FOSSIL

DOE/PC/93254-T1
(DE95005662)

CHARACTERIZING TOXIC EMISSIONS FROM A COAL-FIRED POWER PLANT DEMONSTRATING THE AFGD ICCT PROJECT AND A PLANT UTILIZING A DRY SCRUBBER/BAGHOUSE SYSTEM

Final Report

Bailly Station Units 7 and 8 and AFGD ICCT Project

October 20, 1994

Work Performed Under Contract No. AC22-93PC93254

For
U.S. Department of Energy
Pittsburgh Energy Technology Center
Pittsburgh, Pennsylvania

By
Southern Research Institute
Birmingham, Alabama

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401.

Available to the public from the U.S. Department of Commerce, Technology Administration, National Technical Information Service, Springfield, VA 22161, (703) 487-4650.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DOE/PC/93254--T1
(DE95005662)
Distribution Category UC-105

Characterizing Toxic Emissions from a Coal-Fired Power Plant Demonstrating the AFGD ICCT Project and a Plant Utilizing a Dry Scrubber/Baghouse System

DOE Contract No. DE-AC22-93PC93254

FINAL REPORT

BAILLY STATION UNITS 7 AND 8
and AFGD ICCT PROJECT

October 20, 1994

Submitted by

Southern Research Institute
2000 Ninth Avenue South
P.O. Box 55305
Birmingham, Alabama 35255-5305

Submitted to

U.S.Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, Pennsylvania 15236-0940

Dr. Michael J. Baird, Contracting Officer's Representative
Mr. Eric T. Bell, Contracting Officer

SRI Report No. SRI-ENV-94-627-7960

A Nutoho

Bad [illegible]

FINAL REPORT

BAILLY STATION UNITS 7 AND 8
AND AFGD ICCT PROJECT

Prepared by SOUTHERN RESEARCH INSTITUTE
(Report No. SRI-ENV-94-627-7960)

October 20, 1994

Submitted by:

P. Vann Bush 11/4/94
P. Vann Bush
Date
Program Manager

Edward B. Dismukes 11/4/94
Edward B. Dismukes
Date
Principal Investigator

John M. Coyne 11/4/94
John M. Coyne
Date
Analytical Coordinator

Joseph D. McCain 11/4/94
Joseph D. McCain
Date
Sampling Coordinator

Larry S. Monroe 11/4/94
Larry S. Monroe
Date
Quality Assurance Auditor

Approved by:

John P. Gooch 11/4/94
John P. Gooch
Date
Vice President
Environmental Division

ACKNOWLEDGMENTS

This work was funded under Department of Energy (DOE) Contract No. DE-AC22-93PC93254 through the Pittsburgh Energy Technology Center (PETC). Dr. Richard E. Tischer served as the Contracting Officer's Representative until December 1993, at which time Dr. Michael J. Baird assumed that role. Tom Sarkus, Earl Evans, and Dick Tischer of DOE/PETC took turns at the test site during the time we were on site. Beth Wrobel and Sid Smith of Northern Indiana Public Service Company (NIPSCO) served as liaison with the Bailly Station, and John Cheater and John Henderson served as liaison with the Pure Air AFGD Demonstration Plant. Many other NIPSCO and Pure Air staff were helpful in arranging for and conducting the test.

We appreciate the efforts of the 31 members of the sampling team (24 from Southern Research Institute (SRI) and seven from Guardian Systems, Inc.) to retrieve accurate, representative, and uncontaminated samples to analyze. We also acknowledge the efforts of the numerous staff at SRI and the following organizations who aided in analyses of the samples:

Commercial Testing and Engineering Company
Brooks Rand, Ltd.
Core Laboratories, Inc.
Galbraith Laboratories, Inc.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

APPENDICES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Concluded)

LIST OF FIGURES

LIST OF FIGURES (Concluded)

1.0 EXECUTIVE SUMMARY

1.1 Background

This work is in response to the mandates of the 1990 Clean Air Act Amendments which require the U.S. Environmental Protection Agency to determine emission factors and assess risks associated with emissions of hazardous air pollutants (HAPs) from electric power stations. The U. S. Department of Energy (DOE), the Electric Power Research Institute (EPRI), and Utility Air Regulatory Group (UARG) are participants in a committee for coordinating research activities that influence EPA's ultimate response to the Congress. There are questions such as 1) how are some of the HAPs to be measured correctly when they appear as power-plant emissions, 2) what are the concentrations that appear, 3) how well are the concentrations reduced by existing control technologies, and 4) what advanced control technologies can be introduced to exert control where little or none now exists.

The DOE's Pittsburgh Energy Technology Center issued a solicitation in February 1992 for Comprehensive Assessment of Air Toxic Emissions to gather data on the presence, control, and emission of potential HAPs at eight different coal-burning electric power stations representing a cross-section of the coals, boiler designs, and emissions control technologies in the United States. Southern Research Institute was awarded a contract in April 1993 to assess two of the eight power stations in 1993, with an option to evaluate two more power stations in 1994.

This report describes the results of the assessment at one of the electric power stations, Bailly Station, which is also the site of a Clean Coal Technology project demonstrating the Pure Air Advanced Flue Gas Desulfurization process. This station represents the configuration of no NO_x reduction, particulate control with electrostatic precipitators, and SO_2 control with a wet scrubber. The test was conducted from September 3 through September 6, 1993.

1.2 Bailly Station

1.2.1 Power Plant Description

Bailly Station is owned and operated by the Northern Indiana Public Service Company (NIPSCO). The plant is located on the shores of Lake Michigan near Chesterton, Indiana. This project involved the two coal-fired units of Bailly Station with a combined capacity of 528 MWe; Unit No. 7 has a gross capacity of 183 MWe (160 MW net) and Unit No. 8 has a gross capacity of 345 MWe (320 MW net). Each unit is equipped with a Babcock & Wilcox cyclone boiler and a steam turbine generator. Both units burn an Illinois/Indiana basin high-sulfur bituminous coal (2.5% to 4.5% sulfur). Both units use Lake Michigan water as a once-through cooling medium.

There is no control technology for NO_x emissions. Electrostatic precipitators (ESPs) are used on both units for particulate control. There are two ESPs on Unit 8 and one ESP on Unit 7. The two ESPs of Unit No. 8 are identical to the Unit No. 7

ESP. Ammonia is injected upstream of the ESPs for the control of SO_3 to prevent acid mist emissions. The flue gas streams from the two units join to form a single stream.

1.2.2 Scrubber Description

Sulfur dioxide in the combined flue gas stream from the two units of the Bailly Station is treated by the Advanced Flue Gas Desulfurization (AFGD) demonstration project managed by Pure Air of Allentown, Pennsylvania (a joint venture of Air Products, Inc. and Mitsubishi Heavy Industries, Ltd.) under the Department of Energy's Clean Coal Technology program. Pure Air's AFGD is using innovative wet limestone flue gas desulfurization (FGD) technology to achieve a high level of SO_2 removal (90 to 95+ percent capability) on high sulfur U.S. coals.

A feature of the AFGD process is the purchase and direct injection of powdered limestone in lieu of on-site limestone milling operations. This project includes an in-situ oxidation absorber module that produces high-quality gypsum from a range of high sulfur coals. High-quality, by-product gypsum (93+ percent purity) is being produced and sold to a wallboard manufacturer.

The flue gas stream from the AFGD process is vented to the atmosphere through a 480-foot stack exclusive to the project.

1.2.3 Plant Operation

The plant operated at an average load of 511 MWe during our sampling. There were two occasions during the testing when the fire in one cyclone burner went out because of a plugging of the coal feeder to the cyclone. Since we were still over 90% of the combined full load capacity of the two units we continued sampling. There were three conditions that affected the plant performance:

1) One of the outlet electrical sections on the Unit 7 ESP was out of service during our testing. Furthermore, another outlet field operated at a very low voltage compared to other fields. These problems caused much higher emissions for the Unit 7 ESP than the Unit 8 ESP.

2) There was a virtual loss of ammonia supply to Unit 7 from 9/3 to 9/4. The supply to Unit 8 ran out on the evening of 9/4. Therefore, on 9/3 we had nominally 15 ppm ammonia to both Unit 7 and Unit 8 ESPs. On 9/4 we had nominally 15 ppm ammonia to Unit 8 ESP, but less than 3 ppm ammonia to Unit 7 ESP. On 9/5 we had no ammonia to either Units 7 or 8 ESPs. This reduction in ammonia feed may have affected the particulate emissions, and certainly affected SO_3 carry-over through the ESPs.

3) The major plant upset that truncated our testing was supply of coal to the boilers. There were problems in getting coal from the Captain Mine to the plant site, and

problems at the plant site with the coal unloading and conveying system that delayed, interrupted, and finally prevented sampling.

The following summary lists selected plant data and operating results.

Summary Plant Data

Unit 7	183 MWe (4 B&W cyclone burners)
Unit 8	345 MWe (8 B&W cyclone burners)
Bottom Ash/Fly Ash Split	63/37
Coal	Captain Mine (Illinois/Indiana basin)
Coal Calorific Value	11,100 Btu/lb
Coal Sulfur	3.2%
Coal Ash	10.7%
Unit 8 ESP Inlet Fly Ash Concentration	5.07 g/Nm^3
Unit 8 ESP Outlet Fly Ash Concentration	0.009 g/Nm^3
Unit 8 ESP Particulate Removal Efficiency	99.82%
Unit 7 ESP Outlet Fly Ash Concentration	0.07 g/Nm^3
Unit 8 Gas Volume Flow Rate	309 Nm^3/s
Unit 7 Gas Volume Flow Rate	165 Nm^3/s
AFGD Inlet SO_2 Concentration	2820 ppm
AFGD Ca/S Ratio	1.04
AFGD SO_2 Removal Efficiency	93%
Stack Particulate Emissions	0.05 g/Nm^3

See Section 10.0 Glossary for reference conditions on flue gas volume in Nm^3.

1.3 Sampling

1.3.1 Locations

Samples were collected from Bailly Station Units No. 7 & 8 and the AFGD Demonstration Plant. Material balance for the Bailly Station was limited to Unit 8. A separate material balance was conducted around the AFGD scrubber. The process components which were sampled in order to perform material balances were:

Unit 8 Boiler — The input streams for this subsystem are the coal and the combustion air. Output streams are the flue gas and bottom ash.

Bottom Ash Sluice — The input streams to this system are the bottom ash, sluice return water, and makeup water. The output stream is the bottom ash sluice.

Condenser — The condenser is a once-through system using Lake Michigan water as input. The output stream is returned to the lake.

Unit 8 ESP — The input stream to the ESP is flue gas. The output streams are the hopper ash, and the cleaned flue gas.

AFGD System — The input streams to this system are the combined flue gases from Units 7 and 8, the limestone, and service water. Output streams are the stack flue gas, gypsum, and waste water.

There were five locations from which flue gas samples were collected. We sampled the inlet ducts on both the east and west ESPs on Unit 8, the outlet ducts on Units 7 and 8, and the stack. In addition, we also measured the diluted stack gas by sampling through the SRI Condensibles Air Dilution Train at the Unit 7 outlet sampling location.

The inlet to the ESP of Unit 7 was not sampled; it was not included in DOE's work specifications, and the outlet was included only because it provided part of the input to the scrubber. The gas at the outlet of the Unit 7 ESP was sampled with a simulator of plume dilution and cooling to obtain an estimate of the changes that would have been brought about if the gas had been discharged through a stack without the intervention of the scrubber.

The locations at which samples were collected, in both the generating plant and the AFGD system, are illustrated later in Figures 3-1 and 3-2. Later sections of this report refer to samples from ducts adjacent to the ESPs; Figure 3-1 makes clear that these locations are the inlet to the Unit 8 ESP and the outlets to the Units 7 and 8 ESPs before the gas streams merge and enter the AFGD system.

1.3.2 Sample Collection

We sampled for a total of four days. Triplicate samples were collected for all inorganic analytes during the first three days of sampling. Because of the problems in coal supply, we were only able to collect one sample of the organic analytes from each location. We used extended sampling times for most of the flue gas trains in order to increase the sample volume and thereby make possible the determination of lower analyte concentrations. The following list shows the analytes and the methods we used to collect flue gas samples:

Constituent	Method	Traverse/ Single Point	Duration minutes			
			8 In	8 Out	7 Out	Stack
Semi-volatile organics	MM5/SW846-0010	T	240	280	280	360
Volatile organics	VOST	S	10,20,40	10,20,40	10,20,40	10,20,40
Aldehydes	Impingers	S	30	30	30	30
Ammonia and Cyanide	Impingers	S	30	30	30	30
Simulated plume	SRI diluter	T	-	-	360	-
Gas flows	M2	T	✓	✓	✓	✓
Metals	M29	T	192	240	240	360
Mercury	Carbon trap	S	60	60	60	60
Acid gases	M5	T	48	60	60	48
Radionuclides	M17	T	72	144	144	360
Particle size	Impactor/cyclone	T[a]	60	600	600	480
Size fractionated metals	Dual cyclones	T[b]	-	1020	1020	-
Bulk gas composition	Orsat	T[c]	✓	✓	✓	✓

Notes: a. U of W Mk V impactor at the stack and ESP outlets, 5 Series Cyclone at the ESP inlet
b. Samples from 5 Series Cyclone train for particle size measurement used for the 8 Inlet size-fractionated samples for trace metals analysis.
c. Integrated sample taken in conjunction with M5 type sampling.
✓ Methods not requiring a specific sampling duration.

Solid and liquid grab samples were typically collected five times per day and then combined to yield daily composites for analyses.

1.4 Quality Assurance and Quality Control

1.4.1 Internal QA/QC

Internal quality control auditing was performed by SRI in the collection of samples from the Bailly site and in the analysis of samples in the SRI laboratories at Birmingham. Additionally, quality control analysis of analytical results from subcontractor laboratories, namely Brooks Rand, Commercial Testing and Engineering, and Core Laboratories, was required since no formal auditing of these subcontractors was planned.

The QA Auditor was present during collection of the samples at the Bailly site. The impinger preparation crew was audited in the mixing of solutions and setup of the Method 5 type trains. No substantial discrepancies were found. All of the sampling teams were monitored by the QA Auditor for correct and consistent adherence to the sampling methods. Each sampling crew was observed running the gas sampling equipment, from initial leak checks to operation of the train to recovery of the sample, including insuring that the required custody chain was maintained. None of the sampling runs was aborted or voided.

No formal internal audits of the analytical process were conducted. We relied upon the normal duplicate analyses, matrix spike and matrix spike duplicates, lab QC samples, and our mass balance results to assess the quality of the analytical data.

1.4.2 RTI

Shirley J. Wasson and Lori Pearce of Research Triangle Institute visited the Bailly Station on September 5 and 6 while we were sampling. They conducted an audit of the sampling. The scheduling of their visit permitted them to observe one day of organics sampling and one day of inorganics sampling. There were four facets of the audit: 1) observe the sampling and laboratory procedures, 2) spike some laboratory blanks for Quality Assurance evaluation, 3) spike two VOST samples using a cylinder of audit gas, and 4) check calibration of the sampling trains. In addition, we provided them with our calibration documentation and preliminary data from our testing. We did not receive a formal report of their audit.

1.4.3 Round Robin Coal Analyses

SRI participated in a round robin analysis of coal samples administered by CONSOL, Inc. for DOE. We analyzed 17 coal samples in duplicate under the round robin. There were two samples from each of the eight plants being tested in the DOE air toxics assessment program, plus one reference coal. Analyses specified included proximate and ultimate, 10 major ash constituents, the 16 trace elements in the DOE program scope of work, and fluorine. Results of the round robin analyses do not suggest any general deficiencies in our protocols when SRI's data are compared to the range of results among the other participants. One specific improvement suggested by these results is the use of the method of standard additions for analyzing antimony and arsenic. Because of this finding we altered our analytical protocols accordingly prior to analyzing the samples from Bailly.

1.5 Analytical Results

1.5.1 Trace Metals

Sixteen trace metals were determined in a variety of samples. These metals are listed below:

Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Chromium
Cobalt
Copper
Lead
Manganese
Mercury
Molybdenum
Nickel
Selenium
Vanadium

Five major metals were also determined:

Aluminum
Calcium
Iron
Magnesium
Titanium

Not all of the 16 trace elements listed above satisfy all of the classical criteria of metals. Arsenic, boron, and selenium may be considered non-metallic in some of their properties (certainly not, however, to the degree that four elements discussed on page 1-9 are considered non-metallic). Nevertheless, the classification of all 16 trace elements as metals is retained in this report, which is consistent with the usage in DOE's solicitation for this research program.

Grab samples of the process solids were analyzed by procedures that consisted of two essential steps: 1) preparation for analysis in an aqueous solution and 2) analysis of the solution. Most of the metals were placed in solution by digestion with mineral acids, including hydrofluoric acid, at elevated temperature and pressure in a microwave oven. A different procedure was necessarily followed with boron because boric acid is included in the microwave digestion procedure; boron was extracted in a hot mixture of nitric and hydrochloric acids in an open vessel. Also, initially, a distinct procedure was used for mercury -- extraction with aqua regia in a heated open vessel. Ultimately, however, samples digested by the microwave procedure, especially samples of coal, were found to yield more complete recovery of mercury than the aqua regia procedure.

Inductively coupled argon plasma emission spectroscopy (ICP) was used for the determination of a majority of the metals. Exceptions were 1) hydride generation atomic absorption spectroscopy (HGAAS) for antimony, arsenic, and selenium; 2) graphite furnace atomic absorption spectroscopy (GFAAS) for cadmium and lead, mainly when the concentrations were low and added sensitivity was required; and 3) cold vapor atomic absorption or atomic fluorescence spectroscopy (CVAAS or CVAFS) for mercury. The procedures employed were those described in the EPA manual for the analysis of solid wastes, referred to commonly as SW-846 (1).

Liquid samples (all aqueous) were digested with added nitric acid in a microwave oven. The individual metals were then determined by the procedures described above.

Samples of metals from the gas streams were collected according to EPA's so-called Method 29. This is a method in tentative wording that will ultimately be published in 40 Code of Federal Regulations Part 60; the sampling apparatus, sometimes called the Multiple Metals Train, and the related procedures are now described in 40 CFR Part 266. The samples from Method 29 were processed in three parts: 1) solids deposited on a filter, 2) vapors absorbed in a peroxide impinger solution, and 3) the vapor of mercury absorbed in a permanganate impinger solution. All 16 trace metals and all 5 major metals were determined in the first two components of the train; only mercury was determined in the permanganate.

Mercury was also collected in an entirely different sampling train, in which sorption tubes are packed with solid traps, as described by Bloom (2). The first type of trap traversed by the gas stream consists of soda lime, which selectively adsorbs oxidized forms of mercury vapor, such as $HgCl_2$. The second type of trap, in a back-up location, collects elemental mercury vapor. Mercury in these traps was analyzed by CVAFS by a subcontractor, Brooks Rand, Ltd., of Seattle, Washington.

The data on metals were of interest to answer several questions. The key questions were as follows:

- What are the concentrations of metals contributed by the coal and by the limestone used in the wet scrubber? Although the 16 metals of main concern in this project are referred to as trace metals, their concentrations in the two main feed materials to the plant varied widely. In the raw coal, boron was the most concentrated trace metal, at about 200 µg/g; mercury was present at the lowest concentration, approximately 0.1 µg/g or a value three orders of magnitude lower. In the limestone, boron was again the most concentrated, at a concentrations of about 130 µg/g; mercury once more may have been present at the lowest level, below 0.002 µg/g, although beryllium, cadmium, lead, and selenium were also undetected (albeit at somewhat higher limits).

- How are the metals partitioned between bottom ash and fly ash? A factor having a major bearing on this issue is the partitioning between the two ashes on the basis of mass. Approximately 37% of the mass of coal ash was recovered from the flue gas at the inlet of the Unit 8 ESP. Thus, the split between bottom ash and fly ash within the boiler is assumed to be about 63 parts of the former to 37 parts of the latter. Few of the metals follow this ratio on the basis of concentration. That is, most of the metals are at higher specific concentrations in the fly ash than in the bottom ash. Thus, more than 40% of the mass of most elements from the coal was found in the fly ash. For some of the metals, the difference was not remarkable. For arsenic, however, the difference was large enough to be significant, suggesting that in the high temperatures of the boiler arsenic was in the vapor state, although it condensed before reaching the ESP.

- To what degree is the emission of each metal reduced by the ESP? Metals that occur predominantly in the fly ash, rather than in the vapor state, were removed in the Unit 8 ESP to roughly the same degree as the total ash. The effect of this ESP is seen most clearly from the point of view of its ineffectiveness for removing boron, mercury, and selenium, which occur predominantly as vapors. Comparison of ESP outlet concentrations suggests that the Unit 7 ESP was much less efficient than the Unit 8 ESP. The reason for this difference is presumably the deficient electrical energization of the Unit 7 ESP.

- To what degree is the emission of each metal further reduced in the scrubber? There is some degree of removal of each metal. The greatest effects, however, occur with the three volatile metals named above. Boron occurs in the flue gas most likely as boric acid, which is subject to dissolution with the alkaline scrubber medium. Mercury is removed to the extent it occurs in the oxidized state; $HgCl_2$, the presumed dominant oxidized vapor, is water soluble. Selenium in the vapor state is probably SeO_2, which is an acidic oxide that the alkaline scrubber is likely to convert to a dissolved selenite salt.

- What is the fate of the metals in waste streams? The streams that carry away most of the metals are the bottom ash and the fly ash collected in the ESPs. The relative masses of the metals in the stack and wastes from the scrubber (gypsum and waste water) are quite small.
- The fate of mercury, because of its volatility, is quite different. First of all, it must be acknowledged that roughly one-third of the mercury in the coal was not recovered or otherwise accounted for. Of the two-thirds found in the combustion gas, about one-half was lost to the scrubber and the remaining one-half was emitted through the stack. The ultimate disposition of the mercury removed in the scrubber was mainly as a contaminant in the gypsum.
- How are the metals partitioned between the particulate and vapor states? As indicated by the preceding discussion, boron, mercury, and selenium were present as vapors at high relative concentrations.
- What influence does the cooling and dilution of the plume have on metal concentrations emitted from the stack? This question was not addressed directly. The procedure followed was to sample flue gas at the outlet of the Unit 7 ESP with an apparatus designed to simulate the cooling and dilution of flue gas in the plume. The cooling and humidification that actually occur in the scrubber make the simulation academic insofar as emissions at Bailly per se are concerned. The principal findings with the cooling/dilution device are that significant transformations from vapor to particulate matter occur with all three metals that occur predominantly as vapors at the ESP outlet (that is, boron, mercury, and selenium).
- How are metal concentrations in the suspended solids affected by particle size? The concentrations of essentially all of the metals increase as particle size decreases. This trend is shown most directly by concentrations in ash fractions of different size ranges that were collected in series cyclones. This trend is also revealed indirectly by the fact that concentrations on a specific basis (as weight fractions of the ash) increase across the ESPs. The argument for the conclusion that specific concentrations increase as particle size decreases stems from knowledge that the finer particles have a higher penetration in the ESPs.

- What is the comparison between the concentrations of mercury vapor determined by absorption in the impingers of Method 29 and by adsorption on soda lime and iodated carbon traps? The impingers of Method 29 measured lower total mercury concentrations than the traps and showed an inverse ratio of oxidized mercury to elemental mercury. The latter part of this statement means that the mercury catch in the peroxide impingers of Method 29 (that is, oxidized mercury) was a lower fraction of the total than the catch in the soda lime traps. The choice between the conflicting results, based on other experience by SRI, is to favor the traps over the impingers.

Material balance of the trace metals was an issue of major importance, not so much as a technical issue itself but a criterion of success in achieving credible analytical data on the metals. The matter of material balance of the metals is taken up subsequently in Section 1.6 of this Executive Summary.

1.5.2 Other Inorganic Substances

The coal contained the non-metallic elements fluorine, chlorine, and sulfur at levels capable of producing the acidic gases HF, HCl, and SO_2 at concentrations of approximately 15, 70, and 2800 ppmv, respectively. These gases were captured during sampling in an alkaline solution of peroxide, and the associated concentrations of fluoride, chloride, and sulfate ions were determined. Fluoride was determined with an ion-specific electrode, and chloride and sulfate were determined by ion chromatography. These anions were measured more or less directly in water streams and in solids after the solids were made water-soluble by fusion with sodium hydroxide.

The amount of SO_2 recovered from the gas phase (after oxidation to sulfate in the sampling train) was in good agreement with the expected concentration of SO_2 at the inlet to the scrubber, based on the assumption that all of the sulfur in the coal is converted to SO_2. Fluoride and chloride were recovered at the scrubber inlet at levels reasonably commensurate with the expected HF and HCl concentrations. A fourth non-metallic element, phosphorus, was accounted for not as a component of the flue gas but as a component of the fly ash.

Ammonia and hydrogen cyanide were measured as minor components of the flue gas as presumed contributions from the incomplete oxidation of fuel nitrogen. Some but not all of the ammonia came from the external source used to reduce stack concentrations of sulfuric acid mist.

The acid gases (HF, HCl, and SO_2) penetrate the ESPs with no measurable loss but undergo nearly complete removal in the scrubber. The fourth non-metal of interest, phosphorus, is effectively removed in the ESPs as a component of the fly ash.

1.5.3 Organic Compounds

Carbonyl compounds (aldehydes and ketones). These compounds were determined in various water streams and in the flue gas. Quantitation was based on the formation of stable reaction products with 2,4-dinitrophenylhydrazine (DNPH) and the measurement of each reaction product by high performance liquid chromatography. The reliability of all the results on aldehydes is in doubt. One reason was the lack of success in clean-up of the DNPH reagent. The concentrations in both water streams and in the flue gas varied widely; also, certain aldehyde compounds appeared erratically and, thus, their association with the source materials sampled is in doubt.

Volatile hydrocarbons. Volatile organic compounds (generally, those boiling below 100 °C) were collected in the so-called VOST train and determined by gas chromatography/mass spectroscopy (GC/MS). The results are believed to be defective because of a problem encountered during sampling. This problem is described in Appendix D; it has to do with false indications of the presence of some of the analytes of interest.

Semi-volatile organic compounds. These compounds were collected along with dioxins and furans in the Modified Method 5 train. The samples collected were divided during work-up, prior to compound identification, between 1) compounds commonly referred to as semi-volatiles (which include the important toxic PAH compounds) and 2) the even more toxic dioxins and furans. The first group of compounds were analyzed by low resolution GC/MS and the second group by high resolution GC/MS.

None of the group of PAHs appeared consistently in the analyses. Likewise, negligible concentrations of dioxins and furans seemed to be present but the undependable detection of the PAH compounds in spiked sampling media detracts from the conclusion that they were absent from the gas streams.

The organic substances seemed unaffected by either the ESP or the scrubber; the results on these compounds, however, are not definitive.

1.6 Material Balances

Material balances in the sense they were tested in this report pertain only to trace metals and major metals as defined earlier in this Summary. They do not include the non-metallic elements such as fluorine, chlorine, and sulfur, although in principle they could have included these elements. In any event, the recovery of these elements is discussed in an earlier section of this Summary.

The material balance of a metal is tested by comparing two sums, one for streams flowing into the overall system or some selected subsystem and another for streams leaving the same system or subsystem. Each component of either sum is the products of a stream flow rate and the concentration of the metal being considered. The term "closure" is used to designate how successfully the calculated sums agree. If the sums agree exactly, the closure is 100%. If the sum for outgoing streams is less than the sum for incoming streams, the closure is less than 100%. Conversely, if the sum for outgoing streams is the larger of the two sums, the closure is larger than 100%. (Mathematically, closure is the percentage of all incoming material that is found in the outgoing streams.)

The data for stream flow rates are given in Section 4. Tables 4-8, 4-9, and 4-10 give stream flow rates in terms of total mass for each day of the metal analyses. Tables 4-11 and 4-11A give the averages for the three days and the standard deviations for the three days. Obviously, there should be, ideally, a closure of 100% for stream flow rates pertinent to the entire system or each selected subsystem. Table 4-11 shows that for the Unit 8 boiler the average of daily closures based on mass is 100%, and for the AFGD system the average is again 100%.

The data on concentrations of individual metals in the daily samples of the several streams are given in tables in Section 6. The crucial data, of course, are daily concentrations, either on a mass/mass basis (μg/g) or on a mass/volume basis (μg/Nm^3). (The reference conditions for expressing gas volume in the units Nm^3 are: temperature, 293.15 K; pressure, 1 atm, O_2 concentration, 3% by volume under dry conditions. The temperature and pressure are those defined as standard conditions for performance evaluations of stationary sources; see 40 CFR Part 60, Subpart A, page 15 in the 7/1/93 edition. Constant O_2 in dry gas is employed to facilitate comparisons of concentrations without perturbations due to inleakage of air or dilution with water vapor.)

There are three main systems for which overall material balances are presented in Section 7. One of these is termed the Unit 8 boiler; another is the condenser for the Unit 8 boiler; and the third is the scrubber. The individual main systems and subsystems for which material balances are presented are listed below:

Unit 8 boiler --

the boiler proper -- input streams are the coal and air, and the output streams are the bottom ash and flue gas;

the ESP -- the input stream is the flue gas, and the output streams are the relatively clean flue gas and the hopper ash;

the bottom ash sluice -- incoming water and ash, and outgoing slurry.

Unit 8 condenser -- this is considered separately from the boiler because there is one cooling stream of water incoming and one heated water stream outgoing, with no exchange whatsoever with streams that otherwise comprise the boiler.

AFGD scrubber -- the incoming streams consisting of a) the relatively particle-free gas from the Unit 7 and Unit 8 ESPs, b) the limestone, and c) the slurry makeup water; the outgoing streams consist of a) stack gas, b) waste water, and c) gypsum byproduct. (Although there is an option exercised in calling the Unit 8 condenser a separate system, it is necessary to consider the scrubber separately because it deals with the ESP exit gas from two boilers, not just one.)

Table 1-1 following shows the material balances of elements in the subsystems of the boiler. Table 1-2 following presents the results of calculations for the three main systems that are considered distinct, for reasons indicated above.

The outside ranges for the boiler subsystems (if the preferred result for mercury, on the line denoted BR is used) are 55-256% for the boiler itself, 59-375% for the ESP, and 100-158% for the bottom ash sluice. Both of the first of these two ranges would be sharpened considerable if the concentration of antimony entering the ESP were increased and the concentration of selenium entering the ESP were reduced. Specifically, reanalysis of the suspended fly ash entering the ESP might substantially improve both closures. Rational explanations for the poorest closures cannot, in general, be provided; however, comments on some of the poorest examples are given in Section 7.1.2. Even at best the closure for mercury in the boiler proper signifies that just 55% of the mercury in the coal was accounted for. The median closure values for the three subsystems are 93% for the boiler proper, 111% for the ESP, and 102% for the bottom ash sluice.

The data for the overall Unit 8 boiler system are superior to those in the boiler proper and ESP subsystems, for the outside range of closures is 65-165%. One reason for the improvement is that the errors in antimony and selenium in the boiler and ESP cancel when the overall system is considered. The poorest closures in the three overall systems is for the AFGD, where errors in the analysis of gypsum are believed the main cause of imbalance in inlet and outlet mass flow rates.

Table 1-1
Closures, %, in Unit 8 Subsystems

Element	Symbol	Unit 8 boiler	Unit 8 ESP	Bottom ash sluice
Antimony	Sb	67	375	107
Arsenic	As	70	132	158
Barium	Ba	97	136	100
Beryllium	Be	77	107	100
Boron	B	65	122	100
Cadmium	Cd	64	115	100
Chromium	Cr	79	105	100
Cobalt	Co	116	127	100
Copper	Cu	107	122	100
Lead	Pb	141	110	100
Manganese	Mn	105	111	100
Mercury	Hg	29	116	102*
Mercury (BR)	Hg	55	120	102*
Molybdenum	Mo	79	108	102*
Nickel	Ni	72	106	100
Selenium	Se	256	59	115
Vanadium	V	86	120	100
Aluminum	Al	96	101	100
Calcium	Ca	105	118	100
Iron	Fe	93	101	100
Magnesium	Mg	99	110	100
Titanium	Ti	100	101	100

BR=Brooks Rand Laboratory.
*Closures heavily influenced by non-detectable concentrations.

Table 1-2
Closures, %, in Overall Systems

Element	Symbol	U8 Boiler overall	Condenser	AFGD overall
Antimony	Sb	169	100*	103
Arsenic	As	92	100*	436
Barium	Ba	108	103	82
Beryllium	Be	80	100*	1260
Boron	B	76	0*	126
Cadmium	Cd	71	567*	24
Chromium	Cr	81	100*	2750
Cobalt	Co	130	73*	94*
Copper	Cu	120	130	26
Lead	Pb	151	100*	57*
Manganese	Mn	108	34*	96
Mercury	Hg	31	119	182
Mercury (BR)	Hg	65	119	100
Molybdenum	Mo	85	100*	795
Nickel	Ni	75	126*	750
Selenium	Se	149	100*	161
Vanadium	V	94	100*	65
Aluminum	Al	97	70*	197
Calcium	Ca	109	137	101
Iron	Fe	94	100*	101
Magnesium	Mg	102	100	90
Titanium	Ti	100	100*	163

BR=Brooks Rand Laboratory.
*Closures heavily influenced by non-detectable concentrations.

1.7 Emission Factors

The emission factors for the inorganic substances are presented in Table 1-3. These factors are based on three parameters: 1) the stackconcentration of each substance, 2) the calculated volume of gas per unit weight of coal, and 3) the laboratory result on the calorific value of the coal. The results thus calculated are in very good agreement with alternate results based on the measured gas flow rate in the stack, the recorded firing rate of the coal, and the calorific value, again from the coal analysis.

The range of emission factors is, of course, very wide. The maximum is for SO_2: 395,000 lb/10^{12} Btu. The minimum is for beryllium or cobalt: <0.07 lb/10^{12} Btu.

The Clean Air Act Amendments of 1990 suggest that control of emissions may be required if a single substance is emitted at a rate exceeding 10 tons/yr or if any combinations of substances is emitted at a rate exceeding 20 tons/yr. Units 7 and 8 at Bailly consume 5.03 x 10^9 Btu/hr of thermal energy from the coal when operating at full load. If the operation at this level occurs 70% of the time in one year, the consumption of energy will be 3.08 x 10^{13} Btu. Thus, a substance with an emission factor of 1 lb/10^{12} Btu will be emitted at the rate of 0.0154 tons/yr. Based on this factor, annual emissions of some of the substances listed in the concluding table of this summary are as follows:

Substance emitted	Rate, tons/yr
SO_2	6090
Chloride	15.7
Selenium	2.97
Mercury	0.040
Beryllium	<0.0002

Table 1-3
Emission Factors[a] Calculated from Stack Concentrations
(Uncertainty, 95% confidence limits)

	g/10^{12} J	lb/10^{12} Btu
Antimony	0.121 ± 0.442	0.281 ± 1.03
Arsenic	0.455 ± 1.41	1.06 ± 3.28
Barium	0.544 ± 0.309	1.26 ± 0.716
Beryllium	<0.03	<0.07
Boron	391 ± 269	909 ± 625
Cadmium	0.181 ± 0.166	0.421 ± 0.386
Chromium	1.18 ± 0.48	2.73 ± 1.11
Cobalt	<0.03	<0.07
Copper	0.741 ± 1.20	1.72 ± 2.79
Lead	0.677 ± 0.956	1.57 ± 2.22
Manganese	1.32 ± 0.18	3.07 ± 0.42
Mercury[b]	0.890 ± 0.334 1.12 ± 0.07	2.07 ± 0.78 2.60 ± 0.16
Molybdenum	1.47 ± 0.28	3.41 ± 0.65
Nickel	0.928 ± 0.483	2.16 ± 1.07
Selenium	83.0 ± 106	193 ± 246
Vanadium	1.21 ± 0.71	2.81 ± 1.65
Aluminum	43.6 ± 15.9	101 ± 37
Calcium	196 ± 33	454 ± 76
Iron	89.6 ± 60.1	208 ± 140
Magnesium	36.9 ± 6.5	85.7 ± 15.0
Titanium	6.68 ± 2.62	15.5 ± 6.08
Fluoride	<180	<420
Chloride	440 ± 112	1020 ± 260
SO_2	170000 ± 74000	395000 ± 172000

[a] Based on stack concentration of analyte (µg/Nm^3), calculated volume of flue gas from unit mass of coal (Nm^3/g), and calorific value of coal (J/g).

[b] The first value for mercury is based on samples from Method 29. The second is based on sampling with solid traps.

2.0 INTRODUCTION

2.1 Background

Air toxics is a term designating certain hazardous pollutants that are addressed by the 1990 amendments to the Clean Air Act. Title III of the 1990 legislation establishes a list of 189 toxic chemicals and classes of substances whose effects are to be evaluated and regulated as determined necessary by the U.S. Environmental Protection Agency.

Regulating air toxics will occur in two phases. During the first phase, the EPA must publish a list of source categories emitting 10 tons annually of any one toxic or 25 tons annually of a combination of toxics. The agency must then issue Maximum Achievable Control Technology (MACT) standards based on the best demonstrated control technology or practices in the industry to be regulated. Within two years, EPA is required to issue MACT standards for 40 source categories and set in motion plans to ensure that all controls will be adhered to within 10 years. The second phase of regulation will take effect 8 years after the first-phase MACT standards. Standards based on health risks will be set in place if a facility's emissions present a cancer risk of more than one per million.

Approximately 90% of the hazardous substances listed in the 1990 act are specific organic compounds, which are made up of the elements carbon, hydrogen, oxygen, nitrogen, and chlorine or another halogen. Most of the remainder of the hazardous elements listed are described more generally as compounds of specific metallic elements:

Antimony (Sb)
Arsenic (As)
Beryllium (Be)
Cadmium (Cd)
Chromium (Cr)
Cobalt (Co)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Nickel (Ni)
Selenium (Se)

Most of the compounds of these metals are likely to occur as inorganic compounds, specifically including the oxides. Some, however, may occur in organic compounds; Hg is one such example. Certain other metals that may be cause for concern are:

Barium (Ba)
Boron (B)
Copper (Cu)
Molybdenum (Mo)
Vanadium (V)

Other potentially hazardous pollutants are acidic inorganic gases derived from certain key nonmetallic elements. These include hydrogen fluoride (HF), hydrogen chloride (HCl), sulfur oxides (SO_x), and phosphates such as P_2O_5 and H_3PO_4.

There is not now available a sampling and analytical protocol that would cover all of the compounds listed in the 1990 Clean Air Act Amendments. There are, however, procedures generally recognized to be appropriate for selected representatives of the classes of compounds that are of concern, including specific compounds from the 1990 act. These procedures are largely based upon analytical developments by the EPA.

The EPA is charged with the responsibility of identifying potential sources of these 189 hazardous substances and has already listed electric power stations as having that potential. Power stations that emit as much as 10 tons/yr of any single HAP or that emit as much as 25 tons/yr of any combination of HAPs may be subject to regulation, but there is uncertainty in many areas before regulation can be commenced. There are questions such as 1) how are some of the HAPs to be measured correctly when they appear as power-plant emissions, 2) what are the concentrations that appear, 3) how well are the concentrations reduced by existing control technologies, and 4) what advanced control technologies can be introduced to exert control where little or none now exists.

The U. S. Department of Energy (DOE), the Electric Power Research Institute (EPRI), and the Utility Air Regulatory Group (UARG) are assisting EPA in developing satisfactory responses to the mandates of the 1990 clean air legislation. The four organizations are participants in a committee for coordinating research activities that influence EPA's ultimate response to the Congress. To date, perhaps the greatest impact on development of the required data base has come from EPRI, which for several years has been developing the program known as PISCES (Power Plant Integrated Systems: Chemical Emission Studies) (3).

DOE's Pittsburgh Energy Technology Center issued a solicitation in February 1992 for Comprehensive Assessment of Air Toxic Emissions to gather data on the presence, control, and emission of HAPs at eight different coal-burning electric power stations representing a cross-section of the coals, boiler designs, and emissions control technologies in the United States. Southern Research Institute was awarded a contract in April 1993 to assess two of the eight power stations in 1993, with an option to evaluate two more power stations in 1994. This report describes the results of the assessment at one of the electric power stations, Bailly Station.

The research described in this report addresses several questions that apply directly to the comprehensive assessment of air toxic emissions from coal-burning electric power stations. The several questions of general concern are expressed and discussed in the following paragraphs.

What levels of trace elements (herein usually referred to simply as "metals") occur in different bituminous and subbituminous coals? Certainly there is a large body of data now in existence on this matter, especially in the unpublished PISCES collection, but new information may be useful either because it fills in gaps in what is known or because it clarifies or corrects older data. This information will be vitally important within this project for defining the maximum rates of emissions that can be expected.

How is the discharge of these elements partitioned between the main streams emerging from a coal-fired boiler, up to whatever control devices are employed? The discharge streams from the boiler itself are the bottom ash and the flue gas. On the basis of overall mass, boilers that fire pulverized coal discharge roughly 20% of the coal mineral matter as bottom ash and 80% as fly ash. In boilers that have a cyclone design, the partitioning may be more nearly the opposite, 70% as bottom ash and 30% as fly ash. Specific elements that are relatively volatile do not partition between bottom ash and fly ash as overall mass does but instead are preferentially emitted with fly ash. The truth of this statement has been borne out by direct measurements as in this investigation. Still, however, because of the difficulty of direct measurements on flue gas, it is sometimes useful to compare specific concentrations of elements in the coal and in the bottom ash. If an element occurs, for example, at 5 μg/g in coal ash but at a substantially lower specific concentration in bottom ash, its emission from the furnace as a vapor may be reasonably inferred.

What can be said in response to analogous questions that concern the fate of halogens and phosphorus in the coals, rather than the trace metals? These halogens are most likely to occur in coal in the reduced states, as fluoride ion and chloride ion and, despite the oxidizing environment in the furnace, are most likely to leave the furnace still in these reduced states. The most probable forms of the halogens are the acid gases HF and HCl. Such evidence as we have seen indicates that very little of the halogens appears in bottom ash or fly ash, even fly ash at 150 °C. Phosphorus, on the other hand, appears likely, on the basis of analyses we have seen, to partition very much the same way as overall mass partitions, maintaining approximately the same specific concentration in the bottom ash and the fly ash. Phosphorus in the stable form of phosphate, however, is potentially volatile as P_2O_5 or H_3PO_4 and must be searched for in these forms.

What organic substances emerge from the boiler, either because specific substances occur in coal themselves and are not burned completely, or because they are products of chemical alterations or combinations of naturally occurring organics? Distillation of coal with limited air is noted for producing emissions of polycyclic aromatic hydrocarbons (PAHs) or, more generally, polycyclic organic matter (POMs), which include elements other than carbon and hydrogen, such as oxygen, sulfur, and nitrogen.

What is the effect of control devices on the emissions of inorganic or organic substances? Conventional devices for controlling particulate matter do very well at controlling the trace metals of present concern, especially the majority that occur in the particulate state (4,5). Baghouses are reported to perform somewhat more efficiently in removing volatile metals than electrostatic precipitators (ESPs), perhaps because the gas passes through a filter cake that adsorbs vapor with reasonable effectiveness.

What happens to alter the partition of emitted substances between the particulate and gas phases as flue gas enters the atmosphere and undergoes simultaneous dilution and cooling? Surely extensive condensation occurs, as has been observed for a few metals of present interest. The thermodynamic driving forces to promote condensation are powerful for all of the metals and the organics of higher molecular weight. We can certainly expect, however, that the organics of relatively low molecular weights, such as benzene and formaldehyde, will remain above their dew points in the plume and their appearance in the particulate phase will have to depend entirely on chemical transformation to some other compounds (unlikely for benzene) or adsorption onto fine fly ash particles that penetrate the control devices.

The matter of material balances is important also, not as a fundamental issue itself, but as a discipline for evaluating data and determining whether the fundamental questions above are answered adequately by the data obtained. Material balance considerations apply to elements as such — metals or non-metals (halogens, sulfur, or phosphorus) — at any intersecting streams in the system. Elements are not subject to creation or destruction within the system; if they enter at any point, they must depart somewhere. Material balance considerations apply to organic compounds in a more restricted way. At some point in the system, perhaps at the exit of the air heater, those organic compounds that have their origin exclusively in the coal will reach stability insofar as the gas environment itself is concerned and thus may be justifiably examined with respect to material balance. A complexity arises, however, if a compound enters in a control process (for example, barium as a contaminant in limestone) or if a compound is synthesized from control chemicals (for example, HCN from NH_3 as a NO_x-controlling chemical).

2.2 Objectives

2.2.1 DOE Objectives

The objective of the contract under which the Bailly work was done was phrased as follows:

> The overall objective of this project is to conduct comprehensive assessments of toxic emissions from up to four (4) selected coal-fired electric utility power plants. One of these assessments shall be conducted at a plant demonstrating an Innovative Clean Coal Technology (ICCT) Project. The assessment of toxic emissions from two (2) power plants will be conducted in two phases. Phase I shall consist of assessing the Bailly Station of Northern Indiana Public Service Company (NIPSCO), which includes the ICCT Advanced Flue Gas Desulfurization (AFGD) demonstration project, the Springerville Unit No. 2 of Tucson Electric Power Company, and the Blacksville 2 coal preparation plant of CONSOL Inc. for toxic emissions by the end of calendar year 1993. An optional Phase II could include assessing an additional two (2) power plants and a coal preparation plant.

This report is specific to the assessment of toxic emissions from Units 7 & 8 of the Bailly Station, and the associated AFGD Demonstration Project. Specific objectives of the project that pertain to this plant were as follows:

1) to collect and subsequently analyze representative solid, liquid, and gas samples of all specified input and output streams for selected hazardous air pollutants contained in Title III of the 1990 Clean Air Act Amendments and to assess the potential level (concentration) of release of these pollutants,

2) to determine the removal efficiencies of specified pollution-control subsystems for selected pollutants,

3) to determine material balances for selected pollutants in specified input and output streams of Unit 8 of the Bailly Station and input and output streams of the AFGD Demonstration Project (which includes the output of Unit 7 of the Bailly Station),

4) to determine the concentration of the trace metals associated with the particulate fraction of the flue gas stream as a function of particle size,

5) to determine the concentration of the respective pollutants associated with the particulate and vapor phase fractions of the specified flue gas streams, while assessing the potential level (concentration) of release of these pollutants, and

6) to determine the concentration of the respective pollutants associated with the particulate and vapor phase fractions under simulated plume conditions.

2.2.2 Analytes to be Determined

Table 2-1 indicates the classes of substances collected and the sampling locations for Bailly Station Unit No. 7. Tables 2-2 and 2-3 provide the same information for Unit No. 8, and the AFGD Demonstration Project, respectively. Table 2-4 lists the types of streams sampled and the components analyzed. Table 2-5 indicates the specific analytes measured for all respective solid, liquid, and gas samples collected. In addition, Table 2-6 indicates the respective solid stream constituents/samples and the required component analyses for the Bailly Station and the AFGD Demonstration Project.

Table 2-1

ESP OUTPUT STREAM OF THE BAILLY STATION UNIT NO. 7 CATEGORIZED BY PHYSICAL STATE

Physical State	Sampling Points
SOLIDS–	
Entrained Fly Ash	ESP Outlet Before Combining with Unit No. 8 Flue Gas Stream (with and without dilution, cooling)
GASES–	
Low Dust Gas	ESP Outlet Before Combining with Unit No. 8 Flue Gas Stream (with and without dilution, cooling)

Table 2-2

INPUT AND OUTPUT STREAMS OF THE BAILLY STATION UNIT NO. 8 CATEGORIZED BY PHYSICAL STATE

Physical State	Sampling Points
SOLIDS–	
Boiler Feed Coal	Inlet to Each Cyclone Burner
Bottom Ash	Bottom Ash Outlet Sluice Line
Collected Fly Ash	ESP Hoppers
Entrained Fly Ash[1]	ESP Inlet After Ammonia Injection ESP Outlet Before Combining with Unit No. 7 Flue Gas Stream
LIQUIDS–	
Makeup Water	Service Water at Tap, Each Distinct Source
Bottom Ash Return Pond Water	Return Water (to Sluice)
Sluice Water (Slurry)	Bottom Ash Outlet Sluice
Once Through Condenser Water	Inlet & Outlet of the Condenser
GASES–	
High Dust Gas	ESP[1] Inlet After Ammonia Injection
Low Dust Gas	ESP[1] Outlet Before Combining with Unit No. 7 Flue Gas Stream

---

[1] The flue gases at the inlet of the west ESP on Unit 8 and the combined outlet from the two Unit 8 ESPs were sampled for all of the components listed in Table 2-4. We also measured the mass concentration of fly ash by Method 17 in the inlet flue gas to the east ESP on Unit 8.

Table 2-3

INPUT AND OUTPUT STREAMS OF THE AFGD DEMONSTRATION PROJECT CATEGORIZED BY PHYSICAL STATE

Physical State	Sampling Points
SOLIDS --	
Entrained Fly Ash[1]	AFGD Outlet/Stack After Mist Eliminator
Limestone	Limestone Delivery Trucks
Gypsum	Gypsum From Outlet of Basket Centrifuge
Gypsum Slurry[2]	Absorber Recirculation Line
Other Suspended Solids In Liquid Samples[2]	Outlet of Thickener to Water Treatment Plant
LIQUIDS --	
Makeup Water	Service Water at Tap, Reservoir For All AFGD Process Makeup
Waste Water[2]	Outlet of Thickener Overflow Tank to Waste Water Treatment Plant
Gypsum Slurry[2]	Absorber Recirculation Line
GASES --	
Low Dust Gas	AFGD Outlet/Stack After Mist Eliminator

[1] The composition of the entrained particles and flue gases at the inlet of the AFGD were characterized by the combination of the results measured at the Units 7 and 8 outlet ducts. The composition of the entrained particles and flue gases at the outlet of the AFGD were measured by samples collected in the stack. We sampled for all of the components listed in Table 2-4.

[2] The slurry samples were analyzed for the substances in Tables 2-4, 2-5, and 2-6.

Table 2-4

CLASSES OF SUBSTANCES TO BE COLLECTED AT THE BAILLY STATION UNIT NO. 7 AND UNIT NO. 8, AND THE AFGD DEMONSTRATION PROJECT

Stream Type	Component Analyzed
Gas Stream[1]	Volatile Organics Semivolatile Organics Acid Gases and Aldehydes Vapor-Phase Elements[2] Entrained Particulate Particle Loading (Bulk and Size Fractionated[3])
Liquid Streams (Including Slurries)	Volatile Organics Semivolatile Organics Ionic Species and Aldehydes Elements Dissolved - Filtrate Total - Unfiltered
Solid Streams (Including Filter Cake from Slurries)	All Substances in Table 2-6

[1] Vapor phase and condensable organic and inorganic samples and particulate phase samples from the Unit No. 7 ESP outlet flue gas stream were collected using two methods; (1) hot (typical) flue gas sampling and (2) diluted, cooled flue gas sampling. The samples collected under these two conditions were analyzed to determine the differences in the chemical composition of the vapor phase constituents and of the particles collected under both hot flue gas and the diluted, cooled flue gas conditions. A source dilution sampler that simulates plume conditions at the outlet of a utility stack was used to collect vapor phase constituents and fly ash particles under diluted, cooled flue gas conditions.

[2] SRI collected sufficient quantities of particulate (bulk on sample train filters) and vapor phase (impingers from sampling trains) samples from all the indicated flue gas streams enabling the particulate and impinger solutions to be analyzed separately for the components in Table 2-4, analytes in Tables 2-5, and the samples in Table 2-6. These samples were used to make comparisons between the concentrations of vapor phase and particulate-based target analytes and additional analytes that are present in the samples collected from the indicated flue gas streams. SRI used charcoal sorption tubes for the sampling of mercury in all the indicated flue gas streams as a back-up to the EPA Multi-Metals Train.

[3] Size fraction specifications: >10 μm, 5 to 10 μm, and <5μm.

Table 2-5

ANALYTES FOR TOXIC ASSESSMENT OF THE BAILLY STATION UNIT NO. 7 and NO. 8, AND THE AFGD DEMONSTRATION PROJECT

Trace Elements
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium[1]
- Cobalt
- Copper
- Lead
- Manganese
- Mercury
- Molybdenum
- Nickel
- Selenium
- Vanadium

Radionuclides[2]

Ions
- Phosphate (PO_4^{-3})
- Sulfate (SO_4^{-2})
- Cyanide (CN^-)

Inorganics
- Ammonia
- Hydrogen Chloride
- Hydrogen Fluoride

Organics
- Benzene[3]
- Toluene[3]
- Formaldehyde
- Polycyclic Organic Matter[4]
- Dioxins[5]
- Furans[5]

[1] Reported as total Chromium.

[2] Atoms that undergo spontaneous radioactive decay. The measurements were limited to certain heavy nuclides that are primary alpha emitters: lead 210; polonium 210; radium 226 and 228; thorium 228, 230, and 232; and uranium 234, 235, and 238.

[3] Plus other volatile compounds associated with proposed analytical method.

[4] All organic compounds with more than one aromatic ring that are associated with proposed analytical method.

[5] All polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) associated with proposed analytical method. SRI analyzed separately the entrained fly ash samples (bulk) and vapor phase samples (impingers) collected from the Unit No. 7 ESP outlet under both hot gas and diluted, cooled gas conditions for PCDDs and PCDFs. SRI also analyzed separately the entrained fly ash samples (bulk, which could include scrubber carryover) and vapor phase samples (impingers) collected at the AFGD outlet/stack after the mist eliminator for PCDDs and PCDFs. No other samples were analyzed for PCDDs and PCDFs.

Table 2-6

REQUIRED SOLID STREAM SAMPLES AND ANALYSES FOR BAILLY STATION UNIT NO. 7 AND NO. 8 AND THE AFGD DEMONSTRATION PROJECT CATEGORIZED BY PHYSICAL STATE

Solid Samples and Components To Be Analyzed

Boiler Feed Coal (After Crusher)

- Trace Elements
- Moisture Content
- Heating Value
- Ultimate/Proximate Analysis
- Fluoride
- Chloride
- Phosphate
- Radionuclides

Bottom Ash, ESP Hopper Ash, and Entrained Fly Ash Including the AFGD Project

- Trace Elements
- Semivolatile Organics
- Size and Mass Distributions-
  (Entrained Fly Ash
  and Hopper Ash[1] Only)
- Radionuclides
- Carbon
- Fluoride
- Chloride
- Phosphate
- Sulfate
- Dioxins
- Furans

Limestone

- Trace Elements
- Moisture Content
- Fluoride
- Chloride
- Phosphate
- Radionuclides

FGD Solids (Slurry)

- Trace Elements
- Semivolatile Organics
- Sulfate
- Sulfite
- Fluoride
- Chloride
- Phosphate
- Radionuclides-(Only Gypsum)

[1] There are three rows of hoppers to collect fly ash from the twelve fields of the ESP. Each row of hoppers collect fly ash from four fields of the ESP. We used established techniques to provide the best information on mass particle size distributions of a composite bulk ash sample collected from each of the three rows of hoppers beneath the twelve fields of the ESP. Analytical determinations were not performed on the size fractionated hopper ash samples.

2.2.3 Detection Limits

One of the primary considerations in achieving the objectives in this program was to achieve the necessary detection limits. There were various options for achieving these goals, as will be discussed in the following paragraphs. It is important to realize, however, that the potential risks and the probable concentrations associated with various analytes of concern made the achievement of adequate detection limits far easier for some analytes than others. With the element chlorine occurring in the gas phase as HCl, the risk is relatively low, and the concentration is quite high on a comparative basis (of the order of 100 mg/Nm^3 with coals of ordinary chlorine concentrations). For the chlorine compounds known as dioxins and furans, on the other hand, the risk is presumed to be high, and very low concentrations must be detected (of the order of 1 pg/Nm^3, or levels roughly 11 orders of magnitude below that of chlorine).

Another primary factor was to retain an adequate degree of specificity. Achieving both specificity and sensitivity in analysis is often difficult, and certainly that is the case for the determination of the trace levels of some of the air toxics of greatest concern in this project. The conflict between these two objectives was faced at the outset of the project in regard to the determinations of semi-volatile organics, where the question was whether to retain specificity in a list of some 70 identifiable compounds at moderate levels of sensitivity or attempt to gain as much as three orders of improved sensitivity but risk the occurrence of numerous false positives due to a loss in specificity. The specific question was whether to use low-resolution mass spectroscopy to retain identification of a wide range of compounds, or to adopt high-resolution techniques with selected ion monitoring to achieve higher sensitivity for selected compounds but to risk a higher level of interference and loss of certainty in compound identification.

Still another factor to be considered simultaneously with sensitivity and specificity was the question of analytical costs. Inductively coupled argon plasma emission spectroscopy (ICP) was an attractive analytical tool from the point of view of applicability to most of the trace metals of concern, but favorable costs associated with this aspect of the method had to be sacrificed to achieve improved sensitivity for some metals or improved specificity for certain analytes. Thus, methods of atomic absorption spectroscopy based on hydride generation, graphite furnace, and cold vapor techniques were included in the analytical protocols. Similarly, atomic fluorescence with the cold vapor of mercury was used for enhanced sensitivity.

Once an analytical method with appropriate sensitivity has been selected with due consideration to the conflicting issues of specificity and cost, the analysts have certain ways to modify sensitivity in accord with the requirements of individual circumstances. Two of the options are illustrated by the following equation:

$$\lambda = Av/u$$

In which
λ = in-stack detection limit ($\mu g/Nm^3$),
A = instrumental detection limit ($\mu g/mL$),
v = sample solution volume (mL), and
u = sample gas volume (Nm^3)

Even though the instrumental detection limit is fixed by the choice of a method and a specific instrument, the analyst can improve the detection limit by limiting the volume of solution that contains the sample or by increasing the volume of flue gas sampled.

One of the ways that analytical sensitivity was adjusted to meet circumstances at Bailly was to vary the volume sampled in anticipation of concentrations that might be too high or too low for quantitation. Thus, for volatile organics, three samples with nominal volumes of 5, 10, and 20 L were always collected at each location. Compounds found in amounts that varied linearly or approximately linearly with sample volume could be reasonably concluded to be true components of the gas stream sampled, whereas other compounds found in relatively constant amounts could be regarded as contaminants or artifacts.

Another way in which analytical sensitivity was adjusted by varying sample volumes occurred as a consequence of variations in the composition of the gas streams that were known at the time of sampling. With metals, for example, which were expected to occur predominantly in the particulate phase, recognition was made of the variability of particulate concentrations in selecting sampling time and thus sampling volume. Sampling times were adjusted to yield sample volumes of about 2.2 Nm^3 at the Unit 8 ESP inlet, 2.8 Nm^3 at the Unit 8 ESP outlet, 2.5 Nm^3 at the Unit 7 ESP outlet, and 8 Nm^3 at the stack (where the data ultimately showed particulate concentrations of about 5, 0.01, 0.07, and 0.05 g/Nm^3, respectively).

We also attempted to limit the dilution of samples in the recovery procedures for the trains. In particular, we adopted a modified recovery procedure for the permanganate impingers in the Method 29 train. We reduced the volumes of the rinses from 425 mL to 125 mL in an effort to improve sensitivity for mercury.

Limiting the volume of the dissolved sample to be analyzed proved more difficult an objective to accomplish. In the analysis of the trace metals, the difficulty of digesting the solids completely and getting the analytes in a relatively small volume of solution limited what could be done to keep the sample volume small. A practical target was 0.5 g of particulate matter digested and dissolved in 100 mL of solution. With solution detection limits for individual metals ranging from 0.0002 to 0.02 $\mu g/mL$, the concentrations of the metals in the total solid thus ranged from 0.04 to 10 $\mu g/g$ or, at the total particulate concentrations cited above, the following concentrations on the basis of flue-gas volume:

0.2 to 50 $\mu g/Nm^3$ at the ESP inlet,

0.0004 to 0.7 $\mu g/Nm^3$ at the ESP outlets, or

0.002 to 0.5 $\mu g/Nm^3$ at the stack

A general assessment of how the quality of the results in this program was influenced by the detection limits of the methods and procedures adopted is as follows:

Metals — Obtaining definitive concentration in the stack on a numerical basis was significantly handicapped at the sample size selected because the detection limits imposed were higher than desired. Also, blank corrections limited the numerical validity of the results. Still, the emissions could be assigned limiting values that were low enough to permit the conclusion that a high level of emission control was being exercised by the plant. Demonstrating material balance for a few metals was not possible because of occurrence in the coal at undetectable levels.

Non-metals that produce acidic gases or anions in condensed phases — The principal limitation to establishing concentrations occurred with phosphate, which were low in any case because of low phosphorus concentrations in the coal.

Aldehydes — The detection limits for compounds in this class were not the most significant drawback to establishing concentrations unequivocally. The lack of success in removing contaminants from the reagent used for sampling was a more important constraint.

Volatile organic compounds — The aromatic hydrocarbons on which much attention is being focused (benzene, for example) were detected in all gas streams of interest.

Semi-volatile organic compounds — The magnitudes of the detection limits were less of a deterrent to analytical success than the occurrence of unexpected contaminants. Contaminants to the toluene that was used as a solvent, especially for the purpose of making the determination of dioxins and furans possible with split samples, caused major interference in the determination of semi-volatiles in the range of lower molecular weights (or, more exactly, in the range of lesser gas chromatographic retention times). This interference, however, did <u>not</u> occur with the PAHs in a higher range of molecular weights.

2.3 Auditing

2.3.1 SRI

Internal quality control auditing was performed by SRI in the collection of samples from the Bailly site and in the analysis of samples in the SRI laboratories at Birmingham. QC audits performed during this project are presented in Appendix A. QA procedures followed during sampling and recovery operations are described in Appendices B and C. Additionally, quality control analysis of analytical results from subcontractor laboratories, namely Brooks Rand, Commercial Testing and Engineering

Company, and Core Laboratories, was required since no formal auditing of these subcontractors was planned due to funding limitations.

2.3.1.1 Field Sampling Auditing

The QA Auditor was present during collection of the samples at the Bailly site. All of the sampling teams were monitored by the QA Auditor for correct and consistent adherence to the sampling methods. Initially, before sampling, all of the sampling equipment locations were verified to prevent cross-calibration errors.

In turn, each sampling crew was observed running the gas sampling equipment, from initial leak checks to operation of the train to recovery of the sample, including insuring that the required custody chain was maintained. The operation of the Method 5 type trains was videotaped for reference. No major problems were observed during the gas sampling efforts. Minor operational problems were corrected on the spot. None of the sampling runs was aborted or voided. One run, an acid gases train on the Unit 8 ESP inlet, suffered a cracked filter housing at the conclusion to the run and after the train had been removed from the duct and sampling ceased. The measured water content from the run was consistent with other runs and this run was retained even though the train failed the post-test leak check. See Section 4.2.2 for further details about sampling.

The particulate sampling crew was also observed making velocity traverses, Method 17 runs, cascade impactor, and cyclone runs. As with the other crews, the particulate sampling was videotaped for documentation.

The process sampling team was observed for several rounds of sample collection. No problems were observed with the sampling procedures. Custody labels were applied every day. The process sampling was also videotaped for reference.

The impinger preparation crew was audited in the mixing of solutions and setup of the Method 5 type trains. No substantial discrepancies were found.

The calibration of all of our meter and pump systems were spot-checked with RTI's critical orifice. Although the meter coefficient was not known, the meter boxes showed consistent results for all of the boxes. The meter boxes were allowed to warm up to a steady state temperature and a ten minute flow test was recorded.

2.3.1.2 Analytical Laboratory Auditing

Due to funding limitations, no formal internal audits of the analytical process were conducted. We relied upon the normal duplicate analyses, matrix spike and matrix spike duplicates, lab QC samples, and our mass balance results to assess the quality of the analytical data.

Analyses of the volatile organics, semi-volatile organics, aldehydes, and dioxin/furans are routine for our laboratory, and the normal QA/QC procedures called for by the methods were deemed to be adequate.

Suites of analytical methods were developed for the metals analyses and the anion/acid gases analyses. Because there are no validated methods for these analyses, internal auditing of exploratory procedures is not appropriate. Again, duplicates and spiking provide a reliable check of analytical methodology.

Appendix C contains the QA/QC information, and the reader is referred to it for more information.

2.3.2 RTI

Shirley J. Wasson and Lori Pearce of Research Triangle Institute visited the Bailly Station on September 5 and 6 while we were sampling. They conducted an audit of the sampling. The scheduling of their visit permitted them to observe one day of organics sampling and one day of inorganics sampling. There were four facets of the audit: 1) observe the sampling and laboratory procedures, 2) spike some laboratory blanks for Quality Assurance evaluation, 3) spike two VOST samples using a cylinder of audit gas, and 4) check calibration of the sampling trains. In addition, we provided them with our calibration documentation and preliminary data from our testing. We did not receive a formal report of their audit.

We did receive from DOE the values reported by RTI as the true values for the spikes they applied in the field. Results of these audit spikes are given in Appendix A.

2.3.3 Round Robin Coal Analyses

SRI participated in a round robin analysis of coal samples administered by CONSOL, Inc. for DOE. We analyzed 17 coal samples in duplicate under the round robin. There were two samples from each of the eight plants being tested in the DOE air toxics assessment program, plus one reference coal. Analyses specified included proximate and ultimate, 10 major ash constituents, the 16 trace elements in the DOE program scope of work, and fluorine. Results of the analyses are presented in Appendix A. Results of the round robin analyses do not suggest any general deficiencies in our protocols when SRI's data are compared to the range of results among the other participants. One specific improvement suggested by these results is the use of the method of standard additions for analyzing antimony and arsenic. Because of this finding we altered our analytical protocols accordingly.

2.4 Contractor Organization

We used the staff and resources of three organizational units at Southern Research Institute to do the work of this project: the Environmental Sciences Research Department, the Analytical Chemistry Department, and the Contracting Office. Subcontracting was limited to a small portion of the work under this project. We arranged for the services of seven field sampling crew members from Guardian Systems, Inc., to supplement SRI staff during the tests at the Bailly Station. Commercial Testing & Engineering Company was contracted to do the proximate, ultimate, chlorine, and fluorine analyses on the coal samples from Bailly. Core

Laboratories, Inc., was contracted to analyze samples for radionuclides. Brooks Rand, Ltd., analyzed solids and sorbent traps for mercury. Galbraith Laboratories performed analyses in limestone and gypsum. All other analytical work was performed at SRI.

Five individuals were classified as key personnel for this project:
P. Vann Bush, Program Manager
Edward B. Dismukes, Principal Investigator
Joseph D. McCain, Sampling Coordinator
John M. Coyne, Analytical Coordinator
Larry S. Monroe, QA Auditor

The following paragraphs describe the roles of the key personnel.

Program Manager The Program Manager had the duties of liaison with the DOE Contracting Officer's Representative, liaison with other participants of the project including the host site representatives and other DOE contractors where needed, scheduling the activities of project personnel, and monitoring and reporting the project performance relative to the schedule and budget. The Program Manager scheduled and conducted pre-test site evaluations required for the preparation of site-specific sampling and analytical plans. The Program Manager was on site during the field sampling, participated in review of the analytical results, and directed the preparation of the project reports.

Principal Investigator The Principal Investigator directed the sampling and analytical work. This effort included preparation of site-specific plans. The Principal Investigator was on site during part of the field sampling, assumed custody of the samples collected upon their delivery to the laboratory in Birmingham, and supervised the disposition and analyses of all samples. The Principal Investigator was responsible for reduction of data from the sampling trains, and interpretation of analytical results including mass balance determinations.

Sampling Coordinator The Sampling Coordinator participated in the pre-test site survey and the preparation of the site-specific sampling and QA plans. The Sampling Coordinator supervised the preparation of sampling equipment, the on-site sampling, and delivery of samples for post-test analyses. The Sampling Coordinator assisted the Principal Investigator in the reduction of data from the sampling trains.

Analytical Coordinator The Analytical Coordinator assisted in the preparation of site-specific analytical plans. The Analytical Coordinator directed analyses of trace metals and all organics from the samples collected in Bailly. The Analytical Coordinator was responsible to summarize the analytical results, and to assist the Principal Investigator in the interpretation of results.

Quality Assurance Auditor The Quality Assurance Auditor reviewed the standard operating procedures (SOPs) for each of the sampling trains and analytical instruments. The Auditor monitored the sampling at the power plant and conducted independent checks of procedures against the SOPs and test objectives. The Auditor compiled the quality assurance documentation from pre-test and post-test calibrations of test equipment, and the quality control data records from the analytical work.

2.4.1 Sampling Team

SRI had 24 people on site for the test program, plus 7 subcontracted sampling team members from Guardian Systems, Inc. The staff was divided as follows:

- 4 in the mobile laboratory,
- 3 at the Unit 8 inlet sampling location,
- 3 at the Unit 8 outlet sampling location,
- 3 at the Unit 7 outlet sampling location,
- 1 to make VOST and Hg measurements at Unit 8 inlet and stack,
- 1 to make VOST and Hg measurements at Units 7 and 8 outlets,
- 2 to run cyclones and Method 17 at the Unit 8 East ESP inlet,
- 1 to run Orsat samples,
- 2 to run the dilution sampling system at Unit 7 outlet,
- 5 at the stack sampling location,
- 3 collecting plant samples,
- 1 flue gas sampling coordinator,
- 1 QA auditor, and
- 1 test supervisor.

The organization of the sampling team is shown in Figure 2-1. Tom Sarkus, Earl Evans, and Dick Tischer of DOE/PETC took turns at the test site during the time we were on site. Beth Wrobel and Sid Smith of NIPSCO served as liaison with the Bailly Station, and John Cheater and John Henderson served as liaison with the AFGD Demonstration Plant.

2.4.2 Analytical Team

The analytical team for this project was organized as shown in Figure 2-2. As indicated in the figure, Dr. Dismukes personally directed the analyses of anions, and submitted the samples to and reviewed the results from the subcontracted analytical laboratories. Mr. John Coyne supervised all other analytical work.

2.5 Report Organization

This report is organized into ten sections, including this introductory section and the preceding Executive Summary. Section 3 provides a description of the Bailly Station and the AFGD Demonstration Plant. Section 3 also includes tabulated and plotted plant operating data collected during our test. Section 4 describes the methods we used to collect all samples from solid, liquid, slurry, and gas streams. In addition, Section 4 includes the sampling schedule, and the mass flow rates we measured or otherwise determined for inlet and outlet streams for plant subsystems and the overall plant. Section 5 lists the analytical methods used on all of the collected samples. Section 6 contains all of the analytical results. Section 7, Data Analysis and Interpretation, includes the material balances we calculated from the analytical results, the trace species removal efficiencies across the Bailly Station ESPs and across the AFGD Demonstration Plant, and emissions factors. Section 8 of the report contains four subsections dealing with special topics: 1) particulate and vapor phase partitioning, 2) plume simulation dilution sampling, 3) distribution of trace metals by size, and 4) comparison of Method 29 and carbon traps for mercury measurements. Section 9 lists references used in the report, and Section 10 is a glossary of terms and abbreviations used in the report.

There are seven appendices to the report. They contain descriptions of auditing exercises, supporting information on sampling and analytical protocols, quality assurance and quality control procedures and results, example calculations, description of uncertainty analyses performed, and comprehensive documentation of sampling runs. The reader is referred to the Table of Contents which lists the appendices.

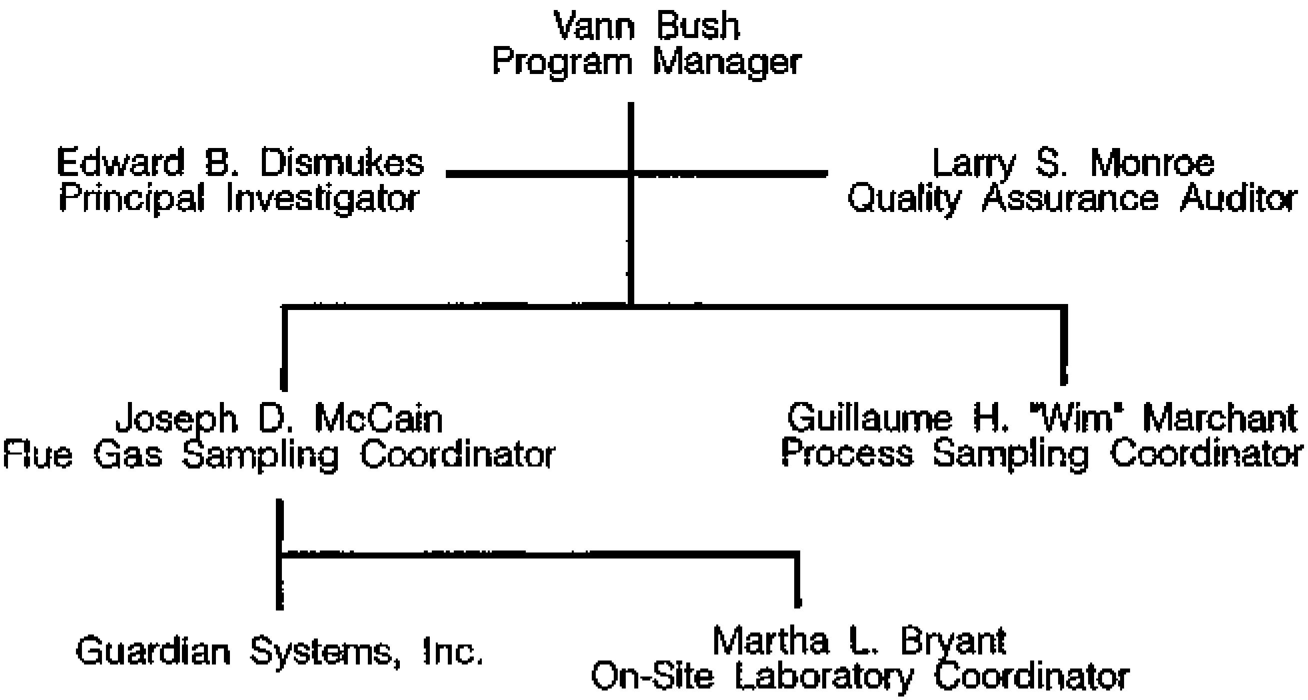


Figure 2-1. Sampling Team Organization

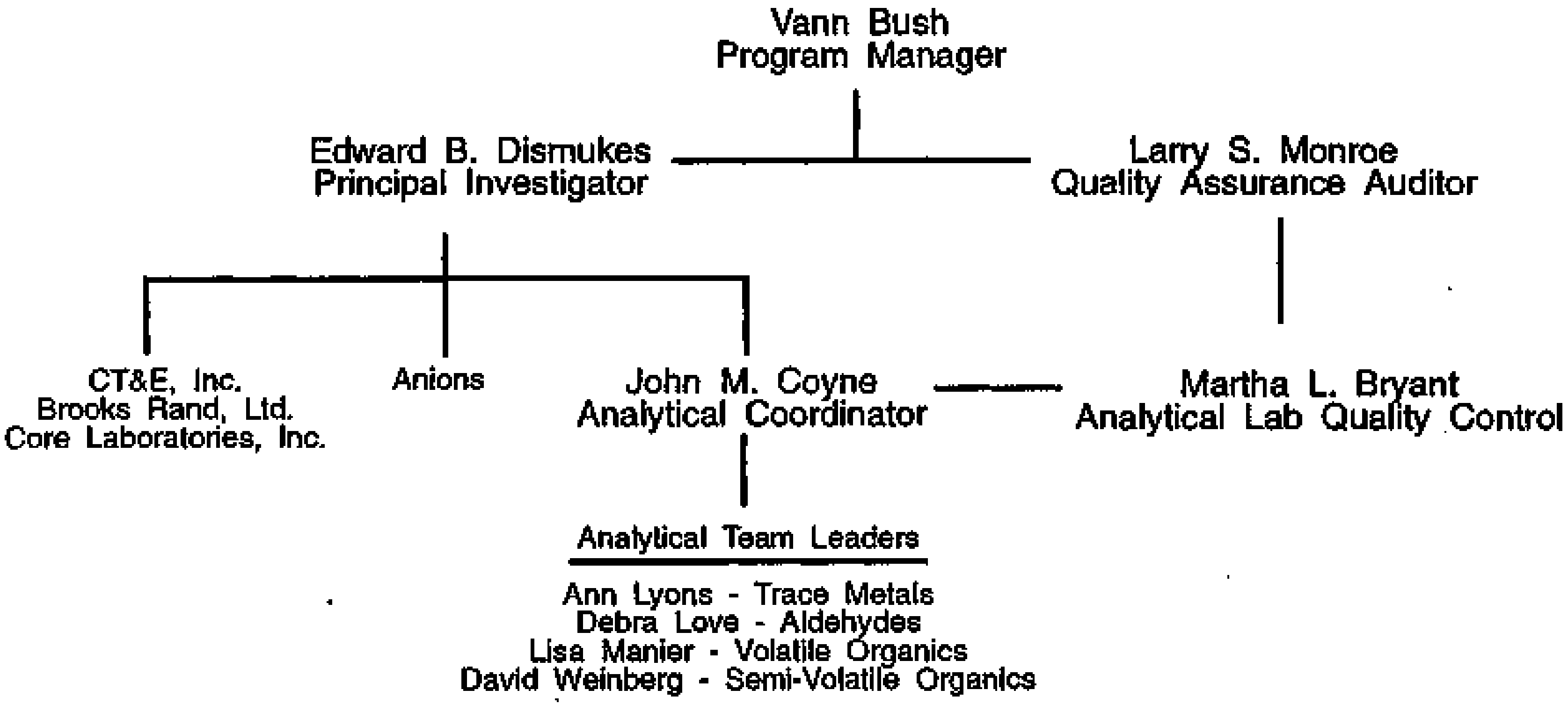


Figure 2-2. Analytical Team Organization

3.0 SITE DESCRIPTION

3.1 Power Plant and Scrubber Design Features

3.1.1 Power Plant

Bailly Generating Station is owned and operated by the Northern Indiana Public Service Company (NIPSCO). The plant is located on the shores of Lake Michigan near Chesterton, Indiana. This project involved the two coal-fired units of Bailly Generating Station with a combined capacity of 528 MWe; Unit No. 7 has a gross capacity of 183 MWe (160 MW net) and Unit No. 8 has a gross capacity of 345 MWe (320 MW net). Figure 3-1 is a schematic illustration of the layout of the Bailly Station Units 7 and 8.

Each unit is equipped with a Babcock & Wilcox cyclone boiler and a steam turbine generator. Both units burn an Illinois/Indiana basin high-sulfur bituminous coal (2.5% to 4.5% sulfur). Unit 7 has four cyclone burners, and Unit 8 has eight cyclone burners. Full load on each unit usually varies by ± 3 MW. There is no control technology for NO_x emissions.

Electrostatic precipitators (ESPs) are used on both units for particulate control. There are two ESPs on Unit 8 and one ESP on Unit 7. The two ESPs of Unit No. 8 are identical to the Unit No. 7 ESP. Each ESP is two shells wide and has twelve electrical fields. In addition, there are three rows of hoppers to collect fly ash from the twelve fields of each ESP. Thus, there are three hoppers in the direction of gas flow along any given lane of the ESP.

Ammonia is injected at a rate to yield 15 ppm concentration prior to the Unit No. 7 ESP and prior to each of the two Unit No. 8 ESPs for the control of SO_3 to prevent acid mist emissions. There are separate ammonia injection systems for the two units.

The Bailly Station Unit No. 7 flue gas flows through a single duct into the ESP. The flue gas stream exits the ESP and subsequently connects downstream of the ESP with the flue gas duct from the combined outlets of the two ESPs of Unit No. 8. These two flue gas streams then join to form a single stream.

There are various ash disposal systems for Units No. 7 and No. 8 at the Bailly Station. Based on four years of records of waste disposal from the plant, nominally 63% of the ash in the coal is collected as bottom ash and the remaining 37% is fly ash. Wet bottom ash is transferred to a slag tank where the ash is sluiced to an ash settling pond. The slag tank is dumped every six hours. The water from the settling pond is recycled back for the sluicing of the bottom ash. Economizer ash is not accumulated or evacuated in sufficient quantity or frequency to be considered as a separate waste stream. Makeup water is obtained from on-site facilities. Fly ash from the precipitators from both units is conveyed dry to an ash silo where it is trucked away to a landfill or sold.

Both units use Lake Michigan water as a once-through cooling medium.

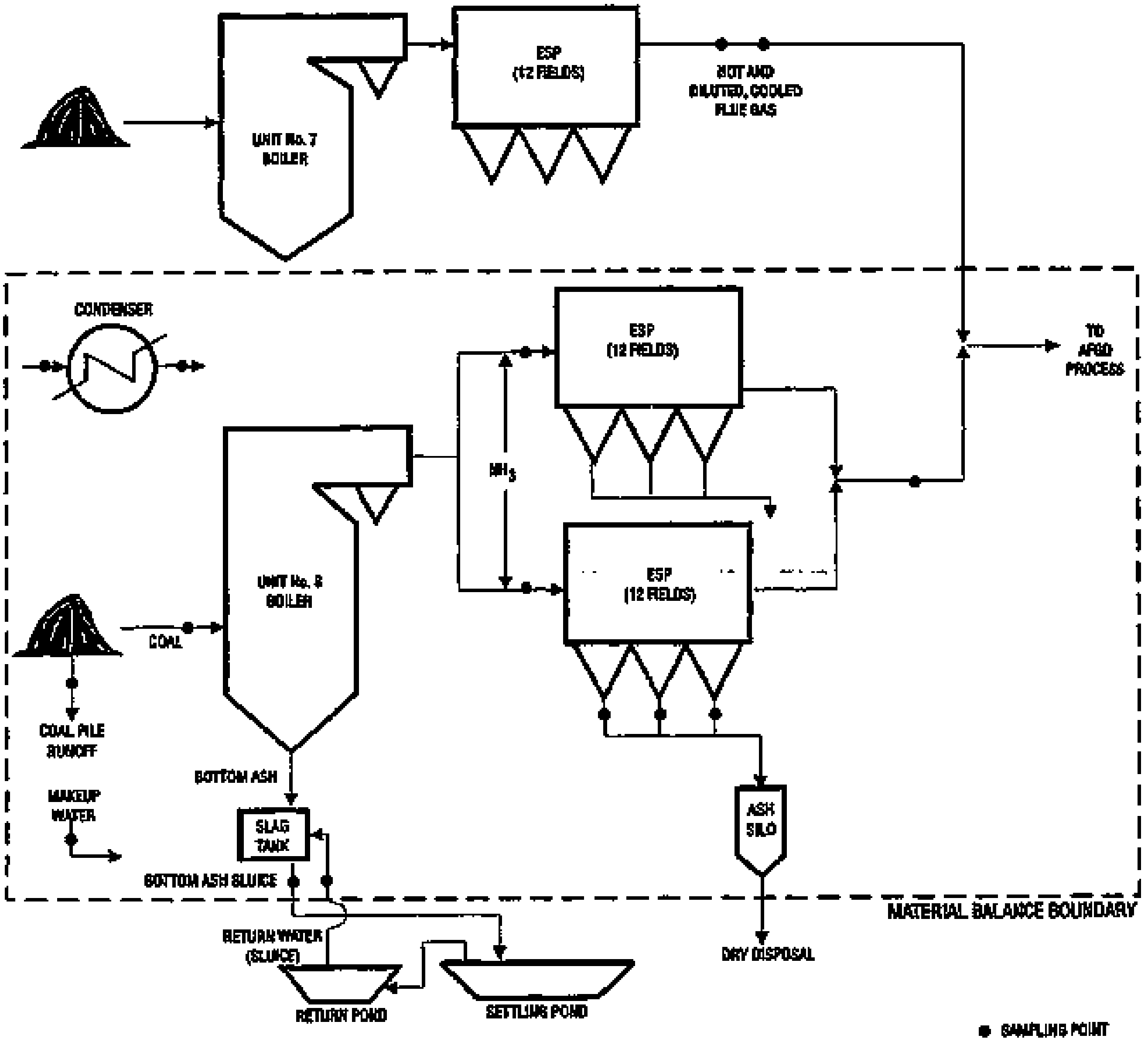


Figure 3-1. Process Flow Diagram and Sampling Locations for Bailly Generating Station Units 7 & 8

3.1.2 Scrubber

Sulfur dioxide in the combined flue gas stream from the two units of the Bailly Generating Station is treated by the Advanced Flue Gas Desulfurization (AFGD) demonstration project managed by Pure Air of Allentown, Pennsylvania (a joint venture of Air Products, Inc. and Mitsubishi Heavy Industries, Ltd.) under the Department of Energy's Clean Coal Technology program. The scrubber is operated by Pure Air on the Lake, a subsidiary of Pure Air. Figure 3-2 is a schematic drawing of the Pure Air AFGD process. Pure Air's AFGD system is using innovative wet limestone flue gas desulfurization (FGD) technology to achieve a high level of SO_2 removal (90 to 95+ percent capability) on high sulfur U.S. coals.

A feature of the AFGD process is the purchase and direct injection of powdered limestone in lieu of on-site limestone milling operations. This project includes an in-situ oxidation absorber module that produces high-quality gypsum from a range of high sulfur coals. These features serve to decrease facility size, and costs for both installation and operation of the process. High-quality, by-product gypsum (93+ percent purity) is being produced and sold to a wallboard manufacturer. This by-product utilization eliminates the problem of solid waste disposal, and also contributes to the cost-effectiveness of the technology.

The flue gas stream from the AFGD process is vented to the atmosphere through a 480-foot stack exclusive to the project.

3.2 Plant Systems Included in This Evaluation

The samples to be collected and their respective sampling points for the Bailly Station Units No. 7 & 8 and the AFGD process are identified in Figures 3-1 and 3-2. Material balance for the Bailly Station was limited to Unit 8, as shown in Figure 3-1. A separate material balance was conducted around the AFGD scrubber. The process components included in the material balances were:

Unit 8 Boiler — The input streams for this subsystem are the coal, makeup water, and combustion air. Output streams are the flue gas and bottom ash.

Unit 8 ESP — The input stream to the ESP is flue gas. The output streams are the hopper ash and the cleaned flue gas.

Condenser — The condenser is a once-through system using Lake Michigan water as input. The output stream is returned to the lake.

Bottom Ash Sluice — The input streams to this system are the bottom ash and sluice return water (that is, make-up water supplied from the settling pond). The output stream is the bottom ash sluice (discharged to the settling pond).

Unit 8 Boiler Overall — The input streams are the coal, combustion air, makeup water, and sluice water return. Output streams are the stack flue gas, gypsum, and water to waste water treatment.

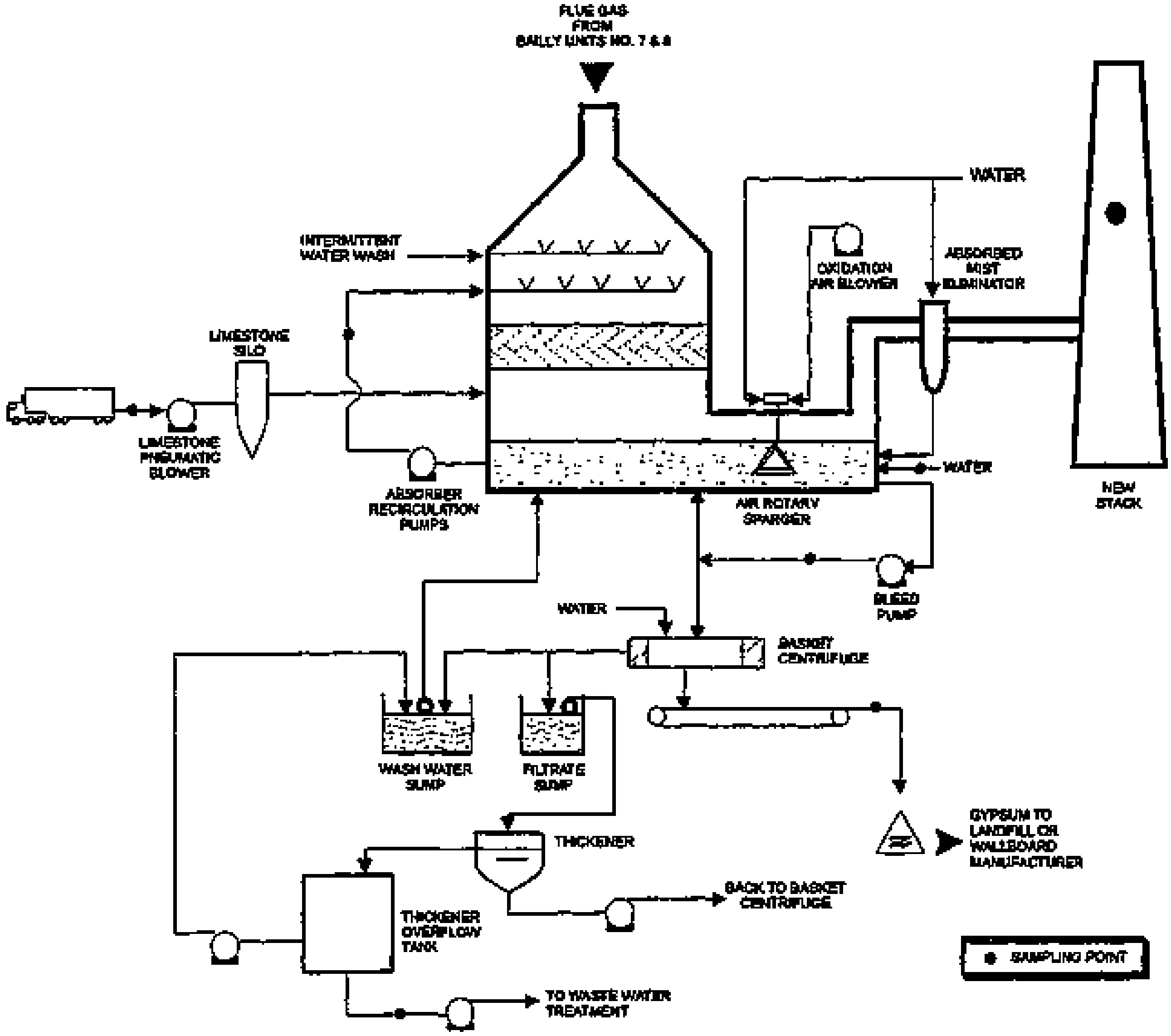


Figure 3-2. AFGD Process Diagram

Flue Gas Mixing — Flue gas from the Unit 7 ESP and the Unit 8 ESP are input streams; the mixed product is output.

AFGD System — The input streams to this system are the combined flue gases from Units 7 and 8, limestone, and service water. Output streams are the stack flue gas, gypsum, and waste water.

3.2.1 Flue Gas Streams

The flue gas streams sampled for the toxic emissions assessment were:

1) the Unit No. 7 ESP outlet before combining with the Unit No. 8 gas stream (with and without dilution cooling),
2) the Unit No. 8 west ESP inlet after ammonia injection,
3) the Unit No. 8 ESP outlet before combining with Unit No. 7 flue gas stream, and
4) the AFGD outlet/stack after mist eliminator.

The flue gas streams sampled for mass particle size distributions and total mass concentrations of entrained fly ash were:

1) the Unit No. 7 ESP outlet before combining with the Unit No. 8 flue gas stream (with and without dilution cooling),
2) the Unit No. 8 west ESP inlet after ammonia injection,
3) the Unit No. 8 east ESP inlet after ammonia injection (only total mass concentration),
4) the Unit No. 8 ESP outlet before combining with Unit No. 7 flue gas stream, and
5) the AFGD outlet/stack after mist eliminator (total mass and size distribution).

The flue gas streams sampled for size-fractionated entrained fly ash for subsequent determinations of trace metals were:

1) the Unit No. 7 ESP outlet before combining with the Unit No. 8 flue gas stream
2) the Unit No. 8 west ESP inlet after ammonia injection, and
3) the Unit No. 8 ESP outlet before combining with Unit No. 7 flue gas stream.

A complete discussion of the flue gas sampling approach is given in Section 4.0.

3.2.2 Solids, Liquids, and Slurries

Solids, liquids, and slurries sampled are listed in Table 3-1. Descriptions of the sampling methods for each of these samples are given in Section 4.3.

Table 3-1

Solids, Liquids, and Slurries Collected at Bailly

SAMPLE	LOCATION
SOLIDS –	
Boiler Feed Coal	augers above cyclone burners
ESP Hopper Ash	hoppers beneath Unit 8 West ESP
Bottom Ash	sluice discharge at pond
Limestone	sampled from supply trucks
Gypsum	automatic sampler on conveyer belt
LIQUIDS –	
Unit 8 Condenser Inlet	intake from Lake Michigan
Unit 8 Condenser Outlet	discharge into Lake Michigan
Sluice Return Water	low pressure water line tap at boiler
Condenser Makeup Water	tap at makeup water tanks
Service Water	water tap in AFGD building
AFGD Waste Water	tap in line to waste water treatment
SLURRIES –	
Bottom Ash Sluice	discharge pipe into pond
Absorber Recirculation Slurry	sample tap at recirculation pump
Bleed Pump Slurry	sample tap at slurry bleed pump

3.3 Plant Operating Conditions

3.3.1 Typical Operating Conditions

Bailly Station Units 7 and 8 operate on load demand, with full load usually between 7 AM and 9 to 10 PM. At full load, Unit 8 generates about 345 gross megawatts, and Unit 7 generates about 183 gross megawatts. The two units are usually run at equivalent percentages of their full load rating.

The primary coal for the plant is from the Illinois/Indiana Basin, and has a 3.0 to 3.5% sulfur content. The main source of coal for the plant is the Captain Mine.. Because of parametric evaluation of the AFGD scrubber, several other coals and blends have been burned at the Bailly Station. During 1993, the plant had burned a blend of Illinois/Indiana Basin coal and Powder River Basin coal in a ratio of 4:1 to give a coal sulfur content of about 2.8%.

The water supply for the plant is Lake Michigan, as mentioned earlier. The Pure Air AFGD scrubber uses a pre-crushed limestone supplied by Huber, Inc.

There are three separate computerized plant monitoring and data acquisition systems: one each for Unit 7, Unit 8, and the Pure Air AFGD. Some of the data are redundant on the Pure Air system, but we obtained records from all three systems covering the period of our testing. We recorded manually readings of voltages and currents in the Units 7 & 8 electrostatic precipitators, and flows (indicated as static pressures and percentages of orifice differential pressures) of ammonia to both units. We also obtained historical records for the previous four years that listed amounts of bottom ash and fly ash disposed of and Units 7 and 8 power generation.

3.3.2 Operating Conditions During Sampling

Tables 3-2 through 3-6 are records of plant operation during the periods we were sampling. Tables 3-2, 3-3, and 3-4 are excerpts from operating logs recorded by computer data acquisition systems. We selected key parameters that describe the major process streams, and can be used to quantify variables required to make material balance calculations or to show system stability. Each data entry in these logs is an hourly average. Table 3-2 presents a subset of the operating data we collected from the Unit 7 data acquisition system. Table 3-3 presents data from the Unit 8 data acquisition system. Table 3-4 presents data from the Pure Air AFGD data acquisition system.

Some of the plant operating data are plotted in Figures 3-3 through 3-7. Figure 3-3 shows the megawatt output of Units 7 and 8 during the intervals of time we were sampling. Figure 3-4 shows the average opacity values recorded in the Unit 7 and Unit 8 ducts at the outlets of the electrostatic precipitators. Figure 3-5 shows the concentrations of SO_2 at the inlet and outlet of the AFGD scrubber. Figure 3-6 shows the measured carbonate and sulfite contents in the scrubber slurry. Figure 3-7 shows the differential pressure across the AFGD plant and the absorber.

Table 3-5 is a record of the operating voltages and currents on the Unit 7 and 8 electrostatic precipitators (ESPs). We recorded these values at two-hour intervals each test day. The table shows the daily average values on each electrical section. Figure 3-8 shows the layout of the ESP electrical sections. The most significant feature of these data is the fact that one of the outlet electrical sections on the Unit 7 ESP (Section 7AT5) was out of service during our testing. Furthermore, another outlet field, 7AT6, operated at a very low voltage compared to other fields. These problems explain the much higher emissions, seen in the opacity numbers in Tables 3-2 and 3-3, for the Unit 7 ESP than the Unit 8 ESP.

Table 3-6 is a record of the flows of ammonia from the two separate systems supplying Units 7 and 8. Figures 3-9 and 3-10 show the ammonia system calibration charts for the two units. The main indicator of ammonia feed rate is the parameter called system output, given as a percentage. As the figures show, a system output setting of 50% is supposed to supply ammonia at a rate equivalent to 15 ppm in the flue gas at full load. The logs show a virtual loss of ammonia supply to Unit 7 from 9/3 to 9/4. The supply to Unit 8 ran out on the evening of 9/4. Therefore, on 9/3 we had nominally 15 ppm ammonia to both Unit 7 and Unit 8 ESPs. On 9/4 we had nominally 15 ppm ammonia to Unit 8 ESP, but less than 3 ppm ammonia to Unit 7 ESP. On 9/5 we had no ammonia to either Unit 7 or 8 ESP. This reduction in ammonia feed may have affected the particulate emissions, and certainly affected SO_3 carry-over through the ESPs.

There were two occasions during the testing when the fire in one cyclone burner went out because of a plugging of the coal feeder to the cyclone. The first of these was at 0900 to 1045 on 9/3/93 when one burner on Unit 7 lost fire. The Unit 7 load dropped from 175 to 145 MW. Since we were still over 90% of the combined full load capacity of the two units we continued sampling. The second occasion for a burner to lose fire was also on 9/3/93 at about 1700 to 1800; this time the burner was on Unit 8. We again continued sampling.

The major plant upset that truncated our testing was supply of coal to the boilers. There were problems in getting coal from the Captain Mine to the plant site, and problems at the plant site with the coal unloading and conveying system that delayed, interrupted, and finally prevented sampling. Because of the strike by the United Mine Workers, the plant had a variety of coals layered on the plant coal stockpile. Therefore, testing while the plant reclaimed coal from the pile was not practical because of the likelihood that variations in coal would render the flue gas samples equivocal.

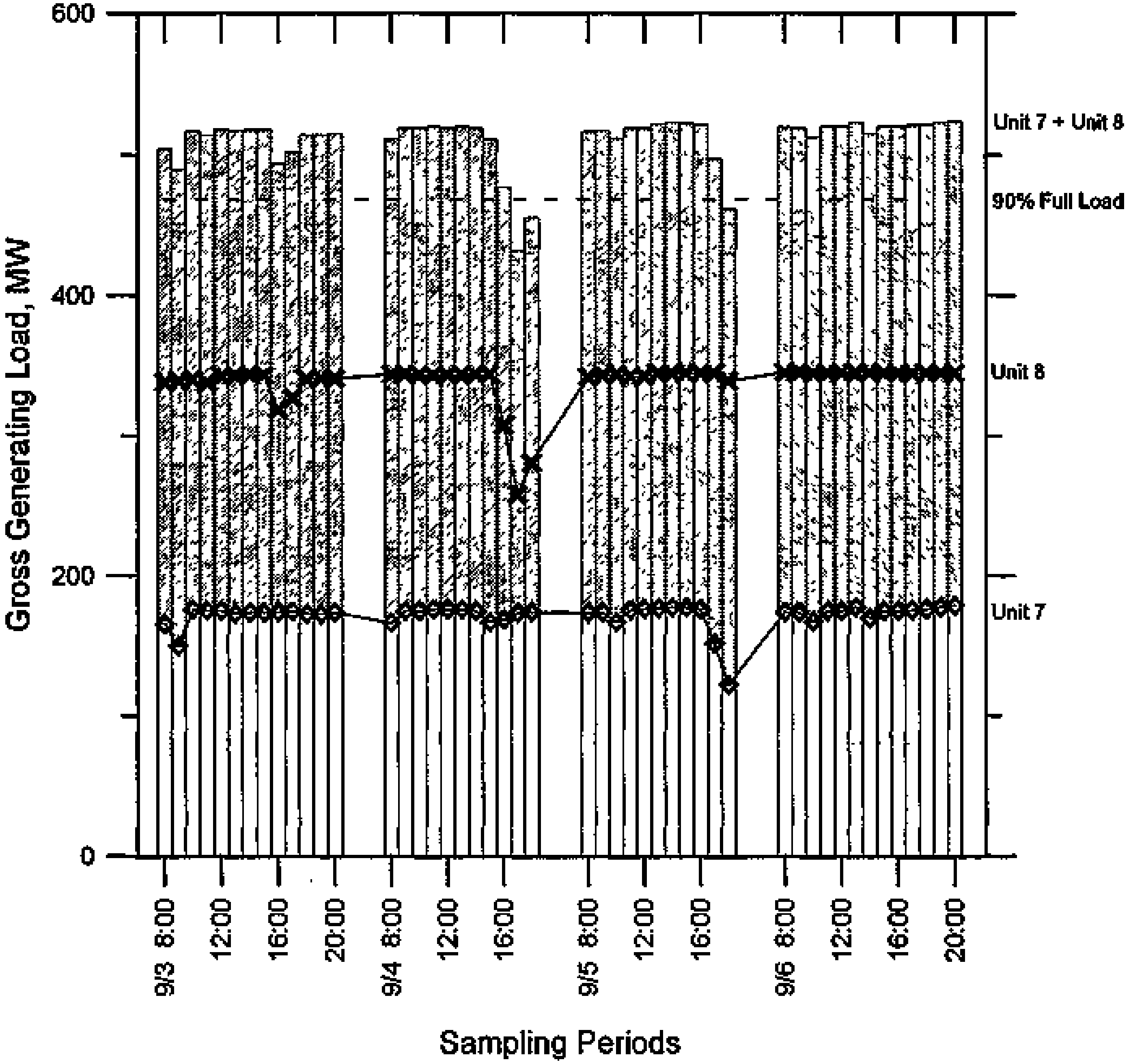


Figure 3-3. Gross Generating Loads for Units 7 & 8 During Test Periods.

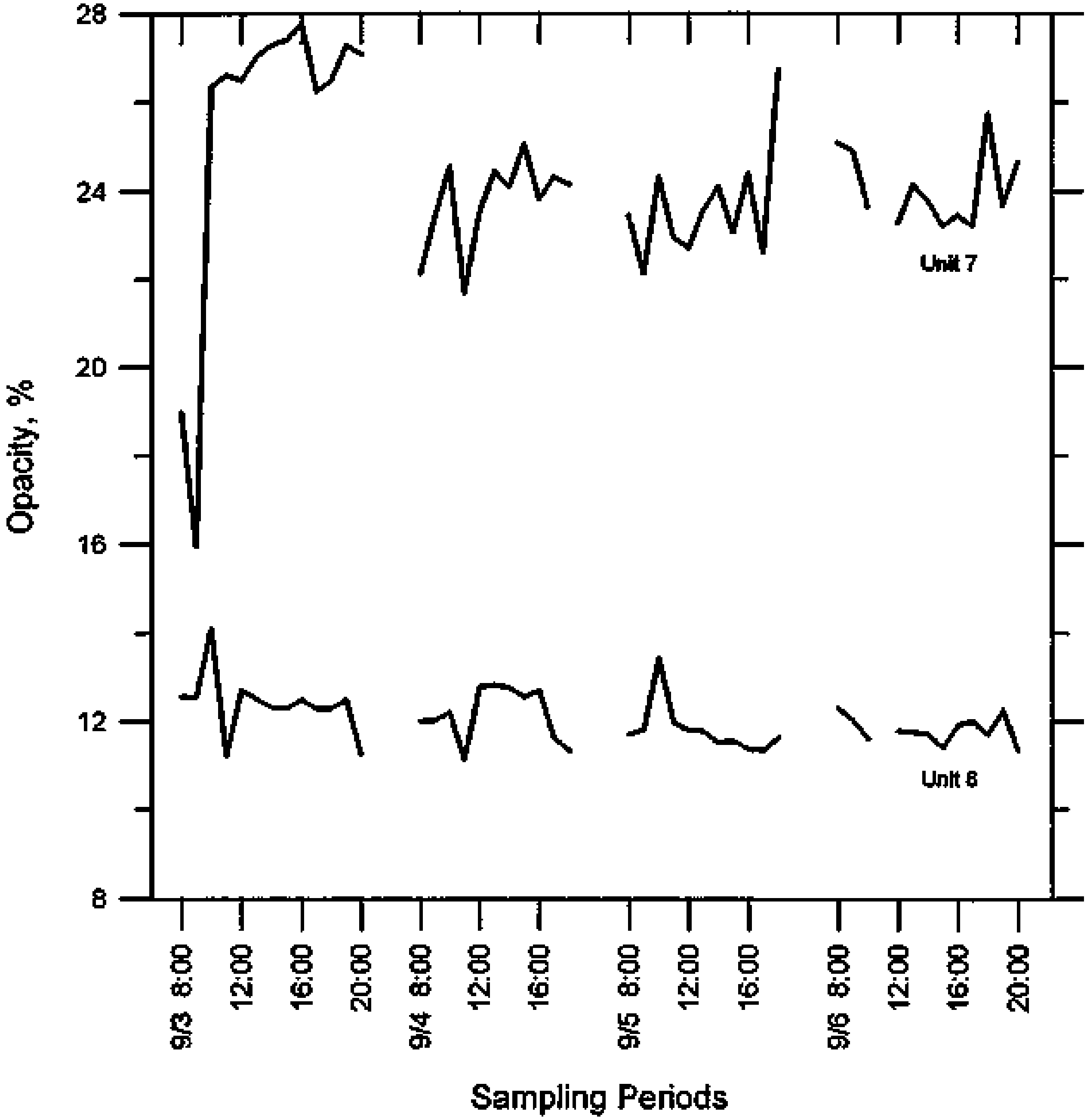


Figure 3-4. Hourly Averages of Readings of Opacity from the Outlets of Units 7 & 6 ESPs.

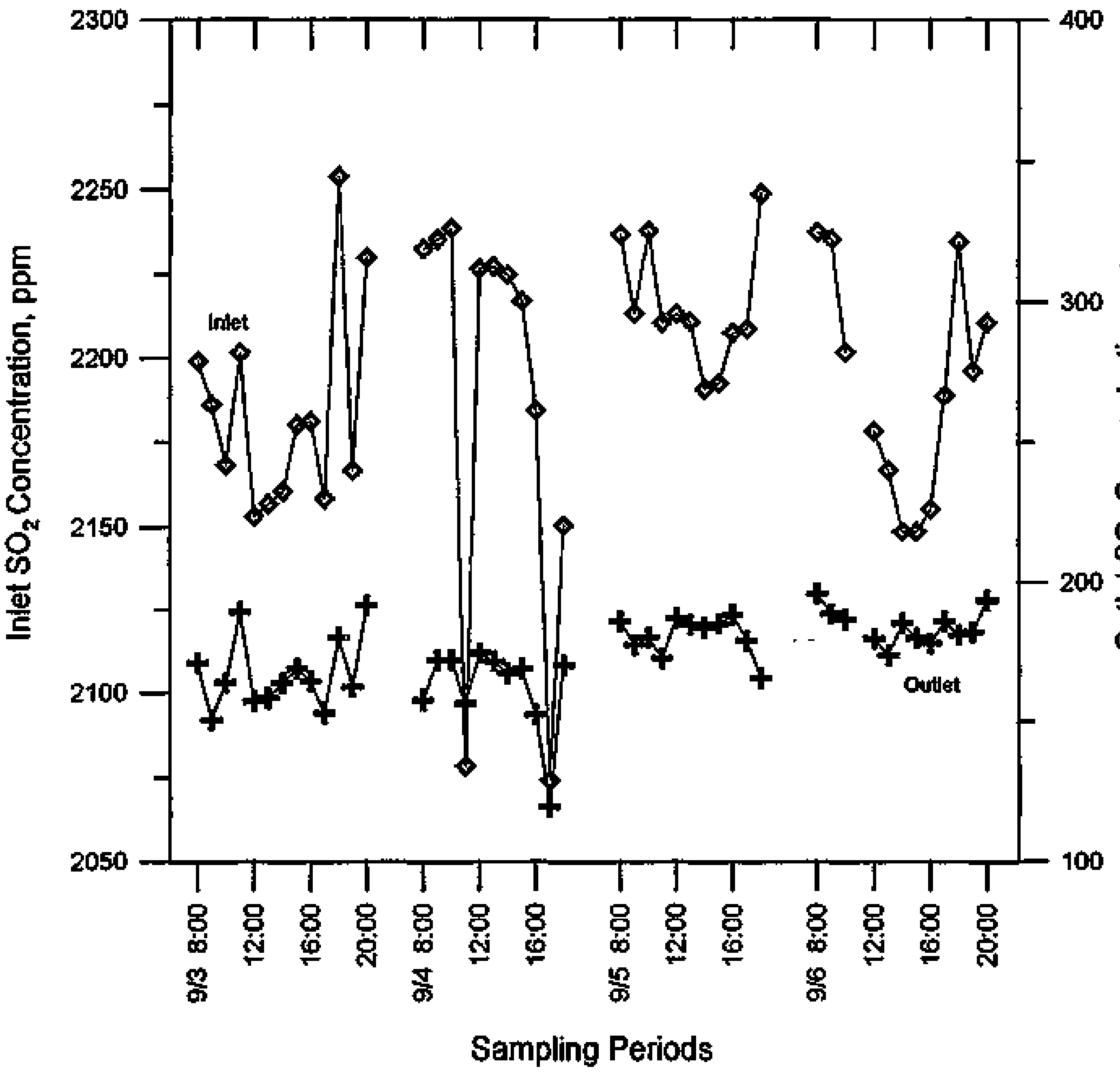


Figure 3-5. Hourly Averages of SO_2 Concentrations at the Inlet and Outlet of the AFGD Scrubber.

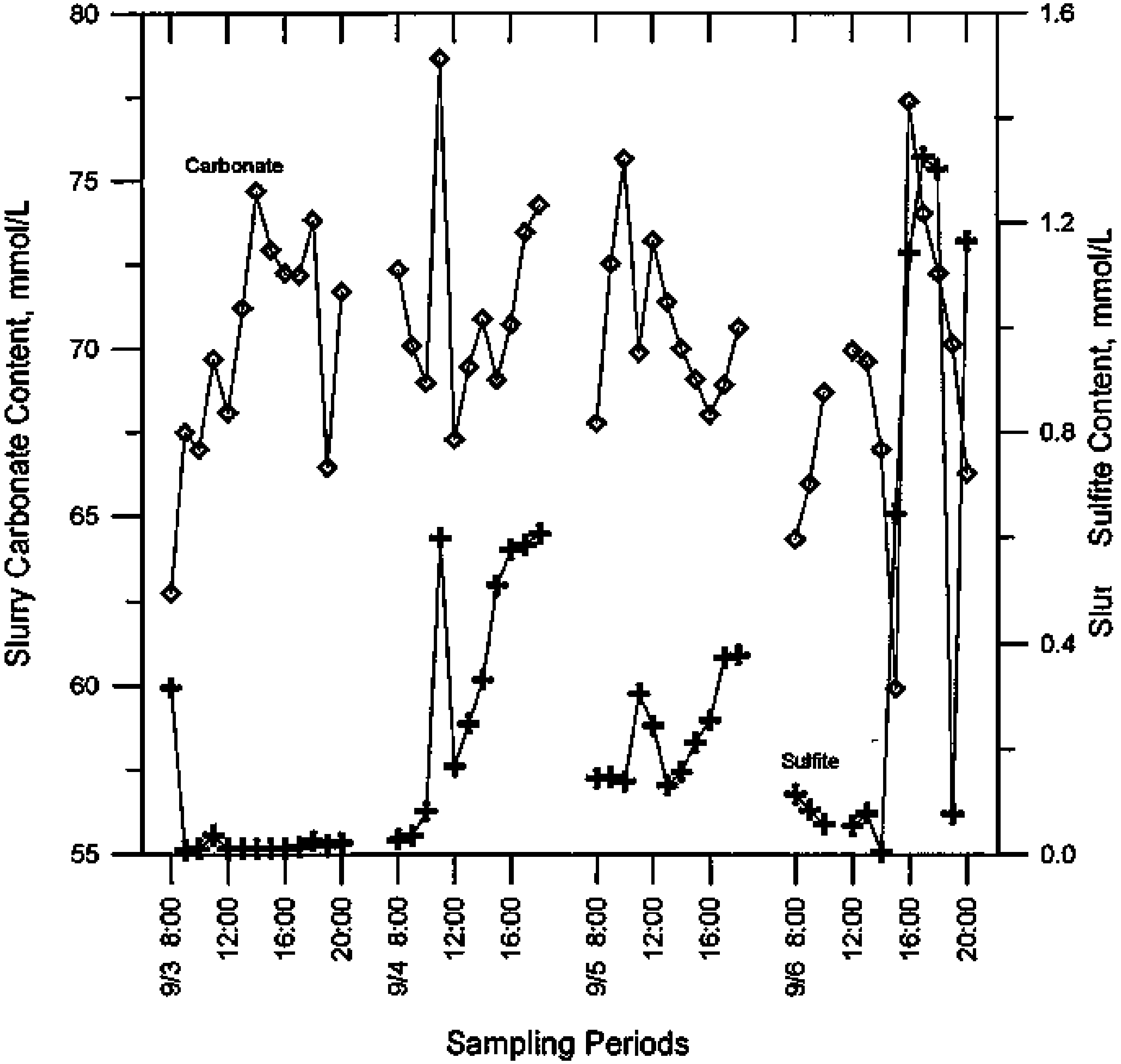


Figure 3-6. Hourly Averages of Concentrations of Carbonate and Sulfite in the AFGD Scrubber Slurry.

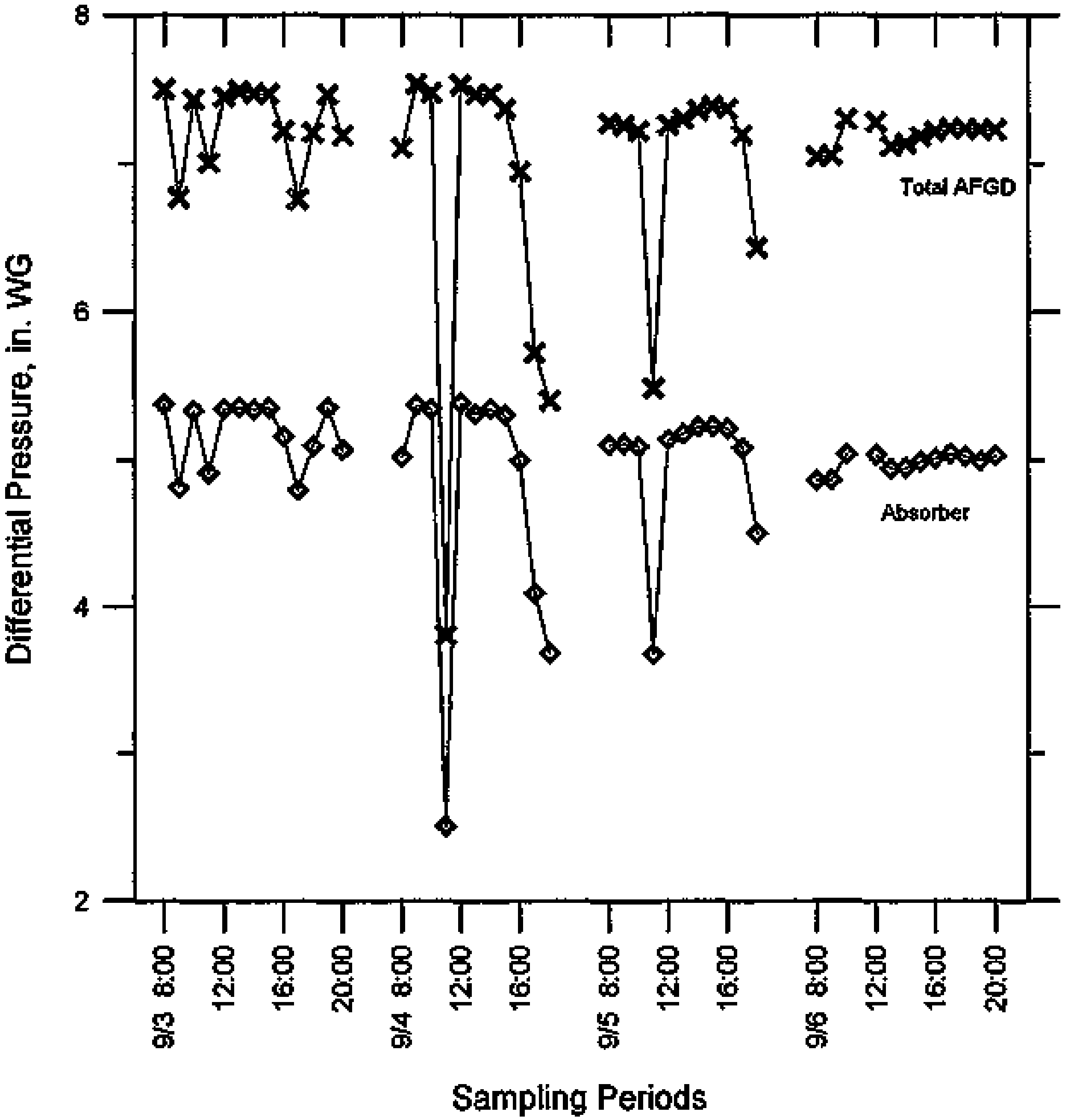


Figure 3-7. Hourly Averages of the Pressure Drops Across the AFGD Absorber and the Entire Scrubber.

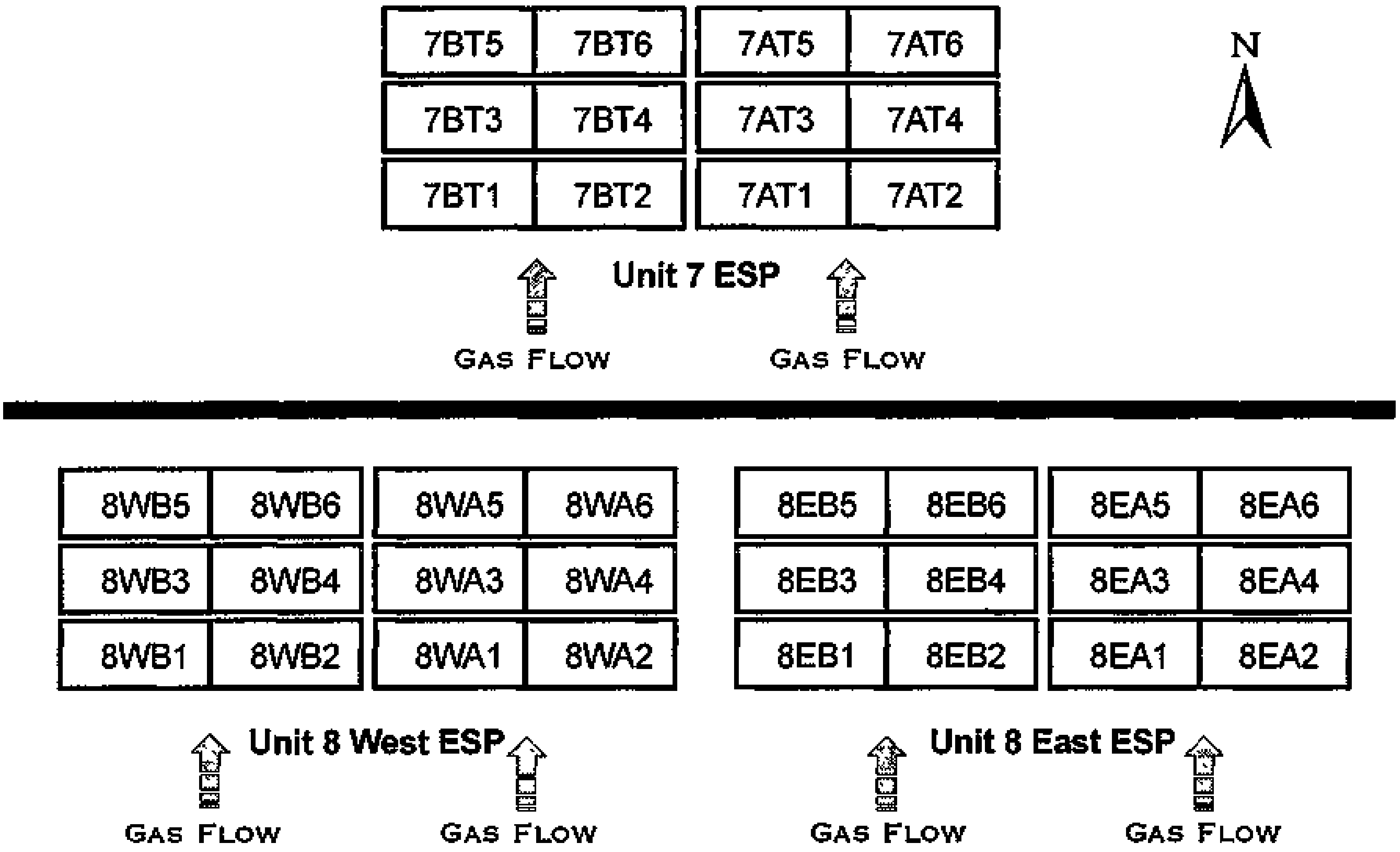
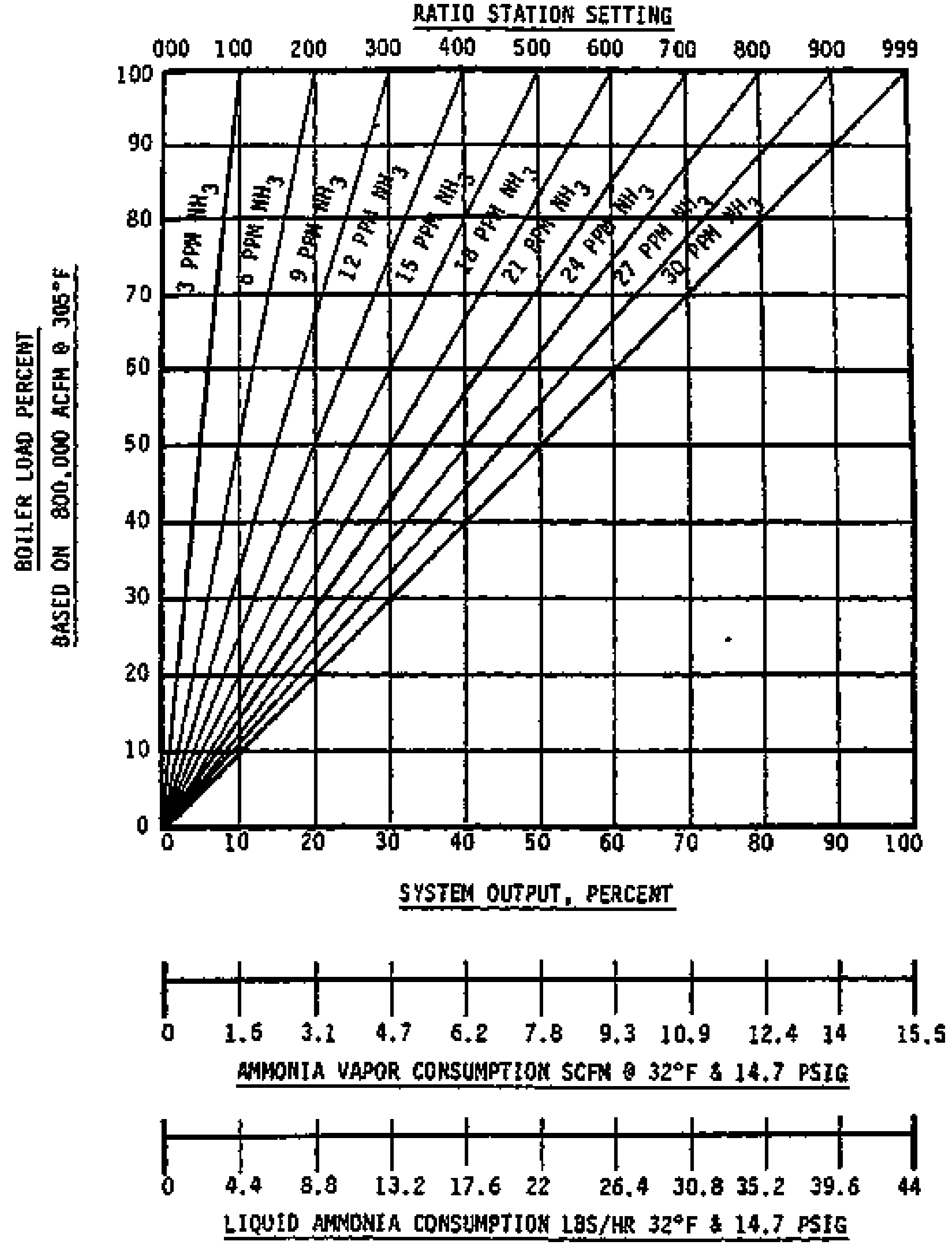


Figure 3-8. Layout of the electrical sections in the Unit 7 and 8 electrostatic precipitators.

WAHLCO AMMONIA GAS CONDITIONER

INPUT/OUTPUT CHART

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION UNIT 7



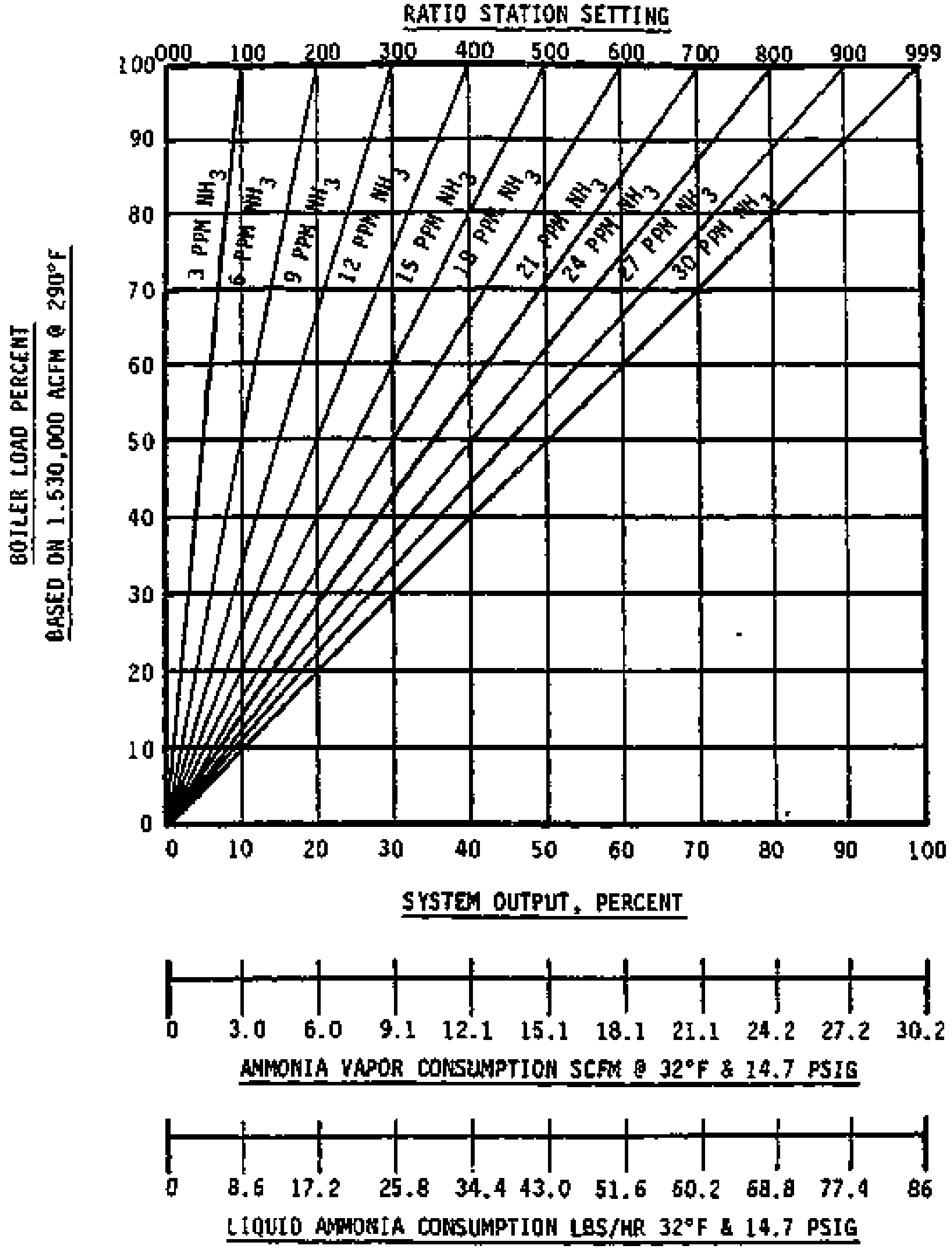
NOTE: CURVE BASED ON USE OF FISHER 1" SIZE, STYLE "EZ" CONTROL VALVE WITH 1/4" MICRO-FORM TRIM AND A .376" ORIFICE PLATE DIAMETER.

Figure 3-9. Calibration Plots for the Unit 7 Ammonia Feed System

WAHLCO AMMONIA GAS CONDITIONER

INPUT/OUTPUT CHART

NORTHERN INDIANA PUBLIC SERVICE COMPANY
BAILLY GENERATING STATION UNIT 8



NOTE: CURVE BASED ON USE OF FISHER 1" SIZE, STYLE "EZ" CONTROL VALVE WITH 3/8" MICRO-FORM TRIM AND A .515" ORIFICE PLATE DIAMETER

Figure 3-10. Calibration Plots for the Unit 8 Ammonia Feed System

Table 3-2
Unit 7 Operating Data (Sheet 1 of 8)

		Generator Gross Load	Feed H_2O Flow	Condensate Flow	Heater Drain Flow	Total Boiler Air Flow	Hi Temp O_2 Avg 7 West	Ambient Temp	West Lower Hi Temp O_2
DATE	TIME	MW	klb/hr	klb/hr	klb/hr	%	%	° F	%
3-Sep	8:00:00	165.9	1163.5	906.9	205.1	74.1	2.429	68.1	2.588
	9:00:00	149.9	1054.5	814.1	190.6	68.6	2.464	68.3	2.614
	10:00:00	176.4	1203.6	934.1	213.5	78.7	2.559	68.5	2.698
	11:00:00	175.7	1177.1	905.2	211.1	77.4	2.548	68.4	2.681
	12:00:00	175.1	1175.2	901.4	211.1	77.3	2.497	68.1	2.622
	13:00:00	173.8	1159.7	893.0	210.2	76.9	2.546	67.8	2.708
	14:00:00	174.0	1157.8	892.0	209.9	77.3	2.485	67.6	2.619
	15:00:00	174.2	1159.6	893.0	210.1	77.2	2.542	67.8	2.637
	16:00:00	174.4	1158.8	894.2	209.6	77.4	2.537	67.7	2.621
	17:00:00	174.6	1160.1	900.0	210.5	77.3	2.539	67.1	2.677
	18:00:00	173.1	1160.2	893.0	208.9	76.3	2.516	66.4	2.630
	19:00:00	173.0	1158.8	889.5	209.0	76.2	2.535	66.2	2.670
	20:00:00	174.1	1159.9	894.5	209.6	76.9	2.487	65.6	2.607
	AVG	171.9	1157.6	893.1	208.4	76.3	2.516	67.5	2.644
	SD	6.79	32.23	25.41	5.44	2.43	0.036	0.88	0.037
4-Sep	8:00:00	166.8	1115.8	853.3	203.6	76.6	2.976	77	2.642
	9:00:00	176.0	1168.7	898.0	210.8	78.2	2.818	76.9	2.678
	10:00:00	175.3	1169.3	900.9	210.9	78.3	2.965	77.5	2.744
	11:00:00	176.3	1171.4	904.9	212.0	78.4	2.756	77.6	2.787
	12:00:00	176.2	1172.4	906.7	212.4	78.4	2.753	74	2.802
	13:00:00	176.2	1171.1	905.6	211.6	77.9	2.771	74.4	2.814
	14:00:00	175.2	1171.2	903.3	211.5	77.5	2.818	73.9	2.783
	15:00:00	167.0	1120.1	868.5	204.2	73.6	2.762	73.6	2.751
	16:00:00	169.0	1129.1	867.9	205.1	76.4	2.850	73.2	2.827
	17:00:00	173.6	1158.6	892.5	209.0	77.9	2.823	72.1	2.862
	18:00:00	174.4	1159.6	901.2	210.3	78.2	2.767	70.9	2.83
	AVG	173.2	1154.1	891.2	209.2	77.3	2.825	74.6	2.774
	SD	3.54	20.82	17.88	3.16	1.45	0.079	2.18	0.064

Table 3-2
Unit 7 Operating Data (Sheet 2 of 8)

DATE	TIME	Boiler Feed Water Make-Up gal/min	Circulating H_2O Out 7 East °F	Circulating H_2O Out 7 West °F	Throttle Stm Press psig	Atemperating Flow to 7 East Superheater klb/hr	Atemperating Flow to 7 West Superheater klb/hr	Coal Flow to Cyclone 7-1 klb/hr
3-Sep	8:00:00	76.4	84.1	84.7	2147	34.04	28.03	23.26
	9:00:00	76.1	82.8	83.4	2141	18.33	25.73	16.74
	10:00:00	58.21	84.8	85.3	2161	32.75	58.45	37.06
	11:00:00	13.64	84.8	85.2	2151	24.38	54.23	38.10
	12:00:00	13.62	84.4	84.8	2150	20.50	56.16	35.95
	13:00:00	13.71	84.0	84.5	2126	25.25	66.80	38.92
	14:00:00	13.80	83.9	84.3	2121	33.13	65.70	37.44
	15:00:00	13.86	84.1	84.5	2122	32.83	62.91	37.35
	16:00:00	13.84	84.8	85.3	2121	29.01	67.40	37.40
	17:00:00	13.80	85.4	85.8	2122	24.90	69.80	37.08
	18:00:00	13.79	85.2	85.5	2122	8.38	51.94	36.72
	19:00:00	13.81	84.5	84.9	2121	6.275	50.18	36.65
	20:00:00	13.78	84.7	85.1	2121	14.38	59.17	37.02
	AVG	26.79	84.4	84.9	2132	23.40	55.04	34.21
	SD	24.15	0.64	0.59	12.83	9.02	13.39	6.45
4-Sep	8:00:00	13.16	83.1	83.8	2124	23.56	62.98	35.9
	9:00:00	13.21	83.8	84.4	2197	20.84	69.7	36.86
	10:00:00	13.2	83.5	84.2	2387	13.03	45.91	36.19
	11:00:00	12.97	83.4	84.1	2388	10.4	52.32	36.63
	12:00:00	12.67	83.2	84.0	2388	9.15	49.34	36.67
	13:00:00	12.89	83.7	84.5	2388	19.9	45.01	36.94
	14:00:00	12.98	83.7	84.4	2389	28.31	50.25	36.79
	15:00:00	13.05	84.0	84.6	2260	16.97	49.93	37.08
	16:00:00	13.13	84.1	84.8	2309	13.52	54.65	35.52
	17:00:00	13.2	84.3	84.9	2359	12.82	57.79	36.01
	18:00:00	13.26	84.6	85.2	2358	13.76	55.01	36.11
	AVG	13.08	83.8	84.4	2324	16.57	53.62	36.43
	SD	0.13	0.44	0.40	85.9	5.67	6.45	0.48

Table 3-2
Unit 7 Operating Data (Sheet 3 of 6)

DATE	TIME	Coal Flow to Cyclone 7-2 klb/hr	Coal Flow to Cyclone 7-3 klb/hr	Coal Flow to Cyclone 7-4 klb/hr	7-1 Air/Fuel Ratio	7-2 Air/Fuel Ratio	7-3 Air/Fuel Ratio	7-4 Air/Fuel Ratio	Gas to Economizer 7 East °F	Gas to Economizer 7 West °F
3-Sep	8:00:00	39.65	42.92	37.15	9.44	8.77	8.89	8.87	795.7	824.1
	9:00:00	37.29	41.21	35.42		8.8	8.87	8.92	775.8	805.2
	10:00:00	37.27	41.28	35.59	9.04	8.99	9.14	9.16	796	845
	11:00:00	36.33	40.27	34.75	9.09	9.03	9.17	9.19	796.7	834.5
	12:00:00	36.16	39.93	34.65	9.11	9.05	9.24	9.21	798.7	830.5
	13:00:00	37.05	41.02	35.45	8.82	8.8	8.95	8.98	806.1	836.2
	14:00:00	37.54	41.51	35.89	8.77	8.76	8.92	8.99	801	838.9
	15:00:00	37.56	41.6	35.94	8.81	8.75	8.91	8.9	800.6	839.8
	16:00:00	37.65	41.68	35.95	8.82	8.76	8.9	8.94	800.3	841.2
	17:00:00	37.31	41.39	35.66	8.85	8.8	8.95	8.98	803.8	843.2
	18:00:00	36.97	41.05	35.34	8.83	8.77	8.91	8.94	796.9	836.2
	19:00:00	36.96	41.07	35.33	8.84	8.79	8.91	8.96	797.5	834.1
	20:00:00	37.31	41.36	35.62	8.83	8.78	8.93	8.97	798.8	830.5
	AVG	37.31	41.25	35.60	8.94	8.83	8.98	9.00	797.5	833.7
	SD	0.77	0.68	0.58	0.19	0.105	0.117	0.109	6.93	9.89
4-Sep	8:00:00	36.2	38.72	34.50	9.01	8.96	9.11	9.12	804.9	827.8
	9:00:00	37.28	40.1	36.16	9.02	8.92	9.10	9.08	813.8	841.1
	10:00:00	36.56	40.94	37.29	9.04	8.97	9.02	9.01	802.5	832.4
	11:00:00	36.93	41.16	37.25	8.98	8.90	9.02	8.96	801.7	837.2
	12:00:00	36.96	41.35	37.23	8.99	8.92	9.00	9.02	797.2	831.3
	13:00:00	37.23	41.88	37.54	8.88	8.82	8.85	8.90	797.3	829.4
	14:00:00	37.08	41.82	37.40	8.85	8.82	8.82	8.87	806.0	822.8
	15:00:00	37.68	30.49	37.51	8.84	8.76	10.79	8.75	788.7	821.0
	16:00:00	35.87	40.69	36.14	9.13	9.05	8.99	8.77	794.0	827.4
	17:00:00	36.32	41.18	36.66	9.11	9.06	9.01	8.92	803.4	836.1
	18:00:00	36.38	41.22	36.71	9.12	9.07	9.04	8.98	803.8	835.2
	AVG	36.77	39.96	36.76	9.00	8.93	9.16	8.94	801.2	831.1
	SD	0.52	3.11	0.86	0.10	0.09	0.52	0.11	6.38	5.87

Table 3-2
Unit 7 Operating Data (Sheet 4 of 8)

		Exit Gas Temp 7 East	Exit Gas Temp 7 West	East Air Heater Gas Side ΔP	West Air Heater Gas Side ΔP
DATE	TIME	° F	° F	in wc	in wc
3-Sep	8:00:00	284.8	294.5	4.922	7.087
	9:00:00	273.3	286.6	4.344	6.26
	10:00:00	292.3	293.2	5.471	7.88
	11:00:00	296.3	297.9	5.32	7.676
	12:00:00	298.3	299.4	5.274	7.61
	13:00:00	295	298.3	5.339	7.687
	14:00:00	293.3	294.3	5.33	7.664
	15:00:00	294.4	296.3	5.333	7.698
	16:00:00	294.2	295.3	5.329	7.68
	17:00:00	293.6	295.1	5.305	7.646
	18:00:00	290.6	293.5	5.213	7.515
	19:00:00	292.1	294.5	5.224	7.509
	20:00:00	292.1	293.2	5.315	7.648
	AVG	291.6	294.6	5.208	7.505
	SD	6.10	2.90	0.277	0.399
4-Sep	8:00:00	301.5	296.5	5.168	7.437
	9:00:00	294.8	293.2	5.461	7.864
	10:00:00	292.5	292.2	5.621	7.925
	11:00:00	294.4	292.8	5.512	7.916
	12:00:00	295.4	292.2	5.560	8.000
	13:00:00	293.5	291.2	5.501	7.914
	14:00:00	293.8	291.3	5.408	7.790
	15:00:00	288.6	293.4	4.986	7.185
	16:00:00	290.7	288.8	5.243	7.555
	17:00:00	293.9	291.7	5.436	7.827
	18:00:00	293.7	292.2	5.456	7.854
	AVG	293.9	292.5	5.386	7.752
	SD	3.03	2.24	0.170	0.240

Table 3-2
Unit 7 Operating Data (Sheet 5 of 8)

		Generator Gross Load	Feed H_2O Flow	Condensate Flow	Heater Drain Flow	Total Boiler Air Flow	Hi Temp O_2 Avg 7 West	Ambient Temp	West Lower Hi Temp O_2
DATE	TIME	MW	klb/hr	klb/hr	klb/hr	%	%	°F	%
5-Sep	8:00:00	173.8	1171.1	898.2	210.3	77.7	3.326	81.7	4.213
	9:00:00	173.9	1176.5	904.0	209.9	77.6	3.185	84.5	3.930
	10:00:00	167.4	1131.0	873.6	204.6	74.4	3.367	84.0	4.434
	11:00:00	176.0	1190.9	909.2	212.3	77.9	2.967	76.3	3.853
	12:00:00	176.8	1197.6	913.8	214.1	77.9	2.835	70.6	3.674
	13:00:00	177.1	1198.0	915.6	214.3	78.4	3.136	70.3	3.992
	14:00:00	177.6	1200.3	923.2	214.3	78.0	2.730	70.0	3.339
	15:00:00	177.5	1188.4	914.3	212.8	78.9	2.591	68.8	2.718
	16:00:00	176.0	1178.5	909.4	211.8	78.2	2.595	67.9	2.736
	17:00:00	152.0	1024.9	793.1	190.0	67.0	2.600	67.1	2.645
	18:00:00	122.2	826.9	642.2	162.3	55.52	2.592	65.3	2.598
	AVG	168.2	1134.8	872.4	205.2	74.68	2.902	73.3	3.466
	SD	16.2	108.7	80.7	15.1	6.87	0.293	6.73	0.655
6-Sep	8:00:00	174.3	1169.5	881.7	208.1	78.6	2.982	60.59	3.088
	9:00:00	173.9	1175.4	898.1	210.3	78.7	2.872	60.29	2.997
	10:00:00	167.6	1141.4	873.6	205.8	76.5	3.021	59.58	3.117
	11:00:00	175	1162.8	906.9	212	79.3	2.977	59.84	3.112
	12:00:00	174.9	1181.3	900.3	211.2	78.9	2.862	60.71	2.993
	13:00:00	177.9	1183.6	913.6	213.6	80	2.868	62.68	3.015
	14:00:00	170	1124.5	878.8	207.2	76.2	2.923	63.36	3.028
	15:00:00	174.9	1186.7	913.9	212.2	77.4	2.646	63.61	2.744
	16:00:00	175.1	1193.1	912.7	212.1	78	2.695	64.2	2.772
	17:00:00	176	1191.5	911.5	212.7	78.7	2.688	65.5	2.81
	18:00:00	176.4	1194.2	913.8	213	79	2.692	64.1	2.796
	19:00:00	177.9	1198.6	917.3	214.1	80.1	2.689	63.09	2.785
	20:00:00	178.9	1198.2	923.3	214.5	80.1	2.689	62.67	2.751
	AVG	174.9	1179.4	905.3	211.6	78.6	2.804	62.48	2.910
	SD	3.11	22.11	14.6	2.54	1.26	0.128	1.85	0.140

Table 3-2
Unit 7 Operating Data (Sheet 6 of 6)

		Boiler Feed Water Make-Up	Circulating H_2O Out 7 East	Circulating H_2O Out 7 West	Throttle Stm Press	Atemperating Flow to 7 East Superheater	Atemperating Flow to 7 West Superheater	Coal Flow to Cyclone 7-1
DATE	TIME	gal/min	° F	° F	psig	klb/hr	klb/hr	klb/hr
5-Sep	8:00:00	13.60	84.3	85.0	2376	7.743	22.65	36.65
	9:00:00	13.56	84.3	85.0	2382	6.612	60.56	36.63
	10:00:00	13.53	83.6	84.8	2389	9.13	38.31	37.87
	11:00:00	13.18	80.9	83.6	2390	16.8	25.96	35.87
	12:00:00	13.37	81.1	82.4	2390	21.38	34.26	36.34
	13:00:00	13.33	82.7	84.7	2389	16.55	34.26	37.24
	14:00:00	13.00	80.3	81.1	2393	23.8	28.02	37.04
	15:00:00	13.05	80.4	81.0	2394	24.63	42.49	36.36
	16:00:00	13.13	80.1	80.8	2378	19.06	46.65	35.95
	17:00:00	13.19	79.2	79.8	2081	5.609	43.99	30.71
	18:00:00	13.31	77.0	77.6	1691.1	2.983	35.2	5.79
	AVG	13.30	81.3	82.3	2295.6	14.382	38.40	33.33
	SD	0.196	2.17	2.37	210.3	7.64	6.42	8.69
6-Sep	8:00:00	20	83.2	78.1	2430	11.21	43.45	38.33
	9:00:00	16.07		83.7	2424	3.436	34.34	36.6
	10:00:00	15.99	82.9	83.6	2306	5.84	26.73	40.68
	11:00:00	15.98	83.2	83.8	2401	3.398	27.8	38.96
	12:00:00	15.93	*103.7*	83.9	2397	3.422	30.91	36.86
	13:00:00	16.03	83	83.8	2404	3.425	35.55	38.46
	14:00:00	16.02	82.7	83.5	2307	5.111	29.35	37.6
	15:00:00	15.99	83.1	83.8	2395	3.141	29.77	37.5
	16:00:00	16	83.1	83.9	2382	3.169	42.39	37.96
	17:00:00	15.99	82.8	83.6	2383	3.182	46.19	38.16
	18:00:00	15.98	82.8	83.5	2382	3.193	44.98	37.95
	19:00:00	15.94	83	83.9	2381	3.193	46.05	38.86
	20:00:00	15.94	83.4	84.2	2383	3.178	46.18	39.31
	AVG	15.99	83.0	83.8	2379	3.642	36.77	38.09
	SD	0.038	0.200	0.214	34.50	0.840	7.92	1.10

Table 3-2
Unit 7 Operating Data (Sheet 7 of 8)

		Coal Flow to Cyclone 7-2	Coal Flow to Cyclone 7-3	Coal Flow to Cyclone 7-4	7-1 Air/Fuel	7-2 Air/Fuel	7-3 Air/Fuel	7-4 Air/Fuel	Gas to Economizer 7 East	Gas to Economizer 7 West
DATE	TIME	klb/hr	klb/hr	klb/hr	Ratio	Ratio	Ratio	Ratio	°F	°F
5-Sep	8:00:00	37.07	40.58	36.32	8.90	9.01	8.85	9.04	814.4	835.3
	9:00:00	36.95	41.02	36.33	8.91	9.00	8.89	9	809.3	832.6
	10:00:00	38.16	30.06	37.68	8.69	8.73	9.63	8.68	788.4	822.3
	11:00:00	38.39	42.43	36.13	8.91	8.99	9.10	9	807.7	828.4
	12:00:00	38.63	43.09	36.62	8.84	8.91	8.93	8.65	812.8	832.6
	13:00:00	37.5	43.4	37.18	8.73	8.8	8.69	8.79	817.4	830.4
	14:00:00	37.37	43.84	37.22	8.7	8.77	8.86	8.77	820.6	825.9
	15:00:00	38.66	42.14	37.68	9.00	9.11	8.96	8.88	820.5	831.8
	16:00:00	36.26	41.67	37.34	9.00	9.13	8.97	8.88	820.8	833.6
	17:00:00	31	35.91	32.15	8.94	9.08	8.76	8.75	789.9	810.2
	18:00:00	35.29	33.15	33.5	16.63	8.58	8.61	8.48	755.5	785.2
	AVG	36.30	39.76	36.20	9.59	8.92	8.95	8.83	805.2	824.4
	SD	1.82	4.39	1.69	2.29	0.17	0.25	0.15	19.11	14.11
6-Sep	8:00:00	38.98	39.98	36.01	0	0	0	0	836.2	856.8
	9:00:00	39.27	39.27	36.15	8.86	8.94	8.84	8.84	816.3	846.4
	10:00:00	42.37	42.37	37.8	8.86	8.67	14.06	14.06	808	832.6
	11:00:00	39.6	39.6	35.55	8.92	8.98	9.15	9.15	817	845.7
	12:00:00	39.48	39.48	35.58	8.91	9	8.89	8.89	814.4	846.1
	13:00:00	40.86	40.86	35.73	8.92	8.95	9.18	9.18	812.4	839.6
	14:00:00	38.36	38.36	35.71	8.82	8.91	9.87	9.87	793.2	819.6
	15:00:00	37.47	37.47	36.62	8.93	8.99	8.88	8.88	791.7	813.2
	16:00:00	37.91	37.91	35.8	8.97	9	9.03	9.03	789	815.4
	17:00:00	38.02	38.02	35.86	9	9.03	9.13	9.13	795.6	819
	18:00:00	37.8	37.8	35.84	9.05	9.09	9.19	9.19	795.8	819.6
	19:00:00	38.74	38.74	35.92	9.04	9.09	9.26	9.26	795.7	819.8
	20:00:00	39.32	39.32	35.98	8.99	9.01	9.21	9.21	797.5	821.6
	AVG	39.10	38.80	36.05	8.94	9.00	9.57	9.57	802.2	828.2
	SD	1.35	0.96	0.62	0.07	0.05	1.36	1.36	10.08	12.41

Table 3-2
Unit 7 Operating Data (Sheet 8 of 8)

DATE	TIME	Exit Gas Temp 7 East °F	Exit Gas Temp 7 West °F	East Air Heater Gas Side ΔP in wc	West Air Heater Gas Side ΔP in wc
5-Sep	8:00:00	297	296.5	5.427	7.756
	9:00:00	298.9	296.6	5.47	7.846
	10:00:00	287.5	301.2	5.094	7.31
	11:00:00	297.4	294.8	5.428	7.808
	12:00:00	298.2	297.9	5.415	7.8
	13:00:00	297.7	298.5	5.525	7.955
	14:00:00	298.1	298.3	5.449	7.827
	15:00:00	299.6	299.1	5.544	7.95
	16:00:00	298.7	298.1	5.455	7.84
	17:00:00	280.7	299.3	4.271	6.142
	18:00:00	265.1	303.2	3.103	4.446
	AVG	294.5	298.6	5.107	7.3
	SD	8.41	2.20	0.723	1
6-Sep	8:00:00	314.2	311.8	5.589	7.864
	9:00:00	308.9	307.8	5.583	7.981
	10:00:00	297	305.3	5.349	7.662
	11:00:00	298.7	301	5.6559	8.09
	12:00:00	299.6	301.9	5.597	7.984
	13:00:00	301.4	300.8	5.766	8.23
	14:00:00	291.8	298.5	5.324	7.56
	15:00:00	295.3	296.7	5.498	7.866
	16:00:00	297.1	297.4	5.507	7.865
	17:00:00	298.6	297.8	5.548	7.941
	18:00:00	299.2	297.7	5.591	7.982
	19:00:00	299.1	297.3	5.756	8.23
	20:00:00	298.3	297	5.715	8.16
	AVG	298.8	299.9	5.574	7.963
	SD	3.84	3.42	0.136	0.195

Table 3-3
Unit 8 Operating Data (Sheet 1 of 8)

		Generator Gross Power	Uncorrected Gross Turbine	Total Feed H_2O Flow	Condensate Flow	Heater Drain Pump Flow	Economizer Outlet Temp	Cold Reheat Atemperating H_2O Flow
DATE	TIME	MW	Btu/kWh	klb/hr	klb/hr	klb/hr	° F	klb/hr
3-Sep	8:00:00	339.3	9483.0	2449	2245	311	614	96.1
	9:00:00	339.7	9758.2	2514	2277	302	618	89.5
	10:00:00	340.5	9580.3	2472	2215	308	605	62.6
	11:00:00	338.3	8686.7	2375	2045	320	617	80
	12:00:00	343.0	8684.7	2412	2062	334	615	76.3
	13:00:00	343.6	8720.4	2420	2064	334	614	69.6
	14:00:00	343.6	8792.9	2424	2065	335	614	66
	15:00:00	343.6	8812.0	2419	2060	329	615	69.2
	16:00:00	319.0	8767.4	2237	1904	263	614	75.4
	17:00:00	327.2	8698.0	2321	1992	294	611	67.2
	18:00:00	340.8	8676.4	2420	2067	329	610	50.8
	19:00:00	340.9	8680.6	2415	2063	327	611	51.4
	20:00:00	341.0	8675.3	2413	2064	325	611	57.4
	AVG	338.4	8924.2	2407	2083	316	613	69.3
	SD	6.98	380.1	65.4	97.2	19.9	3.26	13.4
4-Sep	8:00:00	344.2	8687.0	24.31	2065	328	609	58
	9:00:00	344.2	8687.0	24.21	2084	325	610	69.1
	10:00:00	343.9	8687.0	24.21	2065	329	611	68.7
	11:00:00	343.8	8687.0	24.22	2075	336	611	60.9
	12:00:00	343.5	8687.0	24.26	2077	333	610	55.1
	13:00:00	344.0	8687.0	24.19	2079	335	612	67.2
	14:00:00	343.7	8687.0	24.14	2083	330	613	73.5
	15:00:00	343.9	8687.0	2416	2080	330	613	68.7
	16:00:00	308.1	8687.0	2171	1661	255	613	54.4
	17:00:00	258.1	8687.0	1835	1641	124	606	27.2
	18:00:00	280.9	8687.0	1996	1670	174	598	29.8
	AVG	327.1	8687.0	780.9	1975	291	609.6	57.5
	SD	29.41	0.0	1009.3	186.9	71.1	4.18	14.9

Table 3-3
Unit 8 Operating Data (Sheet 2 of 8)

DATE	TIME	Boiler Feed Water Flow from Boiler Feed Pump 8W klb/hr	Boiler Feed Water Flow from Boiler Feed Pump 8E klb/hr	Total Air Flow klb/hr	8 West Flue Gas O_2 %	8 East Flue Gas O_2 %	Ambient Temp ° F	Air Heater Air Inlet Temp ° F	Air Heater Air Outlet Temp ° F
3-Sep	8:00:00	1211	1212	2951	2.6	2.45	71	127	531
	9:00:00	1243	1244	2985	2.64	2.45	71	124.3	535
	10:00:00	1222	1224	2968	2.62	2.45	71	123.4	531
	11:00:00	1173	1174	2922	2.72	2.47	70	124.6	536
	12:00:00	1192	1194	2962	2.70	2.45	70	122	538
	13:00:00	1197	1197	2971	2.74	2.46	70	120.4	538
	14:00:00	1198	1200	2976	2.74	2.47	70	120.2	537
	15:00:00	1196	1198	2968	2.72	2.46	71	120.7	537
	16:00:00	1103	1105	2766	2.84	2.58	72	122.7	535
	17:00:00	1145	1146	2823	2.67	2.44	72	131.1	532
	18:00:00	1197	1198	2924	2.73	2.45	69	126.5	533
	19:00:00	1194	1195	2914	2.66	2.47	69	125.2	533
	20:00:00	1192	1194	2899	2.62	2.44	68	124.9	533
	AVG	1189	1191	2924	2.69	2.46	70.3	124.1	535
	SD	33.3	33.2	61.0	0.064	0.035	1.14	2.94	2.44
4-Sep	8:00:00	1202	1204	2930	2.66	2.45	67	127.2	532
	9:00:00	1197	1198	2934	2.68	2.46	69	126.8	531
	10:00:00	1197	1198	2943	2.67	2.46	70	126.7	532
	11:00:00	1198	1199	2931	2.67	2.45	71	127.5	533
	12:00:00	1200	2101	2936	2.72	2.46	73	126.6	533
	13:00:00	1196	1197	2944	2.6	2.44	74	126.8	533
	14:00:00	1193	1194	2958	2.59	2.45	75	126.8	533
	15:00:00	1194	1195	2957	2.7	2.44	76	126.6	533
	16:00:00	1070	1070	2692	2.83	2.61	76	127.2	531
	17:00:00	899	899	2.87	2.87	2.75	75	147.7	522
	18:00:00	961	982	2.9	2.9	2.55	73	156.4	520
	AVG	1139	1222	2385	2.72	2.52	72.6	131.4	530
	SD	102.0	295.7	1125.0	0.099	0.127	2.67	9.65	4.45

Table 3-3
Unit 8 Operating Data (Sheet 3 of 8)

		Flue Gas Temp to Economizer	Air Heater Gas Inlet Temp	Total Average Air Heater Gas Outlet Temp	Air Heater Gas Outlet Temp	West ESP Outlet Average Temp	East ESP Outlet Average Temp	8 West Air Heater Hot ΔP
DATE	TIME	° F	° F	° F	° F	° F	° F	in wc
3-Sep	8:00:00	948	662	310.9	300.6	334	289	4.78
	9:00:00	951	670	312.1	301.4	335	290	4.83
	10:00:00	947	662	309.4	299.2	333	288	4.8
	11:00:00	950	669	311.7	301.5	335	290	4.77
	12:00:00	953	671	312	301.3	336	290	4.83
	13:00:00	956	671	311.4	300.6	336	289	4.84
	14:00:00	953	672	310.6	300.3	336	288	4.85
	15:00:00	951	671	310.5	300.5	335	288	4.83
	16:00:00	936	660	308.6	297.6	334	287	4.37
	17:00:00	934	657	311	300.1	335	288	4.51
	18:00:00	941	663	312	301	336	290	4.73
	19:00:00	942	665	311.2	300.4	335	289	4.73
	20:00:00	941	667	310.8	300.2	335	288	4.7
	AVG	946	666	310.9	300.4	335	289	4.74
	SD	6.56	4.77	0.988	0.995	0.828	0.873	0.137
4-Sep	8:00:00	930	663	311.7	300	335	290	4.76
	9:00:00	932	661	311	300.4	334	290	4.76
	10:00:00	937	662	311.3	301.4	334	289	4.77
	11:00:00	936	663	312.5	300.9	336	290	4.77
	12:00:00	937	664	312.1	300.9	336	290	4.79
	13:00:00	941	664	312.1	300.9	335	290	4.78
	14:00:00	941	664	312.1	300.8	335	290	4.81
	15:00:00	943	665	312	300.7	336	290	4.81
	16:00:00	926	657	306.8	296.6	334	288	4.18
	17:00:00	898	637	306.5	294.7	330	285	3.23
	18:00:00	904	634	314.7	302.7	335	293	3.48
	AVG	930	658	311.3	300.0	335	290	4.47
	SD	14.34	10.65	2.021	2.187	1.616	1.627	0.554

Table 3-3
Unit 6 Operating Data (Sheet 4 of 8)

		6 West Air Heater Cold ΔP	O_2 Probe 1 East	O_2 Probe 2 East	O_2 Probe 1 West	O_2 Probe 2 West	Condenser Make Up Flow	Total Coal Flow
DATE	TIME	in wc	%	%	%	%	gal/min	klb/hr
3-Sep	8:00:00	5.63	2.48	2.41	2.63	2.67	82.4	308.8
	9:00:00	5.67	2.49	2.39	2.56	2.7	47	309.6
	10:00:00	5.64	2.49	2.39	2.58	2.66	91.6	310.8
	11:00:00	5.78	2.48	2.43	2.65	2.77	43.2	306.7
	12:00:00	5.67	2.46	2.41	2.63	2.75	65.9	310.3
	13:00:00	5.89	2.48	2.42	2.68	2.79	72	311.6
	14:00:00	5.9	2.52	2.39	2.68	2.79	68.8	314.2
	15:00:00	5.89	2.5	2.4	2.65	2.77	64.9	314.6
	16:00:00	5.21	2.63	2.51	2.76	2.9	51.5	290.6
	17:00:00	5.46	2.46	2.4	2.6	2.7	69	300.0
	18:00:00	5.8	2.49	2.39	2.65	2.79	70.3	311.7
	19:00:00	5.78	2.48	2.42	2.58	2.72	61.5	311.9
	20:00:00	5.74	2.49	2.35	2.54	2.68	68.5	309.4
	AVG	5.76	2.50	2.41	2.62	2.75	65.9	308.5
	SD	0.199	0.041	0.035	0.064	0.064	12.76	6.25
4-Sep	8:00:00	5.88	2.48	2.4	2.61	2.73	67.5	311.8
	9:00:00	5.87	2.48	2.42	2.6	2.74	60.8	312.4
	10:00:00	5.89	2.5	2.41	2.6	2.73	66.8	314.3
	11:00:00	5.9	2.49	2.38	2.6	2.73	67.3	314.1
	12:00:00	5.91	2.52	2.39	2.64	2.78	69.1	315.1
	13:00:00	5.92	2.47	2.39	2.55	2.64	67	315.2
	14:00:00	5.96	2.48	2.39	2.64	2.74	71.8	315.6
	15:00:00	5.98	2.47	2.39	2.63	2.73	68.3	314.3
	16:00:00	5.01	2.83	2.76	2.75	2.89	51.4	265.1
	17:00:00	3.7	2.8	2.68	2.79	2.93	51.2	243.4
	18:00:00	4.2	2.53	2.54	2.83	2.95	69.7	260.5
	AVG	5.47	2.55	2.47	2.66	2.78	64.6	300.2
	SD	0.770	0.126	0.127	0.086	0.094	6.78	24.47

Table 3-3
Unit 8 Operating Data (Sheet 5 of 8)

DATE	TIME	Generator Gross Power MW	Uncorrected Gross Turbine Btu/kWh	Total Feed H_2O Flow klb/hr	Condensate Flow klb/hr	Heater Drain Pump Flow klb/hr	Economizer Outlet Temp ° F	Cold Reheat Atemperating H_2O Flow klb/hr
5-Sep	8:00:00	342.3	8687.0	2417	2068	330	611	58.4
	9:00:00	343.2	8687.0	2430	2072	332	610	50.6
	10:00:00	344.5	8687.0	2029	2084	335	611	67.5
	11:00:00	342.9	8687.0	2014	2073	332	613	76.3
	12:00:00	342.7	8687.0	2025	2064	330	613	54.7
	13:00:00	344.7	8687.0	2039	2080	333	612	51.2
	14:00:00	345.2	8687.0	2035	2091	336	613	67
	15:00:00	344.9	8687.0	2437	2084	335	613	54.7
	16:00:00	345.1	8687.0	2439	2085	333	613	52.6
	17:00:00	345.3	8687.0	2435	2083	335	614	64.8
	18:00:00	339.4	8687.0	2385	2053	327	615	71.8
	AVG	343.7	8687.0	2244.1	2077	333	612.5	60.7
	SD	1.71	0.0	197.5	11.6	2.6	1.37	8.6
6-Sep	8:00:00	345.4	8687.0	2430	2092	338	613	67.9
	9:00:00	345.3	8687.0	2419	2092	339	615	77.6
	10:00:00	345.1	8687.0	2416	2091	337	616	81.2
	11:00:00	345.1	8687.0	2413	2091	338	616	82.1
	12:00:00	345.0	8687.0	2412	2088	336	617	80.7
	13:00:00	345.1	8687.0	2412	2089	339	616	80.4
	14:00:00	345.1	8687.0	2407	2089	338	617	85.6
	15:00:00	345.1	8687.0	2407	2090	339	618	87.7
	16:00:00	345.3	8687.0	2404	2086	338	618	86.9
	17:00:00	344.9	8687.0	2414	2075	334	616	66.0
	18:00:00	345.0	8687.0	2429	2082	337	614	56.6
	19:00:00	345.2	8687.0	2430	2087	336	612	61.7
	20:00:00	344.9	8687.0	2437	2082	334	612	48.1
	AVG	345.1	8687.0	2417.7	2087	337	615.4	74.0
	SD	0.15	0.0	10.1	4.8	1.7	1.88	12.2

Table 3-3
Unit 8 Operating Data (Sheet 6 of 8)

DATE	TIME	Boiler Feed Water Flow from Boiler Feed Pump 8W klb/hr	Boiler Feed Water Flow from Boiler Feed Pump 8E klb/hr	Total Air Flow klb/hr	8 West Flue Gas O_2 %	8 East Flue Gas O_2 %	Ambient Temp °F	Air Heater Air Inlet Temp °F	Air Heater Air Outlet Temp °F
5-Sep	8:00:00	1195	1196	2922	2.69	2.47	72	127	532
	9:00:00	1201	1203	2939	2.64	2.47	72	125.6	532
	10:00:00	1199	1200	2960	2.56	2.44	72	124.9	532
	11:00:00	1188	1189	2943	2.65	2.46	72	125.7	531
	12:00:00	1194	1196	2931	2.64	2.46	72	125.2	532
	13:00:00	1204	1205	2944	2.64	2.43	71	125.2	532
	14:00:00	1201	1203	2963	2.75	2.45	71	125.5	531
	15:00:00	1204	1206	2960	2.73	2.46	70	124.8	532
	16:00:00	1206	1207	2948	2.77	2.44	70	124.6	533
	17:00:00	1204	1205	2963	2.77	2.45	69	124.1	534
	18:00:00	1157	1202	2904	2.65	2.46	68	123.2	535
	AVG	1196	1201	2943	2.68	2.45	70.8	125.1	532
	SD	13.3	5.2	17.9	0.064	0.012	1.34	0.92	1.15
6-Sep	8:00:00	1202	1203	2957	2.55	2.45	63	123.4	534
	9:00:00	1197	1198	2960	2.66	2.45	62	121.1	535
	10:00:00	1195	1196	2966	2.72	2.46	61	120.4	536
	11:00:00	1194	1195	2973	2.73	2.45	63	120.2	537
	12:00:00	1193	1194	2976	2.82	2.47	66	120.2	539
	13:00:00	1193	1195	2967	2.77	2.48	66	119.3	538
	14:00:00	1190	1192	2948	2.69	2.45	66	118.3	539
	15:00:00	1191	1192	2952	2.69	2.46	66	117.5	540
	16:00:00	1189	1190	2951	2.70	2.47	67	117.0	540
	17:00:00	1194	1195	2925	2.65	2.45	68	116.7	538
	18:00:00	1202	1203	2941	2.67	2.46	66	118.9	536
	19:00:00	1202	1203	2937	2.65	2.44	66	119.7	536
	20:00:00	1206	1207	2952	2.77	2.49	66	119.9	535
	AVG	1198	1197	2954	2.71	2.46	65.1	119.4	537
	SD	5.2	5.0	14.0	0.052	0.012	2.02	1.76	1.66

Table 3-3
Unit 8 Operating Data (Sheet 7 of 8)

		Flue Gas Temp to Economizer	Air Heater Gas Inlet Temp	Total Average Air Heater Gas Outlet Temp	Air Heater Gas Outlet Temp	West ESP Outlet Average Temp	East ESP Outlet Average Temp	8 West Air Heater Hot ΔP
DATE	TIME	°F	°F	°F	°F	°F	°F	in wc
5-Sep	8:00:00	936	664	312.5	301.3	337	292	4.76
	9:00:00	938	665	311.4	300.5	336	289	4.79
	10:00:00	936	666	311	300.4	336	289	4.82
	11:00:00	938	664	310.3	299.9	335	288	4.76
	12:00:00	939	665	311	300.4	336	289	4.77
	13:00:00	939	665	310.8	300.1	336	289	4.76
	14:00:00	939	665	311	300.3	336	289	4.83
	15:00:00	942	666	311.6	300.6	337	289	4.83
	16:00:00	943	667	311.3	300.3	337	288	4.8
	17:00:00	946	669	311.4	300.6	337	288	4.82
	18:00:00	948	668	310.5	299.7	336	287	4.69
	AVG	941	666	311.2	300.4	336	289	4.79
	SD	4.05	1.59	0.565	0.398	0.617	1.192	0.038
6-Sep	8:00:00	947	670	311.3	300.5	334	293	4.83
	9:00:00	949	670	310.6	300.3	334	292	4.86
	10:00:00	952	671	310.7	300.5	335	292	4.87
	11:00:00	953	672	311.0	300.9	335	292	4.88
	12:00:00	954	673	311.7	301.3	336	293	4.89
	13:00:00	954	674	311.3	301.0	336	293	4.89
	14:00:00	957	674	311.0	300.8	336	292	4.86
	15:00:00	958	676	311.1	300.8	336	292	4.87
	16:00:00	955	676	311.2	300.9	336	292	4.88
	17:00:00	952	674	309.8	299.1	336	292	4.79
	18:00:00	953	674	309.5	299.2	335	291	4.79
	19:00:00	948	673	310.5	300.2	335	292	4.80
	20:00:00	946	672	310.3	300.2	335	292	4.83
	AVG	952	673	310.8	300.4	335	292	4.85
	SD	3.57	2.16	0.602	0.633	0.722	0.533	0.036

Table 3-3
Unit 8 Operating Data (Sheet 8 of 8)

		8 West Air Heater Cold ΔP	O_2 Probe 1 East	O_2 Probe 2 East	O_2 Probe 1 West	O_2 Probe 2 West	Condenser Make Up Flow	Total Coal Flow
DATE	TIME	in wc	%	%	%	%	gal/min	klb/hr
5-Sep	8:00:00	5.97	2.48	2.44	2.63	2.74	64.8	310.0
	9:00:00	5.99	2.51	2.41	2.58	2.69	68.2	311.8
	10:00:00	6.03	2.46	2.38	2.5	2.6	65.7	313.2
	11:00:00	5.97	2.52	2.38	2.58	2.69	54.2	311.4
	12:00:00	5.98	2.53	2.38	2.58	2.69	59.8	311.6
	13:00:00	5.98	2.49	2.35	2.58	2.69	70.9	311.7
	14:00:00	6.05	2.49	2.38	2.68	2.8	68.2	311.2
	15:00:00	6.06	2.53	2.38	2.68	2.77	62.6	312.5
	16:00:00	6	2.49	2.37	2.7	2.82	69	310.1
	17:00:00	6.04	2.49	2.39	2.7	2.83	68.7	310.8
	18:00:00	5.83	2.49	2.42	2.59	2.7	63.4	305.1
	AVG	5.99	2.50	2.39	2.62	2.73	65.0	310.9
	SD	0.060	0.018	0.024	0.062	0.067	4.65	2.03
6-Sep	8:00:00	6.08	2.51	2.37	2.58	2.71	66.5	314.0
	9:00:00	6.11	2.48	2.40	2.59	2.71	59.9	314.0
	10:00:00	6.11	2.46	2.41	2.65	2.77	66.5	314.6
	11:00:00	6.12	2.49	2.38	2.66	2.79	65.1	315.2
	12:00:00	6.14	2.50	2.41	2.76	2.86	65.8	315.9
	13:00:00	6.13	2.52	2.42	2.69	2.82	66.8	317.2
	14:00:00	6.09	2.47	2.41	2.61	2.75	66.3	317.1
	15:00:00	6.11	2.47	2.41	2.63	2.74	66.9	317.8
	16:00:00	6.13	2.54	2.38	2.63	2.75	64.9	318.3
	17:00:00	6.02	2.47	2.41	2.57	2.72	66.5	317.1
	18:00:00	6.04	2.50	2.39	2.58	2.74	68.4	317.8
	19:00:00	6.08	2.47	2.39	2.57	2.72	67.5	317.9
	20:00:00	6.10	2.51	2.42	2.69	2.83	60.2	319.2
	AVG	6.10	2.49	2.40	2.63	2.76	65.5	316.6
	SD	0.035	0.022	0.016	0.055	0.047	2.48	1.64

Tab. [illegible]-4
AFGD Operating Data (Sheet 1 of 12)

		Unit #7 Air Flow	Unit #8 Air Flow	Unit #7 Load	Unit #8 Load	Unit #7 Opacity	Unit #8 Opacity	#7 Duct Pressure	#8 Duct Pressure	Pressure Before Mist Eliminator	Pressure After Mist Eliminator	#8 Air Heater Outlet Duct Temp
DATE	TIME	lb/hr	lb/hr	MW	MW	%	%	in H_2O	in H_2O	in H_2O	in H_2O	°F
3-Sep	8:00	1002.16	2958.72	163.17	342.81	18.98	12.56	8.261	7.678	2.844	0.713	372.64
	9:00	832.57	2974.82	134.80	343.66	15.97	12.57	7.231	6.725	2.401	0.447	374.34
	10:00	983.55	2971.88	160.26	345.04	26.37	14.09	7.836	7.388	2.647	0.561	373.96
	11:00	978.60	2841.61	163.15	334.29	26.82	11.24	7.904	7.361	2.989	0.904	372.12
	12:00	982.72	2971.40	163.32	346.10	26.51	12.71	8.027	7.476	2.762	0.669	375.27
	13:00	979.58	2998.63	162.99	348.20	27.02	12.61	8.295	7.753	2.936	0.792	375.14
	14:00	976.05	3003.23	162.56	348.14	27.29	12.32	8.204	7.654	2.823	0.692	374.79
	15:00	981.39	2999.99	162.99	348.50	27.41	12.30	8.163	7.592	2.792	0.872	374.37
	16:00	980.56	2909.48	162.89	339.17	27.79	12.49	7.968	7.425	2.768	0.718	373.84
	17:00	984.00	2744.25	163.40	316.64	26.26	12.28	7.475	6.967	2.681	0.713	371.20
	18:00	973.43	2949.59	162.22	346.00	26.50	12.29	8.065	7.521	2.965	0.851	374.56
	19:00	966.84	2984.61	164.77	343.44	27.28	12.49	8.006	7.429	2.703	0.607	373.14
	20:00	974.66	2921.84	162.20	345.45	27.11	11.27	8.114	7.566	3.037	0.898	372.60
	AVG	970.46	2940.78	160.67	342.11	25.47	12.39	7.973	7.426	2.798	0.711	373.69
	SD	40.40	71.22	7.53	8.27	3.49	0.66	0.293	0.276	0.164	0.126	1.20
4-Sep	8:00	902.25	2955.91	143.01	348.60	22.13	12.00	7.916	7.407	2.903	0.831	373.91
	9:00	994.79	2959.80	161.24	348.82	23.43	12.03	8.399	7.834	3.050	0.863	373.18
	10:00	988.98	2967.41	160.03	348.56	24.58	12.21	8.304	7.721	2.921	0.804	371.77
	11:00	693.58	2322.92	107.93	254.51	21.69	11.13	3.649	3.515	1.355	0.018	365.60
	12:00	998.56	2962.30	162.04	348.68	23.52	12.78	8.418	7.867	3.059	0.919	373.85
	13:00	992.52	2970.43	161.82	349.07	24.46	12.83	8.337	7.803	2.973	0.826	374.02
	14:00	982.52	2962.05	160.86	349.08	24.10	12.77	8.220	7.700	2.876	0.774	373.45
	15:00	976.32	2963.82	160.42	348.79	25.06	12.56	8.151	7.627	2.795	0.723	373.66
	16:00	930.50	2887.66	148.12	338.58	23.84	12.70	7.452	6.971	2.449	0.531	373.18
	17:00	891.06	2394.46	158.87	266.29	24.33	11.63	6.020	5.600	1.985	0.353	367.14
	18:00	989.61	2485.97	159.87	276.19	24.17	11.35	5.981	5.614	2.275	0.553	371.68
	AVG	946.97	2806.61	153.07	325.02	23.75	12.18	7.368	6.869	2.604	0.656	371.89
	SD	65.76	251.82	15.45	36.80	0.98	0.58	1.406	1.341	0.515	0.260	2.77

Table 3-4
AFGD Operating Data (Sheet 2 of 12)

DATE	TIME	AFGD Inlet Flue Gas Temp ° F	Inlet SO_2 Concentration ppm	Flue Gas Flow mscfm	Limestone Feed tons/hr	Limestone Feed tons/hr	Lime Feed tons/hr	Outlet SO_2 Concentration ppm	Absorber Makeup Flow gpm	Absorber Level ft	Absorber Level ft
3-Sep	8:00	319.05	2199.18	1908.00	0.022	16.007	0.013	170.774	302.070	20.368	20.378
	9:00	318.71	2186.15	1908.45	0.023	15.805	0.014	150.326	267.596	20.425	20.429
	10:00	318.73	2168.48	1908.39	0.022	14.714	0.014	163.700	238.141	20.438	20.450
	11:00	318.36	2201.66	1908.70	0.021	16.002	0.013	189.237	253.017	20.336	20.379
	12:00	319.84	2153.29	1907.14	0.025	16.000	0.014	156.961	220.101	20.470	20.493
	13:00	320.32	2157.01	1906.43	0.023	16.011	0.013	158.134	144.847	20.428	20.449
	14:00	319.84	2160.70	1906.96	0.024	14.745	0.014	163.580	133.227	20.323	20.353
	15:00	319.51	2180.15	1907.38	0.023	15.317	0.013	168.537	203.567	20.265	20.319
	16:00	318.94	2181.26	1908.20	0.023	15.763	0.013	164.058	357.853	20.339	20.356
	17:00	314.60	2158.53	1913.50	0.023	16.000	0.014	152.739	283.738	20.397	20.429
	18:00	320.09	2253.91	1906.74	0.024	15.263	0.013	179.669	291.537	20.503	20.518
	19:00	318.15	2166.74	1909.06	0.024	15.969	0.014	162.047	276.539	20.436	20.433
	20:00	318.88	2229.97	1908.10	0.024	14.999	0.013	191.567	198.535	20.368	20.381
	AVG	318.85	2184.39	1908.24	0.023	15.519	0.013	167.042	243.905	20.393	20.413
	SD	1.39	29.05	1.71	0.001	0.603	0.000	12.396	60.941	0.063	0.058
4-Sep	8:00	320.15	2232.57	1704.45	16.121	0.310	0.013	157.548	262.451	20.428	20.436
	9:00	320.07	2235.39	1706.12	15.571	0.310	0.013	171.634	240.593	20.436	20.422
	10:00	318.81	2238.63	1614.52	15.777	0.310	0.013	171.933	244.883	20.439	20.461
	11:00	310.33	2078.44	1382.81	13.086	0.310	0.014	158.096	182.209	20.674	20.698
	12:00	320.38	2226.80	1576.92	16.214	0.310	0.013	174.294	212.354	20.393	20.404
	13:00	320.83	2227.45	1513.14	16.636	0.310	0.013	171.310	279.508	20.403	20.451
	14:00	320.85	2224.96	1462.70	16.759	0.310	0.013	167.139	301.202	20.458	20.600
	15:00	321.12	2217.02	1457.76	15.589	0.310	0.013	168.642	271.635	20.469	20.501
	16:00	319.38	2164.52	1542.01	16.067	0.310	0.013	152.201	157.307	20.466	20.508
	17:00	311.03	2074.22	1542.57	15.731	0.310	0.013	119.689	197.308	20.379	20.421
	18:00	313.46	2150.52	1492.46	14.013	0.310	0.013	169.878	197.488	20.479	20.501
	AVG	317.86	2190.05	1545.22	15.596	0.310	0.013	161.851	231.539	20.456	20.482
	SD	3.94	59.07	96.47	1.052	0.000	0.000	15.083	43.296	0.075	0.077

Tab. -4
AFGD Operating Data (Sheet 3 of 12)

DATE	TIME	Centrifuge FD Tank %	Slurry Density g/mL	Slurry pH	Slurry pH	Slurry Sulfite mmol/L	Slurry Carbonate mmol/L	"A" Header Pressure psig	"B" Header Pressure psig	Filtrate Sump Level %	Filtrate Sump pH	Filtrate Sump pH
3-Sep	8:00	60.547	1.145	5.704	5.654	0.316	62.754	16.657	17.256	50.097	6.962	7.707
	9:00	61.130	1.129	5.694	5.706	0.008	67.484	16.645	17.242	49.980	6.964	7.701
	10:00	60.461	1.128	5.684	5.686	0.010	66.972	16.632	17.228	50.017	6.960	7.703
	11:00	61.048	1.132	5.752	5.600	0.037	68.699	16.709	16.369	50.033	6.946	7.697
	12:00	60.226	1.127	5.704	5.710	0.010	68.086	16.649	17.266	49.844	6.865	7.701
	13:00	60.964	1.124	5.729	5.742	0.010	71.200	16.676	17.241	49.808	6.977	7.703
	14:00	60.830	1.123	5.760	5.792	0.010	74.700	16.648	17.231	49.867	6.961	7.721
	15:00	62.056	1.126	5.742	5.782	0.010	72.936	16.715	17.276	49.853	6.951	7.734
	16:00	59.816	1.129	5.744	5.766	0.010	72.236	16.781	17.312	50.133	6.954	7.742
	17:00	61.490	1.129	5.769	5.814	0.013	72.195	16.744	17.045	50.034	6.973	7.728
	18:00	60.050	1.130	5.767	5.816	0.025	73.835	16.747	16.352	49.883	6.967	7.715
	19:00	59.482	1.128	5.702	5.694	0.016	66.434	16.632	17.250	50.066	6.921	7.699
	20:00	60.476	1.131	5.752	5.604	0.022	71.683	16.720	16.358	50.010	6.957	7.701
	AVG	60.669	1.129	5.731	5.753	0.036	70.016	16.687	17.033	49.979	6.950	7.712
	SD	0.675	0.005	0.029	0.054	0.081	3.328	0.045	0.374	0.098	0.030	0.014
4-Sep	8:00	61.629	1.128	5.769	5.813	0.027	72.350	16.673	17.355	50.139	6.975	7.726
	9:00	59.836	1.127	5.742	5.809	0.034	70.080	16.718	17.390	49.977	6.968	7.723
	10:00	60.938	1.127	5.732	5.808	0.081	68.969	16.686	17.384	50.137	6.967	7.716
	11:00	61.960	1.135	5.856	5.902	0.598	78.650	15.016	15.183	49.935	6.934	7.729
	12:00	61.419	1.128	5.717	5.799	0.166	67.277	16.717	17.429	49.973	6.939	7.709
	13:00	60.231	1.130	5.739	5.799	0.247	69.451	16.701	17.461	50.030	6.823	7.712
	14:00	60.505	1.130	5.739	5.802	0.331	70.863	16.773	17.490	50.142	6.948	7.713
	15:00	59.771	1.129	5.738	5.796	0.510	69.075	16.776	17.451	49.983	6.911	7.704
	16:00	59.871	1.128	5.753	5.812	0.576	70.721	16.749	17.412	49.893	6.934	7.705
	17:00	61.613	1.134	5.797	5.846	0.585	73.469	16.728	17.323	49.936	6.923	7.711
	18:00	61.225	1.135	5.777	5.851	0.606	74.277	15.497	16.336	50.107	6.943	7.721
	AVG	60.818	1.130	5.760	5.822	0.342	71.382	16.458	17.110	50.032	6.944	7.715
	SD	0.770	0.003	0.037	0.031	0.229	3.023	0.576	0.684	0.079	0.022	0.006

Table 3-4
AFGD Operating Data (Sheet 4 of 12)

		Thickener Overflow Tank Level	Waste H_2O Flow to Wastewater	Thickener Underflow to Wastewater	Absorber Sump Level	Absorber Hold Tank Sump	Thickener Sump Level	Total H_2O to Facility	Totalized H_2O	Air to Fixed Air Sparger
DATE	TIME	%	gpm	gpm	%	%	%	gpm	gal	scfm
3-Sep	8:00	50.016	97.937	65.544	36.381	27.864	34.551	1394.452	48374.769	7248.577
	9:00	49.968	96.015	66.267	32.346	27.814	34.669	1412.076	48461.083	7414.719
	10:00	50.093	91.459	65.428	36.446	27.911	34.745	1322.326	48543.000	7399.271
	11:00	49.984	90.031	65.162	32.098	27.885	34.874	1315.615	49437.167	7169.323
	12:00	49.979	89.682	65.902	35.016	27.935	34.744	1368.880	48711.500	7475.646
	13:00	49.891	89.961	65.765	33.794	27.860	34.775	1273.039	48781.333	7393.104
	14:00	50.097	89.899	64.897	33.686	27.971	34.877	1259.302	48867.167	7196.385
	15:00	50.057	90.097	64.474	34.609	27.851	34.838	1301.884	48945.333	7177.000
	16:00	50.034	89.970	66.136	32.064	27.976	34.847	1396.516	49027.667	7163.531
	17:00	50.026	89.848	65.889	35.793	27.861	34.841	1322.703	49113.417	7113.177
	18:00	50.118	89.969	64.953	31.218	27.870	34.838	1413.435	49197.887	7185.469
	19:00	50.023	90.106	65.243	32.410	27.886	34.737	1414.974	48627.750	7366.115
	20:00	50.026	89.829	65.631	31.859	27.899	34.866	1359.808	49355.167	7184.333
	AVG	50.024	91.309	65.482	33.679	27.900	34.785	1350.215	48881.001	7266.204
	SD	0.059	2.671	0.502	1.762	0.053	0.092	52.476	323.686	117.464
4-Sep	8.00	50.033	70.191	65.197	34.373	27.976	35.000	1488.024	50272.154	7155.844
	9:00	50.067	69.932	65.481	31.699	27.808	34.969	1527.268	50354.917	7161.271
	10:00	50.010	71.340	65.056	33.988	27.900	35.003	1487.690	50438.083	7112.885
	11:00	49.970	80.004	65.813	33.668	28.035	35.121	1297.414	51234.667	7163.260
	12:00	49.995	74.298	65.333	33.035	28.093	35.000	1252.438	50600.333	7146.365
	13:00	50.010	74.945	65.948	34.001	27.941	35.048	1415.940	50681.833	7159.917
	14:00	49.965	79.569	66.302	31.845	27.992	35.048	1404.969	50766.250	7206.959
	15:00	49.942	79.839	65.161	35.251	27.975	35.049	1405.490	50851.500	7134.823
	16:00	49.884	79.914	65.587	30.777	27.824	35.086	1294.156	50934.083	7207.156
	17:00	49.922	80.051	64.875	35.681	27.988	35.109	1302.076	51011.667	7155.958
	18:00	50.043	80.154	65.733	30.806	27.987	35.129	1467.073	51092.333	7126.250
	AVG	49.987	78.385	65.408	33.184	27.954	35.049	1394.778	50767.984	7157.317
	SD	0.056	4.125	0.320	1.631	0.080	0.051	90.067	313.342	27.922

Table 3-4
AFGD Operating Data (Sheet 5 of 12)

DATE	TIME	Air to Rotary Sparger scfm	Gypsum Wt tons	Gypsum Total Wt ktons	Limestone Transfer "A" psig	Limestone Transfer "B" psig	Absorber ΔP in H_2O	Total AFGD System ΔP in H_2O	Mist Eliminator ΔP in H_2O	Recirculation Header "A" Pressure psig
3-Sep	8:00	7993.356	50.026	221.158	0.985	19.471	5.379	7.504	2.131	16.654
	9:00	8000.886	23.138	221.197	0.991	19.677	4.813	6.767	1.948	16.658
	10:00	7999.250	20.828	221.231	0.984	19.272	5.396	7.436	2.101	16.632
	11:00	8011.385	29.478	221.676	0.978	19.152	4.917	7.007	2.092	16.713
	12:00	8002.583	33.670	221.306	0.984	19.768	5.347	7.453	2.107	16.639
	13:00	8017.188	37.376	221.343	0.982	19.898	5.360	7.493	2.134	16.685
	14:00	7986.104	14.989	221.373	0.987	19.250	5.344	7.476	2.126	16.688
	15:00	8001.625	7.267	221.393	0.986	19.628	5.355	7.469	2.113	16.734
	16:00	8018.313	25.630	221.414	0.986	19.145	5.161	7.220	2.056	16.762
	17:00	7978.958	42.109	221.444	0.984	19.832	4.796	6.756	1.954	16.744
	18:00	7976.781	44.003	221.477	0.987	19.730	5.087	7.211	2.113	16.757
	19:00	7987.292	48.143	221.267	0.982	19.610	5.356	7.465	2.111	16.660
	20:00	7984.510	31.946	221.542	0.981	19.323	5.071	7.193	2.131	16.723
	AVG	7998.787	31.431	221.363	0.984	19.520	5.179	7.265	2.066	16.693
	SD	13.177	12.436	0.124	0.003	0.255	0.212	0.261	0.061	0.045
4-Sep	8:00	8000.856	39.270	221.899	19.965	0.360	5.021	7.108	2.094	16.667
	9:00	8031.479	14.978	221.930	19.950	0.359	5.376	7.598	2.168	16.721
	10:00	8010.688	43.371	221.964	20.132	0.358	5.349	7.477	2.127	16.702
	11:00	8004.469	26.344	222.311	19.060	0.361	2.503	3.812	1.305	15.026
	12:00	7993.344	30.671	222.030	20.330	0.359	5.390	7.528	2.133	16.719
	13:00	7979.344	31.704	222.059	20.334	0.366	5.314	7.468	2.138	16.704
	14:00	8003.521	29.492	222.088	20.181	0.362	5.348	7.470	2.111	16.777
	15:00	8005.479	26.487	222.122	19.773	0.373	5.302	7.371	2.067	16.778
	16:00	7982.083	29.525	222.159	20.057	0.371	4.998	6.943	1.944	16.754
	17:00	7969.729	27.960	222.190	19.556	0.363	4.092	5.725	1.641	16.722
	18:00	8016.250	33.608	222.217	19.123	0.348	3.690	5.405	1.712	16.500
	AVG	7999.749	30.492	222.088	19.860	0.362	4.762	6.713	1.949	16.461
	SD	16.895	6.901	0.122	0.423	0.007	0.898	1.160	0.265	0.574

Table 3-4
AFGD Operating Data (Sheet 6 of 12)

DATE	TIME	Recirculation Header "A" Pressure psig	Oxidation Air Pressure psig	# of Pumps Running	SO$_2$ Removal Efficiency lb/mmBtu	Feed to Thickener gpm	AFGD System Outlet Temp °F	Absorber Tank pH	Wastewater Outlet pH	A Silo Level %	B Silo Level %
3-Sep	8:00	17.264	10.207	10.000	0.432	623.462	132.396	7.084	6.848	62.677	63.619
	9:00	17.253	10.192	10.000	0.382	728.915	132.016	7.084	6.855	62.497	63.504
	10:00	17.251	10.203	10.000	0.413	688.041	131.693	7.084	6.857	62.059	61.187
	11:00	16.359	10.204	9.000	0.476	672.497	131.350	7.088	6.827	70.549	63.654
	12:00	17.241	10.199	10.000	0.395	785.679	131.831	7.085	6.853	64.612	59.791
	13:00	17.268	10.217	10.000	0.398	691.611	131.822	7.090	6.862	65.426	59.634
	14:00	17.239	10.182	10.000	0.414	499.211	131.745	7.090	6.856	66.686	60.313
	15:00	17.278	10.195	10.000	0.426	462.910	131.740	7.089	6.848	66.902	60.606
	16:00	17.306	10.200	10.000	0.414	570.092	131.455	7.089	6.842	68.641	60.393
	17:00	17.072	10.225	9.750	0.389	670.138	131.131	7.090	6.834	68.761	60.822
	18:00	16.358	10.208	9.000	0.819	666.171	131.315	7.090	6.833	66.845	59.914
	19:00	17.257	10.202	10.000	0.406	633.020	131.736	7.092	6.856	62.883	61.057
	20:00	16.347	10.198	9.000	0.481	670.025	131.544	7.089	6.827	70.509	63.339
	AVG	17.038	10.202	9.750	0.449	673.982	131.686	7.087	6.846	65.780	61.372
	SD	0.378	0.010	0.416	0.110	108.026	0.311	0.003	0.011	2.700	1.504
4-Sep	8:00	17.344	10.202	10.000	0.396	600.611	131.225	7.083	6.828	71.029	68.964
	9:00	17.398	10.184	10.000	0.432	663.891	131.248	7.085	6.820	70.623	69.913
	10:00	17.384	10.210	10.000	0.432	701.306	131.014	7.086	6.820	71.036	70.954
	11:00	15.184	10.194	6.667	0.416	668.117	129.709	7.091	6.861	56.461	67.386
	12:00	17.422	10.204	10.000	0.438	615.352	131.086	7.089	6.851	71.069	71.705
	13:00	17.465	10.223	10.000	0.430	571.151	130.995	7.088	6.851	68.392	71.689
	14:00	17.464	10.181	10.000	0.418	665.349	130.846	7.092	6.851	65.744	69.087
	15:00	17.473	10.199	10.000	0.423	696.649	130.770	7.091	6.860	63.017	68.958
	16:00	17.438	10.193	10.000	0.386	731.479	130.642	7.092	6.863	62.151	66.793
	17:00	17.314	10.215	9.917	0.312	545.726	130.440	7.092	6.861	62.823	67.620
	18:00	16.353	10.221	8.000	0.758	633.961	130.216	7.093	6.860	66.404	71.718
	AVG	17.119	10.202	9.508	0.440	648.327	130.745	7.089	6.848	66.249	69.345
	SD	0.682	0.013	1.064	0.108	56.457	0.447	0.003	0.016	4.552	1.879

Ta. 3-4
AFGD Operating Data (Sheet 7 of 12)

DATE	TIME	Unit #7 Air Flow lb/hr	Unit #8 Air Flow lb/hr	Unit #7 Load MW	Unit #8 Load MW	Unit #7 Opacity %	Unit #8 Opacity %	#7 Duct Pressure in H_2O	#8 Duct Pressure in H_2O	Pressure Before Mist Eliminator in H_2O	Pressure After Mist Eliminator in H_2O	#8 Air Heater Outlet Duct Temp °F
5-Sep	8:00	973.91	2974.61	156.69	348.23	23.45	11.71	8.222	7.679	3.117	0.845	375.35
	9:00	986.55	2954.69	169.57	347.20	22.13	11.82	8.223	7.676	3.125	0.973	373.60
	10:00	967.56	2985.25	157.62	348.00	24.33	13.43	8.193	7.667	3.098	0.965	373.02
	11:00	661.00	2925.41	100.49	343.45	22.95	11.96	6.174	5.759	2.500	0.664	372.80
	12.00	988.33	2958.92	163.17	347.86	22.71	11.81	8.163	7.650	3.039	0.927	372.40
	13:00	992.89	2984.22	163.92	348.67	23.57	11.78	8.213	7.701	3.084	0.969	372.52
	14:00	967.39	2987.13	163.57	349.99	24.11	11.52	8.272	7.759	3.088	0.950	371.47
	15:00	997.21	2992.41	163.38	349.74	23.08	11.57	8.321	7.784	3.105	0.952	371.98
	16:00	997.97	2973.69	162.63	349.76	24.41	11.37	8.272	7.713	3.087	0.934	372.59
	17:00	950.47	2989.88	155.17	349.80	22.61	11.34	8.079	7.597	2.993	0.871	372.44
	18:00	778.28	2951.29	126.98	345.98	26.73	11.63	7.088	6.634	2.603	0.679	372.24
	AVG	934.51	2969.32	152.11	348.15	23.64	11.81	7.929	7.414	2.965	0.894	372.76
	SD	105.17	18.97	19.17	1.91	1.20	0.54	0.645	0.607	0.209	0.104	0.97
6-Sep	8:00	997.20	2973.44	160.25	349.28	25.09	12.31	7.798	7.251	2.943	0.770	372.95
	9:00	964.63	2987.36	153.90	349.57	24.92	12.03	7.852	7.285	2.976	0.791	372.40
	10:00	1012.82	2980.32	161.94	349.29	23.88	11.62	8.193	7.623	3.168	0.912	372.84
	11:00	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*issing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*
	12:00	1008.44	3002.61	163.03	349.23	23.29	11.79	8.117	7.544	3.095	0.869	373.35
	13:00	979.40	2988.95	158.56	349.41	24.15	11.77	7.856	7.244	2.878	0.712	373.48
	14:00	973.89	2978.21	160.86	349.55	23.80	11.72	7.938	7.352	2.996	0.814	373.24
	15:00	984.44	2981.64	161.23	349.36	23.22	11.42	8.098	7.514	3.104	0.898	373.14
	16:00	994.95	2983.02	161.63	349.56	23.46	11.93	8.123	7.559	3.122	0.923	373.00
	17:00	1005.97	2959.71	162.30	349.16	23.22	12.00	8.105	7.518	3.091	0.897	372.88
	18:00	1010.61	2961.47	163.29	349.12	25.75	11.71	8.151	7.572	3.129	0.927	371.10
	19:00	995.90	3000.44	160.93	348.98	23.68	12.26	8.146	7.576	3.147	0.900	372.74
	20:00	1012.61	2971.27	164.84	349.67	24.65	11.36	8.095	7.551	3.127	0.908	371.71
	AVG	995.08	2982.37	161.08	349.35	24.07	11.83	8.038	7.469	3.065	0.859	372.74
	SD	15.54	13.76	2.65	0.20	0.81	0.28	0.131	0.134	0.089	0.097	0.67

Table 3-4
AFGD Operating Data (Sheet 8 of 12)

DATE	TIME	AFGD Inlet Flue Gas Temp ° F	Inlet SO_2 Concentration ppm	Flue Gas Flow mscfm	Limestone Feed tons/hr	Limestone Feed tons/hr	Lime Feed tons/hr	Outlet SO_2 Concentration ppm	Absorber Makeup Flow gpm	Absorber Level ft	Absorber Level ft
5-Sep	8:00	322.62	2236.73	0.00	0.029	16.502	0.014	185.781	104.934	20.344	20.374
	9:00	321.33	2213.37	0.00	0.033	17.112	0.014	177.309	163.395	20.218	20.249
	10:00	321.20	2237.81	0.00	0.029	16.173	0.014	179.816	510.540	20.285	20.307
	11:00	317.99	2210.59	0.00	15.011	0.310	0.014	172.536	177.868	20.505	20.638
	12:00	320.69	2213.16	0.00	0.029	15.497	0.014	186.943	227.694	20.446	20.487
	13:00	320.50	2210.86	0.00	0.029	15.504	0.014	184.644	324.148	20.496	20.540
	14:00	320.16	2190.87	0.00	0.027	15.499	0.013	183.284	257.043	20.576	20.592
	15:00	320.56	2192.48	0.00	0.033	15.493	0.014	184.673	150.026	20.520	20.558
	16:00	320.56	2207.42	0.00	0.028	15.685	0.014	188.264	456.713	20.626	20.562
	17:00	320.33	2208.73	0.00	0.033	16.763	0.015	178.761	323.443	20.721	20.753
	18:00	319.69	2248.76	0.00	0.029	15.000	0.014	165.251	166.788	20.720	20.760
	AVG	320.50	2215.53	0.00	1.392	14.602	0.014	180.678	260.236	20.487	20.520
	SD	1.08	17.47	0.00	4.307	4.530	0.000	6.627	124.887	0.162	0.154
6-Sep	8:00	316.87	2237.51	0.00	4.315	13.363	0.016	195.922	323.262	20.314	20.367
	9:00	316.59	2235.56	0.00	0.038	16.438	0.016	188.592	310.886	20.456	20.516
	10:00	316.91	2201.79	0.00	0.038	16.297	0.016	186.620	163.076	20.576	20.624
	11:00	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*ssing data*	*missing data*
	12:00	319.01	2178.34	0.00	0.038	15.491	0.016	179.468	77.006	20.452	20.492
	13:00	318.97	2166.91	0.00	14.648	1.575	0.016	173.419	187.206	20.377	20.419
	14:00	319.13	2148.70	0.00	16.409	0.310	0.016	185.146	250.609	20.453	20.491
	15:00	319.21	2148.71	0.00	17.434	1.926	0.016	179.639	196.552	20.598	20.634
	16:00	319.41	2155.49	0.00	16.053	0.310	0.016	177.827	169.695	20.606	20.627
	17:00	319.17	2188.79	0.00	15.430	0.310	0.016	165.834	136.177	20.624	20.656
	18:00	318.10	2234.71	0.00	16.810	0.310	0.016	160.738	129.740	20.622	20.639
	19:00	317.74	2196.01	0.00	0.038	15.497	0.016	181.813	81.858	20.519	20.585
	20:00	318.56	2210.50	1908.56	16.493	0.310	0.016	193.324	184.271	20.642	20.683
	AVG	318.30	2191.92	159.05	9.812	6.845	0.016	164.030	183.370	20.620	20.569
	SD	0.99	31.83	527.50	7.645	7.297	0.000	6.235	75.488	0.104	0.097

Table 3-4
AFGD Operating Data (Sheet 9 of 12)

		Centrifuge FD Tank	Slurry Density	Slurry pH	Slurry pH	Slurry Sulfite	Slurry Carbonate	"A" Header Pressure	"B" Header Pressure	Filtrate Sump Level	Filtrate Sump pH	Filtrate Sump pH
DATE	TIME	%	g/mL			mmol/L	mmol/L	psig	psig	%		
5-Sep	8:00	61.279	1.126	5.742	5.801	0.144	67.773	16.724	16.251	49.800	6.956	7.720
	9:00	63.447	1.131	5.750	5.810	0.147	72.513	16.740	16.327	50.044	6.969	7.724
	10:00	59.893	1.134	5.756	5.809	0.139	75.655	16.782	16.351	50.081	6.954	7.729
	11:00	60.779	1.136	5.748	5.824	0.304	69.877	15.505	16.265	49.986	6.956	7.673
	12:00	59.938	1.132	5.746	5.810	0.245	73.193	16.610	16.349	50.003	6.927	7.691
	13:00	60.849	1.133	5.735	5.802	0.131	71.379	16.798	16.357	50.015	6.901	7.679
	14:00	60.188	1.132	5.748	5.808	0.157	70.005	16.799	16.346	49.811	6.901	7.676
	15:00	59.806	1.133	5.721	5.795	0.212	69.095	16.805	16.360	50.050	6.904	7.679
	16:00	60.881	1.133	5.713	5.798	0.254	68.034	16.802	16.356	50.050	6.899	7.676
	17:00	60.778	1.132	5.743	5.801	0.373	68.920	16.797	16.334	49.907	6.900	7.678
	18:00	60.334	1.132	5.739	5.815	0.378	70.619	16.753	16.290	50.018	6.884	7.686
	AVG	60.743	1.132	5.740	5.807	0.226	70.642	16.665	16.325	49.979	6.923	7.692
	SD	0.970	0.002	0.012	0.006	0.089	2.276	0.368	0.037	0.093	0.029	0.020
6-Sep	8:00	58.550	1.132	5.723	5.765	0.115	64.309	15.457	17.167	50.115	6.889	7.651
	9:00	61.288	1.129	5.734	5.779	0.084	65.954	15.470	17.196	49.818	6.806	7.660
	10:00	62.245	1.129	5.748	5.786	0.058	68.697	15.476	17.192	50.065	6.788	7.720
	11:00	*missing data*	*issing data*	*issing data*	*issing data*	*missing data*	*issing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*
	12:00	60.284	1.132	5.743	5.788	0.055	69.935	15.513	17.230	50.282	6.779	7.731
	13:00	60.004	1.132	5.752	5.802	0.078	69.614	15.509	17.204	49.859	6.777	7.717
	14:00	61.034	1.130	5.722	5.791	0.005	66.987	15.500	17.208	50.020	6.749	7.711
	15:00	60.781	1.128	5.761	5.812	0.644	59.917	15.544	17.251	49.732	6.842	7.731
	16:00	61.687	1.131	5.756	5.813	1.143	77.372	15.552	17.286	50.209	6.802	7.749
	17:00	60.134	1.131	5.741	5.796	1.326	74.027	15.567	17.250	49.951	6.792	7.748
	18:00	59.439	1.132	5.735	5.801	1.303	72.242	15.556	17.264	50.022	6.763	7.735
	19:00	60.829	1.132	5.740	5.790	0.078	70.122	15.491	17.248	50.012	6.750	7.743
	20:00	57.768	1.133	5.700	5.762	1.165	66.250	15.517	17.318	49.692	6.832	7.751
	AVG	60.345	1.131	5.738	5.791	0.604	68.766	15.512	17.235	49.981	6.781	7.721
	SD	1.230	0.002	0.016	0.018	0.542	4.410	0.035	0.041	0.171	0.039	0.032

Table 3-4
AFGD Operating Data (Sheet 10 of 12)

		Thickener Overflow Tank Level	Waste H_2O Flow to Wastewater	Thickener Underflow to Wastewater	Absorber Sump Level	Absorber Hold Tank Sump	Thickener Sump Level	Total H_2O to Facility	Totalized H_2O	Air to Fixed Air Sparger
DATE	TIME	%	gpm	gpm	%	%	%	gpm	gal	scfm
5-Sep	8:00	49.817	80.068	64.661	34.516	28.078	35.290	1162.154	52133.848	7204.442
	9:00	50.002	79.937	65.136	30.497	28.049	35.271	1291.854	52207.917	7208.615
	10:00	49.968	80.023	64.914	35.598	28.181	35.243	1637.060	52293.917	7164.990
	11:00	50.064	79.889	64.926	35.534	28.186	35.452	1300.008	53218.167	7210.635
	12:00	49.943	79.936	65.424	35.658	28.237	35.281	1321.083	52468.417	7169.063
	13:00	50.068	80.114	65.641	30.719	28.191	35.307	1375.393	52552.167	7218.094
	14:00	49.826	79.983	66.014	38.022	28.077	35.280	1369.589	52640.833	7190.573
	15:00	50.080	79.948	66.664	30.648	28.278	35.301	1328.373	52721.833	7207.510
	16:00	49.991	80.068	65.432	35.255	28.241	35.292	1544.930	52807.250	7165.573
	17:00	50.018	79.941	65.481	30.569	28.270	35.352	1423.989	52900.250	7121.740
	18:00	50.090	80.009	65.503	31.061	28.251	35.357	1228.391	52983.083	7181.563
	AVG	49.981	79.992	65.436	33.281	28.185	35.310	1382.073	52629.789	7185.709
	SD	0.086	0.067	0.532	2.383	0.078	0.056	128.826	323.764	27.412
6-Sep	8:00	49.958	80.090	65.987	33.325	36.108	35.727	1623.173	54036.077	7125.019
	9:00	49.904	80.228	65.889	34.836	36.163	35.785	1526.911	54127.417	7210.594
	10:00	49.976	79.920	65.794	34.387	36.392	35.815	1359.552	54217.250	7164.531
	11:00	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*
	12:00	49.928	80.106	65.427	35.475	36.562	35.771	1268.089	54377.167	7112.583
	13:00	49.871	80.027	65.588	36.208	36.677	35.807	1440.643	54460.500	7151.865
	14:00	49.869	79.969	65.652	36.733	36.578	35.818	1477.427	54549.417	7098.417
	15:00	49.987	80.001	66.454	34.265	36.563	35.934	1454.745	54639.750	7146.281
	16:00	50.146	79.964	66.530	36.683	36.568	36.254	1447.084	54724.917	7178.635
	17:00	49.951	80.092	66.042	33.030	36.640	36.581	1383.438	54808.417	7164.885
	18:00	50.149	79.972	64.528	32.816	36.568	36.617	1448.060	54892.500	7160.198
	19:00	50.171	80.080	65.067	35.223	36.619	35.844	1287.380	54297.083	7188.719
	20:00	49.987	79.537	64.493	28.033	36.551	36.632	1502.667	55028.333	7130.750
	AVG	50.000	79.999	65.621	34.249	36.499	36.049	1423.265	54513.238	7154.373
	SD	0.096	0.161	0.629	2.269	0.176	0.350	85.857	301.456	31.971

Table 3-4
AFGD Operating Data (Sheet 11 of 12)

DATE	TIME	Air to Rotary Sparger scfm	Gypsum Wt tons	Gypsum Total Wt ktons	Limestone Transfer "A" psig	Limestone Transfer "B" psig	Absorber ΔP in H_2O	Total AFGD System ΔP in H_2O	Mist Eliminator ΔP in H_2O	Recirculation Header "A" Pressure psig
5-Sep	8:00	7985.077	19.386	222.606	0.817	19.616	5.104	7.274	2.170	16.710
	9:00	7973.333	13.858	222.624	0.811	19.852	5.110	7.259	2.153	16.735
	10:00	8040.677	13.839	222.644	0.810	19.434	5.092	7.222	2.135	16.795
	11:00	7975.760	34.585	222.999	19.687	0.483	3.679	5.491	1.812	15.496
	12:00	8011.313	33.143	222.703	0.801	19.149	5.142	7.263	2.119	16.801
	13:00	7984.813	27.181	222.735	0.800	19.356	5.180	7.303	2.121	16.833
	14:00	7989.573	48.068	222.768	0.797	19.246	5.226	7.360	2.138	16.793
	15:00	8014.583	12.611	222.800	0.799	19.442	5.232	7.369	2.159	16.777
	16:00	7972.021	26.691	222.833	0.803	19.477	5.216	7.370	2.152	16.773
	17:00	8008.833	33.908	222.866	0.807	20.087	5.085	7.196	2.113	16.786
	18:00	7981.313	25.686	222.895	0.809	19.329	4.502	6.428	1.920	16.762
	AVG	7994.299	26.268	222.770	2.540	17.770	4.961	7.050	2.090	16.659
	SD	20.690	10.417	0.117	5.486	5.473	0.449	0.555	0.109	0.369
6-Sep	8:00	7994.500	35.181	223.306	5.442	15.293	4.861	7.048	2.185	15.460
	9:00	7974.948	37.840	223.346	0.279	19.200	4.865	7.055	2.183	15.466
	10:00	8037.552	36.212	223.375	0.270	19.854	5.040	7.300	2.265	15.462
	11:00	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*issing data*	*missing data*
	12:00	8019.365	26.291	223.432	0.261	19.230	5.037	7.262	2.244	15.523
	13:00	7988.365	48.127	223.469	17.002	1.938	4.944	7.118	2.182	15.506
	14:00	7995.771	33.260	223.510	19.726	0.332	4.949	7.137	2.182	15.487
	15:00	8010.594	44.463	223.545	20.829	5.684	4.988	7.185	2.197	15.545
	16:00	7999.677	26.451	223.571	19.765	2.670	5.010	7.218	2.207	15.552
	17:00	7998.938	32.605	223.599	19.776	2.655	5.046	7.242	2.191	15.559
	18:00	8037.729	22.237	223.631	20.141	2.551	5.028	7.236	2.196	15.555
	19:00	7978.271	27.806	223.400	0.268	19.281	4.995	7.235	2.241	15.500
	20:00	8054.625	23.642	223.684	18.965	2.503	5.031	7.230	2.196	15.567
	AVG	8007.530	32.842	223.489	11.695	9.263	4.983	7.191	2.206	15.517
	SD	23.994	7.730	0.116	9.091	8.015	0.062	0.080	0.027	0.036

Table 3-4
AFGD Operating Data (Sheet 12 of 12)

		Recirculation Header "A" Pressure	Oxidation Air Pressure	# of Pumps Running	SO_2 Removal Efficiency	Feed to Thickener	AFGD System Outlet Temp	Absorber Tank pH	Wastewater Outlet pH	A Silo Level	B Silo Level
DATE	TIME	psig	psig		lb/mmBtu	gpm	°F			%	%
5-Sep	8:00	16.273	10.203	9.000	0.457	404.581	131.698	7.093	6.861	54.228	56.536
	9:00	16.340	10.194	9.000	0.440	411.874	131.662	7.094	6.856	54.189	54.827
	10:00	16.357	10.169	9.000	0.445	534.770	131.387	7.094	6.855	54.602	55.385
	11:00	16.276	10.186	8.000	0.445	698.689	130.233	7.090	6.849	53.654	44.608
	12:00	16.344	10.188	9.000	0.459	663.549	131.803	7.097	6.863	58.721	58.865
	13:00	16.367	10.197	9.000	0.458	665.000	131.694	7.097	6.864	58.721	55.090
	14:00	16.370	10.188	9.000	0.455	652.619	131.442	7.097	6.864	56.791	53.872
	15:00	16.343	10.186	9.000	0.459	664.417	131.494	7.096	6.865	55.640	49.832
	16:00	16.363	10.221	9.000	0.468	666.085	131.173	7.096	6.865	54.169	46.615
	17:00	16.340	10.206	9.000	0.446	626.277	130.871	7.095	6.863	54.055	45.045
	18:00	16.303	10.218	9.000	0.688	650.121	130.686	7.094	6.856	54.149	44.766
	AVG	16.334	10.196	8.909	0.474	603.453	131.304	7.095	6.860	55.538	51.222
	SD	0.033	0.014	0.287	0.068	100.088	0.493	0.002	0.005	2.019	4.854
6-Sep	8:00	17.180	10.208	9.000	0.487	929.846	131.201	7.083	6.837	43.765	44.587
	9:00	17.162	10.196	9.000	0.471	704.600	131.191	7.083	6.838	43.762	42.990
	10:00	17.214	10.167	9.000	0.463	681.720	131.316	7.082	6.837	43.757	39.411
	11:00	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*missing data*	*ssing data*	*ssing data*
	12:00	17.210	10.193	9.000	0.443	839.966	131.572	7.082	6.837	43.487	37.908
	13:00	17.244	10.215	9.000	0.430	953.371	131.163	7.083	6.841	43.592	36.102
	14:00	17.209	10.225	9.000	0.458	871.655	131.051	7.083	6.835	44.489	36.883
	15:00	17.250	10.196	9.000	0.443	694.963	131.049	7.084	6.834	42.718	37.818
	16:00	17.264	10.186	9.000	0.437	680.309	131.216	7.085	6.836	40.598	36.490
	17:00	17.260	10.211	9.000	0.467	782.447	131.271	7.088	6.837	37.841	36.378
	18:00	17.291	10.175	9.000	0.736	773.249	130.928	7.091	6.840	38.358	38.238
	19:00	17.236	10.207	9.000	0.450	766.698	131.583	7.082	6.837	43.519	39.227
	20:00	17.301	10.200	9.000	0.476	717.688	130.918	7.097	6.841	38.134	38.005
	AVG	17.236	10.200	9.000	0.479	781.379	131.205	7.085	6.837	41.688	39.021
	SD	0.040	0.013	0.000	0.079	93.738	0.205	0.004	0.002	2.990	2.316

Table 3-5 Average Voltages and Currents in Unit 7 and 8 ESPs

UNIT 7

Unit 7 ESP T/R SET No.

	7AT1		7AT2		7AT3		7AT4		7AT5		7AT6		7BT1		7BT2		7BT3		7BT4		7BT5		7BT6	
DATE	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA
9/3/93	38	75	50	500	49	200	50	950	*	*	24	750	47	100	46	200	46	350	44	200	46	600	48	1250
9/4/93	39	150	50	700	50	200	50	1000	*	*	25	750	48	100	46	260	46	300	46	300	49	500	48	1300
9/5/93	38	150	50	700	48	250	50	1000	*	*	25	700	48	200	44	300	48	500	46	400	47	450	50	1500
9/6/93	37	200	49	700	50	300	50	1000	*	*	25	720	46	200	44	350	46	550	45	450	46	500	48	1400

UNIT 8

Unit 8 "EAST" ESP T/R SET No.

	8EA1		8EA2		8EA3		8EA4		8EA5		8EA6		8EB1		8EB2		8EB3		8EB4		8EB5		8EB6	
DATE	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA
9/3/93	55	550	59	250	50	950	54	750	48	1200	36	500	50	200	45	300	53	850	55	850	39	700	50	1050
9/4/93	54	700	*	*	49	950	55	350	46	1150	37	500	50	150	45	200	53	850	55	850	38	700	47	1000
9/5/93	52	700	56	250	47	950	55	750	46	1150	37	500	50	750	47	600	49	850	52	1250	40	700	48	1000
9/6/93	52	700	54	250	47	950	53	850	46	1150	36	500	51	700	47	550	48	850	52	1250	40	700	47	1050

Unit 8 "WEST" ESP T/R SET No.

	8WA1		8WA2		8WA3		8WA4		8WA5		8WA6		8WB1		8WB2		8WB3		8WB4		8WB5		8WB6	
DATE	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA	kV	mA
9/3/93	50	600	48	800	45	650	47	750	36	1100	49	1000	44	750	38	300	42	700	31	400	36	500	42	400
9/4/93	50	550	47	650	43	450	44	600	35	1050	49	1000	42	550	38	300	42	700	36	600	41	550	43	500
9/5/93	50	600	48	750	46	700	46	700	38	1200	51	1050	44	750	37	250	43	700	37	600	42	600	43	500
9/6/93	50	550	48	650	46	600	46	600	37	1200	45	650	44	750	38	250	43	650	35	400	40	500	43	450

* transformer/rectifier set out of service

Table 3-6. Record of Flows for Ammonia Injection Systems

	DATE	TIME	Pressure, psig	System Output, %
UNIT 7	9/3/93	0907	10	52
	9/3/93	1047	10	48
	9/3/93	1226	10	50
	9/3/93	1450	9.8	50
	9/3/93	1624	9.9	52
	9/3/93	1835	9.8	51
	9/3/93	2011	9.8	50
	AVERAGE		9.9	50
	9/4/93	0826	10.1	10
	9/4/93	1105	10	10
	9/4/93	1310	9.5	8
	9/4/93	1522	8	8
	9/4/93	1722	6.8	8
	AVERAGE		8.9	9
UNIT 8	9/3/93	0936	10.4	50
	9/3/93	1105	10.4	51
	9/3/93	1240	10.4	50
	9/3/93	1400	10.25	50
	9/3/93	1627	10.2	51
	9/3/93	1829	10.3	50
	AVERAGE		10.3	50
	9/4/93	0829	10.2	51
	9/4/93	1118	9.6	51
	9/4/93	1329	8.8	51
	9/4/93	1508	7.8	51
	9/4/93	1702	6.7	51
	AVERAGE		8.6	51

(There were no flows from either system on 9/5 or 9/6)

4.0 FLUE GAS SAMPLING

4.1 Ducting Arrangements

Five potential sampling locations were called out for this program which were as follows:

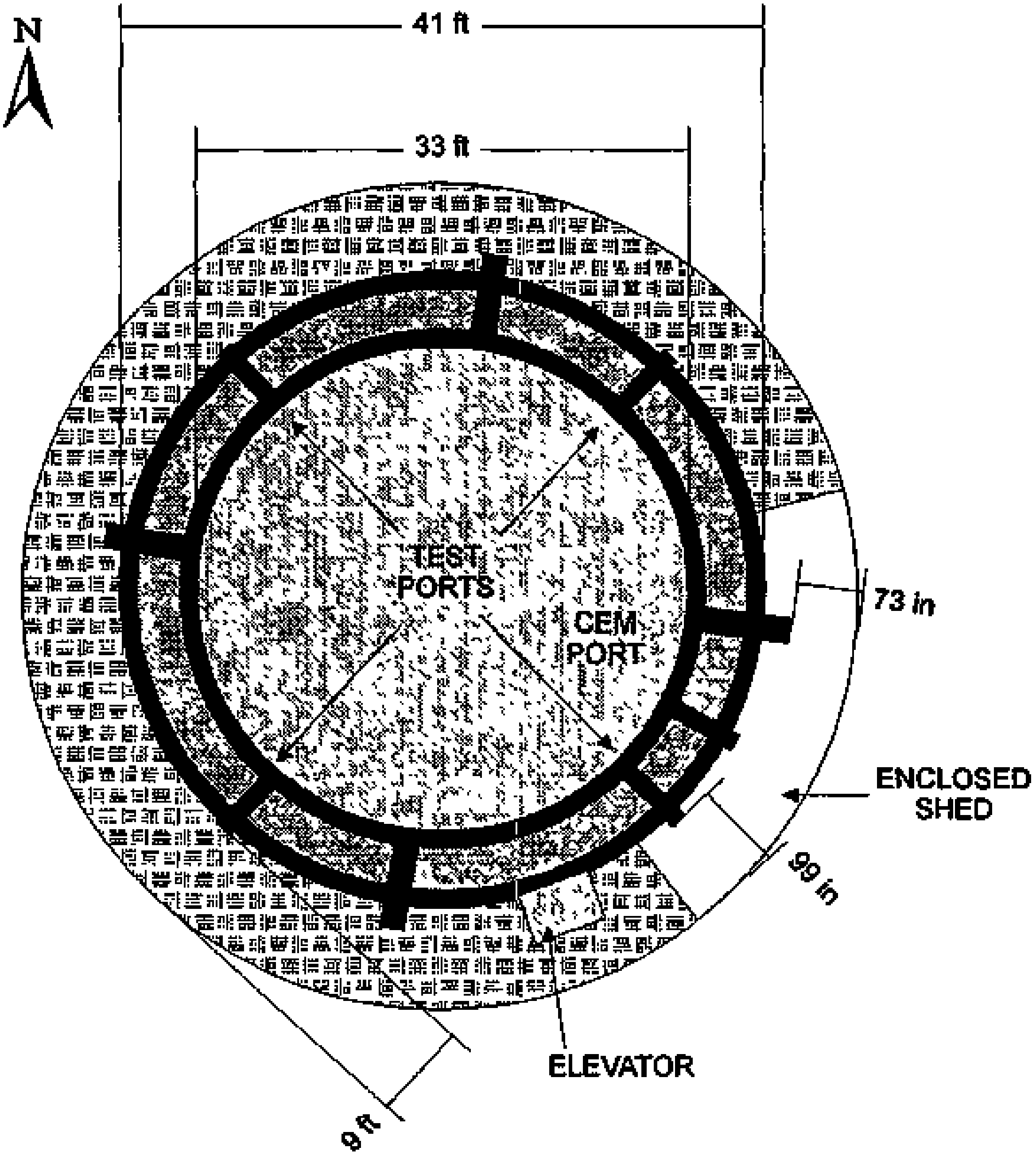
1) the inlet to the Unit 8 ESP,
2) the outlet of the Unit 8 ESP,
3) the outlet of the Unit 7 ESP,
4) the combined inlet to the scrubber,
5) and the stack.

Sampling at the combined inlet duct to the scrubber was eliminated in our plan. This was done for two principal reasons. First, the sampling location was very close to the point at which the two exit ducts from the ESPs combine and the gases were unlikely to be mixed well. This fact would make the results from any of the single-point sampling methods (VOST, Hg, aldehydes, and ammonia/HCN) unlikely to be representative. Second, the results from the two ESP outlet ducts could be summed to provide the needed information regarding the flue gas input to the scrubber. Thus it would not have been cost effective to carry out sampling on the combined gas stream as well as the two ESP exit streams.

The Unit 8 ESP is fed by two ducts from the air heaters which divide into four ducts at the ESP inlet. Ammonia injection takes place in the upstream portions of the two ducts from the air heaters and the ESP inlet sampling ports are located in these ducts. Sampling at the Unit 8 inlet was concentrated on one of the two ducts (the west duct), but a Method 17 sample was obtained on the other (the east duct) so that the gas and particulate flows to the ESP would be known.

The stack had four ports at 90° to one another at the 358-foot level which could be used for sampling with those methods that required traversing the duct. (All particulate sampling methods have this requirement.) Additional ports were available that were used for the sampling methods that did not require a traverse. The layout of the ports at the stack sampling location is shown in Figure 4-1.

The types of samples to be collected in the flue gas streams were summarized in Section 2.2.2 above. Details of the sampling activities are provided in the following discussion.



NOTE: All test ports are 42 in above the grating.

Figure 4-1. Stack Sampling Platform at 109-m Elevation

4.2 Sampling Schedule

Table 4-1 below lists the manual flue-gas sampling methods employed in this test program.

Table 4-1. Flue Gas Sampling Methods

Constituent	Method	Traverse/ Single Point	Duration minutes		
			In	Out	Stack
Inorganic Day:					
Stack, Unit 8 Inlet, Unit 7 & 8 Outlets:					
Metals	M29	T	192^d	240^d	360
Mercury	Carbon trap	S	60	60	60
Acid gases	M5	T	48	60	48
Particle size distribution	Impactor/cyclone	T^a	60	600	480
Size fractionated composition	Dual cyclones	T^c	60	1020	--
Unit 7 Outlet:					
Simulated plume (Metals, Hg, acid gases)	SRI diluter	S	--	360	--
Organic Day:					
Stack, Unit 8 Inlet, Unit 7 & 8 Outlets:					
SVOCs & PCDDs/PCDFs	MM5/SW846-0010	T	240	280	360
Volatile organics	VOST	S	10,20,40	10,20,40	10,20,40
Radionuclides	M17	T^e	72	144	360
Aldehydes	Impingers	S	30	30	30
Ammonia and Cyanide	Impingers	S	30	30	30
Unit 7 Outlet:					
Simulated plume (SVOCs)	SRI diluter	S	–	360	–
Inorganic & Organic Days:					
Bulk gas composition	Orsat	T^b	✓	✓	✓

Notes:
- a. Impactor at the stack and ESP outlets, series cyclone at the Unit 8 inlet.
- b. Integrated sample taken in conjunction with M5 type sampling.
- c. ESP outlets and stack only. Samples from 5 Series Cyclone train for particle size measurement were used for the Unit 8 inlet size-fractionated samples for trace metals analysis.
- d. Required greater than normal amounts of H_2O_2 in impingers because of high SO_2 concentrations.
- e. Sample taken on east ESP inlet duct so that the total gas and particulate flow rates to the Unit 8 ESP would be measured. This sample was also used for radionuclide analysis.
- ✓ Denotes sample not requiring a specific sampling time.

The number of sampling methods and trains required in utilizing all of these methods precluded doing them all simultaneously. In fact, it was not possible to do them all on any one sampling day at the stack because of limits in the numbers of ports, people, and equipment available for the tests. Therefore we planned to take three sets of samples of all types shown in Table 4-1 over a six-day period. The first three days were to be nominal inorganic sampling days during which the methods in the upper part of Table 4-1 were to be employed. The last three days were to be nominal organic sampling days during which the methods shown in the lower part of Table 4-1 were to be employed.

4.2.1 Sampling Details

Figures 4-2 and 4-3 show our planned sampling schedule for each of the four flue gas sampling locations - Unit 8 inlet, Units 7 and 8 outlets, and the stack. Spreading the sampling out over a two-day period for each set of samples also permitted greater sample volumes to be obtained than would otherwise have been the case. Thus the sensitivity of the methods, especially for metals and semivolatile organics, could be increased by sampling substantially greater than the minimum volumes called for by the methods.

A UMW strike, in progress at the time the tests had to be conducted, created difficulties in obtaining the correct coal needed for the tests. Therefore the DOE requested that the three replicate days of inorganic sampling be carried out before commencing the organic sampling. This was done in order to insure that a full set of the inorganic samples, to which the DOE gave a greater priority than the organic samples, was taken. A combination of coal supply difficulties and mechanical problems with parts of the plant's coal handling system forced a cessation of sampling after four test days, so only one of the three planned sets of organic samples was obtained.

Figures 4-4 through 4-7 present the actual schedule for flue gas sampling over the four test days. These charts show the time intervals over which flue gas sampling actually took place for each sampling method each day. The indicated intervals include the time required for port-to-port movement during traversing, so they represent the total elapsed time required to acquire the samples. Sampling of solids, liquids, and slurries is not indicated in Figures 4-4 through 4-7. Collection of these samples began as soon as flue gas sampling was underway. For those nine types of samples that were taken four or five times each test day, the sample collection was made at approximately two-hour intervals to span the flue gas testing period. The four samples that were taken once per day were collected in the late afternoon so that the sample represented material accumulated during the flue gas sampling period. One sample, the limestone, was obtained from Pure Air who had a plastic jar (~1 L) set aside for us from each of the trucks that delivered the limestone from Huber, Inc. (about 20 trucks per day).

We attempted to arrange the sampling schedules given in Figures 4-2 and 4-3 so that quantitative measures of particulate loading would be made each day at each location. On the nominal organics day we made Method 17 measurements, and on the nominal inorganic days the Method 29 and acid gases trains provided mass loading data.

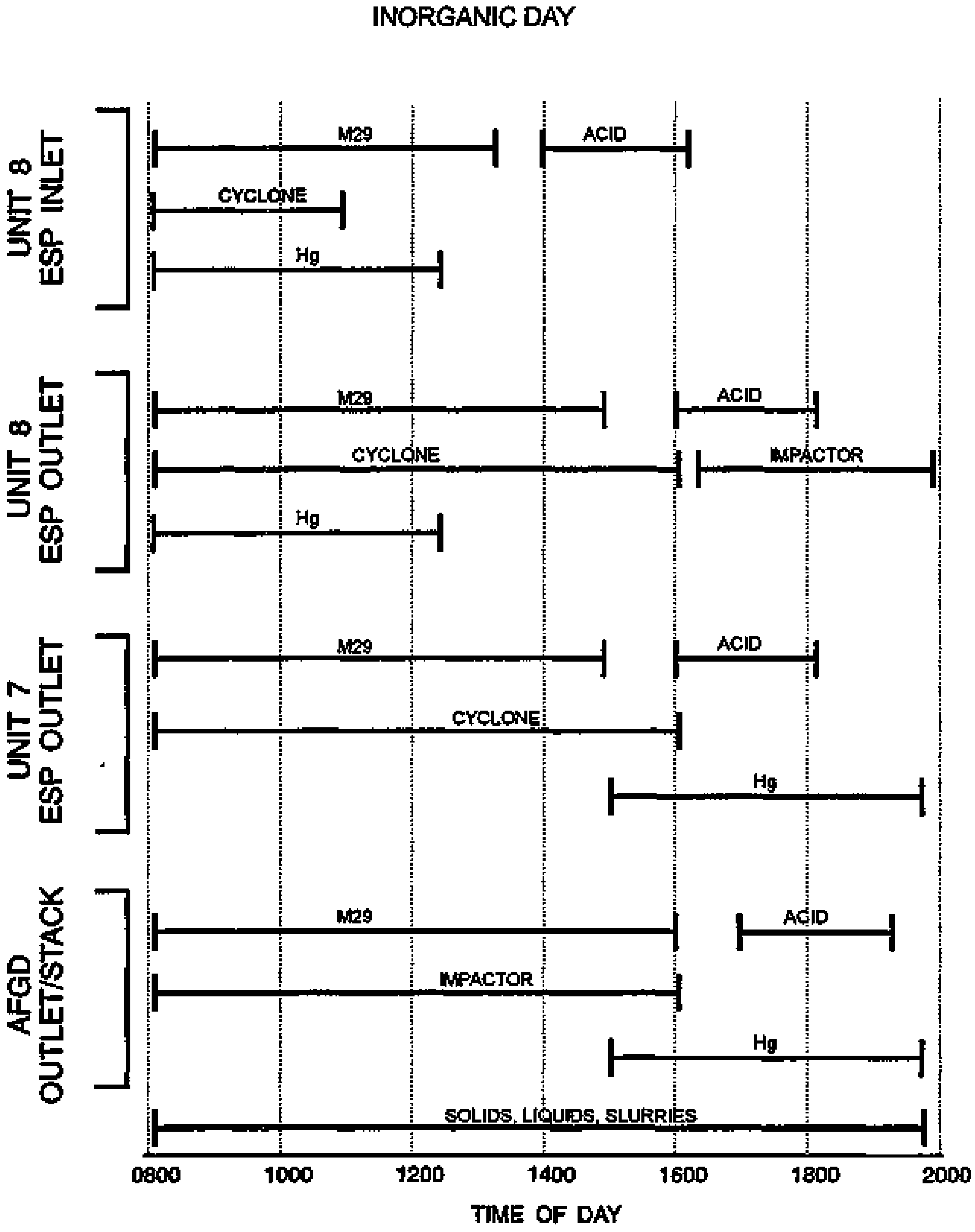


Figure 4-2 Typical Sampling Schedule for Inorganics

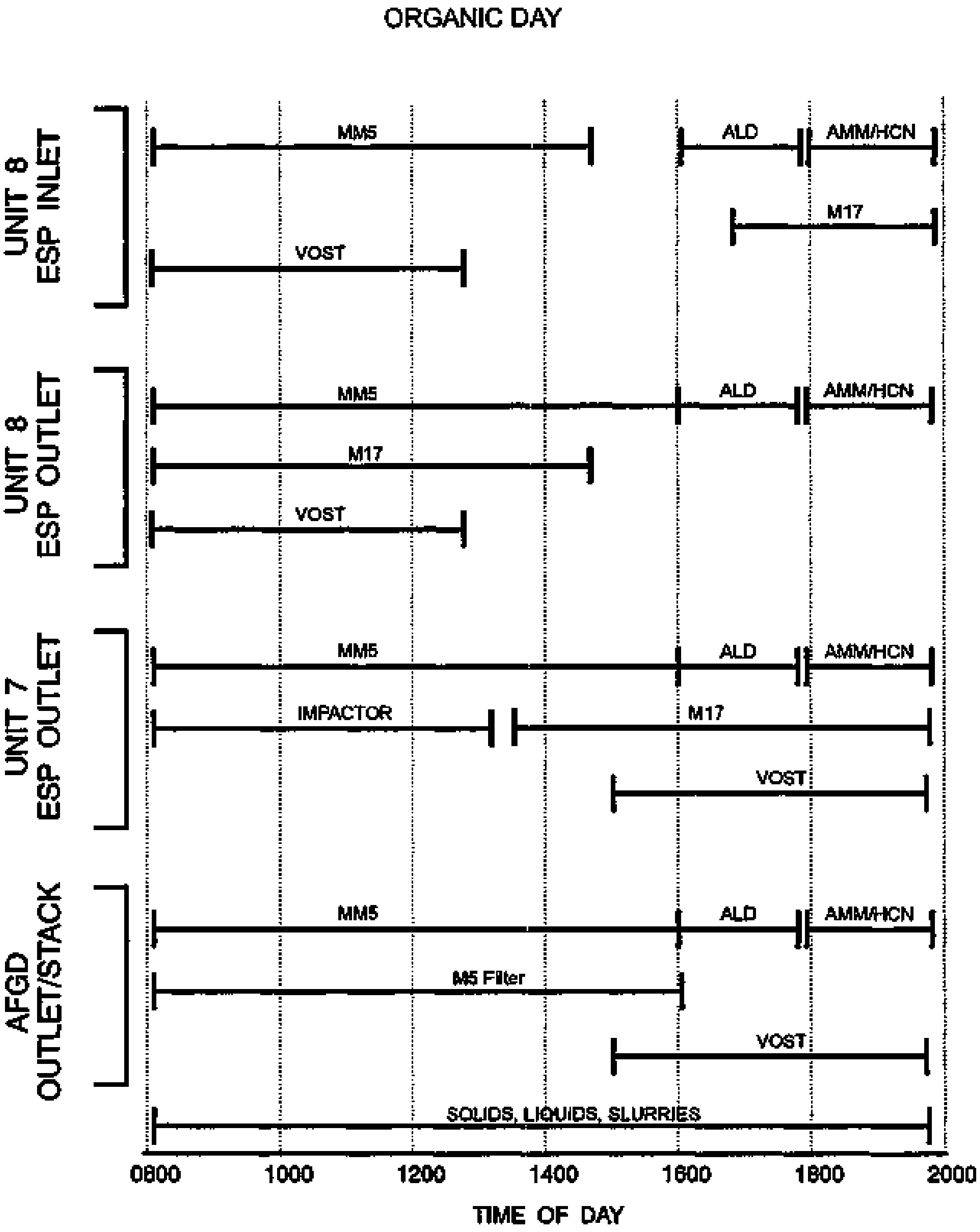


Figure 4-3 Typical Sampling Schedule for Organics

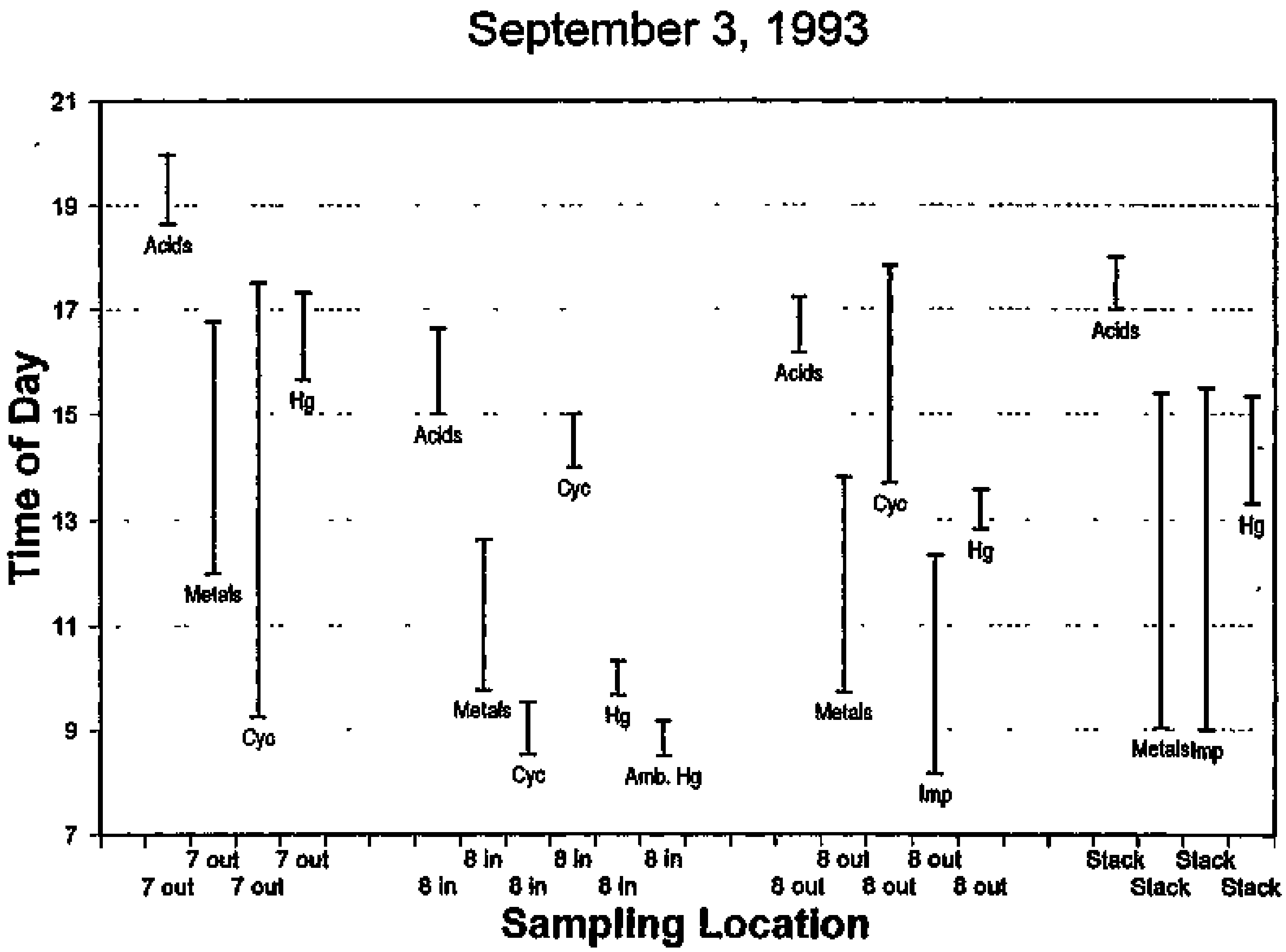


Figure 4-4. Actual Schedule of Sampling on September 3, 1993.

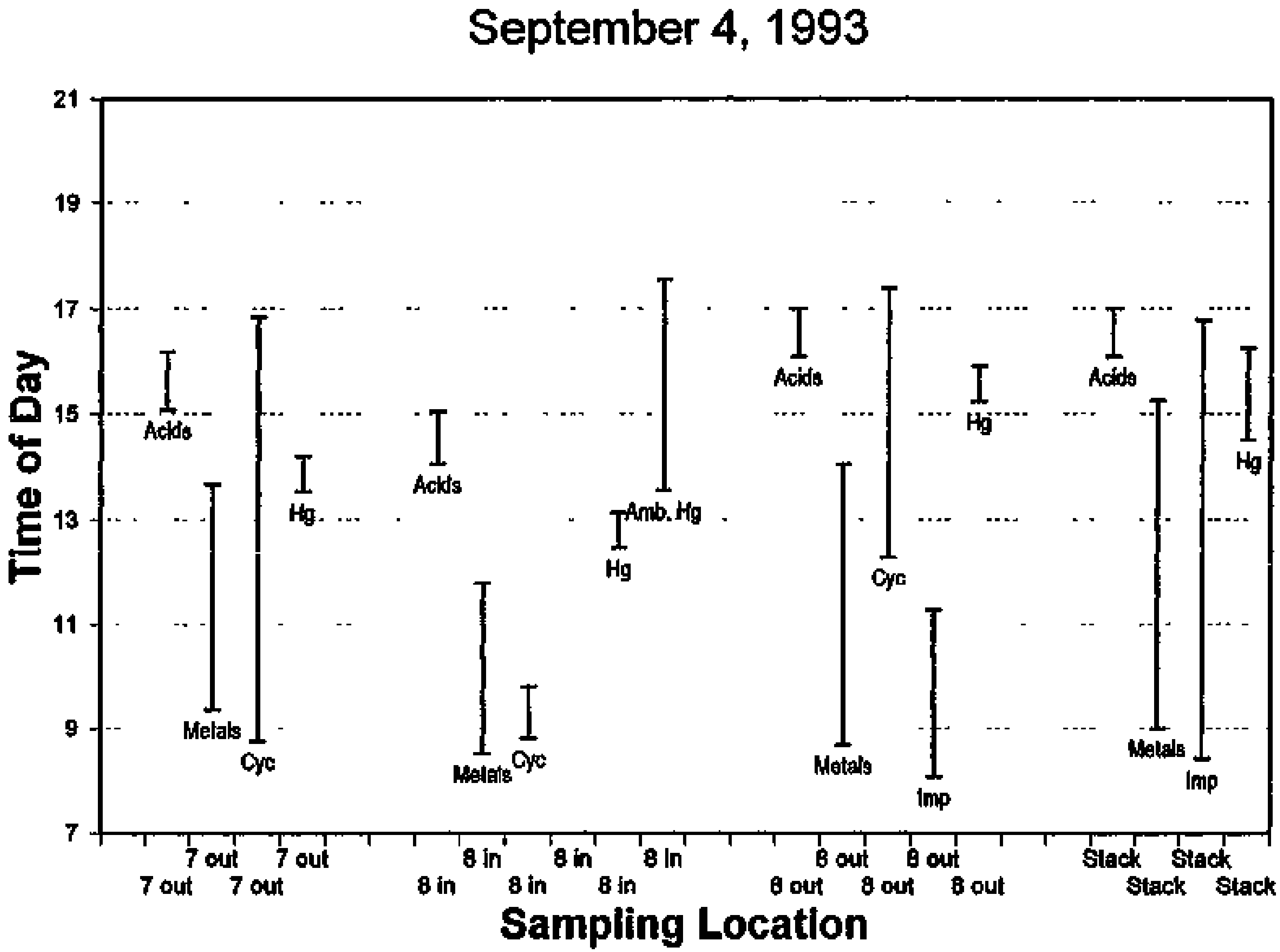


Figure 4-5. Actual Schedule for Sampling on September 4, 1993.

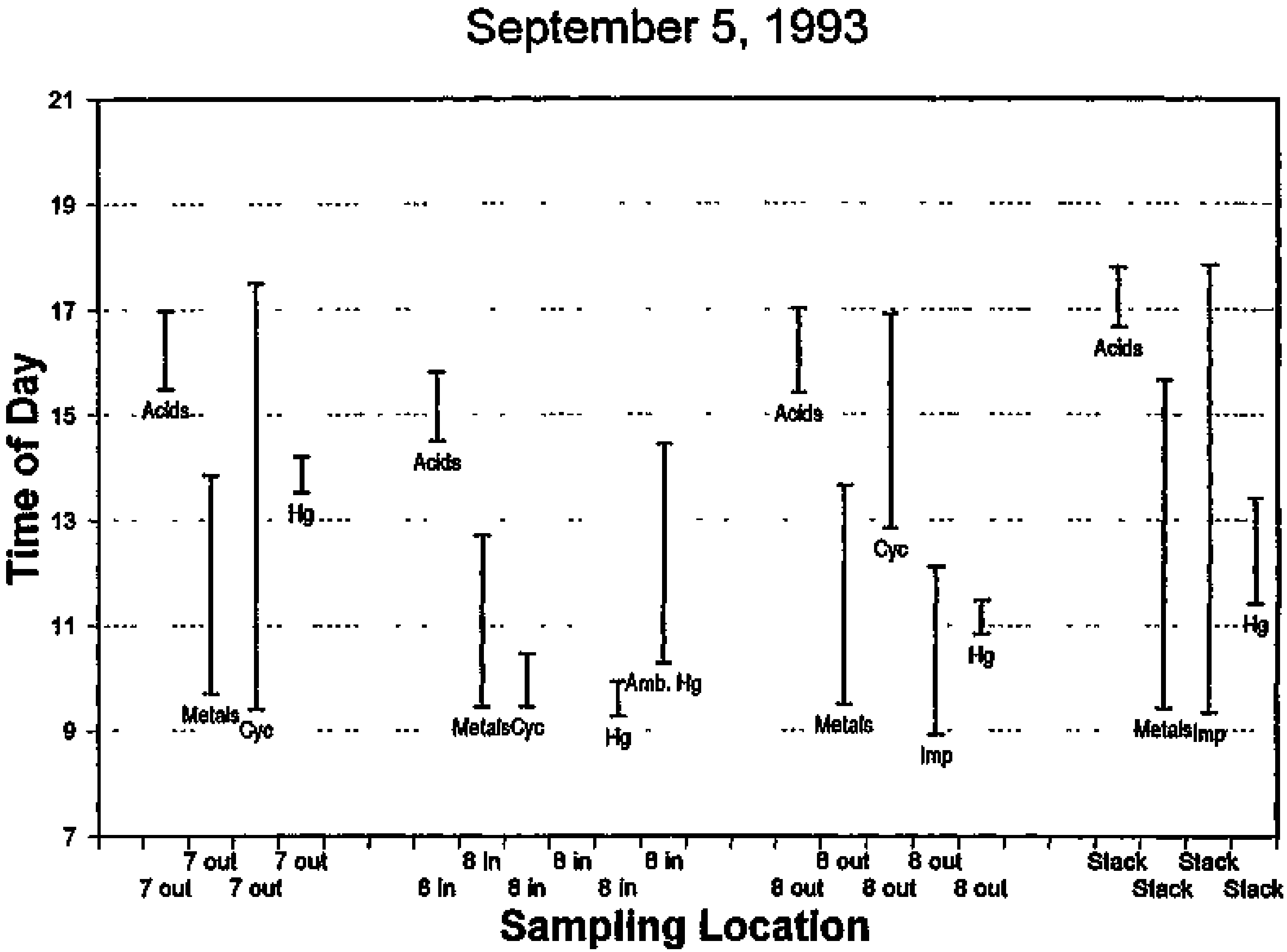


Figure 4-6. Actual Schedule for Sampling on September 5, 1993.

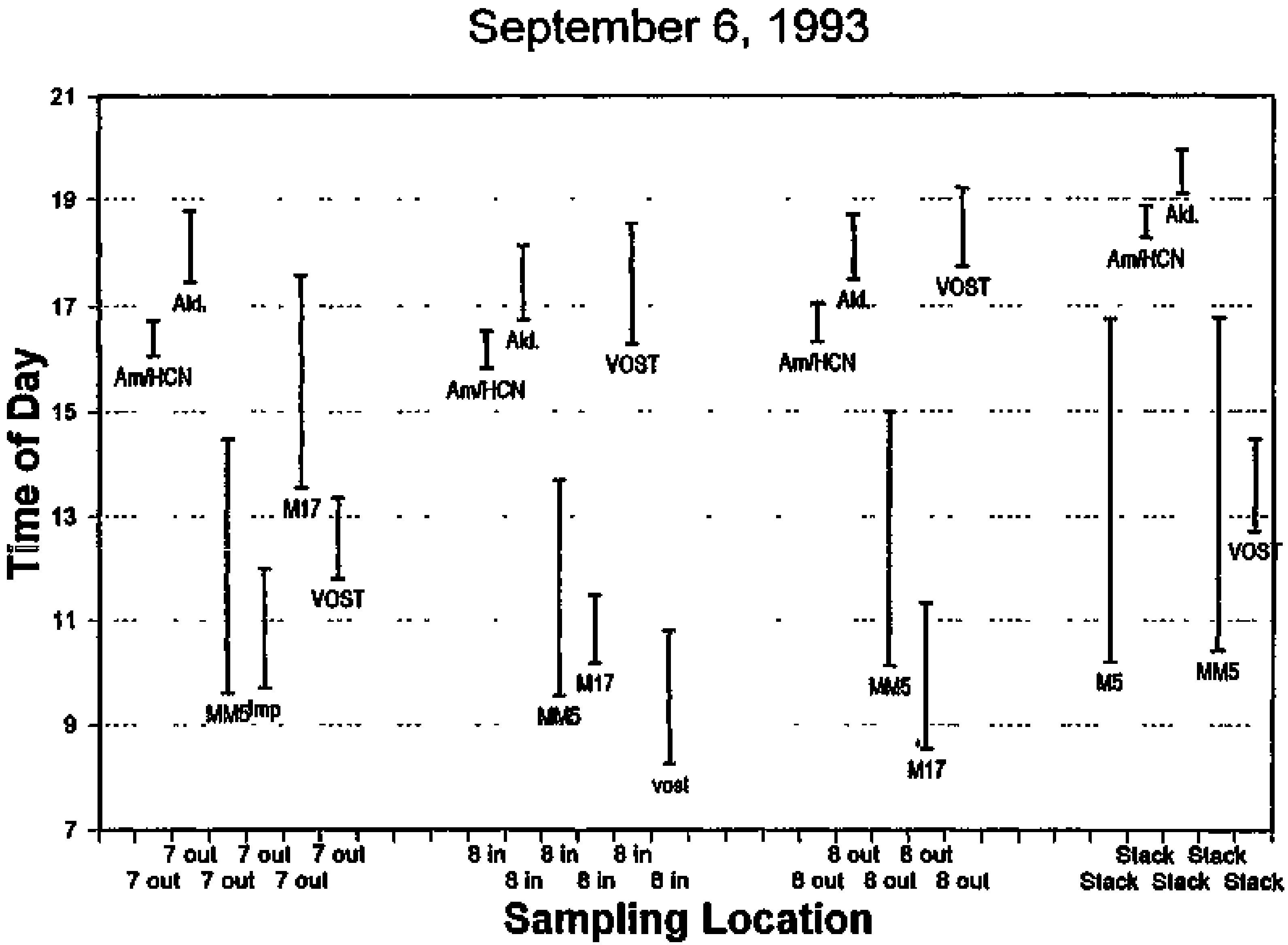


Figure 4-7. Actual Schedule for Sampling on September 6, 1993.

4.2.2 Deviations from Standard Techniques

The Method 5 type traversing samples were obtained using Pyrex glass and/or quartz-lined nozzles and probes in all cases. An *in situ* thimble type particulate collector was used for the Method 17 sampling at the Unit 8 inlet and 63 mm flat quartz fiber filters were used at the ESP outlet. A conventional Method 5 probe and oven was used at the stack for the radionuclide sampling because of the high moisture content and entrained water. The Method 5 type sampling at all locations was done using a small oven to contain the filter mounted at the external end of the probe. A flexible teflon umbilical line was used to convey the filtered sample gases to the condenser/impinger portions of the trains. The impingers were positioned at some convenient location adjacent to the sampling ports. Materials deposited in these umbilicals was recovered as part of the "back half" catches. All glass-to-glass connections were sealed with DuPont KryTox® sealant, a liquid fluorocarbon of the teflon family. SRI has used KryTox® on several tests of the type being done here, and it has proven satisfactory (non-interfering and low blank levels) for Method 29, Method 5, Method 23, and SW846 Method 0010 and offers superior performance in obtaining leak-free sampling systems.

Sampling at the stack posed three special problems. First, the *in situ* samplers had to contend with a saturated gas stream containing entrained water. Therefore, the impactor and its precollector used for particle size measurement were heated using an externally-mounted heating jacket and tape to collect the samples in a dry state. Second, the very long nipples (66 inches) through which the probes had to be inserted, together with the large stack diameter (33 feet), made it impractical to use the standard 12-point traverse pattern. Probes with working lengths in excess of 15 feet (overall lengths in excess of 16½ feet) would have been required - an impractical length for the glass-lined probes required for the acid gases, metals and semi-volatile organics trains. Consequently, the sampling was done with 12-foot working length probes and sampling at the innermost sampling point that could be reached was repeated to make up for the point that could not be reached. Finally, a permanent shelter on the sampling platform restricted access to the ports in one quadrant of the stack (see Figure 4-1). At that location, probe assemblies with overall lengths greater than about 8½ feet could not be used. Method 5 assemblies of that size would have barely been long enough to reach through the nipple into the flue gas. Therefore only three of the four ports to be used for traverse-type sampling were suitable for much of the sampling to be done here. One of the accessible ports was traversed a second time by each train to make up for the port that could not be used.

Similarly, the Unit 8 ESP outlet duct was so deep and the port nipples were so long that glass-lined probes longer than 16 feet would have been required to do the full, standard traverse. Again, 12-foot working length probes were used, with the consequence that the farthest point of the traverse at each port could not be reached. During our preliminary measurements a temporary extension was added to a pitot tube from which we found that the velocity at the point that could not be reached was about the same as that at the last point that could be reached with the 12-foot working length probe. Hence, the farthest point was omitted during the sampling and the second farthest was sampled twice to compensate.

The particulate concentration at the outlet of the Unit 8 ESP was so low that insufficient material could be collected with the cascade impactor in a single day of sampling to obtain useful results. Therefore, the measurement of particle size distribution at the Unit 8 ESP outlet was made using a single sample taken over three successive tests days rather than with three samples taken one per day for three days as was done at the Unit 8 ESP inlet, the Unit 7 ESP outlet, and the stack.

Sampling for ESP outlet and stack samples was four to six hours in duration, permitting gas volumes of about 5 to 6 m^3 of stack gas to be sampled with the Modified Method 5 and Method 29 trains. Because of the high SO_2, substantially smaller sample volumes were obtained with the acid trains. Sampling at the Unit 8 inlet for M29 (metals) trains was about three hours duration and for MM5 trains was about four hours duration, permitting volumes of 3 to 5 m^3 of gas to be sampled with these Method 5 type trains. VOST samples of 20, 10, and 5 liters were taken at all locations. Aldehyde and ammonia/cyanide gas sample volumes were about 0.5 m^3 at all locations. Sampling times for acid gases and anions were about one hour at all locations. This train was traversed to ensure representative collection of anions in the particulate phase. Radionuclide sampling times were about 1 to 6 hours, depending on location, and were set to provide particulate catches of 150 mg or more.

Because of the greater than normal gas volumes being sampled in order to reduce detection limits in the M29 trains, we feared that the H_2O_2 would be depleted by the SO_2 in the flue gas. Consequently, an additional 40 mL of the peroxide solution was added to the impingers on the first day of sampling (9/3/93). Thereafter, the impinger solutions were made up with the liquid volumes specified by the method but the peroxide concentrations in the solutions were increased from 10% to 15%. Similarly, because the permanganate impingers lost most of their color during the first day of sampling, we concluded that the amount of permanganate called for by the method was marginal for our sampling circumstances and an additional 50 mL, a 50% increase, was used thereafter.

Further, we concluded that the sample recovery protocol for the M29 permanganate impingers resulted in unnecessary dilution and consequent loss of sensitivity for Hg. The volumes of rinse solutions used were reduced so that a total of 125 mL of solutions were used as compared to 425 mL called for by the method protocol.

On 9/3/93 the primary circuit providing power to the Unit 7 outlet location was overloaded, causing a loss of power to all trains in use at the time at that location. The cyclone sampler was without power for about 2 minutes and the diluter lost power for several minutes while a new power source was located and a new drop cord was strung to avoid a recurrence of the problem.

Also on 9/3/93, when the probe for the diluter was withdrawn the sampling nozzle was found to have rotated about 65 degrees from its proper orientation. A combination of glass tape and wire was used to secure it more firmly for all subsequent runs.

All sampling trains passed the required pre-test and post-test leak checks throughout the test program with one exception. One acid gases train at the Unit 8 inlet was accidentally dropped after the sampling had been completed and before the post-test leak check could be made. Inspection revealed that a ball-joint connector on the filter holder had been cracked, almost certainly when the train was dropped. The moisture content calculated from the data from this run was consistent with that from previous and subsequent runs; therefore, the data from the run were retained as being valid.

4.3 Samples Collected

4.3.1 Lists of Samples

The types of samples collected for analysis from solid and liquid streams are listed in Table 4-2. Three of the streams listed under liquids were slurries; both the liquid and solid phases of these slurries were included in the analysis (as separate materials). Although typically five daily samples of the solids and liquids were collected (with the exception of the bottom ash sluice which was collected only one time per day), composites were prepared so that only one sample representing the daily set had to be analyzed. The methods of preparing composites are described later in this section.

The types of samples collected from the gas streams for the purpose of analysis are listed in Table 4-3. For all analyses except particulate mass loading, only the west ESP inlet duct to Unit 8 was sampled to represent the entirety of the boiler flue gases entering the ESPs. The samples listed in Table 4-3 were in no case composited. In fact, some samples listed individually consisted of several components that were analyzed separately. One example was the sample of trace metals, which consisted of 1) the filter and solids rinsed from the probe, 2) the peroxide impingers, and 3) the permanganate impingers.

4.3.2 Sampling Methods

4.3.2.1 Bulk Solids

Coal Pile Runoff -- Boiler feed coal was used to determine the leaching characteristics of the coal. The collection of boiler feed coal is described below. SRI split the boiler feed samples to produce a composite to be used for the Toxicity Characteristic Leaching Procedure, commonly referred to as TCLP (6). Four daily composite samples, one for each day of testing, were riffled together to yield a single composite sample for TCLP analysis to represent the boiler feed coal during the test period.

Boiler Feed Coal -- Samples of the coal being burned in Unit No. 8 were taken with augers installed at the base of the coal silos feeding each of the eight cyclone burners. Only five of the eight augers were operational, so the samples collected were

Table 4-2

Samples Collected for Analysis from Solid, Liquid, and Slurry Streams

	Number of Samples Daily
SOLIDS	
Coal	5
ESP Hopper Ash	3
Limestone [a]	~20
Bottom Ash	1
Gypsum [b]	1
LIQUIDS	
Unit 8 Condenser Inlet	5
Unit 8 Condenser Outlet	5
Bottom Ash Sluice Water Supply	5
Bottom Ash Sluice Water [c]	1
Condenser Makeup Water [d]	10
AFGD Service Makeup Water	5
AFGD Waste Water	5
SLURRIES	
Bleed Pump Slurry	5
Absorber Recirculation Pump	5

NOTES:

a. Sample from each truck of pulverized limestone delivered during the test day. Sample taken by Huber, Inc.
b. Composite automatically taken with a sampler maintained by Pure Air.
c. Liquid phase of the bottom ash sluice.
d. Five samples were taken each day from each of two storage tanks in use.

Table 4-3

Samples Collected for Analysis from Flue Gas Streams (sum of all test days)

Type of Sample	Unit 8 ESP Inlet	Unit 8 ESP Outlet	Unit 7 ESP Outlet	Unit 7 Outlet /Diluter	Stack	Ambient
Trace Metals	3	3	3	3	3	
Mercury [a]	3	3	3	3	3	2
Acid Gases	3	3	3	3	3	
Ammonia/HCN	1	1	1		1	
Aldehydes [b]	1	1	1		1	1
Volatile Organics [c]	3	3	3		3	3
Semivolatile Organics	1	1	1	1	1	
Cyclone Solids	3	1	1			
Impactor Solids		3	3		3	

NOTES:

a. Two of the three flue gas samples and one ambient sample were for speciation of mercury using soda lime and carbon traps. The third flue gas sample and one ambient sample were for total mercury using only carbon traps.

b. The "ambient" aldehyde sample was a sample of $\sim 2\ m^3$ of air from inside the trailer being used for DNPH reagent preparation and recovery.

c. Three sample volumes were collected on one test day.

from these augers. Each day we collected one sample every two hours for a 10-hour period concurrent with the flue gas sampling. We collected each two-hour sample in a single 5-gallon bucket that was itself a composite of the feed to the five cyclones with operational augers. We sealed and labeled each bucket. Before analysis these five buckets per day were combined by riffling the coal into a single composite sample for each test day.

Bottom Ash — Bottom ash is collected in a wet storage hopper beneath the boiler, passes through a clinker grinder, and is then discharged as a sluice stream at about eight-hour intervals. Bottom ash is approximately 63% of the ash from the coal. The only accessible sampling location for bottom ash was at the sluice discharge into the settling pond. Therefore the sampling of bottom ash was coordinated with the bottom ash discharge. A type 316 stainless steel bucket was used to collect a sample of the sluice as it was discharged into the pond. One sample of bottom ash sluice was collected per test day. These were stored in glass jars with teflon-lined lids, sealed and labeled appropriately.

ESP Hopper Ash — There are three rows of hoppers in the direction of gas flow in each of the ESPs. The ESP hoppers are evacuated twice per shift each day. To collect a representative sample of the distribution of ash collected in the ESP, we attempted to collect samples from one hopper in each of the three rows before the hoppers were evacuated. On the first day of sampling we were unable to get any ash from the last row of hoppers. On the subsequent days we obtained samples from a hopper in all three rows. Grab samples were collected before the hoppers were emptied through poke holes at the base of the hoppers with a type 304 stainless steel ladle, and placed in sealed and labeled 500 mL glass jars with teflon-lined lids. The samples from the three hoppers were subsequently combined in proportions based on the collection efficiency of the ESP and the exponential nature of mass collection in ESPs to make daily composite samples.

Limestone — Finely ground limestone is delivered to the AFGD plant daily from the nearby supplier (Huber). The limestone is pneumatically transported into the storage hopper which is sealed and pressurized. Huber takes grab samples of the limestone delivered in each truck, and provided us with a sample collected from each truck. About 20 truckloads per day are required to operate the unit at full load. We later combined the samples provided by Huber into a daily composite sample.

Gypsum — An automatic sampler collects samples of the gypsum from the centrifugal dryer off of the conveyer belt that delivers the gypsum to the storage building. The sampler has a programmable frequency, and normally collects a sample every 48 minutes. SRI obtained a daily composite sample of gypsum from this sampler that is operated by Pure Air.

4.3.2.2 Liquid Streams

In the collection of all liquid streams, we allowed residue to clear the sample source (water or slurry tap or pipe outlet) by discharging some of the sample stream before collecting the sample to be analyzed. We collected five samples per day at two-hour intervals, except for the bottom ash slurry described above, in glass jars with teflon-lined lids. We also collected two samples per day from each stream in Volatile Organic Analysis vials (40 ml). None of the streams were sampled through rubber hoses or plastic pipes.

Condenser Inlet Water — Circulating water is not treated. We collected samples of condenser inlet water from the intake from Lake Michigan.

Condenser Outlet Water — Condenser outlet water samples were taken at the point of discharge into Lake Michigan.

Bottom Ash Sluice — Bottom ash sluice was sampled at the discharge into the settling pond (see Section 4.3.2.1).

Sluice Return Water — The supply of water for the bottom ash sluice is a return pond containing clarified water from the bottom ash sluice. We sampled the sluice return water from a tap on the low pressure side of the bottom ash sluice pump located in the basement of Unit 8.

Makeup Water — Treated water is used for makeup water to the condensers. We sampled from the two storage tanks for Unit 8 makeup water.

Service Water — Service water is used for makeup water throughout the AFGD process. We sampled the service water from a tap in the AFGD scrubber building.

AFGD Waste Water — Waste water from the AFGD process was sampled at the outlet of the thickener overflow tank.

Bleed Pump Slurry — This slurry was collected from the bleed pump on the forced oxidation side of the scrubber slurry collection system in the AFGD process. It was collected at the outlet of the bleed pump.

Absorber Recirculation Pump Slurry — This slurry was collected from the recycle side of the scrubber slurry collection system in the AFGD process. It was collected at the outlet of the absorber recirculation pump that feeds the slurry spray system.

4.3.2.3 Flue Gases

Tables 4-1 and 4-3 list the manual flue gas sampling methods employed in this test program. All glassware and probes, etc., were cleaned per EPA specification prior to use. Pallflex QAST 2500 pure quartz filters were used as the collection medium for all particulate sampling. The Method 5 type traversing samples were obtained using Pyrex glass and/or quartz lined nozzles and probes in all cases. An *in situ* thimble type particulate collector was used for the Method 17 sampling at the East inlet to the Unit 8 ESP. For the Method 5 sampling variants at all locations a small oven was mounted at the external end of the probe to contain the filter. A flexible teflon umbilical line was then used to convey the filtered sample gases to the condenser/impinger portions of the train. The latter were positioned at some convenient fixed location adjacent to the sampling ports. Materials deposited in these umbilicals was recovered as part of the "back half" catches. All glass-to-glass connections except those in the high temperature parts of the trains were sealed with DuPont KryTox® sealant, a liquid fluorocarbon of the teflon family. SRI has used KryTox® on several tests of the type done here, including RCRA Trial Burns, and it has proven satisfactory (non-interfering and low blank levels) for Method 29, Method 5, Method 23, and SW846 Method 0010 and offers superior performance in obtaining leak-free sampling systems.

Three of the sampling methods listed in Table 4-3 were carried out as described in EPA publications, which are identified in one of the footnotes of the table:

- Method 29, proposed for eventual incorporation in Code of Federal Regulations, for sampling trace metals in both particulate and vapor forms (based on a filter for collecting solids, peroxide-based impingers for vapors of all metals, and permanganate-based impingers for mercury vapor alone that penetrates the peroxide impingers).

- Method 0030, Volatile Organic Sampling Train (VOST), which is described in SW-846, Test Methods for Evaluating Solid Waste. This train collects vapors only, first in a sorption tube of the resin Tenax and then in a second sorption tube containing Tenax in the leading section and charcoal in the back section. The train also collects the condensate of water vapor, which is set aside for analysis along with the two sorption tubes.

- Method 0010, Modified Method 5 train, which is also an SW-846 method. This train collects semi-volatile organic compounds (including dioxins and furans) in a three-component sampling section; 1) a filter for solids, 2) an XAD-2 resin cartridge, and 3) water-containing impingers.

Several of the sampling methods are not incorporated in the EPA methods published in CFR or SW-846. These methods are described briefly in the paragraphs that follow:

- Mercury was included in the samples collected by Method 29. It was also collected as the single analyte by a sorption method described by Bloom (2). Two iodated carbon tubes purchased from Mine Safety Appliances were arranged in a tandem fashion to adsorb mercury from the vapor state. The gas is not sampled isokinetically in this method, but particulate matter is kept out of the sorption tubes by use of a quartz wool plug. The particulate matter from the gas stream that is retained in the quartz wool may be analyzed or may be discarded. When it is analyzed, it is included with the sorption tubes and usually contains a negligible quantity of mercury. The particulate matter was discarded in this project; only the vapor collected on the sorption tubes was analyzed.

- The acid gases were sampled by use of the Method 5 train in which each of two impingers are filled with a solution 2.5 g of sodium carbonate, 2.5 g of sodium bicarbonate, and 10 mL of 30% hydrogen peroxide. The solids on the filter were retained for analysis as well as the impinger solutions.

- The gases ammonia and hydrogen cyanide were collected in a seperate sampling train of the Method 5 type in which the first two impingers each contained 100 mL of the mixture of carbonate and bicarbonate described above, but no peroxide, and the second two impingers each contained 100 mL of 0.1 N sulfuric acid. Both of the gases to be collected are highly soluble in water, and both may be retained to a high degree even in plain water with no added acid of base, especially at the low partial pressures of the gases expected. The purpose of the carbonate and bicarbonate, then, were to add insurance for the retention of HCN (a weak acid), and the purpose of the sulfuric acid was to retain any NH_3 that might penetrate the first alkaline impingers.

- Aldehydes were collected with a Method 5 train in which two impingers containing 100 mL of 0.025% 2,4-dinitrophenylhydrazine were used as the collection medium. The filter of the train was not retained. The operation of the aldehyde sampling train was similar to the aldehyde collection procedures in EPA Method T05 for ambient air and EPA tentative SW-846 Method 0011.

Dilution Sampling

The custom SRI diluter was operated to collect simulated plume samples each day. The dilution air was ambient air that has conditioned by being dried by passing it over silica gel, chilled by passage through an ice bath chiller, scrubbed by passing it through activated charcoal, and finally filtered through an absolute filter. The sample gas stream was withdrawn through a glass nozzle and glass-lined probe to the diluter. The interior surfaces of the diluter were teflon coated. On the "inorganics" sampling days the following samplers were used with the dilution system: two M29 impinger trains (to be pooled for analysis), an iodated charcoal trap for total mercury in the vapor phase, and an acid gas impinger train. On the "organics" test days two MM5 condenser/sorbent trap/impinger trains were run on the diluted gas stream. The MM5 condensers and traps were chilled as they are for conventional stack sampling. The catches of the two trains were pooled for analysis to increase sensitivity. No VOST sampling was done from the diluter. First, because there would be no conventional stack sampling methods to which dilution samples might be compared and, second, the solvents used in the recovery of the particulate samples from the front half of the dilution train for particulate phase metals and semivolatile organics would result in severe contamination problems for VOST samples. A flue gas sampling rate of about 0.5 dscfm was used. At one point during the test program a blank run was made as a QA/QC measure in which only dilution air was sampled with one of each of the impinger trains for the same duration as in the actual tests.

Particle Size Distribution Measurements

The combination of high gas velocity and high particulate loading at the Unit 8 inlet made the use of cascade impactors for particle size measurement at that location impractical. High particulate concentration gas streams require low flow rate impactors in order to provide reasonably long sampling times with a minimum of several minutes being needed. However, the gas velocities in the duct, 24 m/s, would have resulted in sub-millimeter nozzle tip sizes being required for isokinetic sampling with low flow rate impactors. Obtaining accurate and/or representative samples with such small tip sizes is problematical. Therefore, instead of impactors, we used the SRI/EPA Five Series Cyclone sampler for the Unit 8 inlet particle size distribution measurements. The series cyclone system provides data in six size fractions with cuts at about 10μm, 6.5μm, 4.5μm, 2μm, and 1μm - comparable to those obtained with most impactors. The cyclones have very large holding capacities and thus avoid the rapid overloading problems encountered with impactors and they do not suffer from particle bounce problems. Consequently they can be operated at higher flow rates than impactors, thus avoiding the problem of small nozzle tip sizes. The same samples obtained for size distribution purposes at the Unit 8 inlet were also used for the purpose of trace element analysis by size for that location. The catches of the three cyclones with cuts smaller than 5μm and the filter were combined after weighing to form a single sample for the <5μm fraction, while the catches of the first two cyclones were retained intact. The sampling at the ESP outlets for trace metal composition versus size was done using the first two cyclones of the SRI/EPA set followed by a filter.

More complete descriptions of sampling methods and trains are given in Appendix B.

4.3.3 Compositing of Solids and Liquids

The procedures used to obtain daily composites of four types of solids (coal, ESP hopper ash, limestone, and gypsum) were described in Section 4.3.2.1. More complete information in regard to blending of ash from different rows of the ESP is presented in Section 6.1.1.2.

As for samples of plain water and slurries, composite were prepared from five daily samples of each. Composites of plain water consisted of equal volumes (approximately 100 mL) of each of the five available samples. Composites of the liquid phase of the absorber recirculating slurry and bleed pump slurry were prepared similarly; that is, a selected volume of the clear supernatant aqueous phase was decanted from each of five daily samples, and the five portions were combined. Composites of the wet, compacted solids from the slurries were similarly prepared after the supernatant had been decanted; 50 g portions of the wet solid matter from daily samples were combined and mixed. In addition, the percentage of solids in each daily sample of these two types of slurries was determined. For the bottom ash sluice, in contrast to the two types of slurries from the scrubber, there was only a single daily sample, and thus compositing was not performed. The liquid samples were prepared and analyzed without the addition of preservatives.

4.4 Mass Flow Rates

Mass flow rates for the process streams at Bailly Station Units 7 and 8 and the Pure Air AFGD were either measured by SRI, recorded with the plant control/data acquisition systems, calculated from mass and energy balances, or estimated. The test periods are taken as stable operating periods, and a single flow rate for each process stream, representing the pseudo-steady-state conditions, is calculated for each day of inorganic element testing. The data supplied by the plant system were averaged for the test period.

Table 4-4 lists measured flow rates of flue gases at the sampling locations. These data are normalized to a constant oxygen level (3% by volume). Measured oxygen and carbon dioxide values (dry basis) are given in Table 4-5. Data from Tables 4-4 and 4-5 should be considered together to account for air leaks into the flue gas stream. Also important to the calculation of mass flows is the water measured in the flue gases. Table 4-6 gives the water as a percentage of the flue gas volumes at the sampling locations for all of the sampling trains. These results suggest that there were no significant leaks in any of the sampling trains.

Particulate concentrations in the flue gas streams are shown in Table 4-7. These data and the flow rates in Table 4-4 yield, in combination, the mass flow rate of solids in the flue gases at the sampling locations, and are therefore used in material balance calculations for solid phase pollutants. There is a large discrepancy between the mass loadings determined at Unit 8 outlet with the Method 29 metals train and the acid gases train. We were unsuccessful in resolving this discrepancy. Output from the opacity monitor at the Unit 8 outlet does not show any difference in emissions from the ESP during the two sampling times. We obtained opacity data with a six-minute resolution to evaluate this difference. There are two potential explanations, however. First and most likely, we were obtaining grab samples from the ESP hoppers during the time when the acid gases train was sampling at the ESP outlet. Because of the suction caused by the static pressure in the ESP, we may have entrained ash from the hoppers into the outlet duct by opening an access port on a hopper. Another but unlikely possibility is that the timing of the acid gases train coincided more with the rapping of the last field in the ESP than did the metals train sampling. We were told that the rapping interval on the last ESP field was one hour. We used the mass concentrations measured by the Method 29 metals trains for the mass flows of particulate matter.

The power plant can be broken into six sub-systems: the Unit 8 boiler, the Unit 8 ESPs, the Unit 8 condenser, the bottom ash removal, flue gas mixing, and the AFGD scrubber system. In the following section, the main inlet and outlet flows for each of these areas are discussed.

Mass flows for the plant for each of the three inorganic test days are presented in Tables 4-8 through 4-10 (these tables are presented beginning on page 4-29). Appendix E is a step-by-step example that shows how the mass flows were calculated, using September 3, 1993 as the example. Table 4-11 lists the average mass flows for the plant over the three test days; Table 4-11A lists the sample standard deviations.

Table 4-11 shows the mass balance closure (out/in) as an average of the closures for the three days and as a closure of the average flows. Each day is considered to be an independent measurement, so that the average of the daily closures is valid. If there is a change in conditions or coal from day to day, the average of the closures would show no effect, whereas the closure of the average flows could be disturbed.

4.4.1 Unit 8 Boiler

The boiler is taken as the cyclone barrels, the slag quenching system, the economizers, and the air heaters. Thus the input streams are the crushed coal and the combustion air. The output streams are the flue gas and particulate flows into the electrostatic precipitators and the bottom ash (or slag) from the cyclone barrels. According to the plant and consistent with cyclone firing, the economizer hoppers do not collect any ash of note, and are ignored for the boiler balance.

The coal is gravimetrically fed to the cyclone barrels via weigh-belt feeders, and the total flow rate for all eight cyclone barrels is recorded in the Unit 8 control computer. The combustion air flow rate is calculated by a stoichiometric combustion calculation with the measured amount of excess air added. The flue gas flow rate is measured at the ESP inlet, and the particulate flow taken from the measurements in the Method 29 metals train operation. The bottom ash flow is calculated from an ash balance, the coal ash input minus the fly ash flow rate at the ESP inlet. This approach yields a fly ash to bottom ash ratio of 33/67, which is close to the historical average of 37/63 for Units 7 and 8 combined for 1992, 1991, and 1990.

The average closure for the boiler is 114%, which represents the imbalance between the calculated combustion air and the flue gas flow.

4.4.2 Unit 8 Electrostatic Precipitators

The Unit 8 particulate control is achieved through the use of parallel ESPs. The western ESP was sampled by SRI using the Method 29 metals train, and the eastern ESP was sampled for particulate flows by EPA Method 17. The data, reported in Table 4-7, show similar fly ash loadings in each ESP inlet, so the Method 29 values of particulate loading were used for both ESPs. The actual flow rate of flue gas through each side was taken to be the measured value. Outlet measurements of the Unit 8 ESPs were performed on the duct after the flow through both ESPs was mixed. Therefore, the values of flue gas flows and particulate loadings were measured directly by Method 29. The flow rate of ash collected in the ESP hoppers is calculated by the difference in the particulate flow rate into and out of the ESPs.

The Unit 8 ESP average closure is 109%, which indicates the differences in the measured inlet flow and the outlet flow.

4.4.3 Unit 8 Condensers

The condensers for Unit 8 use a once-through cooling water flow obtained from Lake Michigan. The cooling water inlet and outlet temperatures were recorded by the plant data acquisition system. The actual flow rate of cooling water was not obtained from the plant, but was estimated from the condensate flow rate. The condensers operate mainly to condense the steam exiting the turbines to be recycled to the boiler feed pumps. By calculating the latent heat required to condense the amount of water making up the condensate flow and the cooling water temperature change, the cooling water flow rate was estimated. This calculated flow was checked by using a 33% plant efficiency, assuming the rejected heat was all taken by the cooling water. This estimate was about 10% higher than the flow calculated by the condensate flow.

The condenser average closure is assumed to be 100%.

4.4.4 Bottom Ash Sluice

The flows in the bottom ash sluice are estimated. The bottom ash flow rate into the sluicing system is determined in the boiler balance. From the two-phase samples taken and observations of the sluicing operation, it is estimated that the water mass used to remove the slag is 10 times the mass of the bottom ash. The slag is assumed not to dissolve in the water, except for very trace amounts. Therefore, the bottom ash in equals the bottom ash out.

The average closure for the bottom ash sluice is assumed to be 100%.

4.4.5 Unit 8 Overall

The boiler system is a summation of the boiler, the ESP, and the bottom ash sluice. The condenser loop is not included in the overall balance. The condenser flows are 20 times larger than any other flow, and tend to dampen out any other result, especially since the condenser system is assumed to balance perfectly. The input streams are the coal, combustion air, makeup water, and sluice return water. The output streams are the bottom ash sluice, the ESP hopper ash, and the flue gas to the Pure Air AFGD system.

The overall average closure for Unit 8 is 101%.

4.4.6 Flue Gas Mixing

The flue gas from the Unit 8 ESPs is mixed with the Unit 7 ESP output before going to the AFGD system. A perfect flue gas and particulate balance is assumed in this sub-system. The measurements of the ESP outlets are algebraically combined to give the output.

The average closure for the flue gas mixing is assumed to be 100%.

4.4.7 AFGD System Overall

The Pure Air Advanced Flue Gas Desulfurization (AFGD) system material balance is drawn around the entire process. The inputs are the combined flue gas streams from Units 7 and 8 electrostatic precipitators, limestone, compressed air, and service water. The output streams are the flue gas to the stack, gypsum, and waste water. The flue gas input and output were measured by Method 29, and the SO_2 concentrations were measured by calibrated continuous monitors. The SO_2 removed from the flue gas was assumed to exit the system as sulfate in gypsum, and the gypsum flow rate was calculated on that basis using the measured sulfate concentration of the gypsum. A calcium balance around the AFGD system determined the limestone flow rate. The compressed air flow rate was taken from the AFGD process data, as was the flow rate of waste water to wastewater treatment. The service water supplied to the AFGD system was calculated by a water balance around the system. As can be seen in Table 4-11, the overall balance of the flow rates is quite good, at 101 percent closure, based on these assumptions.

The average closure for the AFGD system is 101%.

Table 4-4. Bailly Measured Gas Flow Rates

(Reference conditions: dry, 3% O2, 293.15 K, 1 atm)

Flows in kdscfm

		LOCATIONS				
DATE		Unit 8 Inlet	Unit 8 Outlet	Unit 7 Outlet	Combined Outlet	Stack
9/3	M29	592	655	366	1021	1026
	Acid	596	681	366	1047	965
9/4	M29	575	646	349	995	1014
	Acid	582	583	334	917	1009
9/5	M29	567	658	352	1010	993
	Acid	541	704	350	1054	1006
9/6	MM5	586	651	348	999	1075
	M17	638	665	330	995	973
AVERAGE		585	655	349	1005	1008

RATIOS

DATE		Unit 8 Out/In	Stack/ 7+8 Out
9/3	M29	1.11	1.00
	Acid	1.14	0.92
9/4	M29	1.12	1.02
	Acid	1.00	1.10
9/5	M29	1.16	0.98
	Acid	1.30	0.95
9/6	MM5	1.11	1.08
	M17	1.04	0.98
AVERAGE		1.12	1.00

Flows in Nm3/s

		LOCATIONS				
DATE		Unit 8 Inlet	Unit 8 Outlet	Unit 7 Outlet	Combined Outlet	Stack
9/3	M29	279	309	173	482	484
	Acid	281	321	173	494	455
9/4	M29	271	305	165	470	479
	Acid	275	275	158	433	476
9/5	M29	268	310	166	476	469
	Acid	255	332	165	497	475
9/6	MM5	277	307	164	471	507
	M17	301	314	155	470	459
AVERAGE		276	309	165	474	476

Table 4-5. Orsat Results: Flue Gas O_2 and CO_2 as Volume Percentages

Date		Unit 8 Inlet	Unit 7 Outlet	Unit 8 Outlet	Stack
9/3	O_2	5.5	6.2	5.7	6.3
	CO_2	13.4	12.8	13.3	12.8
	O_2	5.3			
	CO_2	13.7			
9/4	O_2	5.2	6.8	6.4	6.6
	CO_2	14.0	12.6	12.8	12.8
	O_2	4.9	7.2	7.4	6.7
	CO_2	14.3	12.4	12.8	12.8
9/5	O_2	5.0	6.4	6.2	6.5
	CO_2	14.0	13.0	12.8	12.9
	O_2	5.0	6.6	5.4	
	CO_2	14.2	12.8	14.0	
9/6	O_2	4.6	6.6	6.6	6.4
	CO_2	14.4	12.8	10.2	13.0
	O_2	4.6	6.6	6.4	6.6
	CO_2	14.6	12.8	12.8	12.8

Table 4-6. Percentages of Water Vapor in Flue Gases

Location & Train	Date			
	3	4	5	6
7 Outlet:				
Acid	8.2	8.4	8.2	
Metals	9.4	8.9	9.6	
Cyclone	<——	8.6	——>	
Ammonia				7.8
Aldehyde				9.3
MM5				8.1
Impactor				8.1
M17				9.6
8 Inlet:				
Acid	10.0	9.3	9.5	
Metals	10.5	9.7	10.0	
Cyclone	8.8	9.7	10.0	
Ammonia				10.6
Aldehyde				9.4
MM5				9.2
M17				9.0
8 Outlet:				
Acid	9.3	8.1	8.6	
Metals	9.4	8.8	9.3	
Cyclone	<——	9.6	——>	
Ammonia				9.9
Aldehyde				9.3
MM5				8.9
Impactor	<——	9.0	——>	
M17				8.9
Stack:				
Acid	15.1	14.4	14.0	
Metals	16.0	15.3	15.8	
Radio.				15.8
Ammonia				13.5
Aldehyde				15.7
MM5				15.0
Impactor	15.4	15.9	15.7	

Table 4-7. Particulate Concentrations, g/Nm^3

(Reference conditions: dry, 293.15 K, 1 atm, actual O_2 concentration)

		Date			
		3	4	5	6
8 Inlet					
	Metals	4.556	5.243	5.404	
	Acid	4.455	4.706	4.738	
	M17				4.316
	Imp.				
	Cyc.	3.93	4.48	4.48	
7 Outlet					
	Metals	0.0698	0.0527	0.0827	
	Acid	0.0679	0.0761	0.0831	
	M17				0.0434
	Imp.				0.0457
	Cyc.	← 0.0407 →			
8 Outlet					
	Metals	0.0145	0.00778	0.00511	
	Acid	0.0789	0.0444	0.0096	
	M17				0.00645
	Imp.	← 0.00503 →			
	Cyc.	← 0.00442 →			
Stack					
	Metals	0.027	0.0543	0.0815	
	Acid	0.045	0.0574	0.1021	
	Imp.	0.0231	0.0386	0.00672	

Metals: EPA Method 29

Acid: EPA Method 5-type train for anions

M17: EPA Method 17

Imp.: University of Washington Mark III/V cascade impactor

Cyc.: SRI/EPA Five Series Cyclone

Table 4-8
Bailly Mass Balance for Total Flows
Data for September 3, 1993

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	38.9			38.9
	Combustion Air			430	430
	Makeup Water		4.16		4.16
Out	Flue Gas	1.46		438	439
	Bottom Ash	2.59			2.59
Closure, %					93.4
UNIT 8 ESP					
In	Flue Gas	1.46		438	439
Out	ESP Hopper Ash	1.44			1.44
	Flue Gas to AFGD	0.0173		499	499
Closure, %					114
CONDENSER					
In	Inlet Water		11600		11600
Out	Outlet Water		11600		11600
Closure, %					100
BOTTOM ASH SLUICE					
In	Bottom Ash	2.59			2.59
	Sluice Return		25.9		25.9
Out	Bottom Ash Sluice	2.59	25.9		28.4
Closure, %					100
BOILER OVERALL BALANCE					
In	Coal	38.9			38.9
	Combustion Air			430	430
	Makeup Water		4.16		4.16
	Sluice Return		25.9		25.9
Out	Bottom Ash Sluice	2.59	25.9		28.4
	ESP Hopper Ash	1.44			1.44
	Flue Gas to AFGD	0.0173		499	499
Closure, %					106
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0145		281	281
	Unit 8 Flue Gas	0.0173		499	499
Out	Flue Gas to AFGD	0.0318		780	780
Closure, %					100.0
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0318		780	780
	Limestone	6.81			6.81
	Service Water		84.7		84.7
	Compressed Air			8.69	8.69
Out	Stack Flue Gas	0.0207		806	806
	Gypsum	9.11			9.11
	Wastewater		9.90		9.90
Closure, %					93.7

Table 4-9
Bailly Mass Balance for Total Flows
Data for September 4, 1993

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	39.2			39.2
	Combustion Air			417	417
	Makeup Water		4.16		4.16
Out	Flue Gas	1.53		416	418
	Bottom Ash	2.90			2.90
Closure, %					91.3
UNIT 8 ESP					
In	Flue Gas	1.53		416	418
Out	ESP Hopper Ash	1.52			1.52
	Flue Gas to AFGD	0.00967		495	495
Closure, %					119
CONDENSER					
In	Inlet Water		11400		11400
Out	Outlet Water		11400		11400
Closure, %					100
BOTTOM ASH SLUICE					
In	Bottom Ash	2.90			2.90
	Sluice Return		29.0		29.0
Out	Bottom Ash Sluice	2.90	29.0		31.9
Closure, %					100
BOILER OVERALL BALANCE					
In	Coal	39.2			39.2
	Combustion Air			417	417
	Makeup Water		4.16		4.16
	Sluice Return		29.0		29.0
Out	Bottom Ash Sluice	2.90	29.0		31.9
	ESP Hopper Ash	1.52			1.52
	Flue Gas to AFGD	0.00967		495	495
Closure, %					108
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0134		277	277
	Unit 8 Flue Gas	0.00967		495	495
Out	Flue Gas to AFGD	0.0230		771	771
Closure, %					100.0
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0230		771	771
	Limestone	6.65			6.65
	Service Water		47.7		47.7
	Compressed Air			8.63	8.63
Out	Stack Flue Gas	0.0335		835	835
	Gypsum	8.99			8.99
	Wastewater		8.89		8.89
Closure, %					102

Table 4-10
Bailly Mass Balance for Total Flows
Data for September 5, 1993

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	39.3			39.3
	Combustion Air			423	423
	Makeup Water		4.16		4.16
Out	Flue Gas	1.49		398	399
	Bottom Ash	2.70			2.70
Closure, %					86.2
UNIT 8 ESP					
In	Flue Gas	1.49		398	399
Out	ESP Hopper Ash	1.49			1.49
	Flue Gas to AFGD	0.00280		511	511
Closure, %					128
CONDENSER					
In	Inlet Water		11300		11300
Out	Outlet Water		11300		11300
Closure, %					100
BOTTOM ASH SLUICE					
In	Bottom Ash	2.70			2.70
	Sluice Return		27.0		27.0
Out	Bottom Ash Sluice	2.70	27.0		29.7
Closure, %					100
BOILER OVERALL BALANCE					
In	Coal	39.3			39.3
	Combustion Air			423	423
	Makeup Water		4.16		4.16
	Sluice Return		27.0		27.0
Out	Bottom Ash Sluice	2.70	27.0		29.7
	ESP Hopper Ash	1.49			1.49
	Flue Gas to AFGD	0.00280		511	511
Closure, %					110
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0171		276	276
	Unit 8 Flue Gas	0.00280		511	511
Out	Flue Gas to AFGD	0.0199		786	786
Closure, %					100.0
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0199		786	786
	Limestone	6.89			6.89
	Service Water		43.9		43.9
	Compressed Air			8.65	8.65
Out	Stack Flue Gas	0.0538		817	817
	Gypsum	9.08			9.08
	Wastewater		9.17		9.17
Closure, %					98.7

Table 4-11
Daily Mass Balance for Total Flows
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	39.1			39.1
	Combustion Air			424	424
	Makeup Water		4.16		4.16
Out	Flue Gas	1.50		417	419
	Bottom Ash	2.73			2.73
Average of Daily Closures, %					90.3
Closure of Average Flows, %					90.3
UNIT 8 ESP					
In	Flue Gas	1.50		417	419
Out	ESP Hopper Ash	1.49			1.49
	Flue Gas to AFGD	0.00994		501	501
Average of Daily Closures, %					120
Closure of Average Flows, %					120
CONDENSER					
In	Inlet Water		11500		11500
Out	Outlet Water		11500		11500
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOTTOM ASH SLUICE					
In	Bottom Ash	2.73			2.73
	Sluice Return		27.3		27.3
Out	Bottom Ash Sluice	2.73	27.3		30.0
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	39.1			39.1
	Combustion Air			424	424
	Makeup Water		4.16		4.16
	Sluice Return		27.3		27.3
Out	Bottom Ash Sluice	2.73	27.3		30.0
	ESP Hopper Ash	1.49			1.49
	Flue Gas to AFGD	0.00994		501	501
Average of Daily Closures, %					100
Closure of Average Flows, %					100

Table 4-11 (Continued)
Bailly Mass Balance for Total Flows
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0150		278	278
	Unit 8 Flue Gas	0.00994		501	501
Out	Flue Gas to AFGD	0.0249		779	779
Average of Daily Closures, %					100.0
Closure of Average Flows, %					100.0
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0249		779	779
	Limestone	6.78			6.78
	Service Water		86.4		86.4
	Compressed Air			8.66	8.66
Out	Stack Flue Gas	0.0360		819	819
	Gypsum	9.06			9.06
	Wastewater		9.32		9.32
Average of Daily Closures, %					95.1
Closure of Average Flows, %					95.1

Table 4-11A
Bailly Mass Balance for Total Flows
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	0.230			0.230
	Combustion Air			6.45	6.45
	Makeup Water		1.32E-09		1.32E-09
Out	Flue Gas	0.0376		20.1	20.1
	Bottom Ash	0.159			0.159
Std Dev of Daily Closures, %					3.71
UNIT 8 ESP					
In	Flue Gas	0.0376		20.1	20.1
Out	ESP Hopper Ash	0.0416			0.0416
	Flue Gas to AFGD	0.00727		8.38	8.38
Std Dev of Daily Closures, %					7.36
CONDENSER					
In	Inlet Water		163		163
Out	Outlet Water		163		163
Std Dev of Daily Closures, %					0.00
BOTTOM ASH SLUICE					
In	Bottom Ash	0.159			0.159
	Sluice Return		1.59		1.59
Out	Bottom Ash Sluice	0.159	1.59		1.75
Std Dev of Daily Closures, %					0.00
BOILER OVERALL BALANCE					
In	Coal	0.230			0.230
	Combustion Air			6.45	6.45
	Makeup Water		1.32E-09		1.32E-09
	Sluice Return		1.59		1.59
Out	Bottom Ash Sluice	0.159	1.59		1.75
	ESP Hopper Ash	0.0416			0.0416
	Flue Gas to AFGD	0.00727		8.38	8.38
Std Dev of Daily Closures, %					0.0834

Table 4-11A (Continued)
Bailly Mass Balance for Total Flows
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.00190		2.85	2.85
	Unit 8 Flue Gas	0.00727		8.38	8.38
Out	Flue Gas to AFGD	0.00619		7.41	7.41
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.00619		7.41	7.41
	Limestone	0.123			0.123
	Service Water		1.69		1.69
	Compressed Air			0.0307	0.0307
Out	Stack Flue Gas	0.0167		14.6	14.7
	Gypsum	0.0604			0.0604
	Wastewater		0.523		0.523
Std Dev of Daily Closures, %					2.08

Back 'Y' L
[illegible]

5.0 SAMPLE ANALYSES

The kinds of analyses performed on different types of samples are listed in the next three tables:

Table 5-1 Solids

Table 5-2 Liquids

Table 5-3 Gases (including entrained solids)

Brief descriptions of published methods cited in these three tables are given in the following paragraphs. More detailed descriptions of methods are given in Appendix C.

5.1 Solids

Metals. The trace metals of concern in this project are listed below, as are a lesser number of certain major metals (see page 1-6 for a qualification of the trace species as metals or non-metals):

Trace metals

Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Chromium
Cobalt
Copper
Copper
Lead
Manganese
Mercury
Molybdenum
Nickel
Selenium
Vanadium

Major metals

Aluminum
Calcium
Iron
Magnesium
Titanium

Samples of coal or ash to be analyzed for the metals listed above, except boron, were digested in a microwave oven by a procedure recommended by CEM Corporation, the manufacturer of the oven. For boron determination, the coal or ash was extracted with a mixture of 1 part of HNO_3 and 6 parts of HCl in the open atmosphere on a hotplate.

Limestone was digested with the same HNO_3-HCl mixture in the open environment on a hotplate. With this solid, the microwave procedure could be avoided, since this solid is easily dissolved in the acid without elevated pressure.

Gypsum and the very similar solids from the absorption recirculation slurry and the bleed pump slurry at the scrubber were digested by the same microwave procedure as that described above. The solutions thus prepared were analyzed for trace metals and also major metals. The concentrations of calcium thus found, however, were too low to be accepted and were believed to reflect the incomplete dissolution of samples; as an alternative, then, digestion with a mixture of HNO_3, HF, and H_2SO_4 (ASTM Method D2795) in an open environment was followed as a substitute procedure.

Once solutions had been prepared from the coal, ash, limestone, or gypsum, analysis proceeded generally as described in SW-846 (1). Method 6010 was used for metals to be determined by inductively coupled argon plasma emission spectroscopy (ICP). Graphite furnace, hydride generation, or cold-vapor versions of AAS (GFAAS, HGAAS, and CVAAS) were used for other metals as needed.

- The metals determined by ICP were: barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, vanadium, aluminum, calcium, iron, magnesium, and titanium.
- The metals determined by GFAAS when not determined with the necessary sensitivity by ICP were cadmium and lead.
- The metals determined by HGAAS rather than by ICP were antimony, arsenic, and selenium.
- Mercury was determined by CVAAS. At very low concentration, when extra sensitivity was needed, mercury was determined by atomic fluorescence spectroscopy (CVAFS).

The major metals were on occasion determined by flame-injection AAS.

Anions. The non-metallic elements that produce anionic substances when combustion occurs were analyzed as follows:

Fluorine and chlorine — ASTM D3761, D4208

Sulfur — ASTM 3177

Phosphorus — Coal was ashed at 750 °C, the ash was digested in a mixture of mineral acids (ASTM Method D2795), and phosphorus was determined colorimetrically with molybdovanadate reagent (ASTM D2795).

Anions present in ash or lime were determined by making the solid mostly water soluble by fusing it with molten NaOH (ratio, 0.5 of solid to 6.7 g of NaOH). The solidified cake of NaOH was broken up in water; the aqueous solution was filtered and diluted to 1 L. Fluoride was determined by acidifying an aliquot and measuring the anion with a fluoride-specific electrode (SIE). Chloride and sulfate were determined in the original basic solution, diluted as necessary, by ion chromatography (IC). Phosphate was measured by IC.

Carbon, hydrogen, and nitrogen. These elements were determined as the elements in a Perkin-Elmer Model 2400 analyzer. The elements are converted to gases and measured as CO_2, H_2O, and N_2.

Semi-volatile organic compounds. These compounds were extracted from the solids with methylene chloride according to SW-846 Method 3540 and analyzed by gas chromatography (GC/MS) as described in SW-846 Method 8270B.

Radionuclides. These metals were measured by Core Laboratories, Casper, Wyoming. Total uranium was measured fluorimetrically. The individual isotopes of uranium (masses 234, 235, and 238), the isotopes of thorium (232), radium 226, and polonium 210 were measured by alpha-ray counting. Radium 228 and lead 210 were measured by counting beta emissions.

5.2 Liquids

The samples to be analyzed for metals were prepared for analysis according to SW-846 Method 3010A. Analysis then proceeded according to the ICP and AAS methods cited in connection with analysis of solids.

The samples to be analyzed for aldehydes were taken in the amount of 100 mL each. To each, 30 mL of a solution of 2,4-dinitrophenyl-hydrazine was added (the stock solution contained 0.5% DNPH and 6N HCl). The mixture was extracted with methylene chloride; the extracted material was then dried by evaporation and redissolved in methanol. The analysis was by HPLC with a UV detector, according to EPA Method 0011 (7).

The other organic constituents were determined by use of SW-846 Methods 5041 and 8240B for volatile compounds and Methods 3420 and 8270B for semi-volatile compounds. Both classes of compounds were measured by GC/MS.

5.3 Gases

The term "gases" here refers to the components of flue-gas streams, both gaseous substances per se and entrained solids. When both particulate and vapor fractions of a given class of analytes were to be determined, the front half and the back half of the sampling train components were analyzed separately.

Samples of metals from the Multiple Metals Train (Method 29) were processed in preparation for analysis by the general guidelines of the published method. The digestion of solids from the front half of the train, however, was based on a modified microwave method recommended by CEM Corporation (see Appendix C). The impingers were processed by the EPA protocol in the published method. The analysis by ICP and AAS methods ensued, as previously described for samples of solids.

Mercury from the iodated carbon sorption tubes was determined by Brooks Rand, Ltd., in Seattle, Washington, by use of the method described by Bloom (2). Mercury was extracted from the carbon in a mixture of sulfuric and nitric acids, fully oxidized with BrCl, then reduced to the element with $SnCl_2$, and vaporized as the element in a stream passing to the analyzer.

Portions of the solids from the Multiple Metals Train were analyzed for anions by the method already described for samples of process solids: fusion with NaOH and analysis of the resulting aqueous preparation by ion chromatography and use of a fluoride-responsive electrode. The impingers from the acid gases train were analyzed by the same techniques.

Ammonia from the impingers in the special train used for ammonia and hydrogen cyanide was ultimately determined with the phenol-hypochlorite colorimetric method described by Weatherburn (8) or by use of an ammonia-specific electrode. Cyanide was determined by use of a cyanide-specific electrode.

Aldehydes were collected during sampling in impingers containing DNPH. The contents of the impingers were extracted in the analytical laboratory with a hexane-methylene chloride mixture, temporarily isolated as the hydrazone solids by evaporation of the extraction solvent, and then redissolved in methanol for analysis by HPLC. The method is described in the literature as EPA Method 0011 (7).

The components of the VOST sample train — Tenax and Tenax/charcoal tubes and aqueous condensate — were analyzed by SW-846 Methods 5041 and 8240B (1). The volatile organics in each sampling matrix are quantitatively desorbed and transferred to an intermediate matrix in one step and then are desorbed from the intermediate matrix into the GC/MS analyzer.

The components of the Modified Method 5 sampling train (SW-846 Method 0010) — front half solids and back half vapors on XAD and in water-filled impingers — were analyzed separately. Each half was processed to permit separate analyses of semi-volatile compounds (listed subsequently in Table 6-12) and dioxins and furans. The extract of each half of the train was separated into two fractions — one-tenth to be processed for semi-volatiles (SW-846 Method 8270B) and nine-tenths for dioxins and furans (SW-846 Method 8290).

Table 5-1
Analyses of Solids

Type of solid	Components determined	Analytical methods
Coal (each type)	Ultimate, proximate Calorific value Chlorine Fluorine Phosphorus Trace metals Radionuclides Water-extractable metals	ASTM D3172, D3176 ASTM D2015 ASTM D4208 ASTM D3761 See note[a] See note[b] See note[c] TCLP procedure
Bottom ash	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3} Semi-volatile organics Carbon, hydrogen, nitrogen (CHN) Radionuclides Semi-volatile organics Ammonia	See note[b] SIE, IC[d] SW-8270 Elemental analyzer See note[c] SW-846 3540, 8270 SIE[d]
Economizer ash	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3} Semi-volatile organics Carbon, hydrogen, nitrogen (CHN) Radionuclides Semi-volatile organics Ammonia	See above
Limestone and gypsum	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3} Carbon, hydrogen, nitrogen (CHN)	See above
Solids from slurries	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3}	See above
ESP hopper ash	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3} Semi-volatile organics Carbon, hydrogen, nitrogen (CHN) Radionuclides Semi-volatile organics	See above

[a] Phosphorus. Ash digested in HNO_3, HF, and H_2SO_4 (ASTM Method D2795); phosphorus determined colorimetrically with molybdovanadate.

[b] Microwave digestion. ICP or AAS analysis by SW-846 methods or, for Hg on sorbents, by CVAFS. See text for further information.

[c] Analysis by Core Laboratories (see text).

[d] IC=Ion chromatography. SIE=ion selective electrode.

Table 5-2
Analyses of Water

Types of samples
Condenser inlet
Condenser outlet
Boiler makeup water
Bottom ash sluice water supply
Bottom ash sluice (supernatant water)
Condenser makeup water
AFGD service makeup water
Bleed pump slurry (supernatant water)
Absorber recirculation pump slurry (supernatant water)
AFGD waste water

Components determined (all samples)	**Analytical methods**
Trace metals	See note[a]
F^-, Cl^-, SO_4^{-2}, PO_4^{-3}	IC/SIE
Aldehydes	HPLC/UV
Volatile organics	SW-846 5041
Semivolatile organics	SW-846 3420, 8270

[a] Microwave digestion. ICP or AAS analysis by SW-846 method. See text for information.

[b] Omitted cooling tower makeup water.

Table 5-3
Analyses of Gases
(including entrained solids)

Type of sample	Components determined	Analytical methods
Entrained solids	Trace metals F^-, Cl^-, SO_4^{-2}, PO_4^{-3} Semi-volatile organics Dioxins and furans Radionuclides	See note[a] IC/SIE SW-846 8270A SW-846 8290 Core Laboratories
Gas phase	Trace metals Mercury HF, HCl, SO_2, H_3PO_4 NH_3, HCN Aldehydes Volatile organics Semi-volatile organics Dioxins and furans	See note[a] CVAFS IC/SIE SIE/Colorimetry HPLC/UV SW-846 5041, 8240B SW-846 8270A SW-846 8290

[a] Sample digestion by microwave procedure. Sample analyses according to SW-846 methods. See text.

Back up
blank

6.0 ANALYTICAL RESULTS

6.1 Boiler and Electrostatic Precipitators

6.1.1 Solids

6.1.1.1 Coal

Tables 6-1 through 6-5 give the analytical properties for the coal fired at Bailly Units 7 and 8. All of these tables relate specifically to the coal as fired. The boilers in these two units are the cyclone type; there is no alteration in the composition as received due to drying, milling, or pyrite removal.

Table 6-1 gives the data from proximate and ultimate analyses of samples representing the three inorganic sampling days. The data indicate that the properties of the coal were within the ranges expected for an Eastern bituminous coal. The calorific value was approximately 11,000 Btu/lb; the moisture and ash levels were approximately 10% each, and the sulfur concentration was, on the average, 3.17%. Table 6-1 includes the concentrations of nonmetallic elements other than sulfur: the average values were fluorine, 0.0094%; chlorine, 0.10%; and phosphorus, 0.0119%. The variance of each parameter listed in this table was relatively small; thus, the constancy of the coal properties was adequate for replication of the emission measurements.

Table 6-2 presents the results of calculations on the expected composition of the flue gas, based on the ultimate analyses. The concentrations in this table are for the standard reference conditions used throughout this report: dry gas at 3% O_2, at 293.15 K and 1 atm. The average concentrations calculated for the four acidic gases measured in this program, assuming complete conversion of the corresponding elements to the gas phase of the combustion products, are as follows:

SO_2	2900 ppmv
HCl	80.1 ppmv
HF	15.2 ppmv
H_3PO_4	11.2 ppmv

The average concentration of fly ash, assuming complete entrainment of the ash components of the coal (no rejection of bottom ash), is listed as 13.11 g/Nm^3. This value is used for calculating the actual partitioning between bottom ash and fly ash, based on the measured concentration of the latter; it is a key factor in performing material balance calculations. The approximate mass ratio of bottom ash to fly ash is 63/37, as observed previously in Section 4. There is an approximation in the calculation of partitioning; the chemical combinations of each element (for example, iron as Fe_2O_3) are assumed to be the same in both the coal ash prepared by coal combustion in performing the laboratory proximate analysis and the ash produced from coal combustion in the boiler.

The last line in Table 6-2 gives the volume of flue gas expected from 100 g of coal; the indicated average volume per gram of coal is 0.008204 Nm^3.

The concentrations of metals in the coal are given in Table 6-3. For the hypothetical coal ash, the concentrations are those listed in this table divided by the fraction of ash in the coal. Thus, if the concentration of ash in the coal were precisely 10%, the concentration of each metal in the hypothetical coal ash would be 10 times that in the coal itself.

Several of the metals appear to have occurred at significantly higher levels on the third test day compared to the first two days. This should not be said for antimony, for which the third-day result can be discarded for statistical reasons. The possibility does exist, however, for arsenic, chromium, molybdenum, nickel, and selenium. The higher concentrations of the last four of these metals on the third test day coincides with higher concentrations in the flue gas stream at the inlet of the Unit 8 ESP on the third test day; thus, there is some confirmation for the differences found in the coal analyses.

Extended comments on the metals will be deferred until later sections of this report, when comparisons can be made with data on metals in other process samples. Further comments will be found, in particular, in Appendix A.3, where the results of analyses of the Bailly coal in the Round Robin involving the other four DOE contractors are presented. At this point, however, the data for mercury in the coal do require comment. The concentrations of mercury given in Table 6-3, which were determined in the SRI laboratory, have an average of 0.100 µg/g, based on analyses of two of the samples (instrumental break-down preventing the analysis of the third from being completed). The average of earlier results in this laboratory was just 0.04 µg/g, clearly too low to be correct. The difference in the two series of mercury determinations is that the earlier, which yielded the low result, was performed after the coal samples were leached with aqua regia, whereas the second was performed after the samples were digested, and more thoroughly dissolved, by the microwave acid procedure.

The individual daily samples listed in Table 6-3 were analyzed also in the Brooks Rand laboratory, and the following data resulted:

Date of sample	Concn. µg/g
September 3	0.117
September 4	0.0954
September 5	0.0865
Avg. ± std. dev.	0.0996 ± 0.0157

This average is in good agreement with the value from the SRI laboratory cited above and with the average of 0.094 µg/g in all laboratories in the Round Robin.

The activities of radionuclides in the coal, as determined by Core Laboratories, are listed in Table 6-4. The definitions of the three forms of data are presented in the footnote. None of the radionuclides was present at a concentration high enough to be clearly significant. The measured activity of each radionuclide was close to the lowest level considered detectable; it was sometimes above and sometimes below that level. The 95% confidence interval for each activity level made the result in effect not distinguishable from the lowest level of detection.

It is of interest to translate the activity of uranium 238 (the most abundant isotope of this element) from a specific counting level to a weight-based concentration in the coal. Uranium has a half life of 4.51×10^{9} y, or 1.42×10^{17} s. The maximum counting rate observed, 0.5 pCi/g, corresponds to a disintegration rate of $0.5 \times 3.7 \times 10^{-2}\ s^{-1} = 1.85 \times 10^{-2}\ s^{-1}$. The number of radionuclei present in 1 gram of coal is then calculated as follows:

$$-dn/dt = kn$$

$$1.85 \times 10^{-2} = 0.693/(1.42 \times 10^{17})n$$

$$n = 3.79 \times 10^{15} \text{ radionuclei}$$

The mass of the radionuclei is the ratio of the number of radionuclei to Avogadro's number, multiplied by the atomic mass (238):

$$\text{mass} = 3.79 \times 10^{15} \times 238/(6.023 \times 10^{23})$$

$$\text{mass} = 1.50 \times 10^{-6} \text{ g}$$

Thus, the calculated concentration of uranium 238 in the coal, and for all intents and purposes the concentration of total uranium as well, is 1.50 μg/g.

The leachability of metals in the coal was examined by preparing a composite of the three daily samples and performing an extraction with acetic acid according to EPA's TCLP procedure (8). The procedure calls for use of 100 g of coal and 2 L of dilute acetic acid. Table 6-5 shows the average concentrations of leached metals in two determinations and shows how the amounts relate to the total concentrations of metals in the coal.

Table 6-1
Proximate and Ultimate Analyses of the Coal

	Sept. 3	Sept. 4	Sept. 5	Average	Std.dev.
Proximate					
% moisture	10.40	9.99	10.48	10.25	0.21
% ash	10.41	11.11	10.68	10.73	0.29
% volatile	35.29	35.75	36.69	35.91	0.58
% fixed carbon	43.90	42.95	42.15	43.00	0.72
Btu/lb	11100	11101	11098	11103	5
J/g	25825	25804	25797	25809	12
Ultimate					
% carbon	61.78	60.81	61.97	61.52	0.51
% hydrogen	4.58	4.49	4.33	4.47	0.10
% nitrogen	1.08	1.06	1.05	1.06	0.01
% sulfur	3.19	3.07	3.26	3.17	0.08
% oxygen	8.56	11.31	8.23	9.37	1.38
% chlorine	0.10	0.09	0.10	0.10	0.00
% fluorine	0.0096	0.0095	0.0092	0.0094	0.0001
% phosphorus	0.0090	0.0144	0.0122	0.0119	0.0027

Table 6-2
Calculated Combustion Products from the Coal
(Basis, 100 g of the coal; dry flue gas
with 3% O_2 at 293 K)

Flue gas component	Sept. 3	Sept. 4	Sept. 5	Average	Std.dev.
CO_2, % vol	15.0	15.0	15.1	15.0	0.0
SO_2, ppmv	2900	2830	2980	2900	10
HCl, ppmv	82.0	75.0	83.4	80.1	4.5
HF, ppmv	14.7	14.8	16.0	15.2	0.7
H_3PO_4, ppmv	8.4	13.7	11.5	11.2	2.7
Ash, g/Nm^3	12.60	13.67	13.05	13.11	0.54
Total gas, Nm^3	0.8264	0.8127	0.8222	0.8204	0.0070

Table 6-3
Metal Concentrations in the Coal[a]
(Data are in μg/g)

	Sept. 3	Sept. 4	Sept. 5	Average	Std.dev.
Trace metals					
Antimony	0.61	0.68	5.63[b]	0.64	0.05
Arsenic	2.16	2.24	4.06	2.82	1.07
Barium	40.9	40.5	44.4	41.9	2.1
Beryllium	1.56	1.54	2.06	1.72	0.29
Boron	184	206	214	201	15.5
Cadmium	2.23	3.63	2.11	2.66	0.85
Chromium	38.2	31.5	56.0	41.9	12.7
Cobalt	2.35	2.37	2.80	2.51	0.25
Copper	10.5	8.82	9.01	9.44	0.91
Lead	7.80	6.38	8.71	7.63	1.17
Manganese	28.9	29.0	28.4	28.8	0.32
Mercury[c]	0.0893	0.112	–	0.100	--
Molybdenum	5.33	5.07	11.3	7.24	3.54
Nickel	15.6	19.3	34.5	23.2	10.0
Selenium	0.861	0.810	2.26	1.31	0.82
Vanadium	51.0	38.2	53.3	47.5	8.16
Major metals					
Aluminum	10000	11000	10900	10600	600
Calcium	3210	2550	3930	3230	690
Iron	14000	14200	12000	13400	1200
Magnesium	624	737	741	700	66
Titanium	560	609	586	585	24

[a] The values given for the major metals are averages obtained by ashing the coal and analyzing the coal ash by AAS. The data from ICP were variable and of low accuracy.

[b] Excluded as an outlier by Dixon's rules (9).

[c] See text for alternative data from Brooks Rand.

Table 6-4 Activities of Radionuclides in the Coal[a]
(All data in pCi/g)

	9/3/93			9/4/93			9/5/93		
	Activity	Error	LLD	Activity	Error	LLD	Activity	Error	LLD
Lead 210	1.3	0.7	1.1	1.5	0.7	1.1	0.8	0.7	1.1
Polonium 210	0.2	0.2	0.5	0.3	0.2	0.4	0.3	0.2	0.3
Radium 226	0.8	0.5	0.6	0.7	0.5	0.6	0.7	0.5	0.6
228	1.1	1.7	2.8	4.0	1.9	2.8	0.7	1.7	2.8
Thorium 228	0.4	0.2	0.3	0.5	0.2	0.3	0.5	0.2	0.3
230	0.8	0.4	0.5	0.8	0.3	0.4	0.7	0.4	0.5
232	0.2	0.2	0.2	0.2	0.1	0.2	0.5	0.2	0.3
Uranium 234	1.5	1.0	0.5	0.2	0.4	0.9	1.3	0.8	0.9
235	0.1	0.3	0.9	ND	0.1	0.6	ND	0.1	0.4
238	0.5	0.6	1.1	0.3	0.4	0.8	0.5	0.5	0.8
Total	1.0	--	--	0.8	--	--	1.1	--	--

[a] The terms for which values are given are:

$$\text{Activity} = \frac{S + B}{2.22 \cdot V \cdot E}$$

(which may be an extrapolated value below the lower limit of detection)

$$\text{Error} = \frac{1.96 \cdot \sqrt{S/t + B/t}}{2.22 \cdot V \cdot E}$$

(the range above and below the activity, which corresponds to the 95% confidence interval);

$$\text{LLD} = \frac{4.65 \cdot \sqrt{B/t}}{2.22 \cdot V \cdot E}$$

(the lower limit of detection given the constraints of the measurements).

where S = sample counts per minute,
B = background counts per minute,
t = counting time,
V = sample volume, and
E = counter efficiency.

Table 6-5. Concentrations of Metals Extracted from the Coal by the TCLP Procedure

	Avg. concn., µg/mL, in extract	Calc'd % of metal extracted
Antimony	0.0033	2.9
Arsenic	<0.002	<1.4
Barium	0.1165	5.6
Beryllium	<0.001	<1.2
Boron	0.623	6.2
Cadmium	0.01175	8.8
Chromium	<0.01	<0.5
Cobalt	0.0635	50.7
Copper	0.0265	5.6
Lead	0.0395	10.4
Manganese	0.736	51.1
Mercury	0.000035	1.7
Molybdenum	<0.01	2.8
Nickel	0.201	17.4
Selenium	<0.002	<3.0
Vanadium	<0.01	<0.4
Aluminum	0.4395	0.1
Calcium	159.5	98.3
Iron	0.7725	0.1
Magnesium	3.54	10.0
Titanium	<0.05	<0.01

6.1.1.2 Bottom ash and ESP ash

Bottom ash was collected for analysis once daily. ESP ash was a composite of ash taken daily from the hoppers of the Unit 8 ESP. This ESP had three rows of hoppers progressing from the inlet toward the outlet, each collecting ash from one-third of the total plate area of the ESP but collecting progressively less on moving from the inlet row to the outlet row. The sample from each day of testing was blended from the samples from individual hopper rows, as indicated by the following example:

On September 3, the total penetration of fly ash through the ESP was, as a decimal fraction, 0.00318:

Inlet concentration, 4.576 g/Nm^3

Outlet concentration, 0.01457 g/Nm^3

Penetration, 0.01457/4.576 = 0.00318

According to the Deutsch relationship for an ESP with three equal-area sections, the overall penetration is the cube of penetrations in each field:

Penetration = p^3

Thus, the relative concentration of entrained fly ash at the exit of each field can be calculated, and also the relative mass of ash collected in each field can be evaluated. For the overall penetration of 0.00318, the results are as follows:

Field	Penetration at exit	Relative mass collected
1	0.1471	0.8529
2	0.0216	0.1255
3	0.00318	0.0184
	Total	0.9968

Thus, the correct blending of ash from the three rows of hoppers would require the fraction 0.8529/0.9968 from the first, 0.1255/0.9968 from the second, and 0.0184/0.9968 from the third.

These were the proportions used for the composites on September 4 and September 5 when samples of ash from all three hopper rows were available. Only ash from the first and middle rows was available on September 3; thus, the composite for that day was a blend of samples from the first and second rows in the ratio 0.8529/0.1255. The absence of third-row ash from the September 3 composite was not expected to bias the composition significantly because the relative mass of that ash would have been low.

The metals data for the bottom ash and the ESP ash are presented in Tables 6-6 and 6-7. The data are for individual daily samples; they include the averages of concentrations in the daily samples and the standard deviations. Two metals were not consistently at measurable levels in the bottom ash: mercury and molybdenum. Mercury was near the detection limit in the ESP also, at an average concentration of just 0.006 µg/g. The precision of the data is indicated by the comparison of averages and standard deviations. For selenium in the bottom ash, for example, the relative standard deviation is about 50%, whereas for aluminum it is about 3%. Generally, the precision of the daily concentrations was somewhat better for the ESP ash, where most of the metals were at higher concentrations and thus were more easily measured.

The metals data for the bottom ash and the ESP ash are compared with corresponding data for the hypothetical coal ash (discussed in Section 6.1.1) in Table 6-8. If there were no partitioning of metals between the bottom ash and the combustion gas leaving the boiler, the concentration of each metal should be about the same in each and the same as in the coal ash. Evidence for partitioning, however, was found for the majority of the metals, as indicated by the following statements:

> Antimony, arsenic, beryllium, boron, cadmium, copper, lead, molybdenum, mercury, and selenium are present at higher concentrations in the ESP ash than in the bottom ash, as the presumed consequence of volatility at boiler temperatures, causing exit from the boiler in the gas phase but partial transfer to the particulate phase upstream from the ESP.
>
> Boron, mercury, and selenium are poorly recovered in the ESP ash, as the presumed occurrence is in the gas phase even at the ESP temperature (about 150 °C).

The activities of the metal radionuclides in the ESP ash are listed in Table 6-9. Most of the radionuclides occurred at measurable levels in this ash. Lead 210, for example, had a measured activity near 25 pCi/g, which is more than 10 times the limit of detection. The uncertainty (range for 95% confidence limits) was only about one-tenth of the measured activity. Uranium 238 was also found at a statistically significant activity, corresponding to a weight-based concentration around 35 µg/g. The amplification for uranium in the ash over that in the coal exceeds 10, the factor corresponding to recalculation of the value for coal to the value for coal ash. Thus, by implication, the process of combustion favored partitioning of uranium into the combustion gas and eventually the fly ash.

The concentrations of anions in the bottom ash and the ESP ash are presented in Table 6-10. Fluoride and chloride were near or below the detection limit in both materials. Phosphate was near the same level in both materials — around 4000 to 5000 µg/g — or perhaps at a somewhat higher concentration in the ESP ash. A concentration of 3700 µg/g of phosphate would account completely for all of the phosphorus reported for the coal (Table 6-1) if phosphate were present uniformly in all of the ash. Sulfate increased sharply, by an order of magnitude on going from the bottom ash to the ESP ash. This change probably reflects the fact that, as the flue gas cools from the boiler temperature to the ESP temperature, SO_2 undergoes the transition to SO_3 or sulfuric acid vapor and is taken up, in part, by the fly ash, as sulfate salts. The sulfate concentration of about 0.2% in the bottom ash represents only about 0.4% of the sulfur in the coal; the sulfate concentration of 3% in the ESP ash represents about 1.2% of the sulfur in the coal. Thus, the data are consistent with other information yet to be presented, showing that most of the sulfur from the coal remained in the gas phase as SO_2 up to the point where removal occurred in the scrubber. (The estimates of the percentages of sulfur accounted for in the two ashes are based on the approximate 60/40 ratio of bottom ash to fly ash or ESP ash.)

Table 6-11 gives the results of CHN elemental analysis of the bottom ash and the ESP ash. Percent carbon is the focus of interest in this table. The data indicate that the carbon retained by the bottom ash was a negligible quantity, but the carbon in the ESP ash (unburned coal) was about 2.5% of the total mass. The concentrations of hydrogen are all essentially zero and, if they could be discerned, would most likely represent about one-tenth of the moisture present (hydrogen accounts for about 10% of the weight of water). The concentrations of nitrogen could only be indicative of a real constituent in the case of the ESP ash; the specific form of nitrogen representing about 0.4% of the ash conceivably was due to ammonia from the injection system that minimizes the penetration of sulfuric acid through the ESP.

Extraction of the ESP ash and determination of the extracted ammonia gave these results:

September 3	0.0173% NH_3
September 4	0.0154% NH_3
September 5	<0.0054% NH_3

These concentrations are much less than those that would accord with 0.4% nitrogen in the ash, as indicated by information in the footnote of the table. The level of nitrogen in the ash thus remains largely unaccounted for. The concentrations of ammonia in the ash correspond to very low vapor-phase concentrations of ammonia. If all the ammonia in the ash were placed in the flue gas from which the ash was removed, the ammonia concentrations on the first two sampling days would be about 1.1 ppmv and that on the third day less than 0.4 ppmv. The relative concentrations are, however, in accord with what is known about the operation of the ammonia injection system: it operated during the first two days in Unit 8, but it did not operate the third day.

Table 6-6
Metal Concentrations in Bottom Ash
(Data are in $\mu g/g$)

	Sept. 3	Sept. 4	Sept. 5	Average	Std.dev.
Trace metals					
Antimony	1.75	1.70	2.40	1.95	0.39
Arsenic	0.189	0.418	0.429	0.345	0.136
Barium	381	372	435	396	34
Beryllium	10.1	8.45	8.03	8.86	1.10
Boron	159	169	135	154	17
Cadmium	1.59	9.04	10.5	7.04	4.78
Chromium	218	231	312	254	51
Cobalt	24.4	21.6	21.0	22.3	1.8
Copper	49.2	37.4	59.6	48.7	11.1
Lead	5.83	6.19	4.70	5.57	0.78
Manganese	313	319	313	315	4
Mercury	<0.002	0.002	<0.002	≤0.002	–
Molybdenum	<0.50	<0.50	0.733	≤0.7	--
Nickel	98	89	114	100	13
Selenium	0.140	0.406	0.337	0.294	0.138
Vanadium	291	300	364	318	40
Major metals					
Aluminum	95600	99100	101000	98700	2920
Calcium	34500	37100	40400	37300	2920
Iron	122000	116000	108000	115000	7100
Magnesium	6370	6410	7640	6810	723
Titanium	4870	4730	4930	4840	103

Table 6-7
Metal Concentrations in ESP Ash
(Data are in μg/g)

	Sept. 3	Sept. 4	Sept. 5	Average	Std.dev.
Trace metals					
Antimony	18.0	35.8	21.6	25.1	9.4
Arsenic	61.6	61.4	60.6	61.2	0.5
Barium	570	409	424	468	89
Beryllium	19.3	18.8	19.5	19.2	0.4
Boron	1120	870	952	981	128
Cadmium	29.1	29.4	40.5	33.0	6.5
Chromium	369	364	447	393	46
Cobalt	40.8	39.1	53.1	44.3	7.7
Copper	214	191	220	208	15
Lead	293	294	270	286	13
Manganese	257	232	228	239	16
Mercury	0.008	0.005	0.005	0.006	0.002
Molybdenum	140	129	169	146	21
Nickel	223	210	272	235	33
Selenium	9.27	6.39	8.08	7.91	1.45
Vanadium	566	540	577	561	19
Major metals					
Aluminum	87800	95100	83800	88900	5760
Calcium	24400	19200	17700	20400	3530
Iron	121000	122000	110000	118000	6480
Magnesium	6590	6230	6170	6330	230
Titanium	6320	7000	6250	6520	419

Table 6-8. Comparison of Metal Concentrations in Coal Ash, Bottom Ash, and ESP Ash (Data in $\mu g/g$)

	Coal ash[a]	Bottom ash[b]	ESP ash[b]
Trace metals			
Antimony	5.96	1.95	25.1
Arsenic	26.3	0.345	61.2
Barium	390	396	468
Beryllium	16.0	8.86	19.2
Boron	1870	154	981
Cadmium	24.8	7.04	33.0
Chromium	390	754	393
Cobalt	23.4	22.3	44.3
Copper	88.0	48.7	208
Lead	71.1	5.57	286
Manganese	268	315	239
Mercury	0.37	≤0.002	0.006
Molybdenum	67.5	<0.07	146
Nickel	216	100	235
Selenium	12.2	0.294	7.91
Vanadium	443	318	561
Major metals			
Aluminum	98800	98700	88900
Calcium	30100	37300	20400
Iron	125,000	115,000	118,000
Magnesium	6520	6810	6330
Titanium	5450	4840	6520

[a] Data calculated from average metal concentrations in Table 6-3 and average % ash in Table 6-1.

[b] Data are averages from Tables 6-6 and 6-7.

Table 6-9. Activities of Radionuclides in the ESP Ash[a] (All data in pCi/g)

	9/3/93			9/4/93			9/5/93		
	Activity	Error	LLD	Activity	Error	LLD	Activity	Error	LLD
Lead 210	24.0	1.4	1.1	20.5	1.3	1.1	29.9	1.5	1.1
Polonium 210	16.5	3.1	0.6	20.2	2.8	0.4	30.6	4.5	0.5
Radium 226	13.7	1.4	0.6	12.9	1.4	0.6	14.9	1.5	0.6
228	4.4	1.9	2.8	3.2	1.8	2.8	4.8	1.9	2.8
Thorium 228	0.7	0.2	0.2	0.3	0.2	0.4	0.7	0.4	0.7
230	2.2	0.4	0.3	1.0	0.3	0.4	2.9	0.7	0.4
232	0.6	0.2	0.2	0.3	0.1	0.1	0.6	0.2	0.1
Uranium 234	11.6	1.8	0.3	8.4	1.4	0.1	13.4	2.9	0.2
235	0.3	0.2	0.2	0.3	0.2	0.1	2.7	0.9	0.4
238	11.9	1.8	0.3	8.0	1.4	0.1	16.7	3.5	0.4
Total	23.6	–	--	22.7	--	--	29.8	--	–

[a] See footnote in Table 6-4 on page 6-7, for definition of terms.

Table 6-10
Anion Concentrations in Bottom Ash and ESP Ash
(Data in μg/g)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Bottom ash					
Fluoride	<400	<400	<400	<400	--
Chloride	<100	120	<100	<120	--
Sulfate	1740	1120	2240	1700	560
Phosphate	5480	2650	3060	3730	1530
ESP ash					
Fluoride	<400	<400	<400	<400	--
Chloride	<100	<100	<100	<100	--
Sulfate	30600	24000	30900	28500	3900
Phosphate	4920	3930	6130	4990	1100

Table 6-11
Carbon/Hydrogen/Nitrogen Analysis of Bottom Ash and ESP Ash

	9/3/93	9/4/93	9/5/93
Bottom ash			
Carbon %	0.01	0.05	0.48
Hydrogen %	0.01	-0.04	-0.05
Nitrogen %	0.12	0.10	0.12
ESP ash			
Carbon %	2.36	2.65	2.76
Hydrogen %	0.04	-0.04	-0.02
Nitrogen %[a]	0.44	0.47	0.32

[a] Corresponds to an ammonia concentration in ash of 0.36, 0.39, or 0.26%.

6.1.2 Water Streams

There are five different streams of water associated with the boiler (others identified with the FGD system are discussed later in Section 6.2.2). They are listed below:

Condenser inlet water

Condenser outlet water

Makeup water

Supply water for sluicing bottom ash

Bottom ash sluice (two-phase stream, water and ash)

The results of analyses of the daily composites of each type of water are presented in Tables 6-12 through 6-16. Averages of the daily samples of all five types are listed for comparison in Table 6-17. The footnote of Table 6-17 indicates that the results are for two days, rather than three days, in some instances. This is due to inconsistent daily results illustrated by the following for calcium in the makeup water: September 3, 1.59 µg/mL; September 4 and 5, <0.10 µg/mL. The "average" listed in Table 6-17 is <0.10 µg/mL.

The makeup water was certainly the purest. This is not evident from the concentration of trace metals; it is, however, apparent from the data for the major metals and the anions. The water into and out of the condenser is essentially the same, as expected; one anomaly that cannot be explained is an undetectable concentration of boron at the outlet, in contrast to 9.2 µg/mL at the inlet. The sluice water was not much affected, if affected at all, by the addition of bottom ash. There are differences for some metals in the supply and discharge streams, but it is not clear whether the differences are significant.

The weight proportions of water and solids in the bottom ash sluice are not known. The assumption was made, however, that there were 10 parts of water to 1 part of solids. Based on this assumption, the relative contribution of the liquid to the total amount of each analyte was calculated. For this purpose, the average liquid-phase concentration of each analyte in Table 6-17 was compared to the average solid-phase concentration in Table 6-6. The ratios of the mass in the liquid to that in the solid are listed below:

Antimony	0.21	Copper	0.0010
Arsenic	1.1	Lead	0.0035
Barium	0.00050	Manganese	0.000076
Beryllium	0.00019	Mercury	1.7
Boron	<0.0040	Molybdenum	0.20
Cadmium	0.0010	Nickel	0.0016
Chromium	<0.0024	Selenium	0.16
Cobalt	0.00094	Vanadium	<0.000094

Aluminum	<0.00001	Magnesium	0.0154
Calcium	0.00077	Titanium	<0.00021
Iron	<0.00001		
Fluoride	Indeterminate	Sulfate	0.60
Chloride	310	Phosphate	<0.013

With rare exceptions, the contribution from the solid phase is dominant.

Table 6-18 summarizes the results of determinations of carbonyl compounds (aldehydes and ketones) in the water samples. Just a few of the positive results can be argued to be significant if a measurement in excess of the range for blanks is taken as the criterion of significance. Examples are 1) formaldehyde in the condenser inlet water and 2) acetone in the condenser inlet and outlet water and the make-up water. Samples on only one day (September 6) were available for analysis. The lack of logic in some of the results makes their significance questionable. For example, formaldehyde appeared to be present in the condenser inlet stream but not the outlet stream; how could this be?

Each of the composites of water samples (all from September 6) was analyzed for volatile organic compounds.

Each of the composites of water samples (all from September 6) was analyzed for volatile organic compounds. The analytical and computational procedure was programmed to identify and quantify the 37 compounds listed, along with detection limits, in Table 6-19. Only three of these analytes were detected in the entire set of samples: acetone, bromomethane, and methylene chloride. They were detected erratically, however, and never in all samples of a given type. The results are summarized below:

Type of water	No. samples	Analyte	Concn, ng/mL
Condenser, inlet	one	methylene chloride	4.0
Condenser, outlet	two	methylene chloride	2.4
			2.8
Makeup	one	acetone	2.6
	one	bromomethane	2.3
Sluice supply	one	bromomethane	5.3
Sluice discharge	none	none	-

Blanks were free of these analytes. Based on this criterion, the positive results for the samples cannot be rejected. Evaluated subjectively, however, they lack confirmation from replicate measurements and thus lack credibility.

Each of the water samples (again, all from September 6) was also analyzed for semivolatile organic compounds. The target list and detection limits for this set of compounds is given in Table 6-20. The only compounds detected were a few phthalate esters, which are believed to be contaminants inadvertently introduced in the laboratory. Although presumed not to be an authentic component of any of the water samples, di-n-butylphthalate was detected consistently. The concentrations were those listed below:

Stream	Concn, ng/mL
Condenser inlet water	2.98
Condenser outlet water	4.04
Makeup water	3.80
Supply water for sluicing	5.04
Liquid phase of sluice	2.38

Table 6-12 Daily Metal and Anion Concentrations in Condenser Inlet Water (Data in µg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	<0.0006	<0.0006	<0.0006
Arsenic	<0.0003	<0.0003	<0.0003
Barium	0.0182	0.0174	<0.006
Beryllium	<0.0005	<0.0005	<0.0005
Boron	11.1	9.02	7.53
Cadmium	<0.0003	<0.0003	<0.0003
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	<0.002	0.005
Copper	0.0056	0.0045	0.0055
Lead	<0.005	<0.005	<0.005
Manganese	<0.0125	<0.0125	<0.0125
Mercury	0.00009	0.00015	0.00017
Molybdenum	<0.006	<0.006	<0.006
Nickel	<0.010	<0.010	<0.010
Selenium	<0.0006	<0.0006	<0.0006
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	<0.10	<0.10	<0.10
Calcium	19.7	20.7	19.8
Iron	<0.10	<0.10	<0.10
Magnesium	11.1	11.7	10.9
Titanium	<0.10	<0.10	<0.10
Anions			
F^-	<0.4	<0.4	<0.4
Cl^-	9.92	10.85	11.10
SO_4^{-2}	22.95	23.52	23.29
PO_4^{-3}	<0.50	<0.50	<0.50

Table 6-13 Daily Metal and Anion Concentrations in Condenser Outlet Water (Data in µg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	<0.0006	<0.0006	<0.0006
Arsenic	<0.0003	<0.0003	<0.0003
Barium	0.0174	0.0189	0.0186
Beryllium	<0.0005	<0.0005	<0.0005
Boron	<0.0625	<0.0625	<0.0625
Cadmium	<0.0003	0.0008	0.0016
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	<0.002	<0.002
Copper	<0.005	0.0089	0.0081
Lead	<0.005	<0.005	<0.005
Manganese	0.0028	0.0031	0.0023
Mercury	0.00016	0.00025	<0.00004
Molybdenum	<0.006	<0.006	<0.006
Nickel	0.0092	<0.010	<0.010
Selenium	<0.0006	<0.0006	<0.0006
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	0.324	<0.10	<0.10
Calcium	28.2	38.1	16.4
Iron	<0.10	<0.10	<0.10
Magnesium	10.84	10.93	11.74
Titanium	<0.10	<0.10	<0.10
Anions			
F^-	<0.4	<0.4	<0.2
Cl^-	10.98	13.27	13.86
SO_4^{-2}	23.60	24.94	25.00
PO_4^{-3}	<0.50	<0.50	<0.50

Table 6-14 Daily Metal and Anion Concentrations in Makeup Water for Boiler Streams (Data in µg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	<0.0006	<0.0006	<0.0006
Arsenic	<0.0003	<0.0003	<0.0003
Barium	<0.006	<0.006	0.0041
Beryllium	<0.0005	<0.0005	<0.0005
Boron	15.4	29.0	17.1
Cadmium	<0.0003	<0.0003	<0.0003
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	<0.002	<0.002
Copper	0.0039	0.0025	0.0036
Lead	<0.005	<0.005	<0.005
Manganese	<0.0125	<0.0125	<0.0125
Mercury	0.00013	0.00028	0.00019
Molybdenum	<0.006	<0.006	<0.006
Nickel	<0.010	<0.010	<0.010
Selenium	0.0036	0.0063	<0.0006
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	<0.10	<0.10	<0.10
Calcium	1.59	<0.10	<0.10
Iron	<0.1	<0.10	<0.10
Magnesium	0.396	<0.10	<0.10
Titanium	<0.10	<0.10	<0.10
Anions			
F^-	<0.4	<0.4	<0.4
Cl^-	<0.05	<0.05	<0.05
SO_4^{-2}	<0.10	<0.10	<0.10
PO_4^{-3}	<0.50	<0.50	<0.50

Table 6-15 Daily Metal and Anion Concentrations in Supply Water for Bottom Ash Sluice (Data in µg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	0.0119	0.0095	0.0057
Arsenic	0.0159	0.0125	0.0148
Barium	0.0238	0.0266	0.0299
Beryllium	<0.0005	<0.0005	<0.0005
Boron	<0.0625	<0.0625	<0.0625
Cadmium	<0.0003	0.0016	0.0008
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	<0.002	<0.002
Copper	0.0086	0.0069	0.0077
Lead	<0.005	<0.005	<0.005
Manganese	<0.0125	<0.0125	0.0083
Mercury	0.00012	0.00015	0.00026
Molybdenum	<0.006	<0.006	0.0087
Nickel	<0.010	<0.010	<0.010
Selenium	0.0051	0.0095	0.0058
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	<0.10	<0.10	<0.10
Calcium	23.3	30.0	28.5
Iron	<0.10	<0.10	0.154
Magnesium	10.08	10.33	10.49
Titanium	<0.10	<0.10	<0.10
Anions			
F^-	<0.4	<0.4	<0.4
Cl^-	13.36	16.46	14.38
SO_4^{-2}	71.25	100.6	126.4
PO_4^{-3}	<0.50	<0.50	<0.50

Table 6-16 Daily Metal and Anion Concentrations in Liquid Phase of Bottom Ash Sluice
(Data in μg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	0.0302	0.0210	0.0146
Arsenic	0.0566	0.0360	0.0222
Barium	0.0231	0.0263	0.0114
Beryllium	<0.0005	0.00051	<0.0005
Boron	<0.0625	<0.0625	<0.0625
Cadmium	0.0014	0.0006	<0.0003
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	0.0062	<0.002
Copper	0.0064	0.0084	<0.005
Lead	0.0059	<0.005	<0.005
Manganese	<0.0125	0.0045	0.0028
Mercury	0.00018	0.00016	0.00017
Molybdenum	<0.006	<0.006	0.0147
Nickel	0.0149	0.0151	0.0186
Selenium	0.0149	0.0111	0.0026
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	0.258	<0.10	<0.10
Calcium	27.7	32.1	26.8
Iron	0.334	<0.10	<0.10
Magnesium	10.21	10.71	10.56
Titanium	<0.10	<0.10	<0.10
Anions			
F^-	<0.4	<0.4	<0.4
Cl^-	12.28	12.98	12.80
SO_4^{-2}	78.58	121.6	105.2
PO_4^{-3}	<0.50	<0.50	<0.50

Table 6-17 Average Metal and Anion Concentrations in Water Streams Associated with the Boiler (Data in µg/mL)

	Condenser inlet	Condenser outlet	Make-up	Bottom ash sluice	
				Supply	Discharge
Trace metals					
Antimony	<0.0006	<0.0006	<0.0006	0.011	0.022
Arsenic	<0.0003	<0.0003	<0.0003	0.014	0.038
Barium	0.012	0.018	<0.006[a]	0.025	0.020
Beryllium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005[a]
Boron	9.2	<0.062	20.5	<0.062	<0.062
Cadmium	<0.0003	0.0012[a]	<0.0003	0.0008	0.0010[a]
Chromium	<0.006	<0.006	<0.006	0.0012[a]	<0.006
Cobalt	<0.002[a]	<0.002	<0.002	<0.006	<0.0021[a]
Copper	0.0052	0.0085[a]	0.0033	0.0078	0.0074[a]
Lead	<0.005	<0.005	<0.005	<0.005	<0.005[a]
Manganese	<0.012	0.0021	<0.012	<0.012	0.036[a]
Mercury	0.00014	0.00014	0.00020	0.00014	0.00017
Molybdenum	<0.006	<0.006	<0.006	<0.006[a]	<0.006[a]
Nickel	<0.010	<0.010[a]	<0.010	<0.010	0.0162
Selenium	<0.0006	<0.0006	0.0050[a]	0.0068	0.0095
Vanadium	<0.003	<0.003	<0.003	<0.003	<0.003
Major metals					
Aluminum	<0.10	<0.10[a]	<0.10	<0.10	<0.10[a]
Calcium	20.1	27.5	<0.10[a]	26.6	28.9
Iron	<0.10	<0.10	<0.10	<0.10[a]	<0.10[a]
Magnesium	11.2	11.2	<0.10[a]	10.2	10.5
Titanium	<0.10	<0.10	<0.10	<0.10	<0.10
Anions					
F^-	<0.40	<0.40	<0.40	<0.40	<0.40
Cl^-	10.6	12.7	<0.05	14.9	12.7
SO_4^{-2}	23.3	24.5	<0.10	85.9	101.8
PO_4^{-3}	<0.50	<0.50	<0.50	<0.50	<0.50

[a] Based on two daily values, not three.

Table 6-18
Carbonyl Compounds
in Water Streams Associated with the Boiler
(September 6, 1993)

Stream	Concn, µg/L
Condenser inlet	
Formaldehyde	122
Acetaldehyde	<5
Acetone	34
Condenser outlet	
Formaldehyde	14
Acetaldehyde	<5
Acetone	137
Make-up water	
Formaldehyde	38
Acetaldehyde	<5
Acetone	16
Sluice supply	
Formaldehyde	<5
Acetaldehyde	<5
Acetone	<5
Bottom ash sluice	
Formaldehyde	15
Acetaldehyde	<5
Acetone	<5
Blanks	
Formaldehyde	14-57[a]
Acetaldehyde	<5
Acetone	<5

[a] Range of values.

Table 6-19
Target Volatile Organic Compounds and Their Detection Limits^a

	Compound	Detection limits			Compound	Detection limits	
		Flue gas^b µg/Nm^3	Water^c µg/L			Flue gas^b µg/Nm^3	Water^c µg/L
✓	Chloromethane	0.12	0.48		1,2-Dichloropropane	0.12	0.48
✓	Vinyl chloride	0.16	0.64		Bromodichloromethane	0.12	0.50
✓	Bromomethane	0.42	1.7	✓	cis-1,3-Dichloropropene	0.045	0.18
✓	Chloroethane	1.9	7.6		2-Hexanone	0.17	0.70
	1,1-Dichloroethene	0.060	0.24	✓	Toluene	0.60	0.24
	Acetone	2.4	9.8	✓	trans-1,3-Dichloropropene	0.089	0.36
	Methyl iodide	-	-	✓	1,1,2-Trichloroethane	0.11	0.44
✓	Carbon disulfide	0.15	0.62	✓	Tetrachloroethene	0.060	0.24
✓	Methylene chloride	0.30	1.2		4-Methyl-2-pentanone	0.030	1.2
	trans-1,2-dichloroethene	0.055	0.22		Dibromochloromethane	0.074	0.30
	1,1-Dichloroethane	0.089	0.36	✓	Chlorobenzene	0.030	0.12
	2-Butanone	1.3	5.1	✓	Ethylbenzene	0.074	0.30
✓	Chloroform	0.11	0.46	✓	m- & p-Xylene	0.074	0.30
	1,1,1-Trichloroethane	0.42	1.7	✓	o-Xylene	0.030	0.12
✓	Carbon tetrachloride	0.10	0.42	✓	Styrene	0.064	0.26
✓	Benzene	0.064	0.26	✓	Bromoform	0.054	0.22
✓	1,2-Dichloroethane	0.13	0.54	✓	1,1,2,2-Tetrachloroethane	0.13	0.52
✓	Trichloroethene	0.084	0.34				

[a] Compounds listed in Title III of the Clean Air Act Amendments of 1990 are designated by checkmarks.
[b] Based on gas volume of 20 L.
[c] Based on injection of 5 mL into the instrument.

Table 6-20
Target Semi-Volatile Compounds and Their Detection Limits[a,b]

		Detection limit				Detection limit	
	Compound	µg/L	µg/Nm³		Compound	µg/L	µg/Nm³
✓	Phenol	1.9	0.16		2-Nitroaniline	2.4	0.20
✓	Aniline	1.6	0.14		Acenaphthene	3.6	0.30
✓	Bis(2-Chloroethyl) ether	1.1	0.09	✓	2,4-Dinitrophenol	5.0	-
	2-Chlorophenol	2.1	0.18	✓	4-Nitrophenol	2.6	0.22
	1,3-Dichlorobenzene	1.6	0.14	✓	Dibenzofuran	1.5	0.13
✓	1,4-Dichlorobenzene	1.5	0.13	✓	2,4-Dinitrotoluene	1.0	0.08
	Benzyl alcohol	-	-		Diethyl phthalate	1.2	0.09
✓	1,2-Dichlorobenzene	1.8	0.15		4-Chlorophenyl phenyl ether	-	-
	2-Methylphenol	1.9	0.16		Fluorene	2.8	0.24
	Bis(2-Chloroisopropyl) ether	1.0	0.08		4-Nitroaniline	3.2	0.27
	4-Methylphenol	6.3	0.52		4,6-Dinitro-2-methylphenol	-	-
	N-Nitroso-di-N-propylamine	9.0	0.75		N-Nitrosodiphenylamine	0.7	0.06
✓	Hexachloroethane	1.2	0.10		4-Bromophenyl phenyl ether	0.5	0.04
✓	Nitrobenzene	1.9	0.16	✓	Hexachlorobenzene	0.9	0.07
	Isophorone	2.0	0.17	✓	Pentachlorophenol	-	-
	2,4-Dimethylphenol	7.0	1.8		Phenanthrene	1.4	0.12
	2-Nitrophenol	1.0	0.08		Anthracene	1.6	0.14
	Benzoic acid	5.8	0.48		Di-n-Butyl phthalate	3.6	0.63
	Bis(2-Chloroethoxy) methane	1.0	0.08		Fluoranthene	1.4	0.12
	2,4-Dichlorophenol	8.4	0.70	✓	Benzidine	16.4	1.4
✓	1,2,4-Trichlorobenzene	1.8	0.15		Pyrene	6.0	0.50
✓	Naphthalene	4.0	0.34		Butyl benzyl phthalate	2.0	0.16
	4-Chloroaniline	3.5	0.29	✓	3,3'-Dichlorobenzidine	4.8	0.41
✓	Hexachlorobutadiene	2.0	0.17		Benzo(a)anthracene	1.0	0.08
	4-Chloro-3-methylphenol	-	-		Bis(2-Ethylhexyl) phthalate	-	-
	2-Methylnaphthalene	1.6	0.14		Chrysene	21.2	0.14
	2,4,6-Trichlorophenol	10.8	0.90		Di-N-Octyl phthalate	-	-
✓	Hexachlorocyclopentadiene	2.4	0.20		Benzo(b)fluoranthene	12.0	1.0
	2,4,5-Trichlorophenol	15.1	1.3		Benzo(k)fluoranthene	20.4	1.7
	2-Chloronaphthalene	2.0	0.17		Benzo(a)pyrene	11.2	0.93
	3-Nitroaniline	0.9	0.07		Indeno(1,2,3-cd)pyrene	-	-
✓	Dimethyl phthalate	1.5	0.13		Dibenz(a,h)anthracene	-	-
	2,6-Dinitrotoluene	0.9	0.07		Benzo(g,h,i)perylene	-	-
	Acenaphthylene	3.8	0.31				

[a] Compounds listed in Title III of the 1990 Clean Air Act Amendments are designated by checkmarks.

[b] Detection limits are given in the units µg/L for 0.5 L of a water sample, or µg/Nm³ for 3 Nm³ of a flue-gas ample.

6.1.3 Gas Streams

6.1.3.1 Metals

This section presents data on gas streams at three locations:

- Inlet of the Unit 8 ESP
- Outlet of the Unit 8 ESP
- Outlet of the Unit 7 ESP

The data on the gas stream in the stack are deferred for presentation in Section 6.3. Not all of the data pertinent to the three locations adjacent to the ESPs are presented here. The exceptions are 1) the metal concentrations in fly ash segregated by size with cyclones and 2) the metal concentrations in flue gas that had been sampled with the dilution device. The cyclone samples came from all three of the locations listed above; the analytical data for these samples appear in Section 8.3. The dilution sampling was performed at the outlet of the Unit 7 ESP; the results are presented in Section 8.2.

The data on metals in the three locations enumerated above appear in three sets of five tables each: Tables 6-21 through 25 for the Unit 8 ESP inlet, Tables 6-26 through 30 for the Unit 8 ESP outlet, and Tables 6-31 through 35 for the Unit 7 ESP outlet. All of the data presented are blank-corrected; that is, the results for samples were reduced by the corresponding results for a blank train.

> The first three tables for each location give the concentrations measured in the particulate and vapor states and the sum in the two states on the five successive sampling days (September 3, 4, and 5). The units are micrograms per normal cubic meter ($\mu g/Nm^3$). Each table lists the sample volume used to calculate concentrations from the total amounts of analytes found.
>
> The fourth table for each location gives the averages, with standard deviations, for the three days, in the same units ($\mu g/Nm^3$).
>
> The fifth table for each location presents the averages for the three days, presented in the units micrograms per gram ($\mu g/g$). Data in these units were calculated by dividing each daily metal concentration by the corresponding total particulate concentration and computing the average for all three days. The daily total particulate concentrations are listed in the footnote of the table.

All of the data in these tables were obtained by analyzing samples from the Method 29 train by ICP and related AAS methods. There are additional data for mercury from the train with solid traps that were generated in the laboratory at Brooks Rand. On September 3, only the iodated carbon traps were used for sampling; thus, only data for total mercury in the vapor state were obtained. On September 4 and 5, however, the combination of soda lime and iodated carbon was used, and data for both oxidized mercury and elemental mercury vapors were obtained. The data from samples in the traps are presented in detail in Table 6-36. A synopsis is given below:

- The average percentage of mercury found in the oxidized state was 67.0%. Presumably, the specific form of mercury in the oxidized state is the vapor $HgCl_2$. A factor that is presumed to be consistent with the finding of two-thirds of the mercury as the divalent chloride is the occurrence of chlorine in the coal at the concentration of 0.10% by weight. SRI investigators have seen lesser fractions of total mercury in the flue gas in the oxidized state when the coal contained less chlorine, and they have found a higher fraction oxidized when the coal contained more chlorine.

- The concentrations of total mercury were lower when the two types of traps permitting speciation were in use. This result may have been coincidental. There is evidence, however, from the mercury determinations in coal at Brooks Rand that the concentrations in the coal were lower on the second and third sampling dates, when the total concentrations of mercury in the gas streams were lower.

- It is appropriate to calculate the average mercury vapor concentration in all three duct locations since no removal of mercury from the vapor state should have occurred in either ESP. The average based on sampling with solid sorbents is 8.0 $\mu g/Nm^3$ in the vapor state. The averages based on sampling by Method 29 (calculated from the data in Tables 6-24, 6-29, and 6-34) are 4.0 $\mu g/Nm^3$ in the vapor state and 0.2 $\mu g/Nm^3$ in the particulate state. This comparison suggests that using the solid sorbents led to only a negligible error from not collecting the particulate mercury but yielded, nevertheless, a substantially higher recovery of mercury vapor.

The comparison of total vapor concentrations by both methods can best be discussed in the context of the expected mercury concentrations based on analyses of the coal. The two sets of mercury determinations in the coal are in good agreement; both are essentially 0.100 $\mu g/g$. The corresponding value for the flue gas is obtained by dividing this value by the expected volume of flue gas from the coal — 0.008204 Nm^3/g, according to Table 6-2. Thus, the expected mercury concentration in the flue gas is $0.100/0.008204 = 12.2\ \mu g/Nm^3$. With this expected value for reference, the recovery of mercury with solid sorbents was 66%; that with Method 29 was just 33%.

It is appropriate to focus much of the discussion on mercury, as has been done above, because of the high degree of interest of this particular metal as a component of the emissions from coal combustion. Certain other highlights of the data on metals in the gas streams merit attention, however, such as those listed below:

- Three metals occurred at higher concentrations as vapors than as components of the particulate matter. These are boron, mercury, and selenium. The following tabulation shows the percentages of the total of each found in the vapor phase at different locations:

	Inlet Unit 8 ESP	Outlet Unit 8 ESP	Outlet Unit 7 ESP
Boron	85	>99.9	99.6
Mercury	94	99	99
Selenium	57	99	79

  The higher percentages at the outlet of the ESP of Unit 8 than at the inlet indicate the removal of the element in the particulate phase. The higher percentages at the outlet of the Unit 8 ESP than at the outlet of the Unit 7 ESP probably are the result of the greater removal of particulate matter in the Unit 8 ESP than in the Unit 7 ESP, as illustrated elsewhere in this report.

- Generally, the metals that occurred predominantly in the particulate phase ranked in relative concentrations as follows: highest at the Unit 8 ESP inlet, next highest at the Unit 7 ESP outlet, and least at the Unit 8 ESP outlet. This order is illustrated below for one trace metal (barium) and one major metal (aluminum). The data are in µg/Nm^3:

	Inlet Unit 8 ESP	Outlet Unit 8 ESP	Outlet Unit 7 ESP
Barium	1920	5.66	23.7
Aluminum	481000	606	4920

  These data further illustrate the higher efficiency of the Unit 8 ESP for removing particulate matter.

On the issue of partitioning between the vapor and particulate states, a necessary qualification about the data is that the indicated partitioning is due in part to the *performance characteristics of the sampling method*. The filter in the Method 29 sampling train operates at 121 °C. This temperature is cooler than that of any of the gas ducts adjacent to the ESPs; thus, it may cause the fraction of a metal in the particulate matter to appear higher than the actual fraction in the duct. This means, of course, that the above percentages of boron, mercury, and selenium in the vapor phase may be understated. A contrary observation is that a metal in the particulate matter may somehow penetrate or bypass the filter and appear as a vapor. Several of the metals of interest are not likely to have measurable vapor concentrations at the duct temperatures (much less at the filter temperature), and the apparent fractions in the vapor state may be spurious. One example is barium. The occurrence of this element at a concentration of 2.44 μg/Nm^3 (as reported in Table 6-34) is problematical; such a concentration, although low, corresponds to a concentration of barium vapor of 4.27×10^{-10} atm, whereas the JANAF Tables (10) indicate that at 150 °C (the approximate duct temperature) the vapor pressure of this metal is just 3.09×10^{-17} atm. The possibility of erroneous high indications of vapor concentrations does not detract from the observations about boron, mercury, and selenium, because high vapor concentrations of these metals are consistent with their thermodynamic properties.

Table 6-37 compares the metal concentrations in the three gas streams adjacent to the ESPs on the basis of the ratio to total particulate. The data here are in the units μg/g; they were taken from the last columns of Tables 6-25, 6-30, and 6-35 which give totals (particulate plus vapor) in the three gas streams. The data columns are arranged in Table 6-37 in the order Unit 8 ESP inlet, Unit 7 ESP outlet, and Unit 8 ESP outlet because total particulate concentration decreased in that order. Generally, the data show very sharp increases as the total particulate concentration decreased, which suggests either that the metals are either significantly in the vapor state or that they occur primarily on the surfaces of particles, the smaller the particle size the greater the specific surface area and the specific metal concentration. The most notable trends are for boron, mercury, and selenium, which are predominantly vapors that are removed in the ESPs. The trends for some of the other metals, however, signify changes in particulate composition; examples are barium, cadmium, and chromium, among others.

The data in Table 6-37 for the inlet of the Unit 8 ESP should compare well in general with the corresponding data for the ash from the Unit 8 ESP hoppers (see Tables 6-8 and 6-9). Examples of metals that are more concentrated in the inlet (before collection) than in the hoppers (after collection) are the three that are significantly volatile: boron (3490 vs. 981 μg/g), mercury (0.850 vs. 0.006 μg/g), and selenium (81.1 vs. 7.91 μg/g). The most notable examples of other metals that differ in the two locations are believed to be spurious, resulting from analytical error (for example, antimony at 8.32 μg/g in the gas stream and 25.1 in the hopper).

Table 6-21
Metal Concentrations in the Gas Stream at the Inlet of the Unit 8 ESP (September 3, 1993)
(Data in μg/Nm^3)
(All data here by Method 29; sample volume 2.329 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	25.8	<0.04	25.8
Arsenic	244	3.01	371
Barium	1630	2.49	1630
Beryllium	87.8	<0.02	87.8
Boron	3310	15600	18900
Cadmium	127	0.54	127
Chromium	1940	2.28	1940
Cobalt	167	<0.20	167
Copper	763	0.34	763
Lead	1290	<0.20	1290
Manganese	1030	<0.80	1030
Mercury[a]	0.30	1.12/4.09	5.51
Molybdenum	575	<0.40	575
Nickel	1070	0.39	1070
Selenium	201	171	372
Vanadium	2190	0.21	2190
Major metals			
Aluminum	470000	277	470000
Calcium	90100	2300	92400
Iron	647000	137	647000
Magnesium	29900	75.3	30,000
Titanium	33900	12.2	34000

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-22
Metal Concentrations in the Gas Stream at the Inlet of the Unit 8 ESP (September 4, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 2.173 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	33.1	0.89	34.0
Arsenic	262	1.14	394
Barium	1850	3.80	1850
Beryllium	96.5	0.53	97.0
Boron	168	13700	13800
Cadmium	156	1.7	157
Chromium	1860	4.17	1870
Cobalt	189	<0.20	189
Copper	930	2.64	933
Lead	1690	1.88	1690
Manganese	1200	4.10	1200
Mercury[a]	0.25	0.93/2.50	3.68
Molybdenum	726	0.43	726
Nickel	1100	10.5	1100
Selenium	152	199	351
Vanadium	2600	2.58	2610
Major metals			
Aluminum	479000	689	480000
Calcium	90000	2400	92600
Iron	629000	580	630000
Magnesium	31200	103	31300
Titanium	35600	42.9	35600

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-23
Metal Concentrations in the Gas Stream at the Inlet of the Unit 8 ESP (September 5, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 2.123 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	67.6	1.72	69.3
Arsenic	253	3.33	256
Barium	2280	4.31	2290
Beryllium	110	2.15	112
Boron	4470	14900	19400
Cadmium	199	4.62	204
Chromium	2380	7.24	2390
Cobalt	218	0.45	219
Copper	1170	2.34	1180
Lead	1350	2.71	1350
Manganese	1340	<0.80	1340
Mercury[a]	0.25	1.08/2.02	3.36
Molybdenum	978	2.70	981
Nickel	1490	3.50	1490
Selenium	180	322	502
Vanadium	2960	5.97	2960
Major metals			
Aluminum	493000	1200	494000
Calcium	102000	2880	105000
Iron	638000	992	639000
Magnesium	33500	141	33700
Titanium	36400	81.7	36500

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-24
Average Metal Concentrations in the Gas Stream at the Inlet of Unit 6 ESP[a]
(Data in $\mu g/Nm^3$; with standard deviations)

	Particulate	Vapor	Total
Trace metals			
Antimony	42.2 ± 22.3	0.858 ± 0.701	43.0 ± 23.1
Arsenic	129 ± 5.17	2.49 ± 0.963	132 ± 5.19
Barium	1920 ± 311	3.53 ± 0.768	1920 ± 332
Beryllium	98.1 ± 11.1	0.895 ± 0.917	99.0 ± 12.3
Boron	2650 ± 2230	14700 ± 788	17400 ± 3080
Cadmium	160 ± 36.4	2.28 ± 1.72	163 ± 38.4
Chromium	2080 ± 282	4.57 ± 2.04	2080 ± 284
Cobalt	191 ± 25.7	0.132 ± 0.223	191 ± 25.9
Copper	956 ± 207	1.78 ± 1.02	958 ± 208
Lead	1440 ± 214	1.53 ± 1.14	1440 ± 215
Manganese	1200 ± 154	0.784 ± 2.4	1200 ± 154
Mercury	0.266 ± 0.0279	3.92 ± 0.926	4.2 ± 1.16
Molybdenum	759 ± 204	1.04 ± 1.18	760 ± 205
Nickel	1240 ± 237	5.14 ± 4.21	1240 ± 236
Selenium	177 ± 24.3	231 ± 65.6	408 ± 81.7
Vanadium	2580 ± 383	2.98 ± 2.37	2590 ± 386
Major metals			
Aluminum	481000 ± 11700	721 ± 376	481000 ± 12200
Calcium	94200 ± 7060	2530 ± 252	96700 ± 7370
Iron	638000 ± 8690	570 ± 349	638000 ± 8480
Magnesium	31500 ± 1870	107 ± 27.1	31600 ± 1900
Titanium	35300 ± 1250	45.6 ± 28.5	35400 ± 1280

[a] Data based on Tables 6-21, 6-22, and 6-23.

Table 6-25
Ratios of Metal Concentrations in the Gas Stream at the Inlet of the Unit 8 ESP to the Total Concentration of Entrained Solids*
(Data in μg/g; averages of daily results)

	Particulate	Vapor	Total
Trace metals			
Antimony	8.16	0.164	8.32
Arsenic	50.1	0.504	50.6
Barium	378	0.698	378
Beryllium	19.3	0.171	19.5
Boron	529	2960	3490
Cadmium	31.4	0.441	31.9
Chromium	411	0.893	412
Cobalt	37.7	0.0251	37.7
Copper	187	0.342	188
Lead	285	0.292	285
Manganese	235	0.135	236
Mercury	0.0530	0.797	0.850
Molybdenum	148	0.199	149
Nickel	244	0.987	245
Selenium	35.4	45.0	80.4
Vanadium	508	0.571	509
Major metals			
Aluminum	95300	140	95400
Calcium	18600	504	19100
Iron	127000	110	127000
Magnesium	6240	21.1	6260
Titanium	6990	8.81	7000

*Calculated by dividing the individual concentrations in Tables 6-21, 6-22, and 6-23 by the appropriate total particulate concentrations. The three daily concentrations of total particulate were, in succession, 4.556, 5.243, and 5.404 g/Nm^3.

Table 6-26
Metal Concentrations in the Gas Stream at
the Outlet of the Unit 8 ESP (September 3, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 2.870 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.20	0.16	0.26
Arsenic	0.80	0.92	1.72
Barium	4.53	1.98	6.52
Beryllium	0.09	<0.02	0.10
Boron	<0.2	11900	11900
Cadmium	4.42	2.18	6.60
Chromium	4.74	3.29	8.03
Cobalt	<0.20	0.08	0.18
Copper	1.33	0.81	2.14
Lead	6.81	0.53	7.34
Manganese	0.27	0.90	1.17
Mercury[a]	0.06	0.91/3.15	4.12
Molybdenum	4.27	<0.40	4.47
Nickel	2.10	6.91	9.01
Selenium	2.32	110	112
Vanadium	3.72	0.08	3.80
Major metals			
Aluminum	494	229	723
Calcium	613	174	2350
Iron	887	114	1000
Magnesium	29.3	54.5	83.7
Titanium	44.4	8.77	53.2

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-27
Metal Concentrations in the Gas Stream at the Outlet of the Unit 8 ESP (September 4, 1993)
(Data in µg/Nm³)
(All data here by Method 29; sample volume 2.826 Nm³)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.20	0.01	0.11
Arsenic	0.71	1.59	2.29
Barium	2.54	2.57	5.11
Beryllium	0.12	<0.02	0.13
Boron	<0.2	14500	14500
Cadmium	1.58	1.49	3.07
Chromium	5.24	2.87	8.11
Cobalt	<0.20	<0.20	<0.20
Copper	1.32	3.44	4.76
Lead	4.37	0.68	5.05
Manganese	0.62	<0.80	1.02
Mercury[a]	0.01	1.15/2.73	3.89
Molybdenum	4.60	<0.40	4.70
Nickel	2.33	2.47	4.80
Selenium	1.39	194	195
Vanadium	4.95	0.21	5.16
Major metals			
Aluminum	306	275	581
Calcium	103	2200	2300
Iron	532	82.2	614
Magnesium	29.7	71.6	101
Titanium	38.0	11.2	49.2

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-28
Metal Concentrations in the Gas Stream at the Outlet of the Unit 8 ESP (September 5, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 2.644 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.20	0.24	0.34
Arsenic	0.58	1.71	2.29
Barium	2.31	3.03	5.34
Beryllium	<0.02	<0.02	<0.02
Boron	<0.2	14300	14300
Cadmium	0.94	0.82	1.75
Chromium	3.80	3.30	7.10
Cobalt	<0.20	0.26	0.36
Copper	2.34	0.95	3.29
Lead	0.45	0.85	1.30
Manganese	1.24	<0.80	1.64
Mercury[a]	0.02	1.63/2.39	4.04
Molybdenum	4.83	<0.40	5.03
Nickel	3.23	1.57	4.80
Selenium	1.76	204	206
Vanadium	3.08	0.21	3.29
Major metals			
Aluminum	194	320	514
Calcium	56.9	2560	2620
Iron	357	152	509
Magnesium	20.1	87.1	107
Titanium	25.1	14.2	39.3

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-29
Average Metal Concentrations in the Gas Stream at the Outlet of Unit 8 ESP[a]
(Data are in μg/Nm^3; with standard deviations)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.20	0.135 ± 0.0929	0.235
Arsenic	0.696 ± 0.0897	1.4 ± 0.347	2.10 ± 0.33
Barium	3.13 ± 0.998	2.53 ± 0.429	5.66 ± 0.753
Beryllium	≤0.07	<0.02	≤0.09
Boron	<0.20	13600 ± 1180	13600 ± 1180
Cadmium	2.31 ± 1.51	1.5 ± 0.558	3.81 ± 2.51
Chromium	4.59 ± 0.594	3.15 ± 0.2	7.75 ± 0.555
Cobalt	<0.20	0.0582 ± 0.177	0.158
Copper	1.67 ± 0.480	1.73 ± 1.21	3.40 ± 1.31
Lead	3.88 ± 2.62	0.688 ± 0.134	4.57 ± 3.05
Manganese	1.73 ± 0.380	0.00195 ± 0.681	1.73 ± 0.84
Mercury	0.0303 ± 0.0219	3.97 ± 0.0755	4.02 ± 0.110
Molybdenum	4.57 ± 0.228	<0.40	4.57
Nickel	2.56 ± 0.488	3.94 ± 2.33	6.50 ± 2.43
Selenium	1.82 ± 0.382	169 ± 42.3	171 ± 51.4
Vanadium	4.1 ± 0.774	0.215 ± 0.0614	4.32 ± 0.962
Major metals			
Aluminum	332 ± 124	275 ± 37.3	606 ± 107
Calcium	257 ± 252	2160 ± 337	2420 ± 171
Iron	592 ± 24	116 ± 28.6	708 ± 259
Magnesium	26.4 ± 4.42	71 ± 13.3	97.4 ± 12.2
Titanium	35.9 ± 8.02	11.4 ± 2.23	47.2 ± 7.11

[a] Based on data in Tables 6-26, 6-27, and 6-28.

Table 6-30
Ratios of Metal Concentrations in the Gas Stream at the Outlet of the Unit 8 ESP to the Total Concentration of Entrained Solids[a]
(Data in μg/g; averages of daily results)

	Particulate	Vapor	Total
Trace metals			
Antimony	<26	19.6	<46
Arsenic	86.6	200	287
Barium	363	353	716
Beryllium	7.85	<2.6	<10.4
Boron	<26	1830000	1830000
Cadmium	230	167	397
Chromium	581	414	995
Cobalt	<26	23.1	<49
Copper	240	228	468
Lead	372	97.1	469
Manganese	114	<64	<178
Mercury	3.06	520	523
Molybdenum	610	<52	<662
Nickel	359	366	725
Selenium	228	24100	24400
Vanadium	413	24.5	438
Major metals			
Aluminum	37100	37900	75000
Calcium	22100	265000	287000
Iron	66400	16000	82400
Magnesium	3260	4000	7250
Titanium	4280	1600	5890

[a] Calculated by dividing the individual concentrations in Tables 6-26, 6-27, and 6-28 by the appropriate total particulate concentration. The three daily concentrations of total particulate were, in succession, 0.01456, 0.00778, and 0.00511 g/m^3.

Table 6-31
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP (September 3, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 3.518 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	0.43	0.14	0.56
Arsenic	7.72	4.41	12.1
Barium	22.2	2.13	24.3
Beryllium	1.77	<0.02	1.78
Boron	62.3	10900	11000
Cadmium	8.84	3.64	12.5
Chromium	29.9	2.26	32.1
Cobalt	2.66	0.14	2.80
Copper	15.5	1.64	17.1
Lead	28.2	0.76	29.0
Manganese	10.2	<0.80	11.0
Mercury[a]	0.03	0.83/3.08	3.94
Molybdenum	16.3	<0.40	16.5
Nickel	8.68	1.18	9.86
Selenium	11.5	135	146
Vanadium	43.2	0.45	43.7
Major metals			
Aluminum	7010	249	7260
Calcium	744	1640	2380
Iron	8120	166	8280
Magnesium	277	57.2	334
Titanium	425	11.3	436

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-32
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP (September 4, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29; sample volume 2.457 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	0.25	<0.04	0.27
Arsenic	3.07	0.88	3.95
Barium	17.0	2.57	19.5
Beryllium	1.08	<0.02	1.09
Boron	38.0	14900	14900
Cadmium	4.11	3.23	7.33
Chromium	17.8	2.89	20.7
Cobalt	1.52	<0.20	1.62
Copper	10.8	2.73	13.5
Lead	20.1	<0.50	20.3
Manganese	6.61	<0.80	7.01
Mercury[a]	0.05	1.98/2.97	5.00
Molybdenum	14.9	<0.40	15.1
Nickel	1.56	1.96	3.52
Selenium	71.0	482	553
Vanadium	33.1	0.10	33.2
Major metals			
Aluminum	3190	287	3480
Calcium	754	2380	3130
Iron	5500	92.9	5590
Magnesium	223	77.9	300
Titanium	334	12.0	346

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-33
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP (September 5, 1993)
(Data in µg/Nm^3)
(All data here by Method 29; sample volume 2.518 Nm^3)

	Particulate	Vapor	Total
Trace metals			
Antimony	0.43	0.03	0.46
Arsenic	2.58	0.54	3.12
Barium	24.8	2.61	27.4
Beryllium	1.27	<0.02	1.27
Boron	51.0	13900	13900
Cadmium	6.59	1.97	8.56
Chromium	27.6	2.90	30.5
Cobalt	1.77	<0.20	1.87
Copper	13.8	0.79	14.6
Lead	21.0	<0.50	21.0
Manganese	9.36	<0.80	9.76
Mercury[a]	0.08	1.38/2.23	3.68
Molybdenum	19.0	<0.40	19.0
Nickel	8.51	2.30	10.8
Selenium	134	206	340
Vanadium	36.8	0.19	37.0
Major metals			
Aluminum	3780	258	4040
Calcium	1010	2250	3260
Iron	6570	143	6720
Magnesium	282	69.2	351
Titanium	384	11.0	395

[a] The column for vapor gives separate data from peroxide and permanganate impingers. See Table 6-36 for other mercury data.

Table 6-34
Average Metal Concentrations in the Gas Stream at the Outlet of Unit 7 ESP[a]
(Data in μg/Nm^3; with standard deviations)

	Particulate	Vapor	Total
Trace metals			
Antimony	0.369 ± 0.0855	0.0472 ± 0.189	0.416 ± 0.173
Arsenic	4.46 ± 2.31	1.94 ± 1.44	6.40 ± 4.98
Barium	21.3 ± 3.24	2.44 ± 10.6	23.7 ± 3.95
Beryllium	1.37 ± 0.288	<0.02	1.38
Boron	50.4 ± 9.95	13200 ± 6260	13300 ± 2040
Cadmium	6.51 ± 1.93	2.94 ± 1.5	9.45 ± 2.69
Chromium	32.8 ± 4.52	2.68 ± 15.8	35.4 ± 5.37
Cobalt	1.98 ± 0.489	<0.20	2.18
Copper	13.3 ± 1.94	1.72 ± 5.49	15.1 ± 1.84
Lead	23.1 ± 3.62	0.255 ± 9.75	23.4 ± 4.87
Manganese	10.3 ± 1.37	<0.80	10.7
Mercury	0.0518 ± 0.0207	4.16 ± 2.1	4.21 ± 0.697
Molybdenum	16.7 ± 1.68	<0.40	16.9
Nickel	14.9 ± 2.77	2.1 ± 7.6	17.0 ± 3.52
Selenium	72.2 ± 50	274 ± 164	347 ± 204
Vanadium	37.9 ± 4.16	0.293 ± 17.3	38.2 ± 5.27
Major metals			
Aluminum	4660 ± 1680	265 ± 1650	4920 ± 2040
Calcium	837 ± 125	2090 ± 558	2930 ± 474
Iron	6730 ± 1070	134 ± 3040	6860 ± 1350
Magnesium	260 ± 26.9	68.1 ± 101	329 ± 25.8
Titanium	381 ± 37.3	11.4 ± 176	392 ± 45.3

[a]Based on data in Tables 6-31, 6-32, and 6-33.

Table 6-35
Ratios of Metal Concentrations in the Gas Stream at the Outlet of Unit 7 ESP to the Total Concentration of Entrained Solids[a]
(Data in $\mu g/g$; averages of daily results)

	Particulate	Vapor	Total
Trace metals			
Antimony	5.25	0.615	5.87
Arsenic	66.1	28.7	94.7
Barium	307	36.4	344
Beryllium	20.1	<0.26	20.2
Boron	732	199000	200000
Cadmium	93.2	45.3	138
Chromium	475	40.1	515
Cobalt	29.0	<1.5	29.7
Copper	194	28	222
Lead	342	3.65	346
Manganese	150	<11	155
Mercury	0.745	63.7	64.4
Molybdenum	244	<5.3	246
Nickel	213	31.1	244
Selenium	1013	4480	5490
Vanadium	559	4.2	563
Major metals			
Aluminum	68000	3980	72000
Calcium	122000	31400	43600
Iron	98500	1930	100000
Magnesium	3800	1030	4830
Titanium	5600	172	5770

[a] Calculated by dividing the individual concentrations in Tables 6-31, 6-32, and 6-33 by the appropriate total particulate concentration. The three daily concentrations of total particulate were, in succession, 0.0698, 0.0527, and 0.0877 g/Nm^3.

Table 6-36
Concentrations of Mercury Vapor Based on Sampling with Solid Sorbents at Locations Adjacent to the ESPs

	Date	Concn[a], μg/Nm^3			Percent oxidized
		Hg(II)	Hg(0)	Total	
U8 inlet	9/3	--	--	10.3	--
	9/4	5.19	1.31	6.50	79.8
	9/5	4.79	2.40	7.19	66.6
U8 outlet	9/3	--	--	10.2	--
	9/4	3.25	4.46	7.71	42.2
	9/5	5.05	1.97	7.02	71.9
U7 outlet	9/3	--	--	8.81	--
	9/4	4.91	2.73	7.64	64.3
	9/5	4.88	1.43	6.31	77.3
Ambient[b]	9/4	0.02	0.11	0.13	15
	9/5	0.03	0.11	0.14	21

[a] All data here were derived by subtracting blanks from raw data.

[b] These data, unlike the remainder, are for the actual O_2 concentration.

Table 6-37
Comparison of Metal Concentrations in the Different Gas Streams Adjacent to the ESPs[a]
(Data in $\mu g/g$)

	Unit 8 inlet	Unit 7 outlet	Unit 8 outlet
Trace metals			
Antimony	8.32	5.87	<46
Arsenic	26.1	94.7	287
Barium	378	344	716
Beryllium	19.5	20.2	<10.4
Boron	3490	200000	1830000
Cadmium	31.9	138	397
Chromium	412	515	995
Cobalt	37.7	29.7	<49
Copper	188	222	468
Lead	285	346	469
Manganese	236	155	<178
Mercury	0.850	64.4	523
Molybdenum	149	246	<662
Nickel	245	244	725
Selenium	81.1	5490	24400
Vanadium	509	563	438
Major metals			
Aluminum	95400	72000	75000
Calcium	19100	43600	787000
Iron	127000	100000	82400
Magnesium	6260	4830	7250
Titanium	7000	5770	5890

[a] Data from Tables 6-25, 6-30, and 6-35.

6.1.3.2 Acid Gases

Table 6-38 presents the apparent concentrations of anions in flue gas in the three gas ducts associated with the boiler and ESPs. Table 6-39 gives the corresponding concentrations of the acid gases that contain these anions (or, more exactly, in the case of SO_2, the sulfate produced by reaction in the sampling medium). The following tabulation gives the expected concentrations based on the coal analysis and the average observed concentrations at each location:

	Concn, ppmv			
	HF	HCl	SO_2	H_3PO_4
Expected	15.2	80.1	2900	11.2
Observed, Unit 8 ESP inlet	15.5	67.7	2820	<3.0
Observed, Unit 8 ESP outlet	16.4	69.2	2820	<3.0
Observed, Unit 7 ESP outlet	16.4	72.2	2760	<2.9

For HF, HCl, and SO_2, the agreement between expected and observed values is excellent. Clearly, SO_2 as a gas must be the antecedent of the sulfate measured. The agreement between the calculated values for HF and HCl signify that fluoride and chloride also occur as the gaseous compounds, not as salts in the particulate matter.

For H_3PO_4, on the other hand, the agreement is much poorer, although it is indefinite because of insufficient sensitivity in the measurement of phosphate. Not more than 25% of the possible concentration of H_3PO_4 actually occurred; moreover, because of high recoveries of phosphorus as phosphate in particulate matter, it is reasonable to conclude that H_3PO_4 was an inconsequential or even nonexistent component of the flue gas.

For reasons to be discussed subsequently, sulfate was measured in the solids entrained in the gas streams. The solid matter collected on the filter of the acid gases train was used for this purpose; the solids were extracted with water and sulfate was determined in the extract. The results were as follows:

	Concentration, wt%		
	Sept. 3	Sept. 4	Sept. 5
Inlet, Unit 8 ESP	4.8	5.9	4.5
Outlet, Unit 8 ESP	3.9	4.8	15.6
Outlet, Unit 7 ESP	32.4	54.4	59.3

None of these concentrations in the solids represents a significant concentration of SO_2 in the gas phase. Some of the results are quite unexpected, however, especially the very high concentrations at the outlet of the Unit 7 ESP. Some elevation at an

ESP outlet is plausible because of the decreased particle size and increased specific particle surface area (sulfate is regarded as a surface constituent of ash in the main). Clearly, the elevation at the outlet of the Unit 7 ESP is abnormal compared to that at the outlet of the Unit 8 ESP, especially since the Unit 7 ESP was less efficient than the Unit 8 ESP. Perhaps for reasons not known the ESP causes a higher degree of conversion of SO_2 to SO_3 (or sulfuric acid).

Table 6-38
Anion Concentrations in Ducts Adjacent to the ESPs
(Data in $\mu g/Nm^3$)

	9/3/93	9/4/93	9/5/93	Avg.	Std.dev.
Unit 8 ESP inlet					
Fluoride	9890	15600	11300	12300	3000
Chloride	90800	107000	102000	99900	8300
Sulfate	11400000	11300000	11200000	11300000	100000
Phosphate	<8800	<11900	<8500	<11900	
Unit 8 ESP outlet					
Fluoride	11100	19200	13200	14500	4200
Chloride	87900	116000	103000	102000	14000
Sulfate	10600000	12300000	1000000	11000000	1100000
Phosphate	<10300	<11700	<7600	<11700	--
Unit 7 ESP outlet					
Fluoride	12400	14600	11800	12900	1500
Chloride	86600	127000	106000	106000	20000
Sulfate	10600000	11400000	11000000	11000000	4000000
Phosphate	<10800	<11300	<9900	<11300	--

Table 6-39
Acid Gas Concentrations in Ducts Adjacent to the ESPs
(Data in ppmv)

	9/3/93	9/4/93	9/5/93	Avg.	Std.dev.
Unit 8 ESP inlet					
HF	12.5	19.7	14.4	15.5	3.7
HCl	61.5	72.8	68.8	67.7	5.7
SO_2	2850	2820	2800	2820	25
H_3PO_4	<2.2	<3.0	<2.2	<3.0	--
Unit 8 ESP outlet					
HF	14.1	24.3	16.7	18.4	5.3
HCl	59.6	78.3	69.7	69.2	9.4
SO_2	2640	3080	2740	2820	230
H_3PO_4	<2.6	<3.0	<1.9	<3.0	--
Unit 7 ESP outlet					
HF	15.7	18.5	15.0	16.4	1.8
HCl	58.7	86.0	71.9	72.2	13.6
SO_2	2650	2860	2760	2760	110
H_3PO_4	<2.7	<2.9	<2.5	<2.9	--

6.1.3.3 Ammonia and Hydrogen Cyanide

The concentrations of these two components of the gas phase in the three sampling ducts adjacent to the ESPs are listed in Table 6-41. Each analyte is reported in two units: $\mu g/Nm^3$ and ppmv. All of the data are from September 6; only one sampling run was performed at each location. On this date, all injection of ammonia had reportedly terminated.

Ammonia was measurable at the inlet of the Unit 8 ESP (0.06 ppmv) but not at the outlet of this ESP. It was measurable at the outlet of the Unit 7 ESP, on the other hand (0.03 ppmv). If, as NIPSCO reported, the injection of ammonia to treat the problem of excess sulfuric acid vapor had been discontinued two days earlier, the ammonia observed on September 6 presumably has to be attributed to boiler operation.

Hydrogen cyanide, in contrast to ammonia, appeared at roughly the same concentration (approximately 0.3 ppmv) at each site. This gas has to be considered a product of boiler operation.

Ammonia was measured in selected samples of entrained solids as well as in the gas phase. The filter solids from the acid gases train on September 3-5 (three days in advance of the gas-phase sampling while ammonia injection was still in progress) were extracted with water and the extracts analyzed for ammonia. The analyses were performed by two methods: the electrochemical method based on the ammonia-selective electrode and the colorimetric method. Both methods gave the same result for each solid sample; the results are listed below (%), along with the corresponding equivalent concentrations for the gas phase (ppmv):

	Concentration, % (ppmv)		
	Sept. 3	Sept. 4	Sept. 5
Inlet solids, Unit 8 ESP	0.02 (1.4)	0.1 (0.7)	<0.1 (<0.7)
Outlet solids, Unit 8 ESP	0.30 (0.016)	0.45 (0.025)	1.2 (0.13)
Outlet solids, Unit 7 ESP	3.3 (2.5)	0.59 (0.45)	0.31 (0.24)

There is not necessarily any error in the apparent inconsistency between the solid-phase and the calculated equivalent gas-phase data; the apparent inconsistency is explained by the very large differences in concentrations of entrained particulate matter at the three locations. The solid matter accounts for very little ammonia in comparison with the reported injection level of about 15 ppmv on September 3 in both Units 7 and 8 and again 15 ppm on September 4 in Unit 8 (see Table 3-6). The data give little indication of the cessation of ammonia injection on September 5.

Table 6-40
Ammonia and Sulfate Concentrations in Fly Ash in Ducts Adjacent to the ESPs

(Concentrations in solids are given in %; corresponding
equivalent concentrations in the gas phase
are given in ppmv within parenthesis.)

	9/3/93	9/4/93	9/5/93
Inlet, Unit 8 ESP			
NH_3, % (ppmv)	0.02 (1.3)	0.01 (0.7)	<0.01 (<0.7)
SO_4^{-2}, % (ppmv)	4.8 (55)	5.9 (77)	4.5 (61)
Outlet, Unit 8 ESP			
NH_3, % (ppmv)	0.30 (0.06)	0.45 (0.05)	1.2 (0.09)
SO_4^{-2}, % (ppmv)	3.9 (0.14)	4.8 (0.09)	15.6 (0.20)
Outlet, Unit 7 ESP			
NH_3, % (ppmv)	3.3 (2.5)	0.59 (0.4)	0.31 (0.4)
SO_4^{-2}, % (ppmv)	32.4 (4.4)	54.4 (7.2)	59.3 (13.0)

Table 6-41
Concentrations of Ammonia and Hydrogen Cyanide in Ducts Adjacent to the ESPs
(September 6, 1993)

	Concn, μg/Nm^3		Concn, ppmv	
	NH_3	HCN	NH_3	HCN
Inlet, Unit 8 ESP	41.0	340	0.058	0.31
Outlet, Unit 8 ESP	<3.0	305	<0.007	0.27
Outlet, Unit 7 ESP	11.8	407	0.030	0.36

6.1.3.4 Carbonyl Compounds

The information presented here pertains to all three sampling ducts adjacent to the ESPs. It is limited, however, to a single sampling day — September 6, 1993 — for reasons already discussed.

Three carbonyl compounds were detected. The individual compounds and their calculated concentrations are listed in Table 6-42. Formaldehyde was found at the highest apparent concentration at each duct. Acetone was evidently present in the ducts at Unit 8 but was evidently present at a lower concentration, or absent, at the outlet of the Unit 7 ESP. Acetaldehyde followed the same pattern as acetone.

There is a serious question as to whether the carbonyl compounds can be correctly measured with the sampling train employed. This statement is made because of the result of an experiment with a spiked sampling train. The usual impingers containing the DNPH trapping reagent were employed; in addition, downstream from the usual impingers, two spiked impingers were added in series. Auditors from RTI injected 16 μg of formaldehyde into each of the extra impingers (the amount was only disclosed to SRI several months later, after the impingers were all analyzed). The sampling train with the spikes was actually used for sampling at the stack, with the results described later in Section 6.3. The crux of the results, however, is that no formaldehyde was found in the spiked impingers. The absence of the spikes, or any detectable fraction, would seem to say that the actual concentration of formaldehyde in a duct or stack may be much higher than is found. The mechanism of loss of formaldehyde in the experiment at Bailly is not known.

Table 6-42
Concentrations of Carbonyl Compounds in Ducts Adjacent to the ESPs
(September 6, 1993)

Streams	Mass collected, µg	Calculated concn,ᵃ µg/Nm³
Inlet, Unit 8 ESP		
Formaldehyde	10.6	6.5
Acetaldehyde	1.4	0.3
Acetone	5.2	3.0
Outlet, Unit 8 ESP		
Formaldehyde	19.1	14.5
Acetaldehyde	1.3	0.3
Acetone	4.1	2.3
Outlet, Unit 7 ESP		
Formaldehyde	11.6	8.4
Acetaldehyde	<1.0	<1.0
Acetone	<1.0	<1.0
Blanks		
Formaldehyde	3.7, 2.5, 1.4	--
Acetaldehyde	1.2, <1.0, <1.0	--
Acetone	1.4, <1.0, 2.5	--

[a] Corrected for average blanks -- 2.5 µg for formaldehyde, 1.0 µg for acetaldehyde (estimated value), and 1.5 µg/for acetone.

6.1.3.5 Volatile Organic Compounds

Presentation of the data from experiments on volatile organic compounds is deferred to Appendix D. These data are not credible, for reasons discussed in the Appendix. Briefly stated, the hydrocarbons found are believed to be unlikely components of the gas streams at Bailly — certainly unlikely at the concentrations that are apparent from the analytical data. The anomalous high concentrations are believed due to generation of the compounds from organic constituents in a heating tape located within the annulus of the sampling probes.

6.1.3.6 Semi-Volatile Organic Compounds

This class of compounds was sampled at all three duct locations adjacent to the ESPs. In common with all the other organics, however, sampling was limited to just one day, September 6, 1993.

The samples from the Modified Method 5 sampling train — both front half (principally the filter) and the back half (principally the XAD sorbent) — were examined particularly for evidence of polycyclic aromatic hydrocarbons (PAHs). There are 16 of these compounds, listed below first in Column 1 and then in Column 2 in order of increasing retention time during analysis by gas chromatography:

- Naphthalene
- Acenaphthalene
- Acenaphthene
- Fluorene
- Phenanthrene
- Anthracene
- Fluroanthene
- Pyrene
- Benzo(a)anthracene
- Chrysene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(a)pyrene
- Indeno(1,2,3-cd)pyrene
- Dibenzo(a,h)anthracene
- Benzo(g,h,i)perylene

The absence of these compounds in samples from each sampling location is a plausible indication of their absence in the duct, since each compound was detected in blind audit samples prepared by RTI. The amounts in the audit spikes corresponded to levels corresponding to concentrations as low as 0.1 $\mu g/Nm^3$ in the flue gas (see Table 6-20).

There were certain compounds detected other than those listed above. They can be identified as artifacts, however, rather than as presumed components of the flue gas. Generally, they are residues of impurities in the solvents used for sample work-up or phthalate esters introduced from contaminated laboratory apparatus.

6.1.3.7 Dioxins and Furans

This class of compounds was sampled from the outlet of the Unit 7 ESP but not from either duct adjacent to the Unit 8 ESP. Because only one sampling day was involved (September 6, 1993), there are only two samples to be discussed — one from the front half of the sampling train and one from the back half:

Front half (particulate) — No compound having the characteristics of any dioxin or furan with chlorine substituents at the 2, 3, 7, and 8 positions was detected. These are the compounds with particular toxicity. Likewise, no compound with four, five, six, seven, or eight chlorine constituents REGARDLESS of ring location was detected.

Back half (vapor) — Several compounds were detected, but the significance of detection is ambiguous. All but one of the compounds was detected in an amount BELOW the routine level used for confirmed detection (the lowest amount used for calibration of the analytical procedure). The results are listed in Table 6-43 beside the normal reporting level (all data are in picograms). Formally speaking, only one specific compound can be reported present; this is the 1,2,3,4,6,7,8-substituted furan. Also, with substituent locations ignored, only two groups of compounds can be reported present; these are the tetra-substituted dioxins and the hexa-substituted furans. The improbably of finding dioxins and furans in the vapor state when none was found in the particulate state essentially eliminates any creditability of compound detection in the vapor state.

Table 6-43
Dioxins and Furans Identified as Vapor-Phase Fractions at the Outlet of the Unit 7 ESP

Compounds with 2,3,7,8-Substitution

Substituent group	Individual compound	Amount found, pg	Reporting level, pg
Tetra	None		20 20
Penta	1,2,3,7,8-PeCDF 2,3,4,7,8-PeCDF	2 6	100 100
Hexa	1,2,3,4,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF	20 7 40	100 100 100
Hepta	1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF	218 51	100 100
Octa	OCDF OCDD	184 123	200 200

All Compounds

Substituent group	Compound type	Amount found, pg	Reporting level, pg
Tetra	Furans Dioxins	18 42	20 20
Penta	Furans Dioxins	22 15	100 100
Hexa	Furans Dioxins	139 69	100 100
Hepta	Furans Dioxins	22 68	100 100
Octa	Furans Dioxins	184 123	200 200

6.2 Scrubber

6.2.1 Solids

Tables 6-44 and 6-45 give the concentrations of metals and anions in the two solids associated with the scrubber: 1) the limestone feed and 2) the gypsum product. The analyses of these materials required certain auxiliary procedures to correct for obvious errors encountered by the ordinary procedures cited previously in this report:

- The calcium concentrations averaging 38.1% for the limestone were obtained by dissolving the material in hydrochloric acid and determining calcium by flame injection AAS. The results originally obtained, by sample digestion with the mixed acids in the microwave oven and subsequent analysis by ICP, averaged 47.4%, which is clearly higher than expected. The formula value for $CaCO_3$ is 40.1%.

- All four of the major metals in the gypsum were redetermined by sample digestion according to ASTM method and solution analysis by flame injection AAS. The average result for calcium by this method was 25.2%, in reasonable agreement with the formula value of 23.3% for $CaSO_4 \cdot 2H_2O$. Owing to incomplete dissolution of the samples in the microwave procedure, ICP yielded values below 10%.

In addition to calcium, two other components of these two solids can be checked by the analyses performed. One of these is carbon in limestone. The data from CHN analyses are presented in Table 6-46. For limestone, the carbon concentration is 12.1%, in satisfactory agreement with the formula value of 12.0% for $CaCO_3$. The other constituent that can be checked is sulfate in gypsum. The average result is 56.8%; the formula value is 55.8%.

The anions listed in the analytical tables are the four species customarily determined in the Bailly samples. Sulfite was another species determined in the gypsum because of the uncertainty that oxidation of sulfite to sulfate would be complete. The analytical results showed that the sulfite concentration in the gypsum was negligible; whereas the sulfate concentration was approximately 56%, the sulfite concentration was about 0.5%. This sulfite level was not established clearly; the actual sulfite level may have been less than that stated.

The average concentration of carbon in the gypsum was 0.34%. If this is assumed to be a residue of carbonate from the original limestone, the apparent residue of limestone is about 3% by weight in the gypsum. The slight excess of sulfate over that calculated from the formula for gypsum, however, suggests that there cannot be this much residual limestone present. Hydrogen found in the gypsum may be explained as a component of the water of hydration. Nitrogen is not significant in either limestone or gypsum.

The activities of radionuclides in the limestone and gypsum are shown in Table 6-47. The activities are generally too low to be significant.

The average concentration of mercury in the gypsum, 0.25 µg/g, is of particular interest because gypsum seems to be the primary form of disposal of mercury removed from the flue gas in the scrubber. As later data will show, the mercury removed in the scrubber represents about 50% of the mercury in the flue gas at the scrubber inlet or about 33% of the mercury supplied by the coal. The comparative levels of mercury in the coal and gypsum and their relative flow rates indicate that the gypsum contains about 33% of the mercury from the coal. Thus, the loss of mercury to the scrubber is balanced by the appearance of mercury in the gypsum.

As indicated later by data on material balance (Table 7-23), closures for the AFGD system based on the trace metal concentrations in Tables 6-44 and 6-45 were quite unsatisfactory in some instances. Some of the poor closures are illusory, in the sense that they depend on assumed concentrations that were set at one-half of the detection limits. Most of the poor closures seemed attributable to doubtful results for the limestone and gypsum. Thus, in an effort to obtain improved closures, composites of the limestone and the gypsum for the three test days (9/3, 9/4, and 9/5) were submitted to Galbraith Laboratories for independent analyses by ICP and related AAS methods. The results from Galbraith are listed below:

	Concentrations, µg/g	
	Limestone	Gypsum
Antimony	<1.0	<1.0
Arsenic	1.5	<1.0
Barium	1.0	1.0
Beryllium	<1.0	<1.0
Boron	5.9	19.1
Cadmium	<1.0	<1.0
Chromium	<1.0	1.0
Cobalt	<1.0	<1.0
Copper	1.2	<1.0
Lead	1.2	1.0
Manganese	45.9	5.1
Mercury	<0.01	0.20
Molybdenum	<1.0	<1.0
Nickel	1.7	1.2
Selenium	<2.4	3.9
Vanadium	2.4	2.0

Boron is one of the metals for which major differences exist between the analytical results above and those in Tables 6.44 and 6.45. Other metals have less obvious differences, but the effects on closures are still dramatic.

Table 6-44
Metal and Anion Concentrations in the Limestone
(Data are in μg/g)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Trace metals					
Antimony	1.87	0.642	0.456	0.989	0.768
Arsenic	0.292	0.260	0.327	0.293	0.034
Barium	1.30	1.48	1.36	1.38	0.095
Beryllium	<0.008	<0.008	<0.008	<0.008	--
Boron	145	105	138	129	21
Cadmium	<0.005	<0.005	0.097	<0.097	--
Chromium	0.563	0.636	0.613	0.604	0.037
Cobalt	0.390	0.302	0.149	0.280	0.122
Copper	2.23	2.33	2.26	2.27	0.05
Lead	<0.125	<0.125	<0.125	<0.125	--
Manganese	71.2	67.9	69.1	69.4	1.71
Mercury	<0.002	<0.002	<0.002	<0.002	--
Molybdenum	0.785	0.198	0.104	0.362	0.369
Nickel	2.63	2.46	2.60	2.56	0.091
Selenium	<0.10	<0.10	<0.10	<0.10	--
Vanadium	3.62	3.64	3.64	3.63	0.01
Major metals					
Aluminum	4160	4150	3050	3790	638
Calcium*	380000	380000	382000	381000	1150
Iron	811	751	735	766	40
Magnesium	3570	3460	3430	3490	72
Titanium	13.3	15.4	14.7	14.5	1.1
Anions					
Fluoride	<400	<400	<400	<400	--
Chloride	967	460	2030	1150	800
Sulfate	4470	1870	9200	5180	3720
Phosphate	<1000	<1000	<1000	<1000	--

*The true value is 401,000 μg/g.

Table 6-45
Metal and Anion Concentrations in Gypsum
(Data are in $\mu g/g$)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Trace metals					
Antimony	0.29	0.33	0.78	0.47	0.27
Arsenic	1.60	1.71	1.60	1.64	0.06
Barium	1.38	1.19	0.99	1.18	0.19
Beryllium	0.41	0.41	0.40	0.41	0.01
Boron	387	408	287	361	65
Cadmium	<0.020	<0.020	<0.020	<0.020	--
Chromium	80.2	13.9	12.6	35.6	38.7
Cobalt	<0.30	<0.30	<0.30	<0.30	--
Copper	0.95	0.18	0.17	0.43	0.45
Lead	<0.50	<0.50	<0.50	<0.50	--
Manganese	7.43	5.38	5.35	6.05	1.19
Mercury	0.24	0.25	0.25	0.25	0.01
Molybdenum	12.5	1.8	2.0	5.4	6.1
Nickel	32.0	7.3	12.2	17.2	13.1
Selenium	4.14	3.98	4.42	4.18	0.22
Vanadium	2.36	1.92	2.06	2.11	0.22
Major metals					
Aluminum	4500	5500	6700	5600	1100
Calcium*	284000	281000	290000	285000	4600
Iron	615	716	805	712	95
Magnesium	988	976	870	945	65
Titanium	24.2	28.3	42.6	31.7	9.7
Anions					
Fluoride	600	600	800	670	120
Chloride	1300	134	504	650	600
Sulfate*	563000	568000	572000	568000	4500
Phosphate	<1000	<1000	<1000	<1000	--

*The true values for $CaSO_4 \cdot 2H_2O$ are: Calcium, 232000; sulfate, 558000 $\mu g/g$.

Table 6-46
Carbon/Hydrogen/Nitrogen Analysis of Limestone and Gypsum

	9/3/93	9/4/93	9/5/93	Avg.	Std.dev.
Limestone					
Carbon %	12.09	12.10	12.12	12.10	0.02
Hydrogen %	<0.1	<0.1	<0.1	<0.1	--
Nitrogen %	<0.1	<0.1	<0.1	<0.1	--
Gypsum					
Carbon %	0.26	0.34	0.42	0.34	0.08
Hydrogen %	0.88	1.01	1.19	1.03	0.16
Nitrogen %	<0.1	<0.1	<0.1	<0.1	--

Table 6-47 Activities of Radionuclides*
in the Limestone and Gypsum
(All data in pCi/g)

	9/3/93			9/4/93			9/5/93		
	Activity	Error	LLD	Activity	Error	LLD	Activity	Error	LLD
Limestone									
Lead 210	1.7	0.8	1.1	1.4	0.7	1.1	1.8	0.8	1.1
Polonium 210	0.9	0.4	0.4	1.1	0.4	0.3	0.9	0.4	0.2
Radium 226	1.5	0.6	0.6	0.9	0.5	0.6	1.0	0.5	0.6
228	0.1	1.4	2.4	0.8	1.5	2.4	5.5	1.7	2.4
Thorium 228	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
230	1.3	0.3	0.4	1.2	0.3	0.3	1.5	0.3	0.3
232	ND	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Uranium 234	1.2	0.4	0.2	0.5	0.3	0.2	0.4	0.2	0.3
235	0.1	0.2	0.2	0.1	0.1	0.3	ND	0.1	0.2
238	1.3	0.5	0.1	1.2	0.5	0.3	0.8	0.3	0.3
Total	1.7	--	--	1.7	--	--	1.9	--	--
Gypsum									
Lead 210	1.2	0.7	1.1	1.4	0.7	1.1	1.0	0.7	1.1
Polonium 210	0.5	0.3	0.3	0.7	0.3	0.4	0.5	0.4	0.4
Radium 226	0.1	0.4	0.6	0.6	0.5	0.6	0.3	0.4	0.6
228	0.7	1.7	2.8	1.4	1.5	2.4	0.8	1.4	2.4
Thorium 228	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2
230	0.8	0.3	0.4	0.7	0.3	0.4	0.9	0.3	0.4
232	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2
Uranium 234	1.1	0.4	0.2	0.7	0.3	0.3	0.6	0.3	0.3
235	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2
238	0.9	0.3	0.2	0.4	0.2	0.2	0.5	0.2	0.2
Total	0.8	--	--	0.8	--	--	1.0	--	--

*See footnote on Table 6-4, page 6-7, for definitions of terms.

6.2.2 Water Streams

There are four aqueous streams associated with the scrubber:

Makeup water

Absorber recirculating pump slurry

Bleed pump slurry

Waste water

The first and last of the streams listed above contained negligible amounts of suspended solids; thus, they were analyzed only for dissolved metals and anions. The two slurries contained 22-23% solids by weight. The solids and aqueous phases of each were separated and analyzed for metals and anions; the compositions of the composites were then calculated. All of these data are presented in Tables 6-48 through 6.56.

The solids in the slurries were expected to be essentially gypsum. This expectation was satisfied by the measured concentrations of calcium and sulfate, which were essentially the same as for the gypsum product (Table 6-45). The mercury concentrations in all three materials were nearly the same, as they should have been; the range was 0.25-0.30 µg/g. Sulfite was a negligible component of the slurry solids, just as it was in the gypsum product.

Table 6-56 gives the measured concentrations of carbonyl compounds in the water streams. The concentrations in the makeup water are about the same as those in the condenser inlet water for the boiler but substantially higher than those in the makeup water for the boiler.

The concentrations in the slurries and the waste water are higher than those of the scrubber makeup water.

Concentrations of volatile and semivolatile organic compounds were also measured in the water. The results were similar to the results for water streams at the boiler. In summary, the results were variable and logically attributed to artifacts, such as contaminants introduced inadvertently.

Table 6-48
Daily Metal and Anion Concentrations in Scrubber Makeup Water
(Data in μg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	<0.0006	<0.0006	<0.0006
Arsenic	<0.0003	<0.0003	<0.0003
Barium	0.0162	0.0194	0.0189
Beryllium	<0.0005	<0.0005	<0.0005
Boron	<0.0625	<0.0625	<0.0625
Cadmium	0.0009	0.0010	0.0018
Chromium	<0.006	<0.006	<0.006
Cobalt	<0.002	<0.002	0.0037
Copper	0.0057	0.0058	0.0046
Lead	<0.005	<0.005	<0.005
Manganese	0.0027	<0.0125	<0.0125
Mercury	0.00009	0.00011	0.00009
Molybdenum	<0.006	0.0660	<0.006
Nickel	<0.010	0.0053	<0.010
Selenium	<0.0006	<0.0006	0.0032
Vanadium	<0.003	<0.003	<0.003
Major metals			
Aluminum	<0.10	<0.10	<0.10
Calcium	17.7	17.4	18.0
Iron	<0.10	<0.10	<0.10
Magnesium	10.94	11.35	11.28
Titanium	<0.10	<0.10	<0.10
Anions			
Fluoride	<0.4	<0.4	<0.4
Chloride	11.32	12.14	12.13
Sulfate	23.36	24.30	24.38
Phosphate	<0.50	<0.50	<0.50

Table 6-49
Daily Metal and Anion Concentrations in the Liquid Phase of the Absorber Recirculating Pump Slurry
(Data in μg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	0.0070	0.018	0.0058
Arsenic	0.0061	0.0062	0.0062
Barium	0.207	0.256	0.240
Beryllium	0.00085	0.0006	<0.0005
Boron	974	1001	1059
Cadmium	0.0483	0.0513	0.0050
Chromium	<0.006	0.0558	0.0061
Cobalt	0.0905	0.0917	0.0961
Copper	0.0090	0.0102	0.0082
Lead	0.0059	<0.005	<0.005
Manganese	52.9	56.0	59.9
Mercury	0.00018	0.00013	0.00032
Molybdenum	0.138	0.165	0.192
Nickel	0.884	0.876	0.946
Selenium	0.304	0.378	0.371
Vanadium	<0.003	<0.003	0.0056
Major metals			
Aluminum	0.146	0.222	<0.10
Calcium	1904	2042	1746
Iron	<0.10	<0.10	<0.10
Magnesium	2370	2281	2305
Titanium	<0.10	<0.10	<0.10
Anions			
Fluoride	15.2	15.2	12.1
Chloride	6047	6010	6716
Sulfate	2270	2216	2122
Phosphate	<25.0	<25.0	<25.0

Table 6-50
Daily Metal and Anion Concentrations in the Liquid Phase of the Bleed Pump Slurry
(Data in μg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	0.005	0.0048	0.0044
Arsenic	0.0066	0.0062	0.0068
Barium	0.2261	0.2329	0.2604
Beryllium	0.00053	<0.0005	<0.0005
Boron	1024	1033	1062
Cadmium	0.0438	0.0444	0.0449
Chromium	<0.006	0.0042	<0.006
Cobalt	0.1072	0.0911	0.1006
Copper	0.0126	0.0124	0.0133
Lead	<0.005	<0.005	<0.005
Manganese	59.9	57.0	60.0
Mercury	0.00035	0.00020	0.00029
Molybdenum	0.144	0.140	0.174
Nickel	0.9242	0.8922	0.9152
Selenium	0.355	0.354	0.461
Vanadium	<0.003	0.0047	0.0072
Major metals			
Aluminum	0.156	<0.10	<0.10
Calcium	2124	2081	2248
Iron	0.243	<0.10	0.236
Magnesium	2339	2259	2233
Titanium	<0.10	<0.10	<0.10
Anions			
Fluoride	14.0	14.2	11.7
Chloride	6018	6238	6707
Sulfate	2226	2189	1682
Phosphate	<25.0	<25.0	<25.0

Table 6-51
Daily Metal and Anion Concentrations in the Scrubber Waste Water
(Data in μg/mL)

	9/3/93	9/4/93	9/5/93
Trace metals			
Antimony	0.0063	0.0053	0.0069
Arsenic	0.013	0.011	0.010
Barium	0.204	0.257	0.1614
Beryllium	<0.0005	<0.0005	<0.0005
Boron	58.8	865	891
Cadmium	0.039	0.0386	0.0325
Chromium	0.0082	<0.006	<0.006
Cobalt	0.0657	0.0840	0.0939
Copper	0.0086	0.0089	0.0077
Lead	<0.005	<0.005	<0.005
Manganese	40.3	42.5	44.8
Mercury	0.00034	0.00042	0.00026
Molybdenum	0.121	0.1177	0.1233
Nickel	0.697	0.7359	0.7767
Selenium	0.283	0.296	0.345
Vanadium	0.0095	0.0126	0.0142
Major metals			
Aluminum	0.225	0.185	0.229
Calcium	1746	2010	2192
Iron	0.193	0.121	0.220
Magnesium	1304	1521	1579
Titanium	<0.10	<0.10	<0.10
Anions			
Fluoride	16.6	16.0	15.8
Chloride	4706	4878	5165
Sulfate	2292	2300	2234
Phosphate	<10.0	<10.0	<10.0

Table 6-52 Average Metal and Anion Concentrations in Water Streams Associated with the Scrubber (Data in μg/mL)

	Makeup	ARP slurry	BP slurry	Waste water
Trace metals				
Antimony	<0.0006	0.0103	0.0048	0.0062
Arsenic	<0.0003	0.0062	0.0065	0.0113
Barium	0.0182	0.2343	0.2398	0.2075
Beryllium	<0.0005	0.0007^a	<0.0005^a	<0.0005
Boron	<0.062	101	1040	605
Cadmium	0.0012	0.0349	0.0444	0.0367
Chromium	<0.0061	0.031^a	<0.006^a	<0.006^a
Cobalt	<0.002^a	0.0928	0.0996	0.0812
Copper	0.0054	0.0091	0.0128	0.0084
Lead	<0.0005	<0.0005^a	<0.0005	<0.0005
Manganese	<0.012^a	56.3	59.0	42.5
Mercury	0.0001	0.0002	0.0003	0.0003
Molybdenum	<0.006^a	0.1650	0.1527	0.1207
Nickel	<0.010^a	0.9020	0.9105	0.7365
Selenium	<0.0006^a	0.3510	0.3900	0.3080
Vanadium	<0.003	<0.003^a	0.0040	0.0121
Major metals				
Aluminum	<0.10	0.184^a	<0.10^a	0.2130
Calcium	17.7	1900	2150	1980
Iron	<0.10	<0.10	0.240^a	0.178
Magnesium	11.19	2320	2240	1470
Titanium	<0.010	<0.10	<0.10	<0.10
Anions				
F^-	<0.40	14.2	13.3	16.1
Cl^-	11.9	6260	6320	4920
SO_4^{-2}	24.0	2200	2030	2280
PO_4^{-3}	<0.50	<0.50	<0.50	<0.50

^{a}Based on two daily values, not three.

Table 6-53
Metal and Anion Concentrations in Solids from the Absorber Recirculating Pump Slurry
(Data are in $\mu g/g$)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Trace metals					
Antimony	0.37	0.27	0.29	0.31	0.05
Arsenic	1.26	0.51	0.60	0.79	0.41
Barium	1.72	2.95	3.07	2.58	0.75
Beryllium	<0.03	<0.03	<0.03	<0.03	–
Boron	124	135	139	133	8
Cadmium	<0.02	<0.02	<0.02	<0.02	--
Chromium	0.778	1.496	0.504	0.926	0.51
Cobalt	<0.30	<0.30	<0.30	<0.3	–
Copper	0.62	1.40	1.00	1.01	0.39
Lead	<0.50	<0.50	<0.50	<0.50	--
Manganese	6.95	15.00	11.69	11.21	4.05
Mercury	0.25	0.27	0.33	0.28	0.04
Molybdenum	<0.50	1.34	<0.50	<1.34	--
Nickel	1.79	3.05	2.75	2.53	0.66
Selenium	4.68	7.06	8.89	6.88	2.11
Vanadium	2.50	5.14	4.17	3.94	1.34
Major metals					
Aluminum	764	695	914	790	112
Calcium	278000	282000	289000	283000	5600
Iron	716	826	1160	901	231
Magnesium	1050	1220	1720	1330	348
Titanium	36.5	72.0	32.2	46.9	21.9
Anions					
Fluoride	600	800	1000	800	200
Chloride	<100	<100	<100	<100	–
Sulfate	547,000	544,000	543,000	545,000	2100
Phosphate	<1000	<1000	<1000	<1000	–

Table 6-54
Metal and Anion Concentrations in Solids from the Bleed Pump Slurry
(Data are in $\mu g/g$)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Trace metals					
Antimony	0.31	0.25	0.37	0.31	0.06
Arsenic	0.92	0.46	0.59	0.66	0.24
Barium	2.47	1.94	3.09	2.50	0.57
Beryllium	<0.03	<0.03	<0.03	<0.03	--
Boron	117	129	137	128	10.07
Cadmium	<0.02	<0.02	<0.02	<0.02	--
Chromium	1.44	1.11	1.91	1.49	0.40
Cobalt	<0.30	<0.30	0.304	<0.30	--
Copper	1.21	0.65	1.24	1.04	0.33
Lead	<0.50	<0.50	<0.50	<0.50	--
Manganese	8.68	8.06	11.46	9.40	1.81
Mercury	0.27	0.25	0.37	0.30	0.06
Molybdenum	<0.50	<0.50	<0.50	<0.50	--
Nickel	2.07	1.95	3.07	2.36	0.62
Selenium	5.43	4.82	9.34	6.53	2.45
Vanadium	3.34	2.78	4.45	3.53	0.85
Major metals					
Aluminum	442	738	755	645	176
Calcium	284000	278000	284000	282000	3465
Iron	721	820	879	807	80
Magnesium	1060	1150	1860	1360	440
Titanium	40.8	30.2	37.9	36.3	5.5
Anions					
Fluoride	600	600	1000	730	230
Chloride	158	<100	598	<285	--
Sulfate	526,000	531,000	545,000	534,000	9800
Phosphate	<1000	<1000	<1000	<1000	--

Table 6-55
Composite Concentrations of Metals and Anions in the Absorber Recirculating Pump and Bleed Pump Slurries*
(Data in μg/g)

	ARP slurry	BP slurry
Trace metals		
Antimony	0.0776	0.0786
Arsenic	0.181	0.165
Barium	0.757	0.790
Beryllium	<0.0071	<0.0077
Boron	815	817
Cadmium	<0.032	0.038
Chromium	0.222	0.363
Cobalt	<0.14	0.0753
Copper	0.231	0.262
Lead	<0.11	<0.12
Manganese	46.2	46.9
Mercury	0.0630	0.0724
Molybdenum	0.128	<0.237
Nickel	1.26	1.26
Selenium	1.81	189
Vanadium	0.880	0.863
Major metals		
Aluminum	1030	1070
Calcium	64600	70400
Iron	201	197
Magnesium	2100	2050
Titanium	10.5	8.85
Anions		
Fluoride	189	189
Chloride	4860	6320
Sulfate	123000	132000
Phosphate	<220	<240

*Calculated from proportions of solids and liquid and average concentrations in each: ARP slurry, 22.3% solids and 77.7% liquid; BP slurry, 24.4% solids and 75.6% liquid.

Table 6-56
Carbonyl Compounds in Water Streams Associated with the Scrubber
(September 6, 1993)

Stream	Concn, µg/L
Makeup	
Formaldehyde	116
Acetaldehyde	<5
Acetone	31
Absorber recirculating pump slurry	
Formaldehyde	371
Acetaldehyde	46
Acetone	87
Bleed pump slurry	
Formaldehyde	185
Acetaldehyde	65
Acetone	26
Waste water	
Formaldehyde	198
Acetaldehyde	23
Acetone	99
Blanks	
Formaldehyde	14-57[a]
Acetaldehyde	<5
Acetone	<5

[a] Range of values.

6.3 Stack Gas Stream

6.3.1 Metals

Metal concentrations in the stack are given in Tables 6-57 through 6-60. Attention may be focused on the last two of these tables, which give average concentrations for the three days of testing. Table 6-60 presents the averages in $\mu g/Nm^3$; Table 6-61 gives the averages in $\mu g/g$ where, as in similar tables earlier, the numerator counts both particulate and vaporous forms of the metals and the denominator counts only the total particulate matter.

Mercury concentrations based on sampling with solid sorbents are presented separately in Table 6-62. These data for mercury are believed to be more reliable than the data for this element in the preceding tables, which were based on samples from Method 29. Table 6-62 includes the results of calculations to show the degree of mercury removal in the scrubber. The average in three days of sampling was about 50% of that entering the scrubber from the combination of ducts leaving the Units 7 and 8 ESPs. Apparently, the mercury removed was mainly that occurring in the divalent form; this is logical, since divalent mercury, especially in the form of $HgCl_2$, is readily dissolved in water, whereas elemental mercury is not.

Nearly all of the metals concentrations expressed in $\mu g/Nm^3$ are lower than the corresponding values at either ESP outlet. This fact, of course, implies some degree of removal of all metals in the scrubber. The exceptions are intermediate concentrations for antimony, manganese, and selenium for the stack; these exceptions are believed to be due to spurious data at one of the three locations of concern. The spray-chamber type of scrubber at Bailly is not expected to be highly efficient for particulate removal; nevertheless, it is not likely to vary in effectiveness for different metals except through discriminating between the forms in the particulate matter and the vapor phase.

Approximate values of the fractional penetrations of the scrubber efficiencies may be calculated by dividing the stack concentrations of individual metals by the average ESP outlet concentrations, where the average ESP outlet value is two-thirds of the Unit 8 outlet concentration plus one-third of the Unit 7 outlet concentration. (Unit 8 has approximately twice the gas flow of Unit 7.) The discrimination between an element that is present mainly in the particulate matter (barium) and one present mainly as vapor (boron) can thus be illustrated:

Barium — Penetration = 1.43/[(0.667(2.10) + 0.333(0.416)] = 0.40
Efficiency = 60%

Boron — Penetration = 1230/[0.667(13600) + 0.333(13300)] = 0.091
Efficiency = 90.9%

For mercury (utilizing the data from Brooks Rand in Table 6-62), the efficiency is about 50%. The implied reason for limited efficiency is that only part of the mercury is oxidized (divalent) and thus soluble in the aqueous phase of the scrubber.

For selenium, there is an anomaly: the calculated efficiency is negative; the stack concentration is 1.14 times the average ESP outlet concentration. The daily average selenium concentrations (μg/Nm^3) in the three locations of concern are as follows:

	Particulate	Vapor	Total
Unit 8 outlet	1.82	169	171
Unit 7 outlet	72	274	347
Stack	131	130	261

The stack particulate concentration is, in a sense, "impossible;" it is higher than either ESP outlet concentration. The lower gas temperature in the stack, however, makes conversion of vapor to particulate likely, and this tentative effort to find the flawed item of data may be misleading.

6.3.2 Anions and Acid Gases

Data on these species for the gas phase in the stack appear in Table 6-63. They reveal sharp reductions in the concentrations of HF, HCl, and SO_2 from the levels seen at the outlets of the ESPs. If a composite concentration of each of these gases at the inlet of the ESP is calculated (the average of twice the Unit 8 outlet value and one times the Unit 7 ESP, since the gas flows are essentially in a 2:1 ratio), the data in Table 6-63 lead to calculated acid gas removals in the scrubber as follows:

Gas	Removal, %
HF	96
HCl	99
SO_2	93

Phosphate was not measurable in the stack gas. This is not a result of any significance, since phosphate was never found as the constituent of the gas phase in the preceding ducts.

Sulfate was measured in the particulate phase of the stack gas. The results were as follows:

Date	SO_4^{-2}, %
Sept. 3	72.6
Sept. 4	75.6
Sept. 5	73.6

These data suggest that only about 25% of the particulate matter in the stack was fly ash from the two boilers and that 75% was sulfate entrained from the scrubber. A tentative conclusion, to be moderated somewhat in a later paragraph, embraces the following concepts:

- Calcium represents, on the average, 1.1% of the stack particulate. Some of this is in the ash; the balance may be considered to be gypsum from the scrubber. The gypsum content of the stack particulate cannot exceed 4.7% (the mole formula of gypsum weighs 172 g; that of calcium is 40 g and the ratio is 4.3).
- The average concentration of stack particulate was 0.0543 g/Nm^3. If 75% of this were sulfate from condensed sulfuric acid vapor, the original concentration of sulfuric acid, or SO_3, would be 10 ppmv, a level that is easily consistent with the composition of combustion gas from a coal containing 3% sulfur. Certainly, if the gas preceding the scrubber contained 10 ppmv sulfuric acid, the

cooler gas at the outlet would necessarily contain that concentration as the condensate, probably in the form of fine aerosol particles.

Thus, the tentative argument that 75% of the mass of the stack particulate is a contribution from the scrubber can be supported to a minor degree in terms of entrained gypsum but entirely in terms of condensed sulfuric acid vapor. This conclusion must be tempered, however, for two reasons:

- The particulate matter at the outlet of the Unit 7 ESP contained, for no evident reason, about 50% sulfate, as indicated previously in Section 6.1.3.2. Thus, not all of the sulfate in the stack can be traced to the scrubber.

- The variability of the observed concentrations of stack particulate matter undermines confidence in the conclusion above that is based on the average stack concentration of particulate matter. On successive days, the concentrations were 0.0270, 0.0543, and 0.0815 g/Nm^3, of which 75% would correspond to sulfuric acid concentrations of 5, 10, 15 ppmv. It is not possible to say why variable concentrations of sulfuric acid might be expected, unless the trend toward higher particulate concentrations is a result of decreasing rates of ammonia injection.

6.3.3 Ammonia and Hydrogen Cyanide

These gases were measured only on September 6. Their observed concentrations in the stack were as follows:

Ammonia	20.2 μg/Nm^3, equivalent to 0.029 ppmv of NH_3
Hydrogen cyanide	15.6 μg/Nm^3, equivalent to 0.014 ppmv as HCN

The concentration of NH_3 is not consistent with both of the ESP outlet concentrations, which were <0.007 ppmv in Unit 8 and 0.030 ppmv in Unit 7. Although NH_3 is a basic gas and might be expected to pass through a limestone scrubber without being absorbed, NH_3 is soluble at the pH levels observed in the waste water (around pH 6.9).

The concentration of HCN above is less than the values at the ESP outlets — 0.27 ppmv in Unit 8 and 0.36 ppmv in Unit 7. Logically, HCN should be removed in a limestone scrubber, but with a scrubber pH of 6.9 the removal may be inefficient, as the data suggest.

The particulate in the stack, as well as the flue gas, was analyzed for ammonia. This, however, was done on September 3, 4, and 5, prior to the determination in the gas phase, when there was the expectation initially that ammonia was being injected from the conditioning system. The ammonia concentrations in the solid on the three successive dates were 2.2, 1.1, and 0.27%, corresponding to gas-phase concentrations of 0.84, 0.84, and 0.31 ppmv. The trend was downward, during the period when ammonia injection was terminated.

6.3.4 Organic Compounds

The findings with respect to organic compounds, each class being sampled only on September 6, are as follows:

- The data for carbonyl compounds are given in Table 6-64.
- The data for volatile organics in the stack, as in the preceding ducts, are believed to be erroneous, as discussed in Appendix D.
- No semi-volatile compound believed to be an authentic component of the gas stream was identified. Those compounds that were detected were similar to those detected in the preceding ducts and were regarded similarly as artifacts.
- A few dioxins and furans were detected in particulate fractions of samples from the stack. The names of the detected compounds with 2,3,7,8 substitution, their apparent concentrations, and (in parentheses) the lowest concentrations believed to be reliably identifiable are listed below:

Compound	Concn, pg/Nm^3
1,2,3,4,7,8-HxCDF	2 (23)
2,3,4,6,7,8-HxCDF	3 (23)
1,2,3,4,6,7,8-HpCDF	13 (23)
1,2,3,4,6,7,8-HpCDD	4 (23)
OCDD	7 (45)

The corresponding results for all compounds with a given number of constituents were as follows:

TCDF	1 (4.5)
HxCDF	14 (23)
HxCDD	7 (23)
HpCDF	22 (23)
HpCDD	8 (23)
OCDD	7 (45)

Table 6-57
Metal Concentrations in the Gas Stream at the Stack
(September 3, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29)

	Particulate	Vapor	Total
Trace metals			
Antimony	0.02	1.01	1.04
Arsenic	3.50	1.68	5.18
Barium	1.89	<0.20	1.99
Beryllium	0.14	<0.01	0.14
Boron	<0.2	944	944
Cadmium	0.63	0.16	0.79
Chromium	4.13	0.27	4.40
Cobalt	0.11	<0.10	0.16
Copper	2.74	1.32	4.06
Lead	3.05	0.47	3.52
Manganese	2.97	<0.40	3.17
Mercury[a]	<0.01	0.14/3.14	3.28
Molybdenum	4.80	<0.20	4.90
Nickel	1.90	0.17	2.07
Selenium	131	43.0	174
Vanadium	4.64	0.03	4.67
Major metals			
Aluminum	154	6.41	161
Calcium	570	14.1	584
Iron	330	27.5	358
Magnesium	112	2.20	114
Titanium	24.4	<0.2	24.5

[a] The column for vapor gives separate data from peroxide and permanganate impingers.

Table 6-58
Metal Concentrations in the Gas Stream at the Stack
(September 4, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.05	0.07	0.09
Arsenic	0.40	0.17	0.57
Barium	1.26	<0.20	1.36
Beryllium	0.07	<0.01	0.07
Boron	<0.2	1150	1150
Cadmium	0.32	0.06	0.38
Chromium	3.17	0.14	3.31
Cobalt	0.09	<0.10	0.09
Copper	0.84	0.33	1.17
Lead	1.53	<0.25	1.65
Manganese	3.19	<0.40	3.19
Mercury[a]	0.01	0.16/2.37	2.54
Molybdenum	4.12	<0.20	4.22
Nickel	1.16	1.72	2.88
Selenium	69.9	124	193
Vanadium	3.53	0.08	3.61
Major metals			
Aluminum	130	5.42	136
Calcium	593	6.33	600
Iron	256	27.0	283
Magnesium	107	1.11	108
Titanium	20.6	0.72	21.3

[a] The column for vapor gives separate data from peroxide and permanganate impingers.

Table 6-59
Metal Concentrations in the Gas Stream at the Stack (September 5, 1993)
(Data in $\mu g/Nm^3$)
(All data here by Method 29)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.05	0.01	0.03
Arsenic	0.40	<0.05	0.42
Barium	1.97	<0.20	2.07
Beryllium	<0.10	<0.10	<0.10
Boron	<0.2	1600	1600
Cadmium	0.28	0.26	0.54
Chromium	3.25	0.13	3.38
Cobalt	0.09	<0.10	0.14
Copper	1.10	0.67	1.77
Lead	1.09	0.25	1.34
Manganese	2.68	<0.40	2.88
Mercury[a]	0.01	0.13/2.43	2.57
Molybdenum	4.63	<0.20	4.73
Nickel	1.84	1.40	3.24
Selenium	191	223	415
Vanadium	2.84	<0.10	2.89
Major metals			
Aluminum	114		114
Calcium	651	10.7	661
Iron	202	3.45	206
Magnesium	122	2.48	124
Titanium	17.8	<0.2	17.9

[a] The column for vapor gives separate data from peroxide and permanganate impingers.

Table 6-60
Average Metal Concentrations in the Gas Stream at the Stack[a]
(Data in µg/Nm^3; with standard deviations)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.05	0.36 ± 0.56	0.38 ± 0.56
Arsenic	1.43 ± 1.79	<0.62	1.43 ± 1.79
Barium	1.71 ± 0.39	<0.20	1.71 ± 0.39
Beryllium	<0.09	<0.10	<0.10
Boron	<0.2	1230 ± 340	1230 ± 340
Cadmium	0.41 ± 0.193	0.16 ± 0.10	0.57 ± 0.21
Chromium	3.52 ± 0.53	0.18 ± 0.07	3.70 ± 0.61
Cobalt	0.099 ± 0.011	<0.10	<0.10
Copper	1.56 ± 1.03	0.77 ± 0.50	2.33 ± 1.52
Lead	1.89 ± 1.03	0.24 ± 0.24	2.13 ± 1.21
Manganese	3.96 ± 0.22	<0.40	4.16 ± 0.22
Mercury	0.010 ± 0.006	2.79 ± 0.43	2.80 ± 0.42
Molybdenum	4.51 ± 0.35	<0.20	4.61 ± 0.35
Nickel	1.63 ± 0.41	1.28 ± 0.82	2.92 ± 0.61
Selenium	131 ± 61	130 ± 90	261 ± 134
Vanadium	3.79 ± 0.90	<0.05	3.81 ± 0.90
Major metals			
Aluminum	133 ± 20	<8	137 ± 20
Calcium	605 ± 41	10.4 ± 3.9	615 ± 41
Iron	263 ± 64	19.3 ± 13.7	282 ± 76
Magnesium	114 ± 7	1.93 ± 0.72	116 ± 8
Titanium	20.9 ± 3.3	<0.4	21.0 ± 3.3

[a] Based on data in Tables 6-57, 6-58, and 6-59.

Table 6-61
Ratios of Metal Concentrations in the Gas Stream at the Stack to the Total Concentration of Entrained Solids[a]
(Data in µg/g; averages of daily results)

	Particulate	Vapor	Total
Trace metals			
Antimony	<0.8	13	13
Arsenic	47	<22	58
Barium	16	<5	18
Beryllium	<2.6	<2.3	<5
Boron	<5	25,300	25,300
Cadmium	10.9	3.4	14.3
Chromium	83.7	4.7	88.4
Cobalt	34.7	<2.3	35.8
Copper	43.5	21.1	64.6
Lead	13.8	<8.4	18.0
Manganese	67.2	<4.5	69.4
Mercury	<0.2	66.5	66.6
Molybdenum	103	<3	104
Nickel	29.0	18.4	47.4
Selenium	2830	2200	5030
Vanadium	90.6	<1.3	91.2
Major metals			
Aluminum	3160	<153	3240
Calcium	10900	169	11,100
Iron	6470	180	6650
Magnesium	2540	44	2580
Titanium	500	<5	500

[a] Calculated by dividing the individual concentrations in Tables 6-57, 6-58, 6-59 by the appropriate total particulate concentration. The three daily concentrations of total particulate were, in succession, 0.0270, 0.0543, and 0.0815 g/Nm^3.

Table 6-62
Concentrations of Mercury Vapor Based on Sampling with Solid Sorbents at the Stack

Date	Concn, µg/Nm³			Percent oxidized[a]
	Hg(II)	Hg(0)	Total	
Data from the stack				
9/3/93	--	--	3.48	--
9/4/93	0.09	3.50	3.59	2.5
9/5/93	0.08	3.42	3.50	2.3
Calculated data for the scrubber inlet				
9/3/93	--	--	9.18	--
9/4/93	3.84	3.84	7.68	50.0
9/5/93	4.99	1.78	6.77	73.7
Calculated removals of the scrubber				
9/3/93	--	--	5.70	(62.1%)[a]
9/4/93	3.75	0.34	4.09	(53.3%)[a]
9/5/93	4.91	-1.64	3.27	(48.3%)[a]

[a] The last three lines show instead the percentage of total mercury removed in scrubber.

Table 6-63
Acid Gas Concentrations at the Stack

	9/3/93	9/4/93	9/5/93	Avg	Std.dev.
Data in µg/Nm^3					
Fluoride	<487	<556	<444	<556	--
Chloride	1480	1220	1440	1380	140
Sulfate	646000	848000	904000	800000	140000
Phosphate	<3000	<3000	<2300	<3000	--
Data in ppmv					
HF	<0.62	<0.70	<0.56	<0.70	--
HCl	1.0	0.8	1.0	0.9	0.1
SO_2	162	212	226	200	34
H_3PO_4	<0.8	<0.8	<0.6	<0.8	--

Table 6-64
Carbonyl Compounds in the Stack
(September 6, 1993)

Stream	Mass collected, µg	Calculated concn, µg/Nm^3
Formaldehyde	13.2	15.0
Acetaldehyde	<1.0	<1.2
Acetone	10.0	11.4

7.0 DATA ANALYSIS AND INTERPRETATION

7.1 Material Balances

The mass flow rates presented previously as Tables 4-8 through 4-10 were used to calculate material balances for the major metals and trace metal species around each of the system defined in Section 3.2. The measured concentrations of the metals for each day were used with that day's flows to calculate a material balance for each day of the inorganic testing. If the concentration was below the detection limit, the detection limit was divided by two and that concentration was used for the material balance. Since this procedure inevitably leads to extreme imbalances, the mass flows derived from non-detectable concentrations are identified in the mass balances with italics. If a multi-phase flow has one component with a non-detectable concentration and it is more than 20% of the total mass flow, then the total flow is identified with italics also. Closures in which one flow is a non-detect and is more than 20% of the summed input or output are also presented in italics. Using this procedure, it is easy to see whether an extreme imbalance is the result of non-detectable concentrations.

Appendix E provides an annotated example calculation for trace metal material balances, using cobalt as an example.

7.1.1 Major Element Balances

Five metals, iron (Fe), aluminum (Al), titanium (Ti), calcium (Ca), and magnesium (Mg), were chosen as tracers to evaluate the overall material balance procedures. These metals are refractory and should serve as a tracer for ash flows. The mass balances are presented as Tables 7-1 through 7-5. The material balances were calculated for each day, and the average flows for the three days of testing are shown in the tables. The average of the closures for each day is calculated and shown along with the closure of the average flows. (Closure is defined as the sum of the output mass flows divided by the sum of the input flows, expressed as a percentage.) Tables 7-1A through 7-5A list the sample standard deviations for the mass flows and the daily closures. The mass balance closures are summarized in Table 7-23, with the variability as sample standard deviation summarized in Table 7-23A.

The closures for the major metals for the boiler system overall are good, with numbers ranging from 101% for iron to 111% for calcium. This result, along with the good closures for the subunits in the boiler system, indicate that the total flow rates are reliable. The condenser closures range from 70% for aluminum (non-detect) to 137% for calcium. However, the closures for the AFGD system are poorer, with a range of 92% for magnesium to 196% for aluminum. The closures for only iron, calcium, and magnesium lie within the 80 to 120% range.

7.1.2 Trace Metal Balances

Mass balances were calculated for each day of testing for each of 16 trace metal species. These balances are presented as Tables 7-6 through 7-22, which includes two balances for mercury. The mass balance closures (average of three daily closures) are summarized in Table 7-23, with the variability as sample standard deviation summarized in Table 7-23A. Alternate values of mass balance closures for the AFGD system are given in Table 7-23B. The two sets of numbers compare closures calculated from the SRI data on average daily metal concentrations in limestone and gypsum and closures calculated from the Galbraith data on metal concentrations in composites of the three daily limestone and gypsum samples (see Section 6.2.1).

The trace metal balances for the boiler system are typical for this type of testing, with overall good results for some elements and poor results for others. The average closures range from 29% for mercury to 256% for selenium. Of the 17 balances (16 elements with a second mercury balance), five lie within an 80 to 120 percent range, and 13 lie within a 60 to 140 percent range. For the overall balances, non-detectable concentrations do not affect these balances using the 20% criterion mentioned above. The worst balances are calculated for the elements that typically give poor results: 256% for selenium, 141% for lead, 29% and 55% for mercury, and 64% for cadmium. The poor mercury results are from a coal concentration that appears to be too high (by 2x) as compared to the consistent flue gas measurements. Table 7-18, which shows the balance for mercury using Brooks Rand as the analytical subcontractor, presents data from the measurement of mercury contamination in the ambient air. The mass flow of mercury in the combustion air is about 1% of the mercury contained in the coal and about 2% of the mercury found in the flue gas.

It is usually not possible to attribute poor closures to specific analytical data that are in error. Nevertheless, certain useful suggestions can be offered; as follows:

- The poor closures for antimony in the Unit 8 boiler and the Unit 8 ESP would be overcome to significant degrees if the fly ash between the boiler and ESP contained more of this element than reported. Raising the antimony concentration in the fly ash would raise the closure at the boiler and lower the closure at the ESP.

- The poor closures for lead at the same two locations would be improved if the fly ash could be shown to contain less of the element then reported (just the opposite from the shift hypothesized for antimony).

- The poor closures of selenium at the same two locations would be improved if the fly ash concentration of this element were lowered.

- The poor closure for cadmium at the condenser may be regarded as largely an illusion that stems from limitations in analytical sensitivity. For three days at the condenser inlet, the results reported are all less than 0.0003 µg/mL. For the three days at the condenser outlet, one result is <0.0003 µg/ml and the other two are 0.0008 and 0.0012 µg/mL. In the judgment of the SRI staff, the data do not justify computation of a closure. However, following instructions on data treatment, one lists 0.00015, 0.0008, and 0.0016). The ratio of outlet to inlet is 5.67, or the recovery is reported as 567%. As a matter of fact, of course, there may have been contamination from an unrecognized source in the real system, or there may have been contamination in handling of the outlet samples.

The trace metal balances for the AFGD system, as summarized in Table 7-22B, are disappointing, with a range of 24% for cadmium to 2750% for chromium. Of the 17 balances, only 5 lie within an 80 to 120% range and 7 within a 60 to 140% band. The AFGD mass balances are dominated by the comparison of trace metal concentrations in the limestone to that in the gypsum.

Some of the poorest closures for the AFGD system were improved by use of the Galbraith data, as revealed in Table 7-23B. Notably improved closures occurred for arsenic, beryllium, cadmium, chromium, molybdenum, and nickel when the Galbraith data were used. Only two of the closures — for cobalt and manganese — were degraded by the substitute data.

Table 7-1
Bailly Mass Balance for Iron
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	524			524
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
Out	Flue Gas	173		0.152	173
	Bottom Ash	315			315
Average of Daily Closures, %					93.3
Closure of Average Flows, %					93.1
UNIT 8 ESP					
In	Flue Gas	173		0.152	173
Out	ESP Hopper Ash	175			175
	Flue Gas to AFGD	0.183		0.0362	0.219
Average of Daily Closures, %					101
Closure of Average Flows, %					101
CONDENSER					
In	Inlet Water		*0.573*		*0.573*
Out	Outlet Water		*0.573*		*0.573*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	315			315
	Sluice Return		*0.00230*		*0.00230*
Out	Bottom Ash Sluice	315	*0.00381*		315
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	524			524
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
	Sluice Return		*0.00230*		*0.00230*
Out	Bottom Ash Sluice	315	*0.00381*		315
	ESP Hopper Ash	175			175
	Flue Gas to AFGD	0.183		0.0362	0.219
Average of Daily Closures, %					93.6
Closure of Average Flows, %					93.4

Italics indicate numbers derived from non-detectable concentrations.

Table 7-1 (Continued)
Bailly Mass Balance for Iron
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.13		0.0224	1.15
	Unit 8 Flue Gas	0.183		0.0362	0.219
Out	Flue Gas to AFGD	1.31		0.0587	1.37
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.31		0.0587	1.37
	Limestone	5.19			5.19
	Service Water		*0.00432*		*0.00432*
	Compressed Air				
Out	Stack Flue Gas	0.124		0.00915	0.133
	Gypsum	6.45			6.45
	Wastewater		0.00167		0.00167
Average of Daily Closures, %					101
Closure of Average Flows, %					100

Italics indicate numbers derived from non-detectable concentrations.

Table 7-1A
Bailly Mass Balance for Iron
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	46.0			46.0
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	7.41		0.111	7.30
	Bottom Ash	22.3			22.3
Std Dev of Daily Closures, %					3.48
UNIT 8 ESP					
In	Flue Gas	7.41		0.111	7.30
Out	ESP Hopper Ash	11.0			11.0
	Flue Gas to AFGD	0.0861		0.0125	0.0839
Std Dev of Daily Closures, %					6.44
CONDENSER					
In	Inlet Water		*0.00814*		*0.00814*
Out	Outlet Water		*0.00814*		*0.00814*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	22.3			22.3
	Sluice Return		*0.00161*		*0.00161*
Out	Bottom Ash Sluice	22.3	*0.00418*		22.3
Std Dev of Daily Closures, %					0.00169
BOILER OVERALL BALANCE					
In	Coal	46.0			46.0
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00161*		*0.00161*
Out	Bottom Ash Sluice	22.3	*0.00418*		22.3
	ESP Hopper Ash	11.0			11.0
	Flue Gas to AFGD	0.0861		0.0125	0.0839
Std Dev of Daily Closures, %					3.31

Italics indicate numbers derived from non-detectable concentrations.

Table 7-1A (Continued)
Daily Mass Balance for Iron
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.260		0.00693	0.267
	Unit 8 Flue Gas	0.0861		0.0125	0.0839
Out	Flue Gas to AFGD	0.334		0.0176	0.343
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.334		0.0176	0.343
	Limestone	0.286			0.286
	Service Water		*0.0000844*		*0.0000844*
	Compressed Air				
Out	Stack Flue Gas	0.0299		0.00651	0.0356
	Gypsum	0.853			0.853
	Wastewater		0.000516		0.000516
Std Dev of Daily Closures, %					19.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-2
Bailly Mass Balance for Aluminum
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	416			416
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
Out	Flue Gas	130		0.193	131
	Bottom Ash	269			269
Average of Daily Closures, %					96.2
Closure of Average Flows, %					96.1
UNIT 8 ESP					
In	Flue Gas	130		0.193	131
Out	ESP Hopper Ash	132			132
	Flue Gas to AFGD	0.102		0.0849	0.187
Average of Daily Closures, %					101
Closure of Average Flows, %					101
CONDENSER					
In	Inlet Water		*0.573*		*0.573*
Out	Outlet Water		*0.398*		*0.398*
Average of Daily Closures, %					*70.0*
Closure of Average Flows, %					*69.5*
BOTTOM ASH SLUICE					
In	Bottom Ash	269			269
	Sluice Return		*0.00136*		*0.00136*
Out	Bottom Ash Sluice	269	*0.00316*		269
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	416			416
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
	Sluice Return		*0.00136*		*0.00136*
Out	Bottom Ash Sluice	269	*0.00316*		269
	ESP Hopper Ash	132			132
	Flue Gas to AFGD	0.102		0.0849	0.187
Average of Daily Closures, %					96.5
Closure of Average Flows, %					96.5

Italics indicate numbers derived from non-detectable concentrations.

Table 7-2 (Continued)
Bailly Mass Balance for Aluminum
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.784		0.0440	0.828
	Unit 8 Flue Gas	0.102		0.0849	0.187
Out	Flue Gas to AFGD	0.886		0.129	1.01
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.886		0.129	1.01
	Limestone	25.6			25.6
	Service Water		*0.00432*		*0.00432*
	Compressed Air				
Out	Stack Flue Gas	0.0627		*0.00187*	0.0646
	Gypsum	50.4			50.4
	Wastewater		0.00199		0.00199
Average of Daily Closures, %					197
Closure of Average Flows, %					189

Italics indicate numbers derived from non-detectable concentrations.

Table 7-2A
Bailly Mass Balance for Aluminum
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	23.8			23.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	1.45		0.118	1.34
	Bottom Ash	20.4			20.4
Std Dev of Daily Closures, %					1.96
UNIT 8 ESP					
In	Flue Gas	1.45		0.118	1.34
Out	ESP Hopper Ash	11.1			11.1
	Flue Gas to AFGD	0.0481		0.0160	0.0353
Std Dev of Daily Closures, %					8.29
CONDENSER					
In	Inlet Water		*0.00814*		*0.00814*
Out	Outlet Water		*0.294*		*0.294*
Std Dev of Daily Closures, %					*52.0*
BOTTOM ASH SLUICE					
In	Bottom Ash	20.4			20.4
	Sluice Return		*0.0000794*		*0.0000794*
Out	Bottom Ash Sluice	20.4	*0.00304*		20.4
Std Dev of Daily Closures, %					0.00126
BOILER OVERALL BALANCE					
In	Coal	23.8			23.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.0000794*		*0.0000794*
Out	Bottom Ash Sluice	20.4	*0.00304*		20.4
	ESP Hopper Ash	11.1			11.1
	Flue Gas to AFGD	0.0481		0.0160	0.0353
Std Dev of Daily Closures, %					3.68

Italics indicate numbers derived from non-detectable concentrations.

Table 7-2A (Continued)
Bailly Mass Balance for Aluminum
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.374		0.00196	0.373
	Unit 8 Flue Gas	0.0481		0.0160	0.0353
Out	Flue Gas to AFGD	0.418		0.0154	0.408
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.418		0.0154	0.408
	Limestone	4.02			4.02
	Service Water		*0.0000844*		*0.0000844*
	Compressed Air				
Out	Stack Flue Gas	0.00931		*0.00163*	0.0108
	Gypsum	9.95			9.96
	Wastewater		0.000306		0.000306
Std Dev of Daily Closures, %					73.0

Italics indicate numbers derived from non-detectable concentrations.

Table 7-3
Bailly Mass Balance for Titanium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	22.9			22.9
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
Out	Flue Gas	9.58		0.0122	9.59
	Bottom Ash	13.2			13.2
Average of Daily Closures, %					99.7
Closure of Average Flows, %					99.6
UNIT 8 ESP					
In	Flue Gas	9.58		0.0122	9.59
Out	ESP Hopper Ash	9.70			9.70
	Flue Gas to AFGD	0.0110		0.00353	0.0146
Average of Daily Closures, %					101
Closure of Average Flows, %					101
CONDENSER					
In	Inlet Water		*0.573*		*0.573*
Out	Outlet Water		*0.573*		*0.573*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	13.2			13.2
	Sluice Return		*0.00136*		*0.00136*
Out	Bottom Ash Sluice	13.2	*0.00136*		13.2
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	22.9			22.9
	Combustion Air				
	Makeup Water		*0.000208*		*0.000208*
	Sluice Return		*0.00136*		*0.00136*
Out	Bottom Ash Sluice	13.2	*0.00136*		13.2
	ESP Hopper Ash	9.70			9.70
	Flue Gas to AFGD	0.0110		0.00353	0.0146
Average of Daily Closures, %					100
Closure of Average Flows, %					100

Italics indicate numbers derived from non-detectable concentrations.

Table 7-3 (Continued)
Bailly Mass Balance for Titanium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0636		0.00190	0.0655
	Unit 8 Flue Gas	0.0110		0.00353	0.0146
Out	Flue Gas to AFGD	0.0746		0.00543	0.0801
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0746		0.00543	0.0801
	Limestone	0.0981		- -	0.0981
	Service Water		*0.00432*		*0.00432*
	Compressed Air				
Out	Stack Flue Gas	0.00990		*0.000146*	0.0100
	Gypsum	0.287			0.287
	Wastewater		*0.000466*		*0.000466*
Average of Daily Closures, %					163
Closure of Average Flows, %					163

Italics indicate numbers derived from non-detectable concentrations.

Table 7-3A
Baily Mass Balance for Titanium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	1.07			1.07
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	0.121		0.00898	0.122
	Bottom Ash	0.571			0.571
Std Dev of Daily Closures, %					1.71
UNIT 8 ESP					
In	Flue Gas	0.121		0.00898	0.122
Out	ESP Hopper Ash	0.848			0.848
	Flue Gas to AFGD	0.00297		0.000931	0.00208
Std Dev of Daily Closures, %					7.50
CONDENSER					
In	Inlet Water		*0.00814*		*0.00814*
Out	Outlet Water		*0.00814*		*0.00814*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	0.571			0.571
	Sluice Return		*0.0000794*		*0.0000794*
Out	Bottom Ash Sluice	0.571	*0.0000794*		0.571
Std Dev of Daily Closures, %					0.00
BOILER OVERALL BALANCE					
In	Coal	1.07			1.07
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.0000794*		*0.0000794*
Out	Bottom Ash Sluice	0.571	*0.0000794*		0.571
	ESP Hopper Ash	0.848			0.848
	Flue Gas to AFGD	0.00297		0.000931	0.00208
Std Dev of Daily Closures, %					1.93

Italics indicate numbers derived from non-detectable concentrations.

Table 7-3A (Continued)
Daily Mass Balance for Titanium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.00979		0.0000703	0.00980
	Unit 8 Flue Gas	0.00297		0.000931	0.00208
Out	Flue Gas to AFGD	0.0116		0.000861	0.0112
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0116		0.000861	0.0112
	Limestone	0.00655			0.00655
	Service Water		*0.0000844*		*0.0000844*
	Compressed Air				
Out	Stack Flue Gas	0.00153		*0.000171*	0.00154
	Gypsum	0.0878			0.0878
	Wastewater		*0.0000261*		*0.0000261*
Std Dev of Daily Closures, %					46.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-4
Bailly Mass Balance for Calcium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	126			126
	Combustion Air				
	Makeup Water		*0.00235*		*0.00235*
Out	Flue Gas	25.5		0.684	26.2
	Bottom Ash	102			102
Average of Daily Closures, %					105
Closure of Average Flows, %					101
UNIT 8 ESP					
In	Flue Gas	25.5		0.684	26.2
Out	ESP Hopper Ash	30.3			30.3
	Flue Gas to AFGD	0.0805		0.505	0.586
Average of Daily Closures, %					118
Closure of Average Flows, %					118
CONDENSER					
In	Inlet Water		230		230
Out	Outlet Water		316		316
Average of Daily Closures, %					137
Closure of Average Flows, %					137
BOTTOM ASH SLUICE					
In	Bottom Ash	102			102
	Sluice Return		0.748		0.748
Out	Bottom Ash Sluice	102	0.791		103
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	126			126
	Combustion Air				
	Makeup Water		*0.00235*		*0.00235*
	Sluice Return		0.748		0.748
Out	Bottom Ash Sluice	102	0.791		103
	ESP Hopper Ash	30.3			30.3
	Flue Gas to AFGD	0.0805		0.505	0.586
Average of Daily Closures, %					109
Closure of Average Flows, %					105

Italics indicate numbers derived from non-detectable concentrations.

Table 7-4 (Continued)
Baily Mass Balance for Calcium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.139		0.347	0.486
	Unit 8 Flue Gas	0.0805		0.505	0.586
Out	Flue Gas to AFGD	0.220		0.852	1.07
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.220		0.852	1.07
	Limestone	2580			2580
	Service Water		1.53		1.53
	Compressed Air				
Out	Stack Flue Gas	0.286		0.00490	0.291
	Gypsum	2580			2580
	Wastewater		18.4		18.4
Average of Daily Closures, %					101
Closure of Average Flows, %					101

Italics indicate numbers derived from non-detectable concentrations.

Table 7-4A
Bailly Mass Balance for Calcium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	27.2			27.2
	Combustion Air				
	Makeup Water		*0.00370*		*0.00370*
Out	Flue Gas	1.07		0.0597	1.12
	Bottom Ash	11.1			11.1
Std Dev of Daily Closures, %					24.6
UNIT 8 ESP					
In	Flue Gas	1.07		0.0597	1.12
Out	ESP Hopper Ash	4.48			4.48
	Flue Gas to AFGD	0.0978		0.401	0.305
Std Dev of Daily Closures, %					18.8
CONDENSER					
In	Inlet Water		5.39		5.39
Out	Outlet Water		124		124
Std Dev of Daily Closures, %					50.9
BOTTOM ASH SLUICE					
In	Bottom Ash	11.1			11.1
	Sluice Return		0.135		0.135
Out	Bottom Ash Sluice	11.1	0.122		11.2
Std Dev of Daily Closures, %					0.0846
BOILER OVERALL BALANCE					
In	Coal	27.2			27.2
	Combustion Air				
	Makeup Water		*0.00370*		*0.00370*
	Sluice Return		0.135		0.135
Out	Bottom Ash Sluice	11.1	0.122		11.2
	ESP Hopper Ash	4.48			4.48
	Flue Gas to AFGD	0.0978		0.401	0.305
Std Dev of Daily Closures, %					25.5

Italics indicate numbers derived from non-detectable concentrations.

Table 7-4A (Continued)
Baily Mass Balance for Calcium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0247		0.0550	0.0663
	Unit 8 Flue Gas	0.0978		0.401	0.305
Out	Flue Gas to AFGD	0.0901		0.453	0.371
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0901		0.453	0.371
	Limestone	53.0			53.0
	Service Water		0.0280		0.0280
	Compressed Air				
Out	Stack Flue Gas	0.0198		0.00181	0.0193
	Gypsum	53.0			53.0
	Wastewater		1.48		1.48
Std Dev of Daily Closures, %					0.0356

Italics indicate numbers derived from non-detectable concentrations.

Table 7-5
Bailly Mass Balance for Magnesium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	27.4			27.4
	Combustion Air				
	Makeup Water		*0.000688*		*0.000688*
Out	Flue Gas	8.55		0.0287	8.58
	Bottom Ash	18.6			18.6
Average of Daily Closures, %					99.2
Closure of Average Flows, %					99.0
UNIT 8 ESP					
In	Flue Gas	8.55		0.0287	8.58
Out	ESP Hopper Ash	9.40			9.40
	Flue Gas to AFGD	0.00810		0.0220	0.0301
Average of Daily Closures, %					110
Closure of Average Flows, %					110
CONDENSER					
In	Inlet Water		129		129
Out	Outlet Water		128		128
Average of Daily Closures, %					99.6
Closure of Average Flows, %					99.4
BOTTOM ASH SLUICE					
In	Bottom Ash	18.6			18.6
	Sluice Return		0.281		0.281
Out	Bottom Ash Sluice	18.6	0.287		18.9
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	27.4			27.4
	Combustion Air				
	Makeup Water		*0.000688*		*0.000688*
	Sluice Return		0.281		0.281
Out	Bottom Ash Sluice	18.6	0.287		18.9
	ESP Hopper Ash	9.40			9.40
	Flue Gas to AFGD	0.00810		0.0220	0.0301
Average of Daily Closures, %					102
Closure of Average Flows, %					102

Italics indicate numbers derived from non-detectable concentrations.

Table 7-5 (Continued)
Bailly Mass Balance for Magnesium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0435		0.0113	0.0548
	Unit 8 Flue Gas	0.00810		0.0220	0.0301
Out	Flue Gas to AFGD	0.0516		0.0333	0.0849
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0516		0.0333	0.0849
	Limestone	23.6			23.6
	Service Water		0.967		0.967
	Compressed Air				
Out	Stack Flue Gas	0.0537		0.000911	0.0547
	Gypsum	8.56			8.56
	Wastewater		13.6		13.6
Average of Daily Closures, %					90.1
Closure of Average Flows, %					90.1

Italics indicate numbers derived from non-detectable concentrations.

Table 7-6A
Bailly Mass Balance for Magnesium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
UNIT 8 BOILER					
In	Coal	2.75			2.75
	Combustion Air				
	Makeup Water		*0.000832*		*0.000832*
Out	Flue Gas	0.191		0.00789	0.199
	Bottom Ash	2.09			2.09
Std Dev of Daily Closures, %					4.65
UNIT 8 ESP					
In	Flue Gas	0.191		0.00789	0.199
Out	ESP Hopper Ash	0.176			0.176
	Flue Gas to AFGD	0.00146		0.00551	0.00406
Std Dev of Daily Closures, %					4.43
CONDENSER					
In	Inlet Water		4.71		4.71
Out	Outlet Water		4.70		4.70
Std Dev of Daily Closures, %					7.34
BOTTOM ASH SLUICE					
In	Bottom Ash	2.09			2.09
	Sluice Return		0.0196		0.0196
Out	Bottom Ash Sluice	2.09	0.0233		2.10
Std Dev of Daily Closures, %					0.0259
BOILER OVERALL BALANCE					
In	Coal	2.75			2.75
	Combustion Air				
	Makeup Water		*0.000832*		*0.000832*
	Sluice Return		0.0196		0.0196
Out	Bottom Ash Sluice	2.09	0.0233		2.10
	ESP Hopper Ash	0.176			0.176
	Flue Gas to AFGD	0.00146		0.00551	0.00406
Std Dev of Daily Closures, %					4.90

Italics indicate numbers derived from non-detectable concentrations.

Table 7-5A (Continued)
Daily Mass Balance for Magnesium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, g/s	Liquid, g/s	Gas, g/s	Total, g/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.00657		0.00134	0.00546
	Unit 8 Flue Gas	0.00146		0.00551	0.00406
Out	Flue Gas to AFGD	0.00641		0.00620	0.00741
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.00641		0.00620	0.00741
	Limestone	0.648			0.648
	Service Water		0.0371		0.0371
	Compressed Air				
Out	Stack Flue Gas	0.00338		0.000337	0.00366
	Gypsum	0.582			0.582
	Wastewater		0.789		0.789
Std Dev of Daily Closures, %					3.07

Italics indicate numbers derived from non-detectable concentrations.

Table 7-6
Bailly Mass Balance for Antimony
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	25.2			25.2
	Combustion Air				
	Makeup Water		*0.00125*		*0.00125*
Out	Flue Gas	11.3		0.233	11.5
	Bottom Ash	5.31			5.31
Average of Daily Closures, %					66.7
Closure of Average Flows, %					66.8
UNIT 8 ESP					
In	Flue Gas	11.3		0.233	11.5
Out	ESP Hopper Ash	37.6			37.6
	Flue Gas to AFGD	*0.0309*		0.0435	*0.0744*
Average of Daily Closures, %					375
Closure of Average Flows, %					326
CONDENSER					
In	Inlet Water		*3.44*		*3.44*
Out	Outlet Water		*3.44*		*3.44*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	5.31			5.31
	Sluice Return		0.246		0.246
Out	Bottom Ash Sluice	5.31	0.595		5.91
Average of Daily Closures, %					107
Closure of Average Flows, %					106
BOILER OVERALL BALANCE					
In	Coal	25.2			25.2
	Combustion Air				
	Makeup Water		*0.00125*		*0.00125*
	Sluice Return		0.246		0.246
Out	Bottom Ash Sluice	5.31	0.595		5.91
	ESP Hopper Ash	37.6			37.6
	Flue Gas to AFGD	*0.0309*		0.0435	*0.0744*
Average of Daily Closures, %					169
Closure of Average Flows, %					171

Italics indicate numbers derived from non-detectable concentrations.

Table 7-6 (Continued)
Bailly Mass Balance for Antimony
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0619		0.0108	0.0727
	Unit 8 Flue Gas	*0.0309*		0.0435	*0.0744*
Out	Flue Gas to AFGD	*0.0928*		0.0543	*0.147*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	*0.0928*		0.0543	*0.147*
	Limestone	6.71			6.71
	Service Water		*0.0259*		*0.0259*
	Compressed Air				
Out	Stack Flue Gas	*0.0110*		0.171	0.182
	Gypsum	4.23			4.23
	Wastewater		0.0576		0.0576
Average of Daily Closures, %					103
Closure of Average Flows, %					64.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-6A
Daily Mass Balance for Antimony
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	1.48			1.48
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	5.58		0.222	5.79
	Bottom Ash	1.04			1.04
Std Dev of Daily Closures, %					26.4
UNIT 8 ESP					
In	Flue Gas	5.58		0.222	5.79
Out	ESP Hopper Ash	15.1			15.1
	Flue Gas to AFGD	*0.00166*		0.0376	*0.0392*
Std Dev of Daily Closures, %					206
CONDENSER					
In	Inlet Water		*0.0488*		*0.0488*
Out	Outlet Water		*0.0488*		*0.0488*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	1.04			1.04
	Sluice Return		0.0810		0.0810
Out	Bottom Ash Sluice	1.04	0.194		0.850
Std Dev of Daily Closures, %					3.09
BOILER OVERALL BALANCE					
In	Coal	1.48			1.48
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		0.0810		0.0810
Out	Bottom Ash Sluice	1.04	0.194		0.850
	ESP Hopper Ash	15.1			15.1
	Flue Gas to AFGD	*0.00166*		0.0376	*0.0392*
Std Dev of Daily Closures, %					48.3

Italics indicate numbers derived from non-detectable concentrations.

Table 7-6A (Continued)
Bailly Mass Balance for Antimony
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0188		0.0116	0.0276
	Unit 8 Flue Gas	*0.00166*		0.0376	*0.0392*
Out	Flue Gas to AFGD	*0.0204*		0.0419	*0.0621*
Std Dev of Daily Closures, %					*0.00*
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	*0.0204*		0.0419	*0.0621*
	Limestone	5.24			5.24
	Service Water		*0.000507*		*0.000507*
	Compressed Air				
Out	Stack Flue Gas	*0.00143*		0.263	0.262
	Gypsum	2.47			2.47
	Wastewater		0.00908		0.00908
Std Dev of Daily Closures, %					98.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-7
Bailly Mass Balance for Arsenic
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	110			110
	Combustion Air				
	Makeup Water		*0.000625*		*0.000625*
Out	Flue Gas	68.7		0.675	69.4
	Bottom Ash	0.954			0.954
Average of Daily Closures, %					69.7
Closure of Average Flows, %					63.7
UNIT 8 ESP					
In	Flue Gas	68.7		0.675	69.4
Out	ESP Hopper Ash	90.9			90.9
	Flue Gas to AFGD	0.215		0.434	0.648
Average of Daily Closures, %					132
Closure of Average Flows, %					132
CONDENSER					
In	Inlet Water		*1.72*		*1.72*
Out	Outlet Water		*1.72*		*1.72*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	0.954			0.954
	Sluice Return		0.391		0.391
Out	Bottom Ash Sluice	0.954	1.04		1.99
Average of Daily Closures, %					158
Closure of Average Flows, %					148
BOILER OVERALL BALANCE					
In	Coal	110			110
	Combustion Air				
	Makeup Water		*0.000625*		*0.000625*
	Sluice Return		0.391		0.391
Out	Bottom Ash Sluice	0.954	1.04		1.99
	ESP Hopper Ash	90.9			90.9
	Flue Gas to AFGD	0.215		0.434	0.648
Average of Daily Closures, %					91.9
Closure of Average Flows, %					84.4

Italics indicate numbers derived from non-detectable concentrations.

Table 7-7 (Continued)
Bailly Mass Balance for Arsenic
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.752		0.331	1.08
	Unit 8 Flue Gas	0.215		0.434	0.648
Out	Flue Gas to AFGD	0.967		0.765	1.73
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.967		0.765	1.73
	Limestone	1.99			1.99
	Service Water		*0.0130*		*0.0130*
	Compressed Air				
Out	Stack Flue Gas	0.675		*0.294*	*0.969*
	Gypsum	14.8			14.8
	Wastewater		0.106		0.106
Average of Daily Closures, %					436
Closure of Average Flows, %					426

Italics indicate numbers derived from non-detectable concentrations.

Table 7-7A
Bailly Mass Balance for Arsenic
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	42.5			42.5
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	2.70		0.316	2.41
	Bottom Ash	0.403			0.403
Std Dev of Daily Closures, %					23.3
UNIT 8 ESP					
In	Flue Gas	2.70		0.316	2.41
Out	ESP Hopper Ash	2.45			2.45
	Flue Gas to AFGD	0.0338		0.132	0.0982
Std Dev of Daily Closures, %					3.48
CONDENSER					
In	Inlet Water		*0.0244*		*0.0244*
Out	Outlet Water		*0.0244*		*0.0244*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	0.403			0.403
	Sluice Return		0.0255		0.0255
Out	Bottom Ash Sluice	0.403	0.432		0.251
Std Dev of Daily Closures, %					53.5
BOILER OVERALL BALANCE					
In	Coal	42.5			42.5
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		0.0255		0.0255
Out	Bottom Ash Sluice	0.403	0.432		0.251
	ESP Hopper Ash	2.45			2.45
	Flue Gas to AFGD	0.0338		0.132	0.0982
Std Dev of Daily Closures, %					29.3

Italics indicate numbers derived from non-detectable concentrations.

Table 7-7A (Continued)
Bailly Mass Balance for Arsenic
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.505		0.374	0.879
	Unit 8 Flue Gas	0.0338		0.132	0.0962
Out	Flue Gas to AFGD	0.538		0.249	0.785
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.538		0.249	0.785
	Limestone	0.262			0.262
	Service Water		*0.000253*		*0.000253*
	Compressed Air				
Out	Stack Flue Gas	0.840		*0.430*	*1.27*
	Gypsum	0.478			0.478
	Wastewater		0.0199		0.0199
Std Dev of Daily Closures, %					74.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-8
Baily Mass Balance for Barium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	1640			1640
	Combustion Air				
	Makeup Water		*0.0140*		*0.0140*
Out	Flue Gas	519		0.954	520
	Bottom Ash	1080			1080
Average of Daily Closures, %					97.4
Closure of Average Flows, %					97.6
UNIT 8 ESP					
In	Flue Gas	519		0.954	520
Out	ESP Hopper Ash	692			692
	Flue Gas to AFGD	0.969		0.781	1.75
Average of Daily Closures, %					136
Closure of Average Flows, %					133
CONDENSER					
In	Inlet Water		204		204
Out	Outlet Water		210		210
Average of Daily Closures, %					103
Closure of Average Flows, %					103
BOTTOM ASH SLUICE					
In	Bottom Ash	1080			1080
	Sluice Return		0.732		0.732
Out	Bottom Ash Sluice	1080	0.556		1080
Average of Daily Closures, %					100.0
Closure of Average Flows, %					100.0
BOILER OVERALL BALANCE					
In	Coal	1640			1640
	Combustion Air				
	Makeup Water		*0.0140*		*0.0140*
	Sluice Return		0.732		0.732
Out	Bottom Ash Sluice	1080	0.556		1080
	ESP Hopper Ash	692			692
	Flue Gas to AFGD	0.969		0.781	1.75
Average of Daily Closures, %					108
Closure of Average Flows, %					106

Italics indicate numbers derived from non-detectable concentrations.

Table 7-8 (Continued)
Bailly Mass Balance for Barium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	3.56		0.405	3.97
	Unit 8 Flue Gas	0.969		0.781	1.75
Out	Flue Gas to AFGD	4.53		1.19	5.72
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	4.53		1.19	5.72
	Limestone	9.35			9.35
	Service Water		1.57		1.57
	Compressed Air				
Out	Stack Flue Gas	0.806		*0.0473*	0.854
	Gypsum	10.8			10.8
	Wastewater		1.93		1.93
Average of Daily Closures, %					81.6
Closure of Average Flows, %					81.3

Italics indicate numbers derived from non-detectable concentrations.

Table 7-8A
Bailly Mass Balance for Barium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	89.9			89.9
	Combustion Air				
	Makeup Water		*0.00264*		*0.00264*
Out	Flue Gas	70.7		0.226	70.9
	Bottom Ash	95.3			95.3
Std Dev of Daily Closures, %					5.81
UNIT 8 ESP					
In	Flue Gas	70.7		0.226	70.9
Out	ESP Hopper Ash	112			112
	Flue Gas to AFGD	0.398		0.178	0.287
Std Dev of Daily Closures, %					38.6
CONDENSER					
In	Inlet Water		7.19		7.19
Out	Outlet Water		6.34		6.34
Std Dev of Daily Closures, %					6.65
BOTTOM ASH SLUICE					
In	Bottom Ash	95.3			95.3
	Sluice Return		0.102		0.102
Out	Bottom Ash Sluice	95.3	0.230		95.1
Std Dev of Daily Closures, %					0.0238
BOILER OVERALL BALANCE					
In	Coal	89.9			89.9
	Combustion Air				
	Makeup Water		*0.00264*		*0.00264*
	Sluice Return		0.102		0.102
Out	Bottom Ash Sluice	95.3	0.230		95.1
	ESP Hopper Ash	112			112
	Flue Gas to AFGD	0.398		0.178	0.287
Std Dev of Daily Closures, %					5.13

Italics indicate numbers derived from non-detectable concentrations.

Table 7-8A (Continued)
Bailly Mass Balance for Barium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.724		0.0332	0.723
	Unit 8 Flue Gas	0.398		0.178	0.287
Out	Flue Gas to AFGD	0.935		0.208	0.935
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.935		0.208	0.935
	Limestone	0.496			0.496
	Service Water		0.176		0.176
	Compressed Air				
Out	Stack Flue Gas	0.179		*0.000393*	0.178
	Gypsum	1.79			1.79
	Wastewater		0.410		0.410
Std Dev of Daily Closures, %					14.2

Italics indicate numbers derived from non-detectable concentrations.

Table 7-9
Bailly Mass Balance for Beryllium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	67.3			67.3
	Combustion Air				
	Makeup Water		*0.00104*		*0.00104*
Out	Flue Gas	26.6		0.237	26.8
	Bottom Ash	24.1			24.1
Average of Daily Closures, %					77.1
Closure of Average Flows, %					75.7
UNIT 8 ESP					
In	Flue Gas	26.6		0.237	26.8
Out	ESP Hopper Ash	28.5			28.5
	Flue Gas to AFGD	0.0221		*0.00309*	0.0252
Average of Daily Closures, %					107
Closure of Average Flows, %					106
CONDENSER					
In	Inlet Water		*2.86*		*2.86*
Out	Outlet Water		*2.86*		*2.86*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	24.1			24.1
	Sluice Return		*0.00682*		*0.00682*
Out	Bottom Ash Sluice	24.1	*0.00934*		24.1
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	67.3			67.3
	Combustion Air				
	Makeup Water		*0.00104*		*0.00104*
	Sluice Return		*0.00682*		*0.00682*
Out	Bottom Ash Sluice	24.1	*0.00934*		24.1
	ESP Hopper Ash	28.5			28.5
	Flue Gas to AFGD	0.0221		*0.00309*	0.0252
Average of Daily Closures, %					80.0
Closure of Average Flows, %					78.2

Italics indicate numbers derived from non-detectable concentrations.

Table 7-9 (Continued)
Bailly Mass Balance for Beryllium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.230		*0.00167*	0.232
	Unit 8 Flue Gas	0.0221		*0.00309*	0.0252
Out	Flue Gas to AFGD	0.252		*0.00475*	0.257
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.252		*0.00475*	0.257
	Limestone	*0.0271*			*0.0271*
	Service Water		*0.0216*		*0.0216*
	Compressed Air				
Out	Stack Flue Gas	*0.0409*		*0.00944*	*0.0504*
	Gypsum	3.68			3.68
	Wastewater		*0.00233*		*0.00233*
Average of Daily Closures, %					1260
Closure of Average Flows, %					1220

Italics indicate numbers derived from non-detectable concentrations.

Table 7-9A
Bailly Mass Balance for Beryllium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	11.8			11.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	2.08		0.291	2.37
	Bottom Ash	2.23			2.23
Std Dev of Daily Closures, %					12.1
UNIT 8 ESP					
In	Flue Gas	2.08		0.291	2.37
Out	ESP Hopper Ash	0.630			0.630
	Flue Gas to AFGD	0.0167		*0.000166*	0.0166
Std Dev of Daily Closures, %					7.13
CONDENSER					
In	Inlet Water		*0.0407*		*0.0407*
Out	Outlet Water		*0.0407*		*0.0407*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	2.23			2.23
	Sluice Return		*0.000397*		*0.000397*
Out	Bottom Ash Sluice	2.23	*0.00473*		2.23
Std Dev of Daily Closures, %					0.0178
BOILER OVERALL BALANCE					
In	Coal	11.8			11.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.000397*		*0.000397*
Out	Bottom Ash Sluice	2.23	*0.00473*		2.23
	ESP Hopper Ash	0.630			0.630
	Flue Gas to AFGD	0.0167		*0.000166*	0.0166
Std Dev of Daily Closures, %					14.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-9A (Continued)
Bailly Mass Balance for Beryllium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0680		*0.0000583*	0.0681
	Unit 8 Flue Gas	0.0167		*0.000166*	0.0166
Out	Flue Gas to AFGD	0.0710		*0.000210*	0.0711
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0710		*0.000210*	0.0711
	Limestone	*0.000492*			*0.000492*
	Service Water		*0.000422*		*0.000422*
	Compressed Air				
Out	Stack Flue Gas	*0.0221*		*0.0123*	*0.0164*
	Gypsum	0.0518			0.0518
	Wastewater		*0.000131*		*0.000131*
Std Dev of Daily Closures, %					241

Italics indicate numbers derived from non-detectable concentrations.

Table 7-10
Bailly Mass Balance for Boron
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	7880			7880
	Combustion Air				
	Makeup Water		85.4		85.4
Out	Flue Gas	714		4000	4720
	Bottom Ash	422			422
Average of Daily Closures, %					65.1
Closure of Average Flows, %					64.5
UNIT 8 ESP					
In	Flue Gas	714		4000	4720
Out	ESP Hopper Ash	1450			1450
	Flue Gas to AFGD	*0.0309*		4180	4180
Average of Daily Closures, %					122
Closure of Average Flows, %					119
CONDENSER					
In	Inlet Water		106000		106000
Out	Outlet Water		*358*		*358*
Average of Daily Closures, %					*0.348*
Closure of Average Flows, %					*0.338*
BOTTOM ASH SLUICE					
In	Bottom Ash	422			422
	Sluice Return		*0.853*		*0.853*
Out	Bottom Ash Sluice	422	*0.853*		423
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	7880			7880
	Combustion Air				
	Makeup Water		85.4		85.4
	Sluice Return		*0.853*		*0.853*
Out	Bottom Ash Sluice	422	*0.853*		423
	ESP Hopper Ash	1450			1450
	Flue Gas to AFGD	*0.0309*		4180	4180
Average of Daily Closures, %					76.3
Closure of Average Flows, %					76.1

Italics indicate numbers derived from non-detectable concentrations.

Table 7-10 (Continued)
Bailly Mass Balance for Boron
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	8.44		2200	2200
	Unit 8 Flue Gas	*0.0309*		4180	4180
Out	Flue Gas to AFGD	8.48		6380	6390
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	8.48		6380	6390
	Limestone	879			879
	Service Water		*2.70*		*2.70*
	Compressed Air				
Out	Stack Flue Gas	*0.0473*		582	582
	Gypsum	3270			3270
	Wastewater		5480		5480
Average of Daily Closures, %					126
Closure of Average Flows, %					128

Italics indicate numbers derived from non-detectable concentrations.

Table 7-10A
Bailly Mass Balance for Boron
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	652			652
	Combustion Air				
	Makeup Water		30.9		30.9
Out	Flue Gas	591		330	815
	Bottom Ash	63.3			63.3
Std Dev of Daily Closures, %					13.5
UNIT 8 ESP					
In	Flue Gas	591		330	815
Out	ESP Hopper Ash	147			147
	Flue Gas to AFGD	*0.00166*		423	423
Std Dev of Daily Closures, %					22.6
CONDENSER					
In	Inlet Water		22100		22100
Out	Outlet Water		*5.09*		*5.09*
Std Dev of Daily Closures, %					*0.0667*
BOTTOM ASH SLUICE					
In	Bottom Ash	63.3			63.3
	Sluice Return		*0.0497*		*0.0497*
Out	Bottom Ash Sluice	63.3	*0.0497*		63.4
Std Dev of Daily Closures, %					0.00
BOILER OVERALL BALANCE					
In	Coal	652			652
	Combustion Air				
	Makeup Water		30.9		30.9
	Sluice Return		*0.0497*		*0.0497*
Out	Bottom Ash Sluice	63.3	*0.0497*		63.4
	ESP Hopper Ash	147			147
	Flue Gas to AFGD	*0.00166*		423	423
Std Dev of Daily Closures, %					3.43

Italics indicate numbers derived from non-detectable concentrations.

Table 7-10A (Continued)
Baily Mass Balance for Boron
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	2.32		275	273
	Unit 8 Flue Gas	*0.00166*		423	423
Out	Flue Gas to AFGD	2.32		662	660
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	2.32		662	660
	Limestone	157			157
	Service Water		*0.0528*	-	*0.0528*
	Compressed Air				
Out	Stack Flue Gas	*0.000393*		158	158
	Gypsum	577			577
	Wastewater		4250		4250
Std Dev of Daily Closures, %					50.4

Italics indicate numbers derived from non-detectable concentrations.

Table 7-11
Bailly Mass Balance for Cadmium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	104			104
	Combustion Air				
	Makeup Water		*0.000625*		*0.000625*
Out	Flue Gas	43.4		0.608	44.0
	Bottom Ash	19.6			19.6
Average of Daily Closures, %					64.4
Closure of Average Flows, %					61.2
UNIT 8 ESP					
In	Flue Gas	43.4		0.608	44.0
Out	ESP Hopper Ash	49.0			49.0
	Flue Gas to AFGD	0.718		0.461	1.18
Average of Daily Closures, %					115
Closure of Average Flows, %					114
CONDENSER					
In	Inlet Water		*1.72*		*1.72*
Out	Outlet Water		9.67		9.67
Average of Daily Closures, %					*567*
Closure of Average Flows, %					*563*
BOTTOM ASH SLUICE					
In	Bottom Ash	19.6			19.6
	Sluice Return		0.0240		0.0240
Out	Bottom Ash Sluice	19.6	0.0192		19.6
Average of Daily Closures, %					100
Closure of Average Flows, %					100.0
BOILER OVERALL BALANCE					
In	Coal	104			104
	Combustion Air				
	Makeup Water		*0.000625*		*0.000625*
	Sluice Return		0.0240		0.0240
Out	Bottom Ash Sluice	19.6	0.0192		19.6
	ESP Hopper Ash	49.0			49.0
	Flue Gas to AFGD	0.718		0.461	1.18
Average of Daily Closures, %					71.3
Closure of Average Flows, %					67.1

Italics indicate numbers derived from non-detectable concentrations.

Table 7-11 (Continued)
Bailly Mass Balance for Cadmium
Average of 9/3, 9/4, 9/6/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.09		0.492	1.59
	Unit 8 Flue Gas	0.718		0.461	1.18
Out	Flue Gas to AFGD	1.81		0.953	2.76
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.81		0.953	2.76
	Limestone	*0.234*			*0.234*
	Service Water		0.107		0.107
	Compressed Air				
Out	Stack Flue Gas	0.194		0.0755	0.269
	Gypsum	*0.0906*			*0.0906*
	Wastewater		0.342		0.342
Average of Daily Closures, %					23.6
Closure of Average Flows, %					22.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-11A
Bailly Mass Balance for Cadmium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	33.3			33.3
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	8.24		0.543	8.78
	Bottom Ash	13.4			13.4
Std Dev of Daily Closures, %					29.5
UNIT 8 ESP					
In	Flue Gas	8.24		0.543	8.78
Out	ESP Hopper Ash	9.90			9.90
	Flue Gas to AFGD	0.590		0.213	0.798
Std Dev of Daily Closures, %					8.49
CONDENSER					
In	Inlet Water		*0.0244*		*0.0244*
Out	Outlet Water		8.22		8.22
Std Dev of Daily Closures, %					*484*
BOTTOM ASH SLUICE					
In	Bottom Ash	13.4			13.4
	Sluice Return		0.0214		0.0214
Out	Bottom Ash Sluice	13.4	0.0162		13.4
Std Dev of Daily Closures, %					0.504
BOILER OVERALL BALANCE					
In	Coal	33.3			33.3
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		0.0214		0.0214
Out	Bottom Ash Sluice	13.4	0.0162		13.4
	ESP Hopper Ash	9.90			9.90
	Flue Gas to AFGD	0.590		0.213	0.798
Std Dev of Daily Closures, %					31.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-11A (Continued)
Baily Mass Balance for Cadmium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.432		0.153	0.508
	Unit 8 Flue Gas	0.590		0.213	0.798
Out	Flue Gas to AFGD	0.970		0.363	1.28
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.970		0.363	1.28
	Limestone	*0.376*			*0.376*
	Service Water		0.0427		0.0427
	Compressed Air				
Out	Stack Flue Gas	0.0893		0.0470	0.0957
	Gypsum	*0.000604*			*0.000604*
	Wastewater		0.0441		0.0441
Std Dev of Daily Closures, %					4.34

Italics indicate numbers derived from non-detectable concentrations.

Table 7-12
Bailly Mass Balance for Chromium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	1640			1640
	Combustion Air				
	Makeup Water		*0.0125*		*0.0125*
Out	Flue Gas	558		1.22	559
	Bottom Ash	692			692
Average of Daily Closures, %					78.9
Closure of Average Flows, %					76.3
UNIT 8 ESP					
In	Flue Gas	558		1.22	559
Out	ESP Hopper Ash	584			584
	Flue Gas to AFGD	1.41		0.977	2.39
Average of Daily Closures, %					105
Closure of Average Flows, %					105
CONDENSER					
In	Inlet Water		*34.4*		*34.4*
Out	Outlet Water		*34.4*		*34.4*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	692			692
	Sluice Return		*0.0819*		*0.0819*
Out	Bottom Ash Sluice	692	*0.0819*		692
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	1640			1640
	Combustion Air				
	Makeup Water		*0.0125*		*0.0125*
	Sluice Return		*0.0819*		*0.0819*
Out	Bottom Ash Sluice	692	*0.0819*		692
	ESP Hopper Ash	584			584
	Flue Gas to AFGD	1.41		0.977	2.39
Average of Daily Closures, %					80.7
Closure of Average Flows, %					78.0

Italics indicate numbers derived from non-detectable concentrations.

Table 7-12 (Continued)
Bailly Mass Balance for Chromium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	4.20		0.446	4.65
	Unit 8 Flue Gas	1.41		0.977	2.39
Out	Flue Gas to AFGD	5.61		1.42	7.04
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	5.61		1.42	7.04
	Limestone	4.10			4.10
	Service Water		*0.259*		*0.259*
	Compressed Air				
Out	Stack Flue Gas	1.66		0.0850	1.75
	Gypsum	323			323
	Wastewater		*0.0451*		*0.0451*
Average of Daily Closures, %					2750
Closure of Average Flows, %					2850

Italics indicate numbers derived from non-detectable concentrations.

Table 7-12A
Bailly Mass Balance for Chromium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	501			501
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	58.5		0.631	59.0
	Bottom Ash	141			141
Std Dev of Daily Closures, %					14.8
UNIT 8 ESP					
In	Flue Gas	58.5		0.631	59.0
Out	ESP Hopper Ash	71.7			71.7
	Flue Gas to AFGD	0.165		0.126	0.129
Std Dev of Daily Closures, %					5.97
CONDENSER					
In	Inlet Water		*0.488*		*0.488*
Out	Outlet Water		*0.488*		*0.488*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	141			141
	Sluice Return		*0.00477*		*0.00477*
Out	Bottom Ash Sluice	141	*0.00477*		141
Std Dev of Daily Closures, %					0.00
BOILER OVERALL BALANCE					
In	Coal	501			501
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00477*		*0.00477*
Out	Bottom Ash Sluice	141	*0.00477*		141
	ESP Hopper Ash	71.7			71.7
	Flue Gas to AFGD	0.165		0.126	0.129
Std Dev of Daily Closures, %					16.4

Italics indicate numbers derived from non-detectable concentrations.

Table 7-12A (Continued)
Daily Mass Balance for Chromium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.19		0.0483	1.16
	Unit 8 Flue Gas	0.165		0.126	0.129
Out	Flue Gas to AFGD	1.15		0.122	1.23
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.15		0.122	1.23
	Limestone	0.228			0.228
	Service Water		*0.00507*		*0.00507*
	Compressed Air				
Out	Stack Flue Gas	0.241		0.0363	0.277
	Gypsum	353			353
	Wastewater		*0.0312*		*0.0312*
Std Dev of Daily Closures, %					2840

Italics indicate numbers derived from non-detectable concentrations.

Table 7-13
Bailly Mass Balance for Cobalt
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	98.1			98.1
	Combustion Air				
	Makeup Water		*0.00416*		*0.00416*
Out	Flue Gas	51.8		0.0577	51.9
	Bottom Ash	60.8			60.8
Average of Daily Closures, %					116
Closure of Average Flows, %					115
UNIT 8 ESP					
In	Flue Gas	51.8		0.0577	51.9
Out	ESP Hopper Ash	65.8			65.8
	Flue Gas to AFGD	*0.0309*		0.0459	*0.0768*
Average of Daily Closures, %					127
Closure of Average Flows, %					127
CONDENSER					
In	Inlet Water		*26.6*		*26.6*
Out	Outlet Water		*11.5*		*11.5*
Average of Daily Closures, %					*73.3*
Closure of Average Flows, %					*43.1*
BOTTOM ASH SLUICE					
In	Bottom Ash	60.8			60.8
	Sluice Return		*0.0273*		*0.0273*
Out	Bottom Ash Sluice	60.8	*0.0776*		60.9
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	98.1			98.1
	Combustion Air				
	Makeup Water		*0.00416*		*0.00416*
	Sluice Return		*0.0273*		*0.0273*
Out	Bottom Ash Sluice	60.8	*0.0776*		60.9
	ESP Hopper Ash	65.8			65.8
	Flue Gas to AFGD	*0.0309*		0.0459	*0.0768*
Average of Daily Closures, %					130
Closure of Average Flows, %					129

Italics indicate numbers derived from non-detectable concentrations.

Table 7-13 (Continued)
Bailly Mass Balance for Cobalt
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.333		*0.0190*	0.352
	Unit 8 Flue Gas	*0.0309*		0.0459	*0.0768*
Out	Flue Gas to AFGD	0.363		*0.0649*	0.428
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.363		*0.0649*	0.428
	Limestone	1.90			1.90
	Service Water		*0.164*		*0.164*
	Compressed Air				
Out	Stack Flue Gas	0.0457		*0.0236*	*0.0693*
	Gypsum	*1.36*			*1.36*
	Wastewater		0.752		0.752
Average of Daily Closures, %					*94.1*
Closure of Average Flows, %					*87.6*

Italics indicate numbers derived from non-detectable concentrations.

Table 7-13A
Bailly Mass Balance for Cobalt
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	10.4			10.4
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	5.09		0.0520	5.14
	Bottom Ash	3.54			3.54
Std Dev of Daily Closures, %					10.6
UNIT 8 ESP					
In	Flue Gas	5.09		0.0520	5.14
Out	ESP Hopper Ash	11.5			11.5
	Flue Gas to AFGD	*0.00166*		0.0326	*0.0337*
Std Dev of Daily Closures, %					11.6
CONDENSER					
In	Inlet Water		*26.1*		*26.1*
Out	Outlet Water		*0.163*		*0.163*
Std Dev of Daily Closures, %					*46.2*
BOTTOM ASH SLUICE					
In	Bottom Ash	3.54			3.54
	Sluice Return		*0.00159*		*0.00159*
Out	Bottom Ash Sluice	3.54	*0.0886*		3.58
Std Dev of Daily Closures, %					0.139
BOILER OVERALL BALANCE					
In	Coal	10.4			10.4
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00159*		*0.00159*
Out	Bottom Ash Sluice	3.54	*0.0886*		3.58
	ESP Hopper Ash	11.5			11.5
	Flue Gas to AFGD	*0.00166*		0.0326	*0.0337*
Std Dev of Daily Closures, %					5.30

Italics indicate numbers derived from non-detectable concentrations.

Table 7-13A (Continued)
Bailly Mass Balance for Cobalt
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.113		*0.00453*	0.117
	Unit 8 Flue Gas	*0.00166*		0.0326	*0.0337*
Out	Flue Gas to AFGD	0.113		*0.0306*	0.111
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.113		*0.0306*	0.111
	Limestone	0.820			0.820
	Service Water		*0.135*		*0.135*
	Compressed Air				
Out	Stack Flue Gas	0.00519		*0.000196*	*0.00506*
	Gypsum	*0.00906*			*0.00906*
	Wastewater		0.105		0.105
Std Dev of Daily Closures, %					*32.9*

Italics indicate numbers derived from non-detectable concentrations.

Table 7-14
Daily Mass Balance for Copper
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	369			369
	Combustion Air				
	Makeup Water		0.0139		0.0139
Out	Flue Gas	258		0.476	258
	Bottom Ash	132			132
Average of Daily Closures, %					107
Closure of Average Flows, %					106
UNIT 8 ESP					
In	Flue Gas	258		0.476	258
Out	ESP Hopper Ash	309			309
	Flue Gas to AFGD	0.518		0.519	1.04
Average of Daily Closures, %					122
Closure of Average Flows, %					120
CONDENSER					
In	Inlet Water		59.6		59.6
Out	Outlet Water		74.1		74.1
Average of Daily Closures, %					130
Closure of Average Flows, %					124
BOTTOM ASH SLUICE					
In	Bottom Ash	132			132
	Sluice Return		0.210		0.210
Out	Bottom Ash Sluice	132	0.159		132
Average of Daily Closures, %					100.0
Closure of Average Flows, %					100.0
BOILER OVERALL BALANCE					
In	Coal	369			369
	Combustion Air				
	Makeup Water		0.0139		0.0139
	Sluice Return		0.210		0.210
Out	Bottom Ash Sluice	132	0.159		132
	ESP Hopper Ash	309			309
	Flue Gas to AFGD	0.518		0.519	1.04
Average of Daily Closures, %					120
Closure of Average Flows, %					120

Italics indicate numbers derived from non-detectable concentrations.

Table 7-14 (Continued)
Bailly Mass Balance for Copper
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	2.23		0.285	2.52
	Unit 8 Flue Gas	0.518		0.519	1.04
Out	Flue Gas to AFGD	2.75		0.804	3.56
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	2.75		0.804	3.56
	Limestone	15.4			15.4
	Service Water		0.464		0.464
	Compressed Air				
Out	Stack Flue Gas	0.736		0.365	1.10
	Gypsum	3.94			3.94
	Wastewater		0.0783		0.0783
Average of Daily Closures, %					26.4
Closure of Average Flows, %					26.3

Italics indicate numbers derived from non-detectable concentrations.

Table 7-14A
Bailly Mass Balance for Copper
Std Dev of 9/3, 9/4, 9/6/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	33.8			33.8
	Combustion Air				
	Makeup Water		0.00307		0.00307
Out	Flue Gas	46.1		0.334	46.4
	Bottom Ash	26.7			26.7
Std Dev of Daily Closures, %					24.3
UNIT 8 ESP					
In	Flue Gas	46.1		0.334	46.4
Out	ESP Hopper Ash	18.3			18.3
	Flue Gas to AFGD	0.203		0.415	0.353
Std Dev of Daily Closures, %					19.6
CONDENSER					
In	Inlet Water		7.42		7.42
Out	Outlet Water		39.2		39.2
Std Dev of Daily Closures, %					78.0
BOTTOM ASH SLUICE					
In	Bottom Ash	26.7			26.7
	Sluice Return		0.0113		0.0113
Out	Bottom Ash Sluice	26.7	0.0882		26.6
Std Dev of Daily Closures, %					0.0647
BOILER OVERALL BALANCE					
In	Coal	33.8			33.8
	Combustion Air				
	Makeup Water		0.00307		0.00307
	Sluice Return		0.0113		0.0113
Out	Bottom Ash Sluice	26.7	0.0882		26.6
	ESP Hopper Ash	18.3			18.3
	Flue Gas to AFGD	0.203		0.415	0.353
Std Dev of Daily Closures, %					16.2

Italics indicate numbers derived from non-detectable concentrations.

Table 7-14A (Continued)
Bailly Mass Balance for Copper
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.470		0.155	0.400
	Unit 8 Flue Gas	0.203		0.415	0.353
Out	Flue Gas to AFGD	0.546		0.551	0.0806
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.546		0.551	0.0806
	Limestone	0.208			0.208
	Service Water		0.0591		0.0591
	Compressed Air				
Out	Stack Flue Gas	0.481		0.235	0.713
	Gypsum	4.08			4.08
	Wastewater		0.00731		0.00731
Std Dev of Daily Closures, %					24.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-15
Bailly Mass Balance for Lead
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	298			298
	Combustion Air				
	Makeup Water		*0.0104*		*0.0104*
Out	Flue Gas	392		0.417	392
	Bottom Ash	15.2			15.2
Average of Daily Closures, %					141
Closure of Average Flows, %					137
UNIT 8 ESP					
In	Flue Gas	392		0.417	392
Out	ESP Hopper Ash	424			424
	Flue Gas to AFGD	1.19		0.212	1.40
Average of Daily Closures, %					110
Closure of Average Flows, %					108
CONDENSER					
In	Inlet Water		*28.6*		*28.6*
Out	Outlet Water		*28.6*		*28.6*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	15.2			15.2
	Sluice Return		*0.0682*		*0.0682*
Out	Bottom Ash Sluice	15.2	*0.0975*		15.3
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	298			298
	Combustion Air				
	Makeup Water		*0.0104*		*0.0104*
	Sluice Return		*0.0682*		*0.0682*
Out	Bottom Ash Sluice	15.2	*0.0975*		15.3
	ESP Hopper Ash	424			424
	Flue Gas to AFGD	1.19		0.212	1.40
Average of Daily Closures, %					151
Closure of Average Flows, %					148

Italics indicate numbers derived from non-detectable concentrations.

Table 7-15 (Continued)
Bailly Mass Balance for Lead
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	3.86		0.0710	3.93
	Unit 8 Flue Gas	1.19		0.212	1.40
Out	Flue Gas to AFGD	5.05		0.283	5.33
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	5.05		0.283	5.33
	Limestone	*0.424*			*0.424*
	Service Water		*0.216*		*0.216*
	Compressed Air				
Out	Stack Flue Gas	0.893		0.133	1.03
	Gypsum	*2.26*			*2.26*
	Wastewater		*0.0233*		*0.0233*
Average of Daily Closures, %					*56.8*
Closure of Average Flows, %					*55.5*

Italics indicate numbers derived from non-detectable concentrations.

Table 7-15A
Baily Mass Balance for Lead
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	46.2			46.2
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	60.3		0.350	60.3
	Bottom Ash	2.63			2.63
Std Dev of Daily Closures, %					44.8
UNIT 8 ESP					
In	Flue Gas	60.3		0.350	60.3
Out	ESP Hopper Ash	23.0			23.0
	Flue Gas to AFGD	1.00		0.0547	0.950
Std Dev of Daily Closures, %					10.7
CONDENSER					
In	Inlet Water		*0.407*		*0.407*
Out	Outlet Water		*0.407*		*0.407*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	2.63			2.63
	Sluice Return		*0.00397*		*0.00397*
Out	Bottom Ash Sluice	2.63	*0.0477*		2.63
Std Dev of Daily Closures, %					0.335
BOILER OVERALL BALANCE					
In	Coal	46.2			46.2
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00397*		*0.00397*
Out	Bottom Ash Sluice	2.63	*0.0477*		2.63
	ESP Hopper Ash	23.0			23.0
	Flue Gas to AFGD	1.00		0.0547	0.950
Std Dev of Daily Closures, %					33.2

Italics indicate numbers derived from non-detectable concentrations.

Table 7-15A (Continued)
Bailly Mass Balance for Lead
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.881		0.0522	0.933
	Unit 8 Flue Gas	1.00		0.0547	0.950
Out	Flue Gas to AFGD	1.76		0.0406	1.76
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.76		0.0406	1.76
	Limestone	*0.00768*			*0.00768*
	Service Water		*0.00422*		*0.00422*
	Compressed Air				
Out	Stack Flue Gas	0.480		0.0816	0.550
	Gypsum	*0.0151*			*0.0151*
	Wastewater		*0.00131*		*0.00131*
Std Dev of Daily Closures, %					*7.03*

Italics indicate numbers derived from non-detectable concentrations.

Table 7-16
Bailly Mass Balance for Manganese
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	1130			1130
	Combustion Air				
	Makeup Water		*0.0260*		*0.0260*
Out	Flue Gas	322		*0.445*	323
	Bottom Ash	860			860
Average of Daily Closures, %					105
Closure of Average Flows, %					105
UNIT 8 ESP					
In	Flue Gas	322		*0.445*	323
Out	ESP Hopper Ash	355			355
	Flue Gas to AFGD	0.221		*0.176*	*0.397*
Average of Daily Closures, %					111
Closure of Average Flows, %					110
CONDENSER					
In	Inlet Water		*71.6*		*71.6*
Out	Outlet Water		24.5		24.5
Average of Daily Closures, %					*34.2*
Closure of Average Flows, %					*34.3*
BOTTOM ASH SLUICE					
In	Bottom Ash	860			860
	Sluice Return		*0.189*		*0.189*
Out	Bottom Ash Sluice	860	0.123		860
Average of Daily Closures, %					100.0
Closure of Average Flows, %					100.0
BOILER OVERALL BALANCE					
In	Coal	1130			1130
	Combustion Air				
	Makeup Water		*0.0260*		*0.0260*
	Sluice Return		*0.189*		*0.189*
Out	Bottom Ash Sluice	860	0.123		860
	ESP Hopper Ash	355			355
	Flue Gas to AFGD	0.221		*0.176*	*0.397*
Average of Daily Closures, %					108
Closure of Average Flows, %					108

Italics indicate numbers derived from non-detectable concentrations.

Table 7-16 (Continued)
Bailly Mass Balance for Manganese
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.46		*0.0666*	1.53
	Unit 8 Flue Gas	0.221		*0.176*	*0.397*
Out	Flue Gas to AFGD	1.68		*0.243*	1.92
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.68		*0.243*	1.92
	Limestone	471			471
	Service Water		*0.440*		*0.440*
	Compressed Air				
Out	Stack Flue Gas	1.39		*0.0946*	1.49
	Gypsum	54.9			54.9
	Wastewater		396		396
Average of Daily Closures, %					95.5
Closure of Average Flows, %					95.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-16A
Bailly Mass Balance for Manganese
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	10.8			10.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	31.2		*0.584*	31.2
	Bottom Ash	59.2			59.2
Std Dev of Daily Closures, %					6.51
UNIT 8 ESP					
In	Flue Gas	31.2		*0.584*	31.2
Out	ESP Hopper Ash	15.4			15.4
	Flue Gas to AFGD	0.161		*0.0934*	*0.118*
Std Dev of Daily Closures, %					15.9
CONDENSER					
In	Inlet Water		*1.02*		*1.02*
Out	Outlet Water		8.95		8.95
Std Dev of Daily Closures, %					*12.1*
BOTTOM ASH SLUICE					
In	Bottom Ash	59.2			59.2
	Sluice Return		*0.0321*		*0.0321*
Out	Bottom Ash Sluice	59.2	0.0435		59.2
Std Dev of Daily Closures, %					0.00899
BOILER OVERALL BALANCE					
In	Coal	10.8			10.8
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.0321*		*0.0321*
Out	Bottom Ash Sluice	59.2	0.0435		59.2
	ESP Hopper Ash	15.4			15.4
	Flue Gas to AFGD	0.161		*0.0934*	*0.118*
Std Dev of Daily Closures, %					3.97

Italics indicate numbers derived from non-detectable concentrations.

Table 7-16A (Continued)
Bailly Mass Balance for Manganese
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.357		*0.00233*	0.359
	Unit 8 Flue Gas	0.161		*0.0934*	*0.118*
Out	Flue Gas to AFGD	0.380		*0.0956*	0.432
Std Dev of Daily Closures, %					*0.00*
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.380		*0.0956*	0.432
	Limestone	17.2			17.2
	Service Water		*0.183*		*0.183*
	Compressed Air				
Out	Stack Flue Gas	0.129		*0.000786*	0.130
	Gypsum	11.1			11.1
	Wastewater		16.7		16.7
Std Dev of Daily Closures, %					1.05

Italics indicate numbers derived from non-detectable concentrations.

Table 7-17
Bailly Mass Balance for Mercury
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	4.09			4.09
	Combustion Air				
	Makeup Water		0.000833		0.000833
Out	Flue Gas	0.0726		1.07	1.14
	Bottom Ash	*0.00370*			*0.00370*
Average of Daily Closures, %					29.2
Closure of Average Flows, %					28.0
UNIT 8 ESP					
In	Flue Gas	0.0726		1.07	1.14
Out	ESP Hopper Ash	0.00887			0.00887
	Flue Gas to AFGD	0.00941		1.23	1.24
Average of Daily Closures, %					116
Closure of Average Flows, %					110
CONDENSER					
In	Inlet Water		1.56		1.56
Out	Outlet Water		1.64		1.64
Average of Daily Closures, %					119
Closure of Average Flows, %					105
BOTTOM ASH SLUICE					
In	Bottom Ash	*0.00370*			*0.00370*
	Sluice Return		0.00483		0.00483
Out	Bottom Ash Sluice	*0.00370*	0.00463		*0.00833*
Average of Daily Closures, %					*102*
Closure of Average Flows, %					*97.7*
BOILER OVERALL BALANCE					
In	Coal	4.09			4.09
	Combustion Air				
	Makeup Water		0.000833		0.000833
	Sluice Return		0.00483		0.00483
Out	Bottom Ash Sluice	*0.00370*	0.00463		*0.00833*
	ESP Hopper Ash	0.00887			0.00887
	Flue Gas to AFGD	0.00941		1.23	1.24
Average of Daily Closures, %					31.3
Closure of Average Flows, %					30.8

Italics indicate numbers derived from non-detectable concentrations.

Table 7-17 (Continued)
Bailly Mass Balance for Mercury
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.00883		0.690	0.699
	Unit 8 Flue Gas	0.00941		1.23	1.24
Out	Flue Gas to AFGD	0.0182		1.92	1.94
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0182		1.92	1.94
	Limestone	*0.00678*			*0.00678*
	Service Water		0.00836		0.00836
	Compressed Air				
Out	Stack Flue Gas	0.00395		1.32	1.32
	Gypsum	2.23			2.23
	Wastewater		0.00316		0.00316
Average of Daily Closures, %					182
Closure of Average Flows, %					182

Italics indicate numbers derived from non-detectable concentrations.

Table 7-17A
Bailly Mass Balance for Mercury
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	0.535			0.535
	Combustion Air				
	Makeup Water		0.000314		0.000314
Out	Flue Gas	0.0101		0.345	0.355
	Bottom Ash	*0.00182*			*0.00182*
Std Dev of Daily Closures, %					13.4
UNIT 8 ESP					
In	Flue Gas	0.0101		0.345	0.355
Out	ESP Hopper Ash	0.00231			0.00231
	Flue Gas to AFGD	0.00842		0.0930	0.0984
Std Dev of Daily Closures, %					32.2
CONDENSER					
In	Inlet Water		0.458		0.458
Out	Outlet Water		1.32		1.32
Std Dev of Daily Closures, %					92.8
BOTTOM ASH SLUICE					
In	Bottom Ash	*0.00182*			*0.00182*
	Sluice Return		0.00201		0.00201
Out	Bottom Ash Sluice	*0.00182*	0.0000312		*0.00183*
Std Dev of Daily Closures, %					*26.2*
BOILER OVERALL BALANCE					
In	Coal	0.535			0.535
	Combustion Air				
	Makeup Water		0.000314		0.000314
	Sluice Return		0.00201		0.00201
Out	Bottom Ash Sluice	*0.00182*	0.0000312		*0.00183*
	ESP Hopper Ash	0.00231			0.00231
	Flue Gas to AFGD	0.00842		0.0930	0.0984
Std Dev of Daily Closures, %					6.07

Italics indicate numbers derived from non-detectable concentrations.

Table 7-17A (Continued)
Daily Mass Balance for Mercury
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.00409		0.101	0.0986
	Unit 8 Flue Gas	0.00842		0.0930	0.0984
Out	Flue Gas to AFGD	0.00669		0.0327	0.0354
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.00669		0.0327	0.0354
	Limestone	*0.000123*			*0.000123*
	Service Water		0.00115		0.00115
	Compressed Air				
Out	Stack Flue Gas	0.00138		0.192	0.191
	Gypsum	0.0433	—		0.0433
	Wastewater		0.000698		0.000698
Std Dev of Daily Closures, %					4.86

Italics indicate numbers derived from non-detectable concentrations.

Table 7-18
Bailly Mass Balance for Mercury (B-R)
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	**3.89**			**3.89**
	Combustion Air			**0.0481**	**0.0481**
	Makeup Water		0.000833		0.000833
Out	Flue Gas			**2.18**	**2.18**
	Bottom Ash	*0.00370*			*0.00370*
Average of Daily Closures, %					54.8
Closure of Average Flows, %					55.4
UNIT 8 ESP					
In	Flue Gas			**2.18**	**2.18**
Out	ESP Hopper Ash	0.00887			0.00887
	Flue Gas to AFGD			**2.57**	**2.57**
Average of Daily Closures, %					120
Closure of Average Flows, %					118
CONDENSER					
In	Inlet Water		1.56		1.56
Out	Outlet Water		1.64		1.64
Average of Daily Closures, %					119
Closure of Average Flows, %					105
BOTTOM ASH SLUICE					
In	Bottom Ash	*0.00370*			*0.00370*
	Sluice Return		0.00483		0.00483
Out	Bottom Ash Sluice	*0.00370*	0.00463		*0.00833*
Average of Daily Closures, %					*102*
Closure of Average Flows, %					*97.7*
BOILER OVERALL BALANCE					
In	Coal	**3.89**			**3.89**
	Combustion Air			**0.0481**	**0.0481**
	Makeup Water		0.000833		0.000833
	Sluice Return		0.00483		0.00483
Out	Bottom Ash Sluice	*0.00370*	0.00463		*0.00833*
	ESP Hopper Ash	0.00887			0.00887
	Flue Gas to AFGD			**2.57**	**2.57**
Average of Daily Closures, %					65.2
Closure of Average Flows, %					65.5

Italics indicate numbers derived from non-detectable concentrations.

Bold entries show the Brooke-Rand mercury data.

Table 7-18 (Continued)
Baily Mass Balance for Mercury (B-R)
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas			**1.27**	**1.27**
	Unit 8 Flue Gas			**2.57**	**2.57**
Out	Flue Gas to AFGD			**3.84**	**3.84**
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas			**3.84**	**3.84**
	Limestone	*0.00678*			*0.00678*
	Service Water		0.00836		0.00836
	Compressed Air				
Out	Stack Flue Gas			**1.52**	**1.52**
	Gypsum	2.23			2.23
	Wastewater		0.00316		0.00316
Average of Daily Closures, %					99.7
Closure of Average Flows, %					97.6

Italics indicate numbers derived from non-detectable concentrations.

Bold entries show the Brooks-Rand mercury data.

Table 7-18A
Bailly Mass Balance for Mercury (B-R)
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	**0.589**			**0.589**
	Combustion Air			**0.00214**	**0.00214**
	Makeup Water		0.000314		0.000314
Out	Flue Gas			**0.614**	**0.614**
	Bottom Ash	*0.00182*			*0.00182*
Std Dev of Daily Closures, %					7.94
UNIT 8 ESP					
In	Flue Gas			**0.614**	**0.614**
Out	ESP Hopper Ash	0.00231			0.00231
	Flue Gas to AFGD			**0.560**	**0.560**
Std Dev of Daily Closures, %					7.37
CONDENSER					
In	Inlet Water		0.458		0.458
Out	Outlet Water		1.32		1.32
Std Dev of Daily Closures, %					92.8
BOTTOM ASH SLUICE					
In	Bottom Ash	*0.00182*			*0.00182*
	Sluice Return		0.00201		0.00201
Out	Bottom Ash Sluice	*0.00182*	0.0000312		*0.00183*
Std Dev of Daily Closures, %					*26.2*
BOILER OVERALL BALANCE					
In	Coal	**0.589**			**0.589**
	Combustion Air			**0.00214**	**0.00214**
	Makeup Water		0.000314		0.000314
	Sluice Return		0.00201		0.00201
Out	Bottom Ash Sluice	*0.00182*	0.0000312		*0.00183*
	ESP Hopper Ash	0.00231			0.00231
	Flue Gas to AFGD			**0.560**	**0.560**
Std Dev of Daily Closures, %					5.46

Italics indicate numbers derived from non-detectable concentrations.

Bold entries show the Brooks-Rand mercury data.

Table 7-18A (Continued)
Bailly Mass Balance for Mercury (B-R)
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas			**0.240**	**0.240**
	Unit 8 Flue Gas			**0.560**	**0.560**
Out	Flue Gas to AFGD			**0.786**	**0.786**
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas			**0.786**	**0.786**
	Limestone	*0.000123*			*0.000123*
	Service Water		0.00115		0.00115
	Compressed Air				
Out	Stack Flue Gas			**0.272**	**0.272**
	Gypsum	0.0433			0.0433
	Wastewater		0.000698		0.000698
Std Dev of Daily Closures, %					17.3

Italics indicate numbers derived from non-detectable concentrations.

Bold entries show the Brooks-Rand mercury data.

Table 7-19
Bailly Mass Balance for Molybdenum
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	283			283
	Combustion Air				
	Makeup Water		*0.0125*		*0.0125*
Out	Flue Gas	205		0.293	205
	Bottom Ash	*1.12*			*1.12*
Average of Daily Closures, %					78.8
Closure of Average Flows, %					72.9
UNIT 8 ESP					
In	Flue Gas	205		0.293	205
Out	ESP Hopper Ash	217			217
	Flue Gas to AFGD	1.41		*0.0618*	1.47
Average of Daily Closures, %					108
Closure of Average Flows, %					106
CONDENSER					
In	Inlet Water		*34.4*		*34.4*
Out	Outlet Water		*34.4*		*34.4*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	*1.12*			*1.12*
	Sluice Return		*0.133*		*0.133*
Out	Bottom Ash Sluice	*1.12*	*0.187*		*1.30*
Average of Daily Closures, %					*102*
Closure of Average Flows, %					*104*
BOILER OVERALL BALANCE					
In	Coal	283			283
	Combustion Air				
	Makeup Water		*0.0125*		*0.0125*
	Sluice Return		*0.133*		*0.133*
Out	Bottom Ash Sluice	*1.12*	*0.187*		*1.30*
	ESP Hopper Ash	217			217
	Flue Gas to AFGD	1.41		*0.0618*	1.47
Average of Daily Closures, %					85.3
Closure of Average Flows, %					77.5

Italics indicate numbers derived from non-detectable concentrations.

Table 7-19 (Continued)
Bailly Mass Balance for Molybdenum
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	2.79		*0.0333*	2.82
	Unit 8 Flue Gas	1.41		*0.0618*	1.47
Out	Flue Gas to AFGD	4.20		*0.0951*	4.29
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	4.20		*0.0951*	4.29
	Limestone	2.46			2.46
	Service Water		*2.11*		*2.11*
	Compressed Air				
Out	Stack Flue Gas	2.14		*0.0473*	2.18
	Gypsum	61.8			61.8
	Wastewater		1.12		1.12
Average of Daily Closures, %					795
Closure of Average Flows, %					735

Italics indicate numbers derived from non-detectable concentrations.

Table 7-19A
Bailly Mass Balance for Molybdenum
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	139			139
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	47.6		0.359	48.0
	Bottom Ash	*0.749*			*0.749*
Std Dev of Daily Closures, %					21.0
UNIT 8 ESP					
In	Flue Gas	47.6		0.359	48.0
Out	ESP Hopper Ash	30.5			30.5
	Flue Gas to AFGD	0.123		*0.00333*	0.125
Std Dev of Daily Closures, %					15.4
CONDENSER					
In	Inlet Water		*0.488*		*0.488*
Out	Outlet Water		*0.488*		*0.488*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	*0.749*			*0.749*
	Sluice Return		*0.0884*		*0.0884*
Out	Bottom Ash Sluice	*0.749*	*0.182*		*0.931*
Std Dev of Daily Closures, %					*4.22*
BOILER OVERALL BALANCE					
In	Coal	139			139
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.0884*		*0.0884*
Out	Bottom Ash Sluice	*0.749*	*0.182*		*0.931*
	ESP Hopper Ash	30.5			30.5
	Flue Gas to AFGD	0.123		*0.00333*	0.125
Std Dev of Daily Closures, %					24.0

Italics indicate numbers derived from non-detectable concentrations.

Table 7-19A (Continued)
Bailly Mass Balance for Molybdenum
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.374		*0.00117*	0.374
	Unit 8 Flue Gas	0.123		*0.00333*	0.125
Out	Flue Gas to AFGD	0.483		*0.00420*	0.487
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.483		*0.00420*	0.487
	Limestone	2.52			2.52
	Service Water		*3.21*		*3.21*
	Compressed Air				
Out	Stack Flue Gas	0.150		*0.000393*	0.150
	Gypsum	49.2			49.2
	Wastewater		0.0760		0.0760
Std Dev of Daily Closures, %					543

Italics indicate numbers derived from non-detectable concentrations.

Table 7-20
Bailly Mass Balance for Nickel
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	906			906
	Combustion Air				
	Makeup Water		*0.0208*		*0.0208*
Out	Flue Gas	330		1.30	331
	Bottom Ash	273			273
Average of Daily Closures, %					72.3
Closure of Average Flows, %					66.7
UNIT 8 ESP					
In	Flue Gas	330		1.30	331
Out	ESP Hopper Ash	349			349
	Flue Gas to AFGD	0.792		1.13	1.93
Average of Daily Closures, %					106
Closure of Average Flows, %					106
CONDENSER					
In	Inlet Water		*57.3*		*57.3*
Out	Outlet Water		*73.6*		*73.6*
Average of Daily Closures, %					*128*
Closure of Average Flows, %					*128*
BOTTOM ASH SLUICE					
In	Bottom Ash	273			273
	Sluice Return		*0.136*		*0.136*
Out	Bottom Ash Sluice	273	0.442		274
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	906			906
	Combustion Air				
	Makeup Water		*0.0208*		*0.0208*
	Sluice Return		*0.136*		*0.136*
Out	Bottom Ash Sluice	273	0.442		274
	ESP Hopper Ash	349			349
	Flue Gas to AFGD	0.792		1.13	1.93
Average of Daily Closures, %					74.9
Closure of Average Flows, %					68.9

Italics indicate numbers derived from non-detectable concentrations.

Table 7-20 (Continued)
Bailly Mass Balance for Nickel
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.05		0.300	1.35
	Unit 8 Flue Gas	0.792		1.13	1.93
Out	Flue Gas to AFGD	1.85		1.43	3.28
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	1.85		1.43	3.28
	Limestone	17.4			17.4
	Service Water		*0.441*		*0.441*
	Compressed Air				
Out	Stack Flue Gas	0.771		0.520	1.29
	Gypsum	156			156
	Wastewater		6.85		6.85
Average of Daily Closures, %					750
Closure of Average Flows, %					777

Italics indicate numbers derived from non-detectable concentrations.

Table 7-20A
Bailly Mass Balance for Nickel
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	396			396
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	51.6		1.42	51.3
	Bottom Ash	30.3			30.3
Std Dev of Daily Closures, %					19.9
UNIT 8 ESP					
In	Flue Gas	51.6		1.42	51.3
Out	ESP Hopper Ash	48.8			48.8
	Flue Gas to AFGD	0.213		0.911	0.796
Std Dev of Daily Closures, %					1.94
CONDENSER					
In	Inlet Water		*0.814*		*0.814*
Out	Outlet Water		*29.0*		*29.0*
Std Dev of Daily Closures, %					*48.5*
BOTTOM ASH SLUICE					
In	Bottom Ash	30.3			30.3
	Sluice Return		*0.00794*		*0.00794*
Out	Bottom Ash Sluice	30.3	0.0588		30.4
Std Dev of Daily Closures, %					0.00934
BOILER OVERALL BALANCE					
In	Coal	396			396
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00794*		*0.00794*
Out	Bottom Ash Sluice	30.3	0.0588		30.4
	ESP Hopper Ash	48.8			48.8
	Flue Gas to AFGD	0.213		0.911	0.796
Std Dev of Daily Closures, %					21.3

Italics indicate numbers derived from non-detectable concentrations.

Table 7-20A (Continued)
Bailly Mass Balance for Nickel
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.696		0.0896	0.682
	Unit 8 Flue Gas	0.213		0.911	0.796
Out	Flue Gas to AFGD	0.808		0.825	1.29
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.808		0.825	1.29
	Limestone	0.897			0.897
	Service Water		*0.0230*		*0.0230*
	Compressed Air				
Out	Stack Flue Gas	0.189		0.390	0.287
	Gypsum	120			120
	Wastewater		0.293		0.293
Std Dev of Daily Closures, %					490

Italics indicate numbers derived from non-detectable concentrations.

Table 7-21
Bailly Mass Balance for Selenium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	51.3			51.3
	Combustion Air				
	Makeup Water		0.0142		0.0142
Out	Flue Gas	48.3		62.2	110
	Bottom Ash	0.817			0.817
Average of Daily Closures, %					256
Closure of Average Flows, %					217
UNIT 8 ESP					
In	Flue Gas	48.3		62.2	110
Out	ESP Hopper Ash	11.7			11.7
	Flue Gas to AFGD	0.567		52.2	52.7
Average of Daily Closures, %					58.5
Closure of Average Flows, %					58.3
CONDENSER					
In	Inlet Water		*3.44*		*3.44*
Out	Outlet Water		*3.44*		*3.44*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	0.817			0.817
	Sluice Return		0.188		0.188
Out	Bottom Ash Sluice	0.817	0.259		1.08
Average of Daily Closures, %					115
Closure of Average Flows, %					107
BOILER OVERALL BALANCE					
In	Coal	51.3			51.3
	Combustion Air				
	Makeup Water		0.0142		0.0142
	Sluice Return		0.188		0.188
Out	Bottom Ash Sluice	0.817	0.259		1.08
	ESP Hopper Ash	11.7			11.7
	Flue Gas to AFGD	0.567		52.2	52.7
Average of Daily Closures, %					149
Closure of Average Flows, %					127

Italics indicate numbers derived from non-detectable concentrations.

Table 7-21 (Continued)
Bailly Mass Balance for Selenium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	11.9		45.0	56.9
	Unit 8 Flue Gas	0.567		52.2	52.7
Out	Flue Gas to AFGD	12.4		97.2	110
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	12.4		97.2	110
	Limestone	*0.339*			*0.339*
	Service Water		*0.109*		*0.109*
	Compressed Air				
Out	Stack Flue Gas	61.7		61.5	123
	Gypsum	37.9			37.9
	Wastewater		2.86		2.86
Average of Daily Closures, %					161
Closure of Average Flows, %					149

Italics indicate numbers derived from non-detectable concentrations.

Table 7-21A
Bailly Mass Balance for Selenium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	32.4			32.4
	Combustion Air				
	Makeup Water		0.0125		0.0125
Out	Flue Gas	7.50		19.4	18.5
	Bottom Ash	0.416			0.416
Std Dev of Daily Closures, %					92.5
UNIT 8 ESP					
In	Flue Gas	7.50		19.4	18.5
Out	ESP Hopper Ash	1.83			1.83
	Flue Gas to AFGD	0.164		15.8	15.7
Std Dev of Daily Closures, %					11.3
CONDENSER					
In	Inlet Water		*0.0488*		*0.0488*
Out	Outlet Water		*0.0488*		*0.0488*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	0.416			0.416
	Sluice Return		0.0768		0.0768
Out	Bottom Ash Sluice	0.416	0.167		0.385
Std Dev of Daily Closures, %					31.5
BOILER OVERALL BALANCE					
In	Coal	32.4			32.4
	Combustion Air				
	Makeup Water		0.0125		0.0125
	Sluice Return		0.0768		0.0768
Out	Bottom Ash Sluice	0.416	0.167		0.385
	ESP Hopper Ash	1.83			1.83
	Flue Gas to AFGD	0.164		15.8	15.7
Std Dev of Daily Closures, %					61.4

Italics indicate numbers derived from non-detectable concentrations.

Table 7-21A (Continued)
Bailly Mass Balance for Selenium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	10.1		28.8	31.9
	Unit 8 Flue Gas	0.164		15.8	15.7
Out	Flue Gas to AFGD	10.0		38.0	44.0
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	10.0		38.0	44.0
	Limestone	*0.00614*			*0.00614*
	Service Water		*0.145*		*0.145*
	Compressed Air				
Out	Stack Flue Gas	28.4		42.5	62.7
	Gypsum	2.17			2.17
	Wastewater		0.271		0.271
Std Dev of Daily Closures, %					62.1

Italics indicate numbers derived from non-detectable concentrations.

Table 7-22
Bailly Mass Balance for Vanadium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	1860			1860
	Combustion Air				
	Makeup Water		*0.00625*		*0.00625*
Out	Flue Gas	699		0.775	700
	Bottom Ash	869			869
Average of Daily Closures, %					86.2
Closure of Average Flows, %					84.5
UNIT 8 ESP					
In	Flue Gas	699		0.775	700
Out	ESP Hopper Ash	833			833
	Flue Gas to AFGD	1.20		0.0512	1.25
Average of Daily Closures, %					120
Closure of Average Flows, %					119
CONDENSER					
In	Inlet Water		*17.2*		*17.2*
Out	Outlet Water		*17.2*		*17.2*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	869			869
	Sluice Return		*0.0409*		*0.0409*
Out	Bottom Ash Sluice	869	*0.0409*		869
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	1860			1860
	Combustion Air				
	Makeup Water		*0.00625*		*0.00625*
	Sluice Return		*0.0409*		*0.0409*
Out	Bottom Ash Sluice	869	*0.0409*		869
	ESP Hopper Ash	833			833
	Flue Gas to AFGD	1.20		0.0512	1.25
Average of Daily Closures, %					93.5
Closure of Average Flows, %					91.7

Italics indicate numbers derived from non-detectable concentrations.

Table 7-22 (Continued)
Bailly Mass Balance for Vanadium
Average of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	6.30		0.0418	6.34
	Unit 8 Flue Gas	1.20		0.0512	1.25
Out	Flue Gas to AFGD	7.50		0.0930	7.59
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	7.50		0.0930	7.59
	Limestone	24.6			24.6
	Service Water		*0.130*		*0.130*
	Compressed Air				
Out	Stack Flue Gas	1.73		*0.0253*	1.76
	Gypsum	19.2			19.2
	Wastewater		0.112		0.112
Average of Daily Closures, %					64.9
Closure of Average Flows, %					65.0

Italics indicate numbers derived from non-detectable concentrations.

Table 7-22A
Bailly Mass Balance for Vanadium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	317			317
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
Out	Flue Gas	80.5		0.753	81.3
	Bottom Ash	116			116
Std Dev of Daily Closures, %					18.4
UNIT 8 ESP					
In	Flue Gas	80.5		0.753	81.3
Out	ESP Hopper Ash	23.5			23.5
	Flue Gas to AFGD	0.224		0.0227	0.224
Std Dev of Daily Closures, %					11.6
CONDENSER					
In	Inlet Water		*0.244*		*0.244*
Out	Outlet Water		*0.244*		*0.244*
Std Dev of Daily Closures, %					*0.00*
BOTTOM ASH SLUICE					
In	Bottom Ash	116			116
	Sluice Return		*0.00238*		*0.00238*
Out	Bottom Ash Sluice	116	*0.00238*		116
Std Dev of Daily Closures, %					0.00
BOILER OVERALL BALANCE					
In	Coal	317			317
	Combustion Air				
	Makeup Water		*0.00*		*0.00*
	Sluice Return		*0.00238*		*0.00238*
Out	Bottom Ash Sluice	116	*0.00238*		116
	ESP Hopper Ash	23.5			23.5
	Flue Gas to AFGD	0.224		0.0227	0.224
Std Dev of Daily Closures, %					17.6

Italics indicate numbers derived from non-detectable concentrations.

Table 7-22A (Continued)
Bailly Mass Balance for Vanadium
Std Dev of 9/3, 9/4, 9/5/93

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	1.08		0.0321	1.11
	Unit 8 Flue Gas	0.224		0.0227	0.224
Out	Flue Gas to AFGD	0.998		0.0140	1.01
Std Dev of Daily Closures, %					0.00
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.998		0.0140	1.01
	Limestone	0.440			0.440
	Service Water		*0.00253*		*0.00253*
	Compressed Air				
Out	Stack Flue Gas	0.422		*0.0121*	0.417
	Gypsum	2.15			2.15
	Wastewater		0.0181		0.0181
Std Dev of Daily Closures, %					5.33

Italics indicate numbers derived from non-detectable concentrations.

Table 7-23
Baily Average Mass Balance Closures

Element	Symbol	Unit 8 Boiler	Unit 8 ESP	Bottom Ash Sluice	U8 Boiler Overall	Condenser	Flue Gas Mixing	AFGD Overall
Antimony	Sb	66.7	375	107	169	*100*	*100*	103
Arsenic	As	69.7	132	158	91.9	*100*	100	436
Barium	Ba	97.4	136	100.0	106	103	100	61.6
Beryllium	Be	77.1	107	100	60.0	*100*	100	1260
Boron	B	65.1	122	100	76.3	*0.348*	100	126
Cadmium	Cd	64.4	115	100	71.3	*567*	100	23.6
Chromium	Cr	78.9	105	100	60.7	*100*	100	2750
Cobalt	Co	116	127	100	130	*73.3*	100	*94.1*
Copper	Cu	107	122	100.0	120	130	100	26.4
Lead	Pb	141	110	100	151	*100*	100	*56.8*
Manganese	Mn	105	111	100.0	108	*34.2*	*100*	95.6
Mercury	Hg	29.2	116	*102*	31.3	119	100	162
Mercury (BR)	Hg	54.8	120	*102*	65.2	119	100	99.7
Molybdenum	Mo	76.8	108	*102*	65.3	*100*	100	795
Nickel	Ni	72.3	106	100	74.9	*128*	100	760
Selenium	Se	256	56.5	115	149	*100*	100	161
Vanadium	V	86.2	120	100	93.5	*100*	100	64.9
Iron	Fe	93.3	101	100	93.6	*100*	100	101
Aluminum	Al	96.2	101	100	96.5	*70.0*	100	197
Titanium	Ti	99.7	101	100	100	*100*	100	163
Calcium	Ca	105	118	100	109	137	100	101
Magnesium	Mg	99.2	110	100	102	99.6	100	90.1
Total		90.3	120	100	100	100	100.0	95.1
Ash		101	100	100	101	NA	100	120
Carbon		98.8	104	100	103	NA	100	98.4

Italics represent numbers heavily influenced by non-detectable concentrations.

Table 7-23A
Baily Std Dev of Daily Mass Balance Closures

Element	Symbol	Unit 8 Boiler	Unit 8 ESP	Bottom Ash Sluice	U8 Boiler Overall	Condenser	Flue Gas Mixing	AFGD Overall
Antimony	Sb	26.4	206	3.09	48.3	*0.00*	0.00	98.6
Arsenic	As	23.3	3.48	53.5	29.3	*0.00*	0.00	74.9
Barium	Ba	5.81	38.6	0.0238	5.13	6.65	0.00	14.2
Beryllium	Be	12.1	7.13	0.0178	14.9	*0.00*	0.00	241
Boron	B	13.5	22.6	0.00	3.43	*0.0667*	0.00	50.4
Cadmium	Cd	29.5	8.49	0.504	31.6	*484*	0.00	4.34
Chromium	Cr	14.8	5.97	0.00	16.4	*0.00*	0.00	2840
Cobalt	Co	10.6	11.6	0.139	5.30	*46.2*	0.00	*32.9*
Copper	Cu	24.3	19.6	0.0647	16.2	78.0	0.00	24.9
Lead	Pb	44.8	10.7	0.335	33.2	*0.00*	0.00	*7.03*
Manganese	Mn	6.61	15.9	0.00899	3.97	*12.1*	*0.00*	1.05
Mercury	Hg	13.4	32.2	*26.2*	6.07	92.8	0.00	4.86
Mercury (BR)	Hg	7.94	7.37	*26.2*	5.46	92.8	0.00	17.3
Molybdenum	Mo	21.0	15.4	*4.22*	24.0	*0.00*	0.00	543
Nickel	Ni	19.9	1.94	0.00934	21.3	*48.5*	0.00	490
Selenium	Se	92.5	11.3	31.5	61.4	*0.00*	0.00	62.1
Vanadium	V	18.4	11.6	0.00	17.6	*0.00*	0.00	5.33
Iron	Fe	3.48	6.44	0.00169	3.31	*0.00*	0.00	19.6
Aluminum	Al	1.96	8.29	0.00126	3.68	*52.0*	0.00	73.0
Titanium	Ti	1.71	7.60	0.00	1.93	*0.00*	0.00	46.9
Calcium	Ca	24.6	18.8	0.0846	25.5	50.9	0.00	0.0356
Magnesium	Mg	4.65	4.43	0.0259	4.90	7.34	0.00	3.07
Total		3.71	7.36	0.00	0.0834	0.00	0.00	2.08
Ash		1.04	0.00	0.00	1.04	NA	0.00	1.61
Carbon		2.38	4.80	0.00	2.32	NA	0.00	2.81

Italics represent numbers heavily influenced by non-detectable concentrations.

Table 7-23B
AFGD Closures from Two Data Sources

Elements	Closure %	
	SRI analysis[a]	Galbraith analysis
Antimony	65	134
Arsenic	426	47
Barium	81	86
Beryllium	1220	123
Boron	128	91
Cadmium	67	90
Chromium	2850	98
Cobalt	88	135
Copper	26	47
Lead	56	73
Manganese	96	142
Mercury	182	132
Molybdenum	735	50
Nickel	777	125
Selenium	149	135
Vanadium	65	82

[a] Data from the last line of entries in Tables 7-6 through 7-22, which are based on averages of daily flows. (They are not the averages of closures for each three days, which are found in Table 7-23.)

[b] Data equivalent to those in the second column, except that flows of limestone and are based on the results at Galbraith (see page 6-64).

7.2 Efficiencies of Removal of Trace Species

There are two direct ways for expressing the efficiency of removal of trace species from the Bailly investigation:

- Removal within the Unit 8 ESP. This is based on the direct comparison of concentrations expressed in $\mu g/Nm^3$ or ppmv (either at constant, 3% O_2) at the inlet and the outlet of the ESP.

- Removal within the scrubber. This is based on a comparison of a weighted average of the concentrations at the outlets of the Units 7 and 8 ESPs and the stack. Weighting takes into account the relative gas volume fraction and the species concentrations in the two outlet ducts. The volume fraction for Unit 7 is approximately 0.33 and that for Unit 8 is approximately 0.67. It will be understood that the removal of fly ash in the scrubber may not be equal to the net removal of particulate matter, because the entrainment of scrubber solids, such as gypsum, and the condensation of sulfuric acid vapor within the scrubber will make the net removal less than the removal of incoming fly ash.

It is also possible to compute an approximate efficiency of ash removal across the Unit 7 ESP. The two units burned the same coal and have the same type of boiler. The uncertainty about Unit 7 is the carryover of coal ash to fly ash at the ESP inlet. It seems reasonable to use the inlet concentration observed at Unit 8 as the value at Unit 7. Even if the actual concentration of inlet ash in Unit 7 were just 75% of that at Unit 8, the error in the ESP efficiency would not change proportionally. If, for example, the removal efficiency were stated to be 99.00% with an inlet concentration of 4.0 g/Nm^3, the efficiency would change only to 98.67% if the inlet concentration were corrected to 3.0.

7.2.1 Metals

The efficiencies of removal of metals across the two ESPs and the scrubber are listed in Tables 7-24, 7-25, and 7-26. The value for the Unit 7 ESP is based on an assumed equality of metal concentrations at the inlet of two ESPs each sampling day. The efficiencies were calculated from the blank-corrected data with no effort to mask irregularities. The anomalies thus entered in the table are commented on in the following paragraphs.

The equation used to calculate efficiencies of the two ESPs is of the following simple form:

Efficiency = 100[1 - (ESP outlet concn.)/(ESP inlet concn.)]

Table 7-24
Efficiencies of Metal Removal in the Unit 8 ESP
(Data in %)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Antimony	99.86	100.23	99.83	99.97	0.22
Arsenic	98.64	98.26	98.33	98.41	0.20
Barium	99.60	99.72	99.77	99.70	0.09
Beryllium	99.90	99.88	100.00	99.92	0.07
Boron	36.86	-5.04	26.49	19.43	21.83
Cadmium	94.81	98.05	99.14	97.33	2.25
Cobalt	99.59	99.57	99.70	99.62	0.07
Chromium	99.97	100.33	100.10	100.14	0.18
Copper	99.72	99.49	99.72	99.64	0.13
Lead	99.43	99.70	99.90	99.68	0.24
Manganese	99.74	99.88	99.92	99.85	0.09
Mercury[a]	25.72 0.97	-5.50 -18.62	-20.34 2.36	-0.04 -5.10	23.52 11.73
Molybdenum	99.26	99.37	99.51	99.38	0.13
Nickel	99.15	99.55	99.66	99.45	0.27
Selenium	69.88	44.36	58.95	57.73	12.81
Vanadium	99.82	99.79	99.88	99.83	0.05
Aluminum	99.85	99.88	99.90	99.87	0.03
Calcium	97.46	97.51	97.51	97.50	0.03
Iron	99.85	99.90	99.92	99.89	0.04
Magnesium	99.72	99.68	99.68	99.69	0.02
Titanium	99.84	99.86	99.89	99.87	0.02

[a] The second line is based on data from the solid traps, which purportedly measure only vapor and thus should not show any ESP effect.

Table 7-25
Efficiencies of Metal Removal in the Unit 7 ESP
(Data in %)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Antimony	97.82	99.33	99.34	98.83	0.88
Arsenic	90.43	97.01	97.72	95.05	4.02
Barium	98.51	98.94	98.80	98.75	0.22
Beryllium	97.99	98.88	98.86	98.58	0.51
Boron	41.79	-7.67	28.27	20.80	25.57
Cadmium	90.20	95.34	95.80	93.78	3.11
Cobalt	98.05	98.45	98.38	98.29	0.21
Chromium	98.32	99.30	99.28	98.97	0.56
Copper	97.76	98.55	98.76	98.36	0.53
Lead	97.76	98.81	98.44	98.34	0.53
Manganese	99.00	99.42	99.26	99.22	0.22
Mercury[a]	28.47 13.63	-35.90 0.91	-9.72 10.11	-5.72 8.22	32.38 6.57
Molybdenum	97.16	97.95	98.07	97.72	0.49
Nickel	98.45	98.80	98.64	98.63	0.17
Selenium	60.62	-57.68	32.21	11.71	61.77
Vanadium	98.00	98.72	98.74	98.49	0.42
Aluminum	98.46	99.28	99.18	98.97	0.45
Calcium	97.42	96.62	96.90	96.98	0.41
Iron	98.72	99.11	98.95	98.93	0.20
Magnesium	98.88	99.04	98.96	98.96	0.08
Titanium	98.72	99.03	98.92	98.89	0.16

[a] The second line is based on data from the solid traps, which purportedly measure only vapor and thus should not show any ESP effect.

Table 7-26
Efficiencies of Metal Removal in the Scrubber
(Data in %)

	9/3/93	9/4/93	9/5/93	Average	Std.dev.
Antimony	-335.83	42.58	120.76	-57.50	244.24
Arsenic	10.75	78.39	85.64	58.26	41.31
Barium	88.11	90.61	88.82	89.18	1.29
Beryllium	81.51	84.60	100.00	88.70	9.91
Boron	92.55	91.41	89.53	91.16	1.52
Cadmium	91.60	90.94	87.90	90.15	1.97
Cobalt	78.13	76.92	82.83	79.30	3.12
Chromium	99.59	-21.40	104.76	60.98	71.41
Copper	49.20	83.75	77.39	70.11	18.39
Lead	78.20	84.01	84.85	82.35	3.62
Manganese	69.88	42.43	75.03	62.45	17.35
Mercury[a]	25.10 60.50	34.92 53.01	39.10 44.53	33.04 52.68	7.19 7.99
Molybdenum	47.88	45.77	56.09	49.92	5.45
Nickel	82.61	58.71	69.70	70.34	11.96
Selenium	-29.65	34.63	-52.01	-15.68	44.99
Vanadium	75.27	73.55	81.95	76.92	4.44
Aluminum	95.07	90.89	94.54	93.50	2.28
Calcium	77.20	74.65	78.43	76.76	1.93
Iron	90.70	87.19	92.90	90.26	2.88
Magnesium	38.51	31.38	40.33	36.74	4.73
Titanium	87.99	85.06	89.95	87.67	2.46

[a] The second line is based on data from the solid traps, and it presumed to show the scrubber effect more accurately.

The equation for the scrubber is more complex; it includes the measured flow rate of gas at each location:

$$\text{Efficiency} = 100C_SF_S/[C_7F_7 + C_8F_8]$$

where the C and F terms designate concentration and flow rate, respectively; the subscripts S, 7, and 8 indicate stack, Unit 7 outlet, and Unit 8 outlet.

Table 7-24 for the Unit 8 ESP shows four values that exceed 100%, three for daily values and one for an average. These are the results of relatively large errors in small numbers that make the outlet concentration negative (that is, the blank correction exceeds the value corrected). The consequence of this anomaly is that the efficiency is not defined; certainly, a conservative conclusion is that the efficiency is very close to 100%. There are three daily efficiencies and one average that are negative, signifying that the outlet concentration was higher than the inlet concentration as the result of errors in sampling or analysis. Not surprisingly, all of these anomalies are for elements that are largely in the vapor state and not well controlled in an ESP; the anomalies are for boron and mercury.

The data in Table 7-24 are based on Method 29. The results for mercury based on sampling with solid traps (Table 6-36) are also negative (- 5%).

The following is a summary of the averages of the efficiencies for the Unit 8 ESP (Table 7-24):

Efficiency range, %	Elements
<20	B, Hg
20-60	Se
60-98	Cd, Ca
98-99	As
99.0-99.9	Ba, Co, Cu, Pb, Mn, Mo, Ni, V, Al, Fe, Mg, Ti
>99.9	Sb, Be, Cr

Table 7-25 for Unit 7 ESP has the anomaly of negative efficiencies. Classification of the individual elements gives the following:

Efficiency range, %	Elements
<20	Hg, Se
20-60	B
60-98	As, Cd, Mo, Ca
98-99	Sb, Ba, Be, Co, Cr, Cu, Pb, Ni, V, Al, Fe, Mg, Ti
>99	Mn

Generally, the efficiencies in Unit 7 ESP are shifted to lower values from those seen in Unit 8 ESP. This shift follows that of total particulate removal efficiency: 98.7% for Unit 7 and 99.8% for Unit 8 (assuming the same inlet concentration at both ESPs).

The data in Table 7-26 suffer severely from the anomalies due to large relative errors in small numbers. Some of the conclusions that can nevertheless be drawn from these data are as follows:

- The average efficiency of removal of boron (largely in the vapor state and subject to absorption in the aqueous spray droplets in the scrubber) is 91% — one of the highest values, but not significantly different from efficiencies of removal of metals in the particulate state (barium and beryllium, for example).

- The average efficiency for mercury is listed as 33%. The data based on sampling with solid traps indicate that the value is nearer 50% (Table 6-62). The extent of mercury removal is believed to be controlled by the fraction in the oxidized (divalent) state.

- The efficiency for the third volatile metal, selenium, is not defined. The difficulty with this metal was previously discussed in Section 6.3.

- The efficiency for antimony is not defined.

- The efficiencies of the remaining metals can be classified by range, but the uncertainties of some of the data are clearly very large. An effort to interpret all of the differences on a rational basis can hardly be worthwhile. Nevertheless, the classification (including all metals except the two not defined) is as follows:

Efficiency range, %	Elements
<50	Hg, Mo, Mg
50-80	As, Co, Cr, Cu, Mn, Ni, V, Ca
80-90	Ba, Be, Pb, Ti
>90	B, Cd, Al, Fe

7.2.2 Anions and Acid Gases

Anions that are components of particulate matter are probably removed by the ESPs and scrubber about to the same degree as the particulate matter itself. This report contains very little data to support this assumption; whether it is precisely correct is of little consequence, however, because of the compelling evidence that except for phosphate the anions occur mainly in the gas phase as acid gases.

The control of the acid gases HF, HCl, and SO_2 in the ESPs is negligible (see Table 6-35). The control in the scrubber is very effective, on the other hand. The following data were previously given in Section 6.3.2:

Gas	Removal in scrubber, %
HF	98
HCl	99
SO_2	93

7.2.3 Organic Compounds

The data for organic compounds are not sufficiently definitive to justify any conclusion about their removal in either the ESPs or the scrubber.

7.3 Emission Factors

Emission factors were calculated from three items of information:

- Concentration of the species in the stack ($\mu g/Nm^3$)
- Flue gas production per unit mass of coal (Table 6-2 shows that the volume is, on the average, 0.008204 Nm^3 per gram of coal burned).
- Calorific value of the coal (Table 6-1 shows that the average value is 25809 J per gram of coal).

The emission factor for the unit concentration in the stack (1.0 $\mu g/Nm^3$) is thus calculated as follows:

$$1.0\ \mu g/Nm^3 \times 0.008204\ Nm^3/g \times 1\ g/25809\ g/J = 0.318 \times 10^{6}\ \mu g/J$$

or

$$1.0\ \mu g/Nm^3 = 0.318\ g/10^{12}\ J = 0.739\ lb/10^{12}\ Btu$$

The product of the second two terms in the above equation gives the value $0.318 \times 10^{6}\ m^3/J$. This value can be compared with the value based on coal feed rates and gas flow rate in the stack. The daily values are as follows:

September 3	$0.320 \times 10^{6}\ Nm^3/J$
September 4	$0.316 \times 10^{6}\ Nm^3/J$
September 5	$0.320 \times 10^{6}\ Nm^3/J$

Thus, the calculated volume of flue gas gives essentially the same ratio of gas volume to thermal energy as the recorded rate of coal consumption and the measured rate of gas flow in the stack.

As an example, mercury has an average stack concentration of 3.52 $\mu g/Nm^3$. Hence, the emission factor of this metal is 1.12 $g/10^{12}$ J or 2.60 $lb/10^{12}$ Btu. (This result is based on the analysis at Brooks Rand.)

The emission factors of the metals and anionic substances are given in Table 7-27. The uncertainty range given for each is the 95% confidence interval. This range is derived by use of the theory of error propagation (11). The uncertainty analysis is discussed in Appendix F.

Table 7-27
Emission Factors[a] Calculated from Stack Concentrations (Uncertainty, 95% confidence limits)

	g/10^{12} J	lb/10^{12} Btu
Antimony	0.121 ± 0.442	0.281 ± 1.03
Arsenic	0.455 ± 1.41	1.06 ± 3.28
Barium	0.544 ± 0.309	1.26 ± 0.716
Beryllium	<0.03	<0.07
Boron	391 ± 269	909 ± 625
Cadmium	0.181 ± 0.166	0.421 ± 0.386
Chromium	1.18 ± 0.48	2.73 ± 1.11
Cobalt	<0.03	<0.07
Copper	0.741 ± 1.20	1.72 ± 2.79
Lead	0.677 ± 0.956	1.57 ± 2.22
Manganese	1.32 ± 0.18	3.07 ± 0.42
Mercury[b]	0.890 ± 0.334 1.12 ± 0.07	2.07 ± 0.78 2.60 ± 0.16
Molybdenum	1.47 ± 0.28	3.41 ± 0.65
Nickel	0.928 ± 0.483	2.16 ± 1.07
Selenium	83.0 ± 106	193 ± 246
Vanadium	1.21 ± 0.71	2.81 ± 1.65
Aluminum	43.6 ± 15.9	101 ± 37
Calcium	196 ± 33	454 ± 76
Iron	89.6 ± 60.1	208 ± 140
Magnesium	36.9 ± 6.5	85.7 ± 15.0
Titanium	6.68 ± 2.62	15.5 ± 6.08
Fluoride	<180	<420
Chloride	440 ± 112	1020 ± 260
SO_2	170000 ± 74000	395000 ± 172000

[a] Based on stack concentration of analyte (μg/Nm^3), calculated volume of flue gas from unit mass of coal (Nm^3/g), and calorific value of coal (J/g).

[b] The first value for mercury is based on samples from Method 29. The second is based on sampling with solid traps.

8.0 SPECIAL TOPICS

8.1 Particulate and Vapor Phase Partitioning

The partitioning of a metal between the particulate and vapor phases can, in general, be a continuous process as the gas progresses from the boiler to the much lower temperatures at the stack. A gradual shift from the vapor state to the particulate state as the temperature decreases can be expected for two reasons: 1) the vapor pressure of any given species of a metal falls as the temperature falls, and thus condensation or adsorption ensues; 2) the chemical state of the metal will change, typically toward greater molecular complexity, and thus the tendency to change from the vapor state to the particulate state will be enhanced. An example of a metal shifting in species is mercury, which is most stable at the high temperatures in the boiler as the element (a highly volatile species, even at ambient temperature) but becomes increasingly more stable and less volatile as the compounds HgO and $HgCl_2$ at lower temperatures.

A comparison of trace metal concentrations in bottom ash and fly ash gives an indication of how partitioning between solid and gas occurs in the boiler. Table 6-6 in an earlier section of this report presented data making that comparison possible. The conclusions were as follows:

> Antimony, arsenic, beryllium, boron, cadmium, copper, lead, molybdenum, mercury, and selenium were present at higher concentrations in the ESP ash than in the bottom ash, as the presumed consequence of volatility at boiler temperatures, causing exit from the boiler in the gas phase but partial transfer to the particulate phase before the gas stream reached the ESP.
>
> Boron, mercury, and selenium were poorly recovered in the ESP ash, as the presumed occurrence in the gas phase even at the ESP temperature (about 150 °C).

A comparison of the specific metal concentrations in the ducts adjacent to the ESPs was given earlier, in Table 6-37. This table confirms the predominance of boron, mercury, and selenium in the vapor state and indicates that many or most of the other metals were in the vapor state at high temperatures upstream from the ESPs, because their concentrations in the units $\mu g/Nm^3$ increase sharply as particle size decreases.

A further comparison can be made by inspecting the data in the stack (Table 6-61). Here the trends toward increasing specific concentration with decreasing particle size break down because each of the volatile metals is appreciably absorbed in the scrubber.

8.2 Plume Simulation Dilution Sampling

8.2.1 SRI Condensibles Air Dilution Train

Sampling both without dilution and with dilution was performed at the Unit 7 ESP outlet. Sampling with dilution lowers both the flue gas concentrations and the gas temperature, thus simulating the two important changes that occur in the plume as stack gas emerges into the atmosphere. These processes will cause condensation of certain vaporous substances or, alternatively, may cause adsorption of these substances on pre-existing particulate matter. The net effect, whether there is homogeneous or heterogeneous condensation, is the transfer of vapors to particulate of small particle size.

Sulfuric acid vapor is the primary condensible substance in flue gas other than water vapor. If flue gas exits a stack at a typical temperature, 150 °C, it may contain up to 75 ppm of H_2SO_4 vapor; when the gas is cooled, however, the vapor will essentially disappear and the corresponding amount of acid will be found as a fine aerosol mist. There is also evidence that certain metal vapors will condense and be concentrated on small aerosol particles. This has been demonstrated for As and Se, for example, with a dilution sampler of the type to be described in the following paragraphs. Certainly, this increase of metal concentrations on fine particulate matter in the plume from a stack is to be expected; there is compelling evidence that this phenomenon occurs before the gases reach the exit from the stack, while the flue gas is being cooled on passage from the boiler to the base of the stack. A continuation and amplification of the process in the plume must occur. The corresponding condensation of certain organic matter is to be expected also.

During the last 15 years, SRI developed several sampling trains incorporating dilution and cooling for purposes similar to those of present concern. The most recent dilution train was developed for widespread measurement of condensibles; it is called the CADT (Condensibles Air Dilution Train). It is illustrated in Figure 8-1. It was designed and built for EPA under the scenario that in-stack total particulate matter (or PM_{10}) is a material separate from condensibles. For condensibles measurement with the CADT, process gas is conveyed to the dilution chamber through an in-stack filter, Method 5 probe, and heated sample flow-measuring orifice. Process gas is diluted in rapid mixing with filtered, cooled ambient air to obtain a final gas mixture near 20 °C. A residence time of 2 to 3 sec, sufficient for condensation, is provided prior to collection of condensed particulate matter on a quartz filter, 150 mm in diameter. Tests indicated that condensation on walls of the dilution chamber is low (<10%). The criteria of practical operation and precise measurements, which are needed for formal emission measurement methodology, were of primary concern in design of the CADT. Although losses of particulate passing through the CADT have not been specifically measured, it is believed that particles smaller than 5 μm would reach the condensibles filter with high efficiency and that this size fraction is the more important. Details of CADT operation are given in the following paragraphs.

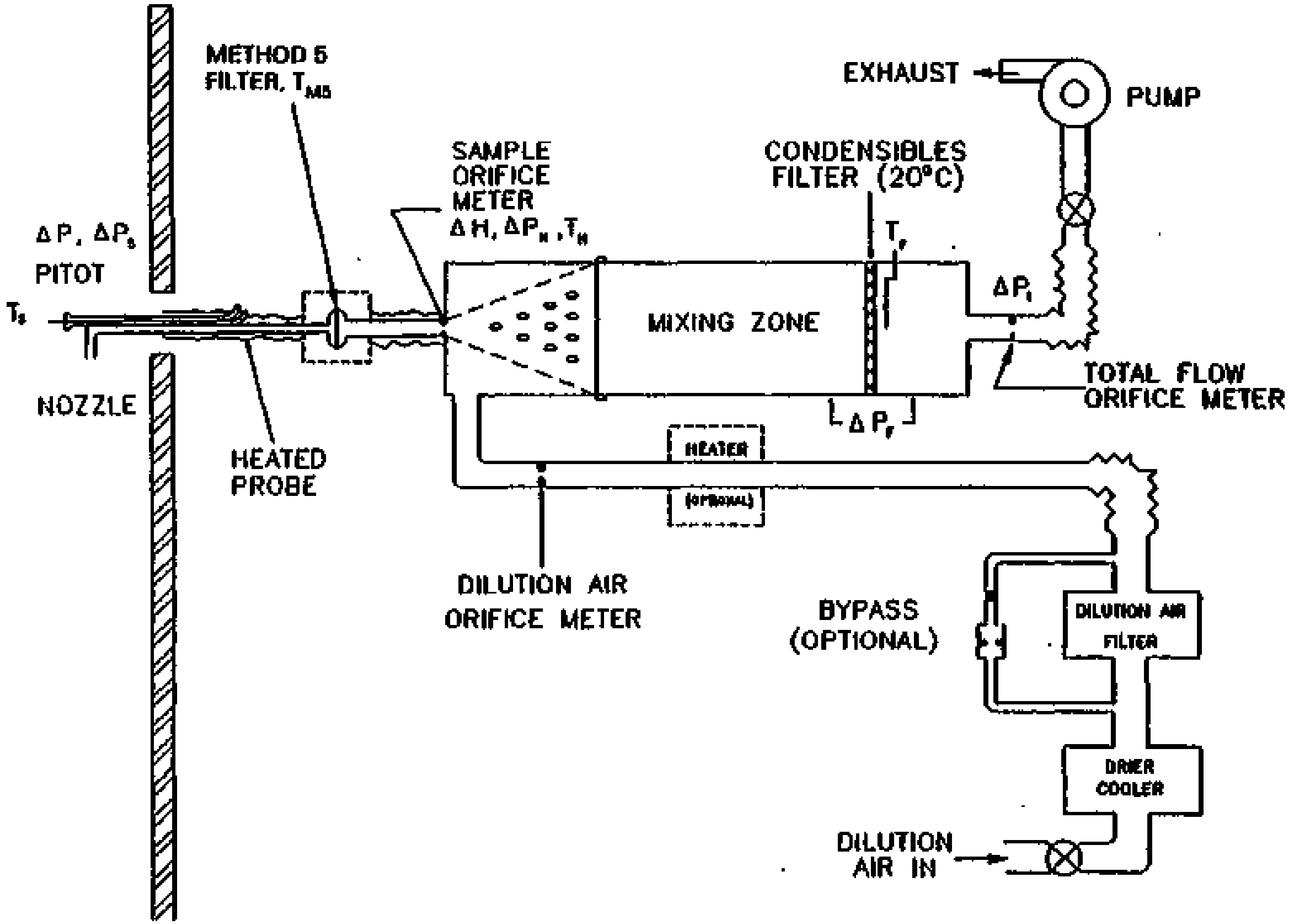


Figure 8-1. Schematic of Condensibles Air Dilution Train

Description and operation of the CADT

The condensible air dilution train is illustrated in Figure 8-1. The portion of the sampling train from the nozzle up to and including the Method 5 filter is identical to the Method 5 train. The in-stack portion may be replaced by probes specified for Method 17 or the Constant Sampling Rate (CSR) approach for PM_{10}. Sample flow and dilution air flow are established by the pump at the exhaust end of the CADT and regulated with valves in the dilution air inlet and the exhaust branches. Sample gas is passed to the sample orifice meter through a heated glass tube. The sample orifice meter is located at the apex of the perforated diluter cone where dilution gas is injected to rapidly mix with the sample gas. The diluted sample then passes through the mixing zone to the filter for condensibles where condensed particulate matter is collected. Gas passing this filter then passes through the total flow orifice meter and flow control valves before being exhausted through the pump.

The sample orifice meter, diluter cone, the housing of the cone, and all internal surfaces downstream to the diluter exit are coated with Teflon. The sample orifice meter is fabricated from stainless steel, and all components of the diluter are fabricated from aluminum. The overall weight of the diluter cylinder is about 15 kg, its length is 85 cm, and the outside diameter, including flanges and insulation, is 23 cm.

The dilution air consists of ambient air conditioned by cooling in an ice bath condenser, passing through a column of silica gel, passing through a bed of activated charcoal, and being filtered through an absolute filter. The temperature of the dilution air must be controlled at less than 20 °C to obtain the desired temperature of the total diluted gas (sample gas and dilution air). Insulation of the dilution air conduit serves to prevent overheating of the dilution air during warm weather. A heater is included on the dilution air conduit to warm the dilution air in cold weather. The purpose of the bypass around the dilution air filter in the illustration is to permit passage of a small fraction of particles from the ambient air to pass into the diluter if needed as condensation nuclei.

Dilution factor and flow rates

While the dilution approach is attractive conceptually because it simulates a source/ambient interface more nearly than other approaches, its major procedural advantage is that sufficient dilution prevents condensation of large quantities of water vapor from the stack gas. For a specified sampling rate, the amount of dilution is limited by sizes and costs of the train components that are reasonable. The gas flow rate of the cyclone identified for PM_{10} measurements is limited to about 0.5 scfm to obtain a particle cut size at 10 μm, and limiting the sampling rate with a Method 5 train to less than about 0.5 scfm is reasonable. Pumps with a loaded capacity of 10 scfm (which is about 20 times the PM_{10} flow rate value) are practical for source sampling. These factors led to selection of 20 for the maximum volume dilution factor. This dilution factor is high enough to avoid condensation of water for moisture contents up to 35%, higher than moisture contents of most sources including many with wet scrubbers. At Bailly we selected a target dilution factor of 10, giving sample and total diluted gas flow rates for the CADT of 0.5 and 5 scfm, respectively. This dilution factor was selected to maximize the detection limits for the analytes without severely compromising the effect of dilution cooling on condensation or causing problems from the condensation of moisture.

Dilution and mixing zone

The geometry of the diluter cone is a 50% scale-up of one used extensively to extract flue gas for measurement of size distribution. The 82 dilution air jets are designed for high, small-scale turbulence and low net swirl to produce a flat velocity distribution at the cone exit. The length of the cone is 23 cm, and its exit diameter is 15.2 cm. The inside diameter of the mixing zone is 15.2 cm, and its length is 48.9 cm. The primary criterion for selecting these dimensions was to provide residence time in the range 1.5 to 2 sec, previously recommended by the literature survey performed by McCain and Williamson of our staff (12), at a total diluted gas flow rate of 10 scfm.

Sample orifice meter (sample gas flow rate and volume)

The sample gas temperature from the probe up to and including the orifice disc of the sample orifice meter is maintained at 120 °C to prevent condensation of moisture in the sample gas. The orifice meter serves the same purpose as that used in Method 5, the monitoring of sample flow rate required to maintain isokinetic sampling. In addition, it serves the purpose of the dry gas meter in Method 5; the total sample gas volume is measured at this point, before dilution of the sample. Calibration of the orifice meter is performed in the same manner as in Method 5 (with a wet test meter installed upstream of the orifice meter and a leak check to verify that gas flow through the wet test meter and orifice meter is the same). Sample gas volume is measured in the CADT through digital electronic integration of the signal from a differential pressure transducer across the orifice.

8.2.2 Plume Simulation Dilution Sampling at Bailly

The CADT was operated to collect samples at the outlet of the Unit 7 ESP each day. Particles larger than about 8 µm were removed by means of a cyclone mounted at the inlet end of the probe to minimize/prevent possible fouling of the sample flow-metering orifice. Multiple gas trains were used behind the filter for parallel sampling each day. Two of the trains were identical — for metals on the days of inorganic sampling and for semi-volatile organics and dioxins/furans on the one day of organic sampling. The third sampler on the inorganics days consisted of solid sorbents for mercury, and the fourth collected acid gases. There were only two gas samples on the organics day, for the purpose already indicated.

Several sample components were recovered each day. Different types of analytes were determined on the basis of the following components:

- Metals. The quantity in the particulate fraction was a composite of the amounts found in three fractions: 1) probe rinse, 2) filter, and 3) dilution chamber rinse. The combined amounts in the three fractions were assumed to be all of the particulate matter in the total gas volume. The original concentration of each metal in the duct was calculated by correcting the total gas volume through the three sampling elements first for the dilution factor and then for the actual O_2 level in the duct. Thus, the concentration was expressed in μg/Nm^3.

The quantities of each vapor collected in the two impinger trains were consolidated and expressed as an original duct concentration by using the combined sample volumes, corrected as described above.

- Calculation of duct concentrations of the acid gases was based only on the amounts collected in the impinger train.
- Calculation of mercury vapor in the duct was based on the amounts in the solid traps behind the filter.
- Organic compounds were pooled and expressed as duct concentrations as described for metals.

The approximate dilution factor in the collection of all the samples was 10:1. The gas volume from the duct was approximately 5 m^3; the total including dilution air was thus about 50 m^3. The gas was cooled in the dilution chamber to approximately 20-25 °C in each experiment.

8.2.3 Analytical Results for Diluter Samples

The main question to be considered is whether simulated plume dilution changed the distribution of trace substances between the particulate and vapor states. One other question that potentially can be addressed is whether dilution changed the distribution of mercury in different species.

Certain types of species were sampled at the stack with and without the diluter. Those sampled both ways were trace metals at large (Method 29), mercury with iodated carbon traps, acid gases, semi-volatile organics, and dioxins and furans. Those not sampled with dilution were ammonia, hydrogen cyanide, aldehydes, and volatile organics.

8.2.3.1 Trace Metals

Tables 8-1, 8-2, and 8-3 present the results of daily measurements of trace metals at the stack with the simulated plume diluter used in a modification of Method 29. The data presented for dilution sampling have been corrected for dilution to show the original duct concentrations. The data from previous tables that give the concentrations observed with direct sampling (that is, without dilution) are also included in these tables. Thus, concentrations in each state (particulate or vapor) and as the total can be compared.

Consider first the question of whether the three volatile metals give evidence of condensing with cooling and dilution. The question has to be answered by considering not the total concentrations but the proportions of particulate and vapor concentrations. (The lack of agreement between total concentrations with and without dilution makes the comparison of total concentrations of little use.) For boron, there was strong evidence of vapor condensation or adsorption on particulate matter; without dilution, over 99% of the boron was in the vapor state, whereas with dilution only 33% was in the vapor state. For mercury, dilution reduced the vapor percentage from a value in excess of 99% to just 39%. For selenium, the reduction in percent vapor was from 80% to 14%. The percentages cited are averages from three days of sampling; there is considerable spread in the individual values, but even so the data are consistent from day to day in showing the effects described.

The data from mercury vapor sampling with solid traps permits consideration of the question of the effect of cooling and dilution on the proportions of mercury in the divalent and elemental species. The vapor data (concentrations in $\mu g/Nm^3$) are presented below in a summary that includes particulate data from Tables 8-1, 8-2, and 8-3:

	Sept. 3	Sept. 4	Sept. 5
Direct sampling			
Particulate	0.03	0.05	0.08
Vapor			
Hg(II)	–	4.91	4.88
Hg(0)	–	2.73	1.43
Total	8.84	7.69	6.39
Dilution sampling			
Particulate	2.97	4.72	7.78
Vapor			
Hg(II)	–	2.41	2.79
Hg(0)	–	2.79	2.29
Total	11.91	9.98	12.86

Percentages of vapor in the divalent state on the two days when vapor speciation was accomplished were 64 and 77% with direct sampling or 46 and 55% with dilution sampling. Thus, for the vapor alone, there was a minor shift from the divalent state to the elemental state. The appropriate interpretation of the data is made indefinite, however, by the lack of agreement between the total concentrations with and without dilution. Perhaps the most reasonable interpretation is to point to the large increase in the particulate mercury with dilution as a consequence of a net shift toward the divalent state rather than the elemental state. If, as seems reasonable, the total concentration of divalent mercury is taken to be the sum of the particulate mercury and the divalent mercury in the vapor state, the percentages in the divalent state are 64 and 68% with direct sampling and 71 and 78% with dilution sampling.

8.2.3.2 Acid Gases

Table 8-4 compares the observed concentrations of the acid gases HF, HCl, and SO_2 (in ppmv at 3% O_2 for the duct, before dilution).

The data indicate that the only likely effect of dilution and sampling was a reduction in the concentration of HCl. The average HCl concentration decreased from 72.2 ppmv with direct sampling to 53.4 ppmv with dilution sampling. The question to be considered is whether the loss of HCl was due to condensation or adsorption. This question can be considered by attempting to assign a value to the dew point of a gaseous mixture of HCl and water vapor: would 75 ppmv of HCl and 9% water vapor (the approximate concentrations in the duct) reach the dew point on being diluted 1:10 and cooled to 20-25 °C, with air containing about 1% water vapor (dew point 40 °F)? Unpublished work by the author does not address this question specifically, but it indicates that the answer is very likely no. The loss of HCl, therefore, is more likely due to adsorption.

8.2.3.3 Organic Compounds

No clear-cut effect on either semi-volatile compounds or dioxins and furans could be detected. The possible presence of semi-volatiles was obscured by contaminants, as elsewhere in the system. The dioxins and furans were reduced to even lower concentrations than those present in the duct; they were undetectable after dilution.

Table 8-1
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP from Dilution Sampling (September 3, 1993)
(Comparison with undiluted metals at the same location; data in $\mu g/Nm^3$)
(All data by Method 29)

	Particulate	Vapor	Total
	w/Diln (w/o Diln)	w/Diln (w/o Diln)	w/Diln (w/o Diln)
Trace metals			
Antimony	0.67 (0.43)	<0.04 (0.14)	0.89 (0.56)
Arsenic	25.4 (7.72)	3.07 (4.41)	28.4 (12.1)
Barium	46.3 (22.2)	3.83 (2.13)	50.2 (24.3)
Beryllium	1.79 (1.77)	<0.02 (<0.02)	1.80 (1.78)
Boron	12010 (62.3)	6530 (10900)	18540 (11000)
Cadmium	6.03 (8.84)	0.05 (3.64)	6.08 (12.5)
Chromium	36.8 (29.9)	2.43 (2.26)	39.2 (32.1)
Cobalt	6.85 (2.66)	0.47 (0.14)	7.32 (2.80)
Copper	18.6 (15.5)	3.16 (1.64)	21.8 (17.1)
Lead	23.8 (28.2)	<0.10 (0.76)	23.8 (29.0)
Manganese	11.6 (10.2)	<0.80 (<0.80)	12.0 (11.0)
Mercury*	2.97 (0.03)	0.64/3.09 (0.83/3.08)	6.70 (3.94)
Molybdenum	20.9 (16.3)	<0.40 (<0.40)	21.1 (16.5)
Nickel	16.7 (8.68)	0.76 (1.18)	17.5 (9.86)
Selenium	165 (11.5)	46.5 (135)	212 (146)
Vanadium	42.7 (43.2)	0.28 (0.45)	42.9 (43.7)
Major metals			
Aluminum	4080 (7010)	260 (249)	4340 (7260)
Calcium	980 (744)	1840 (1640)	2820 (2380)
Iron	6180 (8120)	160 (166)	6340 (8280)
Magnesium	234 (277)	64.3 (57.2)	298 (334)
Titanium	356 (425)	10.9 (11.3)	367 (436)

*The column for vapor gives separate data from peroxide and permanganate impingers.

Table 8-2
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP from Dilution Sampling (September 4, 1993)
(Comparison with undiluted metals at the same location; data in μg/Nm³)
(All data here by Method 29)

	Particulate	Vapor	Total
	w/Diln (w/o Diln)	w/Diln (w/o Diln)	w/Diln (w/o Diln)
Trace metals			
Antimony	0.68 (0.25)	<0.04 (<0.04)	0.70 (0.27)
Arsenic	15.3 (3.07)	0.35 (0.88)	15.7 (3.95)
Barium	52.4 (17.0)	3.26 (2.57)	55.7 (19.5)
Beryllium	1.22 (1.08)	<0.02 (<0.02)	1.23 (1.09)
Boron	13508 (38.0)	5590 (14900)	19098 (14900)
Cadmium	3.13 (4.11)	<0.10 (3.23)	3.18 (7.33)
Chromium	30.4 (17.8)	3.53 (2.89)	34.0 (20.7)
Cobalt	2.27 (1.52)	<0.20 (<0.20)	2.37 (1.62)
Copper	17.4 (10.8)	3.79 (2.73)	21.2 (13.5)
Lead	17.47 (20.1)	<0.50 (<0.50)	17.7 (20.3)
Manganese	14.4 (6.61)	<0.80 (<0.80)	14.8 (7.01)
Mercury[a]	4.72 (0.05)	0.66/1.94 (1.98/2.97)	7.32 (5.00)
Molybdenum	22.0 (14.9)	<0.40 (<0.40)	22.2 (15.1)
Nickel	11.4 (1.56)	0.99 (1.96)	12.4 (3.52)
Selenium	473 (71.0)	113 (482)	586 (553)
Vanadium	35.6 (33.1)	0.11 (0.10)	35.7 (33.2)
Major metals			
Aluminum	3480 (3190)	298 (287)	3780 (3480)
Calcium	760 (754)	2240 (2380)	3010 (3130)
Iron	5170 (5500)	162 (92.9)	5330 (5590)
Magnesium	180 (223)	80.8 (77.9)	261 (300)
Titanium	286 (334)	12.6 (12.0)	299 (346)

[a] The column for vapor gives separate data from peroxide and permanganate impingers.

Table 8-3
Metal Concentrations in the Gas Stream at the Outlet of the Unit 7 ESP from Dilution Sampling (September 5, 1993)
(Comparison with undiluted metals at the same location; data in µg/Nm³)
(All data here by Method 29)

	Particulate	Vapor	Total
	w/Diln (w/o Diln)	w/Diln (w/o Diln)	w/Diln (w/o Diln)
Trace metals			
Antimony	0.63 (0.43)	<0.04 (0.03)	0.65 (0.46)
Arsenic	11.6 (2.58)	0.14 (0.54)	11.7 (3.12)
Barium	42.0 (24.8)	3.66 (2.61)	45.7 (27.4)
Beryllium	0.87 (1.27)	<0.02 (<0.02)	0.88 (1.28)
Boron	12075 (51.0)	6656 (13900)	18732 (13900)
Cadmium	2.71 (6.59)	<0.10 (1.97)	2.76 (8.56)
Chromium	26.3 (27.6)	4.82 (2.90)	31.1 (30.5)
Cobalt	0.79 (1.77)	<0.20 (<0.20)	0.89 (1.87)
Copper	11.7 (13.8)	3.58 (0.79)	15.3 (14.6)
Lead	12.1 (21.0)	<0.50 (<0.50)	12.3 (21.2)
Manganese	6.03 (9.36)	<0.80 (<0.80)	6.43 (9.76)
Mercury[a]	7.68 (0.08)	0.67/1.84 (1.38/2.22)	10.2 (3.68)
Molybdenum	17.8 (19.0)	<0.40 (<0.40)	18.0 (19.2)
Nickel	8.36 (8.51)	3.11 (2.30)	11.5 (10.8)
Selenium	508 (134)	9.4 (206)	517 (340)
Vanadium	25.9 (36.8)	0.03 (0.19)	25.9 (37.0)
Major metals			
Aluminum	2410 (3780)	292 (258)	2700 (4040)
Calcium	560 (1010)	2140 (2250)	2700 (3260)
Iron	3010 (6570)	128 (143)	3130 (6720)
Magnesium	119 (282.0)	97.0 (69.2)	215 (351)
Titanium	198 (384)	12.7 (11.0)	210 (395)

[a] The column for vapor gives separate data from peroxide and permanganate impingers.

Table 8-4
Anion and Corresponding Acid Gas Concentrations at the Outlet of the Unit 7 ESP from Dilution Sampling
(Comparison with undiluted metals at the same location; data in $\mu g/Nm^3$)

	September 3, 1993 w/Diln (w/o Diln)	September 4, 1993 w/Diln (w/o Diln)	September 5, 1993 w/Diln (w/o Diln)
Anions - $\mu g/Nm^3$			
Fluoride	10,400 (12,400)	11,100 (14,600)	13,600 (11,800)
Chloride	66,100 (86,600)	78,800 (127,000)	91,500 (106,000)
Sulfate	11.05×10^6 (10.60×10^6)	9.50×10^6 (11.40×10^6)	10.3×10^6 (11.00×10^6)
Phosphate	<9400 (<10,800)	<8300 (<11,300)	<8500 (<11,300)
Acid gases - ppmv			
HF	13.1 (15.7)	14.1 (18.5)	17.2 (16.4)
HCl	44.8 (58.7)	53.4 (86.0)	62.0 (71.9)
SO_2	2760 (2650)	2380 (2860)	2570 (2760)
H_3PO_4	<2.4 (<2.7)	<2.1 (<2.9)	<2.2 (<2.5)

8.3 Particle Size

8.3.1 Particle Mass versus Particle Size

Particle size distributions of the particulate matter suspended in the flue gases were measured *in-situ* using cascade impactors at the ESP outlet locations and stack and series (cascade) cyclones at the ESP inlet location. A University of Washington (Pilat) Mark V/III impactor was used with an SRI/EPA right angle precollector at the ESP outlets and stack to provide data in seven size fractions with separation diameters ranging from 0.19 μm to 9.5 μm. SRI/EPA Five Series Cyclones were used at the Unit 8 ESP inlet to provide data in six size fractions with separation diameters ranging from 1.06 μm to 10.3 μm.

Results of the size distribution measurements are shown in Figures 8-2, 8-3, 8-4, and 8-5 in the conventional cumulative percentage of mass concentration contributed by particles smaller than the indicated diameter. The data are shown on an aerodynamic diameter basis - one in which the actual particle behaves in air as though it were a unit density sphere of the indicated size. The physical size of the particle may differ from the aerodynamic size because of its shape and/or density. The extrapolations to sizes larger than the first stage D_{50} and smaller than the last stage D_{50} were obtained by means of cubic splines with forced continuity in slope and value and subject to the conditions that there is zero accumulated concentration at some minimum diameter (0.01 μm in this case) and no further accumulation at sizes greater than some maximum diameter (1000 μm in this case) as described in "Procedures Manual for the Recommended ARB Particle Size Distribution Method (Cascade Impactors)" (13).

The result of series cyclone measurements at the Unit 8 ESP inlet is presented in Figure 8-2. The solid line in this figure represents the average result for the three runs and the broken lines show the 90% confidence limits for the average based on the scatter in the data from the individual runs. Figure 8-3 presents the results of the particle size measurements made with a cascade impactor at the Unit 8 outlet (as only one sample was obtained, confidence limits cannot be shown). There was a reduction in mean diameter from ~20 μm to ~4 μm across the ESP. Figure 8-4 shows the size distribution measured with a cascade impactor at the outlet of the Unit 7 ESP. This distribution has a mean diameter of ~8 μm. The coarser distribution of particle sizes leaving the Unit 7 ESP than were measured leaving Unit 8 ESP is consistent with the higher mass emissions from the Unit 7 ESP. Figure 8-5 shows the average particle size distribution and associated 90% confidence intervals for triplicate cascade impactor measurements in the stack. The distribution has a mean size of ~0.55 μm. The fineness of this distribution is largely attributable to condensed acid droplets which we determined constituted about 75% of the total mass emissions.

The collection efficiency of the Unit 8 ESP as a function of particle size is shown in Figure 8-6. The figure shows the typical dependence on size that characterizes ESPs, and causes the shift in size distributions presented in Figures 8-2, and 8-3. Figure 8-7 is the ratio of outlet to inlet mass concentrations across the AFGD scrubber and across the Unit 8 ESP. The AFGD system inlet mass concentration was determined by combining the fractional mass flow rates from Units 7 and 8 weighted by the measured gas flow rates. This plot shows that acid vapor condensation affects the fractional penetration of submicron particles through the scrubber.

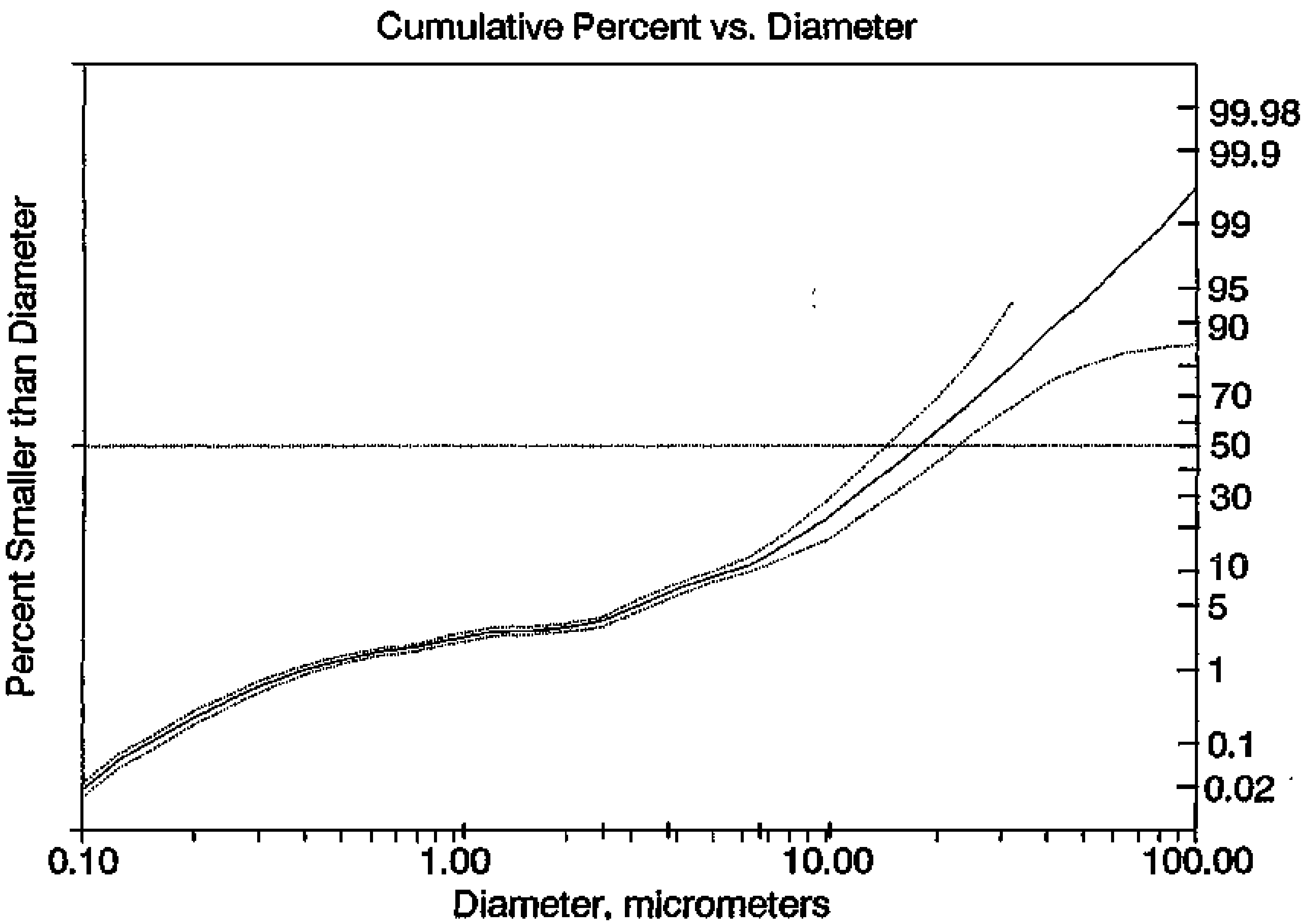


Figure 6-2. Particle Size Distribution (Aerodynamic Diameter Basis) of Fly Ash Entering the Unit 6 ESP as Measured by Series Cyclones. The Heavy Vertical Ticks Show the Approximate Fractionation Diameters.

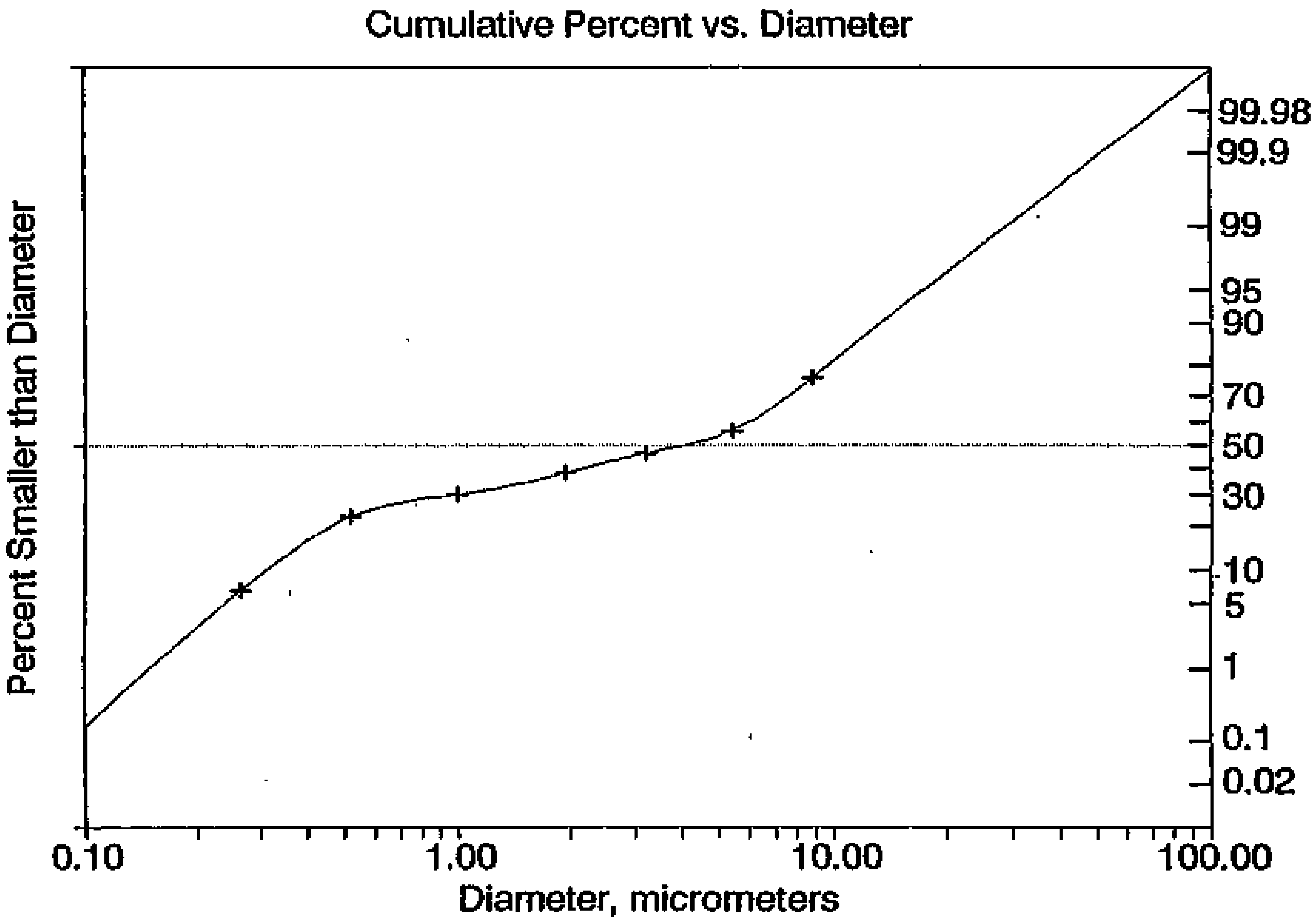


Figure 8-3. Particle Size Distribution of Fly Ash at the Unit 8 ESP Outlet as Measured by Cascade Impactor.

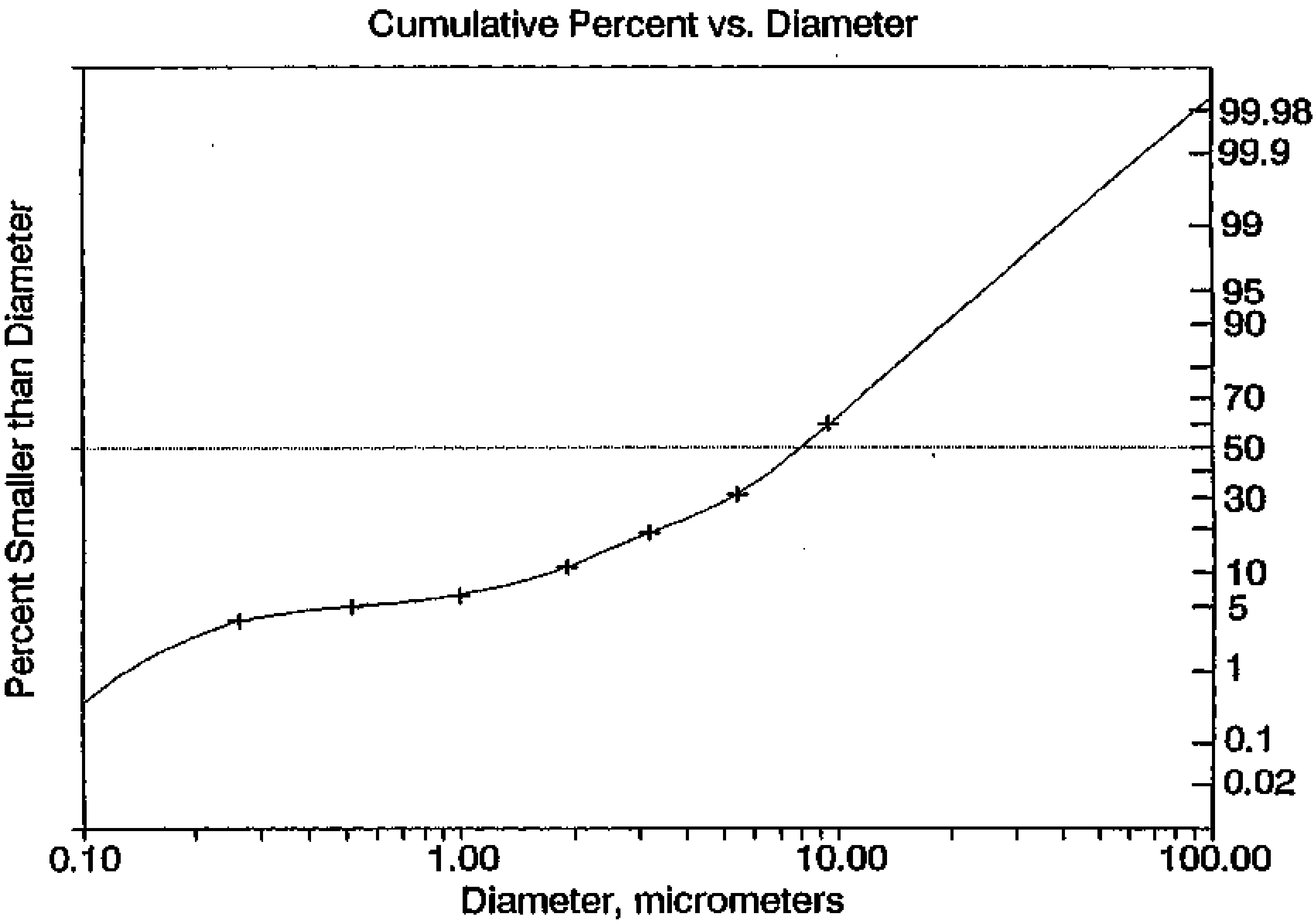


Figure 8-4. Particle Size Distribution of Fly Ash at the Unit 7 ESP Outlet as Measured by Cascade Impactor.

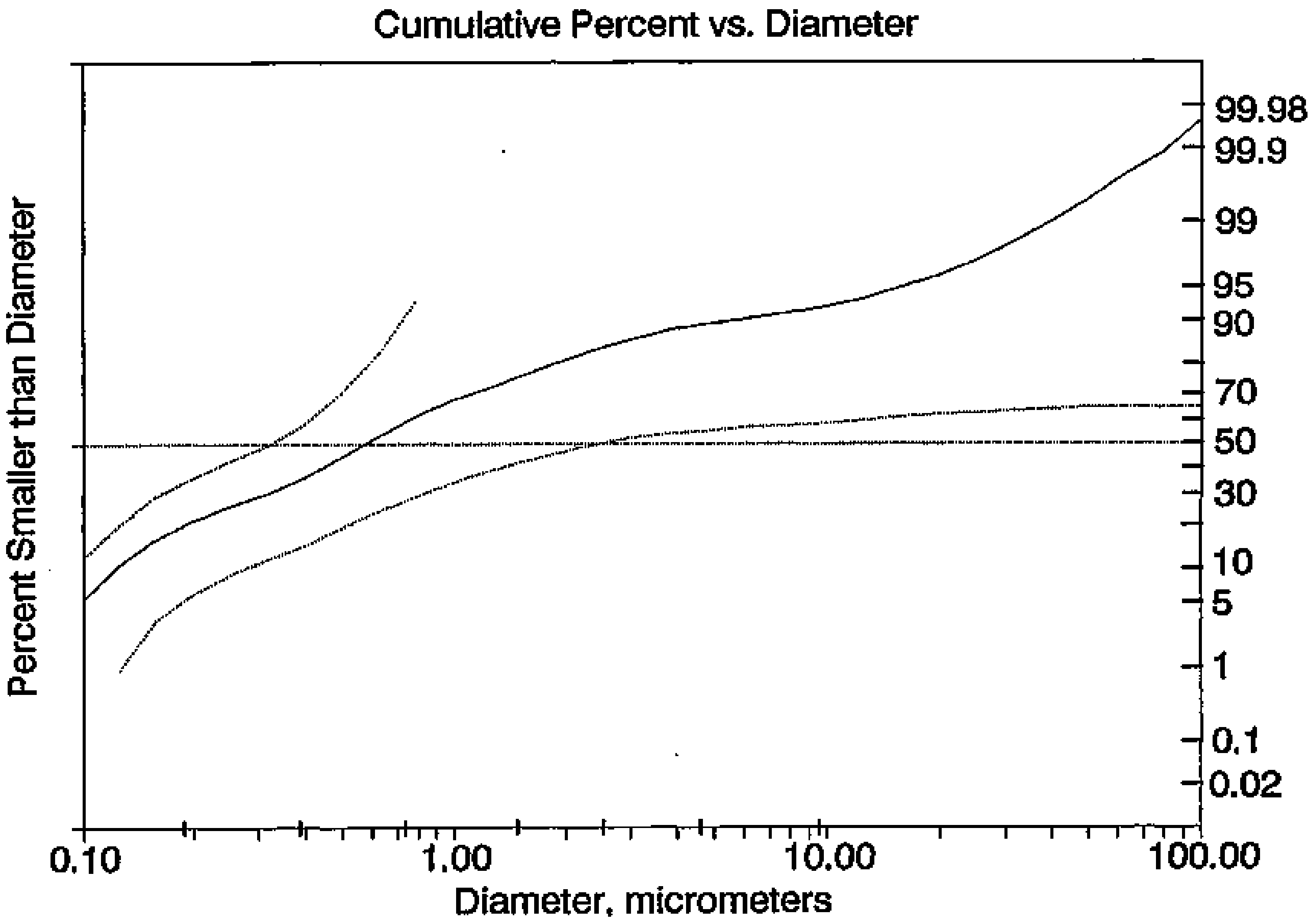


Figure 8-5. Particle Size Distribution (Aerodynamic Diameter Basis) of Fly Ash in the Stack as Measured by Cascade Impactor. The Heavy Vertical Ticks Show the Approximate Fractionation Diameters.

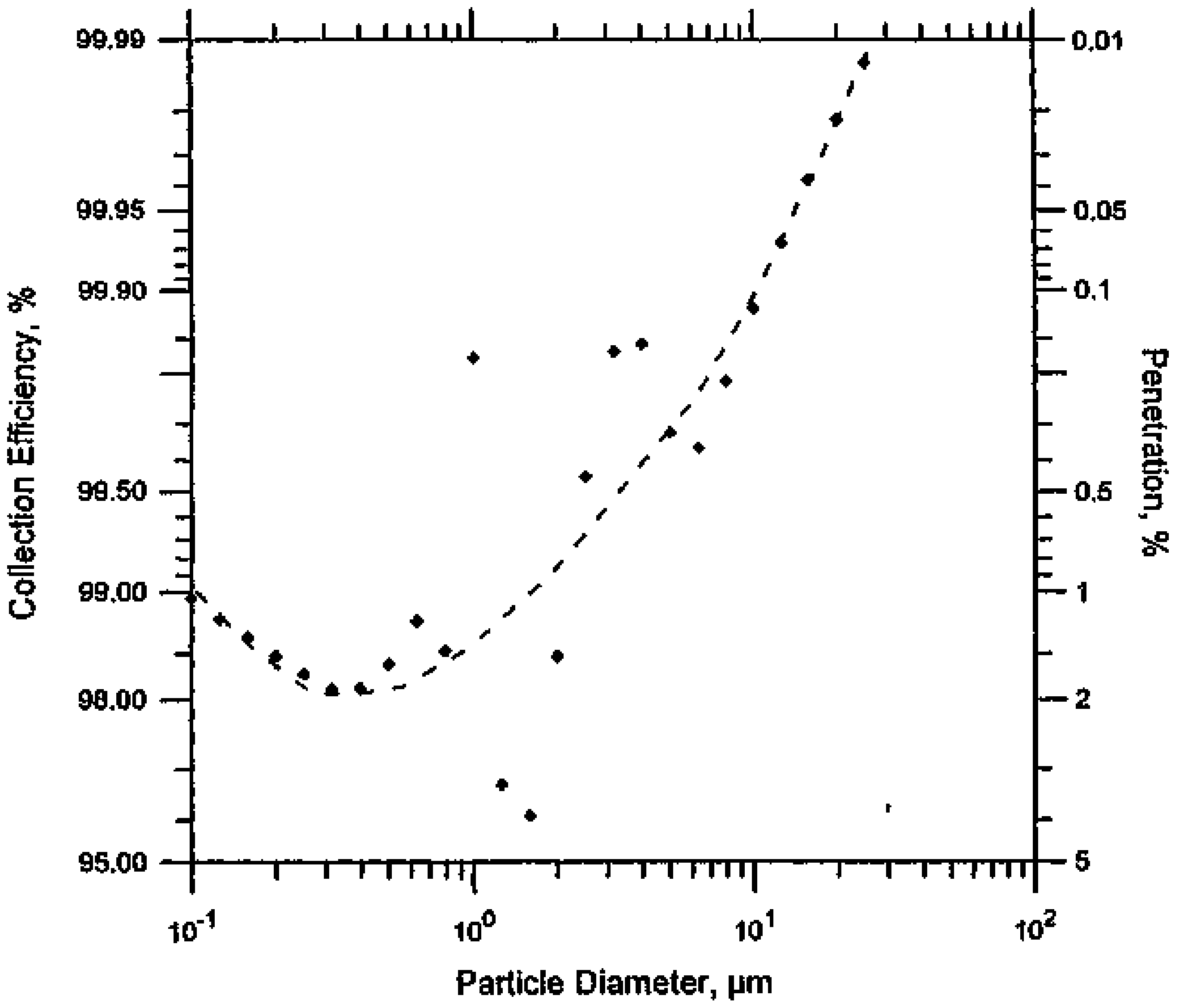


Figure 8-6. Fractional Collection Efficiency of the Unit 8 ESP.

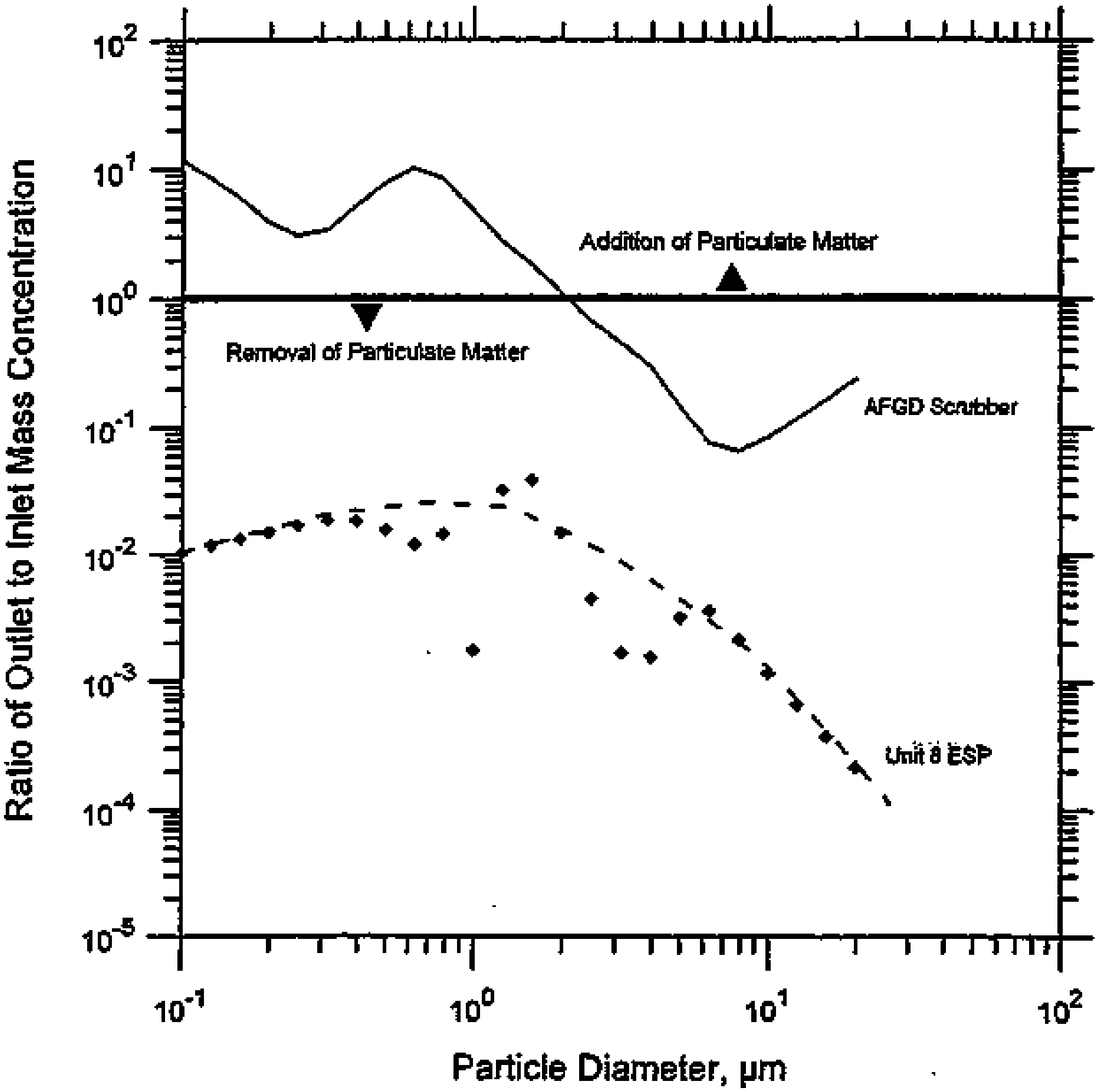


Figure 8-7. Ratio of Outlet to Inlet Mass Across the AFGD System and the Unit 8 ESP.

8.3.2 Concentrations of Trace Metals versus Particle Size

Tables 8-5 through 8-9 give metal concentrations as a function of ash particle size in samples collected from the entrained state with series cyclones. The top of each table presents the particle range and the percentage of the total particulate mass in that range. The first three tables present the results for samples collected at the inlet of the Unit 8 ESP; the last two tables give data for the outlets of the two ESPs.

The particles in the two larger size ranges were collected separately, in the first two cyclones of the series. For the Unit 8 inlet location, the particles in the finer size ranges, on the other hand, were collected in different size ranges in different cyclones and combined as a composite for analysis. For the ESP outlet locations the finer size ranges were all collected on a filter downstream of two cyclones. The last column in the tables gives the weighted average metal concentrations in the three size ranges.

The metals that do NOT show increasing concentrations with decreasing particle size are more the exception than the rule. The more notable exceptions to the rule of the inverse relationship between concentration and particle size in the data sets at the ESP inlet are found in one but not three of the data sets. There are more frequent exceptions to the rule in the outlet data, especially for the Unit 8 ESP. In this instance, the middle-size particles present most of the anomaly, but represent only a very small fraction of the total mass.

Table 8-10 compares, for the inlet of the Unit 8 ESP, the averages of the concentrations in the cyclone composites with the averages from the Method 29 filter. The concentrations of the trace metals agree remarkably well. Ironically, the concentrations of the major metals, which should be more easily established, do not agree as well.

Table 8-5
Metal Concentrations in Cyclone Fractions at the Inlet of the Unit 8 ESP on September 3, 1993
(Data in μg/g)

	Stage 1	Stage 2	Stage 3	Composite[a]
Particle size, µm	>10.3	6.7-10.3	<6.7	--
Mass, %	72.98	14.51	12.51	100.00
Trace metals, µg/g				
Antimony	4.70	10.0	40.1	9.90
Arsenic	14.7	25.4	92.4	26.00
Barium	360	407	462	380.00
Beryllium	15.3	20.4	7.74	34.4
Boron[b]	--	--	--	--
Cadmium	15.2	38.2	59.0	24.0
Chromium	233	450	1360	406
Cobalt	35.5	44.9	51.5	38.8
Copper	134	202	359	172
Lead	180	318	637	257
Manganese	212	221	281	222
Mercury	0.023	0.801	0.142	0.15
Molybdenum	55.7	172	820	168
Nickel	178	262	359	213
Selenium	3.70	10.7	73.3	13.4
Vanadium	354	615	147	532
Major metals, µg/g				
Aluminum	52600	58400	59500	54300
Calcium	10500	16800	20800	12700
Iron	65600	73900	91500	70000
Magnesium	3210	5980	6430	4010
Titanium	3350	8120	10900	4980

[a] Computed as the sum of individual products of decimal fraction times concentration (µg/g).

[b] No data available for boron. See Table 8-6.

Table 8-6
Metal Concentrations in Cyclone Fractions at the Inlet of the Unit 8 ESP on September 4, 1993
(Data in μg/g)

	Stage 1	Stage 2	Stage 3	Composite[a]
Particle size, µm	>10.2	6.6-10.2	<6.6	–
Mass, %	74.25	13.22	12.53	100.00
Trace metals, µg/g				
Antimony	5.22	9.04	43.2	10.5
Arsenic	11.7	20.6	85.5	22.1
Barium	335	347	427	348
Beryllium	15.1	18.34	32.8	17.8
Boron	499	730	1670	676
Cadmium	14.9	32.9	65.2	23.6
Chromium	219	380	1280	373
Cobalt	33.2	37.9	55.0	36.6
Copper	140	173	342	170
Lead	156	286	722	244
Manganese	213	208	278	220
Mercury	0.023	0.117	0.004	0.03
Molybdenum	49.9	121	711	142
Nickel	172	225	354	202
Selenium	5.13	9.99	82.3	15.4
Vanadium	350	530	1350	499
Major metals, µg/g				
Aluminum	50800	55600	94800	57000
Calcium	9500	6050	19300	10300
Iron	66400	67000	152000	77200
Magnesium	5650	5750	6670	5790
Titanium	6500	7530	11300	7240

[a] Computed as the sum of individual products of decimal fraction times concentration (µg/g).

Table 8-7
Metal Concentrations in Cyclone Fractions at the Inlet of the Unit 8 ESP on September 5, 1993
(Data in μg/g)

	Stage 1	Stage 2	Stage 3	Composite[a]
Particle size, µm	>10.2	6.6-10.2	<6.6	--
Mass, %	76.60	12.68	10.71	99.99
Trace metals, µg/g				
Antimony	6.84	13.3	37.0	10.9
Arsenic	18.0	32.5	196	38.9
Barium	357	402	457	373
Beryllium	15.5	22.1	36.0	18.6
Boron[b]	--	--	--	--
Cadmium	26.7	16.7	80	31.1
Chromium	258	584	1470	430
Cobalt	32.7	46.6	59.3	37.3
Copper	172	256	397	207
Lead	154	339	737	240
Manganese	222	226	277	228
Mercury	0.017	0.069	0.049	0.03
Molybdenum	73.1	223	844	175
Nickel	221	352	519	270
Selenium	5.54	11.4	47.0	10.7
Vanadium	400	704	1450	551
Major metals, µg/g				
Aluminum	49200	54300	97200	55500
Calcium	11100	15800	20300	12700
Iron	62100	71300	143000	71900
Magnesium	5960	6250	6700	6070
Titanium	6400	8400	11300	7170

[a] Computed as the sum of individual products of decimal fraction times concentration (µg/g).
[b] No data available for boron. See Table 8-6.

Table 8-8
Metal Concentrations in Cyclone Fractions at the Unit 8 ESP Outlet on September 6, 1993
(Data in µg/g)

	Stage 1	Stage 2	Stage 3	Composite*
Particle size, µm	>9.1	5.5-9.1	<5.5	--
Mass, %	51.68	1.12	47.2	100.00
Trace metals, µg/g				
Antimony	10.7	<400	67.8	38.0
Arsenic	58.4	1320	249	149
Barium	172	1230	564	359
Beryllium	7.45	<10	27.7	17.1
Boron	--	--	--	--
Cadmium	109	308	104	107
Chromium	2150	88200	2120	2130
Cobalt	50.2	2020	46.3	48.3
Copper	142	3420	391	261
Lead	103	<50	658	368
Manganese	2250	7500	399	1370
Mercury	1.04	30.0	0.71	0.88
Molybdenum	113	<50	1570	807
Nickel	1560	78600	746	1170
Selenium	623	4660	592	609
Vanadium	219	870	1120	651
Major metals, µg/g				
Aluminum	40500	103000	41900	41200
Calcium	12400	6610	19800	15900
Iron	291000	312000	88800	195000
Magnesium	2960	11500	4790	3830
Titanium	3250	11900	6400	4752

*Stage 2 deleted from calculations because of suspected unreliable data from small sample.

Table 8-9
Metal Concentrations in Cyclone Fractions at the Unit 7 ESP Outlet on September 5, 1993
(Data in µg/g)

	Stage 1	Stage 2	Stage 3	Composite
Particle size, µm	>10.4	6.7-10.4	<6.7	--
Mass, %	45.42	16.51	38.07	100.00
Trace metals, µg/g				
Antimony	17.8	33.7	61	36.9
Arsenic	35.9	97.9	169	96.9
Barium	397	494	–[a]	>262
Beryllium	28.3	34.3	39.4	33.5
Boron	--	--	--	--
Cadmium	42.2	115	127	86.7
Chromium	503	984	2450	1320
Cobalt	51.2	65.0	60	56.8
Copper	258	308	373	310
Lead	381	539	1260	740
Manganese	377	277	282	325
Mercury	0.172	0.277	0.232	0.21
Molybdenum	245	390	1570	775
Nickel	345	673	634	509
Selenium	156	112	145	145
Vanadium	589	842	1260	887
Major metals, µg/g				
Aluminum	77900	55400	126000	92400
Calcium	17000	20700	18700	18200
Iron	755000	79900	261000	455000
Magnesium	4980	5910	5410	5300
Titanium	6370	8310	8820	7620

[a] Not reported.

Table 8-10
Comparison of Metal Concentrations at the Inlet of the Unit 8 ESP in Samples from the Method 29 Filter and the Series Cyclones
(Data in $\mu g/g$)

	M29 filter[a]	Cyclone composite[b]
Antimony	8.2	10.4
Arsenic	25.6	29.0
Barium	378	367
Beryllium	19.3	18.2
Boron	529	676
Cadmium	31.4	26.2
Chromium	411	403
Cobalt	37.7	37.6
Copper	187	183
Lead	285	247
Manganese	235	224
Mercury	0.053	0.070
Molybdenum	148	162
Nickel	244	228
Selenium	35.4	13.2
Vanadium	508	527
Aluminum	95300	55400
Calcium	18600	11900
Iron	127000	73100
Magnesium	6240	5290
Titanium	6990	6460

[a] From first data column of Table 6-25 (averages).
[b] From last columns of Tables 8-5, 8-6, and 8-7 (averages, except for the single value for boron).

8.4 Comparison of Method 29 and Carbon Traps for Mercury Measurements

Concentrations of mercury in the vapor state were determined on the filter and in the peroxide and permanganate impingers of Method 29 and the solid traps devised by Bloom (2). The data from the two methods are compared in Table 8-11.

One of the observations from this table is that the total mercury concentration in the gas stream at each location was usually lower when measured by Method 29. Another observation is that at duct locations preceding the stack the proportions as divalent and elemental mercury were essentially opposite by the two methods. This statement is based on the prevailing concept that the peroxide impingers of Method 29 should capture divalent mercury selectively, leaving only elemental mercury to be captured in the permanganate. One possible interpretation is that the retention of the divalent vapor in the peroxide was incomplete and the vapor that penetrated the peroxide was subsequently collected in the permanganate. This interpretation, however, is at variance with other studies that have shown excellent correlation between speciation results from the two methods.

The two methods do, however, seem in sensible agreement as to total mercury at the stack. They are also in agreement as to speciation at the stack, where both concur in showing evidence for nearly complete removal in the scrubber of the divalent vapor.

Table 8-11
Comparison of Mercury Concentrations from Two Sampling Trains

Method 29		Concentration, $\mu g/Nm^3$				% of Total
		9/3/93	9/4/93	9/5/93	Average	
Unit 8 ESP Inlet	Filter	0.30	0.25	0.25	0.27	6%
	H_2O_2/HNO_3	1.12	0.93	1.08	1.04	25%
	$KMnO_4$	4.09	2.50	2.02	2.87	69%
	TOTAL	5.51	3.68	3.35	4.18	
Unit 8 ESP Outlet	Filter	0.06	0.01	0.02	0.03	1%
	H_2O_2/HNO_3	0.91	1.15	1.63	1.23	31%
	$KMnO_4$	3.15	2.73	2.39	2.76	69%
	TOTAL	4.12	3.89	4.04	4.02	
Unit 7 ESP Outlet	Filter	0.03	0.05	0.08	0.05	1%
	H_2O_2/HNO_3	0.83	1.98	1.38	1.40	33%
	$KMnO_4$	3.08	2.97	2.23	2.76	66%
	TOTAL	3.94	5.00	3.69	4.21	
Stack	Filter		0.01	0.01	0.01	0%
	H_2O_2/HNO_3	0.14	0.16	0.13	0.14	5%
	$KMnO_4$	3.14	2.37	2.43	2.65	95%
	TOTAL	3.28	2.54	2.57	2.80	

Table 8-11 (Concluded)
Comparison of Mercury Concentrations from Two Sampling Trains

		Concentration, μg/Nm³				% of Total
		9/3/93	9/4/93	9/5/93	Average	
Solid traps[a]						
Unit 8 ESP Inlet	Hg(II)		5.19	4.79	4.99	62%
	Hg(0)		1.31	2.40	1.86	23%
	TOTAL	10.30	6.50	7.19	8.00	
Unit 8 ESP Outlet	Hg(II)		3.25	5.05	4.15	50%
	Hg(0)		4.46	1.97	3.22	39%
	TOTAL	10.20	7.71	7.02	8.31	
Unit 7 ESP Outlet	Hg(II)		4.91	4.88	4.90	65%
	Hg(0)		2.73	1.43	2.08	27%
	TOTAL	8.81	7.64	6.31	7.59	
Stack	Hg(II)		0.09	0.08	0.09	2%
	Hg(0)		3.50	3.42	3.46	98%
	TOTAL	3.48	3.59	3.50	3.52	

[a] On 9/3/93, only traps of iodated carbon were used, and only total mercury was determined.

Back [illegible]

9.0 REFERENCES

1. U.S. Environmental Protection Agency. Test Methods for Evaluating Solid Waste. EPA/SW-846, Third Edition, November 1986 (Revision 1, July 1992).

2. Nicolas S. Bloom. "Mercury Speciation in Flue Gases: Overcoming the Analytical Difficulties." Presented at Managing Hazardous Pollutants - State of the Art. Washington, D.C. Nov. 4-6, 1991.

3. W. Chow, "PISCES: Tracking Trace Chemicals in Power Plants." J. Air Waster Manage. Assoc. 40, 806 (1990).

4. Edward B. Dismukes. "Measurements of Air Toxics Emissions from a Coal-Fired Boiler Equipped with a Tangentially Fired Low NO_x Combustion System." Second Annual Clean Coal Technology Conference. September 7-9, 1993, Atlanta, GA.

5. J. T. Yeh, C. R. McCann, J. J. Demeter, and D. Bienstock. Removal of Toxic Trace Elements from Coal Combustion Effluent Gas, in Trace Contaminants from Coal. S. Torrey, editor. Noyes Publishing Corporation (1978).

6. Method 1311. Toxicity Characteristic Leaching Procedure. Federal Register 55, No. 61, p. 11863 (March 29, 1990).

7. U.S. Environmental Protection Agency. Methods Manual for Compliance with the BIF Regulations. EPA/530-SW-91-010. December 1990.

8. M. W. Weatherburn. Phenol-Hypochlorite Reaction for the Determination of Ammonia. Anal. Chem. 39, 971 (1967).

9. W. J. Dixon. "Processing Data for Outliers." Biometrics 9, No. 1, Appendix, p. 89 (1953).

10. M. W. Chase, Jr., C. A. Davies, J. R. Downey, Jr., D. J. Frurip, R. A. McDonald, and A. N. Syverud. JANAF Thermochemical Tables. Third Edition. American Chemical Society and the American Institute of Physics. New York, New York (1986).

11. American Society of Mechanical Engineers. Measurement Uncertainty. ANSI/ASME PTC 19.1-1985. United Engineering Center. New York, New York (1985).

12. J. D. McCain and Ashley D. Williamson. "A Review of Current Methods for Measuring Particulate Matter Including Condensables from Stationary Sources." EPA-600/12-88-765, U.S. Environmental Protection Agency, Research Triangle Park, NC. pp. 25 (1988).

13. J. D. McCain, et al. Procedures Manual for the Recommended ARB Particle Size Distribution Method (Cascade Impactors). Attachment 1 to the Final Report for ARB Contract A3-092-32. "Recommended Methodology for the Determination of Particle Size Distribution in Ducted Sources." May 1986 (NTIS PB 86-218666/WEP).

10.0 GLOSSARY

AAS	Atomic absorption spectroscopy
acfm	Actual cubic feet per minute
AFGD	Advanced Flue Gas Desulfurization (Pure Air scrubber for SO_2 at Bailly)
ALD	Aldehyde sampling train
Amm/HCN	Ammonia/hydrogen cyanide sampling train
ARP	Absorber recirculation pump
BP	Bleed pump
Btu	British thermal unit
CADT	Condensibles Air Dilution System (device for plume simulation)
CT&E	Commercial Testing & Engineering Company
CVAAS	Cold vapor atomic absorption spectroscopy
CVAFS	Cold vapor atomic fluorescence spectroscopy
D_{50}	Particle size at which an impactor stage retains 50% of the incoming sample and passes the balance
DIL	Dilution sampling train
DOE	Department of Energy
DNPH	2,4-Dinitrophenylhydrazine
DQO	Data Quality Objective
dscfm	Dry standard cubic feet per minute (at 273 K)
EPRI	Electric Power Research Institute
ESP	Electrostatic precipitator
FGD	Flue gas desulfurization
g	gram
GC/MS	Gas chromatography/mass spectroscopy

GFAAS	Graphite furnace atomic absorption spectroscopy
HAP	Hazardous air pollutant
HG	Mercury sampling train
HGAAS	Hydride generation atomic absorption spectroscopy
HPLC	High performance liquid chromatography
ICCT	Innovative Clean Coal Project
ICP	Inductively coupled argon plasma emission spectroscopy
J	Joule
lb	pound
LLD	lower limit of detection
m	meter
M2	EPA Method 2
M5	EPA Method 5
M5AT	EPA Method 5 train for acid gases
M5MMT	EPA Method 5 train for multiple metals
M17	EPA Method 17
M29	EPA Method 29
MACT	Maximum Available Control Technology
mg	milligram
ug	microgram
um	micrometer
MM5	Modified Method 5
MMD	Mass-median diameter
MMT	Multiple Metals Train
MW	Megawatt net

MWe	Megawatt electrical
ND	Not determined
NIPSCO	Northern Indiana Public Service Company
Nm^3	Normal cubic meter (dry gas volume adjusted to reference conditions of 293.15 K, 1 atm, 3% O_2) (This temperature and pressure are the values stipulated as standard conditions for reporting performance characteristics of stationary sources. See 40 CFR, Part 60, Subpart A, page 15, in 7/1/93 edition.)
NR	No result
PAH	Polycyclic aromatic hydrocarbon
PCDD	Perchlorinated dibenzodioxin
PCDF	Perchlorinated dibenzofuran
PETC	Pittsburgh Energy Technology Center
pg	picogram
PISCES	Power Plant Integrated Systems: Chemical Emission Studies
PM_{10}	Particles smaller than 10 um
ppbv	parts per billion by volume
ppmv	parts per million by volume
QA	Quality Assurance
QC	Quality Control
RTI	Research Triangle Institute
SIE	Specific Ion Electrode
SOP	Standard Operation Procedure
SRI	Southern Research Institute
SV	Semi-volatile (organic compound)
SVOC	Semi-volatile organic compounds
SW-846	Manual for the analysis of solid wastes (EPA; Reference 6)

TCLP	Toxicity characteristic leaching procedure
U of W Mk V	University of Washington Mark V impactors
UARG	Utility Air Regulatory Group
UV	Ultraviolet
VOST	Volatile Organic Sampling Train
XAD	Resin for adsorbing organic vapors

APPENDIX A

AUDITING

APPENDIX A1

ROUND ROBIN COAL ANALYSES

SRI participated in round robin analyses of coal samples administered by CONSOL, Inc. for DOE. We analyzed 17 coal samples in duplicate under the round robin. There were two samples from each of the eight plants being tested in the DOE air toxics assessment program, plus one reference coal. Analyses specified included proximate and ultimate, 10 major ash constituents, the 16 trace elements in the DOE program scope of work, and fluorine.

Results of the analyses of those two coal samples determined to be from Bailly are presented in the following tables. SRI was designated as Lab V in the CONSOL compilation of results; Lab V designation is used in the following tables. BRL stands for Brooks Rand, Ltd., which provided additional determinations of mercury under arrangement with SRI.

On a relative basis, the worst flaw in the SRI results was with antimony, the concentration of which was not really defined. For most of the metals, the SRI data were not at either extreme (high or low) in the results compiled by all five laboratories. The exceptions were SRI data showing the lowest concentrations of chromium, cobalt, and selenium and the highest concentrations of beryllium and vanadium.

Table A1-1
Round Robin Proximate and Ultimate Analytical Data on Baily Coal
(Data in wt% or Btu/lb for moisture-free coal)

	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
Ash	B	12.68	12.69	12.56	12.45	12.43
		12.54	12.72	12.53	12.55	12.48
	K	12.59	12.63	12.44	12.47	12.44
		12.38	12.6	12.49	12.46	12.62
Carbon	B	68.33	70.23	70.12	68.86	68.84
		67.79	70.07	69.95	68.82	68.78
	K	68.06	70.23	69.61	68.99	68.7
		81.55	70.02	69.21	68.92	68.93
Hydrogen	B	5.1	4.82	4.83	4.51	4.68
		5.29	4.84	4.81	4.56	4.68
	K	4.98	4.82	4.91	4.55	4.69
		4.6	4.87	4.9	4.53	4.7
Nitrogen	B	1.26	1.33	1.42	1.35	1.33
		1.23	1.44	1.4	1.3	1.27
	K	1.33	1.34	1.41	1.29	1.33
		1.35	1.32	1.36	1.35	1.26
Sulfur	B	3.63	3.43	3.46	3.48	3.51
		3.63	3.49	3.47	3.47	3.48
	K	4	3.4	3.51	3.48	3.44
		3.88	3.43	3.54	3.45	3.39
Chlorine	B	0.05	0.084	0.079	ND	0.1
		0.05	0.077	0.078	ND	0.12
	K	0.04	0.073	0.086	ND	0.07
		0.03	0.09	0.088	ND	0.07
Fluorine	B	<0.001	0.093	0.0090	ND	0.0073
		<0.001	0.092	0.0090	ND	0.0078
	K	0.000001	0.088	0.0080	ND	0.0056
		<0.001	0.089	0.0080	ND	0.0056
Calorific value	B	11900	12398	12376	12390	12350
		11480	12402	12367	12378	12321
	K	11326	12359	12391	12392	12384
		11013	12363	12411	12389	12388

Table A1-2
Round Robin Data on Metal Oxides in Ash from Bailly Coal
(Data in wt% for moisture-free coal)

	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
Na_2O	B	0.7	0.79	0.78	0.73	0.86
		0.71	0.79	0.7	ND	0.84
	K	0.7	0.77	0.8	0.77	0.92
		0.27	0.76	0.7	ND	0.82
K_2O	B	2.37	2.39	2.25	2.26	2.2
		2.19	2.38	2.22	ND	2.2
	K	2.19	2.36	1.71	1.95	2.2
		2.32	2.35	2.05	ND	2.2
MgO	B	0.3	1.09	0.77	ND	1.1
		0.36	1.1	0.77	ND	1.1
	K	0.3	1.09	0.74	ND	1.1
		0.26	1.09	0.81	ND	1.1
CaO	B	1.84	3.94	1.84	ND	3.6
		1.62	3.85	1.97	ND	3.3
	K	1.5	3.81	1.92	ND	3.5
		1.41	3.68	1.81	ND	3.5
Al_2O_3	B	18.59	19.41	18.28	19.05	19
		18.69	19.46	19.4	ND	18.9
	K	15.6	19.36	18.74	18.5	18.6
		17.43	19.39	17	ND	18.4
Fe_2O_3	B	16.42	17.97	16.7	ND	17.1
		16.5	17.83	16.42	ND	16.7
	K	14.17	19.07	1.74	ND	17.5
		15.59	18.9	1.59	ND	17.4
SiO_2	B	49.21	51.04	ND	50.95	49.2
		49.47	51.01	ND	ND	49.3
	K	46	51.78	ND	48.95	50.6
		46.73	51.75	ND	ND	51
TiO_2	B	1.01	1	0.86	0.96	0.8
		1	0.99	0.78	ND	0.8
	K	0.94	0.99	0.85	1.68	0.9
		0.98	0.98	0.71	ND	1

Table A1-2 Concluded
Round Robin Data on Metal Oxides in Ash from Baily Coal
(Data in wt% for moisture-free coal)

	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
P_2O_5	B	0.3	0.26	0.51	ND	0.43
		0.3	0.27	0.51	ND	0.3
	K	0.26	0.31	0.59	ND	0.39
		0.27	0.28	0.51	ND	0.32
SO_3	B	ND	1.94	ND	ND	3
		ND	1.96	ND	ND	3.2
	K	ND	1.87	ND	ND	3.56
		ND	1.86	ND	ND	3.54

Table A1-3
Round Robin Data on Major Metals in Baily Coal
(Data in wt% for moisture-free coal)[*]

Metal	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
Aluminum	B	1.23	1.29	1.21	1.26	1.26
		1.24	1.29	1.29	–	1.25
	K	1.04	1.28	1.24	1.23	1.23
		1.16	1.29	1.13	–	1.22
Calcium	B	0.165	0.353	0.165	ND	0.323
		0.145	0.345	0.177	ND	0.296
	K	0.134	0.341	0.172	ND	0.314
		0.126	0.330	0.162	ND	0.314
Iron	B	1.44	1.58	1.46	ND	1.50
		1.45	1.56	1.44	ND	1.96
	K	1.24	1.67	0.153	ND	1.59
		1.37	1.66	0.139	ND	1.53
Magnesium	B	0.023	0.082	0.058	ND	0.083
		0.027	0.083	0.058	ND	0.083
	K	0.023	0.082	0.056	ND	0.083
		0.020	0.082	0.061	ND	0.083
Titanium	B	0.076	0.075	0.065	0.072	0.060
		0.075	0.074	0.059	ND	0.060
	K	0.071	0.074	0.064	0.126	0.068
		0.074	0.074	0.053	ND	0.075

[*] Calculated from the average ash content calculated from Table A3-1 (12.54%) and the individual oxide concentrations the coal ash.

Table A1-4
Round Robin Data on Trace Metals in Bailly Coal[a]
(Data in μg/g for moisture-free coal)

Metal	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
Antimony	B	1.97	1.72	1.38	1	4.43
		0.99	1.72	1.63	1	3.22
	K	1.42	1.7	1.77	2	2.6
		1.97	1.73	1.55	1	ND
Arsenic	B	1.53	2.53	1	2	0.75
		1.65	2.57	1	ND	1.21
	K	1.75	2.48	1	1	2.3
		2.19	2.6	1	ND	2.4
Barium	B	95.36	404.6	402	250	365
		88.87	417.4	461	250	389
	K	82.08	397.2	495	230	385
		79.87	377.8	462	240	374
Beryllium	B	1.53	1.33	1.2	1	1.47
		1.21	1.4	1.2	1.3	1.39
	K	1.42	1.14	1.2	1.3	1.32
		1.42	1.16	1.4	1.1	1.35
Boron	B	95.36	87.94	86	82	60.7
		74.61	90.9	84	65	47.4
	K	89.74	75.17	80	82	45.2
		90.81	75.9	77	74	65.9
Cadmium	B	<0.06	0.01	<0.4	<0.6	0.036
		<0.06	<0.01	<0.4	<0.6	0.34
	K	<0.06	<0.1	<0.4	<0.6	0.018
		2.95	<0.1	<0.4	<0.6	ND
Chromium	B	10.96	12.89	10.2	9	7
		8.56	10.44	10	10	7.5
	K	10.84	9.42	10.8	10	7.6
		10.72	9.9	9.9	9	7.4
Cobalt	B	5.59	3.96	4.24	4	2.34
		4.83	4.07	4.38	4	2.38
	K	6.24	4.15	4.34	5	2.74
		6.24	4	3.97	3	3.41

Table A1-4 Concluded
Round Robin Data on Trace Metals in Bally Coal[a]
(Data in μg/g for moisture-free coal)

Metal	Coal	Lab I	Lab II	Lab III	Lab IV	Lab V
Copper	B	52.61	10.44	<40.5	10	14.1
		10.53	10.47	<42.9	10	14.7
	K	13.13	11.56	<39.2	11	13.7
		14.22	11.49	<35.7	10	13.4
Lead	B	6.25	10.02	12	10	6.1
		5.05	10.06	12	11	7.5
	K	7.33	9.45	11	10	6.72
		8.1	9.63	9	9	7
Manganese	B	54.81	99.5	73.9	77	76.3
		50.47	100.7	82.7	82	75.5
	K	51.44	90.6	82.5	87	77.1
		47.05	90.6	79.1	79	75.4
Mercury	B	<0.1	0.097	0.08	0.07	0.078
		<0.1	0.093	0.08	0.07	0.071
	K	<0.1	0.082	0.07	0.08	0.078
		0.16	0.089	0.08	0.08	0.077
Molybdenum	B	2.52	1.75	6.65	<6	0.429
		<2	1.73	5.92	<6	0.795
	K	2.96	1.68	<19.6	<8	0.488
		2.95	1.66	<17.8	<8	ND
Nickel	B	7.45	8.4	<15.2	6	6.4
		6.69	7.74	<16.1	4	6.4
	K	8.54	7.28	<14.7	5	5.9
		8.1	8.23	<13.4	6	7.3
Selenium	B	<0.6	1.62	1	2	1.07
		<0.6	1.84	1	ND	1.77
	K	1.2	1.59	1	<1	0.79
		1.03	1.72	1	ND	0.26
Vanadium	B	29.6	24.82	25	27	27
		24.14	25.52	26.8	29	27.9
	K	26.27	22.37	26.1	28	27
		27.35	23.81	21.6	26	26.1

[a] The data here are for dry coal and thus differ, in principle, from the data for the as-received coal presented in the body of the report.

APPENDIX A2

RESULTS OF AUDIT SPIKE ANALYSES

Tables A2-1 through A2-4 present the results of analyses of samples intended to contain only the spikes placed in the sampling media by the auditing team from Research Triangle Institute. The application of spikes was performed at the Bailly site on September 6, 1993. The spiked samples were subsequently analyzed as blind samples at SRI during the subsequent months; that is, the analysts were not aware that the samples were supposed to contain only the spikes applied by RTI. All of the spikes were in the four analyte classifications discussed; none of the spikes were dioxins or furans.

The amounts of analytes in the spikes were disclosed by DOE to SRI in a communication on December 17, 1993. Later, on July 26, 1994, Shrikant Kulkarni of RTI notified the SRI staff about an error in the amounts of the formaldehyde spikes in the DOE communication. The data in Table A2-2 are based on the corrections supplied by RTI.

<u>a. Metals</u>. Two filters, two impingers containing the peroxide sampling medium, and two impingers containing the permanganate sampling medium were spiked. The results from the SRI laboratory and the specified spike amounts are given in Table A1-1. The recoveries of the five metals applied as spikes are listed below; the answers to the question of whether or not the recoveries were in accord with the data quality objectives (DQO, 80-120% recovery) are also listed:

		Recovery	Satisfaction of DQO?
Arsenic	Filter 1	27%	No
	Filter 2	18%	No
	Impinger 1	85%	Yes
	Impinger 2	50%	No
Cadmium	Filter 1	116%	Yes
	Filter 2	115%	Yes
	Impinger 1	77%	No
	Impinger 2	76%	No
Lead	Filter 1	120%	Yes
	Filter 2	120%	Yes
	Impinger 1	76%	No
	Impinger 2	90%	Yes
Mercury	Impinger 1	142%	No
	Impinger 2	81%	Yes
Selenium	Filter 1	76%	No
	Filter 2	78%	No
	Impinger 1	69%	No
	Impinger 2	85%	Yes

In addition to the rather mediocre record of spike recovery, we also had several false positive results for metals that were detected even though they were not spikes from RTI. The data, it will be acknowledged, have not been corrected for blanks. Nevertheless, the possible effects of blank corrections have been considered carefully, and the considered judgment is that blank correction, although required for a rigorous data analysis, could not make a large change in the results. Correction would, in principle, lower the recoveries of actual spiked metals, but the magnitude of correction would be small.

b. Carbonyl compounds. Two pairs of DNPH impingers were spiked. The pertinent data are presented in Table A2-2. There was initially uncertainty about the actual amounts of formaldehyde, the only compound introduced by RTI, as indicated by the preceding discussion. The corrected data on these spikes indicated that the formaldehyde recoveries were 74 and 108%, which are reasonably consistent with the DQO — that is, recovery between 80 and 120%.

c. Volatile organic compounds. Three pairs of sampling tubes (Tenax and Tenax/charcoal) were used to collect analytes from a mixture supplied by RTI in a cylinder. Only one cylinder was provided, and sample volumes were near the same value each time. Consequently, the analyte amounts did not vary significantly.

The data for this group of compounds are given in Table A2-3 on three successive pages. The compounds listed were all of those detected or applied by RTI. The table shows that some false positive detections occurred, and three compounds in the spikes were never reported by the analysts because they were not in the group the SRI laboratory is programmed to detect and quantify. The table designates the compounds that met the DQO (recovery within the limits 50-150%). The score with respect to DQO is as follows:

	Detections within DQO limits	Detections outside DQ limits	Misses	False +
Audit 1	13	3	3	1
Audit 2	9	5	3	3
Audit 3	9	6	4	1

d. Semivolatile organic compounds. Two filters and two XAD cartridges were spiked with a single mixture which contained 16 polycyclic aromatic hydrocarbons. Table A2-4 lists the compounds and their amounts in the spiked sampling media; this table also lists the amounts found in the SRI analysis. Those data marked with asterisks conform to the DQO limits (recoveries of 20-150%).

Obviously, the analytical results for the XAD are much superior to the reported results for one of the filters. All 16 compounds were found in both resin samples, and all results satisfied the DQO. For the one spiked filter reported, 12 of the 16 compounds were detected, although three did not satisfy the DQO. The remaining four compounds were detected but at such low levels that their detection must be said to be equivocal. For the other spiked filter, no data are reported because part of the extract of this filter was spilled; recoveries of analytes were certainly incomplete.

Table A2-1
Audit Spikes of Metals in M29 Filter and Impingers
(Data in μg)

	Observed at SRI			Reported by RTI		
	Filter	Peroxide	Permanganate	Filter	Peroxide	Permanganate
Spike set 1						
Arsenic	54	8.49		200	10	
Cadmium	16.2	7.74		14	10	
Lead	170	15.2		142	20	
Mercury	<0.02	0.031	14.2			10
Selenium	60.7	10.3		80	15	
Spike set 2						
Arsenic	1.81	4.96		10	10	
Cadmium	11.5	7.65		10	10	
Lead	36.0	18.0		30	20	
Mercury	<0.02	<0.02	8.09			10
Selenium	38.9	25.6		50	30	

Table A2-2
Audit Spikes of Carbonyl Compounds in DNPH Impingers
(Data in μg)

	Spike No. 1		Spike No. 2	
	SRI	RTI[a]	SRI	RTI[a]
Formaldehyde	11.9	16	8.63	8
Acetaldehyde	1.22		1.42	
Acetone	7.02		8.26	

[a] The recoveries for Spikes Nos. 1 and 2 are 74 and 108%, respectively, approximately the lower and upper limits of the DQO.

Table A2-3
Audit Spikes of Volatile Organic Compounds in VOST Media
(Data in ng)

	Observed at SRI			Reported by RTI	Recovery[a] %
	Tenax	T/char.	Total		
Audit 1					
Chloromethane			0	0	--*
Vinyl chloride	55.8		56	243	23
Bromomethane	49.2	13.2	62	136	46
Methylene chloride	395	26.5	422	0	False +
Chloroform	486		486	498	98*
1,1,1-Trichloroethane	140		140	432	32
Carbon tetrachloride	618	8.46	626	527	119*
Benzene	330	5.73	336	310	108*
1,2-Dichloroethane	408		408	427	96*
Trichlorethene	551		551	553	100*
1,3-Dichloropropane	160		160	145	110*
Toluene	153	28	181	137	132*
Tetrachloroethene	701		701	645	109*
Chlorobenzene	154		154	156	99*
Ethylbenzene	129		129	146	88*
m- & p-xylene			0	0	--*
o-xylene	123		123	150	82*
Trichlorofluoromethane[b]			0	187	0
1,2-Dibromoethane[b]			0	259	0
1,3-Butadiene[b]			0	229	0

[a] The asterisks designate results that were compatible with the DQO: recovery between 50 and 150%. False + indicates an erroneous compound detection.

[b] The last three compounds were not within SRI's detection capability.

Table A2-3 Continued
Audit Spikes of Volatile Organic Compounds in VOST Media
(Data in ng)

	Observed at SRI			Reported by RTI	Recovery[a] %
	Tenax	T/char.	Total		
Audit 2					
Chloromethane	56.6		57	0	False +
Vinyl chloride	39.2	135	174	246	71*
Bromomethane	53.9	16.8	71	138	51*
Methylene chloride	499	49.2	548	0	False +
Chloroform	464		464	504	92*
1,1,1-Trichloroethane	179		179	438	41
Carbon tetrachloride	580		580	534	109*
Benzene	248		248	313	79*
1,2-Dichloroethane	391		391	432	91*
Trichlorethene	441		441	560	79*
1,3-Dichloropropane	114		114	147	78*
Toluene	59.5		60	139	43
Tetrachloroethene	366		366	653	56*
Chlorobenzene	54.9		55	158	35
Ethylbenzene	46.6		47	147	32
m- & p-xylene	37		37	0	False +
o-xylene	43.7		44	152	29
Trichlorofluoromethane[b]			0	189	0
1,2-Dibromoethane[b]			0	262	0
1,3-Butadiene[b]			0	232	0

[a] The asterisks designate results that were compatible with the DQO: recovery between 50 and 150%. False + indicates an erroneous compound detection.
[b] The last three compounds were not within SRI's detection capability.

Table A2-3 Concluded
Audit Spikes of Volatile Organic Comounds in VOST Media
(Data in ng)

	Observed at SRI			Reported by RTI	Recov.%
	Tenax	T/char.	Total		
Audit 3					
Chloromethane			0	0	--*
Vinyl chloride	41.3	142	183	250	73*
Bromomethane	52.3	14.9	67	140	48
Methylene chloride	500	29.5	530	0	False +
Chloroform	496		496	511	97*
1,1,1-Trichloroethane	189	14.2	203	444	46
Carbon tetrachloride	614		614	542	113*
Benzene	270		270	318	85*
1,2-Dichloroethane	399		399	438	91*
Trichlorethene	468		468	568	82*
1,2-Dichloropropane	115		115	149	77*
Toluene	40.7		41	141	29
Tetrachloroethene	307		307	663	46
Chlorobenzene	28.9		29	160	18
Ethylbenzene			0	149	0
m- & p-xylene			0	0	--*
o-xylene	12.8		13	154	8
Trichlorofluoromethane[b]			0	192	0
1,2-Dibromoethane[b]			0	266	0
1,3-Butadiene[b]			0	236	0

[a] The asterisks designate results that were compatible with the DQO: recovery between 50 and 150%. False + indicates an erroneous compound detection.

[b] The last three compounds were not within SRI's detection capability.

Table A2-4
Audit Spikes of Semi-Volatiles in Modified Method 5 Sampling Media
(Data in µg)

	Filter 1 (see Note)			Filter 2		
	SRI	RTI	Recov.%	SRI	RTI	Recov.%
Naphthalene		90		<0.166	75	<0.2
Acenaphthalene		180		<0.413	150	<0.3
Acenaphthene		90		1.82	75	2
Fluorene		18		2.65	15	18
Phenanthrene		9		2.7	7.5	36*
Anthracene		9		<0.304	7.5	<4.0
Fluoranthrene		18		6	15	40*
Pyrene		9		1.82	7.5	24*
Chrysene		9		4.24	7.5	57*
Benzo(a)anthracene		9		1.17	7.5	16
Benzo(b)fluoranthene		18		20.1	15	134*
Benzo(k)fluoranthene		9		9.5	7.5	127*
Benzo(a)pyrene		9		<0.42	7.5	<5.6
Indeno(1,2,3-cd)pyrene		9		5.55	7.5	74*
Dibenzo(a,h)anthracene		18		11.5	15	77*
Benzo(a)perylene		18		10.2	15	68*

*Within DQO limits (20 - 150%).
Note: No valid data were obtained because of partial sample loss.

Table A2-4 Concluded
Audit Spikes of Semi-Volatiles in Modified Method 5 Sampling Media
(Data in μg)

	XAD 1			XAD 2		
	SRI	RTI	Recov.%	SRI	RTI	Recov.%
Naphthalene	62.7	90	70*	51.5	75	69*
Acenaphthalene	130	180	72*	84.5	150	56*
Acenaphthene	61.2	90	68*	51.5	75	69*
Fluorene	11	18	61*	9.01	15	60*
Phenanthrene	5.84	9	65*	5.05	7.5	67*
Anthracene	2.9	9	32*	4.14	7.5	55*
Fluoranthrene	11.7	18	65*	9.69	15	65*
Pyrene	6.22	9	69*	5.45	7.5	73*
Chrysene	6.65	9	74*	5.25	7.5	70*
Benzo(a)anthracene	5.89	9	65*	5.4	7.5	72*
Benzo(b)fluoranthene	11.3	18	63*	10.1	15	67*
Benzo(k)fluoranthene	6.3	9	70*	5.29	7.5	71*
Benzo(a)pyrene	2.38	9	26*	3.71	7.5	49*
Indeno(1,2,3-cd)pyrene	6.97	9	77*	5.9	7.5	79*
Dibenzo(a,h)anthracene	10.8	18	60*	9.82	15	65*
Benzo(g,h,i)perylene	11.3	18	63*	9.92	15	66*

*Within DQO limits (20 - 150%).

APPENDIX B

SAMPLING PROTOCOL

Sample Name: Particle Size

Process Location: Stack

Equipment: University of Washington Mark V/III cascade impactor with SoRI/EPA Right Angle Precollector and EPA M5 sampling train with stainless steel probe; tared quartz fiber substrates and filters with plastic Petri dishes for each.

Collection Frequency: Sampling time based on particle concentrations found at time of test. A single sample may be run over several tests depending on the time required to obtain optimum stage catches.

Procedure Summary: Stack gas sampling equipment is calibrated no later than 60 days after last calibration as described in the Quality Assurance Plan. An initial traverse is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate, and to check for cyclonic air flow. The sampling train is assembled with tared substrates and particulate filter, a stainless steel condenser for moisture, and a dryer containing 200 to 300 grams of silica gel. EPA Method 5 procedures are followed for pre-test and post-test leak checks, isokinetic sampling rate, and data recording. If the velocity distribution is flat, sampling will be done by traversing in a standard Method 5 fashion, but at a constant sampling rate. Otherwise, sampling is done at a constant sampling rate at four points within the duct which are selected by virtue of having velocities equal to the average duct velocity. The impactor section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The collection substrates and particulate filter are removed from the impactor and precollector, carefully placed into their original plastic Petri dishes and placed in a desiccator to equilibrate before weighing. All weighing is done on site with a Cahn microbalance with weights recorded to the nearest 10 micrograms.

The internal surfaces of the nozzle, and precollector are cleaned by brushing into a tared aluminum foil container which is weighed with the precollector collection substrate.

The contents of the condenser and dryer are weighed to nearest 0.5 gram to determine the amount of water condensed.

References:

Methods 1, 2, 3, 4, and 5, Appendix A, <u>Reference Methods. New Source Performance Standards</u>, 40 CFR 60, revised 7/9/85

J. D. McCain et al, Procedures Manual for the Recommended ARB Particle Size Distribution Method (Cascade Impactors). Attachment No. 1 to the Final Report for ARB Contract A3-092-32 "Recommended Methodology for the Determination of Particle Size Distribution in Ducted Sources". SoRI-EAS-86-466, May 1986. NTIS PB 86-218666/WEP.

Sample Name:	Particle Size and Size Fractionated Samples for Chemical Analysis
Process Location:	Particle Size: Unit 8 ESP Inlet Size Fractionated Sample for Analysis: Unit 8 ESP Inlet, and Units 7 & 8 ESP Outlets.
Equipment:	SRI/EPA Five Series Cyclone with stainless steel probe; tared quartz fiber filters with plastic Petri dishes and glass vials for cyclone catches. Only the first two cyclones and a filter were used at the ESP outlet locations.
Collection Frequency:	Sampling times will be in based on particle concentrations found at time of test: typically about 60 to 1000 minutes at the ESP inlet and outlet locations, respectively. One sample per pair of test days at the inlet. The sampling time at the outlets may run over several tests depending on the time required to obtain optimum stage catches.
Procedure Summary:	Stack gas sampling equipment is calibrated no later than 60 days after last calibration as described in the Quality Assurance Plan. An initial traverse is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate, and to check for cyclonic air flow. The sampling train is assembled with clean cyclones and a 63 mm quartz fiber particulate filter, a stainless steel condenser and a dryer containing 200-300 grams of silica gel. EPA Method 5 procedures are followed for pre-test and post-test leak checks, isokinetic sampling rate, and data recording. If the velocity distribution is flat, sampling will be done by traversing in a standard Method 5 fashion, but at a constant sampling rate. Otherwise, sampling is done at a constant sampling rate at four points within the duct which are selected by virtue of having velocities equal to the average duct velocity. Alternatively, sampling may be confined to the high velocity portion of the duct if the velocity distribution is badly skewed on the basis that the bulk of the particle transport would be expected to occur in the high velocity area. The cyclone/filter section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The cyclone catches are removed in two portions for each cyclone. First, loose particles in a cyclone are poured or brushed into a tared vial. The remaining material in a cyclone is then rinsed out with a stiff bristle brush and acetone. Both portions are then desiccated (the acetone is evaporated prior to desiccation). The filter is removed separately and is carefully placed into its original plastic Petri dish. All catches are then weighed after 24 hours of desiccation. All weighing is done on site with a four or five place Mettler balance with weights recorded to the nearest 0.1 milligrams.

The contents of the condenser/drier are weighed to nearest 0.5 gram to determine the amount of water condensed.

References:

Methods 1, 2, 3, 4, and 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised 7/9/85

J. D. McCain et al, Procedures Manual for the Recommended ARB Sized Chemical Sampling Method (Cascade Cyclones). Attachment No. 2 to the Final Report for ARB Contract A3-092-32 "Recommended Methodology for the Determination of Particle Size Distribution in Ducted Sources". SoRI-EAS-86-467, May 1986. NTIS PB 86-218674/WEP.

Sample Name: Dilution Sample (Simulated Plume)

Process Location: Unit 7 ESP Outlet

Equipment: Custom SRI air dilution sampling train SoRI/EPA Cyclone Precollector and glass lined probe; conditioned, scrubbed and filtered dilution air at approximate 10:1 dilution ratio; tared quartz fiber filters with sealed teflon envelopes; various EPA and other impinger trains and sorbent traps for vapor phase constituents behind the filter.

Collection Frequency: One sample per test day.

Procedure Summary: Stack gas sampling equipment is calibrated no later than 60 days after last calibration as described in the Quality Assurance Plan. An initial traverse is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate, and to check for cyclonic air flow. The sample flow is metered using a calibrated orifice located at the diluter inlet. The integrated sample volume is totalized continuously by means of an electronic flow totalizer which receives a signal from a pressure transducer across the orifice. Compensation is made in the totalizer for absolute gas pressure, temperature and density. The moisture content of the stack gas is obtained from concurrent Method 5 train samples.

The sampling train is assembled with a tared quartz filter mounted at the exit of the diluter to collect particulate phase material. Sample takeoffs are used as needed behind the filter to supply diluted gases to various traps and/or impingers for vapor phase components. EPA Method 5 procedures are followed for pre-test and post-test leak checks separately for the dilution train and the individual vapor phase samplers to be run downstream of the filter. EPA Method 5 techniques are also used for isokinetic sampling rate, and data recording. Sampling will be done by traversing in a standard Method 5 fashion.

After sampling is completed the diluter section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The particulate filter is removed from the diluter and is carefully placed into its teflon jacket for transport to the lab.

The probe and cyclone catches are recovered like Method 5 nozzle and probe washes.

Finally, the internal surfaces of the diluter are washed with solvents appropriate to the primary target species for the sampling day.

References:

Methods 1, 2, 3, 4, and 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised 7/9/85

W. E. Farthing, Development of Sampling Methodology for Dilution Air Sampling of Condensible Emissions from Stationary Sources. Southern Research Institute Task Report on Contract 68-02-4442 with the US EPA, AREAL, RTP, NC. August, 1990

Sample Name: Multiple Metals and Particulates -- EPA Method 29 (Tentative; 40 CFR) or Method 0012 (SW-846)

Process Location: Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack, Dilution Sampler at Unit 7 ESP Outlet

Equipment: Multiple metals sampling train (Figure A.1); plastic Petri dish with tared particulate filter; 8 glass jars (500 mL) with Teflon-lined lids

Filters used by SRI are preweighed quartz fiber filters. Weights are obtained with a Mettler Model HK balance, or equivalent, after filters are desiccated to constant weight.

Collection Frequency: Sampling time will be in accordance with EPA procedures which require 60 min of sampling to acquire a 1.25 m^3 or greater sample. One sample at each location per inorganic test day.

Procedure Summary: Stack gas sampling equipment is calibrated no later than 60 days after last previous calibration. An initial traverse of the duct to be sampled is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate, and to check for cyclonic air flow. The sampling train is assembled with a tared particulate filter, 100 mL of 5% HNO_3/10% H_2O_2 in the first and third impingers, with the second and fourth impingers empty, 100 mL of 4% $KMnO_4$/10% H_2SO_4 in the fifth and sixth impingers, an empty seventh impinger, and 200-300 g of silica gel in a final impinger. EPA Method 5 procedures are followed for pre-test and post-test leak checks, isokinetic sampling rate, filter change-outs (if needed), and data recording. The impinger section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The particulate filter is removed from its holder, carefully placed into a 250 ml glass bottle and sealed with a teflon lined lid.

The internal surfaces of the nozzle, probe and front half of the filter holder are cleaned by rinsing and brushing with acetone, followed by a final rinsing with a 0.1 normal nitric acid solution into a separate sample jar (probe rinse sample).

The liquid contents of each impinger is measured to nearest milliliter to determine the amount of water condensed. After emptying the contents of impingers one through three into one or more sample bottles as needed, the back half of the filter holder, connecting glassware, and impingers one through three are thoroughly rinsed with 0.1 normal nitric acid. The rinsate is added to the liquid contents of the impingers. The liquid contents of impingers four through six are then poured into one or more sample jars as needed and these impingers are rinsed with a 10 normal HCl solution with the rinsate being added to the sample jar containing the impinger solutions. The silica gel contents of the final impinger are recovered and weighed to the nearest 0.5 g to determine the amount of water collected.

Samples for analysis:

Acetone rinse of probe and front housing
Nitric acid rinse of probe and front housing
Filter
HNO_3 impingers and rinse
$H_2SO_4/KMnO_4$ impingers and rinse

References:

Methods 1, 2, 3, 4, and 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised July 1, 1991.

Methodology for the Determination of Metals Emissions in Exhaust Gases from Hazardous Waste Incinerator and Similar Combustion Processes. EPA Method 29 (tentative) -- pp 3-1 through 3-47, Methods Manual for Compliance with the BIF Regulations, EPA/530/SW-91- 010, December 1990.

Sample Name: Acid Gases and Anions.

Process Location: Acid Gases and Anions: Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack, Dilution Sampler at Unit 7 ESP Outlet

Equipment: Method 5 sampling train (Figure A.2); plastic Petri dish with tared particulate filter; 8 glass jars (500 mL) with Teflon-lined lids.

Collection frequency: Sampling time will be in accordance with the method procedure. One sample at each location per inorganic test day.

Procedure summary: Stack gas sampling equipment is calibrated no later than 60 days after last calibration. An initial traverse is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate, and to check for cyclonic air flow. The sampling train is assembled with tared particulate filter, an empty first impinger, and 100 mL of a solution consisting of 25 g/l of sodium carbonate, 25 g/l of sodium bicarbonate, and 100 ml/l of 33% hydrogen peroxide in the second and third impingers. These are followed by a dry impinger and a final impinger loaded with 200 to 300 g of silica gel. Method 5 procedures are followed for pre-test and post-test leak checks, filter change-outs (if needed), and data recording. The impinger section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The particulate filter is removed from its holder, carefully placed in a 250 ml glass bottle which is sealed with a teflon lined lid.

The internal surfaces of the nozzle, probe and front half of the filter holder are cleaned by rinsing, brushing, and final rinsing with acetone into a separate sample jar (probe rinse sample).

The liquid contents of the impingers are measured to nearest milliliter to determine the amount of water condensed; the liquid contents of the first three impingers are collected in a separate container and the back half of the filter holder, connecting glassware, and the impingers are thoroughly rinsed with distilled water. The rinsate is added to the sample jar(s) containing the impinger contents; the silica gel contents of the final impinger are recovered and weighed to the nearest 0.5 g to determine amount of water collected.

References:

Methods 1, 2, 3, 4, and 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised July 1, 1991.

Isokinetic HCl/Cl_2 Emission Sampling Train (Method 0050) – pp 3-70 through 3-96, Methods Manual for Compliance with the BIF Regulations, EPA/530-SW-91-010, December 1990.

Sample Name: Volatile Organics – EPA Method 0030 (SW-846)

Process Location: Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack, and ambient air

Equipment: Volatile organic sampling train (VOST); sorbent cartridges, glass culture tubes with screw caps, aluminum foil

Collection frequency: Continuous run at approximately 0.5 L/min with replacement of sorbent tube pairs after each of the prescribed sampling intervals (for example, 4, 10, and 20 min). Various intervals are used to ensure that the capacity of the sorbents is not exceeded and that, at the same time, sufficient sample is collected. One group of samples at each location per organic test day.

Procedure summary: Sorbent cartridge preparation. The procedures for preparing, handling, storing, and analyzing the cartridges will be those described in the EPA protocol referenced below. As described in the protocol, new sorbent material (Tenax resin and charcoal) will be Soxhlet-extracted, vacuum-dried, thermally conditioned with organic-free nitrogen, and loaded into cartridges which are subsequently pressure-leak tested. Three of the conditioned cartridges will be analyzed to confirm that they are free of background contamination before sample collection. Each sorbent tube will be labeled with an identification number.

The sorbent cartridges will be protected from contamination by placing them in culture tubes which contain clean charcoal. The cartridges will be stored at 4 °C in an area free from sources of organic contamination. The cartridges will be packed separately and kept cold with "blue ice" in insulated containers during transport to the test site.

Before each replicate sampling run, the sample coordinator will supply the resin cartridges, including a field blank, to the stack sampling manager. At the end of each run, the sample coordinator will recover the cartridges, pack them in cold chests, and complete the appropriate records.

VOST operation. The sample collection procedures is described in the EPA protocol referenced below. As described in the protocol, the sample train will be cleaned and assembled before installing the resin cartridges. The caps to the cartridges will be stored in a clean glass jar while the cartridges are in the train. The train will then be leak tested at 10 in. Hg above the train's operating vacuum in such a manner as to prevent exposure of the train components to the ambient air.

Before sampling is started, ice water will be circulated throughout the condensers and the probe will be purged of ambient air and located in the stack at a point with a typical stack velocity and temperature. The probe will be heated to 130 to 150 °C (266 to 302 °F). The train will be operated under "SLOW-VOST" conditions, i.e., at a rate of 0.5 L/min for up to 40 min to collect a maximum volume of 20 L for each pair of sorbent cartridges. Four pairs of cartridges will be collected during each test run. The SLOW-VOST conditions were selected to make the VOST sampling period approach the time required for collecting semivolatile organics from the stack gas by the modified EPA Method 5.

Two cartridges will be removed and the end caps replaced; the cartridges will be labeled with date, time, and test-run number, wrapped in aluminum foil, and returned to the culture tubes. Samples of the condensate water will also be collected as described in the EPA protocol to prevent the loss of volatile organics.

The sample collection data will be recorded for each cartridge pair. The samples will be given to the sample coordinator along with the chain-of-custody sheet. The VOST will be removed from the stack to a organic-free area where it will be cleaned and prepared for the next test run.

Reference:	U.S. EPA, November 1986, Test Methods for Evaluating Solid Wastes, Method 0010, SW-846.

Sample Name:	Semi-Volatile Organics (known as Modified Method 5 or Semi-VOST) -- EPA Method 0010 (SW-846) and PCDDs and PCDFs
Process Location:	Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack, Dilution Sampler at Unit 7 ESP Outlet (back half only). (PCDDs and PCDFs at Unit 7 Outlet and Stack only.)
Equipment:	Modified EPA Method 5 sampling train; sorbent cartridges, aluminum foil, glass jars with Teflon-lined lids
Collection frequency:	Continuous except for possible filter changes and port moves with a minimum 3 m3 sample volume to be collected. One sample at each location per organic test day except for the diluter where two will be run in parallel .
Procedure summary:	Sorbent cartridge preparation. The procedures for preparing, handling, storing, and analyzing the cartridges will be those described in the EPA method referenced below. New sorbent material will be cleaned by Soxhlet extraction and one of the conditioned tubes will be analyzed to confirm that the tubes are free of background contamination. Before each sampling run, the sample coordinator will supply the sorbent tubes, including a field blank, to the stack sampling team. At the end of each run, the sample coordinator will recover the sorbent tubes, along with a sample collection data sheet. The samples will be stored in insulated cold chests in an area that is free from sources of organic contamination. The sampling train is assembled as follows: All openings are kept covered until just prior to assembly, to prevent contamination Particulate filter in holder Organic collection module (gas conditioning section, sorbent trap, condensate knockout trap) First impinger empty with a short stem to collect the condensate; 100 mL distilled water in second and

third impingers; fourth impinger empty; fifth impinger containing indicating silica gel weighed to nearest 0.5 g. The condensate impinger bottle must be large enough to contain all of the expected condensate without overflowing.

Silicone grease may not be used in train.

Stack sampling:

The MM5 unit, exclusive of the sorbent trap and the particulate filters, will be provided by the stack sampling manager. With the exception of the necessary modification for installing and recovering the condenser and sorbent trap, the sampling procedures will be as specified in EPA Methods 1 and 2 for stack gas air flow measurements, and Method 5 for moisture content and particulates. Ice water is circulated around the condenser and sorbent trap to maintain a gas exit temperature below 20°C at the exit of the sorbent module. The sampling technicians record the data as recommended in Method 5.

The sampling equipment will be calibrated no later than 60 days after the last calibration. The sampling train will be operated according to standard procedures so that at least 3 m^3 of sample will be obtained.

Recovery:

The samples will be recovered from the MM5 train as follows:

Particulate filter – Will be removed from the holder, placed in an amber glass bottle with a Teflon-lined lid, sealed with tape, then wrapped in aluminum foil, placed in a plastic bag, and sealed.

Probe rinse – The nozzle, probe and front half of the filter holder and any connecting glassware will be brushed and rinsed three times each with methanol and methylene chloride. The rinses will be measured volumetrically and placed in a glass sample jar with a Teflon-lined lid. A toluene rinse will also be made at the Unit 7 outlet and stack for PCCD/PCDF analysis.

Condensate – The condensate will be volumetrically measured and placed in a glass sample jar. The glassware from the back half of the filter will be rinsed through the condenser to the sorbent trap with the same solvents as used for the front half of the train. The rinses will be measured volumetrically and placed in a glass sample jar with a Teflon-lined lid.

Sorbent cartridge – Will be removed from the sampling train, capped, wrapped with aluminum foil, and sealed in a plastic bag.

Impinger water – The contents of the first, second, and third impingers will be volumetrically measured and placed in amber glass sample bottles along with a distilled water rinse of these impingers and connecting glassware.

Silica gel – The silica gel impinger will be reweighed to nearest 0.5 g.

All of the sample containers will be assigned numbers and labeled with date, time and test-run number. The samples will be turned over to the sample coordinator along with the chain-of-custody sheet. The sample coordinator will record the appropriate data in the field log book and pack the samples in the original shipping package which will be stored in the sample cleanup area. The sample train data sheet will be reviewed by the sampling team manager and forwarded on to the sampling coordinator.

References:

Method 5, Appendix A, Test Methods and Procedures, New Source Performance Standards, 40 CFR 60, revised July 1, 1991.

Method S008, Sampling and Analysis Methods for Hazardous Waste Combustion, EPA-600/8-84-002, February 1984.

Modified Method 5 Sampling Train (Proposed), Test Methods for Evaluating Solid Wastes; Physical/Chemical Methods, SW-846, Second Edition, NTIS PB85-103026, 1984.

Sample Name:	Aldehydes
Process Location:	Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack
Equipment:	Method 5 sampling train (Figure A.2); particulate filter; 3 glass jars (500 mL) with Teflon-lined lids
Collection Frequency:	One sample at each location per organic test day. Sample volumes of about 0.5 m^3 are collected.
Procedure Summary:	Stack gas sampling equipment is calibrated no later than 60 days after last calibration. Single point samples The sampling train is assembled with an untared particulate filter (to be discarded), followed by two impingers loaded with 100 ml each of an aqueous solution of DNPH (dinitrophenylhydrazine). These are followed by a dry impinger and a final impinger loaded with 200 to 300 g of silica gel. Method 5 procedures are followed for pre-test and post-test leak checks, and data recording. The impinger section of the sampling train is moved intact to the cleanup area for sample recovery as follows: The particulate filter is removed and discarded. The liquid contents of the impingers are measured to nearest milliliter to determine the amount of water condensed; the liquid contents of the two DNPH impingers are collected in a glass container and the back half of the filter holder, connecting glassware, and the impingers are thoroughly rinsed with distilled water. The rinsate is added to the sample jar(s) containing the impinger contents; the silica gel contents of the final impinger are recovered and weighed to the nearest 0.5 g to determine amount of water collected.
References:	Methods 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised July 1, 1991. EPA Method T05 for aldehydes.

Sample Name: Ammonia and Cyanide

Process Location: Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack

Equipment: Method 5 sampling train (Figure A.2); untared particulate filter; 4 glass jars (500 mL) with Teflon-lined lids.

Collection frequency: Single point sampling will be done at point having a typical gas temperature for the duct being sampled. A sample gas volume of approximately 0.5 m^3 will be collected. One sample will be collected at each location per pair of test days.

Procedure summary: Stack gas sampling equipment is calibrated no later than 60 days after last calibration. The sampling train is assembled with an untared particulate filter (to be discarded, two impingers containing 100 mL of a solution consisting of 25 g/l of sodium carbonate, 25 g/l of sodium bicarbonate in water, a dry impinger, and a fourth and fifth impinger, each containing 100 ml of a 0.1 normal H_2SO_4 solution. The first two impingers collect ammonia and cyanide and the fourth and fifth collect any ammonia passed by the previous impingers. These are followed by a dry impinger and a final impinger loaded with 200 to 300 g of silica gel. Method 5 procedures are followed for pre-test and post-test leak checks, and data recording. The impinger section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The particulate filter is removed and discarded.

The liquid contents of the impingers are measured to nearest milliliter to determine the amount of water condensed; the liquid contents of the first and second impingers are collected a one container and the back half of the filter holder, connecting glassware, and the impingers are thoroughly rinsed with distilled water. The rinsate is added to the sample jar(s) containing the impinger contents of the first two impingers; The contents of the third impinger are poured into a separate container and the impinger is rinsed with water with the rinsate being added to the impinger contents. The silica gel contents of the final impinger are recovered and

	weighed to the nearest 0.5 g to determine amount of water collected.
References:	Methods 1, 2, 3, 4, and 5, Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised July 1, 1991.

Sample Name:	Mercury
Process Location:	Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack, Diluter, ambient air
Equipment:	Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack: Heated probe with glass or quartz wool plug to remove particulate matter, two soda lime traps and two iodated charcoal traps in series for collection of mercuric compounds and mercury. Diluter: Two soda lime traps and two iodated charcoal traps for collection of mercuric compounds and mercury.
Collection Frequency:	One sample per inorganic test day.
Procedure Summary:	Single point samples are obtained at a flow rate of about 0.5 liters per minute to collect about 25 liters (250 liters for dilution probe). The traps are maintained at about 110°C to eliminate moisture condensation. Traps are sealed with teflon caps at the end of each run and the capped tubes are placed in a sealed plastic bag.
References:	Personal communications from Nicholas Bloom and Eric Prestbo of Brooks-Rand Inc., Seattle, WA. Bloom, Nicolas S. "Mercury Speciation in Flue Gases: Overcoming the Analytical Difficulties." Presented at: Managing Hazardous Pollutants - State of the Art. Washington, D.C. Nov. 4-6, 1991.

Sample Name: Particulates – EPA Method 17

Process Location: Unit 8 ESP Inlet, Units 7 & 8 ESP Outlets, Stack

Equipment: Method 17 sampling train, sample bottle with tared particulate thimble

Thimbles used by SRI are preweighed glass fiber thimbles. Weights are obtained with a Mettler Model HK balance, or equivalent, after thimbles are desiccated to constant weight.

Collection Frequency: Sampling time will be 72 to 360 minutes to acquire a 1.0 m^3 or greater sample. One sample at each location per organic test day.

Procedure Summary: Stack gas sampling equipment is calibrated no later than 60 days after last previous calibration. An initial traverse of the duct to be sampled is made with a pitot tube at each sample port following EPA Methods 1 and 2 to establish sample traverse points, gas velocity profile, temperature, and flow rate. The sampling train is assembled with a tared particulate thimble, stainless steel condenser, and silica gel column. EPA Method 5 procedures are followed for pre-test and post-test leak checks, isokinetic sampling rate, thimble change-outs (if needed), and data recording. The thimble and nozzle section of the sampling train is moved intact to the cleanup area for sample recovery as follows:

The particulate thimble is removed from its holder, carefully placed into a 500 ml glass bottle and sealed with a teflon lined lid.

The internal surfaces of the nozzle and thimble holder are cleaned by rinsing and brushing with acetone into a separate sample jar (probe rinse sample).

The liquid content of the condenser is measured to nearest 0.1 gram to determine the amount of water condensed. The silica gel contents of the drying column are weighed to the nearest 0.1 g to determine the amount of water collected.

Samples for analysis: Acetone rinse of nozzle and filter holder
Filter

References:
Methods 1, 2, 3, 4, 5, and 17 Appendix A, Reference Methods, New Source Performance Standards, 40 CFR 60, revised July 1, 1991.

APPENDIX C

ANALYTICAL METHODOLOGY AND QUALITY ASSURANCE/QUALITY CONTROL

APPENDIX C

ANALYTICAL METHODOLOGY AND QUALITY ASSURANCE/QUALITY CONTROL

C.1 QA Objectives

The analytical objective for this project was to provide data to conduct comprehensive assessments of toxic emissions from the Bailly Generating Station. SRI's compliance with the QA/QC requirements identified for this project in our Site Specific Quality Assurance Plan for the Bailly facility is discussed in this appendix.

As part of our discussion, we describe changes to or deviations from the analytical methods cited in our Site Specific Analytical Plan for the Bailly facility and their likely impact on the quality of the data. We also describe any difficulties encountered with the analysis and its impact on the data. We discuss instrument calibration, precision of replicate determinations, and recovery of surrogates and standard matrix spikes where appropriate. Precision and accuracy are calculated and reported as relative percent difference and as percent recovery respectively.

Precision and accuracy data are reported in the tables found in this Appendix for:

Metals

Anions

Carbonyl compounds (aldehydes and ketones)

Volatile organic compounds

Semivolatile organic compounds

Dioxins and furans

Relative percent difference is calculated using the equation,

$$R\%D = ((V_1 - V_2) \div ((V_1 + V_2)/2)) \times 100,$$

where:

R%D = relative percent difference,

V_1 = The higher result from duplicate analyses, and

V_2 = The lower result from duplicate analyses.

Recovery is calculated using the equation

$$\%R = ((V_1 - V_2) + V_3) \times 100.$$

where:

$\%R$ = percent recovery

V_1 = The result for a matrix spike sample,

V_2 = The result for the unspiked sample, and

V_3 = The known amount of spike added to the matrix spike sample.

Initially, no data base for any of the check samples existed from which to calculate mean values and control limits based on standard deviations for precision, accuracy and recovery. Although QC samples were analyzed with actual samples, the data points required to generate a data base large enough for each type of QC check sample were not obtained. As stated in the Site Specific Quality Assurance Plan, prescribed objectives were: for accuracy ±10%; for precision 15% RSD; for recovery 80-120%; and for completeness 90%.

The analytical methods employed on this project have not been validated for several of the matrices encountered. Performance characteristics such as recovery and reproducibility for these methods when used to analyze coal, ash, and pollution control by-products were not established at the start of this project. Throughout the analytical effort, it became evident that the methods used to analyze the samples collected at the Bailly facility would have to be modified and optimized to obtain data suitable for use in establishing mass balances. Major method adaptations employed on this project and our success or lack thereof will be described.

C.2 Sample Custody Procedures

C.2.1 Chain of Custody

Chain of custody procedures were established to identify and trace samples from collection to final analysis. Such documentation included labels to prevent mix-up, container seals to prevent unauthorized tampering with contents of the sample containers, custody forms, and records necessary for documentation of the data.

The field sampling operations included:

- Documentation of the procedure used for sample collection and of information pertaining to the reagents or supplies that became an integral part of the sample (e.g., filters and absorbing reagent).

- Procedures and forms for recording the exact location and specific considerations associated with sample acquisition.
- Documentation of specific sample-preservation method.
- Use of pre-prepared sample labels containing all information necessary for effective sample tracking.
- Standardized field-tracking reporting forms to establish sample custody in the field prior to shipment.

C.2.2 Documentation

As needed, forms were updated or new ones were created as determined by the QA Coordinator and the Program Manager. Completed forms were kept in files of the Environmental Sciences Department or the Analytical Chemistry Division, as appropriate.

C.2.3 Document Storage

All documents received with samples have been maintained by the sample custodian. For all original documents retained by the analyst or other project participants, a memo identifying the documents and location of the documents has been prepared for submission to the QA Coordinator. The QA Coordinator will maintain a directory for all outstanding documents that lists the project, the document(s), the custodian, and the location of the documents.

C.2.4 Sample Custody

The analytical laboratories have maintained retrievable records of the chain of custody for all samples collected and analyzed.

C.3 Analytical Method Descriptions and QA/QC Data

In this section, the methods used for analyses of the different classes of analytes are described. In addition, the results of QA/QC experiments are presented in tabular form.

C.3.1 Metals

Samples were prepared for metal analysis by digestion in a microwave oven. The digestion procedures were based on recommendations from the oven manufacturer, CEM Corporation. The principal steps in digestion are outlined below (these steps apply to the simultaneous treatment of 12 filled digestion vessels):

> Solids (coal, 0.5 g; other solids, 1.0 g). The solid was placed in one of the polytetrafluorethylene microwave vessels; 10 mL of concentrated nitric acid was added and then the first step of heating was followed.

This first step required a power input of 75 W for a total of 20 min, with gradually increasing pressure control points (maximum, 200 psi). Next, 5 mL of hydrofluoric acid and 1 mL of hydrochloric acid were added; heating was performed with 60 W of power for 20 min with initial pressure control at 150 psi and concluding control at 20 psi. Finally, with 30 mL of saturated aqueous boric acid added, heating occurred with 100 W of power input for 6 min with the pressure initially at 50 psi and finally at 20 psi. The resulting liquid was diluted in a polyethylene volumetric flask to a final volume of 100 mL.

Liquids (40 mL). After the liquid was placed in a microwave vessel, an addition of 5 mL of concentrated nitric acid was made. The mixture was heated with 100 W of power for 20 min at an initial pressure of 70 psi and a final pressure of 20 psi. The resulting solution was diluted with water to a total of 50 mL in a polyethylene volumetric flask.

C.3.1.1 Methods for Aluminum, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Titanium, and Vanadium.

These metals were determined by inductively coupled plasma/atomic emission spectroscopy (ICP/AES), SW-846 Method 6010. Yttrium and scandium were used as the internal standards for determinations of both the trace metals and the major metals (Al, Ca, Fe, Mg, and Ti). Section 3.1.3 below discusses alternative methods for cadmium and lead.

C.3.1.2 Methods for Antimony, Arsenic, and Selenium.

Arsenic determinations by gaseous hydride generation involve the reduction of arsenic with potassium iodide in the presence of HCl to its trivalent form. Arsenic was then reacted with sodium borohydride to form the hydride in a vessel being purged with nitrogen to sweep the hydride into the absorption cell. In the cell lined up in the optical path of the spectrophotometer the arsenic concentration was determined by reading absorption at 193.7 nm.

Antimony determinations by gaseous hydride generation followed the procedure outlined above for arsenic. Antimony was reduced with potassium iodide in the presence of HCl then reacted with sodium borohydride to form the hydride. Antimony concentrations were determined by reading absorption at 217.6 nm. This method represented the best available technique for achieving the desired detection levels for antimony.

Selenium determinations by gaseous hydride generation involve the reduction of selenium in the presence of HCl. Selenium was then reacted with sodium borohydride to form the hydride and purged from a reaction vessel into an absorption cell with nitrogen. Selenium concentration was determined by reading absorption at 196.0 nm.

The method of standards addition was selected as the calibration technique for antimony and arsenic. The analysis of antimony and arsenic by either GFAAS or by HGAAS produced more accurate results when the method of standards addition was employed. Selenium determination, on the other hand, by either GFAAS or HGAAS, provided acceptable values with or without standards addition.

C.3.1.3 Alternative Methods for Cadmium and Lead.

Cadmium and lead were determined by GFAAS when element levels necessitated lower detection levels. The method required that 20 µL of the sample be introduced into a graphite tube. The tube was heated in a furnace to bring the sample to dryness, further heating charred the sample eventually atomizing the element of interest. For cadmium, the absorption of light caused by the excitation of the elements electrons was measured at a wavelength of 228.8 nm. For lead, absorption was measured at a wavelength of 283.3 nm.

C.3.1.4 Mercury

Mercury was determined by cold-vapor AAS and AFS in a single experiment. That is, the gas train bearing elemental mercury vapor was passed first through the absorption cell and then through the fluorescence cell. Customarily, the data from CVAFS were reported; the detection limit for mercury by fluorescence was of the order of 0.01 µg/mL in the solution in which elemental mercury was produced and vaporized. On occasion, the data from CVAAS were used when the concentration was above the range of the nine-point calibration curve.

Determination of mercury in coal using the sample preparation technique provided in SW-846 Method 7471 (in which the silicate component of the ash is not chemically decomposed) provided results that proved to be systematically low. Coal digestion in the microwave procedure, on the other hand, was deemed satisfactory. This procedure employs HF, which is capable of decomposing silicate and releasing mercury that may be inaccessible otherwise.

C.3.1.5 Recovery of Metal Spikes in Various Types of Samples

Tables C-1 through C-9 present the results of analyses of samples of several types both as received and after spiking with the metals of interest at known concentrations. There are certain notations that are common to all of these tables:

NR	No result
ND	Not determined
NV	No certified value

Table C-1. Recovery of Metal Spikes in Coal
(Data in µg/mL)

Element	Sample		Spike level	Spike/ sample	Spikes			% Recovery		
	Conc.	Dup. conc.			MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.0034	0.0042	0.1	26.3	0.083	0.103	22	80	99	89
Arsenic	0.0011	0.0015	0.05	38.5	0.036	0.045	22	70	87	78
Barium	0.2044	0.2122	0.4	1.9	0.6595	0.6234	6	114	103	108
Beryllium	0.0078	0.0087	0.1	12.1	0.1061	0.1026	3	98	94	96
Cadmium	0.00146	0.00204	0.02	11.4	0.0165	0.0167	1	75	73	74
Chromium	0.1588	0.2582	0.2	1.0	0.523	0.5449	4	182	143	163
Cobalt	0.012	0.0125	0.4	32.7	0.4329	0.4222	3	105	102	104
Copper	0.0445	0.0504	0.2	4.2	0.2363	0.2346	1	96	92	94
Lead	0.0322	0.0353	0.1	3.0	0.0889	0.0938	5	57	59	58
Manganese	0.1465	0.1575	0.2	1.3	0.3594	0.3449	4	107	94	100
Molybdenum	0.0256	0.0372	0.2	6.4	0.256	0.2676	4	115	115	115
Nickel	0.0974	0.1538	0.4	3.2	0.5944	0.6191	4	124	116	120
Selenium	0.00408	0.0059	0.05	10.0	0.032	0.036	12	56	60	58
Vanadium	0.1925	0.2155	0.1	0.5	0.3156	0.3602	13	123	145	134

Table C-2. Recovery of Metal Spikes in Limestone
(Data in µg/mL)

	Sample		Spike	Spike/	Spikes			% Recovery		
Element	Conc.	Dup. conc.	level	sample	MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.018	0.017	0.1	5.7	0.127	0.131	3	109	114	112
Arsenic	0.013	0.013	0.05	3.8	0.074	0.078	5	122	130	126
Barium	0.0546	0.0579	0.4	7.1	0.431	0.431	0	94	93	94
Beryllium	ND	ND	0.1	Ind.	0.095	0.0944	1	95	94	95
Cadmium	0.0041	0.00368	0.02	5.1	0.0206	0.0214	4	83	89	86
Chromium	0.0246	0.0229	0.2	8.4	0.214	0.202	6	95	90	92
Cobalt	0.006	0.0112	0.4	46.5	0.375	0.39	4	92	95	94
Copper	0.0906	0.095	0.2	2.2	0.33	0.334	1	120	120	120
Lead	ND	ND	0.1	Ind.	0.039	0.077	66	39	77	58
Manganese	2.767	2.881	0.2	0.1	3.01	2.979	1	122	49	85
Molybdenum	ND	0.017	0.2	Ind.	0.214	0.216	1	107	100	103
Nickel	0.1043	0.1079	0.4	3.8	0.452	0.457	1	87	87	87
Selenium	ND	ND	0.05	Ind.	0.0444	0.0455	2	89	91	90
Vanadium	0.146	0.153	0.1	0.7	0.245	0.254	4	99	101	100

Table C-3. Recovery of Metal Spikes in ESP Hopper Ash
(Data in µg/mL)

Element	Sample		Spike	Spike/	Spikes			% Recovery		
	Conc.	Dup. conc.	level	sample	MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.315	0.316	0.1	0.317	0.402	0.412	3	87	96	92
Arsenic	0.607	0.333	0.05	0.106	0.476	0.53	11	0	394	197
Barium	NR	4.08	1.4	0.343	5.34	5.4	1	90	94	92
Beryllium	0.23	0.226	0.1	0.439	0.329	0.332	1	99	106	103
Boron	19.2	19.2	1.0	0.052	21.9	22.2	1	270	300	285
Cadmium	0.49	0.49	1.02	2.082	1.38	1.39	1	87	88	88
Chromium	4.75	4.76	1.2	0.252	5.89	5.95	1	95	99	97
Cobalt	0.432	0.421	0.4	0.938	0.818	0.858	5	97	109	103
Copper	2.43	2.42	1.2	0.495	3.67	3.75	2	103	111	107
Lead	2.56	2.57	1.1	0.429	3.64	3.48	5	98	83	90
Manganese	2.35	2.31	1.2	0.515	3.42	3.43	0	89	93	91
Molybdenum	1.693	1.75	0.2	0.116	1.896	1.97	4	102	110	106
Nickel	2.86	2.82	1.4	0.493	4.18	4.19	0	94	98	96
Selenium	0.081	0.085	0.05	0.602	0.124	0.123	1	86	76	81
Vanadium	6.17	6.06	1.1	0.180	7.1	7.19	1	85	103	94

Table C-4. Recovery of Metal Spikes in Sluice Water Supply
(Data in µg/mL)

Element	Sample		Spike	Spike/	Spikes			% Recovery		
	Conc.	Dup. conc.	level	sample	MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.0095	0.0034	0.1	15.5	0.18	0.169	6	171	160	110
Arsenic	0.0129	0.0014	0.05	7.0	0.0582	0.0621	7	91	98	63
Barium	0.019	0.0183	0.4	21.4	0.382	0.359	6	91	85	59
Beryllium	ND	ND	0.1		0.093	0.085	9	93	85	59
Boron	0.117	0.18	1	6.7	1.08	0.9	18	96	78	59
Cadmium	ND	ND	0.02		0.0233	0.022	6	117	110	76
Chromium	0.0052	0.0098	0.2	26.7	0.186	0.18	3	90	87	59
Cobalt	ND	ND	0.4		0.371	0.342	8	93	86	60
Copper	0.0069	0.0108	0.2	22.6	0.19	0.176	8	92	85	59
Lead	ND	ND	0.1		0.076	0.075	1	76	75	50
Manganese	ND	0.0093	0.2	21.5	0.185	0.173	7	93	87	60
Molybdenum	0.005	ND	0.2	40.0	0.191	0.184	4	93	90	61
Nickel	0.0058	ND	0.4	69.0	0.365	0.337	8	90	83	58
Selenium	0.0021	ND	0.05	23.8	0.0501	0.0443	12	96	84	60
Vanadium	ND	ND	0.1		0.096	0.087	10	96	87	61

Table C-5. Recovery of Metal Spikes in MMT Front-Half Solids (Data in µg/mL)

Element	Sample conc.	Spike level	Spike/ sample	Spikes			% Recovery		
				MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.289	0.1	0.346	0.404	0.415	3	115	126	121
Arsenic	0.5	0.05	0.100	0.519	0.514	1	38	28	33
Barium	3.6	1.4	0.389	5	4.104	20	100	36	68
Beryllium	0.213	0.1	0.469	0.304	0.311	2	91	98	95
Cadmium	0.381	1.02	2.677	1.28	1.28	0	88.1	88.1	88
Chromium	3.7	1.2	0.324	4.93	5.05	2	102.5	112.5	108
Cobalt	0.382	0.4	1.047	0.8	0.794	1	104.5	103	104
Copper	1.93	1.2	0.622	3.25	3.26	0	110	110.8	110
Lead	2.56	1.1	0.430	3.59	3.76	5	93.6	109.1	101
Manganese	2.3	1.2	0.522	3.47	3.49	1	97.5	99.2	98
Molybdenum	1.32	1.2	0.909	2.41	2.49	3	90.8	97.5	94
Nickel	2.21	1.4	0.633	3.66	3.64	1	103.6	102.1	103
Selenium	0.291	0.05	0.172	0.372	0.36	3	162	138	150
Vanadium	5.23	1.1	0.210	6.4	6.51	2	106.4	116.4	111

Table C-6. Recovery of Metal Spikes in MMT Back-Half Impingers (Data in µg/mL)

Element	Method Blank	Spike level	Spike/ sample	Spikes			% Recovery		
				MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.0016	0.1	62.5	0.0883	0.0946	7	86.7	93	90
Arsenic	0.0002	0.05	250.0	0.0432	0.0436	1	86	86.8	86
Barium	ND	0.4		0.3761	0.3975	6	94	99.4	97
Beryllium	ND	0.1		0.0972	0.0948	3	97.2	94.8	96
Boron	3.94	1	0.3	8.16	5.91	32	422	197	310
Cadmium	ND	0.02		0.0177	0.0166	6	88.5	83	86
Chromium	0.005	0.2	40.0	0.1839	0.1826	1	89.5	88.8	89
Cobalt	ND	0.4		0.3766	0.3606	4	94.2	90.2	92
Copper	ND	0.2		0.1994	0.1955	2	99.7	97.8	99
Lead	ND	0.1		0.084	0.0911	8	84	91.1	88
Manganese	ND	0.2		0.1878	0.1902	1	93.9	95.1	95
Molybdenum	ND	0.2		0.1912	0.1916	0	95.6	95.8	96
Nickel	ND	0.4		0.3698	0.3615	2	92.5	90.4	91
Selenium	0.00053	0.05	94.3	0.0301	0.0315	5	59.1	61.9	61
Vanadium	ND	0.1		0.0952	0.0923	3	95.2	92.3	94

Table C-7. Recovery of Metal Spikes in ARP Liquid Phase
(Data in µg/mL)

Element	Sample		Spike	Spike/	Spikes			% Recovery		
	Conc.	Dup. conc.	level	sample	MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.00056	0.0002	0.1	263.2	0.0924	0.0952	3	92	95	93
Arsenic	0.0049	0.002	0.05	14.5	0.0561	0.0543	3	102	105	104
Barium	0.166	0.103	0.4	3.0	0.506	0.493	3	85	98	91
Beryllium	ND	ND	0.1		0.102	0.102	0	102	102	102
Boron	974	979	1.0	0.0	1018	1040	2	4400	6100	5250
Cadmium	0.0348	0.0265	0.02	0.7	0.076	0.0494	42	206	115	160
Chromium	0.0036	ND	0.2	55.6	0.198	0.198	0	97	97	97
Cobalt	0.0724	0.0491	0.4	6.6	0.445	0.443	1	93	99	96
Copper	0.0072	0.0027	0.2	40.4	0.219	0.219	0	106	108	107
Lead	0.0047	ND	0.1	21.3	0.0897	0.0714	23	85	67	76
Manganese	1.69	1.12	1.02	0.7	3	2.68	11	128	153	141
Molybdenum	0.1101	0.072	0.2	2.2	0.294	0.277	6	92	103	97
Nickel	0.707	0.439	0.4	0.7	0.846	0.845	0	35	102	68
Selenium	0.243	0.152	0.05	0.3	0.157	0.203	26	0	102	51
Vanadium	ND	ND	0.1		0.107	0.102	5	107	102	105

Table C-8. Recovery of Metal Spikes in ARP Solids
(Data in µg/mL)

Element	Sample		Spike	Spike/	Spikes			% Recovery		
	Conc.	Dup. conc.	level	sample	MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Antimony	0.0029	0.0051	0.1	25.0	0.089	0.098	10	86	93	90
Arsenic	0.006	0.0119	0.05	5.6	0.044	0.0136	106	76	3	40
Barium	0.0308	0.0324	0.4	12.7	0.434	0.45	4	101	104	103
Beryllium	ND	ND	0.1		0.0931	0.0935	0	93	94	93
Cadmium	ND	0.00248	0.02	8.1	0.04	0.04	0	200	188	194
Chromium	0.0051	0.0219	0.2	14.8	0.22	0.278	23	108	128	118
Cobalt	ND	ND	0.4		0.512	0.537	5	128	134	131
Copper	0.01	0.013	0.2	17.4	0.241	0.257	6	116	122	119
Lead	ND	ND	0.1		0.0572	0.0588	3	57	59	58
Manganese	0.117	0.0928	0.2	1.9	0.331	0.341	3	107	124	116
Molybdenum	ND	ND	0.2		0.221	0.273	21	111	137	124
Nickel	0.0276	0.0459	0.4	10.9	0.491	0.533	8	116	122	119
Selenium	0.0893	0.0961	0.05	0.5	0.158	0.138	14	137	84	111
Vanadium	0.0419	0.0369	0.1	2.5	0.176	0.145	19	134	108	121

Table C-9. Recovery of Mercury Spikes in Various Media (Data in µg/mL)

Sample description	Sample		Spike level	Spike/ sample	Spikes			% Recovery		
	Conc.	Dup. conc.			MS conc.	MSD conc.	Rel. % Diff.	MS	MSD	Avg.
Coal	1.2	1.08	1.0	0.9	1.84	1.94	13	70	80	75
Coal	0.505	NR	1.0	2.0	1.18	1.18	0	68	68	68
Lime	<0.02	<0.02	1.0	1.0	1.09	1.08	1	109	108	109
Bottom Ash	0.031	<0.002	1.0	32.3	0.949	0.97	2	93	95	94
Cyclone	0.0366	0.0332	1.0	28.7	0.962	0.925	4	93	89	91
Water	<0.20	<0.20	1.0	1.0	1.14	1.16	2	114	116	115
Water	0.054	0.057	1.0	18.0	1.08	1.09	1	102	103	103
MMT/Filter	0.395	0.442	1.0	2.4	1.19	1.06	18	77	64	71
MMT/Filter	0.0531	NR	0.5	9.4	0.589	0.647	11	107	119	113
MMT/Filter	0.122	0.917	1.0	1.9	0.964	NR		86	NR	
MMT/Peroxide	1.72	NR	1.0	0.6	2.78	2.84	6	106	112	109
MMT/Peroxide	<0.02	NR	1.0	1.0	0.989	1.14	14	99	114	107
MMT/KMnO4	0.188	NR	1.0	5.3	1.22	1.34	10	110	122	116
MMT/KMnO4	1.37	NR	1.0	0.7	2.32	2.3	2	95	93	94
MMT/KMnO4	0.116	0.12	1.0	8.5	NR	1.25		NR	113	
MMT/KMnO4	0.617	0.617	1.0	1.6	1.68	1.55	13	106	93	100
MMT/KMnO4	0.144	0.13	1.0	7.3	1.01	1.05	9	87	91	89

The tables all have the same format:

the results of metal determinations in the sample as received, usually in duplicate;

the spike level calculated for the solution prepared to be analyzed;

the ratio of the spike concentration to the average of the sample concentrations;

the results of duplicate sample analyses with spikes added;

the relative percent difference in results for the spiked samples;

the recovery of the spike in duplicate analyses (that is, the difference observed between spiked and unspiked samples, compared with the spike level.

Generally, the values of relative percent difference are more satisfactory than the values of percent recovery. This is hardly surprising, as will be explained. The following show the maximum values of relative percent difference in the determinations of metals other than mercury in spiked samples of various types:

Sample	Maximum R%D
Coal	22%
Limestone	6% (with one exception, 66%)
ESP hopper ash	11%
Sluice water supply	18%
MMT front half	20%
MMT back half	7%
ARP liquid phase	42%
ARP solids	23% (with one exception, 106%)

For mercury, the maximum value is 18%. The two exceptions are noted above specifically as exceptions to avoid conveying the impression that the highest values are part of the general population of results.

Consider the result of 66% noted above as an exception. The result is for lead, which was not detectable in the sample and the spike level was 0.1 µg/mL; the concentrations found after spiking were 0.039 and 0.077 µg/mL. Consider also the result of 106%, which occurred for arsenic in the ARP solids. The duplicate results for the sample were 0.006 and 0.012 µg/mL; with a spike of 0.05 µg/mL added, results were 0.044 and 0.014 µg/mL. The two elements associated with very poor replication, arsenic and lead, were chronic causes of difficulty at the low concentrations that occurred in these two instances.

Achieving satisfactory results in terms of spike recovery was more difficult because in many instances it involved measurement of small differences between relatively large numbers. Consider recoveries of 270 and 300% for boron spikes in the ESP hopper ash. The spike was only about 5% of the background concentration in the sample; hence, achieving poor recovery was not surprising. Consider even more absurd results for the boron spike in the ARP liquid phase. The recoveries were around 5000%, but then the spike was only 0.1% of the sample concentration.

The mismatch in magnitude between boron spikes and boron spike concentrations occurred because the unspiked sample and the spiked sample were digested and analyzed at the same time and the appropriate magnitude of the spike was not known. In retrospect, if the recovery of a boron spike in the given medium had been an issue in itself, the sample would have been spiked again but at a more appropriate level and reanalyzed. There are data for boron in other forms, however, that suggest that determination of boron was not a matter for urgent attention.

C.3.1.6 Recovery of Metals at Known Concentrations in Laboratory QC Samples and in Standard Reference Materials

Tables C-10 through C-14 present data showing recovery of metals in media other than field samples — either laboratory QC solutions prepared to contain metals at known concentrations or Standard Reference Materials purchased from the National Institute of Standards and Technology or Brammer Standards Company.

Solutions obviously constitute easier analytical problems because the sources of error encountered in putting a solid into solution are absent. This statement is borne out by the data on the general set of metals in Table C-10 and the data for mercury in particular in Table C-14. For mercury, the worst recovery value is 131% in a solution where the concentration was quite low. For the other metals, there are two indefensible results — recoveries around 300% for chromium and nickel, which may have been due to laboratory contamination.

For the solid SRMs — either coal or ash — a major problem is getting complete digestion and thus getting all of the metals to the analyzer. In both of the coal SRMs, the certified value for antimony is quite low and thus even having adequate sensitivity is a problem. Other sources of error are contamination during sample digestion and during sample dilution and subsequent chemical processing as is involved for the atomic absorption methods employed for antimony, arsenic, cadmium, lead, and selenium.

The data for SRMs in Tables C-11, C-12, and C-13 reveal that several metals frequently are not determined satisfactorily in solid media:

- In one instance the concentration of antimony was twice the certified value. In analyses of the NIST coal, the determination of antimony was not completed successfully.
- Cadmium was always at a low concentration and not determined adequately.
- Components of stainless steel — chromium, molybdenum, and nickel — were sometimes found at excessive concentrations.

Table C-10
Recoveries of Metals at Known Concentrations in a Laboratory QC Solution
(Data in μg/mL)

Element	Known conc.	Analysis 1		Analysis 2		Analysis 3	
		Conc.	Recov.%	Conc.	Recov.%	Conc.	Recov.%
Barium	4.00	4.21	105	4.23	106	4.18	105
Beryllium	1.00	0.93	93	1.04	104	0.94	94
Cadmium	0.25	0.33	130	0.27	108	0.33	131
Chromium	1.00	1.05	105	0.99	99	3.35	335
Cobalt	1.00	0.89	89	1.01	101	0.93	93
Copper	1.00	0.89	89	0.99	99	0.68	68
Lead	1.00	1.10	110	0.55	55	1.09	109
Manganese	1.00	0.93	93	0.88	88	1.03	103
Molybdenum	2.00	1.98	99	2.05	103	2.16	108
Nickel	1.00	0.92	92	0.94	94	2.95	295
Vanadium	2.50	2.46	98	2.71	108	2.27	91

Table C-11
Recoveries of Metals at Certified Concentrations in SARM 20 Coal[a]
(Data in μg/g)

Element	Certified value	Analysis	
		Conc.	Recov. %
Antimony	0.4	0.88	220
Arsenic	4.7	5.42	115
Barium	372	353	95
Beryllium	2.5	1.11	44
Boron	90	NR	–
Chromium	67	59.8	89
Cobalt	8.3	4.93	59
Copper	18	15.1	84
Lead	26	15.3	59
Manganese	80	71.4	89
Nickel	25	25.9	104
Selenium	0.8	0.295	37
Vanadium	47	42.6	91

[a] Purchased from Brammer Standard Company, Houston, TX.

Table C-12
Recoveries of Metals at Certified Concentrations in NIST 1632b Coal[a]
(Data in $\mu g/g$)

Element	Certified value	Analysis 1		Analysis 2		Relative diff. %
		Conc.	Recov.%	Conc.	Recov.%	
Antimony	0.24	ND	--	NR	–	--
Arsenic	3.72	3.60	97	2.57	69	33
Barium	67.5	67.4	100	69.9	104	4
Cadmium	0.0573	0.028	49	ND	--	--
Chromium	11	8	73	20	181	85
Cobalt	2.29	1.80	79	1.14	50	45
Copper	6.28	8.60	137	6.28	100	31
Lead	3.67	5.60	153	2.46	67	78
Manganese	12.4	11.0	89	10.7	86	3
Molybdenum	0.9	ND	--	2.0	217	--
Nickel	6.1	5.6	92	11.7	192	71
Selenium	1.29	1.98	153	0.16	12	170
Vanadium	14	15	107	14	99	8

[a] Purchased from National Institute of Standards and Technology, Gaithersburg, MD.

Table C-13
Recoveries of Metals at
Certified Concentrations in NIST 1633a Fly Ash[a]
(Data in $\mu g/g$)

Element	Certified value	Analysis 1		Analysis 2		Relative diff. %
		Conc.	Recov.%	Conc.	Recov.%	
Antimony	6.8	17.98	264.4	4.45	65.4	121
Arsenic	145	115	79.3	159	109.7	32
Barium	1500	1293	86.2	1358	90.5	5
Beryllium	12	16.02	133.5	16.8	140	5
Cadmium	1	0.859	85.9	NR	--	–
Chromium	196	167.95	85.7	174.2	88.9	4
Cobalt	46	39.06	84.9	38.6	83.9	1
Copper	118	115	97.5	101	85.6	13
Lead	72.4	NR	--	NR	–	--
Manganese	179	159	88.8	159	88.8	0
Molybdenum	29	17.84	61.5	16.72	57.7	6
Nickel	127	109.9	86.5	112	88.2	2
Selenium	10.3	7.9	76.7	7.88	76.5	0
Vanadium	297	306	103	286	96.3	7

[a] Purchased from National Institute of Standards and Technology, Gaithersburg, MD.

Table C-14
Recoveries of Mercury in Various SRMs and Laboratory QC Standards
(Data in μg/g or μg/L)

Sample[a]	Reference conc.	Observed conc.	% Recovery
SARM 20	0.25	0.142	57
SARM 20	0.25	0.136	54
SARM 20	0.25	0.163	65
SARM 20	0.25	0.183	73
NBS 1633a	0.16	0.195	122
NBS 1633a	0.16	0.215	134
QC095	250	24	110
QC095	250	230	92
QC095	250	238	95
QC095	250	208	83
QC095	250	275	110
QC095	250	249	100
QC095	250	229	92
QC043	4.00	4.60	115
QC044	4.00	4.27	107
QC045	2.00	2.21	111
QC047	0.080	0.105	131
QC048	0.120	0.066	55

[a] First group — solids (µg/g).
[b] Second group — solutions (µg/L).

The occurrence of these elements in stainless steel may be coincidental, but the fact may point indirectly to a source of contamination.

- Selenium was often recovered at very low levels although in one instance reported here was found at a high level.

C.3.1.7 Blanks for Metals Recovered by Method 29

Table C-15 compares the quantities of metals recovered in actual sampling runs with the quantities from so-called "blank trains." The differences between measured sample quantities and corresponding blank quantities were used for calculating net sample amounts and for calculating the sample concentrations reported in Section 6. Data are not presented for all sampling experiments; instead, they are given for two experiments, one at the inlet and one at the outlet of the Unit 8 ESP. These two locations had the extremes in sample concentrations; thus, the blank corrections had effects at these locations.

The first page of the table presents data for the front half of the sampling train at each location. The second page gives data for the back half. Clearly, the blank sometimes exceeded the sample amount and led to apparent negative concentrations (which were reported as less than the appropriate detection limit). The absolute value of the blank correction for the inlet filter is about 1.7 times the value for the outlet filter because of the difference in filter sizes in the inlet sampling train and the blank train.

C.3.2 Anions

As described previously in Section 5, three anions (chloride, sulfate, and phosphate) in acid gas impingers were determined by ion chromatography, and the fourth (fluoride) was determined by use of an ion-selective electrode. These ions were determined by use of the same techniques in water and solid samples. In the case of the latter, the solids had first been made water-soluble by fusion with NaOH.

Table C-16 presents the results of measurements of anion spikes in selected samples of the various media. The recoveries range, with just a few exceptions, between 90 and 110%.

Table C-17 gives recoveries of spikes of cyanide and ammonia in impinger solutions that had been used for sampling flue gas. The three examples given are in the range 95-100%.

Blanks were inconsequential in comparison with reported sample quantities.

C.3.3 Carbonyl Compounds (Aldehydes and Ketones)

These compounds were analyzed by HPLC according to EPA Method 0011 (7), which was written specifically for formaldehyde.

Table C-15
Comparison of Sample and Blank
Amounts of Metals

Metal	Inlet, Unit 8 ESP		Outlet, Unit 8 ESP	
	Sample, µg	Blank, µg	Sample, µg	Blank, µg
FRONT HALF				
Antimony	61.3	1.13	0.31	0.66*
Arsenic	289	0.77	2.75	0.45
Barium	3810	9.4	18.5	5.5
Beryllium	205	0.043	0.29	0.025
Boron	7760	58	1.59	34*
Cadmium	296	1.0	13.3	0.
Chromium	4560	8.5	18.6	5.0
Cobalt	392	2.6	1.46	1.55*
Copper	1780	6.8	7.84	4.01
Lead	3010	0.43	19.8	0.25
Manganese	2420	2.6	6.62	1.48
Mercury	0.76	0.067	0.22	0.039
Molybdenum	1370	36	33.5	21.2
Nickel	2540	4.3	2.10	2.55*
Selenium	468	0.94	2.32	0.55
Vanadium	5105	0.43	3.90	0.25

*Produces a net result that is negative.

Table C-15 (Concluded)
Comparison of Sample and Blank Amounts of Metals

	Inlet, Unit 8 ESP		Outlet, Unit 8 ESP	
Metal	**Sample, µg**	**Blank, µg**	**Sample, µg**	**Blank, µg**
BACK HALF				
Antimony	0.56	0.10	0.16	0.10
Arsenic	2.74	0.10	0.92	0.10
Barium	8.23	2.54	1.98	2.54*
Beryllium	0.025	0.02	0.00	0.02*
Boron	34600	403	11900	403
Cadmium	6.28	0.01	2.18	0.01
Chromium	10.7	1.23	3.29	1.23
Cobalt	0.95	0.72	0.08	0.72*
Copper	6.57	4.2	0.81	4.2*
Lead	1.76	0.25	0.53	0.25
Manganese	16.8	14.3	0.90	14.3*
Mercury	11.6	0.03	4.03	0.03
Molybdenum	0.25	0.25	0.00	0.25*
Nickel	21.1	0.50	7.19	0.50
Selenium	316	1.25	110	1.25
Vanadium	0.62	0.25	0.13	0.25*

*Produces a net result that is negative.

Table C-16
Recoveries of Anion Spikes in Various Samples

Type of sample	Analyte	Dil factor	Concn, µg/mL		Spike recovery, %
			Sample	Spike	
Acid Train Impingers					
Unit 8 inlet	chloride	50	2.25	2.00	102
	chloride	50	2.23	9.90	99.0
	fluoride	1	1.00	16.3	100
Unit 8 outlet	sulfate	1000	12.8	19.6	98.0
	sulfate	1000	11.9	90.9	97.0
Unit 8 outlet	sulfate	1000	17.7	19.6	99.0
Stack	chloride	5	0.202	0.196	99.0
Diluter	fluoride	1	13.8	2.00	95.0
Liquid Samples					
Condenser inlet	fluoride	1	<0.40	4.00	100
Condenser outlet	sulfate	10	2.50	2.50	104
	chloride	20	0.693	0.50	100
	fluoride	1	<0.40	3.00	100
Boiler makeup water	sulfate	1	<0.10	0.20	116
	chloride	1	<0.05	0.10	108
Sluice water supply	sulfate	50	2.53	2.50	111
	chloride	20	0.719	1.00	106
Bottom ash sluice water	phosphate	1	<0.50	1.00	104
	fluoride	1	<0.40	1.00	90.0
Bleed pump slurry	sulfate	200	8.41	8.00	105
	chloride	2500	2.68	2.00	114
	phosphate	20	<0.50	1.00	85.7
Abs. recirc. pump slurry	phosphate	50	<0.50	1.00	83.3
Boiler waste water	phosphate	20	<0.50	1.00	88.0

Table C-16 Concluded
Recoveries of Anion Spikes in Various Samples

Type of sample	Analyte	Dil factor	Concn, µg/mL		Spike recovery, %
			Sample	Spike	
Solid Samples					
Bottom ash	sulfate chloride phosphate	2 1 2	0.565 0.111 0.770	0.50 0.107 1.00	104 115 96.6
ESP hopper ash	sulfate chloride phosphate	5 1 4	3.07 0.781 0.763	3.00 1.00 0.800	98.2 108 103
Abs. recirc. pump slurry	sulfate chloride phosphate fluoride	25 1 1 1	10.9 0.138 <0.50 0.50	10.0 0.25 1 0.50	96.8 110 102 140
Gypsum	sulfate	25	11.45	10.0	101

Table C-17
Recoveries of Cyanide and Ammonia Spikes in Impinger Samples

Type of sample	Analyte	Dil factor	Concn, µg/mL		Spike recovery, %
			Sample	Spike	
Unit 8 inlet	cyanide	--	0.394	0.741	99.0
Stack	cyanide	--	0.026	0.196	97.0
Unit 7 outlet	ammonia	--	0.041	0.069	97.1

One of the significant handicaps to the method is obtaining the sampling reagent DNPH in a sufficiently pure state. Normally, the 70%-pure reagent that is widely available commercially is used for the method (the 30% balance of the reagent content is mainly water). In the work at Bailly, however, an ultra-pure reagent was purchased from Radian Corporation. Nevertheless, significant and variable blank values were encountered, as revealed by the tables presenting sample data in the body of this report.

Another factor introducing uncertainty in the data is the stability or lack of stability of formaldehyde in the sampling reagent while sampling is in progress. Section 6.1.3.4 recounts the experience in recovering formaldehyde that had been spiked into sampling reagent before stack gas was drawn through the reagent. The results of the spiking experiment suggest either that the complex between formaldehyde and DNPH is not sufficiently stable to prevent the volatilization of the aldehyde or that unknown constituents in flue gas can destroy the complex.

Opposing the possible loss of formaldehyde during sampling is the possibility that some level of contamination occurred from the environment. The laboratory made available for preparation and work-up of the sampling trains was a trailer that was suspected to contain element of construction based on formaldehyde-containing resins; thus, the trailer atmosphere was sampled with a blank train for about the twice the volume sampled from flue gas. A quite significant amount of formaldehyde, 58 μg, was collected, compared with 10-20 μg from flue gas. There was not necessarily a significant contamination in any sample from the flue gas, but the possibility of some level of contamination does exist.

The level of recovery of spikes applied in the laboratory was disappointing. For the unused sampling medium, recovery of formaldehyde spikes ranged from 72 to 97%. For aqueous media from the plant, the following are illustrative results:

Water sample	Formaldehyde recovery, % Spike	Formaldehyde recovery, % Duplicate
Condenser inlet	-28	-23
Boiler makeup	117	68
Bleed pump slurry	35	112

The concentrations in the three samples before spiking were 112, 38, and 185 μg/L, respectively; the spike produced an increment of 97.5 μg/L. In the first instance, where negative recoveries are listed, recalculation of recoveries assuming the true sample value was zero yields recoveries of 97 and 103%. It is probable, but not subject to proof at this date, that the observed concentration before spiking was near zero and the recalculated recovery values are approximately the true results.

Data on blanks are given in Table 6-42 in the body of the report. The ranges in micrograms were 1.4-3.7 for formaldehyde, <1.0-1.2 for actaldehyde and <1.0-2.5 for acetone.

C.3.4 Volatile Organic Compounds

C.3.4.1 Experimental Methods

EPA Methods 8240B and 5041 were modified for the determination of volatile organic compounds by replacing the packed column with a capillary column. At the beginning of each day, the GC/MS system tuning performance criteria were checked for a 50-ng sample of bromofluorobenzene (BFB). Three isotopically labelled compounds were used as internal standards during calibration of the GC/MS system to avoid matrix interferences. The analyst prepared calibration curves with calibration standards at five concentration levels for each volatile organic compound. Each calibration standard included a known, constant amount of internal standard.

Most system performance check compounds used to assess instrument readiness for the analyses of liquids and VOST tubes met the minimum requirements listed in Methods 8240B. Bromoform was the only SPCC that did not meet listed method requirements. Calibration curves relative response factors were verified on each working day by measurement of the middle calibration check standard. The response of all calibration check compounds met method requirements. The continuing calibration check compounds met method requirements.

C.3.4.2 QA/QC Data

Data on the recovery of compounds that were present in known concentrations in samples analyzed for volatile organics are presented in Tables C-18, C-19, and C-20. The first two of these tables give the recoveries of three so-called surrogates, which were always added to the samples to be analyzed. One of the table deals with samples of water; the second pertains to samples collected on Tenax and Tenax-charcoal sampling tubes from the VOST. The final table presents the data on other compounds that were added as spikes in the water samples.

The specifications in SW-846 for acceptable recoveries of the individual compounds are included in the tables. Clearly, the actual recoveries were well within the ranges of acceptable values.

The rejection of the field data as being of improbable value follows not from any objective criteria in terms of laboratory performance but from the subjective reasoning presented subsequently in Appendix D.

C.3.4.3 VOST Blanks

Table C-21 lists the quantities of volatile organics found in three types of blanks as defined in the table. The lowest-boiling compounds in the first four columns were found erratically as the result, it is believed, of poor laboratory handling. The benzene and toluene in the blanks would have made inconsequential corrections in the observed samples quantities of these compounds but, of course, are irrelevant because the sample quantities are considered erroneous.

Table C-18 Recovery of Surrogate Volatile Organic Compounds in Water Samples

Sample	Recovery, %		
	Surrogate 1[a]	Surrogate 2[b]	Surrogate 3[c]
Boiler makeup water	91.9	95.4	92.6
Condenser inlet	89	98.3	94.9
Sluice water supply	90.7	95.7	95.9
Bottom ash sluice	89.4	95.5	92.3
Abs. recirc. pump slurry	90.7	93.7	95.2
Bleed pump slurry	93.1	97	94.1
Scrubber waste water	91.5	97.2	98.2

[a] 1,2-Dichloroethane-d_4 (SW-846: 76-114%).
[b] Toluene-d_8 (SW-846: 88-110%).
[c] 4-Bromofluorobenzene (SW-846: 86-115%).

Table C-19 Recovery of Surrogate Volatile Organic Compounds in VOST Samples

Sample[a]	Recovery, %		
	Surrogate 1[b]	Surrogate 2[c]	Surrogate 2[d]
Unit 8 inlet - T	101	98	101
T/C	93	97	102
Unit 8 outlet - T	93	97	95
T/C	98	101	105
Unit 7 outlet - T	94	97	92
T/C	93	98	101
Stack - T	92	95	77
T/C	92	96	97

[a] T=Tenax; T/C=Tenax/charcoal. The samples indicated here are the 20-L samples at the four VOST locations.

[b] 1,2-Dichloroethane-d_4 (SW-846: 76-114%).

[c] Toluene-d_8 (SW-846: 88-110%)

[d] 4-Bromofluorobenzene (SW-846: 86-115%).

Table C-20 Recovery of Spikes of Volatile Compounds in Selected Water Samples

Spiking compound[a]	SW-846 specification	Recovery, %							
		Boiler makeup		Condenser outlet		Bleed pump slurry		Scrubber waste water	
		MS	MSD	MS	MSD	MS	MSD	MS	MSD
1,2-dichloroethane-d_4	76-114	94.2	92.4	90	93.4	93.4	95.6	86.8	90
toluene-d_8	88-110	97.6	96.2	96.4	100	95.2	98.2	94.6	93.8
4-bromofluorobenzene	86-115	100	94.4	97.4	97.6	92	94.8	93.6	96.8
1,1-dichloroethene	50.5-150	116	112	123	121	102	105	95.8	80.2
benzene	64-136	95.6	97.2	94.8	96.6	92.4	96	90	94
trichloroethene	66.5-134	90.8	95	92.6	94	91.4	93.2	88	95.2
toluene	74.5-126	91.8	96.2	94	94.2	90.6	94.8	87.4	90.4
chlorobenzene	66-134	90.8	91.8	92.4	90	89	91.4	87.6	91

[a] Each at 50 µg/L. The first three compounds are the three surrogates cited in the preceding two tables.

Table C-21
Compounds Measured in VOST Blanks

Sampling location	Sample type*	Quantity in nanograms					
		Bromo-methane	Acetone	Carbon disulfide	Methylene chloride	Benzene	Toluene
Inlet, ESP Unit 8	T(LC)		17			8.6	
	TC(LC)	25			6.0	5.8	
	T(FB)				2110		
	TC(FB)	19		20	2530	5.8	
	T(TB)				497		
	TC(TB)			45			
Outlet, ESP Unit 8	T(LC)	15				12	7.2
	TC(LC)				26	7.2	
	T(FB)						
	TC(FB)			22			
Outlet, ESP Unit 7	T(LC)		24			9.6	
	TC(LC)						
	T(FB)	18	36		5.1		
	TC(FB)						
	T(TB)	10					
	TC(TB)		10				
Stack	T(LC)	34	21		21	9.2	60
	TC(LC)	20			21	6.2	
	T(FB)		11		71		
	TC(FB)	10			57		
	T(TB)						
	TC(TB)				10	6.2	

*T=Tenax
TC=Tenax/charcoal
LC=leak check blank (assembled apparatus checked for air leaks under vacuum with sampling tubes installed)
FB=field blank (sample tubes opened momentarily in the field but not exposed to a flow of air)
TB=trip blank (sample tubes shipped to and from the field without ever being opened)

C.3.5 Semivolatile Organic Compounds

C.3.5.1 Experimental Methods

Semivolatile organic compounds were analyzed by capillary column GC/MS according to EPA Method 8270B from SW-846. A number of samples analyzed for semivolatile organic compounds were also analyzed for dioxins. These samples were prepared for semivolatile analysis as required by Method 8270B using toluene rather than methylene chloride to extract the samples. The use of toluene as an extractant resulted in some loss of the earlier eluting target compounds with lower boiling points.

A 50-ng sample of decafluorotriphenylphosphine (DFTPP) was analyzed at the start of each day prior to analysis of semivolatile compounds. The spectrum-validation criteria were met before any samples, blanks, or standards were analyzed. When the criteria for this analysis were not achieved, the analyst retuned the mass spectrometer and repeated the test until all criteria were achieved.

The analysts prepared calibration curves with calibration standards at five concentration levels for each semivolatile organic compound of interest. Each calibration standard included known, constant amounts of six internal standards. Calibration curve relative response factors for target compounds were verified on each working day by the measurement of one or more calibration check standards. If the response for any calibration check compound (CCC) varied from the curve response factor by more than ±20, the analyst noted the variance and evaluated the potential impact of the variance on the analysis to be performed. If the response for any calibration check compound varied from the curve response by more than ±25%, the test was repeated with a fresh calibration standard. If the response of the check compound still varied from the calibration curve by more than ±25%, a new calibration curve was prepared.

Difficulties encountered with several samples necessitated specific departures from the method.

- For the samples extracted with toluene, the surrogates with lower boiling points typically showed reduced recoveries. This problem was not typically observed for those samples extracted with methylene chloride. It is believed that the higher temperature required to evaporate toluene during the concentration step contributed to the loss of the target compounds with a lower boiling point.

- Contamination with very low levels of benzyl alcohol, 2-methylphenol, and 4-methylphenol of samples and blanks resulted from the toluene used to wash sampling equipment in the field and to extract the samples in the laboratory. The toluene used on this project was purchased form our supplier for use only on this project. The supplier worked with SRI to identify the source of the problem. Other contaminants that may have originated in the toluene are benzoic acid and phenol.

- Analysis of a calibration check sample at the end of a 12-hr operating period and after completion of a sequence of five samples showed a total loss of retention and resolution on the column. The column was replaced and the instrument retuned and recalibrated before analysis was resumed. Analysis of the five samples in question had to be repeated.

C.3.5.2 QA/QC Data

QA/QC data for samples that contained known added concentrations of selected semivolatile compounds are presented in Tables C-22, C-23, and C-24. Tables C-23 and C-24 give recoveries of surrogates that were added to the samples after field sampling took place. The recoveries of the field spikes provide a measure of the expected efficiency of analyte recovery throughout both field sampling and laboratory analysis; the recoveries of the surrogates reflect the efficiency of recovery as influenced by laboratory operations alone. Finally, Table C-24 presents recovery data on other compounds that were added to the water samples as spikes.

SW-846 gives the following as acceptable limits for the surrogates:

2-Fluorophenol	21-100%
Phenol-d_3	10-94%
Nitrobenzene-d_5	35-114%
2-Fluorobiphenyl	43-116%
2,4,6-Tribromophenol	10-123%
p-Terphenyl	33-141%

Even though the specifications tolerate large deviations from 100% recovery, the data in Tables C-22 and C-23 show recoveries that still are very poor. The first two surrogates, with the lowest chromatographic retention times, were sometimes not even observed in sample analysis; their absence may be attributed to loss by evaporation during the removal of toluene processing solvent by evaporation. Moreover, traces of unremoved toluene had retention times not very different from these surrogates and cause interference in assessing recovery accurately. The very high recoveries in some instances are attributed to reaction of some unknown sample component with the column, which effectively destroyed the usefulness of the column.

The recovery data of the spiking compounds in water (Table C-24) were far more satisfactory. It is not known why the recoveries of compounds in the group referred to a spiking compounds differed so markedly from those termed surrogates when both were added and determined simultaneously.

C.3.5.3 Blanks

The blank filters and blank XAD from the field (components of blank trains or field and trip blanks) were all extracted with toluene. The analyses showed the contamination already attributed to this solvent during the discussion of sample analysis. The list below reveals the range of levels of individual contaminants:

Phenol	0-13 µg
Benzoic acid	277-6680 µg
Benzoic acid	23-1340 µg
Naphthalene	0-4 µg
Phthalate ester	1-9 µg (total of all phthalate compounds)

C.3.6 Dioxins and Furans

Dioxins and furans were determined using SW-846 Method 8290. Each sample was fortified with PCDD/PCDF isotope dilution standards (14 isotopically-labeled compounds) and was extracted with toluene in a Soxhlet extractor. The extracts were concentrated and exchanged into hexane. One isotopically labeled clean-up surrogate was added to the laboratory blanks at this point (0.8 ng/sample). For actual samples, 2 ng of the surrogate was added to the XAD-2 resin before the resin was sent to the field; 0.8 ng of the surrogate was added to filters being sent to the field. The extract was partitioned against 5% NaCl, 20% aqueous KOH, 5% NaCl, several portions of H_2SO_4, and 5% NaCl. The extract was concentrated and eluted through an alumina column with further clean up on an AX-21 carbon/Celite 545 column. The toluene eluant fraction was spiked with isotopically labeled internal standard, concentrated, and exchanged into nonane. The final sample extracts were analyzed by high-resolution GC/MS.

A five-point calibration curve was generated, having the lowest concentration corresponding to 0.02 ng of TCDD or TCDF in 20 µL of solution; therefore the nominal detection limit for TCDD and TCDF in MM5 samples was 0.02 ng. Similarly, the nominal detection limits for PECDD, PECDF, HXCDD, HXCDF, HPCDD, and HPCDF were 0.10 ng and for OCDD and OCDF 0.20 ng. Concentrations less than these values were determined by extrapolating the calibration curve.

The linearity of the instrument response was verified by the successful initial calibration of the instrument. The linear range of the analyte injected into the gas chromatograph is 0.001 to 0.2 ng/µL of TCDD and TCDF; 0.005 to 1.0 ng/µL of PECDD, PECDF, HXCDD, HXCDF, HPCDD, and HPCDF; and 0.01 to 2.0 ng/µL of OCDD and OCDF. The data indicate that the instrument retained its linearity of response throughout the analyses.

The surrogate 2,3,7,8-tetrachlorodibenzodioxin with chlorine-37 labels was used as a spiking compound in both filters and XAD resin. The amount of the spiking compound was 0.8 ng for filters and 2.0 ng for XAD cartridges (these amounts are to be contrasted to the lowest reporting level of 0.01 ng). Recoveries were as follows:

Blanks		
Field blank	XAD	80%
Trip blank	XAD	66%
Blank trains (2)	filter	80, 89%
	XAD	81, 106%
Samples		
Unit 7 ESP outlet	filter	77%
	XAD	74%
Dilution device	filter	74%
	XAD	155%
Stack	filter	82%
	XAD	70%

Table C-22. Recoveries of Surrogates from MM5 Samples

Sample[a]		Recovery, % of Surrogate[b]					
		1	2	3	4	5	6
Unit 8 Inlet	- F	46	22	72	83	76	84
	- B	61	60	95	90	91	114
Unit 8 Outlet	- F	54	58	78	87	76	88
	- B	49	58	74	73	53	89
Unit 7 Outlet	- F	0	0	55	451	446	148
	- B	0	0	56	105	117	36
Stack	- F	0	0	38	467	394	68
	- B	0	0	42	69	89	74

[a] F = front (filter); B = back (XAD)

[b] Surrogate 1 = 2-Fluorophenol
2 = Phenol-d_5
3 = Nitrobenzene-d_5
4 = 2-Fluorobiphenyl
5 = 2,4,6-Tribromophenol
6 = p-Terphenyl-d_{14}

Table C-23. Recoveries of Surrogates from Water Samples

Sample	Recovery, % of Surrogate[a]					
	1	2	3	4	5	6
Boiler makeup	11	63	88	80	17	94
Condenser inlet	38	42	44	44	42	48
Sluice	81	83	76	79	77	86
ARP slurry	34	41	41	41	32	51

[a] Surrogate 1 = 2-Fluorophenol
2 = Phenol-d_5
3 = Nitrobenzene-d_5
4 = 2-Fluorobiphenyl
5 = 2,4,6-Tribromophenol
6 = p-Terphenyl-d_{14}

Table C-24
Recovery of Spikes of Semivolatile Compounds in Water Samples

Compounds	Concn., µg/L	Boiler Makeup		Condenser Outlet		ARP Liquid		Boiler Waste water	
		MS	MSD	MS	MSD	MS	MSD	MS	MSD
Phenol	400	69	76	73.5	66.8	77.4	66.7	68.3	78.3
2-Chlorophenol	400	72	79.5	75.5	69.8	77.9	67.8	66.3	78
1,4-Dichlorobenzene	200	47.7	62.5	48	48.7	58.4	44.3	41.6	52
N-Nitroso-di-n-Propylamine	200	82	80.5	87	82.5	72	76.4	67.5	71.6
1,2,4-Trichlorobenzene	200	50.5	62.5	57	58	61.9	47.7	44.4	55
4-Chloro-3-methylphenol	400	74.8	74.5	86.3	80.8	78.1	67.5	68.3	78.5
Acenaphthene	200	87	89	97.5	96	87.8	79.5	75	86
4-Nitrophenol	400	62.8	61.3	82.5	86.8	85.5	75.5	73	70.3
2,4-Dinitrotoluene	200	86	88	97.5	92	90.2	86.7	82.5	93.5
Pentachlorophenol	400	62.8	73.8	81.8	87.5	76.7	48.7	58	65
Pyrene	200	96	102	106	99.5	89.9	88.7	81	91

APPENDIX D

DATA ON VOLATILE ORGANICS

APPENDIX D

DATA ON VOLATILE ORGANICS

D.1 INTRODUCTION

The previous study by SRI of air toxics at Tuscon Electric Power Company's Springerville generating station provided part of the background for rejecting the data on volatiles from Bailly. The first sampling trip to Springerville in June 1993 yielded data somewhat like the data from Bailly presented here. A second sampling trip in February 1994 (five months later than the investigation at Bailly) made use of certain laboratory studies in the interim to identify possible causes of spurious high concentration of the aromatic hydrocarbons (benzene, toluene, and xylenes). The samples of the second trip yielded much lower concentrations and seemed to confirm the conclusion from the interim studies as to the true source of these compounds.

The specific hypothesis tested during the interim studies was that ambient air drawn into the inlet of the sample line introduces contamination. The assumed path of in-leaking air is the annulus between the glass liner and the sheath of the probe, where a tape-wrapped heating wire is used to keep the liner hot. A force tending to promote the air sweep would, of course, be a negative duct pressure, drawing ambient air into the duct in proximity to the inlet of the sampling line. Only recently have probes from the commercial supplier had provisions for blocking the path of the air sweep by a seal.

The findings were as follows:

1) Tape similar to that used by the probe manufacturer evolved benzene, toluene, and xylenes when heated in the laboratory under conditions quite independent of those associated with the VOST probe.

2) Adjusting a probe supplied by a commercial source permitted the investigators to raise or lower benzene, toluene, and xylene impurities in the sample stream drawn from the pilot combustor with gas firing. Pulling the liner into the probe, to restrict the access of flue gas but improve the access of leakage air to the probe inlet, increased the impurity levels. It also decreased the recovery of a deuterated benzene spike from the combustor flue gas. Extending the probe into the flue gas, on the other hand — shifting the relative access to the opposite of that first described — decreased the contaminant level and increased the spike recovery.

3) Comparative measurements all indicated that negligible concentrations of normal benzene were produced in the combustor but that appropriate levels of a deuterated benzene spike were recovered. These measurements consisted of:

a) VOST sampling with a probe extension to minimize infiltration of heating tape off-gases, followed by GC/MS analysis;
b) Carbon-tube sampling as prescribed by NIOSH, followed by GC/FID analysis; and
c) Tedlar-bag sampling, followed by analysis with a portable GC equipped with an argon-ionization detector.

With the VOST probe modified to minimize contamination from the tape source, we then returned to Springerville in February 1994 and found previous erratic, sometimes high concentrations of volatile hydrocarbons no longer present. The carbon-tube sampling and the portable GC analysis yielded results similar to those obtained with the modified VOST probe.

It cannot be said positively that the high concentrations of volatiles at Bailly were spurious because of the heated tape as the source. Nevertheless, the probability seems high that this is so.

D.2 DATA FROM BAILLY

The data on volatile organics from Bailly (all collected on September 6) are presented in Table D-1, D-2, D-3, and D-4. These data are believed to be spurious for the reason discussed above and, thus, do not appear in the body of the report. Moreover, no excerpt of the data can be said to be credible. In other words, the entire compilation of data have to be disregarded. It is appropriate, however, to comment upon some aspects of the data.

Each table gives the quantities of the individual compounds in nanograms observed in two of the three components of the Volatile Organics Sampling Train (VOST) (described in SW-846, (1)). The first of these sampling element is designated as T, which stands for a sampling tube filled with Tenax resin. The second element is designated as TC, which represents a sampling tube containing Tenax in the first half and charcoal in the second half. The third element is not listed in these tables; it was a water condensate, which did not usually contain a significant amount of any of the analytes.

In each table there are data for three sampling runs, which differed in duration and thus in gas volume sampled. The nominal values of the sample volumes were 20, 10, and 5 L, collected in runs of 40, 20, and 10 min duration.

There were numerous analytes identified. Some were definitely not components of the gas streams sampled, however, because they also occurred in blanks. Three of the components for which this NOT true are benzene, toluene, and xylenes. Benzene can be singled out for particular remarks. Approximate concentrations of benzene at the three locations, calculated for approximate sample volumes of 20, 10, and 5 L, respectively, are as follows:

Location	Concn, $\mu g/Nm^3$
Inlet, Unit 8 ESP	3870, - , 2820
Outlet, Unit 8 ESP	2795, 2070, 2420
Outlet, Unit 7 ESP	129, 102, 160
Stack	514, 252, 192

There is remarkable difference in calculated benzene concentrations between Unit 8 and Unit 7 or the stack. There is no justification, however, for believing that the difference reflects a real difference in gas composition. For reasons described in the preceding paragraphs, difference is attributed to unidentified differences in the sampling procedure, sampling apparatus, or environment.

Table D-1
Apparent Quantities of Volatile Organics Collected at the Inlet of the Unit 8 ESP
(Data in ng)

	Run 1 (ca. 29 L)		Run 2 (ca. 10 L)		Run 3 (ca. 5 L)	
	T 5000	TC 5001	T 5002	TC 5003	T 5004	TC 5005
Chloromethane	3430				832	
Vinyl chloride	31.3			18.5		
Bromomethane		50.7				
Chloroethane						
1,1-Dichloroethene						
Acetone	207	387		150	101	24.6
Methyl iodide	24.1	158		31.5		
Carbon disulfide	24.9	48.3			470	45
Methylene chloride		8.12		15.8		
trans-1,2-Dichloroethene						
1,1-Dichloroethane						
2-Butanone						
Chloroform						
1,1,1-Trichlorethane						
Carbon tetrachloride						
Benzene	7940	79.3		83.2	1410	19.3
1,2-Dichlorethane	176					
Trichloroethene						
1,2-Dichloropropane						
Bromodichloromethane						
cis-1,3-Dichloropropene						
2-Hexanone						
Toluene	38.9	11.1		11.3	19.8	9.6
trans-1,3-Dichloropropene						
1,1,2-Trichloroethene						
Tetrachloroethene		133		83.9		
4-Methyl-2-pentanone	10.6					
Dibromochloromethane						
Chlorobenzene						
Ethylbenzene		5.07		20.8		17.0
m- & p-xylene	19.6	5.35		16.5		13.5
o-xylene						
Styrene						
Bromoform						
1,1,2,2-Tetrachloroethane						

Table D-2
Apparent Quantities of Volatile Organics Collected at the Outlet of the Unit 8 ESP
(Data in ng)

	Run 1 (ca. 20 L)		Run 2 (ca. 10 L)		Run 3 (ca. 5 L)	
	T 5032	TC 5033	T 5034	TC 5035	T 5036	TC 5037
Chloromethane	2340		1120		1160	
Vinyl chloride		9.96	5.16		5.64	
Bromomethane		36			11.9	73.1
Chloroethane						
1,1-Dichloroethene						
Acetone	140	144	144		104	71.6
Methyl iodide						
Carbon disulfide		23.9			24.8	
Methylene chloride					1680	30000
trans-1,2-Dichloroethene						
1,1-Dichloroethane						
2-Butanone						
Chloroform						50.5
1,1,1-Trichlorethane						
Carbon tetrachloride						
Benzene	5590	699	2070		1210	88.9
1,2-Dichlorethane	130		49.5		9.18	
Trichloroethene						
1,2-Dichloropropane						
Bromodichloromethane						
cis-1,3-Dichloropropene						
2-Hexanone						
Toluene	44.2	10.5	38		29.6	11
trans-1,3-Dichloropropene						
1,1,2-Trichloroethene						
Tetrachloroethene						
4-Methyl-2-pentanone						
Dibromochloromethane						
Chlorobenzene						
Ethylbenzene	28.9	24.8	38.8		13.5	32.2
m- & p-xylene	23.5	19.7	31.5		11	25.6
o-xylene						
Styrene						
Bromoform						
1,1,2,2-Tetrachloroethane						

Table D-3
Apparent Quantities of Volatile Organics Collected at the Outlet of the Unit 7 ESP
(Data in ng)

	Run 1 (ca. 20 L)		Run 2 (ca. 10 L)		Run 3 (ca. 5 L)	
	T 5016	TC 5017	T 5018	TC 5019	T 5020	TC 5021
Chloromethane	1990				313000	
Vinyl chloride					291	
Bromomethane		44.4		39	1240	37.6
Chloroethane						
1,1-Dichloroethene						
Acetone	123	195	84.1	122	7490	
Methyl iodide		100		7		
Carbon disulfide	27.8	36.4	25.9		1800	
Methylene chloride		26.8		17.4		
trans-1,2-Dichloroethene						
1,1-Dichloroethane						
2-Butanone						
Chloroform						
1,1,1-Trichloroethane	19.6					
Carbon tetrachloride						
Benzene	257	76.9	102	58.9	79.6	27.6
1,2-Dichlorethane						
Trichloroethene						
1,2-Dichloropropane						
Bromodichloromethane						
cis-1,3-Dichloropropene						
2-Hexanone						
Toluene	45.2	10.7	36.8	8.69	24.6	
trans-1,3-Dichloropropene						
1,1,2-Trichloroethene						
Tetrachloroethene		30.8		45		1280
4-Methyl-2-pentanone						
Dibromochloromethane						
Chlorobenzene						
Ethylbenzene	22.7			22.3	6.93	
m- & p-xylene	18.5	29.5		17.7	5.63	
o-xylene						
Styrene						
Bromoform						
1,1,2,2-Tetrachloroethane						

Table D-4
Apparent Quantities of Volatile Organics Collected at the Stack
(Data in ng)

	Run 1 (ca. 20 L)		Run 2 (ca. 10 L)		Run 3 (ca. 5 L)	
	T 5048	TC 5049	T 5050	TC 5051	T 5052	TC 5053
Chloromethane			22.5		22.3	
Vinyl chloride						
Bromomethane		19		38.6		
Chloroethane	28				70.1	
1,1-Dichloroethene						
Acetone	302	22	189	13.4	145	
Methyl iodide						
Carbon disulfide	26.9		22.3		47.2	
Methylene chloride	70300	30000		48.8	66.8	
trans-1,2-Dichloroethene						
1,1-Dichloroethane						
2-Butanone						
Chloroform	27.3					
1,1,1-Trichlorethane	59.7					
Carbon tetrachloride	14.4					
Benzene	257	59.2	126	55.8	95.9	
1,2-Dichlorethane	28.6					
Trichloroethene	145					
1,2-Dichloropropane	82.9					
Bromodichloromethane						
cis-1,3-Dichloropropene						
2-Hexanone						
Toluene	196	14.6	58.8	13.8	58.3	
trans-1,3-Dichloropropene						
1,1,2-Trichloroethene						
Tetrachloroethene	482		41		31.2	
4-Methyl-2-pentanone	6.31					
Dibromochloromethane						
Chlorobenzene	127		19.7			
Ethylbenzene	111	35.5	22.8			
m- & p-xylene	54.8	28.2	32.5	31.5	12.9	
o-xylene	97		12.3		10.4	
Styrene						
Bromoform						
1,1,2,2-Tetrachloroethane						

APPENDIX E

BAILLY MASS BALANCES EXAMPLE CALCULATION

APPENDIX E BAILLY MASS BALANCES EXAMPLE CALCULATION

This example uses the testing performed on September 3, 1993, as the basis for the example calculation. First the mass flow of the input and output streams are calculated, then the mass balance for a single element, cobalt in this case, is calculated. Table E-1 displays the gross flows for the day, while Table E-2 shows the cobalt balance for this day. Table E-3 presents the measured concentrations for cobalt in the input and output streams.

The philosophy used to make mass balances in this report is to assume that there exists a single flow for each stream that represents a pseudo-steady state operation of the power plant. Because of storage capacities in the plant, there can be errors in using measured flows without knowing the rate of change of various levels in storage tanks, bunkers, and other equipment. Gross material balances, single phase material balances, and elemental material balances are all used in calculating the plant flow conditions. Where the flows are consistent, measured flows are used in the material balances. If obvious errors exist, other measured flows are used in the material balances. In a few cases, intelligent guesses of flow rates are made, such as the sluice water flow.

E.1 Gross Material Balances

E.1.1 Unit 8 Boiler

The Unit 8 boiler balance includes coal, makeup water, and combustion air as input streams and flue gas and bottom ash as output streams.

E.1.1.1 Coal Flow Rate

The coal flow rate is taken from the plant data acquisition system. Table 3-3 presents the data taken from the plant, and the coal feed rate is listed on Sheet 6, with units of thousand pounds per hour. The average for the test period is 308.5 klb/hr.

$$\frac{308.5\text{ klb}}{\text{hr}}\;\Big|\;\frac{1000\text{ lb}}{\text{klb}}\;\Big|\;\frac{0.454\text{ kg}}{1\text{ lb}}\;\Big|\;\frac{1\text{ hr}}{60\text{ min}}\;\Big|\;\frac{1\text{ min}}{60\text{ sec}} = 38.9\text{ kg/s}$$

E.1.1.2 Combustion Air

The combustion air calculation is performed on the coal flow rate above with the furnace exit oxygen as reported in Table 4-5 as 5.4% (average of 5.5 and 5.3). That calculation can be performed using Combustion Engineering's Steam, or any combustion handbook, and will not be repeated here. The combustion air result is 430 kg/s.

Table E-1
Daily Mass Balance for Total Flows
Data for September 3, 1993

	Process Stream	Solid, kg/s	Liquid, kg/s	Gas, kg/s	Total, kg/s
UNIT 8 BOILER					
In	Coal	38.9			38.9
	Combustion Air			430	430
	Makeup Water		4.16		4.16
Out	Flue Gas	1.46		438	439
	Bottom Ash	2.59			2.59
Closure, %					93.4
UNIT 8 ESP					
In	Flue Gas	1.46		438	439
Out	ESP Hopper Ash	1.44			1.44
	Flue Gas to AFGD	0.0173		499	499
Closure, %					114
CONDENSER					
In	Inlet Water		11600		11600
Out	Outlet Water		11600		11600
Closure, %					100
BOTTOM ASH SLUICE					
In	Bottom Ash	2.59			2.59
	Sluice Return		25.9		25.9
Out	Bottom Ash Sluice	2.59	25.9		28.4
Closure, %					100
BOILER OVERALL BALANCE					
In	Coal	38.9			38.9
	Combustion Air			430	430
	Makeup Water		4.16		4.16
	Sluice Return		25.9		25.9
Out	Bottom Ash Sluice	2.59	25.9		28.4
	ESP Hopper Ash	1.44			1.44
	Flue Gas to AFGD	0.0173		499	499
Closure, %					106
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.0145		281	281
	Unit 8 Flue Gas	0.0173		499	499
Out	Flue Gas to AFGD	0.0318		780	780
Closure, %					100.0
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.0318		780	780
	Limestone	6.81			6.81
	Service Water		84.7		84.7
	Compressed Air			8.69	8.69
Out	Stack Flue Gas	0.0207		806	806
	Gypsum	9.11			9.11
	Wastewater		9.90		9.90
Closure, %					93.7

Table E-2
Bailly Mass Balance for Cobalt
Data for September 3, 1993

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
UNIT 8 BOILER					
In	Coal	91.3			91.3
	Combustion Air				
	Makeup Water		*0.00416*		*0.00416*
Out	Flue Gas	46.8		0.0280	46.8
	Bottom Ash	63.1			63.1
Average of Daily Closures, %					120
Closure of Average Flows, %					120
UNIT 8 ESP					
In	Flue Gas	46.8		0.0280	46.8
Out	ESP Hopper Ash	58.8			58.8
	Flue Gas to AFGD	*0.0315*		0.0252	*0.0567*
Average of Daily Closures, %					126
Closure of Average Flows, %					126
CONDENSER					
In	Inlet Water		*11.6*		*11.6*
Out	Outlet Water		*11.6*		*11.6*
Average of Daily Closures, %					*100*
Closure of Average Flows, %					*100*
BOTTOM ASH SLUICE					
In	Bottom Ash	63.1			63.1
	Sluice Return		*0.0259*		*0.0259*
Out	Bottom Ash Sluice	63.1	*0.0259*		63.1
Average of Daily Closures, %					100
Closure of Average Flows, %					100
BOILER OVERALL BALANCE					
In	Coal	91.3			91.3
	Combustion Air				
	Makeup Water		*0.00416*		*0.00416*
	Sluice Return		*0.0259*		*0.0259*
Out	Bottom Ash Sluice	63.1	*0.0259*		63.1
	ESP Hopper Ash	58.8			58.8
	Flue Gas to AFGD	*0.0315*		0.0252	*0.0567*
Average of Daily Closures, %					134
Closure of Average Flows, %					134

Italics indicate numbers derived from non-detectable concentrations.

Table E-2 (Continued)
Bailly Mass Balance for Cobalt
Data for September 3, 1993

	Process Stream	Solid, mg/s	Liquid, mg/s	Gas, mg/s	Total, mg/s
FLUE GAS MIXING					
In	Unit 7 Flue Gas	0.459		*0.0242*	0.484
	Unit 8 Flue Gas	*0.0315*		0.0252	*0.0567*
Out	Flue Gas to AFGD	0.491		*0.0494*	0.540
Average of Daily Closures, %					100
Closure of Average Flows, %					100
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas	0.491		*0.0494*	0.540
	Limestone	2.65			2.65
	Service Water		*0.0847*		*0.0847*
	Compressed Air				
Out	Stack Flue Gas	0.0517		*0.0235*	*0.0752*
	Gypsum	*1.37*			*1.37*
	Wastewater		0.650		0.650
Average of Daily Closures, %					*63.8*
Closure of Average Flows, %					*63.8*

Italics indicate numbers derived from non-detectable concentrations.

Table E-3
Bailly Cobalt Concentrations for 9/3/93

	Process Stream	Solid, ug/g	Liquid, ug/ml	Part. in Gas, ug/Nm3 @ 3% O2	Vapor in Gas ug/Nm3 @ 3% O2
UNIT 8 BOILER					
In	Coal	2.35 (6-3)			
	Combustion Air				
	Makeup Water		<0.002 (6-14)		
Out	Flue Gas			167 (6-21)	<0.20 (6-21)
	Bottom Ash	24.4 (6-6)			
UNIT 8 ESP					
In	Flue Gas			167 (6-21)	<0.20 (6-21)
Out	ESP Hopper Ash	40.8 (6-7)			
	Flue Gas to AFGD			<0.20 (6-26)	0.08 (6-26)
CONDENSER					
In	Inlet Water		<0.002 (6-12)		
Out	Outlet Water		<0.002 (6-13)		
BOTTOM ASH SLUICE					
In	Bottom Ash	24.4 (6-6)			
	Sluice Return		<0.002 (6-15)		
Out	Bottom Ash Sluice	24.4 (6-6)	<0.002 (6-16)		
BOILER OVERALL BALANCE					
In	Coal	2.35 (6-3)			
	Combustion Air				
	Makeup Water		<0.002 (6-14)		
	Sluice Return		<0.002 (6-15)		
Out	Bottom Ash Sluice	24.4 (6-6)	<0.002 (6-16)		
	ESP Hopper Ash	40.8 (6-7)			
	Flue Gas to AFGD			<0.20 (6-26)	0.08 (6-26)
FLUE GAS MIXING					
In	Unit 7 Flue Gas			2.66 (6-31)	0.14 (6-31)
	Unit 8 Flue Gas			<0.20 (6-26)	0.08 (6-26)
Out	Flue Gas to AFGD				
OVERALL AFGD SYSTEM BALANCE					
In	Flue Gas				
	Limestone	0.390 (6-44)			
	Service Water		<0.002 (6-48)		
	Compressed Air				
Out	Stack Flue Gas			0.11 (6-57)	<0.10 (6-57)
	Gypsum	<0.30 (6-45)			
	Wastewater		0.0657 (6-51)		

E.1.1.3 Makeup Water

The makeup water flow rate is taken from the plant data acquisition system, as presented in Table 3-3, Sheet 6. The rate is given as gallons per minute, and the average for the testing period was 65.9 gpm.

65.9 gal	1 min	8.33 lb	0.454 kg	= 4.15 kg/s
min	60 sec	1 gal	1 lb	

E.1.1.4 Flue Gas

The flue gas was measured in the Method 5-type trains, and is summarized in Tables 4-4 through 4-7. The total flow is reported in Table 4-4 as 594 kdscfm (average of 592 and 596). The oxygen concentration is reported in Table 4-5 as 5.4% (average of 5.5 and 5.3). The water content of the flue gas was measured as 10.25% (average of 10.0 and 10.5) from Table 4-6.

594,000 dscf @ 3% O_2	(20.9-3) dscf @ 5.4 %	1 min	100 scf	1 Nm^3
min	(20.9-5.4) dscf @ 3%	60 sec	(100-10.25) dscf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	29.19 g	1 kg	= 438 kg/s
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g	

The molecular weight was calculated from the composition of the flue gas using O_2 and CO_2 from Tables 4-5, and the H_2O from Table 4-6.

The particulate flow rate is calculated from the measured flue gas flow rate, 280 Nm^3/sec (average of 279 and 281), and the measured fly ash loading. Table 4-7 lists the particulate loading for the Unit 8 ESP inlet on 9/3/93 as 4.506 g/Nm^3 (average of 4.556 and 4.455).

280 Nm^3	4.506 g	(20.9-3) m^3 @ 5.4% O_2	1 kg	= 1.46 kg/sec
sec	Nm^3	(20.9-5.4) m^3 @ 3% O_2	1000 g	

E.1.1.5 Bottom Ash

The bottom ash flow rate is calculated by difference from the flow rate of particulates into the ESP and the ash entering with the coal. The coal analysis is shown in Table 6-1, and the ash content is 10.4%. The fly ash is assumed to be completely ash, although the hopper ash does contain a few percent of carbon.

$$\frac{38.9\text{ kg coal}}{\text{sec}}\,\Big|\,\frac{10.41\text{ kg ash}}{100\text{ kg coal}} - \frac{1.46\text{ kg fly ash}}{\text{sec}} = 2.59\text{ kg/s bottom ash}$$

E.1.1.6 Closure

The closure is defined as output divided by input expressed as a percentage. The sum of inputs, coal plus air plus makeup water, equals 473.1 kg/s. The sum of the outputs, flue gas plus particulates plus bottom ash, is 442.0 kg/s.

$$\frac{442.0\text{ kg/s output}}{473.1\text{ kg/s input}}\,\Big|\,\frac{100\text{ percent}}{1.0\text{ fractional}} = 93.4\text{ percent}$$

E.1.2 Unit 8 ESP

The Unit 8 ESP balance consists of flue gas into the ESP as the input and flue gas out of the ESP and ESP hopper ash as the output streams.

E.1.2.1 Flue Gas In

The flue gas in is the same as the flue gas out of the boiler system, 438 kg/s flue gas with 1.46 kg/s fly ash.

E.1.2.2 Flue Gas Out

The flue gas was measured in the Method 5-type trains, and is summarized in Tables 4-4 through 4-7. The total flow is reported in Table 4-4 as 668 kdscfm (average of 655 and 681). The oxygen concentration is presented in Table 4-5 as 5.7%. The water content of the flue gas was measured as 9.35% (average of 9.3 and 9.4) from Table 4-6.

668,000 dscf @ 3% O_2	(20.9-3) dscf @ 5.7%	1 min	100 scf	1 Nm^3
min	(20.9-5.7) dscf @ 3%	60 sec	(100-9.35) dscf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	29.27 g	1 kg	=	499 kg/s
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g		

The molecular weight was calculated from the composition of the flue gas using O_2 and CO_2 from Tables 4-5, and the H_2O from Table 4-6.

The particulate flow rate is calculated from the measured flue gas flow rate, 313 Nm^3/sec (average of 309 and 321), and the measured fly ash loading. Table 4-7 lists the particulate loading for the Unit 8 ESP outlet on 9/3/93 as 0.0467 g/Nm^3 (average of 0.0145 and 0.0789).

315 Nm^3	0.0467 g	(20.9 -3) Nm^3 @ 5.7% O_2	1 kg	=	0.0173 kg/s
sec	Nm^3	(20.9-5.7) Nm^3 @ 3% O_2	1000 g		

E.1.2.3 ESP Hopper Ash

The ESP hopper ash flow rate is calculated by difference from the flow rate of particulates into the ESP and the fly ash leaving the ESP.

$$\frac{1.46 \text{ kg fly ash}}{\text{sec}} - \frac{0.0173 \text{ kg fly ash}}{\text{sec}} = 1.44 \text{ kg/s bottom ash}$$

E.1.2.4 Closure

The closure is defined as output divided by input expressed as a percentage. The sum of inputs, flue gas plus particulates, equals 439.5 kg/s. The sum of the outputs, flue gas plus particulates plus ESP hopper ash, is 490.3 kg/s.

500.5 kg/s output	100 percent	= 114 percent
439.5 kg/s input	1.0 fractional	

E.1.3 Unit 8 Condenser

The condensers are assumed to be not leaking, and the input flow equals the output flow.

E.1.3.1 Condenser Inlet

The cooling water flow through the condensers is calculated by assuming that the condensate flow on the steam side has to transfer the latent heat of vaporization from the steam to the cooling water. The cooling water temperature change can be found from the Unit 8 plant data. The inlet cooling water temperature is recorded as 72.9°F and the outlet cooling water temperature was recorded as 95.6°F, for a delta of 22.7°F. The condensate flow was recorded as 2097.8 klb/hr.

2,097,000 lb Cd	1 hr	1000 Btu Cd		1 lb °F	0.454 CW	≈ 11,650 kg/s
hr	3600 s	1 lb Cd	22.7 °F	1 Btu CW	1 lb CW	

E.1.3.2 Condenser Outlet

The condenser outlet is assumed to be equal to the inlet flow of 11,650 kg/s.

E.1.3.3 Closure

Since the inlet equals the outlet, the closure is 100% by definition.

E.1.4 Bottom Ash Sluice

E.1.4.1 Bottom Ash

The bottom ash flow rate is calculated above as 2.59 kg/s.

E.1.4.2 Sluice Return

The sluice return is the water that is used to carry the bottom ash to the pond. It is assumed to be 10 times the mass of the bottom ash, from collected samples and observations of the process. Therefore, the sluice return is 25.9 kg/s.

E.1.4.3 Bottom Ash Sluice

The bottom ash sluice is the two phase flow that is sent to the pond. It is assumed that the solids from the bottom ash and the water do not appreciably affect each other. Therefore, the bottom ash sluice is assumed to be 28.49 kg/s (2.59 kg/s solids plus 25.9 kg/s water).

E.1.4.4 Closure

The closure, by definition, is 100%.

E.1.5 Boiler Overall Balance

E.1.5.1 Balance

The boiler balance is taken as the sum of the inputs: coal, air, makeup water, and sluice return. The inputs equal 498.96 kg/s. The outputs, bottom ash sluice, ESP hopper ash, and flue gas, equals 528.93 kg/s.

E.1.5.2 Closure

$$\frac{528.93\ \text{kg/s output}}{498.96\ \text{kg/s input}} \left| \, \frac{100\ \text{percent}}{1.0\ \text{fractional}} \right. = 106\ \text{percent}$$

E.1.6 Flue Gas Mixing

E.1.6.1 Unit 7 Flue Gas

The flue gas was measured in the Method 5-type trains, and is summarized in Tables 4-4 through 4-7. The total flow is reported in Table 4-4 as 366 kdscfm. The oxygen concentration is presented in Table 4-5 as 6.2%. The water content of the flue gas was measured as 8.8% (average of 8.2 and 9.4) from Table 4-6.

366,000 dscf @ 3% O_2	(20.9-3) dscf @ 6.2 %	1 min	100 scf	1 Nm^3
min	(20.9-6.2) dscf @ 3%	60 sec	(100-8.8) dscf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	29.29 g	1 kg		
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g	=	281 kg/s

The molecular weight was calculated from the composition of the flue gas using O_2 and CO_2 from Tables 4-5, and the H_2O from Table 4-6.

The particulate flow rate is calculated from the measured flue gas flow rate and the measured fly ash loading. Table 4-7 lists the particulate loading for the Unit 8 ESP outlet on 9/3/93 as 0.0689 g/Nm^3 (average of 0.0698 and 0.0679).

173 Nm^3	0.0689 g	(20.9 -3) Nm^3 @ 6.2% O_2	1 kg		
sec	Nm^3	(20.9-6.2) Nm^3 @ 3% O_2	1000 g	=	0.0145 kg/s

E.1.6.2 Unit 8 Flue Gas

The Unit 8 ESP outlet flue gas flow rates are calculated above: 499 kg/s of flue gas carrying 0.0173 kg/s of fly ash.

E.1.6.3 Flue Gas to AFGD

The flue gas to the AFGD is assumed to be the algebraic sum of the two inlet streams. The sum is: 780 kg/s of flue gas carrying 0.0318 kg/s fly ash.

E.1.6.4 Closure

The closure is 100%, by definition.

E.1.7 Overall AFGD Balance

E.1.7.1 Flue Gas Input

The flue gas input calculated above is 780 kg/s flue gas carrying 0.0318 kg/s fly ash.

E.1.7.2 Limestone

The limestone is calculated from a calcium balance around the AFGD. The calcium content of the gypsum exiting the AFGD is 28.4% as reported in Table 6-45. The calcium content of the limestone is 38.0% as reported in Table 6-44. The gypsum flow rate of 9.08 kg/s is calculated in a following section, in E.1.7.6.

9.08 kg gypsum	28.4 kg Ca	100 kg limestone	
sec	100 kg gypsum	38.0 kg Ca	= 6.79 kg/s limestone

E.1.7.3 Service Water

The service water used in the AFGD system is taken from the plant data. Table 3-4, Sheet 6, lists total water to facility as 1350 gpm.

1350 gal	1 min	8.33 lb	0.454 kg	
min	60 sec	1 gal	1 lb	= 85.09 kg/s

E.1.7.4 Compressed Air

The compressed air is taken from the AFGD data in Table 3-4. Sheet 6 lists air to FAS and air to ARS as 7268 scfm and 7997 scfm, respectively.

15,265 dscf	1 min	1 Nm^3
min	60 sec	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	28.83 g	1 kg	
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g	= 8.64 kg/s

E.1.7.5 Stack Flue Gas

The flue gas was measured in the Method 5-type trains, and is summarized in Tables 4-4 through 4-7. The total flow is reported in Table 4-4 as 996 kdscfm average of 1026 and 965). The oxygen concentration is presented in Table 4-5 as 6.3%. The water content of the flue gas was measured as 15.55% (average of 15.1 and 16.0) from Table 4-6.

996,000 dscf @ 3% O_2	(20.9-3) dscf @ 6.3 %	1 min	100 scf	1 Nm^3
min	(20.9-6.3) dscf @ 3%	60 sec	(100-15.55) dscf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	28.41 g	1 kg	=	806.6 kg/s
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g		

The molecular weight was calculated from the composition of the flue gas using O_2 and CO_2 from Tables 4-5, and the H_2O from Table 4-6.

The particulate flow rate is calculated from the measured flue gas flow rate and the measured fly ash loading. Table 4-7 lists the particulate loading for the Bailly stack on 9/3/93 as 0.0270 g/Nm^3.

469.5 Nm^3	0.0360 g	(20.9 -3) Nm^3 @ 6.2% O_2	1 kg	=	0.0207 kg/s
sec	Nm^3	(20.9-6.3) Nm^3 @ 3% O_2	1000 g		

E.1.7.6 Gypsum

The gypsum exiting the AFGD system is calculated from a sulfur balance around the system. The SO_2 inlet concentration is taken from Table 3-4, Sheet 2, as 2184 ppm (assumed to be dry). The exit SO_2 is also taken from Table 3-4, Sheet 3, as 167 ppm dry. The sulfur flow rate into the scrubber is calculated below. Unit 7 supplies 366 kdscfm at 6.2% O_2 and Unit 8 supplies 668 kdscfm at 5.7% O_2. The sum is 1034 kdscfm at 5.88% O_2.

1,034,000 dscf @ 3% O_2	(20.9-3) dscf @ 6.3 %	1 min	100 dscf	2184 scf SO_2	1 Nm^3
min	(20.9-5.88) dscf @ 3%	60 sec	(100-9.15) scf	10^6 scf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	64	1 kg
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g

= 3.72 kg/s

The sulfur flow rate out of the scrubber is calculated below. The stack flow is 1026 kdscfm at 6.3% O_2.

1,034,000 dscf @ 3% O_2	(20.9-3) dscf @ 6.3 %	1 min	100 dscf	167 scf SO_2	1 Nm^3
min	(20.9-6.3) dscf @ 3%	60 sec	(100-15.55) scf	10^6 scf	35.31 scf

1000 l	1 g mole	(460+32)R Std. l	64	1 kg
1 Nm^3	22.4 Std. l	(460+68)R Nor. l	1 g mole	1000 g

= 0.315 kg/s

The captured SO_2 is 3.72 - 0.315 = 3.41 kg/s SO_2 or 1.71 kg/s of sulfur. Table 6-45 lists the sulfate content of the gypsum as 563000 ppm by weight, or 56.3%. The sulfur in the gypsum is equal to 56.3% * 32/96 = 18.77%. So, to capture the 1.71 kg/s of sulfur in the AFGD, 1.71*100/18.77 = 9.11 kg/s gypsum are required.

E.1.7.7 Wastewater

The wastewater flow is taken from the AFGD data summary. Table 3-4, Sheet 5, lists the average as 91.31 gpm for wastewater plus 65.48 gpm from the thickener underflow.

156.8 gal	1 min	8.33 lb	0.454 kg
min	60 sec	1 gal	1 lb

= 9.88 kg/s

E.1.7.8 Balance

The sum of the inputs (flue gas, limestone, compressed air, and water) equals 880.6 kg/s. The sum of the outputs (stack flue gas, gypsum, and wastewater) equals 825.6 kg/s.

E.1.7.9 Closure

$$\begin{array}{c|c} 825.6\text{ kg/s output} & 100\text{ percent} \\ \hline 880.6\text{ kg/s input} & 1.0\text{ fractional} \end{array} = 93.7\text{ percent}$$

E.2 Cobalt Material Balance

The cobalt mass balance is shown in Table E-2 (the same as Table 7-13). Table E-3 contains the measured concentrations of cobalt in the process streams along with references to the Tables where they are presented.

E.2.1 Solid Phases

The solid concentrations are given in ppm by weight. The coal example is shown below.

$$\begin{array}{c|c|c} 38.9\text{ kg coal} & 2.35\text{ kg Co} & 10^6\text{ mg Co} \\ \hline \text{sec} & 10^6\text{ kg coal} & 1\text{ kg Co} \end{array} = 91.4\text{ mg/s Co}$$

Solid	Mass Flow, kg/s Table E-1	Conc., µg/g Table E-3	Co Flow, mg/s Table E-2
Coal	38.9	2.35	91.4
Bottom Ash	2.59	24.4	63.2
ESP Hopper Ash	1.44	40.8	58.8
Limestone	6.81	0.390	2.66
Gypsum	9.11	0.15	1.37

E.2.2 Liquid Phases

The liquid concentrations are given in μg per ml. The condenser inlet example is shown below.

$$\begin{array}{c|c|c|c} 11{,}600\ \text{kg Cond In} & 0.001\ \mu\text{g Co} & 10^3\ \text{ml} & 1\ \text{mg Co} \\ \hline \text{sec} & 1\ \text{ml Cond In} & 1\ \text{kg} & 1000\ \mu\text{g Co} \end{array} = 11.6\ \text{mg/s Co}$$

Liquid	Mass Flow, kg/s Table E-1	Conc., μg/ml Table E-3	Co Flow, mg/s Table E-2
Makeup Water	4.16	0.001	0.0042
Cond Inlet	11600	0.001	11.6
Cond Outlet	11600	0.001	11.6
Sluice Return	25.9	0.001	0.0259
Sluice Water	25.9	0.001	0.0259
AFGD Service H_2O	84.7	0.001	0.0847
Wastewater	9.90	0.0657	0.650

E.2.2 Gas Phases

The flue gas concentrations are given in μg per Nm³ at 3% O_2. The flue gas exiting the Unit 8 boiler example is shown below.

Solid Phase in the Flue Gas:

$$\begin{array}{c|c|c} 280\ \text{Nm}^3\ @\ 3\% & 167\ \mu\text{g Co} & 1\ \text{mg Co} \\ \hline \text{sec} & 1\ \text{Nm}^3\ @\ 3\% & 10^3\ \mu\text{g Co} \end{array} = 46.8\ \text{mg/s Co}$$

Vapor Phase in the Flue Gas:

$$\begin{array}{c|c|c} 280\ \text{Nm}^3\ @\ 3\% & 0.10\ \mu\text{g Co} & 1\ \text{mg Co} \\ \hline \text{sec} & 1\ \text{Nm}^3\ @\ 3\% & 10^3\ \mu\text{g Co} \end{array} = 0.0280\text{mg/s Co}$$

Flue Gas Stream	Vol. Flow, Nm^3 at 3% O_2 Table 4-4	Solid Conc., $\mu g/Nm^3$ 3% O_2 Table E-3	Solid Co Flow, mg/s Table E-2
Unit 8 ESP In	280	167	46.8
Unit 8 ESP Out	315	0.10	0.0315
Unit 7 ESP Out	173	2.66	0.460
AFGD In	488		0.492[1]
Stack	469.5	0.11	0.0516

[1] Calculated from the sum of Unit 7 outlet and Unit 8 outlet.

Flue Gas Stream	Vol. Flow, Nm^3 at 3% O_2 Table 4-4	Vapor Conc., $\mu g/Nm^3$ 3% O_2 Table E-3	Vapor Co Flow, mg/s Table E-2
Unit 8 ESP In	280	0.10	0.0280
Unit 8 ESP Out	315	0.08	0.0252
Unit 7 ESP Out	173	0.14	0.0242
AFGD In	488		0.0494[2]
Stack	469.5	0.05	0.0235

[2] Calculated from the sum of Unit 7 outlet and Unit 8 outlet.

APPENDIX F

UNCERTAINTY ANALYSES OF EMISSION FACTORS

APPENDIX F

UNCERTAINTY ANALYSIS OF EMISSION FACTORS

This analysis is based on the theory of error propagation as set forth in the publication "Uncertainty Analysis" by the American Society of Mechanical Engineers (14). This appendix first gives the relevant nomenclature, then the derivation of the pertinent mathematical relationships, and finally an example of the input data and the results for mercury.

Nomenclature

E = emission factor

U_E = uncertainty in emission factor

β_E = bias component in U_E

S_E = imprecision component in U_E

f_E = degrees of freedom in E

β_i = bias error in parameter i

S_i = sample standard deviation of parameter i

N_i = number of measurements of parameter i

θ_i = sensitivity of E to a change in parameter i

ω_i = quotient of $S_i / N_i^{½}$

ψ_i = product of θ_i and ω_i

t = Student "t" factor, defined by degrees of freedom in E

Derivation

The uncertainty in the calculated value of an emission factor E is given as follows:

$$U_E = [\beta_E^2 + (S_E\, t)^2]^{½} \qquad (1)$$

where β_E is a factor associated with bias in each of the experimental measurements, $S_E t$ is a factor associated with random errors in the measurements (as illustrated by the sample standard deviation), and t is Student's t factor, as defined for the factor E.

Each β_E term is a composite of similar terms for all of the parameters used in computing E. Consider the three parameters discussed in Section 7.3 that are combined for computing E:

C = stack concentration;

V = ratio of flue gas flow rate to coal firing rate;

H = the calorific value of the coal).

The equation for combining these parameters is as follows:

$$E = CV/H \tag{2}$$

Each of the three parameters, in principle, has associated with it a bias β_i. Each of these parameters also has associated with it a term θ_i, which is a measure of the sensitivity of E to a change in the parameter:

$$\theta_i = \text{partial derivative of E with respect to the parameter in question} \tag{3}$$

The definition of the composite term β_E is then given by the following equation:

$$\beta_E = [\Sigma\ (\beta_i\ \theta_i)^2]^{½} \tag{4}$$

Similarly, each S_E term is a composite of corresponding terms involving each parameter:

$$S_E = [\Sigma\ (\psi_i)^2]^{½} \tag{5}$$

where ψ_i is the product of the sensitivity factor, θ_i, for each parameter, as defined above, and the term ω_i, as defined under Nomenclature:

$$\psi_i = \theta_i\ \omega_i \tag{6}$$

The final term in Equation 1 that requires comment is Student's t_r.which is assigned the appropriate value from the conventional tables once the number of degrees of freedom in E is calculated. The number of degrees of freedom f_E is obtained from the following equation, which consists of terms already defined and the degree of freedom f_i of each parameter:

$$f_E = (S_E)^4 / \Sigma\ (\omega_i\ \theta_i)^4 / f_i \tag{7}$$

In this report, the value of t selected is that corresponding the 95% confidence intervals.

Illustration

The above concepts will now be illustrated in terms of the emission factor E for mercury, for which the relevant data (from the carbon sorption traps) are presented as follows:

	Metal concn, C ($\mu g/Nm^3$)	Gas rate, V (Nm^3/g coal)	Calorific value, H (J/g coal)
Mean value	3.52	8.20×10^{-3}	25,809
Std dev	0.06	0.70×10^{-4}	12
β	Variable	2.05×10^{-4}	645
N	3	3	3
f	2	2	2
θ	3.18×10^{7}	1.36×10^{-4}	-4.34×10^{-11}
ω	0.03	4.04×10^{-5}	6.93

a) As the first assumption, let there be zero bias in the concentration: For the volume and calorific values, a bias of 2.5% is arbitrarily assumed for each term. Conceivably, assignment of a higher bias to the volume and a lesser bias to the calorific value would be justified, but any such shift would be further arbitrariness.

The values of θ and ω are based on the mathematical definitions previously given and require no further comment.

The intermediate derived quantities based on the above data are as follows:

$\beta_E = 3.96 \times 10^{-8}$ $\mu g/J$

$S_E = 1.25 \times 10^{-8}$ $\mu g/J$

$f_E = 3$

$t = 4.303$

Finally, there are the values of the emission factor and its uncertainty, corresponding the 95% confidence interval. These results are obtained initially, by direction calculation from the equations given here, in the units $\mu g/J$. They are listed below, however, in the more customary units:

$E = 1.12$ $g/10^{12}$ J or 2.60 $lb/10^{12}$ Btu

$U_E = 0.066$ $g/10^{12}$ J or 0.16 $lb/10^{12}$ Btu

b) As the second assumption, let the bias in concentration be 2.5% (0.088 $\mu g/L$). For this assumption:

$\beta_E = 4.85 \times 10^{-8}$ $\mu g/J$

$S_E = 1.25 \times 10^{-8}$ µg/J (unchanged)

$f_E = 3$ (unchanged)

$t = 4.303$ (unchanged)

$E = 1.12 \times 10^{-6}$ µg/J (unchanged)

$U_E = 0.072$ g/10^{12} J or 0.17 lb/10^{12} Btu

The assumed 2.5% bias in concentration changes the uncertainty factor (U_E) by 9% (from 5.9% to 6.4% of the reported emission (E)).

c) As the third assumption, let the bias in concentration be 10% or 25%. The uncertainty U(E) at 10% bias is 11.6%, or at 25% bias it is 25.6% of E. Thus, the larger the bias in concentration at constant values of other uncertainty factors, the more nearly the percentage bias in concentration and the percentage bias in E coincide.

APPENDIX G

SAMPLING DATA SHEETS

CONTENTS

Appendix G1

Preliminary Traverses and September 3 Tests

PAGE 2 OF 2

METALS

METHOD 5 FIELD DATA

Plant/Location #7 Outlet
Operator Kirby
Date 9-3-93
Test No./Run No. 1
Meter Box ID Dutch 3
Gas Meter Cal. Factor 1.89
Orifice ID
Orifice DHD 1.89

Pitot Coefficient, Cp .82
Nozzle ID T22
Average Nozzle Dia., inches .202
Barometric Pressure, in. Hg 29.26
Ambient Temp., deg. F 79°
Assumed Moisture, % 7.0
Filter ID
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .000
Leakrate, cfm, Post-test .001 @ 6"
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 511.~~008~~ 137
START TIME 12:00

GAS METER END, cf 633957
END TIME 16:46

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
12:00	~~[illegible]~~	12 min.					1.37 511.~~008~~						
12:00	A 1	12	3.5	308	1.50 ~~2.00~~	1.75 ~~2.34~~	519.97	291	266		72	77	76
	2	24	3.0	309	1.30	1.52	528.3	307	257		51	85	77
	3	36 [illegible]	2.0	309	.55	.64	533.7 [illegible]	268	244		55	86	78
13:25	4	48	2.0	311	.50	.58	~~538.727~~	250	244		54	82	81
	B 1	12^{60}	2.0	315	.60	.70	544.27	282	241		60	86	83
	2	24^{12}	2.0	315	.55	.64	549.53	312	254		54	90	83
	3	36^{24}	2.0	314	.50	.58	554.6	297	254		57	92	85
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				312	0.848	0.87						87.1	

G-4

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet - Unit #8 Run No. 1

Set Up By WOK / DWS Date 05/03/93 Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 40134

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	601.4 g	802.9 g	201.5 g
Second	591.3 g	601.5 g	10.2 g
Third	442.0 g	443.6 g	1.6 g
Fourth	610.0 g	611.2 g	1.2 g
Fifth	578.2 g	578.2 g	0 g
Sixth	487.6 g	488.7 g	1.1 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	772.0 g	793.5 g net 21.5
	g	g
Totals	g	g

TOTAL 237.1

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

Page 2 of 3

Method 5 Field Data Continued. Date 09/03 Location Out #8 Run No. #1 Metals Operator RNC / T.L.

Clock Time START	Travese Point Number	Sample Time MIN	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
0943	6-1	10	2.1	300	.75	.69	406.92	250	246		76	79	78
	6-2	20	2.1	313	.70	.64	411.50	261	242		65	81	79
	6-3	30	3.0	308	1.1	1.01	415.92	255	257		65	81	79
	6-4	40	3.0	310	1.5	1.3	421.41	250	260		66	82	79
							427.41						
	5-1	10	2.0	311	.70	.64	427.41	253	260		70	82	80
1033	5-2	20	2.1	312	.72	.66	431.90	255	250		70	82	80
	5-3	30	3.1	310	1.1	1.01	436.34	254	261		68	83	80
	5-4	40	3.1	310	1.3	1.2	441.41	256	264		68	83	80
					4		447.95						
	4-1	10	2.2	317	.75	.69	447.95	250	260		70	83	80
	4-2	20	2.2	318	.75	.69	452.60	257	261		70	83	80
	4-3	30	2.9	316	.92	.85	457.20	255	265		70	83	81
1145	4-4	40	2.5	274	.83	.75	462.29	260	259		71	84	81
							467.11						

NUTech #1 A7250

LEAK CHK 13" HG = .005/MIN

AMB = 77°F

PAGE 2 OF 4

METHOD 5 FIELD DATA

Plant/Location Bailly Outlet 8
Operator RNC / T
Date 09/03/93
Test No./Run No. Metals #1
Meter Box ID 1
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHD ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., Inches 0.192
Barometric Pressure, in. Hg 29.24
Ambient Temp., deg. F 78°F
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest ✓ .005/min
Leakrate, cfm, Post-test ✓ .000 in @ 15
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 406.92
START TIME 0943

GAS METER END, cf 530.71
END TIME 1349

=> 123.75 cf @ meter cond.

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				323	0.989	0.91							

Started on another Sheet
RE 2 of 3

~~82~~
82

Page 2 of 2

372.798

Method 5 Field Data Continued Date 9/3/93 Location INLET Run No. METALS-1 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
64	3-1	1014	-4.5	326	1.40	1.16	373.190	221	253	—	51	80	76
72	3-2		-5.0	358	1.40	1.16	377.765	215	260	—	51	82	76
80	3-3	1034	-5.0	358	1.20	1.00	382.305	221	263	—	51	82	76
88	3-4		-4.0	362	.60	.50	~~386.615~~ 389.760	217	263		54	82	76
96	4-1		-5.0	338	1.30	1.08	~~389.760~~ 390.275	220	269	—	53	82	76
104	4-2		-5.0	350	1.40	1.96	394.725	202	237		53	81	76
112	4-3		-5.0	362	1.15	.96	399.265	214	253	—	50	82	77
120	4-4		-4.0	349	~~.54~~ .55	.46	403.595 406.610	220	240	—	51	84	77
128	5-1		-5.0	313	1.30	1.08	~~406.640~~ 407.245	245	262	—	54	82	76
136	5-2		-5.0	331	.92	.77	411.695	219	265	—	52	85	79
144	5-3		-5.0	338	1.20	1.06	415.[illegible]	227	263	—	53	85	79
152	5-4		-5.0	337	1.0	.83	419.750 423.645	225	262	—	52	86	80
160	6-1		-5.0	317	1.05	.87	423.790	269	216	—	53	86	80
168	6-2		-5.5	325	1.10	.91	427.64	212	274	—	53	86	81
176	6-3		-5.0	342	1.05	.87	431.720	226	262	—	52	87	82
184	6-4		-5.0	345	.94	.78	435.742 439.565	211	245		52	86	80
192	END												

Page ~~2~~ 3 of 3

Method 5 Field Data Continued Date 09/03 Location 047 [illegible] Run No. # Metals Operator Eric / T.C.

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pilot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	3-1	10	2.6	326	.88	.80	467.11	255	253		73	84	81
	3-2	20	2.9	328	.94	.80	472.10	252	253		72	83	82
	3 3	30	3.1	330	1.05	.96	477.04	255	263	add ice	72	83	81
	3-4	40	2.8	328	.95	.87	482.41	265	265		66	83	82
							487.51						
1237	2-1	10	2.4	335	.70	.64	487.51	282	252		63	83	81
	2-2	20	2.8	335	.70	.64	492.14	290	250		63	83	81
	2-3	30	3.8	343	1.35	1.24	496.68 ~~496.44~~	300	253		61	83	82
	2-4	40	3.8	340	1.35	1.24	502.40	270	256		63	84	81
		Coming out of Port Last [illegible]					508.24						
	1-1	10	3.9	339	.90	.83	508.28	271	250		67	84	81
	1-2	20	3.0	339	.90	.83	513.28	310	250		65	84	82
	1-3	30	3.9	345	1.4	1.3	518.30	320	258		64	85	82
	1-4	40	4.0	348	1.8	1.5	524.42	252	258		65	86	83
STOP	1349		STOP				530.71						

MASS TRAIN OPERATIO	8 Out
GAS ANALYSIS - O2 :	6.3
CO2 :	12.5
H2O :	7.0
AMB PRESS, In Hg :	29.26
STACK dP, In H2O :	7.5
Enter Gas vel., fps	
or AVG SQR ROOT d :	1.01
MINIMUM PITOT dP :	0.50
dP INCREMENT :	0.050
STACK GAS TEMP, F :	318
GAS METER TEMP, F :	90
PITOT CONSTANT :	0.81
ORIFICE CONSTANT :	1.87
Nutech 1	
NOZZLE DIA, in :	0.192
SYSTEM FLOW, scfm :	0.794
dp	1.01
FLOW, scfm	0.4902
Target volume	110
Minutes to Vol.	224.41
hours to vol.	3.7401
No. of points:	24
Reqd Min./point	9.3503
Use Minutes/point	10

dp PITOT	dP ORI	dp PITOT	dP ORI
0.500	0.46	1.400	1.28
0.550	0.50	1.450	1.33
0.600	0.55	1.500	1.38
0.650	0.60	1.550	1.42
0.700	0.64	1.600	1.47
0.750	0.69	1.650	1.51
0.800	0.73	1.700	1.56
0.850	0.78	1.750	1.61
0.900	0.83	1.800	1.65
0.950	0.87	1.850	1.70
1.000	0.92	1.900	1.74
1.050	0.96	1.950	1.79
1.100	1.01	2.000	1.84
1.150	1.06	2.050	1.88
1.200	1.10	2.100	1.93
1.250	1.15	2.150	1.97
1.300	1.19	2.200	2.02
1.350	1.24	2.250	2.06

117.6 predicted vol.

nozzle T40

9/3/93 Outlet 8 metals train operation

MASS TRAIN OPERATIO	Inlet 8
GAS ANALYSIS - O2 :	6.3
CO2 :	12.5
H2O :	7.0
AMB PRESS, in Hg :	29.36
STACK dP, in H2O :	-20.0
Enter Gas vel., fps	
or AVG SQR ROOT d :	1.09
MINIMUM PITOT dP :	0.50
dP INCREMENT :	0.050
STACK GAS TEMP, F :	332
GAS METER TEMP, F :	90
PITOT CONSTANT :	0.81
ORIFICE CONSTANT :	1.87
Nutech 4 ✓	
NOZZLE DIA, in :	0.192
SYSTEM FLOW, acfm :	0.891
dp	1.18
FLOW, scfm	0.5418
Target volume	100
Minutes to Vol.	184.58
hours to vol.	3.0763
No. of points:	24
Reqd Min./point	7.6907
Use Minutes/point	8

dp PITOT	dP ORI	dp PITOT	dP ORI
0.500	0.42	1.400	1.16
0.550	0.46	1.450	1.20
0.600	0.50	1.500	1.25
0.650	0.54	1.550	1.29
0.700	0.58	1.600	1.33
0.750	0.62	1.650	1.37
0.800	0.66	1.700	1.41
0.850	0.71	1.750	1.45
0.900	0.75	1.800	1.50
0.950	0.79	1.850	1.54
1.000	0.83	1.900	1.58
1.050	0.87	1.950	1.62
1.100	0.91	2.000	1.66
1.150	0.96	2.050	1.70
1.200	1.00	2.100	1.74
1.250	1.04	2.150	1.79
1.300	1.08	2.200	1.83
1.350	1.12	2.250	1.87

104.0 predicted vol.

nozzle T39 ✓

9/3/93 Inlet metals train operation

192.

PAGE 1 OF ___

METHOD 5 FIELD DATA

Plant/Location SALLY [redacted]
Operator CAH
Date 9-3-93
Test No./Run No. METALS 1
Meter Box ID 71-16
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 21
Average Nozzle Dia., Inches .255
Barometric Pressure, In. Hg 29.06
Ambient Temp., deg. F 70
Assumed Moisture, % 18
Filter ID ______
Stack Pressure, In. H2O .7

1st Filter:
Leak Rate, cfm, Pretest .02 cfm @ 10 "Hg
Leakrate, cfm, Post-test .015 cfm @ 5 "Hg
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 060.08
START TIME ~~8:55~~ 9:02

GAS METER END, cf 257.12
END TIME 1523

Clock Time	Travese Point Number	Sample Time	Vacuum In. Hg	Stack Temp deg. F	Pitot DP In. H2O	Orifice DH In. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DCM In	DCM out
9:02	PORT-POINT ~~1-1~~	0	—	131	.36	1.07	060.08	198	242			70	70
9:22	1-1	20 ~~30~~	3.2	131	.36	1.07	073.33	239	251		48	76	70
9:32	~~2~~	30 ~~60~~	3.3	130	.36	1.07	080.08	253	254		46	76	70
9:47	1-2 ~~3~~	45 ~~90~~	3.5	129	.38	1.13	090.21	257	255		49	78	71
10:02	1-2	60	3.4	129	.36	1.07	099.76	258	255		51	78	71
10:17	1-3 ~~2-1~~	75	2.6	129	.28	.83	107.16	234	251		53	76	72
10:32	1-3 ~~2~~	90	2.8	128	.30	.89	114.33	232	249		53	76	72
	~~3~~												
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				127	0.581	1.00						73	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 8 Run No. 1

Set Up By ZCK/DWS Date 09/03/93 Run Date

Comments Multiple Metals (40 ml of 30% H_2O_2 added to 1st 2 impingers b/c H_2O_2 conc.)

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q129
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

-40cc Corrected above

IMPINGER SOLUTIONS:	Initial		Final		Gain	
First	648.3 ~~603.6~~ 40cc	g	839.4	g	191.1	g
Second	625.2 ~~584.9~~ 40cc	g	647.9	g	22.7	g
Third	425.3	g	427.2	g	1.9	g
Fourth	584.9	g	589.6	g	4.7	g
Fifth	592.8	g	598.2	g	5.4	g
Sixth	466.0	g	470.5	g	4.5	g
Seventh	–	g	–	g	–	g

SILICA GEL WEIGHTS:	Initial		Final		
	852.7	g	886.5	g	33.8
		g		g	
Totals		g		g	
			264.1		TOTAL

COMMENTS:

Color of Silica Gel: 1/2 gel pink, remainder blue (Dw Smith)

Description of Impinger Water:

PAGE 1 OF ___

METHOD 5 FIELD DATA

Plant/location BALLY [illegible]
Operator CAH
Date 9-3-93
Test No./Run No. metals 1
Meter Box ID 71-16
Gas Meter Cal. Factor ___
Orifice ID ___
Orifice DH@ ___

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 21
Average Nozzle Dia., inches .255
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F 70
Assumed Moisture, % 18
Filter ID ___
Stack Pressure, in. H2O .7

1st Filter:
Leak Rate, cfm, Pretest .02 cfm @ 10 "Hg
Leakrate, cfm, Post-test .015 cfm @ 5 "Hg
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 060.08
START TIME ~~8:55~~ 9:02

GAS METER END, cf 257.12
END TIME 1523

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
9:02	PORT-POINT ~~1-1~~	0	—	131	.36	1.07	060.08	198	242			70	70
9:22	1-1	20 ~~30~~	3.2	131	.36	1.07	073.33	239	251		48	76	70
9:32	~~2~~	30 ~~60~~	3.3	130	.36	1.07	080.08	253	254		46	76	70
9:47	1-2 ~~3~~	45 ~~90~~	3.5	129	.38	1.13	090.21	257	255		49	78	71
10:02	1-2	60	3.4	129	.36	1.07	099.76	258	255		51	78	71
10:17	1-3 ~~2-1~~	75	2.6	129	.28	.83	107.16	234	251		53	76	72
10:32	1-3 ~~2~~	90	2.8	128	.30	.89	114.33	232	249		53	76	72
	~~3~~												
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				127	0.581	1.00						73	

Page 2 of 2

Method 5 Field Data Continued Date 9-3-93 Location BAILLY STACK Run No. Metals 1 Operator CAH

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 10:44	2-1	0	2.0	128	.36	1.07	114.33						
10:59	2-1	105	2.5	129	.36	1.07	121.15	210	251		49	76	71
11:14	2-2	120	2.8	129	.36	1.07	130.30	213	256		48	76	71
11:29	2-2	135	2.9	129	.36	1.07	138.16	213	254		49	75	72
11:44	2-2	150	2.9	129	.34	1.01	146.24	205	257		48	75	71
11:59	2-1	165	2.9	128	.36	1.07	154.50	215	255		47	75	72
12:14	2-1	180	3.0	128	.38	1.13	163.60	214	256		49	75	72
12:29	2-1	195	3.0	130	.36	1.07	171.95	215	252		46	74	71
12:44	2-1	210	3.0	130	.36	1.07	180.02	217	254		47	74	71
1259	2-2	225	3.0	128	.30	.89	187.81	211	257		49	74	71
1314	2-2	240	2.9	129	.30	.89	195.57	207	255		47	73	71
1329	2-2	255	2.9	129	.32	.95	203.02	210	253		49	73	71
1344	2-2	270 ~~310~~	3.0	127	.32	.95	210.77	214	256		50	74	71
1353 1408	3-1	285	3.0	125	.34	1.01	217.65	205	254		49	74	71
1423	3-1	300	3.0	123	.34	1.01	226.24	203	256		47	74	71
1438	3-2	315	3.0	120	.30	.89	234.00	198	256		49	75	71
1453	3-2	330	3.0	111	.30	.89	241.56	211	253		50	75	71
1508	3-1	345	3.0	123	.32	.95	249.18	213	254		50	74	71
1523	3-1	360	3.0	126	.32	.1	257.12	214	255		52	74	

```
ASS TRAIN OPERATION  Stack              dp PITOT   dP ORI     dp PITOT   dP ORI
****************************            --------   ------     --------   ------
GAS ANALYSIS - O2  :      6.3              0.100     0.30        0.460     1.36
              CO2  :     12.5              0.120     0.36        0.480     1.42
              H20  :     18.0              0.140     0.42        0.500     1.48
AMB PRESS, in Hg   :    29.06              0.160     0.47        0.520     1.54
STACK dP, in H20   :      0.7              0.180     0.53        0.540     1.60
Enter Gas vel., fps                        0.200     0.59        0.560     1.66
or AVG SQR ROOT d  :     0.60              0.220     0.65        0.580     1.72
MINIMUM PITOT dP   :     0.10              0.240     0.71        0.600     1.78
dP INCREMENT       :    0.020              0.260     0.77        0.620     1.84
                                           0.280     0.83        0.640     1.90
STACK GAS TEMP, F  :      157              0.300     0.89        0.660     1.96
GAS METER TEMP, F  :       90              0.320     0.95        0.680     2.02
                                           0.340     1.01        0.700     2.08
PITOT CONSTANT     :     0.80              0.360     1.07        0.720     2.14
ORIFICE CONSTANT   :     1.94              0.380     1.13        0.740     2.20
CAE 71-16                                  0.400     1.19        0.760     2.25
NOZZLE DIA, in     :    0.255              0.420     1.25        0.780     2.31
SYSTEM FLOW, scfm  :    0.747              0.440     1.31        0.800     2.37
dp                       0.36
FLOW, scfm              0.526
Target volume             185          189.4 predicted vol.
Minutes to Vol.        351.69                nozzle T2
hours t, vol.          5.8615
No. of points:             12
Reqd Min./point        29.307          9/3/93 Stack metals train operation
Use Minutes/poinc          30
```

```
MASS TRAIN OPERATION  Stack             dp PITOT   dP ORI     dp PITOT   dP ORI
****************************            --------   ------     --------   ------
GAS ANALYSIS - O2  :      6.3              0.100     0.30        0.460     1.36
              CO2  :     12.5              0.120     0.36        0.480     1.42
              H20  :     18.0              0.140     0.42        0.500     1.48
AMB PRESS, in Hg   :    29.06              0.160     0.47        0.520     1.54
STACK dP, in H20   :      0.7              0.180     0.53        0.540     1.60
Enter Gas vel., fps                        0.200     0.59        0.560     1.66
or AVG SQR ROOT d  :     0.60              0.220     0.65        0.580     1.72
MINIMUM PITOT dP   :     0.10              0.240     0.71        0.600     1.78
dP INCREMENT       :    0.020              0.260     0.77        0.620     1.84
```

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bally

Sampling Location Stack   Run No. 1

Set Up By WDK/DWS   Date 09/03/93   Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By   Report Date

FILTERS USED

Filter No. 3Q133

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	948.7 g	1177.2 g	228.5 g
Second	580.0 ~~589.5~~ g	588.7 g	8.7 g
Third	415.2 g	417.0 g	1.8 g
Fourth	580.5 g	581.5 g	1.0 g
Fifth	669.4 g	668.3 g	-0.9 g
Sixth	473.8 ~~478.0~~ g	475.2 g	-1.4 g
Seventh	— g	— g	- g

SILICA GEL WEIGHTS:	Initial	Final
	837.2 g	873.9 Net 36.7 g
	g	g
Totals	g	g

TOTAL: 774.4

COMMENTS:

Color of Silica Gel: 50% Pink

Description of Impinger Water:

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/Location #7 Outlet Acids
Operator Kirby
Date 9-3-93
Test No./Run No. 1 Acids
Meter Box ID Nutech #3
Gas Meter Cal. Factor ____
Orifice ID ____
Orifice DH@ 1.89

Pitot Coefficient, Cp .83
Nozzle ID. T 43
Average Nozzle Dia., inches .190
Barometric Pressure, in. Hg 29.26
Ambient Temp., deg. F 68°
Assumed Moisture, % 7.0
Filter ID ____
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .003 cfm
Leakrate, cfm, Post-test .004 cfm
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 634.197
START TIME 18:39

GAS METER END, cf 660.745
END TIME 19:58

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		3min	[illegible]	[illegible]	[illegible]	[illegible]	634.197 [illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
	A 1	0	1.5	311	.50	.46	635.3 [illegible]	294	242		66	72	71
	2	6	1.5	311	.50	.46	636.5	305	266		55	73	71
	3	9	2.0	311	.65	.59	637.7	291	260		55	73	71
	4	12	2.3	310.	1.00	.92	639.37	238	251		54	74	71
	B 1	15	2.0	311	.90	.82	640.7	267	234		59	72	71
	2	18	2.0	311	.85	.78	642.2	287	238		53	74	71
	3	21	2.0	311	.75	.69	643.5	298	245		52	75	71
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				311	0.836	0.105							

72.6

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bally

Sampling Location Stack   Run No. 1

Set Up By WDK/DNS   Date 09/23/93   Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By   Report Date

FILTERS USED	
Filter No.	3Q133
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	948.7 g	1677.2 g	728.5 g
Second	580.0 ~~529.3~~ g	588.7 g	8.7 g
Third	415.2 g	417.0 g	1.8 g
Fourth	580.5 g	591.5 g	1.0 g
Fifth	669.4 g	668.3 g	-0.9 g
Sixth	478.8 ~~423.0~~ g	475.3 g	-1.4 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	837.2 g	873.9 Net g 36.7
	g	g
Totals	g	g

TOTAL: 774.4

COMMENTS:

Color of Silica Gel: 50% Pink

Description of Impinger Water:

Page 2 of 2

372.998

Method 5 Field Data Continued Date 9/3/93 Location INLET Run No. METALS-1 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
64	3-1	1019	-4.5	326	1.40	1.16	373.190	221	253	—	51	80	76
72	3-2		-5.0	358	1.40	1.16	377.765	215	260	—	51	82	76
80	3-3	1034	-5.0	358	1.20	1.00	382.305	221	263	—	51	82	76
88	3-4		-4.0	362	.60	.50	386.615 389.760	217	263		54	82	76
96	4-1		-5.0	338	1.30	1.08	~~389.760~~ 390.275	220	269	—	53	82	76
104	4-2		-5.0	350	1.40	1.96	394.125	202	237		53	81	76
112	4-3		-5.0	362	1.15	.96	399.265	214	253	—	50	82	77
120	4-4		-4.0	349	~~.54~~ .55	.46	403.595 406.610	220	240	—	51	84	77
128	5-1		-5.0	313	1.30	1.08	~~[illegible]~~ 407.245	245	262	—	54	82	76
136	5-2		-5.0	331	.92	.77	411.695	219	265	—	52	85	79
144	5-3		-5.0	338	1.20	1.06	415.[illegible]	227	263	—	53	85	79
152	5-4		-5.0	337	1.0	.83	419.750 423.645	225	262	—	52	86	80
160	6-1		-5.0	317	1.05	.87	423.790	269	216	—	53	86	80
168	6-2		-5.5	325	1.10	.91	427.64	212	274	—	53	86	81
176	6-3		-5.0	342	1.05	.87	431.720	226	262	—	52	87	82
184	6-4		-5.0	345	.94	.78	435.743 439.565	211	245		52	86	80

192 END

G-19

MASS TRAIN OPERATIO	Inlet 8	dp PITOT	dP ORI	dp PITOT	dP ORI
GAS ANALYSIS - O2 :	6.3	0.500	0.42	1.400	1.16
CO2 :	12.5	0.550	0.46	1.450	1.20
H2O :	7.0	0.600	0.50	1.500	1.25
AMB PRESS, in Hg :	29.36	0.650	0.54	1.550	1.29
STACK dP, in H2O :	-20.0	0.700	0.58	1.600	1.33
Enter Gas vel., fps		0.750	0.62	1.650	1.37
or AVG SQR ROOT d :	1.09	0.800	0.66	1.700	1.41
MINIMUM PITOT dP :	0.50	0.850	0.71	1.750	1.45
dP INCREMENT :	0.050	0.900	0.75	1.800	1.50
		0.950	0.79	1.850	1.54
STACK GAS TEMP, F :	332	1.000	0.83	1.900	1.58
GAS METER TEMP, F :	90	1.050	0.87	1.950	1.62
		1.100	0.91	2.000	1.66
PITOT CONSTANT :	0.81	1.150	0.96	2.050	1.70
ORIFICE CONSTANT :	1.87	1.200	1.00	2.100	1.74
Nutech 4 ✓		1.250	1.04	2.150	1.79
NOZZLE DIA, in :	0.192	1.300	1.08	2.200	1.83
SYSTEM FLOW, acfm :	0.891	1.350	1.12	2.250	1.87
dp	1.18				
FLOW, scfm	0.5418				
Target volume	100	104.0	predicted vol.		
Minutes to Vol.	184.58		nozzle T39 ✓		
hours to vol.	3.0763				
No. of points:	24				
Reqd Min./point	7.6907	9/3/93	inlet metals train operation		
Use Minutes/point	8				

192.

PAGE 1 OF 3

INLET ACID #1

METHOD 5 FIELD DATA

Plant/location Baily Inlet
Operator WJP/DJ
Date 9/3/93
Test No./Run No. ACID-1
Meter Box ID NUTECH 4
Gas Meter Cal. Factor
Orifice ID
Orifice DH@ 1.87

Pitot Coefficient, Cp .81
Nozzle ID. T-47 (Port 1,2)(Port 3,4,5,6 T-
Average Nozzle Dia., Inches .190
Barometric Pressure, In. Hg 29.36
Ambient Temp., deg. F 75
Assumed Moisture, %
Filter ID 40-140
Stack Pressure, In. H2O -20.0

1st Filter:
Leak Rate, cfm, Pretest .000 cfm/min @ 11" H2O
Leakrate, cfm, Post-test .000 cfm @ 9" H2O
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 441.695 ✓
START TIME 1500

GAS METER END, cf
END TIME .1638

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	Temperatures (deg. F) 2 Probe	3 Filter	Sorb.	5 Imp. Outlet	6 DGM in	7 DGM out
							441.695						
2	1-1		4.5	327	.90	.72	441.695	200	243		55	76	75
4	1-2		5.0	331	1.05	.84	—	—	—		—	—	—
6	1-3		5.0	344	1.05	.84	443.6—	139 193	243		52	77	76
8	1-4		5.0	354	1.1	.88	44.68	198.	243		52	77	76
	2						445.82	202	245		52	77	76
10	2-1		5.0	320	1.2	.96	446.055	↓	↓		↓		
12	2-2		5.0	330	1.25	1.0	446.500	205	245		52	77	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				340	1.024	0.88						80.3	

SAMPLING TRAIN SET-UP AND IMPINGER WEIGHT SHEET

Plant BAILLY
Sampling Location OUTLET - UNIT 7 Run No. 1
Set Up By WDK/DWS Date 05/03/93 Run Date
Comments ACIDS
Analyst Responsible for Recovery
Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. ~~30133~~ wdk 30135

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	641.9 ~~642.1~~ wdk g	675.7 g	33.8 g
Second	600.3 g	~~[illegible]~~ 605.5 g	5.2 g
Third	478.7 g	480.7 g	2.0 g
Fourth	— g	— g	g
Fifth	— g	— g	g
Sixth	— g	— g	g
Seventh	— g	— g	g

SILICA GEL WEIGHTS:	Initial	Final
	812.8 g	821.1 net 8.3 g
	g	g
Totals	g	g

Total 49.3

COMMENTS:
Color of Silica Gel:
Description of Impinger Water:

Page 2 of 3

INLET ACID #1

Method 5 Field Data Continued Date Location Run No. Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
14	2-3		5.0	346	1.0	.80	447.985	150	243		55	79	76
16	2-4	1517	5.0	357	1.1	.88	448.950	202	244		54	79	75
*							449.940	~~200~~	~~263~~		~~51~~	~~79~~	~~77~~
18	3-1	1525		322	1.2	.96	451.050	200	263		51	79	77
20	3-2		6.0	351	1.3	1.04	452.25	201	266		52	80	77
22	3-3		6.0	360	1.1	.88	453.28	198	268		48	80	77
24	3-4		5.0	363	.60	.48	454.27	199	264		49	82	78
—	—	—	—	—	—	—	455.04	—	—	—	—	—	—
26	4-1	1550	5.5	318	1.20	.96	455.46	240	263		52	81	78
28	4-2		5.5	347	1.25	1.0	—	—	—		52	81	78
30	4-3		5.5	360	1.1	.88	457.58	199	268		49	84	79
32	4-4		5.5	363	.55	.44	458.59	216	266		49	84	79
—	—	—	—	—	—	—	459.375	—					—
34	5-1		~~7.0~~ 6.0	321	1.30	1.04	459.780	199	266		50	86	81
36	5-2		6.0	337	.92	.74	460 895	198	270		49	86	81

T46

?

BAG. SAMPLE 1538 TO 1554

BROKE NOZZLE (T-47)
PULLING OUT OF PORT 2
REPLACED WITH T-46 LEAK CHECK OK.

1a 3 of 3

INLET ACIDS #1

Method 5 Field Data Continued Date Location Run No. Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
38	5-3		5.5	347	.94	.74	461.85	169	272		50	86	81
40	5-4		5.0	352	.96	.78	462.785	189	271		51	86	81
						~~[illegible]~~	465.740	—					
42	6-1	1629	6.5	318	1.05	.84	464.090	199	277		52	83	82
44	6-2		6.0	324	1.1	.88	465.18	—	—		52	86	83
46	6-3		6.0	324	1.15	.92	466.29	202	279		52	86	83
48	6-4	16	5.5	341	1.0	.80	467.25	207	279		51	89	84
							468.210						

YES BY CRIKEY WE BROKE ANOTHER
FINNISHED RUN (PORT 6) WITH NOZZLE
T-45.

```
 ASS TRAIN OPERATION  Inlet 8      dp PITOT   dP ORI     dp PITOT    dP ORI
----------------------------      --------   ------     --------    ------
GAS ANALYSIS - O2  :     6.3          0.500     0.40        1.400     1.12
              CO2  :    12.5          0.550     0.44        1.450     1.16
              H2O  :     7.0          0.600     0.48        1.500     1.20
AMB PRESS, in Hg   :   29.36          0.650     0.52        1.550     1.24
STACK dP, in H2O   :   -20.0          0.700     0.56        1.600     1.27
Enter Gas vel., fps                   0.750     0.60        1.650     1.31
or AVG SQR ROOT d  :    1.09          0.800     0.64        1.700     1.35
MINIMUM PITOT dP   :    0.50          0.850     0.68        1.750     1.39
dP INCREMENT       :   0.050          0.900     0.72        1.800     1.43
                                      0.950     0.76        1.850     1.47
STACK GAS TEMP, F  :     332          1.000     0.80        1.900     1.51
GAS METER TEMP, F  :      90          1.050     0.84        1.950     1.55
                                      1.100     0.88        2.000     1.59
PITOT CONSTANT     :    0.83          1.150     0.92        2.050     1.63
ORIFICE CONSTANT   :    1.87          1.200     0.96        2.100     1.67
Nutech 4                              1.250     1.00        2.150     1.71
NOZZLE DIA, in     :   0.190          1.300     1.04        2.200     1.75
SYSTEM FLOW, acfm  :   0.872          1.350     1.08        2.250     1.79
dp                      1.18
FLOW, scfm            0.5306
Target volume             20         25.5 predicted vol.
Minutes to Vol.       37.697              nozzle 147
hours to vol.         0.6283
No. of points:            24
Reqd Min./point       1.5707
Use Minutes/point          2
```

25.5 predicted vol.
nozzle 147

ACID
9/3/93 inlet ~~metals~~ train operation

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location INLET - UNIT 8 Run No. 1

Set Up By Yock lows Date 09/03/93 Run Date 09/03/93

Comments ACIDS

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 4Q140

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	622.8 g	631.7 g	8.9 g
Second	597.4 g	634.1 g	36.7 g
Third	474.5 g	474.9 g	0.4 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final	
	823.2 g	832.3	9.1 g
	g		g
Totals	g		g

TOTAL 55.1

COMMENTS:

Color of Silica Gel: 100% Blue - No Change

Description of Impinger Water: Clear

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly Outlet #4
Operator RNC / Tommy L.
Date 09/03
Test No./Run No. #1 ACID
Meter Box ID NUTECH #1
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O 7"

1st Filter: 10" ,000
Leak Rate, cfm, Pretest –
Leakrate, cfm, Post-test < 7" ,000
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf 559.48
START TIME 1610

GAS METER END, cf 584.83
END TIME 1714

Clock Time	Travese Point Number	Sample Time MIN	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1610	6-1	2.0	1.9	310	.80	.70	START 559.48	272	250		77	82	82
	6-2	4	1.8	307	.80	.70	561.36	317	250		74	81	82
	6-3	6	1.8	307	1.3	1.14	562.47	335	250		73	81	82
	6-4	8	2.4	315	1.5	1.3	563.68	340	249		73	81	82
	5-1	2	2.8	310	.75 ~~.95~~	.66 ~~.75~~	563.62	341	250		68	80	81
	5-2	4	2.7	310	.75	.66	564.60	341	251		67	81	81
	5-3	6		310	1.1	.97	565.51	360	249		67	82	82
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				322	1.026	0.94						85.5	

PITOT POST TEST – R – 6" H2O
S – 6" H2O

Page 2 of 3

Method 5 Field Data Continued Date 09/03 Location Outlet #8 Run No. ACID #1 Operator RNC

Clock Time	Travese Point Number	Sample Time min	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	5-4	8		309	1.4	1.2	566.54	360	249				
						out	567.76						
	4-1	2	1.9	316	.80	.75	567.83	360	249		73	85	83
	4-2	4	1.9	316	.80	.75	568.85	361	251		73	85	83
	4-3	6	2.1	318	1.0	.88	569.75	362	250		73	85	83
	4-4	8	2.1	317	.90	.79	570.76	368	255		74	88	84
						out	571.72						
1640	3-1	2	2.1	324	.90	.79	start 571.72		260		75	88	85
	3-2	4	2.1	331	.90	.79	572.78		260		75	88	85
	3-3	6	2.2	331	1.1	.97	573.78	365	260		74	89	86
	3-4	8	2.2	328	1.0	.88	574.88	355	258		74	90	86
							575.98						
	1-1	2	2.2	328	1.0	.88	575.98	320	256		75	91	86
	1-2	4	2.2	300	1.0	.88	576.95	313	255		75	90	86
	1-3	6	2.7	344	1.5	1.3	577.99	328	251		75	92	87

Page 3 of 3

Method 5 Field Data Continued Date 09/03 Location #8 Outlet Run No. # 1 ACIP Operator RM

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	1-4	8	3.1	344	1.9	1.65	579.16						
							580.49						
	2-1	2	2.1	336	.85	.75	start 580.53	301	240		80	91	88
	2-2	4	2.1	336	.85	.75	581.58	308	245		80	91	88
	2-3	6	2.5	343	1.5	1.30	582.55	341	246		77	91	88
	2-4	8	2.3	340	1.3	1.1	583.74	288	248		77	92	84
1714				Stop			584.83						

```
    TRAIN OPERATION  8 Out            dp PITOT    dP ORI      dp PITOT    dP ORI
   -------------------------          --------    ------      --------    ------
IAS ANALYSIS - O2  :       6.3           0.500      0.44         1.400      1.23
              CO2  :      12.5           0.550      0.48         1.450      1.28
              H2O  :       7.0           0.600      0.53         1.500      1.32
MB PRESS, in Hg    :     29.26           0.650      0.57         1.550      1.36
STACK dP, in H2O   :       7.5           0.700      0.62         1.600      1.41
Enter Gas vel., fps                      0.750      0.66         1.650      1.45
or AVG SQR ROOT d  :      1.01           0.800      0.70         1.700      1.50
MINIMUM PITOT dP   :      0.50           0.850      0.75         1.750      1.54
dP INCREMENT       :     0.050           0.900      0.79         1.800      1.58
                                         0.950      0.84         1.850      1.63
STACK GAS TEMP, F  :       318           1.000      0.88         1.900      1.67
IAS METER TEMP, F  :        90           1.050      0.92         1.950      1.72
                                         1.100      0.97         2.000      1.76
PITOT CONSTANT     :      0.81           1.150      1.01         2.050      1.80
ORIFICE CONSTANT   :      1.87           1.200      1.06         2.100      1.85
Nutech 1                                 1.250      1.10         2.150      1.89
NOZZLE DIA, in     :     0.190           1.300      1.14         2.200      1.94
SYSTEM FLOW, acfm  :     0.778           1.350      1.19         2.250      1.98
dp                        1.01
FLOW, acfm                0.48
Target volume               20            23.0 predicted vol.
Minutes to Vol.         41.665                 nozzle T48
Hours to vol.           0.6944
No. of points:              24                        ACID
Reqd Min./point          1.736          9/3/93 Outlet 8 [redacted] train operatio
Use Minutes/point            2
```

PAGE 2 OF 2

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-3-93
Test No./Run No. ACID 1
Meter Box ID 71-16
Gas Meter Cal. Factor ____
Orifice ID ____
Orifice DH@ 1.94

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 6
Average Nozzle Dia., inches .251
Barometric Pressure, in. Hg 29.06
Ambient Temp., deg. F 72
Assumed Moisture, % 18
Filter ID ____
Stack Pressure, in. H2O .7

1st Filter:
Leak Rate, cfm, Pretest .02cfm @ 10" Hg
Leakrate, cfm, Post-test .02cfm
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 257.94
START TIME @ 1700

GAS METER END, cf 281.02
END TIME ____

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1700	PORT - POINT	0	—	—	.30	.84	257.94	219	243		71	73	73
1704	3-1	4	4.0	119	.30	.84	259.93	226	255		66	74	73
1708	2	8	4.1	118	.30	.84	261.92	229	255		64	75	73
1712	3	12	4.1	119	.28	.78	263.77	224	254		61	75	74
START 1718													
1722	2-1	16	4.1	117	.30	.84	264.76	229	256		62	77	75
1726	2	20	4.1	117	.28	.78	267.77	231	257		62	78	76
1730	3	24	4.1	115	.28	.78	269.56	222	251		61	78	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				113	0.535	0.80						77.1	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY

Sampling Location OUTLET - UNIT 8 Run No. 1

Set Up By ZOE/DWS Date 09/03/93 Run Date 09/03/93

Comments ACIDS

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 3Q 144

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		-

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	636.0 g	662.8 g	26.8 g
Second	586.1 g	597.9 g	11.8 g
Third	476.0 g	479.9 g	3.9 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	769.5 g	779.8 10.3 g
	g	g
Totals	g	g

TOTAL 52.8

COMMENTS:

Color of Silica Gel: 1/10 Pink

Description of Impinger Water:

Page 5 of 5

Method 5 Field Data Continued Date 9-3 93 Location STACK Run No. ACID 1 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1734	2-1	28	4.1	114	.28	.78	271.45	216	253		60	79	77
1738	2	32	4.2	114	.30	.84	273.40	219	253		60	79	77
1742	3	36	4.2	113	.28	.78	275.30	216	258		60	80	78
START 1749													
1753	1-1	40	4.2	102	.28	.78	277.27	250	262		63	80	79
1757	2	44	4.3	102	.28	.78	279.14	254	258		62	81	79
1801	3	48	4.3	103	.28	.78	281.02	265	253		62	81	80

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY

Sampling Location STACK Run No. 1

Set Up By KGT/DWY Date 09/03/93 Run Date

Comments ACIDS

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q 143
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		-
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	638.7 g	709.5 g	70.8 g
Second	606.0 g	609.8 g	3.8 g
Third	478.3 g	479.8 g	1.5 g
Fourth	— g	— g	— g
Fifth	— g	— g	— g
Sixth	— g	— g	— g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	867.2 g	874.8 7.6 g
	g	g
Totals	g	g

TOTAL 83.7

COMMENTS:

Color of Silica Gel: 100% Blue

Description of Impinger Water:

MASS TRAIN OPERATIO	7 Out
GAS ANALYSIS - O2 :	6.3
CO2 :	12.5
H2O :	7.0
AMB PRESS, in Hg :	29.26
STACK dP, in H2O :	7.5
Enter Gas vel., fps	
or AVG SQR ROOT d :	0.79
MINIMUM PITOT dP :	0.50
dP INCREMENT :	0.050
STACK GAS TEMP, F :	302
GAS METER TEMP, F :	90
PITOT CONSTANT :	0.82
ORIFICE CONSTANT :	1.89
Nutech 3	
NOZZLE DIA, in :	0.202
SYSTEM FLOW, acfm :	0.688
dp	0.63
FLOW, scfm	0.4336
Target volume	100
Minutes to Vol.	230.62
hours to vol.	3.8436
No. of points:	20
Reqd Min./point	11.531
Use Minutes/point	12

dp PITOT	dP ORI	dp PITOT	dP ORI
0.500	0.58	1.400	1.64
0.550	0.64	1.450	1.70
0.600	0.70	1.500	1.75
0.650	0.76	1.550	1.81
0.700	0.82	1.600	1.87
0.750	0.88	1.650	1.93
0.800	0.94	1.700	1.99
0.850	0.99	1.750	2.05
0.900	1.05	1.800	2.10
0.950	1.11	1.850	2.16
1.000	1.17	1.900	2.22
1.050	1.23	1.950	2.28
1.100	1.29	2.000	2.34
1.150	1.34	2.050	2.40
1.200	1.40	2.100	2.45
1.250	1.46	2.150	2.51
1.300	1.52	2.200	2.57
1.350	1.58	2.250	2.63

104.1 predicted vol.

nozzle T2 2

5 ports X 4 points/port

9/3/93 Unit 7 Outlet metals train operation

PAGE 1 OF —

PORT ID - I

LEAK CHECK PITOT TO ~~10" H2O~~ 8" H2O

METHOD 5 FIELD DATA

Plant/Location COCKEYED BAILEY / INLET
Operator WJP / DT CW
Date 9/3/93
Test No./Run No. METALS 1
Meter Box ID NUTECH 4
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHð 1.87

Pitot Coefficient, Cp .81
Nozzle ID T-39
Average Nozzle Dia., Inches .192
Barometric Pressure, In. Hg 29.36
Ambient Temp., deg. F 73
Assumed Moisture, % ______
Filter ID 49.137
Stack Pressure, In. H2O -20.0

1st Filter:
Leak Rate, cfm, Pretest .000/min @ 15"
Leakrate, cfm, Post-test .000/min @ 10"
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf 339.145 ?
START TIME 0845

GAS METER END, cf ______
END TIME 1838

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) 2 Probe	3 Filter	Sorb.	Imp. 4 Outlet	DGM6 In	DGM7 out
0	1-1	0926	-3.0	321	.80	.66	~~339.000~~ 339.500	247	254	—	72	75	75
8	1-2		-3.5	327	1.05	.87	343.245	190	190	-	55	77	73
16	1-3	093	-4.0	340	1.10	.91	347.20	191	193		53	78	74
24	1-4	START 0935	-4.0	346	1.05	.87	351.280 351.720	251	253		56	78	75
32	2-1		-4.0	319	1.10	.91	355.875 356.190	205	246		53	79	75
40	2-2		-4.0	336	1.25	1.04	360.280	198	244		54	79	75
48	2-3		-4.0	345	.90	.75	364.605	210	244		56	80	75
56	2-4		-4.5	356	1.10	.91	368.365 372.540	209	246		52	80	75
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				338	1.033	0.90						79.4	

FILTER + PROBE TEMP DROPPING
REMOVED PROBE FROM PORT
TO INVESTIGATE. SEEZ.
NEEDED TO WRAP HOT BOX (OVEN).

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet - Unit 7 Run No. 1

Set Up By KK Date 09/08/93 Run Date

Comments Multiple Metals (40 ml of 30% H_2O_2 added to imp 1+2 to inc. H_2O_2 conc.)

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q130
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	619.1 ~~575.8~~ wet g	839.3 g	220.2 g
Second	611.8 ~~568.1~~ wet g	622.8 g	11.0 g
Third	426.6 g	426.8 g	0.2 g
Fourth	592.8 g	592.3 g	-0.5 g
Fifth	560.8 g	561.6 g	0.8 g
Sixth	502.7 g	503.7 g	1.0 g
Seventh	— g	— g	— g

not per comments above

SILICA GEL WEIGHTS:	Initial	Final
	793.1 g	817.3 g
	g	g
Totals	g	g

[illegible] 24.2

TOTAL 256.9

COMMENTS:

Color of Silica Gel: 1/3 PINK

Description of Impinger Water:

```
MASS TRAIN OPERATION  Stack        dp PITOT   dP ORI     dp PITOT   dP ORI
-----------------------------      --------   ------     --------   ------
GAS ANALYSIS - O2  :     6.3          0.100     0.28        0.460     1.28
              CO2  :    12.5          0.120     0.33        0.480     1.34
              H2O  :    18.0          0.140     0.39        0.500     1.39
AMB PRESS, in Hg   :   29.06          0.160     0.45        0.520     1.45
STACK dP, in H2O   :     0.7          0.180     0.50        0.540     1.50
Enter Gas vel., fps                   0.200     0.56        0.560     1.56
or AVG SQR ROOT d  :    0.60          0.220     0.61        0.580     1.62
MINIMUM PITOT dP   :    0.10          0.240     0.67        0.600     1.67
dP INCREMENT       :   0.020          0.260     0.72        0.620     1.73
                                      0.280     0.78        0.640     1.78
STACK GAS TEMP, F  :     137          0.300     0.84        0.660     1.84
GAS METER TEMP, F  :      90          0.320     0.89        0.680     1.89
                                      0.340     0.95        0.700     1.95
PITOT CONSTANT     :    0.80          0.360     1.00        0.720     2.00
ORIFICE CONSTANT   :    1.94          0.380     1.06        0.740     2.06
CAE 71-16                             0.400     1.11        0.760     2.12
NOZZLE DIA, in     :   0.251          0.420     1.17        0.780     2.17
SYSTEM FLOW, acfm  :   0.724          0.440     1.23        0.800 -   2.23
dp                      0.36
FLOW, scfm            0.5097
Target volume             20         24.5 predicted vol.
Minutes to Vol.       39.242              nozzle [illegible] 56
hours to vol.          0.654
No. of points:            12                    ACID
   1 Min./point       3.2701         9/3/93 Stack metals train operation
    Minutes/point          4
```

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY
Sampling Location STACK
Set Up By Kevin Dozzy Date 08/25/93
Comments Acid gases
Analyst Responsible for Recovery
Calculations & Report Reviewed By
Run No. BLANK TRAIN
Run Date 8/25/93
Report Date

FILTERS USED

Filter No. 30124

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	617.8 g	20 ~~621.~~ 618.9 g	g
Second	590.5 g	590.0 g	g
Third	472.1 g	472.2 g	g
Fourth	g	g	g
Fifth	g	g	g
Sixth	g	g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	817.7 g	818.8 g
	g	g
Totals	g	g

COMMENTS:
Color of Silica Gel: No noticeable change.
Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location outlet #8 Run No. Blank
Set Up By Kevin Dorietz Date 8/26/93 Run Date 8/26/93
Comments NH3/CN
Analyst Responsible for Recovery WOK
Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED	
Filter No.	
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	582.5 ~~584.9~~ KD g	581.9 ~~581.8~~ WOK g	g
Second	598.9 g	598.7 g	g
Third	476.9 g	476.9 g	g
Fourth	580.4 g	580.3 g	g
Fifth	566.2 g	566.2 g	g
Sixth	470.1 g	470.1 g	g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	KD ~~773.7~~ 770.4 g	771.7 g
	g	g
Totals	g	g

COMMENTS:
Color of Silica Gel: No noticeable change.
Description of Impinger Water: "

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Unit 7 Outlet — Run No. Blank Train

Set Up By YLOK — Date 05/26/93 — Run Date 05/26/93

Comments MMS

Analyst Responsible for Recovery YLOK/MB/KD/DWS

Calculations & Report Reviewed By ______ — Report Date ______

FILTERS USED	
Filter No.	unweighed
Sorbent Trap No.	~~H550-55-35~~ H590-55-35
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	452.8 g	452.8 g	g
Second	593.5 g	592.5 g	g
Third	605.9 g	605.7 g	g
Fourth	498.4 g	498.4 g	g
Fifth	g	g	g
Sixth	g	g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	791.5 g	793.1 g
	g	g
Totals	g	g

COMMENTS:

Color of Silica Gel: No noticeable change

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location ~~Stack~~ Inlet Run No. BLANK

Set Up By YCK Date 08/26/93 Run Date 08/26/93

Comments Multiple Metals

Analyst Responsible for Recovery YCK/CLI/MCB

Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED

Filter No. 2Q 136

Sorbent Trap No. ______

Condenser No. ______

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	574.9 g	574.8 g	g
Second	573.1 g	573.1 g	g
Third	425.5 g	425.5 g	g
Fourth	594.8 g	594.5 g	g
Fifth	597.1 g	596.9 g	g
Sixth	460.2 g	460.2 g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	796.3 g	796.5 g
	g	g
Totals	g	g

COMMENTS:

Color of Silica Gel: No noticeable change

Description of Impinger Water: "

PLANT: Bailey			DATE: 08/25/83
LOCATION: UNIT 8 OUTLET			TIME: 1630
ΔPstk:	Amb P:	Amb T. 82	PROBE ID.

1 2 3 4 5 6
0 0 0 0 0 0
↑

Reed Probe

POINT	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5		PORT 6	
NO.	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T
1	.90		.92	314	.73	310	.72	305	.75		.85	310
2	.92		.93		.75		.75		.80		.88	
3	1.2		1.4		.88		.78		.85		1.20	311
4	1.9		1.1		.90		.88		1.1		1.4	310
5												
6												
7												
8												
9												
10												

POINT	PORT 7		PORT 8		PORT 9		PORT 10		PORT 11		PORT 12	
NO.	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

3874-4

8·25-93 STACK VELOCITY

		ΔP	TEMP
PORT 1			
POINT	1 (118")	.30	133
	2 (77.25")	.26	132
PORT 2			
	1	.30	133
	2	.24	133
PORT 3			
	1	.30	133
	2	.28	133

Method 2 Data Sheet

Plant: BAILLY Date: 8/27/93

Location: unit 7 outlet Time: 0930~1000

$\%O_2$= ______ $\%N_2$= ______ $\%CO_2$= ______ %CO= ______ $\%H_2O$= ______

P_{amb} (HG)= ______ $\pm\Delta P_{stack}(H_2O)$= +7.63 T_{amb}(°F)= 90°F

Pitot Constant= .832 (Guardian 17-4) ← Lakeside

Point No.	Port 1		Port 2		Port 3		Port 4		Port 5		Port 6		Port 7		Port 8		Port 9	
	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T
1	.45		.38		.40		.38		.30									
2	.45		.38		.38		.38		.36									
3	.54		.34		.38		.34		.35									
4	.48		.28		.32		.38		.53									
5																		
6																		
7																		
8																		
9																		
10																		
Avg.*																		

* Averages are $\sqrt{\Delta p}$, not Δp.

AVERAGE DUCT VELOCITY = ______

AVERAGE DUCT TEMPERATURE = 312°F

8 INLET DUCT 10 ft deep + 3 ft nipples

Meas: 13'4" total
with 36" nipple

6 port X 4 point traverse

4'3½", 6'9½", 9'3½", 11'9½"

8 ESP OUTLET 24 wide X 13'6" deep

~2 ft deep nipples

194 - 31

6 port x 4 point traverse

3'8", 6'3½", 9'2½", 12'1"

UNIT 7 ESP OUTLET 16' wide X 13'6" deep

5 ports 2' deep nipples

5 port x 4 point traverse

mark probe like UNIT 8 OUTLET.

ITINERARY

512 #914797

NAME: Vann Bush, Joe McCain, Wim Marchant, Steve Piccot*
*(hotel only)

Trip Dates: 5/11 - 5/13/93

Charge: 7960.11.6

Purpose: Pre-test site visit - Bailey Gener. Stat.

Contact: Beth Wrobel, NIPSCO

Day/Date	LEAVE City	LEAVE Flight #	LEAVE Time	ARRIVE City	ARRIVE Time	Accommodations	Car Rental
Tues. 5/11	Birmingham	SW-134	D 11:05am	Chicago	A 1:25pm		yes
	Chicago	--	D p. m.	Porter, IN	A p. m.	Spring House Inn $62	
						303 North Mineral Springs Rd.	
						Porter, IN 219/929-4600	
Thurs. 5/13	Chicago	SW-758	D 5:55pm	Birmingham	A 8:15pm	Rooms guaranteed by P.J. for	
						PVD, JDM, GHM, SDP MDPR 46/26	

Cash Advance $ 250.00 (PVB)

Confirmations: Flight: Brownell - Cheryl

Hotel: "

Rental car: " Hertz, Full-size (PVB)
Conf #85201A7B4B7

Toll Free Phone Numbers for Hotels:

Best Western	800/528-1234	LaQuinta	800/531-5900
Hilton	800/445-8667	Quality Inn	800/228-5151
Holiday Inn*	800/465-4329	Ramada Inn	800/228-2828
Howard Johnson	800/654-2000	Sheraton	800/325-3535
Hyatt	800/228-9000		

*Holiday Inn Corporate Account #501220

8/27/93 (Unit 7 outlet)

Port #	1	2	3	4	5 (Lakeside)
Point # 1)	.45	.38	.40	.38	.30
2)	.45	.38	.38	.38	.30
3)	.54	.34	.32	.34	.35
4)	.48	.28	.32	.38	.53

?

Guardian
17-4
Pitot CF .832

RAC Box # 1285-2995

ΔP STK + 7.63" H_2O
TSTK 312°F

2446 John Gooch

2269

✓FAX TIME SHEET
5812448

ORDER BOOKS FROM ATTITUDE LIST

Pic

[redacted]

RAY's #5
&
Jimmy's #5

unit 7&8 outlet
NIPPLE + DUCT = 194 inches
Nipple = 31 inches

173 5/8 ← CAN'T REACH MAX INTO DUCT
132 7/8
92 1/8
51 3/8

PLANT: Bailly Generating Stn. #8. IN.	DATE: 8/25/93
LOCATION: INLET TO	TIME: 1630-1730
ΔPstk: - 20" H_2O · Amb P: 9 · Amb T. 98°F	PROBE ID. 12'
Pitot I	

POINT	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5		PORT 6	
NO.	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T
1	.83	322	1.00	325	1.45	332	1.65	324	1.55	326	1.25	319
2	.86	326	1.04	334	1.20	346	1.55	329	1.10	329	1.30	326
3	.90	344	1.02	330	1.25	352	1.40	343	1.25	340	1.35	335
4	[illegible]	346	2.10	331	.65	329	.54	342	.71	328	.73	329
5	.93											
6												
7												
8												
9												
10												

POINT	PORT 7		PORT 8		PORT 9		PORT 10		PORT 11		PORT 12	
NO.	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T	ΔP_V	T
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

3879-4

METHOD 3 DATA SHEET

Sheet I.D._____

Test Name: Bailly

Sample Location: __________

Date	Operator	Time	Calibration Check: Zero (✓)	Oxygen Source	Oxygen Reading	Carbon Dioxide Source	Carbon Dioxide Reading	Stack Analysis: Zero (✓)	O_2	CO_2	Comments
8/27	H. Castle	1130	✓				~~12.8~~	✓	6.2	12.8	#7 outlet
			✓	ambient	20.8	ambient	0.0	✓	6.2	12.8	
		1135						✓	6.4	12.6	#8 outlet
								✓	6.4	12.6	
		1150						✓	6.4	12.8	stack
↓	↓							✓	6.4	12.8	
		1240						✓	4.8	14.2	#8 Inlet
↓	↓							✓	4.8	14.2	

PLANT: BAILLY	DATE: 9-2-93
LOCATION: STACK	TIME: 13:45
ΔPstk: ±0.78" H₂O	Amb P:
Amb T.	PROBE ID. GADREAN

Stk = 137°F

POINT	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5		PORT 6	
NO.	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T
1	.40		.41		.37		.37					
2	.40		.40		.35		.42					
3	.34		.33		.28		.30					
4												
5												
6												
7												
8												
9												
10												

Port #1 Next to elevator - Port 2 then 4 numbered Clockwise.

POINT	PORT 7		PORT 8		PORT 9		PORT 10		PORT 11		PORT 12	
NO.	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T	ΔP$_V$	T
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

2870-4

Method 2 Data Sheet

Plant: Bailly UNIT 7 OUTLET Date: 07/02/93

Location: UNIT 7 OUTLET Time: 1130

%O_2= ______ %N_2= ______ %CO_2= ______ %CO= ______ %H_2O= ______

P_{amb} (HG)= 29.2 ±ΔP_{stack}(H_2O)= ______ T_{amb}(°F)= ______

Pitot Constant= ______

Point No.	Port 1		Port 2		Port 3		Port 4		Port 5		Port 6		Port 7		Port 8		Port 9	
	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T
1	.33	301	.76	300	.68	302	.75	300	.31	302								
2	.68	303	.78	302	.61	304	.68	298	.64	300								
3	.97	303	.60	304	.57	303	.44	301	.66	302								
4	.94	304	.68	304	.52	302	.48	304	.58	302								
5																		
6																		
7																		
8																		
9																		
10																		
Avg.*																		

Static

+7.8

* Averages are $\sqrt{\Delta p}$, not Δp.

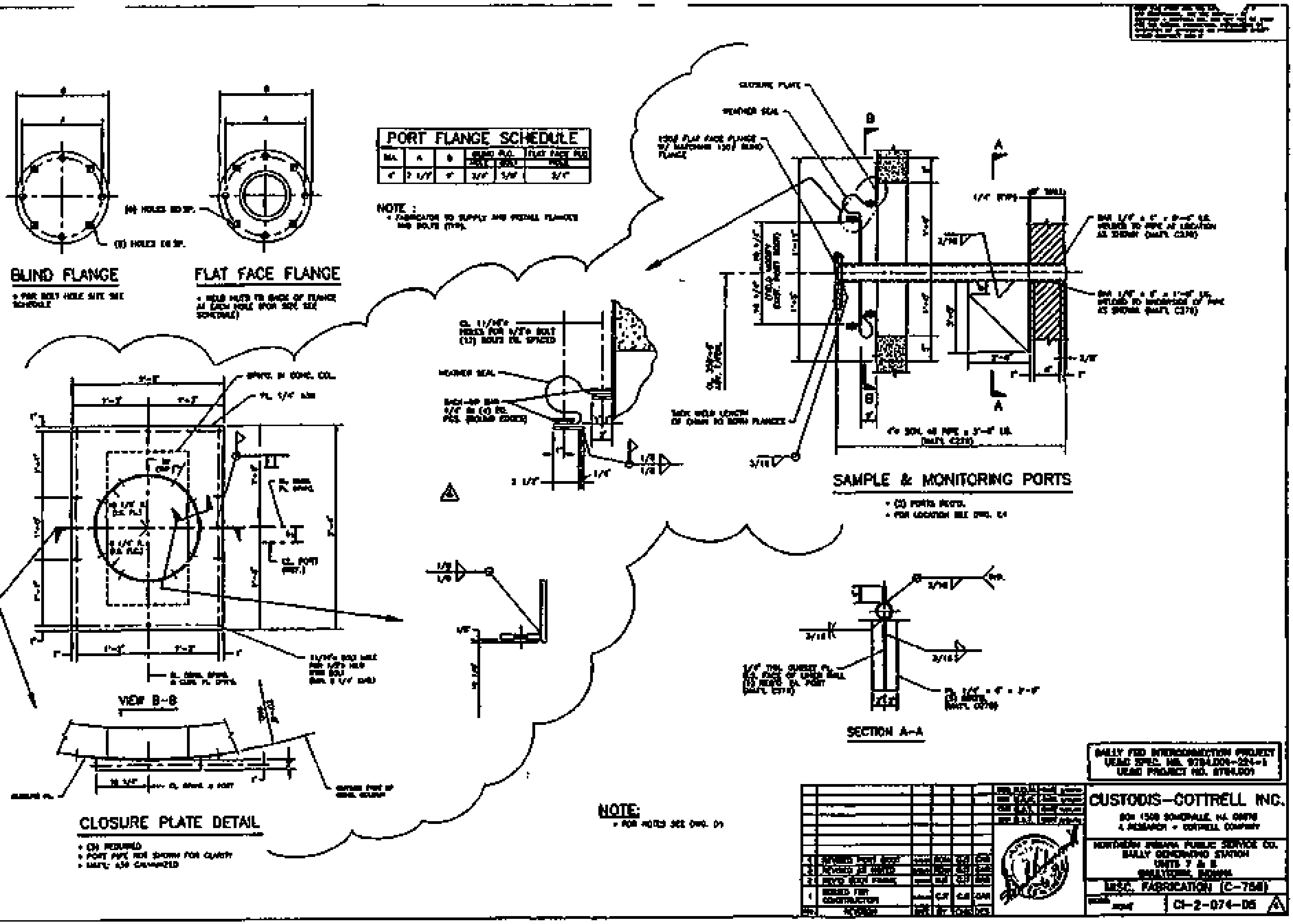
AVERAGE DUCT VELOCITY = ______

AVERAGE DUCT TEMPERATURE = ______

RAC BOY # 1 Traverse

Pitots + 5.0 ✓

\- 62 ✓


BLIND FLANGE
FLAT FACE FLANGE
PORT FLANGE SCHEDULE
NOTE :
CLOSURE PLATE DETAIL
VIEW B-B
SAMPLE & MONITORING PORTS
SECTION A-A
NOTE:
A
B
CUSTODIS-COTTRELL INC.
BAILLY FGD INTERCONNECTION PROJECT
MISC. FABRICATION (C-758)
CI-2-074-06

Method 2 Data Sheet

Plant: Bailly
Date: 09/02/93
Location: UNIT 8 outlet
Time: ~~1100~~ 1130
%O_2= %N_2= %CO_2= %CO= %H_2O=
P_{amb} (HG)= 29.2 ±ΔP_{stack}(H_2O)= 7" H_2O T_{amb}(°F)= 70°
Pitot Constant=

Point No.	Port 1		Port 2		Port 3		Port 4		Port 5		Port 6		Port 7		Port 8		Port 9	
	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T	ΔP_v	T
1	.50	332	.52	332	.64	313	.65	304	.70	298	.73	295						
2	.80	339	.85	340	1.1	321	.77	308	.74	303	.45	300						
3	1.5	342	1.4	336	1.2	325	.95	312	1.1	306	1.4	303						
4	1.8	339	1.4	334	1.1	323	.92	312	1.6	304	1.8	305						
5																		
6																		
7																		
8																		
9																		
10																		
Avg.*																		

* Averages are $\sqrt{\Delta p}$, not Δp.

AVERAGE DUCT VELOCITY =

AVERAGE DUCT TEMPERATURE =

9.2.93

	CO_2		O_2	
#8 outlet	12.6	12.6	5.0	5.6
#7 outlet	12.0	12.0	6.8	6.8
Stack	12.8	12.8	6.2	6.2

Bailly Unit 7 ESP outlet prelim vel. 9/2

%O2 :	6.2	%H20	7.0	AMB PRESS, Hg:	29.20	PITOT CAL:	0.832
%CO2 :	12.8			STACK dP, H20:	7.5	DUCT #2 :	216

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	0.36	301	0.76	300	0.68	302	0.75	300	0.31	302
POINT 2	0.68	303	0.78	302	0.61	304	0.68	298	0.64	300
POINT 3	0.97	303	0.6	304	0.59	303	0.44	301	0.66	303
POINT 4	0.94	304	0.68	304	0.52	302	0.48	304	0.58	302
POINT 5										
POINT 6	0	0	0	0	0	0	0	_0	0	0

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1										0
POINT 2										0
POINT 3										0
POINT 4										0
POINT 5			0	0	0	0	0	0	0	0
POINT 6	0	0	0	0	0	0	0	0	0	0

----------------COMPUTED VELOCITY DATA----------------

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	40.9	301	57.8	300	54.7	302	57.4	300	36.9	302
POINT 2	54.7	303	58.6	302	51.9	304	54.6	298	53.0	300
POINT 3	65.4	303	51.5	304	51.0	303	44.0	301	53.9	303
POINT 4	64.4	304	54.8	304	47.8	302	46.0	304	50.5	302
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	56.3	303	55.6	303	51.4	303	50.5	301	48.6	302

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

AVG STACK VELOCITY, ft/s :	52.5	GAS VOL FLOW, kacfm :	680.2
AVG STACK TEMPERATURE, F :	302	GAS VOL FLOW,kdscfm :	435.8
AVG SQRT(VEL P) :	0.791		

EXCESS AIR, % : 40.832

JDM

9/2 Bailly Unit 8 ESP outlet prelim vel.

%O2 :	6.0	%H20	7.0	AMB PRESS, Hg:	29.20	PITOT CAL:	0.832
%CO2 :	13.0			STACK dP, H20:	7.0	DUCT ft2 :	324

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	0.5	332	0.52	332	0.64	313	0.65	304	0.7	298
POINT 2	0.8	339	0.85	340	1.1	321	0.77	308	0.78	303
POINT 3	1.5	342	1.4	338	1.2	325	0.95	312	1.1	306
POINT 4	1.8	339	1.4	334	1.1	323	0.92	312	1.6	306
POINT 5										
POINT 6	0	0	0	0	0	0	0	0	0	0

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	0.73	300								0
POINT 2	0.85	300								0
POINT 3	1.4	303								0
POINT 4	1.8	305								0
POINT 5	0	0	0	0	0	0	0	0	0	0
POINT 6	0	0	0	0	0	0	0	0	0	0

COMPUTED VELOCITY DATA

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	47.8	332	48.8	332	53.5	313	53.6	304	55.4	298
POINT 2	60.8	339	62.7	340	70.5	321	58.5	308	58.6	303
POINT 3	83.4	342	80.3	338	73.8	325	65.1	312	69.8	306
POINT 4	91.2	339	80.1	334	70.5	323	64.1	312	84.2	306
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	70.8	338	68.0	336	67.1	321	60.3	309	67.0	303

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	56.6	300	0.0	0	0.0	0	0.0	0	0.0	0
POINT 2	61.1	300	0.0	0	0.0	0	0.0	0	0.0	0
POINT 3	78.6	303	0.0	0	0.0	0	0.0	0	0.0	0
POINT 4	89.2	305	0.0	0	0.0	0	0.0	0	0.0	0
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	71.4	302	0.0	0	0.0	0	0.0	0	0.0	0

AVG STACK VELOCITY, ft/s :	67.4	GAS VOL FLOW, kacfm :	1310.6
AVG STACK TEMPERATURE, F :	318	GAS VOL FLOW,kdscfm :	821.4
AVG SQRT(VEL P) :	1.005		

EXCESS AIR, % : 39.002

JDM

Bailly Unit 8 ESP inlet prelim vel.

%O2 :	6.0	%H20	7.0	AMB PRESS, Hg:	29.40	PITOT CAL:	0.806
%CO2 :	13.0			STACK dP, H20:	-20.0	DUCT ft2 :	146.7

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	0.83	322	1.5	325	1.45	332	1.65	324	1.55	326
POINT 2	1.35	326	1.04	334	1.2	346	1.55	329	1.1	329
POINT 3	1.3	344	1.02	340	1.25	352	1.4	343	1.25	310
POINT 4	0.93	346	2.1	331	0.65	329	0.54	342	0.71	328
POINT 5										
POINT 6	0	0	0	0	0	0	0	0	0	0

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	1.25	319								0
POINT 2	1.3	326								0
POINT 3	1.35	335								0
POINT 4	0.73	329								0
POINT 5	0	0	0	0	0	0	0	0	0	0
POINT 6	0	0	0	0	0	0	0	0	0	0

COMPUTED VELOCITY DATA

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	61.3	322	82.6	325	81.6	332	86.6	324	84.0	326
POINT 2	78.4	326	69.2	334	74.9	346	84.2	329	70.9	329
POINT 3	77.8	344	68.8	340	76.7	352	80.7	343	74.7	310
POINT 4	65.9	346	98.1	331	54.5	329	50.1	342	57.0	328
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	70.9	335	79.7	333	71.9	340	75.4	335	71.7	323

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	75.1	319	0.0	0	0.0	0	0.0	0	0.0	0
POINT 2	77.0	326	0.0	0	0.0	0	0.0	0	0.0	0
POINT 3	78.9	335	0.0	0	0.0	0	0.0	0	0.0	0
POINT 4	57.8	329	0.0	0	0.0	0	0.0	0	0.0	0
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	72.2	327	0.0	0	0.0	0	0.0	0	0.0	0

AVG STACK VELOCITY, ft/s :	73.6	GAS VOL FLOW, kacfm :	648.1
AVG STACK TEMPERATURE, F :	332	GAS VOL FLOW,kdscfm :	375.1
AVG SQRT(VEL P) :	1.067		

EXCESS AIR, % : 39.002

9/2 Baily stack prelim vel.

16.

%O2 :	7.8	%H20	20.0	AMB PRESS, Hg:	29.40	PITOT CAL:	0.8
%CO2 :	12.0			STACK dP, H20:	0.0	DUCT ft2 :	855.3

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1	0.4	137	0.41	137	0.37	137	0.37	137		
POINT 2	0.4	137	0.41	137	0.35	137	0.42	137		
POINT 3	0.34	137	0.33	137	0.28	137	0.3	137		
POINT 4										
POINT 5										
POINT 6	0	0	0	0	0	0	0	0	0	0

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP	VEL P	TEMP
POINT 1										0
POINT 2										0
POINT 3										0
POINT 4										0
POINT 5	0	0	0	0	0	0	0	0	0	0
POINT 6	0	0	0	0	0	0	0	0	0	0

COMPUTED VELOCITY DATA

	PORT 1		PORT 2		PORT 3		PORT 4		PORT 5	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	37.0	137	37.4	137	35.6	137	35.6	137	0.0	0
POINT 2	37.0	137	37.4	137	34.6	137	37.9	137	0.0	0
POINT 3	34.1	137	33.6	137	30.9	137	32.0	137	0.0	0
POINT 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	36.0	137	36.1	137	33.7	137	35.2	137	0.0	0

	PORT 6		PORT 7		PORT 8		PORT 9		PORT 10	
	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP	VELg	TEMP
POINT 1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POINT 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
AVERAG	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

AVG STACK VELOCITY, ft/s :	35.3	GAS VOL FLOW, kacfm :	1809.1
AVG STACK TEMPERATURE, F :	137	GAS VOL FLOW,kdscfm :	1257.7
AVG SQRT(VEL P) :	0.603		

EXCESS AIR, % : 58.327

```
                    IMPACTOR D50 EXPLORATION PROGRAM, VERSION 10

              INPUT DATA

       PART. DIAMETER    CLASSICAL AERODYNAMIC
       DATE OF TEST:  6/3/93
       TIME OF TEST:
       TEST DESIG.:  ind
       TEST TYPE          OUTLET
       RUN NUMBER:  0-FILE NAME:TindR0.OT
       RUN REMARKS:  ~~springerville~~ stack setup
       IMPACTOR TYPE:
     RAPC 3 4 5 7 9 11

       WATER VAPOR          14.00%
        CO2  12.00%          CO     0.00%
        O2     7.00%         N2   81.00%
        H2   0.00%             CH4  0.00%
       SUBSTRATE MATERIAL:    F

       GAS METER VOL         0.000 cf
       IMPACTOR DELTA P      0.00 IN. HG. (0 for calc. from theory)
       ORIFICE DELTA P       0.00 INCHES H2O
       STACK PRESSURE       -1.0  INCHES H2O
       BAROMETRIC PRES      29.95 INCHES HG
       STACK TEMP          127     DEGREES F
       METER TEMP           85     DEGREES F
       IMPACTOR TEMP       175     DEGREES F
       SAMPLE TIME           1.00 MINUTES
       AVG GAS VEL          33.00 FEET/SEC
       ORI P WRT PBAR        0.00 INCHES HG
       NOZZLE DIA            0.188 INCHES
       PITOT delta P         0.000 INCHES
       WATER VOLUME        0.0  CC
       METER FACTOR        1.0000

                 RESULTS
     ACTUAL FLOW RATE           0.411 CFM
     FLOW RATE AT STANDARD CONDITIONS     0.293 CFM
     PERCENT ISOKINETIC         100.002 %
     VISCOSITY                189.6E-06 GM/CM-SEC
     CALCULATED IMPACTOR DELTA P =  1.55 IN. HG

 STAGE    CUNN.     D50       D50       INLET    RE.     V*D50    NO.   JET DIA.
          CORR.  (CLAS AERO)(IMP AERO)  PRES.    NO.     UM-M/S   JETS     CM
   1      1.016    10.148    10.231    29.8765  1076     14.4       1    1.2700
   2      1.036     5.071     5.163    29.8765   438     17.5      12    0.2438
   3      1.066     2.814     2.905    29.8734   180     12.4      90    0.0790
   4      1.111     1.671     1.761    29.8688   229     14.5     110    0.0508
   5      1.214     0.867     0.955    29.8503   340     16.5     110    0.0343
   6      1.405     0.468     0.555    29.7592   466     16.1     105    0.0262
   7      1.796     0.254     0.340    29.4573   874     16.5      56    0.0262

 STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS
```

A5228

BAILY

STACK

3/16 ~.136

.173

.193

Use This

6 hrs to 50mg

```
                  IMPACTOR D50 EXPLORATION PROGRAM, VERSION 10

             INPUT DATA

      PART. DIAMETER    CLASSICAL AERODYNAMIC
      DATE OF TEST:  6/27/93
      TIME OF TEST:
      TEST DESIG.:  mip
      TEST TYPE          OUTLET
      RUN NUMBER:  0-FILE NAME:TmipR0.OT
      RUN REMARKS:  springerville stack setup
      IMPACTOR TYPE:
   RAPC 3 4 5 7 9 11

      WATER VAPOR        20.00%
       CO2  12.00%       CO    0.00%
       O2    7.00%       N2   61.00%
       H2   0.00%          CH4  0.00%
      SUBSTRATE MATERIAL:   F

      GAS METER VOL       0.000 cf
      IMPACTOR DELTA P    0.00 IN. HG. (0 for calc. from theory)
      ORIFICE DELTA P     0.00 INCHES H2O
      STACK PRESSURE      0.5  INCHES H2O
      BAROMETRIC PRES    29.57 INCHES HG
      STACK TEMP         133    DEGREES F
      METER TEMP          95    DEGREES F
      IMPACTOR TEMP      160    DEGREES F
      SAMPLE TIME         1.00 MINUTES
      AVG GAS VEL        32.00 FEET/SEC
      ORI P WRT PBAR      0.00 INCHES HG
      NOZZLE DIA          0.193 INCHES
      PITOT delta P       0.000 INCHES
      WATER VOLUME       0.0  CC
      METER FACTOR       1.0000

            RESULTS
   ACTUAL FLOW RATE          0.408 CFM
   FLOW RATE AT STANDARD CONDITIONS    0.275 CFM
   PERCENT ISOKINETIC        100.002 %
   VISCOSITY                182.3E-06 GM/CM-SEC
   CALCULATED IMPACTOR DELTA P =  1.52 IN. HG


STAGE   CUNN.    D50       D50       INLET   RE.    V*D50   NO.  JET DIA.
        CORR. (CLAS AERO)(IMP AERO) PRES.   NO.    UM-M/S  JETS     CM
  1     1.017   10.145    10.229   29.6068  1070    14.7      1    1.2700
  2     1.036    4.992     5.081   29.6068   447    17.2     12    0.2638
  3     1.065    2.762     2.850   29.6038   184    12.1     90    0.0790
  4     1.110    1.638     1.725   29.5993   234    14.1    110    0.0508
  5     1.212    0.850     0.936   29.5813   347    16.1    110    0.0343
  6     1.400    0.460     0.545   29.4923   476    15.7    105    0.0262
  7     1.781    0.251     0.335   29.1975   892    16.2     56    0.0262

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS
```

```
                    IMPACTOR D50 EXPLORATION PROGRAM, VERSION 10

                INPUT DATA

      PART. DIAMETER    CLASSICAL AERODYNAMIC
      DATE OF TEST:  8/27/93
      TIME OF TEST:
      TEST DESIG.:  nlp
      TEST TYPE          OUTLET
      RUN NUMBER:  0-FILE NAME:TnlpR0.OT
      RUN REMARKS:  ESP Outlet setup
      IMPACTOR TYPE:
    MAPC 3 4 5 7 9 11

      WATER VAPOR          8.00%
       CO2  12.00%        CO    0.00%
       O2    7.00%        N2   81.00%
       H2   0.00%           CH4  0.00%
      SUBSTRATE MATERIAL:   F

      GAS METER VOL        0.000 cf
      IMPACTOR DELTA P     0.00 IN. HG. (0 for calc. from theory)
      ORIFICE DELTA P      0.19 INCHES H2O
      STACK PRESSURE       6.0  INCHES H2O
      BAROMETRIC PRES     29.57 INCHES HG
      STACK TEMP         300    DEGREES F
      METER TEMP         100    DEGREES F
      IMPACTOR TEMP      300    DEGREES F
      SAMPLE TIME          1.00 MINUTES
      AVG GAS VEL         62.00 FEET/SEC
      ORI P WRT PBAR       0.00 INCHES HG
      NOZZLE DIA           0.135 INCHES
      PITOT delta P        0.000 INCHES
      WATER VOLUME       0.0  CC
      METER FACTOR       1.0000

             RESULTS
    ACTUAL FLOW RATE           0.370 CFM
    FLOW RATE AT STANDARD CONDITIONS    0.237 CFM
    PERCENT ISOKINETIC        100.002 %
    VISCOSITY               222.2E-06 GM/CM-SEC
    CALCULATED IMPACTOR DELTA P =  1.05 IN. HG


STAGE   CUNN.    D50      D50       INLET   RE.    V*D50   NO.  JET DIA.
        CORR. (CLAS AERO)(IMP AERO) PRES.   NO.    UM-M/S  JETS     CM
  1     1.025    9.386    9.502    30.0112   667    12.9      1    1.2700
  2     1.040    5.806    5.921    30.0112   290    18.1     12    0.2438
  3     1.067    3.495    3.609    30.0091   119    13.8     90    0.0790
  4     1.109    2.145    2.258    30.0058   152    16.8    110    0.0508
  5     1.209    1.120    1.231    29.9932   225    19.2    110    0.0343
  6     1.405    0.589    0.699    29.9313   308    18.2    105    0.0262
  7     1.830    0.307    0.415    29.7268   576    17.9     56    0.0262

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS
```

METHOD 3 DATA SHEET

Sheet I.D. ______

Test Name: ____________________

Sample Location: ADJACENT

Sample Taken 9/1/83

Date	Operator	Time	Calibration Check					Stack Analysis			Comments
			Zero (✓)	Oxygen Source	Oxygen Reading	Carbon Dioxide Source	Carbon Dioxide Reading	Zero (✓)	O_2	CO_2	
9/1/83	LGT?	1800							6.2	12.5	[illegible]
									6.2	12.8	12:00
									6.2	12.8	
9/2/83		1833							6.2	12.5	Stack
									6.4	12.5	
									6.4	12.5	

METHOD 3 DATA SHEET

Sheet I.D.______

Test Name: Inlet Metals 0540-1115

Sample Location: Stack [illegible] Sample Set [illegible]

All Samples Taken 9/3/93

Date	Operator	Time	Calibration Check					Stack Analysis			Comments
			Zero (✓)	Oxygen Source	Oxygen Reading	Carbon Dioxide Source	Carbon Dioxide Reading	Zero (✓)	O_2	CO_2	
9/3/93	LRL	1530	57.0✓	5.04	5.0	15.2	15.1	22.5	5.5	13.3	#8 Inlet Metals
				5.04	5.0	15.2	15.2		5.5	13.4	0540-1115
				5.04	5.0	15.2	15.1		5.5	13.4	
		1625						5.4✓	~~14~~ 5.7	13.3	Outlet #5 ESP
									5.8	13.2	
									5.7	13.3	
		1745						22.0✓	5.3	13.7	Acid Man #1
									5.1	13.7	1535-1554
									5.4	13.6	

Inlet Acid

Appendix G2
September 4 Tests

PAGE 1 of 2

METHOD 5 FIELD DATA

Plant/Location #7 outlet
Operator Kirby
Date 9-4-93
Test No./Run No. 2 metal
Meter Box ID Nutech #3
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHD 1.89

Pitot Coefficient, Cp .82
Nozzle ID. T22
Average Nozzle Dia., inches .202
Barometric Pressure, in. Hg 29.40
Ambient Temp., deg. F 85°
Assumed Moisture, % 10.0
Filter ID ______
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .003
Leakrate, cfm, Post-test .003
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 662.496
START TIME 9:21

GAS METER END, cf 780.094
END TIME 13:40

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
							662.496						
9:21	E 1	12	2.0	317	.65	.71	668.3	279	248		66	94	91
	2	24	2.1	317	.75	.82	674.3	309	254		53	98	92
	3	36	2.1	316	.75	.82	680.4	305	248		52	100	93
	4	48	2.0	316	1.10	1.20	687.097	252	249		55	102	95
	D 1	12 60	2.5	315	1.00	1.09	694.8	266	248		62	104	98
	2	24 12	2.5	314	1.00	1.09	701.7	310	254		55	106	99
	3	36 24	2.5	313	1.00	1.09	708.6	296	252		56	105	99
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				313	0.835	0.77						100.7	

Page 2 of 2

Method 5 Field Data Continued Date 9-4-93 Location #7 outlet Run No. 2 metals Operator Kirby

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	4**	48**	2.5	313	.95	1.03	715.290	249	245		56	102	98
	C 1	12	2.0	312	.50	.54	720.3	271	250		66	98	96
	2	24	2.0	311	.55 ~~.50~~	.60 ~~.54~~	725.5	308	254		60	99	96
	3	36	2.1	312	.60	.65	730.9	291	249		54	100	96
	4	48	2.1	312	.65	.71	736.678	252	248		53	103	97
	A 1	12	2.0	311	.60	.65	742.1	274	250		57	103	99
	2	24	2.0	311	.60	.65	747.7	307	254		49	105	100
	3	36	2.0	311	.55	.60	752.9	285	248		51	106	101
	4	48	2.0	311	.50	.54	757.920	251	249		51	107	102
	B 1	12	2.5	312	.75	.82	764.0	265	252		60	107	104
	2	24	2.3	312	.70	.76	770.0	307	254		50	110	105
	3	36	2.0	312	.50	.54	775.0	289	247		49	108	104
	4	48	2.0	313	.50	.54	780.094	251	248		52	106	103

Pitot leak ✓@
+@ 6.6 "H2O
-@ 6.2 "H2O

Final leak ✓@
5 "Hg

780 148
780 145
.03

```
 TRAIN OPERATION  7 Out          dp PITOT   dP ORI    dp PITOT    dP ORI
---------------------------      --------   ------    --------    ------
GAS ANALYSIS - O2  :     6.2       0.500     0.54       1.400      1.52
               CO2 :    12.8       0.550     0.60       1.450      1.58
               H2O :    10.0       0.600     0.65       1.500      1.63
AMB PRESS, in Hg   :   29.40       0.650     0.71       1.550      1.69
STACK dP, in H2O   :     7.5       0.700     0.76       1.600      1.74
Enter Gas vel., fps                0.750     0.82       1.650      1.80
or AVG SQR ROOT d  :    0.79       0.800     0.87       1.700      1.85
MINIMUM PITOT dP   :    0.50       0.850     0.93       1.750      1.90
dP INCREMENT       :   0.050       0.900     0.98       1.800      1.96
                                   0.950     1.03       1.850      2.01
STACK GAS TEMP, F  :     312       1.000     1.09       1.900      2.07
GAS METER TEMP, F  :      67       1.050     1.14       1.950      2.12
                                   1.100     1.20       2.000      2.18
PITOT CONSTANT     :    0.82       1.150     1.25       2.050      2.23
ORIFICE CONSTANT   :    1.89       1.200     1.31       2.100      2.29
Nutech 3                           1.250     1.36       2.150      2.34
NOZZLE DIA, in     :   0.202       1.300     1.41       2.200      2.39
SYSTEM FLOW, acfm  :   0.695       1.350     1.47       2.250      2.45
dp                      0.63
FLOW, scfm            0.4203
Target volume            100       100.9 predicted vol.
Minutes to Vol.       237.94             nozzle T22
hours to vol.         3.9657
No. of points:            20             5 ports X 4 points/port
Reqd Min./point       11.897     9/4/93 Unit 7 Outlet metals train ope
Use Minutes/point         12
```

7 OUT

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY

Sampling Location UNIT 7 OUTLET   Run No. 2

Set Up By ZDK/DWS   Date 09/04/93   Run Date 9-4-93

Comments MULTIPLE METALS

Analyst Responsible for Recovery DWS

Calculations & Report Reviewed By ______   Report Date ______

FILTERS USED

Filter No. 30145

Sorbent Trap No. ______

Condenser No. ______

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	574.8 g	754.7 g	179.9 g
Second	573.1 g	590.9 g	17.8 g
Third	427.0 g	427.2 g	0.2 g
* Fourth - [illegible]	661.3 g	663.4 g	2.1 g
Fifth	591.7 g	592.6 g	0.9 g
Sixth	504.3 g	504.9 g	0.6 g
Seventh	– g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	824.2 g	849.6 25.4 g
	g	g
Totals	g	g

TOTAL 226.9

COMMENTS:

Color of Silica Gel: ~1/4 pink, remainder original blue color

Description of Impinger Water: ______

DRY MOLECULAR WEIGHT DETERMINATION

Cal. Gas

PLANT Bally Stea Plant

DATE 9/14/83 TEST NO. #2

SAMPLING TIME (24 hr CLOCK) 1010

SAMPLING LOCATION Cal. Check

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Bag

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 75°

OPERATOR Lutz

ORSAT LEAK CHECKED 14.6✓ 14.4✓

COMMENTS:

CO2 14.9 - 15.2 - 15.5

O2 4.94 - 5.04 - 5.14

±2%

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	44/100	
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	20.3	5.1	20.3	5.1	20.3	5.1	5.1	32/100	
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)								28/100	

TOTAL

DRY MOLECULAR WEIGHT

Guardian SYSTEMS INCORPORATED
P.O. BOX 190 LEEDS, ALABAMA 35094
205/699-6647

SAMPLE ID: INLET METALS UNIT 8
PARAMETERS: PORTS 1—5
0904 – 1105
DATE: 9/14/93 TIME:
SAMPLED BY: Bill Page

PLANT Bailey Steam Plant
DATE 9/14/93 TEST NO. 2
SAMPLING TIME (24 hr CLOCK) 0904 – 1105
SAMPLING LOCATION Inlet Metals Unit #8
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Bag Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 75
OPERATOR LTZ
ORSAT LEAK CHECKED 20.4 ✓ 13.4 ✓

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	13.9	13.9	14.0	14.0	14.0	14.0	13.97	44/100	6.15
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	5.2	19.2	5.2	19.1	5.1	5.2	32/100	1.66
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.83	28/100	22.63
								TOTAL	30.[illegible]

Guardian SYSTEMS INCORPORATED
P.O. BOX 190 LEEDS, ALABAMA 35094
205/699-6847

DRY MOLECULAR WEIGHT

PLANT Barry Steam Plant
DATE 9/4/93 TEST NO 2
SAMPLING TIME (24 hr CLOCK) 921
SAMPLING LOCATION #7 Outlet Metals Train
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated Bag
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 75
OPERATOR LOTZ
ORSAT LEAK CHECKED 18.6 ✓ 15.4 ✓

SAMPLE ID: #7 Outlet Metals Train
PARAMETERS:
Run #2
DATE: 9-4-93 TIME: 9:21 SAMPLED BY:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.6	12.6	12.6	12.6	12.6	12.6	12.6	44/100	5.544
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.8	19.4	6.8	19.4	6.8	6.8	32/100	2.176
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568

TOTAL 30.288

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant
DATE 2/4/92 TEST NO. 2
SAMPLING TIME (24 hr CLOCK) 0841-1400
SAMPLING LOCATION #8 unit outlet [illegible]
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated Bag
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 71
OPERATOR LWZ
ORSAT LEAK CHECKED 15.4 18.2

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	6.4	19.2	6.4	19.2	6.4	6.4	32/100	2.048
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.8	28/100	22.624

TOTAL 30.304

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailey Steam Plant
DATE 9/4/79 TEST NO. 2
SAMPLING TIME (24 hr CLOCK) 09:25 – 15:25
SAMPLING LOCATION Stack Meters Train
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated Bag
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 75
OPERATOR Lotz
ORSAT LEAK CHECKED 16.4 ✓ 12.2 ✓

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) Md, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.6	19.4	6.6	19.4	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.312

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant

DATE 9/4/92 TEST NO. @ Actual

SAMPLING TIME (24 hr CLOCK) 1412 – 1432

SAMPLING LOCATION Inlet to Acid Plant. Runs 2, 3, 4 only

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated Bag

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 75

OPERATOR LPL

ORSAT LEAK CHECKED 19.2✓ 18.4✓

COMMENTS:

Indicated Possible Leak..
Bag – Data Does not
Support this.

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF EACH GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.3	14.3	14.3	14.3	14.3	14.3	14.3	44/100	6.292
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	4.9	19.2	4.9	19.2	4.9	4.9	32/100	1.568
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.8	28/100	22.624
								TOTAL	30.484

Guardian SYSTEMS INCORPORATED
P.O. BOX 180 LEEDS, ALABAMA 35094
205/699-6647

DRY MOLECULAR WEIGHT D

SAMPLE ID: #7 outlet

PARAMETERS: Run #2 Acids

DATE: 9-4-93 TIME: 15:04 1610 SAMPLED BY:

PLANT Bailly Steam Plant

DATE 9/4/93 TEST NO

SAMPLING TIME (24 hr CLOCK) 1524-1610

SAMPLING LOCATION #7 OUTLET AIR TRAIN

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated Bag

ANALYTICAL METHOD EPA 3A

AMBIENT TEMPERATURE 73

OPERATOR LUTZ

ORSAT LEAK CHECKED 20.6 ✓ 11.6 ✓

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF EACH GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.4	12.4	12.4	12.4	12.4	12.4	12.4	44/100	5.456
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.6	7.2	19.6	7.2	19.6	7.2	7.2	32/100	2.304
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.4	28/100	22.512
								TOTAL	30.272

GUARDIAN SYSTEMS INC

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Brick Ste-Plant

DATE 9/14/93 TEST NO.

SAMPLING TIME (24 hr CLOCK) 1605 – 1700

SAMPLING LOCATION # 8 outlet

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 75

OPERATOR LTL

ORSAT LEAK CHECKED 16.4" 18.6"

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	15.4	7.4	15.4	7.4	15.4	7.4	7.4	32/100	2.368
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.568

Gas Meter Cal. Factor ______ Orifice ID

Assumed Moisture, % ______

G-80 GUARDIAN SYSTEMS

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Baily Stm Plant

DATE 9/5/93 TEST NO ______

SAMPLING TIME (24-hr CLOCK) 1605 - 1651

SAMPLING LOCATION Stack

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 73

OPERATOR LWZ

ORSAT LEAK CHECKED 16.2 18.4

COMMENTS:

GAS \ RUN	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	15.6	6.8	15.4	6.6	15.4	6.6	6.67	32/100	2.134
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.53	28/100	22.548
								TOTAL	30.314

PAGE of 2

INLET METALS DAY 2

UNIT 8

METHOD 5 FIELD DATA

Plant/Location BAILY INLET
Operator WSP/DJ
Date 9/4/93
Test No./Run No. METALS-2
Meter Box ID NUTECH 4 (A-9215)
Gas Meter Cal. Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp .81
Nozzle ID T-39
Average Nozzle Dia., inches .192
Barometric Pressure, in. Hg 29.45
Ambient Temp., deg. F 65°F
Assumed Moisture, %
Filter ID 40-142
Stack Pressure, in. H2O -20.0 (-19.5)

1st Filter:
Leak Rate, cfm, Pretest .000 cfm/min @ 11"
Leakrate, cfm, Post-test .000 cfm/min @ 12"
2nd Filter (if used):
Leak Rate, cfm, Pretest N/A
Leakrate, cfm, Post-test N/A

GAS METER START, cf 469.800
START TIME 0831

GAS METER END, cf 559.895
END TIME 1148

				1				2	3		4	6	7
								Temperatures (deg. F)					
Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
0830	—	0	—	65 (AMBIENT)	—	—	—	250	285	—	61	70	70
0831	1-1	8	-3.0	320	.83	.64	469.300	244	280	—	54	70	71
	1-2	16	-3.5	329	.92	.72	472.880	208	203	-	49	74	69
	1-3	24	-4.0	343	1.0	.77	476.48	208	213	-	49	74	69
0855	1-4	32	-4.0	356	.86	.67	480.265	220	209	-	49	78	71
0903							483.770						
0904	2-1	40	-4.0	320	1.25	.97	484.050	221	217	-	51	81	73 (#1)
	2-2	48	-4.5	337	1.20	.93	488.33	229	220	-	52	83	74
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				341	0.978	0.75						77.6	

(#1) START BAG SAMPLE SET 1.

Page 1 of 2

INLET METALS DAY 2

Method 5 Field Data Continued Date 9/4/93 Location INLET Run No. METALS # 2 Operator WJ

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
0919	2-3	56	-4.0	345	.86	.67	492.490	229	228		57	82	75
0927	2-4	64	-4.5	352	.95	.74	496.080	226	226		55	81	76
0935							499.740						
0434	3-1	72	-4.5	328	1.25	.97	499.980	225	230		52	81	76 ← 2
	3-2	80	-4.5	344	1.20	.93	504.190	219	231		54	83	76
0952	3-3	88	-5.0	358	.99	.76	508.320	227	232		56	83	77
1000	3-4	96	-5.0	363	.65	.50	512.12	229	233		55	83	77
1008							515.225						
1010	4-1	104	-5.0	321	1.25	.97	515.390	221	241		56	85	78
	4-2	112	-5.0	350	1.15	.89	519.67	220	239		56	84	78
	4-3	120	-5.0	362	.98	.76	523.805	234	239		58	84	78
	4-4	128	-4.5	362	.62	.48	527.500	230	240		58	83	79
1043							530.535						
	5-1	136	-5.0	318	1.05	.81	530.725	225	239		58	81	78
	5-2	144	-	336	.89	.69	534.745	227	237		58	80	76

#2 MOVED BAG SAMPLE LINE TO
PORT 2 (WILL CONTINUE TO FOLLOW BEHIND PR")

1 of 2

INLE METALS DAY 2

Method 5 Field Data Continued Date 9/4/93 Location INLET Run No. METALS - 2 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	5-3	152	-5.0	348	.92	.72	538.300	231	238	/	59	80	76
	5-4	160	-5.0	351	.90	.70	541.950	230	238	/	60	81	77
							545.520						
1124	6-1	168	-5.0	319	.70	.54	545.860	232	246		61	80	77
1132	6-2	176	-5.0	324	1.05	.81	548.—	235	247		60	80	77
1140	6-3	184	-5.0	341	.88	.68	552.86	224	239		62	81	76
1148	6-4	192	-5.0	347	.82	.64	556.350	227	239		65	83	77
	END						559.895						

INLET METALS
DAY 2

```
MASS TRAIN OPERATION  Inlet 8       dp PITOT    dP ORI     dp PITOT    dP ORI
----------------------------        --------    ------     --------    ------
GAS ANALYSIS - O2  :      5.5          0.500      0.39        1.400      1.08
              CO2  :     13.4          0.550      0.43        1.450      1.12
              H2O  :     10.0          0.600      0.46        1.500      1.16
AMB PRESS, in Hg   :    29.45          0.650      0.50        1.550      1.20
STACK dP, in H2O   :    -20.0          0.700      0.54        1.600      1.24
Enter Gas vel., fps                    0.750      0.58        1.650      1.28
or AVG SQR ROOT d  :     1.09          0.800      0.62        1.700      1.32
MINIMUM PITOT dP   :     0.50          0.850      0.66        1.750      1.35
dP INCREMENT       :    0.050          0.900      0.70        1.800      1.39
                                       0.950      0.74        1.850      1.43
STACK GAS TEMP, F  :      335          1.000      0.77        1.900      1.47
GAS METER TEMP, F  :       82          1.050      0.81        1.950      1.51
                                       1.100      0.85        2.000      1.55
PITOT CONSTANT     :     0.81          1.150      0.89        2.050      1.59
ORIFICE CONSTANT   :     1.87          1.200      0.93        2.100      1.63
Nutech 4                               1.250      0.97        2.150      1.66
NOZZLE DIA, in     :    0.192          1.300      1.01        2.200      1.70
SYSTEM FLOW, acfm  :    0.895          1.350      1.04        2.250      1.74
dp                       1.18
FLOW, acfm             0.5265
Target volume             100        101.1 predicted vol.
Minutes to Vol.        189.95              nozzle T39
hours to vol.          3.1658
No. of points:             24
Reqd Min./point        7.9144       9/4/93 Inlet metals train operation
l      utes/point           8
```

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 2

Set Up By YOK/DWS Date 09/04/93 Run Date 09/04/93

Comments Multiple Metals

Analyst Responsible for Recovery YOK/DWS

Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED

Filter No. ~~39139~~ 40142

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	611.6 g	766.0 g	154.4 g
Second	598.6 g	616.3 g	17.7 g
Third	442.4 g	443.8 g	1.4 g
Fourth	604.9 g	607.7 g	2.8 g
Fifth	577.2 g	577.0 g	-0.2 g
Sixth	488.8 g	490.0 g	1.2 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	795.0 g	817.5 g
	g	g
Totals	g	g
		22.5g

COMMENTS:

Color of Silica Gel: ≈ 1/4 pink

TOTAL 197.8

Description of Impinger Water:

PAGE OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly #8 Outlet
Operator RWC
Date 09/04/93
Test No./Run No. #2 Acid
Meter Box ID
Gas Meter Cal. Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp
Nozzle ID.
Average Nozzle Dia., Inches
Barometric Pressure, in. Hg
Ambient Temp., deg. F 82
Assumed Moisture, %
Filter ID
Stack Pressure, in. H_2O 7"

1st Filter:
Leak Rate, cfm, Pretest ✓ 10"Hg ,005
Leakrate, cfm, Post-test ✓ 10"Hg ,000
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

Pitot R = 7.5"H_2O ,000
L = 7.5"H_2O ,000

GAS METER START, cf: 759.58
START TIME 1405

GAS METER END, cf 784.08
END TIME 1700

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H_2O	Orifice DH in. H_2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	6-1	2	1.5	310	.70	.58	759.58	280	240		63	86	88
	6-2	4	1.5	310	.73	.60	760.95	280	242		63	86	84
	6-3	6	2	311	1.1	1.0	761.79	280	243		63	87	89
	6-4	8	2	311	1.5	1.25	762.89	260	242		63	87	90
			OUT.		Stop		764.10						
	5-1	2	1.5	312	.70	.58	764.24	280	245		67	89	90
	5-2	4	1.5	313	.70	.58	765.09	302	245		65	88	90
	5-3	6	1.9	312	.90	.75	765.94	310	245		63	88	90
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				325	.978	0.81						895	

1o x 2 of 3

Method 5 Field Data Continued Date 09/04 Location 4 & 5 Run No. #2Acid Operator RWC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1622	5-4	8	2.0	311	1.3	1.08	766.92	310	249		61	87	89
				out	stop		768.02						
	4-1	2	1.8	317	.80	.67	768.02	294	255		66	89	90
	4-2	4	1.8	317	.80	.67	768.95						
	4-3	6	1.9	318	.90	.75	769.87	310	260		64	90	91
	4-4	8	1.9	317	.80	.67	770.82		265		65	91	91
							771.74						
	3-1	2	1.9	332	.85	.71	771.78	302	260		68	91	91
	3-2	4		332	.85	.71							
	3-3	6	2.0	330	1.1	.92	773.66	320	262		66	91	91
	3-4	8	2.0	329	.90	.75	774.68	320	261		65	90	91
1643				out	stop		775.67						
	2-1	2	2.0	336	.85	.71	775.69	294	256		69	90	91
	2-2	4	2.0	336	.85	.71	776.66	294	256		69	90	91
	2-3	6	2.4	343	1.5	1.25	777.61	330	251		68	90	90

Page 3 of 3

Method 5 Field Data Continued Date 09/04 Location 4 OUT Run No. ACID # 2 Operator RMC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2-4	8	2.1	340	1.1	.92	778.77	320	252		67	90	90
				out stop			779.82						
	1-1	2	1.9	337	.85	.71	779.82	289	250		68	89	90
	1-2	4	2.0	338	.85	~~.85~~ .71	780.85	300	249		68	89	90
	1-3	6	2.6	343	1.5	1.25	781.76	316	248		68	89	90
1700	1-4	8	2.2	340	1.2	1.0	782.95	780	248		68	89	90
STOP							784.08						

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location Outlet Unit 8 Run No. 2
Set Up By DWS/WDK Date 9-4-93 Run Date 9-4-93
Comments Acid Train
Analyst Responsible for Recovery
Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q 147
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	640.8 g	660.9 g	20.1 g
Second	584.7 g	595.3 g	10.6 g
Third	479.2 g	482.3 g	3.1 g
Fourth	– g	– g	– g
Fifth	– g	– g	– g
Sixth	– g	– g	– g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	787.5 g	796.6 Net g 9.1
	g	g
Totals	g	g

TOTAL 42.9

COMMENTS:
Color of Silica Gel: No Change
Description of Impinger Water:

```
MASS TRAIN OPERATION  8 Out         dp PITOT   dP ORI     dp PITOT   dP ORI
----------------------------        --------   ------     --------   ------
GAS ANALYSIS - O2  :    5.7            0.500     0.42        1.400     1.17
              CO2 :    13.3            0.550     0.46        1.450     1.21
              H2O :    10.0            0.600     0.50        1.500     1.25
AMB PRESS, in Hg   :  29.40            0.650     0.54        1.550     1.29
STACK dP, in H2O   :    7.5            0.700     0.58        1.600     1.33
Enter Gas vel., fps                    0.750     0.62        1.650     1.37
or AVG SQR ROOT d  :   1.01            0.800     0.67        1.700     1.42
MINIMUM PITOT dP   :   0.50            0.850     0.71        1.750     1.46
dP INCREMENT       :  0.050            0.900     0.75        1.800     1.50
                                       0.950     0.79        1.850     1.54
STACK GAS TEMP, F  :    320            1.000     0.83        1.900     1.58
GAS METER TEMP, F  :     90            1.050     0.87        1.950     1.62
                                       1.100     0.92        2.000     1.67
PITOT CONSTANT     :   0.81            1.150     0.96        2.050     1.71
ORIFICE CONSTANT   :   1.87            1.200     1.00        2.100     1.75
Nutech 1                               1.250     1.04        2.150     1.79
NOZZLE DIA, in     :  0.190            1.300     1.08        2.200     1.83
SYSTEM FLOW, acfm  :  0.781            1.350     1.12        2.250     1.87
dp                     1.01
FLOW, scfm           0.4673
Target volume            20          22.4 predicted vol.
Minutes to Vol.      42.803               nozzle 148
hours to vol.        0.7134
No. of points:           24
Read Min./point      1.7835          9/4/93 Outlet 8 metals train operatio
t       tes/point         2
```

8 OUT
9-4
ACID

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-4-93
Test No./Run No. METALS 2
Meter Box ID 71-16
Gas Meter Cal. Factor ____
Orifice ID ____
Orifice DH@ 1.94

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 21
Average Nozzle Dia., inches .255
Barometric Pressure, in. Hg 29.20
Ambient Temp., deg. F 70
Assumed Moisture, % 18
Filter ID ____
Stack Pressure, in. H2O .85

1st Filter
Leak Rate, cfm, Pretest .015 cfm @10" Hg
Leakrate, cfm, Post-test .01 cfm
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf 282.77
START TIME 9:00

GAS METER END, cf 476.51
END TIME 1515

193.74 cf meter

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 0900	PORT-POINT	0	–	118	.32	.94	282.77	245	247		60	74	72
0915	1-1	15	2.6	115	.32	.94	290.64	246	252		49	78	73
0930	1	30	2.8	121	.36	1.06	298.64	253	254		49	79	73
0945	2	45	2.8	125	.36	1.06	307.14	239	252		52	80	73
1000	2	60	2.8	125	.36	1.06	315.62	242	253		56	80	74
1015	3	75	2.7	127	.32	.94	323.41	216	251		57	79	73
1030	3	90	2.7	126	.32	.94	331.25	213	253		57	78	73
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				127	0.581	1.00							

78.2

Page 2 of 2

Method 5 Field Data Continued Date 2-4-93 Location STACK Run No. MEF2/S 2 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1038					.34	1.00	331.25						
1053	2-1	105	2.8	118	.34	1.00	339.25	214	254		57	77	72
1108	1	120	2 8	116	.34	1.00	347.25	211	251		56	75	71
1123	2	135	2.9	131	.36	1.06	355.52	203	256		53	79	73
1138	2	150	2.9	130	.36	1.06	363.81	204	254		54	80	73
1153	3	165	2.9	127	.34	1.00	372.21	224	253		48	81	74
1208	3	180	2.9	130	.34	1.00	380.10	223	254		49	81	75
1223	2-1	195	2.9	130	.34	1.00	388.15	224	254		51	82	76
1238	1	210	2.9	130	.32	.94	395.96	225	253		55	82	76
1253	2	225	3.0	130	.36	1.06	404.22	205	256		54	82	77
1308	2	240	3.0	131	.36	1.06	412.52	207	254		52	83	77
1323	3	255	3.0	132	.34	1.00	420.63	212	251		55	83	77
1338	3	270	3.0	128	.34	1.00	428.70	219	254		56	83	77

Page 1 of 2

Method 5 Field Data Continued. Date 9-4-93 Location STACK Run No. MEF2/S 2 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1345			2.9	124	.32	.94	428.70 ~~46~~	249	258		62	81	77
1400	3-1	285	2.9	131	.32	.94	436.56	255	252		46	83	77
1415	12	300	3.0	130	.34	1.00	444.78	258	253		46	83	77
1430	2 3	315	3.0	131	.34	1.00	452.68	260	254		46	84	76
1445	2	330	3.0	130	.32	.94	460.76	264	253		47	84	79
1500	3	345	3.0	130	.32	.94	467.82	259	255		48	84	79
1515	3	360	3.0	129	.32	.94	476.51	255	253		49	84	79

```
MASS TRAIN OPERATION  Stack        dp PITOT   dP ORI    dp PITOT  dP ORI
---------------------------        --------   ------    --------  ------
GAS ANALYSIS - O2  :     6.4          0.100     0.29       0.460    1.35
              CO2  :    12.8          0.120     0.35       0.480    1.41
              H2O  :    18.0          0.140     0.41       0.500    1.47
AMB PRESS, in Hg   :   29.20          0.160     0.47       0.520    1.53
STACK dP, in H2O   :     0.7          0.180     0.53       0.540    1.58
Enter Gas vel., fps                   0.200     0.59       0.560    1.64
or AVG SQR ROOT d  :    0.60          0.220     0.65       0.580    1.70
MINIMUM PITOT dP   :    0.10          0.240     0.70       0.600    1.76
dP INCREMENT       :   0.020          0.260     0.76       0.620    1.82
                                      0.280     0.82       0.640    1.88
STACK GAS TEMP, F  :     133          0.300     0.88       0.660    1.94
GAS METER TEMP, F  :      80          0.320     0.94       0.680    1.99
                                      0.340     1.00       0.700    2.05
PITOT CONSTANT     :    0.80          0.360     1.06       0.720    2.11
ORIFICE CONSTANT   :    1.94          0.380     1.11       0.740    2.17
CAE 71-16                             0.400     1.17       0.760    2.23
NOZZLE DIA, in     :   0.255          0.420     1.23       0.780    2.29
SYSTEM FLOW, acfm  :   0.742          0.440     1.29       0.800    2.35
dp                      0.36
FLOW, acfm            0.5287
Target volume            185          190.3 predicted vol.
Minutes to Vol.       349.93                nozzle T2
hours to vol.         5.8322
No. of points:            12
Read Min./point       29.161          9/4/93 Stack metals train operation
L      utes/point         30
```

STACK METALS

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack Run No. 2

Set Up By [illegible] Date 09/04/93 Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. ~~3Q139~~ 3Q139

Sorbent Trap No.

Condenser No.

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	950.9 g	1625.4 g	674.5 g
Second	588.0 g	596.1 g	8.1 g
Third	416.2 ~~416.8~~ g	417.4 g	1.2 g
Fourth	583.3 g	582.8 g	−0.5 g
Fifth	664.7 g	664.3 g	−0.4 g
Sixth	475.4 g	476.1 g	0.7 g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	820.7 g	856.5 g
	g	g
Totals	g	NET 35.8 g

TOTAL 719.4

COMMENTS:

Color of Silica Gel: 1/3 pink

Description of Impinger Water:

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-4-93
Test No./Run No. ACID 2
Meter Box ID 71-16
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ 1.94

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 6
Average Nozzle Dia., inches .251
Barometric Pressure, in. Hg 29.20
Ambient Temp., deg. F 70
Assumed Moisture, % 18
Filter ID ______
Stack Pressure, in. H20 .85

1st Filter:
Leak Rate, cfm. Pretest <.01 cfm
Leakrate, cfm. Post-test .01 cfm
2nd Filter (if used):
Leak Rate, cfm. Pretest ___
Leakrate, cfm. Post-test ___

GAS METER START, cf: 477.00
START TIME 1605

GAS METER END, cf 501.88
END TIME 1700

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
START 1605	PORT-POINT	0	—	119	.36	.99	477.00	241	212		72	76	75
1609	3-1	4	3.1	120	.36	.99	479.23	247	235		66	77	76
1613	2	8	3.1	120	.36	.99	481.46	250	255		63	79	76
1617	3	12	3.0	120	.30	.83	483.35	253	256		62	79	76
1617													
1621	2-1	16	3.0	123 ~~.36~~	.36	.99	485.47	249	252		61	79	76
1625	2	20	3.0	125	.36	.99	487.61	248	252		61	81	76
1629	3	24	2.8	128	.28	.77	489.51	255	254		64	82	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				127	0.577	0.91							

77

Page 2 of 4

Method 5 Field Data Continued Date 9-4-93 Location STACK Run No. ACID 2 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1636			3.0	128	.30	.83	489.51	237	253		74	79	77
1640	1-1	28	3.0	128	.30	.83	491.51	244	256		69	81	77
1644	2	32	3.0	132	.34	.94	493.59	243	256		68	81	77
1648	3	36	3.0	132	.32	.88	495.71	228	254		66	82	77
1652	1-1	40	3.0	132	.36	.99	497.72	232	251		66	83	78
1656	2	44	3.0	132	.36	.99	499.88	238	253		66	83	78
1700	3	48	3.0	134	.30	.83	501.88	242	255		66	84	79

```
MASS TRAIN OPERATION  Stack          dp PITOT   dP ORI     dp PITOT   dP ORI
****************************         ********   ******     --------   ------
GAS ANALYSIS - O2  :      6.4           0.100     0.28        0.460     1.27
              CO2 :      12.8           0.120     0.33        0.480     1.32
              H2O :      18.0           0.140     0.39        0.500     1.38
AMB PRESS, in Hg   :    29.20           0.160     0.44        0.520     1.43
STACK dP, in H2O   :      0.7           0.180     0.50        0.540     1.49
Enter Gas vel., fps                     0.200     0.55        0.560     1.54
or AVG SQR ROOT d  :     0.60           0.220     0.61        0.580     1.60
MINIMUM PITOT dP   :     0.10           0.240     0.66        0.600     1.65
dP INCREMENT       :    0.020           0.260     0.72        0.620     1.71
                                        0.280     0.77        0.640     1.76
STACK GAS TEMP, F  :      133           0.300     0.83        0.660     1.82
GAS METER TEMP, F  :       80           0.320     0.88        0.680     1.87
                                        0.340     0.94        0.700     1.93
PITOT CONSTANT     :     0.80           0.360     0.99        0.720     1.98
ORIFICE CONSTANT   :     1.94           0.380     1.05        0.740     2.04
CAE 71-16                               0.400     1.10        0.760     2.09
NOZZLE DIA, in     :    0.251           0.420     1.16        0.780     2.15
SYSTEM FLOW, acfm  :    0.719           0.440     1.21        0.800     2.20
dp                       0.36
FLOW, scfm             0.5122
Target volume              20          24.6 predicted vol.
Minutes to Vol.        39.046               nozzle T2
hours to vol.          0.6508
No. of points:             12
Read Min./point        3.2538        9/4/93 Stack metals train operation
l       utes/point          4
```

STACK
9-4
ACID

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack   Run No. 2

Set Up By DWS / WAK   Date 9-4-93   Run Date 9-4-93

Comments Acid Train

Analyst Responsible for Recovery

Calculations & Report Reviewed By   Report Date

FILTERS USED	
Filter No.	3Q 146
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First (Teflon impinger)	633.4 g	705.3 g	71.9 g
Second	598.6 g	602.9 g	4.3 g
Third	491.0 g	492.3 g	1.3 g
Fourth	g	g	g
Fifth	g	g	g
Sixth	g	g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	840.1 g	848.1 NET g 8.0
	g	g
Totals	g	g

TOTAL 85.5

COMMENTS:

Color of Silica Gel: No Change

Description of Impinger Water:

PAGE 1 OF ___

BAILLY

METHOD 5 FIELD DATA

PITOT LEAK CHECKED AT 10" H2O

Plant/Location INLET UNIT 8
Operator WJP/DJ/MD
Date 9/4/94
Test No./Run No. ACID #2
Meter Box ID NUTECH 4
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ 1.87

Pitot Coefficient, Cp .81
Nozzle ID T-45
Average Nozzle Dia., inches ___
Barometric Pressure, in. Hg 29.40
Ambient Temp., deg. F 79
Assumed Moisture, % ______
Filter ID -40-143
Stack Pressure, in. H2O -19.5

1st Filter:
Leak Rate, cfm, Pretest .000 cfm/min @8"
Leakrate, cfm, Post-test .000 cfm/min @18"
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: ~~[illegible]~~ 560.895
START TIME ~~[illegible]~~ 1403

GAS METER END, cf ~~542.250~~ 584.250 WJP
END TIME 1503

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
					.85	.63	560.895						
1403	1-1	2	3.5	318	.85	.63	560.895	231	247		80	80	78
	1-2	4	3.5	329	.92	.69	561.90	226	236		63	80	78
	1-3	6		339	1.0	.74	562.86	—	233		63	81	78
	1-4	8		352	.98	.72	563.76						
1411							564.69						
	2-1	10		310	1.1	.82	564.925	220	247	X	61	82	75
	2-2	12		335	1.2	89	565.88	221	257	—	63	82	79
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				340	.969	0.70							

82.7

[illegible] 2

Method 5 Field Data Continued Date 9/4/93 Location INLET U-8 Run No. ACID #2 Operator WSP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2-3	14	-3.5	345	.82	.61	566.89	—	—	—	—	83	80
	2-4	16	-4.0	354	.93	.69	567.75	200	266	—	62	83	80
							568.646						
	3-1	18	-4.0	323	1.20	.89	568.880	185	261	—	63	83	80
	2	20	-4.0	347	1.10	.82	—	189	281	—	66	84	80
	3	22	-4.0	356	.98	.76	570.985	—	—	—	—	85	81
	4	24	-4.0	362	.65	.48	571.391	186	291	—	67	—	81
							572.630						
	4-1	26	-4.0	332	1.2	.89	572.920	195	287	—	67	85	82
	2	28	-4.0	346	1.1	.82	573.810	202	281	—	67	85	82
	3	30	-4.0	359	.98	.76	574.84	203	286	—	66	85	82
	4	32	-4.0	364	~~.46~~ .61	~~.61~~ .46	575.185	—	—	—	66	86	82
							576.595						
	5-1	34	-4.5	321	1.05	.78	576.110	—	—		—	—	—
	5-2	36	-5.0	335	.90	.67	577.65	200	290	—	66	86	83

Page 5 of 5

Method 5 Field Data Continued Date 9/4/93 Location INLET 8 Run No. ACID #2 Operator WJP.

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-3	38	-4.0	349	.88	.65	578.675	190	291		65	87	83
	5-4	40	-4.0	352	.86	.64	579.560	194	294		66	87	83
							580.420						
	6-1	42	-4.0	318	.75	.56	580.730	198	293	—	66	87	83
	6-2	44	-4.0	324	.98	.72	581.690	—	—	—	—	—	—
	6-3	46	-4.0	338	~~.84~~ .85	.63	582.515	199	290	—	66	88	84
	6-4	48	-4.0	346	.80	.59	583.395	202	290	—	66	88	84
	END						542.250	w/ [illegible]					
1503							584.150						

```
MASS TRAIN OPERATION  Inlet 8        dp PITOT   dP ORI     dp PITOT   dP ORI
----------------------------         --------   ------     --------   ------
GAS ANALYSIS - O2  :     5.5            0.500     0.37        1.400     1.04
              CO2  :    13.4            0.550     0.41        1.450     1.08
              H2O  :    10.0            0.600     0.45        1.500     1.11
AMB PRESS, in Hg   :   29.40            0.650     0.48        1.550     1.15
STACK dP, in H2O   :   -20.0            0.700     0.52        1.600     1.19
Enter Gas vel., fps                     0.750     0.56        1.650     1.22
or AVG SQR ROOT d  :    1.09            0.800     0.59        1.700     1.26
MINIMUM PITOT dP   :    0.50            0.850     0.63        1.750     1.30
dP INCREMENT       :   0.050            0.900     0.67        1.800     1.34
                                        0.950     0.71        1.850     1.37
STACK GAS TEMP, F  :     332            1.000     0.74        1.900     1.41
GAS METER TEMP, F  :      80            1.050     0.78        1.950     1.45
                                        1.100     0.82        2.000     1.48
PITOT CONSTANT     :    0.81            1.150     0.85        2.050     1.52
ORIFICE CONSTANT   :    1.87            1.200  -  0.89        2.100     1.56
Nutech 4                                1.250     0.93        2.150     1.60
NOZZLE DIA, in     :   0.190            1.300     0.96        2.200     1.63
SYSTEM FLOW, acfm  :   0.875            1.350     1.00        2.250     1.67
dp                      1.18
FLOW, scfm            0.5161
Target volume             20          24.8 predicted vol.
Minutes to Vol.       38.751               nozzle T45
hours to vol.         0.6459
No. of points:            24
Reqd Min./point       1.6146        9/4/93 Inlet metals train operation
Use Minutes/point          2
```

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 2

Set Up By DWS/WDK Date 9-4-93 Run Date 9-4-93

Comments Acid Train

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 40 193

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	640.9 g	669.1 g	28.2 g
Second	605.0 g	612.5 g	7.5 g
Third	478.8 g	480.8 g	2.0 g
Fourth	– g	– g	– g
Fifth	– g	– g	– g
Sixth	– g	– g	– g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	809.6 g	818.3 net g 8.7
	g	g
Totals	g	g

[illegible] 46.4

COMMENTS:

Color of Silica Gel: Very little.

Description of Impinger Water:

PA 2 of 3

METHOD 5 FIELD DATA

Pretest Pitot R= 6.5" H2O
6.5" H2O

Plant/Location Bailly UNIT 8 OUTLET
Operator ZUC
Date 09/04/93
Test No./Run No. #2 Metals
Meter Box ID Nutech #1
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID. T40
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F 70°
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H20 7.5"

1st Filter:
Leak Rate, cfm, Pretest ✓ 10" Hg ~~.000~~ .005 H.
Leakrate, cfm, Post-test ✓ 10" Hg .000/ Hg
2nd Filter (if used):
Leak Rate, cfm, Pretest ______
Leakrate, cfm, Post-test ______

NOTE % LEAK CHK = HORIZ + VERT.

GAS METER START, cf: 603.44
START TIME 0840

GAS METER END, cf 779.66
END TIME 1403

G-105

Clock Time	Travese Point Number	Sample Time MIN	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
0840	6-1	10	1.8	310	.82	.70	START 603.44	332	248		54	72	72
	6-2	20	1.8	310	.85	.73	608.07	345	257		51	74	73
	6-3	30	2.0	311	1.2	1.03	612.76	332	250		50	79	75
	6-4	40	2.5 ~~2.2~~	310	1.7 ~~1.5~~	1.46 ~~1.29~~	618.24	270	252		53	81	77
							624.52 ~~624.4~~						
0946	5-1	10	1.8	311	.70 ~~.75~~	.90 ~~.65~~	624.52	311	248		54	76	76
	5-2	20	1.9	312	.75	.65	629.40	320	254		53	79	77
	5-3	30	2.1	311	1.1 ~~1.05~~	.95 ~~.97~~	633.29	315	253		54	80	78
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				325	1.014	0.90							

NOTE: ~~Pitots clogged - Blowout~~

78.4

Page 2 of 3

Method 5 Field Data Continued Date 09/04 Location 8 Outlet Run No. #2 Metals Operator RK

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-4	40	2.2	310	1.4	1.2	638.63	250	247		55	76	77
		Changed Port			STOP		644.56						
	4-1	10	2.0	315	.90	.77	644.58	290	250		60	77	76
	4-2	20	2.0	316	.90	.77	649.41	318	246		59	78	76
	4-3	30	2.0	315	.97	.84	654.21	315	253		59	77	76
	4-4	40	2.0	315	.85	.73	659.25	256	255		56	77	76
				STOP.	OUT		663.90						
1114	3-1	10	2.0	330	.95	.82	663.90	306	248		59	77	76
	3-2	20	2.0	330	.94	.81	668.85	325	254		57	78	76
	3-3	30	2.2	332	1.1	.95	673.78	330	262		60	79	77
	3-4	40	2.0	328	.90	.77	679.13	284	256		62	80	78
1157	OUT				STOP		683.98						
	2-1	10	2.1	337	.95 ~~.88~~	.82 ~~.75~~	683.98	314	245		64	80	79
	2-2	20	2.0	337	.85	.73	688.89	335	246		62	80	79
	2-3	30	2.0	343	.85	.73	693.57	333	254		65	82	80

NOTE: PITOTS Clogged BLEW OUT

[illegible] 3 of 3   Bad Pitot

Method 5 Field Data Continued Date 09/04 Location #8 Outlet Run No. #2 Metals Operator RLC

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	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
→	2-4	40	4.8	339	1.5 ~~3.5~~		699.45	300	245	-	73	82	81
					STOP	1.3 -	707.52						
	1-1	10	2.0	338	.90	.77	707.52	274	248		67	81	81
1335	1-2	20	2.0	340	.85	.73	712.41	338	248		67	83	82
	1-3	30	2.2	344	1.4	1.2	717.14	342	255		69	84	83
	1-4	40	2.8	348	1.8	1.55	723.12	250	250		76	86	84
1403 ~~1400~~	~~2-4~~	— STOP		—			729.66						
	~~2-4~~												
	~~2-4~~												
	~~2-2~~												
	~~2-4~~												
	~~2-2~~												
	~~2-5~~												
	~~2-3~~												
	~~2-5~~												

NOTE : Found Pitot melted

Leak checked system before starting run 10" Hg = .005"
R = 7.0' 20 ok
[illegible] 7.0" H2O ok

MASS TRAIN OPERATION		8 Out
GAS ANALYSIS - O2	:	5.7
CO2	:	13.3
H2O	:	10.0
AMB PRESS, in Hg	:	29.40
STACK dP, in H2O	:	7.5
Enter Gas vel., fps		
or AVG SQR ROOT d	:	1.01
MINIMUM PITOT dP	:	0.50
dP INCREMENT	:	0.050
STACK GAS TEMP, F	:	320
GAS METER TEMP, F	:	85
PITOT CONSTANT	:	0.81
ORIFICE CONSTANT	:	1.87
Nutech 1		
NOZZLE DIA, in	:	0.192
SYSTEM FLOW, acfm	:	0.797
dp		1.01
FLOW, scfm		0.4771
Target volume		110
Minutes to Vol.		230.54
hours to vol.		3.8423
No. of points:		24
Reqd Min./point		9.6058
nutes/point		10

dp PITOT	dP ORI	dp PITOT	dP ORI
0.500	0.43	1.400	1.20
0.550	0.47	1.450	1.25
0.600	0.52	1.500	1.29
0.650	0.56	1.550	1.33
0.700	0.60	1.600	1.38
0.750	0.65	1.650	1.42
0.800	0.69	1.700	1.46
0.850	0.73	1.750	1.51
0.900	0.77	1.800	1.55
0.950	0.82	1.850	1.59
1.000	0.86	1.900	1.63
1.050	0.90	1.950	1.68
1.100	0.95	2.000	1.72
1.150	0.99	2.050	1.76
1.200	1.03	2.100	1.81
1.250	1.08	2.150	1.85
1.300	1.12	2.200	1.89
1.350	1.16	2.250	1.94

114.5 predicted vol.
nozzle T40

9/4/93 Outlet 8 metals train operatio

8 OUT

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location Unit 8 Outlet Run No. 2
Set Up By YOK/DWS Date 04/04/93 Run Date 04/04/93
Comments Multiple Metals
Analyst Responsible for Recovery ALIF
Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 30138

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	612.3 g	798.8 g	186.5 g
Second	591.7 g	613.4 g	21.7 g
Third	428.0 g	430.7 g	2.7 g
*Fourth - [illegible]	627.1 g	630.1 g	3.0 g
Fifth	593.4 g	594.7 g	1.3 g
Sixth	467.4 g	469.6 g	2.2 g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final	
	852.4 g	885.9 g	33.5
	g	g	
Totals	g	g	
		TOTAL	250.9

COMMENTS:
Color of Silica Gel: Bottom 1/4 pink; some white crystals on one side, rest bl
Description of Impinger Water:

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/Location #7 Outlet
Operator Kirby / Sanderford
Date 9-4 93
Test No./Run No. 2 Acids
Meter Box ID Nutech #3
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ 1.89

Pitot Coefficient, Cp .82
Nozzle ID. T 2
Average Nozzle Dia., inches .190
Barometric Pressure, in. Hg 29.40
Ambient Temp., deg. F 91°
Assumed Moisture, % 10.0
Filter ID ______
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .000
Leakrate, cfm, Post-test .000
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 780.231
START TIME 15:04

GAS METER END, cf 805.744
END TIME 1640

25.513 cf metered

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	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
							780.231						
	A 1	3	1.8	310	.60	.50	781.4	271	235		62	101	100
	2	6	1.8	310	.60	.50	782.6	289	236		60	100	100
	3	9	1.8	310	.60	.50	783.9	287	246		56	100	100
	4	12	1.5	310	.50	.42	785017	251	248		55	101	100
	B 1	15	1.8	310	.65	.54	786.2	256	250		61	101	100
	2	18	1.8	310	.65	.54	787.5	270	251		56	101	100
	3	21	1.5	310	.50	.42	788.6	281	255		53	102	100
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				311	0.819	0.57							

95.3

Page 2 of 2

Method 5 Field Data Continued Date 9-4-93 Location # 7 outlet Run No. 2 4 holes Operator Kirby

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	4	24	1.5	310	.50	.42	789.783	240	255		53	100	100
	C 1	27	2.0	310	.75	.62	791.0	245	249		58	102	100
	2	30	2.0	311	.80	.67	792.4	287	247		53	101	100
	3	33	1.5	311	.50	.42	793.5	276	247		52	102	99
	4	36	1.5	310	.50	.42	794.683	245	249		53	101	99
	D 1 1	39	2.1	311	.90	.75	796.1	267	243		59	100	99
	~~2~~ 1	42	2.1	311	.90	.75	797.6	289	242		53	100	98
	~~3~~ 2	45	2.1	311	.85	.71	799.0	285	246		52	101	98
	~~4~~ 2	48	2.1	312	.90	.75	800.4	302	251		52	101	98
	D ~~1~~ 3	51	2.0	311	.65	.54	801.7	295	256		53	102	98
	~~2~~ 3	54	2.0	311	.65	.54	803.0	264	257		53	101	98
	~~3~~ 4	57	2.0	312	.75	.62	804.3	244	256		54	102	98
	~~4~~ 4	60	2.	312	.80	.67	805.744	246	254		54	101	98

Pitot leak ✓
~~to~~ @ 6.0 " H2O
: 5.7 " H2O

Final leak ✓@
5 "Hg.

805.772
805.772
.000

```
MASS TRAIN OPERATION  7 Out          dp PITOT   dP ORI    dp PITOT   dP ORI
-----------------------------        --------   ------    --------   ------
GAS ANALYSIS - O2  :     6.2            0.500     0.42       1.400     1.17
               CO2 :    12.8            0.550     0.46       1.450     1.21
               H2O :    10.0            0.600     0.50       1.500     1.25
AMB PRESS, in Hg   :   29.40            0.650     0.54       1.550     1.29
STACK dP, in H2O   :     7.5            0.700     0.58       1.600     1.33
Enter Gas Vel., fps                     0.750     0.62       1.650     1.37
or AVG SQR ROOT d  :    0.79            0.800     0.67       1.700     1.42
MINIMUM PITOT dP   :    0.50            0.850     0.71       1.750     1.46
dP INCREMENT       :   0.050            0.900     0.75       1.800     1.50
                                        0.950     0.79       1.850     1.54
STACK GAS TEMP, F  :     312            1.000     0.83       1.900     1.58
GAS METER TEMP, F  :      75            1.050     0.87       1.950     1.62
                                        1.100     0.92       2.000     1.67
PITOT CONSTANT     :    0.82            1.150     0.96       2.050     1.71
ORIFICE CONSTANT   :    1.89            1.200     1.00       2.100     1.75
Nutech 3                                1.250     1.04       2.150     1.79
NOZZLE DIA, in     :   0.190            1.300     1.08       2.200     1.83
SYSTEM FLOW, acfm  :   0.615            1.350     1.12       2.250     1.87
dp                      0.63
FLOW, scfm            0.3718
Target volume             20           22.3 predicted vol.
Minutes to Vol.       53.789                nozzle T2
Hours to vol.         0.8965
No. of points:            20                5 ports X 4 points/port
Req'd Min./point      2.6894         9/4/93 Unit 7 Outlet metals train ope
U      utes/point          3
```

7 OUT

9.4
ACID

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit #7 Run No. 2

Set Up By DWS/WAK Date 9-4-93 Run Date 9-4-93

Comments Acid Train

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED		CYCLONES	Used (Yes/No)	Prepared Container (No.)
Filter No.	30148	10 µ		
		5 µ		
Sorbent Trap No.		2.0 µ		
		1.0 µ		
Condenser No.		0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	636.8 g	664.1 g	27.3 g
Second	582.7 g	592.2 g	9.5 g
Third	477.0 g	479.0 g	2.0 g
Fourth	g	g	g
Fifth	g	g	g
Sixth	g	g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final	
	836.4 g	844.7 g	Net 8.3
	g	g	
Totals	g	g	
		TOTAL	47.1

COMMENTS:

Color of Silica Gel: No Visible Changel

Description of Impinger Water:

Appendix G3

September 5 Tests

Pg. 1 of 2

METHOD 5 FIELD DATA

Plant/Location #7 Outlet
Operator Kirby
Date 9.5.93
Test No./Run No. 3 metals
Meter Box ID Nutech #3
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHD 1.89

Pitot Coefficient, Cp .82
Nozzle ID. T22
Average Nozzle Dia., Inches .202
Barometric Pressure, in. Hg 29.30
Ambient Temp., deg. F 75°
Assumed Moisture, % 10.0
Filter ID ______
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .004
Leakrate, cfm, Post-test .004
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 806.796
START TIME 9:42

GAS METER END, cf 921.733
END TIME 13:51

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
							806.796						
	C 1	12	2.0	312	.75	.82	812.8	265	232		68	85	83
	2	24	2.0	311	.75	.82	818.8	307	253		52	90	85
	3	36	2.7	317	1.00	1.09	825.8	246	247		50	93	86
	4	48	2.5	317	.90	.98	832.384	250	252		51	97	89
	D 1	12	2.3	317	~~.75~~ .80	~~.82~~ .87	838.5	270	250		56	95	90
	2	24	2.5	318	.85	.93	845.0	312	253		53	97	91
	3	36	2.0	318	.65	.71	850.6	292	249		53	97	91
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				314	0.829	0.75							

88.4

Page 2 of 2

Method 5 Field Data Continued Date 9-5-93 Location# 7 outlet Run No. 3 metals Operator Kirby

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	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	4	48	2.3	319	.80	.87	856.851	250	250		55	97	92
	C 1	12	2.5	316	.80	.87	863.0	262	249		53	95	92
	2	24	2.5	314	.80	.87	869.2	310	255		47	97	92
	3	36	2.0	308	.50	.54	874.2	285	249		46	98	92
	4	48	2.0	309	.50	.54	879.226	248	245		46	95	92
	A 1	12	2.0	310	.55	.60	884.4	265	244		50	90	89
	2	24	2.0	313	.55	.60	889.6	310	254		45	90	88
	3	36	2.3	314	.60	.65	895.1	294	248		45	89	87
	4	48	2.0	315	.50	.54	900.030	247	242		47	88	85
	B 1	12	2.5	314	.75	.82	906.0	259	241		51	85	83
	2	24	2.5	314	.70	.76	911.8	309	254		47	86	82
	3	36	2.0	314	.50	.54	916.8	295	246		48	84	81
	4	48	2.0	313	.50	.54	921.733	248	244		51	82	79

Pitot ✓
+@ 5.2 " H2O
-@ 6.9 " H2O

Final leak ✓@
5 " Hg.

921.784
921.780
.004

```
  $ TRAIN OPERATION  7 Out        dp PITOT   dP ORI    dp PITOT   dP ORI
-----------------------------     --------   ------    --------   ------
GAS ANALYSIS - O2  :     6.2         0.500     0.54       1.400     1.52
              CO2  :    12.8         0.550     0.60       1.450     1.58
              H2O  :    10.0         0.600     0.65       1.500     1.63
AMB PRESS, in Hg   :   29.30         0.650     0.71       1.550     1.69
STACK dP, in H2O   :     7.5         0.700     0.76       1.600     1.74
Enter Gas vel., fps                  0.750     0.82       1.650     1.80
or AVG SQR ROOT d  :    0.79         0.800     0.87       1.700     1.85
MINIMUM PITOT dP   :    0.50         0.850     0.93       1.750     1.90
dP INCREMENT       :   0.050         0.900     0.98       1.800     1.96
                                     0.950     1.03       1.850     2.01
STACK GAS TEMP, F  :     312         1.000     1.09       1.900     2.07
GAS METER TEMP, F  :      87         1.050     1.14       1.950     2.12
                                     1.100     1.20       2.000     2.18
PITOT CONSTANT     :    0.82         1.150     1.25       2.050     2.23
ORIFICE CONSTANT   :    1.89         1.200     1.31       2.100     2.29
Nutech 3                             1.250     1.36       2.150     2.34
NOZZLE DIA, in     :   0.202         1.300     1.41       2.200     2.39
SYSTEM FLOW, acfm  :   0.696         1.350     1.47       2.250     2.45
dp                      0.63
FLOW, scfm            0.4195
Target volume            100       100.7 predicted vol.
Minutes to Vol.       238.35             nozzle 722
hours to vol.         3.9726
No. of points:            20             5 ports X 4 points/port
Reqd Min./point       11.918      9/5/93 Unit 7 Outlet metals train ope
Use Minutes/point         12
```

7 OUT

9/5/93

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 7 Run No. 3

Set Up By WOK/DWZ Date 09/05/93 Run Date 09/05/93

Comments Multiple Metals

Analyst Responsible for Recovery WOK/KD/ALB

Calculations & Report Reviewed By ________ Report Date ________

FILTERS USED

Filter No. 3Q140

Sorbent Trap No. ________

Condenser No. ________

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	610.9 g	818.1 g	207.2 g
Second	576.1 g	588.3 g	12.2 g
Third	426.9 g	427.6 g	0.7 g
Fourth	634.6 g	634.8 g	0.2 g
Fifth	578.5 g	580.4 g	1.9 g
Sixth	467.5 g	467.8 g	0.3 g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final	
	849.5 g	874.2 g	gain 24.7
	g	g	
Totals	g	g	

TOTAL 247.2

COMMENTS:

Color of Silica Gel: 1/4 pink

Description of Impinger Water: ________

Pg. 1 of 2

METHOD 5 FIELD DATA

Plant/Location #7 outlet
Operator Kirby
Date 9-5-93
Test No./Run No. #3 Acids
Meter Box ID Nutech #3
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHD 1.89

Pitot Coefficient, Cp .82
Nozzle ID. T2
Average Nozzle Dia., Inches .190
Barometric Pressure, In. Hg 29.36
Ambient Temp., deg. F 70°
Assumed Moisture, % 10.0
Filter ID ______
Stack Pressure, In. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .000
Leakrate, cfm, Post-test .000
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 921.867
START TIME 15:29

GAS METER END, cf 955.251
END TIME 16:58

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
							921.867						
	E 1	4	2.1	313	.70	.58	923.5	266	232		65	76	74
	2	8	2.1	314	.70	.58	925.2	279	247		54	76	74
	3	12	3.0	314	1.00	.83	927.2	281	262		52	80	75
	4	16	2.8	314	.95	.79	929.234	249	259		57	81	76
	A 1	4	2.0	312	.55	.46	930.7	273	240		56	79	75
	2	8	2.0	312	.55	.46	932.2	298	239		52	80	76
	3	12	2.0	312	.55	.46	933.7	275	247		51	81	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				314	0.823	0.57							

77.65

Page 2 of 2

Method 5 Field Data Continued Date 9.5.93 Location #7 outlet Run No. #3 Acids Operator Kirby

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP In. H20	Orifice DH In. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	4	16	2.0	313	.50	.42	935.252	247	250		51	81	76
	B 1	4	2.5	313	.70	.58	936.9	262	250		55	79	76
	2	8	2.5	314	.70	.58	938.6	286	256		52	80	76
	3	12	2.0	314	.50	.42	940.0	295	256		51	81	76
	4	16	2.0	313	.50	.42	941.541	257	252		51	80	76
	C 1	4	2.5	314	.75	.62	943.3	267	241		55	78	75
	2	8	2.5	314	.75	.62	945.0	280	248		51	79	75
	3	12	2.1	314	.60	.50	946.6	291	246		51	79	75
	4	16	2.0	314	.50	.42	948.046	246	251		51	79	75
	D 1	4	2.8	314	.85	.71	949.9	266	243		56	77	74
	2	8	2.0	314	.90	.75	951.8	292	246		52	78	74
	3	12	2.1	314	.70	.58	953.5	286	252		51	80	75
	4	16	2.5	314	.75	.62	955.251	247	252		52	80	75

Pitot leak ✓
+@ 6.3 "H2O
-@ 6.3 "H2O

Final leak ✓@
5 "Hg.

955.285
955.285
.000

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 7 Run No. 3

Set Up By WX / DWS Date 09/05/93 Run Date 09/05/93

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q149
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	625.0 g	669.8 g	44.8 g
Second	597.2 g	602.7 g	5.5 g
Third	478.8 g	480.3 g	1.5 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	842.4 g	852.2 g wt 9.8
	g	g
Totals	g	g
		TOTAL

COMMENTS:

Color of Silica Gel: No change.

Description of Impinger Water:

```
MASS TRAIN OPERATION  7 Out          dp PITOT   dP ORI     dp PITOT    dP ORI
----------------------------         --------   ------     --------    ------
 1S ANALYSIS - O2  :      6.2           0.500     0.42        1.400      1.17
               CO2 :     12.8           0.550     0.46        1.450      1.21
               H2O :     10.0           0.600     0.50        1.500      1.25
AMB PRESS, in Hg   :    29.30           0.650     0.54        1.550      1.29
STACK dP, in H2O   :      7.5           0.700     0.58        1.600      1.33
Enter Gas vel., fps                     0.750     0.62        1.650      1.37
or AVG SQR ROOT d  :     0.79           0.800     0.67        1.700      1.42
MINIMUM PITOT dP   :     0.50           0.850     0.71        1.750      1.46
dP INCREMENT       :    0.050           0.900     0.75        1.800      1.50
                                        0.950     0.79        1.850      1.54
STACK GAS TEMP, F  :      312           1.000     0.83        1.900      1.58
GAS METER TEMP, F  :       75           1.050     0.87        1.950      1.62
                                        1.100     0.92        2.000      1.67
PITOT CONSTANT     :     0.82           1.150     0.96        2.050      1.71
ORIFICE CONSTANT   :     1.89           1.200     1.00        2.100      1.75
Nutech 3                                1.250     1.04        2.150      1.79
NOZZLE DIA, in     :    0.190           1.300     1.08        2.200      1.83
SYSTEM FLOW, acfm  :    0.616           1.350     1.12        2.250      1.87
dp                       0.63
FLOW, scfm             0.3712
Target volume              20             22.3 predicted vol.
Minutes to Vol.        53.882                  nozzle f2
hours to vol.           0.898
No. of points:             20                  5 ports X 4 points/port
Reqd Min./point        2.6941          9/9/93 Unit 7 Outlet ~~[illegible]~~ train ope
Use Minutes/point          ~~5~~
                           4
```

PAGE 1 OF 2

PITOT LEAK CHK =
.000 → + = 7.5" H2O
− = 7.5" H2O

METHOD 5 FIELD DATA

Plant/Location Bailly outlet #8
Operator RNC / T.L.
Date 09/05/93
Test No./Run No. #7 Metals
Meter Box ID #1 Nutech
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, In. Hg ______
Ambient Temp., deg. F 76 @ START
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, In. H2O 7.0 "H2O

1st Filter:
Leak Rate, cfm, Pretest ✓ 10" Hg = .005"/MIN
Leakrate, cfm, Post-test ✓
2nd Filter (if used): ~~15~~ 14" Hg = .01"/MIN
Leak Rate, cfm, Pretest ______
Leakrate, cfm, Post-test ______

POST PITOT: + −

1 2 3 4 5 6
o o o o o o
↑
FLOW

GAS METER START, cf 806.30
START TIME 0930

GAS METER END, cf 924.60
END TIME ~~1300~~ 1540

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
0930	6-1	10	2.1	310	.80	.69	START 806.30	300	240		63	76	77
	6-2	20	2.1	310	.80	.69	811.10	305	242		54	77	77
	6-3	30	2.8	308	1.3	1.1	815.56	300	248		52	79	77
	6-4	40	3.2	309	~~1.4~~ 1.9	~~1.2~~ 1.6	821.26	273	250		54	82	79
1010			STOP				827.86						
1011	5-1	10	2.1	312	.80	.69	827.88	286	253		58	84	80
	5-2	20	2.1	312	.80	.69	832.54	300	251		56	83	81
	5-3	30	2.4	314	1.1	.95	837.16	310	258		57	87	85
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				325	1.026	0.84							

84.5

Page 2 of 2

Method 5 Field Data Continued Date 09/05 Location OUTLET #8 Run No. #3 Metals Operator RNC/T.L.

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP In. H20	Orifice DH In. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-4	40	2.9	310	1.5	1.3	842.54	250	257		58	88	85
			STOP	OUT			848.76						
1055	4-1	10	2.0	318	.85	.73	849.00	271	253		60	86	85
	4-2	20	2.0	319	.95	.73	853.73	308	251		61	87	85
	4-3	30	2.2	316	1.05	.90	858.58	295	252		66	90	88
	4-4	40	2.2	312	.91	.78	863.82	240	252		67	90	89
1135			STOP	OUT	~~1.05~~		868.67						
	3-1	10	2.5	330	1.05	.90	868.67	280	250		65	89	88
	3-2	20	2.6	331	1.05	.90	873.91	317	251		60	90	89
	3-3	30	2.9	332	1.2	1.03	879.16	313	255		61	90	89
	3-4	40	3.9	334	.98	.84	884.67	250	258		58	85	86
			STOP	OUT			889.56						
	2-1	10	4.8	336	.85	.73	889.65	250	258		62	83	85
	2-2	20	5.9	337	.85	.73	—	270	253		60	83	84
	2-3	30	10.5	342	1.4	1.2	898.91	296	260		57	83	83

Page 2 of 2

Method 5 Field Data Continued Date 09/15 Location [illegible] Run No. #3 Metals Operator RNC/T.L

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2-4	40	12.9	340	1.2	1.00	904.16	255 ~~270~~	265		60	84	84
			STOP	OUT			909.22						
*	1-1	10	12.9	338	.85	~~[illegible]~~ .53	909.22	270	253		63	85	85
*	1-2	20	12.9	338	.85	~~[illegible]~~ .53	913.53	290	251		64	84	85
*	1-3	30	13.5	344	1.4	.46	917.49	277	260		67	86	86
~~EM1340~~ *	1-4	40	13.5	342	1.3	.40	921.19	250	258		67	89	87
EM1540				STOP	OUT		924.60						
*	Max ~~Flow~~	ΔP		13.5" Hg	(NO MORE	CONTROL ON	VACUUM)						

Post Leak Chk 15" Hg = .01"/MIN
14"

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Unit 8 Outlet Run No. 3

Set Up By DQ / DWS Date 04/05/93 Run Date 04/05/93

Comments Multiple Metals

Analyst Responsible for Recovery DQ

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 30141

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	580.3 g	764.5 g	184.2 g
Second	578.4 g	605.3 g	26.9 g
Third	426.7 g	427.8 g	1.1 g
Fourth	648.7 g	651.8 g	3.1 g
Fifth	581.0 g	581.5 g	0.5 g
Sixth	504.1 g	505.4 g	1.3 g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	781.2 g	812.2 g net 31.0
	g	g
Totals	g	g

Total 248.1

COMMENTS:

Color of Silica Gel: Bottom 1/3 pink

Description of Impinger Water:

* Nozzle was chipped; ~~apparently~~ DWS should n't affect run.

DWS 4-5-93

st 2 of 3

METHOD 5 FIELD DATA

Plant/Location	BAILY INLET U-8	Pitot Coefficient, Cp	.81	1st Filter:	
Operator	BP/BT/	Nozzle ID	T-45	Leak Rate, cfm. Pretest	.000/min @ 9"
Date	ACID #3	Average Nozzle Dia., inches	.190	Leakrate, cfm. Post-test	~~.005/min @12"~~
Test No./Run No.		Barometric Pressure, in. Hg	29.35	2nd Filter (if used):	.050/min @12"
Meter Box ID	NUTECH 4	Ambient Temp., deg. F	71°F	Leak Rate, cfm. Pretest	
Gas Meter Cal Factor		Assumed Moisture, %	–	Leakrate, cfm. Post-test	
Orifice ID		Filter ID	49-144		
Orifice DH@	1.87	Stack Pressure, in. H2O	-19.5		

GAS METER START, cf: 676.280
START TIME 1430

GAS METER END, cf
END TIME 708.785

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	.	0		—	—	—						82	80
1430	1-1	3	-4.0	320	.80	.59	676.280	228	257		62	82	80
	1-2	6	-4.0	330	.92	.69	677.670	201	259		62	82	81
	1-3	9	-4.0	339	.98	.72	679.000	200	259		62	82	81
	1-4	12	-4.0	352	.85	.63	680.390	183	271		60	83	81
1442							681.680						
	2-1	15	-4.0	323	1.05	.78	681.880	185	272		57	84	81 *
	2-2	18	-4.0	338	1.00	.74	683.340	187	268		57	85	81
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				340	0.949	0.63						84.4	

* START BAG SAMPLE

```
               M  8 Out        dp PITOT   dP ORI    dp PITOT   dP ORI
             ----------        --------   ------    --------   ------
                 :    5.7         0.500     0.43       1.400     1.20
            > d2 :   13.3         0.550     0.47       1.450     1.25
             H2O :   10.0         0.600     0.52       1.500     1.29
            Hg   :  29.30         0.650     0.56       1.550     1.33
           H2O   :    7.5         0.700     0.60       1.600     1.38
         el., fps                 0.750     0.65       1.650     1.42
       & ROOT d  :   1.01         0.800     0.69       1.700     1.46
        PITOT dP :   0.50         0.850     0.73       1.750     1.51
   CREMENT       :  0.050         0.900     0.77       1.800     1.55
                                  0.950     0.82       1.850     1.59
STACK GAS TEMP, F  :  320         1.000     0.86       1.900     1.63
GAS METER TEMP, F  :   85         1.050     0.90       1.950     1.68
                                  1.100     0.95       2.000     1.72
PITOT CONSTANT     :   0.81       1.150     0.99       2.050     1.76
ORIFICE CONSTANT   :   1.87       1.200     1.03       2.100     1.81
Nutech 1                          1.250     1.08       2.150     1.85
NOZZLE DIA, in     :  0.192       1.300     1.12       2.200     1.89
SYSTEM FLOW, acfm  :  0.798       1.350     1.16       2.250     1.94
dp                     1.01
FLOW, scfm           0.4763
Target volume           110      114.3 predicted vol.
Minutes to Vol.      230.94            nozzle T40
hours to vol.         3.849
No. of points:           24
Reqd Min./point      9.6225     9/5/93 Outlet 8 metals train operatio
Use Minutes/point        10
```

8 OUT

9/5

Page 2 of 2 9/5/93 INLET ACID #3 WJP

Method 5 Field Data Continued. Date 9/5/93 Location Run No. Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2-3	21	-4.0	346	.72	.54	684.74	189	269		57	86	81
	2-4	24	-4.0	356	.80	.59	685.98	190	269		57	86	81
							687.190						
	3-1	27	-4.0	325	1.05	.78	687.400	185	291		57	86	82
	3-2	30	-4.0	338	1.00	.74	—	189	290		57	86	82
	3-3	33	-4.5	355	.95	.71	690.27	189	299		57	87	83
	3-4	36	-4.5	360	.58	.43	69.640	190	287		58	87	83
							692.770						
	4-1	39	-5.0	320	1.1	.82	692.94	181	295		56	87	82
	4-2	42	-5.0	348	.98	.72	694.420	178	290		56	88	82
	4-3	45	-5.0	363	.85	.63	696.790	180	284		56	88	82
	4-4	48	-5.0	362	.49	.36	697.080	181	284		56	89	83
							698.08						
	5-1	51	-5.0	318	1.0	.74	698.280	177	284		56	89	83
	5-2	54	-5.0	335	1.70	.52	699.89	179	280		56	89	83

age 3 of 3

Method 5 Field Data Continued. Date 9/5/93 Location INLET Run No. ACID #3 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-3	57	-5.0	347	.83	.61	~~710.03~~ 701.03	179	293		57	88	83
	5-4	60	-5.0	350	.75	.56	702.30	179	291		~~60~~ 57	89	84
							703.560						
1537	6-1	63	-5.0	316	.76	.57	703.810	199	290		57	89	84
	6-2	66	-5.0	326	.91	.68	705.06	201	294		59	88	84
	6-3	69	-5.0	340	.73	.54	706.41	179	296		58	88	84
	6-4	72	-5.0	341	.70	.52	707.625	185	291		59	89	84 *2
							708.785						
1549	END												

(*2) BAGSAMPLE SAID "KABOOM"
DON SAID "ACit [illegible] + [illegible],"
COCKEYED THING

probe/oven dropped when ORSAT BAG BURST. [after sampling was complete]
Resulted in cracked glass fitting in oven [filter to bulkhead connection]
M1/8.v2

ACID RUN #3
INLET U-8.

```
MASS TRAIN OPERATION  Inlet 8       dp PITOT   dP ORI    dp PITOT   dP ORI
----------------------------        --------   ------    --------   ------
GAS ANALYSIS - 02  :      5.5          0.500     0.37       1.400     1.04
               CO2 :     13.4          0.550     0.41       1.450     1.08
               H2O :     10.0          0.600     0.45       1.500     1.11
AMB PRESS, in Hg   :    29.35          0.650     0.48       1.550     1.15
STACK dP, in H20   :    -20.0          0.700     0.52       1.600     1.19
Enter Gas vel., fps                    0.750     0.56       1.650     1.22
or AVG SQR ROOT d  :     1.09          0.800     0.59       1.700     1.26
MINIMUM PITOT dP   :     0.50          0.850     0.63       1.750     1.30
dP INCREMENT       :    0.050          0.900     0.67       1.800     1.34
                                       0.950     0.71       1.850     1.37
STACK GAS TEMP, F  :      332          1.000     0.74       1.900     1.41
GAS METER TEMP, F  :       80          1.050     0.78       1.950     1.45
                                       1.100     0.82       2.000     1.48
PITOT CONSTANT     :     0.81          1.150     0.85       2.050     1.52
ORIFICE CONSTANT   :     1.87          1.200     0.89       2.100     1.56
Nutech 4                               1.250     0.93       2.150     1.60
NOZZLE DIA, in     :    0.190          1.300     0.96       2.200     1.63
SYSTEM FLOW, acfm  :    0.676          1.350     1.00       2.250     1.67
dp                       1.18
FLOW, acfm             0.5157
Target volume              20           24.8 predicted vol.
Minutes to Vol.        38.782                nozzle T45
hours to vol.          0.6464
No. of points:             24
Reqd Min./point        1.6159         9/5/93 Inlet metals train operation
Use Minutes/point
```

3 minutes/point

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 3

Set Up By [illegible] Date 09/04/93 Run Date 09/05/93

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 4Q144

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	641.4 g	687.1 g	45.7 g
Second	607.4 g	617.2 g	9.8 g
Third	474.5 g	477.9 g	3.5 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	798.6 g	807.3 g
	g	g
Totals	g	g

+8.70

Total 67.7g

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/Location BAILEY STACK
Operator CAH
Date 9-5-93
Test No./Run No. ACID 3
Meter Box ID 71-16
Gas Meter Cal. Factor
Orifice ID
Orifice DH@ 1.94

Pitot Coefficient, Cp .80
Nozzle ID SHANK 6
Average Nozzle Dia., Inches .251
Barometric Pressure, in. Hg 29.10
Ambient Temp., deg. F 57
Assumed Moisture, % 18
Filter ID
Stack Pressure, in. H2O .8

1st Filter:
Leak Rate, cfm, Pretest .01 cfm
Leakrate, cfm, Post-test
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 691.08
START TIME 1640

GAS METER END, cf 721.51
END TIME 1748

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1643	PORT- POINT	0	—	113 ~~109~~	.32	.88	691.08	229	225		67	70	69
1648	3-1	~~4~~ 5	5.0	118	.32	.88	693.94	245	254		63	72	70
1653	2	~~8~~ 10	4.8	115	.34	.94	696.52	255	250		60	73	70
1658	3	~~12~~ 15	4.1	124	.26	.72	698.80	254	251		59	73	70
1703	38-1	~~16~~ 20	4.8	120	.32	.88	701.42	244	258		59	74	70
1708	2	~~20~~ 25	4.5	123	.30	.83	703.71	240	255		59	74	70
1713	3	~~24~~ 30	4.1	128	.26	.72	706.00	240	250		59	74	70
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				124	0.565	0.88							

7225

Page 2 of 2

Method 5 Field Data Continued. Date 9-5-93 Location STACK Run No. ACID 3 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1718	PORT-POINT												
1723	1-1	35	5.0	125	.36	.99	708.73	233	253		63	73	70
1728	2	40	5.0	126	.34	.94	711.28	233	252		59	74	71
1733	3	45	4.9	127	.32	.88	713.77	236	256		59	75	71
1738	2-1	50	5.0	128	.34	.94	716.36	230	251		59	76	71
1743	2	55	5.0	129	.34	.94	719.00	235	251		59	76	71
1748	3	60	5.0	130	.34	.94	721.51	230	253		60	77	71

```
   i TRAIN OPERATION  Stack          dp PITOT   dP ORI    dp PITOT   dP ORI
 ----------------------------        --------   ------    --------   ------
GAS ANALYSIS - O2  :    6.4            0.100     0.28       0.460     1.27
              CO2  :   12.8            0.120     0.33       0.480     1.32
              H20  :   18.0            0.140     0.39       0.500     1.38
AMB PRESS, in Hg   :  29.10            0.160     0.44       0.520     1.43
STACK dP, in H20   :    0.7            0.180     0.50       0.540     1.49
Enter Gas vel., fps                    0.200     0.55       0.560     1.54
or AVG SQR ROOT d  :   0.60            0.220     0.61       0.580     1.60
MINIMUM PITOT dP   :   0.10            0.240     0.66       0.600     1.65
dP INCREMENT       :  0.020            0.260     0.72       0.620     1.71
                                       0.280     0.77       0.640     1.76
STACK GAS TEMP, F  :    133            0.300     0.83       0.660     1.82
GAS METER TEMP, F  :     80            0.320     0.88       0.680     1.87
                                       0.340     0.94       0.700     1.93
PITOT CONSTANT     :   0.80            0.360     0.99       0.720     1.98
ORIFICE CONSTANT   :   1.94            0.380     1.05       0.740     2.04
CAE 71-16                              0.400     1.10       0.760     2.09
NOZZLE DIA, in     :  0.251            0.420     1.16       0.780     2.15
SYSTEM FLOW, acfm  :  0.720            0.440     1.21       0.800     2.20
dp                     0.36
FLOW, scfm           0.5113
Target volume            20             24.5 predicted vol.
Minutes to Vol.      39.113                  nozzle 12
hours to vol.        0.6519
No. of points:           12
Reqd Min./point      3.2594           9/5/93 Stack metals train operation
Use Minutes/point         5
```

STACK

ACID

5 minutes/point

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack Run No. 3

Set Up By BOK / DWS Date 09/05/93 Run Date 09/05/93

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 3Q151

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	636.1 g	718.6 g	82.5 g
Second	591.7 g	609.0 g	17.3 g
Third	491.0 g	493.5 g	2.5 g
Fourth	— g	— g	— g
Fifth	— g	— g	— g
Sixth	— g	— g	— g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	803.1 g	798.4 g	-4.7 (?)
	g	g	
Totals	g	g	

TOTAL (less gel) 102.3

COMMENTS:

Color of Silica Gel: No Change.

Description of Impinger Water:

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-5-93
Test No./Run No. METALS 3
Meter Box ID 71-16
Gas Meter Cal. Factor
Orifice ID
Orifice DHO 1.94

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 21 [illegible]
Average Nozzle Dia., inches
Barometric Pressure, in. Hg 2[illegible]
Ambient Temp., deg. F 75
Assumed Moisture, % 18
Filter ID
Stack Pressure, in. H2O .85

1st Filter:
Leak Rate, cfm, Pretest <.01 cfm
Leak Rate, cfm, Post-test <.01 cfm
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leak Rate, cfm, Post-test

GAS METER START, cf: 502.58
START TIME 0925

GAS METER END, cf 690.76
END TIME 1540

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	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 0925	PORT-POINT	0	2.7	131	.34	1.00	502.58	268	265		61	79	74
0940	1-1	15	2.6	132	.34	1.00	510.57	264	256		51	83	76
0955	1	30	2.6	132	.34	1.00	518.53	266	253		53	85	77
1010	2	45	2.5	130	.32	.94	526.30	308	253		55	85	78
1025	2	60	2.5	131	.32	.94	534.19	308	250		53	84	78
1040	3	75	2.5	130	.30	.88	541.65	305	249		54	80	76
1055	3	90	2.5	129	.30	.88	549.21	300	251		56	78	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				130	0.571	0.96							

76.8

age 2 of 3

Method 5 Field Data Continued. Date 9-5-93 Location STACK Run No. 3 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
START 1055							549.21						
1110	1-1	105	2.7	129	.34	1.00	557.19	260	252		54	78	74
1125	1	120	2.8	130	.34	1.00	565.26	269	253		57	78	74
1140	2	135	2.8	130	.34	1.00	573.34	304	253		56	77	73
1155	2	150	2.8	129	.34	1.00	581.35	298	252		55	77	72
1210	3	165	2.8	129	.34	1.00	589.35	282	251		54	77	72
1225	3	180	2.8	129	.34	1.00	597.36	286	252		53	77	72
START 1234													
START 1249 ~~1234~~	2-1	195	3.0	129	.36	1.06	605.45	243	252		64	74	72
1304	1	210	3.0	129	.36	1.06	613.61	234	252		50	79	73
1319	2	225	3.0	130	.36	1.06	621.77	210	252		46	78	73
1334	2	240	3.0	129	.36	1.06	630.01	218	254		47	80	73
1349	3	255	2.9	129	.32	.94	637.87	231	254		49	80	74
1404	3	270	3.0	130	.34	1.00	645.87	233	252		49	81	75

Page 3 of 3

Method 5 Field Data Continued Date 9-5-93 Location STACK Run No. [illegible] Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
5													
START 1410					.30	.88	465.87	24	[illegible]		[illegible]	78	75
1425	3-1	285	3.0	130	.32	.94	653.58	239	248		48	79	75
1440	1	300	3.0	130	.32	.94	661.37	241	252		49	80	75
1455	2	315	2.9	131	.30	.88	668.90	237	252		49	79	75
1510	2	330	2.9	130	.30	.88	676.42	242	251		49	78	74
1525	3	345	2.9	128	.28	.82	683.75	240	251		50	78	74
1540	3	360	2.8	128	.26	.76	690.76	250	252		50	77	74

```
MASS TRAIN OPERATION  Stack          dp PITOT   dP ORI    dp PITOT   dP ORI
-----------------------------        --------   ------    --------   ------
GAS ANALYSIS - O2  :     6.4            0.100     0.29       0.460     1.35
              CO2 :     12.8            0.120     0.35       0.480     1.41
              H2O :     18.0            0.140     0.41       0.500     1.47
AMB PRESS, in Hg   :   29.00            0.160     0.47       0.520     1.53
STACK dP, in H2O   :     0.7            0.180     0.53       0.540     1.58
Enter Gas vel., fps                     0.200     0.59       0.560     1.64
or AVG SQR ROOT d  :    0.60            0.220     0.65       0.580     1.70
MINIMUM PITOT dP   :    0.10            0.240     0.70       0.600     1.76
dP INCREMENT       :   0.020            0.260     0.76       0.620     1.82
                                        0.280     0.82       0.640     1.88
STACK GAS TEMP, F  :     133            0.300     0.88       0.660     1.94
GAS METER TEMP, F  :      80            0.320     0.94       0.680     1.99
                                        0.340     1.00       0.700     2.05
PITOT CONSTANT     :    0.80            0.360     1.06       0.720     2.11
ORIFICE CONSTANT   :    1.94            0.380     1.11       0.740     2.17
CAE 71-16                               0.400     1.17       0.760     2.23
NOZZLE DIA, in     :   0.255            0.420     1.23       0.780     2.29
SYSTEM FLOW, acfm  :   0.745            0.440     1.29       0.800     2.35
dp                      0.36
FLOW, acfm            0.5269
Target volume            185         189.7 predicted vol.
Minutes to Vol.       351.14               nozzle T2
hours to vol.         5.8523
No. of points:            12
Rend Min./point       29.261         9/5/93 Stack metals train operation
     linutes/point        30
```

Stack
9/5

Pt 1 of 3

METHOD 5 FIELD DATA

Plant/location Bailly unit 8 dat
Operator RNC
Date 09/05/93
Test No./Run No. ACID #3
Meter Box ID #1 NUTECH
Gas Meter Cal Factor ____
Orifice ID ____
Orifice DH@ ____

Pitot Coefficient, Cp ____
Nozzle ID ____
Average Nozzle Dia., inches ____
Barometric Pressure, in. Hg ____
Ambient Temp., deg. F ____
Assumed Moisture, % ____
Filter ID ____
Stack Pressure, in. H2O 7.0

1st Filter:
Leak Rate, cfm. Pretest ✓ 12" Hg = .01/min
Leakrate, cfm. Post-test ✓ 9" Hg = .000
2nd Filter (if used):
Leak Rate, cfm. Pretest ____
Leakrate, cfm. Post-test ____

PITOT 3" H2O + .000
\- .000

o o o o o o
↑
FLOW

GAS METER START, cf: 954.82
START TIME ~~052~~ 1526

GAS METER END, cf 992.31
END TIME 1701

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1526	1-1	3	4.2	338	1.0	.83	START 954.82	250	262		77	76	76
3 STOP	1-2	6	4.2	340	1.0	.83	957.30	255	262		77	77	76
	1-3	9	5.1	340	1.4	1.2	958.75	255	~~266~~ 262		70	76	76
	1-4	12	6.5	347	1.9	1.58	960.43	320	260		67	76	76
				STOP			962.30						
	2-1	3	4.1	330	~~1.1~~ .95	.79	Start 962.41	307	259		67	77	76
	2-2	6	4.1	330	.95	.94	963.90	310	256		67	77	76
	2-3	9	4.8	324	1.1	.92	965.38	310	257		66	77	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max	Avg.	Avg.
				324	1.037	0.86							

75.5

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY
Sampling Location STACK
Run No. 3
Set Up By WOK/DWS
Date 09/05/93
Run Date 09/05/93
Comments Multiple Metals
Analyst Responsible for Recovery
Calculations & Report Reviewed By
Report Date

FILTERS USED

Filter No. 3Q 142

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	945.7 g	1614.2 g	668.5 g
Second	588.3 g	601.8 g	13.5 g
Third	416.7 g	418.7 g	2.0 g
Fourth	567.5 g	568.5 g	1.0 g
Fifth	665.8 ~~[illegible]~~ g	665.0 g	-0.8 g
Sixth	475.5 g	476.8 g	1.3 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	805.4 g	841.5 wt g 36.1
	g	g
Totals	g	g

TOTAL 721.6

COMMENTS:
Color of Silica Gel: 1/2 pink
Description of Impinger Water:

Page 2 of 3

Method 5 Field Data Continued Date 09/05 Location Output #4 Run No. #3 ACID Operator RNC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp Outlet	DGM in	DGM out
	MTP 12	3-4	~~4~~ 5.0	328	.98	.81	966.94	285	256		59	75	75
			STOP				968.42					~~75~~	~~76~~
1604	3	~~3~~ 4-1	3.9	317	.90	.75	968.42	310	260		60	75	76
	6	~~3~~ 4-2	4.0	317	.90	.75	969.83	315	261		60	75	76
	9	~~3~~ 4-3	4.8	316	1.05	.87	971.24	318	262		58	76	75
	12	~~3~~ 4-4	4.2	315	.90	.75	972.79	310	265		59	75	75
				STOP			974.~~24~~ 17						
	3	~~4~~ 5-1	4.0	311	.84	.70	start 974.17	304	266		62	75	75
	6	~~4~~ 5-2	4.0	311	.84	.70	975.57	304	266		61	76	75
	9	~~4~~ 5-3	5.1	310	1.1	.92	976.99	305	264		60	75	75
	12	~~4~~ 5-4	5.9	309	1.4	1.17	978.56	308	262		59	76	75
					STOP		980.25	~~294~~	~~258~~		~~59~~	~~75~~	~~74~~
	3	6-1	4.0	306	.80	.67	980.25	294	258		59	75	74
	6	6-2	4.0	308	.80	.67	981.62	290	255		59	75	74
	9	6-3	5.9	307	1.3	1.08	982.99	301	253		59	75	74

age 2 of 2

Method 5 Field Data Continued Date 09/05 Location OUT Run No. #3 ACID Operator RNC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	6-4	12	6.1	307	1.5	1.25	984.65	300	254		58	76	75
				STOP			986.40						
1648	6^{2}-1	3	5.0	338	.98	.81	986.40	315	253		59	75	74
	6^{2}-2	6	5.0	339	.98	.81	987.92	315	253		59	76	74
	6^{2}-3	9	6.5	344	1.5	1.25	989.41	318	258		58	77	76
	6^{2}-4	12	6.1	339	1.3	1.08	991.15	305	250		57	76	76
END 1704				STOP			992.81						

```
  , TRAIN OPERATION  8 Out            dp PITOT   dP ORI     dp PITOT   dP ORI
------------------------------        --------   ------     --------   ------
GAS ANALYSIS - O2  :     5.7            0.500     0.42        1.400     1.17
               CO2 :    13.3            0.590     0.46        1.450     1.21
               H2O :    10.0            0.600     0.50        1.500     1.25
AMB PRESS, in Hg   :   29.30            0.650     0.54        1.550     1.29
STACK dP, in H2O   :     7.5            0.700     0.58        1.600     1.33
Enter Gas vel., fps                     0.750     0.62        1.650     1.37
or AVG SQR ROOT d  :    1.01            0.800     0.67        1.700     1.42
MINIMUM PITOT dP   :    0.50            0.850     0.71        1.750     1.46
dP INCREMENT       :   0.050            0.900     0.75        1.800     1.50
                                        0.950     0.79        1.850     1.54
STACK GAS TEMP, F  :     320            1.000     0.83        1.900     1.58
GAS METER TEMP, F  :      90            1.050     0.87        1.950     1.62
                                        1.100     0.92        2.000     1.67
PITOT CONSTANT     :    0.81            1.150     0.96        2.050     1.71
ORIFICE CONSTANT   :    1.87            1.200     1.00        2.100     1.75
Nutech 1                                1.250     1.04        2.150     1.79
NOZZLE DIA, in     :   0.190            1.300     1.08        2.200     1.83
SYSTEM FLOW, acfm  :   0.782            1.350     1.12        2.250     1.87
dp                      1.01
FLOW, acfm            0.4664
Target volume             20             22.4 predicted vol.
Minutes to Vol.       42.878                  nozzle I48
hours to vol.         0.7146
No. of points:            24
Reqd Min./point       1.7866           9/5/93 Outlet 8 metals train operatio
Use Minutes/point
```

3

8 OUT ACID.

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 8 Run No. 3

Set Up By WDL / DWS Date 09/05/93 Run Date 09/05/93

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	3Q150
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	635.3 g	678.6 g	43.3 g
Second	580.3 g	594.5 g	14.2 g
Third	479.6 g	483.5 g	3.9 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final	
	757.4 g	769.9 g	12.5
	g	g	
Totals	g	g	
		TOTAL	73.9

COMMENTS:

Color of Silica Gel: 1/6 Pink

Description of Impinger Water:

DRY MOLECULAR WEIGHT DETERMINATION

CAL Gas

PLANT Bailly Steam Plant
DATE 9/15/83 TEST NO. 3
SAMPLING TIME (24-hr CLOCK) 845
SAMPLING LOCATION CAL Check
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 75
OPERATOR Lotz
ORSAT LEAK CHECKED 16.4" 21.4"

COMMENTS:
CO_2 14.5 - 15.2 - 15.1
O_2 4.54 - 5.04 - 5.14
±2%

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	44/100	6.688
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	20.2	5.0	20.2	5.0	20.2	5.0	5.0	32/100	1.600
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							79.8	28/100	22.344

TOTAL 30.632

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Beig Steam Plant

DATE 9/15/93 TEST NO. 2

SAMPLING TIME (24-hr CLOCK) Audit Sample

SAMPLING LOCATION Audit Sample

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Bag

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 70

OPERATOR LCTZ

ORSAT LEAK CHECKED ~~[illegible]~~ 24.0✓ 19.6✓

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	5.0	5.0	5.0	5.0	5.1	5.1	5.05	44/100	2,213
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	15.0	10.0	15.1	10.1	15.0	9.9	10.0	32/100	3 20
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)								28/100	
								TOTAL	

DRY MOLECULAR WEIGHT DETERMINATION

PLANT: Baily Steam Plant
DATE 3/5/93 TEST NO. 1
SAMPLING TIME (24-hr CLOCK) NA
SAMPLING LOCATION Zero Audit Gas
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) BAG
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 70
OPERATOR Lutz
ORSAT LEAK CHECKED 24.0 ✓ 24.0 ✓

COMMENTS:

Zero Audit Gas

Z 15:7

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44/100	—
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32/100	—
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)								28/100	
								TOTAL	

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant
DATE 9/5/93 TEST NO.
SAMPLING TIME (24-hr CLOCK) 0931 –
SAMPLING LOCATION STACK
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 70
OPERATOR Lutz
ORSAT LEAK CHECKED 22.4✓ 28.2✓

COMMENTS:

Only one Bag Sample

Mixing Stage

RUN / GAS	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) Md, lb/lb-mole
CO_2	12.9	12.9	12.9	12.9	12.9	12.9	12.9	44/100	5.676
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.5	19.4	6.5	19.4	6.5	6.5	32/100	2.08
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.324

GUARDIAN SYSTEMS INC

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Baily Stm Plant

DATE 9/15/83 TEST NO. 3

SAMPLING TIME (24 hr CLOCK) 0942-1357

SAMPLING LOCATION #7 Outlet metal

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 23

OPERATOR Liz

ORSAT LEAK CHECKED 18.2" 26.0"

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	13.0	13.0	13.0	13.0	13.0	13.0	13.0	44/100	5.72
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.4	19.5	6.5	19.4	6.4	6.43	32/100	2.058
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.57	28/100	22.560
								TOTAL	30.338

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant

DATE 2/15/82 TEST NO. 3

SAMPLING TIME (24-hr CLOCK) 0930-1340

SAMPLING LOCATION # 8 Boiler [illegible] [illegible]

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 70

OPERATOR WTL

ORSAT LEAK CHECKED 14.2✓ 14.2✓

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.0	6.2	19.1	6.3	19.0	6.2	6.17	32/100	1.974
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							81.03	28/100	22.688
								TOTAL	30.294

G-153

GUARDIAN SYSTEMS INC

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailey Stm Plant

DATE 9/15/93 TEST NO. 3

SAMPLING TIME (24-hr CLOCK) 1000-1205

SAMPLING LOCATION Inlet #8 Motors Fan

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 70°F

OPERATOR L.T.Z.

ORSAT LEAK CHECKED 25.0 ✓ 12.6 ✓

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.0	14.0	14.0	14.0	14.0	14.0	14.0	44/100	6.16
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.0	5.0	19.0	5.0	19.0	5.0	5.0	32/100	1.60
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							81.0	28/100	22.68
								TOTAL	30.44

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Brick

DATE 5/15/83 TEST NO. 4

SAMPLING TIME (24 hr CLOCK) 1525

SAMPLING LOCATION #7 Outlet HCl's

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 70

OPERATOR Lord

ORSAT LEAK CHECKED 24.1 ✓ 22.4 ✓

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.6	15.4	6.6	15.4	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568

TOTAL	30.312

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailey Steam Plant

COMMENTS:

DATE 9/5/92 TEST NO.

SAMPLING TIME (24 hr CLOCK) 1524 -

SAMPLING LOCATION #8 Outlet

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 70

OPERATOR Lutz

ORSAT LEAK CHECKED 186 ✓ 24.2 ✓

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.0	14.0	14.0	4.0	14.0	14.0	14.0	44/100	6.16
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	5.4	19.4	5.4	19.4	5.4	5.4	32/100	1.728
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.456

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Stm Plant

COMMENTS:

DATE 9/5/93 TEST NO.

SAMPLING TIME (24 hr CLOCK) 1620-1640

SAMPLING LOCATION [illegible] After Air [illegible]

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) BAG

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 70

OPERATOR LOTZ

ORSAT LEAK CHECKED 14.6" 15.6"

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	44/100	6.248
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	5.0	19.2	5.0	19.2	5.0	5.0	32/100	1.600
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.8	28/100	22.624
								TOTAL	30.472

PAGE 1 OF 3   INLET-U8   DAY 3. METALS.

METHOD 5 FIELD DATA

Plant/Location BAILLY / INLET U-8
Operator WSP / DJ / SD
Date 9/5/93
Test No./Run No. METALS #3
Meter Box ID NUTECH 4
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp .81
Nozzle ID T-39
Average Nozzle Dia., inches .192
Barometric Pressure, in. Hg 29.30
Ambient Temp., deg. F 75°F
Assumed Moisture, % ______
Filter ID (4")
Stack Pressure, in. H2O -19.5

1st Filter:
Leak Rate, cfm, Pretest .009/min @ 10" H2O
Leakrate, cfm, Post-test .800/min @ 8" H
2nd Filter (if used): NONE
Leak Rate, cfm, Pretest —
Leakrate, cfm, Post-test —

- PITOT LEAK CHECK @ ~~10"H~~ 8.5" H2O OK
WSP

GAS METER START, cf: 585.550
START TIME 0927

GAS METER END, cf 675.520 ✓
END TIME 1243

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb	Imp. Outlet	DGM in	DGM out
0925	—	0	—	—	~~.84~~	~~.65~~	—	248	249	—	73	84	81
	1-1	8	-3.5	324	.84	.65	585.550	215	225	—	57	86	81
	1-2	16	-4.0	332	.93	.72	589.125	211	214	—	57	89	83
	1-3	24	-4.0	340	.96	.75	592.800	227	221	—	56	92	85
	1-4	32	-4.0	348	.86	.67	596.6	226	223	—	56	93	85
0950	—	—	—	—	—	—	600.150	—	—	—	—	—	—
1000	2-1	40	-4.0	327	1.15	.89	600.38	234	246	—	58	97	89 (*1)
	2-2	48	-4.0	338	1.10	.85	604.510	232	246	—	56	98	90
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				341	0.959	0.72						92.6	

(*1) START BAG SAMPLE PORT 1
WILL FOLLOW PORT TO PORT
SAMPLE TRAIN

Page 2 of 3

DAY 5 METALS INLET U-8

Method 5 Field Data Continued Date 9/5/93 Location INLET U-8 Run No. METALS #3 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	2-3	56	-4.0	346	.72	.56	608.500	235	249	—	55	100	91
	2-4	64	-4.0	358	.90	.70	611.875	235	254	—	57	100	93
1032	—	—	—	—	—	—	615.520	—	—	-	—	..	
	3-1	72	-4.0	~~325~~ 352	1.20	.93	615.745	234	251	—	57	100	94
	3-2	80	-4.5	348	1.20	.93	620.00	234	251	—	57	100	94
	3-3	88	-5.0	356	1.00	.77	624.225	231	251	—	59	100	94
	3-4	96	-5.0	363	.62	.48	628.110	226	248	—	59	99	94
1105	—	—	—	—	—	—	631.19	—	—	—	-	...	-
1106	4-1	104	-5.0	320	1.25	.97	631.395	229	248	—	59	99	94
	4-2	112	-5.0	351	1.15	.89	635.605	223	251	—	59	97	93
	4-3	120	-5.0	361	1.0	.77	639.—	223	251	—	59	96	93
	4-4	128	-5.0	364	.60	.46	643.600	229	253	—	61	96	92
1138	—	—	—	—	—	—	646.640	—	—	—	—	—	—
	5-1	136	-5.0	322	1.1	.85	646.785	232	259	—	62	95	91
	5-2	144	-5.5	334	.80	.62	650.865	235	253	—	63	96	91

Page 3 of 3

DAY 3 METALS INLET U-8

Method 5 Field Data Continued Date 9/5/93 Location IN-U-8 Run No. METALS #3 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum In. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-3	152	-5.0	347	.90	.70	654.375	229	254	—	62	95	90
	5-4	160	-5.0	351	.77	.60	658.030	229	251	—	62	93	89
1210	—	—	—	—	—	—	661.480	—	—	—	—	—	—
1211	6-1	168	-5.0	315	~~.87~~ .90	~~.68~~ .70	661.680	225	255	—	63	92	88
	6-2	176	-5.0	323	.81	.63	665.310	211	247	—	62	93	88
	6-3	184	-5.0	338	.80	.62	668.785	223	250	—	62	93	88
	6-4	192	-5.0	346	.72	.56	672.185	219	251	—	62	93	88
1243	END	—	—	—	—	—	675.520 ✓	—	—	—	—	—	—

DAY 3 — METALS TRAIN UNIT 8 INLET

```
MASS TRAIN OPERATION  Inlet 8       dp PITOT   dP ORI     dp PITOT   dP ORI
----------------------------        --------   ------     --------   ------
GAS ANALYSIS - O2  :     5.5          0.500     0.39        1.400     1.08
              CO2  :    13.4          0.550     0.43        1.450     1.12
              H2O  :    10.0          0.600     0.46        1.500     1.16
AMB PRESS, in Hg   :   29.30          0.650     0.50        1.550     1.20
STACK dP, in H20   :   -20.0          0.700     0.54        1.600     1.24
Enter Gas vel., fps                   0.750     0.58        1.650     1.28
or AVG SQR ROOT d  :    1.09          0.800     0.62        1.700     1.32
MINIMUM PITOT dP   :    0.50          0.850     0.66        1.750     1.35
dP INCREMENT       :   0.050          0.900     0.70        1.800     1.39
                                      0.950     0.74        1.850     1.43
STACK GAS TEMP, F  :     335          1.000     0.77        1.900     1.47
GAS METER TEMP, F  :      82          1.050     0.81        1.950     1.51
                                      1.100     0.85        2.000     1.55
PITOT CONSTANT     :    0.81          1.150     0.89        2.050     1.59
ORIFICE CONSTANT   :    1.87          1.200     0.93        2.100     1.62
Nutech 4                              1.250     0.97        2.150     1.66
NOZZLE DIA, in     :   0.192          1.300     1.01        2.200     1.70
SYSTEM FLOW, acfm  :   0.897          1.350     1.04        2.250     1.74
dp                      1.18
FLOW, scfm            0.5252
Target volume            100         100.8 predicted vol.
Minutes to Vol.       190.41               nozzle T39
hours to vol.         3.1734
No. of points:            24
Reqd Min./point       7.9336        9/5/93 Inlet metals train operation
l     inutes/point         8
```

Buchanan P
Lilian L

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 3

Set Up By [illegible]/DWS Date 09/05/93 Run Date 09/05/93

Comments Multiple Metals

Analyst Responsible for Recovery [illegible]

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. 4Q 141

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	584.8 g	748.8 g	164 g
Second	669.5 ~~666.2~~ g	680.1 g	10.6 g
Third	427.6 g	427.6 g	~~2.5~~ g 0
Fourth	597.4 g	598.9 g	1.5 g
Fifth	567.0 g	565.0 g	-2.0 g
Sixth	461.8 g	463.7 ~~463.6~~ g	1.9 g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	793.9 g	817.3 g Net 23.4
	g	g
Totals	g	g

TOTAL 199.6

COMMENTS:

Color of Silica Gels 1/4 pink

Description of Impinger Water:

Back-up [illegible]

Appendix G4
September 6 Tests

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/Location #7 Outlet
Operator Kirby
Date 9-6-93
Test No./Run No. #1 [illegible]
Meter Box ID Nutech #3
Gas Meter Cal. Factor
Orifice ID
Orifice DH@ 1.89

Pitot Coefficient, Cp —
Nozzle ID —
Average Nozzle Dia., Inches —
Barometric Pressure, In. Hg 29.46
Ambient Temp., deg. F 70°
Assumed Moisture, % 10.0
Filter ID
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .000 @ 15"
Leakrate, cfm, Post-test
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 87.603
START TIME 16:03

GAS METER END, cf 113.004
END TIME

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	Single Point						87.603						
16:03		5	3.0	310	—	1.2	90.6	260	234	—	68	81	79
		10	3.0	313	—	1.2	93.7	287	230	—	64	84	79
		15	3.0	313	—	1.2	97.1	294	240	—	61	87	80
		20	3.0	313	—	1.2	100.4	295	252	—	62	89	80
		25	3.0	313	—	1.2	103.3	296	251	—	60	90	80
		30	3.0	313	—	1.2	106.3	296	248	—	59	89	80
		35	3.3	313	—	1.2	109.3	297	248		54	89	80
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				313		1.2							

837

Page 2 of 2

Method 5 Field Data Continued Date 9-6-93 Location #7 Outlet Run No. # 1 Ammonium Cyanide Operator Kirby

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	Single Point	[illegible]											
		40	3.0	313	—	1.2	112.3	297	249	—	55	89	81
		41 min	3.10	314	—	1.2	113.004	298	251	—	57	91	81

Final leak @ .15 "Hg.

113.130
113.130
.000

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/Location #7 Outlet
Operator Kirby
Date 9-6-95
Test No./Run No. #1 Aldehydes
Meter Box ID Nutech #3
Gas Meter Cal Factor ____
Orifice ID ____
Orifice DH@ 1.89

Pitot Coefficient, Cp —
Nozzle ID. —
Average Nozzle Dia., inches —
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F 75°
Assumed Moisture, % 10.0
Filter ID —
Stack Pressure, in. H2O 2.5

1st Filter:
Leak Rate, cfm, Pretest .004 @ 15"Hg
Leakrate, cfm, Post-test .004 @ 15"Hg
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 113.436
START TIME 17:27

GAS METER END, cf 163.606
END TIME 18.48

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	Single Point						113.436						
		5	3.0	312	—	1.2	116.6	253	244		67	86	83
		10	3.0	313	—	1.2	119.8	281	244		53	90	83
		15	2.5	313	—	1.2	122.8	286	250		50	93	83
		30	2.5	314	—	1.2	132.1	286	254		50	93	84
		45	2.5	313	—	1.2	141.3	291	246		54	95	85
		60	2.5	313	—	1.2	150.6	291	247		54	94	85
		15	2.5	313	—	1.2	160.0	292	251		55	93	84
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				313		1.2							

88

Page [illegible] of [illegible]

Method 5 Field Data Continued Date 9-6-93 Location # 7 outlet Run No. # 1 Aldehydes Operator Kirby

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	Single Point						160.0						
	[illegible]	21		312	—	1.2	163.606	293	249	—	54	89	82

Final leak ✓ @ 15 " Hg.

163.717
163.713
.004

PAGE 1 OF 3
6HR/30 pt (3)

CHECK COLUMNS 7+8

Final
METHOD 5 FIELD DATA

Plant/location Stack
Operator T. H.
Date 9-6-93
Test No./Run No. 1
Meter Box ID 5728
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID. ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest NONE (1"Hg)
Leakrate, cfm, Post-test ___
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 226.357
START TIME 10/2

GAS METER END, cf 404.244
END TIME 1645

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
* 10/2	3/1	0	4.0	128	.28	.69	226.357	229	282	N/A	N/A	62	62
	3/1	15	3.5	129	.28	.69	233.4	232	276			75	63
	3/2	30	4.0	131	.32	.79	241.1	231	293			95	73
	3/2	45	3.5	131	.26	.64	247.9	225	282			99	77
	3/3	60	3.5	131	.28	.69	255.0	205	282			101	82
	3/3	75	3.5	131	.28	.69	262.1	183	281			103	84
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				130	0.546	0.74							

91.8

* Point #1; Probe all the way in.

Page 2 of 3

Method 5 Field Data Continued. Date 9-6-93 Location Stack Run No. 1 Operator T.H.

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	3/1	90	3.5	131	.32	.79	269.4	196 ~~282~~	282 ~~196~~			103	85
	3/1	105	4.0	131	.32	.79	277.1	213	284			105	86
	3/2	120	4.0	131	.32	.79	284.7	228 ~~284~~	284			103	86
	2	135	4.0	131	.32	.79	292.5	227 ~~285~~	~~287~~			101	87
	3/3	150	3.5	132	.28	.69	300.1	223	285			100	87
	3	165	3.5	130	.28	.69	307.5	211	291			98	88
1326	2/1	180	4.8	129	.32	.79	315.20	189	302			92	86
	2/1	195	4.8	130	.32	.79	3220	193	296			102	87
	2/2	210	5.0	129	.34	.84	329.8	186	297			104	88
	2/2	225	5.0	130	.34	.84	337.7	180	293			106	88

Page 3 of 3

Method 5 Field Data Continued Date 9-6-93 Location Stack Run No. Stack #1 Operator

1511

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2/3	240	3.5	130	.24	.59	346.5	177	292			104	88
	2/3	255	3.5	129	.24	.59	352.4	175	291			102	88
	P/1	270	5.0	130	.34	.84	359.9	209	293			96	88
	P/1	285	5.0	130	.34	.84	367.1	241	296			106	88
	P/2	300	5.0	130	.32	.79	375.0	253	295			109	91
	P/2	315	5.0	130	.32	.79	382.5	246	296			109	[illegible]
	P/3	330	4.5	130	.26	.64	390.6	238	298			109	93
	P/3	345	4.5	131	.26	.64	398.4	232	295			107	92
stop	X	360					404.244						

638 Total
738 mL water

Final leak check - .02 ft³ in 26 seconds -
found union fitting on nozzle to probe loose

#7) 872.6
857.6
15.0

#8) 885.9
870.0
15.9

```
MASS TRAIN OPERATION  Stack        dp PITOT   dP ORI     dp PITOT   dP ORI
------------------------------     --------   ------     --------   ------
 S ANALYSIS - O2  :     6.4           0.100     0.25        0.460     1.14
             CO2  :    12.8           0.120     0.30        0.480     1.19
             H2O  :    18.0           0.140     0.35        0.500     1.24
AMB PRESS, in Hg  :   29.16           0.160     0.40        0.520     1.29
STACK dP, in H2O  :     0.7           0.180     0.45        0.540     1.34
Enter Gas vel., fps                   0.200     0.50        0.560     1.39
or AVG SQR ROOT d :    0.60           0.220     0.55        0.580     1.44
MINIMUM PITOT dP  :    0.10           0.240     0.59        0.600     1.49
dP INCREMENT      :   0.020           0.260     0.64        0.620     1.54
                                      0.280     0.69        0.640     1.59
STACK GAS TEMP, F :     133           0.300     0.74        0.660     1.64
GAS METER TEMP, F :      80           0.320     0.79        0.680     1.69
                                      0.340     0.84        0.700     1.74
PITOT CONSTANT    :    0.80           0.360     0.89        0.720     1.78
ORIFICE CONSTANT  :    1.75           0.380     0.94        0.740     1.83
RAC 5728                              0.400     0.99        0.760     1.88
NOZZLE DIA, in    :   0.251           0.420     1.04        0.780     1.93
SYSTEM FLOW, acfm :   0.719           0.440     1.09        0.800     1.98
dp                     0.36
FLOW, scfm           0.5119
Target volume           185        190.4 predicted vol.
Minutes to Vol.      361.42              nozzle 12
hours to vol.        6.0237
No. of points:           12
Reqd Min./point      30.118        9/6/93 Stack Radionuclides train oper
Use Minutes/point        31
```

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-6-93
Test No./Run No. PAMS 1
Meter Box ID 71-16
Gas Meter Cal. Factor
Orifice ID
Orifice DH@ 1.94

Pitot Coefficient, Cp .80
Nozzle ID. SHANK 21
Average Nozzle Dia., inches .255
Barometric Pressure, in. Hg 29.16
Ambient Temp., deg. F 57
Assumed Moisture, % 18
Filter ID
Stack Pressure, in. H2O .8

1st Filter:
Leak Rate, cfm, Pretest .02 cfm
Leakrate, cfm, Post-test .02 cfm
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 731.40
START TIME 10:25

GAS METER END, cf 928.95
END TIME 1646

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1025	PORT-POINT	0	—	129	.40	1.17	731.40	253	262		57	61	60
1040	1-1	15	5.0	128	.40	1.17	739.73	260	253		50	66	63
1055	1	30	5.0	130	.40	1.17	748.03	268	251		47	71	64
1110	2	45	5.0	130	.40	1.17	756.38	255	251		48	73	65
1125	2	60	5.5	129	.44	1.29	765.00	247	250		50	73	66
1140	3	75	5.0	129	.30	1.06	773.17	242	249		48	72	66
1155	3	90	5.0	129	.36	1.06	781.21	259	251		47	72	66
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max.	Avg.	Avg.
				127	0.606	1.08							

70.3

Page 2 of 2

Method 5 Field Data Continued Date 9-6-93 Location STACK Run No. MM5 1 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1155							781.21						
1210	1-1	105	5.2	121 [illegible]	.40	1.17	789.82	273	251		48	73	67
1225	1	120	5.4	125	.40	1.17	798.38	279	250		49	75	67
1240	2	135	5.6	126	.42	1.23	807.17	277	250		50	76	69
1255	2	150	5.6	126	.42	1.23	816.02	270	250		52	77	69
1310	3	165	5.0	127	.32	.94	823.71	256	249		53	76	70
1325	3	180	5.0	128	.32	.94	831.67	241	252		54	75	70
START 1335													
1350	3-1	195	5.9	123	.36	1.06	839.99	199	249		52	74	69
1405	1	210	5.9	124	.36	1.06	848.60	203	250		51	74	68
1420	2	225	5.5	129	.34	1.00		207	251		52	74	68
1435	2	240	5.5	128	.34	1.00		206	253		51	73	68
1450	3	255	5.1	126	.30	.88	872.19	194	250		49	73	68
1505	3	270	5.1	126	.30	.88	879.78	195	250		48	72	68

Page 3 of 3

Method 5 Field Data Continued Date 9-6-93 Location STACK Run No. MM5 1 Operator

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
START 1516							879.78						
1531	2-1	285	5.9	111	.36	1.06	887.95	213	250		50	71	68
1546	1	300	5.9	110	.36	1.06	896.11	215	252		50	71	68
1601	2	315	6.0	125	.36	1.06	904.31	216	250		51	75	69
1616	2	330	6.0	123	.40	1.17	912.76	201	251		53	75	70
1631	3	345	5.6	127	.32	.94	921.25	205	251		53	76	70
1646	3	360	5.6	126	.32	.94	928.95	210	250		52	75	69

```
MASS TRAIN OPERATION  Stack          dp PITOT   dP ORI    dp PITOT   dP ORI
-----------------------------        --------   ------    --------   ------
GAS ANALYSIS - O2  :      6.4           0.100     0.29       0.460     1.35
               CO2 :     12.8           0.120     0.35       0.480     1.41
               H2O :     18.0           0.140     0.41       0.500     1.47
AMB PRESS, in Hg   :    29.16           0.160     0.47       0.520     1.53
STACK dP, in H2O   :      0.7           0.180     0.53       0.540     1.58
Enter Gas vel., fps                     0.200     0.59       0.560     1.64
or AVG SQR ROOT d  :     0.60           0.220     0.65       0.580     1.70
MINIMUM PITOT dP   :     0.10           0.240     0.70       0.600     1.76
dP INCREMENT       :    0.020           0.260     0.76       0.620     1.82
                                        0.280     0.82       0.640     1.88
STACK GAS TEMP, F  :      133           0.300     0.88       0.660     1.94
GAS METER TEMP, F  :       80           0.320     0.94       0.680     1.99
                                        0.340     1.00       0.700     2.05
PITOT CONSTANT     :     0.80           0.360     1.06       0.720     2.11
ORIFICE CONSTANT   :     1.94           0.380     1.11       0.740     2.17
CAE 71-16                               0.400     1.17       0.760     2.23
NOZZLE DIA, in     :    0.255           0.420     1.23       0.780     2.29
SYSTEM FLOW, acfm  :    0.742           0.440     1.29       0.800     2.35
dp                       0.36
FLOW, acfm             0.5283
Target volume             185          190.2 predicted vol.
Minutes to Vol.        350.17                nozzle T2
hours to vol.          5.8362
No. of points:             12
Reqd Min./point        29.181          9/6/93 Stack MM5 train operation
U    inutes/point          30
```

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Baily Stn Plant

DATE 9/6/97 TEST NO. 4

SAMPLING TIME (24 hr CLOCK) 730

SAMPLING LOCATION Out Check

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) BAG

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 68

OPERATOR LOTZ

ORSAT LEAK CHECKED 15.2 17.4

COMMENTS: CALCS

CO2 14.9-15.2-15.5

O2 4.94-5.04-5.14

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.9	14.9	15.0	15.0	15.0	15.0	14.97	44/100	6.587
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	20.0	5.1	20.0	5.0	20.0	5.0	5.03	32/100	1.600
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80	28/100	22.40

TOTAL 30.577

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant

DATE 9/6/93 TEST NO

SAMPLING TIME (24 hr CLOCK) 930

SAMPLING LOCATION #7 Outlet MMS

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 67

OPERATOR LC.TZ

ORSAT LEAK CHECKED 16.4

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.6	19.4	6.6	19.4	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568

TOTAL 30.312

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Stm Plant

DATE 9/6/91 TEST NO.

SAMPLING TIME (24-hr CLOCK) 1007

SAMPLING LOCATION #5 outlet MM5 Train

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 66

OPERATOR LZK

ORSAT LEAK CHECKED 18.2 16.4

COMMENTS: Changed out gel Tube, used Silica Gel

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS), M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	44/100	4.488
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	16.8	6.6	16.8	6.6	16.8	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							83.2	28/100	23.296
								TOTAL	29.896

GUARDIAN SYSTEMS inc

DRY MOLECULAR WEIGHT

Guardian SYSTEMS INCORPORATED
P.O. BOX 190 LEEDS, ALABAMA 35094
205/699-6047

PLANT Bailey Steam Plant
DATE 9/6/87 TEST NO. 5
SAMPLING TIME (24 hr CLOCK) 1015-1300
SAMPLING LOCATION #1 Inlet MM5 Train
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 67
OPERATOR LZ
ORSAT LEAK CHECKED 12:40 13:20

SAMPLE ID: MM5 - 1 Inlet U-8
PARAMETERS: 1015 - 1300
DATE: 9/6 TIME:
SAMPLED BY: WJP

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF EACH GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.4	14.4	14.4	14.4	14.4	14.4	14.4	44/100	6.336
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.0	4.6	19.0	4.6	19.0	4.6	4.6	32/100	1.472
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							81.0	28/100	22.68
								TOTAL	30.488

G-181 GUARDIAN SYSTEMS INC

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bacc. Stem Plnt

DATE 9/6/93 TEST NO. 5

SAMPLING TIME (24-hr CLOCK) 1615-1632

SAMPLING LOCATION Stack

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 67

OPERATOR LGL

ORSAT LEAK CHECKED 18.2 ✓ 12.4 ✓

COMMENTS:

RUN / GAS	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	13.0	13.0	13.0	13.0	13.0	13.0	13.0	44/100	5.72
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.4	19.4	6.4	19.4	6.4	6.4	32/100	2.048
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.336

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Stm Plant

COMMENTS:

DATE 3/6/92 TEST NO.

SAMPLING TIME (24 hr CLOCK) 1620-1720

SAMPLING LOCATION #8 INLET - Dry Ash/Hydrovactor Pc

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) INTEGRATED

ANALYTICAL METHOD ORSAT

AMBIENT TEMPERATURE 67

OPERATOR KZZ

ORSAT LEAK CHECKED 18.4 26.4

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14.6	14.6	14.6	14.6	14.6	14.6	14.6	44/100	6.424
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	4.6	19.2	4.6	19.2	4.6	4.6 ~~19.2~~	32/100	1.472
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.8	28/100	22.624
								TOTAL	30.52

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant
DATE 9/6/82 TEST NO.
SAMPLING TIME (24-hr CLOCK) 1732-1742
SAMPLING LOCATION Stack
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 67
OPERATOR Lutz
ORSAT LEAK CHECKED 12.4✓ 18.4✓

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF EACH GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.6	19.4	6.6	19.4	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.312

G-184

GUARDIAN SYSTEMS inc

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailey Steam Plant

DATE 9/6/83 TEST NO.

SAMPLING TIME (24 hr CLOCK)

SAMPLING LOCATION #7 Outlet

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 67

OPERATOR WTE

ORSAT LEAK CHECKED 22.4 ✓ 22.4 ✓

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	12.8	12.8	12.8	12.8	12.8	12.8	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.4	6.6	19.4	6.6	19.4	6.6	6.6	32/100	2.112
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.6	28/100	22.568
								TOTAL	30.312

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Bailly Steam Plant
DATE 9/6/93 TEST NO.
SAMPLING TIME (24-hr CLOCK) 1618
SAMPLING LOCATION #8 Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS) Integrated
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 67
OPERATOR Lutz
ORSAT LEAK CHECKED 26.4 ✓ 22.4 ✓

COMMENTS:

~~[illegible]~~ Silica gel not used

RUN / GAS	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	12.8	128	12.8	128	12.8	128	12.8	44/100	5.632
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	19.2	6.4	19.2	6.4	19.2	6.4	6.4	32/100	2.048
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	
N_2 (NET IS 100 MINUS ACTUAL CO READING)							80.8	28/100	22.624
								TOTAL	30.304

Pg 1 of 5

METHOD 5 FIELD DATA

Plant/location Bailly OUTLET
Operator KC
Date 09/06/93 ✓
Test No./Run No. #1 MMS
Meter Box ID NUT. #1
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F 68 START
Assumed Moisture, % ______
Filter ID 4" FILTER
Stack Pressure, in. H2O 7.0 "H2O

1st Filter:
Leak Rate, cfm, Pretest ✓ 12"/Hg = .000
Leakrate, cfm, Post-test ✓
2nd Filter (if used):
Leak Rate, cfm, Pretest ___ 10"/Hg = .000
Leakrate, cfm, Post-test ___

GAS METER START, cf: 017.79
START TIME 1007

GAS METER END, cf 166.95
END TIME 1459

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1007	6-1	12	3.1	312	.82	.71	START 017.79	283	240		50	65	64
	6-2	24	3.1	308	.82	.71	023.27	290	241		51	67	65
	6-3	36	5.2 ~~6.0~~	309 ~~32~~	1.4	1.2	MISSED READING	290	247		62	70	66
	6-4	48	5.5	304	1.3	1.1	035.46	250	241		60	73	68
—	—	—	STOP	—	—	—	042.50	—	—	—	—	—	—
	5-1	12	4.1	308	.88	.75	042.50	269	246		56	74	69
	5-2	24	4.4	308	.84	.75	048.17	308	255		54	72	69
	5-3	36	5.1	310	1.1	.95	053.78	308	248		51	72	69
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				325	1.037	0.94							

69.2

24
12
48
24

Page 2 of 3

Method 5 Field Data Continued Date 09/06 Location OAT ~~TR~~ Run No. #1 MMS— Operator RNC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	5-4	48	5.2	306	1.3	1.1	060.06	250	242		50	71	69
1145	—	—	STOP		—	—	066.67	—	—	—			
	4-1	12	4.5	321	.85	.73	066.89	250	258		53	71	69
	4-2	24	4.6	322	.86	.74	072.39	300	249		49	71	69
	4-3	36	5.1	319	1.1 ~~.95~~	.95	077.98	302	241		49	72	70
	4-4	48	4.2	323	.90 ~~.95~~	.69 ~~.73~~	084.29	250	247		50	74	70
	—	—	STOP		—	—	089.79	—	—	—			
1235	3-1	12	5.1	343 ~~294~~	1.1	.95	089.79	267	261		50	73	70
	3-2	24	5.1	342	1.1	.95	096.14	275	247		51	74	71
	3-3	36	5.1	328	1.05	.90	102.42	298	243		57	73	70
	3-4	48	4.8	325	.90	.77	108.58	270	242		53	73	70
1323	—	—	STOP		—	—	114.30	—	—	—			
	2-1	12	4.5 ~~4.4~~	337	.90 ~~.90~~	.77 ~~.77~~	114.30	313	240		54	71	70
	2-2	24	4.5	336	.96	.74	120.02	326	259		50	71	70
	2-3	36	7.0	343	1.9	1.6	125.65	312	246		50	72	70

Page 2 of 2

Method 5 Field Data Continued Date 09/06 Location OUT #8 Run No. #1 MM 5 Operator KNC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	2.4	48	5.0	336	1.1	.95	133.45	250	238		52	73	70
				STOP			139.79						
	1-1	12	4.9	338	.95	.82	START 139.82	284	240		52	72	70
	1-2	24	4.9	339	.95	.82	145.74	330	240		52	72	70
	1-3	36	6.1	344	1.5	1.3	151.62	292	263		52	73	70
	1-4	48	7.0	347	2.0	1.7	158.90	250	248		53	74	71
				STOP			166.95						
								LK chk 10" Hg = .000					

```
NA       4 OPERATION  8 Out          dp PITOT   dP ORI     dp PITOT   dP ORI
-----------------------------        --------   ------     --------   ------
GAS ANALYSIS - O2  :     5.7            0.500     0.43        1.400     1.20
               CO2 :    13.3            0.550     0.47        1.450     1.25
               H2O :    10.0            0.600     0.52        1.500     1.29
AMB PRESS, in Hg   :   29.46            0.650     0.56        1.550     1.33
STACK dP, in H2O   :     7.3            0.700     0.60        1.600     1.38
Enter Gas vel., fps                     0.750     0.65        1.650     1.42
or AVG SQR ROOT d  :    1.01            0.800     0.69        1.700     1.46
MINIMUM PITOT dP   :    0.50            0.850     0.73        1.750     1.51
dP INCREMENT       :   0.050            0.900     0.77        1.800     1.55
                                        0.950     0.82        1.850     1.59
STACK GAS TEMP, F  :     320            1.000     0.86        1.900     1.63
GAS METER TEMP, F  :      85            1.050     0.90        1.950     1.68
                                        1.100     0.95        2.000     1.72
PITOT CONSTANT     :    0.81            1.150     0.99        2.050     1.76
ORIFICE CONSTANT   :    1.87            1.200     1.03        2.100     1.81
Nutech 1                                1.250     1.08        2.150     1.85
NOZZLE DIA, in     :   0.192            1.300     1.12        2.200     1.89
SYSTEM FLOW, acfm  :   0.796            1.350     1.16        2.250     1.94
dp                      1.01
FLOW, scfm            0.4776
Target volume            110            137.6 predicted vol.
Minutes to Vol.        230.3                  nozzle T40
hours to vol.         3.8383
No. of points:            24
Reqd Min./point       9.5958           9/6/93 Outlet 8 MM5 train operation
Use Minutes/point         12
```

ge 1 of 1

METHOD 5 FIELD DATA

Plant/Location Boiler # 8 outlet
Operator RML / TLL
Date 09-06-93
Test No./Run No. #1 ALDEHIDE
Meter Box ID #1 NUTECH
Gas Meter Cal. Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp
Nozzle ID.
Average Nozzle Dia., Inches
Barometric Pressure, In. Hg
Ambient Temp., deg. F
Assumed Moisture, %
Filter ID
Stack Pressure, In. H2O 2.0" H_2O

1st Filter: 9"Hg ,000
Leak Rate, cfm, Pretest ✓
Leakrate, cfm, Post-test ✓ 8"Hg =
2nd Filter (if used) .000
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

1.2" per 50 C.F.

GAS METER START, cf 203.6
START TIME 203.60 1730

GAS METER END, cf 254.49
END TIME

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	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
	single	0		310		1.2	203.60	301	227		66	74	74
	point	20		311		1.2	216.30	302	251		64	75	74
		40	4.5	310		1.2	228.37	305	263				
1830		60	4.7	310		1.2	240.52	307	265		54	77	75
		80	4.8	310		1.2	252.66	308	238		54	76	74
		83	stop				254.49						

Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
		310		1.2							

75

PAGE 1 OF 1

METHOD 5 FIELD DATA

177,
25
202

15" HS = .000

Plant/Location #8 OUTLET
Operator KVL
Date 09/06/93
Test No./Run No. #1 Ammonia cyanide
Meter Box ID Nutech #1
Gas Meter Cal. Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp
Nozzle ID.
Average Nozzle Dia., inches
Barometric Pressure, in. Hg
Ambient Temp., deg. F
Assumed Moisture, %
Filter ID
Stack Pressure, in. H20 7.0"

1st Filter:
Leak Rate, cfm, Pretest ✓
Leakrate, cfm, Post-test ✓
2nd Filter (if used) 5" .000
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

NOTE@ 1.2" H2O @ for 25 CU. FT.

#4 PORT

GAS METER START, cf: ~~176.96~~ 177.0 ~~176.96~~ 177.0
START TIME 1618

GAS METER END, cf 204.10
END TIME

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	Single	0	2.1	311		1.2	177.0 ~~176.90~~	260	225		67	73	69
	Point	10	2.1	311		1.2	183.03	288	230		63	74	69
		20	2.1	311		1.2	189.04	292	238		63	74	71
		30	2.1	311		1.2	195.10	294	235		66	75	72
		40	2.1	310		1.2	201.13	286	242		67	75	72
STOP → 1703		45	2.1	310		1.2	204.10	289	239		67	75	72
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				311		1.2						72.7	

[illegible] 2 of 3

MMS DAY 4
METHOD 5 FIELD DATA

Plant/Location BAILLY INLET U-8
Operator WJP
Date 9/6/93
Test No./Run No. MMS-1
Meter Box ID NUTECH-4 (A9215)
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ 1.87

Pitot Coefficient, Cp .81
Nozzle ID. T-37
Average Nozzle Dia., Inches .192
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F 63
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest .000 cfm/min @ 13" Hg
Leakrate, cfm, Post-test __
2nd Filter (if used):
Leak Rate, cfm, Pretest __
Leakrate, cfm, Post-test __

GAS METER START, cf: 761.990
START TIME 0933

GAS METER END, cf 872.445
END TIME 1341

Pitot Leak Check At 8" OK ✓

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	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		0					761.990	249	259		57	71	69
0933	1-1	10	-4.0	323	.87	.67	766.300	202	254		52	73	71
	2	20	-4.0	332	.91	.71	770.780	186	281		50	75	71
	3	30	-5.0	349	.92	.72	775.340	190	268		50	76	71
0	4	40	-6.0	355	.88	.69	777.800	161	272		52	77	71
1014	2-1	50	-6.0	525	1.15	.89	780.090	169	269		54	78	71
	2	60	-6.0	337	1.20	.93	785.185	181	275		55	78	72
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				342	0.958	0.72						76.0	

Page 2 of 2

TEST DAY #4

Method 5 Field Data Continued Date 9/6/93 Location INLET U-8 Run No. MM5-1 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP In. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	3	70	-6.0	348	.92	.72	790.4	178	272		54	79	72
	4	80	-6.0	358	.93	.72	794.88	169	277		54	79	72
							799.49						
1057 ~~1055~~	3-1	90	-6.5	331	1.15	.89	799.990	177	274		52	78	72 *
	2	100	-6.5	352	1.1	.85	804.910	185	274		52	79	72
	3	110	-6.5	359	.93	.72	809.89	177	271		52	79	73
	4	120	-6.0	365	.65	.50	814.410	177	271		52	79	73
			~~-7.0~~	~~319~~	~~1.20~~	~~.93~~	~~818.29~~	~~168~~	~~270~~		~~47~~	~~77~~	~~72~~
	4-1	130	-7.0	319	1.20	.93	818.39	168	270		47	77	72
	2	140	-6.5	348	1.0	.77	825.—	170	272		48	78	72
	3	150	-6.5	366	.95	.74	—	175	273		49	78	72
	4	160	-6.5	367	.62	.48	832.910	175	273		48	78	72
							836.695						
	5-1	170	-6.5	318	1.1	.85	837.040	174	275		47	80	73
	2	180	-6.5	337	.76	.59	842.04	179	276		48	80	73

* LEAK CHECK @ 10" OK.

age 3 of 3 EST DAY # 4

Method 5 Field Data Continued Date 9/6/93 Location INLET U-8 Run No. MM5-1 Operator WJP

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
[illegible]	3	190	-6.5	350	.89	.69	846.190	181	277		48	82	74
	4	200	-6.5	346	.87	.67	850.620	179	276		48	82	75
							855.03						
1301	6-1	210	-6.0	320	.78	.60	855.40	186	274		49	82	77 *
	2	220	-6.0	327	.85	.66	859.650	185	275		49	82	77
	3	230	-6.0	340	.82	.63	864.06	181	278		49	82	77
	4	240	-6.5	345	.74	.57	868.35	169	280		49	83	77
1341	END	—					872.445						

* LEAK CHECK OK. @ 12" Hg.

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 1

Set Up By [illegible]/DWS Date 09/06/93 Run Date 09/06/93

Comments MMS

Analyst Responsible for Recovery [illegible]

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. unweighted

Sorbent Trap No. H590-55-8

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	438.0 g	631.8 g	193.8 g
Second	577.5 g	580.5 g	3.0 g
Third	580.5 g	582.3 g	1.8 g
Fourth	489.6 g	491.7 ~~491.6~~ [illegible] g	2.1 g
Fifth	— g	— g	g
Sixth	— g	— g	g
Seventh	— g	— g	g

SILICA GEL WEIGHTS:	Initial	Final
	826.0 g	855.0 g net 29.0
	g	g
Totals	g	g

DSAL 229.7

COMMENTS:

Color of Silica Gel: 1/3 pink

Description of Impinger Water:

i of 1 of 1

TEST DA #4

25ft³ = 899.100
@ 1.2 dH

METHOD 5 FIELD DATA

Plant/Location Bally Inlet U-8
Operator WJP/CD/DJ
Date 9/6/93
Test No./Run No. Nutech 4 A .9215
Meter Box ID ~~Acid~~ Cyanide ?
Gas Meter ~~Cal Factor~~ ______
Orifice ID ______
Orifice DH@ 1.87

Amended
3/30/94

Pitot Coefficient, Cp N/A
Nozzle ID N/A
Average Nozzle Dia., Inches N/A
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O -19.0

1st Filter:
Leak Rate, cfm, Pretest .000/min @ 10"
Leakrate, cfm, Post-test .000/min @ 8"
2nd Filter (if used):
Leak Rate, cfm, Pretest N/A
Leakrate, cfm, Post-test N/A

GAS METER START, cf 874.100
START TIME 1548

GAS METER END, cf 899.100
END TIME 1631

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1548	3-2	0	-5.0	355	–	1.2	874.100	240	250			72	70
		11	-5.0	355	–	1.2	881.020	204	226			77	72
		20	-5.0	355	-	1.2	885.915	205	231			79	72
		30	-5.0	355	-	1.2	891.650	207	235			82	74
		40	-5.0	355	-	1.2	897.495	206	236			83	75
1631	END	42.8					899.100						
		(42 8/10)											
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				355		1.2						75.3	

PAGE 1 OF ___

TEST DAY #4

50 FT3 @ 1.2 DH.

949.980

METHOD 5 FIELD DATA

Plant/Location INLET BAILY U-8
Operator WJP/DJ/DJ
Date 9/6/93
Test No./Run No. ALDEHYDE #1
Meter Box ID NUTECH #4 A9215
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ 1.87

Pitot Coefficient, Cp N/A
Nozzle ID. N/A
Average Nozzle Dia., inches N/A
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O -14.0

1st Filter:
Leak Rate, cfm, Pretest .000 cfm/Max
Leakrate, cfm, Post-test __
2nd Filter (if used):
Leak Rate, cfm, Pretest N/A
Leakrate, cfm, Post-test N/A

GAS METER START, cf: 899.980
START TIME 1644

GAS METER END, cf ~~XX~~ 949.980
END TIME 1809

Clock Time	Travese Point Number	Sample Time Min	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1644	3-2	0	-5.0	355	–	1.2	899.980	230	249	6	66	80	75
1700		16	-5.0	355	–	1.2	909.345	209	243		63	83	76
1707		23	-5.0	355	–	1.2	913.425	209	243		66	84	77
1716		32	-5.0	355	–	1.2	918.650	210	245		65	85	78
1726		42	-6.0	355.	–	1.2	924.400	209	246		64	86	79
1734		50	-6.0	356	–	1.2	929.100	208	246		63	87	80
1748		65	-7.0	356	–	1.2	937.89	207	246		61	87	81
1809		85.6	8.0	–			949.980	–	–		61	87	80
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				355		1.2						81.6	

85%

```
MASS TRAIN OPERATION  Inlet 8        dp PITOT   dP ORI    dp PITOT   dP ORI
----------------------------         --------   ------    --------   ------
GAS ANALYSIS - O2  :     5.5           0.500     0.39       1.400     1.08
              CO2  :    13.4           0.550     0.43       1.450     1.12
              H2O  :    10.0           0.600     0.46       1.500     1.16
AMB PRESS, in Hg   :   29.46           0.650     0.50       1.550     1.20
STACK dP, in H2O   :   -20.0           0.700     0.54       1.600     1.24
Enter Gas vel., fps                    0.750     0.58       1.650     1.28
or AVG SQR ROOT d  :    1.09           0.800     0.62       1.700     1.32
MINIMUM PITOT dP   :    0.50           0.850     0.66       1.750     1.35
dP INCREMENT       :   0.050           0.900     0.70       1.800     1.39
                                       0.950     0.74       1.850     1.43
STACK GAS TEMP, F  :     335           1.000     0.77       1.900     1.47
GAS METER TEMP, F  :      82           1.050     0.81       1.950     1.51
                                       1.100     0.85       2.000     1.55
PITOT CONSTANT     :    0.81           1.150     0.89       2.050     1.59
ORIFICE CONSTANT   :    1.87           1.200     0.93       2.100     1.63
Nutech 4                               1.250     0.97       2.150     1.66
NOZZLE DIA, in     :   0.192           1.300     1.01       2.200     1.70
SYSTEM FLOW, acfm  :   0.895           1.350     1.04       2.250     1.74
dp                      1.18
FLOW, acfm            0.5266
Target volume            100           126.4 predicted vol.
Minutes to Vol.       189.92                 nozzle T39
hours to vol.         3.1653
No. of points:            24
Reqd Min./point       7.9131         9/9/93 Inlet MMS train operation
    Minutes/point         10
```

DAY 4 OF TEST

WERE MAKING THE BIG BUCKS TODAY

Note

874.1
25.0
899.1

9/6/93

PAGE 1 OF 1

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-6-93
Test No./Run No. ~~[illegible]~~ /CYANIDE
Meter Box ID 71-16
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ 1.94

Pitot Coefficient, Cp —
Nozzle ID. —
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm. Pretest A-OK
Leakrate, cfm. Post-test ______
2nd Filter (if used):
Leak Rate, cfm. Pretest ______
Leakrate, cfm. Post-test ______

GAS METER START, cf: 929.13
START TIME 1817

GAS METER END, cf 955.24
END TIME 1852

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1817			6.3	118		1.2	929.13	240	215		67	69	69
1852			6.5	132			955.00	240	251		66	77	70
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				125?		1.2						71	

25 cf

GE 1 of ___

METHOD 5 FIELD DATA

Plant/Location BAILLY STACK
Operator CAH
Date 9-6-93
Test No./Run No. Aldehyde 1
Meter Box ID 71-16
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ 1.94

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., Inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest ______
Leakrate, cfm, Post-test ______
2nd Filter (if used):
Leak Rate, cfm, Pretest ______
Leakrate, cfm, Post-test ______

GAS METER START, cf: 955.21
START TIME 1906

GAS METER END, cf 995.21
END TIME ______

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1906			5.0	132			955.21	239	249	~~65~~	65	73	70
1920			5.0	132			966.00	210	250		58	78	70
1940			5.0	132			982.15	236	250		57	76	70
1957							995.21						
							995.21						
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
				132		1.2						73.	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 8 Run No. 1

Set Up By Date 09/06/93 Run Date

Comments Aldehydes

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	602.9 g	~~703.5~~ 686.7	83.8 g
Second	681.4 g	686.3 g	4.9 g
Third	474.2 g	476.1 g	1.9 g
Fourth	— g	g	g
Fifth	— g	g	g
Sixth	— g	g	g
Seventh	— g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	844.7 g	862.6 g Net 17.9
	g	g
Totals	g	g

Total 108.5

COMMENTS:

Color of Silica Gel: 5% pink

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet Unit 8 Run No. 1

Set Up By Date 09/06/93 Run Date

Comments Aldehydes

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED		CYCLONES	Used (Yes/No)	Prepared Container (No.)
Filter No.		10 μ		
		5 μ		
Sorbent Trap No.		2.0 μ		
		1.0 μ		
Condenser No.		0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	~~604.4~~ 605.6 g	688.5 g	82.9 g
Second	604.4 g	608.8 g	4.4 g
Third	475.9 g	475.8 g	1.9 g
Fourth	– g	g	g
Fifth	– g	g	g
Sixth	– g	g	g
Seventh	– g	g	g

SILICA GEL WEIGHTS:	Initial	Final	
	~~803.1~~ RO 801.3 g	819.5	18.2 g wet
	g		g
Totals	g		g

107.4 total

COMMENTS:

Color of Silica Gel: 5% pink

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location Outlet Unit 7 Run No. 1
Set Up By Date 05/06/93 Run Date
Comments Aldehydes
Analyst Responsible for Recovery
Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	593.1 g	673.7 g	80.6 g
Second	652.6 g	657.9 g	5.3 g
Third	500.5 g	502.8 g	2.3 g
Fourth	— g	g	g
Fifth	— g	g	g
Sixth	g	g	g
Seventh	— g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	811.7 g	828.8 g wt 17.1
	g	g
Totals	g	g

Total 105.3

COMMENTS:
Color of Silica Gel: 5% purple
Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack Run No. 1

Set Up By Date 08/06/93 Run Date

Comments Aldehydes

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	577.5 g	683.6 g	106.1 g
Second	633.0 g	658.3 g	25.3 g
Third	491.4 g	496.4 g	5.0 g
Fourth	609.7 g	612.0 g	2.3 g
Fifth	KD ~~546~~ 510.3 g	511.5 g	1.2 g
Sixth	— g	g	g
Seventh	— g	g	g

SILICA GEL WEIGHTS:	Initial	Final	
	791.7 g	805.4 g	Net 13.7
	g	g	
Totals	g	g	153.6 TOTAL ~~[illegible]~~

COMMENTS:

Color of Silica Gel: No Change ?

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Inlet - Unit 8 Run No. 1

Set Up By WOC Date 09/06/93 Run Date 09/06/93

Comments Ammonia / Cyanide

Analyst Responsible for Recovery WOC/[illegible]

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. —

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	591.5 g	640.5 g	49.0 g
Second	588.5 ~~588.4~~ mL g	591.1 g	2.6 g
Third	479.6 g	480.9 g	1.3 g
Fourth	585.9 g	586.4 g	0.5 g
Fifth	594.9 g	594.8 g	-0.1 g
Sixth	470.1 g	471.7 g	1.6 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	830.1 g	837.6 g Net 7.1
	g	g
Totals	g	g

TOTAL 62

COMMENTS:

Color of Silica Gel: Pink circle seen at bottom

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Unit 8 Outlet

Run No. 1

Set Up By

Date 09/06/93

Run Date

Comments Ammonia/Cyanide

Analyst Responsible for Recovery

Calculations & Report Reviewed By

Report Date

FILTERS USED

Filter No. —

Sorbent Trap No.

Condenser No.

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	590.8 g	634.2 g	43.4 g
Second	606.4 g	610.9 g	4.5 g
Third	474.7 g	476.5 g	1.8 g
Fourth	584.2 g	584.5 g	0.3 g
Fifth	562.2 g	563.1 g	0.9 g
Sixth	492.9 g	494.5 g	1.6 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	775.6 g	785.3 g	Net 9.7
	g	g	
Totals	g	g	Total 62.2

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack Run No. 1

Set Up By MPK Date 05/06/93 Run Date

Comments Ammonia / Cyanide

Analyst Responsible for Recovery MLB

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. —

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	604.3 g	668.9 g	64.6 g
Second	608.9 g	631.8 g	22.9 g
Third	480.3 g	485.1 g	4.8 g
Fourth	598.8 g	600.9 g	2.1 g
Fifth	605.6 g	605.1 g	-0.5 g
Sixth	504.4 g	505.9 g	1.5 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	789.9 g	799.0 9.1 g net
	g	g
Totals	g	g

TOTAL 84.5

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location Unit 7 Outlet Run No. 1
Set Up By YOK Date 09/04/93 Run Date 09/04/93
Comments Ammonia /Cyanide
Analyst Responsible for Recovery
Calculations & Report Reviewed By Report Date

FILTERS USED		CYCLONES	Used (Yes/No)	Prepared Container (No.)
Filter No.		10 µ		
		5 µ		
Sorbent Trap No.		2.0 µ		
		1.0 µ		
Condenser No.		0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	587.7 g	617.8 g	30.1 g
Second	575.4 g	578.8 g	3.4 g
Third	456.3 g	457.4 g	1.1 g
Fourth	668.1 g	668.3 g	0.2 g
Fifth	577.1 g	575.9 g	-1.2 g
Sixth	491.0 g	492.5 g	1.5 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	777.4 g	786.4 g	9.0
	g	g	
Totals	g	g	

TOTAL 44.1

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 8 Run No. 1

Set Up By WOL / DWS Date 09/06/93 Run Date 09/06/93

Comments MMS

Analyst Responsible for Recovery WOL

Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED

Filter No. unweighed

Sorbent Trap No. H590-55-3

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	447.8 ~~[illegible]~~ g	~~[illegible]~~ 700.3 g	252.5 g
Second	561.2 g	569.7 g	8.5 g
Third	581.0 g	585.9 g	4.9 g
Fourth	501.7 g	503.6 g	1.9 g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	845.6 g	885.3 g Net 39.7
	g	g
Totals	g	g

TOTAL 307.5

COMMENTS:

Color of Silica Gel: slightly less than 1/2 pink

Description of Impinger Water: slightly yellow

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Outlet Unit 7

Run No. 1

Set Up By WDC/DWS Date 09/06/93

Run Date 09/06/93

Comments MM5

Analyst Responsible for Recovery WDC

Calculations & Report Reviewed By

Report Date

FILTERS USED

Filter No. unweighed

Sorbent Trap No. H590-55-11

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	451.5 g	648.6 g	197.1 g
Second	592.9 g	609.8 g	6.9 g
Third	605.2 g	606.4 g	1.2 g
Fourth	489.7 g	491.1 g	1.4 g
Fifth	— g	— g	— g
Sixth	— g	— g	— g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	844.1 g	877.5 net 33.4 g
	g	g
Totals	g	g

TOTAL 240.0

COMMENTS:

Color of Silica Gel: 1/3 pink ; pink to white scattering in upper 2/3

Description of Impinger Water:

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Stack

Run No. 1

Set Up By MC/DWS Date 09/06/93

Run Date 09/06/93

Comments MMS

Analyst Responsible for Recovery

Calculations & Report Reviewed By

Report Date

FILTERS USED

Filter No. unweighed

Sorbent Trap No. H590-55-9

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 μ		
5 μ		
2.0 μ		
1.0 μ		
0.5 μ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	780.4 g	1457.5 g	677.1 g
Second	669.3 g	670.0 g	0.7 g
Third	592.5 g	591.2 g	-1.3 g
Fourth	471.6 g	474.8 g	3.2 g
Fifth	— g	— g	— g
Sixth	— g	— g	— g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	880.1 g	925.0 g net 44.9
	g	g
Totals	g	g

total 724.6

COMMENTS:

Color of Silica Gel: 3/4 pink

Description of Impinger Water:

Code: BAILY B1 E M. 1. MT	Date: 9/6/93	Location: B INLET EAST
Plant: BAILEY B	Box No: A 7386	Holder No: T1
Operators: 1. CH 2. TL	Run Time: 72 min 3 /pt	Probe ID: 12' MT 3
Pre-Test Leak Check: OK ✓	Post-Test Leak Check:	Duct Static Press, "H2O:

Start Time 1010	Tube No.	3	Filter No.	1214		Nozzle
	Final Wt.	819.2 g.	Final Wt.	6.0713		1.6934
	Initial Wt.	807.0 g.	Initial Wt.	2.2154		1.5717
End Time 1129	Wt. Gain	g.				
	Vol. H2O:	63 ml.	+ Noz. Wt.			
	TOT H2O		WT. GAIN			

Port/Pt	Time (min)	Meter Reading	ΔP Pitot	ΔH Orifice	System Vacuum	Stack Temp	Meter Temp Inlet	Meter Temp Outlet
'/1	0	914.546						
A/1	3	915.6	.91	.54	4.6	337	63	62
/2	6	917.4	1.20	.71	5.4	316	66	78
/3	9	918.8	1.55	.92	5.4	337	68	64
/4	12	920.424	1.35	.80	5.4	376	72	64
/								
B/1	15	922.1	1.70	1.00	6.1	300	72	65
/2	18	923.7	1.60	.94	5.6	313	74	66
/3	21	925.3	1.35	.80	5.6	330	76	67
/4	24	926.684	1.05	.62	5.0	340	77	67
C/								
C/1	27	928.4	1.70	1.00	6.7	273	77	67
/2	30	930.2	1.70	1.00	6.7	287	78	69
/3	33	931.7	1.35	.80	5.7	317	79	70
/4	36	933.007	.84	.50	4.6	312	79	70
/								
D/1	39	934.7	1.65	.98	6.5	271	77	70
/2	42	936.2	1.50	.89	6.2	284	79	71
/3	45	937.8	1.40	.83	6.0	289	80	71
/4	48	939.108	.80	.47	4.5	284	80	71
/								
E/1	51	940.8	1.50	.85	6.0	264	77	72
/2	54	942.3	1.40	.83	6.0	260	81	72
/3	57	943.8	1.20	.71	5.6	257	81	73
/4	60	945.332	1.15	.68	5.5	258	81	73
/								
F/1	63	946.8	1.35	.74	5.7	265	79	72
/2	66	948.4	1.33	.77	5.7	263	81	73
/3	69	949.9	1.35	.80	5.8	254	82	73
/4	72	951.396	1.10	.65	5.0	247	86	73
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
TOTAL			(ΔP)avg	//////	///////	////////	Avg	Avg
AVG	///////	///////////			///////			

GAS ANALYSIS - O2 :	6.0
CO2:	13.0
H2O:	9.5
AMB PRESS, in Hg :	29.50
STACK dP, in H2O :	-20.0
AVG SQR ROOT dP :	1.090
STACK GAS TEMP, F :	332
GAS METER TEMP, F :	90
PITOT CONSTANT :	0.78
ORIFICE CONSTANT :	1.71
NOZZLE DIA, in :	0.188
SYSTEM FLOW, acfm :	0.806

dPp	dPo	dPp	dPo
0.30	0.18	1.00	0.59
0.32	0.19	1.02	0.60
0.34	0.20	1.04	0.61
0.36	0.21	1.06	0.63
0.38	0.22	1.08	0.64
0.40	0.24	1.10	0.65
0.42	0.25	1.12	0.66
0.44	0.26	1.14	0.67
0.46	0.27	1.16	0.68
0.48	0.28	1.18	0.70
0.50	0.30	1.20	0.71
0.52	0.31	1.22	0.72
0.54	0.32	1.24	0.73
0.56	0.33	1.26	0.74
0.58	0.34	1.28	0.76
0.60	0.35	1.30	0.77
0.62	0.37	1.32	0.78
0.64	0.38	1.34	0.79
0.66	0.39	1.36	0.80
0.68	0.40	1.38	0.81
0.70	0.41	1.40	0.83
0.72	0.43	1.42	0.84
0.74	0.44	1.44	0.85
0.76	0.45	1.46	0.86
0.78	0.46	1.48	0.87
0.80	0.47	1.50	0.89
0.82	0.48	1.52	0.90
0.84	0.50	1.54	0.91
0.86	0.51	1.56	0.92
0.88	0.52	1.58	0.93
0.90	0.53	1.60	0.94
0.92	0.54	1.62	0.96
0.94	0.55	1.64	0.97
0.96	0.57	1.66	0.98
0.98	0.58	1.68	0.99
1.00	0.59	1.70	1.00

SOUTHERN RESEARCH INSTITUTE

METHOD 17 MASS TRAIN DATA REDUCTION - Page 1
Initial Calculations and Input Data

Run Identification	BAILYSIE-1-MT	Run Date	9/8/93
Ambient Pressure, in Hg	29.56	Duct Area, ft2	146.7
Stack dP, in H2O	-20.0		
Nozzle Diameter, in	0.188	**Gas Meter Volume**	
Pitot Constant	0.76	Final Volume, ft3	951.396
Gas Meter Calibration	0.990	Initial Volume, ft3	914.546
Time Sampled, min	72	Volume Sampled, ft3	36.850

Particle Mass, mg

	Filter	Nozzle	Total
Final	6071.300	1693.400	▨
Initial	2215.400	1571.700	▨
Total	3855.900	121.700	3977.600

Water Collected

Final Dryrite Mass, g	819.2
Initial Dryrite Mass, g	807.0
Volume H2O, ml	63.0
Total Water, ml	75.2

Point	Pitot dP, in H2O	Sq. Root Pitot dP	Orifice dP, in H2O	Stk Temp, deg F	GM Inlet, deg F	GM Outlet, deg F	Oxygen, %
1	0.91	0.954	0.54	317	63	62	6.0
2	1.20	1.095	0.71	316	66	76	6.0
3	1.55	1.245	0.92	337	68	64	6.0
4	1.35	1.162	0.80	336	72	64	6.0
5	1.70	1.304	1.00	300	72	65	6.0
6	1.60	1.265	0.94	313	74	66	6.0
7	1.35	1.162	0.80	330	76	67	6.0
8	1.05	1.025	0.62	340	77	67	6.0
9	1.70	1.304	1.00	272	77	69	6.0
10	1.70	1.304	1.00	287	78	69	6.0
11	1.35	1.162	0.80	317	79	70	6.0
12	0.84	0.917	0.50	312	79	70	6.0
13	1.65	1.285	0.98	271	77	70	6.0
14	1.50	1.225	0.89	284	79	71	6.0
15	1.40	1.183	0.83	289	80	71	6.0
16	0.80	0.894	0.47	284	80	71	6.0
17	1.50	1.225	0.89	264	79	72	6.0
18	1.40	1.183	0.83	260	81	72	6.0
19	1.20	1.095	0.71	257	81	73	6.0
20	1.15	1.072	0.68	258	81	73	6.0
21	1.25	1.118	0.74	263	79	72	6.0
22	1.30	1.140	0.77	263	81	73	6.0
23	1.35	1.162	0.8	254	82	73	6.0
24	1.10	1.049	0.65	247	85	73	6.0
25							
26							
27							
28							
29							
30							
31							
32							
Avg	1.329	1.147	0.825	290	77	70	6.0

Avg GM Temp, deg F.................. 73

METHOD 17 MASS TRAIN DATA REDUCTION - Page 2
Calculation Results

Run Identification	BAILYSIE-1-#	Run Date	9/8/93
Flue Gas Composition		Dry MW, #/#-mole	29.90
O2	3.5	Wet MW, #/#-mole	28.83
CO2	11.0	Stack Pressure, in Hg	28.09
Calculated % H2O	9.0		
Isokinetic Agreement, %	99.6	Particle Mass Loading	
Avg Gas Velocity, ft/s	71.7	gr/acf	1.0300
Avg Gas Temperature, F	280	gr/dscf	1.7136
		mg/acm	2361.62
Gas Volume Flow		mg/dscm	3920.59
acfm	631,438		
dscfm	379,496	Particle Emission Rate	
wscfm	417,078	lb/E6-Btu	2.8678
dscfm (0% O2)	315,944	lb/hour	5574.525

DUCT
24' x 13.5'

Code: BAILY B0-1-MT	Date: 9/5/93	Location: B OUTLET
Plant: BAILEY B	Box No: A864Z	Holder No: G1
Operators: 1 DWS 2 RB	Run Time: 144 min 6 /pt	Probe ID: 12' MT 2
Pre-Test Leak Check: Good (B.D)	Post-Test Leak Check:	Duct Static Press, "H2O: 7.1"

Start Time	Tube No. 9	Filter No.	1MT	BLK	Nozzle
0832	Final Wt. 895.9 g.	Final Wt.	108.142	101.066	58.592
	Initial Wt. 876.1 g.	Initial Wt.	101.434	100.164	55.667
End Time	Wt. Gain g.				
1120	Vol. H2O: 127 ml.	+ Noz. Wt.			
	TOT H2O	WT. GAIN			

Port/Pt	Time (min)	Meter Reading	ΔP Pitot	ΔH Orifice	System Vacuum	Stack Temp	Meter Temp Inlet	Meter Temp Outlet
6/1	0	628.422	.99	.67	4.5	302	63	62
/2	6	631.0	1.05	.71	4.0	306	70	63
/3	12	633.8	1.35	.92	6.5	323	78	63
/4	18	637.0	1.60	1.09	7.0	336	83	65
/								
5/1	24	640.298	.92	.62	4.5	339	81	69
/2	30	642.8	.90	.61	5.0	332	88	70
/3	36	645.4	1.30	.88	7.0	316	91	77
/4	42	648.5	1.40	.95	8.0	314	94	74
/								
4/1	48	651.369	.98	.66	5.5	318	90	76
/2	54	654.4	.96	.65	5.5	318	97	77
/3	60	657.1	1.15	.78	6.5	316	101	79
/4	66	660.6	.82	.59	4.5	316	102	81
/								
3/1	72	662.669	1.10	.75	6.0	331	94	80
/2	78	665.3	1.10	.75	6.5	331	101	81
/3	84	668.2	1.20	.81	7.0	332	102	82
/4	90	671.1	.98	.66	5.5	327	103	83
/								
2/1	96	673.874	1.25	.85	7.0	341	93	82
/2	102	676.8	1.20	.81	7.0	341	102	83
/3	108	679.9	1.30	1.15	10.0	344	98	83
/4	114	683.2	1.35	.92	8.5	339	102	83
/								
1/1	120	686.367	1.25	.85	7.5	343	98	83
/2	126	689.3	1.20	.81	7.5	343	105	84
/3	132	692.3	1.70	1.15	10.5	347	105	84
/4	138	695.8	2.00	1.36	12.0	349	109	85
/								
STOP	144	699.391						
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
/								
TOTAL			√ΔP)avg	//////	///////	////////	Avg	Avg
AVG	//////	//////////			//////			

GAS ANALYSIS - O2 :	6.0
CO2:	13.0
H2O:	9.5
AMB PRESS, in Hg :	29.56
STACK dP, in H2O :	7.0
AVG SQR ROOT dP :	1.005
STACK GAS TEMP, F :	318
GAS METER TEMP, F :	95
PITOT CONSTANT :	0.78
ORIFICE CONSTANT :	1.77
NOZZLE DIA, in :	0.186
SYSTEM FLOW, acfm :	0.715

dPp	dPo	dPp	dPo
1.00	0.68	2.75	1.87
1.05	0.71	2.80	1.90
1.10	0.75	2.85	1.93
1.15	0.78	2.90	1.97
1.20	0.81	2.95	2.00
1.25	0.85	3.00	2.03
1.30	0.88	3.05	2.07
1.35	0.92	3.10	2.10
1.40	0.95	3.15	2.14
1.45	0.98	3.20	2.17
1.50	1.02	3.25	2.20
1.55	1.05	3.30	2.24
1.60	1.09	3.35	2.27
1.65	1.12	3.40	2.31
1.70	1.15	3.45	2.34
1.75	1.19	3.50	2.37
1.80	1.22	3.55	2.41
1.85	1.25	3.60	2.44
1.90	1.29	3.65	2.48
1.95	1.32	3.70	2.51
2.00	1.36	3.75	2.54
2.05	1.39	3.80	2.58
2.10	1.42	3.85	2.61
2.15	1.46	3.90	2.65
2.20	1.49	3.95	2.68
2.25	1.53	4.00	2.71
2.30	1.56	4.05	2.75
2.35	1.59	4.10	2.78
2.40	1.63	4.15	2.81
2.45	1.66	4.20	2.85
2.50	1.70	4.25	2.88
2.55	1.73	4.30	2.92
2.60	1.76	4.35	2.95
2.65	1.80	4.40	2.98
2.70	1.83	4.45	3.02
2.75	1.87	4.50	3.05

SOUTHERN RESEARCH INSTITUTE

METHOD 17 MASS TRAIN DATA REDUCTION - Page 1
Initial Calculations and Input Data

Run Identification...................	BAILY8O-1-MT	Run Date......................	9/6/93
Ambient Pressure, in Hg	29.56	Duct Area, ft2..............	324
Stack dP, in H2O	7.0		
Nozzle Diameter, in	0.188	**Gas Meter Volume**	
Pitot Constant	0.78	Final Volume, ft3	699.391
Gas Meter Calibration............	1.042	Initial Volume, ft3	628.422
Time Sampled, min................	144	Volume Sampled, ft3	70.969

Particle Mass, mg

	Filter	Nozzle	Total
	209.208	58.392	
Inital	201.598	55.667	
Total	7.610	2.725	10.335

Water Collected

Final Dryrite Mass, g	895.9
Initial Dryrite Mass, g	876.1
Volume H2O, ml	127.0
Total Water, ml	146.8

Point	Pitot dP, In H2O	Sq. Root Pitot dP	Orifice dP, in H2O	Stk Temp, deg F	GM Inlet, deg F	GM Outlet, deg F	Oxygen, %
1	0.99	0.995	0.67	302	63	62	6.0
2	1.05	1.025	0.71	306	70	63	
3	1.35	1.162	0.92	323	77	63	
4	1.60	1.265	1.09	336	83	65	
5	0.92	0.959	0.62	339	81	69	
6	0.90	0.949	0.61	332	88	70	
7	1.30	1.140	0.88	316	91	72	
8	1.40	1.183	0.95	314	94	74	
9	0.98	0.990	0.66	318	90	76	
10	0.96	0.980	0.65	318	97	77	
11	1.15	1.072	0.78	316	101	79	
12	0.87	0.933	0.59	316	102	81	
13	1.10	1.049	0.75	331	94	80	
14	1.10	1.049	0.75	331	101	81	
15	1.20	1.095	0.81	332	102	82	
16	0.98	0.990	0.66	327	103	83	
17	1.25	1.118	0.85	341	93	82	
18	1.20	1.095	0.81	341	102	83	
19	1.70	1.304	1.15	344	98	83	
20	1.35	1.162	0.92	339	102	83	
21	1.25	1.118	0.85	343	98	83	
22	1.20	1.095	0.81	343	105	84	
23	1.70	1.304	1.15	347	105	84	
24	2.00	1.414	1.36	349	109	85	
25							
26							
27							
28							
29							
30							
31							
32							
Avg	1.229	1.102	0.690	329	94	77	6.0

Avg GM Temp, deg F...................... 85

METHOD 17 MASS TRAIN DATA REDUCTION - Page 2
Calculation Results

Run Identification	BAILY8O-1-MT
Flue Gas Composition	
O2	6.0
CO2	11.0
Calculated % H2O	8.9
Isokinetic Agreement, %	99.4
Avg Gas Velocity, ft/s	70.0
Avg Gas Temperature, F	329
Gas Volume Flow	
acfm	1,360,300
dscfm	833,387
wscfm	914,632
dscfm (0% O2)	594,137

Run Date	9/6/93
Dry MW, ##-mole	30.00
Wet MW, ##-mole	28.93
Stack Pressure, in Hg	30.07
Particle Mass Loading	
gr/acf	0.0014
gr/dscf	0.0022
mg/acm	3.15
mg/dscm	5.15
Particle Emission Rate	
lb/E6-Btu	0.0044
lb/hour	16.03984

2

DUCT
16' x 13.5'

Code: BAILY90-1-MT	Date: 9/6/93	Location: 7 OUTLET
Plant: BAILLEY 7	Box No: A8643	Holder No: G2
Operators: 1. [illegible] 2. [illegible]	Run Time: 240 min 12 /pt	Probe ID: 12' MT-1
Pre-Test Leak Check: .01/min (10"Hg)	Post-Test Leak Check: 0.0/min 10"Hg	Duct Static Press, "H2O:

Start Time	Tube No.	#2	Filter No.	2MT	BLK	Nozzle
1333	Final Wt.	858.3 g.	Final Wt.	171.085	102.771	56.452
	Initial Wt.	830.1 g.	Initial Wt.	90.034	102.013	52.369
End Time	Wt. Gain	g.	+ Noz. Wt.			
1735	Vol. H2O:	170 ml.				
	TOT H2O		WT. GAIN			

	Port/Pt	Time (min)	Meter Reading	ΔP Pitot	ΔH Orifice	System Vacuum	Stack Temp	Meter Temp Inlet	Meter Temp Outlet
*	2/2	0	490.985	.64	.49	~.1	316	86	70
	2/2	12	495.50	.67	.51	~.1	314	86	70
	2/3	24	500.25	~~.48~~	~~.36~~	~.1	311	93	74
	2/4	36	503.99	.40	.30	~.1	310	94	79
	/	48							
	/								
:48	2/2	0	507.13	.60	.44	~.1	309	98	82
:00	2/2	12	512.35	.60	.44	~.1	309	101	85
1:12	2/3	24	516.50	.38	.29	2.0	308	102	86
1:24	2/4	36	520.87	.37	.28	~.1	309	103	88
	/	48	524.73						
	/								
1:36	3/2	0	524.74	.625	.48	2.25	315	109	90
48	3/2	12	529.20	.625	.48	2.4	318	107	91
2:00	3/3	24	533.90	.55	.42	2.4	318	108	92
2:12	3/4	36	538.63	.41	.31	1.5	320	107	93
	/	48	542.720						
	/			.70		3.25			
2:24	4/2	0	542.730	~~.67~~	.53	~~[illegible]~~	320	103	91
2:36	4/2	12	547.96	.70	.53	3.25	320	99	91
2:48	4/3	24	552.54	.60	.46	3.0	318	100	87
3:00	4/4	36	557.13	.72	.55	4.0	320	98	84
	/	48	562.120						
	/								
3:12	5/2	0	562.170	.62	.47	3.8	322	104	85
3:24	5/2	12	566.88	.65	.495	4.0	320	101	85
3:36	5/3	24	571.65	.83	.63	~~4.8~~	320	104	86
3:48	5/4	36	577.0	.89	.68	6.0	321	~~1[illegible]~~	91
off 4:00	/	48	582.55						
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	/								
	TOTAL	240		(√ΔP)avg	//////////	//////////	//////////	Avg	Avg
	AVG	//////////	//////////			//////////			

GAS ANALYSIS - O2 :	6.2
CO2:	12.8
H2O:	9.5
AMB PRESS, in Hg :	29.56
STACK dP, in H2O :	7.5
AVG SQR ROOT dP :	0.791
STACK GAS TEMP, F :	302
GAS METER TEMP, F :	90
PITOT CONSTANT :	0.83
ORIFICE CONSTANT :	1.76
NOZZLE DIA, in :	0.185
SYSTEM FLOW, acfm :	0.567

dPp	dPo	dPp	dPo
0.20	0.15	0.90	0.68
0.22	0.17	0.92	0.70
0.24	0.18	0.94	0.72
0.26	0.20	0.96	0.73
0.28	0.21	0.98	0.75
0.30	0.23	1.00	0.76
0.32	0.24	1.02	0.78
0.34	0.26	1.04	0.79
0.36	0.27	1.06	0.81
0.38	0.29	1.08	0.82
0.40	0.30	1.10	0.84
0.42	0.32	1.12	0.85
0.44	0.33	1.14	0.87
0.46	0.35	1.16	0.88
0.48	0.37	1.18	0.90
0.50	0.38	1.20	0.91
0.52	0.40	1.22	0.93
0.54	0.41	1.24	0.94
0.56	0.43	1.26	0.96
0.58	0.44	1.28	0.97
0.60	0.46	1.30	0.99
0.62	0.47	1.32	1.00
0.64	0.49	1.34	1.02
0.66	0.50	1.36	1.03
0.68	0.52	1.38	1.05
0.70	0.53	1.40	1.07
0.72	0.55	1.42	1.08
0.74	0.56	1.44	1.10
0.76	0.58	1.46	1.11
0.78	0.59	1.48	1.13
0.80	0.61	1.50	1.14
0.82	0.62	1.52	1.16
0.84	0.64	1.54	1.17
0.86	0.65	1.56	1.19
0.88	0.67	1.58	1.20
0.90	0.68	1.60	1.22

* Ran port # 2 Twice, port # 1 plugged

SOUTHERN RESEARCH INSTITUTE

G-219

Ran point # 2 Twice ~~[illegible]~~ probe will not Reach point # 1

METHOD 17 MASS TRAIN DATA REDUCTION - Page 1
Initial Calculations and Input Data

Run Identification....................	BAILY7O-1-MT	Run Date......................	9/6/93
Ambient Pressure, in Hg	29.56	Duct Area, ft2..............	216
Stack dP, in H2O	7.5		
Nozzle Diameter, in	0.165	**Gas Meter Volume**	
Pitot Constant	0.83	Final Volume, ft3	582.550
Gas Meter Calibration............	1.010	Initial Volume, ft3	490.985
Time Sampled, min................	240	Volume Sampled, ft3	91.565

Particle Mass, mg

	Filter	Nozzle	Total
	273.856	56.452	
Inital	192.047	52.369	
Total	81.809	4.083	85.892

Water Collected

Final Dryrite Mass, g	858.3
Initial Dryrite Mass, g	830.1
Volume H2O, ml	170.0
Total Water, ml	198.2

Point	Pitot dP, in H2O	Sq. Root Pitot dP	Orifice dP, in H2O	Stk Temp, deg F	GM Inlet, deg F	GM Outlet, deg F	Oxygen, %
1	0.64	0.800	0.49	316	86	70	6.2
2	0.67	0.819	0.51	314	86	70	
3	0.40	0.632	0.30	311	93	74	
4	0.40	0.632	0.30	310	94	79	
5	0.60	0.775	0.46	309	98	82	
6	0.60	0.775	0.46	309	101	85	
7	0.38	0.616	0.29	308	102	86	
8	0.37	0.608	0.28	308	103	88	
9	0.63	0.794	0.48	315	104	90	
10	0.63	0.794	0.48	318	107	91	
11	0.55	0.742	0.42	318	108	92	
12	0.41	0.640	0.31	320	107	93	
13	0.70	0.837	0.53	320	103	91	
14	0.70	0.837	0.53	320	99	91	
15	0.60	0.775	0.46	318	100	87	
16	0.72	0.849	0.55	320	98	84	
17	0.62	0.787	0.47	322	104	85	
18	0.65	0.806	0.50	320	101	85	
19	0.83	0.911	0.63	320	104	86	
20	0.89	0.943	0.68	321	114	91	
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
Avg	0.600	0.769	0.500	316	101	85	6.2

Avg GM Temp, deg F.................... 93

METHOD 17 MASS TRAIN DATA REDUCTION - Page 2
Calculation Results

Run Identification	BAILY7O-1-MT
Flue Gas Composition	
O2	6.2
CO2	11.0
Calculated % H2O	9.5
Isokinetic Agreement, %	102.0
Avg Gas Velocity, ft/s	51.5
Avg Gas Temperature, F	316
Gas Volume Flow	
acfm	667,850
dscfm	413,289
wscfm	457,408
dscfm (0% O2)	290,686

Run Date	9/6/93
Dry MW, #/#-mole	30.01
Wet MW, #/#-mole	28.85
Stack Pressure, in Hg	30.11
Particle Mass Loading	
gr/acf	0.0094
gr/dscf	0.0151
mg/acm	21.48
mg/dscm	34.70
Particle Emission Rate	
lb/E6-Btu	0.0302
lb/hour	53.6161

PAGE 1 OF 2

METHOD 5 FIELD DATA

Plant/location # 7 outlet
Operator Kirby
Date 9-6-93
Test No./Run No. #1 MM5
Meter Box ID Nutech #3
Gas Meter Cal. Factor
Orifice ID
Orifice DH@ 1.89

Pitot Coefficient, Cp .82
Nozzle ID T-22
Average Nozzle Dia., inches .202
Barometric Pressure, in. Hg 29.46
Ambient Temp., deg. F 68°
Assumed Moisture, % 10.0
Filter ID
Stack Pressure, in. H2O 7.5

1st Filter:
Leak Rate, cfm, Pretest .003 @ 15" Hg
Leakrate, cfm, Post-test .006 @ 20" Hg
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 955.445
START TIME 9:36

GAS METER END, cf 1087.157
END TIME 14:28

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
							955.445						
	21	14	3.5	325	.75	.82	962.8	284	234		58	73	71
	2	28	4.0	325	.70	.76	969.5	319	246		52	79	72
	3	42	4.5	321	.65	.71	976.0	300	249		51	80	73
	4	56	4.7	320	.75	.82	983.037	241	239		49	81	73
A	● 1	14	4.5	318	.75	.82	989.9	270	238		54	78	73
	2	28	4.0	320	.65	.71	996.4	318	242		50	83	75
	3	42	4.5	319	.65	.71	1002.9	289	246		49	84	76
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
				319	0.819	0.74							

81.2

ge 2 of 2

Method 5 Field Data Continued Date 9-6-93 Location #7 outlet Run No. #1 mm5 Operator [illegible]

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	4	56	4.0	318	.50	.54	1008.545	248	238		49	85	77
B	1	14	4.8	316	.75	.82	1015.4	266	239		54	82	77
	2	28	4.8	318	.75	.82	1022.4	316	237		48	85	77
	3	42	4.0	318	.50	.54	1028.1	299	256		49	86	78
	4	56	4.5	318	.50	.54	1033.918	249	243		50	86	79
C	1	14	8.5	318	.80	.87	1040.8	262	251		55	84	80
	2	28	10.5	319	.75	.82	1047.8	315	249		49	90	81
	3	42	12.0	318	.70	.76	1054.4	300	249		47	91	83
	4	56	10.8	318	.50	.54	1060.183	249	242		48	90	83
D	1	14	13.3	319	.70	.76	1066.8	268	242		53	88	83
	2	28	15.0	319	.80	.87	1074.0	316	251		49	89	82
	3	42	14.8	317	.60	.65	1080.2	292	247		50	89	82
	4	56	17.0	315	.75	.82	1087.197	246	238		51	88	82

Pitot leak ✓
+ @ 5.0 "H2O
− @ 6.8 "H2O

Final leak ✓@
20 " Hg.

1087.356
1087.350
.006

Page 1 of

TRAI' 'RATION 7 Out

; ANALYSIS - O2 : 6.2
CO2 : 12.8
H2O : 10.0
3 PRESS, in Hg : 29.46
ACK dP, in H2O : 7.5
ter Gas vel., fps
AVG SQR ROOT d : 0.79
NIMUM PITOT dP : 0.50
· INCREMENT : 0.050

'ACK GAS TEMP, F : 312
IS METER TEMP, F : 87

ITOT CONSTANT : 0.82
RIFICE CONSTANT : 1.89
utech 3
OZZLE DIA, in : 0.202
YSTEM FLOW, acfm : 0.694
0.63
p
LOW, acfm 0.4207
'arget volume 100
Minutes to Vol. 237.69
lours to vol. 3.9616
No. of points: 20
Reqd Min./point 11.885
Use Minutes/point 14

dp PITOT	dP ORI	dp PITOT	dP ORI
0.500	0.54	1.400	1.52
0.550	0.60	1.450	1.58
0.600	0.65	1.500	1.63
0.650	0.71	1.550	1.69
0.700	0.76	1.600	1.74
0.750	0.82	1.650	1.80
0.800	0.87	1.700	1.85
0.850	0.93	1.750	1.90
0.900	0.98	1.800	1.96
0.950	1.03	1.850	2.01
1.000	1.09	1.900	2.07
1.050	1.14	1.950	2.12
1.100	1.20	2.000	2.18
1.150	1.25	2.050	2.23
1.200	1.31	2.100	2.29
1.250	1.36	2.150	2.34
1.300	1.41	2.200	2.39
1.350	1.47	2.250	2.45

117.8 predicted vol.
nozzle T22

5 ports X 4 points/port
9/6/93 Unit 7 Outlet NMS train operat

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Rental Trailer Run No. ~~8~~ 5

Set Up By DWS Date 9-7-93 Run Date 9-7-93

Comments Aldehyde

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No. un weighed

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	581.2 g	585.6 g	g
Second	622.7 g	624.6 g	g
Third	493.0 g	494.4 g	g
Fourth	g	g	g
Fifth	g	g	g
Sixth	g	g	g
Seventh	g	g	g

SILICA GEL WEIGHTS:	Initial	Final
	804.9 g	815.5 g
	g	g
Totals	g	g

COMMENTS:

Color of Silica Gel: Slight increase in pink color in bottom

Description of Impinger Water:

Appendix G5

Mercury Sampling

Hg

	Sample #	Location	Std. Liters
	BA - 8000	AMB Inlet Unit 8	20.0
9-3	BA - 8001	[redacted] Inlet Unit 8	19.6
9-3	BA - 8005	Field Blank - Inlet	0
9-3	BA - 8007	Outlet Unit 7	18.6
9-3	BA - 8014	Outlet Unit7 Diluter	172.2
9-3	BA - 8021	Outlet Unit 8	17.7
9-3	BA - 8026	Outlet Unit 8 Field Blank	0
9-3	BA - 8028	Stack	50.6
9-3	BA - 8033	Stack Field Blank	0
9-4	BA - 8035	Inlet Unit 8	19.3
9-4	BA - 8036	AMB. Inlet Unit 8	121.5
9-4	BA - 8040	Inlet Unit 8 Field Blank	0
9-4	BA - 8042	Outlet Unit 7	17.7
9-4	BA - 8047	Outlet Unit 7 Field Blank	0
9-4	BA - 8049	Outlet Unit 7 Diluter	111.5
9-4	BA - 8056	Outlet Unit 8	17.0
9-4	BA - 8063	Stack	38.6
9-4	BA - 8068	Stack Field Blank	0
9-5	BA - 8070	Inlet Unit 8	19.6
9-5	BA - 8071	Inlet Unit 8	122.8
9-5	BA - 8075	Inlet Unit 8 Field Blank	0
9-5	BA - 8077	Outlet Unit 7	18.4
9-5	BA - 8084	Outlet Unit 7 Diluter	167.2
9-5	BA - 8091	Outlet Unit 8	16.7
9-5	BA - 8096	Outlet Unit 8 Field Blank	0
9-5	BA - 8097	Trip Blank	0
9-5	BA - 8098	Stack	49.3
9-5	BA - 8103	Stack Field Blank	0
9-5	BA - 8104	Trip Blank	0
8-27	BA - 8112	Outlet Unit 7 Diluter Blank	162.3

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9-3-93	*Project Number:* 7960.11.6	*Test Number:* 1

Location: INLET (U8)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8000		Ambient Air
Pair #2 Charcoal	BA-8001		Inlet Port
Pair #3 Charcoal	~~BA-8002~~		
Pair #4 Charcoal	~~BA-8003~~		
Pair #5 Charcoal	~~BA-8004~~		
Field Blank - Charcoal	BA-8005		
Trip Blank - Charcoal	~~BA-8006~~		

Train Prepared By: M Steele	Date: 9-3 93	Time: 8:15 AM
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

~~VOST~~ Hg FIELD DATA

Job No. ______

Job Name Bailly

Run No. 1 Leak Check Blank #A-Tow

Location Inlet U-8

Date 9-3-93

Operator M Streck

Meter No. 71-V12

Ambient Temp. °C ______

Barometer No. ______

Probe Length ______

Sample Point ______

Initial Leak @ 25 "Hg - 0 cfm

Final Leak @ ______ "Hg - ______ cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
8:02										

V_m = Dry Gas Meter Calibration Factor .9992 x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \_\_\_\_ \times \left(\frac{\_\_\_\_ + \frac{\_\_\_\_}{13.6}}{\_\_\_\_ + 460}\right) = \_\_\_\_ \text{ standard liters}$$

Hg FIELD DATA

Job No.		Probe Length 5'
Job Name Bailly	Operator M. Steele	Sample Point Ambient Air
Run No. 2 Ambient Air (A-Train)	Meter No. 71-V12	Initial Leak @ 25 "Hg - 0 cfm
Location Inlet U8	Ambient Temp. °C	Final Leak @ 25 "Hg - 0 cfm
Date 9-3-93	Barometer No.	Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet °F	Outlet		
8:30	0230.35	0.5	1.0	230			75		1.0	
8:35	232.50	0.5	1.0	230			75		1.0	
8:40	235.15	0.5	1	230			75		1.0	
8:45	237.67	0.5	1	230			75		1.0	
8:50	240.32	0.5	1	230			75		1.0	
8:55	242.95	0.5	1	230			75		1.0	
9:00	245.64	0.5	1	230			75		1.0	
9:05	248.29	0.5	1	230			75		1.0	
9:10	251.02	0.5	1	230			75		1.0	
	20.67						75			

V_m = Dry Gas Meter Calibration Factor .9992 × 20.67 = 20.65 T_a°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\,V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 20.65 \times \left(\frac{\overset{29.43}{29.36 + \frac{1.0}{13.6}}}{\underset{535}{75 + 460}}\right) = 20.0 \text{ standard liters}$$

Hg FIELD DATA

Job No.

Job Name Bailly

Run No. 3 M-Pool

Location Inlet U8

Date 9-3-93

Operator M. Steele

Meter No. 71-V12

Ambient Temp. °C

Barometer No.

Probe Length 5'

Sample Point Inlet side port

Initial Leak @ 25 "Hg = 0 cfm

Final Leak @ 25 "Hg = 0 cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
9:40	252.60	0.5	5	230			72		1.0	
9:45	255.06	0.5	5½	230			72		1.0	
9:50	257.80	0.5	6	230			72		1.0	
9:55	260.32	0.5	6¼	230			72		1.0	
10:00	262.90	0.5	6¾	230			73		1.0	
10:05	265.33	0.5	7½	230			73		1.0	
10:10	267.70	0.5	8½	230			74		1.0	
10:15	270.29	0.5	9½	230			74		1.0	
10:20	272.76	0.5	10	230			74		1.0	
	20.16 L						72.89			

V_m = Dry Gas Meter Calibration Factor .9992 × 20.16 = 20.14 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

29.43

$$V_{std} = 17.65\,V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 20.14 \times \left(\frac{29.36 + \frac{1.0}{13.6}}{72.89 + 460}\right) = 19.6 \text{ standard liters}$$

5, 89

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/3/93

Project Number: 7960.11.6

Test Number: 1

Location: OUTLET (U8)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8021		
~~Pair #2 Charcoal~~	~~BA-8022~~		
~~Pair #3 Charcoal~~	~~BA-8023~~		
~~Pair #4 Charcoal~~	~~BA-8024~~		
~~Pair #5 Charcoal~~	~~BA-8025~~		
Field Blank - Charcoal	BA-8026		
~~Trip Blank - Charcoal~~	~~BA-8027~~		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No.

Job Name Bailly

Run No. U7M1 (BA-8007)

Location U7 outlet

Date 9/3/93

Operator JSO

Meter No. New SRI Vost

Ambient Temp. °C 19

Barometer No.

Probe Length 3'

Sample Point

Initial Leak @ 15 "Hg = 0.0 cfm

Final Leak @ 15.0 "Hg = 0.00 cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °F		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks ET (min)
					1st	2nd	Inlet	Outlet		
1539	1386.73	0.5	1.5	243			19		1.0	0
1544	1389.3	0.5	1.8	243			20		1.0	5
1549	1391.9	0.5	2.0	243			20		1.0	10
1554	1394.5	0.5	2.0	243			20		1.0	15
1559	1397.2	0.5	2.0	243			20		1.0	20
1604	1399.7	0.5	2.0	243			21		1.0	25
1609	1402.2	0.5	2.0	243			21		1.0	30
1614	1404.75	0.5	2.0	243			21		1.0	35
1619	1407.51	0.5	2.0	243			21		1.0	40
	20.78 L						20.3			

V_m = Dry Gas Meter Calibration Factor .912 × 20.78 = 18.95 T_m °C × $\frac{9}{5}$ + 32 = T_m °F

$$V_{m_{std}} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 18.95 \times \left(\frac{\overset{29.43}{29.36 + \frac{1.0}{13.6}}}{68.6 + 460}\right) = 18.6 \text{ standard liters}$$

.8.6

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	*Project Number:*	*Test Number:*
9/3/93	7960.11.6	1

Location:
OUTLET (U7)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8007		
~~Pair #2 Charcoal~~	~~BA-8008~~		
~~Pair #3 Charcoal~~	~~BA-8009~~		
Pair #4 Charcoal	BA-8010		
Pair #5 Charcoal	BA-8011		
Field Blank - Charcoal	~~BA-8012~~		
Trip Blank - Charcoal	BA-8013		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg ~~[illegible]~~ FIELD DATA

Job No. Bailly

Job Name

Run No. Merc 1-Di1 (BA-8414)

Location Unit 7 heater

Date 9/3/93

Operator 550

Meter No. 71-V1

Ambient Temp. °C 73

Barometer No.

Probe Length N/A

Sample Point Diluter

Initial Leak @ ~~[illegible]~~ 15.0 "Hg = 0.00 cfm

Final Leak @ "Hg = cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1106	2980.0	83mm	2.5	N/A	N/A	N/A	74	N/A	1.0	
1206	3019.1	83	2.5				89		1.05	
106	3049.7	83	2.5				93		1.05	
226	3069.6	83	2.5				91		1.15	
326	3101.3	83	2.5				96		1.15	
426	3132.2	83	2.5				96		1.15	
1726	3163.54	83	2.5				99		1.15	

183.54 L

91.14

V_m = Dry Gas Meter Calibration Factor .9954 × 183.54 = 182.69 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 182.69 \times \left(\frac{\overset{29.44}{29.36 + \frac{1.1}{13.6}}}{91.14 + 460}\right) = 172.2 \text{ standard liters}$$

551.14

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/3/93	***Project Number:*** 7960.11.6	***Test Number:*** 1

Location:
OUTLET (U8)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8021		
~~Pair #2 Charcoal~~	~~BA-8022~~		
~~Pair #3 Charcoal~~	~~BA-8023~~		
~~Pair #4 Charcoal~~	~~BA-8024~~		
~~Pair #5 Charcoal~~	~~BA-8025~~		
Field Blank - Charcoal	BA-8026		
~~Trip Blank - Charcoal~~	~~BA-8027~~		

Train Prepared By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg ~~VOST~~ FIELD DATA

Job No. Bailly

Job Name

Run No. U8M1 (BA-8021)

Location U8 OUT

Date 9/3/93

Operator 350

Meter No. A-7500

Ambient Temp. °F ~74°F

Barometer No.

Probe Length 3'

Sample Point U8 outer

Initial Leak @ 15 "Hg = 0.00 cfm

Final Leak @ 15 "Hg = 0.00 cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading (mm)	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks min
					1st	2nd	Inlet	Outlet		
1250	121.530	83	3.5	243	N/A	N/A	27	N/A		0
1255	124.0	83	3.7	243			27	N/A		5
1300	126.51	83	3.7	243			27			10
1305	128.95	83	3.8	243			28			15
1310	131.51	83	3.8	243			28			20
1315	133.92	83	3.8	243			28			25
1320	136.4	83	3.8	243			28			30
1330	138.8	83	3.8	243			29			35
1335	141.37	83	3.8	243			29			40
1340										45

19.84L

27.9

V_m = Dry Gas Meter Calibration Factor .930 x 19.84 = 18.45 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\,V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 18.45 \times \left(\frac{\overset{29.43}{29.36 + \frac{1.6}{13.6}}}{82.° + 460}\right) = 17.7 \text{ standard liters}$$

2.2

G-238

Hg
[redacted] FIELD DATA

Job No. Bailey - 7960.11.0
Job Name BLANK
Run No. U8 MBL1 (BA-8020)
Location U8 OUT
Date 9/3/93

Operator JSO
Meter No. A-7500
Ambient Temp. °C
Barometer No.

Probe Length 3'
Sample Point Amb - BLANK
Initial Leak @ 15 "Hg - 0.0 cfm
Final Leak @ "Hg - cfm
Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1349	BLANK						29			

V_m = Dry Gas Meter Calibration Factor ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \_\_\_\_ \times \left(\frac{\_\_\_ + \frac{\_\_\_}{13.6}}{\_\_\_ + 460}\right) = \_\_\_\_ \text{standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	*Project Number:*	*Test Number:*
9-3-93	7960.11.6	1

Location:
STACK

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8028		
Pair #2 Charcoal	~~BA-8029~~		
Pair #3 Charcoal	~~BA-8030~~		
Pair #4 Charcoal	~~BA-8031~~		
Pair #5 Charcoal	~~BA-8032~~		
Field Blank - Charcoal	BA-8033		
Trip Blank - Charcoal	~~BA-8034~~		

Train Prepared By: M. Steele	Date: 9-3-93	Time: 1:15 PM
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg ~~VOST~~ FIELD DATA

Job No. ____________

____

Probe Length ____________

Job Name Bailly

Operator M. Steele

Sample Point Blank

Run No. 1 Blank BA-8033

Meter No. VO-1

Initial Leak @ 22 "Hg = 0 cfm

Location Stack

Ambient Temp. °C ____________

Final Leak @ ______ "Hg = ______ cfm

Date 9-3-93

Barometer No. ____________

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum In. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure In. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = Dry Gas Meter Calibration Factor 1.0015 × ________ = ________ T_m°C × $\frac{9}{5}$ + 32 = T_m°F

V_{mstd} = 17.65 V_m $\left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right)$ = 17.65 × ________ × $\left(\frac{\_\_\_\_ + \frac{\_\_\_\_}{13.6}}{\_\_\_\_ + 460}\right)$ = ________ standard liters

G-241

Hg

FIELD DATA

Job No. ______

Job Name Bailly

Run No. 2   SA-8028

Location Stack

Date 9-9-93

______

Operator M. Steele

Meter No. VD-1

Ambient Temp. °C ______

Barometer No. ______

Probe Length 7'

Sample Point port in shelter

Initial Leak @ 23 "Hg = 0 cfm

Final Leak @ 23 "Hg = 0 cfm

Baro. Pressure P_b 29.36 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1:19	118.13	0.5	1	230			69		1.0	
1:29	122.00	0.5	1	230			70		1.0	
1:39	126.20	0.5	1	230			72		1.0	
1:49	130.30	0.5	1	230			74		1.0	
1:59	134.50	0.5	1	230			75		1.0	
2:09	138.75	0.5	1	230			77		1.0	
2:20	143.30	0.5	1	230			78		1.0	
2:30	147.90	0.5	1	230			79		1.0	
2:40	152.40	0.5	1	230			80		1.0	
2:55	158.90	0.5	1	230			81		1.0	
3:20	170.30	0.5	1	230			82		1.0	
	52.17 L						76.09			

V_m = Dry Gas Meter Calibration Factor 1.0015 x 52.17 = 52.25 T_m °C x $\frac{9}{5}$ + 32 = T_m °F

29.43

$$V_{m_{std}} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 52.25 \times \left(\frac{29.36 + \frac{1.0}{13.6}}{76.09 + 460}\right) = 50.6 \text{ standard liters}$$

5 ..09

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9-4-93
Project Number: 7960.11.6
Test Number: 2
Location: INLET (U8)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8035		
Pair #2 Charcoal	BA-8036		
Pair #3 Charcoal	~~BA-8037~~		
Pair #4 Charcoal	~~BA-8038~~		
Pair #5 Charcoal	~~BA-8039~~		
Field Blank - Charcoal	BA-8040		
Trip Blank - Charcoal	~~BA-8041~~		

Train Prepared By: Al Steele	Date: 9-4-93	Time: 12:15 PM
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No.__________ __________ Probe Length__________

Job Name Bailly

Operator M. Streb

Sample Point Blank

Run No. 1 BA-TC40

Meter No. 71 - V12

Initial Leak @ 25 "Hg = 0 cfm

Location Inlet Blank

Ambient Temp. °C__________

Final Leak @______"Hg = ______cfm

Date 9-4-93

Barometer No.__________

Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = Dry Gas Meter Calibration Factor ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$V_{m,std} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right)$ = 17.65 x ______ x $\left(\frac{\quad + \frac{\quad}{13.6}}{\quad + 460}\right)$ = ______standard liters

Hg FIELD DATA

Job No.		Probe Length 5'
Job Name Bailly	Operator M. Steele	Sample Point Inlet side port
Run No. 2 BA-8835	Meter No. 71-V12	Initial Leak @ 25 "Hg = 0 cfm
Location Inlet	Ambient Temp. °C	Final Leak @ 25 "Hg = 0 cfm
Date 9-4-93	Barometer No.	Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °F		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet °F	Outlet		
12:28	273.70	0.5	7.0	230			68		1.0	
12:33	276.00	0.5	8	230			68		1.1	
12:38	278.60	0.5	9½	230			69		1.0	
12:43	280.90	0.5	10	230			70		1.0	
12:48	283.50	0.5	11	230			71		1.0	
12:53	286.00	0.5	12	230			72		1.0	
12:58	288.40	0.5	14	230			73		1.0	
1:03	290.85	0.5	17	230			73		1.0	
1:08	293.35	0.5	20	230			74		1.0	
	19.65 L						70.89			

V_m = Dry Gas Meter Calibration Factor .9992 × 19.65 = 19.63 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{std} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 19.63 \times \left(\frac{\overset{29.55}{29.48 + \frac{1.0}{13.6}}}{\underset{530.89}{70.89 + 460}}\right) = 19.3 \text{ standard liters}$$

Hg
[redacted] FIELD DATA

Job No. ______

Job Name Bailly

Run No. 3 Ambient Air

Location Inlet BA-807B

Date 9-4-93

______

Operator M. Steele

Meter No. 71-V12

Ambient Temp. °C ______

Barometer No. ______

Probe Length 5'

Sample Point Ambient Air

Initial Leak @ 25 "Hg - 0 cfm

Final Leak @ 25 "Hg - 0 cfm

Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1:33	294.40	0.5	4½	230			73		1.0	
5:33	420.20	0.5	4½	230			86		1.0	

125.8 L

79.5

V_m = Dry Gas Meter Calibration Factor .9992 × 125.8 = 125.69 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\, V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \underline{125.69} \times \left(\frac{\overset{29.55}{29.48 + \frac{1.0}{13.6}}}{\underset{5.\ \ 5}{79.5 + 460}}\right) = \underline{121.5} \text{ standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	Project Number:	Test Number:
9/4/93	7960.11.6	2

Location:
OUTLET (U8)

Description	SRI Number	Volume	Comments
Pair #1 Charcoal	BA-8056		
~~Pair #2 Charcoal~~	~~BA-8057~~		
~~Pair #3 Charcoal~~	~~BA-8058~~		
~~Pair #4 Charcoal~~	~~BA-8059~~		
~~Pair #5 Charcoal~~	~~BA-8060~~		
~~Field Blank - Charcoal~~	~~BA-8061~~		
~~Trip Blank - Charcoal~~	~~BA-8062~~		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No.	7960.11.6			Probe Length	3'
Job Name	Bailly	Operator	SSO	Sample Point	Unit 7 Outlet
Run No.	D7M2 (BA-8042)	Meter No.	New SRI Vost	Initial Leak @	15 "Hg = 0.00 cfm
Location	Unit 7 Out	Ambient Temp. °C	23	Final Leak @	15 "Hg = 0.00 cfm
Date	9/4/93	Barometer No.		Baro. Pressure P_b	29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks ET(min)
					1st	2nd	Inlet	Outlet		
1331	1424.64	0.5	4.8	243			23		1.0	0
1336	1427.2	0.5	5.5	243			23		1.0	5
1341	1429.89	0.5	5.5	243			23		1.0	10
1346	143.23	0.5	5.5	243			24		1.0	15
1351	1434.68	0.5	5.7	243			24		1.0	20
1356	1436.2	0.5	6.2	243			25		1.0	25
1401	1439.72	0.5	6.5	243			26		1.0	30
1406	1442.15	0.5	6.5	243			26		1.0	35
1411	1444.24	0.5	6.5	243			27		1.0	40
	20.1 L						24.6			

V_m = Dry Gas Meter Calibration Factor .912 x 20.1 = 18.3 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m,std} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 18.3 \times \left(\frac{\overset{29.47}{29.46 + \frac{1.0}{13.6}}}{\underset{63}{76.3 + 460}}\right) = 17.7 \text{ standard liters}$$

BLANK Hg [illegible] FIELD DATA

Job No. 7960.11.6

Job Name BAILLY

Run No. 07MBL1 (BA-8047)

Location UNIT 7 OUTLET

Date 9/9/93

Operator SSO

Meter No. New SRE VOST

Ambient Temp. °C 24

Barometer No. ________

Probe Length N/A

Sample Point N/A - BLANK

Initial Leak @ 15 "Hg - 0.00 cfm

Final Leak @ ______ "Hg - ______ cfm

Baro. Pressure P_b 29.90 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1432										

V_m = *Dry Gas Meter Calibration Factor* ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460} \right) = 17.65 \times \_\_\_\_ \times \left(\frac{\_\_\_\_ + \frac{\_\_\_\_}{13.6}}{\_\_\_\_ + 460} \right) = \_\_\_\_ \text{ standard liters}$$

Hg ~~[illegible]~~ FIELD DATA

Job No. 7960.11.6
Job Name Bailly
Run No. 08M2 (BA8056)
Location Unit 8 outlet
Date 9/4/93

Operator SSO
Meter No. A-7500
Ambient Temp. °C 32
Barometer No.

Probe Length 3'
Sample Point Unit 8 outlet
Initial Leak @ 15 "Hg = 0.00 cfm
Final Leak @ 15 "Hg = 0.00 cfm
Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks ET (min)
					1st	2nd	Inlet	Outlet		
1514	162.23	83mm	3.5	247			32		1.0 ? *	0
1519	164.11	83	4.5	247			32			5
1524	167.18	83	4.5	242			31			10
1529	169.48	83	4.5	242			31			15
1534	172.0	83	4.5	242			31			20
1539	174.3	83	4.5	242			31			25
1544	176.55	83	4.5	246			31			30
1549	—	83	4.5	242			31			35
1554	181.47	83	4.5	242			31			40

19.24L. 31.2

* Meter out - all thru run ~1.0

V_m = Dry Gas Meter Calibration Factor .930 × 19.24 = 17.89 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \underline{17.89} \times \left(\frac{\overset{29.47}{29.40 + \frac{1.0}{13.6}}}{\underset{5\ \ 7.2}{88.2} + 460}\right) = \underline{17.0}\ \text{standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/4/93	***Project Number:*** 7960.11.6	***Test Number:*** 2

Location: OUTLET (U7)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8042		
~~Pair #2 Charcoal~~	~~BA-8043~~		
~~Pair #3 Charcoal~~	~~BA-8044~~		
~~Pair #4 Charcoal~~	~~BA-8045~~		
~~Pair #5 Charcoal~~	~~BA-8046~~		
Field Blank - Charcoal	BA-8047		
~~Trip Blank - Charcoal~~	~~BA-8048~~		

Train Prepared By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No. Bailey
Job Name
Run No. U7M Dil 2 M-5049
Location U7 Diluter
Date 9/4/93

Operator SSO
Meter No. 71-V1
Ambient Temp. °C
Barometer No.

Probe Length Diluter
Sample Point Diluter
Initial Leak @ 15 "Hg = 0.00 cfm
Final Leak @ 15 "Hg = 0.00 cfm
Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1212	3164.50	83mm	3.2	N/A	N/A	N/A	82	N/A	1.1	
1324	3199.5	83	3.2				98		1.1	
1412	3223.7	83	3.2				102		1.1	
1530	3262.7	83	3.4				105		1.1	
1612	3284.68	83	3.4				104		1.1	

120.18 L

98.2

V_m = Dry Gas Meter Calibration Factor .9954 × 120.18 = 119.63 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{mstd} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 119.63 \times \left(\frac{\overset{29.48}{29.40 + \frac{1.1}{13.6}}}{\underset{558.2}{98.2 + 460}}\right) = 111.5 \text{ standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/4/93	***Project Number:*** 7960.11.6	***Test Number:*** 2

Location: OUTLET (U7) DIL

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8049		
~~Pair #2 Charcoal~~	~~BA-8050~~		
~~Pair #3 Charcoal~~	~~BA-8051~~		
~~Pair #4 Charcoal~~	~~BA-8052~~		
~~Pair #5 Charcoal~~	~~BA-8053~~		
~~Field Blank - Charcoal~~	~~BA-8054~~		
~~Trip Blank - Charcoal~~	~~BA-8055~~		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg

FIELD DATA

Job No.
Job Name Bailly
Run No. 2 BA-8063
Location Stack
Date 9-4-93

Operator M. Stark
Meter No. VD-1
Ambient Temp. °C
Barometer No.

Probe Length 7'
Sample Point Port inside shelter
Initial Leak @ 23 "Hg = 0 cfm
Final Leak @ 23 "Hg = 0 cfm
Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
2:30	173.05	0.5	3½	230			75		1.0	
2:45	179.00	0.5	4½	230			77		1.0	
3:00	185.50	0.5	4¾	230			80		1.0	
3:15	192.15	0.5	5	230			83		1.0	
3:30	198.50	0.5	5	230			84		1.0	
3:45	204.65	0.5	5½	230			86		1.1	
4:00	210.10	0.5	17	230			86		1.0	
4:15	213.10	0.3	22	230			86		1.0	

40.05 L

82.13

V_m = Dry Gas Meter Calibration Factor 1.0015 × 40.05 = 40.11 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 40.11 \times \left(\frac{\overset{29.55}{29.48 + \frac{1.0}{13.6}}}{\underset{5\quad .13}{82.13 + 460}}\right) = 38.6 \text{ standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	Project Number:	Test Number:
9-5-93	7960.11.6	3

Location:
INLET (U8)

Description	SRI Number	Volume	Comments
Pair #1 Charcoal	BA-8070		
Pair #2 Charcoal	BA-8071		Ambient Air
Pair #3 Charcoal	~~BA-8072~~		
Pair #4 Charcoal	~~BA-8073~~		
Pair #5 Charcoal	~~BA-8074~~		
Field Blank - Charcoal	BA-8075		
Trip Blank - Charcoal	~~BA-8076~~		

Train Prepared By: M. Steele	Date: 9-5-93	Time: 9:00 AM
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	***Project Number:***	***Test Number:***
9-4-93	7960.11.6	2

Location: STACK

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8063		
Pair #2 Charcoal	~~BA-8064~~		
Pair #3 Charcoal	~~BA-8065~~		
Pair #4 Charcoal	~~BA-8066~~		
Pair #5 Charcoal	~~BA-8067~~		
Field Blank - Charcoal	BA-8068		No Soda Lime
Trip Blank - Charcoal	~~BA-8069~~		

Train Prepared By: M. Steele	Date: 9-4-93	Time: 2:15 PM
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relingushed By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No.__________

Job Name Bailly

Run No. 1 BA-8068

Location Stack Blank

Date 9-4-93

Operator M. Steele

Meter No. UD-1

Ambient Temp. °C__________

Barometer No.__________

Probe Length__________

Sample Point Blank

Initial Leak @ 23 "Hg - 0 cfm

Final Leak @_____ "Hg - _____ cfm

Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = Dry Gas Meter Calibration Factor ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\,V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \underline{\quad\quad} \times \left(\frac{\underline{\quad\quad} + \frac{\underline{\quad\quad}}{13.6}}{\underline{\quad\quad} + 460}\right) = \underline{\quad\quad}$$ standard liters

Hg FIELD DATA

Job No. ____________

____

Probe Length ____________

Job Name Bailly

Operator M. Steele

Sample Point Blank

Run No. 1 BA-8068

Meter No. UD-1

Initial Leak @ 23 "Hg - 0 cfm

Location Stack Blank

Ambient Temp. °C ____________

Final Leak @ ______ "Hg - ______ cfm

Date 9-4-93

Barometer No. ____________

Baro. Pressure P_b 29.48 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = *Dry Gas Meter Calibration Factor* ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.63 \times \_\_\_\_ \times \left(\frac{\_\_\_\_ + \frac{\_\_\_\_}{13.6}}{\_\_\_\_ + 460}\right) = \_\_\_\_ \text{ standard liters}$$

Hg FIELD DATA

Job No. ____
Job Name Bailly
Run No. 1 BA-8075
Location Inlet Blank
Date 9-5-93

____
Operator M. Steele
Meter No. 71-V12
Ambient Temp. °C ____
Barometer No. ____

Probe Length ____
Sample Point Blank
Initial Leak @ 25 "Hg = 0 cfm
Final Leak @ ____ "Hg = ____ cfm
Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = Dry Gas Meter Calibration Factor ____ × ____ = ____ T_m°C × $\frac{9}{5}$ + 32 = T_m°F

V_{std} = 17.65 V_m $\left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right)$ = 17.65 × ____ × $\left(\frac{\_\_\_\_ + \frac{\_\_\_\_}{13.6}}{\_\_\_\_ + 460}\right)$ = ____ standard liters

G-259

Hg FIELD DATA

Job No. ________

Job Name Bailly

Run No. 2 BA-8070

Location Inlet

Date 9-5-93

Operator M. Steele

Meter No. 71-V12

Ambient Temp. °C ________

Barometer No. ________

Probe Length 5'

Sample Point Side port

Initial Leak @ 25 "Hg - 0 cfm

Final Leak @ 25 "Hg - 0 cfm

Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
9:16	421.80	0.5	5	230			70		1.0	
9:21	424.20	0.5	5½	230			71		1.0	
9:26	426.70	0.5	6	230			72		1.0	
9:31	429.40	0.5	6½	230			74		1.0	
9:36	431.90	0.5	6½	230			75		1.0	
9:41	434.60	0.5	7½	230			77		1.0	
9:46	437.10	0.5	7½	230			78		1.0	
9:51	439.60	0.5	8	230			79		1.0	
9:56	442.03	0.5	9	230			80		1.0	
	20.23 L						75.11			

V_m = Dry Gas Meter Calibration Factor .9992 x 20.23 = 20.21 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \underline{20.21} \times \left(\frac{\overset{29.47}{\underline{29.40} + \frac{1.0}{13.6}}}{\underset{535.11}{75.11 + 460}}\right) = \underline{19.6} \text{ standard liters}$$

Hg
FIELD DATA

Job No. ________

Job Name Bailly

Run No. 3 BA-8071

Location Inlet Ambient Air

Date 9-5-93

Operator M. Steele

Meter No. 71-V12

Ambient Temp. °C ________

Barometer No. ________

Probe Length 5'

Sample Point Ambient Air

Initial Leak @ 25 "Hg = 0 cfm

Final Leak @ 25 "Hg = 0 cfm

Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °~~C~~F	Condenser Temp °C 1st	Condenser Temp °C 2nd	Dry Gas Temp °~~C~~F Inlet	Dry Gas Temp °~~C~~F Outlet	Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
10:27	442.80	0.5	4	230			80		1.0	
2:27	571.70	0.5	4	230			91		1.0	

128.9 L

85.5

V_m = Dry Gas Meter Calibration Factor .9992 x 128.9 = 128.79 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

29.47

$$V_{m,std} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 128.79 \times \left(\frac{29.40 + \frac{1.0}{13.6}}{85.5 + 460}\right) = 122.8 \text{ standard liters}$$

5 .5

G-261

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/5/93	*Project Number:* 7960.11.6	*Test Number:* 3

Location:
OUTLET (U8)

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8091		
~~Pair #2 Charcoal~~	~~BA-8092~~		
~~Pair #3 Charcoal~~	~~BA-8093~~		
~~Pair #4 Charcoal~~	~~BA-8094~~		
~~Pair #5 Charcoal~~	~~BA-8095~~		
Field Blank - Charcoal	BA-8096		
Trip Blank - Charcoal	BA-8097		

Train Prepared By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg

~~[illegible]~~ FIELD DATA

Job No. 7960.11.6		Probe Length 3'
Job Name Bailly	Operator SSD	Sample Point U8 out
Run No. U8M3 (BH-8091)	Meter No. A7500	Initial Leak @ 15 "Hg = 0.00 cfm
Location UNIT 8 OUTLET	Ambient Temp. °C 35	Final Leak @ 15" "Hg = 0.00 cfm
Date 9/5/93	Barometer No.	Baro. Pressure P_b 29.3 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading mm	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks ET
					1st	2nd	Inlet	Outlet		
1049	182.390	83	5.0	244			35		~1.0 *	0
1054	184.90	83	4.5	244			35			5
1059	187.35	83	4.7	244			35			10
1104	189.75	83	4.7	244			35			15
1109	192.0	83	4.7	244			36			20
1114	194.47	83	4.7	244			36			25
1119	197.0	83	4.8	244			36			30
1124	199.2	83	4.8	244			36			35
1129	201.70	83	4.8	244			36			40

19.31 L

35.6

* OUT OF ORDER

V_m = Dry Gas Meter Calibration Factor .930 x 19.31 = 17.96 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

29.37

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 17.96 \times \left(\frac{29.30 + \frac{1.0}{13.6}}{96.1 + 460}\right) = 16.7 \text{ standard liters}$$

556.1

Hg

~~[illegible]~~ FIELD DATA

Job No. 7960.11.6

Job Name U8MBL2 Bailly

Run No. U8MBL2 8A-8096

Location Unit 8 Booster

Date 9/5/93

Operator 550

Meter No. A-7500

Ambient Temp. °C 35

Barometer No.

Probe Length 3'

Sample Point N/A

Initial Leak @ 16 "Hg = 0.00 cfm

Final Leak @ "Hg = cfm

Baro. Pressure P_b 29.3 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1145										

V_m = Dry Gas Meter Calibration Factor ______ x ______ = ______ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

V_{std} = 17.65 V_m $\left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right)$ = 17.65 x ______ x $\left(\frac{\_\_\_ + \frac{\_\_\_}{13.6}}{\_\_\_ + 460}\right)$ = ______ standard liters

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	Project Number:	Test Number:
9/5/93	7960.11.6	3

Location:
OUTLET (U7)

Description	SRI Number	Volume	Comments
Pair #1 Charcoal	BA-8077		
~~Pair #2 Charcoal~~	~~BA-8078~~		
~~Pair #3 Charcoal~~	~~BA-8079~~		
~~Pair #4 Charcoal~~	~~BA-8080~~		
~~Pair #5 Charcoal~~	~~BA-8081~~		
~~Field Blank - Charcoal~~	~~BA-8082~~		
~~Trip Blank - Charcoal~~	~~BA-8083~~		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No. 7960.11.6

Job Name Bailly

Run No. U7M3 (BA-8077)

Location Unit 7 outlet

Date 9/5/93

Operator JSO

Meter No. New Sec Vost

Ambient Temp. °C 19

Barometer No.

Probe Length 3'

Sample Point U7 out

Initial Leak @ 15 "Hg = 0.00 cfm

Final Leak @ 15 "Hg = 0.00 cfm

Baro. Pressure P_b 29.30 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °F	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks ET (min)
					1st	2nd	Inlet	Outlet		
1332	1445.37	0.5	4.8	243			18		1.0	0
1337	1448.0	0.5	5.8	243			18		1.0	5
1342	1450.6	0.5	5.8	243			19		1.0	10
1347	1453.15	0.5	5.8	243			19		1.0	15
1352	1455.73	0.5	6.0	243			19		1.0	20
1357	1458.2	0.5	6.2	243			19		1.0	25
1402	1460.72	0.5	6.2	243			20		1.0	30
1407	1463.28	0.5	6.3	243			21		1.0	35
1412	1465.92	0.5	6.3	243			21		1.0	40
	20.55 L						19.3			

V_m = Dry Gas Meter Calibration Factor .912 x 20.55 = 18.74 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m,std} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times \underline{18.74} \times \left(\frac{\overset{29.37}{29.36 + \frac{1.0}{13.6}}}{\underset{526.7}{66.7 + 460}}\right) = \underline{18.4} \text{ standard liters}$$

G-266

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 9/5/93	***Project Number:*** 7960.11.6	***Test Number:*** 3

Location:
OUTLET (U7) DIL

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8084		
~~Pair #2 Charcoal~~	~~BA-8085~~		
~~Pair #3 Charcoal~~	~~BA-8086~~		
~~Pair #4 Charcoal~~	~~BA-8087~~		
~~Pair #5 Charcoal~~	~~BA-8088~~		
~~Field Blank - Charcoal~~	~~BA-8089~~		
~~Trip Blank - Charcoal~~	~~BA-8090~~		

Train Prepared By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinguished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinguished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg ~~[illegible]~~ FIELD DATA

Job No. 796011.6

Job Name Bailly

Run No. U7M DIL 3 (BA-8084)

Location Unit 7 outlet

Date 9/5/93

Operator SSD

Meter No. 71-V1

Ambient Temp. °F 77F

Barometer No. ____

Probe Length Diluter

Sample Point Diluter

Initial Leak @ 15 "Hg = 0.00 cfm

Final Leak @ 15 "Hg = 0.00 cfm

Baro. Pressure P_b 29.30 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading mm	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C 1st	Condenser Temp °C 2nd	Dry Gas Temp °C Inlet	Dry Gas Temp °C Outlet	Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
1008	3285.34	83mm	6.5				82		1.1	
1108	3315.3	83	7.0				99		~~1.15~~ 1.15	
1240	3361.0	83	7.0				104		1.15	
1309	3376.4	83	7.0				109		1.15	
1409	3406.1	88	7.0				105		1.1	
1511	3437.5	43	7.0				100		1.1	
1608	3466.72	83	7.0				96		1.1	

181.38L

99.86

V_m = Dry Gas Meter Calibration Factor .9954 x 181.38 = 180.54 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 180.54 \times \left(\frac{\overset{29.38}{29.30 + \frac{1.1}{13.6}}}{\underset{559.86}{99.86 + 460}}\right) = 167.2 \text{ standard liters}$$

G-268

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date: 8/27/93	***Project Number:*** 7960.11.6	***Test Number:*** BLANK

Location: OUTLET (U7) DIL

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8112		
Pair #2 Charcoal	~~BA-8113~~		
Pair #3 Charcoal	~~BA-8114~~		
Pair #4 Charcoal	~~BA-8115~~		
Pair #5 Charcoal	~~BA-8116~~		
Field Blank - Charcoal	~~BA-8117~~		
Trip Blank - Charcoal	~~BA-8118~~		

Train Prepared By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg

~~[illegible]~~ FIELD DATA

Job No. BA- 8112
Job Name BAILEY
Run No. Bi - Dil (BA-8112)
Location 7 out
Date 8/27/93

Operator SSD
Meter No. 71-V1
Ambient Temp. @ 101 °F
Barometer No.

Probe Length N/A
Sample Point Diluter
Initial Leak @ 0.0 "Hg - .20 cfm
Final Leak @ "Hg - cfm
Baro. Pressure P_b 29.57 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
1059	2787.75	83mm	1.5	NA			92		1.1	
1159	2816.75	83	1.5				111		1.1	
1259	2845.25	83	1.5				117		1.1	
159	2876.42	83	1.5				117		1.15	
259	2906.53	83	1.5				118		1.15	
359	2936.83	83	1.5				118		1.1	
459p	2966.15	83	1.5				115		1.1	

178.4 L

112.57

V_m = Dry Gas Meter Calibration Factor .9954 × 178.4 = 177.58 T_m°C × $\frac{9}{5}$ + 32 = T_m°F

$$V_{std} = 17.65\,V_m\left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 177.58 \times \left(\frac{\overset{29.65}{29.57 + \frac{1.1}{13.6}}}{\underset{572.57}{112.57 + 460}}\right) = 162.3 \text{ standard liters}$$

Southern Research Institute
Birmingham, AL

Plant Bailly
COC FORM - Mercury

Date:	*Project Number:*	*Test Number:*
9-5-93	7960.11.6	3

Location:
STACK

Description	*SRI Number*	*Volume*	*Comments*
Pair #1 Charcoal	BA-8098		
Pair #2 Charcoal	~~BA-8099~~		
Pair #3 Charcoal	~~BA-8100~~		
Pair #4 Charcoal	~~BA-8101~~		
Pair #5 Charcoal	~~BA-8102~~		
Field Blank - Charcoal	BA-8103		No Soda Lime
Trip Blank - Charcoal	BA-8104		

Train Prepared By: M. Steele	Date: 9-5-93	Time: 11:10 AM
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Train Relinquished By:	Date:	Time:
Train Received By:	Date:	Time:
Samples Recovered By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:
Samples Relinquished By:	Date:	Time:
Samples Received By:	Date:	Time:

Hg FIELD DATA

Job No.__________

Job Name Bailly

Run No. 1 9A - 8/03

Location Stack Blank

Date 9-5-93

____

Operator M. Stwa

Meter No. VD-1

Ambient Temp. °C__________

Barometer No.__________

Probe Length__________

Sample Point Blank

Initial Leak @ 23 "Hg = 0 cfm

Final Leak @_____ "Hg = _____ cfm

Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °C	Condenser Temp °C		Dry Gas Temp °C		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		

V_m = Dry Gas Meter Calibration Factor _____ x _____ = _____ T_m°C x $\frac{9}{5}$ + 32 = T_m°F

V_{std} = 17.65 V_m $\left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right)$ = 17.65 x _____ x $\left(\frac{\_\_\_ + \frac{\_\_\_}{13.6}}{\_\_\_ + 460}\right)$ = _____ standard liters

Hg
FIELD DATA

Job No. ____
Job Name Bailly
Run No. 2 BA-8098
Location Stack
Date 9-5-93

Operator M. Steele
Meter No. VS-1
Ambient Temp. °C ____
Barometer No. ____

Probe Length 7'
Sample Point Port in shelter
Initial Leak @ 23 "Hg - 0 cfm
Final Leak @ 23 "Hg - 0 cfm
Baro. Pressure P_b 29.40 "Hg

Clock Time	Dry Gas Meter, liters	Rotometer Reading	Pump Vacuum in. Hg Gauge	Probe Temp. °~~C~~F	Condenser Temp °C		Dry Gas Temp °~~C~~F		Dry Gas Meter Pressure in. H_2O (P_m)	Remarks
					1st	2nd	Inlet	Outlet		
11:25	215.00	0.5	2½	230			70		1.0	
11:40	221.40	0.5	3½	230			72		1.0	
11:55	227.90	0.5	3½	230			75		1.0	
12:10	234.20	0.5	4	230			77		1.0	
12:25	240.50	0.5	4½	230			79		1.0	
12:40	247.60	0.5	4½	230			80		1.0	
12:55	253.15	0.5	5	230			81		1.0	
1:10	259.65	0.5	5	230			81		1.0	
1:25	265.90	0.5	5	230			81		1.0	
	50.9 L						77.33			

V_m = Dry Gas Meter Calibration Factor 1.0015 x 50.9 = 50.98 T_m°C x $\frac{9}{5}$ + 32 = T_m°F

$$V_{m_{std}} = 17.65\ V_m \left(\frac{P_b + \frac{P_m}{13.6}}{T_m + 460}\right) = 17.65 \times 56.98 \times \left(\frac{\overset{29.47}{29.40 + \frac{1.0}{13.6}}}{\underset{5\quad .33}{77.33 + 460}}\right) = 49.3 \text{ standard liters}$$

G-273

Appendix G6

Dilution Train Field Data

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TEG
Date 5/6/93
Test No./Run No. MM5 1-0L1
Meter Box ID Nutech 2B
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test ___
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf 752.500
START TIME 1016

GAS METER END, cf 998.591
END TIME 1616

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	6.25			1.23	752.5					66	
		15	6.25				762.6					66	
		30	6.25				772.8					66	
		45	6.25				783.3					66	
		60	6.25				793.3					67	
		15	6.25				803.5					67	
		30	6.25				813.8					67	
		45	6.25				824.0					67	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

70

age 2 of 2

Method 5 Field Data Continued Date Location Run No. MM5 1-DiL 1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	6.25			1.23	834.6					67	
		15	6.25				844.7					67	
		30	6.25				855.0					68	
		45	6.25				865.1					68	
		60	6.25				875.6					71	
		15	6.25				885.7					72	
		30	6.25				895.9					73	
		45	6.25				906.4					73	
		60	6.25				916.8					73	
		15	6.0				926.9					73	
		30	6.0				937.4					73	
		45	6.0				947.4					73	
		60	6.0				957.6					74	
		15	6.0				967.9					75	
		30	6.0			↓	978.2					75	

Page 3 of 3

Method 5 Field Data Continued Date Location Run No. MM51-Dil1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	6.00			1.23	988.6					75	
		60	6.0			↓	998.591					75	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location DIL 1 Outlet Unit 7
Run No. 1
Set Up By WDLows
Date 09/06/93
Run Date
Comments MM5
Analyst Responsible for Recovery
Calculations & Report Reviewed By
Report Date

FILTERS USED

Filter No.

Sorbent Trap No. H590-55-16

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	446.0 g	458.5 g	12.5 g
Second	645.8 g	656.7 g	10.9 g
Third	572.7 g	573.1 g	0.4 g
Fourth	456.9 g	460.7 g	3.8 g
Fifth	– g	– g	– g
Sixth	– g	– g	– g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final	
	845.2 g	890.2 g	+45.0
	g	g	
Totals	g	g	

TOTAL 72.6

COMMENTS:

Color of Silica Gel: 1/2 pink

Description of Impinger Water:

✓

(Total) Exhaust 0.31
Dilution 0.81

Impingers started at 1101

(Blank)

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	BL-DIL
Date	8-27-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	— "H2O
Barometric Pressure	— "Hg
"g" scaling factor	—

Filter ID	B-1
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	1.0	"H2O/min @ 100"
Leak Check:	Sample Gas	—	ΔP(sample orifice)

Pitot Cp	—
Nozzle Diameter	—

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1049										—	165	170	180	105	101	100	102	93	92
1101										—	140	171	182	105	101	100	102	93	93
1104	—	—	0	2.9	0.33	0.80	-3	—	—	—	133	171	182	105	101	99	102	93	93
1117	—	—	—	2.9	0.33	0.80	-3	—	—	—	165	171	181	102	97	97	98	91	95
1127	—	—	—	2.9	0.33	0.80	-3	—	—	—	173	171	182	101	95	95	96	89	93
1143	—	—	—	2.9	0.33	0.80	-3	—	—	—	177	171	181	99	93	95	94	88	95
1158	—	—	—	2.9	0.33	0.80	-3	—	—	—	171	170	181	99	94	93	94	88	95
1215	—	—	—	2.9	0.33	0.80	-3	—	—	—	175	171	181	99	94	94	94	89	95
1230	—	—	—	2.9	0.33	0.80	-3	—	—	—	181	168	179	99	94	94	94	90	97
1245	—	—	—	2.9	0.33	0.80	-3	—	—	—	176	162	171	97	93	93	94	90	97
1300	—	—	—	2.9	0.33	0.80	-3	—	—	—	181	161	171	98	94	97	95	90	98
1315	—	—	—	2.9	0.33	0.80	-3	—	—	—	159	160	170	98	94	94	95	90	95
1330	—	—	—	2.9	0.33	0.80	-3	—	—	—	172	158	167	97	93	93	94	90	94
1345	—	—	—	2.9	0.33	0.80	-3	—	—	—	176	157	167	97	93	93	94	89	96

✓

Page 2

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	
Date	9-27-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	29.57 " Hg
"g" scaling factor	

Filter ID	
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	"H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	[illegible] ΔP	[illegible] Orifice ΔP	[illegible] Orifice P	[illegible] ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1400	—	—	—	2.9	0.33	0.80	-3	—	—	—	178	156	165	98	94	95	95	92	97
1415	—	—	—	2.9	0.33	0.80	-3	—	—	—	177	156	164	98	95	95	95	92	98
1430	—	—	—	2.9	0.33	0.80	-3	—	—	—	181	157	167	98	95	96	76	93	99
1445	—	—	—	2.9	0.33	0.80	-3	—	—	—	179	158	167	99	93	96	96	93	98
1500	—	—	—	2.9	0.33	0.80	-3	—	—	—	172	157	166	99	96	96	97	94	97
1515	—	—	—	2.9	0.33	0.80	-3	—	—	—	176	154	162	99	96	95	96	94	96
1530	—	—	—	2.9	0.33	0.80	-3	—	—	—	180	154	163	99	96	96	97	94	96
1545	—	—	—	3.0	0.33	0.80	-3	—	—	—	182	155	164	100	97	97	98	95	99
1600	—	—	—	3.0	0.33	0.80	-3	—	—	—	184	157	167	101	98	99	99	95	100
1615	—	—	—	3.0	0.33	0.80	-3	—	—	—	180	157	166	101	98	96	99	95	96
1630	—	—	—	3.0	0.33	0.80	-3	—	—	—	173	156	166	101	98	96	98	95	96
1645	—	—	—	3.0	0.33	0.80	-3	—	—	—	178	157	167	101	98	97	99	95	94
1700	—	—	—	3.0	0.33	0.80	-3	—	—	—	178	158	168	102	99	97	99	95	95
Avg's:				2.9	0.33	0.80	-3										97	92	

PAGE 1 OF 5

METHOD 5 FIELD DATA

Plant/location Bailey
Operator TG/JBO
Date 8/27/93
Test No./Run No. MM5 DIL 1 BLANK
Meter Box ID Nutech 2
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg 29.57
Ambient Temp., deg. F 100
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.0
Leakrate, cfm, Post-test 0.0
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

NET G.M. VOL = 244.291
358 min

GAS METER START, cf: 758.943
START TIME 1101

GAS METER END, cf 1003.234
END TIME 1659

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Avg. Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	5.0	103	N/A	1.23	758.943					96	
		15	5.0	103			768.8					98	
		30	5.0	103			778.7					101	
		45	5.0	112			788.5					101	
		60	5.0	112			798.3					101	
		15	5.0	112			808.2					102	
		30	5.0	113			818.3					102	
		45	5.0	112			8294					102	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
						1.23						102	

G-283

Page 2 of 3

MMS DR 1 BLANK

Method 5 Field Data Continued Date Location Run No. Operator TG/JSO

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	5.0	101	NA	1.23	838.3					102	
		15	5.0	98			844.7					102	
		30	5.0	96			858.8					102	
		45	5.0	99			869.2					102	
		60	5.0	99			879.5					102	
		15	5.0	101			889.7					102	
		30	5.0	98			900.1					102	
		45	5.0	101			910.4					102	
		60	5.0	98			920.8					102	
		15	5.8	100			931.0					102	
		30	5.0	102			941.3					102	
		45	5.0	102			951.7					102	
		60	5.0	101			962.1					103	
		15	5.0	102			972.7					102	
		30	5.0	101			982.5					102	

Page 3 of 3

MMS DIL 1 BLANK

Method 5 Field Data Continued Date Location Run No. Operator TG, SSO

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	5.0			1.23	999.8					101	
		60		102			1003.234						

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Di#1 Run No. BLANK

Set Up By ZLDC Date 08/24/95 Run Date

Comments MMS

Analyst Responsible for Recovery KD/WLS

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No. H590-55-17 [illegible]

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	450.6 g	451.5 g	+0.9 g
Second	581.2 g	575.9 g	-5.3 g
Third	598.3 g	597.2 g	-1.1 g
Fourth	488.4 g	492.0 g	-3.6 g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final	
	801.5 g	841.6 g	+40.1
	g	g	
Totals	g	g	

Total = +31.0

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bally
Operator TG/SSD
Date 8/27/93
Test No./Run No. MM5 DIL 2 BL
Meter Box ID Nutech 4
Gas Meter Cal Factor
Orifice ID
Orifice DHP

Pitot Coefficient, Cp N/A
Nozzle ID. N/A
Average Nozzle Dia., inches N/A
Barometric Pressure, in. Hg 29.57
Ambient Temp., deg. F
Assumed Moisture, %
Filter ID
Stack Pressure, in. H2O

1st Filter:
Leak Rate, cfm, Pretest 0.0
Leakrate, cfm, Post-test 0.0
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

G.M. Vol =215.781 cf
358 minutes

GAS METER START, cf 061.198
START TIME 1101

GAS METER END, cf 276.979
END TIME 1659

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		0	3.0	Amb. 103		1.23	61.198					116	
		15	3.0	103			69.7					118	
		30	3.0	103			77.8					118	
		45	3.0	112			86.6					118	
		60	3.0	112			95.3					118	
		75	3.0	112			104.1					119	
		90	3.0	113			112.9					119	
		45	3.0	112			121.9					119	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
						1.23						119	

Page 2 of 3

MMS Dil 2 BLANK

Method 5 Field Data Continued Date Amb Location Run No. Operator TG, JSO

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	3.0	101		1.23	130.6					120	
		15	3.0	97			139.7					120	
		30	3.0	96			148.7					120	
		45	3.0	99			157.9					120	
		60	3.0	100			167.1					119	
		15	3.0	101			176.2					119	
		30	3.0	98			185.3					121	
		45	3.0	101			194.5					120	
		60	3.0	98			203.7					120	
		15	3.0	100			212.4					119	
		30	3.0	102			222.0					119	
		45	3.0	102			231.2					119	
		60	3.0	101			240.6					119	
		15	3.0	102			250.1					119	
		30	3.0	101			258.7					119	

Page 3 of 3

MMS DIC 2 BLANK

Method 5 Field Data Continued. Date Location Run No. Operator TB JSO

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45		100		1.23	268.7					119	
		60		102			276.979						

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location DIL #2 Run No. BLANK

Set Up By TLK Date 04/26/93 Run Date

Comments MMS

Analyst Responsible for Recovery KD/WLS

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No. H 540- 55- 7 Batch 1

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	445.2 g	445.4 g	0.2 g
Second	641.6 ~~599.5~~ WLS g	630.3 g	−11.3 g
Third	572.3 g	567.7 g	−4.6 g
Fourth	455.5 g	463.1 g	+7.6 g
Fifth	– g	– g	– g
Sixth	– g	– g	– g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	885.2 g	933.5 g +48.3
	g	g
Totals	g	g

Total +40.2

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

PAGE 1 of 2

METHOD 5 FIELD DATA

Plant/Location Baicy
Operator TG 550
Date 8/27/93
Test No./Run No. METAL TK BLANK
Meter Box ID A8643
Gas Meter Cal. Factor ____
Orifice ID ____
Orifice DH@ ____

Pitot Coefficient, Cp —
Nozzle ID —
Average Nozzle Dia., inches ____
Barometric Pressure, in. Hg 29.57
Ambient Temp., deg. F ____
Assumed Moisture, % ____
Filter ID ____
Stack Pressure, in. H2O ____

1st Filter:
Leak Rate, cfm, Pretest 0.0
Leakrate, cfm, Post-test 0.0
2nd Filter (if used):
Leak Rate, cfm, Pretest ____
Leakrate, cfm, Post-test ____

Net Gm vol = 234.181
358 min

GAS METER START, cf: 556.981
START TIME 1101

GAS METER END, cf 791.162
END TIME 1659

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	AMB. Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	0	103	N/A	1.21	556.981					100	100
		15	0	103			566.7					120	101
		30	0	103			575.4					125	106
		45	0	112			585.6					133	115
		60	0	112			595.0					136	119
		15	0	112			604.7					139	123
		30	0	113			614.4					141	125
		45	0	112			624.2					142	127
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
						1.21						132	

Page 2 of 2

METALS D/C BLANK

Method 5 Field Data Continued Date Location Run No. Operator TG ISO

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		60	0	101	NA	1.21	633.8					144	129
		15	0	98			643.9					144	130
		30	0	96			653.3					143	130
		45	0	100			663.0					143	129
		60	0	99			672.9					143	129
		15	0	101			682.6					145	130
		30	0	98			692.5					147	132
		45	0	100			702.4					146	132
		60	0	98			712.3					144	131
		15	0	100			722.2					143	130
		30	0	102			732.0					144	130
		45	0	102			741.9					145	131
		60	0	101			752.0					146	133
		15	0	102			762.0					145	132
		30	0	101			771.4					144	133

Page 3 of 3

METALS DIL BLANK

Method 5 Field Data Continued Date Location Run No. Operator 550 TG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	0	100		1.21	782.2					143	131
		60		101			791.162						

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Dile #1 Run No. BLANK

Set Up By WDK/DWS Date 08/27/93 Run Date 8/27/93

Comments Multiple Metals

Analyst Responsible for Recovery KD/WLS

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	606.1 g	604.4 g	−1.7 g
Second	592.4 g	597.0 g	+4.6 g
Third	440.4 g	441.8 g	+1.4 g
Fourth	605.7 g	605.[illegible] g	−0.7 g
Fifth	590.9 g	589.8 g	−1.1 g
Sixth	486.4 g	487.8 g	+1.4 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	818.8 g	852.6 g	+33.8
	g	g	
Totals	g	g	

TOTAL: +37.7

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

DOE DILUTION TRAIN OPERATION

Mode

DRY MW, #/#-mole :	30.32
WET MW, #/#-mole :	29.46
STACK PRESS, in Hg:	30.01
INTERM CONST 1 :	0.7586
INTERM CONST 2 :	1.3E 07

GAS ANALYSIS - O2 :	6.0
CO2 :	13.0
H2O :	7.0
AMB PRESS, in Hg :	29.57
STACK dP, in H2O :	6.0
Enter Gas vel., fps	54
or AVG SQR ROOT dp :	
Dil. Factor:	******
STACK GAS TEMP, F :	300
GAS METER TEMP, F :	100
Dil Air Temp	70
Exh air temp	85
PITOT CONSTANT :	0.81
SAMP. ORI. DH@ :	26.02
Dil Air Ori DH@:	0.033
Exhaust flow DH@	0.041
Filter DP	6

NOZZLE DIA, in :	0.180				
SYSTEM FLOW, acfm :	0.636	0.407			
[illegible]	0.00	26.02	13.34	DHso	
FLOW, acfm	0.407				
Total flow in	3.67				
Dil flow scfm	3.67				
Dil Bw	0				
Side stream 1 flow, dscfm		0.6			
Side stream 1 DH@		1.786	1.23	DH1	Nutech 2
[redacted]					
Side stream 2 flow, dscfm		0.6			
Side stream 2 DH@		1.7898	1.23	DH2	Nutech 4B
[redacted]					
Side stream 3 flow, dscfm		0.6			
Side stream 3 DH@		1.76	1.21	DH3	RAC 8843
[redacted]					
Exhaust flow dscfm		1.87			
Exhaust flow DHexh		0.0413	0.31	DHexh	
		3.67			
Dilution flow DHda		0.0334	0.61	DHda	

01 ✓
C7 ✓
D27
I32
03 ✓
D19
02 ✓

1108 start

Run Sheet for the PM10 Dilution Train

Plant Name	Baily
Run ID	Metals 1
Date	9-2-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	"H2O
Barometric Pressure	"Hg
"g" scaling factor	0.57

Filter ID	2
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	< 1.0 "H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (In. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1042										73	155	177	196	79	73	72	72	72	78
1052										74	223	188	213	79	73	72	74	73	81
1108	—	19.5	+7	4.8	0.75	1.18	+6	.458	2.5	300	288	228	282	93	89	74	83	73	77
1122	—	19.5	+7	4.8	0.78	1.20	+6	.456	7.8	302	320	233	287	93	90	75	84	73	75
1138	—	19.5	+7	4.8	0.79	1.21	+6	.460	15.9	304	306	265	313	92	91	76	85	71	75
1152	—	20.6	+7	4.8	0.80	1.22	+6	.460	21.4	304	318	256	301	91	91	76	85	70	78
1207	—	19.7	+7	4.8	0.79	1.23	+6	.458	29.6	304	327	253	301	91	90	77	85	68	78
1222	—	19.7	+7	4.8	0.79	1.23	+6	.458	35.0	305	320	255	300	91	91	77	85	68	75
1240	—	19.5	+7	4.8	0.78	1.22	6	.457	43.9	306	321	253	301	91	90	78	85	67	79
1255	—	19.5	7	4.8	0.79	1.22	6	.458	51.2	309	316	252	300	91	90	78	85	67	78
1315	—	19.4	7	4.8	0.78	1.21	6	.458	60.4	310	318	253	301	92	91	79	86	67	81
1330	—	19.8	6	4.8	0.79	1.21	6	.458	66.9	311	321	257	302	92	91	79	86	67	79
1351	—	19.8	5	4.8	0.78	1.21	6	.458	78.0	309	320	258	303	93	92	80	88	67	82
AVGS:		19.6	6	4.8	.79	1.22	6.5			307			302				88	68	

} PRE TEST

START

Sample orifice pressure - deflects below zero on magnehelic
Dilution orifice pressure - reads correctly (shows positive)

ACTUAL DIL RATIO = 10.39

0.476 dscfm sample flow

4.47 dscfm dil flow

G-296

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	Metals 1
Date	9-3-97
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	" Hg
"g" scaling factor	

Filter ID	
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	"H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

G-297

Time	System Pressures (In. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1415	—	19.6	5	4.65	0.80	1.23	6	.458	1.8	309	308	198	258	92	92	81	87	69	80
1429	—	19.6	5	4.65	0.80	1.23	6	.460	6.6	309	318	236	295	93	92	81	87	69	82
1445	—	19.6	5	4.65	0.79	1.22	6	.460	15.0	308	318	258	302	94	94	83	89	69	82
1500	—	19.8	5	4.7	0.79	1.22	7	.458	22.1	308	319	261	304	96	95	85	91	69	82
1513	—	19.8	5	4.7	0.79	1.22	7	.458	27.0	307	318	258	304	95	95	85	90	69	78
1532	—	19.6	5	4.9	0.79	1.22	7	.459	37.1	307	316	260	305	95	94	84	90	69	82
1547	—	19.5	5	4.9	0.78	1.21	7	.458	43.7	307	315	262	305	96	95	84	90	69	83
1600	—	19.5	5	4.9	0.78	1.21	7	.458	49.6	307	315	265	305	96	95	84	91	70	76
1615	—	19.5	5	4.9	0.78	1.21	7	.458	56.6	308	315	264	305	94	94	84	90	69	84
1630	—	19.5	5	4.9	0.79	1.22	7	.458	64.3	307	314	262	305	95	94	84	90	68	84
1646	—	19.5	5	4.9	0.79	1.21	7	.458	72.1	307	314	262	306	96	95	85	90	69	87
1659	—	19.5	5	4.9	0.79	1.21	7	.458	76.1	307	311	263	305	96	95	85	90	69	76
1715	—	19.6	5	4.9	0.78	1.21	7	.458	84.6	308	312	264	306	96	95	85	91	69	84
1723	—	19.4	5	4.9	0.78	1.21	7	.458	88.4	307	311	263	306	97	95	85	91	69	82

1727 Stop impinger train
1729 pull out dilution probe

Sample nozzle reoriented during run
positioned at ~ 1 O'Clock

```
 DOE DILUTION TRAIN OPERATION

6/9/93
MM5
------------------------------
GAS ANALYSIS - O2  :     6.0
               CO2 :    13.0
               H2O :     7.0
AMB PRESS, In Hg   :   29.26
STACK dP, in H2O   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

Dil. Factor:          10.000

STACK GAS TEMP, F  :     318
GAS METER TEMP, F  :     100
Dil Air Temp              75
Exh air temp              85

PITOT CONSTANT     :    0.81
SAMP. ORI. DH@   :     26.02

Dil Air Ori DH@:      0.0334
Exhaust flow DH@      0.0413
Filter DP                  6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788           0.486 dscfm
dp                      1.00           26.02    19.72 DHso
FLOW, acfm            0.4863
Total flow In           4.86
Dil flow acfm           4.38
Dil Bw                     0

Side stream 1 flow, dscfm                0.6
Side stream 1 DH@                      1.788      1.24 DH1
Nutech 2

Side stream 2 flow, dscfm                0.6
Side stream 2 DH@                     1.7898      1.24 DH2
Nutech 48

Side stream 3 flow, dscfm                0.6
Side stream 3 DH@                       1.76      1.22 DH3
RAC 8643


Exhaust flow dscfm                      3.06
Exhaust flow DHexh                    0.0413      0.87 DHexh

                                        4.38
Dilution flow DHda                    0.0334      1.19 DHda
```

Dilution
Sample orifice dH

dilution exhaust dH
& Dil Flow dH

af

SETUP FOR OPERATION OF DILUTION TRAIN (constant sample rate)

Dilution constant, Cdil =	10	Sample orifice constant, dH@ =	26.02
Dilution factor in terms of standard conditions, fstd, is: Cdi(Tstd/TF)(PF/Pstd)		Total flow orifice constant, dH =	0.0413
		Diluted gas filter differential pressure	10
		Expected initial probe differential press	2
Sample rate (Q, stack cond.) =	0.60		
Ambient pressure, Pamb =	29.26		
Previous stack diff. pressure, dP =	6	Stack pressure, P =	29.7012
Previous stack temperature, T =	302	Expected orifice temperature, TH =	312
Stack gas O2 fraction, fo =	0.06	Stack gas dry molecular wgt., Md =	30.16
Stack gas CO2 fraction, fc =	0.12	Stack gas wet molecular wgt., Mw =	29.31
Stack gas water fraction, Bws =	0.07	Diluted gas molecular wgt., Mt =	28.87

The target for the diluter filter temperature, TF, is 68°F.

Keep orifice temperature, TH, at 10 °F above stack temperature.

Use settings based on orifice temperature, TH.

INCREMENTS		
T & TH	dPH	Q
20	5	0.02

dPH = P diff. to ambient at sample orifice inlet

Q (acfm)	dPH (in. H2O)=		-9.00	-4.00	1.00	6.00	11.00	16.00	21.00	26.00
		fstd=	10.00	9.88	9.75	9.63	9.51	9.39	9.26	9.14
T=		282	TH=	292						
		g=	0.55	0.55	0.56	0.56	0.57	0.57	0.57	0.58
0.58		dPI=	1.20	1.19	1.17	1.16	1.14	1.13	1.11	1.10
	dH(fyi)=		11.03	11.16	11.30	11.45	11.60	11.75	11.90	12.06
0.60		dPI=	1.29	1.27	1.25	1.24	1.22	1.20	1.19	1.17
	dH(fyi)=		11.80	11.95	12.10	12.25	12.41	12.57	12.74	12.91
0.62		dPI=	1.37	1.35	1.34	1.32	1.30	1.28	1.26	1.25
	dH(fyi)=		12.60	12.76	12.92	13.08	13.25	13.43	13.60	13.79
T=		302	TH=	312						
		g=	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58
0.58		dPI=	1.14	1.13	1.11	1.10	1.08	1.07	1.05	1.04
	dH(fyi)=		10.73	10.87	11.00	11.14	11.29	11.44	11.59	11.74
0.60		dPI=	1.22	1.20	1.19	1.17	1.16	1.14	1.13	1.11
	dH(fyi)=		11.49	11.63	11.78	11.93	12.08	12.24	12.40	12.57
0.62		dPI=	1.30	1.28	1.27	1.25	1.23	1.22	1.20	1.18
	dH(fyi)=		12.27	12.42	12.57	12.74	12.90	13.07	13.24	13.42
T=		322	TH=	332						
		g=	0.57	0.57	0.57	0.58	0.58	0.58	0.59	0.59
0.58		dPI=	1.08	1.07	1.06	1.04	1.03	1.02	1.00	0.99
	dH(fyi)=		10.46	10.59	10.72	10.86	11.00	11.14	11.29	11.44
0.60		dPI=	1.16	1.14	1.13	1.11	1.10	1.08	1.07	1.05
	dH(fyi)=		11.19	11.33	11.47	11.62	11.77	11.92	12.06	12.24
0.62		dPI=	1.24	1.22	1.20	1.19	1.17	1.16	1.14	1.12
	dH(fyi)=		11.95	12.10	12.25	12.41	12.57	12.73	12.90	13.07

G-299

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TZG
Date 5/13/93
Test No./Run No. Acid 1-01
Meter Box ID RAC A-8643
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.000
Leakrate, cfm, Post-test 0.000
2nd Filter (if used)
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GMVu
= 229.848
360 min.

GAS METER START, cf: 793.700
START TIME 1106

GAS METER END, cf 1023.548
END TIME 1726

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp Outlet	DGM in	DGM out
1106		0	1.0			1.22	793.7					132	113
		15	1.0				803.6					127	107
		30	1.0				813.1					128	109
		45	1.0				822.6					125	111
		60	1.0				832.3					124	111
		15	1.0				842.0					130	113
		30	1.0				851.4					129	115
		45	1.0				861.2					129	115
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.

1.22

121

Page 2 of 3

Method 5 Field Data Continued Date Location Run No. Acid 1-O:L Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	1.0			1.22	871.0					130	114
		15	1.0				880.4					129	115
		30	1.0				890.5					130	114
		45	1.0				899.8					129	115
Resume 2:14	Pow. lost	47:18 60	1.0				900.621 909.8					118	104
		15	1.0				917.9					124	107
		30	1.0				927.4					127	109
		45	1.0				936.4					128	112
		60	1.0				946.2					129	112
		15	1.0				956.1					129	113
		30	1.0				965.4					131	114
		45	1.0				975.2					131	114
		60	1.0				984.9					133	116
		15	1.0				994.6					131	117
		30	1.0			↓	1004.1					131	114

Page 3 of 3

Method 5 Field Data Continued Date Location Run No. Acid 1 - D.L Operator TE6

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	1.0			1.22	1013.8					132	117
		60:2	1.0				1023.548					133	119

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location D11 (Outlet ual) Run No. 1

Set Up By Lee Lowry Date 09/03/93 Run Date

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED	
Filter No.	
Sorbent Trap No.	
Condenser No.	

CYCLONES	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	643.7 g	656.3 g	12.6 g
Second	587.2 g	607.8 g	20.6 g
Third	490.0 g	493.5 g	3.5 g
Fourth	- g	- g	- g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final	
	769.9 g	807.8 g	37.9
	g	g	
Totals	g	g	74.6

COMMENTS:

Color of Silica Gel: about 40% pink

Description of Impinger Water:

ge 2 of 3

✓

METHOD 5 FIELD DATA

Plant/Location Bally
Operator TEG
Date 9/3/93
Test No./Run No. Metals 1-D/2
Meter Box ID Nutech #4B
Gas Meter Cal. Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp
Nozzle ID
Average Nozzle Dia., Inches
Barometric Pressure, in. Hg
Ambient Temp., deg. F
Assumed Moisture, %
Filter ID
Stack Pressure, in. H2O

1st Filter:
Leak Rate, cfm, Pretest .000
Leakrate, cfm, Post-test
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

G.M vol = 217.25

GAS METER START, cf 279.419
START TIME 1106 -

GAS METER END, cf 496.669
END TIME 1726

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
0		0	2.0			1.24	279.419					100	
		15	2.0				288.4					100	
		30	3.0				297.4					100	
		45	3.0				306.4					100	
		60	3.0				315.5					101	
		15	3.0				324.6					101	
		30	3.0				333.7					101	
		45	3.0				342.7					101	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max.	Max.	Avg.	Avg.
												106	

Page 2 of 7

Method 5 Field Data Continued Date Location Run No. metals 1- 0i/2 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	3.0			1.24	351.8					106	
		15	3.0				361.0					106	
		30	3.0				370.4					108	
		45	3.0				379.2					109	
Resume 2:14	power lost	47.18 60	3.0				380.138 382.8					104	
		15	3.0				396.7					104	
		30	3.0				405.7					108	
		45	3.0				414.7					108	
		60	3.0				423.6					108	
		15	3.0				432.9					110	
		30	3.0				441.9					110	
		45	3.0				451.1					108	
		60	3.0				460.2					108	
		15	3.0				469.3					108	
		30	3.0				478.2					110	

Page 2 of 2

Metals / Dil I

Method 5 Field Data Continued Date Location Run No. Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	3.0			1.24	487.3					110	
		60	3.0				496.669					110	

DOE DILUTION TRAIN OPERATION

I/93
IM6

GAS ANALYSIS - O2 :	6.0			
.CO2 :	13.0			
H2O :	7.0			
AMB PRESS, In Hg :	29.26			
STACK dP, In H2O :	7.0			
Enter Gas vel., fps	67.4			
or AVG SQR ROOT dp :				
Dil. Factor:	10.000			
STACK GAS TEMP, F :	318			
GAS METER TEMP, F :	100			
Dil Air Temp	75			
Exh air temp	85			
PITOT CONSTANT :	0.81			
SAMP. ORI. DH@ :	26.02			
Dil Air Ori DH@:	0.0334			
Exhaust flow DH@	0.0413			
Filter DP	6			
NOZZLE DIA, in :	0.169			
SYSTEM FLOW, acfm :	0.788	0.466	dscfm	
[illegible]	1.00	26.02	19.72	DHso
FLOW, scfm	0.4663			
Total flow in	4.86			
Dil flow scfm	4.38			
Dil Bw	0			
Side stream 1 flow, dscfm		0.6		
Side stream 1 DH@		1.788	1.24	DH1
Nutech 2				
Side stream 2 flow, dscfm		0.6		
Side stream 2 DH@		1.7896	1.24	DH2
Nutech 4B				
Side stream 3 flow, dscfm		0.6		
Side stream 3 DH@		1.76	1.22	DH3
RAC 8843				
Exhaust flow dscfm		3.08		
Exhaust flow DHexh		0.0413	0.87	DHexh
		4.38		
Dilution flow DHda		0.0334	1.19	DHda

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly
Sampling Location Dil #2 (outlet) Run No. 1
Set Up By KAK/DWS Date 09/03/93 Run Date
Comments Multiple Metals
Analyst Responsible for Recovery
Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	585.7 g	620.7 g	35.0 g
Second	571.8 g	577.3 g	5.5 g
Third	426.6 g	427.5 g	0.9 g
Fourth	602.7 g	602.3 g	-0.4 g
Fifth	589.8 g	588.6 g	-0.8 g
Sixth	460.2 g	462.3 g	2.1 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	793.4 g	829.6 g	36.2
	g	g	
Totals	g	g	
			78.5

COMMENTS:

Color of Silica Gel:

Description of Impinger Water:

PAGE 1 OF 3

G-309

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TEG
Date 9/3/93
Test No./Run No. Metal #1 / Dil #1
Meter Box ID Nutech #2
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID. ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.000
Leakrate, cfm, Post-test 0.000
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GMvol = 246.742

GAS METER START, cf: 5.950
START TIME 1106 -

GAS METER END, cf 252.692
END TIME 1226

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
1106		0	4.0			1.24	5.95					76	
		15	4.0				17.0					78	
		30	4.0				27.4					80	
		45	4.0				37.1					80	
		60	4.0				47.4					81	
		15	4.0				57.8					82	
		90	4.0				68.0					81	
		45	4.0				78.4					81	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

81

ge 2 of 7

Method 5 Field Data Continued Date Location Run No. Metals #1, 01 #1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	4.0			1.24	88.9					80	
		15	4.0				99.0					79	
		30	4.0				109.8					80	
		45	4.0				119.7					81	
Resume power lost 2:14		47:18 60	4.0				120,376 129.5					79	
		15	4.0				139.5					80	
		30	4.0				149.8					82	
		45	4.0				160.1					82	
		60	4.0				170.1					82	
		15	4.0				180.8					81	
		30	4.0				190.9					83	
		45	4.0				201.4					84	
		60	4.0				211.8					84	
		15	4.0				222.1					83	
		30	4.0				232.2					82	

Page 3 of 3

Method 5 Field Data Continued. Date Location Run No. Metals #1 - Oil #1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	4.0			1.24	242.5					83	
		60	4.0				252.692					82	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Dil #1 (outlet MT) Run No. 1

Set Up By JAK/DWS Date 09/03/93 Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	617.8 g	655.1 g	37.3 g
Second	659.2 g	663.7 g	4.5 g
Third	439.8 g	442.0 g	2.2 g
Fourth	573.1 g	573.4 g	0.4 g
Fifth	573.7 g	572.4 g	−1.3 g
Sixth	484.2 g	486.7 g	2.5 g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final	
	796.7 g	KD ~~826.6~~ 835.0 g	38.3
	g	g	
Totals	g	g	
			85.9.

COMMENTS:

Color of Silica Gel: 40% pink

Description of Impinger Water:

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	METALS 2
Date	9-4-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	" Hg
"g" scaling factor	0.58

Filter ID	3
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	4.0 "H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

G-313

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1003							[illegible]			—	276	121	134	82	83	81	83	73	81
1016	—	20.0	+5	4.2	0.73	1.14	-6	.461	0.2	309	345	179	253	95	95	83	91	74	71
1030	—	19.5	+5	4.2	0.71	1.12	-6	.459	6.1	310	325	220	290	94	95	83	89	73	71
1045	—	19.5	+5	4.2	0.70	1.11	-6	.458	12.7	311	323	245	297	93	95	82	88	71	73
1102	—	19.4	+5	4.2	0.71	1.12	-6	.458	21.4	308	323.	262	309	93	94	81	88	69	72
1115	—	19.5	+5	4.2	0.70	1.11	-6	.458	26.9	307	323	266	311	94	94	81	88	68	72
1130	—	19.5	+5	4.2	0.70	1.12	-6	.458	33.7	308	324	274	316	95	95	82	89	68	78
1145	—	19.5	+5	4.2	0.70	1.12	-6	.458	41.7	308	324	265	304	96	95	84	90	69	83
1200	—	19.5	+5	4.25	0.70	1.11	-6	.458	48.5	309	322	258	300	96	96	84	90	69	78
1215	—	19.4	+5	4.3	0.70	1.11	-6	.459	55.7	310	322	261	302	97	96	85	91	70	82
1230	—	19.3	+5	4.4	0.70	1.11	-6	.459	62.3	310	322	261	303	97	97	86	92	71	83
1245	—	19.5	+5	4.4	0.71	1.12	-6	.460	69.3	309	322	263	304	99	98	87	94	72	84
1300	—	19.5	+5	4.4	0.70	1.13	-6	.460	76.6	309	270	263	293	98	97	87	92	73	75
1315	—	19.5	+5	4.4	0.70	1.13	-6	.460	83.6	310	269	260	295	97	96	85	91	72	79
avgs		19.4	+5	4.4	0.70	1.12				309							93	72	

1014 Start

364 minutes

page 2

Run Sheet for the PM10 Dilution Train

Plant Name	Baily
Run ID	METALS 2
Date	9-4-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	" Hg
"g" scaling factor	.58

Filter ID	3
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	"H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1330	–	19.5	+5	4.45	0.71	1.13	7	.463	90.9	310	310	259	296	97	97	85	91	71	75
1345	–	19.5	+5	4.45	0.71	1.12	7	.464	96.5	312	321	261	299	97	97	86	91	71	84
1400	–	19.5	+5	4.45	0.71	1.12	7	.463	105.8	309	320	259	300	98	98	87	93	71	86
1415	–	19.5	+5	4.45	0.71	1.14	7	.464	113.0	308	318	259	298	99	99	88	94	73	86
1430	–	19.4	+5	4.45	.71	1.14	7	.462	119.2	309	320	261	300	100	100	89	95	73	92
1448	–	19.4	+5	4.45	0.71	1.13	7	.462	128.4	307	318	258	301	101	101	90	96	74	88
1500	–	19.4	+5	4.6	0.71	1.13	7	.459	134.8	308	318	262	302	102	101	91	97	75	92
1515	–	19.5	+5	4.6	0.71	1.14	7	.458	141.0	308	316	258	299	102	101	92	97	75	92
1530	–	19.5	+5	4.6	0.70	1.14	7	.459	147.7	307	318	262	301	103	102	92	97	76	88
1546	–	19.4	+5	4.6	0.71	1.14	7	.459	156.0	307	317	260	299	102	102	91	97	77	83
1600	–	19.4	+5	4.6	0.71	1.14	7	.456	161.5	307	317	261	301	103	102	92	98	77	90
1611	–	19.2	+5	4.6	0.71	1.13	7	.456	167.0	307	318	261	301	105	102	93	98	77	93
1618									170.2										

19.4 65

1618 – pull probe out, cease sampling

;4

```
HDE DILUTION TRAIN OPERATION

                9/4/93
MHS
****************************
GAS ANALYSIS - O2  :     6.2
              CO2  :    12.8
              H2O  :    10.0
AMB PRESS, in Hg   :   29.40
STACK dP, in H2O   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

DIL. Factor:          10.000

STACK GAS TEMP, F  :     320
GAS METER TEMP, F  :     100
Dil Air Temp              75
Exh air temp              85

PITOT CONSTANT     :    0.81
SAMP. ORI. DH@   :     26.02

Dil Air Ori DH@:      0.0334
Exhaust flow DH@      0.0413
Filter DP                  6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788            0.472 dscfm
 dp                     1.00            26.02    19.50 DHso
FLOW, scfm            0.4717
Total flow In           4.72
Dil flow scfm           4.24
Dil Bw                     0

Side stream 1 flow, dscfm                 0.6
Side stream 1 DH@                       1.788    1.24 DH1
Nutech 2

Side stream 2 flow, dscfm                 0.6
Side stream 2 DH@                      1.7898    1.24 DH2
Nutech 4B

Side stream 3 flow, dscfm                 0.6
Side stream 3 DH@                        1.76    1.22 DH3
RAC 8643


Exhaust flow dscfm                       2.92
Exhaust flow DHexh                     0.0413    0.78 DHexh

                                         4.24
Dilution flow DHda                     0.0334    1.11 DHda
```

RANDY

Sample orifice

~ "TOTAL" EXPECTED

DIL. AIR SET

&F

```
SETUP FOR OPERATION OF DILUTION TRAIN (constant sample rate)

        Dilution constant, Cdil =          10 Sample orifice constant, dHQ =   26.02
Dilution factor in terms of standard          Total flow orifice constant, d  0.0413
conditions, fstd, is:                         Diluted gas filter differentia      10
        Cdil(Tstc/TF)(PF/Pstd)                Expected initial probe differe       1

Sample rate (Q, stack cond.) =           0.60
Ambient pressure, Pamb =                 29.4
Previous stack diff. pressure, dP =         7 Stack pressure, P =            29.91471
Previous stack temperature, T =           320 Expected orifice temperature,      330
Stack gas O2 fraction, fo =             0.062 Stack gas dry molecular wgt.,    30.30
Stack gas CO2 fraction, fc =            0.128 Stack gas wet molecular wgt.,    29.07
Stack gas water fraction, Bws =           0.1 Diluted gas molecular wgt., Mt   28.84

The target for the diluter filter temperature, TF, is 60°F.         INCREMENTS
Keep orifice temperature, TH, at 10 °F above stack temperatur T & TH   dPH      Q
Use settings based on orifice temperature, TH.                    20      5   0.02

        dPH = P diff. to ambient at sample orifice inlet
Q (acfm) dPH (in. H2O) -11.00  -6.00   -1.00   4.00   9.00  14.00  19.00   24.00
            fstd=  10.10   9.97    9.85   9.73   9.61   9.48   9.36    9.24
     T=       300    TH=    310
               g=   0.56   0.56    0.56   0.57   0.57   0.58   0.58    0.58
   0.58      dPt=   1.17   1.16    1.15   1.13   1.12   1.10   1.09    1.07
        dH(fyi)=   10.81  10.94   11.07  11.21  11.36  11.51  11.66   11.81
   0.60      dPt=   1.26   1.24    1.22   1.21   1.19   1.18   1.16    1.14
        dH(fyi)=   11.56  11.71   11.85  12.00  12.15  12.31  12.47   12.64
   0.62      dPt=   1.34   1.32    1.30   1.29   1.27   1.25   1.24    1.22
        dH(fyi)=   12.35  12.50   12.65  12.81  12.98  13.15  13.32   13.50
     T=       320    TH=    330
               g=   0.56   0.57    0.57   0.58   0.58   0.58   0.59    0.59
   0.58      dPt=   1.12   1.10    1.09   1.07   1.06   1.05   1.03    1.02
        dH(fyi)=   10.52  10.65   10.79  10.92  11.06  11.21  11.35   11.50
   0.60      dPt=   1.19   1.18    1.16   1.15   1.13   1.12   1.10    1.09
        dH(fyi)=   11.26  11.40   11.54  11.69  11.84  11.99  12.15   12.31
   0.62      dPt=   1.27   1.26    1.24   1.22   1.21   1.19   1.17    1.16
        dH(fyi)=   12.03  12.17   12.33  12.48  12.64  12.81  12.97   13.15
     T=       340    TH=    350
               g=   0.57   0.58    0.58   0.58   0.59   0.59   0.59    0.60
   0.58      dPt=   1.06   1.05    1.03   1.02   1.01   0.99   0.98    0.97
        dH(fyi)=   10.26  10.38   10.51  10.65  10.78  10.92  11.07   11.21
   0.60      dPt=   1.13   1.12    1.11   1.09   1.08   1.06   1.05    1.03
        dH(fyi)=   10.98  11.11   11.25  11.39  11.54  11.69  11.84   12.00
   0.62      dPt=   1.21   1.19    1.18   1.16   1.15   1.13   1.12    1.10
        dH(fyi)=   11.72  11.87   12.01  12.17  12.32  12.48  12.65   12.81
```

g- 0.58

9/4/93

METHOD 5 FIELD DATA

Plant/Location Bally
Operator TLB
Date 9/4/93
Test No./Run No. Metals 2, OL 1
Meter Box ID Nutech 2
Gas Meter Cal Factor
Orifice ID
Orifice DH@

Pitot Coefficient, Cp
Nozzle ID
Average Nozzle Dia., inches
Barometric Pressure, in. Hg
Ambient Temp., deg. F
Assumed Moisture, %
Filter ID
Stack Pressure, in. H20

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (if used):
Leak Rate, cfm, Pretest
Leakrate, cfm, Post-test

GAS METER START, cf: 254.100
START TIME 1012

GAS METER END, cf 501.576
END TIME 1612

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	3.5			1.24	254.100					80	
		15	3.5				265.2					82	
		30	3.5				276.3					82	
		45	3.5				286.0					82	
		60	3.5				296.3					82	
		15	3.5				306.5					82	
		30	3.5				316.7					83	
		45	3.5				327.3					85	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

86

2 of 2

Method 5 Field Data Continued Date Location Run No. Metals 2, OL1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	3.5			1.24	337.7					86	
		15	3.5				348.2					87	
		30	3.5				358.0					88	
		45	3.5				367.9					87	
		60	3.5				378.4					87	
		15	3.5				388.7					87	
		30	3.5				399.0					86	
		45	3.5				409.4					87	
		60	3.5				419.5					87	
		15	3.5				429.9					88	
		30	3.5				441.1					89	
		45	3.5				450.4					89	
		60	3.5				460.7					89	
		15	3.5				471.2					89	
		30	3.5				481.3					88	

Page 3 of 3

Method 5 Field Data Continued. Date Location Run No. Metals 2, DL 1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	3.5			1.24	491.7					89	
		60	3.5			↓	501.576					89	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location DI #1 (outlet at T) Run No. 2

Set Up By WDK/DWT Date 09/04/93 Run Date

Comments Multiple Metals

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	589.2 g	628.0 g	38.8 g
Second	579.2 g	584.7 g	5.5 g
Third	427.3 g	427.8 g	0.5 g
Fourth	577.4 g	577.5 g	0.1 g
Fifth	590.7 g	589.3 g	-1.4 g
Sixth	462.9 g	463.7 g	0.8 g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	776.0 g	813.2 37.2 net g
	g	g
Totals	g	g

81.5 total

COMMENTS:

Color of Silica Gel: 2/5 Pink

Description of Impinger Water:

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TLG
Date 9/4/99
Test No./Run No. Metals2, 012
Meter Box ID Nutech 46
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID. ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 498.000
START TIME 1012

GAS METER END, cf 718.753
END TIME 1612

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	3.0			1.24	498.0					104	
		15	3.0				507.8					104	
		30	3.0				517.4					103	
		45	3.0				526.1					102	
		60	3.0				535.2					102	
		15	3.0				544.2					102	
		30	3.0				553.3					102	
		45	3.0				562.6					104	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Metals 2, Dil 2 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	3.0			1.24	571.7					106	
		15	3.0				581.1					108	
		30	3.0				590.0					108	
		45	3.0				598.8					107	
		60	3.0				608.1					106	
		15	3.0				617.2					107	
		30	3.0				626.3					107	
		45	3.0				635.6					108	
		60	3.0				644.8					110	
		15	3.0				654.0					110	
		30	3.0				664.0					112	
		45	3.0				672.4					112	
		60	3.0				681.5					113	
		15	3.0				961.0					114	
		30	3.0				700.1					114	

Page 3 of 3

Method 5 Field Data Continued Date Location Run No. Metals 2, DL 2 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	3.0			1.24	709.4					118	
		60	3.0			↓	718.753					117	

```
DOE DILUTION TRAIN OPERATION

NH5
-----------------------------
GAS ANALYSIS - O2  :     6.2
              CO2 :     12.8
              H20 :     10.0
AMB PRESS, in Hg   :    29.40
STACK dP, in H20   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

Dil. Factor:           10.000

STACK GAS TEMP, F  :      320
GAS METER TEMP, F  :      100
Dil Air Temp               75
Exh air temp               85

PITOT CONSTANT     :     0.81
SAMP. ORI. DHB   :      26.02

Dil Air Ori DHa:       0.0534
Exhaust flow DHa       0.0413
filter DP                   6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788            0.472 dscfm
dp                      1.00            26.02     19.50 DHso
FLOW, scfm            0.4717
Total flow in           4.72
Dil flow scfm           4.24
Dil Bw                     0

Side stream 1 flow, dscfm            0.6
Side stream 1 DHa                  1.788      1.24 DH1
Nutech 2

Side stream 2 flow, dscfm            0.6
Side stream 2 DHa                 1.7898      1.24 DH2
Nutech 45

Side stream 3 flow, dscfm            0.6
Side stream 3 DHa                   1.76      1.22 DH3
RAC 8643


Exhaust flow dscfm                  2.92
Exhaust flow DHexh                0.0413      0.78 DHexh

                                    4.24
Dilution flow DHda                0.0334      1.11 DHda
```

9/4/93

Sampling Train

Inl. Mixer Boxes

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY

Sampling Location DIL #2 (WEST 7 OUTLET) Run No. 2

Set Up By JWC/DWS Date 09/09/93 Run Date

Comments MULTIPLE METALS

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	613.1 g	650.4 g	37.3 g
Second	665.4 g	669.5 g	4.1 g
Third	441.0 g	443.1 g	2.1 g
Fourth	605.2 g	603.9 g	-1.3 g
Fifth	564.7 g	562.2 g	-2.5 g
Sixth	486.0 g	486.9 g	0.9 g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	835.4 g	872.3 ⇒ 36.9 net g
	g	g
Totals	g	g

TOTAL 77.5

COMMENTS:

Color of Silica Gel: 1/3 Pink

Description of Impinger Water:

ge 1 of 2

METHOD 5 FIELD DATA

Plant/Location Bally
Operator TEG
Date 9/4/97
Test No./Run No. Aerds 2, Oil
Meter Box ID RAC A-8643
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf 25.100
START TIME 1012

GAS METER END, cf 257.163
END TIME 1612

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	3.0			1.22	25.1					126	105
		15	2.5				35.6					128	111
		30	2.5				45.7					130	111
		45	2.5				54.9					130	112
		60	2.5				64.5					131	112
		15	2.5				74.1					131	113
		30	2.5				83.6					132	113
		45	2.5				93.5					132	114
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

125

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Acids 2, DL Operator TEL

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	2.5			1.22	103.2					134	115
		15	2.5				113.1					132	116
		30	2.5				122.2					135	117
		45	2.5				131.5					135	117
		60	2.5				141.4					135	118
		15	2.75				151.0					136	118
		30	2.75				160.6					136	118
		45	2.75				170.4					135	119
		60	2.75				179.9					135	119
		15	2.75				189.5					136	119
		30	2.75				200.0					138	120
		45	2.75				208.8					137	121
		60	3.0				218.5					134	121
		15	3.0				228.5					137	121
		30	3.0				237.9					135	119

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Acids 2, ALO Operator TEL

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		45	3.0			1.22	247.7					137	120
		60	3.0			↓	257.163					136	120

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Dil (Outlet-Unit 7) Run No. 2

Set Up By [illegible] Date 04/09/93 Run Date

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	644.1 g	653.9 g	9.8 g
Second	605.5 g	626.6 g	21.1 g
Third	474.7 g	479.3 g	4.6 g
Fourth	— g	— g	— g
Fifth	— g	— g	— g
Sixth	— g	— g	— g
Seventh	— g	— g	— g

SILICA GEL WEIGHTS:	Initial	Final
	873.0 g	911.2 g 38.2 Net
	g	g
Totals	g	g

73.7 total

COMMENTS:

Color of Silica Gel: 1/2 Pink

Description of Impinger Water:

Page 2

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	METALS 3
Date	9-5-93
Operator	Randy Merrill

Run Conditions	
ΔP duct (static)	"H2O
Barometric Pressure	" Hg
"g" scaling factor	

Filter ID	
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	"H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

G-330

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1315	–	19.3	+5	4.6	0.70	1.15	6	.456	88.0	312	298	256	305	105	102	93	99	74	85
1330	–	19.3	+5	4.6	0.70	1.14	6	.456	95.1	312	297	254	305	105	102	91	98	74	86
1345	–	19.2	+5	4.6	0.70	1.14	6	.457	102.5	312	297	253	303	103	100	90	96	72	83
1400	–	19.3	+5	4.6	0.70	1.13	6	.459	109.5	312	297	252	302	103	100	90	96	73	85
1415	–	19.5	+5	4.6	0.69	1.13	6	.461	116.1	312	295	252	302	103	100	89	95	72	85
1433	–	19.5	+5	4.6	0.69	1.12	6	.463	125.1	313	295	251	301	101	99	87	94	70	82
1445	–	19.3	+5	4.6	0.70	1.13	6	.463	130.9	312	295	251	301	101	98	86	93	69	85
1500	–	19.3	+5	4.6	0.69	1.12	6	.460	137.5	311	298	250	300	100	97	85	92	69	85
1518	–	19.3	+5	4.6	0.69	1.12	6	.460	146.2	309	298	249	299	101	97	84	91	68	82
1530	–	19.3	±5	4.6	0.68	1.12	6	.460	151.8	309	299	247	298	100	96	83	90	68	82
1545	–	19.3	+5	4.6	0.68	1.11	6	.459	158.9	308	299	246	297	100	95	82	89	68	81
1602	–	19.3	+5	4.6	.69	1.11	6	.459	167.3	309	297	246	297	99	95	82	89	67	86
1612									171.5										
Avg.		19.4	+5	4.6	.69	1.12	6		[illegible] 83.5	311			304				94	74	

1608 stop train.

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	METALS 3
Date	9-5-93
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	29.30 " Hg
"g" scaling factor	.59

Filter ID	4
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	5	"H2O/min @ 100"
Leak Check:	Sample Gas		ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1004										—	192	169	189	81	78	79	81	77	75
1010	—	19.5	+5	5.4	0.68	1.13	6	.461	0.9	311	233	189	241	89	90	81	87	77	75
1015	—	19.0	+5	4.1	0.68	1.10	6	.459	3.0	313	257	202	260	92	93	82	89	77	79
1025	—	19.5	+5	4.25	0.70	1.15	6	.463	7.2	313	275	221	278	95	96	84	92	77	82
1040	—	19.4	+5	4.25	0.70	1.11	6	.460	14.7	314	282	245	298	100	100	87	94	75	83
1055	—	19.5	+5	4.3	0.70	1.11	6	.464	21.5	315	285	255	308	102	100	88	96	74	86
1110	—	19.5	+5	4.3	0.68	1.11	6	.464	28.4	315	287	255	305	103	101	90	97	73	84
1132	—	19.5	+5	4.4	0.69	1.12	6	.458	39.6	312	286	252	303	105	102	92	98	72	84
1144	—	19.5	+5	4.6	0.70	1.14	6	.459	45.3	308	292	253	303	105	102	93	98	72	85
1157	—	19.5	+5	4.6	0.68	1.11	6	.457	51.7	307	296	253	303	105	103	92	98	72	90
1215	—	19.3	+5	4.6	0.68	1.11	6	.455	58.6	310	295	254	304	106	103	92	98	72	85
1230	—	19.5	+5	4.6	0.70	1.15	6	.454	65.5	314	296	257	306	106	102	92	98	73	89
1250		19.5	+5	4.6	0.70	1.15	6	.458	76.2	313	300	256	306	105	102	92	98	73	89
1302		19.5	+5	4.6	0.70	1.15	6	.457	81.8	313	298	256	306	105	102	93	98	73	88

1008 · Start boxes

glass sample nozzle position reinforced
w/ glass fiber tape on outside of nozzle, as was

~1130 vacuum hose pulled out at large ball valve
for 20-30 seconds.

DDE DILUTION TRAIN OPERATION

~~[illegible]~~ 9/5/93

```
MM5
----------------------------
GAS ANALYSIS - O2  :    6.2
              CO2 :    12.8
              H2O :    10.0
AMB PRESS, in Hg   :   29.30
STACK dP, in H2O   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

Dil. Factor:          10.000

STACK GAS TEMP, F  :     320
GAS METER TEMP, F  :     100
Dil Air Temp              75
Exh air temp              85

PITOT CONSTANT     :    0.81
SAMP. ORI. DHQ   :     26.02

Dil Air Ori DHQ:      0.0334
Exhaust flow DHQ      0.0413
Filter DP                  6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788          0.470 dscfm
dp                      1.00          26.02    19.43 DHso
FLOW, scfm            0.4701
Total flow in           4.70
Dil flow scfm           4.23
Dil Bw                     0

Side stream 1 flow, dscfm              0.6
Side stream 1 DHQ                    1.788     1.24 DH1
Nutech 2

Side stream 2 flow, dscfm              0.6
Side stream 2 DHQ                   1.7898     1.24 DH2
Nutech 4B

Side stream 3 flow, dscfm              0.6
Side stream 3 DHQ                     1.76     1.22 DH3
RAC 8643


Exhaust flow dscfm                    2.90
Exhaust flow DHexh                  0.0413     0.78 DHexh

                                      4.23
Dilution flow DHda                  0.0334     1.11 DHda
```

DIL 9/5

```
:TUP FOR OPERATION OF DILUTION TRAIN (constant sample rate)

        Dilution constant, Cdil =          10 Sample orifice constant, dHQ =   26.02
Dilution factor in terms of standard          Total flow orifice constant, d  0.0413
conditions, fstd, is:                         Diluted gas filter differentia      10
        Cdil(Tstd/TF)(PF/Pstd)                Expected initial probe differe       1

Sample rate (Q, stack cond.) =           0.60
Ambient pressure, Pamb =                 29.3
Previous stack diff. pressure, dP =         7 Stack pressure, P =           29.81471
Previous stack temperature, T =           320 Expected orifice temperature,      330
Stack gas O2 fraction, fo =             0.062 Stack gas dry molecular wgt.,    30.30
Stack gas CO2 fraction, fc =            0.120 Stack gas wet molecular wgt.,    29.07
Stack gas water fraction, Bws =           0.1 Diluted gas molecular wgt., Mt   28.84

The target for the dilutor filter temperature, TF, is 68▮F.          INCREMENTS
Keep orifice temperature, TH, at 10 ▮F above stack temperatur T & TH   dPH       Q
Use settings based on orifice temperature, TH.                     20     5    0.02

        dPH = P diff. to ambient at sample orifice inlet
Q (acfm) dPH (in. H2O) -11.00  -6.00   -1.00   4.00   9.00  14.00  19.00   24.00
              fstd=    10.06   9.94    9.82   9.69   9.57   9.45   9.33    9.20
    T=          300      TH=    310
                 g=     0.56   0.56    0.57   0.57   0.57   0.58   0.58    0.58
  0.58         dPt=     1.16   1.15    1.13   1.12   1.10   1.09   1.07    1.06
         dH(fyi)=      10.77  10.90   11.04  11.18  11.32  11.47  11.62   11.78
  0.60         dPt=     1.24   1.23    1.21   1.20  .1.18   1.16   1.15    1.13
         dH(fyi)=      11.52  11.67   11.81  11.96  12.12  12.27  12.44   12.60
  0.62         dPt=     1.33   1.31    1.29   1.27   1.26   1.24   1.22    1.21
         dH(fyi)=      12.31  12.46   12.61  12.77  12.94  13.11  13.28   13.46
    T=          320      TH=    330
                 g=     0.57   0.57    0.57   0.58   0.58   0.58   0.59    0.59
  0.58         dPt=     1.10   1.09    1.08   1.06   1.05   1.03   1.02    1.01
         dH(fyi)=      10.49  10.62   10.75  10.89  11.03  11.17  11.32   11.47
  0.60         dPt=     1.18   1.17    1.15   1.14   1.12   1.11   1.09    1.07
         dH(fyi)=      11.22  11.36   11.51  11.65  11.80  11.95  12.11   12.27
  0.62         dPt=     1.26   1.24    1.23   1.21   1.19   1.18   1.16    1.15
         dH(fyi)=      11.99  12.13   12.29  12.44  12.60  12.77  12.93   13.11
    T=          340      TH=    350
                 g=     0.57   0.58    0.58   0.58   0.59   0.59   0.60    0.60
  0.58         dPt=     1.05   1.04    1.02   1.01   1.00   0.98   0.97    0.96
         dH(fyi)=      10.22  10.35   10.48  10.61  10.75  10.89  11.03   11.18
  0.60         dPt=     1.12   1.11    1.09   1.08   1.07   1.05   1.04    1.02
         dH(fyi)=      10.94  11.08   11.21  11.36  11.50  11.65  11.81   11.96
  0.62         dPt=     1.20   1.18    1.17   1.15   1.14   1.12   1.11    1.09
         dH(fyi)=      11.68  11.83   11.97  12.13  12.28  12.44  12.61   12.77
```

9/5/93

Page 2 of 3

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TEG
Date 9/5/93
Test No./Run No. Acids 3 - Dil
Meter Box ID RAC - A-9643
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHD ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 258.400
START TIME 1008 - 1608

GAS METER END, cf 490.831
END TIME 1608

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	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		0	1.0			1.22	258.4					120	103
		15	1.0				268.0					125	106
		30	1.0				277.6					127	105
		45	1.0				287.3					127	112
		60	1.0				296.9					129	112
		15	1.0				306.5					130	113
		30	1.0				316.1					131	114
		45	1.0				325.7					131	115
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.

122

Page 2 of 3

Method 5 Field Data Continued Date Location Run No. Acids 3 -D.L Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	1.0			1.22	335.6					132	116
		15	1.0				345.4					131	117
		30	1.0				355.1					132	117
		45	1.0				364.9					131	116
		60	1.0				374.5					133	116
		15	1.0				384.4					133	117
		30	1.0				394.2					133	115
		45	1.0				403.7					133	115
		60	1.0				413.5					132	116
		15	1.0				423.2					131	115
		30	1.0				432.4					131	114
		45	1.0				442.5					130	114
		60	1.0				452.7					130	114
		15	1.0				462.9					128	114
		30	1.0				471.5					129	114

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Acids 3-Dil Operator TEC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	1.0			1.22	481.3					124	117
		60	1.0				490831					128	117

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location Oil (Outlet Unit 7) Run No. 3

Set Up By DDK / DWD Date 09/05/93 Run Date 09/05/93

Comments Acids

Analyst Responsible for Recovery

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No.

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	636.7 g	645.3 g	8.6 g
Second	581.6 g	603.5 g	21.9 g
Third	477.2 g	480.3 g	3.1 g
Fourth	– g	– g	– g
Fifth	– g	– g	– g
Sixth	– g	– g	– g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final	
	916.2 g	952.3 g	NL 36.1
	g	g	
Totals	g	g	

TOTAL 69.7

COMMENTS:

Color of Silica Gel: 1/2 pink

Description of Impinger Water:

ge 1 of 2

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TEG
Date 4/5/93
Test No./Run No. Metals 3-D:L 1
Meter Box ID Aptech 2B
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DHØ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., Inches ______
Barometric Pressure, In. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, In. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test ___
2nd Filter (if used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 502.800
START TIME 1008 - 1604

GAS METER END, cf 750.537
END TIME 1604

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		0	5.0			1.24	502.8					82	
		15	5.0				513.3					83	
		30	4.75				523.6					84	
		45	4.75				534.0					85	
		60	4.75				544.2					85	
		15	4.75				554.5					85	
		30	4.75				564.7					86	
		45	4.75				575.2					87	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
												85	

Page 2 of 3

Method 5 Field Data Continued Date Location Run No. Metals 3- Oil 1 Operator TEA

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	4.75			1.24	585.5					87	
		15	4.75				596.0					97	
		30	4.75				606.3					88	
		45	4.75				616.7					88	
		60	4.75				627.0					85	
		15	4.75				637.6					88	
		30	4.75				647.9					87	
		45	4.75				658.1					87	
		60	4.75				668.5					87	
		15	4.75				678.9					85	
		30	4.75				689.2					85	
		45	4.75				699.5					84	
		60	4.75				710.5					83	
		15	4.75				721.1					82	
		30	4.75				730.1					81	

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Metals 3 -D.L 1 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F)					
								Probe	Filter	Sorb	Imp. Outlet	DGM in	DGM out
		45	4.75			1.24	740.6					80	
		60	4.75			↓	750.537					80	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant BAILLY

Sampling Location DIL #1 (OUTLET UNIT) Run No. 3

Set Up By JLK/DWS Date 09/05/93 Run Date 09/05/93

Comments MULTIPLE METALS

Analyst Responsible for Recovery

Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED

Filter No. ______

Sorbent Trap No. ______

Condenser No. ______

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	612.4 g	643.9 g	31.5 g
Second	595.8 g	600.8 g	5.0 g
Third	442.0 g	443.1 g	1.1 g
Fourth	601.0 g	597.6 g	– 3.4 g
Fifth	584.4 g	584.6 g	0.2 g
Sixth	488.2 g	490.1 g	1.9 g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	798.7 g	837.2 g net 38.5
	g	g
Totals	g	g

TOTAL 74.8

COMMENTS:

Color of Silica Gel: 1/2 Pink

Description of Impinger Water:

rt 1 of 2

METHOD 5 FIELD DATA

Plant/Location Bally
Operator TEC
Date 5/5/93
Test No./Run No. Metals 3-DL 2
Meter Box ID Nutech 4B
Gas Meter Cal. Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (if used):
Leak Rate, cfm, Pretest ______
Leakrate, cfm, Post-test ______

GAS METER START, cf 720.100
START TIME 1008 – 1608

GAS METER END, cf 939.975
END TIME 1608

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM In	DGM out
		0	3.5			1.24	720.1					100	
		15	3.5				729.3					102	
		30	3.5				738.4					104	
		45	3.5				747.5					105	
		60	3.25				756.8					106	
		15	3.25				766.0					107	
		30	3.25				775.2					107	
		45	3.25				784.4					107	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
												107	

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. Metals3-0L2 Operator TEL

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	3.25			1.24	793.7					108	
		15	3.25				802.8					108	
		30	3.25				812.0					110	
		45	3.25				821.1					110	
		60	3.25				830.2					110	
		15	3.25				839.5					109	
		30	3.25				848.6					106	
		45	3.25				857.7					106	
		60	3.25				866.8					106	
		15	3.25				875.9					109	
		30	3.25				885.1					108	
		45	3.25				894.2					108	
		60	3.25				903.8					108	
		15	3.25				912.4					108	
		30	3.25				921.7					108	

age 2 of 2

Method 5 Field Data Continued Date Location Run No. Metals 3 - DL 2 Operator TEC

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		45	3.25			1.24	930.8					108	
		60	3.25			0	939.975					108	

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location DIL #2 (outlet unit 7) Run No. 3

Set Up By WK/ws Date 09/03/93 Run Date 09/03/93

Comments Multiple Metals

Analyst Responsible for Recovery Will L. H

Calculations & Report Reviewed By ______ Report Date ______

FILTERS USED

Filter No. ______

______

Sorbent Trap No. ______

______

Condenser No. ______

______

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	617.6 g	649.3 g	31.7 g
Second	585.2 g	591.9 g	6.7 g
Third	441.4 g	442.7 g	1.3 g
Fourth	582.8 g	580.5 g	-2.3 g
Fifth	596.6 g	598.5 g	1.9 g
Sixth	486.6 g	486.6 g	0 g
Seventh	– g	– g	– g

SILICA GEL WEIGHTS:	Initial	Final
	878.4 g	914.2 Net 35.8 g
	g	g
Totals	g	g

TOTAL 75.1

COMMENTS:

Color of Silica Gel: 1/2 Pink

Description of Impinger Water: ______

```
 DOE DILUTION TRAIN OPERATION

6/9/93
MM5
------------------------------
GAS ANALYSIS - O2  :     6.2
               CO2 :    12.8
               H2O :    10.0
AMB PRESS, in Hg   :   29.30
STACK dP, in H2O   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

Dil. Factor:          10.000

STACK GAS TEMP, F  :     320
GAS METER TEMP, F  :     100
Dil Air Temp              75
Exh air temp              85

PITOT CONSTANT     :    0.81
SAMP. ORI. DHG   :     26.02

Dil Air Ori DHG:      0.0334
Exhaust flow DHG      0.0413
Filter DP                  6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788            0.470 dscfm
dp                      1.00            26.02     19.43 DHso
FLOW, scfm            0.4701
Total flow in           4.70
Dil flow scfm           4.23
Dil Bw                     0

Side stream 1 flow, dscfm                 0.6
Side stream 1 DHG                       1.788     1.24 DH1
Nutech 2

Side stream 2 flow, dscfm                 0.6
Side stream 2 DHG                      1.7898     1.24 DH2
Nutech 4B

Side stream 3 flow, dscfm                 0.6
Side stream 3 DHG                        1.76     1.22 DH3
RAC 8643


Exhaust flow dscfm                       2.90
Exhaust flow DHexh                     0.0413     0.78 DHexh

                                         4.23
Dilution flow DHdo                     0.0334     1.11 DHdo
```

DIL
9,15

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	ORGANICS 1
Date	9-6-93
Operator	Randy Merrill

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	" Hg
"g" scaling factor	.58

Filter ID	5
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	5	"H2O/min @ 100"
Leak Check:	Sample Gas		ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
955										—	234	120	133	65	62	62	63	63	63
1006									0	—	245	139	152	65	62	62	62	62	63
1020	—	18.5	+5	4.0	0.82	1.07	6	.450	3.9	318	282	167	227	80	76	65	70	64	63
1030	-	18.7	+5	4.0	0.82	1.07	6	.457		330	295	176	240	80	76	64	70	64	64
1040	-	18.6	+5	4.0	0.84	1.10	6	.450	11.6	350	307	195	258	81	77	65	71	63	66
1055	-	18.6	+5	4.0	0.85	1.08	6	.448	18.4	340	279	213	268	82	78	66	72	61	64
1110	-	18.7	+5	4.0	0.84	1.07	6	.451	26.5	—	282	222	272	82	79	67	72	61	64
1130	-	18.6	+5	4.0	0.83	1.07	6	.452	34.9	—	297	231	285	83	80	67	73	59	66
1145	—	18.7	+5	4.0	0.85	1.07	6	.449	41.3	—	297	236	288	84	80	68	73	59	64
1200	-	18.6	+5	4.05	0.83	1.07	6	.452	48.3	—	296	238	290	84	80	68	73	58	65
1216	-	18.5	+5	4.05	0.82	1.07	6	.449	56.3	—	296	246	297	84	80	68	74	58	64
1230	-	18.5	+5	4.15	0.83	1.07	6	.450	62.2	—	296	249	299	85	80	69	74	58	66
1245	-	18.6	+5	4.10	0.82	1.07	6	.450	69.0	-	296	253	302	85	81	69	74	58	66
1255	—	18.6	+5	4.10	0.81	1.07	6	.448	74.1	—	296	254	303	86	81	70	75	58	67
Avgs:		18.7	+5	4.1	.83	1.08	5.5										74	59	

1017 Start dilution

my T1 reading is probably high
: unit 7 outlet MT only reading ~5° higher th yesterday

Page 2

Run Sheet for the PM10 Dilution Train

Plant Name	Bailly
Run ID	ORGANICS 1
Date	9-6-99
Operator	Randy Merritt

Run Conditions	
ΔP duct (static)	" H2O
Barometric Pressure	" Hg
"g" scaling factor	

Filter ID	
Post-weight (gms)	
Pre-weight (gms)	
Weight Gain (gms)	

Orifice Constants ΔH@	
Sample (.093)	26.02
Dilution Air	0.0334
Total Flow	0.0413

Leak Check:	Entire System	"H2O/min @ 100"
Leak Check:	Sample Gas	ΔP(sample orifice)

Pitot Cp	
Nozzle Diameter	

Time	System Pressures (in. H2O)							Flow Totalizer		System Temperatures (°F)									
	Pitot ΔP	Sample Orifice ΔP	Sample Orifice P	Filter ΔP	Total Flow Orif ΔP	Dil. Orif. ΔP	Dil. Orif. P	Flow	Total Volume (ft3)	T1 Stack	T2 Probe	T3 Sample Orifice Heater	T4 Sample Orifice Gas	T5 Cone Inlet	T6 Cone Exit	T7 Outside Wall	T8 Diluted Filtered Gas	T9 Dilution Air	T10 Ambient Air
1316	–	18.5	+5	4.20	0.82	1.07	5	.451	84.0	—	296	255	304	87	82	70	76	58	69
1330	–	18.6	+5	4.20	0.81	1.07	5	.452	90.0	–	297	255	304	87	82	71	76	58	67
1345	–	18.7	+5	4.20	0.82	1.07	5	.457	96.8	–	298	255	303	87	82	70	76	59	68
1400	–	18.7	+5	4.20	0.84	1.09	5	.453	104.0	–	298	255	303	87	81	70	75	59	68
1416	–	18.8	+5	4.20	0.84	1.08	5	.456	118.9	–	299.	255	303	87	81	70	75	59	70
1451	—	18.9	+5	4.25	0.84	1.09	5	.458	119.5	–	299	255	303	87	81	70	75	59	71
1445	–	18.9	+5	4.25	0.84	1.08	5	.457	125.2	–	300	255	303	87	82	70	75	59	70
1500	–	18.9	+5	4.3	0.85	1.08	5	.456	131.7	—	300	256	303	87	82	71	76	59	69
1515	–	18.9	+5	4.3	0.84	1.08	5	.456	138.7	—	301	257	304	87	82	71	76	60	71
1530	–	18.8	+5	4.3	0.82	1.07	5	.457	146.1	—	300	257	304	87	82	71	76	60	70
1545	–	18.7	+5	4.3	0.83	1.07	5	.451	152.6	–	301	258	304	87	82	71	76	60	71
1600	–	18.8	+5	4.3	0.85	1.09	5	.452	160.0	–	300	258	304	87	83	71	77	60	69
1615	–	18.8	+5	4.3	0.83	1.09	5	.451	166.6	–	300	258	304	87	83	71	77	60	61
1620									168.8										

1618 Stop dilution.

```
° 1

  IDE DILUTION TRAIN OPERATION

9/6/93
MM5
***************************
GAS ANALYSIS - O2  :      6.2
              CO2 :     12.8
              H2O :     10.0
AMB PRESS, in Hg   :    29.46
STACK dP, in H2O   :      7.0
Enter Gas vel., fps      67.4
or AVG SQR ROOT dp :

Dil. Factor:           10.000

STACK GAS TEMP, F  :      320
GAS METER TEMP, F  :      100
Dil Air Temp               75
Exh air temp               85

PITOT CONSTANT     :     0.81
SAMP. ORI. DHQ   :      26.02

Dil Air Ori DHQ:       0.0334
Exhaust flow DHQ       0.0413
Filter DP                   6

NOZZLE DIA, in     :   0.187 Shank #25
SYSTEM FLOW, acfm  :   0.771          0.463 dscfm
%o                      1.00          26.02     18.72 DHso
 .OW, scfm             0.4627
Total flow in           4.63
Dil flow scfm           4.16
Dil Bw                     0

Side stream 1 flow, dscfm             0.6
Side stream 1 DHQ                   1.788      1.23 DH1
Nutech 2

Side stream 2 flow, dscfm             0.6
Side stream 2 DHQ                  1.7898      1.23 DH2
Nutech 4B

Side stream 3 flow, dscfm               0
Side stream 3 DHQ                    1.76      0.00 DH3
RAC 6643

Exhaust flow dscfm                   3.43
Exhaust flow DHexh                 0.0413      1.07 DHexh

                                     4.16
Dilution flow DHda                 0.0334      1.07 DHda
```

RCM

9/6/93

Revised

~~after~~

for

new

nozzle

```
 DOE DILUTION TRAIN OPERATION

9/6/93
MM5
----------------------------
GAS ANALYSIS - O2  :     6.2
              CO2 :     12.8
              H2O :     10.0
AMB PRESS, in Hg   :   29.46
STACK dP, in H2O   :     7.0
Enter Gas vel., fps     67.4
or AVG SQR ROOT dp :

Dil. Factor:          10.000

STACK GAS TEMP, F  :     320
GAS METER TEMP, F  :     100
Dil Air Temp              75
Exh air temp              85

PITOT CONSTANT     :    0.81
SAMP. ORI. DH@   :     26.02

Dil Air Ori DH@:      0.0334
Exhaust flow DH@      0.0413
Filter DP                  6

NOZZLE DIA, in     :   0.189 Shank #9
SYSTEM FLOW, acfm  :   0.788          0.473 dscfm
dp                      1.00          26.02    19.54 DHss
FLOW, scfm            0.4726
Total flow in           4.73
Dil flow scfm           4.25
Dil Bw                     0

Side stream 1 flow, dscfm               0.6
Side stream 1 DH@                     1.788      1.23 DH1
Nutech 2

Side stream 2 flow, dscfm               0.6
Side stream 2 DH@                    1.7898      1.23 DH2
Nutech 4B

Side stream 3 flow, dscfm               0
Side stream 3 DH@                      1.76      0.00 DH3
RAC 8643


Exhaust flow dscfm                     3.53
Exhaust flow DHexh                   0.0413      1.14 DHexh

                                       4.25
Dilution flow DHda                   0.0334      1.12 DHda
```

9/6/93

```
DOE DILUTION TRAIN OPERATION

9/6/93
MM5
****************************
GAS ANALYSIS - O2  :      6.2
               CO2 :     12.8
               H2O :     10.0
AMB PRESS, in Hg   :    29.46
STACK dP, in H2O   :      7.0
Enter Gas vel., fps      67.4
or AVG SQR ROOT dp :

Dil. Factor:           10.000

STACK GAS TEMP, F  :      320
GAS METER TEMP, F  :      100
Dil Air Temp               75
Exh air temp               85

PITOT CONSTANT     :     0.81
SAMP. ORI. DHQ   :      26.02

Dil Air Ori DHQ:       0.0334
Exhaust flow DHQ       0.0413
Filter DP                   6

NOZZLE DIA, in     :    0.189 Shank #9
SYSTEM FLOW, acfm  :    0.788          0.473 dscfm
dp                       1.00          26.02     19.54 DHso
FLOW, scfm             0.4726
Total flow In            4.73
Dil flow scfm            4.25
Dil Bw                      0

Side stream 1 flow, dscfm                0.6
Side stream 1 DHQ                      1.788     1.23 DH1
Nutech 2

Side stream 2 flow, dscfm                0.6
Side stream 2 DHQ                     1.7898     1.23 DH2
Nutech 40

Side stream 3 flow, dscfm                  0
Side stream 3 DHQ                       1.76     0.00 DH3
RAC 8643


Exhaust flow dscfm                      3.53
Exhaust flow DHexh                    0.0413     1.14 DHexh

                                        4.25
Dilution flow DHda                    0.0334     1.12 DHda
```

RLM

9/6/93

&F

```
SETUP FOR OPERATION OF DILUTION TRAIN (constant sample rate)

        Dilution constant, Cdil =          10 Sample orifice constant, dHB =   26.02
Dilution factor in terms of standard          Total flow orifice constant, d  0.0413
conditions, fstd, is:                         Diluted gas filter differentia      10
        Cdil(Tstd/TF)(PF/Pstd)                Expected initial probe differe       1

Sample rate (Q, stack cond.) =           0.60
Ambient pressure, Pamb =                29.46
Previous stack diff. pressure, dP =         7 Stack pressure, P =           29.97471
Previous stack temperature, T =           320 Expected orifice temperature,      330
Stack gas O2 fraction, fo =             0.062 Stack gas dry molecular wgt.,    30.30
Stack gas CO2 fraction, fc =            0.128 Stack gas wet molecular wgt.,    29.07
Stack gas water fraction, Bws =           0.1 Diluted gas molecular wgt., Mt   28.84

The target for the diluter filter temperature, TF, is 60°F.         INCREMENTS
Keep orifice temperature, TH, at 10 °F above stack temperatur T & TH   dPH       Q
Use settings based on orifice temperature, TB.                     20      5    0.02

        dPH = P diff. to ambient at sample orifice inlet
Q (acfm) dPH (in. H2O) -11.00  -6.00    -1.00    4.00   9.00   14.00  19.00   24.00
              fstd=    10.12   9.99     9.87    9.75   9.63    9.50   9.38    9.26
    T=         300       TH=    310
                 g=     0.56   0.56     0.56    0.57   0.57    0.57   0.58    0.58
   0.58        dPt=     1.18   1.17     1.15    1.14   1.12    1.11   1.09    1.08
        dH(fyi)=       10.83  10.96    11.10   11.24  11.38   11.53  11.68   11.83
   0.60        dPt=     1.26   1.25     1.23    1.21   1.20    1.18   1.17    1.15
        dH(fyi)=       11.59  11.73    11.88   12.02  12.18   12.34  12.50   12.66
   0.62        dPt=     1.35   1.33     1.31    1.30   1.28    1.26   1.24    1.23
        dH(fyi)=       12.37  12.52    12.68   12.84  13.00   13.17  13.36   13.52
    T=         320       TH=    330
                 g=     0.56   0.57     0.57    0.57   0.58    0.58   0.59    0.59
   0.58        dPt=     1.12   1.11     1.09    1.08   1.07    1.05   1.04    1.02
        dH(fyi)=       10.55  10.68    10.81   10.94  11.08   11.23  11.37   11.53
   0.60        dPt=     1.20   1.18     1.17    1.15   1.14    1.12   1.11    1.09
        dH(fyi)=       11.29  11.42    11.57   11.71  11.86   12.02  12.17   12.33
   0.62        dPt=     1.28   1.26     1.25    1.23   1.21    1.20   1.18    1.16
        dH(fyi)=       12.05  12.20    12.35   12.51  12.67   12.83  13.00   13.17
    T=         340       TH=    350
                 g=     0.57   0.57     0.58    0.58   0.59    0.59   0.59    0.60
   0.58        dPt=     1.07   1.05     1.04    1.03   1.01    1.00   0.99    0.97
        dH(fyi)=       10.28  10.41    10.53   10.67  10.80   10.94  11.09   11.23
   0.60        dPt=     1.14   1.13     1.11    1.10   1.08    1.07   1.05    1.04
        dH(fyi)=       11.00  11.14    11.27   11.42  11.56   11.71  11.86   12.02
   0.62        dPt=     1.22   1.20     1.19    1.17   1.15    1.14   1.12    1.11
        dH(fyi)=       11.75  11.89    12.04   12.19  12.35   12.51  12.67   12.84
```

10

PAGE 1 OF 3

METHOD 5 FIELD DATA

Plant/Location Bailly
Operator TEG
Date 9/6/93
Test No./Run No. MM51-DL2
Meter Box ID Nutech 4B
Gas Meter Cal Factor ______
Orifice ID ______
Orifice DH@ ______

Pitot Coefficient, Cp ______
Nozzle ID ______
Average Nozzle Dia., inches ______
Barometric Pressure, in. Hg ______
Ambient Temp., deg. F ______
Assumed Moisture, % ______
Filter ID ______
Stack Pressure, in. H2O ______

1st Filter:
Leak Rate, cfm, Pretest 0.00
Leakrate, cfm, Post-test 0.00
2nd Filter (If used):
Leak Rate, cfm, Pretest ___
Leakrate, cfm, Post-test ___

GAS METER START, cf: 942.100
START TIME 10:16

GAS METER END, cf 1159.949
END TIME 1616

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F)					
								Probe	Filter	Sorb.	Imp. Outlet	DCM in	DCM out
		0	5.75			1.23	942.1					84	
		15	5.75				951.2					84	
		30	5.75				960.2					84	
		45	5.75				969.4					84	
		60	5.5				978.3					86	
		15	5.5				987.4					86	
		30	5.5				996.5					86	
		45	5.25				1005.6					86	
		Total	Max	Avg.	Avg sqrt	Avg.	Total	Avg.	Avg.	Max	Max	Avg.	Avg.
												87	

Page 2 of 2

Method 5 Field Data Continued Date Location Run No. MM51-OIL2 Operator TEG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H20	Orifice DH in. H20	Meter Vol. cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
		60	5.25			1.23	1014.7					86	
		15	5.25				1023.8					87	
		30	5.25				1032.9					88	
		45	5.25				1041.9					88	
		60	5.25				1051.2					88	
		15	5.5				1060.4					89	
		30	5.5				1069.6					89	
		45	5.5				1078.5					89	
		60	5.5				1087.7					89	
		15	5.5				1096.6					88	
		30	5.5				1105.8					88	
		45	5.5				1114.6					88	
		60	5.5				1123.6					89	
		15	5.5				1132.6					89	
		30	5.5				1141.2					89	

Page 3 of 3

Method 5 Field Data Continued Date Location Run No. MM51-DiL2 Operator TSG

Clock Time	Travese Point Number	Sample Time	Vacuum in. Hg	Stack Temp deg. F	Pitot DP in. H2O	Orifice DH in. H2O	Meter Vol cf	Temperatures (deg. F) Probe	Filter	Sorb.	Imp. Outlet	DGM in	DGM out
	|	45	5.5	|	|	1.23	1150.9	|	|	|	|	90	|
	|	60	5.5	|	|	↓	1158849	|	|	|	|	90	|
	|			|	|			|	|	|	|		|

SAMPLING TRAIN SET-UP
AND IMPINGER WEIGHT SHEET

Plant Bailly

Sampling Location DIL 2 outlet Unit 7 Run No. 1

Set Up By WDK/DWS Date 09/06/93 Run Date 09/06/93

Comments MM5

Analyst Responsible for Recovery WDK/MLB

Calculations & Report Reviewed By Report Date

FILTERS USED

Filter No.

Sorbent Trap No. H590-55-15

Condenser No.

CYCLONES

	Used (Yes/No)	Prepared Container (No.)
10 µ		
5 µ		
2.0 µ		
1.0 µ		
0.5 µ		

IMPINGER SOLUTIONS:	Initial	Final	Gain
First	471.8 g	492.2 g	20.4 g
Second	580.8 g	590.0 g	9.2 g
Third	602.1 g	602.7 g	0.6 g
Fourth	498.4 g	501.2 g	2.8 g
Fifth	- g	- g	- g
Sixth	- g	- g	- g
Seventh	- g	- g	- g

SILICA GEL WEIGHTS:	Initial	Final
	856.2 g	899.0 g Net 42.8
	g	g
Totals	g	g

total 75.9

COMMENTS:

Color of Silica Gel: 1/2 pink/peach

Description of Impinger Water:

Appendix G7

Reduced Data: Impactor and Cyclones

```
****** RESULTS OF STATIS(TICS) WITH ISOKINETIC CORRECTIONS ******

 RESULTS OF AVERAGES FOR RUNS :   BAILLY 8 ESP INLET
TnipR1.IT
TnipR2.IT
TnipR3.IT

CLASS. AERO DIA.

 DIA.    DM/DLOGD  STD DEV   90% CON       CUM LOAD.  90% CON   CUM%
 MICRON   MG/DNM3              INT          MG/DNM3     INT

   0.10  8.01E+00  1.34E+00  2.27E+00      7.57E-01  2.20E-01   0.02
   0.13  1.87E+01  2.98E+00  5.03E+00      2.27E+00  5.94E-01   0.05
   0.16  3.75E+01  5.60E+00  9.44E+00      4.77E+00  1.22E+00   0.11
   0.20  6.51E+01  8.92E+00  1.50E+01      1.04E+01  2.16E+00   0.24
   0.25  9.83E+01  1.21E+01  2.03E+01      1.80E+01  3.32E+00   0.42
   0.32  1.29E+02  1.37E+01  2.31E+01      2.99E+01  4.53E+00   0.70
   0.40  1.48E+02  1.28E+01  2.15E+01      4.34E+01  5.53E+00   1.02
   0.50  1.43E+02  9.15E+00  1.54E+01      5.79E+01  6.13E+00   1.36
   0.63  1.12E+02  6.82E+00  1.15E+01      7.12E+01  6.42E+00   1.67
   0.79  5.42E+01  1.20E+01  2.02E+01      7.85E+01  6.83E+00   1.84
   1.00  4.80E+02  3.30E+01  5.56E+01      9.81E+01  9.04E+00   2.30
   1.26  3.66E+01  1.68E+01  2.84E+01      1.17E+02  1.10E+01   2.73
   1.58  3.83E+01  1.79E+01  3.03E+01      1.20E+02  1.17E+01   2.82
   2.00  1.13E+02  2.81E+01  4.74E+01      1.29E+02  1.30E+01   3.03
   2.51  3.80E+02  6.06E+01  1.02E+02      1.49E+02  1.72E+01   3.50
   3.16  8.11E+02  1.13E+02  1.91E+02      2.16E+02  2.77E+01   5.07
   3.98  8.70E+02  9.48E+01  1.60E+02      2.99E+02  3.72E+01   7.01
   5.01  8.35E+02  9.39E+01  1.58E+02      3.84E+02  4.35E+01   9.00
   6.31  1.29E+03  2.62E+02  4.41E+02      4.82E+02  6.40E+01  11.31
   7.94  2.42E+03  6.72E+02  1.13E+03      6.87E+02  1.37E+02  16.10
  10.00  3.61E+03  1.07E+03  1.80E+03      9.68E+02  2.53E+02  22.71
  12.59  4.57E+03  1.25E+03  2.11E+03      1.39E+03  3.75E+02  32.68
  15.85  5.27E+03  1.23E+03  2.07E+03      1.87E+03  4.78E+02  43.95
  19.95  5.46E+03  9.62E+02  1.62E+03      2.41E+03  5.46E+02  56.60
  25.12  5.06E+03  5.22E+02  8.80E+02      2.95E+03  5.76E+02  69.10
  31.62  4.15E+03  1.49E+02  2.52E+02      3.39E+03  5.83E+02  79.55
  39.81  2.98E+03  3.05E+02  5.14E+02      3.77E+03  5.86E+02  88.37
  50.12  1.86E+03  3.85E+02  6.50E+02      3.99E+03  5.92E+02  93.62
  63.10  1.00E+03  3.13E+02  5.28E+02      4.15E+03  5.98E+02  97.31
  79.43  4.56E+02  1.88E+02  3.17E+02      4.21E+03  6.01E+02  98.81
 100.00  1.75E+02  8.71E+01  1.47E+02      4.25E+03  6.02E+02  99.66
 125.89  5.56E+01  3.14E+01  5.30E+01      4.26E+03  6.02E+02  99.88
 158.49  1.45E+01  8.87E+00  1.50E+01      4.26E+03  6.02E+02  99.98
 199.53  3.09E+00  1.95E+00  3.29E+00      4.26E+03  6.02E+02  99.99
 251.19  5.34E-01  3.32E-01  5.60E-01      4.26E+03  6.02E+02 100.00
 316.23  7.43E-02  4.34E-02  7.32E-02      4.26E+03  6.02E+02 100.00
 398.11  8.33E-03  4.29E-03  7.23E-03      4.26E+03  6.02E+02 100.00
 501.19  7.57E-04  3.11E-04  5.25E-04      4.26E+03  6.02E+02 100.00
 630.96  5.60E-05  1.54E-05  2.60E-05      4.26E+03  6.02E+02 100.00
 794.33  3.40E-06  3.85E-07  6.49E-07      4.26E+03  6.02E+02 100.00
1000.00  1.72E-07  1.14E-08  1.92E-08      4.26E+03  6.02E+02 100.00

FOR TOTAL MASS: (UNCORRECTED)
9999.00  3.78E+03  3.30E+02  5.56E+02
```

```
                    CYCLONE DATA REDUCTION PROGRAM, VERSION 10

              INPUT DATA

    PART. DIAMETER    CLASSICAL AERODYNAMIC
    DATE OF TEST:  9/5
    TIME OF TEST:  0927
    LOCATION OF TEST:  Bailly Unit 8
    TEST DESIG.:  NIP
    TEST TYPE          INLET
    RUN NUMBER:  3-FILE NAME:TNIPR3.IT
    RUN REMARKS:
    CYCLONE TYPE:  sori5
      SRI 5 SERIES CYCLONE (NEW #4)

    WATER VAPOR          9.95%
     CO2  14.00%        CO    0.00%
     O2    5.00%        N2   81.00%
    ORIFICE ID (OPTIONAL):

    GAS METER VOL       20.715 cf
    CYCLONE DELTA P      0.00 IN. HG.
    ORIFICE DELTA P      0.38 INCHES H2O
    STACK PRESSURE     -20.0  INCHES H2O
    BAROMETRIC PRES     29.40 INCHES HG
    STACK TEMP         341    DEGREES F
    METER TEMP          77    DEGREES F
    CYCLONE TEMP       341    DEGREES F
    SAMPLE TIME         60.00 MINUTES
    AVG GAS VEL         65.70 FEET/SEC
    ORI P WRT PBAR      -0.06 INCHES HG
    NOZZLE DIA           0.155 INCHES
    MAX PART DIA      1000    MICRONS
    WATER VOLUME      46.8   CC
    METER FACTOR       1.0020

  MASS GAIN OF STAGE  1 1735.70 MG
  MASS GAIN OF STAGE  2  287.30 MG
  MASS GAIN OF STAGE  3  126.00 MG
  MASS GAIN OF STAGE  4   65.70 MG
  MASS GAIN OF STAGE  5    4.40 MG
  MASS GAIN OF FILTER     46.00 MG

 MASS GAIN OF BLANK SUBSTRATE    0.70
 MASS GAIN OF BLANK FILTER       0.00
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 3
 SRI 5 SERIES CYCLONE (NEW #4)

ACTUAL FLOW RATE          0.601 CFM
FLOW RATE AT STANDARD CONDITIONS    0.333 CFM
PERCENT ISOKINETIC        116.441 %
VISCOSITY                228.8E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  0.81 IN. HG


STAGE    CUNN.     D50        D50        CUM      RE.    sqr(Psi50)
         CORR. (CLAS AERO)(IMP AERO)    FREQ.     NO.
   1     1.026    10.264     10.395    23.2844    931      0.215
   2     1.040     6.671      6.803    10.6120   1182      0.202
   3     1.070     3.777      3.907     5.0716   1576      0.178
   4     1.105     2.531      2.661     2.1976   2317      0.217
   5     1.253     1.072      1.200     2.0340   3875      0.211

STAGE CUT DIAMETERS BASED ON      PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.99E+03 MG/DRY NORMAL CUBIC METER
                         =    2.21E+03 MG/ACTUAL CUBIC METER
                         =    1.74E+00 GRAINS/DRY STD CUBIC FOOT
                         =    9.67E-01 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 3

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR     CUMFR      CUM.MASS     DM/DLOGD
  (MICRONS)   (STDDEV)(PERCENT)    (MG/DRY  N.CU.METER)

    0.100     -3.5202     0.02     8.67E-01     9.13E+00
    0.126     -3.2492     0.06     2.32E+00     2.11E+01
    0.158     -3.0002     0.14     5.41E+00     4.20E+01
    0.200     -2.7752     0.28     1.10E+01     7.19E+01
    0.251     -2.5761     0.50     2.00E+01     1.07E+02
    0.316     -2.4051     0.81     3.23E+01     1.38E+02
    0.398     -2.2641     1.18     4.71E+01     1.54E+02
    0.501     -2.1550     1.56     6.23E+01     1.44E+02
    0.631     -2.0800     1.88     7.50E+01     1.05E+02
    0.794     -2.0409     2.06     8.24E+01     4.05E+01
    1.000     -2.0398     2.07     8.26E+01     4.85E+02
    1.259     -2.0412     2.06     8.24E+01     1.71E+01
    1.585     -2.0325     2.11     8.41E+01     1.74E+01
    1.995     -2.0239     2.15     8.58E+01     8.28E+01
    2.512     -2.0203     2.17     8.66E+01     3.28E+02
    3.162     -1.8113     3.50     1.40E+02     7.29E+02
    3.981     -1.5955     5.53     2.21E+02     7.90E+02
    5.012     -1.4461     7.41     2.96E+02     7.63E+02
    6.310     -1.2944     9.78     3.90E+02     1.25E+03
    7.943     -1.0643    14.36     5.73E+02     2.47E+03
   10.000     -0.7651    22.21     8.87E+02     3.76E+03
   12.589     -0.4432    32.88     1.31E+03     4.72E+03
   15.849     -0.1111    45.58     1.82E+03     5.34E+03
   19.953      0.2307    59.12     2.36E+03     5.37E+03
   25.119      0.5816    71.96     2.87E+03     4.78E+03
   31.623      0.9411    82.67     3.30E+03     3.72E+03
   39.811      1.3087    90.47     3.61E+03     2.51E+03
   50.119      1.6838    95.39     3.81E+03     1.46E+03
   63.096      2.0659    98.06     3.92E+03     7.27E+02
   79.433      2.4544    99.29     3.96E+03     3.07E+02
  100.000      2.8488    99.78     3.98E+03     1.09E+02
  125.893      3.2486    99.94     3.99E+03     3.27E+01
  158.489      3.6533    99.99     3.99E+03     8.20E+00
  199.526      4.0622   100.00     3.99E+03     1.71E+00
  251.189      4.4749   100.00     3.99E+03     2.96E-01
  316.228      4.8908   100.00     3.99E+03     4.25E-02
  398.107      5.3094   100.00     3.99E+03     5.06E-03
  501.187      5.7302   100.00     3.99E+03     4.98E-04
  630.957      6.1526   100.00     3.99E+03     4.06E-05
  794.328      6.5760   100.00     3.99E+03     2.75E-06
 1000.000      7.0000   100.00     3.99E+03     1.55E-07

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:   82.63     2.0693 %
CUM MASS LESS THAN  2.512 MICRON:   86.59     2.1685 %
CUM MASS LESS THAN 10.000 MICRON:  886.87    22.2110 %
CUM MASS LESS THAN 15.849 MICRON: %1819.81    45.5758 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    CYCLONE DATA REDUCTION PROGRAM, VERSION 10

          INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/4
   TIME OF TEST:  0848
   LOCATION OF TEST:  Bailly Unit 8
   TEST DESIG.:  NIP
   TEST TYPE          INLET
   RUN NUMBER:  2-FILE NAME:TNIPR2.IT
   RUN REMARKS:
   CYCLONE TYPE:  sori5
     SRI 5 SERIES CYCLONE (NEW #4)

   WATER VAPOR          9.67%
    CO2  13.97%        CO    0.00%
    O2    5.20%        N2   80.83%
   ORIFICE ID (OPTIONAL):

   GAS METER VOL        20.925 cf
   CYCLONE DELTA P       0.00 IN. HG.
   ORIFICE DELTA P       0.39 INCHES H2O
   STACK PRESSURE      -20.0  INCHES H2O
   BAROMETRIC PRES      29.48 INCHES HG
   STACK TEMP          341    DEGREES F
   METER TEMP           74    DEGREES F
   CYCLONE TEMP        341    DEGREES F
   SAMPLE TIME          60.00 MINUTES
   AVG GAS VEL          66.80 FEET/SEC
   ORI P WRT PBAR       -0.06 INCHES HG
   NOZZLE DIA            0.155 INCHES
   MAX PART DIA       1000    MICRONS
   WATER VOLUME       46.2  CC
   METER FACTOR       1.0020

  MASS GAIN OF STAGE  1 1690.60 MG
  MASS GAIN OF STAGE  2  301.00 MG
  MASS GAIN OF STAGE  3  144.40 MG
  MASS GAIN OF STAGE  4   80.40 MG
  MASS GAIN OF STAGE  5   11.00 MG
  MASS GAIN OF FILTER    49.30 MG

 MASS GAIN OF BLANK SUBSTRATE    0.30
 MASS GAIN OF BLANK FILTER       0.00
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 2
 SRI 5 SERIES CYCLONE (NEW #4)

ACTUAL FLOW RATE          0.609 CFM
FLOW RATE AT STANDARD CONDITIONS    0.340 CFM
PERCENT ISOKINETIC        115.954 %
VISCOSITY               229.0E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  0.84 IN. HG


STAGE    CUNN.      D50        D50        CUM      RE.    sqr(Psi50)
         CORR. (CLAS AERO)(IMP AERO)   FREQ.     NO.
   1     1.026    10.169     10.301   25.7076     945     0.214
   2     1.040     6.574      6.705   12.4912    1200     0.200
   3     1.071     3.715      3.845    6.1577    1600     0.176
   4     1.106     2.494      2.623    2.6371    2353     0.215
   5     1.257     1.057      1.184    2.1668    3935     0.210

STAGE CUT DIAMETERS BASED ON      PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.94E+03 MG/DRY NORMAL CUBIC METER
                         =    2.20E+03 MG/ACTUAL CUBIC METER
                         =    1.72E+00 GRAINS/DRY STD CUBIC FOOT
                         =    9.61E-01 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 2

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

     0.100    -3.5405    0.02    7.93E-01     8.40E+00
     0.126    -3.2691    0.05    2.14E+00     1.96E+01
     0.158    -3.0190    0.13    5.02E+00     3.94E+01
     0.200    -2.7922    0.26    1.04E+01     6.85E+01
     0.251    -2.5905    0.48    1.89E+01     1.03E+02
     0.316    -2.4160    0.79    3.10E+01     1.36E+02
     0.398    -2.2704    1.16    4.58E+01     1.56E+02
     0.501    -2.1559    1.56    6.14E+01     1.52E+02
     0.631    -2.0743    1.90    7.51E+01     1.18E+02
     0.794    -2.0276    2.13    8.41E+01     5.78E+01
     1.000    -2.0176    2.18    8.61E+01     5.06E+02
     1.259    -2.0039    2.26    8.89E+01     4.73E+01
     1.585    -1.9815    2.38    9.38E+01     4.94E+01
     1.995    -1.9591    2.51    9.88E+01     1.40E+02
     2.512    -1.9318    2.67    1.05E+02     4.42E+02
     3.162    -1.7050    4.41    1.74E+02     9.10E+02
     3.981    -1.4844    6.88    2.72E+02     9.29E+02
     5.012    -1.3347    9.10    3.59E+02     8.78E+02
     6.310    -1.1842   11.82    4.66E+02     1.40E+03
     7.943    -0.9603   16.85    6.64E+02     2.61E+03
    10.000    -0.6741   25.01    9.86E+02     3.78E+03
    12.589    -0.3662   35.71    1.41E+03     4.62E+03
    15.849    -0.0466   48.14    1.90E+03     5.11E+03
    19.953     0.2840   61.18    2.41E+03     5.08E+03
    25.119     0.6251   73.40    2.89E+03     4.48E+03
    31.623     0.9759   83.55    3.30E+03     3.48E+03
    39.811     1.3360   90.92    3.59E+03     2.35E+03
    50.119     1.7047   95.59    3.77E+03     1.37E+03
    63.096     2.0813   98.13    3.87E+03     6.86E+02
    79.433     2.4653   99.31    3.92E+03     2.92E+02
   100.000     2.8561   99.78    3.94E+03     1.05E+02
   125.893     3.2530   99.94    3.94E+03     3.17E+01
   158.489     3.6554   99.99    3.94E+03     7.99E+00
   199.526     4.0628  100.00    3.94E+03     1.68E+00
   251.189     4.4744  100.00    3.94E+03     2.92E-01
   316.228     4.8897  100.00    3.94E+03     4.22E-02
   398.107     5.3081  100.00    3.94E+03     5.03E-03
   501.187     5.7289  100.00    3.94E+03     4.96E-04
   630.957     6.1516  100.00    3.94E+03     4.04E-05
   794.328     6.5755  100.00    3.94E+03     2.73E-06
  1000.000     7.0000  100.00    3.94E+03     1.53E-07

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:  86.08      2.1825 %
CUM MASS LESS THAN  2.512 MICRON: 105.31      2.6701 %
CUM MASS LESS THAN 10.000 MICRON: 986.49     25.0126 %
CUM MASS LESS THAN 15.849 MICRON: %1898.61    48.1399 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    CYCLONE DATA REDUCTION PROGRAM, VERSION 10

             INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/3
   TIME OF TEST:  0832
   LOCATION OF TEST:  Bailly Unit 8
   TEST DESIG.:  NIP
   TEST TYPE         INLET
   RUN NUMBER:  1-FILE NAME:TNIPR1.IT
   RUN REMARKS:
   CYCLONE TYPE:  sori5
     SRI 5 SERIES CYCLONE (NEW #4)

   WATER VAPOR         8.79%
    CO2  13.40%       CO     0.00%
    O2    5.50%       N2    81.10%
   ORIFICE ID (OPTIONAL):

   GAS METER VOL      21.310 cf
   CYCLONE DELTA P     0.00 IN. HG.
   ORIFICE DELTA P     0.40 INCHES H2O
   STACK PRESSURE    -20.0  INCHES H2O
   BAROMETRIC PRES    29.36 INCHES HG
   STACK TEMP        338    DEGREES F
   METER TEMP         79    DEGREES F
   CYCLONE TEMP      338    DEGREES F
   SAMPLE TIME        60.00 MINUTES
   AVG GAS VEL        70.80 FEET/SEC
   ORI P WRT PBAR     -0.06 INCHES HG
   NOZZLE DIA          0.155 INCHES
   MAX PART DIA     1000    MICRONS
   WATER VOLUME     41.7  CC
   METER FACTOR      1.0000

 MASS GAIN OF STAGE  1 1552.40 MG
 MASS GAIN OF STAGE  2  179.50 MG
 MASS GAIN OF STAGE  3  111.90 MG
 MASS GAIN OF STAGE  4   63.10 MG
 MASS GAIN OF STAGE  5    8.40 MG
 MASS GAIN OF FILTER    43.60 MG

MASS GAIN OF BLANK SUBSTRATE   -1.80
MASS GAIN OF BLANK FILTER       0.00
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 1
 SRI 5 SERIES CYCLONE (NEW #4)

ACTUAL FLOW RATE          0.605 CFM
FLOW RATE AT STANDARD CONDITIONS    0.340 CFM
PERCENT ISOKINETIC        108.703 %
VISCOSITY                229.2E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  0.83 IN. HG


STAGE   CUNN.     D50        D50        CUM      RE.   sqr(Psi50)
        CORR. (CLAS AERO)(IMP AERO)    FREQ.     NO.
   1    1.026    10.220     10.351   21.0224     939     0.215
   2    1.040     6.621      6.752   11.8095    1193     0.200
   3    1.071     3.744      3.875    6.0318    1590     0.177
   4    1.106     2.512      2.641    2.7339    2339     0.215
   5    1.255     1.064      1.192    2.2156    3911     0.211

STAGE CUT DIAMETERS BASED ON      PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.40E+03 MG/DRY NORMAL CUBIC METER
                         =    1.91E+03 MG/ACTUAL CUBIC METER
                         =    1.49E+00 GRAINS/DRY STD CUBIC FOOT
                         =    8.36E-01 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 1

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR      CUM.MASS     DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

     0.100    -3.5694    0.02     6.13E-01     6.52E+00
     0.126    -3.2984    0.05     1.66E+00     1.54E+01
     0.158    -3.0479    0.12     3.93E+00     3.12E+01
     0.200    -2.8200    0.24     8.19E+00     5.50E+01
     0.251    -2.6163    0.45     1.51E+01     8.45E+01
     0.316    -2.4389    0.74     2.51E+01     1.14E+02
     0.398    -2.2895    1.10     3.75E+01     1.33E+02
     0.501    -2.1701    1.50     5.11E+01     1.34E+02
     0.631    -2.0825    1.87     6.35E+01     1.10E+02
     0.794    -2.0286    2.13     7.23E+01     6.32E+01
     1.000    -2.0102    2.22     7.56E+01     4.43E+02
     1.259    -1.9940    2.31     7.85E+01     4.47E+01
     1.585    -1.9699    2.44     8.31E+01     4.69E+01
     1.995    -1.9459    2.58     8.79E+01     1.12E+02
     2.512    -1.9218    2.73     9.29E+01     3.50E+02
     3.162    -1.7143    4.32     1.47E+02     7.20E+02
     3.981    -1.5024    6.65     2.26E+02     7.79E+02
     5.012    -1.3521    8.82     3.00E+02     7.24E+02
     6.310    -1.2166   11.19     3.81E+02     9.56E+02
     7.943    -1.0434   14.84     5.05E+02     1.55E+03
    10.000    -0.8274   20.40     6.94E+02     2.23E+03
    12.589    -0.5840   27.96     9.51E+02     2.92E+03
    15.849    -0.3178   37.53     1.28E+03     3.58E+03
    19.953    -0.0301   48.80     1.66E+03     4.04E+03
    25.119     0.2780   60.95     2.07E+03     4.15E+03
    31.623     0.6053   72.75     2.47E+03     3.80E+03
    39.811     0.9505   82.91     2.82E+03     3.06E+03
    50.119     1.3126   90.53     3.08E+03     2.12E+03
    63.096     1.6902   95.45     3.25E+03     1.25E+03
    79.433     2.0821   98.13     3.34E+03     6.19E+02
   100.000     2.4873   99.36     3.38E+03     2.53E+02
   125.893     2.9044   99.82     3.40E+03     8.45E+01
   158.489     3.3323   99.96     3.40E+03     2.28E+01
   199.526     3.7698   99.99     3.40E+03     4.92E+00
   251.189     4.2157  100.00     3.40E+03     8.44E-01
   316.228     4.6688  100.00     3.40E+03     1.14E-01
   398.107     5.1278  100.00     3.40E+03     1.22E-02
   501.187     5.5917  100.00     3.40E+03     1.03E-03
   630.957     6.0591  100.00     3.40E+03     6.79E-05
   794.328     6.5290  100.00     3.40E+03     3.54E-06
  1000.000     7.0000  100.00     3.40E+03     1.46E-07

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:  75.57     2.2214 %
CUM MASS LESS THAN  2.512 MICRON:  92.94     2.7321 %
CUM MASS LESS THAN 10.000 MICRON: 693.98   20.3997 %
CUM MASS LESS THAN 15.849 MICRON: %1276.75   37.5306 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    IMPACTOR DATA REDUCTION PROGRAM, VERSION 10

          INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/3-9/5
   TIME OF TEST:
   LOCATION OF TEST:  Bailly 8 ESP OUTLET
   TEST DESIG.:  NIP
   TEST TYPE          OUTLET
   RUN NUMBER:  1-FILE NAME:TNIPR1.OT
   RUN REMARKS:  Run over 3 consecutive days
   IMPACTOR TYPE: uwpc3-11
     soripc 3 4 5 7 9 11

   WATER VAPOR          9.01%
    CO2  13.00%        CO    0.00%
    O2    6.10%        N2   80.90%
   ORIFICE ID (OPTIONAL):
   SUBSTRATE MATERIAL, G)rease or Bare metal, F)ilter:   F

   GAS METER VOL      159.908 cf
   IMPACTOR DELTA P     0.00 IN. HG. (0 for calc. from theory)
   ORIFICE DELTA P      0.00 INCHES H2O
   STACK PRESSURE       7.0  INCHES H2O
   BAROMETRIC PRES     29.41 INCHES HG
   STACK TEMP         320    DEGREES F
   METER TEMP          83    DEGREES F
   IMPACTOR TEMP      320    DEGREES F
   SAMPLE TIME        600.00 MINUTES
   AVG GAS VEL         66.60 FEET/SEC
   ORI P WRT PBAR       0.00 INCHES HG
   NOZZLE DIA           0.134 INCHES
   MAX PART DIA      1000    MICRONS
   WATER VOLUME     328.4  CC
   METER FACTOR       1.0240

 MASS GAIN OF STAGE  1   5.39 MG
 MASS GAIN OF STAGE  2   4.77 MG
 MASS GAIN OF STAGE  3   2.68 MG
 MASS GAIN OF STAGE  4   2.48 MG
 MASS GAIN OF STAGE  5   2.58 MG
 MASS GAIN OF STAGE  6   2.36 MG
 MASS GAIN OF STAGE  7   4.02 MG
 MASS GAIN OF FILTER    2.40 MG

MASS GAIN OF BLANK SUBSTRATE    1.05
MASS GAIN OF BLANK FILTER       1.18
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 1
 soripc 3 4 5 7 9 11

ACTUAL FLOW RATE          0.423 CFM
FLOW RATE AT STANDARD CONDITIONS    0.261 CFM
PERCENT ISOKINETIC        108.201 %
VISCOSITY               225.4E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  1.35 IN. HG


STAGE   CUNN.      D50        D50        CUM       RE.      V*D50
        CORR.  (CLAS AERO)(IMP AERO)    FREQ.     NO.      UM-M/S
   1    1.027      8.787      8.907   76.0731     732       13.9
   2    1.044      5.441      5.559   55.5776     318       19.4
   3    1.075      3.202      3.320   46.6071     131       14.5
   4    1.124      1.943      2.060   38.7399     166       17.4
   5    1.240      1.004      1.118   30.2990     246       19.8
   6    1.477      0.522      0.634   23.0829     338       18.5
   7    2.016      0.264      0.375    6.7196     633       17.7

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    4.09E+00 MG/DRY NORMAL CUBIC METER
                         =    2.52E+00 MG/ACTUAL CUBIC METER
                         =    1.79E-03 GRAINS/DRY STD CUBIC FOOT
                         =    1.10E-03 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 1

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)    (MG/DRY N.CU.METER)

    0.100     -2.9562    0.16     6.39E-03     7.65E-02
    0.126     -2.5910    0.48     1.96E-02     2.04E-01
    0.158     -2.2371    1.27     5.17E-02     4.65E-01
    0.200     -1.8954    2.90     1.19E-01     9.07E-01
    0.251     -1.5669    5.86     2.39E-01     1.54E+00
    0.316     -1.2547   10.48     4.28E-01     2.22E+00
    0.398     -0.9784   16.39     6.70E-01     2.52E+00
    0.501     -0.7650   22.21     9.08E-01     2.10E+00
    0.631     -0.6353   26.26     1.07E+00     1.23E+00
    0.794     -0.5662   28.56     1.17E+00     7.30E-01
    1.000     -0.5164   30.28     1.24E+00     7.72E-01
    1.259     -0.4516   32.58     1.33E+00     1.10E+00
    1.585     -0.3691   35.60     1.46E+00     1.36E+00
    1.995     -0.2743   39.19     1.60E+00     1.56E+00
    2.512     -0.1753   43.04     1.76E+00     1.54E+00
    3.162     -0.0889   46.46     1.90E+00     1.21E+00
    3.981     -0.0206   49.18     2.01E+00     1.20E+00
    5.012      0.0819   53.27     2.18E+00     2.32E+00
    6.310      0.2824   61.12     2.50E+00     3.98E+00
    7.943      0.5703   71.58     2.93E+00     4.31E+00
   10.000      0.8859   81.22     3.32E+00     3.48E+00
   12.589      1.2008   88.51     3.62E+00     2.49E+00
   15.849      1.5144   93.50     3.82E+00     1.62E+00
   19.953      1.8266   96.61     3.95E+00     9.58E-01
   25.119      2.1375   98.37     4.02E+00     5.15E-01
   31.623      2.4472   99.28     4.06E+00     2.52E-01
   39.811      2.7558   99.71     4.08E+00     1.13E-01
   50.119      3.0633   99.89     4.08E+00     4.59E-02
   63.096      3.3699   99.96     4.09E+00     1.71E-02
   79.433      3.6756   99.99     4.09E+00     5.80E-03
  100.000      3.9804  100.00     4.09E+00     1.80E-03
  125.893      4.2845  100.00     4.09E+00     5.12E-04
  158.489      4.5879  100.00     4.09E+00     1.33E-04
  199.526      4.8907  100.00     4.09E+00     3.16E-05
  251.189      5.1930  100.00     4.09E+00     6.87E-06
  316.228      5.4949  100.00     4.09E+00     1.37E-06
  398.107      5.7964  100.00     4.09E+00     2.49E-07
  501.187      6.0975  100.00     4.09E+00     4.15E-08
  630.957      6.3985  100.00     4.09E+00     6.32E-09
  794.328      6.6993  100.00     4.09E+00     8.81E-10
 1000.000      7.0000  100.00     4.09E+00     1.12E-10

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:    1.24    30.2812 %
CUM MASS LESS THAN  2.512 MICRON:    1.76    43.0405 %
CUM MASS LESS THAN 10.000 MICRON:    3.32    81.2160 %
CUM MASS LESS THAN 15.849 MICRON:    3.82    93.5039 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    CYCLONE DATA REDUCTION PROGRAM, VERSION 10

            INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/3-6
   TIME OF TEST:
   LOCATION OF TEST:  Bailly 8 ESP OUTLET
   TEST DESIG.:  nip
   TEST TYPE    6     OUTLET      6
   RUN NUMBER: ~~1~~-FILE NAME:TnipR~~1~~.OT
   RUN REMARKS:
   CYCLONE TYPE:  doe2
     SRI 5 SERIES CYCLONE (NEW #4)

   WATER VAPOR          9.59%
    CO2  12.90%        CO     0.00%
    O2    6.30%        N2    80.80%
   ORIFICE ID (OPTIONAL):

   GAS METER VOL      438.180 cf
   CYCLONE DELTA P      0.00 IN. HG.
   ORIFICE DELTA P      0.59 INCHES H2O
   STACK PRESSURE       7.0  INCHES H2O
   BAROMETRIC PRES     29.40 INCHES HG
   STACK TEMP         322     DEGREES F
   METER TEMP          85     DEGREES F
   CYCLONE TEMP       322     DEGREES F
   SAMPLE TIME       1020.00 MINUTES
   AVG GAS VEL         67.00 FEET/SEC
   ORI P WRT PBAR      -0.09 INCHES HG
   NOZZLE DIA          0.172 INCHES
   MAX PART DIA      1000     MICRONS
   WATER VOLUME     956.0  CC
   METER FACTOR       1.0240

 MASS GAIN OF STAGE  1    23.10 MG
 MASS GAIN OF STAGE  2     0.50 MG
 MASS GAIN OF FILTER     20.40 MG

MASS GAIN OF BLANK SUBSTRATE     0.00
MASS GAIN OF BLANK FILTER        0.70
```

```
          RESULTS


TEST DESIG.: nip  RUN NUMBER: 1
 SRI 5 SERIES CYCLONE (NEW #4)

ACTUAL FLOW RATE          0.683 CFM
FLOW RATE AT STANDARD CONDITIONS    0.417 CFM
PERCENT ISOKINETIC        105.314 %
VISCOSITY               225.6E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  0.01 IN. HG


STAGE   CUNN.     D50        D50        CUM      RE.    sqr(Psi50)
        CORR. (CLAS AERO)(IMP AERO)   FREQ.     NO.
   1    1.027      9.082      9.202   46.6513    1173    0.204
   2    1.044      5.455      5.575   45.4965    1490    0.177

STAGE CUT DIAMETERS BASED ON      PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.59E+00 MG/DRY NORMAL CUBIC METER
                         =    2.19E+00 MG/ACTUAL CUBIC METER
                         =    1.57E-03 GRAINS/DRY STD CUBIC FOOT
                         =    9.59E-04 GRAINS/ACTUAL CUBIC FOOT
```

TEST DESIG.: nip RUN NUMBER: 1

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY	DM/DLOGD N.CU.METER)
0.100	-3.4601	0.03	9.77E-04	1.16E-02
0.126	-3.1425	0.08	3.02E-03	3.21E-02
0.158	-2.8354	0.23	8.25E-03	7.77E-02
0.200	-2.5396	0.56	2.00E-02	1.65E-01
0.251	-2.2561	1.20	4.33E-02	3.12E-01
0.316	-1.9858	2.35	8.46E-02	5.26E-01
0.398	-1.7298	4.18	1.50E-01	7.99E-01
0.501	-1.4888	6.83	2.45E-01	1.10E+00
0.631	-1.2640	10.31	3.71E-01	1.40E+00
0.794	-1.0562	14.54	5.23E-01	1.63E+00
1.000	-0.8663	19.32	6.94E-01	1.78E+00
1.259	-0.6954	24.34	8.75E-01	1.81E+00
1.585	-0.5444	29.31	1.05E+00	1.74E+00
1.995	-0.4141	33.94	1.22E+00	1.57E+00
2.512	-0.3057	37.99	1.37E+00	1.33E+00
3.162	-0.2199	41.30	1.48E+00	1.04E+00
3.981	-0.1578	43.73	1.57E+00	7.08E-01
5.012	-0.1203	45.21	1.63E+00	3.54E-01
6.310	-0.1069	45.74	1.64E+00	7.85E-02
7.943	-0.0988	46.06	1.66E+00	2.30E-01
10.000	-0.0644	47.43	1.71E+00	8.01E-01
12.589	0.0135	50.54	1.82E+00	1.43E+00
15.849	0.1338	55.32	1.99E+00	2.00E+00
19.953	0.2942	61.57	2.21E+00	2.47E+00
25.119	0.4925	68.88	2.48E+00	2.75E+00
31.623	0.7264	76.62	2.75E+00	2.77E+00
39.811	0.9938	83.99	3.02E+00	2.48E+00
50.119	1.2924	90.19	3.24E+00	1.95E+00
63.096	1.6200	94.74	3.41E+00	1.32E+00
79.433	1.9743	97.58	3.51E+00	7.50E-01
100.000	2.3532	99.07	3.56E+00	3.51E-01
125.893	2.7543	99.71	3.58E+00	1.33E-01
158.489	3.1755	99.92	3.59E+00	3.99E-02
199.526	3.6146	99.98	3.59E+00	9.33E-03
251.189	4.0692	100.00	3.59E+00	1.68E-03
316.228	4.5373	100.00	3.59E+00	2.30E-04
398.107	5.0164	100.00	3.59E+00	2.38E-05
501.187	5.5045	100.00	3.59E+00	1.86E-06
630.957	5.9993	100.00	3.59E+00	1.09E-07
794.328	6.4985	100.00	3.59E+00	4.85E-09
1000.000	7.0000	100.00	3.59E+00	1.65E-10

INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN 1.000 MICRON:	0.69	19.3151 %
CUM MASS LESS THAN 2.512 MICRON:	1.37	37.9926 %
CUM MASS LESS THAN 10.000 MICRON:	1.71	47.4332 %
CUM MASS LESS THAN 15.849 MICRON:	1.99	55.3234 %

NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE ON CLASSICAL AERODYNAMIC BASIS.

```
                    IMPACTOR DATA REDUCTION PROGRAM, VERSION 10

            INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/6
   TIME OF TEST:
   LOCATION OF TEST:  Bailly 7 ESP OUTLET
   TEST DESIG.:  NIP
   TEST TYPE         OUTLET
   RUN NUMBER:  5-FILE NAME:TNIPR5.OT
   RUN REMARKS:
   IMPACTOR TYPE: uwpc3-11
     soripc 3 4 5 7 9 11

   WATER VAPOR         8.10%
    CO2  12.80%        CO     0.00%
    O2    6.60%        N2    80.60%
   ORIFICE ID (OPTIONAL):
   SUBSTRATE MATERIAL, G)rease or Bare metal, F)ilter:   F

   GAS METER VOL       33.205 cf
   IMPACTOR DELTA P     0.00 IN. HG. (0 for calc. from theory)
   ORIFICE DELTA P      0.20 INCHES H2O
   STACK PRESSURE       7.0  INCHES H2O
   BAROMETRIC PRES     29.56 INCHES HG
   STACK TEMP         316    DEGREES F
   METER TEMP          70    DEGREES F
   IMPACTOR TEMP      316    DEGREES F
   SAMPLE TIME        124.50 MINUTES
   AVG GAS VEL         53.80 FEET/SEC
   ORI P WRT PBAR      -0.03 INCHES HG
   NOZZLE DIA           0.154 INCHES
   MAX PART DIA      1000    MICRONS
   WATER VOLUME       0.0   CC
   METER FACTOR       1.0240

 MASS GAIN OF STAGE  1  14.80 MG
 MASS GAIN OF STAGE  2  10.77 MG
 MASS GAIN OF STAGE  3   5.03 MG
 MASS GAIN OF STAGE  4   3.67 MG
 MASS GAIN OF STAGE  5   2.46 MG
 MASS GAIN OF STAGE  6   1.36 MG
 MASS GAIN OF STAGE  7   1.32 MG
 MASS GAIN OF FILTER    3.09 MG

MASS GAIN OF BLANK SUBSTRATE    0.87
MASS GAIN OF BLANK FILTER       1.83
```

```
        RESULTS

TEST DESIG.: NIP  RUN NUMBER: 5
 soripc 3 4 5 7 9 11

ACTUAL FLOW RATE          0.427 CFM
FLOW RATE AT STANDARD CONDITIONS     0.268 CFM
PERCENT ISOKINETIC        102.270 %
VISCOSITY               225.4E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  1.39 IN. HG

STAGE   CUNN.      D50         D50        CUM       RE.      V*D50
        CORR.  (CLAS AERO)(IMP AERO)     FREQ.      NO.      UM-M/S
   1    1.025      9.479       9.597    59.6910     748       15.1
   2    1.044      5.416       5.533    31.0663     325       19.5
   3    1.075      3.172       3.288    19.0465     134       14.5
   4    1.124      1.921       2.037    10.9408     170       17.4
   5    1.241      0.992       1.105     6.3469     252       19.7
   6    1.477      0.516       0.628     4.9236     345       18.5
   7    2.016      0.262       0.372     3.6363     648       17.7

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.65E+01 MG/DRY NORMAL CUBIC METER
                         =    2.30E+01 MG/ACTUAL CUBIC METER
                         =    1.60E-02 GRAINS/DRY STD CUBIC FOOT
                         =    1.00E-02 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 5

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)   (STDDEV)(PERCENT)    (MG/DRY N.CU.METER)

    0.100     -2.6579     0.39     1.44E-01     1.28E+00
    0.126     -2.3771     0.87     3.19E-01     2.24E+00
    0.158     -2.1401     1.62     5.91E-01     3.15E+00
    0.200     -1.9510     2.55     9.33E-01     3.56E+00
    0.251     -1.8137     3.49     1.27E+00     3.10E+00
    0.316     -1.7298     4.18     1.53E+00     1.99E+00
    0.398     -1.6845     4.60     1.68E+00     1.17E+00
    0.501     -1.6562     4.88     1.78E+00     1.00E+00
    0.631     -1.6251     5.21     1.90E+00     1.40E+00
    0.794     -1.5826     5.68     2.07E+00     2.07E+00
    1.000     -1.5243     6.37     2.33E+00     3.08E+00
    1.259     -1.4457     7.41     2.71E+00     4.64E+00
    1.585     -1.3412     8.99     3.28E+00     7.08E+00
    1.995     -1.2051    11.41     4.17E+00     1.08E+01
    2.512     -1.0414    14.88     5.44E+00     1.43E+01
    3.162     -0.8780    19.00     6.94E+00     1.51E+01
    3.981     -0.7325    23.19     8.47E+00     1.64E+01
    5.012     -0.5647    28.62     1.05E+01     2.45E+01
    6.310     -0.3241    37.29     1.36E+01     3.89E+01
    7.943     -0.0147    49.41     1.80E+01     4.82E+01
   10.000      0.3244    62.72     2.29E+01     4.72E+01
   12.589      0.6653    74.71     2.73E+01     3.97E+01
   15.849      1.0050    84.26     3.08E+01     2.98E+01
   19.953      1.3438    91.05     3.33E+01     2.00E+01
   25.119      1.6816    95.37     3.48E+01     1.20E+01
   31.623      2.0184    97.82     3.57E+01     6.39E+00
   39.811      2.3544    99.07     3.62E+01     3.06E+00
   50.119      2.6896    99.64     3.64E+01     1.31E+00
   63.096      3.0241    99.87     3.65E+01     5.03E-01
   79.433      3.3578    99.96     3.65E+01     1.73E-01
  100.000      3.6909    99.99     3.65E+01     5.34E-02
  125.893      4.0235   100.00     3.65E+01     1.48E-02
  158.489      4.3555   100.00     3.65E+01     3.67E-03
  199.526      4.6871   100.00     3.65E+01     8.19E-04
  251.189      5.0183   100.00     3.65E+01     1.64E-04
  316.228      5.3491   100.00     3.65E+01     2.95E-05
  398.107      5.6796   100.00     3.65E+01     4.76E-06
  501.187      6.0099   100.00     3.65E+01     6.90E-07
  630.957      6.3400   100.00     3.65E+01     8.99E-08
  794.328      6.6700   100.00     3.65E+01     1.05E-08
 1000.000      7.0000   100.00     3.65E+01     1.10E-09

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:    2.33     6.3709 %
CUM MASS LESS THAN  2.512 MICRON:    5.44    14.8839 %
CUM MASS LESS THAN 10.000 MICRON:   22.91    62.7169 %
CUM MASS LESS THAN 15.849 MICRON:   30.77    84.2571 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                  CYCLONE DATA REDUCTION PROGRAM, VERSION 10

            INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/3-5
   TIME OF TEST:
   LOCATION OF TEST:  Bailly 7 ESP OUTLET
   TEST DESIG.:  nip
   TEST TYPE    1    OUTLET          1
   RUN NUMBER:  2-FILE NAME:TnipR2.OT
   RUN REMARKS:
   CYCLONE TYPE:  doe2
     SRI 5 SERIES CYCLONE (NEW #4)

   WATER VAPOR           8.58%
    CO2  12.70%         CO    0.00%
    O2    6.50%         N2   80.80%
   ORIFICE ID (OPTIONAL):

   GAS METER VOL       525.260 cf
   CYCLONE DELTA P       0.00 IN. HG.
   ORIFICE DELTA P       0.38 INCHES H2O
   STACK PRESSURE        7.0  INCHES H2O
   BAROMETRIC PRES      29.40 INCHES HG
   STACK TEMP          314    DEGREES F
   METER TEMP           95    DEGREES F
   CYCLONE TEMP        314    DEGREES F
   SAMPLE TIME        1440.00 MINUTES
   AVG GAS VEL          55.00 FEET/SEC
   ORI P WRT PBAR       -0.06 INCHES HG
   NOZZLE DIA           0.176 INCHES
   MAX PART DIA       1000    MICRONS
   WATER VOLUME      999.0  CC
   METER FACTOR        1.0262

 MASS GAIN OF STAGE  1  210.80 MG
 MASS GAIN OF STAGE  2   76.60 MG
 MASS GAIN OF FILTER   172.80 MG

MASS GAIN OF BLANK SUBSTRATE    0.00
MASS GAIN OF BLANK FILTER       3.90
```

```
          RESULTS


TEST DESIG.: nip  RUN NUMBER: 2
 SRI 5 SERIES CYCLONE (NEW #4)

ACTUAL FLOW RATE         0.560 CFM
FLOW RATE AT STANDARD CONDITIONS    0.349 CFM
PERCENT ISOKINETIC       100.370 %
VISCOSITY              224.6E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  0.01 IN. HG


STAGE   CUNN.     D50         D50        CUM      RE.   sqr(Psi50)
        CORR. (CLAS AERO)(IMP AERO)    FREQ.     NO.
   1    1.023     10.439     10.558   53.8023     979     0.213
   2    1.036      6.672      6.790   37.0151    1243     0.196

STAGE CUT DIAMETERS BASED ON      PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    3.21E+01 MG/DRY NORMAL CUBIC METER
                         =    2.00E+01 MG/ACTUAL CUBIC METER
                         =    1.40E-02 GRAINS/DRY STD CUBIC FOOT
                         =    8.74E-03 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: nip  RUN NUMBER: 2

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

    0.100     -4.5458    0.00    8.89E-05     1.01E-03
    0.126     -4.3035    0.00    2.73E-04     2.94E-03
    0.158     -4.0620    0.00    7.88E-04     8.05E-03
    0.200     -3.8215    0.01    2.15E-03     2.07E-02
    0.251     -3.5820    0.02    5.50E-03     5.00E-02
    0.316     -3.3437    0.04    1.33E-02     1.14E-01
    0.398     -3.1065    0.10    3.05E-02     2.43E-01
    0.501     -2.8706    0.21    6.59E-02     4.89E-01
    0.631     -2.6361    0.42    1.35E-01     9.26E-01
    0.794     -2.4030    0.81    2.61E-01     1.66E+00
    1.000     -2.1715    1.50    4.80E-01     2.79E+00
    1.259     -1.9415    2.61    8.37E-01     4.45E+00
    1.585     -1.7132    4.33    1.39E+00     6.70E+00
    1.995     -1.4867    6.85    2.20E+00     9.56E+00
    2.512     -1.2620   10.35    3.32E+00     1.29E+01
    3.162     -1.0392   14.93    4.79E+00     1.65E+01
    3.981     -0.8185   20.65    6.62E+00     2.01E+01
    5.012     -0.5998   27.43    8.80E+00     2.33E+01
    6.310     -0.3832   35.08    1.12E+01     2.56E+01
    7.943     -0.1681   43.32    1.39E+01     2.73E+01
   10.000      0.0526   52.10    1.67E+01     2.90E+01
   12.589      0.2882   61.34    1.97E+01     3.00E+01
   15.849      0.5411   70.58    2.26E+01     2.89E+01
   19.953      0.8102   79.11    2.54E+01     2.55E+01
   25.119      1.0947   86.32    2.77E+01     2.05E+01
   31.623      1.3937   91.83    2.94E+01     1.48E+01
   39.811      1.7062   95.60    3.07E+01     9.52E+00
   50.119      2.0314   97.89    3.14E+01     5.38E+00
   63.096      2.3684   99.11    3.18E+01     2.65E+00
   79.433      2.7162   99.67    3.20E+01     1.13E+00
  100.000      3.0740   99.89    3.20E+01     4.11E-01
  125.893      3.4408   99.97    3.21E+01     1.27E-01
  158.489      3.8158   99.99    3.21E+01     3.34E-02
  199.526      4.1980  100.00    3.21E+01     7.35E-03
  251.189      4.5865  100.00    3.21E+01     1.35E-03
  316.228      4.9805  100.00    3.21E+01     2.08E-04
  398.107      5.3789  100.00    3.21E+01     2.67E-05
  501.187      5.7810  100.00    3.21E+01     2.86E-06
  630.957      6.1859  100.00    3.21E+01     2.55E-07
  794.328      6.5925  100.00    3.21E+01     1.90E-08
 1000.000      7.0000  100.00    3.21E+01     1.19E-09

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:   0.48    1.4958 %
CUM MASS LESS THAN  2.512 MICRON:   3.32   10.3461 %
CUM MASS LESS THAN 10.000 MICRON:  16.70   52.0968 %
CUM MASS LESS THAN 15.849 MICRON:  22.63   70.5762 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
****** RESULTS OF STATIS(TICS) WITH ISOKINETIC CORRECTIONS ******

 RESULTS OF AVERAGES FOR RUNS :          BAILLY STACK
TnipR2.OT
TnipR3.OT
TnipR4.OT

CLASS. AERO DIA.


  DIA.    DM/DLOGD  STD DEV   90% CON       CUM LOAD.  90% CON  CUM%
 MICRON    MG/DNM3              INT          MG/DNM3     INT

   0.10   6.00E+00  3.87E+00  6.52E+00      8.39E-01  9.45E-01    5.69
   0.13   8.00E+00  5.04E+00  8.50E+00      1.57E+00  1.43E+00   10.67
   0.16   8.51E+00  5.38E+00  9.08E+00      2.39E+00  1.89E+00   16.21
   0.20   7.30E+00  4.90E+00  8.25E+00      3.16E+00  2.26E+00   21.44
   0.25   6.39E+00  4.73E+00  7.97E+00      3.86E+00  2.53E+00   26.19
   0.32   7.33E+00  5.47E+00  9.23E+00      4.56E+00  2.81E+00   30.95
   0.40   1.06E+01  7.62E+00  1.28E+01      5.40E+00  3.22E+00   36.67
   0.50   1.34E+01  9.36E+00  1.58E+01      6.65E+00  3.81E+00   45.14
   0.63   1.32E+01  8.82E+00  1.49E+01      7.98E+00  4.39E+00   54.17
   0.79   1.02E+01  6.17E+00  1.04E+01      9.10E+00  4.75E+00   61.77
   1.00   7.76E+00  3.78E+00  6.37E+00      1.00E+01  4.90E+00   68.15
   1.26   6.59E+00  2.30E+00  3.88E+00      1.07E+01  4.96E+00   72.89
   1.58   6.28E+00  1.58E+00  2.67E+00      1.14E+01  4.98E+00   77.29
   2.00   5.46E+00  1.19E+00  2.00E+00      1.20E+01  4.99E+00   81.18
   2.51   4.06E+00  9.39E-01  1.58E+00      1.25E+01  5.00E+00   84.57
   3.16   2.80E+00  6.40E-01  1.08E+00      1.28E+01  5.00E+00   86.76
   3.98   1.99E+00  2.66E-01  4.48E-01      1.30E+01  5.00E+00   88.48
   5.01   1.49E+00  2.60E-01  4.38E-01      1.32E+01  5.00E+00   89.60
   6.31   1.28E+00  3.37E-01  5.69E-01      1.33E+01  5.00E+00   90.57
   7.94   1.33E+00  5.84E-01  9.85E-01      1.35E+01  5.00E+00   91.46
  10.00   1.61E+00  1.35E+00  2.27E+00      1.36E+01  5.01E+00   92.43
  12.59   1.85E+00  2.08E+00  3.51E+00      1.38E+01  5.03E+00   93.63
  15.85   1.93E+00  2.51E+00  4.23E+00      1.40E+01  5.06E+00   94.90
  19.95   1.83E+00  2.60E+00  4.38E+00      1.42E+01  5.09E+00   96.17
  25.12   1.58E+00  2.37E+00  3.99E+00      1.43E+01  5.13E+00   97.35
  31.62   1.23E+00  1.92E+00  3.23E+00      1.45E+01  5.15E+00   98.26
  39.81   8.63E-01  1.38E+00  2.32E+00      1.46E+01  5.17E+00   99.02
  50.12   5.36E-01  8.69E-01  1.47E+00      1.47E+01  5.18E+00   99.45
  63.10   2.92E-01  4.79E-01  8.07E-01      1.47E+01  5.18E+00   99.76
  79.43   1.38E-01  2.28E-01  3.84E-01      1.47E+01  5.18E+00   99.89
 100.00   5.58E-02  9.26E-02  1.56E-01      1.47E+01  5.18E+00   99.97
 125.89   1.92E-02  3.18E-02  5.37E-02      1.47E+01  5.18E+00   99.99
 158.49   5.52E-03  9.17E-03  1.55E-02      1.47E+01  5.18E+00  100.00
 199.53   1.33E-03  2.20E-03  3.70E-03      1.47E+01  5.18E+00  100.00
 251.19   2.65E-04  4.35E-04  7.33E-04      1.47E+01  5.18E+00  100.00
 316.23   4.38E-05  7.07E-05  1.19E-04      1.47E+01  5.18E+00  100.00
 398.11   6.00E-06  9.39E-06  1.58E-05      1.47E+01  5.18E+00  100.00
 501.19   6.87E-07  1.02E-06  1.71E-06      1.47E+01  5.18E+00  100.00
 630.96   6.72E-08  8.85E-08  1.49E-07      1.47E+01  5.18E+00  100.00
 794.33   5.87E-09  6.02E-09  1.02E-08      1.47E+01  5.18E+00  100.00
1000.00   4.96E-10  3.12E-10  5.25E-10      1.47E+01  5.18E+00  100.00

FOR TOTAL MASS: (UNCORRECTED)
9999.00   1.46E+01  7.99E+00  1.35E+01
```

```
                  IMPACTOR DATA REDUCTION PROGRAM, VERSION 10

           INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/3
   TIME OF TEST:  0900
   LOCATION OF TEST:  Bailly Stack
   TEST DESIG.:  NIP
   TEST TYPE         OUTLET
   RUN NUMBER:  2-FILE NAME:TNIPR2.OT
   RUN REMARKS:
   IMPACTOR TYPE: uwpc3-11
     soripc 3 4 5 7 9 11

   WATER VAPOR          15.38%
    CO2  12.80%         CO    0.00%
    O2    6.30%         N2   80.90%
   ORIFICE ID (OPTIONAL):
   SUBSTRATE MATERIAL, G)rease or Bare metal, F)ilter:   F

   GAS METER VOL       124.257 cf
   IMPACTOR DELTA P      0.00 IN. HG. (0 for calc. from theory)
   ORIFICE DELTA P       0.33 INCHES H2O
   STACK PRESSURE        0.5  INCHES H2O
   BAROMETRIC PRES      29.36 INCHES HG
   STACK TEMP          131     DEGREES F
   METER TEMP           91     DEGREES F
   IMPACTOR TEMP       250     DEGREES F
   SAMPLE TIME         360.00 MINUTES
   AVG GAS VEL          33.40 FEET/SEC
   ORI P WRT PBAR       -0.05 INCHES HG
   NOZZLE DIA            0.193 INCHES
   MAX PART DIA       1000     MICRONS
   WATER VOLUME      459.8  CC
   METER FACTOR        1.0240

 MASS GAIN OF STAGE  1    1.38 MG
 MASS GAIN OF STAGE  2    2.17 MG
 MASS GAIN OF STAGE  3    2.58 MG
 MASS GAIN OF STAGE  4    4.83 MG
 MASS GAIN OF STAGE  5   10.45 MG
 MASS GAIN OF STAGE  6   18.43 MG
 MASS GAIN OF STAGE  7   13.69 MG
 MASS GAIN OF FILTER    15.48 MG

MASS GAIN OF BLANK SUBSTRATE    0.62
MASS GAIN OF BLANK FILTER       1.23
```

```
         RESULTS

TEST DESIG.: NIP  RUN NUMBER: 2
 soripc 3 4 5 7 9 11

ACTUAL FLOW RATE          0.536 CFM
FLOW RATE AT STANDARD CONDITIONS    0.332 CFM
PERCENT ISOKINETIC        109.635 %
VISCOSITY               205.9E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  2.36 IN. HG

STAGE   CUNN.      D50         D50        CUM       RE.      V*D50
        CORR. (CLAS AERO)(IMP AERO)   FREQ.     NO.      UM-M/S
   1    1.018      9.530      9.614   98.7995     1235      15.8
   2    1.047      4.588      4.694   96.3481      462      20.7
   3    1.086      2.513      2.618   93.2508      190      14.4
   4    1.147      1.471      1.575   86.6134      242      16.7
   5    1.293      0.744      0.846   71.1126      358      18.6
   6    1.593      0.385      0.486   43.0444      492      17.3
   7    2.328      0.188      0.287   22.4501      922      16.1

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    1.88E+01 MG/DRY NORMAL CUBIC METER
                         =    1.39E+01 MG/ACTUAL CUBIC METER
                         =    8.21E-03 GRAINS/DRY STD CUBIC FOOT
                         =    6.09E-03 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 2

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR   CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

     0.100    -1.5857    5.64    1.06E+00     8.01E+00
     0.126    -1.2355   10.83    2.03E+00     1.13E+01
     0.158    -0.9400   17.36    3.26E+00     1.28E+01
     0.200    -0.7039   24.08    4.52E+00     1.20E+01
     0.251    -0.5177   30.23    5.68E+00     1.13E+01
     0.316    -0.3438   36.55    6.86E+00     1.28E+01
     0.398    -0.1414   44.38    8.33E+00     1.70E+01
     0.501     0.1099   54.38    1.02E+01     1.98E+01
     0.631     0.3774   64.71    1.21E+01     1.83E+01
     0.794     0.6204   73.25    1.38E+01     1.36E+01
     1.000     0.8196   79.38    1.49E+01     9.79E+00
     1.259     0.9937   83.98    1.58E+01     7.73E+00
     1.585     1.1648   87.80    1.65E+01     6.66E+00
     1.995     1.3388   90.97    1.71E+01     5.16E+00
     2.512     1.4949   93.25    1.75E+01     3.42E+00
     3.162     1.6180   94.72    1.78E+01     2.24E+00
     3.981     1.7247   95.77    1.80E+01     1.81E+00
     5.012     1.8394   96.71    1.82E+01     1.73E+00
     6.310     1.9746   97.58    1.83E+01     1.54E+00
     7.943     2.1272   98.33    1.85E+01     1.25E+00
    10.000     2.2930   98.91    1.86E+01     9.24E-01
    12.589     2.4687   99.32    1.86E+01     6.42E-01
    15.849     2.6536   99.60    1.87E+01     4.19E-01
    19.953     2.8472   99.78    1.87E+01     2.57E-01
    25.119     3.0490   99.88    1.88E+01     1.48E-01
    31.623     3.2585   99.94    1.88E+01     7.90E-02
    39.811     3.4752   99.97    1.88E+01     3.93E-02
    50.119     3.6988   99.99    1.88E+01     1.82E-02
    63.096     3.9285  100.00    1.88E+01     7.76E-03
    79.433     4.1641  100.00    1.88E+01     3.06E-03
   100.000     4.4050  100.00    1.88E+01     1.11E-03
   125.893     4.6508  100.00    1.88E+01     3.73E-04
   158.489     4.9009  100.00    1.88E+01     1.15E-04
   199.526     5.1548  100.00    1.88E+01     3.25E-05
   251.189     5.4121  100.00    1.88E+01     8.45E-06
   316.228     5.6723  100.00    1.88E+01     2.02E-06
   398.107     5.9350  100.00    1.88E+01     4.43E-07
   501.187     6.1995  100.00    1.88E+01     8.96E-08
   630.957     6.4656  100.00    1.88E+01     1.67E-08
   794.328     6.7325  100.00    1.88E+01     2.88E-09
  1000.000     7.0000  100.00    1.88E+01     4.59E-10

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:   14.90    79.3786 %
CUM MASS LESS THAN  2.512 MICRON:   17.51    93.2530 %
CUM MASS LESS THAN 10.000 MICRON:   18.57    98.9064 %
CUM MASS LESS THAN 15.849 MICRON:   18.70    99.6009 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    IMPACTOR DATA REDUCTION PROGRAM, VERSION 10

          INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/4
   TIME OF TEST:  0825
   LOCATION OF TEST:  Bailly Stack
   TEST DESIG.:  NIP
   TEST TYPE          OUTLET
   RUN NUMBER:  3-FILE NAME:TNIPR3.OT
   RUN REMARKS:
   IMPACTOR TYPE: uwpc3-11
     soripc 3 4 5 7 9 11

   WATER VAPOR         15.91%
    CO2  12.80%        CO     0.00%
    O2    6.60%        N2    80.60%
   ORIFICE ID (OPTIONAL):
   SUBSTRATE MATERIAL, G)rease or Bare metal, F)ilter:   F

   GAS METER VOL      166.996 cf
   IMPACTOR DELTA P     0.00 IN. HG. (0 for calc. from theory)
   ORIFICE DELTA P      0.34 INCHES H2O
   STACK PRESSURE       0.5  INCHES H2O
   BAROMETRIC PRES     29.48 INCHES HG
   STACK TEMP         127    DEGREES F
   METER TEMP          98    DEGREES F
   IMPACTOR TEMP      250    DEGREES F
   SAMPLE TIME        480.00 MINUTES
   AVG GAS VEL         33.20 FEET/SEC
   ORI P WRT PBAR      -0.05 INCHES HG
   NOZZLE DIA          0.193 INCHES
   MAX PART DIA     1000    MICRONS
   WATER VOLUME     637.7  CC
   METER FACTOR       1.0240

 MASS GAIN OF STAGE  1  13.32 MG
 MASS GAIN OF STAGE  2   3.36 MG
 MASS GAIN OF STAGE  3   4.78 MG
 MASS GAIN OF STAGE  4   8.11 MG
 MASS GAIN OF STAGE  5  14.68 MG
 MASS GAIN OF STAGE  6  22.59 MG
 MASS GAIN OF STAGE  7  11.21 MG
 MASS GAIN OF FILTER   19.83 MG

MASS GAIN OF BLANK SUBSTRATE    1.03
MASS GAIN OF BLANK FILTER       1.91
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 3
 soripc 3 4 5 7 9 11

ACTUAL FLOW RATE         0.537 CFM
FLOW RATE AT STANDARD CONDITIONS    0.331 CFM
PERCENT ISOKINETIC       109.716 %
VISCOSITY               205.7E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  2.38 IN. HG


STAGE   CUNN.      D50        D50       CUM      RE.      V*D50
        CORR. (CLAS AERO)(IMP AERO)   FREQ.     NO.      UM-M/S
   1    1.018      9.522      9.606   86.1546   1248      15.8
   2    1.047      4.582      4.688   83.5321    464      20.7
   3    1.086      2.508      2.613   79.3114    191      14.4
   4    1.147      1.467      1.571   71.3389    243      16.7
   5    1.293      0.742      0.844   55.9563    360      18.5
   6    1.592      0.384      0.484   31.6623    494      17.3
   7    2.324      0.188      0.287   20.1905    926      16.1

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    1.97E+01 MG/DRY NORMAL CUBIC METER
                         =    1.47E+01 MG/ACTUAL CUBIC METER
                         =    8.61E-03 GRAINS/DRY STD CUBIC FOOT
                         =    6.42E-03 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 3

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR   CUMFR     CUM.MASS    DM/DLOGD
  (MICRONS)  (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

     0.100    -1.5237    6.38     1.26E+00    8.44E+00
     0.126    -1.2125   11.27     2.22E+00    1.05E+01
     0.158    -0.9688   16.63     3.28E+00    1.02E+01
     0.200    -0.7987   21.22     4.18E+00    7.60E+00
     0.251    -0.6891   24.54     4.83E+00    5.89E+00
     0.316    -0.5906   27.74     5.46E+00    7.31E+00
     0.398    -0.4497   32.65     6.43E+00    1.27E+01
     0.501    -0.2402   40.51     7.98E+00    1.77E+01
     0.631    -0.0043   49.83     9.82E+00    1.82E+01
     0.794     0.2054   58.14     1.15E+01    1.40E+01
     1.000     0.3627   64.16     1.26E+01    1.01E+01
     1.259     0.4869   68.68     1.35E+01    8.07E+00
     1.585     0.6015   72.62     1.43E+01    7.60E+00
     1.995     0.7159   76.30     1.50E+01    6.72E+00
     2.512     0.8178   79.33     1.56E+01    5.11E+00
     3.162     0.8958   81.48     1.61E+01    3.47E+00
     3.981     0.9511   82.92     1.63E+01    2.26E+00
     5.012     0.9877   83.84     1.65E+01    1.42E+00
     6.310     1.0146   84.49     1.66E+01    1.27E+00
     7.943     1.0472   85.25     1.68E+01    1.85E+00
    10.000     1.1014   86.47     1.70E+01    3.00E+00
    12.589     1.1879   88.26     1.74E+01    3.99E+00
    15.849     1.3065   90.43     1.78E+01    4.49E+00
    19.953     1.4555   92.72     1.83E+01    4.46E+00
    25.119     1.6331   94.88     1.87E+01    3.96E+00
    31.623     1.8378   96.69     1.90E+01    3.16E+00
    39.811     2.0677   98.07     1.93E+01    2.24E+00
    50.119     2.3213   98.99     1.95E+01    1.41E+00
    63.096     2.5968   99.53     1.96E+01    7.71E-01
    79.433     2.8926   99.81     1.97E+01    3.66E-01
   100.000     3.2069   99.93     1.97E+01    1.48E-01
   125.893     3.5381   99.98     1.97E+01    5.10E-02
   158.489     3.8845   99.99     1.97E+01    1.47E-02
   199.526     4.2444  100.00     1.97E+01    3.52E-03
   251.189     4.6162  100.00     1.97E+01    6.99E-04
   316.228     4.9980  100.00     1.97E+01    1.14E-04
   398.107     5.3883  100.00     1.97E+01    1.54E-05
   501.187     5.7853  100.00     1.97E+01    1.70E-06
   630.957     6.1874  100.00     1.97E+01    1.54E-07
   794.328     6.5928  100.00     1.97E+01    1.16E-08
  1000.000     7.0000  100.00     1.97E+01    7.33E-10

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:  12.64   64.1599 %
CUM MASS LESS THAN  2.512 MICRON:  15.63   79.3254 %
CUM MASS LESS THAN 10.000 MICRON:  17.03   86.4656 %
CUM MASS LESS THAN 15.849 MICRON:  17.81   90.4322 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

```
                    IMPACTOR DATA REDUCTION PROGRAM, VERSION 10

           INPUT DATA

   PART. DIAMETER    CLASSICAL AERODYNAMIC
   DATE OF TEST:  9/5
   TIME OF TEST:  0920
   LOCATION OF TEST:  Bailly Stack
   TEST DESIG.:  NIP
   TEST TYPE         OUTLET
   RUN NUMBER:  4-FILE NAME:TNIPR4.OT
   RUN REMARKS:
   IMPACTOR TYPE: uwpc3-11
     soripc 3 4 5 7 9 11

   WATER VAPOR         15.74%
    CO2  12.90%        CO    0.00%
    O2    6.50%        N2   80.60%
   ORIFICE ID (OPTIONAL):                    .
   SUBSTRATE MATERIAL, G)rease or Bare metal, F)ilter:   F

   GAS METER VOL      165.497 cf
   IMPACTOR DELTA P     0.00 IN. HG. (0 for calc. from theory)
   ORIFICE DELTA P      0.34 INCHES H2O
   STACK PRESSURE       0.5  INCHES H2O
   BAROMETRIC PRES     29.40 INCHES HG
   STACK TEMP         130    DEGREES F
   METER TEMP          87    DEGREES F
   IMPACTOR TEMP      250    DEGREES F
   SAMPLE TIME        480.00 MINUTES
   AVG GAS VEL         32.90 FEET/SEC
   ORI P WRT PBAR      -0.05 INCHES HG
   NOZZLE DIA           0.193 INCHES
   MAX PART DIA      1000    MICRONS
   WATER VOLUME     634.5  CC
   METER FACTOR       1.0240

 MASS GAIN OF STAGE  1   2.25 MG
 MASS GAIN OF STAGE  2   2.48 MG
 MASS GAIN OF STAGE  3   4.03 MG
 MASS GAIN OF STAGE  4   5.73 MG
 MASS GAIN OF STAGE  5   5.94 MG
 MASS GAIN OF STAGE  6   4.67 MG
 MASS GAIN OF STAGE  7   3.99 MG
 MASS GAIN OF FILTER    5.12 MG

MASS GAIN OF BLANK SUBSTRATE    1.16
MASS GAIN OF BLANK FILTER       1.50
```

```
          RESULTS


TEST DESIG.: NIP  RUN NUMBER: 4
 soripc 3 4 5 7 9 11

ACTUAL FLOW RATE          0.542 CFM
FLOW RATE AT STANDARD CONDITIONS    0.334 CFM
PERCENT ISOKINETIC        112.265 %
VISCOSITY                205.8E-06 GM/CM-SEC
CALCULATED IMPACTOR DELTA P =  2.42 IN. HG


STAGE   CUNN.     D50        D50        CUM      RE.      V*D50
        CORR. (CLAS AERO)(IMP AERO)    FREQ.     NO.      UM-M/S
   1    1.018     9.477     9.561    95.5664    1251      15.9
   2    1.047     4.561     4.667    90.2095     468      20.8
   3    1.087     2.493     2.599    78.5520     192      14.5
   4    1.148     1.458     1.562    59.9756     245      16.7
   5    1.296     0.737     0.839    40.5206     363      18.6
   6    1.599     0.381     0.481    26.2518     497      17.3
   7    2.346     0.186     0.285    14.7244     933      16.1

STAGE CUT DIAMETERS BASED ON THEORETICAL VALUES OF STAGE CONSTANTS

PARTICLE DENSITY =  1

TOTAL MASS CONCENTRATION =    5.41E+00 MG/DRY NORMAL CUBIC METER
                         =    4.02E+00 MG/ACTUAL CUBIC METER
                         =    2.37E-03 GRAINS/DRY STD CUBIC FOOT
                         =    1.76E-03 GRAINS/ACTUAL CUBIC FOOT
```

```
TEST DESIG.: NIP  RUN NUMBER: 4

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA.  CUMFR    CUMFR     CUM.MASS     DM/DLOGD
  (MICRONS)   (STDDEV)(PERCENT)   (MG/DRY N.CU.METER)

     0.100    -1.7827    3.73     2.02E-01     1.54E+00
     0.126    -1.4606    7.21     3.90E-01     2.19E+00
     0.158    -1.1955   11.59     6.28E-01     2.48E+00
     0.200    -0.9925   16.05     8.69E-01     2.26E+00
     0.251    -0.8450   19.91     1.08E+00     1.94E+00
     0.316    -0.7272   23.36     1.26E+00     1.86E+00
     0.398    -0.6115   27.04     1.46E+00     2.21E+00
     0.501    -0.4803   31.55     1.71E+00     2.66E+00
     0.631    -0.3379   36.77     1.99E+00     2.97E+00
     0.794    -0.1917   42.40     2.30E+00     3.11E+00
     1.000    -0.0410   48.37     2.62E+00     3.40E+00
     1.259     0.1282   55.10     2.98E+00     3.93E+00
     1.585     0.3303   62.94     3.41E+00     4.52E+00
     1.995     0.5628   71.32     3.86E+00     4.40E+00
     2.512     0.7982   78.76     4.26E+00     3.57E+00
     3.162     1.0122   84.43     4.57E+00     2.59E+00
     3.981     1.1982   88.46     4.79E+00     1.80E+00
     5.012     1.3538   91.21     4.94E+00     1.22E+00
     6.310     1.4845   93.12     5.04E+00     8.85E-01
     7.943     1.6060   94.59     5.12E+00     7.27E-01
    10.000     1.7342   95.86     5.19E+00     6.56E-01
    12.589     1.8801   96.99     5.25E+00     5.72E-01
    15.849     2.0441   97.95     5.30E+00     4.62E-01
    19.953     2.2252   98.70     5.34E+00     3.44E-01
    25.119     2.4225   99.23     5.37E+00     2.35E-01
    31.623     2.6349   99.58     5.39E+00     1.47E-01
    39.811     2.8616   99.79     5.40E+00     8.40E-02
    50.119     3.1016   99.90     5.41E+00     4.33E-02
    63.096     3.3540   99.96     5.41E+00     2.01E-02
    79.433     3.6178   99.99     5.41E+00     8.36E-03
   100.000     3.8920   99.99     5.41E+00     3.10E-03
   125.893     4.1757  100.00     5.41E+00     1.02E-03
   158.489     4.4680  100.00     5.41E+00     2.96E-04
   199.526     4.7679  100.00     5.41E+00     7.59E-05
   251.189     5.0744  100.00     5.41E+00     1.71E-05
   316.228     5.3866  100.00     5.41E+00     3.40E-06
   398.107     5.7036  100.00     5.41E+00     5.95E-07
   501.187     6.0244  100.00     5.41E+00     9.16E-08
   630.957     6.3480  100.00     5.41E+00     1.25E-08
   794.328     6.6735  100.00     5.41E+00     1.50E-09
  1000.000     7.0000  100.00     5.41E+00     1.62E-10

   INHALABLE PARTICULATE MATTER

CUM MASS LESS THAN  1.000 MICRON:    2.62    48.3652 %
CUM MASS LESS THAN  2.512 MICRON:    4.26    78.7610 %
CUM MASS LESS THAN 10.000 MICRON:    5.19    95.8555 %
CUM MASS LESS THAN 15.849 MICRON:    5.30    97.9520 %
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

Appendix G8
Spreadsheet Template for Methods 5 and 17

```
A1: [W20] 'RUN IDENTIFICATION:
B1: U [W13] 'INAC13.W02
C1: [W29] "             REDUCED MASS TRAIN DATA
G1: [W21] 'DRY MW, #/#-mole  :
H1: (F2) 0.32*B3+0.44*B4+0.28*(100-B3-B4)
A2: [W20] 'RUN DATE          :
B2: (G) U [W13] "6/3/93
C2: [W29] "       -----------------------------------
G2: [W21] 'WET MW, #/#-mole  :
H2: (F2) U +H1*(1-D5/100)+18*(D5/100)
A3: [W20] 'GAS ANALYSIS - O2 :
B3: (F1) U [W13] 6.4
C3: [W29] "ISOKINETIC AGREEMENT, %:
D3: (F1) [W10] 1.667*H6/(B15*D7*((B8/2)^2*0.00694*@PI))
G3: [W21] 'STACK PRESS, in Hg:
H3: (F2) +B6+B7/13.6
A4: [W20] " (Dry Basis) - CO2:
B4: (F1) U [W13] 12.7
G4: [W21] 'STAND SAMPLE VOL  :
H4: (F4) 17.65*B16*B10*(B6+B18/13.6)/(B20+460)
A5: U [W20] "PRETEST SETUP %H2O:
B5: (F1) U [W13] 8
C5: [W29] "CALCULATED % H2O       :
D5: (F1) [W10] +H5*100
G5: [W21] 'FRACTION H2O      :
H5: (F3) (0.04707*B13)/(0.04707*B13+H4)
A6: [W20] 'AMB PRESS, in Hg  :
B6: (F2) U [W13] 23.35
G6: [W21] 'ACTUAL SAMPLE VOL :
H6: (F2) +H4*29.921/H3*(B19+460)/528*(1/(1-H5))
A7: [W20] 'STACK dP, in H2O  :
B7: (F1) U [W13] -10
C7: [W29] "AVG GAS VELOCITY, ft/s :
D7: (F1) [W10] 85.48*B9*B17*@SQRT((B19+460)/(H3*H2))
A8: [W20] 'NOZZLE DIA, in    :
B8: (F3) U [W13] 0.202
C8: [W29] "AVG GAS TEMPERATURE, F :
D8: (F0) [W10] +B19
A9: [W20] 'PITOT CONSTANT    :
B9: (F2) U [W13] 0.787
C9: [W29] "GAS VOLUME FLOW, acfm  :
D9: (,0) [W10] +D7*60*B11
A10: [W20] 'GAS METER CALIB   :
B10: (F3) U [W13] 1.0099
C10: [W29] "dscfm :
D10: (,0) [W10] +D7*1056.82*B11*(1-H5)*H3/(B19+460)
A11: [W20] 'DUCT AREA, ft2    :
B11: (F1) U [W13] 126.6
C11: [W29] "wacfm :
D11: (,0) [W10] +D10*(1/(1-H5))
C12: [W29] "Dry Gas lb/hr:
D12: (F0) [W10] +D10*0.075*H1*60/28.95
A13: [W20] 'H2O COLLECTED, ml :
B13: (F1) U [W13] 97.5
C13: [W29] "Moisture lb/hr:
D13: (F0) [W10] (D11-D10)*0.075*18*60/28.95
```

```
A14: [W20] 'PARTICLE MASS, mg :
B14: (F2) U [W13] 23585.9
C14: [W29] "Total lb/hr:
D14: (F0) [W10] +D12+D13
A15: [W20] 'TIME SAMPLED, min :
B15: (F0) U [W13] 96
C15: [W29] "MASS LOADING, gr/acf    :
D15: (S2) [W10] +B14*0.0154/H6
A16: [W20] 'GAS METER VOL, ft3:
B16: (F3) U [W13] 151.5-82.7-0.2-0.2-0.7-0.4-0.3
C16: [W29] "gr/dscf  :
D16: (S2) [W10] +B14*0.0154/H4
A17: [W20] 'AVG SQRT PITOT dp :
B17: (F3) U [W13] 1.051
C17: [W29] "mg/acm   :
D17: (S2) [W10] +B14/(H6*0.02832)
A18: [W20] 'AVG ORI dP, in H20:
B18: (F3) U [W13] 1.41
C18: [W29] "mg/dscm  :
D18: (S2) [W10] +B14/(H4*0.02832)
A19: [W20] 'AVG STACK TEMP, F :
B19: (F0) U [W13] 293
C19: [W29] "gr/dscf @3% O2    :
D19: (S2) [W10] +D16*((20.9-3)/(20.9-B3))
A20: [W20] 'GAS METER TEMP, F :
B20: (F0) U [W13] 89
C20: [W29] " g/dscm @3% O2    :
D20: (S2) [W10] +D19/0.43699
C22: [W29] "EMISSION RATE, lb/hr    :
D22: (S2) [W10] +D16*60*D10/7000
C23: [W29] "EMISSION RATE, #/E6-Btu:
D23: (S2) [W10] +D16*9820*(20.9/(20.9-B3))/7000
A25: U [W20] "Fo:
B25: (F2) U [W13] (20.9-B3)/B4
```

Appendix G9
Spreadsheet Template for Dilution Train

```
A1: [W6] ' DOE DILUTION TRAIN DATA REDUCTION
N1: 'SP
O1: 29.92
N2: 'FS
O2: 528
A3: [W6] '6/2/93
N3: 'FR
O3: 460
A4: [W6] 'MM5 & Acids
N4: 'MA
O4: 28.97
A5: [W6] "-----------------------------
K5: [W21] 'DRY MW, #/#-mole  :
L5: (F2) 0.32*D6+0.44*D7+0.28*(100-D6-D7)
A6: [W6] 'GAS ANALYSIS - O2  :
D6: (F1) U [W7] 7
K6: [W21] 'WET MW, #/#-mole  :
L6: (F2) +L5*(1-D8/100)+18*(D8/100)
A7: [W6] "                CO2 :
D7: (F1) U [W7] 12
K7: [W21] 'STACK PRESS, in Hg:
L7: (F2) +D9+D10/13.6
A8: [W6] "                H2O :
D8: (F1) U [W7] 12.1
K8: [W21] 'INTERM CONST 1     :
L8: (F4) 85.48*D21*0.0005074*(D30*25.4)^2*@SQRT((D16+460)/(L7*L6))
A9: [W6] 'AMB PRESS, in Hg    :
D9: (F2) U [W7] 23.15
K9: [W21] 'INTERM CONST 2     :
L9: ((1-D8/100)*L7)^2*L5*(D17+460)*1.087*D22/D9
A10: [W6] 'STACK dP, in H2O   :
D10: (F1) U [W7] -1.4
A11: [W6] 'Enter Gas vel., fps
A12: [W6] 'or AVG SQR ROOT dp :
D12: (F2) U [W7] 1.3
A14: [W6] 'Target Dil. Factor:
D14: (F3) U [W7] 10
A16: [W6] 'STACK GAS TEMP, F  :
D16: (F0) U [W7] 205
A17: [W6] 'GAS METER TEMP, F  :
D17: (F0) U [W7] 100
A18: [W6] 'Dil Air Temp
D18: [W7] 72
A19: [W6] 'Exh air temp
D19: [W7] 86
A21: [W6] 'PITOT CONSTANT      :
D21: (F2) U [W7] 0.81
A22: [W6] 'SAMP. ORI. DH@      :
D22: (F2) U [W7] 9.2
A23: [W6] 'SAMPLE DURATION, min:
D23: [W7] 360
A25: [W6] 'Dil Air Ori DH@:
D25: [W7] 0.0334
A26: [W6] 'Exhaust flow DH@
D26: [W7] 0.0413
A27: [W6] 'Filter DP
```

```
D27: [W7] 6.3
A28: [W6] 'Pdm
D28: [W7] 11
A30: [W6] 'NOZZLE DIA, in      :
D30: (F3) U [W7] 0.175
A31: [W6] 'SAMPLE FLOW, acfm  :
D31: (F3) [W7] 0.9785
E31: (F3) [W15] +D33
F31: (F2) [W9] +D31
A32: [W6] 'dp pitot
D32: (F2) U [W7] +D12*D12
E32: [W15] +D22
F32: [W9] (F31*$L$7/($D$3+$D$16))
G32: [W12] +F32*F32*($D$3+$D$16)*$L$6
H32: [W9] +$D$2*E32/($D$1*$D$4)
I32: (F2) +G32*H32/(0.5625*$L$7)
J32: 'DHso
A33: [W6] 'SAMPLE FLOW, dscfm :
D33: [W7] +D31*(1-D8/100)*(528/(460+D16))*(D9/29.92)
A34: [W6] 'Total flow in, dscfm
D34: (F2) [W7] +D35+D33
A35: [W6] 'Dil flow dscfm
D35: (F2) [W7] 3.92
E35: [W15] "   True Dilution Factor:
J35: (F2) (E39+E31)/E31
A36: [W6] 'Dil Bw
D36: [W7] 0
E36: [W15] "   Sample Volume, dscf :
J36: (F2) +E31*D23
I37: "dncm:
J37: (F2) +J36*0.02832
E39: (F2) [W15] +D35
F39: [W9] +E39*$D$1/(D9+D28/13.6)*($D$3+$D$18)/$D$2
G39: [W12] "* flow at orifice conditions
A40: [W6] 'Dilution flow DHdo
E40: [W15] +D25
F40: [W9] (F39*$D$1/$D$2)
G40: [W12] +F40*F40*($D$3+$D$18)*$D$4
H40: [W9] +$D$2*E40/($D$1*$D$4)
I40: (F2) +G40*H40/(0.5625*(D9+D28/13.6))
J40: 'DHdo
G41: [W12] "beta
H41: [W9] "Hconst
A42: [W6] 'Side stream 1 flow, dscfm
E42: [W15] 0
F42: [W9] +E42*$D$1/$D$9*($D$3+$D$17)/$D$2
A43: [W6] 'Side stream 1 DH@
E43: [W15] 1.788
F43: [W9] (F42*$D$9/($D$3+$D$17))
G43: [W12] +F43*F43*($D$3+$D$17)*$D$4
H43: [W9] +$D$2*E43/($D$1*$D$4)
I43: (F2) +G43*H43/(0.5625*$D$9)
J43: 'DH1
K43: [W21] 'Nutech 2
A44: [W6] 'NT #4 (old)
A46: [W6] 'Side stream 2 flow, dscfm
```

```
46: [W15] 0.75
F46: [W9] +E46*$D$1/$D$9*($D$3+$D$17)/$D$2
A47: [W6] 'Side stream 2 DH@
E47: [W15] 1.7898
F47: [W9] (F46*$D$9/($D$3+$D$17))
G47: [W12] +F47*F47*($D$3+$D$17)*$D$4
H47: [W9] +$D$2*E47/($D$1*$D$4)
I47: (F2) +G47*H47/(0.5625*$D$9)
J47: 'DH2
K47: [W21] 'Nutech 48
A48: [W6] 'guardian 100
A50: [W6] 'Side stream 3 flow, dscfm
E50: [W15] 0.71
F50: [W9] +E50*$D$1/$D$9*($D$3+$D$17)/$D$2
A51: [W6] 'Side stream 3 DH@
E51: [W15] 1.76
F51: [W9] (F50*$D$9/($D$3+$D$17))
G51: [W12] +F51*F51*($D$3+$D$17)*$D$4
H51: [W9] +$D$2*E51/($D$1*$D$4)
I51: (F2) +G51*H51/(0.5625*$D$9)
J51: 'DH3
K51: [W21] 'RAC 8643
A52: [W6] 'CAE 71-16
A55: [W6] 'Exhaust flow dscfm
E55: (F2) [W15] +D34-E42-E46-E50
F55: [W9] +E55*$D$1/($L$7-(D27+I32)/13.6)*($D$3+$D$19)/$D$2
A56: [W6] 'Exhaust flow DHexh
E56: [W15] +D26
F56: [W9] (F55*$L$7/($D$3+$D$19))
G56: [W12] +F56*F56*($D$3+$D$19)*$D$4
H56: [W9] +$D$2*E56/($D$1*$D$4)
I56: (F2) +G56*H56/(0.5625*($L$7-(D27+I32)/13.6))
J56: 'DHexh
```