ENVIRONMENTAL RESEARCH GROUP, INC.
1400 53rd Street Emeryville, California 94608 (415) 652-2300

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ZIMPRO
ENVIRONMENTAL CONTROL SYSTEMS
MILITARY ROAD
ROTHSCHILD, WI 54474

REPORT #2446-A

TEST LOCATION: Honouluili Wastewater Treatment Plant
Ewa, Hawaii

TEST DATE: November 15, 1983

REQUESTED BY: Zimpro
Environmental Control System
Military Road
Rothschild, WI 54474

Submitted by; E. H. Gallagher
Environmental Testing Services
Ultrachem, A Division of Environmental
Research Group

Report Date: November 30, 1983

ENVIRONMENTAL RESEARCH GROUP, INC.

1400 53rd Street Emeryville, California 94608 (415) 652-2300

November 30, 1983

Zimpro
Environmental Control Systems
Military Rd.
Rothschild, Wi. 54474

Attention: Bruce L. Brandenburg

Report #2446-A

Subject: Sampling and analysis of air pollutant effluent from multihearth sewage sludge incinerator to demonstrate compliance with:

1) The U.S. Environmental Protection Agency (EPA) new source performance standards as given in CFR-Title 40; Part 60: Subpart O; Section 60.150 to 60.154, and

2) Rules and Regulation of the State of Hawaii Air Pollution Regulations as given in Chapter 43 of the Hawaii Environmental Laws and Regulations.

Sampling Site: Hawaii

Sampling Date: November 15, 1983

Sampling Personnel: E.H. Gallagher and E. Diethelm of Ultrachem a division of ERG collected stack emission samples.

Observing Personnel: Cedric S. Takamoto of the State of Hawaii.

Submitted Samples: Feed samples were collected by Zimpro personnel. The feed material being charged to the furnace was heat conditioned sewage sludge.

Summary of Results:

1) The unit as tested complied with particulate emission rate limitations of the Hawaii State Air Pollution Regulations. This limitation is 0.2 pounds per 100 pounds of refuse charged. The average emissions were 0.020 pounds/100 pounds.

2) The unit as tested complied with the opacity limitation of 20% in CFR-Title 40; Part 60: Subpart O; Section 60.152, Standard of Performances for Sewage Treatment Plants for all test periods.

3) The unit as tested complied with the particulate matter emission rate of 1.3 lb./ton of dry sludge as given in CFR Title 40; Part 60; Subpart O; Section 60.152. The average emission rate of particulate matter was found to be 0.54 lb/ton of dry sludge.

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Sampling Program:

Three consecutive tests were conducted on the exhaust stack. During each test, measurements were made for the following parameters: Particulate matter, oxygen, carbon dioxide, water vapor, and exhaust stack volume flow.

A chronological summary of tests conducted is as follows:

Test	Date	Time of Test Exhaust Stack
A	11-15-83	1303 - 1426
B	11-15-83	1449 - 1611
C	11-15-83	1630 - 1752

Sampling Stations:

The circular 17.5 inch I.D. exhaust stack was fitted with two 3-inch diameter ports at 90 degrees. These openings in the stack were in a horizontal plane 9' 10" feet above the last bend in the stack and three feet below the top of the stack. (See Appendix 5).

Sampling Procedures - Source Test:

Sampling methods were as described in Environmental Protection Agency (EPA) methods 1,2,3, and 5 given in the Code of Federal Regulations; 40 CfR 60, Appendix A.

Exhaust Stack:

Prior to sampling, the velocity of the gas was determined at each of the specified traverse points by a special pitot tube and magnehelic differential pressure gage. The gas temperature was measured with a potentiometer and thermocouple. A traverse was made across the duct over both diameters. This traverse was used for preliminary sampling information and nozzle selection and not used for particulate emission calculations.

For the selection of the location of the traverse points for velocity measurements, method 1 was used. A total of sixteen traverse points were used.

Exhaust Stack: (continued)

For all particulate tests, the particulate sampling train used was a "Modified EPA Method 5" particulate sampling train assembled to meet all sampling requirements of Method 5. The train consisted of an in-stack filter followed by a probe assembly and cooled water-filled impingers, with attached apparatus for collecting samples for measurement of CO_2 and O_2 and an attached pitot tube for monitoring velocities and maintaining isokinetic sampling rates. An illustration of the particulate sampling train is attached. (Appendix 3).

The particulate matter sampling train consisted of the following components connected in series: A specially sized glass nozzle connected to two pre-weighed glass tubes filled with glass wool and a type 5A, 1 1/2 inch diameter glass fiber filter contained with a heated holder followed by four impingers, a leak-tight aspiration pump, and a dry gas test meter to measure the sampled gas volume.

The filter portion of the sampling train was maintained at 225 to 275^0 F to prevent condensation of moisture.

The first two impingers contained distilled water to collect condensible particulate matter, while the third was empty and the fourth contained silica gel. The temperature around all impingers was controlled with ice to maintain the temperature of the empty impingers below 90^{0}F. The increase in water volume in the impingers and in weight of the silica gel at the conclusion of the test was used to calculate the water vapor content of the sampled gas.

The gas sample was aspirated through the particulate sampling train at the isokinetic rate computed from the velocity monitored with the pitot tube adjacent to the sampling nozzle. All pertinent tests parameters were recorded at 4-minute intervals during each test.

Additional simultaneous samples were collected for the measurement of gaseous hydrocarbons, oxygen and carbon dioxide. Samples for each of these tests were taken through an individual stainless steel sampling tube inserted directly into the gas stream, and positioned adjacent to the particuate sampling nozzle and pitot tube.

All sampling data are appended to this report. (Appendix 1 and 2)

Opacity Monitoring Procedures:

All opacity readings were made according to EPA Method 9 as published in November 12, 1974, Federal Register. Readings were made by E.Gallagher and E.Diethelm who are certified by the California Air Resources Board under a training program recognized by the EPA.

Results are tabulated on the attached visible emissions sheets.

The stack was continously observed during each test period for one hour during Test A & B and 30 minutes during Test C. No readings were taken within 30 minutes of sunset.
The tabulated results include a rating of viewing conditions for each test. A rating of "excellent" would require:

- -Observer at a distance from plume approximately equal to relative stack-heights
- -Sun at the observer's back
- -Wind perpendicular to line of sight
- -Plume free of condensed steam
- -Plume of uniform and fairly steady opacity
- -Emission point well defined
- -Plume background of color contrasting with plume color
- -Plume illumination steady and adequate
- -Interfering plumes and other view-obstructions absent

The ratings are included as an aid in evaluating the accuracy of the readings. Each reading is recorded to nearest 5%. In EPA studies referenced in Method 9, 99% of black plumes and 95% of white plumes were read with a positive error of less than 5% opacity.

Analytical Procedures - Source Test:

Particulate Matter: The filter tubes containing the filters were dried in an oven at 105^{0}C for two hours, desiccated over Drierite, and weighted on an analytical balance. Water and acetone washings from the nozzle and probe were dried and weighed in a similar manner. This constitutes "total particulate" according to the EPA difinitions, and will also be referred to in this report as "probe and filter" particulate or "front half" particulate.

Water samples from the impingers combined with acetone washings of connecting tubing were dried at 105^{0} C and all containers were desiccated to a constant weight, and weighed on an analytical balance. This portion is generally referred to as "condensible" particuate, or "back half" particulate. The sum of the front half and back half constitute particulate matter by State of Hawaii definitions.

Carbon Dioxide, and Oxygen: Carbon Dioxide and Oxygen were determined on the gas tank samples with an Orsat volumetric gas analyzer, according to EPA Method 3.

Total hydrocarbons and methane were determined on the gas tank samples by direct injection into a gas chromatograph with a flame ionization detector.

Feed Material Analysis:

The following analyses were performed:

1) Proximate Analysis: Percent moisture, volatiles and ash.

This was done by drying an aliquot of the composite sample for each test period at 105^{0}C to constant weight. The portion lost is considered moisture content.

The dried aliquot was then ashed to 550^{0}C to a constant weight. The percent loss on ignition is considered to be percent volatile or combustibles, percentage of remaining material to be percent ash.

2) Heating Value (BTU Content) was determined by bomb colorimetry on a composite sludge sample as submitted.

3) Percent Hexane Soluble: This was done by hexane extraction in a Soxhlet extractor on a dried aliquot of the sludge samples.

Comments: The heating value (BTU Content) was also determined on a sample of fuel oil being used as auxilliary fuel in the furnace.

Submitted by:

E.H. Gallagher
Branch Manager, Environmental Services

EHG/mab

Enclosures

ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS

Page

Client: Zimpro

Location Tested: Honouluili W.W.T.F

Test No: A, B, & C

PARTICULATE TESTS

--TABULATED RESULTS--

epa

Test Date: 11/15/83

Test	A	B	C	AVERAGE	LIMITA
Velocity, Ft.sec (average)	44.6	44.8	45.9		
Duct Temp;/Part Sample; ^{o}F	108	117	118	114	
Volume Flow, CFM	4470	4490	4600		
Volume Flow, SDCFM	3950	3920	3960	3940	
Water Vapor, Vol. % H_2O	5.5	5.1	6.3	5.6	
Oxygen, vol. % O_2 (Dry basis)	10.0	10.4	10.8	10.4	
Carbon Dioxide, Vol. % CO_2 (dry)	7.8	7.2	7.0	7.3	
Carbon Monoxide, vol. ppm CO (dry)					
Time of Sampling	1303-1426	1449-1611	1630-1752		
Duration of test; Minutes	80	80	80		
Sampled Volume, SDCF	53.3	35.45	38.60		
Particulate, Front Half Only (Filter Catch):					
Weight of Sample, Grams	0.0243	0.0184	0.0257		
Particulate Concentration, grains/SDCF	0.0070	0.0080	0.0103	0.0084	
Particulate Emissions, Lb/Hour	0.24	0.27	0.35	0.29	
Particulate Emissions, Lb/Ton (dry)	0.45	0.50	0.67	0.54	1.3
Particulate Emissions, Lb/100 Lb. (dry)	0.023	0.025	0.034	0.027	
Charging Rate to Furnace, Lb/Hour (wet)	3512	3474	3390		
Charging Rate to Furnace, Lb/Hour (dry)	1071	1077	1051		
Solids content of charge, %	30.5	31.0	31.0		

ULTRACHEM CORPORATION

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AIR POLLUTION ANALYSIS

Client: Zimpro

State of Hawaii

Location Tested: Honouluili W.W.T.F

Test No: State of Hawaii Dept. of Health

PARTICULATE TESTS
--TABULATED RESULTS--

Test Date: 11/15/83

Test	A	B	C	AVERAGE	LIMITATION
Velocity, Ft.sec (average)	44.6	44.8	45.9		
Duct Temp;/Part Sample; ^{o}F	108	117	117	114	
Volume Flow, CFM	4470	4490	4600		
Volume Flow, SDCFM	3950	3920	3960	3940	
Water Vapor, Vol. % H_2O	5.5	5.1	6.3	5.6	
Oxygen, vol. % O_2 (Dry basis)	10.0	10.4	10.8	10.4	
Carbon Dioxide, Vol. % CO_2 (dry)	7.8	7.2	7.0	7.3	
Carbon Monoxide, vol. ppm CO (dry)					
Time of Sampling	1303-1426	1449-1611	1630-1752		
Duration of test; Minutes					
Sampled Volume, SDCF	53.3	35.45	38.60		
Particulate, Front Half Only (Filter Catch):					
Weight of Sample, Grams	0.0639	0.0500	0.0500		
Particulate Concentration, grains/SDCF	0.0185	0.0217	0.0220	0.021	
Particulate Emissions, Lb/Hour	0.63	0.73	0.75	0.70	
Particulate Emissions, Lb/Ton (wet)	0.36	0.42	0.44	0.41	4.0
Particulate Emissions, Lb/100 Lb. (wet)	0.018	0.021	0.022	0.020	0.[illegible]
Charging Rate to Furnace, Lb/Hour (wet)	3512	3474	3390		
Charging Rate to Furnace, Lb/Hour (dry)					
Solids content of charge, %					

Report #2446-A

Report Date: 11/30/83

ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS

Page

Client: Zimpro

Location Tested:

Test No: A, B, & C

Test Date: 11/15/83

--TABULATED RESULTS--

GAS ANALYSIS

	A	B	C		
Methane, ppm by volume	1.7	2.1	1.3		
Total non-methane Hydrocarbons, ppm	5.8	11.9	3.4		

ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS
VISIBLE EMISSIONS EVALUATION

Client Zimpro

Test Date 11/15/83

Location Honouluili

Test No. A, B, & C

Type Facility Sewage Sludge Furnace

Observer E. H. Gallagher & E. Diethelm

Emission Point Scrubber Exhaust

Recertification Date 1983

Control Device Venting Scrubber

Certifying Agency Calif. ARB

TABULATED RESULTS

Set #	Time Start-End	# of Readings	% Opacity Avg	% Opacity Range	Compliance Status	Observer Position	Viewing Conditions	Remarks
A	1322-1429	240	0.0	0-5	Pass	40 foot/ stack	Excellant	
B	1450-1559	240	0.3	0-5	Pass	40 foot/ stack	Excellant	
C	1631-1700	120	2.0	0-15	Pass	45 feet/ stack	Good	Near Sunset

ULTRACHEM CORPORATION

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AIR POLLUTION ANALYSIS

Client: Zimpro

Location Tested: Honouluili

Test No: A, B, & C

Test Date: 11/15/83

--TABULATED RESULTS--

Feed Material Analyses

	A	B	C	Sludge Composite	Ash Composi
As Received, Percent Water	69.4	69.0	69.0	68.4	0.1
As Received, Percent Solids	30.6	31.0	31.0	31.6	99.9
Bry Basis, Percent Volatiles	81.8	81.9	82.1	81.4	0.5
Dry Basis, Percent Ash	18.2	18.1	17.9	18.6	99.5
Heating Value; BTU/Pound Dry Solids				8,700	
Heating Value; BTU/Pound Dry Volatiles				10,690	
NOTE: The fuel oil had a heating value					
of 19,700 BTU/Pound					

SUMMARY SHEET #1

FEED RATES TO FURNACE

CHARGE RATE

Time	Belt Scale	#/Hour wet sludge
1300	233060 232510	
1310	233060	3300
1320	233614	3324
1330	234250	3816
1340	234805	3330
1350	235450	3870
1400	236007	3342
1410	236606	3594
1420	237193	3522
1430	237770	3462
1440	238387	3702
1450	238938	3306
1500	239545	3642
1510	240149	3624
1520	240729	3480
1530	241256	3162
1540	241946	3540
1550	242460	3684
1600	243015	3330
1610	243598	3498
1620	244203	3630
1630	244770	3402
1640	245348	3468
1650	245928	3480
1700	246493	3390

$\frac{550 \times 60}{10} = 3300$

CHARGE RATE (cont.)

Time	Belt Scale	#/Hour
1710	247030	3222
1720	247604	3444
1730	248144	3240
1740	248728	3504
1750	249288	3360

$100668/29 = 3471.3$

Report # 2446-A

ULTRACHEM CORPORATION

Report Date: 11/30/83

AIR POLLUTION ANALYSIS

Page

Client: Zimpro

Location Tested: Honouluili

Test No:

Test Date: 11/15/83

SUMMARY SHEET #2
DISTRIBUTION OF PARTICULATE MATTER

	A	B	C		
Total Weight in Nozzle; grams	0.0010	0.0007	0.0006		
Total weight in Lead Filter; grams	0.0170	0.0080	0.0168		
Total weight in Back-Up Filter; grams	0.0063	0.0097	0.0083		
Total weight front half; grams	0.0243	0.0184	0.0257		
Total weight Acetone washings	0.0036	0.0010	0.0018		
Total weight Impingers; grams	0.0360	0.0306	0.0276		
Total weight back half; grams	0.0396	0.0316	0.0294		
Total weight; grams	0.0639	0.0500	0.0551		

APPENDIX I

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested :11/15/83

Test No. :A Time :1303-1426

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
8E	.65	90	44.4
7E	.65	91	44.4
6E	.65	91	44.4
5E	.65	104	44.9
4E	.6	108	43.3
3E	.6	94	42.8
2E	.6	99	43
1E	.55	114	41.7
8S	.75	115	48.7
7S	.75	116	48.8
6S	.75	117	48.8
5S	.75	117	48.8
4S	.65	118	45.5
3S	.6	121	43.8
2S	.5	120	40
1S	.5	125	40.1

$$Vs = Cp\,[h\,*(T + 460)]^{.5}\,[1/M.W.\,*\,Ps]^{.5} * 85.49$$

Conc. of CO2 = 7.8 % Conc. of O2 = 10 %

Conc. of H2O = 5.5 %

Avg. Gas Velocity; Vs, Avg. 44.6 Ft/Sec

Pitot Tube Correction Factor, Cp .81

Duct Gas Molecular Weight, M.W. 29.13

Duct Pressure, Ps. 29.9 ''Hg Barometric Pressure 29.93 ''Hg

Duct Size Round 17.5 In. Diameter Static Pressure -.35 ''H2O

Duct Area 1.67 Sq. Ft Avg. Gas Temp. 108

Gas Flow Rate 44.6 Ft/Sec * 1.67 Sq. Ft * 60 = 4468 CFM

4468 CFM* 530 / 568 * 29.9 /29.92*(1.00- 5.5 /100%H2O)= 3947 SDCFM

M.W. Factor = .0338 Standard Cond. Temp. 70

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested : 11/15/83

Test No. : A (EPA FORMAT) Time : 1303-1426

GAS FLOW DATA

Sample Points 1-8 SOUTH;1-8 EAST

Barometric Pressure 29.93 Sample Nozzle Area .000291 ft^2

Duct Pressure 29.9 ''Hg Condensate 65 ml.

Avg. Gas Meter Pressure .5 in.Hg Vol. of Gas Samples 56.32 CF

Avg Gas Meter Temp 109 F Avg Duct Temp 108 F

Wgt. Collected .0243 Gms. Duration of Test 80 Min.

Avg. Velocity at Sampling Pts 44.6 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 65 * (460 + 70)/29.92 = 3.07 SCF

Corrected Meter Volume:

Vo = 56.32 * 30.4 / 29.92 * 530 / 569 = 53.3 SDCF

Percent Water Vapor:

% H2O = 3.07 / 56.38 * 100 = 5.5 %

Particulate Concentration (Grain Loading):

Go = (.0243 Gms. * 15.43)/ 53.3 SDCF = .007 Grs/SDCF

Particulate Emission Rate:

(.007 Grs/SDCF * 3947 SDCFM * 60)/7000 = .24 Lbs/Hr.

ULTRACHEM/ERG

Client : ZIMPRO/HONOULULI Date Tested : 11/15/83

Test No. : A - HAWAII Time : 1303-1426

GAS SAMPLE DATA

Sample Points 1-8 SOUTH;1-8 EAST Sample Nozzle Area .000291 ft^2

Avg Gas Meter Pressure .5 ''Hg Duct Pressure 29.9 ''Hg

Avg Gas Meter Temp 109 F Duration of Test 80 Min.

Barometric Pressure 29.93 ''Hg Avg Duct Temp 108 F

Condensate 65 ml Avg Vel at Sample Points 44.6 ft/sec

Sample Volume 56.32 CF Standard Temp 70 F

Total Weight of Particulate Collected .0639 Grams

Condensed Water Vapor:

Vw = 0.00267 * 65 * 530 / 29.92 = 3.07 SDCF

Corected Meter Volume:

Vo = 56.32 * 30.4 / 29.92 * 530 / 569 = 53.35 SDCF

Percent Water Vapor:

% H2O = 3.07 / 56.43 * 100 = 5.4 %

Particulate Concentration (Grain Loading):

Go= (.0639 Gms.* 15.43)/ 53.35 SDCF = .0185 Grains/SDCF

Particulate Emission Rate:

(.0185 Grains/SDCF* 3947 SDCFM * 60)/7000 = .63 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: 97 %

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested :11/15/83

Test No. :B Time :1449-1611

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
8S	.85	117	52
7S	.9	118	53.5
6S	.85	117	52
5S	.75	118	48.9
4S	.6	118	43.7
3S	.6	117	43.7
2S	.5	121	40
1S	.35	123	33.5
8E	.75	117	48.8
7E	.8	116	50.4
6E	.6	115	43.6
5E	.5	114	39.8
4E	.5	114	39.8
3E	.6	114	43.6
2E	.6	116	43.6
1E	.5	121	40

Vs = Cp [h *(T + 460)]^.5 [1/M.W. * Ps]^.5 * 85.49

Conc. of CO2 = 7.2 % Conc. of O2 = 10.4 %

Conc. of H2O = 5.1 %

Avg. Gas Velocity; Vs, Avg. 44.8 Ft/Sec

Pitot Tube Correction Factor, Cp .81

Duct Gas Molecular Weight, M.W. 29.1

Duct Pressure, Ps. 29.9 ''Hg Barometric Pressure 29.93 ''Hg

Duct Size Round 17.5 In. Diameter Static Pressure -.35 ''H2O

Duct Area 1.67 Sq. Ft Avg. Gas Temp. 117

Gas Flow Rate 44.8 Ft/Sec * 1.67 Sq. Ft * 60 = 4488 CFM

4488 CFM* 530 / 577 * 29.9 /29.92*(1.00- 5.1 /100%H2O)= 3923 SDCFM

M.W. Factor = .0339 Standard Cond. Temp. 70

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested : 11/15/83

Test No. : B (EPA FORMAT) Time : 1449-1611

GAS FLOW DATA

Sample Points 1-8 EAST;1-8 SOUTH

Barometric Pressure 29.93 Sample Nozzle Area .00019 ft^2

Duct Pressure 29.9 ''Hg Condensate 40 ml.

Avg. Gas Meter Pressure .35 in.Hg Vol. of Gas Samples 36.52 CF

Avg Gas Meter Temp 92 F Avg Duct Temp 117 F

Wgt. Collected .0184 Gms. Duration of Test 80 Min.

Avg. Velocity at Sampling Pts 44.8 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 40 * (460 + 70)/29.92 = 1.89 SCF

Corrected Meter Volume:

Vo = 36.52 * 30.25 / 29.92 * 530 / 552 = 35.45 SDCF

Percent Water Vapor:

% H2O = 1.89 / 37.34 * 100 = 5.1 %

Particulate Concentration (Grain Loading):

Go = (.0184 Gms. * 15.43)/ 35.45 SDCF = .008 Grs/SDCF

Particulate Emission Rate:

(.008 Grs/SDCF * 3923 SDCFM * 60)/7000 = .27 Lbs/Hr.

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested : 11/15/83

Test No. : B - HAWAII Time : 1449-1611

GAS SAMPLE DATA

Sample Points 1-8 EAST;1-8 SOUTH Sample Nozzle Area .00019 ft^2

Avg Gas Meter Pressure .35 ''Hg Duct Pressure 29.9 ''Hg

Avg Gas Meter Temp 92 F Duration of Test 80 Min.

Barometric Pressure 29.93 ''Hg Avg Duct Temp 117 F

Condensate 40 ml Avg Vel at Sample Points 44.8 ft/sec

Sample Volume 36.52 CF Standard Temp 70 F

Total Weight of Particulate Collected .05 Grams

Condensed Water Vapor:

Vw = 0.00267 * 40 * 530 / 29.92 = 1.89 SDCF

Corected Meter Volume:

Vo = 36.52 * 30.25 / 29.92 * 530 / 552 = 35.49 SDCF

Percent Water Vapor:

% H2O = 1.89 / 37.38 * 100 = 5.1 %

Particulate Concentration (Grain Loading):

Go= (.05 Gms.* 15.43)/ 35.49 SDCF = .0217 Grains/SDCF

Particulate Emission Rate:

(.0217 Grains/SDCF* 3923 SDCFM * 60)/7000 = .73 Lbs/Hr.

Percentage of Isokinetic Sampling Attained: 99 %

Client : ZIMPRO/HONOULUILI Date Tested :11/15/83

Test No. :[C] Time :1630-1752

Gas Flow Rate Data

Point	h	T.	Vel.Ft/Sec
8E	.75	119	49.1
7E	.7	119	47.4
6E	.7	119	47.4
5E	.7	118	47.4
4E	.7	119	47.4
3E	.65	119	45.7
2E	.65	118	45.6
1E	.5	121	40.1
8S	.85	118	52.2
7S	.8	118	50.6
6S	.8	118	50.6
5S	.7	118	47.4
4S	.6	118	43.8
3S	.6	118	43.8
2S	.5	118	40
1S	.4	120	35.9

$$Vs = Cp\,[h\,*(T + 460)]^{.5}\,[1/M.W.\,*\,Ps]^{.5}\,*\,85.49$$

Conc. of CO2 = 7 % Conc. of O2 = 10.8 %

Conc. of H2O = 6.3 %

Avg. Gas Velocity; Vs, Avg. 45.9 Ft/Sec

Pitot Tube Correction Factor, Cp .81

Duct Gas Molecular Weight, M.W. 28.94

Duct Pressure, Ps. 29.9 ''Hg Barometric Pressure 29.93 ''Hg

Duct Size Round 17.5 In. Diameter Static Pressure -.35 ''H2O

Duct Area 1.67 Sq. Ft Avg. Gas Temp. 118

Gas Flow Rate 45.9 Ft/Sec * 1.67 Sq. Ft * 60 = 4599 CFM

4599 CFM* 530 / 578 * 29.9 /29.92*(1.00- 6.3 /100%H2O)= 3957 SDCFM

M.W. Factor = .034 Standard Cond. Temp. 70

ULTRACHEM/ERG

Client : ZIMPRO/HONOULULI Date Tested : 11/15/83

Test No. : [C] (EPA FORMAT) Time : 1630-1752

GAS FLOW DATA

Sample Points 1-8 SOUTH;1-8 EAST

Barometric Pressure 29.93 Sample Nozzle Area .000202 ft^2

Duct Pressure 29.9 ''Hg Condensate 55 ml.

Avg. Gas Meter Pressure .4 in.Hg Vol. of Gas Samples 39.63 CF

Avg Gas Meter Temp 91 F Avg Duct Temp 118 F

Wgt. Collected .0257 Gms. Duration of Test 80 Min.

Avg. Velocity at Sampling Pts 45.9 ft/sec.

Calculations

Condensed Water Vapor:

vw = 0.00267 * 55 * (460 + 70)/29.92 = 2.6 SCF

Corrected Meter Volume:

Vo = 39.63 * 30.3 / 29.92 * 530 / 551 = 38.6 SDCF

Percent Water Vapor:

% H2O = 2.6 / 41.21 * 100 = 6.3 %

Particulate Concentration (Grain Loading):

Go = (.0257 Gms. * 15.43)/ 38.6 SDCF = .0103 Grs/SDCF

Particulate Emission Rate:

(.0103 Grs/SDCF * 3957 SDCFM * 60)/7000 = .35 Lbs/Hr.

ULTRACHEM/ERG

Client : ZIMPRO/HONOULUILI Date Tested : 11/15/83

Test No. : C - HAWAII Time : 1630-1752

GAS SAMPLE DATA

Sample Points 1-8 SOUTH;1-8 EAST Sample Nozzle Area .000202 ft^2

Avg Gas Meter Pressure .4 ''Hg Duct Pressure 29.9 ''Hg

Avg Gas Meter Temp 91 F Duration of Test 80 Min.

Barometric Pressure 29.93 ''Hg Avg Duct Temp 118 F

Condensate 55 ml Avg Vel at Sample Points 45.9 ft/sec

Sample Volume 39.63 CF Standard Temp 70 F

Total Weight of Particulate Collected .0551 Grams

Condensed Water Vapor:

Vw = 0.00267 * 55 * 530 / 29.92 = 2.6 SDCF

Corected Meter Volume:

Vo = 39.63 * 30.3 / 29.92 * 530 / 551 = 38.64 SDCF

Percent Water Vapor:

% H2O = 2.6 / 41.24 * 100 = 6.3 %

Particulate Concentration (Grain Loading):

Go= (.0551 Gms.* 15.43)/ 38.64 SDCF = .022 Grains/SDCF

Particulate Emission Rate:

(.022 Grains/SDCF* 3957 SDCFM * 60)/7000 = .75 Lbs/Hr.

APPENDIX II

ULTRACHEM CORPORATION

8.2% CO_2
10.4% O_2

TEST A

AIR POLLUTION ANALYSIS

PARTICULATE FIELD DATA FORM

condensate 48 ml's + 17g = 65g.

Plant Honolulu W.W.T.P.
City Honolulu (EWA)
Location
Operator
Date 11-15-83
Run number
Stack diam, ~~mm~~ (in.) 17.5"
Sample box number
Meter box number 062
Meter ΔH@

Meter calibration (Y) #062
Pitot tube (C_p) A = .81
Probe length 3' - All glass
Probe liner material S.S. Behind Filter
Probe heater setting
Ambient temperature
Barometric pressure (P_b) 29.93 mm (in.) Hg
Assumed moisture 7.5%
Statis pressure (P_a) -0.3 mm (in.) H_2O
C Factor
Reference ΔP mm (in.) H_2O

Sheet 1 of 2
Nozzle identification number C
Nozzle diameter 6 mm (in.) .00029
Thermometer number
Final leak rate .004 ~~m³/min~~ (cfm) (INITIAL = .005 cfm)
Vacuum during leak check 20" Hg. (PRE)
21" (POST) ~~mm~~ (in.) Hg
Filter number GA#64 EPH#9
Remarks
TANK #11
MAG. BOX #1

R_3 = 2.25
.0145
R_0 = .

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	meter ~~Vacuum, PRESS~~ mm (in.) Hg	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm (in.) H_2O	(CFM)	Pressure differential across orifice meter (ΔH), mm (in.) H_2O		Gas sample volume (V_m), m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C (°F)	Gas sample temperature at dry gas meter: Outlet, °C (°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	PUMP	Filter temp, °C (°F)
8E	1303	0	0.6	90	.65	.74	55.1	1.52	297.86	114	112	88	15"	218
7	1308	5	0.6	91	.65	.74	55.1	1.53	300.92	118	112	92	16"	205
6	1313	10	0.6	91	.65	.74	55.1	1.53	304.28	120	110	92	16"	211
5	1318	15	0.6	104	.65	.73	55.8	1.49	307.76	120	112	96	16"	216
4	1323	20	0.6	108	.60	.70	53.8	1.37	311.26	120	114	92	16"	242
3	1328	25	0.4	94	.60	.71	53.1	1.40	314.70	120	110	90	16"	265
2	1333	30	0.4	99	.60	.71	53.3	1.40	318.20	120	104	90	16"	245
1	1338	35	0.4	114	.55	.67	51.7	1.24	321.60	120	102	90	16"	247
STOP	1343	40							326.60					
						.72								
	Total		Avg	Avg					Total 2834	Avg	Avg	Max		

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ULTRACHEM CORPORATION

TEST A (CONT.)

AIR POLLUTION ANALYSIS

PARTICULATE FIELD DATA FORM

Plant Honolulu WWTP
City Honolulu
Location FWA
Operator
Date
Run number
Stack diam, mm (in.)
Sample box number
Meter box number
Meter ΔH@

Meter calibration (Y)
Pitot tube (C_p)
Probe length
Probe liner material
Probe heater setting
Ambient temperature
Barometric pressure (P_b) mm (in.) Hg
Assumed moisture
Statis pressure (P_a) mm (in.) H_2O
C Factor
Reference ΔP mm (in.) H_2O

Sheet 2 of 2
Nozzle identification number
Nozzle diameter mm (in.)
Thermometer number
Final leak rate m^3/min (cfm)
Vacuum during leak check
mm (in.) Hg
Filter number
Remarks

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	Meter press, mm (in.) Hg	Stack temperature (T_s), °C(°F)	Velocity head (ΔP_s), mm (in.) H_2O	Pressure differential across orifice meter (ΔH), mm (in.) H_2O	Gas sample volume (V_m), m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C(°F)	Gas sample temperature at dry gas meter: Outlet, °C(°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	Filter temp, °C(°F)
85	1346	40	0.6	115	.75 / .78	60.5 / 1.69	326.60	110	92	80	232
7	51	45	0.6	116	.75 / .78	60.5 / 1.69	328.85	116	92	82	207
6	56	50	0.6	117	.75 / .76	60.6 / 1.65	332.64	118	94	76	218
5	1401	55	0.6	117	.75 / .76	60.6 / 1.65	336.05	118	94	72	232
4	06	60	0.6	118	.65 / .71	56.5 / 1.43	339.65	118	94	72	218
3	11	65	0.4	121	.60 / .68	54.4 / 1.31	343.20	116	92	70	216
2	16	70	0.4	120	.50 / .62	49.6 / 1.10	346.65	116	92	70	247
1	21	75	0.4	115	.50 / .62	49.8 / 1.09	349.95	112	90	70	258
STOP	1426	80					353.54				
						.71					
							27.94				
	Total	80 min	Avg 0.5	Avg 108		55.3	Total 5632	Avg 117	Avg 101	Max 96°	18" Hg

56.64 109 OK

OK

3.4.12-13

ULTRACHEM CORPORATION

$CO_2 = 7.2\%$

$O_2 = 11.0\%$

TEST B

AIR POLLUTION ANALYSIS

PARTICULATE FIELD DATA FORM

Plant Honolulu WWTP
City Honolulu
Location EWA
Operator
Date 11-15-84
Run number
Stack diam, mm (in.) 17.5"
Sample box number
Meter box number D62
Meter ΔH@

Meter calibration (Y)
Pitot tube (C_p)
Probe length
Probe liner material
Probe heater setting
Ambient temperature
Barometric pressure (P_b) mm (in.) Hg
Assumed moisture
Statis pressure (P_s) mm (in.) H_2O
C Factor
Reference ΔP mm (in.) H_2O

Condensate 34 wet 6g = 40g.
Sheet of
Nozzle identification number 4
Nozzle diameter 5mm mm (in.) .000190
Thermometer number
Final leak rate m^3/min (cfm) PRE .003CFM at 21" Hg.
Vacuum during leak check
mm (in.) Hg
Filter number 66 + EPA19
Remarks
Tank #14
MAG BOX #1

$R_3 = 1.620$

$R_D = .0093$

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	Meter Vacuum, P_{ms} (in.) Hg	Stack temperature (T_s), °C(°F)	Velocity head (ΔP_s), mm (in.) H_2O (CFM)		Pressure differential across orifice meter (ΔH), (VEL) mm (in.) H_2O		Gas sample volume (V_m), m^3 (ft^3)^m	Gas sample temperature at dry gas meter: Inlet, °C(°F)	Gas sample temperature at dry gas meter: Outlet, °C(°F)	Temperature of gas leaving condenser or last impinger, °C (°F) (PUMP)		Filter temp, °C(°F)
85	0	1449	.4	117	.85	.53	64.5	.78	353.88	87	85	68	12	227
7	5	54	.4	118	.90	.53	66.4	.82	357.05	85	85	70	12	310
6	10	59	.4	117	.85	.53	64.5	.82	359.50	100	85	72	12	258
5	15	1504	.4	118	.75	.50	60.6	.72	362.15	105	85	84	12	230
4	20	09	.3	118	.60	.45	54.2	.58	364.50	105	85	84	12	216
3	25	14	.3	117	.60	.45	54.2	.58	366.90	105	85	80	11	261
2	30	19	.3	121	.50	.41	49.6	.48	368.85	105	85	80	11	270
1	35	24	.3	123	.35	.34	41.6	.33	370.90	100	85	82	11	273
Stop	40	29							372.63					
	Total		Max	Avg					Total 18.75	Avg	Avg	Max		

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ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS

Test B (con't)

PARTICULATE FIELD DATA FORM

Plant _____
City _____
Location _____
Operator _____
Date _____
Run number _____
Stack diam, mm (in.) _____
Sample box number _____
Meter box number _____
Meter ΔH@ _____

Meter calibration (Y) _____
Pitot tube (C_p) _____
Probe length _____
Probe liner material _____
Probe heater setting _____
Ambient temperature _____
Barometric pressure (P_b) _____ mm (in.) Hg
Assumed moisture _____
Statis pressure (P_a) _____ mm (in.) H_2O
C Factor _____
Reference ΔP _____ mm (in.) H_2O

Sheet _____ of _____
Nozzle identification number _____
Nozzle diameter _____ mm (in.)
Thermometer number 3
Final leak rate .004 ~~m³/min~~ ~~(cfm)~~ cfm
Vacuum during leak check _____
15 ~~mm~~ (in.) Hg Post Leak ✓
Filter number _____
Remarks _____

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	Vacuum, mm (in.) Hg	Stack temperature (T_s), °C(°F)	Velocity head (ΔP_s), mm (in.) H_2O	Pressure differential across orifice meter (ΔH), mm (in.) H_2O	Gas sample volume (V_m), m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C(°F)	Gas sample temperature at dry gas meter: Outlet, °C(°F)	Temperature of gas leaving condenser or last impinger, °C (°F)	Filter temp, °C(°F)
8	40	1532	.4	117	.75 .60	60.6 .72	372.63	95	85	84 (11" pump)	265
7	45	36	.4	116	.80 .52	62.5 .77	374.85	98	85	87 11"	253
6	50	41	.4	115	.60 .45	54.1 .58	377.45	100	85	86 11"	210
5	55	46	.4	114	.50 .41	49.3 .48	379.70	100	85	89 11"	220
4	60	57	.3	114	.50 .41	49.3 .49	381.85	104	85	87 11"	215
3	65	56	.3	114	.60 .45	54.1 .58	383.80	100	85	88 11"	211
2	70	1601	.3	116	.60 .45	54.1 .58	386.05	100	85	87 11"	256
1	75	06	.3	121	.50 .41	49.6 .48	388.30	100	85	88 11"	243
END	80	11					390.40				
							17.77				
	Total		Max 0.35	Avg 117		55.6	Total 36.52	Avg 99	Avg 85	Max 87° 12" Hg	

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ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS

Test C

PARTICULATE FIELD DATA FORM

condensate 46 set 9g = ~~mls~~ 55g

Plant _____
City _____
Location _____
Operator _____
Date _____
Run number _____
Stack diam, ~~mm~~ (in.) 17.5"
_____
Sample box number _____
Meter box number _____
Meter ΔH@ _____

Meter calibration (Y) _____
Pitot tube (C_p) _____
Probe length _____
Probe liner material _____
Probe heater setting _____
Ambient temperature _____
Barometric pressure (P_b) _____ mm (in.) Hg
Assumed moisture _____
Statis pressure (P_a) _____ mm (in.) H_2O
C Factor _____
Reference ΔP _____ mm (in.) H_2O

Sheet 1 of 2
Nozzle identification number F
Nozzle diameter 3/16 ~~mm~~ (in.) .000202
Thermometer number 3
~~Pitot~~ leak rate .006 ~~m³/min~~ (cfm) Pre Leak ✓
Vacuum during leak check 16" mm (in.) Hg
Filter number 39 + EPA 18
Remarks
Tank #4
MAG Box #1

R_B = .0340
R_3 = 1.62
R_o = .0098

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	Meter Vacuum, ~~mm~~ (in.) Hg	Stack temperature (T_s), ~~°C~~ (°F)	Velocity head (ΔP_s), mm (in.) H_2O (CFM)		Pressure differential across orifice meter (ΔH), (VEL) mm (in.) H_2O		Gas sample volume (V_m), m^3 (ft^3)	Gas sample temperature at dry gas meter: Inlet, °C(°F)	Gas sample temperature at dry gas meter: Outlet, °C(°F)	Temperature of gas leaving condenser or last impinger, °C (°F) (Pump)	Filter temp, °C(°F)
8	0	1630	.4	119	.75	.52	60.7	.80	390.47	85	85	67	11"	265
7	5	35	.4	119	.70	.51	58.6	.75	393.07	90	85	73	11"	243
6	10	40	.4	119	.70	.51	58.6	.75	395.55	95	85	80	11"	232
5	15	45	.4	118	.70	.51	58.6	.76	398.00	97	85	85	11"	235
4	20	50	.4	119	.70	.51	58.6	.76	400.55	100	85	86	11"	210
3	25	55	.4	119	.65	.49	56.5	.70	403.10	100	83	85	11"	223
2	30	1700	.4	118	.65	.49	56.5	.70	405.50	100	83	88	11"	240
1	35	05	.3	121	.50	.43	49.6	.54	407.94	100	83	85	11"	250
Stop	40	10							410.20				
	Total		Max	Avg					Total 9.73	Avg	Avg	Max	

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ULTRACHEM CORPORATION

Orsat
%CO_2 = 7.8
%O_2 = 10.8

AIR POLLUTION ANALYSIS

Test C (cont)

PARTICULATE FIELD DATA FORM

Plant _____
City _____
Location _____
Operator _____
Date _____
Run number _____
Stack diam, mm (in.) _____
Sample box number _____
Meter box number _____
Meter ΔH@ _____

Meter calibration (Y) _____
Pitot tube (C_p) _____
Probe length _____
Probe liner material _____
Probe heater setting _____
Ambient temperature _____
Barometric pressure (P_b) _____ mm (in.) Hg
Assumed moisture _____
Statis pressure (P_s) _____ mm (in.) H_2O
C Factor _____
Reference ΔP _____ mm (in.) H_2O

Sheet 2 of 2
Nozzle identification number ____
Nozzle diameter _____ mm (in.)
Thermometer number ____
Final leak rate .006 m³/min (cfm) Post Leak ✓
Vacuum during leak check _____
15 mm (in.) Hg
Filter number _____
Remarks _____

Traverse point number	Sampling time, (θ), min	Clock time, (24 h)	meter Vacuum, mm (in.) Hg	Stack temperature (T_s), °C(°F)	Velocity head (ΔP_s), mm (in.) H_2O		Pressure differential across orifice meter (ΔH), mm (in.) H_2O		Gas sample volume (V_m), m^3 (ft^3)$_m$	Gas sample temperature at dry gas meter		Temperature of gas leaving condenser or last impinger, °C (°F)		Filter temp, °C(°F)
										Inlet, °C(°F)	Outlet, °C(°F)			
8S	40	1712	.4	118	.85	.57	64.6	.92	410.20	100	83	85	11" pump	210
7	45	17	.4	118	.80	.55	62.6	.87	413.00	100	83	87	11"	230
6	50	22	.4	118	.80	.55	62.6	.87	416.85	100	82	87	11"	210
5	55	27	.4	118	.70	.51	58.6	.76	418.90	100	82	83	11"	206
4	60	32	.4	118	.60	.47	54.2	.65	421.00	100	82	83	11"	210
3	65	37	.4	118	.60	.47	54.2	.65	423.40	100	80	83	11"	220
2	70	42	.3	118	.50	.43	49.5	.54	425.75	100	80	85	11"	230
1	75	47	.3	120	.40	.39	44.4	.43	428.00	97	80	80	11"	238
END	80	52							430.10					
									19.90					
	Total		Max 0.4	Avg 119			56.8		Total 39.63	Avg 98	Avg 83	Max 88°	11" Hg	

3.4.12-13

ULTRACHEM CORPORATION

AIR POLLUTION ANALYSIS
VISIBLE EMISSIONS EVALUATION

Client Zimpro, Honoulului Sewage Treatment Plant

Location Ewa, Hawaii

Type Facility Sewage Treatment

Emission Point Furnace Exhaust

Control Device Wet Scrubber

Test Date 11/15/83

Test No. A, B, & C

Observer Eric Diethelm & E. H. Gallaghe

Recertification Date

Certifying Agency Calif. A.R.B.

FIELD DATA

	A	B	C		
Observer Location:					
Position on map	Refer to map				
Distance to discharge	40 ft.	40 ft	45 ft.		
Direction from discharge	SE	S	SW		
Direction from sun	North	NNE	ENE		
Height of discharge, a.g.l.	120'	120'	120'		
Height of observation point, a.g.l.	110'	110'	110'		
Weather Conditions:					
Wind speed, m.p.h., & direction	SW	E	E		
Ambient temp., °F	5-10mph	6-10mph	8-12mph		
Relative humidity, %	88/62%	85/64%	83/62%		
Precipitation	none	none	none		
Cloud cover	scattered	scattered	scattered		
Plume Description:					
Color	white	white	gray		
Distance Visible	0	0	max. 20'		
Steam plume type	N/A	N/A	N/A		
Distance to steam formation	N/A	N/A	N/A		
Distance to steam dissipation	N/A	N/A			
Illumination	Good Sunlight	Good Sunlight			
Background	Cloudy-blue skies	Blue Sky			

OBSERVATION RECORD PAGE 2 OF 2

COMPANY Zimpro OBSERVER E. Diethelm
LOCATION Honolulu, Hawaii (EWA) TYPE FACILITY Sewage
TEST NUMBER A POINT OF EMISSIONS Exhaust
DATE 11-15-83. Furnace Stack

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if applicable) Attached	Detached	Comments
1359	0	0	0	0	0			
	1	0	0	0	0			
	2	0	0	0	0			
	3	0	0	0	0			
	4	0	0	0	0			
	5	0	0	0	0			
	6	0	0	0	0			
	7	0	0	0	0			
	8	0	0	0	0			
	9	0	0	0	0			
	10	0	0	0	0			
	11	0	0	0	0			
	12	0	0	0	0			
	13	0	0	0	0			
	14	0	0	0	0			
	15	0	0	0	0			
	16	0	0	0	0			
	17	0	0	0	0			
	18	0	0	0	0			
	19	0	0	0	0			
	20	0	0	0	0			
	21	0	0	0	0			
	22	0	0	0	0			
	23	0	0	0	0			
	24	0	0	0	0			
	25	5	0	0	0			
	26	0	0	0	0			
	27	0	0	0	0			
	28	0	0	0	0			
	29	0	0	0	0			

OBSERVATION RECORD (Continued) PAGE ___ OF ___

COMPANY ___ OBSERVER ___
LOCATION ___ TYPE FACILITY ___
TEST NUMBER ___ POINT OF EMISSIONS ___
DATE ___

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if Applicable) Attached	Detached	Comments
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
	41							
	42							
	43							
	44							
	45							
	46							
	47							
	48							
	49							
	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

Figure 6-7. Observation Record

TEST B

OBSERVATION RECORD PAGE 1 OF 1

COMPANY Zimpro
LOCATION Honolulu
TEST NUMBER B
DATE 11-15-83

OBSERVER Eddy
TYPE FACILITY Furnace Gr.
POINT OF EMISSIONS Scrubber Exhaust

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if applicable) Attached	Detached	Comments
14 50	0	0	0	0	0			
51	1	0	0	0	0			
52	2	0	0	0	0			
53	3	0	0	0	0			
54	4	0	0	0	0			
55	5	0	0	0	0			
56	6	0	0	0	0			
57	7	0	0	0	0			
58	8	0	0	0	0			
59	9	0	0	0	0			
15 00	10	0	0	0	0			
01	11	0	0	0	0			
02	12	0	0	0	0			
03	13	0	0	0	0			
04	14	0	0	0	0			
05	15	0	0	0	0			
06	16	0	0	0	0			
07	17	0	0	0	0			
08	18	0	0	0	0			
09	19	0	0	0	0			
15 10	20	0	0	0	0			
11	21	0	0	0	0			
12	22	0	0	0	0			
13	23	0	0	5	0			
14	24	0	5	5	5			
15	25	0	0	0	0			
16	26	0	0	5	5			
17	27	0	5	0	0			
18	28	0	0	0	0			
19	29	5	5	0	0			

OBSERVATION RECORD (Continued) PAGE ___ OF ___

COMPANY
LOCATION
TEST NUMBER B (Cont)
DATE

OBSERVER Eddy
TYPE FACILITY
POINT OF EMISSIONS

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if Applicable) Attached	Detached	Comments
15	30	0	0	0	0			
	31	5	0	0	0			
	32	0	5	0	0			
	33	0	0	0	0			
	34	0	5	5	0			
	35	5	5	0	0			
	36	0	0	0	0			
	37	0	0	0	5			
	38	0	0	0	0			
	39	0	5	5	0			
15	40	0	5	5	0			
	41	0	0	0	0			
	42	0	0	0	0			
	43	0	0	0	0			
	44	0	0	0	0			
	45	0	0	0	0			
	46	0	0	0	0			
	47	0	0	0	0			
	48	0	0	0	0			
	49	0	0	0	0			
15	50	0	0	0	0			
	51	0	0	0	0			
	52	0	0	0	0			
	53	0	0	0	0			
	54	0	0	0	0			
	55	0	0	0	0			
	56	0	0	0	0			
	57	0	0	0	0			
	58	0	0	0	0			
	59	0	0	0	0			

Figure 6-7. Observation Record

TEST C

OBSERVATION RECORD PAGE __ OF __

COMPANY ZIMPRO
LOCATION HONOLULU
TEST NUMBER C
DATE 11-15-83

OBSERVER EHG
TYPE FACILITY FURNACE
POINT OF EMISSIONS SCRUBBER EXHAUST

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if applicable) Attached	Detached	Comments
	0							
16	31	0	0	0	0			
	32	0	0	0	0			
	33	0	5	5	10			
	34	10	5	0	5			
	35	0	0	0	0			
	36	0	0	0	0			
	37	5	0	5	5			
	38	10	5	10	10			
	39	10	5	15	5			
16	40	0	0	0	0			
	41	0	0	0	0			
	42	5	0	0	0			
	43	0	0	10	10			
	44	10	5	5	0			
	45	0	0	0	0			
	46	0	0	0	0			
	47	0	0	0	0			
	48	0	0	0	5			
	49	10	5	0	0			
16	50	0	0	0	0			
	51	0	0	0	0			
	52	0	0	0	0			
	53	0	0	0	0			
	54	5	10	10	5			
	55	0	0	0	0			
	56	0	0	0	0			
	57	0	0	0	0			
	58	5	0	10	0			
	59	5	10	0	0			
17	00	0	0	0	0			

OBSERVATION RECORD (Continued) PAGE __ OF __

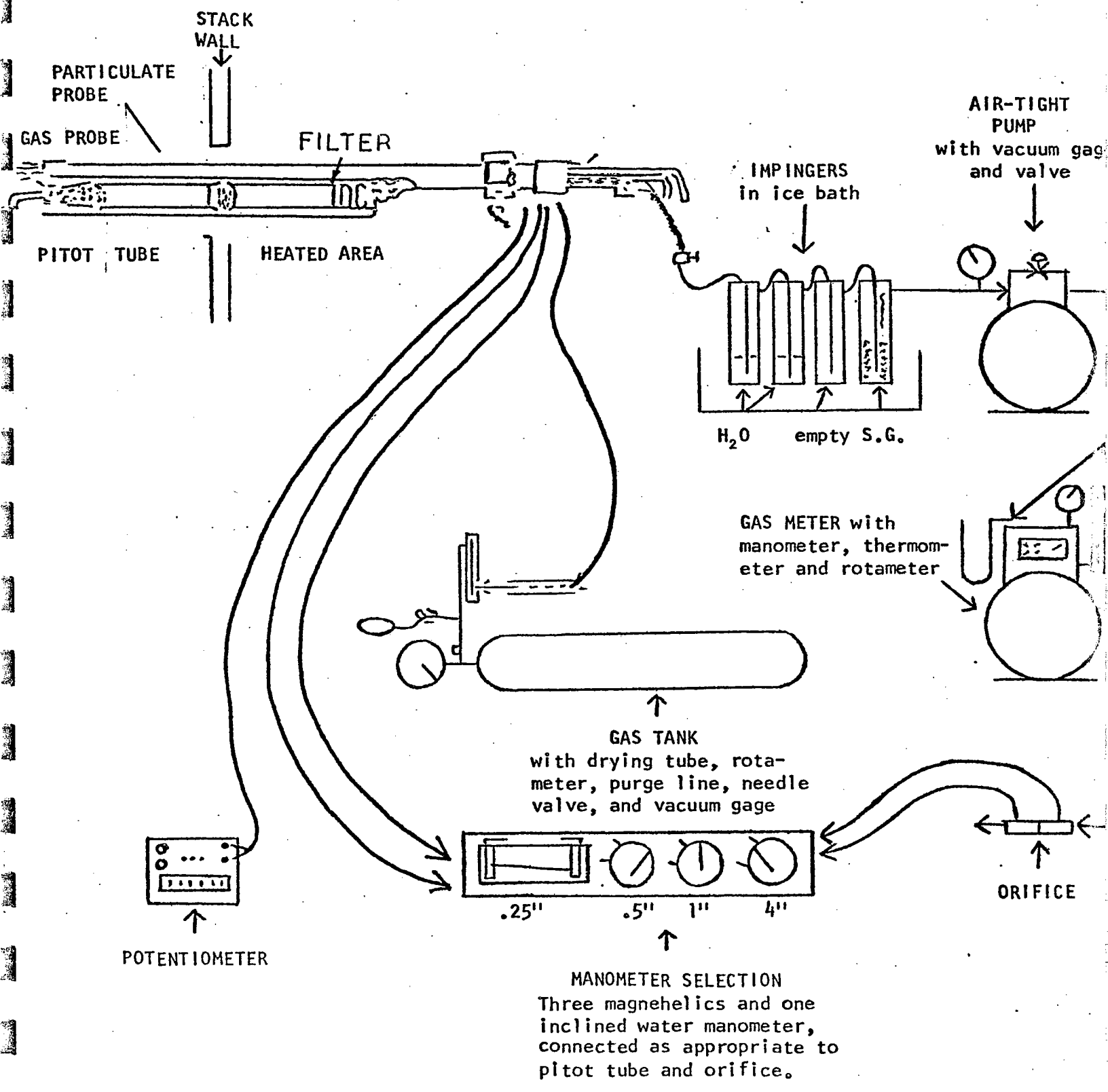
COMPANY
LOCATION
TEST NUMBER
DATE

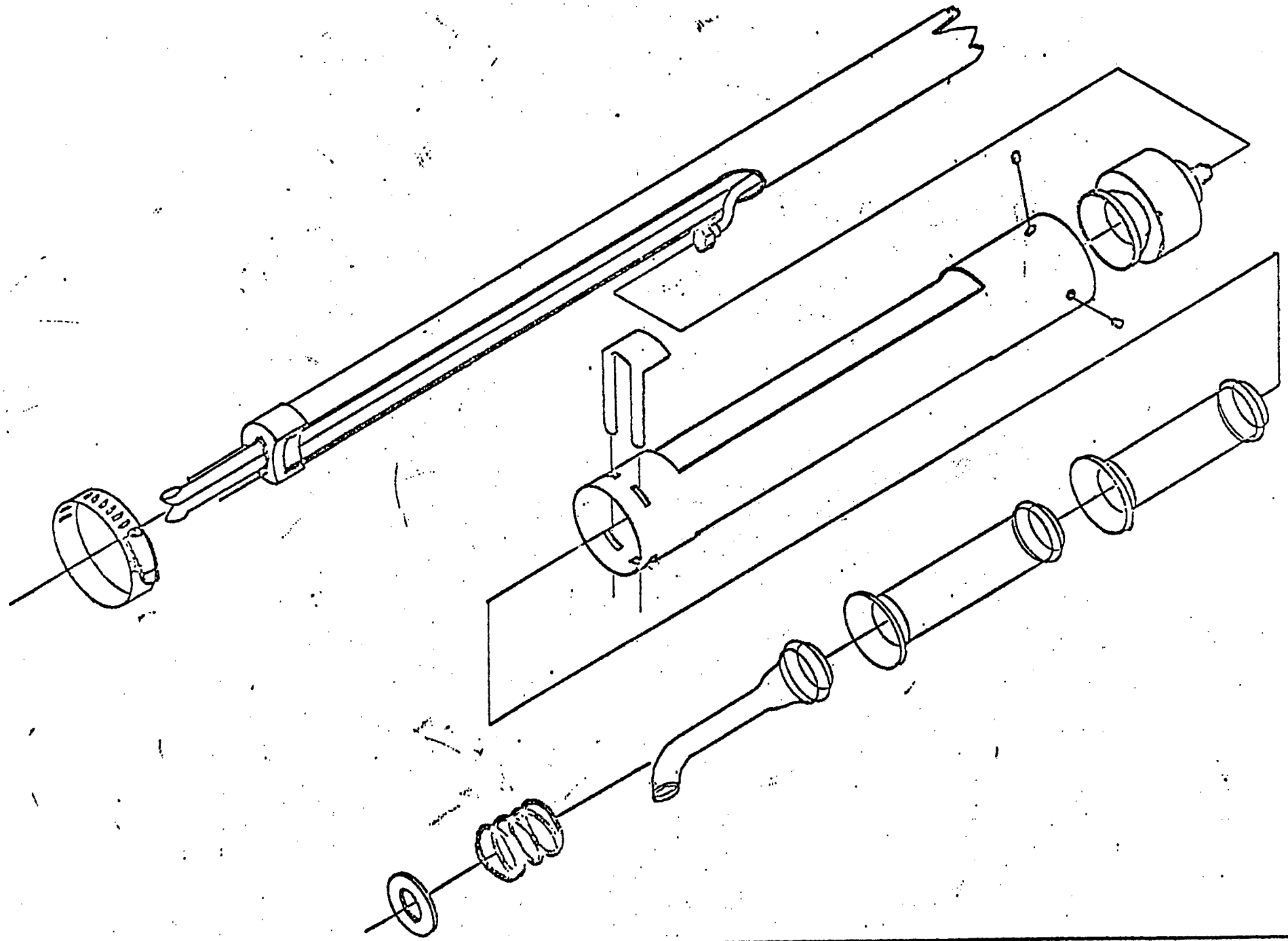
OBSERVER
TYPE FACILITY
POINT OF EMISSIONS

Hr.	Min.	Seconds 0	15	30	45	Steam Plume (Check if Applicable) Attached	Detached	Comments
	30							
	31							
	32							
	33							
	34							
	35							
	36							
	37							
	38							
	39							
	40							
	41							
	42							
	43							
	44							
	45							
	46							
	47							
	48							
	49							
	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

Figure 6-7. Observation Record

APPENDIX III


STACK WALL
PARTICULATE PROBE
GAS PROBE
FILTER
PITOT TUBE
HEATED AREA
IMPINGERS in ice bath
AIR-TIGHT PUMP with vacuum gag and valve
H_2O
empty S.G.
GAS METER with manometer, thermometer and rotameter
GAS TANK with drying tube, rotameter, purge line, needle valve, and vacuum gage
ORIFICE
.25"
.5"
1"
4"
POTENTIOMETER
MANOMETER SELECTION
Three magnehelics and one inclined water manometer, connected as appropriate to pitot tube and orifice.



PROPELLER ASSEMBLY

APPENDIX IV

EQUATIONS FOR CALCULATIONS

1) Average Stack Gas Velocity (See Gas Flow Rate Data Sheet)

$$V_s, \text{ Ft/Sec} = C_p \times \left[h \times (T_s + 460)\right]^{1/2} \times \left[\frac{1}{M.W. \times P_s}\right]^{1/2} \times 85.49$$

where h = velocity head of stack gas, inches H_2O

where T_s = stack gas temperature, °R

where 85.49 is a constant with units of $\frac{\text{ft}}{\text{sec.}} \quad \frac{(\text{lb/lb-mole})\ (\text{in. Hg})}{(°R)\ \ (\text{in. } H_2O)}^{1/2}$

where C_p is the dimensionless correction factor for pitot tube obtained by calibration against a standard pitot tube.

where P_s is the absolute stack pressure in inches Hg.

where M.W. is the stack gas molecular weight and is calculated by the equation.

$$M.W. = 0.44\ (\%\ CO_2)\ \left(1-\frac{\%H_2O}{100}\right) + 0.32\ (\%O_2)\ \left(1-\frac{\%H_2O}{100}\right) + 0.2815\ (\%N_2)\ \left(1-\frac{\%H_2O}{100}\right) + 0.18\ (\%H_2O)$$

0.44 x 100 is the molecular weight of carbon dioxide.
0.32 x 100 is the molecular weight of oxygen.
0.2815 x 100 is the molecular weight of nitrogen.. plus the argon contribution to air.
0.18 x 100 is the molecular weight of water.

2) Stack Volumetric Flow Rate (See Gas Flow Rate Data Sheet).

CFM (Stack) = Duct Area x 60 x V_s (ave).

$$\text{SDCFM (Stack)} = \text{CFM (Stack)} \times \frac{530}{T_s\ (\text{ave})} \times \frac{P_s}{29.92} \times \left(1 - \frac{\%H_2O}{100}\right)$$

where T_s (ave) = Average stack temperature °R.

P_s = Stack Pressure, inches Hg.

where Duct area is in ft^2.

where 60 converts seconds to minutes.

3) Percent water vapor and Corrected Meter Volume

$$\%H_2O \text{ (vol)} = \frac{Vw}{Vw + Vo} \times 100$$

where $Vw = 0.00267 \times \text{ml condensate} \times \frac{460 + 70}{29.92}$

where 0.00267 is a constant with units of $\frac{\text{in.Hg} - \text{ft}^2}{\text{ml} - {}^\circ\text{R}}$

and Vo = Corrected Meter Volume in cubic feet

$$Vo = \text{Sampled Volume (CF)} \times \frac{Pb + Pm}{29.92} \times \frac{530}{460 + Tm}$$

Pb = Barometric Pressure, in. Hg.
Pm = Average Meter Pressure, in. Hg.
Tm = Average Meter Temperature, °F
528 °R is standard temperature condition
29.92 in. Hg is standard pressure condition
460°R equals 0°F.

4) Percentage of Isokinetic Sampling Attained:

$$\%I = \frac{100}{60} \times \frac{460 + TS}{} \times \left[\frac{0.00267 \times \text{condensate ml} + \frac{(\text{spl.vol}) \text{ CF} \times (Pm + Pb)}{460 + Tm}}{\text{time (min)} \times Vs \text{ (avg.) ft/sec} \times Pb \times An \text{ ft}^2} \right] =$$

Ts = Average stack temperature, °F
Ps = Stack pressure, in. Hg.
An = Nozzle area, ft^2
Time = Total sampling time, min.
Vs (ave) = Average stack gas velocity at sampled points (see equation #1)
Pb = Barometric pressure, in. Hg.

5) Particulate Concentration (Grain Loading)

$$Go = \frac{\text{Grams particulate}}{Vo} \times 15.43$$

where Vo = corrected meter volume, SDCF

and 15.43 is a constant which converts $\frac{\text{grams}}{ft^3}$ to $\frac{\text{grains}}{ft^3}$

6) Particulate Emission Rate, lb/hr

$$E = Go \times SDCFM\ (stack) \times \frac{60}{7000}$$

where 60 converts minutes to hours

and 7000 converts grains to pounds

7) Particulate Emission Rate, pounds per 1000 pounds of flue gas

(Wet Basis) $$\#/1000\#\text{flue gas} = \frac{1000 \times E\ (\#/hr)}{SCFM \times 60 \times \text{wet gas density}}$$

(Dry Basis) $$\#/1000\#\text{flue gas} = \frac{1000 \times E\ (\#/hr)}{SCFM \times 60 \times \text{dry gas density}}$$

8) Particulate Emission Rate, pounds per 1000 pounds of flue gas corrected to 12% CO_2

$$\#/1000\#\text{flue gas at 12\% } CO_2 \text{ (Wet Basis)} = \#/1000\#\text{flue gas (wet basis)} \times \frac{12}{\%CO_2}$$

$$\#/1000\#\text{flue gas at 12\% } CO_2 \text{ (Dry Basis)} = \#/1000\#\text{flue gas (dry basis)} \times \frac{12}{\%CO_2}$$

where $\%CO_2$ is the measured CO_2 content in percent at the scrubber fan on a dry basis

9) Flue Gas Density in pounds per cubic foot

$$\text{Wet Gas Density} = \frac{0.0458 \times M.W.\ (wet) \times Ps}{Ts}$$

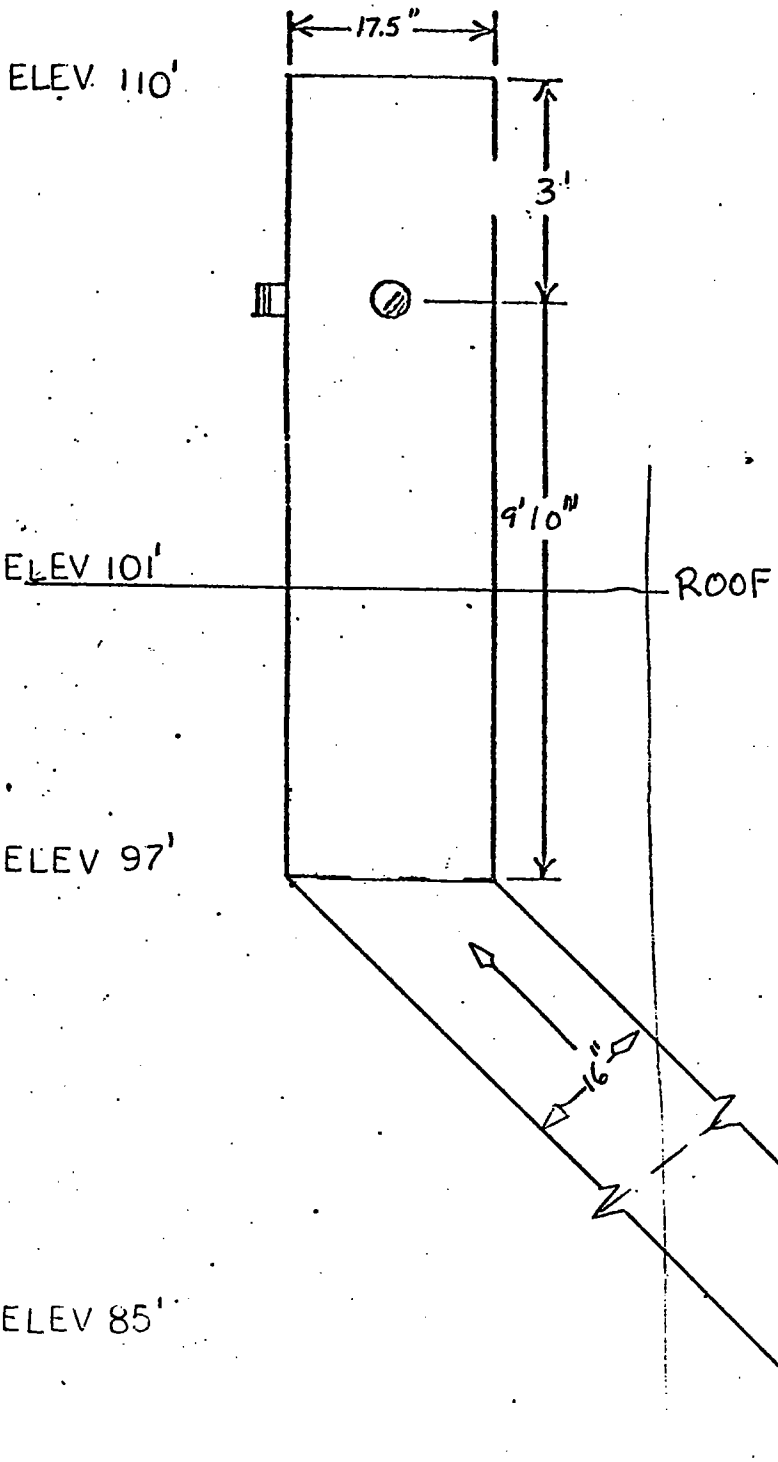
$$\text{Dry Gas Density} = \frac{0.0458 \times M.W.\ (dry) \times Ps}{Ts}$$

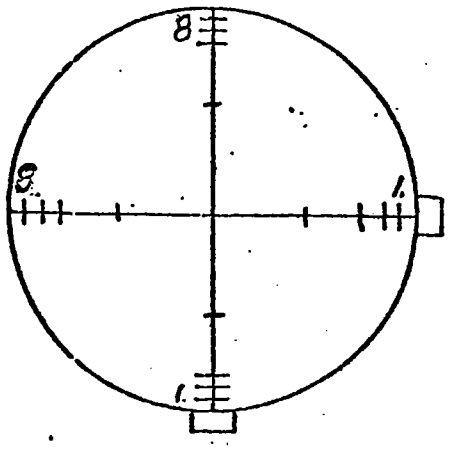
where Ps is the absolute stack pressure in inches of Hg.
and Ts is the stack temperature in °R
and 0.0458 is a constant with units of $\frac{\text{pound-mole-°R}}{\text{grams-in.Hg.-ft}}$

this assumes a density of dry air to be 0.0760 #/CF at 520°R and 29.92 in.Hg.

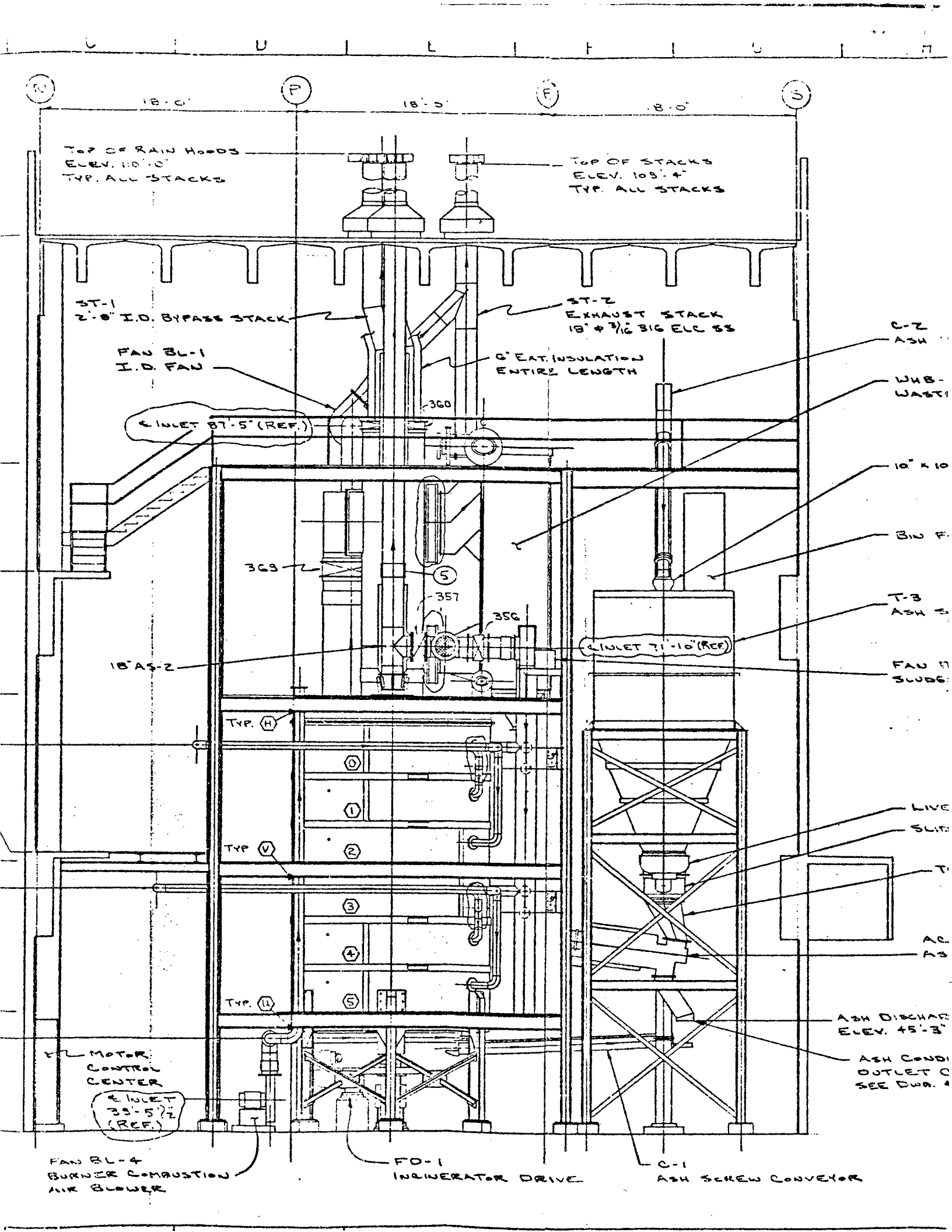
APPENDIX V

STACK DIAGRAM





POINT	DISTANCE FROM CENTER
1	8"
2	7.125"
3	5.5
4	3.25
5	3.25
6	5.5
7	7.125
8	8


18'-0"
18'-0"
18'-0"
TOP OF RAIN HOODS ELEV. 110'-0" TYP. ALL STACKS
TOP OF STACKS ELEV. 109'-4" TYP. ALL STACKS
ST-1 2'-8" I.D. BYPASS STACK
ST-2 EXHAUST STACK 18' ø 3/16" 316 ELC SS
6" CAL. INSULATION ENTIRE LENGTH
FAN BL-1 I.D. FAN
℄ INLET 87'-5" (REF.)
360
369
357
356
℄ INLET 71'-10" (REF.)
18" AS-2
TYP. H
TYP V
TYP. U
MOTOR CONTROL CENTER
℄ INLET 33'-5 1/2" (REF.)
FAN BL-4 BURNER COMBUSTION AIR BLOWER
FD-1 INCINERATOR DRIVE
C-1 ASH SCREW CONVEYOR
C-2 ASH
WHB - WAST
10" x 10
BIN F
T-3 ASH
FAN H SLUDG
LIVE
SLIP
T
AC
AS
ASH DISCHAR ELEV. 45'-3"
ASH CONDI OUTLET C SEE DWG.

STAPPA / ALAPCO
2.5

logged 06/12/86
#19
23

NOV - 3
2.2/4.0
27

EMISSIONS TESTING OF INCINERATOR NO. 2
GREEN BAY METROPOLITAN SEWERAGE DISTRICT
GREEN BAY, WISCONSIN

Submitted to

Green Bay Metropolitan Sewerage District
P.O. Box 1015
Green Bay, Wisconsin, 54305

October 1981
9728.40/15

Submitted by

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