TEST NUMBER FA-4

AIRCO Alloys And Carbide

Charleston, South Carolina

C. C. Gonzalez/R. N. Allen

Resources Research, Inc.
A Subsidiary of TRW Inc.
7600 Colshire Drive
McLean, Virginia 22101

Contract Number CPA 70-91

Furnace Exhaust,

Stack No. East Duct, Port B Date 23 Sept 71

Sample No. 11 - Simultaneous with 10

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dpc
1	3.2917	3.2888	2.9	11.8	88.2
2	3.5992	3.5910	8.2	32.1	56.1
3	3.0704	3.0682	~~5.9~~ 2.2	8.6	47.5
4	3.6209	3.6150	~~2.8~~ 5.9	23.1	24.4
5	3.3610	3.3582	2.8	10.8	13.6
filter	0.1298	0.1263	3.5	13.6	

TOTAL 25.5

Start 1346

Stop 1345

ΔP = 5" Hg

Precipitator

Stack No. Exhaust

Date 23 Sept 71

Sample No. 12

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dac
1	3.5674	3.5636	2.8	36.3	63.7
2	3.5796	3.5793	0.3	3.9	59.8
3	3.5782	3.5780	0.2	2.6	57.2
4	3.6508	3.6487	0.2	27.3	29.9
5	3.5887	3.5879	2.1	10.4	19.5
filter	0.1294	0.1279	0.8	19.5	
			Total 7.7		

Time	Meter reading (CF)	ΔP across Sampler (in hg)	
1800	202.59	10	start
2000	287.10	10	stop

APPENDIX K

CHEMICAL ANALYSIS OF EMISSIONS

PREFACE

The following report, covering chemical analysis of emissions from reactive metal smelting operations at Charleston, South Carolina, has been prepared by the technical staff of TRW Systems Group, One Space Park, Redondo Beach, California.

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CHEMICAL ANALYSES OF EMISSIONS FROM REACTIVE METALS SMELTING OPERATIONS

1. INTRODUCTION

Particulate fumes and gaseous emissions are generated during processing of an important class of ferroalloy materials called reactive metals. The particulate portion of the emissions is collected on glass fiber filters strategically placed in the air stream of a ventilation system. Two such filters from Airco Corporation (Charleston, South Carolina) were analyzed by the combined techniques of electron beam X-ray analysis and atomic absorption analysis, and the results are detailed in the following paragraphs.

2. TEST RESULTS

2.1 Optical Examination and Compositing

The two samples were gray and were labeled WCD and ECD. Small portions were cut for electron microprobe analyses. The remainder was shaken and a copious amount of loose powder was gathered, blended, and designated Charleston Airco Inlet Duct CD-M.

2.2 Electron Beam X-Ray Microanalysis and Atomic Absorption

The electron microprobe is an advanced piece of equipment which uses a small beam of electrons to produce characteristic X-ray emissions from a sample volume with a radius of ~1 micron. Curved crystal X-ray spectrometers are used to analyze the resultant characteristic X-ray spectra. In these analyses, the electron beam was defocused to a diameter of 150 microns (0.006 inch) to cover a larger segment of the sample. The electron beam impinged in vacuum upon the untouched surfaces of small pie-shaped pieces of sample-covered filter pads. An examination was made of the complex spectrum of X-rays given off by the specimen under electron beam excitation, and it was found that the entire spectrum could be identified uniquely. All portions of the X-ray spectrum in the wavelength range 1-100Å covering all elements except H, He, Li, and Be were taken into account.

Atomic Absorption (A.A.) means that a cloud of atoms in the un-ionized and unexcited state is capable of absorbing radiation at wavelengths that are specific in nature and characteristic of the element in consideration. The atomic absorption spectrophotometer used in these analyses consists of a series of lamps which emit the spectra of the elements determined, a gas burner to produce an atomic vapor of the sample, a monochromator to isolate the wavelengths of interest, a detector to monitor the change of absorption due to the specimen, and a readout meter to visualize this change in absorption.

The qualitative electron microprobe results are in Table 1, along with the quantitative atomic absorption results. The latter were generated on the composited samples mechanically separated from the filter (collector) pads by shaking and lightly scraping the filters. A negligible amount of collector filter material was included in the blended sample, and therefore no unused filter pad was needed.

The sum of the percent values, after conversion to equivalent oxide values, is 84% and indicates adequate closure in the sense that all the major constituents have been taken into account. The remaining 16% could well be accounted for by the presence of chlorine, carbon, and titanium.

The major conclusion is that the sample is a mixture of oxides: SiO_2, Cr_2O_3, MgO, and Al_2O_3.

X-ray diffraction analyses were not executed, and hence it is not known if the oxide mixture is amorphous (non-crystalline), crystalline (spinel structure), or partially amorphous-partially crystalline.

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II. INTRODUCTION

Source emission tests are being performed on a series of electric furnace installations, known as reactive metals or ferroalloys, for the Office of Air Programs, Environmental Protection Agency. These surveys include the determination of filterable and total particulate matter, sulfur dioxide, particle size analyses and chemical analyses for a variety of furnace formulations and control devices. The series of tests, contained in this report, were performed at the Pittsburgh Metallurgical Company Division of Air Reduction Company, Incorporated, P. O. Box 130, Pittsburgh Avenue, Charleston, South Carolina 23405.

Emissions from this particular plant were determined for a high carbon ferro chrome furnace (No. 14). This unit was hooded, with a conditioning tower leading to an electrostatic precipitator. A large draft fan, located after the precipitator, forced the cleaned gases into the stack. The ten-foot diameter exhaust stack was provided with two 3-inch sample ports mounted 90 degrees apart on a single cross sectional plane. Two rectangular inlet ducts, mounted at an angle, were sampled through five properly spaced ports for equal area sampling.

All sample locations are shown in Figure 1 on the following page. Further detailed diagrams and descriptions are included in Sections IV and V of this report (Process Description and Location of Sampling Points).

Three particulate collection efficiency tests were conducted. Each inlet test included two ducts. These tests were assumedly triplicate runs for the normal, typical operating condition.

During this particular survey particulate matter was sampled using the EPA train as described in Appendix E-1. Sulfur oxides were sampled using the Shell Development method and integrated combustion gases were sampled in a gas bag with analysis by standard Orsat. Particle size was measured in situ with a Brink Sampler. The overall survey included 9 particulate emission runs, 3 Orsat measurements, 3 sulfur dioxide samples, 2 metals filters and 12 particle size distribution analyses.

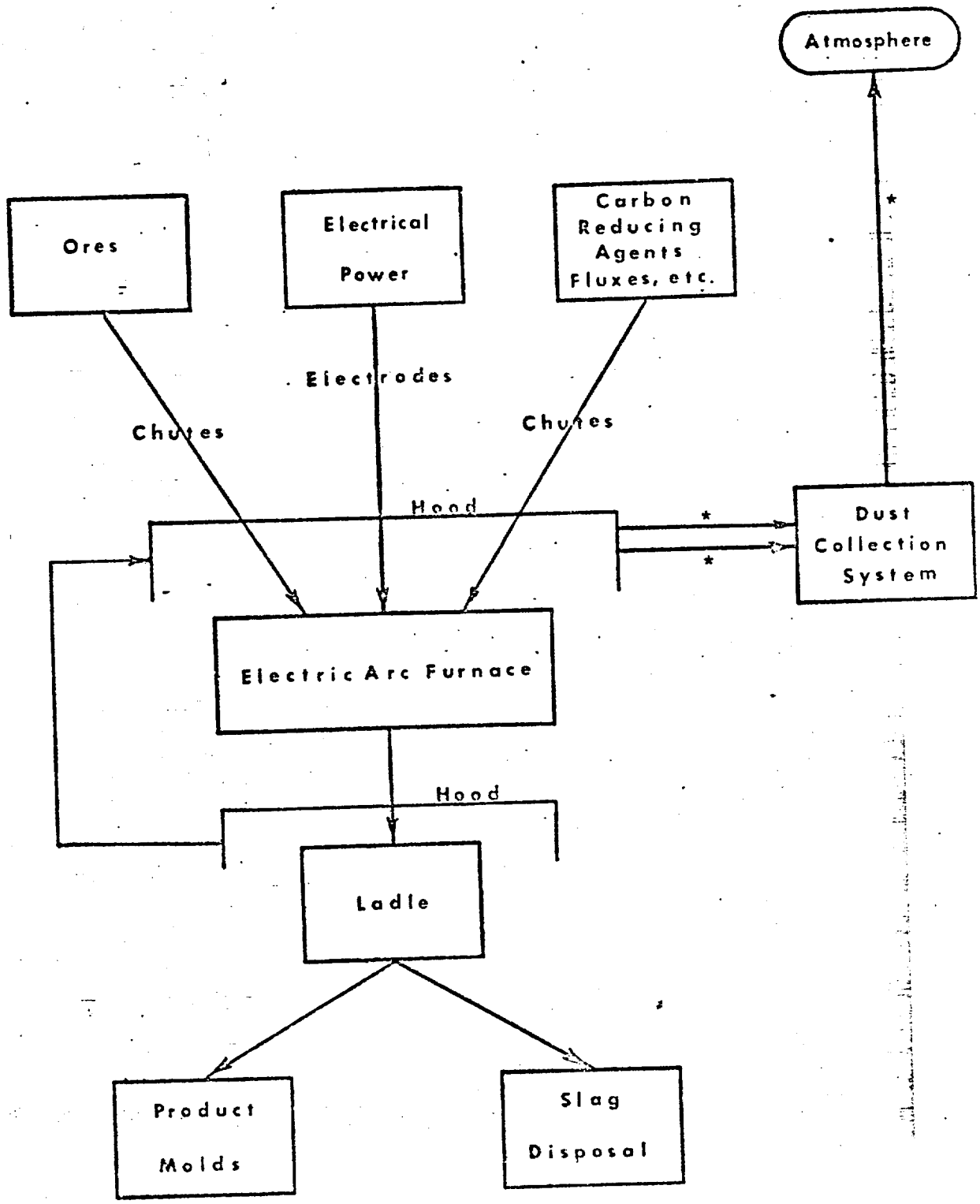


FIGURE 1. BLOCK DIAGRAM—SAMPLE LOCATIONS

III. SUMMARY OF RESULTS

Shown below in Table 1 are the results and averages for "in" and "out" tests of the precipitator system along with the corresponding collection efficiencies.

Table 1

OVERALL SUMMARY OF RESULTS AND COLLECTION EFFICIENCY

		Stack Exhaust (Outlet)			Inlet Ducts (Combined)		
Date(1971)	Run No.	Particulate grains/SCF	Particulate lb/hr	SO_2 PPM	Particulate grains/SCF	Particulate lb/hr	Percent Efficiency
9/21	One	0.0310	39.4	8.	2.04	1394	97.2
9/22	Two	0.0115	15.7	0.8	1.67	1150	98.6
9/23	Three	0.0125	17.2	8.	1.90	1397	98.8
	Average	0.0183	24.1	8.*	1.87	1312	98.1

* Does not include value from Run 2.

The higher particulate inlet loading and lower collection efficiency on Run No. 1 apparently relate to a furnace blow which reduced the effect of the conditioning tower. This in turn affected the efficiency of the precipitator. A much heavier plume was visually evident at the stack exhaust during part of this run.

The SO_2 concentration for Run 2 is believed to be in error and was not included in the average. Results are within the ranges previously obtained for sulfur dioxide emission concentrations at three other reactive metal furnaces.

Particulate and gaseous emission summaries for the precipitator exhaust, and both inlet ducts, are shown in Tables 2 and 3 on the following pages. Flue gas conditions are included and percent particulate matter in the impinger train has been calculated. This "condensible" portion was extremely low prior to the collection system.

Gas temperatures and velocities at the exhaust sampling location remained relatively stable. Conditions at both inlet ducts, during each run, included some fairly wide variations in both temperature and velocities, but their final averages agreed rather well.

Particle size distributions of furnace emissions are shown in Appendix J. Average size of individual particles was typically from one to two microns (MMD). Frequently there was little difference between the sizes measured before or following the precipitator system.

Chemical analyses of the inlet composite sample are shown in Appendix K. The larger quantities of material were oxides of silicon, chromium, magnesium and aluminum.

Carbon monoxide concentrations ranged from 200 to 400 ppm for short periods and then for several minutes at levels exceeding 500 ppm.

TABLE 2

PRECIPITATOR EXHAUST STACK

SUMMARY OF RESULTS

un Number	PCE-1	PCE-2	PCE-3			
ate	9/21/71	9/22/71	9/23/71			
tack Flow Rate - SCFM * dry	148,400	159,000	161,000			
Water Vapor - % Vol.	8.4	9.5	8.9			
CO_2 - Vol % dry	1.6	2.4	2.2			
O_2 - Vol % dry	20.2	19.8	19.4			
Excess air @ sampling point	3370.	2200.	1290.			
O Emissions - ppm dry	7.86	0.781	7.91			
O_x Emissions - ppm dry	N/A	N/A	N/A			
articulates						
r be, Cyclone, & Filter Catch						
r/SCF* dry	0.0286	0.00916	0.01032			
r/CF @ Stack Conditions	0.0207	0.00656	0.00748			
b /hr.	36.3	12.5	14.2			
articulate from Impinger rain (% of Total)	8.	20.	17.			
otal Catch						
/SCF * dry	0.0310	0.0115	0.01247			
/CF @ Stack Conditions	0.0224	0.00824	0.00904			
os./hr.	39.4	15.7	17.2			
tack Temperature, °F	219	217	215			

°F, 29.92" Hg

TABLE 3

PRECIPITATOR INLET DUCTS

SUMMARY OF RESULTS

n Number	ECD-1	ECD-2	ECD-3	WCD-1	WCD-2	WCD-3
te	9/21/71	9/22/71	9/23/71	9/21/71	9/22/71	9/23/71
ack Flow Rate - SCFM * dry	78,100	85,500	85,500	81,500	75,200	85,500
Water Vapor - % Vol.	4.8	3.8	3.6	3.92	2.85	4.12
CO_2 - Vol % dry	NA	NA	NA	NA	NA	NA
O_2 - Vol % dry	NA	NA	NA	"	"	"
Excess air @ sampling point	NA	NA	NA	"	"	"
$_2$ Emissions - ppm dry	NA	NA	NA	"	"	"
$_x$ Emissions - ppm dry	NA	NA	NA	"	"	"
rticulates						
obe, Cyclone, & Filter Catch						
/SCF* dry	0.892	0.819	1.107	1.09	0.835	0.782
/CF @ Stack Conditions	0.510	0.457	0.620	0.590	0.465	0.452
s./hr.	597	600	811	761	538	573
rticulate from Impinger rain (% of Total)	3.2	1.0	0.7	0.8	1.1	0.9
t l Catch						
/SCF * dry	0.922	0.827	1.114	1.113	0.845	0.789
/CF @ Stack Conditions	0.528	0.463	0.624	0.603	0.471	0.457
s /hr.	617	606	817	777	544	578
ack Temperature, °F	432	463	464	492	475	429

IV. PROCESS DESCRIPTION

Reactive metals are generally ferroalloys which are produced in submerged arc electric furnaces. The facility under consideration in this report is an open furnace, with hooding and an electrostatic precipitator system to reduce the emission of fumes and dust following collection. Figure 2 is a cross sectional view process flow diagram indicating the actual furnace under test in this survey.

The electric arc is employed as a concentrated source of heat. Chrome, manganese and other ores are added to the surface of the furnace through mechanized equipment and chutes. Additional carbon in the form of coke, wood chips, etc., is an integral part of the furnace mix, along with specialized fluxes, etc. The mix is added directly to the surface of the furnace through chutes and is then spread over the surface with stoking machines.

The very high temperatures produced initiate a reaction in the bottom of the furnaces and form a layer of metal which is tapped at appropriate times. As the ores and carbonaceous materials gradually settle to the bottom of the furnace, the heat, in conjunction with a lack of oxygen, react with the oxide ores in order to remove oxygen and thus produce the elemental metal. Escaping gases, composed largely of carbon monoxide, are burned at the surface of the furnace in the so-called open units.

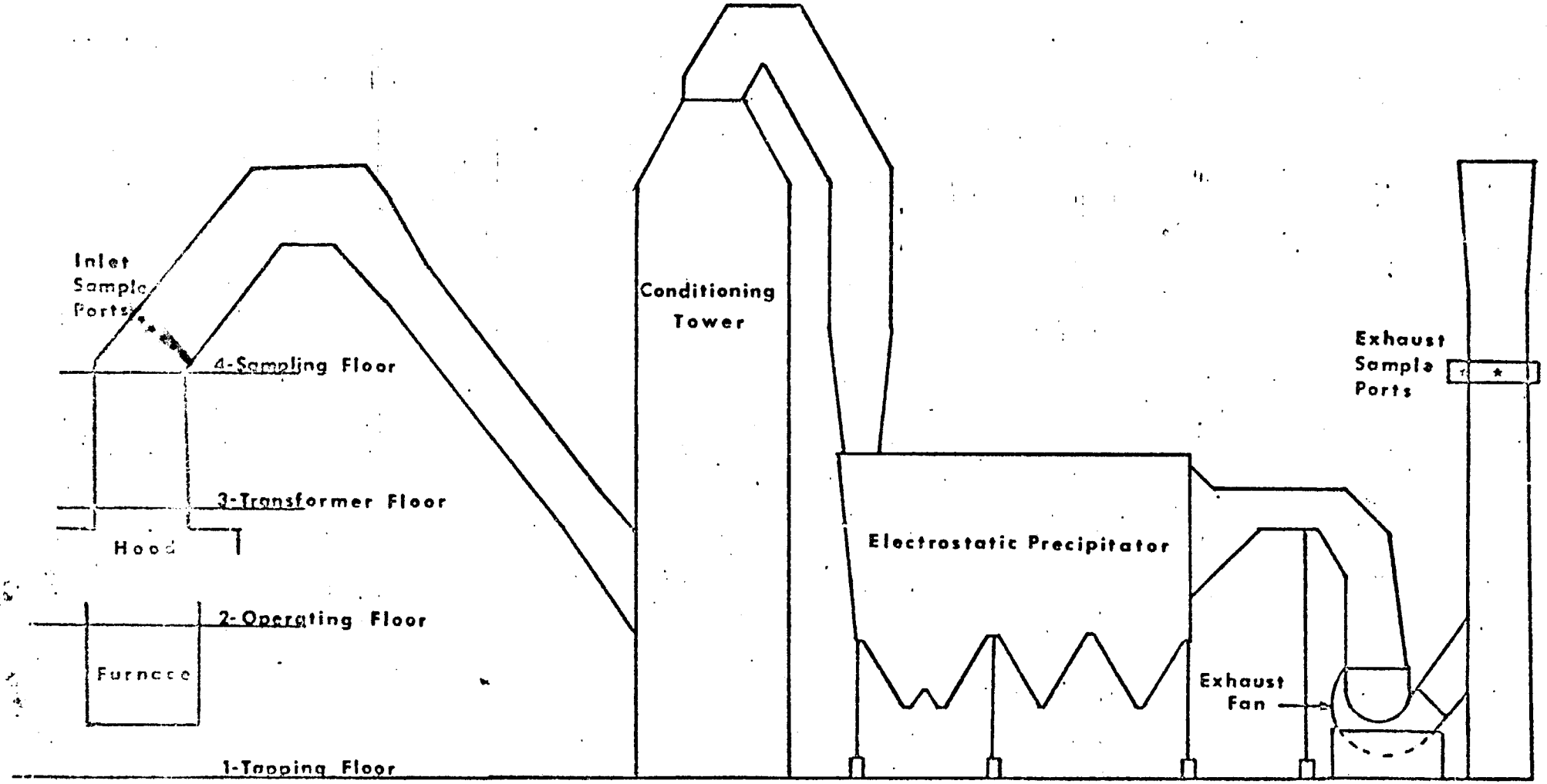


FIGURE 2. PROCESS FLOW DIAGRAM- FURNACE 14

Furnace 14 is a nominal 40 megawatt unit producing a high carbon ferro-chrome using Soderberg type electrodes, formed in place from a "paste", rather than using prebaked carbon electrodes. Induced draft fans are employed to pull fumes from various hoods into the exhaust system. Gases and fumes from the normal furnace operation are passed through a conditioning tower and an electrostatic precipitator for cleaning, prior to discharge into the atmosphere. The collection of fumes around the furnace is almost 100 percent effective during normal operation. A page of technical data is shown in Appendix C.

The furnace is tapped at intervals of approximately one and a half hours, depending upon the total power fed and thereby the amount of metal produced. Molten metal and slag pour into ladles. Fumes produced in this operation are drawn off by a separate exhaust fan but they are introduced into the furnace hooding and thereby enter the standard precipitator collection system. The collection of these fumes was only about 80 percent effective when observed, and was said to be only 50 percent effective when the tap is particularly violent. The slag is removed from the ladle and disposed of by various means. Molten product is poured into molds, after which it is broken into usable sizes.

V. LOCATION OF SAMPLING POINTS

Sample port locations were installed by plant personnel prior to the arrival of the test team, and approved by the EPA project officer. There were five sample ports, mounted at an angle, on one side of each inlet duct. As shown in Figure 3 the cross section of each duct was divided into five equal layers, thus forming a sample profile with 25 equal areas. Particulate tests were conducted for 4 minutes at the centroid of each area. A special step arrangement, resting on one-inch rollers, provided horizontal and vertical access to each sampling point in the duct.

Two sample ports at the exhaust stack were located 90° apart. The stack was ten feet in diameter at the sampling location and was divided into nine equal areas, as shown in Figure 4. The railing was extended in order to support a 12-foot plank and allow the probe to reach each sampling point. A complete run was conducted by traversing both ports (36 points) for a total duration of six hours.

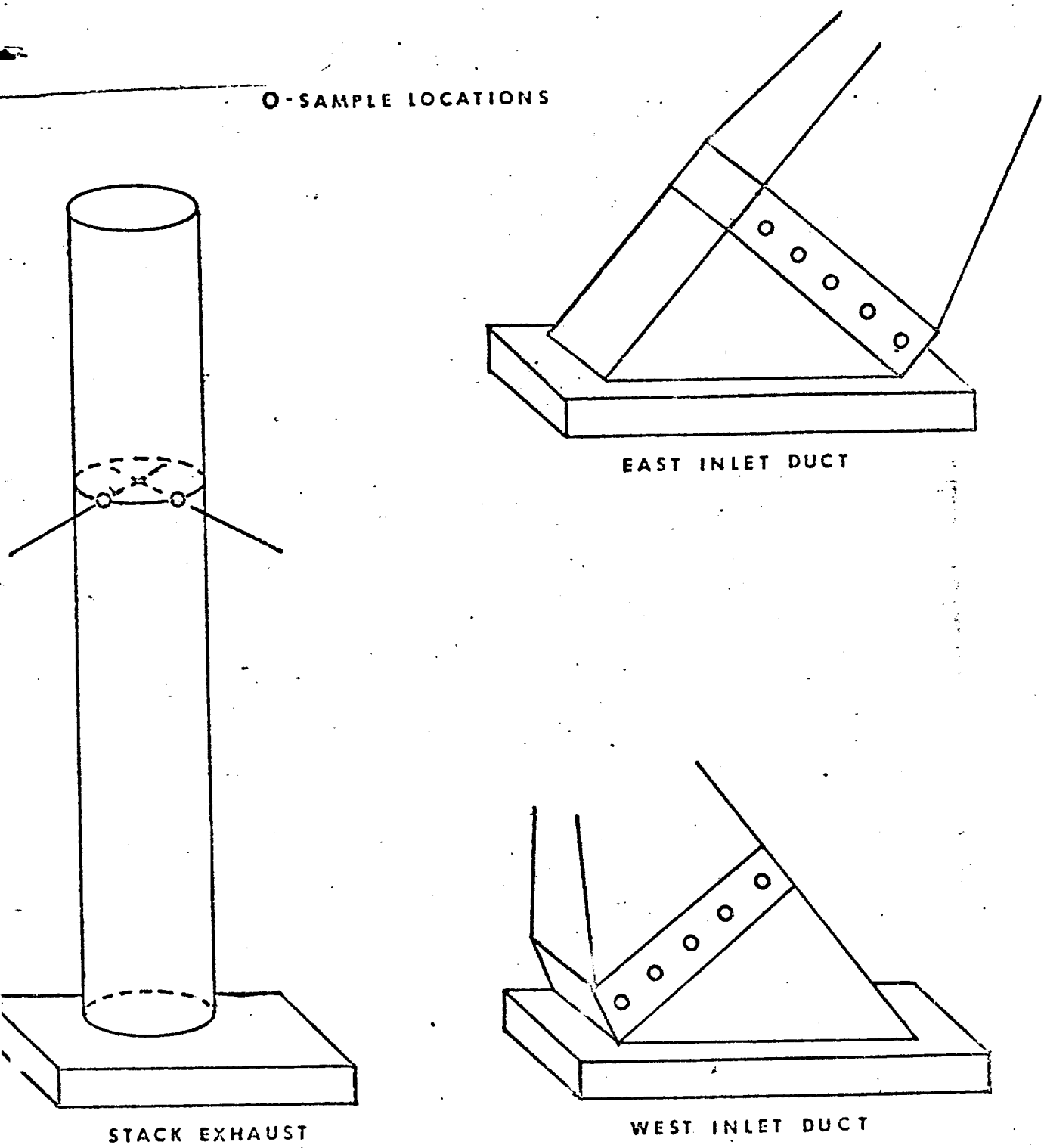
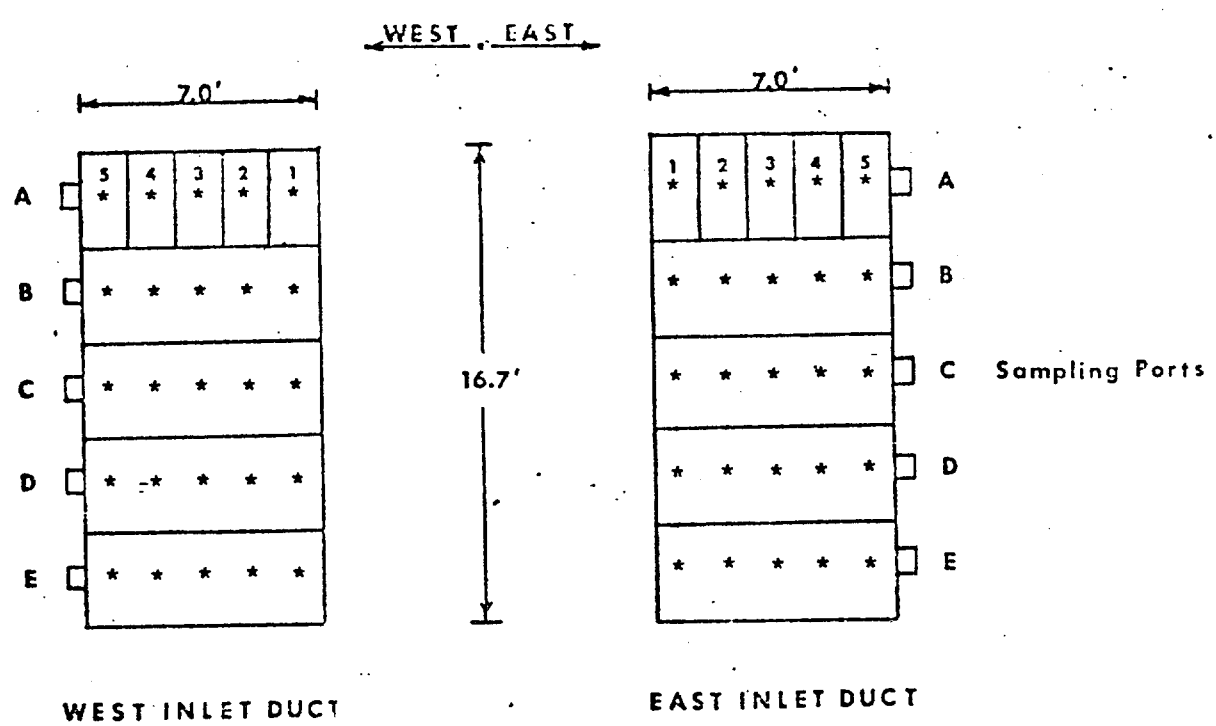


FIGURE 3.—ISOMETRIC DIAGRAM—SAMPLE LOCATIONS, FURNACE 14.



*-SAMPLING POINTS

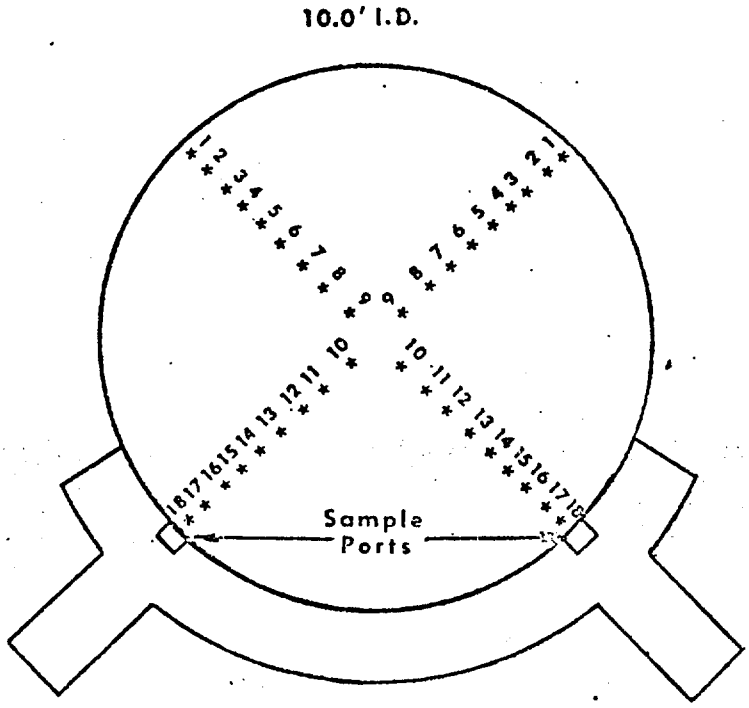


FIGURE 4. SAMPLING POINT LOCATIONS

VI. PROCESS OPERATION

Practically all sampling was carried out while the process was running normally. There were periods with furnace "blows" or minor process load variations but these special conditions were rapidly corrected so that the sampling was not seriously affected.

Appendix C tabulates the tapping data, operating data, and indicates the furnace load during the sampling periods. There were some fluctuations in the furnace load during testing, but these were considered to be within normal operating conditions. Normal operating levels were indicated when the furnace operated between 35 and 37 megawatts. Tapping was conducted as often as necessary, depending upon the total power input to the furnace.

VII. SAMPLING PROCEDURES

All test procedures were discussed with the Project Officer in advance. They were essentially the same as those being issued by the Environmental Protection Agency for source sampling.

Preliminary velocity and temperature readings were obtained in order to select nozzle sizes for isokinetic sampling. Particulate sampling was conducted using the EPA train as described in Appendix E-1. The metals sampling train was essentially the same as the ordinary particulate train, but it specifically called for a glass-lined probe.

Gas sampling was also conducted in accordance with the proposed EPA Standard Source Testing Methods. Sulfur dioxide was sampled with midget impingers using isopropyl alcohol and hydrogen peroxide solutions. Combustion gases were sampled in plastic bags for immediate analysis with an Orsat analyzer. Carbon monoxide was sampled directly into the infrared analyzer.

Particle sizing was performed using the Brink impactor. Further information and details are included in Appendix J.

Special care was taken, not only to obtain all samples during normal operating conditions, but for each particulate test to include one tap cycle. Any deviation from the standard methods was either approved or recommended by the EPA project engineer at the site.

VIII. CLEANUP AND ANALYTICAL PROCEDURES

The methods employed for cleanup of the EAP particulate train have become relatively standardized through testing incinerators, furnaces, etc., for government approval. Various sections of the sampling train were washed with acetone and water. The filter was removed carefully and each portion of the collected particulate matter was placed in separate containers. All portions were then dried at ambient conditions and the water was extracted for organic material, as well as being evaporated to dryness. These procedures are outlined in detail in Appendix E-2.

SO_2 samples employed simple means of cleanup, using distilled, deionized water as a rinsing medium. The analytical procedure is somewhat more involved and details are outlined in Appendix E-2. Both cleanup and analytical procedures were conducted in accordance with approved methods.

Special procedures for particle sizing and for chemical analysis of the metals samples are discussed, respectively, in Appendixes J and K.

IX. DISCUSSION

A. RESULTS

Precipitator Efficiency

The efficiency of the overall electrostatic precipitator system was determined under what was understood to be routine conditions. Efficiencies of approximately 97, 99, and 99 percent were obtained during normal process variations. The lower efficiency occurred during a period in which there was a prolonged furnace blow and subsequent cooling.

During periods in which the furnace temperatures are cooled below normal, for one reason or another, the exhaust gases are also cooled until operation resumes normal load. During the period in which the gases are emitted at a reduced temperature it is necessary to reduce the moisture content of these gases, as controlled by the conditioning tower, to prevent condensation within the precipitator section of the system. This change in conditioning reduces the efficiency of the precipitator to a very noticeable degree.

In the above incident emissions from the exhaust stack were clearly visible, while normally the emissions can be seen only when viewed against a very clear sky or dark background. Under the circumstances associated with this installation it is peculiar, but when the actual emissions from the furnace are reduced, and therefore usually at a cooler temperature, the exhaust emissions from the system are noticeably increased over normal.

The minimum emission of particulate matter occurred during Run 2, when the lowest inlet dust loadings were produced. Correspondingly, the greatest efficiency occurred in association with the highest inlet loadings, during Run 3.

Each efficiency has been calculated on the basis of total pounds per hour (mass rate) in spite of the fact that inlet and exhaust flue gas volumes did not always match as closely as desired. It must be remembered that the mass emission rates are calculated for a specific period of time, and that this rate will vary depending upon the actual plant operating conditions.

Emissions

The inlet duct measurements were conducted over a relatively short period of time (100 minutes) while the exhaust measurements were obtained over a six-hour period in order to obtain larger quantities of material for increased accuracy of weighing. Relatively high dust loadings at the inlet duct provided plenty of material for accurate weights in a short period of time.

Exhaust emissions appeared to be rather uniform except for the known occasions where the unit was not operating at peak efficiencies. Inlet grain loadings and emissions varied sharply between individual samples,

as well as between the two ducts during the same time periods. Considering the inherent variability of furnace operation, all of the inlet duct dust concentrations are considered to be quite reasonable.

Tapping

No separate samples were obtained from the tapping exhaust ducts because these systems led directly into the overall furnace hooding system, and therefore were sampled with each ordinary test. Every sample period was timed such that a tapping cycle was included midway during that test.

Although the collection efficiency of the tapping ladle hood was not very efficient, these escaping fumes were relatively insignificant in comparison to the total amount of dust and fumes being produced. These fumes, of course, were not subject to collection and scrubbing in any manner. They were therefore actually emitted to the atmosphere from one point or another, while the collected fumes were normally reduced by about 99 percent.

Particulate Versus Total Catch

The ratio of particulate trapped by the impingers, versus the total catch, was quite different for samples collected at different locations. With a single exception, the inlet duct samples contained approximately one percent of the total catch as trapped by the impingers.

These results are similar to other uncontrolled emissions from reactive metal furnaces. Niagara Falls (Test FA-3) is the only possible exception to this pattern.

The percentage of "condensible" material at the exhaust stack was considerably greater. These samples averaged 15 percent of the catch caught in the impinger train. It should not be too surprising that there is an increased ratio of "condensible" material at the precipitator exhaust because the electrostatic precipitator would not be effective in trapping non-filterable material. Although the conditioning tower acts as a low efficiency scrubber (removing about 50 percent of the total material caught by the system), the proportion of any condensible material originating from the furnace would be increased greatly by the time the exhaust gases were leaving the stack.

Flue Gas Conditions

Considering the normal variation in operating conditions, and observing gas flow from the furnace, the flue gas volume was considered to be relatively stable for the test runs. However, the total flue gas volumes at standard conditions, for Run 1 and Run 3, were approximately seven percent greater at the inlet ducts than was measured at the exhaust stack. Measurements during Run 2 indicated the flue gas volume to be almost equivalent at both locations.

Due to the one sample with matching volumes, it is difficult to believe that there was a uniform leakage of seven percent. Flue gases at the inlet ducts were under a slight positive pressure, therefore some leakage could be possible, although the quantities involved should have been readily visible. The EPA train has been designed for extreme care and accuracy, and it is believed that flue gas volume measurements should be more accurate than the above figures would indicate.

There appear to be two possible explanations, in addition to that of inherent error. The exhaust flow was relatively stable and uniform, as well as being located after several pipe diameters of straight flow, therefore these figures are assumed to be the more accurate.

Gas flow at the inlet ducts was highly variable from one point to another as well as from one moment to the next. Measurements were conducted at a bend in the rather large duct. Multiple measurements usually result in a satisfactory average, simply because of many measurements and averaging. However, it is sometimes possible that inlet and exhaust flows appear to differ greatly because the angle of gas flow is not parallel to the walls of the cross section in the area being tested. If this should occur (as is common with tangential flow in a round vertical stack) it is possible that the actual flue gas volume does not match that as measured.

A second reason for the apparent discrepancy may simply be that the exhaust samples cover a period of some six hours while the inlet measurements cover a period of only 100 minutes.

Temperatures at the exhaust stack were extremely stable between runs. Corresponding temperatures at the inlet ducts varied widely during each test, yet the averages for these two ducts over the entire test period were relatively stable.

Gaseous Emissions

Sulfur dioxide concentrations were measured only at the exhaust stack. The first and third runs matched exactly but the second sample was almost certainly in error. Run 2 indicated a meter volume two to three times larger than Runs 1 or 3. Based upon almost identical meter conditions and sampling times, it appears evident that there was air leakage during this second sample.

Carbon dioxide content was within the range expected, after having conducted tests at previous installations with similar hooding arrangements. The infrared analyzer for carbon monoxide (CO) operated without problem. This is the first survey, however, in which the unit was available for low concentrations. The extreme fluctuations in values is apparently due to the inherent, yet perhaps small, "blows" associated with normal feeding operations.

Particle Sizing

The particle size of material emitted from the furnace and the exhaust stack is so small that major differences are hard to determine. The mass median diameter (MMD) ranged between 0.4 microns and 2.5 microns in all exhaust samples and between 1.2 microns and 2.6 microns in all inlet duct samples.

It must be remembered that that sample time at the inlet duct was only five to seven minutes at a single point. It is unlikely that any single value would represent a true average of material being emitted from the furnace.

Exhaust samples were obtained during periods ranging from 90 minutes to 240 minutes. This time period was probably long enough for average results. However, the average particle size was so extremely small, that it was difficult to obtain wholly satisfactory results.

All of the above particle size results are explained in detail in Appendix J. A graphical representation of each sample is available in Sub-appendix J-1 along with details of the date, operating condition, and time sampled.

Chemical Analyses

An inlet sample was composited from particulate matter obtained at each inlet duct and was analyzed by qualitative electron beam X-ray micro analysis and atomic absorption. Samples collected for these chemical analyses were obtained through all-glass pyrex probes between the second and third particulate runs. Both of these tests were conducted isokinetically at a single point until the smaller (two and one-half inch) filter began clogging.

B. OPERATING CONDITIONS

Precipitator System

As far as can be determined there were no problems with the operation of the electrostatic precipitator during any testing. On the day in which the first samples were obtained, the ammonia supply for the conditioning towers was shut down to Furnace 15. Although the test was being conducted on Furnace 14 this unit was shut off while they were cleaning this system. Fortunately, this occurred early in the morning and the exhaust samples were not quite ready to begin. By the time the testing was completely ready, the ammonia was back in proper operation.

Furnace 14

It is understood that the operating conditions of the furnace were fairly uniform. Detailed operating conditions were being recorded by plant personnel but these are not available in time to be included as part of this report (normally Appendix C). Every particulate sample was timed into the ordinary operating schedule, in order to include one tapping cycle during the middle of the test period.

C. TEST CONDITIONS

Inlet Duct

There was no other feasible location for sampling the two inlet ducts, but these were poor locations in most respects, except access. There was little or no straight flow of gases prior to the sample point and very little straight flow following the sample location. The sample ports were located on a sharp bend of nearly 45 degrees. The location was very hot, and relatively dusty, but fans were put into position to alleviate some of the heat.

A special platform was prepared so that the EPA train could be mounted directly in front of each sample port. These sample ports formed a line which sloped upward and therefore ranged from about one foot above floor level to nearly ten feet above the floor level. A

step arrangement platform was placed on pipe rollers such that it could be moved, and access arranged for each port. The platform was too short in length, and therefore great care had to be taken to assure that each of the five sampling points was within reach.

Outlet Duct

The vertical exhaust stack, with long straight flow before and after the sampling location, should have provided good representative sampling. A newly expanded platform was quite satisfactory and provided two sample ports. A specially prepared EPA train platform was made in advance and carried to the job site so that a ten-foot probe could reach all points within the stack.

The weather was good during the test survey and there were no problems due to the nature of this location or platform. A telephone system connected the exhaust stack location to the inlet location so that there were no problems of communication during the survey.

Power

Individual circuits were available for the testing equipment so that there were no power failures at either duct or stack.

Filter Plugging

In all previous surveys at reactive metal furnaces there has been a severe problem of clogging and vacuum buildup in the sample train, because of the accumulation of fine particulate matter on the glass fiber filters. The ultimate cure for the problem has been to employ a small size nozzle, so that less overall sample was obtained, in addition to being ready to change filter holders frequently.

Four-inch filter holders were available at Charleston for the first time. During the first sample a one-quarter inch nozzle was employed at the inlet ducts to "play safe". A single four-inch filter was required for the entire run and this required a negligible buildup in pressure drop. A larger nozzle was then employed for future runs in order to achieve a higher and more accurate sampling rate. The new rate was kept at isokinetic without incident. Although the plugging problems were reduced to a surprising degree, it is difficult to believe that the nature of the fume and particulate matter could have been appreciably different from previous surveys.

Particle Sizing

Analyses for the distribution of particle size were conducted with a Brink cascade impactor. These tests were conducted at both inlet and exhaust locations, with considerably fewer problems that had previously been experienced. There was no problem with high moisture content and all problems with high temperatures had been resolved at previous locations.

Miscellaneous Problems

A preliminary moisture run at the inlet duct was being conducted while the EPA equipment was being brought into position and set up. This moisture equipment was not being closely observed and the mercury was inadvertently sucked into the dry gas meter, therefore, moisture at both inlet ducts was estimated between two and three percent.

Due to the extremely hot and difficult sampling conditions the preliminary traverse was completed only on the west duct. When the apparent velocities were duplicated at the east duct, a few readings were taken as a check, and the nozzle size was estimated from these few readings in conjunction with the traverse on the other duct. Although the average velocity and temperature readings were very close between ducts, there were wide variations in individual readings both between the ducts and among the various ports. The ducts had areas with very low velocity and at times the gage registered zero. During these instances no sampling was conducted at those points. The lost time was made up at nearby points with measurable velocities in order to complete the normal time period for each run. Although the two inlet ducts were geometrically similar, the velocity pattern was sometimes quite different for equivalent locations.

The first runs at the inlet ducts were discarded. It was found that the vacuum was building up very rapidly, and investigation proved that the glass fiber filters had been placed on the wrong side of the support disc by a new technician. Both trains were then thoroughly cleaned and reloaded. Run 1 was satisfactorily conducted that afternoon.

X. APPENDIX.

APPENDIX A

COMPLETE PARTICULATE RESULTS WITH EXAMPLE CALCULATIONS

PRECIPITATOR EXHAUST STACK

SUMMARY OF RESULTS

Run Number	PCE-1	PCE-2	PCE-3			
Date	9/21/71	9/22/71	9/23/71			
Stack Flow Rate - SCFM * dry	148,400	159,000	161,000			
% Water Vapor - % Vol.	8.4	9.5	8.9			
% CO_2 - Vol % dry	1.6	2.4	2.2			
% O_2 - Vol % dry	20.2	19.8	19.4			
% Excess air @ sampling point	3370.	2200.	1290.			
SO_2 Emissions - ppm dry	7.86	0.781	7.91			
NO_x Emissions - ppm dry	N/A	N/A	N/A			
Particulates Probe, Cyclone, & Filter Catch gr/SCF* dry	0.0286	0.00916	0.01032			
gr/CF @ Stack Conditions	0.0207	0.00656	0.00748			
lbs./hr.	36.3	12.5	14.2			
Particulate from Impinger Train (% of Total)	8.	20.	17.			
Total Catch gr /SCF * dry	0.0310	0.0115	0.01247			
gr /CF @ Stack Conditions	0.0224	0.00824	0.00904			
lbs./hr.	39.4	15.7	17.2			
Stack Temperature, °F	219	217	215			

* 70°F, 29.92" Hg

REPORT NO. PAGE OF PAGES

SOURCE TESTING CALCULATION FORMS

Test. No. PCE No. Runs Three

Name of Firm Airco

Location of Plant Charleston, South Carolina

Type of Plant Reactive Metals

Control Equipment Electrostatic Precipitator

Sampling Point Locations Exhaust

Pollutants Sampled Total Particulate, SO_2, CO_2, O_2, CO

Time of Particulate Test:

Run No. PCE-1 Date 9/21/71 Begin 0930 End 1600

Run No. PCE-2 Date 9/22/71 Begin 0900 End 1510

Run No. PCE-3 Date 9/23/71 Begin 0850 End 1520

PARTICULATE EMISSION DATA

Run No.	PCE-1	PCE-2	PCE-3			
P_b barometric pressure, "Hg Absolute	30.3	30.3	30.3			
P_m orifice pressure drop, "H_2O	1.48	1.78	1.79			
V_m volume of dry gas sampled @ meter conditions, ft.^{3}	232.59	254.1	258.68			
T_m Average Gas Meter Temperature, ^oF	110	90	94			
$V_{m_{std.}}$ Volume of Dry Gas Sampled @ Standard conditions, ft.^{3}	219.5	249.	251.0			
V_w Total H_2O collected, ml., Impingers & Silical Gel.	425	553	510			
$V_{w_{std.}}$ Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	20.2	26.2	24.2			

*60^oF, 29.92" Hg.

PARTICULATE EMISSION DATA (CONT'D)

o.	PCE-1	PCE-2	PCE-3			
Moisture in the stack gas by olume	8.42	9.52	8.9			
Mole fraction of dry gas	0.916	0.905	0.911			
2	1.6	2.4	2.2			
	20.2	19.8	19.4			
	78.2	77.8	78.4			
- Molecular weight of dry stack gas	29.0	29.2	29.1			
- Molecular weight of stack gas	28.1	28.1	28.1			
- Velocity Head of stack gas, In.H_2O	0.45	0.53	0.54			
- Stack Temperature, °F	219	217	215			
$\sqrt{}$ X(T_s + 460)	17.5	19.0	19.1			
Stack Pressure,"Hg.Absolute	30.3	30.3	30.3			
Stack Velocity @ stack conditions, fpm	2610	2830	2830			
Stack Area, in.^{2}	11,300	11,300	11,300			
Stack Gas Volume @ Standard Conditions, *SCFM	148,400	159,000	161,000			
Net Time of Test, min.	360	360	360			
Sampling Nozzle Diameter, in.	0.25	0.25	0.25			
Percent isokinetic	1007	102	98			
Particulate - probe, cyclone and filter, mg.	407.6	148.3	168.4			
Particulate - total, mg	441.6	185.8	203.5			
- Particulate - probe, cyclone, and filter, gr/SCF	0.0286	0.00916	0.01032			
Particulate - total, gr/SCF	0.0310	0.0115	0.01247			
- Particulate - probe, cyclone, and filter, gr/cf @ stack conditions	0.0207	0.00656	0.00748			

PARTICULATE EMISSION DATA (cont'd)

Run No.	PCE-1	PCE-2	PCE-3			
C_{au} - Particulate, total, gr/cf @ stack cond.	0.0224	0.00824	0.00904			
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.	36.3	12.5	14.2			
C_{ax} - Particulate - total, lb/hr.	39.4	15.7	17.2			
% EA - % Excess air @ sampling point	3370.	2200.	1293.			

*70°F. 29.92" Hg.

PRECIPITATOR INLET DUCTS

SUMMARY OF RESULTS

un Number	ECD-1	ECD-2	ECD-3	WCD-1	WCD-2	WCD-3
a.e	9/21/71	9/22/71	9/23/71	9/21/71	9/22/71	9/23/71
tack Flow Rate - SCFM * dry	78,100	85,500	85,500	81,500	75,200	85,500
Water Vapor - % Vol.	4.8	3.8	3.6	3.92	2.85	4.12
CO_2 - Vol % dry	NA	NA	NA	NA	NA	NA
O_2 - Vol % dry	NA	NA	NA	"	"	"
Excess air @ sampling point	NA	NA	NA	"	"	"
O_2 Emissions - ppm dry	NA	NA	NA	"	"	"
O_x Emissions - ppm dry	NA	NA	NA	"	"	"
articulates robe, Cyclone, & Filter Catch r/SCF* dry	0.892	0.819	1.107	1.09	0.835	0.782
r/CF @ Stack Conditions	0.510	0.457	0.620	0.590	0.465	0.452
bs./hr.	597	600	811	761	538	573
articulate from Impinger Train (% of Total)	3.2	1.0	0.7	0.8	1.1	0.9
otal Catch r /SCF * dry	0.922	0.827	1.114	1.113	0.845	0.789
r /CF @ Stack Conditions	0.528	0.463	0.624	0.603	0.471	0.457
bs./hr.	617	606	817	777	544	578
tack Temperature, °F	432	463	464	492	475	429

70°F, 29.92" Hg

PORT NO. PAGE OF PAGES

SOURCE TESTING CALCULATION FORMS

st. No. No. Runs

me of Firm Airco

cation of Plant Charleston, South Carolina

pe of Plant Reactive Metals

trol Equipment Electrostatic Precipitator

ampling Point Locations East and West Inlet Ducts

ollutants Sampled Total Particulate

ime of Particulate Test:

un No. ECD-1	Date 9/21/71	Begin 1410	End 1630
un No. ECD-2	Date 9/22/71	Begin 0903	End 1104
un No. ECD-3	Date 9/23/71	Begin 0942	End 1135
un No. WCD-1	Date 9/22/71	Begin 1416	End 1620
un No. WCD-2	Date 9/22/71	Begin 0904	End 1104
un No. WCD-3	Date 9/23/71	Begin 0941	End 1135

PARTICULATE EMISSION DATA

un No.	ECD-1	ECD-2	ECD-3	WCD-1	WCD-2	WCD-3
b barometric pressure, "Hg Absolute	30.3	30.3	30.3	30.3	30.3	30.3
orifice pressure drop, "H_2O	0.20	1.13	1.11	0.23	0.93	1.11
m volume of dry gas sampled @ meter conditions, ft.^{3}	25.21	56.25	57.38	27.795	56.14	59.765
m Average Gas Meter Temperature, ^oF	126	122	129	131	117	119
$m_{std.}$ Volume of Dry Gas Sampled @ Standard conditions, ft.^{3}	23.1	53.7	52.3	25.7	52.2	55.5
w Total H_2O collected, ml., Impingers & Silical Gel.	24.7	44.3	41	22.1	32.2	50.2
W_{gas} Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	1.17	2.1	1.94	1.05	1.53	2.36

* 70°F, 29.92" Hg.

PARTICULATE EMISSION DATA (CONT'D)

No.	ECD-1	ECD-2	ECD-3	WCD-1	WCD-2	WCD-3
Moisture in the stack gas by volume	4.8	3.8	3.6	3.92	2.85	4.12
Mole fraction of dry gas	0.952	0.962	0.964	0.961	0.972	0.959
2	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
	NA	NA	NA	NA	NA	NA
- Molecular weight of dry stack gas	29.0	29.2	29.1	29.0	29.2	29.1
- Molecular weight of stack gas	28.5	28.8	28.7	28.6	28.9	28.6
s - Velocity Head of stack gas, In.H_2O	0.07	0.086	0.085	0.08	0.066	0.082
- Stack Temperature, °F	432	463	464	492	475	429
s $X(T_s + 460)$	7.9	8.9	8.85	8.7	7.83	8.55
- Stack Pressure,"Hg.Absolute	30.3	30.3	30.3	30.3	30.3	30.3
- Stack Velocity @ stack conditions, fpm	1170	1310	1310	1290	1153	1265
- Stack Area, in.^{2}	16,800	16,800	16,800	16,800	16,800	16,800
- Stack Gas Volume @ Standard Conditions, *SCFM	78,100	85,500	85,500	81,500	75,200	85,500
- Net Time of Test, min.	100	100	100	100	100	100
- Sampling Nozzle Diameter, in.	0.25	0.375	0.375	0.25	0.375	0.375
- Percent isokinetic	110	99.3	101	116	89	106
- Particulate - probe, cyclone and filter, mg.	1339.9	2855.2	3758.1	1818.9	2829.9	2820.7
- Particulate - total, mg	1382.3	2880.5	3783.4	1855.2	2863.6	2842.6
- Particulate - probe, cyclone, and filter, gr/SCF	0.892	0.819	1.107	1.09	0.835	0.782
- Particulate - total, gr/SCF	0.922	0.827	1.114	1.113	0.845	0.789
- Particulate - probe, cyclone, and filter, gr/cf @ stack conditions	0.810	0.457	0.620	0.590	0.	

PARTICULATE EMISSION DATA (cont'd)

Run No.	ECD-1	ECD-2	ECD-3	WCD-1	WCD-2	WCD-3
C_{au} - Particulate, total, gr/cf @ stack cond.	0.528	0.463	0.524	0.603	0.471	0.45
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.	597	600	811	761	538	573
C_{ax} - Particulate - total, lb/hr.	617	606	817	777	544	578
% EA - % Excess air @ sampling point	NA	NA	NA	NA	NA	NA

*70°F. 29.92" Hg.

EXAMPLE PARTICULATE CALCULATIONS

(PCE-1)

1. Volume of dry gas sampled at standard conditions - 70°F, 29.92" Hg, ft^3.

$$V_{m_{std}} = \frac{17.7 \times V_m \left(P_B + \frac{P_m}{13.6} \right)}{(T_m + 460)} = Ft.^3$$

$$= \frac{(17.7)\ (232.59)\ (30.3 + \frac{1.48}{13.6})}{(110 + 460)}$$

$$= \frac{(17.7)\ (232.59)\ (30.409)}{(570)}$$

$$= 219.5$$

2. Volume of water vapor at 70°F and 29.92" Hg, $Ft.^3$

$$V_{w_{gas}} = 0.0474 \times V_w = ft.^3$$

$$= (0.0474)\ (425)$$

$$= 20.2$$

3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} = \%$$

$$= \frac{(100)\ (20.2)}{(219.5) + (20.2)}$$

$$= \frac{2020}{239.7}$$

$$= 8.42$$

4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100}$$

$$= \frac{100 - 8.42}{100}$$

$$= \frac{91.58}{100}$$

$$= .916$$

5. Average molecular weight of dry stack gas

$$MW_d = (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + (\%N_2 \times \frac{28}{100})$$

$$= (1.6)\ (.44) + (20.2)\ (.32) + (78.2)\ (.28)$$

$$= .704 + 6.44 + 21.9$$

$$= 29.0$$

6. Molecular weight of stack gas

$$MW = MW_d \times M_d + 18\ (1 - M_d)$$

$$= (29)\ (.916) + 18\ (1 - .916)$$

$$= 26.6 + 18\ (.084)$$

$$= 26.6 + 1.51$$

$$= 28.1$$

7. Stack velocity @ stack conditions, fpm

$$V_s = 4350 \times \sqrt{\Delta P_s \times (T_s + 460)} \left\{ \frac{1}{P_s \times MW} \right\}^{1/2} = \text{fpm}$$

$$= (4350)(17.5)\ \left(\frac{1}{(30.3)(28.1)} \right)^{1/2}$$

$$(4350)(17.5)\ \left(\frac{1}{850}\right)^{1/2}$$

$$= (76000.)\ \left(\frac{1}{29.2} \right)$$

$$= 2610$$

8. Stack gas volume @ standard conditions, SCFM

$$Q_s = \frac{0.123 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM}$$

$$= \frac{(0.123)(2610)(11,300)(.916)(30.3)}{679}$$

$$= 148,400$$

9. Percent isokinetic

$$\%I = \frac{1032 \times (T + 460) \times V_m}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \%$$

$$= \frac{(1032)(679)(232.59)}{(2610)(360)(30.3)(.916)(.0625)}$$

$$= \frac{163500000.}{1635000.}$$

$$= 100\%$$

10. Particulate - probe, cyclone, and filter, gr/SCF

$$C_{an} = 0.0154 \times \frac{M_f}{V_{m_{std}}} = \text{gr/scf}$$

$$= \frac{(0.0154)(407.6)}{219.5}$$

$$= 0.0286$$

11. Particulate total, gr/SCF

$$C_{ao} = 0.0154 \times \frac{M_t}{V_{m_{std}}} = \text{gr/SCF}$$

$$= \frac{(0.0154)(441.6)}{219.5}$$

$$= 0.0310$$

12. Particulate - probe, cyclone and filter, gr/CF at stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF}$$

$$= \frac{(17.7)(0.0286)(30.3)(.916)}{679}$$

$$= 0.0207$$

13. Particulate - total, gr/CF @ stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_s \times M_d}{(T_x + 460)} = \text{gr/CF}$$

$$= \frac{(17.7)(0.0310)(30.3)(.916)}{679}$$

$$= 0.0224$$

14. Particulate - probe, cyclone and filter, lb/hr.

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = \text{lb/hr.}$$

$$= (0.00857)(0.0286)(148,400)$$

$$= 36.3$$

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = \text{lb/hr.}$$

$$= (0.00857)(0.0310)(148,400)$$

$$= 39.4$$

16. % excess air at sampling point

$$\% \text{ EA} = \frac{100 \times \% O_2}{(0.266 \times \% N_2) - \% O_2} = \%$$

$$= \frac{(100)(20.2)}{(0.266)(78.2)} - 20.2$$

$$= 3370$$

APPENDIX B

COMPLETE GASEOUS RESULTS WITH EXAMPLE CALCULATIONS

CO CONCENTRATION

CO concentrations were measured by a Mine Safety Appliance, Model 1160, Infrared Analyzer with a range of 0-500 ppm. Measurements were taken at port C of the east duct, and port B of the west duct of the furnace exhaust.

CO concentrations in both ducts varied from 200 ppm to 400 ppm for short periods of one to two minutes followed by concentrations exceeding 500 ppm for periods of five to ten minutes. The concentration measurements were very unstable and unpredictable.

SO_2 EMISSION DATA

Run No.	PCE-1	PCE-2	PCE-3			
Date (1971)	9/21	9/22	9/23			
mg SO_2	8.9	1.8	6.8			
T_m - Average Gas Meter Temperature, ^oF	90	78	83			
P_b - Barometric Pressure, "Hg abs.	30.3	30.3	30.3			
V_m - Volume of dry gas sampled @ meter conditions, $ft.^3$	20.65	41.1	15.0			
ppm SO_2	7.86	0.781	7.91			
Vacuum	8.0	8.0	7.3			
Vstd - Volume of gas sampled at standard conditions	14.83	30.2	11.26			

$$\text{ppm } SO_2 = \frac{0.7332 \times \text{mg } SO_2 \times (T_m + 460)}{P_b \times V_m}$$

Not used as the meter was under vacuum.

PCE-1

$$Vstd = (Vm)\left(\frac{530}{Tm}\right)\left(\frac{Pb - Pm}{29.92}\right)$$

$$= (20.65)\left(\frac{530}{550}\right)\left(\frac{30.3 - 8.0}{29.92}\right)$$

$$= 14.83$$

PCE-1

$$PPM\ SO_2 = \frac{Mg\ SO_2}{Vstd} \times 13.1$$

$$PPM\ SO_2 = \frac{(8.9)(13.1)}{14.83} = 7.86$$

ORSAT RESULTS

Date	Run No.	% CO_2	% O_2
9/21/71	PCE-1	1.6	20.2
9/22/71	PCE-2	2.4	19.8
9/23/71	PCE-3	2.2	19.4

The above results are all for the exhaust location. No Orsat analyses were conducted at the inlet sampling location.

APPENDIX C

COMPLETE OPERATION RESULTS WITH EXAMPLE CALCULATIONS

No operating data was available in time for publication. A technical data sheet is included.

1. Technical Data

1.1 Waste Gases from the Furnace

Waste-gas volume	162,000 scfm	276,000 Nm^3/h
Waste-gas temperature	390 - 625 °F	200 - 330 °C
Waste-gas dust content	0.79 gr/scf	1.8 g/Nm^3
Dust volume	19 lbs/m	500 kg/h

1.2 Waste Gases behind Cooler

Conditioning the waste gas behind the evaporation cooler	248,000 cfm actual	420,000 Bm3/h
Pertinent temperature	194 - 203 °F	90 - 95 °C
Water dew point	104 - 118 °F	40 - 48 °C

1.3 Electrostatic precipitator

Number of electric zones in the gas flow direction	3	
Number of H.T. installation	3	
Secondary voltage	78 kVs	
Secondary power	3 x 1,000 mA arith.	
Clean-gas dust content	0.05 gr/scf	0.114 g/Nm^3

APPENDIX D

FIELD DATA

VELOCITY TRAVERSE FIELD DATA

Plant Airco, South Carolina

Test Preliminary Vel. Traverse

Location Precipitator Exhaust

Date 9/20/71

Operator Baxley and Avery

ck	Point	South ΔP, in.	East H_2O	Stack Temp., °F	Stack Pres., In. Hg	ΔP x (T+460)**	$\sqrt{\Delta P \times (T+460)}$
	1	0.30	0.45	205			
	2	0.35	0.40				
	3	0.35	0.35				
	4	0.30	0.35				
	5	0.35	0.35				
	6	0.35	0.30				
	7	0.35	0.30				
	8	0.35	0.35				
	9	0.40	0.50				
	10	0.50	0.50	205			

Calculation columns, not Field data

ents:

29 (12/67)

RESOURCES RESEARCH, INC.

Personnel Baxley and Avery Entered ______

Checked ______

Conditions, etc. Preliminary Moisture Run.

Airco, South Carolina Date 9/20/71

e Location Precipitator Exhaust

e	Sample Number	Meter # ___ Cu.Ft. Reading	Cu.Ft.(Vm) Difference	Elaps. Min.	(Rm) C.F.M.	(+460=Tm) Temp °F	(Rm) Vacuum"Hg		Thimble Number
05		112.60				85	6		
0		125.80				84	6		
.		138.12				83	5.6		
.		25.52				84	5.9		

GAS METER CONDITIONS Pump # ______

ck/Duct Measurement ______ Estimated Mc- ______ Actual - ______

ck Diameter, inches (D) ______ Estimated Rm(Corrected) ______

ck Area, Ft^2, (A) ______ Calculated Rm(Corrected) ______

al Gas Temp ______ °F Sample Nozzle Dia.,In.(d) ______

[illegible] ______ [illegible] ______ °R % Moisture of Gas ______

metric Pressure,"Hg,(Pb) ______ Avg.Gas Velocity,fpm(Vsx60) ______

ck Static Pressure, In.H_2O ______ + - $Vs=(2.9 \times F_s) \times \sqrt{H} \times \sqrt{T}$ ______

or

2.46

densate.ml (Vw) 4 ml ______

PRECIPITATOR EXHAUST

TRIAL MOISTURE CALCULATIONS

1. Isokinetic Sampling (Dry Gas) (cfm)

$$R_m = .33 \times \frac{T_m}{T_s} \times V_s \times d^2 \times \frac{P_s}{P_b - P_m} \quad : \quad Rm \text{ (corrected)} = Rm \times Mc$$

Estimated Value:

Calculated Value:

2. Water Vapor Volume (cu. ft.)

$$V_v = .00267 \times \frac{V_w \times T_m}{P_b - P_m} \qquad .00267 \times \frac{4 \times 544}{24.4} = .24$$

3. Condensate Correction for Meter Rate

$$M_c = \frac{V_m}{V_m + V_v}$$

4. Moisture in Metered Gas (cu. ft.)

$$M_a = \frac{V.P. \times V_m}{P_b - P_m} \qquad \frac{1.18 \times 25.52}{24.4} = 1.24$$

Percent Moisture (%) Stack Gas

$$\% \text{ Moisture} = \frac{V_v + M_a}{V_v + V_m} \times 100 \qquad \frac{.24 + 1.24}{.24 + 25.52} = \frac{1.48}{25.76} = 5.8 \%$$

Saturated at _____ %

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Airco - Charleston, S.C.

Run No. CS-1

Location Precipitator Exhaust

Date 9-21-71

Operator Boxley and Avery

Sample Box No. 4

Meter Box No. 4

Probe Length 10'

Probe Heater Setting 70

Ambient Temp °F 80

Bar. Press. "Hg 30.3

Assumed Moisture % 5.8

Heater Box Setting, °F 250

Probe Tip Dia., In. 1/4

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
South Port												
	1330	671.70										
1	1340	680.36	0.55	1.90	1.90	90	90	2.0	250	65		220
2	1350	688.00	0.68	2.10	2.10	116	94	2.5	250	65		220
3	1400	695.40	0.63	2.10	2.10	118	94	2.5	250	65		220
4	1410	703.04	0.63	2.10	2.10	118	100	2.5	250	65		218
5	1420	710.05	0.52	1.70	1.70	120	102	2.2	250	70		222
6	1430	716.78	0.45	1.50	1.50	124	104	2.0	250	70		220
7	1440	723.63	0.40	1.35	1.35	124	106	2.0	250	65		218
8	1450	730.00	0.35	1.20	1.20	128	106	2.0	250	65		228
9	1500	734.98	0.35	1.20	1.20	130	108	2.0	250	65		222
10	1510	740.85	0.35	1.20	1.20	134	110	2.0	250	65		228
11	1520	746.25	0.28	0.92	0.92	134	110	2.0	250	75		220
12	1530	751.80	0.28	0.92	0.92	134	110	2.0	250	70		218
13	1540	757.08	0.28	0.92	0.92	134	110	2.0	250	75		218
14	1550	762.33	0.25	0.86	0.86	116	110	2.0	250	75		220
15	1600	767.60	0.25	0.86	0.86	116	110	2.0	250	75		222
16	1610	772.86	0.25	0.86	0.86	116	110	2.0	250	75		220
17	1620	776.50	0.12	0.42	0.42	116	110	1.5	250	75		210
18	1630	779.85	0.08	0.29	0.29	116	110	1.0	250	75		200
[illegible]	[illegible]											
	Pt.	108.15	0.37	1.23	1.23	123	105	2.0	250	70		212

CONTINUED TO NEXT PAGE

Point	Clock Time	Dry Gas Meter, CF	in. H_2O ΔP	in H_2O Desired	in H_2O Actual	°F Inlet	°F Outlet	In Hg Gauge	Temp. °F	Temp °F	Press in. Hg	Temp °F
Start Port	1300	779.85										
1	1310	787.30	0.65	2.20	2.20	94	94	4.0	250	70		218
2	1320	796.85	0.78	2.60	2.60	110	100	4.5	250	75		218
3	1330	804.19	0.78	2.60	2.60	114	102	4.5	250	75		220
4	1340	812.47	0.75	2.50	2.50	114	102	5.0	250	75		220
5	1350	820.30	0.66	2.20	2.20	114	102	5.5	250	75		218
6	1400	826.90	0.50	1.70	1.70	114	102	6.0	250	75		220
7	1410	833.75	0.42	1.40	1.40	113	99	6.0	250	75		225
8	1420	839.48	0.37	1.25	1.25	114	100	6.0	250	75		225
9	1430	845.10	0.40	1.35	1.35	114	100	5.5	250	75		220
10	1440	851.40	0.45	1.50	1.50	112	100	6.0	250	75		225
11	1450	857.85	0.45	1.50	1.50	114	101	6.0	250	70		220
12	1500	864.80	0.50	1.65	1.65	115	102	7.0	250	75		220
13	1510	871.83	0.52	1.70	1.70	115	102	7.0	250	75		220
14	1520	879.10	0.55	1.85	1.85	115	102	7.5	250	75		220
15	1530	886.10	0.50	1.65	1.65	114	101	7.0	250	75		220
16	1540	892.70	0.45	1.50	1.50	112	100	6.5	250	75		205
17	1550	878.60	0.40	1.35	1.35	109	99	5.5	250	75		200
18	1600	904.29	0.40	1.35	1.35	109	98	5.5	250	75		
Average	Total											218
	3 hr.	124.44	0.53	1.77	1.77	113	100	5.84	250	75		
Average	Total South and East Ports											219
36 pts.	6 hr	232.59	0.45	1.48	1.48	118	103	3.9	250	72		

Comments:

NCRP-37 (10/67)

P-5

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Airco - Charleston, S. C.

Run No. [illegible]B-2

Location Precipitator Exhaust

Date 9-22-71

Operator [illegible]kley and Avery

Sample Box No. 4

Meter Box No. 4

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 90

Bar. Press. "Hg 30.3

Assumed Moisture % 5.8

Heater Box Setting, °F 250

Probe Tip Dia., In. 1/4

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
Past Port												
Start	[illegible]00	904.43										
1	[illegible]10	913.59	0.75	2.50	2.50	76	76	4.0	250	60		230
2	[illegible]20	921.66	0.75	2.50	2.50	90	76	4.0	250	60		220
3	[illegible]30	930.10	0.74	2.40	2.40	90	76	4.0	250	70		220
4	[illegible]40	938.59	0.74	2.40	2.40	92	80	4.0	250	75		218
5	[illegible]50	946.59	0.67	2.20	2.20	96	80	3.5	250	75		218
6	[illegible]00	954.58	0.60	2.00	2.00	94	82	3.0	250	70		218
7	[illegible]10	961.73	0.55	1.90	1.90	92	82	3.0	250	65		222
8	[illegible]20	968.46	0.45	1.50	1.50	92	82	2.5	250	65		216
9	[illegible]30	974.66	0.38	1.30	1.30	92	82	2.5	250	65		216
10	[illegible]40	981.12	0.45	1.50	1.50	92	82	2.5	250	65		220
11	[illegible]50	987.95	0.45	1.50	1.50	92	82	2.5	250	65		220
12	[illegible]00	994.95	0.52	1.80	1.80	94	84	3.0	250	65		220
13	[illegible]10	1001.89	0.55	1.85	1.85	94	84	3.5	250	65		220
14	[illegible]20	1002.05	0.52	1.75	1.75	94	84	3.0	250	65		220
15	[illegible]30	1016.50	0.55	1.85	1.85	94	84	3.0	250	65		220
16	[illegible]40	1023.36	0.50	1.70	1.70	96	86	3.0	250	65		212
17	[illegible]50	1029.34	0.40	1.35	1.35	96	86	3.0	250	65		205
18	[illegible]00	1036.19	0.40	1.35	1.35	94	86	3.0	250	65		205
[illegible]	[illegible]0											
		131.76	0.[illegible]	1.85	1.85	92.2	82	3.2	250	66		218.3

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
South Port												
	1210	1036.19										
1	1220	1045.59	0.87	2.9	2.9	82	82	4.0	250	65		217
2	1230	1054.31	0.85	2.8	2.8	98	86	4.0	250	70		215
3	1240	1062.85	0.82	2.6	2.6	102	88	4.0	250	70		210
4	1250		0.70	2.3	2.3	106	90	3.5	250	70		220
5	1300		0.58	1.9	1.9	100	90	4.0	250	70		230
6	1310		0.45	1.5	1.5	98	90	3.0	250	70		210
7	1320		0.42	1.4	1.4	96	90	3.0	250	75		220
8	1330		0.45	1.5	1.4	96	90	3.0	250	75		200
9	1340		0.42	1.4	1.4	96	90	3.0	250	75		210
10	1350		0.42	1.4	1.4	96	90	3.0	250	75		220
11	1400	1115.90	0.42	1.4	1.4	95	89	3.0	250	75		220
12	1410	1122.27	0.42	1.4	1.4	95	89	3.0	250	75		220
13	1420	1128.40	0.42	1.4	1.4	97	90	3.0	250	75		220
14	1430	1134.25	0.42	1.4	1.4	97	90	3.0	250	75		220
15	1440	1141.00	0.42	1.4	1.4	97	90	3.0	250	75		220
16	1450	1147.10	0.42	1.4	1.4	97	90	3.0	250	75		210
17	1500	1152.87	0.38	1.28	1.28	96	90	3.0	250	75		210
18	1510	1158.58	0.38	1.28	1.28	96	90	3.0	250	75		210
Average	Total											
		122.39	0.514	1.7	1.7	96.7	89.1	3.25	250	73		216.2
Average	Total East and South Port											
36 pts.	6 hrs.	254.15	0.534	1.78	1.78	95	86	3.2	250	70		217

Comments:

NCAP-37 (1-87)

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant [illegible]co - Charleston, S. C.

Run No. [illegible]L-3

Location [illegible]ecipitator Exhaust

Date [illegible]-23-71

Operator [illegible]exlay and Avery

Sample Box No. 4

Meter Box No. 4

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 80

Bar. Press. "Hg 30.3

Assumed Moisture % 5.8

Heater Box Setting, °F 250

Probe Tip Dia., In. 1/4

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
[illegible]uth Port												
	[illegible]50	161.30										
1	[illegible]00	169.83	0.86	2.80	2.80	80	74	4.0	250	70		216
2	[illegible]10	178.28	0.88	2.90	2.90	98	78	4.5	250	70		218
3	[illegible]20	188.36	0.90	2.95	2.95	106	80	5.0	250	70		218
4	[illegible]30	197.45	0.82	2.70	2.70	110	84	5.0	250	70		218
5	[illegible]40	205.90	0.72	2.40	2.40	106	86	5.4	250	70		218
6	[illegible]50	213.80	0.66	2.20	2.20	102	84	4.0	250	70		218
7	[illegible]00	221.12	0.58	1.85	1.85	102	86	3.5	250	65		218
8	[illegible]010	228.35	0.52	1.75	1.75	102	86	3.5	250	65		218
9	[illegible]020	235.40	0.46	1.55	1.55	104	88	3.5	250	70		220
10	[illegible]030	242.20	0.52	1.75	1.75	104	88	4.0	250	70		218
11	[illegible]040	248.97	0.46	1.55	1.55	100	90	4.0	250	70		216
12	[illegible]050	254.90	0.42	1.40	1.40	100	90	3.5	250	70		216
13	[illegible]00	262.03	0.42	1.40	1.40	102	88	3.5	250	65		218
14	[illegible]10	268.52	0.42	1.40	1.40	102	88	3.5	250	65		210
15	[illegible]20	275.06	0.42	1.40	1.40	102	90	3.5	250	65		220
16	[illegible]30	281.56	0.42	1.40	1.40	104	92	3.5	250	65		216
17	[illegible]40	288.12	0.40	1.35	1.35	104	92	3.5	250	65		206
[illegible]	[illegible]50	296.90	0.35	1.20	1.20	104	92	3.0	250	65		216
[illegible]	[illegible]											
[illegible]	[illegible].	125.60	0.57	1.89	1.89	101.8	86.4	3.7	250	67		216.6

CONTINUED TO NEXT PAGE

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
East Port	1220	296.90										
1	1230	303.00	0.45	1.5	1.5	84	84	3.0	250	75		210
2	1240	310.99	0.65	2.2	2.2	96	86	5.0	250	75		210
3	1250	318.85	0.65	2.2	2.2	100	86	5.0	250	75		225
4	1300	326.00	0.60	2.0	2.0	101	88	4.5	250	80		215
5	1310	333.20	0.54	1.8	1.8	101	88	4.0	250	75		215
6	1320		0.51	1.7	1.7	100	90	4.0	250	75		215
7	1330		0.42	1.4	1.4	100	90	4.0	250	75		215
8	1340		0.44	1.45	1.45	100	92	4.5	250	75		215
9	1350		0.44	1.45	1.45	100	90	5.0	250	75		215
10	1400		0.42	1.60	1.60	98	90	5.0	250	75		210
11	1410		0.52	1.70	1.70	98	90	5.5	250	75		220
12	1420		0.52	1.70	1.70	98	90	5.5	250	75		220
13	1430	386.20	0.52	1.7	1.7	100	90	5.5	250	75		220
14	1440	393.50	0.55	1.8	1.8	100	90	5.5	250	75		230
15	1450	400.70	0.55	1.8	1.8	102	90	5.5	250	75		205
16	1500	407.30	0.50	1.6	1.6	99	89	5.0	250	75		205
17	1510	413.86	0.46	1.5	1.5	100	90	4.5	250	75		200
18	1520	419.98	0.40	1.3	1.3	98	89	4.5	250	75		200
Average of [illegible]												
18 pts.	hrs.	123.08	0.51	1.69	1.69	98.6	89	4.75	250	75		213.6
Average of Total South and East Port-												
36 pts.	6 hrs.	258.68	0.54	1.79	1.79	100	88	4.2	250	71		215

Comments:

NCAP-37 (7 87)

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Airco - Charleston, S.C.

Run No. ECD-1

Location 14 Furnace Inlet

Date 9-21-71

Operator Gonzalez and Patchell

Sample Box No. 3

Meter Box No. 3

Probe Length 10+ ft.

Probe Heater Setting 60

Ambient Temp °F 124

Bar. Press. "Hg 30.3

Assumed Moisture % 3.0

Heater Box Setting, °F 250

Probe Tip Dia., In. 1/4

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
	1410	620.44										
A-3	1414		0.20	0.56	0.56	116	116	2	250	100		380
A-4	1418		0.15	0.43	0.43	122	118	2	250	90		390
A-3	1422		0.13	0.37	0.37	122	118	2	250	90		420
A-2	1426		0.14	0.40	0.40	124	118	2	250	90		480
A-1	1430	628.55	0.14	0.40	0.40	128	124	2	250	90		450
	1433											
B-5	1437		0.10	0.28	0.28	130	120	2	250	90		400
B-4	1441		0.09	0.26	0.26	130	120	2	250	90		450
B-3	1445		0.08	0.25	0.25	132	122	2	250	90		440
B-2	1449		0.09	0.26	0.26	132	124	2	250	90		520
B-1	1453	634.97	0.09	0.26	0.26	134	126	2	250	90		470
C-5	1457		0.04	0.10	0.10	134	126	1.5	250	90		420
C-4	1501		0.04	0.10	0.10	134	126	1.5	250	90		410
C-3	1505		0.04	0.10	0.10	134	126	1.5	250	90		470
C-2	1509		0.05	0.12	0.12	134	126	1.5	250	90		470
C-1	1513	639.54	0.05	0.12	0.12	134	126	1.5	250	90		470
				CONTINUED TO NEXT PAGE								

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
D-5	-											
D-4	-		0.00									
D-3	1532		0.00									
D-2	1536		0.02	0.05	0.05	130	124	0.5	250	90		400
D-1	1540		0.04	0.11	0.11	130	124	1.0	250	90		410
	1552	642.53	0.04	0.11	0.11	130	124	1.0	250	90		400
E-5		-	0.00						250			-
E-4			0.00									-
E-3	1610		0.00			130	124	2.0	250			-
E-2	1620		0.02	0.05	0.05	130	126	2.0	250	100		350
E-1	1630	645.65	0.05	0.12	0.12	130	126	2.5	250	100		420
Average	Total											
25 pts.	80 min.	25.21	0.07	0.20	0.20	130	123	1.7	250	92		432

Comments:

NCMP-37[illegible]/87

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Alcoa - Charleston, S. C.

Run No. [illegible]-2

Location [illegible]4 Furnace Inlet

Date 9-[illegible]-71

Operator [illegible]onzalez and Brown

Sample Box No. 3

Meter Box No. 3

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 120

Bar. Press. "Hg 30.3

Assumed Moisture % 3.0

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/8

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
	[illegible]03	645.65										
E-5	[illegible]07		0.02	0.28	0.28	108	108	1.0	250	95		400
E-4	[illegible]11		0.02	0.28	0.28	110	110	1.0	250	90		380
E-3	[illegible]15		0.03	0.42	0.42	114	112	1.0	250	85		400
E-2	[illegible]19		0.03	1.1	1.1	122	118	1.5	250	85		460
E-1	[illegible]23	653.36	0.03	1.1	1.1	122	120	1.5	250	85		470
	[illegible]33											
D-5	[illegible]42		0.02	0.28	0.28	124	118	1.5	250	85		470
D-4	[illegible]46		0.02	0.28	0.29	124	116	1.5	250	85		440
D-3	[illegible]50		0.03	0.42	0.42	124	116	2.0	250	85		470
D-2	[illegible]54		0.03	0.42	0.42	124	116	2.0	250	85		470
D-1	[illegible]58	660.94	0.05	0.80	0.80	124	120	2.0	250	85		460
	[illegible]02											
C-5	[illegible]06		0.06	0.80	0.80	126	124	2.0	250	85		530
C-4	[illegible]10		0.06	0.80	0.80	124	120	2.5	250	85		470
C-3	[illegible]14		0.06	0.80	0.80	124	120	2.5	250	85		470
C-2	[illegible]18		0.06	0.80	0.80	128	122	2.5	250	85		530
C-1	[illegible]22	671.73	0.07	0.95	0.95	128	122	4.0	250	85		

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Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
	[illegible]020											
B-5	[illegible]24		0.16	2.0	2.0	128	126	5.0	250	85		600
B-4	[illegible]028		0.12	1.6	1.6	128	126	5.5	250	85		400
B-3	[illegible]32		0.09	1.2	1.2	128	126	6.0	250	85		550
B-2	[illegible]		0.09	1.2	1.2	128	126	6.0	250	85		450
B-1	[illegible]	685.17	0.08	1.1	1.1	128	126	6.0	250	85		430
	[illegible]											
A-5	[illegible]		0.22	2.8	2.8	126	124	6.0	250	85		430
A-4	[illegible]2		0.21	2.7	2.7	126	124	14.0	250	85		440
A-3	[illegible]6		0.15	1.8	1.8	128	126	14.0	250	85		440
A-2	[illegible]		0.13	1.75	1.75	128	126	9.0	250	85		450
A-1	[illegible]4	701.90	0.20	2.6	2.6	128	126	15.0	250	85		460
Average of Total												
25 pts.	[illegible] min.	56.25	0.086	1.13	1.13	124	121	4.6	250	85		463

Comments:

NCAP-37 ([illegible] 7)

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Airco - Charleston, S. C.

Run No. BCD-3

Location #14 Furnace Inlet

Date 9-13-71

Operator Gonzalez and Brown

Sample Box No. 3

Meter Box No. 3

Probe Length 10 ft.

Probe Heater Setting 60

Ambient Temp °F 125

Bar. Press. "Hg 30.3

Assumed Moisture % 3.0

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/8

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
	0942	716.29										
E-5	0946		0.02	0.29	0.29	114	114	1.5	250	85		350
E-4	0950		0.02	0.29	0.29	116	116	1.5	250	90		430
E-3	0954		0.02	0.29	0.29	118	118	1.5	250	90		430
E-2	0958		0.03	0.42	0.42	122	118	2.6	250	90		480
E-1	1002	722.31	0.03	0.42	0.42	122	118	2.0	250	90		470
	1005											
D-5	1009		0.04	0.55	0.55	122	118	2.0	250	90		440
D-4	1013		0.03	0.42	0.42	122	120	2.0	250	90		440
D-3	1017		0.02	0.29	0.29	122	120	2.0	250	90		480
D-2	1021		0.03	0.42	0.42	126	122	2.5	250	90		540
D-1	1025	730.35	0.05	0.67	0.67	128	124	3.0	250	90		550
	1029											
C-5	1033		0.10	1.32	1.32	130	122	5.5	250	90		420
C-4	1037		0.06	0.80	0.80	130	124	7.0	250	90		390
C-3	1041		0.06	0.80	0.80	130	124	7.0	250	90		440
C-2	1045		0.05	0.67	0.68	130	124	6.0	250	85		460
C-1	1049	744.37	0.05	0.67	0.68	132	126	6.0	250	85		470

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Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
	1032											
B-5	1036		0.22	2.8	2.8	136	124	15.0	250	85		460
B-4	1040		0.14	1.75	1.75	138	126	10.0	250	85		430
B-3	1047		0.14	1.75	1.75	138	126	10.0	250	85		420
B-2	1106		0.10	1.35	1.35	146	128	9.5	250	90		550
B-1	1112	756.20	0.10	1.35	1.35	148	128	10.5	250	90		570
	1115											
A-5	1119		0.20	2.6	2.6	146	130	20.5	250	90		460
A-4	1123		0.20	2.6	2.6	146	132	22.0	250	85		420
A-3	1127		0.14	1.75	1.75	156	132	20.0	250	90		460
A-2	1131		0.12	1.60	1.60	160	134	16.0	250	90		520
A-1	1135	773.67	0.16	2.00	2.00	160	134	22.0	250	90		560
Average	Total											
25 psig	40 min.	57.38	0.085	1.11	1.11	134	124	7.9	250	88		464

Comments:

NCAP-37 (67)

VELOCITY TRAVERSE FIELD DATA

Plant Airco, South Carolina

Test Preliminary

Location West Inlet Duct

Date 9/20/71

Operator Eggleston

lock ime	Point	ΔP, in. H_2O	Stack Temp., °F	Stack Pres., In. Hg	ΔP x (T+460)**	$\sqrt{\Delta P \times (T+460)}$**
	A-1	0.03	440	+0.20		
	A-2	0.04	490	+0.20		
	A-3	0.03	500	+0.20		
	A-4	0.05	460	+0.20		
	A-5	0.07	500	+0.20		
	A-6	0.06	520	+0.20		
	B-1	0.05	490	+0.20		
	B-2	0.07	500	+0.20		
	B-3	0.06	530	+0.20		
	B-4	0.05	550	+0.20		
	B-5	0.04	550	+0.20		
	B-6	0.05	550	+0.20		

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** - Calculation columns, not Field data

Remarks:

AP-29 (12/67)

VELOCITY TRAVERSE FIELD DATA

CONTINUED

Plant Airco, South Carolina

Test Preliminary

Location West Inlet Duct

Date 9/20/71

Operator Eggleston

Clock Time	Point	ΔP, in. H_2O	Stack Temp., °F	Stack Pres., In. Hg	ΔP x (T+460)**	$\sqrt{\Delta P \times (T+460)}$**
	C-1	0.05	450	+0.20		
	C-2	0.05	460	+0.20		
	C-3	0.05	490	+0.20		
	C-4	0.06	510	+0.20		
	C-5	0.05	520	+0.20		
	C-6	0.05	520	+0.20		
Avg.		0.055	510			

** - Calculation columns, not Field data

CAP-29 (12/67)

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Condensate + 14 ml

Plant Alcoa, Charleston, S.C.

Run No. WCD-1

Location West Inlet Duct

Date 9/21/71

Operator Charleston

Sample Box No. 2

Meter Box No. 2

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 120

Bar. Press. "Hg 30.3

Assumed Moisture % 2

Heater Box Setting, °F 250

Probe Tip Dia., In. .25

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
Start	1416	956.015				120	120		250	120	Nil	
A-1	1421	956.95	0.03	0.08	0.08	124	124	1	250	115	Nil	440
A-2	1426	957.97	0.04	0.10	0.10	122	126	1	250	110	Nil	480
A-3	1431	959.10	0.03	0.08	0.08	122	128	1	250	110	Nil	400
A-4	1436	959.84	0.04	0.10	0.10	124	130	1	250	110	Nil	450
A-5	1441	960.80	0.04	0.10	0.10	126	130	1	250	110	Nil	410
Start	1443											
B-1	1448	962.13	0.06	0.16	0.16	126	130	1.5	250	110	Nil	460
B-2	1453	963.39	0.05	0.12	0.12	126	130	1.5	250	100	Nil	440
B-3	1458	964.42	0.06	0.16	0.16	130	134	1.5	250	105	Nil	430
B-4	1503	965.68	0.09	0.24	0.24	130	134	1.5	250	100	Nil	420
B-5	1508	967.25	0.09	0.24	0.24	130	134	1.5	250	100	Nil	480
Start	1514											
C-1	1518	968.60	0.09	0.24	0.26	130	130	2	250	110	Nil	490
C-2	1522	970.28	0.09	0.24	0.26	130	130	2	250	110	Nil	540
C-3	1526	971.43	0.09	0.24	0.26	130	130	2	250	110	Nil	530
C-4	1530	972.41	0.09	0.24	0.26	130	130	2	250	110	Nil	500
C-5	1534	973.70	0.09	0.24	0.26	130	132	2	250	110	Nil	500
				CONTINUED TO NEXT PAGE								

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
Start	1341											
D-1	1344	974.65	0.09	0.24	0.24	132	134	2	250	120	Nil	500
D-2	1347	975.79	0.10	0.26	0.26	132	134	2	250	120	Nil	500
D-3	1350	976.60	0.10	0.25	0.25	132	136	2	250	110	Nil	470
D-4	1353	977.59	0.13	0.34	0.34	132	136	2	250	110	Nil	480
D-5	1356	978.425	0.13	0.34	0.34	132	136	2	250	110	Nil	460
Start	1605											
E-1	1608	979.60	0.12	0.32	0.32	132	136	2.5	250	110	Nil	600
E-2	1611	981.00	0.12	0.32	0.32	132	136	2.5	250	110	Nil	570
E-3	1614	981.95	0.12	0.32	0.32	132	136	2.5	250	100	Nil	520
E-4	1617	982.85	0.12	0.32	0.32	132	136	2.5	250	100	Nil	540
E-5	1620	983.81	0.12	0.32	0.32	132	136	2.5	250	100	Nil	530
Average	Total											
25 pt	100 min.	27.795	0.08	0.22	0.23	129	132	1.8	250	108	Nil	492

Comments:

NCAP-37 (2/67)

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Airco - Charleston, S. C.

Run No. MCD-2

Location #4 Furnace Inlet

Date 9-22-71

Operator Eggleston

Sample Box No. 2

Meter Box No. 2

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 120

Bar. Press. "Hg 30.3

Assumed Moisture % 2

Heater Box Setting, °F 250

Probe Tip Dia., In. .375

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
E-1	0904	983.86	0.06	0.84	0.84	108	108	2.		100		520
E-2	[illegible]	986.65	0.06	0.84	0.84	108	108	2.		90		500
E-3	[illegible]	988.64	0.07	1.0	1.0	108	108	2.5		90		490
E-4	[illegible]	990.70	0.07	1.0	1.0	108	108	2.5		85		460
E-5	[illegible]	992.78	0.10	1.4	1.4	108	108	3.0		80		470
Stop	[illegible]	995.2	0.10	1.4	1.4	108	108	3.0		80		470
Start D-1	[illegible]	995.2	0.06	0.84	0.84	112	112	3.0		80		425
D-2	[illegible]	997.82	0.06	0.84	0.84	114	116	3.0		80		450
D-3	[illegible]	999.865	0.07	1.0	1.0	114	116	3.2		80		460
D-4	0942	1002.29	0.07	1.0	1.0	116	118	3.2		85		420
D-5	0946	1004.65	0.09	1.3	1.3	118	120	3.5		80		440
Stop	0950	1006.81	0.09	1.3	1.3	118	120	3.5		80		430
Start C-1	[illegible]	1006.81	0.13	1.8	1.8	118	120	4.5		80		400
C-2	[illegible]	1010.78	0.06	0.84	0.84	120	122	3.5		80		415
C-3	[illegible]	1013.15	0.04	0.55	0.55	122	124	3.0		80		420
C-4	[illegible]	1015.02	0.05	0.7	0.7	122	124	3.0		80		420
C-5	[illegible]	1016.82	0.05	0.7	0.7	122	124	3.0		85		460
Stop	[illegible]	1018.69	0.05	0.7	0.7	122	124	3.0		85		460

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Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
Start B-1	1020	1018.89	0.07	1.0	1.0	120	124	4.0		90		410
B-2	1024	1021.07	0.07	1.0	1.0	120	124	4.0		85		450
B-3	1028	1023.50	0.07	1.0	1.0	120	124	4.4		85		480
B-4	1032	1025.69	0.08	1.2	1.2	122	124	4.6		85		520
B-5	1036	1028.19	0.07	1.0	1.0	118	122	4.8		85		450
Stop	1040	1030.365	0.07	1.0	1.0	116	120	4.8		85		460
Start A-1	1044	1030.365	0.04	0.6	0.6	116	120	3.5		100		500
A-2	1048	1032.25	0.03	0.46	0.46	116	120	3.2		105		500
A-3	1050	1032.87	0.05	0.74	0.74	116	120	4.2		100		500
A-4	1052	1034.44	0.05	0.74	0.74	116	120	4.4		95		500
A-5	1056	1036.32	0.06	0.8	0.8	118	122	5.0		90		600
A-6	1100	1033.22	0.05	0.65	0.65	118	122	4.5		90		220
Stop	1104	1040.00	0.05	0.65	0.64	118	122	4.5		90		600
Average	Total											
25 ft	60 min.	56.14	0.066	0.93	0.93	116	118	3.6	250	86		475

Comments:

NCAP-37 (1/67)

Read and record at the start of each test point or, if single point sampling, read and record every 5 minutes.

Plant Alco - Charleston, S. C.

Run No. MCD-3

Location #14 Furnace Inlet

Date 9-23-71

Operator Eggleston

Sample Box No. 2

Meter Box No. 2

Probe Length 10'

Probe Heater Setting 60

Ambient Temp °F 120

Bar. Press. "Hg 30.3

Assumed Moisture % 2

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/8

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
E-1	0941	58.035	0.09	1.2	1.2	104	106	2.2	250	120		410
E-2	0945	60.60	0.08	1.1	1.1	106	108	2.2	250	110		430
E-3	0949	62.81	0.09	1.2	1.2	108	110	2.2	250	100		450
E-4	0953	65.10	0.11	1.5	1.5	110	114	3.0	250	100		480
E-5	0957	67.88	0.12	1.6	1.6	112	120	3.5	250	100		480
Stop	1001	70.55	0.12	1.6	1.6	114	122	3.5	250	100		480
Start D-1	1005	70.55	0.07	0.95	0.95	112	124	3.0	250	95		420
D-2	1009	72.99	0.09	1.2	1.2	112	126	3.5	250	95		450
D-3	1013	75.48	0.08	1.1	1.1	112	126	3.5	250	90		400
D-4	1017	77.59	0.08	1.1	1.1	114	126	3.5	250	90		420
D-5	1021	80.1	0.11	1.5	1.5	114	126	4.0	250	90		420
Stop	1025	83.425	0.11	1.5	1.5	114	126	4.0	250	90		420
Start C-1	1029	83.425	0.09	1.2	1.2	116	128	4.0	250	90		390
C-2	1033	86.25	0.08	1.1	1.1	116	128	4.0	250	90		410
C-3	1037	88.62	0.09	1.2	1.2	116	128	4.0	250	85		440
C-4	1041	90.83	0.07	0.95	0.95	118	128	3.8	250	85		400
C-5	1045	93.34	0.06	0.82	0.82	120	132	3.8	250	85		410
Stop	1049	93.36	0.06	0.82	0.82	120	132	3.8	250	85		410
Start B-1	1053	95.36	0.08	1.1	1.1	120	132	4.5	250	85		450
B-2	1057	97.79	0.09	1.2	1.2	120	132	4.5	250	85		450
B-3	1101	100.16	0.10	1.4	1.4	120	130	5.2	250	85		450
B-4	1105	102.74	0.09	1.2	1.2	120	132	5.0	250	85		430
B-5	1109	105.26	0.09	1.2	1.2	120	132	5.0	250	85		420
Stop	1113	107.97	0.09	1.2	1.2	120	132	5.5	250	85		420

Point	Clock Time	Dry Gas Meter, CF	Pitot in. H_2O ΔP	Orifice ΔH in H_2O		Dry Gas Temp. °F		Pump Vacuum In. Hg Gauge	Box Temp. °F	Impinger Temp °F	Stack Press in. Hg	Stack Temp °F
				Desired	Actual	Inlet	Outlet					
Start A-	1115	107.57	0.07	0.95	0.95	116	124	4.5	250	85		430
A-	1119	110.00	0.06	0.82	0.82	114	120	4.5	250	85		400
A-	1123	112.11	0.06	0.82	0.82	110	120	4.6	250	85		420
A-	1127	114.23	0.05	0.68	0.68	110	120	4.2	250	85		410
A-	1131	116.10	0.04	0.55	0.55	110	120	3.8	250	85		420
Stop	1135	117.80	0.04	0.55	0.55	110	120	3.8	250	85		430
Average	Total											
25 pts.	100 min	59.765	0.082	1.11	1.11	114	124	3.9	250	90		429

Comments:

NCAP-37 (1 67)

RESOURCES RESEARCH, INC.

Personnel Gonzalez and Eggleston Entered

Checked

Plant Conditions, etc. Metals Runs

Plant Airco, South Carolina Date 9/22/71

Sample Location Inlet Ducts

Time	Sample Number	Meter # GAS METER CONDITIONS Pump # Cu.Ft. Reading	Cu.Ft.(Vm) Difference	Elaps. Min.	(Rm) C.F.M.	(+460=Tm) Temp °F	(Pm) Vacuum"Hg	Stack Temp.	Thimble Number
1450	ECD	702.96						470	
1455						116	14	470	
1500						122	18	470	
1507		714.88				126	24	470	
1443	WCD	40.00				120	8.5	470	
1447		43.70				121	15.	470	
1451		46.70				122	22.	470	
1452		48.40				125	23.	470	
1455		50.50				126	23.	470	
1459		53.80				129	24.	470	
1503		56.49				129	25.	470	

RESOURCES RESEARCH, INC.

Personnel Avery Entered

Checked

ant Conditions, etc. SO_2 - PCE - 1,2,3

ant Airco, Charleston, S. C. Date 9-21 - 9-23

mple Location PCE (Precipitator Exhaust)

Time	Sample Number	Meter # GAS METER CONDITIONS Pump # Cu.Ft. Reading	Cu.Ft.(Vm) Difference	Elaps. Min.	(Rm) C.F.M.	(+460=Tm) Temp °F	(Pa) Vacuum"Hg	Pb	Thimble Number
1121	PCE-1	140.00				90	8.0	30.3	
1142		147.00				90	8.0	30.3	
1200		153.00				90	8.0	30.3	
1221		160.65				90	8.0	30.3	
Avg.		20.65							
1026	PCE-2	180.50				75	8.0	30.3	
1053		199.00				78	8.0	30.3	
1126		221.60				82	8.0	30.3	
Avg.		41.10				78	8.0	30.3	
1030	PCE-3	247.60				81	8.0	30.3	
1100		255.90				84	8.0	30.3	
1130		262.60				84	6.0	30.3	
Avg.		15.00				83	7.3	30.3	

ORSAT FIELD DATA

Location Precipitator Exhaust Comments:

Date 9/21/73

Time During particulate run.

Operator Gonzalez

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
PCE 1-A	1.6	21.8	Nil
PCE 1-B	1.6	21.8	Nil
Avg.	1.6	21.8	Nil
	1.6%	20.2%	Nil

NCAP-31 (12/67)

ORSAT FIELD DATA

Location Precipitator Exhaust

Date 9/22/71

Time During particulate run.

Operator Gonzalez

Comments:

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
PCE 2-A	2.4	22.2	Nil
PCE 2-B	2.4	22.2	Nil
Avg.	2.4	22.2	Nil
	2.4%	19.8%	Nil

ORSAT FIELD DATA

Location Precipitator Exhaust Comments:

Date 9/23/71

Time During particulate run.

Operator Gonzalez

Test	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
PCE 3-A	2.2	21.6	Nil
PCE 3-B	2.2	21.6	Nil
Avg.	2.2	21.6	Nil

APPENDIX E

STANDARD SAMPLING PROCEDURES

APPENDIX E-1

STANDARD SAMPLING PROCEDURES

PARTICULATE SAMPLING

With an unstable plant operation a trial run is often conducted. If the trial turns out to be satisfactory it may be considered a part of the final testing. Preliminary data is obtained for gas velocity, temperature, moisture content and other variables which might affect the isokinetic sampling rate. Each sample port traverse is divided into a number of equal areas for each location. Each test run is designed to obtain simultaneous samples at each location, for such a period of time that plant operation will be representative, and that sufficient material will have been obtained for accurate analysis.

Particulate samples are obtained using the equipment and test procedures as stipulated in "Sample Collection Procedures," published by OAP. The sampling train is basically the same as that designed by the Control Development Program of OAP (formerly the Air Pollution Control Office), "Gas Stack Sampling Improved and Simplified with New Equipment," and described in Paper No. 67-119, presented at the Air Pollution Control Association meeting at Cleveland, Ohio, in June, 1967.

The above sample equipment is referred to in this report as the EPA train. It is essentially the same as that recently described in Federal Register, Volume 36, Number 159, August 17, 1971, Part II as Test Method 5. Its operation, briefly, is as follows:

Sample gases are drawn into an all-glass sampling train through a button-hook stainless steel nozzle with the proper diameter for isokinetic sampling. A pyrex glass probe is fitted inside the stainless steel sheath with a probe heating element. The glass probe is connected to a glass cyclone with an Erlenmeyer flask to collect the solids from the cyclone. The sampled gases flow from the cyclone through a tared MSA 1106 BH glass fiber filter. This filter, and the cyclone assembly, are enclosed in a heated box which is maintained near 250°F. The filter holder is connected to an impinger train consisting of four Greenburg-Smith impingers with the high velocity tip removed from the first impinger. The second impinger is used with the tip while the third and fourth impingers are modified as the first. These first two impingers each contain a measured volume (100 ml) of distilled, deionized water, while the third impinger is used dry, and the fourth impinger contains approximately 175 grams of silica gel. A sampling train exit is connected, in line, to a vacuum gauge, a leakless vacuum pump, a dry gas meter, and a calibrated orifice. This calibrated orifice differential is measured with an inclined-vertical manometer. Velocity variations at the sampling point are constantly monitored by a pitot tube attached to the probe sheath. Prior to each test, the sampling train, with probe and nozzle attached, is leak tested.

Isokinetic sampling is maintained by appropriate adjustment of the sampling rate, as indicated by the pressure drop across the orifice following the dry gas meter. The necessary orifice pressure differential is

determined by using the nomographs presented in APCA Paper No. 67-119. This nomograph relates stack gas velocity, temperature, and moisture content to the flow rate required for isokinetic sampling.

The ASME train, run in parallel with the EPA train, consists of a stainless steel filter holder containing a pre-weighed alundum filter. Its operation, briefly, is as follows:

Sample gases are drawn through a stainless steel nozzle and filter holder, placed within the stack, into a set of water filled Greenburg-Smith impingers. Isokinetic sampling rates are not determined during the test but are precalculated from initial pitot and temperature readings. Only the material collected by the alundum filter is normally considered as particulate. No ASME train was employed during this survey.

SULFUR DIOXIDE SAMPLING

Sulfur dioxide emission tests are normally conducted at the same location as the exhaust particulate tests. Sample gas is drawn through a glass wool filter into an electrically heated glass probe, followed by a coarse frit midget impinger and a second glass wool filter. The filter leads to three midget impingers in an ice bath, followed in turn by a silica gel tube drier, vacuum gauge, dry gas meter and vacuum pump.

The midget bubbler contains 15 milliliters of 80 percent isopropyl alcohol. The first two impingers contain 15 milliliters of three percent hydrogen peroxide solution and the third is operated dry. Equipment is leak tested before each run. The three percent hydrogen peroxide is prepared the day of the test by dilluting 10 milliliters of 30 percent reagent grade hydrogen peroxide with 90 milliliters of distilled water.

Temperatures, vacuum and gas meter readings are taken and tabulated in order to calculate standard volumes. After sampling, the train is purged with clean air in order to carry over any SO_2 trapped in the isopropyl alcohol.

NITROGEN OXIDES SAMPLING (Not Conducted In This Survey).

Nitrogen oxides sampling is normally carried out at the same exhaust location as the sulfur dioxide and particulate tests. The sample gas is pulled through a glass wool filter and a glass probe into an evacuated two-liter flask containing dilute sulfuric acid-hydrogen peroxide solution. This is prepared according to EPA directions for nitrogen oxides sampling. The flask is fitted with a three-way stopcock and a pump is employed to evacuate the flask and purge the probe lines. Vacuum present in the flask is measured by a vacuum gauge and the sampling train is leak tested by pulling a vacuum of 27 inches Hg and observing the pressure gauge. Initial and final readings of pressure, flask temperature and atmospheric pressure are recorded after the probe is purged. After collecting the sample the flask is sealed and shaken for 5 minutes, then allowed to stand overnight, before being washed into sample containers for transfer to the laboratory.

ORSAT SAMPLING

An integrated gas sample is obtained with a mylar bag and a peristaltic pump with adjustable flow rate. The gases are filtered and cooled prior to reaching an all plastic and glass flow meter where the sampling rate is monitored. Gas samples are taken during the same period during which velocities, temperatures, and particulate samples are obtained. Analyses are performed at the site immediately after each sample is collected.

APPENDIX E.2

CLEANUP AND ANALYTICAL PROCEDURES

CLEANUP (EPA PARTICULATE TRAIN)

Probe, Nozzle, Cyclone, and Front Half of Filter Holder

The nozzle, probe, cyclone, flask, and front half of the filter holder are washed with reagent grade acetone, the washings collected in a container and transported to the laboratory for analysis. A brush and/or rubber policeman is used with the acetone to remove any particles adhering to the cyclone walls or the flask. The reagent acetone used for washing is tested to determine the blank or residue upon evaporation.

Filter

The tared circular MSA type 1106BH filter paper is carefully removed from the fritted glass support and transferred to a glass petri dish for later weighing.

Impingers

Water in the first three impingers (the original water plus the condensate) is measured, then emptied into a polyethylene container. The impingers are then water washed and the washings combined with the condensate and original water.

Acetone Train Wash

The rear half of the filter holder, including the fritted glass support, the impingers, and impinger connections up to but excluding the

fourth impinger, are washed with acetone. These washings are collected in a polyethylene (since changed to glass) bottle and sealed for later analysis.

Silica Gel

Silica gel is transferred (dry) from the fourth impinger to an air-tight container and sealed. The impinger is then washed with acetone, the acetone being discarded because it contains fine silica gel particles.

CLEANUP (SO_2 TRAIN)

The impinger containing 80 percent isopropyl alcohol is discarded and the impingers containing three percent hydrogen peroxide are saved. These latter impingers contain SO_2 gas in the form of H_2SO_4. A glass jar is used as a sample container for transportation to the laboratory.

CLEANUP (NO_x TRAIN)

After storage overnight and shaking for another two minutes the contents are rinsed into glass containers for shipment to the laboratory.

ANALYTICAL PROCEDURES (EPA PARTICULATE TRAIN)

Acetone Washings

The acetone washings from the nozzle, probe, cyclone, flask, and filter front; from the fritted glass, filter back and impinger train; are analyzed separately by evaporation and drying at ambient temperatures.

Filter Particulate

The filter and particulate collected thereon are dried for 24 hours in a desiccator at ambient temperature and weighed. Tare weight of the filter is then deducted.

Impinger Water

Water collected in the impingers, along with the water washings of the impingers, is extracted with ether and chloroform. The extracts are transferred to a tared dish and evaporated to dryness at room temperature. After extraction, the remaining water and solvent are evaporated to dryness on a steam bath and this additional net weight is added to the total weight of particulate matter.

SPECIAL NOTE

All samples are now dried in 250 ml beakers to a constant weight.

ANALYSIS (ORSAT MEASUREMENTS)

Orsat measurements for determination of carbon dioxide, oxygen and carbon monoxide are made using a Burrell Industrial Gas Analyzer or equivalent.

ANALYSIS (SO_2 TRAIN)

SO_2 samples are analyzed by the modified Shell Development method. Barium perchlorate is used instead of barium chloride (as in the new EPA source testing Method 6) because of the sharper titration end point obtainable with the former reagent.

ANALYSIS (NO_x TRAIN)

Samples are analyzed by the standard phenoldisulfonic acid method. This is now incorporated in the new EPA source testing Method 7.

APPENDIX F

LABORATORY REPORT

Acetone Before Wt. | Total Wt.

MPLES Airco RM Charleston SC

CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Acetone Blank	MG in ALIQ.			Total Wt.
	PCE-1	88.6077 88.3212 0.2865	300 ml	88.6077 88.3212 0.2865			-	0.2873 0.0060 0.2813	0.2813
	PCE-2	83.6675 83.5457 0.1218	250 ml	83.6675 83.5457 0.1218			-	0.1218 0.0050 0.1168	0.1168
	PCE-3	89.3631 89.2516 0.1115	190 ml	89.3631 89.2516 0.1115	89.3631 89.2541 0.1090	89.3631 89.2516 0.1115	-	0.1069 0.0038 0.1031	0.1031
	WCD-1								
	WCD-2	92.5308 91.5379 0.9929	165 ml	92.5308 91.5379 0.9929			-	0.9929 0.0033 0.9896	0.9896
	WCD-3	93.9633 92.6280 1.3353	165 ml	93.9633 92.6280 1.3402	93.9633 92.6280 1.3353		-	1.3357 0.0033 1.3324	1.3324
	WCD-4	94.2233 92.9785 1.2448	210 ml	94.2233 92.9785 1.2448			-	1.2488 0.0042 1.2446	1.2446
	ECD-1								
	ECD-2	80.8836 80.1542 0.7294	250 ml	80.8845 80.1542 0.7301			-	0.7301 0.0050 0.7251	0.7251
	ECD-3	90.7729 89.3812 1.3917	180	90.7729 89.3812 1.3917			-	1.3917 0.0036 1.3881	1.3881
	ECD-4	90.5630 89.0973 1.4657	300	90.5630 89.0973 1.4657	90.5630 89.0973 1.4649		-	1.4677 0.0088 1.4589	1.4589
RA	Blank Acetone	89.8626 89.8579 0.0047	200 ml	89.8626 89.8579 0.0026	89.8626 89.8579 0.0041	89.8626 89.8579 0.0047	0.0020		

Project No. 359491

Collection Date 9/2 - 9/24

Analysis Date October 13, 1981

G.F. filter   Total wt.

SAMPLES Airco . . RM Charleston S.C.

NO.	CR	LOCATION and SAMPLE NO.	Wt of filter [illegible]	SAMPLE WEIGHT	TIT. ALIQ.	Residue Blank	MG in ALIQ.			Total wt.	
1		PCE-1 000177	0.1757	27.2935 0.1767 27.4705	[illegible] 27.4710 .1261	[illegible] 27.4[illegible] .1263				0.1663	
2		PCE-2 000 197	0.1753	27.1875 0.1753 27.3645	[illegible] 27.3648 .0[illegible]	[illegible] 27.3[illegible] .0315				0.0315	
3		PCE-3 000093	0.1765	29.3351 0.1766 29.509[illegible]	29.57[illegible] 29.5[illegible] .06[illegible]	29.5[illegible] 29.5096 .0653				0.0653	
		~~WCD-1~~	NO	SAMPLE							
4		WCD-2 000 212	0.6023	25.6417 0.6023 26.2440	27.0[illegible] 26.2440 .8319	27.0[illegible] 26.2[illegible] .8[illegible]	27.066[illegible] 26.2440 .824[illegible]	[illegible] 26.2440 .8[illegible]	[illegible]	0.8[illegible]3	
5		WCD-3 000207	0.5968	28.3592 0.5968 28.9560	30.4[illegible] 28.95[illegible] 1.5[illegible]	30.4[illegible] 28.9560 1.5123	30.4[illegible] 28.956[illegible] 1.4[illegible]81	[illegible] 28.9560 1.5[illegible]33	[illegible] 1.[illegible]	30.4[illegible] 28.95[illegible] 1.[illegible]	30.45[illegible] 28.95[illegible] [illegible]
6		WCD-4 000209	0.5532	25.5253 0.5532 26.1085	27.6[illegible] 26.1085 1.5725	27.6[illegible] 26.1085 1.5753	27.67[illegible] 26.1085 1.582[illegible]	27.6[illegible] 26.1085 1.5761		1.5761	
		~~ECD-1~~	NO	SAMPLE							
7		ECD-2 000 208	0.6094	29.6296 0.609[illegible] 30.2390	30.8512 30.2390 .6[illegible]	30.8[illegible] 30.2390 .6[illegible]12	30.855[illegible] 30.2390 .616[illegible]	[illegible] [illegible]	30.8538 30.2390 .6148	0.6148	
8		ECD-3 000206	0.5921	2[illegible].8230 0.5921 29.4151	30.8[illegible] 29.4151 1.4731	30.886[illegible] 29.4151 1.4[illegible]	30.8840 29.4151 1.46[illegible]	30.[illegible] 29.4151 1.[illegible]	[illegible]	30.[illegible] 29.4151 1.4671	1.4671
9		ECD-4 000216	0.6052	26.74[illegible] 0.605[illegible] 27.3486	29.6[illegible] 27.3[illegible] 2.3135	29.6[illegible] 27.3[illegible] 2.307[illegible]	29.646[illegible] 27.3490 2.2987	29.[illegible] 27.3490 2.3181	29.[illegible] [illegible] 2.[illegible]	29.64[illegible] 27.3[illegible] 2.29[illegible]	2.29[illegible]
10		B/27/[illegible] #000102 2" G.F.	0.1813	26.542[illegible] 0.1813 26.7235	Used as Control in weighing						
11		B/27/ #000196 4[illegible]" G.F.	0.6100	26.4970 0.6100 27.1070							

Project No. 857491

Collection Date [illegible]

Analysis Date October 15, 1971

GF Filter

SAMPLES Airco RM Charlotte, S.C.

CR NO.	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading/Blank	ML in ALIQ.			
	ECD-Metals 000090	0.1735							
	WCD-Metals 000189	0.1740							

Project No. [illegible]

Collection Date 9/25/79

Analysis Date _____

Acetone Aldehyde total wt.

SAMPLES Arco RM Charleston

GR	LOCATION and SAMPLE NO.		SAMPLE ~~WEIGHT~~ VOLUME	TIT. ALIQ.	Reading Blank	NG in ALIQ.			Total Wt.
	PCF-1	76.9343 76.9134 0.0209	105	76.9324 76.9134 .0190	76.9340 76.9134 .0206		-	0.0206 0.0021 0.0185	0.0185
	PCF-2	80.4214 80.4016 0.0198	100 ml	[illegible] 80.4016 .0201			-	0.0201 0.0020 0.0181	0.0181
	PCF-3	84.[illegible] 84.8792 0.0151	120	[illegible] 84.8792 .0099			-	0.0099 0.0024 0.0075	0.0075
	~~WCD-1~~	No good							
	WCD-2	91.8271 91.8187 0.0084	75	91.8246 91.8187 .0059	91.8277 91.8187 .0090		-	0.0090 0.0015 0.0075	0.0075
	WCD-3	89.6647 89.6476 0.0171	75	89.6643 89.6476 0.0167			-	0.0169 0.0015 0.0154	0.0154
	WCD-4	87.7465 87.7307 0.0158	125	87.7451 87.7307 0.0144	87.7462 87.7307 .0155		-	0.0159 0.0025 0.0134	0.0134
	~~ECD-1~~	No good							
	ECD-2	88.6277 88.6195 0.0082	70	88.6267 88.6195 .0072			-	0.0072 0.0014 0.0058	0.0058
	ECD-3	86.1429 86.1313 0.0116	100	86.1414 86.1313 0.0101	86.1429 86.1313 .0116		-	0.0114 0.0020 0.0094	0.0094
	FCD-4	77.3319 77.3179 0.0140	215	77.3300 77.3179 0.0121	77.3314 77.3179 .0135		-	0.0135 0.0043 0.0092	0.0092

Project No. 85947I

Collection Date 9/20 - 9/21

Analysis Date October 12, 1981

Ether Phase Extract [illegible]   Total wt

SAMPLES Aiken Rm. Charlestown S.C.

NO.	CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT Volume	TIT. ALIQ.	Reading for Blank	MG in ALIQ.			Total wt.
[illegible]8		PCE-1	84.5725 / 84.5693 / 0.0032	105 ml	84.5710 / 84.5696 / 0.0014	[illegible]	84.5725 / 84.5691 / 0.0034	–	0.0034 / 0.0007 / 0.0027	0.0027
[illegible]9		PCE-2	82.9929 / 82.9907 / 0.0022	115 ml	[illegible] / [illegible] / 0.0013			–	0.0013 / 0.0008 / 0.0005	0.0005
[illegible]1		PCE-3	72.2935 / 72.2930 / 0.0005	105	[illegible] / [illegible] / 0.0014			–	0.0014 / 0.0007 / 0.0007	0.0007
		WCD-1	No	5		Good				
[illegible]2		WCD-2	92.0289 / 92.0279 / 0.0010	125	92.0314 / 92.0277 / 0.0033	[illegible]		–	0.0000 / 0.0009 / 0.0000	0
[illegible]2		WCD-3	84.3251 / 84.3210 / 0.0041	125	84.3255 / 84.3210 / 0.0045			–	0.0045 / 0.0009 / 0.0036	0.0036
[illegible]3		WCD-4	90.9344 / 90.9321 / 0.0023	114	90.9395 / 90.9371 / 0.0024			–	0.0024 / 0.0008 / 0.0016	0.0016
		~~ECD-1~~	No			Good				
[illegible]4		ECD-2	87.3180 / 87.3152 / 0.0028	135	87.3177 / 87.3152 / 0.0025			–	0.0025 / 0.0009 / 0.0016	0.0016
[illegible]5		ECD-3	83.2165 / 83.2161 / 0.0004	150	[illegible] / 83.2161 / [illegible]			–	0.0001 / 0.0011 / 0.0000	0
[illegible]		ECD-4	80.0735 / 80.0708 / 0.0027	130	80.0737 / 80.0708 / 0.0029			–	0.0029 / 0.0009 / 0.0020	0.0020
Blank		CEB-1	77.6143 / 77.6125 / 0.0018	125	77.6123 / 77.6123 / 0.0002	[illegible] / 0.0009	0.0007 / 125 = 0.00056 / 100			
Blank		CEB-2	81.2200 / 81.2190 / 0.0010	130	81.2198 / 81.2190 / 0.0008	0.0008 / 130	= 0.00059 / 100		0.00059 / 100	

Project No. [illegible] 491

Collection Date [illegible]

Analysis Date Oct. [illegible] 14, 1977

Water Imp. Remainder — total wt.

SAMPLES Arco R M Charleston S.C.

CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT Volume	TIT. ALIQ.	Reading-Blank	IS in ALIQ.				Total Wt.
	[illegible] D-1	[illegible] / 90.8393 / [illegible]	650	[illegible]				-	0.0252 / 0.0124 / 0.0128	0.0128
	[illegible] 2	89.7343 / 89.7311 / [illegible]	730	[illegible]				-	0.0328 / 0.0139 / 0.0189	0.0189
	[illegible] 3	[illegible] / 89.6517 / 0.0419	740	[illegible]	[illegible] / 89.6517 / 0.0434	[illegible] / 89.6517 / 0.0410		-	0.0410 / 0.0141 / 0.0269	0.0269
	[illegible]	No good								
	[illegible] D-2	84.4274 / 84.3865 / 0.0459	310	[illegible]	[illegible]			-	0.0347 / 0.0057 / 0.0289	0.0285
	[illegible]	77.6654 / 77.6454 / 0.0200	330	[illegible]				-	0.0210 / 0.0063 / 0.0147	0.0147
	[illegible] D-4	89.1254 / 89.6105 / 0.0149	400	[illegible]				-	0.0147 / 0.0076 / 0.0071	0.0071
	[illegible] D-1	No good								
	[illegible] D-2	85.8626 / 85.8170 / 0.0456	300	[illegible]	[illegible]	[illegible]		-	0.0407 / 0.0057 / 0.0350	0.0350
	[illegible] D-3	88.8145 / 88.7936 / 0.0209	285	[illegible]	[illegible] / 0.0276	[illegible] / 0.0234	[illegible] / 0.0213		88.8047 / 88.7836 / 0.0213	0.0213 / 0.0054 / 0.0159 — 0.0159
	[illegible] D-4	84.8839 / 84.8658 / 0.0181	300	[illegible]	[illegible] / 0.0179			-	0.0174 / 0.0057 / 0.0122	0.0122
Blank	CEWB-1	[illegible] / 36.0777 / 0.0025	470	[illegible]	36.0777 / 0.0042	[illegible] / 0.0010	.0004 / 100ml			
Blank	CEWB-2	81.8215 / 81.8039 / 0.0176	475	[illegible]	[illegible] / 0.0150	.0002 / 100ml			[illegible] / 100ml	

Project No. [illegible] 991

Collection Date [illegible]

Analysis Date October 18, 1991

Silica gel — Total Weight Gain H_2O

AMPLES Airco RM Charleston S.C.

CS No.	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading Blank	MG in ALIQ.			Total wt. Gain - gms.
	PCE-1	388.1 195.6 192.5	433.9 – wt. of sample 388.9 – wt. of sample -5.0 Gain		30 Hi + wt.	Total Dry			45.0
	PCE-2	381.1 240.1 199.0	431.7 389.1 42.6						42.6
	PCE-3	334.5 282.5 191.7	428.2 384.5 43.7						43.7
	WCD-1	NO	9000						
	WCD-2	376.1 185.5 190.4	385.0 376.9 8.1						8.1
	WCD-3	373.4 196.5 192.9	405.6 393.4 12.2						12.2
	WCD-4	373.0 196.8 196.2	397.2 373.0 24.2						24.2
	ECD-1	NO	9000						
	ECD-2	350.0 187.4 162.6	373.7 350.0 23.7						23.7
	ECD-3	350.00 193.80 156.20	376.3 350.0 26.3						26.3
	ECD-4	384.1 204.0 180.1	401.1 384.1 17.6						17.0

Project No. [illegible]

Collection Date [illegible]

Analysis Date 9/30/71

Total mg - SO2

SAMPLES Airco, RM Charleston S.C.

NO.	CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading Blank	tit. ALIQ. Net	x 1.24		Total mg SO_2
		PCE-1			25/100	7.20	7.15			8.9
		PCE-2			25/100	1.50	1.45			1.8
		PCE-3			25/100	5.55	5.50			6.8

Project No. [illegible]

Collection Date 9/26 – [illegible]

Analysis Date 10/7/71

APPENDIX G

TEST LOG

Relat

under this

as follows

Test Numbe

FA-1

FA-2

FA-3

FA-4

FA-5

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APPENDIX H

RELATED REPORTS

APPENDIX I

PROJECT PARTICIPANTS AND TITLES

PROJECT PARTICIPANTS AND TITLES

R. N. Allen, P.E., Project Manager

C. C. Gonzalez, Chemist, Crew Leader

T. E. Eggleston, Project Engineer

G. B. Patchell, Senior Technician

J. R. Avery, Technician

L. W. Baxley, Technician

B. M. Brown, Technician

E. Cook, Technician

W. C. Hall, Technician

J. McReynolds, Technician

J. E. Sloan, Jr. Technician

APPENDIX J

PARTICLE SIZING SAMPLES

PARTICLE SIZE DISTRIBUTION OF METAL FUME

INTRODUCTION

Determinations of particle size distribution of fume emissions at the Ferroalloy Plant of the Air Reduction Company, Charleston, South Carolina, were conducted September 22 and 23. Emissions were evaluated at the east and west exhaust ducts of furnace 14, and at the exhaust stack of the electrostatic precipitator of furnace 14.

METHODS

Samples for the evaluation of particle size distribution were gathered using Brink samplers. The samplers, with attached 47 millimeter glass fiber filters, were mounted on probes and connected to vacuum pumps by rubber tubing. The inlet sides of the pumps were fitted with vacuum gauges calibrated in inches of mercury and metering valves to adjust the air flow through the samplers. The outlet sides of the pumps were connected to dry gas meters when samples were collected longer than seven minutes.

Prior to collecting samples in the field, the samplers were calibrated to determine air flow rates at various operating conditions. Air was drawn through the samplers for 10 minutes at each pressure drop (ΔP) of two inches of mercury, five inches of mercury, and ten inches of mercury. The corresponding volume of air flow through the samplers was measured by a dry gas meter. A calibration curve was constructed by plotting the pressure drop across the samplers versus the air flow rates.

Volumetric flow rates for short duration samples of seven minutes, or less were measured by the ΔP across the samplers. For samples of

longer duration, volume was measured by a dry gas meter. A ΔP of five inches of mercury at the furnace exhaust ducts, and ten inches of mercury at the precipitator exhaust was maintained during sampling. The samplers were grounded during sampling to prevent electrostatic deposition of particles.

When exhaust temperatures were higher than ambient temperature the samplers were plugged and allowed to thermally equilibrate before sampling to avoid thermal deposition of particles. The plugs were then removed from the samplers and the samples collected.

RESULTS

The field data sheets are included in Sub-Appendix J-2. The characteristic diameter of an aerosol particle for each impactor stage (i.e., Dpc) has been calculated for pressure drops across the impactor of five inches of mercury and ten inches of mercury assuming particles of unit density (1 gram/cubic centimeter), using the equation described by J. A. Brink, Jr.* The characteristic diameters are as follows:

For a Pressure Drop of Five Inches of Mercury Across the Impactor		For a Pressure Drop of Ten Inches of Mercury Across the Impactor	
Stage No.	Dpc micron	Stage No.	Dpc micron
1	3.40	1	3.06
2	2.00	2	1.80
3	1.36	3	1.23
4	0.69	4	0.63
5	0.42	5	0.38

* Industrial Engineering and Chemistry, Vol.50, April 1958, pp 645-648.

Graphical presentation of the data, that is, log-probability plots of cumulative percent less than stated micron size versus the Dpc for each stage in microns, is included in Sub-Appendix J-1. A graphically determined mass median diameter (MMD) and geometric standard deviation (σ_g) for each sample are presented in Table A, on the following page.

DATE	SAMPLE NO.	LOCATION OF SAMP. E	NO	DUCT OR STACK (FT)	SAMPLING (MINUTES)	SAMPLER (IN.Hg)	(μ)	(μ)	
9-22-71	1	Precipitator Exhaust	NA	4	90	5	1.04	3.54	
9-22-71	2	Precipitator Exhaust	NA	4	180	10	2.54	1.41	
9-22-71	3	Precipitator Exhaust	NA	4	180	10	<0.38	*	
9-22-71	4	Furnace Exhaust East Duct	C	4	7	5	1.30	4.13	Simultaneously with 5
9-22-71	5	Furnace Exhaust West Duct	C	4	7	5	2.62	8.19	Simultaneously with 4
9-22-71	6	Precipitator Exhaust	NA	4	240	10	1.94	5.10	
9-23-71	7	Furnace Exhaust West Duct	A	4	5	5	1.75	4.60	Simultaneously with 8
9-23-71	8	Furnace Exhaust East Duct	A	4	5	5	1.85	3.06	Simultaneously with 7
9-23-71	9	Precipitator Exhaust	NA	4	240	10	1.80	5.63	
9-23-71	10	Furnace Exhaust West Duct	B	4	5	5	1.21	3.97	Simultaneously with 11
9-23-71	11	Furnace Exhaust East Duct	B	4	5	5	1.36	2.97	Simultaneously with 10
9-23-71	12	Precipitator Exhaust	NA	4	240	10	1.36	4.53	

* Data [illegible] were at the extremity of the [illegible] and OR could not be determined

TABLE 1

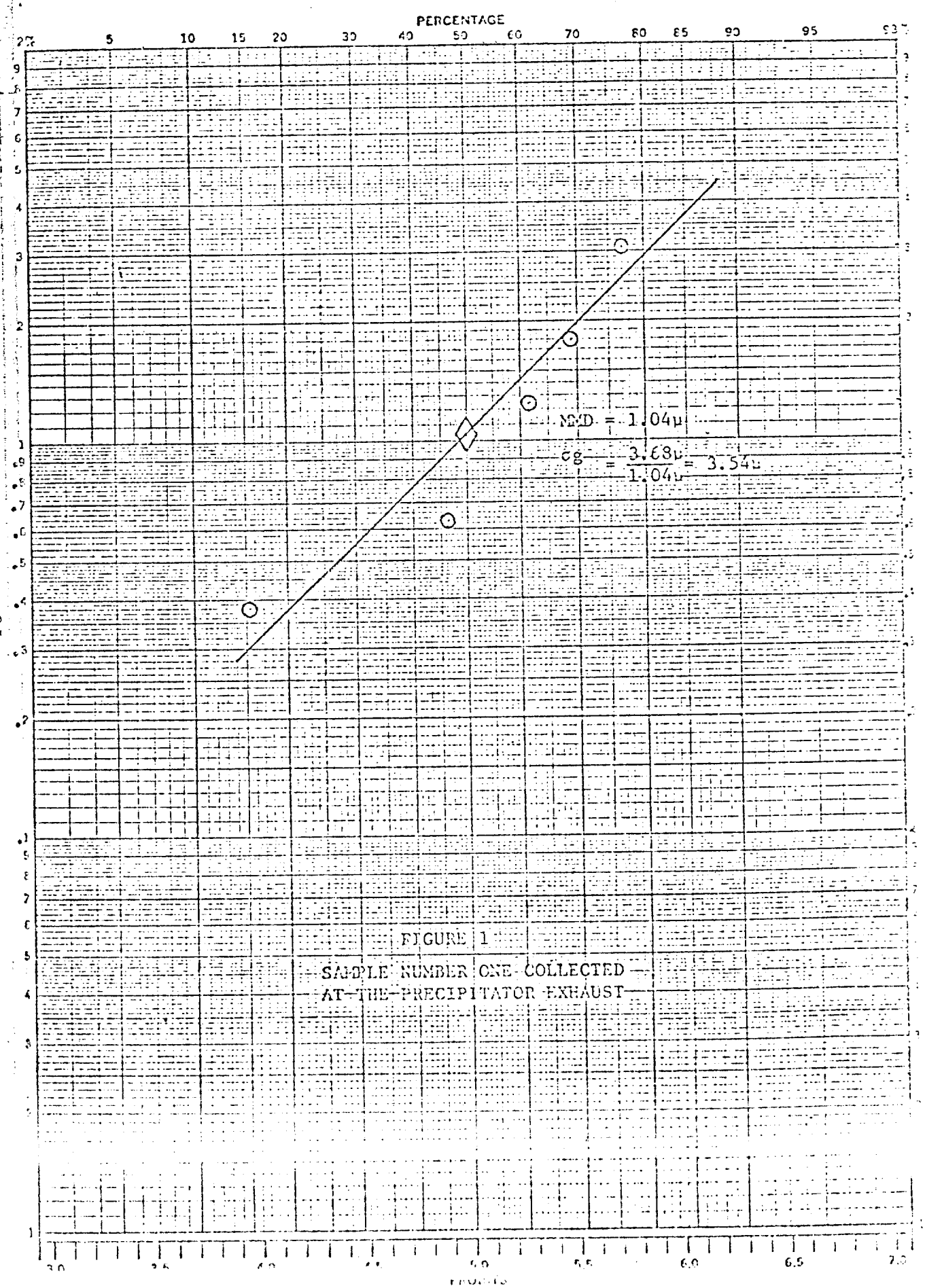

FIGURE 1

SAMPLE NUMBER ONE COLLECTED AT THE PRECIPITATOR EXHAUST

CUMULATIVE MASS PERCENT LESS THAN STATED MICRON SIZE (D_p)

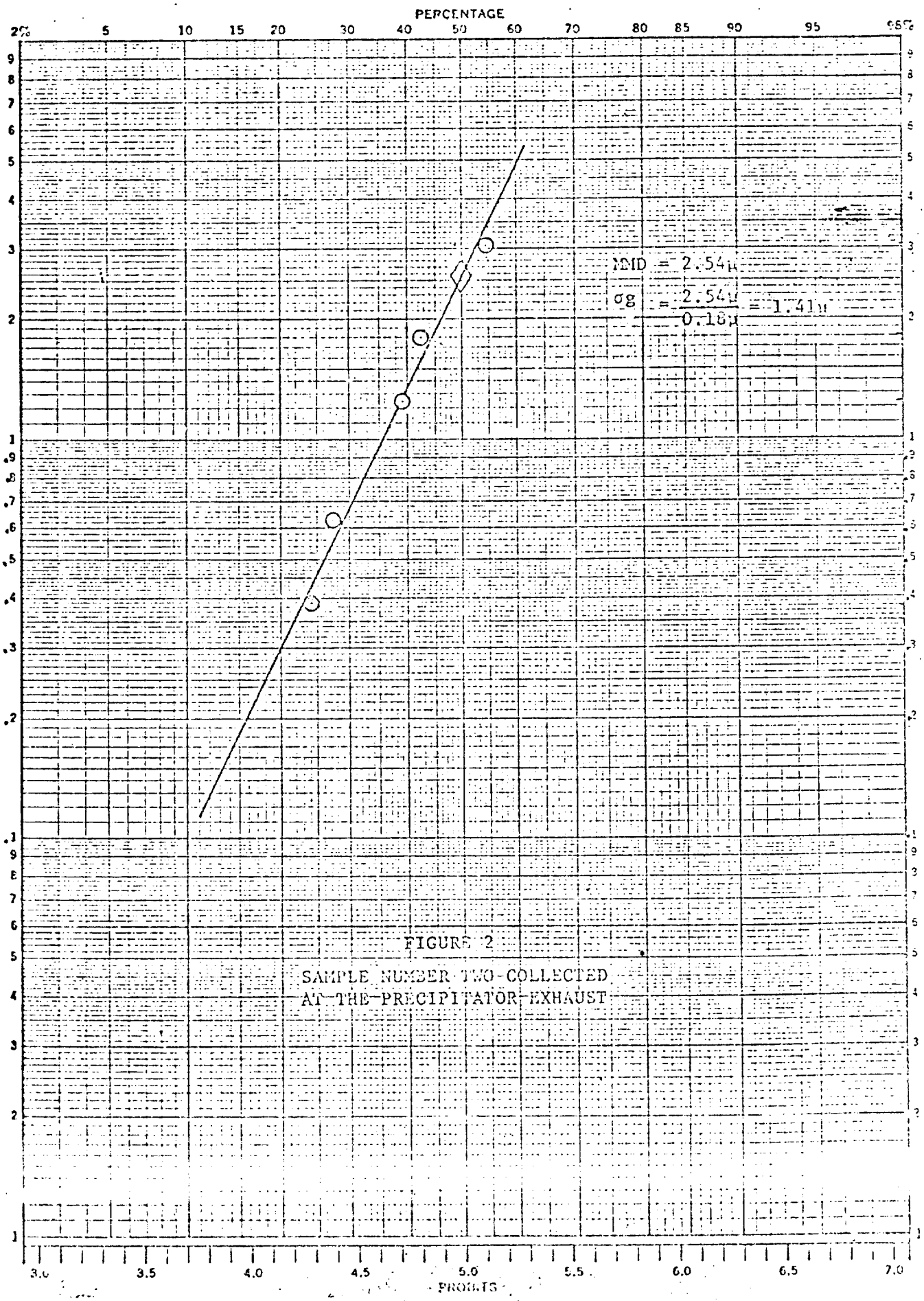

FIGURE 2

SAMPLE NUMBER TWO-COLLECTED AT THE PRECIPITATOR EXHAUST

CUMULATIVE MASS PERCENT LESS THAN STATED MICRON SIZE (D_p)

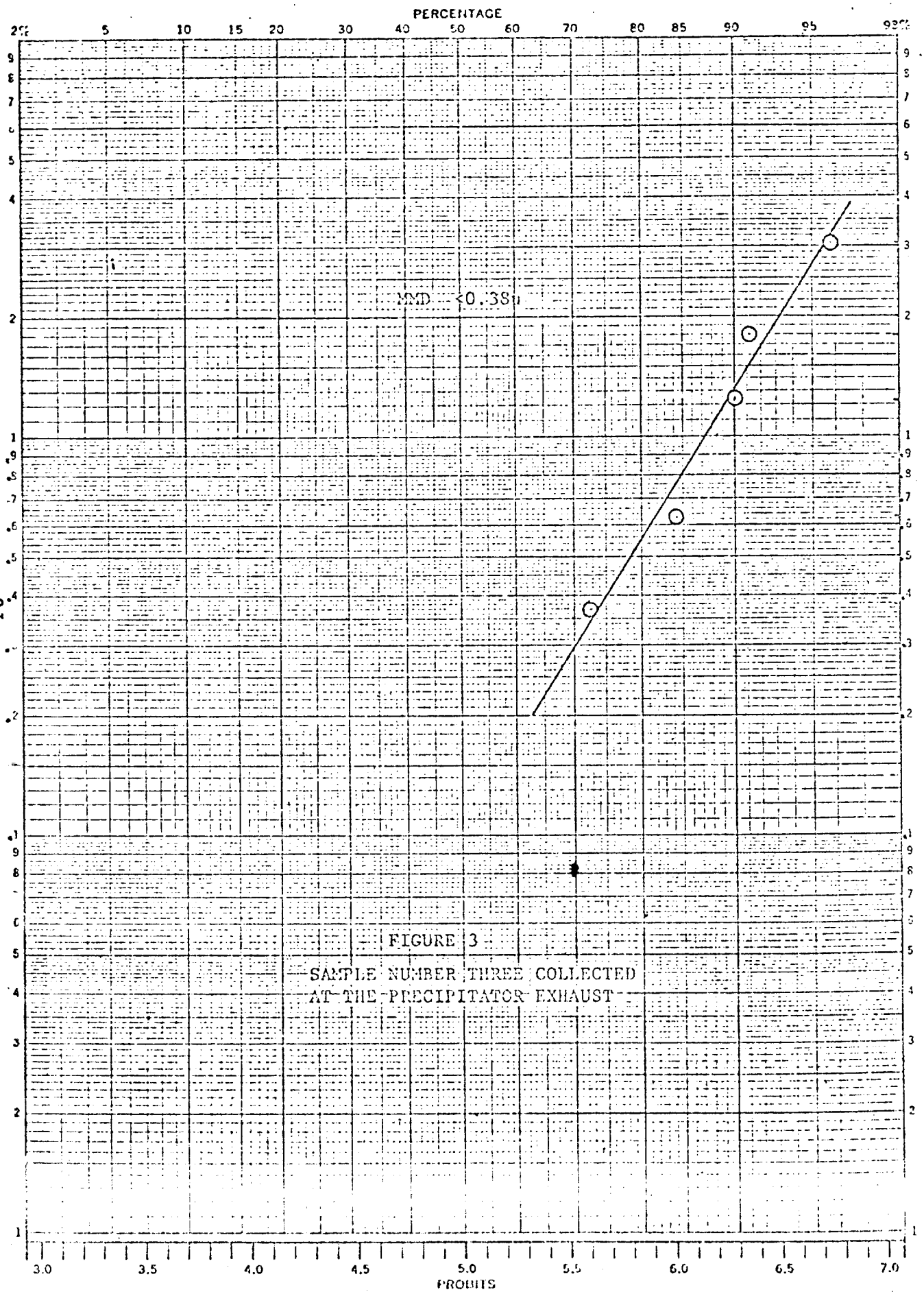

FIGURE 3

SAMPLE NUMBER THREE COLLECTED AT THE PRECIPITATOR EXHAUST

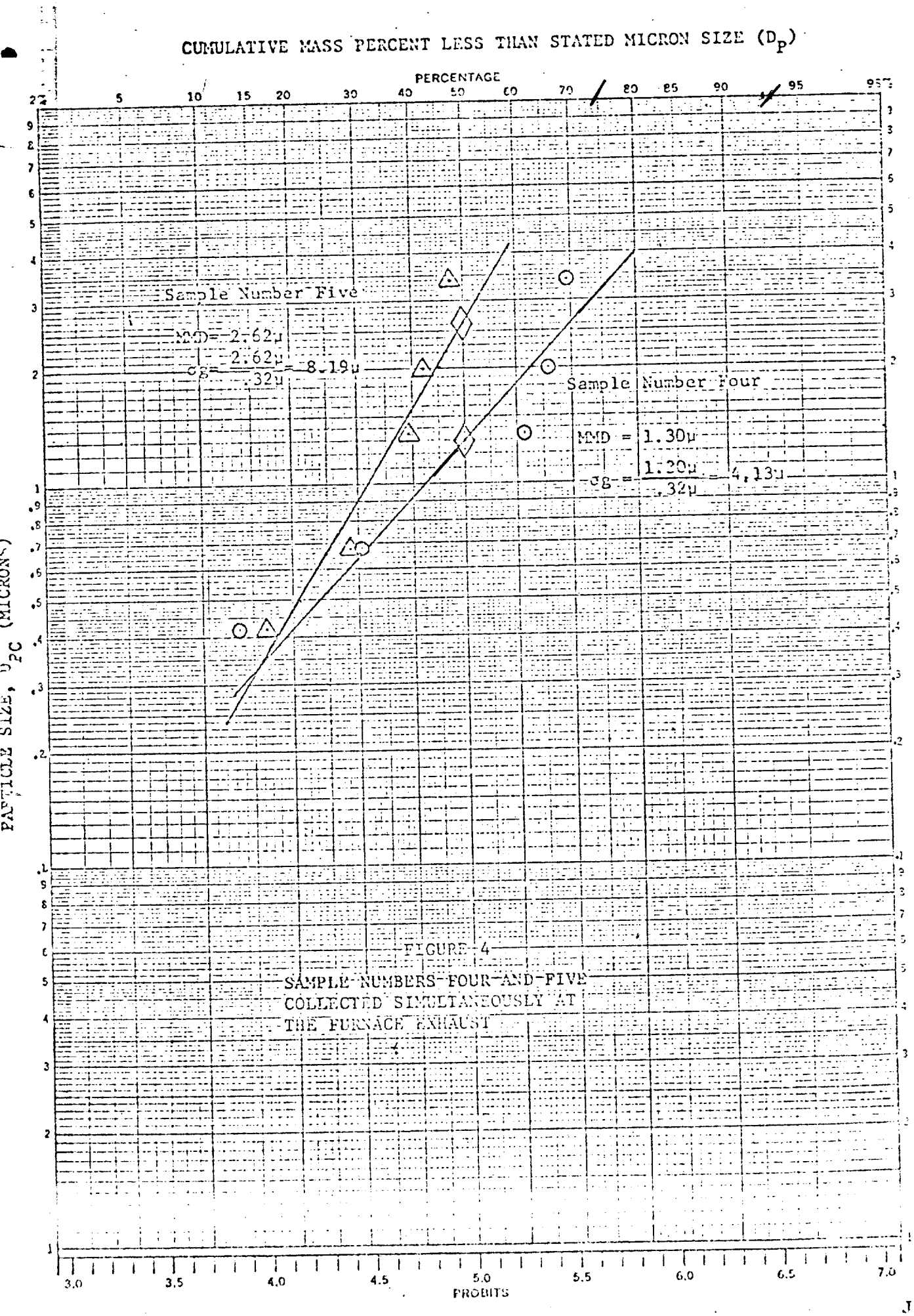

FIGURE 4

SAMPLE NUMBERS FOUR AND FIVE COLLECTED SIMULTANEOUSLY AT THE FURNACE EXHAUST

CUMULATIVE MASS PERCENT LESS THAN STATED MICRON SIZE (D_P)

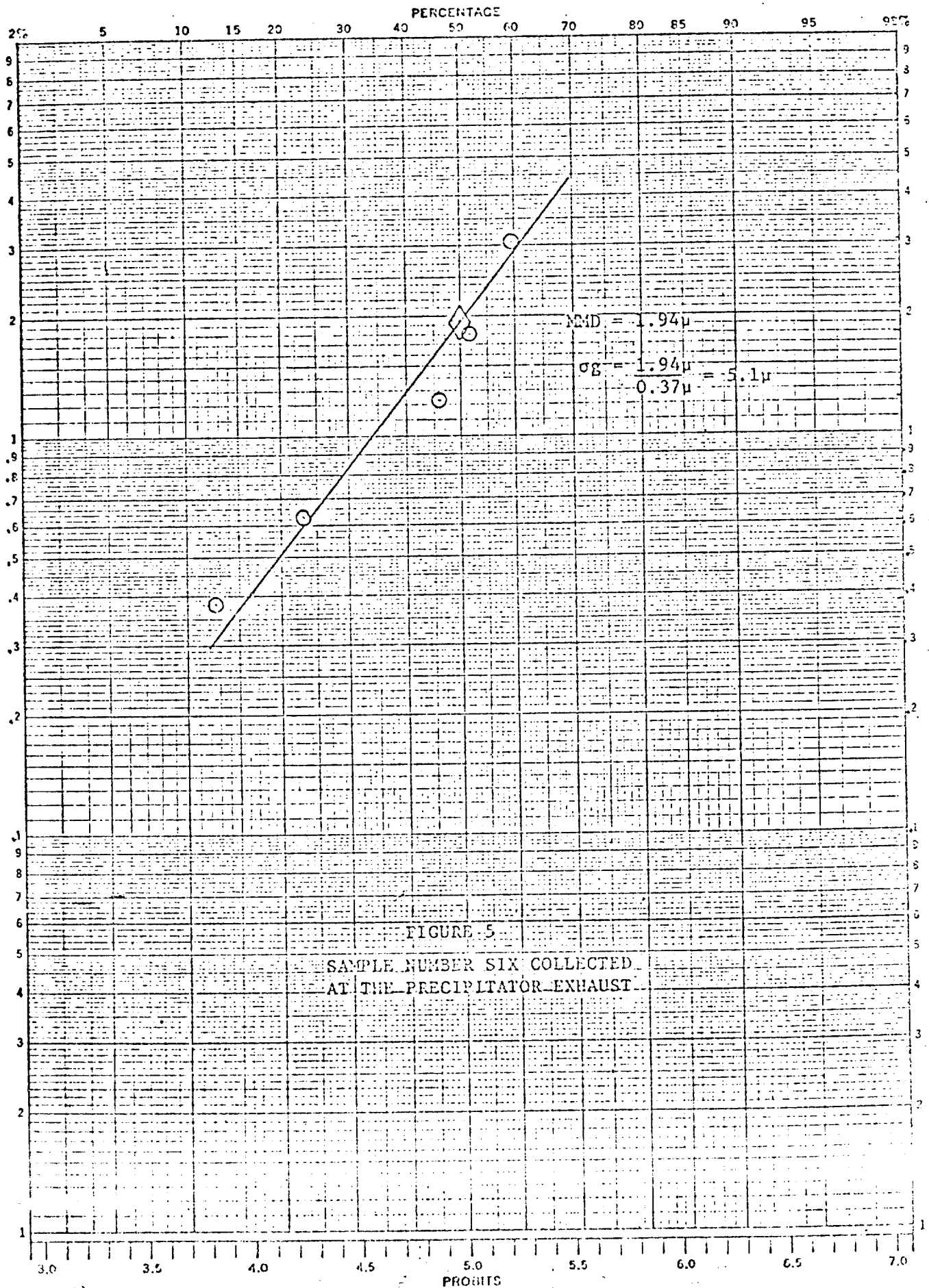

FIGURE 5

SAMPLE NUMBER SIX COLLECTED AT THE PRECIPITATOR EXHAUST

CUMULATIVE MASS PERCENT LESS THAN STATED MICRON SIZE (D_P)

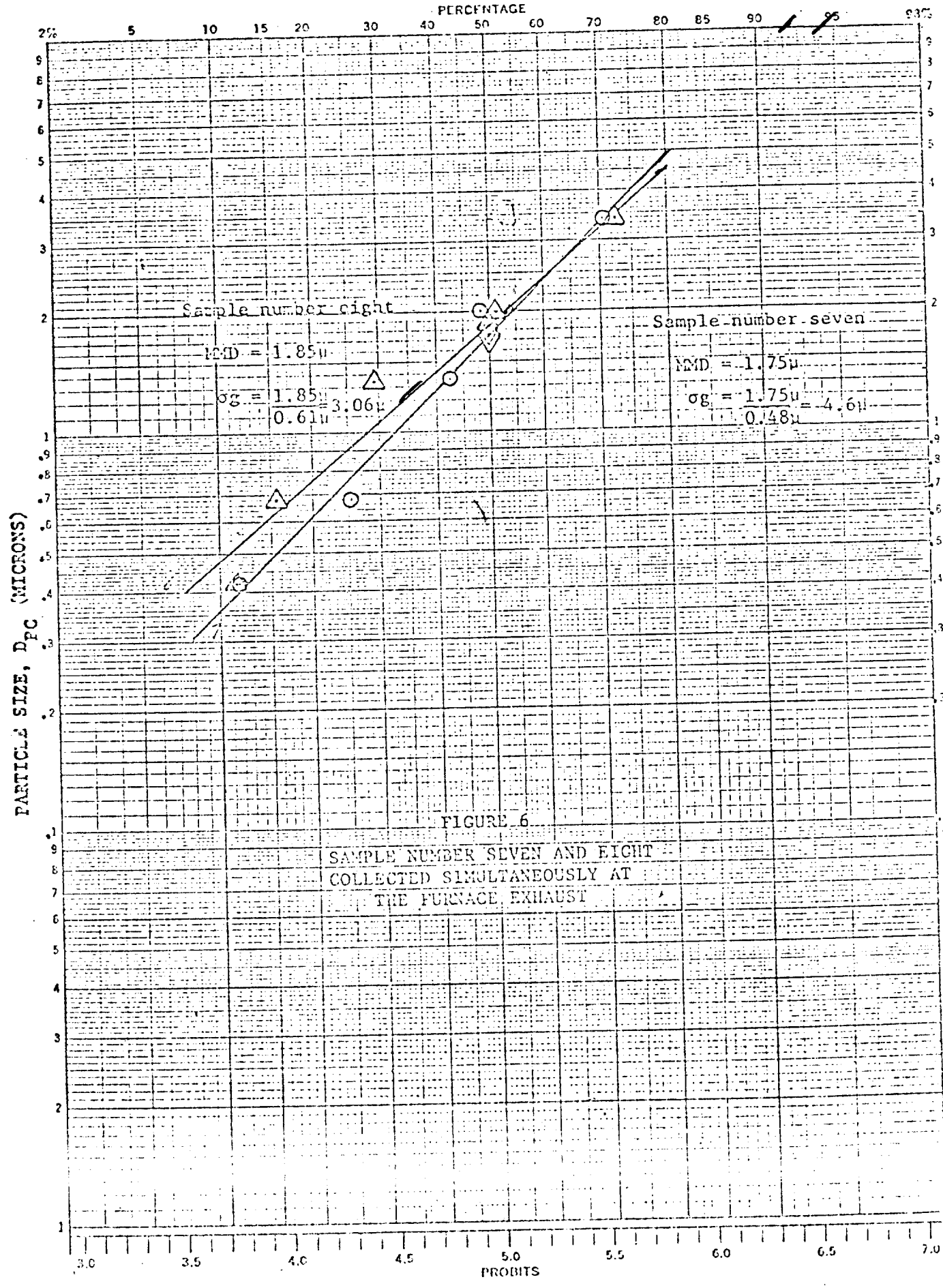

FIGURE 6

SAMPLE NUMBER SEVEN AND EIGHT COLLECTED SIMULTANEOUSLY AT THE FURNACE EXHAUST

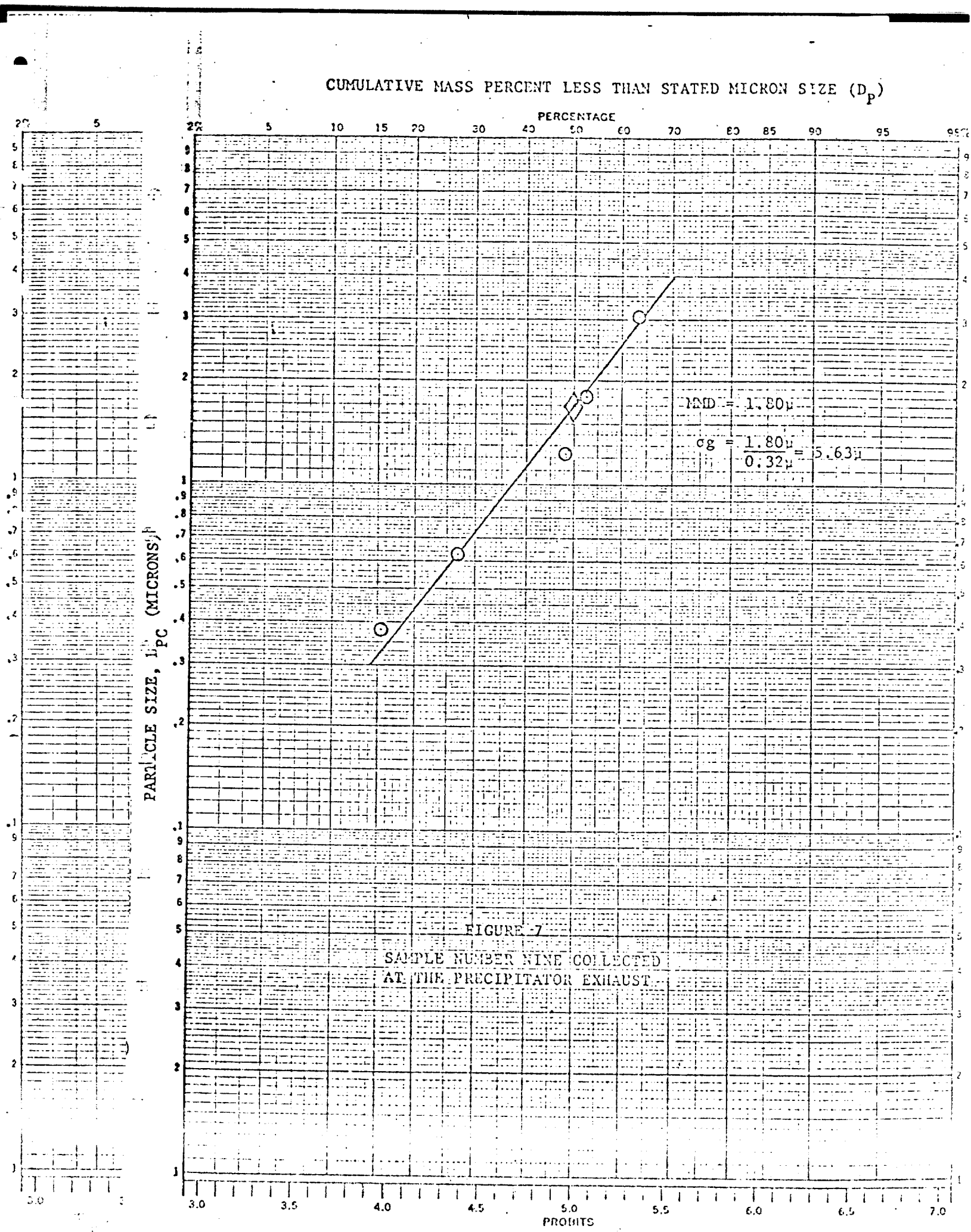

FIGURE 7

SAMPLE NUMBER NINE COLLECTED AT THE PRECIPITATOR EXHAUST

CUMULATIVE MASS PERCENT LESS THAN STATED MICRON SIZE (D_p)

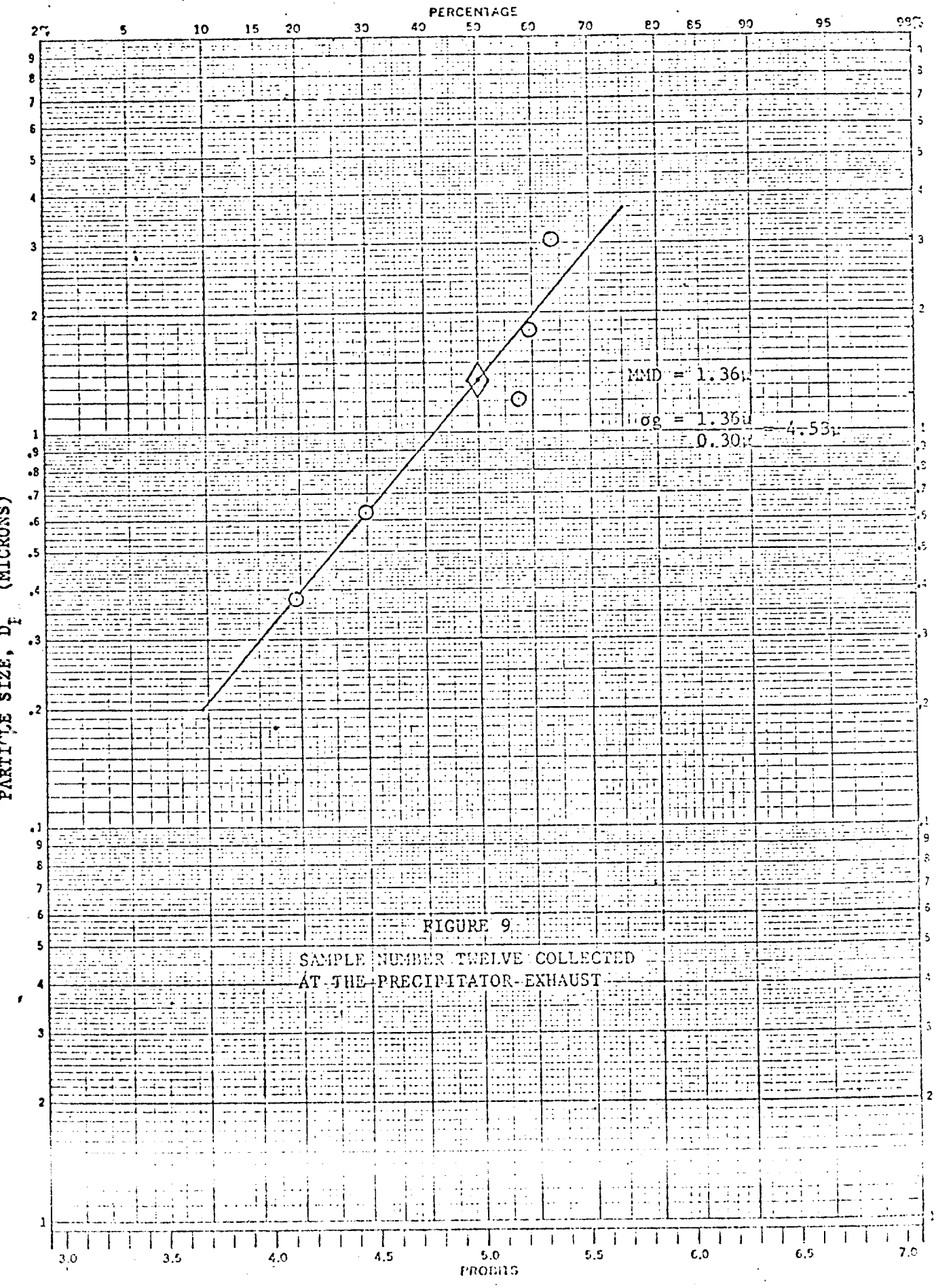

FIGURE 9

SAMPLE NUMBER TWELVE COLLECTED AT THE PRECIPITATOR EXHAUST

SUB-APPENDIX J-2

FIELD DATA

Date SEPT 22, 1971

Stack No. Precipitator Exhaust

Sample No. 1

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dac
1	3.6344	3.6341	0.3	23.0	77.0
2	3.5899	3.5898	0.1	7.7	69.3
3	3.2435	3.2434	0.1	7.7	61.6
4	3.6848	3.6846	0.2	15.4	46.2
5	3.5324	3.5320	0.4	30.8	15.4
filter	0.1298	0.1296	0.2	15.4	

TOTAL 1.3

TIME	METER READING (CF)	Δ P ACROSS SAMPLE (IN. Hg)	
1150	001.12	5	Start sampling
1210	003.00	5	
1320	010.96	5	stop sampling

90 min

Precipatator

Stack No. Exhaust

Date Sept 22, 1971

Sample No. 2

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dae
1	3.3385	3.3370	1.5	45.5	54.5
2	3.3106	3.3102	0.4	12.1	42.4
3	3.1374	3.1374	0.1	3.1	39.3
4	3.1564	3.1560	0.4	12.1	27.2
5	3.5759	3.5794	0.1	3.0	24.2
filter	0.1268	0.1260	0.8	24.2	

Total 3.3

ime	METER READING (CF)	ΔP ACROSS SAMPLE (IN. Hg)	
720	010.96	10"	Start sampling
: 0	034.08	10"	Start sampling

min

Precipitator

Stack No. Exhaust

Date Sept 22, 1971

Sample No. 3

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dac
1	3.6003	3.5991	1.2	14.1	95.9
2	3.6205	3.6201	0.4	4.7	91.2
3	3.5817	3.5816	0.1	1.2	90.0
4	3.5662	3.5657	0.5	5.9	84.1
5	3.6087	3.6086	0.1	1.2	72.9
filter	0.1332	0.1270	6.2	72.9	
		TOTAL	8.5		

Time	Meter Reading (CF)	ΔP across Impactor (in hg)	
1555	221.64	10"	start
1855	245.66	10	stop

100

Furnace Exhaust,
Stack No. East Duct, Port C

Date Sept 23 1971

Sample No. 4 Simultaneously with #5

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dac	
1	3.6044	3.5940	10.4	30.9	69.1	3.9
2	3.3867	3.3857	1.0	2.9	66.2	2.0
3	3.5970	3.5955	1.5	4.5	61.7	1.36
4	3.2583	3.2478	10.5	31.3	30.4	.69
5	3.2943	3.2887	5.6	16.7	13.7	.42
filter	0.1306	0.1260	4.6	13.7		
			TOTAL	33.6		

Start 1732
Stop ~~1737~~ 1739
ΔP = 5" hg

Stack No. Furnace Exhaust West Duct, Port C

Date Sept 22, 1971

Sample No. 5 Simultaneous with 4

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dso
1	3.48884	3.4692	19.2	52.5	47.5
2	3.55414	3.5524	2.0	5.4	42.1
3	3.6394	3.6384	1.0	2.8	39.3
4	3.2885	3.2846	3.9	10.6	28.7
5	3.6243	3.6199	4.4	12.0	16.7
filter	0.1327	0.1266	6.1	16.7	
			Total 36.6		

Start 1732

Stop 1739

ΔP = 5" hg

Precipitator

Date Sept 23, 1971

Stack No. Exhaust

Sample No. 6

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dac
1	3.1550	3.1499	5.1	46.5	59.5
2	3.6250	3.6240	1.0	7.9	51.6
3	3.6184	3.6177	0.7	5.6	46.0
4	3.6029	3.6000	2.9	23.0	23.0
5	3.4616	3.4603	1.3	10.3	12.7
filter	0.1349	0.1333	1.6	12.7	
			Total 12.6		

Time	Meter Reading (CF)	ΔP across sampler (in Hg)	
0850	034.10	10	Start
1250	072.36	10	Stop

Stack No. Furnace Exhaust, West Duct, Port A

Date Sept 23, 1971

Sample No. 7 Simultaneous with 8

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dso	
1	3.6419	3.6385	3.4	29.6	70.4	< 3.4
2	3.6675	3.6650	2.5	22.0	48.4	2.0
3	3.6267	3.6260	0.7	6.2	42.2	1.3
4	3.5789	3.5770	1.9	16.7	25.5	.69
5	3.6025	3.6009	1.6	14.0	11.5	.42
filter	0.1280	0.1267	1.3	11.5		

Total 11.4

Start - 1031

Stop - 1036

ΔP = 5" hg

Furnace Exhaust, Date Sept 23, 1971

Stack No. East duct, Port A

Sample No. 8 Simultaneous with 7

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dmc
1	3.7403	3.7293	11.0	27.1	72.9
2	3.6976	3.6888	8.8	21.6	51.3
3	3.5910	3.5821	8.9	21.9	29.4
4	3.5308	3.5273	5.5	13.6	15.8
5	3.3670	3.3654	1.6	4.0	11.8
filter	0.1311	0.1263	4.8	11.8	
			Total 40.6		

Start 1031

Stop 1036

ΔP = 5" hg