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OGDEN PROJECTS, INC.

AN OGDEN COMPANY

WATERGATE TOWER
SUITE 400
1900 POWELL STREET
EMERYVILLE, CALIFORNIA 94608
(415) 420-1766

Environmental Engineering Department

ENVIRONMENTAL TEST REPORT

Appendix A

Entropy Environmentalists, Inc., Stationary Source Sampling Report 6323A, June 27-30, 1989.

PREPARED FOR:	Ogden Martin Systems of Indianapolis, Inc. 2320 So. Harding Street Indianapolis, IN 46221
REGARDING:	Indianapolis Resource Recovery Facility
REGULATORY AGENCY:	City of Indianapolis, Department of Public Works, Air Pollution Control Division and State of Indiana, Department of Environmental Management
PURPOSE:	Demonstration of Compliance with Certificate of Operation No. 0123 with City of Indianapolis and PSD (49) 1602 for the State of Indiana and the U.S. EPA.
TEST DATES:	June 27 through July 1, 1989

August 25, 1989
OPI Report No. 221

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ENTROPY
ENVIRONMENTALISTS INC

POST OFFICE BOX 12291
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

STATIONARY SOURCE SAMPLING REPORT

REFERENCE NO. 6323A

INDIANAPOLIS RESOURCE RECOVERY FACILITY

INDIANAPOLIS, INDIANA

EMISSIONS TESTING FOR:
Hydrogen Chloride
Lead
Mercury
Nitrogen Oxides
Particulate
Total Hydrocarbons

UNIT NOS. 1, 2, AND 3

PERFORMED FOR: OGDEN PROJECTS, INC.

JUNE 27 THROUGH 30, 1989

REPORT CERTIFICATION

The sampling and analysis performed for this report was carried out under my direction and supervision.

Date August 21, 1989 Signature Gary L. Williams

Gary L. Williams

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

Date August 21, 1989 Signature

D. James Grove, P.E

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INTRODUCTION

1.1 Outline of Test Program. Stationary source sampling was performed Ogden Projects, Inc. at the Indianapolis Resource Recovery Facility in Indianapolis, Indiana, from June 27 through 30, 1989. The testing was perfo at Unit Nos. 1, 2, and 3 stacks. Table 1-1 is a test log which presents the sampling locations, emissions measured, sampling methods, test dates, and ru numbers.

1.2 Test Participants. Table 1-2 lists the personnel involved in the program.

TABLE 1-1

TEST LOG

Sampling Location	Emissions Measured *	Sampling Method	Test Date	Run Numbers** Repetition 1	Repetition 2	Repetition
Unit No. 1 Stack	Pb and Hg	EPA 12/101A	6/29	1-S-M12/101A-1	1-S-M12/101A-2	1-S-
"	CO_2, O_2	EPA 3	6/29	1-S-M12/101A-M3-1	1-S-M12/101A-M3-2	1-S-M1
"	Particulate and HCl	EPA 5	6/27	1-S-M5/HCl-1	1-S-M5/HCl-2	1-
"	CO_2, O_2	EPA 3	6/27	1-S-M5/HCl-M3-1	1-S-M5/HCl-M3-2	1-S-M
"	THC	EPA 25A	6/27	1-S-M25A-1	1-S-M25A-2	
"	NO_x	EPA 7E	6/27	1-S-M7E-1	- - -	
Unit No. 2 Stack	Particulate and HCl	EPA 5	6/29	2-S-M5/HCl-1	2-S-M5/HCl-2	2-S
"	CO_2, O_2	EPA 3	6/29	2-S-M5/HCl-M3-1	2-S-M5/HCl-M3-2	2-S-M5
"	THC	EPA 25A	6/29	2-S-M25A-1	2-S-M25A-2	2
"	NO_x	EPA 7E	6/29	2-S-M7E-1	- - -	
			6/30	2-S-M7E-2	- - -	
Unit No. 3 Stack	Particulate and HCl	EPA 5	6/28	3-S-M5/HCl-1	3-S-M5/HCl-2	3-S-
"	CO_2, O_2	EPA 3	6/28	3-S-M5/HCl-M3-1	3-S-M5/HCl-M3-2	3-S-M5
"	THC	EPA 25A	6/28	3-S-M25A-1	3-S-M25A-2	3-
"	NO_x	EPA 7E	6/28	3-S-M7E-1	- - -	

* THC = Total Hydrocarbons; NO_x = Nitrogen Oxides

** Run numbers reflect: unit number, sampling location, sampling method, and repetition.

TABLE 1-2

TEST PARTICIPANTS

Ogden Projects, Inc.	Ronald A. Zu Test Coordir
Indianapolis Resource Recovery Facility	Paul Claerbc Test Coordir
	Daryl Timby Chief Engin
Environmental Elements Corporation	Claus Jorge: Test Coordi.
	Chuck Faunc Process Dat
City of Indianapolis	David Foste Test Observ
	Daniel Jord. Test Observ
	Matt Mosier Test Observ
Indiana Department of Environmental Management	Mike Dicem Test Observ
	Raymond Sch Test Observ
Entropy Environmentalists Inc.	Gary L. Wil Project Mar
	Barry F. Ru Project Sup
	Allan F. Lc Sampling Te
	John J. Mit Sampling Te
	R. Lee Marc Engineering
	Clyde E. Na Engineering
	Bryan K. Gr Laboratory
	Matthew L. Laboratory

SUMMARY OF RES

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TABLE 2-1

CONCENTRATIONS AND EMISSION RATES SUMMARY

	Repetition 1	Repetition 2	
Unit No. 1 Stack			
Concen., gr/DSCF at 12% CO_2			
Lead	< 1.82E-06	< 1.76E-06	< 1.
Mercury	1.52E-04	8.88E-05	1.
Particulate	0.00637	0.00205	0
Concen., ppmvd at 12% CO_2			
Hydrogen Chloride	34.7	10.9	
Total Hydrocarbons as Carbon	3.81	3.07	
Emission Rate, lb/hr			
Hydrogen Chloride	14.7	4.64	
Lead	< 0.00125	< 0.00127	< 0.
Mercury	0.105	0.0643	0
Particulate	4.08	1.32	
Total Hydrocarbons as Carbon	0.534	0.430	
Unit No. 2 Stack			
Concen., gr/DSCF at 12% CO_2			
Particulate	0.00378	0.00499	0.0
Concen., ppmvd at 12% CO_2			
Hydrogen Chloride	0.528	0.110	0
Total Hydrocarbons as Carbon	3.57	3.49	
Emission Rate, lb/hr			
Hydrogen Chloride	0.240	0.0438	0.0
Particulate	2.60	2.99	2
Total Hydrocarbons as Carbon	0.536	0.457	0.
Unit No. 3 Stack			
Concen., gr/DSCF at 12% CO_2			
Particulate	0.00312	0.00111	0.00

(continued next page)

TABLE 2-1 (continued)

CONCENTRATIONS AND EMISSION RATES SUMMARY

	Repetition			
Unit No. 3 Stack	1	2	3	Average
Concen., ppmvd at 12% CO_2				
Hydrogen Chloride	0.656	0.492	0.202	0.45C
Total Hydrocarbons as Carbon	2.68	2.81	2.30	2.6C
Emission Rate, lb/hr				
Hydrogen Chloride	0.301	0.209	0.0816	0.197
Particulate	2.16	0.711	2.14	1.67
Total Hydrocarbons as Carbon	0.405	0.394	0.307	0.369

	Unit			
Nitrogen Oxides as NO_2	1	2		3
		Run 1	Run 2	
Concen., ppmvd at 12% CO_2	232	279	270	265
Emission Rate, lb/hr	125	145	142	130

TABLE 2-2

LEAD AND MERCURY TESTS SUMMARY

Unit No. 1 Stack

		1-S-M12/101A-1		1-S-M12/101A-2		1-S-M1
Test Date		6/29/89		6/29/89		
Run Start Time		820		1130		
Run Finish Time		1035		1352		
Test Train Parameters						
Volume Of Dry Gas Sampled, SCF*		107.375		108.311		
Percent Isokinetic		109.0		106.9		
Flue Gas Parameters						
Volumetric Air Flow Rates						
SCFM*, Dry		101,530		104,396		
ACFM, Wet		186,348		188,731		1
Temperature, Degrees F		294		293		
Percent Excess Air		91		91		
Lead Results						
Concentration, gr/DSCF*	<	1.44E-06	<	1.42E-06	<	1.
Concentration, gr/DSCF at 12% CO2	<	1.82E-06	<	1.76E-06	<	1.
Emission Rate, lb/hr	<	0.00125	<	0.00127	<	0
Mercury Results						
Concentration, gr/DSCF*		1.20E-04		7.18E-05		9.
Concentration, gr/DSCF at 12% CO2		1.52E-04		8.88E-05		1.
Emission Rate, lb/hr		0.105		0.0643		

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

TABLE 2-3

NITROGEN OXIDES TESTS SUMMARY

Unit No. 1 Stack

	1-S-M7E-1
Run Date	6/27-28/89
Run Start Time	1000
Run Finish Time	1000
Parameters Per Run	
O_2, % by Vol., dry	9.9
CO_2, % by Vol., dry*	9.8
Nitrogen Oxides as NO_2	
Concentration,	
ppmvd	190
ppmvd at 12% CO_2	232
Emission Rate, lb/hr**	125

* From plant process data.

** Calculated from facility F-factor and average steam flow during NO_x test.

TABLE 2-4

PARTICULATE AND HYDROGEN CHLORIDE TESTS SUMMAR

Unit No. 1 Stack

	1-S-M5/HCL-1	1-S-M5/H
Test Date	6/27/89	6/27
Run Start Time	1115	1
Run Finish Time	1241	1.
Test Train Parameters		
Volume Of Dry Gas Sampled, SCF*	49.301	49.
Percent Isokinetic	106.7	10
Flue Gas Parameters		
Volumetric Air Flow Rates		
SCFM*, Dry	94,548	94,5
ACFM, Wet	171,209	171,2
Temperature, Degrees F	291	2
Percent Excess Air	89	
Particulate Results		
Concentration, gr/DSCF*	0.00504	0.001
Concentration, gr/DSCF at 12% CO2	0.00637	0.002
Emission Rate, lb/hr	4.08	1.
Hydrogen Chloride Results		
Concentration, ppmvd	27.5	8.6
Concentration, ppmvd at 12% CO2	34.7	10.
Emission Rate, lb/hr	14.7	4.6

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

TABLE 2-5

TOTAL HYDROCARBONS TESTS SUMMARY

Unit No. 1 Stack

	1-S-M25A-1	1-S-M25A-2	1-S-M25A-3
Run Date	6/27/89	6/27/89	6/27/89
Run Start Time	1215	1430	1655
Run Finish Time	1310	1525	1750
Volumetric Air Flow Rate, Dry SCFM*	94,548	94,573	98,502
Total Hydrocarbon as Carbon Results			
Concentration,	3.02	2.43	1.38
ppmvd	3.81	3.07	1.73
ppmvd at 12% CO2	0.534	0.430	0.254
Emission Rate, lb/hr			

* From concurrent particulate/HCl testing.

TABLE 2-6

NITROGEN OXIDES TESTS SUMMARY

Unit No. 2 Stack

	2-S-M7E-1	2-S-M7E-2
Run Date	6/29-30/89	6/30-7/1/89
Run Start Time	1145	1445
Run Finish Time	1145	1630
Parameters Per Run		
O_2, % by Vol., dry	10.5	10.5
CO_2, % by Vol., dry*	9.1	9.2
Nitrogen Oxides as NO_2		
Concentration,		
ppmvd	212	207
ppmvd at 12% CO_2	279	270
Emission Rate, lb/hr**	145	142

* From plant process data.

** Calculated from facility F-factor and average steam flow during NO_x tests.

TABLE 2-7

PARTICULATE AND HYDROGEN CHLORIDE TESTS SUMMARY

Unit No. 2 Stack

	2-S-M5/HCL-1	2-S-M5/HCL-2	2-S-M5/HCL-3
Test Date	6/29/89	6/29/89	6/29/89
Run Start Time	840	1155	1515
Run Finish Time	955	1315	1630
Test Train Parameters			
Volume Of Dry Gas Sampled, SCF*	53.906	48.918	50.379
Percent Isokinetic	102.0	101.2	102.4
Flue Gas Parameters			
Volumetric Air Flow Rates			
SCFM*, Dry	108,147	98,868	100,677
ACFM, Wet	187,163	171,058	175,069
Temperature, Degrees F	295	293	295
Percent Excess Air	100	122	102
Particulate Results			
Concentration, gr/DSCF*	0.00281	0.00353	0.00257
Concentration, gr/DSCF at 12% CO2	0.00378	0.00499	0.00339
Emission Rate, lb/hr	2.60	2.99	2.22
Hydrogen Chloride Results			
Concentration, ppmvd	0.391	0.0780	0.0991
Concentration, ppmvd at 12% CO2	0.528	0.110	0.131
Emission Rate, lb/hr	0.240	0.0438	0.0567

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

TABLE 2-8

TOTAL HYDROCARBONS TESTS SUMMARY

Unit No. 2 Stack

	2-S-M25A-1	2-S-M25A-2	2-S-M25A-3
Run Date	6/29/89	6/29/89	6/29/89
Run Start Time	840	1200	1525
Run Finish Time	935	1250	1620
Volumetric Air Flow Rate, Dry SCFM*	108,147	98,868	100,677
Total Hydrocarbons as Carbon Results			
Concentration, ppmvd	2.65	2.47	1.54
ppmvd at 12% CO2	3.57	3.49	2.03
Emission Rate, lb/hr	0.536	0.457	0.290

* From concurrent particulate/HCl testing.

TABLE 2-9

NITROGEN OXIDES TESTS SUMMARY

Unit No. 3 Stack

	3-S-M7E-1
Run Date	6/28-29/89
Run Start Time	1105
Run Finish Time	1105
Parameters Per Run	
O_2, % by Vol., dry	9.9
CO_2, % by Vol., dry*	9.7
Nitrogen Oxides as NO_2	
Concentration,	
ppmvd	213
ppmvd at 12% CO_2	265
Emission Rate, lb/hr**	130

* From plant process data.

** Calculated from facility F-factor and average steam flow during NO_x test.

TABLE 2-10

PARTICULATE AND HYDROGEN CHLORIDE TESTS SUMMARY

Unit No. 3 Stack

	3-S-M5/HCL-1	3-S-M5/HCL-2	3-S-M5/HC
Test Date	6/28/89	6/28/89	6/28/
Run Start Time	930	1225	14
Run Finish Time	1040	1400	16
Test Train Parameters			
Volume Of Dry Gas Sampled, SCF*	49.903	48.505	49.2
Percent Isokinetic	105.2	102.8	103
Flue Gas Parameters			
Volumetric Air Flow Rates			
SCFM*, Dry	97,086	96,576	97,15
ACFM, Wet	169,369	169,580	172,89
Temperature, Degrees F	292	296	29
Percent Excess Air	84	96	10
Particulate Results			
Concentration, gr/DSCF*	0.00260	0.000859	0.0025
Concentration, gr/DSCF at 12% CO2	0.00312	0.00111	0.0035
Emission Rate, lb/hr	2.16	0.711	2.1
Hydrogen Chloride Results			
Concentration, ppmvd	0.547	0.381	0.14
Concentration, ppmvd at 12% CO2	0.656	0.492	0.20
Emission Rate, lb/hr	0.301	0.209	0.081

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

TABLE 2-11

TOTAL HYDROCARBONS TESTS SUMMARY

Unit No. 3 Stack

	3-S-M25A-1	3-S-M25A-2	3-S-M25A-3
Run Date	6/28/89	6/28/89	6/28/89
Run Start Time	945	1230	1500
Run Finish Time	1040	1325	1555
Volumetric Air Flow Rate, Dry SCFM*	97,086	96,576	97,159
Total Hydrocarbons as Carbon Results			
Concentration, ppmvd	2.23	2.18	1.69
ppmvd at 12% CO2	2.68	2.81	2.30
Emission Rate, lb/hr	0.405	0.394	0.307

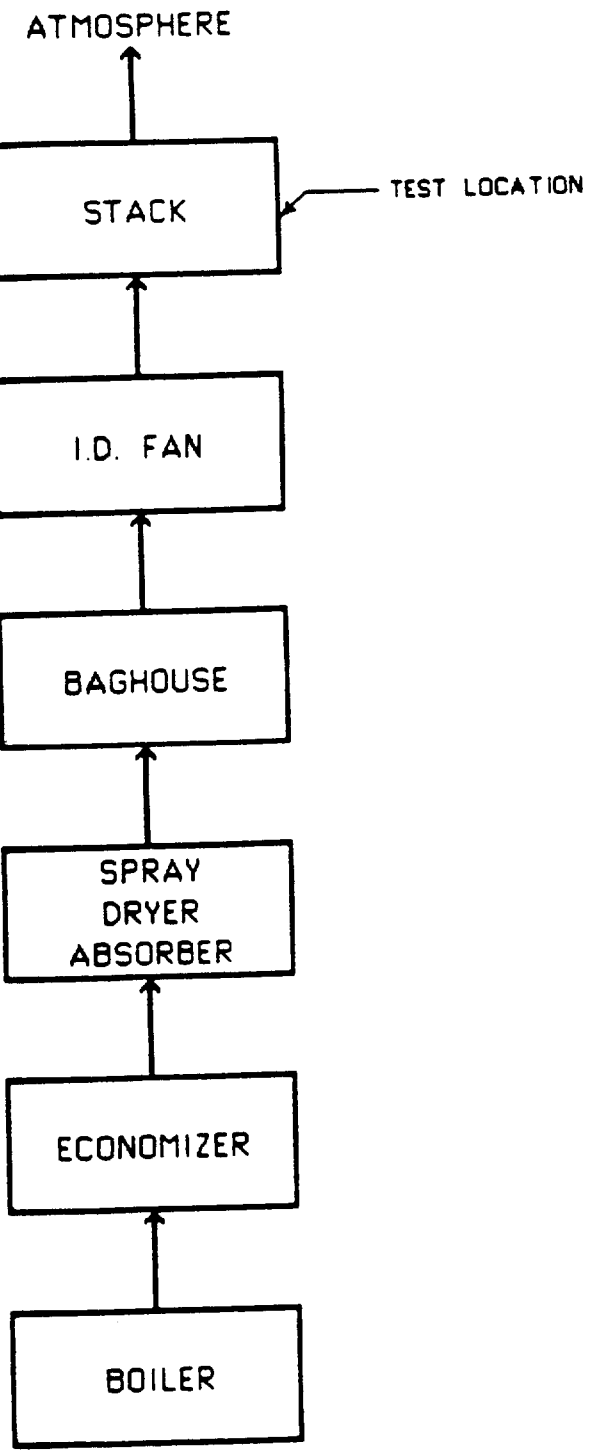
* From concurrent particulate/HCl testing.

PROCESS DESCRIPTION AND OPERATION

3.1 General. The Indianapolis Resource Recovery Facility in Indianapc Indiana burns municipal solid waste in three mass-fired refuse boilers. Each boiler train consists of a boiler with a capacity to process 787 tons of municipal solid waste per day. Each boiler train is equipped with a spray dr absorber (SDA), baghouse, and stack. The testing covered in this report was performed at the Unit Nos. 1, 2, and 3 stacks. A fourth stack exists in the liner, but is not in use.

3.2 Source Air Flow. Figure 3-1 is an air flow schematic which shows t passage of flue gases exhausted from the boilers.

3.3 Operation During Testing. Detailed process data will be supplied b Ogden Projects, Inc. under separate cover.



NOTE: UNIT NOS. 2 AND 3 ARE IDENTICAL.

FIGURE 3-1. UNIT NO. 1 AIR FLOW SCHEMATIC.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 General. All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the Indiana Department of Environmental Management. This section provides brief descriptions of the sampling and analytical procedures. Detailed descriptions of the procedures are provided in Appendix E.

4.2 Sampling Points. For the methods incorporating multipoint sampling, the number and location of the sampling points were determined according to EPA Method 1. Each stack cross section was divided into 12 equal areas with six sampling points on each of two traverse axes, as shown in Figure 4-1.

4.3 Volumetric Air Flow Rates

4.3.1 Flue Gas Velocity. EPA Method 2 was used to take the velocity measurements during the traverses of the stack cross sections.

4.3.2 Flue Gas Composition. Multipoint, integrated flue gas samples were collected and analyzed using EPA Method 3. The results were used to determine the flue gas composition, molecular weight, excess air, and emissions correction factors for each of the concurrent runs.

4.3.3 Flue Gas Moisture Content. Moisture content was determined by analyzing the sampling train impinger reagents according to the procedures outlined in the respective EPA Methods.

4.4 Emissions Determinations

4.4.1 Lead and Mercury. A combined EPA Method 12/101A sampling train was used to determine the lead and mercury emissions. The isokinetic sampling rate was maintained below 28 L/min (1.0 cfm), and a 2-hour minimum sampling time was employed. Borosilicate glass probe liners and nozzles were used and all sample train glassware was precleaned by rinsing with 0.1N nitric acid, tap water, 8 N hydrogen chloride, tap water, and finally deionized, distilled water. The first and second impingers were charged with 100 mL of 0.1N nitric acid, the third

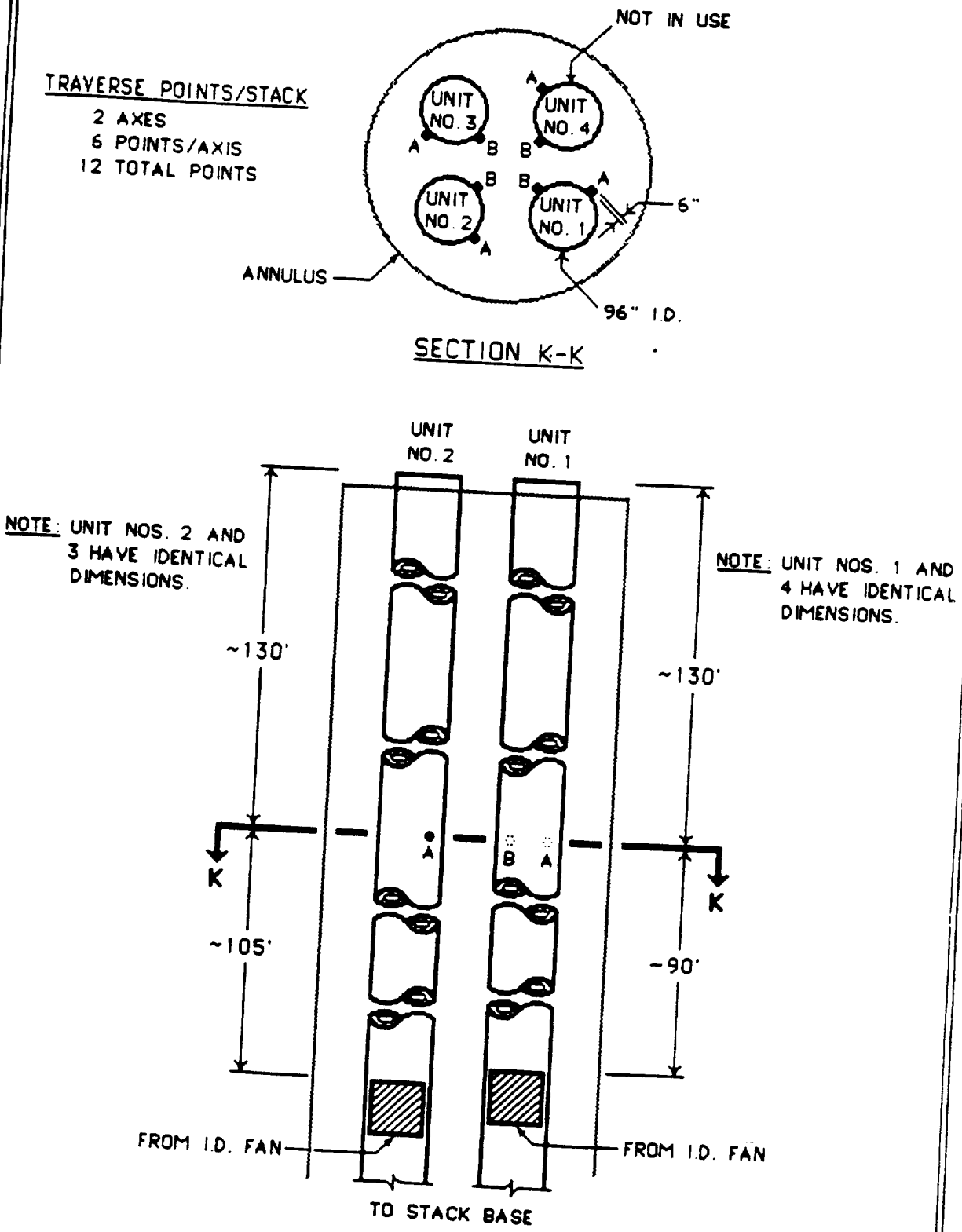


FIGURE 4-1. UNIT NOS. 1, 2, AND 3 STACKS TEST LOCATIONS.

impinger remained dry, the fourth impinger contained 100 mL of 4% $KMnO_4$, and th fifth impinger contained preweighed silica gel. A Pallflex 2500QAT-UP quartz filter with Teflon frit was placed between the probe exit and the first impinger

Sample Recovery. Lead and mercury were quantitatively recovered as follows the probe and front half of the filter were rinsed with 0.1N nitric acid, and impingers 1, 2, and 3 were rinsed with 0.1N nitric acid. The fourth impinger wa rinsed with 4% $KMnO_4$ solution; washings were added to 1000 mL glass sample jars; residual brown deposits on the glassware were removed using a minimal amount of 8N hydrochloric acid; and the hydrochloric acid rinse was added to the sample container. The filter was removed and placed in a glass jar with the use of a Teflon spatula and Teflon coated tweezers. All components of the sampling train and their rinses were placed into separate jars.

Sample Analysis. The samples were submitted to the laboratory for atomic absorption (AA) analysis for lead and cold vapor atomic absorption (CVAA) analysis for mercury. Samples, standards, QA/QC materials, and blanks were prepared in the same matrix prior to analysis.

4.4.2 Nitrogen Oxides. Twenty-four hour continuous emissions monitoring (CEM) for nitrogen oxides (NO_x) was conducted according to EPA Method 7E. A monitoring system consisting of sample acquisition/conditioning equipment, a NO_x analyzer, and a computer-based data acquisition system was used.

The sample acquisition/conditioning system provided a dry, particulate-free flue gas sample stream to the NO_x analyzer. The system consisted of: a heated, stainless steel sample probe; a heated Teflon sample line; a refrigerator-type condenser to remove water vapor from the effluent sample; unheated Teflon sample transport lines, a Teflon-lined sample pump, an ice-bath condenser, and a flow distribution system to control the flow of effluent sample and calibration standards to the analyzer. All components of the sampling system which contacted the sample were constructed of Type 316 stainless steel, Teflon, or borosilicate glass.

The sample was extracted through a sampling probe constructed of a 5/8-inch O.D. stainless steel tube enclosed within a 1-inch O.D. stainless steel liner. All portions of the probe outside the stack were heated to prevent condensation of water vapor within the effluent sample. The effluent sample was obtained from

a single point located at the centroid of the stack, and was transported from th probe to the condenser via heated 3/8-inch O.D. Teflon tubing. Moisture was removed from the sample stream as it passed through the refrigerator-type condenser. Here the sample was dried to a dewpoint of approximately 34°F.

The sample exiting the condenser passed through a 2-micron fine particulate filter. Then, the sample was transported through unheated 3/8-inch O.D. Teflon tubing by way of a Teflon-lined sample pump to a second condenser, and then to the flow distribution system where the flow to the analyzer was monitored and controlled.

NO_x concentrations were determined by analysis of the flue gas sample streams using a Thermo Electron Model 10 NO/NO_x analyzer, which uses the chemiluminescence measurement technique. The analyzer was operated on the 0-100 ppm measurement range.

A portable personal computer equipped with an analog-to-digital converter was used to convert the output signal of the NO_x analyzer to NO_x concentration values. The system provided real-time display of NO_x concentration and logged and printed 1-minute averages of NO_x concentration values. The monitoring syster was calibrated with a series of certified, EPA protocol 1 calibration gases. Calibration gas injection points are located both at the outlet of the sample probe and immediately upstream of the analyzer. This arrangement provided both ease in checking the analyzer performance and a means of evaluating the entire monitoring system. Calibration checks of the monitoring system were conducted before, during, and after each run throughout the monitoring program so that any calibration drift could be detected and corrected in order to ensure the best possible quality in the NO_x measurement data.

For each run, the raw NO_x concentration data from each period between calibration checks was first averaged and then corrected for calibration bias anc drift. A time-weighted average NO_x concentration for the entire run was then calculated from the corrected data of each period during the run. Finally, NO_x concentration in terms of the standard (ppm NO_x @ 12% CO_2) was calculated using the average NO_x concentration for each run and CO_2 concentration provided by the plant.

4.4.3 Particulate and Hydrogen Chloride

Sample Collection. An EPA Method 5 sampling train was used to determine the particulate and hydrogen chloride emissions. The first two impingers each

contained 100 mL of 0.1N NaOH, the third remained empty, and the fourth container 200 grams of preweighed silica gel. During each run, each of the 12 areas of the stack cross section was sampled for five minutes, resulting in a total sampling time of 60 minutes. Sampling data was recorded every five minutes. Glass nozzles were used to avoid possible contamination.

Sample Recovery. The filter was removed and placed in a glass jar. The front half of the sampling train was rinsed with acetone. The back half of the filter and the first three impingers were rinsed with DI water and the rinses were placed into a separate jar.

Sample Analyses. The analytical procedures described in EPA Method 5 were used to determine the particulate emissions. The impinger reagent (NaOH) was analyzed for hydrogen chloride content using ion chromatography.

4.4.4 Total Hydrocarbons. For total hydrocarbon sampling, the gas sample was extracted through a heated Teflon line using the sampling procedures outlined in EPA Method 25A. The sample was sent straight into a Ratfisch RS55 FID for the determination of total hydrocarbons. Concentrations were recorded continuously on a strip chart.

4.5 Equipment Calibration. Pertinent calibration data are provided in Appendix D.

QUALITY ASSURANCE/QUALITY CONTROL

5.1 General. Entropy Environmentalists Inc. (EEI) is committed to the continued implementation of a Quality Assurance Program to assure the quality of sampling and analytical procedures of environmental measurement data. The Quality Assurance measures taken during this test project equals or exceeds the minimum QA/QC recommendations as set forth by the U.S. Environmental Protection Agency (EPA) for a particular method.

The following sections outline the QA program implemented by EEI to justify the validity of the test procedures. The QA system for this test program addresses the following areas:

- Project Organization
- Preventive Maintenance & Equipment Calibration
- QA Sample Processing
- Analytical Instrument Calibration
- Blanks and Spiked Samples
- Internal/External System Checks
- Data Reduction & Validation
- Continuous Emissions Monitoring
- QA/QC Summary

5.2 Project Organization. The organization of the project team, including QA functions, are shown in Figure 5-1. Note that the QA structure is independent of the organizational groups which generate measurement data during the test program.

5.3 Preventive Maintenance and Equipment Calibration. An effective preventive maintenance program decreases downtime and thus increases data completeness and quality. Pretest and posttest equipment calibrations are conducted in a manner and at a frequency which meets or exceeds U.S. EPA specifications.

Each item transported to the field is inspected to detect equipment problems which may originate during periods of storage. All equipment returning from the field are cleaned, repaired, reconditioned, and recalibrated as necessary. Routine maintenance on equipment (dry gas meters, pumps, magnehelics/manometers, pitot tubes, and nozzles) is carried out periodically for leaks, corrosion, dents, or any other damage. Table 5-1 shows the activities for equipment calibration.

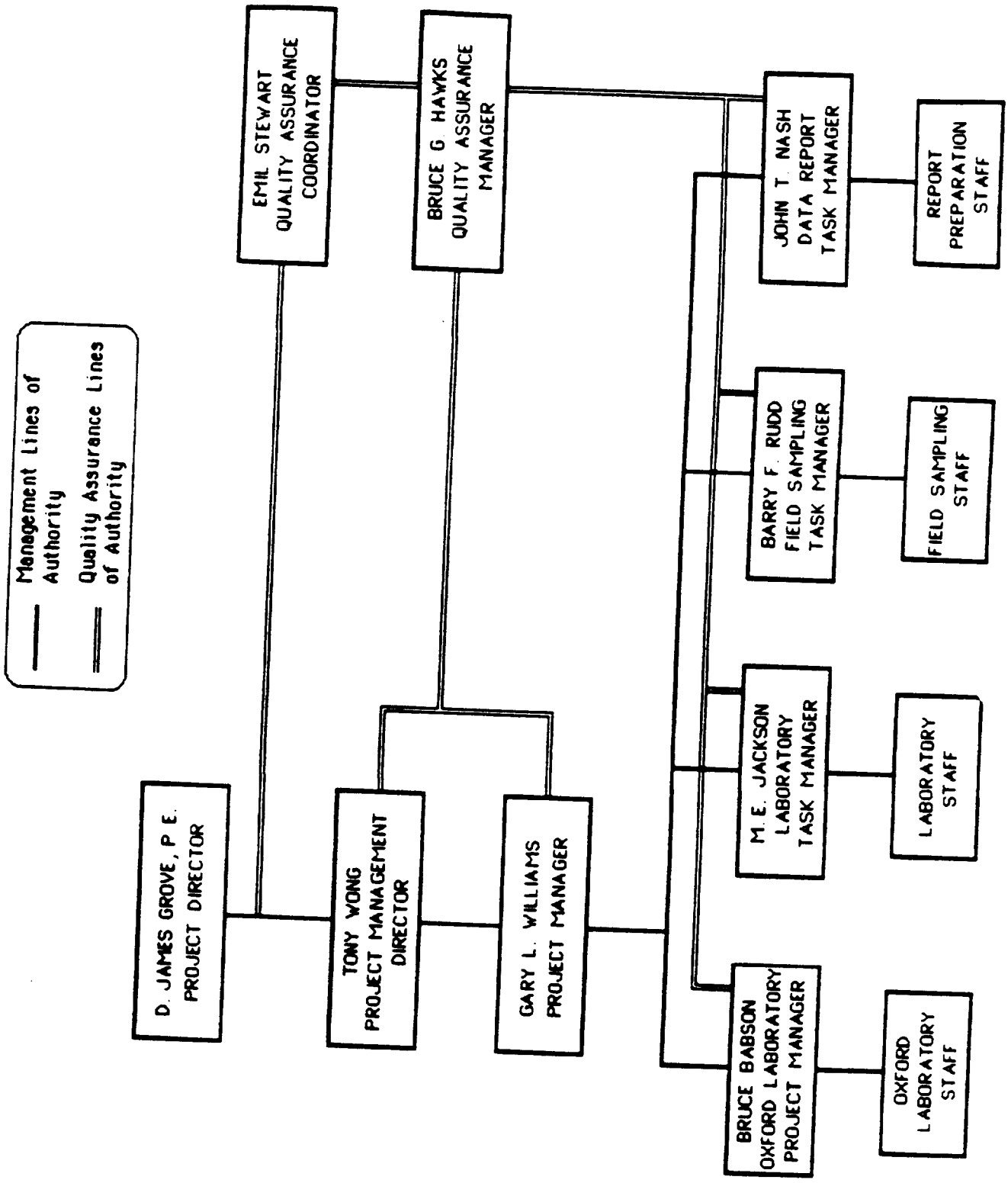


FIGURE 5-1. PROJECT ORGANIZATION

TABLE 5-1

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Type S Pitot Tubes	Standards contained in EPA Method 2.	Coefficient of 0.84 ± 0.02	Refurbish or recalibrate.
	Visual inspection prior to shipment to test site and again prior to each day of testing.		
Manometers	Leak checked before and after each field use.		Repair or replace
Magnahelic Gauges	Initially calibrated over full range.	0-10" water column	
	After each field use, checked against inclined manometer at average settings encountered during testing.	Within ± 5%	Repair and Recalibrate.
Thermometers -Impinger -Dry Gas Meter -Filter Box	After purchase and prior to each field use, using ASTM mercury-in-glass thermometer.	Imp = ± 2°F DGM = ± 5.4°F FB = ± 5.4°F	Adjust, determine correction factor, or reject.
Thermocouple/ Potentiometer	After purchase. 3-point (ice bath, boiling water, (and hot oil) using ASTM mercury-in-glass thermometer.	± 1.5% of absolute temperature.	Adjust, determine correction factor, or reject.
	Before and after each field use compared to ASTM mercury-in-glass thermometer at ambient conditions.		
Dry Gas Meter and Orifice	Full calibration (every 6 months) over wide range of orifice settings to obtain calibration factor.	DGM = ± 2% of avg. factor for each calib. run. Ori. = ± 0.15" H20 over delta H range of 0.4" to 4.0".	Adjust or reject
	10-minute quick calibration before sending to test site and again prior to each day of field use.	± 3% of full. ± 5% of full.	Use if no backup. Do not use.
	Posttest (at average delta H and highest vacuum) to determine if meter gamma has changed.	± 5% of full calibration. Factor (initial or recalibration) that yields the lowest sample volume for the testing is used.	Meter calibration, meter coefficient
Dry Gas Meter Transfer Standard	Annual calibrations conducted in triplicate using EPA wet test meter. Calibrations conducted at 7 flow rates from 0.25 to 1.40 cfm.	± 2% of average factor for each calibration run.	Adjust and recalibrate.
Barometer	Before and after each field use against an ASTM mercury-in-glass barometer.	± 0.1" mercury.	Adjust to agree.
	Reference barometer adjusted for elevation differences.		
Probe Nozzle	Average of 5 I.D. measurements using a micrometer. Visual inspection before and after each field use.	Difference between high and low measurement < 0.004"	Repair and recalibrate.

5.4 Sample Processing. Entropy employs systems which ensure the integrity of an environmental sample from the time of acquisition, through analysis, and ultimately to proper disposal. These systems are necessary to allow valid conclusions to be drawn from analytical results separated in time and space from the sampling operation. In addition, these systems recognize that samples are occasionally of value even after analytical results have been reported.

Samples are collected, transported, and stored in clean containers which are constructed of materials inert to the analytical matrix. Containers are used which allow air tight seals. When necessary, containers are employed which prevent photochemical reactions. All sample containers are labeled with the following information:

- Unique source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Sample analyst identifier

Additional information relating to the sample is recorded on the data sheet for the sampling run that afforded the subject sample. Accordingly, the sample data sheet contains all the information listed above, plus the date and time the sample was acquired and supplemental information such as observations pertinent to the quality of the sample. For condensed samples, e.g., samples in liquid media, the sample levels are marked on the outside of the container; this mark is used to indicate sample loss, and as such, may serve as a reference in adjusting results accordingly.

For transport from the field to the laboratory, samples are stored in locked boxes and secured in a fashion which minimizes movement and thus prevents breakage of containers. Boxes used for transporting glass containers are packed with foam.

Samples remain in the custody of the sampler from acquisition until conveyance to the laboratory analyst, if the analyst is different from the sampler. The sampler initiates a sample chain of custody record at the time of sample collection in the field. All custody transfers are documented on the chain of custody form, which remains with the sample at all times.

Analytical data are identified in a manner identical to that of the sampling data. Accordingly, all data generated from the analysis of samples are documented with the following information:

- Source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Analyst identifier
- Analysis date

Portions of samples remaining after analysis are returned to their original sample containers. These samples are stored in designated storage areas until their destruction is authorized.

5.5 Instrument Calibration. Instrument calibration is one of the most important functions in generating precise and accurate quality data. A listing of major in-house instrumentation and the corresponding Quality Assurance program is given in Table 5-2.

All of the contract laboratories involved in the analytical testing for the test program maintained rigorous QA programs for instrument calibration.

5.6 Blanks and Spikes. Field blanks, method blanks, trip blanks, lab-proof blanks and filter blanks are obtained, digested and analyzed when applicable. The blanks reflect the background contamination obtained from the various sources during the sampling and analysis. Thus, data adjustment or correction can be made accordingly.

In most cases, it is not necessary to digest and analyze the method blanks, reagent blanks or the lab-proof blanks unless the field blank shows a high level of contamination. If a high level of contamination is present, it is imperative to individually analyze the above blanks to help determine the cause of contamination.

Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method. During spiking, a known amount of stock solutions of the substance of interest is added to the sample prior to sample extraction, digestion, and analysis.

TABLE 5-2

IN-HOUSE INSTRUMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Analytical & Top Loading Balance	Daily and monthly checks with a series of class S weights. Balance serviced annually by a qualified service representative and checked with a series of NBS weights.	± 1 mg of class S weights.	Adjust or repair.
Gas Chromatograph	3-point calibration curve at the expected range. Duplicate injection of the sample until ± 5% variation is achieved. Calibration repeated at the end of each test series.		
HPLC/Ion Chromatograph	Calibrations conducted at the beginning, after the first injection, and after the second injection.		
Fisher Accumet 925 pH/Selective Ion Meter	5-point calibration prior to analyzing the samples for the specific ions.		

5.7 Internal/External System Audit Checks. System and performance audits are routine elements of all Entropy QA/QC programs.

Internal Systems Audit: The following sampling equipment checks were conducted prior to sample collection.

- All sampling equipment was thoroughly checked to ensure clean and operable components.
- Equipment was inspected for possible damage from shipment.
- The oil manometers or Magnehelic gauges were leveled and zeroed.
- The temperature measurement systems were checked for damage and operability by measuring the ambient temperature.

Performance Audits: Performance audits of the laboratory are conducted prior to the processing of any compliance samples for analysis. Audit materials typically include samples available from the EPA prior to new source testing. Also, samples of known concentration are specially prepared in-house or obtained from the EPA for Internal QA checks.

External Systems Audits: Entropy is subject to a system audit each time a test is conducted for any Air Pollution Control agency. This procedure entails an EPA observer on-site to do qualitative evaluation of performance to demonstrate compliance with the applicable regulations.

5.8 Data Reduction and Validation. The test team leader is responsible for reviewing and validating data as they are acquired. Each team leader has extensive knowledge of sampling methodology and the characteristic of the process being measured and is capable of evaluating the accuracy, representativeness, and completeness of raw data on-site, where action to replace inadequate data can be taken immediately.

Data obtained during calibrations and test runs are recorded on standardized forms which are checked twice for completeness and accuracy by the QA Director. Data reduction and consistency are achieved by using the standardized forms and using Entropy's in-house computer facilities.

5.9 QA/QC Summary. The following sections outline the most significant QA parameters used during this test program.

EPA Method 12/101A: A field blank was prepared at the Unit No. 1 stack and analyzed for lead and mercury with results of < 10.0 and 21.63 ug, respectively. The blank results were not subtracted from the sample catches because the values were considered insignificant. The optical cell heating system, Atomic Absorption Spectrophotometer, and recorder were calibrated before sample analysis.

EPA Method 5: Chloride calibration curves were generated prior to sample analysis. A blank was analyzed with < 0.05 mg chlorides detected.

EPA Method 25A: The 3-point linearity checks were all within 3% of the known cylinder gas concentrations.

APPENDIX A.1.a

A. TEST RESULTS

1. Unit No. 1 Stack

a. Lead and Mercury

FIELD DATA AND RESULTS TABULATION

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 1 Stack

		1-S-M12/101A-1	1-S-M12/101A-2	1-S-M12/101A-3
	Test Date	6/29/89	6/29/89	6/29/89
	Run Start Time	820	1130	1455
	Run Finish Time	1035	1352	1737
	Net Traversing Points	12	12	12
Theta	Net Run Time, Minutes	120.00	120.00	120.00
Dia	Nozzle Diameter, Inches	0.273	0.273	0.273
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9964	0.9964	0.9964
Pbar	Barometric Pressure, Inches Hg	29.5	29.5	29.5
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H2O	2.93	3.03	2.85
Vm	Volume Of Metered Gas Sample, Dry ACF	114.716	116.724	110.861
tm	Dry Gas Meter Temperature, Degrees F	98	103	102
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	107.375	108.311	103.008
Vlc	Total Liquid Collected In Impingers & Silica Gel, grams	602.0	569.5	554.0
Vwstd	Volume of Water Vapor, SCF*	28.336	26.806	26.077
%H2O	Moisture Content, Percent by Volume	20.9	19.8	20.2
Mfd	Dry Mole Fraction	0.791	0.802	0.798
%CO2	Carbon Dioxide, Percent By Volume, Dry	9.5	9.7	9.5
%O2	Oxygen, Percent By Volume, Dry	10.1	10.1	10.1
%CO+N2	CO + N2, Percent By Volume, Dry	80.4	80.2	80.4
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	29.92	29.96	29.92
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	27.43	27.59	27.51
Pg	Flue Gas Static Pressure, Inches H2O	-0.96	-0.90	-0.89
Ps	Absolute Flue Gas Pressure, Inches Hg	29.43	29.43	29.43
ts	Flue Gas Temperature, Degrees F	294	293	289
Delta-p	Average Velocity Head, Inches H2O	0.7927	0.8188	0.7704
vs	Flue Gas Velocity, Feet/Second	61.79	62.58	60.63
A	Stack/Duct Area, Square Inches	7,238	7,238	7,238
Qsd	Volumetric Air Flow Rate, Dry SCFM*	101,530	104,396	101,176
Qaw	Volumetric Air Flow Rate, Wet ACFM	186,348	188,731	182,850
%I	Isokinetic Sampling Rate, Percent	109.0	106.9	104.9
%EA	Excess Air, Percent	91	91	91

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

(continued next page)

FIELD DATA AND RESULTS TABULATION

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 1 Stack

		1-S-M12/101A-1	1-S-M12/101A-2	1-S-M12/101A-3
Lead Results				
fwt	Formula Weight, lb/lb-mole	207.19	207.19	207.19
ug	Catch Weight, micrograms	< 10.0	< 10.0	< 10.0
gr/DSCF	Concentration, grains/DSCF*	< 1.44E-06	< 1.42E-06	< 1.50E-06
gr@12%CO2	Concentration, gr/DSCF at 12% CO2	< 1.82E-06	< 1.76E-06	< 1.89E-06
lb/hr	Emission Rate, lb/hr	< 0.00125	< 0.00127	< 0.00130
Mercury Results				
fwt	Formula Weight, lb/lb-mole	200.59	200.59	200.59
ug	Catch Weight, micrograms	836.2	504.0	649.9
gr/DSCF	Concentration, grains/DSCF*	1.20E-04	7.18E-05	9.74E-05
gr@12%CO2	Concentration, gr/DSCF at 12% CO2	1.52E-04	8.88E-05	1.23E-04
lb/hr	Emission Rate, lb/hr	0.105	0.0643	0.0844

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

A. TEST RESULTS

1. Unit No. 1 Stack

b. Nitrogen Oxides

FIELD DATA AND RESULTS TABULATION

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 1 Stack

		1-S-M7E-1
	Test Date	6/27-28/89
	Run Start Time	1000
	Run Finish Time	1000
%O2	Oxygen, Percent by Volume, Dry	9.9
%CO2	Carbon Dioxide, Percent by Volume, Dry*	9.8
	Nitrogen Oxides as NO2 Results	
fwt	Formula Weight, lb/lb-mole	46.00
	Concentration,	
ppmvd	ppmvd	190
ppmvd@12%	ppmvd at 12% CO2	232
lb/hr	Emission Rate, lb/hr**	125

* From plant process data.

** Calculated from facility F-factor and average steam flow during NOx test.

APPENDIX A.1.c

A. TEST RESULTS

1. Unit No. 1 Stack

c. Particulate and Hydrogen Chloride

FIELD DATA AND RESULTS TABULATI

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 1 Stack

		1-S-M5/HCL-1	1-S-M5/HCL-2	1-S-M5/HCL-3
	Test Date	6/27/89	6/27/89	6/27/89
	Run Start Time	1115	1425	1650
	Run Finish Time	1241	1542	1804
	Net Traversing Points	12	12	12
Theta	Net Run Time, Minutes	60.00	60.00	60.00
Dia	Nozzle Diameter, Inches	0.274	0.274	0.274
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	1.0106	1.0106	1.0106
Pbar	Barometric Pressure, Inches Hg	29.4	29.4	29.4
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H2O	2.58	2.53	2.71
Vm	Volume Of Metered Gas Sample, Dry ACF	52.339	52.291	54.214
tm	Dry Gas Meter Temperature, Degrees F	100	99	100
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	49.301	49.338	51.084
Vlc	Total Liquid Collected In Impingers & Silica Gel, grams	259.5	259.0	258.0
Vwstd	Volume of Water Vapor, SCF*	12.215	12.191	12.144
%H2O	Moisture Content, Percent by Volume	19.9	19.8	19.2
Mfd	Dry Mole Fraction	0.801	0.802	0.808
%CO2	Carbon Dioxide, Percent By Volume, Dry	9.5	9.5	9.5
%O2	Oxygen, Percent By Volume, Dry	10.0	10.1	10.0
%CO+N2	CO + N2, Percent By Volume, Dry	80.5	80.4	80.4
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	29.92	29.92	29.94
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	27.55	27.56	27.65
Pg	Flue Gas Static Pressure, Inches H2O	-0.77	-0.81	-0.80
Ps	Absolute Flue Gas Pressure, Inches Hg	29.34	29.34	29.34
ts	Flue Gas Temperature, Degrees F	291	292	292
Delta-p	Average Velocity Head, Inches H2O	0.6727	0.6724	0.7211
vs	Flue Gas Velocity, Feet/Second	56.77	56.79	58.71
A	Stack/Duct Area, Square Inches	7,238	7,238	7,238
Qsd	Volumetric Air Flow Rate, Dry SCFM*	94,548	94,573	98,502
Qaw	Volumetric Air Flow Rate, Wet ACFM	171,209	171,269	177,060
%I	Isokinetic Sampling Rate, Percent	106.7	106.7	106.1
%EA	Excess Air, Percent	89	91	89

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

(continued next page)

FIELD DATA AND RESULTS TABULATION

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 1 Stack

		1-S-M5/HCL-1	1-S-M5/HCL-2	1-S-M5/HCL-3
	Particulate Results			
mg	Catch Weight, milligrams	16.1	5.2	9.5
gr/DSCF	Concentration, grains/DSCF*	0.00504	0.00163	0.00287
gr@12%CO2	Concentration, gr/DSCF at 12% CO2	0.00637	0.00205	0.00359
lb/hr	Emission Rate, lb/hr	4.08	1.32	2.42
	Hydrogen Chloride Results			
fwt	Formula Weight, lb/lb-mole	36.46	36.46	36.46
mg	Catch Weight, milligrams	58.1	18.3	7.5
ppmvd	Concentration, ppmvd	27.5	8.64	3.42
ppm@12%CO2	Concentration, ppmvd at 12% CO2	34.7	10.9	4.28
lb/hr	Emission Rate, lb/hr	14.7	4.64	1.91

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

OGDEN PROJECTS, INC.

WATERGATE TOWER
SUITE 400
1900 POWELL STREET
EMERYVILLE, CALIFORNIA 94608
(415) 420-1766

Environmental Engineering Department

ENVIRONMENTAL TEST REPORT

Appendix B, Volume 1

Entropy Environmentalists, Inc., Stationary Source Sampling Report 6323B, Volume 1, June 27-30, 1989.

PREPARED FOR:	Ogden Martin Systems of Indianapolis, Inc. 2320 So. Harding Street Indianapolis, IN 46221
REGARDING:	Indianapolis Resource Recovery Facility
REGULATORY AGENCY:	City of Indianapolis, Department of Public Works, Air Pollution Control Division and State of Indiana, Department of Environmental Management
PURPOSE:	Demonstration of Compliance with Certificate of Operation No. 0123 with City of Indianapolis and PSD (49) 1602 for the State of Indiana and the U.S. EPA.
TEST DATES:	June 27 through July 1, 1989

August 25, 1989
OPI Report No. 221

ENTROPY
ENVIRONMENTALISTS INC.

POST OFFICE BOX 12291
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

VOLUME I

TEXT AND APPENDICES

STATIONARY SOURCE SAMPLING REPORT

REFERENCE NO. 6323B

INDIANAPOLIS RESOURCE RECOVERY FACILITY

INDIANAPOLIS, INDIANA

PCDD/PCDF EMISSIONS TESTING

UNIT NO. 2 STACK

PERFORMED FOR: OGDEN PROJECTS, INC.

JUNE 27 THROUGH 28, 1989

REPORT CERTIFICATION

The sampling and analysis performed for this report was carried out under my direction and supervision.

Date August 23, 1989 Signature Gary L. Williams

Gary L. Williams

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

Date August 23, 1989 Signature

D. James Grove, P.E.

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VOLUME I

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TABLE OF CONTENTS (continued)

VOLUME I (continued)

CONTENTS OF SUPPLEMENTAL ANALYTICAL DATA VOLUME

VOLUME II

LIST OF TABLES AND FIGURES

INTRODUCTION

1.1 Outline of Test Program. Stationary source sampling was performed for Ogden Projects, Inc. at the Indianapolis Resource Recovery Facility in Indianapolis, Indiana, from June 27 through 28, 1989. Three Modified Method 5 runs were performed at the Unit No. 2 stack to determine PCDD/PCDF emissions.

1.2 Test Participants. Table 1-2 lists the personnel involved in the test program.

TABLE 1-2

TEST PARTICIPANTS

Ogden Projects, Inc.	Ronald A. Zurlinden Test Coordinator
Indianapolis Resource Recovery Facility	Paul Claerbout Test Coordinator
	Daryl Timby Chief Engineer
Environmental Elements Corporation	Claus Jorgensen Test Coordinator
	Chuck Faunce Process Data Collector
City of Indianapolis	David Foster Test Observer
	Daniel Jordan Test Observer
	Matt Mosier Test Observer
Indiana Department of Environmental Management	Mike Dicem Test Observer
	Raymond Schick Test Observer
Entropy Environmentalists Inc.	Gary L. Williams Project Manager
	Barry F. Rudd Project Supervisor
	Allan F. Lowe Sampling Team Leader
	John J. Mitricska Sampling Team Leader
	R. Lee Marchman Engineering Technician
	Clyde E. Nack Engineering Technician
	Bryan K. Greer Laboratory Technician
	Matthew L. Hamilton Laboratory Technician

SUMMARY OF RESULTS

2.1 Presentation. Tables 2-1 through 2-3 present the run-by-run PCDD/PCDF emissions summaries for the Unit No. 2 stack. Table 2-4 presents a toxic equivalency summary for the PCDD/PCDF emissions. Refer to the "List of Tables and Figures" on page iv of the Table of Contents for a cross reference. Detailed results of the testing can be found in the appendices. The chromatogram data generated for the PCDD/PCDF analyses are presented in Volume II.

2.2 PCDD/PCDF Data Reporting. The data reporting procedures outlined in the Environmental Standards Workshop (ESW) methods for sampling and analysis of PCDD/PCDF emissions were used for presenting all analytical results. A number of sample analyses yielded results for specific PCDD/PCDF isomers that were below the detection limit (BDL) or were an EMPC. These BDL and EMPC data do not meet reporting criteria given in section 8.5 of the ESW Analytical Procedures. All BDL and EMPC results are considered as ND (not detected; zero value) in the preceding tables. The PCDD/PCDF emission concentration totals therefore include only data not reported as ND in accordance with procedures described in section 10.1.5 of the ESW method.

Each isomer result value shown in the field data and results tabulation in Appendix A.1 as ND and followed by a value enclosed in parentheses represents the detection limit for the isomer. All isomer results shown as ND and followed by a value enclosed in brackets represents an EMPC catch value. An EMPC is reported for GC/MS signals eluting within the PCDD/PCDF retention time windows established with the daily GC/MS performance analyses but not meeting the ion abundance ratio criteria of the analytical method.

TABLE 2-1
PCDD/PCDF EMISSIONS SUMMARY
Unit No. 2 Stack

	Concentration, ng/DSCM at 12% CO2		
	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
PCDD			
2378-TCDD	7.48E-03	ND	ND
Other TCDD	9.97E-02	2.25E-01	5.88E-02
12378-PeCDD	ND	ND	1.70E-02
Other PeCDD	5.26E-01	3.64E-01	1.46E-01
123478-HxCDD	5.06E-02	6.08E-02	3.20E-02
123678-HxCDD	1.56E-01	1.96E-01	9.15E-02
123789-HxCDD	1.90E-01	2.31E-01	1.12E-01
Other HxCDD	1.61E+00	1.87E+00	1.10E+00
1234678-HpCDD	1.67E+00	1.84E+00	8.04E-01
Other HpCDD	1.53E+00	1.50E+00	7.69E-01
OCDD	2.01E+00	3.66E+00	1.14E+00
Total PCDD	7.85E+00	9.95E+00	4.27E+00
PCDF			
2378-TCDF	4.16E-02	5.03E-02	2.12E-02
Other TCDF	7.88E-01	1.11E+00	4.22E-01
12378-PeCDF	7.90E-02	1.08E-01	3.40E-02
23478-PeCDF	1.44E-01	1.70E-01	8.23E-02
Other PeCDF	7.27E-01	9.02E-01	1.02E-01
123478-HxCDF	2.70E-01	3.21E-01	1.54E-01
123678-HxCDF	1.66E-01	1.99E-01	7.48E-02
234678-HxCDF	3.14E-01	2.97E-01	1.29E-01
123789-HxCDF	2.99E-02	4.51E-02	ND
Other HxCDF	7.11E-01	6.94E-01	2.92E-01
1234678-HpCDF	8.26E-01	8.34E-01	3.84E-01
1234789-HpCDF	ND	ND	1.41E-01
Other HpCDF	1.02E+00	7.01E-01	2.30E-01
OCDF	7.33E-01	6.78E-01	3.18E-01
Total PCDF	5.85E+00	6.11E+00	2.39E+00
Total PCDD/PCDF	1.37E+01	1.61E+01	6.65E+00

ND = Not detected or EMPC catches; used as zero (0)

TABLE 2-2
PCDD/PCDF EMISSIONS SUMMARY
THREE-RUN AVERAGES
Unit No. 2 Stack

	Concentration, ng/DSCM at 12% CO2 Average	Emission Rate, Grams/Second Average
PCDD		
2378-TCDD	2.49E-03	9.00E-11
Other TCDD	1.28E-01	4.64E-09
12378-PeCDD	5.67E-03	1.98E-10
Other PeCDD	3.45E-01	1.25E-08
123478-HxCDD	4.78E-02	1.73E-09
123678-HxCDD	1.48E-01	5.35E-09
123789-HxCDD	1.78E-01	6.42E-09
Other HxCDD	1.53E+00	5.52E-08
1234678-HpCDD	1.44E+00	5.19E-08
Other HpCDD	1.27E+00	4.57E-08
OCDD	2.27E+00	8.22E-08
Total PCDD	7.36E+00	2.66E-07
PCDF		
2378-TCDF	3.77E-02	1.36E-09
Other TCDF	7.73E-01	2.80E-08
12378-PeCDF	7.37E-02	2.67E-09
23478-PeCDF	1.32E-01	4.77E-09
Other PeCDF	5.77E-01	2.10E-08
123478-HxCDF	2.48E-01	8.98E-09
123678-HxCDF	1.47E-01	5.31E-09
234678-HxCDF	2.47E-01	8.90E-09
123789-HxCDF	2.50E-02	9.10E-10
Other HxCDF	5.66E-01	2.04E-08
1234678-HpCDF	6.81E-01	2.46E-08
1234789-HpCDF	4.70E-02	1.65E-09
Other HpCDF	6.50E-01	2.35E-08
OCDF	5.76E-01	2.08E-08
Total PCDF	4.78E+00	1.73E-07
Total PCDD/PCDF	1.21E+01	4.39E-07

TABLE 2-3

PCDD/PCDF SAMPLE TRAIN AND FLUE GAS PARAMETERS SUMMARY

Unit No. 2 Stack

	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
Test Date	6/27/89	6/28/89	6/28/89
Run Start Time	1100	920	1420
Run Finish Time	1524	1255	1810
Net Run Time, minutes	180	180	180
Test Train Parameters			
Volume Of Gas Sampled*			
Dry Stand. Cubic Feet	193.233	154.221	147.373
Dry Stand. Cubic Meters	5.472	4.368	4.174
Average Sampling Rate*			
Dry Stand. Cubic Feet/min	1.074	0.857	0.819
Dry Stand. Cubic Meters/min	0.0304	0.0243	0.0232
Percent Isokinetic	100.5	101.2	100.1
Flue Gas Parameters			
Combustion Products			
Percent CO2 by Volume	8.8	8.9	8.8
Percent O2 by Volume	10.7	10.6	10.6
Temperature			
Degrees Fahrenheit	295	296	297
Degrees Celsius	146	147	147
Volumetric Flow Rates			
Dry Stand. Cubic Ft/Min*	104,446	104,652	101,155
Dry Stand. Cubic Meters/Min*	2,958	2,964	2,865
Actual Cubic Ft/Min	189,907	185,263	176,728
Actual Cubic Meters/Min	5,378	5,247	5,005
Moisture Percent by Volume	19.5	17.8	16.6

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

TABLE 2-4

EPA TOXIC EQUIVALENCY SUMMARY FOR PCDD/PCDF EMISSIONS

Unit No. 2 Stack

	Concentration, ng/DSCM at 12% CO2 Average	Emission Rate, Grams/Second Average	Toxic Equiv. Factor	- - - - Toxic Equivalencies - - - - Concentration, ng/DSCM at 12% CO2 Average	Emission Rate, Grams/Second Average
PCDD					
2378-TCDD	2.49E-03	9.00E-11	1.00000	2.49E-03	9.00E-11
Other TCDD	1.28E-01	4.64E-09	0.01000	1.28E-03	4.64E-11
12378-PeCDD	5.67E-03	1.98E-10	0.50000	2.84E-03	9.90E-11
Other PeCDD	3.45E-01	1.25E-08	0.00500	1.73E-03	6.25E-11
123478-HxCDD	4.78E-02	1.73E-09	0.04000	1.91E-03	6.92E-11
123678-HxCDD	1.48E-01	5.35E-09	0.04000	5.92E-03	2.14E-10
123789-HxCDD	1.78E-01	6.42E-09	0.04000	7.12E-03	2.57E-10
Other HxCDD	1.53E+00	5.52E-08	0.00040	6.12E-04	2.21E-11
1234678-HpCDD	1.44E+00	5.19E-08	0.00100	1.44E-03	5.19E-11
Other HpCDD	1.27E+00	4.57E-08	0.00001	1.27E-05	4.57E-13
OCDD	2.27E+00	8.22E-08	0.00000	0.00E+00	0.00E+00
Total PCDD	7.36E+00	2.66E-07		2.53E-02	9.12E-10
PCDF					
2378-TCDF	3.77E-02	1.36E-09	0.10000	3.77E-03	1.36E-10
Other TCDF	7.73E-01	2.80E-08	0.00100	7.73E-04	2.80E-11
12378-PeCDF	7.37E-02	2.67E-09	0.10000	7.37E-03	2.67E-10
23478-PeCDF	1.32E-01	4.77E-09	0.10000	1.32E-02	4.77E-10
Other PeCDF	5.77E-01	2.10E-08	0.00100	5.77E-04	2.10E-11
123478-HxCDF	2.48E-01	8.98E-09	0.01000	2.48E-03	8.98E-11
123678-HxCDF	1.47E-01	5.31E-09	0.01000	1.47E-03	5.31E-11
234678-HxCDF	2.47E-01	8.90E-09	0.01000	2.47E-03	8.90E-11
123789-HxCDF	2.50E-02	9.10E-10	0.01000	2.50E-04	9.10E-12
Other HxCDF	5.66E-01	2.04E-08	0.00010	5.66E-05	2.04E-12
1234678-HpCDF	6.81E-01	2.46E-08	0.00100	6.81E-04	2.46E-11
1234789-HpCDF	4.70E-02	1.65E-09	0.00100	4.70E-05	1.65E-12
Other HpCDF	6.50E-01	2.35E-08	0.00100	6.50E-04	2.35E-11
OCDF	5.76E-01	2.08E-08	0.00000	0.00E+00	0.00E+00
Total PCDF	4.78E+00	1.73E-07		3.38E-02	1.22E-09
Total PCDD/PCDF	1.21E+01	4.39E-07		5.91E-02	2.13E-09

PROCESS DESCRIPTION AND OPERATION

3.1 General. The Indianapolis Resource Recovery Facility in Indianapolis, Indiana burns municipal solid waste in three mass-fired refuse boilers. Each boiler train consists of a boiler with a capacity to process 787 tons of municipal solid waste per day. Each boiler train is equipped with a spray dryer absorber (SDA), baghouse, and stack. The testing covered in this report was performed at the Unit No. 2 stack.

3.2 Source Air Flow. Figure 3-1 is an air flow schematic which shows the passage of flue gases exhausted from the boiler.

3.3 Operation During Testing. Detailed process data will be supplied by Ogden Projects, Inc. under separate cover.

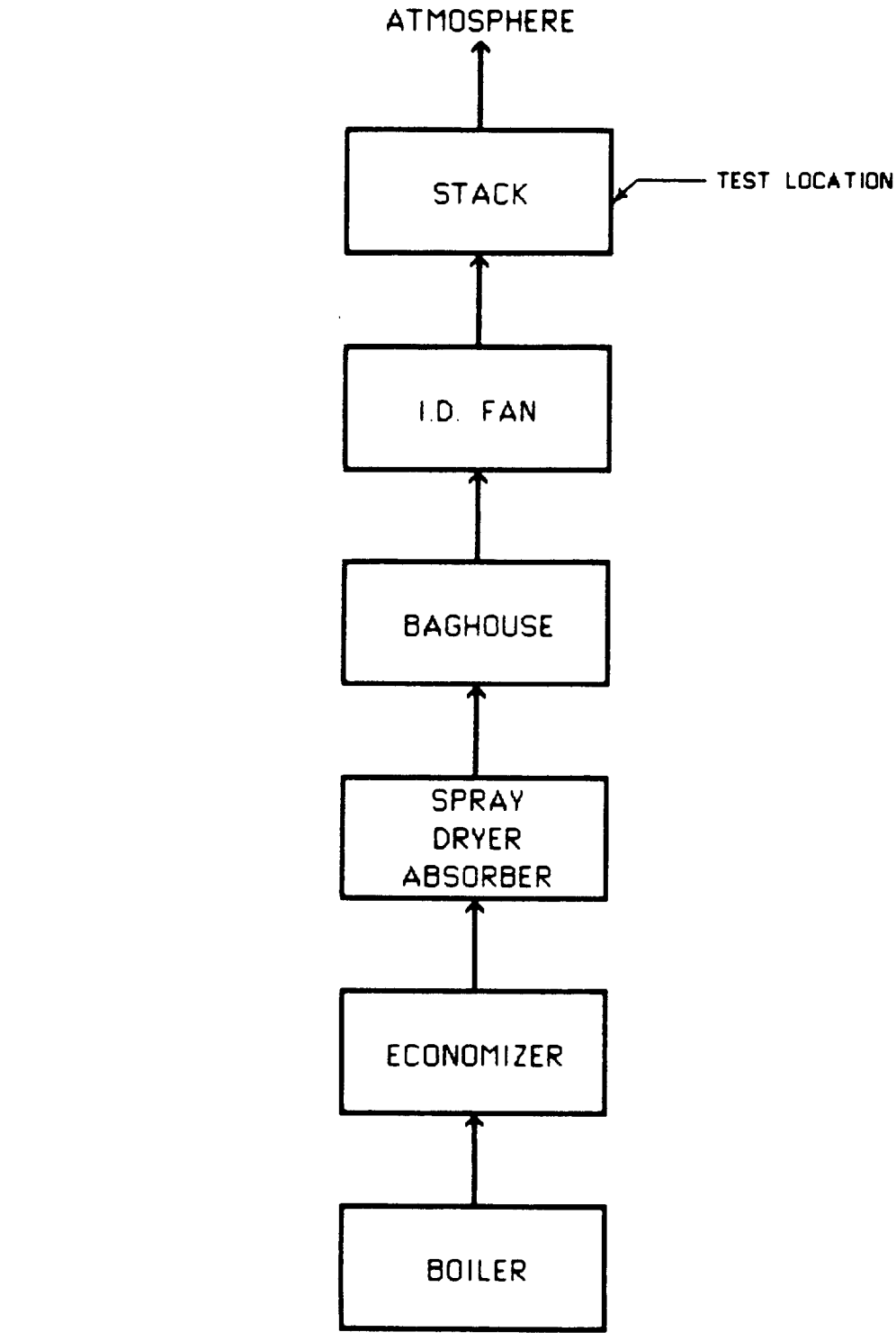

FIGURE 3-1. UNIT NO. 2 AIR FLOW SCHEMATIC.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 General. All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the Indiana Department of Environmental Management. This section provides brief descriptions of the sampling and analytical procedures. Detailed descriptions of the procedures are provided in Appendix F.

4.2 Sampling Points. The number and location of the sampling points were determined according to EPA Method 1. The stack cross section was divided into 12 equal areas with six sampling points on each of two traverse axes, as shown in Figure 4-1.

4.3 Volumetric Air Flow Rates

4.3.1 Flue Gas Velocity. EPA Method 2 was used to take the velocity measurements during the traverses of the stack cross section.

4.3.2 Flue Gas Composition. Multipoint, integrated flue gas samples were collected during each run and analyzed using EPA Method 3. The results were used to determine the flue gas composition, molecular weight, excess air, and emissions correction factor.

4.3.3 Flue Gas Moisture Content. Moisture content was determined by analyzing the sampling train impinger reagents according to the procedures outlined in EPA Method 5.

4.4 PCDD/PCDF Emissions Determinations. A Modified Method 5 sampling train was used to determine the PCDD/PCDF emissions. Sampling and analysis were performed according the procedures outlined in the ASME protocol, "Sampling for the Determination of Chlorinated Organic Compounds in Stack Emissions." Instead of hexane, methylene chloride was used as the final rinse solvent. The change from hexane to methylene chloride was made to improve recovery of higher molecular weight PCDD/PCDF. Sample train components were prepared as follows:

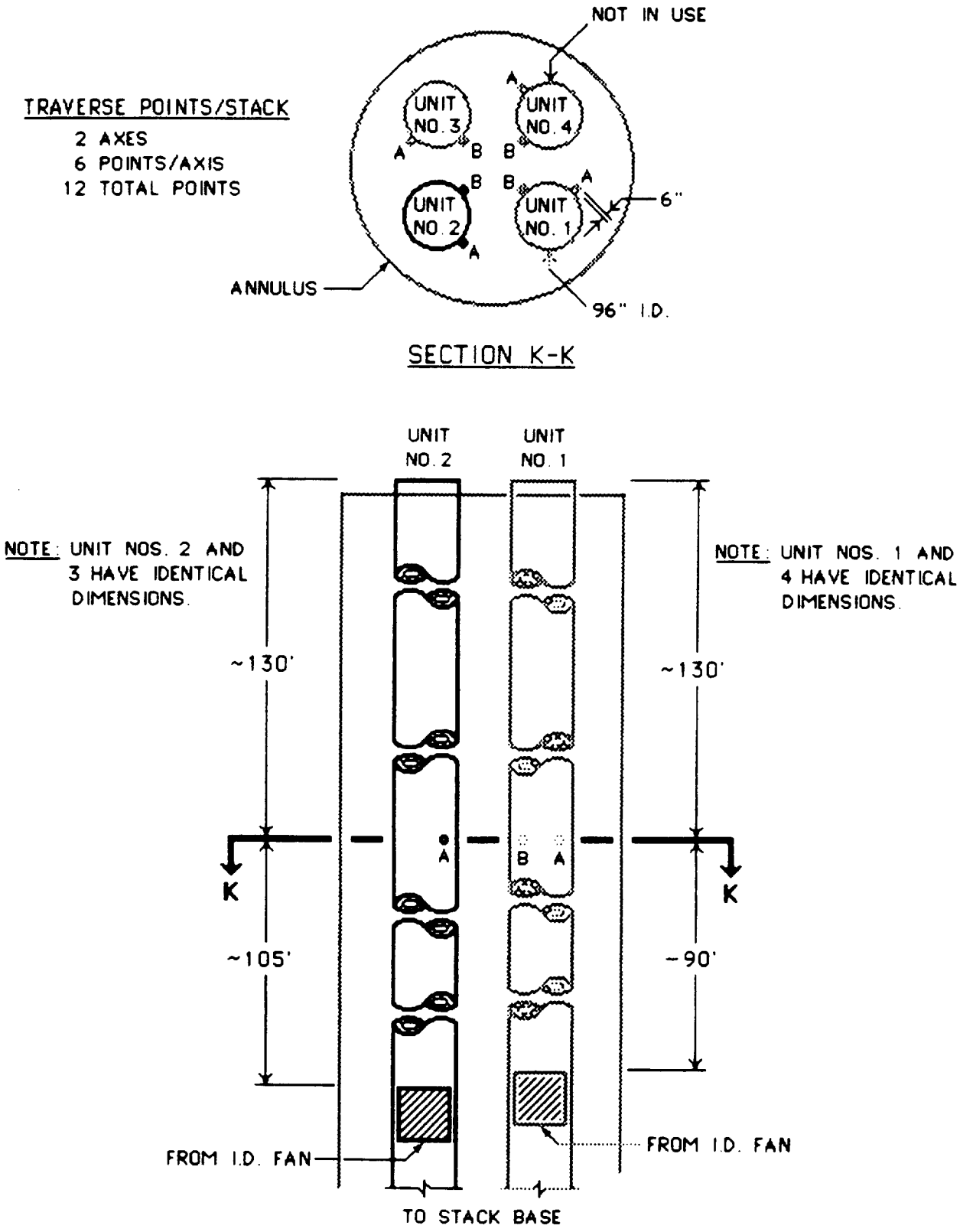

FIGURE 4-1. UNIT NO. 2 STACK TEST LOCATION.

Filter. Prior to use in the field, the glass fiber filters (EPM2000) were precleaned and checked for contamination. A total of up to 50 filters from the same lot were extracted simultaneously with methylene chloride in a Soxhlet extractor for a period of 24 hours. Triangle Laboratories analyzed the filter extract by gas chromatography/mass spectrometry to verify that the filters were free of contamination. The precleaned filters were used in the field for sample collection. To prevent contamination of the filters, the filters were placed in a precleaned petri dish and sealed with military specification Teflon tape.

XAD-2 Resin. Precleaned XAD-2 resin was purchased from Supleco Chromatography Products. Care was taken to ensure that the resin was kept at temperatures below 120°F before and after sample collection to prevent resin decomposition. The sorbent tube was charged with 20 to 30 grams of the precleaned resin. Prior to field use, the resin was spiked with PCDD/PCDF surrogates. The period of time between charging the sorbent tube and use in the field was minimized and was not allowed to exceed 14 days.

Glassware. All glass components of the sample train, including the sorbent tube, were precleaned prior to sampling according to the procedures listed in Table 4-1. Cleaned glassware was sealed with precleaned foil until sample train assembly. Assembly of the sample trains was conducted in the laboratory. Following sample recovery, the glassware was reused at the same sampling location.

TABLE 4-1

MM5 GLASSWARE PRECLEANING PROCEDURES

1. Glassware soaked in hot soapy water (Alconox) 50°C or higher.
2. H_2O rinsed (three times).
3. Distilled, deionized water rinsed (three times).
4. Rinsed with pesticide grade acetone (three times).
5. Rinsed with pesticide grade methylene chloride (three times).
6. Baked at 450°F for two hours.
7. Glassware capped with methylene chloride rinsed aluminum foil.

4.4.1 Sample Collection. Each of the 12 points was sampled for 15 minutes, with meter readings and pertinent metering adjustments conducted every five minutes. Each run was 180 minutes in duration.

Flue gas was extracted from the effluent through a glass nozzle and glass probe. Particulate matter was removed from the gas stream by means of a glass fiber filter housed in a glass holder maintained at 248 ± 25°F. The filter holder contained a Teflon frit to support the filter. The gas passed through a condenser and into a sorbent trap for removal of organic constituents. A chilled impinger train was used to remove water from the flue gas, and a dry gas meter was used to measure the sample gas flow.

4.4.2 Sample Recovery. Recovery of the samples was conducted in the laboratory located at the plant site. Access to this area was limited to those individuals involved in the sample recovery process.

The solvents used for rinsing were pesticide grade acetone and methylene chloride. Each sample train component was rinsed first with acetone followed by methylene chloride. Acetone and methylene chloride rinses were combined in the same containers. All sample containers containing water were extracted for analysis by Triangle Laboratories, Inc. within 7 to 14 days after sample collection.

4.4.3 Sample Analysis. All analyses were performed using accepted laboratory procedures in accordance with the specified analytical protocols. Refer to the Triangle Laboratories, Inc. users manual in Appendix F for a detailed explanation.

4.5 Equipment Calibration. Pertinent calibration data are provided in Appendix D.

QUALITY ASSURANCE/QUALITY CONTROL

5.1 General. Entropy Environmentalists Inc. (EEI) is committed to the continued implementation of a Quality Assurance Program to assure the quality of sampling and analytical procedures of environmental measurement data. The Quality Assurance measures taken during this test project equals or exceeds the minimum QA/QC recommendations as set forth by the U.S. Environmental Protection Agency (EPA) for a particular method.

The following sections outline the QA program implemented by EEI to justify the validity of the test procedures. The QA system for this test program addresses the following areas:

- Project Organization
- Preventive Maintenance & Equipment Calibration
- QA Sample Processing
- Analytical Instrument Calibration
- Blanks and Spiked Samples
- Internal/External System Checks
- Data Reduction & Validation
- Continuous Emissions Monitoring
- QA/QC Summary

5.2 Project Organization. The organization of the project team, including QA functions, are shown in Figure 5-1. Note that the QA structure is independent of the organizational groups which generate measurement data during the test program.

5.3 Preventive Maintenance and Equipment Calibration. An effective preventive maintenance program decreases downtime and thus increases data completeness and quality. Pretest and posttest equipment calibrations are conducted in a manner and at a frequency which meets or exceeds U.S. EPA specifications.

Each item transported to the field is inspected to detect equipment problems which may originate during periods of storage. All equipment returning from the field are cleaned, repaired, reconditioned, and recalibrated as necessary. Routine maintenance on equipment (dry gas meters, pumps, magnehelics/manometers, pitot tubes, and nozzles) is carried out periodically for leaks, corrosion, dents, or any other damage. Table 5-1 shows the activities for equipment calibration.

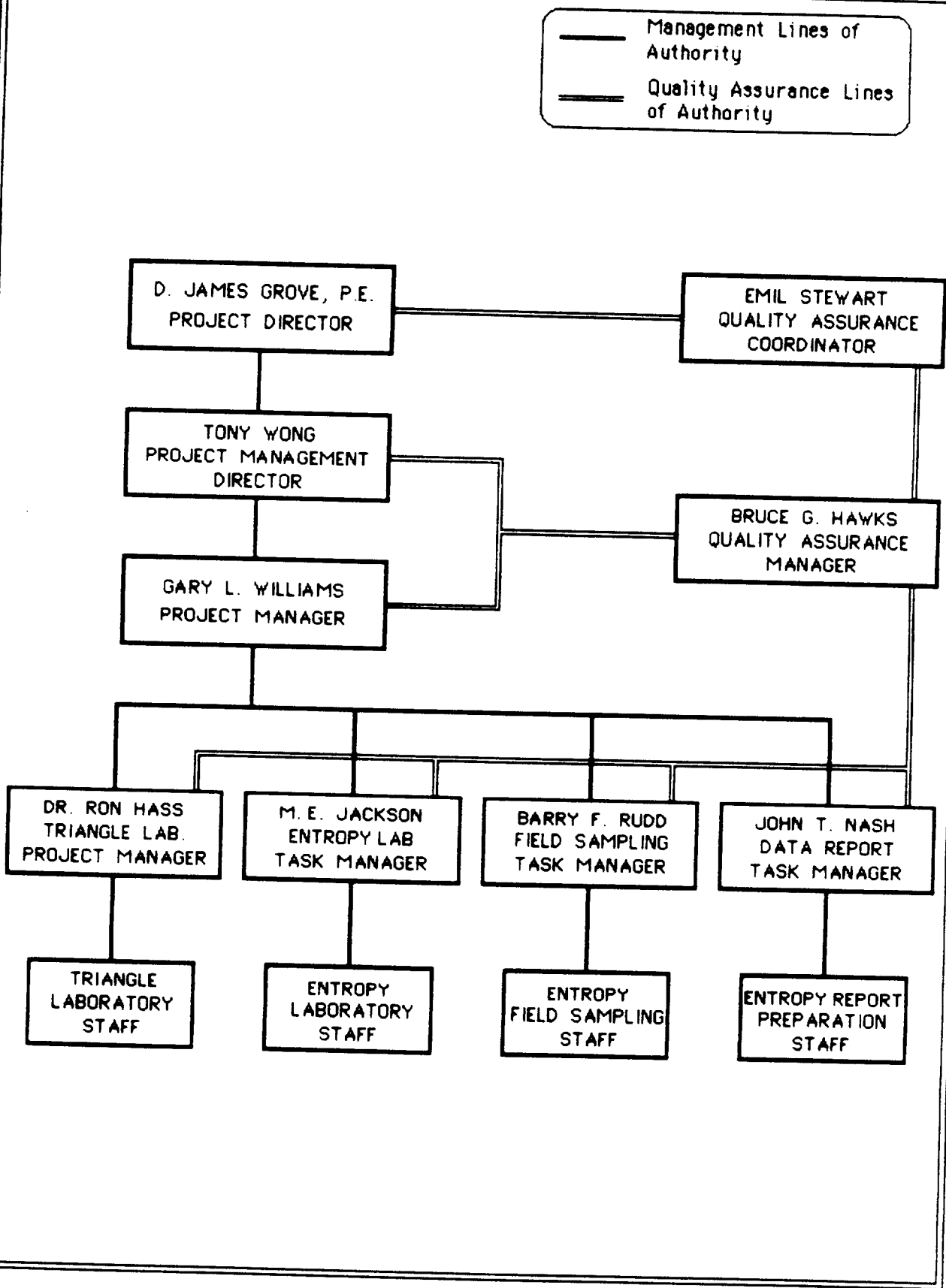

FIGURE 5-1. PROJECT ORGANIZATION.

TABLE 5-1

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Type S Pitot Tubes	Standards contained in EPA Method 2.	Coefficient of 0.84 ± 0.02	Refurbish or recalibrate.
	Visual inspection prior to shipment to test site and again prior to each day of testing.		
Manometers	Leak checked before and after each field use.		Repair or replace
Magnehelic Gauges	Initially calibrated over full range.	0-10" water column	
	After each field use, checked against inclined manometer at average settings encountered during testing.	Within ± 5%	Repair and Recalibrate.
Thermometers -Impinger -Dry Gas Meter -Filter Box	After purchase and prior to each field use, using ASTM mercury-in-glass thermometer.	Imp = ± 2°F DGM = ± 5.4°F FB = ± 5.4°F	Adjust, determine correction factor, or reject.
Thermocouple/ Potentiometer	After purchase. 3-point (ice bath, boiling water, (and hot oil) using ASTM mercury-in-glass thermometer.	± 1.5% of absolute temperature.	Adjust, determine correction factor, or reject.
	Before and after each field use compared to ASTM mercury-in-glass thermometer at ambient conditions.		
Dry Gas Meter and Orifice	Full calibration (every 6 months) over wide range of orifice settings to obtain calibration factor.	DGM = ± 2% of avg. factor for each calib. run. Ori. = ± 0.15" H20 over delta H range of 0.4" to 4.0".	Adjust or reject
	10-minute quick calibration before sending to test site and again prior to each day of field use.	± 3% of full. ± 5% of full.	Use if no backup. Do not use.
	Posttest (at average delta H and highest vacuum) to determine if meter gamma has changed.	± 5% of full calibration. Factor (initial or recalibration) that yields the lowest sample volume for the testing is used.	Meter calibration, meter coefficient
Dry Gas Meter Transfer Standard	Annual calibrations conducted in triplicate using EPA wet test meter. Calibrations conducted at 7 flow rates from 0.25 to 1.40 cfm.	± 2% of average factor for each calibration run.	Adjust and recalibrate.
Barometer	Before and after each field use against an ASTM mercury-in-glass barometer.	± 0.1" mercury.	Adjust to agree.
	Reference barometer adjusted for elevation differences.		
Probe Nozzle	Average of 5 I.D. measurements using a micrometer. Visual inspection before and after each field use.	Difference between high and low measurement < 0.004"	Repair and recalibrate.

5.4 Sample Processing. Entropy employs systems which ensure the integrity of an environmental sample from the time of acquisition, through analysis, and ultimately to proper disposal. These systems are necessary to allow valid conclusions to be drawn from analytical results separated in time and space from the sampling operation. In addition, these systems recognize that samples are occasionally of value even after analytical results have been reported.

Samples are collected, transported, and stored in clean containers which are constructed of materials inert to the analytical matrix. Containers are used which allow air tight seals. When necessary, containers are employed which prevent photochemical reactions. All sample containers are labeled with the following information:

- Unique source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Sample analyst identifier

Additional information relating to the sample is recorded on the data sheet for the sampling run that afforded the subject sample. Accordingly, the sampling data sheet contains all the information listed above, plus the date and time the sample was acquired and supplemental information such as observations pertinent to the quality of the sample. For condensed samples, e.g., samples in liquid media, the sample levels are marked on the outside of the container; this mark is used to indicate sample loss, and as such, may serve as a reference in adjusting results accordingly.

For transport from the field to the laboratory, samples are stored in locked boxes and secured in a fashion which minimizes movement and thus prevents breakage of containers. Boxes used for transporting glass containers are packed with foam.

Samples remain in the custody of the sampler from acquisition until conveyance to the laboratory analyst, if the analyst is different from the sampler. The sampler initiates a sample chain of custody record at the time of sample collection in the field. All custody transfers are documented on the chain of custody form, which remains with the sample at all times.

Analytical data are identified in a manner identical to that of the sampling data. Accordingly, all data generated from the analysis of samples are documented with the following information:

- Source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Analyst identifier
- Analysis date

Portions of samples remaining after analysis are returned to their original sample containers. These samples are stored in designated storage areas until their destruction is authorized.

5.5 Instrument Calibration. Instrument calibration is one of the most important functions in generating precise and accurate quality data. A listing of major in-house instrumentation and the corresponding Quality Assurance program is given in Table 5-2.

All of the contract laboratories involved in the analytical testing for the test program maintained rigorous QA programs for instrument calibration.

5.6 Blanks and Spikes. Field blanks, method blanks, trip blanks, lab-proof blanks and filter blanks are obtained, digested and analyzed when applicable. The blanks reflect the background contamination obtained from the various sources during the sampling and analysis. Thus, data adjustment or correction can be made accordingly.

In most cases, it is not necessary to digest and analyze the method blanks, reagent blanks or the lab-proof blanks unless the field blank shows a high level of contamination. If a high level of contamination is present, it is imperative to individually analyze the above blanks to help determine the cause of contamination.

Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method. During spiking, a known amount of stock solutions of the substance of interest is added to the sample prior to sample extraction, digestion, and analysis.

TABLE 5-2

IN-HOUSE INSTRUMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Analytical & Top Loading Balance	Daily and monthly checks with a series of class S weights. Balance serviced annually by a qualified service representative and checked with a series of NBS weights.	± 1 mg of class S weights.	Adjust or repair.
Gas Chromatograph	3-point calibration curve at the expected range. Duplicate injection of the sample until ± 5% variation is achieved. Calibration repeated at the end of each test series.		
HPLC/Ion Chromatograph	Calibrations conducted at the beginning, after the first injection, and after the second injection.		
Fisher Accument 925 pH/Selective Ion Meter	5-point calibration prior to analyzing the samples for the specific ions.		

5.7 Internal/External System Audit Checks. System and performance audits are routine elements of all Entropy QA/QC programs.

Internal Systems Audit: The following sampling equipment checks were conducted prior to sample collection.

- All sampling equipment was thoroughly checked to ensure clean and operable components.
- Equipment was inspected for possible damage from shipment.
- The oil manometers or Magnehelic gauges were leveled and zeroed.
- The temperature measurement systems were checked for damage and operability by measuring the ambient temperature.

Performance Audits: Performance audits of the laboratory are conducted prior to the processing of any compliance samples for analysis. Audit materials typically include samples available from the EPA prior to new source testing. Also, samples of known concentration are specially prepared in-house or obtained from the EPA for Internal QA checks.

External Systems Audits: Entropy is subject to a system audit each time a test is conducted for any Air Pollution Control agency. This procedure entails an EPA observer on-site to do qualitative evaluation of performance to demonstrate compliance with the applicable regulations.

5.8 Data Reduction and Validation. The test team leader is responsible for reviewing and validating data as they are acquired. Each team leader has extensive knowledge of sampling methodology and the characteristic of the process being measured and is capable of evaluating the accuracy, representativeness, and completeness of raw data on-site, where action to replace inadequate data can be taken immediately.

Data obtained during calibrations and test runs are recorded on standardized forms which are checked twice for completeness and accuracy by the QA Director. Data reduction and consistency are achieved by using the standardized forms and using Entropy's in-house computer facilities.

5.9 QA/QC Summary. The following section outlines the most significant QA parameters used during this test program.

Modified Method 5: The analysis was performed by GC/MS. The surrogates and internal standards were added immediately prior to analysis. PCDD/PCDF surrogate recoveries are presented in Table 5-3 and PCDD/PCDF internal standards recoveries are presented in Table 5-4.

TABLE 5-3

PCDD/PCDF SURROGATES RECOVERY

Unit No. 2 Stack

	Recovery, %				
Sample ID	37CL-TCDD	13C12-PeCDF	13C12-HxCDF	13C12-HxCDD	13C12-HpCDF
2-S-MM5-1	103	98.7	76.6	77.7	128
2-S-MM5-1-CF	97.1	- -	- -	- -	- -
2-S-MM5-2	104	87.1	87.6	98.0	122
2-S-MM5-2-CF	92.4	- -	- -	- -	- -
2-S-MM5-3	96.5	86.7	83.7	90.0	116
2-S-MM5-3-CF	87.9	- -	- -	- -	- -
2-S-MM5-FB	95.0	81.0	70.4	73.1	96.5
2-S-MM5-FB-CF	92.8	- -	- -	- -	- -
TLI Blank	98.9	82.6	72.2	83.3	128

CF = Confirmation Analysis

TABLE 5-4

PCDD/PCDF INTERNAL STANDARDS RECOVERY

Unit No. 2 Stack

	Recovery, %								
Sample ID	13C12-TCDF	2378-13C12-TCDD	13C12-PeCDF	13C12-PeCDD	13C12-HxCDF	13C12-HxCDD	13C12-HpCDF	13C12-HpCDD	13C12-OCDD
2-S-MM5-1	69.2	82.4	111	120	83.8	98.3	90.0	98.4	114
2-S-MM5-1-CF	70.5	77.8	- -	- -	- -	- -	- -	- -	- -
2-S-MM5-2	69.0	73.2	83.2	81.0	77.8	77.9	79.3	87.2	75.6
2-S-MM5-2-CF	59.2	70.0	- -	- -	- -	- -	- -	- -	- -
2-S-MM5-3	78.5	87.1	108	109	86.3	91.7	93.3	105	87.8
2-S-MM5-3-CF	65.6	71.0	- -	- -	- -	- -	- -	- -	- -
2-S-MM5-FB	54.4	63.3	75.1	77.9	80.3	87.1	67.9	68.9	50.2
2-S-MM5-FB-CF	56.1	57.3	- -	- -	- -	- -	- -	- -	- -
TLI Blank	72.6	84.4	97.7	106	82.9	92.9	77.9	90.0	91.5

CF = Confirmation Analysis

APPENDIX A

TEST RESULTS AND EXAMPLE CALCULATIONS

FIELD DATA AND RESULTS TABULATION

PLANT: Indianapolis Resource Recovery Facility, Indianapolis, Indiana

SAMPLING LOCATION: Unit No. 2 Stack

		2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
	Test Date	6/27/89	6/28/89	6/28/89
	Run Start Time	1100	920	1420
	Run Finish Time	1524	1255	1810
	Net Traversing Points	12	12	12
Theta	Net Run Time, Minutes	180.00	180.00	180.00
Dia	Nozzle Diameter, Inches	0.307	0.273	0.273
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9858	0.9964	0.9964
Pbar	Barometric Pressure, Inches Hg	29.3	29.5	29.5
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H2O	4.59	2.74	2.50
Vm	Volume Of Metered Gas Sample, Dry ACF	213.711	166.910	161.288
tm	Dry Gas Meter Temperature, Degrees F	110	105	111
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	193.233	154.221	147.373
Vlc	Total Liquid Collected In Impingers & Silica Gel, grams	991.3	710.8	622.2
Vwstd	Volume of Water Vapor, SCF*	46.660	33.457	29.287
%H2O	Moisture Content, Percent by Volume	19.5	17.8	16.6
Mfd	Dry Mole Fraction	0.805	0.822	0.834
%CO2	Carbon Dioxide, Percent By Volume, Dry	8.8	8.9	8.8
%O2	Oxygen, Percent By Volume, Dry	10.7	10.6	10.6
%CO+N2	CO + N2, Percent By Volume, Dry	80.5	80.5	80.6
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	29.84	29.85	29.83
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	27.53	27.74	27.87
Pg	Flue Gas Static Pressure, Inches H2O	-1.00	-0.85	-0.80
Ps	Absolute Flue Gas Pressure, Inches Hg	29.23	29.44	29.44
ts	Flue Gas Temperature, Degrees F	295	296	297
Delta-p	Average Velocity Head, Inches H2O	0.8195	0.7906	0.7218
vs	Flue Gas Velocity, Feet/Second	62.97	61.43	58.60
A	Stack/Duct Area, Square Inches	7,238	7,238	7,238
Qsd	Volumetric Air Flow Rate, Dry SCFM*	104,446	104,652	101,155
Qaw	Volumetric Air Flow Rate, Wet ACFM	189,907	185,263	176,728
%I	Isokinetic Sampling Rate, Percent	100.5	101.2	100.1
%EA	Excess Air, Percent	101	100	99

* 68 Degrees F -- 29.92 Inches Mercury (Hg)

(continued next page)

PCDD	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
2378-TCDD			
Formula Weight, Lb/Lb-Mole	322.00	322.00	322.00
Catch Weight, Nanograms	0.030	ND (0.008)	ND [0.030]
Concentration, ng/DSCM *	5.48E-03	ND(1.83E-03)	ND[7.19E-03]
Concentration, ng/DSCM at 12% CO2	7.48E-03	ND(2.47E-03)	ND[9.80E-03]
Emission Rate, Pounds/Hour	2.14E-09	ND(7.18E-10)	ND[2.72E-09]
Emission Rate, Grams/Second	2.70E-10	ND(9.05E-11)	ND[3.43E-10]
Other TCDD			
Formula Weight, Lb/Lb-Mole	322.00	322.00	322.00
Catch Weight, Nanograms	0.400	0.730	0.180
Concentration, ng/DSCM *	7.31E-02	1.67E-01	4.31E-02
Concentration, ng/DSCM at 12% CO2	9.97E-02	2.25E-01	5.88E-02
Emission Rate, Pounds/Hour	2.86E-08	6.55E-08	1.63E-08
Emission Rate, Grams/Second	3.60E-09	8.26E-09	2.06E-09
12378-PeCDD			
Formula Weight, Lb/Lb-Mole	356.44	356.44	356.44
Catch Weight, Nanograms	ND [0.137]	ND [0.132]	0.052
Concentration, ng/DSCM *	ND[2.50E-02]	ND[3.02E-02]	1.25E-02
Concentration, ng/DSCM at 12% CO2	ND[3.41E-02]	ND[4.08E-02]	1.70E-02
Emission Rate, Pounds/Hour	ND[9.80E-09]	ND[1.18E-08]	4.72E-09
Emission Rate, Grams/Second	ND[1.23E-09]	ND[1.49E-09]	5.95E-10
Other PeCDD			
Formula Weight, Lb/Lb-Mole	356.44	356.44	356.44
Catch Weight, Nanograms	2.111	1.180	0.448
Concentration, ng/DSCM *	3.86E-01	2.70E-01	1.07E-01
Concentration, ng/DSCM at 12% CO2	5.26E-01	3.64E-01	1.46E-01
Emission Rate, Pounds/Hour	1.51E-07	1.06E-07	4.07E-08
Emission Rate, Grams/Second	1.90E-08	1.33E-08	5.13E-09
123478-HxCDD			
Formula Weight, Lb/Lb-Mole	390.88	390.88	390.88
Catch Weight, Nanograms	0.203	0.197	0.098
Concentration, ng/DSCM *	3.71E-02	4.51E-02	2.35E-02
Concentration, ng/DSCM at 12% CO2	5.06E-02	6.08E-02	3.20E-02
Emission Rate, Pounds/Hour	1.45E-08	1.77E-08	8.90E-09
Emission Rate, Grams/Second	1.83E-09	2.23E-09	1.12E-09
123678-HxCDD			
Formula Weight, Lb/Lb-Mole	390.88	390.88	390.88
Catch Weight, Nanograms	0.628	0.636	0.280
Concentration, ng/DSCM *	1.15E-01	1.46E-01	6.71E-02
Concentration, ng/DSCM at 12% CO2	1.56E-01	1.96E-01	9.15E-02
Emission Rate, Pounds/Hour	4.49E-08	5.71E-08	2.54E-08
Emission Rate, Grams/Second	5.66E-09	7.19E-09	3.20E-09

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* 68 Deg. F -- 29.92 inches Hg

(Continued next page)

FIELD DATA AND RESULTS TABULATION

Continued

PCDD	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
123789-HxCDD			
Formula Weight, Lb/Lb-Mole	390.88	390.88	390.88
Catch Weight, Nanograms	0.762	0.749	0.343
Concentration, ng/DSCM *	1.39E-01	1.71E-01	8.22E-02
Concentration, ng/DSCM at 12% CO2	1.90E-01	2.31E-01	1.12E-01
Emission Rate, Pounds/Hour	5.45E-08	6.72E-08	3.11E-08
Emission Rate, Grams/Second	6.86E-09	8.47E-09	3.92E-09
Other HxCDD			
Formula Weight, Lb/Lb-Mole	390.88	390.88	390.88
Catch Weight, Nanograms	6.467	6.063	3.370
Concentration, ng/DSCM *	1.18E+00	1.39E+00	8.07E-01
Concentration, ng/DSCM at 12% CO2	1.61E+00	1.87E+00	1.10E+00
Emission Rate, Pounds/Hour	4.62E-07	5.44E-07	3.06E-07
Emission Rate, Grams/Second	5.83E-08	6.86E-08	3.86E-08
1234678-HpCDD			
Formula Weight, Lb/Lb-Mole	425.32	425.32	425.32
Catch Weight, Nanograms	6.690	5.956	2.460
Concentration, ng/DSCM *	1.22E+00	1.36E+00	5.89E-01
Concentration, ng/DSCM at 12% CO2	1.67E+00	1.84E+00	8.04E-01
Emission Rate, Pounds/Hour	4.78E-07	5.35E-07	2.23E-07
Emission Rate, Grams/Second	6.03E-08	6.74E-08	2.81E-08
Other HpCDD			
Formula Weight, Lb/Lb-Mole	425.32	425.32	425.32
Catch Weight, Nanograms	6.130	4.870	2.355
Concentration, ng/DSCM *	1.12E+00	1.12E+00	5.64E-01
Concentration, ng/DSCM at 12% CO2	1.53E+00	1.50E+00	7.69E-01
Emission Rate, Pounds/Hour	4.38E-07	4.37E-07	2.14E-07
Emission Rate, Grams/Second	5.52E-08	5.51E-08	2.69E-08
OCDD			
Formula Weight, Lb/Lb-Mole	459.76	459.76	459.76
Catch Weight, Nanograms	8.069	11.841	3.478
Concentration, ng/DSCM *	1.47E+00	2.71E+00	8.33E-01
Concentration, ng/DSCM at 12% CO2	2.01E+00	3.66E+00	1.14E+00
Emission Rate, Pounds/Hour	5.77E-07	1.06E-06	3.16E-07
Emission Rate, Grams/Second	7.27E-08	1.34E-07	3.98E-08

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* 68 Deg. F -- 29.92 inches Hg

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FIELD DATA AND RESULTS TABULATION

Continued

PCDF	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
2378-TCDF			
Formula Weight, Lb/Lb-Mole	306.00	306.00	306.00
Catch Weight, Nanograms	0.167	0.163	0.065
Concentration, ng/DSCM *	3.05E-02	3.73E-02	1.56E-02
Concentration, ng/DSCM at 12% CO2	4.16E-02	5.03E-02	2.12E-02
Emission Rate, Pounds/Hour	1.19E-08	1.46E-08	5.90E-09
Emission Rate, Grams/Second	1.50E-09	1.84E-09	7.44E-10
Other TCDF			
Formula Weight, Lb/Lb-Mole	306.00	306.00	306.00
Catch Weight, Nanograms	3.161	3.606	1.293
Concentration, ng/DSCM *	5.78E-01	8.26E-01	3.10E-01
Concentration, ng/DSCM at 12% CO2	7.88E-01	1.11E+00	4.22E-01
Emission Rate, Pounds/Hour	2.26E-07	3.24E-07	1.17E-07
Emission Rate, Grams/Second	2.85E-08	4.08E-08	1.48E-08
12378-PeCDF			
Formula Weight, Lb/Lb-Mole	340.44	340.44	340.44
Catch Weight, Nanograms	0.317	0.350	0.104
Concentration, ng/DSCM *	5.79E-02	8.01E-02	2.49E-02
Concentration, ng/DSCM at 12% CO2	7.90E-02	1.08E-01	3.40E-02
Emission Rate, Pounds/Hour	2.27E-08	3.14E-08	9.44E-09
Emission Rate, Grams/Second	2.86E-09	3.96E-09	1.19E-09
23478-PeCDF			
Formula Weight, Lb/Lb-Mole	340.44	340.44	340.44
Catch Weight, Nanograms	0.578	0.551	0.252
Concentration, ng/DSCM *	1.06E-01	1.26E-01	6.04E-02
Concentration, ng/DSCM at 12% CO2	1.44E-01	1.70E-01	8.23E-02
Emission Rate, Pounds/Hour	4.13E-08	4.95E-08	2.29E-08
Emission Rate, Grams/Second	5.21E-09	6.23E-09	2.88E-09
Other PeCDF			
Formula Weight, Lb/Lb-Mole	340.44	340.44	340.44
Catch Weight, Nanograms	2.917	2.923	0.313
Concentration, ng/DSCM *	5.33E-01	6.69E-01	7.50E-02
Concentration, ng/DSCM at 12% CO2	7.27E-01	9.02E-01	1.02E-01
Emission Rate, Pounds/Hour	2.09E-07	2.62E-07	2.84E-08
Emission Rate, Grams/Second	2.63E-08	3.31E-08	3.58E-09
123478-HxCDF			
Formula Weight, Lb/Lb-Mole	374.88	374.88	374.88
Catch Weight, Nanograms	1.083	1.041	0.471
Concentration, ng/DSCM *	1.98E-01	2.38E-01	1.13E-01
Concentration, ng/DSCM at 12% CO2	2.70E-01	3.21E-01	1.54E-01
Emission Rate, Pounds/Hour	7.74E-08	9.34E-08	4.28E-08
Emission Rate, Grams/Second	9.76E-09	1.18E-08	5.39E-09

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* 68 Deg. F -- 29.92 inches Hg

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Continued

PCDF	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
123678-HxCDF			
Formula Weight, Lb/Lb-Mole	374.88	374.88	374.88
Catch Weight, Nanograms	0.667	0.645	0.229
Concentration, ng/DSCM *	1.22E-01	1.48E-01	5.49E-02
Concentration, ng/DSCM at 12% CO2	1.66E-01	1.99E-01	7.48E-02
Emission Rate, Pounds/Hour	4.77E-08	5.79E-08	2.08E-08
Emission Rate, Grams/Second	6.01E-09	7.29E-09	2.62E-09
234678-HxCDF			
Formula Weight, Lb/Lb-Mole	374.88	374.88	374.88
Catch Weight, Nanograms	1.259	0.963	0.394
Concentration, ng/DSCM *	2.30E-01	2.20E-01	9.44E-02
Concentration, ng/DSCM at 12% CO2	3.14E-01	2.97E-01	1.29E-01
Emission Rate, Pounds/Hour	9.00E-08	8.64E-08	3.58E-08
Emission Rate, Grams/Second	1.13E-08	1.09E-08	4.51E-09
123789-HxCDF			
Formula Weight, Lb/Lb-Mole	374.88	374.88	374.88
Catch Weight, Nanograms	0.120	0.146	ND [0.046]
Concentration, ng/DSCM *	2.19E-02	3.34E-02	ND[1.10E-02]
Concentration, ng/DSCM at 12% CO2	2.99E-02	4.51E-02	ND[1.50E-02]
Emission Rate, Pounds/Hour	8.58E-09	1.31E-08	ND[4.18E-09]
Emission Rate, Grams/Second	1.08E-09	1.65E-09	ND[5.26E-10]
Other HxCDF			
Formula Weight, Lb/Lb-Mole	374.88	374.88	374.88
Catch Weight, Nanograms	2.853	2.249	0.895
Concentration, ng/DSCM *	5.21E-01	5.15E-01	2.14E-01
Concentration, ng/DSCM at 12% CO2	7.11E-01	6.94E-01	2.92E-01
Emission Rate, Pounds/Hour	2.04E-07	2.02E-07	8.13E-08
Emission Rate, Grams/Second	2.57E-08	2.54E-08	1.02E-08
1234678-HpCDF			
Formula Weight, Lb/Lb-Mole	409.32	409.32	409.32
Catch Weight, Nanograms	3.313	2.703	1.175
Concentration, ng/DSCM *	6.05E-01	6.19E-01	2.82E-01
Concentration, ng/DSCM at 12% CO2	8.26E-01	8.34E-01	3.84E-01
Emission Rate, Pounds/Hour	2.37E-07	2.43E-07	1.07E-07
Emission Rate, Grams/Second	2.98E-08	3.06E-08	1.34E-08
1234789-HpCDF			
Formula Weight, Lb/Lb-Mole	409.32	409.32	409.32
Catch Weight, Nanograms	ND [1.490]	ND [0.821]	0.433
Concentration, ng/DSCM *	ND[2.72E-01]	ND[1.88E-01]	1.04E-01
Concentration, ng/DSCM at 12% CO2	ND[3.71E-01]	ND[2.53E-01]	1.41E-01
Emission Rate, Pounds/Hour	ND[1.07E-07]	ND[7.37E-08]	3.93E-08
Emission Rate, Grams/Second	ND[1.34E-08]	ND[9.29E-09]	4.95E-09

ND - not detected. Detection limits are shown in parentheses ( ); estimated maximum possible concentrations for analytes found above the detection limit, but not meeting all the qualitative identification criteria, are shown in brackets [ ].

* 68 Deg. F -- 29.92 inches Hg

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Continued

PCDF	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
Other HpCDF			
Formula Weight, Lb/Lb-Mole	409.32	409.32	409.32
Catch Weight, Nanograms	4.085	2.272	0.703
Concentration, ng/DSCM *	7.46E-01	5.20E-01	1.68E-01
Concentration, ng/DSCM at 12% CO2	1.02E+00	7.01E-01	2.30E-01
Emission Rate, Pounds/Hour	2.92E-07	2.04E-07	6.38E-08
Emission Rate, Grams/Second	3.68E-08	2.57E-08	8.04E-09
OCDF			
Formula Weight, Lb/Lb-Mole	443.76	443.76	443.76
Catch Weight, Nanograms	2.940	2.196	0.974
Concentration, ng/DSCM *	5.37E-01	5.03E-01	2.33E-01
Concentration, ng/DSCM at 12% CO2	7.33E-01	6.78E-01	3.18E-01
Emission Rate, Pounds/Hour	2.10E-07	1.97E-07	8.84E-08
Emission Rate, Grams/Second	2.65E-08	2.48E-08	1.11E-08

ND - not detected. Detection limits are shown in parentheses ( ); estimated maximum possible concentrations for analytes found above the detection limit, but not meeting all the qualitative identification criteria, are shown in brackets [ ].

* 68 Deg. F -- 29.92 inches Hg

PCDD/PCDF Detection Limits, Unit No. 2 Baghouse Outlet

	Nanograms		
	2-S-MM5-1	2-S-MM5-2	2-S-MM5-3
PCDD			
2378-TCDD	Detected	ND(0.008)	ND[0.03]
Total TCDD	Detected	Detected	Detected
12378-PeCDD	ND[0.137]	ND[0.132]	Detected
Total PeCDD	Detected	Detected	Detected
123478-HxCDD	Detected	Detected	Detected
123678-HxCDD	Detected	Detected	Detected
123789-HxCDD	Detected	Detected	Detected
Total HxCDD	Detected	Detected	Detected
1234678-HpCDD	Detected	Detected	Detected
Total HpCDD	Detected	Detected	Detected
OCDD	Detected	Detected	Detected
PCDF			
2378-TCDF	Detected	Detected	Detected
Total TCDF	Detected	Detected	Detected
12378-PeCDF	Detected	Detected	Detected
23478-PeCDF	Detected	Detected	Detected
Total PeCDF	Detected	Detected	Detected
123478-HxCDF	Detected	Detected	Detected
123678-HxCDF	Detected	Detected	Detected
234678-HxCDF	Detected	Detected	Detected
123789-HxCDF	Detected	Detected	ND[0.046]
Total HxCDF	Detected	Detected	Detected
1234678-HpCDF	Detected	Detected	Detected
1234789-HpCDF	ND[1.49]	ND[0.821]	Detected
Total HpCDF	Detected	Detected	Detected
OCDF	Detected	Detected	Detected

( ) = Detectable limits are presented in parentheses.
[ ] = Estimated maximum possible concentrations are presented in brackets.

EXAMPLE TEST CALCULATIONS

UNIT NO. 2 STACK

Run Number: 2-S-MM5-1

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$Vmstd = 17.64 * Y * Vm * \frac{Pbar + (Delta\ H/13.6)}{460 + tm}$$

$$Vmstd = 17.64 * 0.9858 * 213.711 * \frac{29.3 + (4.59/13.6)}{460 + 110} = 193.233\ DSCF$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

Vwstd = 0.04707 * Vlc

Vwstd = 0.04707 * 991.3 = 46.660 SCF

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN FLUE GAS

%H2O = 100 * Vwstd / (Vwstd + Vmstd)

%H2O = 100 * 46.660 / (46.660 + 193.233) = 19.5 %

DRY MOLE FRACTION OF FLUE GAS

Mfd = 1 - (%H2O / 100)

Mfd = 1 - (19.5 / 100) = 0.805

DRY MOLECULAR WEIGHT OF FLUE GAS

Md = (%CO2 * 0.44) + (%O2 * 0.32) + (%CO + %N2 * 0.28)

Md = (8.8 * 0.44) + (10.7 * 0.32) + (80.5 * 0.28) = 29.84 lb/lb-mole

WET MOLECULAR WEIGHT OF FLUE GAS

Ms = (Md * Mfd) + (0.18 * %H2O)

Ms = (29.84 * 0.805) + (0.18 * 19.5) = 27.53 lb/lb-mole

ABSOLUTE FLUE GAS PRESSURE

$$Ps = Pbar + (Pg / 13.6)$$

$$Ps = 29.3 + (-1.00 / 13.6) = 29.23 \text{ inches Hg.}$$

AVERAGE FLUE GAS VELOCITY - Note: (Delta p) avg. is square of avg. sq root

$$vs = 85.49 * Cp * SQRT \left[\frac{\text{Delta p avg.} * (460 + ts)}{Ps * Ms}\right]$$

$$vs = 85.49 * 0.84 * SQRT \left[\frac{0.8195 * (460 + 295)}{29.23 * 27.53}\right] = 62.97 \text{ ft/sec}$$

DRY VOLUMETRIC FLUE GAS FLOW RATE AT STANDARD CONDITIONS

$$Qsd = \frac{60}{144} * Mfd * vs * A * \frac{Tstd}{ts + 460} * \frac{Ps}{Pstd}$$

$$Qsd = \frac{60}{144} * 0.805 * 62.97 * 7{,}238 * \frac{528}{295 + 460} * \frac{29.23}{29.92} = 104{,}446 \text{ SCFM}$$

WET VOLUMETRIC FLUE GAS FLOW RATE AT STACK CONDITIONS

$$Qaw = 60 / 144 * vs * A$$

$$Qaw = 60 / 144 * 62.97 * 7{,}238 = 189{,}907 \text{ ACFM}$$

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{Pstd}{Tstd} * \frac{100}{60} * \frac{(ts + 460) * Vmstd}{Ps * vs * Mfd * Theta * \text{Area-nozzle, sq.ft.}}$$

$$\%I = \frac{29.92}{528} * \frac{100}{60} * \frac{(295 + 460) * 193.233}{29.23 * 62.97 * 0.805 * 180 * 0.0005140} = 100.5 \%$$

PERCENT EXCESS AIR

$$\%EA = \frac{\%O2 - (0.5 * \%CO)}{(0.264 * \%N2) - (\%O2 - (0.5 * \%CO))} * 100$$

$$\%EA = \frac{10.7 - (0.5 * 0.0)}{(0.264 * 80.5) - (10.7 - (0.5 * 0.0))} * 100 = 101\ \%$$

NANOGRAMS PER DRY STANDARD CUBIC METER, 123478-HXCDD

$$ng/DSCM = ng / (Vmstd * 0.02832)$$

$$ng/DSCM = 0.203 / (193.233 * 0.02832) = 3.71E\text{-}02\ ng/DSCM$$

NANOGRAMS PER DRY STANDARD CUBIC METER CORRECTED TO 12% CO2, 123478-HXCDD

$$ng/DSCM@12\%CO2 = (12 / \%CO2) * ng/DSCM$$

$$ng/DSCM@12\%CO2 = (12 / 8.8) * 3.71E\text{-}02 = 5.06E\text{-}02\ ng/DSCM\ @\ 12\%\ CO2$$

POUNDS PER HOUR, 123478-HXCDD

$$Lb/Hr = \frac{60 * ng * Qsd}{453{,}592 * Vmstd * 10^6}$$

$$Lb/Hr = \frac{60 * 0.203 * 104{,}446}{453{,}592 * 193.233 * 10^6} = 1.45E\text{-}08\ lb/hr$$

GRAMS PER SECOND, 123478-HXCDD

$$g/sec = \frac{(ng / 10^9) * Qsd}{60 * Vmstd}$$

$$g/sec = \frac{(0.203 / 10^9) * 104{,}446}{60 * 193.233} = 1.83E\text{-}09\ g/sec$$

APPENDIX B

FIELD DATA

Preliminary Field Data

PLANT NAME Indianapolis Resource Recovery

LOCATION Indianapolis, IN

SAMPLING LOCATION Units # 2 & 3 Stacks

NO. OF PORTS 2

PORT INSIDE DIAMETER 6 "

DUCT DEPTH
FROM INSIDE FAR WALL TO OUTSIDE OF PORT 102 "

NIPPLE LENGTH 6 "

DEPTH OF DUCT 96

WIDTH (RECTANGULAR DUCT) —

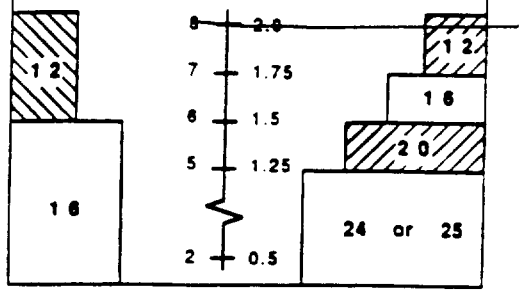
EQUIVALENT DIAMETER:
$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} = —$

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE	UPSTREAM	DOWNSTREAM
	~105'	~130'
DIAMETERS	13.125	16.25

STACK AREA = $\pi(48")^2$ = 7238.2 IN²

DRAW HORIZONTAL LINE THROUGH DIAMETERS

If more than 8 and 2 diameters and if duct dia. is less than 24", use 8 or 9 points.



LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	4.4	4 1/4 "	10 1/4 "
2	14.6	14	20
3	29.6	28 3/8	34 3/8
4	70.4	67 5/8	73 5/8
5	85.4	82	88
6	95.6	91 3/4	97 3/4
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

ORSAT FIELD DATA

Plant Name Indianapolis Resource Recovery Facility

Sampling Location Unit #2 Stack Fuel Type MSW

Run and/or Sample No. 2-5-MWS-M3-1 Leak Test? ✓ Date 6/27 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	$\%O_2$ B-A	%CO C-B	$\%N_2$ 100-C
1100	1745	8.7	19.5	~~10.8~~	10.8		
1524	1755	8.9	19.5	~~10~~	10.6		
	1800	8.9	19.5		10.6		
	Avg.	8.8		Avg.	10.7	—	80.5

Run and/or Sample No. 2-5-MWS-M3-2 Leak Test? ✓ Date 6/28 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	$\%O_2$ B-A	%CO C-B	$\%N_2$ 100-C
0920	1305	8.9	19.5	—	10.6		
1255	1314	9.0	19.5		10.5		
	1322	8.9	19.5		10.6		
	Avg.	8.9		Avg.	10.6	—	80.5

Run and/or Sample No. 2-5-MWS-M3-3 Leak Test? ✓ Date 6/29 Operator JJM

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	$\%O_2$ B-A	%CO C-B	$\%N_2$ 100-C
1430	18:30	8.8	19.4	—	10.6		
〃	〃	8.9	19.5		10.6		
18:10	〃	8.8	19.5		10.7		
	Avg.	8.8		Avg.	10.6	—	80.6

PARTICULATE AND MM5 FIELD DATA

COMPANY NAME Ogden Products
ADDRESS Indianapolis, IN
SAMPLING LOCATION Unit #2 Stack
DATE 6-27-89
TEAM LEADER AFL
BAROMETRIC PRESSURE, IN. HG 29.3
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG .005 .003 .008 .006
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 15 12 12 15

RUN NUMBER 2-S-MM5-1
TIME START 1100
TIME FINISH 1524
TECHNICIANS BFR
STATIC PRESSURE, IN. H_2O -1.00

LK. TEST READINGS
836.870
838.760
~~876.349~~

EQUIPMENT CHECKS
- ✓ PITOTS, PRE-TEST
- ✓ PITOTS, POST-TEST
- ✓ ORSAT SAMPLING SYSTEM
- ✓ TEDLAR BAG
- ✓ THERMOCOUPLE @ 100 °F

IDENTIFICATION NUMBERS
REAGENT BOX DF176 NOZZLE SGL46 DIAMETER .307
METER BOX N10 T/C READOUT T-1
UMBILICAL U-17 T/C PROBE ~~T-1~~ 8-10
SAMPLE BOX 12 ORSAT PUMP 16
PROBE SGL46 TEDLAR BAG 288

FILTER # DF 0-4 TARE 201.3 intared

NOMOGRAPH SET-UP
ΔH@ 1.846
METER TEMP 110
% MOISTURE 16%
K = 5.5478
C FACTOR
STACK TEMP 300
REF. ΔP

NOMOGRAPH # AFL

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	GAS TEMP °F FILTER BOX	GAS TEMP °F CONDEN. EXIT	GAS TEMP °F IMPIN. EXIT	STACK TEMP.	*
A						~~108~~						
1	0	733.293	.47	2.60	2.61	106	8	255	42	40	280	
	5	737.71	.47	2.61	2.61	106	8	240	52	49	278	
	10	742.41	.49	2.72	2.72	107	9	240	50	48	284	
2	15	747.10	.95	5.27	5.27	108	10	245	45	43	296	
	20	752.90	.90	4.99	4.99	108	10	245	46	43	296	
	25	758.88	.90	4.99	4.99	110	10	245	50	45	298	
3	30	764.90	.85	4.71	4.71	110	10	242	52	50	297	
	35	771.7	.90	4.99	4.99	111	10	241	49	47	297	
	40	777.84	.86	4.77	4.77	110	10	243	47	46	296	
4	45	783.31	.82	4.55	4.55	110	10	243	45	43	297	
	50	789.27	.70	3.88	3.88	110	9	241	43	41	296	
	55	793.95	.80	4.44	4.44	110	10	243	46	44	296	
5	60	801.13	.85	4.71	4.71	110	10	243	45	44	297	
	65	806.68	.80	4.44	4.44	110	10	245	49	47	297	
	70	812.62	.85	4.71	4.71	110	10	245	54	48	296	
6	75	818.48	.85	4.71	4.71	110	10	246	51	48	295	
	80	824.55	.76	4.22	4.22	112	10	249	52	50	296	
	85	830.05	.87	4.83	4.83	112	10	255	55	52	297	
B	90	836.870	.65	3.61	3.61	112	8	250	43	40	294	
	5	842.92	.65	3.61	3.61	104	8	248	46	40	291	
	10	849.13	.65	3.61	3.61	106	8	248	50	46	293	
2	15	854.52	.85	4.71	4.71	107	9	250	56	50	296	
	20	860.34	.75	4.16	4.16	108	9	245	61	63	297	
	25	866.12	.80	4.44	4.44	109	9	245	57	54	297	
3	30	872.48	.80	4.44	4.44	109	9	247	57	55	297	

V_M $(\sqrt{\Delta P})^2$ ΔH T_M T_S

ENTROPY

PARTICULATE FIELD DATA

Page 2 Run Number 2-S-MM5

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. ^oF	PUMP VACUUM IN. HG GAUGE	GAS TEMP ^oF FILTER BOX	GAS TEMP ^oF CONDEN. EXIT	GAS TEMP ^oF IMPIN. EXIT	STACK TEMP.	*
3	35	877.48	.85	4.72	4.72	110	10	260	63	60	296	
	40	883.99	.85	4.72	4.72	110	10	255	68	64	297	
4	45	889.99	1.0	5.55	5.55	110	10/12	230	64 60	64	297	
	50	896.51	.97	5.38	5.38	111	11	233	54	60	297	
	55	902.97	1.03	5.71	5.71	111	12	240	68	63	297	
5	60	909.71	1.03	5.71	5.71	112	12	245	62	61	296	
	65	915.88	1.00	5.55	5.55	112	12	245	59	59	296	
	70	922.97	1.00	5.55	5.55	112	12	247	56	54	296	
6	75	929.45	.95	5.27	5.27	113	12	250	53	53	297	
	80	936.07	.95	5.27	5.27	113	12	250	54	53	296	
	85	942.85	.89	4.94	4.94	114	12	254	53	51	296	
3 2 OFF	90	946.894										

~~315.60~~ 0.735 / 2.3.711 V_M / $(\sqrt{\Delta P})^2$ 4.59 / ΔH 110 / T_M 295 / T_S

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ENTROPY

PARTICULATE AND MM5 FIELD DATA

COMPANY NAME Ogden Products Inc.
ADDRESS Indianapolis, In
SAMPLING LOCATION Unit #2 Stack
DATE 6-28-99
TEAM LEADER AFL
TECHNICIANS BFR
BAROMETRIC PRESSURE, IN. HG 29.5
STATIC PRESSURE, IN. H_2O -.85
RUN NUMBER 2-MM5-2
TIME START 920
TIME FINISH 1255
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 10 10 10
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.002 0.004 0.002 0.002
LK. TEST READINGS 1032.571 1032.750

EQUIPMENT CHECKS
- PITOTS, PRE-TEST
- PITOTS, POST-TEST
- ORSAT SAMPLING SYSTEM
- TEDLAR BAG
- THERMOCOUPLE @ 100 °F

IDENTIFICATION NUMBERS
REAGENT BOX DFB 176 NOZZLE G-488 DIAMETER .273
METER BOX N-20 T/C READOUT T-1
UMBILICAL U17 T/C PROBE K-12
SAMPLE BOX 8 ORSAT PUMP 16
PROBE G488 TEDLAR BAG 16

FILTER # / TARE
Filter 0-8 — Non, 176.2

NOMOGRAPH SET-UP
NOMOGRAPH # AFL
ΔH@ 1.846 C FACTOR —
METER TEMP 110 STACK TEMP 300
% MOISTURE 16% REF. ΔP —
K = 3.4491

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	GAS TEMP °F FILTER BOX	GAS TEMP °F CONDEN. EXIT	GAS TEMP °F IMPIN. EXIT	STACK TEMP.	*
A												
1	0	949.557	.60	2.07	2.07	98	4	235	66	60	296	
	5	953.32	.62	2.14	2.14	100	4	235	57	54	296	
	10	956.89	.65	2.24	2.24	100	5	250	55	51	298	
2	15	961.60	.75	2.59	2.59	101	5	250	55	52	298	
	20	966.24	.77	2.66	2.66	102	6	250	57	52	297	
	25	971.81	.85	2.93	2.93	104	7	250	57	53	297	
3	30	975.42	.85	2.93	2.93	105	7	245	52	51	297	
	35	980.38	.80	2.75	2.75	105	7	240	52	50	297	
	40	984.88	.82	2.83	2.83	106	7	245	53	50	297	
4	45	989.61	.82	2.83	2.83	106	7	245	54	52	298	
	50	994.69	.80	2.75	2.75	107	7	250	54	52	297	
	55	999.13	.87	3.00	3.00	107	7	250	54	52	297	
5	60	1003.99	.90	3.10	3.10	108	8	250	52	52	295	
	65	1008.96	.75	2.59	2.59	108	8	250	53	52	296	
	70	1013.58	.85	2.93	2.93	108	8	250	53	52	296	
6	75	1018.31	.85	2.93	2.93	108	8	255	54	52	296	
	80	1023.66	.80	2.75	2.75	109	8	250	54	52	296	
	85	1027.78	.75	2.59	2.59	109	8	250	56	53	299	
6	90	1032.571	.85	2.93	2.93	100	7	245	51	50	297	
	5	1037.14	.85	2.93	2.93	102	7	245	53	51	296	
	10	1041.65	.82	2.83	2.83	102	7	240	55	52	296	
5	15	1046.28	.80	2.76	2.76	104	7	250	53	51	296	
	20	1051.04	.85	2.93	2.93	104	8	250	47	45	295	
	25	1055.69	.80	2.76	2.76	104	8	235	56	53	299	
4	30	1060.42	.95	3.28	3.28	104	8	240	57	56	297	

B 4/26

V_M $\overline{(\sqrt{\Delta P})^2}$ $\overline{\Delta H}$ $\overline{T_M}$ $\overline{T_S}$

PARTICULATE FIELD DATA

Page 3 Run Number 2-5-MM5-

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	GAS TEMP °F FILTER BOX	GAS TEMP °F CONDEN. EXIT	GAS TEMP °F IMPIN. EXIT	STACK TEMP.	*
4	35	1065.41	.90	3.10	3.10	105	8	250	60	60	296	
	40	1070.05	1.00	3.45	3.45	105	9	250	58	62	297	
3	45	1075.53	.95	3.28	3.28	106	8	247	56	60	298	
	50	1080.47	.95	3.28	3.28	106	9	245	54	60	298	
	55	1085.92	.92	3.17	3.17	106	9	245	62	61	298	
2	60	1090.98	.75	2.59	2.59	107	8	248	58	61	297	
	65	1095.52	.75	2.88	2.59	108	8	248	56	60	297	
	70	1100.21	.65	2.24	2.24	108	6	245	51	60	297	
1	75	1104.78	.60	2.07	2.07	108	6	240	55	60	286	
	80	1108.84	.55	1.90	1.90	110	6	245	51	62	287	
	85	1112.75	.57	1.96	1.96	110	6	245	52	60	288	
~~5~~	90	1116.646										

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
36.710	0.7926	2.74	105	296

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ENTROPY

PARTICULATE AND MM5 FIELD DATA

COMPANY NAME Ogden Products Inc. — RUN NUMBER 2-S-mm5-3
ADDRESS Indianapolis, IN — TIME START 1420
SAMPLING LOCATION Unit #2 Stack — TIME FINISH 1810
DATE 6-28-99 — TEAM LEADER AFL — TECHNICIANS BFR
BAROMETRIC PRESSURE, IN. HG 29.5 — STATIC PRESSURE, IN. H_2O -.8

SAMPLING TRAIN LEAK TEST VACUUM, IN. HG	.003	.004 .007	
SAMPLING TRAIN LEAK RATE, CU. FT./MIN.	15	10 13	

LK. TEST READINGS: 198,241 / 202,226

EQUIPMENT CHECKS
- PITOTS, PRE-TEST
- PITOTS, POST-TEST
- ORSAT SAMPLING SYSTEM
- TEDLAR BAG
- THERMOCOUPLE @ ____ °F

IDENTIFICATION NUMBERS
DF
REAGENT BOX 105 — NOZZLE G482 — DIAMETER .273
METER BOX N120 — T/C READOUT T-1
UMBILICAL U17 — T/C PROBE S-12
SAMPLE BOX 18 — ORSAT PUMP 16
PROBE 9-2 — TEDLAR BAG 21

FILTER # — TARE
0-2 — 1914
Filter — Voided

NOMOGRAPH SET-UP — NOMOGRAPH # AFL
ΔH@ 1.846 — C FACTOR —
METER TEMP 110 — STACK TEMP 300
% MOISTURE 16% — REF. ΔP —
K = 3.4491

	SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	GAS TEMP °F FILTER BOX	GAS TEMP °F CONDEN. EXIT	GAS TEMP °F IMPIN. EXIT	STACK TEMP.	*
A	1	0	117.047	.65	2.24	2.24	104	6	250	42	58	300	
		5	121.46	.65	2.24	2.24	106	6	250	42	56	298	
		10	126.78	.55	1.90	1.90	106	6	245	43	57	296	
	2	15	129.91	.70	2.41	2.41	107	7	240	39	56	298	
		20	133.74	.70	2.41	2.41	108	7	245	49	55	298	
		25	137.57	.75	2.59	2.59	110	7	250	55	55	298	
	3	30	141.96	.80	2.76	2.76	110	7	260	59	56	300	
		35	146.39	.81	2.79	2.79	112	7	260	54	57	297	
		40	150.15	.75	2.59	2.59	110	7	255	45.2	55	298	
	4	45	155.72	.80	2.76	2.76	112	8	260	43	50	294	
		50	160.52	.85	2.93	2.93	112	8	255	48	54	299	
		55	164.97	.77	2.66	2.66	112	8	255	49	58	298	
	5	60	169.88	.75	2.59	2.59	112	8	250	48	58	298	
		65	174.31	.75	2.59	2.59	112	8	250	48	59	300	
		70	178.84	.80	2.76	2.76	112	8	245	50	58	298	
	6	75	183.32	.70	2.41	2.41	113	7	245	50	58	297	
1640		80	188.24	.80	2.76	2.76	113	8	245	56	57	298	
		85	192.98	.75	2.59	2.59	113	7	245	57	57	290	
B	1	90	198.24	.55	1.90	1.90	106	7	260	37	52	299	
		95	206.12	.70	2.41	2.41	106	7	260	55	53	298	
		10	210.53	.70	2.41	2.41	108	7	250	56	56	298	
	2	15	214.99	.75	2.59	2.59	109	8	250	61	60	298	
		20	219.24	.75	2.59	2.59	109	7	245	58	54	299	
		25	223.94	.75	2.59	2.59	110	8	245	64	60	299	
	3	30	228.51	.70	2.41	2.41	110	8	250	61	60	297	

V_M — $(\sqrt{\Delta P})^2$ — ΔH — T_M — T_S

PARTICULATE FIELD DATA

Page 2 Run Number 2-5-mm5-3

SAMPLE POINT	CLOCK TIME. MIN.	DRY GAS METER READING. CU. FT.	PITOT READING (ΔP). IN. H_2O	ORIFICE SETTING (ΔH). IN. H_2O IDEAL	ORIFICE SETTING (ΔH). IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	GAS TEMP. °F FILTER BOX	GAS TEMP. °F CONDEN. EXIT	GAS TEMP. °F IMPIN. EXIT	STACK TEMP.	*
3	35	232.59	.75	2.59	2.59	113	8	255	62	60	299	
	40	237.43	.75	2.59	2.59	112	8	255	62	61	302	
4	45	241.96	.75	2.59	2.59	113	8	250	67	68	300	
	50	247.01	.75	2.59	2.59	113	8	250	62	66	296	
	55	251.32	.77	2.66	2.66	115	8	245	48	65	297	
5	60	256.12	.72	2.48	2.48	115	8	240	50	60	297	
	65	260.60	.70	2.41	2.41	115	8	245	54	60	296	
	70	265.06	.70	2.41	2.41	115	8	245	53	61	297	
6	75	270.14	.65	2.24	2.24	115	8	250	48	62	297	
	80	273.78	.60	2.07	2.07	113	8	250	50	60	297	
	85	277.86	.70	2.41	2.41	110	9	250	45	58	297	
OFF	90	282.320										

$\frac{161.288}{V_M}$ $\frac{2.7218}{(\sqrt{\Delta P})^2}$ $\frac{2.50}{\Delta H}$ $\frac{111}{T_M}$ $\frac{297}{T_S}$

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ENTROPY

APPENDIX C

ANALYTICAL DATA

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name: INDIANAPOLIS RESOURCE RECOVERY FACILITY EEI Ref# 6323

Sampling Location: Unit No. 2 Stack

Date Received: 7/5 Date Analyzed: 7/5 Reagent Box(es): DF105,DF180

Run Number Run Date	2-S-MM5-1 6/27	2-S-MM5-2 6/28	2-S-MM5-3 6/28
ANALYSIS OF MOISTURE CATCH			
Reagent 1 (H2O)			
Final Weight, g.	1413.5	1254.0	1149.1
Tared Weight, g.	598.5	591.5	586.0
Water Catch,g.	815.0	662.5	563.1
Reagent 2 (XAD)			
Final Weight, g.	203.5	177.4	194.5
Tared Weight, g.	201.3	176.2	191.4
Water Catch,g.	2.2	1.2	3.1
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
CONDENSED WATER, g.	817.2	663.7	566.2
Silica Gel:			
Final Weight, g.	774.1	447.1	456.0
Tared Weight, g.	600.0	400.0	400.0
ADSORBED WATER, g.	174.1	47.1	56.0
TOTAL WATER COLLECTED, g.	991.3	710.8	622.2

TRIANGLE LABORATORIES, INC.
801-10 CAPITOLA DRIVE
RESEARCH TRIANGLE PARK, NC 27713

Phone: (919) 544-5729
Fax: (919) 544-5491

DATE :	* 08 AUGUST 1989
CLIENT ID :	* ENTROPY
P.O. NUMBER :	* 6323 A-2,6349 A-1
TLI PROJECT No. :	* 14097,14098

CASE NARRATIVE
MODEL 8290X

ANALYSIS OF SAMPLES FOR THE PRESENCE OF

POLYCHLORINATED DIBENZO-p-DIOXINS

AND

DIBENZOFURANS

BY

HIGH-RESOLUTION GAS CHROMATOGRAPHY / HIGH-RESOLUTION MASS SPECTROMETRY

Six MM5 samples were received from ENTROPY in good condition July 5, 1989 and stored in a refrigerator at 4°C. The samples were extracted and analyzed according to procedures described in the Triangle Labs User Manual provided with this data package. Any particular difficulties encountered during the sample handling by Triangle Labs will be discussed in the QA/QC remark section below.

Quality Assurance/Quality Control Samples

A laboratory method blank -- identified as the TLI Blank -- is prepared along with the batch of samples.

QA/QC Remarks

The release of this particular set of ENTROPY analytical data by Triangle Labs was authorized by the Quality Assurance Officer who has reviewed each sample data package individually following a series of inspections/reviews conducted at two other levels of the data production line. When applicable, general deviations from acceptable QA/QC requirements are identified below. Comments on the effect of these deviations upon the validity and reliability of the results can be obtained from the User Manual (Data Quality Objectives; Section 5). Specific QA/QC Problems Associated with this Particular Project are:

Sample Preparation Laboratory: None

Mass Spectrometry: None

Data Review: None

Should ENTROPY have any questions or comments to formulate regarding this data package please feel free to contact us.

For Triangle Laboratories,

Analyst	QA Project Officer	Program Manager
Michael D. Chu	Hani S. Karam, Ph.D.	Yves Tondeur, Ph.D.

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X)

08/03/89

FILE NAME....: M892452
CONCAL.....: M892448
ANALYST.....: DM
SAMPLE SIZE..: 1.00
ICAL DATE....: 12/07/88
SPIKE FILE...: SPE82910

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-1
ANALYSIS DATE: 07/17/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-98-1A
PROJECT NUMBER: 14098
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: n/a

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.03				0.87	29:45	
12378-PeCDD	ND			0.14			
123478-HxCDD	0.20				1.40	39:47	
123678-HxCDD	0.63				1.15	39:55	
123789-HxCDD	0.76				1.16	40:22	
1234678-HpCDD	6.7				1.09	44:45	
OCDD	8.1				0.81	50:06	B
2378-TCDF	0.78				0.80	28:59	
12378-PeCDF	0.32				1.52	33:38	
23478-PeCDF	0.58				1.77	34:34	
123478-HxCDF	1.1				1.09	38:38	
123678-HxCDF	0.67				1.22	38:48	
234678-HxCDF	1.3				1.17	39:35	
123789-HxCDF	0.12				1.18	40:45	
1234678-HpCDF	3.3				0.96	43:13	
1234789-HpCDF	ND			1.5			
OCDF	2.9				0.84	50:21	
TOTAL TCDD	0.43	5		0.77	0.75		
TOTAL PeCDD	2.1	4		3.0	1.58		
TOTAL HxCDD	8.1	6		9.0	1.30		
TOTAL HpCDD	12.8	2			1.06		
TOTAL TCDF	3.8	11		4.1	0.75		
TOTAL PeCDF	3.8	9		5.1	1.55		
TOTAL HxCDF	6.0	10		6.4	1.18		
TOTAL HpCDF	7.4	3		8.4	0.92		

TRIANGLE LABORATORIES, INC. Page 2 of 2
PCDD/PCDF ANALYSIS (8290X) QA/QC SUMMARY 08/03/89

FILE NAME....:	M892452	CLIENT ID....:	ENTROPY	TLI NUMBER....:	19-98-1A
CONCAL.....:	M892448	SAMPLE ID....:	2-5-MM5-1		
ANALYST.....:	DM	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14098
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

SURROGATE RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	10.3	103		29:44	___
13C12-PeCDF 234	9.9	98.7	1.58	34:33	___
13C12-HxCDF 478	7.7	76.6	0.53	38:38	___
13C12-HxCDD 478	7.8	77.7	1.23	39:46	___
13C12-HpCDF 789	12.8	128	0.43	45:25	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	9.1	91.0	0.49	40:44	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	6.9	69.2	0.79	28:56	___
13C12-2378-TCDD	8.2	82.4	0.81	29:42	___
13C12-PeCDF 123	11.1	111	1.57	33:37	___
13C12-PeCDD 123	12.0	120	1.57	35:02	___
13C12-HxCDF 678	8.4	83.8	0.48	38:47	___
13C12-HxCDD 678	9.8	98.3	1.22	39:53	___
13C12-HpCDF 678	9.0	90.0	0.42	43:12	___
13C12-HpCDD 678	9.8	98.4	1.01	44:44	___
13C12-OCDD	22.8	114	0.95	50:05	___

TRIANGLE LABORATORIES, INC.
CONFIRMATION ANALYSIS (DB-225)

08/08/89

FILE NAME....: T322702
CONCAL.....: T893226
ANALYST.....: JA
SAMPLE SIZE..: 1.00
ICAL DATE....: 05/03/89
SPIKE FILE...: SPCONF10

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-1
ANALYSIS DATE: 08/01/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-98-1A-G
PROJECT NUMBER: 14097/98
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: OGDEN

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.06				0.80	14:53	PR
2378-TCDF	0.17				0.68	16:14	—
TOTAL TCDD	1.0	9		1.2	0.79		—
TOTAL TCDF	3.3	18		3.7	0.72		—

SURROGATE STD. RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.7	97.1		14:52	—

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	7.1	70.5	0.73	16:14	—
13C12-2378-TCDD	7.8	77.8	0.80	14:51	—

CONF_RPT rev:3.01

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X)

08/03/89

FILE NAME....: M892453
CONCAL.....: M892448
ANALYST.....: PMC
SAMPLE SIZE..: 1.00
ICAL DATE....: 12/07/88
SPIKE FILE...: SPE82910

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-2
ANALYSIS DATE: 07/17/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-98-2A
PROJECT NUMBER: 14098
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: n/a

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.008				
12378-PeCDD	ND			0.13			
123478-HxCDD	0.20				1.39	39:36	
123678-HxCDD	0.64				1.41	39:45	
123789-HxCDD	0.75				1.30	40:12	
1234678-HpCDD	6.0				1.04	44:35	
OCDD	11.8				0.84	49:54	B
2378-TCDF	0.86				0.75	28:52	
12378-PeCDF	0.35				1.33	33:30	
23478-PeCDF	0.55				1.45	34:26	
123478-HxCDF	1.0				1.14	38:28	
123678-HxCDF	0.65				1.19	38:39	
234678-HxCDF	0.96				1.11	25:.7	
123789-HxCDF	0.15				1.19	40:35	
1234678-HpCDF	2.7				0.92	43:02	
1234789-HpCDF	ND			0.82			
OCDF	2.2				0.93	50:10	
TOTAL TCDD	0.73	5		0.86	0.78		
TOTAL PeCDD	1.2	4		2.6	1.62		
TOTAL HxCDD	7.6	6		8.1	1.35		
TOTAL HpCDD	10.8	2			1.04		
TOTAL TCDF	3.4	9		4.2	0.79		
TOTAL PeCDF	3.8	10		4.9	1.54		
TOTAL HxCDF	5.0	8		5.7	1.17		
TOTAL HpCDF	5.0	3		5.5	0.90		

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X) QA/QC SUMMARY

08/03/89

FILE NAME....:	M892453	CLIENT ID....:	ENTROPY	TLI NUMBER....:	19-98-2A
CONCAL.....:	M892448	SAMPLE ID....:	2-5-MM5-2		
ANALYST.....:	PMC	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14098
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

SURROGATE RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	10.4	104		29:36	
13C12-PeCDF 234	8.7	87.1	1.59	34:24	
13C12-HxCDF 478	8.8	87.6	0.50	38:29	
13C12-HxCDD 478	9.8	98.0	1.18	39:36	
13C12-HpCDF 789	12.2	122	0.42	45:15	

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	8.9	88.8	0.48	40:35	

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	6.9	69.0	0.76	28:49	
13C12-2378-TCDD	7.3	73.2	0.76	29:35	
13C12-PeCDF 123	8.3	83.2	1.54	33:30	
13C12-PeCDD 123	8.1	81.0	1.62	34:53	
13C12-HxCDF 678	7.8	77.8	0.50	38:38	
13C12-HxCDD 678	7.8	77.9	1.33	39:43	
13C12-HpCDF 678	7.9	79.3	0.44	43:02	
13C12-HpCDD 678	8.7	87.2	1.03	44:34	
13C12-OCDD	15.1	75.6	0.89	49:53	

TRIANGLE LABORATORIES, INC.
CONFIRMATION ANALYSIS (DB-225)

08/08/89

FILE NAME....: T322703
CONCAL.....: T893226
ANALYST.....: JA
SAMPLE SIZE..: 1.00
ICAL DATE....: 05/03/89
SPIKE FILE...: SPCONF10

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-2
ANALYSIS DATE: 08/01/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-98-2A-F
PROJECT NUMBER: 14097/98
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: OGDEN

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	0.07				0.75	14:53	PR
2378-TCDF	0.16				0.67	16:15	
TOTAL TCDD	0.98	10		1.1	0.75		
TOTAL TCDF	3.8	20		3.8	0.71		

SURROGATE STD. RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.2	92.4		14:53	

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	5.9	59.2	0.73	16:14	
13C12-2378-TCDD	7.0	70.0	0.81	14:52	

CONF_RPT rev:3.01

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X)

08/03/89

FILE NAME....:	M892454	CLIENT ID....:	ENTROPY	TLI NUMBER....:	19-98-3A
CONCAL.....:	M892448	SAMPLE ID....:	2-5-MM5-3		
ANALYST.....:	PMC	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14098
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND			0.03			___
12378-PeCDD	0.05				1.63	34:55	___
123478-HxCDD	0.10				1.30	39:38	___
123678-HxCDD	0.28				1.29	39:45	___
123789-HxCDD	0.34				1.19	40:12	___
1234678-HpCDD	2.5				1.08	44:34	___
OCDD	3.5				0.89	49:52	B
2378-TCDF	0.35				0.65	28:52	___
12378-PeCDF	0.10				1.46	33:30	___
23478-PeCDF	0.25				1.32	34:26	___
123478-HxCDF	0.47				1.07	38:29	___
123678-HxCDF	0.23				1.06	38:40	___
234678-HxCDF	0.39				1.27	39:26	___
123789-HxCDF	ND			0.05			___
1234678-HpCDF	1.2				0.98	43:02	___
1234789-HpCDF	0.43				0.94	45:15	___
OCDF	0.97				0.78	50:06	___
TOTAL TCDD	0.18	3		0.40	0.80		___
TOTAL PeCDD	0.50	4		1.2	1.55		___
TOTAL HxCDD	4.1	6		4.3	1.24		___
TOTAL HpCDD	4.8	2			1.07		___
TOTAL TCDF	1.7	10		1.9	0.74		___
TOTAL PeCDF	0.67	5		2.0	1.45		___
TOTAL HxCDF	2.0	6		2.4	1.15		___
TOTAL HpCDF	2.3	3		2.7	0.96		___

TRIANGLE LABORATORIES, INC. Page 2 of 2
PCDD/PCDF ANALYSIS (8290X) QA/QC SUMMARY 08/03/89

FILE NAME....:	M892454	CLIENT ID....:	ENTROPY	TLI NUMBER....:	19-98-3A
CONCAL.....:	M892448	SAMPLE ID....:	2-5-MM5-3		
ANALYST.....:	PMC	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14098
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

SURROGATE RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.6	96.5		29:36	
13C12-PeCDF 234	8.7	86.7	1.54	34:24	
13C12-HxCDF 478	8.4	83.7	0.53	38:29	
13C12-HxCDD 478	9.0	90.0	1.25	39:36	
13C12-HpCDF 789	11.6	116	0.45	45:14	

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	9.4	93.5	0.51	40:35	

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	7.9	78.5	0.80	28:49	
13C12-2378-TCDD	8.7	87.1	0.77	29:35	
13C12-PeCDF 123	10.8	108	1.46	33:29	
13C12-PeCDD 123	10.9	109	1.53	34:53	
13C12-HxCDF 678	8.6	86.3	0.53	38:38	
13C12-HxCDD 678	9.2	91.7	1.29	39:44	
13C12-HpCDF 678	9.3	93.3	0.44	43:02	
13C12-HpCDD 678	10.5	105	1.01	44:33	
13C12-OCDD	17.6	87.8	0.88	49:51	

TRIANGLE LABORATORIES, INC.
CONFIRMATION ANALYSIS (DB-225)

08/08/89

FILE NAME....: T322709
CONCAL.....: T893226
ANALYST.....: JA
SAMPLE SIZE..: 1.00
ICAL DATE....: 05/03/89
SPIKE FILE...: SPCONF10

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-3
ANALYSIS DATE: 08/01/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-98-3A-F
PROJECT NUMBER: 14097/98
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: OGDEN

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.02				
2378-TCDF	0.07				0.74	16:15	
TOTAL TCDD	0.44	5		0.50	0.77		
TOTAL TCDF	1.4	15		1.7	0.72		

SURROGATE STD. RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	8.8	87.9		14:52	

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	6.6	65.6	0.74	16:13	
13C12-2378-TCDD	7.1	71.0	0.84	14:51	

CONF_RPT rev:3.01

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X)

08/03/89

FILE NAME....: M892457
CONCAL.....: M892456
ANALYST.....: PMC
SAMPLE SIZE..: 1.00
ICAL DATE....: 12/07/88
SPIKE FILE...: SPE82910

CLIENT ID....: ENTROPY
SAMPLE ID....: 2-5-MM5-FB
ANALYSIS DATE: 07/17/89
SAMPLE MATRIX: MM5
SAMPLE ORIGIN: n/a

TLI NUMBER....: 19-99-1A
PROJECT NUMBER: 14098
DATE RECEIVED.: 07/05/89
DATE COLLECTED: / /
SHIPMENT NO...: n/a

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.01				
12378-PeCDD	ND		0.01				—
123478-HxCDD	ND		0.01				—
123678-HxCDD	ND		0.01				—
123789-HxCDD	ND		0.02				—
1234678-HpCDD	ND			0.23			—
OCDD	0.72				0.85	50:09	B
2378-TCDF	0.07				0.68	28:59	
12378-PeCDF	ND		0.01				—
23478-PeCDF	ND			0.02			—
123478-HxCDF	ND			0.03			—
123678-HxCDF	ND		0.008				—
234678-HxCDF	ND		0.01				—
123789-HxCDF	ND		0.02				—
1234678-HpCDF	0.06				0.90	24:.1	—
1234789-HpCDF	ND		0.02				—
OCDF	ND		0.05				—
TOTAL TCDD	ND		0.01				
TOTAL PeCDD	ND		0.01				—
TOTAL HxCDD	0.05	1		0.17	1.39		—
TOTAL HpCDD	ND			0.41			—
TOTAL TCDF	0.17	3		0.34	0.74		
TOTAL PeCDF	ND			0.11			—
TOTAL HxCDF	0.05	1		0.08	1.25		—
TOTAL HpCDF	0.08	1			0.90		—

E829_RPT rev:3.01

TRIANGLE LABORATORIES, INC. Page 2 of 2
PCDD/PCDF ANALYSIS (8290X) QA/QC SUMMARY 08/03/89

FILE NAME....:	M892457	CLIENT ID....:	ENTROPY	TLI NUMBER....:	19-99-1A
CONCAL.....:	M892456	SAMPLE ID....:	2-5-MM5-FB		
ANALYST.....:	PMC	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14098
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

SURROGATE RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.5	95.0		29:44	___
13C12-PeCDF 234	8.1	81.0	1.53	34:33	___
13C12-HxCDF 478	7.0	70.4	0.53	38:38	___
13C12-HxCDD 478	7.3	73.1	1.16	39:46	___
13C12-HpCDF 789	9.7	96.5	0.42	45:26	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	7.8	77.8	0.49	40:44	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	5.4	54.4	0.76	28:56	___
13C12-2378-TCDD	6.3	63.3	0.77	29:42	___
13C12-PeCDF 123	7.5	75.1	1.60	33:37	___
13C12-PeCDD 123	7.8	77.9	1.63	35:02	___
13C12-HxCDF 678	8.0	80.3	0.53	38:47	___
13C12-HxCDD 678	8.7	87.1	1.29	39:53	___
13C12-HpCDF 678	6.8	67.9	0.41	43:12	___
13C12-HpCDD 678	6.9	68.9	1.07	44:45	___
13C12-OCDD	10.0	50.2	0.86	50:06	___

E829_RPT rev:3.01

TRIANGLE LABORATORIES, INC. Page 1 of 1
CONFIRMATION ANALYSIS (DB-225) 08/08/89

FILE NAME....: T322708 CLIENT ID....: ENTROPY TLI NUMBER....: 19-99-1A-F
CONCAL.....: T893226 SAMPLE ID....: 2-5-MM5-FB
ANALYST.....: JA ANALYSIS DATE: 08/01/89 PROJECT NUMBER: 14097/98
SAMPLE SIZE..: 1.00 SAMPLE MATRIX: MM5 DATE RECEIVED.: 07/05/89
ICAL DATE....: 05/03/89 SAMPLE ORIGIN: n/a DATE COLLECTED: / /
SPIKE FILE...: SPCONF10 SHIPMENT NO...: OGDEN

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.02				___
2378-TCDF	0.03				0.80	16:14	___
TOTAL TCDD	ND		0.02				___
TOTAL TCDF	0.22	7		0.34	0.79		___

SURROGATE STD. RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.3	92.8		14:52	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	5.6	56.1	0.74	16:14	___
13C12-2378-TCDD	5.7	57.3	0.80	14:51	___

CONF_RPT rev:3.01

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X)

08/03/89

FILE NAME....: M892449	CLIENT ID....: ENTROPY	TLI NUMBER....: n/a	
CONCAL.....: M892448	SAMPLE ID....: TLI BLANK		
ANALYST.....: JA	ANALYSIS DATE: 07/17/89	PROJECT NUMBER: 14097	
SAMPLE SIZE..: 1.00	SAMPLE MATRIX: MM5	DATE RECEIVED.: 07/05/89	
ICAL DATE....: 12/07/88	SAMPLE ORIGIN: n/a	DATE COLLECTED: / /	
SPIKE FILE...: SPE82910		SHIPMENT NO...: n/a	

NAME	AMT(ng)	NUMBER	DL	EMPC	RATIO	RT	FLAGS
2378-TCDD	ND		0.04				
12378-PeCDD	ND		0.04				
123478-HxCDD	ND		0.04				
123678-HxCDD	ND		0.04				
123789-HxCDD	ND		0.05				
1234678-HpCDD	ND		0.07				
OCDD	0.40				0.88	50:22	
2378-TCDF	ND		0.03				
12378-PeCDF	ND		0.03				
23478-PeCDF	ND		0.03				
123478-HxCDF	ND		0.03				
123678-HxCDF	ND		0.03				
234678-HxCDF	ND		0.04				
123789-HxCDF	ND		0.05				
1234678-HpCDF	ND		0.04				
1234789-HpCDF	ND		0.07				
OCDF	ND		0.10				
TOTAL TCDD	ND		0.04				
TOTAL PeCDD	ND		0.04				
TOTAL HxCDD	ND			0.91			
TOTAL HpCDD	ND		0.07				
TOTAL TCDF	ND		0.03				
TOTAL PeCDF	ND		0.03				
TOTAL HxCDF	ND		0.03				
TOTAL HpCDF	ND		0.05				

TRIANGLE LABORATORIES, INC.
PCDD/PCDF ANALYSIS (8290X) QA/QC SUMMARY 08/03/89

FILE NAME....:	M892449	CLIENT ID....:	ENTROPY	TLI NUMBER....:	n/a
CONCAL.....:	M892448	SAMPLE ID....:	TLI BLANK		
ANALYST.....:	JA	ANALYSIS DATE:	07/17/89	PROJECT NUMBER:	14097
SAMPLE SIZE..:	1.00	SAMPLE MATRIX:	MM5	DATE RECEIVED.:	07/05/89
ICAL DATE....:	12/07/88	SAMPLE ORIGIN:	n/a	DATE COLLECTED:	/ /
SPIKE FILE...:	SPE82910			SHIPMENT NO...:	n/a

SURROGATE RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
37CL-TCDD	9.9	98.9		29:41	___
13C12-PeCDF 234	8.3	82.6	1.55	34:58	___
13C12-HxCDF 478	7.2	72.2	0.50	39:04	___
13C12-HxCDD 478	8.3	83.3	1.25	40:09	___
13C12-HpCDF 789	12.8	128	0.44	45:45	___

ALTERNATE STANDARDS RECOVERY SUMMARY (TYPE A)

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-HxCDF 789	9.2	91.8	0.48	41:08	___

INTERNAL STANDARDS RECOVERY SUMMARY

NAME	AMT (ng)	% REC.	RATIO	RT	FLAGS
13C12-2378-TCDF	7.3	72.6	0.79	28:53	___
13C12-2378-TCDD	8.4	84.4	0.76	29:40	___
13C12-PeCDF 123	9.8	97.7	1.62	33:47	___
13C12-PeCDD 123	10.6	106	1.71	35:26	___
13C12-HxCDF 678	8.3	82.9	0.51	39:10	___
13C12-HxCDD 678	9.3	92.9	1.15	40:17	___
13C12-HpCDF 678	7.8	77.9	0.41	43:33	___
13C12-HpCDD 678	9.0	90.0	1.06	45:05	___
13C12-OCDD	18.3	91.5	0.88	50:22	___

CUSTODY SHEET FOR MMS COOLER # PF105

Date of Makeup 5/26/89 Initials PR Sealed? ✓

Individual Tare of Reagent: 200 mls. of dH_2O

Individual Silica Gel Tare Weight 200 gms.

Filter used? ✓ Knockout Impinger Catch? _____ (✓ or X)

XAD Trap? ✓ Trap # and Tare wt., gms. _____

Rinse reagent identification Acetone and methylene chloride

PLANT NAME Indianapolis Resource Recovery Facility

SAMPLING LOCATION Unit #2 Stack

Run I.D.	Date Used	Initials	Sealed?	Date Cleaned	% SilGel Spent	Initials	Sealed?
2-S-MMS-1	6/27/89	CW	✓	6/27	95%	CW	✓
2-S-MMS-2	6/28/89	CW	✓	6/28	40%	CW	✓

Received in Lab Date 7-5-89 Initials ~~ATM~~ Sealed? ✓

Sampling Method _____

Remarks:

CUSTODY SHEET FOR MM5 COOLER # DF 180

Date of Makeup 19 May 1989 Initials BJG Sealed? ~

Individual Tare of Reagent: 200 mls. of DI H_2O

Individual Silica Gel Tare Weight 200 gms.

Filter used? ✓ Knockout Impinger Catch? _____ (✓ or X)

XAD Trap? ✓ Trap # and Tare wt., gms. _____

Rinse reagent identification Acetone and methylene chloride

PLANT NAME Indianapolis Resource Recovery Facility

SAMPLING LOCATION Unit #2 Stack

Run I.D.	Date Used	Initials	Sealed?	Date Cleaned	% SilGel Spent	Initials	Sealed?
2-S-MM5-3	6/28/89	GV	✓	6/28	50%	GV	✓
2-S-MM5-FB	6/28/89	GV	✓	6/28	00%	GV	✓

Received in Lab Date 7-5-89 Initials KTM Sealed? ✓

Sampling Method _____

Remarks:

ENTROPY
ENVIRONMENTALISTS INC

POST OFFICE BOX 12291
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

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REQUEST FOR ANALYSIS

PURCHASE ORDER # 6323 A-1

JOB NAME: OGDEN

LABORATORY: TLI

DATE SAMPLES WERE TRANSMITTED: 6-21-89

EXPECTED DATE OF RESULTS: 6-23-89

SAMPLE MATRIX:

TYPE OF ANALYSIS REQUESTED: Prepare 9 XAD's spiked with D/F surrogate.

SUBMITTED BY: Richard Markworth

ENTROPY
ENVIRONMENTALISTS INC

POST OFFICE BOX 12291
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

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REQUEST FOR ANALYSIS

PURCHASE ORDER # 6323 A-2

JOB NAME: OGDEN

LABORATORY: TLI

DATE SAMPLES WERE TRANSMITTED: 7-6-89

EXPECTED DATE OF RESULTS: 8-7-89

SAMPLE MATRIX: MM5 Sample train.

TYPE OF ANALYSIS REQUESTED: Tetra-octa D/F with confirms
Front ½ and Back ½ pooled

Sample #	RUN ID			Components
1	2-S-MM5-1	Filter, XAD	Reagent (2 of 2),	Front ½, Back ½, Imp. rinses
2	2-S-MM5-2	" "	Reagent (1 of 1),	" " "
3	2-S-MM5-3	" "	"	" " "
4	2-S-MM5-FB	" "	"	" " "

SUBMITTED BY: Richard Markwardt

L-0005a
8/86

APPENDIX D

CALIBRATION DATA

Dry Gas Meter Identification: 6838323 Calibration by: T. McDonald

Date: 2-26-88 Barometric Pressure (P_b): 29.26 in. Hg

*Date: 2-29-88 *Barometric Pressure (P_b): 29.74 −.47 = 29.27 in. Hg

29.68

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.404	78.8	2.535	76	0.37	10:00	0.2303	0.9425	
	2.532	78.8	2.523	76.5	0.37	10:00	0.2426	0.9984	
	2.587	78.8	2.527	77	0.38	10:00	0.2478	1.0194	
	4.135	78.8	4.075	75	0.67	10:00	0.4026	1.0059	
	4.171	78.8	4.052	75	0.65	10:00	0.4061	1.0205	
	4.162	78.8	4.019	75.5	0.65	10:00	0.4052	1.0276	
	5.036	78.8	4.887	76	0.95	10:00	0.4824	1.0227	
	5.064	80.0	4.900	76	0.95	10:00	0.4840	1.0234	
	5.027	80.6	4.839	76	0.95	10:00	0.4800	1.0276	
	7.787	78.8	7.711	75	2.04	10:00	0.7582	0.9977	
	7.851	78.8	7.684	75	2.03	10:00	0.7644	1.0095	
	7.814	78.8	7.724	75	2.05	10:00	0.7608	0.9995	
	9.900	78.8	9.845	75	3.17	10:00	0.9639	0.9907	
	9.900	78.8	9.773	75	3.17	10:00	0.9639	0.9980	
	10.018	78.8	9.882	76	3.22	10:00	0.9754	1.0005	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{\text{---------------------------------}}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{\text{----------}}$$

Dry Gas Meter Identification: 6838323 Calibration by: T. McDaniel

Date: 2-26-88 Barometric Pressure (P_b): 29.26 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: 2-29-88 *Barometric Pressure (P_b): ~~29.74~~ 29.72 ~~29.68~~ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	11.658	77.9	11.640	76.5	4.20	10:00	1.1362	0.9887	
	11.694	77.9	11.594	77	4.275	10:00	1.1397	0.9964	
	11.548	77.9	11.547	77	4.23	10:00	1.1240	0.9881	
	13.042	77.9	12.946	77	5.25	10:00	1.2694	0.9928	
	12.851	78.8	12.784	77.5	5.23	10:00	1.2487	0.9823	
	12.933	79.7	12.859	78	5.17	10:00	1.2546	0.9899	

$Y_{ds} = 1.001$

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{\text{---------------------------------}}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{\text{----------}}$$

Dry Gas Meter Identification: 6838323 Calibration by: WLS

Date: 3-30-89 Barometric Pressure (P_b): 29.56 in. Hg

*Date: 3-31-89 *Barometric Pressure (P_b): 29.34 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (θ) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.859	77	2.757	77	.5	10	.2776		1.0357
	2.823	77	2.726	77	.5		.2741		1.0343
	2.796	79	2.710	77	.5		.2705		1.0266
	4.144	79	4.127	77	.8		4009		0.9984
	4.189	79	4.133	77	.8		4053		1.0078
	4.262	79	4.136	77	.8		4123		1.0246
	5.027	79	4.92	77	1.0		.4863		1.0154
	4.945	79	4.884	77	1.0		.4784		1.0062
	5.055	79	4.909	77	1.0		.4890		1.0234
	8.069	79	7.955	77	2.2		.7806		1.0051
	8.078	79	7.917	77	2.2		.7815		1.011
	8.051	79	7.938	77	2.2		.7789		1.005
*	10.700	79	10.436	76	3.4		1.0274		1.011
*	10.665	79	10.525	76	3.4		1.0241		0.9991
*	10.565	79	10.457	76	3.4		1.0145		0.9967

$$Y = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{\qquad\qquad}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{\qquad\qquad}$$

Dry Gas Meter Identification: 6838323 Calibration by: WLS

Date: 3-30-89 Barometric Pressure (P_b): 29.56 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: 3-31-89 *Barometric Pressure (P_b): 29.34 in. Hg

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (θ) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
*	12.168	79	12.110	77	4.52	10	1.1684		0.9898
*	12.231	79	12.180	77	4.52		1.1744		0.9893
*	12.186	79	12.177	77	4.52		1.1701		0.9859
	13.461	79	13.355	77	5.50		1.3022		0.9906
	13.661	79	13.575	77	5.50		1.3216		0.9891
	13.461	79	13.413	77	5.50		1.3022		0.9864

$Y_{DS} = 1.0063$

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{\text{---------------------------------}}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{\text{----------}}$$

Meter Box Number: N10 Calibration by: MC/BW

Standard Meter Number: 6838323 Standard Meter Gamma: 1.001

Date: 2-23-89 Barometric Pressure (P_b): 29.44 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

METERBOX CALIBRATION

Standard Meter			Meter Box Metering System				
Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Time (θ) min.	Orifice Setting (ΔH) in. H_2O	Gas Volume (V_d) ft^3	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H_@$ in. H_2O
4.047	70	10	0.5	4.164	80	.9935	1.901
4.030	70	10	0.5	4.171	81	.9628	1.950
7.860	70	10	2.1	8.106	83	.9892	1.890
7.854	70	10	2.1	8.126	86	.9915	1.882
12.047	71	10	4.8	12.381	87	.9990	1.832
12.103	71	10	4.8	12.431	88	.9939	1.812
					Average	.9858	1.812

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ON-SITE DRY GAS METER AUDIT

Date 6-29-89 Meter Box Identification Number N10

Time 0745 Pretest Gamma (Y) 0.9858 ΔH_a 1.812

Auditor WTC Barometric Pressure (P_{bar}) 29.5 in.Hg

Dry Gas Meter Readings, ft^3	Meter Temperatures, °F	Upper and Lower Limits for Audit Gamma
Initial 760.430	Initial 75	0.97 * Y = 0.9562
Final 767.967	Final 81	1.03 * Y = 1.0154

Dry Gas Volume Metered, ft^3	Average Meter Temperature, °F	Run Time, min.	Calculated Audit Gamma
Vm = 7.537	Tm = 78	10	Y_c = 1.012

$$Y_c = \frac{10}{Vm} * \sqrt{\frac{0.0319\ (Tm + 460)}{P_{bar}}}$$

$$Y_c = \frac{10}{7.537} * \sqrt{\frac{0.0319\ (78 + 460)}{29.5}} = 1.012$$

Audit Gamma Within Acceptable Limits? Yes ✓ No ___

F-1040
9/86

Meter Box Number N10 Calibration by M B C

Meter Box Vacuum 15 (in Hg) Job No 6349 / 6323

Standard Meter Number 683323 Standard Meter Gama 1.0063

Date 7-13-35 Barometric Pressure (P_b) 29.37 (in Hg)

POST TEST CALIBRATION

Standard Meter			Meter Box Metering System				
Gas Volume (V_{ds}) ft³	Temp (t_{ds}) °F	Time (θ) min	Orifice Setting (ΔH) in. H_2O	Gas Volume (V_d) ft³	Temp (t_d) °F	Coeff (Y_d)	$\Delta H_@$ in. H_2O
11.852	75	10	4.35	12.361	92	.9848	1.711
11.787	75	10	4.35	12.359	95	.9845	1.723
11.790	75	10	4.35	12.383	98	.9885	1.711
					Average	.9859	1.715

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ΔP (Magnehelic®)	ΔP (Manometer)	% Difference
.27	.27	0
.65	.65	0
1.03	1.03	0

F-1038
7/89

Meter Box Number: N20 Calibration by: MC/JWS

Standard Meter Number: 638323 Standard Meter Gamma: 1.0063

Date: 5-23-89 Barometric Pressure (P_b): 29.48 in. Hg

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

METERBOX CALIBRATION

Standard Meter			Meter Box Metering System				
Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Time (θ) min.	Orifice Setting (ΔH) in. H_2O	Gas Volume (V_d) ft^3	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H_@$ in. H_2O
4.017	75	10	0.5	4.136	83	.9907	1.734
3.979	75	10	0.5	4.126	86	.9852	1.758
7.820	75	10	2.1	8.050	89	.9939	1.901
7.756	75	10	2.1	8.025	92	.9982	1.922
13.005	75	11	4.8	13.392	95	1.0018	1.881
11.814	75	10	4.8	12.203	96	1.0005	1.880
					Average	.9964	1.846

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ON-SITE DRY GAS METER AUDIT

Date 06.26.89

Time 1733 - 1743

Auditor B. Rood

Meter Box Identification Number NJ-20

Pretest Gamma (Y) 0.9964 ΔH_a 1.846

Barometric Pressure (P_{bar}) 29.5 in.Hg

Dry Gas Meter Readings, ft^3	Meter Temperatures, ^oF	Upper and Lower Limits for Audit Gamma
Initial 725.100	Initial 112	0.97 * Y = 0.9665
Final 732.771	Final 114	1.03 * Y = 1.0263

Dry Gas Volume Metered, ft^3	Average Meter Temperature, ^oF	Run Time, min.	Calculated Audit Gamma
Vm = 7.671	Tm = 113	10	Y_c = 1.0261

$$Y_c = \frac{10}{Vm} * \sqrt{\frac{0.0319\ (Tm + 460)}{P_{bar}}}$$

$$Y_c = \frac{10}{7.671} * \sqrt{\frac{0.0319\ (113 + 460)}{29.5}} = 1.0261$$

Audit Gamma Within Acceptable Limits? Yes ✓ No ___

F-1040
9/86

Meter Box Number N20 Calibration by: MBC

Meter Box Vacuum 9 (in. Hg) Job No 6349/6323

Standard Meter Number 683323 Standard Meter Gama: 1.0063

Date 7-13-89 Barometric Pressure (P_b) 29.37 (in Hg)

POST TEST CALIBRATION

Standard Meter			Meter Box Metering System				
Gas Volume (V_{ds}) ft³	Temp. (t_{ds}) °F	Time (θ) min.	Orifice Setting (ΔH) in. H_2O	Gas Volume (V_d) ft³	Temp. (t_d) °F	Coeff (Y_d)	$\Delta H_@$ in. H_2O
8.451	75	10	2.5	8.588	88	1.0058	1.995
8.416	75	10	2.5	8.650	94	1.0034	1.990
8.409	75	10	2.5	8.615	99	1.0071	1.996
					Average	1.0054	1.987

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \Delta H/13.6)}$$

$$\Delta H_@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ΔP (Magnehelic®)	ΔP (Manometer)	% Difference
.4	.4	0
.7	.7	0
1.0	1.0	0

F-1038
7/89

NOZZLE NUMBER: GL46

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
5-12-98	WLS	.305	.309	.305	.308	.308	.307

NOTE: All diameters measured in inches.

ENTROPY ENVIRONMENTALISTS, INC

NOZZLE NUMBER: GL82

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
3-31-89	MC	271	275	275	275	271	273

NOTE: All diameters measured in inches.

ENTROPY ENVIRONMENTALISTS, INC.

NOZZLE NUMBER: GL-88

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
4.20.89	JJM	.274	.273	.272	.274	.274	.273

NOTE: All diameters measured in inches.