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EPA-76-BAT-4

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REPORT NO. 76-BAT-4

STORAGE BATTERY
PRODUCTION
AP-42 Section 7.15
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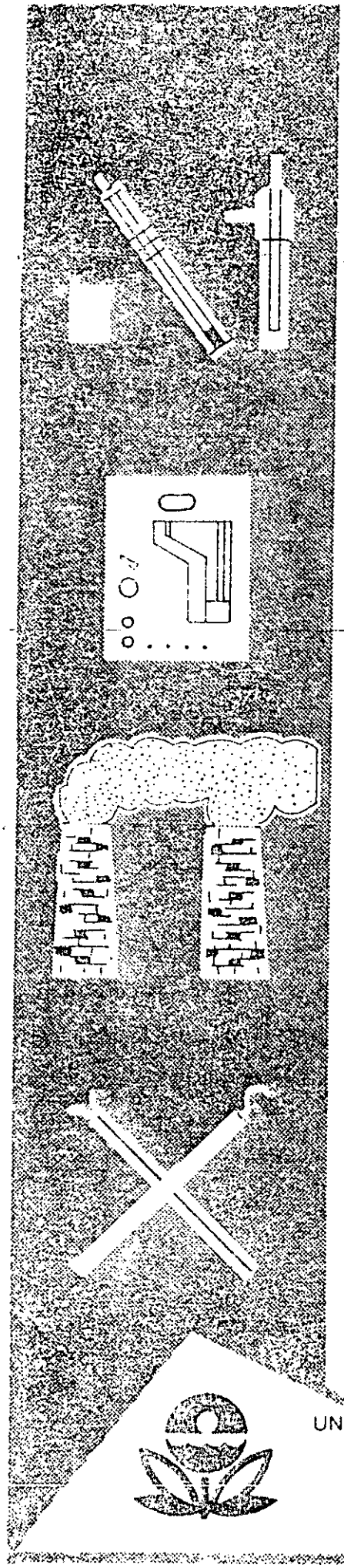
3



AIR POLLUTION EMISSION TEST

GLOBE UNION, INC.
CANBY, OREGON

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Emission Measurement Branch
Research Triangle Park, North Carolina

SOURCE TESTING OF A LEAD ACID BATTERY MANUFACTURING PLANT

Globe Union, Inc.
Canby, Oregon

Test No. 76-BAT-4

Test Conducted by

U.S. Environmental Protection Agency
Emission Measurement Branch
Research Triangle Park, North Carolina 27711

Report Prepared by

Robert M. Martin
Environmental Protection Specialist
Emission Measurement Branch
Research Triangle Park, North Carolina 27711

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INTRODUCTION

The purpose of this test was to obtain data in support of new source performance standards for lead acid battery manufacturing plants. Three control devices were tested at both inlet and outlets. These devices controlled a variety of processes and a detailed discussion can be found in the process description section of this report. Inlet sampling was performed according to Method 5 with the modification of using .1 normal nitric acid in the impingers in order to collect any lead passing through the filter. Outlet sampling was conducted using a simultaneous dual sampling system. One of these was the same as that used on the inlet. The other differed in the placing of the filter behind two impingers. These trains also contained .1 nitric acid. The purpose of the dual sampling train was to establish whether there was any lead entrapment occurring in the glass frit of the standard Method 5 train. Details of this method are discussed in the analytical section of this report.

A total of 45 samples was collected with the positive loss of only one as a result of sampling error and one through apparent contamination. Mass analysis could not be performed because of the use of nitric acid which would possibly react with lead, creating compounds which would cause erroneous weight results.

The lead analysis was performed by Monsanto Research at Dayton, Ohio, using atomic absorption analysis as prescribed in Method 22. Details can be found in the analytical procedure section of this report.

This test was the first conducted using the draft method and is the basis for Method 22 evaluation.

Particle sizing was conducted at all locations and trace metals analysis was conducted at all outlet locations.

Due to the cyclic operation of the various processes, transversing was not always in accordance with Method 1.

Visible emission evaluations were also conducted at various times during the testing program.

SUMMARY AND DISCUSSION OF RESULTS

Please refer to Table 1 showing the results of the 45 sampling runs. Only two of the runs are obviously void. Run 5B2 apparently was contaminated but no explantation of where or how this occurred can be found. Run 14B2 is void because of sampling error. The probe was not connected during the first 20 minutes (one-third of the test). This is reflected in the data as the results are about one-third lower than 14B1. Even though this correlation can be made, 14B2 must be voided as invalid data.

INLET DATA

The inlet data appears to be quite erratic. This is probably due to the fact that most of the operation is manual, consequently much variation can be expected due to personnel changes, inconsistent work habits, or accidental spillages of lead oxide, etc. Points C and F are almost totally manual and also exhibit the above mentioned inconsistencies. Only the grid casting operation going to point AX can be considered semi-automatic with a minimum of manual operation and these data are somewhat consistent. Point A also reflects this pattern for those times when only grid casting cycles were being sampled.

OUTLET DATA

As can be seen on Table 1, the outlet data is relatively consistent considering the quite low concentrations encountered. As mentioned above, two of the outlet tests are void. To further substantiate the validity of the outlet testing,comparison of data from points B and G should be noted. Data from Point B is consistently lower than that from Point G and it was

suspected that there was a problem with the baghouse at point G. Also, note that at point G samples number 8 and 11 are noticeably higher and these correspond with the dry portion of the cycle when paste was being dumped and vented to the baghouse.

PARTICLE SIZING

Particle sizing tests were conducted at all points by Monsanto Research Company. A summary of these results can be found in Tables 21-45.

OPACITY

Opacity observations were made wherever possible during the test. There were never any visible emissions observed from any of the three sources during the week of testing.

TRACE METALS

Trace metal samples were collected using an in-stack filter containing a glass fiber filter. The purpose of these samples was to discern if any elements of the hazardous variety existed in the stack effluent. This analsis was of a qualitative nature to determine if future tests or standards should consider any parameters other than lead emissions. Data from this and two other plants verify that no other hazardous pollutants are identified as constituents of battery manufacturing emissions.

Table I. SUMMARY OF LEAD EMISSIONS

Run	DSCF	µg FH	µg Filter	µg BH	µg Total	a µg/DSCF	b gr/DSCF	c mg/NM^3	Comments
1C	61.29	.82	453	936	1389.8	1133.8	.01746	40.039	
2C	58.15	1181	577.5	4.41	1762.9	1515.8	.02334	53.529	
3C	59.67	2.8	48.1	31.6	82.5	69.1	.00106	2.440	
4A	32.27	440	1.54	25.16	466.7	723.1	.01114	25.536	
5A	37.94	27.9	3.66	2.94	34.5	45.5	.00070	1.607	
6AX	37.81	15.63	3.35	.61	19.6	25.9	.00039	0.915	
7AX	35.82	15.63	3.85	.81	20.3	28.3	.00044	0.999	
8F	26.74	1116	597.8	38.7	1752.5	3276.9	.05046	115.720	
9F	25.20	718.5	202.5	31.1	952.1	1889.1	.02909	6.678	
10F	27.88	499.3	164.6	18.34	682.2	1223.5	.01884	43.207	
11F	19.02	82.2	203.76	77.4	363.4	955.3	.01471	33.735	
12AX	40.67	121.4	Broken	14.72	136.1	167.3	.00256	5.908	
13AX	45.02	63.5	2.6	5.66	71.8	79.7	.00123	2.815	
14A	31.09	48.3	4.24	3.47	56.0	90.1	.00139	3.182	
15A	37.72	46.8	3.81	1.16	51.8	68.7	.00106	2.426	
1D1	67.53	14.57	10.91	.35	25.83	19.12	.00029	0.675	
1D2	67.20	22.96	2.73	--	25.69	19.11	.00029	0.675	
2D1	60.24	23.32	13.48	.35	37.15	30.83	.00047	1.089	
2D2	60.36	31.9	2.97	--	34.87	28.89	.00044	1.020	Full cycle
3D1	68.87	16.56	2.4	.71	19.67	14.28	.00022	0.504	
3D2	68.29	25.36	.52	--	25.88	18.95	.00029	0.669	
4B1	48.92	1.78	4.52	.7	7.00	7.15	.00001	0.252	
4B2	48.25	4.73	2.7	--	7.43	7.70	.00012	0.272	3 Full cycles
5B1	48.23	1.03	3.21	.23	4.47	4.63	.00007	0.164	
*1 5B2	46.43	842	2.19	--	844.19	909.10	.01400	32.104	4 Wet cycles
6B1	28.17	.78	2.27	.73	3.78	6.71	.00010	0.237	
6B2	26.97	2.57	1.37	--	3.94	7.30	.00011	0.258	Dry only
7B1	20.99	.57	.82	1.9	3.29	7.84	.00012	0.277	
7B2	20.12	2.34	.59	--	2.93	7.28	.00011	0.257	1 Full cycle
8G1	35.86	13.48	7.15	.35	20.98	29.25	.00045	1.033	
8G2	35.79	23.51	.25	--	23.76	33.19	.00051	1.172	4 Dry cycles
9G1	38.94	7.47	7.47	.4	15.34	19.70	.00030	0.696	
9G2	38.42	25.15	.16	--	25.31	32.94	.00051	1.163	1 Full cycle
10G1	38.77	5.94	6.58	.59	13.11	16.91	.00026	0.597	
10G2	38.43	20.1	.28	--	20.38	26.52	.00041	0.937	2 Wet cycles
11G1	29.76	15.91	6.67	.41	22.99	38.63	.00059	1.364	
11G2	30.03	22.3	.88	--	23.18	38.59	.00059	1.363	3 Dry cycles
12B1	32.04	1.21	2.7	.76	4.67	7.29	.00011	0.257	
12B2	30.71	3.81	1.95	--	5.76	9.38	.00014	0.331	3 Dry cycles
13B1	43.19	.83	2.11	.77	3.71	4.29	.00007	0.151	
13B2	41.57	2.72	1.96	--	4.68	5.63	.00009	0.199	2 Full cycles
14B1	32.10	1.06	3.91	1.03	6.00	9.35	.00014	0.330	
*2 14B2	30.43	2.64	1.6	--	4.24	6.97	.00011	0.246	2 Wet cycles
15B1	43.56	1.08	3.31	1.08	5.47	6.28	.00010	0.222	
15B2	42.42	2.76	2.74	--	5.50	6.48	.00010	0.229	2 Full cycles

[a] Total µg x 50/DSCF.

[b] µg/DSCF x 0.00001543.

[c] µg/DSCF x 0.035314.

*1. Sample apparently contaminated - void.

*2. Probe not attached during one-third of run - void.

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1C	2C	3C
DATE OF RUN		6 15 76	6 15 76	6 16 76
STACK AREA	FT2	7.070	7.070	7.070
NET TIME OF RUN	MIN	72.0	72.0	72.0
BAROMETRIC PRESSURE	IN.HG	29.89	29.86	29.82
AVG ORIFICE PRES DROP	IN.H2O	3.010	2.680	3.150
VOL DRY GAS-METER COND	DCF	63.07	59.21	60.11
AVG GAS METER TEMP	DEG.F	88.8	82.1	76.1
VOL DRY GAS-STD COND	DSCF	61.29	58.15	59.67
TOTAL H2O COLLECTED	ML	8.9	18.7	17.6
VOL H2O VAPOR-STD COND	SCF	.42	.89	.83
PERCENT MOISTURE BY VOL		.7	1.5	1.4
MOLE FRACTION DRY GAS		.993	.985	.986
PERCENT CO2 BY VOL, DRY		.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0
*PERCENT N2 BY VOL, DRY		100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.92	28.83	28.85
AVG STACK TEMPERATURE	DEG.F	75.0	75.0	73.7
NBR SAMPLING POINTS		1	1	1
STACK PRESSURE, ABSOLUTE	IN.HG	29.86	29.82	29.78
AVG STACK GAS VELOCITY	FPS	81.707	76.434	76.616
STK FLOWRATE, DRY,STD CN	DSCFM	34026.	31525.	31674.
ACTUAL STACK FLOWRATE	ACFM	34660.	32423.	32500.
PERCENT ISOKINETIC		86.2	89.2	90.1

OUTPUT INTERRUPT

*Computed given actual molecular weight rather than percentages. As set up this prints out N_2 as 100 percent.

Table 2

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	4A	5A	14A	15A
DATE OF RUN		6-17-76	6-17/18	6 23 76	6 23 76
STACK AREA	FT2	5.500	5.500	5.500	5.500
NET TIME OF RUN	MIN	60.0	74.0	51.0	64.0
BAROMETRIC PRESSURE	IN.HG	29.93	29.88	30.25	30.22
AVG ORIFICE PRES DROP	IN.H2O	1.040	.970	1.300	1.290
VOL DRY GAS-METER COND	DCF	32.85	38.98	30.90	38.36
AVG GAS METER TEMP	DEG.F	81.0	85.0	74.0	86.0
VOL DRY GAS-STD COND	DSCF	32.27	37.94	31.09	37.72
TOTAL H2O COLLECTED	ML	9.6	11.8	10.3	9.6
VOL H2O VAPOR-STD COND	SCF	.46	.56	.49	.46
PERCENT MOISTURE BY VOL		1.4	1.5	1.5	1.2
MOLE FRACTION DRY GAS		.986	.985	.985	.988
PERCENT CO2 BY VOL, DRY		,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	,0	,0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.85	28.84	28.83	28.87
AVG STACK TEMPERATURE	DEG.F	133.0	131.0	132.0	140.0
NET SAMPLING POINTS		1	1	1	1
STACK PRESSURE, ABSOLUTE	IN.HG	29.58	29.53	29.88	29.85
AVG STACK GAS VELOCITY	FPS	53.428	53.330	58.646	58.660
STK FLOWRATE, DRY,STD CN	DSCFM	15359,	15347,	17032,	16852,
ACTUAL STACK FLOWRATE	ACFM	17631.	17599.	19353.	19358.
PERCENT ISOKINETIC		94.8	90.4	96.9	94.7

OUTPUT INTERRUPT

Table 3

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	AAX	7AX	12AX	13AX
DATE OF RUN		6-18-76	6- 18-76	6 22 76	6 22 76
STACK AREA	FT2	4.400	4.400	4.400	4.400
NET TIME OF RUN	MIN	60.0	60.0	60.0	68.0
BAROMETRIC PRESSURE	IN,HG	29.76	29.76	30.08	30.08
AVG ORIFICE PRES DROP	IN,H2O	1.570	1.410	1.720	1.680
VOL DRY GAS-METER COND	DCF	40.23	38.74	41.81	46.59
AVG GAS METER TEMP	DEG,F	103.0	112.0	90.0	93.5
VOL DRY GAS-STD COND	DSCF	37.81	35.82	40.67	45.02
TOTAL H2O COLLECTED	ML	11.3	9.4	13.9	15.1
VOL H2O VAPOR-STD COND	SCF	.54	.45	.66	.72
PERCENT MOISTURE BY VOL		1.4	1.2	1.6	1.6
MOLE FRACTION DRY GAS		.986	.988	.984	.984
PERCENT CO2 BY VOL, DRY		,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	,0	,0
PERCENT CO BY VOL, DRY		,0	,0	,0	,0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29,00	29,00	29,00	29,00
MOLECULAR WT-STK GAS		28,85	28,86	28,82	28,83
AVG STACK TEMPERATURE	DEG,F	162.0	157.0	150.0	129.0
NET SAMPLING POINTS		1	1	1	1
STACK PRESSURE, ABSOLUTE	IN,HG	29,36	29,36	29,68	29,68
AVG STACK GAS VELOCITY	FPS	67,135	64,144	68,934	66,769
STK FLOWRATE, DRY,STD CN	DSCFM	14609,	14095,	15432,	15484,
ACTUAL STACK FLOWRATE	ACFM	17724,	16934,	18199,	17627,
PERCENT ISOKINETIC		93.4	91.8	95.1	92.6

OUTPUT INTERRUPT

Table 4

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	8F	9F	10F	11F
DATE OF RUN		6 21 76	6 21 76	6-21-76	6 22 76
STACK AREA	FT2	5,940	5,940	5,940	5,940
NET TIME OF RUN	MIN	34.0	36.0	36.0	24.0
BAROMETRIC PRESSURE	IN.HG	29.88	29.89	29.89	30.08
AVG ORIFICE PRES DROP	IN.H2O	2.360	2.210	2.340	2.250
VOL DRY GAS-METER COND	DCF	27.05	26.08	28.97	19.04
AVG GAS METER TEMP	DEG.F	78.4	90.8	93.2	76.4
VOL DRY GAS-STD COND	DSCF	26.74	25.20	27.88	19.02
TOTAL H2O COLLECTED	ML	5.9	7.9	7.1	4.0
VOL H2O VAPOR-STD COND	SCF	.28	.37	.34	.19
PERCENT MOISTURE BY VOL		1.0	1.5	1.2	1.0
MOLE FRACTION DRY GAS		.990	.985	.988	.990
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0
PERCENT I2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.89	28.84	28.87	28.89
AVG STACK TEMP READING	DEG.F	86.7	90.0	91.3	85.0
NBR SAMPLING POINTS		1	1	1	1
STACK PRES DIF, ABSOLUTE	IN.HG	29.28	29.29	29.26	29.47
AVG STACK GAS VELOCITY	FPS	71.930	69.244	72.621	70.135
STK FLOWRATE, DRY,STD CN	DSCFM	24064.	22935.	24038.	23701.
ACTUAL STACK FLOWRATE	ACFM	25636.	24679.	25882.	24996.
PERCENT ISOKINETIC		95.6	89.3	94.2	97.8

OUTPUT INTER INT

Table 5

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	101	102	201	202	301	302
DATE OF RUN		6-15-76	6 15 76	6-15-76	6-15-76	6 16 76	6 16 76
STACK AREA	FT2	9.900	9.900	9.900	9.900	9.900	9.900
NET TIME OF RUN	MIN	72.0	72.0	72.0	72.0	72.0	72.0
BAROMETRIC PRESSURE	IN.HG	29.89	29.89	29.89	29.89	29.85	29.85
AVG ORIFICE PRES DROP	IN.H2O	3.310	3.310	2.650	2.600	3.400	3.400
VOL DRY GAS-METER COND	DCF	70.51	70.73	62.28	61.88	70.44	69.45
AVG GAS METER TEMP	DEG.F	97.2	101.6	90.8	86.1	85.2	82.1
VOL DRY GAS-STD COND	DSCF	67.53	67.20	60.24	60.36	68.87	68.29
TOTAL H2O COLLECTED	ML	15.8	22.6	17.5	14.7	21.5	16.1
VOL H2O VAPOR-STD COND	SCF	.75	1.07	.83	.70	1.02	.76
PERCENT MOISTURE BY VOL		1.1	1.6	1.4	1.1	1.5	1.1
MOLE FRACTION DRY GAS		.989	.984	.986	.989	.985	.989
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.88	28.83	28.85	28.87	28.84	28.88
AVG STACK TEMPERATURE	DEG.F	65.0	65.0	65.0	65.0	65.0	65.0
NET SAMPLING POINTS		1	1	1	1	1	1
STACK PRES DIF, ABSOLUTE	IN.HG	29.90	29.90	29.90	29.90	29.86	29.86
AVG STACK GAS VELOCITY	FPS	48.058	48.101	41.620	41.603	48.050	48.018
STK FLOWRATE, DRY,STD CN	DSCFM	28477.	28366.	24597.	24641.	28330.	28413.
ACTUAL STACK FLOWRATE	ACFM	28546.	28572.	24722.	24712.	28542.	28523.
PERCENT ISOKINETIC		94.2	94.8	98.0	98.0	96.5	96.2

OUTPUT INTERRUPT

Table 6

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	4B1	4B2	5B1	5B2	6B1	6B2	7B1	7B2
DATE OF RUN		6 17 76	6 17 76	6 17 76	6 18 76	6 18 76	6 18 76	6 18 76	6 18 76
STACK AREA	FT2	9.000	9.000	9.000	9.000	9.000	9.000	9.000	9.000
NET TIME OF RUN	MIN	78.0	78.0	76.0	76.0	46.0	46.0	34.0	34.0
BAROMETRIC PRESSURE	IN.HG	29.93	29.93	29.82	29.82	29.76	29.76	29.76	29.76
AVG ORIFICE PRES DROP	IN.H2O	1.530	1.580	1.530	1.530	1.380	1.380	1.430	1.430
VOL DRY GAS-METER COND	DCF	50.59	50.12	49.50	48.39	29.56	28.75	22.19	21.68
AVG GAS METER TEMP	DEG.F	90.2	92.8	84.0	92.4	94.9	103.7	99.0	110.0
VOL DRY GAS-STD COND	DSCF	48.92	48.25	48.23	46.43	28.17	26.97	20.99	20.12
TOTAL H2O COLLECTED	ML	41.0	32.5	33.0	40.5	21.0	18.5	17.0	16.7
VOL H2O VAPOR-STD COND	SCF	1.94	1.54	1.56	1.92	1.00	.88	.81	.79
PERCENT MOISTURE BY VOL		3.8	3.1	3.1	4.0	3.4	3.1	3.7	3.8
MOLE FRACTION DRY GAS		.962	.969	.969	.960	.966	.969	.963	.962
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.58	28.66	28.65	28.56	28.62	28.65	28.59	28.58
AVG STACK TEMPERATURE	DEG.F	86.1	85.6	90.7	90.7	100.0	100.0	102.0	102.0
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	IN.HG	29.94	29.94	29.83	29.83	29.77	29.77	29.97	29.77
AVG STACK GAS VELOCITY	FPS	32,626	32,581	32,009	32,060	32,956	32,939	33,352	33,469
STK FLOWRATE, DRY,STD CN	DSCFM	16453.	16569.	16061.	15949.	16183.	16219.	16380.	16313.
ACTUAL STACK FLOWRATE	ACFM	17618.	17594.	17285.	17312.	17796.	17787.	18010.	18073.
PERCENT ISOKINETIC		99.8	97.0	103.5	100.3	99.1	94.0	98.7	95.0

OUTPUT INTERRUPT

Table 7

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	8G1	8G2	9G1	9G2	10G1	10G2	11G1	11G2
DATE OF RUN		6 21 76	6 21 76	6 21 76	6 21 76	6-21-76	6 21 76	6-22-76	6-22-76
STACK AREA	FT2	9.000	9.000	9.000	9.000	9.000	9.000	9.000	9.000
NET TIME OF RUN	MIN	40.3	40.3	43.5	43.5	45.0	45.0	34.0	34.0
BAROMETRIC PRESSURE	IN.HG	29.87	29.87	29.88	29.88	29.88	29.88	30.08	30.08
AVG ORIFICE PRES DROP	IN.H2O	2.830	2.830	2.980	2.980	2.820	2.820	2.910	2.910
VOL DRY GAS-METER COND	DCF	36.10	36.24	40.04	40.17	40.16	40.46	29.40	29.61
AVG GAS METER TEMP	DEG.F	76.2	79.3	88.1	97.3	92.0	101.0	70.0	79.0
VOL DRY GAS-STD COND	DSCF	35.86	35.79	38.94	38.42	38.77	38.43	29.76	29.03
TOTAL H2O COLLECTED	ML	10.0	8.5	13.0	8.6	12.0	7.9	8.5	6.3
VOL H2O VAPOR-STD COND	SCF	.47	.40	.62	.41	.57	.37	.40	.30
PERCENT MOISTURE BY VOL		1.3	1.1	1.6	1.0	1.4	1.0	1.3	1.0
MOLE FRACTION DRY GAS		.987	.989	.984	.990	.986	.990	.987	.990
PERCENT CO2 BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT CO BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.86	28.88	28.83	28.88	28.84	28.89	28.85	28.89
AVG STACK TEMPERATURE	DEG.F	66.0	66.0	70.0	70.0	70.0	70.0	62.0	62.0
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	IN.HG	29.83	29.83	29.84	29.84	29.84	29.84	30.04	30.04
AVG STACK GAS VELOCITY	FPS	45.102	45.085	46.605	46.560	45.385	45.343	45.199	45.169
STK FLOWRATE, DRY,STD CN	DSCFM	24142.	24180.	24703.	24806.	24084.	24179.	24543.	24614.
ACTUAL STACK FLOWRATE	ACFM	24355.	24346.	25167.	25142.	24508.	24485.	24408.	24391.
PERCENT ISOKINETIC		96.5	96.2	95.0	92.6	93.7	92.5	93.4	93.2

DATA ENTERED

Table 8

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1281	1282	1381	1382	1481	1482	1581	1582
DATE OF RUN		6 22 76	6 22 76	6 22 76	6 22 76	6 23 76	6 23 76	6 23 76	6 23 76
STACK AREA	FT2	9.000	9.000	9.000	9.000	9.000	9.000	9.000	9.000
NET TIME OF RUN	MIN	49.0	49.0	68.0	68.0	50.0	50.0	64.0	64.0
BAROMETRIC PRESSURE	IN.HG	30.13	30.13	29.08	29.08	30.24	30.24	30.22	30.22
AVG ORIFICE PRES DROP	IN.H2O	1.480	1.480	1.520	1.520	1.370	1.370	1.670	1.670
VOL DRY GAS-METER COND	DCF	32.12	30.74	45.41	43.61	31.73	30.58	43.77	43.57
AVG GAS METER TEMP	DEG.F	77.0	76.0	83.6	82.4	71.2	80.0	80.0	81.9
VOL DRY GAS-STD COND	DSCF	32.04	30.71	43.19	41.57	32.10	30.43	43.56	42.42
TOTAL H2O COLLECTED	ML	17.0	13.5	23.0	21.5	16.5	10.5	22.5	18.5
VOL H2O VAPOR-STD COND	SCF	.81	.64	1.09	1.02	.78	.50	1.07	.88
PERCENT MOISTURE BY VOL		2.5	2.0	2.5	2.4	2.4	1.6	2.4	2.0
MOLE FRACTION DRY GAS		.975	.980	.975	.976	.976	.984	.976	.980
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.73	28.78	28.73	28.74	28.74	28.82	28.74	28.78
AVG STACK TEMPERATURE	DEG.F	88.0	88.0	82.0	82.0	87.5	89.0	101.0	101.0
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	IN.HG	30.14	30.14	29.09	29.09	30.25	30.25	30.23	30.23
AVG STACK GAS VELOCITY	FPS	32.472	32.446	34.352	34.348	33.037	33.040	36.784	36.758
STK FLOWRATE, DRY,STD CN	DSCFM	16661.	16718.	17198.	17208.	17041.	17130.	18503.	18559.
ACTUAL STACK FLOWRATE	ACFM	17535.	17521.	18550.	18548.	17840.	17842.	19863.	19849.
PERCENT ISOKINETIC		102.8	98.2	96.7	93.1	98.7	93.1	96.4	93.6

OUTPUT INTERRUPT

Table 9

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1C	2C	3C
DATE OF RUN		6 15 76	6 15 76	6 16 76
STACK AREA	M2	.657	.657	.657
NET TIME OF RUN	MIN	72.0	72.0	72.0
BAROMETRIC PRESSURE	MM,HG	759.21	758.44	757.43
AVG ORIFICE PRES DROP	MM,H2O	76.454	68.072	80.010
VOL DRY GAS-METER COND	DM3	1.79	1.68	1.70
AVG GAS METER TEMP	DEG,C	31.5	27.8	24.5
VOL DRY GAS-STD COND	DNM3	1.74	1.65	1.69
TOTAL H2O COLLECTED	ML	8.9	18.7	17.6
VOL H2O VAPOR-STD COND	NM3	.01	.03	.02
PERCENT MOISTURE BY VOL		.7	1.5	1.4
MOLE FRACTION DRY GAS		.993	.985	.986
PERCENT CO2 BY VOL, DRY		.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.92	28.83	28.85
AVG STACK TEMPERATURE	DEG,C	23.9	23.9	23.2
NET SAMPLING POINTS		1	1	1
STACK PRESSURE, ABSOLUTE	MM,HG	758.44	757.43	756.41
AVG STACK GAS VELOCITY	M/S	24.904	23.297	23.352
STK FLOWRATE, DRY,STD CN	DNM3/M	964.	893.	897.
ACTUAL STACK FLOWRATE	AM3/M	981.	918.	920.
PERCENT ISOKINETIC		86.2	89.2	90.1

OUTPUT INTERRUPT

Table 10

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	4A	5A	14A	15A
DATE OF RUN		6-17-76	6-17/18	6 23 76	6 23 76
STACK AREA	M2	.511	.511	.511	.511
NET TIME OF RUN	MIN	60.0	74.0	51.0	64.0
BAROMETRIC PRESSURE	MM.HG	760.22	758.95	768.35	767.59
AVG ORIFICE PRES DROP	MM.H2O	26.416	24.638	33.020	32.766
VOL DRY GAS-METER COND	DM3	.93	1.10	.87	1.09
AVG GAS METER TEMP	DEG.C	27.2	29.4	23.3	30.0
VOL DRY GAS-STD COND	DNM3	.91	1.07	.88	1.07
TOTAL H2O COLLECTED	ML	9.6	11.8	10.3	9.6
VOL H2O VAPOR-STD COND	NM3	.01	.02	.01	.01
PERCENT MOISTURE BY VOL		1.4	1.5	1.5	1.2
MOLE FRACTION DRY GAS		.986	.985	.985	.988
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.85	28.84	28.83	28.87
AVG STACK TEMPERATURE	DEG.C	56.1	55.0	55.6	60.0
NET SAMPLING POINTS		1	1	1	1
STACK PRESSURE, ABSOLUTE	MM.HG	751.33	750.06	758.95	758.19
AVG STACK GAS VELOCITY	M/S	16.285	16.255	17.875	17.880
STK FLOWRATE, DRY,STD CN	DNM3/M	435.	435.	482.	477.
ACTUAL STACK FLOWRATE	AM3/M	499.	498.	548.	548.
PERCENT ISOKINETIC		94.8	90.4	96.9	94.7

OUTPUT INTERRUPT

Table 11

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	6AX	7AX	12AX	13AX
DATE OF RUN		6-18-76	6-118-76	6 22 76	6 22 76
STACK AREA	M2	.409	.409	.409	.409
NET TIME OF RUN	MIN	60.0	60.0	60.0	68.0
BAROMETRIC PRESSURE	MM.HG	755.90	755.90	764.03	764.03
AVG ORIFICE PRES DROP	MM.H2O	39.878	35.814	43.688	42.672
VOL DRY GAS-METER COND	DM3	1.14	1.10	1.18	1.32
AVG GAS METER TEMP	DEG.C	39.4	44.4	32.2	34.2
VOL DRY GAS-STD COND	DNM3	1.07	1.01	1.15	1.27
TOTAL H2O COLLECTED	ML	11.3	9.4	13.9	15.1
VOL H2O VAPOR-STD COND	NM3	.02	.01	.02	.02
PERCENT MOISTURE BY VOL		1.4	1.2	1.6	1.6
MOLE FRACTION DRY GAS		.986	.988	.984	.984
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.85	28.86	28.82	28.83
AVG STACK TEMPERATURE	DEG.C	72.2	69.4	65.6	53.9
NET SAMPLING POINTS		1	1	1	1
STACK PRESSURE, ABSOLUTE	MM.HG	745.74	745.74	753.87	753.87
AVG STACK GAS VELOCITY	M/S	20.463	19.551	21.011	20.351
STK FLOWRATE, DRY,STD CN	DNM3/M	414.	390.	437.	438.
ACTUAL STACK FLOWRATE	AM3/M	502.	480.	515.	499.
PERCENT ISOKINETIC		93.4	91.8	95.1	92.6

OUTPUT INTERRUPT

Table 12

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	8F	9F	10F	11F
DATE OF RUN		6 21 76	6 21 76	6-21-76	6 22 76
STACK AREA	M2	.552	.552	.552	.552
NET TIME OF RUN	MIN	34.0	36.0	36.0	24.0
BAROMETRIC PRESSURE	MM.HG	758.95	759.21	759.21	764.03
AVG ORIFICE PRES DROP	MM.H2O	59.944	56.134	59.436	57.150
VOL DRY GAS-METER COND	DM3	.77	.74	.82	.54
AVG GAS METER TEMP	DEG.C	25.8	32.7	34.0	24.7
VOL DRY GAS-STD COND	DNM3	.76	.71	.79	.54
TOTAL H2O COLLECTED	ML	5.9	7.9	7.1	4.0
VOL H2O VAPOR-STD COND	NM3	.01	.01	.01	.01
PERCENT MOISTURE BY VOL		1.0	1.5	1.2	1.0
MOLE FRACTION DRY GAS		.990	.985	.988	.990
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.89	28.84	28.87	28.89
AVG STACK TEMPERATURE	DEG.C	30.4	32.2	32.9	29.4
NET SAMPLING POINTS		1	1	1	1
STACK PRESSURE, ABSOLUTE	MM.HG	743.71	743.97	743.20	748.54
AVG STACK GAS VELOCITY	M/S	21.924	21.106	22.135	21.377
STK FLOWRATE, DRY,STD CN	DNM3/M	681.	649.	681.	671.
ACTUAL STACK FLOWRATE	AM3/M	726.	699.	733.	708.
PERCENT ISOKINETIC		95.6	89.3	94.2	97.8

OUTPUT ENTER IPT

Table 13

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	101	102	201	202	301	302
DATE OF RUN		6-15-76	6 15 76	6-15-76	6-15-76	6 16 76	6 16 76
STACK AREA	M2	.920	.920	.920	.920	.920	.920
NET TIME OF RUN	MIN	72.0	72.0	72.0	72.0	72.0	72.0
BAROMETRIC PRES AVE	MM.HG	759.21	759.21	759.21	759.21	758.19	758.19
AVG ORIFICE PRES DROP	MM.H2O	84.074	84.074	67.310	66.040	86.360	86.360
VOL DRY GAS-METER COND	DCM	2.00	2.00	1.76	1.75	1.99	1.97
AVG GAS METER TEMP	DEG.C	36.2	38.7	32.7	30.1	29.6	27.8
VOL DRY GAS-STD COND	DNM3	1.91	1.90	1.71	1.71	1.95	1.93
TOTAL H2O COLLECTED	ML	15.8	22.4	17.5	14.7	21.5	16.1
VOL H2O VAPOR-STD COND	NM3	.02	.03	.02	.02	.03	.02
PERCENT MOISTURE BY VOL		1.1	1.6	1.4	1.1	1.5	1.1
MOLE FRACTION DRY GAS		.989	.984	.986	.989	.985	.989
PERCENT CO2 BY VOL, DRY		,0	,0	,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	,0	,0	,0	,0
PERCENT CO BY VOL, DRY		,0	,0	,0	,0	,0	,0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT,DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT,STK GAS		28.88	28.83	28.85	28.87	28.84	28.88
AVG STACK TEMPERATURE	DEG.C	18.3	18.3	18.3	18.3	18.3	18.3
NOT SAMPLING POINTS		1	1	1	1	1	1
STACK PRES, ABSOLUTE	MM.HG	759.46	759.46	759.46	759.46	758.44	758.44
AVG STACK GAS VELOCITY	M/S	14.648	14.661	12.686	12.681	14.646	14.636
STK FLOWRATE, DRY,STD CN	DNM3/M	806.	803.	697.	698.	802.	805.
ACTUAL STACK FLOWRATE	AM3/M	808.	809.	700.	700.	808.	808.
PERCENT ISOKINETIC		94.2	94.8	98.0	98.0	96.5	96.2

Table 14

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	4B1	4B2	5B1	5B2	6B1	6B2	7B1	7B2
DATE OF RUN		6 17 76	6 17 76	6 17 76	6 18 76	6 18 76	6 18 76	6 18 76	6 18 76
STACK AREA	M2	.836	.836	.836	.836	.836	.836	.836	.836
NET TIME OF RUN	MIN	78.0	78.0	76.0	76.0	46.0	46.0	34.0	34.0
BAROMETRIC PRESSURE	MM,HG	760.22	760.22	757.43	757.43	755.90	755.90	755.90	755.90
AVG ORIFICE PRES DROP	MM,H2O	38.862	40.132	38.862	38.862	35.052	35.052	36.322	36.322
VOL DRY GAS-METER COND	DM3	1.43	1.42	1.40	1.37	.84	.81	.63	.61
AVG GAS METER TEMP	DEG.C	32.4	33.8	28.9	33.6	35.0	39.9	37.2	43.3
VOL DRY GAS-STD COND	DNM3	1.39	1.37	1.37	1.31	.80	.76	.59	.57
TOTAL H2O COLLECTED	ML	41.0	32.5	33.0	40.5	21.0	18.5	17.0	16.7
VOL H2O VAPOR-STD COND	NM3	.06	.04	.04	.05	.03	.02	.02	.02
PERCENT MOISTURE BY VOL		3.8	3.1	3.1	4.0	3.4	3.1	3.7	3.8
MOLE FRACTION DRY GAS		.962	.969	.969	.960	.966	.969	.963	.962
PERCENT CO2 BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT CO BY VOL, DRY		,0	,0	,0	,0	,0	,0	,0	,0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.58	28.66	28.65	28.56	28.62	28.65	28.59	28.58
AVG STACK TEMPERATURE	DEG.C	30.1	29.8	32.6	32.6	37.8	37.8	38.9	38.9
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	MM,HG	760.48	760.48	757.68	757.68	756.16	756.16	761.24	756.16
AVG STACK GAS VELOCITY	M/S	9.944	9.931	9.756	9.772	10.045	10.040	10.166	10.201
STK FLOWRATE, DRY,STD CN	DNM3/M	466.	469.	455.	452.	458.	459.	464.	462.
ACTUAL STACK FLOWRATE	AM3/M	499.	498.	489.	490.	504.	504.	510.	512.
PERCENT ISOKINETIC		99.8	97.0	103.5	100.3	99.1	94.0	98.7	95.0

OUTPUT INTERRUPT

Table 15

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	RG1	RG2	9G1	9G2	10G1	10G2	11G1	11G2
DATE OF RUN		6 21 76	6 21 76	6 21 76	6 21 76	6-21-76	6 21 76	6-22-76	6-22-76
STACK AREA	M2	.836	.836	.836	.836	.836	.836	.836	.836
NET TIME OF RUN	MIN	40.3	40.3	43.5	43.5	45.0	45.0	34.0	34.0
BAROMETRIC PRESSURE	MM.HG	758.70	758.70	758.95	758.95	758.95	758.95	764.03	764.03
AVG ORIFICE PRES DROP	MM.H2O	71.882	71.882	75.692	75.692	71.628	71.628	73.914	73.914
VOL DRY GAS-METER COND	DM3	1.02	1.03	1.13	1.14	1.14	1.15	.83	.84
AVG GAS METER TEMP	DEG.C	24.6	26.3	31.2	36.3	33.3	38.3	21.1	20.6
VOL DRY GAS-STD COND	DNM3	1.02	1.01	1.10	1.09	1.10	1.09	.84	.85
TOTAL H2O COLLECTED	ML	10.0	8.5	13.0	8.6	12.0	7.9	8.5	6.3
VOL H2O VAPOR-STD COND	NM3	.01	.01	.02	.01	.02	.01	.01	.01
PERCENT MOISTURE BY VOL		1.3	1.1	1.6	1.0	1.4	1.0	1.3	1.0
MOLE FRACTION DRY GAS		.987	.989	.984	.990	.986	.990	.987	.990
PERCENT CO2 BY VOL, DRY		,0	,0	.0	,0	,0	,0	,0	,0
PERCENT O2 BY VOL, DRY		,0	,0	.0	,0	,0	,0	,0	,0
PERCENT CO BY VOL, DRY		,0	,0	.0	,0	,0	,0	,0	,0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.86	28.88	28.83	28.88	28.84	28.89	28.85	28.89
AVG STACK TEMPERATURE	DEG.C	18.9	18.9	21.1	21.1	21.1	21.1	16.7	16.7
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	MM.HG	757.68	757.68	757.94	757.94	757.94	757.94	763.02	763.02
AVG STACK GAS VELOCITY	M/S	13.747	13.742	14.205	14.192	13.833	13.821	13.777	13.767
STK FLOWRATE, DRY,STD CN	DNM3/M	684,	685,	700,	702,	682,	685,	695,	697,
ACTUAL STACK FLOWRATE	AM3/M	690,	689,	713,	712,	694,	693,	691,	691,
PERCENT ISOKINETIC		96.5	96.2	95.0	92.6	93.7	92.5	93.4	93.2

OUTPUT INTER ICT

Table 16

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1281	1282	1381	1382	1481	1482	1581	1582
DATE OF RUN		6 22 76	6 22 76	6 22 76	6 22 76	6 23 76	6 23 76	6 23 76	6 23 76
STACK AREA	M2	.836	.836	.836	.836	.836	.836	.836	.836
NET TIME OF RUN	MIN	49.0	49.0	68.0	68.0	50.0	50.0	64.0	64.0
BAROMETRIC PRESSURE	MM,HG	765.30	765.30	738.63	738.63	768.10	768.10	767.59	767.59
AVG ORIFICE PRES DROP	MM,H2O	37.592	37.592	38.608	38.608	34.798	34.798	42.418	42.418
VOL DRY GAS-METER COND	DM3	.91	.87	1.29	1.23	.90	.87	1.24	1.23
AVG GAS METER TEMP	DEG.C	25.0	24.4	28.7	28.0	21.8	26.7	26.7	33.3
VOL DRY GAS-STD COND	DNM3	.91	.87	1.22	1.18	.91	.86	1.23	1.20
TOTAL H2O COLLECTED	ML	17.0	13.5	23.0	21.5	16.5	10.5	22.5	18.5
VOL H2O VAPOR-STD COND	NM3	.02	.02	.03	.03	.02	.01	.03	.02
PERCENT MOISTURE BY VOL		2.5	2.0	2.5	2.4	2.4	1.6	2.4	2.0
MOLE FRACTION DRY GAS		.975	.980	.975	.976	.976	.984	.976	.980
PERCENT CO2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT O2 BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT CO BY VOL, DRY		.0	.0	.0	.0	.0	.0	.0	.0
PERCENT N2 BY VOL, DRY		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOLECULAR WT-DRY STK GAS		29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00
MOLECULAR WT-STK GAS		28.73	28.78	28.73	28.74	28.74	28.82	28.74	28.78
AVG STACK TEMPERATURE	DEG.C	31.1	31.1	27.8	27.8	30.8	31.7	38.3	38.3
NET SAMPLING POINTS		1	1	1	1	1	1	1	1
STACK PRESSURE, ABSOLUTE	MM,HG	765.56	765.56	738.89	738.89	768.35	768.35	767.84	767.84
AVG STACK GAS VELOCITY	M/S	9.897	9.890	10.471	10.469	10.070	10.071	11.212	11.204
STK FLOWRATE, DRY,STD CN	DNM3/M	472.	473.	487.	487.	483.	485.	524.	526.
ACTUAL STACK FLOWRATE	AM3/M	497.	496.	525.	525.	505.	505.	562.	562.
PERCENT ISOKINETIC		102.8	98.2	96.7	93.1	98.7	93.1	96.4	93.6

OUTPUT INTERRUPT

Table 17

LOCATION OF SAMPLING PORTS AND EXPLANATION OF SAMPLING PROGRAM

The overall plant layout and location of the sampling points are shown in Figure 1B.

Point AX - This location isolated the grid casting operation enabling the collection of samples of emissions from this operation into the rotoclone providing inlet data from that source. The sampling was conducted from a single port using a horizontal and vertical traverse. A swiveling probe adaptor was fabricated in order to conduct angular probe movement to reach the vertical traverse points. The horizontal duct was reached by means of a hydraulic man lift. This point was ideal in that it met Method 1 criteria for up-and-down stream diameters. The port was arranged by removing a cleanout door and replacing it with an aluminum sheet with a 3" diameter hole in the center. Due to building interference, the nearest Point (H1) could not be reached so Point H2 was sampled for two periods. Four, one-hour samples were obtained at this point.

Point A - This point functions the same as Point AX with the addition of emissions from the wet portion of the paste mixing operation. The wet portion is when acid is being added to the paste. Therefore, Point A would furnish data on grid casting plus paste mixing emissions. This point was also traversed in vertical and horizontal planes. The first sample (A1) was conducted during three entire cycles for a total of 60 minutes. The second sample (A2) was run only during the wet

portion of the paste mixing operation. Test A3 was conducted during four of these cycles for a total of 74 minutes. Three additional traverse points were sampled because of the unpredictability of cycle time. Figure 1A shows how these cycles were sampled.

After making these two runs, we moved to baghouse F and G to ensure getting data on all sources in the time available. We later returned to Point A. Run A4 and A5 were conducted over full cycles.

Point B - Point B was the exhaust of the rotoclone controlling grid casting and the wet cycle of paste mixing. An extension was erected and a traverse of 25 points was selected. A dual sampling train was used in order to compare Method 5 with a modified Pb collection method. These train diagrams can be seen in Figures 2 and 3 . Sixteen samples were collected during 8 runs. The runs were conducted simultaneously with runs at A and AX. Figure 1A graphically illustrates how these runs were made in relation to process cycles.

Points C and D - Point C was the inlet to the baghouse controlling emissions from the assembly (or three process operation). Point D is the outlet, this being a continuous operation, three simultaneous samples of 72 minutes each were obtained without incident.

Points F and G - Points F and G are the inlet and outlet of the baghouse controlling emissions from the grid pasting operation and the dry portion of the paste mixing operation. Figure 1A illustrates the sampling periods for this source.

NUMBER OF CYCLES

Run number	1 DRY	1 WET	2 DRY	2 WET	3 DRY	3 WET	4 DRY	4 WET	Total time
4B	XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXX				66
5B		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX	63
6B		XXXXXXXXX		XXXXXXXXX					44
7B	XXXXXXXXXXXXXXXXXX								34
12B	XXXXXXXXXX		XXXXXXXXX		XXXXXXXXX				39
13B	XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXX						70
14B		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX			54
15B	XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXX						64
4A	XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXX				66
5A		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX	63
14A		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX			54
15A	XXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXX						64
8F-G	XXXXXXXXXX		XXXXXXXXX		XXXXXXXXX		XXXXXXXXX		41
9F-G	XXXXXXXXXXXXXXXXXX								43
10F-G		XXXXXXXXX		XXXXXXXXX					45
11F-G	XXXXXXXXXX		XXXXXXXXX		XXXXXXXXX				34

DRY -- When Paste Mixer Directed to Baghouse

WET -- When Paste Mixer Directed to Rotoclone

Samples AX, C and D were done on Continuous Operations

Graphic Showing how Sampling was Conducted
During Operation Cycles

FIGURE 1A

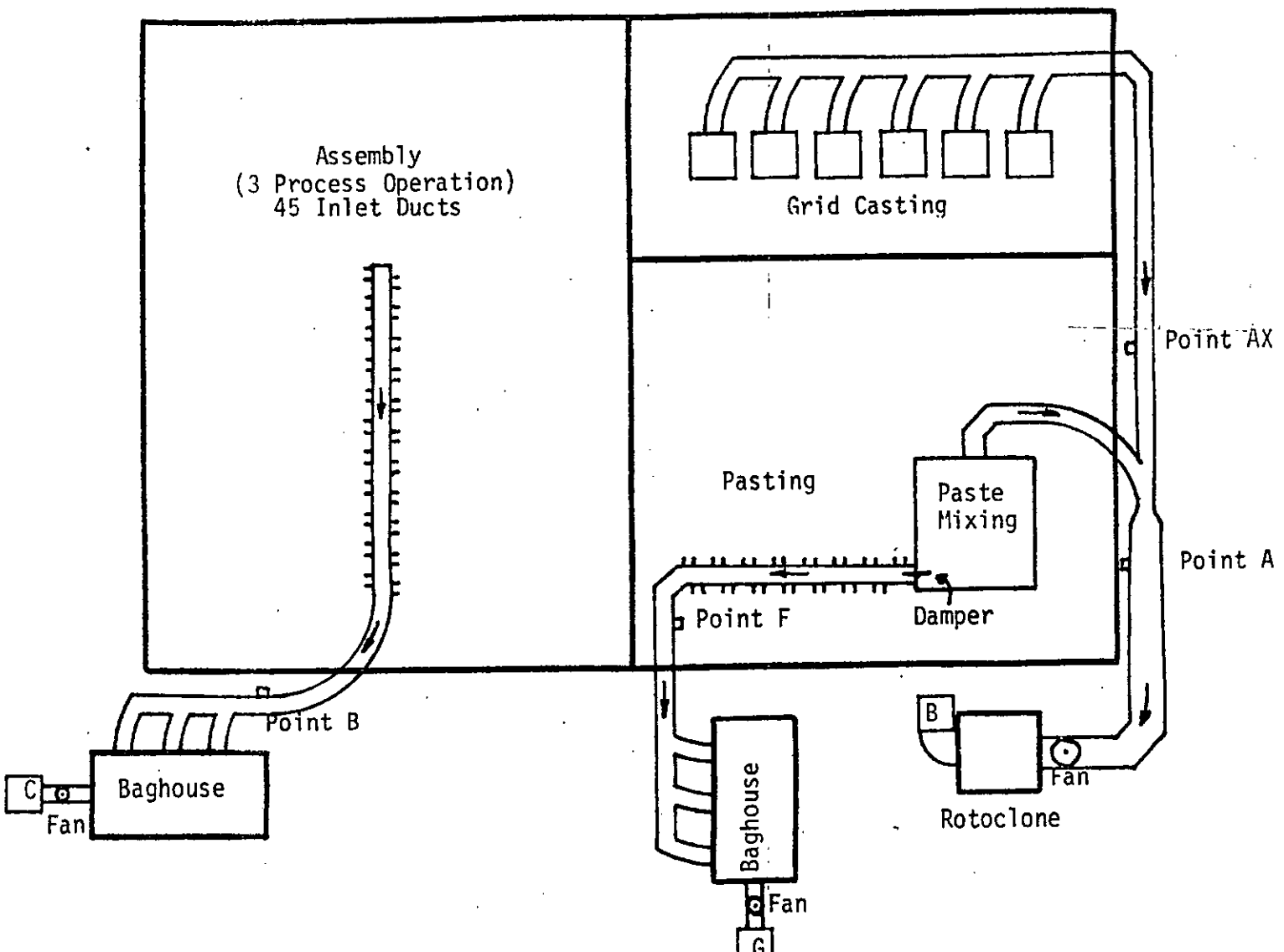


Figure 1B. Plant Diagram

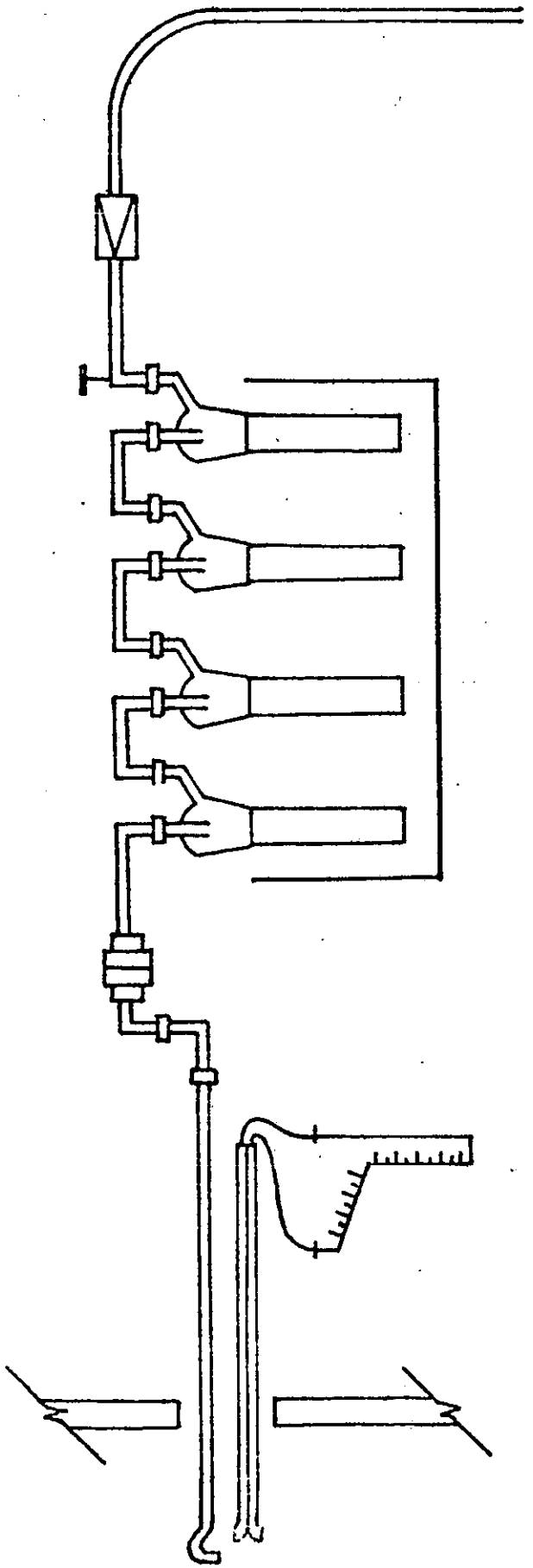


FIGURE 2

STANDARD MEHTOD 5 TRAIN

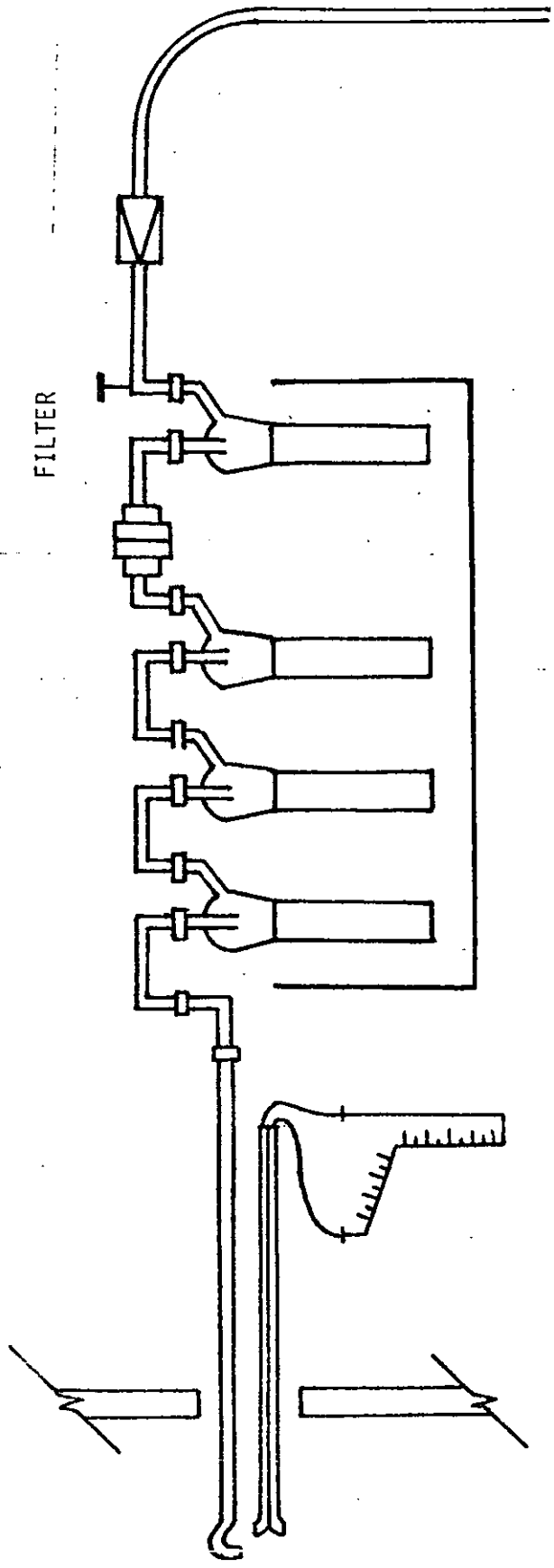


FIGURE 3

MODIFIED Pb TRAIN

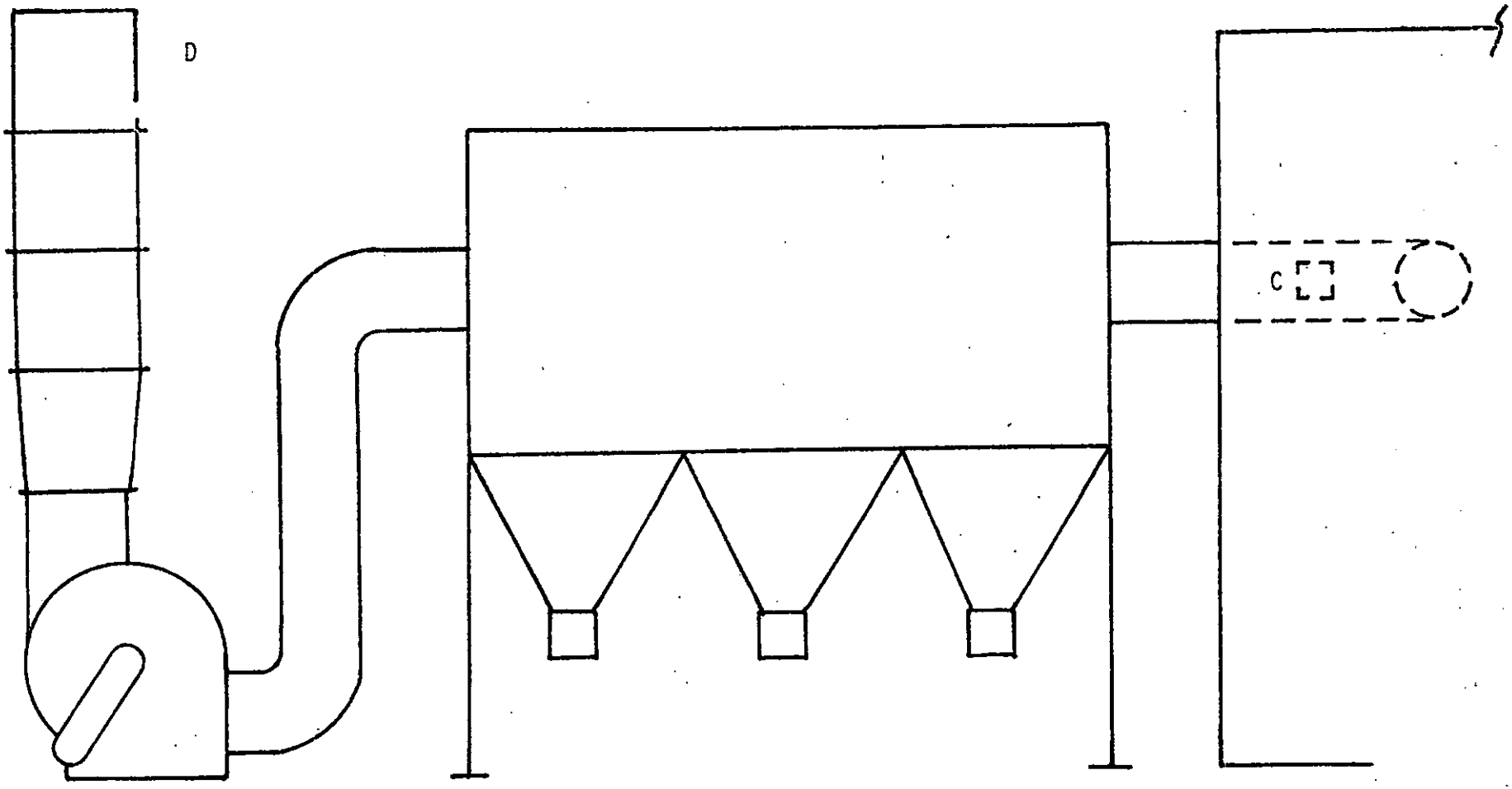


FIGURE 4

BAGHOUSE CONTROLLING

THREE PROCESS OPERATION

POINTS C AND D

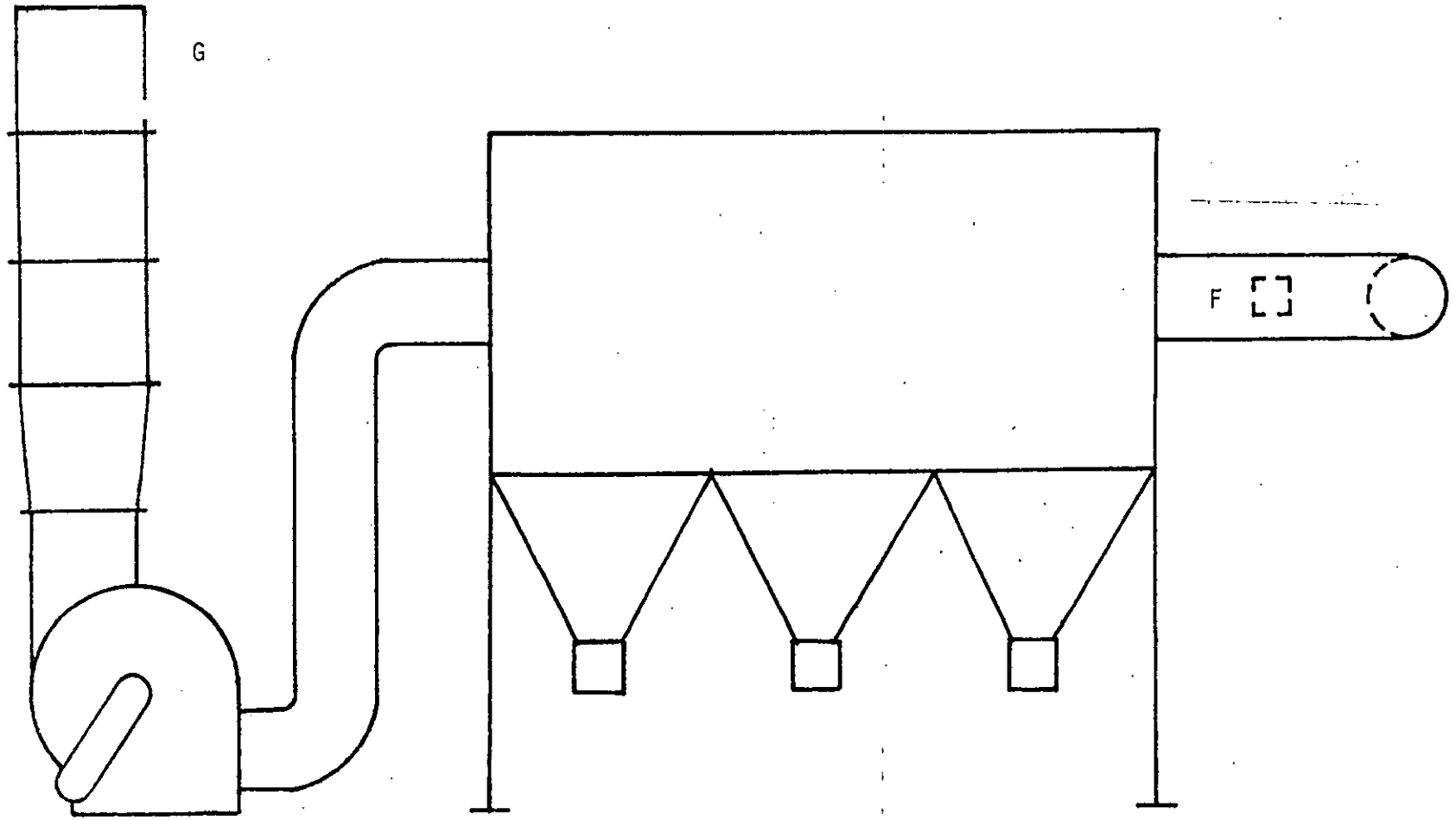


FIGURE 5

BAGHOUSE CONTROLLING

GRID PASTING AND PASTE MIXING OPERATIONS

POINTS F AND G

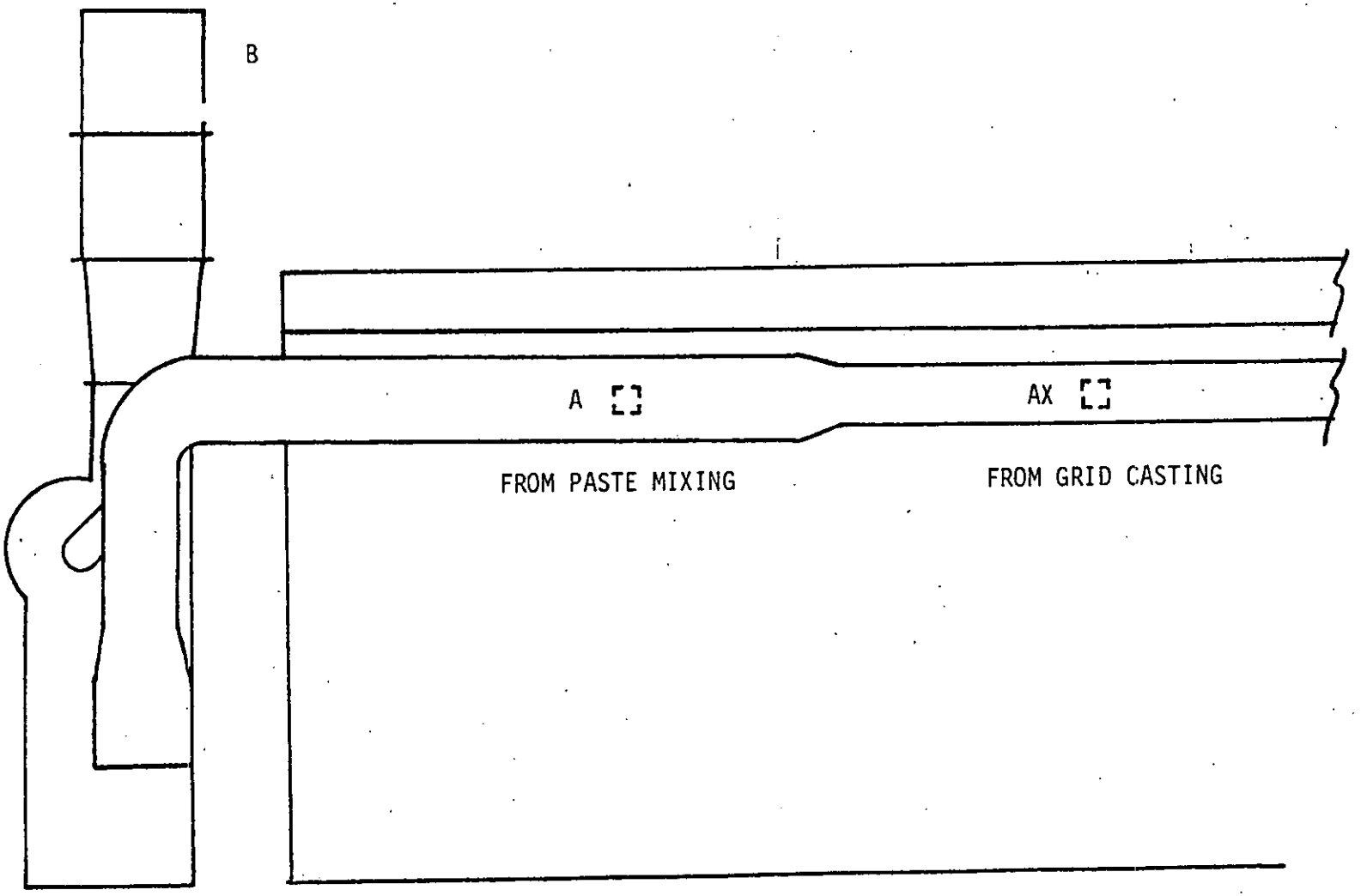


FIGURE 6

ROTOCLONE CONTROLLING GRID CASTING

AND PASTE MIXING OPERATIONS

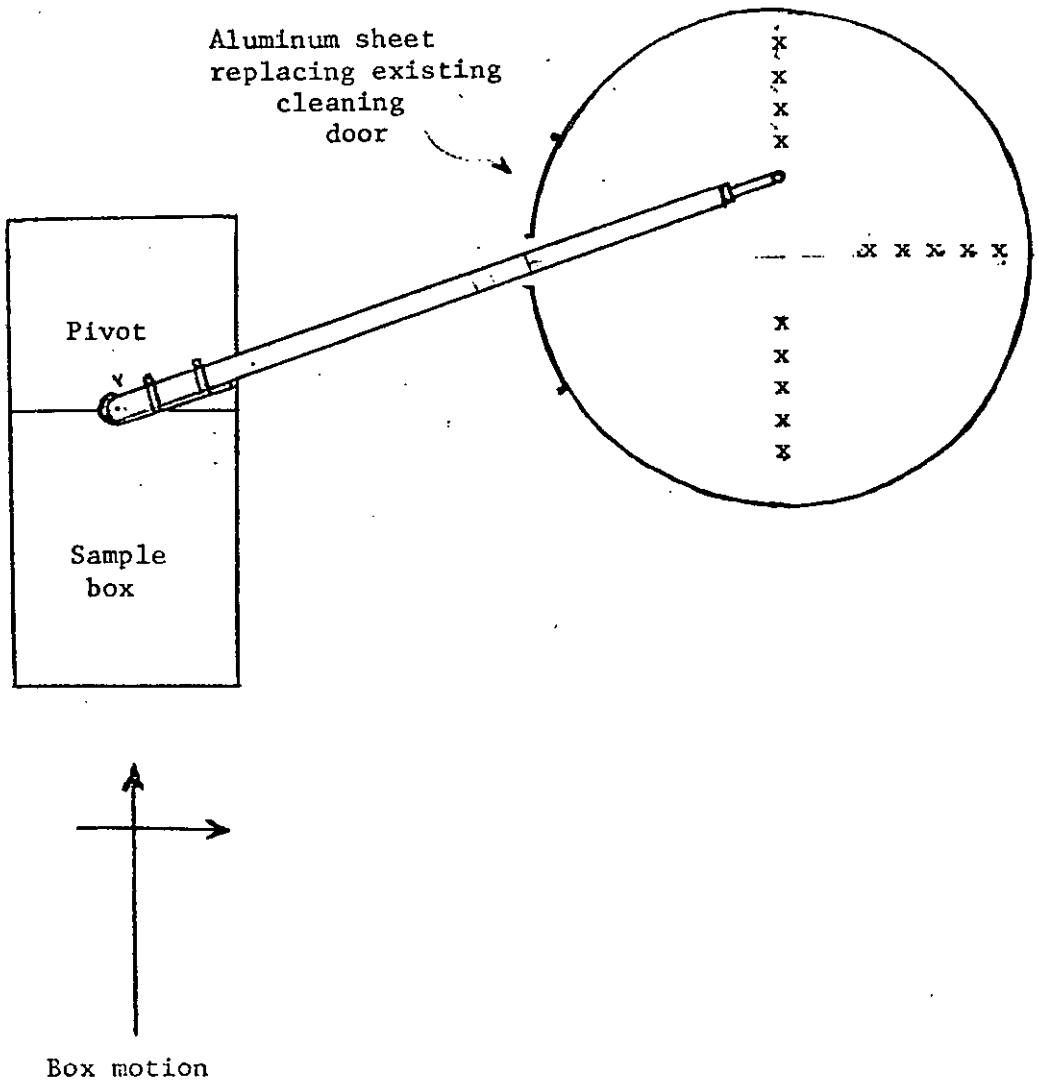
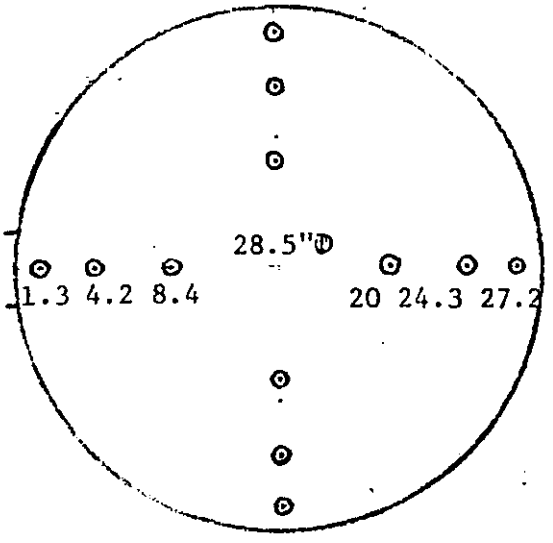
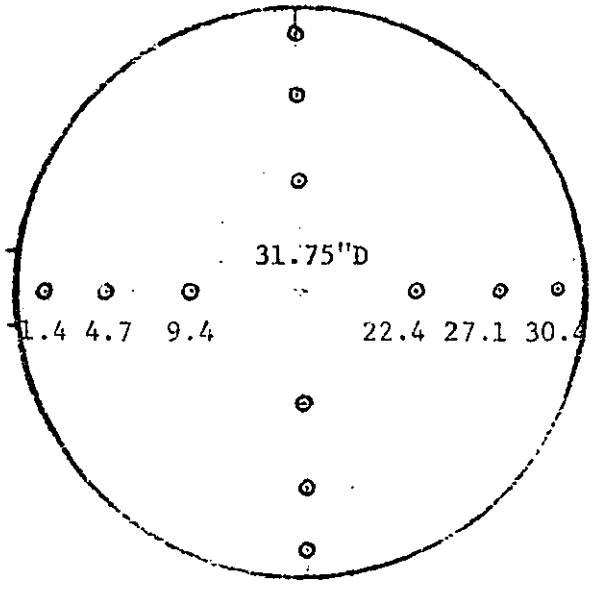


FIGURE 7

DIAGRAM OF PIVITOL SINGLE PORT TRAVERSE
OF HORIZONTAL DUCT

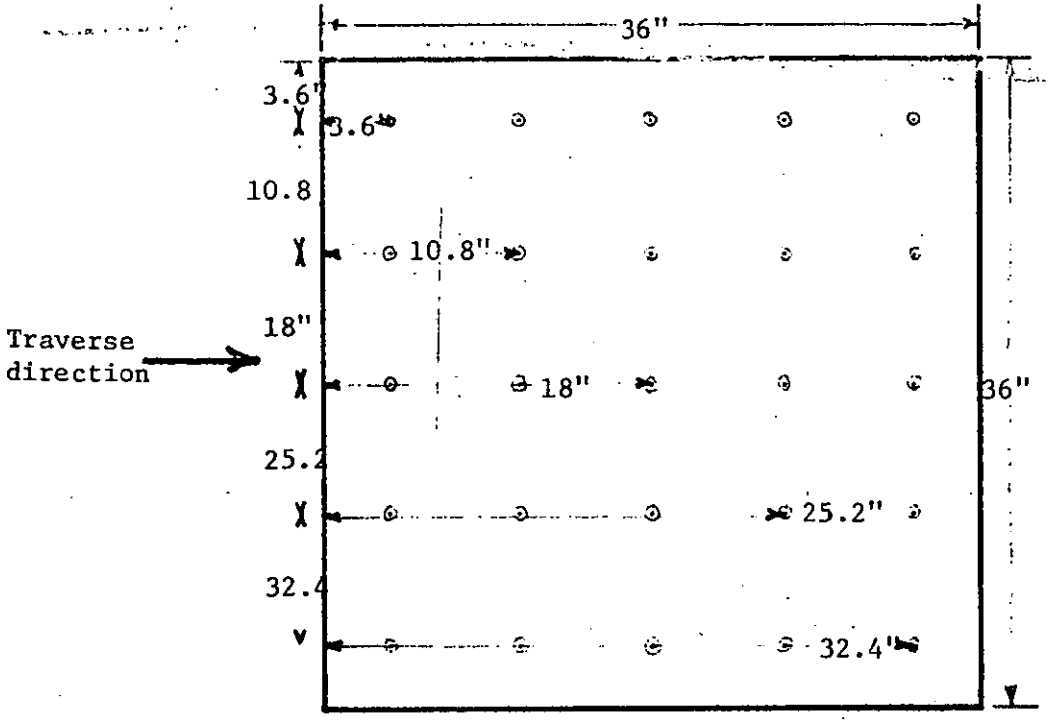


POINT AX

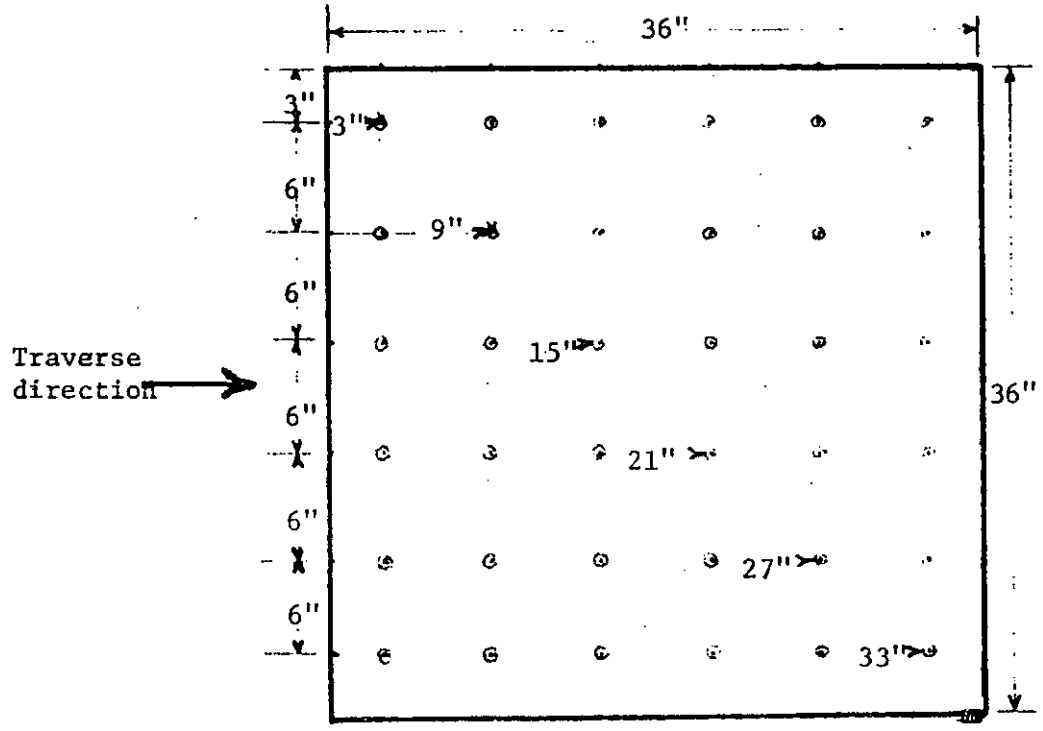


POINT A

FIGURE 8
SAMPLING POINTS - POINTS AX AND A

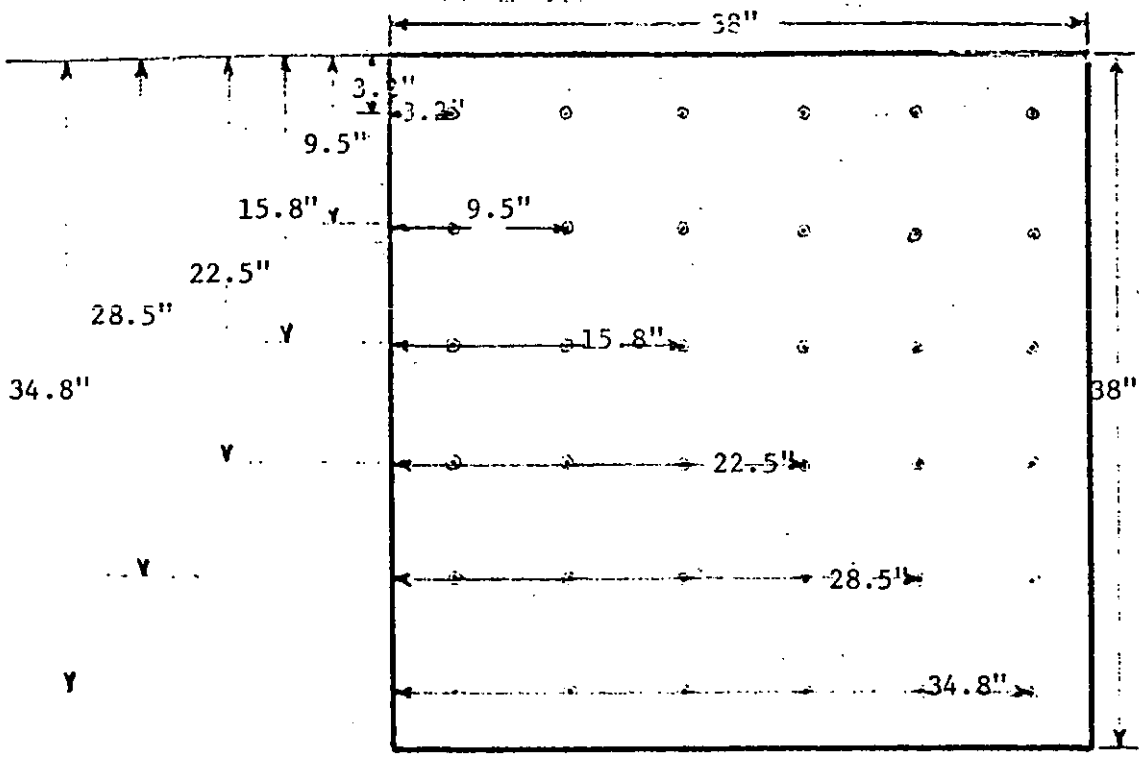


25 Points
Points B & G

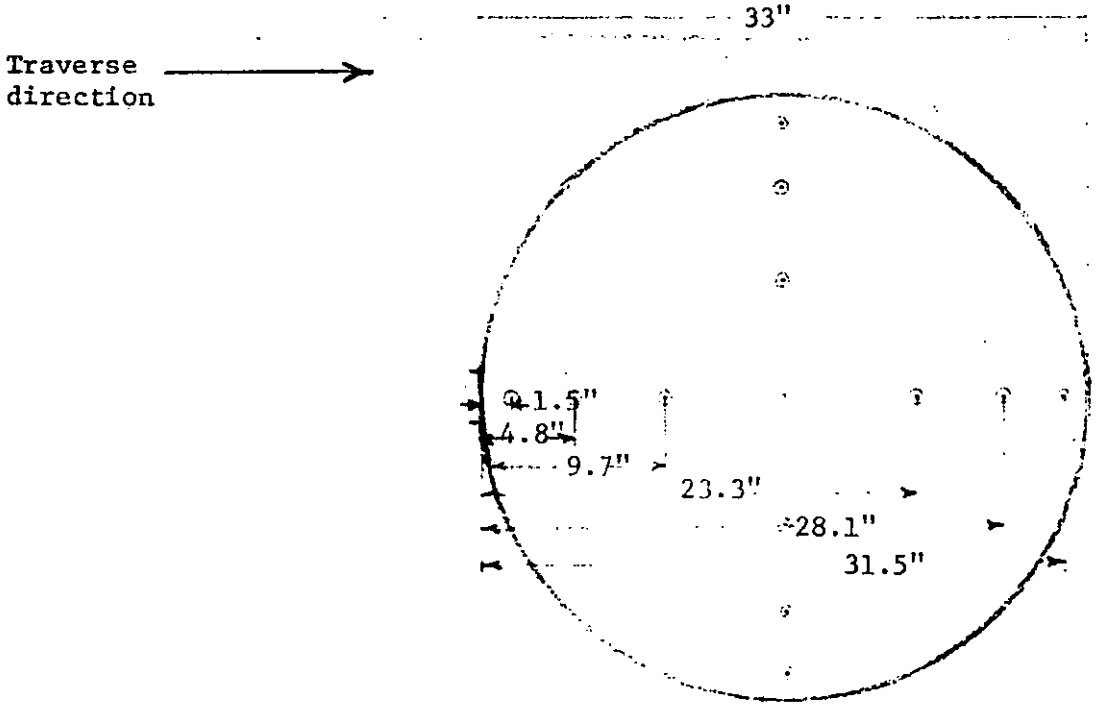


36 Points
Point C

FIGURE 9
POINTS B, G & C - SAMPLING POINTS



36 Points
Point D



12 Points
Point F

FIGURE 10
TRAVERSE POINTS - POINTS D & F

PROCESS DESCRIPTION AND OPERATION

GENERAL DESCRIPTION OF LEAD-ACID BATTERY MANUFACTURING

Battery manufacturing begins with two unrelated operations; grid casting and paste mixing. The grids are generally cast from lead hardened by the addition of between 6 and 12 percent antimony.

Casting techniques for grids vary with the alloy used, the type of molds, and mold preparation before casting. Grid casting machines can have melting pots attached directly to them or have a central pot furnace from which the molten lead is either pumped or fed by gravity. Lead alloy ingots are melted in these gas-fired lead pots at approximately 700°F. The produced grids are sent to the grid pasting operation.

The paste making operation, a batch-type process, takes place in either a muller, Day, or dough-type mixer. From 600 to 3,000 pounds of lead oxide is added to the mixer, water and sulfuric acid is then added, and the mixture is blended to form a stiff paste. Because of the exothermic conditions, mixers are usually water-jacketed and air-cooled to prevent excessive temperature build-up which causes the paste to become stiff and difficult to apply to the grids.

Varying amounts of expander and other constituents are added depending on whether a positive or negative paste batch is desired. The time of the mixing cycle is dependent on the type of mixer utilized. Mixing cycles range from 15 minutes up to an hour in duration.

Pasting machines force the lead sulfate paste into the interstices of the grid structure at production rates exceeding 200 plates per minute (the grids are called plates after the paste has been applied). The freshly pasted plates are transported by a horizontal chain through a temperature controlled, heated tunnel about 20 feet long, where the surface water is removed. This allows the plates to be stacked without sticking together. It is important that only the surface water be removed since the plates depend on moisture to produce the chemical reaction within the paste while curing - very much similar to a cementitious process. The plates are cured for about 72 hours to increase plate strength.

Following the curing stage, the plates are normally sent to the three-process operation. This operation encompasses stacking, burning, and assembly. First, the plates are stacked in an alternating positive and negative block formation. Insulators are sandwiched between each plate to insulate the oppositely charged plates while permitting free ionic flow. These dividers are made from

materials such as wood, treated paper, plastics, or rubber. While machines have been designed which can stack the plates and separators automatically, hand stacking is not uncommon, even in some relatively large plants.

Leads (pronounced leeds) are welded to the tabs of each positive plate and each negative plate, fastening the assembly (element) together. This is the burning operation. An alternative to the welding or burning process is the "cast strap" process. In the latter, molten lead is poured around and between the plate tabs, thus forming the connection. Then a positive and negative terminal is welded to the element. The completed elements can go to either the wet or dry battery lines.

In the wet battery line, elements are placed within cases made of durable plastic or hard rubber. Covers equipped with openings and lead inserts are aligned so that the terminals project out of the inserts. The covers are sealed to the cases and the batteries are filled with dilute sulfuric acid and made ready for formation.

The only difference between the wet battery and the dry battery process is that, for dry batteries, the elements are formed prior to being placed in a sealed case. The dry batteries are shipped without acid. Sulfuric acid is then added to the battery at the point of use. This gives the battery an indefinite shelf-life.

Formation is a chemical process wherein the inactive lead oxide-sulfate paste is converted into an active electrode. Formation is essentially an oxidation-reduction reaction wherein the positive plates are oxidized from lead oxide to lead peroxide, and the negative plates are reduced from lead oxide to metallic lead. This is accomplished by placing the unformed plates in a dilute sulfuric acid solution and connecting the positive plates to the positive pole of a dc source and the negative plates to the negative pole of the dc source.

When manufacturing wet lead-acid batteries it is common practice to place the cells into the battery cases, place the lid on the battery, and add sulfuric acid. The plates are then formed within the battery case itself. After formation, the spent acid is dumped from the batteries, new acid added, and a boost charge given to the battery. The unit is then ready for use and only requires decoration and manufacturer's markings.

The plates used in dry batteries are formed in one of several ways. Some plates are individually formed in tanks of sulfuric acid and then assembled. However, most dry batteries are made by assembling the plates into the elements beforehand. The completed elements are then formed in one of two manners. First, the elements themselves can be placed into large tanks of sulfuric acid, electrically

connected, and formed. Some companies place the assembled elements directly into the battery case. Thereafter, the formed elements are removed, the acid dumped, and the cases and elements rinsed and dried, reassembled and shipped dry.

Formation takes anywhere from one to four days. Most plants use a 36- to 48-hour forming cycle. The charging rate is high during the first 24 to 36 hours, the lower during the remaining 12 hours. The ampere rates are dependent upon the battery size. Figure 11 shows a typical battery plant flow diagram.

PROCESS DESCRIPTION

Globe Union's Canby, Oregon plant has a normal operating output of 2,400 batteries per day with a maximum of 4,000 batteries per day. The plant is a conventional wet-battery operation, except the finished units are sent to another plant for formation. Figure 12 is a schematic diagram of the Globe Union facility.

Lead oxide is received by truck approximately three times per week and pneumatically conveyed to storage hoppers.

The plant has three Wirtz grid casting furnaces each with three grid casters (a total of nine casters) vented to a common stack. The exhaust ducting is designed for a fourth furnace. A small parts casting furnace connects to the main casting exhaust system which is cleaned through an

American Air Filter Type N Roto-Clone system (size 24, Arrangement D). The small parts produced are battery element straps used at the Tiegel burning machine. There are typically from 26,500 to 30,000 pounds of lead alloy used in the grid casting furnaces per 24 hour day. Another 930 pounds of lead per shift are used to produce small parts.

Globe is operating one Beardsley and Piper paste mixer in Canby, although two identical mixers were originally installed. The second mixer, transfer conveyor, dryer, and curing station have been removed. The common components, such as the baghouse and lead oxide hopper, were designed as part of the two mixer system. A typical amount of lead oxide charged during a shift is 28,950 lb. Positive batches require 2,400 lbs. while negative batches require 1,800 lbs of lead oxide.

The paste mixer exhaust vents to two separate control systems. As the lead oxide is dumped, the gases are vented through an American Air Filter Type 3-96 baghouse. The system has a 75 horsepower fan. This baghouse has three compartments with a total of 636 bags. Total cloth area is 8,755 square feet, yielding an air-to-cloth ratio of 3.3 to 1. However, one compartment is closed for approximately ten minutes each hour for shaking and dust settling. The air-to-cloth ratio during this period increases to 4.9 to 1. The exhaust gases are

rerouted during mixing via an automatic damper to the [illegible] Type N Roto-Clone which also cleans the cast furnace exhaust gas.

The paste is continuously applied to the grids as they are automatically fed to the pasting machine. The pasted grid is then dried, slit (each grid becomes two plates after pasting and slitting) and stacked. The pasting operation is not vented but the drying operation is. Slitting and stacking operations are vented to the same baghouse that controls the mixer during the portion of the mixing cycle when dry ingredients are added to the mix. The slitting machine can handle 23,500 plates per hour. There is a spare slitting machine that is periodically used. This is also vented to the baghouse. However, it was idle during the tests and its exhaust system was dampered from the baghouse.

The plates are stacked in the proper sequence and joined on three production lines. Two of these lines have mechanical stackers and a cast-on-strap (COS) machine which casts the straps onto the elements. The other line has a mechanical stacker but the elements are joined by burning on leads with a Tiegel machine. This unit is much slower than the COS machines. Normal production rates are 800 six-celled batteries per eight hour shift for each of the COS machines and 150 three-celled batteries on the Tiegel machine. The COS machines produce six-celled batteries

exclusively but the Tiegel machine produces industrial batteries with both three, four and six cells. Typically the COS operation requires 1.56 pounds of lead per battery. The amount used per battery on the Tiegel burner is estimated by plant personnel at one pound of lead per element burned. Vents from the assembly area enter a common 36 inch diameter manifold which connects to an AAF Type 3-106 baghouse equipped with a 100 horsepower fan. Total cloth area is 9757 square feet, yielding an air-to-cloth ratio of 3.3 to 1. However, one compartment is closed for approximately ten minutes each hour for shaking and dust settling. The air-to-cloth ratio during this period increases to 4.9 to 1. The assembly area hoods and ducts were designed to capture particulate emissions.

Globe reclaims lead in-house and also sends lead residue to RSR* for reclaim. In Globe's remelt room, the exhaust gases from the lead reclaim furnace are controlled by a Roto-Clone.

The plant cleans process equipment using a Hoffman vacuum cleaning system. The dust is collected in one of three storage silos. Air is transported through the cleaning system via a 100 horsepower fan, and out an eight inch diameter stack approximately 30 feet high.

NORMAL PROCESS OPERATION

Source testing was done at Globe Union's Canby plant on

*Reserve Smelting & Refining, Portland, Oregon

June 15-18, 1976 and June 21-23, 1976. Tested were grid and small parts casting (stack 2), slitting (stack 1), paste mixing (Stacks 1 and 2) and element assembly (Stack 7). Test locations are shown in Figure 13. Element assembly (stacking, cast-on-strap, and burning) tests were conducted continuously for each test while other source tests were synchronized with the mixing cycle. Source tests for Stacks 1 and 2 were done during an entire mixing cycle, while the mixer was ducted only to Stack 2 (Roto-clone), and while the mixer was ducted only to Stack 1 (baghouse).

Element Assembly

The two COS machines and automatic stacker operate continuously. The stackers jam frequently but the operation is down only momentarily--rarely over two or three minutes. This does not affect strap casting because there is a surge bin for plate stacks between each stacker and cast-on-strap machine. Likewise, a minor malfuniction of a COS machine does not effect the stacker. A five to ten minute shut-down occurs when there is a change in battery types. This changeover requires a change in plate type, clearing the surge bin and adjustment of the stacker and COS machine to accommodate a different number of plates per element.

The Tiegel machine is much slower than the COS machines. The associated stacker is operated only as required to keep pace with the manual burning operation. Leads (pronounced

leeds) are obtained from small parts casting and placed on each element assembly by hand. These element assemblies are then dipped in a flux solution and burned manually. After burning, glue is applied to each element prior to placing it into the battery case. Changeover to a different battery model requires a much longer time than the automated element assembly machines because of the wide size range of industrial batteries.

Handling operations on all three assembly lines are essentially the same. Before the plate stacks are placed in the mechanical stackers they are struck against a grating to assure plate separation. This is done again after stacking and when the element is complete to square the stacks. These grates are vented to the baghouse controlling the other assembly operations. The assembled elements are manually placed in the battery cases.

Grid and Small Parts Casting

Grid casting at the Canby plant is completely automated. All three casting machines receive lead alloy from individual pots. After the grid is cast it is trimmed, then placed on a rack. The operator removes the grids from the rack in groups of 50 and puts several groups on a skid to be sent to the pasting operations. Trimming scraps and imperfect grids are returned to the associated melting pot. The pots are independent of the casting machines. Casting is

stopped at times to change from one grid type to another or to adjust the mold. These shutdowns are brief (less than 5 minutes).

Small parts casting is a manual operation. Melted lead alloy is transferred by a hand held ladle to one of several molds. After the lead cools and solidifies, the parts are removed. These parts are used at the Tiegel machine as battery element leads. Small parts casting is not done on a regular basis but the associated lead pot is kept hot even when the operation is down. Emissions from small parts casting are estimated by plant personnel to be less than 10 percent of grid casting.

Paste Mixing

Positive and negative batches of paste are mixed with the same mixer. Positive batches are always mixed first each day because residual positive paste will not affect a negative batch but residual negative paste will ruin a positive batch. Therefore, after mixing negative paste, the mixer must be thoroughly cleaned. This cleaning is done on the night shift. The number of positive and negative batches depends on plant requirements.

Lead oxide requirements are 2,400 and 1,800 pounds for a positive and negative batch, respectively. However, approximately 450 pounds of salvage material, about 5 pounds of carbon black, and a small amount of expander are added to

negative batches. The salvage material contains lead oxide that has been removed from defective plates. Carbon black is added for color coding the plates. Sulfuric acid is added to both positive and negative batches and additional water is added to the positive batch. Both types of paste are mixed approximately 21 to 24 minutes. The dumping cycle (the time interval when the mixer is vented to the baghouse) is normally 10-15 minutes. However, the average mixer charging time is approximately five minutes. If the operator is not at the mixer control station at the end of a mixing cycle, the mixer automatically shuts off and the swinging gate valve vents the mixer to the baghouse after approximately 24 minutes of mixing.

Slitting

During normal operation, the slitting machine can slit up to 196 pasted grids (392 plates) per minute. As the plates exit the slitter hood, two operators remove the plates in stacks of 50, strike them against a grated table to square them, and place several stacks in layers on skids to be taken to the curing room. The grated table is vented to the baghouse. Common causes of slitter shutdown are replacing the conveyor belt, changing grid type, changing paste type (positive or negative), and removal of defective grids.

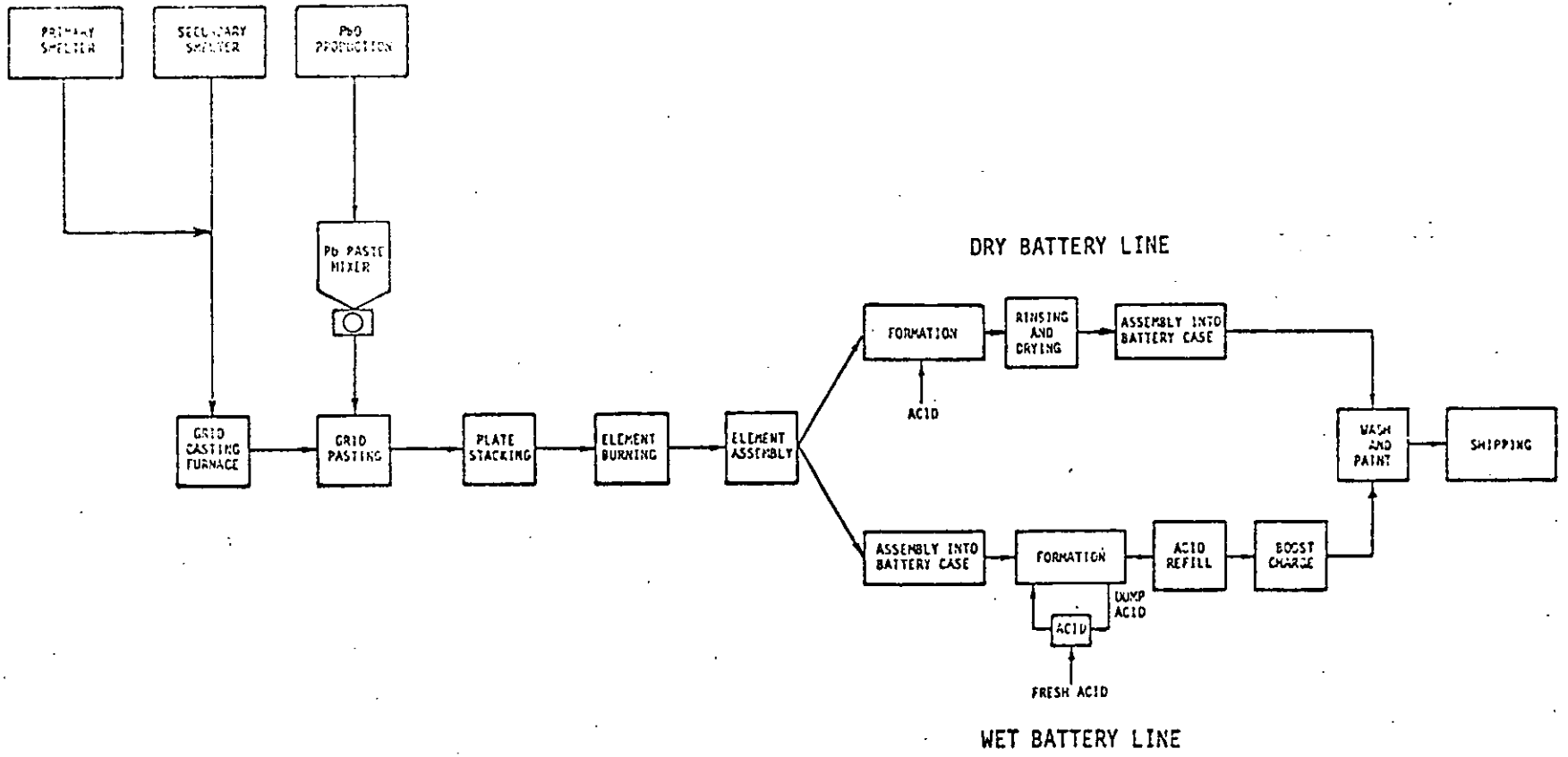


Figure 11. Process flow diagram - lead-acid battery manufacture.

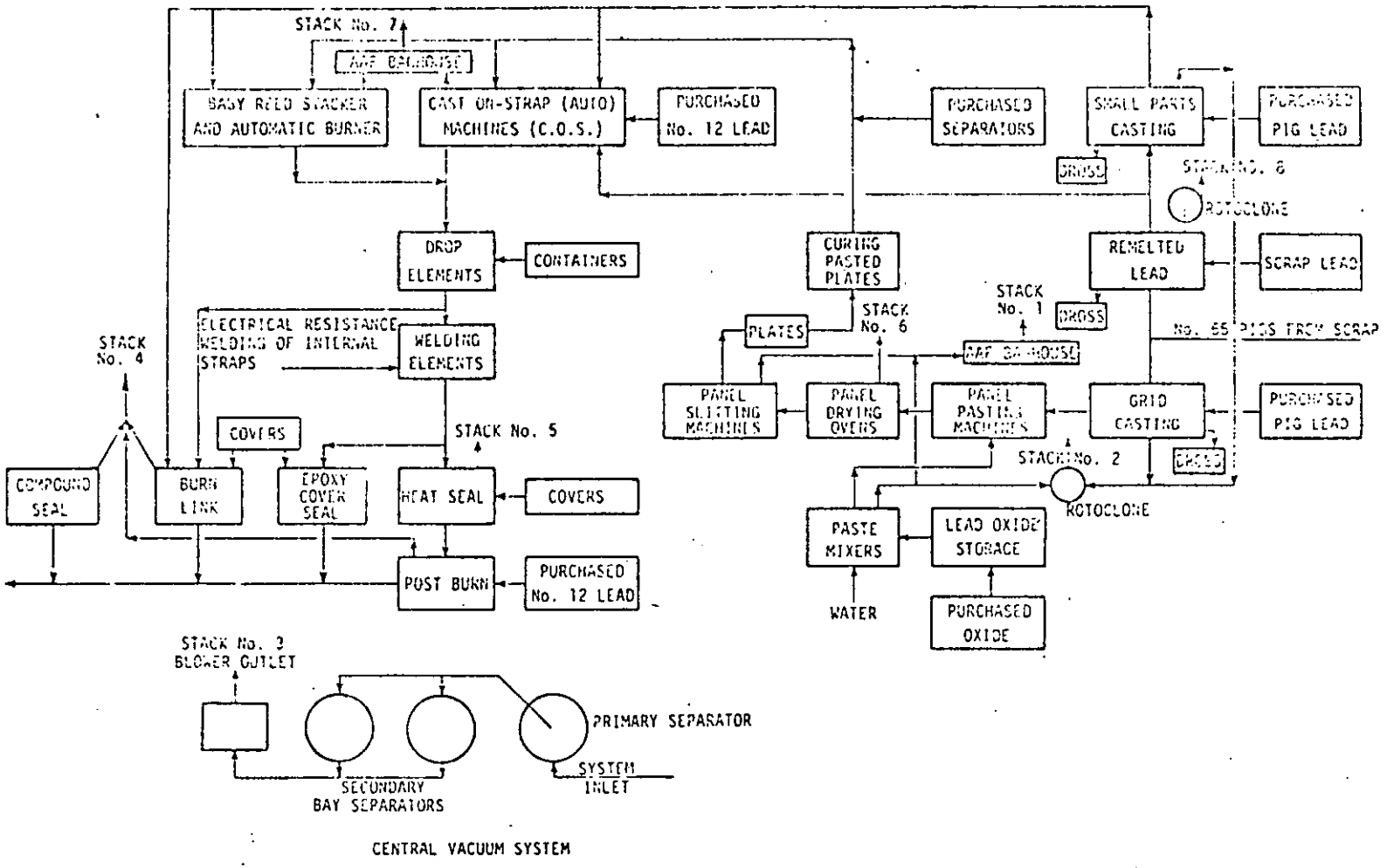


Figure 12. Production flow diagram, Globe-Union, Inc.

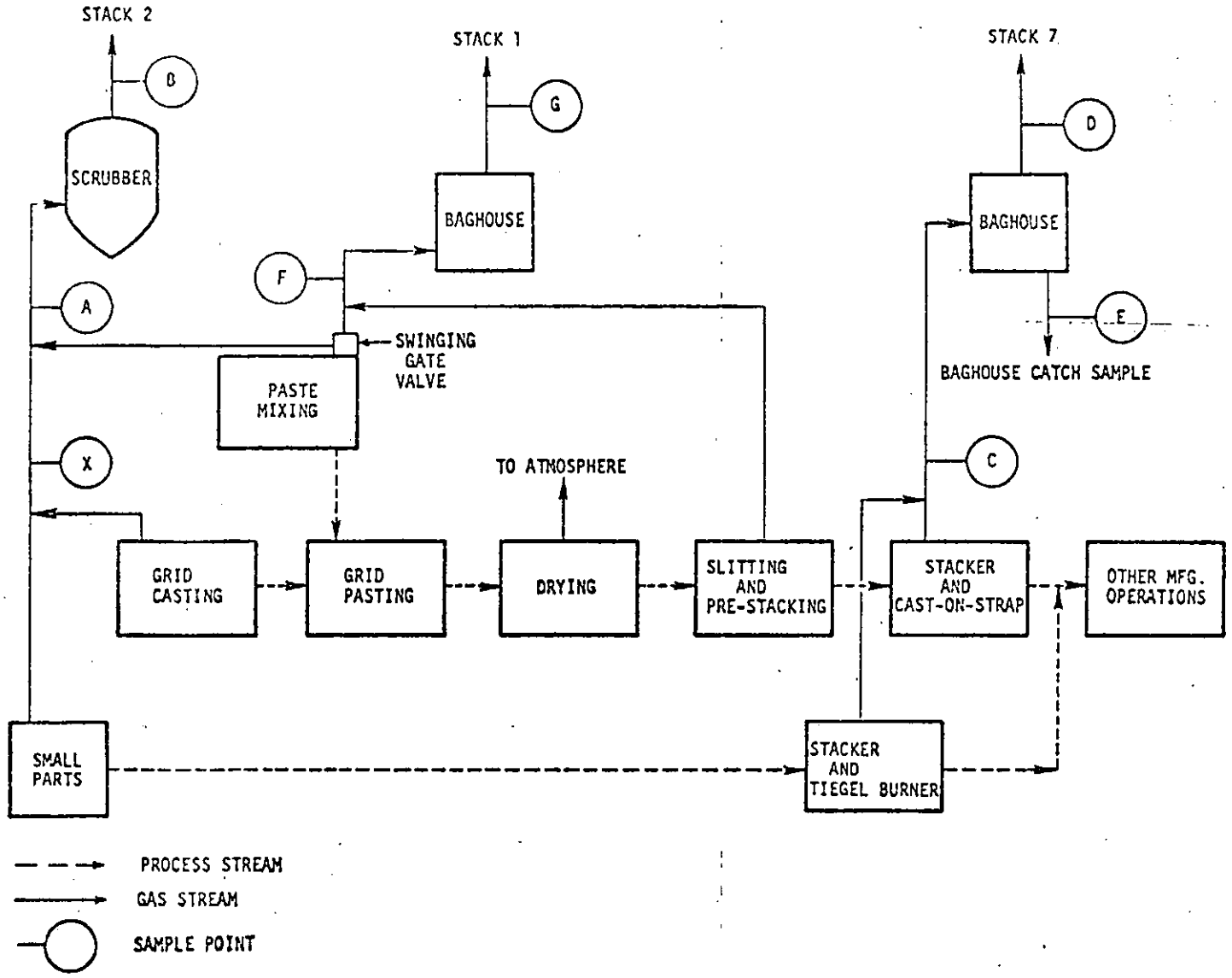


Figure 13. Source test locations for Globe Union's Canby Plant.

PROCESS OPERATION DURING SOURCE TESTS

Element Assembly (Stack 7)

All of the source tests for Globe Union's element assembly operations were done on June 15 and 16, 1976. Lead throughput for each test varied from 8,580 lb during test C and D1, down to 4,790 lb. during C and D2. However, day shift battery production was 1,532 and 1,619 batteries on the COS machines for June 15 and 16, respectively. Tiegel machine production is best stated in elements, since it produces batteries with varying voltages. On the June 15 day shift, 420 elements were produced and on the June 16 day shift, 552 elements were produced. The large variance in lead throughput was due to differences in total plate weights for each type of battery produced during each test. Table 18 shows important process parameters for each element assembly source test. For the calculations, batteries were prorated over a 7 hour day because of breaks, lunch and cleanup time.

During sample C3 and D3, one of the three COS machines was shut down for battery conversion after the test had started. Since this was a normal occurrence, testing continued. Unexpected difficulties delayed startup of the COS machine, but the stacker was operational. After determining that there was an abnormal delay in startup of the COS machine (26 minutes after shutdown), testing was discon-

tinued. Tests resumed when all processes were operating normally. Since lapses in production are common in the COS operation, the 26 minute production stoppage at one machine should not invalidate the test results for samples C3 and D3.

Grid and Small Parts Casting and Paste Mixer During Wet Cycle (Stack 2)

Uncontrolled emissions from grid and small parts casting were sampled exclusively on June 18 and 22 at Point X (Tests X1 through X4). Roto-Clone controlled emissions were sampled at Point B on June 22, 1976 when the mixer was ducted to the baghouse (Test B5). All other tests (Tests A1 through A4, B1 through B4 and B6 through B8) at Stack 2 included emissions from the paste mixing operation. The process operating mode for each test of Stack 2 was as follows:

Exhaust gases vented thru Stack 2 during test*	Test Description
Grid casting and small parts casting pot	X1, X2, B5, X3, X4
Grid casting, small parts casting pot, and mixer (sample extracted only during wet cycle of mixer)	A2, B2, B3, B4, B7, A3
Grid casting, small parts casting pot, and mixer (sample extracted over entire mixing cycle)	A1, B1, B6, B8, A4

* Tests B1 and A1, B2 and A2, B3 and X1, B4 and X2, B5 and X3, B6 and X4, B8 and A4 were conducted concurrently.

Table 18. PROCESS PARAMETERS DURING ELEMENT ASSEMBLY SOURCE TESTS

Element Assembly Test No.[a]	C1, D1	C2, D2	C3, D3
Date June 1975	15	15	16
COS battery production (day shift)	1,532	1,532	1,619
Tiegel element production (day shift)	420	420	552
Test interval (24 hour clock)	1024-1150	1415-1534	1034-1315[b]
Lead throughput, lbs			
Paste	4,880	4,440	2,540
Straps	480	480	480
Grids	3,220	2,960	1,825
Total lead	8,580	7,880	4,850

[a] Refer to Figure for location of test sites C and D.

[b] This test was stopped from 1118 to 1237 during equipment shutdown.

There were no small parts produced throughout the tests. However, the small parts pot contained molten lead and was vented to the Roto-Clone during the tests. Therefore, while the lead throughput from small parts casting is considered zero, a small amount of lead emissions may be attributed to small parts casting.

Though all lead pots associated with the casting machines were heated at all times, tests A2, B2, and B6 were run with only six of the nine grid casting machines operating. However, these tests were designed to determine emissions from the paste mixer. Tests at site X were performed to determine emissions from grid casting. Decreased grid production will not affect emissions from paste mixing.

Lead throughput for all stack 2 tests is shown in Table 19. Grid casting lead throughput was calculated by using the appropriate shift's lead usage and prorating over the test interval. Since tests were of varying time lengths, throughputs are also reported in pounds per hour. Hourly throughputs for the mixer are given for comparison only since this is a batch operation.

The mixer was operating normally throughout all applicable tests. Tests were performed during the mixing of both positive and negative pastes. Table 19A lists the types of paste mixed during the various tests.

Table 19. LEAD THROUGHPUT FOR EACH STACK 2 TEST

(SIMULTANEOUS TESTS WITH IDENTICAL LEAD THROUGHPUTS ARE LISTED TOGETHER)

Stack 3 test no.[a]	B1,A1	B7,A2	B3	X1	B4	X2	B5	X3	D6	X4	B7	A3	B8,A4
Date June 1976	17	18	18	18	18	18	22	22	22	22	23	23	23
Test interval (24 hour clock)	1010-1136	0750-0911	144-1312	1144-1248	1410-1444	1356-1456	1306-1444	1306-1406	1611-1720	1611-1720	0853-1044	0853-1047	1241-1345
Lead throughput, during test period													
Grids	1,740	1,180	820	1,120	640	1,120	1,070	1,640	1,280	1,280	1,180	1,250	1,400
Mixer	4,490	6,840	4,320	N.A.	4,000	N.A.	N.A.	N.A.	4,050	N.A.	6,850	6,850	4,580
Total	6,230	8,020	5,140	1,120	4,640	1,120	1,070	1,640	5,330	1,280	8,030	8,100	5,980
Lead throughput, lbs/hr													
Grids	1,580	1,120	1,120	1,120	1,130	1,120	1,650	1,640	1,100	1,100	1,310	1,320	1,310
Mixer	4,080	6,510	5,890	N.A.	7,060	N.A.	N.A.	N.A.	3,470	N.A.	7,610	7,210	4,290
Total	5,660	7,630	7,010	1,120	8,190	1,120	1,650	1,640	4,570	1,100	8,920	8,530	5,600

Table 19A. PASTE TYPE(S) MIXED DURING EACH APPLICABLE TEST

Positive	Negative	Positive & Negative
B1, A1	B4	B3
B2, A2	B6	
B7, A3		
B8, A4		

The weight of lead oxide used in the mix was recorded during appropriate tests. For calculation of lead throughput, the composition of the lead oxide was assumed to be 72.5 percent PbO and 27.5 percent Pb. Four-hundred fifty pounds of salvage material (in a slurry form) was used in each negative batch. A plant representative estimated that this material contained approximately 70 percent solids consisting of lead oxide and a negligible amount of lead sulfate. Lead throughput attributed to the mixer for each Stack 2 test is shown in Table .

Slitter and Paste Mixer During Dumping Cycle (Stack 1)

Slitting and stacking operations alone were tested during concurrent tests G3 and F3. All other tests (F and G 1, 2, and 4) involved the dumping cycle of the paste mixer. All tests involved concurrent samples of the baghouse inlet and outlet gas streams. The process operating mode during each test was as follows:

F1, G1	Mixer dumping cycles
F2, G2	Complete mixing cycles
F3, G3	Slitting and stacking only
F4, G4	Mixer dumping cycles

Slitting and stacking operations appeared normal throughout applicable tests. During Tests F2 and G2, there was a problem with the paste feeder which slowed slitting considerably for less than a ten minute interval. However, the overall test results should not be affected significantly. Slitting and stacking lead throughput during the tests was calculated using total number of plates slit during the shift and an average lead content of 0.324 pounds per plate. Table 20 shows the lead throughput for Stack No. 1 tests.

The mixer operated normally during the Stack 1 tests. However, both positive and negative paste batches were mixed depending on plant demand. For both batch types, PbO dumping is first initiated before the wet ingredients are added. The type of paste mixed during each pair of concurrent tests was as follows:

F1 and G1	3 positive and 1 negative
F2 and G2	1 positive
F3 and G4	Not applicable because the paste mixer was not ducted to the control device sampled during these tests
F4 and G4	3 positive

Table 20. LEAD THROUGHPUT FOR EACH STACK 1 TEST.

(CONCURRENT TESTS ARE LISTED TOGETHER)

Stack 1 test number[a]	F1,G1	F2,G2	F3,G3	F4,G4
Date, June 1976 Test interval (24 hour clock)	21 1024-1302	21 1421-1504	21 1621-1712	22 0823-0942
Lead throughput, during test period, lbs.				
Slitting and stacking	3,430	3,600	3,560	3,260
Mixer	8,860	1,990	N.A.	6,900
Total	12,300	5,590	3,560	10,160
Lead throughput, lb/hr				
Slitting and stacking	5,020	5,020	4,750	5,750
Mixer	13,000	2,780	N.A.	12,200
Total	18,000	7,800	4,750	17,900

[a] Refer to Figure for location of test sites F and G.

N.A. - Not applicable

The weight of lead oxide and of salvage slurry used in each paste mixing charging cycle was recorded for each test. Lead used in the mixer was calculated from these figures.

METHOD 22--DETERMINATION OF LEAD EMISSIONS FROM THE MANUFACTURING OF LEAD BATTERIES

1. Principle, Applicability and Range

1.1 Principle - Particulate and gaseous emissions are isokinetically sampled from the source. The collected samples are digested in acid solution and analyzed by atomic absorption spectrophotometry.

1.2 Applicability - This method is applicable for the determination of lead emissions from the manufacturing of lead batteries.

1.3 Range - The upper limit can be considerably extended by dilution. For a minimum analysis accuracy of ± 10%, a minimum lead mass of 50 µg should be collected in each sample fraction.

2. Apparatus

2.1 Sampling train. A schematic of the sampling train used in this method is shown in Figure 22-1. Commercial models of this train are available. However, if one desires to build his own, complete construction details are described in APTD-0581; for changes from the APTD-0581 document and for allowable modifications to Figure 22-1, see the following subsections.

The operating and maintenance procedures for the sampling train are described in APTD-0576. Since correct usage is important in obtaining valid results, all users should read the APTD-0576 document and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein.

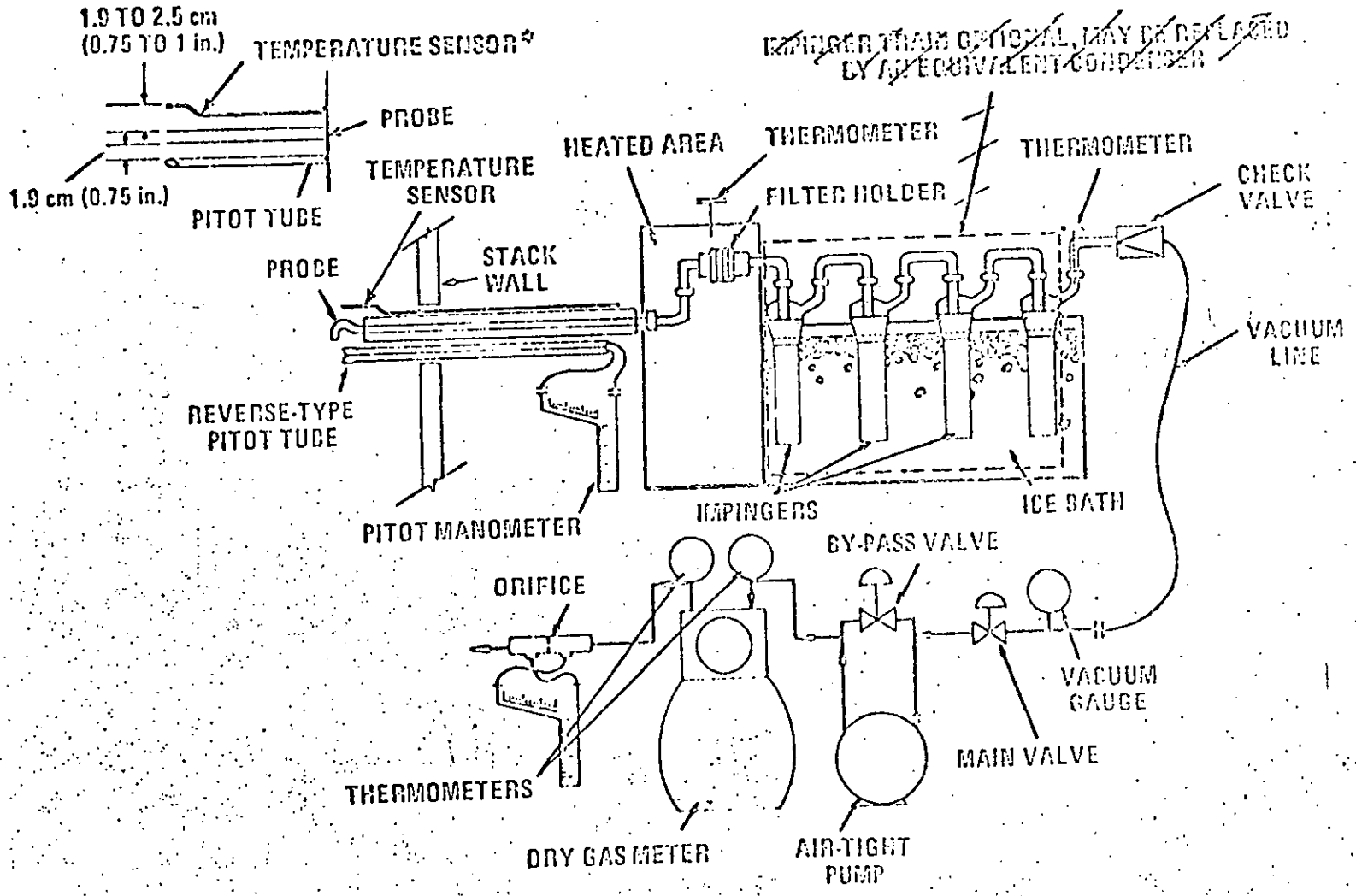


Figure 21-1. Lead Sampling Train

*If difficulty is expected in inserting the temperature sensor-pitot tube-probe assembly into the stack due to spacing requirements, the temperature sensor may be located between the probe and pitot tube so that the tip of the temperature sensor is no closer than 5cm (2 in.) from the tip of the pitot tube.

2.1.1 Probe nozzle--Stainless steel (316) with sharp, tapered leading edge. The angle of taper shall be $\leq 30^{\circ}$ and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise approved by the Administrator. The nozzle shall be constructed from seamless stainless steel tubing. Other configurations and construction material may be used subject to approval from the Administrator.

A range of sizes suitable for isokinetic sampling should be available, e.g., 0.32 cm (1/8 in.) up to 1.27 cm (1/2 in.) (or larger if higher volume sampling trains are used) inside diameter (ID) nozzles in increments of 0.16 cm (1/16 in.). Each nozzle shall be calibrated according to the procedures outlined in the calibration section.

2.1.2 Probe liner--Borosilicate or quartz glass tubing with a heating system capable of maintaining a gas temperature at the exit end during sampling of no greater than $120 \pm 14^{\circ}$ C ($248 \pm 25^{\circ}$ F) or no greater than such other temperature as specified by an applicable subpart of the standards. Since the actual temperature at the outlet of the probe is not monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 or calibrated according to the procedure outlined in APTD-0576 will be considered as acceptable.

When length limitations, i.e. greater than about 2.5 m (8.2 ft), are encountered, stainless steel (316) or Incoloy 825[1] (both of seamless tubing), or other materials as approved by the Administrator, may be used.

2.1.3 Pitot tube--Type S, or other device approved by the Administrator, attached to probe to allow constant monitoring of the stack gas velocity. The face openings of the pitot tube and the probe nozzle shall be adjacent and parallel to each other, not necessarily on the same plane, during sampling. The free space between the nozzle and pitot tube shall be at least 1.9 cm (0.75 in.). The free space shall be set based on a 1.3 cm (0.5 in.) ID nozzle. If the sampling train is designed for sampling at higher flow rates than that described in APTD-0581, thus necessitating the use of larger sized nozzles, the largest sized nozzle shall be used to set the free space.

The pitot tube must also meet the criteria specified in Method 2 and calibrated according to the procedure in the calibration section of that method.

[1]Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.1.4 Differential pressure gauge--Inclined manometer ca[pable] of measuring velocity head to within 10% of the minimum measur[ed] or ± 0.013 mm (0.0005 in.), whichever is greater. Below a diff[erential] pressure of 1.3 mm (0.05 in.) water gauge, micromanometers wi[th] sensitivities of 0.013 mm (0.0005 in.) should be used. However, micromanometers are not easily adaptable to field conditions and are not easy to use with pulsating flow. Thus, methods or other devices acceptable to the Administrator may be used when conditions warrant.

2.1.5 Filter holder--Borosilicate glass with a glass frit filter support and a silicone rubber gasket. Other materials of construction may be used with approval from the Administrator, e.g., if probe liner is stainless steel, then the filter holder may be stainless steel. The holder design shall provide a positive seal against leakage from the outside or around the filter.

2.1.6 Filter heating system--Optional. Any heating system capable of maintaining a temperature around the filter holder during sampling of no greater than 10°C (18°F above the gas dewpoint, or such other temperature as specified by an applicable subpart of the standards. A temperature gauge capable of measuring temperature to within 3° C (5.4° F) shall be installed such that temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than shown in APTD-0581 may be used.

2.1.7 ~~5~~ Impingers - Four Greenburg-Smith impingers connected in series with glass ball joint fittings. Impingers one, three, and four are modified by replacing the tip with a 1/2-inch ID glass tube extending to 1/2-inch from the flask bottom.

2.1.8 Metering system--Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3° C (5.4° F), dry gas meter with 2% accuracy, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume. Sampling trains utilizing metering systems designed for higher flow rates than that described in APTD-0581 or APTD-0576 may be used provided that the specifications in section 2 of this method are met. When the metering system is used in conjunction with a pitot tube, the system shall enable checks of isokinetic rates.

2.1.9 Barometer--Mercury, aneroid, or other barometers capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases, the barometric reading may be obtained from a nearby weather bureau station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.10 Gas density determination equipment--Temperature and pressure gauges and gas analyzer as described in Methods 2 and 3.

2.2 Sample recovery.

2.2.1 Probe liner and probe nozzle brushes--Nylon bristles with stainless steel wire handles. The probe brush shall have extensions, at least as long as the probe, of stainless steel, nylon, teflon, or similarly inert material. Both brushes shall be properly sized and shaped to brush out the probe liner and nozzle.

2.2.2 Glass wash bottles--Two.

2.2.3 Glass sample storage containers--Chemically resistant, 0.1N HNO_3 impinger and probe ~~acetone~~ washes and borosilicate glass bottles, for ~~acetone~~ washes, 500 ml or 1,000 ml. Screw cap closures shall be teflon rubber-backed liners or of such construction so as to be leak free and prevent chemical attack from 0.1N HNO_3 the ~~acetone~~. (Narrow mouth glass bottles have been found to be less prone to leakage.) Other types of containers must be approved by the Administrator.

2.2.4 Petri dishes--For filter samples, glass or polyethylene, unless otherwise specified by the Administrator.

2.2.5 Graduated cylinder and/or balance--To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances are suitable for use here and in section 2.3.4.

2.2.6 Plastic storage containers--Air tight containers to store silica gel.

2.2.7 Funnel and rubber policeman--To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

2.3 Analysis.

2.3.1 Atomic Absorption Spectrophotometer with lead hollow cathode lamp and burner for air/acetylene flame.

2.3.2 Steam bath.

2.3.3 Hot plate.

2.3.4 Reflux condensers - 24/40 ȿ to fit Erlenmeyer flasks.

2.3.5 Erlenmeyer flasks - 125 ml 24/40 ȿ.

2.3.6 Membrane filters - Millipore* SCWP0 4700 or equivalent.

2.3.7 Filtering apparatus - Millipore filtering unit, consisting of one of the assemblies shown in Figure 22-1.

2.3.8 Graduated cylinder - 50 ml.

3. Reagents

3.1 Sampling.

3.1.1 Filters--High purity glass fiber filters, without organic binder exhibiting at least 99.95% efficiency ($\leq$ 0.05% penetration) on 0.3 micron diotyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM standard method D 2986-71. Test data from the supplier's quality control program is sufficient for this purpose. Filters shall be Gelman Spectro Grade, or equivalent, with lot Assay for Pb.

3.1.2 Silica gel--Indicating type, 6-16 mesh. If previously used, dry at 175°C (350°F) for 2 hours. New silica gel may be used as received.

3.1.3 0.1 N HNO_3--Prepared from reagent grade HNO_3 and distilled water. It may be desirable to run blanks prior to field use to eliminate a high blank on test samples. Prepare by diluting 6.5 ml of concentrated nitric acid (69%) to 1 liter with distilled water.

3.1.4 Crushed ice.

additional readings when significant changes (20% variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer.

Clean the portholes prior to the test run to minimize the chance of sampling the deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe are up to temperature, and that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs are available for sampling trains using type S pitot tubes with 0.85 ± 0.02 coefficient and when sampling in air or a stack gas with equivalent density (molecular weight equal to 29 ± 4), which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations. APTD-0576 details the procedure for using these nomographs. If C_p and M_d are outside the above stated ranges, do not use the nomograph unless appropriate steps (see Reference 7.7) are taken to compensate for the deviations.

When the stack is under significant negative stack pressure (height of impinger stem), take care to close the coarse adjust valve before inserting the probe into the stack to avoid water backing into the filter holder. If necessary, the pump may be turned on with the coarse adjust valve closed.

When the probe is in position, block off the openings around the probe and porthole to prevent unrepresentative dilution of the gas stream.

Traverse the stack cross section, as required by Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the portholes, to minimize chance of extracting deposited material.

During the test run, make periodic adjustments to keep the temperature around the filter holder at the proper temperature and add more ice and, if necessary, salt to maintain a temperature of less than 20° C (68° F) at the impinger silica gel outlet to avoid excessive moisture losses. Also, periodically check the level and zero of the manometer.

If the pressure drop across the filter becomes too high making isokinetic sampling difficult to maintain, the filter may be replaced in the midst of a sample run. It is recommended that another complete filter assembly be used rather than attempting to change the filter itself. After the new filter or filter assembly is installed conduct a leak check. The leak measurement shall include the summation of all filter assembly catches.

A single train shall be used for the entire sample run, except for filter and silica gel changes. However, if approved by the Administrator, two or more trains may be used for a single test run when there are two or more ducts or sampling ports. The results shall be the total of all sampling train catches.

At the end of the sample run, turn off the pump, remove the probe and nozzle from the stack, and record the final dry gas meter reading. Perform a leak check at a vacuum equal to or greater than the maximum reached during sampling. Calculate percent isokinetic (see calculation section) to determine whether another test run should be

3.1.5 Stopcock grease--Acetone insoluble, heat stable silicone grease. This is not necessary if screw-on connectors with teflon sleeves, or similar, are used.

3.2 Pretest Preparation

3.2.1 6N HNO_3--Prepared from reagent grade HNO_3 and distilled water. Prepare by diluting 390 ml of concentrated nitric acid (69%) to 1 liter with distilled water.

3.3 Sample recovery.

3.2.1 0.1N HNO_3--Prepared from reagent grade HNO_3 and distilled water (same solution as 3.1.3)

3.4 Analysis

3.4.1 Deionized, distilled water.

3.4.2 Nitric acid, redistilled ACS reagent grade, concentrated.

3.4.3 30% HNO_3, v/v. Dilute 300 ml of redistilled concentrated nitric acid to 1 liter with deionized distilled water.

3.4.4 Stock lead standard, 100 µg Pb/ml - Dissolve 0.1598 g of reagent grade Pb $(NO_3)_2$ in about 700 ml of distilled water, add 10 ml redistilled concentrated HNO_3, and dilute to 1000 ml.

3.4.5 Lead Standards - Pipet aliquots of 1.0, 5.0, 10.0 and 20.0 ml of the 100 µg/ml stock lead standard into 100 ml volumetric flasks. Add 30 ml redistilled concentrated HNO_3 and dilute to volume with deionized distilled water. These working standards contain 1.0, 5.0, 10.0, and 20.0 µg Pb/ml, respectively. Additional standards at other concentrations should be prepared as needed. Use 30% HNO_3, v/v (Reagent 3.4.3) as the reagent blank.

3.4.6 Air - of a quality suitable for atomic absorption analysis.

3.4.7 Acetylene - of a quality suitable for atomic absorption analysis.

4. Procedure

4.1 Sampling. The sampling shall be conducted by competent personnel experienced with this test procedure.

4.1.1 Pretest preparation. All the components shall be maintained and calibrated according to the procedure described in APTD-0576. In addition to those equipment cleaning procedures, rinse all sample exposed surfaces with GN HNO_3 followed by distilled water.

Weigh approximately 200-300 g of silica gel in air tight containers to the nearest 0.5 g. Record the total weight, both silica gel and container, on the container. More silica gel may be used but care should be taken during sampling that it is not entrained and carried out from the impinger. As an alternative, the silica gel may be weighed directly in the impinger or its sampling holder just prior to the train assembly.

Check filters visually against light for irregularities, flaws or pinhole leaks.

~~Five,~~ Label the shipping containers (glass or plastic petri dishes) and keep each filter in its respective container at all times except during sampling and weighing.

4.1.2 Preliminary determinations. Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and the range of velocity heads using Method 2 and moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate calculations. Estimates may be used. However, final results will be based on actual measurements made during the test.

Select a nozzle size based on the range of velocity heads such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the differential pressure gauge is capable of measuring the minimum velocity head value to within 10%, or as specified by the Administrator.

Select a suitable probe liner and probe length such that all traverse points can be sampled. Consider sampling from opposite sides for large stacks to reduce the length of probes.

Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that the sampling time per point is not less than 2 min. or some greater time interval as specified by the Administrator and the sample volume that will be taken will exceed the required minimum total gas sample volume specified in the test procedures. The latter is based on an approximate average sampling rate. Note also that the minimum total sample volume is corrected to standard conditions.

It is recommended that 1/2 or an integral number of minutes be sampled at each point in order to avoid timekeeping errors.

In some circumstances, e.g. batch cycles, it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

4.1.3 Preparation of collection train. During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

Place 100 ml of ~~water~~ 0.1^{N} HNO_3 in each of the first two impingers, leave the third impinger empty, and place approximately 200-300 g or more, if necessary, of preweighed silica gel in the fourth impinger. Record

the weight of the silica gel and container to the nearest 0.5 g. Place the container in a clean place for later use in the sample recovery.

Using a tweezer or clean disposable surgical gloves, place the labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed so as not to allow the sample gas stream to circumvent the filter. Check filter for tears after assembly is completed.

When glass liners are used, install selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F) or an asbestos string gasket when temperatures are higher. The Viton A O-ring and asbestos string gasket are installed as a seal where the nozzle is connected to a glass liner. See APTD-0576 for details. When metal liners are used, install the nozzle as above or by a leak free direct mechanical connection. Mark probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

Unless otherwise specified by the Administrator, attach a temperature probe to the metal sheath of the sampling probe so that the sensor extends beyond the probe tip and does not touch any metal. Its position should be about 1.9 to 2.54 cm (0.75 to 1 in.) from both the pitot tube and probe nozzle to avoid interference with the gas flow.

Set up the train as in Figure 5-1, using, if necessary, a very light coat of silicone grease on all ground glass joints, greasing only the outer portion (see APTD-0576) to avoid possibility of

contamination by the silicone grease. With approval from the Administrator, a glass cyclone may be used between the probe and filter holder.

Place crushed ice around the impingers.

4.1.4 Leak check procedure--After the sampling train has been assembled, turn on and set the filter and probe heating system to the power required to reach a temperature of 120 ± 14° C (248 ± 25° F) or such other temperature as specified by an applicable subpart of the standards for the leak check. (If water condensation is not a problem the probe and/or filter heating system need not be used.) Allow time for the temperature to stabilize. If a Viton A O-ring or other leak free connection is used in assembling the probe nozzle to the probe liner, leak check the train at the sampling site by plugging the nozzle and pulling a 380 mm Hg (15 in. Hg) vacuum. (Note: A lower vacuum may be used provided that it is not exceeded during the test.) If an asbestos string is used, do not connect the probe to the train during the leak check. Instead, leak check the train as above by first plugging the inlet to the filter holder. Then connect the probe to the train and leak check at about 25 mm Hg (1 in. Hg) vacuum. A leakage rate in excess of 4% of the average sampling rate or 0.00057 m^3/min. (0.02 cfm), whichever is less, is unacceptable in either case.

The following leak check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with by-pass valve fully open and coarse adjust valve completely closed. Partially open the coarse adjust valve and slowly close the by-pass valve until 380 mm Hg (15 in. Hg) vacuum is reached. Do not reverse direction of by-pass valve. This will cause ~~water~~ impinger solution to back up into the filter holder. If 380 mm Hg (15 in. Hg) is exceeded,

either leak check at this higher vacuum or end the leak check as shown below and start over.

When the leak check is completed, first slowly remove the plug from the inlet to the probe or filter holder and immediately turn off the vacuum pump. This prevents the impingers solution from being forced backward into the filter holder and silica gel from being entrained backward into the third impinger.

Leak checks shall be conducted as described whenever the train is disengaged, e.g. for silica gel or filter changes during the test, prior to each test run, and at the completion of each test run. If leaks are found to be in excess of the acceptable rate, the test will be considered invalid. To reduce lost time due to leakage occurrences, it is recommended that leak checks be conducted between port changes at the highest vacuum reading drawn during that sampling traverse.

4.1.5 Particulate train operation--During the sampling run, isokinetic sampling rate to within 10%, or as specified by the Administrator, of true isokinetic and the temperature around the filter of no greater than 120 ± 14° C (248 ± 25° F), or as specified by an applicable subpart of the standards, shall be maintained.

For each run, record the data required on the example data sheet shown in Figure 5-2. Be sure to record the initial dry gas meter reading. Record the dry gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, and when sampling is halted. Take other data point readings at least once at each sample point during each time increment and

PLANT _____

LOCATION _____

OPERATOR _____

DATE _____

RUN NO. _____

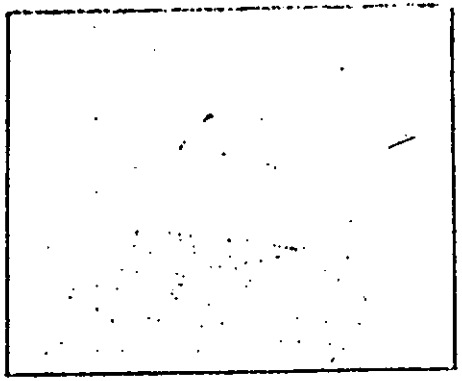
SAMPLE BOX NO. _____

METER BOX NO. _____

METER $\Delta H_@$ _____

C FACTOR _____

PITOT TUBE COEFFICIENT, C_p _____



SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE _____

BAROMETRIC PRESSURE _____

ASSUMED MOISTURE, % _____

PROBE LENGTH, m (ft) _____

NOZZLE IDENTIFICATION NO. _____

AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) _____

PROBE HEATER SETTING _____

LEAK RATE, m^3/min (cfm) _____

PROBE LINER MATERIAL _____

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE mm Hg (in Hg)	STACK TEMPERATURE (T_S) °C (°F)	VELOCITY HEAD (ΔP_S), mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERAT OF GA LEAVIN CONDENSE LAST IMPIN °C (°F
							INLET °C (°F)	OUTLET °C (°F)		
TOTAL							Avg.	Avg.		
AVERAGE							Avg.			

Figure 22-2. Field Data

the chances of contaminating or losing the sam[illegible] .ll be m[illegible]
0.1N HNO_3 sampling and

Save a portion of the ~~acetone~~ used for cle[illegible] as a bla[illegible]
0.1N HNO_3

Place about 200 ml of this ~~acetone~~ taken directly from the ~~[illegible]~~ 0.1N HNO_3
bottle being used in a glass sample container labeled "~~ace[illegible]~~ [illegible]ank."

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

Container No. 1. Carefully remove the filter from the filter holder and place in its identified petri dish container. Use a pair of tweezers and/or clean disposable surgical gloves to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Quantitatively remove any particulate matter and/or filter which adheres to the filter holder gasket by carefully using a dry nylon bristle brush and/or a sharp-edged blade and place into this container. Seal the container.

Container No. 2. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with ~~acetone~~ 0.1 N HNO_3 and placing the wash into a glass container in the following manner:

/ / /

Carefully remove the probe nozzle and clean the inside surface by rinsing with ~~acetone~~ 0.1 N HNO_3 from a wash bottle and brushing with a nylon

made. If there is difficulty in maintaining isokinetic rat to source conditions, consult with the Administrator for po e variance on the isokinetic rates.

4.2 Sample recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it to prevent losing or gaining leak. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing solution from the impingers into the filter.

Before moving the sample train to the cleanup site, remove the probe from the sample train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate, if present. Wipe off the silicone grease from the filter inlet where the probe was fastened and cap it. Remove the umbilical cord from the last impinger and cap the impinger.

After wiping off the silicone grease, cap off the filter holder outlet and impinger inlet. Either ground glass stoppers or plastic caps or serum caps may be used to close these openings.

Transfer the probe and filter-impinger assembly to the cleanup area. This area should be clean and protected from the wind so that

0.1 N HNO_3

bristle brush. Brush until acetone rinse shows no visible particles, 0.1 N HNO_3,

after which make a final rinse of the inside surface with acetone.

0.1 N HNO_3

Brush and rinse with acetone the inside parts of the Swagelok fitting in a similar way until no visible particles remain.

0.1 N HNO_3

Rinse the probe liner with acetone by tilting the probe and squirting 0.1 N HNO_3 into its upper end, while rotating the probe so that all inside surfaces will be rinsed with 0.1 N HNO_3. Let the 0.1 N HNO_3 drain from the lower end into the sample container. A funnel may be used to aid in transferring liquid washes to the container.

0.1 N HNO_3

Follow the acetone rinse with a probe brush. Hold the probe in an inclined position, squirt 0.1 N HNO_3 into the upper end as the probe brush is being pushed with a twisting action through the probe, hold a sample container underneath the lower end of the probe, and catch any 0.1 N HNO_3 and particulate matter which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the 0.1 N HNO_3 or remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. 0.1 N HNO_3 Rinse the brush with acetone and quantitatively collect these washings in the sample container. After the brushing make a final 0.1 N HNO_3 rinse of the probe as described above.

It is recommended that two people be used to clean the probe to minimize losing the sample. Between sampling runs, keep brushes clean and protected from contamination.

After ensuring that all joints are wiped clean of silicone grease, clean the inside of the front half of the filter holder by rubbing the surfaces with a nylon bristle brush and rinsing with 0.1N HNO_3. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. After all 0.1N HNO_3 washings and particulate matter are collected in the sample container, tighten the lid on the sample container so that 0.1N HNO_3 will not leak out when it is shipped to the laboratory. Measure and record the total quantity of 0.1N HNO_3 used for rinsing. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label container to clearly identify its contents.

Container No. 3. Note color of indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to the original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the walls and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure under analysis.

Container No. 4. Each of the first three impingers and their connecting

glassware is cleaned in the same manner using the following procedures:

(1) Impinger ball joints are wiped free of silicone grease and capped.

(2) Impingers are rotated and agitated using the first impinger contents as the rinse solution.

(3) The impinger parts (inner and outer tubes) must not be separated while transferring their contents to a measuring container. The outlet ball joint cap should be removed and the contents drained through this opening.

---

(4) The liquid in the first three impingers is measured either to within ± 1 ml by using a 500-ml graduated container or to within ± 0.5 g by using a balance. The volume or weight of liquid present, along with a notation of any color or film observed in the impinger catch, is recorded in the log. This amount of liquid (less the initial charge) is added to the moisture data recorded from the silica gel. The measured impinger contents are poured into the No. 4 container.

(5) Approximately 50 ml of 0.1N HNO_3 is poured into each of the three impingers and again agitated. The ~~water~~ 0.1N HNO_3 is then drained through the outlet ball joints into the No. 4 sample container as before. This operation is repeated a second time after which the impingers are inspected for any abnormal conditions.

(6) The ball joints of the glassware connecting the impingers, and the back half of the filter holder are wiped free of silicone grease and rinsed twice with 0.1N HNO_3. This rinse is placed in the impinger contents container. (Note: Do not rinse or brush the glass-fritted support.)

(7) Measure and record the total amount 0.1N HNO_3 used for rinsing.

4.3 Analysis

4.3.1 Weigh the silica gel to the nearest gram.

4.3.2 Lead Sample Preparation.

4.3.2.1 Filter. Cut the filter into strips and transfer the strips and all loose particulate matter to a 125 ml Ϙ Erlenmeyer flask. Rinse the petri dish with a small portion of distilled water to assure a quantitative transfer and add these rinsings to the flask. Evaporate the solution to dryness in a hood over a steam bath. Add 15 ml deionized distilled water and 15 ml redistilled concentrated nitric acid. Reflux for two hours and cool to room temperature. Rinse the condenser column with a small amount of deionized distilled water and remove the flask. Filter the sample through the millipore filter, rinse the filter and the remaining glass fiber mass with several small portions of deionized distilled water, and combine with the filtrate. Dilute to 50 ml, using a 50-ml graduated cylinder.

4.3.2.2 Impinger samples - Evaporate the liquid sample to approximately 15 ml, transfer to an Erlenmeyer flask, and add 15 ml of redistilled concentrated nitric acid. Reflux for two hours, rinse the condenser column, cool to room temperature, and dilute to 50 ml with deionized distilled water.

4.3.2.3 Probe wash - Treat in the same manner as directed in Section 4.3.2.2.

4.3.2.4 Filter blank - Determine a filter blank using one filter from each lot of filters used in the sampling train. Cut the filter into strips and treat in the same manner as directed in Section 4.3.2.1.

4.3.2.5 Instrument Preparation - Turn on the power, set the wavelength, slit width, and lamp current as instructed by the manufacturer's manual for the particular atomic absorption spectrophotometer. Adjust the burner and flame characteristics as necessary.

4.3.2.6 Lead Determination - After the absorbance values have been obtained for the standard curve (Section 5), determine the absorbance of the filter

blank and each sample against the reagent blank. Determine the lead concentration in the filter blank and in each sample from the standard curve. If the sample concentration falls above the limits of the curve, make an appropriate dilution with 30% v/v HNO_3 such that the final concentration falls within the range of the curve.

5. Calibration and Standards

5.1 Calibration - Determine the absorbance of the standards against the reagent blank (Section 3.4.5). These absorbances should be checked frequently during the analysis to assure that no drift has occurred. Prepare a standard curve of absorbance versus concentration. (Note: For instruments equipped with direct concentration readout devices preparation of a standard curve will not be necessary.) In all cases, the manufacturer's instruction manual should be consulted for proper calibration and operational procedures.

6. Calculations

6.1 Amount of lead collected -

$M_n = M_a \times A \times F_d$ where

M_n = Total µg of lead collected in a fraction

M_a = µg/ml of lead in the aliquot as read from the standard curve

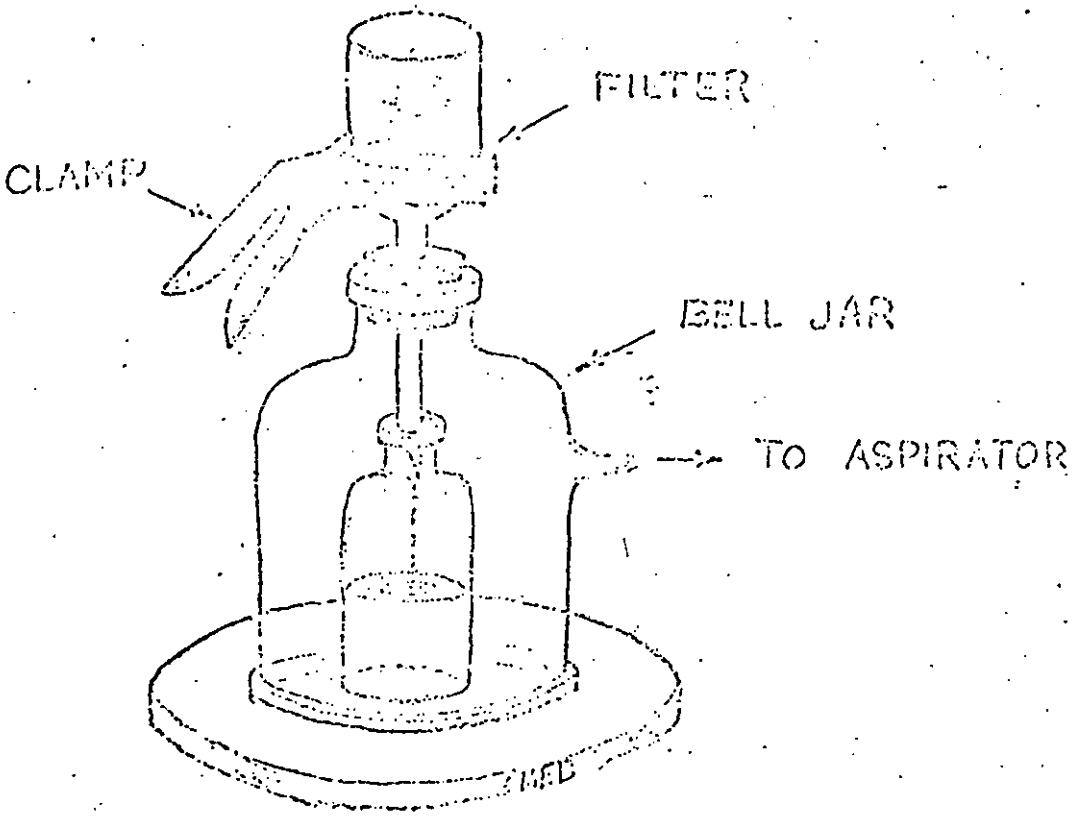
A = 50 ml/aliquot = sample volume

F_d = dilution factor = 1 if the sample hasn't been diluted

$M_t = M_n$ (filter) + M_n (probe wash) + M_n (impingers) - M_n (filter blank), where

M_t = Total lead collected

6.2 Refer to EPA Method 5 for other necessary calculations.



OR

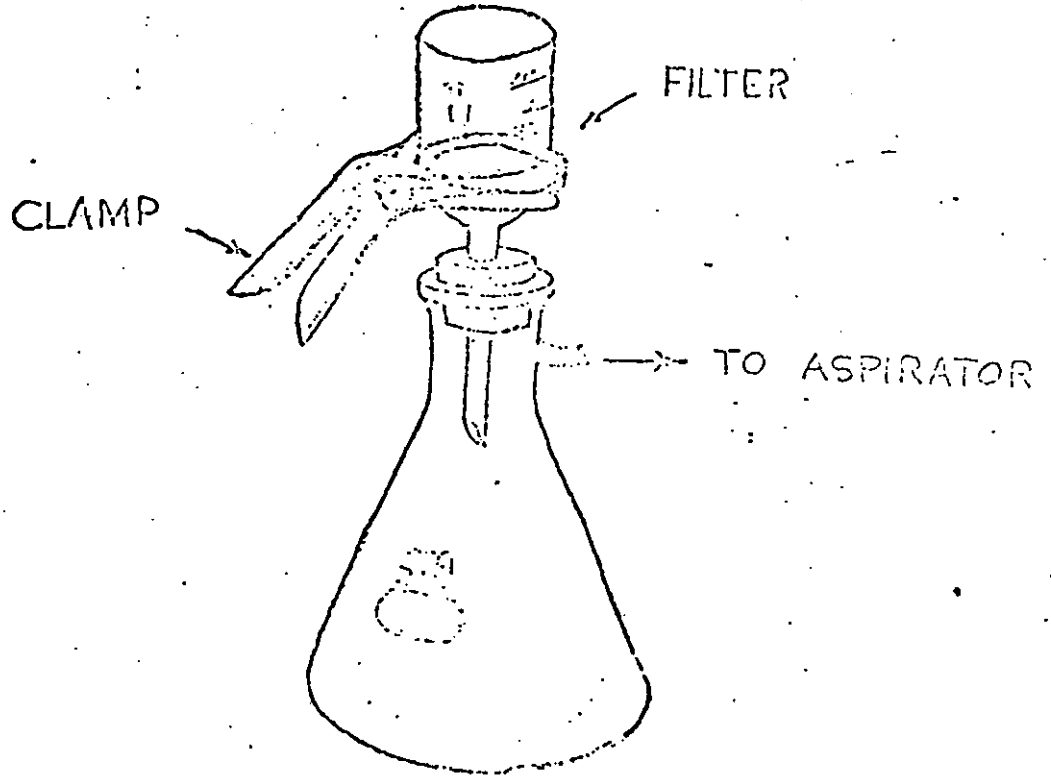


FIGURE ④ FILTERING APPARATUS

22-3

PARTICLE SIZING - SUMMARY AND DISCUSSION OF RESULTS

Particle sizing tests were conducted at all points by personnel from Monsanto Research, Inc. Because of space limitations, these samples were not obtained simultaneously but were taken during periods of similar activity in the process. Inlet samples were collected using "Brinks" apparatus. Ten-minute samples were collected in triplicate at inlets A, X, and C. Only one sample could be collected at point F due to time limitations. Outlet samples were collected using "Anderson" equipment. Three one-hour samples were collected at each outlet. All weighing was done in the plant lab using a balance belonging to Monsanto. The particle size results and size breaks can be seen on the following pages.

The results are as expected, showing good separation on the inlets and quite low loading on the outlets, confirming the efficiency of the baghouses.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	5.50
STATIC PRESSURE	IN H2O	-5.00
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.76
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	96.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	0.300		0.27	27.37	100.00
1	0.705	0.99	0.62	64.32	72.63
2	0.030	0.56	0.03	2.74	8.30
3	0.010	0.36	0.01	0.91	5.57
4	0.041	0.15	0.04	3.74	4.65
5	0.010	0.07	0.01	0.91	0.91
FILTER	0.000		0.00	0.00	0.00

Table 21.

GLORE UNION 9 SEPTEMBER 1976

CASCADE IMPACTOR PARTICLE SIZE DISTPIBUTION FOR RUN 1X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	13.97
STATIC PRESSURE	CM H2O	-12.70
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	75.59
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	35.6
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	0.300		0.01	27.37	100.00
1	0.705	0.99	0.02	64.32	72.63
2	0.030	0.56	0.00	2.74	8.30
3	0.010	0.36	0.00	0.91	5.57
4	0.041	0.15	0.00	3.74	4.65
5	0.010	0.07	0.00	0.91	0.91
FILTER	0.000		0.00	0.00	0.00

Table 22.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	5.50
STATIC PRESSURE	IN H2O	-6.00
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.92
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	93.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	1.200		1.07	59.29	100.00
1	0.701	1.00	0.62	34.63	40.71
2	0.016	0.56	0.01	0.79	6.08
3	0.028	0.36	0.02	1.38	5.29
4	0.019	0.15	0.02	0.94	3.90
5	0.010	0.07	0.01	0.49	2.96
FILTER	0.050		0.04	2.47	2.47

Table 23.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	13.97
STATIC PRESSURE	CM H2O	-15.24
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.00
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	33.9
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	1.200		0.03	59.29	100.00
1	0.701	1.00	0.02	34.63	40.71
2	0.016	0.56	0.00	0.79	6.08
3	0.028	0.36	0.00	1.38	5.29
4	0.019	0.15	0.00	0.94	3.90
5	0.010	0.07	0.00	0.49	2.96
FILTER	0.050		0.00	2.47	2.47

Table 24.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 3X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	5.50
STATIC PRESSURE	IN H2O	-6.10
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.92
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	90.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	2.300		2.05	49.84	100.00
1	0.700	1.00	0.62	15.17	50.16
2	0.001	0.56	0.00	0.02	34.99
3	0.006	0.36	0.01	0.13	34.97
4	0.004	0.15	0.00	0.09	34.84
5	0.004	0.07	0.00	0.09	34.76
FILTER	1.600		1.43	34.67	34.67

Table 25.

GLOBE UNION 9 SEPTEMBER 1976

CASCADE IMPACTOR PARTICLE SIZE DISTPIBUTION FOR RUN 3X

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	13.97
STATIC PRESSURE	CM H2O	-15.49
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.00
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	32.2
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	2.300		0.06	49.84	100.00
1	0.700	1.00	0.02	15.17	50.16
2	0.001	0.56	0.00	0.02	34.99
3	0.006	0.36	0.00	0.13	34.97
4	0.004	0.15	0.00	0.09	34.84
5	0.004	0.07	0.00	0.09	34.76
FILTER	1.600		0.04	34.67	34.67

Table 26

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	3.80
STATIC PRESSURE	IN H2O	-5.00
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.92
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	98.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	1.060		1.11	71.48	100.00
1	0.188	1.09	0.20	12.68	28.52
2	0.006	0.62	0.01	0.40	15.85
3	0.002	0.40	0.00	0.13	15.44
4	0.006	0.18	0.01	0.40	15.31
5	0.155	0.08	0.16	10.45	14.90
FILTER	0.066		0.07	4.45	4.45

Table 27.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	9.65
STATIC PRESSURE	CM H2O	-12.70
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.00
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	36.7
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	1.060		0.03	71.48	100.00
1	0.188	1.09	0.01	12.68	28.52
2	0.006	0.62	0.00	0.40	15.85
3	0.002	0.40	0.00	0.13	15.44
4	0.006	0.18	0.00	0.40	15.31
5	0.155	0.08	0.00	10.45	14.90
FILTER	0.066		0.00	4.45	4.45

Table 28.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	3.80
STATIC PRESSURE	IN H2O	-5.60
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.92
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	70.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	2.600		2.78	58.94	100.00
1	0.403	1.10	0.43	9.14	41.06
2	0.001	0.63	0.00	0.02	31.92
3	0.000	0.41	0.00	0.00	31.90
4	0.005	0.18	0.01	0.11	31.90
5	0.002	0.09	0.00	0.05	31.78
FILTER	1.400		1.49	31.74	31.74

Table 29.

GLOBE UNION 9 SEPTEMBER 1976

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	9.65
STATIC PRESSURE	CM H20	-14.22
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.00
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	21.1
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	2.600		0.08	58.94	100.00
1	0.403	1.10	0.01	9.14	41.06
2	0.001	0.63	0.00	0.02	31.92
3	0.000	0.41	0.00	0.00	31.90
4	0.005	0.18	0.00	0.11	31.90
5	0.002	0.09	0.00	0.05	31.78
FILTER	1.400		0.04	31.74	31.74

Table 30.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 3A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	3.80
STATIC PRESSURE	IN H2O	-5.60
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.92
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	77.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	0.200		0.21	11.07	100.00
1	1.005	1.10	1.07	55.65	88.93
2	0.001	0.62	0.00	0.06	33.28
3	0.000	0.41	0.00	0.00	33.22
4	0.000	0.18	0.00	0.00	33.22
5	0.000	0.09	0.00	0.00	33.22
FILTER	0.600		0.64	33.22	33.22

Table 31.

GLOBE UNION 9 SEPTEMBER 1976

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 3A

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	9.65
STATIC PRESSURE	CM H2O	-14.22
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.00
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	25.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	0.200		0.01	11.07	100.00
1	1.005	1.10	0.03	55.65	88.93
2	0.001	0.62	0.00	0.06	33.28
3	0.000	0.41	0.00	0.00	33.22
4	0.000	0.18	0.00	0.00	33.22
5	0.000	0.09	0.00	0.00	33.22
FILTER	0.600		0.02	33.22	33.22

Table 32.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	6.00
STATIC PRESSURE	IN H2O	-6.80
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.86
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	88.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	2.230		1.91	60.50	100.00
1	0.360	0.98	0.31	9.77	39.50
2	0.091	0.55	0.08	2.47	29.73
3	0.074	0.35	0.06	2.01	27.27
4	0.021	0.15	0.02	0.57	25.26
5	0.010	0.06	0.01	0.27	24.69
FILTER	0.900		0.77	24.42	24.42

Table 33.

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CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	15.24
STATIC PRESSURE	CM H2O	-17.27
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	75.84
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	31.1
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	2.230		0.05	60.50	100.00
1	0.360	0.98	0.01	9.77	39.50
2	0.091	0.55	0.00	2.47	29.73
3	0.074	0.35	0.00	2.01	27.27
4	0.021	0.15	0.00	0.57	25.26
5	0.010	0.06	0.00	0.27	24.69
FILTER	0.900		0.02	24.42	24.42

Table 34.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	6.00
STATIC PRESSURE	IN H2O	-6.90
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.86
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	97.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	2.200		1.87	60.98	100.00
1	0.315	0.97	0.27	8.73	39.02
2	0.123	0.55	0.10	3.41	30.29
3	0.073	0.35	0.06	2.02	26.88
4	0.047	0.15	0.04	1.30	24.86
5	0.050	0.06	0.04	1.39	23.56
FILTER	0.800		0.68	22.17	22.17

Table 35.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 2C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	15.24
STATIC PRESSURE	CM H2O	-17.53
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	75.84
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	36.1
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	2.200		0.05	60.98	100.00
1	0.315	0.97	0.01	8.73	39.02
2	0.123	0.55	0.00	3.41	30.29
3	0.073	0.35	0.00	2.02	26.88
4	0.047	0.15	0.00	1.30	24.86
5	0.050	0.06	0.00	1.39	23.56
FILTER	0.800		0.02	22.17	22.17

Table 36.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 3C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	6.00
STATIC PRESSURE	IN H2O	-7.00
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	29.86
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	106.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	3.100		2.62	65.00	100.00
1	1.641	0.97	1.39	34.41	35.00
2	0.025	0.54	0.02	0.52	0.59
3	0.003	0.35	0.00	0.06	0.06
4	0.000	0.15	0.00	0.00	0.00
5	0.000	0.06	0.00	0.00	0.00
FILTER	0.000		0.00	0.00	0.00

Table 37.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 3C

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	15.24
STATIC PRESSURE	CM H2O	-17.78
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	75.84
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	41.1
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	3.100		0.07	65.00	100.00
1	1.641	0.97	0.04	34.41	35.00
2	0.025	0.54	0.00	0.52	0.59
3	0.003	0.35	0.00	0.06	0.06
4	0.000	0.15	0.00	0.00	0.00
5	0.000	0.06	0.00	0.00	0.00
FILTER	0.000		0.00	0.00	0.00

Table 38.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1F

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	IN HG	3.40
STATIC PRESSURE	IN H2O	-8.60
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	IN HG	30.12
GAS MOL WT		28.8
GAS TEMPERATURE	DEG F	106.0
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STATE	WT OF MATERIAL	DPC	MG/ACF	WT PCNT	CUM WT PCNT
CYCLONE	2.100		2.29	47.13	100.00
1	0.903	1.11	0.98	20.26	52.87
2	0.055	0.63	0.06	1.23	32.61
3	0.081	0.41	0.09	1.82	31.37
4	0.002	0.18	0.00	0.04	29.56
5	0.015	0.09	0.02	0.34	29.51
FILTER	1.300		1.42	29.17	29.17

Table 39.

CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION FOR RUN 1F

INPUT VARIABLE	UNITS	INPUT DATA
SAMPLING TIME	MIN	10.0
PRESSURE DROP	CM HG	8.64
STATIC PRESSURE	CM H2O	-21.84
PARTICLE DENSITY	G/CC	9.53
BAROMETRIC PRESSURE	CM HG	76.50
GAS MOL WT		28.8
GAS TEMPERATURE	DEG C	41.1
GAS VISCOSITY	POISE	0.00019
GAS DENSITY	G/CC	0.00100

STAGE	WT OF MATERIAL	DPC	MG/ACM	WT PCNT	CUM WT PCNT
CYCLONE	2.100		0.06	47.13	100.00
1	0.903	1.11	0.03	20.26	52.87
2	0.055	0.63	0.00	1.23	32.61
3	0.081	0.41	0.00	1.82	31.37
4	0.002	0.18	0.00	0.04	29.56
5	0.015	0.09	0.00	0.34	29.51
FILTER	1.300		0.04	29.17	29.17

Table 40.

Table 41. Andersen Particle Size Data

RUN 1D

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>3.43	1.8	58.06	100.00
0	3.43	0.1	3.23	41.94
1	2.22	0	0	38.71
2	1.51	0	0	38.71
3	1.05	0.4	12.90	38.71
4	.670	0.4	12.90	25.81
5	.343	0.3	9.68	12.91
6	.209	0.1	3.23	3.23
7	.141	0	0	0
F	<.141	0	0	0

RUN 2D

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>3.63	0.3	60.00	100.00
0	3.63	0.1	20.00	40.00
1	2.29	0	0	0
2	1.51	0	0	0
3	1.06	0.1	20.00	20.00
4	.684	0	0	0
5	.347	0	0	0
6	.210	0	0	0
7	.139	0	0	0
F	<.139	0	0	0

RUN 3D

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	73.57	0.7	35.00	100.00
0	3.57	0	0	0
1	2.22	0	0	0
2	1.48	0.1	5.00	65.00
3	1.03	0.3	15.00	60.00
4	.655	0.3	15.00	45.00
5	.330	0.5	25.00	30.00
6	.203	0.1	5.00	5.00
7	.137	0	0	0
F	<.137	0	0	0

Table 42. Andersen Particle Size Data - Continued

RUN 1B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.13	1.1	35.48	100.00
0	4.13	0.1	3.23	64.52
1	2.58	0.4	12.90	61.29
2	1.74	0.2	6.45	48.39
3	1.22	0.2	6.45	41.94
4	.796	0	0	35.49
5	.393	0.1	3.23	35.49
6	.240	0.3	9.68	32.26
7	.161	0.2	6.45	22.58
F	<.161	0.5	16.13	16.13

RUN 2B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.06	1.2	63.16	100.00
0	4.06	0.1	5.26	36.85
1	2.55	0	0	31.59
2	1.71	0	0	31.59
3	1.21	0	0	31.59
4	.822	0	0	31.59
5	.383	0	0	31.59
6	.235	0.2	10.53	31.59
7	.158	0.2	10.53	21.06
F	<.158	0.2	10.53	10.53

RUN 3B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.00	0.9	37.50	100.00
0	4.00	0.1	4.17	62.50
1	2.51	0.2	8.333	58.33
2	1.68	0	0	49.99
3	1.18	0	0	49.99
4	.739	0	0	49.99
5	.377	0.2	8.333	50.00
6	.232	0.2	8.333	41.67
7	.155	0.2	8.333	33.33
F	<.155	0.6	25.00	25.00

Table 43. Andersen Particle Size Data - Continued

RUN 4B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.19	1.1	42.31	100.00
0	4.19	0.1	3.85	57.69
1	2.65	0.2	7.69	53.84
2	1.75	0	0	46.15
3	1.24	0	0	46.15
4	.773	0	0	46.15
5	.400	0.2	7.69	46.15
6	.242	0.2	7.69	38.46
7	.163	0.2	7.69	30.77
F	<.163	0.6	23.08	23.08

RUN 5B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.23	1.0	29.41	100.00
0	4.23	0	0	70.59
1	2.69	0.1	2.94	70.59
2	1.76	0.1	2.94	67.65
3	1.24	0.2	5.882	64.71
4	.873	0.2	5.882	58.82
5	.400	0.2	5.882	52.94
6	.242	0.7	20.59	47.06
7	.164	0.3	8.82	26.47
F	<.164	0.6	17.65	17.65

RUN 6B

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.23	0.4	23.53	100.00
0	4.23	0	0	76.47
1	2.69	0	0	76.47
2	1.76	0	0	76.47
3	1.24	0	0	76.47
4	.873	0.1	5.88	76.47
5	.400	0.2	11.76	70.59
6	.242	0.3	17.65	58.83
7	.164	0.3	17.65	41.18
F	<.164	0.4	23.53	23.53

Table 44. Andersen Particle Size Data - Continued

RUN 1G

Stack	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.63	0.2	66.67	100.00
0	4.63	0	0	33.33
1	2.95	0	0	33.33
2	1.91	0	0	33.33
3	1.34	0	0	33.33
4	.857	0	0	33.33
5	.437	0	0	33.33
6	.269	0	0	33.33
7	.182	0	0	33.33
F	<.182	0.1	33.33	33.33

RUN 2G

Stack	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.10	0.6	54.55	100.00
0	4.10	0	0	45.45
1	2.56	0	0	45.45
2	1.71	0	0	45.45
3	1.21	0	0	45.45
4	.833	0.1	9.09	45.45
5	.383	0.2	18.18	36.36
6	.235	0.1	9.09	18.18
7	.160	0	0	9.09
F	<.160	0.1	9.09	9.09

RUN 3G

Stack	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.00	0.8	72.73	100.00
0	4.00	0	0	27.27
1	2.51	0	0	27.27
2	1.69	0.1	9.09	27.27
3	1.19	0.1	9.09	18.18
4	.806	0.1	9.09	9.09
5	.377	0	0	0
6	.232	0	0	0
7	.155	0	0	0
F	<.155	0	0	0

Table 45. Andersen Particle Size Data - Continued

RUN 4G

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.00	0.7	53.85	100.00
0	4.00	0.1	7.69	46.15
1	2.51	0.1	7.69	38.46
2	1.68	0	0	30.77
3	1.19	0.2	15.385	30.77
4	.806	0.2	15.385	15.385
5	.377	0	0	0
6	.232	0	0	0
7	.155	0	0	0
F	<.155	0	0	0

RUN 5G

Stage	DPC	Wt of Material (mg)	WT PCT	CUM WT PCT
nozzle	>4.03	1.5	78.95	100.00
0	4.03	0	0	21.05
1	2.52	0	0	21.05
2	1.69	0	0	21.05
3	1.19	0.1	5.26	21.05
4	.809	0.1	5.26	15.79
5	.377	0.2	10.53	10.53
6	.233	0	0	0
7	.156	0	0	0
F	<.156	0	0	0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Analysis of Filter Strips from Lead Acid Battery Industry DATE: September 24, 1976

FROM: Robert H. Jungers, Chief RHJ
EMSL:ACB:SFMCS (MD-78)

TO: Mr. Tom Bibb
(MD-13)

P.O. Robert Martin
Ref: Globe Union, Canby, Oregon

The samples were submitted on 1 inch by 8 inch glass fiber filter strips. The samples and blanks were acid extracted and the extract analyzed by optical emission spectrography.

Because no sample were provided the blank corrected results are reported in micrograms of element per as received sample. Lead was found in all samples while autimony, silver, tin, and iron were found in lesser amounts in a few samples.

Point	Sample No.	Pb	Sb	Ag	Sn	Fe	Mn	Cr
B-outlet	S-77-002-061	87.	17	1.6	1.7	18	0.1	1.3
	S-77-002-062	86.	17	<0.1	1.7	18	<0.05	<0.2
	S-77-002-063	92.	9	<0.1	1.8	<0.3	<0.05	<0.2
D-outlet	S-77-002-064	340	<0.05	<0.1	<0.2	<0.3	<0.05	<0.2
	S-77-002-065	180	<0.05	<0.1	<0.2	<0.3	<0.05	<0.2
	S-77-002-066	180	<0.05	0.2	<0.2	<0.3	<0.05	<0.2
C-outlet	S-77-002-067	35	<0.05	<0.1	<0.2	<0.3	<0.05	<0.2
	S-77-002-068	360	<0.05	<0.1	<0.2	<0.3	<0.05	<0.2
	S-77-002-069	560	<0.05	<0.1	<0.2	<0.3	<0.05	<0.2

Table 46.

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