AP-42 Section Number: 12.15

Reference Number: 4

Title: Source Test

EPA-74-BAT-1

US EPA

March 1974

STORAGE BATTERY
PRODUCTION
AP-42 Section 7.15
Reference Number
2

74-BAT-1

(REPORT NUMBER)

65068

H616-9

AIR POLLUTION EMISSION TEST

(PLANT NAME)

ESB, Incorporated

(PLANT ADDRESS)

Milpitas, California

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

PEDCo-ENVIRONMENTAL
SUITE 8 · ATKINSON SQUARE
CINCINNATI, OHIO 45246
513/771-4330

65068

ORIG

TEST NUMBER 74-BAT-1

ESB INCORPORATED

MILPITAS, CALIFORNIA

September, 1973

Prepared by:

Norman Kulujian, P.E.

Contract No. 68-02-0237
Task 28

EPA Project Officers: John Snyder
Susan Wyatt

Prepared for

U.S. Environmental Protection Agency
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

Final Report: March 1974

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ACKNOWLEDGEMENT

It is impossible to acknowledge every ESB individual who cooperated with test personnel, but special recognition is given to Mr. Robert Kriesman, who manipulated plant schedules for our convenience.

Miss Susan Wyatt, ESED, and Mr. John Snyder, EMB, are two EPA Engineers responsible for this study's direction and management.

The testing crew consisted of Mr. Al O'Connor, Mr. Gene Forte, Mr. Ed Meer, and Mr. John Adkins. Mr. Richard Gerstle reviewed the final report.

I. INTRODUCTION

Emission tests from sources using lead constituents will provide data needed to develop emission factors, which will determine the extent of nationwide lead emissions. A Preferred Standards Path Analysis for Lead (PSPAL) will determine whether a specific standard for lead is warranted, and, if so, whether it should be an air quality, new source performance, or hazardous pollutant standard.

The ESB plant located in Milpitas, California, manufacturing motor vehicle batteries, was considered to be a good emission testing model. This plant contains three casting furnaces with no control equipment, a paste mixer with a scrubber system, and the stacking, element burning, and casing operation which vented into a baghouse. A schematic diagram of the ESB operation is Shown in Figure 3.1. An initial survey of the plant by PEDCo-Environmental Specialists in August 1973 confirmed that the process operation and vent system layout would provide suitable test data.

Triplicate tests were conducted to determine particulate and lead emission rates at the inlet and outlet of each control system. The casting furnace has no control device and therefore only one sampling location was used.

The tests were performed September 24-28, 1973 by PEDCo-Environmental Specialists using a five man crew. No EPA personnel were on site, and all pertinent process information was obtained by the PEDCo crew leader.

Three two hour tests were performed September 25 on the continuously operating casting furnaces. Two mixer tests were scheduled on September 26, but a motor burned out forcing the operation down. Therefore the three process (stacking, burning, and battery assembly) emission tests were conducted on September 26th and 27th. A new motor for the paste mixer was installed and tests were performed on September 27th and 28th.

In the paste mixing operation, lead oxide and other components are dumped into the mixer approximately every 3 to 4 hours. Maximum concentrations were expected (and observed) at the time the material entered the mixer. Test sequences were carefully run to ensure that one "dump" occurred during each of the three mixer tests.

II. SUMMARY AND DISCUSSION OF RESULTS

A total of nine runs were made during the testing period for the determination of lead and particulate matter. Three runs were made on the casting furnace, three process operation, and paste mixer. A run consisted of the simultaneous collection of an isokinetic sample at the inlet and outlet of the control device (except the casting furnace which was uncontrolled).

An overall test summary of particulate and lead concentrations is presented in Tables 2.1 through 2.3 in U.S. and metric units. Tables 2.4 through 2.6 tabulate the data for each of the three processes. Control device efficiencies appear in Table 2.7. Lead concentrations in the three process and past mixer operations are shown in Table 2.8.

A comparison of the process and emission variables for each set of three tests do not display significant variation. Therefore every group of data can confidently be averaged to obtain emission factors.

A slight (nine percent) increase in flow volume occurred in the three process operation between the inlet and outlet sampling sites. A leak in the system could account for excess air being sucked into the system by the ID fan.

The only complications that arose during testing was that water was left out of the impingers for the first inlet mixer

Table 2.1 OVERALL SUMMARY OF RESULTS FROM CASTING FURNACE

Pollutant	Units		Particulate				Lead			
Measurement System	U. S.	Metric	U. S.		Metric		U. S.		Metric	
				Outlet		Outlet		Outlet		Outlet
Volume of Gas Sampled	DSCF[b]	DNm^3[e]		98.261		2.782		98.261		2.782
Percent Moisture by Volume	%	%		2.20		2.20		2.20		2.20
Average Stack Temperature	°F	°C		234		112		234		112
Dry Stack Volumetric Flow Rate	DSCFM[c]	DNm^3/sec[f]		398.8		0.1882		398.8		0.1882
Actual Stack Volumetric Flow Rate	ACFM[d]	M^3/sec[g]		533.4		0.2517		533.4		0.2517
Percent Isokinetic	%	%		99.2		99.2		99.2		99.2
Feed Rate	Ton/hr	Mton/hr		0.1575		0.1429		0.1575		0.1429
Partial Catch[a]										
Weight	mg	mg		42.3		42.3		12.25		12.25
Concentration/Dry Volume	gr/DSCF	mg/DN_3^m		0.00659		15.1		0.00189		4.33
Concentration/Actual Volume	gr/ACF	mg/m^3		0.00492		11.3		0.00141		3.23
Concentration/Time	lb/hr	kg/hr		0.0226		0.0102		0.00653		0.00296
Lb/ton, Feed Concentration/ Input Feed Rate	lb/ton	kg/Mton		0.144		0.0718		0.0415		0.0207
Total Catch										
Weight	mg	mg		57.9		57.9		12.41		12.41
Concentration/Dry Volume	gr/DSCF	mg/DN_3^m		0.00909		20.8		0.00191		4.39
Concentration/Actual Volume	gr/ACF	mg/m^3		0.00679		15.5		0.00143		3.27
Concentration/Time	lb/hr	kg/hr		0.0311		0.0141		0.00663		0.00301
Lb/ton, Feed Concentration/ Input Feed Rate	lb/ton	kg/Mton		0.197		0.0985		0.0421		0.0211
Percent Impinger Catch	%	%		27.4		27.4		1.39		1.39

a) Partial catch includes probe, cyclone, and filter.
b) Dry standard cubic feet at 70°F, 29.92 in. Hg.
c) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
d) Actual cubic feet per minute.
e) Dry normal cubic meters at 21.1°C, 760 mm Hg.
f) Dry normal cubic meters per second at 21.1°C, 760 mm Hg.
g) Actual cubic meters per second.
h) Input feed rate is pure lead fed into furnace.

Overall summary based on average from three emission tests.

Table 2.2 OVERALL SUMMARY OF RESULTS FROM THREE PROCESS OPERATION

Pollutant Measurement System	Units		Particulate				Lead			
			U. S.		Metric		U. S.		Metric	
	U. S.	Metric	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Volume of Gas Sampled	DSCF[b]	DNm^3[e]	74.542	82.582	2.111	2.338	74.542	82.582	2.111	2.338
Percent Moisture by Volume	%	%	1.06	1.02	1.06	1.02	1.06	1.02	1.06	1.02
Average Stack Temperature	°F	°C	80	90	27	32	80	90	27	32
Dry Stack Volumetric Flow Rate	DSCFM[c]	DNm^3/sec[f]	11473	12573	5.414	5.933	11473	12573	5.414	5.933
Actual Stack Volumetric Flow Rate	ACFM[d]	M^3/sec[g]	11850	13166	5.592	6.213	11850	13166	5.592	6.213
Percent Isokinetic	%	%	104.1	105.2	104.1	105.2	104.1	105.2	104.1	105.2
Feed Rate	Ton/hr	Mton/hr	-	-	-	-	-	-	-	-
Partial Catch[a]										
Weight	mg	mg	37.1	24.2	37.1	24.2	8.83	0.17	8.83	0.17
Concentration/Dry Volume	gr/DSCF	mg/DN^3	0.00771	0.00451	17.6	10.3	0.00183	0.000031	4.20	0.072
Concentration/Actual Volume	gr/ACF	mg/m^3	0.00755	0.00430	17.3	9.85	0.00178	0.000029	4.07	0.067
Concentration/Time	lb/hr	kg/hr	0.756	0.486	0.343	0.220	0.179	0.0034	0.0813	0.0015
Lb/ton, Feed Concentration/ Input Feed Rate	lb/ton	kg/Mton	-	-	-	-	-	-	-	-
Total Catch										
Weight	mg	mg	72.1	51.1	72.1	51.1	9.03	0.30	9.03	0.30
Concentration/Dry Volume	gr/DSCF	mg/DN^3	0.01494	0.00955	34.19	21.85	0.00187	0.000056	4.29	0.13
Concentration/Actual Volume	gr/ACF	mg/m^3	0.01450	0.00911	33.17	20.85	0.00182	0.000054	4.16	0.12
Concentration/Time	lb/hr	kg/hr	1.469	1.029	0.6665	0.4666	0.184	0.0061	0.0833	0.0028
Lb/ton, Feed Concentration/ Input Feed Rate	lb/ton	kg/Mton	-	-	-	-	-	-	-	-
Percent Impinger Catch	%	%	48.0	52.8	48.0	52.8	2.30	44.0	2.30	44.0

a) Partial catch includes probe, cyclone, and filter.
b) Dry standard cubic feet at 70°F, 29.92 in. Hg.
c) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
d) Actual cubic feet per minute.
e) Dry normal cubic meters at 21.1°C, 760 mm Hg.
f) Dry normal cubic meters per second at 21.1°C, 760 mm Hg.
g) Actual cubic meters per second.

Overall summary based on average from three emission tests.

Table 2.3 OVERALL SUMMARY OF RESULTS FROM PASTE MIXER

Pollutant Measurement System	Units		Particulate				Lead			
			U. S.		Metric		U. S.		Metric	
	U. S.	Metric	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Volume of Gas Sampled	DSCF[b]	DNm^3[e]	97.120	55.959	2.750	1.585	97.120	55.959	2.750	1.585
Percent Moisture by Volume	%	%	3.75	5.33	3.75	5.33	3.75	5.33	3.75	5.33
Average Stack Temperature	°F	°C	104	87	40	31	104	87	40	31
Dry Stack Volumetric Flow Rate	DSCFM[c]	DNm^3/sec[f]	927.7	909.3	0.4378	0.4291	927.7	909.3	0.4378	0.4291
Actual Stack Volumetric Flow Rate	ACFM[d]	M^3/sec[g]	1027	986.1	0.4848	0.4653	1027	986.1	0.4848	0.4653
Percent Isokinetic	%	%	106.0	101.9	106.0	101.9	106.0	101.9	106.0	101.9
Feed Rate	Ton/hr	Mton/hr	0.889	0.889	0.806	0.806	0.889	0.889	0.806	0.806
Partial Catch[a]										
Weight	mg	mg	369.3	36.0	369.3	36.0	212.5	18.33	212.5	18.33
Concentration/Dry Volume	gr/DSCF	mg/DN^3	0.05868	0.00994	134.3	22.75	0.03379	0.00505	77.32	11.6
Concentration/Actual Volume	gr/ACF	mg/m^3	0.05298	0.00916	121.2	20.97	0.03046	0.00465	69.68	10.6
Concentration/Time	lb/hr	kg/hr	0.466	0.0774	0.212	0.0351	0.268	0.0394	0.122	0.0179
Lb/ton, Feed Concentration/ Rate of Product Output	lb/ton	kg/Mton	0.524	0.0870	0.262	0.0435	0.302	0.0443	0.151	0.0222
Total Catch										
Weight	mg	mg	386.6	51.6	386.6	51.6	212.7	18.50	212.7	18.50
Concentration/Dry Volume	gr/DSCF	mg/DN^3	0.06140	0.01424	140.5	32.59	0.03382	0.00510	77.39	11.7
Concentration/Actual Volume	gr/ACF	mg/m^3	0.05547	0.01313	126.9	30.04	0.03049	0.00470	69.77	10.8
Concentration/Time	lb/hr	kg/hr	0.488	0.110	0.221	0.500	0.268	0.0398	0.122	0.0180
Lb/ton, Feed Concentration/ Rate of Product Output	lb/ton	kg/Mton	0.545	0.124	0.273	0.062	0.302	0.0447	0.151	0.0224
Percent Impinger Catch	%	%	4.36	30.2	4.36	30.2	0.11	0.91	0.11	0.91

a) Partial catch includes probe, cyclone, and filter.
b) Dry standard cubic feet at 70°F, 29.92 in. Hg.
c) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
d) Actual cubic feet per minute.
e) Dry normal cubic meters at 21.1°C, 760 mm Hg.
f) Dry normal cubic meters per second at 21.1°C, 760 mm Hg.
g) Actual cubic meters per second.

Overall summary based on average from three emission tests.

Table 2.4. PARTICULATE AND LEAD EMISSION DATA SUMMARY CASTING FURNACE - ESB, MILPITAS, CALIFORNIA

Run	1	2	3
Date	9-25-73	9-25-73	9-25-73
Volume of Gas Sampled-DSCF[a]	107.19	101.042	86.553
Percent Moisture by Volume	2.13	2.13	2.33
Average Stack Temperature-°F	227	237	239
Stack Volumetric Flow Rate-DSCFM[b]	419.2	408.6	368.5
Stack Volumetric Flow Rate-ACFM[c]	555.2	548.3	496.8
Percent Isokinetic	103.1	99.7	94.7
Percent CO_2	1.8	1.9	1.7
Percent O_2	19.7	19.0	19.3
Percent CO	0.0	0.0	0.0
Feed Rate-ton/hr	0.1575	0.1575	0.1575
Particulates-probe and filter catch			
mg	43	54.5	29.5
gr/DSCF	0.00619	0.00832	0.00525
gr/ACF	0.00468	0.00620	0.00390
lb/hr	0.0222	0.0291	0.0166
lb/ton feed[d]	0.141	0.185	0.105
Particulates-total catch			
mg	52.7	73.6	47.5
gr/DSCF	0.00758	0.01124	0.00846
gr/ACF	0.00573	0.00837	0.00628
lb/hr	0.0272	0.0394	0.0267
lb/ton feed[d]	0.173	0.249	0.169
Percent impinger catch	18.4	26.0	37.9
Lead-probe and filter catch			
mg	10.25	20.00	6.50
gr/DSCF	0.00147	0.00305	0.00115
gr/ACF	0.00111	0.00227	0.00085
lb/hr	0.00528	0.0107	0.00362
lb/ton feed[d]	0.0335	0.0679	0.0230
Lead-total catch			
mg	10.36	20.23	6.63
gr/DSCF	0.00149	0.00308	0.00118
gr/ACF	0.00112	0.00230	0.00087
lb/hr	0.00535	0.0108	0.00373
lb/ton feed[d]	0.0340	0.0686	0.0237
Percent impinger catch	1.06	1.14	1.96

a) Dry standard cubic feet at 70°F, 29.92 in. Hg.
b) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
c) Actual cubic feet per minute.
d) Input feed rate is pure lead fed into furnace.

Table 2.5. PARTICULATE AND LEAD EMISSION DATA SUMMARY
THREE PROCESS OPERATION - ESB, MILPITAS, CALIFORNIA

	INLET			OUTLET		
Run	4I	5I	6I	4O	5O	6O
Date	9-26-73	9-26-73	9-27-73	9-26-73	9-26-73	9-27-73
Volume of Gas Sampled-DSCF[a]	73.048	76.166	74.413	82.076	80.985	84.684
Percent Moisture by Volume	0.74	1.21	1.23	0.84	1.28	0.93
Average Stack Temperature-°F	83	81	77	95	88	88
Stack Volumetric Flow Rate-DSCFM[b]	11348	11704	11366	12545	12454	12719
Stack Volumetric Flow Rate-ACFM[c]	11479	12261	11809	13230	13026	13243
Percent Isokinetic	103.1	104.3	104.9	104.8	104.2	106.7
Percent CO_2	0.4	0.4	0.2	0.4	0.4	0.2
Percent O_2	19.9	19.9	20.0	19.9	19.9	20.0
Percent CO	0.0	0.0	0.0	0.0	0.0	0.0
Feed Rate-ton/hr						
Particulates-probe and filter catch						
mg	48.5	30.0	32.9	29.9	19.1	23.5
gr/DSCF	0.01024	0.00607	0.00682	0.00562	0.00363	0.00428
gr/ACF	0.01013	0.00580	0.00656	0.00533	0.00347	0.00411
lb/hr	0.996	0.609	0.664	0.604	0.388	0.466
lb/ton feed						
Particulates-total catch						
mg	86.5	75.1	54.7	63.4	43.0	46.9
gr/DSCF	0.01827	0.01521	0.01134	0.01192	0.00819	0.00854
gr/ACF	0.01806	0.01452	0.01091	0.01130	0.00783	0.00820
lb/hr	1.777	1.526	1.105	1.281	0.874	0.931
lb/ton feed						
Percent impinger catch	43.9	60.1	39.9	52.8	55.6	49.9
Lead-probe and filter catch						
mg	12.00	5.50	9.00	0.26	0.10	0.14
gr/DSCF	0.00253	0.00111	0.00186	0.000049	0.000019	0.000026
gr/ACF	0.00250	0.00106	0.00179	0.000046	0.000018	0.000024
lb/hr	0.246	0.111	0.181	0.0053	0.0020	0.0028
lb/ton feed						
Lead-total catch						
mg	12.32	5.72	9.04	0.39	0.16	0.36
gr/DSCF	0.00260	0.00115	0.00187	0.000073	0.000030	0.000066
gr/ACF	0.00257	0.00110	0.00180	0.000069	0.000029	0.000063
lb/hr	0.253	0.116	0.182	0.0078	0.0032	0.0072
lb/ton feed						
Percent impinger catch	2.60	3.85	0.44	33.3	37.5	61.1

a) Dry standard cubic feet at 70°F, 29.92 in. Hg.
b) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
c) Actual cubic foot per minute

Table 2.6. PARTICULATE AND LEAD EMISSION DATA SUMMARY PASTE MIXER - ESB, MILPITAS, CALIFORNIA

	INLET			OUTLET		
Run	7I	8I	9I	70	80	90
Date	9-27-73	9-28-73	9-28-73	9-27-73	9-28-73	9-28-73
Volume of Gas Sampled-DSCF[a]	97.768	99.990	93.603	59.455	53.131	55.29
Percent Moisture by Volume	2.46	4.39	4.40	4.47	6.00	5.52
Average Stack Temperature-°F	99	103	109	85	85	88
Stack Volumetric Flow Rate-DSCFM[b]	936.3	945.4	901.3	974.8	836.9	916.3
Stack Volumetric Flow Rate-ACFM[c]	1014	1053	1015	1045	913.2	1000
Percent Isokinetic	105.7	107.1	105.1	100.9	105.0	99.8
Percent CO_2	0.2	0.2	0.1	0.2	0.2	0.1
Percent O_2	20.5	20.5	20.7	20.5	20.5	20.7
Percent CO	0.0	0.0	0.0	0.0	0.0	0.0
Feed Rate-ton/hr	0.897	0.885	0.885	0.897	0.885	0.885
Particulates-probe and filter catch						
mg	359.6	386.2	362.0	38.5	36.2	33.4
gr/DSCF	0.05676	0.05960	0.05968	0.00999	0.01051	0.00932
gr/ACF	0.05243	0.05351	0.05301	0.00932	0.00963	0.00854
lb/hr	0.455	0.483	0.461	0.0835	0.0754	0.0732
lb/ton feed	0.507	0.545	0.520	0.0930	0.0852	0.0827
Particulates-total catch						
mg	395.4	401.2	363.1	52.7	52.2	49.8
gr/DSCF	0.06241	0.06192	0.05986	0.01367	0.01516	0.01390
gr/ACF	0.05765	0.05559	0.05317	0.01276	0.01389	0.01273
lb/hr	0.500	0.501	0.462	0.114	0.108	0.109
lb/ton feed	0.558	0.556	0.522	0.127	0.122	0.123
Percent impinger catch	9.05	3.74	0.30	26.9	30.7	32.9
Lead-probe and filter catch						
mg	175.0	237.5	225.0	18.75	16.25	20.00
gr/DSCF	0.02762	0.03665	0.03709	0.00486	0.00471	0.00558
gr/ACF	0.02551	0.03291	0.03295	0.00453	0.00432	0.00511
lb/hr	0.221	0.297	0.286	0.0406	0.0338	0.0438
lb/ton feed	0.247	0.335	0.323	0.0453	0.0382	0.0495
Lead-total catch						
mg	175.22	237.87	225.06	19.00	16.43	20.06
gr/DSCF	0.02765	0.03671	0.03710	0.00493	0.00477	0.00559
gr/ACF	0.02554	0.03296	0.03296	0.00460	0.00437	0.00513
lb/hr	0.221	0.297	0.286	0.0412	0.0342	0.0439
lb/ton feed	0.247	0.336	0.323	0.0459	0.0387	0.0496
Percent impinger catch	0.13	0.16	0.03	1.32	1.10	0.30

a) Dry standard cubic feet at 70°F, 29.92 in. Hg.
b) Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
c) Actual cubic feet per minute

Table 2.7. SUMMARY OF POLLUTANTS AND CONTROL DEVICE EFFICIENCY

Operation	Run	Inlet Loading (Lb/hr)				Outlet Loading (Lb/hr)				Efficiency			
		Particulate		Lead		Particulate		Lead		Particulate		Lead	
		Front	Total	Front	Total	Front	Total	Front	Total	Front	Total	Front	Total
Cast Furnace (No control device)	1					0.0222	0.0272	0.00528	0.00535				
	2					0.0291	0.0394	0.0107	0.0108				
	3					0.0166	0.0267	0.00362	0.00373				
	Average					0.0226	0.0311	0.00653	0.00663				
Three Process (Fabric filter)	4	0.996	1.777	0.246	0.253	0.604	1.281	0.0053	0.0078	39.4	27.9	97.8	96.9
	5	0.609	1.526	0.111	0.116	0.388	0.874	0.0020	0.0032	36.3	42.7	98.2	97.2
	6	0.664	1.105	0.181	0.182	0.466	0.931	0.0028	0.0072	29.8	15.7	98.5	96.0
	Average	0.756	1.469	0.179	0.184	0.486	1.029	0.0034	0.0061	35.2	28.8	98.2	96.7
Paste Mixer (Scrubber)	7	0.455	0.500	0.221	0.221	0.0835	0.114	0.0406	0.0412	81.6	77.2	81.6	81.4
	8	0.483	0.501	0.297	0.297	0.0754	0.108	0.0338	0.0342	84.4	78.4	88.6	88.5
	9	0.461	0.462	0.286	0.286	0.0732	0.109	0.0438	0.0439	84.1	76.4	84.7	84.7
	Average	0.466	0.488	0.268	0.268	0.0774	0.110	0.0394	0.0398	83.4	77.3	85.0	84.9

Table 2.8. SUMMARY OF MIXER PASTE, SCRUBBER WATER, AND BAGHOUSE DUST

Item	Run	Lead concentration (ppm)*
Three Process Baghouse Dust	4,5,6	4989
Mixer Paste (Positive Plates)	7	2328
Mixer Paste (Negative Plates)	8	3991
Mixer Paste (Negative Plates)	9	4656
Scrubber Water	7	250
Scrubber Water	8	330
Scrubber Water	9	440

*Parts per million by weight.

test. However, the percent of lead caught by the inlet impingers during runs 8 and 9 were only 0.16 and 0.03 percent respectively, indicating the absence of water during test 7 was insignificant.

At the time of the tests on the three process operation, emissions were expected to be low for the night shift run (no. five). This is confirmed by the lead data, but particulate values do not bear this out. One explanation is that the stacking operation may have stirred up a considerable amount of dirt while not stacking many battery elements.

A surprising feature of the control systems (Table 2.7) is that the fabric filter system on the three process operation has a particulate efficiency of only 29 percent, but captures lead with an efficiency of 96.7 percent. There is no explanation for this variance, except that the lead particles may be quite large in relation to the particulate matter; hence the finer particulate escapes through the bags.

The amount of lead in the impinger catches was negligible, except for the three process operation. However, the total lead concentrations from the three processes were much lower than emissions from the casting and mixing operations.

Paste and scrubber water samples were taken during each mixer test. A dust sample was also taken from the baghouse discharge collector. The lead content was found in the samples and tabulated in Table 2.8. The baghouse dust is relayed to a covered 55 gallon drum and will be taken to a smelter for

recovery.* The lead sludge formed in the scrubber settling tank is reused to make negative paste (Table 3.1).

The measured stack gas moistures for the paste mixer outlet (Runs 7-0, 8-0, 9-0) are in error. The crew leader used a psychrometric chart in the field, and it appeared the scrubber outlet gas stream was at the saturation point. It was later confirmed from vapor pressure tables that the gas stream was slightly super saturated. Table A.6 in Appendix A tabulates the moisture data.

Subsequent calculations showed that the calculated values (including results) are correct to two significant figures. Therefore, the numbers were not revised.

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* The 55 gallon drum was full at the time of the test. It took approximately five months to fill the drum. Therefore estimate that the baghouse on the three process operation yields approximately 150 gallons of lead dust per year.

III. PROCESS DESCRIPTION AND OPERATION

Approximately thirty thousand batteries per month are produced at the ESB plant. This is less than an average battery plant will manufacture. The Milpitas plant was chosen over larger battery plants because of the desirable testing sites. Figure 3.1 is a schematic diagram of the ESB battery process. Of significance for emission tests are the casting furnaces, paste mixer, and the "three process" operation (stacking, burning, and battery assembly). The four points of atmospheric emissions are noted from the various processes.

Three gas-fired casting furnaces mold grids into the proper form. Fifty pound lead ingots are manually fed to each furnace. The heat and emissions from each furnace are vented separately to the atmosphere using no control equipment. The grids are then sent to the mixer area and coated with the lead sulfate paste. During a ten hour shift, 189 lead ingots were fed to the three casting furnaces. This represents a process weight of 315 lb. per hour per furnace, or 0.1575 tons per hour per furnace.

The plant received lead oxide from an outside source and conveys the lead grindings to the roof where it enters a 3000 lb. capacity weigh hopper. The lead oxide is made up of 98 percent PbO_2 and 2 percent Pb. The dust from the conveyor system is vented through a baghouse located on the roof. This operation was not considered for testing because many battery

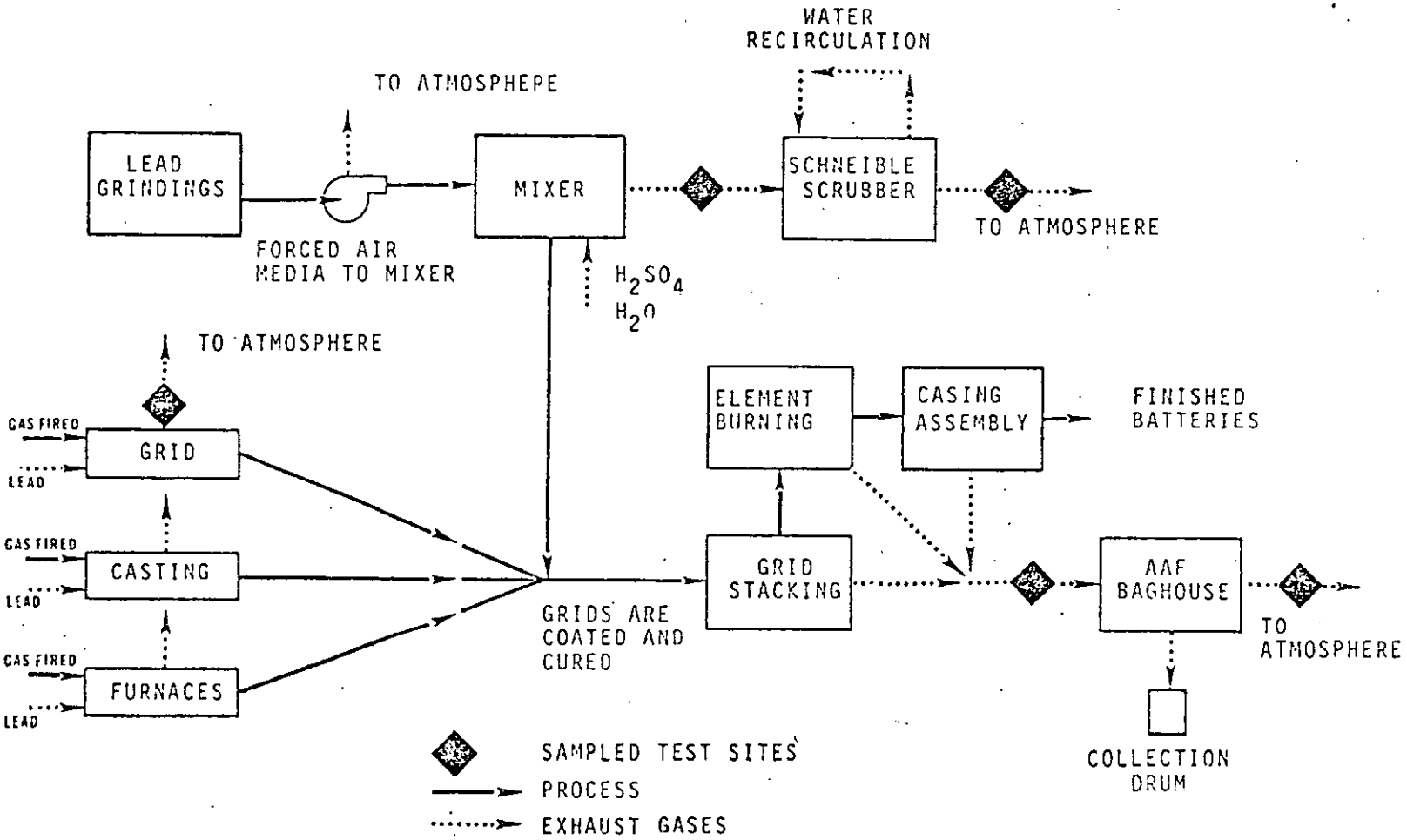


Figure 3.1 Schematic diagram of ESB lead battery manufacturing process.

manufacturing plants generate their own lead grindings. In addition, this process occurs approximately once per week which would result in an inadequate test period.

PbO grindings are dropped into the mixer where sulfuric acid, water, and other ingredients are combined to form a lead sulfate paste. The additives depend on whether positive or negative paste is being made; a description of the paste constituents are listed in Table 3.1. The three mixer tests consisted of one test (Run 4) during which positive paste was used; the final two tests (Runs 5 and 6) used negative paste to coat the grids. The process weights in Table 3.1 were divided by the test duration (120 minutes) to determine process weight rates at 0.885 and 0.897 tons per hour for negative and positive cases.

The exhaust gases from the mixer are vented to a Schneible scrubber by an induced draft fan. Scrubber specifications are included in Appendix G. Particulate matter is caught by a recycled water system. The spent water enters a settling tank where a sludge is formed. The sludge is later reused in the paste manufacturing operation.

After the paste is applied to the grids they are cured for approximately three days. No lead emissions are produced during lead sulfate application onto the grids since the paste is in a moist state.

After the plates are dry, they are stacked in an area where three hoods are used to vent the dust to a collection system.

Table 3.1. LEAD PASTE COMPOSITION (PER BATCH)

NEGATIVE PASTE		POSITIVE PASTE	
CONSTITUENT	WEIGHT (LB)	CONSTITUENT	WEIGHT (LB)
Lead Oxide Grindings	3000	Lead Oxide Grindings	3000
108 liters conc. H_2SO_4	435	85 liters conc. H_2SO_4	343
3 bags "Dynel"	150	3 bags "Dynel"	150
3 liters Oil	6	40 gallons Water	334
2 bags Expander	100		
10% Reclamation Mix	85		
TOTAL WT/BATCH	3776		3827

The plates are then transferred to the element burning operation where they are unified into elements by welding leads to a specified number of individual plates. The element burning operation has six individual work stations, each equipped with its own hood. Stacked elements are then assembled into battery casings in another hooded area.

Ducts from the plate stacking, element burning, and casing operation are joined in a common duct leading to an American Air Filter "Amerpulse" baghouse. Control device specifications are included in Appendix G. Plants capable of manufacturing greater quantities of batteries usually exhaust gases through individual egress points due to higher volumes of air. Process weight rates for the three processes which are vented together are difficult to determine because of their separate functions.

Usual plant procedure is to employ two shifts per day, as was the case during the emission testing period. Table 3.2 summarizes the output of the individual operations leading to the manufacture of 29,400 batteries per month. The first shift output is the maximum operating rate.

During the plant presurvey PEDCo assumed that some testing may extend through the second shift. However, it was not anticipated that the output from second shift personnel would be significantly less than from the first shift. This was the case, as witnessed by the field crew leader and confirmed later by emission test data.

Table 3.3 lists emission factors derived from the test and process data. It was impossible to segregate emissions

and flow volumes from the individual three process operations. Emission factor calculations are in Appendix A.

Table 3.2. PROCESS CAPACITIES DURING EMISSION TEST PERIOD

OPERATION	UNITS	CAPACITY/UNIT FIRST SHIFT[a]	APPROXIMATE SECOND SHIFT OUTPUT[b]
Cast Furnace	3	28 grids/minute[c]	all tests during first shift
Mixer	1	Variable	40%
Plate Stacking	1	130 batteries/hour[d]	20%
Element Burning	6	21 batteries/hour	30%
Battery Assembly	1	112 batteries/hour	50%

a) Values noted by ESB personnel and reported to PEDCo.
b) Values assumed by PEDCo field crew leader.
c) Average weight per grids cast during test-0.26 pounds
d) Average number of grids per batteries assembled during test-66 (6 elements containing 11 grids). Total battery weight-38 lb.

20,10

Table 3.3 EMISSION FACTORS FROM TEST AND PROCESS PARAMETERS

Area	Emission factor units	Particulate emission factor		Lead emission factor	
		Total train	Front half	Total train	Front half
Total Plant	lb/ton of material processed	0.884	0.442	0.0546	0.0515
	lb/ton of product	0.668	0.334	0.0293	0.0276
Casting Furnace	lb/ton of lead input	0.197	0.144	0.0421	0.0415
	lb/MM grids	24.6	18.0	5.25	5.19
Paste Mixer	lb/ton of lead oxide feed	0.147	0.103	0.0530	0.0525
	lb/ton of paste produced	0.124	0.0774	0.0447	0.0443
Three Process	lb/MM batteries produced	11000	5130	59.4	33.6

IV. LOCATION OF SAMPLING POINTS

No previous emission tests were made on any of the operations at the ESB plant. Therefore, none of the stacks or ducts were equipped with sampling ports. Sampling locations were chosen and marked (if possible) during the presurvey. A scaffolding firm in close proximity to the plant was hired to position scaffolding at the chosen sites. Individual test locations are discussed below:

Casting Furnace

A diagram of a casting furnace is shown in Figure 4.1. Each of the three furnaces and stacks are identical. The crew leader witnessed which operator was most proficient, and chose a furnace to sample solely on that basis. Sample ports were inserted by PEDCo personnel in the circular 11 inch diameter duct as shown in Figure 4.2. Two metallic concentric ducts handle the room ventilation and furnace exhause, so the inner and outer duct were cut to gain access to the inner (furnace) exhaust gases. The sample section was taken as low as possible to maximize the distance between the points and the stack exit. Ten points were chosen on each of the two traverse locations for a total of twenty points. Each point was sampled for 6 minutes resulting in a two hour test duration.

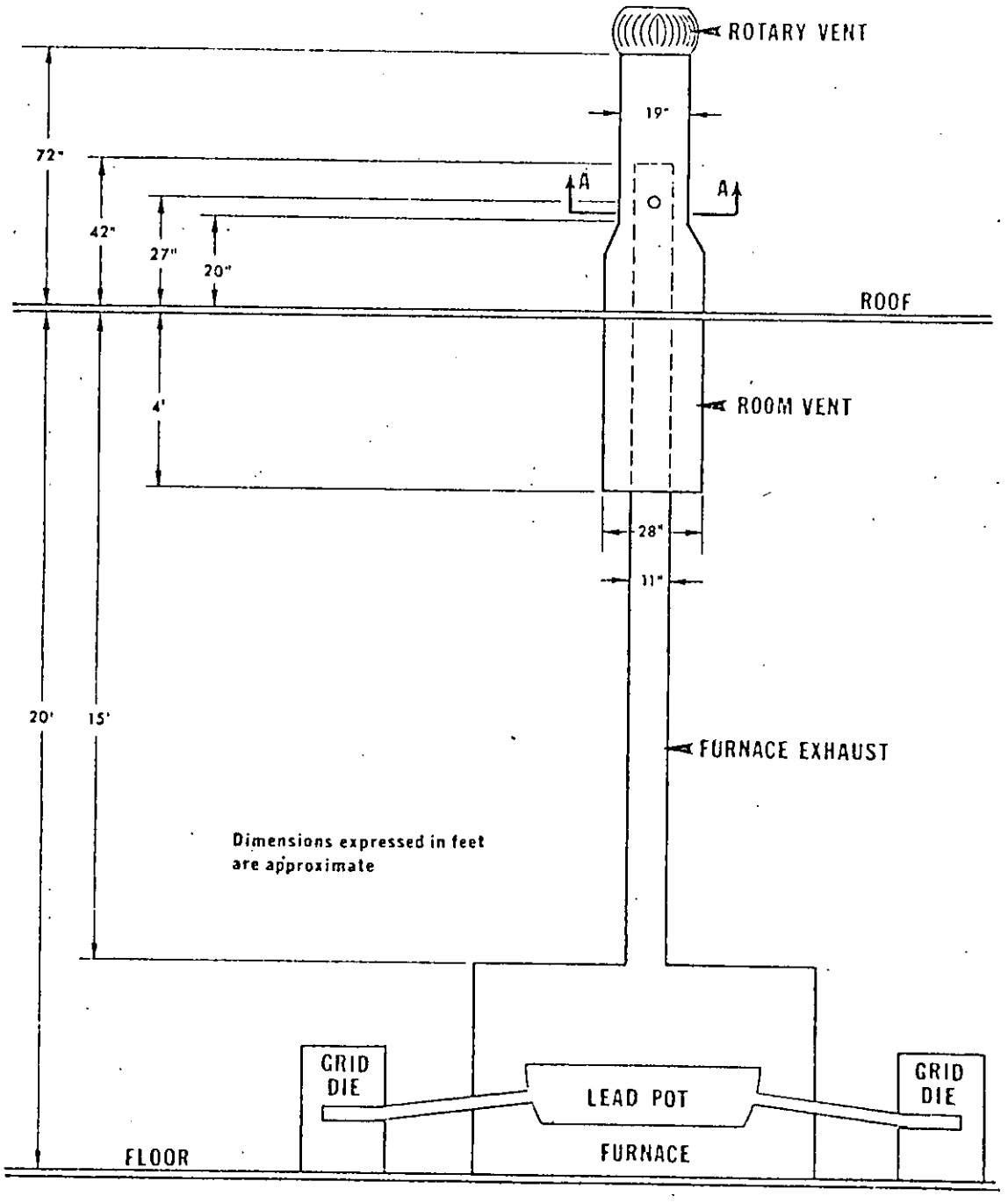
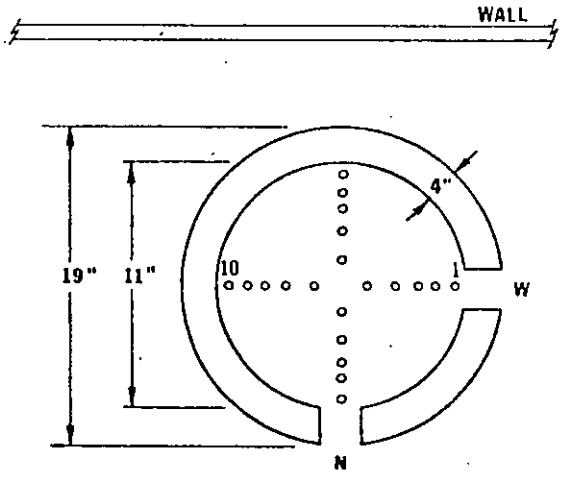


Figure 4.1 Elevation of typical casting furnace.



Section AA

Point	Distance From Outer Duct, inches
1[a]	5.00
2[a]	5.00
3	5.60
4	6.49
5	7.75
6	11.25
7	12.51
8	13.40
9[a]	14.00
10[a]	14.00

a) Minimum sampling distance from duct walls was one inch.

Figure 4.2. Casting furnace sampling points.

"Three Process" Operation

The ducts from the stacking, burning, and battery assembly operations are joined on the building roof, as shown in Figure 4.3.

The inlet sampling site, located on the roof about 4 feet from the edge of the building, is 38 inches downstream of a pipe transition. It was impossible to sample further downstream because of a water pipe which would have interfered with the position of the sample box. Twenty points, as illustrated in Figure 4.4, were chosen for each of the two sample ports on the horizontal metallic ducts. The vertical sampling was done from a hole placed in the bottom of the duct. The 40 sample points were each tested for 3 minutes, for a two hour test period.

A scaffolding was erected to gain access to an acceptable outlet test section. Figure 4.5 shows an elevation of the "three process" baghouse and exhaust stack. Ten points were chosen on each of two traverse directions on the 26 inch diameter vertical stack. Three of the ten sampling points on the "south" port were not sampled due to a scaffolding placement obstruction. The first accessable point was sampled for 24 minutes instead of 6 minutes to "make up" sampling time. Each point was sampled for six minutes, for a total 120 minute test duration.

Mixer Operation

The exhaust duct from the mixer spans approximately 20 feet exiting horizontally through the side of the building. It was impossible to gain a desirable access to the duct due to the location of plant machinery and other immovable obstructions. A scaffolding was placed inside the plant where the inlet duct could be sampled approximately two diameters downstream from a

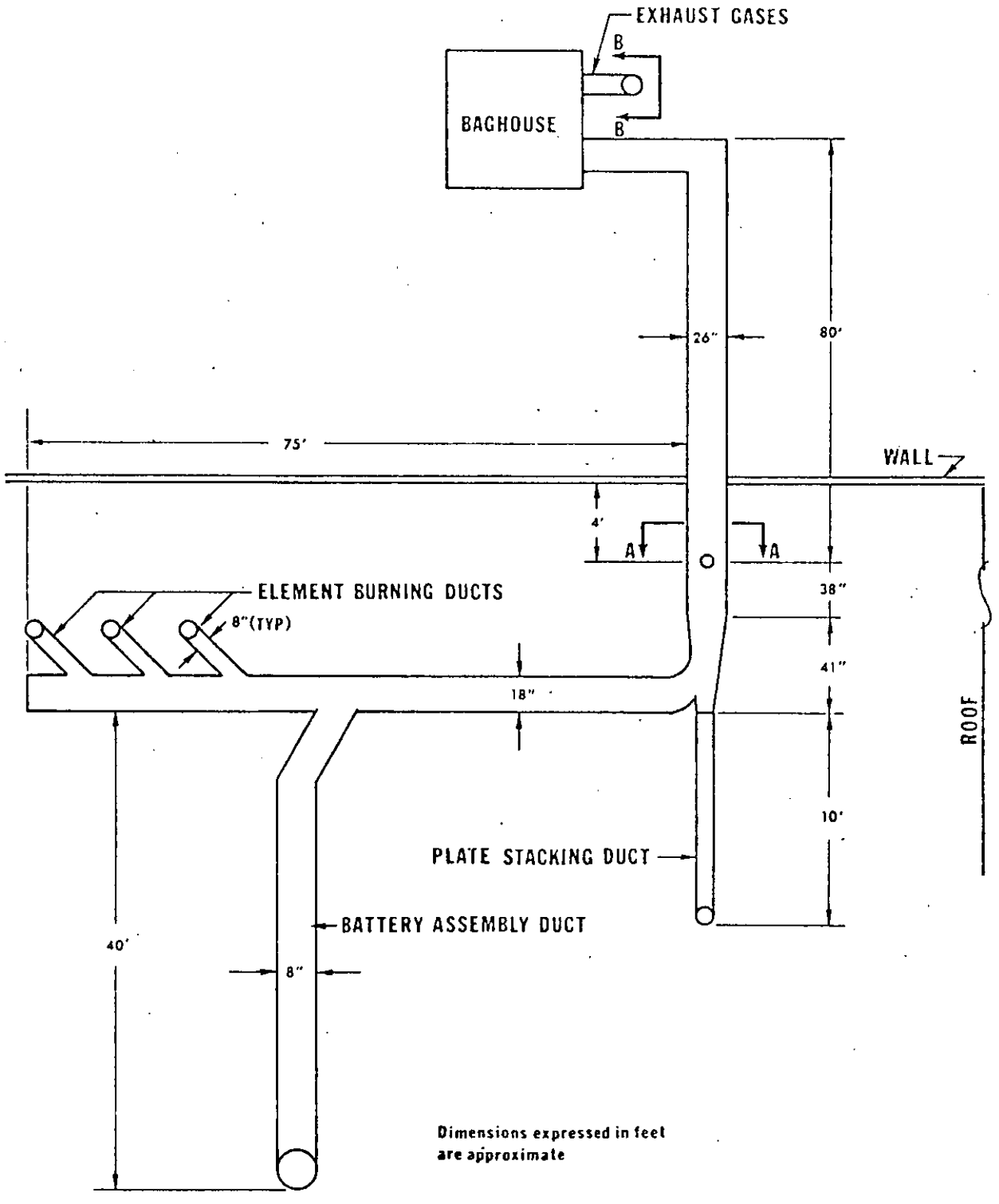
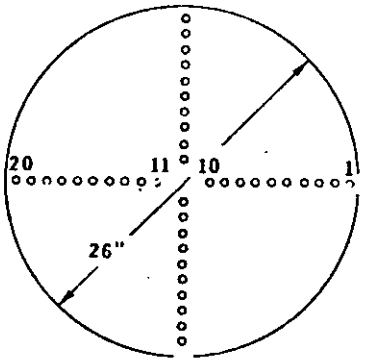
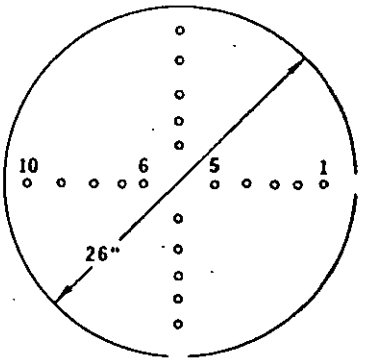


Figure 4.3 Plan view of three process ducting.



Section AA
Three Process Inlet
Test Section
(Looking Upstream)



Section BB
Three Process Outlet
Test Section
(Looking Down)

Point	Traverse Distance, inches
1[a]	1.00
2	1.01
3	1.74
4	2.52
5	3.35
6	4.30
7	5.30
8	6.50
9	7.96
10	10.10
11	15.90
12	18.04
13	19.50
14	20.70
15	21.70
16	22.65
17	23.48
18	24.26
19[a]	24.99
20	25.00

Point	Traverse Distance, inches
1[a]	1.00
2	2.13
3	3.80
4	5.90
5	8.90
6	17.10
7	20.10
8	22.20
9[a]	23.87
10	25.00

a) Minimum sampling distance from duct walls was one inch.

Figure 4.4. Three process sampling points.

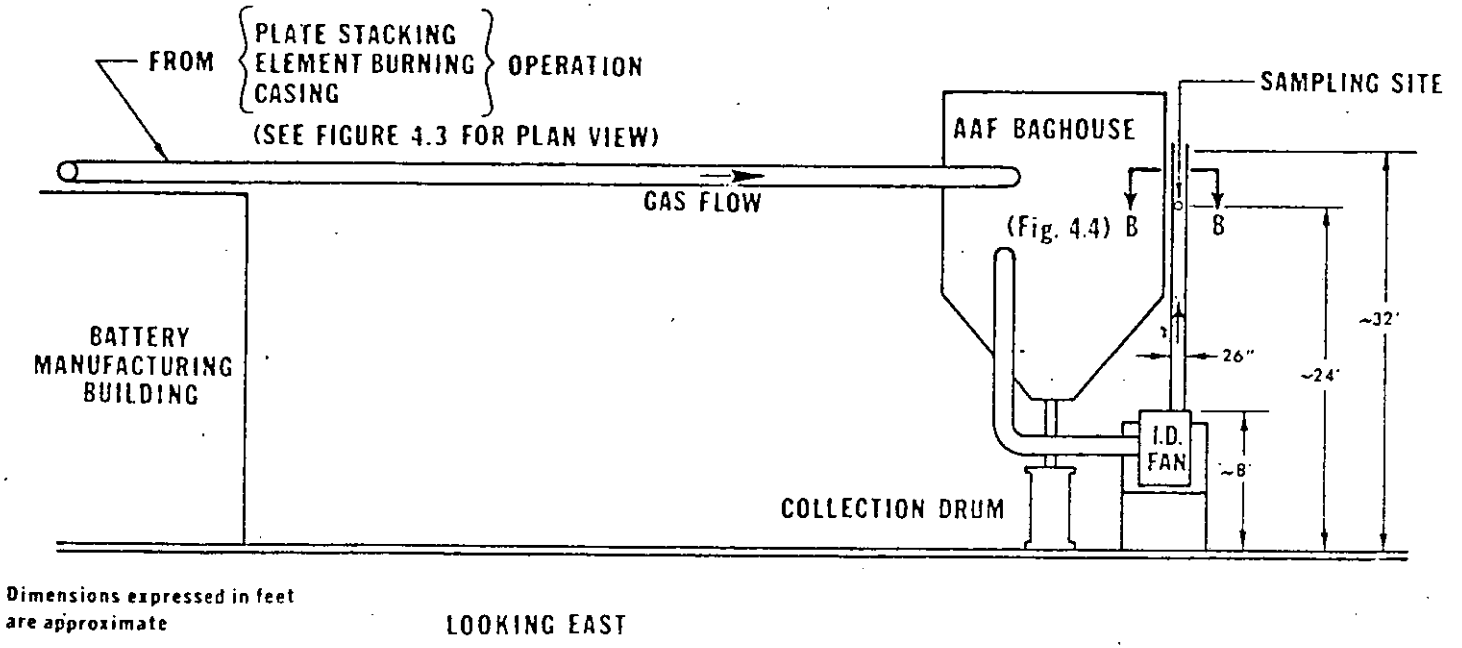


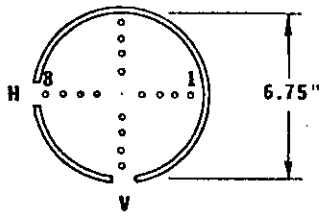
Figure 4.5 Elevation of "Three Process" baghouse and exhaust stack.

30 degree bend in the duct. Eight sample points per diameter, as shown in Figure 4.6, were chosen for the mixer inlet test; samples were taken horizontally and vertically. Each of the sixteen points was sampled for eight minutes, resulting in a 128 minute test.

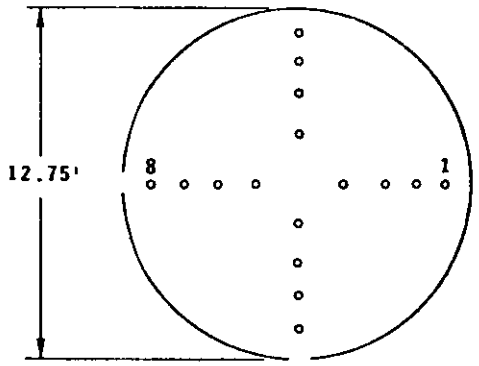
A photograph of the scrubber outlet appears in Figure 4.7. The test location was chosen downstream of the fan, approximately 14 feet above the discharge section. Two sampling ports were cut in the 12.75 inch ID stack 90 degrees apart. Each port has eight sample points (Figure 4.6), which were tested for eight minutes apiece.

No caps and threaded fittings were added to the sample areas. Therefore when the test was being conducted through one port, the other was taped to avoid atmospheric air from interfering at the test section.

Table 4.1 summarizes the sampling point data at the five test sections.



Mixer Scrubber Inlet
(Horizontal Duct)



Mixer Scrubber Outlet
(Vertical Stack)

Point	Traverse Distance, inches
1[a]	1.00
2[a]	1.00
3	1.31
4	2.22
5	4.43
6[a]	5.44
7[a]	5.75
8	5.75

Point	Traverse Distance inches
1[a]	1.00
2	1.34
3	2.47
4	4.12
5	8.63
6	10.28
7[a]	11.41
8	11.75

a) Minimum sampling distance from duct walls was one inch.

Figure 4.6. Paste Mixer sampling points.

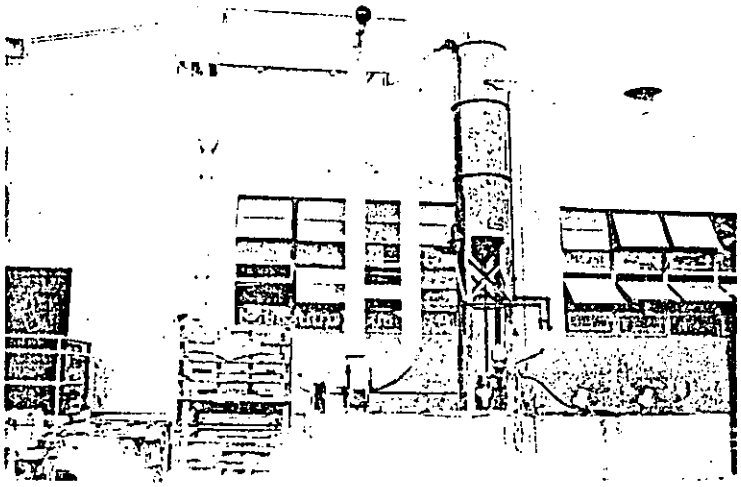


Figure 4.7 Mixer outlet site

Table 4.1. SUMMARY OF SAMPLING POINT PARAMETERS

SITE	DUCT DIAMETER (INCHES)	TYPE	NEAREST UP-STREAM DISTURBANCE (DIAMETERS)	NEAREST DOWN-STREAM DISTURBANCE (DIAMETERS)	NO. OF SAMPLE POINTS REQUIRED BY FED. REG.	NO. OF SAMPLE POINTS CHOSEN	TEST DURATION (MINUTES)	COMMENTS
Casting Furnace	11.00	Vert.	8	1.4	16	20	120	20 points chosen for better representation of velocity profile
Three Process Inlet	26.0	Horiz.	1.5	2	48	40	120	velocity traverse indicated relatively uniform flow; therefore 48 points deemed unnecessary
Three Process Outlet	26.0	Vert.	8	2	12	20	120	20 points chosen for better representation of velocity profile
Mixer Scrubber Inlet	6.75	Horiz.	2.3	2	30	16	128	6.75 inch duct not appropriate for 30 point traverse
Mixer Scrubber Outlet	12.75	Vert.	7.4	2	8	16	128	16 points chosen for better representation of velocity profile

V. SAMPLING AND ANALYTICAL PROCEDURES

All particulate and lead sampling procedures were selected and approved by EPA prior to field sampling. PEDCo-Environmental Specialists performed all testing, sample recovery, analysis, and calculations for particulate and lead samples.

Stack measurements and velocity traverses were taken at each sampling site with a type "S" pitot tube and inclined draft gage. Gas flow temperatures were measured with long stem dial thermometers. An appropriate nozzle size was chosen after determining velocity head readings.

No moisture tests were run due to the dry nature of the processes. After each initial run, the moisture content was calculated to compare against assumed values. In all cases the assumed and actual moisture were within five percent.

Particulate and lead matter were isokinetically sampled with a train similar to the one discussed in Method 5 of the Federal Register.* A detailed description of the sampling and analysis technique is included in Appendix D. An integrated sample of the stack gases was collected during each run by pumping flue gas into a Tedlar bag. This bag sample was then analyzed on site with an Orsat analysis for CO_2, O_2, and CO. Prior to the first test all chemical reagents were changed to assure accurate readings.

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*Federal Register, Vol. 36, No. 247, Section 60.85, December 23, 1971. All test methods discussed hereafter refer to the same Federal Register.

The sampling crew at each site consisted of a two man team which included a probe and meter technician. At all five sampling sites the meter box was kept on ground level. The sample box, either on the building roof or scaffolding, was connected to the meter box by an umbilical cord containing the sampling and velocity lines.

After each test the sample boxes were transferred to a clean up room where the samples were appropriately put into Wheaton jars previously washed with nitric acid. Blanks of acetone, water, and filters were taken to identify background concentration. The samples were shipped by air freight to the PEDCo laboratory in Cincinnati, Ohio for analysis. All samples arrived in satisfactory condition.

Laboratory personnel initially analyzed the samples for particulate concentrations and later measured lead concentrations using an atomic absorption spectrophotometer as described in Appendix D. Particulate values were determined using the Federal Register Method 5 technique. Organics are not used in any of the processes, so a chloroform-ether extraction of organic particulate was not performed.

Field data sheets are presented in Appendix C. The laboratory report is contained in Appendix E. Appendices A and B include a summary of particulate and lead data with a sample calculation of the emission parameters.