

Air



# Secondary Lead Smelter

Arsenic,  
Cadmium, and  
Lead Emissions  
General Battery  
Corporation  
Reading,  
Pennsylvania

SOURCE SAMPLING REPORT FOR  
GENERAL BATTERY CORPORATION:  
MEASUREMENT OF ARSENIC/LEAD/CADMIUM

UNIT #1  
SECONDARY LEAD SMELTER PROCESS  
READING, PENNSYLVANIA

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EPA Project Officer: Frank Clay

Prepared for:  
Emission Measurement Branch  
Emission Standards and Engineering Division  
U.S. Environmental Protection Agency  
Research Triangle Park, North Carolina 27711

Prepared by:  
M. Hartman and C. Stackhouse  
TRW, Environmental Operations  
Post Office Box 13000  
Research Triangle Park, North Carolina 27709

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## 1. INTRODUCTION

TRW Energy and Environmental Division conducted arsenic testing at the General Battery Plant, Process Unit #1 at Reading, Pennsylvania under Contract #68-02-3545, Project #83-SNF-15 to EPA/EMB. The inlet and outlet locations around the two control devices, fabric filter baghouse and wet scrubber systems, were tested June 19, 1983, to June 23, 1983. The purpose of the sampling and field measurement was part of the Arsenic Emission Test Program for secondary lead smelters sponsored by the Office of Air Quality Planning and Standards in coordination with Emission Standards and Engineering Division (ESED) and Emission Measurement Branch (EMB), of the U.S. Environmental Protection Agency.

The immediate objective of the sampling was to obtain sufficient multimedia samples of the Unit #1 secondary lead smelter process and with subsequent analytical procedures, to perform an arsenic material balance. The ultimate objective of the emission testing program is providing data for developing arsenic emission factors and establish arsenic emission control device efficiencies for process sources of arsenic emissions at secondary lead smelters.

The primary sampling method was EPA Draft Method 108 with EPA Reference Methods 1, 2, 3, and 6 used for flow and gas constituents. Special Method 108 runs were performed with the train maintained at process temperatures. The testing was performed by the field test crew from TRW's Research Triangle Park Operations. Mr. Neil Lebo of General Battery provided the liason between the test crew and General Battery operations. Present and representing the Environmental Protection Agency was Mr. Frank Clay - Emission Measurement Branch (EMB) and Mr. Lee Beck - Emission Standards and Engineering Division (ESED). Also, present was Mr. Larry Keller of Radian Corporation for monitoring the process and collecting process samples during testing periods.

## 2. SUMMARY AND DISCUSSION OF RESULTS

Figure 2-1 is a schematic diagram of the secondary lead plant. The smelter operation at the Reading Plant is used to regenerate lead for use in new batteries. The furnace exhaust gas passes through an after burner section. The gas exiting the afterburner is cooled by a large array of surface gas coolers using the ambient air to cool the gases. The exhaust gases then are pulled through an I.D. fan to the baghouse preceding a venturi scrubber. The exhaust stack immediately follows the demister section of the scrubber. The three sample locations were: the baghouse inlet prior to the I.D. fan (BHI), the baghouse outlet or scrubber inlet (baghouse outlet - scrubber inlet referred to in this report as scrubber inlet (SCI)) prior to the venturi scrubber (SCI), and the venturi scrubber outlet (SCO). The sample location specifics are provided in Section 5.

### 2.1 EMISSION RATE RESULTS FOR ARSENIC, CADMIUM, AND LEAD

The emission rate results of the Method 108 tests conducted at General Battery on Process Unit #1 is summarized in Table 2-1. A further breakdown of the results is provided in Section 2.2. Tables 2-2 to 2-4 present the removal efficiency of the baghouse system and the complete system. The baghouse system was calculated from the difference of the emission rate between the baghouse inlet (BHI) location and the baghouse outlet or scrubber inlet (SCI) location. The complete system was calculated from the difference of the emission rate between the baghouse inlet to the scrubber outlet (SCO) location.

The complete system had a removal efficiency of 99.61% for arsenic, 99.95% for cadmium, and 99.91% for lead. The baghouse system had a removal efficiency of 99.57% for arsenic, 99.87% for cadmium, and 99.70% for lead. There was a problem with the BHI-3 Standard Method 108 run but the efficiency was calculated by using the BHI-3 hot results. The



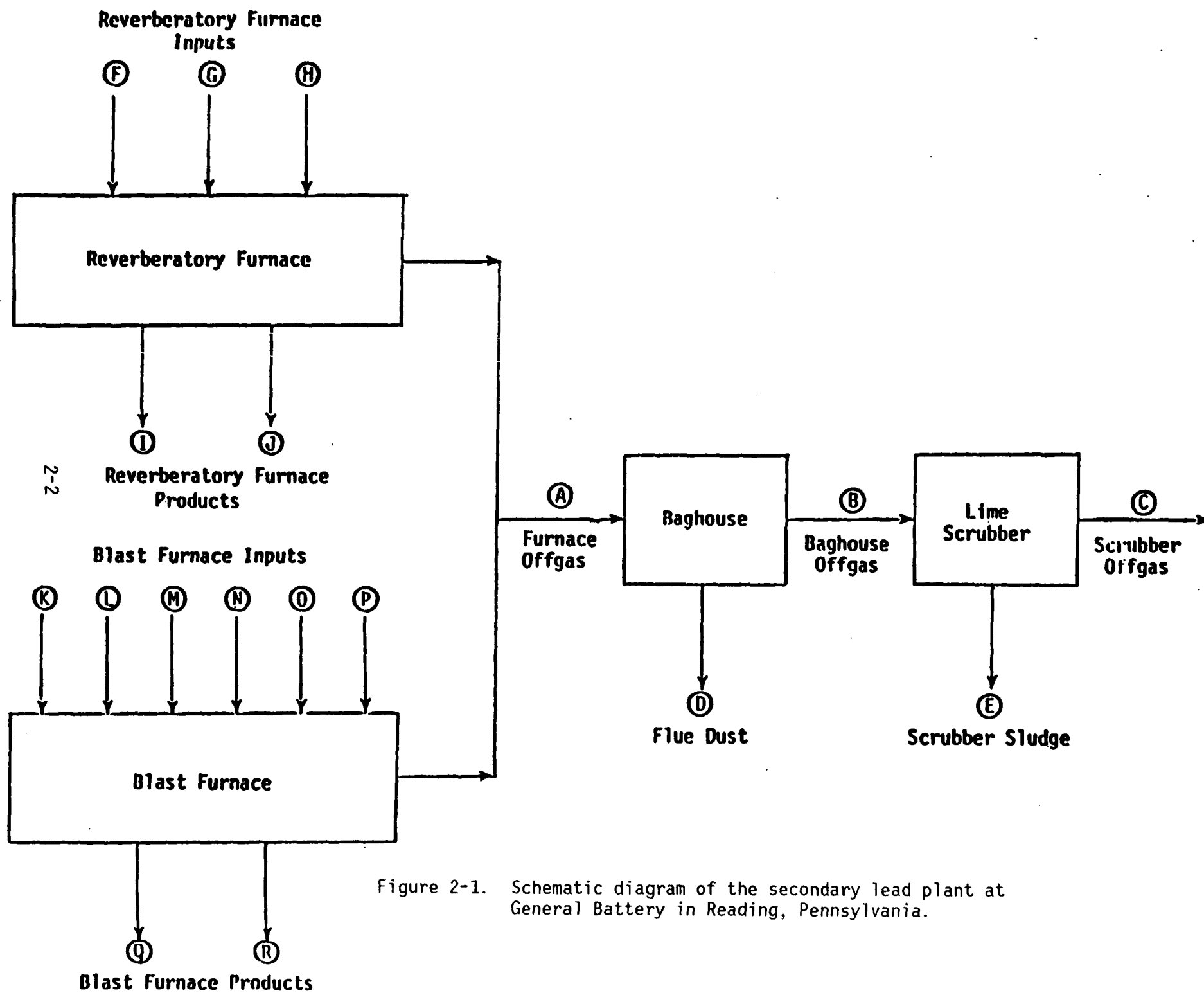


Figure 2-1. Schematic diagram of the secondary lead plant at General Battery in Reading, Pennsylvania.

Table 2-1. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
SUMMARY OF EMISSION RATE RESULTS

	Arsenic emission rates		Cadmium emission rates		Lead emission rates	
	(lbs/hr)	(kg/hr)	(lbs/hr)	(kg/hr)	(lbs/hr)	(kg/hr)
BHI-1	2.90	1.31	16.37	7.43	258.39	117.20
SCI-1	$4.73 \times 10^{-2}$	$2.15 \times 10^{-2}$	$1.64 \times 10^{-2}$	$7.45 \times 10^{-3}$	$8.36 \times 10^{-1}$	$3.79 \times 10^{-1}$
SCO-1	$1.80 \times 10^{-2}$	$8.17 \times 10^{-3}$	$2.03 \times 10^{-3}$	$9.19 \times 10^{-4}$	$8.78 \times 10^{-2}$	$3.90 \times 10^{-2}$
BHI-2	8.48	3.85	8.13	3.69	804.10	364.74
SCI-2	$4.95 \times 10^{-3}$	$2.24 \times 10^{-3}$	$1.50 \times 10^{-2}$	$6.78 \times 10^{-3}$	2.00	$9.09 \times 10^{-1}$
SCO-2	$1.80 \times 10^{-2}$	$8.14 \times 10^{-3}$	$2.08 \times 10^{-3}$	$9.44 \times 10^{-4}$	$1.36 \times 10^{-1}$	$6.16 \times 10^{-2}$
BHI-3H	7.86	3.56	8.64	3.92	599.09	271.74
SCI-3	$5.10 \times 10^{-2}$	$2.31 \times 10^{-2}$	$8.66 \times 10^{-3}$	$3.93 \times 10^{-3}$	1.93	$8.78 \times 10^{-1}$
SCI-3H	$4.61 \times 10^{-2}$	$2.09 \times 10^{-2}$	$1.20 \times 10^{-2}$	$5.44 \times 10^{-3}$	2.06	$9.36 \times 10^{-1}$
SCO-3	$2.78 \times 10^{-2}$	$1.26 \times 10^{-2}$	$1.81 \times 10^{-3}$	$8.23 \times 10^{-4}$	$1.58 \times 10^{-1}$	$7.15 \times 10^{-2}$
BHI-4	6.18	2.81	3.63	1.65	441.6	200.4
BHI-4H	4.62	2.10	3.48	1.58	315.7	143.3

Table 2-2. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
REMOVAL EFFICIENCY FOR ARSENIC

Sample location	Emission rate (lbs/hr)			Average removal efficiency
	Run #1	Run #2	Run #3	
BHI	2.90	8.48	7.86 <sup>a</sup>	
SCI	0.0473	0.00495 <sup>b</sup>	0.0510	
SCO	0.0180	0.0180	0.0278	
<u>Removal Efficiency (%)</u>				
Baghouse System	98.37	99.94 <sup>c</sup>	99.35	98.86
Complete System	99.38	99.79	99.65	99.61

<sup>a</sup>BHI-3H results used because BHI-3 run was aborted.

<sup>b</sup>Suspect number, analytical results being rechecked.

<sup>c</sup>This number not used for average of baghouse system.

Table 2-3. GENERAL BATTERY PLANT PROCESS UNIT #1  
 READING, PENNSYLVANIA  
 REMOVAL EFFICIENCY FOR CADMIUM

Sample location	Emission rate (lbs/hr)			Average removal efficiency
	Run #1	Run #2	Run #3	
BHI	16.37	8.13	8.64	
SCI	0.0164	0.0150	0.00866	
SCO	0.00203	0.00208	0.00181	
<u>Removal Efficiency (%)</u>				
Baghouse System	99.90	99.81	99.90	99.87
Complete System	99.99	99.97	99.90	99.95

Table 2-4. GENERAL BATTERY PLANT PROCESS UNIT #1  
 READING, PENNSYLVANIA  
 REMOVAL EFFICIENCY FOR LEAD

Sample location	Emission rate (lbs/hr)			Average removal efficiency
	Run #1	Run #2	Run #3	
BHI	258.39	804.10	599.09	
SCI	0.836	2.00	1.93	
SCO	0.0878	0.136	0.158	
<u>Removal Efficiency (%)</u>				
Baghouse System	99.68	99.75	99.68	99.70
Complete System	99.97	99.98	99.97	99.97

comparison of the Standard and Hot Method 108 runs provided results of 1-14% difference for arsenic and lead with cadmium results varying to approximately 25%.

## 2.2 ARSENIC/LEAD/CADMIUM RESULTS

The sampling for arsenic/lead/cadmium was performed in accordance with procedures set forth in the Standard Method 108 for determination of particulate and gaseous arsenic emissions from non-ferrous smelters. The standard sampling trains were operated according to Federal Register guideline with the addition of a cyclone system for particulate collection at the BHI location due to high grain loading. Also special hot trains were operated at process temperatures as a comparison study. The operation and results are discussed in Section 2.3.

## 2.3 METHOD 108 COMPARISON RUNS - STANDARD VS. HOT

A comparison study was performed at the BHI and SCI sample locations. The purpose of the study was to see if gaseous arsenic at a stack temperature greater than 250°F would condense on the filter (creating an artificially high arsenic loading on the filter) rather than passing through the filter and being caught by the impingers. Two trains were operated simultaneously: one train according to Method 108, while the special train (hot train) maintained a filter temperature that was as close as possible to the process gas temperature. The Standard 108 train traversed the stack while the hot train sampled from a single point. (A second comparison run was required at the BHI location when the high temperature (>400°F) destroyed the Standard 108 filter system during the third test period.)

If gaseous arsenic above 250°F condenses on the filter of a Standard Method 108 train, then a train with the filter temperature maintained at the stack gas temperature should allow the gaseous arsenic to pass through the filter and be caught by the impingers. It would be expected, then, that if the two trains were operated simultaneously as previously described, the per cent arsenic caught in the front half of the hot train would be less than the Standard 108 train, and back half of the hot train would be greater than the Standard 108 train.

The two completed comparison runs were SCI-3/3H and BHI-4/4H; the hot trains were operated at temperatures from 370-400°F. The results of

the simultaneous sampling are shown in Table 2-5. At each location, the per cent arsenic collected in the back half of the hot trains was greater than the per cent arsenic collected in the back half of the corresponding Standard 108 train. The per cent arsenic collected in the front half of the Standard 108 train was higher than the per cent arsenic collected in the front half of the corresponding hot train. Thus from these limited data, it appears that some gaseous arsenic may indeed condense on the filter if the process gas temperature is above the filter temperature.

In looking at Table 2-5, it is possible to see that the hot train filter temperature at the SCI location was maintained more closely to the process gas temperature than was the filter temperature at the BHI location. This may partially account for the percentage differences in the results from the two locations.

In addition to the arsenic analysis, the trains in the comparison study were also analyzed for cadmium and lead. Arsenic, cadmium, and lead results are found in Tables 2-6 to 2-8.

#### 2.4 SO<sub>2</sub>/SO<sub>3</sub> RESULTS

One Method 6 test run was completed at each site for providing oxides of sulfur concentrations. Also, the Method 108 H<sub>2</sub>O<sub>2</sub> impingers solution were analyzed for all the 108 test runs. The concentration results from the analysis are presented in Tables 2-9A and 2-9B.

#### 2.5 PARTICULATE RESULTS

Tables 2-10 and 2-10B present the results of the particulate analysis on the front half of the Method 108 runs. The analytical work sheet is provided in Appendix C.

The results are consistent with the higher reduction efficiencies across the baghouse (BHI location to SCI location). The Method 108 analytical procedures for metals caused difficulty in weighing of the particulate catch. Due to the fact that the drying of the probe rinse and cyclone catch (used at BHI location only) for weighing would have caused loss in the metal analysis, the priority was determined for performing the analysis first and then attempting to dry the digested particulate catch. Therefore, the particulate results for the filter (weighed dry before digesting) are accurate. But, the probe rinse and cyclone catches will be biased low because the digesting of the metals would produce lower particulate results.

Table 2-5. GENERAL BATTERY PLANT PROCESS PLANT UNIT #1  
READING, PENNSYLVANIA  
ARSENIC EMISSIONS

	Stack temperature (°F)	Filter temperature (°F)	Temperature difference (°F)	Arsenic sampled			Arsenic concentration			Arsenic collection	
				Front (Mg)	Back (Mg)	Total (Mg)	Front (gr/DSCF)	Back (gr/DSCF)	Total (gr/DSCF)	Front half (%)	Back half (%)
BHI-3 (ABORT)	468	269									
BHI-3-H	474	397	-77	91.0	0.875	91.875	0.027	0.0003	0.029	99.05	0.95
BHI-4	424	238		30.8	0.2	31.0	0.0213	0.0001	0.0214	99.35	0.65
BHI-4-H	423	372	-51	25.1	0.3	25.4	0.0151	0.0002	0.153	98.82	1.18
SCI-3	379	251		0.562	0.162	0.724	$1.47 \times 10^{-4}$	$4.26 \times 10^{-5}$	$1.90 \times 10^{-4}$	77.62	23.38
SCI-3-H	380	388	+8	0.415	0.222	0.637	0.0001	0.00006	0.00016	65.15	34.85



Table 2-6. GENERAL BATTERY PLANT PROCESS PLANT UNIT #1  
READING, PENNSYLVANIA  
ARSENIC EMISSION RATES

	<u>Volume meter</u> (DSCF)	<u>Flow rate</u> (DSCFM)	<u>Arsenic sampled</u> (mg)	<u>Arsenic concentration</u> (gr/DSCF)	<u>Arsenic emission rate</u>	
					(lbs/hr)	(kg/hr)
BHI-1	46.375	33,463	30.4	$1.01 \times 10^{-2}$	2.90	1.31
SCI-1	57.963	33,855	0.615	$1.63 \times 10^{-4}$	$4.73 \times 10^{-2}$	$2.15 \times 10^{-2}$
SCO-1	69.011	33,642	0.280	$6.25 \times 10^{-5}$	$1.80 \times 10^{-2}$	$8.17 \times 10^{-3}$
BHI-2	48.070	34,119	90.4	$2.90 \times 10^{-2}$	8.48	3.85
SCI-2	61.985	33,954	0.0684	$1.70 \times 10^{-5}$	$4.95 \times 10^{-3}$	$2.24 \times 10^{-3}$
SCO-2	74.331	34,995	0.289	$5.99 \times 10^{-5}$	$1.80 \times 10^{-2}$	$8.14 \times 10^{-3}$
BHI-3H	48.869	31,668	91.9	$2.80 \times 10^{-3}$	7.86	3.56
SCI-3	58.879	31,413	0.724	$1.89 \times 10^{-4}$	$5.10 \times 10^{-2}$	$2.31 \times 10^{-2}$
SCI-3H	60.309	32,975	0.637	$1.63 \times 10^{-4}$	$4.61 \times 10^{-2}$	$2.09 \times 10^{-2}$
SCO-3	70.131	32,153	0.460	$1.01 \times 10^{-4}$	$2.78 \times 10^{-2}$	$1.26 \times 10^{-2}$
BHI-4	22.319	33,655	31.0	$2.14 \times 10^{-2}$	6.18	2.80
BHI-4H	25.688	35,359	25.4	$1.53 \times 10^{-1}$	4.62	2.10

Table 2-7. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
CADMIUM EMISSION RATES

	<u>Volume meter</u> (DSCF)	<u>Flow rate</u> (DSCFM)	<u>Cadmium sampled</u> (mg)	<u>Cadmium concentration</u> (gr/DSCF)	<u>Cadmium emission rate</u>	
					(lbs/hr)	(kg/hr)
BHI-1	46.375	33,463	172	$5.71 \times 10^{-2}$	16.37	7.43
SCI-1	57.963	33,855	0.213	$5.66 \times 10^{-5}$	$1.64 \times 10^{-2}$	$7.45 \times 10^{-3}$
SCO-1	69.011	33,642	0.0315	$7.03 \times 10^{-6}$	$2.03 \times 10^{-3}$	$9.19 \times 10^{-4}$
BHI-2	48.070	33,119	86.9	$2.78 \times 10^{-2}$	8.13	3.69
SCI-2	61.985	33,954	0.207	$5.14 \times 10^{-5}$	$1.50 \times 10^{-2}$	$6.78 \times 10^{-3}$
SCO-2	74.331	34,995	0.0335	$6.94 \times 10^{-6}$	$2.08 \times 10^{-3}$	$9.44 \times 10^{-4}$
BHI-3H	48.869	31,668	101	$3.18 \times 10^{-2}$	8.64	3.92
SCI-3	58.879	31,413	0.123	$3.22 \times 10^{-5}$	$8.66 \times 10^{-3}$	$3.93 \times 10^{-3}$
SCI-3H	60.309	32,975	0.166	$4.24 \times 10^{-5}$	$1.20 \times 10^{-2}$	$5.44 \times 10^{-3}$
SCO-3	70.131	32,153	0.0300	$6.59 \times 10^{-6}$	$1.81 \times 10^{-3}$	$8.23 \times 10^{-4}$
BHI-4	22.319	33,655	18.2	$1.26 \times 10^{-2}$	3.63	1.58
BHI-4H	25.688	35,359	19.1	$1.15 \times 10^{-2}$	3.48	1.51

Table 2-8. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
LEAD EMISSION RATES

	<u>Volume meter</u> (DSCF)	<u>Flow rate</u> (DSCFM)	<u>Lead sampled</u> (mg)	<u>Lead concentration</u> (gr/DSCF)	<u>Lead emission rate</u>	
					(lbs/hr)	(kg/hr)
BHI-1	46.375	33,463	2,714	$9.01 \times 10^{-1}$	258.39	117.20
SCI-1	57.963	33,855	10.835	$2.88 \times 10^{-3}$	$8.36 \times 10^{-1}$	$3.79 \times 10^{-1}$
SCO-1	69.011	33,642	1.365	$3.05 \times 10^{-4}$	$8.78 \times 10^{-2}$	$3.90 \times 10^{-2}$
BHI-2	48.070	34,119	8,601	2.75	804.10	364.74
SCI-2	61.985	33,954	27.645	$6.87 \times 10^{-3}$	2.00	$9.09 \times 10^{-1}$
SCO-2	74.331	34,995	2.185	$4.53 \times 10^{-4}$	$1.36 \times 10^{-1}$	$6.16 \times 10^{-2}$
BHI-3H	48.869	31,668	7,005	2.21	599.09	271.74
SCI-3	58.879	31,413	27.485	$7.19 \times 10^{-3}$	1.93	$8.78 \times 10^{-1}$
SCI-3H	60.309	32,975	28.595	$7.30 \times 10^{-3}$	2.06	$9.36 \times 10^{-1}$
SCO-3	70.131	32,153	2.605	$5.72 \times 10^{-4}$	$1.58 \times 10^{-1}$	$7.15 \times 10^{-2}$
BHI-4	22.319	33,655	2,214	1.53	441.6	192.4
BHI-4H	25.688	35,359	1,734	1.04	315.7	137.5

Table 2-9A. GENERAL BATTERY PLANT PROCESS UNIT #1  
 READING, PENNSYLVANIA  
 SUMMARY OF SO<sub>2</sub> ANALYSIS

Run	ppm	Run	ppm	Run	ppm
BHI-1	2676	SCI-1	2870	SCO-1	308
BHI-2	2542	SCI-2	2780	SCO-2	112
BHI-3	Aborted	SCI-3	3513	SCO-3	216
BHI-3-H	3256	SCI-3-H	3580		
BHI (Method 6)	3225	SCI (Method 6)	2855	SCO (Method 6)	173
BHI-4	1386				
BHI-4-H	1280				

Table 2-9B. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
SUMMARY OF SO<sub>2</sub> ANALYSIS

TRW Lab #	Field Run #	Sample type	Sample volume (Vm) (scm)	Total collected	
				(mg)	(ppm)
4823	BHI	SO <sub>3</sub> <sup>a</sup>	0.34	4.24	3.8
4827	SCO	SO <sub>3</sub>	0.52	0.215	0.1
4826	SCI	SO <sub>3</sub>	0.52	2.59	1.5
4824	BHI	SO <sub>2</sub> <sup>b</sup>	0.34	2,869	3,221
4830	SCO	SO <sub>2</sub>	0.52	236	173
4827	SCI	SO <sub>2</sub>	0.52	3,887	2,853
4836	BHI-1	108 <sup>c</sup>	1.31	9,183	2,676
4842	BHI-2	108	1.36	9,056	2,542
4853	BHI-4	108	0.63	2,288	1,386
4848	BHI-3-H	108	1.38	11,771	3,256
4858	BHI-4-H	108	0.73	2,449	1,280
4863	SCI-1	108	1.04	12,331	2,870
4867	SCI-2	108	1.76	12,821	2,780
4871	SCI-3	108	1.67	15,369	3,513
4875	SCI-3-H	108	1.71	16,040	3,580
4879	SCO-1	108	1.98	1,596	308
4883	SCO-2	108	2.11	618	112
4887	SCO-3	108	1.99	1,128	216

<sup>a</sup>Method 6 - IPA impinger.

<sup>b</sup>Method 6 - H<sub>2</sub>O<sub>2</sub> impinger.

<sup>c</sup>Method 108 - H<sub>2</sub>O<sub>2</sub> impinger.

Table 2-10A. GENERAL BATTERY PLANT PROCESS UNIT #1  
 READING, PENNSYLVANIA  
 SUMMARY OF PARTICULATE RESULTS<sup>a</sup>

Run	gr/DSCF	lb/hr	Run	gr/DSCF	lb/hr	Run	gr/DSCF	lb/hr
BHI-1	3.74	1071	SCI-1	.0056	1.62	SC0-1	.0011	.303
BHI-2	5.29	1521	SCI-2	.0086	2.49	SC0-2	.0109	3.28
BHI-3	ABORTED		SCI-3	.0092	2.48	SC0-3	.0015	.400
BHI-3-H	8.50	2306	SCI-3-H	.0078	2.19			
BHI-4	2.84	820						
BHI-4-H	2.95	894						

<sup>a</sup>Suspect low results, see explanation in Section 2.5.

Table 2-10B. GENERAL BATTERY PLANT PROCESS UNIT #1  
READING, PENNSYLVANIA  
SUMMARY OF PARTICULATE RESULTS

Run	Volume meter (DSCF)	Particulate results			Particulate concentration (gr/DSCF)
		Filter (mg)	+ Probe/cyclone <sup>b</sup> (mg)	= Total (mg)	
BHI-1	46.375	6,183.8	5,100	11,238.5	3.73
SCI-1	57.963	21.0	a	21.0	$5.58 \times 10^{-3}$
SCO-1	69.011	4.7	a	4.7	$1.05 \times 10^{-3}$
BHI-2	48.070	7,162.8	9,330	16,492.8	5.28
SCI-2	61.985	34.5	a	34.5	$8.57 \times 10^{-3}$
SCO-2	74.331	52.6	a	52.6	$1.09 \times 10^{-2}$
BHI-3H	48.869	11,173.5	15,730	26,903.5	8.48
SCI-3	58.879	35.2	a	35.2	$9.21 \times 10^{-3}$
SCI-3H	60.309	30.3	a	30.3	$7.74 \times 10^{-3}$
SCO-3	70.131	6.6	a	6.6	$1.45 \times 10^{-3}$
BHI-4	22.319	2,382.3	1,730	4,112.3	2.84
BHI-4H	25.688	2,489.3	2,420	4,909.3	2.94

<sup>a</sup>No cyclone used or substantial amount of particulate in probe at these locations.

<sup>b</sup>Suspect low results, see explanation in Section 2.5.

## 2.6 STATIONARY GAS RESULTS

EPA Reference Method 3 (Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight; Federal Register 42 FR 41768) was utilized to characterize the flue gas. The results are provided in Appendix A computer printouts and example field chromatograms are included in Appendix C.

## 2.7 PROCESS MATERIAL RESULTS

The process material samples were composited and analyzed by atomic absorption. The results are presented in Table 2-11. A description of the process is provided in Section 3 and a further description with the process sampling information is provided in Appendix H.



Table 2-11. GENERAL BATTERY PLANT PROCESS UNIT #1 - READING, PENNSYLVANIA

Sample Identification	Sample Time	Sample date	TRW no.	Arsenic (mg/g)	Cadmium (mg/g)	Lead (mg/g)
Process/Ventilation Baghouse Dust Feed to Reverb	10:00 am	6/21/83	4803	5.19	9.55	242
Process/Ventilation Baghouse Dust Feed to Reverb	1:00 pm	6/22/83	4804	14.3	8.73	249
Process Baghouse Dust	10:00 am	6/21/83	4805	5.82	10.2	324
Process/Ventilation Baghouse Dust Feed to Reverb	6:05 pm	6/21/83	4806	7.22	10.2	185
Process Baghouse Dust	1:00 pm	6/22/83	4807	7.39	11.2	290
Ventilation Baghouse Dust	10:00 am	6/21/83	4808	8.99	2.67	225
Ventilation Baghouse Dust	6:00 pm	6/21/83	4809	10.3	7.72	315
Ventilation Baghouse Dust	1:00 pm	6/22/83	4810	8.85	2.67	248
Scrubber Sludge from #1 Cone	6:30 pm	6/21/83	4811	$1.48 \times 10^{-2}$	$7.25 \times 10^{-2}$	0.186
Scrubber Sludge from #1 Cone	11:30 am	6/21/83	4812	$3.7 \times 10^{-2}$	$5.17 \times 10^{-3}$	0.271
Scrubber Sludge from #1 Cone	1:15 pm	6/22/83	4813	$1.52 \times 10^{-2}$	$5.83 \times 10^{-3}$	0.233
#1 Scrubber Slurry	6:30 pm	6/21/83	4814	$1.15 \times 10^{-2}$	$4.09 \times 10^{-3}$	0.165
#1 Scrubber Slurry	11:25 am	6/21/83	4815	$8.79 \times 10^{-3}$	$4.86 \times 10^{-3}$	0.200
#1 Scrubber Slurry	1:15 pm	6/22/83	4816	$8.80 \times 10^{-3}$	$1.69 \times 10^{-3}$	0.105
Composite Blast Furnace Slag, Blast #1	9:15am-2:35pm	6/21/83	4896	$1.83 \times 10^{-4}$	$1.32 \times 10^{-2}$	7.54
Composite Reverb Furnace Slag, Reverb #1	9:50am-5:00pm	6/21/83	4897	$4.96 \times 10^{-3}$	2.12	532
Composite Blast Furnace Slag, Blast #1	12:10-2:15pm	6/22/83	4898	$6.97 \times 10^{-4}$	$1.48 \times 10^{-2}$	21.3
Composite Reverb Furnace Slag, Reverb #1	12:10-2:15pm	6/22/83	4899	$4.64 \times 10^{-3}$	1.57	623

(continued)

Table 2-11. Continued

Sample Identification	Sample Time	Sample date	TRW no.	Arsenic (mg/g)	Cadmium (mg/g)	Lead (mg/g)
Blast Furnace Metal	10:00 am	6/21/83	4900	$4.07 \times 10^{-2}$	0.107	865
Blast Furnace Metal	9:15 am	6/21/83	4901	0.425	$6.65 \times 10^{-2}$	936
Blast Furnace Metal	10:50 am	6/21/83	4902	$1.75 \times 10^{-2}$	$6.95 \times 10^{-2}$	937
Blast Furnace Metal	11:40 am	6/21/83	4903	0.362	$9.16 \times 10^{-2}$	885
Blast Furnace Metal	12:36 am	6/21/83	4904	$4.23 \times 10^{-2}$	$3.76 \times 10^{-2}$	946
Blast Furnace Metal	1:05 pm	6/21/83	4905	$7.54 \times 10^{-3}$	$4.00 \times 10^{-2}$	981
Blast Furnace Metal	2:35 pm	6/21/83	4906	$4.86 \times 10^{-2}$	$4.94 \times 10^{-2}$	882
Blast Furnace Metal	4:35 pm	6/21/83	4907	$2.22 \times 10^{-2}$	$6.23 \times 10^{-2}$	987
Blast Furnace Metal	5:55 pm	6/21/83	4908	$1.61 \times 10^{-2}$	$3.09 \times 10^{-2}$	849
Blast Furnace Metal	6:55 pm	6/21/83	4909	$3.26 \times 10^{-2}$	$1.99 \times 10^{-2}$	722
Blast Furnace Metal	8:00 pm	6/21/83	4910	$4.62 \times 10^{-2}$	$8.00 \times 10^{-2}$	753
Blast Furnace Metal	12:10 pm	6/22/83	4911	0.504	0.139	924
Blast Furnace Metal	12:30 pm	6/22/83	4912	$6.39 \times 10^{-2}$	$9.10 \times 10^{-2}$	822
Blast Furnace Metal	1:30 pm	6/22/83	4913	$2.66 \times 10^{-2}$	$6.90 \times 10^{-2}$	894
Blast Furnace Metal	2:15 pm	6/22/83	4914	ND	$5.68 \times 10^{-2}$	889
Reverb Furnace Metal	10:50 am	6/21/83	4915	$8.9 \times 10^{-4}$	$1.34 \times 10^{-2}$	836
Reverb Furnace Metal	5:00 pm	6/21/83	4916	$1.77 \times 10^{-3}$	$5.31 \times 10^{-2}$	887
Reverb Furnace Metal	12:15 pm	6/22/83	4917	ND	$2.07 \times 10^{-2}$	851
Reverb Furnace Metal	1:50 pm	6/22/83	4918	$1.91 \times 10^{-3}$	$4.54 \times 10^{-2}$	906

(continued)

Table 2-11. Concluded

Sample Identification	Sample Time	Sample date	TRW no.	Arsenic (mg/g)	Cadmium (mg/g)	Lead (mg/g)
Yard Sample #1; Reverb Slag, Dross and Battery Group Mix		6/22/83	4919	1.22	0.328	494
Yard Sample #2; Rerun Blast Furnace Slag Heel		6/22/83	4920	$5.47 \times 10^{-2}$	$4.48 \times 10^{-3}$	4.12
Yard Sample #3, Battery Group and Dross Mix		6/22/83	4921	1.00	0.327	448
Yard Sample #4, Blast Furnace Slag		6/22/83	4922	$4.86 \times 10^{-2}$	$9.65 \times 10^{-2}$	8.71
Yard Sample #5, Shredded Batteries, Whole		6/22/83	4923	0.270	$1.00 \times 10^{-2}$	378
Yard Sample #6, Coke		6/22/83	4924	$8.9 \times 10^{-2}$	$4.49 \times 10^{-3}$	2.92
Yard Sample #7, Reverb Slag		6/22/83	4925	3.01	0.392	275
Yard Sample #8, Refining Dross Sample		6/22/83	4926	1.24	0.399	720
Yard Sample #9, Industrial Battery Plates		6/22/83	4927	0.105	$4.64 \times 10^{-3}$	348
Yard Sample #10, Regular Battery Plates		6/22/83	4928	0.143	$2.29 \times 10^{-3}$	474

### 3. SMELTER OPERATIONS AND PROCESS EMISSION CONTROL EQUIPMENT\*

#### 3.1 PROCESS DESCRIPTION

The General Battery plant in Reading Pennsylvania is a large secondary lead smelter with a total rated lead production capacity of 240 tons/day. The primary lead-bearing input materials to the plant are recycled lead-acid batteries obtained from various sources and battery plant scrap obtained from the adjacent battery manufacturing facilities. Arsenic is present in these materials as an alloying agent in the lead used to manufacture most battery plates (i.e., all lead-acid battery plates except for those used in maintenance-free calcium-lead batteries). The lead product produced by the plant is used primarily for new battery manufacture and can contain various levels of arsenic depending on the buyer's specifications. Metallic arsenic is added directly to the refining kettles to meet some of the specifications.

The General Battery plant has two reverberatory furnaces; two blast furnaces; ten refining kettles; two fabric filter/wet scrubber systems for treating process offgases from the reverberatory and blast furnaces; and two sanitary baghouse systems for treating ventilation gases from the refining kettles, smelting furnace tapping points, and other ventilation sources. Arsenic emission tests were performed on the #1 baghouse/wet scrubber system that treats the combined offgas from the #1 blast furnace/reverberatory furnace pair.

Each of the two reverberatory furnaces has a rated lead production capacity of 70 tons/day. The reverberatory furnace charge consists of shredded whole batteries including the case, battery plant scrap, and recycled baghouse dust captured by the process baghouse and sanitary baghouse systems. The shredded plastic cased batteries and battery

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\*Authored by Radian, Incorporated.

plant scrap (i.e., decased battery group materials and battery plant drossed) are charged continuously to the reverberatory furnaces by ram feeders that are fed by hoppers containing feed mixture. The baghouse dust is charged continuously to the reverberatory furnaces using a screw conveyor system. The feed materials are smelted in the furnace by combusting natural gas with oxygen-enriched air. Reverberatory furnace slag and reverberatory furnace lead are tapped from the furnace on an irregular basis when the lead in the furnace accumulates to a sufficiently high level. Typically, lead and slag are tapped from the furnace once every 3 or 4 hours. Data on the #1 reverberatory furnace feed rates and metal production rates during the test periods are contained in Appendix H. The #1 reverberatory furnace ran smoothly with no upset conditions during each of the test periods. The average hourly lead production from the #1 reverberatory furnace was 9,500 pounds of lead per hour during the test periods.

Each of the two blast furnaces has a rated lead production capacity of 50 tons/day. The charge materials to the blast furnace consist of reverberatory furnace slag, refining kettle dross, and fluxing agents (coke, iron, and limestone). The blast furnace is charged roughly every 20 minutes in 5,000 lb. charges that are introduced to the top of the furnace through a "thimble" that is filled using front end loaders. Lead is tapped from the blast furnace continuously while slag is tapped approximately every 40-50 minutes. Data on the #1 blast furnace feed rates and metal production rates during the test periods are contained in Appendix H. The #1 blast furnace ran smoothly with no upset conditions during each of the test periods. The average hourly lead production from the #1 blast furnace was 5,400 pounds of lead per hour during the test periods.

### 3.2 PROCESS EMISSION CONTROL EQUIPMENT

Offgases from each blast furnace/reverberatory furnace pair are combined and sent to an afterburner to destroy combustibles. The afterburner offgas from each furnace pair are cooled in U-tube cooling system before being directed to one of two process baghouse/wet scrubber systems for removal of particulate matter and SO<sub>2</sub> (see Figure 2-1 and Table 3-1). Each of the process baghouses consists of seven equivalent sections, each section containing 80 fiberglass bags (30 ft. long and

Table 3-1. SAMPLE POINT KEY FOR DIAGRAM OF GENERAL BATTERY  
SECONDARY LEAD PLANT, READING, PENNSYLVANIA

Sample point	Description
A	Combined reverberatory and blast furnace offgas downstream of afterburner (afterburner not shown)
B	Baghouse offgas
C	Lime scrubber offgas
D	Baghouse flue dust catch
E	Lime scrubber sludge
F	Crushed battery plates, lead scrap
G	Recycled flue dust
H	Miscellaneous reverberatory furnace inputs
I	Semisoft lead
J	Reverberatory furnace slag
K	Drosses
L	Reverberatory furnace slag
M	Recycle blast furnace slag
N	Battery scrap
O	Coke
P	Miscellaneous blast furnace inputs
Q	Hard lead
R	Blast furnace slag, matte

11½ inches in diameter). The bags are cleaned using reverse air pulses every 30 minutes, and equal time intervals are maintained between reverse flow in all sections. Representative baghouse inlet temperature data and individual section pressure drop data are contained in Appendix H for the #1 process baghouse during the test periods. A bag breakage occurred in Section 6 of process baghouse #1 prior to the sampling period during which test runs BHI-1, SCI-1, and SCO-1 were completed. Section 6 was sealed off prior to the sampling period and the baghouse operated using only six sections during the sampling run. However, it is expected that this would not significantly affect the arsenic emissions measurements made other than the effect of the increased air to cloth ratio. The #1 process baghouse ran smoothly with no unusual occurrences during all of the other test periods. Section 6 was repaired prior to the next sampling period, and the #1 process baghouse ran smoothly with no unusual occurrences during all subsequent test periods. The inlet temperature to the baghouse ranged from 330°F to 468°F during the tests.

Offgases from each of the two process baghouse systems are sent to venturi scrubbers. The lime scrubbers have a design SO<sub>2</sub> removal efficiency of 99 percent. Approximately 2,000 gpm of a 15 to 20 percent lime slurry solution are introduced at the throat of each of the two venturi scrubbers. The scrubbing system was designed to maintain a pH value of 8 to 10 and to operate under a design pressure drop of 8 inches of water. Scrubber sludge is periodically removed from the system using tank trucks. Scrubber operating data and scrubber sludge removal rates for venturi scrubber system #1 are contained in Appendix H. The system operated normally with no upset conditions during all of the test periods. The scrubber slurry pH ranged from pH 6.8 to pH 7.6, which is lower than the design pH range but is representative of normal operation at the General Battery plant. The pressure drop across the throat of the scrubber was not measured, but the pressure drop across the throat and the demister was typically between 13 and 14 inches of water. The scrubber slurry recirculation rate ranged from 2,100 to 2,150 gallons per minute. Approximately 7,500 gallons of scrubber sludge was removed from venturi scrubbing system #1 during each 8 hour shift of the two day test period.

Table 2-11. GENERAL BATTERY PLANT PROCESS UNIT #1 - READING, PENNSYLVANIA

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Process/Ventilation Baghouse Dust Feed to Reverb	1:00 pm	6/22/83	4804	14.3	8.73	249
Process Baghouse Dust	10:00 am	6/21/83	4805	5.82	10.2	324
Process/Ventilation Baghouse Dust Feed to Reverb	6:05 pm	6/21/83	4806	7.22	10.2	185
Process Baghouse Dust	1:00 pm	6/22/83	4807	7.39	11.2	290
Ventilation Baghouse Dust	10:00 am	6/21/83	4808	8.99	2.67	225
Ventilation Baghouse Dust	6:00 pm	6/21/83	4809	10.3	7.72	315
Ventilation Baghouse Dust	1:00 pm	6/22/83	4810	8.85	2.67	248
Scrubber Sludge from #1 Cone	6:30 pm	6/21/83	4811	$1.48 \times 10^{-2}$	$7.25 \times 10^{-2}$	0.186
Scrubber Sludge from #1 Cone	11:30 am	6/21/83	4812	$3.7 \times 10^{-2}$	$5.17 \times 10^{-3}$	0.271
Scrubber Sludge from #1 Cone	1:15 pm	6/22/83	4813	$1.52 \times 10^{-2}$	$5.83 \times 10^{-3}$	0.233
#1 Scrubber Slurry	6:30 pm	6/21/83	4814	$1.15 \times 10^{-2}$	$4.09 \times 10^{-3}$	0.165
#1 Scrubber Slurry	11:25 am	6/21/83	4815	$8.79 \times 10^{-3}$	$4.86 \times 10^{-3}$	0.200
#1 Scrubber Slurry	1:15 pm	6/22/83	4816	$8.80 \times 10^{-3}$	$1.69 \times 10^{-3}$	0.105
Composite Blast Furnace Slag, Blast #1	9:15am-2:35pm	6/21/83	4896	$1.83 \times 10^{-4}$	$1.32 \times 10^{-2}$	7.54
Composite Reverb Furnace Slag, Reverb #1	9:50am-5:00pm	6/21/83	4897	$4.96 \times 10^{-3}$	2.12	532
Composite Blast Furnace Slag, Blast #1	12:10-2:15pm	6/22/83	4898	$6.97 \times 10^{-4}$	$1.48 \times 10^{-2}$	21.3
Composite Reverb Furnace Slag, Reverb #1	12:10-2:15pm	6/22/83	4899	$4.64 \times 10^{-3}$	1.57	623

(continued)



Table 2-11. Continued

Sample Identification	Sample Time	Sample date	TRW no.	Arsenic (mg/g)	Cadmium (mg/g)	Lead (mg/g)
Blast Furnace Metal	10:00 am	6/21/83	4900	$4.07 \times 10^{-2}$	0.107	865
Blast Furnace Metal	9:15 am	6/21/83	4901	0.425	$6.65 \times 10^{-2}$	936
Blast Furnace Metal	10:50 am	6/21/83	4902	$1.75 \times 10^{-2}$	$6.95 \times 10^{-2}$	937
Blast Furnace Metal	11:40 am	6/21/83	4903	0.362	$9.16 \times 10^{-2}$	885
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Blast Furnace Metal	1:05 pm	6/21/83	4905	$7.54 \times 10^{-3}$	$4.00 \times 10^{-2}$	981
Blast Furnace Metal	2:35 pm	6/21/83	4906	$4.86 \times 10^{-2}$	$4.94 \times 10^{-2}$	882
Blast Furnace Metal	4:35 pm	6/21/83	4907	$2.22 \times 10^{-2}$	$6.23 \times 10^{-2}$	987
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Blast Furnace Metal	6:55 pm	6/21/83	4909	$3.26 \times 10^{-2}$	$1.99 \times 10^{-2}$	722
Blast Furnace Metal	8:00 pm	6/21/83	4910	$4.62 \times 10^{-2}$	$8.00 \times 10^{-2}$	753
Blast Furnace Metal	12:10 pm	6/22/83	4911	0.504	0.139	924
Blast Furnace Metal	12:30 pm	6/22/83	4912	$6.39 \times 10^{-2}$	$9.10 \times 10^{-2}$	822
Blast Furnace Metal	1:30 pm	6/22/83	4913	$2.66 \times 10^{-2}$	$6.90 \times 10^{-2}$	894
Blast Furnace Metal	2:15 pm	6/22/83	4914	ND	$5.68 \times 10^{-2}$	889
Reverb Furnace Metal	10:50 am	6/21/83	4915	$8.9 \times 10^{-4}$	$1.34 \times 10^{-2}$	836
Reverb Furnace Metal	5:00 pm	6/21/83	4916	$1.77 \times 10^{-3}$	$5.31 \times 10^{-2}$	887
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(continued)

Table 2-11. Concluded

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Yard Sample #9, Industrial Battery Plates		6/22/83	4927	0.105	$4.64 \times 10^{-3}$	348
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### 3. SMELTER OPERATIONS AND PROCESS EMISSION CONTROL EQUIPMENT\*

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The General Battery plant has two identical reverberatory furnaces; two identical blast furnaces; ten refining kettles; two identical fabric filter/wet scrubber systems for treating process offgases from the reverberatory and blast furnaces; and two identical sanitary baghouse systems for treating ventilation gases from the refining kettles, smelting furnace tapping points, and other ventilation sources. Arsenic emission tests were performed on the #1 baghouse/wet scrubber system that treats the combined offgas from the #1 blast furnace/reverberatory furnace pair.

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plant scrap (i.e., decayed battery group materials and battery plant drossed) are charged continuously to the reverberatory furnaces by ram feeders that are fed by hoppers containing feed mixture. The baghouse dust is charged continuously to the reverberatory furnaces using a screw conveyor system. The feed materials are smelted in the furnace by combusting natural gas with oxygen-enriched air. Reverberatory furnace slag and reverberatory furnace lead are tapped from the furnace on an irregular basis when the lead in the furnace accumulates to a sufficiently high level. Typically, lead and slag are tapped from the furnace once every 3 or 4 hours. Data on the #1 reverberatory furnace feed rates and metal production rates during the test periods are contained in Appendix H. The #1 reverberatory furnace ran smoothly with no upset conditions during each of the test periods. The average hourly lead production from the #1 reverberatory furnace was 9,500 pounds of lead per hour during the test periods.

Each of the two blast furnaces has a rated lead production capacity of 50 tons/day. The charge materials to the blast furnace consist of reverberatory furnace slag, refining kettle dross, and fluxing agents (coke, iron, and limestone). The blast furnace is charged roughly every 20 minutes in 5,000 lb. charges that are introduced to the top of the furnace through a "thimble" that is filled using front end loaders. Lead is tapped from the blast furnace continuously while slag is tapped approximately every 40-50 minutes. Data on the #1 blast furnace feed rates and metal production rates during the test periods are contained in Appendix H. The #1 blast furnace ran smoothly with no upset conditions during each of the test periods. The average hourly lead production from the #1 blast furnace was 5,400 pounds of lead per hour during the test periods.

### 3.2 PROCESS EMISSION CONTROL EQUIPMENT

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H	Miscellaneous reverberatory furnace inputs
I	Semisoft lead
J	Reverberatory furnace slag
K	Drosses
L	Reverberatory furnace slag
M	Recycle blast furnace slag
N	Battery scrap
O	Coke
P	Miscellaneous blast furnace inputs
Q	Hard lead
R	Blast furnace slag, matte

11½ inches in diameter). The bags are cleaned using reverse air pulses every 30 minutes, and equal time intervals are maintained between reverse flow in all sections. Representative baghouse inlet temperature data and individual section pressure drop data are contained in Appendix H for the #1 process baghouse during the test periods. A bag breakage occurred in Section 6 of process baghouse #1 prior to the sampling period during which test runs BHI-1, SCI-1, and SCO-1 were completed. Section 6 was sealed off prior to the sampling period and the baghouse operated using only six sections during the sampling run. However, it is expected that this would not significantly affect the arsenic emissions measurements made other than the effect of the increased air to cloth ratio. The #1 process baghouse ran smoothly with no unusual occurrences during all of the other test periods. Section 6 was repaired prior to the next sampling period, and the #1 process baghouse ran smoothly with no unusual occurrences during all subsequent test periods. The inlet temperature to the baghouse ranged from 330°F to 468°F during the tests.

Offgases from each of the two process baghouse systems are sent to venturi scrubbers. The lime scrubbers have a design SO<sub>2</sub> removal efficiency of 99 percent. Approximately 2,000 gpm of a 15 to 20 percent lime slurry solution are introduced at the throat of each of the two venturi scrubbers. The scrubbing system was designed to maintain a pH value of 8 to 10 and to operate under a design pressure drop of 8 inches of water. Scrubber sludge is periodically removed from the system using tank trucks. Scrubber operating data and scrubber sludge removal rates for venturi scrubber system #1 are contained in Appendix H. The system operated normally with no upset conditions during all of the test periods. The scrubber slurry pH ranged from pH 6.8 to pH 7.6, which is lower than the design pH range but is representative of normal operation at the General Battery plant. The pressure drop across the throat of the scrubber was not measured, but the pressure drop across the throat and the demister was typically between 13 and 14 inches of water. The scrubber slurry recirculation rate ranged from 2,100 to 2,150 gallons per minute. Approximately 7,500 gallons of scrubber sludge was removed from venturi scrubbing system #1 during each 8 hour shift of the two day test period.

#### 4. SAMPLING LOCATIONS

This section presents descriptions of the sampling locations with sample points used during the source testing program at the General Battery Plant in Reading, Pennsylvania. Figure 2-1 presents a schematic diagram of the process flow with gaseous and process sampling locations. Figure 4-1 provides a schematic of the baghouse/scrubber system with the gas sampling locations. The gaseous and process sample locations are described in Table 3-1 utilizing the sample point key for Figure 2-1. The gaseous sample locations A, B, and C were referenced during the test as the Baghouse Inlet (BHI), Scrubber Inlet (SCI), and Scrubber Outlet (SCO) respectively.

##### 4.1 BAGHOUSE INLET

Two sample ports were located at the Baghouse Inlet position. Figure 4-2 provides a description of the BHI position with the location of the sample traverse points. Six traverse points were utilized for each test port to traverse the cross section of the duct. Ten minute sample periods at each sample point gave a 120 minute test run period. This run had one more run than the other two locations; because the high temperatures of the process during Run #3 destroyed the source train filter system. Also only one port was traversed during Runs 3 and 4 because of the high temperatures.

The testing at the BHI location included a preliminary velocity traverse by EPA Method 2, a  $\text{SO}_2/\text{SO}_3$  determination by EPA Method 6, four Standard EPA Method 108 test runs (Test Run #3 was aborted), two Modified EPA Method 108 test runs, and four stationary gas determination in accordance with EPA Method 3.

##### 4.2 SCRUBBER INLET

Two sample ports were located at the Scrubber Inlet position. Figure 4-3 provides a description of the SCI position with the location

# PROCESS FLOW DIAGRAM

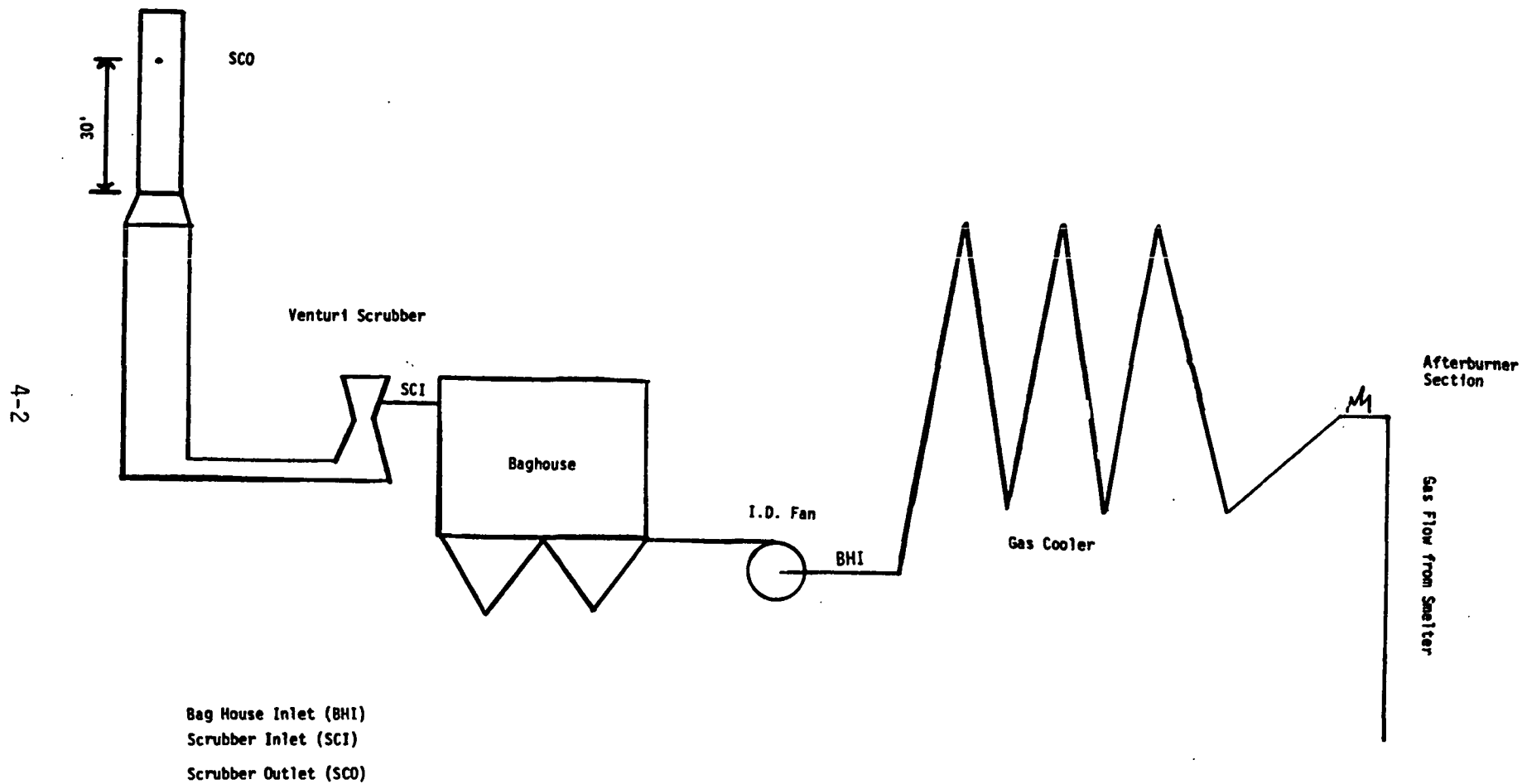
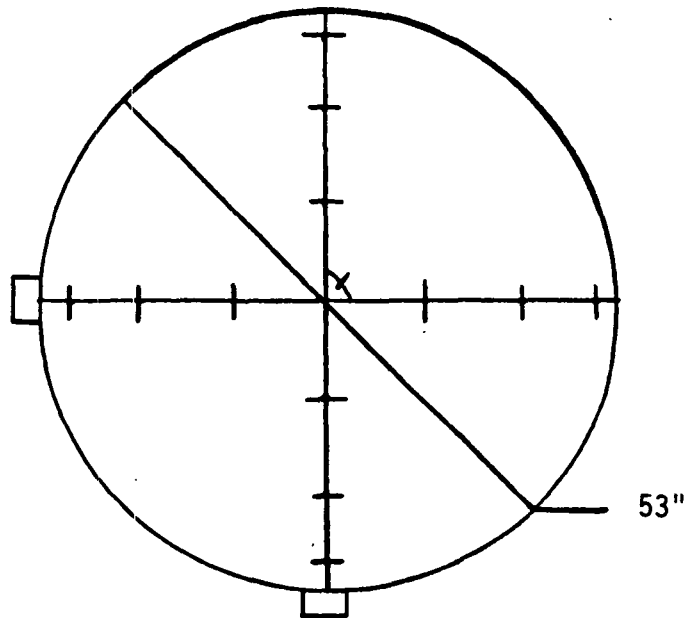


Figure 4-1. General Battery, Reading, Pennsylvania: schematic of the baghouse/scrubber system with the gas sampling locations.



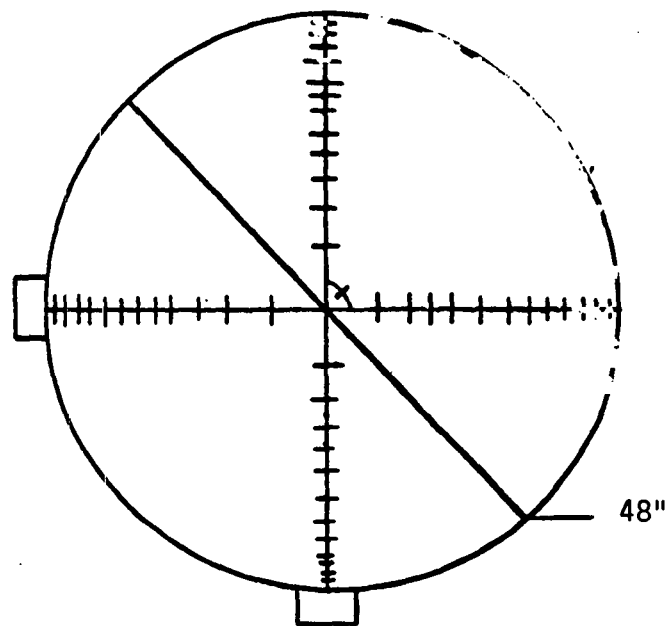
BAGHOUSE INLET (BHI)



<u>Traverse Point Number</u>	<u>Distance from Sample Port, Inches</u>
1	2.3
2	7.8
3	15.7
4	37.3
5	45.2
6	50.7

Figure 4-2. General Battery, Reading, Pennsylvania: baghouse inlet location with sample traverse points.

# SCRUBBER INLET (SCI)



## Traverse Point Number

## Distance from Sample Port, Inches

1	1.0
2	1.6
3	2.6
4	3.8
5	5.0
6	6.3
7	7.8
8	9.3
9	11.0
10	13.0
11	15.5
12	19.1
13	28.9
14	32.5
15	35.0
16	37.0
17	38.7
18	40.2
19	41.7
20	43.0
21	44.2
22	45.4
23	46.4
24	56.0

Figure 4-3. General Battery, Reading, Pennsylvania: scrubber inlet location with sample traverse points.

of the sample traverse points. Twenty-four traverse points were utilized for each test port to traverse the cross section of the duct. Sample periods of 150 seconds per sample point were maintained for a 120 minute test run period. Three test runs were completed at the SCI location.

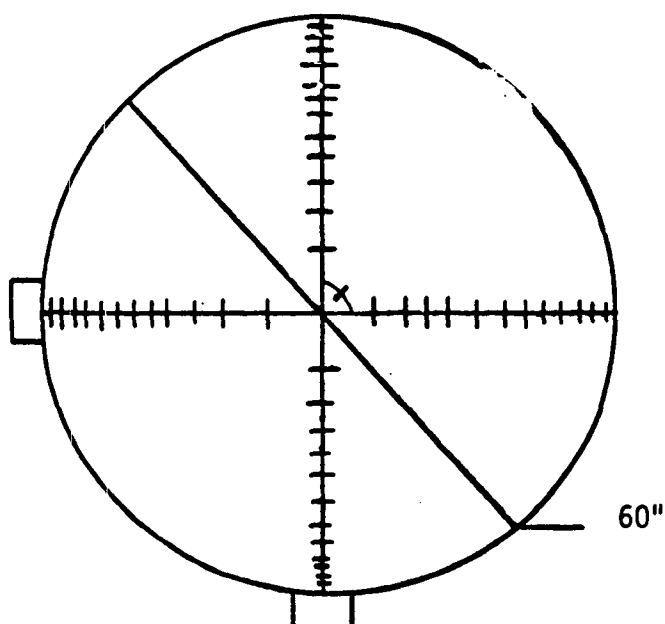
The testing at the SCI location included a preliminary velocity traverse by EPA Method 2, a  $\text{SO}_2/\text{SO}_3$  determination by EPA Method 6, three standard EPA Method 108 test runs, one Modified EPA Method 108 test run, and three stationary gas determinations in accordance with EPA Method 3.

#### 4.3 SCRUBBER OUTLET

Two sample ports were located at the Scrubber Outlet position. Figure 4-4 provides a description of the SCO position with the location of the sample traverse points. Twenty-four traverse points were utilized for each test port to traverse the cross section of the duct. Sample periods of 150 seconds per sample point were maintained for a 120 minute test run period. Three test runs were completed at the SCI location.

The testing at the SCO location included a preliminary velocity traverse by EPA Method 2, a  $\text{SO}_2/\text{SO}_3$  determination by EPA Method 6, three standard EPA Method 108 test runs, one modified EPA Method 108 test run, and three stationary gas determination in accordance with EPA Method 3.

# SCRUBBER OUTLET (SCO)



<u>Traverse Point Number</u>	<u>Distance from Sample Port, Inches</u>
1	1.0
2	1.9
3	3.3
4	4.8
5	6.3
6	7.9
7	9.7
8	11.6
9	13.8
10	16.3
11	19.4
12	23.9
13	36.1
14	40.6
15	43.7
16	46.2
17	48.4
18	50.3
19	52.1
20	53.7
21	55.2
22	56.7
23	58.1
24	59.0

Figure 4-4. General Battery, Reading, Pennsylvania: scrubber outlet location with sample traverse points.

## 5. SAMPLING AND ANALYSIS METHODS

This section presents general descriptions of sampling and analytical procedures employed during the source testing project conducted at the secondary lead smelter of General Battery's Reading, Pennsylvania. Standard EPA sampling and analysis procedures are detailed in the Federal Register and the modified procedure are presented in Appendix D.

### 5.1 EPA REFERENCE METHODS UTILIZED DURING TESTING OF THE READING FACILITY

The following EPA Reference Methods were used during this emission testing program. These methods are taken from "Standards of Performance for New Stationary Sources," Appendix A, Federal Register, Volume 42, No. 160, Thursday, August 18, 1977, pp 41755 ff.

- Method 1 - Sample and Velocity Traverses for Stationary Sources - This method specified the number and location of sampling points within a duct, taking into account duct size and shape and local flow disturbances. In addition, this method discusses the pitot-nulling technique used to establish the degree of cyclonic flow in a duct.
- Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate - This method specifies the measurement of gas velocity and flow rate using a pitot tube, manometer and temperature sensor. The physical dimensions of the pitot tube and its spatial relationship to the temperature sensor and any sample probe are also specified.
- Method 3 - Gas Analysis for CO<sub>2</sub>, O<sub>2</sub>, Excess Air and Dry Molecular Weight - This method describes the extraction of a grab or integrated gas sample from a stack and the analysis of that sample for CO<sub>2</sub> and O<sub>2</sub> with a thermal conductivity gas chromatograph.

- Method 4 - Determination of Moisture Content in Stack Gases -  
This method describes the extraction of a gas sample from a stack and the removal and measurement of the moisture in that sample by condensation impingers. The assembly and operation of the required sampling train is specified.

Monitoring of emission conditions during the Method 108 periods were maintained at the three gaseous sampling locations. The conditions monitored were the stationary gas contents, the gas flow rate, the moisture per cent particulate levels, and the SO<sub>2</sub> concentrations.

A single point integrated bag sample was obtained over each test run at the separate test locations. The samples were analyzed in the field by gas chromatography with thermal conductivity detection (GC/TC). Analyzed sample runs were compiled, calculated, and recorded for providing stationary gas levels.

The gas flow rate was determined from the Method 108 Isokinetic sampling results. Based on EPA Methodology, the flow rate during the test period was calculated and Isokinetic rate determined.

The moisture level present in the sampled gas stream was determined by utilizing the differential volumes of the Method 108 impingers. The impinger solution volume changes and silica gel weight changes were measured and recorded (before rinses) so that water vapor concentrations could be determined.

The particulate levels present during the sample runs were determined according to EPA Method 5. The Method 108 filters were weighed prior to and after the test run for determining the particulate catch over the test period.

The measurement of the SO<sub>2</sub> concentration required a Method 6 train to be run at each sampling site. The train was operated according to EPA methodology. An effort was made for obtaining the Method 6 sample during each test run, but the problem of operating a third train at the BHI and SCI location allowed only one Method 6 sample to be taken.

## 5.2 EPA REFERENCE METHOD 108 AND MODIFIED 108 HOT FOR ARSENIC/LEAD SAMPLING

Simultaneous sampling utilizing Method 5 trains modified for Method 108 procedures were performed at the Baghouse Inlet (BHI), the Scrubber Inlet (SCI), and the Scrubber Outlet (SCO). The Method 108

procedure (Federal Register) was followed with the exception of the Whatman Filter being replaced with a glass fiber filter (per request by EMB/Frank Clay - see memo in Appendix D).

At the General Battery Unit #1 process, the gas stream leaving the gas cooler was in excess of 250°F at the BHI location and the SCI location. In order to insure the sampling methodology, two extra sampling trains were designed to operate at 400°F. These trains were set up at both the BHI and SCI locations for one test run with the Method 108 trains and operated at approximately the process temperature.

The Method 108 train samples were used to provide moisture and particulate data, in addition to the arsenic samples. Flow measurements and stationary gas samples, were taken at the BHI, SCI, and SCO location during the test runs. The EPA Reference Methods describe the methods for obtaining moisture, particulate, SO<sub>2</sub>, flow, and stationary gas results.

The sampling train was prepared, set-up, and operated to collect samples according to EPA Method 108. The only difference with standard Method 108 methodology was the third impinger was maintained as a blank for a moisture condensation check; since the low SO<sub>2</sub> concentration levels did not require the three H<sub>2</sub>O<sub>2</sub> impinger traps. The two trains designed with the 400°F capabilities (referred to as the "hot" trains) were operated according to Method 108 with the exception of the probe and filter box will be maintained at the process temperature. Figure 5-1 provides the sampling system. Table 5-1 provides the sample handling and transfer of impinger samples for the recovery procedure.

The sampling periods were in accordance with Standard U.S. EPA methodology for particulate sampling (Method 5) as specified in the Federal Register. The objective of the gaseous sampling activity was to take three representative samples during the testing periods at the three locations. The samples of the three locations were conducted simultaneously. The extreme temperature conditions at the BHI location caused the abortion of Run #3. Therefore, a Run #4 was completed at the BHI location with a 108 and 108 HOT train.

### 5.3 ANALYTICAL METHODS

#### 5.3.1 Analytical Method for Arsenic/Lead/Cadmium Samples

Particulate and gaseous emissions of arsenic, lead, and cadmium were isokinetically sampled from the source and collected on glass mat

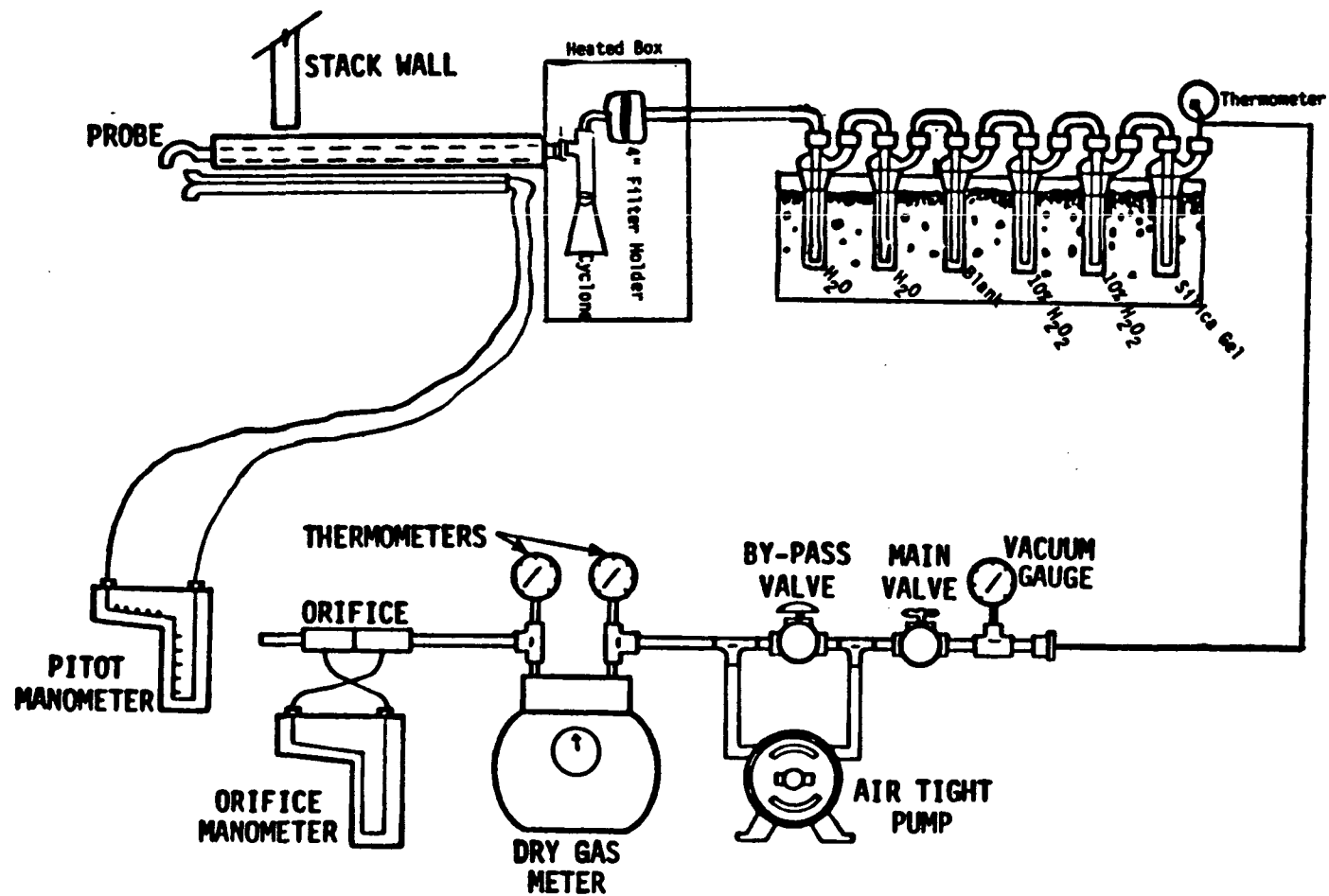
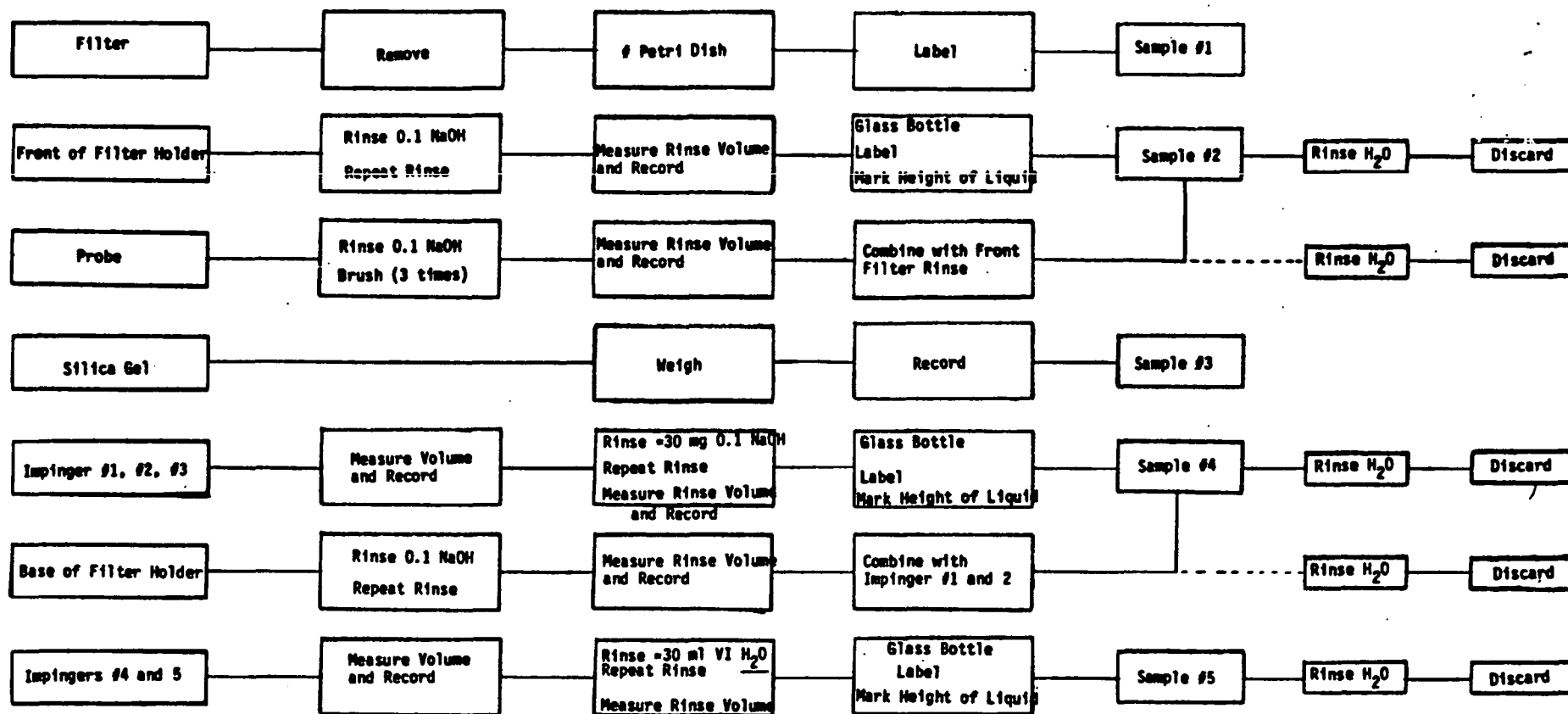


Figure 5-1. General Battery, Reading, Pennsylvania: Method 108 sampling train.



TABLE 5-1. GENERAL BATTERY, READING, PENNSYLVANIA: METHOD 108 RECOVERY PROCEDURES

5-5



filters and in water. The collected methods were then analyzed using atomic absorption spectrophotometry.

5.3.1.1 Sample preparation. Particulate samples and liquids were prepared as described in Method 108, "Method for Determination of Particulate and Gaseous Arsenic Emission from Non-Ferrous Smelters".

Each solid sample was first crushed approximately to a grain size of one cubic centimeter in a jawcrusher manufactured by Chipmunk Incorporated. The fragments were collected in a container lined with high-purity Phillips 1-mil-thick polyethylene film. The fragments were then randomly mixed and placed in their original container. Between each sample crushing, any residue left from the previous sample was removed from the jawcrusher and the plastic lining was replaced with Phillips polyethylene. The jawcrusher was brushed clean between each sample.

Each crushed sample was ground into a fine powder with a Bilco pulverizer. The particles were collected on a sheet of uncontaminated polyethylene, and were transferred to the pre-washed bottles. Between the grinding of each sample, the pulverizer was cleaned in a three-step procedure. First, the pulverizer was brushed clean of excess sample residue. Next, approximately 0.5 liters of quartz sand was ground in the pulverizer to remove any remaining sample residue; the pulverized quartz was then discarded. Finally, approximately 0.25 to 0.33 liters of quartz sand was ground in the pulverizer to remove any sample material possibly remaining in the machine. This pulverized quartz was collected to exhibit any possible contamination from previous samples. This material was taken as blank and checked for contamination. Disposal polyethylene gloves were worn during the entire procedure, and were changed after each sample crushing was completed.

Ore samples and particulate residues were treated as undissolved solids by PARR acid digestion. Each sample (0.25 gm) was placed in a PARR acid digestion bomb and 5 ml each of concentrated nitric acid and hydrofluoric acids were added. The bomb was sealed and placed in the oven for 5 hours at 150°C. The sample was then transferred to a 50 ml polypropylene volumetric flask and diluted with deionized distilled water.

5.3.1.2 Sample analysis. Arsenic ( $>1.0 \mu\text{g/ml}$  of As), lead, and cadmium were determined by atomic absorption spectrophotometry with background correction. Standard conditions used for each determination is presented in the appendix (Figures C-3, C-4, and C-5). Arsenic samples that contain less than  $1 \mu\text{g/ml}$  were determined by hydride generation utilizing a Perkin Elmer in H-10 hydride generation with determination background correction (Figure C-6). Samples concentration outside the analytical working range were diluted and reanalyzed.

#### 5.3.2 Analytical Method for Stationary Gases

EPA Reference Method 3 (Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight; Federal Register 42 FR 41768) was utilized to characterize the flue gas. As permitted under Section 1.2, Paragraph 2 of the reference document, a modification to the sampling procedures and use of an alternative analytical procedure was implemented. A single point integrated sample was collected. In lieu of an Orsat analyzer, a gas chromatograph with a thermal conductivity detector (GC/TCD) was utilized to measure the concentrations of oxygen ( $\text{O}_2$ ), carbon dioxide ( $\text{CO}_2$ ), and nitrogen ( $\text{N}_2$ ) in the integrated bag sample.

An example of the filed chromatograms are presented in Appendix C. This alternative field analytical method offers greater accuracy than an Orsat and a permanent hard copy record of the analysis. Previous test programs have demonstrated the acceptability of this substitution and have been approved by regulatory authorities.

The gas chromatograph utilized was a Shimadzu GC-38T with a Shimadzu Chromatopac<sup>®</sup> to integrate and record the chromatogram peak area and peak heights. Helium was the carrier gas. Compound separation was achieved with a packed stainless steel Chromosorb<sup>®</sup> 102/Molecular Sieve column. Calibration gas standards were injected prior to and after sample by injection for a quantification by retention time and peak area. A one point calibration method was employed utilizing a Scotty II-Mix 10 calibration ( $\pm 2\%$  certified) mixture. This mixture contained stationary gas components as follows:

- $\text{CO}_2$  - 14.8%
- $\text{O}_2$  - 7.07%
- $\text{N}_2$  - 78.13%

#### 5.4 PROCESS SAMPLING

Bulk grab sampling of process solids was obtained during each test period. The sampling was performed by the Radian personnel on-site. Most process samples were obtained from General Battery personnel. The samples were labeled and transported in bulk form to the TRW-Research Triangle Park Facility for compositing and analysis.