EMB 73-PLD-1

(REPORT NUMBER)

AIR POLLUTION EMISSION TEST

AMERICAN SMELTING AND REFINING COMPANY

(PLANT NAME)

GLOVER PLANT

P.O. BOX 7

(PLANT ADDRESS)

GLOVER, MISSOURI 63646

U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Emission Standards and Engineering Division
Emission Measurement Branch
Research Triangle Park, N. C. 27711

SOURCE SAMPLING REPORT
EMB Project Report Number 73 PLD-1

Emissions from Lead Smelter

at

American Smelting and Refining Company
Glover, Missouri

17 July 1973 to 23 July 1973

by

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EPA Contract No. 68-02-0228, Task No. 27
(MRI Project No. 3585-C)

PREFACE

The work reported herein was conducted by Midwest Research Institute (MRI), pursuant to a Task Order issued by the Environmental Protection Agency (EPA) under the terms of EPA Contract No. 68-02-0228. Mr. E. P. Shea served as the Project Chief and directed the MRI Field Team consisting of: Messrs. Henry Moloney, Douglas Weatherman, Harold Branine, Frank Hanis, Jeff Sprinkle, Kevin Cline, Bill Maxwell, Bob Swartz, Bill Cunningham, Dick Cobb, Mike Becktold, and Dave Hardin. Dr. J. Spigarelli assisted by Mrs. Carol Green performed the pollutant analyses at the MRI laboratories. Ms. Christine Guenther coded the data for the computer calculations. Ms. Susan Wyatt, EPA, was the Process Engineer. Mr. E. P. Shea prepared this final report.

Approved for:

MIDWEST RESEARCH INSTITUTE

Paul C. Constant, Jr.
Program Manager

9 August 1974

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II. INTRODUCTION

This emission test is a part of a comprehensive study to determine a control strategy for lead emissions from stationary sources. The entire project is referred to as the preferred standards path analysis on lead. The purpose of this preferred standards path analysis is to recommend a statutory and regulatory course of action for the control of stationary sources of lead emissions. The recommendations must be based on a thorough assessment of the pollutant effects and emissions as related to the Clean Air Act of 1970, as amended. If it is decided that a regulatory program is desirable, there are three available options for developing standards: Section 109-110 - Ambient Air Quality Standards, Section 111 - New Source Performance Standards accompanied by state standards for existing sources, and Section 112 - Hazardous Pollutant Standards.

A well defined emission inventory, which is not at this time available, is vital to the development of a regulatory strategy for lead. Such an inventory will define the extent of the problem by identifying the major lead emitters, quantifying the emissions from these sources and determining the extent and effectiveness of presently employed general particulate control technology for lead.

A preliminary emission inventory of lead sources was developed through an EPA contract to determine, from the literature and plant data, the nature, magnitude and extent of industrial lead emissions to the atmosphere in the United States in 1970. However, only a small amount of the data was supported by emission testing. A listing of industries for emission testing has been compiled by EPA, based on information supplied by the emissions inventory. The emission data gathered during the testing programs will be used to determine the nature and extent of lead emissions from stationary sources, i.e., whether a problem exists in the industry, and if so the nature and extent of the problem. The data will also be used to help determine the degree to which particulate standards are effective in controlling lead emissions. Finally, emission data can be used in conjunction with other information on number and location of plants, trends in lead usage, growth rates, and affected populations to determine which industries are of highest priority for regulation.

Several lead smelters were surveyed for the purpose of conducting emission testing. None of the smelters were completely satisfactory for emission testing, and at some of them, emission testing was not considered to be economically feasible. The ASARCO Lead Smelter at Glover was considered to be the best of the lot.

This report presents the results of the emission testing and particle sizing which was performed by Midwest Research Institute at the American Smelting and Refining Company (ASARCO) sinter plant and blast furnace in Glover, Missouri. The particulate emission tests were 2-hr tests using the RAC* Staksampler equipment conforming with the Federal Register, 36, No. 159, 17 August 1971. The particle size testing was conducted using an Andersen eight plate impactor; the tests were conducted

* Mention of a company name does not imply endorsement by EPA.

for 1 hr, 2 hr and 1-1/2 hr. The sinter baghouse was not tested using the EPA method 5 train, because there were no ports in the stack and not enough room in the breeching to conduct isokinetic testing. For convenience and in order to have some emission data from this plant, we utilized the "Askania" sampler which was installed by ASARCO in the breeching between the baghouse and the stack.

At the ASARCO smelter domestic ore containing about 70% lead is sintered to prepare a concentrate for blast furnace feed. The ore is mixed with coke, recycled clay, and baghouse dust, ignited and the sulfur burned off. The sinter cake is disintegrated, mixed with coke, baghouse dust, scrap iron, and dross, and fed to the blast furnace. The lead bullion from the blast furnace goes to the refinery on site for production of refined lead. The control system for the sinter plant consists of a humidifying chamber, fresh air intake, fan and baghouse. The blast furnace control system has a humidifying chamber, fresh air inlet, lime addition and baghouse. Measured emissions from the sinter plant and blast furnace operation consisted of particulates. Carbon dioxide, carbon monoxide and oxygen were measured by Orsat Analysis. Another emission, sulfur dioxide, was estimated by Dräger tube readings only for the purpose of calculating carrier gas molecular weight. All particulate samples collected in this test program were analyzed for lead content.

The two inlet ducts and the baghouse outlet sampling point for the sinter plant are shown in Figure 1. The sampling points for the blast furnace are shown in Figure 2.

The following sections of the report treat (1) the summary and discussion of results, (2) the description and operation of the process, and (3) sampling and analytical procedures.

III. SUMMARY AND DISCUSSION OF RESULTS

Tables I, IA, II, IIA, III, IIIA, IV, IVA, V and VA present a summary of particulate and lead results from the emission testing on the sinter plant. Total particulate emissions were sampled and all samples analyzed for lead content. Table I contains an average of the controlled and uncontrolled emissions from the sinter plant (see Figure 1); Table IA presents the calculated data in metric units. The operation of the sinter plant, during the test period, was not constant and in the opinion of the writer was atypical. The baghouse particulate emission rate was 4.94 lb/hr, and the lead emission rate, 0.624 lb/hr; the calculated feed rate for the sinter machine during the "Askania" baghouse sampling period was 52.2 tons/hr. The baghouse emission rate based on this feed rate was: particulate - 0.0946 lb/ton; lead - 0.0119 lb/ton. The average feed rate for the sinter machine during particulate testing was 55.1 tons/hr. The average sinter plant uncontrolled emissions based on the above feed rate were: particulate front half catch (probe tip, probe, cyclone and filter) - 55.0 lb/ton; particulate total catch - 58.2 lb/ton; lead front half and total catch 5.95 lb/ton.

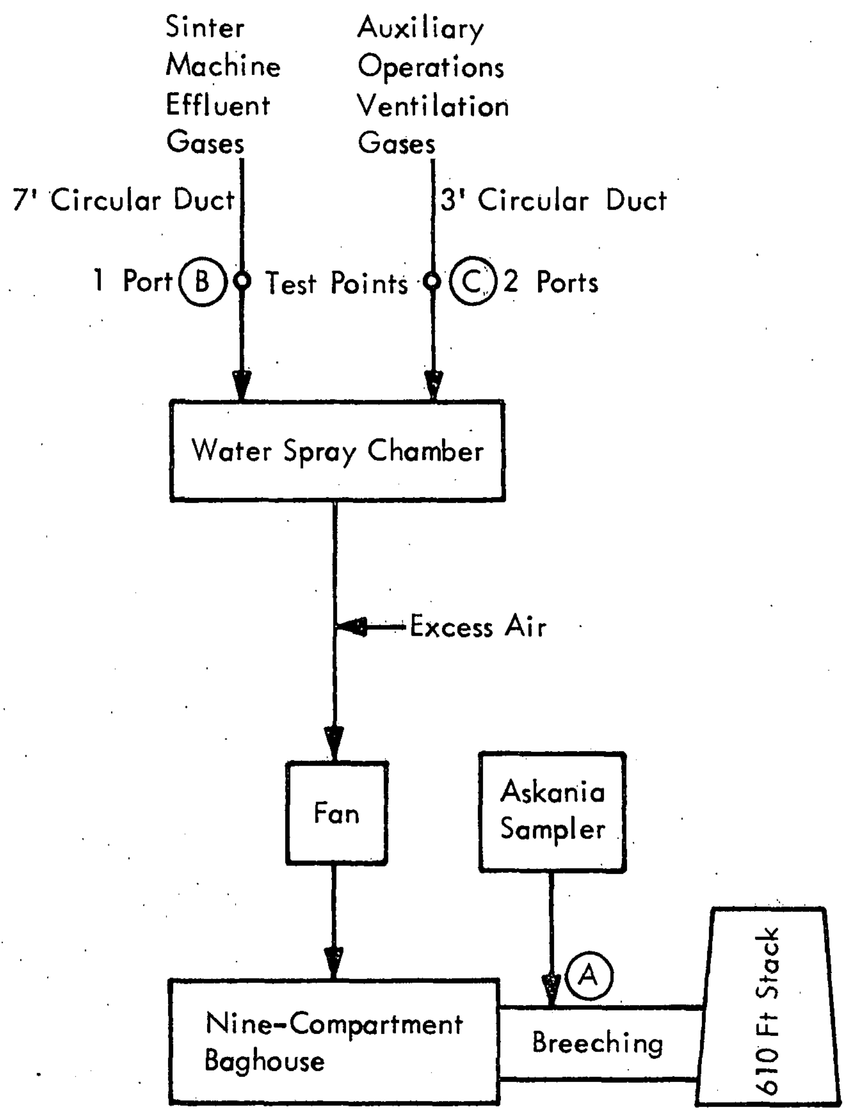


Figure 1 - Sinter Plant Sampling Points

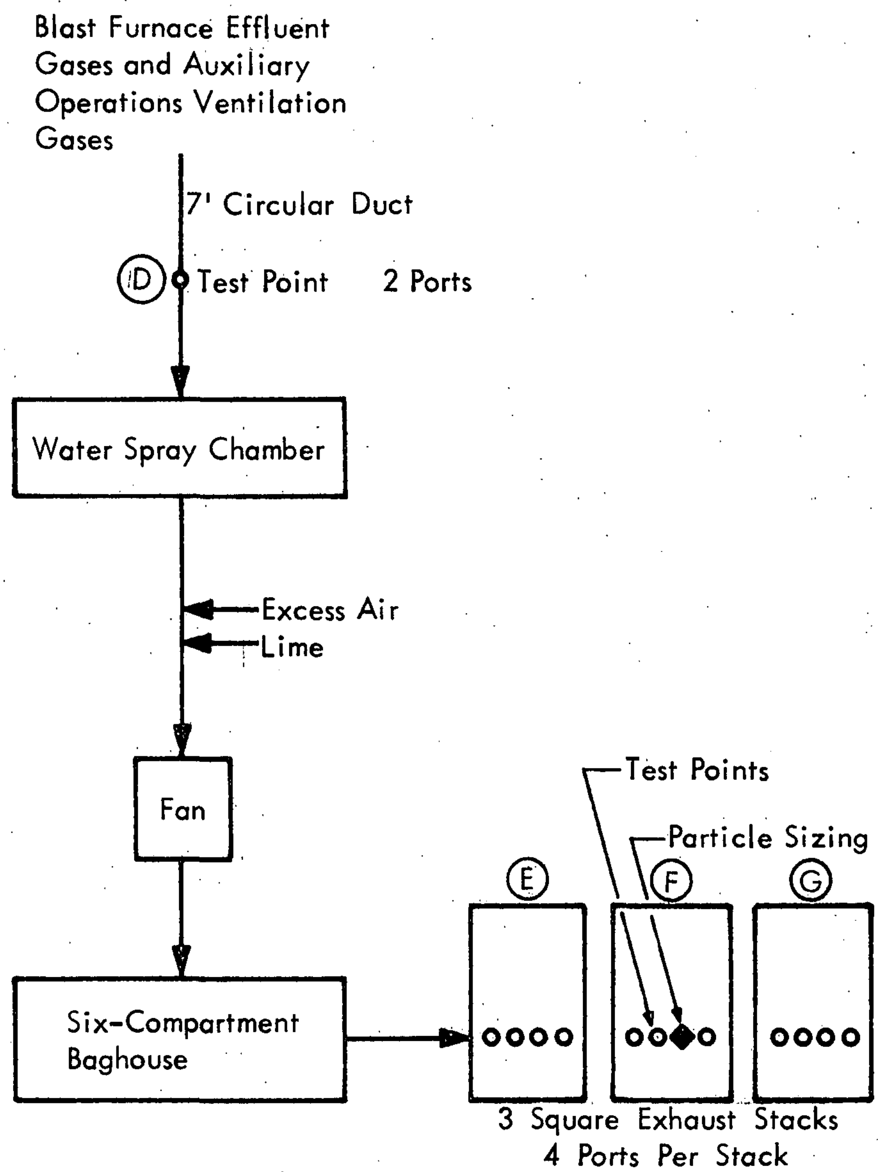


Figure 2 - Blast Furnace Sampling Points

TABLE I

AVERAGE CONTROLLED AND UNCONTROLLED EMISSIONS FROM SINTER MACHINE AND ASSOCIATED OPERATIONS

		Sampling Point	
Description	Units	Sinter Machine and Associated Operations (uncontrolled)	Baghouse (controlled)[a]
Particulate Emissions - Partial (Probe Tip, Probe, Cyclone Filter)	lb/hr gr/DSCF	3,031 2.94[b]	-- --
Particulate Emissions - Total (Probe, Tip Probe, Cyclone, Filter and Impingers)	lb/hr gr/DSCF	3,207 3.47[b]	4.94 0.00271
Lead Emissions - Partial	lb/hr gr/DSCF	328 0.352[b]	-- --
Lead Emissions - Total	lb/hr gr/DSCF	328 0.352[b]	0.624 0.000341
Feed Rate	tons/hr	55.1	52.2
Particulate Emissions - Partial	lb/ton	55.0	--
Particulate Emissions - Total	lb/ton	58.2	0.0946
Lead Emissions - Partial	lb/ton	5.95	--
Lead Emissions - Total	lb/ton	5.95	0.0119
% Lead - Partial		10.8	--
% Lead - Total		10.2	12.6

a/ This sample was not taken with the EPA Method 5 sampling train. It was taken with an "Askania" sampler installed by ASARCO. It is not equivalent to EPA Method 5, but was used as it was the only method available for sampling at this location.

b/ Since this baghouse has two inlet ducts, the average concentrations are calculated from weighted averages based on duct flowrate for each run pair. Runs B-6 and C-1, although not simultaneous, were used as a run pair because the process feed rates differed by only 2%.

TABLE IA

AVERAGE CONTROLLED AND UNCONTROLLED EMISSIONS FROM SINTER MACHINE AND ASSOCIATED OPERATIONS

Description	Units	Sampling Point: Sinter Machine and Associated Operations (uncontrolled)	Sampling Point: Baghouse (controlled)[a]
Particulate Emissions - Partial (Probe Tip, Probe, Cyclone and Filter)	Kg/hr Mg/NM3	1,376 6,732[b]	-- --
Particulate Emissions - Total (Probe Tip, Probe, Cyclone, Filter and Impingers)	Kg/hr Mg/NM3	1,456 7,945[b]	2.24 6.205
Lead Emissions - Partial	Kg/hr Mg/NM3	149 806[b]	-- --
Lead Emissions - Total	Kg/hr Mg/NM3	149 806[b]	0.283 0.781
Feed Rate	MT/hr	50.0	47.3
Particulate Emissions - Partial	Kg/MT	27.6	--
Particulate Emissions - Total	Kg/MT	29.2	0.0473
Lead Emissions - Partial	Kg/MT	2.98	--
Lead Emissions - Total	Kg/MT	2.98	0.00596
% Lead - Partial		10.8	--
% Lead - Total		10.2	12.6

a/ This sample was not taken with the EPA Method 5 sampling train. It was taken with an "Askania" sampler installed by ASARCO. It is not equivalent to EPA Method 5, but was used as it was the only method available for sampling at this location.

b/ Since this baghouse has two inlet ducts, the average concentrations are calculated from weighted averages based on duct flowrate for each run pair. Runs B-6 and C-1, although not simultaneous, were used as a run pair because the process feed rates differed by only 2%.

TABLE II

POUND PARTICULATE/TON SINTER PRODUCED

Run No.	Total Particulate Emission Rate (lb/hr)	Rate of Sinter Produced[a] (tons/hr)	Lb/Hr ÷ Tons/Hr = Lb/Ton
Controlled			
A	4.94	48.5	0.102
Uncontrolled - Sinter Machine			
B-2	2,060	44.3	46.5
B-5	1,810	53.5	33.8
B-6	2,450	56.5	43.4
Average	2,107	51.4	41.2
Uncontrolled - Sinter - Associated Operations			
C-1	1,360	55.4	24.5
C-2	1,090	44.3	24.6
C-5	852	53.5	15.9
Average	1,101	51.1	21.7

a/ Estimated from:

Rate of sinter produced (tons/hr) = Rate of sintering feed material (tons/hr) x 0.93

TABLE IIA

Kg PARTICULATE/MTON SINTER PRODUCED

Run No.	Total Particulate Emission Rate (kg/hr)	Rate of Sinter Produced[a] (Mton/hr)	Kg/Hr ÷ MTon/Hr = Kg/MTon
Controlled			
A	2.24	44.0	0.0509
Uncontrolled - Sinter Machine			
B-2	935	40.2	23.3
B-5	822	48.5	16.9
B-6	1,110	51.2	21.7
Average	956	46.6	20.6
Uncontrolled - Sinter - Associated Operations			
C-1	617	50.2	12.3
C-2	495	40.2	12.3
C-5	387	48.5	7.98
Average	500	46.3	10.9

a/ Estimated from:

Rate of sinter produced (Mton/hr) = Rate of sintering feed material (Mton/hr) x 0.93

TABLE III

POUND LEAD/TON OF LEAD IN THE SINTER PRODUCED (ESTIMATED)

Run No.	Total Lead Emission Rate (lb/hr)	Percent Lead in Sinter	Rate of Lead in Sinter (tons/hr)[a]	Lb/Hr ÷ Tons/Hr = Lb/Ton
Controlled				
A	0.624	45.4	22.5	0.0277
Uncontrolled - Sinter Machine				
B-2	368	47.6	21.1	17.4
B-5	113	47.1	25.2	4.48
B-6	175	47.1	26.7	6.55
Average	219	47.3	24.3	9.48
Uncontrolled - Sinter-Associated Operations				
C-1	178	46.6	25.8	6.90
C-2	73.6	47.6	21.1	3.49
C-5	76.9	47.1	25.2	3.05
Average	110	47.1	24.0	4.48

a/ Estimated from:

Rate of lead in sinter produced (tons/hr) = Rate of sintering feed material (tons/hr) x Percent Lead in feed to sinter machine x 0.93

TABLE IIIA

KILOGRAM LEAD/MTON OF LEAD IN SINTER PRODUCED (ESTIMATED)

Run No.	Total Lead Emission Rate (kg/hr)	Percent Lead in Sinter	Rate of Lead in Sinter (Mton/hr)[a/]	Kg/Hr ÷ MTon/Hr = Kg/Mton
Controlled				
A	0.283	45.4	20.4	0.0139
Uncontrolled - Sinter Machine				
B-2	167	47.6	19.1	8.74
B-5	51.3	47.1	22.9	2.24
B-6	79.4	47.1	24.2	3.28
Average	99.2	47.3	22.1	4.75
Uncontrolled - Sinter-Associated Operations				
C-1	80.8	46.6	23.4	3.45
C-2	33.4	47.6	19.1	1.75
C-5	34.9	47.1	22.9	1.52
Average	49.7	47.1	21.8	2.24

a/ Estimated from:

Rate of lead in sinter produced (Mton/hr) = Rate of sintering feed material (Mton/hr) x Percent Lead in feed to sinter machine x 0.93

TABLE IV

SUMMARY OF UNCONTROLLED SINTER MACHINE EMISSIONS

Name	Description Date of Run	Units	B-2 07-18-73	B-5 07-21-73	B-6 07-21-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	25.98	22.50	23.15
PMOS	Percent Moisture by Vol		2.2	7.8	10.2
TS	Avg Stack Temperature	DEG.F	492.7	427.8	484.5
QS	Stk Flowrate, Dry, Std Cn	DSCFM	92394	83958	85046
QA	Actual Stack Flowrate	ACFM	173882	157652	174612
PERI	Percent Isokinetic		116.0[a]	107.2	108.9
	PARTICULATES -- PARTIAL CATCH[b]				
MF	Particulate Wt-Partial[a]	MG	3766.90	3402.40	4818.60
CAN	Part Load-Ptl, Std Cn	GR/DSCF	2.23	2.33	3.20
CAT	Part Load-Ptl, Stk Cn	GR/ACF	1.19	1.24	1.56
CAW	Partic Emis-Partial	LB/HR	1770	1680	2340
	PARTICULATES -- TOTAL CATCH[c]				
MT	Particulate Wt-Total[b]	MG	4391.00	3685.30	5048.00
CAO	Part Load-Ttl, Std Cn	GR/DSCF	2.60	2.52	3.36
CAU	Part Load-Ttl,Stk Cn	GR/ACF	1.38	1.34	1.64
CAX	Partic Emis-Total	LB/HR	2060	1810	2450
IC	Perc Impinger Catch		14.20	7.68	4.54
	LEAD -- PARTIAL CATCH[b]				
MF	Wt-Partial[a]	MG	784.06	229.64	360.12
CAN	Load-Ptl, Std Cn	GR/DSCF	0.465	0.157	0.240
CAT	Load-Ptl, Stk Cn	GR/ACF	0.247	0.0837	0.117
CAW	Emis-Partial	LB/HR	368	113	175
	LEAD -- TOTAL CATCH[c]				
MT	Wt-Total[b]	MG	784.16	229.75	360.30
CAO	Load-Ttl, Std Cn	GR/DSCF	0.465	0.157	0.240
CAU	Load-Ttl, Stk Cn	GR/ACF	0.247	0.0838	0.117
CAX	Emis-Total	LB/HR	368	113	175
IC	Perc Impinger Catch		0.01	0.05	0.05
	Feedrate	T/HR	47.6	57.5	60.8
	Part Emission Total	LB/T	43.3	31.5	40.3
	Lead Emissions Total	LB/T	7.73	1.97	2.88
	Perc Lead Ptl	%	20.8	6.73	7.48
	Perc Lead Ttl	%	17.9	6.24	7.15
	Avg Perc Lead Ptl	%		11.7	
	Avg Perc Lead Ttl	%		10.4	

a/ This value is six over the upper limit of the acceptable isokinetic range of 90-110%. This difference has no significant effect on other results. The high value is unexplainable. A portion of the value may be due to an error in stack temperature readings. The thermocouple was replaced after the run.

b/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

c/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE IVA

SUMMARY OF UNCONTROLLED SINTER MACHINE EMISSIONS
(Metric Units)

Name	Description / Date of Run	Units	B-2 07-18-73	B-5 07-21-73	B-6 07-21-73
VMSTM	Vol Dry Gas-Std Cond	NCM	0.735	0.637	0.655
PMOS	Percent Moisture by Vol		2.2	7.8	10.2
TSM	Avg Stack Temperature	DEG.C	255.9	219.9	251.3
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	2616.3	2377.4	2408.3
QAM	Actual Stack Flowrate	M3/MIN	4923.8	4464.2	4944.5
PERI	Percent Isokinetic		116.0a/	107.2	108.9
	PARTICULATES -- PARTIAL CATCHb/				
MF	Particulate Wt-Partiala/	MG	3766.90	3402.40	4818.60
CANM	Part Load-Ptl, Std Cn	MG/NM3	5109.98	5329.00	7334.09
CATM	Part Load-Ptl, Stk Cn	MG/M3	2715.26	2837.99	3572.15
CAWM	Partic Emis-Partiala/	KG/HR	802.03	760.03	1059.56
	PARTICULATES -- TOTAL CATCHc/				
MT	Particulate Wt-Totalb/	MG	4391.00	3685.30	5048.00
CAOM	Part Load-Ttl, Std Cn	MG/NM3	5956.60	5772.09	7683.24
CAUM	Part Load-Ttl, Stk Cn	MG/M3	3165.12	3073.96	3742.20
CAXM	Partic Emis-Totalb/	KG/HR	934.91	823.23	1110.00
IC	Perc Impinger Catch		14.21	7.68	4.54
	LEAD -- PARTIAL CATCHb/				
MF	Wt-Partiala/	MG	784.06	229.64	360.12
CANM	Load-Ptl, Std Cn	MG/NM3	1063.62	359.67	548.12
CATM	Load-Ptl, Stk Cn	MG/M3	565.17	191.55	266.97
CAWM	Emis-Partiala/	KG/HR	166.937	51.297	79.187
	LEAD -- TOTAL CATCHc/				
MT	Wt-Totalb/	MG	784.16	229.75	360.30
CAOM	Load-Ttl, Std Cn	MG/NM3	1063.75	359.85	548.39
CAUM	Load-Ttl, Stk Cn	MG/M3	565.24	191.64	267.10
CAXM	Emis-Totalb/	KG/HR	166.959	51.322	79.226
IC	Perc Impinger Catch		0.01	0.05	0.05
	Feedrate	MTON/HR	43.2	52.2	55.1
	Part Emission Total	KG/MTON	21.6	15.8	20.1
	Lead Emission Total	KG/MTON	3.87	0.983	1.44
	Perc Lead Ptl	%	20.8	6.73	7.48
	Perc Lead Ttl	%	17.9	6.24	7.15
	Avg Perc Lead Ptl	%		11.7	
	Avg Perc Lead Ttl	%		10.4	

a/ This value is six over the upper limit of the acceptable isokinetic range of 90-110%. This difference has no significant effect on other results. The high value is unexplainable. A portion of the value may be due to an error in stack temperature readings. The thermocouple was replaced after the run.

b/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

c/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE V

SUMMARY OF UNCONTROLLED EMISSIONS FROM SINTERING-ASSOCIATED OPERATIONS

Name	Description Date of Run	Units	C-1 07-17-73	C-2 07-18-73	C-5 07-21-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	103.30	93.29	87.25
PMOS	Percent Moisture by Vol		1.4	0.9	2.6
TS	Avg Stack Temperature	DEG.F	98.0	102.5	112.6
QS	Stk Flowrate, Dry, Std Cn	DSCFM	21732	21055	19017
QA	Actual Stack Flowrate	ACFM	23900	23156	21901
PERI	Percent Isokinetic		91.6	92.5	95.8
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial[a/]	MG	48843.80	36533.30	29616.30
CAN	Part Load-Ptl, Std Cn	GR/DSCF	7.28	6.03	5.23
CAT	Part Load-Ptl, Stk Cn	GR/ACF	6.62	5.48	4.54
CAW	Partic Emis-Partial[a/]	LB/HR	1360	1090	852
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total[b/]	MG	48863.10	36549.50	29646.30
CAO	Part Load-Ttl, Std Cn	GR/DSCF	7.28	6.03	5.23
CAU	Part Load-Ttl, Stk Cn	GR/ACF	6.62	5.49	4.54
CAX	Partic Emis-Total[b/]	LB/HR	1360	1090	852
IC	Perc Impinger Catch		0.04	0.04	0.10
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial[a/]	MG	6399.85	2469.70	2672.50
CAN	Load-Ptl, Std Cn	GR/DSCF	0.954	0.408	0.472
CAT	Load-Ptl, Stk Cn	GR/ACF	0.868	0.371	0.410
CAW	Emis-Partial[a/]	LB/HR	178	73.6	76.9
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total[b/]	MG	6399.94	2469.84	2672.63
CAO	Load-Ttl, Std Cn	GR/DSCF	0.954	0.408	0.472
CAU	Load-Ttl, Stk Cn	GR/ACF	0.868	0.371	0.410
CAX	Emis-Total[b/]	LB/HR	178	73.6	76.9
	Feedrate	TON/HR	59.6	47.6	57.5
	Part Emis-Ttl	LB/TON	22.8	22.9	14.8
	Lead Emis-Ttl	LB/TON	2.99	1.55	1.34
	Perc Lead Ptl	%	13.1	6.77	9.02
	Perc Lead Ttl	%	13.1	6.77	9.02
	Ave Perc Lead Ptl	%		9.63	
	Ave Perc Lead Ttl	%		9.63	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE VA

SUMMARY OF UNCONTROLLED EMISSIONS FROM SINTERING-ASSOCIATED OPERATIONS
(Metric Units)

Name	Description / Date of Run	Units	C-1 / 07-17-73	C-2 / 07-18-73	C-5 / 07-21-73
VMSTM	Vol Dry Gas-Std Cond	NCM	2.92	2.64	2.47
PMOS	Percent Moisture by Vol		1.4	0.9	2.6
TSM	Avg Stack Temperature	DEG.C	36.7	39.2	44.8
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	615.4	596.2	538.5
QAM	Actual Stack Flowrate	N3/MIN	676.8	655.7	620.2
PERI	Percent Isokinetic		91.6	92.5	95.8
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial[a/]	MG	48843.80	36533.30	29616.30
CANM	Part Load-Ptl, Std Cn	MG/NM3	16662.42	13800.73	11961.88
CATM	Part Load-Ptl, Stk Cn	MG/M3	15151.44	12548.18	10387.02
CAWM	Partic Emis-Partial[a/]	KG/HR	615.13	493.60	386.43
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total[b/]	MG	48863.10	36549.50	29646.30
CAOM	Part Load-Ttl, Std Cn	MG/NM3	16669.01	13806.85	11974.00
CAUM	Part Load-Ttl, Stk Cn	MG/M3	15157.43	12553.75	10397.54
CAXM	Partic Emis-Total[b/]	KG/HR	615.38	493.82	386.82
IC	Perc Impinger Catch		0.04	0.04	0.10
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial[a/]	MG	6399.85	2469.70	2672.50
CANM	Load-Ptl, Std Cn	MG/NM3	2183.22	932.95	1079.41
CATM	Load-Ptl, Stk Cn	MG/M3	1985.25	848.27	937.30
CAWM	Emis-Partial[a/]	KG/HR	80.599	33.368	34.87
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total	MG	6399.94	2469.84	2672.63
CAOM	Load-Ttl, Std Cn	MG/NM3	2183.26	933.00	1079.46
CAUM	Load-Ttl, Stk Cn	MG/M3	1985.27	848.32	937.34
CAXM	Emis-Total	KG/HR	80.60	33.37	34.872
IC	Perc Impinger Catch		0.00	0.01	0.00
	Feedrate	MTON/HR	54.1	43.2	52.2
	Part Emis Ttl	KG/MTON	11.4	11.4	7.41
	Lead Emis Ttl	KG/MTON	1.49	.773	.668
	Perc Lead Ptl	%	13.1	6.77	9.02
	Perc Lead Ttl	%	13.1	6.77	9.02
	Ave Perc Lead Ptl	%		9.63	
	Ave Perc Lead Ttl	%		9.63	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

Table II contains the average of the controlled and uncontrolled particulate data from the emission tests, in pounds of particulate per ton of sinter produced. Table IIA contains the same data reported in metric units. The controlled particulate emission rate is 0.102 lb particulate/ton sinter produced. The uncontrolled emission rate averaged 41.2 and 21.7 lb particulate/ton sinter produced for the sinter machine and sinter-associated operations, respectively.

Table III presents the emission rates for lead per ton of lead in the sinter produced for both the controlled and uncontrolled emissions; Table IIIA shows the data in metric units. The controlled lead emission rate is 0.0277 lb Pb/ton. The average uncontrolled lead emission rate is 9.48 and 4.48 lb Pb/ton for the sinter machine and sinter-associated operations, respectively.

Table IV contains the summary of the particulate and lead data from the emission tests at Point "B," the 7-ft diameter main exhaust duct from the sinter furnace to the inlet of the control system. Table IVA contains the same data reported in metric units. In figuring the gas molecular weight the percent SO_2 estimated from Dräger tube readings was subtracted from the CO_2 value found in the Orsat analysis, and the SO_2 value was then used in the molecular weight calculation. The average values for particulate and lead are: particulate in the front half catch - 1,930 lb/hr; particulate in the total catch - 2,110 lb/hr; front half catch and total catch lead - 219 lb/hr. The wide variation in loading from B stack can be attributed to the variance in the continuity of operation of the sinter plant. Run No. 2 shows the highest lead emission values and the plant was shut down more times during this run than in any other run.

Table V presents the particulate and lead data from the "C" duct, the 3-ft diameter hygienic duct (collection duct for sintering-associated operations), which also is a feed duct for the pollution control system. Table VA contains the metric conversion for Table V. There was less than 200 ppm SO_2 in the duct as shown in Dräger tube analysis, and therefore the SO_2 was not used in calculating carrier gas molecular weight for the hygienic duct.

The average values for particulate emissions and lead analytical values for all three runs are: particulate front half catch and particulate total catch - 1,100 lb/hr; and lead front half and total catch - 110 lb/hr. The wide variations in loading on "C" duct can also be attributed to the manner of operation of the sinter plant.

Tables VI, VIA, VII, VIIA, VIII, VIIIA, IX, IXA, X, XA, XI, XIA, XII, XIIA, XIII, XIIIA, XIV, XIVA, XV and XVA contain the results of the emission testing on the uncontrolled and controlled emissions from the blast furnace and associated operations. Table VI is a summary table that shows the average uncontrolled and controlled emissions from the blast furnace operation for all three tests combined.

TABLE VI

AVERAGE OF EMISSIONS FROM BLAST FURNACE AND BAGHOUSE

Description	Units	Sampling Point: Inlet to Control System	Sampling Point: Total Baghouse Emissions
Particulate Emissions - Partial (Probe Tip, Probe, Cyclone and Filter)	lb/hr gr/DSCF	2370 3.11	17.7 0.0142[a]
Particulate Emissions - Total (Probe Tip, Probe, Cyclone, Filter and Impingers)	lb/hr gr/DSCF	2400 3.16	34.2 0.0275[a]
Lead Emissions - Partial	lb/hr gr/DSCF	307 0.403	5.97 0.00482[a]
Lead Emissions - Total	lb/hr gr/DSCF	307 0.403	6.01 0.00485[a]
Production Rate	tons/hr	13.8	13.8
Particulate Emissions - Partial	lb/ton	172	1.28
Particulate Emissions - Total	lb/ton	174	2.47
Lead Emissions - Partial	lb/ton	22.2	0.433
Lead Emissions - Total	lb/ton	22.2	0.450
% Lead - Partial		12.9	33.7
% Lead - Total		12.8	17.6
Collection Efficiency			
Particulate - Partial		99.25%	
Particulate - Total		98.57%	
Lead - Partial		98.05%	
Lead - Total		98.04%	

a/ Since this baghouse has three stacks, the average concentration was calculated from the weighted averages, based on the flowrate, of the individual simultaneous sets of runs.

TABLE VIA

AVERAGE OF EMISSIONS FROM BLAST FURNACE AND BAGHOUSE
(Metric Units)

Description	Units	Sampling Point: Inlet to Control System	Sampling Point: Total Baghouse Emissions
Particulate Emissions - Partial (Probe Tip, Cyclone and Filter)	Kg/hr Mg/NM3	1070 7110	8.01 32.5 a/
Particulate Emissions - Total (Probe Tip, Probe, Cyclone, Filter and Impingers)	Kg/hr Mg/NM3	1090 7220	15.5 63.0 a/
Lead Emissions - Partial	Kg/hr Mg/NM3	139 922	2.71 11.0 a/
Lead Emissions - Total	Kg/hr Mg/NM3	139 922	2.73 11.1 a/
Production Rate	MT/hr	12.5	12.5
Particulate Emissions - Partial	Kg/MT	86.2	0.641
Particulate Emissions - Total	Kg/MT	87.2	1.23
Lead Emissions - Partial	Kg/MT	11.1	0.217
Lead Emissions - Total	Kg/MT	11.1	0.224
% Lead - Partial		12.9	33.7
% Lead - Total		12.8	17.6
Collection Efficiency			
Particulate - Partial		99.25%	
Particulate - Total		98.57%	
Lead - Partial		98.05%	
Lead - Total		98.04%	

a/ Since the baghouse has three stacks, the average concentration was calculated from the weighted averages, based on flowrate, of the individual simultaneous sets of runs.

TABLE VII

TOTAL EMISSIONS BLAST FURNACE - BAGHOUSE PER TEST

Description	Units	Test 3	Test 4	Test 7
Particulate Emission Blast - Partial[a]	lb/hr	2,650	2,500	1,950
Particulate Emission Blast - Total[b]	lb/hr	2,690	2,530	1,990
Lead Emission Blast - Partial[a]	lb/hr	424	303	193
Lead Emission Blast - Total[b]	lb/hr	424	303	193
Particulate Emission Baghouse - Partial	lb/hr	20.2	10.7	22.2
Particulate Emission Baghouse - Total	lb/hr	36.8	24.2	41.7
Lead Emission Baghouse - Partial	lb/hr	6.43	2.59	8.89
Lead Emission Baghouse - Total	lb/hr	6.47	2.64	8.93
Particulate Efficiency - Partial	%	99.2	99.6	98.9
Particulate Efficiency - Total	%	98.6	99.0	97.9
Lead Efficiency - Partial	%	98.5	99.1	95.4
Lead Efficiency - Total	%	98.5	99.1	95.4
Production Rate	ton/hr	13.9	13.8	13.8
Particulate Emission Blast - Partial	lb/ton	191	181	141
Particulate Emission Blast - Total	lb/ton	194	183	144
Lead Emission Blast - Partial	lb/ton	30.5	22.0	14.0
Lead Emission Blast - Total	lb/ton	30.5	22.0	14.0
Particulate Emission Baghouse - Partial	lb/ton	1.45	0.775	1.61
Particulate Emission Baghouse - Total	lb/ton	2.65	1.75	3.02
Lead Emission Baghouse - Partial	lb/ton	0.463	0.188	0.644
Lead Emission Baghouse - Total	lb/ton	0.465	0.191	0.647

a/ Partial refers to the material caught in the probe tip, probe, cyclone and filter.
b/ Total refers to the partial plus the material caught in the impingers.

TABLE VIIA

TOTAL EMISSIONS BLAST FURNACE - BAGHOUSE PER TEST
(Metric Units)

Description	Units	Test 3	Test 4	Test 7
Particulate Emission Blast - Partial[a/]	Kg/hr	1,200	1,140	883
Particulate Emission Blast - Total[b/]	Kg/hr	1,220	1,150	903
Lead Emission Blast - Partial	Kg/hr	192	137	87.7
Lead Emission Blast - Total	Kg/hr	192	137	87.7
Particulate Emission Baghouse - Partial	Kg/hr	9.17	4.86	10.1
Particulate Emission Baghouse - Total	Kg/hr	16.7	11.0	18.9
Lead Emission Baghouse - Partial	Kg/hr	2.92	1.18	4.03
Lead Emission Baghouse - Total	Kg/hr	2.93	1.20	4.05
Production Rate	MT/hr	12.6	12.5	12.5
Particulate Emission Blast - Partial	Kg/MT	95.2	91.2	70.6
Particulate Emission Blast - Total	Kg/MT	96.8	92.0	72.2
Lead Emission Blast - Partial	Kg/MT	15.2	11.0	7.02
Lead Emission Blast - Total	Kg/MT	15.2	11.0	7.02
Particulate Emission Baghouse - Partial	Kg/MT	0.728	0.389	0.808
Particulate Emission Baghouse - Total	Kg/MT	1.33	0.880	1.51
Lead Emission Baghouse - Partial	Kg/MT	0.232	0.0944	0.322
Lead Emission Baghouse - Total	Kg/MT	0.233	0.0960	0.324

a/ Partial refers to the material caught in the probe tip, probe, cyclone and filter.

b/ Total refers to the partial plus the material caught in the impingers.

TABLE VIII

POUND PARTICULATE/TOTAL TONS OF FEED MATERIAL INTO THE BLAST FURNACE

Run No.	Total Particulate Emission Rate (lb/hr)	Rate of Feed Material[a/] (tons/hr)	Lb/Hr ÷ Tons/Hr = Lb/Ton
Uncontrolled			
D-3	2,690	35.9	74.9
D-4	2,530	34.2	74.0
D-7	1,990	36.1	55.1
Average	2,403	35.4	68.0
Controlled			
Run 3 (E, F, and G)	36.83	35.9	1.02
Run 4 (E, F, and G)	24.22	34.2	0.708
Run 7 (E, F, and G)	41.65	36.1	1.15
Average	34.23	35.4	0.959

a/ From Table C-II, Page 142.
Rate of feed material into blast furnace = (tons/hr) Sinter smelted (tons/day)+ Coke smelted (tons/day)+ Scrap iron smelted (tons/day)+ Caustic skims smelted (tons/day)/ (24 hr/day)

TABLE VIIIA

KILOGRAM PARTICULATE/MTONS OF FEED MATERIAL INTO BLAST FURNACE

Run No.	Total Particulate Emission Rate (kg/hr)	Rate of Feed Material[a/] (Mton/hr)	Kg/Hr ÷ MTon/Hr = Kg/MTon
Uncontrolled			
D-3	1,220	32.6	37.5
D-4	1,150	31.0	37.1
D-7	903	32.7	27.6
Average	1,091	32.1	34.1
Controlled			
Run 3 (E, F, and G)	16.72	32.6	0.513
Run 4 (E, F, and G)	11.00	31.0	0.355
Run 7 (E, F, and G)	18.91	32.7	0.578
Average	15.54	32.1	0.482

a/ From Table C-II, Page 142.
Rate of feed material into blast furnace = (Mton/hr)   Sinter smelted (Mton/day) + Coke smelted (Mton/day) + Scrap iron smelted (Mton/day) + Caustic skims smelted (Mton/day) / (24 hr/day)

TABLE IX

POUND PARTICULATE/TOTAL TONS OF LEAD PRODUCED

Run No.	Total Particulate Emission Rate (lb/hr)	Lead Produced[a/] (tons/hr)	Lb/hr ÷ Tons/Hr = Lb/Ton
Uncontrolled			
D-3	2,690	13.9	194
D-4	2,530	13.8	183
D-7	1,990	13.8	144
Average	2,403	13.8	174
Controlled			
Run 3 (E, F, and G)	36.83	13.9	2.65
Run 4 (E, F, and G)	24.22	13.8	1.75
Run 7 (E, F, and G)	41.65	13.8	3.02
Average	34.23	13.8	2.47

a/ From Table C-II, Page 142.

$$\text{Lead Produced (tons/hr)} = \frac{\text{Bullion Produced (tons/day)}}{\text{(24 hr/day)}}$$

TABLE IXA

KILOGRAM PARTICULATE/TOTAL MTONS OF LEAD PRODUCED

Run No.	Total Particulate Emission Rate (kg/hr)	Lead Produced[a/] (Mton/hr)	Kg/Hr ÷ MTon/Hr = Kg/MTon
Uncontrolled			
D-3	1,220	12.6	96.8
D-4	1,150	12.5	92.0
D-7	903	12.5	72.2
Average	1,091	12.5	87.0
Controlled			
Run 3 (E, F, and G)	16.72	12.6	1.32
Run 4 (E, F, and G)	11.00	12.5	.88
Run 7 (E, F, and G)	18.91	12.5	1.51
Average	15.54	12.5	1.23

a/ From Table C-II, Page 142.

$$\text{Lead Produced (Mton/hr)} = \frac{\text{Bullion Produced (Mton/day)}}{\text{(24 hr/day)}}$$

TABLE X

POUND LEAD/TON OF LEAD IN THE SINTER FEED TO THE BLAST FURNACE (ESTIMATED)

Run No.	Total Lead Emission Rate (lb/hr)	Percent Lead in Feed Material	Rate of Lead in Sinter Feed Material to Blast Furnace (tons/hr) [a/]	Lb/Hr ÷ Tons/Hr = Lb/Ton
Uncontrolled				
D-3	424	47.0	15.1	28.1
D-4	303	45.9	14.2	21.3
D-7	193	45.4	14.8	13.0
Average	307	46.1	14.7	20.8
Controlled				
Run 3 (E, F, and G)	6.47	47.0	15.1	0.428
Run 4 (E, F, and G)	2.64	45.9	14.2	0.186
Run 7 (E, F, and G)	8.93	45.4	14.8	0.603
Average	6.01	46.1	14.7	0.405

a/ Estimated from Table C-II, Page 142.

$$\text{Rate of lead in sinter feed material to blast furnace (tons/hr)} = \frac{\text{Sinter smelted}}{24} \text{ (tons/hr)} \times \text{\% Lead into blast furnace}$$

TABLE XA

KG LEAD/MTON OF LEAD IN SINTER FEED TO THE BLAST FURNACE (ESTIMATED)
(metric units)

Run No.	Total Lead Emission Rate (Kg/hr)	Percent Lead in Feed Material	Rate of Lead in Sinter Feed Material to Blast Furnace[a/] (Mton/hr)	Kg/Hr ÷ MTon/hr = Kg/MTon
Uncontrolled				
D-3	192	47.0	13.7	14.0
D-4	138	45.9	12.9	10.7
D-7	87.6	45.4	13.4	6.54
Average	139	46.1	13.3	10.4
Controlled				
Run 3 (E, F, and G)	2.93	47.0	13.7	.214
Run 4 (E, F, and G)	1.20	45.9	12.9	.093
Run 7 (E, F, and G)	3.85	45.4	13.4	.287
Average	2.66	46.1	13.3	.198

a/ Estimated from Table C-II, Page 142.

$$\text{Rate of lead in sinter feed material to blast furnace (Mton/hr)} = \frac{\text{Sinter smelted}}{24} \text{(Mton/hr)} \times \text{\% Lead into blast furnace}$$

TABLE XI

POUND LEAD/TON OF LEAD PRODUCED

Run No.	Total Lead Emission Rate (lb/hr)	Rate of Lead Produced by Blast Furnace[a] (tons/hr)	Lb/Hr ÷ Tons/Hr = Lb/Ton
Uncontrolled			
D-3	424	13.4	31.6
D-4	303	13.3	22.8
D-7	193	13.3	14.5
Average	307	13.3	23.0
Controlled			
Run 3 (E, F, and G)	6.47	13.4	.482
Run 4 (E, F, and G)	2.64	13.3	.198
Run 7 (E, F, and G)	8.93	13.3	.671
Average	6.01	13.3	.450

a/ From Table C-II, Page 142.

$$\text{Rate} = \frac{\text{Bullion produced (tons/day)}}{\text{24 hr/day}} \times \text{percent of lead in bullion}$$

TABLE XIA

KILOGRAM LEAD/MTON OF LEAD PRODUCED

Run No.	Total Lead Emission Rate (kg/hr)	Rate of Lead Produced[a/] (Mton/hr)	Kg/Hr ÷ MTon/Hr = Kg/MTon
Uncontrolled			
D-3	192	12.2	15.7
D-4	138	12.1	11.4
D-7	87.6	12.1	7.24
Average	139	12.1	11.4
Controlled			
Run 3 (E, F, and G)	2.93	12.2	.240
Run 4 (E, F, and G)	1.20	12.1	.099
Run 7 (E, F, and G)	4.05	12.1	.334
Average	2.72	12.1	.224

a/ From Table C-II, Page 142.

$$\text{Rate} = \frac{\text{Bullion produced (Mton/day)}}{\text{24 hr/day}} \times \text{percent of lead in bullion}$$

TABLE XII

SUMMARY OF UNCONTROLLED BLAST FURNACE EMISSIONS

Name	Description	Units	D-3	D-4	D-7
	Date of Run		07-19-73	07-20-73	07-23-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	26.03	26.73	25.85
PMOS	Percent Moisture by Vol		3.1	2.0	4.1
TS	Avg Stack Temperature	DEG.F	258.0	253.0	206.8
QS	Stk Flowrate, Dry, Std Cn	DSCFM	87582	90137	89140
QA	Actual Stack Flowrate	ACFM	125923	127423	120025
PERI	Percent Isokinetic		110.8	110.6	108.2
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial	MG	5978.00	5626.70	4278.60
CAN	Part Load-Ptl, Std Cn	GR/DSCF	3.54	3.24	2.55
CAT	Part Load-Ptl, Stk Cn	GR/ACF	2.46	2.29	1.89
CAW	Partic Emis-Partial[a/]	LB/HR	2650	2500	1950
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total[b/]	MG	6065.10	5675.40	4376.30
CAO	Part Load-Ttl, Std Cn	GR/DSCF	3.59	3.27	2.61
CAU	Part Load-Ttl, Stk Cn	GR/ACF	2.50	2.31	1.94
CAX	Partic Emis-Total[b/]	LB/HR	2690	2530	1990
IC	Perc Impinger Catch		1.44	0.86	2.23
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial[a/]	MG	954.57	680.71	424.83
CAN	Load-Ptl, Std Cn	GR/DSCF	0.565	0.392	0.253
CAT	Load-Ptl, Stk Cn	GR/ACF	0.393	0.277	0.188
CAW	Emis-Partial[a/]	LB/HR	424	303	193
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total[b/]	MG	955.12	680.81	424.99
CAO	Load-Ttl, Std Cn	GR/DSCF	0.565	0.392	0.253
CAU	Load-Ttl, Stk Cn	GR/ACF	0.393	0.277	0.188
CAX	Emis-Total[b/]	LB/HR	424	303	193
IC	Perc Impinger Catch		0.06	0.01	0.04
	Prod Rate	TON/HR	13.9	13.8	13.8
	Part Emis Ttl	LB/TON	194	183	144
	Lead Emis Ttl	LB/TON	30.5	22.0	14.0
	Perc Lead Ptl	%	16.0	12.1	9.90
	Perc Lead Ttl	%	15.8	12.0	9.70
	Ave Perc Lead Ptl	%		12.7	
	Ave Perc Lead Ttl	%		12.5	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XIIA

SUMMARY OF UNCONTROLLED BLAST FURNACE EMISSIONS
(Metric Units)

Name	Description Date of Run	Units	D-3 07-19-73	D-4 07-20-73	D-7 07-23-73
VMSTM	Vol Dry Gas-Std Cond	NCM	0.737	0.756	0.732
PMOS	Percent Moisture by Vol		3.1	2.0	4.1
TSM	Avg Stack Temperature	DEG.C	125.5	122.8	97.1
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	2480.1	2552.4	2524.2
QAM	Actual Stack Flowrate	N3/MIN	3565.8	3608.2	3398.8
PERI	Percent Isokinetic		110.8	110.6	108.2
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial	MG	5978.00	5626.70	4278.60
CANM	Part Load-Ptl, Std Cn	MG/NM3	8093.77	7418.02	5831.83
CATM	Part Load-Ptl, Stk Cn	MG/M3	5629.37	5247.41	4331.17
CAWM	Partic Emis-Partial	KG/HR	1204.17	1135.84	883.09
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total	MG	6065.10	5675.40	4376.30
CAOM	Part Load-Ttl, Std Cn	MG/NM3	8211.69	7482.23	5965.00
CAUM	Part Load-Ttl, Stk Cn	MG/M3	5711.39	5292.82	4430.07
CAXM	Partic Emis-Total	KG/HR	1221.72	1145.67	903.25
IC	Perc Impinger Catch		1.44	0.86	2.23
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial	MG	954.57	680.71	424.83
CANM	Load-Ptl, Std Cn	MG/NM3	1292.42	897.42	579.05
CATM	Load-Ptl, Stk Cn	MG/M3	898.90	634.82	430.05
CAWM	Emis-Partial	KG/HR	192.283	137.412	87.683
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total	MG	955.12	680.81	424.99
CAOM	Load-Ttl, Std Cn	MG/NM3	1293.16	897.55	579.27
CAUM	Load-Ttl, Stk Cn	MG/M3	899.42	634.92	430.21
CAXM	Emis-Total	KG/HR	192.394	137.432	87.716
IC	Perc Impinger Catch		0.06	0.01	0.04
	Prod Rate	MTON/HR	12.6	12.5	12.5
	Part Emis Ttl	KG/MTON	96.9	91.6	72.2
	Lead Emis Ttl	KG/MTON	15.2	11.0	7.02
	Perc Lead Ptl	%	16.0	12.1	9.90
	Perc Lead Ttl	%	15.8	12.0	9.70
	Ave Perc Lead Ptl	%		12.7	
	Ave Perc Lead Ttl	%		12.5	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XIII

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - E STACK

Name	Description	Units	E-3	E-4	E-7
	Date of Run		07-19-73	07-20-73	07-23-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	51.72	63.72	52.53
PMOS	Percent Moisture by Vol		3.9	5.3	4.4
TS	Avg Stack Temperature	DEG.F	141.4	126.4	131.7
QS	Stk Flowrate, Dry, Std Cn	DSCFM	55424	70367	57497
QA	Actual Stack Flowrate	ACFM	66816	84169	68474
PERI	Percent Isokinetic		102.0	99.0	99.9
	PARTICULATES -- PARTIAL CATCH[a]				
MF	Particulate Wt-Partial	MG	82.50	37.80	73.80
CAN	Part Load-Ptl, Std Cn	GR/DSCF	0.0246	0.00914	0.0216
CAT	Part Load-Ptl, Stk Cn	GR/ACF	0.0204	0.00764	0.0182
CAW	Partic Emis-Partial	LB/HR	11.7	5.51	10.7
	PARTICULATES -- TOTAL CATCH[b]				
MT	Particulate Wt-Total[b]	MG	137.20	83.80	147.00
CAO	Part Load-Ttl, Std Cn	GR/DSCF	0.0408	0.0202	0.0431
CAU	Part Load-Ttl, Stk Cn	GR/ACF	0.0339	0.0169	0.0362
CAX	Partic Emis-Total[b]	LB/HR	19.4	12.2	21.2
IC	Perc Impinger Catch		39.87	54.89	49.80
	LEAD -- PARTIAL CATCH[a]				
MF	Wt-Partial[a]	MG	24.85	7.75	25.47
CAN	Load-Ptl, Std Cn	GR/DSCF	0.00740	0.00187	0.00747
CAT	Load-Ptl, Stk Cn	GR/ACF	0.00614	0.00157	0.00627
CAW	Emis-Partial[a]	LB/HR	3.51	1.13	3.68
	LEAD -- TOTAL CATCH[b]				
MT	Wt-Total[b]	MG	24.94	7.88	25.60
CAO	Load-Ttl, Std Cn	GR/DSCF	0.00743	0.00190	0.00750
CAU	Load-Ttl, Stk Cn	GR/ACF	0.00616	0.00159	0.00630
CAX	Emis-Total[b]	LB/HR	3.53	1.15	3.70
IC	Perc Impinger Catch		0.36	1.65	0.51
	Prod Rate	TON/HR	13.9	13.8	13.8
	Part Emis Ttl	LB/TON	1.40	0.884	1.54
	Lead Emis Ttl	LB/TON	0.254	0.0833	0.268
	Perc Lead Emis Ptl	%	30.0	20.5	34.4
	Perc Lead Emis Ttl	%	18.2	9.43	17.4
	Avg Perc Lead Emis Ptl	%		28.3	
	Avg Perc Lead Emis Ttl	%		15.0	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XIIIA

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - E STACK
(Metric Units)

Name	Description Date of Run	Units	E-3 07-19-73	E-4 07-20-73	E-7 07-23-73
VMSTM	Vol Dry Gas-Std Cond	NCM	1.465	1.804	1.488
PMOS	Percent Moisture by Vol		3.9	5.3	4.4
TSM	Avg Stack Temperature	DEG.C	60.8	52.5	55.4
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	1569.4	1992.6	1628.2
QAM	Actual Stack Flowrate	M3/MIN	1892.0	2383.4	1939.0
PERI	Percent Isokinetic		102.0	99.0	99.9
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial	MG	82.50	37.80	73.80
CANM	Part Load-Ptl, Std Cn	MG/NM3	56.21	20.91	49.51
CATM	Part Load-Ptl, Stk Cn	MG/M3	46.63	17.48	41.57
CAWM	Partic Emis-Partial	KG/HR	5.29	2.50	4.84
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total	MG	137.20	83.80	147.00
CAOM	Part Load-Ttl, Std Cn	MG/NM3	93.48	46.35	98.61
CAUM	Part Load-Ttl, Stk Cn	MG/M3	77.54	38.75	82.81
CAXM	Partic Emis-Total	KG/HR	8.80	5.54	9.63
IC	Perc Impinger Catch		39.87	54.89	49.80
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial	MG	24.85	7.75	25.47
CANM	Load-Ptl, Std Cn	MG/NM3	16.93	4.29	17.09
CATM	Load-Ptl, Stk Cn	MG/M3	14.05	3.58	14.35
CAWM	Emis-Partial	KG/HR	1.594	0.512	1.669
	Lead -- TOTAL CATCH[b/]				
MT	Wt-Total	MG	24.94	7.88	25.60
CAOM	Load-Ttl, Std Cn	MG/NM3	16.99	4.36	17.17
CAUM	Load-Ttl, Stk Cn	MG/M3	14.10	3.64	14.42
CAXM	Emis-Total	KG/HR	1.600	0.521	1.677
IC	Perc Impinger Catch		0.36	1.65	0.51
	Prod Rate	MTON/HR	12.6	12.5	12.5
	Part Emis Ttl	KG/MTON	0.698	0.443	0.770
	Lead Emis Ttl	KG/MTON	0.127	0.0416	0.134
	Perc Lead Emis Ptl	%	30.0	20.5	34.4
	Perc Lead Emis Ttl	%	18.2	9.43	17.4
	Avg Perc Lead Emis Ptl	%		28.3	
	Avg Perc Lead Emis Ttl	%		15.0	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XIV

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - F STACK

Name	Description Date of Run	Units	F-3 07-19-73	F-4 07-20-73	F-7 07-23-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	76.05	74.13	73.88
PMOS	Percent Moisture by Vol		4.6	4.9	4.1
TS	AVG Stack Temperature	DEG.F	151.3	147.3	141.3
QS	Stk Flowrate, Dry, Std Cn	DSCFM	39425	38839	39256
QA	Actual Stack Flowrate	ACFM	48664	47918	47385
PERI	Percent Isokinetic		93.7	92.7	91.4
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial	MG	38.50	52.30	64.20
CAN	Part Load-Ptl, Std Cn	GR/DSCF	0.00780	0.0109	0.0134
CAT	Part Load-Ptl, Stk Cn	GR/ACF	0.00632	0.00881	0.0111
CAW	Partic Emis-Partial	LB/HR	2.63	3.62	4.50
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total	MG	111.40	101.60	123.40
CAO	Part Load-Ttl, Std Cn	GR/DSCF	0.0226	0.0211	0.0257
CAU	Part Load-Ttl, Stk Cn	GR/ACF	0.0183	0.0171	0.0213
CAX	Partic Emis-Total	LB/HR	7.62	7.03	8.65
IC	Perc Impinger Catch		65.44	48.52	47.97
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial	MG	8.37	15.72	27.22
CAN	Load-Ptl, Std Cn	GR/DSCF	0.00170	0.00327	0.00567
CAT	Load-Ptl, Stk Cn	GR/ACF	0.00137	0.00265	0.00470
CAW	Emis-Partial	LB/Hr	0.570	1.09	1.91
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total	MG	8.47	15.89	27.32
CAO	Load-Ttl, Std Cn	GR/DSCF	0.00172	0.00330	0.00569
CAU	Load-Ttl, Stk Cn	GR/ACF	0.00139	0.00268	0.00472
CAX	Emis-Total	LB/HR	0.580	1.10	1.92
IC	Perc Impinger Catch		1.18	1.07	0.37
	Prod Rate	TON/HR	13.9	13.8	13.8
	Part Emis Ttl	LB/TON	0.548	0.509	0.627
	Lead Emis Ttl	LB/TON	0.0417	0.0797	0.139
	Perc Lead Emis Ptl	%	21.7	30.1	42.4
	Perc Lead Emis Ttl	%	7.61	15.6	22.2
	Avg Perc Lead Ptl	%		31.4	
	Avg Perc Lead Ttl	%		15.1	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XIVA

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - F STACK
(Metric Units)

Name	Description / Date of Run	Units	F-3 07-19-73	F-4 07-20-73	F-7 07-23-73
VMSTM	Vol Dry Gas-Std Cond	NCM	2.154	2.099	2.092
PMOS	Percent Moisture by Vol		4.6	4.9	4.1
TSM	Avg Stack Temperature	DEG.C	66.3	64.1	60.7
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	1116.4	1099.8	1111.6
QAM	Actual Stack Flowrate	M3/MIN	1378.0	1356.9	1341.8
PERI	Percent Isokinetic		93.7	92.7	91.4
	PARTICULATES -- PARTIAL CATCH a/				
MF	Particulate Wt-Partial	MG	38.50	52.30	64.20
CANM	Part Load-Ptl, Std Cn	MG/NM3	17.84	24.86	30.62
CATM	Part Load-Ptl, Stk Cn	MG/M3	14.45	20.15	25.37
CAWM	Partic Emis-Partial	KG/HR	1.19	1.64	2.04
	PARTICULATES -- TOTAL CATCH b/				
MT	Particulate Wt-Total	MG	111.40	101.60	123.40
CAOM	Part Load-Ttl, Std Cn	MG/NM3	51.62	48.30	58.86
CAUM	Part Load-Ttl, Stk Cn	MG/M3	41.82	39.15	48.76
CAXM	Partic Emis-Total	KG/HR	3.46	3.19	3.93
IC	Perc Impinger Catch		65.44	48.52	47.97
	LEAD -- PARTIAL CATCH a/				
MF	Wt-Partial	MG	8.37	15.72	27.22
CANM	Load-Ptl, Std Cn	MG/NM3	3.88	7.47	12.98
CATM	Load-Ptl, Stk Cn	MG/M3	3.14	6.06	10.76
CAWM	Emis-Partial	KG/HR	0.260	0.493	0.866
	LEAD -- TOTAL CATCH b/				
MT	Wt-Total	MG	8.47	15.89	27.32
CAOM	Load-Ttl, Std Cn	MG/NM3	3.93	7.55	13.03
CAUM	Load-Ttl, Stk Cn	MG/M3	3.18	6.12	10.80
CAXM	Emis-Total	KG/HR	0.263	0.498	0.869
IC	Perc Impinger Catch		1.18	1.07	0.37
	Prod Rate	MTON/HR	12.6	12.5	12.5
	Part Emis Ttl	KG/MTON	0.275	0.255	0.314
	Lead Emis Ttl	KG/MTON	0.0208	0.0398	0.0695
	Perc Lead Emis Ptl	%	21.7	30.1	42.4
	Perc Lead Emis Ttl	%	7.61	15.6	22.2
	Avg Perc Lead Emis Ptl	%		31.4	
	Avg Perc Lead Emis Ttl	%		15.1	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XV

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - G STACK

Name	Description	Units	G-3	G-4	G-7
	Date of Run		07-19-73	07-20-73	07-23-73
VMSTD	Vol Dry Gas-Std Cond	DSCF	82.43	84.49	91.52
PMOS	Percent Moisture by Vol		4.8	5.4	4.3
TS	Avg Stack Temperature	DEG.F	150.1	138.5	154.2
QS	Stk Flowrate, Dry, Std Cn	DSCFM	43723	44762	49840
QA	Actual Stack Flowrate	ACFM	54002	54665	61612
PERI	Percent Isokinetic		91.6	91.7	89.2
	PARTICULATES -- PARTIAL CATCH[a/]				
MF	Particulate Wt-Partial	MG	83.80	22.00	97.40
CAN	Part Load-Ptl, Std Cn	GR/DSCF	0.0157	0.00401	0.0164
CAT	Part Load-Ptl, Stk Cn	GR/ACF	0.0127	0.00328	0.0133
CAW	Partic Emis-Partial	LB/HR	5.87	1.54	7.00
	PARTICULATES -- TOTAL CATCH[b/]				
MT	Particulate Wt-Total	MG	140.20	71.40	164.00
CAO	Part Load-Ttl, Std Cn	GR/DSCF	0.0262	0.0130	0.0276
CAU	Part Load-Ttl, Stk Cn	GR/ACF	0.0212	0.0107	0.0223
CAX	Partic Emis-Total	LB/HR	9.81	4.99	11.8
IC	Perc Impinger Catch		40.23	69.19	40.61
	LEAD -- PARTIAL CATCH[a/]				
MF	Wt-Partial	MG	33.52	5.35	45.97
CAN	Load-Ptl, Std Cn	GR/DSCF	0.00626	0.000980	0.00774
CAT	Load-Ptl, Stk Cn	GR/ACF	0.00507	0.000800	0.00626
CAW	Emis-Partial	LB/HR	2.35	0.370	3.30
	LEAD -- TOTAL CATCH[b/]				
MT	Wt-Total	MG	33.71	5.64	46.05
CAO	Load-Ttl, Std Cn	GR/DSCF	0.00630	0.00103	0.00775
CAU	Load-Ttl, Stk Cn	GR/ACF	0.00510	0.000840	0.00627
CAX	Emis-Total	LB/HR	2.36	0.390	3.31
IC	Perc Impinger Catch		0.56	5.14	0.17
	Prod Rate	TON/HR	13.9	13.8	13.8
	Part Emis Ttl	LB/TON	0.706	0.362	0.855
	Lead Emis Ttl	LB/TON	0.170	0.0283	0.240
	Perc Lead Emis Ptl	%	40.0	24.0	47.1
	Perc Lead Emis Ttl	%	24.0	7.82	28.1
	Avg Perc Lead Emis Ptl	%		37.0	
	Avg Perc Lead Emis Ttl	%		20.0	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

TABLE XVA

SUMMARY OF EMISSIONS FROM BLAST FURNACE BAGHOUSE - G STACK
(Metric Units)

Name	Description	Units	G-3	G-4	G-7
	Date of Run		07-19-73	07-20-73	07-23-73
VMSTM	Vol Dry Gas-Std Cond	NCM	2.334	2.393	2.592
PMOS	Percent Moisture by Vol		4.8	5.4	4.3
TSM	Avg Stack Temperature	DEG.C	65.6	59.2	67.9
QSM	Stk Flowrate, Dry, Std Cn	NM3/MIN	1238.1	1267.5	1411.3
QAM	Actual Stack Flowrate	M3/MIN	1529.2	1547.9	1744.7
PERI	Percent Isokinetic		91.6	91.7	89.2
	PARTICULATES -- PARTIAL CATCH a/				
MF	Particulate Wt-Partial	MG	83.80	22.00	97.40
CANM	Part Load-Ptl, Std Cn	MG/NM3	35.83	9.18	37.51
CATM	Part Load-Ptl, Stk Cn	MG/M3	29.01	7.51	30.34
CAWM	Partic Emis-Partial	KG/HR	2.66	0.700	3.18
	PARTICULATES -- TOTAL CATCH b/				
MT	Particulate Wt-Total	MG	140.20	71.40	164.00
CAOM	Part Load-Ttl, Std Cn	MG/NM3	59.94	29.78	63.15
CAUM	Part Load-Ttl, Stk Cn	MG/M3	48.53	24.38	51.08
CAXM	Partic Emis-Total	KG/HR	4.45	2.26	5.35
IC	Perc Impinger Catch		40.23	69.19	40.61
	LEAD -- PARTIAL CATCH a/				
MF	Wt-Partial	MG	33.52	5.35	45.97
CANM	Load-Ptl, Std Cn	MG/NM3	14.33	2.23	17.70
CATM	Load-Ptl, Stk Cn	MG/M3	11.60	1.83	14.32
CAWM	Emis-Partial	KG/HR	1.064	0.170	1.499
	LEAD -- TOTAL CATCH b/				
MT	Wt-Total	MG	33.71	5.64	46.05
CAOM	Load-Ttl, Std Cn	MG/NM3	14.41	2.35	17.73
CAUM	Load-Ttl, Stk Cn	MG/M3	11.67	1.93	14.34
CAXM	Emis-Total	KG/HR	1.070	0.179	1.501
IC	Perc Impinger Catch		0.56	5.14	0.17
	Prod Rate	MTON/HR	12.6	12.5	12.5
	Part Emis Ttl	KG/MTON	0.353	0.181	0.428
	Lead Emis Ttl	KG/MTON	0.0849	0.0143	0.120
	Perc Lead Emis Ptl	%	40.0	24.0	47.1
	Perc Lead Emis Ttl	%	24.0	7.82	28.1
	Avg Perc Lead Emis Ptl	%		37.0	
	Avg Perc Lead Emis Ttl	%		20.0	

a/ Partial catch refers to the particulate and lead caught in the probe tip, probe, cyclone and filter.

b/ Total catch refers to all the particulate and lead caught in the partial catch plus the impingers.

Table VIA is the same except in metric units. Since the baghouse has three stacks, the average concentrations shown are calculated from weighted averages, based on stack flowrate, for each run. The collection efficiencies for the collection system, humidifying chamber, the excess air addition, lime addition and baghouse are 98+%. The data in Table VI show that most of the lead emitted from the baghouse was caught in the front half of the collection train (i.e., the probe tip, probe, cyclone and filter), and therefore is composed of larger particles. The particles caught in the impingers (which are located after the filter) are smaller than 0.3 μ in diameter and account for only 0.04 lb/hr emission. The filters used capture all particles larger than 0.3 μ in diameter.

Table VII summarizes the data by test. Table VIIA presents the data in metric units. For Test 3, the first test on the blast furnace and pollution control system, the efficiency of the collection system was 98.5-99.2%. In Test 4, the second test on the blast furnace and its pollution control system, the efficiency of the collection system varied from 99 to 99.6%. In Test 7, the third and final test on the blast furnace and its pollution control system, the collection efficiency varied from 95.4 to 98.9%. During the first and second emission tests on the blast furnace and control system, the bagshaking was done on a very irregular schedule.

Little or no automatic bagshaking occurred during the period when samples were being collected. While Test 7 (the last test) was being conducted, the bags were manually shaken several times in addition to the so-called automatic shaking. This test shows the lowest collection efficiency for the baghouse and the highest lead and particulate emissions. Shaking the bags cleans them and allows the fine material to pass through, rather than collecting on a particulate film covering the surface of the bag. The highest visible emissions occur during bagshaking.

Table VIII shows the pounds of particulate per ton of feed to the blast furnace, and Table VIIIA has the same information in metric units. The average emission rate for the uncontrolled particulate is 68 lb/ton of feed and for the particulate from the control system 0.959 lb/ton of feed.

Table IX has the particulate emission data in pounds per ton of lead produced and Table IXA in metric units. The average uncontrolled emission rate is 174 lb/ton of lead, and the average controlled emission rate is 2.47 lb/ton of lead.

Table X presents the emission factors for pounds of lead from the blast furnace per ton of feed to the furnace, and Table XA presents the data in metric units. The average uncontrolled emission rate is 20.8 lb of lead per ton of feed, and the average controlled emission rate is 0.405 lb/ton of feed.

Table XI presents the lead emission rate for ton of lead produced by the blast furnace, and Table XIA presents the data in metric units. The average uncontrolled emission rate is 23.0 lb of lead per ton of lead produced, and the average controlled emission rate is 0.450 lb of lead per ton of lead produced.

Table XII presents a summary of results from the emission tests on the duct from the blast furnace (7-ft diameter) to the control system. Table XIIA presents the same information in metric units. The percent lead in the particulate catch is: front half of train - average 12.7%; total catch - average 12.5%.

The particulate emissions in the total catch from sample location "D" (inlet duct to blast furnace control system) varied from 1,990 lb/hr to 2,690 lb/hr, and 144 lb/ton to 194 lb/ton. The lead emissions in the total catch varied from 193 lb/hr to 424 lb/hr, and from 14.0 lb/ton to 30.5 lb/ton.

Table XIII presents the summary of results from the three tests run on the baghouse exhaust stack E (Figure 2). Table XIIIA presents the data in metric units. The percent lead in the particulate catch is: front half of train - average 28.3%; total catch - average 15.0%. The particulate emissions in the total catch varied from 12.2 lb/hr to 21.2 lb/hr and 0.884 lb/ton to 1.54 lb/ton. The lead emissions in the total catch ranged from 1.15 lb/hr to 3.70 lb/hr and 0.0833 lb/ton to 0.268 lb/ton.

Table XIV contains the summary of results for the emission tests from the baghouse exhaust stack F (Figure 2). Table XIVA presents the data in metric units. The average percent lead in the particulate catch is: front half of train 31.4%; total catch - 15.1%. The particulate emissions in the total catch ranged from 7.62 lb/hr to 8.65 lb/hr and from 0.509 lb/ton to 0.627 lb/ton. The lead emissions in the total catch ranged from 0.580 lb/hr to 1.92 lb/hr and 0.0417 lb/ton to 0.139 lb/ton.

Table XV contains the summary of results from the baghouse exhaust stack G (Figure 2). In Table XVA the data are presented in metric units. The average percent lead in the particulate catch from the front half of the train is 37.0%. The average percent lead in the particulate catch from the complete train is 20.0%. The particulate emissions in the total catch ranged from 4.99 lb/hr to 11.8 lb/hr and from 0.362 lb/ton to 0.855 lb/ton. The lead emissions in the total catch ranged from 0.390 lb/hr to 3.31 lb/hr and from 0.0283 lb/ton to 0.240 lb/ton.

Figures 3, 4, 5 and 6 and Tables XVI, XVII and XVIII refer to the Andersen particle size test program conducted at the blast furnace and baghouse exhaust stack F. The Andersen tests were conducted at point 3, port 3 of this stack (see Figure 14, p. 80). There were three particle size tests; Test F3A lasted 60 min, Test F4A 120 min, and Test F7A 92 min.

The Andersen sampler was used with a backup filter to capture particles not collected on the plates. The results, not including the filter net weight, are listed in Table XVII as "without filter." The results which include the filter net weight are listed as "with filter."

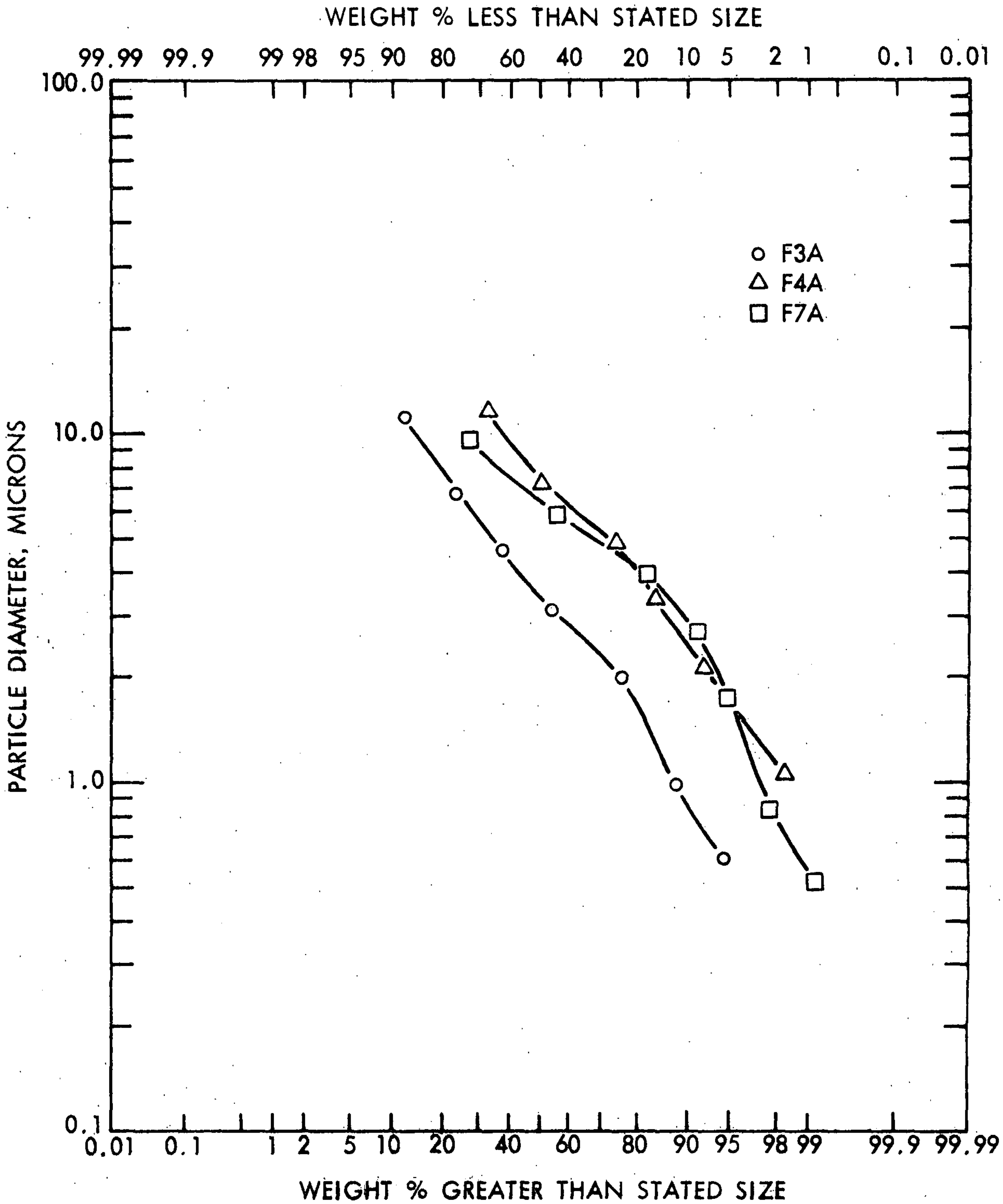


Figure 3 - Particulate Without Filter

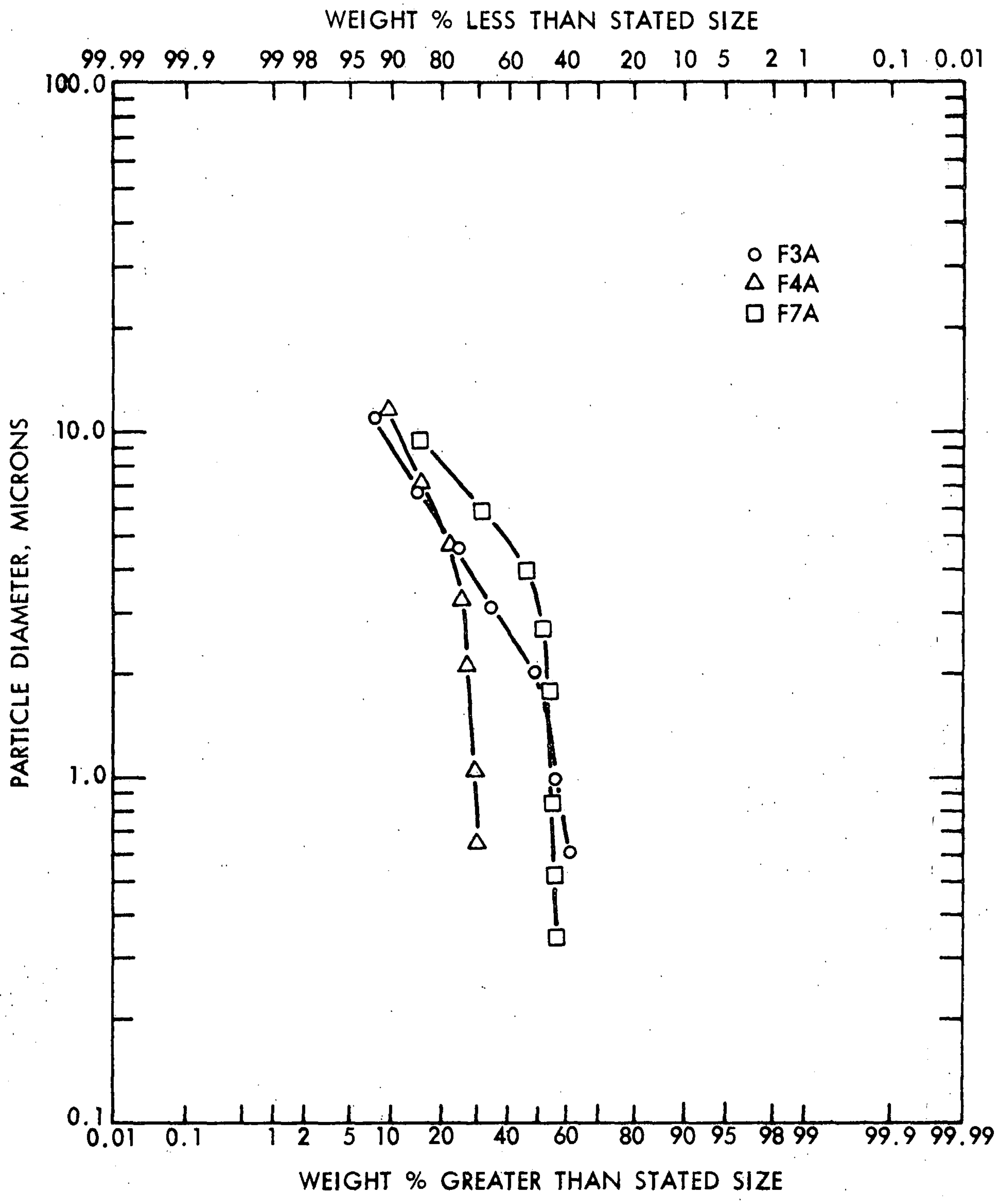


Figure 4 - Particulate With Filter

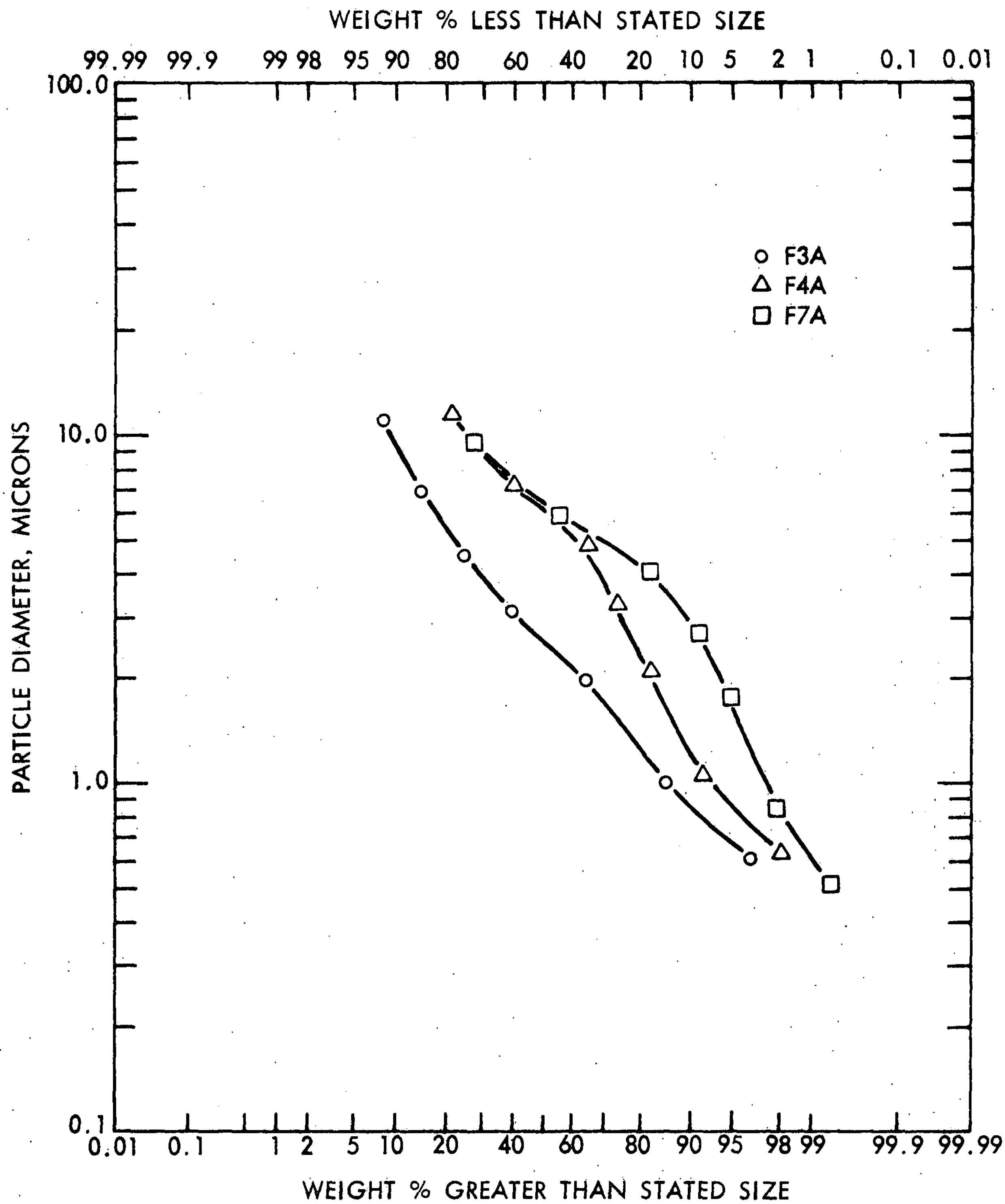


Figure 5 - Lead Without Filter

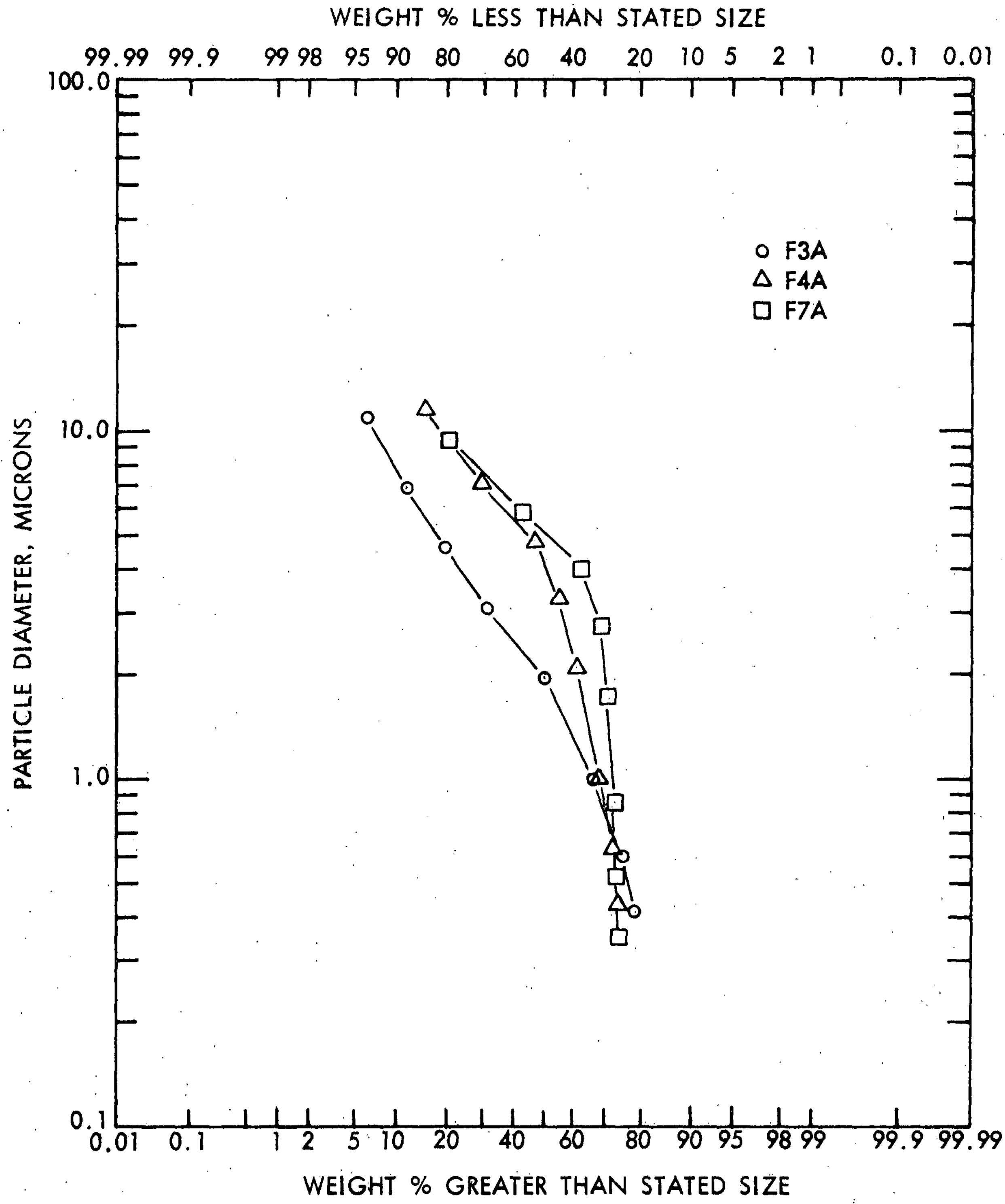


Figure 6 - Lead With Filter

TABLE XVI

PERCENT LEAD IN PARTICULATE FOR ANDERSEN TEST

Plate No.		Wt. Part. (g)	Wt. Lead (mg)	% Lead
F3A	0	0.00206	0.3515	17.1
	1	0.00276	0.6765	24.5
	2	0.00446	0.8265	18.5
	3	0.00557	1.2765	22.9
	4	0.00617	1.8265	29.6
	5	0.00904	3.3265	36.8
	6	0.00461	2.6015	56.4
	7	0.00248	1.3415	54.1
	8	0.00207	0.4365	21.1
Subtotal		0.03922	12.6635	32.3
Filter		0.02370	3.3973	14.3
Total		0.06292	16.0608	25.5
F4A	0	0.00105	0.4915	46.8
	1	0.00084	0.3640	43.3
	2	0.00110	0.7615	6.9
	3	0.00142	1.0415	73.3
	4	0.00057	0.3815	66.9
	5	0.00045	0.3215	71.4
	6	0.00035	0.3915	112.0
	7	0.00010	0.2515	25.2
	8	0.0	0.0	0.0
Subtotal		0.00588	4.0045	68.1
Filter		0.01450	1.3823	9.5
Total		0.02038	5.3868	26.4
F7A	0	0.01376	7.3265	53.0
	1	0.02441	13.3515	54.7
	2	0.04042	21.9765	54.4
	3	0.03737	21.2265	56.8
	4	0.01261	6.5265	51.8
	5	0.00510	2.9265	57.3
	6	0.00402	2.1265	52.9
	7	0.00211	1.3265	62.9
	8	0.00116	0.4915	42.4
Subtotal		0.14096	77.2785	54.8
Filter		0.10490	25.4723	24.3
Total		0.24586	102.7508	43.7

TABLE XVII

ANDERSEN ANALYSIS SUMMARY

RUN NUMBER F3A
DATE 071973

DENSITY= 1.000
IMP.EFF.C= .140

SAMPLING RATE = .78110 CFM

FILTER WT= .02230 GM
TOTAL WT= .06152 GM

STAGE/ PLATE	SAMPLE PLATE + PAN	PAN FOR SAMPLE	TARE PLATE + PAN	PAN FOR TARE	TARE OF PLATE	SAMPLE WEIGHT (GM)	-WITHOUT FILTER-		--WITH FILTER--		JET VEL. (CM/S)	PARTIC. DIAM. (MICR)
							WEIGHT PERCENT	CUM. WEIGHT PERCENT	WEIGHT PERCENT	CUM. WEIGHT PERCENT		
/0	47.63437	17.36350	51.20703	20.93822	30.26881	.00206	5.25	5.25	3.35	3.35		
0/1	37.38783	17.51861	40.80516	20.93870	19.86646	.00276	7.04	12.29	4.49	7.83	60.14	10.99
1/2	37.99770	17.36051	41.57186	20.93913	20.63273	.00446	11.37	23.66	7.25	15.08	112.15	6.86
2/3	38.37489	17.51416	41.79439	20.93923	20.85516	.00557	14.20	37.86	9.05	24.14	187.12	4.65
3/4	39.09322	17.37078	42.65582	20.93955	21.71627	.00617	15.73	53.60	10.03	34.17	309.32	3.16
4/5	29.08619	17.50546	32.51144	20.93975	11.57169	.00904	23.05	76.64	14.69	48.86	549.90	2.03
5/6	29.03880	17.36314	32.61109	20.94004	11.67105	.00461	11.75	88.40	7.49	56.36	1330.63	1.01
6/7	28.91710	17.50431	32.35057	20.94026	11.41031	.00248	6.32	94.72	4.03	60.39	2425.07	.62
7/8	37.91781	17.36192	41.49457	20.94075	20.55382	.00207	5.28	100.00	3.36	63.75	4850.14	.42

TABLE XVII (Continued)

ANDERSEN ANALYSIS SUMMARY

RUN NUMBER F4A DENSITY= 1.000 SAMPLING FILTER WT= .01360 GM
DATE 072073 IMP.EFF.C= .140 RATE = .70920 CFM TOTAL WT= .01948 GM

							-WITHOUT FILTER-		--WITH FILTER--			
STAGE/ PLATE	SAMPLE PLATE + PAN	PAN FOR SAMPLE	TARE PLATE + PAN	PAN FOR TARE	TARE OF PLATE	SAMPLE WEIGHT (GM)	WEIGHT PERCENT	CUM. WEIGHT PERCENT	WEIGHT PERCENT	CUM. WEIGHT PERCENT	JET VEL. (CM/S)	PARTIC. DIAM. (MICR)
/0	47.54297	17.34190	47.56231	17.36229	30.20002	.00105	17.86	17.86	5.39	5.39		
0/1	37.44772	17.49750	37.31178	17.36240	19.94938	.00084	14.29	32.14	4.31	9.70	54.61	11.54
1/2	38.45145	17.34356	38.46902	17.36223	21.10679	.00110	18.71	50.85	5.65	15.35	101.83	7.20
2/3	38.72037	17.49893	38.58227	17.36225	21.22002	.00142	24.15	75.00	7.29	22.64	169.90	4.88
3/4	39.64761	17.34281	39.66647	17.36224	22.30423	.00057	9.69	84.69	2.93	25.56	280.85	3.32
4/5	29.14621	17.49803	29.01016	17.36243	11.64773	.00045	7.65	92.35	2.31	27.87	499.28	2.13
5/6	28.83634	17.34262	28.85598	17.36261	11.49337	.00035	5.95	98.30	1.80	29.67	1208.14	1.06
6/7	29.13314	17.49745	28.99814	17.36255	11.63559	.00010	1.70	100.00	.51	30.18	2201.84	.65
7/8	38.72241	17.35103	38.73347	17.36209	21.37138	.00000	.00	100.00	.00	30.18	4403.68	.44

TABLE XVII (Concluded)

ANDERSEN ANALYSIS SUMMARY

RUN NUMBER F7A   DENSITY= 1.000   SAMPLING   FILTER WT= .10490 GM
DATE 072373   IMP.EFF.C= .140   RATE = 1.03750 CFM   TOTAL WT= .24586 GM

STAGE/ PLATE	SAMPLE PLATE + PAN	PAN FOR SAMPLE	TARE PLATE + PAN	PAN FOR TARE	TARE OF PLATE	SAMPLE WEIGHT (GM)	-WITHOUT FILTER- WEIGHT PERCENT	CUM. WEIGHT PERCENT	--WITH FILTER-- WEIGHT PERCENT	CUM. WEIGHT PERCENT	JET VEL. (CM/S)	PARTIC. DIAM. (MICR)
/0	47.61919	17.33652	47.77276	17.50385	30.26891	.01376	9.76	9.76	5.60	5.60		
0/1	37.38215	17.49122	37.37055	17.50403	19.86652	.02441	17.32	27.08	9.93	15.53	79.88	9.52
1/2	38.01382	17.34025	38.13734	17.50419	20.63315	.04042	28.67	55.75	16.44	31.97	148.97	5.94
2/3	38.41076	17.51814	38.35971	17.50446	20.85525	.03737	26.51	82.26	15.20	47.17	248.54	4.02
3/4	39.06809	17.33916	39.22112	17.50480	21.71632	.01261	8.95	91.21	5.13	52.29	410.86	2.73
4/5	29.08781	17.51060	29.07705	17.50494	11.57211	.00510	3.62	94.83	2.07	54.37	730.41	1.75
5/6	29.02014	17.34482	29.17675	17.50545	11.67130	.00402	2.85	97.68	1.64	56.00	1767.41	.86
6/7	28.92835	17.51553	28.91633	17.50562	11.41071	.00211	1.50	99.18	.86	56.86	3221.11	.53
7/8	37.89888	17.34322	38.06024	17.50574	20.55450	.00116	.82	100.00	.47	57.33	6442.22	.35

TABLE XVIII

ANDERSEN ANALYSIS SUMMARY (LEAD)

	mg Pb	gm Partic	mg Pb/gm Partic	Pb without Filter Weight (%)	Pb without Filter Cum Weight (%)	Pb with Filter Weight (%)	Pb with Filter Cum. Weight (%)	Particle Diameter (μ)
Run F3A								
0	0.3515	0.00206	171	2.8	2.8	2.2	2.2	
1	0.6765	0.00276	245	5.3	8.1	4.2	6.4	10.99
2	0.8265	0.00446	185	6.5	14.6	5.1	11.5	6.86
3	1.2765	0.00557	229	10.1	24.7	7.9	19.4	4.65
4	1.8265	0.00617	296	14.4	39.1	11.4	30.8	3.16
5	3.3265	0.00904	368	26.3	65.4	20.7	51.5	2.03
6	2.6015	0.00461	564	20.5	85.9	16.2	67.7	1.01
7	1.3415	0.00248	541	10.6	96.5	8.3	76.0	0.62
8	0.4365	0.00207	211	3.5	100.0	2.7	78.7	0.42
Filter	3.3973	0.0237	143			21.3	100.0	
Run F4A								
0	0.4915	0.00105	468	12.0	12.0	9.0	9.0	
1	0.3640	0.00084	433	8.9	20.9	6.7	15.7	11.54
2	0.7615	0.00110	692	18.7	39.6	13.9	29.6	7.20
3	1.0415	0.00142	733	25.5	65.1	19.1	48.7	4.88
4	0.3815	0.00057	669	9.3	74.4	7.0	55.7	3.32
5	0.3215	0.00045	714	7.9	82.3	5.9	61.6	2.13
6	0.3915	0.00035	1,119	9.6	91.9	7.2	68.8	1.06
7	0.2515	0.00010	2,515	6.2	98.1	4.6	73.4	0.65
8	0.0755	0	--	1.9	100.0	1.3	74.7	0.44
Filter	1.3823	0.0145	95.3			25.3	100.0	
Run F7A								
0	7.3265	0.01376	532	9.5	9.5	7.1	7.1	
1	13.3515	0.02441	547	17.3	26.8	13.0	20.1	9.52
2	21.9765	0.04042	544	28.4	55.2	21.4	41.5	5.94
3	21.2265	0.03737	568	27.5	82.7	20.6	62.1	4.02
4	6.5265	0.01261	518	8.4	91.1	6.4	68.5	2.73
5	2.9265	0.00510	574	3.8	94.9	2.8	71.3	1.75
6	2.1265	0.00402	529	2.8	97.7	2.1	73.4	0.86
7	1.3265	0.00211	689	1.7	99.4	1.3	74.7	0.53
8	0.4915	0.00116	424	0.6	100.0	0.5	75.2	0.35
Filter	25.4723	0.1049	243			24.8	100.0	

Figures 3, 4 and 5 are plots of the data in Table XVII using the cumulative weight percent as the "weight % greater than stated size" and using the particle diameter in microns calculated from MRI's Andersen computer program, a development of the Ranz and Wong equation.[1/]

Figure 3 shows the particle size distribution of the particles caught in the Andersen analyzer for all three tests. In Test F3A, 94.5% of the particles are larger than 0.62 μ, and 12% are larger than 11 μ. Test F4A shows that 98.3% of the particulates are larger than 1.1 μ, and 32% are larger than 11.5 μ. The results of Test F7A show that 99.2% are larger than 0.52 μ, and that 27% are larger than 9.6 μ.

Figure 4 presents the results of the particulate size analysis including the particles that passed through the Andersen and were caught on the filter. In Test F3A, 62% of the particles are larger than 0.62 μ, and 8% are larger than 11.1 μ. The results of Test F4A show that 30% of the particles are larger than 0.66 μ, and that 9.5% of the particles are larger than 11.15 μ. Test F7A shows that 58% of the particles are larger than 0.35 μ, and 16% are larger than 9.6 μ.

The particle size analysis of the particulate emissions shows that more than 65% of the material emitted is smaller than 3.5 μ, and about half of the particulate emission is smaller than 1 μ.

1/ Ranz, W. E., and J. B. Wong, "Jet Impactors for Determining the Particle Size Distribution of Aerosols," Industrial Hygiene and Occupational Medicine, Vol. 5, pp. 464-477 (1952).

The data for the Andersen particle size tests are presented in two ways. The first presentation is for the particles which are caught on the Andersen plates. This gives a particle size distribution from about 0.6 μ to 11 μ.

The data including filter are presented to spread the particle size distribution from 0.3 μ to 11 μ. The purpose of the filter is to catch small particles which pass through the Andersen without being captured.

Figure 5 shows the plot as a result of the analysis for lead of the particulate catch during the Andersen test. This does not include the material caught on the filter. The figure shows that on the average 96.0% of the lead was larger than 0.7 μ, and that half of the lead was found in particles larger than 5 μ.

Figure 6 presents the lead data for the same three runs but includes the lead caught on the filter. About 24% of the lead was smaller than 0.4 μ, and 80% of the lead was smaller than 9.0 μ.

Table XVI presents the percent lead in the particulate on each stage of the Andersen particle size analyzer as well as on the filter for each of the three tests. The percent lead in the total catch varied from 25.5 to 43.7% with Test F7A having the highest percentage lead. The difference in method and frequency of bagshaking between the first two tests when the bags were shaken very infrequently and Test 7 (D, E, F, G and FA) when the bags were shaken manually every 25 min explains the higher particulate and lead yield for Test 7. The same reasoning might explain the higher percentage lead in the total Andersen catch.

Table XVIII is a summary of the analytical data for lead on the particulate catch; in the Andersen tests the filter weights are included.

IV. PROCESS DESCRIPTION AND OPERATION

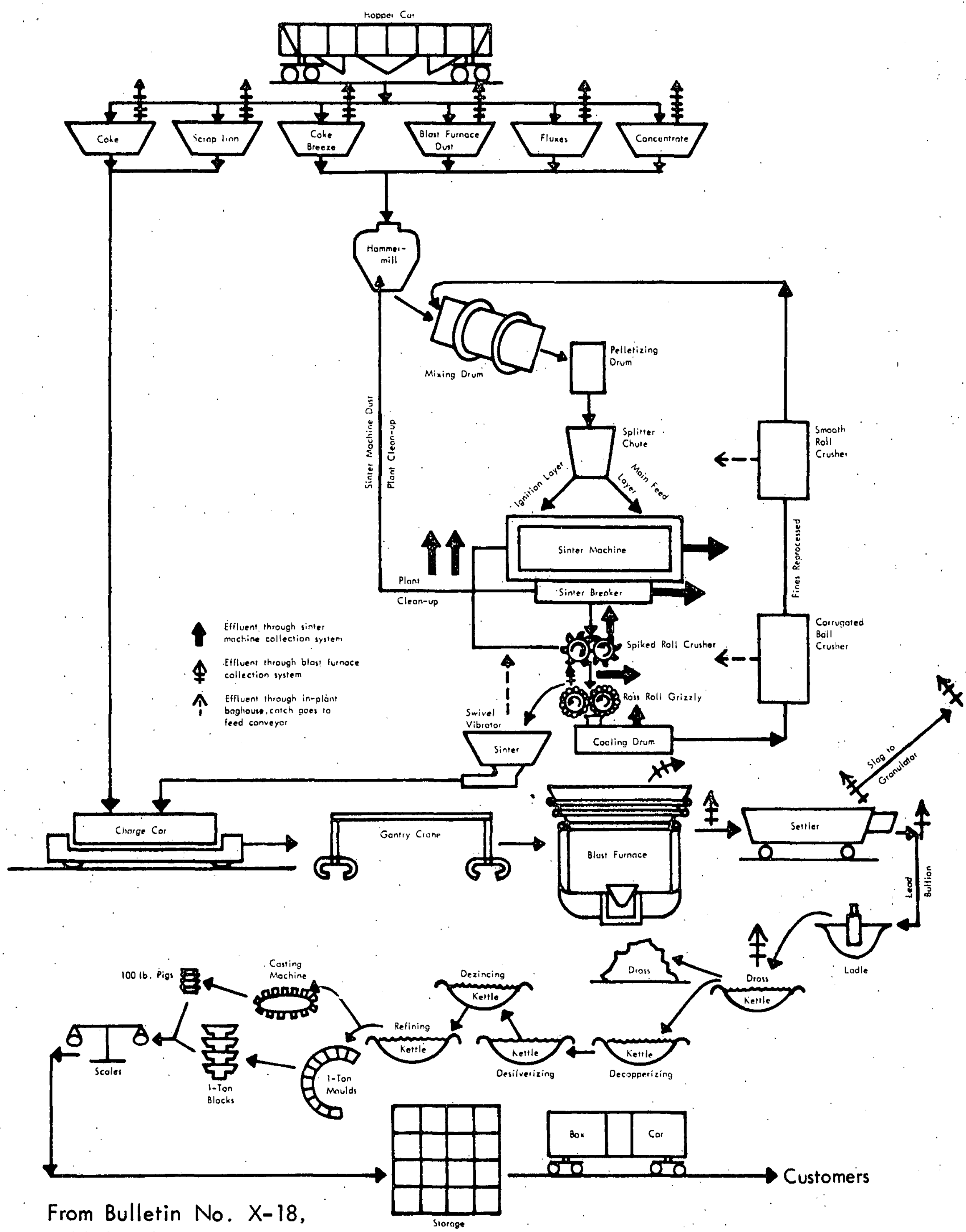
A. Process Flow[1/]

The ASARCO smelter at Glover is a custom smelter in that all ore is purchased from other companies. It has a design capacity of 90,000 tons of lead per year and started production in 1968. The average inlet concentrate analysis is 70-75% lead, 2-1/2% zinc, and 1% copper. Figure 7 is the Glover plant flow sheet. The plant is further described in the following paragraphs.

1. Sinter machine: ASARCO's plant at Glover has a highly automated updraft sinter machine designed to handle more than 1,500 tons of material per day. Figure 8 is a photograph showing the sinter machine, mixing drum, feed conveyors and updraft fans. A lead charge which is sized, mixed, pelletized, and moistened, is fed to the sinter machine where sulfur is eliminated and the heat of the oxidizing reactions converts the charge to a fused cellular cake, known as sinter. The basic chemical reactions are as follows:

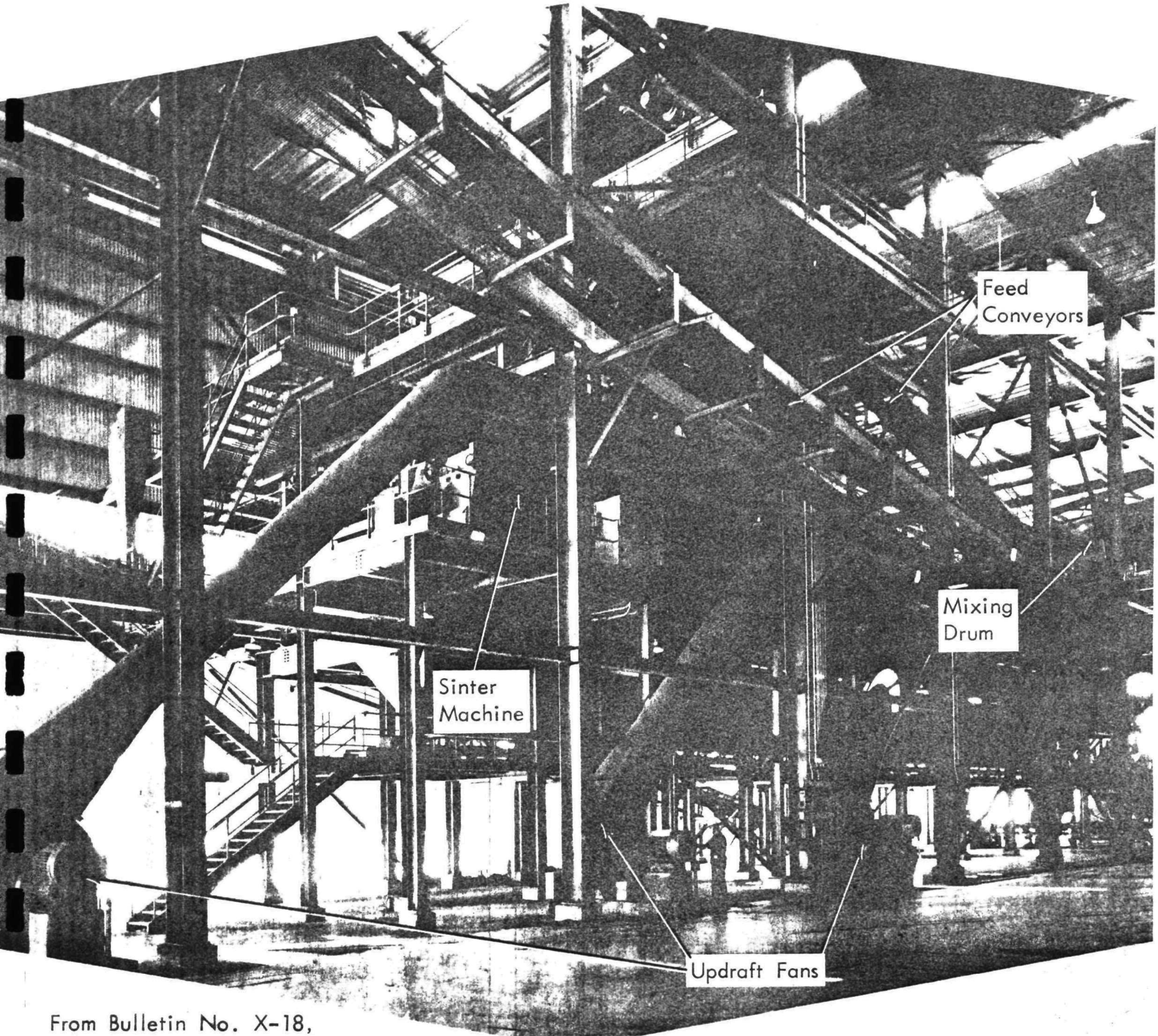
1/ The following process description is based on information obtained from plant personnel, Bulletin No. X-18, published by ASARCO, AIME World Symposium on Mining and Metallurgy of Lead and Zinc, Donald O. Rauski and Burt C. Auacher, Eds. AIME, New York (1970); and Lead--Progress and Prognosis: The State of the Art: Lead Recovery, A. Worcester and D. H. Beilstein, TMS, AIME, New York, Paper No. A71-87.

GLOVER PLANT FLOW SHEET



From Bulletin No. X-18, published by ASARCO.

Figure 7



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Sinter Plant

Figure 8

$$PbS + 1\text{-}1/2\ O_2 \longrightarrow PbO + SO_2$$

$$2PbO + PbS \longrightarrow 3Pb + SO_2$$

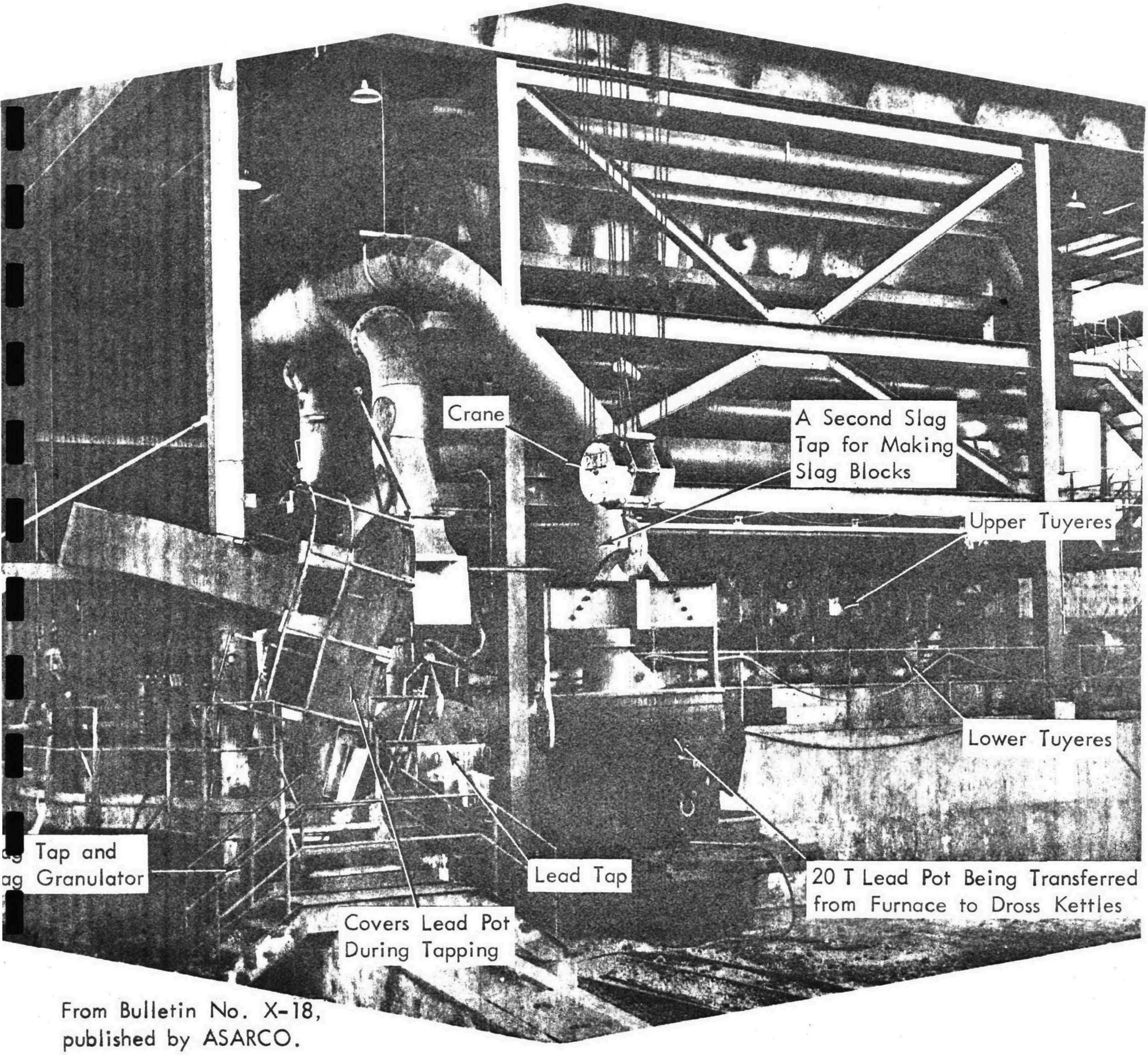
Charge materials to the sinter machine include lead concentrates, return sinter, blast furnace slag, and "plant clean-up" materials. The lead concentrate is conveyed from a storage bin through a Pennsylvania Impactor where six hammers break the material into smaller pieces. Return sinter, which consists of fines rejected from the final product of the sinter machine, is added to the sulfur-containing lead concentrates to dilute the total sulfur content down to a level that can be handled by the machine (5-6%). Return sinter passes through a cooling drum where it is quenched and then onto an enclosed conveyor which takes it through two crushers (corrugated rolls and smooth rolls) and finally to a storage bin.
Slag from the blast furnace which contains a minimum of 3% lead travels by conveyors to the sinter plant. Spillage from the sinter machine, sinter breaker, spiked rolls and windbox cleanings is picked up by two apion conveyors and, together with floor clean-up and baghouse dust, are conveyed to a storage bin and then through the Pennsylvania Impactor. The concentrate, return sinter, slag, and plant clean-up are fed through two 3.05-m by 9.5-m mixing drums where the feed is moistened and conditioned.

The feed is conveyed to a splitter chute where it is divided into an ignition layer and a main feed layer. A baffle diverts part of the feed into the hopper for the ignition layer, and when that demand is satisfied, the majority of the feed passes into the main feed hopper. The ignition layer passes through a vibrating grizzly which rejects oversized material and returns it to the main feed hopper. The ignition feed is distributed evenly across the width of the machine by shuttle conveyors operated by a hydraulic system and then passes through a gas-fired ignition muffle which is over a downdraft windbox. The main feed layer is next placed on top of the ignition layer and the entire bed flows through the updraft section of the machine, which is 29 m in length and consists of 12 windboxes each 2.44 m long. In the updraft section of the machine, the airflow is reversed so that the heat from the ignition layer flows upward to ignite the main feed layer. The material burns as it travels the length of the machine. The material is cooled as it reaches the end of the machine "so that the cake will not collapse nor will metallic lead run out of the sinter to blind the pallet grate bars" (Rauski and Mauacher, p. 78). The sinter passes into the sinter breaker and then to a spiked roll, where the material is pulverized. Spillage from these pulverizers is passed onto the clean-up conveyors as part of the plant clean-up that is later recharged to the sinter machine. A pan conveyor transfers the hot sinter from the spiked roll to the Ross Classifying Rolls. The coarser sinter is pushed by the Ross Rolls into one of two sinter bins which feed the furnace. A swivel vibrator diverts the sinter into one of the two bins according to the level of material within each. The fine sinter falls through the Ross Rolls into a storage bin and then passes through the cooling drum as return sinter to the sinter machine.

Two small baghouses within the sinter plant handle ventilation air from the conveyors and crushers for the return sinter. The material collected by the baghouses is added directly to the belt carrying the sinter feed. In addition, a wet scrubber system is planned for in-plant ventilation.

Air from the sinter machine passes through a main duct to the water spray chamber and then into the sinter plant baghouse. Ventilation air from the sinter breaker, the spiked roll, the pan conveyor which carries the product sinter to the Ross Rolls, two clean-up conveyors, and the cooling drum, passes through a second, auxiliary duct to the water spray chamber and into the sinter plant baghouse. Ventilation air from the Ross Classifying Rolls and swivel vibrator (transfer of sinter to storage bin) is cleaned by the blast furnace control system.

2. Blast furnace: ASARCO has an Australian step jacket design blast furnace, with a nominal capacity of 300 tons of lead boullion per day. The furnace proper is 7.6 m long, 1.5 m wide at the lower tuyeres and 3.0 m wide at the upper tuyeres. A blower can provide up to 510 cu m of air per minute at 0.26 kg/sq cm to the furnace. This air is distributed between the lower and upper tuyeres by a proportioning controller. The lower section of the furnace, where the tuyeres are located, is tapered (see Figure 9). The top of the furnace, where charging takes place and effluent gases are ducted to the control system, is of a typical thimble top design.



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Blast Furnace

Figure 9

A large building at ASARCO houses all receiving and storage bins for the sinter machine and blast furnace. The charge materials for the furnace, consisting of coarse sinter, iron, coke, caustic skims, etc., are stored in a row of bins. The charge materials are automatically weighed as they pass through feed hoppers into a charge car. The charge car is positioned on a transfer car and moved along a track which runs past the row of feed hoppers to the side of the furnace. An automated gantry crane lifts the charge car from the transfer car and elevates it to the top of the furnace where the contents are dumped through the bottom of the car. According to the management, the charge to the furnace was a constant mixture of feed materials during the course of the test program. Charging usually takes place 17-18 times per shift.

A Roy tapper is situated at the front of the furnace, where a continuous stream of molten material flows from a 5-ft long slit in the furnace into a box-shaped settler. As the material cools in the settler, the lead settles to the bottom and the slag accumulates at the top. The lead is tapped continuously into 20 T ladles. The slag is tapped continuously into a slag granulator where two jets of water break the slag into small granules of material. The water forces the slag from the granulator underground to an elevator. The elevator transports the slag up to a pair of wooden silos for dewatering. From there the slag with a relatively high lead content (3.2 Pb - June) is transferred by conveyor to the sinter machine and the slag with a low lead content is transported by truck to a dumping area. A second slag tap is occasionally used, if a customer specifies a need. The second slag tap, similarly to the lead tap, consists of a continuous flow of material directly from the settler into large ladles to form solid slag blocks. Ventilation gases from the front of the furnace, including the Roy tapper, the two slag taps, and the lead tap, are handled by one fan, and pass through the blast furnace water spray chamber and baghouse. Ventilation air from the slag granulator is handled by a separate fan, but is also ducted through the blast furnace control system.

When a 20 T lead ladle has been filled, the lead tap is plugged, the hooding over the ladle is lifted, and the ladle is transferred by a 27-ton crane to one of two dross kettles. The lead ladle is partially covered by a lid to minimize fuming during tapping, during transfer of the lead ladle to the dross kettle, and during pouring of the molten lead into the dross kettle.

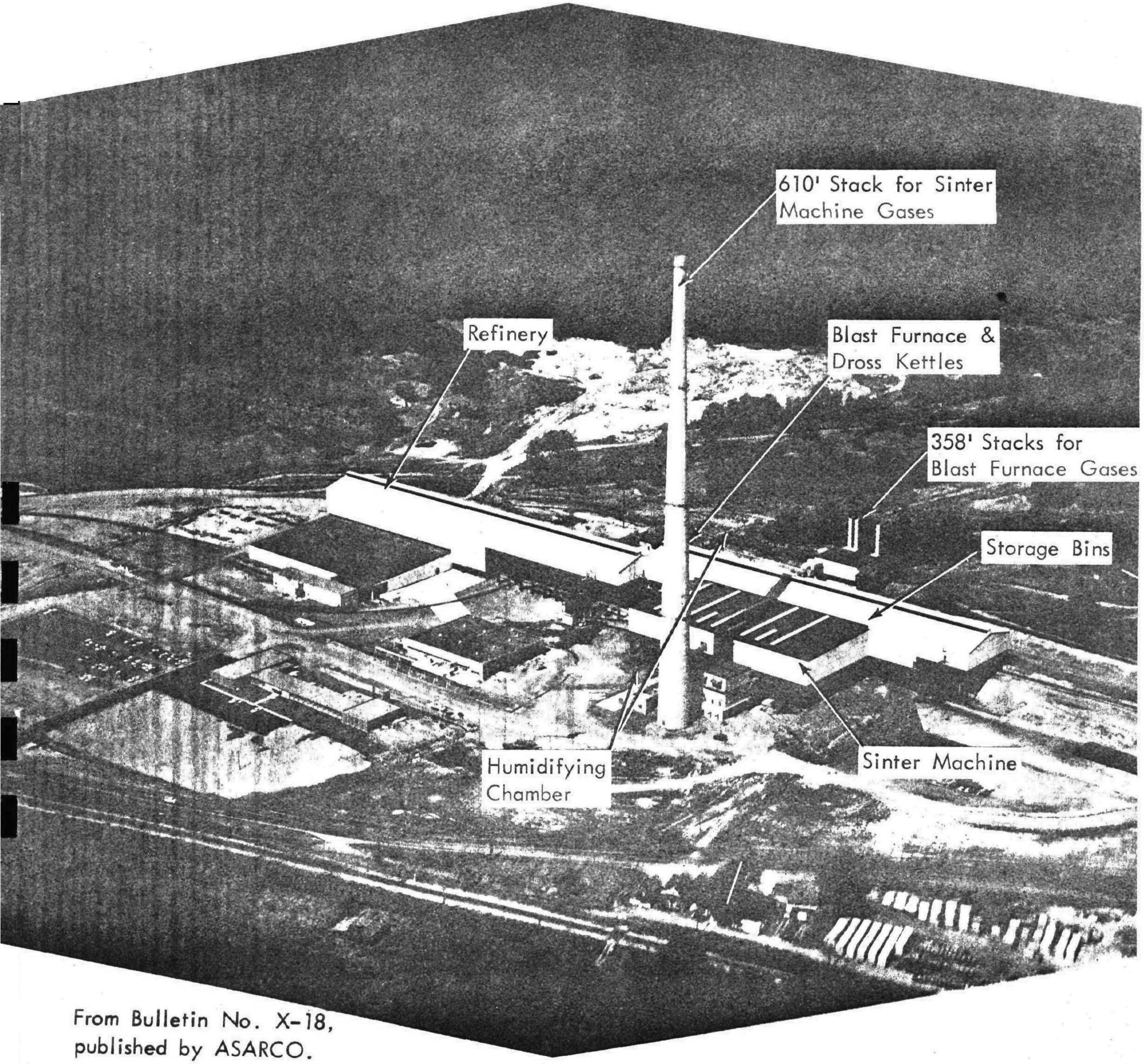
A dome-shaped hood is used to cover the dross kettles for ventilation only during pouring of the molten lead into the dross kettles. This ventilation air passes through the blast furnace control system.

There are two dross kettles, one with a capacity of 300 tons and the other with a capacity of 250 tons. The lead is poured into one of two kettles which is maintained at 540°C. The copper solidifies and floats to the top where it is drossed off. The lead which remains is transferred to a second dross kettle which is maintained at a temperature of approximately 425°C. The copper dross from the second kettle and some drosses from the refinery are transferred back to the first kettle to reclaim lead that may be mixed in the copper dross. In several of the lead smelters, the copper dross is treated in a reverberatory furnace to make copper matte, but at ASARCO in Glover the copper dross is transferred by rail to a separate facility for treatment. The lead from the dross kettles is transferred by crane to the refinery.

3. Refinery system: Figure 10 is an aerial photo of the smelter which shows the baghouses and the exhaust stacks as well as the general outline of the buildings, along with the humidifying chambers. The humidifiers and baghouses are the control systems. ASARCO operates a refinery at the Glover plant which removes impurities from the lead bullion and casts the metal into 100-lb pigs or 1-ton blocks for shipment. The refinery was surveyed during the course of the testing, but no emission tests were conducted at this facility.

The lead concentrate at the Glover plant contains a high percentage of lead and minimal impurities compared with the two other ASARCO plants. The lead bullion passes through a series of four kettles for decopperizing, desilverizing, and dezincing and then to a fifth kettle for refining with caustic soda and sodium nitrate before it is cast into pigs or blocks.

No visible emissions were observed within the plant. None of the refinery kettles are vented to the outside. The only two operations vented to the outside are combustion air from heating of the kettles and air from the baghouse used to collect zinc produced in a zinc-silver separating retort.



From Bulletin No. X-18, published by ASARCO.

Aerial View

Figure 10

B. Control Systems

1. Sinter machine water spray chamber and baghouse: Effluent gases from the sinter machine, two clean-up conveyors, sinter breaker, spiked roll, pan conveyor, and the cooling drum are vented through a water spray chamber and a baghouse containing microtan synthetic bags which are resistant to the high temperature of the sintering machine exhaust. The inlet to the water spray chamber from the sinter machine is 450°-500°C. The inlet to the water spray chamber from the discharge system is 150°C.

The sinter plant baghouse was designed by ASARCO and is an enclosed concrete structure of the compartmented, pressure type with a design efficiency of 99.8%. The bags are 12-1/2 in. diameter by 20 ft long with 204 per compartment and the bags had an average age of 9 months during our test. The baghouse is inspected daily to insure proper maintenance of the bags.

In the sinter machine control system for the purpose of cooling, an undetermined quantity of air is introduced through a vent located between the water spray chamber and baghouse. The nine compartment baghouse (total cloth area 129,000 sq ft) has an inlet gas rate of 232,000 ACFM at 204°F (air-to-cloth ratio of 1.8 or 2.0 ACFM per sq ft with one compartment being cleaned). Gases from the baghouse are vented through a 12 in. thick, 610 ft tall concrete stack of 20 ft diameter. The stack has four temperature monitors which in conjunction with a ground level ambient air SO_2 monitor, are used to regulate the smelter production rate based upon weather conditions to prevent an excess ground level concentration of SO_2. There is a sampling house on the ductwork between the baghouse and stack which has an "Askania" sampler. This bag sampler collects a continuous isokinetic sample at one point for a 3-4 day period after which the collected material is weighed.

The water used in the spray chamber is recycled continuously. The baghouse dust is burned to prevent ignition and to compact the dust. Both the water spray chamber and the baghouse are cleaned out every 3 weeks, and the collected material is recycled through the sinter machine. A grab sample from each of these systems is analyzed for lead at this time.

The baghouse compartments shake consecutively once the pressure has reached a specified point. Each compartment shakes for approximately 33 sec; a complete baghouse shake continues for 6 min 40 sec.

From 1 January 1973 through 16 July 1973 the sinter machine water spray chamber has collected on the average 19 tons of particulate per day (54.2% Pb) and the sinter machine baghouse has collected on the average 33.5 tons of particulate per day (59.7% Pb). These figures are based on measurements made when the control system is cleaned (approximately every 3 weeks).

2. Blast furnace water spray chamber and baghouse: Effluent gases from the blast furnace, swivel vibrator (transfer of sinter to storage bins), Ross Classifying Rolls, dross kettles, Roy Tapper, slag granulator, lead tap, slag taps and feed hopper drop points are cooled in a water spray chamber before going to the baghouse.

The blast furnace baghouse was designed by ASARCO and is an enclosed concrete structure of the compartmented, pressure type with a design efficiency of 99.8%. The blast furnace baghouse contains wool bags which are less flammable than synthetic bags. The bags are 12-1/2 in. diameter by 20 ft with 204 in each of six compartments and the average age of the bags was 8.2 months. The baghouse is inspected daily to insure proper maintenance of the bags. The six compartment baghouse (total cloth area 77,000 sq ft) has an inlet gas rate of 131,000 ACFM at 137°F (air-to-cloth ratio of 1.7 or 2.0 ACFM per sq ft with one compartment being cleaned). Gases from the baghouse are vented through three 58-ft stacks, each handling gases from two compartments.

An undetermined quantity of air is introduced through a vent between the water spray chamber and baghouse for cooling purposes. In the blast furnace control system, lime is also added between the water spray chamber and the baghouse to aid in collection efficiency and to retard ignition of collected dust.

The bags in each compartment are mechanically vibrated for cleaning. A damper is closed to prevent flow while vibrating and left closed for about 20 sec after vibration to allow particulate settling. Compartments are cleaned on a rotation basis when the pressure drop across the baghouse exceeds 3 in. of water. If cleaning one compartment fails to lower the pressure drop enough to satisfy the present value, the next compartment is cleaned. During the testing program, it was observed that two compartments were generally cleaned at one time.

The collected dust from the blast furnace operation usually contains a high percentage of lead and appreciable quantities of cadmium and arsenic. From 1 January 1973 through 16 July 1973, the blast furnace water spray chamber has collected on the average 10.8 tons of particulate per day (56.0% Pb), and the blast furnace baghouse has collected on the average 30 tons of particulate per day (56.0% Pb). These figures are based on measurements made when the control system chambers are cleaned out (approximately every 1-1/2 to 2 weeks).

C. Sampling Conditions

1. Sinter machine: An isokinetic sample could not be obtained with the EPA train at the outlet of the sinter machine baghouse. There is no port in the stack, and the breeching between the baghouse and the stack is not enough duct diameters long for isokinetic sampling. Outlet measurements are therefore based on results from the Askania sampler which is operated continuously by the plant. Three inlet tests were conducted upstream from the water spray chamber, thus providing information on uncontrolled emissions from the sinter machine and from auxiliary operations (crushers, conveyors, cooling drum, etc.) associated with the sinter machine. A particulate sizing test on the two inlet ducts was planned but was not completed due to sampling problems. The Askania sampler, which consists of a bag filter, collects an isokinetic sample from the single point of average velocity. For the purposes of this test, a pre-weighed clean bag was inserted in the sampler at 8:30 a.m. on 20 July and removed 23 July at 4:00 p.m.

Historically the lead companies have installed the pollution control equipment (water spray chamber and baghouse) as material recovery systems, part of their production equipment. Recovery of lead, not pollution control, was the primary reason for the installation of the baghouse. In order to more nearly complete their material balance calculations, which are made on a yearly basis, ASARCO decided that they should make an attempt to sample the outlet of the baghouse and analyze for lead. Realizing that the recognized isokinetic sampling equipment would not work, they set out to design a fixed sampler to approximate an isokinetic sampler. They installed a couple of ports in the breeching and conducted a pitot temperature traverse to determine the point of average velocity. Calculations determined the orifice size and pumping rate for drawing a proportional sample from the breeching. The sample system consists of a fixed stainless orifice with a stainless heated delivery line to a heated chamber in which a bag filter (same material as the bags in the baghouse but much tighter weave) is installed to trap the samples, and a vacuum pump calibrated to deliver fixed volume of gas from the breeching. The temperature pressure and gas flow are measured. At the end of a specified period, generally during a scheduled shutdown of the sinter machine, the bag is removed, weighed and placed on a pan in an oven for drying. After drying, the bag and pan are removed and reweighed to obtain a sample weight. This sample is then analyzed by ASARCO for lead content to determine lead losses to the atmosphere.

During the first test, the sinter machine was off during 9 min at the beginning of the test. During four of those minutes a main feed hopper was being emptied. Emissions from the main feed hopper are ventilated through the blast furnace control system, so that no operation ventilated to the sinter machine was functioning during the 9-min shutdown. The sinter machine duct was not sampled within ± 10% of 100% isokinetic during the first run and was repeated at a later date; therefore, only the auxiliary duct measurement was affected by the sinter machine shutdown.

2. Fugitive emissions: Occasionally, fugitive emissions within the one-sided sinter machine building were observed to be fairly high. In particular, the cooling drum at some times was a source of in-plant emissions. One scrubber has been installed by the plant in the sinter machine building as a trial unit to collect fugitive dusts for the purpose of industrial hygiene. A complete scrubber system is planned to control in-plant dust. The dust released by the cooling drum has a high moisture content which would clog a baghouse, thus necessitating wet scrubber control.

3. Blast furnace: Measurements at the inlet and the outlet of the blast furnace control system were made simultaneously. The inlet test was made upstream from the water spray chamber, and the outlet test was made on all three stacks simultaneously. A lime sample was collected at the point where lime is introduced into the gas stream between the water spray chamber and baghouse to ascertain the total particulate loading to the baghouse. The lime sample was obtained by catching a sample from the

lime feeder for 1 min. The sample was weighed and lime addition rate calculated on this data. Particle sizing was planned on both the inlet and the outlet, but due to sampling problems at the inlet, only the outlet was tested for particle size.

Dynamiting of the blast furnace was a common occurrence during the course of testing. The purpose of dynamiting is to decrease the possibility of a furnace blow, when emissions would seemingly be highest. A blow occurs when the material which has built up on the sides of the furnace, forming a chimney within the furnace collapses. When a chimney forms within the furnace, the air moves directly through the furnace without maximum contact with the furnace material.

During the first test at the blast furnace (19 July 1973), the sinter machine was not operating. Therefore, ventilation air from the Ross Classifying Rolls and Swivel Vibrator was being ducted through the blast furnace baghouse. According to plant personnel, these two operations may be expected to contribute a low gas volume, but a relatively large amount of dust to the blast furnace control system. During the second test, one baghouse compartment was closed down.

During the third test at the blast furnace (23 July 1973), the baghouse compartments were manually shaken six times. Review of the control room charts indicated that the bags which usually shake when the pressure has reached 3 in. of water, had shaken on the average of 70 times/day (2.8 times per hour) between 15 June and 15 July. The maximum number of bag shakes was 111 times-day and 4 or 5 shakes an hour was not uncommon. From our arrival on 16 July through 22 July, the bags shook on the average of only 33.7 times per day (1.4 times per hour). During Runs No. 1 and 2, the bag shakes occurred very infrequently during the actual test time. The infrequent shaking of the bags is assumed to be related to the frequent dynamiting of the furnace. When material adheres to the sides of the furnace, the air moving through the furnace has less contact with it and the emissions would seemingly be less. Because the highest visible emissions to the atmosphere have been observed to follow baghouse shakes, it was decided to manually shake the bags in order to compare the emissions with the first and second tests when the bags were shaken infrequently. The manual shaking of the bags was continued during the particle sizing test.

4. Fugitive emissions: Fugitive emissions from several operations associated with the blast furnace--dross kettles, ray tapper, slag granulator, lead tap, slag taps, and feed hopper drop points--are reduced by hooding and ventilation to the blast furnace control system. The lead tap, particularly at windy times when the lead tap was heavy, produced some fugitive emissions. At the slag tap, the hooding is not in direct contact with the receiving chamber, and did not appear to be adequate for complete collection of fumes. According to plant personnel, problems with the slag granulator fan contributed to the fuming at the slag tap. The ladles which receive the lead at the lead tap are partially covered to minimize fugitive emissions. Occasionally fuming occurs, especially when there is spillage during the transfer of lead bullion from the furnace to the dross kettles.

V. SAMPLING AND ANALYTICAL PROCEDURES

This section of the report discusses the physical layout of the sampling locations and sampling points at each location. The sampling procedures used to collect particulate samples at the smelter are presented herein. The analytical procedures are also discussed.

A. Location of Sampling Ports and Points

For the sinter plant the two sampling locations are shown in Figure 11. In the 3-ft duct which vents the operations associated with sintering, the sample ports were 25 ft, 8-1/3 pipe diameters, downstream from the elbow, and 10 ft, 3-1/3 pipe diameters, upstream from a disturbance. There were two ports 90 degrees apart in the duct. Due to the physical layout one port was located at 30 degrees from the vertical axis and the other 30 degrees below the horizontal.

The single port in the 7-ft duct was located 56 ft, 8 pipe diameters, downstream from the nearest flow obstruction, but only 7 ft, 1 pipe diameter, from the nearest upstream obstruction, a 45-degree elbow. This port was located at the center line of the duct. The port was at 90 degrees to the duct. The duct came from the fourth floor of the sinter plant to the roof of the single-story humidifying chamber at 45 degrees.

The location of the sample points in each duct is shown in Table XIX. There were 16 points in Duct B and each point was sampled twice for a total of 32 sample points per test. There were six points in each port of Duct C.

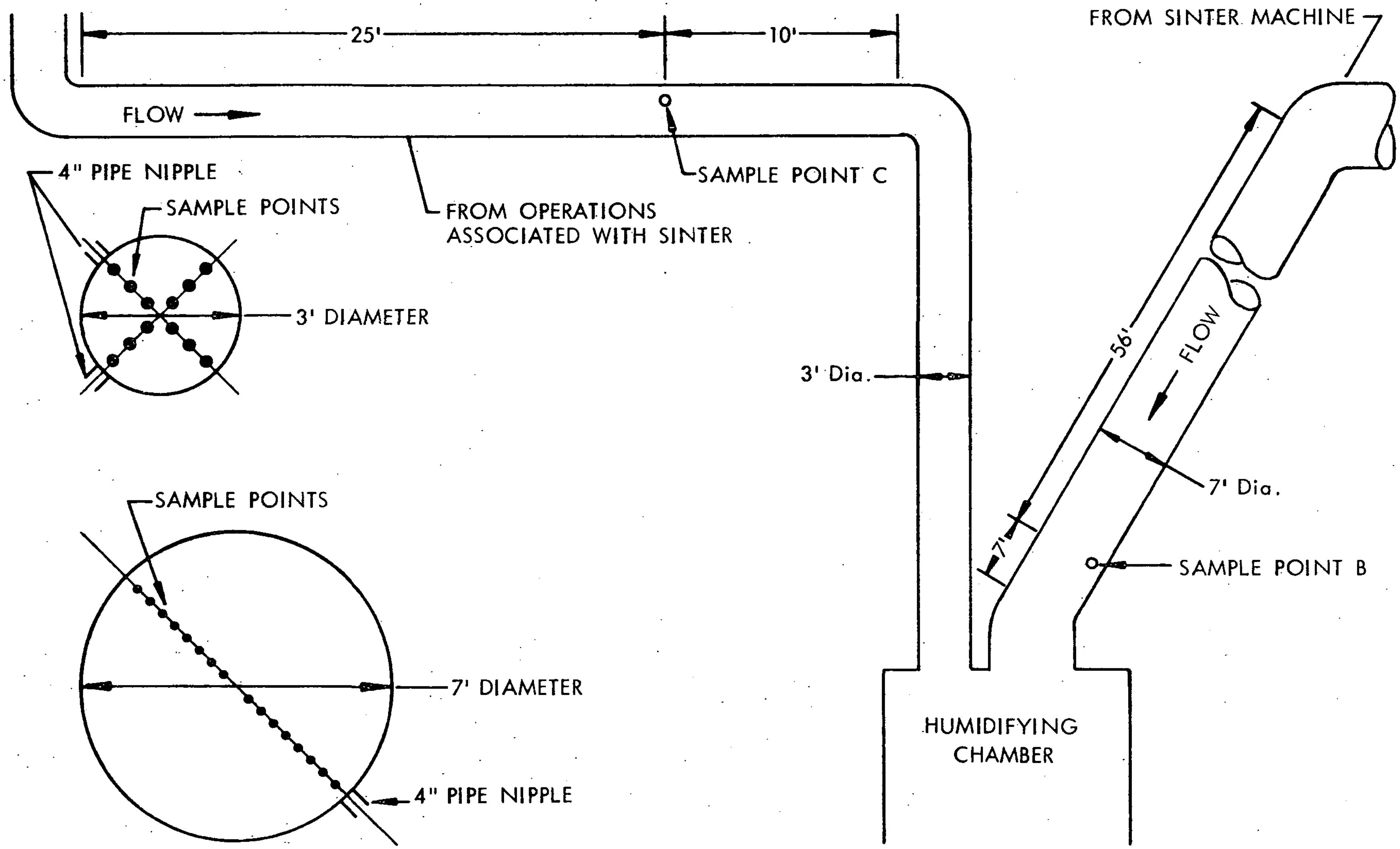


Figure 11 - Sample Ports in Sinter Plant Ducts

TABLE XIX

SAMPLING POINTS D AND C LOCATIONS
SINTER DUCTS

Port	Point No.	Duct Diameter (in.)	%	Location in Duct (in.)	Outside Port to Inside Duct (in.)	Use (in.)
Duct I/B	1	89-9/16	1.6	1-1/2	3-1/4	4-3/4
	2	89-9/16	4.9	4-3/8	3-1/4	7-5/8
	3	89-9/16	8.5	7-5/8	3-1/4	10-7/8
	4	89-9/16	12.5	11-1/4	3-1/4	14-1/2
	5	89-9/16	16.9	15-1/8	3-1/4	18-3/8
	6	89-9/16	22.0	17-7/8	3-1/4	21-1/8
	7	89-9/16	28.3	25-3/8	3-1/4	28-5/8
	8	89-9/16	37.5	32-3/4	3-1/4	36
	9	89-9/16	62.5	56-13/16	3-1/4	60-1/16
	10	89-9/16	71.7	64-3/16	3-1/4	67-7/16
	11	89-9/16	78.0	71-11/16	3-1/4	74-15/16
	12	89-9/16	83.1	74-7/16	3-1/4	77-11/16
	13	89-9/16	87.5	78-5/16	3-1/4	81-9/16
	14	89-9/16	91.5	81-15/16	3-1/4	85-3/16
	15	89-9/16	95.1	85-3/16	3-1/4	88-7/16
	16	89-9/16	98.4	88-1/16	3-1/4	91-5/16
Duct U/C	1	39-5/8	4.4	1-3/4	3-1/8	4-7/8
	2	39-5/8	14.7	5-7/8	3-1/8	9
	3	39-5/8	29.5	11-5/8	3-1/8	14-3/4
	4	39-5/8	70.5	28	3-1/8	31-1/8
	5	39-5/8	85.3	33-3/4	3-1/8	36-7/8
	6	39-5/8	95.6	37-7/8	3-1/8	41
Duct L/C	Same as upper port					

The sample location in the 7-ft duct from the blast furnace is shown in Figure 12. The ports were located at 45 degrees with the horizontal, one on the north axis and the other on the south. The ports were 60 ft, 8.57 pipe diameters, from the upstream 90-degree elbow and 15 ft, 2.14 pipe diameters, from the downstream 90-degree elbow. The sample point dimensions, six in each port, are in Table XX.

Figure 13 shows the configuration of the blast furnace baghouse and stacks E, F and G. Figure 14 shows the location of the ports and sample points in each of the three stacks. The ports were located 36 ft 6 in., 4-1/2 pipe diameters, above the breeching or inlet to the stack and 11 ft 6 in., 1-2/3 pipe diameters, from the outlet to the atmosphere. The sampling point calculations yielded a value of 32 sampling points, eight per port.

B. Sampling Procedures

An RAC* Model 2343 Staksampler train was used to sample for particulates. Glass-lined probes were used for all sampling. The procedures used are those in the Federal Register, 36, 159, 17 August 1971. There were two exceptions: (1) the exhaust duct from the sinter baghouse was sampled using the ASARCO's permanent continuous sampler called Askania; this sampler is supposedly an isokinetic sampler; and (2) as it was not possible to install and use two 90-degree ports in Duct B, one port was used and each of the 16 points was sampled twice.

* Mention of a specific company does not constitute endorsement by EPA.

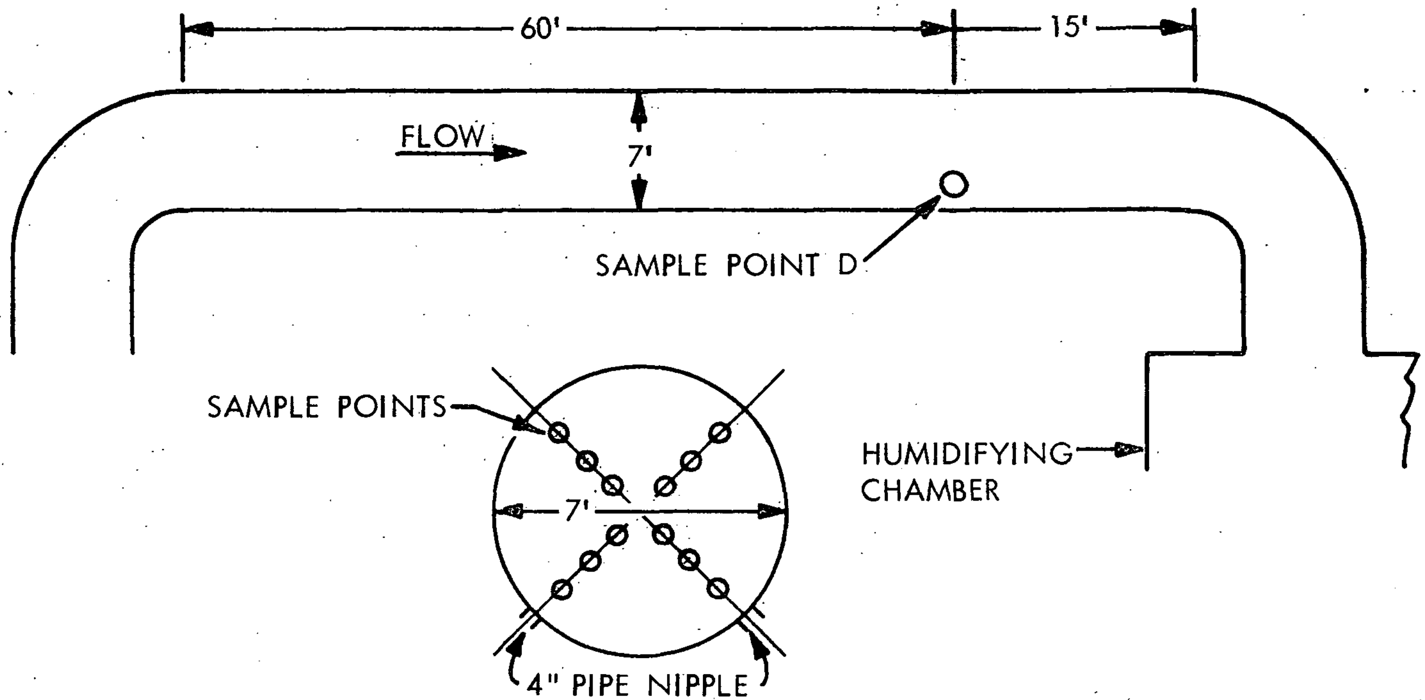


Figure 12 - Sample Ports in Blast Furnace Exhaust Duct

TABLE XX

SAMPLING POINTS IN BLAST FURNACE DUCT SAMPLING LOCATION D

Port	Point No.	Duct Diameter (in.)	%	Location in Duct (in.)	Outside Port to Inside Wall (in.)	Use (in.)
Duct N/D	1	83-3/4	4.4	3-5/8	3-1/4	6-7/8
	2	83-3/4	14.7	12-1/4	3-1/4	15-1/2
	3	83-3/4	29.5	24-5/8	3-1/4	27-7/8
	4	83-3/4	70.5	59-1/8	3-1/4	62-3/8
	5	83-3/4	85.3	71-1/2	3-1/4	74-3/4
	6	83-3/4	95.6	80-1/8	3-1/4	83-3/8
Duct S/D	Same as North Port					

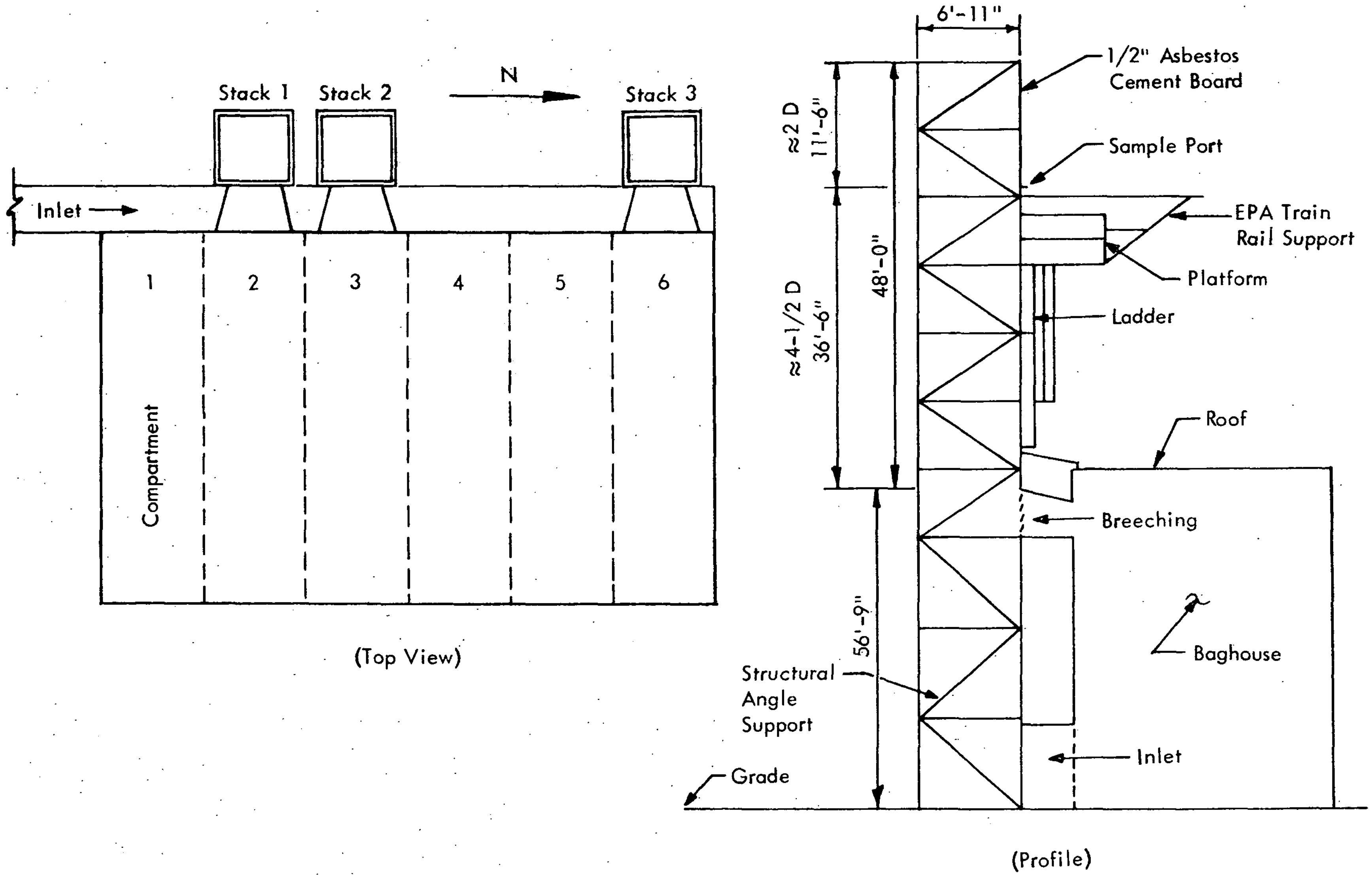
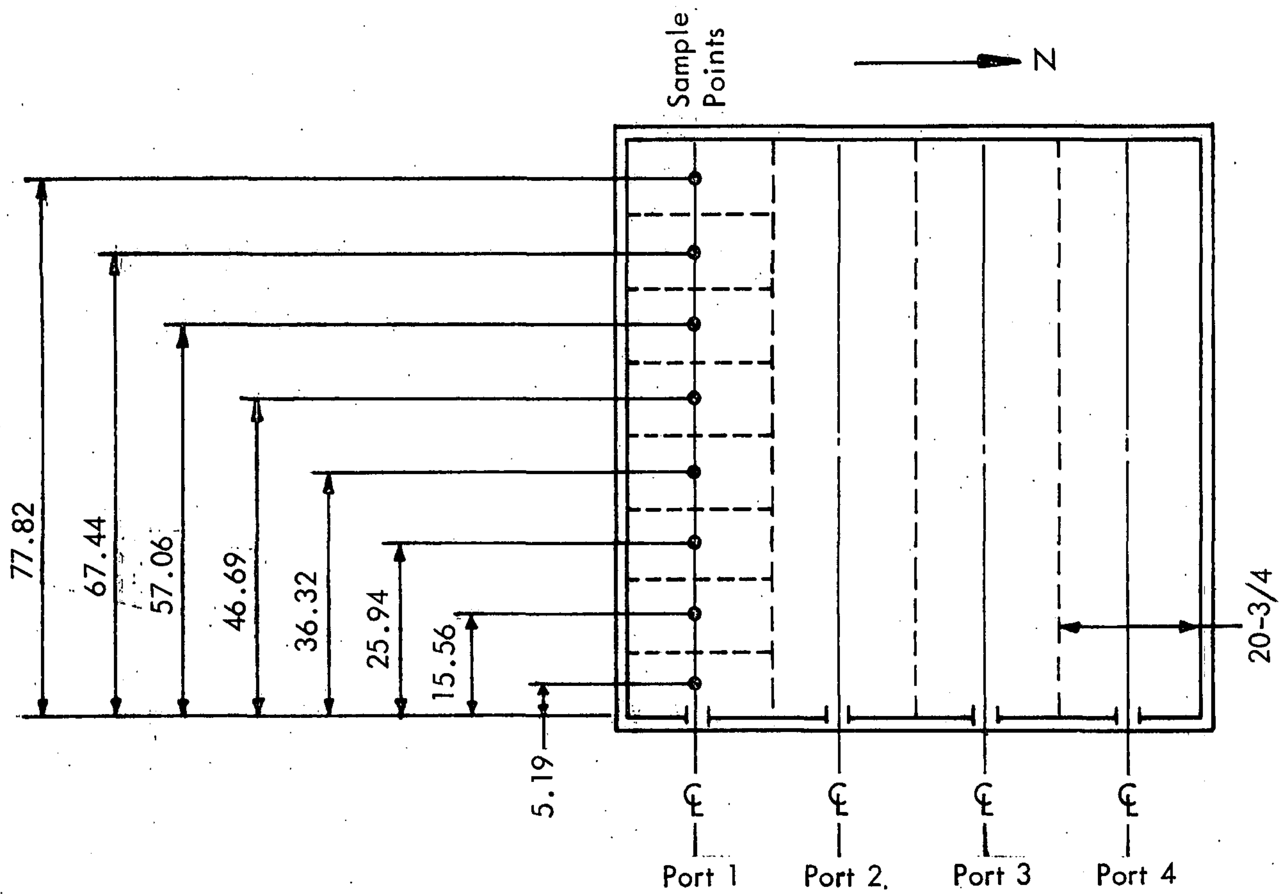
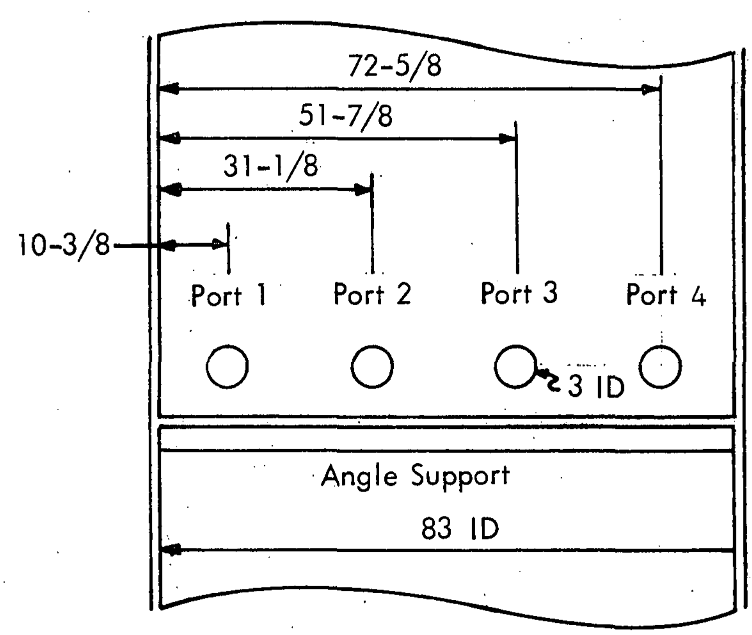


Figure 13 - Blast Furnace Baghouse and Stack(s) Configuration





(All Dimensions--Inches)

Figure 14 - Sample Port-Point Configuration

Ducts B and C were sampled simultaneously for 2 hr. The points in Duct C were sampled for 10 min with readings every 5 min, a total of 2 hr. The 16 points in Duct B were sampled for 4 min with a total time of 64 min per traverse or 2 hr 8 min total sampling. When sampling was discontinued on Duct C to change ports, the sampling on Duct B was continued for 4 min and then discontinued until sampling was started again on Duct C.

At the blast furnace all particulate sampling was conducted simultaneously for a minimum of 2 hr. The 7-ft duct (12 points) was sampled for 10 min on a point (total of 2 hr) with readings taken every 5 min. Sampling on the exhaust stacks was 4 min per point, 32 points for a total of 2 hr 8 min. When the crews on the exhaust stacks stopped to change ports the crew on the duct also stopped until all four crews were ready to go.

The Andersen* particle size sampling was conducted at Stack F Port 3 Point 3 using the RAC* Staksampler equipment with a 3-ft glass lined probe and an Andersen* sampler.

The Orsat samples were taken by using a stainless steel probe which contained a glass wool filter. The probe was inserted to Point 3 of each stack and samples were pumped directly into the Orsat analyzer for 5 min to purge the probe, line and Orsat. Three analyses were made for each test, and each analysis lasted 5 min. Ducts B, C and D were sampled

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* Mention of a company name or product does not constitute endorsement by EPA.

and analyzed for each test. Stacks E, F and G were analyzed for Test 3. On Tests 4 and 7 only G was analyzed. The results of the Orsat analyses for Test 3 showed that the three stacks had the same composition within the accuracy of the method.

A Dräger tube was used to obtain approximate analysis of the SO_2 in the gases from the sinter exhaust ducts and the blast furnace exhaust duct. A stainless steel probe with a glass wool filter was inserted into the stack to Point 3 and a sample withdrawn into the tube using an MSA* hand pump. This was done for each test.

Lime is added to the particulate from the blast furnace in the duct between the water spray chamber and the baghouse. Each day that particulate sampling was conducted around the pollution control system for the baghouse, a lime sample was taken for the purpose of determining the lime addition rate. The sample was taken from the vibratory feeder for a period of 1 min. The lime was weighed and the lime addition rate of 44.7 lb/hr was determined from the weight of lime collected in 1 min.

C. Analytical Procedures

The particulate analysis was accomplished using the procedures in the Federal Register, 36 (159), 15,715-15,716, 17 August 1971.

After the samples were analyzed for particulates, the solid residue was digested in 10 ml of boiling aqua regia for 1 hr with reflux.

* Mention of a company name or product does not constitute endorsement by EPA.

The liquid was cooled, diluted to 50 ml and analyzed for lead on the atomic absorption spectrophotometer.

The Andersen particle analysis on the plates was done in the field. Then each plate was carefully washed with acetone into a sample container. The probe wash and filter were treated as particulate samples and returned to the MRI laboratories for particulate and lead analysis. The acetone was evaporated from each of the particulate samples and then they were analyzed for lead content using the procedure described above.

Orsat and SO_2 (approximate) analyses were conducted in the field as described in Section V-B.

The large filter used to collect particulate samples from the inlet ducts to the sinter and blast furnace control system had enough particulate that it was not necessary to digest the filters for lead analysis. A weighed sample of the particulate from the large filters was digested for lead analysis. The small filters used in the baghouse exhaust stacks were digested along with the particulate for lead analysis.

All particulate and lead blanks have been subtracted from the values before they were reported.