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LEVEL 1 ENVIRONMENTAL ASSESSMENT OF CUPOLA EMISSIONS AT THE TIOGA FOUNDRY

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K. T. Menzies
J. W. Adams
K. E. Thrun

January 1984

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Arthur D. Little, Inc.
Cambridge, MA 02140

Prepared for
Pennsylvania State University
University Park, PA 16801

And the
U.S. Department of Energy
Under DOE Contract No. DE-AS02-76CS40028

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U. S. DEPARTMENT OF ENERGY
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I. SUMMARY AND CONCLUSIONS

Sampling and analysis was undertaken to characterize and quantify particulate, organic and inorganic chemical concentrations in gaseous effluents downstream of an afterburner (AFB) or stack air addition (SAA) system in a cupola at the Tioga Casting Company in Owego, New York. The U.S. Environmental Protection Agency/Industrial Environmental Research Laboratory (EPA/IERL) Level 1 environmental assessment procedures (1) were used to determine if the level of pollutants present differed when using the AFB versus the SAA control device for reduction of carbon monoxide (CO) concentrations.

Triplicate measurements made for the two control systems indicate total particulate loadings of 4.8 and 3.7 g/m^3 for the afterburner and stack air addition system, respectively. The difference between these values is not significant at the 95% confidence level (Student's t-test). The total organic loading was observed to be 10 and 18 mg/m^3 for the AFB and SAA, respectively. Again, the difference is not statistically significant. However, there are some differences in the distribution of organic material among fractions, such as compounds with boiling points between 100°-300°C, that do appear to be significant based on the t-test. Also, the bag-house particulate samples collected downstream of the SAA were black, while those collected from the AFB effluent were gray. These findings tend to indicate a slightly greater organic loading in the effluent from the SAA, but the difference is similar in magnitude to the factor of two uncertainty associated with the Level 1 sampling and analysis protocols used in this study.

Microscopic examination revealed that the particulate matter present in the cupola effluent consists mainly of silicates. The mass concentration of trace metals in the particulate, as measured by spark source mass spectrometry, is not significantly different during operation of the afterburner and stack air addition system. The concentration of elements

designated as hazardous air pollutants (2), i.e., beryllium and mercury, is not significantly different during operation of the two control systems.

Major organic compound classes present during operation of both the afterburner and stack air addition control systems include: (1) aliphatic hydrocarbons of molecular weight up to and exceeding 450, (2) polycyclic aromatic hydrocarbons (PAH) of molecular weight less than 216, and (3) carboxylic acids such as benzoic acid. Of these, the polycyclic aromatic hydrocarbons might seem to be of most interest in terms of potential implications for health, since some compounds of this type are suspect cancer agents. However, most of the polycyclic aromatic hydrocarbons present have fewer than five fused rings and are not suspected carcinogens. Higher molecular weight polycyclic aromatic hydrocarbon species, including some of those suspected of carcinogenic activity, might also be present at lower concentrations. The low resolution mass spectrometric (LRMS) data indicate that the total PAH content is somewhat lower for the stack air addition system than for the afterburner.

For both control systems, the LRMS data indicate that aliphatic hydrocarbons are relatively more abundant than polycyclic aromatic hydrocarbons. The same data indicate a higher relative concentration of aliphatic hydrocarbons with the stack air addition system. Although aliphatic hydrocarbons of high molecular weight, e.g., MW >360, are not suspect carcinogens, they may be promoters. Their relative abundance may, therefore, be important.

During operation of the stack air addition system, a higher mass concentration of organic compounds, in the boiling range of 100°-300°C, was observed than during operation of the afterburner. The possible health implications of these observations are uncertain, especially since the difference in concentrations is small compared to the variance expected from the sampling and analysis procedures.

Thus, the differences in organic mass concentration and chemical character observed between the afterburner and stack air addition system may or may not be significant from a health aspect. The magnitude of the quantitative differences in mass concentrations of organic matter is not large (i.e., less than a factor of two) and is near the magnitude of precision associated with the analytical procedures used in this work. Qualitative differences, i.e., lower abundance of polycyclic aromatic hydrocarbons and higher abundance of aliphatic hydrocarbons, are not large on a subjective basis and any synergistic impact is uncertain. The small differences between organic compound concentrations and character during operations of the two control systems would indicate that they are also likely to be comparable in terms of potential health impact. It is possible that compound-specific analysis of the cupola effluent might indicate some exceptions to this general statement by revealing more substantial differences in levels of emissions of individual organic species.

Combustion gases are present in statistically similar concentration levels (95% confidence) during operation of the AFB and SAA. Carbon monoxide appears to be oxidized to carbon dioxide with comparable efficiency by either control system.

In summary, the concentration of partial combustion gases, e.g., carbon monoxide, nitrogen oxides, and hydrocarbons, are equivalent during operation of the afterburner and stack air addition system. Inorganic particulates account for about 95% of the total mass of material collected from the cupola effluent under both conditions. The mass concentration of total particulates and selected elements, e.g., trace metals, is equivalent during the use of either control device.

The mass concentration of total organic extractable matter is not significantly different during operation of the stack air addition system or the afterburner. However, for organic compounds with boiling points between 100° and 300°C, the mean mass concentration is about a factor of two greater for the SAA than the AFB. This is a significant

difference at the 95% confidence level, but not at the 99% level. The health impact of these differences is uncertain but on the basis of the precision of the experimental data and current understanding of risk assessment for complex effluents, the two systems appear to be comparable in emissions and probable impact on health and the environment.

II. INTRODUCTION

In the spring of 1981, a stack air addition system (SAA) was installed on the 40-inch divided blast cupola at the Tioga Foundry in Owego, New York. The stack air addition system consists of two rings, seven and nine feet below the charge door sill, with four equally spaced ports in each ring offset from one another; air is provided to the ports by a Roots blower capable of an 850 scfm flow rate. The lower ring is 10'6" above the lower tuyeres. Flow rates are monitored using annubars and water manometers. A schematic diagram of the system is shown in Figure 1 and the locations of the ports in the cupola shell in Figure 2.

The SAA was installed in partial fulfillment of the terms of a research contract (#DE-AS02-76CS40028), conducted by the Pennsylvania State University, which has as its goals to:

1. Develop methods for eliminating afterburners from production cupolas;
2. Improve cupola operating efficiency;
3. Transfer this technology to the foundry industry.

Field and laboratory studies indicated that, by introducing air at the proper point in the cupola shell, carbon monoxide can be ignited and burned to carbon dioxide in the stack. Thus, the afterburner may be eliminated and a reduction in the amount of energy required for melting a unit of iron achieved.

A necessary input to this program is a demonstration that the change in technology does not have an adverse effect on air quality. To achieve this goal, Arthur D. Little, Inc. conducted an environmental assessment of the stack emissions from the cupola. For these tests, EPA/IERL Level 1 environmental test procedures (1) were used.

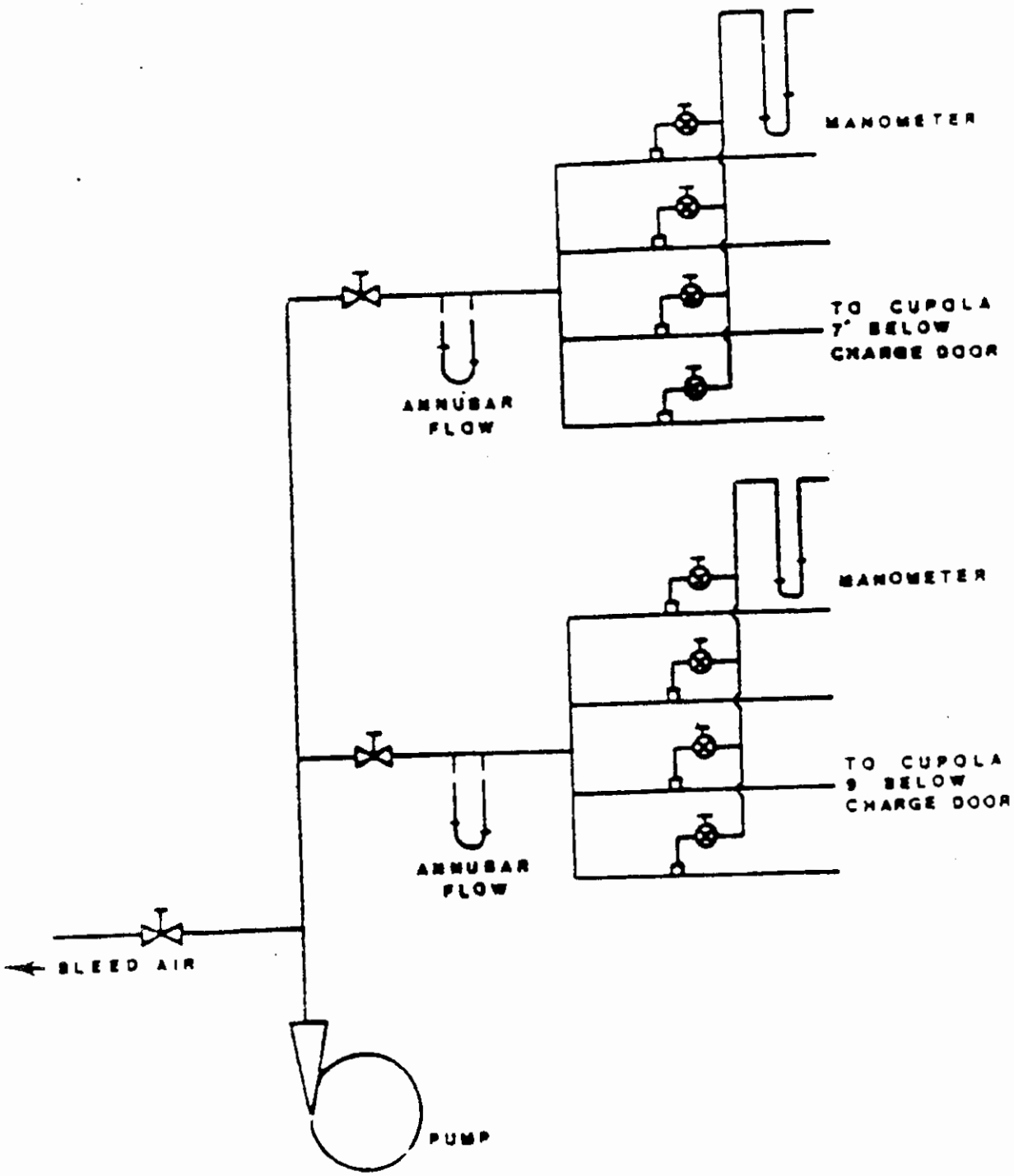


FIGURE 1. SCHEMATIC DIAGRAM OF THE SAA AIR FLOW SYSTEM

Source: Reference 12

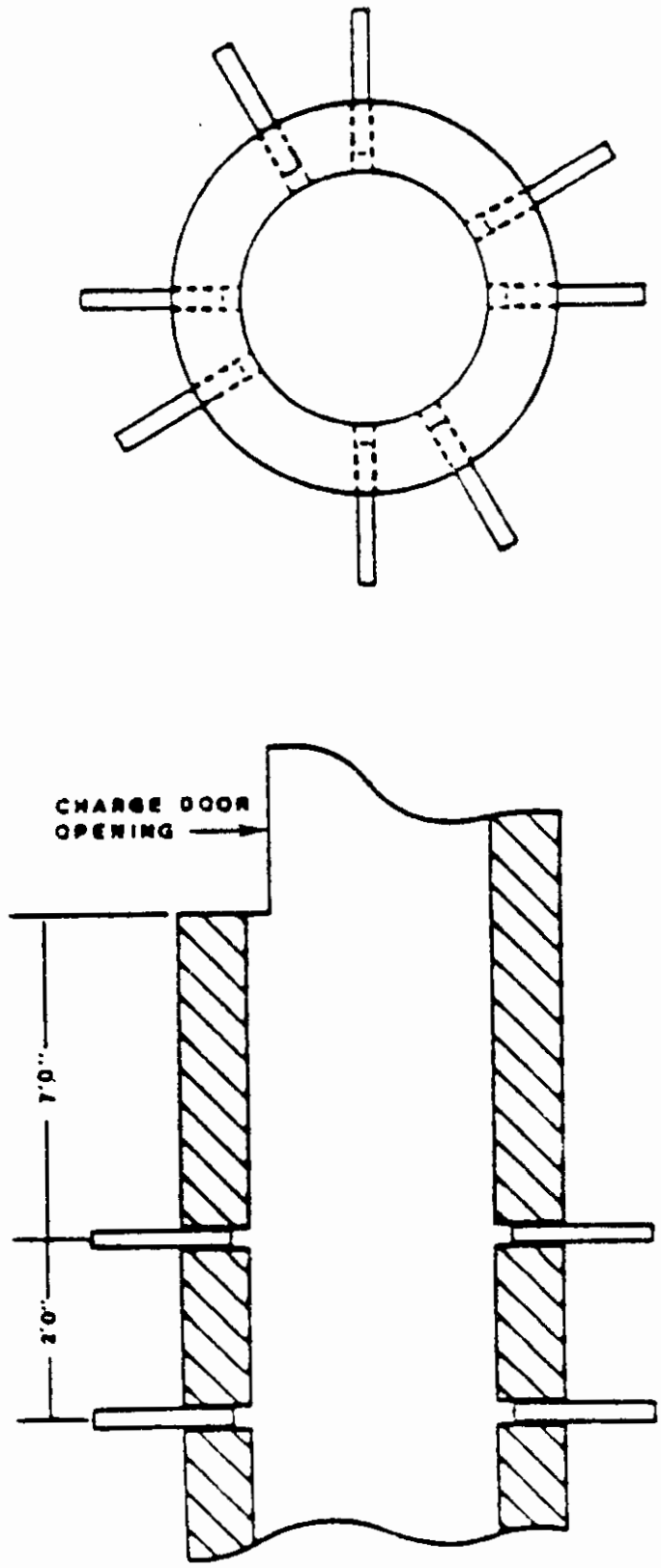


FIGURE 2. SCHEMATIC DIAGRAM OF THE SAA PORT LOCATIONS

Source: Reference 12

Samples of gaseous effluent from the cupola were collected downstream of the afterburner or the stack air addition system depending upon the test conditions being sampled, and upstream of emission control devices. The test consisted of triplicate collections of:

1. The gaseous effluent during cupola operation with the afterburner, and
2. The gaseous effluent during cupola operation with the stack air addition system.

The samples collected with a Modified Method 5 (MM5) train were analyzed by EPA/IERL Level 1 procedures. Figure 3 shows a schematic diagram of the Level 1 analytical scheme. For the purposes of this program, all of the particulate catches were combined prior to analysis. Both organic and inorganic species were analyzed via the appropriate Level 1 procedures. Spark source mass spectrometry was used to survey the inorganic species from lithium (Li) to uranium (U) except for volatile inorganics, mercury (Hg), antimony (Sb), and arsenic (As), which were determined by atomic absorption spectrometry. Infrared spectrometry and low resolution mass spectrometry were used to identify and characterize the organic components of the collected samples. In addition to the Modified Method 5 samples, concentrations of combustion gases, i.e., carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), oxygen (O_2) and hydrocarbons (HC) were measured during sample collection.

The actual tests were conducted during the weeks of September 14 and 21, 1981. On September 15, 16, 17, and 21, the foundry operated with a natural gas-fired afterburner; on September 22, 23, and 24 only the stack air addition system was in operation.

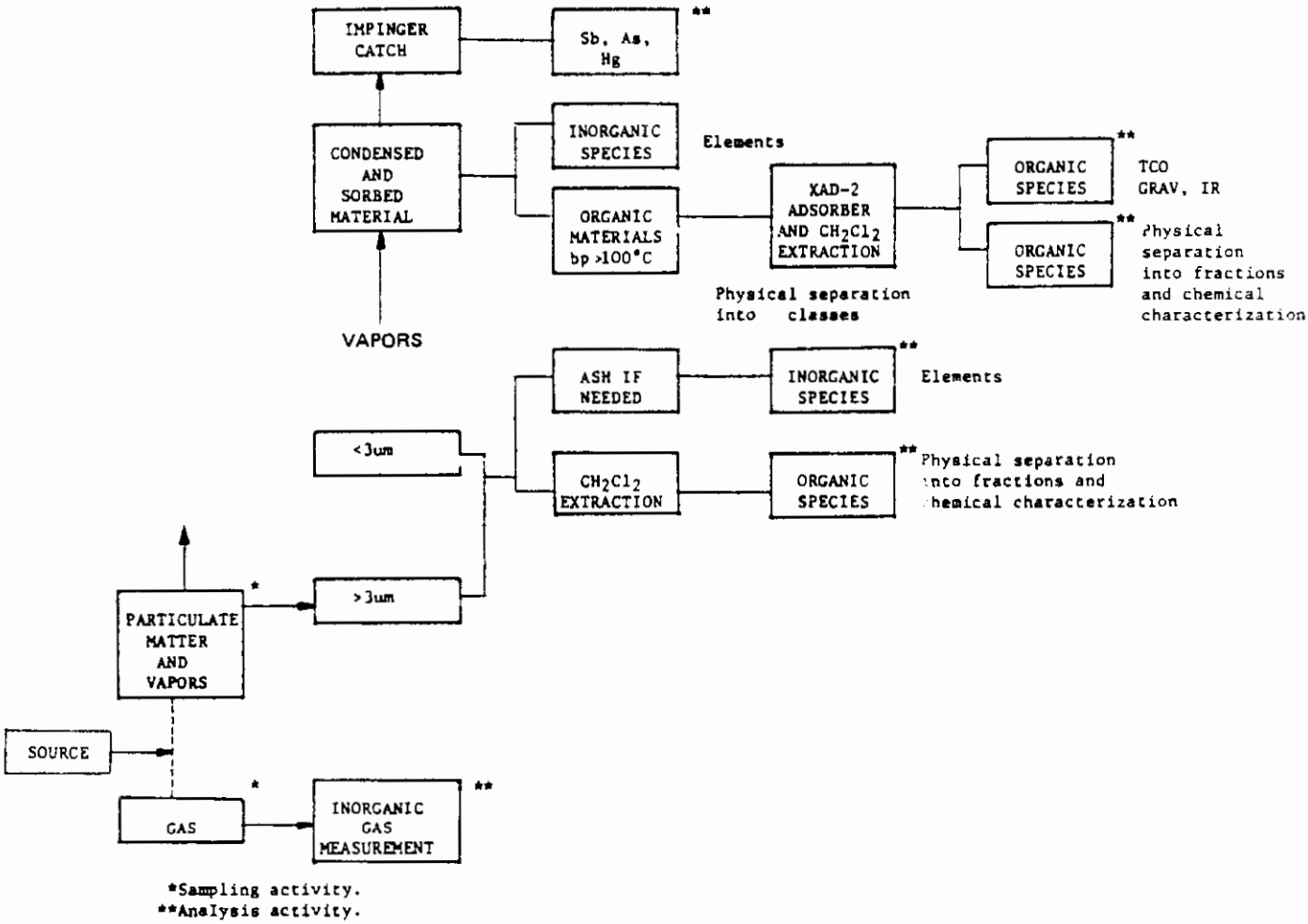


FIGURE 3. LEVEL 1 SAMPLING AND ANALYTICAL SCHEME FOR PARTICULATES AND GASES

Source: Reference 1

III. EXPERIMENTAL PROCEDURES

A. SAMPLING FOR COMPREHENSIVE ANALYSIS

The objectives of this test program include quantitative estimation of total particulate matter concentrations and comprehensive characterization of organic and inorganic materials present. To accomplish this task, samples were collected using a Modified Method 5 train (MM5), shown schematically in Figure 4. This sampling train incorporated a water-cooled, quartz-lined, stainless steel probe; a heated cyclone and filter; a heat exchanger; sorbent trap; condensate trap and impinger train. The probe was water-cooled so as to reduce the temperature of the stack gas (800°-1100°C) to about 120°C prior to passage into the cyclone and filter oven. The cyclone was used upstream of the filter to limit potential overloading of the filter. In order to cool the gas stream to a temperature (i.e., 20°C) consistent with efficient collection of organic vapors on the XAD-2® sorbent trap, a heat exchanger (Figure 5) was installed upstream of the solid sorbent trap. The heat exchanger was fabricated from a glass condenser and cold finger through which water from the impinger ice bath was circulated with a peristaltic pump. A thermocouple was installed in a glass tip in the gas stream to monitor the temperature of the gas entering the sorbent trap.

An impinger train containing six 500 milliliter impingers was installed downstream of the sorbent trap. An empty impinger was used for collection of condensate from the sorbent trap. Two oxidizing impingers containing hydrogen peroxide for removal of acid gases were followed by two oxidizing impingers containing ammonium persulfate and silver nitrate to collect volatile metals, i.e., mercury, antimony and arsenic. A sixth impinger containing silica gel was used to dry the air prior to volume measurement in a dry gas meter.

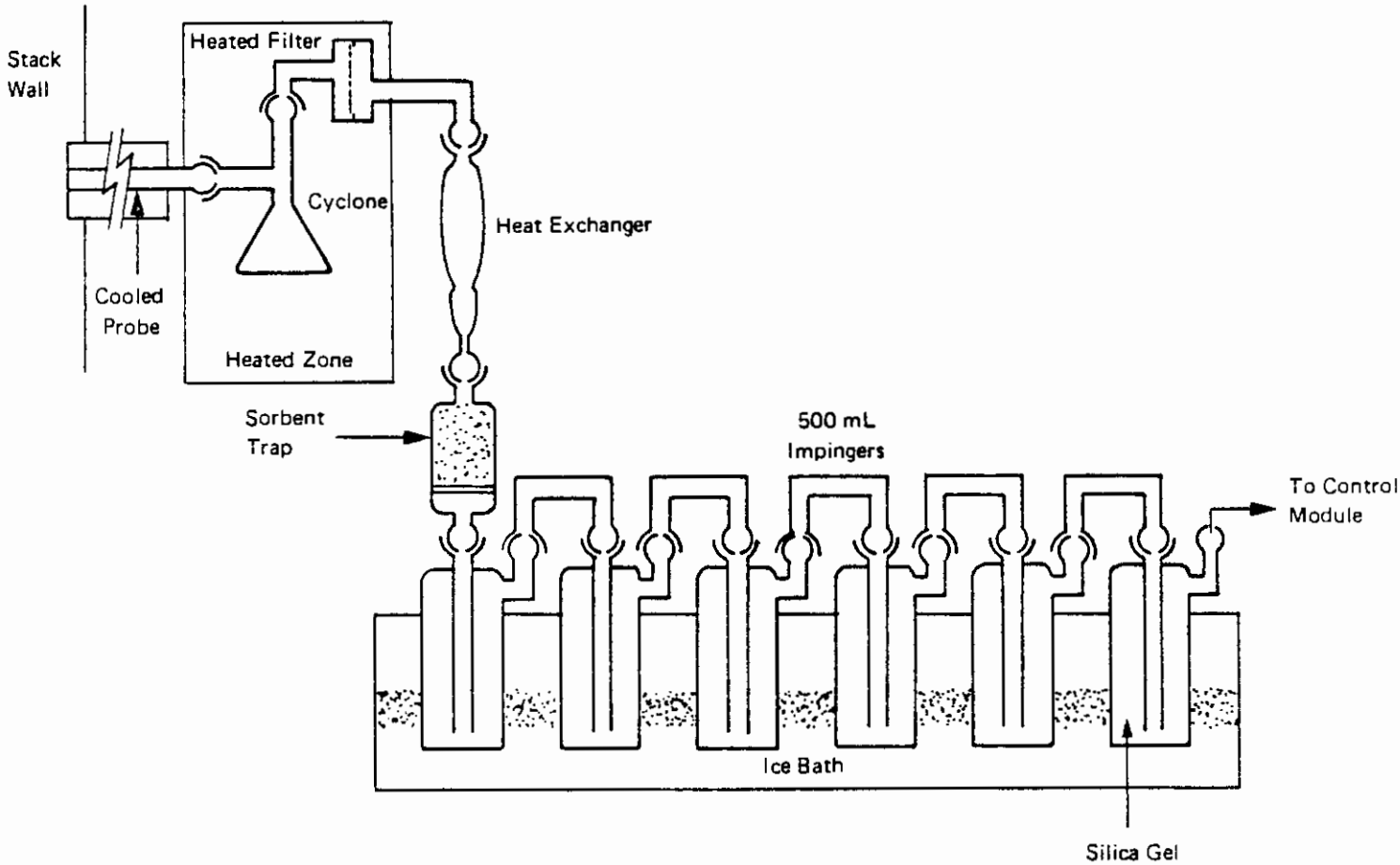


FIGURE 4 METHOD 5 TRAIN MODIFIED FOR COLLECTION OF ORGANIC VAPORS

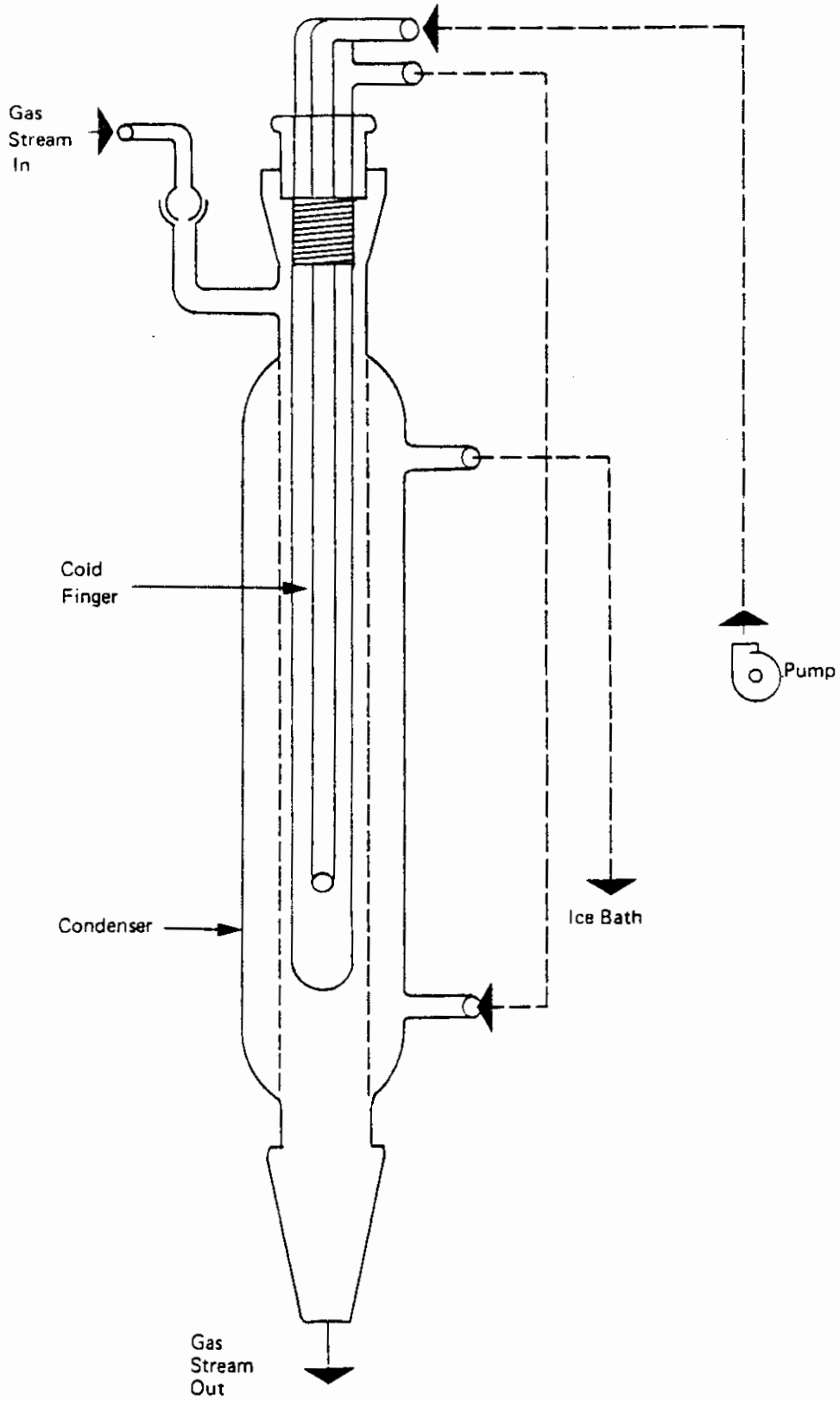


FIGURE 5 HEAT EXCHANGER

During sampling, the probe nozzle was positioned in the stack at a fixed point of average velocity, determined by a preliminary traverse with a pitot tube according to EPA Method 2 (3). The sampling system was operated as close to isokinetic conditions as was possible within the constraints of available nozzle sizes and operating parameters. Approximately 3-5 m^3 of gas (STP) were collected during each test at a flow rate ranging from 15-30 liters per minute.

At the completion of each sampling run the train was disassembled and samples recovered according to Level 1 procedures (1). The residue from the probe was recovered with a nylon brush and flushed with equal volumes of HPLC-grade methanol and dichloromethane. The residue in the cyclone and front half of the filter holder was rinsed with the same solvent into the glass bottle containing the probe rinse. Individual filter samples were placed in petri dishes for transport. The solvent rinse from the back half of the filter holder, heat exchanger and condensate trap were collected in a separate glass bottle. The sorbent trap was sealed with Teflon® film for transportation. The two H_2O_2 impinger samples and rinses were placed in a common glass bottle. The ammonium persulfate/silver nitrate impinger samples and rinses were also combined in a separate glass bottle. The silica gel was transferred to a tared nalgene bottle for subsequent analysis of percent moisture according to EPA Method 4 (3).

B. ON-SITE GAS ANALYSIS

1. Carbon Monoxide (CO), Nitrogen Oxide (NO_x) and Total Hydrocarbons (HC)

The gas sampling train consisted of a 3/8"-OD porcelain probe inserted into the stack; a 75-ft long, heat-traced (100°C) Teflon line; a heated (175°C) oven containing a metal bellows pump and glass fiber filter; and instrumental analyzers for measurement of CO, NO_x and HC, i.e., Beckman 864, Beckman 955 and Beckman 402, respectively.

After exiting the oven, the gas stream entered a heat-traced manifold which split the flow to the NO_x and HC analyzers. Excess gas was

collected in a Tedlar® bag over a period of 10 minutes and, after cooling, was pumped through silica gel and into the CO analyzer for measurement of concentration.

2. Orsat Device

An Orsat device was used to collect and analyze stack gas for O_2, CO_2 and CO on an infrequent basis. Samples were also collected from the stack (through the pitot tube on the probe) and at the continuous analyzer manifold to check for leaks, confirm the accuracy of the gaseous analyzers, and to compare with concentrations measured independently by a Pennsylvania State University field team.

C. BAG-HOUSE SAMPLES

Grab samples of the particulate removed from the cupola stack in the bag-house were collected during operation of the cupola with the afterburner and with the stack air addition system. These two samples were stored in glass bottles for possible future analysis.

D. ANALYSIS PROCEDURES

The MM5 train samples collected in the field were stored in ice and returned on a weekly basis to the laboratories of Arthur D. Little, Inc. for analysis. The samples received for analysis included six components from each MM5 sampling run and two solvent blanks corresponding to the solvents used for extraction of the sorbent, condensate, and for probe and cyclone rinses. Each sample was subjected to the Level 1 analytical program, including inorganic and organic analysis. Figures 6-9 show the actual step-by-step analysis scheme used for each sample. All samples were carried through the entire Level 1 program except in those cases where the sample size and concentration was below that required for further analysis. Only two sorbent samples contained sufficient material to warrant fractionation by liquid chromatography.

	Initial Prep.			Inorganic Analysis					Organic Analysis								
	Dry	Weigh	Combine	Sample Preparation	SSMS (Li-U)	Hg	Sb	As	Extraction	TCO	GRAV	IR	LC Fraction	TCO*	GRAV*	IR*	LRMS*
Particulate																	
Probe and Cyclone Washes	✓	✓															
>3μ Particulate***		✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
Filter		✓															
Gaseous																	
XAD-2 Resin				✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
XAD-2 Module Rinse				✓	✓	✓											
XAD-2 Condensate			**				✓	✓									
First Impinger Catch			**	✓**	✓**		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Second & Third Impinger Catch			**				✓	✓									

*Step performed on each of the LC fractions.

**Combined aliquots for inorganic analysis by SSMS.

***Due to the large amount of particulate present in cupola gaseous effluent, a knockdown stage with an approximately 3μ cutoff will be added to the modified Method 5 train prior to the filter.

Brackets indicate combined fractions.

FIGURE 6. PROCEDURAL STEPS INVOLVED IN THE LEVEL 1 ANALYSIS OF A SINGLE MODIFIED METHOD 5 SAMPLE

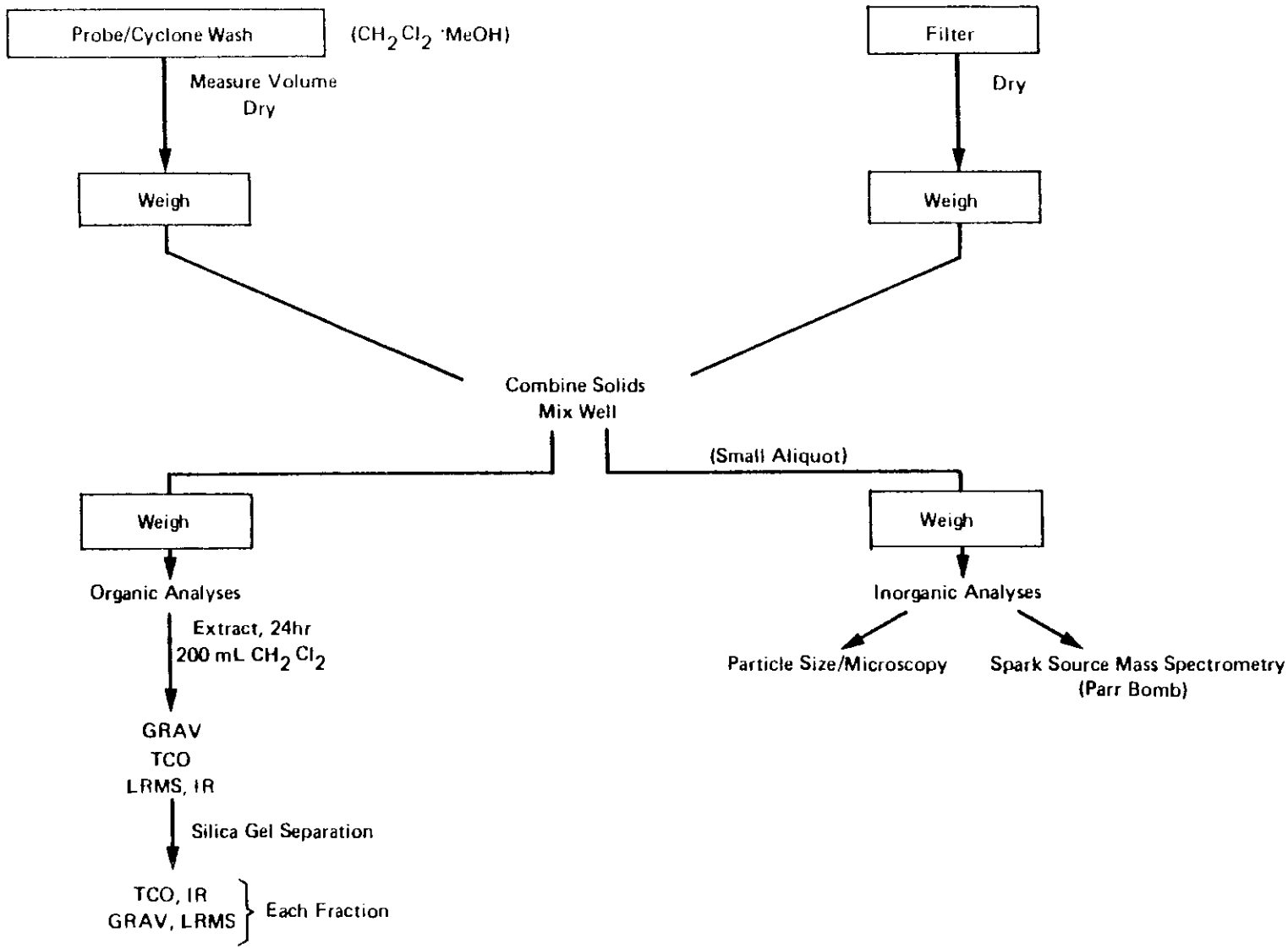


FIGURE 7 ANALYTICAL SCHEME FOR PARTICULATE CATCH

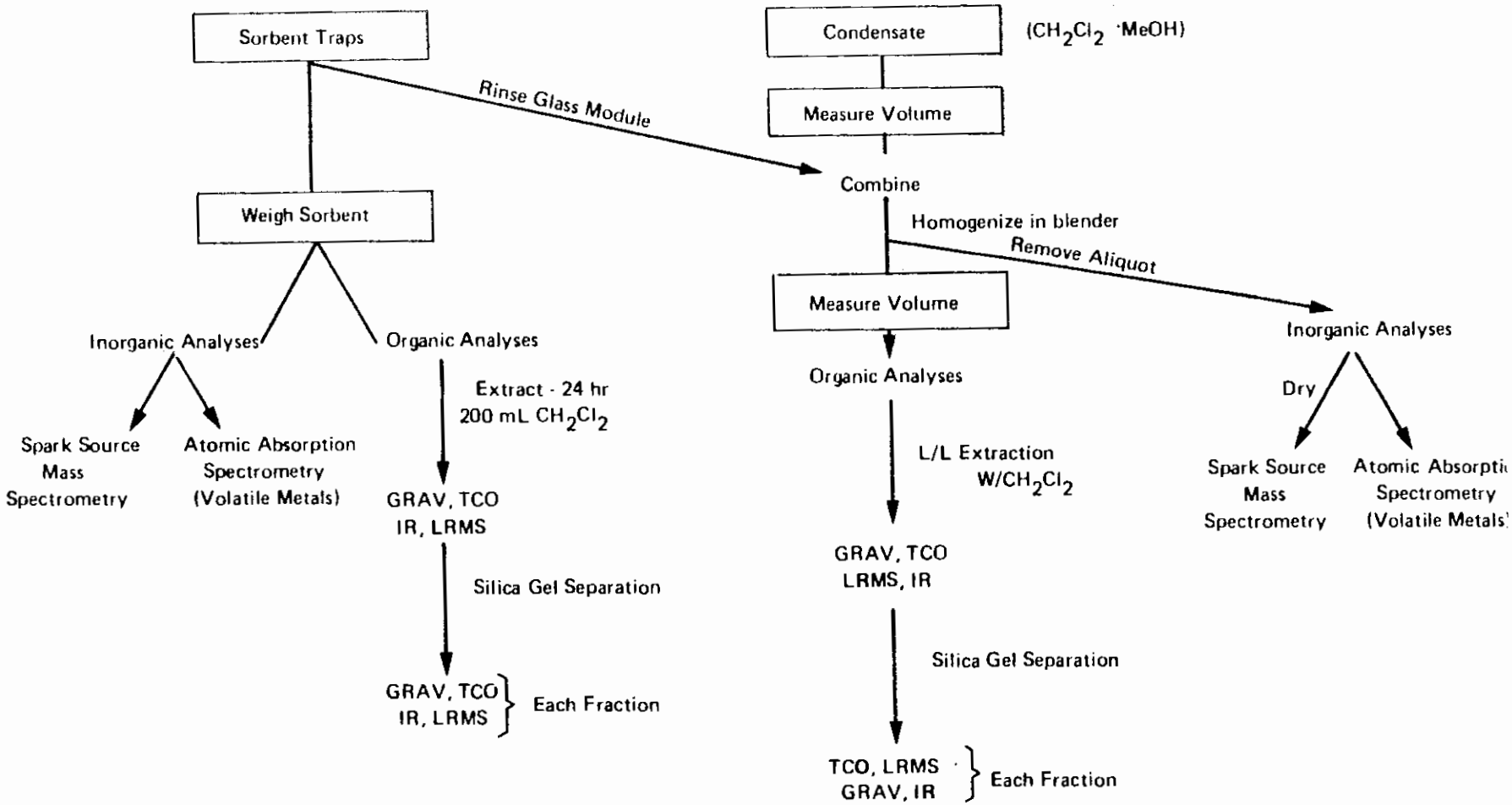


FIGURE 8 ANALYTICAL SCHEME FOR ORGANIC VAPORS

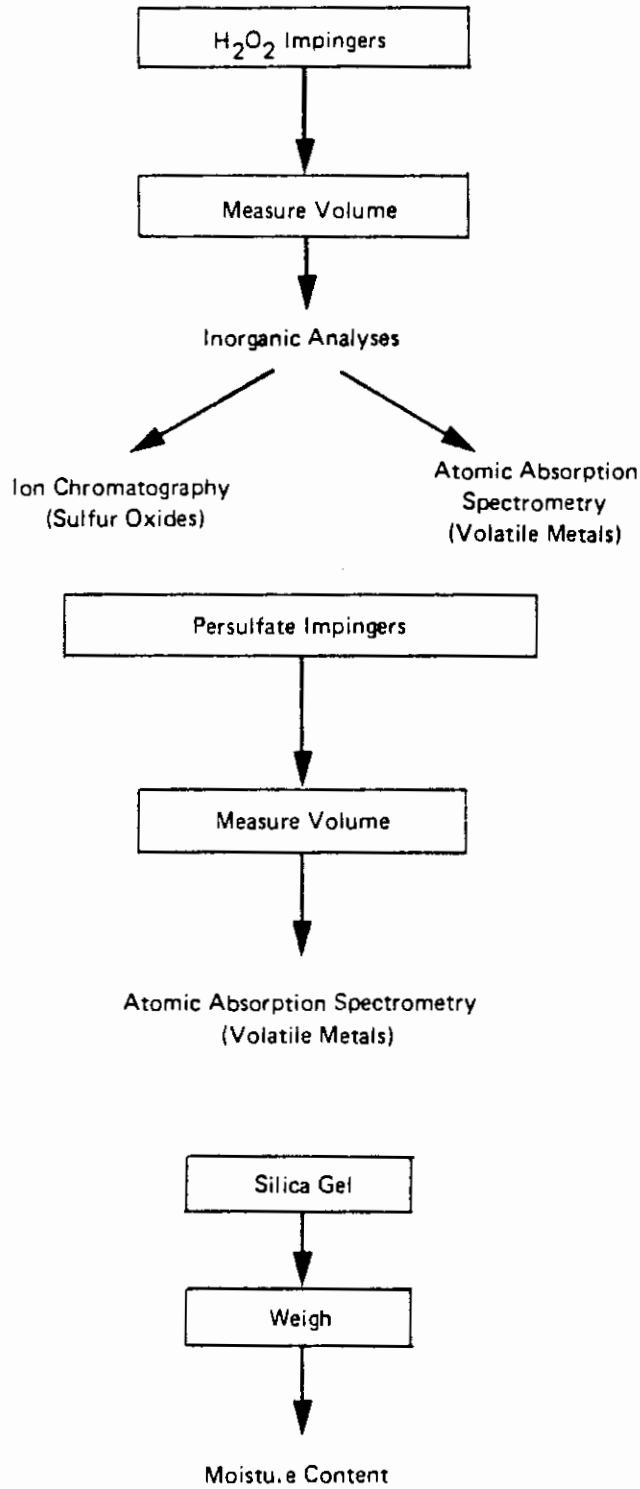


FIGURE 9 ANALYTICAL SCHEME FOR VOLATILE METALS AND SULFUR OXIDES

1. Level 1 Organic Analysis

Level 1 organic analysis procedures as described in the EPA procedures manuals (1) were followed. A brief summary of the various steps is given below.

(a) Particulate Masses

The masses of the particulate samples (filter and cyclone catches; probe; cyclone rinses) were obtained by drying the samples to constant weight (±0.1 mg) in tared evaporating dishes at 50°C and cooling to room temperature in a desiccator.

(b) Soxhlet Extraction

All extractions were carried out for a 24-hour period using high-purity methylene chloride (Fisher Scientific, Inc., HPLC-grade). The following procedures were used:

- XAD-2® Resins - Extracted with 200 mL of methylene chloride.
- Probe, cyclone catches and filter sample - Weighed individually and then combined. Portions of the combined particulates were removed for microscopy and inorganic analysis and the remainder extracted with 200 mL of methylene chloride.

(c) Total Chromatographable Organics Analysis (TCO)

The quantity of the total organic material with boiling point in the range of 100-300°C was determined by gas chromatography using a flame ionization detector. The concentration of each sample was calculated from the ratio of the peak areas of the sample to that of the known

standards. The following instrument conditions were used:

Column:	10% OV-101 on 100/120 mesh Supelcoport
Injector Temperature:	270°
Detector Temperature:	305°C
Temperature Program:	Room temperature for 5 minutes, then programmed at 20°C/min up to 250°C
Carrier Gas Flow:	Helium at 30 mL/min

(d) Gravimetric Analysis (GRAV)

The quantity of organic material with a boiling point higher than 300°C was determined by the gravimetric analysis method (GRAV). One to five mL aliquots were pipetted into precleaned, dried and weighed aluminum dishes, and were dried at room temperature in a desiccator to constant weight (±0.1 mg).

(e) Infrared (IR)

The IR spectra of all samples were obtained on a Digilab 15C FTIR spectrometer, using potassium bromide plates. Spectra were interpreted with the aid of References 4-7.

(f) Liquid Chromatographic (LC) Separation

Samples for liquid chromatography were initially concentrated to 10 mL using a Kuderna-Danish apparatus followed by concentration to 1 mL under a nitrogen stream and then subjected to three consecutive solvent exchanges with cyclopentane. The resultant cyclopentane solutions were introduced onto a silica gel column, and seven fractions were collected by elution with solvent mixtures of increasing polarity. Fractions 2 and 3 were combined, as were Fractions 4 through 7.

(g) Low Resolution Mass Spectrometry (LRMS)

LRMS analysis was carried out on a Dupont 21-110B mass spectrometer. Both batch inlet and direct insertion probe techniques were used depending on the TCO content of the samples. Sample sizes varied from 20 μL to 50 μL. Typically, a sample was run at 15 eV and 70 eV ionization potentials over a temperature of 70-350°C. Interpretation of the mass spectra was based on References 8-11.

2. Level 1 Inorganic Analysis

Elemental analysis was performed on each sample after the appropriate sample preparation (described below), using a JOEL Spark Source Mass Spectrometer and photographic detection system. These analyses were conducted by GCA Corporation, Technology Division.

Sample Preparation

Particulates: Mixed with carbon to form an electrode

XAD-2® resin: Parr Bomb combustion over nitric acid

Arsenic, mercury and antimony in impingers were determined by atomic absorption spectroscopy. A Perkin-Elmer 503 Spectrophotometer was used.

3. Microscopic Analysis

A particulate sample from one MM5 train sample from each control system was examined under a standard polarizing microscope. Photomicrographs were made on Ektachrome High Speed film, with samples immersed in a medium of 1.44 index to provide good contrast. Additional samples were examined by scanning electron microscopy.

4. Sulfur Oxides Analysis

Aliquots of impinger samples were analyzed by ion chromatography using a Dionex Model 14. Samples were analyzed using the following conditions:

Column:	500 mm anion type, glass columns with precolumn
Eluent:	0.003M $NaHCO_3$/0.0024M Na_2CO_3
Flow:	35%
Run time:	22 min
Sensitivity:	100 and 10 μmhos/cm

All samples were diluted by a factor of ten prior to analysis so that solutions injected on the column contained a maximum of 3% hydrogen peroxide.

IV. TEST RESULTS

A. ON-SITE ANALYSES

As noted previously, individual Modified Method 5 (MM5) samples were collected on each of seven days during the weeks of September 15 and September 22, 1981. Four samples were collected from the stack (on September 15, 16, 17, and 21, 1981) when the cupola was operating with the afterburner (AFB). Three samples were collected on September 22-24, 1981 when the cupola was operating with the stack air addition system (SAA).

Table 1 summarizes the sampling data acquired during the seven runs. Run 1 was the first collection conducted on the cupola. Due to minor system malfunctions, e.g., leaks, and the realization that future runs would benefit from this experience and familiarity with the interaction of the sampling train and the high temperature environment, this run was discarded. Samples from other runs were analyzed in accordance with Level 1 procedures (1). The low volume of gas collected during Run 5 is due to a significant leak which occurred during sampling. This problem was noted in the field, resolved, and the field data satisfactorily corrected by careful analysis of temperature and pressure drop data. Run 5 samples were, therefore, analyzed and the data included in this report.

Table 2 summarizes the results of the on-site analyses of stack gases. Due to the large variability in concentrations observed for the three gases which were monitored with instrumental analyzers (i.e., carbon monoxide, nitrogen oxides, and hydrocarbons), the observed differences in concentration for these gases with the afterburner or stack air addition system are not statistically significant. Observation of operation of the cupola during daily sampling and analysis indicates that short-term variation in scrap metal charging rate and blower operation dramatically influenced the concentration of these partial combustion gases. This variation is illustrated by the range of temperature observed during a run.

TABLE 1

SUMMARY OF SAMPLING DATA

Sample Run	1	2	3	4	5	6	7
Control Device	AFB	AFB	AFB	AFB	SAA	SAA	SAA
Volume of gas sampled* (m^3)	0.987	2.138	3.890	3.306	0.972	3.333	4.327
Stack temperature (°C)	926-1053	926-1093	732-985	735-920	772-1059	629-963	143-947

*Gas volumes are corrected to standard conditions of 101 kPa (29.9" Hg) and 21.1°C (528°R).

AFB = Afterburner

SAA = Stack Air Addition System

TABLE 2

RESULTS OF ON-SITE GAS ANALYSES

(Concentration, ppmv)

CONTROL DEVICE	AFTERBURNER				STACK AIR ADDITION SYSTEM			
Species	N[1]	Mean	SD[2]	Range	N	Mean	SD	Range
Carbon Monoxide	15	720	478	18-16000	105	700	280	20-13000
Nitrogen Oxides	14	22	8.9	5-39	100	35	11	15-91
Hydrocarbons (As CH_4)	17	73	58	9-166	90	100	130	10-820
Carbon Dioxide (%)	3	16.6	2.4	13.3-18.5	3	18.2	0.5	17.6-18.6
Oxygen (%)	3	3.7	2.1	2.0-6.3	3	2.4	0.6	1.8-3.0

[1]N = Number of Measurements

[2]SD = Standard Deviation

As a quality assurance step, the proper operation of the gas sampling train was checked prior to routine collection of gas concentration data. The major point of concern was whether the sampling line/manifold was leak tight. Duplicate ORSAT samples (EPA Method 3) were taken at the stack through the pitot tube on the probe and subsequently at the exhaust point of the heated gas sampling manifold. The data which are shown below, indicate that no appreciable leak was present.

COMPARATIVE ORSAT DATA
(Concentration, v/v)

Species	Stack	Gas Sample Manifold
Carbon Dioxide (CO_2)	18.5%	16.7%
Oxygen (O_2)	2.1%	2.1%
Carbon Monoxide (CO)	0.2%	0.2%

The difference in CO_2 levels is typical of fluctuations in the stack concentrations over time. Although the lower CO_2 concentration in the manifold could have resulted from a small leak of ambient air, the identical concentrations for O_2 and CO indicate that the system is in fact leak-free. Following this QA check, the ORSAT method was used once daily (duplicate measurement) to measure the concentration of CO_2 and O_2 in the stack. These data are also reported in Table 2.

B. RESULTS OF COMPREHENSIVE ANALYSIS

1. Total Particulate Loading

The total mass of collected particulates as well as the concentration of particulates in the source for six (Runs 2-7) MM5 samples are given in Table 3. The mean concentration of particulates in the stack is slightly lower when operating the stack air addition system rather than the afterburner. Specifically, the mean concentrations for the stack air addition system and afterburner are 3.7 g/m^3 and 4.8 g/m^3, respectively. However, the difference is not statistically significant. That is, the means are not different at the 95% confidence level as determined by the Student's t-test.

TABLE 3

MASS AND CONCENTRATION OF PARTICULATES

Run	2	3	4
Control Device	----------AFTERBURNER----------		
Volume of gas sampled m^3 (STP)	2.14	3.89	3.30
Collected mass of particulates (g)			
Probe; cyclone	5.7699	11.8304	8.5459
Filter	4.8137	7.4849	6.2617
Total	10.5836	19.3153	14.8076
Concentration (g/m^3)			
Probe; cyclone	2.70	3.04	2.59
Filter	2.25	1.92	1.90
Total	4.94	4.96	4.49

Mean Total Concentration (g/m^3) - 4.8

Standard Deviation - 0.26

TABLE 3 (continued)

MASS AND CONCENTRATION OF PARTICULATES

Run	5	6	7
Control Device	--------STACK AIR ADDITION--------		
Volume of gas sampled m^3 (STP)	0.97	3.33	4.33
Collected mass of particulates (g)			
Probe; cyclone	2.2964	7.6387	6.2293
Filter	0.8642	9.0259	5.9096
Total	3.1606	16.6646	12.1389
Concentration (g/m^3)			
Probe; cyclone	2.37	2.29	1.44
Filter	0.89	2.71	1.36
Total	3.26	5.00	2.80

Mean Total Concentration (g/m^3) - 3.7

Standard Deviation - 1.2

In much of the data discussed in following sections, it is apparent that the agreement within stack air addition (SAA) data is poorer than within afterburner (AFB) data. It is not known whether this greater variability in SAA data is due to operation of the SAA system or operation of the foundry itself. That is, was variation due to differences in charging production rates during the week that the SAA was tested? Variability in operation of the MM5 train is not a probable cause of the observed data variance, except in case of malfunction; no unusual situations were noted.

The variation in concentrations calculated for the probe/cyclone and filter sections of the MM5 train is great enough that it is difficult to confirm the shift in particle size distribution reported for the SAA control device by Davis and Draper, 1981 (12). However, the data generated in the present study do not contradict this earlier observation.

2. Level 1 Organic Analysis

Mass concentrations of total extractable organic material collected in the various MM5 train components (i.e., filter, sorbent, condensate) from both afterburner and stack air addition runs are reported in Table 4 and summarized in Figure 10 and 11. In comparison to the total particulate mass concentration observed (Table 3), very little organic matter was extracted from the samples. Only about 0.1% of the total particulate mass collected in the probe, filter, and cyclone was extractable while about 1% of the total mass of material collected in the entire sampling train (i.e., including sorbent and condensate) was extractable in dichloromethane. All dichloromethane-extractable mass has been identified as organic matter.

The organic extractable matter was experimentally divided into a low boiling point fraction defined as total chromatographable organics (TCO) and a high boiling point fraction defined as gravimetric analysis (GRAV) organics.

TABLE 4

TOTAL EXTRACTABLE ORGANICS (mg/m^3)

(Corrected for blanks)

CONTROL DEVICE		AFTERBURNER			STACK AIR ADDITION SYSTEM		
		TCO	GRAV	Total	TCO	GRAV	Total
Particulate Extract		0.44	2.8	3.2	0.21	3.1	3.3
n=3		0.28	1.3	1.6	0.29	1.2	1.5
		0.08	0.3	0.4	0.35	4.8	5.1
	$\bar{x}$	0.27	1.5	1.7	0.28	3.0	3.3
	SD	0.18	1.2	1.4	0.07	1.8	1.8
XAD-2 Extract		2.2	8.4	11	5.0	7.2	12
n=3		1.6	3.1	4.7	3.3	2.4	5.7
		3.5	6.1	9.6	4.5	20	24
	$\bar{x}$	2.4	5.9	8.4	4.3	9.9	14
	SD	0.97	2.6	3.3	0.87	9.1	9.3
Condensate		0.09	28	28	1.4	39	40
n=3		0.24	7.7	7.9	1.0	64	65
		0.09	15	15	0.04	10	10
	$\bar{x}$	0.14	17	17	0.81	38	38
	SD	0.09	10	10	0.70	27	28
Total Extract		2.7	39	42	6.6	49	56
n=3		2.1	12	14	4.5	68	73
		3.7	21	25	4.9	35	40
	$\bar{x}$	2.8	24	27	5.3	51	56
	SD	0.81	14	14	1.1	16	16
Total Extract		2.7	11	14	6.6	10	17
Without Condensate		2.1	4.4	6.5	4.5	3.6	8.1
n=3		3.7	6.4	10	4.9	25	30
	$\bar{x}$	2.8	7.3	10	5.3	13	18
	SD	0.81	3.4	3.8	1.1	11	11

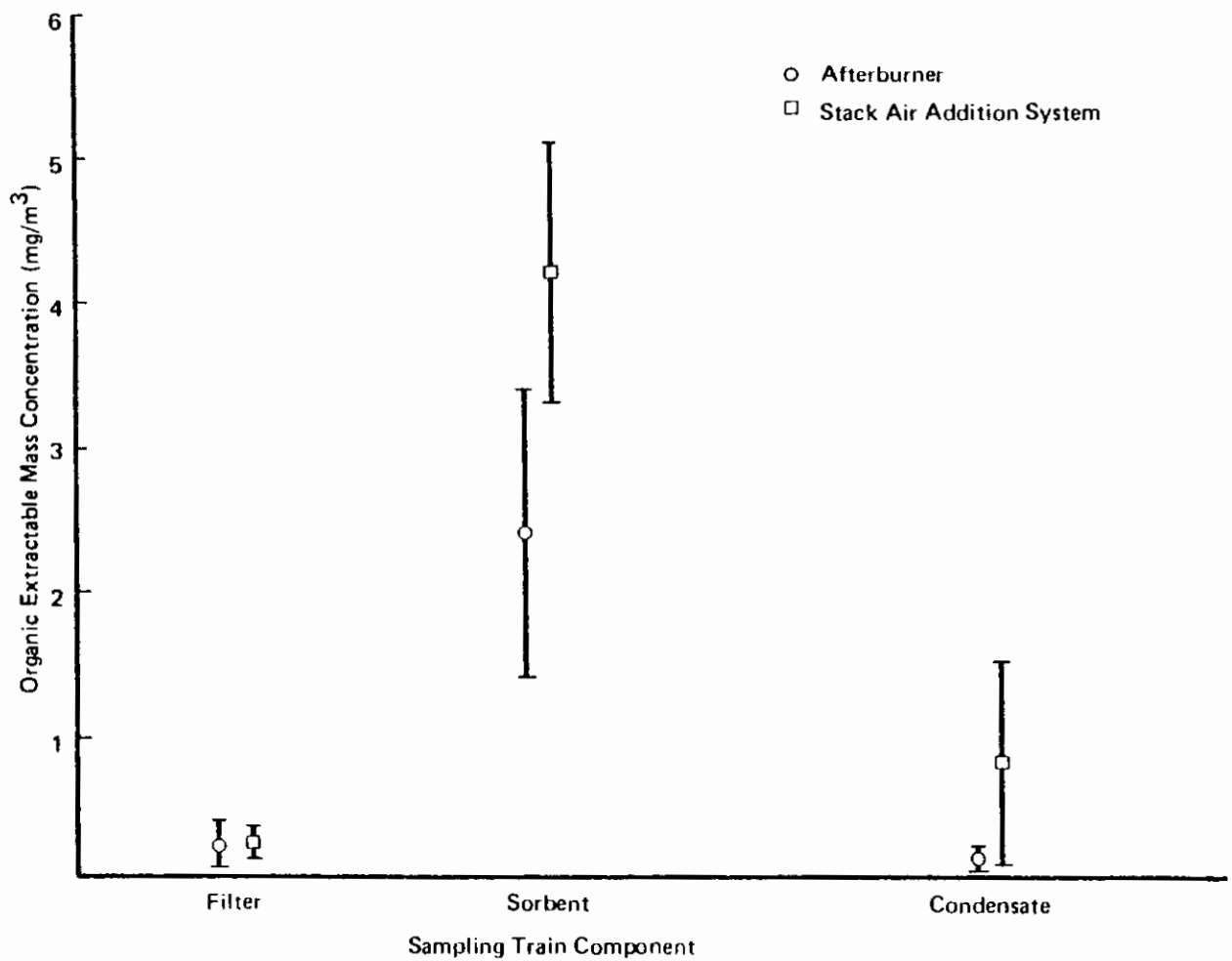


FIGURE 10 DISTRIBUTION OF LOW BOILING (TCO) ORGANICS

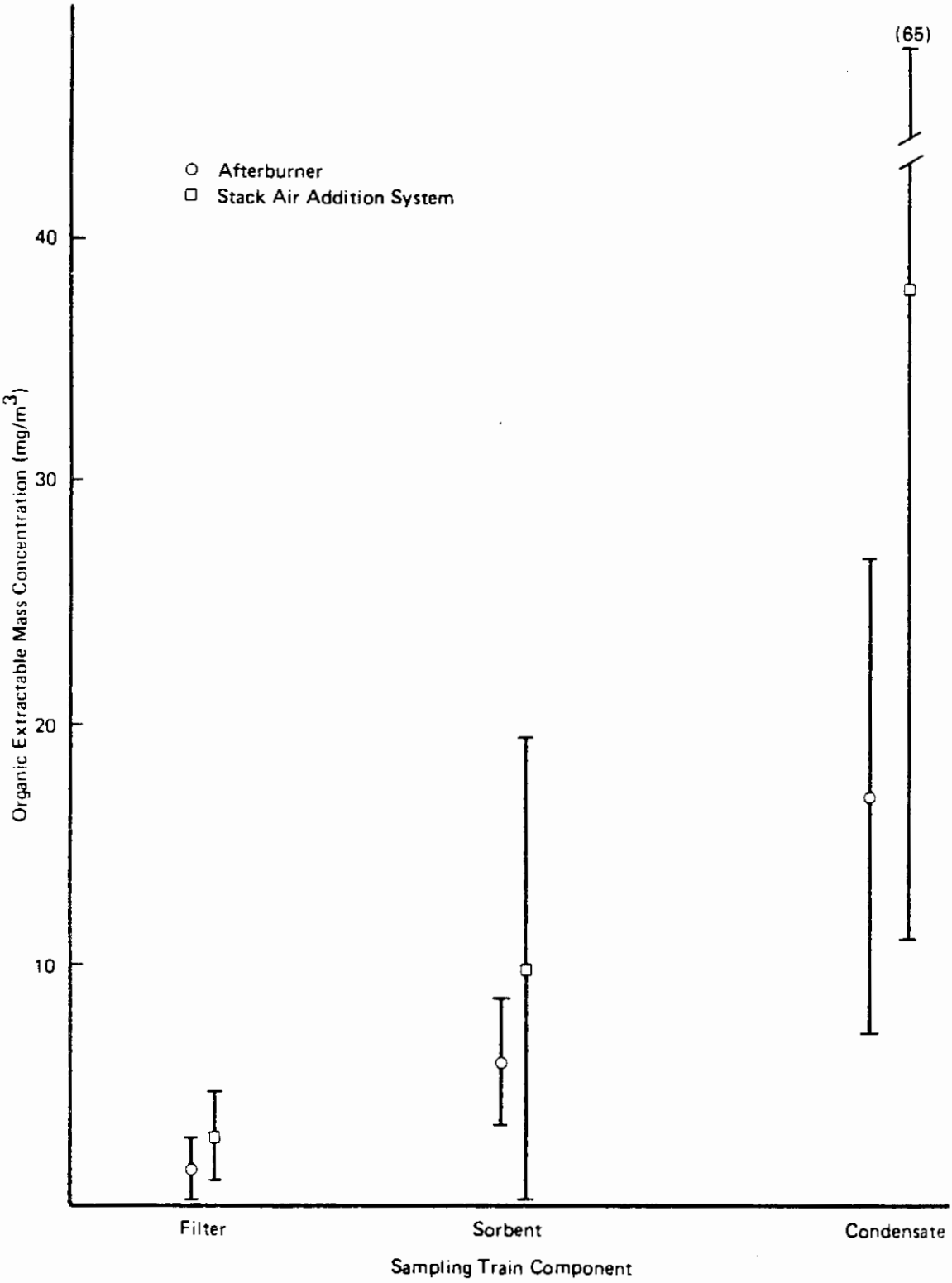


FIGURE 11 DISTRIBUTION OF HIGH BOILING (GRAV) ORGANICS

The distribution of extractable organic matter in the sampling train components indicates that about 80-86% of the organics which fall into the TCO range (boiling point between 100° and 300°C) are found in the XAD-2 extract. About 71-75% of the organics which fall into the GRAV range (boiling point greater than 300°C) are found in the condensate. Organic material with boiling points greater than 300°C accounts for about 89-91% of the total organic mass. These observations are not completely consistent with findings of other ferroalloy process emission measurements (13). The presence of most of the organic mass in the condensate trap is unexpected. In fact, a careful review of the low resolution mass spectroscopy (LRMS) data (Appendix A) indicates that most of the organic material present in the condensate extract consists of dioctylphthalate (DOP) and related esters. This compound is probably due to contamination of the condensate samples in the field, although it is not obvious why the contamination appears only in these samples; other train components show minimal DOP contamination. In any case, it seems inappropriate to include the DOP-material in estimates of source-related organic emission. Therefore, the estimated total extractable organic mass concentration is calculated excluding the condensate sample data (Table 4) and is summarized in Figure 12.

A comparison of organic concentration data for the afterburner and stack air addition runs indicates that the low boiling (100°-300°C) organic material is present at significantly (i.e., 95% confidence level by Student's t-test) higher levels in the stack air addition samples. Although the trend is the same for the high boiling (>300°C) organic material, and thus total organic material, the latter differences are not statistically significant as determined by the Student's t-test.

In order to obtain additional information related to health implications of the observed differences between the organic emission concentrations from the afterburner and stack air addition system, various EPA/IERL Level 1 chemical analyses were conducted. Individual extracts were analyzed by infrared spectrometry (IR) and low resolution mass spectrometry (LRMS).

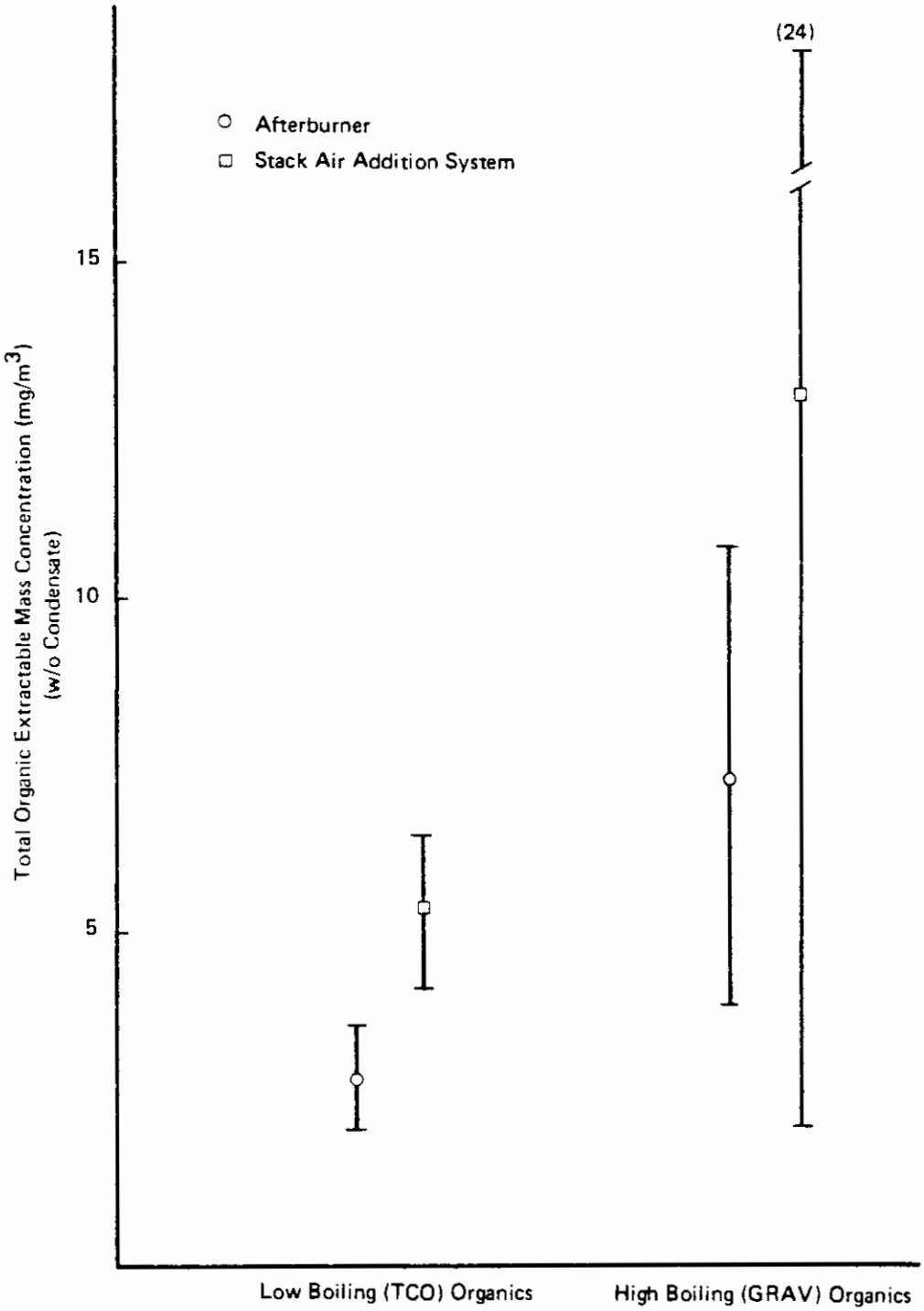


FIGURE 12 COMPARISON OF TOTAL ORGANIC EXTRACTABLE MASS CONCENTRATIONS

The chemical classification data obtained from these analyses are reported in Appendix A. Due to the low mass of organic extractable material in most samples (excluding condensate samples), only two (sorbent) extracts were of sufficiently high concentration (i.e., greater than 8 mg/m^3) to warrant a liquid chromatographic separation on silica gel prior to LRMS analysis. Three composite fractions representative of aliphatic hydrocarbons such as dodecane (Fraction 1) and aromatic hydrocarbons, such as benzene and benzo(a)pyrene (Fractions 2-4), and polar compounds, such as benzoic acid (Fractions 5-7) were collected from each of these two extracts.

On the basis of analysis of unfractionated and fractionated extracts, the organic species in each extract were classified into compound categories and the intensity (relative amount) of each category was estimated using a method developed by Arthur D. Little, Inc. (14). The major components (intensity = 100) of each fraction of the sampling train are shown in Table 5. Note that a comparison of filter and condensate extracts from the afterburner and stack air addition samples shows identical major components, that is, aliphatic hydrocarbons and esters (contamination). The LRMS data for the sorbent extracts from the afterburner and stack air addition samples show marked similarity but indicate that aliphatic hydrocarbons may be somewhat more abundant than fused alternate, non-alternate hydrocarbons (i.e., polycyclic aromatic hydrocarbons) in the stack air addition samples. This may indicate that the larger organic mass concentration observed on the sorbent sample for the stack air addition system may be due to increased amounts of aliphatic hydrocarbons rather than polycyclic aromatic hydrocarbons. In any case, the most abundant polycyclic aromatic hydrocarbons in all samples from both control devices are of less than five rings (molecular weight <216), most of which are considered to be non-carcinogenic (15). Less abundant amounts of a class of potentially strongly carcinogenic fused hydrocarbons of five or greater rings (molecular weight >216) were observed in a few samples from both control systems. It is difficult to state unequivocally that the lower concentration of polycyclic aromatic hydrocarbons in the stack air addition system will mean less health hazard since it is impossible to preclude possible synergistic

TABLE 5

MAJOR ORGANIC COMPOUND CATEGORIES

(Intensity = 100 or as stated)

		Control Device	
		Afterburner	Stack Air Addition System
Filter		Aliphatic hydrocarbons	Aliphatic hydrocarbons
Sorbent	(Total)	Fused alternate, non-alternate hydrocarbons Carboxylic acids Aliphatic hydrocarbons (10)	Aliphatic hydrocarbons Fused alternate, non-alternate hydrocarbons (10)
	(Fraction 1)	Aliphatic hydrocarbons	Aliphatic hydrocarbons
	(Fractions 2-4)	Aliphatic hydrocarbons Aromatic hydrocarbons (10)	Aliphatic hydrocarbons Aromatic hydrocarbons (10)
	(Fractions 5-7)	Carboxylic acids, aliphatic alcohols or ketones	Carboxylic acids, aliphatic alcohols or ketones
Condensate		Esters	Esters

effects of high molecular weight aliphatic hydrocarbons, which have been implicated as promoters of the indirect carcinogenesis of polycyclic aromatic hydrocarbons in some studies (16).

3. Inorganic Analysis

The results of mercury determination (cold vapor atomic absorption method) in sorbent, condensate, H_2O_2 impinger, and persulfate impinger fractions are summarized in Table 6. Mercury is distributed quite equally over these fractions and is present at low loadings corresponding to about 1 $\mu g/m^3$. There is no significant difference between the afterburner (AFB) and stack air addition system (SAA) samples. No arsenic or antimony were detected in these fractions at levels above the detection limit (i.e., 0.4 $\mu g/m^3$).

The total inorganics detected by spark source mass spectrometry (Appendix B) are summarized in Tables 7 to 9. Concentrations on a mass emission basis ($\mu g/m^3$) for 10-16 selected elements present at high concentrations are included. Elements with atomic number of less than twelve (lithium to magnesium) are excluded from the summary. The results are grouped according to sampling train component. Specifically, the metal concentration in the particular fraction, probe/cyclone wash and filter catch, sorbent resin and condensate catch are reported separately. As expected, most of the inorganic material present in the cupola stack is collected on the probe, cyclone and filter. Only a small percent of most elements appear to be distributed in the sorbent or condensate. The obvious exception is sulfur; for this element about 10% of the mass is found on the sorbent and 10% in the condensate. This observation is not unexpected due to the potential for the existence of various sulfur compounds in the vapor state.

More importantly, the difference in mass concentration of the elements measured in the samples collected when the afterburner or stack air addition system was in use is not statistically significant. This is consistent with the equivalence of the total particulate mass concentrations for both control devices.

TABLE 6

MERCURY IN SAMPLE FRACTIONS

(Mean Concentration, $\mu g/m^3$)[1]

	Control Device			
	Afterburner		Stack Air Addition	
Matrix	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Sorbent	0.77	1.0	<0.41	--
Condensate	2.2	1.4	12	16
H_2O_2 Impinger	0.60	0.30	0.63	0.31
Persulfate Impinger	0.41	0.14	0.67	0.37

[1]corrected for blank levels

TABLE 7

SELECTED ELEMENTS IN PARTICULATE FRACTION

(Mean Concentration, $\mu g/m^3$)[1]

Element	Afterburner $\bar{x}$	Afterburner S.D.	Stack Air Addition $\bar{x}$	Stack Air Addition S.D.
Silicon (Si)	MC	--	MC	--
Sulfur (S)	150,000	8,900	23,000	22,000
Potassium (K)	53,000	12,000	99,000	110,000
Calcium (Ca)	42,000	12,000	73,000	43,000
Titanium (Ti)	2,900	820	4,900	5,300
Chromium (Cr)	730	380	420	174
Manganese (Mn)	90,000	5,700	130,000	130,000
Iron (Fe)	120,000	8,000	180,000	170,000
Nickel (Ni)	830	1,100	420	600
Copper (Cu)	1,600	830	600	240
Zinc (Zn)	44,000	17,000	62,000	46,000
Bromine (Br)	7,100	2,600	22,000	26,000
Tin (Sn)	13,000	6,900	4,400	470
Antimony (Sb)	1,800	920	670	260
Lead (Pb)	220,000	40,000	140,000	110,000

MC ≡ Greater than about 500,000

[1]corrected for blank levels

TABLE 8

SELECTED ELEMENTS IN SORBENT

(Mean Concentration, $\mu g/m^3$)[1]

Element	Afterburner $\bar{x}$	Afterburner S.D.	Stack Air Addition $\bar{x}$	Stack Air Addition S.D.	Blank
Sulfur (S)	15,000	12,000	4,900	3,000	5,700
Calcium (Ca)	380	240	78	86	59
Titanium (Ti)	51	20	3.2	1.5	9.7
Chromium (Cr)	190	160	32	32	40
Iron (Fe)	1,300	970	400	70	160
Nickel (Ni)	14,000	23,000	140	35	49
Copper (Cu)	230	270	78	86	59
Zinc (Zn)	110	12	320	540	<180
Germanium (Ge)	86	100	<6.8	--	<1.2
Selenium (Se)	86	140	<9.4	--	24

[1]corrected for blank levels

TABLE 9

SELECTED ELEMENTS IN CONDENSATE

(Mean Concentration, $\mu g/m^3$)[1]

Element	Afterburner $\bar{x}$	Afterburner S.D.	Stack Air Addition $\bar{x}$	Stack Air Addition S.D.	Blank
Silicon (Si)	3,900	5,100	860	680	87
Sulfur (S)	9,200	2,500	13,000	5,700	300
Potassium (K)	1,600	2,200	88	26	<7.3
Calcium (Ca)	1,500	1,800	580	470	40
Titanium (Ti)	170	230	6.3	3.0	6.3
Chromium (Cr)	480	660	30	19	8.0
Molybdenum (Mo)	810	1,100	104	135	32

[1] corrected for blank levels

In an attempt to quantify the levels of sulfur oxides (SO_x) in the stack gas, the SO_x collected in the pair of H_2O_2 impingers in the MM5 train were analyzed by ion chromatography as sulfate. The mean concentrations for the samples collected during the operation of the afterburner (AFB) and stack air addition system (SAA) are as follows:

Control Device	Mean Concentration as Sulfate (mg/m^3)	S.D.
AFB	521	86
SAA	488	150

4. Microscopic Analysis

Two particulate samples were examined microscopically to characterize appearance and composition and to measure particle size distribution. A representative aliquot of the particulates (probe, cyclone and filter catches) collected during operation of the afterburner (Run 3) and stack air addition (Run 6) system were examined by optical microscopy at 1,500x and by scanning electron microscopy (SEM) at 5,000-10,000x.

Observations of these samples are as follows:

1. Although a small amount of crystalline material is observed to be present in both samples, X-ray diffraction was not able to resolve the identity of this phase.

2. In the polarizing microscope, both particulate samples are observed to consist principally of an amorphous phase, transparent and light tan in color. There are a few black opaque particles, some of which are subject to movement in a magnetic field, i.e., ferromagnetic. There are a few very small crystalline particles attached to or contained within the larger amorphous particles.

3. Observations on the scanning electron microscope and the associated energy dispersive analyzer indicate that the composition of the principal phase includes silicon as major element with manganese, iron, potassium, calcium and zinc also present and decreasing in the order given. Lead appears as an additional element in small amounts.

4. The elemental composition and the observations in the optical microscope indicate that the light tan amorphous phase is a glassy silicate.

5. Two sets of photomicrographs were taken of each sample. Views at 80x magnification and under partially polarized light illustrate the variety and appearance of both samples (Figures 13 and 14).

6. Photographs taken at 20x were used to obtain the particle size distribution (Table 10). This magnification range was chosen because a number of particles in both samples are relatively large and thus represent a large weight or volume percent. A large number of particles which are smaller than 100 μm are present and are not well resolved at this magnification.

7. Due to the fact that the particle size distribution peaked near the limit of resolution of the optical microscope at 20x to 100x, the samples were reexamined with the optical microscope using an oil immersion 1500x objective. This shows the individual large particles to be aggregates of many smaller particles, some of which are distinctly spherical. Some of these small spheres are colored: red, brown and also black opaque. There are also a few crystalline particles dispersed in the aggregate. It was also noted that a very large percent (on a number basis) of the particulates were of a size range near the limit of resolution.

8. Therefore, additional observations with the scanning electron microscope (SEM) were made. These confirm that these larger particles are, in fact, aggregates of small spherical beads below one micrometer in diamater (Figure 15). These small particles are indicative of condensation and aggregation processes in the cupola.

TABLE 10

PARTICLE SIZE DISTRIBUTION BY OPTICAL MICROSCOPY

	Control Device	
	Afterburner	Stack Air Addition
Size Range:		
0 - 0.2 mm	91	120
0.2 - 0.4	19	40
0.4 - 0.6	1	2
0.6 - 0.8	1	0
0.8 - 1.0	0	0
Number Counted	112	162
Mean Particle Size (mm)	0.14	0.15
Standard Deviation	0.10	0.09

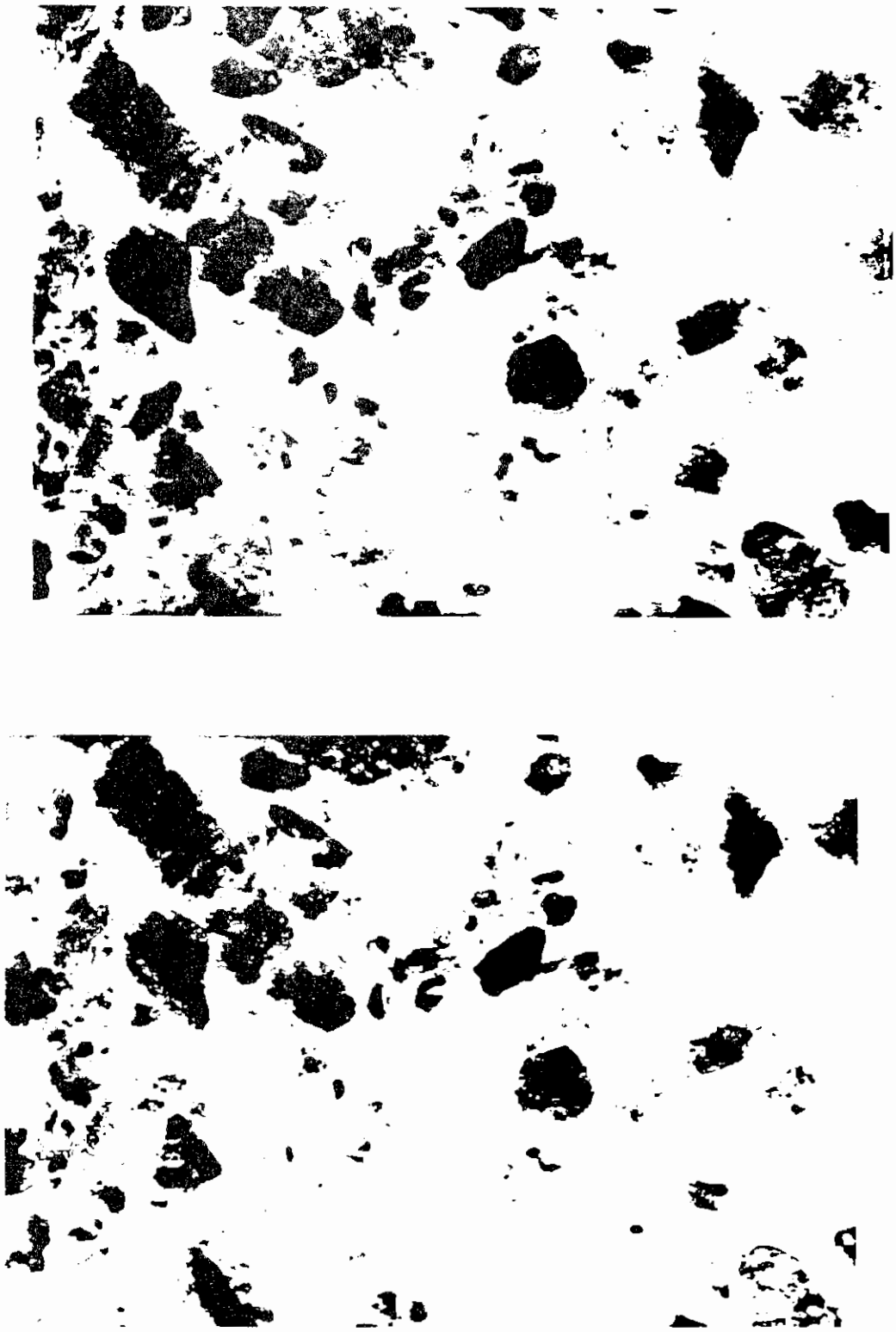


FIGURE 13. PARTICULATE FROM STACK AIR ADDITION SYSTEM

Bright Field Illumination, Top
Partially Polarized Light, Bottom 80x

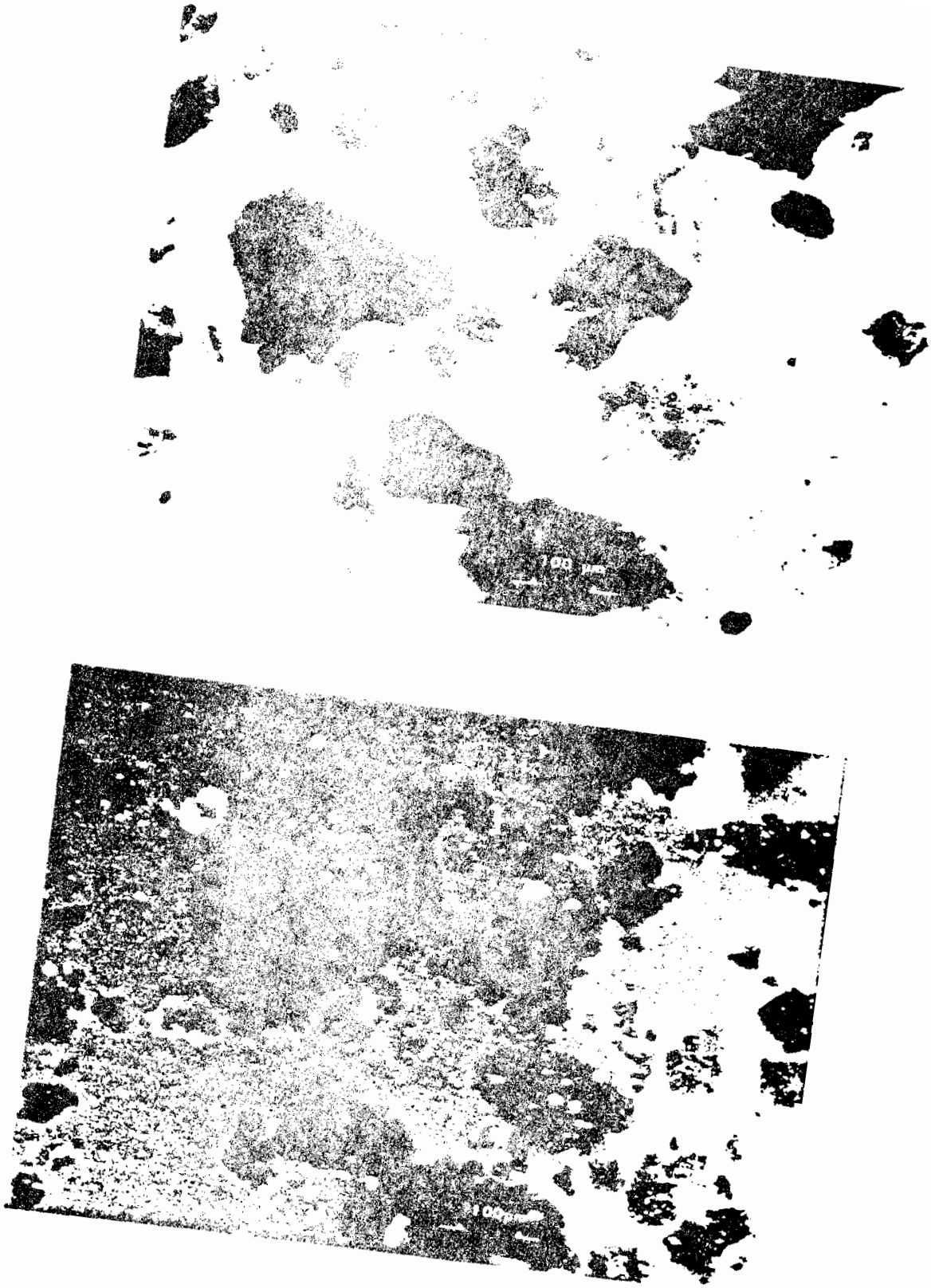
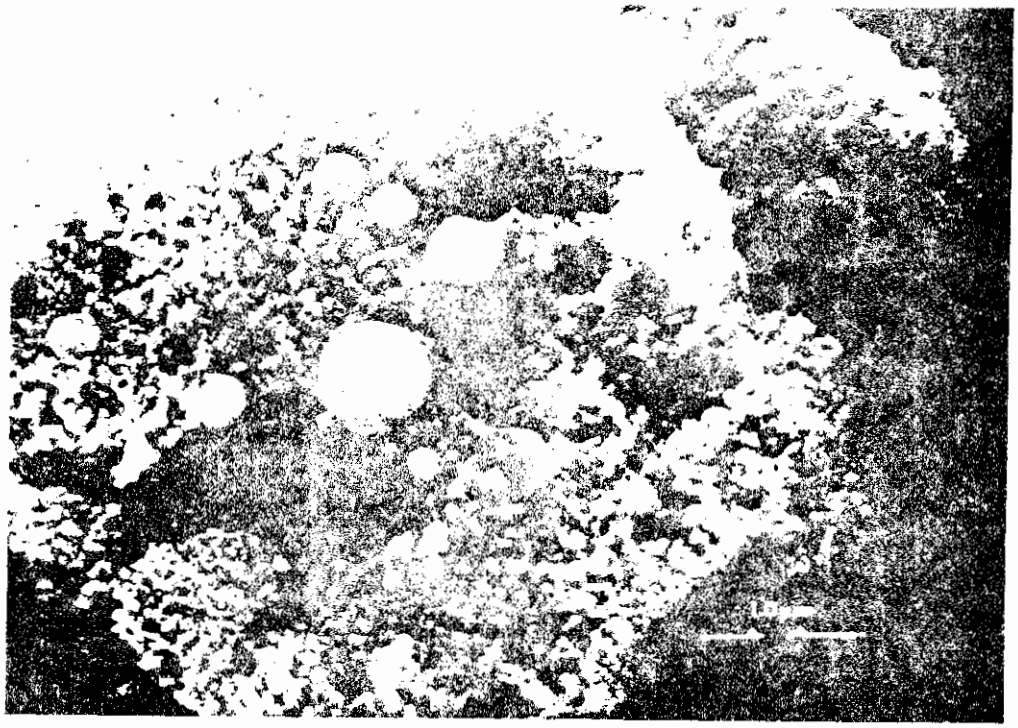


FIGURE [illegible] CARBONATES FROM AFTERBURNER
[illegible] Field Illumination, Top
[illegible] Polarized Light, Bottom

80x



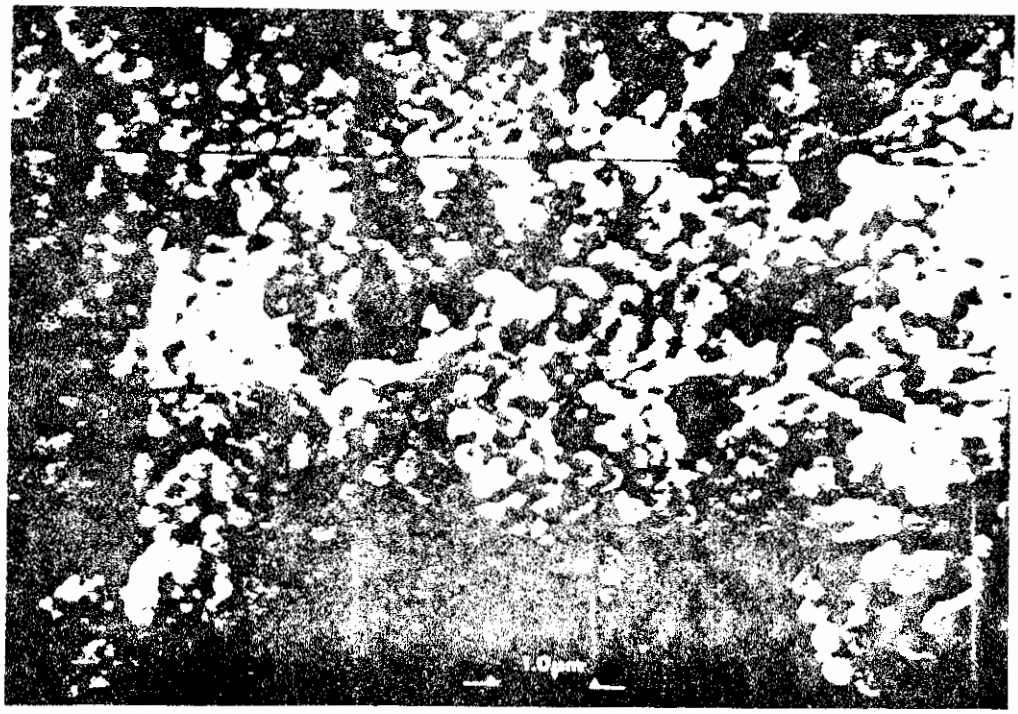


FIGURE 15. SEM PHOTOMICROGRAPH OF AGGREGATE PARTICULATES (12,000x)

9. The SEM observation that a large fraction of particles are less than 10 μm in diameter and the optical microscopic observation of a mean particle size of about 150 μm tends to confirm the bimodal size distribution reported by Davis and Draper, 1981 (12).

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APPENDIX A

LEVEL 1 - ORGANIC ANALYSIS DATA

- INFRARED (IR) REPORTS

- LOW RESOLUTION MASS SPECTROMETRY (LRMS) REPORTS

LEVEL 1 - ORGANIC ANALYSIS DATA

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IR REPORT

SAMPLE: RUN 2 - AFB - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH stretch	
2925	M		
2850	M		
1450, 1380	W	CH deformation	
1260, 1070,	M	indicates silicones	
1020, 800	M		
1120	W	could indicate alcohol	
This is a very weak spectrum. There might be some			
small indication of aromatics but it is not very strong.			

IR REPORT

SAMPLE: RUN 2 - AFB - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3050, 3025	M	aromatic CH	
2960	S	aliphatic CH stretch	
2920	S		
2850	M		
1705	M	C=O of aromatic aldehyde	
1600, 1500	W	aromatic ring mode	
1450, 1380	M	aliphatic CH deformation	
1260	S	methyl silicone	
1090	S		
1040	S		
800	S		
900-700	M	complex aromatic substitution	

IR REPORT

SAMPLE: RUN 2 - AFB - CONDENSATE

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3400	W	OH	
2960	M	aliphatic CH	
2925	S		
2870	M		
2850	M		
1725	S	C=O of ester	
1450	M	CH deformation	
1380	W		

LRMS REPORT

SAMPLE: RUN 2 - AFB - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	To >350
100	SILICONES	To >500
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
10	ESTERS	—
10	UNCLASSIFIED	100 - 350

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	SILANE - NAPHTHALENEDIOXY - BIS (TRIMETHYL -	304	$C_{16}H_{24}O_2S_2$
10	PHTHALATES, NOT SPECIFICALLY IDENTIFIABLE		
10	4 RING PAH (FLUORANTHENE / PYRENE)	202	$C_{16}H_{10}$

Other

10	SILICONES TO m/z ~ 500
10	ALKYL PHENOL LIKE MATERIAL AS PART OF UNCLASSIFIED.

LRMS REPORT

SAMPLE: RUN 2 - AFB - SORBENT

Major Categories

Intensity	Category	MW Range
100	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	<216
10	ESTERS	—
10	SILICONES	TO >400
10	AROMATIC HYDROCARBONS	230

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
10	TEREPHENYL	230	$C_{18}H_{14}$
10	PHTHALATES, NOT SPECIFICALLY		
	IDENTIFIABLE		

Other

LRMS REPORT

SAMPLE: RUN 2 - AFB - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
1	AROMATIC HYDROCARBONS	230
1	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	>216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
10	3 RING PAH (ANTHRACENE / PHENANTHRENE)	178	$C_{14}H_{10}$
10	4 RING PAH (FLUORANTHENE / PYRENE)	202	$C_{16}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
1	METHYL 3 RING PAH	192	$C_{15}H_{12}$
1	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
1	TEREPHENYL	230	$C_{18}H_{14}$

Other

IR REPORT

SAMPLE: RUN 3 - AFB - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH stretch	
2920	M		
2850	M		
3050	VW	aromatic CH	
1450, 1380	M	CH deformation	
1260	S	methyl siloxane	
1090	S		
1020	S		
800	S		
700, 760	W	aromatic substitution could be mono substituted	

IR REPORT

SAMPLE: RUN 3 - AFB - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3025, 3050	W	aromatic CH	
2960	S	aliphatic CH stretch	
2920	S		
2850	M		
1705	M	C=O of aldehyde - aromatic ring modes.	
1600, 1500	W		
1450, 1380	M	CH deformation	
1260	M	methyl siloxane. The 1090 1055 bands are closer than other samples & could indicate a shorter chain	
1090, 1055	M		
800	M		

IR REPORT

SAMPLE: RUN 3 - AFB - CONDENSATE

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3450	w	H bonded OH	
3050	vw	aromatic CH	
1750	very weak	C=O mixed with H_2O vapor	
1450	w	CH.	
1380	w		
1070	w	C-O of alcohol	
Contained almost all DOP			

LRMS REPORT

SAMPLE: RUN 3 - AFB - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	TO > 450
10	SILICONES	—
10	ESTERS	—
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	< 216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
0	PHTHALATE AND TEREPHTHALATE, NOT SPECIFICALLY IDENTIFIABLE		
10	3 RING PAH (ANTHRACENE / PHENANTHRENE)	178	$C_{14}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	4 RING PAH (FLUORANTHENE / PYRENE)	202	$C_{16}H_{10}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$
1	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
1	TEREPHENYL	230	$C_{18}H_{14}$

Other

10	SILICONES TO > 500

LRMS REPORT

SAMPLE: RUN 3 - AFB - SORBENT

Major Categories

Intensity	Category	MW Range
100	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
100	CARBOXYLIC ACIDS	122-200
10	SILICONES	100-400
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	>216
10	UNCLASSIFIED	180-300

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
100	BENZOIC ACID	122	$C_7H_6O_2$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	DIHYDRO 3 RING PAH	180	$C_{14}H_{12}$
10	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$
10	DODECANOIC ACID	200	$C_{12}H_{24}O_2$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$

Other

10	MINOR UNIDENTIFIED PEAKS, m/z 180 TO 300

LRMS REPORT

SAMPLE: RUN 3 - AFB - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	< 216
5	HETEROCYCLIC NITROGEN COMPOUNDS	135
5	HETEROCYCLIC SULFUR COMPOUNDS	135
1	SILICONES	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
10	BENZOTHIAZOLE	135	C_7H_5NS
10	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
10	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
1	METHYL 3 RING PAH	192	$C_{15}H_{12}$
1	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$

Other

1	SILICONES, TO m/z 450

IR REPORT

SAMPLE: RUN 4 - AFB - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	w	CH stretch - aliphatic	
2925	w		
2870	w		
2850	w		
1260, 1080	w	silopane	
1020, 800	w		
Very weak spectrum			

IR REPORT

SAMPLE: RUN 4 - AFB - SORBENT/RUN 5 - SAA - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3300	broad	NH.	
2960	s	aliphatic CH stretch	
2920	s		
2850	M		
3050	w	aromatic CH stretch	
1700	M	C=O - amide in conjunction with 1550	
1600	w		
1550	w	amide NH	
1450	M	CH deformation	
1380	w		
1260	M	silopane	
1090	M		
1020	M		
800	M		
850 to 650	Mw	aromatic substitution band	

IR REPORT

SAMPLE: RUN 4 - AFB - SORBENT - FRACTION 1

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2955	S	CH stretch.	aliphatic
2925	VS		
2870	SH		
2850	S		
1450	M	CH deformation	
1380	M		
720	W	CH rock.	
~~very~~ identical		to Cup 47/S1 F1	

IR REPORT

SAMPLE: RUN 4 - AFB - SORBENT - FRACTIONS 2-4

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3025-3050	M	aromatic CH stretch	
2960	M	aliphatic CH stretch	
2925	M		
2850	M		
1600, 1500	W	aromatic ring modes	
1450, 1380	M, W	CH deformation	
1260	M	silicone	
1090, 1030	S		
800	S		
900-650	S, M	aromatic CH substituents	

SAMPLE: RUN 4 - AFB - SORBENT - FRACTIONS 5-7

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3300	M (very broad)	OH + NH	
3050	W	aromatic CH	
2960, 2925	M	aliphatic CH	
2870, 2850	W		
1680	S	C=O of an amide	
1600	M	aromatic ring mode	
1550, 1250	M	N substituted amide	
1450, 1380	M	CH deformation	
1270	M	phenol	
900 - 700	M, W	aromatic CH.	
800 - 650	broad	a broad band seems to be imposed	
		on the aromatics due to	
		NH of amide	

IR REPORT

SAMPLE: RUN 4 - AFB - CONDENSATE

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3625	M	Al-O vibration	
3450	M (broad)	H bonded H_2O	
1020	S	Si-O	
1075	W		
2950	M	aliphatic CH stretch	
2830	M		
1720	W	C=O stretch	
1460	W	CH deformation	
1420	W	CH deformation	
1340	W	CH deformation	

LRMS REPORT

SAMPLE: RUN 4 - AFB - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	—
10	ESTERS	390
10	SILICONES	—

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$

Other

LRMS REPORT

SAMPLE: RUN 4 - AFB - SORBENT

Major Categories

Intensity	Category	MW Range
100	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	<216
100	CARBOXYLIC ACIDS	122
10	ALIPHATIC HYDROCARBONS	TO 450
10	SILICONES	TO ~600
10	AROMATIC HYDROCARBONS	230

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	3 RING PAH (ANTHRACENE / PHENANTHRENE)	178	$C_{14}H_{10}$
100	BENZOIC ACID	122	$C_7H_6O_2$
100	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	4 RING PAH (FLUORANTHENE / PYRENE)	202	$C_{16}H_{10}$
10	ALKYL 3 RING PAH	192-206	$C_{15}H_{12}$ - $C_{16}H_{14}$
10	DIHYDRO 3 RING PAH	180	$C_{14}H_{12}$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
10	TEREPHENYL	230	$C_{18}H_{14}$

Other

10	ALIPHATIC HYDROCARBONS TO M/Z ~ 450

LRMS REPORT

SAMPLE: RUN 4 - AFB - SORBENT - FRACTION 1

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	222 to 380

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: RUN 4 - AFB - SORBENT - FRACTIONS 2-4

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	TO ~400
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
10	" " " " "	>216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	3 RING PAH (ANTHRACENE / PHENANTHRENE)	178	$C_{14}H_{10}$
10	4 RING PAH (FLUORANTHENE / PYRENE)	202	$C_{16}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
10	TERPHENYL	230	$C_{18}H_{14}$

Other

LRMS REPORT

SAMPLE: RUN 4 - AFB - SORBENT - FRACTIONS 5-7

Major Categories

Intensity	Category	MW Range
100	CARBOXYLIC ACIDS	122
100	ALIPHATIC COMPOUNDS*	NOT IDENTIFIABLE
10	ESTERS	" "
10	UNCLASSIFIED	130 - 300
1	KETONES	180

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	BENZOIC ACID	122	$C_7H_6O_2$
10	PHTHALATES, NOT SPECIFICALLY IDENTIFIABLE.		
1	FLUORENONE	180	$C_{13}H_8O$

Other

*ALIPHATIC COMPOUNDS: THE SPECTRA SHOW ONLY THE C_3 TO ~ C_{10} PORTION OF THE MOLECULES — COULD BE KETONES, ALCOHOLS, OR HYDROCARBON CONTAMINATION.

LRMS REPORT

SAMPLE: RUN 4 - AFB - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
1	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
1	AROMATIC HYDROCARBONS	230
1	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	>216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE	390	$C_{24}H_{38}O_4$
1	4 RING PAH (FLUORANTHENE, PYRENE)	202	$C_{16}H_{10}$
1	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
1	TEREPHENYL	230	$C_{18}H_{14}$
1	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$

Other

IR REPORT

SAMPLE: RUN 5 - SAA - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3400	broad	small amount of OH	
2960	M	aliphatic CH stretch	
2920	S		
2850	M		
1450	M	CH deformation	
1380	W		
1260	M	methyl silofane	
1090	M		
1020	M		
800	M		

IR REPORT

SAMPLE: RUN 5 - SAA - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3300	broad	N H	
2960	S	aliphatic CH stretch	
2920	S		
2850	M		
3050	W	aromatic CH	
1700	M	C=O of amide	
1600	W		
1550	W	amide N H	
1450, 1380	M, W	CH deformation	
1260	M	silofane	
1090	M		
1020	M		
800	M		
850→600	MW	aromatic substitution bands	

IR REPORT

SAMPLE: RUN 5 – SAA – CONDENSATE

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3400	W	H bonded OH	
2920, 2850	S	C - H	
2730	W	C-H of aldehyde	
1780	M	C=O - acetate ester ?	
1700	M	C=O aromatic aldehyde	
1450 - 1380	W	C - H	
1230	W	C - O of acetate ? or phenol	
1095	M	C - O of alcohol	
1030	M	C - O of acetate	
800	M	aromatic substitution	
Contained almost all DOP			

LRMS REPORT

SAMPLE: RUN 5 - SAA - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	>350
10	ESTERS	—
10	SILICONES	—
1	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	<216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	PHTHALATE, NOT SPECIFICALLY IDENTIFIABLE		
1	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
1	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$

Other

LRMS REPORT

SAMPLE: RUN 5 - SAA - SORBENT

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	TO ~400
100	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
100	CARBOXYLIC ACIDS	122-200
100	ESTERS	—
10	SILICONES	100 TO >500
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	>216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	BENZOIC ACID	122	$C_7H_6O_2$
100	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
100	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
10	ALKYL 3 RING PAH	192-200	$C_{15}H_{12}$ - $C_{16}H_{14}$
10	TEREPHENYL	230	$C_{18}H_{14}$
10	4 RING PAH (CHRYSENE, ETC.)	228	$C_{18}H_{12}$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
10	UNDECANOIC ACID	186	$C_{11}H_{22}O_2$
10	DODECANOIC ACID	200	$C_{12}H_{24}O_2$

Other

10 SILICONES, m/z ~100 TO >500

LRMS REPORT

SAMPLE: RUN 5 - SAA - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
10	SILICONES	>400
1	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
0.5	HETEROCYCLIC NITROGEN COMPOUNDS	135
0.5	HETEROCYCLIC SULFUR COMPOUNDS	135

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
1	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
1	BENZOTHIAZOLE	135	C_7H_5NS
1	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
1	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$

Other

10	SILICONES, TO m/z >400

IR REPORT

SAMPLE: RUN 6 - SAA - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH stretch	
2925	S		
2850	M		
1450, 1380	W	CH deformation	
1260, 1070	W	silotane	
1020, 800	W		
1120	W	C-O ester	
1735	W	C=O ester	

IR REPORT

SAMPLE: RUN 6 - SAA - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH stretch	
2925	M		
2870	sh		
2850	M		
1450, 1380	W	CH deformation	
1740	W	C=O of aldehyde	
1260, 1090	S	silotane	
1025, 800	S		

IR REPORT

SAMPLE: RUN 6 – SAA – CONDENSATE

DOP.

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	m	aliphatic C H	
2930	M		
2850	M		
1725	S	C=O of a ketone	
1435	W	CH bend can't see 1380.	These two could also be C-Cl.
1275, 1260	S		
1230	M	CH_2Cl ?	

LRMS REPORT

SAMPLE: RUN 6 - SAA - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	to 400
10	ESTERS	390
10	SILICONES	—
10	HETEROCYCLIC NITROGEN COMPOUNDS	129-157
10	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	<216
1	UNCLASSIFIED	to 350

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	PHTHALATES, NOT SPECIFICALLY IDENTIFIABLE		
10	SILICONES	207, 236, 281	
10	QUINOLINE AND C_1, C_2 QUINOLINES	129-157	C_9H_7N - $C_{11}H_{11}N$
10	3 RING PAH (ANTHRACENE, PHENANTHRENE)	178	$C_{14}H_{10}$
10	4 RING PAH (FLUORANTHENE, PYRENE)	202	$C_{16}H_{10}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$

Other

1 (EACH) MUCH OTHER TRACE LEVEL MATERIAL BETWEEN m/z 150 AND 350 - APPEARS TO CONTAIN POLYCYCLIC MATERIAL AS WELL AS ALIPHATIC.

LRMS REPORT

SAMPLE: RUN 6 - SAA - SORBENT

Major Categories

Intensity	Category	MW Range
100	CARBOXYLIC ACIDS	122-200
100	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216
10	SILICONES	To >500
10	AMINES	327
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	>216
10	UNCLASSIFIED	100-300

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	BENZOIC ACID	122	$C_7H_6O_2$
100	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
100	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$
10	ALKYL 3 RING PAH	192-206	$C_{15}H_{12}$-$C_{16}H_{14}$
10	TRIBROMO ANILINE	327	$C_6H_4Br_3N$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$
10	TEREPHENYL	230	$C_{18}H_{14}$
10	4 RING PAH (eg. CHRYSENE, ETC.)	228	$C_{18}H_{12}$
10	DODECANOIC ACID	200	$C_{12}H_{24}O_2$

Other

10	SILICONES TO m/z > 500
10	UNCLASSIFIED, m/z 100 TO 300

LRMS REPORT

SAMPLE: RUN 6 - SAA - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	222-390

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
10	DIETHYL TEREPHTHALATE	222	$C_{12}H_{14}O_4$

Other

IR REPORT

SAMPLE: RUN 7 - SAA - FILTER

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH stretch	
2925	S		
2850	M		
1740	M	C=O of ester	
1450	M	CH deformation	
1380	W		
1260, 1020	W	indicates siloxane	
800	W		
1180	W	C-O of ester	
Weak spectrum			

IR REPORT

SAMPLE: RUN 7 - SAA - SORBENT

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3400	broad	OH	
2960	S	aliphatic CH stretch	
2930	S		
2875	M		
2860	M		
1450, 1380	M	CH deformation	
1725	M	C=O of ester	
1260, 1180	W	C-O of ester	
1040	W	1° of alcohol	

SAMPLE: RUN 7 - SAA - SORBENT - FRACTION 1

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	S	CH stretch - aliphatic	
2920	S		
2855	S		
2870	sh		
1465, 1380	M	CH deformation	
720	W	$(CH_2)_n$ rock	
Only hydrocarbon. High molecular weight in mineral oil range.			

IR REPORT

SAMPLE: RUN 7 - SAA - SORBENT - FRACTIONS 2-4

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	VS	CH stretches - aliphatic	
2930	VS		
2875	S		
2860	S		
1725	M	C=O of ester unsaturated	could be methacrylates
1640	W	C=C - stretch	
1180, 1270	M	C-O of ester (unsaturated	
1450	M	CH deformation	
1380	M		
810	M	C=C rock	
720	W	CH rock of long chain	
1100	M	aliphatic ether	
1050	M	Could be P-O-C or S=O	

IR REPORT

SAMPLE: RUN 7 - SAA - SORBENT - FRACTIONS 5-7

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3300	broad weak	OH	
2960	S	CH stretches	
2925	S		
2870	M		
2850	M		
1725	S	C=O of ketone	
1450	M	deformations	
1380	M		
3050	w	C=C	
1110	M(broad)	C-O of 2° alcohol	

IR REPORT

SAMPLE: RUN 7 - SAA - CONDENSATE

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3625	M	Al-O	
1075	w	Si O vibration	
1120	M		
2950	M	aliphatic CH	
2830	M		
1720	w	C=O	
1340	w	CH deformation?	

LRMS REPORT

SAMPLE: RUN 7 - SAA - FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	TO M/Z 600
10	SULFUR	256

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	ALIPHATICS - MANY DEGREES OF		
	UNSATURATION PRESENT, BUT OLEFINS		
	STAND OUT SLIGHTLY		TO C_{40}
10	SULFUR	256	S_8

Other

LRMS REPORT

SAMPLE: RUN 7 - SAA - SORBENT

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	TO 450
10	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	< 216
10	AROMATIC HYDROCARBONS	> 500
10	SULFUR	256

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	NAPHTHALENE AND ALKYL NAPHTHALENES	128-184	$C_{10}H_8$ - $C_{14}H_{16}$
10	ALKYL BIPHENYLS	154-224	$C_{12}H_{10}$ - $C_{17}H_{20}$
10	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
10	ALKYL 3 RING PAH	192-206	$C_{15}H_{12}$ - $C_{16}H_{14}$
10	SULFUR	256	S_8

Other

100 ALIPHATICS ARE COMPLEX, BUT OLEFINS AND LONG CHAIN ALKYL BENZENES ARE PROMINENT.

LRMS REPORT

SAMPLE: RUN 7 - SAA - SORBENT - FRACTION 1

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	>500
10	SULFUR	256

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	ALIPHATIC HYDROCARBONS	210-484	C_{20} TO C_{35}
10	SULFUR	256	S_8

Other

LRMS REPORT

SAMPLE: RUN 7 - SAA - SORBENT - FRACTIONS 2-4

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	—
10	FUSED ALTERNATE, NON ALTERNATE HYDROCARBONS	<216

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	NAPATHALENE AND ALKYL NAPHTHALENES	128-156	$C_{10}H_8$ - $C_{12}H_{12}$
10	3 RING PAH (ANTHRACENE/PHENANTHRENE)	178	$C_{14}H_{10}$
1	METHYL 3 RING PAH	192	$C_{15}H_{12}$
1	4 RING PAH (FLUORANTHENE/PYRENE)	202	$C_{16}H_{10}$

Other

100 ALIPHATICS SHOW MAJOR $C_8H_{17}^+$ ION

LRMS REPORT

SAMPLE: RUN 7 - SAA - SORBENT - FRACTIONS 5-7

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC COMPOUNDS *	NOT IDENTIFIABLE
100	CARBOXYLIC ACIDS	122-200
10	HETEROCYCLIC NITROGEN COMPOUNDS	143
10	UNCLASSIFIED	150-300

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	BENZOIC ACID	122	$C_7H_6O_2$
10	METHYL QUINOLINE	143	$C_{10}H_9N$
10	DODECANOIC ACID	200	$C_{12}H_{24}O_2$

Other

* ALIPHATIC COMPOUNDS: THE SPECTRA SHOW ONLY THE C_3 TO ~C_{10} PORTION OF THE MOLECULES — COULD REPRESENT KETONES, ALCOHOLS, OR HYDROCARBON CONTAMINATION.

LRMS REPORT

SAMPLE: RUN 7 - SAA - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
10	UNCLASSIFIED	104-162
0.5	KETONES	147
0.5	HETEROCYCLIC NITROGEN COMPOUNDS	147

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE	390	$C_{24}H_{38}O_4$
1	ISOINDOLE DIONE	147	$C_8H_5NO_2$

Other

10 (TOTAL) UNIDENTIFIED AROMATIC MATERIAL, MW 104 TO 162

IR REPORT

SAMPLE: FILTER BLANK

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2970	M	aliphatic CH-stretch	
2925	W		
2855	W		
1260	S	silofane	
1090	S		
1025	S		
800	S		

IR REPORT

SAMPLE: SORBENT BLANK

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2960	M	aliphatic CH	
2920	M		
2850	M		
3050	VW	aromatic	
1450, 1380	W	CH deformation	
1260	M	silofane	
1090	M		
1020	M		
800	M		
1125	M	aliphatic ether	

IR REPORT

SAMPLE: SORBENT BLANK - FRACTION 1

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2955	W		
2920	S	aliphatic CH stretch	
2850	M		
1450	W	CH deformation	
1380	W		
Very weak spectrum			

IR REPORT

SAMPLE: SORBENT BLANK - FRACTIONS 2-4

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2955	W		
2920	W	CH stretches - aliphatic	
2850	W		
1120	W	could be aliphatic	
other	This is very weak spectrum		

IR REPORT

SAMPLE: SORBENT BLANK - FRACTIONS 5-7

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3400		hydrogen bonded OH	
2960	w	CH stretch aliphatic	
2925	w		
2850	w		
1450, 1380	w	deformations	
1130	w (broad)	aliph 2° alcohol	

IR REPORT

SAMPLE: CONDENSATE BLANK

spectrum of DOP

Wave Number (cm^{-1})	Intensity	Assignment	Comments
3360	w	either NH or OH.	
2960, 2920	M	aliphatic CH	
2850	M		
1735	S	C=O - ester } possibly propionate	
1270	M		
It is also possible that this represents DOP which			
was not fully subtracted out.			

IR REPORT

SAMPLE: SOLVENT BLANK

Wave Number (cm^{-1})	Intensity	Assignment	Comments
1125	M	$SO_4^{=}$?	
This spectrum shows only $SO_4^{=}$ + a very			
weak indication of CH			

LRMS REPORT

SAMPLE: BLANK FILTER

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS	—
10	CARBOXYLIC ACIDS	122-200
10	FUSED ALTERNATE, NONALTERNATE HYDROCARBONS	<216
10	SILICONES	
10	ESTERS	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
10	BENZOIC ACID	122	$C_7H_6O_2$
10	3 RING PAH (ANTHRACENE / PHENANTHRENE)	178	$C_{14}H_{10}$
10	PHTHALATE, DOP TYPE	390	$C_{24}H_{38}O_4$
10	4 RING PAH (FLURANTHENE / PYRENE)	202	$C_{16}H_{10}$
10	PHENYL NAPHTHALENE	204	$C_{16}H_{12}$
10	METHYL 3 RING PAH	192	$C_{15}H_{12}$
10	TEREPHENYL	230	$C_{18}H_{14}$
10	METHYL PHENYL NAPHTHALENE	218	$C_{17}H_{14}$

Other

10	SILICONES TO m/z > 500

LRMS REPORT

SAMPLE: BLANK SORBENT - FRACTION 1

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS *	
* SAMPLE HAD VERY LOW CONCENTRATION - COULD NOT		
IDENTIFY MOLECULAR WEIGHT RANGE		

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: BLANK SORBENT - FRACTIONS 2-4

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS *	
	* VERY LITTLE IN SAMPLE - SIGNAL NOT	
	SIGNIFICANTLY ABOVE INSTRUMENT BACKGROUND	

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: BLANK SORBENT - FRACTIONS 5-7

Major Categories

Intensity	Category	MW Range
100	ALIPHATIC HYDROCARBONS *	
* VERY LITTLE IN SAMPLE - SIGNAL NOT SIGNIFICANTLY		
ABOVE INSTRUMENT BACKGROUND.		

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition

Other

LRMS REPORT

SAMPLE: BLANK SOLVENT - CONDENSATE

Major Categories

Intensity	Category	MW Range
100	ESTERS	390
100	UNCLASSIFIED	~200

Sub-Categories, Specific Compounds

Intensity	Category	m/e	Composition
100	PHTHALATE	390	$C_{24}H_{38}O_4$

Other

100 UNIDENTIFIABLE BENZOYL CONTAING MATERIAL, WITH MAJOR PEAKS AT M/Z 77, 105, 133

APPENDIX B

SPARK SOURCE MASS SPECTROMETRY ANALYSIS DATA

SPARK SOURCE MASS SPECTROMETRY (SSMS) ANALYSIS DATA

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RUN 2 - AFB - FILTER

SAMPLE ID. : 16639

SAMPLE WT. : 0.067 G

PLATE NO. : 1181

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.16	< 2.4	RU	< 0.11	< 1.6
TH	< 0.23	< 3.5	MO	< 1.3	< 20
SI	1.2	18	NB	0.13	2.2
FE	2.9 (MG)	4.3 (%)	ZR	0.27	4.0
TL	< 0.10	< 1.5	Y	0.063	0.94
HG	< 0.22	< 3.3	SR	1.7	26
HO	< 0.13	< 1.9	RB	3.6	54
PT	< 0.37	< 5.6	BR	150	2300
IR	< 0.20	< 2.9	SE	3.5	53
OS	< 0.21	< 3.2	AS	6.9	100
RE	< 0.14	< 2.0	GE	< 0.046	< 0.68
W	< 0.12	< 1.8	GA	< 0.019	< 0.29
TA	< 6.2	< 92	ZN	440	6500
HF	< 0.30	< 4.4	CU	20	300
LU	< 0.072	< 1.1	NI	29	430
TB	< 0.077	< 1.2	CO	6.1	91
TM	< 0.76	< 11	FE	7.3	100
ER	< 0.14	< 2.1	MN	< 16	< 260
HO	< 0.030	< 0.45	CR	14	210
DY	< 0.079	< 1.2	V	2.5	38
TB	< 0.018	< 0.27	TI	30	450
GD	< 0.079	< 1.2	SC	< 0.009	< 0.13
EU	< 0.042	< 0.63	CA	400	6000
SM	< 0.15	< 2.3	K	650	1.3 (%)
ND	< 0.14	< 2.1	CL	<910	< 1.4 (%)
PR	0.031	0.46	S	3.4 (MG)	5.1 (%)
CE	0.16	2.3	P	21	310
LA	0.12	1.8	SI	MC	MC
BA	7.3	100	AL	0.13	2.2
CS	0.11	1.6	MG	41	600
I	0.17	2.6	NA	430	6400
TE	< 0.098	< 1.5	F	530	8000
SB	22	330	O	NR	NR
SN	240	3600	N	NR	NR
IN	$ 10	$ 150	C	NR	NR
CD	2.3	34	B	150	2300
AG	2.2	32	BE	0.30	4.4
PD	< 0.100	< 1.5	LI	5.4	81
RH	130	2000			

$ - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED

RUN 2 - AFB - SORBENT

SAMPLE ID. : 16632

SAMPLE WT. : 0.5084 G

PLATE NO. : 1164

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.16	< 0.31	RU	0.11	0.21
TH	< 0.23	< 0.46	MO	< 0.17	< 0.33
BI	< 0.053	< 0.16	NB	< 0.037	< 0.073
PB	< 1.4	< 2.8	ZR	0.53	1.1
TL	< 0.10	< 0.20	Y	0.063	0.12
HG	< 0.22	< 0.44	SR	0.42	0.94
AU	< 0.13	< 0.25	RB	0.030	0.060
PT	NR	NR	BR	< 2.5	< 5.0
IR	< 0.20	< 0.39	SE	6.6	13
OS	< 0.21	< 0.42	AS	0.87	1.7
RE	< 0.14	< 0.27	GE	3.5	11
W	< 0.12	< 0.24	GA	0.24	0.46
TA	< 12	< 24	ZN	< 3.3	< 6.5
HF	< 0.30	< 0.59	CU	1.1	2.1
LU	< 0.072	< 0.14	NI	3.7	7.2
YB	< 0.077	< 0.15	CO	0.051	0.10
TM	< 0.095	< 0.19	FE	16	35
ER	< 0.14	< 0.27	MN	< 4.2	< 8.3
HO	< 0.030	< 0.060	CR	1.7	3.5
DY	< 0.079	< 0.16	V	0.63	1.2
TB	< 0.018	< 0.035	TI	1.9	3.7
GD	< 0.079	< 0.16	SC	< 0.009	< 0.018
EU	< 0.042	< 0.083	CA	13	25
SM	< 0.15	< 0.30	K	< 1.7	< 3.4
ND	< 0.14	< 0.27	CL	<140	< 280
PR	< 0.031	< 0.060	S	33	64
CE	< 0.041	< 0.081	P	1.9	3.8
LA	< 0.059	< 0.12	SI	< 34	< 67
BA	0.12	0.24	AL	0.68	1.7
CS	< 0.007	< 0.014	MG	40	78
I	< 0.044	< 0.086	NA	< 29	< 55
TE	< 0.098	< 0.19	F	< 1.0	< 2.0
SB	0.19	0.37	O	NR	NR
SN	0.12	0.24	N	NR	NR
IN	$ 10	$ 20	C	NR	NR
CD	0.038	0.075	B	< 1.5	< 3.0
AG	0.036	0.071	BE	0.074	0.15
PD	0.100	0.20	LI	1.1	2.1
RH	< NR	< NR			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 2 - AFB - CONDENSATE

SAMPLE ID. : 16758

SAMPLE WT. : 10 G

PLATE NO. : 1173

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.69	< 0.069	RU	< 0.51	< 0.051
TH	< 1.00	< 0.100	MO	56	5.6
SI	< 0.31	< 0.031	NB	< 0.059	< 0.006
PB	< 0.64	< 0.064	ZR	< 0.11	< 0.011
TL	< 0.39	< 0.039	Y	< 0.091	< 0.009
HG	< 0.89	< 0.089	SR	0.91	0.091
AU	< 0.51	< 0.051	RB	< 0.028	< 0.003
PT	< 1.5	< 0.15	BR	1.2	0.12
IR	< 0.79	< 0.079	SE	1.8	0.18
OS	< 0.86	< 0.086	AS	0.21	0.021
RE	< 0.54	< 0.054	GE	< 0.19	< 0.019
W	< 0.73	< 0.073	GA	< 0.078	< 0.008
TA	< 2.6	< 0.26	ZN	0.57	0.057
HF	< 0.91	< 0.091	CU	0.63	0.063
LU	< 0.21	< 0.021	NI	< 0.13	< 0.013
YB	< 0.31	< 0.031	CO	0.038	0.004
TM	< 0.19	< 0.019	FE	< 15	< 1.5
ER	< 0.56	< 0.056	MN	0.91	0.091
HO	< 0.18	< 0.018	CR	33	3.3
DY	< 0.32	< 0.032	V	7.8	0.78
TB	< 0.066	< 0.009	TI	12	1.2
GD	< 0.32	< 0.032	SC	< 0.027	< 0.003
EU	< 0.14	< 0.014	CA	99	9.9
SM	< 0.55	< 0.055	K	110	11
ND	< 0.70	< 0.070	CL	1.3 (MG)	130
PR	< 0.12	< 0.012	S	390	39
CE	< 0.16	< 0.016	P	43	4.3
LA	< 0.18	< 0.018	SI	260	27
BA	< 0.24	< 0.024	AL	140	15
CS	< 0.029	< 0.003	MG	55	5.5
I	< 0.47	< 0.047	NA	57	5.7
TE	< 0.40	< 0.040	F	< 0.33	< 0.033
SB	< 0.28	< 0.028	O	NR	NR
SN	< 0.39	< 0.039	N	NR	NR
IN	* 10	* 1.0	C	NR	NR
CD	< 0.49	< 0.049	B	1.7	0.17
HG	< 0.14	< 0.014	BE	< 0.008	< 0.001
PD	< 0.40	< 0.040	LI	2.6	0.26
RH	33	3.3			

* - INTERNAL STANDARD

NR - NOT REPORTED

RUN 3 - AFB - FILTER

SAMPLE ID. : 16640

SAMPLE WT. : 0.078 G

PLATE NO. : 1182

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	0.16	2.0	RU	< 0.11	< 1.4
TH	0.47	6.0	MO	< 1.3	< 17
SI	1.2	16	NB	0.30	3.8
PB	2.9 (MG)	3.7 (%)	ZR	2.0	26
TL	0.43	6.2	Y	0.13	1.6
HG	< 0.22	< 2.8	SR	3.4	44
AU	< 0.13	< 1.6	RB	7.6	97
PT	< 0.37	< 4.8	BR	74	950
IR	< 0.20	< 2.5	SE	6.6	85
OS	< 0.21	< 2.7	AS	14	170
RE	< 0.14	< 1.7	GE	< 0.046	< 0.55
W	0.24	3.1	GA	< 0.019	< 0.25
TA	< 1.6	< 21	ZN	550	1.1 (%)
HF	< 0.30	< 3.8	CU	41	520
LU	< 0.072	< 0.92	NI	3.7	47
YB	< 0.077	< 0.99	CO	6.1	78
TM	< 0.095	< 1.2	FE	2.8 (MG)	3.6 (%)
ER	< 0.14	< 1.8	MN	2.1 (MG)	2.7 (%)
HO	0.030	0.39	CR	14	180
DY	< 0.078	< 1.0	V	5.0	64
TB	< 0.018	< 0.23	TI	60	770
GD	< 0.079	< 1.0	SC	< 0.009	< 0.12
EU	0.046	0.59	CA	850	1.1 (%)
SM	0.30	3.8	K	850	1.1 (%)
ND	0.32	4.1	CL	< 1.8 (MG)	< 2.4 (%)
PR	0.061	0.78	S	1.8 (MG)	2.3 (%)
CE	0.62	7.9	P	87	1100
LA	0.23	3.0	SI	MC	MC
BA	7.3	94	AL	0.13	1.7
CS	0.43	5.5	MG	41	520
I	0.17	2.2	NA	210	2700
TE	< 0.098	< 1.3	F	530	6800
SB	43	570	O	NR	NR
SN	240	3100	N	NR	NR
IN	$ 10	$ 130	C	NR	NR
CD	2.3	29	B	400	5100
AG	2.2	28	BE	0.30	3.8
PD	< 0.100	< 1.3	LI	2.3	29
RH	< 0.069	< 0.89			

$ - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED

RUN 3 - AFB - SORBENT

SAMPLE ID. : 16633

SAMPLE WT. : 0.4984 G

PLATE NO. : 1165

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.64	< 1.3	RU	< 0.43	< 0.86
TH	< 0.94	< 1.9	MO	9.4	19
BI	< 0.33	< 0.66	NB	< 0.15	< 0.30
PB	< 21	< 43	ZR	< 0.27	< 0.54
TL	< 0.41	< 0.81	Y	< 0.13	< 0.25
HG	< 0.89	< 1.8	SR	< 0.11	< 0.23
AU	< 0.51	< 1.0	RB	0.12	0.24
PT	NR	NR	BR	< 1.3	< 2.6
IR	< 0.79	< 1.6	SE	< 0.27	< 0.54
OS	< 0.86	< 1.7	AS	< 0.12	< 0.23
RE	< 0.54	< 1.1	GE	1.5	2.9
W	< 0.49	< 0.98	GA	< 0.077	< 0.15
TA	< 12	< 25	ZN	4.9	9.6
HF	< 1.2	< 2.4	CU	4.7	9.5
LU	< 0.29	< 0.58	NI	2.0 (MG)	3900
YB	< 0.31	< 0.62	CO	< 0.051	< 0.10
TM	< 11	< 23	FE	42	84
ER	< 0.56	< 1.1	MN	< 17	< 34
HO	< 0.12	< 0.24	CR	6.7	13
DY	< 0.32	< 0.64	V	0.042	0.084
TB	< 0.072	< 0.14	TI	1.5	3.0
GD	< 0.32	< 0.63	SC	0.036	0.072
EU	< 0.17	< 0.34	CA	27	54
SM	< 0.61	< 1.2	K	22	44
ND	< 0.56	< 1.1	CL	1.9 (MG)	3700
PR	< 0.12	< 0.25	S	930	1800
CE	< 0.16	< 0.33	P	9.6	20
LA	< 0.23	< 0.47	SI	< 10	< 20
BA	< 0.24	< 0.49	AL	8.3	17
CS	3.4	6.9	MG	5.4	11
I	< 0.17	< 0.35	NA	51	100
TE	< 0.39	< 0.78	F	< 33	< 66
SB	< 0.28	< 0.56	O	< 0.004	< 0.009
SN	< 0.36	< 0.72	N	NR	NR
IN	$ 10	$ 21	C	NR	NR
CD	< 0.15	< 0.31	B	6.1	12
AG	< 0.14	< 0.29	BE	0.020	0.040
PD	< 0.40	< 0.80	LI	2.3	5.1
RH	< NR	< NR			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 3 - AFB - CONDENSATE

SAMPLE ID. : 16759

SAMPLE WT. : 10 G

PLATE NO. : 1174

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.54	< 0.054	RU	< 0.25	< 0.025
TH	< 0.50	< 0.050	MO	1.9	0.19
BI	< 0.15	< 0.015	NB	0.030	0.003
PB	1.3	0.13	ZR	0.79	0.079
TL	< 0.19	< 0.019	Y	< 0.046	< 0.005
HG	< 0.44	< 0.044	SR	0.057	0.006
AU	< 0.26	< 0.026	RB	0.028	0.003
PT	< 0.75	< 0.075	BR	340	34
IR	5.3	0.53	SE	< 0.13	< 0.013
OS	< 0.43	< 0.043	AS	0.11	0.011
RE	< 0.27	< 0.027	GE	< 0.094	< 0.009
W	< 0.37	< 0.037	GA	< 0.039	< 0.004
TA	9.1	0.91	IN	5.4	0.54
HF	< 0.45	< 0.045	CU	2.5	0.25
LU	< 0.11	< 0.011	NI	2.3	0.23
YB	< 0.15	< 0.015	CO	0.29	0.029
TM	< 0.095	< 0.009	FE	11	1.1
ER	< 0.28	< 0.028	MN	0.43	0.043
HO	< 0.091	< 0.009	CR	0.97	0.097
DY	< 0.16	< 0.016	V	0.008	0.001
TB	< 0.043	< 0.004	TI	0.77	0.077
GD	< 0.16	< 0.016	SC	< 0.013	< 0.001
EU	< 0.072	< 0.007	CA	24	2.4
SM	< 0.28	< 0.028	K	5.7	0.57
ND	< 0.35	< 0.035	CL	1.0 (NG)	100
PR	< 0.061	< 0.006	S	710	72
CE	< 0.052	< 0.008	P	1.0	0.10
LA	< 0.089	< 0.009	SI	31	3.1
BA	< 0.12	< 0.012	AL	0.27	0.027
CS	< 0.014	< 0.001	MG	27	2.7
I	1.9	0.19	NA	76	7.6
TE	< 0.20	< 0.020	F	3.4	0.34
SB	0.19	0.019	O	NR	NR
SN	8.0	0.80	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.98	0.098	B	< 0.99	< 0.099
AG	< 0.072	< 0.007	BE	< 0.004	< 0.001
PD	< 0.20	< 0.020	LI	10	1.0
RH	0.069	0.007			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 4 - AFB - FILTER

SAMPLE ID. : 16753

SAMPLE WT. : 0.0997 G

PLATE NO. : 1183

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	0.076	0.77	RU	< 0.026	< 0.26
TH	0.23	2.3	MO	< 0.60	< 6.1
BI	2.4	24	NB	0.13	1.3
PB	5.7 (MG)	5.7 (%)	ZR	0.48	4.8
TL	0.47	4.7	Y	0.23	2.3
HG	< 0.053	< 0.53	SR	6.8	69
AU	< 0.031	< 0.31	RB	7.3	73
PT	< 0.090	< 0.90	BR	150	1500
IR	< 0.047	< 0.48	SE	6.4	64
OS	< 0.051	< 0.52	AS	6.9	70
RE	< 0.033	< 0.33	GE	< 0.011	< 0.11
W	0.058	0.59	GA	< 0.005	< 0.046
TA	< 1.5	< 15	ZN	420	4200
HF	< 0.071	< 0.72	CU	20	190
LU	< 0.017	< 0.17	NI	3.5	35
YB	< 0.019	< 0.19	CO	6.1	61
TM	< 0.023	< 0.23	FE	1.5 (MG)	1.5 (%)
ER	< 0.034	< 0.34	MN	1.1 (MG)	1.1 (%)
HO	< 0.007	< 0.073	CR	6.7	68
DY	< 0.019	< 0.19	V	2.5	25
TB	< 0.004	< 0.043	TI	60	600
GD	< 0.019	< 0.19	SC	< 0.002	< 0.022
EU	0.022	0.22	CA	900	9100
SM	< 0.037	< 0.37	K	900	9100
ND	0.30	3.0	CL	<220	<2200
PR	0.029	0.29	S	1.9 (MG)	1.9 (%)
CE	0.30	3.0	P	41	410
LA	0.21	2.1	SI	4.1 (MG)	4.1 (%)
SM	7.0	71	AL	0.16	1.6
CS	0.41	4.1	MG	18	180
I	0.16	1.6	NA	110	1100
TE	< 0.023	< 0.24	F	120	1200
SB	22	220	O	NR	NR
SN	110	1100	N	NR	NR
IN	$ 10	$ 100	C	NR	NR
CD	4.4	44	B	45	450
AG	2.1	21	SE	0.071	0.71
PD	< 0.024	< 0.24	LI	2.5	25
AM	< 0.017	< 0.17			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 4 - AFB - SORBENT

SAMPLE ID. : 16634

SAMPLE WT. : 0.4445 G

PLATE NO. : 1166

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.64	< 1.4	RU	< 0.43	< 0.96
TH	1.9	4.2	MO	< 0.67	< 1.5
SI	< 0.33	< 0.74	NB	0.30	0.67
PB	< 11	< 26	ZR	< 0.27	< 0.60
TL	< 0.41	< 0.91	Y	< 0.13	< 0.28
HG	< 0.89	< 2.0	SR	0.23	0.51
AU	0.51	1.2	RB	0.12	0.27
PT	NR	NR	BR	74	160
IR	2.7	6.0	SE	< 0.27	< 0.61
OS	< 0.86	< 1.9	AS	0.12	0.26
RE	< 0.54	< 1.2	GE	0.73	1.6
W	< 0.49	< 1.1	GA	0.31	0.69
TA	< 3.3	< 7.4	ZN	4.2	9.3
HF	< 1.2	< 2.7	CU	19	44
LU	< 0.29	< 0.65	NI	59	130
YB	< 0.31	< 0.69	CO	0.41	0.92
TM	< 3.0	< 6.8	FE	89	200
ER	< 0.56	< 1.3	MN	< 8.5	< 19
HO	< 0.12	< 0.27	CR	14	30
DY	< 0.32	< 0.71	V	0.17	0.38
TB	< 0.072	< 0.16	TI	2.0	4.3
GD	< 0.32	< 0.71	SC	< 0.036	< 0.081
EU	< 0.17	< 0.38	CA	12	27
SM	< 0.61	< 1.4	K	7.4	17
ND	< 0.36	< 1.2	CL	< 1.2 (MG)	<2600
PR	< 0.12	< 0.27	S	930	2100
CE	< 0.16	< 0.37	P	9.8	22
LA	< 0.23	< 0.53	SI	< 20	< 45
BA	0.93	2.2	AL	< 0.14	< 0.30
CS	< 0.029	< 0.065	MG	5.4	12
I	0.33	0.76	NA	51	110
TE	< 0.39	< 0.88	F	17	37
SB	< 0.28	< 0.63	O	NR	NR
SN	< 0.36	< 0.81	N	NR	NR
IN	* 10	* 23	C	NR	NR
CD	0.30	0.68	B	6.1	14
AG	< 0.14	< 0.32	BE	0.020	0.044
PD	3.2	7.2	LI	< 0.011	< 0.026
RH	< NR	< NR			

* - INTERNAL STANDARD

NR - NOT REPORTED

RUN 4 - AFB - CONDENSATE

SAMPLE ID. : 16760

SAMPLE WT. : 10 G

PLATE NO. : 1175

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.17	< 0.017	RU	< 0.13	< 0.013
TH	< 0.25	< 0.025	MO	< 0.12	< 0.012
SI	< 0.077	< 0.008	NB	< 0.015	< 0.001
PB	0.64	0.064	ZR	0.11	0.011
TL	< 0.096	< 0.010	Y	< 0.023	< 0.002
HG	< 0.22	< 0.022	SR	< 0.029	< 0.003
AU	< 0.13	< 0.013	RB	< 0.007	< 0.001
PT	< 0.37	< 0.037	BR	< 0.34	< 0.034
IR	< 0.20	< 0.020	SE	< 0.067	< 0.007
OS	< 0.21	< 0.021	AS	< 0.027	< 0.003
RE	< 0.14	< 0.014	GE	< 0.047	< 0.005
W	< 0.18	< 0.018	GA	< 0.020	< 0.002
TA	< 1.3	< 0.13	ZN	< 0.053	< 0.005
HF	< 0.23	< 0.023	CU	< 0.042	< 0.004
LU	< 0.053	< 0.005	NI	< 0.031	< 0.003
YB	< 0.077	< 0.008	CO	< 0.010	< 0.001
TM	< 0.047	< 0.005	FE	< 0.015	< 0.002
ER	< 0.14	< 0.014	MN	< 0.016	< 0.002
HO	< 0.046	< 0.005	CR	< 0.016	< 0.002
DY	< 0.079	< 0.008	V	< 0.016	< 0.002
TB	< 0.022	< 0.002	TI	< 0.009	< 0.001
GD	< 0.079	< 0.008	SC	< 0.007	< 0.001
EU	< 0.036	< 0.004	CA	< 0.012	< 0.001
SM	< 0.14	< 0.014	K	< 0.004	< 0.001
ND	< 0.17	< 0.017	CL	< 0.088	< 0.009
PR	< 0.031	< 0.003	S	< 0.050	< 0.005
CE	< 0.041	< 0.004	P	< 0.022	< 0.002
LA	< 0.045	< 0.004	SI	< 0.009	< 0.001
BA	< 0.061	< 0.006	AL	< 0.005	< 0.001
CS	< 0.007	< 0.001	MG	< 0.008	< 0.001
I	< 0.12	< 0.012	NA	< 0.002	< 0.001
TE	< 0.099	< 0.010	F	< 0.083	< 0.008
SB	< 0.070	< 0.007	O	NR	NR
SN	0.53	0.053	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.12	0.012	B	< 0.008	< 0.001
AG	< 0.036	< 0.004	BE	< 0.002	< 0.001
PD	< 0.100	< 0.010	LI	< 0.001	< 0.001
RH	0.033	0.003			

$ - INTERNAL STANDARD

RUN 5 - SAA - FILTER

SAMPLE ID. : 16754

SAMPLE WT. : 0.0759 G

PLATE NO. : 1184

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	0.076	1.0	RU	< 0.051	< 0.68
TH	0.11	1.5	MO	< 1.2	< 16
BI	0.59	7.6	NB	0.27	3.5
FE	5.2 (MG)	6.8 (%)	ZR	0.96	13
TL	0.47	6.1	Y	0.23	3.0
HG	< 0.11	< 1.4	SR	1.6	22
AU	0.062	0.81	RB	3.6	48
PT	< 0.18	< 2.4	BR	1.2 (MG)	1.6 (%)
IR	< 0.095	< 1.2	SE	13	160
OS	< 0.10	< 1.4	AS	14	180
RE	< 0.065	< 0.86	GE	< 0.022	< 0.29
W	< 0.058	< 0.77	GA	< 0.009	< 0.12
TA	< 0.099	< 1.3	ZN	420	5500
HF	5.5	72	CU	20	250
LU	< 0.035	< 0.46	NI	3.5	46
YB	< 0.037	< 0.49	CO	6.1	81
TM	< 0.045	< 0.60	FE	1.4 (MG)	1.9 (%)
ER	< 0.067	< 0.88	MN	1.1 (MG)	1.4 (%)
HO	< 0.015	< 0.19	CR	14	170
DY	< 0.038	< 0.50	V	1.2	16
TB	< 0.009	< 0.11	TI	29	360
GD	< 0.038	< 0.50	SC	< 0.004	< 0.057
EU	< 0.020	< 0.27	CA	850	1.1 (%)
SM	< 0.073	< 0.97	K	850	1.1 (%)
ND	0.15	2.0	CL	<440	<5800
PR	0.029	0.39	S	3.6 (MG)	4.7 (%)
CE	0.16	2.1	P	83	1000
LA	0.23	3.0	SI	MC	MC
BA	3.5	46	AL	0.13	1.8
CS	0.21	2.7	MG	39	510
I	0.064	1.1	NA	210	2800
TE	< 0.047	< 0.62	F	MC	MC
SB	21	280	O	NR	NR
SN	110	1500	N	NR	NR
IN	$ 10	$ 130	C	NR	NR
CD	8.6	110	B	170	2300
AG	2.1	27	BE	0.14	1.9
PD	< 0.048	< 0.63	LI	4.9	64
RH	3.5	50			

$ - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED

SAMPLE ID. : 14639

SAMPLE WT. : 0.5055 G

PLATE NO. : 1167

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.076	< 0.15	RU	< 0.051	< 0.10
TH	< 0.11	< 0.22	MO	< 0.16	< 0.32
SI	< 0.040	< 0.078	NB	0.018	0.035
PB	< 0.17	< 0.34	ZR	< 0.032	< 0.063
TL	< 0.049	< 0.096	Y	< 0.015	< 0.030
HG	< 0.11	< 0.21	SR	< 0.014	< 0.027
AU	< 0.062	< 0.12	RB	< 0.004	< 0.007
PT	NR	NR	BR	< 4.6	< 9.1
IR	< 0.095	< 0.19	SE	< 0.032	< 0.064
OS	< 0.10	< 0.20	AS	< 0.014	< 0.027
RE	< 0.063	< 0.13	GE	< 0.022	< 0.043
W	< 0.058	< 0.12	GA	< 0.009	< 0.018
TA	< 0.099	< 0.20	ZN	< 0.45	< 0.84
HF	< 0.14	< 0.28	CU	0.43	0.84
LU	< 0.035	< 0.068	NI	1.3	2.6
YB	< 0.037	< 0.073	CO	0.012	0.024
TM	< 0.045	< 0.090	FE	< 5.5	< 11
ER	< 0.067	< 0.13	MN	< 0.25	< 0.50
HO	< 0.015	< 0.029	CR	< 0.53	< 1.0
DY	< 0.038	< 0.075	V	0.005	0.010
TB	< 0.009	< 0.017	TI	0.060	0.12
GD	< 0.038	< 0.075	SC	< 0.004	< 0.009
EU	< 0.020	< 0.040	CA	< 0.007	< 0.014
SM	< 0.073	< 0.15	K	< 0.82	< 1.6
ND	< 0.067	< 0.13	CL	< 3.3	< 6.5
PR	< 0.015	< 0.029	S	< 58	< 110
CE	< 0.020	< 0.039	P	< 1.3	< 2.5
LA	< 0.028	< 0.056	SI	< 1.2	< 2.4
BA	< 0.029	< 0.058	AL	< 0.008	< 0.016
CS	< 0.003	< 0.007	MG	< 0.65	< 1.3
I	< 0.021	< 0.041	NA	< 1.5	< 3.5
TE	< 0.047	< 0.093	F	< 0.26	< 0.52
SB	< 0.033	< 0.066	O	NR	NR
SN	< 0.043	< 0.085	N	NR	NR
IN	* 10	* 20	C	NR	NR
CD	< 0.018	< 0.036	B	< 0.73	< 1.4
HG	< 0.017	< 0.034	SE	< 0.001	< 0.001
PD	< 0.048	< 0.095	LI	< 0.69	< 1.4
RH	< NR	< NR			

* - INTERNAL STANDARD

NR - NOT REPORTED

RUN 5 - SAA - CONDENSATE

SAMPLE ID. : 16761

SAMPLE WT. : 10 G

PLATE NO. : 1176

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.082	< 0.008	RU	< 0.061	< 0.006
TH	< 0.12	< 0.012	MO	0.45	0.045
BI	< 0.037	< 0.004	NB	0.007	0.001
PB	0.31	0.031	ZR	0.29	0.029
TL	< 0.046	< 0.005	Y	< 0.011	< 0.001
HG	< 0.11	< 0.011	SR	0.055	0.005
AU	< 0.062	< 0.006	RB	0.007	0.001
PT	< 0.18	< 0.018	BR	20	2.0
IR	< 0.095	< 0.009	SE	< 0.032	< 0.003
OS	< 0.10	< 0.010	AS	0.013	0.001
RE	< 0.065	< 0.007	GE	< 0.023	< 0.002
W	< 0.088	< 0.009	GA	< 0.009	< 0.001
TA	8.7	0.87	ZN	2.5	0.25
HF	< 0.11	< 0.011	CU	0.12	0.012
LU	< 0.026	< 0.003	NI	0.49	0.049
YB	< 0.037	< 0.004	CO	0.069	0.007
TM	< 0.023	< 0.002	FE	< 7.4	< 0.74
ER	< 0.067	< 0.007	MN	0.87	0.087
HO	< 0.022	< 0.002	CR	0.93	0.093
DY	< 0.038	< 0.004	V	< 0.016	< 0.002
TB	< 0.010	< 0.001	TI	0.18	0.018
GD	< 0.038	< 0.004	SC	< 0.003	< 0.001
EU	< 0.017	< 0.002	CA	23	2.3
SM	< 0.066	< 0.007	K	2.0	0.20
ND	< 0.084	< 0.008	CL	960	97
PR	< 0.015	< 0.001	S	350	35
CE	< 0.020	< 0.002	P	< 0.63	< 0.063
LA	< 0.021	< 0.002	SI	27	2.7
BA	< 0.029	< 0.003	AL	< 0.034	< 0.003
CS	< 0.003	< 0.001	MG	6.1	0.61
I	< 0.057	< 0.006	NA	25	2.5
TE	< 0.048	< 0.005	F	< 4.8	< 0.48
SB	0.045	0.004	O	NR	NR
SN	0.96	0.096	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.12	0.012	B	< 0.24	< 0.024
AG	< 0.017	< 0.002	BE	< 0.001	< 0.001
PD	< 0.048	< 0.005	LI	0.028	0.003
RH	0.033	0.003			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 6 - SAA - FILTER

SAMPLE ID. : 16755

SAMPLE WT. : 0.0739 G

PLATE NO. : 1185

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.038	< 0.52	RU	< 0.026	< 0.35
TH	< 0.056	< 0.76	MO	< 0.081	< 1.1
BI	0.30	4.0	NB	0.018	0.24
PB	330	4500	ZR	0.13	1.7
TL	< 0.024	< 0.33	Y	0.030	0.41
HG	< 0.053	< 0.72	SR	0.82	11
AU	< 0.031	< 0.42	RB	3.6	49
PT	< 0.090	< 1.2	BR	36	480
IR	< 0.047	< 0.64	SE	1.6	22
OS	< 0.051	< 0.69	AS	3.3	45
RE	< 0.033	< 0.44	GE	< 0.011	< 0.15
W	< 0.029	< 0.40	GA	< 0.005	< 0.063
TA	< 0.20	< 2.7	ZN	1.6 (MG)	2.2 (%)
HF	< 0.071	< 0.97	CU	9.7	130
LU	< 0.017	< 0.23	NI	0.059	0.79
YB	< 0.019	< 0.25	CO	3.1	41
TM	< 0.023	< 0.31	FE	5.7 (MG)	7.7 (%)
ER	< 0.034	< 0.45	MN	4.2 (MG)	5.7 (%)
HO	< 0.007	< 0.099	CR	3.3	44
DY	< 0.019	< 0.26	V	0.30	4.1
TB	< 0.004	< 0.058	TI	13	190
GD	< 0.019	< 0.26	SC	< 0.002	< 0.029
EU	< 0.010	< 0.14	CA	1.7 (MG)	2.3 (%)
SM	< 0.037	< 0.50	K	3.4 (MG)	4.6 (%)
ND	< 0.033	< 0.45	CL	<220	<2900
PR	< 0.007	< 0.099	S	7.2 (MG)	9.7 (%)
CE	0.040	0.54	P	9.9	130
LA	0.028	0.38	SI	MC	MC
BA	1.8	24	AL	< 0.061	< 0.83
CS	0.10	1.4	MG	< 5.2	< 70
I	0.010	0.14	NA	870	1.2 (%)
TE	< 0.023	< 0.32	F	970	1.3 (%)
SB	11	140	O	NR	NR
SN	59	790	N	NR	NR
IN	$ 10	$ 130	C	NR	NR
CD	1.1	15	B	44	590
AG	0.52	7.0	BE	0.14	1.9
PD	< 0.024	< 0.32	LI	10	130
RH	0.76	11			

$ - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED

RUN 6 - SAA - SORBENT

SAMPLE ID. : 16636

SAMPLE WT. : 0.4955 G

PLATE NO. : 1168

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.038	< 0.077	RU	< 0.026	< 0.052
TH	< 0.056	< 0.11	MO	< 0.040	< 0.081
SI	< 0.020	< 0.040	NB	< 0.009	< 0.018
PB	< 5.2	< 10	ZR	0.48	0.97
TL	< 0.024	< 0.049	Y	< 0.006	< 0.013
HG	< 0.053	< 0.11	SR	< 0.007	< 0.014
AU	< 0.031	< 0.062	RB	0.007	0.015
PT	NR	NR	BR	< 2.3	< 4.6
IR	< 0.047	< 0.096	SE	< 0.016	< 0.033
OS	< 0.051	< 0.10	AS	0.028	0.056
RE	< 0.033	< 0.066	GE	< 0.011	< 0.022
W	< 0.029	< 0.059	GA	< 0.005	< 0.009
TA	< 0.20	< 0.40	ZN	< 0.50	< 1.6
HF	< 0.071	< 0.14	CU	1.0	2.0
LU	< 0.017	< 0.035	NI	7.0	14
YB	< 0.019	< 0.037	CO	0.046	0.093
TM	< 0.023	< 0.046	FE	17	35
ER	< 0.034	< 0.068	MN	< 0.004	< 0.009
HO	< 0.007	< 0.015	CR	0.60	1.2
DY	< 0.019	< 0.038	V	0.010	0.020
TB	< 0.004	< 0.009	TI	0.12	0.24
GD	< 0.019	< 0.038	SC	< 0.002	< 0.004
EU	< 0.010	< 0.020	CA	5.1	10
SM	< 0.037	< 0.074	K	< 6.8	< 14
ND	< 0.033	< 0.067	CL	< 70	< 140
PR	< 0.007	< 0.015	S	88	170
CE	< 0.010	< 0.020	P	1.9	3.9
LA	< 0.014	< 0.028	SI	< 40	< 81
BA	0.12	0.24	AL	< 0.030	< 0.062
CS	< 0.002	< 0.003	MG	< 5.2	< 11
I	< 0.010	< 0.021	NA	< 7.0	< 14
TE	< 0.023	< 0.047	F	< 0.49	< 1.00
SB	< 0.017	< 0.034	O	NR	NR
SN	< 0.022	< 0.043	N	NR	NR
IN	$ 10	$ 21	C	NR	NR
CD	0.073	0.15	B	< 0.73	< 1.5
AG	< 0.009	< 0.017	SE	0.071	0.14
PD	0.096	0.19	LI	< 0.17	< 0.35
RH	< NR	< NR			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 6 - SAA - CONDENSATE

SAMPLE ID. : 16762

SAMPLE WT. : 10 G

PLATE NO. : 1177

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.34	< 0.034	RU	< 0.25	< 0.025
TH	< 0.50	< 0.050	MO	14	1.4
BI	< 0.15	< 0.015	NB	0.030	0.003
PB	2.6	0.26	ZR	0.79	0.079
TL	< 0.19	< 0.019	Y	< 0.046	< 0.005
HG	< 0.44	< 0.044	SR	0.11	0.011
AU	0.26	0.026	RB	0.056	0.006
PT	< 0.75	< 0.075	BR	82	8.2
IR	< 0.40	< 0.040	SE	0.89	0.089
OS	< 0.43	< 0.043	AS	0.11	0.011
RE	< 0.27	< 0.027	GE	< 0.094	< 0.009
W	< 0.37	< 0.037	GA	< 0.039	< 0.004
TA	4.2	0.42	ZN	2.6	0.26
HF	< 0.45	< 0.045	CU	0.59	0.059
LU	< 0.11	< 0.011	NI	1.1	0.11
YB	< 0.15	< 0.015	CO	0.15	0.015
TM	< 0.095	< 0.009	FE	< 15	< 1.5
ER	< 0.28	< 0.028	MN	7.7	0.77
HO	< 0.091	< 0.009	CR	2.0	0.20
DY	< 0.16	< 0.016	V	0.025	0.002
TB	< 0.043	< 0.004	TI	0.38	0.038
GD	< 0.16	< 0.016	SC	< 0.013	< 0.001
EU	< 0.072	< 0.007	CA	24	2.4
SM	< 0.28	< 0.028	K	5.7	0.57
ND	< 0.35	< 0.035	CL	4.3 (MG)	430
PR	< 0.061	< 0.006	S	790	80
CE	< 0.082	< 0.008	P	1.0	0.10
LA	< 0.089	< 0.009	SI	65	6.5
BA	0.12	0.012	AL	0.27	0.027
CS	< 0.014	< 0.001	MG	27	2.7
I	< 0.24	< 0.024	NA	53	5.3
TE	< 0.20	< 0.020	F	3.4	0.34
SB	0.19	0.019	O	NR	NR
SN	2.1	0.21	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.49	0.049	B	1.7	0.17
AG	< 0.072	< 0.007	BE	< 0.008	< 0.001
PD	< 0.20	< 0.020	LI	0.15	0.015
RH	0.14	0.014			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 7 - SAA - FILTER

SAMPLE ID. : 16756

SAMPLE WT. : 0.0757 G

PLATE NO. : 1184

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.038	< 0.50	RU	< 0.026	< 0.34
TH	0.23	3.0	MO	0.72	9.5
SI	1.2	16	NB	0.27	3.5
PB	5.2 (MG)	6.8 (%)	ZR	1.9	25
TL	0.23	3.1	Y	0.45	6.0
HG	< 0.053	< 0.70	SR	6.6	90
AU	< 0.031	< 0.41	RB	3.6	48
PT	< 0.090	< 1.2	BR	300	4000
IR	< 0.047	< 0.63	SE	6.4	84
OS	< 0.051	< 0.68	AS	6.9	92
RE	< 0.033	< 0.43	GE	< 0.011	< 0.14
W	0.12	1.5	GA	< 0.005	< 0.061
TA	< 0.74	< 9.8	ZN	1.6 (MG)	2.1 (%)
HF	< 0.071	< 0.94	CU	9.7	120
LU	< 0.017	< 0.23	NI	29	380
YB	< 0.019	< 0.24	CO	6.1	81
TM	< 0.023	< 0.30	FE	2.8 (MG)	3.6 (%)
ER	< 0.034	< 0.44	MN	2.1 (MG)	2.8 (%)
HO	< 0.007	< 0.097	CR	14	170
DY	< 0.019	< 0.25	V	2.5	33
TB	< 0.004	< 0.057	TI	30	390
GD	< 0.019	< 0.25	SC	< 0.002	< 0.029
EU	< 0.010	< 0.13	CA	1.7 (MG)	2.3 (%)
SM	< 0.037	< 0.48	K	850	1.1 (%)
ND	< 0.033	< 0.44	CL	<440	<5600
PR	0.059	0.77	S	1.7 (MG)	2.3 (%)
CE	0.59	7.8	P	20	260
LA	0.21	2.8	SI	MC	MC
BA	1.8	23	AL	< 0.24	< 3.2
CS	0.41	5.5	MG	6.9	91
I	0.31	4.1	NA	210	2800
TE	< 0.023	< 0.31	F	110	1500
SB	11	140	O	NR	NR
SN	110	1500	N	NR	NR
IN	$ 10	$ 130	C	NR	NR
CD	4.4	58	B	20	260
AG	2.1	27	BE	0.071	0.94
PD	< 0.024	< 0.32	LI	0.43	5.7
RH	< 0.50	< 6.6			

$ - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED

SAMPLE ID. : 16637

SAMPLE WT. : 0.5156 G

PLATE NO. : 1169

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 1.5	< 2.5	RU	< 0.65	< 1.7
TH	< 1.9	< 3.6	MO	< 1.3	< 2.6
BI	< 0.66	< 1.3	NB	< 0.30	< 0.58
PB	< 2.9	< 5.6	ZR	1.1	2.1
TL	< 0.81	< 1.6	Y	< 0.25	< 0.49
HG	< 1.8	< 3.4	SR	< 0.23	< 0.44
AU	< 1.0	< 2.0	RB	0.061	0.12
PT	NR	NR	BR	< 10	< 20
IR	< 1.6	< 3.1	SE	< 0.54	< 1.0
OS	< 1.7	< 3.3	AS	< 0.23	< 0.45
RE	< 1.1	< 2.1	GE	< 0.36	< 0.71
W	< 0.97	< 1.9	GA	< 0.15	< 0.30
TA	< 13	< 26	ZN	51	100
HF	< 2.4	< 4.6	CU	9.7	19
LU	< 0.58	< 1.1	NI	7.3	14
YB	< 0.62	< 1.2	CO	0.10	0.20
TM	< 6.1	< 12	FE	17	33
ER	< 1.1	< 2.2	MN	< 4.2	< 8.2
HO	< 0.24	< 0.47	CR	1.5	2.9
DY	< 0.63	< 1.2	V	0.34	0.65
TB	< 0.14	< 0.26	TI	< 0.099	< 0.19
GD	< 0.63	< 1.2	SC	< 0.072	< 0.14
EU	< 0.34	< 0.65	CA	< 0.11	< 0.22
SM	< 1.2	< 2.4	K	< 6.8	< 13
ND	< 1.1	< 2.2	CL	1.9 (MG)	3500
PR	< 0.24	< 0.47	S	450	870
CE	< 0.33	< 0.64	P	9.8	19
LA	< 0.47	< 0.91	SI	36	69
BA	< 0.49	< 0.95	AL	17	33
CS	1.7	3.3	MG	< 11	< 21
I	< 0.35	< 0.67	NA	22	43
TE	< 0.78	< 1.5	F	< 33	< 64
SB	< 0.56	< 1.1	O	< 0.009	< 0.017
SN	< 0.72	< 1.4	N	NR	NR
IN	$ 10	$ 20	C	NR	NR
CD	< 0.30	< 0.59	B	< 12	< 24
HG	< 0.29	< 0.56	BE	< 0.010	< 0.019
PD	< 0.80	< 1.5	LI	2.3	4.9
AG	< NR	< NR			

$ - INTERNAL STANDARD

NR - NOT REPORTED

RUN 7 - SAA - CONDENSATE

SAMPLE ID. : 16763

SAMPLE WT. : 10 G

PLATE NO. : 1178

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.17	< 0.017	RU	< 0.13	< 0.013
TH	< 0.25	< 0.025	MO	1.8	0.18
BI	< 0.077	< 0.008	NB	< 0.015	< 0.001
PB	0.32	0.032	ZR	< 0.11	< 0.011
TL	< 0.096	< 0.010	Y	< 0.023	< 0.002
HG	< 0.22	< 0.022	SR	0.057	0.006
AU	< 0.13	< 0.013	RB	< 0.007	< 0.001
PT	< 0.37	< 0.037	BR	82	8.2
IR	< 0.20	< 0.020	SE	< 0.067	< 0.007
OS	< 0.21	< 0.021	AS	0.027	0.003
RE	< 0.14	< 0.014	GE	< 0.047	< 0.005
W	< 0.18	< 0.018	GA	< 0.020	< 0.002
TA	9.1	0.91	ZN	2.6	0.26
HF	< 0.23	< 0.023	CU	0.28	0.028
LU	< 0.053	< 0.005	NI	0.51	0.051
YB	< 0.077	< 0.008	CO	0.010	0.001
TM	< 0.047	< 0.005	FE	< 7.4	< 0.74
ER	< 0.14	< 0.014	MN	1.9	0.19
HO	< 0.046	< 0.005	CR	0.48	0.048
DY	< 0.079	< 0.008	V	0.008	0.001
TB	< 0.022	< 0.002	TI	0.19	0.019
GD	< 0.079	< 0.008	SC	< 0.007	< 0.001
EU	< 0.036	< 0.004	CA	12	1.2
SM	< 0.14	< 0.014	K	< 3.6	< 0.36
ND	< 0.17	< 0.017	CL	1.0 (MG)	100
PR	< 0.031	< 0.003	S	390	39
CE	< 0.041	< 0.004	P	0.39	0.039
LA	< 0.045	< 0.004	SI	5.1	0.51
BA	< 0.061	< 0.006	AL	0.021	0.002
CS	3.4	0.34	MG	13	1.3
I	< 0.12	< 0.012	NA	26	2.6
TE	< 0.099	< 0.010	F	< 2.5	< 0.25
SB	< 0.070	< 0.007	O	NR	NR
SN	0.27	0.027	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.49	0.049	B	< 0.50	< 0.050
AG	< 0.036	< 0.004	BE	< 0.002	< 0.001
PD	< 0.100	< 0.010	LI	< 0.019	< 0.002
RH	< 0.033	< 0.003			

$ - INTERNAL STANDARD

NR - NOT REPORTED

FILTER BLANK

SAMPLE ID. : 16757

SAMPLE WT. : 10 G

PLATE NO. : 1172

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.69	< 0.069	RU	< 0.51	< 0.051
TH	< 1.00	< 0.100	MO	< 0.47	< 0.047
BI	< 0.31	< 0.031	NB	< 0.059	< 0.006
PB	< 0.64	< 0.064	ZR	1.7	0.17
TL	< 0.39	< 0.039	Y	< 0.091	< 0.009
HG	< 0.89	< 0.089	SR	< 0.11	< 0.011
AU	< 0.51	< 0.051	RB	3.3	0.33
PT	< 1.5	< 0.15	BR	5.3	0.53
IR	< 0.79	< 0.079	SE	< 0.27	< 0.027
OS	< 0.86	< 0.086	AS	< 0.11	< 0.011
RE	< 0.54	< 0.054	GE	< 0.19	< 0.019
W	< 0.73	< 0.073	GA	< 0.078	< 0.008
TA	9.1	0.91	ZN	2.6	0.26
HF	< 0.91	< 0.091	CU	0.050	0.005
LU	< 0.21	< 0.021	NI	< 0.15	< 0.015
YB	< 0.31	< 0.031	CO	< 0.038	< 0.004
TM	5.7	0.57	FE	< 1.9	< 0.19
ER	< 0.56	< 0.056	MN	< 0.065	< 0.006
HO	< 0.18	< 0.018	CR	0.25	0.025
DY	< 0.32	< 0.032	V	0.025	0.002
TB	< 0.066	< 0.009	TI	0.77	0.077
GD	< 0.32	< 0.032	SC	< 0.027	< 0.003
EU	< 0.14	< 0.014	CA	0.81	0.081
SM	< 0.55	< 0.055	K	< 3.4	< 0.34
ND	< 0.70	< 0.070	CL	8.7 (MG)	870
PR	< 0.12	< 0.012	S	6.2	0.62
CE	< 0.16	< 0.016	P	2.4	0.24
LA	< 0.18	< 0.018	SI	31	3.1
BA	< 0.24	< 0.024	AL	0.27	0.027
CS	< 0.029	< 0.003	MG	27	2.7
I	< 0.47	< 0.047	NA	28	2.8
TE	< 0.40	< 0.040	F	660	66
SB	< 0.28	< 0.028	O	NR	NR
SN	< 0.39	< 0.039	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	< 0.49	< 0.049	B	1.7	0.17
AG	< 0.14	< 0.014	BE	3.9	0.39
PD	< 0.40	< 0.040	LI	2.6	0.26
RH	< 0.14	< 0.014			

$ - INTERNAL STANDARD

NR - NOT REPORTED

SORBENT BLANK

SAMPLE ID. : 16638

SAMPLE WT. : 0.5043 G

PLATE NO. : 1170

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.16	< 0.32	RU	< 0.11	< 0.21
TH	< 0.23	< 0.47	MO	< 0.17	< 0.33
BI	< 0.083	< 0.16	NB	< 0.037	< 0.074
PB	< 0.36	< 0.71	ZR	2.0	4.0
TL	< 0.10	< 0.20	Y	0.031	0.062
HG	< 0.22	< 0.44	SR	0.057	0.11
AU	< 0.13	< 0.25	RB	0.015	0.030
PT	NR	NR	BR	< 2.5	< 5.0
IR	< 0.20	< 0.39	SE	0.89	1.8
OS	< 0.21	< 0.42	AS	0.12	0.23
RE	< 0.14	< 0.27	GE	< 0.046	< 0.090
W	< 0.12	< 0.24	GA	< 0.019	< 0.038
TA	< 25	< 49	ZN	< 6.6	< 13
HF	< 0.30	< 0.59	CU	2.3	4.5
LU	< 0.072	< 0.14	NI	1.8	3.6
YB	< 0.077	< 0.15	CO	0.051	0.10
TM	< 23	< 45	FE	6.1	12
ER	< 0.14	< 0.28	MN	< 8.5	< 17
HO	< 0.030	< 0.060	CR	1.5	3.0
DY	< 0.079	< 0.16	V	0.084	0.17
TB	< 0.018	< 0.036	TI	0.36	0.71
GD	< 0.079	< 0.16	SC	< 0.009	< 0.018
EU	< 0.042	< 0.083	CA	5.4	11
SM	< 0.15	< 0.30	K	< 7.1	< 14
ND	< 0.14	< 0.28	CL	< 5.2 (MG)	< 1.0 (%)
PR	< 0.031	< 0.061	S	210	420
CE	< 0.041	< 0.082	P	15	29
LA	< 0.059	< 0.12	SI	< 68	< 130
SM	< 0.061	< 0.12	AL	< 0.51	< 1.0
CS	< 0.007	< 0.014	MG	17	34
I	< 0.044	< 0.086	NA	45	90
TE	< 0.098	< 0.19	F	< 2.1	< 4.1
SB	0.19	0.37	O	NR	NR
SN	< 0.090	< 0.18	N	NR	NR
IN	$ 10	$ 20	C	NR	NR
CD	0.15	0.30	B	< 3.1	< 6.1
AG	0.072	0.14	BE	0.001	0.002
PD	< 0.100	< 0.20	LI	0.37	0.73
RH	< NR	< NR			

$ - INTERNAL STANDARD

NR - NOT REPORTED

CONDENSATE BLANK

SAMPLE ID. : 16764

SAMPLE WT. : 10 G

PLATE NO. : 1179

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	< 0.34	< 0.034	RU	< 0.25	< 0.025
TH	< 0.50	< 0.050	MO	1.9	0.19
SI	< 0.15	< 0.015	NB	< 0.030	< 0.003
PB	< 0.32	< 0.032	ZR	1.6	0.16
TL	< 0.19	< 0.019	Y	< 0.046	< 0.005
HG	< 0.44	< 0.044	SR	< 0.057	< 0.006
AU	< 0.26	< 0.026	RB	< 0.014	< 0.001
PT	< 0.75	< 0.075	BR	2.6	0.26
IR	10	1.00	SE	< 0.13	< 0.013
OS	< 0.43	< 0.043	AS	< 0.053	< 0.005
RE	< 0.27	< 0.027	GE	< 0.094	< 0.009
W	< 0.37	< 0.037	GA	< 0.039	< 0.004
TA	9.1	0.91	ZN	0.19	0.019
HF	< 0.45	< 0.045	CU	< 0.083	< 0.008
LU	< 0.11	< 0.011	NI	< 0.33	< 0.033
YB	< 0.15	< 0.015	CO	< 0.019	< 0.002
TM	< 0.095	< 0.009	FE	< 7.4	< 0.74
ER	< 0.28	< 0.028	MN	< 0.13	< 0.013
HO	< 0.091	< 0.009	CR	0.46	0.046
DY	< 0.16	< 0.016	V	0.008	0.001
TB	< 0.043	< 0.004	TI	0.35	0.035
GD	< 0.16	< 0.016	SC	< 0.013	< 0.001
EU	< 0.072	< 0.007	CA	2.3	0.23
SM	< 0.28	< 0.028	K	< 0.43	< 0.043
ND	< 0.35	< 0.035	CL	2.1 (MG)	210
PR	< 0.061	< 0.006	S	18	1.8
CE	< 0.082	< 0.008	P	1.0	0.10
LA	< 0.089	< 0.009	SI	5.1	0.51
BA	< 0.12	< 0.012	AL	0.056	0.006
CS	< 0.014	< 0.001	MG	13	1.3
I	< 0.24	< 0.024	NA	13	1.3
TE	< 0.20	< 0.020	F	< 2.5	< 0.25
SB	< 0.14	< 0.014	O	NR	NR
SN	< 0.20	< 0.020	N	NR	NR
IN	$ 10	$ 1.0	C	NR	NR
CD	0.24	0.024	B	< 0.53	< 0.053
AG	< 0.072	< 0.007	SE	< 0.004	< 0.001
PD	< 0.20	< 0.020	LI	0.010	0.001
RH	< 0.069	< 0.007			

$ - INTERNAL STANDARD

NR - NOT REPORTED

SAMPLE ID. : QC 1648 URBAN PARTICULATE

SAMPLE WT. : 0.0663 G

PLATE NO. : 1188

ELEMENT	UG	PPM	ELEMENT	UG	PPM
U	0.13	2.3	RU	0.10	1.5
TH	0.45	6.8	MO	< 1.2	< 18
BI	0.30	4.5	NB	0.54	8.1
FE	330	5100	ZR	7.7	110
TL	0.12	1.8	Y	0.43	6.8
HG	0.11	1.6	SR	14	200
AU	0.062	0.93	RB	1.8	27
PT	0.46	7.2	BR	74	1100
IR	0.080	1.2	SE	1.9	29
OS	0.16	2.4	AS	6.9	100
RE	0.13	2.0	GE	1.3	20
W	0.058	0.88	GA	4.6	70
TA	< 1.5	< 22	ZN	1.4 (MG)	2.2 (%)
HF	0.36	5.5	CU	20	290
LU	0.017	0.26	NI	1.8	27
YB	0.041	0.62	CO	3.1	46
TM	< 0.34	< 5.1	FE	1.9 (MG)	2.9 (%)
ER	0.098	1.5	MN	27	400
HO	0.029	0.44	CR	3.3	49
DY	0.29	4.3	V	5.0	76
TB	0.017	0.26	TI	120	1800
GD	0.086	1.3	SC	4.3	65
EU	0.044	0.67	CA	MC	MC
SM	0.28	4.3	K	220	3300
ND	2.2	34	CL	<360	< 1.3 (%)
PR	0.44	6.6	S	MC	MC
CE	2.4	36	P	340	5200
LA	3.4	51	SI	2.6 (MG)	4.0 (%)
BA	59	880	AL	540	8100
CS	0.10	1.6	MG	91	1300
I	1.3	19	NA	110	1600
TE	0.094	1.4	F	110	1700
SB	2.7	40	O	NR	NR
SN	14	210	N	NR	NR
IN	* 10	* 150	C	NR	NR
CD	1.1	17	B	7.3	110
AG	0.52	7.8	BE	0.071	1.1
PD	0.19	2.9	LI	1.1	17
RH	< 0.067	< 1.0			

* - INTERNAL STANDARD

MC - MAJOR COMPONENT

NR - NOT REPORTED