SN 16544.001

Test Number FA-3

AIRCO Alloys and Carbide Niagara Falls, New York

by

T.E. Eggleston

RESOURCES RESEARCH, INC.
A SUBSIDIARY OF TRW INC.
WESTGATE PARK • 7600 COLSHIRE DRIVE • McLEAN, VIRGINIA 22101

Contract Number CPA 70-81

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TEST NUMBER ~~FA3~~ 71-PC-14

AIRCO ALLOYS AND CARBIDE

NIAGARA FALLS, NEW YORK

by T.E. Eggleston

Revised

DECEMBER, 1971

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

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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. The tests include grain loading measurements, particle size analyses, and chemical analyses for a variety of furnace formulations and control devices. This report covers the tests performed at the AIRCO Alloys and Carbide Plant, Niagara Falls, New York, during the week of August 30, 1971.

Emissions for this particular plant were determined for a ferrochrome silicon furnace (No.9). The furnace was provided with a hood with an induced draft exhaust fan. This hood collected most of the dust and fumes, except during the alloy "tapping" process. Sample point locations are located in Figure 2. Further detailed diagrams and descriptions are included in Section IV and V (Process Description and Location of Sampling Points).

During this particular survey particulate matter was sampled using the standard OAP train. 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 Brink Samplers. Samples for metals analysis were collected using the standard EPA train.

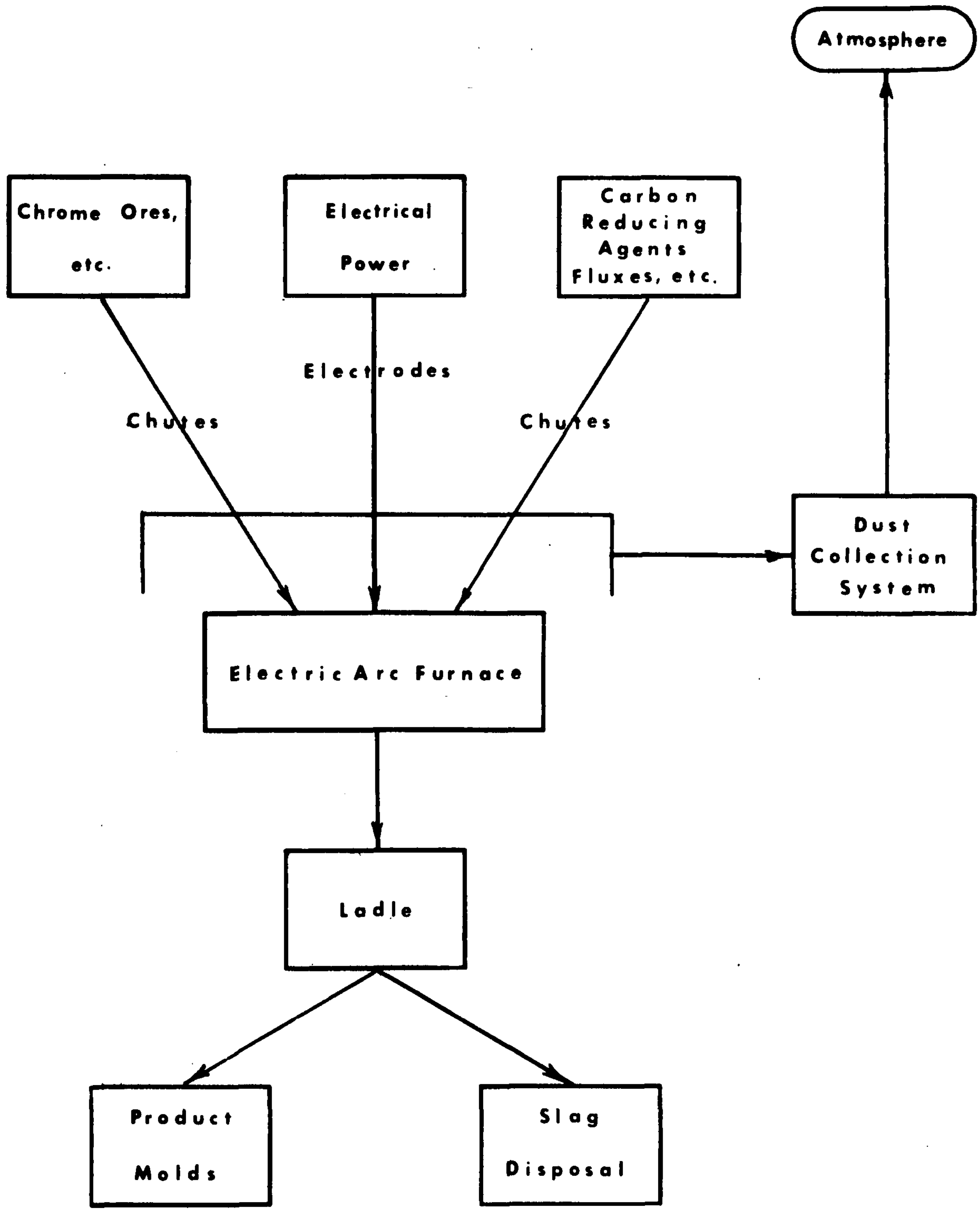


FIGURE 1. BLOCK DIAGRAM

III. SUMMARY OF RESULTS

Table I contains a summary of the results for particulate sampling. They indicate an efficiency for the baghouse of approximately 96.5%. This figure is probably a little low due to the particulate matter entering the baghouse exhaust with the induced air. See the discussion for a more thorough explanation. The average level of emission from the baghouse is approximately 30 pounds per hour. The inlet carries an average of approximately 1,827 pounds per hour.

The duct-work captures most of the fumes during the normal operation of the furnace. During tapping, however, as much as 50% of the fumes generated by tapping escape the duct-work.

Sulfur dioxide emissions from the baghouse averaged 8.8 ppm.

Particle sizing was carried out using BRINK cascade impactors. The mass median diameter (MMD) for the baghouse exhaust was approximately 0.7 to 0.8 microns. The MMD for the furnace exhaust ranged from 0.3 to 3.2 microns during taps and between taps, respectively. Complete results are contained in Appendix J.

Metals analysis revealed a heterogeneous particulate material for the furnace exhaust. Indications are that the material was a mixture of oxides. The majority constituent of all the samples was silicon dioxide. The only other large constituent was manganese. Complete results are contained in Appendix J.

SUMMARY OF RESULTS
BAGHOUSE OUTLET

Run Number	ANE-1	ACE-1	ASE-1	ANE-2	ACE-2	ASE-2
Date	8-31-71	8-31-71	8-31-71	9-1-71	9-1-71	9-1-71
Stack Flow Rate - SCFM * dry	@383,000	@383,000	@383,000	@383,000	@383,000	@383,000
% Water Vapor - % Vol.	1.00	0.22	1.88	0.55	0.42	0.61
% CO_2 - Vol % dry	0.5	0.5	0.5	0.5	0.5	0.5
% O_2 - Vol % dry	20.6	20.6	20.6	20.6	20.6	20.6
% Excess air @ sampling point	5318	5318	5318	5318	5318	5318
SO_2 Emissions - ppm dry	**	-	-	-	-	-
NO_x Emissions - ppm dry	N/A	-	-	-	-	-
Particulates						
Probe, Cyclone, & Filter Catch						
gr/SCF* dry	.0035	.0042	.0023	.0038	.0028	.0020
gr/CF @ Stack Conditions	.0029	.0035	.0019	.0031	.0023	.0017
lbs./hr.	11.49	13.79	7.55	12.47	9.19	6.56
Particulate from impinger train (% of total)	71	69	74	69	71	74
Total Catch						
gr /SCF * dry	.0120	.0135	.0090	.0121	.0098	.0078
gr /CF @ Stack Conditions	.0099	.0112	.0073	.0100	.0082	.0064
lbs./hr.	39.83	44.31	29.54	39.72	32.17	25.60

@ Calculated from inlet volume and induced air

* 70°F , 29.92 " Hg

** Not applicable for these specific samples: See Appendix B for individual results.

SUMMARY OF RESULTS

BAGHOUSE OUTLET/INLET

Run Number	ANE-3	ACE-3	ASE-3	ABD-1	ABD-2	ABD-3
Date	9-1-71	9-1-71	9-1-71	9-1-71	9-1-71	9-1-71
Stack Flow Rate - SCFM * dry	@383,000	@383,000	@383,000	@174,979	@176,093	@181,083
% Water Vapor - % Vol.	0.54	0.52	0.15	1.94	2.2	2.17
% CO_2 - Vol % dry	.5	.5	.5	1.2	1.2	1.2
% O_2 - Vol % dry	20.6	20.6	20.6	19.8	19.8	19.8
% Excess air @ sampling point	5318	5318	5318	1631	1631	1631
SO_2 Emissions - ppm dry	**	-	-	-	-	-
NO_x Emissions - ppm dry	N/A	-	-	-	-	-
Particulates Probe, Cyclone, & Filter Catch gr/SCF* dry	.0023	.0014	.0016	.5334	.1189	.3983
gr/CF @ Stack Conditions	.0019	.0011	.0013	.3486	.0785	.2587
lbs./hr.	7.55	4.60	5.25	799.9	173.2	594.4
Particulate from impinger train (% of total)	63	71	70	16.6	70.3	32.7
Total Catch gr /SCF * dry	.0062	.0049	.0054	.6397	.4001	.5917
gr /CF @ Stack Conditions	.0051	.0040	.0045	.4180	.2641	.3842
lbs./hr.	20.35	16.08	17.72	959.3	603.8	918.2

@ Calcuated from inlet volume and induced air

** Not applicable for these specific samples: See Appendix B for individual results.

* 70°F , 29.92 " Hg

IV. PROCESS DESCRIPTION

The reactive metals are generally ferroalloys which are produced in submerged arc electric furnaces. The facilities under consideration in this report are open furnaces, with hooding, and emissions are ducted through a baghouse after cooling. Figure 1 is a block diagram indicating the inlet and outlet materials.

The electric arc is employed as a concentrated source of heat. Chrome 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 ore and carbonaceous materials settle to the bottom of the furnace, the heat, in conjunction with a lack of oxygen, react with the oxide ores to produce carbon monoxide which reacts further chemically, as a reducing agent, in order to remove oxygen from the original ores and thus produce the elemental metal. Escaping gases are burned at the surface of the furnace in the so-called open units. In closed furnaces, these gases may be burned in such a manner so as to salvage their heat value.

The furnace under test produced a ferrochrome silicon product. Soderberg type electrodes are formed in place from a "paste" rather than using prebaked carbon electrodes. Induced draft fans are employed to pull fumes from the hooding into the cooling system and baghouse. Any escaping fumes rise to louvers or monitors in the roof where they are discharged.

The furnaces are tapped at intervals of somewhat less than two hours into ladles. The slag is removed from this ladle and disposed of by various means. Molten product is poured into molds, after which it is broken into usable sizes.

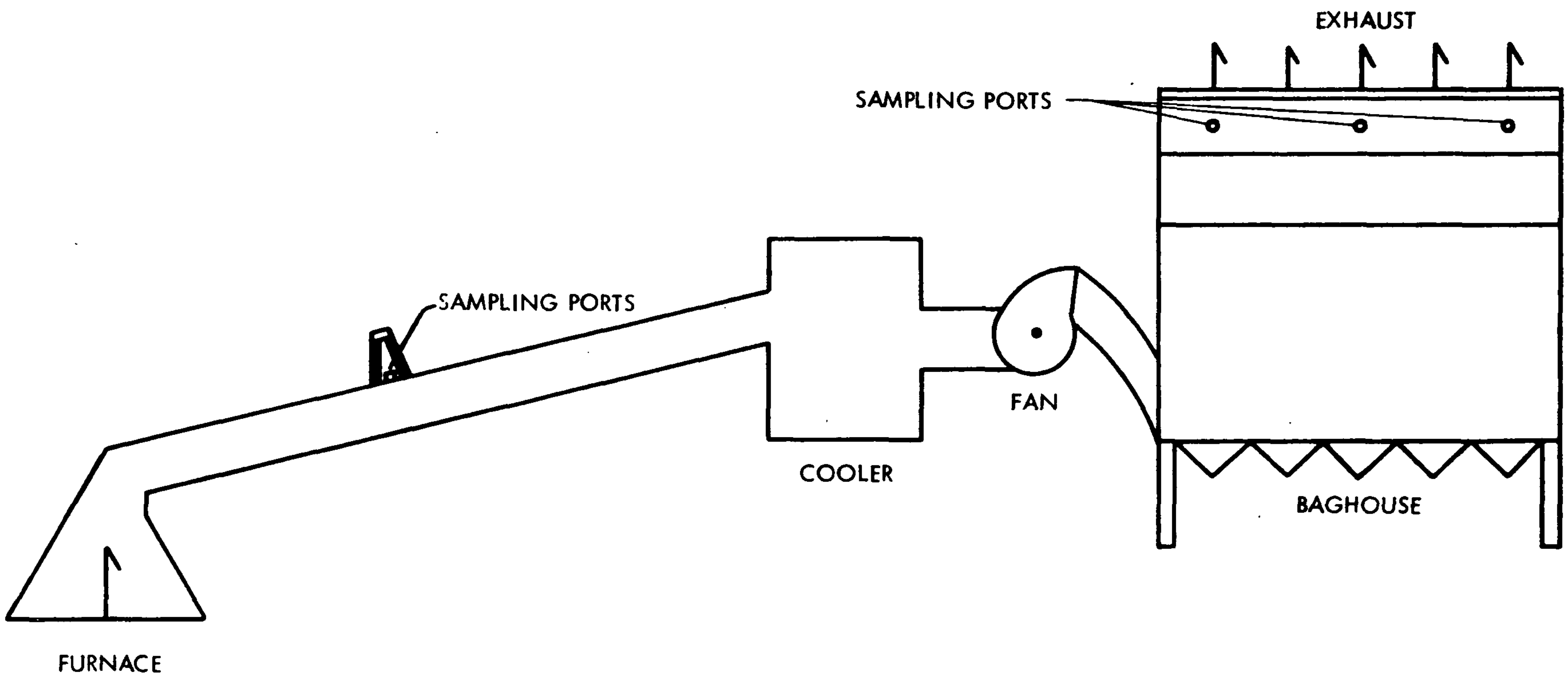


FIGURE 2. PROCESS FLOW DIAGRAM

V. LOCATION OF SAMPLING POINTS

Sample port locations were selected where most satisfactory during a presurvey inspection trip, and approved by the OAP Project Officer. On the collector inlet side four ports were selected on the top side of the rectangular horizontal ducting, in the middle of a long, straight section. On the outlet side three ports were selected at the top of the baghouse. These locations were not ideal, but were in the only available location. The location should have no significant effect on the results due to the particle size and low concentration of emissions from the baghouse. The inlet side required a framework to suspend the sampling train over the ports, capable of moving the train horizontally and vertically. Platforms were required on the outlet side due to the slope of the roof. Sampling ports and platforms were provided by the plant. Figure 2 (page 9) shows a simplified cross-section of the system under test and indicates the relative location of sampling ports.

On the inlet side each of the cross-sections was divided for 5-position sampling, giving a total of 20 equal-area sampling points. On the outlet side three trains were used, one at each port. Only one point was sampled at each port, six feet into the port. Figure 3 shows a sketch of the location of the sample points.

The downstream sampling locations were agreed upon as acceptable, although they did not meet the criteria as established by EPA/OAP. Further discussion of this subject can be found in Section IX.

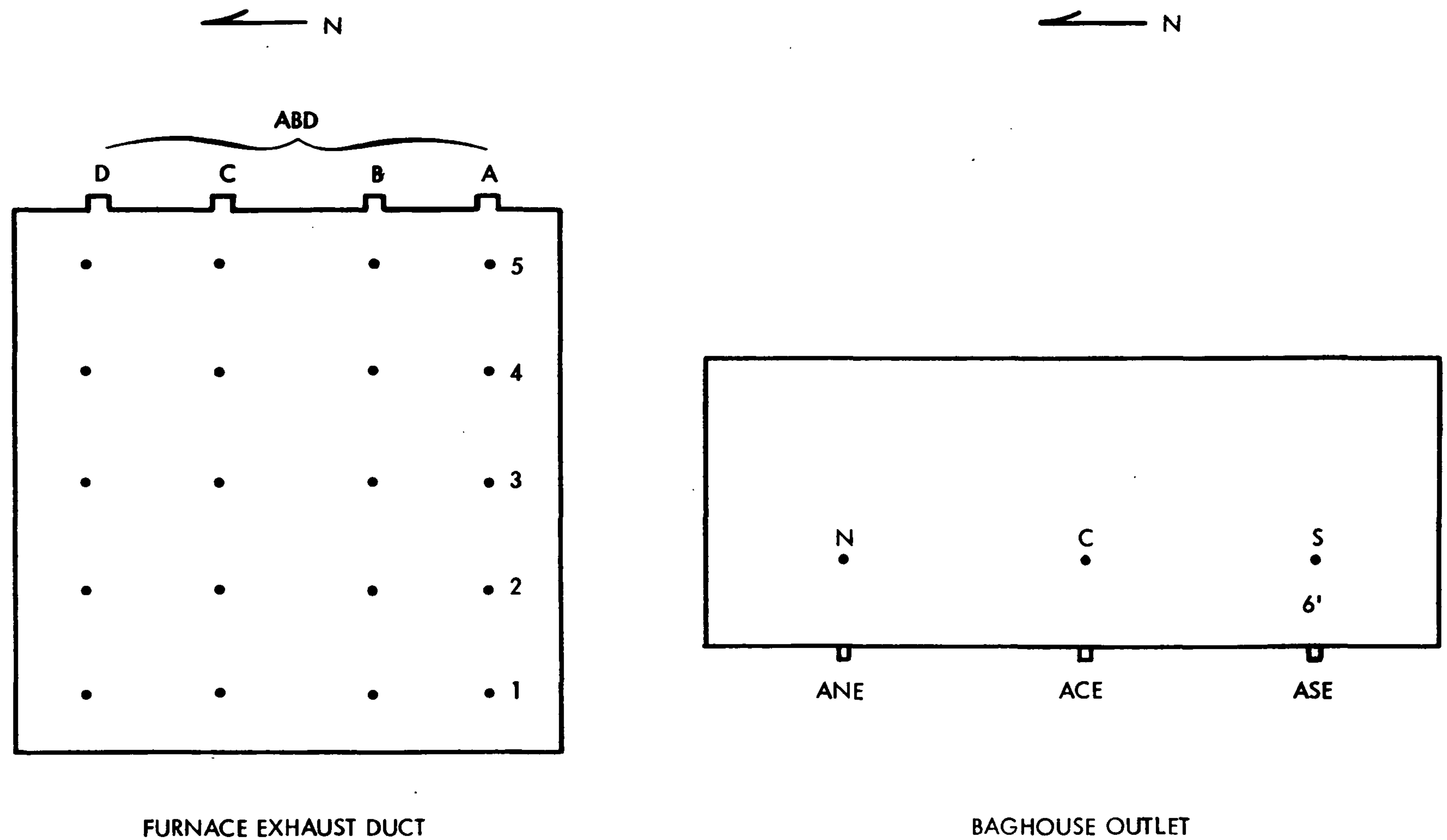


FIGURE 3. SAMPLE POINT LOCATION

VI PROCESS OPERATION

Process operations were within normal parameters throughout the testing period.

Actual operating data for the plant is contained in Appendix C.

The furnace was operating at 20,000 KW during the test periods. The feed rate of materials was 25,000 lb./hr. producing ferrochrome silicon (36 parts chrome and 40 parts silicon).

The toal dust collected from the baghouse storage hopper in a 47-3/4 hour period was 44,620 pounds. This indicates an emission rate of approximately 935 lb./hr.

VII. SAMPLING PROCEDURES

All test procedures were discussed with the Project Officer in advance. All procedures 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 OAP train as described in Appendix E-1.

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.

Particle sizing was carried out using Brink cascade impactor collectors.

Sampling for metals analysis was conducted using the OAP train with glass probe, without the cyclone collector. Only the material collected on the filter was saved for analysis.

VIII. CLEANUP AND ANALYTICAL PROCEDURES

Clean-up of the EPA particulate train was conducted in accordance with the procedures as outlined in the standard EPA source testing methods. Basically the clean-up is accomplished using acetone and water rinsing, placing the various portions of the samples in separate containers, and then drying the samples, and extracting organic material from the water. These procedures are outlined in detail in Appendix E-2.

Sulfur dioxide was analyzed for using the Modified Shell Development Method.

Combustion gases were analyzed on site by Orsat measurement using a Burrell Industrial Gas Analyzer.

Particle size determination was carried out in the plant laboratory using a recently calibrated Mettler scale.

Metals analysis is accomplished using various methods, including electron beam microanalysis and atomic absorption.

See Appendix E-2 for further details.

IX DISCUSSION

A. Results

Continued problems were encountered with the filter of the EPA smapling train plugging during sampling. (See related report FA-1 for previous problems). After experiencing rapid plugging of the filters on sample ABD-1, possible solutions were discussed with the EPA representatives. The decision was made to place the filter after the first three impingers. Therefore, the data resulting from the particulate split is not reliable for samples ABD-2 and ABD-3. It is, however, representative of total emissions. This fix improved the situation and only one other related problem was encountered at this location. During sample ABD-2 one impinger orifice plugged. The train was shutdown and the tip was carefully cleared before continuing the sample.

The outlet samples taken on the baghouse were run non-isokinetically at a high sampling rate. The reason for this was to allow a larger sample volume to be collected. Due to the high efficiency of the baghouse, it was agreed that the concentration of particulate matter would be very low and that the particle sizes would be very small. This would necessitate a large sample volume and would allow representative sampling without iso-kinetic flow. The data collected supported these conclusions. Therefore, the data is considered representative and reliable. Each sample was calculated to give an emission rate in pounds per hour based on the entire air flow through the baghouse.

The computed baghouse efficiency of approximately 96.5% is not necessarily correct. Actual efficiency is probably in excess of 98%. Induced air is over half of the volume of air leaving the baghouse. The air being induced at the bottom of the baghouse is heavily laden with dust from the surrounding area, including the emissions from a near-by-plant. Although the sample locations sampled the air leaving the bags proper, some induced air was probably sampled also, causing the sample not to be completely representative of the emissions from the bags. A high volume air sample taken (not by RRI) near the bottom, but not in, the baghouse during the sampling program supports the belief that a significant amount of what is emitted from the baghouse exhaust is introduced by induced air. Personal experience with baghouse operations and past history support the conclusion that the baghouse is probably a little more efficient than the calculated value.

The induced air was measured using a rotary vane anemometer to measure the air flow around the bag compartments. Three of the total of twelve compartments were measured. Multiple points were measured in each compartment and they indicated a very uniform flow rate from point to point and compartment to compartment. The open area around each compartment was estimated by first measuring the area, then an 80% open area in the grating surface was estimated, using this fraction as effective area. The volume estimated from this information was then added to the average volume measured on the baghouse inlet duct. No correction was made for possible leakage in the system prior to the baghouse.

The samples taken for combustion gas analysis by Orsat showed very low CO_2 and high O_2 concentrations. The calculations indicate that perhaps the Orsat measurement of combusion gases and calculation of "excess air" is not completely representative for this particular process.

The filterable particulate at the outlet of the baghouse ranged from 26% to 37%. Thus the majority of the emissions from the bags are either very fine particulate or "condensible" fumes. This further supports the decision to use non-isokinetic sampling. The only sampling taken on the furnace exhaust with the sampling train in a normal configuration was ABD-1. This sample indicates that this gas carries an approximate 15-85 split between "condensible" and filterable material. Previous tests (FA-1 and FA-2) have indicated the "condensible" portion of the fumes to be less than 5% of the total catch. No feasible explanation can be made as to why this apparent discrepancy exists.

The particle size measurements taken indicate a very small mass median diameter (MMD) at the baghouse outlet. Very long samples were required at this location in order to insure adequate sample deposition on the plates for weighing. Sampling ranged from 2 to 4 hours. The furnace exhaust sampling presented the opposite problem. Sampling time had to be reduced to 5 minutes to avoid overloading the impactor plates. The MMD at this location varied widely between samples (indicative of the nature of the process) and was distinctly larger during non-tapping periods. This would indicate that the tapping process released a finer particulate or fumes than normal non-tapping operation.

Chemical analysis of the particulate emissions revealed that the emissions were largely oxides and primarily silicon dioxide. The results present no new or unexpected information.

B. Operating Conditions

The operation of furnace # 9 is nonuniform, involving a series of feeding, spreading and tapping operations. This would explain at least part of the variation in emission data gathered.

In conjunction with the tests performed by Resources Research, Airco Alloys and Carbide measured the amount of collected dust from the baghouse during a period of almost two days. The material collected came to approximately 935 lb./hr. This correlates closely with the measured amount at the furnace exhaust duct, and very closely with samples ABD-1 and ABD-3 (959.3 lb./hr and 918.2 lb./hr.).

The hood and duct work used to collect the furnace emissions was very efficient during between tap operation, collecting approximately 95% of the emissions. The hood and duct work for the tapping area was far less efficient and collected only about half of the tapping emissions.

C. Sampling and Analytical Procedures

All sampling methods, and analytical procedures where appropriate, were essentially the same as those methods being issued by the Environmental Protection Agency for source sampling. Any deviations are indicated at the appropriate location in this report and were carried out with permission of the EPA project officer.

The sample ports on the furnace exhaust duct presented a minor sampling problem. Their location required vertical traverses at a slight angle from the true vertical. Thus the sample box and probe had to be held in place at all times while being suspended by a block and tackle arrangement. The ports were in the middle of a long straight duct, at least 10 pipe diameters from any bends or obstruction up or downstream.

X APPENDICES

APPENDIX A

COMPLETE PARTICULATE RESULTS WITH EXAMPLE CALCULATIONS

SUMMARY OF RESULTS
BAGHOUSE OUTLET

Run Number	ANE-1	ACE-1	ASE-1	ANE-2	ACE-2	ASE-2
Date	8-31-71	8-31-71	8-31-71	9-1-71	9-1-71	9-1-71
Stack Flow Rate - SCFM * dry	@383,000	@383,000	@383,000	@383,000	@383,000	@383,00
% Water Vapor - % Vol.	1.00	0.22	1.88	0.55	0.42	0.61
% CO_2 - Vol % dry	0.5	0.5	0.5	0.5	0.5	0.5
% O_2 - Vol % dry	20.6	20.6	20.6	20.6	20.6	20.6
% Excess air @ sampling point	5318	5318	5318	5318	5318	5318
SO_2 Emissions - ppm dry	**	-	-	-	-	-
NO_x Emissions - ppm dry	N/A	-	-	-	-	-
Particulates						
Probe, Cyclone, & Filter Catch						
gr/SCF* dry	.0035	.0042	.0023	.0038	.0028	.0020
gr/CF @ Stack Conditions	.0029	.0035	.0019	.0031	.0023	.0017
lbs./hr.	11.49	13.79	7.55	12.47	9.19	6.56
Particulate from impinger train (% of total)	71	69	74	69	71	74
Total Catch						
gr /SCF * dry	.0120	.0135	.0090	.0121	.0098	.0078
gr /CF @ Stack Conditions	.0099	.0112	.0073	.0100	.0082	.0064
lbs./hr.	39.83	44.31	29.54	39.72	32.17	25.60

@ Calculated from inlet volume and induced air

* 70°F, 29.92" Hg

** Not applicable for these specific samples: See Appendix B for individual results.

SUMMARY OF RESULTS

BAGHOUSE OUTLET/INLET

Run Number	ANE-3	ACE-3	ASE-3	ABD-1	ABD-2	ABD-3
Date	9-1-71	9-1-71	9-1-71	9-1-71	9-1-71	9-1-71
Stack Flow Rate - SCFM * dry	@383,000	@383,000	@383,000	@174,979	@176,093	@181,083
% Water Vapor - % Vol.	0.54	0.52	0.15	1.94	2.2	2.17
% CO_2 - Vol % dry	.5	.5	.5	1.2	1.2	1.2
% O_2 - Vol % dry	20.6	20.6	20.6	19.8	19.8	19.8
% Excess air @ sampling point	5318	5318	5318	1631	1631	1631
SO_2 Emissions - ppm dry	**	-	-	-	-	-
NO_x Emissions - ppm dry	N/A	-	-	-	-	-
Particulates Probe, Cyclone, & Filter Catch gr/SCF* dry	.0023	.0014	.0016	.5334	.1189	.3983
gr/CF @ Stack Conditions	.0019	.0011	.0013	.3486	.0785	.2587
lbs./hr.	7.55	4.60	5.25	799.9	173.2	594.4
Particulate from impinger train (% of total)	63	71	70	16.6	70.3	32.7
Total Catch gr /SCF * dry	.0062	.0049	.0054	.6397	.4001	.5917
gr /CF @ Stack Conditions	.0051	.0040	.0045	.4180	.2641	.3842
lbs./hr.	20.35	16.08	17.72	959.3	603.8	918.2

@ Calcuated from inlet volume and induced air

** Not applicable for these specific samples: See Appendix B for individual results.

* 70°F , 29.92 " Hg

SOURCE TESTING CALCULATION FORMS

Test. No. ______ No. Runs 6

Name of Firm AIRCO

Location of Plant NIAGARA FALLS, N. Y.

Type of Plant REACTIVE METAL

Control Equipment BAG FILTERS

Sampling Point Locations BAGHOUSE EXHAUST

Pollutants Sampled PARTICULATE

Time of Particulate Test:

Run No. ANE-1 Date 8-31-71 Begin 17:19 End 19:19

Run No. ACE-1 Date 8-31-71 Begin 17:23 End 19:23

Run No. ASE-1 Date 8-31-71 Begin 17:22 End 19:22

Run No. ANE-2 Date 9-1-71 Begin 09:02 End 13:10

Run No. ACE-2 Date 9-1-71 Begin 09:15 End 13:02

Run No. ASE-2 Date 9-1-71 Begin 09:10 End 12:49

PARTICULATE EMISSION DATA

Run No.	ANE-1	ACE-1	ASE-1	ANE-2	ACE-2	ASE-2
P_b barometric pressure, "Hg Absolute	29.8	29.8	29.8	29.8	29.8	29.8
P_m orifice pressure drop, "H_2O	2.0	2.0	2.0	3.0	4.0	4.0
V_m volume of dry gas sampled @ meter conditions, ft.^{3}	92.54	93.42	95.09	118.38	129.22	136.94
T_m Average Gas Meter Temperature, ^oF	92	114	112	116	122	112
$V_{m_{std.}}$ Volume of Dry Gas Sampled @ Standard Conditions, ft.^{3}	88.72	86.13	87.97	109.13	118.27	127.54
V_w Total H_2O collected, ml., Impingers & Silical Gel.	18.9	4.0	35.7	13.7	11.4	16.5
$V_{w_{gas}}$ Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	.90	.19	1.69	0.6	0.5	0.78

* 70^{o}F, 29.92" Hg

PARTICULATE EMISSION DATA (cont'd)

Run No.	ANE-1	ACE-1	ASE-1	ANE-2	ACE-2	ASE-2
%M - % Moisture in the stack gas by volume	1.00	.22	1.88	0.55	0.42	.61
M_d - Mole fraction of dry gas	0.99	1.00	0.98	0.99	1.0	.99
% CO_2	0.5	0.5	0.5	0.5	0.5	0.5
% O_2	20.6	20.6	20.6	20.6	20.6	20.6
% N_2	78.9	78.9	78.9	78.9	78.9	78.9
MW_d - Molecular weight of dry stack gas	28.9	28.9	28.9	28.9	28.9	28.9
M W - Molecular weight of stack gas	28.8	28.9	28.7	28.9	28.8	28.8
ΔPs - Velocity Head of stack gas, In.H_2O	-	-	-	-	-	-
T_s - - Stack Temperature, ^oF	175	175	175	172	172	172
$\sqrt{\Delta P_s X(T_s+460)}$	-	-	-	-	-	-
P_s - Stack Pressure, "Hg. Absolute	29.8	29.8	29.8	29.8	29.8	29.8
V_s - Stack Velocity @ stack conditions, fpm	-	-	-	-	-	-
A_s - Stack Area, $in.^2$	-	-	-	-	-	-
Q_s - Stack Gas Volume @ Standard Conditions, *SCFM *	383,000	383,000	383,000	383,000	383,000	383,000
T_t - Net Time of Test, min.	120	120	120	138	120	120
D_n - Sampling Nozzle Diameter, in.	.50	.50	.50	.50	.50	.50
%I - Percent isokinetic	-	-	-	-	-	-
m_f - Particulate - probe, cyclone and filter, mg.	20.4	23.4	13.0	26.6	21.8	16.9
m_t - Particulate - total, mg.	69.5	75.3	51.3	85.6	71.2	64.5
C_{an} - Particulate - probe, cyclone, and filter, gr/SCF	.0035	.0042	.0023	.0038	.0028	.0020
C_{ao} - Particulate - total, gr/SCF	.0120	.0135	.0090	.0121	.0098	.0078
C_{at} - Particulate - probe, cyclone, & filter gr/cf @ stack conditions	.0029	.0035	.0019	.0031	.0023	.0017

* Calculated from inlet volume plus induced air

PARTICULATE EMISSION DATA (cont'd)

Run No.	ANE-1	ACE-1	ASE-1	ANE-2	ACE-2	ASE-2
C_{au} - Particulate, total, gr/cf @ stack cond.	.0099	.0112	.0073	.0100	.0082	.0064
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.	11.49	13.79	7.55	12.47	9.19	6.56
C_{ax} - Particulate - total, lb/hr.	39.83	44.31	29.54	39.72	32.17	25.60
% EA - % Excess air @ sampling point	5318	5318	5318	5318	5318	5318

*70°F. 29.92" Hg.

SOURCE TESTING CALCULATION FORMS

Test. No. ______ No. Runs 6

Name of Firm AIRCO

Location of Plant NIAGARA FALLS, N.Y.

Type of Plant REACTIVE METAL

Control Equipment BAG FILTERS

Sampling Point Locations BAGHOUSE EXHAUST/FURNACE EXHAUST

Pollutants Sampled PARTICULATE

Time of Particulate Test:

Run No.	Date	Begin	End
ANE-3	9-1-71	14:34	17:34
ACE-3	9-1-71	14:32	17:32
ASE-3	9-1-71	14:30	17:30
ABD-1	8-31-71	17:17	18:57
ABD-2	9-1-71	09:10	10:50
ABD-3	9-1-71	14:40	16:20

PARTICULATE EMISSION DATA

Run No.	ANE-3	ACE-3	ASE-3	ABD-1	ABD-2	ABD-3
P_b barometric pressure, "Hg Absolute	29.8	29.8	29.8	29.8	29.8	29.8
P_m orifice pressure drop, "H_2O	3.3	4.8	4.3	.86	.86	0.9
V_m volume of dry gas sampled @ meter conditions, ft.^{3}	184.0	214.06	216.26	52.75	51.35	52.01
T_m Average Gas Meter Temperature, ^oF	131	138	130	93	85	100
$V_{m_{std.}}$ Volume of Dry Gas Sampled @ Standard Conditions, ft.^{3}	165.3	191.34	195.28	50.42	49.86	49.15
V_w Total H_2O collected, ml., Impingers & Silical Gel.	18.9	20.4	7.3	21.7	23.7	23.0
$V_{w_{gas}}$ Volume of Water Vapor Collected ft.^{3} @ Standard Conditions*	0.9	0.97	0.3	1.0	1.1	1.09

* 70^oF, 29.92" Hg

PARTICULATE EMISSION DATA (cont'd)

Run No.	ANE-3	ACE-3	ASE-3	ABD-1	ABD-2	ABD-3
%M - % Moisture in the stack gas by volume	0.54	0.52	0.15	1.94	2.2	2.17
M_d - Mole fraction of dry gas	1.0	0.99	1.0	1.0	0.98	0.98
% CO_2	0.5	0.5	0.5	1.2	1.2	1.2
% O_2	20.6	20.6	20.6	19.8	19.8	19.8
% N_2	78.9	78.9	78.9	79.0	79.0	79.0
MW_d - Molecular weight of dry stack gas	28.9	28.9	28.9	29.0	29.0	29.0
M W - Molecular weight of stack gas	28.9	28.8	28.9	28.8	28.8	28.8
ΔPs - Velocity Head of stack gas, In.H_2O	-	-	-	.89	.89	.96
T_s - Stack Temperature, ^oF	178	178	178	331	323	336
$\sqrt{\Delta P_s X(T_s+460)}$	-	-	-	26.5	26.4	27.6
P_s - Stack Pressure, "Hg. Absolute	29.8	29.8	29.8	29.8	29.8	29.8
V_s - Stack Velocity @ stack conditions, fpm	-	-	-	3935	3920	4098
A_s - Stack Area, $in.^2$	-	-	-	9792	9792	9792
Q_s - Stack Gas Volume @ Standard Conditions, *SCFM	383,000	383,000	383,000	174,979	176,093	181,083
T_t - Net Time of Test, min.	180	180	180	100	100	100
D_n - Sampling Nozzle Diameter, in.	.500	.500	.500	.1875	.1875	.1875
%I - Percent isokinetic	-	-	-	107.1	120.8	102.3
m_f - Particulate - probe, cyclone and filter, mg.	24.7	17.6	20.6	1,746.5	385.0	1,271.2
m_t - Particulate - total, mg.	66.1	60.9	68.1	2,094.3	1,297.2	1,888.6
C_{an} - Particulate - probe, cyclone, and filter, gr/SCF	.0023	.0014	.0016	.5334	.1189	.3983
C_{ao} - Particulate - total, gr/SCF	.0062	.0049	.0054	.6397	.4001	.5917
C_{at} - Particulate - probe, cyclone, & filter gr/cf @ stack conditions	.0019	.0011	.0013	.3486	.0785	.2587

PARTICULATE EMISSION DATA (cont'd)

Run No.	ANE-3	ACE-3	ASE-3	ABD-1	ABD-2	ABD-3
C_{au} - Particulate, total, gr/cf @ stack cond.	.0051	.0040	.0045	.4180	.2641	.3842
C_{aw} - Particulate, probe, cyclone, and filter, lb/hr.	7.55	4.60	5.25	799.9	179.4	618.1
C_{ax} - Particulate - total, lb/hr.	20.35	16.08	17.72	959.3	603.8	918.2
% EA - % Excess air @ sampling point	5318	5318	5318	1631	1631	1631

*70°F. 29.92" Hg.

SAMPLE PARTICULATE CALCULATIONS

ABD-1

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

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

$$\frac{17.7 \times 52.75 \left(29.8 + \frac{0.86}{13.6}\right)}{(93 + 460)}$$

50.42

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

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

$$= 0.0474 \times 21.7 =$$

1.0

3. % moisture in stack gas

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

$$= \frac{100 \times 1.0}{50.42 + 1.0} =$$

1.94

4. Mole fraction of dry gas

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

$$\frac{100 - 1.94}{100} =$$

$$0.98$$

5. Average molecular weight of dry stack gas

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

$$(1.2 \times \frac{44}{100}) + (19.8 \times \frac{32}{100}) + (79.0 \times \frac{28}{100}) =$$

$$28.98$$

6. Molecular weight of stack gas

$$M\,W = M\,W_d \times M_d + 18\ (1 - M_d)$$

$$28.98 \times 0.98 + 18\ (1 - 0.98) =$$

$$28.76$$

7. Stack velocity @ stack conditions, fpm

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

$$= 4350 \times \sqrt{.89 \times (331 + 460)} \left[\frac{1}{29.8 \times 28.76}\right] = 1/2$$

$$3935$$

8. Stack gas volume @ standard conditions, SCFM

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

$$= \frac{0.23 \times 3935 \times 9792 \times 0.98 \times 29.8}{(331 + 460)} =$$

174,979

9. Percent isokinetic

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

$$= \frac{1032 \times (331 + 460) \times 52.75}{3935 \times 100 \times 29.8 \times 0.98 \times 0.035} =$$

107.1

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

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

$$= 0.0154 \times \frac{1746.5}{50.42} =$$

0.5334

11. Particulate total, gr/SCF

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

$$= 0.0154 \times \frac{2094.3}{50.42} =$$

0.6397

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

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

$$= \frac{17.7 \times 0.5334 \times 29.8 \times 0.98}{(331 + 460)} =$$

0.3486

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

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

$$= \frac{17.7 \times 0.6397 \times 29.8 \times 0.98}{(331 + 460)} =$$

0.4180

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

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

0.00857 X 0.5334 X 174979

799.9

15. Particulate - total, lb/hr.

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

= 0.00857 X 0.6397 X 174979 =

959.3

16. % excess air at sampling point

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

$$= \frac{100 \times 19.8}{(0.266 \times 79.0) - 19.8} =$$

$$= 1631$$

BAGHOUSE EXHAUST VOLUME (Q_s)

DETERMINATION

AVERAGE Q_s, INLET:	178,000 cfm
NUMBER OF BAG COMPARTMENTS:	12
AREA AROUND EACH COMPARTMENT (including grating)	88 ft^2
AREA OPEN AROUND BAG COMPARTMENTS: (estimated 80% open area)	853 ft^2
VELOCITY (avg.) AROUND BAG COMPARTMENTS: (3 compartments measured and averaged)	240.1 fpm
Q_s INDUCED:	205,000cfm
Q_s TOTAL:	383,000cfm

EFFECTIVE AREA = $88 ft^2 \times .80 \times 12 = 853\ ft^2$

AVG. VELOCITY = $\frac{237.4 + 239.1 + 243.8}{3} = 240.1$ fpm

Q_s INDUCED = 240.1 ft/min. X 853 ft^2 = 204,805 cfm = app. 205,000 cfm

Q_s TOTAL = 205,000 cfm + 178,000 cfm = 383,000 cfm

APPENDIX B

COMPLETE GASEOUS RESULTS WITH EXAMPLE CALCULATIONS

SO_2 EMISSION DATA

Run No. BAGHOUSE EXHAUST	ANE-1	ACE-1	ASE-1			
Date	9/2/71	9/2/71	9/1/71			
mg SO_2	2.5	2.4	10.8			
T_m - Average Gas Meter Temperature, ^oF	84	84	107			
P_b - Barometric Pressure, "Hg abs.	29.8	29.8	29.8			
V_m - Volume of dry gas sampled @ meter conditions, $ft.^3$	3.96	3.82	17.78			
ppm SO_2	9.0	8.9	8.5			

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

NOT USED ON **ACE-1, ANE-1**
DUE TO VACUUM ON METER

$$\frac{\text{mg } SO_2}{\text{VSTD}} \times 13.1 = \text{ppm } SO_2 = \frac{2.5}{3.64} \times 13.1 = 9.0$$

$$\text{VSTD} = \text{Vm} \left(\frac{530}{T_M + 460}\right) \left(\frac{Pb - Pm}{29.92}\right)$$

$$= 3.96 \left(\frac{530}{84+460}\right) \left(\frac{29.8 - 1.6}{29.92}\right) = 3.64$$

DETERMINATION OF SO_2 EMISSIONS*

ACE & ANE-1

Sample Location	Date Sampled	Time Sampled	Sample Number	milligrams	Vstd-Metered Gas Vol. (dry, STD)	milligrams/cu ft	** factor	ppm
Baghouse Exhaust	9/2/71	1239-1339	ANE-1	2.5	3.64	.69	13.1	9.0
	9/2/71	1032-1208	ACE-1	2.4	3.52	.68	13.1	8.9

* This special format was used instead of the OAP forms for samples ANE-1 & ACE1 because the meter was kept under vacuum, that is before the pump.

** From page 173, Source Testing Manual, County of Los Angeles, California.

ORSAT FIELD DATA

Location OUTLET

Comments:

Date 9/2/71

Time A.M.

Operator BLESSING

Test Run	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
1	0.5	21.2	0
2	0.5	21.4	0
3	0.5	20.8	0
Avg.	0.5	21.13	0

NCAP-31 (12/67)

ORSAT FIELD DATA

Location INLET

Date 9/1/71

Time P.M.

Operator Blessing

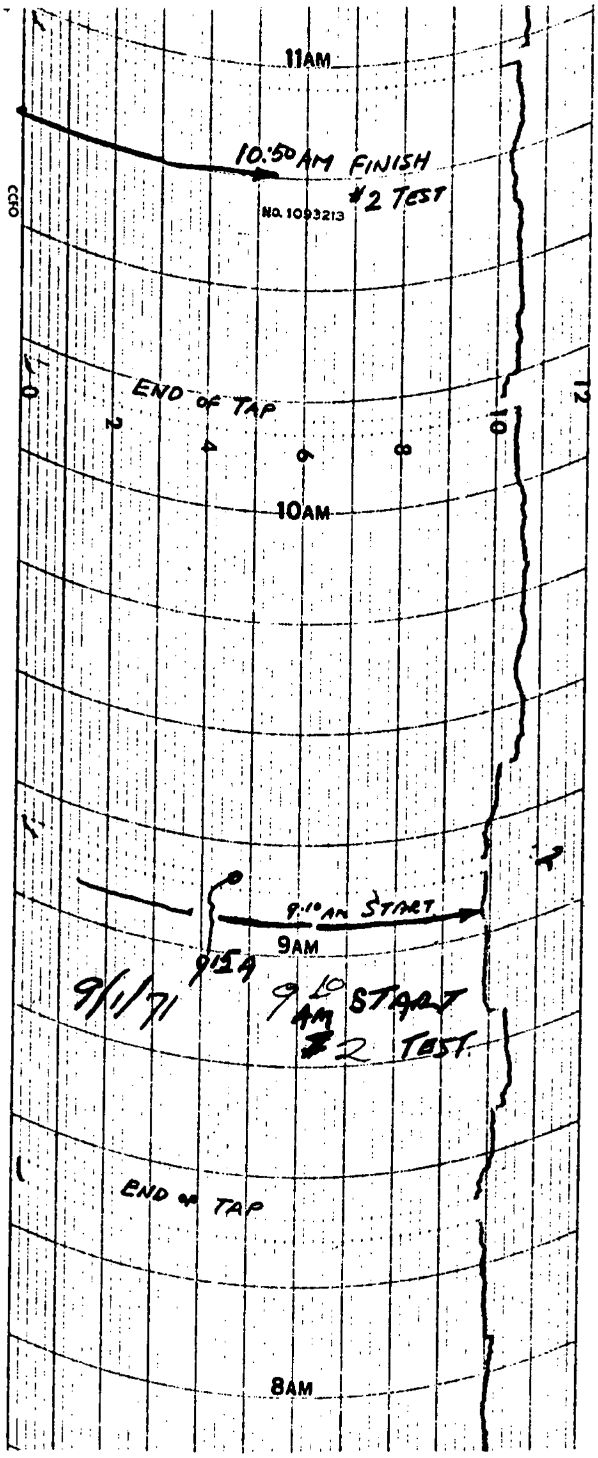
Comments:

Test Run	(CO_2) Reading 1	(O_2) Reading 2	(CO) Reading 3
1	1.2	21.4	0
2	1.2	21.4	0
3	1.2	20.2	0
Avg.	1.2	21.0	0

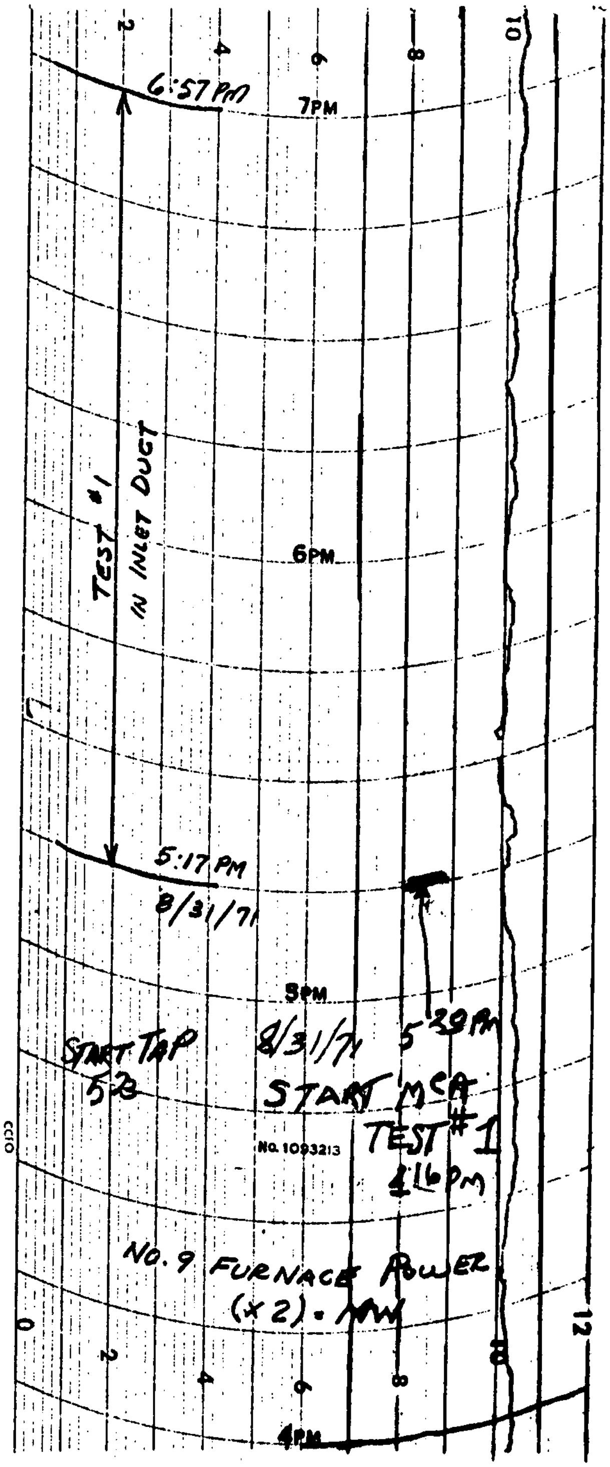
NCAP-31 (12/67)

APPENDIX C

COMPLETE OPERATION RESULTS



TEST #2



TEST #1

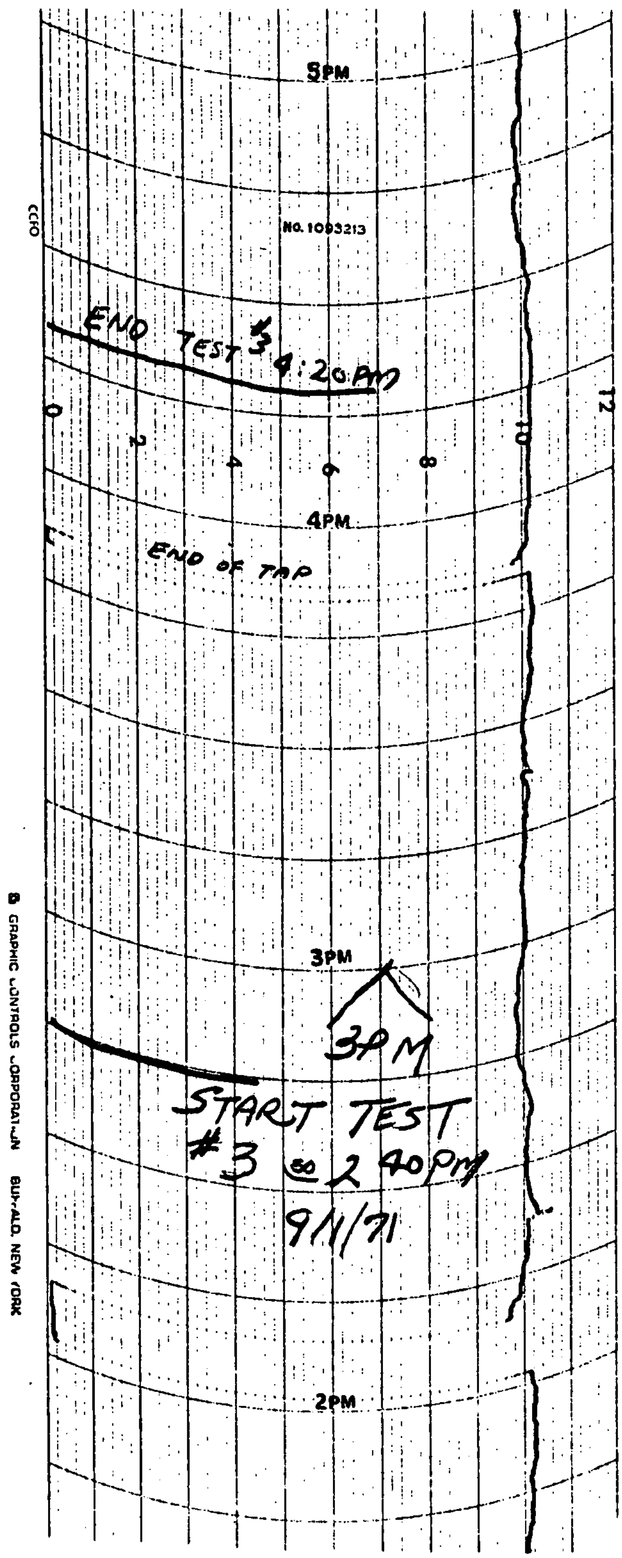
NO. 9 FURNACE LOADS

EMISSION TESTS

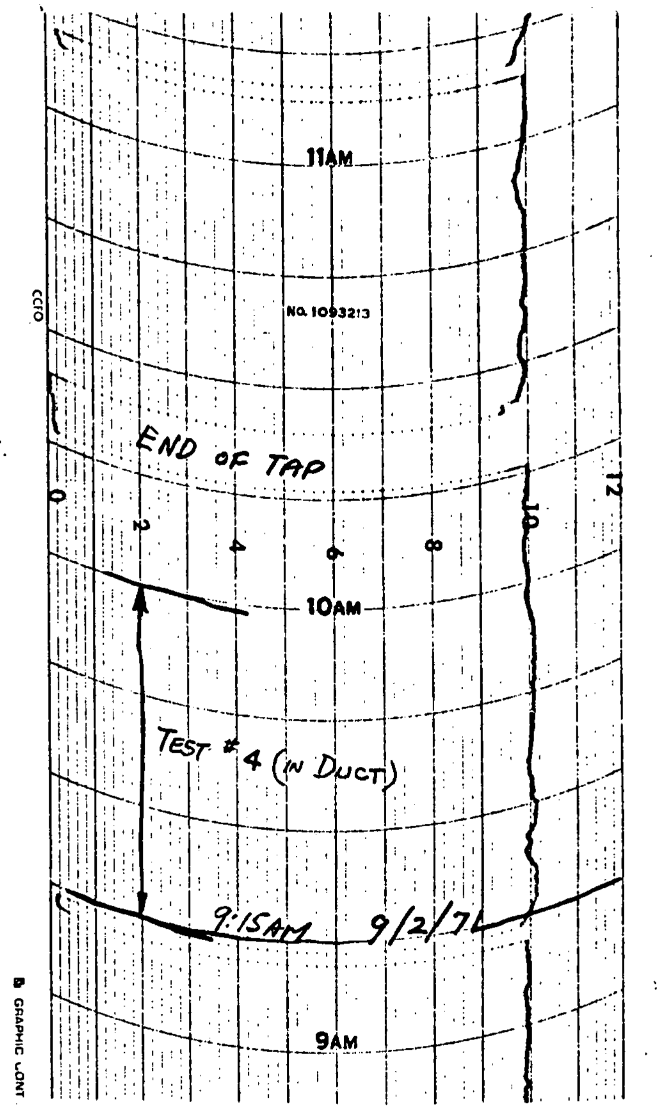
AIRCO ALLOYS & CARBIDE,

NIAGARA FALLS,

N.Y.



TEST # 3



TEST # 4

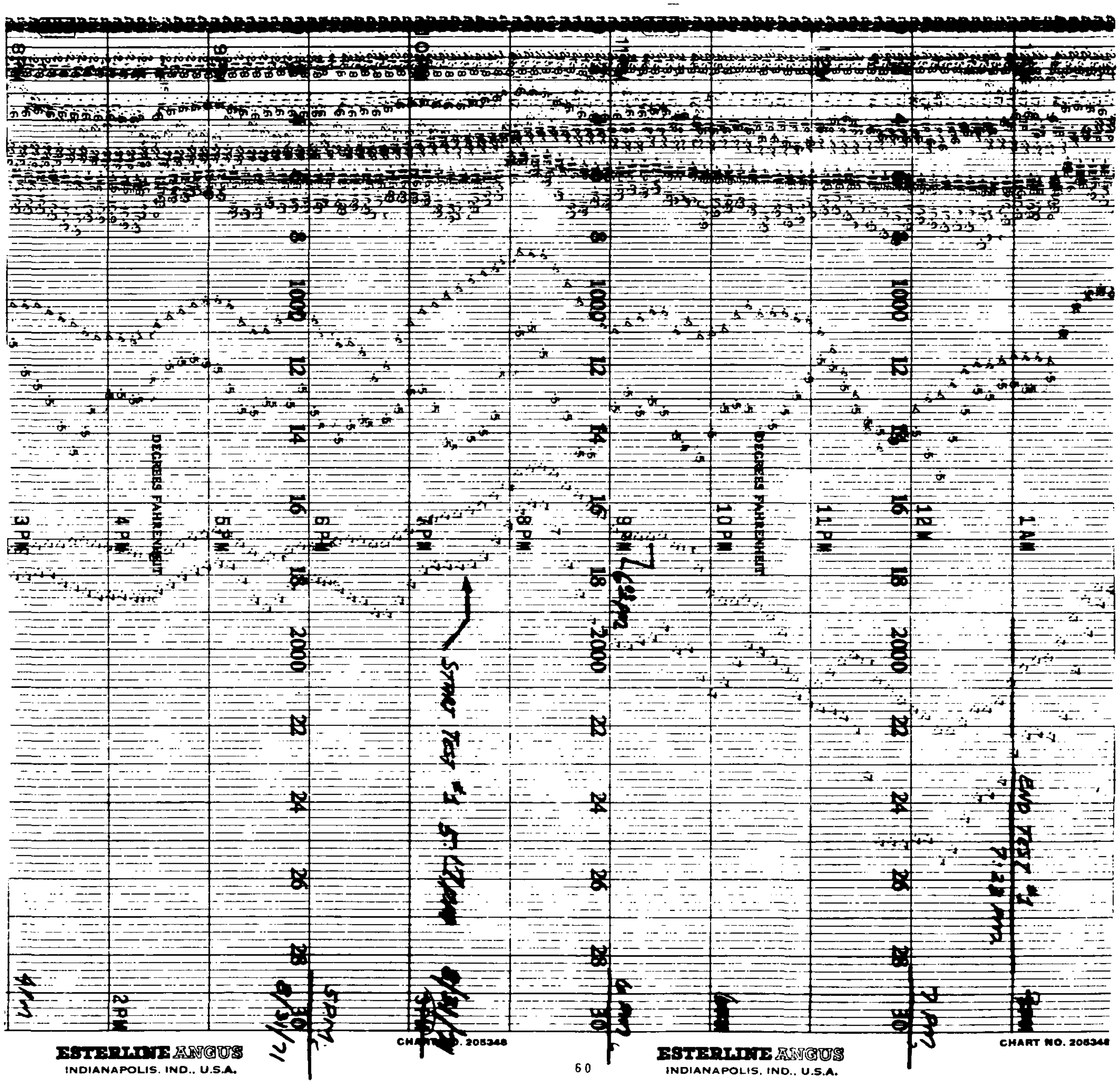
NO. 9 FURNACE LOADS
EMISSION TESTS

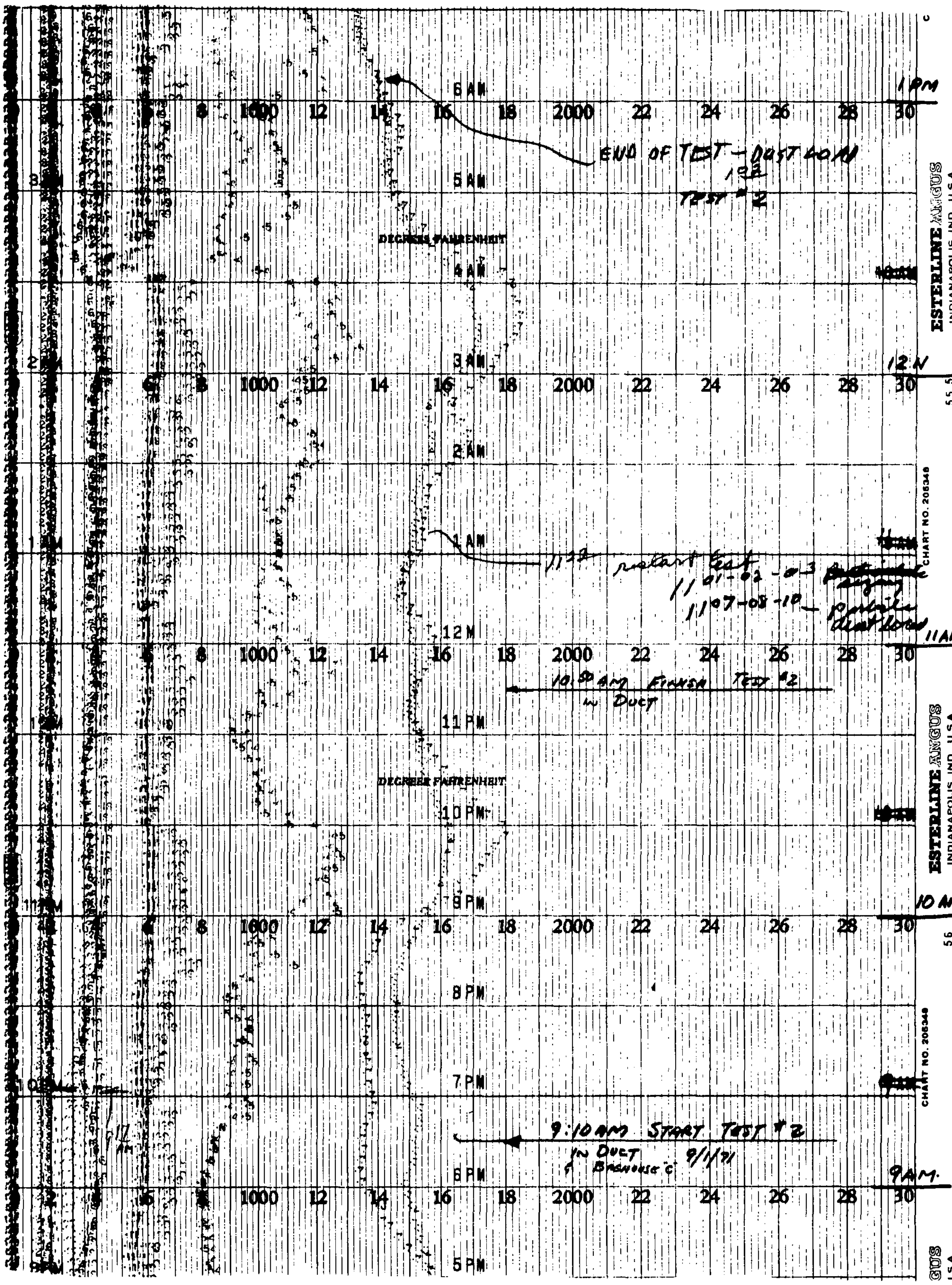
A.A. & C.
NIAGARA FALLS

Temperature Recorder

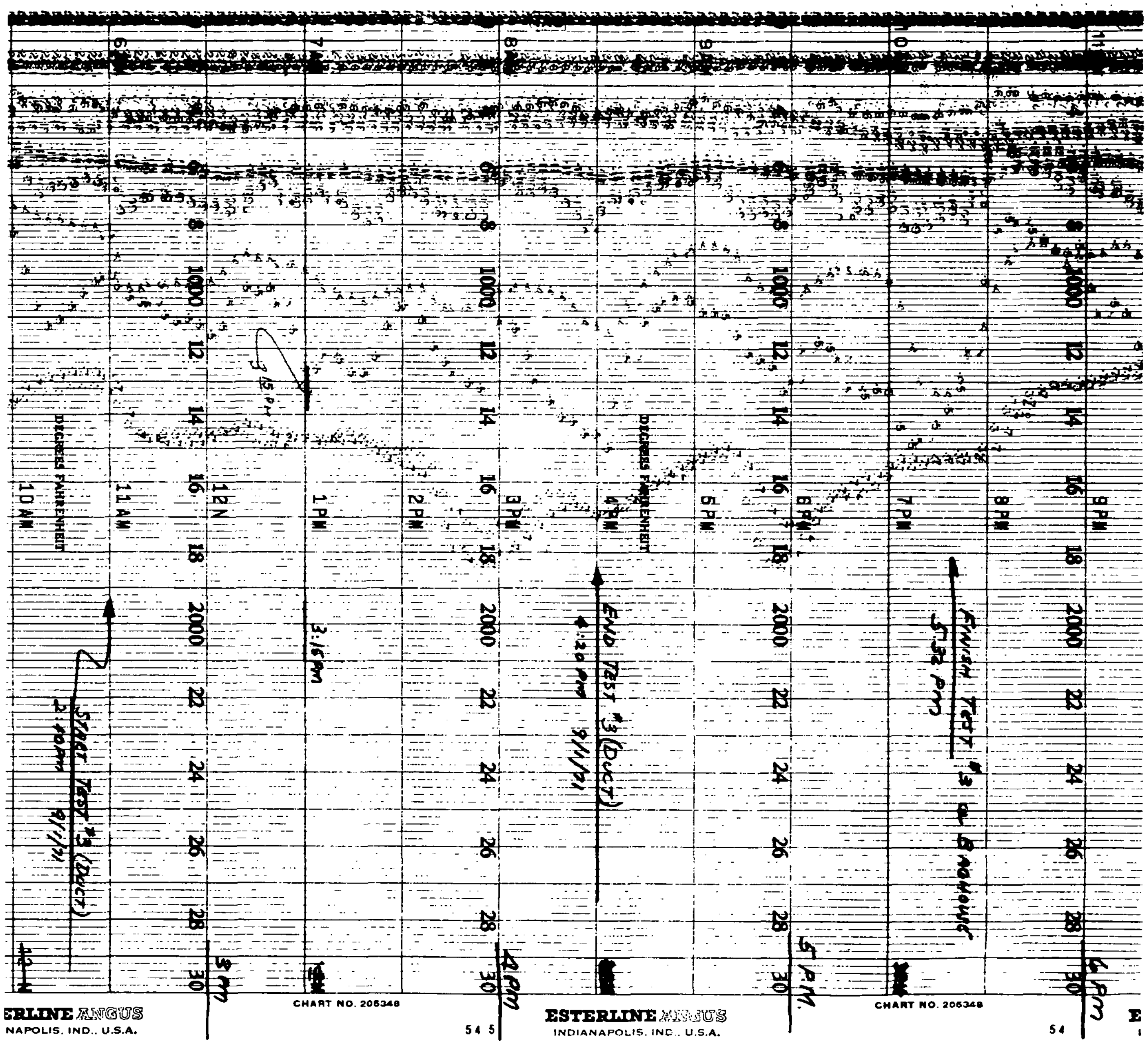
List of thermocouples

Point	Location
TC-1	Hood temp. between North & West electrodes
TC-2	Hood temp. between West & East electrodes
TC-3	Hood temp. between East & North electrodes
TC-4	West doghouse temp.
TC-5	South doghouse temp.
TC-6	East doghouse temp.
TC-7	Center of Hood temp.
TC-8	By-pass duct temp.
TC-9	Furnace Gas duct temp.
TC-10	Cooler inlet Gas temp.
TC-11	Nº 1 Cooler Outlet Gas temp.
TC-12	Nº 2 Cooler Outlet Gas temp.
TC-13	SPARE
TC-14	Nº 1 Exhaust Fan Outlet temp.
TC-15	Nº 2 Exhaust Fan Outlet temp.
TC-16	Collector inlet temp.
TC-17	Collector Outlet temp
TC-18	Dust bin temp.
TC-19	Fume duct temp
TC-20	SPARE
TC-21	Air inlet to Cooler temp.
TC-22	Nº 1 Air Outlet from Cooler temp.
TC-23	Nº 2 Air Outlet from Cooler temp.
TC-24	Spare


3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
12 M
1 AM
DEGREES FAHRENHEIT
1000
12
14
16
18
2000
22
24
26
28
30
Start Test #1 5:47 pm
End Test #1 7:23 pm
8/31/71
ESTERLINE ANGUS
INDIANAPOLIS, IND., U.S.A.
CHART NO. 205348



ESTERLINE ANGUS
INDIANAPOLIS, IND., U.S.A.
CHART NO. 205348
DEGREES FAHRENHEIT
9:10 AM START TEST #2
IN DUCT 9/1/71
10:50 AM FINISH TEST #2
IN DUCT
END OF TEST
TEST #2
9 AM.
10 AM
11 AM
12 N
1 PM



DEGREES FAHRENHEIT
START TEST #3 (DUCT) 2:10 PM 9/1/71
3:16 PM
END TEST #3 (DUCT) 4:20 PM 9/1/71
FINISH TEST #3 @ BAGHOUSE 5:32 PM
ESTERLINE ANGUS
INDIANAPOLIS, IND., U.S.A.
CHART NO. 205348

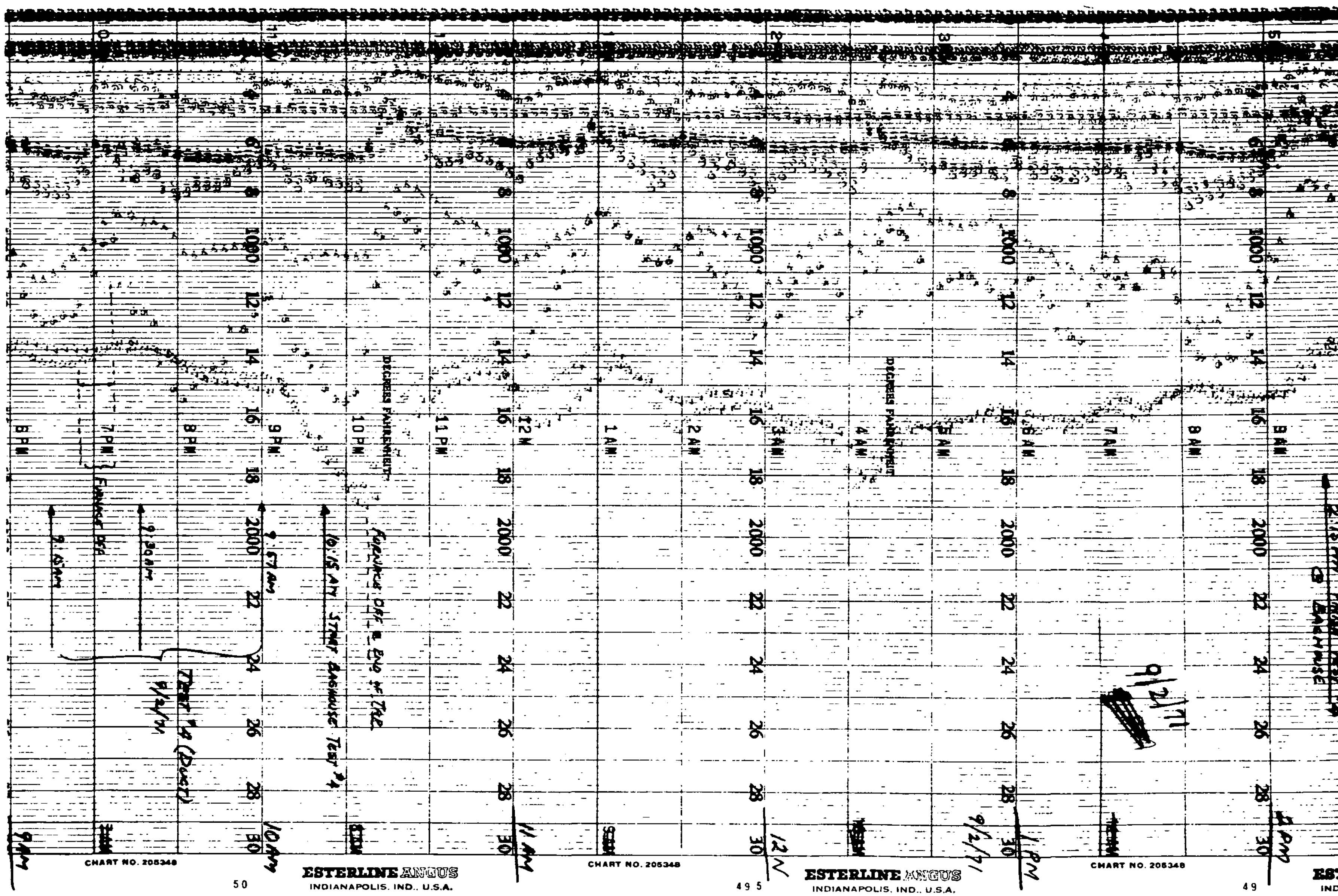


CHART NO. 205348
ESTERLINE ANGUS
INDIANAPOLIS, IND., U.S.A.
DEGREES FAHRENHEIT
1000
2000
9/2/71
Test #4 (Dust)
Start Baghouse Test #4
Furnace off @ end of Test

APPENDIX D

Field Data

PARTICULATE FIELD DATA

Run No. ANE-1

Location Baghouse North Exhaust

Date 8-31-71

Operator Eggleston

Sample Box No. 2

Meter Box No. 51047

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 72° - 82°

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 250

Probe Tip Dia., In. 1/2

Probe Length

Probe Heater Setting

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					
6'	17:19	915.36			2	72	72	7	250	85	29.80	170
	17:25	919.6			2	74	72	7	250	90	"	–
	17:37	928.1			2	82	71	7	250	85	"	155
	17:45	934.6			2	91	75	7	250	85	"	–
	17:55	942.0			2	98	88	7	250	90	"	–
	18:05	949.6			2	108	94	7	250	90	"	–
	18:20	–			"	120	92	7	"	93	"	–
	18:30	–			"	96	90	7	"	95	"	–
	18:40	–			"	110	92	7	"	95	"	–
	18:50	–			"	105	92	7	"	90	"	–
	18:60	–			"	107	90	7	"	80	"	–
	19:10	–			"	109	93	7	"	80	"	–
	19:19	1007.9			"	105	95	7	"	80	"	

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ACE - 1

Location Baghouse Center Exhaust

Date 8-31-71

Operator Blessing

Sample Box No. 4

Meter Box No. 4

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 75°

Bar. Press. "Hg 29.8

Assumed Moisture % 2.0

Heater Box Setting, °F 250

Probe Tip Dia., In. 0.50

Probe Length

Probe Heater Setting

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					
6'	17:23	963.30			2.0	91	91	7.7	250	70	29.8	170
	17:43	979.20			2.0	106	90	7.5	250	75	–	"
	17:53	987.38			2.0	114	94	7.5	250	75	–	"
	18:03	–			"	124	104	7.5	"	75	"	"
	18:13	–			"	123	115	7.5	"	78	"	"
	18:23	–			"	130	110	7.5	"	78	"	"
	18:33	–			"	130	112	7.5	"	78	"	"
	18:43	–			"	132	116	7.5	"	79	"	"
	18:53	–			"	132	116	7.5	"	70	"	"
	19:03	–			"	120	112	7.5	"	70	"	"
	19:13	–			"	127	112	7.5	"	72	"	"
	19:23	1056.72	–	–	"	130	112	7.5	"	74	"	"

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ______

Location ASE-1 Baghouse Exhaust - South

Date 3-31-71

Operator Blessing

Sample Box No. H

Meter Box No. H

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 86

Bar. Press. "Hg 29.8

Assumed Moisture % 2%

Heater Box Setting, °F 250

Probe Tip Dia., In. 50

Probe Length 6.5

Probe Heater Setting 250

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					
6'	17:22	815.91			2.0	85	85	5.0	250	88	29.8	175
	17:42	831.30			2.0	103	88	5.0	250	75	29.8	160
	17:52	839.88			2.0	114	93	5.0	"	75	–	160
	18:02	–			"	120	100	5.0	"	80	"	160
	18:12	–			"	120	112	5.0	"	80	"	160
	18:72	–			"	126	106	5.0	"	80	"	160
	18:32	–			"	125	108	5.0	"	80	?	155
	18:42	–			"	129	110	5.0	"	80	"	170
	18:52	–			"	130	113	5.0	"	77	"	165
	19:02	–			"	125	112	5.0	"	73	"	160
	19:12	–			"	128	112	5.0	"	75	"	160
	19:22	911.0			"	130	114	5.0	"	75	"	160

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ANE-2

Location Bag Exh

Date 9-1-71

Operator McReynolds

Sample Box No. 2

Meter Box No. 2

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. 5

Probe Length 6

Probe Heater Setting 70

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
6*	09:02	08.08	–	–	3.2	88	84	19.0	170	75	29.8	175
*	11:11	–			3.1	102	100	19.2	170	75	"	"
	11:20	17.51			3.0	118	110	2.0	170	75	"	"
	11:30	37.48			3.0	122	106	19.5	"	80	"	"
	11:40	–			3.0	130	108	19.5	"	75	"	"
	11:50				3.0	128	109	19.5	"	75	"	"
	12:00	–			3.0	129	109	19.5	"	75	"	"
	12:10				3.0	130	110	19.5	"	75	"	"
	12:20	–			3.0	134	112	19.5	"	75	"	"
	12:30	–			2.9	132	112	19.2	"	70	"	"
	12:40	–			2.9	132	112	19.1	"	70	"	"
	12:50	–			2.9	130	112	19.1	"	75	"	"
	13:00	–			2.9	136	112	19.1	"	75	"	"
	13:10	126.49			2.9	138	112	19.1	"	75	"	"

Comments: Off @ 9:21 power failure

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ACE-2

Location Bag Exh

Date 9-1-71

Operator McReynolds

Sample Box No. H

Meter Box No. 4

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2%

Heater Box Setting, °F 250

Probe Tip Dia., In. 5

Probe Length 6

Probe Heater Setting 65

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					
6*	09:15	057.71			4.0	92	92	15.0	175	70	29.8	175
	11:08	-			"	100	96	15.0	"	70	"	"
	11:18				"	121	100	16.0	"	70	"	"
	11:28	-			"	129	103	16.0	"	70	"	"
	11:38	-			"	133	102	16.0	"	70	"	"
	11:48	-			"	136	112	16.0	"	70	"	"
	11:58	-			"	134	112	16.5		70	"	"
	12:08	-			"	138	114	16.5	"	70	"	"
	12:18	-			"	138	114	16.5	"	65	"	"
	12:28	-			"	140	116	16.5	"	65	"	"
	12:38	-			"	139	116	16.5	"	65	"	"
	12:48	-			"	138	116	16.5	"	65	"	"
	12:58	-			"	-	-	-	"	-	"	"
	13:02	186.93			"	142	117	165	"	65	"	"

Comments: Off 09:21 power failure

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ASE-2

Location Bag Exh

Date 9-1-71

Operator Blessing

Sample Box No. 4

Meter Box No. H

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2%

Heater Box Setting, °F 250

Probe Tip Dia., In. .5

Probe Length 6'

Probe Heater Setting 65

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
6'	09:10	911:06			4.0	80	80	19.5	250	65	29.8	150
	11:05	–			"	86	86	19.5	"	60	"	175
	11:15	–			"	118	92	18.0	"	60	"	175
	11:25	–			"	124	95	17.5	"	65	"	175
	11:35	–			"	131	100	17.5	"	65	"	175
	11:45	–			"	135	104	17.5	"	65	"	175
	11:55	–			"	135	108	17.5	"	65	"	175
	12:05	–			"	136	110	17.5	"	70	"	175
	12:15	–			"	135	110	17.5	"	65	"	175
	12:25	–			"	135	110	17.5	"	65	"	175
	12:35	–			"	135	110	17.5	"	70	"	175
	12:45	–			–	–	–	–	"	–	"	–
	12:49	1048.00			"	136	110	17.5	"	70	"	175

Comments: Off @ 09:26 power failure

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ANE-3

Location Bag Exh

Date 9-1-71

Operator Hall

Sample Box No. 2

Meter Box No. 2

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 85

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 250

Probe Tip Dia., In. .5

Probe Length 6

Probe Heater Setting 170

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					
6'	14:34	126.46			3.4	118	114	20.0	250	100	29.8	175
	14:44	-			3.6	133	114	19.3	"	95	"	"
	14:54	-			3.4	137	116	19.2	"	93	"	"
	15:04	-			3.4	143	119	19.0	"	85	"	"
	15:14	-			3.4	140	122	18.9	"	80	"	"
	15:24	-			3.4	142	122	19.0	"	80	"	"
	15:34	-			3.4	141	123	19.0	"	80	"	"
	15:44	-			3.4	146	125	19.0	"	85	"	"
	15:54	-			3.4	139	125	19.0	"	80	"	"
	16:04	-			3.4	144	125	19.0	"	85	"	"
	16:14	-			3.4	146	126	19.0	"	85	"	"
	16:24	-			3.2	146	128	19.0	"	90	"	"
	16:34	-			3.2	148	130	19.0	"	90	"	"
	16:44	-			"	146	132	19.0	"	95	"	"
	16:54	-			"	140	130	19.0	"	95	"	"
	17:04	-			"	150	130	18.5	"	75	"	"
	17:14	-			"	146	134	19.0	"	75	"	"
	17:24	-			"	120	115	19.0	"	75	"	"
	17:34	310.46			"	119	109	19.0	"	85	"	"

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ACE-3

Location Bag Exh

Date 9-1-71

Operator Blessing

Sample Box No. H

Meter Box No. 4

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 86

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. .5

Probe Length 6

Probe Heater Setting 60

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
6'	14:32	187.10			4.0	110	110	10	250	80	29.8	175
	14:42	-			"	126	110	10	"	78	"	"
	14:57	-			"	140	116	10	"	80	"	"
	15:02	-			"	142	120	10	"	80	"	"
	15:17	-			"	145	122	10	"	80	"	"
	15:22	-			"	146	124	10	"	75	"	"
	15:32	-			-	-	-	-	-	-	-	-
	15:42	-			4.0	144	126	10	"	70	"	"
	15:52	-			5.5	144	126	18	"	70	"	"
	16:02	-			5.5	150	125	18.1	"	70	"	"
	16:12	-			5.5	152	124	18.1	"	70	"	"
	16:22	-			5.5	156	130	18.1	"	70	"	"
	16:32	-			5.5	156	130	18.0	"	70	"	"
	16:42	-			"	158	132	18.0	"	70	"	"-
	16:52	-			"	158	132	18.0	"	70	"	"
	17:02	-			"	166	136	18.0	"	65	"	"
	17:12	-			"	166	136	18.0	"	65	"	"
	17:22	-			"	164	134	18.0	"	65	"	"
	17:32	401.16			5.5	170	140	18.0	"	70	"	"

Comments:

NCAP-37 (12/67)

D-8

PARTICULATE FIELD DATA

Run No. ASE-3

Location Bag Exh

Date 9-1-71

Operator Blessing

Sample Box No. 4

Meter Box No. H

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 86

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. .5

Probe Length 6

Probe Heater Setting 60

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
6'	14:30	48.04			4.0	96	96	19.0	170	85	29.8	170
	14:40	-			"	118	100	17.0	"	95	"	170
	14:50	-			"	137	106	16.5	"	85	"	160
	15:00	-			"	142	112	16.5	"	80	"	160
	15:10	-			"	142	112	16.5	"	75	"	170
	15:20	-			"	144	116	16.5	"	70	"	180
	15:30	-			"	146	118	16.0	"	65	"	180
1 HR	15:40	-			"	148	120	16.0	"	65	"	180
	15:50	-			4.5	146	120	19.5	"	65	"	180
	16:00	-			"	147	122	19.5	"	65	"	175
	16:10	-			"	146	122	19.5	"	65	"	190
	16:20	-			"	147	122	19.5	"	70	"	200
2 HRS	16:30	-			"	146	122	19.5	"	70	"	185
	16:40	-			"	146	122	19.5	"	70	"	185
	16:50	-			"	146	123	19.5	"	70	"	185
	17:00	-			"	146	123	19.5	"	70	"	180
	17:10	-			"	150	124	19.5	"	70	"	180
Comments:	17:20	-			"	154	125	19.5	"	70	"	180
3 HRS	17:30	264.30			"	155	125	19.5	"	76	"	180

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. 1

Location ABD-1

Date 8-31-71

Operator Baxley

Sample Box No. 3

Meter Box No. 3

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 86

Bar. Press. "Hg 29.8

Assumed Moisture % 4.1

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/16"

Probe Length 114

Probe Heater Setting 65

A 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					
	17:17	766.83	.80	.80	.80	86	86	5	250	65	29.8	310
5	17:22	770.04	1.00	.96	.96	86	86	5	250	65		310
A 4	17:27	773.10	1.00	.96	.96	88	84	11	250	65		310
3	17:32	776.27	1.00	.96	.96	88	84	24	250	70		315
* 2	17:37	778.49	.98	.95	.95	88	84	5	250	70		300
1	17:42	780.55	.80	.76	.76	96	86	5	250	70		320
1	17:47	783.50	.90	.88	.88	100	88	20	250	70		355
* 2	17:52	786.60	1.02	1.15	1.15	100	88	10	250	70		310
3	17:57	789.37	.90	.92	.92	100	88	17	250	70		315
4	18:02	792.07	1.00	.96	.96	102	100	25	250	70		335
5	18:07	794.68	.95	.90	.90	102	93	10	250	75		355
* 1	18:12	797.25	.85	.82	.82	102	93	15	250	75		325
2	18:17	799.82	.92	.88	.88	100	92	5	250	75		330
C 3	18:22	802.53	.95	.92	.92	100	92	15	250	75		335
* 4	18:27	805.30	.95	.92	.92	100	92	20	250	75		330

Comments: * Filter changed

NCAP-37 (12/67)

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					
* 5	18:32	808.46	.85	.82	.82	100	92	15	250	75		330
1	18:37	810.88	.55	.56	.56	100	92	10	250	75		350
2	18:42	812.80	.95	.92	.92	100	92	13	250	70		350
D 3	18:47	815:40	.85	.80	.80	100	92	12	250	70		360
4	18:52	817.88	.85	.80	.80	100	90	15	250	70		340
5	18:57	819.58	.80	.78	.78	100	90	15	250	70		350

Comments: * Filter Change

CAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ABD-2

Location AIR CO NIAGARA

Date 9-1-71

Operator Baxley

Sample Box No. 3

Meter Box No. 3

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 90

Bar. Press. "Hg 29.8

Assumed Moisture % 4.1

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/16"

Probe Length 11'4"

Probe Heater Setting 60

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
	09:10	819.62										
A-1	09:15	821.98	.78	.75	.75	74	74	5	250	60	29.8	325
2	09:20	824.62	.95	.92	.92	80	74	5	"	60		300
3	09:25	827.32	.95	.92	.92	84	74	5	"	60		305
4	09:30	829.88	.90	.87	.87	86	74	5	"	60		302
5	09:35	832.41	.82	.80	.80	90	74	6	"	60		325
1	09:40	834.93	.82	.80	.80	92	76	6	"	60		310
2	09:45	837.65	1.01	1.00	1.00	94	80	18	"	60		365
B 3	09:50	840.39	1.01	1.00	1.00	94	80	24	"	60		365
4	09:55	843.00	.90	.87	.87	94	80	24	"	60		340
5	10:00	845.46	.75	.74	.74	96	82	25	"	60		338
1	10:05	847.35	.90	.86	.86	96	90	24	"	60		310
* 2	10:10	850.35	.90	.86	.86	96	90	25	"	60		310
3	10:15	852.92	.90	.86	.86	90	88	20	"	60		325
C 4	10:20	855.62	1.00	.95	.95	90	88	17	"	60		340
**												

Comments: ** #3 imp. clogged at 10:30
* Filter Change

APTD-37 (12/67)

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
5	10:25	858.37	1.00	.95	.95	90	88	18	"	65		330
1	10:30	860.74	.62	.60	.60	90	88	18	"	65		330
2	10:35	863.30	.95	.92	.92	90	88	3	"	65		308
3	10:40	866.10	1.00	.95	.95	90	88	4	"	65		318
4	10:45	868.57	.85	.82	.82	90	86	5	"	65		315
5	10:50	870.97	.85	.82	.82	90	86	14	"	65		315

omments:

AP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ABD-3

Location AIRCO - Niagara Falls

Date 9-1-71

Operator Baxley

Sample Box No. 3

Meter Box No. 3

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 90

Bar. Press. "Hg 29.8

Assumed Moisture % 4.1

Heater Box Setting, °F 250

Probe Tip Dia., In. 3/16"

Probe Length 11'4"

Probe Heater Setting 60

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
	14:40	870.98										
1	14:45	873.53	.90	.86	.86	86	86	5	250	60	29.8	335
A 2	14:50	876.19	.95	.92	.92	88	86	6	"	60		350
3	14:55	878.75	.90	.86	.86	94	86	11	"	60		355
4	15:00	881.35	.98	.95	.95	100	90	15	"	"		360
5	15:05	883.80	.80	.76	.76	102	92	18	"	"		325
1	15:10	886.56	1.10	1.05	1.05	104	92	25	"	"		355
2	15:15	889.00	1.10	1.05	1.05	102	96	18	"	"		335
B 3	15:20	891.81	.95	.92	.92	100	94	17	"	"		330
4	15:25	894.20	1.00	.94	.94	108	98	20	"	"		355
5	15:30	896.89	.95	.92	.92	110	100	6	"	"		355
1	15:35	899.40	.85	.84	.84	110	100	6	"	"		270
2	15:40	902.20	1.10	1.05	1.05	112	102	8	"	"		330
C 3	15:45	905.03	1.10	1.05	1.05	112	102	10	"	65		330
4	15:50	907.71	1.00	.94	.94	110	100	15	"	65		360
5	15:55	910.00	1.00	.88	.88	110	100	2	"	65		328

Comments:

CAP-37 (12/67)

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					
1	16:00	912.38	.70	.64	.64	110	100	2	250	65		305
2	16:05	915.14	1.10	.98	.98	110	100	3	"	65		310
D3	16:10	917.84	1.05	.95	.95	110	102	4	"	65		325
	16:15	920.40	.95	.86	.86	110	102	9	"	65		365
5	16:20	922.99	.80	.74	.74	110	102	12	"	65		345

omments:

:AP-37 (12/67)

PARTICULATE FIELD DATA

Run No. Metals/Part.

Location ANE - 4M

Date 9-2-71

Operator McReynolds

Sample Box No. 2

Meter Box No. 2

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. –

Probe Length 5

Probe Heater Setting 60

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					
4	10:12	311.04			3.3	82	78	19.5	170	60	29.8	170
	10:27	–			3.3	100	80	19.5	"	75	"	"
	10:42	–			3.3	106	86	19.5	"	75	"	"
	10:57	–			3.3	108	88	19.5	"	80	"	"
1	11:12	–			3.3	105	88	19.5	"	70	"	"
	11:27	–			3.3	108	90	19.2	"	70	"	"
	11:42	–			3.3	108	92	19.5	"	70	"	"
	11:57				3.3	108	92	19.3	"	70	"	"
2	12:12	–			3.3	103	90	19.3	"	70	"	"
	12:27	–			3.3	102	90	19.3	"	70	"	"
	12:42	–			3.3	102	90	19.3	"	70	"	"
	12:57	–			3.3	102	90	19.3	"	70	"	"
3	13:12	–			3.3	102	90	19.3	"	65	"	"
	13:27	–			3.3	108	90	19.3	"	65	"	"
	13:42	–			3.3	106	90	19.3	"	65	"	"
	13:57	–			3.3	106	92	19.3	"	65	"	"
4	14:12	550.50			3.3	102	90	19.3	170	70	"	"

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ACE 4M

Location Center Exhaust

Date 9-2-71

Operator Blessing

Sample Box No. 4

Meter Box No. 4

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. -

Probe Length 5

Probe Heater Setting 70

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					
	10:10	403.42			4.4	90	80	20.5	170	65	29.8	175
	10:25	–			4.4	107	82	20.5	"	70	"	"
	10:40	–			4.4	120	89	20.5	"	70	"	"
	10:55	–			4.4	125	94	20.5	"	70	"	"
	11:10	–			4.4	128	98	20.5	"	70	"	"
	11:25	–			4.5	133	102	"	"	65	"	"
	11:40	–			4.5	137	103	20.5	"	65	"	"
	11:55	–			"	128	102		"	65	"	"
	12:10	–			"	123	101	20.5	"	65	"	"
	12:25	–			"	122	99	20.5	"	65	"	"
	12:40	–			4.5	121	98	20.5	"	70	"	"
	12:55	–			4.4	125	98	20.5	"	70	"	"
	13:10	–			4.4	122	98	20.5	"	60	"	"
	13:25	–			4.4	124	98	20.5	"	60	"	"
	13:40	–			4.4	120	100	20.5	"	65	"	"
	13:55	–			4.4	120	100	20.5	"	65	"	"
	14:10	671.49							"		"	"

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. ASE 4M

Location South Bag Exh

Date 9-2-71

Operator Blessing

Sample Box No. 4

Meter Box No. H

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 80

Bar. Press. "Hg 29.8

Assumed Moisture % 2

Heater Box Setting, °F 170

Probe Tip Dia., In. -

Probe Length 5

Probe Heater Setting 70

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
4 in	10:10	264.35			4.5	76	77	20.0	170	80	29.8	170
	10:25	-			4.5	106	82	20.0	"	80	"	155
	10:40	-			4.5	116	89	20.0	"	80	"	155
	10:55	-			4.5	120	94	20.0	"	75	"	155
	11:10	-			4.5	121	96	20.0	"	70	"	130
	11:25	-			4.6	122	98	19.0	"	65	"	170
	11:40	-			4.6	126	100	19.0	"	65	"	165
	11:55	-			4.6	127	101	19.0	"	65	"	165
	12:10	-			4.6	127	101	19.0	"	65	"	165
	12:25	-			4.6	129	102	19.0	"	65	"	150
	12:45	-			4.6	126	101	19.0	"	65	"	170
	12:55	-			4.6	125	101	19.0	"	70	"	170
	13:10	-			4.6	128	100	19.0	"	60	"	170
	13:25	-			4.6	126	100	19.0	"	60	"	160
	13:40	-			4.6	127	98	19.0	"	60	"	165
	13:55	-			4.6	126	101	19.0	"	65	"	180
	14:10	558.32			4.6	127	100	19.0	"	65	"	175

Comments:

NCAP-37 (12/67)

PARTICULATE FIELD DATA

Run No. 1-2-3

Location INLET ABD Metals 45-6

Date 9-2-71

Operator Baxley

Sample Box No. 3

Meter Box No. 3

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point.

Ambient Temp °F 90

Bar. Press. "Hg 29.8

Assumed Moisture %

Heater Box Setting, °F

Probe Tip Dia., In.

Probe Length 5'

Probe Heater Setting 65'

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					
B-1	09:15	922.90	1.30			70	70	2	250	60		320
	09:30	935.72	1.30			86	86	22				
B-2	09:35	935.72	1.30			84	78	2				
	09:41	939.65	1.00			86	80	22				
B-3	09:50	939.65	1.30			76	76	2				
	09:57	946.17	1.30			88	80	22				

Comments:

NCAP-37 (12/67)

PARTICULATE CLEANUP SHEET

Date: 8-31-71

Plant: AIRCO

Run number: ANE-1 ACE-1 ASE-1

Location of sample port: EXHAUST

Operator: Blessing, Eggleston

Barometric pressure: ____

Sample box number: 1

Ambient temperature: ____

Impinger H_2O 195/195/203

Volume after sampling ____ ml Container No. ____ Ether-chloroform extraction of impinger water ____ mg

Impinger prefilled with 200 ml Extra No. ____

Volume collected -5/-5 ____ ml /3 Impinger water residue ____ mg

---

Impingers and back half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ____ mg

---

Dry probe and cyclone catch: Container No. ____ Extra No. ____ Weight results ____ mg

---

Probe, cyclone, flask, and front half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ____ mg

---

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
000085 ANE-1			
000096 ACE-1			
000100 ASE-1			

Filter particulate weight ____ mg

Total particulate weight ____ mg

Silica Gel

	ANE-1	ACE-1	ASE-1	
Weight after test:				
Weight before test:	172.3	196.3	194.6	
Moisture weight collected:				
Container number:	1.	2.	3.	4.

Moisture total ____ gm

Sample number: ____ Analyze for: ____

Method determination: ____

Comments: ____

PARTICULATE CLEANUP SHEET

Date: 9-1-71 Plant: AIRCO

Run number: ANE-2 ACE-2 ASE-2 Location of sample port: EXHAUST

Operator: Blessing, McReynolds Barometric pressure: ____

Sample box number: 2 Ambient temperature: ____

Impinger H_2O 190/186/195

Volume after sampling ____ ml Container No. ____ Ether-chloroform extraction of impinger water ____ mg

Impinger prefilled with 200 ml Extra No. ____

Volume collected -10/-14 ml -5 Impinger water residue ____ mg

---

Impingers and back half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ____ mg

---

Dry probe and cyclone catch: Container No. ____ Extra No. ____ Weight results ____ mg

---

Probe, cyclone, flask, and front half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ____ mg

---

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
0104	ANE-2		
0107	ACE-2		
2FN-M	ASE-2		

Filter particulate weight ____ mg

Total particulate weight ____ mg

Silica Gel

	ASE-1	ACE-1	ANE-1	
Weight after test:				
Weight before test:	165.7	181.8	184.4	
Moisture weight collected:				
Container number:	1.	2.	3.	4.

Moisture total ____ gm

Sample number: ____ Analyze for: ____

Method determination: ____

Comments: ____

PARTICULATE CLEANUP SHEET

Date: 9/1/71
Plant: AIRCO
Run number ANE-3 ACE-3 ASE-3
Location of sample port: EXHAUST
Operator: Blessing, McReynolds
Barometric pressure: ____
Sample box number: 5
Ambient temperature: ____

Impinger H_2O 187/180/181

Volume after sampling ____ ml
Container No. ____
Impinger prefilled with 200 ml
Extra No. ____
Volume collected -13/-20 ml -19

Ether-chloroform extraction of impinger water ____ mg
Impinger water residue ____ mg

Impingers and back half of filter, acetone wash:
Container No. ____
Extra No. ____
Weight results ____ mg

Dry probe and cyclone catch:
Container No. ____
Extra No. ____
Weight results ____ mg

Probe, cyclone, flask, and front half of filter, acetone wash:
Container No. ____
Extra No. ____
Weight results ____ mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
0100	ANE 3		
091	ACE-3		
092	ASE-3		

Filter particulate weight ____ mg

Total particulate weight ____ mg

Silica Gel

	ANE-3	ACE-3	ASE-3	
Weight after test:				
Weight before test:	177.7	197.7	175.6	
Moisture weight collected:				
Container number:	1.	2.	3.	4.

Moisture total ____ gm

Sample number: ____
Analyze for: ____
Method determination: ____
Comments: ____

PARTICULATE CLEANUP SHEET

Date: 8-31-71 Plant: AIRCO

Run number: ABD-1 Location of sample port: INLET DUCT

Operator: GONZALEZ Barometric pressure: ______

Sample box number: 3 Ambient temperature: ______

Impinger H_2O

Volume after sampling 205 ml Container No. ____ Ether-chloroform extraction of impinger water ______ mg

Impinger prefilled with 200 ml Extra No. ____

Volume collected 5 ml Impinger water residue ______ mg

Impingers and back half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ______ mg

---

Dry probe and cyclone catch: Container No. ____ Extra No. ____ Weight results ______ mg

---

Probe, cyclone, flask, and front half of filter, acetone wash: Container No. ____ Extra No. ____ Weight results ______ mg

---

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
000087			
000088			
2FN-43A			
2FN-27A			
000086			

Filter particulate weight ______ mg

Total particulate weight ______ mg

Silica Gel

Weight after test: ____ ____ ____ ____

Weight before test: 169.0 ____ ____ ____

Moisture weight collected: ____ ____ ____ ____ Moisture total ______ gm

Container number: 1.____ 2.____ 3.____ 4.____

Sample number: ______ Analyze for: ______

Method determination: ______

Comments: ______

PARTICULATE CLEANUP SHEET

Date: 9-1-71 | Plant: AIRCO

Run number: ABD-2 | Location of sample port: INLET

Operator: GONZALEZ | Barometric pressure: ____

Sample box number: 4 | Ambient temperature: ____

Impinger H_2O

Volume after sampling 206 ml | Container No. ____ | Ether-chloroform extraction of impinger water ____ mg

Impinger prefilled with 200 ml | Extra No. ____

Volume collected 6 ml | Impinger water residue ____ mg

Impingers and back half of filter, acetone wash: | Container No. ____ | Extra No. ____ | Weight results ____ mg

Dry probe and cyclone catch: | Container No. ____ | Extra No. ____ | Weight results ____ mg

Probe, cyclone, flask, and front half of filter, acetone wash: | Container No. ____ | Extra No. ____ | Weight results ____ mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
000095			
000152			

Filter particulate weight ____ mg

Total particulate weight ____ mg

Silica Gel

Weight after test: ____ ____ ____ ____

Weight before test: ____ ____ ____ ____

Moisture weight collected: ____ ____ ____ ____ | Moisture total ____ gm

Container number: 1.____ 2.____ 3.____ 4.____

Sample number: ____ | Analyze for: ____

Method determination: ____

Comments: FILTER AFTER IMPINGERS

PARTICULATE CLEANUP SHEET

Date: 9-1-71

Plant: AIRCO

Run number: ABD-3

Location of sample port: INLET

Operator: GONZALEZ

Barometric pressure: ______

Sample box number: 4

Ambient temperature: ______

Impinger H_2O

Volume after sampling 206 ml | Container No. ____ | Ether-chloroform extraction of impinger water ______ mg

Impinger prefilled with 200 ml | Extra No. ____

Volume collected 6 ml | Impinger water residue ______ mg

Impingers and back half of filter, acetone wash: | Container No. ____ | Extra No. ____ | Weight results ______ mg

Dry probe and cyclone catch: | Container No. ____ | Extra No. ____ | Weight results ______ mg

Probe, cyclone, flask, and front half of filter, acetone wash: | Container No. ____ | Extra No. ____ | Weight results ______ mg

Filter Papers and Dry Filter Particulate

Filter number	Container no.	Filter number	Container no.
000185			
000150			
000153			

Filter particulate weight ______ mg

Total particulate weight ______ mg

Silica Gel

Weight after test:				
Weight before test:	183.5			
Moisture weight collected:				
Container number:	1.	2.	3.	4.

Moisture total ______ gm

Sample number: ______

Analyze for: ______

Method determination: ______

Comments: FILTER AFTER IMPINGER

GAS SAMPLING FIELD DATA

Material Sampled for SO_2

Date 9-1-71

Plant AIRCO Location NIAGARA FALLS

Bar. Pressure 29.8 "Hg Comments:

Ambient Temp. 85 °F

Run No. ASE-1

Power Stat Setting NA

Filter Used: Yes X No ___ GLASS WOOL

Operator BLESSING

CLOCK TIME	METER ($Ft.^3$)	VACUUM ~~IN. Hg.~~	METER TEMPERATURE
1539	60.60	NA	105
1551	64.50		106
1603	67.52		108
1615	70.62		108
1627	74.30		108
1639	78.38		108

Comments:
PUMP WAS BEFORE METER IN THE SAMPLE TRAIN

NCAP-36 (12/67)

GAS SAMPLING FIELD DATA

Material Sampled for SO_2

Date 9-2-71

Plant AIRCO

Location NIAGARA FALLS

Bar. Pressure 29.8 "Hg

Comments:

Ambient Temp. 85 °F

Run No. ACE-1

Power Stat Setting NO

Filter Used: Yes x No GLASS WOOL

Operator BLESSING

CLOCK TIME	METER (Ft.^{3})	VACUUM IN. Hg.	METER TEMPERATURE
1032	155.50	1.5	84
1044	156.05	1.5	84
1056	156.60	1.5	84
1108	157.14	1.5	84
1120	157.60	1.5	84
1132	158.10	1.5	84

Comments:

NCAP-36 (12/67)

GAS SAMPLING FIELD DATA

Material Sampled for SO_2

Date 9-2-71

Plant AIRCO Location NIAGARA FALLS

Bar. Pressure 29.8 "Hg Comments:

Ambient Temp. 85 °F

Run No. ANE-1

Power Stat Setting NA

Filter Used: Yes x No ____ GLASS WOOL

Operator BLESSING

CLOCK TIME	METER (Ft.^{3})	VACUUM IN. Hg.	METER TEMPERATURE
1239	158.82	1.6	82
1251	160.60	1.6	84
1315	161.75	1.6	84
1327	162.36	1.6	84
1339	162.78	1.6	86

Comments:

NCAP-36 (12/67)

APPENDIX E

1. STANDARD SAMPLING PROCEDURES
2. CLEANUP AND ANALYTICAL PROCEDURES

APPENDIX E. 1

STANDARD SAMPLING PROCEDURES

PARTICULATE SAMPLING

In an unstable operation a trial run is conducted. Otherwise, preliminary data are obtained for gas velocity, temperature and other variables which might affect the isokinetic sampling rate. Four 5-point, equal area traverses were selected as being most appropriate for the conditions encountered at the exhaust duct. Three single points were selected at the baghouse exit. Each sampling was designed to cover one complete operating and tapping cycle, as a minimum.

Particulate samples were obtained using the equipment and test procedures as stipulated in "Sample Collection Procedures," published by OAP. The sampling train was 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 in June 1967, Cleveland, Ohio.

The sample gases were drawn into the all-glass sampling train through a button-hook stainless steel nozzle with a diameter of 0.1875 inch. An incoloy probe was fitted inside the stainless steel sheath with a probe heating element. The probe was connected to a glass cyclone and an Erlenmeyer flask to collect the solids from the cyclone. The sampled gases passed from the cyclone through a tared 2-1/2 inch diameter MSA 1106BH glass fiber filter. This filter and the cyclone were enclosed in a heated box which was maintained near 250°F. After the first test the filter was moved to a position after the first three impingers (See discussion). The filter holder was connected to an impinger train consisting of four Greenburg-Smith impingers with the high velocity tip removed from the first impinger. The second impinger was used with the tip while the third and fourth impingers were modified as the first. The first two impingers each contained a measured volume (100 ml) of distilled, deionized water. The third impinger was used dry and the fourth impinger contained approximately 175 grams of silica gel. The sampling train exit was connected, in line, to a vacuum gauge, a leakless vacuum pump, a dry gas meter, and a calibrated orifice. The calibrated orifice differential was measured with an inclined-vertical manometer. Velocity variations at the sampling point were constantly monitored by a pitot tube connected to the probe sheath. The sampling train, with probe and nozzle attached, was leak tested prior to each test.

Isokinetic sampling was maintained at the exhaust duct 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 was determined by using the nomographs presented in APCA Paper No. 67-119. This nomograph related stack gas velocity, temperature, and moisture content to the flow rate required for isokinetic sampling. Isokinetic sampling was not attempted on the baghouse outlet (see discussion).

SULFUR DIOXIDE SAMPLING

Sulfur dioxide emission tests were conducted at the same location as the particulate tests. The sample gas was drawn through a glass wool filter into a probe followed by a coarse frit midget impinger and a second glass wool filter. The filter led to three midget impingers in an ice bath followed in turn by a silica gel tube drier, vacuum gauge, valve, leakless pump with by-pass valve, dry gas meter, rate meter, and pitot tube with manometer.

The midget bubbler contained 15 ml of 80 percent isopropyl alcohol. The first two midget impingers contained 15 ml of 3 percent H_2O_2 solution and the third was operated dry. A dry gas meter with vacuum gauge and a pump followed the impingers. Temperatures, vacuum and gas meter readings were taken and tabulated in order to calculate standard volumes. After sampling, the train was purged with clean air in order to carry over any SO_2 trapped in the isopropyl.

ORSAT SAMPLING

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

PARTICLE SIZING

The Brinks cascade impactor, followed by a 47 millimeter glass fiber filter, was mounted on a probe and connected to a vacuum pump by a length of rubber tubing. The inlet side of the pump was fitted with a vacuum gauge calibrated in inches of mercury and a flow controlling valve. The outlet side of the pump was connected to a dry gas meter when samples were collected longer than 5 minutes.

Prior to collecting samples, the Brinks impactor was calibrated to determine air flow rates by connecting it in series with a vacuum pump with a vacuum gauge, and a dry gas meter.

The collector was grounded to prevent electrostatic deposition of particles. It was placed into the stack with the nozzle covered to allow it to thermally equilibrate prior to sampling. The sample was then 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 were washed with reagent grade acetone. Washings were collected in a container and transported to the laboratory for analysis. A rubber policemen was used with the acetone to remove and particles adhering to the cyclone walls or the flask. The reagent acetone used for washing was tested to determine the blank or residue upon evaporation.

Filter

The tared circular MSA type 1106BH filter paper was 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) was measured, then emptied into a polyethylene container. The impingers were then water washed; the washings were combined with the condensate and the 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 impingers, were washed with acetone. These washings were collected in a glass bottle and sealed for later analysis. On those samples where the filter was after the impingers, the filter holder washings were added to this portion of the sample.

Silica Gel

Silica gel was transferred (dry) from the fourth impinger to an airtight container and sealed. The impinger was then washed with acetone, the acetone being discarded because it contained fine silica gel particles.

CLEANUP (SO_2 TRAIN)

The impinger containing 80 percent isopropyl alcohol was discarded and the impingers containing 3 percent H_2O_2 saved. These contained SO_2 gas in the form of H_2SO_4. A glass jar was used as a sample container for transportation to the laboratory for analysis.

ANALYTICAL PROCEDURES (EPA PARTICULATE TRAIN)

Acetone Washings

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

Filter Particulate

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

Impinger Water

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

Analysis-Orsat Measurements

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

Analysis-(SO_2 Train)

SO_2 samples were analyzed by the Shell Development method except that barium perchlorate was used instead of barium chloride (as in the EPA proposed source testing Method 7) because of the sharper titration end point obtainable with the former reagent.

Analysis - Particle Sizes

The individual pre-weighed impactor plates were removed and weighed to the nearest 0.1 milligram. The tared glass fiber filter was also weighed. The weight gains represent particle size fractions.

APPENDIX F

LABORATORY REPORT

PARTICULATE

SILICA GEL Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading Blank	MG in ALIQ.			Total Wt. Gain
		ANE - 3	371.6 - wt. of Jar + Dry Silica Gel 196.0 - wt. of Jar 175.6 - wt. of Dry Silica Gel						403.5 371.6 31.9	31.9
		ACE - 3	382.1 195.8 186.3	"					422.5 382.1 40.4	40.4
		ASE - 3	382.7 205.0 177.7	"					409.0 382.7 26.3	26.3
		ANE - 2	383.2 198.8 184.4	"					406.9 383.2 23.7	23.7
		ACE - 2	377.3 195.5 181.8	"					402.7 377.3 25.4	25.4
		ASE - 2	368.5 202.8 165.7	"					390.0 368.5 21.5	21.5
		ANE - 1	368.4 196.1 172.3	"					392.3 368.4 23.9	23.9
		ACE - 1	384.5 196.3 188.2	"					393.5 384.5 9.0	9.0
		ASE - 1	371.2 194.6 176.6	"					403.9 371.2 32.7	32.7
		ABD - 1	363.8 194.8 169.0	"					380.5 363.8 16.7	16.7
		-2	386.2 203.1 183.1	"					403.9 386.2 17.7	17.7
		-3	384.1 200.6 183.5	"					401.1 384.1 17.0	17.0

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date September 16, 1971.

PARTICULATE

ACETONE BEFORE

Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.	Volume	SAMPLE WEIGHT	TIT. ALIQ.	Readings / Blank	MG in ALIQ.			Total wt.
1		ANE-3	60 mls.	77.5369 77.5152 0.0217	77.5351 77.5152 0.0199	77.5358 77.5152 0.0201		Bk -	0.0201 0.0007 0.0194	0.0194
2		ACE-3	250	79.3784 79.3659 0.0125	79.3751 79.3659 0.0092	79.3774 79.3659 0.0115		-	0.0115 0.0030 0.0085	0.0085
3		ASE-3	50	92.6749 92.6567 0.0180	92.6752 92.6569 0.0183			-	0.0183 0.0006 0.0177	0.0177
4		ANE-2	50	68.9182 68.8966 0.0216	68.9185 68.8966 0.0219			-	0.0219 0.0006 0.0213	0.0213
5		ACE-2	35	84.1027 84.0885 0.0142	84.1035 84.0885 0.0150			-	0.0150 0.0004 0.0146	0.0146
6		ASE-2	35	80.1127 80.1048 0.0079	80.1117 80.1048 0.0069			-	0.0069 0.0004 0.0065	0.0065
7		ANE-1	95	85.0230 85.0087 0.0143	85.0189 85.0087 0.0102	85.0212 85.0087 0.0125	85.0160 85.00[illegible] 0.00[illegible]	85.0197 85.0087 0.0110	0.0110 0.0011 0.0099	0.0099
8		ACE-1	75	74.5529 74.5365 0.0164	74.5539 74.5365 0.0174			-	0.0174 0.0009 0.0165	0.0165
9		ASE-1	145	78.3655 78.3526 0.0129	78.3645 78.3526 0.0119			-	0.0119 0.0017 0.0102	0.0102
10		ABD-1	385	77.5856 77.2411 0.3445	77.5840 77.2411 0.3429	77.5853 77.2411 0.3442		-	0.3442 0.0046 0.3396	0.3396
11		-2	325	82.4141 82.2265 0.1876	82.4100 82.2265 0.1835	82.4127 82.2265 0.1862	82.4118 82.2265 0.1853	-	0.1853 0.0039 0.1814	0.1814
12		-3	440	79.3305 79.1469 0.1836	79.3307 79.1469 0.1838				0.1838 0.0053 0.1785	0.1785
AB		Baker ACS Blank 100 ml =	200 0.0026	86.2961 86.2939 0.0021	86.2962 86.2939 0.0023	Bk - 0.0011/100 ml.				

Project No. 859 490

Collection Date 8/31 - 9/1

Analysis Date 9/28/71

PARTICULATE

ACETONE
AFTER

Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.	Volume	SAMPLE WEIGHT	TIT. ALIQ.	Reading Blank	MG in ALIQ.			Total wt.
13		ANE - 3	150	83.4351 83.4104 0.0247	83.4355 83.4104 0.0251			Bk –	0.0251 0.0018 0.0233	0.0233
14		ACE - 3	95	79.4655 79.4436 0.0219	79.4645 79.4436 0.0209			–	[illegible] 0.0011 0.0198	0.0198
15		ASE - 3	80	77.2774 77.2551 0.0223	77.2731 77.2551 0.0180	77.2748 77.2551 0.0197	77.2745 77.2551 0.0194	–	0.0194 0.0010 0.0184	0.0184
16		ANE - 2	90	78.1009 78.0706 0.0303	78.0993 78.0706 0.0287	78.1010 78.0706 0.0304		–	0.0304 0.0011 [illegible]	[illegible]
17		ACE - 2	25	77.7355 77.7164 0.0191	77.7343 77.7164 0.0179	77.7347 77.7164 0.0183		–	0.0183 0.0003 0.0180	0.0180
18		ASE - 2	65	86.1852 86.1749 0.0103	86.1843 86.1749 0.0094			–	[illegible] 0.0008 0.0086	0.0086
19		ANE - 1	150	76.4912 76.4670 0.0242	76.4910 76.4670 0.0240			–	0.0240 0.0018 0.0222	0.0222
20		ACE - 1	130	84.9214 84.9008 0.0206	84.9208 84.9008 0.0250			–	0.0300 0.0016 0.0284	0.0284
21		ASE - 1	125	75.7569 75.7410 0.0159	75.7562 75.7410 0.0152			–	0.0152 0.0015 0.0137	0.0137
22		ABD - 1	250	82.5185 82.4157 0.1028	82.5163 82.4157 0.1006	82.5154 82.4157 0.0997		–	0.0997 0.0030 0.0967	0.0967
23		- 2 PROBE WASH	315	79.1681 79.0396 0.1285	79.1655 79.0396 0.1259	79.1674 79.0396 0.1278		–	0.1278 0.0038 0.1240	0.1240
24		- 3 PROBE WASH	200	78.3763 78.2359 0.1404	78.3754 78.2359 0.1395			–	0.1395 0.0024 0.1371	0.1370

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date 9/28/71

G.F. Filters
Total wt.

Metals

SAMPLES AIRCO - NIAGARA FALLS -

NO.	CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading / Blank	MG in ALIQ.			Total wt.
		Exhaust - North #000156	E-N 0.1779	0.1779 28.7222 28.9001	28.9066 28.9001 0.0065	28.9076 28.9[illegible]1 0.0075	28.9077 28.9001 0.0076			0.0076
		Exhaust - Center #000094	E-C 0.1760	0.1760 25.7900 25.9660	25.9727 25.9660 0.0067	25.9747 25.9660 0.0087	25.9727 25.9660 0.0067			0.0067
		Exhaust - South # 00[illegible]	E-S 0.1787	0.1787 26.1738 26.3525	26.3544 26.3525 0.0019	26.3561 26.3[illegible]5 0.0036	26.3561 26.3525 0.0036			0.0036

Project No. 859490

Collection Date 9/2/71

Analysis Date 9/27/71

PARTICULATE G.F. FILTERS
Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.	Tare wt.	~~SAMPLE~~ Tare Wt. ~~WEIGHT.~~ Wt. Filter Dish	TIT. ALIQ.	Reading / Blank	MG in ALIQ.			Total wt.
0		ABD-1 GFF #000088	0.1788	0.1788 27.4114 27.5902	27.8179 27.5902 0.2277	27.8201 27.5902 0.2299	27.8200 27.5902 0.2298			0.2298
1		ABD-1 GFF# 000087	0.1803	0.1803 28.4184 28.5987	28.8677 28.5987 0.2690	28.8716 28.5987 0.2729	28.8713 28.5987 0.2726			0.2726
2		ABD-2 GFF#000152	0.1759	0.1759 26.9112 27.0871	27.1188 27.0871 0.0317	27.1229 27.0871 0.0358	27.1220 27.0871 0.03[illegible]			0.0349
3		ABD 3 GFF #000153	0.1753	0.1753 27.5072 27.6827	27.9928 27.6827 0.3101	27.9949 27.6827 0.3122	27.9942 27.6827 0.3115			0.3115
4		ABD-1 2FN-43A	0.1783	0.1783 26.40[illegible] 26.5785	26.7723 26.5785 0.1938	26.7745 26.5785 0.1960	26.[illegible]18 26.5785 0.1933			0.1933
5		ABD-1 GFF#000086	0.1774	0.1774 28.1912 28.3686	28.8196 28.3686 0.4510	28.8229 28.3686 0.4543	28.8173 28.3686 0.4487	28.8153 28.3686 0.4467	28.8152 28.3686 0.4466	0.4466
6		ABD-3 GFF# 000150	0.1761	0.1761 26.9820 27.1581	27.5604 27.1581 0.4023	27.5631 27.1581 0.4050	27.5592 27.1581 0.4011	27.5596 27.1581 0.4015		0.4015
7		ABD-~~000086~~ 2FN-27A	0.1786	0.1786 27.3607 27.5393	27.8022 27.5393 0.2629	27.8047 27.53[illegible]3 0.2654	27.8039 27.5393 0.2646			0.2646
8		ABD-3 GFF#000185	0.1768	0.1768 27.8124 27.9892	28.3686 27.9892 0.3794	28.3689 27.9892 0.3797				0.3797
9		ABD-2 GFF#000095	0.1793	0.1793 28.6133 28.7926	28.9608 28.7926 0.1682	28.9613 28.7926 0.1687				0.1687
0		GFF# 000103 Blank	0.1780	0.1780 25.9500 26.1280						

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date 9/27/71

PARTICULATE G.F. FILTE

Total wt

SAMPLES AIRCO - NIAGARA FALLS

NO. / CR	LOCATION and SAMPLE NO.		Tare wt. ~~SAMPLE~~ WT. ~~WEIGHT~~ Filter + Dish	TIT. ALIQ.	Reading / Blank	MG in ALIQ.			Total wt.
000106	ANE - 3	0.1757	0.1757 27.9101 28.0858	28.0906 28.0858 0.0048	28.0949 28.0858 0.0091	28.0911 28.0858 0.0053			0.0053
000091	ACE - 3	0.1795	0.1795 30.9094 31.0889	31.0976 31.0889 0.0087	31.0980 31.0889 0.0091				0.0091
000092	ASE - 3	0.1771	0.1771 26.7219 26.8990	26.9003 26.8990 0.0013	26.9028 26.8990 0.0038	26.9043 26.8990 0.0053	26.9019 26.8990 0.0029		0.0029
000104	ANE - 2	0.1759	0.1759 [illegible] 23.8004	23.8062 23.8004 0.0058	23.8090 23.8004 0.0086	23.8057 23.8004 0.0053			0.0053
000107	ACE - 2	0.1758	0.1758 25.6545 25.8303	25.8357 25.8303 0.0054	25.8370 25.8303 0.0067	25.8389 25.8303 0.0086	25.8375 25.8303 0.0072		0.0072
2FN-A1	ASE - 2	0.2938	0.2938 29.6563 29.9501	29.9572 29.9501 0.0071	29.9609 29.9501 0.0108	29.9605 29.9501 0.0104			0.0104
000085	ANE - 1	0.1778	0.1778 27.2169 27.3947	27.4033 27.3947 0.0086	27.4060 27.3947 0.0113	27.4052 27.3947 0.0105			0.0105
000100	ACE - 1	0.1765	0.1765 29.5252 29.7017	29.7069 29.7017 0.0052	29.7092 29.7017 0.0075	29.7086 29.7017 0.0069			0.0069
000096	ASE - 1	0.1808	0.1808 26.3868 26.5676	26.5677 26.5676 0.0001	26.5727 26.5676 0.0051	26.5697 26.5676 0.0021	26.5704 26.5676 0.0028		0.0028

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date 9/27/71

SO_2

Total SO_2

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.		SAMPLE WEIGHT	TIT. ALIQ.	Reading / Blank	MG in ALIQ. SO_2			Total mg SO_2
		ANE - 1		0.00482 M $Ba(ClO_4)_2$	25/100	2.0	0.62	x 4		2.5
		ACE - 1		↓	25/100	1.9	0.59			2.4
		ASE - 1		↓	25/100	8.65 / 8.70	2.69	↓		10.8

Project No. 859490

Collection Date 9/2/71

Analysis Date 9/16/71

1 ml 0.00482 M $Ba(ClO_4)_2$ = 0.31 mg SO_2

PARTICULATE

H_2O REMAINDER Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.	Volume	SAMPLE WEIGHT	TIT. ALIQ.	Reading Blank	MG in ALIQ.			Total Wt.
37		ANE-3	260	81.4903 81.4732 0.0171	81.4889 81.4732 0.0157	81.4899 81.4732 0.0167		—	0.0167 0.0013 0.0154	0.0154
38		ACE-3	265	82.4473 82.4286 0.0187	82.4509 82.4286 .0223	82.4459 82.4286 0.0173	82.4502 82.4286 0216	—	0.0216 0.0013 0.0203	0.0203
39		ASE-3	265	75.1749 75.1471 0.0278	75.1779 75.1471 0.0308	75.1731 75.1471 0.0260	75.1802 75.1471 0.0331	75.1750 75.1471 0.0279	0.0277 0.0013 0.0266	0.0266
40		ANE-2	285	85.1591 85.1260 0.0331	85.1624 85.1260 0.0364	85.1547 85.1260 0.0287	85.1606 85.1260 0.0346	85.1562 85.1260 0.0302	85.1513 85. 85.1260 85. 0.0253 0.0	530 85.1605 0.0243 260 85.1260 0.0014 270 0.0243 0.0229 0.0229
41		ACE-2	280	91.2083 91.1824 0.0259	91.2109 91.1824 0.0285	91.2066 91.1824 0.0242	91.2085 91.1824 0.0261	—	0.0261 0.0014 0.0247	0.0247
42		ASE-2	275	75.4481 75.4129 0.0352	75.4528 75.4129 0.0399	75.4497 76.4129 0.0368	75.4507 75.4129 0.0378	—	0.0378 0.0014 0.0364	0.0364
43		ANE-1	310	71.0370 71.0146 0.0224	71.0392 71.0146 0.0246	71.0354 71.0146 0.0208	71.0323 71.0146 [illegible]	71.0350 71.0146 0.0204	0.0204 0.0016 0.0188	0.0188
44		ACE-1	335	81.5179 81.5004 0.0175	81.5171 81.5004 0.0167			—	0.0167 0.0017 0.0150	0.0150
45		ASE-1	320	85.6925 86.6761 0.0164	85.6978 85.6761 0.0217	85.6957 85.6761 0.0196	85.6988 85.6761 0.0227	—	0.0227 0.0016 0.0211	0.0211
46		ABD-1	270	75.9508 75.8431 0.1077	75.9502 75.8431 0.1071			—	0.1071 0.0014 0.1057	0.1057
47		-2	550	87.3736 86.9664 0.4072	87.3824 86.9664 0.4160	87.3768 86.9664 0.4104	87.3832 86.9664 0.4168	—	0.4168 0.0028 0.4140	0.4140
48		-3	325	78.8093 78.5720 0.2373	78.8144 78.5720 0.2424	78.7991 78.5720 0.2271	78.8060 78.5720 0.2340	78.7946 78.5720 0.2226	78.7815 78.5720 0.2095	0.2102
		ABD-3 (cont)		78.7842 78.5720 0.2122	78.7838 78.5720 0.2118	0.2118 0.0016 0.2102	21			
EWB1		Ether - Chloro H_2O remainder Blank	445	77.5689 77.5686 0.0069	77.5695 77.5680 0.0015	(Ave all	results)	100	ml = 0.0005	
EWB 2		↓	470	84.9563 84.9556 0.0007	84.9598 84.9556 0.0042	84.9585 84.9556 0.0029	84.9585 84.9556 0.0029			

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date 9/30/71

PARTICULATE

ETHER-CHLORC
EXTRACTION
Total wt.

SAMPLES AIRCO - NIAGARA FALLS

NO.	CR	LOCATION and SAMPLE NO.	Volume	SAMPLE WEIGHT	TIT. ALIQ.	Reading / Blank	MG in ALIQ.			Total wt.
25		ANE - 3	150	71.0894 71.0881 0.0013	71.0885 71.0881 0.0004			Bk +	0.0004 0.0023 0.0027	0.0027
26		ACE - 3	125	77.4580 77.4561 0.0019	77.4574 77.4561 0.0013			+	0.0013 0.0019 0.0032	0.0032
27		ASE - 3	125	77.1430 77.1409 0.0021	77.1406 77.1409 -0.0003	77.1415 77.1409 0.0006		+	0.0006 0.0019 0.0025	0.0025
28		ANE - 2	125	87.6660 87.6601 0.0059	87.6650 87.66[illegible] [illegible]049			+	0.0049 0.0019 0.0068	0.0068
29		ACE - 2	125	80.7324 80.7272 0.0052	80.7320 80.7272 0.0048			+	0.0048 0.0019 0.0067	0.0067
30		ASE - 2	125	79.3581 79.3530 0.0051	79.3563 79.3530 0.0033	79.3542 79.3530 0.0012	79.3537 79.3530 0.0007	+	0.0007 0.0019 0.0026	0.0026
31		ANE - 1	130	79.3703 79.3676 0.0027	79.3737 79.3676 0.0061	79.3687 79.3676 0.0011	79.3737 79.3676 0.0061	+	0.0061 0.0020 0.0081	0.0081
32		ACE - 1	155	83.5980 83.5347 0.0033	83.5401 83.5347 0.0054	83.5409 83.5347 0.0062		+	0.0062 0.0023 0.0085	0.0085
33		ASE - 1	125	84.7175 84.7156 0.0019	84.7172 84.7156 0.0016			+	0.0016 0.0019 0.0035	0.0035
34		ABD - 1	150	82.3221 82.1787 0.1434	82.3264 82.1787 0.1477	82.3218 82.1787 0.1431		+	0.1431 0.0023 0.1454	0.1454
35		- 2	200	82.9445 82.5731 0.3714	82.9482 82.5731 0.3751	82.9443 82.5731 0.3712		+	0.3712 0.0030 0.3742	0.3742
36		- 3	125	84.5366 84.2673 0.2693	84.5404 84.2673 0.2731	84.5356 84.2673 0.2683		+	0.2683 0.0019 0.2702	0.2702
EB 1		Ether Chloro Blank	120	86.1754 86.1778 - 0.0024	86.1783 86.1778 0.0027	86.1765 86.1778 0.0013	86.1768 86.1778 - 0.0010		(- 0.0015 Add this	100 ml)
EB 2		↓	120	77.9816 77.9833 - 0.0017	77.9819 77.9833 - 0.0014					

Project No. 859490

Collection Date 8/31 - 9/1

Analysis Date 9/30/71

APPENDIX G

TEST LOGS

TEST LOG

Date	Samples Performed
8-30-71	Arrive. Equipment unpacked
8-31-71	Equipment set up. One set particulate samples completed, inlet and outlet. One series of three particle size samples completed on baghouse outlet.
9-1-71	Two sets of particulate samples completed at inlet and outlet. Three baghouse outlet and 5 furnace exhaust particle size samples taken. Combustion gas samples (inlet and outlet) taken and analyzed. One SO_2 sample taken at baghouse outlet. Part of crew return home.
9-2-71	Two SO_2 samples taken at baghouse outlet and 4 furnace exhaust particle size samples taken. Three baghouse outlet and 3 furnace exhaust particulate samples taken for metals analysis. Equipment packed and remainder of crew returned home.

Furnace number 9 was within normal operating parameters during testing.

Tapping schedule each day was: 10:00 A.M.
11:50 A.M.
1:40 P.M.
3:30 P.M.
5:20 P.M.
7:10 P.M.
9:00 P.M.

APPENDIX H

RELATED REPORTS

Related reports covering emissions from reactive metals furnaces, under this same contract for the Environmental Protection Agency are as follows:

Test Number	Survey Location	Emission Control Device	Status
FA-1	Foote Mineral Co., Steubenville, Ohio	None	Issued Aug., 1971
FA-2	Union Carbide Corp., Marietta, Ohio	Venturi Scrubber	Issued Oct., 1971
FA-3	AIRCO Alloys and Carbide, Niagara Falls, New York	Baghouse	This Report
FA-4	AIRCO, Charleston, S. C.	Electrostatic Precipitator	In progress
FA-5			Future

APPENDIX I

PROJECT PARTICIPANTS AND TITLES

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

N. A. Blessing, Chemist

C. C. Gonzalez, Chemist

T. E. Eggleston, Project Engineer

G. B. Patchell, Test & Development Specialist
(Partcle Size Determination)

L. W. Baxley, Technician

J. Avery, Technician

J. McReynolds, Technician

W. Hall, Technician

METALS ANALYSIS

J. R. Ogren, Program Manager

D. F. Carroll

M. L. Kraft

W. B. Hewitt

APPENDIX J

PARTICLE SIZING
DATA & RESULTS

EXPLANATION OF DATA

The field data sheets are included in 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 10 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

Stage No.	Dpc micron
1	3.40
2	2.00
3	1.36
4	0.69
5	0.42

For a Pressure Drop of Ten Inches Of Mercury Across the Impactor

Stage No.	Dpc micron
1	3.06
2	1.80
3	1.23
4	0.63
5	0.38

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

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

TABLE 1

DATE	SAMPLE NO.	LOCATION OF SAMPLE	PORT NO.	DURATION OF SAMPLE (MINUTES)	ΔP ACROSS IMPACTOR (IN. H_g)	MMD (μ)	σg (μ)	REMARKS
8/31/71	1	BAGHOUSE EXHAUST	SE	120	5	1.50	2.26	
"	2	" "	CE	"	"	1.26	2.38	
"	3	" "	NE	"	"	*	*	
9/1/71	4	" "	"	180	10	0.74	3.91	
"	5	" "	CE	"	"	0.86	2.80	
"	6	" "	SE	"	"	0.48	7.10	
"	7	FURNACE EXHAUST	B	5	5	0.62	3.42	Sampled between taps
"	8	" "	C	"	"	3.20	4.85	Sampled simultaneously
"	10	" "	B	"	"	1.01	3.86	between taps
"	9	" "	B	"	"	0.79	3.79	Sampled simultaneously
"	11	" "	C	"	"	0.26	3.81	during tap
9/2/71	12	BAGHOUSE EXHAUST	SE	240	10	**	*	
"	13	" "	CE	"	"	0.83	2.17	Simultaneous samples
"	14	" "	NE	51	"	0.84	3.06	
"	15	FURNACE EXHAUST	C	5	5	0.30	8.47	Sampled simultaneously
"	16	" "	B	"	"	0.59	3.59	during tap
"	17	" "	B	"	"	1.30	5.51	Sampled simultaneously
"	18	" "	C	"	"	0.73	7.70	between taps

* AN INSUFFICIENT QUANTITY OF PARTICLES DEPOSITED ON THE COLLECTOR PLATES TO DETERMINE MMD AND σg

SUB-APPENDIX J-1

GRAPHICAL PRESENTATION OF RESULTS

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

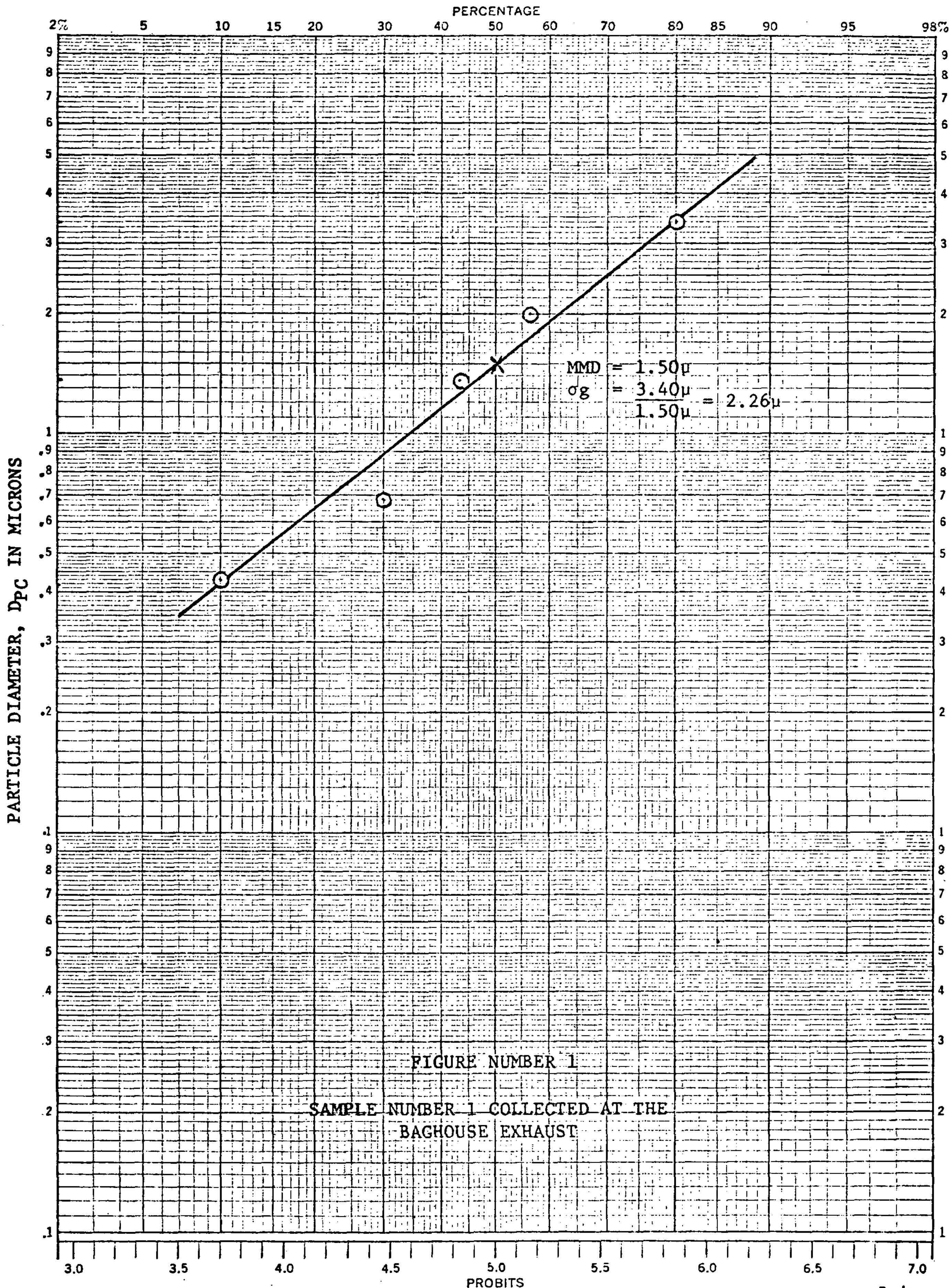


FIGURE NUMBER 1

SAMPLE NUMBER 1 COLLECTED AT THE BAGHOUSE EXHAUST

[redacted] X 3 LOG CYCLES KEUFFEL & ESSER CO. MADE IN U.S.A.

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

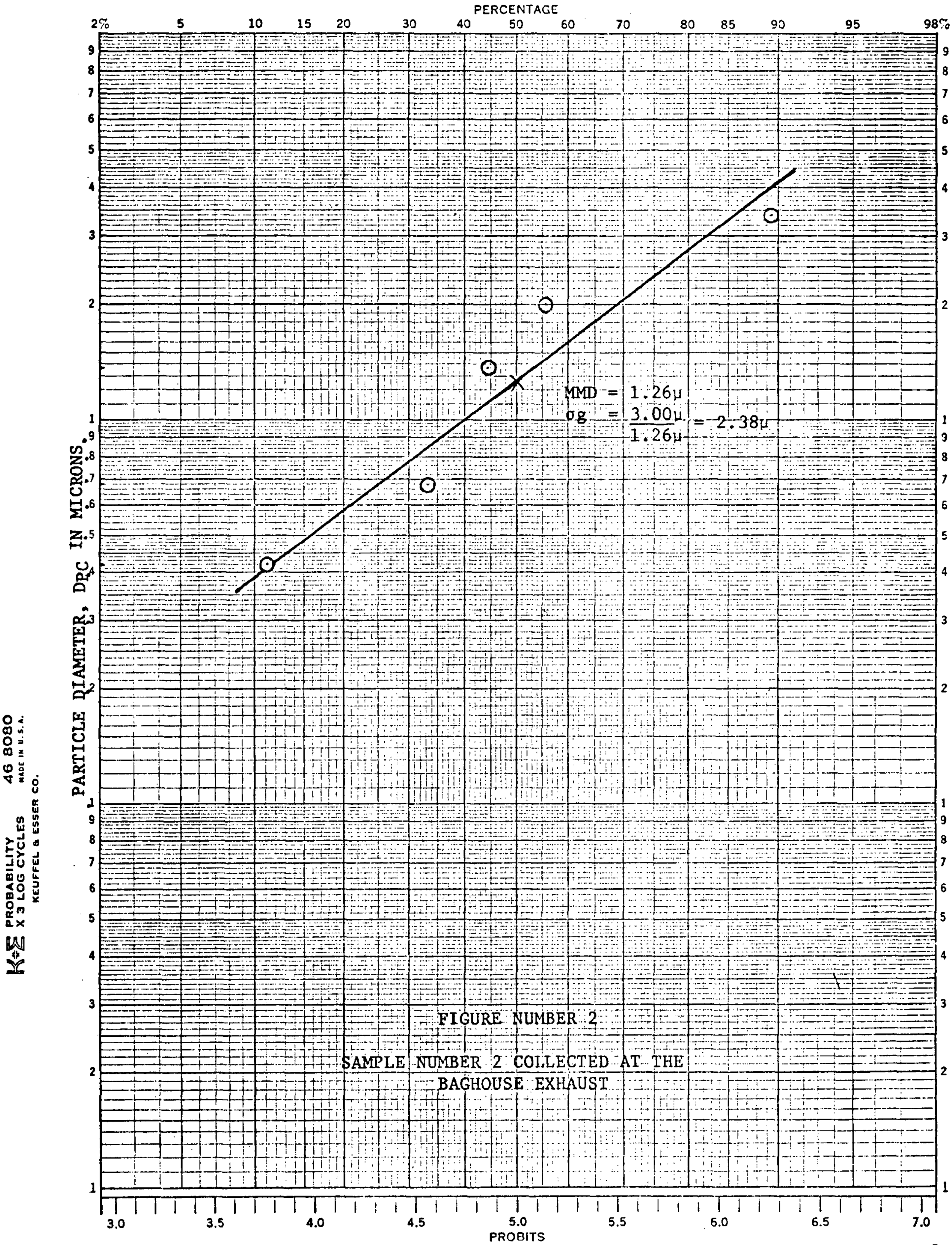


FIGURE NUMBER 2

SAMPLE NUMBER 2 COLLECTED AT THE BAGHOUSE EXHAUST

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

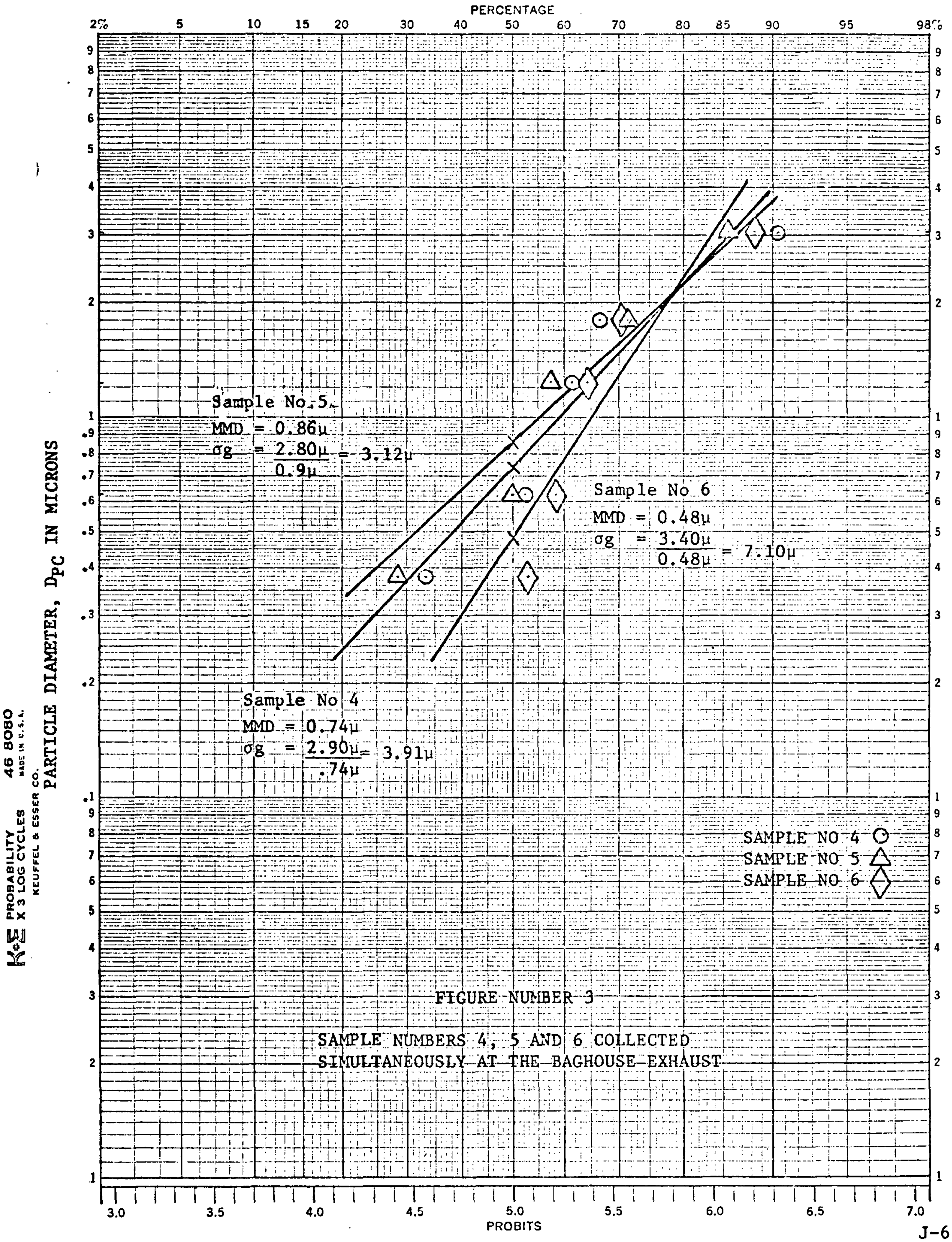


FIGURE NUMBER 3

SAMPLE NUMBERS 4, 5 AND 6 COLLECTED SIMULTANEOUSLY AT THE BAGHOUSE EXHAUST

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

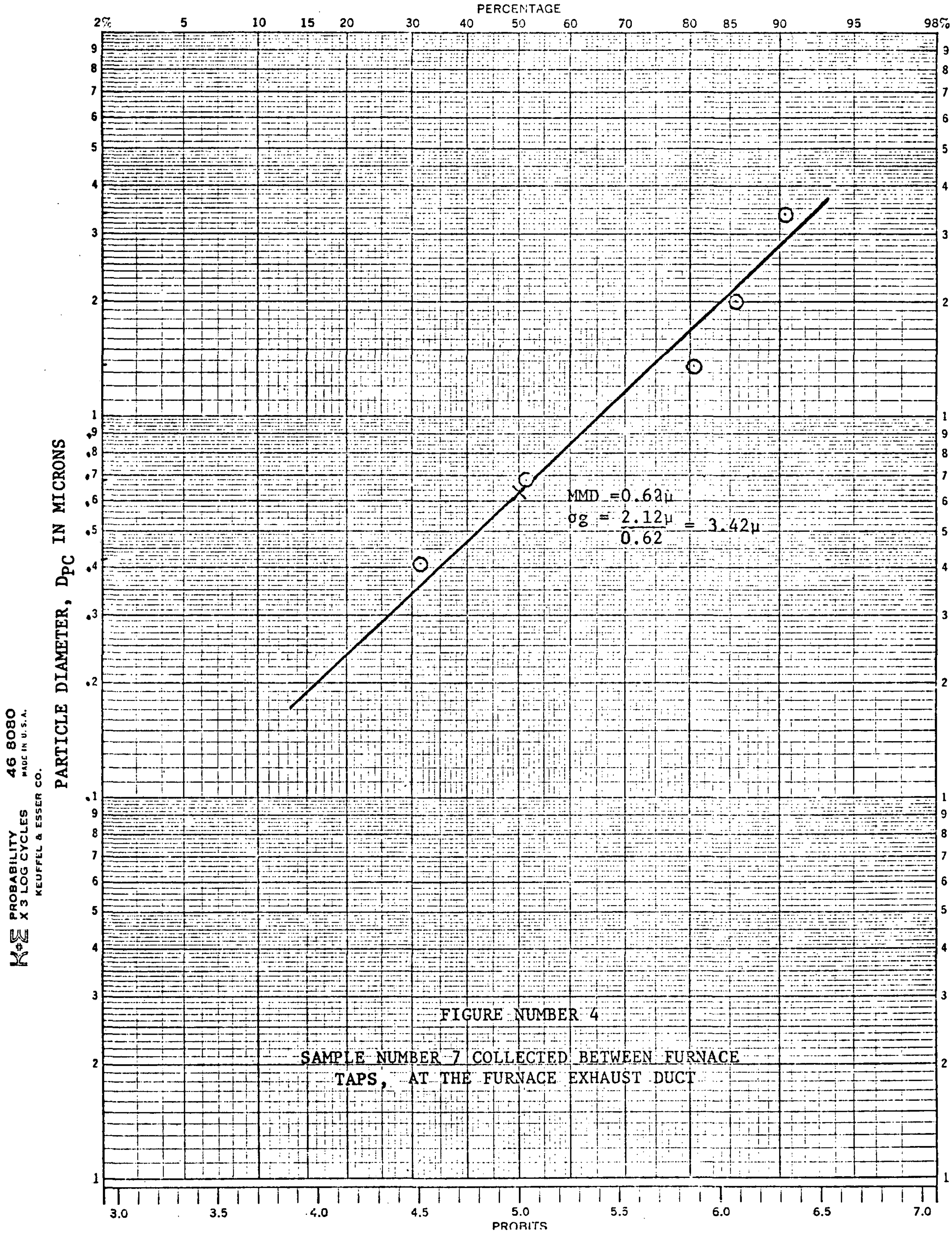


FIGURE NUMBER 4

SAMPLE NUMBER 7 COLLECTED BETWEEN FURNACE TAPS, AT THE FURNACE EXHAUST DUCT

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

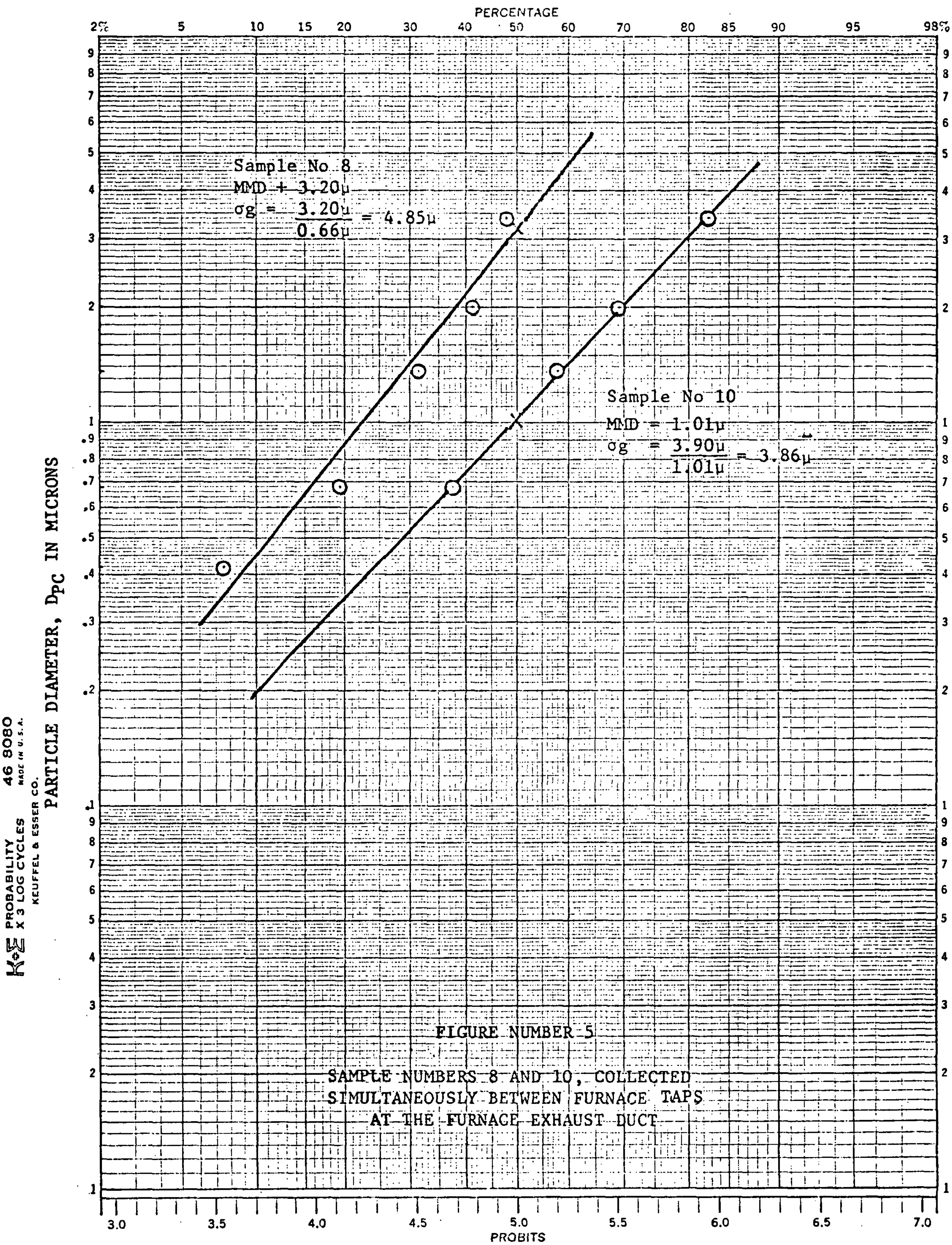


FIGURE NUMBER 5

SAMPLE NUMBERS 8 AND 10, COLLECTED SIMULTANEOUSLY BETWEEN FURNACE TAPS AT THE FURNACE EXHAUST DUCT

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

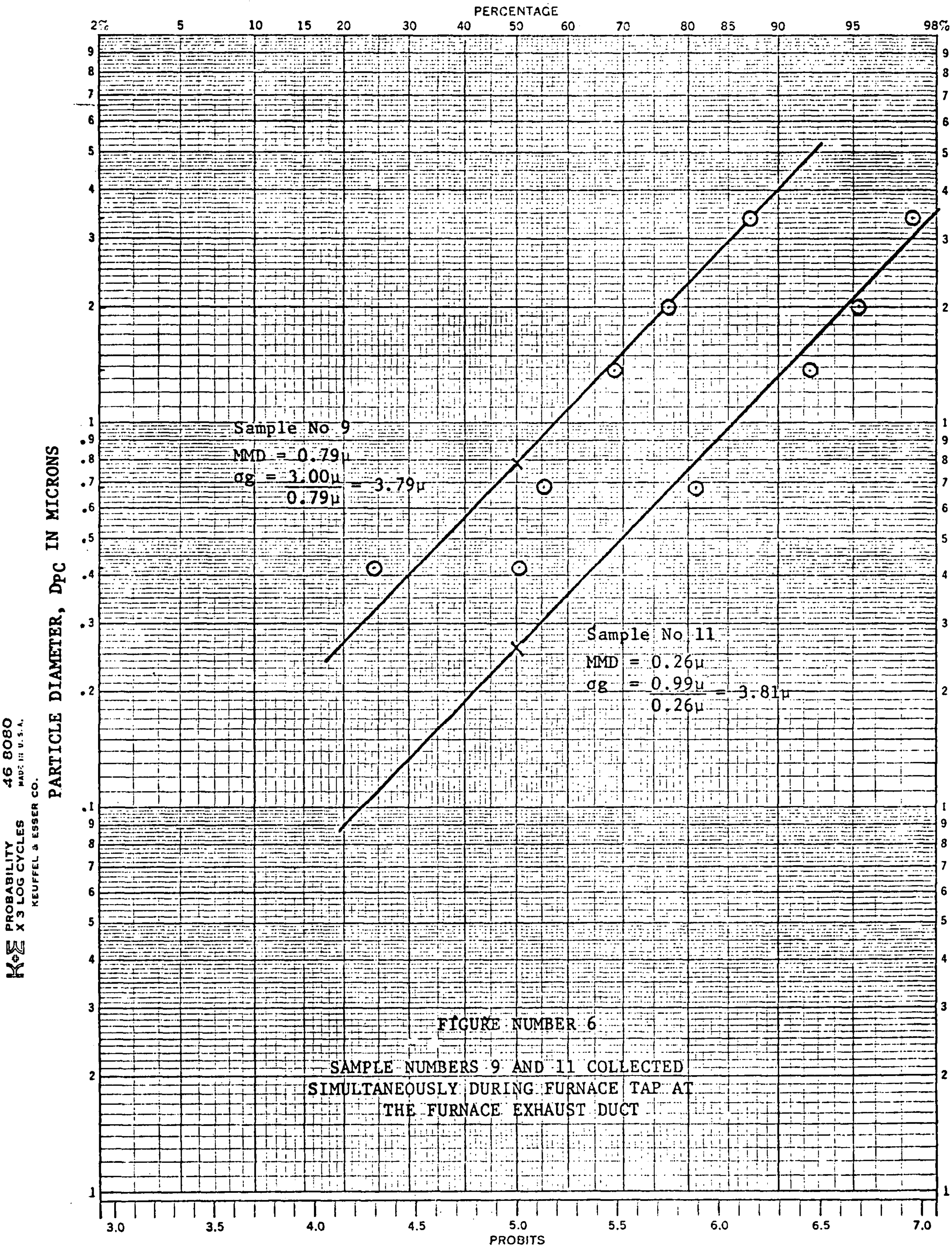


FIGURE NUMBER 6

SAMPLE NUMBERS 9 AND 11 COLLECTED SIMULTANEOUSLY DURING FURNACE TAP AT THE FURNACE EXHAUST DUCT

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

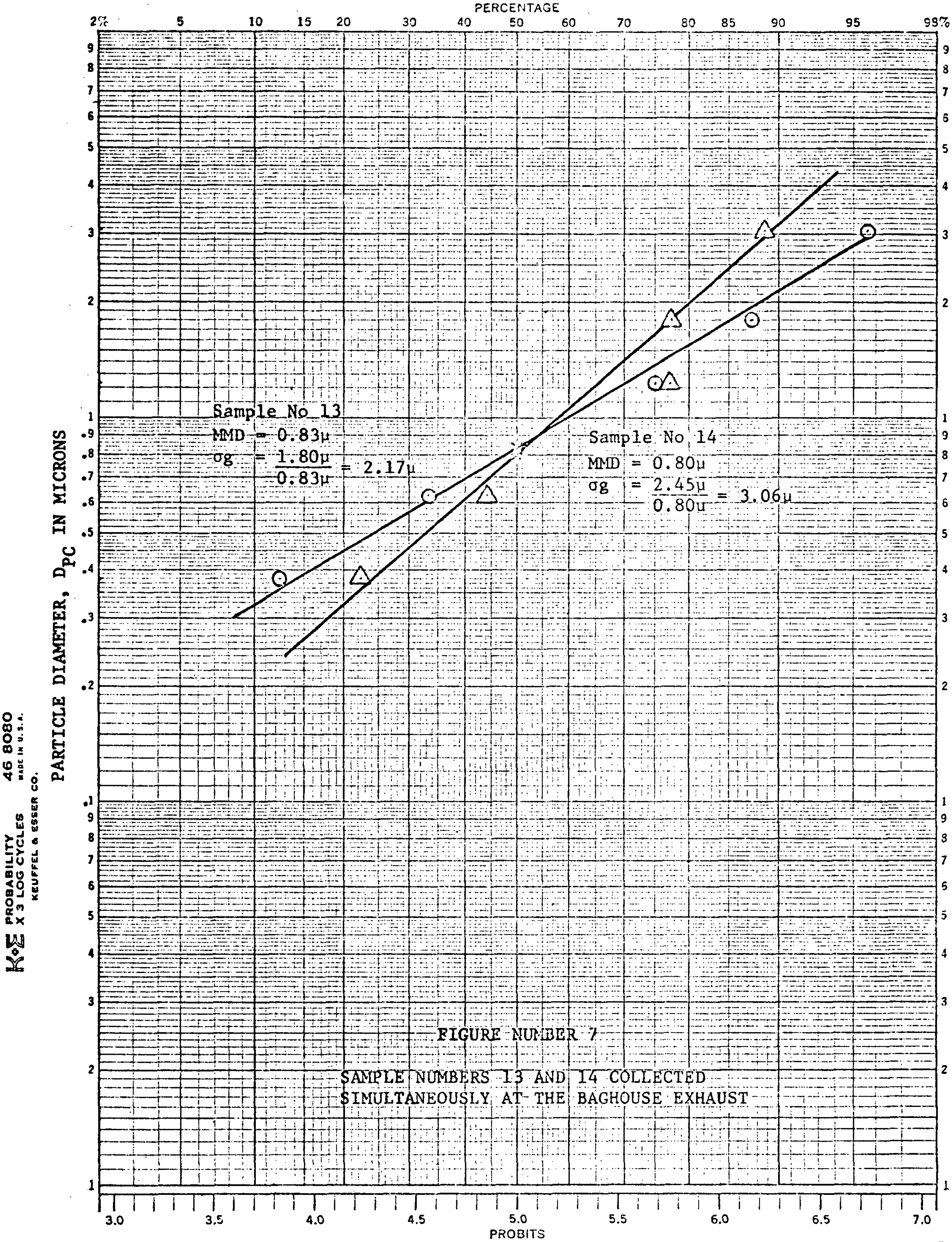


FIGURE NUMBER 7

SAMPLE NUMBERS 13 AND 14 COLLECTED SIMULTANEOUSLY AT THE BAGHOUSE EXHAUST

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

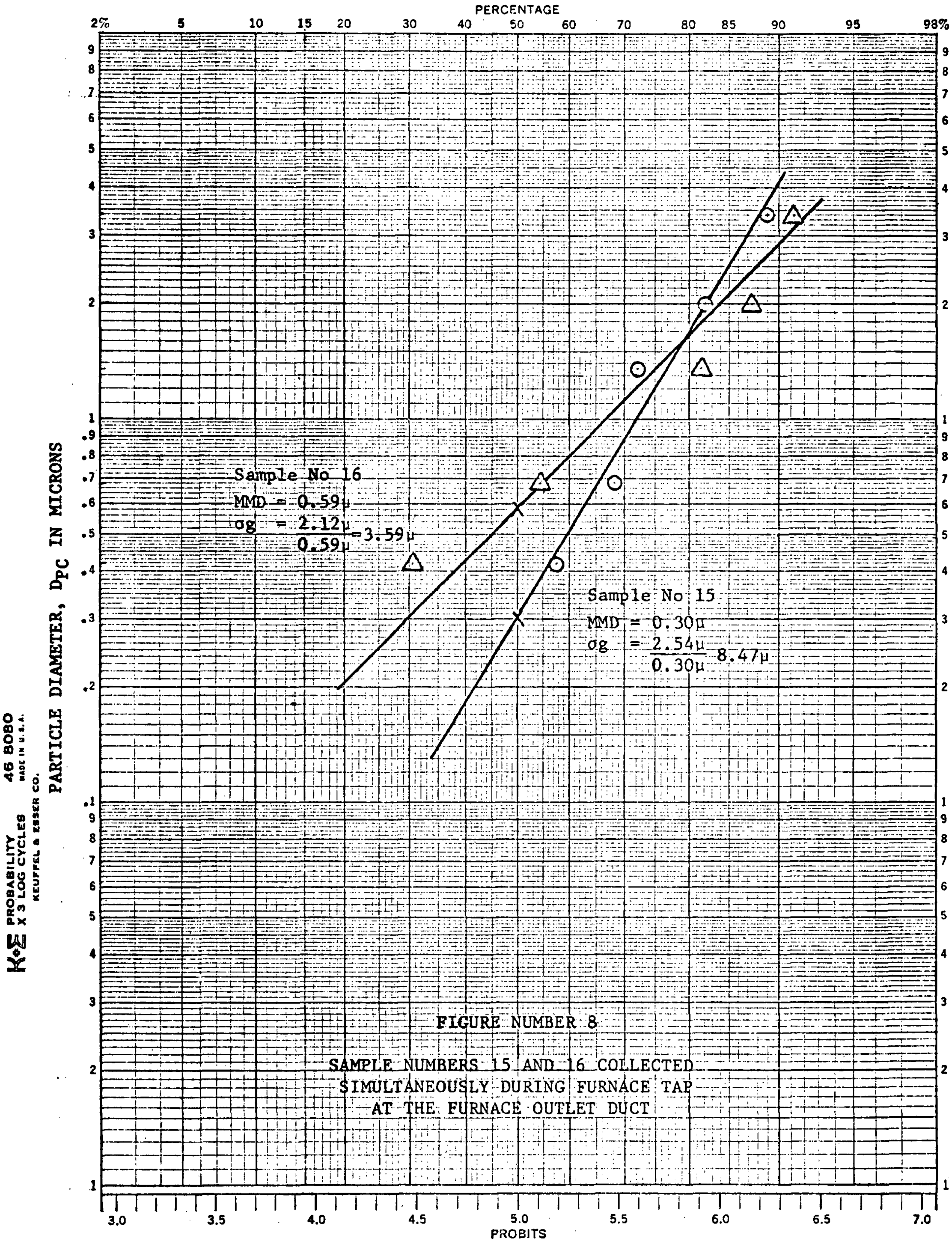


FIGURE NUMBER 8

SAMPLE NUMBERS 15 AND 16 COLLECTED SIMULTANEOUSLY DURING FURNACE TAP AT THE FURNACE OUTLET DUCT

CUMULATIVE PERCENT LESS THAN STATED MICRON SIZE

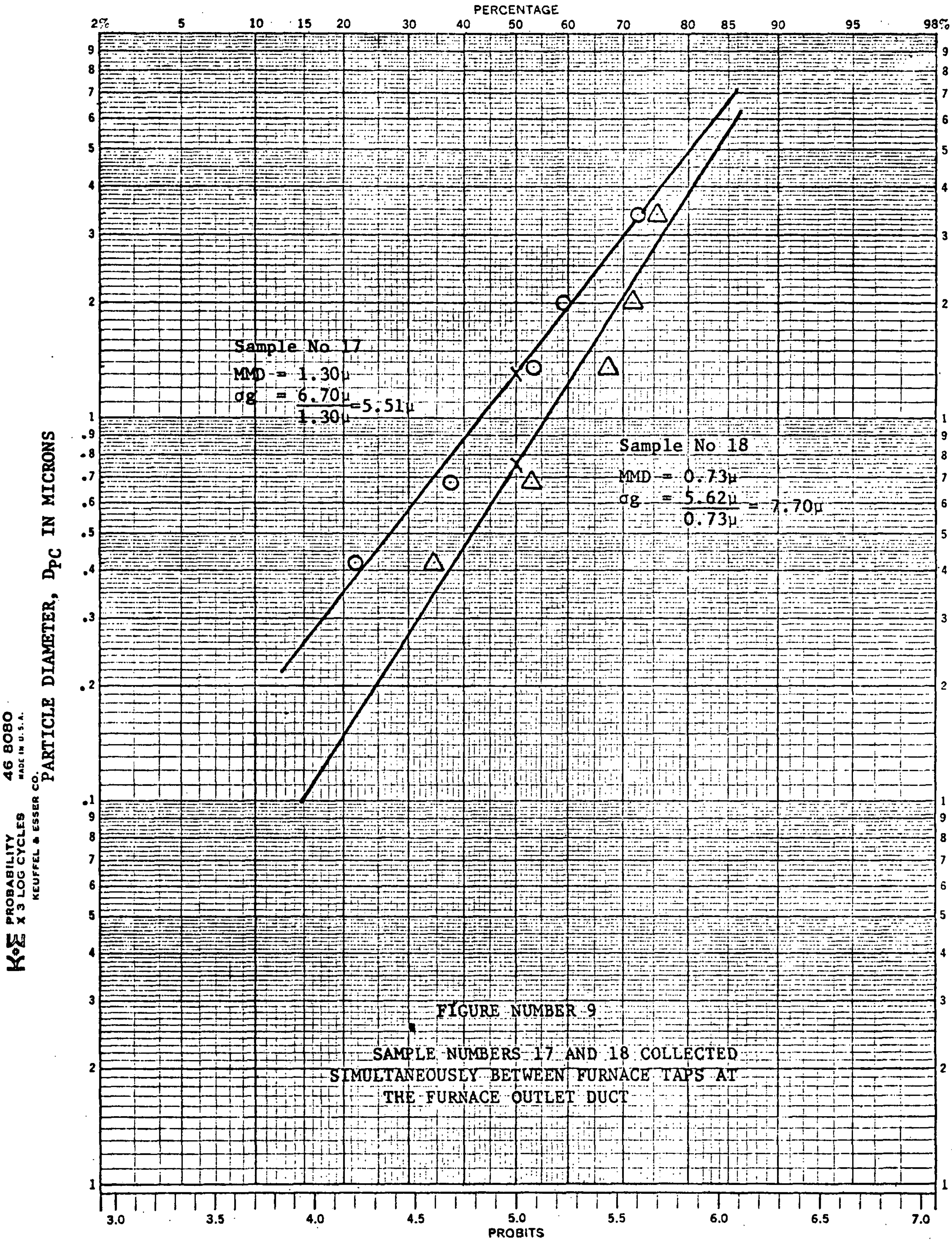


FIGURE NUMBER 9

SAMPLE NUMBERS 17 AND 18 COLLECTED SIMULTANEOUSLY BETWEEN FURNACE TAPS AT THE FURNACE OUTLET DUCT

SUB-APPENDIX J-2

FIELD DATA

PARTICLE SIZING

Stack No. BAGHOUSE EXHAUST
SE PORT

Date 8-31-71

Sample No. 1

Stage	Post Wt.	Pre Wt.	Wt Gain Mg.	%	Cum. % less than Dpc
1	3.6342	3.6336	0.6	20.0	80.0
2	3.5897	3.5890	0.7	23.4	56.6
3	3.2424	3.2430	0.4	13.3	43.3
4	3.6846	3.6842	0.4	13.3	30.0
5	3.5323	3.5317	0.6	20.0	10.0
filter	0.1283	0.1280	0.3	10.0	
		TOTAL	3.0		

TIME	METER READING (CF)	VAC. PRESS ACROSS SAMPLER (IN. Hg)	
12:50	009.60	5.0	START TEST
1410	025.16	5.0	
1425	028.88	5.0	
1436	031.50	5.0	STOP TEST
1450	035.10	5.0	

ΔM = ~~031.50~~ 035.10
~~-009.60~~ -009.60
25.50 CF.

PARTICLE SIZING

Date 8-31-71

Stack No. BAG HOUSE EXHAUST CE PORT

Sample No. 2

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.1320	3.1319	0.1	11.1	89.9
2	3.6193	3.6190	0.3	33.3	55.6
3	3.5909	3.5908	0.1	11.1	44.5
4	3.6656	3.6655	0.1	11.1	33.4
5	3.4734	3.4732	0.2	22.3	11.1
filter	0.1284	0.1283	0.1	11.1	
		TOTAL	0.9		

TIME	METER READING (CF)	ΔP ACROSS SAMPLER	
1307	0.30	5.0	START ~~TEST~~ SAMPLING
1410	METER		
1507	MALFUNCTIONED	5.0	
		5.0	STOP SAMPLING

PARTICLE SIZING

Date 8-31-71

Stack No. BAG HOUSE EXHAUST NE PORT

Sample No. 3

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.6032	3.6032	0.0	There's mat'l here	
2	3.6440	3.6433	0.7		
3	3.6399	3.6400	-0.1	There's mat'l here	
4	3.4556	3.4557	-0.1	There's mat'l here	
5	3.6024	3.6021	0.3		
filter	0.1271	0.1260	1.1		

NOT ENOUGH DATA TO DETERMINE MMD & σ_g

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)	
1259	0.0	5.0	START SAMPLING
1408	16.00	5.0	
1426	19.78	5.0	
1437	21.82	5.0	
1451	24.52	5.0	
1459	26.10	5.0	STOP SAMPLING

ΔM = 26.10 CF

PARTICLE SIZING

Stack No. BAGHOUSE EXHAUST NE PORT

Date 9/1/71

Sample No. 4

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dpc
1	3.6339	3.6336	0.2	9.5	90.5
2	3.5895	3.5890	0.5	23.8	66.7
3	3.2431	3.2430	0.1	4.9	61.8
4	3.6844	3.6842	0.2	9.5	52.3
5	3.5321	3.5317	0.4	19.1	33.2
filter	0.1273	0.1266	0.7	33.2	
		TOTAL	2.1		

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)	
0810	04.85	10.0	START SAMPLING
0837	07.70	10.0	
0850	09.21	10.0	
0919	12.51	10.0	
0921	ELECTRICITY OFF		
1103	ELECTRICITY ON - SAMPLING RESTARTED		
1131	16.21	10.0	
1156	19.20	10.0	
1243	25.00	10.0	STOP SAMPLING

ΔM = 20.15 CF

PARTICLE SIZING

Date 9/1/71

Stack No. BAGHOUSE EXHAUST
CE PORT

Sample No. 5

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	1.6034	3.6032	0.2	14.3	85.7
2	1.6435	3.6433	0.2	14.3	71.4
3	1.6402	3.6400	0.2	14.3	57.1
4	3.4558	3.4557	0.1	7.1	50.0
5	3.6024	3.6021	0.3	21.4	28.6
filter	0.1271	0.1267	0.4	28.6	
		TOTAL	1.4		

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)	
0808	26.10	10.0	START SAMPLING
0836	30.00	10.0	
0849	31.82	10.0	
0918	35.80	10.0	
0926	POWER OFF		
1102	POWER ON - RESUME SAMPLING		
1125	40.50	10.0	
1206	45.98	10.0	
1247		10.0	STOP SAMPLING

PARTICLE SIZING

Stack No. BAGHOUSE EXHAUST SE PORT

Date 9-1-71

Sample No. 6

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.1321	3.1319	0.2	11.7	88.3
2	3.6193	3.6190	0.3	17.6	70.7
3	3.5909	3.5908	0.1	5.9	64.8
4	3.6656	3.6655	0.1	5.9	58.9
5	3.4732	3.4732	0.1	5.9	53.0
filter	0.1278	0.1269	0.9	53.0	
		TOTAL	1.7		

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)	
0804	35.12	10.0	START SAMPLING
0834	38.00	10.0	
0848	40.71	10.0	
0915	44.37	10.0	
0926	POWER OFF		
1101	POWER ON	RESUME SAMPLING	
1129	49.16	10.0	
1148	51.48	10.0	
1205	53.60	10.0	
1225	56.18	10.0	
1251	59.20	10.0	STOP SAMPLING

PARTICLE SIZING

Date 9-1-71

Stack No. FURNACE EXHAUST, PORT B - BETWEEN TAPS

Sample No. 7

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.6280	3.6266	1.4	9.5	90.5
2	3.4636	3.4629	0.7	4.7	85.8
3	3.4521	3.4513	0.8	5.4	80.4
4	3.6398	3.6355	4.3	29.8	51.4
5	3.2184	3.2154	3.0	20.3	31.1
filter	0.1312	0.1266	4.6	31.1	
		TOTAL	14.8		

1942 hrs - START SAMPLING

1947 hrs - STOP SAMPLING

ΔP across sampler = 5" Hg

PARTICLE SIZING

Stack No. FURNACE EXHAUST, PORT C, BETWEEN TAPS   Date 9/1/71

Sample No. 8

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.6005	3.5473	12.2	52.0	48.0
2	3.6200	3.6184	1.6	6.8	41.2
3	3.5817	3.5795	2.2	9.4	31.8
4	3.5682	3.5653	2.9	12.3	19.5
5	3.6102	3.6074	2.8	11.8	7.7
filter	0.1311	0.1293	1.8	7.7	
		TOTAL	23.5		

1750 HRS - START SAMPLING ΔP across sampler = 5" Hg

1755 HRS - STOP SAMPLING

SAMPLING SIMULTANEOUSLY WITH NO. 10

PARTICLE SIZING

Stack No. FURNACE EXHAUST, PORT 8, DURING TAP

Date 9-1-71

Sample No. 9

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.5945	3.5919	2.6	12.6	87.4
2	3.3857	3.3836	2.1	10.2	77.2
3	3.5951	3.5933	1.8	8.7	68.5
4	3.2483	3.2456	2.7	13.0	55.5
5	3.2928	3.2863	6.5	31.4	24.1
filter	0.1359	0.1309	5.0	24.1	
		TOTAL	20.7		

1722 HRS - START SAMPLING

1727 HRS - STOP SAMPLING

ΔP across sampler = 5" Hg

Sampling simultaneously with No. 11

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT 8, BETWEEN TAPS

Date 9-1-71

Sample No. 10

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.1508	3.1480	2.8	17.3	82.7
2	3.6240	3.6218	2.2	13.6	69.1
3	3.6178	3.6160	1.8	11.1	58.0
4	3.6004	3.5971	3.3	20.4	37.6
5	3.4630	3.4581	4.9	30.2	7.4
filter	0.1281	0.1269	1.2	7.4	
		TOTAL	16.2		

1750 hrs - start sampling   ΔP across sampler = 5" hg
1755 hrs - stop sampling

Sampling simultaneously with No. 8

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT C, DURING TAP

Date 9-1-71

Sample No. 11

Stage	Post Wt.	Pre Wt.	Wt Gain	%	Cum. % less than Doc
1	3.6268	3.6264	0.4	2.6	97.4
2	3.4636	3.4633	0.3	2.2	95.2
3	3.4521	3.4517	0.4	2.6	92.6
4	3.6389	3.6372	1.7	11.6	81.0
5	3.2197	3.2152	4.5	30.6	50.4
filter	0.1348	0.1274	7.4	50.4	
		TOTAL	14.7		

1722 hrs - Start sampling
1727 hrs - Stop sampling

ΔP across sampler = 5" Hg

Sampling simultaneously with No. 9

PARTICLE SIZING

BAGHOUSE EXHAUST

Stack No. SE PORT

Date 9-2-71

Sample No. 12

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.4688	3.4688	0.0		
2	3.5522	3.5522	0.0		
3	3.6381	3.6382	-0.1		
4	3.2844	3.2843	0.1		
5	3.6194	3.6193	0.1		
filter	0.1267	0.1270	-0.3		

INSUFFICIENT DATA TO DETERMINE MMD AND σg

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)
0821	78.78	10.0
0909	85.04	10.0
0914	89.70	10.0
1014	94.20	10.0
1047	98.80	10.0
1059	100.52	10.0
1114	102.80	10.0
1132	105.34	10.0
~~1221~~ 1217	112.10	10.0
1228	112.20	10.0

Sampling simultaneously with 13 and 14

PARTICLE SIZING

Stack No. BAGHOUSE EXHAUST CE PORT

Date 9-2-71

Sample No. 13

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dpc
1	3.2886	3.2885	0.1	4.2	95.8
2	3.5910	3.5908	0.2	8.3	87.5
3	3.0681	3.0678	0.3	12.5	75.0
4	3.6157 ~~3.6157~~	3.6147	1.0	41.7	33.3
5	3.3584	3.3579	0.5	20.8	12.5
filter	0.1294	0.1291	0.3	12.5	
		TOTAL	2.4		

TIME	METER READING (CF)	ΔP ACROSS SAMPLER (IN. Hg)
0825	52.68	10.0
0914	59.68	10.0
0944	65.10	10.0
1014	70.00	10.0
1046	75.00	10.0
1059	77.12	10.0
1116	79.50	10.0
1137	82.00	10.0
1214	88.44	10.0
1225	90.39	10.0

Sampled simultaneously with 12 and 14

PARTICLE SIZING

BAGHOUSE EXHAUST

Stack No. NE PORT

Date 9-2-71

Sample No. 14

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.3372	3.3371	0.1	11.1	88.9
2	3.3101	3.3100	0.1	11.1	77.8
3	3.1375	3.1375	0.0	0	77.8
4	3.1561	3.1558	0.3	33.4	44.4
5	3.5790	3.5788	0.2	22.2	22.2
filter	0.1269	0.1269	0.2	22.2	
		TOTAL	0.9		

TIME	METER READING	ΔP ACROSS SAMPLER
0827	27.04	10.0
0911	32.00	10.0
0945	36.20	10.0
1101	46.44	10.0
1129	50.20	10.0
1221	56.90	10.0
1228	58.00	10.0

Sampled simultaneously with 12 and 13

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT C, DURING TAP

Date 9-2-71

Sample No. 15

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.5643	3.5625	1.8	11.0	89.0
2	3.5794	3.5783	1.1	6.8	82.2
3	3.5783	3.5772	1.6	9.8	72.4
4	3.6563	3.6476	0.7	4.3	68.1
5	3.5943	3.5866	1.7	10.5	57.6
filter	0.1357	0.1263	9.4	57.6	
		TOTAL	16.3		

1525 hrs - Start sampling, ΔP across sampler = 5" hg

1530 hrs - Stop sampling

Sampling simultaneously with no. 16

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT B, DURING TAP

Date 2-2-71

Sample No. 16

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Dpc
1	3.6117	3.6091	2.6	8.8	91.2
2	3.6072	3.6061	1.1	3.7	87.5
3	3.6047	3.6030	1.7	5.8	81.7
4	3.5960	3.5879	8.1	27.6	54.1
5	3.6585	3.6515	7.0	23.7	30.4
filter	0.1372	0.1283	8.9	30.4	
			TOTAL 29.4		

1525 hrs - start sampling. ΔP across sampler = 5" hg
1530 hrs - stop sampling

Sampling simultaneously with 15

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT B, BETWEEN TAPS

Date 9-2-71

Sample No. 17

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.6398	3.6374	2.4	27.3	72.7
2	3.6655	3.6643	1.2	13.5	59.2
3	3.6260	3.6255	0.5	5.8	53.4
4	3.5773	3.5759	1.4	15.9	37.5
5	3.6012	3.5998	1.4	15.9	21.6
filter	0.1288	0.1269	1.9	21.6	
		TOTAL	8.8		

1600 hrs - start sampling, ΔP across sampler = 5" Hg
1605 hrs - stop sampling
Sampled Simultaneously with 18

PARTICLE SIZING

Stack No. FURNACE EXHAUST PORT C, BETWEEN TAPS

Date 9-2-71

Sample No. 18

Stage	Post Wt.	Pre Wt.	Wt Gain mg	%	Cum. % less than Doc
1	3.6120	3.6108	1.2	24.5	75.5
2	3.1990	3.1988	0.2	4.1	71.4
3	3.2744	3.2742	0.2	4.1	67.3
4	3.4615	3.4608	0.7	14.3	53.0
5	3.3921	3.3912	0.9	18.3	34.7
filter	0.1296	0.1279	1.7	34.7	
		TOTAL	4.9		

1600 hrs - start sampling, ΔP across sampler = 5" Hg

1605 hrs - stop sampling

Sampled simultaneously with 17

APPENDIX K

CHEMICAL ANALYSIS OF EMISSIONS

CHEMICAL ANALYSES OF EMISSIONS FROM REACTIVE METALS SMELTING OPERATIONS

1. INTRODUCTION

Particulate fumes and gaseous emissions are generated during the processing of a commercially important class of ferroalloy materials called reactive metals. The particulate portion of these emissions is collected on glass fiber filters strategically placed in the air stream of a ventilation system. Six such filters from Airco (Niagara Falls, New York) were analyzed by atomic absorption and qualitative electron beam X-ray microanalysis. Each of the six filters prior to compositing was examined microscopically.

2. TEST RESULTS

2.1 Optical Examination

The loaded filters were examined at magnifications up to 30X. Under tungsten filament illumination the separate filters appeared as follows:

ABD-1M	Dark gray powder with black particles-no quartz fibers from the collector pad visible.
ABD-2M	Light gray powder with very few black particles-no quartz fibers from the collector pad visible.
ABD-3M	Dark gray powder with black particles-quartz fibers from the collector pad visible.
ANE-1M	Light gray powder with black particles-quartz fibers from the collector pad visible.
ACE-1M	A few black particles among the quartz fibers.
ASE-1M	A few black particles among the quartz fibers.

The optical examination revealed that:

1. Four filters had trapped a heterogeneous particulate material consisting predominantly of a gray powder and a minor amount of black particles.

2. The amount of sample collected in four cases was so small that the fibers from the filters could still be seen. In fact, in two such samples, only a small amount of the black particles could be seen against a background that was predominantly the filter material.

Two different techniques were necessary to form composite samples:

1. Simple Blending of Loose Powders

   Samples ABD-1M, ABD-2M, and ABD-3M were shaken, lightly scraped and copious amounts of loose gray material were gathered, blended, and designated as Niagara Falls Airco Inlet Duct Sample ABD-M. A negligible amount of the collector filter material was included in the blended sample.

2. Dissolution in a Common Reagent

   Samples ANE-1M, ACE-1M, and ASE-1M were submerged (particulate matter and filter pads) in a common solution of sulfuric acid. A control experiment was also run on a unused filter pad to determine the contributions of the filter. The composited sample in this case was labeled Niagara Falls Airco Stack Sample ABE-M.

   Small samples for electron beam X-ray microanalysis were cut from every specimen prior to formation of any composite samples.

2.2 Electron Beam X-Ray Microanalysis

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. 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 1-100A covering all elements except H, He, Li, and Be were taken into account.

In these analyses, the electron beam was defocused to a diameter of ~150 microns (0.006 inch) to cover a relatively large area of the specimen and to insure that both the gray condensate and the black particles were analyzed. The electron beam impinged in vacuum on the untouched surfaces of three specimens:

1. Sample ABD-1M

   In this sample, the layer of particulate material was far too thick to allow penetration of the electron beam into the collector (filter) pad. In other words, only the condensed particulate material was analyzed in this case.

2. Sample ABD-3M

   The layer of particulate was sufficiently thin that a contribution from the collector pad may be present.

3. Sample ANE-1M

   A contribution from the collector was definitely present in this case because the fibers from the collector could be seen in the optical microscope viewing system attached to the electron microprobe.

The qualitative results are compiled in Table 1 and provide the basis for selection of elements for quantitative analyses. Note that a total of 15 elements were found* and that the stack sample (ANE-1M contained a small but distinct amount of both sulfur and chlorine. Special mention is made of these

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* The spectral scans were conducted in a manner such that all elements except H, He, Li, Be, B, N could be detected.

Table 1. Qualitative Electron Beam X-Ray Microanalyses

Specimen No.	Cr	Mn	Mg	Fe	Al	Ca	Ba	Na	K	Zn	Cl	S	Si	O	C
ABD-3M	M	T	H	T	L	T	-	T	M	T	-	-	H	H	L
ABD-2M Airco Inlet Duct Sample	M	T	H	T	L	T	-	T	L	T	-	-	H	H	L
ANE-1M Airco Stack Sample	T	-	H	T	M	H	L	M	M	T	T	T	H	H	L

KEY:
- H = greater than 20 wt%
- M = 10-20 wt%
- L = 1-10 wt%
- T = less than 1 wt%

elements because they were not included in the quantitative analyses which will be described in the next paragraph. Note also that oxygen was detected at about the 50%, thereby suggesting that the particulate material was a mixture of oxides.

2.3 Atomic Absorption Analyses

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.

As stated previously, the two sets of samples were composited two different ways for the atomic absorption analyses. The detailed procedures for the physically blended powders are as follows:

1. The particulate material from three specimens was either shaken loose or scraped from the filter pads with a wood tongue depresser and blended in a polyethylene container.

2. Duplicate portions of the blended powder were digested in hot HCl-HNO_3.* After cooling, the suspension was filtered.

3. The filtrate (soluble portion) was analyzed for the elements-of-interest by atomic absorption. The precipitate (non-soluble portion) was analyzed by "large beam" electron microprobe analysis and flame photometry and found to be free of sodium or potassium. This action was done because potassium acid sulfate ($KHSO_4$) was used in the next step.

4. The precipitate was blended with a known quantity of $KHSO_4$ and ignited in a 850°C muffle furnace to form a fused mass which subsequently was dissolved in HCl. Solution was not complete, and a filtration step was needed to separate the solution from a precipitate.

5. The solution was analyzed for the elements of interest by atomic absorption, and the results from this step were added to those from Step 3 to yield the total percentage of each element in the particulate sample.

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* The hot solution used was 8 ml concentrated HCl, 32 ml concentrated HNO_3 and 40 ml distilled water.

6. The precipitate from Step 4 was checked for SiO_2 by a gas evolution technique.* This technique selectively decomposes and volatilizes SiO_2 through reaction with hot H_2SO_4, HNO_3 and HF in a platinum crucible. The portion of the sample that still remained after all these steps was labeled an insoluble residue in Table 2.

A different procedure was needed for those samples in which the quantity of condensable particulate was insufficient for a physical separation. In this case the following procedure was used:

1. Three entire collector pads, with material in and on them, were digested in a common hot H_2SO_4 solution. An unused collector pad was submerged in a second identical solution.

2. The steps described previously were followed for both the unknown and the unused sample. The results for the latter were corrected to account for the fact that three used pads were used with the unknown samples but only one unused pad was employed as a blank.

3. The concentrations of elements in the condensable particulate material was obtained by subtracting the results for the "blank" from the total.

The results of the atomic absorption analyses are compiled in Table 2. The following are observations.

1. Both samples are predominantly silicon dioxide, SiO_2. This conclusion is directly seen in the results for the Inlet Duct Sample where 76.4% of the material is SiO_2. The concentrations of the remaining elements are all low in comparison, and magnesium is the highest at an average 5.44% level. The sum of all the percentage values is 100%, and this indicates excellent closure (mass balance). The 100% value is achieved when all the metal percent values are converted to their equivalent oxide percent values.**

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* N. H. Furman, Editor, <u>Standard Methods of Chemical Analysis, 6th Edition</u>, Volume 1, D. Van Nostrand Company, Princeton, N. J., p. 950.

** Equivalent oxide percentages are obtained by multiplying the weight percent metal in Table 2 by the ratio Mo/Mm where Mo is the molecular weight of the metal oxide and Mm is that of the metal.

Table 2. Elemental Analysis of Particulate Matter

Sample	Element wt%												
	Na	K	Mn	Fe	Zn	Cr	Ca	Mg	Al	Ba	Ti	SiO_2	Insoluble Residue (b)
ABE-M Airco Stack Sample	12.7	0.9	0.1	1.0	0.6	<.4	4.0	0.6	8.0	<4.	<8.	(a)	-
ABD-M Airco Inlet Duct Sample	0.23 0.22	0.25 0.25	0.054 0.050	0.10 0.08	0.32 0.37	0.46 0.42	0.59 0.27	5.28 5.59	0.38 0.35	<.4	<.8	76.8 76.0	11.5 13.2

(a) No SiO_2 quantitative results were determined for this sample which was a composite of three filters and their condensable particulate samples. The sample was known in advance to be predominantely SiO_2.

(b) The residue that seemed to defy attempts at dissolution was analyzed on the electron beam X-ray microanalyzer and found to be primarily (~50%) platinum (from the platinum crucibles used) with lesser amounts of aluminum, sodium, and fluorine. The latter group of elements probably are evidence of incomplete digestion in the hot acid steps conducted early in the analysis-separation scheme.

2. The Stack Sample, in comparison with the Inlet Duct Sample, contains relatively more of every metal cation except magnesium. The absolute amount of the Stack Sample was far less and this had an impact on the sensitivity values. Thus the lower limits for barium and titanium are 4% and 8% in the Stack Sample (rather than 0.4 and 0.8%) because the total sample mass was limited to ~11 milligrams.

3. It must be emphasized that the values have been corrected to account for the contributions from the filter pads. In other words, the 12.7% Na value is for the particulate matter collected on a filter and not for the filter pad.