Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

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FINAL REPORT

EMISSION COMPLIANCE TEST PROGRAM

AT

EAST SHORE WASTEWATER TREATMENT PLANT
NEW HAVEN, CONNECTICUT

CONDUCTED ON

AUGUST 26, 1982

FOR

ZIMPRO, INC.
MILITARY ROAD
ROTHSCHILD, WISCONSIN 54474

BY

YORK SERVICES CORPORATION
ONE RESEARCH DRIVE
STAMFORD, CONNECTICUT 06906

YSC PROJECT NO. 01-4188-00

SEPTEMBER 10, 1982

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1.0 INTRODUCTION

York Services Corporation (YSC) was contracted by Zimpro Pollution Control Systems to conduct an emission test program on the multiple hearth sludge incinerator at the East Shore Wastewater Treatment Plant in New Haven, Connecticut. The purpose of the test program was for the collection of data needed by the Connecticut Department of Environmental Protection (DEP) to determine compliance for particulate emissions according to the DEP New Source Performance Standards (NSPS). The testing was conducted on August 26, 1982.

2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

The results of the emission test program, conducted on the incinerator at the East Shore Wastewater Treatment Plant are presented in this section. All testing was conducted in accordance with methods outlined by the Environmental Protection Agency.

Particulate Results

A total of three particulate emission tests were performed. The average emission rate calculated in pounds of particulate per 1,000 pounds of flue gas corrected to 50% excess air is 0.0321. Table 2-1 summarizes the particulate test data and results.

Section 19-508-18 of the Connecticut Air Pollution Rules states that for existing incinerators "No person shall use or cause to be used for any existing incinerator which will emit more than four-tenths pound of particulates per one thousand pounds of flue gas adjusted to fifty percent excess air." The results of the test program indicate that the sludge incinerator was in compliance during the test period.

TABLE 2-1

SUMMARY OF PARTICULATE TEST DATA AND RESULTS
EAST SHORE WASTEWATER TREATMENT PLANT
NEW HAVEN, CONNECTICUT

General Data	Test 1	Test 2	Test 3	Average
Date	8/26/82	8/26/82	8/26/82	
Time	1430-1536	1940-2045	2120-2235	
Isokinetic Ratio (%)	98.04	100.10	99.59	99.24
Gas Data				
Average Stack Temperature, (°F)	184.6	170.8	166.3	173.9
Volumetric Flow Rate (acfm)	15079	13660	13978	14239
Volumetric Flow Rate (scfmd)	11829	10848	11204	11294
Moisture by Volume (%)	4.44	5.34	5.14	4.97
Gas Composition (Dry Percent Basis)				
Carbon Dioxide	6.17	6.80	8.73	7.23
Oxygen	11.43	10.93	8.40	10.25
Carbon Monoxide	0.0	0.0	0.0	0.0
Sludge Calculations				
Wet Sludge (TPH)	3.991	4.414	4.800	4.402
Percent Solids	31.93	32.24	28.25	30.81
Dry Solids (TPH)	1.2743	1.4230	1.3560	1.3511
Particulate Emission Results				
Pounds per Hour	1.3177	1.3322	0.8229	1.1576
Lb/1,000 lb of Flue Gas Corrected to 50% Excess Air	0.0381	0.0401	0.0182	0.0321
Pounds per Ton of Dry Sludge	1.0341	0.9362	0.6069	0.8591

3.0 PROCESS DESCRIPTION

The Zimpro multiple hearth incinerator system is designed to accomodate approximately 126 tons per day of sludge cake.

The Zimpro multiple hearth incinerator has seven circular hearths, stacked one on top of the other in a cylindrical containment vessel. A central rotating shaft has rabble arms attached. The incinerator system is shown schematically in Figure 3-1.

Sludge enters the incinerator at the top and is dropped directly to Hearth 1, via a peripheral drop hole on Hearth 0 (Hearth 0 is used only for burning of combustible gases). The sludge cake is rabbled inwardly across Hearth 1, drops onto Hearth 2, moves outwardly across Hearth 2, drops onto Hearth 3, and continues alternately until the residual ash is rabbled outwardly across Hearth 6 to a single peripheral ash outlet.

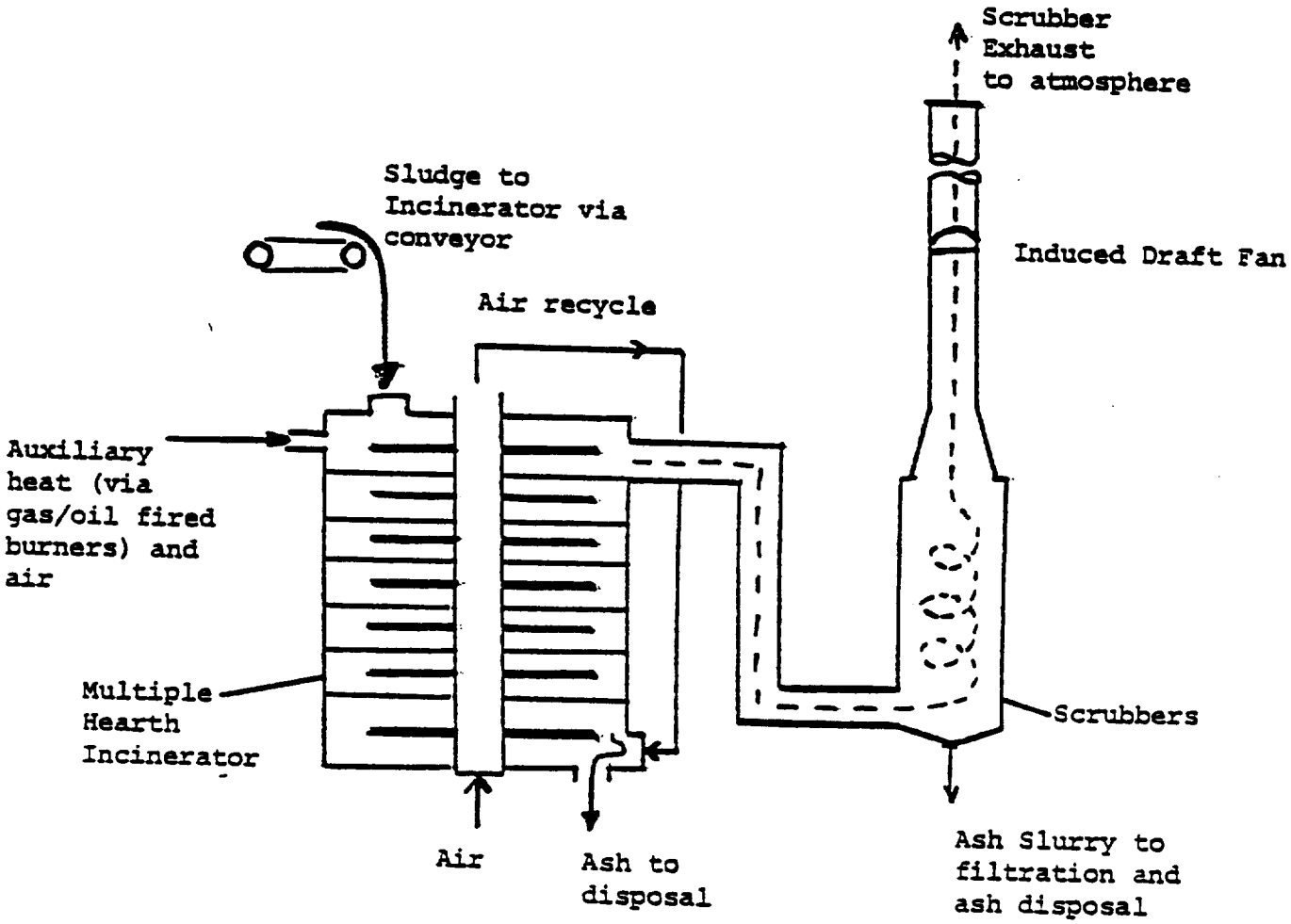
The residual ash that is discharged at the bottom of the incinerator is conveyed to a storage hopper until it is hauled away by truck. The exhaust gases produced by incineration are burned on Hearth 0 and are cleaned and cooled by the gas handling system (series of scrubbers) prior to discharging them to the environment.

The following are scrubber design parameters:

- The scrubber is designed to meet the 1.3 lb of particulate per dry ton of sludge emission regulation

- The design pressure drop across the scrubber is 25" H_2O

- The scrubber is designed to use 1300 gpm of water
- The scrubber gas temperature - 1400°F inlet, 105°F outlet.



MULTIPLE HEARTH INCINERATION SYSTEM

FIGURE 3-1

4.0 SAMPLING LOCATIONS

Scrubber Outlet

Particulate and gas composition samples were taken at the scrubber outlet stack. The location of the sampling points was determined in accordance with EPA Method 1.[1]

The scrubber outlet stack is 4.0 feet in diameter. Two test ports, 90 degrees apart, are located 8.38 stack diameters from the downstream disturbance, and 2.08 diameters from the stack exit. A total of twelve traverse points, six per port, is required at this location in a gas stream (Figure 4-1).

Conveyor Belt

All sludge samples were taken from the conveyor belt after the dewaterization process.

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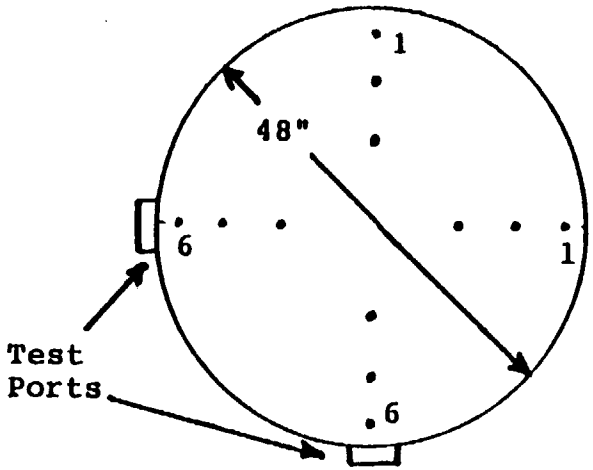
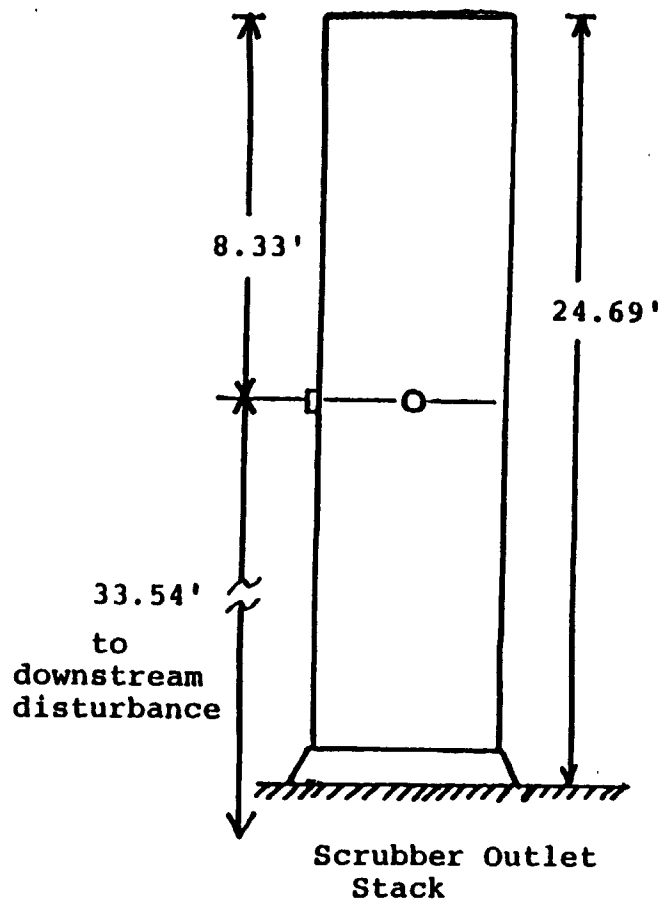
[1] 40 CFR 60, Appendix A, Method - 1 - Sample and Velocity Traverses for Stationary Sources.



TRAVERSE POINT	DISTANCE FROM STACK WALL (inches)
1	2.11
2	7.01
3	14.21
4	33.79
5	40.99
6	45.89



SCRUBBER OUTLET

TEST PORT AND SAMPLING POINT LOCATIONS

FIGURE 4-1

5.0 SAMPLING AND ANALYTICAL PROCEDURES

Measurement procedures, sample recovery, handling techniques and laboratory analytical procedure were conducted in accordance with United States Environmental Protection Agency (USEPA) NSPS guidelines.[2]

5.1 Preliminary Measurements

Preliminary flow characteristics had been determined by YSC during previous test programs. A check, however, was made before each test run to confirm the conditions.

5.2 Flue Gas Composition

The gas composition was determined in accordance with EPA Method 3.[3] A gas sample was collected during each particulate test. A sample line was attached to the sampling probe. A gas sample was drawn by a vacuum pump into an evacuated tedlar bag at a rate proportional to the stack velocity. The contents of the bag were analyzed for O_2, CO_2 and CO with an Orsat Analyzer® immediately after collection. Figure 5-1 illustrates the sampling train and analyzer.

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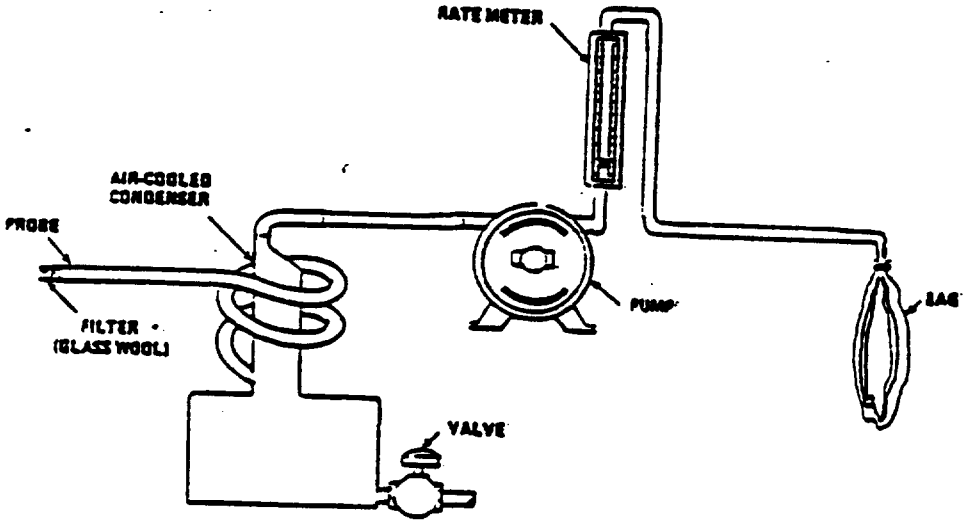
2 "Standards of Performance for New Stationary Sources, Subpart O"-"Standards of Performance for Sewage Treatment Plants", Appendix A, 40 CFR 60, November 9, 1979.

3 40 CFR 60, Appendix A, Method 3 - Gas Analysis for Carbon Dioxide, Excess Air and Dry Molecular Weight.



Integrated Gas Sampling Train
and
Orsat Analyzer

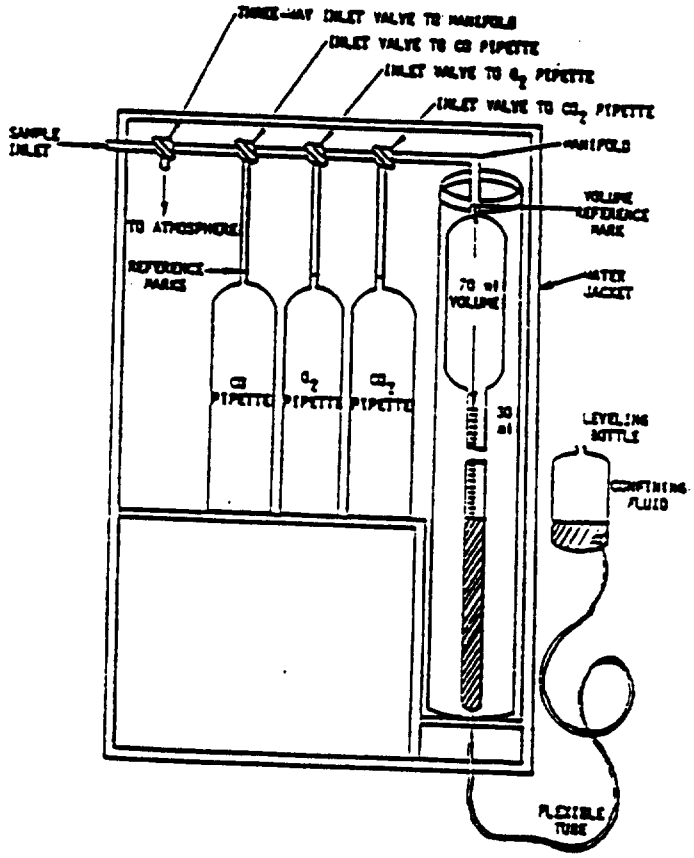


FIGURE 5-1

5.3 Particulate Concentrations

Particulate concentrations were determined in accordance with EPA Method 5.[4] This method calls for isokinetic sampling of the flue gas to ensure a representative particulate sample.

Sampling Apparatus

The particulate sampling apparatus consisted of a probe, pitot tube, filter holder, four impingers, dry gas meter, vacuum pump and flow meter, as shown in Figure 5-2. A calibrated nozzle was attached to the sampling end of the probe which had a heated stainless steel liner. After passing through the nozzle and probe, the sample was drawn through the tared fiberglass filter which was encased in an oven to maintain a temperature of 250°F. The sample then passed through the impinger system which was contained in an ice bath.

The first and second impingers were initially filled with 250 ml each distilled water. The third impinger was left dry and the fourth impinger contained 300 g of indicating type silica gel. The temperature at the exit of the last impinger was monitored with a thermometer that measured to the nearest 1°F. A sample line connected the last impinger to the meter box.

Sampling Procedures

Initial and final leak checks were performed on each sampling train to confirm the presence of a leak-free system (leakage rates did not exceed 0.02 cfm per EPA Standards).

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4 40 CFR 60, Appendix A - Reference Method 5 - Determination of Particulate Emissions from Stationary Sources.

HIGH VOLUME SAMPLING TRAIN

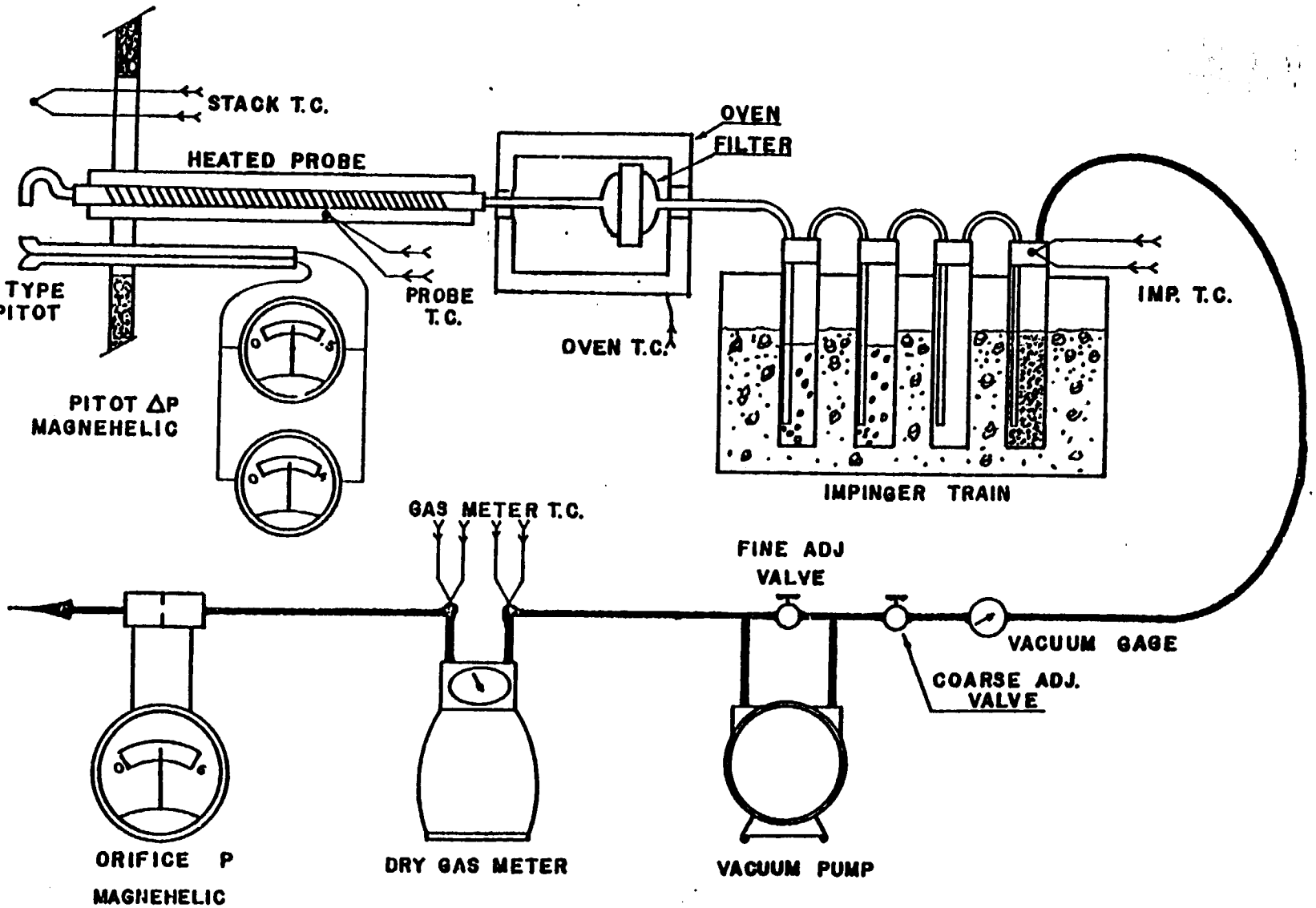

FIGURE 5-2

The proper nozzle size was determined using data obtained from the preliminary tests. The probe and filter assemblies were heated to 248 ± 25°F to prevent condensation.

A programmable calculator was used to correlate all of the sampling variables such that a direct relationship between Δp and ΔH was made and the sampling rate could quickly be adjusted when the gas velocity pressure changed.

During the test, the following data were recorded for each traverse point:

- Point designation
- Sampling time (min)
- Clock time (24 hour clock)
- Dry gas meter reading (V_m, ft^3)
- Δp (in. H_2O)
- Desired ΔH (in. H_2O)
- Actual ΔH (in. H_2O)
- Stack temperature (T_s, °F)
- Dry gas meter temperature, inlet and outlet (T_m, °F)
- Vacuum gauge reading (in. Hg)
- Sample box temperature (°F)
- Dry gas temperature at exit of last impinger (°F)

At the beginning and end of each particulate test, the total sludge feed rate (tons) was recorded:

Sample Recovery

At the completion of each test the samples were recovered in the following manner:

Container No. 1: The probe, nozzle and the front half of the filter holder were brushed and rinsed with acetone until clean. The sample was sealed in a glass sample jar.

Container No. 2: The filter was removed from the filter holder, sealed in a covered petri dish and placed in a plastic zippered bag.

Container No. 3: The silica gel from the fourth impinger was weighed to the nearest 0.1 gram. The weight was recorded on the field data sheet.

Container No. 4: A sample of acetone from the field supply was collected in a glass jar to be used as a blank.

All glass sample jars had Teflon-lined lids. Each sample container was labeled with the date, contents and test number and sealed with tape.

Sample Analysis

Each sample was analyzed in the following manner:

Filter - the filter was removed from its sealed container and placed on a tared watch glass. The filter and watch glass were dessicated over anhydrous $CaSO_4$ for 24 hours and weighed to a constant weight. The weight was recorded to the nearest 0.01 mg.

Front-half Acetone - the acetone was transferred to a tared beaker. The acetone was evaporated at ambient temperature and pressure. The beaker was dessicated for 24 hours and weighed to a constant weight. The weight was recorded to the nearest 0.01 mg.

Acetone Blank - the acetone blank was transferred to a tared beaker. The acetone was evaporated at ambient temperature and pressure. The beaker was dessicated for 24 hours and weighed to a constant weight. The weight was recorded to the nearest 0.01 mg. This weight along with each sample volume was used to determine the blank value to be subtracted from each sample weight. However, in no case was an acetone blank of greater than 0.001% used.

5.4 Sludge Samples

Two sludge samples were taken during each particulate test, one at the beginning and one at the end. The sludge was sampled from the conveyor belt after the dewatering device, before the incinerator. The samples were analyzed for percent solids, in accordance with EPA methods[5].

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5 "Standards of Performance for New Stationary Sources, Subpart O" - "Standards of Performance for Sewage Treatment Plants."

REVIEW FORM

Prepared By: Warren D. Hopkins

Warren D. Hopkins
Director
York Services Corporation

Reviewed By: Abraham J. Kurtz

Abraham J. Kurtz
Vice President
York Services Corporation

6.0 APPENDIX

6.1 Field Data Sheets

YSC

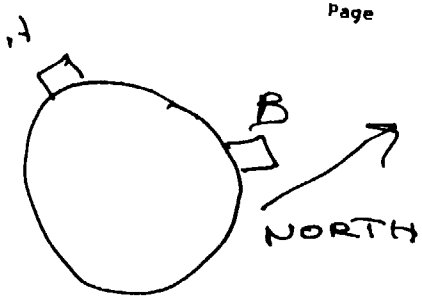
Page

FIELD DATA

JOB. NO.
PLANT EGSTP
DATE 8-26-82
SAMPLING LOCATION
SAMPLE TYPE EPA 5
RUN NUMBER 01
OPERATOR JTB
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 30.01
STATIC PRESSURE, (P_s) -.19
FILTER NUMBER(s) #27
TAR(s) 1.10059

PROBE I.D.
PROBE LENGTH AND TYPE
NOZZLE I.D. .498
ASSUMED MOISTURE, % 3
SAMPLE BOX, I.D.
METER BOX, I.D. AERO #1
METER $\Delta H_@$
Cp .851
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

Vol. H_2O (mls)
Final 550
Initial 500
Net Gain 50 +
Leak Check
Initial .01 @22 "Hg
Final .005 @8 "Hg



Schematic of Port Locations
(Indicate north, Label Ports A,B etc.)

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	By-Pass Temp.
	0	1430	566.134										
A1	5	1435	573.22	.13	1.19	1.19	205	84	84	4.0	270	75	137°
2	10	1440	580.16	.12	1.1	1.1	204	83	84	4.0	260	70	137°
3	15	1445	587.04	.12	1.13	1.13	194	82	83	4.0	263	72	134°
4	20	1450	593.5	.10	.95	.95	190	82	83	3.5	263	76	136
5	25	1455	599.3	.08	.74	.74	194	83	83	3.0	263	72	133
6	30	1500	604.446	.06	.56	.56	194	84	83	2.5	263	71	134°
		1506	604.446										
B1	35	1511	611.65	.13	1.25	1.25	172	82	82	4.0	266	67	131°
2	40	1516	618.9	.12	1.14	1.14	177	82	82	4.0	262	71	130°
3	45	1521	626.05	.12	1.14	1.14	175	82	82	4.0	262	70	128°
4	50	1526	632.32	.09	.86	.86	175	81	82	3.5	264	70	122
5	55	1531	638.0	.08	.76	.76	179	81	81	3.0	262	70	121
6	60	1536	644.366	.09	.85	.85	178	82	81	3.0	262	73	128
			78.232	1.319		.973	184.6	82					
			2										
							57940						
			57943		57944			58092			58091		

COMMENTS:

04-4-80

DRY MOLECULAR WEIGHT DETERMINATION

YSC

PLANT New Haven
DATE 8/26/82
SAMPLING TIME (24-hr CLOCK) Test 1
SAMPLING LOCATION Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 80
OPERATOR BRW/WJB

COMMENTS:

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	6.6	6.6	6.4	6.4	5.5	5.5	6.17	44/100	2.715
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	17.6	11.0	17.4	11.0	17.8	12.3	11.43	32/100	3.658
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	17.6	0	17.4	0	17.8	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)		82.4		82.6		82.2	82.4	28/100	23.072
								TOTAL	29.445

ES-043

YSC

FIELD DATA

JOB. NO. 4188
PLANT
DATE 8-26-82
SAMPLING LOCATION
SAMPLE TYPE EPA
RUN NUMBER 02
OPERATOR JTB BLD.
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 30.21
STATIC PRESSURE, (P_s) -.15
FILTER NUMBER(s)
TAR(s) 1.01956

PROBE I.D.
PROBE LENGTH AND TYPE
NOZZLE I.D. .498
ASSUMED MOISTURE, %
SAMPLE BOX, I.D.
METER BOX, I.D.
METER $\Delta H_@$
Cp .851
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

Vol. H_2O (mls)
Final 550
Initial 500
Net Gain 50 4
Leak Check
Initial .01 @ 18 "Hg
Final .025 @ 15 "Hg

Schematic of Port Locations
(Indicate north, Label Ports A,B etc.)

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1940	660.011									
B1	5	1945	666.5	.1	.94	.94	172	73	73	4.0	262	72
2	10	1950	673.1	.1	.94	.94	173	72	74	4.0	261	66
3	15	1955	679.7	.1	.94	.94	172	72	73	4.0	260	66
4	20	2000	685.4	.09	.846	.846	173	72	73	4.0	255	68
5	25	2005	691.25	.08	.75	.75	173	72	72	3.5	251	68
6	30	2010	697.027	.08	.75	.75	152	71	72	3.0	256	66
	30	2015	697.227									
A1	35	2020	704.1	.1	.94	.94	170	72	72	4.0	256	72
2	40	2025	710.0	.09	.85	.85	174	72	72	4.0	256	71
3	45	2030	716.4	.09	.85	.85	172	72	72	4.0	252	71
4	50	2035	722.0	.08	.75	.75	172	72	72	3.0	251	70
5	55	2040	726.84	.06	.56	.56	173	72	72	3.0	256	70
6	60	2045	731.717	.06	.56	.56	173	71	71	2.5	254	70
			(71.706)	(.292)		.806	170.7	72				

BY PAS TEMP

57936 57945 58093 58094

COMMENTS:

DRY MOLECULAR WEIGHT DETERMINATION

YSC

PLANT New Haven
DATE 8/26/82
SAMPLING TIME (24-hr CLOCK) Test 2
SAMPLING LOCATION OUTLET
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 85
OPERATOR BW/ JJB

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	7.0	7.0	6.8	6.8	6.6	6.6	6.8	44/100	2.992
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	18.0	11	17.6	10.8	17.6	11.0	10.93	32/100	3.499
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	18.0	0	17.6	0	17.6	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)		82		82.4		82.4	82.27	28/100	23.035
								TOTAL	29.526

ES-043

#3 560 ml

QAF S042 Page __ of __
Revision: One
Effective Date: 8/18/77

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	2120	732.054									
A1	5	2125	739.2	.12	1.14	1.14	163	70	70	4.0	258	70
2	10	2130	745.9	.12	1.14	1.14	161	70	70	4.0	253	69
3	15	2135	752.3	.1	.95	.95	166	70	70	4.0	254	69
4	20	2140	758.6	.1	.95	.95	166	70	70	4.0	259	69
5	25	2145	764.6	.08	.76	.76	167	70	70	3.5	251	68
6	30	2150	770.491	.06	.57	.57	168	70	70	3.0	248	68
	30	2205	770.491									
B1	35	2210	776.5	.1	.95	.95	165	69	70	4.0	256	70
2	40	2215	782.5	.09	.85	.85	171	70	70	4.0	251	70
3	45	2220	788.6	.1	.95	.95	168	69	69	4.0	257	70
4	50	2225	794.9	.09	.85	.85	169	69	69	4.0	257	70
5	55	2230	800.7	.08	.76	.76	167	69	69	3.5	258	70
6	60	2235	805.371	.06	.57	.57	164	69	69	3.5	255	70
			(73.317)			.87	166.3	69.6				

TEST 04
#16 1.07954

57939 57938 58095 58096

Moisture TEST 2 550g.

DRY MOLECULAR WEIGHT DETERMINATION

YSC

PLANT New Haven
DATE 8/26/82
SAMPLING TIME (24-hr CLOCK) Test 3
SAMPLING LOCATION Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD ORSAT
AMBIENT TEMPERATURE 72
OPERATOR BRW / DJB

COMMENTS:

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	8.4	8.4	9.0	9.0	8.8	8.8	8.73	44/100	3.843
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	17.0	8.6	17.4	8.4	17.0	82	8.4	32/100	2.688
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	17.0	0	17.4	0	17.0	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)		83		82.6		83	82.87	28/100	23.203
								TOTAL	29.734

ES-043

York Research Corporation

ONE RESEARCH DRIVE, STAMFORD, CONNECTICUT 06906

☐ ENGINEERING NOTES

☐ REPORT DRAFT

REFERENCE No. Y-_____

PAGE_____ of _____ PAGES

CLIENT: Zimpro

SUBJECT: Collection of Sludge sample + belt Totalizer Readings

Aug 26, 1982

Test No.	Time	Reading	
	1415 (2:15)	55360	disengaged
restart at 2:30			
1A	1430 (2:30)	56850	4.17
	1500 (3:00)	59160	
	1530	61020	
1B	1536	61240	
	1610	62450	
2A	1730 (5:30)	Aborted due to overload incorrect	
2A	1900 (7:00)	73330	aborted when Hearty #5 overloaded
2A	1940	76690	4.49
	2010	79240	
	2040	81190	
2B	2045	81470	
3A	2120	84270	
	2150	86300	
	2220	88850	
3B	2235	90270	

6.2 Emission Data Calculations

HP-41 DATA ENTRY FORM

PROGRAM 'STACK'

Job Number	01-4188-00
Plant	EAST SHORE WWTP
Unit	SLUDGE INCIN
Test Location	STACK
Test Condition	NORMAL
Test Date	AUG. 26, 82
Test Number	PART 01
Test Engineer	AJK, JJB, BRW
Barometric Pressure (in. Hg)	30.01
ΔH (in. H_2O)	.973
Dry Gas Meter Volume (cf)	78.032
Meter Temp (^oF)	82.4
Meter Y Factor	.981
Volume of Water Condensed (ml)	73.9
Stack Temp (^oF)	184.6
Average $\sqrt{\Delta p}$	.319
Nozzle Diameter (in.)	.498
CO_2 (%)	6.17
O_2 (%)	11.43
N_2 (%)	82.40
Pitot Tube C_p	.851
Elapsed Time (min.)	60.0
Static Pressure (in. H_2O)	-.17
Type of Stack	ROUND
Stack Diameter (ft.)	4.0
Stack Lenght (ft.)	NA
Stack Width (ft.)	NA
Total Particulate (mg)	63.20
F-Factor	NA

CALCULATIONS

GR/SCF=0.0130
GR/SCF CORECTED
TO 12% CO2=0.0253
GR/ACF=0.0103
LB/HR=1.3177
LB/SCF=1.8566E-6

DATA ENTRY:

PARTICULATE
TOTAL (MG)=
63.20 RUN

JOB NUMBER:
01-4188-00 RUN
PLANT:
EAST SHORE WWTP RUN
UNIT:
SLUDGE INCINERATOR RUN
TEST LOCATION:
STACK RUN
TEST CONDITION:
NORMAL RUN
TEST DATE:
AUGUST 26, 1982 RUN
TEST NO.:
PARTICULATE 01 RUN
TEST ENGINEER:
AJK, JJB, BRW RUN

DATA ENTRY

BAROMETRIC
Pb (IN HG) =
30.01 RUN
DELTA H
DH (IN H20) =
.973 RUN
METER VOL.
AVM (FT3) =
78.032 RUN
METER TEMP.
TM (DEGREE F) =
82.40 RUN
METER Y
FCTR YM =
.981 RUN
VOL. OF H20
VM (ML-GM) =
73.90 RUN
STACK TEMP.
TS (DEGREE) =
184.60 RUN
SQRT AVG.
DELTA P =
.319 RUN
NOZZLE
DIAMETER (IN) =
.498 RUN
% CO2 =
6.17 RUN
% O2 =
11.43 RUN
% N2 =
82.40 RUN
PITOT FCTR
CP =
.851 RUN
ELAPSED
TIME (MIN) =
60.00 RUN
STATIC PRESS.
(IN H20) =
-.17 RUN
STK DIA. FT?
4.00 RUN

CALCULATIONS

METER TEMP (R)=542.40
VOL STD=74.89
STACK TEMP (R)=644.60
%MOISTURE=4.44
MW(DRY)=29.44
MW(WET)=28.94
STAK PRESS.=30.00
VELOCITY (FPS)=20.00
STK AREA (FT2)=12.57
ISOKINETIC (%)=98.04
ACFM=15,079.19
SCFM=11,829.15

HP-41 DATA ENTRY FORM

PROGRAM 'STACK'

Job Number	01-4188-00
Plant	EAST SHORE WWTP
Unit	SLUDGE INCIN.
Test Location	STACK
Test Condition	NORMAL
Test Date	AUGUST 26, 82
Test Number	PART. 02
Test Engineer	AJK, JJB, BRW
Barometric Pressure (in. Hg)	30.01
ΔH (in. H_2O)	.806
Dry Gas Meter Volume (cf)	71.706
Meter Temp (^oF)	72.1
Meter Y Factor	.981
Volume of Water Condensed (ml)	84.0
Stack Temp (^oF)	170.8
Average $\sqrt{\Delta p}$	.292
Nozzle Diameter (in.)	.498
CO_2 (%)	6.80
O_2 (%)	10.93
N_2 (%)	82.27
Pitot Tube C_p	.851
Elapsed Time (min.)	60.0
Static Pressure (in. H_2O)	-.15
Type of Stack	ROUND
Stack Diameter (ft.)	4.0
Stack Lenght (ft.)	NA
Stack Width (ft.)	NA
Total Particulate (mg)	65.24
F-Factor	NA

CALCULATIONS

GR/SCF=0.0143
GR/SCF CORECTED
TO 12% CO2=0.0253
GR/ACF=0.0114
LB/HR=1.3322
LB/SCF=2.0468E-6

DATA ENTRY:

PARTICULATE
TOTAL (MG)=
65.24 RUN

JOB NUMBER:
01-4188-00 RUN
PLANT:
EAST SHORE WWTP RUN
UNIT:
SLUDGE INCINERATOR RUN
TEST LOCATION:
STACK RUN
TEST CONDITION:
NORMAL RUN
TEST DATE:
AUGUST 26, 1982 RUN
TEST NO.:
PARTICULATE 02 RUN
TEST ENGINEER:
AJK, JJB, BRW RUN

DATA ENTRY

BAROMETRIC
Pb (IN HG) =
30.01 RUN
DELTA H
DH (IN H2O) =
.806 RUN
METER VOL.
AVM (FT3) =
71.706 RUN
METER TEMP.
TM (DEGREE F) =
72.10 RUN
METER Y
FCTR YM =
.981 RUN
VOL. OF H2O
VM (ML-GM) =
84.00 RUN
STACK TEMP.
TS (DEGREE) =
170.80 RUN
SQRT AVG.
DELTA P =
.292 RUN
NOZZLE
DIAMETER (IN) =
.498 RUN
% CO2 =
6.80 RUN
% O2 =
10.93 RUN
% N2 =
82.27 RUN
PITOT FCTR
CP =
.851 RUN
ELAPSED
TIME (MIN) =
60.00 RUN
STATIC PRESS.
(IN H2O) =
-.15 RUN
STK DIA, FT?
4.00 RUN

CALCULATIONS

METER TEMP (R)=532.10
VOL STD=70.12
STACK TEMP (R)=630.80
%MOISTURE=5.34
MW(DRY)=29.53
MW(WET)=28.91
STAK PRESS.=30.00
VELOCITY (FPS)=18.12
STK AREA (FT2)=12.57
ISOKINETIC (%)=100.10
ACFM=13,660.24
SCFM=10,847.98

HP-41 DATA ENTRY FORM

PROGRAM 'STACK'

Job Number	01-4188-00
Plant	EAST SHORE WWTP
Unit	SLUDGE INCIN.
Test Location	STACK
Test Condition	NORMAL
Test Date	AUGUST 26, 82
Test Number	PART 03
Test Engineer	AJK, JJB, BRW
Barometric Pressure (in. Hg)	30.01
ΔH (in. H_2O)	.870
Dry Gas Meter Volume (cf)	73.317
Meter Temp (^oF)	696
Meter Y Factor	.981
Volume of Water Condensed (ml)	82.9
Stack Temp (^oF)	166.3
Average $\sqrt{\Delta p}$	.301
Nozzle Diameter (in.)	.498
CO_2 (%)	8.73
O_2 (%)	8.40
N_2 (%)	82.87
Pitot Tube C_p	.851
Elapsed Time (min.)	60
Static Pressure (in. H_2O)	-.15
Type of Stack	ROUND
Stack Diameter (ft.)	4.0
Stack Lenght (ft.)	NA
Stack Width (ft.)	NA
Total Particulate (mg)	40.09
F-Factor	NA

CALCULATIONS

GR/SCF=0.0086
GR/SCF CORECTED
TO 12% CO2=0.0118
GR/ACF=0.0069
LB/HR=0.8229
LB/SCF=1.2242E-6

DATA ENTRY:

PARTICULATE
TOTAL (MG)=
40.09 RUN

JOB NUMBER:
01-4188-00 RUN
PLANT:
EAST SHORE WWTP RUN
UNIT:
SLUDGE INCINERATOR RUN
TEST LOCATION
STACK RUN
TEST CONDITION:
NORMAL RUN
TEST DATE:
AUGUST 26, 1982 RUN
TEST NO.:
PARTICULATE 03 RUN
TEST ENGINEER:
AJK, JJB, BRW RUN

DATA ENTRY

BAROMETRIC
Pb (IN HG) =
30.01 RUN
DELTA H
DH (IN H2O) =
.870 RUN
METER VOL.
AVM (FT3) =
73.317 RUN
METER TEMP.
TM (DEGREE F) =
69.60 RUN
METER Y
FCTR YM =
.981 RUN
VOL. OF H2O
VM (ML-GM) =
82.90 RUN
STACK TEMP.
TS (DEGREE) =
166.30 RUN
SQRT AVG.
DELTA P =
.301 RUN
NOZZLE
DIAMETER (IN) =
.498 RUN
% CO2 =
8.73 RUN
% O2 =
8.40 RUN
% N2 =
82.87 RUN
PITOT FCTR
CP =
.851 RUN
ELAPSED
TIME (MIN) =
60.00 RUN
STATIC PRESS.
(IN H2O) =
-.15 RUN
STK DIA, FT?
4.00 RUN

CALCULATIONS

METER TEMP (R)=529.60
VOL STD=72.05
STACK TEMP (R)=626.30
%MOISTURE=5.14
MW(DRY)=29.73
MW(WET)=29.13
STAK PRESS.=30.00
VELOCITY (FPS)=18.54
STK AREA (FT2)=12.57
ISOKINETIC (%)=99.59
ACFM=13,977.88
SCFM=11,203.59

Calculation of Particulate Emission Concentration

$$ER = \frac{(1000)(P)}{(Q_s)(60)(d_o)}$$

$$d_o = 0.002593\,(MW_d)$$

$$ER@50\%EA = ER\left[(11.30)/(N_2 - 0_2)\right]$$

Where: ER = Particulate Concentration (lb / 1000 lb of flue gas)

P = Particulate Emission Rate (lb/hr)

Q_s = Volumetric Flow Rate (scfmd)

d_o = Density of Flue Gas (lb/scfd)

MW_d = Dry Molecular Weight of Flue Gas

ER@50% EA = Particulate Concentration (lb/1000 lb of flue gas corrected to 50% Excess air)

N_2 = Nitrogen Content of Flue Gas (%)

0_2 = Oxygen Content of Flue Gas (%)

11.30 = Ratio of Nitrogen to Oxygen at 50% Excess Air

TEST #1

$P = 1.3177$

$Q_s = 11829.15$

$MW_d = 29.44$

$N_2 = 82.40$

$O_2 = 11.43$

$d_o = 0.002593 (MW_d)$

$d_o = 0.002593 (29.44)$

$d_o = 0.076338$

$$ER = \frac{(1000)(1.3177)}{(11829.15)(60)(0.076338)}$$

$$ER = 0.02432$$

$$ER_{@\,50\%\,EA} = .02432 \left[11.30 \Big/ \frac{82.40}{11.43} \right]$$

$$ER_{@\,50\%\,EA} = 0.03812$$

TEST NO. 2

$P = 1.3322$

$Q_s = 10847.98$

$MW_d = 29.53$

$N_2 = 82.27$

$O_2 = 10.93$

$d_o = 0.002593\ (MW_d)$

$d_o = 0.002593\ (29.53)$

$d_o = 0.076571$

$$ER = \frac{(1000)(1.3322)}{(10847.98)(60)(0.076571)}$$

$$ER = 0.02673$$

$$ER_{@\ 50\%\ EA} = 0.02673 \left[11.30 \Big/ \frac{82.27}{10.93} \right]$$

$$ER_{@\ 50\%\ EA} = 0.04013$$

TEST NO. 3

$P = 0.8229$

$Q_s = 11203.59$

$MW_d = 29.73$

$N_2 = 82.87$

$O_2 = 8.40$

$d_o = 0.002593\ (MW)$

$d_o = 0.002593\ (29.73)$

$d_o = 0.077090$

$$ER = \frac{(1000)(0.8229)}{(11203.59)(60)(0.077090}$$

$$ER = 0.01588$$

$$ER_{@50\%\ EA} = 0.01588 \left[11.30 \Big/ \frac{82.87}{8.40} \right]$$

$$ER_{@50\%\ EA} = 0.01819$$

6.3 Process Data

Operator: _____ SHIFT: _____

Sheet 1, Page 1

INCINERATOR DATA SHEET
NEW HAVEN, CONNECTICUT

Date: 8-26-82

	Time	Pt. No. 1 Hearth 0	Pt. No. 2 Hearth 1	Pt. No. 3 Hearth 2	Pt. No. 4 Hearth 3	Pt. No. 5 Hearth 4	Pt. No. 6 Hearth 5	Pt. No. 7 Hearth 6	Pt. No. 8 Off Gas	Pt. No. 1 /2 I.D. Inlet °F	Pt. No. 2 /2 Cooling Air Ext.	Pt. No. 3 /2 Scrubber Inlet °F	Incinerator Draft " W.C.	Venturi Scrubber P " W.C.	Impingment Scrubber ΔP/Intermediate	Fuel Consumed (Hourly Difference)	Sludge Feed Rate (#/hour)	Cooling Air Return	O_2 %	WATER TO IMP SCRUBBER GPM	Notes/Comments:
1940	0100	1280	1280	1590	1270	950	680	340	1440	90	480	154	-.6	24"		52340	76852	25	6½	1400	TIME 1940 #1 TEST
	0200	1300	1280	1610	1260	930	660	350	1440	90	480	157	-.6	24"		52371	78136	25	6½	1400	1955
	0300	1310	1290	1620	1250	920	670	350	1430	90	480	156	-.6	24"		52394	79434	25	6.0	1350	2010 RUN 02.
	0400	1330	1210	1450	1200	900	680	380	1440	90	480	158	-.6	24"		52395	80515	23	7.0	1400	2025
2040	0500	1330	1170	1450	1160	790	660	380	1440	90	480	150	-.6	24"		52498	81878	23	8.0	1400	2040
	0600																				[redacted]
	0700																				TIME #2 TEST
2120	0800	1280	1280	1540	1220	780	700	380	1450	90	475	158	-.6	24"		52441	84390	25	6.0	1400	2120
	0900	1310	1260	1440	1140	860	680	400	1440	90	480	152	-.6	24"		52455	85451	25	9.0	1400	2135
	1000	1300	860	1340	1110	860	680	430	1350	85	475	148	-.6	28"		52470	86528	25	7½	1350	2150 RUN 03
	1100	1280	1160	1470	1160	870	660	440	1380	90	480	153	-.6	26"		52485	87869	25	7½	1350	2205
2220	1200	1280	1230	1590	1240	850	720	450	1450	95	495	160	-.6	28		52512	89054	28	6.0	1400	2220
	1300																				[redacted]
	1400																				TIME #3 TEST
	1500																				
	1600																				
	1700																				
	1800																				
	1900																				
	2000																				
	2100																				
	2200																				
	2300																				
	2400																				

Operator: _____ SHIFT: ____

Sheet 1, Page 1

INCINERATOR DATA SHEET
NEW HAVEN, CONNECTICUT

Date: 8-26-82

Time	Pt. No. 1 Hearth 0	Pt. No. 2 Hearth 1	Pt. No. 3 Hearth 2	Pt. No. 4 Hearth 3	Pt. No. 5 Hearth 4	Pt. No. 6 Hearth 5	Pt. No. 7 Hearth 6	Pt. No. 8 Off Gas	Pt. No. 1 /2 I.D. Inlet °F	Pt. No. 2 /2 Cooling Air Ext.	Pt. No. 3 /2 Scrubber Inlet °F	Incinerator Draft " W.C.	Venturi Scrubber P " W.C.	Impingment Scrubber ΔP/Intermediate	Fuel Consumed (Hourly Difference)	Sludge Feed Rate (#/hour)	Cooling Air Return	O_2 %	WATER TO IMP. SCRUBBER	Time
0100																				~~1415~~
0200	1270	1180	1610	1290	960	780	300	1360	85	520	152	-.6	20	—	57880	57020	20	7%	6500	1430
0300	1260	1260	1680	1360	970	720	300	1360	90	470	162	-.6	21	—	51885	58215	20	5%	6400	1445
0400	1280	1120	1380	1180	930	720	310	1300	80	480	142	.6	22	—	51890	59363	20	10%	6400	1500
0500	1250	1120	1400	1120	940	620	310	1280	90	470	150	.6		—	51900	60517	22	9%	6400	1515
0600	1260	1190	1400	1100	860	640	310	1460	90	470	150	.6		—	51910	61686	20	10%	6435	1530
0700	1320	1160	1670	1400	1000	660	310	1420	90	460	160	-.6	30	—	52313	73444	25	6%	6400	~~1545~~
~~0800~~																				1900 (1900)
~~0900~~																				1915
~~1000~~																				1930
~~1100~~																				1945
1200																				
1300																				
1400																				
1500																				
1600																				
1700																				
1800																				
1900																				
2000																				
2100																				
2200																				
2300																				
2400																				

700* 715 730 745 800

Notes/Comments:

RUN 01

6.4 Calibration Data

6.4.1 Pretest Calibration

HV Stack Sampler, Box # 520-089

YSC

CALIBRATION OF THE ORIFICE METER AND CALCULATION OF THE ΔH@ USING THE DRY GAS METER

Procedure

Set up the back-half of the sampling train starting with the fourth impinger. The impinger should be placed in the ice bath and filled with 200–300g of silica gel.

- Operate the pump until the temperature stabilizes at the gas meter.
- For each orifice record the gas meter reading at the beginning and the end of 3-minute periods for orifice ΔH pressure indications of 1 inch, 2 inches, 4 inches and 6 inches H_2O.
- Calculate J_i for each orifice ΔH_i
- Compute an average value of J_i from the four J_i factors obtained.
- Repeat the process for all orifices.

Calculate J from the following equation:

$$J_i = 0.1924 \frac{Q_{mo}}{D_{oi}^2} \sqrt{\frac{P_m}{(T_m)_{avg}\,\Delta H_i}}$$

Allowing for the appropriate units and constants

A $\Delta H@$ can then be calculated from

$$\Delta H@_i = \frac{0.001175}{\left(J_i\, D_{oi}^4\right)^2}$$

Nomenclature

Q_{mo} = sampling flowrate at orifice passing through the meter at meter condition, ft^3/min

D_{oi} = orifice diameter, inches

P_m = absolute meter pressure, in. Hg

$(T_m)_{avg}$ = average absolute gas temperature at gas meter, °R

ΔH_i = orifice differential pressure across orifice i, in. H_2O

ORIFICE CONSTANTS: Averages

Diameter (Doi)	Factor (Ji)	Δ H
.187	.7318	1.7966
.281	.7733	.3156
.358	.9686	.07654

DATE CALIBRATED: 3/19/82

AEROTHERM METER BOX ORIFICE CONSTANT CALCULATIONS

Meter Box # 520-089 Date 3/19/82 Calibrated By WDH

D_o = .358

ΔH_i	Meter Reading	Time (min)	Sample Flow Rate Q_{mo} (cfm)	Meter Pressure P_m (in Hg)	Meter Temperature T_m (°R)	J_i	$\Delta H_@$
0.5	Final: 368.191 Initial: 362.196 Total cf: 5.995	3	1.9983	30.017	527.5	1.0120	.0698
1.0	Final: 377.725 Initial: 369.402 Total cf: 8.323	3	2.7743	30.053	528	.9936	.0724
2.0	Final: 389.999 Initial: 378.405 Total cf: 11.594	3	3.8647	30.127	528	.9799	.0745
1.0	Final: 408.182 Initial: 392.331 Total cf: 15.851	3	5.2837	30.274	530	.9478	.0796
2.0	Final: 433.138 Initial: 411.705 Total cf: 21.433	3	7.1443	30.568	531	.9098	.0864

$$J_i = 0.1924 \frac{Q_{mo}}{D_o^2} \sqrt{\frac{P_m}{(T_m)(\Delta H_i)}}$$

$$\Delta H_@ = \frac{0.001175}{\left[(J_i)(D_o)^2\right]^2}$$

AEROTHERM METER BOX ORIFICE CONSTANT CALCULATIONS

Meter Box # 520-089 Date 3/19/82 Calibrated By WDH

D_o = .281

ΔH_i	Meter Reading	Time (min)	Sample Flow Rate Q_{mo} (cfm)	Meter Pressure P_m (in Hg)	Meter Temperature T_m (°R)	J_i	$\Delta H_@$
0.5	Final: 321.943 Initial: 319.035 Total cf: 2.908	3	.9693	30.017	526	.7979	.2960
1.0	Final: 327.135 Initial: 323.137 Total cf: 3.998	3	1.3327	30.053	526	.7762	.3128
2.0	Final: 339.243 Initial: 333.555 Total cf: 5.688	3	1.896	30.127	527	.7811	.3089
4.0	Final: 348.317 Initial: 340.458 Total cf: 7.859	3	2.6197	30.274	527	.7650	.3220
8.0	Final: 360.471 Initial: 349.679 Total cf: 10.792	3	3.5973	30.568	527	.7464	.3383

$$J_i = 0.1924 \frac{Q_{mo}}{D_o^2} \sqrt{\frac{P_m}{(T_m)(\Delta H_i)}}$$

$$\Delta H_@ = \frac{0.001175}{\left[(J_i)(D_o)^2\right]^2}$$

AEROTHERM METER BOX ORIFICE CONSTANT CALCULATIONS

Meter Box # 520-089 Date 3/18/82 Calibrated By wdH

D_o = .187

ΔH_i	Meter Reading	Time (min)	Sample Flow Rate Q_{mo} (cfm)	Meter Pressure P_m (in Hg)	Meter Temperature T_m (°R)	J_i	$\Delta H_@$
0.5	Final: 301.434 Initial: 300.213 Total cf: 1.221	3	.407	29.947	529	.7535	1.6924
1.0	Final: 306.384 Initial: 304.703 Total cf: 1.681	3	.5603	30.073	526	.7371	1.7686
2.0	Final: 309.216 Initial: 306.834 Total cf: 2.382	3	.794	30.147	526.5	.7392	1.7585
4.0	Final: 312.807 Initial: 309.522 Total cf: 3.285	3	1.095	30.294	527	.7222	1.8423
9.0	Final: 317.870 Initial: 313.343 Total cf: 4.527	3	1.509	30.588	527	.7072	1.9213

$$J_i = 0.1924 \frac{Q_{mo}}{D_o^2} \sqrt{\frac{P_m}{(T_m)(\Delta H_i)}}$$

$$\Delta H_@ = \frac{0.001175}{\left[(J_i)(D_o)^2\right]^2}$$

YSC

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English units)

Date 8/5/82

Meter box number 520-089

Barometric pressure, P_b = 29.53 in. Hg.

Calibrated by RAK

H_2O MANOMETER	Orifice manometer setting (ΔH), in. H_2O	Wet test meter (v_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature[a]: Wet test meter (t_w), °F	Dry gas meter: Inlet (t_{d_i}), °F	Dry gas meter: Outlet (t_{d_o}), °F	Dry gas meter: Average[a] (t_d), °F	Time (Θ), min	Y_i	$\Delta H@_i$
.50	~~0.5~~ .42	5.000	5.058	78.5	78.5	78.5		14.06	.986	1.92
.90	~~1.0~~ .98	5.004	5.076	79.5	79.5	79.5		9.18	.983	1.91
1.45	~~1.5~~ 1.6	10.004	10.158	81.0	82.0	80.0		14.22	.981	1.87
1.65	~~2.0~~ 2.1	10.000	10.157	81.8	83.0	80.5		12.54	.979	1.91
2.35	~~3.0~~ 3.1	10.016	10.175	83.3	85.0	81.5		10.34	.977	1.92
2.80	4.0	10.012	10.168	85.0	87.5	82.5		9.21	.975	1.97
								Average	.981	1.92

ΔH	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\Theta}{V_w}\right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

NOZZLE CALIBRATION

Date 7-19-82 Calibrated by DJB

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
1/2"	.498	.498	.498	.000	.498

where:

$D_{1,2,3}$, = nozzle diameter measured on a different diameter, in.
Tolerance = measure within 0.001 in.

ΔD = maximum difference in any two measurements, in.
Tolerance = 0.004 in.

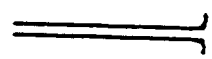
D_{avg} = average of D_1, D_2, and D_3.

Nozzle calibration data.

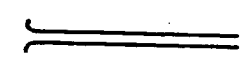
PITOT CALIBRATION

ΔP_{std}	ΔP_s	$\frac{\Delta P_{std}}{\Delta P_s}$	P_s	ΔP_{std}	ΔP_s	$\frac{\Delta P_{std}}{\Delta P_s}$	P_s
.17	.23	.739	.860	.54	.76	.711	.843
.21	.28	.750	.866	.77	1.1	.700	.837
.31	.42	.738	.859	1.10	1.5	.733	.856
.37	.51	.725	.852	1.20	1.70	.706	.840
.42	.59	.712	.844				

P_s = _____



FLOW



FLOW

F_s = _____

$_s = \sqrt{\frac{P_{std}}{P_s}}$ .851

F_{std} = 1.00

Pitot Tube No. AERO – MED

Calibrated by: RAK

DATE 4/29/82

AEROTHERM SAMPLING TRAIN CALIBRATION DATA

ATE: 7/24/82
RAIN # 520089

Temperature Sensors			
Gas Meter Inlet		Gas Meter Outlet	
Digital Readout	Mercury Thermometer	Digital Readout	Mercury Thermometer
77	78	77	78
Impinger Thermocouple		Stack Thermocouple	
Mercury Thermometer	Sensor Readout	Mercury Thermometer	Sensor Readout
70	69	271 277 282	270 275 280

COMMENTS:

YSC

6.4.2 Posttest Data

POSTTEST CACIBRATION CHECKS

Job No.: 01-4188 Date: 9/7/82

Client: ZIMPRO Checked By: WDH

- **Pitot Tube**

  Pretest pitot tube coefficient .851

  Any damage to pitot tube prior to start of any test run? NO

  Pitot tube coefficient for calculations .851

- **Stack Thermocouple**

  Was a pretest temperature correction used? NO

  Average stack temperature during test 174°

  Temperature of reference thermometer during recalibration 172°F

  Temperature of stack thermocouple during recalibration 170°F

  Do values agree within ± 1.5%? YES

- **Impinger Thermometer**

  Was a pretest Temperature correction used? NO

  Posttest reference thermometer reading 74

  Posttest impinger thermometer reading 74

  Do values agree within ± 4°F? YES

- **Dry Gas Meter Thermometers**

  Was a pretest temperature correction used? NO

  Posttest thermometer reading at ambient temperature IN 73 OUT 73

  Posttest reference thermometer reading IN 74 OUT 74

  Do they agree within ± 10.8°F? YES

- **Dry Gas Meter**

  Pretest calibration factor, Y .981

  Posttest calibration factor, Y .972

  Is posttest calibration factor within ± 5% of pretest factor? YES ✓

YSC

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English units)

Date 9/7/82 Meter box number 520-089

Barometric pressure, P_b = 29.96 in. Hg. Calibrated by WdH

Orifice manometer setting (ΔH), in. H_2O	Wet test meter (v_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature[a]: Wet test meter (t_w), °F	Dry gas meter: Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Average (t_d), °F	Time (Θ), min	Y_i	$\Delta H@_i$
0.5	5	811.040 805.920	74	74	74	74	5.25	.975	
1.0	5	816.554 811.428	74	74	74	74	3.8	.973	
1.5	10	827.081 816.809	75	75	76	75.5	6.0	.971	
2.0	10.19	837.808 827.352	75	76	76	76	5.33	.972	
3.0	10.01	848.570 838.321	75	76	76	76	4.38	.971	
4.0	10								
						Average		.972	

ΔH	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \left[\frac{(t_w + 460)\ \Theta}{V_w}\right]^2$
0.5	0.0368	$\frac{5 \times 29.96 (534)}{5.12 (29.96 + .0368)\ 534}$ .975	
1.0	0.0737	$\frac{5 \times 29.96 (534)}{5.126 (29.96 + .0737)\ 534}$ .973	
1.5	0.110	$\frac{299.6\ (535.5)}{10.272\ (29.96 + .11)\ 535}$ .971	
2.0	0.147	$\frac{305.29 (536)}{10.456 (29.96 + .147)\ 535}$ .972	
3.0	0.221	$\frac{299.9 (536)}{10.249 (29.96 + .221)\ 535}$ .971	
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

AEROTHERM SAMPLING TRAIN CALIBRATION DATA

DATE: 9/7/82
TRAIN # 520-089

Temperature Sensors			
Gas Meter Inlet		Gas Meter Outlet	
Digital Readout	Mercury Thermometer	Digital Readout	Mercury Thermometer
73°	74°	73°	74°
Impinger Thermocouple		Stack Thermocouple	
Mercury Thermometer	Sensor Readout	Mercury Thermometer	Sensor Readout
74°	74°	172°	170°

COMMENTS:

YSC

6.5 Scale Calibration Certification

MERRICK SCALE MFG. COMPANY

TEST REPORT

USER East Side New Haven MODEL 160-DS SERIAL # 19222

Rate Display: ☐ % Or ☐ Engl Units

Integrator Registration: Tons Mult. Reading By: .001

Set Point ☐ % Or ☐ Eng. Units Test Wght or Chain Equiv. 4.595 PPF

Measured Belt Length 186.945 ft. 186.945

100% Capacity 10 TPH Measured Time 1 Revolution of Belt 3.63 MIN

100% Speed 50 FPM Measured Conveyor Belt Speed 51.5 FPM

Design Load 6.67 PPF Set Speed To 100% For 1 Belt Rev.

Calibration Time 218 Sec. Counts/Ft. 1200 Analog Rate Output 4-20MA

Pre-Amp Input 3.0 MV L/C Excitation _____ V L/C Tare Output 0 MV

DSP 6 BRM Number _____ Gear Ratio _____ Electronic Calib. Output _____ MV _____ MV

A. Lbs	Tons	Long Tons	(As Found) Metric Tons	(After Adjustment) Kilograms
F. 1.00	2000	2240	2205	2.205

COMPUTATION I (Test Chain or Wt. must be in position)

_____ Belt Meas. Test Results ÷ 1200 Counts/Ft. = 187.610 Ft. of Belt

225/32

COMPUTATION II (Number of Totalized Lbs. for Calibration)

187.610 Ft. of Belt × 4.595 Test Chain Equivalent = 862.068 Total Lbs.

COMPUTATION IIA

862.068 Total Lbs. ÷ 2000 (F) ÷ .001 Integrator Registration = 431.034 Counts

COMPUTATION III (Theoretical Wt. Display with Load)

4.595 Test Chain Equivalent ÷ 6.67 Design Load × 100 = 68.89 % Test Load

Parts Used From Merrick Stock:

TEST CHAIN OR WEIGHT CALIBRATION

	As Found	Test 1	Test 2	Test 3
Tare +1.2%	—	+.068%	-.004	+.048%
Calib. Counts	425	431	431	431
Rate Display	68.3	7.48	70.8	73.1
WL Display	68.7	68.8	67.9	66.2
Speed Display	103.3	103.4	102.3	102.7
% Error	-1.399%	-.033%	-.028%	-.003%
Adjusted	CCW 21	—	—	—

MATERIAL TEST

	Test 1	Test 2	Test 3
Material Wght.			
Integrator Total			
% Error			
Adjusted			

Reported By [signature] Date 8-24-82

6.6 Laboratory Data

York Wastewater Consultants, Inc
One Research Drive
Stamford, Connecticut 06906
Telephone (203) 325-1371
TWX 710 474 3967

PARTICULATE Analysis Form

JOB# YSC # 4188 ZIMPRO

TYPE OF SAMPLE FHA

DATE 9/1/82

SAMPLE #	TYPE	GROSS WT.G.	TARE WT.G.	NET W.G.	VOL ML.	BLANK G.	RESULTS
57943	FHA #1	107.74174	107.69987	0.04187	250	.023859	.01801
57936	FHA #2	107.49723	107.45392	0.04331	325		.01229
57938	FHA #3	108.66415	108.63186	0.03229	165		.01854
5	BLANK	107.90014	107.89050	0.00964	80	.0001205 gm/ml	
57944	Filter #1	1.12390	1.10059	0.02331			0.02331
57945	Filter #2	1.04406	1.01956	0.02450			0.0245
57939	Filter #3	1.11875	1.10964	0.00911			0.0091

ANALYST Robert B Shepherd

APPROVED BY

CORRECTION OF ACETONE RESIDUE FOR BLANK

Client: ZIMPRO, INC.

Job Number: 01-4188

Date: 10/5/82

ARC = AR - ((VA)(DA)(AAB))

WHERE: ARC = Acetone Residue Corrected for Blank (grams)

AR = Acetone Residue (grams)

VA = Sample Volume of Acetone (milliliters)

DA = Density of Acetone (grams/milliliter)

AAB = Allowable Acetone Blank (0.00001%)

Test #1

ARC = 0.04187 - [(250)(.792)(.00001)]

ARC = 0.04187 - 0.00198

ARC = 0.03989

Test #2

ARC = 0.04331 - [(325)(.792)(.00001)]

ARC = 0.04331 - 0.00257

ARC = 0.04074

Test #3

ARC = 0.03229 - [(165)(.792)(.00001)]

ARC = 0.03229 - 0.00131

ARC = 0.03098

Zimpro
01-4188

		% Solids
Sludge Belt	1A	34.20
	1B	29.67
	2A	33.90
	2B	30.59
	3A	32.78
	3B	23.73

6.7 Dry Solid Calculations

FEED RATE CALCULATIONS

$$\frac{\text{Tons of Sludge}}{\text{Time}} = \text{Tons Per Hour Sludge (Wet)}$$

Tons of Sludge Per Hour (Wet) x %Solids = Tons Per Hour Sludge (Dry)

$$\frac{\text{Pounds Per Hour Particulate}}{\text{Tons of Dry Sludge Per Hour}} = \text{Pounds of Particulate Per Ton Of Dry Sludge}$$

Time = Total recorded time of sludge input data during test run

Tons of Sludge = Sludge input during test run (tons)

%Solids = Percent solids of sludge sampled during test run

DRY SLUDGE CALCULATION TEST #1

TIME	SLUDGE BELT READING
1430	56.850
1536	61.240
66 MINS	4.39 TONS / 1.1 HR
1.1 HRS	3.991 TONS / HR

% SOLIDS = 31.93

TONS OF DRY SOLIDS / HR = (3.991)(.3193) = 1.2743

LBS OF PARTICULATE / TON OF DRY SLUDGE = $\frac{1.3177}{1.2743}$

= 1.0341

DRY SLUDGE CALCULATION TEST NO. 2

TIME	SLUDGE BELT READING
1940	76.690
2045	81.470
65 MIN	4.78 TONS / 1.083 HRS
1.083 HRS.	4.4137 TONS / HR

% SOLIDS = 32.24

TONS OF DRY SLUDGE / HR = (4.4137)(.3224) = 1.4230

LBS OF PARTICULATE / TON OF DRY SLUDGE = $\frac{1.3322}{1.4230}$

= 0.936

DRY SLUDGE CALCULATION TEST NO. 3

TIME	SLUDGE BELT READING
2120	84.270
2235	90.270
75 MIN.	6.0 TONS / 1.25 HRS
1.25 HRS	4.8 TONS / HR

% SOLIDS = 28.25

TONS OF DRY SOLIDS / HR = (4.8)(.2825) = 1.3560

LBS OF PARTICULATE / TON OF DRY SLUDGE = $\frac{0.8229}{1.3560}$

= 0.607