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SOURCE SAMPLING EVALUATION FOR

ROCKY RIVER WASTEWATER TREATMENT PLANT

CONCORD, N. C.

PREPARED ESPECIALLY FOR:

PAUL J. CARDINAL MANAGEMENT COMPANY

SAN FRANCISCO, CALIFORNIA
JULY 20, 1982

This Report was Reviewed
by: _____
Date: _____
and found to be
Satisfactory: ☐
Unsatisfactory: ☐
Remarks: _____

This Report was Reviewed
by: _____
Date: 2/3/83
and found to be
Satisfactory: ☑
Unsatisfactory: ☐
Remarks: _____

MOGUL

CONSULTING ENGINEERING SERVICES

SOURCE SAMPLING EVALUATION FOR:

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

PREPARED ESPECIALLY FOR:
PAUL J. CARDINAL MANAGEMENT COMPANY
SAN FRANCISCO, CALIFORNIA

BY

THE MOGUL CORPORATION
CHARLOTTE, NORTH CAROLINA

JULY 20, 1982

TABLE OF CONTENTS

TEST DESCRIPTION

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

TEST DESCRIPTION

On July 20, 1982, personnel from the Professional Services Division of the Mogul Corporation, conducted a source sampling evaluation at the Rocky River Wastewater Treatment facilities in Concord, North Carolina. The purpose of this evaluation, performed at the request of the Paul J. Cardinal Management Company, was to determine the emission levels of particulate emitted from the main exhaust stack. Also included in the program was an analysis of sludge samples composited during the testing period.

A summary of the process tested is as follows: dewatered sludge is conveyed and dropped into a Nichols Herreshoff incinerator. Following incineration, the furnace exhaust travels through a Venturi scrubber and continues into an impingement tray scrubber. An induced draft fan removes the exhaust to the main outlet stack where it is mixed with hot air vented from the furnace and released into the atmosphere.

Sampling took place in the round, twenty-seven (27) inch inner diameter main exhaust stack from the rooftop of the facility. Two (2) sampling ports, three (3) inches in diameter, located ninety (90) degrees to each other at a point 2.96 diameters (80 inches) downstream from the nearest flow obstruction and 2.72 diameters (73.5 inches) from the top of the stack served as actual sampling sites. Particulate concentrations were determined by testing procedures based on the Environmental Protection Agency Method 5. A sampling run

of eighty (80) minutes length consisted of a twenty (20)point traverse in each port, sampling for a time of two (2) minutes at each port.

All sampling methods, equipment, and sample analysis confirmed to the specifications set forth in the FEDERAL REGISTER, Volume 42, Number 160, Methods 1 through 5, August, 1977. Sampling equipment was manufactured by the Research Appliance Company (RAC) and Nutech Corporation and is diagrammed in Appendix V of this report.

In addition to the determination of particulate concentration in the outlet stack, the wastewater treatment plant sludge was analyzed for mercury. Sampling was conducted by Rocky River Wastewater Treatment Plant personnel with assistance from the Mogul Corporation. The specifications for sampling the sludge conformed to those described in Volume 40 of the CODE OF FEDERAL REGULATIONS, Part 61, Subpart E. The sludge was sealed and delivered to the Mogul Corporation's Chagrin Falls, Ohio laboratory for analysis by means of the Environmental Protection Agency Method 105.

Those individuals present during the testing period were:

Mr. Paul Cardinal	Paul Cardinal Management Company
Mr. Michael Landis	N.C. Department of Natural Resources and Community Development
Mr. Stan Faires	The Mogul Corporation
Mr. Keith Freeman	The Mogul Corporation

MOGUL enviroservice

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NC

DATA SUMMARY

RUN #	1	2	3	
DATE	7/20/82	7/20/82	7/20/82	
TIME START	9:00	11:17	13:45	
TIME STOP	10:23	12:44	15:08	
AVERAGE STACK TEMPERATURE (degrees.F)	141.6	136.2	182.2	153.3
PERCENT MOISTURE (by volume)	5.94	5.18	4.64	
AVERAGE STACK VELOCITY - STACK CONDITIONS (feet/minute)	1795	1447	2041	1761 29.35 FPS
STACK VOLUME at STANDARD CONDITIONS (standard cubic feet/ minute)	5763	4725	6223	
DRY GAS SAMPLE VOLUME at STANDARD CONDITIONS (cubic feet)	39.66	33.89	42.80	
PERCENT ISOKINETIC	100.05	104.27	100.55	
PARTICULATE CONCENTRATIONS (lbs./Tons dry sludge)	0.5037	0.3876	0.5201	(.4
ALLOWABLE PARTICULATE EMISSIONS* (lbs./Tons dry sludge)	1.30 ✓	1.30	1.30	
lbs/hr	35 29	90 32	4704	3122

	COMPOSITE # 1	COMPOSITE # 2	COMPOSITE # 3	
	7/20 1700-2040	7/20 2000-0827	7/20 0900-1600	
PERCENT MOISTURE	55.9	55.9	55.9	
MERCURY CONCENTRATIONS (Grams/day)	35.60	44.71	45.45	41.92
ALLOWABLE MERCURY EMISSIONS** (Grams/day)	3200 ✓	3200	3200	

*REFERENCES: CODE OF FEDERAL REGULATIONS (CFR) Title 40, Protection of Environment Parts 53 - 80, Revised July 1, k980, Chapter 1, Part 60, Subpart 0. 60.152

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NC

**REFERENCE: CODE OF FEDERAL REGULATIONS(CFR), Title 40, Protection of Environment, Parts 53 - 80 Revised July 1, 1980, Chapter 1, Part 61, Subpart E, 61.52.

SUMMARY OF TEST DATA

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

DATE: 7/20/82

RUN NO: 1, 2 & 3

SUMMARY OF TEST DATA

PARTICULATE SAMPLING TRAIN

		1	2	3
1) Sampling nozzle diameter, in.	D_{av}	.250	.250	.250
2) Sampling time, min.	T_{aw}	80	80	80
3) Sample gas volume - meter condition, cf	V_{ac}	43.341	37.028	46.129
4) Average orifice pressure drop, in. H_2O	P_{af}	0.799	.566	.911
5) Average meter temperature, ^oF.	T_{ai}	105.0	114.5	97.3
6) Particulate collected - probe & cyclone, mg.	W_{aj}	36.9	41.5	36.7
7) Particulate collected - probe, cyclone & filter, mg	W_{ak}	46.3	42.5	57.1
8) Particulate collected - total, mg	W_{aj}	46.3	42.5	57.1

VELOCITY TRAVERSE DURING TEST - BURNER AND WASTE

1) Stack area, $in.^2$	S_{dd}	572.56✓	572.56	572.56
2) Average stack pressure, in. Hg (absolute)	P_{di}	29.157	29.162	29.152
3) Average stack temperature, ^oF	T_{df}	141.6	136.2	182.2
4) Average $\sqrt{\text{velocity head x stack temperature}}$	S_{de}	11.99	9.68	13.56

STACK MOISTURE CONTENT

1) Total water collected by train, ml	V_{ce}	52.8	39.0	43.9

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

DATE: 7/20/82

RUN NO: 1,2 & 3

STACK MOISTURE CONTENT DATA AND CALCULATIONS FOR TEST

		1	2	3
1) H_2O condensed in impingers = V_{cb}, ml	V_{cb}	39.4	23.0	31.4
2) H_2O absorbed by silica gel = V_{cb}, ml	V_{cd}	13.4	16.0	12.5
3) Total H_2O collected = $V_{ce} = V_{cb} + _{cd}$, ml	V_{cc}	52.8	39.0	43.8
4) Vol. of H_2O vapor @ 70° F & 29.92 in. Hg = $0.0474 \times V_{ce} = V_{cf}$, cf	V_{cg}	2.503	1.850	2.081
5) Moisture in stack gas = V_{cg},% = $\frac{100 \times V_{cf}}{V_{ab} + V_{cf}}$	V_{cg}	5.94	5.18	4.64
6) Mole fraction dry gas, = $M_{ch} = \frac{100 - V_{cg}}{100}$	M_{ch}	.9406	.9480	.9536
7) Molecular weight of stack gas = $M_{ca} = M_{bj} \times M_{ch} + 1B\ (1 - M_{ch})$	M_{ca}	28.97	29.05	28.64

8) Orsat analysis and average molecular weight of dry gas:

	ANALYSIS 1	2	3	x = MOLE WT.	WT/MOLE (DRY) 1	2	3
CO_2 (V_{bf}), % Vol (dry)	7.0	7.0	3.0	44/100	3.08	3.08	1.32
CO (V_{bg}), % Vol (dry)	0.0	0.0	0.0	28/100	+ 0.00	0.00	0.00
O_2 (V_{bh}), % Vol (dry)	13.5	13.5	17.0	32/100	+ 4.32	4.32	5.44
N_2 (V_{bi}), % Vol (dry)	79.5	79.5	80.0	28/100	+22.26	22.26	22.40
				M_{bj} = Avg. molecular wt of dry gas	29.66	29.66	29.16

$$\% \text{ isokinetic} = \frac{1032 \times (T_{df} + 460) \times V_{ab}}{V_{dh} \times T_{aw} \times P_{di} \times M_{ch} \times (D_{av})^2}$$

1	2	3
100.048	104.27	100.547

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

DATE: 7/20/82

RUN NO: 1, 2 & 3

Stack volume & standard conditions, scfm

$$= 0.123 \times \frac{V_{dh} \times S_{dd} \times M_{ch} \times P_{dj}}{(T_{df} + 460)} =$$

	1	2	3
V_{db}	5763.0	4725.0	6223.0

Dry gas sample volume @ standard conditions, cf =

$$17.7 \times Vac \times \frac{P_{ad} + \frac{P_{af}}{13.6}}{(T_{ai} + 460)}$$

V_{ab}	39.66	33.89	42.80

LABORATORY DATA

Particulate - probe & cyclone (W_{aj}), mg =	36.9	41.5	36.7
Particulate - probe, cyclone & filter (W_{ak}), mg =	46.3	42.5	57.1

PARTICULATE CONCENTRATION CALCULATIONS

In grains/scf

Particulate - probe & cyclone, grains/scf

$$C_{am} = 0.0154 \times \frac{W_{aj}}{V_{ab}}$$

C_{am}	0.0143	0.0189	0.0132

Particulate - probe, cyclone & filter, grains/scf

$$C_{an} = \frac{0.0154 \times W_{ak}}{V_{ab}}$$

C_{an}	0.0180	0.0193	0.0205

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

DATE: 7/20/82

RUN NO: 1, 2 & 3

PARTICULATE CONCENTRATION CALCULATIONS (cont'd)

In grains/cf @ stack conditions

Particulate - probe & cyclone, grains/cf @ stack conditions

$$C_{as} = \frac{17.7 \times C_{am} \times P_{dj} \times M_{ch}}{(T_{df} + 460)} = C_{as}$$

	1	2	3
C_{as}	0.0116	0.01795	0.0101

Particulate - probe, cyclone & filter, grains/cg @ stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_{dj} \times M_{ch}}{(T_{df} + 460)} = C_{at}$$

C_{at}	0.0145	0.01584	0.0157

in lb/hr

Particulate - probe & cyclone, lb/hr

$$C_{av} = 0.00857 \times C_{am} \times V_{db} = C_{av}$$

C_{av}	0.7061	0.7652	0.7039

Particulate - probe, cyclone & filter, lb/hr

$$C_{aw} = 0.00857 \times C_{an} \times V_{db} = C_{aw}$$

C_{aw}	0.8888	0.7814	1.0932

Stack velocity @ P_{dj} and P_{df} (stack conditions), fpm

$$= 4350 \times S_{de} \times \frac{1}{P_{dj} \times M_{ca}} = V_{dh}$$

V_{dh}	1795.0	1447.0	2041.0

ANALYTICAL REPORT SHEETS

PARTICULATE DATA

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

PARTICULATE DATA

RUN #	FILTER #/ BEAKER #	FINAL WEIGHT (grams)	TARE WEIGHT (grams)	BLANK CORRECTED	NET WEIGHT (milligrams)
			Filters		
1	28	0.5167	0.5073	-	9.4
2	41	0.5077	0.5067	-	1.0
3	33	0.5234	0.5030	-	20.4
			Probe Wash		
1	RRA	98.4535	98.4121	0.0369	36.9
2	RRB	95.6144	95.5684	0.0415	41.5
3	RRC	95.3696	95.3284	0.0367	36.7
Blank	RRD	96.3646	96.3601	0.000	0.0

Total Particulate collected

RUN #	TOTAL COLLECTED FILTERS (milligrams)		TOTAL COLLECTED PROBE WASH (milligrams)		NET TOTAL PARTICULATE (milligrams)
1	9.4	+	36.9	=	46.3
2	1.0	+	41.5	=	42.5
3	20.4	+	36.7	=	57.1

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

PARTICULATE EMISSION DISCHARGE

$Cd_s = (2000)\ (Caw/S_D)$

Cd_s = particulate emission discharge, lb/ton dry sludge

C_{aw} = particulate matter mass emissions, lb/hr

S_w = average wet sludge charging rate during the run, lb/hr

NOTE: This data provided by customer.

S_D = average dry sludge charging rate during the run, lb/hr

$= S_w$ - % moisture

% moisture = 55.9

RUN # 1

$$C_{ds} = 2000\ \frac{(0.888\ \text{lb./hr})}{3529\ \text{lb/hr}}$$

S_w = 8003 lb/hr
S_D^w = 3529 lb/hr

53'00 ± percent

0.5037 lb/ton dry sludge

RUN # 2

$$C_{ds} = 2000\ \frac{(0.7814\ \text{lb/hr})}{4032\ \text{lb/hr dry sludge}}$$

S_w = 9142 lb/hr
S_d^w = 4032 lb/hr

9150

= 0.3876 lb/Ton dry sludge

RUN # 3

$$C_{ds} = 2000\ \frac{(1.0932\ \text{lb/hr})}{4204\ \text{lb/hr}}$$

S_w = 9533 lb/hr
S_D = 4204 lb/hr

= 0.5201 lb/ton dry sludge

REFERENCE: CODE OF FEDERAL REGULATIONS (CFR)
Title 40 Protection of Environment
Parts 53 - 80 Revised July 1, 1980
Chapter 1 Part 60, Subpart 0, 60.154

MERCURY EMISSIONS DATA

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

MERCURY EMISSIONS DATA

Three (3) composite sludge samples were collected during the 24-hour operating period between 5:00 p.m. on 7/19/82 and 4:00 pm on 7/20/82. Grab samples were collected from the conveyor before incineration at a rate of one (1) per hour. Each of the composites consisted of eight (8) grab samples with each grab sample having at least a volume of 200 milliliters but not more than 400 milliliters.

COMPOSITE # 1 7/19/82		COMPOSITE #2 7/20/82		COMPOSITE # 3 7/20/82	
GRAB SAMPLE #	TIME COLLECTED	GRAB SAMPLE #	TIME COLLECTED	GRAB SAMPLE #	TIME COLLECTED
1	5 pm	9	1 am	17	9 am
2	6 pm	10	2 am	18	10 am
3	7 pm	11	3 am	19	11 am
4	8 pm	12	4 am	20	12 pm
5	9 pm	13	5 am	21	1 pm
6	10 pm	14	6 am	22	2 pm
7	11 pm	15	7 am	23	3 pm
8	12 am	16	8 am	24	4 pm

$$E_{Hg} = 1 \times 10^{-3}\ cQ$$

E_{Hg} = mercury emissions, g/day

c = mercury concentration of sludge on a dry solids basis, µg/g (ppm)

Q = sludge charging rate, kg/day

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NC

MERCURY CONCENTRATION - (c)

COMPOSITE #	DRY SAMPLE ANALYZED (grams)	ppm Hg Detected	c or ug/g
1	0.4557	0.38	0.8339 = .38 mg / .4557 g
2	0.4106	0.43	1.0472
3	0.4509	0.48	1.0645

SLUDGE CHARGING RATE - (Q)

RUN #	PROCESS DRY WEIGHT (lb/hr)	AVERAGE WEIGHT (lb/hr)	CHARGING RATE (kg/day)
1	3529		
2	4032	3922	42,696*
3	4204		

*Conversion Factors:

1. 24 hours = 1 day
2. 1 pound = 0.4536 kg

MERCURY EMISSIONS (E_{H_g})

$$E_{H_g} = 1 \times 10^{-3}\ cQ$$

COMPOSITE #	MERCURY CONCENTRATION (c)	SLUDGE CHARGING RATE (Q)	MERCURY EMISSIONS (E_{H_g})
1	0.8339	42,696	35.60
2	1.0472	42,696	44.71
3	1.0645	42,696	45.45

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

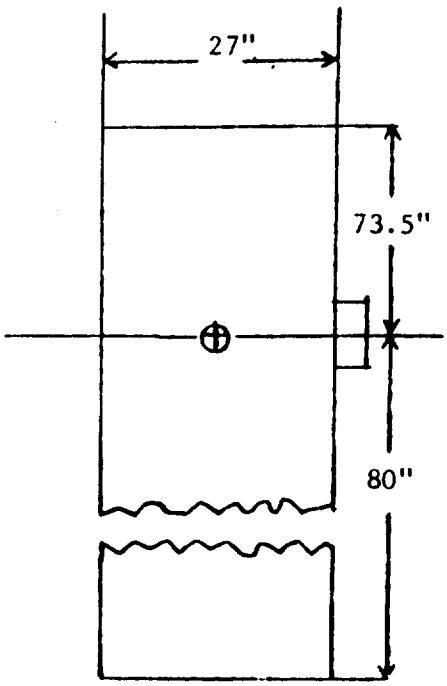
Allowable Emissions - <3200g/day

REFERENCE: CODE OF FEDERAL REGULATIONS (CFR)
Title 40 Protection of Environment
Parts 53 to 80, Revised July 1, 1980
Chapter 1, Part 61, Subpart E 61.52

STACK DIAGRAM AND POINT LOCATIONS

SKETCH OF SAMPLE PORT LOCATION AND SAMPLE POINTS

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA



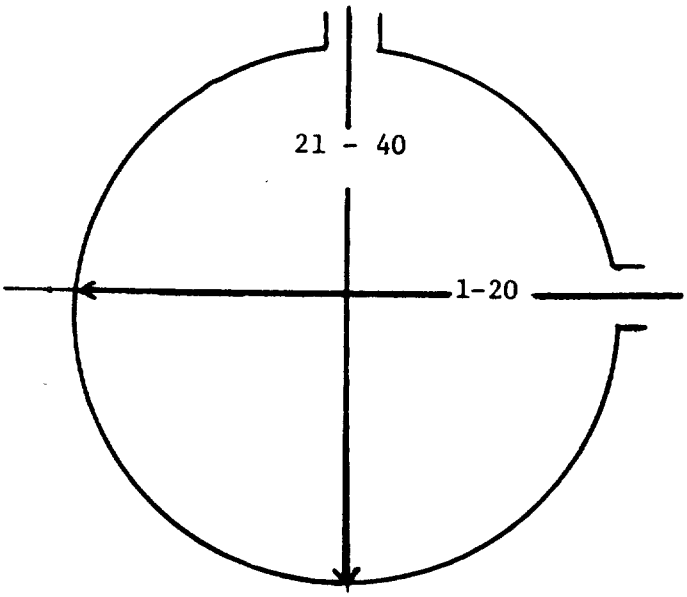
LOCATION OF NEAREST UPSTREAM OBSTRUCTION OR CONFIGURATION CHANGE:

DIAMETER UPSTREAM 2.72

DIAMETER DOWNSTREAM 2.96

STACK AREA (SQ.IN.) 572.56

STACK DIAMETER (IN.) 27



Point	% of Stack Diameter	Inches from inside wall
1,21	1.3	.35
2,22	3.9	1.05
3,23	6.7	1.80
4,24	9.7	2.62
5.25	12.9	3.48
6,26	16.5	4.46
7,27	20.4	5.50
8,28	25.0	6.75
9,29	30.6	8.26
10,30	38.8	10.48
11,31	61.2	16.52
12,32	69.4	18.74
13,33	75.0	20.25
14,34	79.6	21.49
15,35	83.5	22.55
16,36	87.1	23.52
17,37	90.3	24.38
18,38	93.3	25.19
19,39	96.1	25.95
20,40	98.7	26.65

ANALYTICAL METHODS AND REGULATIONS

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

STATEMENT OF METHODS USED TO DETERMINE PARTICULATE EMISSION RATE OF STATIONARY SOURCES

METHOD 1: SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

Principle

To aid in the representative measurement of pollutant emission and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these areas.

Applicability

The method is applicable to flowing gas streams in ducts, stacks and flues. The method cannot be used when: (i) flow is cyclonic or swirling (see section 2.4), (ii) a stack is smaller than about 0.30 meters (12 inches) in diameter, or 0.071 meters^3 (113 inches^2) in cross-sectional area, or (iii) the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance. The requirements of this method must be considered before construction of a new facility from which emissions will be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator, U. S. Evnironmental Protection Agency.

METHOD 2: DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (Type S Pitot Tube)

Principle

The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type 5 (Slausscheibe or reverse type) pitot tube.

Applicability

This method is applicable for measurement of the average velocity of a gas stream and for quantifying gas flow. This procedure is not applicable at measurement sites which fail to meet the criteria of Method 1, Section 2.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; section 2.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, U. S. Environmental Protection Agency, must be employed to make accurate flow rate determinators, examples of such alternative procedures are: (i) install straightening vanes, (ii) to calculate the total volumetric flow rate stoichiometerically, or (iii) to move to another measurement site at which the flow is acceptable.

METHOD 3: GAS ANALYSIS FOR CARBON DIOXIDE, OXYGEN, EXCESS AIR AND DRY MOLECULAR WEIGHT

Principle

A gas sample is extracted from a stack by one of the following methods, (i) single point, grab sampling, or (ii) single point integrated sampling, or (iii) multi point, integrated sampling. The gas sample is analyzed for

percent carbon dioxide (CO_2), percent oxygen (O_2), and if necessary, percent carbon monoxide (CO). If a dry molecular weight determination is to be made, either an Orsat or a Fyrite analyzer may be used for the analysis for excess air or emission rate correction factor determination or Orsat analyzer must be used.

Applicability

This method is applicable for determining CO_2 and O_2 concentrations, excess air, and dry molecular weight of a sample from a gas stream of fossil fuel combustion process. The method may also be applicable to other process where it has been determined that compounds other than CO_2, O_2, CO, and nitrogen (N_2) are not present in concentrations sufficient to affect the results. Other methods, as well as modifications to the procedure described herein, are also applicable for some or all of the above determinations. Examples of specific methods and modifications include: (i) a multi point sampling method using an Orsat analyzer to analyze individual grab samples obtained at each point, (ii) a method using CO_2 or O_2 and stoichiometric calculations to determine dry molecular weight and excess air, (iii) assigning a value of 30.0 for dry molecular weight in lieu of actual measurements, for processes burning natural gas, coal or oil. These methods and modifications may be used, but are subject to the approval of the Administrator.

METHOD 4: DETERMINATION OF MOISTURE CONTENT IN STACK GASES

Principle

A gas sample is extracted at a constant rate from the sources, moisture is

removed from the sample stream and determined either volumetrically or gravimetrically.

Applicability

This method is applicable for determining the moisture content of stack gas. Two procedures are given. The first is a reference method for accurate determinations of moisture content (such as are needed to calculate emission data). The second is an approximation method, which provides estimates of percent moisture to aid in setting isokinetic sampling rates prior to a pollutant emission measurement run. The approximation method described herein is only a suggested approach, alternative means for approximating the moisture content, e.g., drying tubes, wet bulb-dry bulb techniques, condensation techniques, stoichiometeric calculations, previous experience, etc., are also acceptable. The reference method is often conducted simultaneously with a pollutant emission measurement run, when it is, calculation of percent isokinetic, pollutant emission rate, etc., for the run shall be based upon the results of the approximation method, unless the approximation method is shown to the satisfaction of the Administrator, U. S. Environmental Protection Agency, to be capable of yielding results within one percent H_2O of the reference method.

NOTE: The procedure described in Method 5 for determining moisture content is acceptable as a reference method.

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

METHOD 5: DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

Principle

Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature in the range of 120± 14°C (248± 25°F) or such other temperatures as specified by an applicable subpart of the standards or approved by the Administrator, U. S. Environmental Protection Agency, for a particular application. The particulate mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water.

Applicability

This method is applicable for the determination of particulate emissions from stationary sources.

FEDERAL REGISTER, Volume 42, Number 160, Standards of Performance for New Stationary Sources, Revision of Reference Method 1-8, August 18, 1977.

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

METHOD 105: DETERMINATION OF MERCURY IN WASTEWATER TREATMENT PLANT SEWAGE SLUDGES

Principle

A weighed portion of the sewage sludge sample is digested in aqua regia for two (2) minutes at 94°C followed by oxidation with potassium permanganate. Mercury in the digested sample is then measured by the conventional spectrophotometer cold vapor technique.

Applicability

This method is applicable for the determination of total organic and inorganic mercury content in sewage sludges, soils, sediments, and bottom-type materials.

CODE OF FEDERAL REGULATIONS, Title 40, Protection of Environment, Pages 60 - 97

Revised as of July 1, 1978 Chapter 1, Appendix B

DESCRIPTION OF VARIABLES USED

A - Stack area, sq. in.

AN - Sampling nozzle diameter, in.

CP - Pitot tube coefficient

ΔH - Average orifice pressure drop, in. water

ΔP - Average velocity head, in. water

PBAR - Barometric pressure, in. mercury

PG - Average stack pressure (gauge), in. water

TM - Average meter temperature, °F

TS - Average stack temperature, °F

UPR - Unit heat production rate, lb./million BTU

VBF - % CO_2 in stack gas (by volume)

VBG - % CO in stack gas (by volume)

VBH - % O_2 in stack gas (by volume)

VBI - % N_2 in stack gas (by volume)

VCB - Water condensed, ml

VCD - Water absorbed, ml

VM - Sample gas volume at meter conditions, scf

WAK - Particulate collected - probe, cyclone & filter - mg

YAK - Particulate collected - impingers - mg

WAL - Particulate collected - total - mg

Y - Calibration factor

Θ - Total sampling time, min.

EQUATIONS USED IN STACK TESTING PROGRAM

Average Stack Pressure, $PS = \frac{PG}{13.6} + PBAR$

Dry Gas Sample Volume at Std. Conditions, $VMSTD = \frac{17.64 \times VM \times Y \times \left(PBAR + \frac{\Delta H}{13.6}\right)}{TM + 460}$

Water Collected in Impingers & Silica Gel, $VLC = VCB + VCD$

Volume of Water Vapor at Std. Conditions, $VWSTD = (.04707 \times VCB) + (.04715 \times VCD)$

Percent Moisture by Volume, $BWG = \frac{100 \times VWSTD}{VMSTD + VWSTD}$

Mole Fraction of Dry Gas, $MCH = \frac{100 - BWG}{100}$

Avg. Molecular Weight of Dry Stack Gas,
$MD = (VBF \times .44) + (VBG \times .28) + (VBH \times .32) + (VBI \times .28)$

Molecular Weight, Wet Basis, $MS = (MD \times MCH) + (18 \times (1 - MCH))$

Average Stack Velocity, $VS = \frac{85.49 \times CP \times \sqrt{\Delta P} \times \sqrt{TS + 460} \times 60}{\sqrt{PS \times MS}}$

Stack Flow Rate, Dry, Std. Conditions, $QSD = VS \times \frac{A}{144} \times MCH \times \frac{PS}{29.92} \times \frac{528}{TS + 460}$

Actual Stack Flow Rate, $VDA = VS \times \frac{A}{144}$

% Isokinetic, $IAX = \frac{100 \times (TS+460) \times \left((.002669 \times VLC) + \frac{VM}{TM+460}\right) \times \left(PBAR + \frac{\Delta H}{13.6}\right)}{\Theta \times VS \times PS \times \left(\frac{AN}{24}\right)^2 \times 3.14159}$

Excess Air, $EXAIR = \frac{(VBH - (.5 \times VBG)) \times 100}{(.264 \times VBI) + (.5 \times VBG) - VBH}$

PARTICULATE CONCENTRATIONS

In grains per dscf

$$\text{Probe, cyclone \& filters} = \frac{.0154 \times WAK}{VMSTD}$$

$$\text{Impingers} = \frac{.0154 \times YAK}{VMSTD}$$

$$\text{Total} = \frac{.0154 \times WAL}{VMSTD}$$

In pounds per hour

$$\text{Probe, cyclone \& filters} = \frac{.00857 \times .0154 \times WAK \times QSD}{VMSTD}$$

$$\text{Impingers} = \frac{.00857 \times .0154 \times YAK \times QSD}{VMSTD}$$

$$\text{Total} = \frac{.00857 \times .0154 \times WAL \times QSD}{VMSTD}$$

In pounds per million BTU

$$\text{Probe, cyclone \& filters} = \frac{.00857 \times .0154 \times WAK \times QSD}{VMSTD \times UHPR}$$

$$\text{Impingers} = \frac{.00857 \times .0154 \times YAK \times QSD}{VMSTD \times UHPR}$$

$$\text{Total} = \frac{.00857 \times .0154 \times WAL \times QSD}{VMSTD \times UHPR}$$

In grains per dscf, adjusted to 12% CO_2

$$\text{Probe, cyclone \& filters} = \frac{.0154 \times WAK \times 12}{VMSTD \times VBF}$$

$$\text{Impingers} = \frac{.0154 \times YAK \times 12}{VMSTD \times VBF}$$

$$\text{Total} = \frac{.0154 \times WAL \times 12}{VMSTD \times VBF}$$

PARTICULATE CONCENTRATIONS (Cont'd)

In pounds per hour, adjusted to 12% CO_2

$$\text{Probe, cyclone \& filters} = \frac{.00857 \times .0154 \times WAK \times QSD \times 12}{VMSTD \times VBF}$$

$$\text{Impingers} = \frac{.00857 \times .0154 \times YAK \times QSD \times 12}{VMSTD \times VBF}$$

$$\text{Total} = \frac{.00857 \times .0154 \times WAL \times QSD \times 12}{VMSTD \times VBF}$$

ALLOWABLE EMISSIONS

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

ALLOWABLE EMISSIONS

REFERENCE: CODE OF FEDERAL REGULATIONS (CFR) Title 40
Protection of Environment Parts 60 - 98
Revised July 1, 1978 Chapter 1

Subpart 0, 60.152 standard for particulate matter
Section a,

No owner or operator of any sewage sludge incinerator subject to the provisions of this subpart shall discharge or cause the discharge into the atmosphere of:

(1) Particulate matter at a rate in excess of 0.65 g/kg dry sludge input (1.30 lb/ton dry sludge input).

REFERENCE: CODE OF FEDERAL REGULATIONS (CFR) Title 40
Protection of Environment Parts 60 - 99
Revised July 1, 1978 Chapter 1

Subpart E - National Emission Standards for Mercury
61.52 Emission standard. paragraph b

Emissions to the atmosphere from sludge incinerator plants, sludge drying plants, or a combination of these that process wastewater plant sludges shall not exceed 3200 grams of mercury per 24-hour period.

EQUIPMENT DESCRIPTION

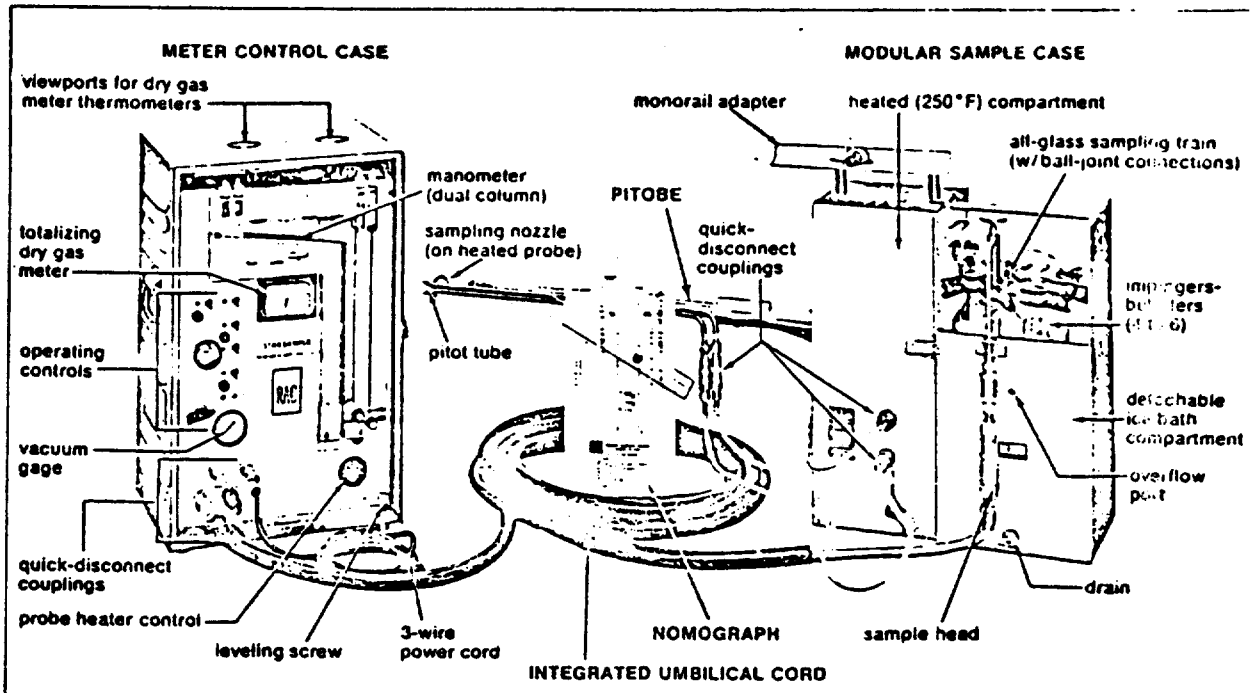


FIGURE 7
RAC Staksamplr components and design features.

Glass Sampling Train: 1 cyclone, 1 flask, 1 filter holder (2.5", 64 mm), 4 impinger-bubbler units* (500 ml), 3 "U" connectors, 1 elbow (all with ball-joint connections: 28/15 inlets & 28/12 outlets); 12 metal clamps.

**Ice bath & sampling train are designed to accommodate 6 impinger-bubbler units.*

PITOBE ASSEMBLY

Combines heated probe & detachable pitot tube; 3', 5' & 10' effective lengths; stainless steel construction; ball-joint & quick-disconnect attachments; 3' & 5' units with Pyrex glass or stainless steel liners; 10' with stainless steel liner only.

Sampling Nozzles: ¼", ⅜" & ½" ID stainless steel units supplied with pitobe; other optional sizes & materials are available.

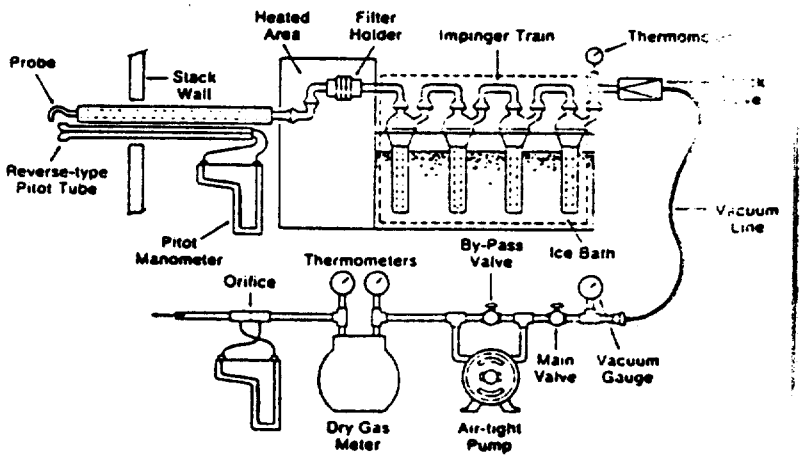
UMBILICAL CORD

Contains pitot & sample lines plus power cable, all with quick disconnects; also contains leads for 2-way intercom; supplied in modular 25', 50' & 100' lengths that weigh 10 lbs per 25' section; custom lengths to 300' available on special order.

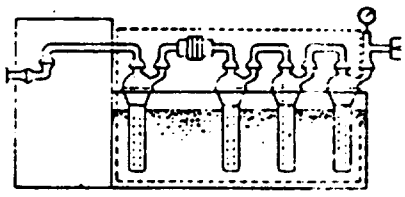
ELECTRICAL

System operates on 115 v, 60 Hz, 13.6 amps (total) in steady running; all connections are twist-lock 3-wire grounding type.

RAC Staksamplr Schematic of EPA Particulate Sampling Train (Method 5)
Same basic configuration used to sample Beryllium & Mercury Vapor (Federal Register, Vol. 36, Nos. 234 [Be, Hg] & 247)



Configuration of Sample Case for sampling SO_3, SO_2 & H_2SO_4 MIST (Method 8)
Heated area is by-passed; particulate filter positioned between 1st & 2nd impingers; all other components same as for particulate sampling.
(Federal Register, Vol. 36, No. 247)



CALIBRATION DATA

ROCKY RIVER WASTEWATER TREATMENT PLANT
CONCORD, NORTH CAROLINA

EXPLANATION OF MOGUL STAKSAMPLER

CALIBRATION SHEETS

ΔH is the same as on the EPA sheet.

Wet test meter volume is the same.

Dry gas meter volume is the same.

Wet test meter temperature is the average of the temperatures taken at the beginning and the end of the calibration run.

WTMT + 460 is the absolute temperature of average temperature of wet test meter in degrees R.

Temperature dry gas plus gas meter:

A. temperature of intake at beginning of run

B. temperature of intake at end of run

C. temperature of outlet at beginning of run

D. temperature of outlet at end of run.

Temperature Dry Gas = A + B + C + D

Average Temperature = $\frac{A + B + C + D}{4}$ = average temperature of intake and outlet of dry gas meter.

Temperature 460 = $\frac{A + B + C + D}{4}$ + 460 = absolute temperature

Time = length of run.

SAMPLE CALCULATION

Run #3, $\Delta H = 6$

1. γ

$$\frac{(Vw)(Pb)(td + 460)}{V_D(Pb + \frac{\Delta H}{13.6})(tw + 460)}$$

2. $$\frac{(19.059)(30.29)(549)}{(19.834)(30.29 + \frac{6}{13.6})(520.35)}$$

3. $\gamma = .999$

Time = 0; length of run.

Date 7/12/82

Box Serial No. Nutech - SD

Barometric Pressure 29.250 "Hg

γ = .9922

$\Delta H@$ = 1.719

Run #	ΔH	Wet Test Meter Volume	Dry Test Meter Volume	WTMT	WTMT + 460	Temp. Dry Gas Meter in A	Temp. Dry Gas Meter in B	Temp. Dry Gas Meter out C	Temp. Dry Gas Meter out D	Average Temp. Dry Gas	Dry Gas Temp. + 460	Time
1	.5	4.301	4.509	73.0	533.0		94.0		94.0	94.0	554.0	10
2	1.0	5.820	6.155	73.0	533.0		102.0		97.0	99.5	559.5	10
3	2.0	7.805	8.196	73.0	533.0		97.0		99.0	98.0	558.0	10
4	4.0	11.216	11.729	73.0	533.0		99.0		103.0	101.0	561.0	10
5	5.0	12.261	12.874	73.0	533.0		102.0		104.0	103.0	563.0	10
6	6.0	13.532	13.978	73.0	533.0		93.0		95.0	94.0	554.0	10
7												
8												

.5	.9902	1.502
1.0	.9900	1.624
2.0	.9924	1.810
4.0	.9960	1.745
5.0	.9935	1.818
6.0	.9912	1.820

S. Faires

Calibrated by: S. Faires

The Mogul Corporation

RAW FIELD DATA

NAME Rocky River Wastewater ADDRESS Concord, N.C.

JOB NO. _____ CUSTOMER NO. _____ LOCATION Incinerator Outlet

RUN NO. 1 DATE OF TEST 7/20/82

Impinger Box # RAC #3
Filter Paper # 28
Meter Box # Nutech

PBAR 29.150, VM 43.301, PG .1

VCB 39.4, VCD 13.4

VBF 3.06, VBG 0.0, VBH 4.32, VBI 22.26

A 5.22.9, CP .84, Y ~~.80~~ .9922

WAK 46.3, YAJ 0.0, WAL 46.3

AN .250, E 80, WTT _____

UPR –, (COMBUSTION ONLY)

☐ Process ☑ English Units
☐ Combustion ☐ Metric Units
☑ Incinerator

Static - .1

CLOCK TIME	POINT	GM READING	~~STACK~~ PRESS. VAC	PITOT ΔP.	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
9.00	1	51.777	.1	.284	133	.80	86	
	2	53.795		.29	140	.96		
	3	54.600	.1	.29	141	.96	90	65
	4	55.700		.25	142	.81		
	5	56.900		.27	142	.90	91	
	6	57.875	.1	.24	142	.80		
	7	59.266		.24	142	.80	94	
	8	60.213		.22	141	.72		67
	9	61.430	.1	.22	140	.72	95	
	10	62.050		.21	140	.70		
	11	63.075		.22	141	.72		
	12	64.420	.1	.22	142	.72	100	69
	13	65.270		.22	144	.72		
	14	66.185		.23	145	.77	102	
	15	67.225		.22	146	.72		
	16	68.250	.1	.21	146	.70		
	17	69.155		.21	146	.70	105	
	18	70.300		.20	146	.67		
	19	71.390	.1	.20	146	.67		66
STOP 940	20	72.560		.21	147	.70	107	
START 943	21	73.333		.24	134	.80		
	22	74.535		.24	135	.80	108	

NAME Rocky River Wastewater ADDRESS Concord

JOB NO. _____ CUSTOMER NO. _____ LOCATION Incinerator Outlet

RUN NO. 1 DATE OF TEST 7/20/82

Impinger Box # SD #3
Filter Paper # 28
Meter Box # Notch

PBAR 29.150, VM 613.341, PG 1 in H_2O

VCB 39.4, VCD 13.4 →

VBF 30 (Clear) VBG 00 (Dry), VBH 4.52 O_2, VBI 2226 ◇ % N_2

A 5.32.56, CP .84, Y .9922

WAK 46.3, YAJ 00, WAL 46.3

AN .250, E 80, WTT _____

UPR _____, (COMBUSTION ONLY)

☐ Process ☑ English Units
☐ Combustion ☐ Metric Units
☑ Incinerator

4% CO_2
15.54

CLOCK TIME	POINT	GM READING (Leak Ck .005 CR)	STACK PRESS.	PITOT ΔP.	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
	23	75.5	.1	26	137	.86		109
	24	76.940		.30	138	99		
	25	77.900		30	137	.99		110
	26	79.250	.1	33	138	1.10		
	27	80.315		.31	137	1.04		113
	28	81.640		.27	139	.90		
	29	82.932		.26	141	.86		
	30	84.100		.20	143	.67		114
	31	85.045	.1	.20	~~134~~ 143	.67		
	32	85.765		.20	144	.67		115
	33	86.854		.19	144	.64		
	34	87.960	.1	.20	145	.67		115
	35	88.830		.25	144	.84		
	36	90.475		.24	143	.80		
	37	91.365		.24	141	.80		117
	38	92.720		.25	142	.84		
	39	93.460	.1	.28	143	.93		
	40	95.118		.24	142	.80		118
		Lk Ck .006		~~19.6096~~ / 40				
STP		1		.4902				
10:23								
			END	.4902	141.6	.775		96

NAME [illegible] ADDRESS CONCORD, N.

JOB NO. _____ CUSTOMER NO. _____ LOCATION INCINERATION ONSITE

RUN NO. 2 DATE OF TEST 1/20/82

PBAR 29.05, VM 37.021, PG .1

VCB 23.0, VCD 16.0

VBF 3.08, VBG 0.0, VBH 1.32, VBI 22.26

A 372.56, CP .841, Y .9922

WAK .025, YAJ 0.0, WAL 42.5

AN .250, E .80, WTT _____

UPR _____, (COMBUSTION ONLY)

KCIL .012 AT 5"

Impinger Box # 2
Filter Paper # 41
Meter Box # Nozzle

☒ Process ☒ English Units
☐ Combustion ☐ Metric Units
☒ Incinerator

CLOCK TIME	POINT	GM READING	STACK PRESS.	PITOT ΔP.	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
~~11:47~~	1	96.502		15	134	.54		
	2	96.466	~~.02~~	19	137	.65		111
	3	98.445	1"	.20	141	.68		
	4	99.610		20	143	.67		
	5	100.630		.21	140	70		110
	6	101.672		.24	138	80		
	7	102.817		.20	130	.67		
	8	103.965	1"	.20	130	.67		110
	9	105.283		.19	133	.65		
	10	106.129		.18	134	.62		113
	11	106.832		.17	135	.58		
	12	109.401	1" Hg	.15	137	.54		114
	13	108.788		.15	136	.54		
	14	109.655		.16	137	.55		114
	15	110.990		17	138	.58		
	16	111.487		.15	138	.54		115
	17	112.410		.15	137	.54		
	18	113.575	1"	.16	139	55		
	19	114.330		.15	138	.54		116
12:51	20	115.185		.15	138	.54		
START 12:XX	21	116.275		.15	131	.54		115
	22	117.050		.14	139	49		

NAME [illegible] ADDRESS [illegible]

JOB NO. _____ CUSTOMER NO. _____ LOCATION Incinerator Outlet

RUN NO. 2 DATE OF TEST 7/20/92

PBAR 29.155, VM 37.026, PG 1

VCB 230, VCD 160

VBF 308, VBG 00, VBH 432, VBI 222

A 572.36, CP .501, Y ~~.98~~ .9922

WAK 465, YAJ 0.0, WAL 425

AN .250, E ~~.80~~ .800, WTT -

UPR -, (COMBUSTION ONLY)

Impinger Box # 2
Filter Paper # 41
Meter Box # [illegible]

☐ Process ☑ English Units
☐ Combustion ☐ Metric Units
☑ Incinerator

O_2 13.5
CO_2 7.0

STP 12.118

CLOCK TIME	POINT	GM READING	STACK PRESS.	PITOT ΔP.	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
				~~.14~~		~~.49~~		~~115°~~
	33	117.825	1"	.14	141	.49		115°
	34	118.601		14	139	49		
	35	119.332		.14	141	.49		
	36	120.750		.15	140	.54		116°
	37	121.500	1"	15	139	.54		
	38	122.610		14	139	.49		
	39	123.400		14	137	.49		
	30	124.35		.13	135	.46		117
	31	125.230		.13	134	.46		
	32	126.972		13	134	.46		117
	33	127.135		.14	133	.49		
	34	127.990	1"	.13	133	.46		
	35	128.990		13	132	.46		
	36	130.000		.15	132	.54		118°
	37	130.355		.14	132	.49		
	38	131.225	1"	.14	133	.49		
	39	132.240		.15	132	.54		119°
STOP	40	133.530		.14	132	.49		
		FINAL LK CK	.009 ✓					
			at 5"	15.8991 / 40				
	STOP							
	12:14			(.3962)	1361	.5515		110.9

NAME [illegible] ADDRESS [illegible]

JOB NO. _____ CUSTOMER NO. _____ LOCATION [illegible]

RUN NO. 2 3 DATE OF TEST 7/30/[illegible]

PBAR 29.115, VM 96.129, PG .1

VCB 31.4, VCD 12.5

VBF 1.32, VBG 0.0, VBH 5.44, VBI 2.2[illegible]

A 572.56[illegible], CP .841, Y .9922

WAK 52.1, YAJ 0.0, WAL 52.1

AN 250, E 80, WTT —

UPR _____, (COMBUSTION ONLY)

Impinger Box # [illegible]
Filter Paper # 33
Meter Box # [illegible]

☐ Process ☑ English Units
☐ Combustion ☐ Metric Units
☑ Incinerator

[illegible] 008 of 5

CLOCK TIME	POINT	GM READING	STACK PRESS.	PITOT ΔP	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
12:45	1	133.617		.15	158	.54		9[illegible]
	2	134.050	1.5"	.17	170	.58		[illegible]
	3	135.940		.18	177	.62		
	4	136.900		.20	178	.66		
	5	137.[illegible]		.21	178	.65		9[illegible]
	6	138.900	2"	.22	173	.67		
	7	139.915		.21	175	.74		
	8	140.35[illegible]		.24	175	.74		
	9	140.990		.23	174	.71		9[illegible]
	10	141.030	2"	.26	173	.80		
	11	141.550		.32	176	1.05		
	12	145.[illegible]80		.36	179	1.12		
	13	146.740		.38	182	1.18		9[illegible]
	14	147.960		.40	184	1.24		
	15	149.930		.39	195	1.20		
	16	150.785	2"	.38	202	1.18		
	17	151.990		.40	199	1.24		
	18	153.[illegible]51		.39	200	1.20		9[illegible]
	19	154.[illegible]10		.39	204	1.20		
STOP	20	156.120		.43	197	1.35		
STEP 228	21	157.350		.21	154	.65		
	22	156.332		.24	179	.71		9[illegible]

NAME [illegible] ADDRESS [illegible]

JOB NO. _____ CUSTOMER NO. _____ LOCATION _____

RUN NO. 3 DATE OF TEST 7/20/92

Impinger Box # None #1
Filter Paper # 33
Meter Box # None

PBAR 29.015, VM 46.129, PG 1

VCB 3.4, VCD 12.5

VBF 1.32, VBG 0.0, VBH 5.44, VBI 22.40

A 572.56, CP .84, Y .992

WAK 57.1, YAJ 0.0, WAL 57.1

AN .250, E 80, WTT _____

UPR _____, (COMBUSTION ONLY)

☐ Process ☐ Combustion ☑ Incinerator

☑ English Units ☐ Metric Units

CLOCK TIME	POINT	GM READING	STACK PRESS.	PITOT ΔP	STACK TEMP. TS	ORIFICE ACT. ΔH	METER T_{in} TAD.	METER T_{out} TAE.
				~~.27~~	~~190~~	~~.84~~		
	23	157.805		.27	170	.84		
	24	160.555		.26	168	.80		95
	25	163.[illegible]		.28	187	.86		
	26	166.915		.23	164	.71		
	27	168.700		.26	177	.80		95
	28	169.950		.28	170	.86		
	29	171.160		.30	164	.92		
	30	172.345	2.5"	.31	161	.96		
	31	173.520		.31	164	.96		95
	32	174.[illegible]		.30	165	.92		
	33	175.708		.31	167	.96		
	34	176.973	2.5"	.33	166	1.03		
	35	178.265		.27	168	.86		98
	36	179.385		.30	169	.92		
	37	180.680		.31	168	.96		
	38	181.910		.33	166	1.05		
	39	183.205		.32	166	.98		105
	40	184.746		.32	164	.98		106
		FINAL LR	CK .0091	~~.40~~				
STOP	3.08							
				.5366	196.7	.9108		96.45

CUSTOMER ROCKY RIVER STACK INCINERATOR OUTLET DATE 11/30/92

ATE		AFTER	BEFORE	+ GAIN - LOSS		AFTER	BEFORE	+ GAIN - LOSS
		RAC BOX # 2	TEST # 2			NUTECH BOX # 1	TEST # 3	
MPINGERS TO .1 GRAMS	1A	592.1	576.3	= + 15.8	2A	607.1	587.2	= 19.9
ACK HALF RAMS OF WATER OLLECTED	1B	596.3	591.3	= + 50	2B	580.6	572.7	= 7.9
	1C	479.6	477.4	= + 2.2	2C	488.8	485.2	= 3.6
	1D	872.5	856.5	= + 16.0	2D	891.5	879.0	= 12.5
				+ 39.0				43.9
		BOX # SD#3	TEST # 1			NUTECH BOX # 2	TEST #	
	3A	623.7	596.6	= 27.1	4A	NOT USED	579.3 KF ~~591.2~~	= NOT USED
	3B	580.8	572.3	= 8.5	4B		574.9	=
	3C	489.3	485.5	= 3.8	4C		473.4	=
	3D	894.7	881.3	= 13.4	4D		860.8	=
				52.8				

THE MOGUL CORPORATION

Consulting Engineering Services

Arlington, TX • Chagrin Falls, OH • Charlotte, NC
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