

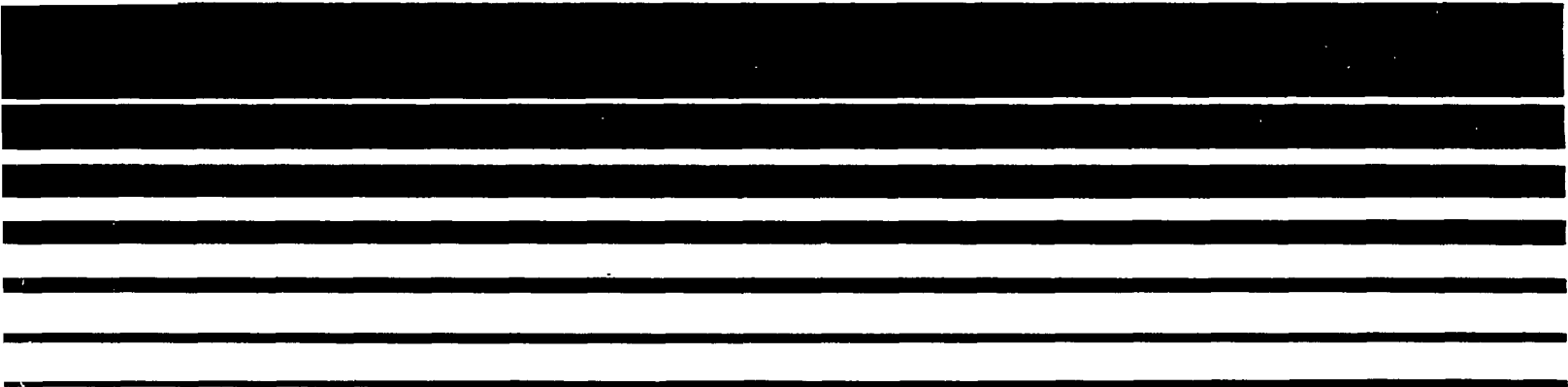
Air



Secondary Lead Smelter Test Of Area Source Fugitive Emissions For Arsenic, Cadmium, And Lead

**Chloride Metals
Tampa, Florida**

Volume 1





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EMISSION TEST REPORT:

CHLORIDE METALS SECONDARY LEAD SMELTER
3507 S. 50th Street
Tampa, Florida

Final Report

Volume 1

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SECTION 1
INTRODUCTION

In January 1981, the Environmental Protection Agency (EPA) listed arsenic as a hazardous air pollutant. In response to the listing of arsenic, the EPA is charged with the responsibility of determining those industries which pose a risk to the health of the population and to the environment. EPA is presently assessing the health and environmental risk posed by arsenic emissions from the secondary lead smelting industry. This report presents the results of an emissions test study at a secondary lead smelter to develop an arsenic emissions data base to assess the health and environmental risks presented by that industry.

1.1 PROGRAM BACKGROUND

The EPA is presently assessing the potential for arsenic emissions from secondary lead smelters. Available data indicate that the secondary lead industry is a source of arsenic, and modeling studies indicate that fugitive sources account for the majority of arsenic emissions from secondary lead smelters. The existing data base for fugitive arsenic emissions from secondary lead smelters is insufficient to accurately quantify the magnitude of arsenic fugitive emissions from the industry. Additionally, no empirical data are available to assess the emissions reduction potential of various fugitive emissions control alternatives. The purpose of this project is to develop relative magnitudes of fugitive arsenic emissions from the secondary lead industry and to provide data to assess the reduction potential of fugitive emissions control techniques. The test data will serve as inputs to the Human Exposure Model (HEM) to assess the risk to the population associated with fugitive arsenic emissions from the secondary lead industry.

1.2 PROGRAM OBJECTIVES

The primary objectives of this program are:

- to estimate fugitive arsenic emissions from a secondary lead smelter;
- to determine relative contributions of emissions from various sources at the smelter; and
- to provide data to assess the reduction potential of fugitive emissions practices typically applied in the secondary lead smelting industry.

In addition to fugitive arsenic emissions, fugitive emissions of lead, cadmium, and particulate matter were also investigated. Lead emissions were determined to allow a comparison of arsenic emissions to lead emissions. Lead fugitive emissions data for secondary lead smelters are available through other studies and relative emissions rates of arsenic to lead determined concurrently in this study may be transferable to other more limited data sets.

EPA is studying the health effects of cadmium and is considering listing cadmium as a hazardous air pollutant. Emission rates for cadmium were determined to be used in future evaluations of the environmental risk of cadmium emissions from the secondary lead industry.

The emissions test for fugitive arsenic, lead, and cadmium emissions utilized test methods developed for particulate matter. The collected particulate was analyzed for arsenic, lead, and cadmium to determine emissions for those parameters. Particulate mass concentrations were determined in this study and particulate emission rates were calculated to allow a comparison of the relative concentrations of arsenic, lead, and cadmium to the particulate loading.

1.3 BRIEF PROCESS DESCRIPTION

Secondary lead smelters process used batteries and lead scrap to produce lead and lead alloys. Typical processing steps at a secondary lead smelter are recovering the lead and lead parts from used batteries, storing that material prior to charging the material into the furnace, smelting the scrap lead to produce crude lead, and refining the lead to produce a high purity lead or a lead alloy. Slag and process dusts are typically retained on the plant site for a period of time prior to reuse or disposal.

The processing steps described above are generally performed in recognizable, definable areas of the plant. Each of these processing areas presents a potential for arsenic emissions.

Testing was conducted at the Chloride Metals secondary lead smelter located in Tampa, Florida. The Chloride Metals plant was selected as the test site because:

- the plant employs emissions controls typical of the industry;
- lead alloys typical of the industry are produced;
- relative to the secondary lead industry as a whole, the physical layout of the facility was judged to be more conducive to the measurement of emissions from areas considered to be the major sources of fugitive emissions; and
- the expected weather during the proposed time of testing was conducive to the performance of the test program.

The Chloride Metals plant processes used batteries almost solely and produces lead and lead alloys. The processing steps are typical of the

secondary lead industry. The layout of the Chloride Metals secondary lead smelter is shown in Figure 1.

1.4 EMISSION TEST PROGRAM

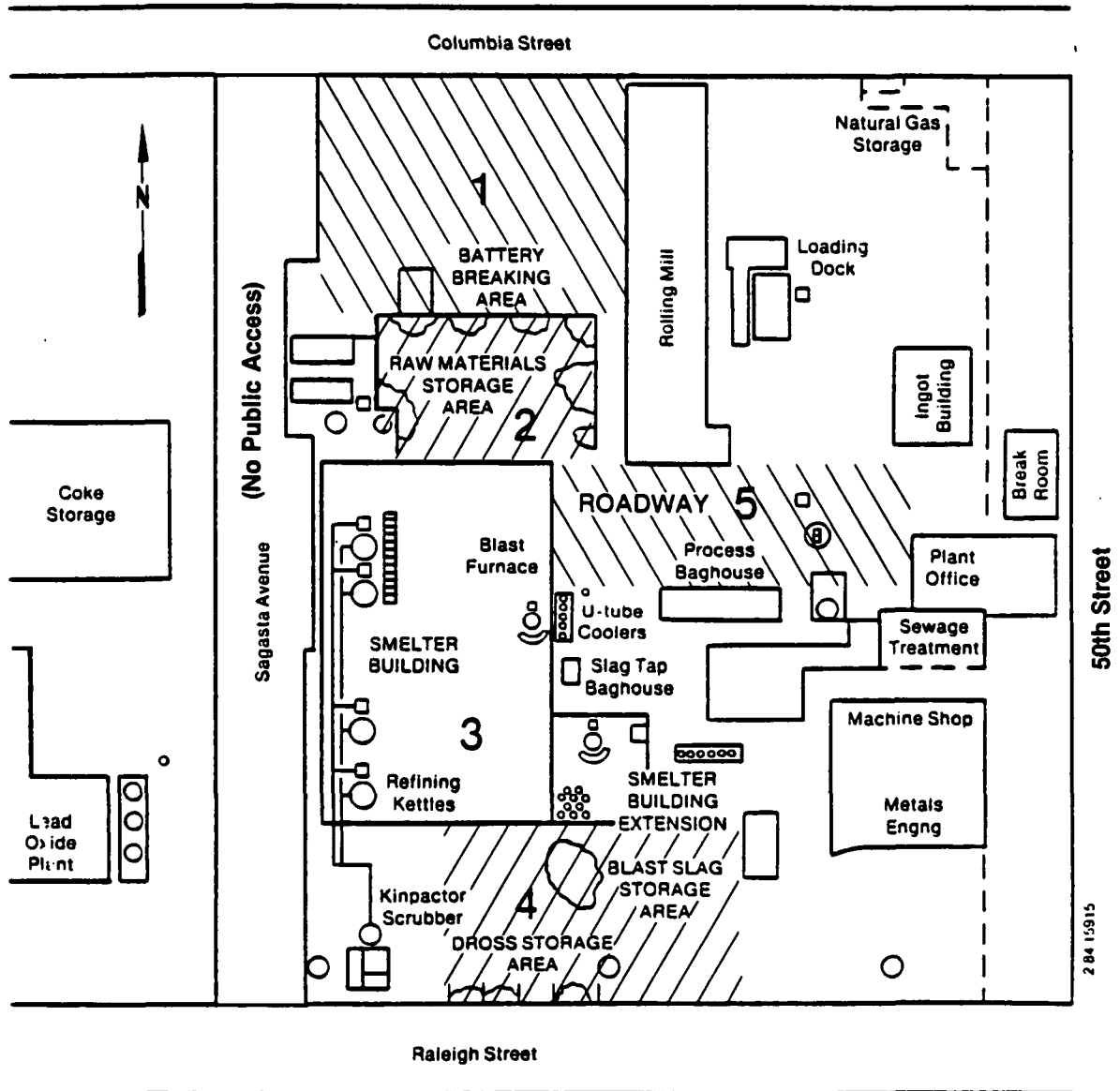
The primary objective of the emission test program is to estimate fugitive emission rates at the Chloride Metals secondary lead smelter. Five process area sources were identified and tested for fugitive emissions at Chloride Metals:

- smelter building,
- raw materials storage,
- battery breaking area,
- slag/dross storage, and
- an intraplant vehicle roadway, i.e., roadway.

The locations of those areas are shown in Figure 1.

Fugitive emission rates for arsenic, lead, cadmium, and particulate were determined for the five sources listed above using an adaptation of the exposure profiling technique. By this method ambient concentrations are measured in the emission plume of the source, and the emission rate is calculated by ventilating the area of the plume by the average wind speed during the sampling period.

Another objective of the program is to assess the reduction potential of fugitive emissions control practices typically applied at secondary lead smelters. Chloride Metals wets most of the smelter complex to control fugitive emissions. This practice is common in the industry. Automatic sprinklers wet the roadway, battery breaking area, and dross bins. The roadway was selected as the site to be tested to assess the reduction potential for controlling fugitive emissions by wetting. The roadway area was tested wet (controlled) as is typically the case at Chloride Metals and



AREA 1	92 ft. x 121 ft. = 11,132 ft ²
AREA 2	59 ft. x 86 ft. = 5,074 ft ²
AREA 3	144 ft. x 78 ft. = 11,232 ft ²
AREA 4	73 ft. x 118 ft. = 8,614 ft ²
AREA 5	48 ft. x 140 ft. = 6,720 ft ²

Figure 1. The layout of the Chloride Metals secondary lead smelter indicating process area sources.

dry (uncontrolled) achieved by turning off the sprinklers and allowing the area to dry.

Chloride Metals also employs other fugitive emissions controls typical of the secondary lead industry. The slag tap and lead well of the blast furnace are hooded and vented through a baghouse. And the refining kettles and associated drossing enclosures are hooded and vented through a high energy wet scrubber. Those two sources were tested to determine arsenic, lead, cadmium, and particulate emissions from the control devices. Concentrations of lead, arsenic, and cadmium were measured in the smelter building to assess fugitive emissions escaping the hooding systems.

1.5 DESCRIPTIONS OF REPORT SECTIONS

The Presentation of Results is in Section 2. Section 3 presents the Process Description. The Sampling Locations are depicted in Section 4. Sampling and Analysis are discussed in Section 5. Quality Assurance activities for the program are described in Section 6. Specific and individual sampling and analytical measurements, calculations, preliminary results, and other pertinent information associated with the program are included in appendices to this report.

SECTION 2

PRESENTATION OF RESULTS

The major objectives of the emissions test at Chloride Metals are to estimate fugitive emissions from process areas at the smelter and to rank the sources of fugitive emissions according to their relative magnitude. The following sections present the results of testing at Chloride Metals. Emission rates for arsenic, lead, cadmium, and particulate are determined and presented.

2.1 FUGITIVE EMISSION RESULTS

Data available prior to the performance of this program indicate that fugitive emissions at secondary lead smelters are the primary source of emissions of the smelter complex. Based on those results, the emphasis of this program was placed on the determination of fugitive emissions. Fugitive emissions from four area sources and the smelter building were measured. The four area sources are:

- slag/dross storage area,
- battery breaking area,
- raw materials storage, and
- the major vehicle pathway or roadway.

Another aspect of this program was to provide data to evaluate typical practices used to control fugitive emissions at secondary lead smelters. One of the most common control practices is the wetting of yard areas and material storage piles to suppress the entrainment of particulate matter. At secondary lead smelters, process areas are usually open areas in which one or possibly more processing steps are performed. At Chloride Metals,

the four area sources listed above and the smelter building are the major process areas. There are other areas at Chloride Metals which contribute to smelter complex emissions, but the emissions of other areas, such as the rolling mill building, are considered minor relative to the four area sources just discussed and the smelter building.

Chloride Metals has an automatic sprinkler system which periodically wets the roadway and battery breaking area. Dross bins are continuously wetted by sprinklers, and the smelter building is occasionally wetted manually. Water used to wet these areas is collected in an underground collection system, and the water is treated and reused.

Because the roadway is paved and dries quickly, it was selected as the test area to evaluate fugitive emissions control by wetting. The roadway was tested wet (controlled) and dry (uncontrolled) to evaluate the effectiveness of wetting for the suppression of fugitive emissions.

Two stationary sources (non-fugitive) were also tested to determine emission rates for arsenic, lead, cadmium, and particulate. These two sources, the slag tap baghouse and a high energy wet scrubber, were tested because they control sources which may be fugitive at other plants. The slag tap baghouse removes particulate matter collected by a hooding system over the slag tap and lead well at the blast furnace. The high energy wet scrubber (the Kinpactor scrubber) controls emissions collected by a hooding system over four refinery kettles and the associated dross bins also located in the smelter building.

Section 2.1.1 presents emission rate results and associated data for the four area sources and the smelter building. Section 2.1.2 discusses the area emission rate results. The data gathered during this program also allowed the determination of emissions from the smelter complex. Those results are presented in Section 2.1.3. Section 2.1.4 presents particle size distribution results. Section 2.2 presents results of arsenic, lead, and cadmium concentration measurements in the smelter building. The results

of stationary (point) source emissions are presented in Section 2.3. Recommendations for future testing programs are given in Section 2.4.

2.1.1 Area Sources Fugitive Emission Results

Arsenic, lead, cadmium, and particulate emission rates were determined for four area sources and the smelter building. The area sources are:

- slag/dross storage,
- battery breaking area,
- raw materials storage, and
- roadway.

As proposed in the test plan for this project, each source was to be tested three times with the exception of the roadway which was to be tested six times--three times wet and three times dry. During the test program, the following number of measurements were performed on the area sources:

- slag/dross storage - 3,
- battery breaking area - 4,
- raw materials storage - 5,
- roadway (dry) - 3,
- roadway (wet) - 3, and
- smelter building - 7.

The extra measurements on the smelter building, raw materials storage, and battery breaking area were conducted to develop more data on those sources which were visually observed during the testing program to be the most significant sources of emissions by either seeing particulate and/or fume emissions or by relative loadings of the particulate filters.

The average fugitive emission rates of arsenic, lead, cadmium, and particulate for the area sources are presented in Table 1. The range of emission rates measured for each area source are also presented.

TABLE 1. AVERAGE AREA SOURCE EMISSION RATES

Area	Emission Rates (Range) (g/hr) ^a				Number of Measurements
	As	Pb	Cd	Particulate	
Smelter Building	0.44 (0.10-0.92)	80 (32-160)	0.093 (0.017-0.23)	280 (110-730)	7
Raw Materials Storage	0.41 (0.027-1.7)	67 (12-240)	0.057 (0.015-0.18)	270 (100-740)	5
Roadway (Dry)	0.26 (0.034-0.66)	82 (8.3-210)	0.17 (0.043-0.39)	390 (180-790)	3
Slag/Dross Storage	0.21 (0.18-0.25)	30 (12-56)	0.049 (0.034-0.063)	180 (84-270)	3
Battery Breaking Area	0.062 (0.027-0.12)	13 (9.3-16)	0.030 (0.010-0.060)	200 (84-310)	4
Roadway (Wet)	0.039 (0.020-0.072)	12 (3.6-19)	0.022 (0.0061-0.049)	170 (170-180)	3

^aEmission rates are not corrected for background (upwind) concentrations.

The area sources listed in Table 1 are ranked by the magnitude of the arsenic emission rate, the element of primary focus in this program. The results indicate that the smelter building is the single largest contributor of arsenic, and ranks second in lead, cadmium, and particulate emissions. These data are consistent with visual observations during the testing program. Note that the roadway (dry) is the third-ranked emission source because of arsenic emissions, but the roadway (dry) has the highest lead, cadmium, and particulate emissions. These results seem inconsistent and are the result of extraordinarily high emissions on one sampling day, March 20, as seen in Table 2. Section 2.1.2.2 discusses this point further. However, it should be pointed out that the roadway is kept wet at Chloride Metals and the roadway (dry) data are not typical of day-to-day operations.

Table 2 presents the individual measurements and average results of emission rates for the four area sources and smelter building. The data are presented with wind speed to allow a quick correlation of wind speed to the magnitude of emissions. During the testing period, wind speed varied from 2.8 to 7.7 miles per hour.

As is discussed in Section 5.1.1.1, the testing of an area source included measuring ambient concentrations of arsenic, lead, cadmium, and particulate just downwind of the area source and also just upwind to evaluate the magnitude of upwind emissions into the area source being tested. Table 2 presents the average upwind and downwind concentrations measured during each run for the determination of area sources emission rates. These data allow an evaluation of the effect of upwind concentrations on the magnitude of downwind concentrations and the emission rate. The average concentrations were determined from results measured at vertical elevations of 4 feet, 8 feet, and 12 feet and for all downwind samplers run concurrently during a test for a given source.

Upwind concentrations were not used to determine the amount of arsenic, lead, cadmium, and particulate entering the four area sources and thus contributing to the downwind concentrations and emission rates. Smelter

TABLE 2. COMPARISON OF EMISSION RATES TO MEASURED CONCENTRATIONS^a

Area	Date	Time	Wind Speed (mph)	Emission Rate ^a (g/hr)				Average Downwind Concentration (µg/m ³)				Average Upwind Concentration (µg/m ³)			
				As	Pb	Cd	Particulate	As	Pb	Cd	Particulate	As	Pb	Cd	Particulate
Smelter Building	3/13	1025-1652	4.1	0.78	120	0.070	340	0.542	84.1	0.0474	234	0.0343	4.31	0.0119	92.8
	3/14	0919-1607	3.8	0.20	47	0.11	180	0.212	52.2	0.109	195	0.0319	10.2	0.0344	99.4
	3/15	0851-1617	5.5	0.17	41	0.090	150	0.236	55.6	0.108	192	0.0340	9.82	0.0349	108
	3/16	0845-1603	3.1	0.66	43	0.097	160	1.76	126	0.255	364	0.0435	9.54	0.0604	85.9
	3/19 (AM)	1005-1315	4.7	0.24	120	0.017	300	0.312	175	0.0304	393	0.0572	6.48	0.0213	79.1
	3/19 (PM)	1348-1552	4.7	0.10	32	0.036	110	0.228	71.0	0.0804	238	0.0572	6.48	0.0213	79.1
	3/20	0901-1333	7.7	0.92	160	0.23	730	0.750	134	0.190	594	0.460	36.8	0.0914	275
Raw Materials Storage	3/13	1040-1657	3.7	0.027	15	0.032	100	0.0595	20.9	0.0312	133	0.628	110	0.0676	271
	3/15	0847-1614	4.5	0.038	12	0.018	140	0.0512	15.9	0.0196	135	0.0148	8.75	0.0131	117
	3/16	0850-1550	2.8	0.23	47	0.040	240	0.189	27.8	0.0318	148	0.0142	15.9	0.00752	119
	3/19	0959-1553	4.3	0.056	23	0.015	150	0.0676	27.2	0.0188	181	0.0749	31.7	0.0334	150
	3/20	0921-1319	7.7	1.7	240	0.18	740	0.460	82.6	0.131	391	0.554	114	0.191	588
Slag/Dross Storage	3/6	1016-1715	7.7	0.25	12	0.049	270	0.160	9.98	0.0162	121	0.173	13.8	0.00936	114
	3/7	1108-1709	4.8	0.18	21	0.063	200	0.150	17.5	0.0377	118	0.271	50.0	0.0938	267
	3/8	1143-1702	4.0	0.20	56	0.034	84	0.190	21.0	0.0367	139	0.0281	<0.516	0.00580	59.2
Roadway (dry)	3/12	0850-1548	6.0	0.034	8.3	0.066	210	0.0460	11.2	0.0238	173	0.0209	4.59	0.0279	123
	3/19	0953-1550	4.3	0.086	29	0.043	180	0.0480	18.4	0.0251	113	0.0126	2.78	0.0116	80.3
	3/20	0910-1337	7.3	0.66	210	0.39	790	0.280	48.9	0.0938	295	0.132	18.4	0.0756	214
Battery Breaking Yard	3/13	1107-1654	3.7	0.049	11	0.060	310	0.0255	8.36	0.0192	123	0.0282	8.16	0.0304	162
	3/14	0925-1615	3.9	0.027	14	0.030	190	0.0221	12.1	<0.0218	141	0.0155	5.79	0.0180	116
	3/15	0856-1611	4.5	0.051	16	0.019	220	0.0266	12.8	0.0120	142	0.0272	9.17	0.0153	146
	3/16	0852-1556	2.8	0.12	9.3	0.010	84	0.0498	8.12	0.0132	95.2	0.0118	6.40	0.0128	112
Roadway (wet)	3/7	1130-1755	4.8	0.072	19	0.011	180	0.0477	10.7	0.00718	112	0.0399	21.9	0.00804	149
	3/8	1122-1717	4.4	0.025	3.6	0.049	170	<0.0114	2.81	0.00722	97.4	<0.00208	1.22	<0.00105	62.6
	3/9	0922-1612	4.4	0.020	14	0.0061	170	<0.00962	3.71	<0.00273	121	0.0172	24.3	0.00413	230

^aEmission rates are not corrected for background (upwind) concentrations.

building emission rates were determined without the background contribution and also by subtracting the background contribution (without and with background correction). Emission rates with and without background correction were determined for the smelter building because of less difficulty in the data reduction methodology in comparison to the ventilation model approach (described in Section 5.1.1.1) used for the data reduction of the four area sources. Smelter building emission rates with and without background correction are presented in Table 3. The arsenic emission rate of the smelter building is reduced by 42 percent by subtracting the background contribution.

2.1.2 Discussion of Results

The area source and smelter building emissions were evaluated for the effect by three factors: upwind concentration, wind speed, and smelter building emission correction. The results were also reviewed for consistency. Roadway data allowed an evaluation of the degree of control on fugitive emissions achievable by wetting.

2.1.2.1 Effects on Area Source Emission Rates--

In the evaluation of the emission rates developed for the area sources, several questions evolved over what may affect fugitive emission rates at the Chloride Metals secondary lead smelter. Those questions include:

- To what extent are area emission rates affected by measured upwind concentrations?
- What effect does wind speed have on fugitive emission rates?
and
- Since visual observations during the test program indicated that the smelter building was the predominant source of emissions and calculated smelter building emission rates were highest, what effect does the location of the smelter

TABLE 3. SMELTER BUILDING EMISSION RATES

Date	Time	Wind Speed (mph)	Emission Rate (g/hr) without Background Correction				Emission Rate (g/hr) with Background Correction			
			As	Pb	Cd	Particulate	As	Pb	Cd	Particulate
3/13/84	1025-1652	4.1	0.78	120	0.070	340	0.73	120	0.052	200
3/14/84	0919-1607	3.8	0.20	47	0.11	180	0.14	28	0.036	B
3/15/84	0851-1617	5.5	0.17	41	0.090	150	0.10	21	B	B
3/16/84	0845-1603	3.1	0.66	43	0.097	160	0.63	36	0.055	98
3/19/84 (AM)	1005-1315	4.7	0.24	120	0.017	300	0.17	110	B	200
3/19/84 (PM)	1348-1552	4.7	0.10	32	0.036	110	0.016	22	0.0037	B
3/20/84	0901-1333	7.7	0.92	160	0.23	730	B	86	0.037	140
Average			0.44	80	0.093	280	0.26	60	0.026	91

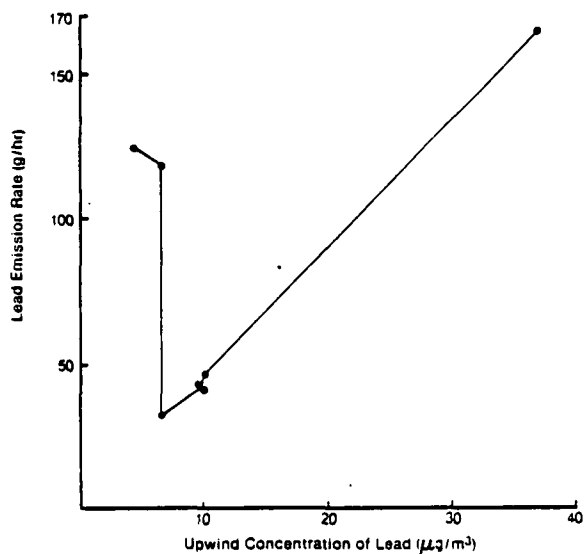
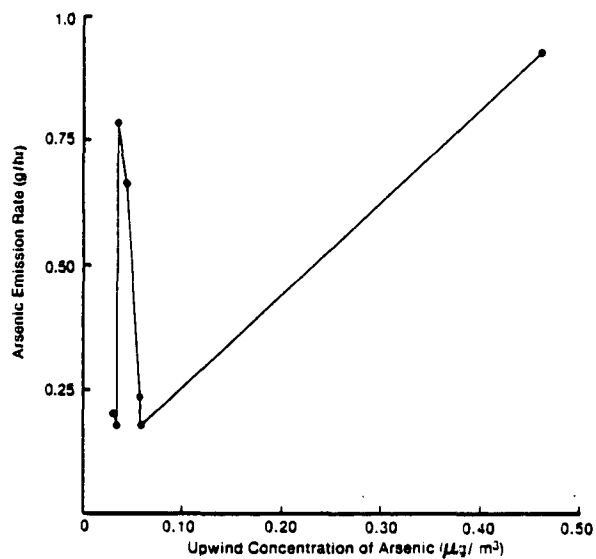
B = background contribution greater than total emission rate.

building relative to the location of the area source and wind direction have on fugitive emissions?

One of the concerns that became apparent upon reviewing the test data was the relative concentrations measured at upwind and downwind samplers. For about one-third of the area source fugitive emission tests, average upwind concentrations were greater than average downwind concentrations. Upwind concentration results were not used to determine background contributions to the source during the testing periods. Obviously, the flow of a species into an area source will affect the emission rate. To evaluate the effect of measured upwind concentrations upon emission rates, graphs were drawn to compare arsenic, lead, and particulate emission rates to upwind concentrations of those respective species. The graphs are shown in Figures 2 through 6. A review of those graphs indicates that arsenic emissions from the roadway demonstrate a dependence upon the upwind concentration of arsenic. If the data generated on March 20 are not included, then that apparent influence is negated.

In a similar fashion, downwind concentrations of arsenic measured at the roadway were plotted against upwind concentrations of arsenic. The purpose of this graph was to investigate if the calculation of emission rates in some way dampened the apparent effect of upwind concentrations. The relationship of the two plots is very similar and indicate that arsenic emissions may be positively influenced by the upwind concentration of arsenic.

Wind speed certainly has an effect upon fugitive emissions of suspended particulate due to the force available to entrain particulate matter. For process operations in obstructed, turbulent wind pattern areas, the effect is less defined. To evaluate the effect of wind speed upon area emission rates, wind speed was plotted against arsenic emission rates. These plots are also shown in Figures 2 through 6. The raw materials storage area and roadway appear to be influenced by wind speed, but that apparent effect is principally the result of data points for emission rates measured on March 20.



7 04 17/194

Figure 2. Smelter building data graphs.
Emission rates are not corrected
for background (upwind) concentrations.

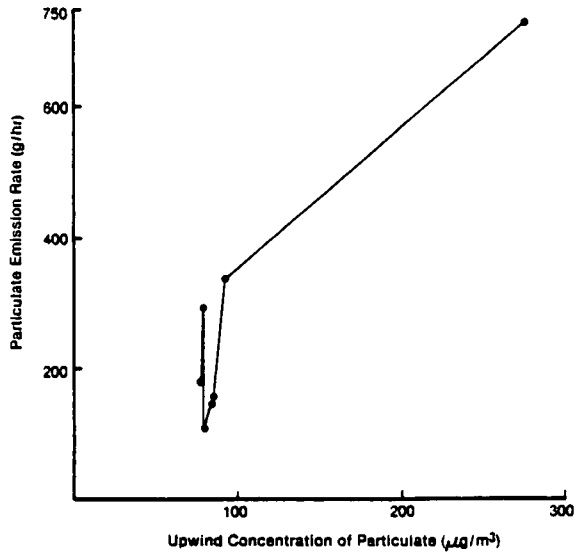
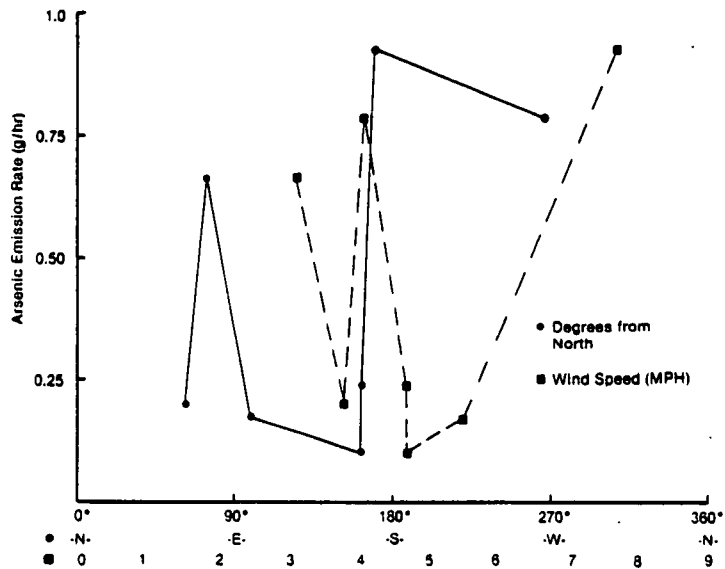


Figure 2. (Continued)

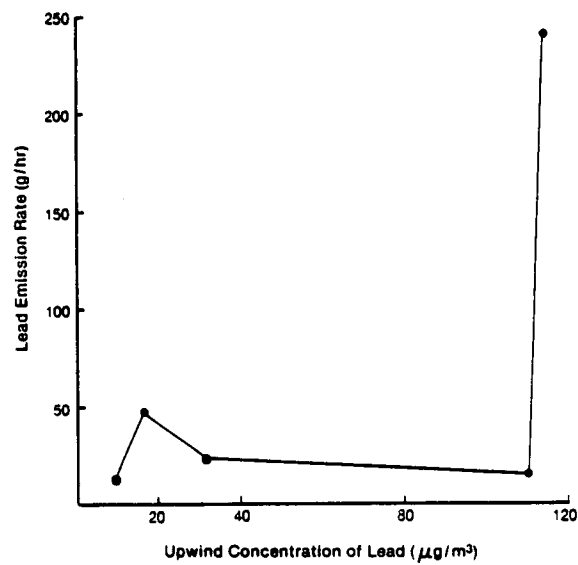
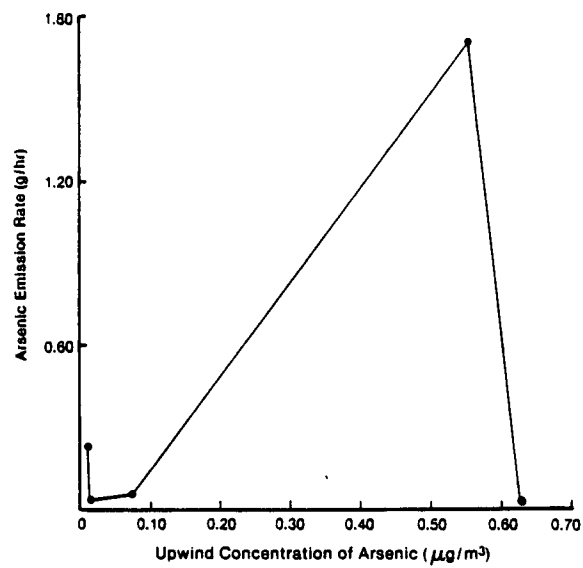


Figure 3. Raw materials storage area data graphs. Emission rates are not corrected for background (upwind) concentrations.

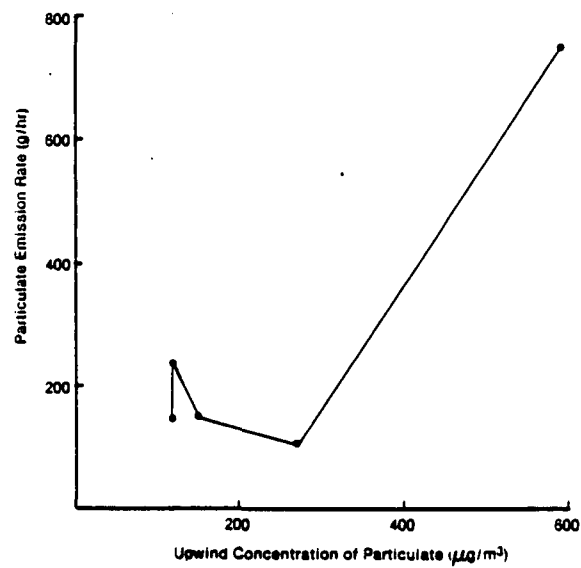
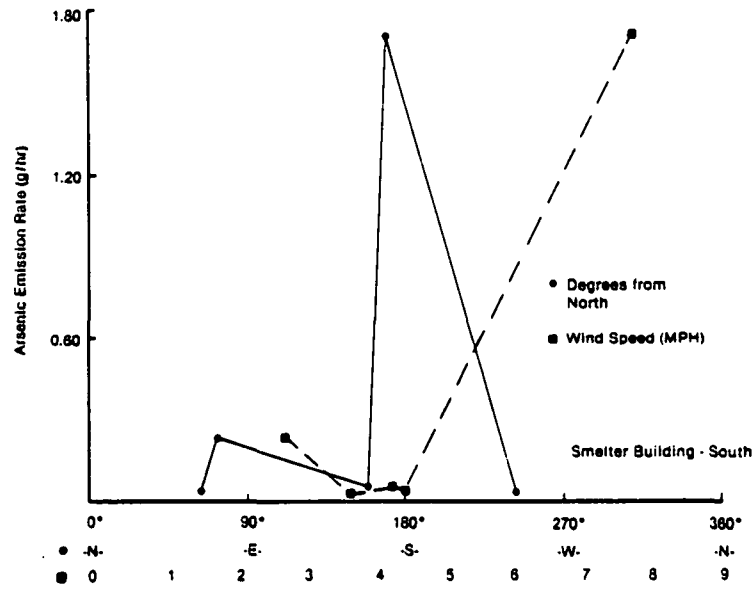
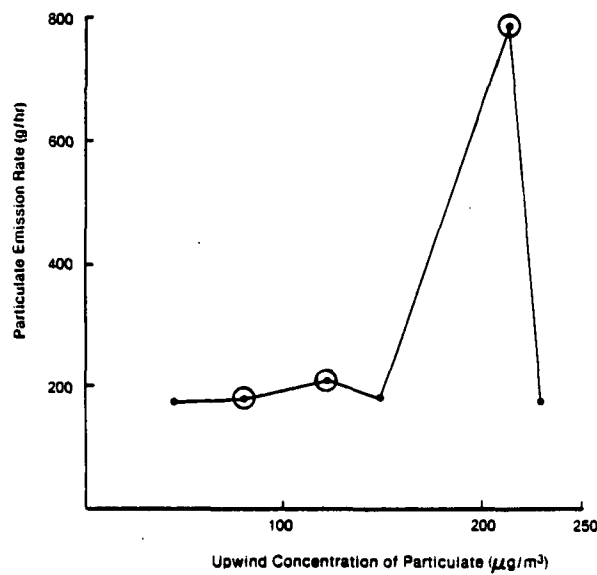
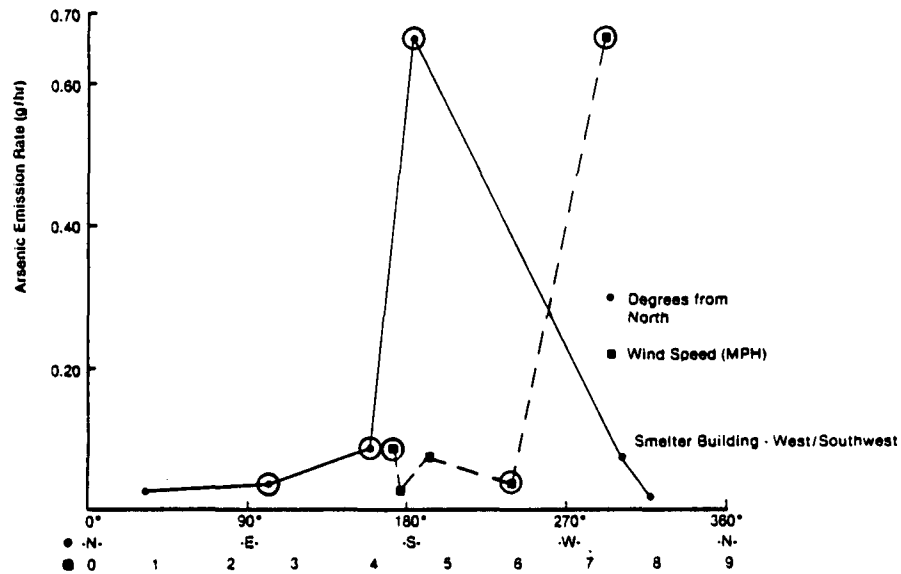
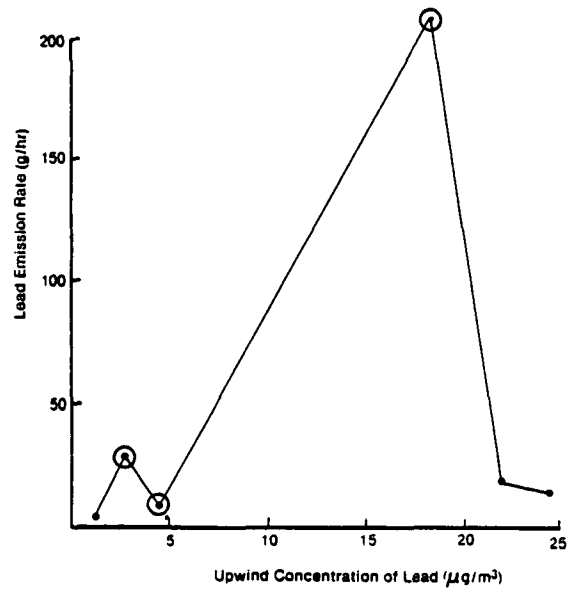
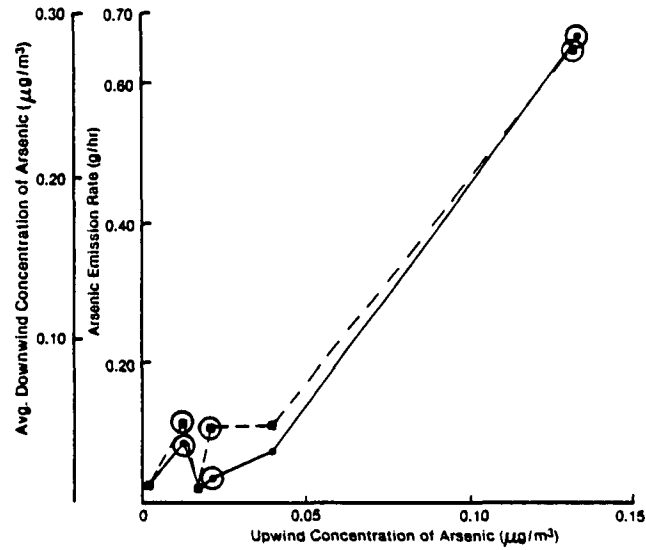


Figure 3. (Continued)



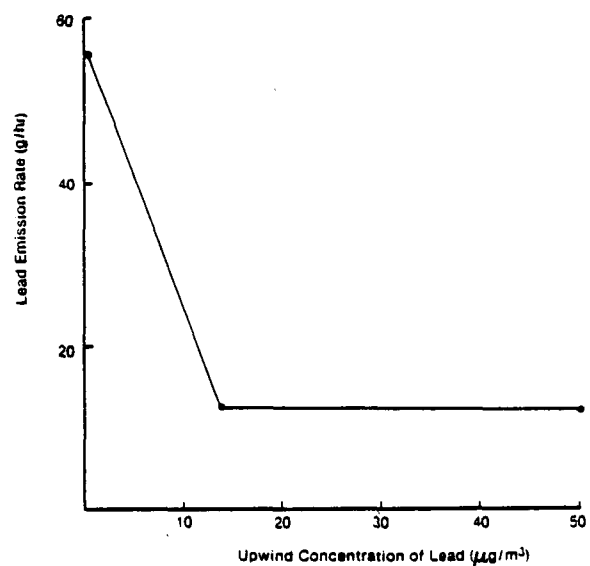
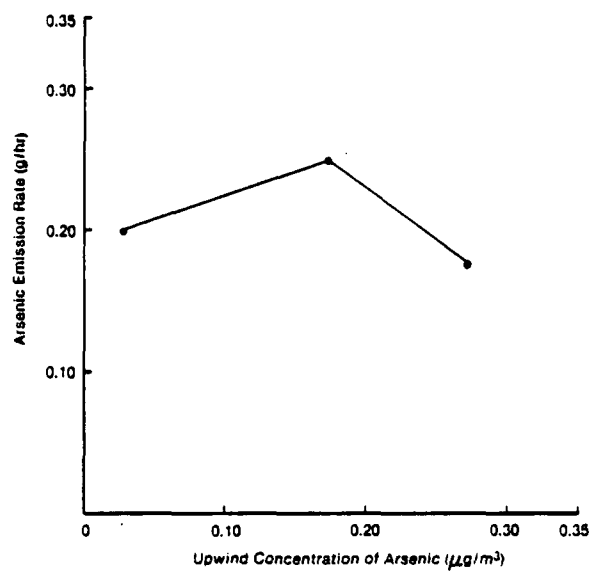
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Figure 4. Roadway (dry and wet) data graphs. Emission rates are not corrected for background (upwind) concentrations. Note: \odot \odot Roadway (dry)
• • Roadway (wet)



7/84 17/104

Figure 4. (Continued)



7 84 17/94

Figure 5. Slag/Dross storage area data graphs. Emission rates are not corrected for background (upwind) concentrations.

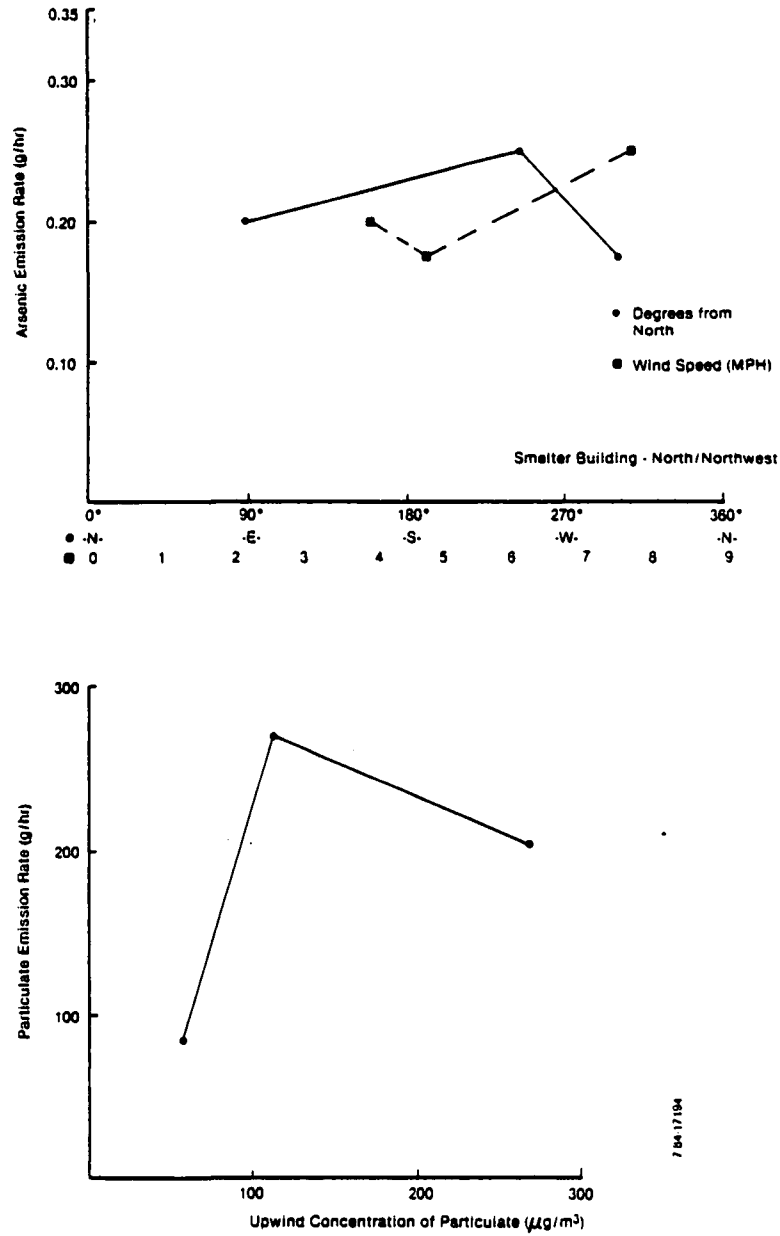
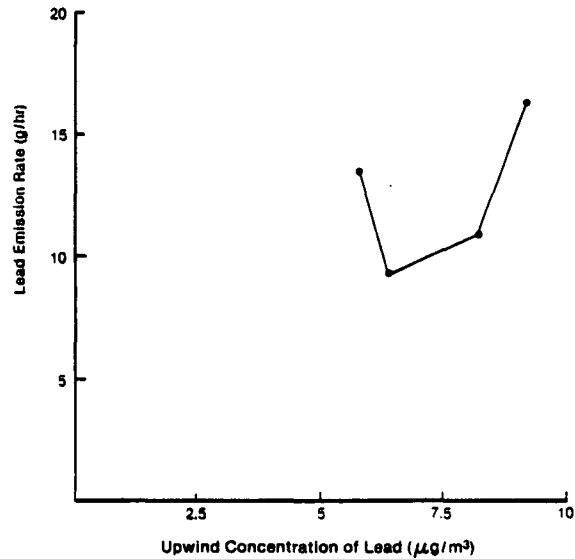
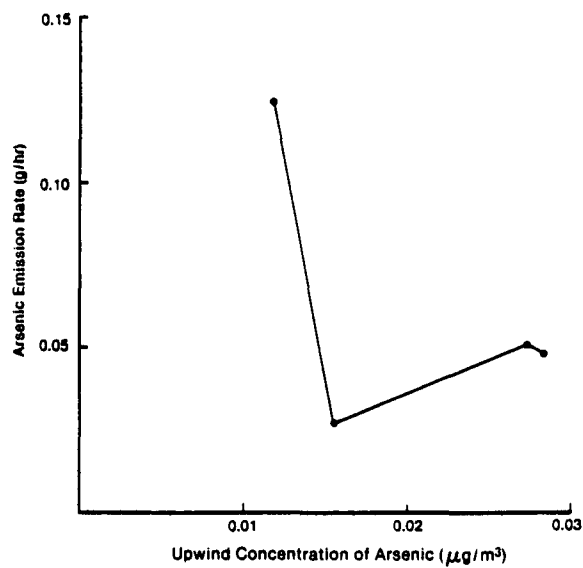


Figure 5. (Continued)



7/84 17/94

Figure 6. Battery breaking area data graphs.
Emission rates are not corrected for
background (upwind) concentrations.

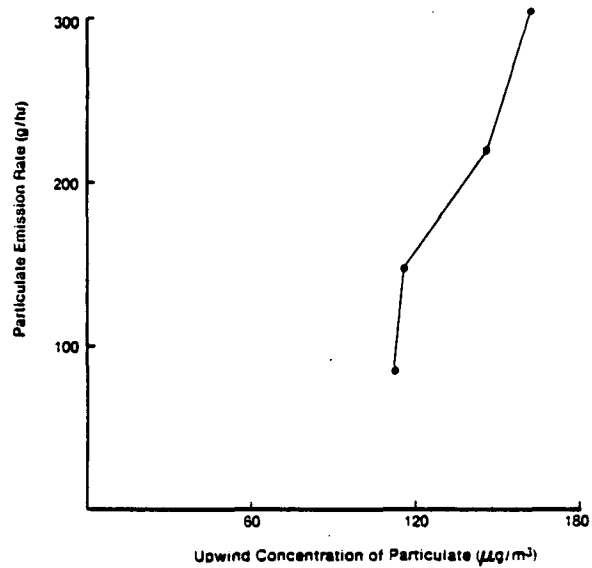
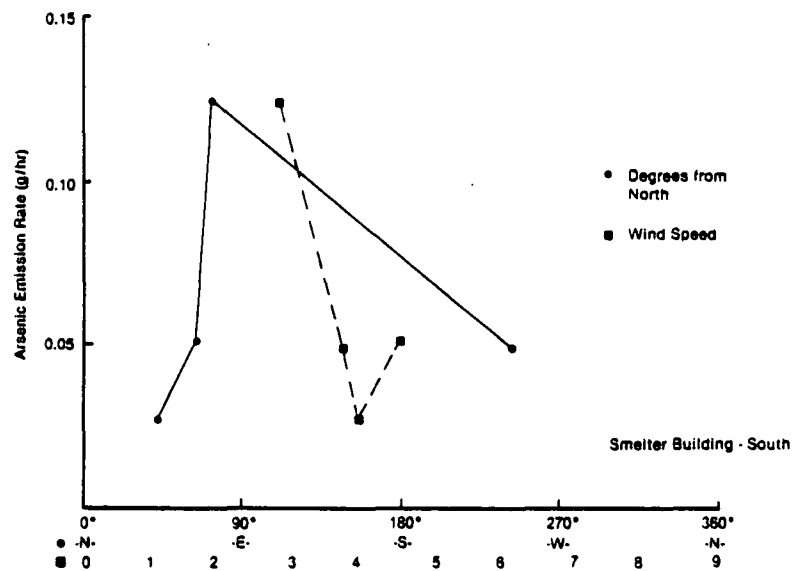


Figure 6. (Continued)

As stated earlier, the smelter building was visually observed to be the greatest emitting source at Chloride Metals during the testing program. A series of plots were developed to evaluate the influence of smelter building emissions on area source emission rates. This effect would be evident if the smelter building is the predominant source of emissions at Chloride Metals. Arsenic emission rates for the area sources and smelter building were plotted against wind direction during the individual test periods. These plots are also shown in Figures 2 through 6. The plots of the four area sources also include the direction of the smelter building from the area source. If the smelter building positively influences area source emissions, then higher area source emission rates would be expected when the wind is from the direction of the smelter building. The raw materials storage area and the roadway indicate that smelter building emissions apparently affect those area emission rates.

The series of plots discussed were developed to evaluate the following influences on area source emission rates:

- upwind concentration of arsenic,
- wind speed, and
- smelter building emissions.

Table 4 presents a subjective evaluation of the effects of those factors on area source emission rates.

The roadway is evaluated to be the only area source for which the arsenic emission rate is positively affected by the upwind concentration of arsenic. However, the apparent positive effect may be due to the very high emissions measured on March 20. The smelter building and raw materials storage area were also sampled on March 20 and of those two sources, the smelter building may possibly indicate a positive effect, and the raw materials storage demonstrates no effect. The deduction of these results would be that arsenic emissions from the roadway are positively affected by upwind concentrations. But since the roadway was the only source of the five

TABLE 4. EFFECT OF INFLUENTIAL FACTORS ON EMISSION RATES

Source	Influential Factor		
	Upwind Concentration (Arsenic)	Wind Speed	Smelter Building Emissions
Smelter Building	Possible Effect	No Effect	--
Raw Materials Storage	No Effect	Positive ^a	Positive
Roadway (dry and wet)	Positive ^a	Positive ^a	Positive
Slag/Dross Storage	No Effect	No Effect	No Effect
Battery Breaking Area	Negative	Negative	Possible Effect

^aEffect may be overestimated due to high emissions measured on March 20

tested to demonstrate such an effect, as a general rule, upwind concentrations of arsenic did not affect the arsenic emission rates measured in this study.

The plots of wind speed versus arsenic emission rates indicate that the raw materials storage and roadway emissions were positively affected by wind speed. Once again, these apparent effects appear to be due to March 20 data. Arsenic emission rates would show no dependence on wind speed if the March 20 data were omitted.

Wind erosion of exposed areas is associated with wind speeds greater than 12 mph, the threshold erosion velocity. An emission factor for determining fugitive particulate emissions by wind erosion of an exposed area includes a term for the percentage of time the wind speed exceeds 12 mph (1). There are no exponentials associated with that term. These references would seem to indicate that it is unlikely that an increase in wind speed from 3.5 to 7.5 mph would increase emissions by as much as several orders of magnitude.

Two area sources indicate a positive influence on arsenic emissions by smelter building emissions. These sources are raw materials storage and the roadway. The battery breaking area is possibly affected. It should be pointed out that the two sources positively affected by the smelter building (raw materials storage and roadway) are the two area sources closest to the smelter building.

2.1.2.2 Data Outliers--

The average emission rates of the area sources are presented in Table 1, and the sources are ranked according to arsenic emission rate. Table 2 presents the individual measurements of area source emission rates. Reviewing the data presented in Table 2, the smelter building, raw materials storage, and dry roadway were sampled March 20. Emission rates measured that day were much higher for all three sources tested for all parameters determined as compared to results from other test periods. Since all three

measured sources had significantly higher emissions on March 20 for all test species, it is not likely that the sampling and analysis procedures are responsible for the increases. On March 20 the wind speed was about 7 1/2 miles per hour which is about twice the average of other testing periods. It is not likely that the increase in wind speed alone accounts for the increase in measured emission rates. Plant lead production on March 20 was typical of the production rates during the sampling program. Particle size distributions measured on March 20 were typical of measured results for other test periods. The addition of alloying agents and removal of drosses from the refining kettles was greater on March 20 than other test dates. But since all three sources had greater emissions for all four measured species, it is unlikely that this factor alone accounts for the entire increase in emissions on March 20. There is no identified, defensible, single explanation for the increased emissions measured on March 20. It is most probable the increased emissions measured that day were due to a combination of influences. With a limited data base, it is difficult to make an assessment as to whether the March 20 data are within the range of emissions representative of the area sources.

Since emission rates measured on March 20 are so much higher than emission rates determined on other days (as much as three orders of magnitude above the average of other runs) and since only three of the six sources were tested on that day, average emission rates were determined for the sources omitting the March 20 data. Those emission rates are shown in Table 5. As seen in Table 5, the ranking of the area sources changes considerably, although the smelter building is still the greatest source of emissions and the wet roadway the lowest.

2.1.2.3 Evaluation of Control Approach--

An aspect of this program is to evaluate fugitive emission control practices generally applied at secondary lead smelters. Chloride Metals operates an automatic, sequential sprinkler system over several high traffic areas and/or areas of heavy dust concentration.

TABLE 5. COMPARISON OF EMISSION RATES^a

Area	Emission Rate (Range) Average of All Measurements				Emission Rate (Range) Average Excluding March 20 Data			
	As	Pb	Cd	Particulate	As	Pb	Cd	Particulate
1. Smelter Building (1) ^b	0.44 (0.10-0.92)	80 (32-160)	0.093 (0.017-0.23)	280 (110-730)	0.36 (0.10-0.78)	67 (32-120)	0.070 (0.017-0.11)	210 (110-340)
2. Raw Materials Storage (3)	0.41 (0.027-1.7)	67 (12-240)	0.057 (0.015-0.18)	270 (100-740)	0.088 (0.027-0.23)	24 (12-47)	0.026 (0.015-0.040)	160 (100-240)
3. Roadway (Dry) (5)	0.26 (0.034-0.66)	82 (8.3-210)	0.17 (0.043-0.39)	390 (180-790)	0.060 (0.034-0.086)	19 (8.3-29)	0.054 (0.043-0.066)	200 (180-210)
4. Slag/Dross Storage (2)	0.21 (0.18-0.25)	30 (12-56)	0.049 (0.034-0.063)	180 (84-270)	0.21 (0.18-0.25)	30 (12-56)	0.049 (0.034-0.063)	180 (84-270)
5. Battery Breaking Area (4)	0.062 (0.027-0.12)	13 (9.3-16)	0.030 (0.010-0.060)	200 (84-310)	0.062 (0.027-0.12)	13 (9.3-16)	0.030 (0.010-0.060)	200 (84-310)
6. Broadway (Wet) (6)	0.039 (0.020-0.072)	12 (3.6-19)	0.022 (0.0061-0.049)	170 (170-180)	0.039 (0.020-0.072)	12 (3.6-19)	0.022 (0.0061-0.049)	170 (170-180)
Smelter Complex ^c	1.2 (0.35-3.1)	200 (69-490)	0.25 (0.082-0.58)	1100 (550-2200)	0.76 (0.35-1.5)	150 (69-260)	0.20 (0.082-0.32)	920 (550-1300)

^aEmission rates are not corrected for background (upwind) concentrations.

^bRelative ranking based on arsenic emission rate.

^cSmelter complex emission rates include wet roadway emission rates and do not include dry roadway emission rates.

The major vehicle pathway or roadway is wetted by sprinklers 3 out of every 15 minutes. The water sprayed on the roadway is collected at a drain near the center of the roadway. The roadway was selected as the area source to be tested for an evaluation of the degree of control achievable by wetting. The reason the roadway was selected is that the roadway is paved and drains well, and the area becomes completely dry in one day if the sprinklers are turned off and it does not rain.

The roadway was tested three times wet and three time dry. The average emission rates for the roadway wet and dry are shown in Table 6 along with the percent of emissions controlled by wetting. The dry roadway was tested on March 20 and the emission rates for that day are considerably higher than other data. The dry roadway emission rates shown in Table 6 include averages including and excluding the data collected on March 20.

Because dry roadway emission rates were calculated using two sets of data, the percentage reduction in roadway emissions achieved by wetting demonstrates a good deal of variability. Reviewing the primary set of data (all measurements), the wetting of a paved roadway can achieve an emissions reduction of 56 to 87 percent.

2.1.3 Smelter Complex Emission Rates

The test data developed at Chloride Metals not only allowed determination of emission rates for the area sources and smelter building, but also allowed the determination of emission rates for the smelter complex by two approaches. Smelter complex emission rates for arsenic, lead, cadmium, and particulate can be determined by summing the respective emission rates of the four area sources and smelter building. This approach assumes that these five sources are the predominant contributors to the smelter complex emissions.

The second approach is to apply the ventilation model to concentration data which can be related to the entire smelter complex. On March 14, 15,

TABLE 6. ROADWAY EMISSIONS REDUCTION BY WETTING

	Emission Rate (g/hr)			
	As	Pb	Cd	Particulate
Roadway (Dry) - Average of all Measurements ^a	0.26	82	0.17	390
Roadway (Wet)	0.039	12	0.022	170
Reduction	85%	85%	87%	56%
Roadway (Dry) - Average excluding March 20 data ^a	0.060	19	0.054	200
Roadway (Wet)	0.039	12	0.022	170
Reduction	35%	37%	59%	15%

^aEmission rates are not corrected for background (upwind) concentrations.

and 16, winds were from the eastnortheast to east and pole samplers were positioned along the length of the western edge of the smelter complex. Figures 7, 8, and 9 indicate the locations of pole samplers on those days.

Data for the pole samplers located away from the smelter building (pole samplers 1, 2, 4, 6, and 7) were reduced using the methodology described in Section 5.1.1.1. The data of the pole samplers at the smelter building (pole samplers 3 and 5) were reduced in a very similar manner according to the approach described by Schwitzgebel (2) for well-mixed emission sources. The pole sampler concentration results were averaged (as opposed to integrating under a curve of varying concentration versus height) because the data indicate that emissions were well-mixed. The concentration data were ventilated through an area defined by the height of the smelter building and 110 percent of the width of the smelter building and at the average wind speed measured during the respective testing periods. The average flux rates for pole samplers away from the smelter building were ventilated across the distance remaining after the smelter building ventilation base was subtracted from the length of the western boundary of the smelter complex (see table in Appendix C). The emission rate for the smelter complex was, therefore, the sum of emission rates across the ventilation base of the smelter building and across the remaining distance of the western boundary of the smelter complex. Emission rates for arsenic, lead, cadmium, and particulate for the smelter complex determined by this approach are presented in Table 7.

Smelter complex emission rates determined by the two approaches are shown in Table 8. The smelter complex emission rates determined by summing the area source emission rates include the wet roadway emission rates and not the dry roadway. On March 14, 15, and 16, the automatic sprinkler system at the roadway was operating.

The correlation between smelter complex emission rates determined by summing area source emission rates and by application of the ventilation model is very good. It would be expected that the ventilation model

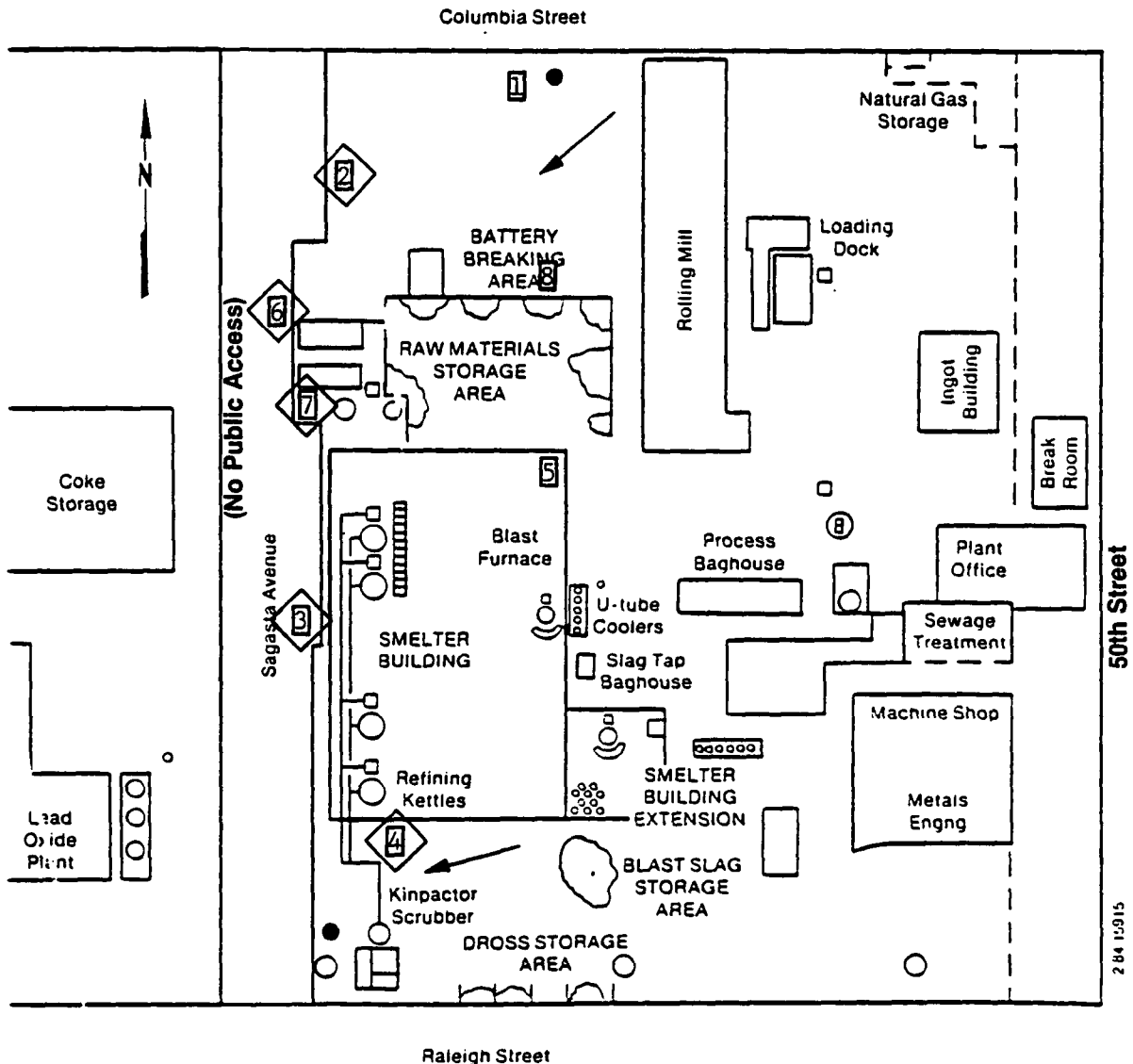
3/14/84

Average Wind Direction (Degrees clockwise from north:

North = 0°): Battery Breaking Area - NE (41°);

Smelter-ENE (62°)

Average Wind Speed (mph) = BB - 3.9; S - 3.8



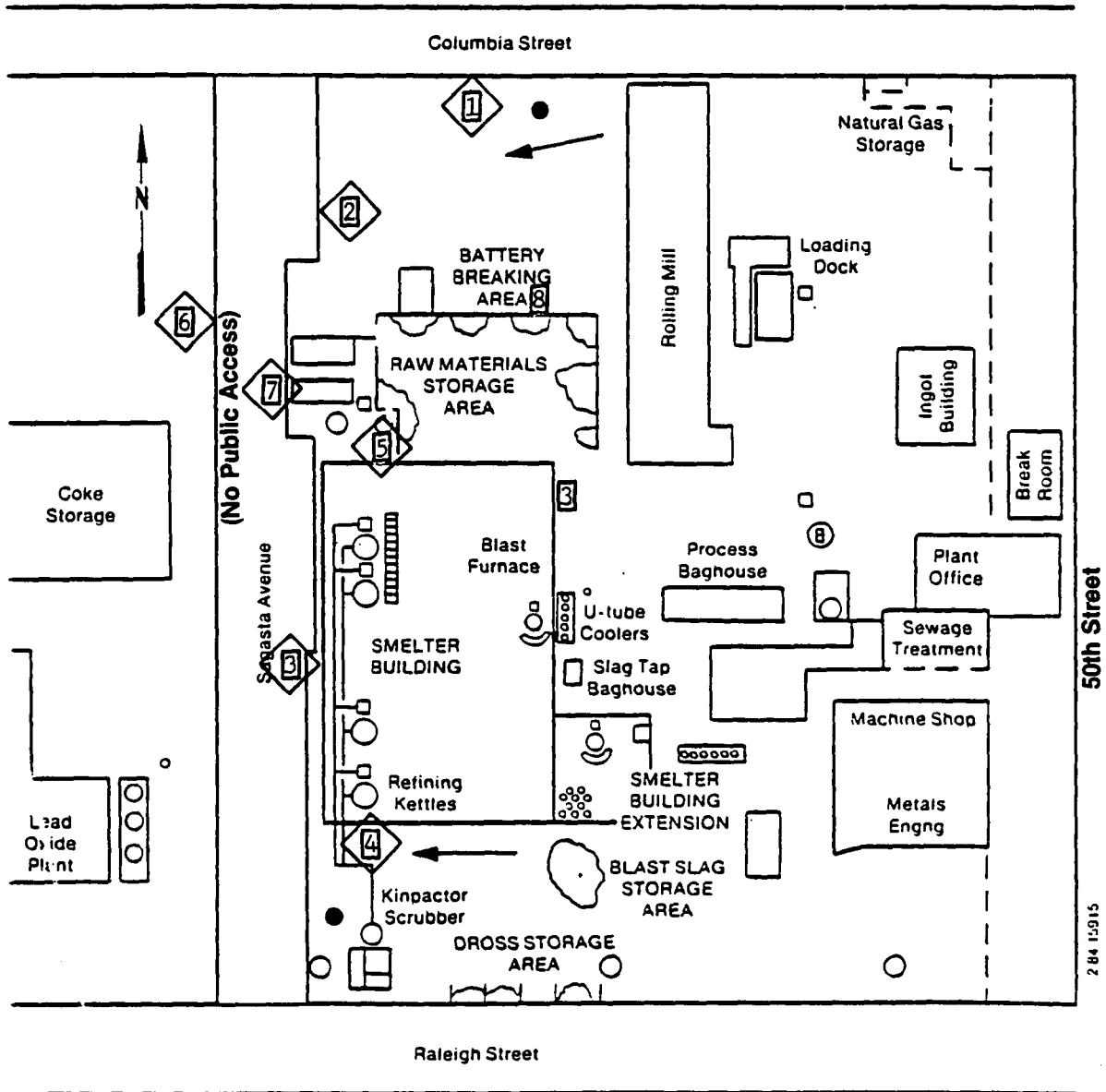
Key:

- 1 through 8 : numbered sample poles
- ◊ : sample poles used to determine smelter complex emission rates
- : meteorological station
- ➔ : approximate wind direction

Figure 7. Sample poles locations on March 14.

3/15/84

Average Wind Direction (Degrees clockwise from north;
North = 0°): Battery Breaking Area - ENE (64°);
Smelter - E (99°)
Average Wind Speed (mph) = BB - 4.5; S - 5.5



Key:

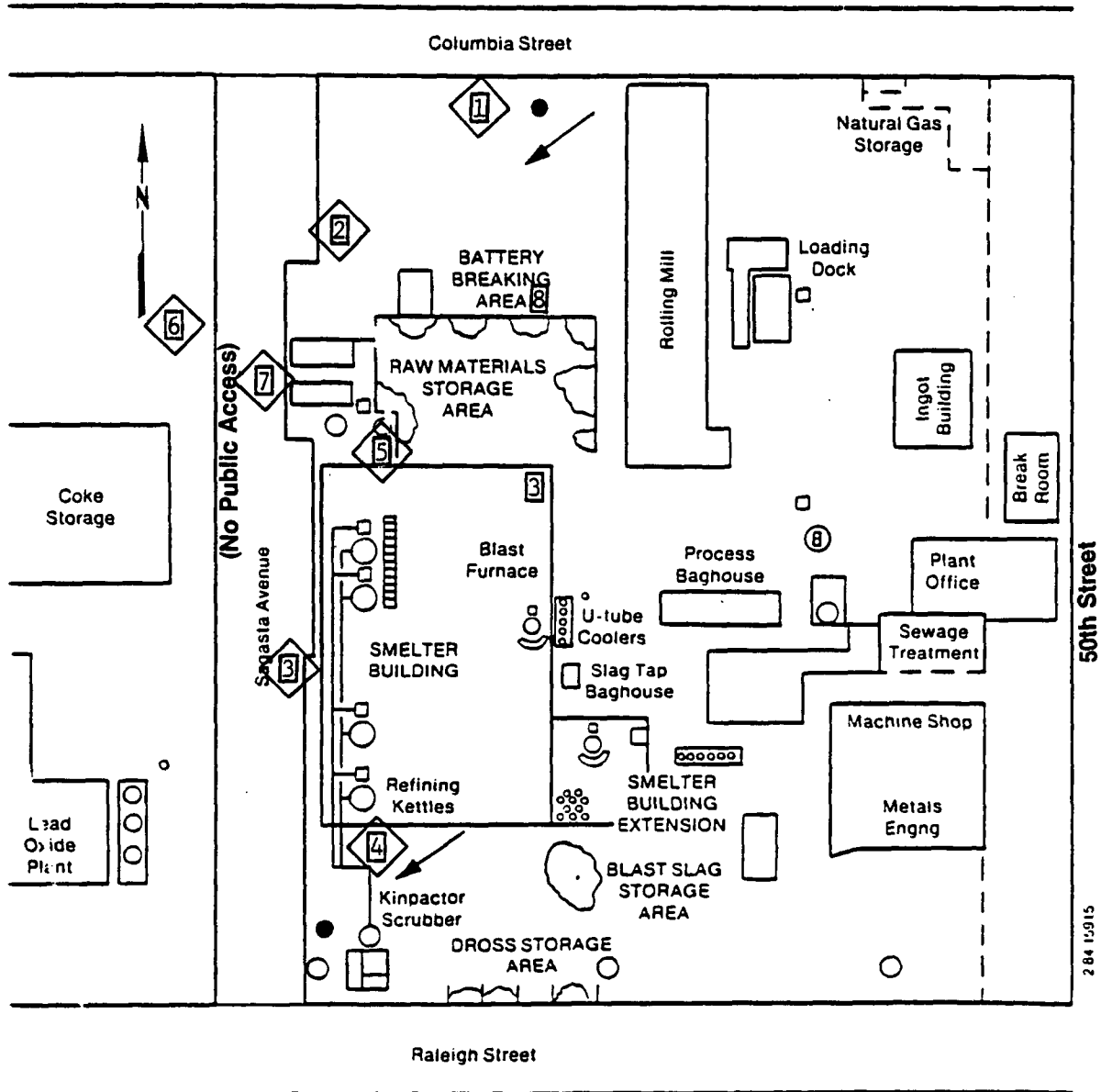
- 1 through 8 : numbered sample poles
- ◊ : sample poles used to determine smelter complex emission rates
- : meteorological station
- ➔ : approximate wind direction

Figure 8. Sample poles locations on March 15.

3/16/84

Average Wind Direction (Degrees clockwise from north;
North = 0°): Battery Breaking Area - ENE (73°);
Smelter - ENE (73°)

Average Wind Speed (mph) = BB - 2.8; S - 3.1



Key:

- 1 through 8 : numbered sample poles
- ◊ : sample poles used to determine smelter complex emission rates
- : meteorological station
- : approximate wind direction

Figure 9. Sample poles locations on March 16.

TABLE 7. SMELTER COMPLEX EMISSION RATES DETERMINED BY
APPLICATION OF THE VENTILATION MODEL

Date	Emission Rate (g/hr)			
	As	Pb	Cd	Particulate
3/14	0.52	140	0.29	710
3/15	0.81	200	0.41	960
3/16	3.4	280	0.50	980
Average	1.6	210	0.40	880

TABLE 8. SMELTER COMPLEX EMISSION RATES

	Emission Rate Range (g/hr)			
	As	Pb	Cd	Particulate
Smelter Complex Emission Rates Determined by Summing Area Sources Emission Rates ^{a,b}	1.2 (0.35-3.1)	200 (69-490)	0.25 (0.082-0.58)	1100 (550-2200)
Smelter Complex Emission Rates Determined by Application of the Ventilation Model ^{c,d}	1.6 (0.52-3.4)	210 (140-280)	0.40 (0.29-0.50)	880 (710-980)

^aArea sources emission rates taken from Table 1.

^bSmelter complex emission rates include wet roadway emission rates and do not include dry roadway emission rates.

^cSmelter complex average emission rates taken from Table 7.

^dSmelter complex emission rates determined using data produced on March 14, 15, and 16.

approach would produce higher emission rates, and it does for arsenic, lead, and cadmium. In the application of the ventilation model, concentrations measured at the smelter building were ventilated over a distance equivalent to 110 percent of the length of the smelter building or a distance of 158 feet. The smelter building is 144 feet long and the west side of the building has only two openings, each 12 feet wide. Therefore, the smelter complex emission rates determined in this manner should be a "worst case" situation.

2.1.4 Particle Size Distribution Results

Particle size distribution measurements were performed during the testing of the four area sources and the smelter building. The measurements were performed using a Sierra Model 235 ambient cascade impactor. One representative sample, including six collection substrates, collected at each of the sources was analyzed for arsenic, lead, and cadmium.

The particle size and analytical results for the representative samples selected are presented in Table 9. Fugitive particulate emissions were very small and since the emissions of arsenic, lead, and cadmium are the result of the transport of particulate emissions, arsenic, lead, and cadmium emissions are associated with very small aerosols. Typically 50 to 80 percent of the total mass of particulate emissions were less than 0.5 microns. All of the particle size distribution results are included in Appendix G.

The particle size distribution (PSD) samples were collected at a height of 4 feet and simultaneously with total suspended particulate filters. There are some discrepancies between total particulate and total arsenic concentrations measured by the particle size distribution sampler and by the total suspended particulate filter at a height of 4 feet. Total particulate and total arsenic results determined from the PSD data are determined by the summing of either total mass gain or arsenic analytical results for the six PSD filters. For that reason, the determination of total particulate and total arsenic concentrations from the PSD data has inherently more error

TABLE 9. CHEMICAL CONCENTRATIONS IN PARTICLE SIZE FRACTIONS

Area	Date	Time	Wind Speed (mph)	Impactor Conditions			Concentrations ($\mu\text{g}/\text{m}^3$)			
				Stage	D_{P50}^a (μm)	Percentage by Weight $<D_{P50}$	As	Pb	Cd	Particulate
Slag/Dross Storage	3/7	1110-1706	4.8	1	7.16	90.4	0.0131	1.12	0.00316	15.3
				2	2.96	78.7	0.00997	1.12	0.00462	18.5
				3	1.45	69.1	0.00948	1.22	0.00681	15.3
				4	0.94	58.5	0.0165	1.46	0.00851	16.8
				5	0.49	48.2	0.0109	0.948	0.00535	16.3
				Back-up			0.107	12.6	0.0253	76.6
Roadway (wet)	3/9	0923-1604	4.4	1	7.34	90.7	0.00158	0.566	0.00045	11.3
				2	3.04	79.4	0.00158	0.521	0.00023	13.8
				3	1.49	72.1	0.00136	0.340	0.00113	8.83
				4	0.96	65.2	<0.00045	0.317	0.00045	8.37
				5	0.50	56.0	0.00068	0.340	0.00068	11.3
				Back-up			0.0136	3.17	0.00367	68.1
Roadway (dry)	3/12	0859-1544	6.0	1	7.18	85.5	0.00321	0.771	0.00015	27.4
				2	2.97	73.9	0.00321	0.643	0.00021	21.8
				3	1.46	67.2	0.00171	0.407	0.00129	12.6
				4	0.94	60.3	0.00236	0.557	0.00643	13.1
				5	0.49	54.0	0.00214	0.429	0.00643	12.0
				Back-up			0.0446	14.6	0.0446	102
Raw Materials Storage	3/20	0926-1319	7.7	1	7.43	87.9	0.0435	5.93	0.00079	51.8
				2	3.07	75.8	0.0304	5.93	0.00040	52.2
				3	1.51	68.3	0.0186	3.36	0.00079	32.0
				4	0.98	61.4	0.0158	3.28	0.00079	29.7
				5	0.51	60.3	0.00198	0.198	<0.00020	4.75
				Back-up			0.158	33.2	0.00474	259

(Continued)

TABLE 9. (Continued)

Area	Date	Time	Wind Speed (mph)	Impactor Conditions			Concentrations ($\mu\text{g}/\text{m}^3$)			
				Stage	D_{p50}^a (μm)	Percentage by Weight $<D_{p50}$	As	Pb	Cd	Particulate
Battery Breaking Area	3/16	0900-1600	2.8	1	7.26	93.5	0.00296	1.67	<0.00011	14.6
				2	3.00	87.5	0.00296	1.44	<0.00011	13.5
				3	1.48	85.7	0.00148	0.993	<0.00011	4.22
				4	0.95	83.7	0.00148	0.824	<0.00011	4.43
				5	0.50	80.6	0.00190	0.845	<0.00011	6.97
				Back-up			0.0372	25.3	0.0203	182
Smelter Building	3/15	0852-1613	5.5	1	7.28	94.1	0.00851	1.72	0.00040	6.08
				2	3.01	91.9	0.00791	1.72	0.00101	2.23
				3	1.48	89.9	0.00446	1.01	0.00081	2.03
				4	0.96	85.2	0.00669	1.56	0.00588	4.86
				5	0.50	83.4	0.00669	1.80	0.0120	1.82
				Back-up			0.0681	14.6	0.0381	85.3

D_{p50}^a is the particle size cut-off (μm) at 50% collection efficiency.

than the determination of those results from the single total suspended particulate filter.

2.2 SMELTER BUILDING CONCENTRATION RESULTS

Concentrations of arsenic, lead, and cadmium were measured in several areas of the smelter building. The samples were collected on filter cassettes with orifice controlled sampling flow rates. The filters were stand mounted at heights of 2 feet, 4 feet, and 6 feet and were located in one of the three following areas in the smelter building:

- refining kettles,
- blast furnace slag tap, or
- blast furnace lead well.

Samples collected near the refining kettles were taken during a variety of operating conditions including:

- hard lead production,
- soft lead production,
- drossing, and
- casting.

The sample collection data sheets included in Appendix E describe process operations during the time of sample collection.

Arsenic, lead, and cadmium concentrations measured in the smelter building are presented in Table 10. All analytical results for arsenic and cadmium were below the instrumental detection limit, but arsenic and cadmium results consistently show concentrations to be less than $0.4 \mu\text{g}/\text{m}^3$. Lead concentrations ranged from less than $7 \mu\text{g}/\text{m}^3$ to $257 \mu\text{g}/\text{m}^3$ with most values in the range of 20 to $70 \mu\text{g}/\text{m}^3$. The measured lead levels in the smelter building are below the lead level estimated by Chloride Metals personnel.

TABLE 10. SMELTER BUILDING CONCENTRATIONS

Sampler Location	Date	Time	Sampler Height (ft)	Concentrations ($\mu\text{g}/\text{m}^3$)		
				As	Pb	Cd
Kettle 1-2	3/7	0933-1717	2	<0.168	67.0	<0.105
			4	<0.117	58.3	<0.077
			6	<0.158	58.0	<0.112
Kettle 2	3/7	0934-1717	2	<0.158	78.8	<0.105
			4	<0.167	66.6	<0.111
			6	<0.159	52.9	<0.106
Kettle 1-2	3/8	0814-1347	2	<0.233	257	<0.156
			4	<0.163	75.9	<0.108
			6	<0.220	72.0	<0.147
Kettle 2	3/8	0814-1347	2	<0.219	27.0	<0.147
			4	<0.232	28.6	<0.154
			6	<0.221	30.9	<0.146
Kettles 3-4	3/9	0839-1426	2	<0.224	48.5	<0.149
			4	<0.156	27.1	<0.104
			6	<0.211	<7.05	<0.141
Kettles 3-4	3/9	0839-1426	2	<0.210	<7.01	<0.140
			4	<0.222	<7.41	<0.148
			6	<0.212	18.4	<0.141
Kettle 4	3/12	0910-1510	2	<0.216	71.9	<0.144
			4	<0.150	135	<0.100
			6	<0.204	115	<0.136
Kettle 3	3/12	0910-1510	2	<0.203	115	<0.135
			4	<0.214	114	<0.143
			6	<0.204	88.5	<0.136
Kettle 4	3/13	0902-1500	2	<0.217	<7.24	<0.145
			4	<0.151	<5.04	<0.101
			6	<0.205	<6.83	<0.137
Kettle 3	3/13	0902-1220	2	<0.369	<12.3	<0.246
			4	<0.390	<13.0	<0.260
			6	<0.371	<12.4	<0.248
Furnace (lead well)	3/16	1000-1513	2	<0.248	<8.28	<0.166
			4	<0.173	11.5	<0.115
			6	<0.234	30.5	<0.156
Furnace (slag tap)	3/16	1002-1513	2	<0.235	102	<0.156
			4	<0.248	99.2	<0.165
			6	<0.236	55.2	<0.158
Furnace (lead well)	3/19	1248-1630	2	<0.350	<11.7	<0.233
			4	<0.244	24.4	<0.163
			6	<0.330	33.0	<0.220

(Continued)

TABLE 10. (Continued)

Sampler Location	Date	Time	Sampler Height (ft)	Concentrations ($\mu\text{g}/\text{m}^3$)		
				As	Pb	Cd
Furnace (slag tap)	3/19	1248-1630	2	<0.329	32.9	<0.219
			4	<0.347	<11.6	<0.231
			6	<0.331	<11.0	<0.221
Kettle 4	3/20	1015-1511	2	<0.247	41.1	<0.164
			4	<0.261	43.4	<0.174
			6	<0.248	<8.28	<0.166
Kettle 1	3/20	1022-1514	2	<0.266	<8.87	<0.177
			4	<0.185	<6.18	<0.124
			6	<0.251	<8.38	<0.168
Furnace (slag tap)	3/21	0946-1318	2	<0.367	<12.2	<0.244
			4	<0.256	<8.52	<0.170
			6	<0.346	<11.5	<0.231
Furnace (lead well)	3/21	0946-1318	2	<0.344	<11.5	<0.230
			4	<0.364	<12.1	<0.242
			6	<0.347	34.7	<0.231

2.3 POINT SOURCE EMISSION RESULTS

Two stationary sources were tested at Chloride Metals, the slag tap baghouse and the high energy wet scrubber. The slag tap baghouse controls emissions collected by a hooding system over the slag tap area and lead well of the blast furnace. The high energy wet scrubber, or Kinpactor scrubber, controls emissions collected by a hooding system over the refining kettles and associated drossing enclosures.

Each source was sampled three times and emission rates for arsenic, lead, cadmium, and particulate were determined. The emission rates of the two stationary sources are presented in Table 11. Emissions from these two sources are considerably less than fugitive emissions from the area sources.

2.4 RECOMMENDATIONS FOR TESTING ACTIVITIES ON FUTURE PROGRAMS

There are several recommendations which result from the Chloride Metals emission test program for future testing activities for industrial fugitive emissions. Those recommendations are:

- to implement a concurrent plant boundary ambient monitoring program;
- to collect samples isokinetically for fugitive particulate (or particulate contained) emissions; and
- if concentrations of arsenic, lead, and cadmium are measured in a secondary lead smelter work place; the total volume of gas sampled should be in excess of 5 standard cubic meters.

2.4.1 Ambient Monitoring Network

The inclusion of an ambient monitoring network in the scope of work for a fugitive emissions study will provide additional information for the

TABLE 11. STATIONARY SOURCES EMISSION RATES

Source	Date	Time	Emission Rate (g/hr)			
			As	Pb	Cd	Particulate
Kinpactor Scrubber	3/13	1530-1730	<0.041	<1.4	<0.0084	130
	3/14	1450-1650	<0.040	<1.3	<0.0083	13
	3/20	1115-1315	<0.040	1.6	<0.0083	67
Slag Tap Baghouse	3/16	1038-1232	<0.021	2.1	0.0038	29
	3/19	1352-1604	<0.017	1.7	<0.0037	32
	3/21	0954-1154	<0.018	1.8	0.0043	41

evaluation of fugitive emissions results. An ambient monitoring network should be operated near plant boundaries concurrently with fugitive (and if necessary point source) measurement activities within the plant. The data would be used for correlation to modeled ambient contributions from fugitive and point sources within the plant. The correlation of results would provide a check of fugitive (and point source) emission rate determinations. The results of area source emissions developed in the Chloride Metals emissions test were extrapolated to the total smelter emissions. This approach neglected other potential sources. Ambient results would be an aid in the identification of the contribution of other sources as well as a check on the accuracy of measured emissions. An ambient monitoring network was not included in this study because the location of the Chloride Metals plant was not amenable to the necessary array of samplers.

2.4.2 Isokinetic Sample Collection

Due to schedule and budgetary constraints, fugitive particulate samples were not collected isokinetically during exposure profiling testing at Chloride Metals. By not sampling isokinetically, it is possible that results are not representative of actual conditions. The concept of isokinetic sampling is applicable to fugitive particulate measurements in the same manner as applied to point source emissions testing (EPA Reference Methods 5 and 17).

Concerning the results at Chloride Metals, samples were typically collected at about 30 percent of isokinetic. At subisokinetic sampling rates, the collected particulate sample may be biased towards the larger particulate, but the extent of the bias is dependent upon the particle size distribution. However, measured particulate mass mean diameters at Chloride Metals were typically less than 0.5 microns. The expected bias effect of subisokinetic sampling for fugitive particulate emissions at Chloride Metals is minimal.

2.4.3 Smelter Building Concentration Sampling

During the study at Chloride Metals, airborne particulate samples were collected in the smelter building to evaluate the source of arsenic, lead, and cadmium emissions. Samples were typically collected for 4 to 6 hours at a rate of 4.9 liters per minute for a total sample volume of about 1.5 cubic meters. All analyses for arsenic and cadmium were below analytical detection limits (0.003 ppm for arsenic and 0.002 ppm for cadmium), and most analyses for lead were below the analytical detection limit (0.1 ppm). If similar samples are collected in future programs, the total sample volume should be increased significantly (in excess of 5 cubic meters) to allow for accurate measurement of arsenic, lead, and cadmium concentrations.

SECTION 3
PROCESS DESCRIPTION

3.1 GENERAL PLANT INFORMATION

Chloride Metals is a small to medium sized secondary lead smelter located in Tampa, Florida. This plant was selected as a fugitive emissions test site because it is considered to be representative of a typical secondary lead smelter. The operational practices employed, the raw materials used, and the products produced are all representative of the secondary lead industry as a whole. The plant operates 5 days per week and has a rated lead production capacity of 12,000 tons of lead per year. During the test period, the plant operated only one of its two blast furnaces. Consequently, lead production at the plant was 50 percent of capacity. The major lead bearing raw materials are recycled automobile batteries and battery plant scrap. The major finished product is a hard lead alloy with an arsenic content of 0.17 weight percent. Hard lead production typically requires the addition of alloying agents such as antimony, tin, and arsenic. The arsenic content of the blast furnace metal is increased in the refining process by the addition of a high arsenic containing master alloy (10 percent arsenic by weight).

The physical layout of the plant is shown in Figure 10. The smelting plant consists of a battery breaking facility, an open raw materials storage area, an open-air smelter building that houses a blast furnace, three 50-ton refining kettles, one 20-ton refining kettle, a lead casting machine, a building extension that houses an inoperative blast furnace and 55-gallon drums containing refining drosses, an open blast furnace slag storage area, and an open refining dross storage area. Also associated with the process activities at the plant are one process baghouse for controlling the

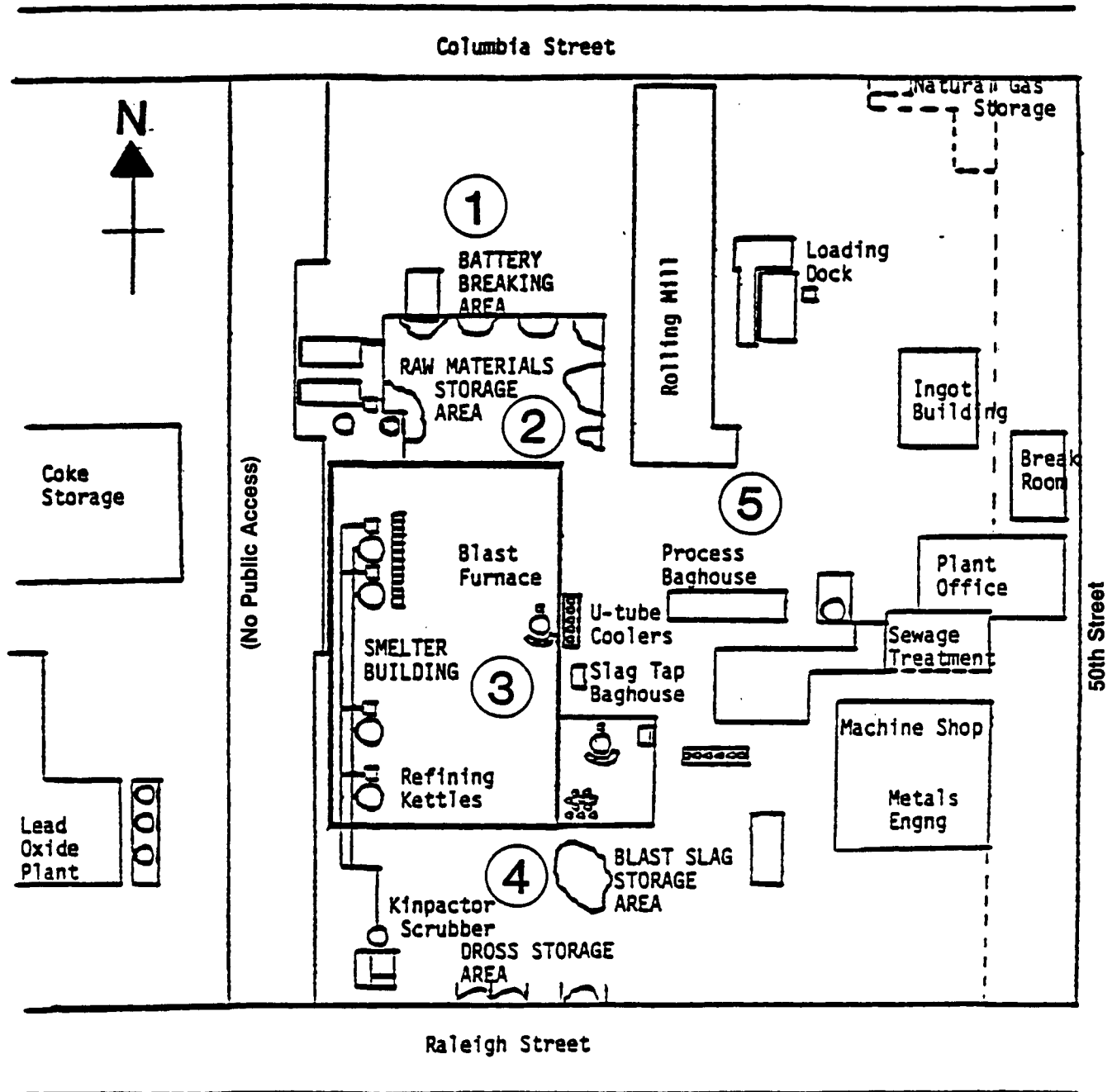


Figure 10. Plot plan of Chloride Metals plant in Tampa, Florida illustrating the five fugitive sampling areas.
(Scale: 1 inch equals approximately 50 feet)

offgases from the blast furnace and the slag tap baghouse for control of emissions from the lead well and furnace slag tapping. A Kinpactor venturi scrubber controls the combined offgases from the refining kettle ventilation system. An enclosed screw conveyor is used for the direct recycle of baghouse dust to the blast furnace.

Area fugitive emissions are controlled at the plant by the use of automatic sprinkler systems coupled with paving of the smelter grounds. The sprinkler systems are controlled by an automatic timer that turns the water on every 15 to 20 minutes. Approximately 1,500 gallons of fresh water are sprayed daily. Water is applied manually in the smelter building (200 gallons/day) and in the battery breaking area (600 gallons/day), in addition to the sprinkler system at the battery breaking area.

In addition to smelter operations, this plant manufactures lead oxide and operates a rolling mill where lead product fabrication occurs. Both of these activities as well as vehicular traffic from a nearby highway contribute to lead levels measured near the plant. The only potential source of arsenic emissions in the area is a coal-fired power plant located roughly one-half mile southwest of the smelter.

3.2 PROCESS INFORMATION

A detailed process description can be found in the NSS contractor trip report dated November 4, 1983 (Appendix K). In general, materials flow through the plant from north to south (refer to the plot plan, Figure 10). Scrap batteries are brought to the north end of the plant by local scrap dealers. The batteries are unloaded and transported to the battery saw where they are separated from the cases, and the lead contents are dumped into the raw material storage area. The battery covers are crushed, and a flotation separator system is used to separate plastic, lead terminals, lead oxide paste, and rubber. The lead scrap is then transported from the raw material storage area to the charge preparation area inside the smelter building. Feed materials are manually shoveled into a skip hoist bucket and

are subsequently charged to the furnace. The furnace feed consists of battery group material, battery paste, refining kettle drosses, battery plant scrap, lead-bearing water treatment sludge, coke, limestone, scrap iron, rerun blast furnace slag, and sand. These materials are fed to the furnace approximately 8 to 12 times per hour. In addition to the prepared feed materials, dust captured by the process baghouse is automatically screw conveyed back to the blast furnace on a continuous basis. Molten lead is tapped continuously from the blast furnace into one of four lead button molds. Slag is intermittently tapped approximately twice an hour from the opposite side of the furnace. The slag is allowed to cool and is transported to an open area beyond the southeast corner of the smelter building. It is eventually either disposed of in an approved landfill or rerun to the blast furnace. Rerun blast furnace slag is manually selected based on a visual assessment of its silica content. High silica content slag is charged back to the blast furnace primarily as a flux material serving as a lead-bearing substitute for sand.

Blast furnace lead is alloyed in one of four gas-fired refining kettles. The two kettles (one 50-ton and one 20-ton) at the northwest corner of the smelter building are used for hard lead refining only. Hard lead refining consists of an initial light dross removal step followed by removal of other drosses and/or addition of alloying agents, depending on the specifications of the product metal. The light dross consists mainly of lead oxide and appears as a dusty black powder when cooled. Other drosses potentially removed in hard lead refining are copper dross and tin dross. Antimony and arsenic are among the alloying agents commonly added to the kettles in the production of hard lead. The hard lead product is cast into ingots using the casting machine.

The two 50-ton kettles at the southwest corner of the smelter building are used for soft lead refining. The production of soft lead typically involves five refining steps. The temperature of the molten lead is increased during the first four steps and then is decreased for the final step. In the first step, a "light dross" consisting primarily of lead oxide

and other impurities forms at the surface of the molten lead bath as the refining kettle is heated. The light dross, which appears as a very dusty black powder, is manually skimmed off the surface and placed in a hopper. This light dross will eventually be recharged to the furnace. The second step involves the addition of sulfur to cause a copper containing dross to form. The copper dross is manually skimmed off the surface and stored in a drum. In the third refining step, the molten lead temperature is increased until a yellow tin-containing dross forms. Both the copper and tin drosses generated during these refining steps are charged to the furnace when high copper and tin specifications are required in the blast furnace metal. The fourth step involves the addition of sodium nitrate under conditions of increasing temperature to form an antimony dross. The antimony dross is skimmed off the surface and placed in a hopper. This dross material is stored in 3-sided open air bins located south of the smelter building. This dross is combined with other furnace charge materials when a high antimony blast furnace metal is desired. In the final refining step, the temperature of the molten lead is reduced and sulfur or caustic is added to the kettle to provide a final cleaning. Upon completion of this final step, the now-soft lead is cast into ingots.

3.3 PRODUCTION

Daily production data were provided by the plant for the period between February 20 and March 21, 1984. This represents the 11 operating days before sampling began as well as the 12 days when sampling actually occurred. These data are presented in Appendix J.

The general trends in blast furnace metal production for this period are presented in Figure 11. As seen in the figure, the blast furnace lead production ranged from 13-42 tons per day during periods in which the furnace was operating. For the period from February 20 to March 21, the average daily furnace production was 33.5 tons per day (excluding weekends and the 2 days that the furnace was not operated). During actual sampling

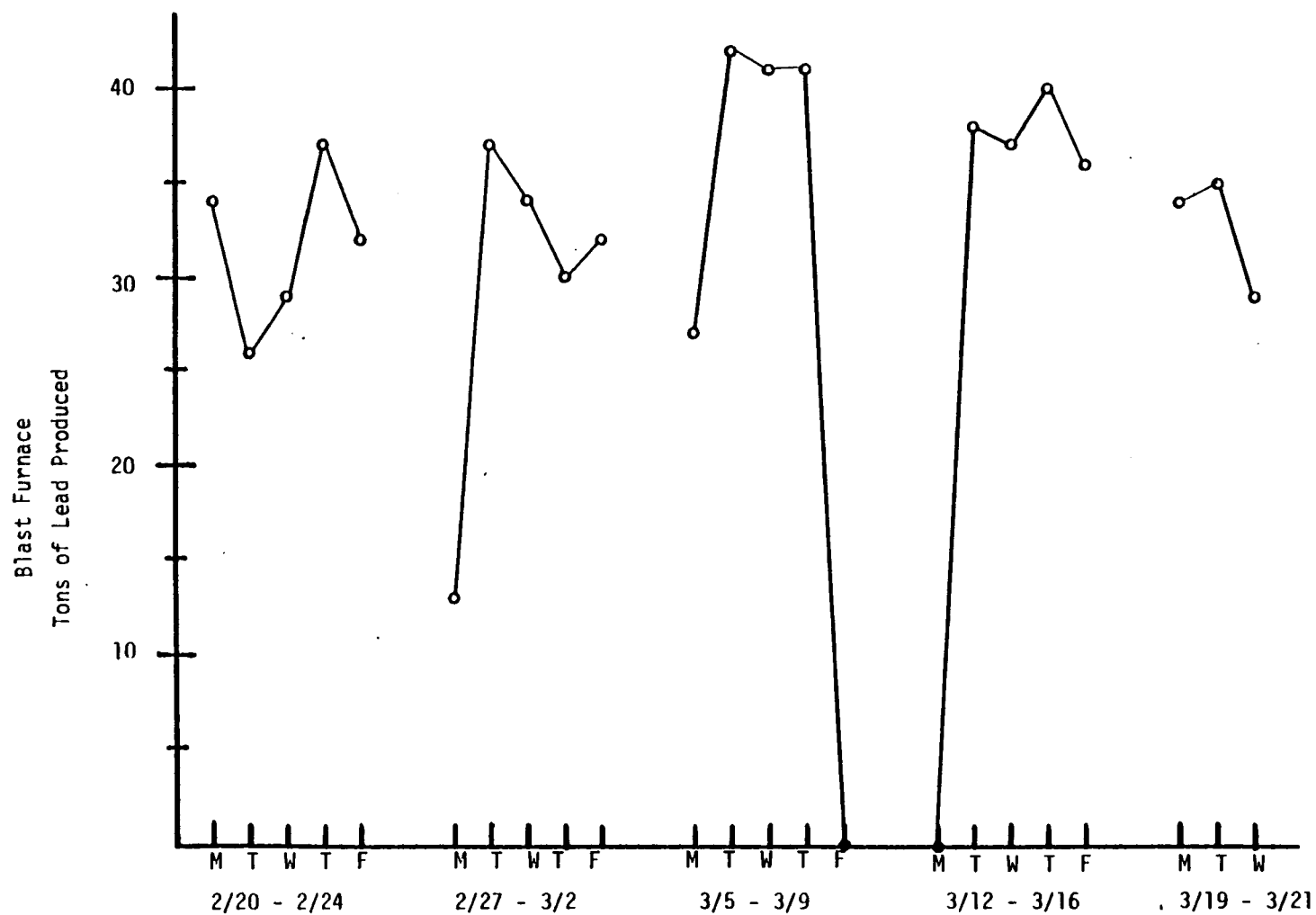


Figure 11. Blast furnace lead production February 20 through March 21, 1984. Daily lead production (tons) prior to and during the testing period.

periods and when the furnace was operating, the average daily lead production was approximately 37 tons per day.

Except for the 2 days in which the blast furnace was not operated, testing at this facility was conducted during periods of typical lead production.

The daily rates of refined metal production are presented in Figure 12. A total of 664 tons of refined metal were either cast into ingots or blocks between February 20 and March 21, 1984. Approximately 39 percent of this was soft lead while the remaining 61 percent was one of several hard lead alloys. A very similar ratio of hard to soft lead was produced during the actual testing period (March 6 - March 21).

Smelter operations and associated activities were monitored during the entire test program. Several short-term episodes of equipment failure occurred (i.e., battery breaking saw, case crusher, skip hoist bucket, screw conveyor, etc.); however, these were considered representative of smelter operation in general. None of these failures resulted in visible fugitive emissions. During the early stages of testing, the water circulation jacket on the blast furnace ruptured and consequently resulted in two days' loss in lead production (3/9/84 and 3/12/84). According to plant personnel, this incident represented a major equipment failure and should not be considered representative of typical smelter operations. Despite the inoperable furnace, the area being tested (the road area between the smelter building and the ingot storage building) was judged to demonstrate typical vehicle activities during the 6-8 hour sampling period.

Since the smelting facility operates 24 hours per day, and the sample collection took place only during daytime hours, it was determined that certain activities were not represented during the 6-8 hour sampling periods. It was observed that some of the potential dust generating activities are routinely performed during night shifts. Activities such as loading of slag into dumpsters and the dumping of dross materials were not

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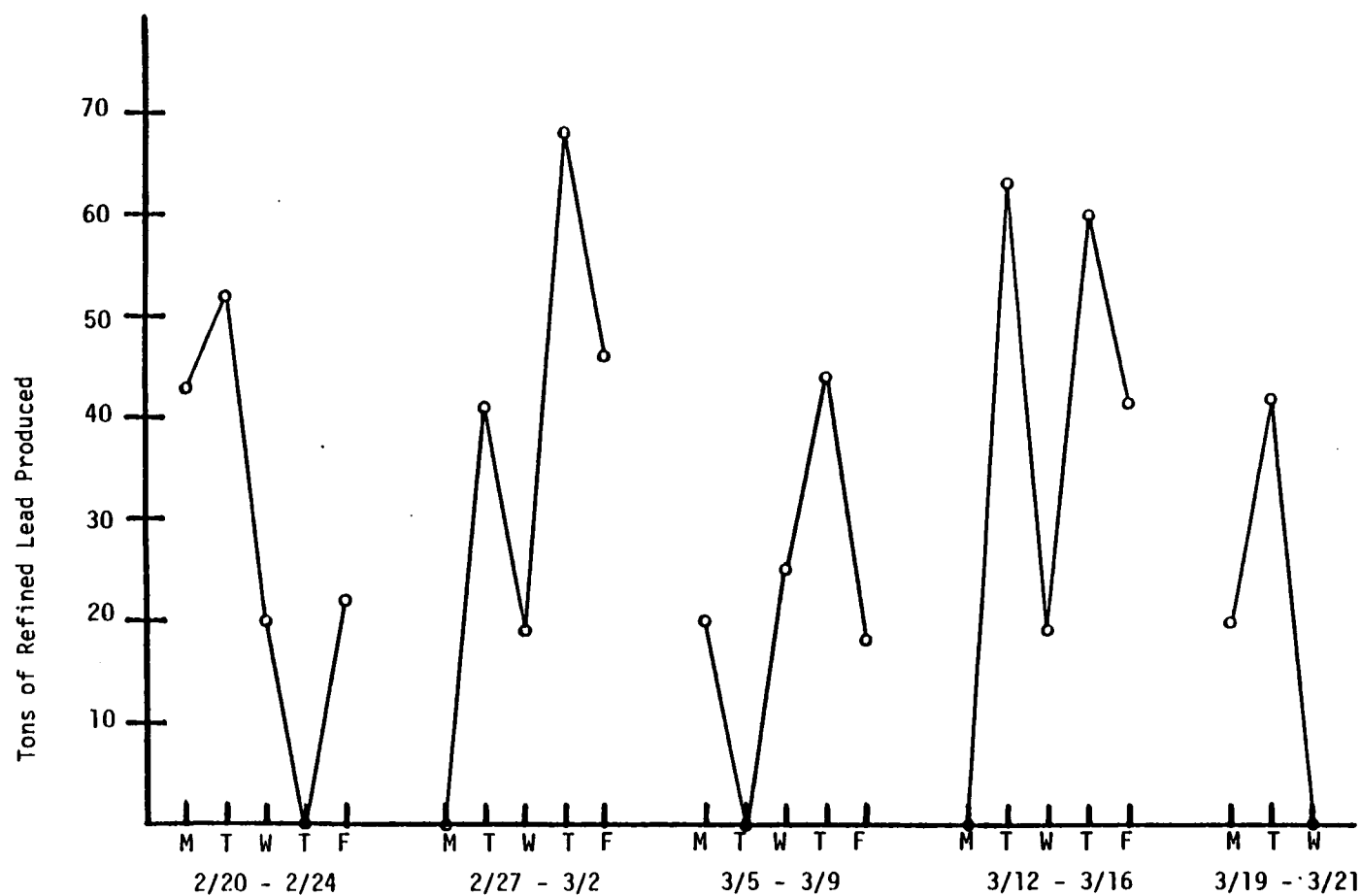


Figure 12. Refined metal production February 20 through March 21, 1984. Daily refined lead production (tons) prior to and during the testing period.

observed during actual testing periods. However, it is assumed that the majority of the activities associated with smelter operation were observed during the sampling periods, and the fugitive emissions measured in this test program represent typical emissions at this smelter.

3.4 AREA FUGITIVE EMISSIONS AND VEHICLE ACTIVITY PATTERNS

Five potential area sources of arsenic emissions were identified at the smelter. These are the battery breaking area, the raw material storage area, the smelter building, the slag and dross storage area, and the intra-plant vehicle roadways. The major area fugitive control technique practiced at the smelter is wet suppression. This technique can be practiced effectively at this location since all of the smelter grounds are paved. An automatic sprinkler system is used to wet the battery breaking area, the raw material storage area, the dross storage area, and the access roadway north of the process baghouse and west of the ingot storage building.

Fugitive particulate emission rates are influenced by the amount of wind, rain, and overall vehicular activity. Based on test results obtained from fugitive studies on other types of outdoor storage, two-thirds of the fugitive particulate emissions may be attributed to loading and unloading of storage piles or reentrainment from vehicular activity.

Each of the factors influencing fugitive emissions were monitored during the entire test period. Vehicle activities were observed, and general traffic patterns associated with smelter operation were characterized. Intraplant vehicle movement is primarily associated with one of four activities. These are battery breaking, blast furnace operation, refining activities, and lead casting.

3.4.1 Blast Furnace Operation

The majority of the vehicle activity at the plant is directly associated with the operation of the blast furnace. These general activity

patterns are listed in Table 12 and illustrated in Figure 13. Much of the activity associated with blast furnace operation is due to front end loaders supplying raw materials to the charge preparation area (Pattern A). This activity occurs every 45 minutes during typical furnace operations. Additional activity is due to forklifts removing lead products and slag from the furnace area (Patterns G and H). Slag buttons are taken to the slag pile, and blast furnace buttons are transported to storage at one and a half hour intervals.

3.4.2 Battery Breaking

The general vehicle activity patterns occurring in the battery breaking area are listed in Table 13 and illustrated in Figure 14. These activities consist of trucks delivering junk batteries to be recycled (Pattern L) and forklifts supplying pallets of batteries to the sawing operation (Pattern J). Additional forklift activity in this area is attributed to removal of empty pallets (Pattern K) and the transport of lead collected in the float sink separation system to the area material storage area (Pattern M). During battery breaking operations, activity patterns J and K (supplying batteries and removing pallets) represent the majority of the vehicle activities. These pathways are used every 10-15 minutes for the duration of the battery breaking campaign. Junk battery deliveries (Pattern L) were very infrequent during the sampling period. On the average, only 3 to 4 small trucks delivered junk batteries each day.

3.4.3 Lead Casting

The general activity patterns associated with casting lead are listed in Table 14 and illustrated in Figure 15. Transporting stacks of lead ingots from the end of the casting line to the ingot storage building (Pattern N) constitutes the single most frequent vehicle activity associated with lead casting. During periods in which lead is being cast, this pathway is used continuously. On the average, forklifts transport a stack of lead every 4 minutes. Depending on the amount of available storage area in the

TABLE 12. GENERAL VEHICLE ACTIVITY PATTERNS ASSOCIATED
WITH BLAST FURNACE OPERATION

Vehicle Pattern (Figure 13)	Description of Vehicle Activity	Pathway Usage/hr
A	Front end loader transporting lead bearing raw materials from storage area to charge preparation area	1.33
B	Front end loader transporting coke from storage area to charge preparation area	0.67
C	Front end loader transporting scrap iron from storage area to charge preparation area	0.50
D*	Forklift transporting drums containing battery plant scrap to charge preparation area	ND
E*	Forklift taking empty drums to storage	ND
F	Forklift removing slag pot from the slag tap hood and transporting to the corner of the smelter building where the slag is allowed to cool	0.67
G	Forklift transporting blast furnace slag to storage pile	0.67
H	Forklift transporting lead buttons from the lead well to the blast metal storage area	0.67
I	Miscellaneous front end loader activity transporting limestone and sand to the charge preparation area	ND

*These vehicle patterns are only observed when battery plant scrap is charged to the furnace.

ND = Not Determined.

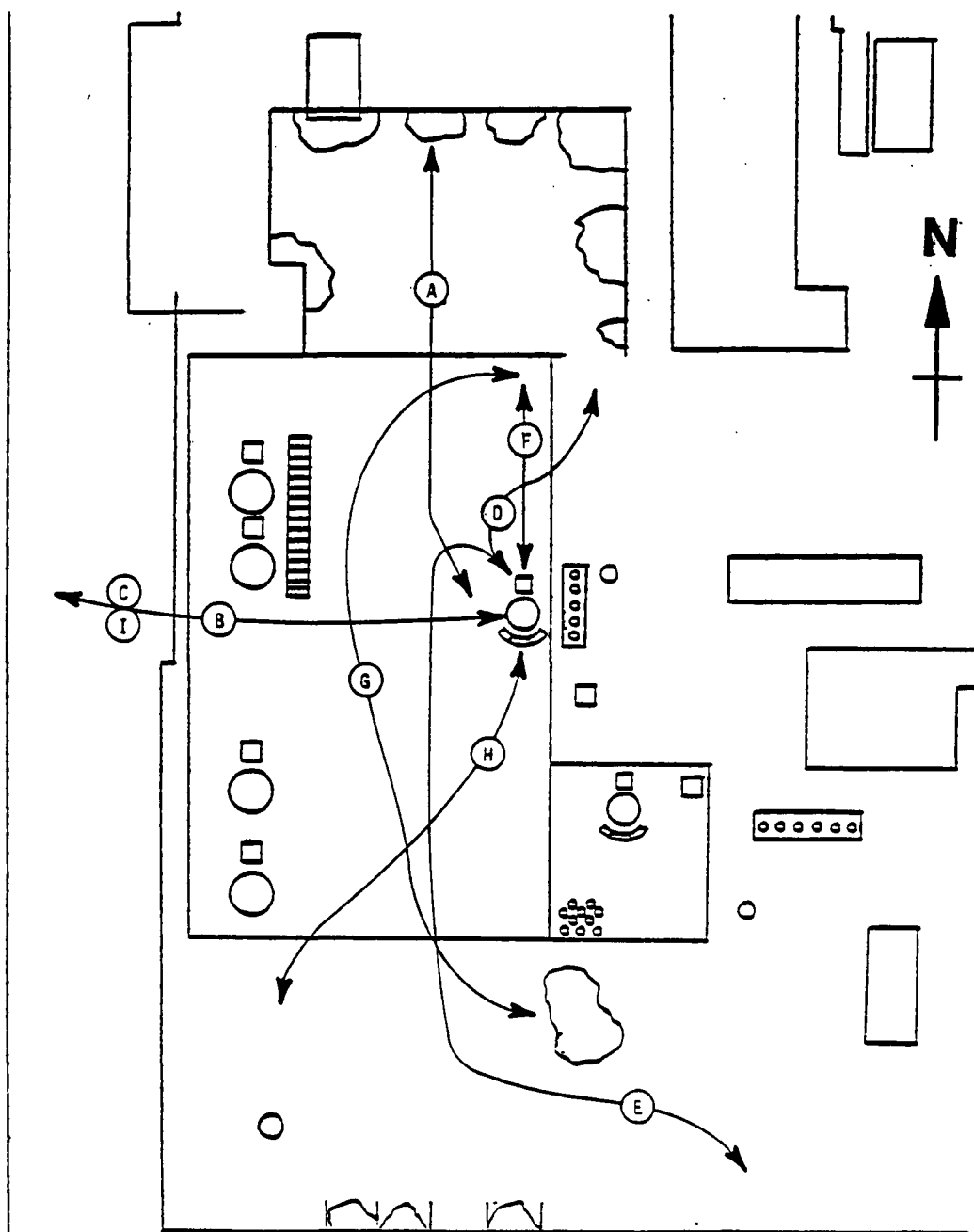


Figure 13. Major vehicle activity patterns associated with blast furnace operation. Refer to Table 11 for descriptions.

TABLE 13. GENERAL VEHICLE ACTIVITY PATTERNS ASSOCIATED WITH THE
BATTERY BREAKING OPERATIONS

Vehicle Pattern (Figure 14)	Description of Vehicle Activity	Pathway Usage/hr
J	Forklift transporting pallets of junk batteries from storage area to battery saw	5
K	Forklift taking empty pallets to storage	5
L	Small trucks carrying scrap batteries	0.5
M	Forklift transporting lead scrap collected in the float-sink operation to the raw material storage area	ND

ND = Not Determined.

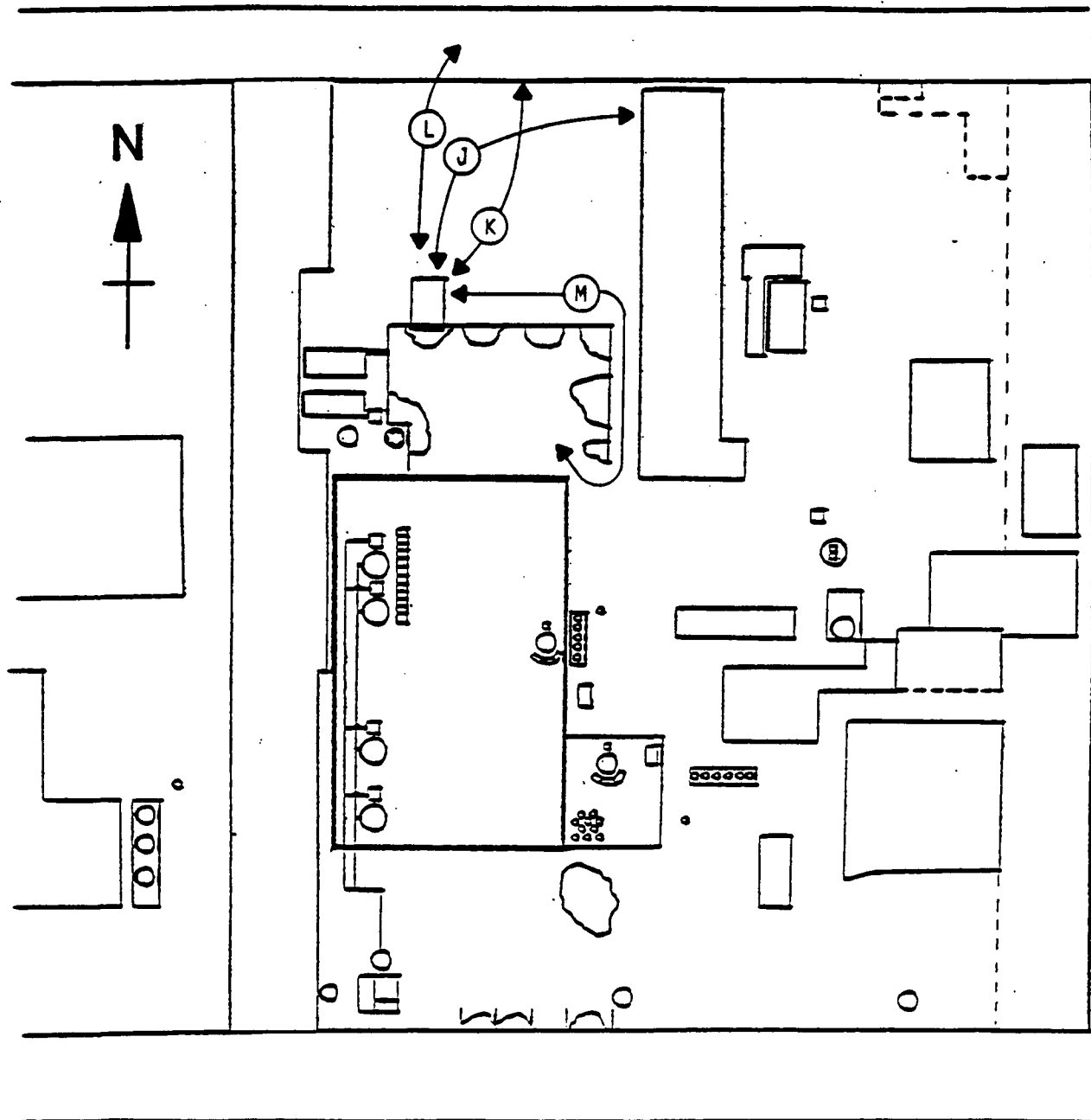


Figure 14. Major vehicle activity patterns associated with the battery breaking operation. Refer to Table 12 for descriptions.

TABLE 14. GENERAL VEHICLE ACTIVITY PATTERNS ASSOCIATED WITH
INGOT CASTING

Vehicle Pattern (Figure 15)	Description of Vehicle Activity	Pathway Usage/hr
N	Forklift transporting stacks of lead ingots from casting area to scales and then to storage area	0.9
O	Forklift transporting stacks of lead ingots from the end of the casting line to temporary storage	0.9
P	Forklifts transporting soft lead blocks from refining kettles to the lead oxide building	1
Q	Forklifts transporting stacks of lead ingots from the casting area to the dock on the north side of the lead oxide building	1

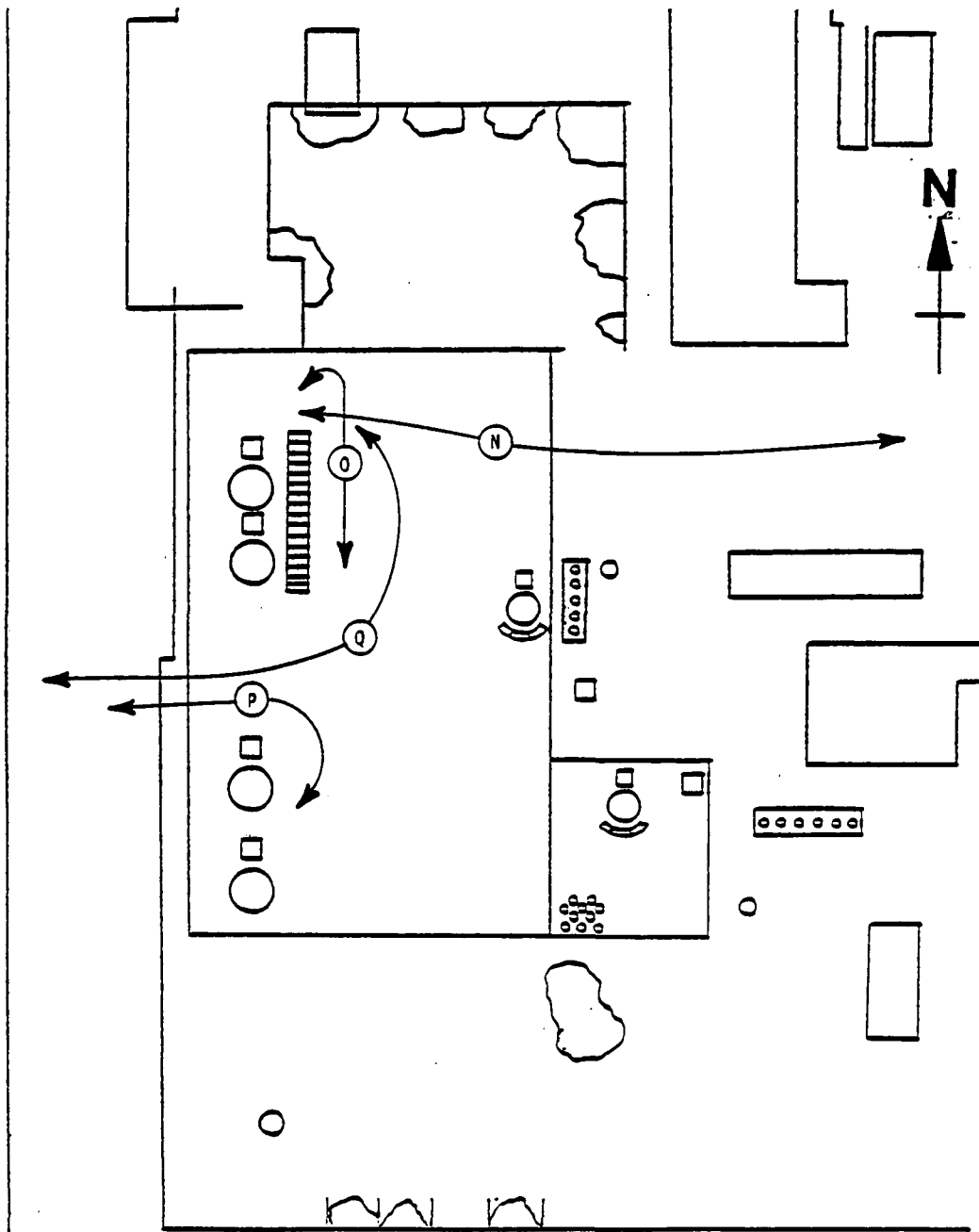


Figure 15. Major vehicle activity patterns associated with the casting or pouring of refined metal. Refer to Table 13 for descriptions.

ingot building, the lead may be temporarily stored in the smelter building (Pattern O). Soft lead is poured into large blocks directly from the refining kettle. These soft lead blocks are transported to the lead oxide building where they are stored (Pattern P).

3.4.4 Refining Activities

The general activity patterns associated with the refining process are listed in Table 15 and illustrated in Figure 16. Initially, forklifts transport blast furnace metal from the storage area to the kettles for melting (Pattern R). The largest kettles have a 50-ton capacity; and, consequently, 50 trips are eventually required to fill the kettles. This is most likely the largest single vehicle activity associated with the refining process. Forklifts also carry alloying additives from the ingot storage building to the refining area (Pattern S), and transport refining drosses to storage area (Pattern T). Although several tons of refinery drosses were generated during the test period, these were primarily removed from the kettles and stored during second and third shifts. Consequently, this vehicle activity (Pattern T) was at a minimum during actual sampling periods.

3.5 TEST AREAS

Five areas which were identified as potential sources of fugitive arsenic emissions were tested using a modified exposure profiling sampling technique. Figure 10 shows the location of the five test areas by number. These are the battery breaking area (Area 1), the raw material storage area (Area 2), the smelter building (Area 3), the slag and dross storage area (Area 4), and the intraplant vehicle roadway (Area 5). A brief physical description of each of these areas along with a summary of the process related activities occurring during the sampling periods will be described in the following sections.

TABLE 15. GENERAL VEHICLE ACTIVITY PATTERNS ASSOCIATED WITH
REFINING KETTLE OPERATIONS

Vehicle Pattern (Figure 16)	Description of Vehicle Activity
R	Forklift transporting blast furnace metal from storage area to refining kettle
S	Forklift transporting alloying additives from ingot storage building to kettles
T	Forklift transporting refining kettle drosses to storage

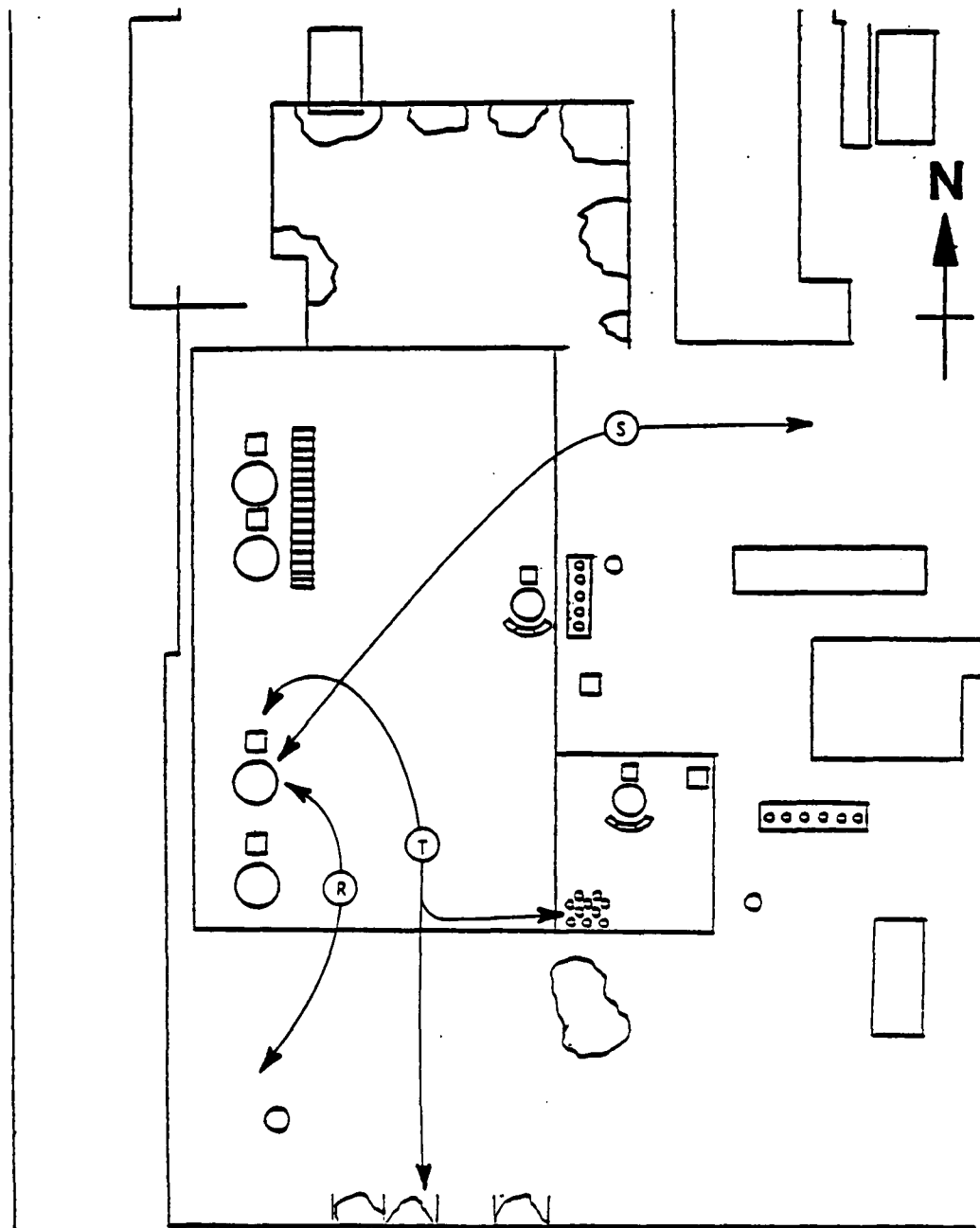


Figure 16. Major vehicle activity patterns associated with refining operations. Refer to Table 14 for descriptions.

3.5.1 Battery Breaking Area (Area 1)

The battery breaking area is located at the north end of the plant and consists of a shed-like structure surrounded by open pavement where pallets of junk batteries are stored. The battery saw facility consists of an open-air building containing an automatic feed conveyor system and a slow speed saw for removing the covers from junk batteries. The facility also houses a hammer mill for breaking battery cases and a float/sink separation system for separating plastic, lead terminals, lead oxide paste, and rubber.

Sprinkler heads mounted on the west side of the rolling mill building serve to keep the battery storage area and the area surrounding the battery cutting facility wet. Manual wetting of the saw equipment and pavement area underneath the saw is practiced routinely.

Table 16 presents a summary of the test conditions and the process related activities recorded during periods in which sampling was conducted in the battery breaking area. Fugitive sampling in this area was performed in conjunction with sampling in the raw material storage area and the smelter building. Samples were collected for 6-8 hours each day for 4 consecutive days.

As seen in Table 16, with the exception of March 13, the vehicle activity counts recorded and the vehicle patterns used were very similar during each of the 3-4 days. Day-to-day differences in test conditions were primarily due to variations in wind direction.

The sprinkler system in the battery breaking area was not operated during the sampling periods due to the positioning of the sampling equipment. Under normal conditions, the sprinklers in this area are operated on a cyclic basis spraying 3 out of every 15 minutes. Manual wetting of the saw and equipment was observed. Manual wetting of the pavement surrounding the building was not observed. The tests conducted under these conditions

TABLE 16. BATTERY BREAKING AREA. SUMMARY OF GENERAL CONDITIONS AND PROCESS-RELATED ACTIVITIES DURING THE SAMPLING PERIOD

Date	Wind Direction	Vehicle ^a Patterns that Affect the Test Area	Vehicle Activity Counts	Number of Batteries Broken	Conditions ^b Wet/Dry	General Observations
3/13	W-SW	J, K, L	13	1,440	Dry	--Initial electrical problems resulted in intermittent operation of sampling equipment --Unloading of coke from a train car represented a potential source of upwind particulate matter
3/14	NE	J, K, L	45	2,162	Dry	
3/15	E-NE	J, K, L	54	2,287	Dry	
3/16	E	J, K, L	47	609	Dry	--A localized whirlwind stirred up substantial amount of dust at one point during the sampling period

^aVehicle patterns are illustrated in Figure 14.

J = Forklifts transporting pallets of junk batteries from storage area to battery saw.

K = Forklifts transporting empty pallets to storage.

L = Small trucks delivering loads of scrap batteries.

^bThe automatic sprinkler system was not operated in this area during the sampling period due to the positioning of the samplers. Manual wetting was observed near the battery saw approximately once per day.

are considered "dry" since the automatic suppression system was not in use and no area wetting was observed.

3.5.2 Raw Material Storage Area

The raw material storage area is located just south of the battery breaking facility and is used for storing battery group materials and other lead bearing raw materials. This area consists of an uncovered, three-sided concrete structure with walls approximately 8 feet high. The dimensions of the raw material storage area are approximately 85 feet by 60 feet. The south side of this area is open to the smelter building. Battery plates and lead oxide paste from scrap batteries constitute the majority of the stored materials. In addition, miscellaneous lead scrap is periodically dumped in this area by local scrap dealers. The battery materials are generally kept wet by battery acid from the broken batteries and by water used in the cutting operation. In addition, wastewaters from the cutting operation are continuously pumped into this area. The material piles are located so that sludge containing waters will slowly filter through the scrap battery plates. This process aids in increasing the lead recovery from the wastewater and simultaneously provides a partial means of wet suppression for the storage piles. Front end loaders are used to transport the lead bearing raw materials from the storage piles into the smelter building where the blast furnace charge is prepared.

Table 17 presents a summary of the test conditions and the process related activities recorded during periods in which sampling was conducted in the raw material storage area. Samples were collected for 6-8 hours each day for 5 test days. This testing was performed in conjunction with sampling in the battery breaking area, the smelter building, and the roadway.

As seen in Table 17, vehicle activity counts are relatively low as compared to those recorded for the battery breaking area (Table 16). Front end loaders remove a load of battery group material from the raw material storage area approximately every 45 minutes. Additional loader activity in

TABLE 17. RAW MATERIALS STORAGE AREA. SUMMARY OF GENERAL CONDITIONS AND PROCESS-RELATED ACTIVITIES DURING THE SAMPLING PERIOD

Date	Wind Direction	Process ^a Activities	Vehicle Affect Test Area	Battery ^b Plates Fed to Furnace (lbs)	Conditions ^c	General Observations
3/13	W-SW	BF BB C RF	7	19,890	Dry	--Initial electrical problems resulted in intermittent operation of sampling equipment --Unloading of coke from a train car represented a potential source of upwind particulate matter
3/15	E-NE	BF BB C RF	10	73,620	Dry	
3/16	E	BF BB C	8	65,600	Dry	
3/19	SE	BF BB C RF	14	68,004	Dry	--Front end loader had a flat tire and consequently charge materials consisted of battery plant scrap from 55-gallon drums
3/20	S	BF RF C	^d	28,044	Dry	--Battery breaking facility was not operating due to electrical problems

^aProcess activities during the actual sampling period.

BF = blast furnace operation, BB = battery breaking, C = casting, RF = refining.

^bData provided by the facility.

^cThe automatic sprinkler system was not operated in this area during the sampling period due to the positioning of the samplers. Manual rinsing of the front end loader was performed each time the loader left the raw materials storage area.

^dData not available.

the storage area relates to the battery breaking operations. The battery contents dumped from the battery breaking facility are cleaned up periodically during the day and redistributed among the existing group storage piles.

The sprinkler system which wets the raw material storage area was not operated due to the positioning of the sampling equipment. Under normal conditions at this plant, this area is intermittently wetted by the automatic sprinkler system. This practice also aids in keeping the raw material storage area wet.

3.5.3 Smelter Building

The dimensions of the smelter building are approximately 90 feet by 145 feet and the roof is 20 to 30 feet high. It is completely open on the north, east, and south sides and is enclosed on the west except for two doorways. The building houses a blast furnace, four refining kettles, and a casting machine. An extension to the smelter building at the southeast houses a currently inoperative furnace and several 55-gallon drums containing refining drosses.

Table 18 presents a summary of the test conditions and the process related activities recorded during periods in which emissions from the smelter building were sampled. Fugitive samples were collected on 4 consecutive days using the high volume pole sampling equipment. Additional low volume, site specific fugitive sampling was conducted within the smelter building near the refining kettles, and near the lead and slag tapping wells of the blast furnace. These samples were collected in order to qualitatively assess the contribution of the process fugitive emissions from these sources to the total area fugitive emissions from the smelter building. Table 19 summarizes the general activities represented during each low volume sampling period.

TABLE 18. SMELTER BUILDING. SUMMARY OF GENERAL CONDITIONS AND PROCESS-RELATED ACTIVITIES DURING THE SAMPLING PERIOD

Date	Wind Direction	Process ^a Activities	Vehicle ^b Patterns that Affect the Test Area	Vehicle Activity Counts	Lead Produced (Tons)	Lead Pumped from Kettles (Tons)	Conditions ^c Wet/Dry	General Observations
3/13	W-SW	BF BB C RF	A,B,C,F,G,H,I N	29	38	63	Dry	--Initial electrical problems resulted in intermittent --Unloading of coke from a train car represented a potential source of upwind particulate matter
3/14	NE	BF BB C RF	A,B,C,F,G,H,I N	91	37	19.5	Dry	--Skip hoist conveyor system broke down, no furnace charging for 2.5 hours --Substantial floor wetting in the smelter area while the skip hoist was inoperable
3/15	E-NE	BF BB C RF	A,B,C,F,G,H,I N	100	40	60	Dry	
3/16	E	BF BB C	A,B,C,F,G,H,I N	81	36	41.5	Dry	
3/19	S-SE	BF BB C RF	A,B,C,D,F,G,H,I O,Q	91	34	20	Dry	--Front end loader had a flat tire and consequently charge materials consisted of battery plant scrap from 55-gallon drums
3/20	S	BF RF C	A,B,C,F,G,H,I N	^d	35	42	Dry	--Sb and As were added to Kettle #4 which was directly upwind of Sampler 5 --Battery breaking facility was not operating due to electrical problems

^aProcess activities during the actual sampling period.

BF = blast furnace operation, BB = battery breaking, C = casting, RF = refining.

^bVehicle patterns are illustrated in Figure 13.

A = Front end loaders transporting lead bearing raw materials from storage area to charge preparation area.

B = Front end loaders transporting coke from storage area to charge preparation area.

C = Front end loaders transporting scrap iron from storage area to charge preparation area.

D = Forklift removing the slag pot from the slag tap hood and transporting to the corner of the smelter building where the slag is allowed to cool.

G = Forklift transporting blast furnace slag to the storage pile.

H = Forklift transporting lead buttons from the lead tapping area to the blast metal storage area.

I = Miscellaneous front end loader activity transporting limestone and sand to the charge preparation area.

N = Forklift transporting stacks of lead ingots from the casting area to scales and then to storage.

^cThe smelter building floor is completely hosed down once per shift.

^dData not available.

TABLE 19. SUMMARY OF GENERAL ACTIVITIES DURING SITE-SPECIFIC LOW VOLUME SAMPLING PERIODS
INSIDE THE SMELTER BUILDING

Dates	Sampler Location	General Activities During Sampling Periods
3/7	Refining kettle #2	--Soft lead kettle (drossing began after sampling)
3/8	Refining kettle #2	--Caustic skim (last clean-up) --Pouring of soft lead --Forklift activity
3/9	Refining kettle #3 and #4	--Casting hard lead (pumped from kettle #3) --Forklift activity
3/12	Refining kettle #3 and #4	--Melting lead in both kettles
3/13	Refining kettle #3 and #4	--Drossing kettle #3 --Casting hard lead (pumped from kettle #4) --Forklift activity --Melting lead in #4
3/16	Blast furnace*; lead and slag tap area	--Produced 10.5 tons of Pb --Produced 4.5 buttons of slag
3/19	Blast furnace*; lead and slag tap area	--Produced 10 tons of Pb --Produced 4.5 buttons of slag
3/20	Refining kettle #1 and #4	--Mixing kettle #1 --Addition of arsenic master alloy (684 lbs of 10% As)
3/21	Blast furnace*; lead and slag tap area	--Produced 8.5 tons of Pb --Produced 4.5 buttons of slag

*Lead and slag production estimates are based on 7 hour sampling periods and daily blast furnace production data reported by the plant.

Process activities during the four high volume sampling periods were very similar, as were the related vehicle activity counts. Production rates of blast furnace lead were also comparable. Day-to-day differences in test conditions were primarily due to variations in wind direction.

As seen by the vehicle counts recorded in Table 18, the smelter building supports the majority of traffic recorded at this smelter. The smelter building is the central location for all process related activities and potentially represents the major source of fugitive emissions. All of the furnace feed materials are transported into the smelter building by front end loaders. Almost all of the furnace products, as well as the refining and casting products, are handled by forklifts. Table 18 includes a listing of the vehicle patterns observed during each sampling period. These patterns were discussed earlier and illustrated in Figures 13 through 16.

3.5.4 Slag and Dross Storage Area

Slag is tapped from the blast furnace into a crucible which is located in the slag tap hood enclosure. After approximately three tappings (one and one-half hours), the slag is removed from the hood and taken to the north-east corner of the smelter building where it is allowed to cool for an additional one and one-half hours. During this cooling period, visible fumes are emitted from the slag. The crucible is then transported to the slag pile where the glass-like aggregate is dumped. Initially, the slag material fumes but later cools and breaks into smaller pieces. Little activity was observed in this area during testing, and the slag pile remained dry during all sample collections.

Two types of slag are generated at this smelter. These are (1) slag which according to the EP toxicity test is not classified as hazardous material and may be landfilled in a normal landfill, and (2) slag which by the EP toxicity test is classified as hazardous and must be disposed of in an approved landfill. The latter type of slag is generated when caustic

drosses and sodium containing materials are charged to the furnace. During the testing period, no hazardous slag was generated.

Little or no slag was rerun in the furnace during the test period. All slag pile clean-up and loading into dumpsters occurred during the second and third shifts; and, consequently, was not captured during the sampling periods.

Dross materials removed from the refining kettles are finely divided and dusty. Some drosses are stored in drums and covered with plastic. Light dross, antimony slags, and caustic skims are all wetted and deposited in the open 3-sided bins along the southern wall of the plant property. Sprinkler heads mounted on the dross bins serve to keep the dross storage area and the access pathway near the bins wet.

Table 20 presents a summary of the test conditions and the process related activities recorded during periods in which emissions from this area were sampled. As seen from this table, vehicle activity counts are relatively low compared to those observed in the smelter building (Table 18) or battery breaking area (Table 16). The majority of the vehicle activity results from the storage of furnace products. It was observed that both lead and slag were transported into this area every one and one-half hour. Although refining activities were conducted, no dross dumping occurred during the actual sampling periods.

The sprinkler system was operated during 2 of the 3 test days. The use of the sprinkler on the last day was prohibited due to exposed electrical connections which were needed to supply power to the sampling equipment. Although no additional water was sprayed during this "dry" test, the area immediately around the dross storage bins remained wet and muddy during the entire sampling period. The slag pile and the area where blast furnace metal is stored remained dry during each of the 3 test days.

TABLE 20. SLAG AND DROSS STORAGE AREA. SUMMARY OF GENERAL CONDITIONS AND PROCESS-RELATED ACTIVITIES DURING THE SAMPLING PERIOD

Date	Wind Direction	Process ^a Activities	Vehicle ^b Patterns that Affect the Test Area	Vehicle Activity Counts	Lead Produced (Tons)	Drosses Removed from Kettles (Tons)	Conditions ^c Wet/Dry	General Observations
3/6	SE	BF BB RF	H,G	7	42	2.6	Wet	--No drosses were dumped during sampling period --No slag was broken or loaded into dumpsters during the sampling period. --Slag pile was dry/dross area wet and muddy.
3/7	NW	BF BB C	H,G	4	41	6.4	Wet	--No drosses were dumped during the sampling period --No slag was broken or loaded into dumpsters during the sampling period --Slag pile was dry/dross area was wet and muddy.
3/8	NE	BF BB C	G,E	12	41	2.7	Dry	--No drosses were dumped during the sampling period. --No slag was broken or loaded into dumpsters during the sampling period --Vehicle activity associated with blast furnace metal storage was not captured due to sampler position --The automatic sprinkler system was not operated due to open electrical connections required to operate the samplers. However, the test area was still muddy during the entire sampling period. The slag pile was dry.

^aProcess activities during the actual sampling period.

BF = blast furnace operation, BB = battery breaking, C = casting, RF = refining.

^bVehicle patterns are illustrated in Figure 13.

E = Forklift taking empty drums to storage.

G = Forklift transporting blast furnace slag to storage pile.

H = Forklift transporting lead buttons from the lead well to the blast metal storage area.

^cWet conditions correspond to periods in which the automatic sprinkler system was operated in the dross storage area. These sprinklers did not wet the slag pile or the area where the blast furnace metal is stored. Dry conditions indicate that the automatic sprinkler was not operated.

3.5.5 Roadway (Major Vehicle Pathway)

The smelter access road is a paved area located between the ingot storage building and the smelter building (Area 5 in Figure 10). In general, the roadway appeared to be the cleanest area in the facility since little dust was observed on the road surface. This roadway is primarily used by forklifts to transport lead from the smelter building to storage or to the rolling mill for fabrication. In addition, this roadway is used as an access to the raw material storage area by local dealers who sell scrap lead to the smelter.

Half circle impact sprinkler heads are mounted on the north side of the process baghouse in order to reduce dust entrainment from vehicle traffic. These sprinklers are operated on a timed cycle operating 3 out of every 15 minutes. Similar manually operated impact sprinkler heads are located on the southwest corner of the rolling mill and the west side of the ingot storage building.

Table 21 presents a summary of the test conditions and the process related activities recorded during the 6 days in which emissions from the area were sampled.

The major vehicle roadway was sampled under both wet and dry conditions in order to assess the fugitive emission reduction potential of wet suppression. The vehicle activity counts recorded in Table 21 are primarily influenced by the casting operations. After casting, if the lead is taken to the ingot storage building (as was on 3/7), the vehicle activity counts in the roadway area are high. If the lead ingots are taken to the loading dock north of the lead oxide building or temporarily stored in the smelter building, the vehicle activity in the roadway is not influenced by the casting operation.

The blast furnace was not operated during 2 of the 6 test days (3/9 and 3/12) due to a broken water jacket in the furnace shaft. The inoperable

TABLE 21. ROADWAY. SUMMARY OF GENERAL CONDITIONS AND PROCESS-RELATED ACTIVITIES DURING THE SAMPLING PERIOD

Date	Wind Direction	Process ^a Activities	Vehicle ^b Patterns that Affect the Test Area	Vehicle Activity Counts	Refined Metal Produced (Tons)	Conditions ^c Wet/Dry	General Observations
3/7	NW	BF BB C	N	73	25	Wet	--Unloading of lead scrap from a truck created a lot of dust
3/8	NE	BF C	D P	13	44	Wet	--Soft lead was cast and taken directly to the lead oxide building
3/9	NW	BB C	Q	17	18	Wet	--Blast furnace was not operating due to a broken water jacket --Maintenance personnel were using a jackhammer in order to remove lead and slag from the blast furnace crucible. This furnace repair activity created dust which was not typical of normal operation --The ingots produced from the casting machine were taken to loading dock at the lead oxide building. Consequently, the road access area showed less vehicle activity than typically expected during casting operations --Vehicle activity was due to maintenance related activities
3/12	E	BB		14	0	Dry	--Blast furnace was undergoing repair --Extensive manual wetting in the raw material storage area --Open burning upwind of the plant resulted in deposition of visible particulate matter in the sampling area --Vehicle activity was due to maintenance related activities
3/19	SE	BF BB C RF	D H O	17	20	Dry	--Ingots from the casting operation were temporarily stored inside the smelter building. Consequently, the road access area showed less vehicle activity than typically expected during casting operations

(Continued)

TABLE 2I. (Continued)

Date	Wind Direction	Process ^a Activities	Vehicle ^b Patterns that Affect the Test Area	Vehicle Activity Counts	Refined Metal Produced (Tons)	Conditions ^c Wet/Dry	General Observations
3/20	SE	BF C RF	P	11	42	Dry	--Soft lead was cast and taken directly to the lead oxide building

^aProcess activities during the actual sampling period.

BF = blast furnace operation, BB = battery breaking, C = casting, RF = refining.

^bVehicle patterns are illustrated in Figure 16.

D = Forklifts transporting drums containing battery plant scrap to charge preparation area.

M = Forklifts transporting lead scrap collected in the float/sink operation to the raw material storage area.

N = Forklifts transporting stacks of lead ingots from the casting areas to scales and then to storage.

O = Forklifts transporting stacks of lead ingots from the end of the casting line to temporary storage inside the smelter building

P = Forklifts transporting soft lead blocks from refining kettles to the lead oxide building.

Q = Forklifts transporting stacks of lead ingots from the casting area to the dock on the north side of the lead oxide building.

^cWet conditions correspond to the cyclic operation of the sprinkler system mounted on the process baghouse. Dry conditions indicate that the automatic sprinkler was not operated.

blast furnace did not significantly affect the vehicle patterns in the roadway area since no vehicle activity in this area is directly associated with supplying feed materials to or storing products from the blast furnace. During the period that the blast furnace was down, crude lead was being refined. The transportation of lead pigs was through the intraplant roadway.

3.5.6 Sanitary Baghouse and Scrubber Testing

The fugitive control devices used at this plant are a sanitary baghouse to control emissions captured by the lead and slag tap hood and a wet scrubber to control emissions captured by the refining kettle and dross hoods. In general, these control devices have short stacks and discharge at low temperatures. As a result of these conditions, stack emissions from the process fugitive control devices have the potential to contribute to or interfere with the smelter area fugitive measurements.

Three stack gas tests were performed on both the scrubber and the sanitary baghouse outlets using EPA Method 108. The lead and slag tap activities during each of the sanitary baghouse stack tests are listed in Table 22. The refining kettle and drossing activities during each of the scrubber outlet tests are listed in Table 23.

TABLE 22. PROCESS CONDITIONS DURING THE SANITARY BAGHOUSE OUTLET TESTS

Date	Time	Buttons of Lead Tapped	Number of Slag Taps ^a
3/16	1038-1232	3	2
3/19	1352-1604	3	5
3/21	0954-1154	2.5	-

^aThe number of times that the damper was opened on the slag tap hood ventilation system. This was determined by the change in stack gas velocity.

TABLE 23. KETTLE ACTIVITIES DURING THE SCRUBBER OUTLET TESTS

Date	Kettle Activities
3/13	Kettle #1: Empty Kettle #2: Mixing (forming antimony/arsenic dross) Kettle #3: Holding molten lead - no activity Kettle #4: Melting blast furnace metal
3/14	Kettle #1: Empty Kettle #2: Holding molten lead - no activity Kettle #3: Casting Kettle #4: Holding molten lead - no activity
3/15	Kettle #1: Mixing (forming antimony/arsenic dross) Kettle #2: Empty Kettle #3: Empty Kettle #4: Addition of arsenic master alloy

SECTION 4
SAMPLING LOCATIONS

Four area sources, one contained source (the smelter building), and two point sources were tested for arsenic, lead, cadmium, and particulate emissions. The following sections describe the sources that were sampled.

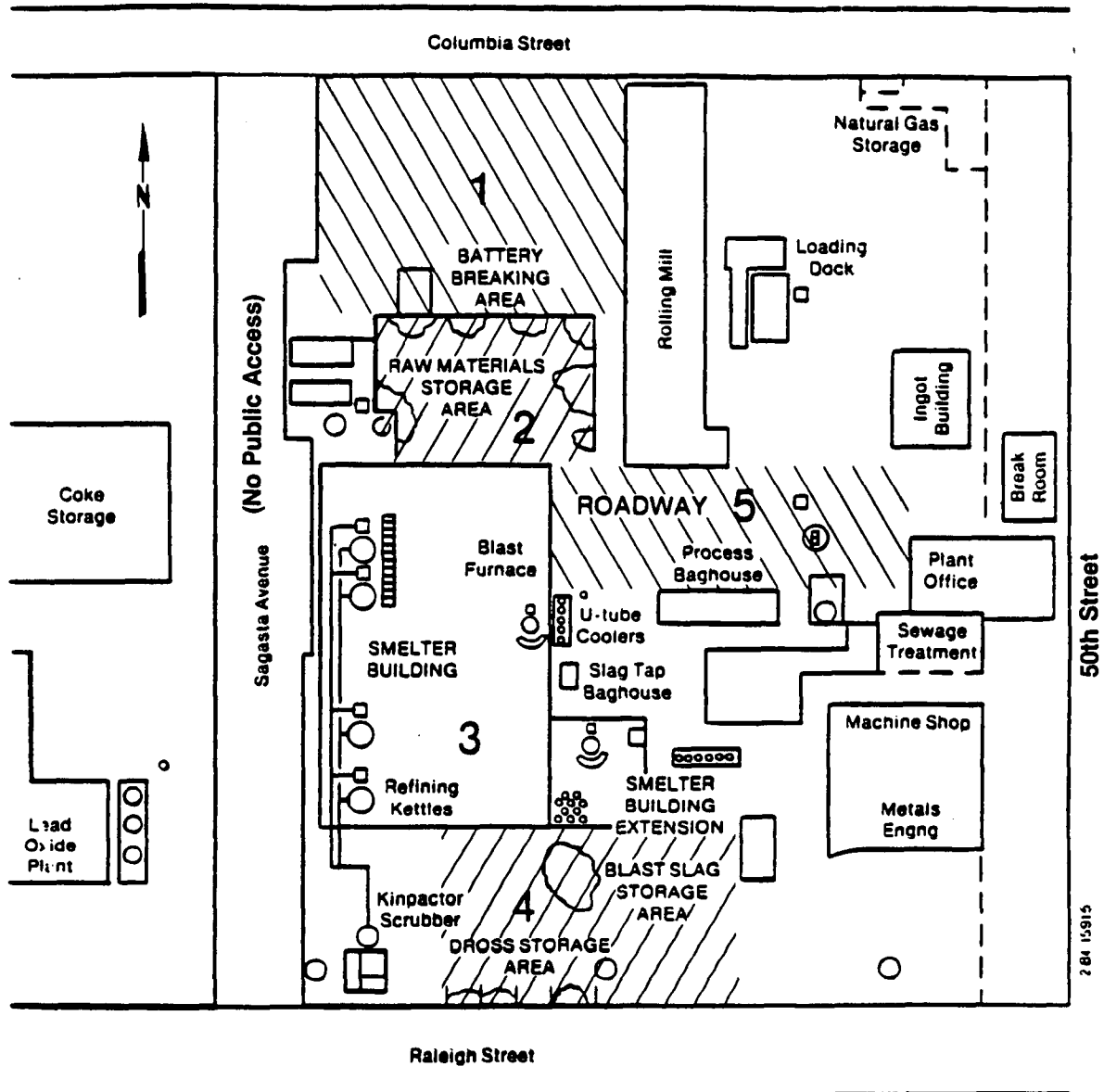
4.1 AREA SOURCES

Following are descriptions of the four area sources tested. Figure 17 identifies the area sources and defines their dimensions.

4.1.1 Battery Breaking Area (Area 1)

Scrap batteries delivered to the plant are received in the battery breaking area and are stored there on pallets until recycled. To recover the scrap lead, scrap bearing parts, and sludges in the batteries, the batteries are manually fed through a slow speed saw and cut in half. The battery internals, the plates primarily, are manually dropped from the battery cases and fall into the raw materials storage area. The cases are then conveyed to a hammer mill, crushed, and fed to a flotation system to separate lead parts, lead bearing sludges, plastic, and rubber. The lead parts and sludges are fed to the blast furnace, the plastic is sold, and the rubber is landfilled.

The battery breaking area is located on the north edge of the plant, due north and adjacent to the charge storage area. For emission rate determinations, the dimensions of the area are defined to be 92 feet by 121 feet. On the eastern boundary is the rolling mill building which does contribute lead fumes. Areas directly north and west of the battery breaking area are



AREA 1	92 ft. x 121 ft.	= 11,132 ft ²
AREA 2	59 ft. x 86 ft.	= 5,074 ft ²
AREA 3	144 ft. x 78 ft.	= 11,232 ft ²
AREA 4	73 ft. x 118 ft.	= 8,614 ft ²
AREA 5	48 ft. x 140 ft.	= 6,720 ft ²

Figure 17. Plot plan of Chloride Metals Secondary Lead Smelter identifying area sources.

open. The battery saw is located about midway on the southern edge of the battery breaking area which is also the northern edge of the raw materials storage area. The flotation system is to the west and adjacent to the battery saw. The battery breaking area is seen in the picture in Figure 18.

Chloride Metals does operate a series of sequential sprinklers located along the rolling mill building for wetting the battery breaking area. During testing, the sprinklers were not operated to prevent the wetting of samplers.

4.1.2 Raw Materials Storage Area (Area 2)

The raw materials storage area is located between the battery breaking area and smelter building. An eight-foot high concrete wall bounds all but about one-half of the boundary at the smelter building for front-end loader access. Lead plates from the battery saw fall directly into the raw materials storage area. The plates and other lead bearing materials are occasionally organized in the area using a front-end loader. Additionally, the sludge containing waters from the flotation system are filtered through the charge materials to remove and collect the lead bearing sludge.

The dimensions of the raw materials storage area are defined to be 59 feet by 86 feet. The northern boundary of the raw materials storage area is the southern boundary of the battery breaking area. The southern boundary of the raw materials storage area is at the edge of the smelter building. On the eastern side of the raw materials storage area is the rolling mill building. Figure 19 is a picture of the raw materials storage area.

4.1.3 Slag/Dross Storage Area (Area 4)

When slag is tapped, the slag kettle typically remains under the hooding at the slag tap until the next tapping period to control emissions from the hot slag containing kettle. When necessary to remove the full kettle to prepare for the next slag tap, the kettle is taken by a forklift

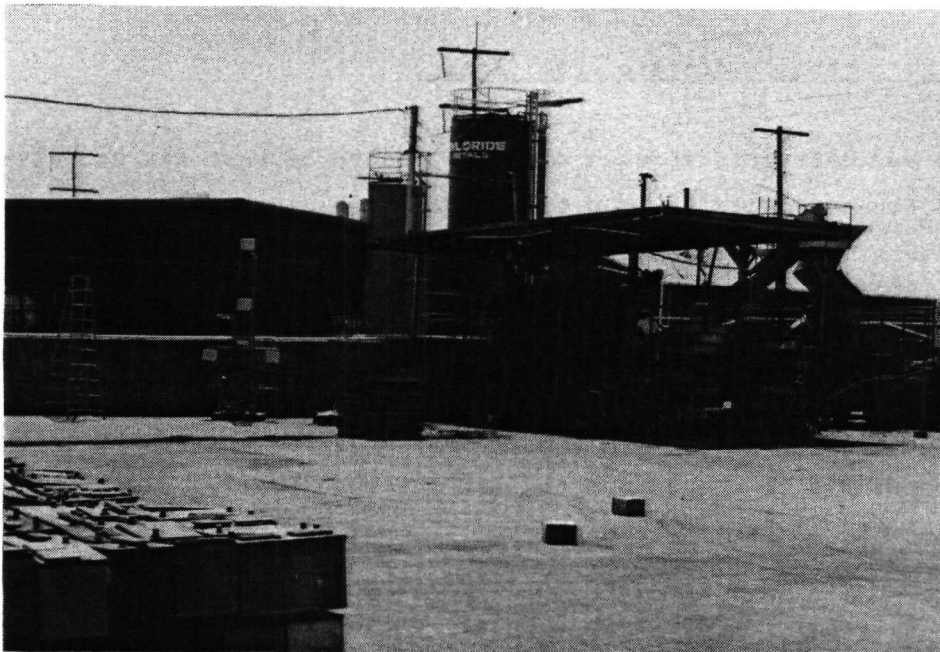


Figure 18. Battery breaking area looking southwest.
Raw materials storage area and smelter
building in background.



Figure 19. Raw materials storage area looking north.
Battery breaking area behind concrete wall.

to the slag storage area just southeast of the smelter building to cool further and complete solidification of the slag. The solid slag is eventually dumped from the kettle into the slag storage area. As necessary, slag is removed from the storage area by front-end loader and emptied into a truck trailer for shipment and landfilling.

Drosses are stored adjacent to the slag storage area in bins east of the smelter building and at the property line. Due to the proximity of the slag storage area and dross storage bins, the two were sampled as a single source, the slag/dross storage area. The dross storage bins are wetted by sprinklers while the slag storage area is not.

The boundaries of the slag/dross storage area are not easily recognizable, but the dimensions of the area were defined to be 73 feet by 118 feet for emission rate calculations. The slag/dross storage area is seen in Figure 20.

4.1.4 Roadway

The roadway, or major vehicle pathway, is a paved area located between the smelter building and ingot building. Along the southern boundary is the process baghouse and along the northern edge is the rolling mill building. Automated sprinklers located on the process baghouse wet the roadway. To evaluate the degree of control achievable by wetting of the roadway, the area was tested wet and dry.

The dimensions of the roadway are defined to be 59 feet by 140 feet for use in determining the area emission rates. The roadway viewing towards the smelter building is shown in Figure 21.

4.2 SMELTER BUILDING

Smelting and refining activities are conducted in the smelter building. Although the plant has two blast furnaces, only one is presently operating.

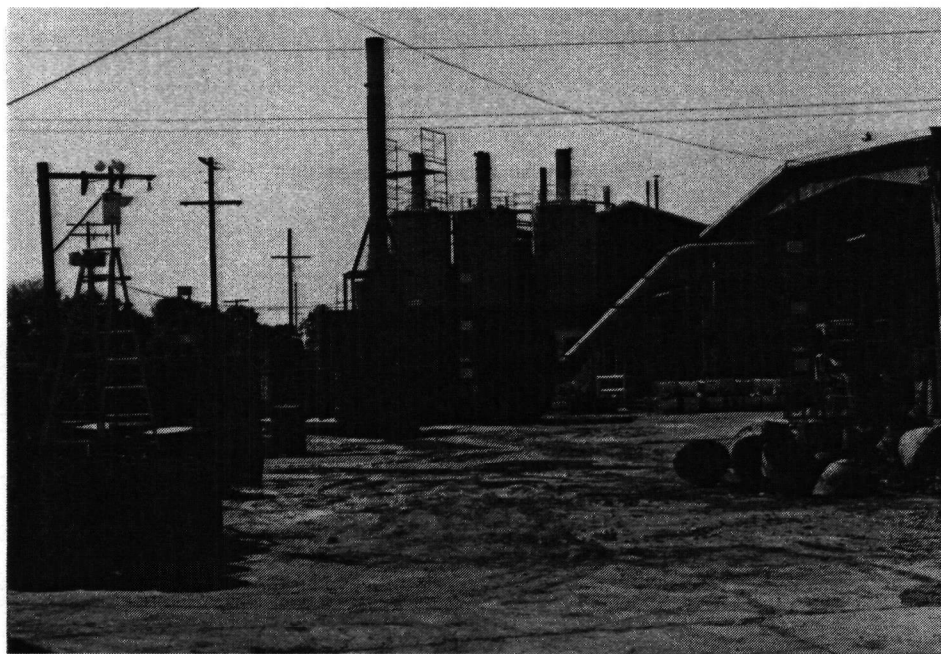


Figure 20. Slag/dross storage area looking west.
Smelter building to the right in picture.

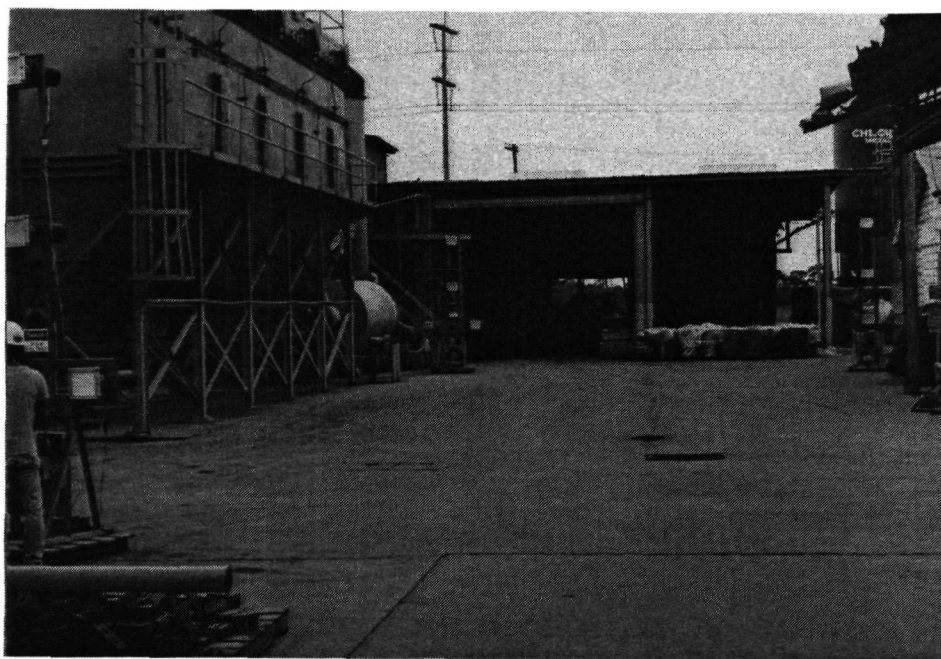


Figure 21. Roadway looking west. Smelter building in background--
process baghouse on the left in picture.

There are four refining kettles in the smelter building. The dimensions of the smelter building are shown in Figure 22.

Flue gas, or process gas, emissions are vented through the process baghouse which was not tested in this program. The slag tap and slag kettle positioned at the slag tap are hooded and vented through the slag tap baghouse. The lead well is also hooded and vented through the slag tap baghouse. Slag tap baghouse emissions were tested.

The four refining kettles and drossing enclosures located directly adjacent to each kettle are hooded and are vented through a high energy wet scrubber, the Kinpactor scrubber. The Kinpactor scrubber was sampled.

The smelter building is the center of activities at the Chloride Metals plant and would be assumed to be the primary source of emissions due to vehicular movement and process operations. Smelter building emission rates for arsenic, lead, cadmium, and particulate were determined but in addition concentrations of arsenic, lead, and cadmium were determined in the smelter building near the refining kettles and near the slag tap and lead well at the blast furnace.

4.3 STATIONARY SOURCES

Two stationary sources, the slag tap baghouse and the Kinpactor scrubber, were sampled at Chloride Metals.

4.3.1 Slag Tap Baghouse

Fugitive emissions collected by hooding systems on the slag tap and lead well at the blast furnace are vented through the slag tap baghouse. The baghouse is located just east of the smelter building. The exhaust fan with a short vent stack is mounted on the side of the baghouse.

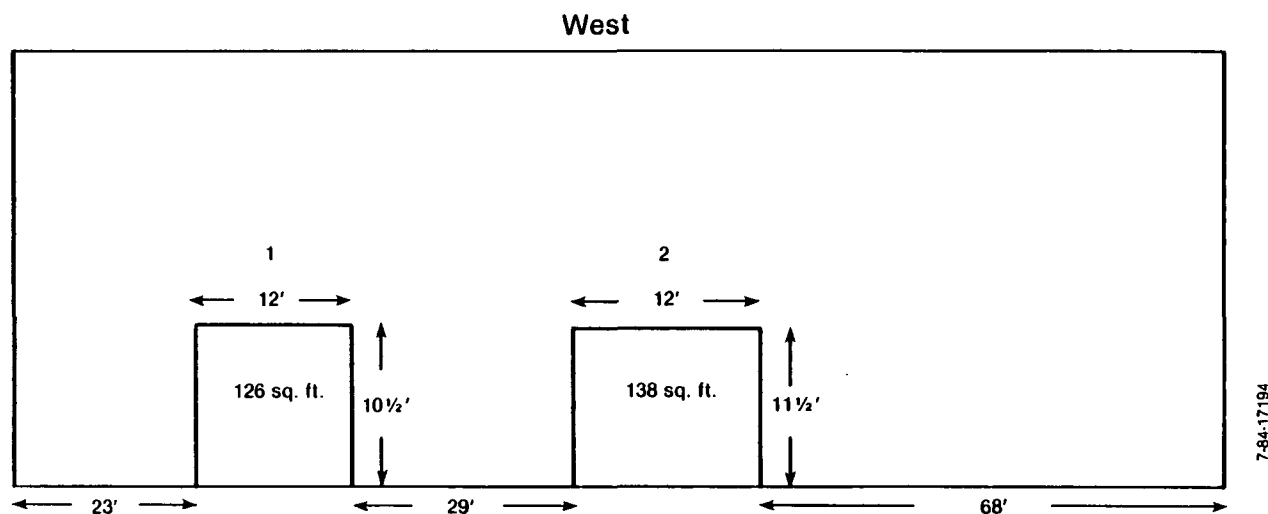
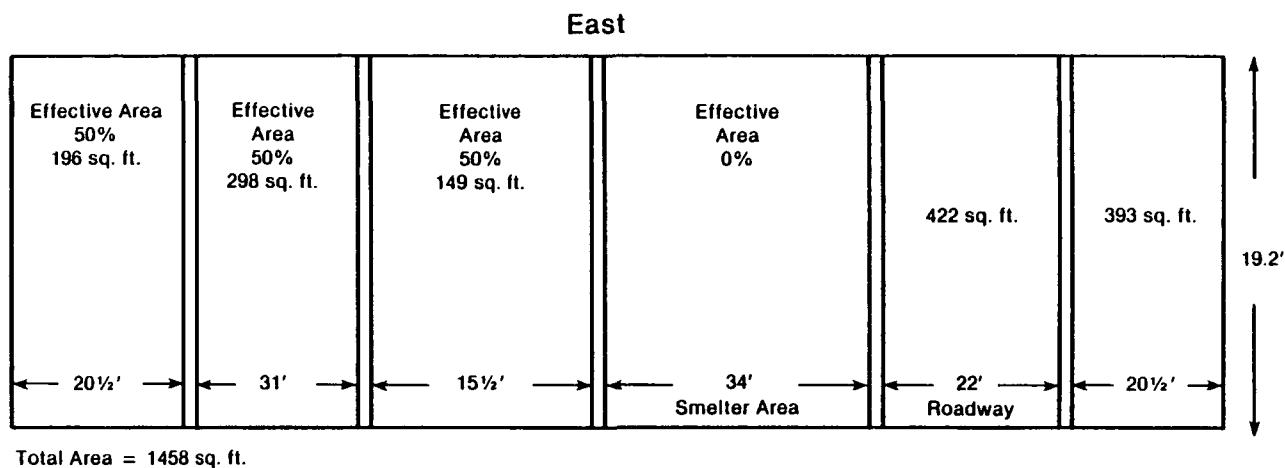
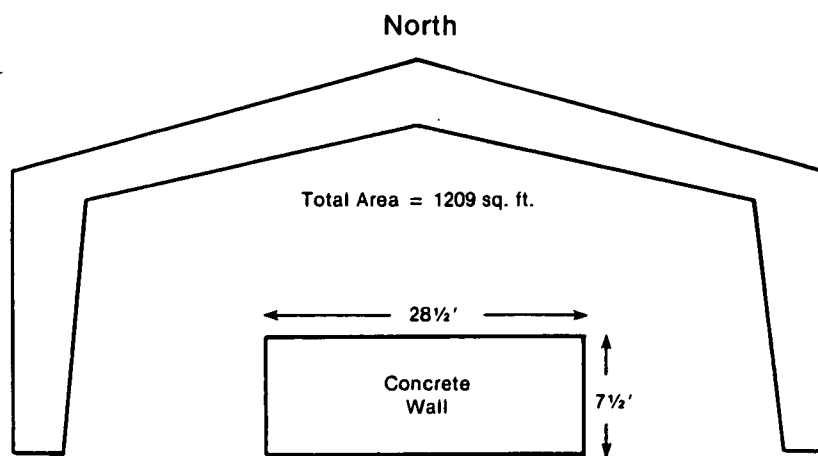
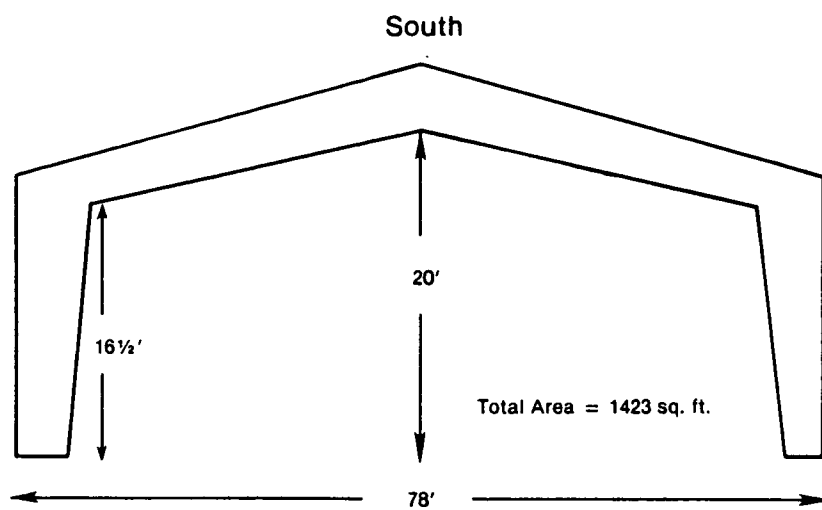


Figure 22. Smelter building dimensions and effective emission areas of openings.



7-84-17194

Figure 22. (Continued)

One 3-inch port in the vent stack was accessible from the top of the baghouse. The inside diameter of the circular stack was 19 1/2 inches.

4.3.2 Kinpactor Scrubber

The refining kettles and dross bins are hooded and vented through a high energy wet scrubber, the Kinpactor scrubber. Scrubber emissions are vented through a stack mounted on top of the scrubber.

One 3-inch port was available for testing on the stack. The port had no access and scaffolding had to be erected to reach the sampling port. The diameter of the circular stack was 22 inches.

SECTION 5
SAMPLING AND ANALYSIS

The following sections describe the sampling and analytical techniques used to determine arsenic, lead, cadmium, and particulate emissions at the Chloride Metals secondary lead smelter. Fugitive emission rates were determined for four area sources and the smelter building. Area sources are defined to be open, unconfined definable process operations areas. Point source emissions were determined on two stacks. Concentrations of arsenic, lead, and cadmium were determined in the smelter building.

5.1 SAMPLING TECHNIQUES

Sampling techniques for determining fugitive particulate emission rates and point source emissions are described in the following sections:

5.1.1 Fugitive Emissions Sampling Techniques

The following sections describe the fugitive emissions measurement techniques.

5.1.1.1 Exposure Profiling Technique--

Area source fugitive emissions were measured using the exposure profiling technique.

Sampling Approach--The exposure profiling technique was used to measure fugitive particulate emissions from the following area sources:

- slag/dross storage,
- raw materials storage,

- battery breaking area, and
- roadway

The exposure profiling method was originally developed by MRI (1) to measure particulate emissions from specific open sources. As developed, the method utilized the isokinetic profiling concept which is the basis for conventional source testing. For measurement of nonbuoyant fugitive emissions, samplers are distributed over a vertical plane positioned just downwind from the source to measure particulate concentrations in the plume from that source. Sample intakes are pointed into the wind, and the sampling velocity is adjusted to match the local wind speed, as monitored by an anemometer in close proximity to the source and samplers. A vertical line grid of samplers is sufficient for measurement of emissions from line or moving point sources while a two-dimensional array (vertical and horizontal) of samplers is required for measurement of area source emissions.

During this program, area sources were tested which necessitated the use of multiple samplers to measure particulate concentrations in both the vertical and horizontal dimensions of the plume from the source. Also, due to budgetary limitations, isokinetic sampling was not attempted. The most important criteria for performance of the exposure profiling method are locating the samplers downwind of the source and having the samplers face into the wind in-line with the source. Those criteria were met in this program by monitoring wind direction and wind speed within the source area and adjusting the location of the samplers accordingly.

During testing at Chloride Metals, the wind speed ranged from 2.8 to 7.7 miles per hour. Sampler flow rates typically ranged from 40 to 60 cubic feet per minute. At those sampling rates, the filter face velocity is 1.0 to 1.3 miles per hour. As discussed previously, because of the small size of particulate emissions, the bias of subisokinetic sampling is minimal.

The exposure profiling technique is designed to measure particulate emissions. In this program, arsenic, lead, and cadmium emissions were also

determined by analyzing the filters for those three elements. The elemental concentrations were handled in the same manner as particulate concentrations to determine emission rates for arsenic, lead, and cadmium.

As the application of the exposure profiling was conceived, samplers were to be distributed over a sufficiently large portion of the plume from an area source to define vertical and lateral boundaries of the plume by spatial extrapolation of exposure measurements. During the performance of the testing effort, the location of samplers was primarily dictated by buildings and/or other obstructions at or near the boundary of the area source and by traffic patterns in the area. As a general rule, samplers were located on or very near the defined boundary of the area source being tested. The samplers were positioned as far from obstructions as possible to reduce the influence of wake effects at the sampler.

Samplers used to determine particulate concentrations during exposure profile method testing were hi-volume ambient samplers marketed by General Metal Works. Three hi-volume filter samplers including a filter plate, motor, and housing with orifice plate were positioned at heights of 4 feet, 8 feet, and 12 feet. The three samplers were attached to a structure of angle iron mounted on a wooden pallet. The timer and flow rate monitors for the hi-volume samplers were attached to the base of the angle iron structure. The structure mounted with the hi-volume samplers and associated timers and flow meters is termed a pole sampler and is depicted in Figure 23.

During the testing of an area source, at least two and usually three pole samplers were positioned downwind of the area source and one upwind of the source. Prior to sampling, a wind direction sensor and an anemometer were stationed near the sampling area, and the wind direction monitored for approximately 30 minutes to establish the wind direction prior to locating the pole samplers. Wind speed and wind direction were monitored over the entire testing period. The wind direction sensor and anemometer were positioned at a height of 10 feet.

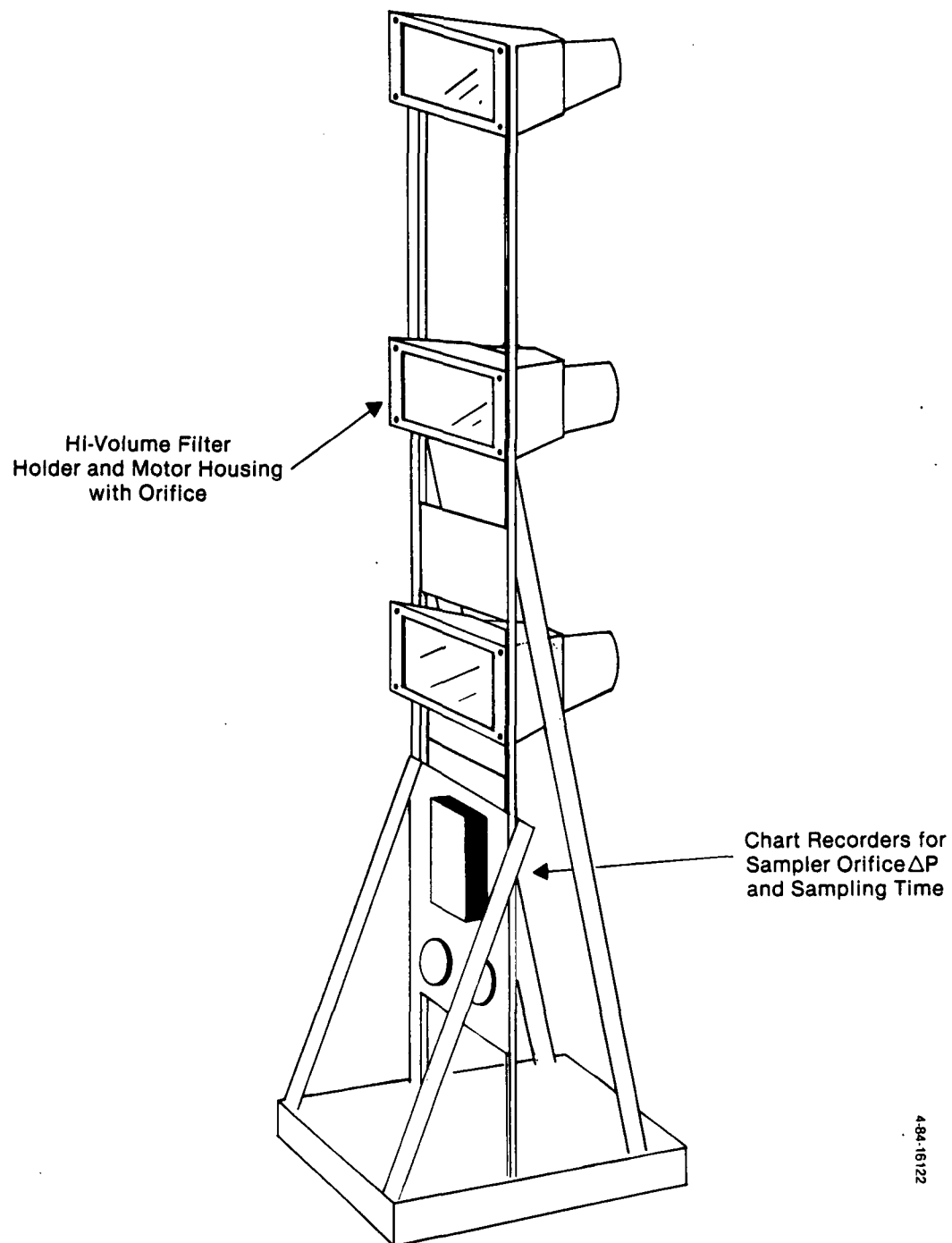


Figure 23. Exposure profiling pole sampler with three total suspended particulate samplers.

Once the pole samplers were positioned, a disk chart was loaded into the hi-volume samplers timer and flow rate monitors, and the hi-volume samplers were loaded with filters. To facilitate filter loading and unloading, the 8-inch by 10-inch filters were contained in filter cartridges. During sampling, the pole samplers and area source were constantly inspected to spot operating problems with the samplers and to document operations within the area being tested. Each hi-volume sampler required 6 to 7 amps of 110 volt electrical power so each pole required about 20 amps, 110V. Considerable problems were experienced with overloading of electrical circuits. These problems were solved over the course of the testing effort.

Typically, the sampling time for determination of area source fugitive emissions was about 6 hours. However, sampling times varied from about 4 hours to about 8 hours. The length of time necessary to collect a representative sample is the result of collecting enough particulate matter to be accurately weighed and sampling over a sufficient period of time to average process fluctuations or process area activities.

Other considerations are the conditions that had been specified that would negate measurements. Those criteria are:

- rainfall in sufficient quantity to wash or knock particulate matter from the filter (only a mist could be tolerated); and
- a change in wind direction of 90° from the wind direction established at the start of sampling. Short-term wind shifts (variability) were not allowed to negate results; only a consistent, well-defined shift in the wind direction of 90° or more.

Fortunately, no tests were negated due to these criteria. There was no rain over the three-week test period. On one or possibly two occasions, wind shifts did cause sampling to be terminated, but the sampling time was adequate for representative collection.

Eight pole samplers were constructed to perform the testing effort at Chloride Metals. Usually two, but at times three, area sources were tested simultaneously. Two met (meteorological) stations were used during the program to allow concurrent measurement of wind speed and wind direction in two areas.

During the exposure profiling testing for fugitive particulate emissions from area sources, the size distribution of suspended particulate matter was measured. Particle size distribution measurements were performed using a Sierra Model 235 five-stage cascade impactor designed for ambient applications. The impactor attaches to a standard hi-volume sampler in like manner to fitting a total particulate filter to a hi-volume sampler. The Sierra Model 235, as all cascade impactors, aerodynamically sizes suspended particulate into discrete size ranges. The particle size cut-points for the Model 235 ambient cascade impactor are presented in Table 24. During this program, the samplers were operated near 40 cubic feet per minute. Sized particulate was collected on glass fiber filter substrates to facilitate sample recovery and provide for more accurate weighing of the mass weight gain.

Three of the eight pole samplers were outfitted with ambient cascade impactors for particle size distribution measurements at the four foot level. Metal cross members were attached horizontally and hi-volume samplers were mounted on each end of the cross members. The samples were located four feet from ground level and eight feet apart.

Particle size distribution measurements were performed at both upwind and downwind sampling sites for each area source. Since there were only three cascade impactors and usually two area sources were sampled concurrently, upwind and downwind samples were not collected simultaneously during all test periods.

Data Reduction--Data reduction to determine area emission rates was performed using an adaptation of the methodology described by Schwitzgebel (2).

TABLE 24. SIERRA MODEL 235 FIVE-STAGE IMPACTOR PARTICLE SIZE CUT-OFFS (MICRONS)^a

Stage Number	Flow Rate	
	40 cfm	20 cfm
1	7.2	10.2
2	3.0	4.2
3	1.5	2.1
4	0.95	1.4
5	0.49	0.73

^aCut-offs at 50% collection efficiency for spherical particles with unity mass density @25°C and 760 mm Hg.

The approach is a ventilation model in which area source emission rates are determined as a function of the height of emissions, the width of the ventilated area, and the wind speed. As depicted in Figure 24, emissions per unit time are assumed to equal the concentration contained in a rectangle defined by a ventilation base (V_b) on the x-axis, the wind speed (v) on the y-axis, and the height (h_{max}) on the z-axis, which is selected in such a way that the vertical concentration approaches zero.

The ventilation base is the width of the effective area source defined by the average wind direction during the sampling period. The dimension of the ventilation base was determined graphically as shown in Figure 25. The wind vector is the average wind speed during the sampling period and measured in or very near the area source. The lead concentration at any height is defined as a function of that height and decreases with increasing height.

With these definitions, the contribution of a horizontal segment at height h and the thickness H can be described as follows:

$$AE_{h,h+\Delta h} = C(h) \cdot \Delta h \cdot v \cdot V_b \quad (1)$$

where, $AE_{h,h+\Delta h}$ = area emissions by the segment between h and $h + \Delta h$

v = wind speed

V_b = ventilation base

$C(h)$ = concentration at height h

h = vertical dimension of ventilated segment.

Schwitzgebel forced the concentration results as a function of height to be a linear function to define the concentration at ground level (C_{h_0}) and the height at which the vertical concentration is zero (h_{max}). With these factors, the area emission rate would be determined by:

$$AE = 1/2 C_{h_0} \cdot h_{max} \cdot v \cdot V_b \quad (2)$$

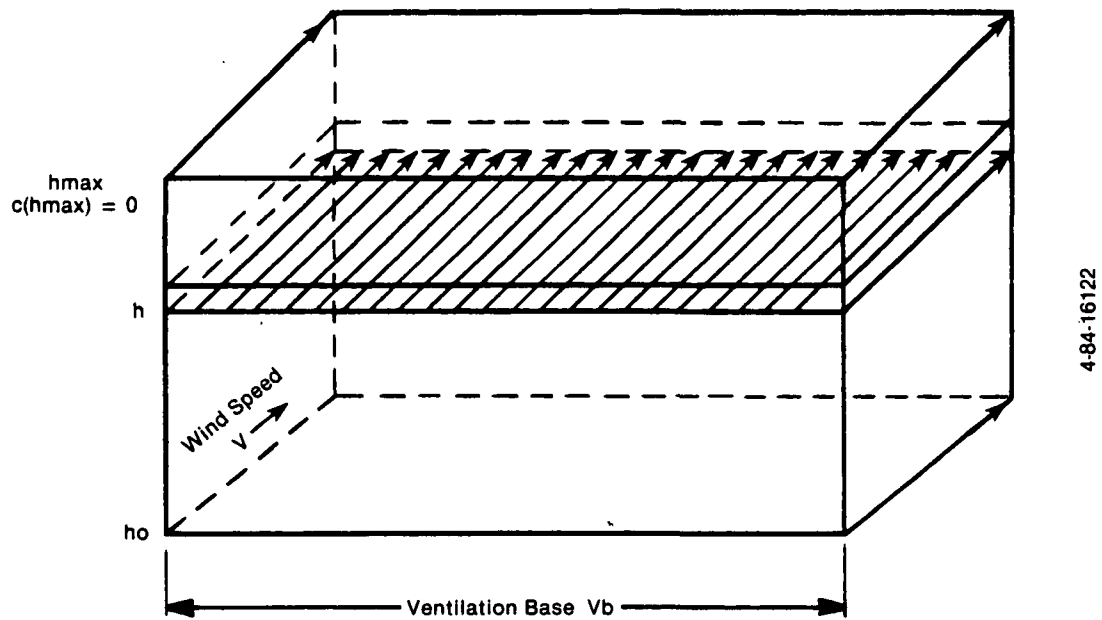


Figure 24. Ventilation model.

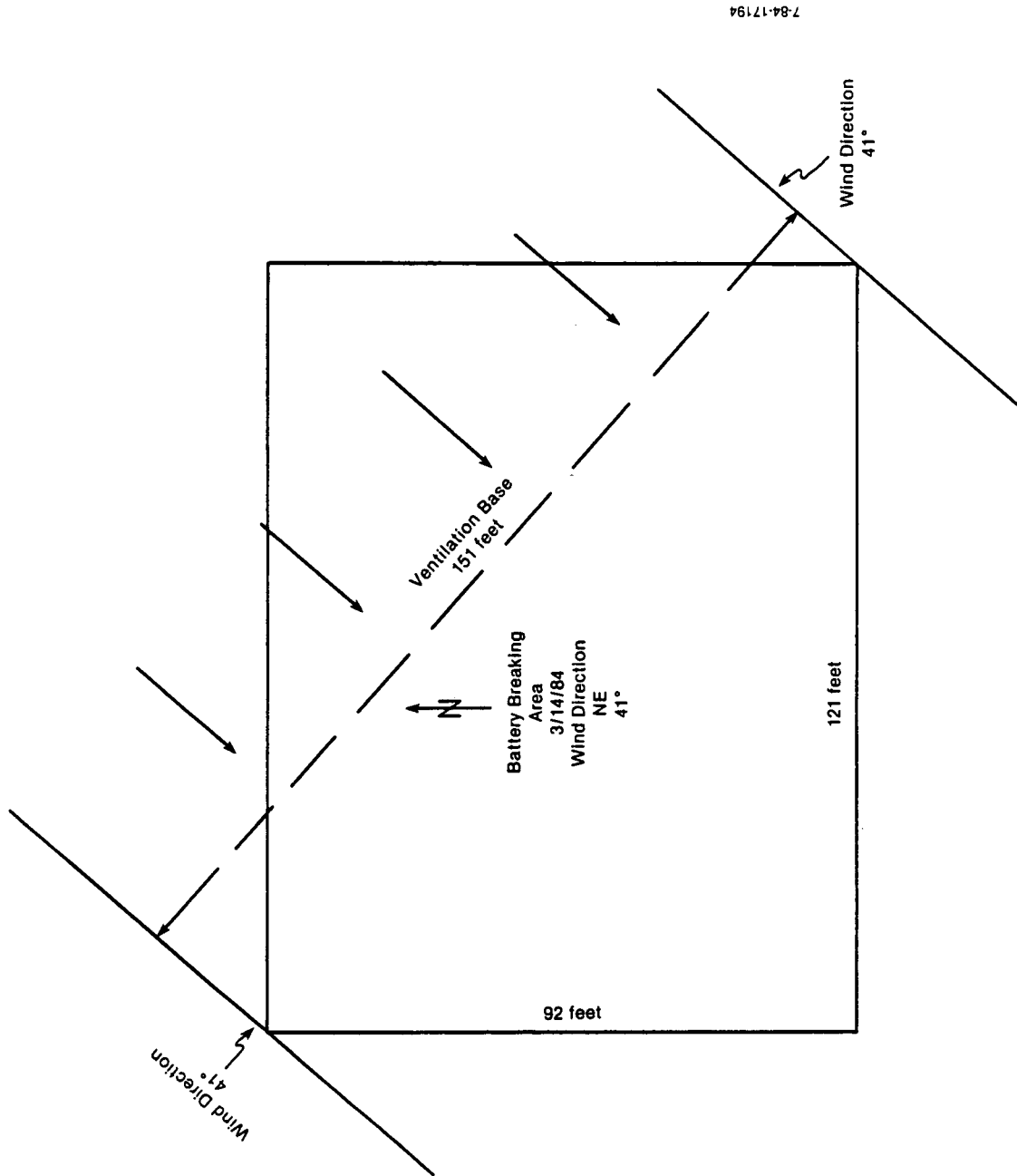


Figure 25. Determination of ventilation base dimensions.

In this program, the measured concentration data for each pole sampler were fitted to a normal curve (actually one-half of a normal curve) as shown in Figure 26. The area of the curve was determined by integrating under the curve to determine the factor $[C(h) \cdot \Delta h]$ in Equation 1, i.e., $\text{Area } (\mu\text{g}/\text{m}^2) = \text{concentration } (\mu\text{g}/\text{m}^3) \cdot \text{height (m)}$. The curve areas for all downwind sampling locations during a sampling period at a given source were averaged and multiplied by the average wind speed in the area source during the sampling period to determine the flux rate ($\mu\text{g}/\text{m}\text{-sec}$). The flux rate is then multiplied by the ventilation base to determine the emission rate.

5.1.1.2 Smelter Building Emissions Measurements--

Arsenic, lead, cadmium, and particulate emissions from the smelter building were measured by applying the pole samplers described in the previous section. Initially wind flow patterns through the smelter building were observed to determine in and out wind flow of the building. One pole sampler was located just outside of the smelter building at a point of flow into the building, i.e., upwind. Two to three pole samplers were located at the edge of the building at locations of wind flow from the building, i.e., downwind.

During the testing period, the air velocity was measured at a series of matrix points at building openings. A Kurz Model 441 M air velocity meter was used to measure air velocity. The meter utilizes a hot-wire anemometer which consists of a velocity sensor and a temperature sensor. The velocity sensor is heated and operated as a constant-temperature thermal anemometer which responds to velocity by sensing the cooling effect of the air as it passes over the heated velocity sensor. The wind direction, i.e., in or out, was also noted. The measured air velocities were related to respective building opening areas to determine the air flow rates into and out of the smelter building. Smelter building dimensions and effective emission areas of building openings used to calculate air flow rates are shown in Figure 22. The smelter building air flow rates are presented in Appendix D.

The concentrations of arsenic, lead, cadmium, and particulate measured at three heights at smelter "downwind" sites typically did not demonstrate a decrease in concentration with an increase in height. More often concentrations increased as height increased. This is understandable due to the heating of building air by the blast furnace and refining kettles in the smelter building. For these reasons the concentrations of building emissions were not integrated as a function of height, but instead, an average concentration was calculated for each of the four species.

The smelter building emission rates were calculated by relating the concentration of each species to the air flow rate at the building opening. In some cases, concentration results were not available for all building openings and data from a near location measured at the smelter building were applied to that opening.

5.1.2 Smelter Building Concentrations Method

Concentrations of arsenic, lead, and cadmium were measured in the smelter building in the vicinity of the blast furnace and the refining kettles. Measurements were taken using a membrane filter and an orifice sampler to control and measure flow.

The filters used were 37 mm Millipore MF-type membrane filters having a 0.8 pore size. The filters were contained in a plastic cassette which affixed directly to the orifice sampler shown in Figure 27. The orifice sampler included a calibrated, critical orifice. The critical orifices are interchangeable. During this program, critical orifices had a flow rate of 4.9 liters per minute at a pressure drop of 16 inches of mercury vacuum. The vacuum drop across the critical orifice was maintained by a double-diaphragm pump equipped with a vacuum gauge to monitor the line vacuum. Heavy-walled rubber vacuum hose was used to connect the sampler to the pump.

Samples were collected concurrently at heights of 2 feet, 4 feet, and 6 feet. The samplers were attached to a single vertical standard affixed to a

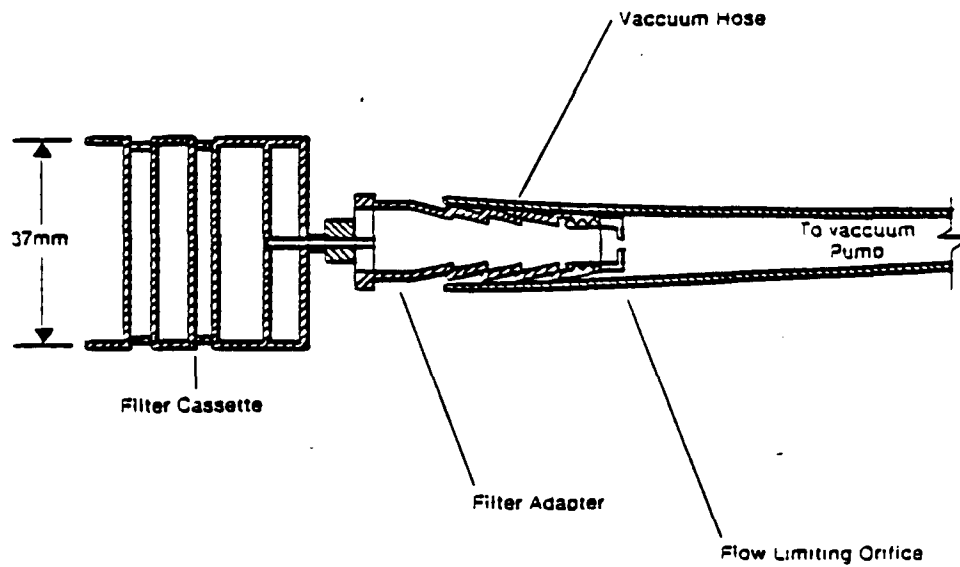


Figure 27. Critical orifice sampler with filter cassette.

board base. All three samplers were manifolded to a single pump to maintain the pressure drop of the critical orifices.

Measurements were taken near the refining kettles during the following process steps:

- production of hard lead (high arsenic),
- production of soft lead,
- lead casting, and
- drossing.

Measurements were also taken near the slag tap and lead well of the blast furnace.

5.1.3 EPA Method 108

EPA Method 108 is an Appendix B test method developed to determine particulate and gaseous arsenic emissions from stationary sources. The method was used to quantify arsenic emissions from the slag tap baghouse (slag tap and lead tap hoods) and the high energy wet scrubber through which off-gases from the refining kettle and drossing hoods are vented.

The method was applied without deviation as printed in the Federal Register, Vol. 48, No. 140, Pages 33166-33172, July 20, 1983. Sample gas was drawn isokinetically through a gooseneck nozzle, a heat-traced, glass-lined probe, and a glass fiber filter maintained at a temperature of 230° to 275°F for particulate collection. The sample then passed through a chilled impinger train for gaseous arsenic and SO₂ collection. The first two impingers contained water for gaseous arsenic collection. The third, fourth, and fifth impingers contained 10% H₂O₂ for SO₂ collection. The filter, the probe wash, and the water impinger solutions were analyzed for arsenic.

The samples collected from the wet scrubber and slag tap baghouse were also analyzed for lead and cadmium. Method 108 may produce low gaseous lead

and cadmium results because of inefficient collection of lead and cadmium in the water impingers. The solution for arsenic collection in Method 108 is water while EPA Method 12 calls for 0.1 N HNO₃ for collection of gaseous lead. There is no protocol procedure for cadmium.

5.2 ANALYTICAL METHODS

All total particulate loading filters and a representative portion of size distribution filter substrates collected during fugitive emissions testing were analyzed for arsenic, lead, and cadmium. In addition, the membrane filters collected in the smelter building and Method 108 samples were analyzed for the three metals.

5.2.1 Arsenic, Lead, Cadmium Analysis

Following sections describe the dissolution technique and instrumental methods followed for the analysis of arsenic, lead, and cadmium.

5.2.1.1 Dissolution Technique--

As stated in Section 5.1.1.1, the 8-inch by 10-inch total suspended particulate filters used for the exposure profiling and smelter building emissions were loaded into filter cartridges which in turn were attached to the hi-volume sampler. After sample collection, the filter cartridge was returned to the mobile laboratory for sample retrieval. As the filter was removed, it was folded in half, face-to-face and inserted in an envelope. The filters were conditioned and weighed on site. At Radian laboratories the exposed area of the filters was quartered, and one-quarter of the filter was analyzed for arsenic, lead, and cadmium. There is a possibility that one-quarter of the filter is not representative of the whole filter if particulate was not homogeneously distributed over the filter. To address that potential problem, two quarters of some filters were analyzed individually.

For the analysis of the membrane cassette filters, particle size distribution filter substrates, and the Method 108 filter, the whole filter was digested for analysis. The Method 108 impinger solutions were analyzed directly.

The filter samples for analysis were first digested to get the elements into solution for instrumental analysis. The filter was placed in a beaker and 5 milliliters of concentrated nitric acid and 5 milliliters of concentrated hydrochloric acid were added to the beaker. The beaker was then heated for one hour. Water was then added to the beaker and heated for another hour. The solute was then transferred to a volumetric flask and taken to volume. Prior to instrumental analysis, the sample solute is filtered.

5.2.1.2 Instrumental Analysis--

Filter dissolution samples and impinger solutions were analyzed for arsenic, lead, and cadmium using atomic absorption spectroscopy. Arsenic was analyzed using a hydride generation attachment for the atomic absorption spectrophotometer. An aliquot of the sample is introduced into the system and acidified. Sodium borohydride is added to reduce the arsenic to the hydride, and the generated gas is purged into a hydrogen-argon flame for analysis. The detection limit for arsenic by the hydride generation technique is 0.003 $\mu\text{g/ml}$ (ppmv).

Samples were analyzed for lead using flame atomic absorption spectroscopy. An air-acetylene flame was used as the source for excitation. The detection limit for lead by the flame atomic absorption spectroscopy method is 0.1 $\mu\text{g/ml}$.

The analysis of cadmium was performed by graphite furnace atomic absorption spectroscopy. The detection limit for cadmium by the graphite furnace atomic absorption spectroscopy technique is 0.002 $\mu\text{g/ml}$.

5.2.2 Filter Weighings

All filters including 8-inch by 10-inch hi-volume filters used in the exposure profiling technique, glass fiber substrates used for ambient particle size distribution measurements, and the filters used in the Method 108 testing, were weighed before and after testing to determine particulate weight gain. The 37 mm cassette filters were not weighed, and the particulate weight gain was not determined.

5.2.2.1 Filter Conditioning--

The 8-inch x 10-inch hi-volume filters and the glass fiber substrates for particle size measurements were conditioned prior to all weighings following the protocol of EPA ambient air monitoring guidelines (4). Prior to weighing, the filters were equilibrated for 24 hours in a conditioning environment controlled by a constant humidity chamber. The chamber controlled temperatures to 20 to 25°C $\pm 3^\circ\text{C}$ and maintained the relative humidity below 50 percent. The ambient air monitoring guidelines require that the relative humidity vary by no more than 5 percent between weighings.

Filters used in the Method 108 testing were baked at 260°C and then dessicated and weighed to a constant weight (± 0.5 mg).

5.2.2.2 Instrument--

Filter weights were determined using a Mettler AE 163 electronic analytical balance. Weighings were made to the nearest 0.1 milligram. Weighings were performed at the plant site in a mobile laboratory.

SECTION 6
QUALITY ASSURANCE

Emission test program quality assurance/quality control guidelines are developed to ensure the production of acceptable and representative data. The performance of a successful quality assurance program provides the following:

- the detection of problems in the sampling and analytical tasks;
- the determination of estimates of precision and accuracy;
- the proper documentation of procedures and methods used in the emissions test program.

Following sections describe the quality assurance activities performed for the Chloride Metals emission test program.

6.1 SAMPLING QUALITY ASSURANCE

Radian implemented quality assurance procedures during all sampling activities. Quality assurance procedures were performed for the three sampling techniques followed during the Chloride Metals emissions test program:

- exposure profiling technique for area fugitive emissions;
- EPA Method 108 for stationary sources emissions; and

- workplace sampling for smelter building concentrations.

The quality control procedures implemented during the sampling program prescribed guidelines for:

- equipment calibration;
- sampling protocol; and
- sample handling techniques.

The major emphasis on quality control for sampling was strict calibration of gas metering systems, wind monitors, temperature control devices, leak testing, and documentation.

Of primary concern was that the sampling equipment be in proper operating condition prior to and during sampling. In order to achieve this, equipment was inspected and cleaned thoroughly prior to the field effort, monitoring devices were checked and calibrated, and volume measurement devices were calibrated prior to sampling. All calibrations were properly documented and retained. During sampling, equipment was monitored continuously for proper operation.

6.1.1 Equipment Calibration

All of the sampling techniques performed at Chloride Metals required flow monitoring and temperature sensing equipment. Table 25 presents a summary of the equipment which was calibrated for the emissions test. The accurate measurement of sample volumes is one of the most critical criteria for assuring proper sample collection. During the Chloride Metals emission test program, sample volume metering devices used included hi-volume samplers, critical orifices, and dry gas meters.

The hi-volume samplers used in this program are identical to ambient air monitoring systems except that the samplers are not contained in an all-weather housing. The flow monitoring system, ΔP transducer, and timer are

TABLE 25. SUMMARY OF CALIBRATED EQUIPMENT USED IN SAMPLING AT CHLORIDE METALS

Parameter	Method	Calibrated Equipment Used in Measuring Parameters							
		Type-S Pitot Tube	Differential Pressure Gauge	Temperature Measuring Device	Gas Metering System	Sampling Nozzle	Fyrite	Anemometer/ Vane or Hot-Wire	Wind Direction Sensor
Volumetric Gas Flow Rate	EPA-1, EPA-2	*	*	*					
Molecular Weight	EPA-3						*		
Moisture	EPA-4		*	*	*				
Particulate & Gaseous Arsenic	EPA-108	*	*	*	*	*			
Particulate	Exposure Profiling		*		*				
Particulate	Critical Orifice Sampler				*				
Wind Speed	Exposure Profiling							*	
Wind Direction	Exposure Profiling								*

identical. Each of the hi-volume gas metering systems (a total of 27 were operated simultaneously) was calibrated at Radian prior to the emissions test program according to methods published in Quality Assurance Handbook for Air Pollution Measurement Systems Volume II - Ambient Air Specific Methods (3). The timers were not calibrated over a 24-hour period because sampling periods were 8 hours or less and because start and stop times were recorded. Calibration data were recorded and the data retained. Following the emissions test program, a single-point calibration check was performed on the hi-volume samplers. The test plan had established an acceptable calibration check to be within 5% of the initial multi-point calibration data. The posttest calibration results were within acceptable limits for all but three of the hi-volume samplers. For those samplers which had posttest calibrations outside of the 5% limit, the pretest and posttest calibration results were averaged, and that value was used in sampling volume determinations. The posttest results and respective pretest results are presented in Table 26.

Critical orifice samplers were used to measure smelter building concentrations. The six critical orifices used during this program were calibrated against an NBS traceable-calibrated wet test meter. The calibration data were dutifully recorded and the records retained.

The dry gas meter used in the EPA Method 108 train was calibrated in conformance to EPA's publication Quality Assurance Handbook for Air Pollution Measurement Systems Volume III - Stationary Source Specific Methods (4). Calibration was performed over a range of flow rates as suggested in the EPA publication and calibration correction factors for the gas meter and orifice meter in the sampling unit were calculated according to suggested procedures. A posttest calibration was performed at the completion of the program. All calibration results were documented using EPA prescribed forms and the results retained.

TABLE 26. HI-VOLUME SAMPLER CALIBRATION CHECKS

	Serial No.	SCFM Pretest	Plate No.	SCFM Posttest	% Difference
1B	12516	56.9	(13)	56.9	0.0
1M	9711	59.7	(13)	59.4	0.5
1T	12635	46.7	(13)	47.7	2.1
2B	13241	57.2	(13)	58.8	2.8
2M	12531	59.7	(13)	59.4	0.5
2T	13229	57.5	(13)	57.8	0.5
3B	8905	56.4	(13)	56.9	0.9
3M	9709	59.7	(13)	58.1	2.7
3T	13631	59.9	(13)	59.1	1.3
4L	9737	39.9	(7)	43.1	8.0
4R	8911	59.1	(13)	57.2	3.2
4M	12638	58.1	(13)	58.3	0.3
4T	12893	58.3	(13)	56.9	2.4
5L	14592	41.5	(7)	43.1	3.9
5R	13629	58.9	(13)	58.9	0.0
5M	12887	55.5	(13)	58.9	6.1
5T	12581	51.5	(13)	59.1	12.6
6B	9705	56.1	(13)	57.5	2.5
6M	9693	55.8	(13)	56.4	1.1
6T	12507	57.8	(13)	58.0	0.3
7B	9736	57.2	(13)	58.1	1.6
7M	9702	58.3	(13)	59.1	1.4
7T	9699	58.3	(13)	58.9	1.0
8L	13106	43.4	(7)	43.8	0.9
8R	12888	58.3	(13)	59.1	1.4
8M	15981	56.9	(13)	59.7	4.9
8T	12886	59.1	(13)	59.9	1.4

6.1.2 Sampling Protocols

Sampling techniques used during this program were EPA referenced or "state-of-the-art" methods, some with modifications to be more applicable. Sample collection was done in accordance with the methods prescribed in the Chloride Metals Test Plan (5).

QA procedure checks to be performed during exposure profiling measurements included:

- use of data forms to record start time, initial ΔP and stop time, final ΔP ;
- performance of visual inspections of sampling systems;
- performance of visual monitoring of wind direction to assure proper alignment of samplers; and
- performance of a single point posttest calibration of each hi-volume sampler.

During sample collection with the critical orifice samplers, the following QA procedures were followed:

- use of data forms to record start time, stop time, and initial, intermittent, and final sampling system pressure drop;
- routine inspection and monitoring of sampling system pressure drop; and
- performance of visual inspections of sampling systems.

The following QA procedure checks were followed during Method 108 sampling:

- use of standard data forms and source sampling data sheet checklist;
- performance of visual inspections of sampling systems,
- performance of system leak checks before and after sampling;
- performance of heating system checks;
- performance of impinger ice checks;
- performance of isokinetic sampling rate checks; and
- performance of daily data review and calculation checks.

6.1.3 Sample Handling Techniques

The objectives of a quality assurance program regarding sample handling techniques are to ensure that the integrity of collected samples is not diminished prior to analysis.

To aid in the retrieval of filter samples collected during the exposure profiling sampling, the filters were contained in filter cartridges. Filters were loaded in the cartridges in the mobile laboratory on site. After sample collection, the filter cartridges were returned to the mobile laboratory for retrieval of samples in an enclosed, controlled environment, having no wind currents.

After samples have been properly obtained in the field, their subsequent handling during transfer to the analytical laboratories becomes an important factor in the successful performance of an emissions characterization

program. All collected samples were labeled at the time of sample collection with adequate descriptions of the samples to prevent confusion among multiple samples, and the sample numbers were entered into a logbook. Samples were inventoried against logbook records prior to shipment.

Samples submitted to Radian Analytical Services Laboratories included a chain-of-custody report to document the receipt of samples and to have a mechanism for tracking the samples through the analyses. The completed chain-of-custody reports used in this project are included in Appendix I.

6.2 ANALYTICAL QUALITY CONTROL

Analytical quality control was performed by ongoing quality control activities in Radian Laboratories and also by project specific quality control activities.

6.2.1 Radian Laboratories Quality Control

A standard regime of analytical quality control is followed routinely by Radian laboratories. The procedures use various checks in order to determine the validity of analyses. These include:

- calibration standards,
- certified standards,
- in-lab standards,
- blanks,
- spikes, and
- replicates.

Quality assurance begins with the sample log and carries through the reporting of data.

The unique identifying number assigned in the field and recorded in the sample log facilitates tracking and identification and prevents mix-ups

during the analysis process. A chain-of-custody report is used to monitor the samples through analytical laboratories.

Chemical characterization of samples was performed using standard atomic absorption spectrophotometry (AAS) and digestion techniques.

The accuracy and precision of these analyses in Radian's laboratories are documented through ongoing QA-QC programs. Accuracy is evaluated by analyzing standards and blind, spiked samples. Precision is monitored by replication of analysis on 5 to 15 percent of samples to establish background concentration and potential interferences.

6.2.2 Project-Specific Quality Control

Project-specific analytical quality control activities involved two major criteria. First, the samples were submitted in three sets. In this project, there were 376 filters and 21 EPA Method 108 samples analyzed for arsenic, lead, and cadmium. To facilitate monitoring of results and identification of any analytical problems, three groups of samples were submitted to the laboratories, with only one group of filters being in the lab at a given time. Analytical results were reviewed before another group of filters was submitted to the lab.

Second, with each group of samples, NBS certified standards for lead were submitted for analysis. The lead standard (SRM 2674) is a set of three filter strips with lead loadings of 100, 303, and 1505 $\mu\text{g}/\text{filter}$. In addition, each group of filters submitted for analysis included blank filters for background correction. Table 27 presents the results of analysis of the NBS lead standard filters submitted with the three sets of filters. The accuracy of the analysis of the first set of filters was rather poor. However, the results of the last two sets of filters were quite good. The quality control results of the first set of filters were below acceptable limits for lead analysis by atomic absorption spectroscopy. Due to budgetary constraints and because the objectives of the program were to develop

TABLE 27. RESULTS OF ANALYSIS OF LEAD QUALITY CONTROL STANDARD^a

	Lead Content ($\mu\text{g}/\text{filter}$)			Relative Accuracy %
	Average Value	Tolerance Limits	Measured Value	
1st Set	100	97-103	75	75
	303	294-312	190	63
	1505	1477-1533	1010	67
2nd Set	100	97-103	47	47
	303	294-312	290	96
	1505	1477-1533	1500	99+
3rd Set	303	294-312	290	116
	1505	1477-1533	1500	99+

qualitative more than quantitative emission rates, the analyses were not repeated.

In preparation for analysis, the exposed area of the 8-inch x 10-inch exposure profiling filters were cut into four equal sections. One-quarter of the filter was submitted for analysis. In response to the concern that one-quarter of the filter would not provide a representative sample because of non-homogeneous distribution of particulate on the filter, analyses for arsenic, lead, and cadmium were performed on two quarters of 24 filters. The results of analysis of these filters are presented in Table 28.

The relative difference in the analysis of lead for 24 duplicate filters was $\pm 12.6\%$ with an average concentration of $28.7 \mu\text{g}/\text{m}^3$. That difference is based upon the ambient sample concentration and is more correlatable to emission rate results. The precision of filter analysis for lead is quite good. The relative difference between analysis of filters for arsenic and cadmium is $\pm 24.6\%$ and $\pm 64.5\%$, respectively, with average concentrations of $0.180 \mu\text{g As}/\text{m}^3$ and $0.042 \mu\text{g Cd}/\text{m}^3$. While the precision of filter analyses for arsenic and cadmium is considerably less than for lead, the results indicate that precision is directly related to the concentration of the element on the filter.

Mass weight gains were determined on all 8-inch x 10-inch hi-volume filters and the impactor substrates used in the exposure profiling sampling. These filters were conditioned for 24-hours prior to weighing in a constant humidity chamber. The filters were conditioned at a constant humidity maintained below 50 percent, and the humidity could not vary by more than 5 percent between initial and final weighings.

To document that proper weighing procedures were being followed and that the methodology was precise, blank filters were weighed on two occasions after conditioning for 24-hour periods. The results of those weighings are presented in Table 29. The repeatability of measurements is excellent. Filter particulate weight gains were typically in the range of

TABLE 28. RESULTS OF ANALYSIS OF DUPLICATE FILTER SAMPLES

Filter Number	Pb Concentration ($\mu\text{g}/\text{m}^3$)			As Concentration ($\mu\text{g}/\text{m}^3$)			Cd Concentration ($\mu\text{g}/\text{m}^3$)		
	Primary Sample	Duplicate	Relative Difference %	Primary Sample	Duplicate	Relative Difference %	Primary Sample	Duplicate	Relative Difference %
1st Set 028251	22.4	16.8	-25.0	0.242	0.218	-9.9	0.010	0.021	110
028214	22.8	24.0	5.3	0.196	0.215	9.7	0.013	0.021	61.5
028219	16.7	17.3	3.6	0.107	0.113	5.6	0.059	0.030	-49.2
028217	45.1	52.9	17.3	0.258	0.271	5.0	0.103	0.023	-77.7
028227	30.4	29.6	-2.6	0.084	0.076	-9.5	0.014	0.008	-42.9
028205	1.37	1.43	4.4	ND	ND		0.001	0.001	0
131149	3.66	3.45	-5.7	0.014	0.010	-28.6	0.006	0.005	-16.7
028203	1.36	1.16	-14.7	ND	ND		0.001	0.001	0
Average	18.0		± 9.8	0.150		± 11.4	0.026		± 44.8
2nd Set 131119	9.05	9.05	0	0.040	0.035	-12.5	0.004	0.005	25.0
131138	15.1	13.3	-11.9	0.070	0.064	-8.6	0.023	0.005	-78.3
131118	16.3	16.5	1.2	0.004	0.007	75.0	0.019	0.005	-73.7
131113	54.3	53.6	-1.3	0.400	0.289	-27.8	0.032	0.010	-68.8
131196	40.6	44.9	10.6	0.229	0.178	-22.3	0.119	0.130	9.2
5189665	13.8	13.8	0	0.039	0.035	-10.3	0.022	0.002	-90.9
5189638	2.14	1.49	30.4	0.010	0.007	-30.0	0.011	0.003	-72.7
5189785	28.2	26.3	-6.7	0.197	0.178	-9.6	0.038	ND	
Average	22.4		± 7.8	0.124		± 24.5	0.033		± 59.8
3rd Set 5189622	8.15	8.74	7.3	0.0105	0.0297	183	0.0204	0.0157	-23.0
5189617	3.11	3.59	15.4	0.0153	0.0134	-12.4	0.0091	0.0115	26.4
5189633	4.91	3.40	-30.8	0.0360	0.0265	-26.4	0.0159	0.0166	4.4
5189751	75.1	84.5	12.5	0.450	0.479	6.4	0.122	0.0563	-53.9
5189773	158	188	19.0	0.988	0.988	0	0.178	0.109	-38.8
5189782	82.2	100	21.7	0.516	0.569	10.3	0.137	0.078	-43.1
5189792	7.70	9.80	27.3	0.031	0.043	38.7	0.0175	0.0322	84.0
5189642	27.3	34.9	27.8	0.084	0.106	26.2	0.0137	0.0737	438
Average	45.8		± 20.2	0.266		± 37.9	0.064		± 89.0
Average (All)	28.7		± 12.6	0.180		± 24.6	0.041		± 64.5

TABLE 29. COMPARISON OF BLANK FILTER WEIGHTS

Filter No.	Initial Weight (g)	Final Weight (g)	Difference (g)	Relative Difference (%)
131139	4.0524	4.0513	0.0011	0.027
131140	4.0519	4.0517	0.0002	0.005
028225	3.5318	3.5326	0.0008	0.023
028224	3.5959	3.5963	0.0004	0.011
5189799	4.1410	4.1405	0.0005	0.012
5189800	4.1579	4.1577	0.0002	0.005
5189699	4.2685	4.2694	0.0009	0.021
5189700	4.2253	4.2259	0.0006	0.014
000072	1.4508	1.4510	0.0002	0.014
000188	1.4182	1.4182	0.0000	0
956024	1.4621	1.4624	0.0003	0.021
956027	1.4633	1.4631	0.0002	0.014
Average			0.0004	0.014

0.10 to 0.05 grams, and the average variability of duplicate filter weighings was 0.0004 grams. The variability of weighings should have no effect on particulate weight gain measurements.

6.3 DATA ANALYSIS QUALITY ASSURANCE

Quality assurance procedures for data processing activities centered on validating sampling data and using computerized data reduction systems.

Exposure profiling measurement data reduction required the following information:

- the configuration of samples relative to the area source and wind direction to determine the ventilation base of the area source and to ensure that samplers were located directly downwind of the source;
- the start time, stop time, average ΔP , and filter location and identification for each sampler to determine the volume of gas sampled; and
- the wind speed.

These data were recorded during sampling on preformatted forms presented in the test plan. In addition to the above data, wind velocities into and out of the smelter building were necessary to determine emission rates for that source.

Flux rate calculations for each pole sampler were determined by computer. Program inputs were keypunched and verified. Computer printouts of flux rates are in Appendix C.

Sampling data for the concentration measurements in the smelter building were also recorded on preformatted forms included in the test plan. The following data were recorded:

- sample location,
- filter number and height,
- start and stop times, and
- critical orifice sampler line vacuum to ensure calibration flow rates.

During Method 108 sampling of the slag tap baghouse and Kinpactor scrubber, data were recorded on field data sheets formatted for coding directly into Radian's Source Sampling Data Reduction Program. The data entered are uniquely identified by sampling location and sample identification number and serve as inputs to the data reduction program. The computerized data reduction program produces an input verification report to review the input data. Gas velocity data were also reduced by the Source Sampling Data Reduction Program. The computerized data reduction results for the slag tap baghouse and Kinpactor scrubber are in Appendix H.

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