AP-42 Section Number: 12.15

Reference Number: 6

Title: Report of Efficiency Testing Performed April 30, 1976, on American Air Filter Roto-clone, General Battery Corporation, Hamburg, PA

Fulton, R. C. and C. W. Zolna

Spotts, Stevens, and McCoy, Inc.

June 1976

STORAGE BATTERY PRODUCTION
AP-42 Section 7.15
Reference Number 4

SPOTTS, STEVENS and McCOY
CONSULTING ENGINEERS PLANNERS - SURVEYORS
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(215) 376 6581

June 9, 1976

Mr. Charles S. Mowbray
Department of Environmental Resources
16 Angelica Street
Reading, Pennsylvania 19611

Dear Sir:

On April 30, 1976, an efficiency test was performed on the American Air Filter Roto-Clone which controls emissions from various sources in the grid casting and small parts areas at General Battery Corporation, Hamburg, Pennsylvania. Enclosed are two copies of the Report of the testing which shows that particulate emissions from the unit during the test period were 0.930 pounds per hour or 0.0026 grains per dry standard cubic foot. This value is well below the allowable particulate concentration of 0.04 grains per dry standard cubic foot.

Lead emissions were shown to be 0.285 pounds per hour. The particulate removal efficiency was determined to be 31.6%; the lead removal efficiency during the test period was 2.1%.

If you have any questions concerning the testing or the contents of the Report, please call this office.

Very truly yours,

Ronald C. Fulton

RONALD C. FULTON
Project Engineer

RCF:dd
Enclosures: Two copies of Report
cc: Mr. Michael Capozzi
General Battery Corporation
File: 1014-001

REPORT OF EFFICIENCY TESTING
PERFORMED
APRIL 30, 1976
ON
AMERICAN AIR FILTER ROTO-CLONE

GENERAL BATTERY CORPORATION
HAMBURG, PENNSYLVANIA

REPORT SUBMITTED
JUNE 1, 1976

SPOTTS, STEVENS and McCOY, Inc.
CONSULTING ENGINEERS
PLANNERS - SURVEYORS

Order No.
1014-001

Testing conducted April 30, 1976 by:

Daniel G. Dellicker
Ronald C. Fulton
Daniel P. Resh, Jr.
Geoffrey W. Zolna

Results calculated and checked by:

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David W. Wolfe

Report prepared by:

Ronald C. Fulton
Geoffrey W. Zolna

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REPORT
OF
EFFICIENCY TESTING
ON
AMERICAN AIR FILTER ROTO-CLONE

GENERAL BATTERY CORPORATION
HAMBURG, PENNSYLVANIA

I. INTRODUCTION

In order to show compliance with the provision of Chapter 123.13 of the Rules and Regulations of the Department of Environmental Resources, to determine the efficiency of operation and to determine the amount of lead emissions, stack tests were performed simultaneously at the inlet and outlet of the American Air Filter Roto-Clone which controls the emissions from the grid casting area at General Battery Corporation, Hamburg, Pennsylvania. The tests were conducted in accordance with the provisions of Chapter 139 of the Rules and Regulations.

II. SUMMARY

On April 30, 1976, tests were taken simultaneously at the inlet and outlet of the recently installed American Air Filter Roto-Clone. The emission test taken at the outlet showed a particulate concentration of 0.0026 grains per dry standard cubic foot. This concentration is well within the Department of Environmental Resources standard of 0.04 grains of particulate per dry standard cubic foot. A comparison of particulate concentrations at the inlet and outlet of the Roto-Clone showed that the unit was operating at an efficiency of 31.6%. The lead emission rate was found to be 0.285 pounds per hour and the Roto-Clone efficiency was 2.1% with respect to lead reduction in the emissions.

III. PERTINENT STANDARDS

Under Commonwealth of Pennsylvania, Title 25 - Rules and Regulations, Part I - Department of Environmental Resources, Subpart C, Article III, Chapter 123.13 (c) (1), the maximum concentration of particulate matter emissions from the grid casting operation is "0.04 grains per dry standard cubic foot...".

IV. SAMPLING AND ANALYTICAL PROCEDURES

The emission testing was performed by methods similar to those outlined in the Code of Federal Regulations, Title 40, Chapter I, Subchapter C, Part 60, Appendix A, Method 5 - Determination of Particulate Emissions from Stationary Sources. The sampling trains used in these tests are shown schematically in Figure 1 of the Appendix. The main constituents of each sampling train were:

Nozzle - stainless steel with sharp, tapered, leading edge; tip was 3/16" diameter at the inlet, 1/8" diameter at the outlet.

Probe - sheathed stainless steel, with heating system to keep the sample gases above the dew point.

Pitot Tube - S-type, attached to probe and inclined manometer in order to monitor stack gas velocity at sampling point.

Temperature Indicator - thermocouple wire attached to probe to monitor stack temperature at the traverse point.

Filter Holder - pyrex glass filter holder, located in heated area. Filters used were flash-fired, glass fiber, RAC #2343-SC7-4, four inch (4") diameter with 0.3 micron retention.

Impingers - four (4) Greenburg-Smith impingers connected in series with glass ball joint fittings. The first, third and fourth impingers were modified by replacing the tip with a one-half inch (1/2") i.d. glass tube extending to one-half inch (1/2") from the bottom of the bottle. The first and second impingers contained 100 ml. each of distilled water and the third impinger was dry at the start of sampling. The fourth impinger contained approximately 200 grams of pre-weighed silica gel.

Metering System - vacuum gauge, leakless pump, thermometers capable of measuring temperatures to within 5°F, calibrated dry gas meter with two percent (2%) accuracy and calibrated orifice meter - all necessary equipment needed to maintain isokinetic sampling rates and determine sample volume.

The inlet duct to the American Air Filter Roto-Clone is square and measures forty inches (40") on each side. Since this duct is square, the equivalent diameter is also forty inches. Due to the fact that the last branch of inlet duct enters the main duct run several inches before the main inlet duct enters the Roto-Clone, the sampling ports could only be located immediately before the Roto-Clone inlet. Figure 2 of the Appendix shows the location of the five sampling ports along the vertical side of the duct.

Forty (40) traverse points in the duct cross-section were sampled, eight (8) in each of the five (5) ports. The distance from the inside wall of the duct to each traverse point was as follows:

Traverse Point 1	2-1/2"
2	7-1/2"
3	12-1/2"
4	17-1/2"
5	22-1/2"
6	27-1/2"
7	32-1/2"
8	37-1/2"

Each inlet traverse point was sampled for four (4) minutes, for a total sampling time of one hundred sixty (160) minutes. Readings of sampling train operational data were taken at each four (4) minute interval. After each set of readings, the sampling rate was rapidly adjusted to isokinetic conditions.

The exhaust duct from the Roto-Clone measures forty inches (40") in diameter and extends for 17'-3" of straight run between the fan outlet transition and the point of atmospheric discharge. Two (2) sampling ports (90° apart) are located seventy-eight inches (78") (1.95 diameters) downstream from the fan outlet transition and one hundred twenty-nine inches (129") (3.23 diameters) upstream from the point of atmospheric discharge (see Figure 3 of the Appendix). Therefore, it was decided to sample a total of forty (40) traverse points in the duct cross-section, twenty (20) points on each of two (2) diameters (90° apart). The distance from the inside wall of the stack to each traverse point was as follows:

Traverse Point 1	1/2" (sampled at 1")
2	1-1/2"
3	2-5/8"
4	3-7/8"
5	5-1/8"
6	6-5/8"
7	8-1/8"
8	10"
9	12-1/4"
10	15-1/2"
11	24-1/2"
12	27-3/4"
13	30"
14	31-7/8"
15	33-3/8"
16	34-7/8"
17	36-1/8"
18	37-3/8"
19	38-1/2"
20	39-1/2" (sampled at 39")

Each outlet traverse point was sampled for four (4) minutes, for a total sampling time of one hundred sixty minutes. The sampling times coincided with those times that air from the inlet was being sampled. Readings of sampling train operational data were taken at each four (4) minute interval. After each set of readings, the sampling rate was rapidly adjusted to isokinetic conditions.

After sampling, the glass fiber filters from both the inlet and the outlet tests were desiccated to remove any moisture and then weighed to determine the final weights. The difference between the final weights and the initial weights was the amount of particulate collected on the filters during the tests. The filters

were then digested in nitric acid and the sample analyzed by an atomic absorption unit to determine the amount of lead in the samples.

The liquid volumes from the inlet and outlet tests were collected from the nozzles, probes and cyclone rinses, and the contents and washings from the first, second, and third impingers and were passed through membrane filters, 0.45 micron pore size, to collect and determine the weight of the insoluble particulate matter in each sample. After passing through the membrane filters, the aqueous portions were processed down to dryness to determine the weight of the remaining residue (soluble portion). At this point, nitric acid was added to the collected material (both the soluble and insoluble) and the samples analyzed for lead content by the atomic absorption unit. At this stage, the following were analyzed separately:

a) Nozzle, probe and cyclone rinses.
b) Contents and washings from the first impinger.
c) Contents and washings from the second impinger.
d) Contents and washings from the third impinger.

Bernville Biological Laboratory, Bernville, Pennsylvania performed all the laboratory analyses of the samples.

V. DISCUSSION OF RESULTS

A total of 11.1 mg of particulate matter was collected in the outlet sampling train during the 160 minute test duration. Of this total, 3.4 mg was determined to be lead.

The particulate mass emission rate at the outlet was 0.930 lb./hr., or a concentration of 0.0026 gr/sft.^{3}. The allowable concentration of particulate matter that can be emitted through this system is 0.04 grains per dry standard cubic foot. Therefore, this source has been shown to be operating in compliance with the emission requirements of Chapter 123 of the Rules and Regulations of the Department of Environmental Resources.

The amount of lead emissions from this system during the test period was 0.285 lb./hr.

Based on the inlet loading of 1.359 lb./hr. of particualte matter and 0.291 lb./hr. of lead, the American Air Filter Roto-Clone was found to be 31.6% efficient in reducing the particulate matter in the process emissions, and 2.1% efficient in the reduction of the lead content.

NOMENCLATURE

A_n = Cross-sectional area of sampling nozzle tip, $ft.^2$

A_s = Cross-sectional area of stack, $ft.^2$.

B_{H_2O} = Proportion by volume of water vapor in the gas stream, dimensionless

C_p = Pitot tube coefficient, dimensionless.

c'_s = Concentration of particulate matter in stack gas, $gr./sft.^3$ (dry basis).

E_n = Efficiency of particulate matter removal, %.

E_{Pb} = Efficiency of lead removal, %.

ΔH = Pressure drop across the orifice meter, in. H_2O.

$\Delta H@$ = Orifice pressure differential that gives a flow rate of 0.75 $ft.^3/min.$ of dry air at a temperature of 530°R and a pressure of 29.92 in. Hg., in. H_2O.

I = Percent of isokinetic sampling.

K_p = $85.53 \frac{ft.}{sec.} \left\{ \frac{lb. - in. Hg.}{lb. mole - °R - in. H_2O} \right\}^{1/2}$

K_w = $0.00267 \frac{in. Hg. - ft.^3}{ml - °R}$

M_d = Dry Molecular weight of stack gas, lb./lb. mole.

M_n = Total amount of particulate matter collected, grams.

M_{Pb} = Total amount of lead collected, grams.

M_s = Molecular weight of stack gas (wet basis), lb./lb. mole.

ΔP = Velocity pressure of stack gas, in. H_2O.

P_{bar} = Astmospheric pressure, in. Hg.

P_s = Absolute stack gas pressure, $P_{bar} \pm$ static pressure, in. Hg.

P_{std} = Absolute pressure at standard conditions, 29.92 in. Hg.

Q_a = Volumetric flow rate of stack gas, actual conditions, $ft.^3/min.$

Q_{std} = Volumetric flow rate of stack gas, standard conditions, $sft.^3/min.$

R_n = Rate of particulate mass emissions. lb./hr.

R_{Pb}	=	Rate of lead mass emissions, lb./hr.
T_m	=	Dry gas meter temperature, °R.
T_s	=	Temperature of stack gas, °R.
T_{std}	=	Absolute temperature standard conditions, 530°R.
$(v_s)_{avg}$	=	Average stack gas velocity, ft./sec.
V_{l_c}	=	Total volume of liquid collected in impingers, ml.
V_m	=	Volume of gas passing through the dry gas meter, actual conditions, $ft.^3$.
V_{m_s}	=	Volume of gas sample through the dry gas meter, stack conditions, $ft.^3$.
$V_{m_{std}}$	=	Volume of gas sample through the dry gas meter, standard conditions, $sft.^3$.
V_{total}	=	Total volume of gas sample, stack conditions, $ft.^3$.
V_{w_s}	=	Volume of water vapor in the gas sample, stack conditions, $ft.^3$.
θ	=	Sampling time, sec.
13.6	=	Specific gravity of mercury.
18	=	Molecular weight of water, lb./lb. mole.

FIELD DATA SHEET - INLET

Date: 4-30-76

Ambient Temperature: 70°F

Barometric Pressure: 30.05 in. Hg.

Sample Box No: 1437

Meter Box No: S-1362

Meter $\Delta H@$: 1.93 in. H_2O

Leak Check: 0.01 $ft.^3$/min. at 15 in. Hg.

Assumed Moisture: 3%

Nozzle Diameter: 3/16 in.

Probe Length: 5 ft.

Probe Heater Setting: 40%

Heater Box Setting: 150 to 200

FIELD DATA SHEET - OUTLET

Date: 4-30-76

Ambient Temperature: 70°F

Barometric Preasure: 30.05 in. Hg.

Smple Box No: 86

Meter Box No: S-1722

Meter ΔH@: 2.04 in. H_2O

Leak Check: 0.02 $ft.^3$/min. at 15 in. Hg.

Assumed Moisture: 2%

Nozzle Diameter: 1/8 in.

Probe Length: 3 ft.

Probe Heater Setting: 60%

Heater Box Setting: 150 to 200

TABULATION OF SAMPLE DATA - INLET

Traverse Point	Clock Time	Sample Duration θ (min.)	Stack Static Pressure $P_s - P_{bar}$ (in. H_2O)	Stack Dry Bulb Temperature T_s (°F)	Stack Velocity Head ΔP (in. H_2O)	Orifice Meter Pressure Drop ΔH (in. H_2O)	Dry Gas Meter Volume Reading (ft.^{3})	Dry Gas Meter Temperature (°F) Inlet T_{m_i}	Dry Gas Meter Temperature (°F) Outlet T_{m_o}	Sample Box Temperature (°F)	Last Impinger Temperature (°F)
A1	12:19	4	-4.5	185	0.93	1.06	247.65	80	78	200	70
A2	12:23	4	-4.7	125	0.95	1.08	250.24	84	77	150	66
A3	12:27	4	-4.4	120	1.15	1.31	252.46	93	78	150	66
A4	12:31	4	-4.1	118	1.10	1.25	254.99	102	80	170	70
A5	12:35	4	-4.2	118	1.10	1.25	257.33	109	81	140	72
A6	12:39	4	-4.1	119	0.95	1.08	259.76	116	84	150	74
A7	12:43	4	-4.1	120	0.79	0.90	261.98	115	86	200	78
A8	12:47	4	-4.2	175	0.11	0.13	264.07	102	82	160	80
Stop	12:51	for 8 minutes to move probe to next port.					264.98				
B1	12:59	4	-4.8	117	1.55	1.77	264.98	85	84	170	75
B2	1:03	4	-3.8	178	0.71	0.81	267.81	90	83	152	70
B3	1:07	4	-3.8	145	1.00	1.14	269.85	92	84	150	72
B4	1:11	4	-3.9	130	1.30	1.48	272.19	94	83	160	72
B5	1:15	4	-3.8	125	0.93	1.06	274.82	96	82	145	71
B6	1:19	4	-3.7	123	0.69	0.79	277.08	94	82	165	72
B7	1:23	4	-3.7	122	0.57	0.65	279.08	94	82	180	74
B8	1:27	4	-3.8	127	0.58	0.66	280.90	92	81	150	74
Stop	1:31	for 5 minutes to move probe to next port.					282.75				
C1	1:36	4	-3.8	140	0.99	1.13	282.75	86	81	140	72
C2	1:40	4	-3.5	165	0.82	0.93	285.11	90	81	135	70
C3	1:44	4	-3.9	155	1.20	1.39	287.31	92	80	145	71
C4	1:48	4	-4.1	142	1.35	1.54	289.79	98	82	160	71
Stop	1:52	for 5 minutes while outlet probe was moved to other port.					292.41				

(continued on following page)

TABULATION OF SAMPLE DATA - INLET
(continued)

Traverse Point	Clock Time	Sample Duration θ (min.)	Stack Static Pressure $P_s - P_{bar}$ (in. H_2O)	Stack Dry Bulb Temperature T_s (°F)	Stack Velocity Head ΔP (in. H_2O)	Orifice Meter Pressure Drop ΔH (in. H_2O)	Dry Gas Meter Volume Reading (ft.^{3})	Dry Gas Meter Temperature (°F) Inlet T_{m_i}	Dry Gas Meter Temperature (°F) Outlet T_{m_o}	Sample Box Temperature (°F)	Last Impinger Temperature (°F)
C5	1:57	4	-4.0	135	1.35	1.54	292.41	93	82	140	72
C6	2:01	4	-4.2	140	1.23	1.40	295.18	97	83	135	68
C7	2:05	4	-3.7	125	0.59	0.67	297.85	99	83	140	73
C8	2:09	4	-3.8	125	0.71	0.81	299.81	97	83	155	74
Stop	2:13	for 5 minutes to move probe to next port.					301.85				
D1	2:18	4	-3.8	152	0.92	1.05	301.85	89	83	150	74
D2	2:22	4	-3.8	157	1.10	1.25	303.82	92	83	145	70
D3	2:26	4	-4.0	160	1.30	1.48	306.38	97	83	168	68
D4	2:30	4	-4.1	145	1.45	1.65	308.98	100	82	135	69
D5	2:34	4	-4.4	130	1.35	1.54	311.75	103	84	145	68
D6	2:38	4	-4.4	125	1.10	1.25	314.54	105	85	155	70
D7	2:42	4	-4.2	125	0.84	0.96	316.95	104	86	135	70
D8	2:46	4	-4.2	120	0.86	0.98	319.20	101	86	150	70
Stop	2:50	for 5 minutes to move probe to next port.					321.35				
E1	2:55	4	-3.8	133	0.96	1.09	321.35	92	84	140	82
E2	2:59	4	-4.4	140	1.40	1.60	323.72	98	85	150	67
E3	3:03	4	-4.5	125	1.70	1.94	326.62	101	85	150	68
E4	3:07	4	-4.6	128	1.65	1.88	329.48	106	86	140	67
E5	3:11	4	-4.2	127	1.65	1.88	332.58	116	86	145	67
E6	3:15	4	-4.2	125	1.60	1.82	335.63	121	88	140	67
E7	3:19	4	-4.1	124	1.60	1.82	338.64	126	90	135	70
E8	3:23	4	-4.4	125	1.60	1.82	341.61	132	94	140	88
Stop	3:27	end of test.					344.76				

TABULATION OF SAMPLE DATA - OUTLET

Traverse Point	Clock Time	Sample Duration θ (min.)	Stack Static Pressure $P_s - P_{bar}$ (in. H_2O)	Stack Dry Bulb Temperature T_s (°F)	Stack Velocity Head ΔP (in. H_2O)	Orifice Meter Pressure Drop ΔH (in. H_2O)	Dry Gas Meter Volume Reading (ft.^{3})	Dry Gas Meter Temperature (°F) Inlet T_{m_i}	Dry Gas Meter Temperature (°F) Outlet T_{m_o}	Sample Box Temperature (°F)	Last Impinger Temperature (°F)
A1	12:19	4	-0.38	90	1.2	0.40	710.04	68	70	145	74
A2	12:23	4	-0.62	93	2.1	0.52	711.87	74	72	160	54
A3	12:27	4	-0.66	100	2.4	0.60	713.43	76	72	205	53
A4	12:31	4	-1.0	103	2.5	0.62	715.20	80	72	145	55
A5	12:35	4	-1.1	103	2.8	0.70	716.88	81	73	166	56
A6	12:39	4	-1.2	101	2.8	0.70	718.64	84	74	195	59
A7	12:43	4	-1.1	102	2.7	0.69	720.45	88	75	220	58
A8	12:47	4	-1.2	105	2.7	0.69	722.24	86	76	207	57
Stop	12:51	for 8 minutes while inlet probe was moved to next port.					724.09				
A9	12:59	4	-1.1	109	2.6	0.65	724.09	79	75	210	60
A10	1:03	4	-1.1	106	2.7	0.69	725.81	83	76	200	56
A11	1:07	4	-1.1	107	2.6	0.65	727.60	84	76	190	57
A12	1:11	4	-1.3	108	2.7	0.69	729.36	84	76	145	58
A13	1:15	4	-1.1	106	2.6	0.65	731.15	86	76	260	58
A14	1:19	4	-1.2	80	2.7	0.69	732.87	87	76	155	58
A15	1:23	4	-1.1	74	2.7	0.69	732.67	87	76	205	58
A16	1:27	4	-1.0	75	2.6	0.65	736.46	87	76	230	60
Stop	1:31	for 5 minutes while inlet probe was moved to next port.					738.19				
A17	1:36	4	-0.95	94	2.5	0.62	738.19	79	74	205	60
A18	1:40	4	-0.93	107	2.1	0.52	739.89	83	76	165	56
A19	1:44	4	-0.88	108	1.8	0.45	741.46	85	77	195	58
A20	1:48	4	-0.79	108	1.6	0.40	742.93	87	78	210	59
Stop	1:52	for 5 minutes to move probe to other port.					744.34				

(continued on following page)

TABULATION OF SAMPLE DATA - OUTLET
(continued)

Traverse Point	Clock Time	Sample Duration θ (min.)	Stack Static Pressure $P_s - P_{bar}$ (in. H_2O)	Stack Dry Bulb Temperature T_s (°F)	Stack Velocity Head ΔP (in. H_2O)	Orifice Meter Pressure Drop ΔH (in. H_2O)	Dry Gas Meter Volume Reading (ft.^{3})	Dry Gas Meter Temperature (°F) Inlet T_{m_i}	Dry Gas Meter Temperature (°F) Outlet T_{m_o}	Sample Box Temperature (°F)	Last Impinger Temperature (°F)
B1	1:57	4	-0.45	96	1.8	0.45	744.34	79	76	185	60
B2	2:01	4	-0.82	96	2.1	0.52	745.78	80	77	190	60
B3	2:05	4	-0.85	108	2.3	0.57	747.34	80	76	215	58
B4	2:09	4	-0.96	110	2.5	0.62	748.98	83	77	215	58
Stop	2:13	for 5 minutes while inlet probe was moved to next port.					750.67				
B5	2:18	4	-1.0	70	2.6	0.65	750.67	77	76	220	55
B6	2:22	4	-1.2	70	2.5	0.62	752.42	79	76	195	58
B7	2:26	4	-1.1	68	2.5	0.62	754.11	81	76	175	58
B8	2:30	4	-1.2	68	2.5	0.62	755.80	84	76	200	59
B9	2:34	4	-1.1	69	2.4	0.60	757.50	87	77	225	59
B10	2:38	4	-1.1	70	2.4	0.60	759.19	87	77	170	59
B11	2:42	4	-1.1	69	2.4	0.60	760.87	87	80	175	59
B12	2:46	4	-1.1	69	2.4	0.60	762.54	89	79	190	54
Stop	2:50	for 5 minutes while inlet probe was moved to next port.					764.23				
B13	2:55	4	-1.1	58	2.4	0.60	764.23	82	76	218	62
B14	2:59	4	-1.2	70	2.4	0.60	765.90	83	79	175	57
B15	3:03	4	-1.1	69	2.4	0.60	767.56	84	78	210	57
B16	3:07	4	-1.2	66	2.4	0.60	769.24	85	78	240	58
B17	3:11	4	-1.3	66	2.5	0.62	770.92	84	77	220	58
B18	3:15	4	-1.2	66	2.5	0.62	772.63	84	77	220	58
B19	3:19	4	-1.3	68	2.4	0.60	774.32	85	77	180	59
B20	3:23	4	-1.3	68	2.4	0.60	775.98	85	77	180	58
Stop	3:27	end of test.					777.67				

SUMMARY OF LABORATORY FINDINGS - INLET

	Particulate Collected (mg)		Lead Collected (mg)	
	Insoluble	Soluble	Insoluble	Soluble
Glass fiber filter #GF-3	6.9	----	5.4	----
Probe, nozzle and cyclone rinse	2.1	5.2	0.037	0.007
First impinger contents and rinse	1.6	2.7	0.007	N.D.
Second impinger contents and rinse	1.4	2.2	N.D.	N.D.
Third impinger contents and rinse	1.2	2.2	N.D.	N.D.
	13.2 +	12.3	5.444 +	0.007

Total particulate catch = 25.5 mg

Total lead catch = 5.451 mg

Total condensate collected in impingers 0 ml

Weight change of silica gel in last impinger + 21 g. = 21 ml

Total volume of water collected from sample 21 ml

Note: N.D. = None Detected

SUMMARY OF LABORATORY FINDINGS - OUTLET

	Particulate Collected (mg)		Lead Collected (mg)	
	Insoluble	Soluble	Insoluble	Soluble
Glass fiber filter #12	4.0	----	3.4	----
Probe, nozzle and cyclone rinse	0.9	2.7	<0.001	N.D.
First impinger contents and rinse	0.6	1.2	N.D.	N.D.
Second impinger contents and rinse	0.1	0.2	N.D.	N.D.
Third impinger contents and rinse	N.D.	1.4	N.D.	N.D.
	5.6 +	5.5	3.4 +	0

Total particulate catch = 11.1 mg

Total lead catch = 3.4 mg

Total condensate collected in impingers 27 ml

Weight change of silica gel in last impinger + 16 g. = 16 ml

Total volume of water collected from sample 43 ml

Note: N.D. = None Detected

CALCULATIONS

Pertinent data used in calculations

Inlet:

A_n	= 0.00019 ft.^{2}	P_{bar}	= 30.05 in. Hg.
A_s	= 11.11 ft.^{2}	$(P_s)_{avg}$	= 29.75 in. Hg.
C_p	= 0.86	$(T_m)_{avg}$	= 551°R
$(\Delta H)_{avg}$	= 1.25 in. H_2O	$(T_s)_{avg}$	= 595°R
M_d	= 28.97 lb./lb. mole*	Vl_c	= 21 ml.
M_n	= 0.0255 g.	V_m	= 97.11 ft.^{3}
M_{Pb}	= 0.005451 g.	θ	= 9600 sec.
$(\sqrt{\Delta P})_{avg}$	= 1.0596 (in. H_2O)$^{1/2}$		

Outlet:

A_n	= 0.000085 ft.^{2}	P_{bar}	= 30.05 in. Hg.
A_s	= 8.73 ft.^{2}	$(P_s)_{avg}$	= 29.97 in. hg.
C_p	= 0.81	$(T_m)_{avg}$	= 541°R
$(\Delta H)_{avg}$	= 0.60 in. H_2O	$(T_s)_{avg}$	= 547°R
M_d	= 28.97 lb./lb. mole*	Vl_c	= 43 ml.
M_n	= 0.0111 g.	V_m	= 67.63 ft.^{3}
M_{Pb}	= 0.0034 g.	θ	= 9600 sec.
$(\sqrt{\Delta P})_{avg}$	= 1.5471 (in. H_2O)$^{1/2}$		

* Assumed value for standard air.

Total Volume of Gas Sampled, Standard Conditions

$$V_{m_{std}} = V_m \frac{T_{std}}{(T_m)_{avg}} \left\{ \frac{P_{bar} + \frac{(\Delta H)_{avg}}{13.6}}{P_{std}} \right\}$$

Volume of Gas Sample Through Dry Gas Meter, Stack Conditions

$$V_{m_s} = V_m \frac{(T_s)_{avg}}{(T_m)_{avg}} \left\{ \frac{P_{bar} + \frac{(\Delta H)_{avg}}{13.6}}{(P_s)_{avg}} \right\}$$

Volume of Water Vapor in Gas Sample, Stack Conditions

$$V_{w_s} = K_w V_{l_c} \frac{(T_s)_{avg}}{(P_s)_{avg}}$$

Total Volume of Gas Sampled, Stack Conditions

$$V_{total} = V_{m_s} + V_{w_s}$$

Moisture Content of Gas Sampled

$$B_{H_2O} = \frac{V_{w_s}}{V_{total}}$$

Molecular Weight of Gas Sampled, Wet Basis

$$M_s = M_d (1 - B_{H_2O}) + 18 (B_{H_2O})$$

Average Velocity of Stack Gas

$$(v_s)_{avg} = K_p C_p (\sqrt{\Delta P})_{avg} \sqrt{\frac{(T_s)_{avg}}{(P_s)_{avg} M_s}}$$

Volumetric Flow Rate, Stack Conditions

$$Q_s = 60 \frac{sec}{min} (v_s)_{avg} A_s$$

Volumetric Flow Rate, Standard Conditions

$$Q_{std} = 60 \frac{sec}{min} (1 - B_{H_2O}) (v_s)_{avg} A_s \left\{ \frac{T_{std}}{(T_s)_{avg}} \right\} \left\{ \frac{(P_s)_{avg}}{P_{std}} \right\}$$

Particulate Mass Emission Rate

$$R_n = \frac{M_n (v_s)_{avg} A_s}{V_{total}} \frac{3600 \text{ sec/hr}}{453.6 \text{ g/lb}}$$

Lead Mass Emission Rate

$$R_{Pb} = \frac{M_{Pb} (v_s)_{avg} A_s}{V_{total}} \frac{3600 \text{ sec/hr}}{453.6 \text{ g/lb}}$$

Concentration of Particulate Matter

$$c'_s = \frac{15.43 \text{ gr}}{g} \left\{ \frac{M_n}{V_{m_{std}}} \right\}$$

Percent of Isokinetic Sampling

$$I = \frac{100 V_{total}}{A_n \theta (V_s)_{avg}}$$

Efficiency of Particulate Matter Removal

$$E_n = \frac{R_n \text{ (inlet)} - R_n \text{ (outlet)}}{R_n \text{ (inlet)}} 100$$

Efficiency of Lead Removal

$$E_{Pb} = \frac{R_{Pb} \text{ (inlet)} - R_{Pb} \text{ (outlet)}}{R_{Pb} \text{ (inlet)}} 100$$

TABULATION OF CALCULATED RESULTS - INLET

$V_{m_{std}}$	=	94.10 sft^3	=	Total volume of gas sampled, standard conditions
V_{m_s}	=	106.25 ft^3	=	Volume of gas sample through dry gas meter, stack conditions
V_{w_s}	=	1.12 ft^3	=	Volume of water vapor in gas sample, stack conditions
V_{total}	=	107.37 ft^3	=	Total volume of gas sampled, stack conditions
B_{H_2O}	=	0.010	=	Moisture content of gas sampled
M_s	=	28.86 lb/lb mole	=	Molecular weight of gas sampled, wet basis
$(v_s)_{avg}$	=	64.9 ft/sec	=	Average velocity of stack gas
Q_a	=	43,300 ft^3/min	=	Volumetric flow rate, stack conditions
Q_{std}	=	37,900 sft^3/min	=	Volumetric flow rate, standard conditions
R_n	=	1.359 lb/hr	=	Actual particulate mass emission rate
R_{Pb}	=	0.291 lb/hr	=	Actual lead mass emission rate
c'_s	=	0.0042 gr/sft^3	=	Concentration of particulate emissions
I	=	90.7%	=	Percent of isokinetic sampling

See page 20 for results of efficiency calculations.

were operated; only one of the

TABULATION OF CALCULATED RESULTS - OUTLET

$V_{m_{std}}$	= 66.63 sft^3	=	Total volume of gas sampled, standard conditions
V_{m_s}	= 68.65 ft^3	=	Volume of gas sample through dry gas meter, stack conditions
V_{w_s}	= 2.10 ft^3	=	Volume of water vapor in gas sample, stack conditions
V_{total}	= 70.75 ft^3	=	Total volume of gas sampled, stack conditions
B_{H_2O}	= 0.030	=	Moisture content of gas sampled
M_s	= 28.64 lb/lb mole	=	Molecular weight of gas sampled, wet basis
$(v_s)_{avg}$	= 85.6 ft/sec	=	Average velocity of stack gas
Q_a	= 44,800 ft^3/min	=	Volumetric flow rate, stack conditions
Q_{std}	= 42,200 sft^3/min	=	Volumetric flow rate, standard conditions
R_n	= 0.930 lb/hr	=	Actual particulate mass emission rate
R_{Pb}	= 0.285 lb/hr	=	Actual lead mass emission rate
c'_s	= 0.0026 gr/sft^3	=	Concentration of particulate emissions
I	= 101.3%	=	Percent of isokinetic sampling
E_n	= 31.6%	=	Efficiency of particulate matter removal
E_{Pb}	= 2.1%	=	Efficiency of lead removal

PROCESS INFORMATION

There are eight lead pots in the grid casting area. Each pot has a 2200 pounds holding capacity and is normally heated to 950°F when operating. During the test period, seven of the eight were operated; only one of the eight was not used, but it was heated.

A total of 104 lead pigs were used in the grid casting during the three hour test period (12:20 - 3:20). Each pig weighed 60 pounds.

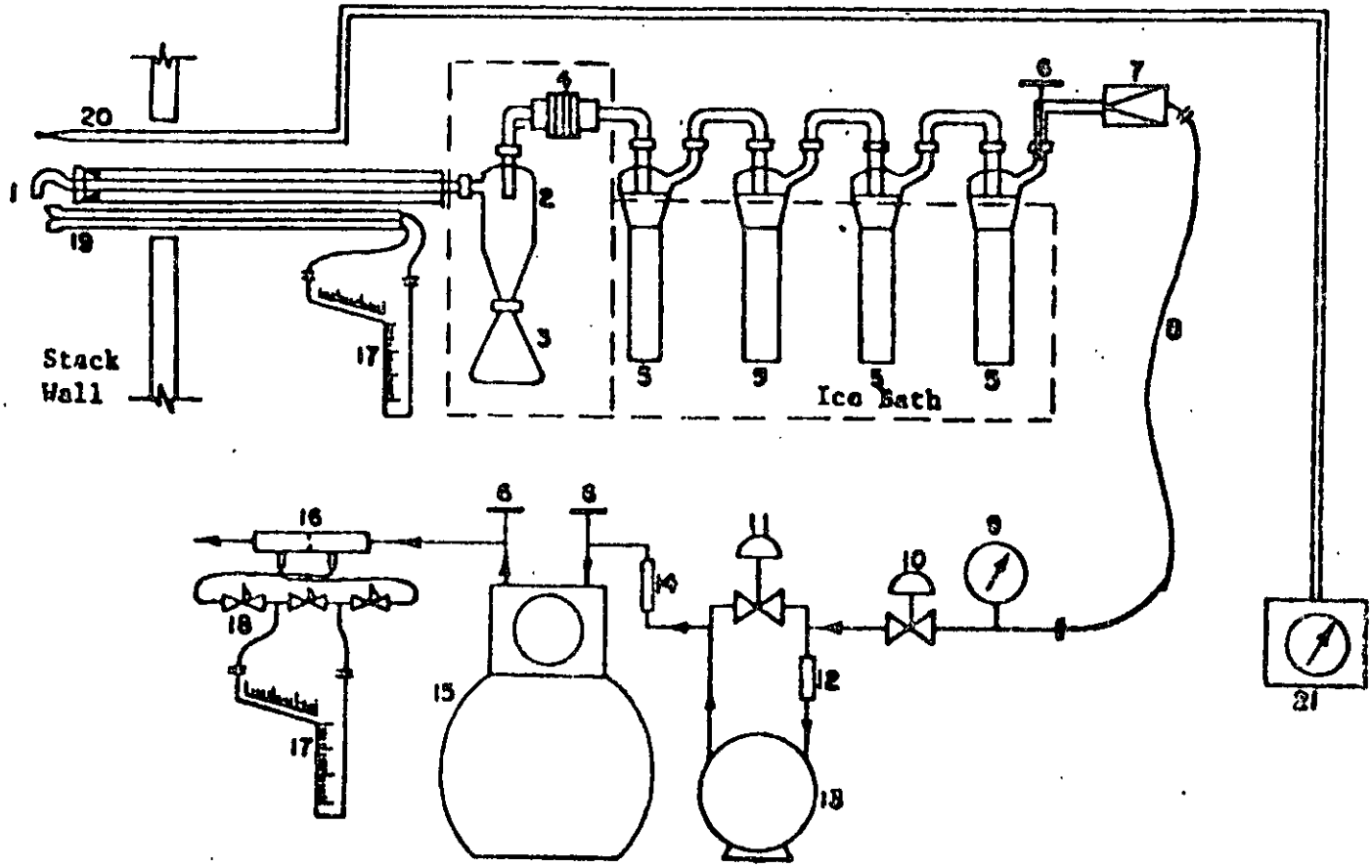
A total of 47 corked molds were produced during the test period with a total cork consumption of 6 gallons.

In the small parts casting area, there are three lead pots. Two of these pots have capacities of 1800 pounds while the third has a 720 pounds capacity. A total of 13,400 pounds of lead was used in the pots in the three hour test period.

A total of 121 parts were cast in the small parts casting area during the test period.

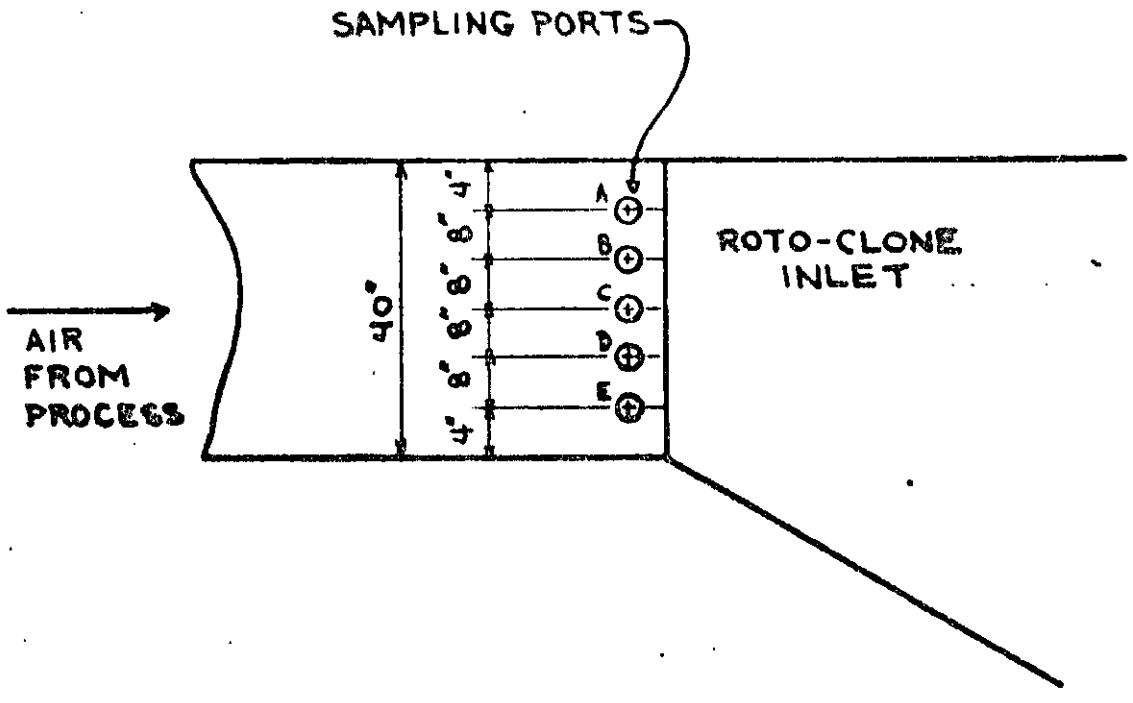
The exhaust air from the various operations discussed above is cleaned by passing through a type "N" Roto-Clone, Size 36, Arrangement C. The water in the Roto-Clone is recirculated through a filter at a rate of 40 gallons per minute.

FIGURE 1 - SAMPLING TRAIN



1) Probe
2) Cyclone
3) Flask
4) Particulate Filter
5) Impingers (Greenburg-Smith)
6) Thermometer
7) Check Valve
8) Umbilical Cord
9) Vacuum Gauge
10) Coarse Flow Adjust Valve
11) Fine Flow Adjust Valve
12) Oiler
13) Vacuum Pump
14) Filter
15) Dry Gas Meter
16) Orifice Tube
17) Incline Manometer
18) Solenoid Valves
19) Pitot Tube
20) Thermocouple
21) Temperature Indicator

Figure 2



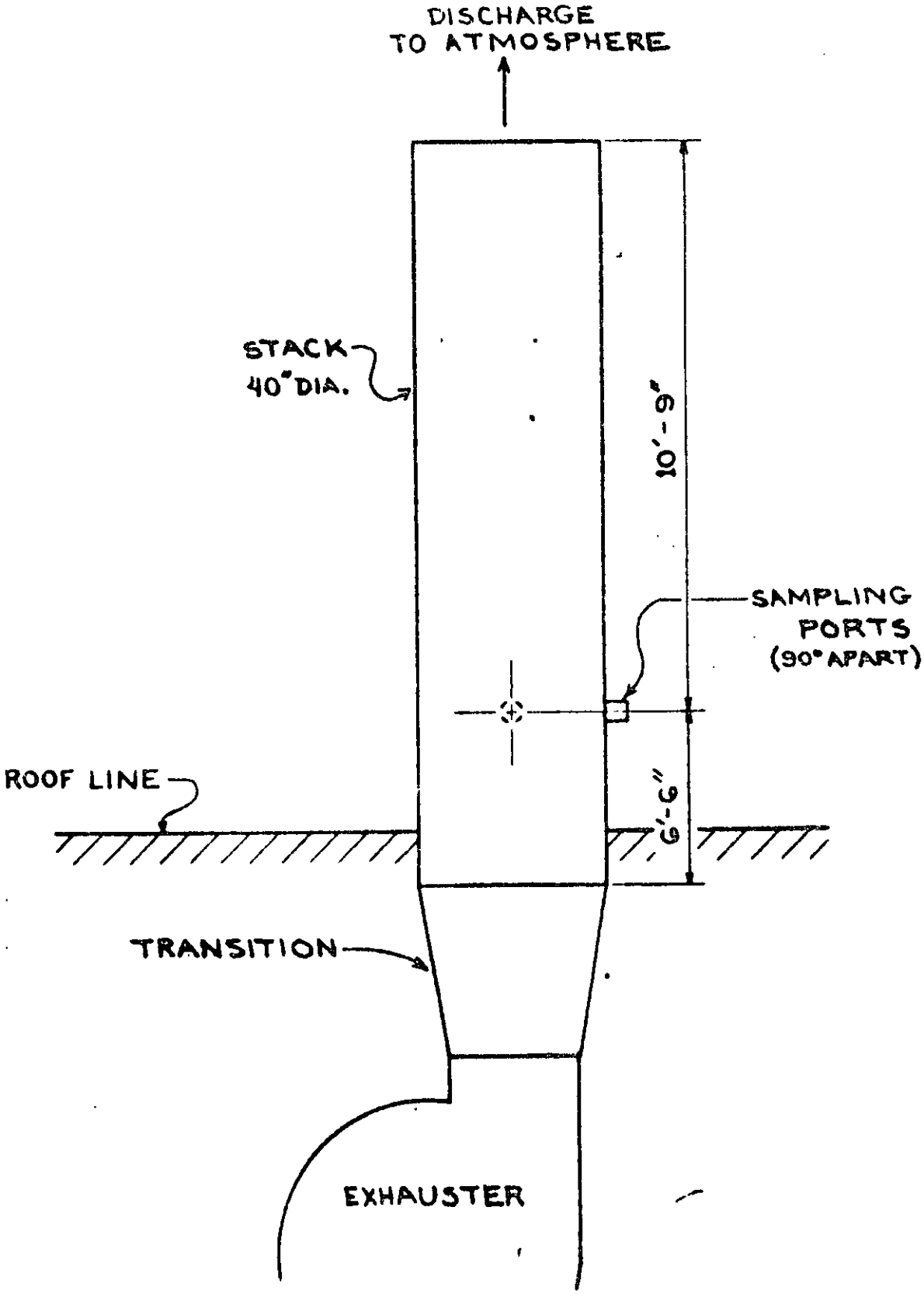
GENERAL BATTERY CORP.
HAMBURG, PA.

LOCATION OF INLET SAMPLING PORTS

SPOTTS, STEVENS and McCOY, Inc.
CONSULTING ENGINEERS PLANNERS SURVEYORS

MWJ DRAWN	PR CHECK	M.C. APPROVAL	5-27-76 DATE
NONE	1014-001-A-001		

Figure 3



GENERAL BATTERY CORP.

HAMBURG, PA.

LOCATION OF OUTLET SAMPLING PORTS

SPOTTS, STEVENS and McCOY, Inc.

CIVIL CONSULTING ENGINEERS PLANNERS SURVEYORS

MADE	CHK'D	APPROVED	DATE
DPR		R.C. Furlow	5-27-76

NONE	1014-001-A-002	—
	DRAWING NUMBER	REV