		37	63	60	5.2
	2/4	40	4.2	252	0.53	0.51	462.9	244	240		37	64	61	4.6
	2/5	45	4.5	186	0.53	0.51	464.8	252	239		37	64	61	4.7
	END	50					466.828							
	3/1	50	3.7	227	0.12	0.11	466.920	247	241		40	63	61	4.9
	3/2	55	4.0	243	0.23	0.22	467.9	235	239		39	63	61	6.2
	3/3	60	4.2	245	0.40	0.38	469.2	257	238		38	64	61	6.1
	3/4	65	4.5	242	0.51	0.49	470.95	237	241		37	63	61	5.8
	3/5	70	4.5	190	0.51	0.49	472.8	254	239		37	64	61	5.2
	END	75					474.915							
	5/1	75	4.0	219	0.23	0.22	474.96	236	239		39	64	61	7.2
	5/2	80	4.2	224	0.38	0.36	476.4	265	238		38	64	62	7.2
	5/3	85	4.2	224	0.45	0.43	477.9	263	240		38	65	62	7.4
	5/4	90	4.2	222	0.44	0.42	479.8	250	241		38	64	62	7.2
	5/5	95	4.5	144	0.65	0.62	481.6	235	239		37	65	62	6.4
	5/1	100	4.0	222	0.23	0.22	482.8	237	237		38	64	62	6.6
	5/2	105	4.0	228	0.37	0.35	485.1	256	239		39	65	62	6.9
	5/3	110	4.4	227	0.47	0.45	486.7	254	242		38	65	62	7.3
	5/4	115	4.5	229	0.45	0.43	488.6	245	242		38	66	62	7.0
	5/5	120	4.4	226	0.63	0.60	490.5	239	240		38	66	62	6.8
	END	125					492.562							



## Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/07/01

Project: A251.2

Train ID: Inlet Run 4

Run No.: ADA-1-I4

Filter ID: QF6

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>587.1</u>	<u>643.2</u>	<u>          </u>	<u>          </u>
Impinger 2 - 100 ml KCl Solution	<u>608.0</u>	<u>610.7</u>	<u>          </u>	<u>          </u>
Impinger 3 - 100 ml KCl Solution	<u>662.5</u>	<u>663.4</u>	<u>          </u>	<u>          </u>
Impinger 4 - empty	<u>454.6</u>	<u>454.6</u>	<u>          </u>	<u>          </u>
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>653.1</u>	<u>657.2</u>	<u>          </u>	<u>          </u>
Impinger 6 - empty	<u>433.0</u>	<u>432.8</u>	<u>          </u>	<u>          </u>
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>597.9</u>	<u>597.6</u>	<u>          </u>	<u>          </u>
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>576.5</u>	<u>577.6</u>	<u>          </u>	<u>          </u>
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>603.9</u>	<u>603.9</u>	<u>          </u>	<u>          </u>
Impinger 10 - empty	<u>479.7</u>	<u>479.7</u>	<u>          </u>	<u>          </u>
Impinger 11 - silica gel	<u>766.2</u>	<u>776.0</u>	<u>          </u>	<u>1/2 spent</u>
			<b>Net Total:</b>	<u>          </u>

Additional Comments:

	Date	Time
Prepared by: <u>Wynema D. Kimbrough</u>	<u>03/07/01</u>	<u>1030</u>
Received for sampling by: <u>J. S. Chiu</u>	<u>03/07/01</u>	<u>1030</u>
Received for recovery by: <u>Wynema D. Kimbrough</u>	<u>03/07/01</u>	<u>1600</u>

INLET 3/7/01

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	8.0	0.020	0.02	0.440	0.42
CO2 :	12.5	0.040	0.04	0.480	0.46
H2O :	8.0	0.060	0.06	0.520	0.50
AVG dP :	0.4761	0.080	0.08	0.560	0.54
AMB PRESS, in Hg :	30.30	0.100	0.10	0.600	0.57
STACK dP, in H2O :	-13.5	0.120	0.11	0.640	0.61
AVG SQR ROOT dP :	0.69	0.140	0.13	0.680	0.65
MINIMUM PITOT dP :	0.02	0.160	0.15	0.720	0.69
dP INCREMENT :	0.020	0.180	0.17	0.760	0.73
		0.200	0.19	0.800	0.77
STACK GAS TEMP, F :	240	0.220	0.21	0.840	0.80
GAS METER TEMP, F :	60	0.240	0.23	0.880	0.84
		0.260	0.25	0.920	0.88
PITOT CONSTANT :	0.83	0.280	0.27	0.960	0.92
ORIFICE CONSTANT :	1.87	0.300	0.29	1.000	0.96
		0.320	0.31	1.040	1.00
T53 NOZZLE DIA, in :	0.193	0.340	0.33	1.080	1.03
SYSTEM FLOW, acfm :	0.540	0.360	0.34	1.120	1.07
		0.380	0.36	1.160	1.11
FLOW, scfm :	0.37932	0.400	0.38	1.200	1.15

5 minutes / point !!



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1230	3-1	0	-4.0	219	.70	.66	670.811	254	249	-	49	66	61	
33	3-2	3	-4.0	222	.85	.80	672.35	251	254	-	49	67	61	
36	3-3	6	-4.0	212	1.0	.94	673.71	250	251	-	49	67	61	
123A	END	9					675.272							
1241	2-1	0	-4.0	218	.60	.56	676.220	247	241	-	48	68	62	
44	2-2	3	-4.0	221	.90	.84	677.51	252	251	-	48	69	62	
47	2-3	6	-4.0	204	1.0	.94	678.97	251	250	-	48	70	63	
1250		9					680.457							
1253	5-1	0	-4.0	216	.55	.52	681.101	247	255	-	47	70	65	
56	5-2	3	-4.0	219	1.0	.94	682.32	252	241	-	47	70	66	
59	5-3	6	-4.0	201	.95	.89	684.00	251	251	-	47	71	66	
1302		9					685.319							
1316	7-1	0	-4.0	243	.75	.70	690.694	241	253	-	47	73	68	
14	7-2	3	-4.0	240	.65	.61	692.26	248	254	-	47	74	68	
22	7-3	6	-4.0		.95	.89	693.48	251	247	-	47	74	68	
1325		9	-4.0				694.912							
1705	6-1	0	-4.0	221	.60	.56	685.442	240	238	-	47	72	67	
06	6-2	3	-4.0	219	.95	.89	686.76	242	254	-	47	72	67	
11	6-3	6	-4.0	208	.95	.89	688.17	253	247	-	47	73	67	
131A		9					681.758							

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1327	8-1	0	-4.0	239	.65	.61	695.132	242	257	-	47	75	69	6.3
30	8-2	3	-4.0	224	.90	.84	696.11	247	251	-	47	76	69	
33	8-3	6	-4.0	211	.85	.80	697.98	254	242	-	47	76	69	
36		9					699.08							
1340	10-1	0	-4.0	247	.70	.66	699.910	244	263	-	48	74	69	
43	10-2	3	-4.0	246	.75	.70	701.45	249	251	-	48	75	69	
46	10-3	6	-4.0	217	.75	.70	702.79	258	260	-	48	74	69	
1349		9					704.03							
1351	9-1	0	-4.0	235	.70	.66	704.210	245	259	-	45	75	70	
54	9-2	3	-4.0	237	.80	.75	705.74	247	251	-	45	75	70	
57	9-3	6	-4.0	219	.75	.70	706.99	247	247	-	45	75	70	
1400		9					708.321							
1402	12-1	0	-4.0	248	.65	.61	708.977	246	243	-	45	74	70	6.3/12
05	12-2	3	-4.0	246	1.0	.94	710.32	247	249	-	44	74	70	
08	12-3	6	-4.0	230	.80	.84	711.51	255	254	-	44	74	70	
1411		9					713.326							
1412	12-1	0	-4.0	249	.65	.61	713.326	243	245	-	44	74	70	
15	12-2	3	-4.0	246	.95	.89	714.64	243	255	-	44	75	71	
18	12-3	6	-4.0	230	.90	.84	715.99	247	258	-	44	75	71	
1421		9					717.645							

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1423	14-1	0	-4.0	253	.75	.70	718.224	246	242	-	44	77	71	
26	14-2	3	-4.0	249	.85	.80	719.01	247	254	-	44	76	71	
29	14-3	6	-4.0	243	1.0	.94	721.12	255	247	-	44	76	71	
1432		9					722.640							
1433	14-1	0	-4.0	251	.75	.70	722.690	251	251	-	44	76	71	
36	14-2	3	<del>249</del>	249	.85	.80	724.02	249	254	-	44	77	71	
39	14-3	6	-4.0	243	1.0	.94	725.51	245	256	-	44	77	71	
1442		9					727.205							
1443	16-1	0	-4.0	252	1.0	.94	727.835	245	247	-	44	77	71	
46	16-2	3	-4.0	252	.85	.80	729.43	251	255	-	44	77	71	
49	16-3	6	-4.0	243	1.0	.94	730.87	251	259	-	44	77	71	
1452		9					732.440							
1453	16-1	0	-4.0	252	1.0	.94	732.440	249	256	-	44	77	71	
56	16-2	3	-4.0	252	.85	.80	734.02	254	201	-	44	77	71	
59	16-3	6	-4.0	243	1.0	.94	735.46	251	259	-	44	77	71	
1502		9					737.092							

OUTLET 3/7/01

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	6.5	0.200	0.19	1.100	1.03
CO2 :	12.5	0.250	0.23	1.150	1.08
H2O :	8.0	0.300	0.28	1.200	1.13
AVG dP :	1.06916	0.350	0.33	1.250	1.17
AMB PRESS, in Hg :	30.30	0.400	0.38	1.300	1.22
STACK dP, in H2O :	-19.0	0.450	0.42	1.350	1.27
AVG SQR ROOT dP :	1.03	0.500	0.47	1.400	1.31
MINIMUM PITOT dP :	0.20	0.550	0.52	1.450	1.36
dP INCREMENT :	0.050	0.600	0.56	1.500	1.41
		0.650	0.61	1.550	1.45
STACK GAS TEMP, F :	230	0.700	0.66	1.600	1.50
GAS METER TEMP, F :	60	0.750	0.70	1.650	1.55
		0.800	0.75	1.700	1.60
PITOT CONSTANT :	0.87	0.850	0.80	1.750	1.64
ORIFICE CONSTANT :	1.87	0.900	0.84	1.800	1.69
		0.950	0.89	1.850	1.74
NOZZLE DIA, in :	0.187	1.000	0.94	1.900	1.78
SYSTEM FLOW, acfm :	0.801	1.050	0.99	1.950	1.83
FLOW, scfm :	0.57111				

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 03/07/01 Project: A251.2  
 Train ID: Outlet Run 4 Run No.: ADA-1-04

Filter ID: QF7 QF5 - Filter Blown during leak check 03/07/01

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>669.1</u>	<u>747.1</u>		
Impinger 2 - 100 ml KCl Solution	<u>584.1</u>	<u>587.7</u>		
Impinger 3 - 100 ml KCl Solution	<u>605.3</u>	<u>606.4</u>		
Impinger 4 - empty	<u>464.8</u>	<u>464.8</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>604.4</u>	<u>607.1</u>		
Impinger 6 - empty	<u>420.1</u>	<u>420.8</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>597.8</u>	<u>598.5</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>572.2</u>	<u>572.2</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>606.8</u>	<u>606.8</u>		
Impinger 10 - empty	<u>527.2</u>	<u>527.7</u>		
Impinger 11 - silica gel	<u>825.6</u>	<u>841.7</u>		
		<b>Net Total:</b>		

Additional Comments:

	<u>Date</u>	<u>Time</u>
Prepared by: <u>Wynema D. Kimberough</u>	<u>03/07/01</u>	<u>1000</u>
Received for sampling by: <u>Fernando O. O'Neil</u>	<u>03/07/01</u>	<u>1039</u>
Received for recovery by: <u>Wynema D. Kimberough</u>	<u>03/07/01</u>	<u>1549</u>

# Chain of Custody: Ontario Hydro Mercury Train

Project Number: <sup>A251.2</sup> ~~A293~~ <sub>2001</sub>

Date: 03/05/01

Location: Inlet Run 1

Test No.: -ADA1-I1

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF1</u>		1Hg- <u>ADA-1-I1-1</u>
Filter No. 2 ID: <u>N/A</u>		1Hg- <u>N/A</u>
• Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-I1-2</u>
• Front Wash (0.1 N HNO3) _____	100 ml	1Hg- <u>ADA-1-I1-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-I1-4</u>
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		1Hg- <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO3/H2O2) _____		1Hg- <u>ADA-1-I1-5</u>
• Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____		1Hg- <u>ADA-1-I1-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		1Hg- <u>N/A</u>
• HNO3/H2O2 Blank ( <u>J881-4-2</u> ) _____	100 ml	1Hg- <u>ADA-1-I1-7</u>
• H2SO4/KMnO4 Blank ( <u>J881-3-7</u> ) _____	100 ml	1Hg- <u>ADA-1-I1-8</u>
• 1M KCl Blank ( <u>J881-3-9</u> ) _____	100 ml	1Hg- <u>ADA-1-I1-9</u>
• Acetone Blank ( <u>J881-4-6</u> ) _____	100 ml	1Hg- <u>ADA-1-I1-10</u>
Acetone Lot No. <u>001793</u>		
• 0.1 N HNO3 Blank ( <u>J881-3-3</u> ) _____	100 ml	1Hg- <u>ADA-1-I1-11</u>
• 10% Hydroxylamine HCl ( <u>J881-4-5</u> ) _____	100 mL	<u>ADA-1-I1-13</u>
0.1 N HNO3 Lot No. _____		
• 10% HNO3 ( <u>J881-3-4</u> ) _____	100 mL	<u>ADA-1-I1-14</u>
• Filter Blank ID: <u>QF8</u>		1Hg- <u>ADA1-I1-12</u>

Sample Recovered By: Wynema D. Kintner Date: 03/05/01 Time: 1900

Sample Relinquished By: Wynema D. Kintner Date: 03/07/01 Time: 1812

Sample Received By: J. Mc Date: 3/7/01 Time: 1812

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/06/01

Location: Inlet Run 2

Test No.: - ADA-I2

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
* Filter No. 1 ID: <u>QF17</u>		1Hg- <u>ADA-1-I2-1</u>
Filter No. 2 ID: _____		1Hg- <u>N/A</u>
* Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-I2-2</u>
* Front Wash (0.1 N HNO3) _____	100 ml	1Hg- <u>ADA-1-I2-3</u>
* Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-I2-4</u>
Impingers 1, 2, and 3 -2 (KCl) _____ (if needed)		1Hg- <u>ADA-1-N/A</u>
Impingers 1, 2, and 3 -3 (KCl) _____ (if needed)		1Hg- <u>N/A</u>
* Impingers 4 and 5 (Dry and HNO3/H2O2) _____		1Hg- <u>ADA-1-I2-5</u>
* Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) _ _		1Hg- <u>ADA-1-I2-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) if needed		1Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	1Hg- _____
H2SO4/KMnO4 Blank _____	100 ml	1Hg- _____
1N KCl Blank _____	100 ml	1Hg- _____
Acetone Blank _____	100 ml	1Hg- _____
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	1Hg- _____
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- _____
Sample Recovered By: <u>Wynema O. Kemberly</u>	Date: <u>03/06/01</u> Time: <u>1530</u>	
Sample Relinquished By: <u>Wynema O. Kemberly</u>	Date: <u>03/07/01</u> Time: <u>1012</u>	
Sample Received By: <u>JAMC</u>	Date: <u>3/7/01</u> Time: <u>1812</u>	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	

Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/06/01

Location: Outlet Run 2

Test No.: -ADA-1-02

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF2</u>		<del>1Hg</del> <u>ADA-1-02-1</u>
Filter No. 2 ID: <u>N/A</u>		<del>1Hg</del> <u>N/A</u>
• Front Wash (Acetone) _____	100 ml	<del>1Hg</del> <u>ADA-1-02-2</u>
• Front Wash (0.1 N HNO3) _____	100 ml	<del>1Hg</del> <u>ADA-1-02-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		<del>1Hg</del> <u>ADA-1-02-4</u>
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO3/H2O2) _____		<del>1Hg</del> <u>ADA-1-02-5</u> <sup>20X</sup>
• Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____		<del>1Hg</del> <u>ADA-1-02-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		<del>1Hg</del> <u>ADA-1-02-6</u> <sup>N/A</sup> <del>20X</del> <u>03/06/01</u>
• HNO3/H2O2 Blank <u>(5881-5-2)</u>	100 ml	<del>1Hg</del> <u>ADA-1-02-7</u>
• H2SO4/KMnO4 Blank <sup>20X</sup> <u>(5881-5-4)</u> <u>(5881-5-1)</u>	100 ml	<del>1Hg</del> <u>ADA-1-02-8</u>
• <del>1M</del> KCl Blank <u>(5881-5-3)</u>	100 ml	<del>1Hg</del> <u>ADA-1-02-9</u>
Acetone Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
Acetone Lot No. _____		
• 0.1 N HNO3 Blank <u>(5881-5-5)</u>	100 ml	<del>1Hg</del> <u>ADA-1-02-10</u>
• 10% Hydroxylamine HCl Blank 0.1 N HNO3 Lot No. _____ <u>(5881-5-7)</u>	100 ml	<u>ADA-1-02-11</u>
Filter Blank ID: _____		<del>1Hg</del> _____
Sample Recovered By: <u>Wynema D. Kumbrogh</u>	Date: <u>03/06/01</u>	Time: <u>1530</u>
Sample Relinquished By: <u>Wynema D. Kumbrogh</u>	Date: <u>03/07/01</u>	Time: <u>1812</u>
Sample Received By: <u>J. Mc</u>	Date: <u>3/7/01</u>	Time: <u>1812</u>
Sample Relinquished By: _____	Date: _____	Time: _____
Sample Received By: _____	Date: _____	Time: _____
Sample Relinquished By: _____	Date: _____	Time: _____
Sample Received By: _____	Date: _____	Time: _____

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/06/01

Location: Outlet Run 3

Test No.: - ADA-1-I3

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF4</u>		1Hg- <u>ADA-1-I3-1</u>
Filter No. 2 ID: <u>N/A</u>		1Hg- <u>N/A</u>
• Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-I3-2</u>
• Front Wash (0.1 N HNO3) _____	100 ml	1Hg- <u>ADA-1-I3-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-I3-4</u>
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		1Hg- <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO3/H2O2) _____		1Hg- <u>ADA-1-I3-5</u>
• Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____		1Hg- <u>ADA-1-I3-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		1Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	1Hg- <u>N/A</u>
• H2SO4/KMnO4 Blank ( <u>J881-5-4</u> ) _____	100 ml	1Hg- <u>ADA-1-I3-7</u>
• 1N KCl Blank ( <u>J881-5-6</u> ) _____	100 ml	1Hg- <u>ADA-1-I3-8</u>
Acetone Blank _____	100 ml	1Hg- _____
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	1Hg- _____
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- _____
Sample Recovered By: <u>Wynona D. [Signature]</u>	Date: <u>03/06/01</u>	Time: <u>1900</u>
Sample Relinquished By: <u>Wynona D. [Signature]</u>	Date: <u>03/07/01</u>	Time: <u>1812</u>
Sample Received By: <u>JDM [Signature]</u>	Date: <u>3/7/01</u>	Time: <u>1812</u>
Sample Relinquished By: _____	Date: _____	Time: _____
Sample Received By: _____	Date: _____	Time: _____
Sample Relinquished By: _____	Date: _____	Time: _____
Sample Received By: _____	Date: _____	Time: _____

# Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/06/01

Location: Outlet Run 3

Test No.: -ADA-1-03

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF3</u>		1Hg- <u>ADA-1-03-1</u>
Filter No. 2 ID: _____		1Hg- <u>N/A</u>
• Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-03-2</u>
• Front Wash (0.1 N HNO3) _____	100 ml	1Hg- <u>ADA-1-03-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-03-4</u>
Impingers 1, 2, and 3 -2 (KCl) _____ (if needed)		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) _____ (if needed)		1Hg- <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO3/H2O2) _____		1Hg- <u>ADA-1-03-5</u>
• Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) _____		1Hg- <u>ADA-1-03-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) if needed		1Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	1Hg- _____
H2SO4/KMnO4 Blank _____	100 ml	1Hg- _____
1N KCl Blank _____	100 ml	1Hg- _____
Acetone Blank _____	100 ml	1Hg- _____
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	1Hg- _____
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- _____
Sample Recovered By: <u>Wynne D. Lynders</u>	Date: <u>03/06/01</u> Time: <u>2:00</u>	
Sample Relinquished By: <u>Wynne D. Lynders</u>	Date: <u>07/07/01</u> Time: <u>18:12</u>	
Sample Received By: <u>J. M. C.</u>	Date: <u>3/7/01</u> Time: <u>18:12</u>	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/07/01

Location: Inlet Run 4

Test No.: ADA-1-I4

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF6</u>		1Hg- <u>ADA-1-I4-1</u>
Filter No. 2 ID: _____		1Hg- <u>N/A</u>
◦ Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-I4-2</u>
◦ Front Wash (0.1 N HNO3) _____	100 ml	1Hg- <u>ADA-1-I4-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-I4-4</u>
Impingers 1, 2, and 3 -2 (KCl) _____ (if needed)		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) _____ (if needed)		1Hg- <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO3/H2O2) _____		1Hg- <u>ADA-1-I4-5</u>
• Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) _____		1Hg- <u>ADA-1-I4-6</u>
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 _____ (vented bottle) if needed		1Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	1Hg- _____
H2SO4/KMnO4 Blank _____	100 ml	1Hg- _____
1N KCl Blank _____	100 ml	1Hg- _____
Acetone Blank _____	100 ml	1Hg- _____
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	1Hg- _____
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- _____
Sample Recovered By: <u>Wynema D. Jambrosh</u>	Date: <u>03/07/01</u> Time: <u>15:30</u>	<u>03/07/01</u> <u>1600</u>
Sample Relinquished By: <u>Wynema D. Jambrosh</u>	Date: <u>03/07/01</u> Time: <u>1812</u>	
Sample Received By: <u>JAMC</u>	Date: <u>3/7/01</u> Time: <u>1812</u>	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A251.2

Date: 03/07/01

Location: Outlet Run 4

Test No.: - ADA-1-04

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
• Filter No. 1 ID: <u>QF7</u>		1Hg- <u>ADA-1-04-1</u>
Filter No. 2 ID: <u>N/A</u>		1Hg- _____
• Front Wash (Acetone) _____	100 ml	1Hg- <u>ADA-1-04-2</u>
• Front Wash (0.1 N HNO <sub>3</sub> ) _____	100 ml	1Hg- <u>ADA-1-04-3</u>
• Impingers 1, 2, and 3 -1 (KCl) _____		1Hg- <u>ADA-1-04-4</u>
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		1Hg- <u>N/A</u>
• Impingers 4 and 5 (Dry and HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> ) _____		1Hg- <u>ADA-1-04-5</u>
• Impingers 6, 7, 8 and 9 (dry and H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> ) -1 (vented bottle) _____		1Hg- <u>ADA-1-04-6</u>
Impingers 6, 7, 8 and 9 (dry and H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> ) -1 (vented bottle) if needed _____		1Hg- <u>N/A</u>
• HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub> Blank ( <u>J881-6-2</u> ) _____	100 ml	1Hg- <u>ADA-1-04-7</u>
• H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Blank ( <u>J881-6-1</u> ) _____	100 ml	1Hg- <u>ADA-1-04-8</u>
• 1M KCl Blank ( <u>J881-6-3</u> ) _____	100 ml	1Hg- <u>ADA-1-04-9</u>
Acetone Blank _____	100 ml	1Hg- <u>N/A</u>
Acetone Lot No. _____		
• 0.1 N HNO <sub>3</sub> Blank ( <u>J881-6-5</u> ) _____	100 ml	1Hg- <u>ADA-1-04-10</u>
• 10% HNO <sub>3</sub> Reagent Blank ( <u>J881-6-4</u> ) 0.1 N HNO <sub>3</sub> Lot No. _____	100 ml	<u>ADA-1-04-11</u>
Filter Blank ID: _____		1Hg- _____
Sample Recovered By: <u>Wynema D. Kuperberg</u> Date: <u>03/07/01</u> Time: <u>1549</u>		
Sample Relinquished By: <u>Wynema D. Kuperberg</u> Date: <u>03/07/01</u> Time: <u>1812</u>		
Sample Received By: <u>[Signature]</u> Date: <u>3/7/01</u> Time: <u>1812</u>		
Sample Relinquished By: _____ Date: _____ Time: _____		
Sample Received By: _____ Date: _____ Time: _____		
Sample Relinquished By: _____ Date: _____ Time: _____		
Sample Received By: _____ Date: _____ Time: _____		

CONSOLIDATED SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3 PROJECT NO. A261.2

PROJECT LEADER: J.D. McCain Page 6 of 6

SRI Box 6

SAMPLE NO.	COMPONENT DESCRIPTION	VOL/WT	REMARKS
ADA-1-I3-1	Filter		combine with I3-2 + I3-3
ADA-1-I1-1	"		combine with I1-2 + I1-3
ADA-1-I2-1	"		combine with I2-2 + I2-3
ADA-1-O3-1	"		combine with O3-2 + O3-3
ADA-1-I4-1	"		combine with I4-2 + I4-3
ADA-1-O4-1	"		combine with O4-2 + O4-3
ADA-1-O2-1	"		combine with O2-2 + O2-3
ADA-1-I1-12	" Blank Filter		
QF11	" "		for spikes, etc.
QF10	" "		"

Relinquished By J.D. McCain Date/Time 3/13/01 11:45 Received By [Signature] 3/13/01 7:45 PM

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Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_/\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

CONSOLIDATED SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3 PROJECT NO. A251.2  
A25

PROJECT LEADER: J.D. McCain Page 5 of 6

SRI BOX 5

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	REMARKS
ADA-1-I1-10	Acetone	100	Blank sol'n
ADA-1-02-10	0.1N HNO <sub>3</sub>	100	" "
ADA-1-02-11	10% Hydroxylamine HCl	100	" "
ADA-1-02-9	1M KCl	100	" "
ADA-1-02-7	HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100	" "
ADA-1-I3-7	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100	" "
ADA-I3-8	<del>0.1M</del> 1M KCl	100	" "
ADA-I04-9	" "	100	" "
ADA-1-04-11	10% Hydroxylamine HCl	100	" "
ADA-1-04-10	0.1N HNO <sub>3</sub>	100	" "
ADA-1-04-8	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100	" "
ADA-1-04-7	HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100	" "
ADA-1-04-2	Front wash, Acetone	100	combine with 04-1 + 04-3
ADA-1-02-2	" "	100	combine with 02-1 + 02-3
ADA-1-03-2	" "	90	combine with 03-1 + 03-3
ADA-1-I4-2	" "	100	combine with I4-1 + I4-3
ADA-1-I2-2	" "	100	combine with I2-1 + I2-3
ADA-1-I3-2	" "	100	combine with I3-1 + I3-3

Relinquished By J.D. McCain Date/Time 3/13/01/145 Received By [Signature] 3/14/01 1:45 PM

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Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_/\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

CONSOLIDATED SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3 PROJECT NO. A251.2

PROJECT LEADER: J. D. McCain Page 4 of 6 SRI Box 4

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	REMARKS
ADA-1-I1-13	10% Hydroxylamine HCl	100	Blank sol'n
ADA-1-I1-8	H <sub>2</sub> SO <sub>4</sub> / KMnO <sub>4</sub>	100	" "
ADA-1-02-8	" "	100	" "
ADA-1-I1-7	HNO <sub>3</sub> / H <sub>2</sub> O <sub>2</sub>	100	" "
ADA-1-I1-14	10% HNO <sub>3</sub>	100	" "
ADA-1-I1-9	1M KCl	100	" "
ADA-1-I1-11	0.1N HNO <sub>3</sub>	100	" "
ADA-1-I4-5	Imp 4+5 HNO <sub>3</sub> / H <sub>2</sub> O <sub>2</sub>	200	
ADA-1-I1-2	Frontwash - Acetone	50	Combine with I1-1 + I1-3
ADA-1-I1-5	Imp 4+5 HNO <sub>3</sub> / H <sub>2</sub> O <sub>2</sub>	200	
ADA-1-I1-3	Frontwash 0.1N HNO <sub>3</sub>	150	Combine with I1-2 + I1-1

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Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_/\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_



CONSOLIDATED SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3 PROJECT NO. A261.2

PROJECT LEADER: J.D.M<sup>c</sup>Cain Page 2 of 6 SRI Box 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	REMARKS
ADA-1-04-6	Imp, 6,7,8,9 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	500	
ADA-1-I4-4	Imp 1,2,3 KCl	800	
ADA-1-I4-6	Imp. 6,7,8,9 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	500	
ADA-1-I3-6	" " "	500	
ADA-1-I3-4	Imp 1,2,3 KCl	700	
ADA-1-04-4	" " "	800	
ADA-1-02-6	Imp. 6,7,8,9 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	475	
ADA-1-03-4	Imp. 1,2,3 KCl	700	
ADA-1-03-6	Imp. 6,7,8,9 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	450	
ADA-1-I2-4	Imp. 1,2,3, KCl	1000	
ADA-1-I2-6	Imp 6,7,8,9 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	500	
ADA-1-02-4	Imp 1,2,3 KCl	725	

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CONSOLIDATED SAMPLE CUSTODY

INSTALLATION: GASTON UNIT 3 PROJECT NO. A2612

PROJECT LEADER: J.D. McCain Page 1 of 6 SRI BOX 1

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	REMARKS
ADA-1-02-5	Imp. 4+5 HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	125	
ADA-1-I2-5	" "	150	
ADA-1-I2-3	Front wash 0.1N HNO <sub>3</sub>	125	Combine with I2-1,2
ADA-1-03-3	" "	100	Combine with 02-1,2
ADA-1-03-5	Imp. 4+5 HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	175	
ADA-1-02-3	Front wash 0.1N HNO <sub>3</sub>	100	
ADA-1-04-3	" "	150	
ADA-1-I3-5	Imp. 4+5 HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	140	
ADA-1-I3-3	Front wash 0.1N HNO <sub>3</sub>	150	
ADA-1-I4-3	" "	200	
ADA-1-04-5	Imp. 4+5 HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	190	

Relinquished By J.D. McCain Date/Time 3/13/01 12:45 PM Received By [Signature] EST 3/13/01 1:45 PM

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Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_/\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

RUN IDENTIFICATION:	Hg-I-2	REDUCED MASS TRAIN DATA	
RUN DATE	: 3/6/01	-----	
GAS ANALYSIS - O2 :	7.0	ISOKINETIC AGREEMENT, %:	94.6
(Dry Basis) - CO2:	13.0		
Setup value - H2O:	8	CALCULATED % H2O :	7.9
AMB PRESS, in Hg :	30.30		
STACK dP, in H2O :	-13.5	AVG GAS VELOCITY, ft/s :	39.2
NOZZLE DIA, in :	0.222	AVG GAS TEMPERATURE, F :	233
PITOT CONSTANT :	0.80	GAS VOLUME FLOW, acfm :	444,466
GAS METER CALIB :	1.002	dscfm :	305,850
DUCT AREA, ft2 :	189	wscfm :	331,945
		Dry Gas lb/hr:	1443359
H2O COLLECTED, ml :	89.3	Moisture lb/hr:	73011
PARTICLE MASS, mg :	2.36E-02	Total lb/hr:	1516370
TIME SAMPLED, min :	120	MASS LOADING, gr/acf :	5.06E-06
GAS METER VOL, ft3:	47.596	gr/dscf :	7.35E-06
AVG SQRT PITOT dp :	0.640	mg/acm :	1.16E-02
AVG ORI dP, in H2O:	0.700	mg/dscm :	1.69E-02
AVG STACK TEMP, F :	233	gr/dscf @7% O2 :	7.35E-06
GAS METER TEMP, F :	57	gr/dscf @12% CO2 :	6.79E-06
		EMISSION RATE, lb/hr :	1.93E-02
		EMISSION RATE, #/E6-Btu:	1.55E-05

RUN IDENTIFICATION:	Hg-I-3	REDUCED MASS TRAIN DATA	
RUN DATE	: 3/6/01	-----	
GAS ANALYSIS - O2 :	7.4	ISOKINETIC AGREEMENT, %:	108.3
(Dry Basis) - CO2:	12.5		
Setup value - H2O:	8	CALCULATED % H2O :	6.7
AMB PRESS, in Hg :	30.20	AVG GAS VELOCITY, ft/s :	41.1
STACK dP, in H2O :	-13.5	AVG GAS TEMPERATURE, F :	226
NOZZLE DIA, in :	0.193	GAS VOLUME FLOW, acfm :	465,879
PITOT CONSTANT :	0.80	dscfm :	326,676
GAS METER CALIB :	1.002	wscfm :	350,291
DUCT AREA, ft2 :	189	Dry Gas lb/hr:	1538391
H2O COLLECTED, ml :	70.1	Moisture lb/hr:	66073
PARTICLE MASS, mg :	1.80E-02	Total lb/hr:	1604464
TIME SAMPLED, min :	120	MASS LOADING, gr/acf :	4.26E-06
GAS METER VOL, ft3:	44.419	gr/dscf :	6.07E-06
AVG SQRT PITOT dp :	0.674	mg/acm :	9.76E-03
AVG ORI dP, in H2O:	0.500	mg/dscm :	1.39E-02
AVG STACK TEMP, F :	226	gr/dscf @7% O2 :	6.25E-06
GAS METER TEMP, F :	59	gr/dscf @12% CO2 :	5.83E-06
		EMISSION RATE, lb/hr :	1.70E-02
		EMISSION RATE, #/E6-Btu:	1.32E-05

RUN IDENTIFICATION: Hg-I-4  
 RUN DATE : 3/7/01  
 GAS ANALYSIS - O2 : 6.5  
 (Dry Basis) - CO2: 12.5  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.30  
 STACK dP, in H2O : -13.5  
 NOZZLE DIA, in : 0.193  
 PITOT CONSTANT : 0.80  
 GAS METER CALIB : 0.989  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 74.2  
 PARTICLE MASS, mg : 2.02E-02  
 TIME SAMPLED, min : 150  
 GAS METER VOL, ft3: 56.040  
 AVG SQRT PITOT dp : 0.688  
 AVG ORI dP, in H2O: 0.500  
 AVG STACK TEMP, F : 230  
 GAS METER TEMP, F : 61

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 105.1  
 CALCULATED % H2O : 5.8  
 AVG GAS VELOCITY, ft/s : 42.0  
 AVG GAS TEMPERATURE, F : 230  
 GAS VOLUME FLOW, acfm : 475,771  
 dscfm : 335,759  
 wscfm : 356,406  
 Dry Gas lb/hr: 1579286  
 Moisture lb/hr: 57767  
 Total lb/hr: 1637053  
 MASS LOADING, gr/acf : 3.85E-06  
 gr/dscf : 5.46E-06  
 mg/acm : 8.83E-03  
 mg/dscm : 1.25E-02  
 gr/dscf @7% O2 : 5.27E-06  
 gr/dscf @12% CO2 : 5.24E-06  
  
 EMISSION RATE, lb/hr : 1.57E-02  
 EMISSION RATE, #/E6-Btu: 1.11E-05

RUN IDENTIFICATION: Hg-0-2  
 RUN DATE : 3/6/01  
 GAS ANALYSIS - O2 : 7.9  
 (Dry Basis) - CO2: 12.5  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.30  
 STACK dP, in H2O : -19.0  
 NOZZLE DIA, in : 0.187  
 PITOT CONSTANT : 0.87  
 GAS METER CALIB : 0.989  
 DUCT AREA, ft2 : 134.24  
  
 H2O COLLECTED, ml : 76.6  
 PARTICLE MASS, mg : 2.16E-02  
 TIME SAMPLED, min : 144  
 GAS METER VOL, ft3: 55.552  
 AVG SQRT PITOT dp : 0.750  
 AVG ORI dP, in H2O: 0.551  
 AVG STACK TEMP, F : 234  
 GAS METER TEMP, F : 68

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 96.7  
 CALCULATED % H2O : 6.1  
 AVG GAS VELOCITY, ft/s : 50.5  
 AVG GAS TEMPERATURE, F : 234  
 GAS VOLUME FLOW, acfm : 406,827  
 dscfm : 280,620  
 wscfm : 298,822  
 Dry Gas lb/hr: 1322373  
 Moisture lb/hr: 50929  
 Total lb/hr: 1373302  
 MASS LOADING, gr/acf : 4.12E-06  
 gr/dscf : 5.97E-06  
 mg/acm : 9.44E-03  
 mg/dscm : 1.37E-02  
 gr/dscf @7% O2 : 6.38E-06  
 gr/dscf @12% CO2 : 5.73E-06  
  
 EMISSION RATE, lb/hr : 1.43E-02  
 EMISSION RATE, #/E6-Btu: 1.35E-05

RUN IDENTIFICATION: Hg-0-3  
 RUN DATE : 3/6/01  
 GAS ANALYSIS - O2 : 7.9  
 (Dry Basis) - CO2: 12.5  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.20  
 STACK dP, in H2O : -19.0  
 NOZZLE DIA, in : 0.187  
 PITOT CONSTANT : 0.87  
 GAS METER CALIB : 0.989  
 DUCT AREA, ft2 : 134.24  
  
 H2O COLLECTED, ml : 92.4  
 PARTICLE MASS, mg : 2.51E-02  
 TIME SAMPLED, min : 144  
 GAS METER VOL, ft3: 61.960  
 AVG SQRT PITOT dp : 0.806  
 AVG ORI dP, in H2O: 0.648  
 AVG STACK TEMP, F : 232  
 GAS METER TEMP, F : 67

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 100.7  
 CALCULATED % H2O : 6.6  
 AVG GAS VELOCITY, ft/s : 54.3  
 AVG GAS TEMPERATURE, F : 232  
 GAS VOLUME FLOW, acfm : 437,637  
 dscfm : 300,345  
 wscfm : 321,452  
 Dry Gas lb/hr: 1415324  
 Moisture lb/hr: 59055  
 Total lb/hr: 1474379  
 MASS LOADING, gr/acf : 4.28E-06  
 gr/dscf : 6.23E-06  
 mg/acm : 9.81E-03  
 mg/dscm : 1.43E-02  
 gr/dscf @7% O2 : 6.66E-06  
 gr/dscf @12% CO2 : 5.98E-06  
  
 EMISSION RATE, lb/hr : 1.60E-02  
 EMISSION RATE, #/E6-Btu: 1.41E-05

RUN IDENTIFICATION:	Hg-O-4	REDUCED MASS TRAIN DATA	
RUN DATE	: 3/7/01	-----	
GAS ANALYSIS - O2 :	6.3	ISOKINETIC AGREEMENT, %:	98.0
(Dry Basis) - CO2:	12.0		
Setup value - H2O:	8	CALCULATED % H2O :	6.6
AMB PRESS, in Hg :	30.30	AVG GAS VELOCITY, ft/s :	61.6
STACK dP, in H2O :	-19.0	AVG GAS TEMPERATURE, F :	231
NOZZLE DIA, in :	0.187	GAS VOLUME FLOW, acfm :	496,357
PITOT CONSTANT :	0.87	dscfm :	341,973
GAS METER CALIB :	0.989	wscfm :	366,219
DUCT AREA, ft2 :	134.24	Dry Gas lb/hr:	1603834
		Moisture lb/hr:	67839
H2O COLLECTED, ml :	103.4	Total lb/hr:	1671673
PARTICLE MASS, mg :	2.41E-02	MASS LOADING, gr/acf :	3.71E-06
TIME SAMPLED, min :	144	gr/dscf :	5.39E-06
GAS METER VOL, ft3:	68.825	mg/acm :	8.51E-03
AVG SQRT PITOT dp :	0.914	mg/dscm :	1.24E-02
AVG ORI dP, in H2O:	0.788	gr/dscf @7% O2 :	5.13E-06
AVG STACK TEMP, F :	231	gr/dscf @12% CO2 :	5.39E-06
GAS METER TEMP, F :	70		
		EMISSION RATE, lb/hr :	1.58E-02
		EMISSION RATE, #/E6-Btu:	1.08E-05

## **ATTACHMENT B2**

### **Carbon Injection Test – Field Data**





MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	4.0	0.020	0.01	0.440	0.27
CO2 :	15.0	0.040	0.02	0.480	0.29
H2O :	7.0	0.060	0.04	0.520	0.31
AVG dP :	0.59753	0.080	0.05	0.560	0.34
AMB PRESS, in Hg :	30.33	0.100	0.06	0.600	0.36
STACK dP, in H2O :	-5.5	0.120	0.07	0.640	0.39
AVG SQR ROOT dP :	0.77	0.140	0.08	0.680	0.41
MINIMUM PITOT dP :	0.02	0.160	0.10	0.720	0.43
dP INCREMENT :	0.020	0.180	0.11	0.760	0.46
		0.200	0.12	0.800	0.48
STACK GAS TEMP, F :	665	0.220	0.13	0.840	0.51
GAS METER TEMP, F :	90	0.240	0.14	0.880	0.53
		0.260	0.16	0.920	0.55
PITOT CONSTANT :	0.84	0.280	0.17	0.960	0.58
ORIFICE CONSTANT :	1.83	0.300	0.18	1.000	0.60
		0.320	0.19	1.040	0.63
NOZZLE DIA, in :	0.189	0.340	0.20	1.080	0.65
SYSTEM FLOW, acfm :	0.730	0.360	0.22	1.120	0.67
		0.380	0.23	1.160	0.70
		0.400	0.24	1.200	0.72
FLOW, scfm :	0.32319		No Points	20	160
Target Volume, dscf:	70		Dwell Time	8	
Time Required, min.:	217		1.48 m <sup>3</sup> in	160 minutes	

4/26/01 ESP INLET



ADA-2-51-4

Test No.

Run No.

Page 2 of 2

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	C 1	72	5.0	651	0.82	0.49	—	251	252	N/A <del>66</del>	66	74	86	
	C 1	80	5.0	650	0.82	0.49	447.9	247	248		65	93	85	
	2	88	5.0	656	0.86	0.52	453.5	249	250		64	93	86	
	3	96	5.0	657	0.94	0.56	456.6	250	250		64	93	85	
	4	104	5.0	655	0.80	0.48	460.0	249	251		64	93	85	
	5	112	5.0	659	0.90 <del>0.82</del>	0.54 <del>0.48</del>	463.2	250	250		64	93	85	3.4/14.8
	E 1	120	3.5	657	0.20	0.17	466.8	251	252		71	88	84	
	2	128	3.0	657	0.72 <del>0.66</del>	0.43	468.9	249	248		68	89	84	
	3	136	5.0	658	0.70	0.42	471.8	246	247		67	91	85	2.8/14.4
	4	144	5.0	664	0.86	0.52	474.9	249	250		68	92	86	
	5	152	5.0	663	0.86	0.52	478.2	250	250		68	92	85	
		160/FINAL					482.0							

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 4.0	0.020	0.01	0.440	0.27
CO2	: 15.0	0.040	0.02	0.480	0.29
H2O	: 7.0	0.060	0.04	0.520	0.31
AVG dP	: 0.59753	0.080	0.05	0.560	0.34
AMB PRESS, in Hg	: 30.27	0.100	0.06	0.600	0.36
STACK dP, in H2O	: -5.5	0.120	0.07	0.640	0.39
AVG SQR ROOT dP	: 0.77	0.140	0.08	0.680	0.41
MINIMUM PITOT dP	: 0.02	0.160	0.10	0.720	0.43
dP INCREMENT	: 0.020	0.180	0.11	0.760	0.46
		0.200	0.12	0.800	0.48
STACK GAS TEMP, F	: 665	0.220	0.13	0.840	0.51
GAS METER TEMP, F	: 90	0.240	0.14	0.880	0.53
		0.260	0.16	0.920	0.55
PITOT CONSTANT	: 0.84	0.280	0.17	0.960	0.58
ORIFICE CONSTANT	: 1.83	0.300	0.18	1.000	0.60
		0.320	0.19	1.040	0.63
NOZZLE DIA, in	: 0.189	0.340	0.20	1.080	0.65
SYSTEM FLOW, acfm	: 0.731	0.360	0.22	1.120	0.67
		0.380	0.23	1.160	0.70
		0.400	0.24	1.200	0.72
FLOW, scfm	: 0.32287		No Points	20	160
Target Volume, dscf:	70		Dwell Time	8	
Time Required, min.:	217		1.48 m <sup>3</sup> in	160 minutes	

4/25

METHOD 5 FIELD DATA

Plant/Location Cashon Unit 3 ESP Inlet Filter #1: ID 06 + 07  
 Operators SS Nozzle ID \_\_\_\_\_ Leak Rate, cfm, Pretest 0.010  
 Date 4/25/01 Nozzle Diameter, inches 0.189 Leak Rate, cfm, Posttest \_\_\_\_\_  
 Test No./Run No. ADA-2 - EI - 3 Barometric Pressure, in. Hg. 30.27 Filter #2: ID (if used) QF-15  
 Meter Box ID 80411 Ambient Temp., Deg. F. \_\_\_\_\_ Leak Rate, cfm, Pretest \_\_\_\_\_  
 Gas Meter Cal. Factor 0.982 Assumed Moisture, % 7 Leak Rate, cfm, Posttest \_\_\_\_\_  
 Orifice ID 80411 Orifice DH@ 1.83 Duct/Stack Pressure Diff., in. H2O -5.5

GAS METER START, cf. 354.056 GAS METER END, cf. 416.642  
 START TIME 11:17 END TIME 14:08

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf.	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	1	8 0	5.0	647	0.48	0.29	354.056	242	246	N/A	70 72	89	86	by Meter
	2	16 8	5.0	656	0.64	0.37	-	274	251		66	91	85	
	3	22 24	5.0	666	0.80	0.48	360.2	249	250		67	93	86	
	4	40 32	5.0	672	0.94	0.57	363.4	250	252		66	95	88	4.1 / 15.5
	5	48 32	5.0	680	0.84	0.51	366.8	250	251		65	96	89	
	5	48 40	5.0	682	0.84	0.51	-	251	251		65	99	89	
	4	56 48	5.0	677	0.72	0.55	373.7	250	252		68	96	88	
	3	64 56	5.0	673	0.78	0.55	-	251	252		68	95	88	3.8 / 15.4
	2	72 64	5.0	668	0.82	0.49	380.0	250	251		68	95	88	

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
		160		669	0.86	0.44	62.48					92.2

89.1 ml



**METHOD 5 FIELD DATA**

Plant/Location Caster Unit 3 ESP Inlet Filter #1: ID QW # 03 + 04  
 Operators SSS/ARCP/IS Nozzle ID 0-1955 RA-2 Leak Rate, cfm, Pretest 0.000 <sup>M10-0.00</sup>  
 Date 7/24/01 Nozzle Diameter, inches 0.189 Leak Rate, cfm, Posttest 0.015  
 Test No./Run No. ADA-2-EI2 Barometric Pressure, in. Hg. 30.21 Filter #2: ID (if used) QF 11  
 Meter Box ID 80411 Ambient Temp., Deg. F. 85 Leak Rate, cfm, Pretest \_\_\_\_\_  
 Gas Meter Cal. Factor 0.782 Assumed Moisture, % 7 Leak Rate, cfm, Posttest \_\_\_\_\_  
 Orifice ID 80411 Orifice DH@ 1.83 Duct/Stack Pressure Diff., in. H2O - 5.5

GAS METER START, cf. 286.268 GAS METER END, cf. 352.165  
 START TIME 10:39 END TIME 12:55

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
0	C 1		4	665	0.48	0.27	286.268	248	252	N/A	70	82	82	
8	2		4.5	665	0.80	0.45	288.4	247	250		67	87	83	
16	3		4.5	666	0.84	0.47	292.92	249	250		63	89	84	
24	4		4.5	664	0.84	0.47	295.6	250	251		62	89	84	38/15.2
32	5		5.0	668	0.92	0.52	298.8	248	254		63	90	85	
40	C 5		5.0	667	0.92	0.52	302.1	249	252		62	90	85	
48	4		5.0	668	0.84	0.47	305.2	250	251		63	90	85	
56	3		5.0	666	0.80	0.45	308.4	252	250		63	90	85	
64	2		5.0	665	0.80	0.45	311.5	250	249		63	91	86	

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg	Max.	Max.	Avg.
			666	0.896	0.46	62.077	88.6	88.6	88.6	88.6

90.7ml

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
C 1	72		5.0	667	0.80	0.45	314.5	251	252	N/A	67	92	86	
C 1	80		4.0	658	0.80	0.45	317.6-320.2	250	254		69	91	86	2.64% <sup>old</sup> out of spec
2	88		5.0	609	0.92	0.52	323.3	251	252		62	94	87	changed
3	96		5.0	668	0.92	0.52	326.9	250	251		62	95	87	in spec.
4	104		5.0	672	0.92	0.52	330.0	251	251		61	95	87	4.2/15.3
5	112		5.0	671	1.00	0.56 <sup>559</sup>	333.2	250	252		61	94	87	
E 1	120		4.0	626	0.30	0.17	357.3	252	251		69	92	86	1.28% <sup>old</sup> out of spec
2	128		4.5	604	0.68	0.38	339.2	250	251		67	92	87	
3	136		4.5	608	0.76	0.43	342.1	252	250		66	94	87	
4	144		5.0	675	0.96	0.54	345.7	251	252		65	95	88	4.1/15.4
5	152		5.0	676	0.96	0.54	348.7	250	252		65	95	88	
	160/Final						352.165							

# ESP INLET 4/24/01

MASS TRAIN OPERATION			dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	:	4.0	0.020	0.01	0.440	0.25
CO2	:	16.0	0.040	0.02	0.480	0.27
H2O	:	7.0	0.060	0.03	0.520	0.29
AVG dP	:	0.59753	0.080	0.05	0.560	0.32
AMB PRESS. in Hg	:	30.39	0.100	0.06	0.600	0.34
STACK dP, in H2O	:	-13.5	0.120	0.07	0.640	0.36
AVG SQR ROOT dP	:	0.77	0.140	0.08	0.680	0.38
MINIMUM PITOT dP	:	0.02	0.160	0.09	0.720	0.41
dP INCREMENT	:	0.020	0.180	0.10	0.760	0.43
			0.200	0.11	0.800	0.45
STACK GAS TEMP, F	:	659	0.220	0.12	0.840	0.47
GAS METER TEMP, F	:	85	0.240	0.14	0.880	0.50
			0.260	0.15	0.920	0.52
PITOT CONSTANT	:	0.84	0.280	0.16	0.960	0.54
ORIFICE CONSTANT	:	1.83	0.300	0.17	1.000	0.56
			0.320	0.18	1.040	0.59
NOZZLE DIA, in	:	0.187	0.340	0.19	1.080	0.61
SYSTEM FLOW, acfm	:	0.719	0.360	0.20	1.120	0.63
			0.380	0.21	1.160	0.65
			0.400	0.23	1.200	0.68

8 min / port

160 min total

Test No. 1 Run No. 1 Page 1 of 4

D

METHOD 5 FIELD DATA

Plant/Location Gaston Unit 3 COMPACTOR UNIT B Pitot Coefficient, Cp .87 Filter #1: ID QF7 QF12  
 Operators KDO/WJP Nozzle ID T11 Leak Rate, cfm, Pretest 0.000/min  
 Date 4/24/01 Nozzle Diameter, inches 0.189 Leak Rate, cfm, Posttest 1.001/min  
 Test No./Run No. ADA-2-CO2 Barometric Pressure, in. Hg. 30.21 Filter #2: ID (if used) NA  
 Meter Box ID WUTTECH 4 Ambient Temp., Deg. F. 75 Leak Rate, cfm, Pretest NA  
 Gas Meter Cal. Factor 1.0128 Assumed Moisture, % 7.3% Leak Rate, cfm, Posttest NA  
 Orifice ID NOTECH 4 Orifice DH@ 1.90 Duct/Stack Pressure Diff., in. H2O -19.0

GAS METER START, cf: 58.058 GAS METER END, cf: 156.640  
 START TIME 1148 END TIME 1538

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1148	16-1	0	-5.0	274	.67	.64	58.058	251	253	267	67	69	69	7.4/12.0
1152	16-2	4	-5.0	274	.40	.40	61.11	249	262	-	56	72	72	6.9/12.0
1156	16-3	8	-5.0	269	.55	.55	62.39	245	246	-	55	72	71	6.5/13.0
	E-0						63.511							
1200	14-1	12	-4.5	264	.40	.40	64.516	247	268	-	57	72	70	7.8/11.0
1204	14-2	16	-4.5	274	.40	.40	66.02	242	250	-	53	73	71	6.4/13
1208	14-3	20	-4.5	261	.85	.84	67.76	248	255	-	52	72	71	6.5/13
	E-0						69.306						71	
1210	15-1	24	-5.0	25	.55	.55	69.865	246	259	-	48	72	71	7.6

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg.	Avg.	Max.	Avg.	Max.	Avg.	Avg.
	192	-5	254	0.959	0.71	90.191							
													7.6/11.8

157.6 ml

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1214	15-2	28	-5.0	273	.75	.74	71.46	243	259	-	45	73	72	6.8/12
1218	15-3	32	-5.0	270	.70	.69	73.37	241	245	-	45	73	72	6.4/12
	END						75.178							
1220	14-1	36	-5.0	269	.45	.45	75.460	249	249	-	47	73	71	7.2/12
1224	14-2	40	-5.0	275	.45	.45	77.01	246	247	-	46	73	71	6.6/13
1228	14-3	44	-5.0	269	.80	.79	78.49	251	251	-	47	73	71	6.6/13
	END						80.328							
1238	12-1	48	-5.0	277	.45	.45	80.939	244	249	-	48	73	72	7.1/2
1242	12-2	52	-5.0	277	.90	.89	82.41	244	252	-	46	73	72	6.9/12.5
1246	12-3	56	-5.5	273	.95	.94	84.53	248	250	-	46	73	72	6.2
	END													
1250	12-3	60	-5.0	273	.95	.94	86.80	247	251	-	47	73	72	6.4/12.5
1254	12-2	64	-5.0	275	.90	.89	88.68	242	263	-	47	73	72	6.8/13
1258	12-2	68	-5.0	276	.45	.45	89.71	243	251	-	47	73	72	6.2/
							92.241							
1315	9-1	72	-5.0	273	.90	.89	93.728	245	251	-	46	73	72	7.5/12.0
1319	9-2	76	-5.0	273	.65	.64	95.90	247	267	-	47	74	73	6.8/13.5
1323	9-3	80	-5.0	273	.65	.64	97.59	247	237	-	47	74	73	6.6/13.0
1324	9-3	84	-5.0	274	.65	.64	99.34	247	262	-	47	74	73	6.6/13.0
1328	4-2	88	-5.0	272	.60	.59	101.24	248	248	-	47	74	73	6.8/
1332	9-1	92	-5.0	275	.90	.89	102.96	243	264	-	47	74	73	6.4
							105.071							
1345	6-1	96	-5.0	252	.95	.94	106.074	244	259	-	47	74	73	

Test No. / Clock Time	Run No. / Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1344	6-2	100	-5.0	251	.90	.81	109.91	242	258	-	47	73	71	7.5
1353	6-3	104	-5.0	247	1.0	.90	111.57	249	251	-	47	73	71	7.0
	Err						113.538							8.0
1359	8-1	108	-5.0	252	1.0	.90	114.173	246	252	-	48	74	72	7.6
1403	8-2	112	-5.0	258	.65	.59	116.25	245	259	-	48	74	72	7.7
1407	8-3	116	-5.0	252	.85	.77	117.97	251	248	-	48	75	73	7.4
							119.850							7.4
1415	7-1	120	-5.0	258	.80	.72	120.280	244	251	-	49	74	72	7.2
1419	7-2	124	-5.0	256	.85	.77	121.99	247	261	-	49	74	72	7.4
1423	7-3	128	-5.0	247	1.0	.90	124.03	247	254	-	49	74	72	8.8
							126.147							8.7
1430	5-1	132	-5.0	233	.90	.81	126.525	246	260	-	49	74	72	9.1
1434	5-2	136	-5.0	234	1.0	.90	128.70	244	255	-	47	73	71	
1438	5-3	140	-5.0	232	.75	.68	132.60	246	244	-	47	72	7.2	
														9.1
1442	5-3	144	-5.0	230	.75	.68	132.410	247	247	-	47	73	72	9.1
1446	5-2	148	-5.0	231	1.0	.90	134.31	247	255	-	47	73	72	8.7
1450	5-1	152	-5.0	239	.90	.81	136.27	247	253	-	48	73	72	8.8
							138.255							9.1
1456	1-1	156	-5.0	241	1.0	.90	138.915	246	255	-	49	72	71	8.9
1500	1-2	160	-5.0	241	1.0	.90	141.01	244	246	-	49	72	71	9.0
1504	1-3	164	-5.0	238	1.0	.90	143.12	249	260	-	49	72	71	
							145.200							9.0
1512	3-1	168	-5.0	233	.90	.81	146.284	251	263	-	48	72	71	



MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 6.5	0.200	0.20	1.100	1.09
CO2	: 12.5	0.250	0.25	1.150	1.14
H2O	: 8.0	0.300	0.30	1.200	1.19
AVG dP	: 0.8354	0.350	0.35	1.250	1.24
AMB PRESS, in Hg	: 30.30	0.400	0.40	1.300	1.29
STACK dP, in H2O	: -19.0	0.450	0.45	1.350	1.34
AVG SQR ROOT dP	: 0.91	0.500	0.50	1.400	1.39
MINIMUM PITOT dP	: 0.20	0.550	0.55	1.450	1.44
dP INCREMENT	: 0.050	0.600	0.59	1.500	1.49
		0.650	0.64	1.550	1.54
STACK GAS TEMP, F	: 230	0.700	0.69	1.600	1.59
GAS METER TEMP, F	: 60	0.750	0.74	1.650	1.64
		0.800	0.79	1.700	1.69
PITOT CONSTANT	: 0.87	0.850	0.84	1.750	1.73
ORIFICE CONSTANT	: 1.90	0.900	0.89	1.800	1.78
		0.950	0.94	1.850	1.83
NOZZLE DIA, in	: 0.189	1.000	0.99	1.900	1.88
SYSTEM FLOW, acfm	: 0.721	1.050	1.04	1.950	1.93
FLOW, scfm	: 0.51403		No Points	48	192

*5 mm/point*

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 6.5	0.200	0.18	1.100	0.99
CO2	: 12.5	0.250	0.23	1.150	1.04
H2O	: 8.0	0.300	0.27	1.200	1.08
AVG dp	: 0.8354	0.350	0.32	1.250	1.13
AMB PRESS, in Hg	: 30.30	0.400	0.36	1.300	1.17
STACK dp, in H2O	: -19.0	0.450	0.41	1.350	1.22
AVG SQR ROOT dp	: 0.91	0.500	0.45	1.400	1.26
MINIMUM PITOT dp	: 0.20	0.550	0.50	1.450	1.31
dp INCREMENT	: 0.050	0.600	0.54	1.500	1.35
		0.650	0.59	1.550	1.40
STACK GAS TEMP, F	: 275	0.700	0.63	1.600	1.44
GAS METER TEMP, F	: 60	0.750	0.68	1.650	1.49
		0.800	0.72	1.700	1.53
PITOT CONSTANT	: 0.87	0.850	0.77	1.750	1.58
ORIFICE CONSTANT	: 1.90	0.900	0.81	1.800	1.62
		0.950	0.86	1.850	1.67
NOZZLE DIA, in	: 0.188	1.000	0.90	1.900	1.71
SYSTEM FLOW, acfm	: 0.732	1.050	0.95	1.950	1.76
FLOW, scfm	: 0.49017		No Points	48	192
Target Volume, dscf:	87.5		Dwell Time	4	
Time Required, min.:	179		2.69 m <sup>3</sup> in	192 minutes	

**B** side

METHOD 5 FIELD DATA

Plant/Location Gaster Unit 3 COMPACTION Pitot Coefficient, Cp 0.87 Filter #1: ID QF14  
 Operators Ko, BP Nozzle ID T11 Leak Rate, cfm, Pretest .002  
 Date 4/25/01 Nozzle Diameter, inches 0.189 Leak Rate, cfm, Posttest .002  
 Test No./Run No. ADA-2-C03 Barometric Pressure, in. Hg. 30.27 Filter #2: ID (if used) N/A  
 Meter Box ID NUTCH 4 Ambient Temp., Deg. F. 80°F Leak Rate, cfm, Pretest N/A  
 Gas Meter Cal. Factor 1.0128 Assumed Moisture, % 8% Leak Rate, cfm, Posttest N/A  
 Orifice ID NUTCH 4 Orifice DH@ 1.90 Duct/Stack Pressure Diff., in. H2O -18.5

GAS METER START, cf. 157.851 GAS METER END, cf. 253.607  
 START TIME 1051 END TIME 1437

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1051	2-1	0	-5.0	238	.85	.81	157.851	248	259	N/A	56	68	68	8.4/10
1055	2-2	4	-5.0	234	1.0	.95	159.82	246	242	-	54	69	68	8.5/10
	2-3	8	-5.0	217	.55	.52	162.19	245	254	-	54	71	69	7.5/10
							163.568							
1104	1-1	12	-5.0	241	.80	.76	163.710	243	242	-	52	72	69	8.3/11
	1-2	16	-5.0	239	.95	.90	165.62	249	257	-	52	72	71	8.6/10
	1-3	20	-5.0	234	.60	.57	167.61	243	265	-	51	73	71	9.2/10
							169.342							
1118	3-1	24	-5.0	232	.85	.81	169.783	252	246	-	50	73	71	9.6

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
	192	15	253	0.87	0.73	88.036	0.73	76	76	76	71	7.4/10

120.6 bmsd

11.78

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	3-2	28	-5.0	227	.65	.62	171.671	242	254	-	51	74	72	9.1/9.5
	3-3	32	-5.0	215	.45	.43	173.42	243	254	-	51	74	71	9.4/9.0
							174.886							
1133	6-1	36	-5.0	234	.95	.90	175.298	252	254	-	52	74	72	8.0/11
	6-2	40	-5.0	248	.80	.76	177.61	247	257	-	51	75	73	7.3/11
	6-3	44	-5.0	244	1.0	.95	179.27	243	251	-	51	75	7.3	8.2/10
							181.425							
1148	5-1	48	-5.0	241	.75	.71	181.718	247	252	-	53	75	72	8.2/11
	5-2	52	-5.0	235	1.0	.95	183.63	243	262	-	53	76	74	8.5/11
	5-3	56	-5.0	233	.85	.81	185.82	248	245	-	53	77	74	8.7/11
1201	5-3	60	-5.0	239	.80	.76	188.02	242	240	-	53	78	75	9.0/10
	5-2	64	-5.0	236	1.0	.95	189.80	248	264	-	52	77	75	8.9/11
	5-1	68	-5.0	231	.75	.71	191.73	244	253	-	52	77	75	8.2/12
							193.615							
1215	8-1	72	-5.0	249	.95	.90	194.522	249	261	-	53	77	76	8.0/11.5
	8-2	76	-5.0	254	.65	.62	196.90	247	264	-	53	77	76	7.6/11.5
	8-3	80	-5.0	248	.80	.76	198.48	245	251	-	52	77	76	7.1/12
							200.400							
1232	7-1	84	-5.0	250	.65	.62	201.100	249	252	-	51	77	76	7.0/11.5
	7-2	88	-5.0	254	.80	.76	202.71	248	254	-	52	78	76	6.9/12.0
	7-3	92	-5.0	252	1.0	.95	204.83	247	257	-	52	78	76	7.0
							206.933	247	257	-	52	78	76	
							206.477							
1247	12-1	96	-5.0	268	.45	.43	207.81	246	254	-	52	78	76	8.2/11

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	12-2	100	-5.0	268	.90	.85	209.10	244	258	-	52	78	75	6.7
	12-3	104	-5.0	268	.90	.85	211.17	247	247	-	53	79	76	6.0 13.0
1255	12-3	108	-5.0	262	.90	.85	213.17	248	260	-	54	79	76	6.2
	12-2	112	-5.0	265	.90	.85	215.06	249	257	-	58	79	77	6.4/13.5
	12-1	116	-5.0	265	.45	.45	216.99	247	250	-	56	78	76	6.2
							218.53							
1315	9-1	120	-5.0	267	.90	.85	218.822	243	258	-	56	78	77	7.1/12
	9-2	124	-5.0	270	.60	.57	220.82	249	253	-	55	78	77	7.0/12
	9-3	128	-5.0	267	.70	.66	222.74	245	258	-	55	78	77	6.2/13
1328	9-3	132	-5.0	269	.70	.66	224.32	247	251	-	56	79	77	6.4/12.5
	9-2	136	-5.0	267	.60	.57	226.28	248	246	-	55	79	77	6.2/13
	9-1	140	-5.0	270	.90	.85	227.89	249	253	-	55	79	77	6.3/13
							230.084							
1343	14-1	144	-5.0	266	.65	.62	231.008	246	262	-	55	79	77	7.0
	14-2	148	-5.0	268	.65	.62	232.99	248	247	-	55	79	77	6.6
	14-3	152	-5.0	266	.80	.76	234.01	246	242	-	56	79	77	6.6/13
1358	14-3	156	-5.0	266	.80	.76	236.45	246	258	-	56	79	77	6.8
	14-2	160	-5.0	266	.65	.62	238.27	247	260	-	55	79	77	6.4/13
	14-1	164	-5.0	268	.65	.62	241.09	243	262	-	58	79	77	6.2
							241.88							
1412	15-1	168	-5.0	267	.85	.81	242.450	244	251	-	57	79	77	6.9







MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	: 8.0	0.200	0.20	1.100	1.08
CO2	: 11.0	0.250	0.25	1.150	1.13
H2O	: 8.0	0.300	0.30	1.200	1.18
AVG dP	: 0.8354	0.350	0.34	1.250	1.23
AMB PRESS, in Hg	: 30.33	0.400	0.39	1.300	1.28
STACK dP, in H2O	: -19.0	0.450	0.44	1.350	1.33
AVG SQR ROOT dP	: 0.91	0.500	0.49	1.400	1.38
MINIMUM PITOT dP	: 0.20	0.550	0.54	1.450	1.43
dP INCREMENT	: 0.050	0.600	0.59	1.500	1.48
		0.650	0.64	1.550	1.53
STACK GAS TEMP, F	: 240	0.700	0.69	1.600	1.58
GAS METER TEMP, F	: 76	0.750	0.74	1.650	1.63
		0.800	0.79	1.700	1.68
PITOT CONSTANT	: 0.87	0.850	0.84	1.750	1.72
ORIFICE CONSTANT	: 1.90	0.900	0.89	1.800	1.77
		0.950	0.94	1.850	1.82
NOZZLE DIA, in	: 0.188	1.000	0.99	1.900	1.87
SYSTEM FLOW, acfm	: 0.720	1.050	1.03	1.950	1.92
FLOW, scfm	: 0.50663		No Points	48	192
Target Volume, dscf:	87.5		Dwell Time	4	
Time Required, min.:	173		2.78 m <sup>3</sup> in	192 minutes	

4/26/01

COMPAC OUTLET



Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	14-2	28	-5.0	262	.70	.69	378.01	248	239	-	48	68	66	6.5/12.5
	14-1	32	-5.0	266	.65	.64	379.48	249	241	-	48	68	66	6.1/13
							381.361							
1135	15-1	36	-5.0	261	.55	.54	381.536	250	259	-	49	68	67	6.8/13
	15-2	40	-5.0	265	.70	.69	383.17	244	254	-	49	68	67	6.2/13
	15-3	44	-5.0	253	.60	.59	384.88	244	253	-	51	71	67	6.6/13
							386.779							
1148	9-1	48	-5.0	252	.75	.74	386.871	252	259	-	51	71	68	6.4/13
	9-2	52	-5.0	267	.70	.69	388.76	249	264	-	51	71	68	6.0/13.5
	9-3	56	-5.0	265	.60	.59	390.49	246	241	-	51	71	68	5.8/13.5
1200	9-3	60	-5.0	265	.60	.59	392.20	248	242	-	51	71	68	6.2
	9-2	64	-5.0	267	.55	.54	393.93	242	247	-	52	72	68	5.7/14
	9-1	68	-5.0	256	.75	.74	395.57	242	267	-	52	72	68	6.1/13
							397.425							
1215	12-1	72	-5.0	266	.45	.44	398.95	250	260	-	53	74	69	6.7/12
	12-2	76	-5.0	270	.80	.79	399.74	244	260	-	52	74	69	6.2/13
	12-3	80	-5.0	270	.80	.89	401.67	249	257	-	52	74	69	6.1
1228	12-3	84	-5.0	269	.90	.89	403.61	245	267	-	52	74	64	6.2
	12-2	88	-5.0	267	.80	.79	405.81	248	251	-	52	74	69	6.4/13
	12-1	92	-5.0	268	.45	.44	407.71	246	262	-	52	74	69	6.5
							409.075							
1241	5-1	96	-5.0	274	.90	.89	409.169	246	251	-	54	73	70	

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1255	5-2	100	-5.0	228	1.0	.99	411.11	248	253	-	52	73	71	7.6
	5-3	104	-5.0	225	.80	.79	412.99	247	253	-	52	72	71	7.4
							415.181							
1255	8-1	108	-5.0	249	.60	.59	415.651	243	248	-	53	72	77	7.4
	8-2	112	-5.0	252	.75	.74	417.22	249	265	-	53	72	77	7.6/11
	8-3	116	-5.0	246	.95	.94	419.12	244	247	-	53	72	77	7.0
							421.291							
1309	7-1	120	-5.0	249	.85	.84	421.247	243	249	-	53	73	70	6.4
	7-2	124	-5.0	247	1.0	.99	422.99	243	242	-	53	73	71	6.6
	7-3	128	-5.0	252	.80	.79	425.17	250	265	-	53	72	71	6.7/10.5
							427.164							
1321	3-1	132	-5.0	238	.85	.84	427.645	245	248	-	53	71	71	8.1
	3-2	136	-5.0	230	.70	.69	429.49	251	258	-	54	72	71	7.9/11
	3-3	140	-5.0	219	.90	.89	431.44	249	241	-	53	72	71	8.8
1334	3-3	144	-5.0	222	.40	.39	433.39	251	244	-	53	72	71	8.6
	3-2	148	-5.0	234	.70	.69	435.06	250	249	-	53	72	71	7.9
	3-1	152	-5.0	240	.85	.84	436.36	248	255	-	54	72	71	8.0
							437.609							
1347	6-1	156	-5.0	247	.90	.89	437.861	250	257	-	53	72	71	7.2
	6-2	160	-5.0	246	.85	.84	440.00	248	261	-	53	72	71	7.6
	6-3	164	-5.0	242	.85	.84	441.88	247	246	-	53	72	71	6.8/12
							443.780							
1400	1-1	168	-5.0	238	.95	.94	444.255	242	251	-	54	72	71	



COHPAC OUTLET 4/25/01

MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITCT	dp ORI	
GAS ANALYSIS - O2	:	8.0	0.200	0.19	1.100	1.04
CO2	:	11.0	0.250	0.24	1.150	1.09
H2O	:	8.0	0.300	0.28	1.200	1.14
AVG dP	:	0.8354	0.350	0.33	1.250	1.18
AMB PRESS, in Hg	:	30.27	0.400	0.38	1.300	1.23
STACK dP, in H2O	:	-19.0	0.450	0.43	1.350	1.28
AVG SQR ROOT dP	:	0.91	0.500	0.47	1.400	1.33
MINIMUM PITOT dP	:	0.20	0.550	0.52	1.450	1.37
dP INCREMENT	:	0.050	0.600	0.57	1.500	1.42
			0.650	0.62	1.550	1.47
STACK GAS TEMP, F	:	260	0.700	0.66	1.600	1.52
GAS METER TEMP, F	:	70	0.750	0.71	1.650	1.56
			0.800	0.76	1.700	1.61
PITOT CONSTANT	:	0.87	0.850	0.81	1.750	1.66
ORIFICE CONSTANT	:	1.90	0.900	0.85	1.800	1.71
			0.950	0.90	1.850	1.75
NOZZLE DIA, in	:	0.188	1.000	0.95	1.900	1.80
SYSTEM FLOW, acfm	:	0.731	1.050	0.99	1.950	1.85
FLOW, scfm	:	0.49908		No Points	48	192
Target Volume, dscf:		87.5		Dwell Time	4	
Time Required, min.:		175		2.74 m <sup>3</sup> in	192 minutes	

MASS TRAIN OPERATION			dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2	:	7.0	0.020	0.03	0.440	0.74
CO2	:	12.0	0.040	0.07	0.480	0.81
H2O	:	8.0	0.060	0.10	0.520	0.88
AVG dP	:	0.4761	0.080	0.13	0.560	0.94
AMB PRESS, in Hg	:	30.33	0.100	0.17	0.600	1.01
STACK dP, in H2O	:	-12.5	0.120	0.20	0.640	1.08
AVG SQR ROOT dP	:	0.69	0.140	0.24	0.680	1.15
MINIMUM PITOT dP	:	0.02	0.160	0.27	0.720	1.21
dP INCREMENT	:	0.020	0.180	0.30	0.760	1.28
			0.200	0.34	0.800	1.35
STACK GAS TEMP, F	:	250	0.220	0.37	0.840	1.41
GAS METER TEMP, F	:	75	0.240	0.40	0.880	1.48
			0.260	0.44	0.920	1.55
PITOT CONSTANT	:	0.83	0.280	0.47	0.960	1.62
ORIFICE CONSTANT	:	1.86	0.300	0.51	1.000	1.68
			0.320	0.54	1.040	1.75
NOZZLE DIA, in	:	0.222	0.340	0.57	1.080	1.82
SYSTEM FLOW, acfm	:	0.716	0.360	0.61	1.120	1.89
			0.380	0.64	1.160	1.95
			0.400	0.67	1.200	2.02
FLOW, scfm	:	0.4965		No Points	30	120
Target Volume, dscf:		52.5		Dwell Time	4	
Time Required, min.:		106		1.70 m <sup>3</sup> in	120 minutes	

4/26/01 COHPAC INLET

CO<sub>2</sub> 13% O<sub>2</sub> 5.8% O<sub>2</sub> (port)

METHOD 5 FIELD DATA

Plant/Location Gasby Unit 3 COMPACT Inlet B Filter #1: ID RF19  
 Operators SSO/ESB/DEO Pitot Coefficient, Cp 0.83 Leak Rate, cfm, Pretest 0.00@10"  
 Date 4/26/01 Nozzle ID T12a Leak Rate, cfm, Posttest 0.00@9"  
 Test No./Run No. ADA-2-CI4 Nozzle Diameter, inches 30.30.2217 Filter #2: ID (if used) \_\_\_\_\_  
 Meter Box ID MUTECHS Barometric Pressure, in. Hg. 30.33 Leak Rate, cfm, Pretest \_\_\_\_\_  
 Gas Meter Cal. Factor \_\_\_\_\_ Ambient Temp., Deg. F. \_\_\_\_\_ Leak Rate, cfm, Posttest \_\_\_\_\_  
 Assumed Moisture, % 8 Duct/Stack Pressure Diff., in. H<sub>2</sub>O -12.2  
 Orifice ID MUTECHS Orifice DH@ 1-86

GAS METER START, cf: 525.600 GAS METER END, cf: \_\_\_\_\_  
 START TIME 1155 END TIME 1410

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H <sub>2</sub> O	Orifice DH in. H <sub>2</sub> O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
11/55	6/1	0	3.8	215	0.34	0.57	525.660	232	242	7	42	69	66	9.3
	6/2	4	4.2	230	0.45	0.76	527.4	270	248		40	70	67	8.2
	6/3	8	4.3	240	0.58	0.97	529.4	258	240		38	73	68	7.6
	6/4	12	4.5	233	0.61	1.03	531.2	256	243		38	75	68	7.6
	6/5	16	4.4	157	0.56	0.94	533.6	255	243		38	76	69	7.6
	END	20					535.512							
	NET 6						<u>9.852</u>							
	5/1	20	3.7	238	0.20	0.34	535.590	235	244		40	75	70	8.4
	5/2	24	4.0	258	0.33	0.56	536.9	256	243		41	75	70	6.6

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
	120	4.6	245	0.5011	0.6	49.82						
											72.6	6.8/12

96ms

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	5/3	28	4.2	256	0.47	0.79	538.4	261	243		40	75	69	6.2
	5/4	32	4.5	247	0.50	0.85	540.2	240	242		39	75	70	6.3
	5/5	36	4.4	154	0.44	0.74	542.2	246	243		39	76	71	6.8
	END	40					544.70							
	NET 5						8.580							
	4/1	40	3.2	230	0.08	0.13	544.267	229	245		44	74	70	8.3
	4/2	44	3.7	251	0.16	0.27	545.3	255	242		44	74	70	6.8
1253	4/3	48	4.0	258	0.35	0.59	546.5	257	243		42	74	70	6.6
	4/4	52	4.2	248	0.44	0.74	548.1	245	243		40	74	70	5.8
	4/5	56	4.5	117	0.44	0.74	549.9	240	241		40	75	71	6.2
	4/1	60	3.5	222	0.08	0.13	551.7	228	242		41	75	73	6.6
	4/2	64	3.8	253	0.16	0.27	552.7	251	242		43	74	70	6.8
	4/3	68	4.3	261	0.35	0.59	553.9	257	244		42	74	71	7.0
	4/4	72	4.6	260	0.48	0.81	555.4	256	241		41	75	71	6.2
	4/5	76	4.2	184	0.46	0.77	—	271	242		41	75	71	6.2
	END	80					559.200							
	NET 4						14.933							
	2/1	80	4.0	256	0.28	0.47	559.360	243	239		44	74	71	7.2
	2/2	84	4.0	274	0.33	0.56	—	270	244		42	75	71	6.2
	2/3	88	4.2	274	0.36	0.61	562.5	240	243		42	76	71	6.2
	2/4	92	4.2	271	0.38	0.64	564.1	234	242		41	76	71	5.8
	2/5	96	4.2	225	0.40	0.67	565.9	232	242		41	76	71	6.4



MASS TRAIN OPERATION

		dp PITOT	dP ORI	dp PITOT	dP ORI
GAS ANALYSIS - O2 :	7.0	0.020	0.03	0.440	0.73
CO2 :	12.0	0.040	0.07	0.480	0.80
H2O :	8.0	0.060	0.10	0.520	0.87
AVG dP :	0.4761	0.080	0.13	0.560	0.93
AMB PRESS, in Hg :	30.27	0.100	0.17	0.600	1.00
STACK dP, in H2O :	-12.5	0.120	0.20	0.640	1.07
AVG SQR ROOT dP :	0.69	0.140	0.23	0.680	1.13
MINIMUM PITOT dP :	0.02	0.160	0.27	0.720	1.20
dP INCREMENT :	0.020	0.180	0.30	0.760	1.27
		0.200	0.33	0.800	1.33
STACK GAS TEMP, F :	250	0.220	0.37	0.840	1.40
GAS METER TEMP, F :	70	0.240	0.40	0.880	1.47
		0.260	0.43	0.920	1.53
PITOT CONSTANT :	0.83	0.280	0.47	0.960	1.60
ORIFICE CONSTANT :	1.86	0.300	0.50	1.000	1.67
		0.320	0.53	1.040	1.73
NOZZLE DIA, in :	0.222	0.340	0.57	1.080	1.80
SYSTEM FLOW, acfm :	0.717	0.360	0.60	1.120	1.87
		0.380	0.63	1.160	1.93
		0.400	0.67	1.200	2.00
FLOW, scfm :	0.49603		No Points	30	120
Target Volume, dscf:	52.5		Dwell Time	4	
Time Required, min.:	106		1.70 m^3 in	120 minutes	

12% CO<sub>2</sub> @ 7.0% O<sub>2</sub>, Part 4/4

METHOD 5 FIELD DATA

Plant/Location Gaston Unit 3 COH PAC INLET B Pitot Coefficient, Cp 0.83 Filter #1: ID 0  
 Operators SSO/GBE/DLO Nozzle ID T12a Leak Rate, cfm, Pretest 0.00 @ 10"  
 Date 4/25/01 Nozzle Diameter, inches 0.2217 Leak Rate, cfm, Posttest 0.00 @ 10"  
 Test No./Run No. ADA-2 - C13 Barometric Pressure, in. Hg. 30.27 Filter #2: ID (if used) \_\_\_\_\_  
 Meter Box ID NUTECH 5 Ambient Temp., Deg. F. ~72°F Leak Rate, cfm, Pretest \_\_\_\_\_  
 Gas Meter Cal. Factor \_\_\_\_\_ Assumed Moisture, % 7 Leak Rate, cfm, Posttest \_\_\_\_\_  
 Orifice ID NUTECH 5 Orifice DH@ +90 1.86 psi Duct/Stack Pressure Diff., in. H<sub>2</sub>O -12.5 H<sub>2</sub>O

GAS METER START, cf. 474.40 GAS METER END, cf. \_\_\_\_\_  
 START TIME 1357 END TIME \_\_\_\_\_

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H <sub>2</sub> O	Orifice DH in. H <sub>2</sub> O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1357	2/1	0	3.8	220	0.28	0.47	474.40	231	235	~	48	67	67	7.2
	2/2	4	3.8	271	0.32	0.53	479.95	251	245	~	44	68	67	6.9
	2/3	8	4.0	275	0.38	0.63	477.5	258	240	~	43	69	67	6.8
	2/4	12	4.2	277	0.44	0.73	479.15	253	242	~	42	71	68	6.4
	2/5	16	4.2	202	0.47	0.78	481.0	252	241	~	42	74	69	6.8
	2/1	20	3.8	224	0.28	0.47	463.1	265	241	~	41	74	69	7.0
	2/2	24	4.0	276	0.32	0.53	484.5	280	244	~	42	74	69	7.0
	2/3	28	4.2	278	0.37	0.61	486.0	238	242	~	42	75	70	6.6
	2/4	32	4.0	279	0.41	0.69	487.7	234	244	~	42	76	70	6.6

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Total	Avg.	Max.	Avg.
	1200		253	0.604	50.569	0.60		7.4/W <sub>2</sub>

77.1 ML

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	2/5	36	4.3	213	0.47	0.78	489.4	234	243		42	77	71	6.8
	END	40					491.705							
	NET 2						16.895							
	4/1	40	3.2	220	0.10	0.17	491.41	238	244		45	75	71	8.3
	4/2	44	3.5	254	0.17	0.29	492.7	264	243		45	76	74	7.8
	4/3	48	3.8	263	0.35	0.58	493.8	256	244		44	75	72	7.6
	4/4	52	4.0	260	0.46	0.76	495.4	254	242		43	77	73	7.0
	4/5	56	4.2	153	0.48	0.80	497.2	259	243		43	77	72	7.3
1504	4/1	60	3.2	218	0.10	0.17	499.1	243	241		44	76	72	7.2
	4/2	64	3.5	260	0.19	0.31	500.1	246	244		45	77	73	7.8
	4/3	68	4.0	266	0.36	0.60	501.3	233	241		45	77	73	7.2
	4/4	72	4.5	266	0.50	0.83	503.0	236	241		44	78	73	6.9
	4/5	76	4.2	191	0.40	0.67	504.9	254	246		43	78	74	8.2
	END	80					506.220							
	NET 4						15.310							
1524	5/1	80	3.5	250	0.20	0.33	506.800	293	242		47	77	74	7.8
	5/2	84	3.8	264	0.32	0.53	508.1	269	241		45	77	74	7.3
	5/3	88	4.2	265	0.46	0.77	509.6	243	242		44	78	74	7.2
	5/4	92	4.3	263	0.52	0.87	511.5	238	241		43	79	74	7.3
	5/5	96	4.3	220	0.51	0.85	513.4	236	240		43	79	74	7.4
	END	100					515.415							
	NET 5						8.615							



12%  $\text{CO}_2$  @ 1%  $\text{O}_2$ , Point 5/12

Test No. 2 Run No. 1 Page 1 of 1

METHOD 5 FIELD DATA

Filter #1: ID RF13  
Leak Rate, cfm, Pretest 0.008/0.1  
Leak Rate, cfm, Posttest 0.008/0.15

Pitot Coefficient, Cp 0.83  
Nozzle ID 7120  
Nozzle Diameter, inches 0.2217  
Barometric Pressure, in. Hg. 30.21  
Ambient Temp., Deg. F. 7  
Assumed Moisture, % 7  
Orifice DH@ 1-86

Plant/Location Waste Unit 3 COMPAC  
Operators SSO/GBR/DLD  
Date 4/24/01  
Test No./Run No. ADA-2-CI2  
Meter Box ID NUTEK B5  
Gas Meter Cal. Factor AHC = 1.06  
Orifice ID AHC = 1.06

GAS METER START, cf. 1420 END TIME 1643

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
1420	6/1	0	3.8	270	0.42	0.70	418.170	222	240	7	57	70	69	9.1
	6/2	4	4.2	237	0.50	0.82	420.0	259	260		54	71	69	8.7
	6/3	8	4.5	242	0.58	0.96	422.0	261	253		52	73	69	8.0
	6/4	12	4.5	241	0.64	1.06	444.1	239	247		50	74	69	7.7
	6/5	16	4.5	182	0.58	0.95	426.2	251	244		49	74	69	8.4
	END	20					428.212							
	NET 6						10.042							
	5/1	20	3.7	243	0.24	0.40	428.32	260	244		51	71	68	8.0

Post-test Summary	Total	Max.	Avg.	Avg. sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.	Avg.
	120		242	0.625	0.70	52.12							7.3/11.7

91.7 MW

\* Had to man downout ~1-2" BEYOND OUTERMO. TRAVERSE POINT TO CLEAR BEAM. INLEAKAGE COOLING TC, BUT NOT BEING SAMPLED (SEE OZ)

Clock Time	Traverse Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe Temp. deg. F	Filter Temp. deg. F	Sorb. Temp. deg. F	Imp. Outlet Temp	DGM Inlet deg. F	DGM Outlet deg. F	O <sub>2</sub> /CO <sub>2</sub> %
	5/2	24	4.0	259	0.36	0.60	430.0	273	246		49	71	68	7.0
	5/3	28	4.5	259	0.52	0.86	431.65	252	242		47	71	68	6.7
	5/4	32	4.5	258	0.55	0.91	433.6	231	249		46	72	68	7.0
	5/5	36	4.5	202	0.55	0.91	435.6	235	232		46	73	69	7.4
	5/1	40	3.8	273	0.22	0.36	437.7	237	230		47	72	68	7.1
	5/2	44	4.2	260	0.36	0.60	439.1	240	251		47	71	68	7.0
	5/3	48	4.5	261	0.52	0.86	440.6	234	239		47	72	68	6.6
	5/4	52	4.6	252	0.53	0.88	442.9	243	247		46	72	68	7.2
	5/5	56	4.6	199	0.53	0.88	444.6	234	246		46	73	68	7.5
	END	60					446.560							
	NETS						18.290							
1537	4/1	60	3.2	215	0.10	0.17	446.63	251	245		48	68	67	7.7
	4/2	64	3.4	257	0.19	0.32	448.3	242	242		48	68	67	7.4
	4/3	68	4.0	259	0.35	0.58	449.5	231	245		46	68	67	7.0
	4/4	72	4.4	238	0.47	0.77	451.0	230	241		45	69	67	6.5
	4/5	76	4.5	112	0.49	0.81	452.8	231	243		44	69	67	7.0
	4/1	80	3.4	226	0.10	0.17	454.7	240	242		45	69	66	6.9
	4/2	84	3.7	251	0.17	0.27	455.7	260	244		46	68	66	7.7
	4/3	88	4.2	261	0.36	0.60	—	232	242		45	68	66	7.6
	4/4	92	4.5	241	0.50	0.82	458.5	257	243		44	68	66	6.9
	4/5	96	4.5	110	0.46	0.76	460.5	248	243		44	69	66	6.8
	END	100					462.085							

NET 4

15.455



MASS TRAIN OPERATION		dp PITOT	dp ORI	dp PITOT	dp ORI
GAS ANALYSIS - O2 :	8.0	0.020	0.03	0.440	0.73
CO2 :	12.5	0.040	0.07	0.480	0.79
H2O :	8.0	0.060	0.10	0.520	0.86
AVG dP :	0.4761	0.080	0.13	0.560	0.93
AMB PRESS, in Hg :	30.30	0.100	0.17	0.600	0.99
STACK dP, in H2O :	-13.5	0.120	0.20	0.640	1.06
AVG SQR ROOT dP :	0.69	0.140	0.23	0.680	1.13
MINIMUM PITOT dP :	0.02	0.160	0.26	0.720	1.19
dP INCREMENT :	0.020	0.180	0.30	0.760	1.26
		0.200	0.33	0.800	1.32
STACK GAS TEMP, F :	240	0.220	0.36	0.840	1.39
GAS METER TEMP, F :	60	0.240	0.40	0.880	1.46
		0.260	0.43	0.920	1.52
PITOT CONSTANT :	0.83	0.280	0.46	0.960	1.59
ORIFICE CONSTANT :	1.86	0.300	0.50	1.000	1.66
		0.320	0.53	1.040	1.72
NOZZLE DIA, in :	0.222	0.340	0.56	1.080	1.79
SYSTEM FLOW, acfm :	0.711	0.360	0.60	1.120	1.85
		0.380	0.63	1.160	1.92
		0.400	0.66	1.200	1.99
FLOW, scfm :	0.49948		No Points	30	120
Target Volume, dscf:	52.5		Dwell Time	4	
Time Required, min.:	105		1.71 m <sup>3</sup> in	120 minutes	

Nozzle T12a 0.2217 inch  
4min/point

RUN IDENTIFICATION: Hg-E2-2  
 RUN DATE : 4/24/01  
 GAS ANALYSIS - O2 : 4.0  
 (Dry Basis) - CO2: 15.3  
 Setup value - H2O: 7  
 AMB PRESS, in Hg : 30.21  
 STACK dP, in H2O : -5.5  
 NOZZLE DIA, in : 0.189  
 PITOT CONSTANT : 0.84  
 GAS METER CALIB : 0.982  
 DUCT AREA, ft2 : 150  
  
 H2O COLLECTED, ml : 90.7  
 PARTICLE MASS, mg : 1.40E-02  
 TIME SAMPLED, min : 160  
 GAS METER VOL, ft3: 62.097  
 AVG SQRT PITOT dp : 0.896  
 AVG ORI dP, in H2O: 0.460  
 AVG STACK TEMP, F : 666  
 GAS METER TEMP, F : 89

REDUCED MASS TRAIN DATA

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ISOKINETIC AGREEMENT, %: 100.4  
 CALCULATED % H2O : 6.7  
 AVG GAS VELOCITY, ft/s : 72.5  
 AVG GAS TEMPERATURE, F : 666  
 GAS VOLUME FLOW, acfm : 652,377  
 dscfm : 284,241  
 wscfm : 304,740  
 Dry Gas lb/hr: 1352341  
 Moisture lb/hr: 57352  
 Total lb/hr: 1409694  
 MASS LOADING, gr/acf : 1.58E-06  
 gr/dscf : 3.63E-06  
 mg/acm : 3.63E-03  
 mg/dscm : 8.33E-03  
 gr/dscf @7% O2 : 2.99E-06  
 gr/dscf @12% CO2 : 2.85E-06  
  
 EMISSION RATE, lb/hr : 8.85E-03  
 EMISSION RATE, #/E6-Btu: 6.30E-06

RUN IDENTIFICATION: Hg-E2-3  
 RUN DATE : 4/25/01  
 GAS ANALYSIS - O2 : 3.7  
 (Dry Basis) - CO2: 15.4  
 Setup value - H2O: 7  
 AMB PRESS, in Hg : 30.27  
 STACK dP, in H2O : -5.5  
 NOZZLE DIA, in : 0.189  
 PITOT CONSTANT : 0.84  
 GAS METER CALIB : 0.982  
 DUCT AREA, ft2 : 150  
  
 H2O COLLECTED, ml : 89.1  
 PARTICLE MASS, mg : 1.71E-02  
 TIME SAMPLED, min : 160  
 GAS METER VOL, ft3: 62.480  
 AVG SQRT PITOT dp : 0.860  
 AVG ORI dP, in H2O: 0.440  
 AVG STACK TEMP, F : 669  
 GAS METER TEMP, F : 92

REDUCED MASS TRAIN DATA

-----  
 ISOKINETIC AGREEMENT, %: 104.7  
 CALCULATED % H2O : 6.6  
 AVG GAS VELOCITY, ft/s : 69.6  
 AVG GAS TEMPERATURE, F : 669  
 GAS VOLUME FLOW, acfm : 626,170  
 dscfm : 272,998  
 wscfm : 292,308  
 Dry Gas lb/hr: 1299016  
 Moisture lb/hr: 54029  
 Total lb/hr: 1353044  
 MASS LOADING, gr/acf : 1.94E-06  
 gr/dscf : 4.44E-06  
 mg/acm : 4.44E-03  
 mg/dscm : 1.02E-02  
 gr/dscf @7% O2 : 3.59E-06  
 gr/dscf @12% CO2 : 3.46E-06  
  
 EMISSION RATE, lb/hr : 1.04E-02  
 EMISSION RATE, #/E6-Btu: 7.57E-06

RUN IDENTIFICATION:	Hg-E2-4	REDUCED MASS TRAIN DATA	
RUN DATE	: 4/26/01	-----	
GAS ANALYSIS - O2 :	3.4	ISOKINETIC AGREEMENT, %:	104.5
(Dry Basis) - CO2:	14.8		
Setup value - H2O:	7	CALCULATED % H2O :	7.0
AMB PRESS, in Hg :	30.27	AVG GAS VELOCITY, ft/s :	71.3
STACK dP, in H2O :	-5.5	AVG GAS TEMPERATURE, F :	656
NOZZLE DIA, in :	0.189	GAS VOLUME FLOW, acfm :	642,092
PITOT CONSTANT :	0.84	dscfm :	282,255
GAS METER CALIB :	0.982	wscfm :	303,341
DUCT AREA, ft2 :	150	Dry Gas lb/hr:	1338326
		Moisture lb/hr:	58997
H2O COLLECTED, ml :	97.1	Total lb/hr:	1397323
PARTICLE MASS, mg :	1.49E-02	MASS LOADING, gr/acf :	1.64E-06
TIME SAMPLED, min :	160	gr/dscf :	3.74E-06
GAS METER VOL, ft3:	63.857	mg/acm :	3.77E-03
AVG SQRT PITOT dp :	0.885	mg/dscm :	8.57E-03
AVG ORI dP, in H2O:	0.480	gr/dscf @7% O2 :	2.97E-06
AVG STACK TEMP, F :	656	gr/dscf @12% CO2 :	3.03E-06
GAS METER TEMP, F :	87		
		EMISSION RATE, lb/hr :	9.05E-03

RUN IDENTIFICATION: Hg-I2-2  
 RUN DATE : 4/24/01  
 GAS ANALYSIS - O2 : 7.3  
 (Dry Basis) - CO2: 11.7  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.21  
 STACK dP, in H2O : -12.5  
 NOZZLE DIA, in : 0.222  
 PITOT CONSTANT : 0.80  
 GAS METER CALIB : 0.988  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 91.7  
 PARTICLE MASS, mg : 1.41E-02  
 TIME SAMPLED, min : 120  
 GAS METER VOL, ft3: 52.172  
 AVG SQRT PITOT dp : 0.625  
 AVG ORI dP, in H2O: 0.700  
 AVG STACK TEMP, F : 242  
 GAS METER TEMP, F : 69

REDUCED MASS TRAIN DATA

-----

ISOKINETIC AGREEMENT, %: 102.6  
 CALCULATED % H2O : 7.7  
 AVG GAS VELOCITY, ft/s : 38.7  
 AVG GAS TEMPERATURE, F : 242  
 GAS VOLUME FLOW, acfm : 438,317  
 dscfm : 297,975  
 wscfm : 322,741  
 Dry Gas lb/hr: 1397116  
 Moisture lb/hr: 69294  
 Total lb/hr: 1466410  
 MASS LOADING, gr/acf : 2.83E-06  
 gr/dscf : 4.16E-06  
 mg/acm : 6.48E-03  
 mg/dscm : 9.54E-03  
 gr/dscf @7% O2 : 4.25E-06  
 gr/dscf @12% CO2 : 4.27E-06  
  
 EMISSION RATE, lb/hr : 1.06E-02

RUN IDENTIFICATION: Hg-12-3  
 RUN DATE : 4/25/01  
 GAS ANALYSIS - O2 : 7.4  
 (Dry Basis) - CO2: 11.6  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.27  
 STACK dP, in H2O : -12.5  
 NOZZLE DIA, in : 0.222  
 PITOT CONSTANT : 0.80  
 GAS METER CALIB : 0.988  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 77.1  
 PARTICLE MASS, mg : 1.23E-02  
 TIME SAMPLED, min : 120  
 GAS METER VOL, ft3: 50.564  
 AVG SQRT PITOT dp : 0.604  
 AVG ORI dP, in H2O: 0.600  
 AVG STACK TEMP, F : 253  
 GAS METER TEMP, F : 74

REDUCED MASS TRAIN DATA

-----

ISOKINETIC AGREEMENT, %:	102.0
CALCULATED % H2O :	6.8
AVG GAS VELOCITY, ft/s :	37.5
AVG GAS TEMPERATURE, F :	253
GAS VOLUME FLOW, acfm :	425,743
dscfm :	288,329
wscfm :	309,279
Dry Gas lb/hr:	1351353
Moisture lb/hr:	58616
Total lb/hr:	1409969
MASS LOADING, gr/acf :	2.56E-06
gr/dscf :	3.78E-06
mg/acm :	5.87E-03
mg/dscm :	8.67E-03
gr/dscf @7% O2 :	3.89E-06
gr/dscf @12% CO2 :	3.91E-06
EMISSION RATE, lb/hr :	9.34E-03

RUN IDENTIFICATION: Hg-12-4  
 RUN DATE : 4/26/01  
 GAS ANALYSIS - O2 : 6.8  
 (Dry Basis) - CO2: 12.0  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.33  
 STACK dP, in H2O : -12.2  
 NOZZLE DIA, in : 0.222  
 PITOT CONSTANT : 0.80  
 GAS METER CALIB : 0.988  
 DUCT AREA, ft2 : 189  
  
 H2O COLLECTED, ml : 96.0  
 PARTICLE MASS, mg : 1.80E-02  
 TIME SAMPLED, min : 120  
 GAS METER VOL, ft3: 49.820  
 AVG SQRT PITOT dp : 0.591  
 AVG ORI dP, in H2O: 0.600  
 AVG STACK TEMP, F : 245  
 GAS METER TEMP, F : 73

REDUCED MASS TRAIN DATA

-----

ISOKINETIC AGREEMENT, %: 104.0  
 CALCULATED % H2O : 8.4  
 AVG GAS VELOCITY, ft/s : 36.6  
 AVG GAS TEMPERATURE, F : 245  
 GAS VOLUME FLOW, acfm : 414,775  
 dscfm : 279,995  
 wscfm : 305,582  
 Dry Gas lb/hr: 1314035  
 Moisture lb/hr: 71590  
 Total lb/hr: 1385625  
 MASS LOADING, gr/acf : 3.78E-06  
 gr/dscf : 5.60E-06  
 mg/acm : 8.67E-03  
 mg/dscm : 1.28E-02  
 gr/dscf @7% O2 : 5.52E-06  
 gr/dscf @12% CO2 : 5.60E-06  
  
 EMISSION RATE, lb/hr : 1.34E-02  
 EMISSION RATE, #/E6-Btu: 1.16E-05

RUN IDENTIFICATION:	Hg-O2-2	REDUCED MASS TRAIN DATA	
RUN DATE	: 4/24/01	-----	
GAS ANALYSIS - O2 :	7.6	ISOKINETIC AGREEMENT, %:	105.4
(Dry Basis) - CO2:	11.8		
Setup value - H2O:	7.3	CALCULATED % H2O :	7.5
AMB PRESS, in Hg :	30.21	AVG GAS VELOCITY, ft/s :	59.0
STACK dP, in H2O :	-19.0	AVG GAS TEMPERATURE, F :	256
NOZZLE DIA, in :	0.189	GAS VOLUME FLOW, acfm :	475,099
PITOT CONSTANT :	0.87	dscfm :	312,087
GAS METER CALIB :	1.013	wscfm :	337,388
DUCT AREA, ft2 :	134.24	Dry Gas lb/hr:	1464642
		Moisture lb/hr:	70791
H2O COLLECTED, ml :	157.6	Total lb/hr:	1535432
PARTICLE MASS, mg :	2.72E-03	MASS LOADING, gr/acf :	3.00E-07
TIME SAMPLED, min :	192	gr/dscf :	4.57E-07
GAS METER VOL, ft3:	90.191	mg/acm :	6.88E-04
AVG SQRT PITOT dp :	0.857	mg/dscm :	1.05E-03
AVG ORI dP, in H2O:	0.710	gr/dscf @7% O2 :	4.78E-07
AVG STACK TEMP, F :	256	gr/dscf @12% CO2 :	4.65E-07
GAS METER TEMP, F :	72		
		EMISSION RATE, lb/hr :	1.22E-03
		EMISSION RATE, #/E6-Btu:	1.01E-06
FEED RATE, lb/hr :	#N/A	DRE, percent :	#N/A
			(maximum)

RUN IDENTIFICATION: Hg-02-3  
 RUN DATE : 4/25/01  
 GAS ANALYSIS - O2 : 7.4  
 (Dry Basis) - CO2: 11.7  
 Setup value - H2O: 7.3  
 AMB PRESS, in Hg : 30.27  
 STACK dP, in H2O : -18.5  
 NOZZLE DIA, in : 0.189  
 PITOT CONSTANT : 0.87  
 GAS METER CALIB : 1.013  
 DUCT AREA, ft2 : 134.24  
  
 H2O COLLECTED, ml : 120.6  
 PARTICLE MASS, mg : 2.61E-03  
 TIME SAMPLED, min : 192  
 GAS METER VOL, ft3: 88.036  
 AVG SQRT PITOT dp : 0.870  
 AVG ORI dP, in H2O: 0.730  
 AVG STACK TEMP, F : 253  
 GAS METER TEMP, F : 76

REDUCED MASS TRAIN DATA

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ISOKINETIC AGREEMENT, %: 99.1  
 CALCULATED % H2O : 6.0  
 AVG GAS VELOCITY, ft/s : 59.5  
 AVG GAS TEMPERATURE, F : 253  
 GAS VOLUME FLOW, acfm : 479,185  
 dscfm : 322,275  
 wscfm : 342,869  
 Dry Gas lb/hr: 1511251  
 Moisture lb/hr: 57622  
 Total lb/hr: 1568874  
 MASS LOADING, gr/acf : 3.04E-07  
 gr/dscf : 4.52E-07  
 mg/acm : 6.97E-04  
 mg/dscm : 1.04E-03  
 gr/dscf @7% O2 : 4.65E-07  
 gr/dscf @12% CO2 : 4.63E-07  
  
 EMISSION RATE, lb/hr : 1.25E-03

RUN IDENTIFICATION: Hg-O2-4  
 RUN DATE : 4/26/01  
 GAS ANALYSIS - O2 : 6.9  
 (Dry Basis) - CO2: 12.3  
 Setup value - H2O: 8  
 AMB PRESS, in Hg : 30.33  
 STACK dP, in H2O : -18.5  
 NOZZLE DIA, in : 0.189  
 PITOT CONSTANT : 0.87  
 GAS METER CALIB : 1.013  
 DUCT AREA, ft2 : 134.24  
  
 H2O COLLECTED, ml : 140.8  
 PARTICLE MASS, mg : 2.37E-03  
 TIME SAMPLED, min : 192  
 GAS METER VOL, ft3: 88.163  
 AVG SQRT PITOT dp : 0.860  
 AVG ORI dP, in H2O: 0.740  
 AVG STACK TEMP, F : 251  
 GAS METER TEMP, F : 70

REDUCED MASS TRAIN DATA

-----

ISOKINETIC AGREEMENT, %:	102.4
CALCULATED % H2O :	6.8
AVG GAS VELOCITY, ft/s :	58.7
AVG GAS TEMPERATURE, F :	251
GAS VOLUME FLOW, acfm :	472,777
dscfm :	316,659
wscfm :	339,939
Dry Gas lb/hr:	1488658
Moisture lb/hr:	65137
Total lb/hr:	1553795
MASS LOADING, gr/acf :	2.71E-07
gr/dscf :	4.04E-07
mg/acm :	6.21E-04
mg/dscm :	9.27E-04
gr/dscf @7% O2 :	4.01E-07
gr/dscf @12% CO2 :	3.94E-07
EMISSION RATE, lb/hr :	1.10E-03

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 07/23/01

Location: ESP Inlet

Test No.: -ADA-2-EI1

	APPROXIMATE VOLUME	SAMPLE NO.
Filter No. 1 ID: <u>01</u>		<del>1Hg</del> <u>ADA-2-EI1-1</u> ✓
Filter No. 2 ID: <u>QF9</u>		<del>1Hg</del> <u>ADA-2-EI1-2</u> ✓
Front Wash (Acetone) _____	<del>100 ml</del> <sup>~30 ml</sup>	<del>1Hg</del> <u>ADA-2-EI1-3</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml ✓	<del>1Hg</del> <u>ADA-2-EI1-4</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	~600 mL	<del>1Hg</del> <u>ADA-2-EI1-5</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	~150 mL	<del>1Hg</del> <u>ADA-2-EI1-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	~510 mL	<del>1Hg</del> <u>ADA-2-EI1-7</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		<del>1Hg</del> <u>N/A</u>
HNO3/H2O2 Blank ( <u>J881-7-4</u> ) _____	100 ml	<del>1Hg</del> <u>ADA-2-EI1-8</u> ✓
H2SO4/KMnO4 Blank ( <u>J881-7-3</u> ) _____	100 ml	<del>1Hg</del> <u>ADA-2-EI1-9</u> ✓
1N KCl Blank ( <u>J881-7-2</u> ) _____	100 ml	<del>1Hg</del> <u>ADA-2-EI1-10</u> ✓
Acetone Blank ( <u>J881-4-6</u> ) _____	100 ml	<del>1Hg</del> <u>ADA-2-EI1-11</u> ✓
Acetone Lot No. <u>001793</u>		
0.1 N HNO3 Blank ( <u>J881-7-1</u> ) _____	100 ml	<del>1Hg</del> <u>ADA-2-EI1-12</u> ✓
0.1 N HNO3 Lot No. _____		
10% Hydroxylamine #Cl ( <u>J881-7-5</u> ) 100 mL _____		<u>ADA-2-EI1-13</u> / 10% HNO3 ( <u>J881-7-6</u> ) 100 mL <u>ADA-2-EI1-14</u> ✓
Filter Blank ID: <u>ADA-2-EI1-QF10</u> <small>2007/23/01</small>		<del>1Hg</del> <u>ADA-2-EI1-15</u> ✓

Sample Recovered By: Wynema D. Kimberrough Date: 07/23/01 Time: 1430

Sample Relinquished By: Wynema D. Kimberrough Date: 07/27/01 Time: 1235

Sample Received By: J. Mc Date: 7/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 04/24/01  
A251.2

Location: ESP Inlet

Test No.: - ADA-2-EI2

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
Filter No. 1 ID: <u>03</u>		Hg- <u>ADA-2-EI2-1</u> ✓
Filter No. 2 ID: <u>QF11</u>		Hg- <u>ADA-2-EI2-2</u> ✓
Front Wash (Acetone) _____	<u>~50ml</u> 100 ml	Hg- <u>ADA-2-EI2-3</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml ✓	Hg- <u>ADA-2-EI2-4</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	<u>~900ml</u>	Hg- <u>ADA-2-EI2-5</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	<u>200ml</u>	Hg- <u>ADA-2-EI2-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	<u>~550ml</u>	Hg- <u>ADA-2-EI2-7</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		Hg- <u>N/A</u>
HNO3/H2O2 Blank <u>(5881-9-3)</u>	100 ml	Hg- <u>ADA-2-EI2-8</u> ✓
H2SO4/KMnO4 Blank <u>(5881-9-1)</u>	100 ml	Hg- <u>ADA-2-EI2-9</u> ✓
1N KCl Blank <u>(5881-9-2)</u>	100 ml	Hg- <u>ADA-2-EI2-10</u> ✓
Acetone Blank _____	100 ml	Hg- <u>ADA-2-EI2</u> <sup>200</sup> <u>04/24/01</u> ✓
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	Hg- <u>N/A</u>
0.1 N HNO3 Lot No. _____		
<sup>Backup Thimble</sup> Filter Blank ID: <u>(ID 04)</u>		Hg- <u>ADA-2-EI2-11</u> ✓
Sample Recovered By: <u>Wynne D. Finlayson</u>	Date: <u>04/24/01</u> Time: <u>1530</u>	
Sample Relinquished By: <u>Wynne D. Finlayson</u>	Date: <u>04/27/01</u> Time: <u>1235</u>	
Sample Received By: <u>JAm-c</u>	Date: <u>4/27/01</u> Time: <u>1235</u>	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 04/25/01

Location: ESP Inlet

Test No.: -ADA-2-EI3

	APPROXIMATE VOLUME	SAMPLE NO.
<i>Thinkle</i> Filter No. 1 ID: <u>06</u>		1Hg- <u>ADA-2-EI3-1</u> ✓
<i>Thinkle</i> Filter No. 2 ID: <u>07</u>		1Hg- <u>ADA-2-EI3-2</u> ✓
Filter No. 3 ID: <u>QF15</u>		ADA-2-EI3-3 ✓
Front Wash (Acetone)	100 ml ✓	1Hg- <u>ADA-2-EI3-4</u> ✓
Front Wash (0.1 N HNO3)	100 ml <sup>~175 mL</sup>	1Hg- <u>ADA-2-EI3-5</u> ✓
Impingers 1, 2, and 3 -1 (KCl)	~900 mL	1Hg- <u>ADA-2-EI3-6</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed)		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed)		1Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2)	~175 mL	1Hg- <u>ADA-2-EI3-7</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle)	~175 mL <sup>500 mL</sup> <i>off 04/25/01</i>	1Hg- <u>ADA-2-EI3-8</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed	2	1Hg- <u>N/A</u>
HNO3/H2O2 Blank <u>(J881-10-3)</u>	100 ml	1Hg- <u>ADA-2-EI3-9</u> ✓
H2SO4/KMnO4 Blank <u>(J881-10-1)</u>	100 ml	1Hg- <u>ADA-2-EI3-10</u> ✓
1N KCl Blank <u>(J881-10-2)</u>	100 ml	1Hg- <u>ADA-2-EI3-11</u> ✓
Acetone Blank	100 ml	1Hg- <u>N/A</u>
Acetone Lot No. _____		
0.1 N HNO3 Blank <u>(J881-10-5)</u>	100 ml	1Hg- <u>ADA-2-EI3-12</u> ✓
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- _____

Sample Recovered By: Wynema D. Kennerly Date: 04/25/01 Time: 1550

Sample Relinquished By: Wynema D. Kennerly Date: 04/27/01 Time: 1235 *JA*

Sample Received By: J.D. Mc G Date: 4/27/01 Time: 1235 *JA*

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

# Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 04/26/01

Location: ESP Inlet

Test No.: - ADA-2-EI4

	APPROXIMATE VOLUME	SAMPLE NO.
<sup>Thimble</sup> Filter No. 1 ID: <u>08</u>		1Hg- <u>ADA-2-EI4-1</u> ✓
Filter No. 2 ID: _____		1Hg- <u>ADA-2-EI4-2</u> ✓ <sup>check 04/26/01</sup> <i>sample not collected</i>
Filter No. 3 ID: <u>14</u>		ADA-2-EI4-3 ✓
Front Wash (Acetone) _____	100 ml ✓	1Hg- <u>ADA-2-EI4-4</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml <sup>150 ml</sup>	1Hg- <u>ADA-2-EI4-5</u> ✓
Impingers 1, 2, and 3-1 (KCl) _____		1Hg- <u>ADA-2-EI4-6</u> ✓
Impingers 1, 2, and 3-2 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 1, 2, and 3-3 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	<u>200 ml</u>	1Hg- <u>ADA-2-EI4-7</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____		1Hg- <u>ADA-2-EI4-8</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		1Hg- <u>N/A</u>
HNO3/H2O2 Blank <u>(5881-12-2)</u>	100 ml	1Hg- <u>ADA-2-EI4-9</u> ✓
H2SO4/KMnO4 Blank <u>(5881-12-1)</u>	100 ml	1Hg- <u>ADA-2-EI4-10</u> ✓
1N KCl Blank <u>(5881-10-6)</u>	100 ml	1Hg- <u>ADA-2-EI4-11</u> ✓
Acetone Blank _____	100 ml	1Hg- <u>N/A</u>
Acetone Lot No. _____		
10% HNO3 Control Rinse	<u>≈ 75 mL</u>	
0.1 N HNO3 Blank _____	100 ml	1Hg- <u>ADA-2-EI4-12</u> ✓ <sup>check 04/26/01</sup>
0.1 N HNO3 Lot No. _____		
<sup>Thimble</sup> Filter Blank ID: <u>10</u>		1Hg- <u>ADA-2-EI4-13</u> ✓

Sample Recovered By: Wynema D. Finlayson Date: 04/26/01 Time: 1616

Sample Relinquished By: Wynema D. Finlayson Date: 04/27/01 Time: 1235

Sample Received By: J.D. McL... Date: 4/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 04/24/01

Location: COHPAC Inlet

Test No.: ADA-2-C12

	APPROXIMATE VOLUME	SAMPLE NO.
Filter No. 1 ID: <u>QF13</u>		<del>1Hg</del> <u>ADA-2-C12-1</u> ✓
Filter No. 2 ID: _____		<del>1Hg</del> <u>N/A</u>
Front Wash (Acetone) _____	100 ml ✓	<del>1Hg</del> <u>ADA-2-C12-2</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml <sup>~150</sup> ml	<del>1Hg</del> <u>ADA-2-C12-3</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	(~750 ml)	<del>1Hg</del> <u>ADA-2-C12-4</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		<del>1Hg</del> <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	~200 ml	<del>1Hg</del> <u>ADA-2-C12-5</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	(~550 ml)	<del>1Hg</del> <u>ADA-2-C12-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		<del>1Hg</del> <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
H2SO4/KMnO4 Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
1N KCl Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
Acetone Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	<del>1Hg</del> <u>N/A</u>
0.1 N HNO3 Lot No. _____		
<u>10% HNO3 Reagent Blank (5881-9-4) 100ml</u>		<u>ADA-2-C12-7</u> ✓
Filter Blank ID: _____		<del>1Hg</del> <u>N/A</u>

Sample Recovered By: Wynema D. Kimbrough Date: 04/24/01 Time: 1810

Sample Relinquished By: Wynema D. Kimbrough Date: 04/27/01 Time: 1235

Sample Received By: J.S. McCie Date: 4/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A2512

Date: 04/25/01

Location: COHPAC Inlet

Test No.: ADA-2-CI3

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
Filter No. 1 ID: <u>QF16</u>		Hg- <u>ADA-2-CI3-1</u> ✓
Filter No. 2 ID: <u>—</u>		Hg- <u>N/A</u>
Front Wash (Acetone) _____	<u>100 ml</u> <sup>~75 mL</sup>	Hg- <u>ADA-2-CI3-2</u> ✓
Front Wash (0.1 N HNO3) _____	<u>100 ml</u> <sup>~150 mL</sup>	Hg- <u>ADA-2-CI3-3</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	<u>~750 ml</u>	Hg- <u>ADA-2-CI3-4</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	<u>~175 ml</u>	Hg- <u>ADA-2-CI3-5</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	<u>~600 ml</u>	Hg- <u>ADA-2-CI3-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	<u>100 ml</u>	Hg- <u>N/A</u>
H2SO4/KMnO4 Blank _____	<u>100 ml</u>	Hg- <u>N/A</u>
1N KCl Blank _____	<u>100 ml</u>	Hg- <u>N/A</u>
Acetone Blank _____	<u>100 ml</u>	Hg- <u>N/A</u>
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	<u>100 ml</u>	Hg- <u>N/A</u>
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		Hg- _____
Sample Recovered By: <u>Wynne D. Kimberleigh</u>	Date: <u>04/25/01</u> Time: <u>1822</u>	
Sample Relinquished By: <u>Wynne D. Kimberleigh</u>	Date: <u>01/27/01</u> Time: <u>1235</u>	
Sample Received By: <u>J. M. Coan</u>	Date: <u>4/27/01</u> Time: <u>1235</u>	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	
Sample Relinquished By: _____	Date: _____ Time: _____	
Sample Received By: _____	Date: _____ Time: _____	

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A2612  
 Location: CORPAC ESP Inlet  
20/04/2001

Date: 07/26/01  
 Test No.: ADA-2-CI4  
ADA-2-CI4  
20/04/2001

	APPROXIMATE VOLUME	SAMPLE NO.
Filter No. 1 ID: <u>QF19</u>		<del>1Hg- ADA-2-CI4-1</del> ✓ ADA-2-CI4-1 ✓
Filter No. 2 ID: _____		1Hg- N/A
Front Wash (Acetone) _____	100 ml ✓	1Hg- ADA-2-CI4-2 ✓
Front Wash (0.1 N HNO3) _____	100 ml <sup>~130 ml</sup>	1Hg- ADA-2-CI4-3 ✓
Impingers 1, 2, and 3 -1 (KCl) _____	~ 800 ml	1Hg- ADA-2-CI4-4 ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		1Hg- N/A
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		1Hg- N/A
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	~ 175 ml	1Hg- ADA-2-CI4-5 ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	~ 550 ml	1Hg- ADA-2-CI4-6 ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		1Hg- N/A
<del>HNO3/H2O2 Blank</del> <u>10% HNO3 Blank</u> ✓	100 ml	1Hg- <del>N/A</del> ADA-2-CI4-8
H2SO4/KMnO4 Blank _____	100 ml	1Hg- N/A
1N KCl Blank _____	100 ml	1Hg- N/A
Acetone Blank _____	100 ml	1Hg- N/A
Acetone Lot No. _____		
<u>10% HNO3 Blank (500-12-3) Control Rinse</u> 0.1 N HNO3 Blank <small>20/04/2001</small>	100 ml	1Hg- <del>N/A</del> ADA-2-CI4-7 ✓
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- N/A

Sample Recovered By: Wynema D. Kurlough Date: 07/26/01 Time: 1840

Sample Relinquished By: Wynema D. Kurlough Date: 07/27/01 Time: 1235

Sample Received By: J.D. McC Date: 07/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

# Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 04/24/01

Location: COHPAC Outlet

Test No.: - ADA-2-CO2  
~~ADA-2-CO2~~ 202  
04/24/01

	<u>APPROXIMATE VOLUME</u>	<u>SAMPLE NO.</u>
Filter No. 1 ID: <u>QF12</u>		tHg- <u>ADA-2-CO2-1</u> ✓
Filter No. 2 ID: <u>—</u>		tHg- <u>N/A</u>
Front Wash (Acetone)	<u>100 ml</u> <sup>~75 ml</sup>	tHg- <u>ADA-2-CO2-2</u> ✓
Front Wash (0.1 N HNO3)	<u>100 ml</u> <sup>~75 ml</sup>	tHg- <u>ADA-2-CO2-3</u> ✓
Impingers 1, 2, and 3 -1 (KCl)	<u>~900 ml</u>	tHg- <u>ADA-2-CO2-4</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed)		tHg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed)		tHg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2)	<u>~180 ml</u>	tHg- <u>ADA-2-CO2-5</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle)	<u>~550 ml</u>	tHg- <u>ADA-2-CO2-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed		tHg- <u>N/A</u>
HNO3/H2O2 Blank	<u>100 ml</u>	tHg- <u>N/A</u>
H2SO4/KMnO4 Blank	<u>100 ml</u>	tHg- <u>N/A</u>
1N KCl Blank	<u>100 ml</u>	tHg- <u>N/A</u>
Acetone Blank	<u>100 ml</u>	tHg- <u>N/A</u>
Acetone Lot No. _____		
0.1 N HNO3 Blank	<u>100 ml</u>	tHg- <u>N/A</u>
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		tHg- <u>N/A</u>

Sample Recovered By: Wynema D. Kinlough Date: 04/27/01 Time: 1645

Sample Relinquished By: Wynema D. Kinlough Date: 04/27/01 Time: 12:35

Sample Received By: J. J. McC Date: 4/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A26.2

Date: 04/25/01

Location: COHPAC Outlet

Test No.: - ADA-2-C03

	APPROXIMATE VOLUME	SAMPLE NO.
Filter No. 1 ID: <u>9F14</u>		1Hg- <u>ADA-2-C03-1</u> ✓
Filter No. 2 ID: <u>—</u>		1Hg- <u>N/A</u>
Front Wash (Acetone) _____	100 ml ✓	1Hg- <u>ADA-2-C03-2</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml ✓	1Hg- <u>ADA-2-C03-3</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	≈ 800 mL	1Hg- <u>ADA-2-C03-4</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		1Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	<u>1180 mL</u>	1Hg- <u>ADA-2-C03-5</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	≈ 550 mL	1Hg- <u>ADA-2-C03-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		1Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	1Hg- <u>N/A</u>
H2SO4/KMnO4 Blank ( <u>5881-10-4</u> ) _____	100 ml	1Hg- <u>ADA-2-C03-7</u> ✓
1N KCl Blank _____	100 ml	1Hg- <u>N/A</u>
Acetone Blank _____	100 ml	1Hg- <u>N/A</u>
Acetone Lot No. _____		
0.1 N HNO3 Blank _____	100 ml	1Hg- <u>N/A</u>
0.1 N HNO3 Lot No. _____		
Filter Blank ID: _____		1Hg- <u>N/A</u>

Sample Recovered By: Weyama D. Ken-Craig Date: 04/25/01 Time: 1658

Sample Relinquished By: Weyama D. Ken-Craig Date: 04/27/01 Time: 1235

Sample Received By: J.A. McCaw Date: 4/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

## Chain of Custody: Ontario Hydro Mercury Train

Project Number: A261.2

Date: 07/26/01

Location: COHPAC Outlet

Test No.: ADA-2-C04

	APPROXIMATE VOLUME	SAMPLE NO.
Filter No. 1 ID: <u>QF18</u>		Hg- <u>ADA-2-C04-1</u> ✓
Filter No. 2 ID: _____		Hg- <u>N/A</u>
Front Wash (Acetone) _____	100 ml ✓	Hg- <u>ADA-2-C04-2</u> ✓
Front Wash (0.1 N HNO3) _____	100 ml <sup>125</sup> ml	Hg- <u>ADA-2-C04-3</u> ✓
Impingers 1, 2, and 3 -1 (KCl) _____	≈ 900ml	Hg- <u>ADA-2-C04-4</u> ✓
Impingers 1, 2, and 3 -2 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 1, 2, and 3 -3 (KCl) (if needed) _____		Hg- <u>N/A</u>
Impingers 4 and 5 (Dry and HNO3/H2O2) _____	175 ml	Hg- <u>ADA-2-C04-5</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) _____	≈ 600ml	Hg- <u>ADA-2-C04-6</u> ✓
Impingers 6, 7, 8 and 9 (dry and H2SO4/KMnO4) -1 (vented bottle) if needed _____		Hg- <u>N/A</u>
HNO3/H2O2 Blank _____	100 ml	Hg- <u>N/A</u>
H2SO4/KMnO4 Blank _____	100 ml	Hg- <u>N/A</u>
1N KCl Blank _____	100 ml	Hg- <u>N/A</u>
Acetone Blank _____	100 ml	Hg- <u>N/A</u>
Acetone Lot No. _____		
<del>10% HNO3 Reagent Blank (3881-12-3)</del>		
<del>0.1 N HNO3 Blank</del>	100 ml	Hg- <u>ADA-2-C04-7</u> ✓
<u>10% HNO3 Control Rinse</u>		<u>ADA-2-C04-8</u>
<u>0.1 N HNO3 Lot No. _____</u>		
Filter Blank ID: _____		Hg- _____

Sample Recovered By: Wynona D. Kintrough Date: 07/26/01 Time: 1733

Sample Relinquished By: Wynona D. Kintrough Date: 07/27/01 Time: 1235

Sample Received By: J. McE Date: 7/27/01 Time: 1235

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Relinquished By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Sample Received By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/23/01

Project: A261.2

Train ID: Block Train (ESP Inlet)

Run No.: <sup>WOC 04/23/01</sup>  
~~ADA-2-ET1~~ ADA-2-EI1

Filter ID: QF9

	Weight, grams			Color
	Initial	Final	Net	
Impinger 1 - 100 ml KCl Solution	<u>604.1</u>	<u>603.9</u>	_____	_____
Impinger 2 - 100 ml KCl Solution	<u>627.5</u>	<u>627.7</u>	_____	_____
Impinger 3 - 100 ml KCl Solution	<u>633.0</u>	<u>633.1</u>	_____	_____
Impinger 4 - empty	<u>440.3</u>	<u>440.4</u>	_____	_____
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>593.4</u>	<u>593.5</u>	_____	_____
Impinger 6 - empty	<u>432.6</u>	<u>432.7</u>	_____	_____
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>576.4</u>	<u>576.5</u>	_____	_____
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>593.1</u>	<u>593.2</u>	_____	_____
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>584.9</u>	<u>585.0</u>	_____	_____
Impinger 10 - empty	<u>482.3</u>	<u>482.4</u>	_____	_____
Impinger 11 - silica gel	<u>764.7</u>	<u>765.1</u>	_____	<u>No Change</u>
			Net Total: _____	

Additional Comments:

Prepared by: <u>Wynema D. Kimbrough</u>	Date	Time
Received for sampling by: <u>Brian W. Hall</u>	<u>04/23/01</u>	<u>12:30</u>
Received for recovery by: <u>Wynema D. Kimbrough</u>	<u>04/23/01</u>	<u>1:45</u>
	<u>04/23/01</u>	<u>14:20</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/23/01

Project: A261.2

Train ID: Black Train (ESP Inlet)

Run No.: <sup>4/23/01</sup>  
~~ADA-2-EI1~~ ADA-2-EI1

Filter ID: QF9

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>604.1</u>	<u>603.9</u>		
Impinger 2 - 100 ml KCl Solution	<u>627.5</u>	<u>627.7</u>		
Impinger 3 - 100 ml KCl Solution	<u>633.0</u>	<u>633.1</u>		
Impinger 4 - empty	<u>440.3</u>	<u>440.4</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>593.4</u>	<u>593.5</u>		
Impinger 6 - empty	<u>432.6</u>	<u>432.7</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>576.4</u>	<u>576.5</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>593.1</u>	<u>593.2</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>584.9</u>	<u>585.0</u>		
Impinger 10 - empty	<u>482.3</u>	<u>482.4</u>		
Impinger 11 - silica gel	<u>764.7</u>	<u>765.1</u>		<u>No Change</u>
			<b>Net Total:</b>	

Additional Comments:

	<u>Date</u>	<u>Time</u>
Prepared by: <u>Wynema D. Kimbrough</u>	<u>04/23/01</u>	<u>12:30</u>
Received for sampling by: <u>Brent W. Hall</u>	<u>4/23/01</u>	<u>1:45</u>
Received for recovery by: <u>Wynema D. Kimbrough</u>	<u>04/23/01</u>	<u>14:20</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/24/01 Project: A261.2

Train ID: ESP Inlet Run No.: ADA-2-EI2

Filter ID: Wolcott/241  
~~3/Thimble~~ a3/Thimble  
QF11

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>607.7</u>	<u>670.8</u>		
Impinger 2 - 100 ml KCl Solution	<u>627.8</u>	<u>634.4</u>		
Impinger 3 - 100 ml KCl Solution	<u>636.0</u>	<u>634.3</u>		
Impinger 4 - empty	<u>442.1</u>	<u>442.4</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>595.9</u>	<u>599.0</u>		
Impinger 6 - empty	<u>434.6</u>	<u>435.1</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>578.9</u>	<u>580.9</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>595.0</u>	<u>597.6</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>586.5</u>	<u>586.5</u>		
Impinger 10 - empty	<u>482.5</u>	<u>483.7</u>		
Impinger 11 - silica gel	<u>765.8</u>	<u>778.8</u>		<u>1/3 spent</u>
			<u>Net Total:</u>	

Additional Comments:

Prepared by: <u>Wynema D. Kimbrough</u>	<u>04/24/01</u>	<u>08:45</u>
Received for sampling by: <u>Kene [Signature]</u>	<u>04/24/01</u>	<u>09:14</u>
Received for recovery by: <u>Wynema D. Kimbrough</u>	<u>04/24/01</u>	<u>14:33</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/25/01 Project: A261.2

Train ID: ESP Inlet Run No.: ADA-2-EE3

Filter ID: QF 15  
Filter - Thimble 06  
 " " 07

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>607.7</u>	<u>673.4</u>		
Impinger 2 - 100 ml KCl Solution	<u>629.8</u>	<u>636.0</u>		
Impinger 3 - 100 ml KCl Solution	<u>634.1</u>	<u>633.6</u>		
Impinger 4 - empty	<u>442.5</u>	<u>442.6</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>595.9</u>	<u>599.7</u>		
Impinger 6 - empty	<u>434.6</u>	<u>434.7</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>577.5</u>	<u>577.5</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>595.1</u>	<u>595.7</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>586.4</u>	<u>586.4</u>		
Impinger 10 - empty	<u>483.9</u>	<u>484.5</u>		
Impinger 11 - silica gel	<u>778.4</u>	<u>790.9</u>		<u>1/2 spent</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynema D. Kimberrough</u>	<u>04/25/01</u>	<u>09:35</u>
Received for sampling by: <u>[Signature]</u>	<u>4/25/01</u>	<u>09:39</u>
Received for recovery by: <u>Wynema D. Kimberrough</u>	<u>04/25/01</u>	<u>14:52</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/26/01 Project: A261.2  
 Train ID: ESP Inlet Run No.: ADA-2-EI4  
 Filter #1 Thimble ID: 08  
 " #2 " " : 09  
 Filter ID: 14

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>607.0</u>	<u>682.7</u>		
Impinger 2 - 100 ml KCl Solution	<u>629.1</u>	<u>632.2</u>		
Impinger 3 - 100 ml KCl Solution	<u>634.2</u>	<u>632.7</u>		
Impinger 4 - empty	<u>442.0</u>	<u>441.6</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>596.8</u>	<u>602.6</u>		
Impinger 6 - empty	<u>450.6</u>	<u>450.9</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>576.5</u>	<u>578.9</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>595.8</u>	<u>596.0</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>586.4</u>	<u>585.5</u>		
Impinger 10 - empty	<u>484.0</u>	<u>484.9</u>		
Impinger 11 - silica gel	<u>728.2</u>	<u>739.7</u>		<u>1/3 spent</u>
			<b>Net Total:</b>	

Additional Comments:

	<u>Date</u>	<u>Time</u>
Prepared by: <u>Wynema D. Kenler</u>	<u>04/26/01</u>	<u>10:06</u>
Received for sampling by: <u>[Signature]</u>	<u>4/26/01</u>	<u>10:17</u>
Received for recovery by: <u>Wynema D. Kenler</u>	<u>04/26/01</u>	<u>1430</u>

## Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/24/01

Project: A261.2

Train ID: COMPAC Inlet

Run No.: ADA-2 -C12

Filter ID: QF13

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>579.3</u>	<u>646.5</u>		
Impinger 2 - 100 ml KCl Solution	<u>584.4</u>	<u>587.9</u>		
Impinger 3 - 100 ml KCl Solution	<u>583.9</u>	<u>585.0</u>		
Impinger 4 - empty	<u>404.2</u>	<u>405.1</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>609.2</u>	<u>612.0</u>		
Impinger 6 - empty	<u>496.3</u>	<u>496.4</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>610.7</u>	<u>612.1</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>608.6</u>	<u>609.8</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>607.6</u>	<u>608.5</u>		
Impinger 10 - empty	<u>473.8</u>	<u>474.6</u>		
Impinger 11 - silica gel	<u>769.7</u>	<u>781.5</u>		<u>1/4 spent</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynema D. Kimberrough</u>	<u>04/24/01</u>	<u>0921</u>
Received for sampling by: <u>[Signature]</u>	<u>04/24/01</u>	<u>1100</u>
Received for recovery by: <u>Wynema D. Kimberrough</u>	<u>04/24/01</u>	<u>17:14</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/25/01

Project: A251.2

Train ID: COHPAC Inlet

Run No.: ADA-2-CE3

Filter ID: QF16

	<u>Weight, grams</u>		<u>Net</u>	<u>Color</u>
	<u>Initial</u>	<u>Final</u>		
Impinger 1 - 100 ml KCl Solution	<u>580.6</u>	<u>640.3</u>		
Impinger 2 - 100 ml KCl Solution	<u>587.2</u>	<u>590.4</u>		
Impinger 3 - 100 ml KCl Solution	<u>585.8</u>	<u>586.2</u>		
Impinger 4 - empty	<u>407.0</u>	<u>407.1</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>615.5</u>	<u>618.2</u>		
Impinger 6 - empty	<u>498.9</u>	<u>498.8</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>614.2</u>	<u>614.8</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>610.8</u>	<u>611.1</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>611.8</u>	<u>611.4</u>		
Impinger 10 - empty	<u>474.2</u>	<u>474.6</u>		
Impinger 11 - silica gel	<u>781.1</u>	<u>791.3</u>		<u>1/3 spent</u>

Net Total: \_\_\_\_\_

Additional Comments:

	Date	Time
Prepared by: <u>Wynema D. Kimberling</u>	<u>04/25/01</u>	<u>10:17</u>
Received for sampling by: <u>ASO</u>	<u>04/25/01</u>	<u>10:20</u>
Received for recovery by: <u>Wynema D. Kimberling</u>	<u>04/25/01</u>	<u>16:55</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/26/01

Project: A261.2

Train ID: ① CATHAC Inlet

Run No.: ADA-2-CI4

Filter ID: QF19

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>581.6</u>	<u>661.0</u>		
Impinger 2 - 100 ml KCl Solution	<u>587.7</u>	<u>590.2</u>		
Impinger 3 - 100 ml KCl Solution	<u>586.6</u>	<u>587.0</u>		
Impinger 4 - empty	<u>406.5</u>	<u>406.5</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>615.0</u>	<u>619.2</u>		
Impinger 6 - empty	<u>498.8</u>	<u>498.9</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>616.9</u>	<u>617.1</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>610.5</u>	<u>610.8</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>611.9</u>	<u>581.4 / 612.3</u> <small>2004/26/01</small>		
Impinger 10 - empty	<u>474.2</u>	<u>474.3</u>		
Impinger 11 - silica gel	<u>790.8</u>	<u>799.2</u>		<u>1/2 spent</u>

Net Total: \_\_\_\_\_

Additional Comments:

Prepared by: <u>Wynema D. Kimberough</u>	<u>04/26/01</u>	<u>10:00</u>
Received for sampling by: <u>[Signature]</u>	<u>4/26/01</u>	<u>10:17</u>
Received for recovery by: <u>Wynema D. Kimberough</u>	<u>04/26/01</u>	<u>14:50</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/24/01 Project: A261.2  
 Train ID: COHPAC <sup>WCK 04/24/01</sup> Inlet Outlet Run No.: ADA-2-CO2

Filter ID: QF12

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>594.1</u>	<u>716.1</u>		
Impinger 2 - 100 ml KCl Solution	<u>585.4</u>	<u>591.4</u>		
Impinger 3 - 100 ml KCl Solution	<u>580.6</u>	<u>580.9</u>		
Impinger 4 - empty	<u>432.3</u>	<u>433.4</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>590.9</u>	<u>597.0</u>		
Impinger 6 - empty	<u>416.3</u>	<u>417.3</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>677.3</u>	<u>675.6</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>600.3</u>	<u>602.3</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>569.7</u>	<u>570.9</u>		
Impinger 10 - empty	<u>542.9</u>	<u>544.0</u>		
Impinger 11 - silica gel	<u>786.4</u>	<u>804.9</u>		<u>1/3 spent</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynema D. Kimbrough</u>	<u>04/24/01</u>	<u>0900</u>
Received for sampling by: <u>W. J. Gagnier</u>	<u>04/24/01</u>	<u>1115</u>
Received for recovery by: <u>Wynema D. Kimbrough</u>	<u>04/24/01</u>	<u>1600</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/25/01

Project: <sup>2004/25/01</sup> ~~ADA~~ A 281.2

Train ID: COHPAE Dullet

Run No.: ADA-2-C03

Filter ID: QF14

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>596.7</u>	<u>685.3</u>		
Impinger 2 - 100 ml KCl Solution	<u>585.9</u>	<u>595.5</u>		
Impinger 3 - 100 ml KCl Solution	<u>582.8</u>	<u>583.8</u>		
Impinger 4 - empty	<u>432.6</u>	<u>432.3</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>590.5</u>	<u>594.9</u>		
Impinger 6 - empty	<u>417.8</u>	<u>417.6</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>679.2</u>	<u>674.8</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>602.6</u>	<u>600.9</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>574.2</u>	<u>576.6</u>		
Impinger 10 - empty	<u>544.4</u>	<u>545.6</u>		
Impinger 11 - silica gel	<u>804.5</u>	<u>824.5</u>		<u>3/4 spent</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynne D. Kimbrough</u>	Date	Time
Received for sampling by: <u>Kenneth D. O'Neil</u>	<u>04/25/01</u>	<u>0800</u>
Received for recovery by: <u>Wynne D. Kimbrough</u>	<u>04/27/01</u>	<u>0932</u>
	<u>04/25/01</u>	<u>14:53</u>

# Ontario Hydro Mercury Train Setup and Recovery Weights

Date: 04/26/01

Project: A261.2

Train ID: Outlet

Run No.: ADA-2-C04

Filter ID: QF18

	<u>Weight, grams</u>			<u>Color</u>
	<u>Initial</u>	<u>Final</u>	<u>Net</u>	
Impinger 1 - 100 ml KCl Solution	<u>595.9</u>	<u>701.8</u>		
Impinger 2 - 100 ml KCl Solution	<u>586.3</u>	<u>596.3</u>		
Impinger 3 - 100 ml KCl Solution	<u>582.1</u>	<u>583.3</u>		
Impinger 4 - empty	<u>432.5</u>	<u>432.4</u>		
Impinger 5 - 100 ml HNO3/H2O2 Solution	<u>591.4</u> <del>615.0</del> <small>used outlet</small>	<u>585.3</u>		
Impinger 6 - empty	<u>417.4</u>	<u>417.6</u>		
Impinger 7 - 100 ml H2SO4/KMnO4 Solution	<u>679.6</u>	<u>681.3</u>		
Impinger 8 - 100 ml H2SO4/KMnO4 Solution	<u>604.6</u>	<u>603.9</u>		
Impinger 9 - 100 ml H2SO4/KMnO4 Solution	<u>572.5</u>	<u>572.0</u>		
Impinger 10 - empty	<u>544.3</u>	<u>544.3</u>		
Impinger 11 - silica gel	<u>753.9</u>	<u>773.1</u>		<u>1/2 spent</u>
			<b>Net Total:</b>	

Additional Comments:

Prepared by: <u>Wynema D. Kimberough</u>	<u>04/26/01</u>	<u>0930</u>
Received for sampling by: <u>WJ</u>	<u>04/26/01</u>	<u>1000</u>
Received for recovery by: <u>Wynema D. Kimberough</u>	<u>04/26/01</u>	<u>14.57</u>

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston

PROJECT NO. A 261.2

TEST NO.: 2

DATE: 5-2-01

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-L-1	Deionized water blank	~100ml	1600	<del>Box</del> Box 7
ADA-2-L-2	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 1	~255	1600	↓
ADA-2-L-3	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 2	~250	1600	
ADA-2-L-4	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 3	~200	1600	
ADA-2-L-5	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> Blank	~100ml	1600	
ADA-2-L-6	H <sub>2</sub> O <sub>2</sub> / HNO <sub>3</sub> SPEC 1	~100	1530	Box 7
ADA-2-L-7	" "	~100	1530	↓
ADA-2-L-8	" "	~105	1530	
ADA-2-L-9	" " Blank	~100ml	1530	

Sample Taken By D. Smith Date/Time 5-2-01 / 1530 Received By JM-C

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gator

PROJECT NO. A 261.2

TEST NO.: 2

DATE: 5-2-01

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-L-10	KCl SPEC1	~203 <sub>ml</sub>	1500	Box 9
ADA-2-L-11	KCl SPEC2	~304 <sub>ml</sub>	1500	↓
ADA-2-L-12	KCl SPEC3	~304 <sub>ml</sub>	1500	
ADA-2-L-13	KCl Blank	~102 <sub>ml</sub>	1500	
ADA-2-L-14	Filter SPEC1	N/A	1630	Desc.
ADA-2-L-15	Filter SPEC2	N/A	1630	↓
<del>ADA-2-L-15</del> ADA-2-L-15 <sup>pus</sup>				
ADA-2-L-16	Filter blank	NA	1636	↓

Sample Taken By P. Smith Date/Time 5-2-01 / 1610 Received By JM<sup>cl</sup>

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Southern Research Institute  
Control Filter Samples for Hg analysis.

Gaston ~~COMPACT~~ <sup>DM</sup> FIELD SAMPLE CUSTODY

INSTALLATION: ASDF

PROJECT NO. A261.2

TEST NO.: 2

DATE: 5-14-01

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2 -L-17	Filter + ash			
ADA-2 -L-18	Filter + ash			

Sample Taken By D. Smith Date/Time 5-14-01 1500 Received By J.D. McCas

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_/\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 1

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI 1-3	ACETONE WASH	~80ml		
ADA-2-EI 1-4	0.1N HNO <sub>3</sub>	~100ml		
ADA-2-EI 1-6	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~150ml		
ADA-2-EI 2-3	ACETONE	~50ml		
ADA-2-EI 2-4	0.1N HNO <sub>3</sub>	~100ml		
ADA-2-EI 2-6	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~200ml		
ADA-2-EI 3-4	ACETONE	~100ml		
ADA-2-EI 3-5	0.1N HNO <sub>3</sub>	~175ml		
ADA-2-EI 3-7	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~175ml		
ADA-2-EI 4-4	ACETONE	~100ml		
ADA-2-EI 4-5	0.1N HNO <sub>3</sub>	~150ml		
ADA-2-EI 4-7	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~200ml		

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By J. McC Date/Time 5/6/01 1601 Received By Cathy Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI4-2	0.1N HNO <sub>3</sub>	~100ml		Blank
ADA-2-CI2-2	ACETONE	~100ml		
ADA-2-CI2-3	0.1N HNO <sub>3</sub>	~150ml		
ADA-2-CI3-2	ACETONE	~75ml		
ADA-2-CI2-5 <sup>span</sup> <del>CI3-2</del>	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~200ml		
ADA-2-CI3-3	0.1N HNO <sub>3</sub>	~150ml		
ADA-2-CI3-5	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~175ml		
ADA-2-CI4-2	ACETONE	~100ml		
ADA-2-CI4-3	0.1N HNO <sub>3</sub>	~130ml		
ADA-2-CI4-5	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~175ml		
ADA-2-CO2-2	ACETONE	~75ml		
ADA-2-CO2-3	0.1N HNO <sub>3</sub>	~75ml		

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JM-Cm Date/Time 5/4/01 / 1601 Received By Cathy Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 3

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-CO2-5	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~180ml		
ADA-2-CO4-2	ACETONE	~100ml		
ADA-2-CO4-3	0.1N HNO <sub>3</sub>	~125ml		
ADA-2-CO4-5	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~175ml		
ADA-2-CO3-2	ACETONE	~100ml		
ADA-2-CO3-3	0.1N HNO <sub>3</sub>	~100ml		
ADA-2-CO3-5	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	~180ml		
ADA-2-CI4-7	10% HNO <sub>3</sub>	~120ml		Control Rinse
ADA-2-CI4-8	10% HNO <sub>3</sub>	~120ml		Blank
ADA-2-CO4-8	10% HNO <sub>3</sub>	~120ml		Control Rinse

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JMC Date/Time 5/7/01/1601 Received By Cathy Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261-2

TEST NO.: ADA-2

DATE: 5/4/01

+ client  
mark out  
crisis/w

Box 4 page 1 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI1-8	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100		Blank
-9	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100		"
-10	<del>60</del> 1N KCl	100		"
-11	ACETONE	100		"
-12	0.1N HNO <sub>3</sub>	100		"
-13	10% Hydroxylamine <del>Acetone</del>	80ml 100ml	100ml	"
-14	10% HNO <sub>3</sub> <del>10% Hydroxylamine/HCl</del>	100ml	*	"
ADA-2-EI2-8	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100ml		"
-9	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100ml		"
-10	1N KCl	100ml		"
ADA-2-EI3-9	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100ml		"
-10	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100ml		"

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By J.M.C. Date/Time 5/7/01 / 1601 Received By C. J. Parto

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

*\*Client marked out on 5/7/01*

TEST NO.: ADA-2

DATE: 5/4/01

Box 4 page 2 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI3-11	1N KCl	100ml		Blank
-12	0.1N HNO <sub>3</sub>	100ml		"
ADA-2-EI4-9	0.1N HNO <sub>3</sub> /H <sub>2</sub> O <sub>2</sub>	100ml		"
-10	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	100ml		"
-11	1N KCl	100ml		"
<del>ADA-2-CI4-7</del>	<del>10% HNO<sub>3</sub></del>	<del>100ml</del>		
ADA-2-CO3-7	H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> <del>10% HNO<sub>3</sub></del>	100ml <del>100ml</del>		Blank
ADA-2-CO4-7	10% HNO <sub>3</sub>	100ml		"
ADA-2-CI2-7	10% HNO <sub>3</sub>	100ml		Blank
<hr/>				

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By J Amc Date/Time 5/7/01 / 1601 Received By C Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 5

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-CO2-4	1N KCl sol'n	~800ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	~550ml		Imp 6-9
ADA-2-CO3-4	1N KCl sol'n	~800ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> sol'n	~550ml		Imp 6-9
ADA-2-CO4-4	1N KCl sol'n	~900ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> sol'n	~600ml		Imp 6-9
ADA-2-EI1-5	1N KCl sol'n	~600ml		Imp 1-3
	-7 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> sol'n	~550ml		Imp 6-9
ADA-2-EI2-5	1N KCl sol'n	~900ml		Imp 1-3
	-7 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> sol'n	~550ml		Imp 6-9
ADA-2-EI3-6	1N KCl sol'n	~900ml		Imp 1-3
	-8 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> sol'n	~550ml		Imp 6-9

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JM Date/Time 5/16/01 / 1601 Received By CMartin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 6 Page 1 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI4-6	IN KCl Soln	~900ml		Imp 1-3
	-8 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub>	~550ml		Imp 6-9
ADA-2-EI4-13	Thimble			
ADA-2-CI2-4	IN KCl Soln	~750ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Soln	~550ml		Imp 6-9
ADA-2-CI3-4	IN KCl Soln	~750ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Soln	~600ml		Imp 6-9
ADA-2-CI4-4	IN KCl Soln	~800ml		Imp 1-3
	-6 H <sub>2</sub> SO <sub>4</sub> /KMnO <sub>4</sub> Soln	~550ml		Imp 6-9
ADA-2-EI1-1	Thimble			
ADA-2-EI2-1	"			
ADA-2-EI2-11	"			

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JM-C Date/Time 5/7/01/1601 Received By C Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261-2

TEST NO.: ADA-2

DATE: 5/4/01

Box 6 page 2 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-EI3-1	Thimble			
ADA-2-EI3-2	"			
ADA-2-EI4-1	"			

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By J McC Date/Time 5/7/01 / 1601 Received By C Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gator

PROJECT NO. A 261.2

TEST NO.: 2

DATE: 5-2-01

Box 7 page 1 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-L-10	KCl SPEC1	~203 <sub>ml</sub>	1500	Box 7
ADA-2-L-11	KCl SPEC2	~304 <sub>ml</sub>	1500	↓
ADA-2-L-12	KCl SPEC3	~304 <sub>ml</sub>	1500	
ADA-2-L-13	KCl Blank	~102 <sub>ml</sub>	1500	
ADA-2-L-14	Filter SPEC1	N/A	1630	Desc.
ADA-2-L-15	Filter SPEC2	N/A	1630	↓
<del>ADA-2-L-15</del> ADA-2-L-15 <sup>pus</sup>				
ADA-2-L-16	Filter blank	NA	1636	✓

Sample Taken By P. Smith Date/Time 5/2/01 / 1610 Received By JM<sup>cl</sup>

Relinquished By JM<sup>cl</sup> Date/Time 5/1/01 / 1601 Received By C Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston

PROJECT NO. A 2 61-2

TEST NO.: 2

DATE: 5-2-01

Box 7 page 2 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-L-1	Deionized water blank	~100ml	1600	<del>Box 7</del> Box 7
ADA-2-L-2	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 1	~ 255	1600	↓
ADA-2-L-3	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 2	~ 250	1600	
ADA-2-L-4	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> SPEC 3	~ 200	1600	
ADA-2-L-5	KMnO <sub>4</sub> / H <sub>2</sub> SO <sub>4</sub> Blank	~100ml	1600	
ADA-2-L-6	H <sub>2</sub> O <sub>2</sub> / HNO <sub>3</sub> SPEC 1	~ 100	1530	Box 7
ADA-2-L-7	" "	~ 100	1530	↓
ADA-2-L-8	" "	~ 105	1530	
ADA-2-L-9	" " Blank	~100ml	1530	

Sample Taken By D. Smith Date/Time 5-2-01 / 1530 / 1600 Received By J.M.C.

Relinquished By J.M.C. Date/Time 5/7/01 / 1601 Received By C. Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A261.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 8 page 1 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2-L16	Filter			
ADA-2-L15	"			
ADA-2-L14	"			
ADA-2-EI1-15	" QF10			
ADA-2-EI2-2	" QF9			
ADA-2-C04-1	" QF18			
ADA-2-C03-1	" QF14			
ADA-2-C02-1	" QF12			
ADA-2-CI4-1	" <del>QF17</del> QF19			
ADA-2-CI3-1	" QF16			
ADA-2-CI2-1	" QF13			
ADA-2-EI2-2	" QF11			

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JAMC Date/Time 5/7/01 / 1601 Received By C. Martin

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

FIELD SAMPLE CUSTODY

INSTALLATION: Gaston Unit 3

PROJECT NO. A2G.2

TEST NO.: ADA-2

DATE: 5/4/01

Box 8 page 2 of 2

SAMPLE NO.	COMPONENT DESCRIPTION	VOL./WT	TIME	REMARKS
ADA-2	EI3-3 Filter QF15			Thinkle leaked badly upstream.
ADA-2	EI4-3 Filter (plain) 14			Filter Blew out. Tare 0.3245g

Sample Taken By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By JPM Date/Time 5/2/01 / 1601 Received By CM

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_ / \_\_\_\_\_ Received By \_\_\_\_\_

## **ATTACHMENT B3**

### **Galbraith Laboratory Analytical Reports**

## **B3a- Baseline Tests**



# Galbraith Laboratories, Inc.

Accuracy with Speed – Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
 Southern Research Institute  
 PO Box 55305  
 Birmingham, AL 35255

Report Date: 07/20/01  
 Purchase Order #: BH86656  
 FAX #: 205-581-2448

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-1-I1-1	I-9026	Mercury	(a)	Filter, 399.01mg
ADA-1-I1-2	I-9027	Mercury	(a)	50mL
ADA-1-I1-3	I-9028	Mercury	(a)	136mL
ADA-1-I1-1,2,3 Combined	I-9029	Mercury	<0.010      µg	Composite (I-9026-28)
ADA-1-I1-4	I-9030	Mercury	0.231      µg/L	669mL
ADA-1-I1-5	I-9031	Mercury	<0.168      (b)      µg/L	166mL
ADA-1-I1-6	I-9032	Mercury	0.406      µg/L	500mL(487mL)      (c)
ADA-1-I1-7	I-9033	Mercury	1.54      (b)      µg/L	100mL
ADA-1-I1-8	I-9034	Mercury	<0.122      (d)      µg/L	90mL
ADA-1-I1-9	I-9035	Mercury	<0.136      µg/L	500mL (97mL)      (c)
ADA-1-I1-10	I-9036	Mercury	(a)	92mL
ADA-1-I1-11	I-9037	Mercury	(a)	105mL
ADA-1-I1-12	I-9038	Mercury	<0.010      µg	Composite (I-9036-37), Filter, 399.01mg
ADA-1-I1-13	I-9039	Mercury	<0.200      µg/L <0.200      (e)      µg/L	98mL 98mL
ADA-1-I1-14	I-9040	Mercury Spike Recovery	<0.100      µg/L 95.0      (f)      %	100mL 100mL
ADA-1-I2-1	I-9041	Mercury	(a)	Filter, 422.10mg

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Page 1 of 6



# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.: I-9026-97

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-1-I2-2	I-9042	Mercury	(a)	86mL
ADA-1-I2-3	I-9043	Mercury	(a)	150mL
ADA-1-I2-1,2,3 Combined	I-9044	Mercury	0.0345 µg	Composite (I-9041-43)
ADA-1-I2-4	I-9045	Mercury	16.6 µg/L	900mL
ADA-1-I2-5	I-9046	Mercury	2.67 (b) µg/L	164mL
ADA-1-I2-6	I-9047	Mercury	16.3 µg/mL	500mL
ADA-1-02-1	I-9048	Mercury	(a)	Filter, 398.94mg
ADA-1-02-2	I-9049	Mercury	(a)	96mL
ADA-1-02-3	I-9050	Mercury	(a)	118mL
ADA-1-02-1,2,3 Combined	I-9051	Mercury	<0.010 µg	Composite (I-9048-50)
ADA-1-02-4	I-9052	Mercury	20.5 µg/L	725mL
ADA-1-02-5	I-9053	Mercury	2.80 (b) µg/L	144mL
ADA-1-02-6	I-9054	Mercury	12.56 µg/L 12.66 (e) µg/L	500mL (485mL) (c) 500mL (485mL) (c)
ADA-1-02-7	I-9055	Mercury	0.676 (b) µg/L	100mL
ADA-1-02-8	I-9056	Mercury	<0.122 (d) µg/L	94mL
ADA-1-02-9	I-9057	Mercury	<0.136 µg/L	500mL (98mL) (c)

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# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.: I-9026-97

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-1-02-10	I-9058	Mercury	<0.100 $\mu\text{g/L}$	100mL
ADA-1-02-11	I-9059	Mercury Spike Recovery	<0.200 $\mu\text{g/L}$ 108.5 (%)	97mL 97mL
ADA-1-I3-1	I-9060	Mercury	(a)	Filter, 433.05mg
ADA-1-I3-2	I-9061	Mercury	(a)	85mL
ADA-1-I3-3	I-9062	Mercury	(a)	166mL
ADA-1-I3-1,2,3 Combined	I-9063	Mercury	0.0410 $\mu\text{g}$	Composite (I-9060-62)
ADA-1-I3-4	I-9064	Mercury	14.1 $\mu\text{g/L}$	680mL
ADA-1-I3-5	I-9065	Mercury	1.43 (b) $\mu\text{g/L}$	140mL
ADA-1-I3-6	I-9066	Mercury	16.02 $\mu\text{g/L}$	512mL
ADA-1-I3-7	I-9067	Mercury	<0.141 $\mu\text{g/L}$ <0.141 (c) $\mu\text{g/L}$	500mL (94mL) (c) 500mL (94mL) (c)
ADA-1-I3-8	I-9068	Mercury	<0.136 $\mu\text{g/L}$	100mL
ADA-1-03-1	I-9069	Mercury	(a)	Filter, 404.01mg
ADA-1-03-2	I-9070	Mercury	(a)	93mL
ADA-1-03-3	I-9071	Mercury	(a)	92mL
ADA-1-03-1,2,3 Combined	I-9072	Mercury	0.0282 $\mu\text{g}$	Composite (I-9069-71)
ADA-1-03-4	I-9073	Mercury	29.8 $\mu\text{g/L}$	680mL

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# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.: I-9026-97

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-1-03-5	I-9074	Mercury	1.58 (b) µg/L	170mL
ADA-1-03-6	I-9075	Mercury	9.161 µg/mL	500mL (494mL) (c)
ADA-1-I4-1	I-9076	Mercury	(a)	Filter, 570.03mg
ADA-1-I4-2	I-9077	Mercury	(a)	66mL
ADA-1-I4-3	I-9078	Mercury	(a)	198mL
ADA-1-I4-1,2,3 Combined	I-9079	Mercury	0.328 µg	Composite (I-9076-78)
ADA-1-I4-4	I-9080	Mercury	18.6 µg/L	725mL
ADA-1-I4-5	I-9081	Mercury	1.65 (b) µg/L	168mL
ADA-1-I4-6	I-9082	Mercury	11.69 µg/L	520mL
ADA-1-04-1	I-9083	Mercury	(a)	Filter, 402.90mg
ADA-1-04-2	I-9084	Mercury	(a)	96mL
ADA-1-04-3	I-9085	Mercury	(a)	124mL
ADA-1-04-1,2,3 Combined	I-9086	Mercury	0.0115 µg	Composite (I-9083-85)
ADA-1-04-4	I-9087	Mercury	26.8 µg/L	733mL
ADA-1-04-5	I-9088	Mercury	0.892 µg/L 1.054 (c) µg/L	165mL 165mL
ADA-1-04-6	I-9089	Mercury	8.472 µg/L	500mL

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# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.: I-9026-97

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-1-04-7	I-9090	Mercury	<0.168 <sup>(b)</sup> µg/L	98mL
ADA-1-04-8	I-9091	Mercury	<0.122 <sup>(d, e)</sup> µg/L	70mL
			<0.122 µg/L	70mL
ADA-1-04-9	I-9092	Mercury	<0.136 <sup>(e)</sup> µg/L	100mL
			<0.136 µg/L	100mL
ADA-1-04-10	I-9093	Mercury	<0.100 µg/L	100mL
ADA-1-04-11	I-9094	Mercury	<0.100 <sup>(e)</sup> µg/L	100mL
			<0.100 <sup>(e)</sup> µg/L	100mL
		Spike Recovery	86.5 <sup>(f)</sup> %	100mL
10% H <sub>2</sub> SO <sub>4</sub> /4% KMnO <sub>4</sub> for spike	I-9095	Mercury	0.291 µg/L	292mL
		Spike Recovery	84.9 <sup>(f)</sup> %	292mL
			84.3 <sup>(e, f)</sup> %	292mL
1M KCl for spike	I-9096	Mercury	<0.136 <sup>(f)</sup> µg/L	290mL
		Spike Recovery	121.0 <sup>(f)</sup> %	290mL
5% HNO <sub>3</sub> /10% H <sub>2</sub> O <sub>2</sub> for spike	I-9097	Mercury	0.441 <sup>(b)</sup> µg/L	695mL
		Spike Recovery	92.6 <sup>(b, f)</sup> %	695mL

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# Galbraith Laboratories, Inc.

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LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.: I-9026-97

## TECHNICAL INFORMATION:

- (a) This sample is part of a composite. There is no individual result for this sample.
- (b) The quality control standard prepared with this sample exhibited a recovery of 119.3%.
- (c) The volume in parentheses is the original sample volume prior to dilution to 500mL as specified in the method.
- (d) The quality control standard prepared with this sample exhibited a recovery of 80.8%.
- (e) Duplicate analysis was performed on this sample as specified by the method.
- (f) A matrix spike was prepared on this sample as specified by the method.

Authorized Release of Data

  
Phillip A. Clark, Technical Manager

PAC:csh

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## **B3b- Carbon Injection Tests**



# Galbraith Laboratories, Inc.

Accuracy with Speed – Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute  
PO Box 55305  
Birmingham, AL 35255

Report Date: 08/15/01  
Purchase Order #: BH87480  
FAX #: 205-581-2448

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-EI1-1	J-5405	Mercury	(a)	Thimble, 3457.10mg
ADA-2-EI1-2	J-5406	Mercury	(a)	Filter, 402.99mg
ADA-2-EI1-3	J-5407	Mercury	(a)	93mL
ADA-2-EI1-4	J-5408	Mercury	(a)	114mL
ADA-2-EI1-1,2,3,4 Combined	J-5409	Mercury	0.125 µg	Composite (J-5405-08)
ADA-2-EI1-5	J-5410	Mercury	0.147 (b) µg/L	605mL
ADA-2-EI1-6	J-5411	Mercury	<0.186 µg/L	140mL
ADA-2-EI1-7	J-5412	Mercury	<0.146 µg/L	502mL
ADA-2-EI1-8	J-5413	Mercury	<0.186 µg/L	96mL
ADA-2-EI1-9	J-5414	Mercury	<0.146 µg/L	97mL
		Matrix Spike Recovery	95.2 (d) %	
		Matrix Spike Recovery	95.7 (d) %	
ADA-2-EI1-10	J-5415	Mercury	0.158 (b, d) µg/L	99mL
		Matrix Spike Recovery	110.0 %	
		Matrix Spike Recovery	114.0 %	
ADA-2-EI1-12	J-5416	Mercury	<0.136 (b) µg/L	97mL

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Page 1 of 9



# Galbraith Laboratories, Inc.

Accuracy with Speed – Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-EI1-11	J-5417	Mercury	<0.014 µg	92mLs
ADA-2-EI1-13	J-5418	Mercury	<0.200 µg/L	96mL
		Matrix Spike Recovery	<0.200 (e) µg/L 99.2 (d) %	
ADA-2-EI1-14	J-5419	Mercury	<0.136 (b) µg/L	97mL
ADA-2-EI1-15	J-5420	Mercury	<0.014 µg	Filter, 401.24mg
ADA-2-EI2-1	J-5421	Mercury	(a)	Thimble, 3331.43mg
ADA-2-EI2-2	J-5422	Mercury	(a)	Filter, 407.34mg
ADA-2-EI2-3	J-5423	Mercury	(a)	62mL
ADA-2-EI2-4	J-5424	Mercury	(a)	90mL
ADA-2-EI2-1,2,3,4 Combined	J-5425	Mercury	0.794 µg	Composite (J-5421-24)
ADA-2-EI2-5	J-5426	Mercury	5.07 (b) µg/L	890mL
ADA-2-EI2-6	J-5427	Mercury	1.101 µg/L	194mL
ADA-2-EI2-7	J-5428	Mercury	15.38 µg/L	551mL
ADA-2-EI2-8	J-5429	Mercury	<0.186 µg/L	97mL
ADA-2-EI2-9	J-5430	Mercury	<0.146 µg/L	96mL
ADA-2-EI2-10	J-5431	Mercury	<0.136 (b) µg/L	97mL
ADA-2-EI2-11	J-5432	Mercury	<0.014 µg	Thimble, 3359.09mg

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# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-EI3-1	J-5433	Mercury	(a)	Thimble, 3944.44mg
ADA-2-EI3-2	J-5434	Mercury	(a)	Thimble, 3581.60mg
ADA-2-EI3-3	J-5435	Mercury	(a)	Filter, 433.77mg
ADA-2-EI3-4	J-5436	Mercury	(a)	115mL
ADA-2-EI3-5	J-5437	Mercury	(a)	154mL
ADA-2-EI3-1,2,3,4,5 Combined	J-5438	Mercury	0.0407 µg	Composite (J-5433-37)
ADA-2-EI3-6	J-5439	Mercury	14.4 (b) µg/L	789mL
ADA-2-EI3-7	J-5440	Mercury	1.542 µg/L	162mL
ADA-2-EI3-8	J-5441	Mercury	10.91 µg/L 11.24 (c) µg/L	495mL
ADA-2-EI3-9	J-5442	Mercury	<0.186 µg/L <0.186 (c) µg/L <0.186 (e) µg/L	98mL
ADA-2-EI3-10	J-5443	Mercury	<0.146 µg/L	98mL
ADA-2-EI3-11	J-5444	Mercury	<0.136 (b) µg/L	109mL
ADA-2-EI3-12	J-5445	Mercury	<0.136 (b) µg/L	97mL
ADA-2-EI4-1	J-5446	Mercury	(a)	Thimble, 3446.89mg
ADA-2-EI4-3	J-5447	Mercury	(a)	Filter, 330.45mg
ADA-2-EI4-4	J-5448	Mercury	(a)	96mL

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Page 3 of 9



# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

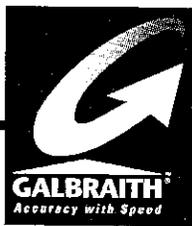
Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-EI4-5	J-5449	Mercury	(a)	132mL
ADA-2-EI4-1,2,3,4,5 Combined	J-5450	Mercury	0.112 µg	Composite (J-5446-49)
ADA-2-EI4-6	J-5451	Mercury	11.7 (b) µg/L	846mL
ADA-2-EI4-7	J-5452	Mercury	1.010 µg/L	191mL
ADA-2-EI4-8	J-5453	Mercury	8.39 µg/L	558mL
ADA-2-EI4-9	J-5454	Mercury	0.188 µg/L	98mL
ADA-2-EI4-10	J-5455	Mercury	<0.146 µg/L <0.146 (c) µg/L	96mL
ADA-2-EI4-11	J-5456	Mercury	<0.136 (b) µg/L	98mL
ADA-2-EI4-12	J-5457	Mercury	0.167 (b) µg/L	85mL
ADA-2-EI4-13	J-5458	Mercury	<0.014 µg	Thimble, 3303.43mg
ADA-2-CO4-1	J-5459	Mercury	(a)	Filter, 407.26mg
ADA-2-CO4-2	J-5460	Mercury	(a)	98mL
ADA-2-CO4-3	J-5461	Mercury	(a)	118mL
ADA-2-CO4-1,2,3 Combined	J-5462	Mercury	0.176 µg	Composite (J-5459-61)
ADA-2-CO4-4	J-5463	Mercury	2.65 (b) µg/L	827mL
ADA-2-CO4-5	J-5464	Mercury	<0.186 µg/L	177mL

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# Galbraith Laboratories, Inc.

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LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-CO4-6	J-5465	Mercury	<0.146 µg/L	594mL
ADA-2-CO4-7	J-5466	Mercury	0.160 (b) 0.151 (c) µg/L	97mL
		Matrix Spike Recovery	97.8 (d) 112.5 (d) %	%
ADA-2-CO4-8	J-5467	Mercury	<1.36 (b) µg/L	102mL
ADA-2-CI4-1	J-5468	Mercury	(a)	Filter, 502.30mg
ADA-2-CI4-2	J-5469	Mercury	(a)	110mL
ADA-2-CI4-3	J-5470	Mercury	(a)	122mL
ADA-2-CI4-1,2,3 Combined	J-5471	Mercury	0.201 0.218 (c) µg µg	Composite (J-5468-70)
ADA-2-CI4-4	J-5472	Mercury	14.4 (b, c) 15.1 µg/L µg/L	752mL
ADA-2-CI4-5	J-5473	Mercury	0.623 0.701 (c) 0.688 (c) µg/L µg/L µg/L	182mL
ADA-2-CI4-6	J-5474	Mercury	11.57 µg/L	569mL
ADA-2-CI4-8	J-5475	Mercury	<0.136 (b) µg/L	90mL
ADA-2-CI4-7	J-5476	Mercury	5.44 (b) µg/L	101mL
ADA-2-CI3-1	J-5477	Mercury	(a)	Filter, 466.54mg
ADA-2-CI3-2	J-5478	Mercury	(a)	80mL
ADA-2-CI3-3	J-5479	Mercury	(a)	128mL

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# Galbraith Laboratories, Inc.

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## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES	
ADA-2-CI3-1,2,3 Combined	J-5480	Mercury	0.530	µg	Composite (J-5477-79)
			0.536	(c) µg	
		Matrix Spike Recovery	116.9	(d) %	
			121.3	(d) %	
ADA-2-CI3-4	J-5481	Mercury	10.0	(b) µg/L	734mL
ADA-2-CI3-5	J-5482	Mercury	1.988	µg/L	167mL
ADA-2-CI3-6	J-5483	Mercury	7.03	µg/L	579mL
ADA-2-CI2-1	J-5484	Mercury		(a)	Filter, 447.57mg
ADA-2-CI2-2	J-5485	Mercury		(a)	122mL
ADA-2-CI2-3	J-5486	Mercury		(a)	152mL
ADA-2-CI2-1,2,3 Combined	J-5487	Mercury	0.164	µg	Composite (J-5484-86)
ADA-2-CI2-4	J-5488	Mercury	9.62	(b, c) µg/L	754mL
			8.26	µg/L	
ADA-2-CI2-5	J-5489	Mercury	0.366	µg/L	197mL
ADA-2-CI2-6	J-5490	Mercury	12.61	µg/L	561mL
ADA-2-CI2-7	J-5491	Mercury	<0.136	(b) µg/L	96mL
ADA-2-CO2-1	J-5492	Mercury		(a)	Filter, 403.40mg
ADA-2-CO2-2	J-5493	Mercury		(a)	80mL
ADA-2-CO2-3	J-5494	Mercury		(a)	64mL
ADA-2-CO2-1,2,3 Combined	J-5495	Mercury	0.257	µg	Composite (J-5492-94)
ADA-2-CO2-4	J-5496	Mercury	2.66	(b) µg/L	842mL

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# Galbraith Laboratories, Inc.

Accuracy with Speed ~ Since 1950  
LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date: 08/15/01  
Lab I.D.: J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-CO2-5	J-5497	Mercury	<0.186 µg/L	185mL
ADA-2-CO2-6	J-5498	Mercury	0.390 µg/L	578mL
ADA-2-CO3-1	J-5499	Mercury	(a)	Filter, 407.89mg
ADA-2-CO3-2	J-5500	Mercury	(a)	88mL
ADA-2-CO3-3	J-5501	Mercury	(a)	108mL
ADA-2-CO3-1,2,3 Combined	J-5502	Mercury	0.450 µg	Composite (J-5499-5501)
		Matrix Spike Recovery	0.451 (c) µg	
			107.7 (d) %	
			122.2 (d) %	
ADA-2-CO3-4	J-5503	Mercury	2.59 (b) µg/L	790mL
ADA-2-CO3-5	J-5504	Mercury	<0.186 µg/L <0.186 (c) µg/L	178mL
ADA-2-CO3-6	J-5505	Mercury	0.223 µg/L	531mL
ADA-2-CO3-7	J-5506	Mercury	<0.152 µg/L	95mL
		Matrix Spike Recovery	88.4 %	
			87.1 %	
ADA-2-L-1	J-5507	Mercury	0.170 µg/L	101mL
ADA-2-L-2	J-5508	Mercury	0.662 µg/L	248mL
ADA-2-L-3	J-5509	Mercury	9.43 µg/L	243mL
ADA-2-L-4	J-5510	Mercury	3.27 µg/L	195mL
ADA-2-L-5	J-5511	Mercury	<0.146 µg/L	100mL
ADA-2-L-6	J-5512	Mercury	9.095 µg/L	100mL

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Page 7 of 9



# Galbraith Laboratories, Inc.

Accuracy with Speed ~ Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.:

08/15/01  
J-5405-5522

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	NOTES
ADA-2-L-7	J-5513	Mercury	46.5      µg/L	100mL
ADA-2-L-8	J-5514	Mercury	4.669      µg/L	104mL
ADA-2-L-9	J-5515	Mercury	<0.186      µg/L	100mL
		Matrix Spike Recovery	84.0      % 110.8      %	
ADA-2-L-10	J-5516	Mercury	26.5      (b)      µg/L	206mL
ADA-2-L-11	J-5517	Mercury	3.66      (b)      µg/L	299mL
ADA-2-L-12	J-5518	Mercury	0.405      (b)      µg/L	306mL
ADA-2-L-13	J-5519	Mercury	<0.136      (b)      µg/L	102mL
		Matrix Spike Recovery	114.5      % 115.2      %	
ADA-2-L-14	J-5520	Mercury	0.393      µg 0.372      (c)      µg	Filter, 402.21mg
ADA-2-L-15	J-5521	Mercury	0.192      µg	Filter, 403.24mg
ADA-2-L-16	J-5522	Mercury	0.107      µg	Filter, 405.44mg

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Page 8 of 9



# Galbraith Laboratories, Inc.

Accuracy with Speed ~ Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute

Report Date:  
Lab I.D.:

08/15/01  
J-5405-5522

### TECHNICAL INFORMATION:

- (a) This sample is part of a composite. There is no individual result for this sample.
- (b) The quality control standard prepared with this sample exhibited a recovery of 112.5%.
- (c) Duplicate analysis was performed on this sample as specified by the method.
- (d) A matrix spike was prepared on this sample as specified by the method.
- (e) An additional replicate was analyzed on this sample.

Authorized Release of Data

  
Phillip A. Clark, Technical Manager

PAC:csh

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Page 9 of 9



# Galbraith Laboratories, Inc.

Accuracy with Speed – Since 1950

## LABORATORY REPORT

Mr. Joe McCain  
Southern Research Institute  
PO Box 55305  
Birmingham, AL 35255

Report Date: 09/17/01  
Purchase Order #: BH87480  
FAX #: 205-581-2448

SAMPLE ID	LAB ID	ANALYSIS	RESULTS	DUPLICATE RESULTS
ADA-2-L-17	J-6080	Mercury	<0.0154 µg/filter	
ADA-2-L-18	J-6081	Mercury	0.0454 µg/filter	0.0389 µg/filter
		Matrix Spike Recovery	87.6 %	

Authorized Release of Data

Phillip A. Clark, Technical Manager

PAC:csh

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## **B3c- QA/QC Results**

Table C1 provides a summary of Galbraith Laboratories' internal QA/QC checks related to the sample analyses. Table C2 provides a summary of Galbraith Laboratories' internal QA/QC checks related to the sample analyses. Table C3 provides a summary of the results for a set of 'blind' spiked samples that were submitted to Galbraith Laboratories for analysis with the actual field samples. The latter include results for two filter samples loaded as indicated with NIST certified flyash provided by the US EPA.

Pre-test and post-test leak checks of the sampling trains were all satisfactory with the exception of the hotside ESP inlet run on 4/26. In the latter case, the post-test leak check showed a leakage rate of 0.09 cfm at the highest vacuum obtained during the test. Ioskinetic ratios for all sampling runs were within the allowable ranges of 90 to 110 percent. Recovery of laboratory matrix spikes performed by Galbraith were acceptable in all cases, falling in the range of 84 to 122 percent with excellent reproducibility in duplicate analyses. Similarly, the results of duplicate analyses of actual samples were good, with deviations of less than 5 percent in most cases and maximum deviations of less than 10 percent.

Recoveries of blind spikes submitted by Southern Research Institute with the samples were mixed. Recoveries of spiked  $\text{HNO}_3/\text{H}_2\text{O}_2$  solutions fell in the range of 85 to 122 percent as did the results for the two higher level spikes in KCl solutions. However, the recovery for the low level spike in the KCl solution was only 31 percent and the recoveries for all of the spiked  $\text{KMnO}_4$  solutions were all low, ranging from 22 to 64 percent. The cause of the latter results are not known; however, given the good recoveries of spikes performed at Galbraith, they may indicate a problem with the preparation of the spikes rather than in the analyses. Unfortunately, by the time the results were obtained the holding times for the samples had long been exceeded and re-analysis of suspect samples were not believed to be worthwhile.

Table C1. Summary of Galbraith Laboratories, Inc. Matrix Spike and Duplicate Analysis Results for Baseline Test.

Spikes:			Duplicate Analyses"		
Sample ID	Matrix	% Recovery	Sample ID	Matrix	µg/L
ADA-1-I1-14	10% HNO3 blank	95	ADA-1-I1-13	10% hydroxylamineHCl	<0.2
ADA-1-O2-11	10% hydroxylamineHCl	108.5	ADA-1-O2-6	H2SO4/KMnO4	12.66
ADA-1-O4-11	10% HNO3 blank	86.5	ADA-1-I3-7	H2SO4/KMnO4 blank	<0.141
H2SO4/KMnO4 sol'n blank		84.9	ADA-1-O4-5	HNO3/H2O2	0.892
1N KCl sol'n blank		121	ADA-1-O4-11	10% HNO3 blank	<0.1
HNO3/H2O2 sol'n blank		92.6	ADA-1-O4-8	H2SO4/KMnO4 blank	<0.122
			ADA-1-O4-9	1N KCl blank	<0.136

Table C2. Summary of Galbraith Laboratories, Inc. Matrix Spike and Duplicate Analysis Results for Carbon Injection Test.

Sample ID	Matrix	% Recovery	Sample ID	Matrix	µg/L
ADA-2-EI1-9	H2SO4/KMnO4 sol'n blank	95.2	ADA-2-EI1-13	10% hydroxylamineHCl blank	<.2
ADA-2-EI1-10	1N KCl sol'n blank	110	ADA-2-EI3-8	H2SO4/KMnO4	10.91
ADA-2-EI1-13	10% hydroxylamineHCl blank	99.2	ADA-2-EI3-9	HNO3/H2O2 blank	<.186
ADA-2-CO4-7	10% HNO3 blank	97.8	ADA-2-EI4-10	H2SO4/KMnO4 blank	<.146
ADA-2-CI3-1,2,3	Front half	116.9	ADA-2-CO4-7	10% HNO3 blank	0.16
ADA-2-CO3-1,2,3	Front half	107.7	ADA-2-CI4-1,2,3	Front half	0.201
ADA-2-CO3-7	H2SO4/KMnO4 blank	88.4	ADA-2-CI4-4	1N KCl	14.4
ADA-2-L-9	HNO3/H2O2 blank	84	ADA-2-CI4-5	HNO3/H2O2	0.623
ADA-2-L-13	1N KCl sol'n blank	114.5	ADA-2-CI3-1,2,3	Front half	0.53
ADA-2-L18	NIST ash on filter	87.6	ADA-2-CO3-1,2,3	Front half	0.45
			ADA-2-CO3-5	HNO3/H2O2	<.186
			ADA-2-L-14	Filter	0.393
			ADA-2-L18	NIST ash on filter	0.0454
					0.372
					0.0389

Spikes: Duplicate Analyses:

Table C3. Mercury Spike Results

Sample ID	Matrix	Ash, g	SPIKE, $\mu\text{g}$	SPIKE, $\mu\text{g/g}$	Reported $\mu\text{g}$	% RECOVERY
ADA-2-L-2	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		0.737		0.164	22.25
ADA-2-L-3	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		5.99		2.29	38.23
ADA-2-L-4	KMnO <sub>4</sub> /H <sub>2</sub> SO <sub>4</sub>		1.0		0.637	63.70
ADA-2-L-6	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		1.0		0.9095	90.95
ADA-2-L-7	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		5.5		4.65	84.55
ADA-2-L-8	H <sub>2</sub> O <sub>2</sub> /HNO <sub>3</sub>		0.400		0.486	121.50
ADA-2-L-10	KCl		6.00		5.459	90.98
ADA-2-L-11	KCl		1.00		1.094	109.40
ADA-2-L-12	KCl		0.400		0.124	31.00
ADA-2-L-14	Filter		1.00		0.394	39.40
ADA-2-L-15	Filter		0.40		0.192	48.00
ADA-2-L-17	NIST Ash	0.0792			<0.0154	
ADA-2-L-18	NIST Ash	0.600			0.0422	

# **ATTACHMENT B4**

## **Calibration Data**

# ARCADIS G&M



ARCADIS G&M, Inc.  
4915 Prospectus Drive  
Suite F  
Durham  
North Carolina 27713  
Tel 919 544 4535  
Fax 919 544 5690

TELEFAX

To:

Copies:

JOE McCAIN

TECHNOLOGY

Fax:

205 581-2448

Total pages:

5

Date:

5-10-01

Subject:

CALIBRATION  
DATA

ARCADIS Project No.:

From:

BRENT HALL

Extension:

242

If you do not receive all pages, please call to let us know as soon as possible.

JOE:

THIS IS THE CALIBRATION DATA FOR METER BOX,  
PITOT TUBES, NOZZLES, & THERMOCOUPLE INDICATOR. IF  
YOU HAVE ANY QUESTIONS, PLEASE CONTACT ME.

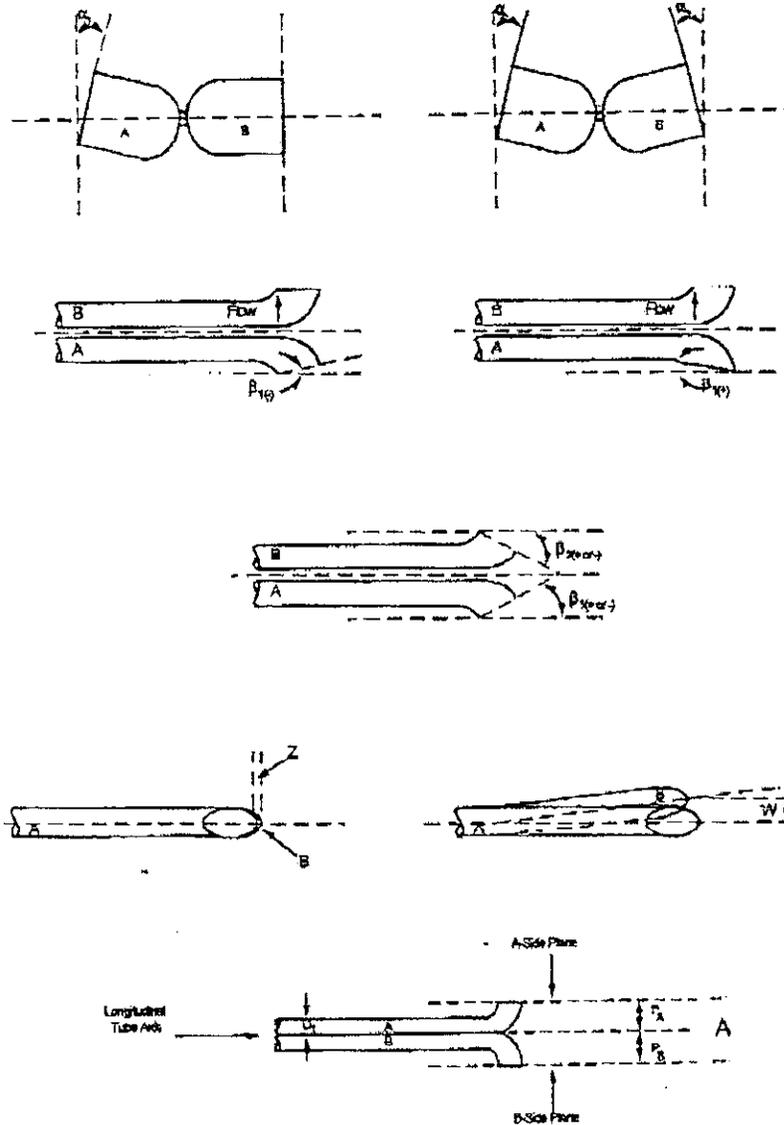
Brent Hall

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# S-TYPE PITOT TUBE INSPECTION DATA SHEET



Pre-Test

4/17/00

Post-Test

Date

yes	Level?	
no	Obstructions?	
no	Damaged?	
yes	$-10^\circ < \alpha_1 < 10^\circ$	
yes	$-10^\circ < \alpha_2 < 10^\circ$	
yes	$-5^\circ < B_1 < 5^\circ$	
yes	$-5^\circ < B_2 < 5^\circ$	
0	Z	
0	W	
0.97	A	
yes	$1.05 D_i < P_A < 1.5 D_i$	
yes	$1.05 D_i < P_B < 1.5 D_i$	
0.375	$3/16" \leq D_i \leq 3/8"$	
yes	$A \tan Z < 0.125"$	
yes	$A \tan W < 0.13125"$	
yes	$P_A = P_B \pm 0.063"$	

Comments: \_\_\_\_\_

Pitot tube number PT-21 meets or exceeds all specifications criteria and/or applicable design features and is hereby assigned a calibration factor of 0.84.

Signature

John Nash

ARCADIS  
GERAGHTY & MILLER

### NOZZLE CALIBRATION

Date 11/9/00  
 Nozzle Box II A

Calibrated By JTN  
 Nozzle Type Quartz

Nozzle Identification Number	D1, inches	D2, inches	D3, inches	D, inches	Average (Use this diameter)
QA-1	0.129	0.129	0.130	0.001	0.129
QA-2	0.190	0.188	0.188	0.002	0.189
QA-3	0.252	0.251	0.251	0.001	0.251
QA-4	0.314	0.314	0.315	0.001	0.314
QA-5	0.378	0.377	0.377	0.001	0.377
QA-6	0.441	0.442	0.442	0.001	0.442
QA-7	0.505	0.505	0.504	0.001	0.505

D1, D2, D3 = Nozzle diameter measured different diameter. Tolerance = 0.001 in.

D = Maximum difference in any two measurements. Tolerance = 0.004 in.

Average = Average of D1, D2, and D3.

### PITOT CALIBRATION DATA SHEET

Probe ID: E (ADA-Inst) By: J. D. M. Date: 6/11/67

Run No.	$\Delta P_{std}$ , in H <sub>2</sub> O	$\Delta P_{test}$ , in H <sub>2</sub> O	$C_{p(test)}$	Deviation, $ C_p - \bar{C}_p $
1	0.46	0.73	0.803	0.004
2	0.46	0.74	0.797	0.002
3	0.46	0.74	0.797	0.002
Average			0.799	0.003

$$C_{p(test)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}} = 0.99 \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

$$\text{Average Deviation} = \frac{\sum_{i=1}^3 |C_{p(i)} - \bar{C}_p|}{3} \quad (\text{Must be } \leq 0.01 \text{ for valid test})$$



SCIENTIFIC GLASS & INSTRUMENTS, INC.

P.O. BOX 6

HOUSTON, TEXAS 77001

PHONE (713) 682-1481

FAX (713) 682-3054

Calibration pitot tube: Type S Size (OD) 0.375 I.D. number: 22301

Type S pitot tube ID number NA Cp(std) = 0.99

Calibration Date: 02/23/01 Performed by: RFM

A-Side Calibration			
$\Delta p(\text{std})$ (cm) H2O (in.) H2O	p(s)	Cp(S)	DEV.
0.210	0.220	0.967	0.095
0.390	0.520	0.857	-0.015
0.540	0.770	0.829	-0.044
0.600	0.840	0.837	-0.036
+ Cp(A side) =		0.873	0.000
B-Side Calibration			
$\Delta p(\text{std})$ (cm) H2O (in.) H2O	p(s)'	Cp(S)	DEV.
0.260	0.270	0.971	0.096
0.390	0.510	0.866	-0.009
0.530	0.760	0.827	-0.048
0.600	0.840	0.837	-0.038
Cp(B side) =		0.875	0.000

$$Cp(S) = Cp(\text{std}) * \frac{\Delta p(\text{std})}{\Delta p(s)}$$

$$Cp(\text{A side}) - Cp(\text{B side}) = \underline{-0.003} \text{ Must be: } \leq \underline{0.010}$$

Calibrations were done in accordance with Federal Register Vol 40 Part 60 Amended July 1, 1989

ADA TESTS - OUTLET PROBE

New Quartz Nozzles received 2/27/01

Numbered by Sharpie only

~~File~~

Nozzle #	i.d. (inches)	i.d. (inches)	i.d. (inches)	avg i.d. (inches)
T0	0.2320	0.2325	0.2310	0.2318
T2	0.2635	0.2635	0.2625	0.2632
T3	0.2800	0.2820	0.2820	0.2813
T5	0.2160	0.2195	0.2170	0.2175
T6	0.2565	0.2635	0.2580	0.2593
T8	0.2870	0.2910	0.2880	0.2887
T9	0.2490	0.2595	0.2510	0.2532

$$S 26 = .2205 \cdot 2115 \cdot 2200$$

$$S 9_{...} 56 = .1860 \cdot 1865 \cdot 1860$$

$$.21 = .2515 \cdot 2520 \cdot 2505$$

$$.20 = .2350 \cdot 2355 \cdot 2345$$

$$14 = .2470 \cdot 2495 \cdot 2460$$

$$.19 = .2345 \cdot 2340 \cdot 2310$$

$$\begin{matrix} .19 \\ \times 46 \\ \hline .01 \end{matrix} = .2525 \cdot 2470 \cdot 2515$$

$$7 = 1825 \cdot 1830 \cdot 1830$$

$$10 = 2500 \cdot 2505 \cdot 2505$$

$$23 = .1855 \cdot 1850 \cdot 1850$$

$$= 1855 \cdot 1855 \cdot \underline{\underline{1840}}$$

$$T 22 = .1990 \cdot 1995 \cdot 1990$$

$$T 42 = 1875 \cdot 1870 \cdot 1875$$

$$T 45 = .1880 \cdot 1880 \cdot 1885$$

$$T 67 = .2215 \cdot 2220 \cdot 2210$$

$$T 44 = 1885 \cdot 1885 \cdot 1885$$

$$T 78 = 1925 \cdot 1930 \cdot 1930$$

$$T 80 = 1930 \cdot 1930 \cdot 1935$$

$$T 53 = 1930 \cdot 1930 \cdot 1930$$

$$781 = 1905 \cdot 1905 \cdot 1910$$

$$T 79 = \cancel{1900} \cdot 1915 \cdot 1900 \cdot 1905$$

$$T 39 = 1875 \cdot 1870 \cdot 1870$$

$$T 48 = 1895 \cdot 1895 \cdot 1900$$

$$T 4 \# = 1870 \cdot 1865 \cdot 1870$$

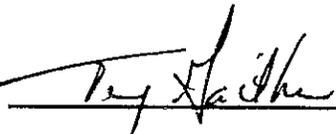
# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

Meter Box Nutech 1  
on 11-6-00

Run Number	1	2	3
Barometric Pres, in Hg	29.88	29.88	29.88
Orifice pres drop, in H2O	0.61	1.10	1.90
Critical Orifice Id #	EG-48	EG-55	EG-63
K Factor	0.3456	0.4596	0.5946
Actual Vacuum, in Hg	20.0	19.0	17.0
Gas Volume Dry Init, CF	171.923	177.003	182.009
Gas Volume Dry Final, CF	177.003	182.009	187.019
Ambient Temp Initial, F	67	74	73
Ambient Temp Final, F	68	68	69
Dry Gas Temp Init In, F	65	65	66
Dry Gas Temp Final In, F	66	66	67
Dry Gas Temp Init Out, F	64	79	78
Dry Gas Temp Final Out, F	65	65	65
Run Time, sec	675	506	393
Meter Calibration Factor, Y	0.9903	1.0044	1.0070
Average Y	<b>1.0006</b>		
Less than +/- 0.02 from average	YES	YES	YES
Delta H@	1.71	1.73	1.78
Average H@	<b>1.74</b>		
Less than +/- 0.20 from average	YES	YES	YES

Signature \_\_\_\_\_



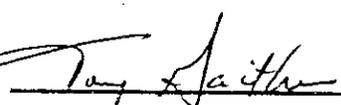
# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

Meter Box Nutech 2  
on 11-6-00

Run Number	1	2	3
Barometric Pres, in Hg	29.88	29.88	29.88
Orifice pres drop, in H2O	0.63	1.20	2.00
Critical Orifice Id #	EG-48	EG-55	EG-63
K Factor	0.3456	0.4596	0.5946
Actual Vacuum, in Hg	24.0	23.0	21.0
Gas Volume Dry Init, CF	207.550	212.556	217.569
Gas Volume Dry Final, CF	212.556	217.569	222.573
Ambient Temp Initial, F	69	70	70
Ambient Temp Final, F	70	70	70
Dry Gas Temp Init In, F	68	69	70
Dry Gas Temp Final In, F	69	70	70
Dry Gas Temp Init Out, F	67	67	67
Dry Gas Temp Final Out, F	67	67	68
Run Time, sec	667	505	393
Meter Calibration Factor, Y	0.9963	1.0008	1.0084
<b>Average Y</b>	<b>1.0018</b>		
Less than +/- 0.02 from average	YES	YES	YES
Delta H@	1.76	1.90	1.89
<b>Average H@</b>	<b>1.85</b>		
Less than +/- 0.20 from average	YES	YES	YES

Signature \_\_\_\_\_



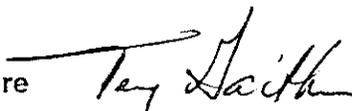
# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

Meter Box Nutech 3  
on 11-6-00

Run Number	1	2	3
Barometric Pres, in Hg	29.88	29.88	29.88
Orifice pres drop, in H2O	0.61	1.10	1.85
Critical Orifice Id #	EG-48	EG-55	EG-63
K Factor	0.3456	0.4596	0.5946
Actual Vacuum, in Hg	21.5	20.0	18.5
Gas Volume Dry Init, CF	937.900	943.003	948.014
Gas Volume Dry Final, CF	943.003	948.014	953.020
Ambient Temp Initial, F	59	59	59
Ambient Temp Final, F	59	59	59
Dry Gas Temp Init In, F	58	57	57
Dry Gas Temp Final In, F	57	57	57
Dry Gas Temp Init Out, F	57	56	56
Dry Gas Temp Final Out, F	56	56	55
Run Time, sec	685	508	388
Meter Calibration Factor, Y	0.9932	0.9954	0.9822
Average Y	<b>0.9903</b>		
Less than +/- 0.02 from average	YES	YES	YES
Delta H@	1.70	1.74	1.75
Average H@	1.73		
Less than +/- 0.20 from average	YES	YES	YES

Signature



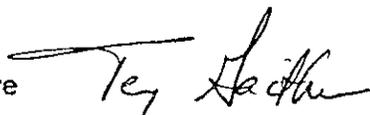
# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

Meter Box Nutech 4  
on 11-3-00

Run Number	1	2	3
Barometric Pres, in Hg	30.16	30.16	30.16
Orifice pres drop, in H2O	0.68	1.20	2.00
Critical Orifice Id #	EG-48	EG-55	EG-63
K Factor	0.3456	0.4596	0.5946
Actual Vacuum, in Hg	22.0	21.0	19.0
Gas Volume Dry Init, CF	701.474	706.476	711.478
Gas Volume Dry Final, CF	706.476	711.478	716.523
Ambient Temp Initial, F	75	73	72
Ambient Temp Final, F	73	72	71
Dry Gas Temp Init In, F	75	74	74
Dry Gas Temp Final In, F	74	74	75
Dry Gas Temp Init Out, F	74	73	72
Dry Gas Temp Final Out, F	73	72	73
Run Time, sec	655	495	386
Meter Calibration Factor, Y	0.9864	0.9901	0.9899
Average Y	<b>0.9888</b>		
Less than +/- 0.02 from average	YES	YES	YES
Delta H@	1.88	1.87	1.86
Average H@	<b>1.87</b>		
Less than +/- 0.20 from average	YES	YES	YES

Signature



# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

Meter Box Nutech 5  
on 11-3-00

Run Number	1	2	3
Barometric Pres, in Hg	30.16	30.16	30.16
Orifice pres drop, in H2O	0.67	1.20	2.00
Critical Orifice Id #	EG-48	EG-55	EG-63
K Factor	0.3456	0.4596	0.5946
Actual Vacuum, in Hg	22.0	20.0	19.0
Gas Volume Dry Init, CF	841.478	846.478	851.478
Gas Volume Dry Final, CF	846.478	851.478	856.642
Ambient Temp Initial, F	64	64	64
Ambient Temp Final, F	64	64	64
Dry Gas Temp Init In, F	69	68	68
Dry Gas Temp Final In, F	68	68	68
Dry Gas Temp Init Out, F	68	68	67
Dry Gas Temp Final Out, F	67	67	67
Run Time, sec	681	516	409
Meter Calibration Factor, Y	1.0241	1.0302	1.0204
<b>Average Y</b>	<b>1.0249</b>		
Less than +/- 0.02 from average	YES	YES	YES
Delta H@	1.83	1.86	1.85
<b>Average H@</b>	<b>1.85</b>		
Less than +/- 0.20 from average	YES	YES	YES

Signature



JDM

**GUARDIAN SYSTEMS INC**  
**INITIAL CALIBRATION**  
**FOR SOUTHERN RESEARCH INSTITUTE**  
 Meter Box Nutech 3, Temperature device Nutech 3  
 on 3-28-01

Run Number	1	2	3	4	5
Barometric Pres, in Hg	30.28	30.28	30.28	30.28	30.28
Orifice pres drop, in H2O	0.63	1.1	2	3.2	5.6
Critical Orifice Id #	EG-48	EG-55	EG-63	EG-73	EG-81
K Factor	0.3456	0.4596	0.5946	0.8170	1.0110
Actual Vacuum, in Hg	23.0	21.0	19.0	16.0	13.0
Gas Volume Dry Init, CF	244.521	249.523	254.524	259.561	264.574
Gas Volume Dry Final, CF	249.523	254.524	259.561	264.574	269.584
Ambient Temp Initial, F	68	68	72	71	70
Ambient Temp Final, F	68	72	75	70	69
Dry Gas Temp Init In, F	67	69	70	72	73
Dry Gas Temp Final In, F	69	70	72	73	74
Dry Gas Temp Init Out, F	68	68	69	70	71
Dry Gas Temp Final Out, F	67	71	70	71	72
Run Time, sec	658	499	390	281	231
Meter Calibration Factor, Y	0.9850	0.9939	0.9937	0.9908	1.0055
Average Y	0.9938				
Less than +/- 0.02 from average	YES	YES	YES	YES	YES
Delta H@	1.73	1.71	1.87	1.57	1.79
Average H@	1.73				
Less than +/- 0.20 from average	YES	YES	YES	YES	YES

Signature



**GUARDIAN SYSTEMS INC**  
**Temperature Calibration for Nutech 3**  
**on 3-28-01 on Box Nutech #3**

<u>Actual Temperature, F</u>	<u>Reading Temperature, F</u>	<u>Correction in Reading, F</u>
50	50	0
100	99	1
150	151	-1
200	200	0
250	250	0
300	300	0
350	348	2
400	400	0
450	450	0
500	500	0
550	550	0
600	600	0
650	651	-1
700	700	0
750	751	-1
800	800	0
850	851	-1
900	900	0
950	950	0
1000	1000	0

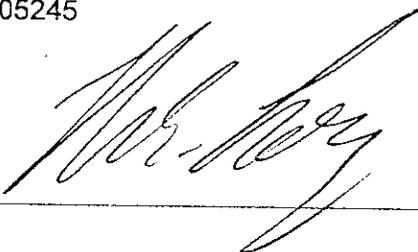
Regression Output:

Constant	0.2918886
Std Err of Y Est	0.6767644
R Squared	0.9999995
No. of Observations	20
Degrees of Freedom	18

Read	Actual
40	40

X Coefficient(s)	0.9993488
Std Err of Coef.	0.0005245

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# GUARDIAN SYSTEMS INC

## INITIAL CALIBRATION

### FOR SOUTHERN RESEARCH INSTITUTE

Meter Box Nutech 5, Temperature device Nutech 5  
on 3-28-01

Run Number	1	2	3	4	5
Barometric Pres, in Hg	30.27	30.27	30.27	30.27	30.27
Orifice pres drop, in H2O	0.68	1.2	2.1	4.0	6.4
Critical Orifice Id #	EG-48	EG-55	EG-63	EG-73	EG-81
K Factor	0.3456	0.4596	0.5946	0.8170	1.0110
Actual Vacuum, in Hg	24.0	23.0	20.5	18.0	16.5
Gas Volume Dry Init, CF	657.375	662.377	667.382	672.384	677.390
Gas Volume Dry Final, CF	662.377	667.382	672.384	677.390	682.401
Ambient Temp Initial, F	65	63	64	65	66
Ambient Temp Final, F	63	63	66	66	67
Dry Gas Temp Init In, F	73	71	70	71	72
Dry Gas Temp Final In, F	72	70	71	72	73
Dry Gas Temp Init Out, F	73	72	71	72	72
Dry Gas Temp Final Out, F	72	71	72	72	72
Run Time, sec	650	492	382	278	228
Meter Calibration Factor, Y	0.9854	0.9883	0.9892	0.9848	0.9927
Average Y	0.9881				
Less than +/- 0.02 from average	YES	YES	YES	YES	YES
Delta H@	1.84	1.83	1.92	1.94	2.03
Average H@	1.91				
Less than +/- 0.20 from average	YES	YES	YES	YES	YES

Signature



**GUARDIAN SYSTEMS INC**  
**Temperature Calibration for Nutech 5**  
**on 3-28-01 on Box Nutech #5**

<u>Actual Temperature, F</u>	<u>Reading Temperature, F</u>	<u>Correction in Reading, F</u>
50	46	4
100	95	5
150	147	3
200	196	4
250	247	3
300	297	3
350	345	5
400	395	5
450	446	4
500	495	5
550	548	2
600	596	4
650	646	4
700	696	4
750	745	5
800	795	5
850	848	2
900	895	5
950	945	5
1000	996	4

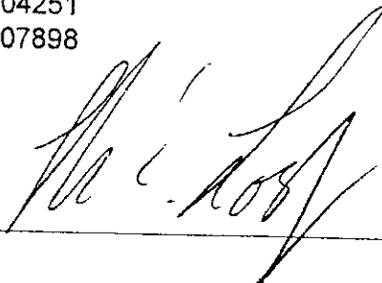
Regression Output:

Constant	3.8285662
Std Err of Y Est	1.0178924
R Squared	0.9999888
No. of Observations	20
Degrees of Freedom	18

Read	Actual
60	64

X Coefficient(s)	1.0004251
Std Err of Coef.	0.0007898

SIGNATURE

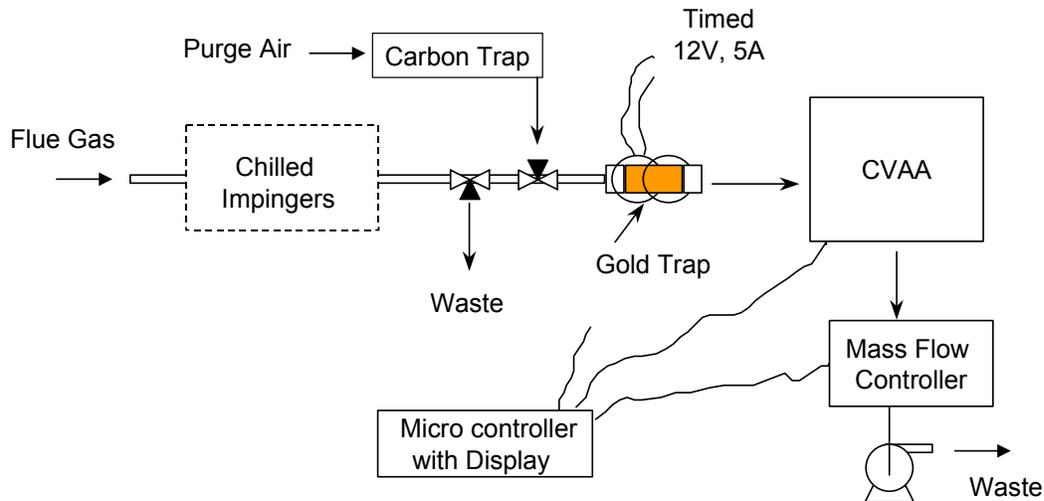


# **ATTACHMENT C**

## **Description of Semi Continuous Emissions Monitor for Mercury**

## Mercury S-CEM

A semi-continuous mercury analyzer will be used during this program to provide near real-time feedback during baseline, parametric and long-term testing. Continuous measurement of mercury at the inlet and outlet of the particulate collector is considered a critical component of a field mercury control program where mercury levels fluctuate with boiler operation (temperature, load, etc.) and decisions must be made concerning parameters such as sorbent feed rate and cooling. The analyzers that will be used for this program consist of a commercially available cold vapor atomic absorption spectrometer (CVAAS) coupled with a gold amalgamation system (Au-CVAAS). Radian developed this type of system for EPRI (Carey, et al., 1998). A sketch of the system is shown in the figure below. One analyzer will be placed at the inlet of the particulate collector and one at the outlet of the particulate collector during this test program.



**Figure C-1**  
**Sketch of Mercury Measurement System**

Although it is very difficult to transport non-elemental mercury in sampling lines, elemental mercury can be transported without significant problems. Since the Au-CVAAS measures mercury by using the distinct lines of UV absorption characteristic of elemental Hg ( $Hg^0$ ), the non-elemental fraction is either converted to elemental mercury (for total mercury measurement) or removed (for measurement of the elemental fraction) near the sample extraction point. This minimizes any losses due to the sampling system.

For total vapor-phase mercury measurements, all non-elemental vapor-phase mercury in the flue gas must be converted to elemental mercury. A reduction solution of stannous chloride in hydrochloric acid is used to convert  $Hg^{2+}$  to  $Hg^0$ . The solution is mixed as prescribed in the draft Ontario Hydro Method for manual mercury measurements.

To measure speciated mercury, an impinger of potassium chloride (KCl) solution mixed as prescribed by the draft Ontario Hydro Method is placed upstream of the stannous chloride solution to capture oxidized mercury. Unique to this instrument is the ability to continuously refresh the impinger solutions to assure continuous exposure of the gas to active chemicals.

The Au-CVAAS system is calibrated using elemental mercury vapor. The instrument is calibrated by injecting a metered volume of mercury-laden air into the analyzer. The mercury-laden air is from the air-space of a vial containing liquid mercury at a precisely measured temperature. The concentration of the mercury in the air is determined by the vapor pressure of the mercury at that temperature.

The Au-CVAAS can measure mercury over a wide range of concentrations. Since the detection limit of the analyzer is a function of the quantity of mercury on the gold wire and not concentration in the gas, the sampling time can be adjusted for different situations. Laboratory tests with stable permeation tube mercury sources and standard mercury solutions indicate that the noise level for this analyzer is 0.2 ng mercury. It is reasonable to sample at 50 – 100 times the noise level, therefore, during field testing the sampling time is set so at least 10 ng mercury is collected on the wire before desorption. The following table shows the sampling time required for different concentrations of mercury in the flue gas with 2 liters per minute sample flow.

**Sampling Time Required for Au-CVAA Analyzer**

<b>VAPOR-PHASE MERCURY CONCENTRATION (<math>\mu\text{G}/\text{M}^3</math>)</b>	<b>MINIMUM SAMPLE TIME (MIN)</b>	<b>NOISE LEVEL (<math>\mu\text{G}/\text{M}^3</math>)</b>
5	1	0.1
2.5	2	0.05
1	5	0.02
0.5	10	0.01

An oxygen analyzer will be placed downstream of the Au-CVAAS to monitor and store the oxygen levels in the gas stream. This is particularly useful when measuring changes in mercury across a pollution control device on a full-scale unit where air inleakage into the unit may dilute the gas sample and bias results. It is also useful to assure that no leaks develop in the sampling system over time.

Particulate is separated from the gas sample using a self-cleaning filter arrangement modified for use with this mercury analyzer under an EPRI mercury control program. This arrangement uses an annular filter arrangement where excess sample flow continuously scours particulate from the filter so as to minimize any mercury removal or conversion due to the presence of particulate.

The mercury analyzer described has been used extensively for lab testing and field testing at three full-scale coal-fired power plants burning Powder River Basin (PRB), eastern bituminous, and lignite coals under EPRI programs. Although draft Ontario Hydro mercury measurements were not conducted while the analyzer was on-site, levels measured by the analyzer were well within the range expected based on previous measurements with either the draft Ontario Hydro Method or a solid carbon trap.

In order to assure the quality of the data to be obtained during the field operations, Standard Operating Procedures have been developed and will be followed for these tests.

## **APPENDIX B**

### **Sorbent Tests and Schedules**

**FIXED BED SORBENT TESTS AND PRELIMINARY RESULTS**  
Memo Dated January 24, 2001

**ALTERNATE SORBENT DISCUSSION**  
Memo Dated February 5, 2001

**TEST SCHEDULE**  
Memo Dated February 22, 2001



## ADA Environmental Solutions, LLC

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1.888.822.8617

# memorandum

---

**To:** Larry Monroe, David Prater, Ramsay Chang, Rich Miller, Ken Cushing, Scott Renninger, Carl Richardson, Sharon Sjostrom  
**From:** Jean Bustard  
**CC:** Cam Martin, Mike Durham, Richard Schlager, Charles Lindsey  
**Date:** January 24, 2001  
**RE:** Trip Update 01/24/01

---

**Note: Information in this memo is proprietary and should not be disclosed to non-Gaston Team Members. Data are preliminary!!**

This memo provides an update on laboratory and field testing conducted since December 26 2000 through mid-day January 24 2001.

### Fixed Bed Laboratory Tests

Fixed bed mercury capacity tests were conducted by URS Radian on activated carbons supplied by Norit, ash from Gaston and sorbents from TDA. Table 1 presents a summary of the sorbents. A sample of a lime based sorbent from EPA was sent to URS Radian this week.

All sorbents were tested using similar, simulated gas conditions. Gas conditions were chosen based on coal and operating conditions at Gaston. Test conditions were:

SO <sub>2</sub> (ppm)	600
NO <sub>x</sub> (ppm)	200
HCl (%)	5
H <sub>2</sub> O (%)	7
CO <sub>2</sub> (%)	12
O <sub>2</sub> (%)	5
Hg* (µg/Nm <sup>3</sup> )	50
Temperature (°F)	275

Preliminary results are presented in Table 2. Gaston sieved ash showed effective capacity for both elemental and oxidized mercury. Gaston COHPAC and ESP ash showed effective capacity for oxidized mercury. Norit GAC sorbents (bituminous and subbituminous based) showed very high capacities for both elemental and oxidized mercury. Not included in this table are the preliminary results from the TDA sorbents. Capacities for the TDA samples ranged from near 50 to 100 µg/g.

**Table 1  
Sorbents for Laboratory Fixed Bed Testing**

NAME	SUPPLIER	DESCRIPTION	POTENTIAL BENEFIT
FGD Carbon	Norit Americas Inc.	Lignite derived activated carbon	Benchmark Sorbent, high capacity
FGL Carbon	Norit Americas Inc.	Lower activity, lignite derived activated carbon	Lower cost
GAC 1240	Norit Americas Inc.	Bituminous coal derived activated carbon	Lower cost
GAC 830	Norit Americas Inc.	Subbituminous coal derived activated carbon	Lower cost
ESP fly ash	Gaston	Sample from Unit 3 hot-side hoppers	Reuse of site ash, lower cost
ESP +200	Gaston	Sieved for + 200 mesh	Reuse of site ash, lower cost
COHPAC	Gaston	COHPAC ash	Data in support of pre baseline tests
TDA Sorbents (3 sorbents)	TDA Research Inc.	Non-carbon based sorbents	Lower cost, non-carbon based
Lime/Carbon	EPA	Sample sent week of January 22	Lower cost, non-carbon based

**Table 3  
Gaston Fixed-Bed Screening Tests**

Sample Name	Mercuric Chloride Equilib. Capacity @ 50 µg/Nm3 (µg Hg/g)	Elemental Mercury Equilib. Capacity @ 50 µg/Nm3 (µg Hg/g)
Gaston ESP Fly ash	65	9.6
Gaston ESP +200	139	38.6
Gaston COHPAC ash	41	2.2
GAC-830 (M-1147)	2441	2976
GAC-1240	2441	3011
FGL M-1182	1931	2278
FGD M-1161	2179	1870
Darco FGD	2852	1826**

**Pre Baseline Mercury Measurements**

Pre baseline mercury measurement tests began on Thursday January 18. Apogee Scientific is supplying two S-CEMs and operating support for these tests. Scheduled test conditions were:

1. Set both instruments at inlet to COHPAC to confirm operation, calibration and compare measurements.

2. Measure mercury across COHPAC baghouse.
3. Measure mercury across hot-side ESP.

Total, elemental and oxidized mercury will be measured at each location. The extraction probe is set at one point in the duct that is representative of average duct velocity. Test point velocities are confirmed with a pitot measurement prior to placing the probe. A summary of the tests to date and preliminary results are presented in Table 3. Most testing was conducted at full load. No significant change in mercury was seen when load decreased to 190 MW from 265 MW. COHPAC inlet temperature was about 265°F, outlet temperature about 250°F.

**Table 3: Preliminary Mercury Measurements Gaston Unit 3**

Condition/S-CEM Locations	Results
Inlet to COHPAC (both instruments)	Total mercury varied between 5 and 10 µg/Nm <sup>3</sup>
Across COHPAC	Inlet: Total varied between 7.7 and 9.9 µg/Nm <sup>3</sup> Inlet: Elemental varied between 5.0 and 6.9 µg/Nm <sup>3</sup> Inlet: Oxidized varied between 30 and 40 % Outlet: Total varied between 7.7 and 9.9 µg/Nm <sup>3</sup> Outlet: Elemental varied between 2.1 and 4.0 µg/Nm <sup>3</sup> Outlet: Oxidized varied between 55 and 72 % Total removal: 0% Elemental oxidized across COHPAC: ~30%
Across Hot-side ESP	Tests to begin 1/24/01

Results show that mercury varies with coal source. There is no native removal across COHPAC. Mercury is oxidized across COHPAC.

**Field Fixed Bed Sorbent Screening Tests**

Fixed bed sorbent tests for mercury capacity are scheduled to begin 1/25/01. Sorbents to be tested at this time include:

1. Norit FGD
2. Norit FGL
3. Norit GAC 830
4. Norit GAC 1240
5. TDA 421B

**Test Notes:**

These baseline tests are being conducted while an outage to overhaul Unit 4 is being conducted. Because of time and resource constraints several activities will not be performed during these tests, which include:

- Ash Samples: Valves and piping needed to remove ash samples are not yet installed.
- Acid Dew Point Measurements: A used Land Dew Point analyzer was purchased. This instrument is need of minor repairs that have not yet been completed.
- ESP Operation: The ESP has had good performance since the cleaning in December. Inlet grain loading is varying between 0.014 and 0.008 gr/dscf. No data is being collected on the ESP.



## ADA Environmental Solutions, LLC

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# memorandum

---

**To:** Charles Lindsey, David Prater, Cam Martin, Travis Starns, Ken Baldrey  
**From:** Jean Bustard  
**CC:** Mike Durham, Richard Schalger, Ramsay Chang, Larry Monroe, Sharon Sjostrom, Carl Richardson, Scott Renniger, Jim Kilgroe  
**Date:** February 5, 2001  
**RE:** Alternate sorbents for parametric tests, ash pond tests

---

### Alternative Sorbents

Preliminary results on equilibrium capacity of sorbents from fixed bed testing on Gaston flue gas are (a separate memo will document results in more detail):

1. Capacity of FGD carbon was higher than laboratory test results;
2. Capacity of GAC carbons were higher than laboratory test results;
3. Capacity of sieved, ground ESP fly ash was in a range showing reasonable ability to absorb mercury;
4. Capacity of TDA sorbent was lower than laboratory results.

Because of the very short time available to procure sorbents for the parametric tests that are scheduled to begin March 12, these preliminary results were discussed with Larry Monroe and Mike Durham on Friday Feb 2. The plan agreed to in this conversation was that:

- It is of interest to evaluate FGD carbon, GAC carbon and ground ESP hopper ash.
- FGD will be the first sorbent tested in the parametric test and will also be the sorbent used in the long term tests.
- GAC carbon is of interest because of the potential high capacity shown in fixed bed tests. This carbon is more expensive than FGD (\$0.62/lb), but there is a chance that we could use less (should have less impact on ash loading and cleaning frequency).
- ESP hopper ash is of interest because it would be significantly less expensive than activated carbons. This test will also provide information on the performance of "lower capacity" sorbents and baghouses.

To actually test the ESP hopper ash we will need to coordinate several activities that were not originally discussed.

1. Larry had a contact that previously ground coal for him. The name of this company is Progressive Industries located in Sylacauga, not far from Gaston. I spoke to Don Jones,

President, (256 249 4965) Friday afternoon and he said he could grind 4000 lbs of fly ash to 90% less than 45 microns. His requirement is that he needs the ash in supersacks to feed into his pilot plant. He then grinds it and puts it back into supersacks, which is what we need for the injection equipment.

2. The next major question is how to get 600°F+ ash from the ESP hoppers into supersacks. Charles Lindsey is investigating. He will contact both David Prater and Don Jones to formulate options.
3. Once we know our options, we will decide on if and how to proceed.

### **Ash Pond Tests**

To assure that injected sorbents will not impact ash pond chemistry or leaching characteristics, a test is scheduled during check out of the injection equipment where hopper ash from 3B will be isolated and samples tested for leaching characteristics. To conduct this test, arrangements need to be made for a vacuum truck and for TCLP tests on the samples. The following items were discussed:

- We are anticipating that carbon will be injected for 8 hours at 1.5 lbs/min. This will occur on Wednesday, Thursday or Friday Feb 28 – Mar 2. The actual date of testing will be determined the week of Feb 19 while equipment is being installed.
- Hoppers on the B-side of unit 3 will be isolated from the hydroveyor system.
- Ash/carbon samples will be removed via the valve/piping system being installed on each of the hoppers.
- At the end of the test, ash/carbon will be removed from the hoppers via a vacuum truck.
- Samples will be sent to APC Environmental Affairs for testing and to an outside contractor. (In the kickoff meeting APC EA indicated that they could run a test with fairly quick turn around, a day or two).
- Larry asked that we talk to David about whether he will make arrangements for the vacuum truck with his existing contractor, or if we should do that.
- It is assumed that the ash/carbon from this test will be disposed of in “dry storage”. David, is this assumption correct?

Timing of this test was discussed because of the possible implications on the baseline Ontario Hydro tests. The baseline tests are scheduled for March 5 8, less than a week after the ash pond tests. Since we do not know how long the effect of carbon will last in terms of either absorption or speciation of the mercury, we would like to keep the option of conducting the OH tests on the A-side open. This will allow baseline testing on bags that have never been exposed to activated carbon. We should be able to track mercury levels and speciation with Apogee's S-CEMs. Action items related to this are:

- Does SRI have to make any special arrangements to test on A-side?
- Decision on which side to test will be made based on data from S-CEMs. We may not know this until March 5.
- ADA-ES to inform team of date when equipment will be ready for ash pond tests as soon as possible after equipment installation efforts are confirmed.
- Will arrangements for the vacuum truck be made internally by David, or should ADA-ES make arrangements?
- Hopper valves/piping need to be installed by Feb 28.
- Who should the samples be sent to at APC EA?

February 5, 2001

- What if tests show that we should isolate all of the ash/carbon from the tests? We are assuming that this will not be the case.

Please let me know if you have questions or comments. Some of you will hear from Charles or me soon to follow up on these questions.

Thanks for everyone's help.



**ADA Environmental Solutions, LLC**

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# memorandum

---

**To:** David Prater, Byron Corina, Eddie Clayton, Larry Monroe, Ken Cushing, Sharon Sjostrom  
**From:** Jean Bustard  
**CC:** Rich Miller, Connie Senior, Charles Lindsey, Cam Martin, Ken Baldrey, Mike Durham, Richard Schlager, Ramsay Chang, Scott Renninger  
**Date:** February 22, 2001  
**RE:** Testing Schedule for Weeks of Feb 28, March 5 and March 12

---

This memo provides a status update for the DOE mercury test program being conducted on Gaston Unit 3. The original schedule is presented in Figure 1.

At this time we are still on schedule. The injection equipment is being installed this week and should be ready for initial checkout by the end of the week. We will not inject carbon into the baghouse until the mercury analyzers are reinstalled and operating and we have coordinated with David to isolate the B-side COHPAC hoppers. We should be ready to do this next Wed. The following week Southern Research Institute will be on-site with a test crew to make manual measurements of mercury following the modified Ontario Hydro test method. These tests will be conducted across A-side of COHPAC. The parametric tests should begin Monday March 12.

In the next couple of weeks we will start tests that require coordination with unit operation. The following paragraphs provide an overview of the tests and detailed requests for assistance from Plant Gaston.

**Week of February 26:**

Test description: Set analyzers at inlet and outlet of COHPAC on B-side and verify operation. This should be completed on Tuesday. Begin injection system shake down on Wed. Plan is to inject for a short period (about 30 minutes) to monitor effect on mercury removal. After initial screening, which should take about 3 hours, injection system will be turned on and will operate until either a) sufficient quantity of carbon/ash is removed from the hoppers for testing or b) system operation is confirmed. Although exact time and quantity of injection may change, we do expect that this test will be completed by Thursday night. Charles Lindsey and Cam Martin will oversee this test.

Install 3 new Ryton bags into both A- and B-side compartments.

**Alabama Power Assistance:**

1. Arrange to isolate B-side COHPAC hoppers from hydroveyor system. Arrange for vacuum truck to clean hoppers after testing is completed. Send ash/carbon samples to APC Environmental Affairs (identify contact name) for TCLP tests.  
Wednesday Feb 28 – Isolate hoppers  
Thursday Mar 1 – Empty hoppers to vacuum truck
2. Valve COHPAC hoppers back in hydroveyor when tests are completed.
3. Install 3 new Ryton bags into compartments. Ken Cushing will work with Plant Gaston to identify bag locations.
4. Install valves and piping on COHPAC hoppers for ash removal.

#### **Week of March 5:**

Test description: Baseline testing. This is the beginning of the actual “sorberent injection tests”. Goals for this week are to:

- a) **measure baseline mercury following EPA approved test procedures (measurements should be made at full load),**
- b) determine coal and ash sampling procedures, and
- c) determine data collection procedures.

Southern Research Institute (SRI) is the contractor for the Ontario Hydro tests. The primary contact is Joe McCain (205 581 2278). SRI should have made arrangements directly with David Prater for their needs.

It is important that consistent, achievable testing and sampling protocol are established and followed during this period. Data collected during this week will be compared to results obtained during the “performance” (long-term) tests. EPA will audit our sampling protocol during the performance tests. Note: EPA refers to our long-term tests as the performance tests.

A separate memo will be issued identifying the amount of material needed and the frequency of collection for the coal and ash samples. We will want both ESP and COHPAC hopper ash samples in addition to daily coal samples.

#### **Alabama Power Assistance:**

1. Request that Unit 3 be operated at full load on Monday afternoon, Tuesday, and Wednesday. We should keep Thursday available as contingency.
2. Obtain coal samples daily.
3. Collect ESP hopper samples per test plan (to be issued).

#### **Week of March 12:**

Test description: Parametric Test Week 1. Sorberent for this test will be Norit FGD activated carbon. Goals for this test are to:

- a) Determine carbon injection rate to obtain 50, 75 and 90% removal.
- b) Collect coal and ash samples and obtain plant operating data.

The plan is to inject during the day (8:00 am – 6:00 pm) and turn the injection system off at night. Injection rate will start low, less than 0.5 lbs/min, and will be increased incrementally to obtain the target removal levels. The mercury S-CEMs will be in operation across COHPAC 24 hours/day. There is a high probability that the results will require a change in this approach.

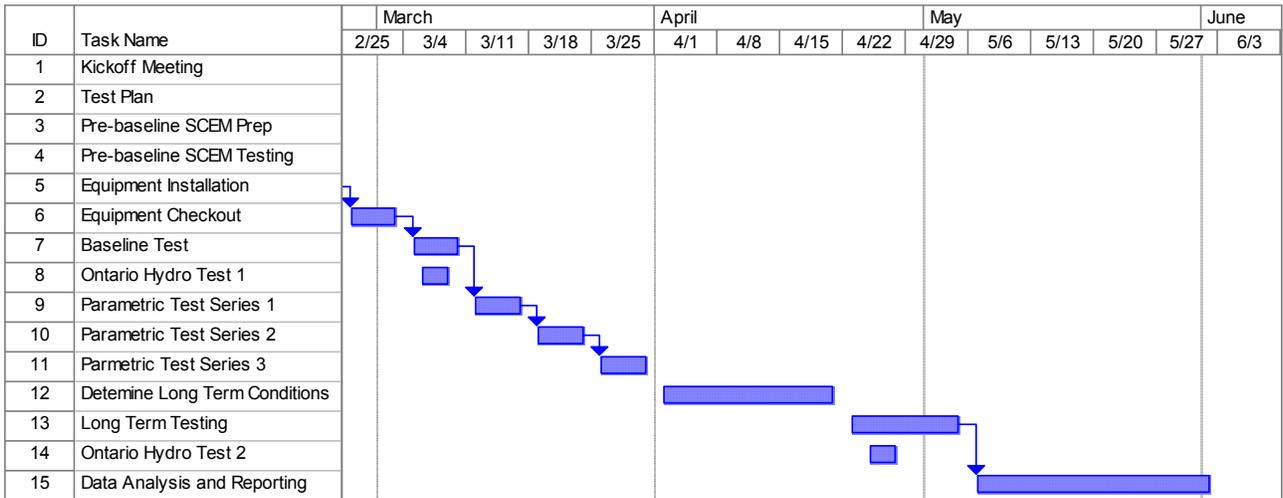
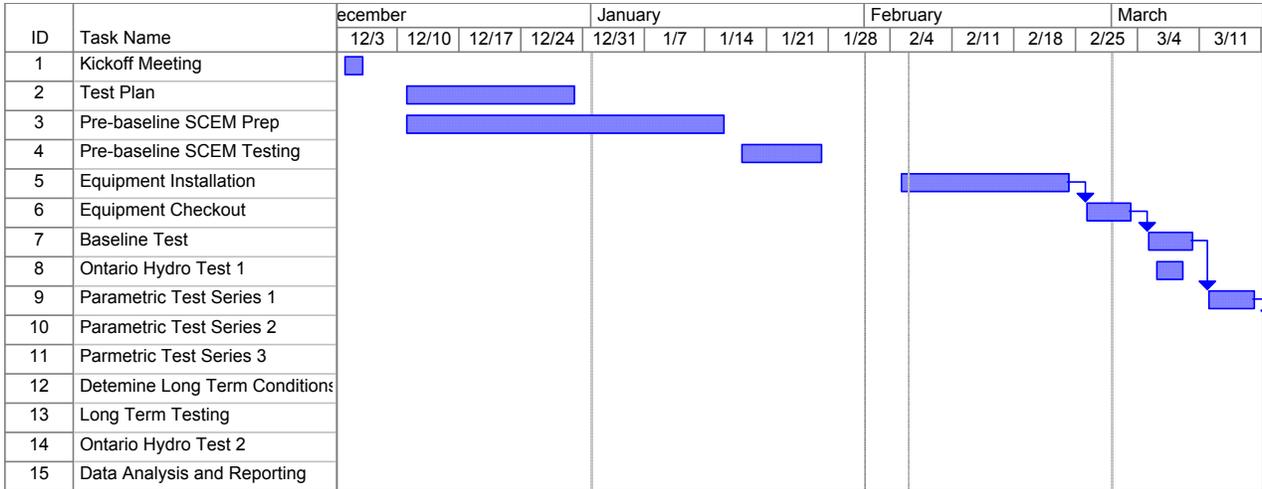
**Alabama Power Assistance:**

- 1) We are assuming that the TCLP tests will show that we do not have to isolate the COHPAC hoppers.
- 2) Request that Unit 3 be operated at full load on Monday through Friday during the day.
- 3) Obtain coal samples daily.
- 4) Collect ESP hopper samples per test plan (to be issued).

**Weeks of March 19 and 26:**

These weeks are set aside for additional parametric tests on different sorbents. The second sorbent will be an activated carbon supplied by Norit called PAC 20B. This is a subbituminous based product. During the third week, the wish is to evaluate ash obtained from the ESP hoppers that is ground to less than 45  $\mu\text{m}$ . My understanding at this time is that a mechanism to actually remove this much ash from the hot-side hoppers has not been determined. We also understand that getting 4,000 pounds of 600+ °F ash from the ESP hoppers is not trivial. Please keep us informed of progress, issues, concerns. etc.

Figure 1



## **APPENDIX C**

### **PARAMETRIC TESTS**

**PLAN FOR PARAMETRIC WEEK ONE TESTS**  
Memo Dated March 7, 2001

**LEACHING TEST RESULTS**  
Memo Dated March 8, 2001

**PARAMETRIC WEEK ONE RESULTS, WEEK TWO  
PLAN**  
Memo Dated March 15, 2001

**PARAMETRIC WEEK TWO RESULTS, WEEK THREE  
PLAN**  
Memo Dated March 25, 2001

**PARAMETRIC WEEK THREE RESULTS**  
Memo Dated May 9, 2001

# ADA Environmental Solutions, LLC



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## memorandum

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---

**To:** Larry Monroe, David Prater, Cam Martin, Charles Lindsey, Travis Starns, Tom Millar, Ken Baldrey, Sharon Sjostrom  
**From:** Jean Bustard  
**CC:** Mike Durham, Richard Schlager  
**Date:** March 7, 2001  
**RE:** Plan for Week 1 Parametric Tests

---

I just talked to Charles (Wed 1700) and Southern Research has completed the Ontario Hydro and particulate tests.

In preparation for next week, this memo presents a proposed test matrix for the first week of parametric testing. Norit FGD activated carbon will be the sorbent used.

As stated in the test plan, we are trying to target three removal rates, 50, 75 and 90%. Table 1 presents the estimated injection rate to achieve these rates. Based on data collected during the leaching sample tests last week, we believe that within the first 30 minutes we will have a pretty good idea of the mercury removal at a given injection rate. The tests last week showed that mercury removal continued to increase with operation, but the change was 10% compared to the 80% seen fairly quickly. Our hope is that we will quickly know if we overshoot a removal efficiency. Data also showed that mercury removal and baghouse operation returned to pre-injection levels after 6 hours. Note: Ken Cushing reviewed COHPAC data from last week and thought the cleaning frequency returned to normal within 2 hours.

**Table 1**  
**Predicted Injection Rates for FGD Carbon on B-Side of COHPAC**

TARGET HG REMOVAL EFFICIENCY (%)	PREDICTED INJECTION RATE (LBS/MIN)
50	<0.5
75	1.0
90	1.5

We are also becoming more confident that mercury concentrations don't vary significantly with boiler operation. S-CEM measurements in January and during the past 2 weeks show inlet concentrations between 7 and 10  $\mu\text{g}/\text{dNm}^3$  regardless of boiler load, and usually were around 9  $\mu\text{g}/\text{dNm}^3$ . There is virtually no mercury removal across COHPAC without carbon injection.

**Goals for the Week 1 of Parametric tests include:**

1. Determine injection rates to achieve nominally 50, 75 and 90% removal.
2. Operate at each target removal rate for a day (would like to see 6 – 8 hours).
3. Determine if continuous injection is required to maintain removal rate between cleans.

Parametric tests are scheduled Monday through Friday, March 12 – 16. Test crew personnel (that will be me and Sharon Sjostrom from Apogee) will be on-site Sunday to start-up the mercury S-CEMs and review Unit 3 operation. If overnight mercury data show similar trends to recent data, we would like to begin injecting carbon sometime on Monday. A proposed test matrix is presented in Table 2.

**Table 2  
Proposed Test Matrix for Week 1 Parametric Test**

Day	Target Removal (%)	Estimated Rate (lbs/min)	Duration (hours)	Test goal
Monday	50%	0.5	4	Determine rate for 50%
Tuesday	50%	0.5	6 - 8	Obtain operating data at 50%
Wednesday	75%	0.75	6 - 8	Obtain operating data at 75%
Thursday	90%	1.5	6 - 8	Obtain operating data at 90%
Friday	TBD	TBD	TBD	Contingency/TBD

**Alabama Power Assistance:**

- We request full load operation between 0800 and 1800 (2000 if possible). ADA-ES will inform operators when injection begins and ends.
- Daily coal samples.
- Periodic manual cleaning of the baghouse may be requested.
- We do not have the TCLP results yet, but I assuming we will not need to isolate hopper ash.



## **ADA Environmental Solutions, LLC**

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# memorandum

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**To:** Larry Monroe, David Prater  
**From:** Jean Bustard  
**CC:** ADA-ES, Apogee  
**Date:** March 8, 2001  
**RE:** Summary of Hg testing week of February 26, 2001

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### **Primary Goals for Week of February 26:**

1. Reinstall Apogee S-CEMs that arrived Monday morning from Salem Harbor.
2. Operate injection system for several hours with COHPAC hoppers isolated from hydroveyors to obtain ash/activated carbon sample for TCLP tests and check out system operation.

### **Completed Tasks:**

1. David Prater installed 3 new Ryton bags into A20 and B20, row 14, bag numbers 25, 26, and 27. These bags will be removed after the long term test for strength tests.
2. Sharon Sjostrom and Tim Ebner installed the two vapor phase mercury S-CEMs at the inlet and outlet of Unit 3, B-side COHPAC. Tim built a third sample probe for COHPAC A-side outlet.
3. Calibrated the carbon injection system. This system was supplied by Norit America. Two representatives from Norit were on-site Wednesday to look at the installation.
4. David Prater made arrangements for procurement and fabrication of valves and piping to facilitate removal of ash hopper samples from the 12 COHPAC hoppers, A- and B-side. Plant Gaston personnel installed.
5. On Thursday afternoon the B-side COHPAC hoppers were isolated from the hydrovactor system.
6. An APC vacuum truck and operators were made available on Friday to evacuate the hoppers.
7. Injected carbon for 30 minutes Thursday night.
8. Injected carbon for 4 hours Friday.
9. Collected ash/activated carbon samples.
10. B-side hoppers evacuated with vacuum truck

11. Requested coal samples.
12. Delivered ash/activated carbon samples to Harold Weston of APC for testing.

### Preliminary Test Results and Analysis:

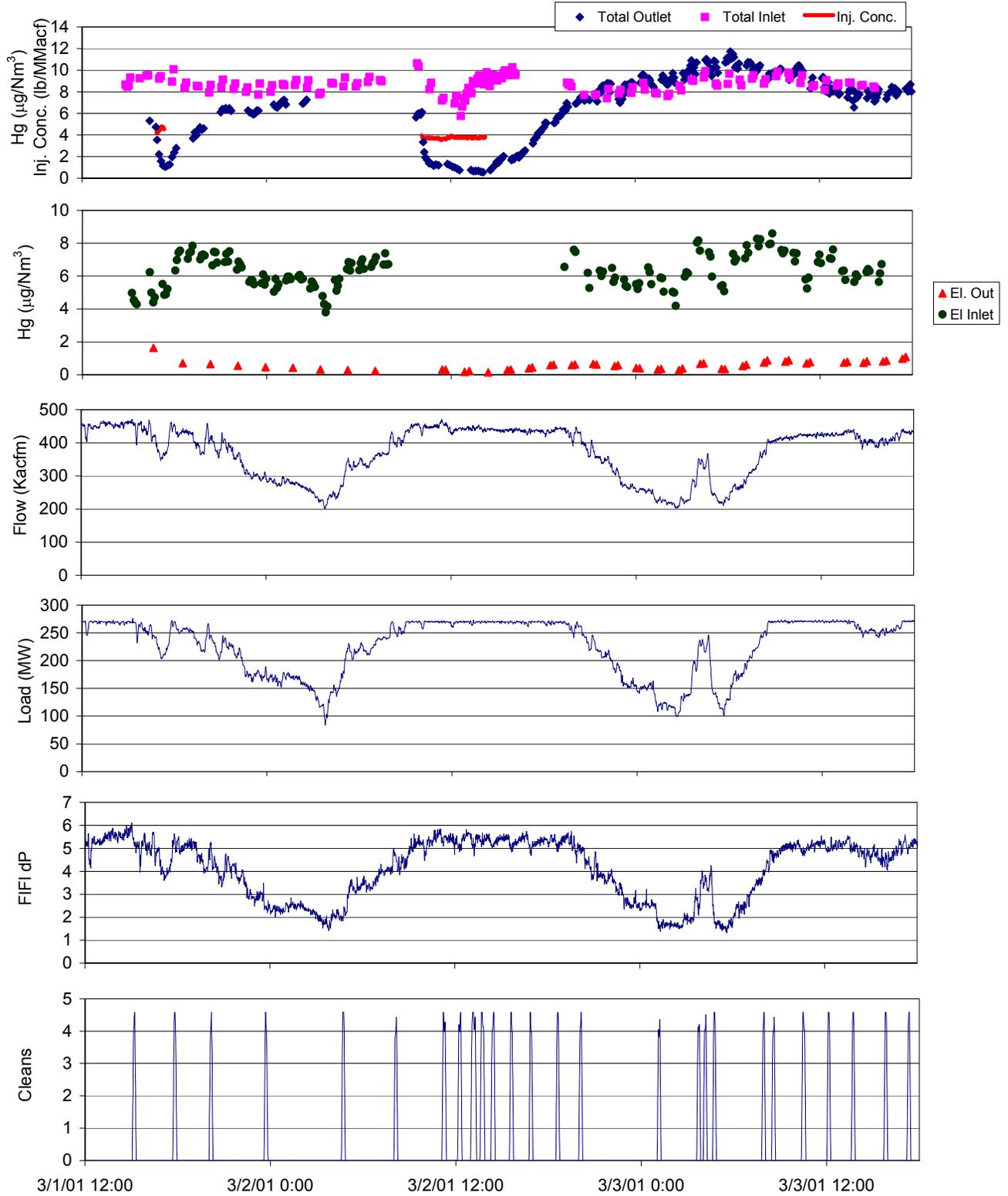
- The attached graphs were provided by Sharon Sjostrom. These graphs show time histories of:
  1. Total vapor phase mercury at the inlet and outlet of COHPAC and carbon injection rate in lb/Mmacf;
  2. Elemental mercury at the inlet and outlet of COHPAC;
  3. B-side COHPAC flow;
  4. Unit 3 boiler load;
  5. B-side COHPAC flange-to-flange pressure drop;
  6. B-side COHPAC cleans.
- A summary of the results are presented in Table 1.
- Previous data presented in the memo dated 030201 showing significant mercury removal (35 – 50%) across COHPAC were incorrect because of low temperatures at the particulate filter. At times it does appear that there may be 10 – 20% removal across COHPAC.
- COHPAC inlet flue gas temperature was about 260°F throughout the tests.
- Inlet mercury concentration is similar to that measurement during prebaseline tests in January.
- Injection system was set at maximum feedrate (100 lbs/h) for both tests. At full load this correlates to an increase in grain loading to the baghouse of about 0.025 gr/acf.
- In the 14 hours prior to the 4-hour test inlet grain loading (measured by the BHA Particulate monitors located in the COHPAC inlet duct) varied between 0.0029 and 0.239 gr/acf, with an average loading of 0.021 gr/acf. On the average, carbon injection doubled the inlet loading.
- **Outlet vapor phase mercury immediately began to decrease when carbon was injected. In the 30 minutes a maximum removal of 88% was measured.**
- **After the injection of activated carbon was halted, outlet mercury appeared to return to pre-test values after about 6 hours. No significant impact on COHPAC performance was noted.**
- The 4-hour test was conducted at full load (270 MW).
- **Similar to the 30-minute test, mercury decreased immediately when carbon was injected and over 80% mercury removal was measured in the first 30 minutes. Mercury removal increased over time during the 4-hour test to a maximum removal of 92%.**
- **Both elemental and oxidized mercury effectively removed with the activated carbon.**
- **COHPAC cleaning frequency increased from nominally once every three hours to once per hour.**
- **After the injection of activated carbon was halted, outlet mercury appeared to return to pre-test values after 6 hours. COHPAC cleaning frequency decreased when injection was stopped. COHPAC performance returned to pre-injection conditions in about 2 hours.**
- After the 4-hour injection test, outlet mercury concentration increased above the inlet concentration. Sharon confirmed that similar behavior has been seen during EPRI tests conducted by Apogee and URS Corporation. After nearly 24 hours the inlet and outlet mercury concentrations were similar.

**Table 1: Preliminary Mercury Concentration Results During Leaching Test**

Condition/S-CEM Locations	Results
Across COHPAC, no injection	Inlet Total: varied between 7.7 and 10.6 $\mu\text{g}/\text{Nm}^3$ Inlet Elemental: varied between 3.8 and 8.6 $\mu\text{g}/\text{Nm}^3$ Outlet Total: varied between 7.0 and 11.7 $\mu\text{g}/\text{Nm}^3$ Outlet Elemental: varied between 0.4 and 1.1 $\mu\text{g}/\text{Nm}^3$ Total removal: nominally 0% Elemental oxidized across COHPAC: ~85%
Across COHPAC, 30 min. injection Injection rate ~ 4.5 lbs/Mmacf	Inlet Total: nominally 9.2 $\mu\text{g}/\text{Nm}^3$ Outlet Total: minimum value 1.1 $\mu\text{g}/\text{Nm}^3$ Total removal: maximum ~88% Hg recovery time: ~ 6 hours
Across COHPAC, 4 hour injection Injection rate ~ 3.8 lbs/MMacf	Inlet Total: varied between 5.8 and 10.3 $\mu\text{g}/\text{Nm}^3$ * Outlet Total: minimum 0.6 $\mu\text{g}/\text{Nm}^3$ Outlet Elemental: varied between 0.1 and 0.3 $\mu\text{g}/\text{Nm}^3$ Total removal: maximum ~92% Hg recovery time: ~ 6 hours

\* Still determining if lower concentrations were caused by carbon injection approximately 10 downstream of analyzer or if analyzer was recovering from changing out chiller.

### Gaston 3B Activated Carbon Injection Leaching Test





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**To:** Larry Monroe, David Prater  
**From:** Jean Bustard, Sharon Sjostrom  
**CC:** ADA-ES, Apogee  
**Date:** March 15, 2001  
**RE:** Preliminary results from Week 1 Parametric Tests, Plan for Week 2

---

### **Primary Goals for Week of March 12:**

1. Perform parametric tests of Norit America's FGD activated carbon.
2. Determine injection rates to achieve nominally 50, 75, and 90% removal.
3. Operate at each target removal rate for 6 – 8 hours.
4. Determine if continuous injection is required to maintain removal rate between cleans.

### **Completed Tasks:**

1. Apogee mercury S-CEMS started up Sunday night.
2. Received go ahead from Larry Monday morning to inject carbon and send ash/activated carbon to the ash pond.
3. Monday: injected at three rates, 20, 25 and 40 lbs/h.
4. Tuesday: injected at 25 lbs/h for 6.5 hours.
5. Wednesday: injected at 60 lbs/h for 2.5 hours and 70 lbs/h for 5.5 hours.
6. Thursday: started injection at very low rate (10 lb/h). After removal rate settled out (3 hours), increase injection rate to 40 lbs/h for about 5 hours.
7. Reviewed data and concluded that sufficient data were collected to develop injection concentration versus mercury removal correlations.
8. Sent Carl Richardson hopper samples from A- and B- side to measure capacity for mercury.
9. APC collected daily coal samples.
10. Collected ash samples from hot-side ESP, B-side COHPAC and A-side COHPAC hoppers.

**Preliminary Test Results and Analysis:**

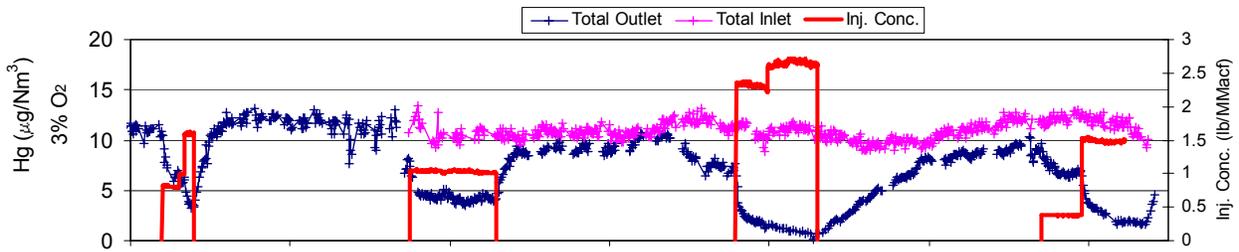
- A summary of the parametric conditions tested during the week of March 12 is presented in Table 1.
- A graph showing mercury concentration at the inlet and outlet during the parametric tests is presented in Figure 1. These data show that inlet mercury concentrations were slightly higher than the previous week, varying between 10 and 12  $\mu\text{g}/\text{dnm}^3$ . This graph also shows when carbon was injected.
- Figure 2 presents removal efficiency with respect to injection concentration. Injection concentration was calculated using B-side flow data from the SRI COHPAC performance computer. Figure 3 presents mercury not removed with respect to injection concentration.
- Figure 4 shows the impact of injection concentration on the number of pulse per hour required to maintain a drag of 0.60.
- Recovery of vapor phase mercury after injection was halted can be seen in Figure 1. On day 1 with a little over 3 hours of injection, outlet mercury concentration returned to pre-injection levels after about 3 hours. Day 2 carbon was injected for about 6 hours and full recovery took 12 hours. Day 3 saw a decrease in mercury concentration when load was increased from nominally 140 to 270 MW. This may have been a result of carbon being stirred-up as flow increased with load. When injection was halted, outlet mercury concentrations did not return to pre-injection levels before testing on Day 4 was started.
- Mercury removal efficiencies in Figures 2 and 3 are the maximum achieved, which usually occurred at the end of the test. At injection concentrations above 0.4 lbs/Mmacf (10 lbs/h), removal efficiency continued to increase for several hours. Filled diamonds identify test conditions run for less than 150 minutes and conditions with greater than 300 minutes are identified by filled squares.
- **Figure 2 shows a strong linear correlation between injection concentration and removal efficiency for test conditions with less than 150 minutes of operation. Figure 3 shows a strong logarithmic correlation between unremoved mercury and injection concentration for test conditions with greater than 300 minutes of operation.**
- **An injection concentration to obtain 90% removal can be projected using the curve fit in Figure 3 to be 2.2 lbs/Mmacf. This is less than the theoretical prediction of 3.0 lbs/Mmacf. Table 2 presents the injection rates and concentrations for 50, 75 and 90% removal based on results with FGD carbon presented in Table 3. Table 2 also shows the predicted injection rates from theoretical models.**
- **A direct correlation between injection concentration and cleaning frequency was seen. This increase in cleaning frequency may become worse with longer operation. Changes in cleaning initiate should be discussed to try and optimize cleaning frequency with this higher inlet mass loading. COHPAC cleaning frequency appeared to recover when injection was halted.**

**Table 1: Summary of Parametric Test Conditions**

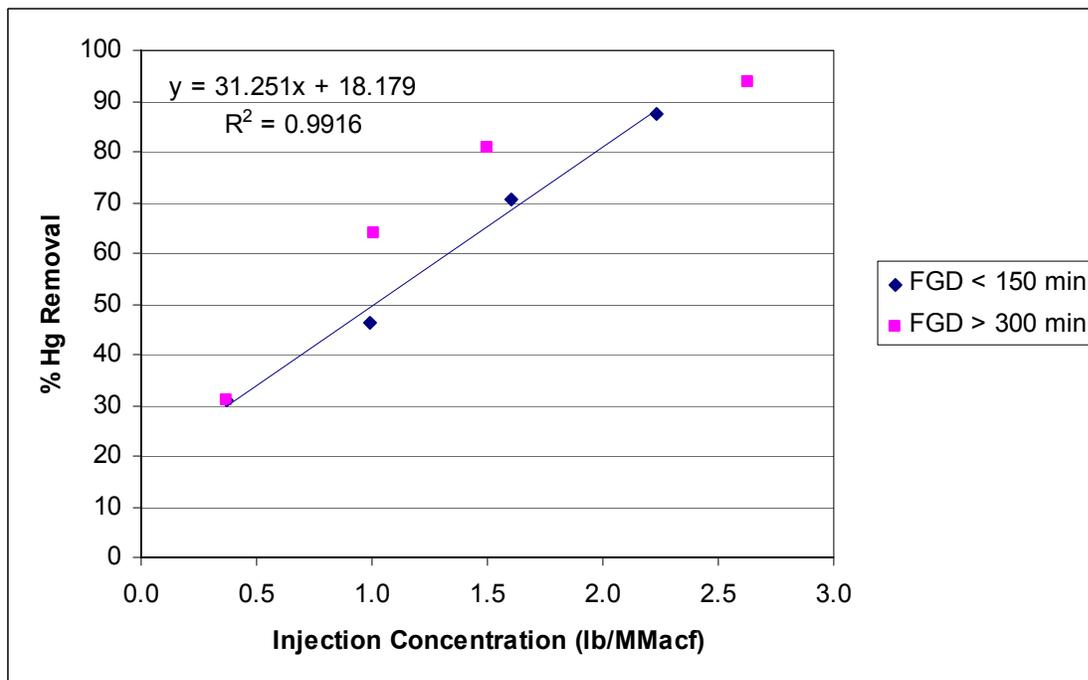
Date	Injection Concentration (lbs/Mmacf)	Feeder Set Point (lbs/h)	Duration (minutes)	Hg Removal at end of test (%)
3/12/01	1.0	25	83	46

3/12/01	1.6	40	120	70
3/13/01	1.0	25	324	64
3/14/01	2.2	60	120	88
3/14/01	2.6	70	307	94
3/15/01	0.4	10	149	31
3/15/01	1.5	40	315	81

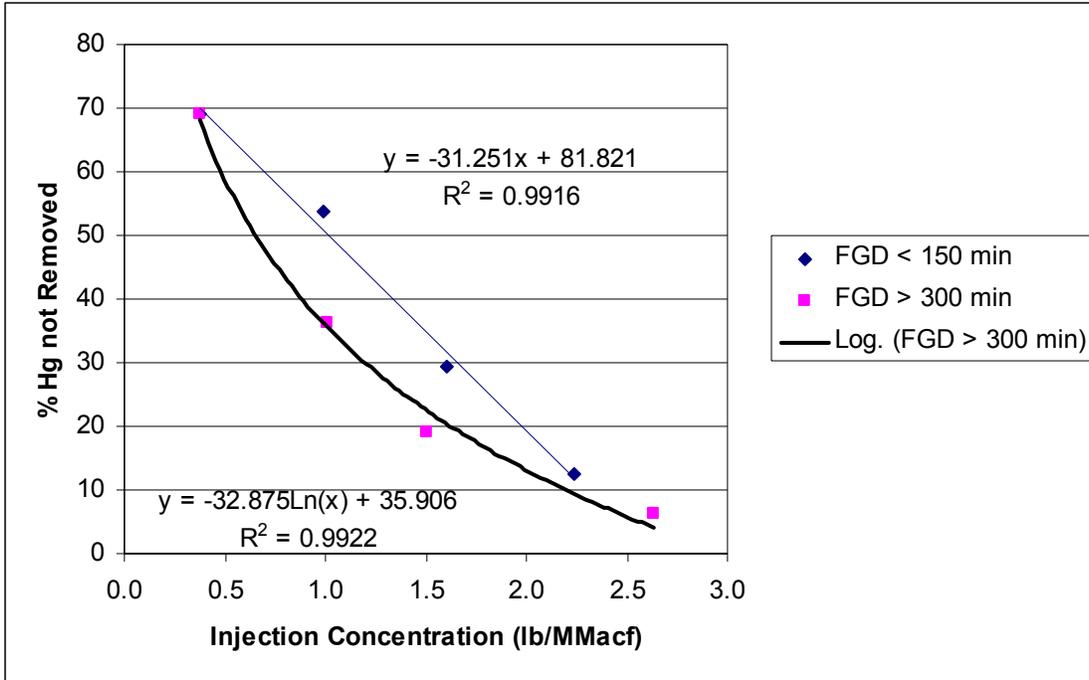
**Figure 1: Inlet and outlet mercury concentration trend graphs**



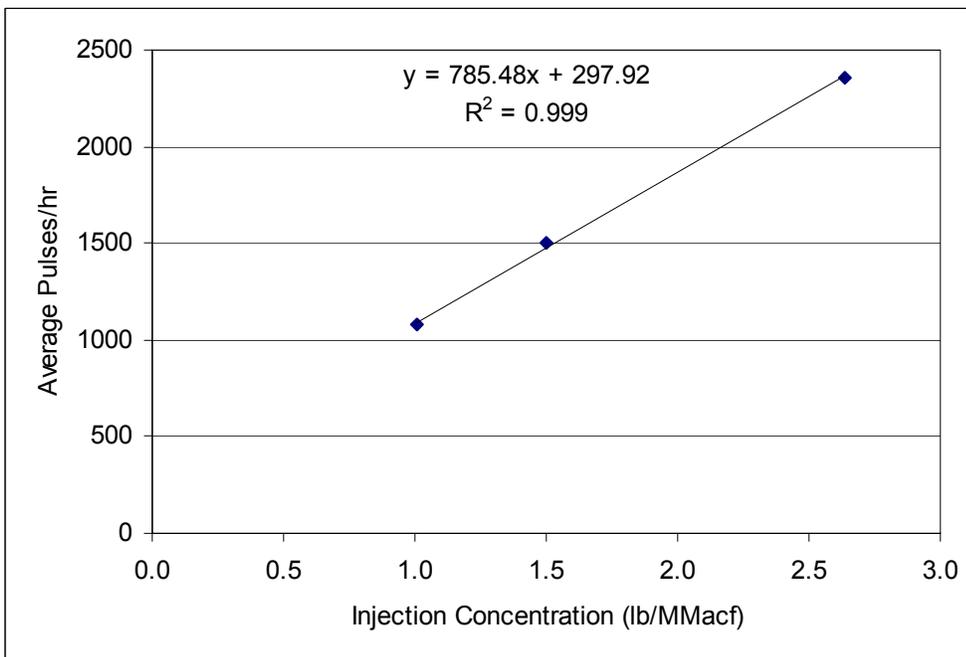
**Figure 2: Mercury removal during week 1 parametric tests**



**Figure 3: Residual vapor phase mercury during week 1 parametric tests**



**Figure 4: Impact of carbon injection on B-side COHPAC cleaning**



**Table 2: Predicted and Measured Injection Rates for Target Mercury Removal**

Target Removal (%)	Predicted Injection		Parametric Test Results	
	(lbs/Mmacf)	(lbs/min) <sup>a</sup>	(lbs/Mmacf)	(lbs/min) <sup>b</sup>
50	1.0	0.5	0.65	0.33
75	2.0	1.0	1.4	0.66
90	3.0	1.5	2.2	1.0

a. Based on estimated flow of 500,000 acfm

b. Based on average actual flow of nominally 420,000 acfm

## Week 2 Parametric Tests

### Goals Include:

1. Conduct performance tests on Norit PAC20B carbon (subbituminous based). This carbon showed higher equilibrium capacity than FGD carbon in laboratory and field screening tests (identified as GAC 830 in screening tests).
2. Inject PAC20B at three injection rates, 20, 40, and 60 lbs/h, targeting 50, 75, and 90% mercury removal. Operate at each condition for about 6 hours.
3. If all goes well, there may be time at the end of the week to start week 3 testing. Proposed test conditions not yet discussed with team members for week 3 include: 1) low flow/load test (determine effect of air-to-cloth ratio on mercury removal), 2) run 1 day at 60 lbs/h to determine if this is the best rate to obtain 90% removal for the long term tests (assuming that 90% removal is the target for the long term tests), 3) TBD after team discussions.

**Table 3: Proposed Test Matrix for Week 2 Parametric Test**

Day	Target Removal (%)	Estimated Rate (lbs/min)	Duration (hours)	Test goal
Monday	50%	0.33	6 - 8	Obtain operating data at 50%
Tuesday	75%	0.66	6 - 8	Obtain operating data at 75%
Wednesday	90%	1.0	6 - 8	Obtain operating data at 90%
Thursday	TBD	TBD	TBD	Contingency/TBD
Friday	TBD	TBD	TBD	Contingency/TBD

### Alabama Power Assistance:

- We request full load operation between 0800 and 2000. ADA-ES will inform operators when injection begins and ends.
- Daily coal samples.
- Periodic manual cleaning of the baghouse may be requested.
- We may request to work with APC to operate at low load (175 MW) for 6 – 8 hours on Thursday.



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**memorandum**

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**To:** Larry Monroe, David Prater, Charles Lindsey, Travis Starns, Sharon Sjostrom  
**From:** Jean Bustard  
**CC:** Ken Cushing, Rich Miller, Ramsay Chang, Mike Durham, Richard Schlager  
**Date:** March 25, 2001  
**RE:** Preliminary results from Week 2 Parametric Tests, Plan for Week 3

---

***Primary Goals for Week 2 Parametric Tests: March 19 - 23***

1. Perform parametric tests of Norit America's PAC-20B activated carbon (made from bituminous coal).
2. Inject PAC20B at three injection rates, 20, 40, and 60 lbs/h, targeting 50, 75, and 90% mercury removal. Operate at each condition for about 6 hours.
3. Operate at each target removal rate for 6 – 8 hours.
4. Thursday and Friday were to-be-determined. These days were used to a) retest low injection concentration of PAC-20B and b) obtain COHPAC performance data at high load with no injection.
5. Meet with Larry and Wallis to discuss long term test conditions.
6. Ramsay Chang, EPRI, and Rene Mengle, Ontario Power visited the site on Thursday.

**Completed Tasks:**

1. Monday: injected PAC-20B at 20 lbs/h for 6 hours.
2. Tuesday: injected at 40 lbs/h for 8 hours.
3. Wednesday: injected at 60 lbs/h for 5.5 hours.
4. Thursday: injected at 20 lbs/h for 2 hours and 30 lbs/h for 1.5 hours.
5. Reviewed data and concluded that:
  - a) mercury removal at 20 lbs/h with PAC-20B was significantly lower than removal at the same rate with FGD, even though at higher rates the two carbons had similar performance. Because of this inconsistency, the test at 20 lbs/h was repeated on Thursday; and
  - b) COHPAC cleaning frequency is high enough during carbon injection that it may not be possible to inject sufficient quantity of carbon for 90% removal within acceptable

baghouse operating conditions for the long term tests. To better understand the impact of carbon on COHPAC operation, during the blocked-out full load period on Friday, no carbon was injected to obtain baseline COHPAC data; and  
 c) it would be interesting to test a coarser carbon that might have less impact on baghouse pressure drop (suggested by Ramsay).

6. APC collected daily coal samples.
7. Collected ash samples from hot-side ESP, B-side COHPAC and A-side COHPAC hoppers. Collected sample of PAC-20B.
8. Fine carbon, "Insul", from Norit arrived. This carbon is a waste product and may provide a cost savings. Also, it was of interest to evaluate the impact of particle size on mercury removal and baghouse operation. This carbon was ordered prior to discussions last week about potential limitations of injection rate due to high cleaning frequencies.
9. Talked with Dennis Restert with Norit and made arrangements for a coarser carbon to be delivered next week. Thanks to Norit for their help in obtaining this alternate product on short notice. Table 1 presents a particle size summary of the four Norit products.

**Table 1: Particle Size of Norit Carbons**

Name	D95 <sup>a</sup>	D50 <sup>b</sup>	D5 <sup>c</sup>
FGD	52	15–20	<2
PAC 20B	52	15-20	<2
Insul	25	6-7	<2
Hydro C	100	30	3

- a. Particle size in microns that 95% of particles are less than.
- b. Particle size in microns that 50% of particles are less than.
- c. Particle size in microns that 5% of particles are less than.

**Preliminary Test Results:**

- Preliminary results with PAC20B were similar to FGD. Although PAC20B showed higher capacity in laboratory and slipstream tests, no significant difference in removal effectiveness was seen at 40 and 60 lbs/h. PAC20B was not as effective as the FGD at the lower injection rate of 20 lbs/h.
- PAC20B had a similar impact on cleaning frequency as FGD.
- Results are still being reviewed and a more detailed analysis will be issued later this week.

***Week 3 Parametric Tests***

**Goals Include:**

1. Conduct performance test on Norit Insul (fine carbon).
2. Evaluate impact of flow (air-to-cloth (A/C) ratio) on mercury removal. Two days are set aside for this test. Carbon will be injected at full load (A/C ~ 7 ft/min) with a target removal

efficiency of 50% (nominally 0.65 lbs/Mmacf) for 1 day. Load will be held at 175 MW (target A/C = 4 ft/min) for one day and carbon will be injected at nominally 0.65 lbs/Mmacf to see if removal efficiency is different. If possible, flows will be confirmed with manual measurements.

3. If the drag setpoint for cleaning is increased, it may be possible to inject at a higher rate than possible with the current drag setting. Increasing the drag setpoint will allow for more ash/carbon to build up on the bag prior to pulsing. In some instances it has been shown that a heavier dustcake cleans better than a light one. The higher drag setpoint will also allow the baghouse to operate at an overall higher pressure drop. This may be necessary with the higher inlet loading with the carbon.
4. It is important to remember that this baghouse cleans on-line. This may contribute to reentrainment of the carbon back onto the bag when pulsed.
5. To evaluate the impact of increasing the drag setpoint on the ability to inject sufficient carbon for 90% removal, a one day test will be conducted with the drag setpoint at 0.74 and a carbon injection rate of 60 lbs/h.
6. A one day test of the coarser carbon will be conducted. Carbon will be injected at 60 lbs/h.
7. A summary of the parametric test conditions for Week 3 is presented in Table 2.

**Table 2: Proposed Test Matrix for Week 3 Parametric Tests**

Day	Carbon	Target Removal	Estimated Rate	Comments
Mon	Insul	50, 75, 90	Start @ 10	Watch cleaning frequency, end test if continuous clean occurs
Tues	FGD	50	10	Load at 175 MW, check A/C
Wed	FGD	50	20	If stable, increase drag setpoint to 0.74 during last 2 hours injection
Thurs	FGD	90	60	Higher drag setpoint
Fri	Hydro C	90	60	If stable, evaluate at 40 lbs/h

**Alabama Power Assistance:**

- We request full load operation between 0700 and 2000 Mon, Wed, Thurs, and Friday. We request 175 MW 0700 to 2000 on Tuesday. ADA-ES will inform operators when injection begins and ends.
- Change drag setpoint and pressure drop setting on Wednesday pm. Timing on this change will depend on test results. Charles, Travis or Sharon will keep David informed.
- Daily coal samples.
- Periodic manual cleaning of the baghouse may be requested.
- A delivery of coarse carbon will arrive mid-week. Request assistance in unloading from truck.



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# memorandum

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**To:** Larry Monroe, David Prater, Charles Lindsey, Travis Starns, Sharon Sjostrom  
**From:** Jean Bustard  
**CC:** Ken Cushing, Rich Miller, Ramsay Chang, Mike Durham, Richard Schlager  
**Date:** May 9, 2001  
**RE:** Preliminary Results from Parametric Tests, Summary of Week 3 Tests

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**Note: These data are for distribution to DOE mercury team members only.**

### **Primary Goals for Week 3 Parametric Tests: March 26 - 30**

1. Conduct performance test on Norit Insul. This product has finer particle size than FGD and is chemically treated.
2. Conduct performance test on coarser FGD product referred to as Hydro C.
3. Evaluate impact of flow (A/C ratio) on mercury removal. Low flow tests to be conducted at boiler load of 175 MW (A/C ~ 4 ft/min).
4. Evaluate impact on cleaning frequency and Hg removal with higher cleaning initiate setpoint.

### **Completed Tasks:**

1. Monday: injected Insul at 12 lbs/h for 5½ hours.
2. Tuesday: injected Hydro C at 60 lbs/h for 6 hours.
3. Wednesday: Conducted increased drag test. Started injection FGD at 40 lbs/h with cleaning initiate setpoint at current drag setting of 0.6. After 2½ hours, increased drag setpoint to 0.74 and injection rate of 40 lbs/hour. Left at this setting overnight. Measured flow at the inlet to COHPAC on both A- and B-side.
4. Thursday: Decreased cleaning initiate setpoint to 0.6. Injected FGD carbon at 23 lbs/h for about 7 hours. Measured flow at A- and B-side COHPAC inlet.
5. Friday: Load steady at 175 MW. Injected FGD at 15 lbs/h for 3 hours.
6. APC collected coal samples.

7. Collected ash samples from hot-side ESP, B-side COHPAC, and A-side COHPAC hoppers. Collected samples of Insul and Hydro C.

#### Preliminary Results:

- Table 1 is a summary of the test conditions, mercury removal and COHPAC cleaning frequency for the 15 parametric tests evaluated in this test series.
- Figure 1 presents mercury removal versus carbon injection concentration as measured during the parametric tests. Figure 2 shows COHPAC cleaning frequency in pulses/bag/h with respect to injection concentration. These graphs were provided by Sharon Sjostrom with Apogee.
- A description of the Norit carbons used during the parametric tests is presented in Table 2. This table includes name, a brief product description, particle size and bulk bag price. Bulk bag price is the commercial price to buy a supersack of these materials.
- **Results with Insul showed high mercury removal at low injection concentrations. Over 90% removal efficiency was achieved at an injection concentration nominally 4½ less than that required for similar removal efficiencies with FGD. Impact on baghouse cleaning frequency was less because the increase in inlet loading was also less by nearly a factor of 5.**
- These results correlate well with EPRI sponsored modeling performed by Frank Meserole. Meserole states that “the sorbent injection rate required to remove a certain fraction of the inlet mercury varies approximately quadratically with the average particle size”. In this case, D50’s decreased from 15–20 microns to 6-7 microns.
- Although results match theory, Insul is a chemically treated carbon product and not just smaller FGD. To assure that the change was just due to the change in particle size, arrangements were made to have FGD ground to a similar size range. Tests with this product will be conducted the week of April 16.
- **Injection with Hydro C showed similar mercury removal efficiencies to those obtained with FGD and PAC20B at similar injection concentrations. The affect of Hydro C on cleaning frequency was slightly lower than the average, but not significantly different (see Figure 2).**
- Because of the significant impact on COHPAC cleaning frequency when carbon is injected, it was of interest to see if allowing a thicker dustcake to form would assist with more efficient removal of the cake when pulsed. To do this, the drag setpoint was increased from 0.6 to 0.74 inches H<sub>2</sub>O/ft/min. At an injection rate of 1.5 lbs/Mmacf (40 lbs/h), it took 3 hours before the first clean. Once the baghouse started cleaning, the time between cleans decreased. The results from this test are inconclusive because what we did not know at the time was that the cleaning program sets the maximum decrease in drag to 0.08 (about ½ inch). We did not run the test long enough to see the long-term effect of the higher drag setpoint.
- **Increasing the drag setpoint and having more carbon on the bag did not increase mercury removal.**
- **Decreasing A/C ratio from 7.0 ft/min to about 4.0 ft/min did not increase mercury removal. Mercury removal at the higher A/C was 58% and at the lower 57%.**

**Table 1: Summary of Mercury Removal and COHPAC Cleaning Frequency From Parametric Test**

Test ID	Date	Norit Carbon Name	Injection Concentration (lbs/Mmacf)	Duration (minutes)	Temperature (°F)	Hg Removal at end of test (%)	Cleaning Frequency (p/bag/h)
1a	3/12/01	FGD	0.8	83	274	46	0.9
1b	3/12/01	FGD	1.6	120	272	69	1.2
2	3/13/01	FGD	1.0	324	267	64	1.4
3a	3/14/01	FGD	2.3	120	272	88	1.5
3b	3/14/01	FGD	2.6	307	272	94	2.9
4a	3/15/01	FGD	0.4	149	266	31	0.8
4b	3/15/01	FGD	1.5	387	267	81	1.9
5	3/16/01	FGD	3.6	232	273	92	4.0
6	3/19/01	PAC20B	0.9	300	269	33	0.9
7	3/20/01	PAC20B	1.7	405	266	82	1.9
8	3/21/01	PAC20B	2.7	275	274	96	2.9
9	3/22/01	PAC20B	0.8	213	279	38	1.0
10	3/23/01	Baseline	0	600	275	0	0.5
11	3/26/01	Insul	0.44	329	280	93	0.6
12	3/27/01	Hydro C	2.3	363	272	94	2.2
13a	3/28/01	FGD	1.5	146	274	59	0.95
13b <sup>a</sup>	3/28/01	FGD	1.5	192	268	80	0.13
13c <sup>a</sup>	3/28/01	FGD	1.9	44	267	82	0.27
14 <sup>b</sup>	3/29/01	FGD	0.85	193	0.85	58	0.95
15	3/30/01	FGD	1.0	183	0.98	57	0.27

a. Drag cleaning initiate increased to 0.74 from 0.6

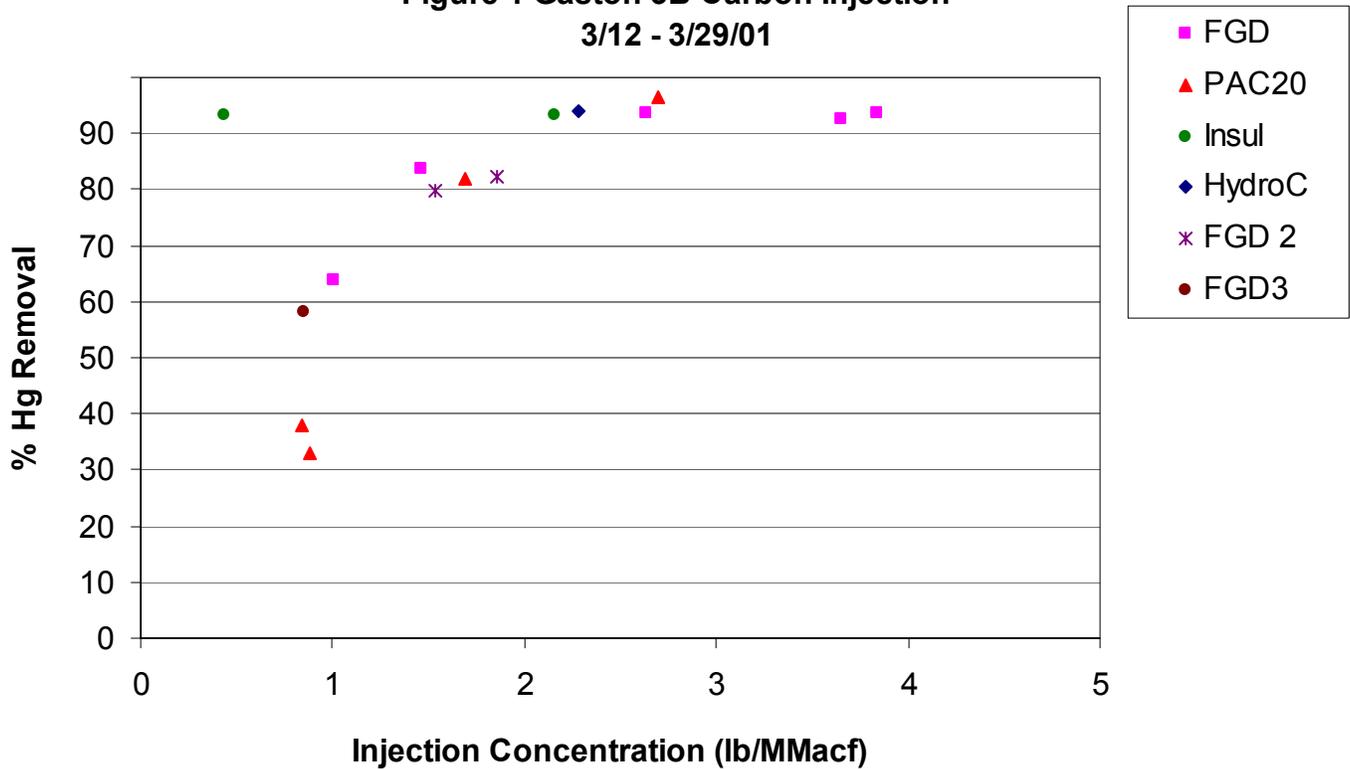
b. Boiler load at 175 MW, A/C = 4.0

**Table 2: Description of Norit Carbons Used in Parametric Tests**

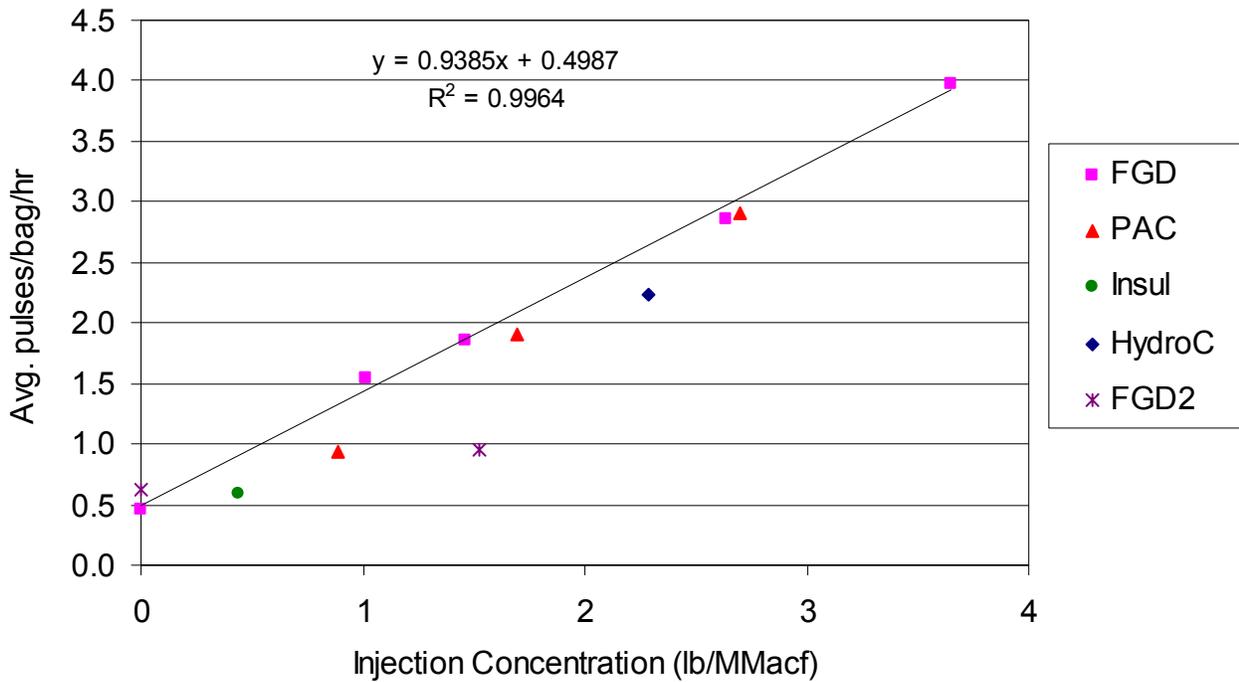
Name	Description	Particle Size Distribution <sup>a</sup>			Bulk Bag Price
		D95	D50	D5	
Darco FGD	Lignite AC	52	15-20	<3	\$0.58
Norit PAC2B	Subbit/Bit Blend AC	52	15-20	<3	\$0.86
Darco Insul	Chemical treated waste product	25	6-7	<2	\$1.31
HydroDarco-C	Coarser FGD	100	30	3	\$0.82

a. Percent of particles less than size in microns

**Figure 1 Gaston 3B Carbon Injection  
3/12 - 3/29/01**



**Figure 2 Gaston 3B FGD Injection  
3/12 - 3/27/01**



**APPENDIX D**

**LONG TERM TESTS**

**ADA Environmental Solutions, LLC**  
8100 SouthPark Way, B-2  
Littleton, Colorado 80120  
Fax: 303.734.0330  
**303.734.1727** or 1.888.822.8617



# memorandum

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**To:** Larry Monroe, David Prater, Ken Cushing, Charles Lindsey, Sharon Sjostrom, Travis Starns, Ken Baldrey  
**From:** Jean Bustard  
**CC:** Mike Durham, Richard Schlager, Scott Renniger, Jim Kilgroe, Rich Miller  
**Date:** April 9, 2001  
**RE:** Proposed Long-Term Test Plan (April 16 – April 27)

---

## **Primary Goals Include:**

1. Inject carbon continuously for ~3 days to obtain longer-term performance data with “fine” FGD activated carbon for mercury removal. Target removal efficiency 90%.
2. Inject carbon continuously for ~7 days with Norit FGD activated carbon to obtain longer-term performance. Injection rate and removal efficiency will be determined based on maintaining COHPAC cleaning frequency around an average 2 p/b/h.
3. Measure flue gas mercury concentration with modified Ontario Hydro tests. These tests will be conducted by Southern Research Institute on April 24, 25, and 26.
4. Obtain performance data with 24 hours/day of full load boiler operation. These conditions are scheduled for Monday – Friday April 23 – 27.
5. Optimize COHPAC cleaning settings to minimize impact of carbon injection on pressure drop and cleaning frequency.
6. Collect ash and coal samples.
7. A summary of the test conditions for each day of the long term test is presented in Table 1.

## **On-site Activities and Support Before and During Long Term Test:**

- One test bag was removed from A- and B-sides on Thursday April 5. These bags will be sent to Theron Grubb for Mullen Burst tests (strength) and pH measurements.
- Cleaning frequency on Unit 3 COHPAC has increased on both sides. Ken Cushing requested that the pressure initiate/terminate setpoints be increased to eliminate interference with the drag initiate/terminate setpoints. Ken also asked to have the cleaning pressure increased.
- In discussions with Ken Cushing and Rich Miller last week, the advantages of cleaning on pressure drop initiate/terminate instead of drag were considered. Based on experience with

Unit 2, which showed better control when using pressure drop initiate, we would like to try pressure drop initiate/terminate on Unit 3.

- On April 8<sup>th</sup> Ken Cushing instructed the operators to change to a pressure initiate with the initiate setting of 7.2 and a terminate setting of 6.5. The cleaning pressure was increased to 10 psi.
- Optimizing baghouse performance with carbon injection during the long-term tests will provide design data on sorbent injection for mercury control at this site and for the design of new systems for other sites. These data will also be used in the economic analysis.
- The long-term/performance test is the culmination of the mercury control evaluation at Plant Gaston. This program has a large number of supporters and team members that are very interested in seeing the set-up and results. To accommodate this interest, meetings are planned for April 18 at Plant Gaston. In addition, others may visit the site at various times during the long-term test. Either Larry or I will do our best to keep David informed of who may come to the site.
- Data from the long-term/performance test is vital to meeting the overall objective of this program. The test crew requests that visitors do not interfere with their daily activities and that people do not spend time in the test trailer without good reason. Please direct visitors either to Mike, Larry or myself.
- Apogee's S-CEMs will be used to facilitate process optimization. The Ontario Hydro tests will provide our final reportable data.
- Two carbon deliveries will be made during the week of April 9. A supersack of the ground FGD from Process Industries should arrive on Tuesday April 10. Twelve supersacks of Norit FGD carbon should arrive on Thursday April 12.
- Jim Kilgroe (EPA) is looking into funding additional Ontario Hydro Tests across the hot-side ESP. We will keep everyone informed of this change in plan.

#### **Alabama Power Assistance:**

- We request full load operation from 0800 to 2000 Monday through Sunday April 16-22.
- We request full load operation 24 hours per day Monday through Friday at 1800, April 23-27.
- Daily coal samples.
- Periodic changes to COHPAC cleaning setting will be requested.
- Support in unloading carbon deliveries on Tuesday and Thursday April 10 and 12. (One bag from Process Industries on Tuesday, 12 bags from Norit on Thursday).
- We have requested certain plant operating data (stack CEM, coal, etc.). We will need these data at the end of the long-term test.
- Southern Research Institute will bring a test crew and truck on-site Monday April 23. The truck will be set next to our trailer. They will be testing through Thursday April 26.

**Table 1: Proposed Test Matrix for Long Term Test Tests (April 16 – 27)**

<b>Day</b>	<b>Carbon</b>	<b>Load</b>	<b>Est. Rate (lbs/Mmacf)</b>	<b>Comments</b>
Mon	Baseline	Full load during day	0	Obtain baseline COHPAC data
Tues	Ground FGD	Full load during day	0.5	Compare ground FGD to Insul performance. Begin 24 h/day injection.
Wed	Ground FGD	Full load during day	0.5	Long term test of ground FGD
Thurs	Ground FGD	Full load during day	0.5	Long term test of ground FGD. Turn carbon off at end of day to observe Hg recovery rate.
Fri	FGD	Full load during day	1.0+	Reset COHPAC cleaning initiate parameters. Start carbon at low rate and increase to obtain highest Hg removal within acceptable COHPAC cleaning.
Sat	FGD	Full load during day	TBD	Increase injection rate to obtain highest Hg removal within acceptable COHPAC cleaning.
Sun	FGD	Full load during day	TBD	Assume that the optimum injection rate is has been determined.
Mon	FGD	Full load 24 hours/day	TBD	Obtain operating data with continuous full load conditions. Ontario Hydro test setup day.
Tues	FGD	Full load 24 hours/day	TBD	Obtain operating data with continuous full load conditions. Ontario Hydro test setup day.
Wed	FGD	Full load 24 hours/day	TBD	Obtain operating data with continuous full load conditions. Ontario Hydro test. EPA audit
Thurs	FGD	Full load 24 hours/day	TBD	Obtain operating data with continuous full load conditions. Ontario Hydro test.
Fri	FGD	Full load until 1600	TBD	Shut down injection at 1000.

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Littleton, Colorado 80120  
Fax: 303.734.0330  
**303.734.1727** or 1.888.822.8617



# memorandum

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**To:** Larry Monroe, David Prater, Joe McCain, Ken Cushing, Rich Miller, Sharon Sjostrom, Connie Senior, Scott Reninger, Jim Kilgroe Michael Durham, Richard Schlager, Cam Martin, Steve Johnson, Charles Lindsey, Travis Starns

**From:** Ken Baldrey, Jean Bustard

**CC:**

**Date:** May 2, 2001

**Re:** **Test Completeness:** Gaston DOE Mercury Long-Term Performance Evaluation

---

The long-term Performance Evaluation for the Gaston Unit 3 DOE Mercury demonstration was completed as planned April 2001. During this period, source sampling and other tests as listed in the project Test Plan and the Quality Assurance Project Plan were successfully conducted. Some observations on the test are included in this memo. Table 1 summarizes the completed test results.

## Process

As requested, unit operation was maintained at a steady, full load condition throughout the week. This contributed greatly to successful completion of the test schedule.

Although cleaning frequency of the baghouse with continuous carbon injection was a major concern, injection rate was not restricted by cleaning during the long-term test. Going into the test, the baghouse cleaning was about 1.1 pulses/bag/hour with carbon injection, less than the agreed-to "action limit" of 1.5 pulses/bag/hour. Therefore it was possible to maintain the injection rate necessary to achieve a high removal efficiency. Prior to the test Unit 3 had been off for several days; this effectively boosted the short-term ESP performance and contributed to the acceptable cleaning frequency.

Carbon was injected 24 hours/day with no interruptions. Calibration checks of the feed rate indicated that carbon injection was relatively steady unless the Super Sacs were nearly empty, then it declined by as much as 25% until a new sack was connected. Overall quantity injected matched closely with the calibration spot checks.

Process data was logged at 1- minute intervals throughout the test period. There was an intermittent problem with a hard drive failure on a plant computer that caused loss of some logged data overnight on April 25 and 26 and all data from April 28. However, complete data was obtained for all critical sampling periods.

### **Source Testing**

A complete set of Ontario-Hydro sample runs were conducted by SRI on each of April 24, 25 and 26. Sampling results were acceptable for all of these runs; final results are pending laboratory analysis. One identified deficiency in the sampling was the inability to test simultaneously at the COHPAC inlet and outlet locations. This was primarily a result of equipment problems at the inlet location. Fortunately process and sorbent injection conditions were extremely steady throughout so that this is only a minor concern.

Ontario-Hydro samples were additionally run by Arcadis at the ESP inlet, as requested by EPA. SRI also contributed one person to help at this location and prepared and recovered the sample trains. Analysis of these samples will be conducted along with the other samples for the Performance Evaluation.

An audit of the sampling methodology and test procedures was conducted by EPA on April 25. Final results are pending, but no serious deficiencies were identified.

### **Coal and Flyash Sampling**

Flyash samples were collected daily at the ESP inlet, COHPAC A, and COHPAC B hoppers. Coal samples were taken daily by APC at the inlet to the coal bunkers. A coal sample was not obtained for April 23. The plant coal quality lab was contacted to see if a split could be obtained for this sample day, but there was insufficient material. Therefore, this day was missed entirely.

Due to the continuous full load on the unit, the Unit 3 coal bunkers were running low during much of the week. It is uncertain how long the residence time was to firing, but it was probably less than the typical 10 – 12 hours. Therefore, it may prove impossible to match a given coal analysis with a specific sample run. If a long-term evaluation at this site is contemplated, coal sampling procedures should be reevaluated.

### **Mercury Monitors**

Apogee Scientific sampled with their extractive monitors at the COHPAC inlet and outlet locations. Data was collected through the majority of the test period. In particular, data was taken simultaneously with each of the Ontario Hydro sample runs. Preliminary results from the S-CEMs indicate 85 – 92% mercury removal at a sorbent injection concentration of 1.5 lbs/Mmacf. Although this is based on sampling at a single point rather than a full traverse it should provide a good comparison to the manual Ontario Hydro tests.

### **Further Work**

All recovered Ontario Hydro samples will be submitted to the analytical laboratory within the next week along with method blanks and prepared QA/QC spikes. Final results should be available within the 45 day holding period or no later than June 15, 2001.

Selected coal and ash samples will be forwarded to Dr. Senior at PSI and then to the analytical subcontract laboratories (Microbeam Technologies, UND EERC, and Hawk Mountain Labs). Results from these tests should also be available by June 15.

**Final results from the Mercury S-CEMs are pending review of data and calibrations by Apogee.**

**Table 1: Test Matrix for Performance Evaluation**

Sampling Location	No. of Runs	Parameters	Sampling Method	Tests Completed	Remarks & Comments
COHPAC Inlet B-side	3	Speciated Hg, moisture, flow, O <sub>2</sub> /CO <sub>2</sub>	Ontario Hydro and EPA Methods 1 - 4	One test per day on 4/24 4/25 and 4/26	OH tests successfully completed each scheduled test day. Simultaneous inlet/outlet testing was not achieved due to equipment failures at inlet location.
COHPAC Outlet B-side	3	Speciated Hg, moisture, flow, O <sub>2</sub> /CO <sub>2</sub>	Ontario Hydro and EPA Methods 1 - 4	One test per day on 4/24 4/25 and 4/26	See above.
ESP Inlet	3	Speciated Hg	Ontario Hydro and EPA Methods 1 - 4	One test per day on 4/24 4/25 and 4/26	Arcadis/SRI additional tests as requested by EPA.
Coal Belt Unit 3	Daily composite	Ultimate/Prox. Hg, Cl in Coal	Composite	Sample not obtained 4/23	Bunkers were low through much of test. Residence time to boiler uncertain.
ESP Hoppers	Daily	Hg, LOI in Ash	Grab	ESP ash samples collected for each sample day.	Fresh ash samples taken from front field hoppers
COHPAC Hoppers B-side	Daily	Hg, LOI in Ash, Hg leachability, Hg Thermal Stability	Grab	Ash samples collected for each sample day.	
COHPAC Hoppers A-side	Daily	Hg, LOI in Ash	Grab	Ash samples collected for each sample day.	
Plant Process Data (COHPAC logging computer)	Continuous	Unit Load, Stack opacity, flue gas temp., baghouse data	1 minute logged data	Data collected for all critical sampling periods.	Overnight data from 4/25 - 4/26 a.m. not available due to plant computer malfunction.
ADA-ES Sorbent Injection Skid	Daily, each feedrate change	Sorbent injection rate	Gravimetric grab plus Screw Feeder RPM	Sorbent rate verified each sample day and for each feed rate change.	
COHPAC Inlet Mercury Monitor	Semi-continuous	Vapor phase speciated mercury	Extractive, impinger-based	Data collected for all critical sampling periods.	Data S-CEM data subject to final quality screening
COHPAC Outlet Mercury Monitor	Semi-continuous	Vapor phase speciated mercury	Extractive, impinger-based	Data collected for all critical sampling periods.	Data S-CEM data subject to final quality screening

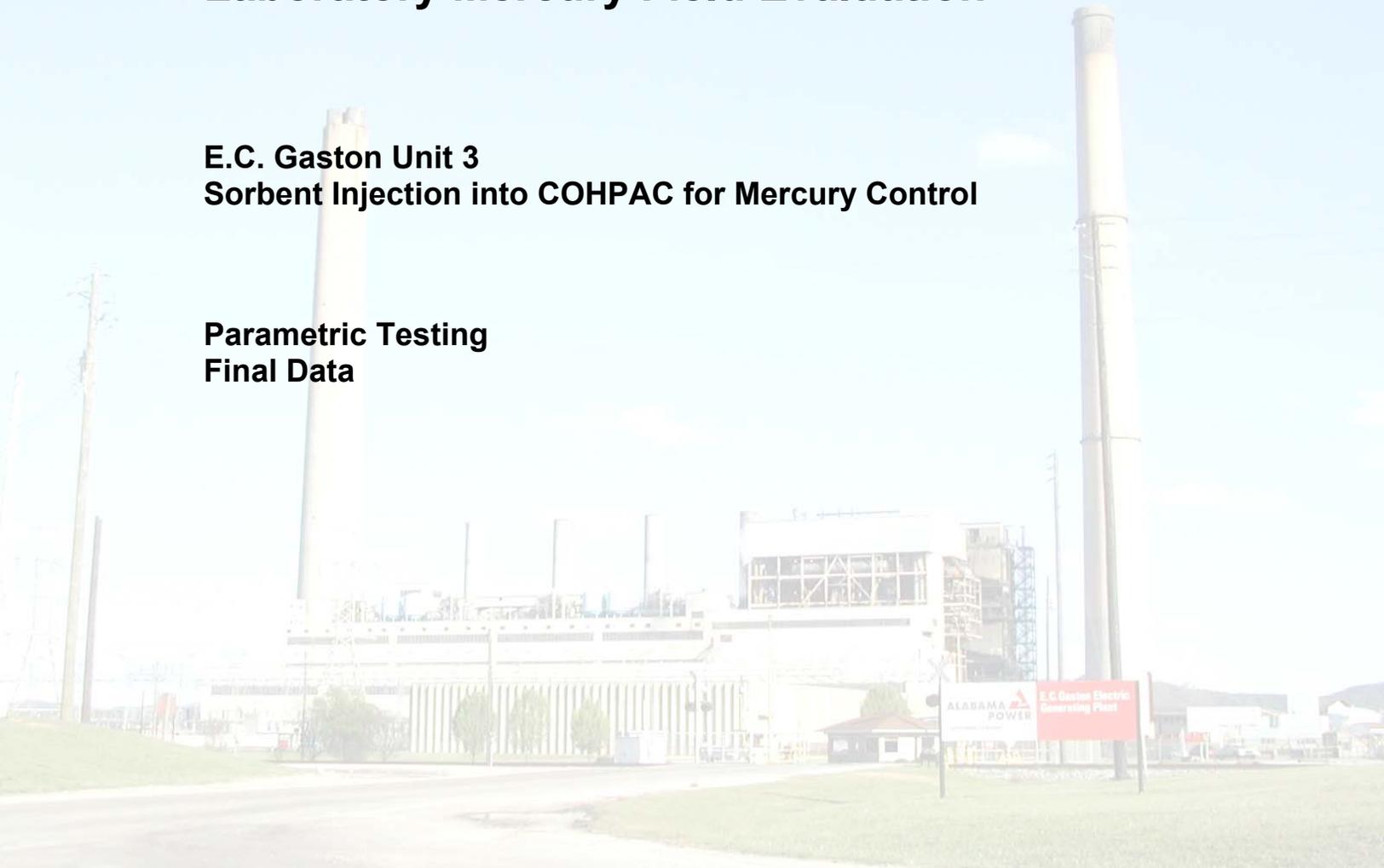
# **APPENDIX E**

## **SCEM Data**

# **DOE National Energy Technology Laboratory Mercury Field Evaluation**

**E.C. Gaston Unit 3  
Sorbent Injection into COHPAC for Mercury Control**

**Parametric Testing  
Final Data**

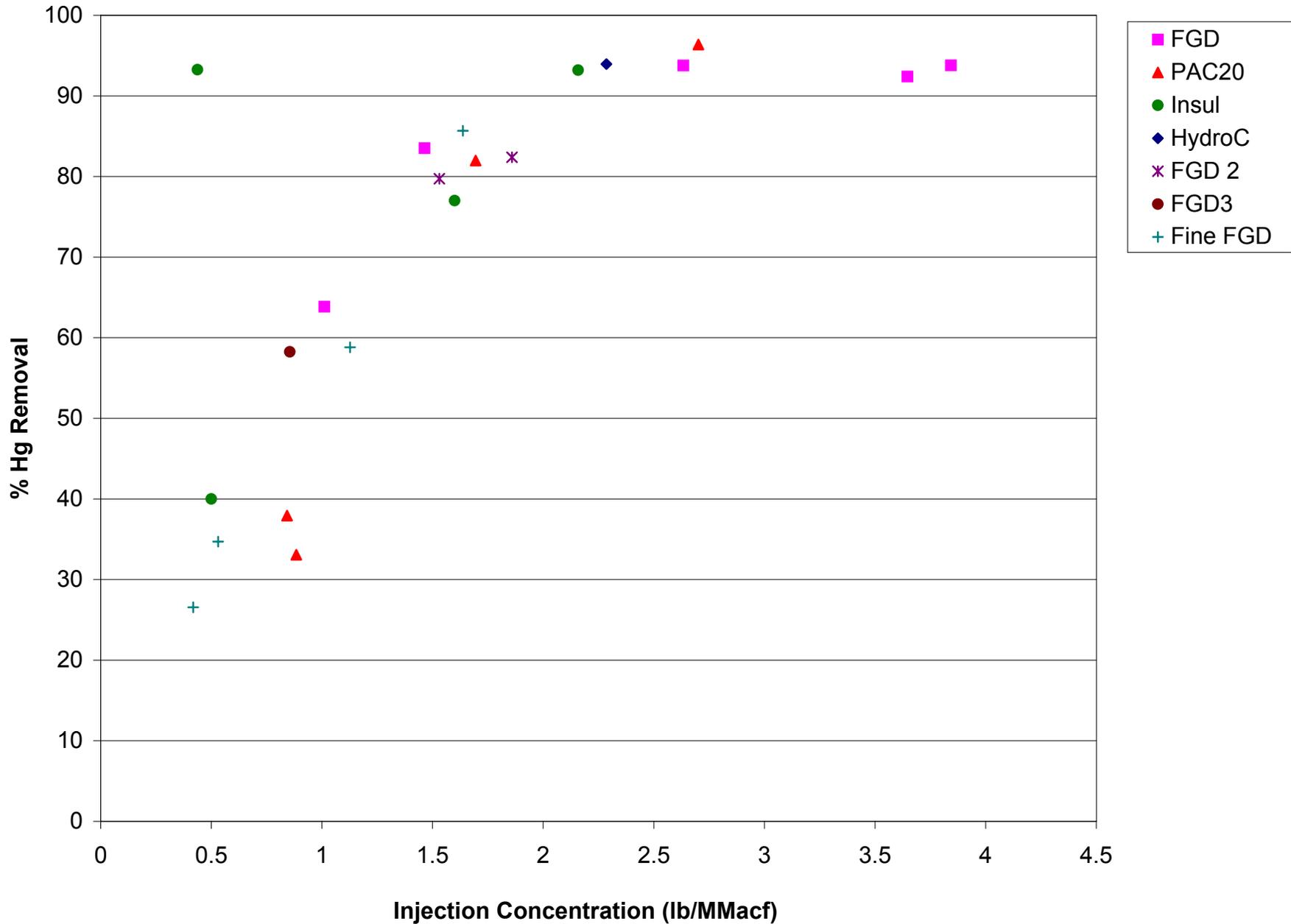


**Prepared by:  
Apogee Scientific, Inc.  
2895 West Oxford Avenue  
Englewood, CO 80110  
(303) 783- 9599**

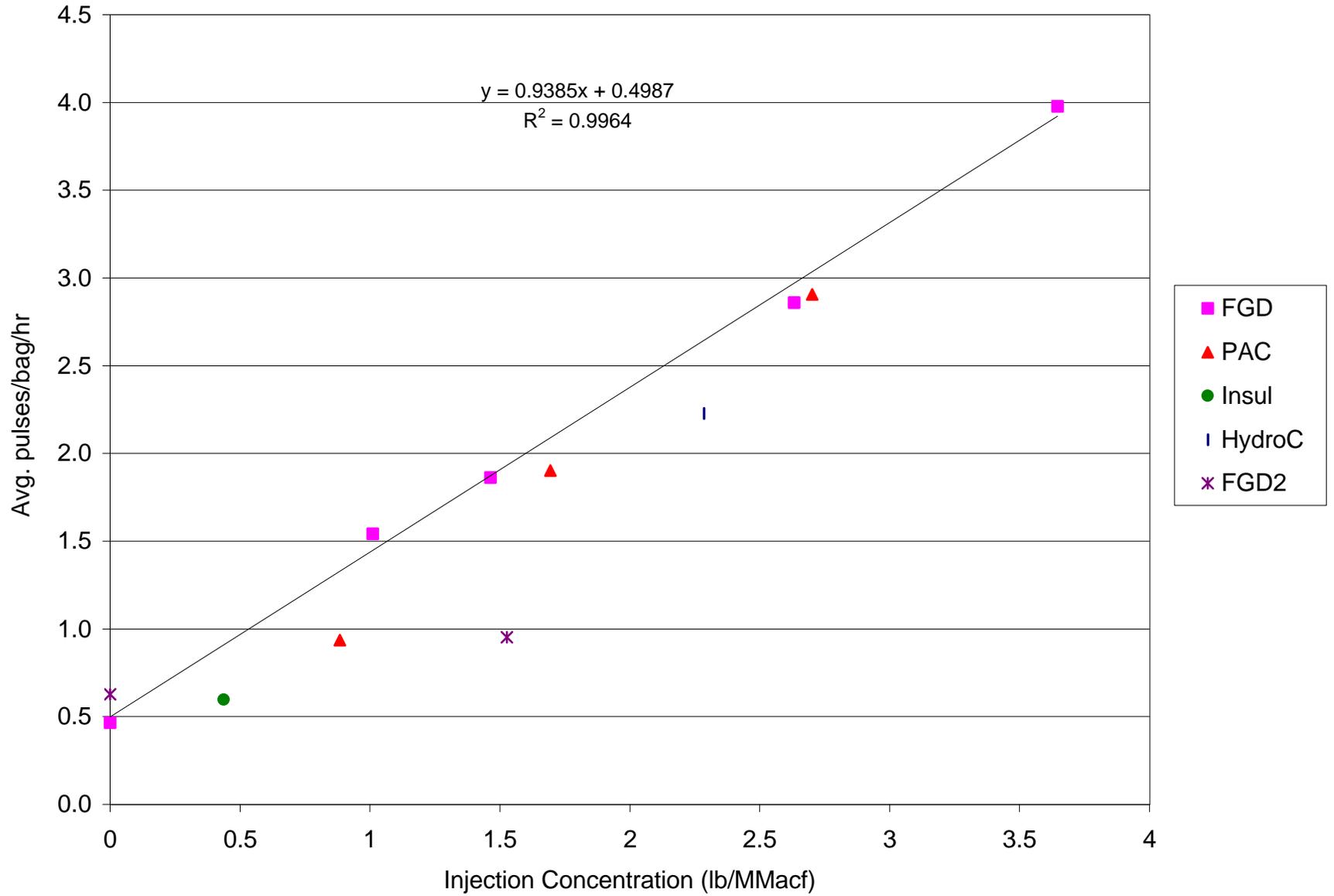
### Gaston 3B COHPAC Parametric Testing

Date/Time	Sorbent	Injection rate lb/hr	Injection Concentration lb/Mmacf	COHPAC flow acfm	A/C Ratio ft/min	Inlet Temp F	FI-FI dP	Load MW	Avg. Pul./hr during test	Avg. P/b/hr	Injection Duration (min)	Inlet Hg ug/Nm3	Outlet Hg ug/Nm3	Hg Removal %	gr/acf ash (BHA)	gr/acf carbon
3/2/2001 11:19	FGD	100	3.6	463897	7.3	274	5.6	271	125	0.8	61	9.8	1.4	86	0.039	0.025
3/12/2001 15:37	FGD	20	0.8	423305	6.6	271	4.8	270	136	0.9	61	11.7	6.3	46	0.052	0.006
3/12/2001 16:24	FGD	40	1.6	417441	6.6	267	5.4	272	182	1.2	100	11.7	3.6	69	0.057	0.011
3/13/2001 10:12	FGD	25	1.0	402990	6.3	264	5.0	272	118	0.8	60	11.5	4.6	60	0.043	0.007
3/14/2001 10:42	FGD	60	2.3	430245	6.8	272	5.0	270	212	1.4	60	10.8	2.1	81	0.036	0.016
3/15/2001 9:42	FGD	10	0.4	448388	7.0	266	5.5	270	123	0.8	60	10.2	6.7	34	0.048	0.003
3/16/2001 9:11	FGD	100	3.7	447909	7.0	269	5.4	269	677	4.3	60	10.2	1.0	90	0.043	0.026
3/2/2001 14:14	FGD	100	3.8	433744	6.8	272	5.4	268	191	1.2	207	9.8	0.6	94	0.036	0.027
3/13/2001 15:29	FGD	25	1.0	412254	6.5	267	4.7	272	242	1.5	324	11.5	4.2	64	0.043	0.007
3/14/2001 15:39	FGD	70	2.6	443072	7.0	272	5.2	270	449	2.9	307	11.2	0.7	94	0.036	0.018
3/15/2001 16:14	FGD	40	1.5	455607	7.2	267	5.6	270	292	1.9	387	10.2	1.7	84	0.045	0.010
3/16/2001 12:37	FGD	100	3.6	457063	7.2	273	5.3	270	624	4.0	232	10.2	0.8	92	0.040	0.026
3/19/2001 14:30	PAC20	21.9	0.9	413634	6.5	269	5.3	271	147	0.9	300	10.2	6.8	33	0.027	0.006
3/20/2001 17:50	PAC20	43.9	1.7	431448	6.8	266	5.4	271	299	1.9	405	9.6	1.7	82	0.030	0.012
3/21/2001 14:15	PAC20	65.8	2.7	405988	6.4	274	4.6	270	456	2.9	275	9.7	0.4	96	0.020	0.019
3/22/2001 14:30	PAC20	21.9	0.8	434217	6.8	279	5.4	270	219	1	213	10.3	6.4	38	0.024	0.006
3/23/2001 10:20	Baseline	0	0.0	434033	6.8	275	5.5	270	73	0.47	0	11.5	11.5	0	0.024	0.000
3/26/2001 8:20	Baseline	0.0	0.00	411750	6.5	272	5.0	270	60	0.38	0	12.5	12.3	2	0.032	0.000
3/26/2001 16:20	Insul	11.6	0.44	442326	6.9	280	5.5	270	94	0.60	329	12.9	0.9	93	0.032	0.003
3/26/2001 16:45	Insul	58.1	2.16	448453	7.0	280	5.2	269	116	0.74	350	12.6	0.9	93	0.050	0.015
4/28/2001 0:00	Insul		0.50											40		
4/29/2001 0:00	Insul		1.60											77		
3/27/2001 8:00	None	0.0	0.00	410045	6.4	264	5.1	270	186	1.19	0	10.7	8.9	17	0.036	0.000
3/27/2001 16:00	HydroC	60.0	2.29	437503	6.9	272	5.7	269	350	2.23	363	10.1	0.6	94	0.038	0.016
3/28/2001 8:15	None	0.0	0.00	434974	6.8	267	5.1	271	98	0.63	0	10.2	10.2	0	0.040	0.000
3/28/2001 11:10	FGD	40.0	1.53	436461	6.9	274	5.3	271	149	0.95	146	9.7	4.0	59	0.035	0.011
3/28/2001 15:00	FGD	40.0	1.53	435583	6.8	268	6.2	270	21	0.13	338	10.1	2.0	80	0.038	0.011
3/28/2001 17:54	FGD	50.0	1.86	448294	7.0	267	5.8	268	42	0.27	482	9.6	1.7	82	0.037	0.013
3/29/2001 13:08	FGD	23.0	0.85	448472	7.0	264	5.1	270	149	0.95	193	9.7	4.0	58	0.030	0.006
3/30/2001 18:00	FGD	15.0	0.98	255550	4.0	262	2.7	175	42	0.27	183	13.5	5.8	57	0.016	0.007
4/27/2001 12:43	FGD Fines	10.9	0.4			297						9.5	7.0	27		
4/27/2001 14:50	FGD Fines	14.0	0.5			301						9.5	6.2	35		
4/27/2001 15:35	FGD Fines	30.3	1.1			302						9.5	3.9	59		
4/28/2001 16:30	FGD Fines	41.3	1.6			308						12.3	1.8	86		

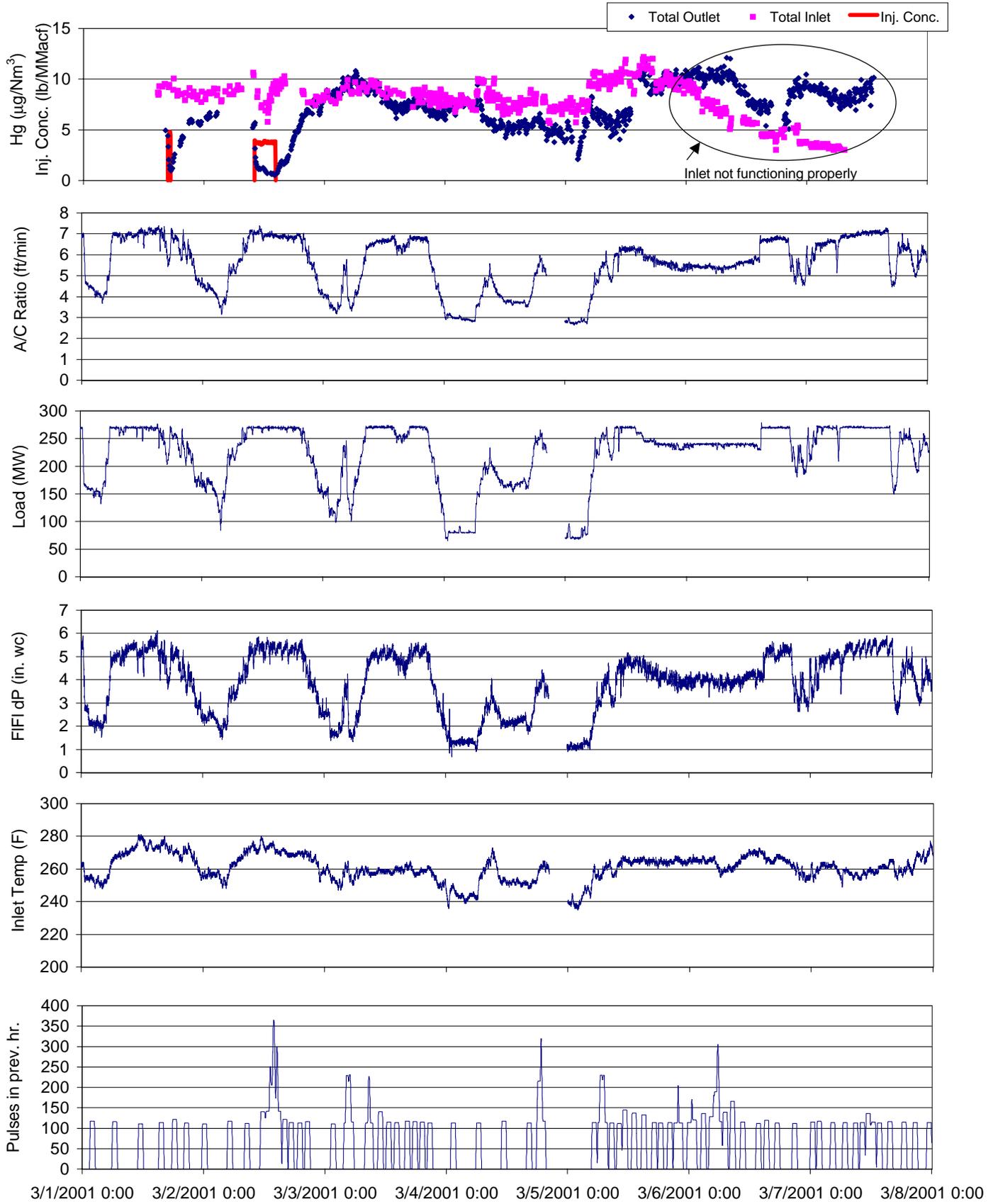
**Gaston 3B Carbon Injection**  
**3/12 - 4/29/01**



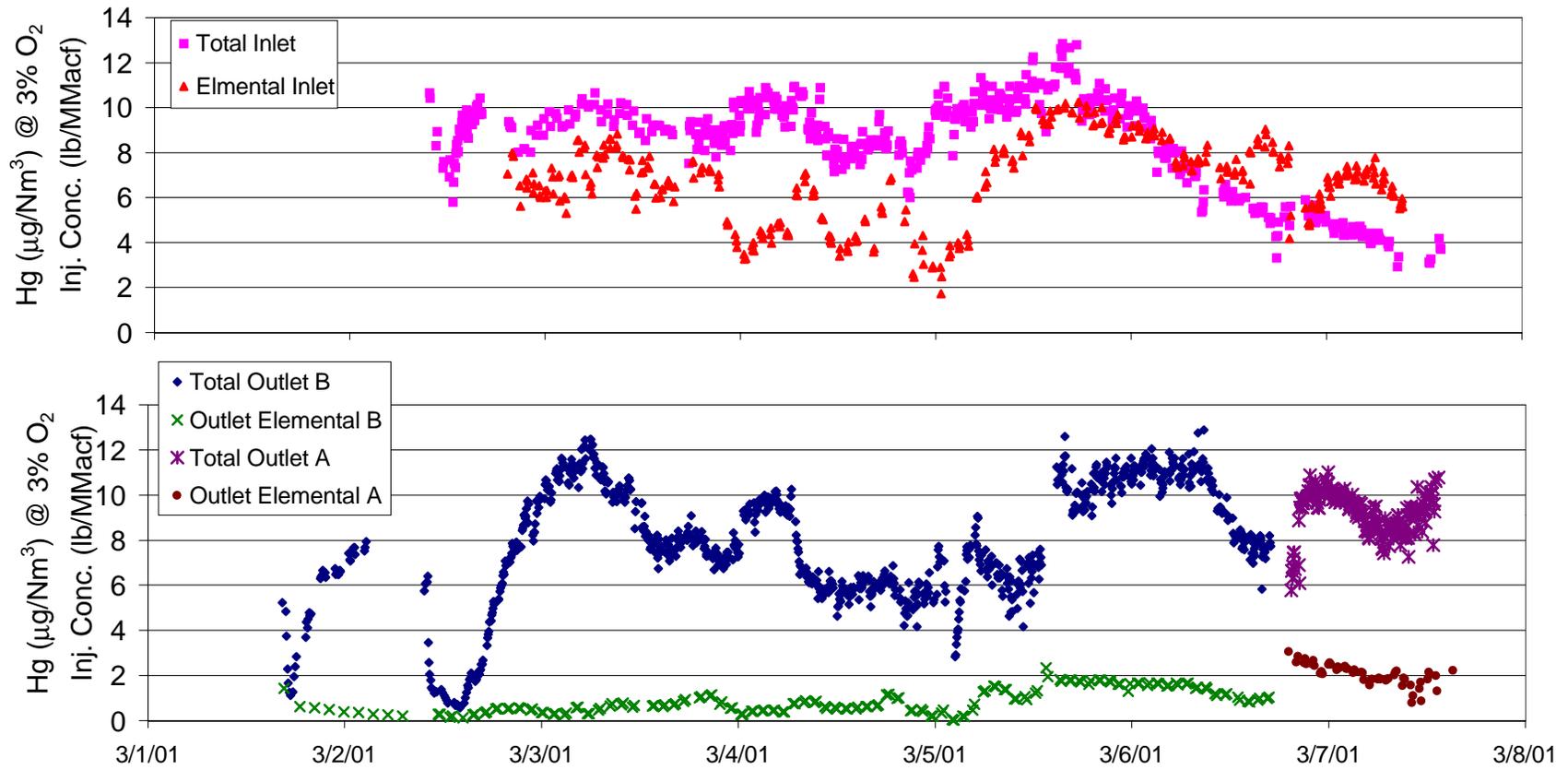
**Gaston 3B FGD Injection**  
**3/12 - 3/27/01**



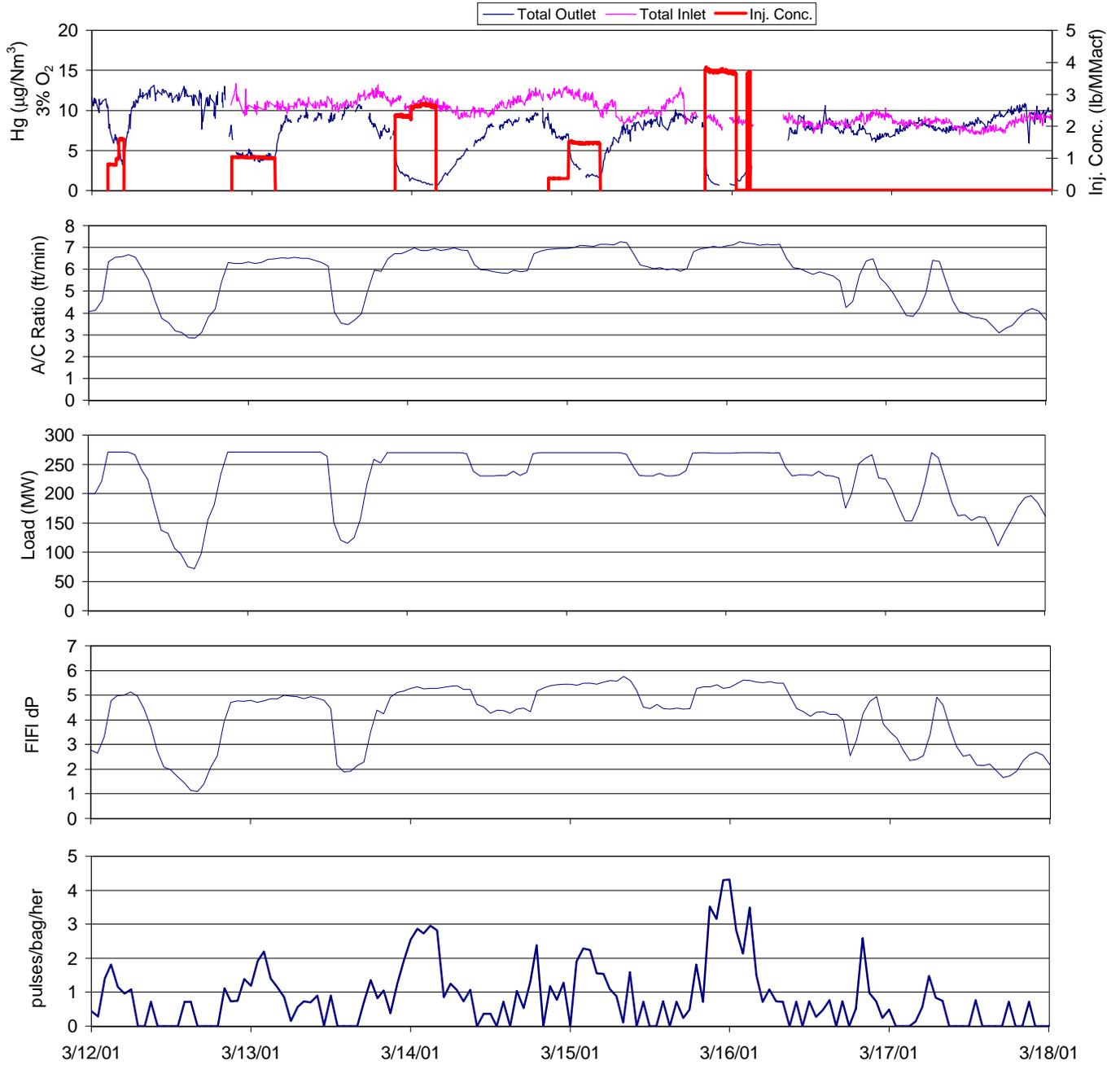
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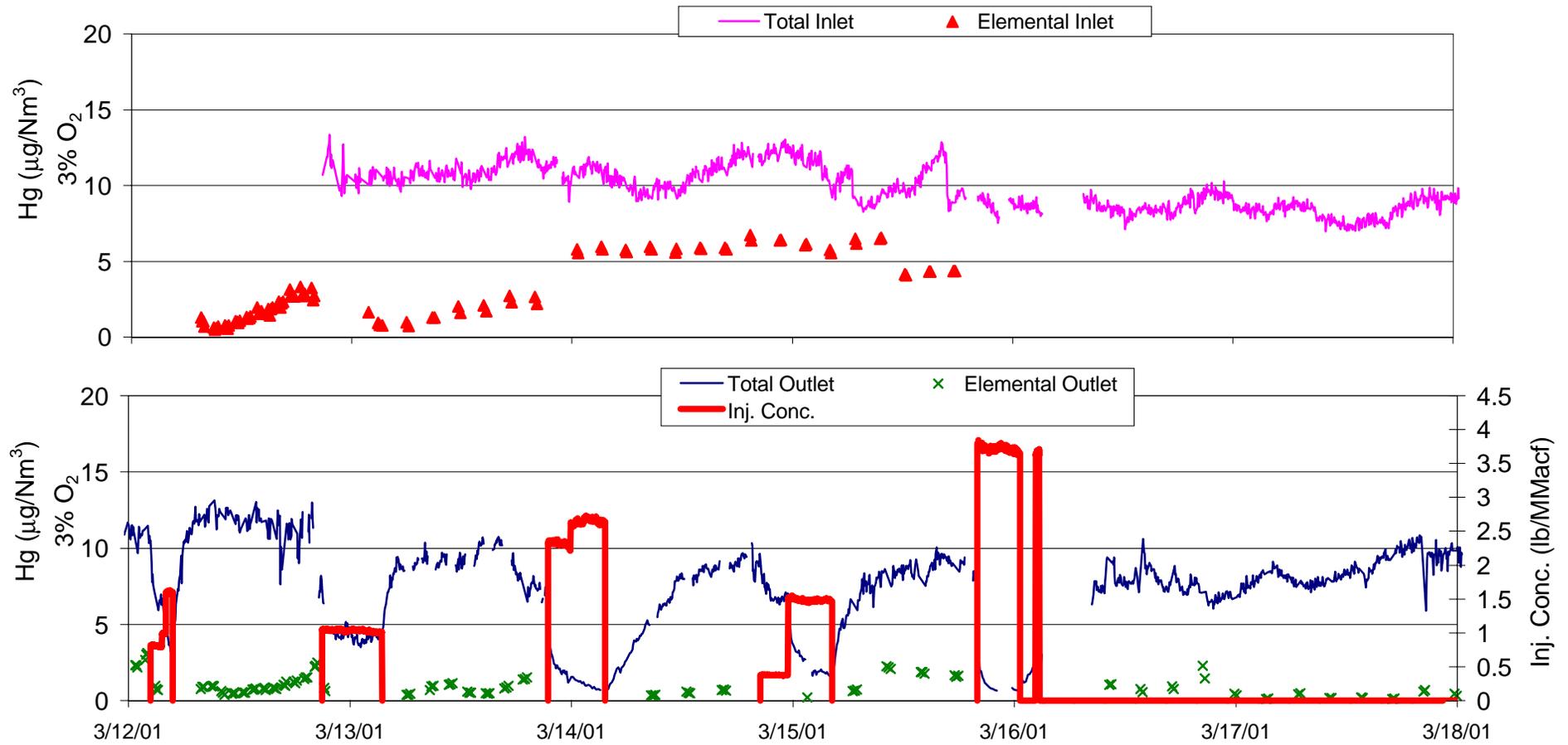
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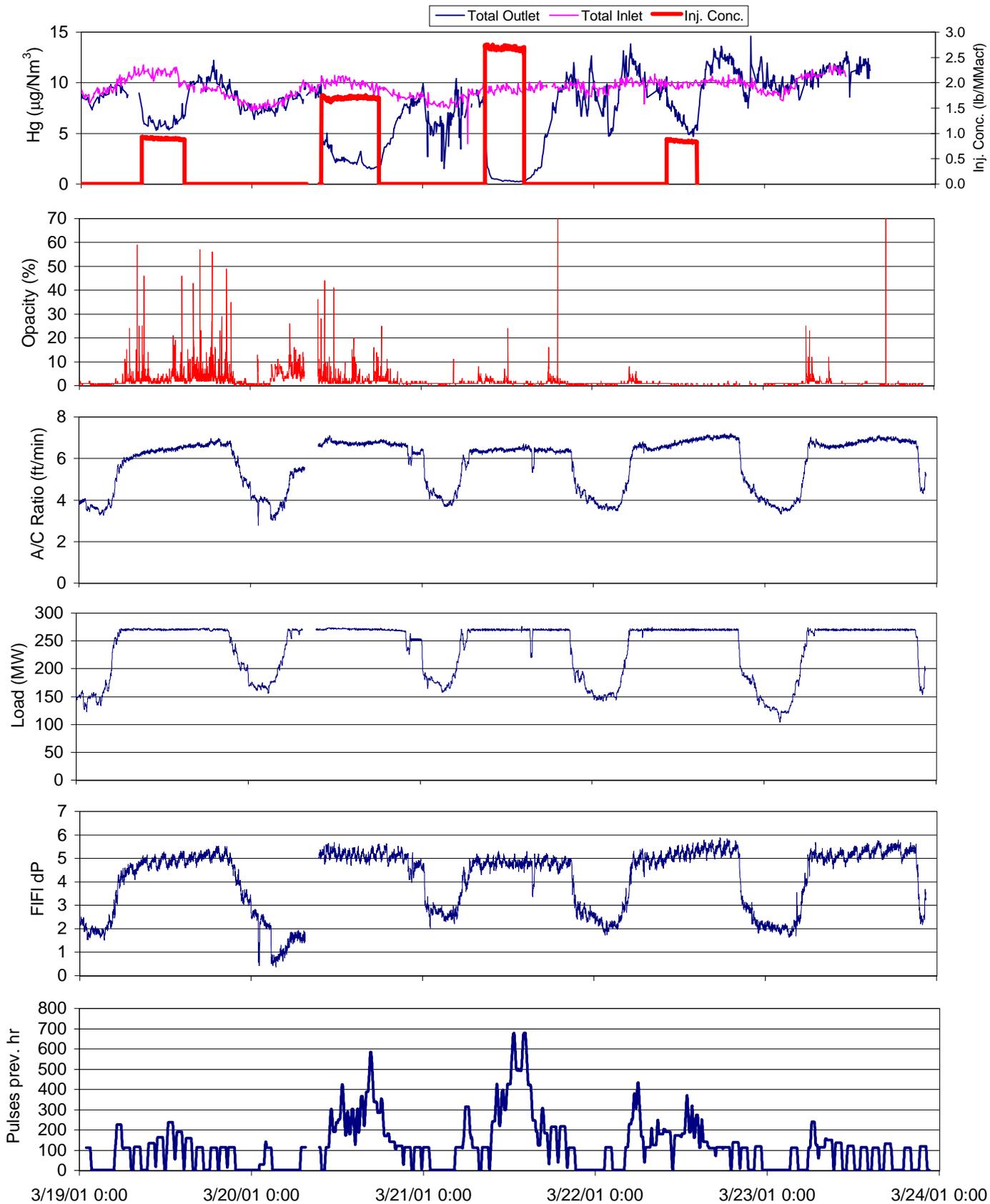
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3/12-3/18/01



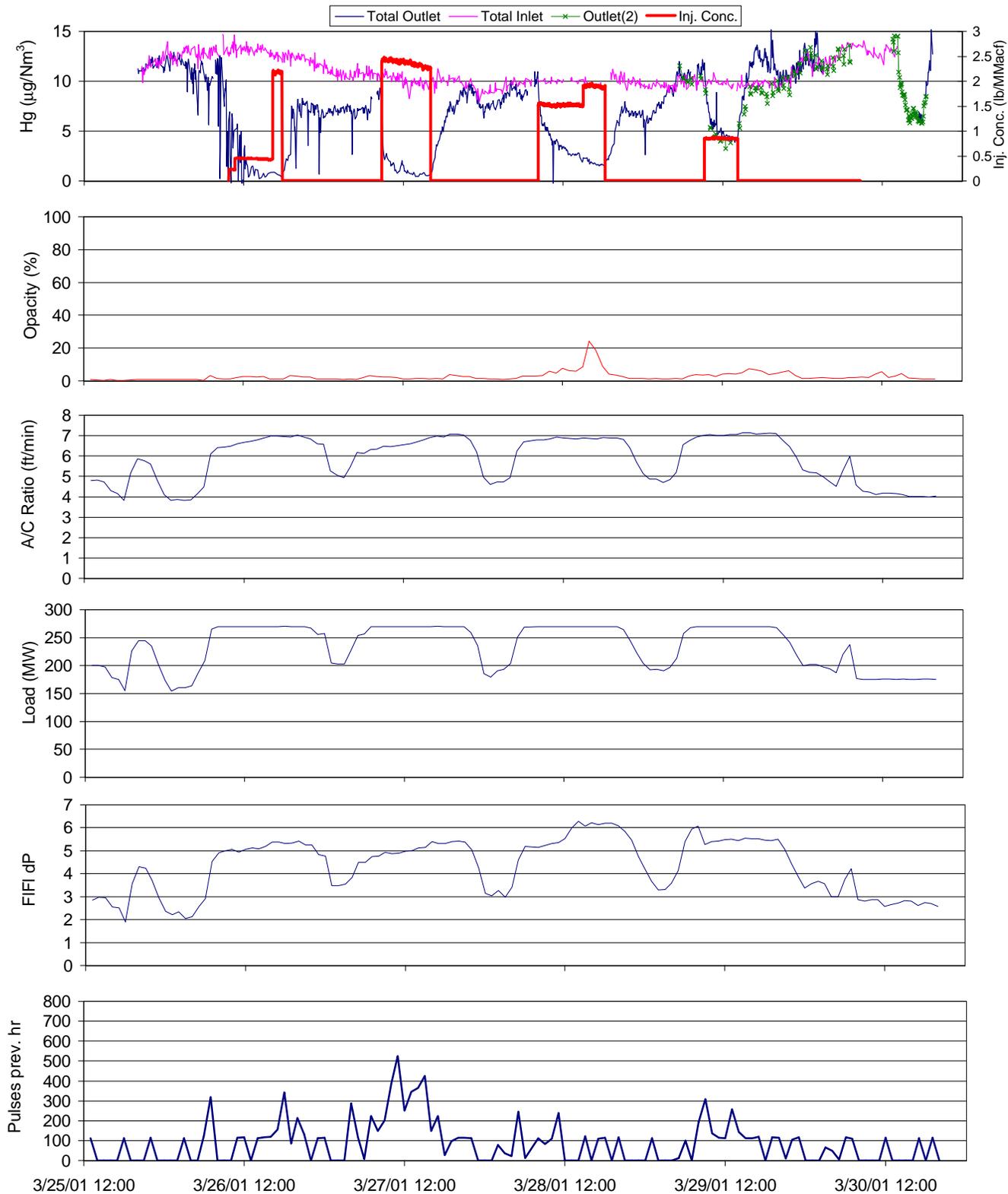
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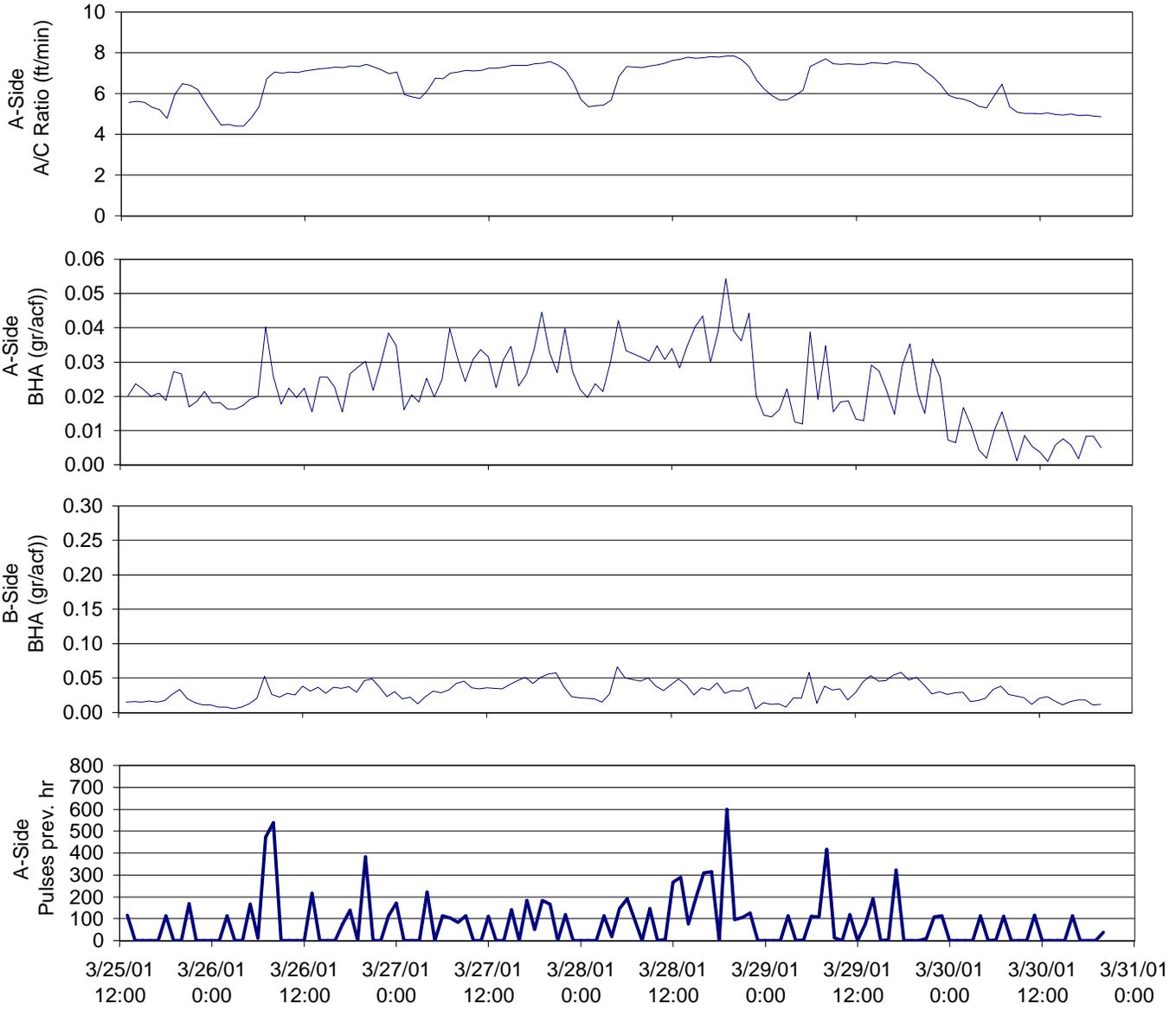
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3/19-3/24/01



Gaston 3B COHPAC Parametric Testing  
3/26-3/30/01



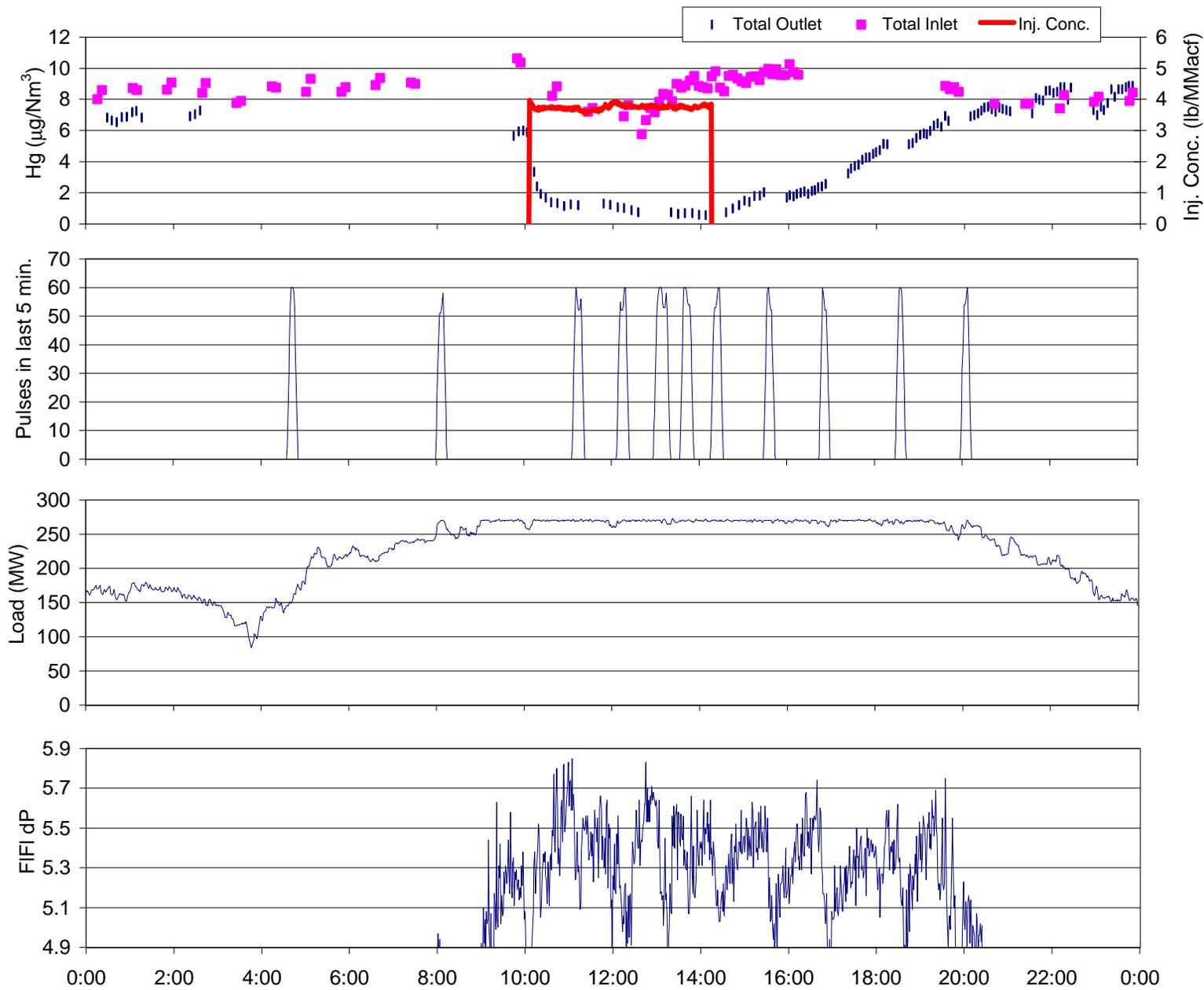
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3/26-3/30/01



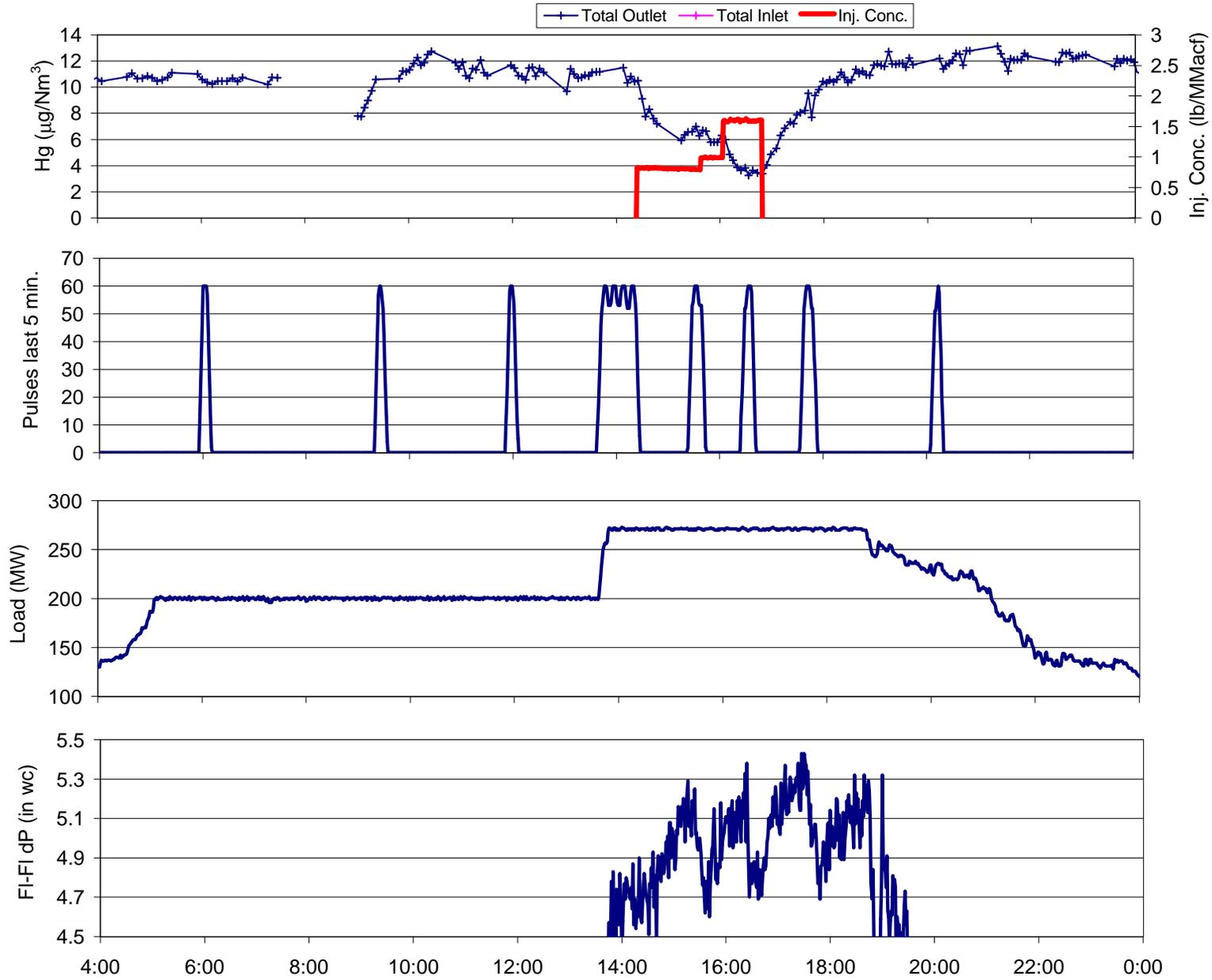
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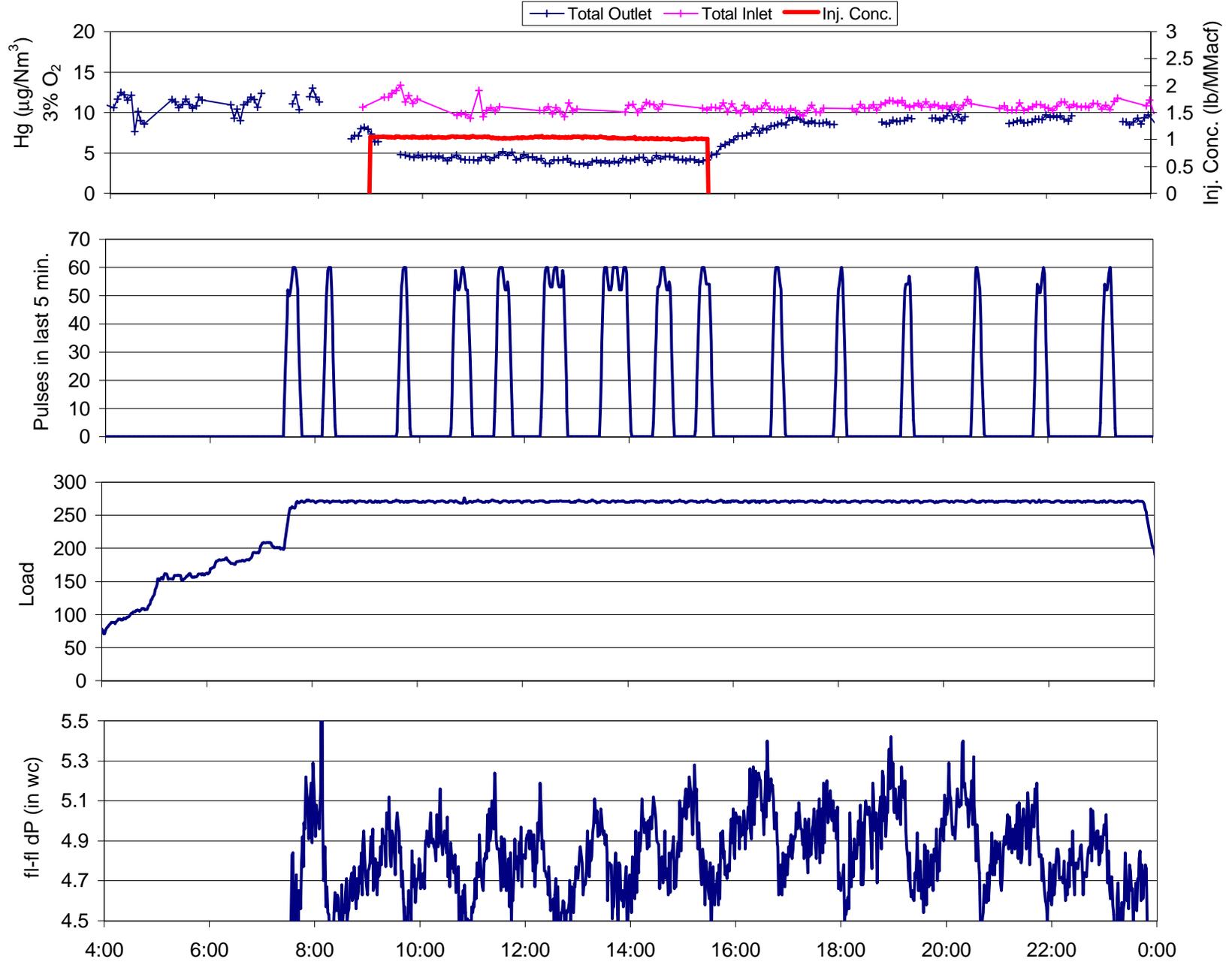
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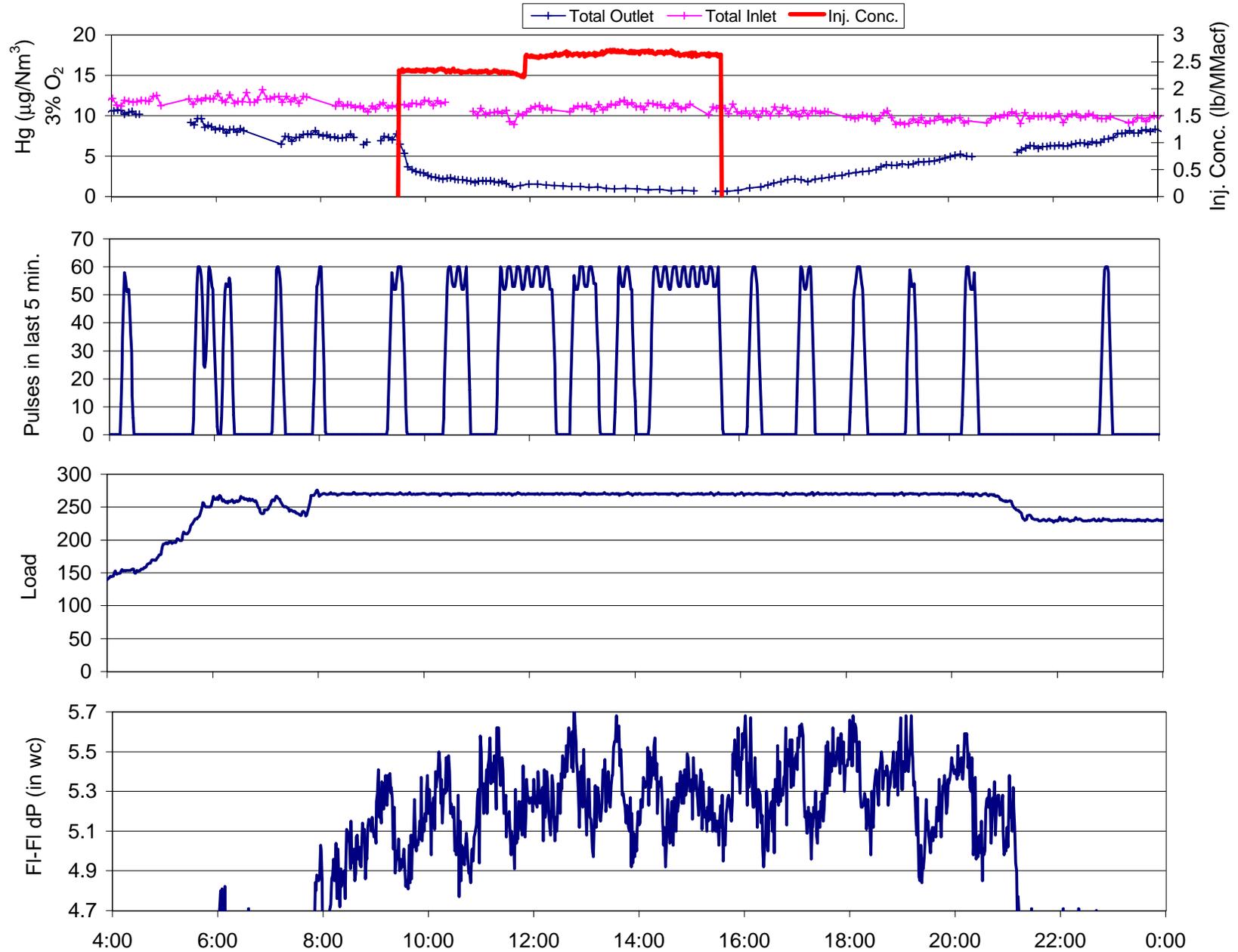
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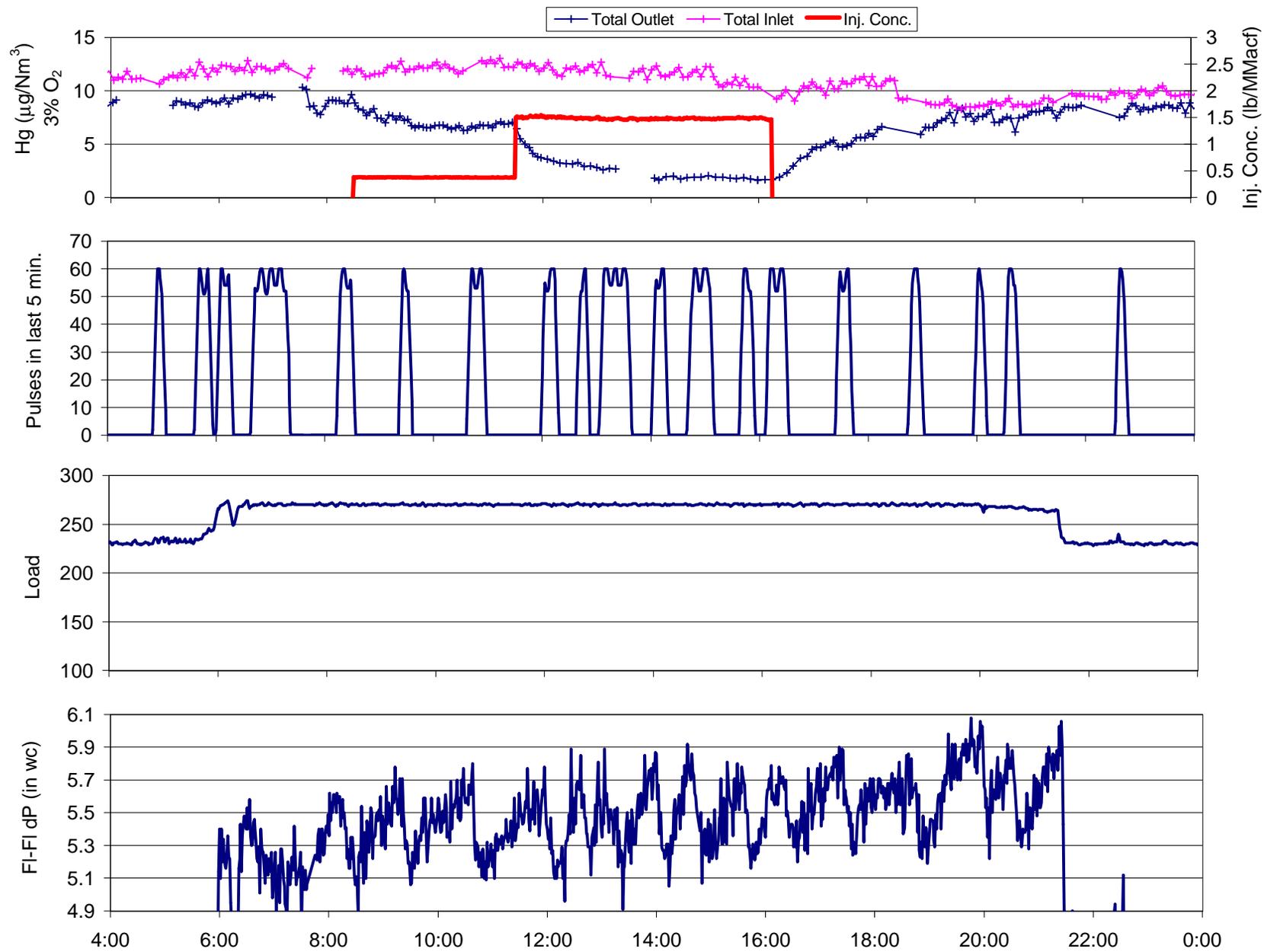
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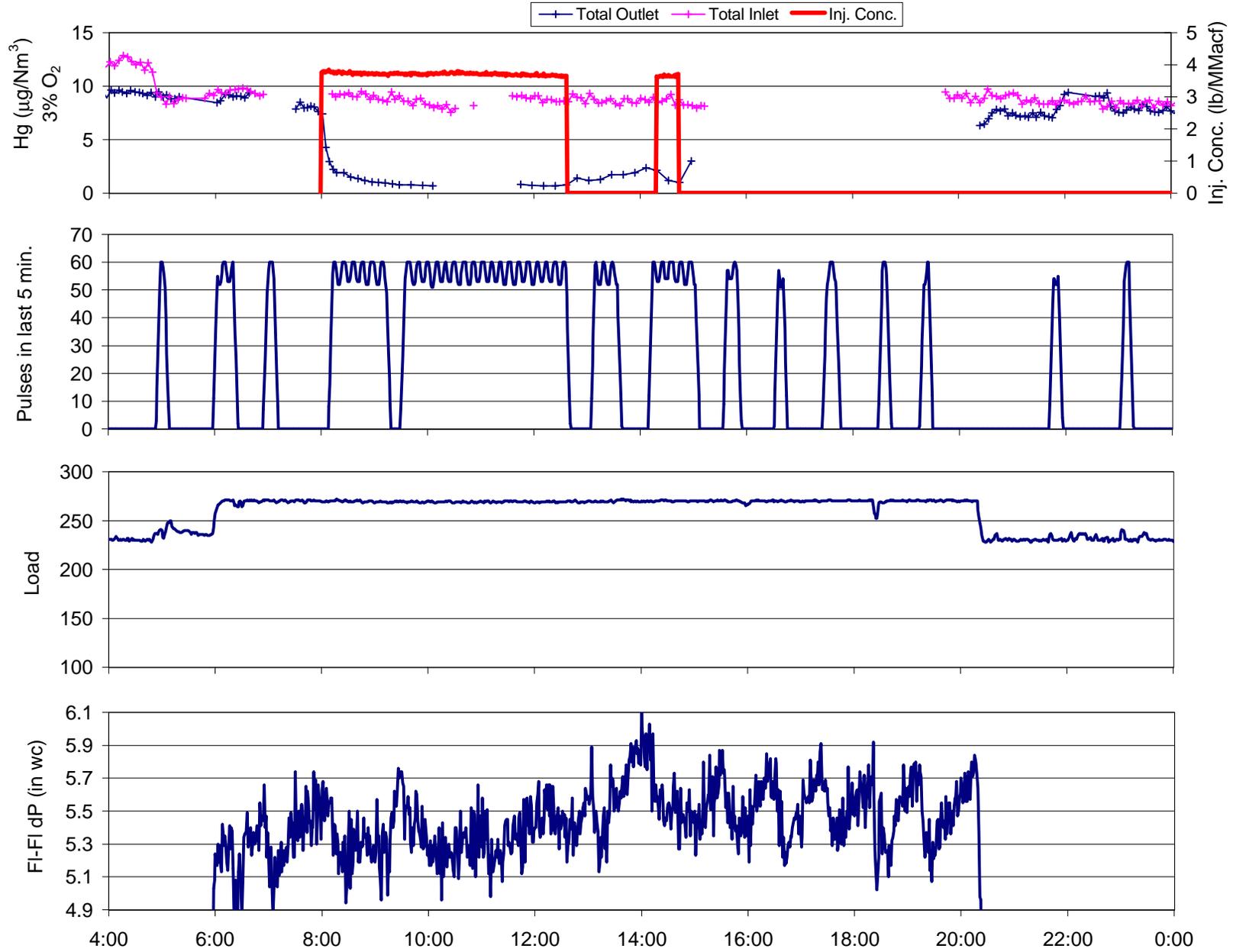
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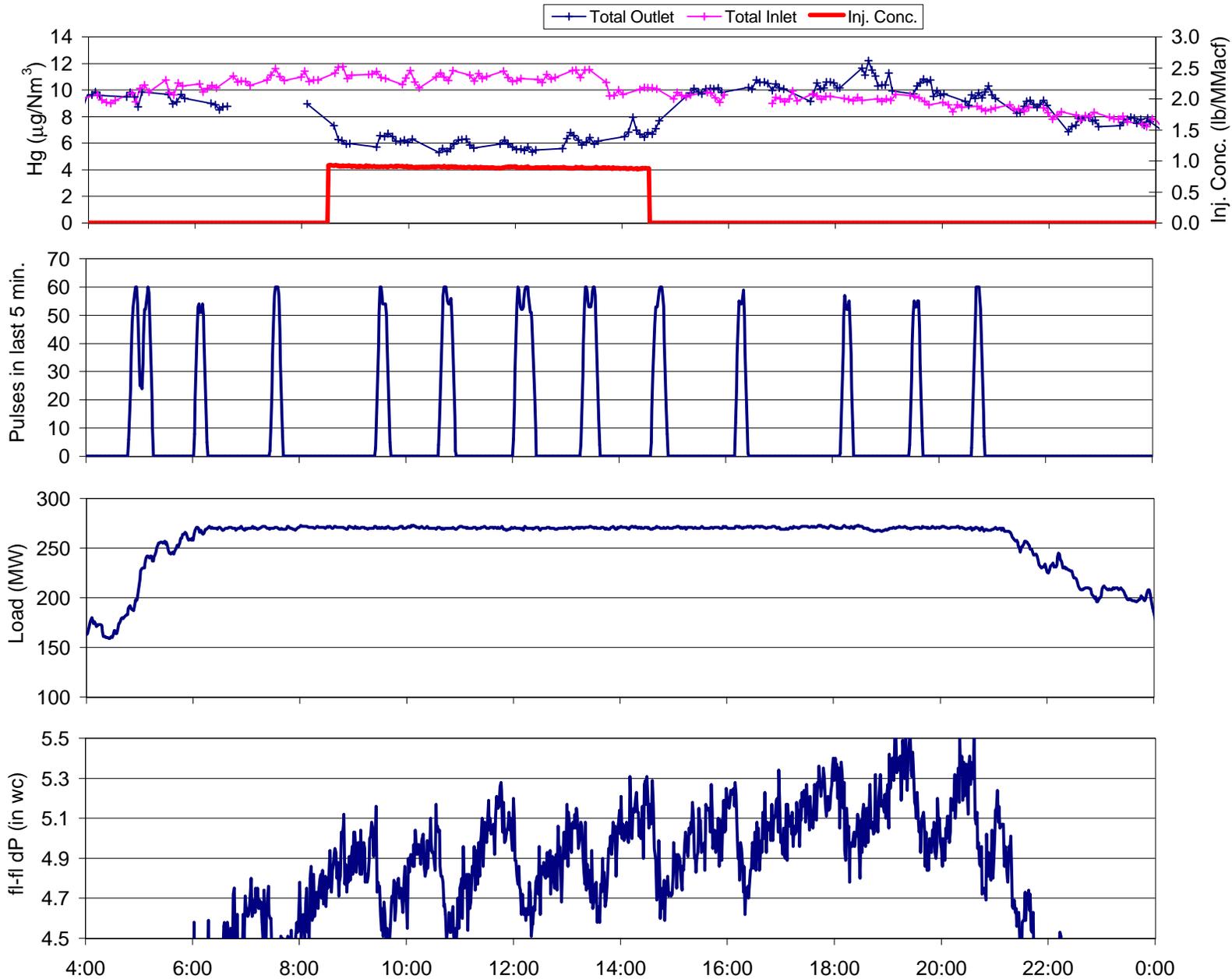
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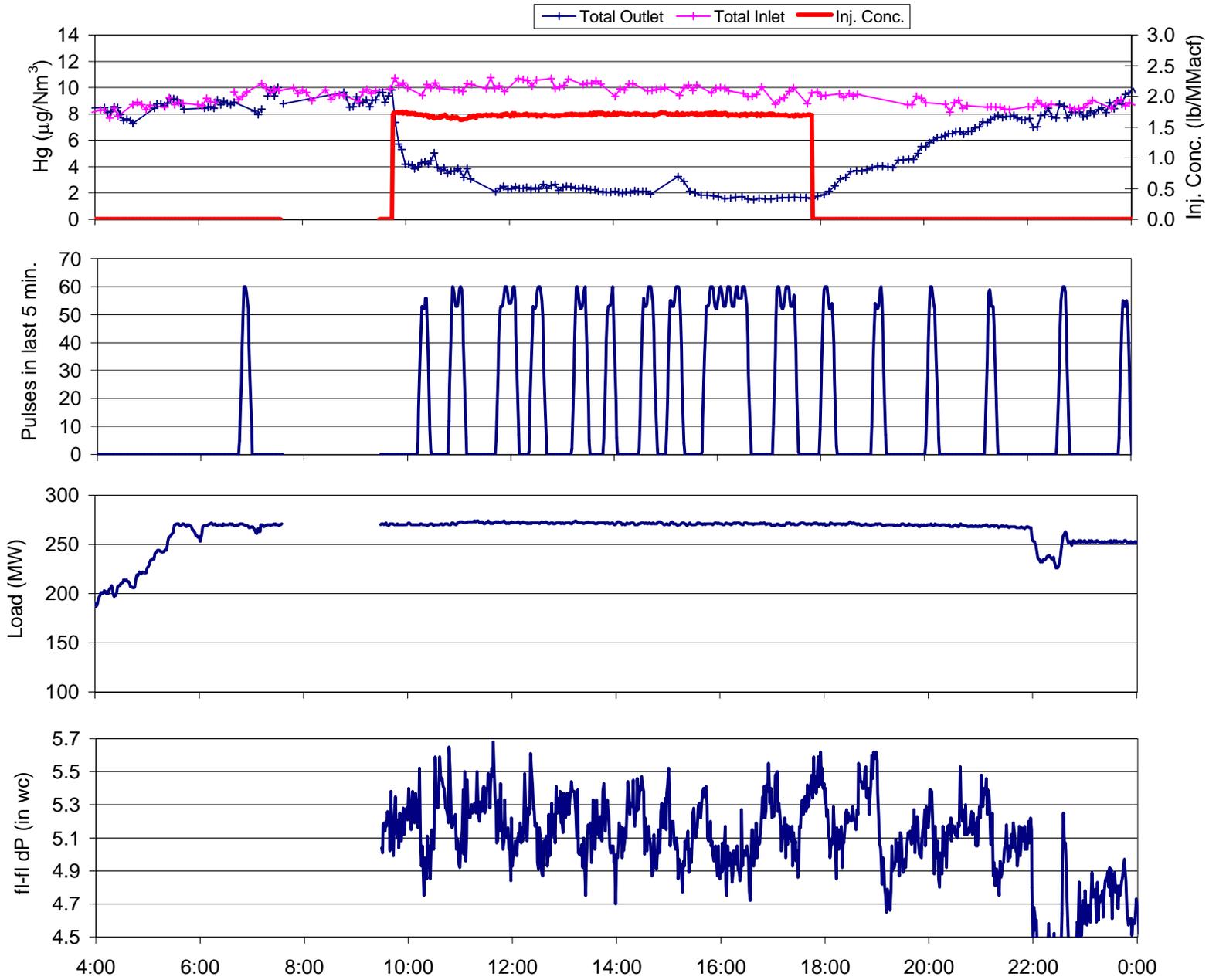
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3/16/2001



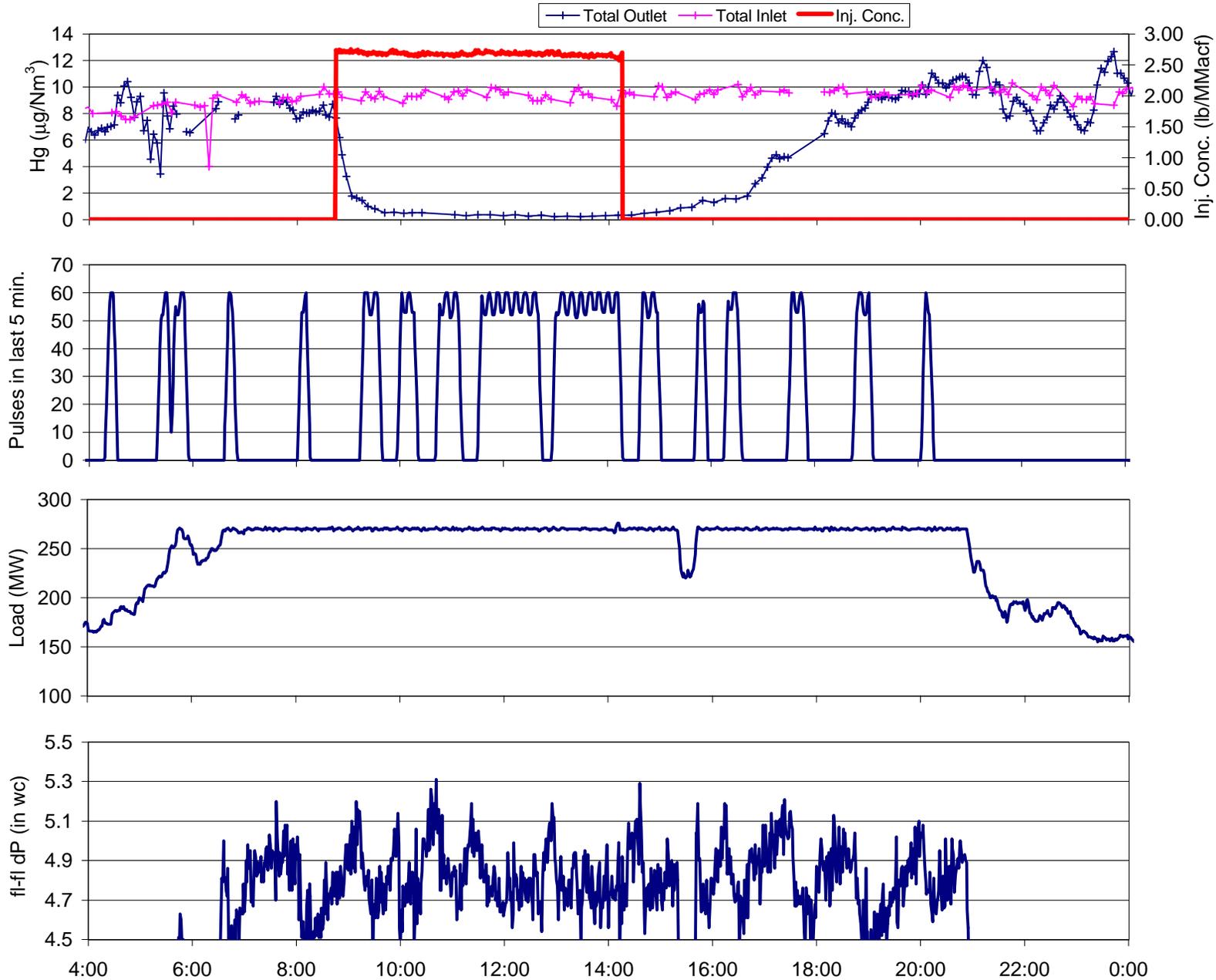
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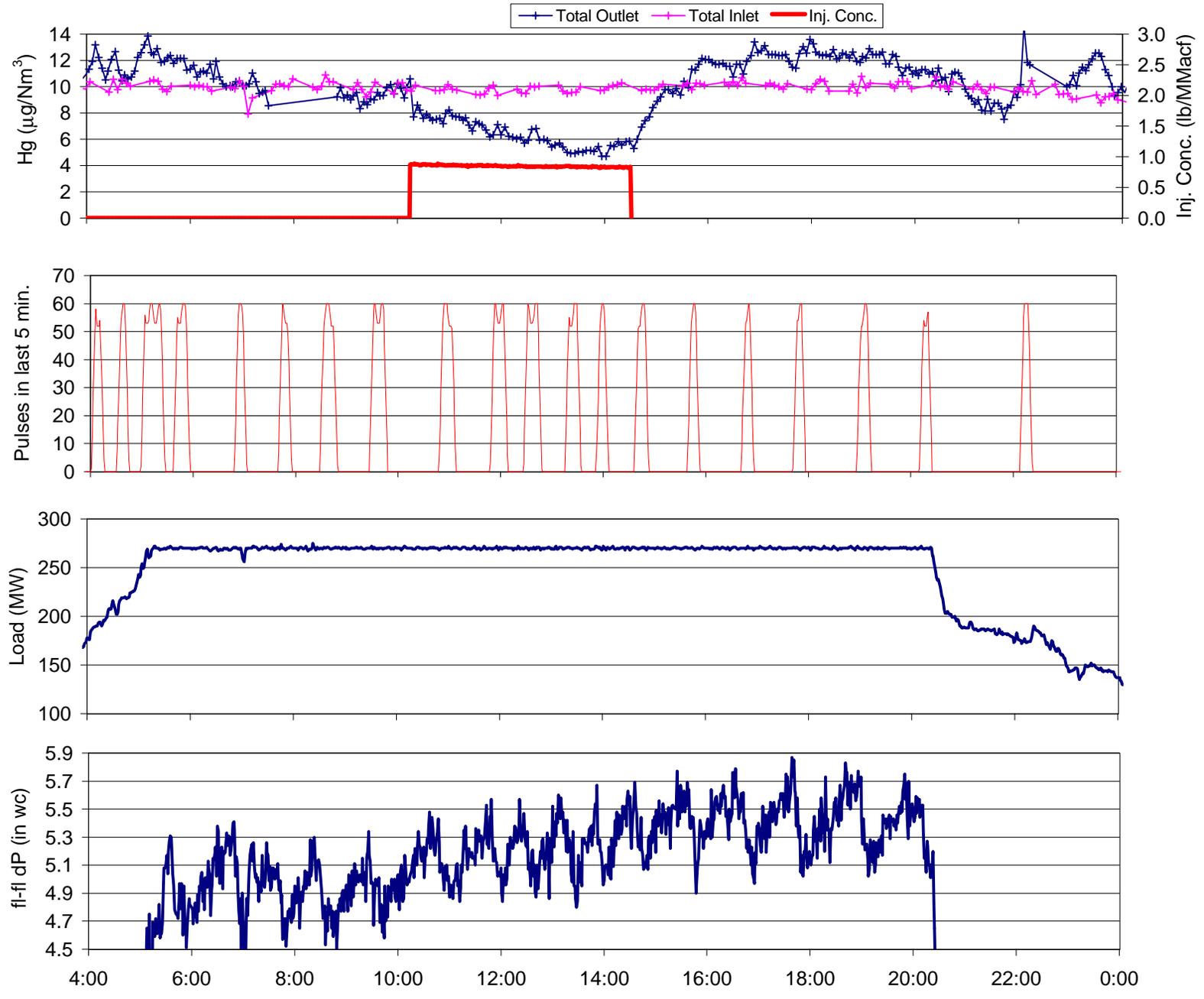
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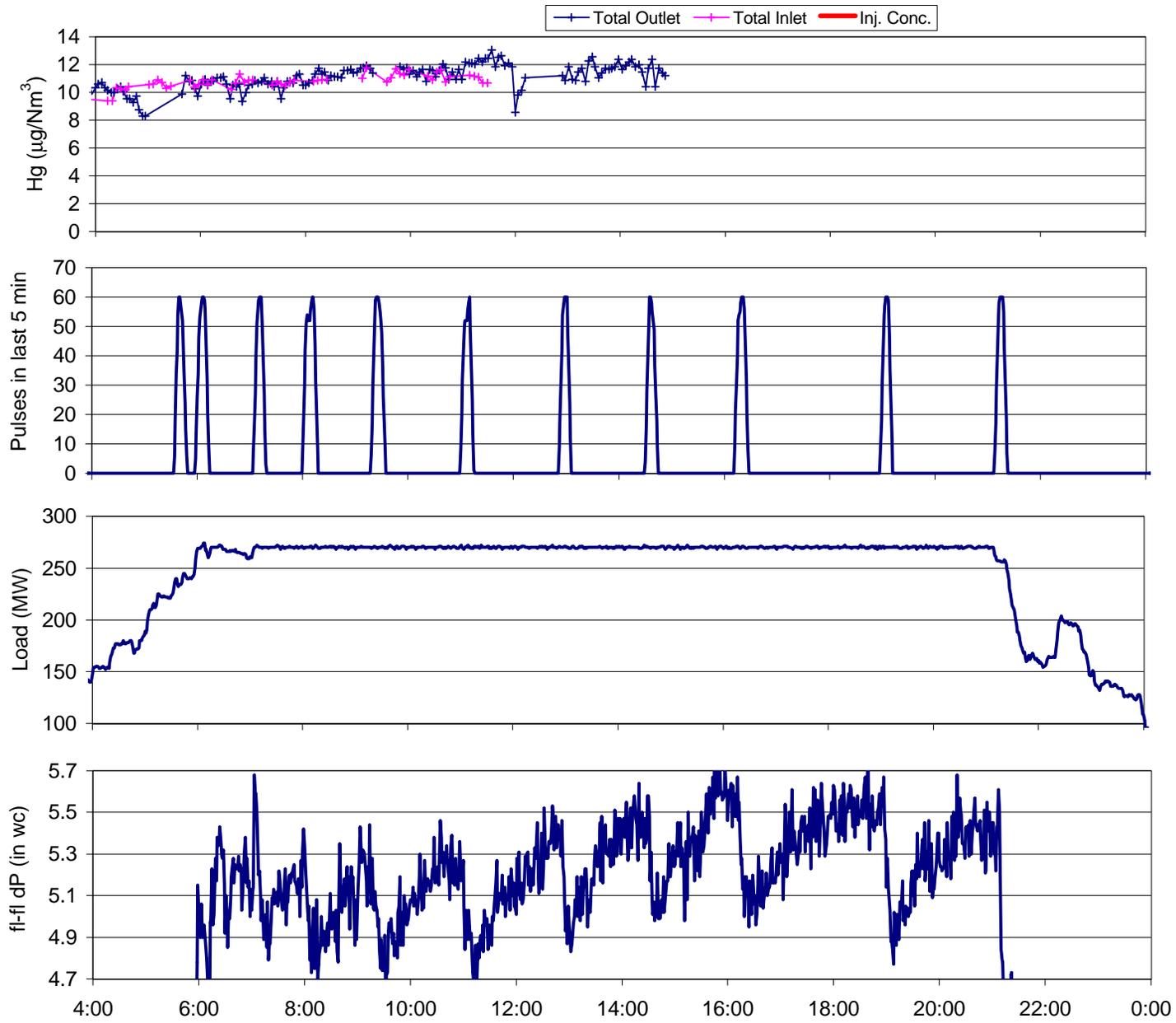
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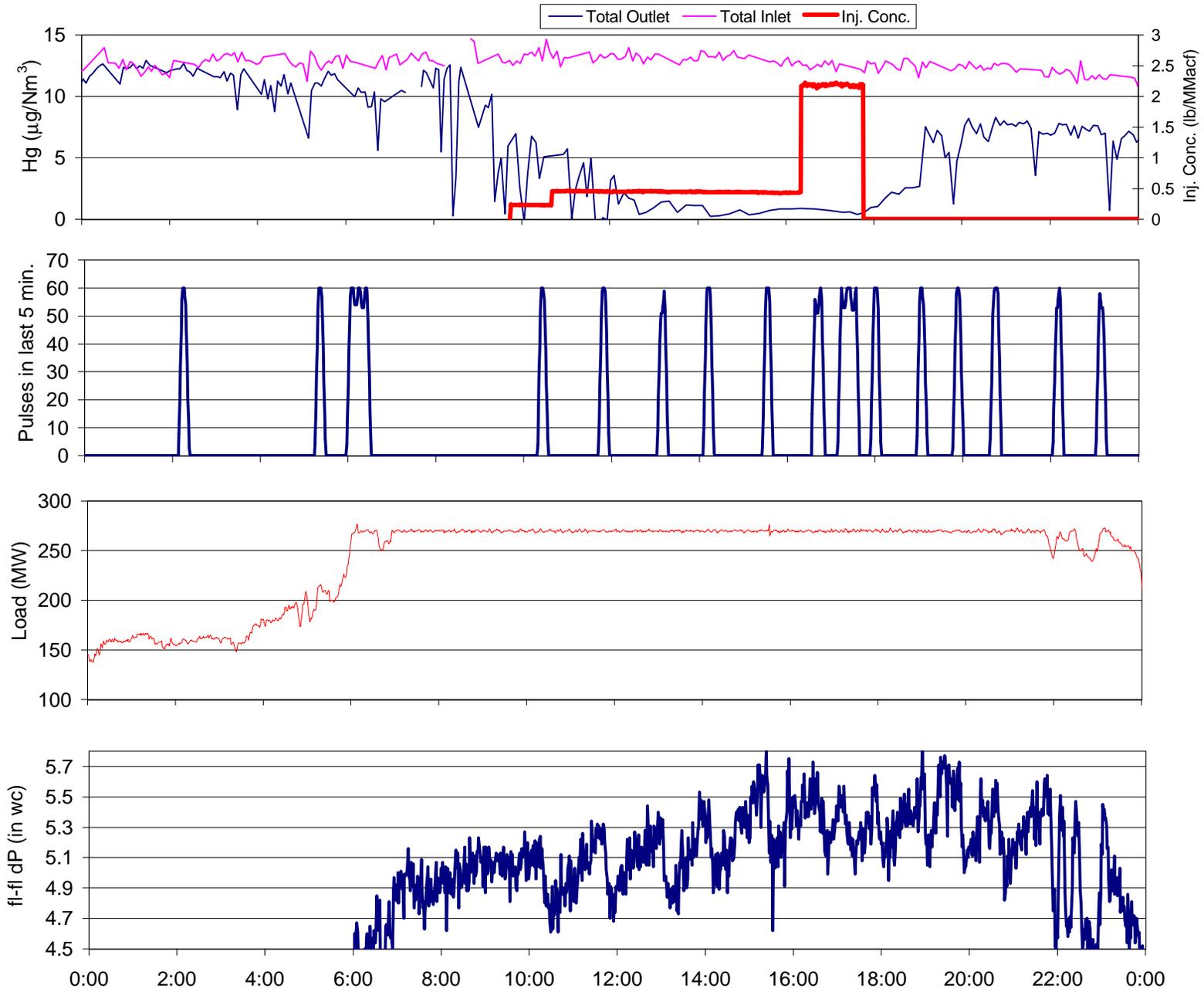
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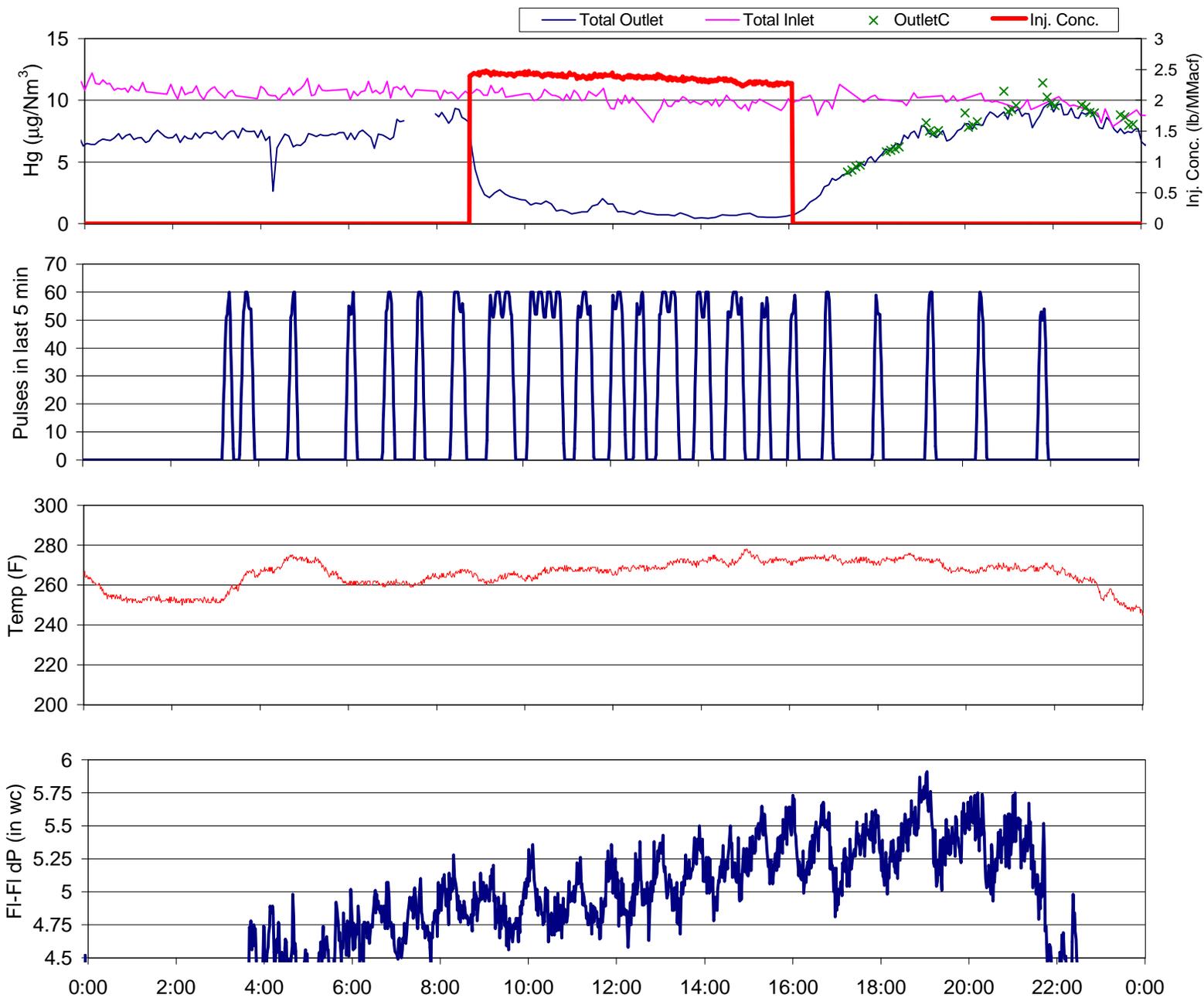
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3/23/2001



Gaston 3b COHPAC Parametric Testing  
3/26/2001

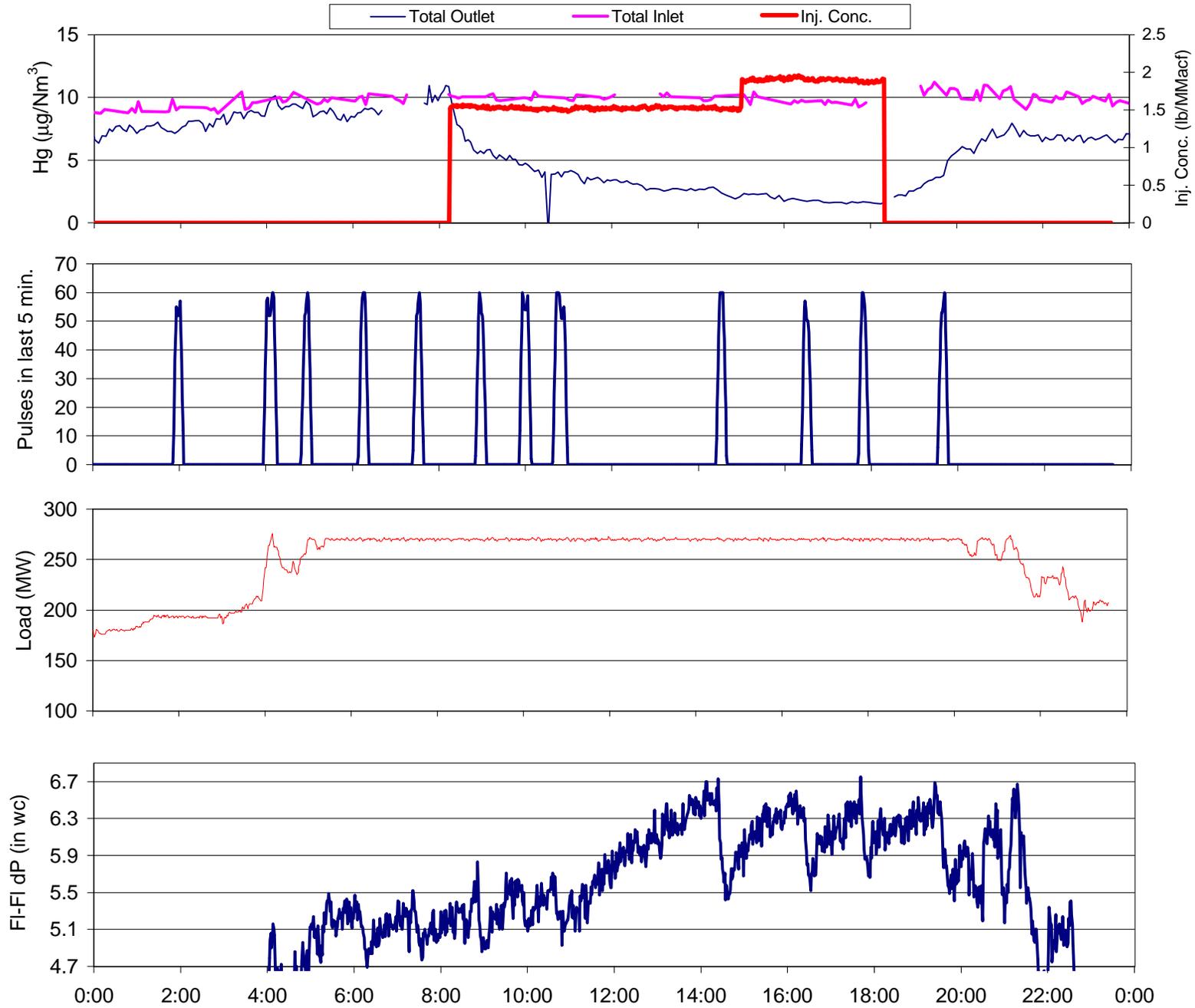


Gaston 3b COHPAC Parametric Testing  
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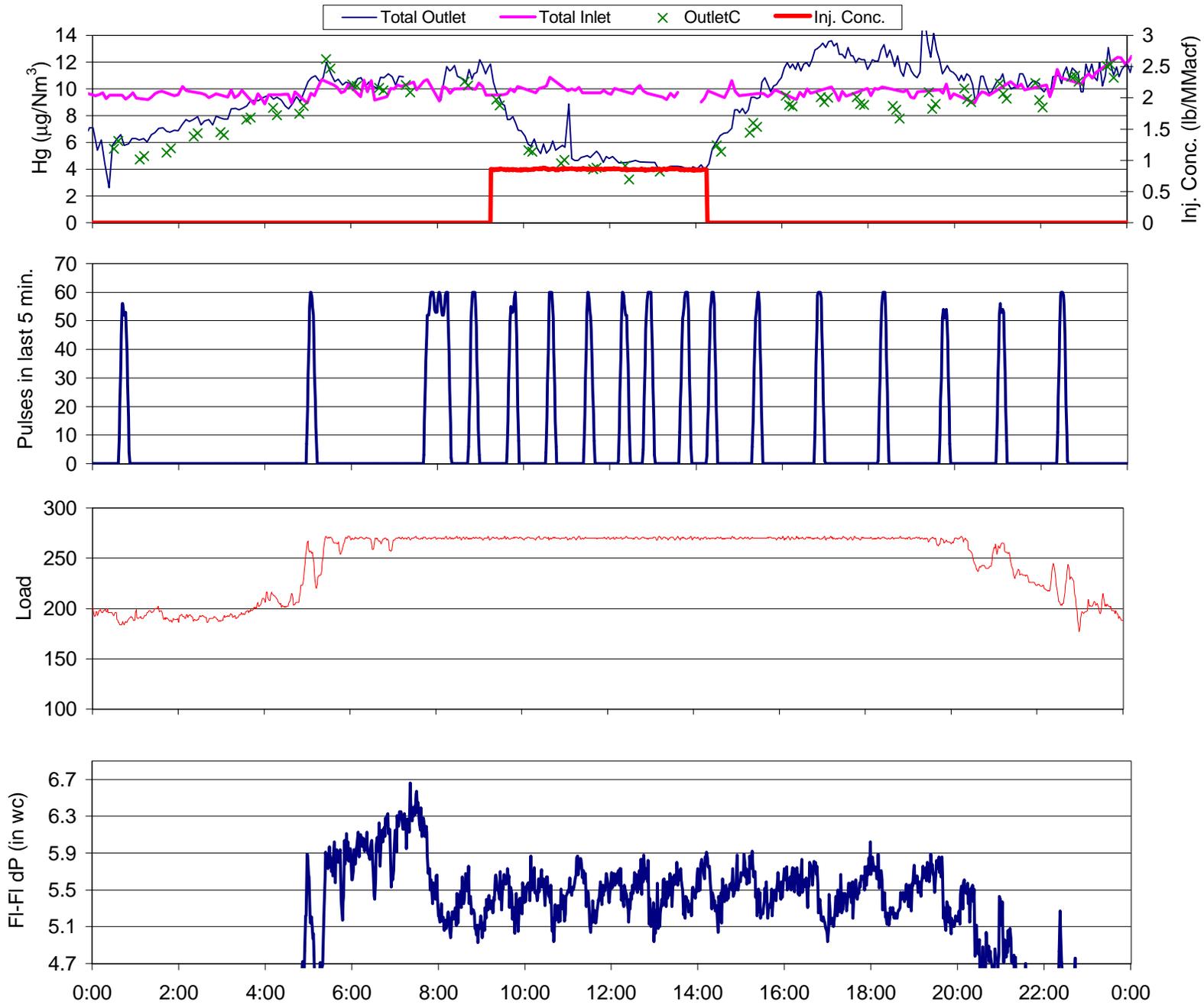


# Gaston 3B COHPAC Parametric Testing

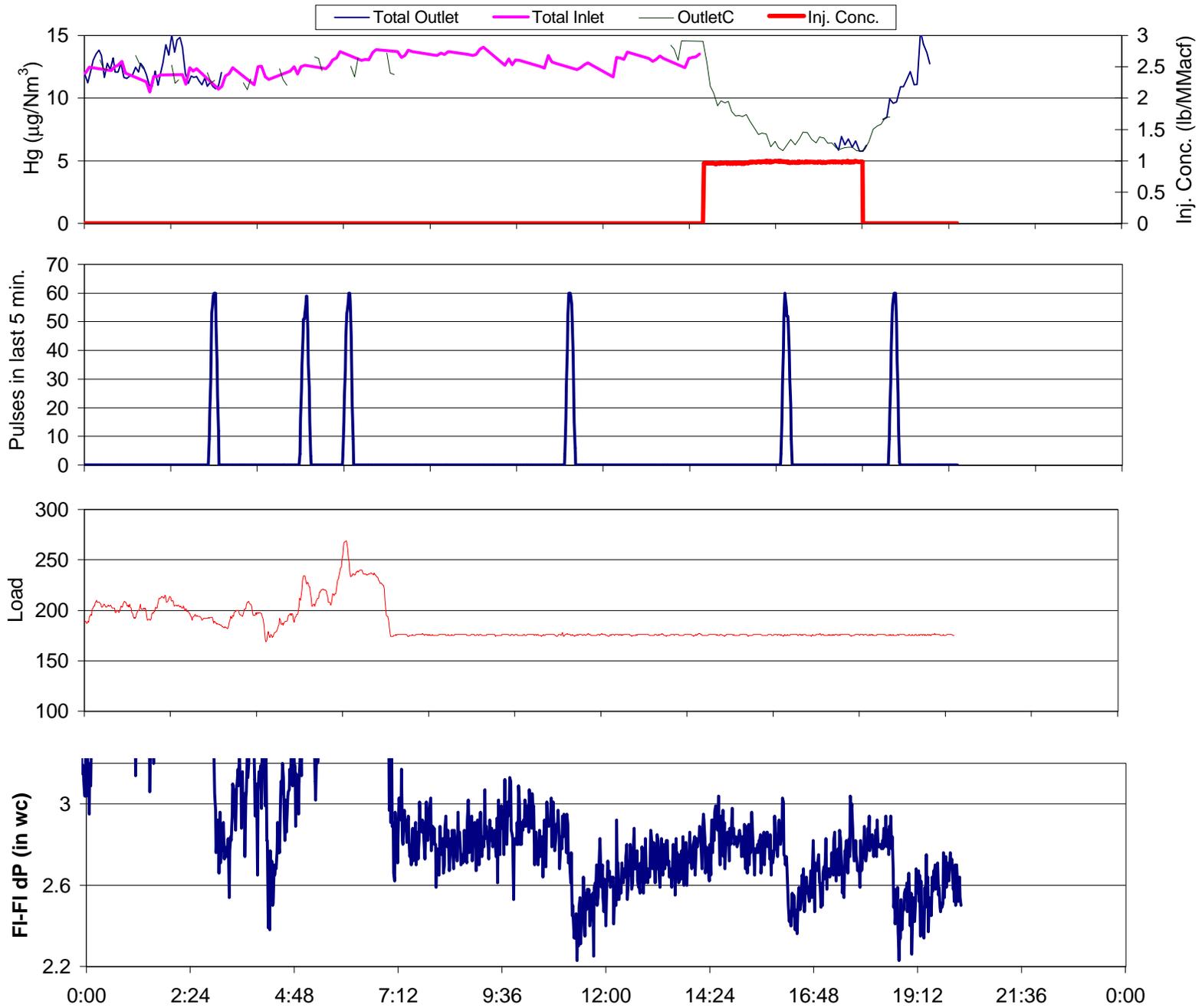
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**3/29/01**

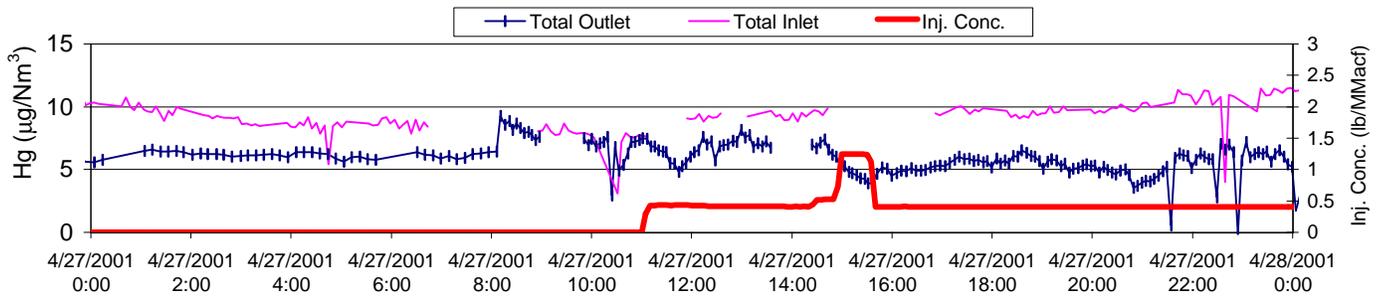


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**3/30/01**

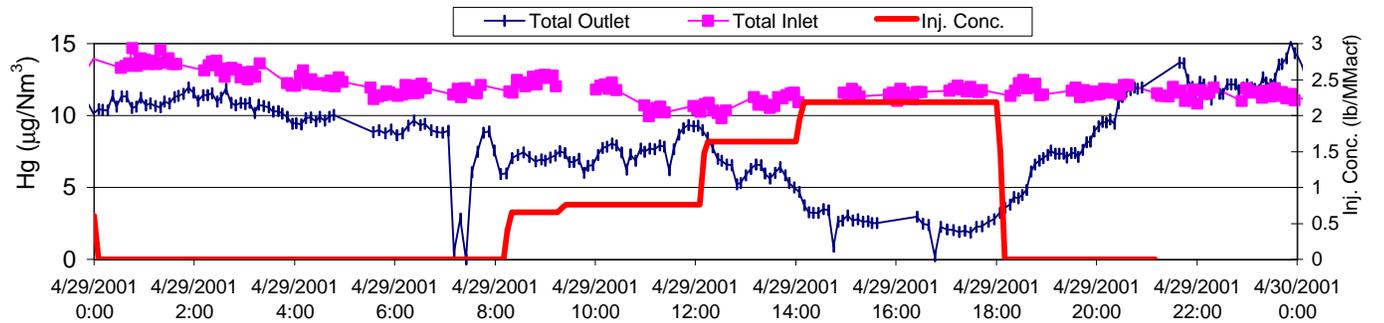
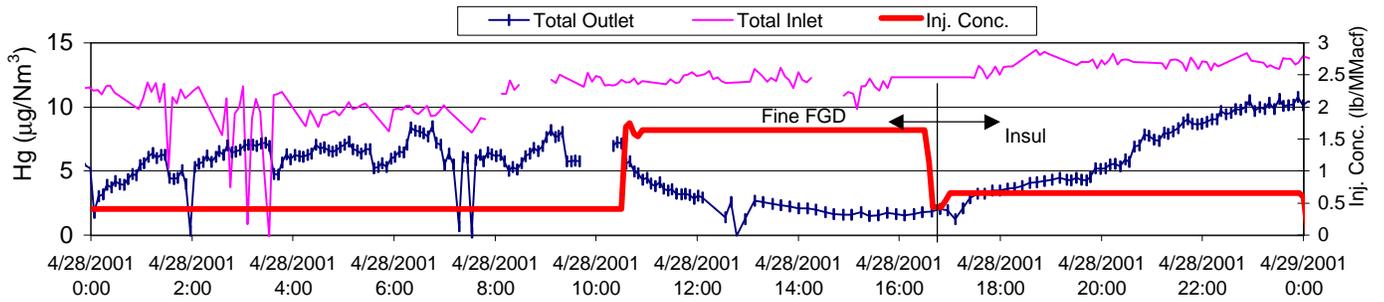


Gaston 3B COHPAC  
4/27-4/29/01

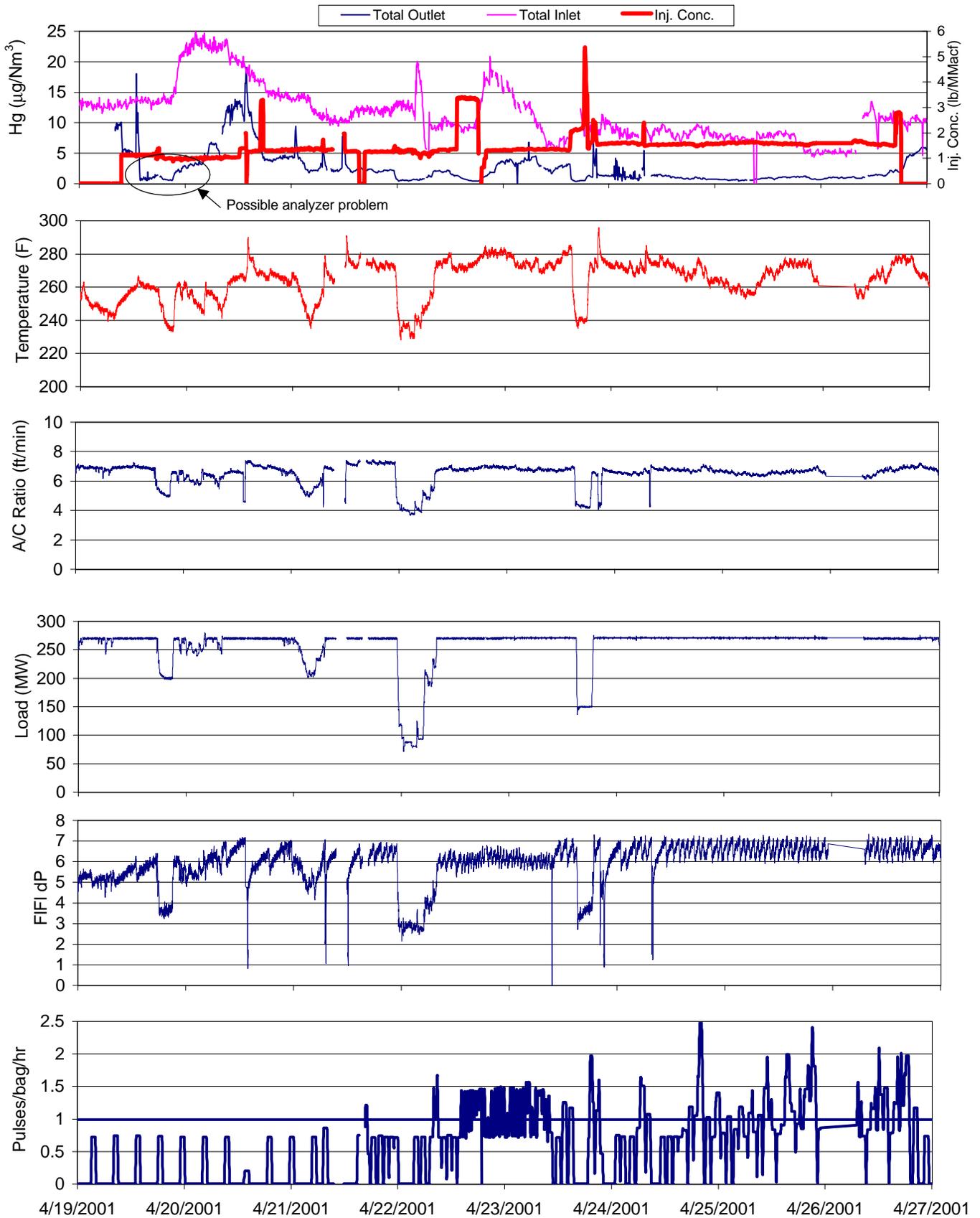
4/27/01 FGD Fines



4/28/01 - 4/29/01 Fine FGD / Insul



Gaston 3B COHPAC Long-Term Testing  
4/19 - 4/24/01



# **APPENDIX F**

## **Bag Strength Tests**



Grubb Filtration Testing Services, Inc.  
Laboratory Report No. 3408  
Page 2

<u>Sample</u>	<u>Mullen Burst Average (psi, net)</u>	<u>Fabric pH (5g per 100 ml)</u>
New Fabric: Average - Range -	496 (433 - 526)	Not Applicable
Used Bag A	451	2.95
Used Bag B	469	3.08

New Mullen burst data is from the fabric QA testing done for Alabama Power on this shipment of bags (GFTS Report No. 3082). Mullen burst values for each used bag are averages of twelve readings; four each on top, middle, and bottom sections.

A copy of Table 2 from GFTS Report No. 3203 is attached for comparison of the carbon injection test bags to the Gaston #3 OEM bags previously tested. Note that the new Mullen burst of the OEM bag fabric averaged only 433 psi (net), 12.7% lower than the replacement bag fabric.

**TABLE 2**  
**Gaston Unit 3 COHPAC – Used Bag Data Comparison**

<b>Length of Service (Hours):</b>	2700	6100	8650	12,176	16,050	23,815	26,770
<b>Casing/Compartment/Bundle</b>	A10	A20	B20	A10	A20/B20	A20/B20	A21/B21*
<b>Permeability (cfm/ft<sup>2</sup>):</b>							
As Received	9.63	6.32	5.74	4.48	-	3.60	3.53
Vacuumed	26.2	18.6	21.2	15.8	-	14.4	15.0
Washed	39.8	42.7	41.8	40.9	-	40.4	32.4
<b>Fabric Weight, washed (oz/yd<sup>2</sup>)</b>	18.8	18.1	18.6	18.6	18.8	19.4	19.1
<b>Residual Dust Load (oz/yd<sup>2</sup>):</b>							
Removable by Vacuuming	3.05	3.4	6.1	5.6	-	6.8	6.3
Removable by Washing	<u>2.95</u>	<u>3.8</u>	<u>3.0</u>	<u>5.3</u>	5.4	<u>7.1</u>	<u>5.9</u>
Total (As-Received)	6.0	7.2	9.3	10.9	-	13.9	12.2
<b>Bag weight, as-received (lb)</b>	5.2	6.0	6.7	6.8	6.6	7.4	8.0
<b>Residual Dust Weight (lb) — est</b>	1.0	1.8	2.5	2.6	2.4	3.1	3.7
<b>Mullen Burst Strength (psi, wet):</b>							
Average (actual)	382	358	318	343	322	305	324
Normalized to 18 oz/yd <sup>2</sup>	366	357	308	332	309	283	305
% Loss (vs new fabric)	-14%	-17%	-28%	-23%	28%	33%	29%
<b>Fabric pH (5g/100 ml):</b>	4.15	4.45	3.44	3.03	2.44	2.45	2.96

\* Data on bags from A11 and A21 are included in the weight (fabric, bag and dust) and Mullen Burst averages.

# **APPENDIX G**

## **Coal and Ash Characterization Tests**

The results of analysis of the solid samples from both Baseline and Long-Term sorbent injection tests at Gaston Unit 3 are presented here. Highlights of the results are summarized as follows:

### General Results of Coal and Ash Analyses

- Characterization of the ash at Gaston Unit 3 consisted of preliminary TCLP testing for acceptability to the plant, followed by comparative analyses for mercury, particle size distribution and LOI on samples collected during testing. Since the ash at this site is significantly smaller in quantity (COHPAC ash only) than ash from a full unit, and is disposed of on-site in ash ponds for eventual landfill, analyses to determine the impacts on byproduct use were not applicable and were not pursued. Leaching tests showed that the ash/sorbent combination was below regulatory maximums.
- The configuration of Gaston Unit 3 is such that the majority of ash is collected in the Hot-Side Electrostatic Precipitator (HESP), while a small fraction is collected in COHPAC. This splitting of the ash makes a mass balance (mercury in coal=mercury in ash + mercury emitted) virtually impossible. No mass balance is attempted here, but trends of LOI content, mercury content, and size of ash are noted. The variation in coals fired at Gaston adds to the unpredictability of mercury concentrations in the ash.
- Coal mercury levels correspond reasonably well with mercury levels measured at the inlet to the HESP and the inlet to COHPAC. Results from analyses of coal grab samples are used to project mercury emissions in the duct, and these are correlated with gaseous sampling results. Those correlations are better in some cases than others. These discrepancies may be caused by the difficulty of obtaining a time-representative coal sample in a unit that fires a variety of coals. The time lag between coal sampling and firing that coal may not correspond to the test period exactly, and as seen in S-CEM data throughout this report, inlet mercury levels vary significantly with time. Samples were taken from the coal bunkers as they were being filled, rather than from the feeders. This means the time lag could be 18-24 hours between the sample time and furnace.

### Baseline Testing

- Significant variation in the coal properties (volatile matter, Hg content) occurred during the baseline-testing period.
- The total mercury at the COHPAC inlet as measured by the Ontario Hydro method averaged  $14.5 \mu\text{g}/\text{Nm}^3$  during a two-day period when the coal mercury as sampled corresponded to  $6.5 \mu\text{g}/\text{Nm}^3$ . The prior day's coal mercury corresponded to  $16.4 \mu\text{g}/\text{Nm}^3$ . During this same period the measurements taken by the S-CEMs showed 8 to  $12.5 \mu\text{g}/\text{Nm}^3$  of vapor-phase mercury. These results correspond reasonably well, but point to the difficulty in obtaining representative coal samples for more-precise mercury calculations.
- The COHPAC A-side (control side) ash had 0.7-0.8 ppm mercury in comparison with 0.005-0.03 ppm mercury in the HESP ash during the baseline tests, indicating that mercury is concentrated in the ash that is captured in COHPAC. The main characteristics

that may affect this difference in mercury capture are: temperature (about 255 F in COHPAC compared with about 690 F in the HESP) and residence time.

### **Long-Term Sorbent Injection Testing**

- The coal for the sorbent injection tests appeared to be similar to that burned during the baseline testing.
- LOI was higher during these tests than the baseline series, with 11.8% average LOI in the HESP and 14.5% average LOI in COHPAC A-side (control side). These values are both several percentage points higher than LOI during baseline tests.
- The B-side (injection side) sorbent-ash mixture showed about 30 wt% LOI as compared to ~15 wt% LOI in the A-side (control side) ash.
- Ash samples show significant data scatter between individual mercury analyses, reflecting the difficulty of obtaining representative ash samples. Based on an average of five samples, the sorbent-ash mixture from the B-side (injection side) hopper contains 50 times the mercury of the A-side (control side) hopper ash, indicating removal of mercury by sorbent across the COHPAC. A-side ash averaged 0.8 ppm mercury, compared with 0.75 ppm during baseline tests. B-side ash averaged 41.8 ppm mercury.

### **Detailed Results: Baseline Testing**

The baseline characterization test was carried out from 3/5/01 to 3/7/01. This involved coal sampling, Ontario Hydro measurements at the inlet and outlet to the COHPAC baghouse, and collection of ash samples from both the HESP hopper and the baghouse hopper (A-side). Table 1 summarizes the analysis carried out on the solid samples collected during this campaign. Ontario Hydro results have been reported and described in the previous subsections of this report. LOI measurements of ash were carried out at PSI, while Microbeam Technologies carried out all other analyses.

Table 2 gives the results of coal analyses for the baseline testing. The plant burns more than one coal, switching coals frequently. This may account for the large variation in the coal properties. The coal is bituminous with about 14 wt% ash (as-received basis). The chlorine content is very low for a bituminous coal (100-160 ppmw, dry basis). The mercury content varied between 0.06 and 0.16 ppmw (dry basis). The notable aspect of the coal data is that the coal properties (volatile matter, moisture, mercury content) changed markedly between 3/5 and 3/6. As mentioned above, these coal samples are a single grab sample taken from the coal bunkers, and do not reflect a well-blended average of fired coal.

**Table 1.** Analyses carried out on baseline solid samples collected 3/5/01 through 3/7/01.

Sample Number	Date/Time Sampled	Sample	Unit	Sample Location	Analysis Required
GAS00010	3/5/01 0:00	Coal	3	Coal Belt	Ultimate, Proximate, Hg, Cl
GAS00014	3/6/01 0:00	Coal	3	Coal Belt	Ultimate, Proximate, Hg, Cl
GAS00011	3/6/01 15:00	Ash	3	ESP 1st row	Hg, LOI
GAS00012	3/6/01 15:20	Ash	3	BH A-side	Hg, LOI
GAS00019	3/7/01 0:00	Coal	3	Coal Belt	Ultimate, Proximate, Hg, Cl
GAS00016	3/7/01 13:30	Ash	3	ESP 1st row	Hg, LOI
GAS00017	3/7/01 14:00	Ash	3	BH A-side	Hg, LOI

**Table 2.** Baseline coal sample results (as-received basis).

ADA Sample	GAS00010	GAS00014	GAS00019
MTI Sample	01-057	01-058	01-059
Date/Time	3/5/2001 0:00	3/6/2001 0:00	3/7/2001 0:00
<b>ULTIMATE ANALYSIS (As Received):</b>			
Carbon	65.31	71.54	73.21
Hydrogen	4.07	3.58	3.66
Oxygen	5.44	1.87	0.94
Nitrogen	1.70	1.56	1.58
Sulfur	1.49	1.05	0.88
Ash	13.64	13.71	14.22
Moisture	8.35	6.69	5.51
Hg, µg/g	0.163	0.077	0.056
Cl, µg/g	148.47	88.64	133.68
HHV, Btu/lb	11,709	12,443	11,990
SO <sub>2</sub> , lb/MBtu	2.55	1.69	1.47
Ash, lb/MBtu	11.65	11.02	11.86
Hg, lb/TBtu	13.93	6.19	4.65
Hg, µg/dnm3 (3%O <sub>2</sub> )	19.09	8.38	5.91
<b>PROXIMATE ANALYSIS (As Received):</b>			
Fixed Carbon	49.71	62.2	61.83
Volatile matter	28.3	17.4	18.44
Ash	13.64	13.71	14.22
Moisture	8.35	6.69	5.51

As shown in Table 3, the Ontario Hydro measurements of total mercury at the inlet to the COHPAC on 3/6 and 3/7 were from 13 to 17  $\mu\text{g}/\text{dscm}$ . For 3/6 and 3/7, the coal analysis indicated a total mercury concentration in the flue gas of 5-7  $\mu\text{g}/\text{dscm}$  (calculated at 3%  $\text{O}_2$ ), or half of the Ontario Hydro measurement. On 3/5, the coal mercury was equivalent to 16  $\mu\text{g}/\text{dscm}$ , which was commensurate with the Ontario Hydro measurements (although one was not made on that day). The lag time of firing bunker (sampled) coal may contribute to the difference between coal and flue gas samples. S-CEM measurements showed total gaseous mercury concentrations in the range of 8-12.5  $\mu\text{g}/\text{dscm}$  at the inlet to the HESP. Since this range of gaseous mercury concentration is similar to the total mercury based on the coal composition, there is reason to believe that the total mercury at the HESP inlet was representative of the total mercury input to the boiler.

**Table 3.** Total mercury in flue gas at COHPAC inlet: comparison of Ontario Hydro measurement and calculation from coal composition

ADA Sample	GAS00010	GAS00014	GAS00019
MTI Sample	01-057	01-058	01-059
Date/Time	5-Mar	6-Mar	7-Mar
<b>Coal measurements</b>			
Hg, $\mu\text{g}/\text{dnm}^3$ (3% $\text{O}_2$ )	16.35	7.55	5.45
<b>Ontario Hydro measurements</b>			
Hg, $\mu\text{g}/\text{dnm}^3$ (3% $\text{O}_2$ )		16.92	12.56
		13.98	

The LOI was measured for the HESP hopper samples and for the COHPAC hopper samples (A-side). The HESP ash has a moderate carbon level (~7 wt% LOI) and the carbon content of the ash increases to ~11 wt% LOI in the COHPAC ash. The apparent increase in LOI could indicate that the carbon is concentrated in finer ash particles that are likely to escape the HESP but be captured by the baghouse.

The mercury content of the HESP ash was generally low and this is supported by previous measurements that showed almost no mercury in the particulate phase at the inlet to the HESP. In contrast, the COHPAC ash had 40 to 100 times as much mercury as the HESP ash, reflecting the effect of lower temperatures and longer residence times in the COHPAC unit as compared to the HESP. Table 4 shows these results in detail.

**Table 4.** Ash analyses from baseline testing at Gaston Unit 3.

Sample ID	MTI ID	Date/Time	Sample Location	Hg, $\mu\text{g}/\text{g}$ (AR)	LOI, wt%
GAS00011	01-060	3/6/2001 15:00	ESP Ash	0.00546	7.1
GAS00012	01-061	3/6/2001 15:20	COHPAC, A-side	0.672	11.8
GAS00016	01-062	3/7/2001 13:30	ESP Ash	0.0262	7.58
GAS00017	01-063	3/7/2001 14:00	COHPAC, A-side	0.83	11.2

#### Detailed Results: Long-Term Sorbent Injection Testing

Sorbent was injected in April, 2001 at Unit 3 into the B-side of the COHPAC unit. No sorbent was injected to the A-side of the baghouse, which served as an approximate control. Table 5 shows the solid samples collected and the analyses performed on them. Once again, LOI measurements were made at PSI and Microbeam Technologies made all other measurements. Particle size distribution (PSD) measurements were made using a Malvern analyzer. Leaching tests were also performed on select samples.

Many standard leaching procedures exist. The procedure used most often is the toxicity characteristic leaching procedure (TCLP). The method was designed to simulate leaching in an unlined, sanitary landfill, based on a co-disposal scenario of 95% municipal waste and 5% industrial waste. The method is an agitated extraction test using leaching fluid that is a function of the alkalinity of the phase of the waste. Typically an acetic acid solution having a pH of 2.88 is used.

The synthetic ground water leaching procedure (SGLP) was developed at the University of North Dakota Energy and Environmental Research Center (EERC) and was designed to simulate the leaching of CUBs under important environmental conditions. It was initially used to characterize highly alkaline CUBs, primarily fly ash produced from the combustion of low rank coals. The procedure was modeled after the TCLP, but allowing for disposal conditions other than those of a sanitary landfill. Deionized water is used as the leaching solution instead of the acidic solutions used in the TCLP. The SGLP was designed primarily for use with materials such as low-rank coal ash that undergo hydration reactions upon contact with water. Test conditions are end-over-end agitation, a 20:1 liquid to solid ratio and a thirteen-hour equilibration time.

The coal analyses from 4/22 through 4/26 are given in Table 6. The coal is similar to the baseline coal, resembling the 3/5 coal sample more than the 3/6 and 3/7 samples in terms of volatile matter, mercury and chlorine content.

**Table 5.** Analyses carried out on solid samples collected 4/22/01 to 4/26/01 on Gaston Unit 3

Sample ID	MTI ID	Date/Time	Sample	Analyses
GAS00125	01-112	4/22/2002	Coal	Ult/Prox, Hg, Cl
GAS00144	01-116	4/24/2001 12:00	Coal	Ult/Prox, Hg, Cl
GAS00150	01-120	4/25/2001 12:00	Coal	Ult/Prox, Hg, Cl
GAS00156	01-124	4/26/2001 12:00	Coal	Ult/Prox, Hg, Cl
GAS00158	01-125	4/27/2001 12:00	Coal	Ult/Prox, Hg, Cl
GAS00137	01-212	4/23/2001	Ash	Hg, LOI, PSD
GAS00138	01-213	4/23/2001	Ash	Hg, LOI
GAS00139	01-214	4/23/2001	Ash	Hg, LOI
GAS00140	01-113	4/24/2001 11:40	Ash	Hg, LOI, PSD
GAS00141	01-114	4/24/2001 14:20	Ash	Hg, LOI, PSD
GAS00142	01-115	4/24/2001 12:20	Ash	Hg, LOI
GAS00146	01-117	4/25/2001 10:40	Ash	Hg, LOI, PSD
GAS00147	01-118	4/25/2001 15:15	Ash	Hg, LOI, PSD
GAS00148	01-119	4/25/2001 15:15	Ash	Hg, LOI, TCLP, SGLC, SAL
GAS00152	01-121	4/26/2001 13:10	Ash	Hg, LOI, PSD
GAS00153	01-122	4/26/2001 13:30	Ash	Hg, LOI, PSD
GAS00154	01-123	4/26/2001 13:30	Ash	Hg, LOI, TCLP, SGLC, SAL
GAS00173	01-211	4/22/2001	Ash	Hg, LOI

**Table 6.** Sorbent injection campaign coal sample results (as-received basis).

ADA Sample	GAS00125	GAS00144	GAS00150	GAS00156	GAS00158
MTI Sample	01-112	01-116	01-120	01-124	01-125
Date/Time	4/22/2001 12:00	4/24/2001 12:00	4/25/2001 12:00	4/26/2001 12:00	4/27/2001 12:00
<b>ULTIMATE ANALYSIS (As Received):</b>					
Carbon	66.23	63.49	72.17	70.78	68.44
Hydrogen	3.30	3.21	3.43	3.23	3.61
Oxygen	4.93	4.63	3.40	3.77	4.03
Nitrogen	1.38	1.26	1.51	1.46	1.45
Sulfur	1.34	1.12	1.24	1.11	1.36
Ash	15.43	18.80	12.14	13.24	14.30
Moisture	7.40	7.49	6.12	6.41	6.82
Hg, µg/g	0.199	0.099	0.161	0.084	0.137
Cl, µg/g	211.42	248.45	132.81	111.65	140.77
HHV, BTU/lb	11,650	11,174	12,389	12,332	11,963
SO <sub>2</sub> , lb/MBtu	2.31	2.00	2.00	1.81	2.27
Ash, lb/MBtu	13.24	16.82	9.80	10.74	11.96
Hg, lb/TBtu	17.09	8.86	13.03	6.82	11.45
Hg, µg/dnm <sup>3</sup> (3%O <sub>2</sub> )	23.80	12.32	17.68	9.46	15.61
<b>PROXIMATE ANALYSIS (As Received):</b>					
Fixed Carbon	50.57	49.85	56.95	56.52	51.94
Volatile matter	26.6	23.86	24.79	23.83	26.94
Ash	15.43	18.8	12.14	13.24	14.3
Moisture	7.4	7.49	6.12	6.41	6.82

**Table 7.** Mercury in flue gas at COHPAC inlet: comparison of S-CEM gaseous measurement and total mercury calculation from coal composition and from Ontario Hydro measurement

ADA Coal Sample				GAS00125	GAS00144	GAS00150	GAS00156	GAS00158
MTI Coal Sample				01-112	01-116	01-120	01-124	01-125
Date	19-Apr-01	20-Apr-01	21-Apr-01	22-Apr-01	24-Apr-01	25-Apr-01	26-Apr-01	27-Apr-01
Coal Analysis				23.80	12.32	17.68	9.46	15.61
OH (COHPAC In)					9.57	8.69	12.88	
S-CEM	14.5	18	12	12	8	7	8	

The coal analyses suggest a lot of variability in the coal mercury content from sample to sample. The S-CEM and Ontario Hydro measurements also show considerable variation in the gaseous mercury in the flue gas. Taken together, this suggests that there is considerable variability in the mercury content of the coal, and that the gas phase mercury varies significantly from day to day. This has implications for implementation of a future sorbent injection system with this particular mix of coals.

The analyses of the ash samples are summarized in Tables 8 and 9 and on Figures 1 and 2. As with the baseline samples, there was a slight increase in LOI between the HESP ash and the COHPAC A-side ash, although the increase was not as large as that seen in the baseline testing. The B-side ash, of course, was mixed with sorbent and showed an average of about 30 wt% LOI. It is not surprising, that the sorbent-ash mixtures from the B-side hopper contain 10 to 100 times the mercury of the A-side hopper ash.

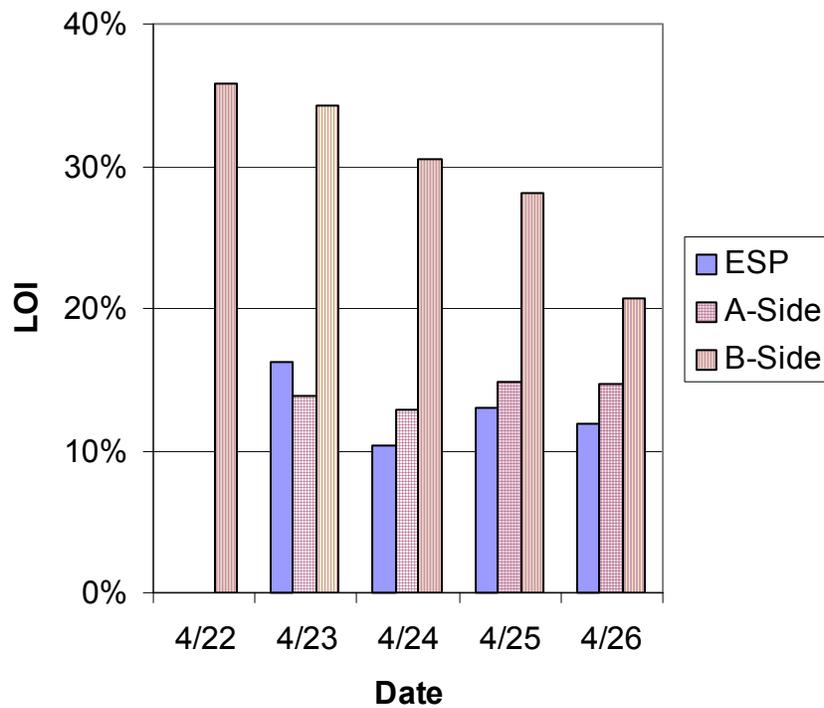
**Table 8.** Ash analyses from long-term sorbent testing at Gaston Unit 3.

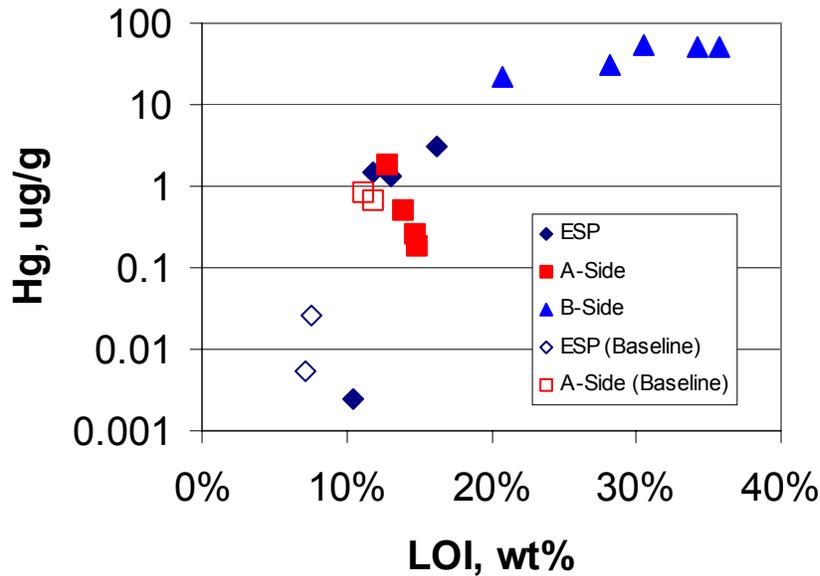
Sample ID	MTI ID	Date/Time	Sample Location	Hg, µg/g (AR)	LOI, wt%
GAS00173	01-211	4/22/2001	B-Side Ash	51.8	35.8%
GAS00137	01-212	4/23/2001	A-Side Ash	3.08	16.2%
GAS00138	01-213	4/23/2001	A-Side Ash	0.496	13.9%
GAS00139	01-214	4/23/2001	B-Side Ash	52	34.2%
GAS00140	01-113	4/24/2001 11:40	ESP 1st row	0.0024	10.38%
GAS00142	01-115	4/24/2001 12:20	BH B-side	53.3	30.55%
GAS00141	01-114	4/24/2001 14:20	BH A-side	1.85	12.80%
GAS00146	01-117	4/25/2001 10:40	ESP 1st row	1.33	13.07%
GAS00147	01-118	4/25/2001 15:15	BH A-side	0.187	14.79%
GAS00148	01-119	4/25/2001 15:15	BH B-side	30.6	28.15%
GAS00152	01-121	4/26/2001 13:10	ESP 1st row	1.48	11.87%
GAS00153	01-122	4/26/2001 13:30	BH A-side	0.267	14.66%
GAS00154	01-123	4/26/2001 13:30	BH B-side	21.7	20.70%

**Table 9.** Summary of Ash Analyses.

Location	Average LOI (%)		Average Hg, $\mu\text{g/g}$	
	Sorbent Injection	Baseline	Sorbent Injection	Baseline
COHPAC A-side (control side) ash	14.5	11.5	0.81	0.75
COHPAC B-side (injection side) ash + sorbent	29.9	N/A	41.8	N/A
HESP ash	11.8	7.3	0.94	0.016

**Figure 1.** LOI (wt%) in ash at various locations during Unit 3 long-term sorbent testing.



**Figure 2.** Mercury content of ash as a function of LOI for Unit 3 sorbent testing.

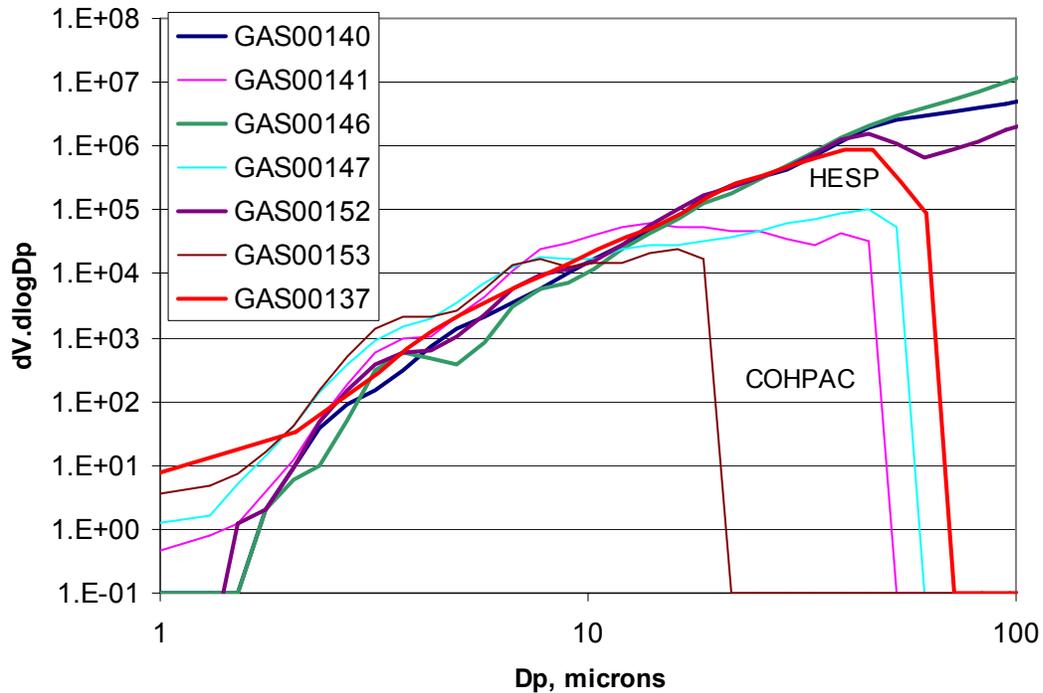
The high values of the mercury content of the ESP ash for the samples taken on 4/25 and 4/26 seemed inconsistent with the baseline (March) measurements of mercury in the HESP ash. The April mercury measurements average an order of magnitude higher than the March measurements.

There was some concern that the HESP ash samples from April could have been mixed up with the COHPAC A samples, which had similar LOI values. Visual inspection of both kinds of ash samples suggests that the ash samples are correctly labeled. As a final check on the identity of the ash samples, particle size distributions were measured for the HESP samples and the COHPAC A samples. These two classes of samples should have very different size distributions and any mislabeling of samples should be readily apparent.

Figure 3 gives the mass distributions for the fly ash from the April sorbent testing program for the HESP samples (140, 146, 152) and the COHPAC A-side samples (137, 141, 147, 153). As one would expect, the ESP samples show a broad size distribution with 50% of the mass greater than 10-20 microns. In contrast, the COHPAC baghouse samples show a more narrow size distribution of smaller particles, with 50% of the mass less than 6-9 microns.

Based on particle size distributions, the ash samples appear to be properly labeled.

**Figure 3.** Differential mass distribution for HESP and COHPAC A-side ash samples from April testing.



Should the high mercury contents of the HESP ash samples be believed? To perform a final check on this, we attempted to do a rough mercury mass balance at the HESP inlet. Assuming that 70% of the ash is present in the gas at the HESP inlet (an estimate provided by Larry Monroe) and an efficiency of 98% for the HESP, the amount of particulate-bound mercury *in the gas-phase* at the inlet to the HESP can be calculated, and compared with the Ontario Hydro measurement; the latter should be a representation of the “in-flight” ash mercury content. This calculation is shown in Table 10. The mercury content of the ash from the HESP hopper ash sample is 200-500 times higher than the estimate of the mercury content of the Ontario Hydro filter sample for two of the three days. While there is some uncertainty in the estimate of the concentration of mercury from the Ontario Hydro filter, it is certainly not two or three orders of magnitude. The discrepancy between mercury content of hopper ash and estimated in-flight ash is a not as large, only 4 to 200 times larger.

If there is any native capture of mercury across the COHPAC baghouse, one would expect some enrichment of the hopper ash in the baghouse relative to the incoming ash. However, the reasons for the enrichment in the HESP hopper are not clear.

The conclusion is that measuring the mercury content of the hopper ash does not give a realistic picture of the amount of mercury adsorption that takes place in the flue gas. The HESP is a particularly challenging sample environment, with ash at hundreds of degrees and a sample location available only at the bottom of the hopper. This limited sampling access results in a grab sample that does not represent an average of the captured ash.

## Leaching Results

Leaching tests were also performed. Samples from Gaston's COHPAC B hoppers were leached at EERC using the standard TCLP procedure and also the synthetic groundwater leaching procedure (SGLP). They were also subjected to sulfuric acid leaching (SAL) at a pH of 2, following procedures similar to TCLP and SGLP. This is an extreme condition that might simulate acid mine drainage. One duplicate measurement was made for the TCLP procedure and one for the SGLP procedure. Table 10 gives the leaching results from EERC. With one exception, all of the results (in terms of Hg in leachate) were below the detection limit of 0.01 mg/L. Compare this with the total mercury in ash, Table 9, which averaged almost 42 µg/g.

**Table 10.** Leaching results (EERC).

Plant	Sample Type	Location	Inj.Rate lb/MMacf	Hg in Leachate (mg/L or ppbw)		
				TCLP	SGLP	SAL
Gaston	COHPAC Ash	B-Side	1.5	0.01	<0.01	<0.01
Gaston	COHPAC Ash	B-Side	1.5		<0.01	
Gaston	COHPAC Ash	B-Side	1.5	<0.01	<0.01	<0.01

## Conclusions and Recommendations:

Gaston Station burns different coals and changes coal frequently. The coal mercury content varied in the long-term testing from 0.08 to 0.2 µg/g. If the plant continues to operate with such a wide range of mercury contents, then effective mercury control can either be achieved by adding enough sorbent for the *maximum expected mercury content* or by using a continuous mercury monitor to determine the level of mercury in the flue gas and the amount of sorbent needed.

Measuring the mercury content of the hopper ash does not give a realistic picture of the amount of mercury adsorption that takes place in the flue gas; either in the HESP or COHPAC baghouse. Without a meaningful number for the mercury content of the hopper ash, it is not possible to do a complete mercury mass balance around the plant.

**Table 10.** Calculated concentration of Mercury in ESP ash and COHPAC Inlet Ash (at 6% O<sub>2</sub>)

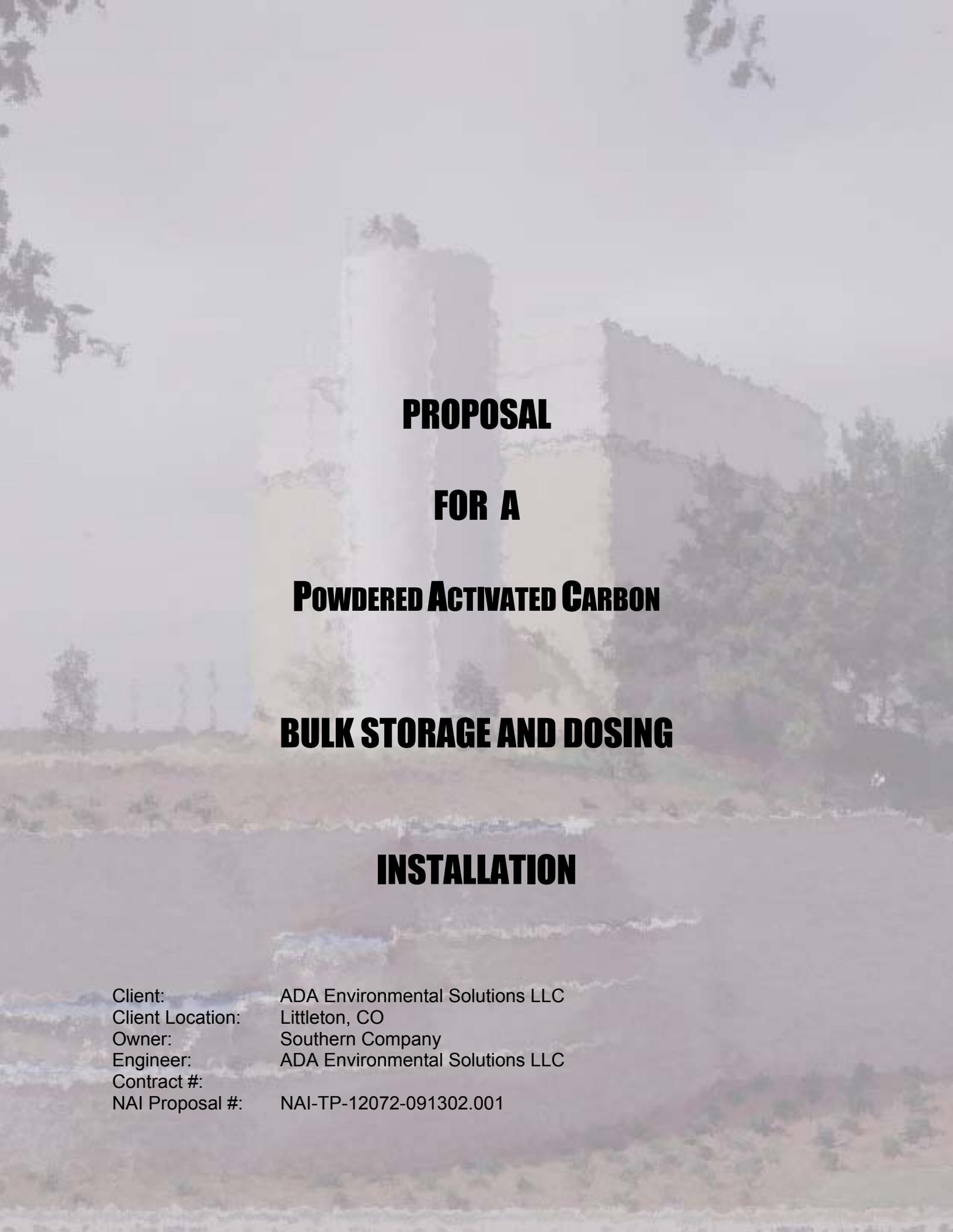
	4/24/2002	4/25/2001	4/26/2001
<b>HESP Inlet</b>			
OH measurement:			
Gas volume, dnm <sup>3</sup>	1.6734	1.6760	1.7293
µg Hg on filter	0.7940	0.0407	0.1120
µg/dnm <sup>3</sup>	0.4745	0.0243	0.0648
Ash:			
LOI	10.4%	13.1%	11.9%
Ash loading, g/dnm <sup>3</sup>	15.5	9.1	10.0
<b>Hg µg/g (OH)</b>	<b>0.0306</b>	<b>0.0027</b>	<b>0.0065</b>
<b>Hg µg/g (measured)</b>	<b>0.0024</b>	<b>1.3300</b>	<b>1.4800</b>
<b>COHPAC Inlet</b>			
OH measurement:			
Gas volume, dnm <sup>3</sup>	1.4680	1.4118	1.3977
µg Hg on filter	0.1640	0.5330	0.2100
µg/dnm <sup>3</sup>	0.1117	0.3775	0.1502
Ash:			
LOI	12.8%	14.8%	14.7%
Ash loading, g/dnm <sup>3</sup>	12.4	7.5	8.2
<b>Hg µg/g (OH)</b>	<b>0.0090</b>	<b>0.0507</b>	<b>0.0182</b>
<b>Hg µg/g (measured)</b>	<b>1.8500</b>	<b>0.1870</b>	<b>0.2670</b>

# **APPENDIX H**

## **Economic Analysis**

**APPENDIX H  
PART 1**

**Costs for Carbon Injection Equipment  
Supplied by NORIT AMERICAS INC.**



**PROPOSAL**

**FOR A**

**POWDERED ACTIVATED CARBON**

**BULK STORAGE AND DOSING**

**INSTALLATION**

Client: ADA Environmental Solutions LLC  
Client Location: Littleton, CO  
Owner: Southern Company  
Engineer: ADA Environmental Solutions LLC  
Contract #:  
NAI Proposal #: NAI-TP-12072-091302.001

# NORIT Americas Inc.

Most Choices + Precise Fit = Best Performance.

## PROPOSAL

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## PROPOSAL

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## PROPOSAL

### BENEFITS NORIT AMERICAS INC. SILO STORAGE & AUTOMATIC FEED SYSTEM

<b>SYSTEM FEATURE</b>	<b>BENEFIT TO Southern Company</b>
<i>PAC System Design from Worlds Largest PAC producer</i>	<ul style="list-style-type: none"> <li>• Experienced Team and Custom Design ensures reliability</li> <li>• Complete turnkey installation</li> <li>• The best system from the people who know PAC the best</li> </ul>
<i>Automatic feed of PAC</i>	<ul style="list-style-type: none"> <li>• Easy start-up</li> <li>• Totally hands off operation which is <u>monitored</u> by the operator</li> <li>• Accurate PAC feedrate</li> <li>• No operator handling or exposure to carbon dust</li> </ul>
<i>Prefabricated Components</i>	<ul style="list-style-type: none"> <li>• Fast Erection &amp; Startup</li> <li>• Minimized plant interruption.</li> </ul>
<i>Totally contained system</i>	<ul style="list-style-type: none"> <li>• <u>NO carbon mess</u></li> <li>• Enhanced Reliability</li> <li>• Improved safety from cleaner work place</li> </ul>
<i>(Optional) Remote telemetry reorder \$750 Adder</i>	<ul style="list-style-type: none"> <li>• No emergency orders of PAC</li> <li>• No danger of plant downtime from loss of carbon feed</li> <li>• No worry about when to reorder - it's automatic</li> <li>• Optimal inventory control</li> </ul>



# NORIT Americas Inc.

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## CONTRACT

NORIT Americas Inc. (hereinafter referred to as "Seller") does hereby propose to furnish to **ADA Environmental Solutions LLC** (hereinafter referred to as "Buyer"), whose address is **8100 South Park Way Unit B-2, Littleton, CO 80120** equipment and or activated carbon, as set forth below.

### NORIT Bulk Storage and PAC Dosing System

**US\$ 312,625.<sup>00</sup>**

Including, but not limited to 14' diameter PAC Storage Silo, Equipment Skid containing all equipment required for a self contained metering and dosing system to convey PAC to two independantly controllable dosing points at the rate of 30-750 #/hr., Prewired/Preprogrammed Control System panel, Level Indicators, Discharge Valve and Flow Control System delivered to site ofr erection by others. As described in NORIT Proposal attached as Exhibit A. FOB ExWorks.

Option	Accept	Decline	Description	Adjustment	Price
A.					
B.					
C.					
D.					
E.					
F.					

All work to be completed in a workmanlike manner according to standard practices and will comply with all local requirements for building permits and inspections. Any alteration or deviation from the above specifications involving extra costs will be executed only upon written orders, and will become an extra charge over and above the proposal. This proposal is valid for sixty (60) days from 20 May, 2003. Payment Terms 10% with Order, 10% with Approval Drawings, 50% with notice to ship, 20% upon erection, 10% upon startup and owner acceptance.

#### General Terms and Conditions on reverse shall govern

**NORIT Americas Inc.**

Dated 20 May, 2003

Authorized Signature \_\_\_\_\_

Authorized Signature \_\_\_\_\_

#### Acceptance of Proposal

The Above prices, specifications and conditions are hereby accepted. NORIT Americas Inc. is authorized to do the work as specified. Payment will be made as outlined above.

Date of Acceptance \_\_\_\_\_

**ADA Environmental Solutions LLC**

Signature \_\_\_\_\_

Signature \_\_\_\_\_



# I GENERAL TERMS & CONDITIONS

The following terms and conditions of sale ("Terms") govern all quotations, offers, purchase orders, order acknowledgements, contracts, and deliveries for the sale and/or installation of all goods (the "goods") supplied by Norit Americas Inc. ("Seller") to the purchaser thereof ("Buyer"). All orders by Buyer for goods are subject to acceptance by Seller at its office in Atlanta, Georgia. Unless modifications or additions are expressly accepted in writing by Seller, these Terms are controlling and no other, inconsistent or additional provisions shall be of any effect, unless accepted by Seller in writing. Seller's acceptance of Buyer's order is expressly conditional on Buyer's assent to these Terms. These Terms and Conditions of Sale shall become effective, and are accepted by Buyer, at the latest upon Buyer's receipt and use of all or part of the goods sold hereunder.

**SCOPE.** Seller's written quotation and order confirmation, if any, and these Terms shall be conclusive in determining the rights and obligations of Seller and Buyer. Data, such as illustrations, drawings or specifications, shall be considered approximations, unless Seller has specifically stated otherwise in writing. Seller reserves the right to make changes in design and construction of the goods to be supplied, provided such changes do not impair the operation or durability of the goods and do not alter the price.

**PURCHASE PRICE AND PAYMENT TERMS.** Buyer shall, without offset or deduction, pay the purchase price for the goods, as well as all federal, state and local sales, use, excise or other similar taxes on the goods. Unless otherwise agreed in writing, payment of the purchase price shall be net F.O.B. origin of shipment and payment shall be made by Buyer at the latest within thirty (30) days from the date of Seller's invoice. On all amounts owed and remaining unpaid more than thirty days from the date of Seller's invoice, interest will automatically accrue and be charged to Buyer without further notice at the rate one percent (1%) per month (12% annually). In addition, Buyer agrees to pay all expenses of collection, including reasonable attorneys' fees, if amounts owing by Buyer are collected by or through an attorney at law. Time is of the essence as to the payment obligations of Buyer.

The terms of payment are subject to the approval of Seller prior to shipment, and Buyer agrees, with respect to its obligation for payment, that (a) if, in Seller's judgment, Buyer's financial condition or other conditions do not justify shipment, Seller may require full or partial payment in advance; (b) after the goods are shipped, it will pay to Seller the amount of the invoice in accordance with the terms of payment stated thereon.

Buyer agrees that all changes which it may request after approval of drawings and settlement of design details are subject to engineering charges and to factory charges on in-process work already completed and affected by the change. Such changes are to be initiated in writing by Buyer and are subject to acceptance by Seller. Buyer agrees that the value of all change order amounts is billable at 100% of face value due net 30 days.

**PROPOSAL VALIDITY** The price in this proposal is valid for 60 days from 20 May, 2003, after which time NORIT Americas Inc. retains the right to review the individual items for price escalation.

**DELIVERY.** Unless otherwise agreed in writing, Seller will deliver the goods F.O.B. Seller's place of shipment upon receipt by Seller of any agreed upon downpayment, other payments, and all documents, permits and data deemed reasonably necessary by Seller for it to perform its contractual obligations. Partial shipments will be permitted and contract modifications will extend time of delivery for a period of time appropriate to permit compliance with same. The times for shipment, delivery, and start-up are Seller's best estimate and Seller will exert reasonable efforts to accomplish shipment, delivery, and start-up at such estimated times. Shipment dates are not guaranteed and are not binding in the event of unforeseen circumstances, including but not limited to acts of God, war, insurrection, labor disputes, delay of delivery of essential materials, and events beyond Seller's control. In the event of cancellation, anticipatory repudiation, nonperformance, breach or default by Buyer prior to shipment, Seller shall be entitled, without proof of actual damages, to liquidated damages equal to twenty-five percent (25%) of the contract price in lieu of actual damages. It is agreed that the liquidated damages referred to herein are not established as a penalty, but are calculated and agreed upon in advance based upon the difficulty, uncertainty and impossibility of determining the actual and consequential damages which would be incurred as a result of such cancellation, repudiation, nonperformance, breach or default by Buyer prior to shipment. This liquidated damages provision is not intended to apply to nonperformance, breach or default of the contract subsequent to shipment, nor, at Seller's option, to cancellation, repudiation, nonperformance, breach or default which gives rise to a remedy other than damages (such as specific performance), and Seller retains every other remedy it may have in connection therewith. In the event of Buyer's breach at the time of or subsequent to shipment, Seller shall be entitled to all reasonable attorneys' fees, collection costs, interest at the maximum rate allowable by law on the unpaid balance due, and all other legal and equitable remedies.

**RISK OF LOSS AND ACCEPTANCE.** The risk of loss passes to Buyer at the time of delivery to carrier, irrespective of whether Seller is required to render additional services under the contract, such as installation. Notwithstanding the passage of risk of loss to Buyer upon delivery of the goods to the carrier, title of the goods shall remain in Seller until delivery to Buyer. In the event of a delay in shipment for which the Buyer is responsible, the risk of loss passes to Buyer as of the date the goods are ready for shipment. Buyer is required to accept delivery of all goods shipped, without prejudice to its warranty rights. Buyer shall upon delivery receive, sign for and unload the goods and within seven (7) days of delivery inspect the goods, and shall within fifteen (15) days of delivery give written notice to Seller of any claim that the goods do not conform or are otherwise unacceptable. No attempt at notice of revocation of acceptance by Buyer shall be effective if not made in writing within fifteen (15) days after Buyer discovers or should have discovered, whichever is earlier, the ground for such revocation. Buyer shall make any claims in writing for shortage or error in filling its order within ten (10) business days after delivery of the goods.

**SECURITY INTEREST.** Until all amounts owed by Buyer to Seller with respect to the goods or services provided hereunder and under any other transaction between Seller and Buyer are paid in full, Seller retains security title to the goods and Buyer grants to Seller a lien upon and purchase money security interest in the goods under the Uniform Commercial Code all of which shall continue notwithstanding any attachment or affixation of the goods to real estate and Buyer agrees to execute all documents and to do and perform all other acts and things which Seller in good faith considers necessary, desirable or appropriate to further establish, perfect or protect Seller's security interest and Buyer authorizes all present and future officers of Seller to execute, and to file, in Buyer's name and on Buyer's behalf any and all financing statements, fixture filings or other documents deemed necessary by Seller to accomplish same.

**WARRANTY, DISCLAIMER AND LIMITATION OF REMEDIES.** NORIT Americas, Inc., Inc. (Seller warrants that, for a period of one (1) year from the date of start-up to the customers site, not to exceed eighteen (18) months after delivery to plant site, those equipment, materials and workmanship described above for the intended normal use and service will be free from defects in material and workmanship. Seller will assign to Buyer (to the extent assignable) all warranties or guarantees of goods of manufacturer other than its own that it sells in connection with the setup and the use of its goods. Notwithstanding the foregoing, Seller does not warrant against abrasion, corrosion or erosion. Seller's limited product warranty will not apply unless Buyer gives written notice to Seller of the specific defect within five (5) business days of discovery and Buyer has met its own obligations under the contract, including payment. Seller further warrants that those goods manufactured by Seller will be designed and manufactured so as to perform the mechanical functions expressly set forth in Seller's written specifications for the goods. This performance warranty shall be effective only if Buyer tests the goods promptly in accordance with the scheduling as agreed to by the parties, if any, notifies Seller in writing of any deficiency in performance within seventy-two (72) hours of the completion of such testing, delivers to Seller a written performance report within ten (10) days after the completion of such testing, and has met its own obligations under the contract, including payment. Seller shall be deemed to have fulfilled its performance warranty, if any, in the event that the applicable specifications can be achieved within 10% upon performance testing. Buyer expressly acknowledges that reloading of materials is required periodically during operation and that such requirement will result in discontinuous operation from time to time. Seller's warranties do not cover defects or deficiencies due to or arising out of (1) normal wear and tear or improper, abnormal, or negligent handling, operation, maintenance, overloading, or use; (2) improper foundation or installation, unless performed by Seller; (3) weather or other influences of nature; (4) tampering, alteration, or repair by Buyer or third parties without the prior written consent of Seller. Seller does not warrant components and parts not manufactured by Seller. Seller does not warrant services by anyone other than Seller, unless such services are provided by an authorized agent of Seller, in which event Seller warrants that the service will be performed in a workmanlike manner.

Buyer shall grant Seller a reasonable time and opportunity after Buyer's written notice to comply with warranty obligations and Seller reserves the right to make adjustments and design modifications to the goods prior to initial operation and during the warranty period to meet its warranties.

Seller shall absorb the costs of warranty repairs and replacements on an ex-works basis. Buyer shall be responsible for the costs of warranty transportation of the goods, outside charges, "back charges" and the expenses of warranty disassembly and installation. With respect to repaired or replaced goods serviced under Seller's product warranty, Seller's product warranty shall apply for the longer of (a) the initial product warranty period then remaining as to the repaired or replaced goods or (b) six (6) months from the date of notification by Seller to Buyer that the work has been completed, whichever is later. All replaced goods shall be the property of Seller.

**THE WARRANTIES SET FORTH ABOVE ARE THE SOLE AND EXCLUSIVE WARRANTIES AND ARE EXPRESSLY IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED.**

Buyer's sole and exclusive remedy for breach of warranty is limited to the repair or replacement at Seller's option of defective or deficient parts. In the event Seller is unable or otherwise fails to repair or replace within a reasonable time, Buyer's sole and exclusive remedy is limited to an amount not in any event to exceed the price actually paid for the goods upon return of the goods to Seller.

Except where expressly acknowledged in writing by an executive officer of Seller, no person or entity other than a corporate officer of Seller is authorized to assume for Seller any undertaking, obligation, liability, or warranty.

**LIMITATION OF LIABILITY.** Seller shall in no event be liable to Buyer for injury to persons or damage to property arising out of or in connection with the sale, delivery, assembly, disassembly, repair, use, installation, or employment of the goods, whether arising from any claim based upon contract, warranty, tort, products liability, strict liability, failure of essential purpose, or any other legal or equitable theory, for any amount in excess of the amount actually paid by Buyer to Seller for the goods. Except, however, in no event shall Seller be liable to Buyer in any manner for any special, indirect, incidental, or consequential damages including but not limited to damages or losses arising out of shut-downs, inoperability of the goods, operating labor, overhead, loss of production or raw materials, production of below-standard products, or loss of profits, whether arising from contract, warranty, tort, products liability, strict liability, failure of essential purpose, or any other legal or equitable theory.

**INSTALLATION.** If the contract provides for installation by Seller, Seller will commence such installation after the site has been made ready, foundations have been completely dried and set, and all construction and preliminary work has been entirely completed. Unless otherwise agreed, installation of the goods and all outside charges and "back charges" shall be carried out at the expense and risk of Buyer. If the contract requires Seller to install the goods and to provide labor, the labor supplied by Seller shall not be required to work overtime or to provide services except as expressly required under the contract, unless Buyer agrees to pay for such additional work against a separate invoice. Trial operations, performance testing and start-up shall be performed during normal working hours and operating materials shall be paid for by Buyer.

**CONFIDENTIALITY.** Seller retains ownership of and all intellectual property rights in and to all information, quotations, drawings, and documents (collectively "the property") furnished by Seller or produced in the performance of this contract.

**SECURITY.** All documents and information made available by either party to the other will be treated as confidential and used exclusively in cooperation with each other for the construction of the plant. NORIT Americas Inc. will abide by all requirements outlined in the previously signed Confidentiality Agreement. If documents and information are transmitted to third parties with the permission of the originator of such documents and information, it will be made binding on such third parties not to disclose documents or information received. If Client deems it necessary, confidentiality agreements will be placed with said third party.

**CHOICE OF LAW AND JURISDICTION.** The interpretation and enforcement of these Terms shall be exclusively governed by and construed in accordance with the substantive laws of Georgia without giving effect to the choice of law principles thereof. Buyer and Seller hereto specifically consent to jurisdiction in any federal or state court within Georgia, which courts shall together constitute the exclusive forum in which disputes under or in connection with this contract are to be resolved. Buyer specifically submits to personal jurisdiction and waives all objections to jurisdiction and venue and waives any claim of forum non conveniens and specifically consents to venue and jurisdiction in the state and federal courts of Georgia for any action instituted pursuant to this contract. Except, however, nothing contained herein shall prevent Seller from bringing any action or exercising any rights within any other state or other jurisdiction against Buyer and against the collateral and any properties or assets of Buyer as to any legal claim arising in connection with these Terms.

**INFRINGEMENT.** If notified promptly in writing of and given sole control of the defense, Seller shall indemnify and hold Buyer harmless from and against claims that the goods themselves infringe a United States patent. Buyer, however, shall defend, indemnify and hold harmless Seller from and against any loss, liability, claim or expense (including reasonable attorney's fees) arising out of a claim of patent or other intellectual property rights infringement made in connection with Buyer's business, its methods, systems or processes; except, there shall be no indemnity by Buyer where Seller's good are the sole cause of such claim.

**MISCELLANEOUS.** Buyer shall use and shall require its employees and others coming in contact with the goods to use safety measures and devices. Buyer shall provide proper warnings and use and require its employees and others coming in contact with the goods to use safe operating procedures around the goods and in operating the goods. Buyer specifically agrees to maintain the goods in compliance with all laws and regulations of any and all government agencies or authorities having jurisdiction with respect to the installation and use of the goods. Seller makes no representation that the goods do or will comply with any law, code, regulation or order of any authority or other governmental body and Seller does not undertake or have any obligation to obtain permits, licenses or approval from said authority or governmental body concerning the goods. If Buyer breaches any of the agreements or undertakes in this Agreement, Buyer shall indemnify and save Seller harmless from and against any claim, loss, liability, obligation or judgment, including expenses of litigation and reasonable attorneys' fees, incurred by Seller arising out of or in connection with injuries to person or damage to property directly or indirectly related to the purchase, installation, use or operation of the goods. Buyer further agrees to notify Seller promptly in writing, but in no event later than thirty days of any accident or malfunction involving the goods, which results in personal injury or damage to property and to at all times cooperate fully with Seller and others in investigating and determining the causes of such accident or malfunction.

This contract shall be binding upon and inure to the benefit of the respective successors and assigns of each of the parties hereto, but shall not be assigned by Buyer without the prior written consent of Seller.

Seller's waiver of any breach, or failure to enforce any of the terms and conditions of this contract at any time, shall not in any way affect, limit or waive Seller's right thereafter to enforce and compel strict compliance with every term and condition hereof.

Buyer shall reimburse Seller for all excise, use or sales taxes, or other charges which Seller may be required to pay to any government (national, state or local) upon, or measured by, the sale, transportation or use of any goods sold hereunder. Seller may at its option add to the price of goods sold hereunder the amount of any increase in transportation charges for shipments to Buyer.

All provisions of these Terms are severable and divisible and if any term or provision of the contract should be held invalid or unenforceable for any reason, such term or provision shall be void to the extent of such invalidity or illegality, without invalidating any of the remaining Terms. The headings contained herein are for convenience of reference only and shall not affect the meaning or interpretation of these Terms.

In the event that NORIT Americas, Inc. should be delayed in the completion of the work by reason of any act or omission of the purchaser or another contractor employed by the purchaser, the period within which the work is to be completed under this contract will be extended for the period resultant from such delay.

These Terms and the documents consistent with and governed by these Terms constitute the entire agreement and understanding between the parties with respect to its subject matter and shall not be modified or amended except by express written amendment signed by the duly authorized representatives of the parties.

# NORIT Americas Inc.

Most Choices + Precise Fit = Best Performance.

## PROPOSAL

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### I INTRODUCTION

The NORIT Americas, Inc. silo storage and flue gas dosing system is the result of many years of experience in the design and installation of powdered activated carbon (PAC) dosing systems worldwide, as well as the experience gained by being one of the largest manufacturers of activated carbons in the world.

NORIT Americas Inc. proposes to design and supply a clean, reliable dosing/injection system, that will receive, store and feed bulk Powdered Activated Carbon (PAC) into the flue gas stream of a coal fired power boiler at the Gaston Plant of Alabama Power.

### II DESCRIPTION OF THE SYSTEM

The NORIT bulk silo storage and feed system will receive bulk PAC in 40,000 pound batches, delivered by tanker trucks. The PAC is unloaded pneumatically into a dry welded steel storage silo where a combination of specially designed air fluidization valves and nozzles, located in the conical discharge section of the silo, pulse compressed air into the bulk of the carbon, promoting mass flow out of the flanged discharge connections. NORIT takes advantage of the natural tendency of fine powders to flow with liquid-like properties when fluidized by a gas, normally air, to move the PAC within the system. By separating the individual carbon particles with a gas, the normal resistance to bulk flow is greatly reduced and the carbon can easily be moved from the silo into the metering equipment.

Fluidized PAC is fed from the silo by a rotary valve into a volumetric feeder hopper where it is temporarily stored until conveyed by the feeder screw into the drop tube. The amount of carbon discharged from feeder is directly proportional to the speed of the feeder screw and an adjustable speed drive motor allows a wide range of carbon delivery rates from the screw. Carbon is fed through the drop tube directly into the eductor inlet, located below the feeder discharge.

The passing of motive air through the eductor nozzle produces a vacuum in the eductor inlet, which helps draw the carbon and air into the mixing zone directly downstream of the mouth. The carbon is transported through the piping system and is injected through a nozzle into the boiler exhaust gas stream.

A programmable logic controller (PLC), with input from remote sensors, controls the sequences of events throughout the system and also provides alarms and interlocks to annunciate problems and protect the system. The system is configured to feed a constant pounds per hour of carbon or to



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follow an analog signal provided by the customers equipment. During normal operation, operator attention is not required, as the system operates automatically once the mode of operation and the feed rates have been selected.

The equipment/system proposed will require a dry compressed air supply, a 480 VAC power supply and injection piping interfaces. All system components will be located under or attached to the storage silo, on the storage silo top deck and in the Power and Control Building. The footprint of the PAC storage silo will be 14 feet in diameter and will require an adjoining area for spotting a pneumatic road tanker for carbon filling. The footprint of the Power and Control Building will be 8 feet by 10 feet. This building will house the Motor Control Center, the Control Panel and the air storage tank.

### III SCOPE OF WORK

NORIT Americas Inc. proposes to provide the following management, design, equipment, installation and support:

#### ***A. MANAGEMENT, DESIGN & SUPPORT***

##### **1. Project Management**

NORIT will provide the services of a Project Manager to oversee the complete project including the following activities:

- a. System design.
- b. Project scheduling.
- c. Project submittals.
- d. Coordination between the Purchaser and NORIT for system details.
- e. Equipment Procurement.
- f. Supervision of fabrication shop for sub-assemblies.
- g. Technical support during equipment installation.
- h. System start-up.
- i. Development of the system O&M Manuals.

##### **2. Design**

NORIT will provide the following design documents and drawings:

- a. General arrangement drawings.



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- b. Piping Instrumentation Diagram.
- c. Mechanical Design/Layout Drawings.
- d. Electrical Schematics.
- e. Point to point wiring diagrams.
- f. Interconnect Diagram & Conduit Routing
- g. Allen Bradley PLC Ladder Logic Diagrams.
- i. I/O List.
- j. Equipment List.
- k. Motor data sheets.
- l. Foundation Loadings provided by the Silo Manufacturer.

### 3. Submittal

NORIT will provide four (4) copies of the following drawings and information, as a minimum, to the Purchaser for approval prior to purchase of equipment.

- a. Written Description of System Operation.
- b. Project Schedule.
- c. System P&ID's.
- d. System General Arrangement Drawings.
- e. System Plan Drawings.
- f. Electrical Schematic Drawings.
- g. Control Panel Layout Drawings.
- h. PLC Ladder Logic.
- i. Equipment Cut Sheets.

### 4. O&M Manuals

NORIT will provide four (4) copies of the O&M manuals prior to installation of the equipment and will provide as-built drawings upon completion of the project. The O&M Manuals will contain, as a minimum, the following information:

- a. Written Description of System Operation.
- b. System P&ID's.
- c. System General Arrangement Drawings.



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- d. System Plan Drawings.
- e. Electrical Wiring Diagrams.
- f. Control Panel Layout Drawings.
- g. PLC Ladder Logic.
- h. Equipment Operation & Installation Manuals.
- i. Silo Design Drawings & Foundation Loading Calculations.

### **5. Installation, Start-Up and Training Services**

NORIT Americas will provide the services of the Project Manager for a period of two (2) weeks to assist the purchaser and his contractor with the installation of the equipment and to provide start-up services and operator training. Additional days on-site at the request of the purchaser will be billed at the standard rate of \$750 per day plus living and travel expenses.

## **B. CIVIL/STRUCTURAL**

### **1. Storage Silo and Building Foundations**

NORIT will provide the storage silo design loads to allow the Purchaser to design and install a suitable foundation for the PAC storage silo. NORIT will also provide the Power and Control Building loads to allow the Purchaser to design and install a suitable sub-base or foundation.

### **2. Power and Control Building**

NORIT Americas will provide a concrete Power and Control Building that houses the Motor Control Center and the Control Panel. This building will have heating and air conditioning and will also contain the air storage tank.

### **3. Equipment Support Structure**

The PAC feed equipment, blower, associated piping and instruments will be mounted on support skids fabricated from 3" A 500 square tubing with base plates for anchoring. The structural members will be of sufficient size to support the equipment without excessive deflection or vibration.

All external carbon steel surfaces will be blasted per SSPC SP6 commercial blast to obtain a 1.5 mil average profile, prime coated



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with Sherwin Williams Epoxy Mastic Aluminum II B62 S 100/B60 V 100 Primer (6.0 mils DFT) and finish coated with Sherwin Williams Aliphatic Polyurethane B65 T 104/B60 V2 (3.0 mils DFT) in "safety" blue.

### **C. MECHANICAL EQUIPMENT**

#### **1. Storage Silo**

A welded carbon steel silo with support legs and load cells will be provided to receive and store the bulk PAC. The silo will be 14 feet in diameter with a working capacity of approximately 2,900 cubic feet. The silo deck will be sloped ten (10) degrees for drainage. The silo will be fabricated with a two (2) cone bottom, each with a 60 degree minimum slope. Each discharge cone will be fitted with a short section of 8" nominal pipe and an 8" flange

The silo will be designed to meet the most stringent of the following conditions:

- a. Per the Uniform Building Code, latest edition.
- b. A weight of 35 pounds per cubic foot for the material contained within the silo.
- c. Transportation, handling and erection loads.
- d. To support a 300 pound person walking on the roof and platform surfaces, in addition to the dead load weight of all equipment and appendages.
- e. A live load of 50 psf on the roof area and 100 psf on walking surfaces.

Anchor bolts will be designed and provided by the silo manufacturer.

The silo will be equipped with a 4" nominal, schedule 40 fill line, with a 48" radius elbow, which enters the silo tangentially, reducing dusting and lowering the demand on the silo vent filter. The fill line will be supported by brackets attached to the silo shell and will be equipped with a 4" male camlok fitting & cap located approximately 4½' above grade for the truck hose connection.

The silo roof deck will be equipped with a bag type vent filter for cleaning the conveying air from the delivery tankers, a 24" pressure and vacuum relieving manway, and a reflex-radar level transmitter to measure PAC Level.



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The silo will be equipped with three (3) each 1½" half couplings located in the sidewall for three (3) point level switches to monitor PAC level.

Each silo discharge pipe will be equipped with one (1) each 1" half coupling and each outlet transition section will be equipped with two (2) 1" half couplings to accommodate fluidizing nozzles. The upper silo discharge cone section will also be equipped with eight (8) each 2" half couplings to accommodate additional air fluidization nozzles near the circumference of the cone.

The silo will be primed with a polyamide epoxy primer over a commercial SSPC SP-6 blast on the exterior surfaces and inside the skirt. The exterior will be coated with an acrylic enamel topcoat of a color chosen from the manufacturer's standard color chart. The silo top deck will be painted with a FerroX non-skid coating.

The silo will be skirted with structural steel legs and load cells such that the weight of the PAC remaining in the silo can be measured at all times. The load cells will feed a weigh-indicator mounted in the Control Panel. The Weigh-Indicator will also provide input to the Allen Bradley PLC System.

A galvanized carbon steel OSHA approved ladder with integral safety cage and intermediate landing will be provided for access to the silo top deck, which will be enclosed with handrail and toe plate. The handrail will be aluminum pipe supported from galvanized carbon steel angle posts with galvanized steel toeboard.

Electrical Equipment installed under, on the side and on top of the silo will be suitable for use in Class II Division 2 Group F Environments.

### **2. Silo Vent Filter**

A self-contained bag-type (Flex Kleen model 58BVBS-25 or approved equal) bin vent filter will be provided and mounted atop the PAC storage silo. The dust collector will be oriented to allow easy operator access of the filter elements for routine maintenance. The dust collector will be designed to provide a 3.3:1 air-to-cloth ratio based on 600 cfm of air volume from the truck mounted blower. The filter bags will be fabricated from 16 oz woven polypropylene material and will be 58 inches long.

The filter bags will be cleaned by a reverse pulse air jet type



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cleaning system which will require approximately seven (7) scfm of compressed air at 100 psig when operating. The vent filter timer board, which actuates the solenoid valves, will be located within a NEMA 4X enclosure mounted on the filter house. The unit will be primed and finish painted safety blue and will be flange mounted on the storage silo roof.

A Dwyer Series 1950 differential pressure switch and a Dwyer Series 2000 Magnahelic differential pressure indicator will be provided to monitor the pressure drop across the filter bags. An Off/Hand selector switch will be provided to control the filter bag cleaning cycle. The time between air pulses and the duration of the pulses are adjustable.

The particulate matter concentration in the effluent gas of the dust collector will not exceed an average of 0.02 grains per actual cubic foot. The guarantee is based on particles two microns and larger in diameter and on the equipment being properly installed and maintained according to the standard Flex Kleen instructions.

### 3. Manual Knifegate Valve

Each silo discharge cone will be equipped with an 8" DeZurik manual knifegate valve to isolate the PAC storage silo from the feed system below. All wetted parts will be of stainless steel construction.

### 4. Rotary Valve

Each silo discharge cone will be equipped with an 8" Rotolok Industries HD8 (OAE) rotary valve to control the flow of fluidized PAC from the silo into the volumetric feeder hopper. The valves will be constructed of cast iron with 8" ANSI flanged inlet and outlet connections and a closed rotor with a minimum of six pockets. The valves will feature externally mounted bearings to separate the product from the bearings. The rotary valve will turn at approximately 10 revolutions per minute, providing a theoretical maximum PAC feed rate of 110 cubic feet per hour to the volumetric feeder hopper. The unit will be located between the knifegate valve and the expansion joint. Each rotary valve will be driven by a 1/2 hp 480/3/60 single speed TEFC motor. The motor will be coupled to a gearbox that drives the valve rotor through a chain and sprocket arrangement encased inside an OSHA approved guard.



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### 5. Volumetric Feeder

Two (2) Acrison model 105Z auger type volumetric feeders, designed to deliver between 30 and 750 pounds per hour of PAC, will be provided to meter the PAC from the feeder hopper into the drop tubes. Each volumetric feeder will be equipped with an eleven (11) cubic foot stainless steel supply hopper with two (2) level switches for level control. All wetted surfaces of the feeders and the supply hoppers will be fabricated from stainless steel.

Each unit will be driven by a 1 hp variable speed DC motor and controlled by a Contrex M-Drive microprocessor controller located in the door of the main control panel. The digital speed controller will allow a 25:1 turndown ratio providing a wide range of dosing levels. The feeder controllers will be programmed to allow feeding of the carbon at a constant rate in pounds per hour or to follow a 4-20 mA analog signal from a remote location.

### 6. Drop Tube

A removable drop tube or hose will be installed between the volumetric feeder outlet and the inlet to the eductor. The drop tube is removed for calibration of the PAC Feeder.

### 7. Blower Package

Two (2) pneumatic motive air blowers: One (1) each blower installed on each feeder skid located under the silo. The blower will be a regenerative type Siemens blower, driven by a 460/3/60 TEFC motor operating at 1800 rpm. The drive motor will be direct coupled to the blower.

Each blower package will be mounted in a structure fabricated from carbon steel and will be equipped with an inlet silencer, pressure relief valve, pressure gauge and expansion joints.

Each blower will provide sufficient volume and pressure to maintain the minimum velocity to keep the PAC in suspension for a distance up to a maximum of 200 feet with an elevation change of 100 feet.

The sound level will not exceed 85 dBA at 3 feet from a single blower operating alone.

A Dwyer 3330 WP pressure switch will be used for sensing high and low pressure signals.



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### 8. Eductor

A 2" hardened carbon steel eductor will be installed at the outlet from the drop tube to convey the carbon/air mixture to the injection point.

### 9. Piping

Motive air piping from the blower to the eductor will be 1½" nominal schedule 40 304 stainless steel pipe with screwed fittings.

Carbon transfer piping or hoses from the eductors to the injection nozzles will be 2" and will be supplied by the Purchaser.

Compressed air piping from the Plant to the fluidizing system and to the silo vent filter will be ASTM B-88 Type K hard drawn copper pipe with solder joint fittings. The Purchaser will supply this piping.

Air fluidization tubing between the air fluidization solenoid valves and the air fluidization nozzles will be poly tubing with compression type fittings.

### 10. Air Receiver

One (1) air receiver will be provided to reduce the surge demand from the compressed air users in the system. The vessel will be 60 gallons rated for 200 psig @ 80°F. This receiver will have an ASME 'U' stamp, automatic drain valve, pressure switch, pressure relief valve and pressure indicator. The vessel will be primed and painted safety blue.

### 11. Air Fluidization Nozzles

Air fluidization nozzles will be placed in strategic locations on the silo discharge cones in the silo under-skirt area. The type and placement of fluidizing nozzles acts to promote reliable mass flow of the PAC from the silo.

## **D. POWER DISTRIBUTION**

1. The PAC system 480 volt power distribution devices will be contained within a Motor Control Center (Allen Bradley Bulletin 2100 or equal MCC), including a main disconnect breaker, individual breakers, motor circuit protectors, motor starters and overloads. The MCC will also house the control power transformer and distribution panel for the PAC System.



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2. A main disconnect breaker will be provided in the power panel which will be utilized to protect and to de-energize the complete PAC system electrical system.
3. A motor circuit protector, a NEMA starter and solid state overload protection will be provided for each 480 volt AC motor.
4. A 480 volt AC to 120 volt AC transformer will furnished to provide 120 volt AC control power. The transformer will be rated at 15 KVA.
5. The 120-volt AC distributions panel will have a main breaker and individual single-phase breakers to feed the various control power loads.

### **E. CONTROL PANEL**

1. The PAC system PanelView (HMI or Operator Interface), PLC, PLC power-supply, manual control devices, feeder speed controllers, control relays, terminal blocks, emergency stop buttons and feeder control switches will be contained within the control panel. All system equipment can be controlled manually from the main control panel.
2. Control wiring philosophy will meet the following requirements:
  - a. The control wiring philosophy will be such that all field control devices utilize normally closed contacts during normal operating condition.
  - b. A contact opening or an open circuit will result in an alarm condition for the specific device.
  - c. Loss of power to a control device will result in an alarm condition.

### **F. PANEL FEATURES**

The power panel and control panel will be provided with the following items and/or features:

1. Panels will be constructed of 304 or 316 stainless steel and rated NEMA 4X.
2. The main control panel will contain a fluorescent work light and 15 amp 120 Volt GFI convenience receptacle.
3. Terminal blocks will be provided for termination of all "field run" cables.



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4. All PLC inputs and outputs will be wired to fused terminal blocks equal to Allen Bradley 1492-H6.
5. Terminal blocks for voltage of 120 volts and less will be equal to Allen Bradley 1492-W10 unless specified otherwise.
6. All selector switches, pilot lights, push buttons and other devices that are visible on the front of the control panels will have Lamacoid nameplates, which are white with black letters.
7. All wiring will be installed in Panduit or similar wireways and separate into categories (i.e., 480 volt power, 120 volt control, etc.) to the extent practical. AC or DC power wiring will not run in any raceway with any type instrument wiring. Wiring will be protected across panel hinges. All terminal strips for all wiring terminations will be numbered.
8. Wiring will be stranded copper, 600 volt, THHN insulated, extra flexible type. As a minimum wire size will be #12 AWG for all power wiring, #16 AWG for all control wiring and #18 AWG twisted shielded pair for analog signal conductors. Wiring will be color coded as follows:
  - a. Ground wiring will be green.
  - b. 120 volt ac and 480 volt ac wiring will be black.
  - c. Neutral wiring will be white.
  - d. 120 volt ac control wiring will be red.
  - e. 24 volt dc control wiring will be brown positive and orange negative.
  - f. 90 volt dc power wiring will be blue.
9. Wiring at all terminals within panels, junction boxes, and field devices will be numbered with shrink fit, machine printed labels.

### **G. ELECTRICAL COMPONENTS**

1. 480 Volt Circuit Breakers: Molded case, thermal magnetic, minimum interrupting capacity of 10,000 amperes symmetrical at 480 volts AC. Acceptable manufacturers are Allen Bradley, General Electric, Siemens, Square D, or Cutler-Hammer.
2. Motor Circuit Protectors: 480 volt AC, three (3) phase, NEMA rated, motor circuit protectors for all 480 volt motors. Acceptable manufacturers are Square D or Cutler-Hammer (Westinghouse).
3. Starters: 480 volt AC, three phase, NEMA rated, with solid state



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overcurrent protection in each phase. Acceptable manufacturers are Allen-Bradley, Square D, General Electric, or Cutler-Hammer.

4. Power Distribution Blocks: Allen Bradley 1492-PD, Square D type LB or IIsco type PDB.
5. 120 Volt Circuit Breakers: Allen Bradley 1492-CB,
6. Control Relays: Allen Bradley type HA, Potter Brumfield type KRP or Square D type KP.
7. Selectors and Push buttons: 30.5 mm, heavy duty, NEMA 4X rated; contacts rated 10 amps continuous, 6 amps break at 120 VAC, equal to Allen-Bradley Type 800H.
8. Indicating Lights: 30.5 mm, heavy duty, NEMA 4X rated, 6 volt transformer type , equal to Allen-Bradley Type 800H.
9. Raceway: Galvanized rigid steel conduit, 3/4" minimum nominal diameter.

### **H. CONTROL COMPONENTS.**

1. Programmable Logic Controller and Panel View (HMI)

A single PLC will be provided to control and monitor the PAC systems. A minimum of 10 percent spare memory capacity, a minimum of 10 percent spare I/O points, and interposing relays for external status/control signals will be provided. Complete software documentation including a ladder logic diagram printout with a complete set of comments and a narrative description of the sequence of operation will be provided. The PLC will be manufactured by Allen-Bradley and will be a Model SLC 5/04. The PanelView 1000 will have a color display and will also be manufactured by Allen-Bradley.

2. Feeder Speed Controller

The screw drive for each of the volumetric feeders will be controlled by a digital microprocessor controller providing finite local adjustment of the PAC feeding rate over a range of 5 to 100 pounds per hour. Based on the system operating mode, the controller will maintain a constant feedrate or will follow a 4-20 ma signal provided by the Purchaser. The feeder microprocessor controller will be a Contrex M-Drive.

3. Fluidizing Solenoid Valves

Solenoid valves will be brass body, soft-seated, with 120V AC solenoid coil. Solenoid operators will be molded coil in NEMA 9



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explosion proof enclosure. Maximum operating pressure differential capability will be 100 psig. Solenoid valves will not require a minimum pressure to either open or close. Valves will be two-way, energize-to-open. Valves will be ASCO Red Hat or approved equal.

#### 4. Point Level Switches

Seven (7) Bindicator point level switches will be provided to control the volumetric feeder hopper fill cycles and to provide storage silo level indication on the main control panel. The units are of the tuning fork type and have local indicating LED lights to indicate when the switch is energized and the state of the switch. The units mount through 1½" half couplings and are easily removable for servicing. The units will be oscillating tuning fork type, of stainless steel construction, Bindicator Pulse Point model LPI-1-A-1-X-A-20-0.

#### 5. Pressure Switches

The silo vent filter differential pressure switch will be a Dwyer series 1620. The eductor discharge pressure switch will be a Dwyer series 3000 Photohelic. The compressed air pressure switch and the motive air pressure switch will be Ashcroft B series, Square D Class 9012, or Allen Bradley Bulletin 836.

### **I. MONITORING DEVICES.**

#### 1. Continuous Level Sensor

A Krohne Reflex Radar level transmitter will be provided to continuously measure and display the level of the carbon within the silo. The transducer will be mounted on a 4" nozzle located in the center of the storage silo roof. A 4-20 mA signal will be provided to the PLC and level indication will be provided on the PanelView.

#### 2. Differential Pressure Switch

The differential pressure across the silo vent filter will be displayed continuously at the vent filter by a Dwyer Magnahelic Series 2000 differential pressure indicator.

#### 3. Pressure Indicators

Pressure indicators will be Bourdon tube type with solid front, phenolic plastic case and 4-1/2 inch dial. Indicators will be Ashcroft Duragauge Style 1279 or approved equal.



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### 4. Silo Weight Indicator/Transmitter

A BLH LCp-100 Weight Indicator/Transmitter and four (4) BLH Z-BLOK Weigh Modules will be provided to continuously monitor the weight of the carbon in the storage silo. The Weight Indicator will be mounted in the Control Panel in the Power and Control Building. A signal from the Weight Indicator will be provided to the PLC and will also be indicated on the PanelView.

### **J. STATUS LIGHTS**

1. The following status lights will be located on the Motor Control Center for each individual feeder/eductator train:
  - a. Red – Blower Running.
  - b. Green – Blower Off.
  - c. Red – Rotary Valve Running.
  - d. Green – Rotary Valve Off.
2. The following silo alarm lights will be located on the Silo Unloading Panel:
  - a. Amber - Silo Level High - Stop Fill.
  - b. Amber - Silo Level Low - OK to Fill.
  - c. Amber - Compressed Air Pressure Low – Stop Fill.
  - d. Amber - Silo Filter DP High – Stop Fill.

### **K. CONTROL SWITCHES**

1. The following control switches will be located on the control panel:
  - a. Emergency Stop pushbutton for each Feed System.
  - b. Hand/Off/Auto Control switches for each Feeder.
2. The following control switches will be located on the Motor Control Center:
  - a. Hand/Off/Auto Control switches for each Blower.
  - b. Hand/Off/Auto Control switches for each Rotary Valve.
3. The following control switches will be located on the Silo Unloading Panel:
  - a. Off/Hand selector switch for the Vent Filter on the silo.



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### **L. CONTROLS AND INDICATORS**

1. The following controls and indicators will be located on the control panel:
  - a. Contrex M-Drive microprocessor speed controller for each Feeder
  - b. BLH Weigh Indicator to indicate the PAC weight remaining.

### **IV SYSTEM OPERATION**

The PAC dosing system will consist of three (3) independent control loops: (1) silo level monitoring and filling; (2) feeder hopper level monitoring and filling and (3) carbon feed/injection.

#### **A. SILO LEVEL MONITORING AND FILLING.**

1. The PAC level in the silo will be monitored continuously by a reflex radar level transmitter. The level signal will be provided to the PLC and PanelView. The silo weight will also be monitored continuously by a Weigh-Indicator mounted in the control panel. The weight signal will be provided to the PLC and PanelView.
2. The PAC level in the storage silo will also be monitored at two points by “tuning fork” type level switches. When ample volume exists in the silo to accept a complete truckload of PAC (~40,000 pounds), the silo low point level switch will be uncovered by the PAC. The contact opening will activate the SILO LEVEL LOW - OK TO FILL light on the silo unloading panel. The silo low point level switch will not stop operation of the PAC feed system, which will operate independently of the PAC level in the silo.
3. The PAC storage silo will be filled by pneumatic road tankers, which will employ a trailer mounted blower to pneumatically transfer the PAC from the tanker into the silo. When the PAC level covers the silo high point level switch, the switch will activate the SILO LEVEL HIGH - STOP FILL alarm and light on the silo unloading panel.
4. During silo filling, the air that is utilized to pneumatically convey the PAC into the silo will be discharged to the atmosphere through the “bag” type silo vent filter. The bags will be sequentially cleaned by pulses of air flowing in the reverse direction through the bags on a preset timed basis (HAND). Filter



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operation will be designated as HAND or OFF via a HO selector switch located on the silo control panel. In the HAND mode, the dust collector will sequentially pulse the bags with cleaning air on a preset time interval continuously as long as the HO switch is in the HAND position. If the vent filter bags are not being cleaned properly, the vent filter differential pressure switch will initiate an alarm on the silo unloading panel to stop filling.

### **B. FEEDER HOPPER LEVEL MONITORING AND FILLING.**

1. Two level switches are used to monitor the PAC level in each feeder supply hopper. With the rotary valve HOA switch in the AUTO position, the low level switch will start the rotary valve and the high level switch will stop the rotary valve. When the rotary valve begins to turn, PAC is fed from the silo into the feeder hopper.
2. With the Fluidizing control in AUTO, the silo fluidizing cycle will also be initiated when the rotary valve motor is started. Under certain conditions it may be advantageous to manually fluidize the silo PAC prior to placing a feeder in service. Manual operation of the fluidizing system will be provided through the PanelView interface.
3. If the hopper low-level switch is uncovered for more than 5 minutes, a feeder hopper level low alarm will be initiated and feeder operation will be terminated.
4. After the rotary valve has been started, the time required to cover the hopper high-level switch is monitored and alarmed if it exceeds 5 minutes. This alarm is called the hopper fill malfunction alarm.

### **C. CARBON FEED**

1. Train 1 and Train 2 can be operated independently or together to feed the same boiler. Each Train will require its own dedicated feed piping or hose and injection points.
2. Terminals for a remote contact permissive will be available if it is desirable to add a permissive, such as ID Fan operating, to limit the PAC injection operation. These terminals will be identified on the drawings.
3. A HAND/OFF/AUTO selector switch for each blower is located on the Motor Control Center. This switch controls the



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blower-operating mode. When placed in HAND, the blower will start. When placed in AUTO, the PanelView touch-keys will start the blower and motive air will be provided to the injection system. The control panel also has lights to indicate blower-operating status.

4. After the blower has started, the system controls will allow ten (10) seconds for motive air pressure to be established via the motive air pressure switch, otherwise the low motive air pressure alarm will be initiated and the feeder will not start until the problem is resolved and the alarm is cleared. Also, a pressure switch connected to the eductor drop tube must indicate a small negative pressure (-3" H<sup>2</sup>O) to verify that the eductor is functioning properly.
5. With the Feeder HOA switch in the AUTO position, the volumetric feeder will begin feeding PAC into the drop tube thirty (30) seconds after motive airflow and pressure have been established. With the Feeder HOA switch in the HAND position, the Feeder can be operated without the blower operating for feeder calibration.
6. Control of the PAC feed rate will be selected on the PanelView. Control selection is either "M-Drive" or "PanelView". In the M-Drive Control mode, the operator will manually set a fixed PAC feed rate in pounds per hour via the feeder controller or M-Drive. The feeder controller will display the feed rate in pounds per hour. In the PanelView Control mode, the feed rate will be set and controlled by PanelView input.
7. If a feeder high speed, low speed or speed deviation condition is detected when the PAC feeder is running, a FEEDER MALFUNCTION alarm will be initiated and the feeder will stop operation.
8. The system will inject PAC into the flue gas stream until stopped by the PLC/PanelView, HOA switches switched to OFF or the Emergency Stop button is depressed. A normal shutdown by the PLC/PanelView will stop the blower thirty (30) seconds after the feeder has been stopped to clear the injection piping of PAC. HOA and E-STOP shutdown will not purge the injection piping of PAC.
9. If an alarm condition has terminated the operation of the system, the alarm must be reset to restart the system.



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### **D. ALARMS.**

The alarm sequence will operate essentially the same for all alarms. When an alarm is initiated, the alarm condition will be displayed on the PanelView Screen. These alarms will also be ACKNOWLEDGED on the PanelView.

1. Silo Level High (Do Not Fill): The silo level high alarm will activate on the silo unloading panel and on PanelView when the silo is full and filling operations should be terminated. This alarm will not have any effect on the filling operations or normal system operation, other than to provide an alarm, and will automatically clear once the PAC level in the silo has fallen below the high point level probe.
2. Silo Level Low (OK To Fill): The silo level low alarm will activate on the silo unloading panel and on the PanelView when the PAC level in the storage silo has fallen below the low point level probe. The silo low-level alarm will indicate sufficient volume in the silo to receive a bulk trailer load of PAC. This alarm will not have any effect on normal system operation, other than to provide an alarm, and will automatically clear once the PAC level in the silo has covered the low point level probe.
3. Blower Discharge Pressure High: The blower discharge pressure high alarm will be initiated on the PanelView when the blower discharge pressure switch is enabled. The alarm will immediately terminate feeder and blower operation and must be ACKNOWLEDGED on the PanelView to restart the system.
5. Silo Vent Filter DP High – Stop Fill: The differential pressure across the vent filter bags will be monitored at all times by a differential pressure switch mounted on the silo deck. If the high differential pressure switch remains in the high differential state for a period of fifteen (15) seconds, the silo vent filter DP high alarm will be initiated on the silo unloading panel and the PanelView. This alarm will not effect the filling operation or normal system operation and will automatically clear when the differential pressure returns to normal.
6. Compressed Air Pressure Low – Stop Fill: A pressure switch mounted on the air receiver will monitor the air system pressure continuously. The compressed air pressure low alarm will be initiated on the silo unloading panel and the PanelView when the air pressure has fallen below a pre-set pressure of 80 psig. The low air pressure alarm will automatically clear when adequate air



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pressure is restored.

7. Motive Air Pressure Low: The motive air pressure low alarm will be initiated on the PanelView when the motive air pressure falls below a pre-set value (approximately 10 psig). Operation of the feeder will be stopped when the alarm is initiated, however, the blower will not be stopped and the alarm will be automatically cleared when adequate air pressure is established. Feeder operation will be automatically restored when the alarm is cleared.
8. Feeder Malfunction - The M-Drive will be configured to provide a feeder malfunction alarm to the PanelView based on a minimum speed, a maximum speed and a speed error condition. The feeder malfunction alarm will immediately stop operation of the feeder. ACKNOWLEDGING the alarm on the PanelView will clear the alarm.
9. Feeder Hopper Fill Malfunction - The feeder hopper fill malfunction alarm will be initiated on the PanelView if the time to cover the hopper high level probe, after the rotary valve has been given a start signal, exceeds five (5) minutes. The feeder hopper fill malfunction alarm will not stop operation of the feeder, the rotary valve or the fluidization system. The alarm will automatically clear when the feeder high-level switch is covered with PAC.
10. Feeder Hopper Level Low - The feeder hopper level low alarm will be initiated on the PanelView if the feeder hopper low level probe is uncovered for more than 5 minutes. The feeder hopper level low alarm will stop operation of the feeder, the rotary valve and the fluidization system until the alarm is cleared. The alarm will automatically clear when the feeder low-level switch is covered with PAC

### **V PURCHASER'S SCOPE OF WORK**

The following items are not included in this offering and shall be supplied by the Purchaser if required:

- A. FOUNDATIONS - The Purchaser shall design and install all foundations for the PAC dosing system from load data provided by the Seller. The Silo Supplier will provide the foundation anchor bolts for the Silo.
- A. ERECTION AND ASSEMBLY OF EQUIPMENT – The Purchaser shall receive and install the equipment provided by the Seller. Installation is not included in this proposal.



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- B. AREA LIGHTING – The Purchaser shall furnish and install area lighting. Seller will provide light fixtures for the area under the storage silo and for the roof. Also, Seller will provide and install the lighting in the Power and Control Building
- C. COMPRESSED AIR SUPPLY - The Purchaser shall provide dry instrument quality compressed air source capable of delivering 10 scfm at 100 psig. The Purchaser shall install compressed air piping to the fluidizing air header and to the vent filter on top of the silo.
- D. ELECTRICAL POWER SUPPLY - The Purchaser shall provide a single electrical power feed capable of delivering 60 amps of three (3) phase sixty (60) cycle power at 460 volts AC. The Purchaser shall install the power feed and terminate the power feed within the MCC.
- E. INTERCONNECTING CABLE & CONDUIT - The Purchaser shall provide and install all interconnecting cable and conduit (including fittings) to connect the MCC and control panel to the furnished equipment. Conduit and wiring between the Control Panel and the MCC will be provided and installed by the Seller prior to delivery of the Building.
- F. POWDERED ACTIVATED CARBON (PAC) - The Purchaser shall provide the initial and all subsequent fills of carbon.
- G. DELIVERY PIPING - The Purchaser shall provide the design and installation of the conveying piping, hoses and injection nozzles.

## VI SPARE PARTS

The following spare parts have been included in this proposal:

- A. Eductor.
- B. Indicator point level probe.
- C. Silo fluidizing air solenoid valve.
- D. Silo vent filter bags (set).
- E. Feeder speed controller (M-Drive).
- F. Feeder drive motor speed pick-up.
- G. Feeder drive motor.
- H. Feeder auger and gasket.



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- I. Three (3) each blower inlet air filters.

### VII PRICING

#### Engineer, Procure and Deliver Silo System Equipment

Pricing for the above-described Silo Dosing System delivered to Gaston, Alabama for erection by Purchaser:

**Three Hundred Twelve Thousand Six Hundred Twenty Five Dollars.**

**US\$ 312,625.00**

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Donald P. Hall  
Engineering Sales  
Systems and Services  
NORIT Americas Inc.

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David A. Perry  
Executive Vice President  
NORIT Americas Inc.

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Robert W. Edwards  
Sales Director  
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**APPENDIX H  
PART 2**

**Estimated Capital and Long Term  
Operating and Maintenance Costs**

<b>Capital Costs</b>			
<b>Decription</b>	<b>Units</b>	<b>Value</b>	<b>Notes</b>
ACI Storage and Injection System	\$	\$320,000	
Piping, Manifolds & Lances	\$	\$25,000	
Foundations and Steel (installed)	\$	\$55,000	
Electrical Supply Upgrades	\$	\$25,000	
Misc Utilities, Lighting		\$20,000	
Controls Integration	\$	\$20,000	
Subtotal		\$465,000	
Taxes	\$	\$27,900	
Freight	\$	<i>incl</i>	
Purchased Equipment Cost Subtotal	\$	\$492,900	
Installation of Process Equipment	\$	\$90,000	
<b>Total Direct Cost</b>	\$	<b>\$582,900</b>	
<b>Indirects</b>			
General Facilities	10%	\$58,290	
Engineering Fees	10%	\$58,290	
Project Contingency	15%	\$87,435	
Process Contingency	5%	\$29,145	
<b>Total Plant Cost (TPC)</b>	\$	<b>\$816,060</b>	
<i>Allow. for Funds During Constr. (AFDC)</i>	\$		\$0 Construction period < 1yr.
<b>Total Plant Investment (TPI)</b>	\$	\$816,060	
<i>Preproduction Costs</i>	\$	\$0	
<i>Inventory Capital</i>	\$	\$0	
<b>Total Capital Requirement (TCR)</b>	\$	<b>\$816,060</b>	
	\$/kW	\$3.15	
<b>Variable O&amp;M and Costs</b>			
	<b>Cost Basis (Year)</b>	<b>2003</b>	
Sorbent Costs		\$245,280	
Waste Disposal Costs		\$0	
Power Consumption	kW	25	
Power Cost (\$0.05/kW)		\$7,665	
Operating Labor ( 4 hours/day, \$45/hr))		\$65,700	
Maintenance Costs		\$17,250	
Periodic Replacement Items		\$10,000	
COHPAC Bag replacement penalty*		Not included	Prelim. Estimate \$53,600
<b>Total</b>	\$	<b>\$345,895</b>	
\$/kW	\$/kW	\$1.34	
mills/kW-hr	mills/kW-hr	\$0.22	

\* Without ACI Bag life was estimated at 4years, With ACI bag life is 2 years.

### ***Economic Factors***

Net Generating Capacity	MW	259	
Annual Capacity Factor	%	70%	
Power costs	\$/kw	\$0.05	
Operating Labor Rate	\$/hr	\$45	
Cost Basis - Year Dollars	Year	2003	
Capital Esc During Construction	%	1.5%	
Construction Years		0.5	
Annual Inflation	%	2.5%	
Discount Rate, % (MAR) =	%	9.2%	
AFUDC Rate	%	10.8%	
First Year Fixed Charge Rate, Current\$	%	22.3%	
First Year Fixed Charge Rate, Const\$	%	15.7%	
Lev Fixed Charge Rate, Current\$ (FCR) =	%	16.9%	
Lev Fixed Charge Rate, Const\$ (FCR) =	%	11.7%	
Service Life (years) =	Years	20	
Escalation Rates :			
Consumables (O & M) =	%	3.0%	
Fuel =	%	5.0%	
Power =	%	3.0%	
		<b>Current\$ Basis</b>	<b>Constant \$ Basis</b>
P/A Factor		9.00	11.45
A/P Factor		0.11	0.09
P/AE Factors			
'Consumables (O&M)		11.45	11.45
'Power		11.45	11.45
Levelizing Factors			
'Consumables (O&M)		1.27	1.00
'Power		1.27	1.00
<b><i>First Year Costs</i></b>		<b>Current\$ Basis</b>	<b>Constant \$ Basis</b>
Fixed Costs		\$128,121	\$128,121
Variable O&M		\$345,895	\$345,895
<b>Total First Year Costs</b>	<b>\$</b>	<b>\$474,016</b>	<b>\$474,016</b>
\$/kw	<b>\$/kW</b>	<b>\$1.83</b>	<b>\$1.83</b>
	<b>mills/kW-hr</b>	<b>\$0.30</b>	<b>\$0.30</b>
<b><i>20 yr Annual Levelized Costs</i></b>		<b>Current \$ Basis</b>	<b>Constant \$ Basis</b>
Fixed Costs		\$95,479	\$95,479
<b>Operating Costs</b>			
'Reagent		\$312,104	\$245,280
'Waste Disposal		\$0	\$0
'Power		\$9,753	\$7,665
'Labor		\$83,599	\$65,700
'Maint		\$21,950	\$17,250
'Spare Parts		\$12,724	\$10,000
<b>Total Annual 20 yr Levelized Costs</b>	<b>\$/year</b>	<b>\$535,610</b>	<b>\$441,374</b>
\$/kW	<b>\$/kW</b>	<b>\$2.07</b>	<b>\$1.70</b>
	<b>mills/kW-hr</b>	<b>\$0.34</b>	<b>\$0.28</b>