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RESULTS OF THE JULY 1987 EMISSION PERFORMANCE TESTS OF THE POPE/DOUGLAS WASTE TO ENERGY FACILITY MSW INCINERATORS IN ALEXANDRIA, MINNESOTA

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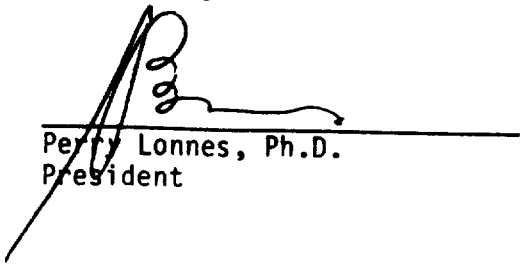

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President

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ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (^{O}F)	degrees Fahrenheit
DIA.	diameter
FT/SEC	feet per second
g	gram
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g/dscm	grams per dry standard cubic meter
HP	horsepower
HRS	hours
IN.	inches
IN. HG.	inches of mercury
IN. WC.	inches of water
LB	pound
LB/DSCF	pounds per dry standard cubic foot
LB/HR	pounds per hour
LB/10^{6}BTU	pounds per million British Thermal Units heat input
LB/MMBTU	pounds per million British Thermal Units heat input
LTPD	long tons per day
MW	megawatt
mg/DSCM	milligrams per dry standard cubic meter
microns (um)	micrometer
MIN.	minutes
ng	nanograms
ohm-cm	ohm-centimeter
PM	particulate matter
PPH	pounds per hour
PPM	parts per million
ppmC	parts per million carbon
ppm,d	parts per million, dry
ppm,w	parts per million, wet
ppt	parts per trillion
PSI	pounds per square inch
SQ. FT.	square feet
ug	micrograms
v/v	percent by volume
w/w	percent by weight

Standard conditions are defined as 68 ^{O}F (20 ^{O}C) and 29.92 IN. of mercury pressure.

1 INTRODUCTION

1.1 General

During the Period July 21-24, 1987, Interpoll Laboratories conducted an emission performance test on the Unit 1 and 2 municipal solid waste (MSW) Incinerators at the Pope/Douglas Waste to Energy Facility in Alexandria, Minnesota. On-site testing was performed by a seven-man team consisting of E. Trowbridge, R. Rosenthal, J. Buresh, C. Mosser, R. Downs, S. Lonnes and T. Lonnes. Coordination between testing activities and plant operation was provided by Bob Evenson of HDR Techserv and John Holmberg of Cadoux Incorporated. A portion of the testing was witnessed by Tom Kelly of the Minnesota Pollution Control Agency (MPCA).

1.2 MSW Incinerator Train Description

The Pope/Douglas Waste to Energy Facility consists of two 38 ton per day identical mass burn MSW incinerators manufactured and installed by Cadoux Incorporated. Each incinerator is equipped with a waste heat boiler and a United McGill two-field electrostatic precipitator dust collection system. The exhaust gas from the two trains feed into a common 70-foot high three-foot diameter radial steel stack.

Municipal solid waste is delivered to the site six days per week via packer-type vehicles. Each truck is weighed on an automatic scale prior to unloading in a completely enclosed unloading facility. The trucks back into one of three stalls and unload into a concrete pit sized for three days of storage capacity.

The unloader operator, whose chair/console is located in the control room overlooking the pit, distributes and mixes the refuse with

an overhead crane and grapple. Large noncombustibles are removed at this point and deposited into a reject container for removal to a nearby landfill. Each incinerator feed hopper is charged with refuse by the operator using one of the two crane and grapples.

Refuse is introduced into each incinerator via a feed hopper and chute with a hydraulic ram feeder system. The incinerator combustor incorporates a downward sloping moving grate which moves the burning refuse through the incinerator and optimizes carbon burnout.

Each incinerator is equipped with independent ash removal systems. Bottom ash is removed from the incinerator by means of a water-sprayed vibrating ash discharger to a drag chain conveyor which deposits the ash into a storage pit. ESP hopper flyash, waste heat boiler hopper ash and other dropout hopper ash is removed and added onto the bottom ash drag chain conveyor. The ash is recovered from the pit using a crane with clamshell and placed in containers for transport to a nearby landfill.

The incinerator is designed to provide adequate combustion air in a controlled manner to maximize combustion efficiency. Auxilary natural gas-fired burners are used during start up and shut down or whenever low BTU or high moisture refuse is encountered to maintain minimum temperatures in the combustion zone. The exhaust gas from the combustion pass from the incinerator through a refractory-lined beeching into a water tube steam boiler. Exhaust gas from the boiler then passes through the electrostatic precipitator dust control system, the ID fan and is exhausted to the atmosphere via the common stack. An emergency heat release stack is located ahead of the waste heat boiler. All of the equipment is located inside the main building except the ESPs, ID fans and the common stack. The ID and precipitator hoppers are enclosed in a separate building.

The heat recovery boilers are of the forced circulation type. Both boilers are equipped with compressed-air operated soot blowers. Steam from the boilers is sold to an adjacent industrial customer and the neighboring hospital.

1.3 Compliance Testing

Compliance tests for particulate and visible emissions were determined on consecutive days on both the Unit 1 and 2 Incinerators in accordance with EPA Methods 1-5 and 9, CFR Title 40, Part 60, Appendix A (revised July 1, 1986). During the Unit 1 test, the Unit 2 was taken off-line and vice versa. A preliminary determination of the gas linear velocity profile was made on each unit prior to the start of the first particulate determination to allow selection of the appropriate nozzle diameter required for isokinetic sample withdrawal. An all-glass impinger assembly with distilled water was used in the back half of the sampling train to provide samples for chloroform diethyl ether extractions to determine total condensible organic compounds. The collected samples were analyzed in accordance with the analytical protocol for condensibles promulgated by the MPCA.

Three one-hour visible emission determinations were performed on each of the incinerators during the particulate portion of the testing by an EPA-certified observer. The remainder of the testing effort was devoted to the Unit 2 Incinerator train.

1.4 Acidic Gases

Hydrogen chloride and sulfur dioxide, both acidic gases, were determined in a common sampling train using a modification of the EPA Method 6 large impinger version. An alkaline absorbing reagent was employed to quantitatively collect the gases. The recovered samples

were returned to the laboratory and analyzed for chloride and sulfate by ion chromatography.

1.5 Nitrogen Oxides

Oxides of nitrogen samples were collected using a separate sampling system in two-liter flasks with on-site evacuation of the flasks. The probe was purged with flue gas before each sample was collected. The collected samples were aged at 70 ^{o}F, shook to complete absorption, recovered from the flasks and analyzed for nitrate by ion chromatography as per EPA Method 7A.

1.6 Size Fractionation

Size fractionation of trace metals and mercury determinations were performed in situ using a Flow Sensor computer-machined seven-stage cascade impactor operated with two stages of impaction. The impactor was operated with conditioned glass-fiber substrates (to minimize bounce off) including the back-up filter. The impactor assembly was attached to an EPA Method 101A sampling train which was operated without the optional filter. The impingers were loaded with acidified potassium permanganate. Gaseous elemental mercury which passes through the in-stack impactor was collected in the impingers where it was converted to the stable nonvolatile complex ion, tetrachloromercurate ($HgCl_4^{-2}$).

One two-hour run was performed. The impactor was returned to the laboratory for sample recovery and gravimetric analysis of the three size-fractionated catches. The catches were then acid extracted and analyzed for trace metals by ICP and AA. The mercury containing permanganate solution was recovered in the field into an all-glass sample container, returned to the laboratory with a field blank and analyzed after extraction by cold vapor atomic absorption as per EPA Method 101A.

1.7 Trace Metal Testing

Lead and beryllium samples were collected using a separate Method 12 sampling train. The train was operated as per Method 12. The recovered samples were extracted and analyzed for lead as per Method 12. The extract was then analyzed for beryllium as per EPA Method 104.

Arsenic determinations were performed using a separate sampling train. The samples were collected and analyzed as per EPA Method 108. The sulfur dioxide determination portion of EPA Method 108 was deleted since SO_2 collection and analysis was performed independently.

1.8 VOCs

VOC concentrations were determined in accordance with EPA Method 25. An all-stainless steel sampling train was used to collect the samples at a constant flow rate over a thirty-minute period. The traps were immerged in a dry ice bath during sampling. Five-liter flasks were used to collect the noncondensible VOCs. Trap samples were stored over dry ice until analysis. VOC samples were collected simultaneously with Nutech stainless steel traps and flasks and Nutech sampling trains.

1.9 PAHs

The total polynuclear aromatic hydrocarbons (PAHs) sampling was conducted in accordance with EPA Method 0010 (SW846, 3rd Ed.) using the Modified Method 5 train with 20g XAD-2 resin. The recovered PAH sample and field biased blank were analyzed by high performance liquid chromatography (HPLC) using a UV and a fluorescent detector in accordance with EPA Method 8310.

1.10 Dioxins and Furans

Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) sampling was also conducted using the MM5 train with XAD-2 resin in accordance with EPA Method 0010. The recovered PCDDs and PCDFs samples were returned to the laboratory, carefully packed and then shipped to California Analytical Laboratory where they were analyzed for tetra- through octachlorodibenzodioxins and chlorodibenzofurans homolog groups as well as for all of the 2,3,7,8-isomers as per EPA Method 8280 except that high resolution mass spectrometry was substituted for low resolution to allow detection of 2,3,7,8-TCDD at the 0.01 ng/dsm^3 level (not possible with low resolution MS).

1.11 Diluent Gas Analysis

Integrated flue gas samples were extracted simultaneously with each of the above-referenced sample trains except the VOC train using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags. Prior to sampling, the Tedlar bags are leak checked at 15 IN.HG. vacuum with an in-line rotameter. Bags with any detectable inleakage are discarded.

After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. The integrated flue gas samples collected during the particulate sampling on Unit 2 were also analyzed for carbon monoxide in accordance with EPA Method 10 (NDIR).

1.12 Exhuast Gas Sampling Extraction Protocol

All of the testing with the exception of the continuous monitoring was performed from a set of four test ports located on the

common stack. These test ports are ten diameters downstream of the two breeching inlet ducts and ten diameters upstream of the stack exit. The four test ports are oriented at 90 degrees on the radial steel gunnite-lined stack. This test location is ideal based on EPA Criteria (Method 1).

Twelve-point traverses were utilized to isokinetically collect particulate, arsenic, beryllium, and lead aerosol samples. Each traverse point was sampled five minutes to give a total sampling time of 60 minutes per run.

Hydrogen chloride, sulfur dioxide and VOC gases were sampled using a three-point traverse (1/6, 3/6, 5/6). Each of the traverse points was sampled ten minutes to give a total sampling time per run of 30 minutes.

The trace metal fractionation and gas phase mercury determination was performed using a single point. The criterion used to select the point was based on the constraints imposed by the in situ fractionation. The impactor had to be operated at a flow rate which gave the desired 50% cutpoints (.5 and 2.0 microns). The traverse point with the volicity pressure which gave the flow rate closest to the desired flow rate was selected and the entire sampling performed at this point. Single point sampling was not considered detrimental for this measurement inasmuch as the test location was downstream of a high efficiency dust collector (ESP), downstream of the ID fan and distant from any flow disturbances which might have stratified the aerosol in the exhaust gas stream.

Semivolatile organic compounds which partition between the gaseous and solid state in exhaust gas streams were also isokinetically sampled using a 12-point traverse. In the case of the PAHs, a single run was performed. Each traverse point was sampled ten minutes to give a total run time of 120 minutes. In the case of the dioxin and furan

sampling, each of the twelve travese points was sampled 20 minutes to give a total of 240 minutes per run.

1.13 Refuse Sampling

The facility has a refuse pit with a three-day storage capacity. The pit is divided into three sections. Each section of the pit is filled every third day. This allows two days of drying before the refuse is combusted. On a given day, trucks unload into one section of the pit. When a truck dumps refuse into the section of the pit being filled, the operator uses the crane to equally distribute and mix the refuse in the pit.

During the performance test, the operator charging the incinerator, would take a smaller load from the same section every 15 minutes and deposit it on the floor. This sample was then quartered by a technician until a 20-30 pound representative sample was obtained. The sample was placed in a double liner polyethylene bag, sealed and returned to the laboratory for size reduction and analysis.

1.14 Report Organization

A summary and discussion of all of the important results of this performance test is given in the following section. More detailed results are presented in Section 3 together with pertinent sampling parameters. Supplemental information such as field data sheets, laboratory results, procedures and calculation equations are presented in the appendices.

2 SUMMARY AND DISCUSSION

2.1 General

The results of the July 1987 performance test on the two 38 TPD MSW incinerators at the Pope Douglas Waste to Energy Facility are summarized in this section. The test protocol for the facility was developed by the Minnesota Pollution Control Agency. Since both incinerator trains were identical, the MPCA only required a particulate and visible emission determination on the Unit 1 Incinerator.

2.2 Unit 1

2.2.1 Particulate Material

The particulate concentration from the ESP for the Unit 1 MSW Incinerator averaged 0.026 GR/DSCF @ 12%CO_2 for normal operation, but increased to .033 GR/DSCF @ 12%CO_2 during soot blowing (see Table 1). These values are well below the maximum allowable concentration permitted by the State of .08 GR/DSCF @ 12%CO_2. The charging rate averaged 45.5, 49 and 54 TPD during these three test runs. This is well above the rated capacity of the incinerator of 38 TPD.

2.2.2 Opacity

The opacity averaged 1.2% with no readings above 10%. The observed opacity is in good agreement with the particulate concentrations and the optical path length (stack diameter).

TABLE 1. Summary of the Results of the July 21, 1987 Particulate Emission Performance Test on Unit 1 at the Pope Douglas Waste to Energy Facility Located in Alexandria, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		07-21-87	07-21-87	07-21-87
Time runs were done	(HRS)	1055/1159	1235/1338	1425/1529
Burning rate	(LB/HR)	3790.0	4089.0	4509.0
Volumetric flow				
actual	(ACFM)	13193	13779	13815
standard	(DSCFM)	6646	7055	7055
Gas temperature	(DEG-F)	415	418	412
Moisture content	(%V/V)	12.96	11.24	12.01
Gas composition	(%V/V,dry)			
carbon dioxide		6.45	6.30	6.80
oxygen		13.80	13.90	13.35
carbon monoxide		0.00	0.00	0.00
nitrogen		79.75	79.80	79.85
Isokinetic variation	(%)	104.8	98.3	99.7
Part. emission rate	(LB/HR)	0.83	1.06	0.86
Particulate concentration				
actual	(GR/ACF)	.00737	.00897	.00725
standard	(GR/DSCF)	.0146	.0175	.0142
std @12%CO2	(GR/DSCF)	.0272	.0334	.0251

* Dry + organic wet catch
** Soot blown during Run 2

Rust Roll PM → 0.0237 0.0289 0.0215
gr/dscf @ 12% CO_2

2.2.3 Combustion Gas Parameters

Continuous monitors were installed by Interpoll Labs on the Unit 1 Incinerator to monitor the temperature of the gases in the combustor and the concentration of the combustion gases at the outlet of the boiler. The combustion temperatures were measured with high temperature ceramic insulated chromel alumel thermocouples which were monitored with a data acquisition system (IBM PC equipped with an Omega DAS board, five-minute averaging with internal TC linearization). The first thermocouple was located on the side of the incinerator just off the inclined grate (TEMP 1). The second thermocouple was inserted into the top of the combustor through a flanged port (TEMP 2). See Appendix BB.

Combustion gas composition was determined using an extractive system. A 1 LPM slip stream was extracted from a test port located at the outlet of the waste heat boiler just upstream of the ESP. Prior to monitoring, a stratification test was performed with an oxygen analyzer which showed that the gas composition was areally uniform. The conditioned gas stream was pumped to a continuous combustion gas monitoring (CCGM) system consisting of two Fugi NDIRs (0 to 20% CO_2 and 0 to 1000 ppm CO) and a Teledyne Model 320 Electrochemial Oxygen Analyzer. The monitors were calibrated at the beginning and end of each test day using zero gas and two upscale standard gases. A linear regression analysis was performed on each calibration.

The results from the CCGM system for the Unit 1 Incinerator are given in Section 3.13 (15-minute averages). Strip charts are reproduced in Appendix BB. Temperatures at the grate test site ranged from 1300 to 1650 ^{o}F. Temperatures

in the upper portion of the combustor ranged from 1770 to 1990 ^{o}F which is well above the ASME recommended temperature of 1500 ^{o}F for minimizing dioxin production. The oxygen and carbon dioxide contents averaged about 13.8% and 7.5%, respectively. This is in relatively good agreement with the results of the Orsat analysis of the integrated flue gas sample collected from the stack test site during the particulate test. The CO_2 content measured by the CCGM was approximately 1% higher than that from the Orsat analysis. This may be due to interference from infrared absorbing species in the exhaust gas stream.

Carbon monoxide concentrations were very low on the average indicating excellent combustion efficiency. For the most part, carbon monoxide concentrations tracked at 5 to 10 ppm with occasional rapid excursions to higher values which were most likely caused by the nature and mass of a given charge. The CO concentrations were well below the recommended value of 100 ppm for low dioxin production.

2.3 Unit 2

A comprehensive battery of tests was conducted on the Unit 2 Incinerator Train. In addition to particulates, visible emissions and continuous monitoring of combustion parameters, tests were performed for trace metals, PAHs, dioxins, hydrogen chloride, sulfur dioxide, oxides of nitrogen, VOCs and size fractionation of trace metals. The results of each of these tests is summarized below.

The start of the first test (particulate) on the Unit 2 MSW Incinerator Train was delayed for several hours as a result of a mechanical failure in the rapper system of one of the fields in the ESP. The rapper system was repaired prior to staring the test, however, considerable buildup on the plates may have occured prior to the detection of this failure. If a buildup on the plates did occur, it may have affected the performance of the ESP.

2.3.1 Particulate Material

The results of the particulate test on the Unit 2 Incinerator are given in Table 2. The particulate concentration for this unit ranged from .039 to .048 GR/DSCF @ 12%CO_2. This is somewhat higher than the particulate concentration measured on the Unit 1 ESP, but nonetheless, well below the maximum allowable concentration permitted by the State of 0.08 GR/DSCF @ 12%CO_2. The charging rate of refuse to the incinerator during the above test runs was 31.5, 38.4 and 55.3 TPD, respectively.

2.3.2 Opacity

The plume opacity averaged 1.2% during the particulate emission tests. See Section 3.6. The highest reading was

TABLE 2. Summary of the Results of the July 22, 1987 Particulate Emission Performance Test on the Unit 2 Incinerator at the Pope Douglas Waste to Energy Facility Located in Alexandria, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		07-22-87	07-22-87	07-22-87
Time runs were done	(HRS)	1235/1340	1415/1520	1600/1706
Burning rate	(LB/HR)	2625.0	3200.0	4609.0
Volumetric flow				
actual	(ACFM)	13734	13518	13377
standard	(DSCFM)	6781	6721	6553
Gas temperature	(DEG-F)	415	425	417
Moisture content	(%V/V)	14.09	12.50	14.61
Gas composition	(%V/V,dry)			
carbon dioxide		6.80	7.50	6.20
oxygen		13.35	12.90	14.00
carbon monoxide		0.00	0.00	0.00
nitrogen		79.85	79.60	79.80
Isokinetic variation	(%)	101.6	99.4	102.0
Part. emission rate	(LB/HR)	1.57	1.40	1.14
Particulate concentration				
actual	(GR/ACF)	.0133	.0121	.00991
standard	(GR/DSCF)	.0269	.0243	.0202
std @12%CO2	(GR/DSCF)	.0475	.0388	.0392
Front half only Unit 1 →		0.0237	0.0289	0.0215
Unit 2 →		0.0417	0.0340	0.0343
		gr/dscf at 12% CO_2		

* Dry + organic wet catch

** Soot blown during Run 3

only 15%. Comparison of the particulate samples collected during the Unit 1 and Unit 2 test indicated a slightly higher mass percentage of larger diameter particulate material was collected from Unit 2. Larger particles do not scatter as much light as fine particulates due to the relatively lower number concentration. The greater penetration of the ESP by particles in the greater than 5 micron size range may be related to the Unit 2 ESP rapper problem discussed above.

2.3.3 Combustion Gas Parameters

The Unit 2 Incinerator Train was equipped by Interpoll Labs with identical combustion gas monitoring equipment to that employed on Unit 1. The temperature sensors were identically located and the sample gas stream was again extracted from a test port located between the boiler outlet and the ESP inlet. The results of the continuous monitoring are given in Section 3.13 as 15-minute averages. The strip charts are presented in Appendix BB. Examination of these results indicates excellent combustion efficiency in general. Carbon monoxide concentrations tracked about 5 to 10 ppm for the majority of time with rapid short term excursions up to much higher levels reflecting variability in the mass and nature of the material being charged.

2.3.4 Sulfur Dioxide and Hydrogen Chloride

Sulfur Dioxide concentrations ranged from 54 to 73 ppm (dry) with corresponding emission rates of 3.8 to 5.1 LB/HR. See Table 3. This emission rate is very low and may indicate significant retention in the ash. Hydrogen chloride (HCl) concentrations, although not as low, were very constant ranging only from 142 to 184 ppm (dry). The emission rates of HCl ranged from 5.6 to 7.3 LB/HR.

2.3.5 Oxides of Nitrogen, Carbon Monoxide and VOCs

The results of the NO_X, CO and VOCs tests are also presented in Table 3. Oxides of nitrogen (NO_X) concentrations averaged 153 ppm (dry) which corresponds to an average NO_X emission rate of 7.3 LB/HR. This low NO_X emission rate is not

Table 3. Results of the Sulfur Dioxide, Hydrochloric Acid, Oxides of Nitrogen, Carbon Monoxide and VOC Determinations on Unit 2 at the Pope Douglas Waste to Energy Facility in Alexandria, Minnesota.

Item	Run 1	Run 2	Run 3
Concentration (ppm,d)			
Sulfur dioxide	54	70	73
Hydrochloric acid	142	154	184
Oxides of nitrogen	149	164	145
Carbon monoxide	11	10	21
VOCs	38	0	173
Emission Rate (LB/HR)			
Sulfur dioxide	3.78	4.87	5.08
Hydrochloric acid	5.61	6.07	7.27
Oxides of nitrogen	7.24	7.89	6.81
Carbon monoxide	.33	.29	.60
VOCs	.47	0	2.13

surprising considering the combustion temperature which was less than 2000 ^{o}F.

Carbon monoxide concentrations were determined from one-hour integrated flue gas samples collected during the particulate emission test. The average one-hour carbon monoxide concentrations were very low, which, once again, is indicative of good combustion efficiency. This time-integrated result obtained from the manual EPA Method 10 procedure is in excellent agreement with the results reported above from the CCGM System.

Total gaseous nonmethane organic compounds, sometimes referred to as VOCs, were measured using EPA Method 25. These results ranged from 0 to 173 ppm carbon (dry) corresponding to an overall average emission rage of only 0.86 LB/HR. Whether the variability of these results is due to experimental error or actual variations in the stack gas concentration is impossible to say. Variations as large as this are not unusual with this procedure.

2.3.6 Lead, Beryllium and Arsenic

The results of the lead, beryllium and arsenic emissions determinations are shown in Table 4. Beryllium was not detected in the exhaust gas stream which corresponds to an emission rate of less than or equal to .00006 LB/HR. Arsenic concentrations were also very low. The average arsenic emission rate was .000014 LB/HR.

Lead concentrations and emission rates were substantially higher. The lead concentration varied significantly from run to run ranging from 340 to 880 ug/dsm^3. The average lead emission rate was .014 LB/HR.

Table 4. Results of the Lead, Beryllium and Arsenic Emission Determinations on the Unit 2 Incinerator at the Pope Douglas Waste to Energy Facility in Alexandria, Minnesota.

Item	Run 1	Run 2	Run 3
Concentration (ug/DSCM)			
Lead	420	880	340
Beryllium	LT 2.4	LT 2.4	LT 2.4
Arsenic	.66	.50	.59
Emission Rate (10^{-3}LB/HR)			
Lead	11	22	8
Beryllium	LT .06	LT .06	LT .06
Arsenic	.02	.01	.01

LT = less than

2.3.7 Trace Metal Fractionation and Mercury

An in sutu two stage cascade impactor was used to aerodynamically classify particulate emissions into three aerodynamic size ranges:

>1.9 microns
0.45-1.9 microns
<0.45 microns

The cascade impactor was operated using the standard EPA Method 101A sampling train for mercury so that volatile mercury emissions could be simultaneously collected and analyzed. The results of the trace metal aerosol size fractionation are summarized in Table 5.

As will be noted, all of the arsenic was found in the less than 0.45 micron size range. Most of the chromium (72%) was also observed to be in the less than 0.45 micron size range. The rest of the metals seem to be more or less uniformly size distributed with mercury being the exception. Solid mercury represents only about 2% of the total mercury emission. Of the solid mercury (at 425 ºF), about 51% was present in the less than 0.45 micron size range. Volatile (elemental) mercury emissions averaged .0016 LB/HR (two-hour) average. See Section 3.10. This corresponds to a concentration of 65.5 ug/dsm^3. Thus lead and mercury are seen to be the two most prevalent trace metals emitted from this MSW incinerator.

Table 5. Results of the In-Situ Metal Size Fractionation Determination Performed on the Unit 2 Incinerator Stack on July 23, 1987 using a Flow Sensor Impactor with Stages 2 and 7 (Flow rate = 0.60 acfm).

	Percent By Weight in Size Category		
Particle Size Range*	< 0.45	0.45-1.9	> 1.9
Arsenic	100	0	0
Beryllium	nd	nd	nd
Cadmium	30	28	42
Chromium	72	11	17
Lead	38	24	37
Zinc	38	29	34
Mercury**	51	20	29
Total particulates	35	14	51

nd = not detected

*Equivalent aerodynamic diameter.

**The mercury reported above is solid or particulate mercury at 425 °F and represents only about 2% by weight of the total mercury emissions. See pages 60 and R-1.

2.3.8 Polynuclear Aromatic Hydrocarbons

PAHs are semivolatile condensed ring compounds which have been shown to be generated in almost all type of combustion of carbonaceous fuel at low oxygen concentrations. They are classified by EPA as products of incomplete combustion (PICs) and are well known byproducts of wood, fossel fuel and municipal solid waste combustion. The results of a one-hour determination of PAH are presented in Table 6. The sample was collected using a Modified Method 5 (MM5) sampling train with 20g of XAD-2 resin as per USEPA SW 846 3rd edition: Method 0010. The recovered four-part sample was analyzed as per EPA Method 8310 by high performance liquid chromotography (HPLC). Most of the sixteen targeted PAHs were not detected. Of those detected, fluoranthene was present at the highest concentration (3900 ng/dsm^3). Benzo(a)pyrene, a known carcinogen, was present at 341 ng/dsm^3.

Table 6. Results of the July 22, 1987 PAH Determination on the Unit 2 Incinerator at the Pope Douglas Waste to Energy Facility in Alexandria, Minnesota.

Item	Run 1
Concentration (ng/dsm^3)	
Napthalene	LT 20
Acenaphthylene	LT 26
Acenaphthene	LT 20
Fluorene	LT 2.4
Phenanthrene	LT 7.4
Anthracene	LT 7.4
Fluoranthene	3930
Pyrene	LT 3.1
Benzo-a-anthracene	382
Chrysene	LT 1.7
Benzo-b-fluoranthene	272
Benzo-k-fluoranthene	301
Benzo-a-pyrene	341
Dibenzo-a,h-anthracene	284
Benzo-g,h,i-pyrene	392
Indeno-1,2,3-pyrene	392
Emission Rate (10^{-8} g/sec)	
Napthalene	LT 58
Acenaphthylene	LT 76
Acenaphthene	LT 58
Fluorene	LT 7.0
Phenanthrene	LT 22
Anthracene	LT 22
Fluoranthene	11500
Pyrene	LT 9.0
Benzo-a-anthracene	1113
Chrysene	LT 5.0
Benzo-b-fluoranthene	792
Benzo-k-fluoranthene	877
Benzo-a-pyrene	993
Dibenzo-a,h-anthracene	827
Benzo-g,h,i-pyrene	1140
Indeno-1,2,3-pyrene	1140

LT = less than

2.3.9 Polychlorinated Dibenzodioxins and Furans

A polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) emission test was performed on the Unit 2 Incinerator. The sampling was conducted in an identical manner to that used to collect the PAHs except that 32g of XAD-2 resin was used. Three separate four-hour determinations were performed plus a field biased blank. The samples were analyzed as per EPA Method 8280 except that HRGC/HRMS was substituted for HRGC/LRMS to provide greater analytical sensitivity to attain the targeted detection limit of 0.01 ng/dsm^3. The samples were analyzed first for homolog distribution (tetra- through octa-) and then for 2,3,7,8-isomers. See Tables 7 and 8. As will be noted, the homolog distributions of PCDD and PCDF favor the higher chlorination levels. The most prevalent homologs are the HpCDDs and OCDDs. This homolog distribution is typical of MSW Incinerators.

Various groups have attempted to develop procedures for assessing the total toxicity burden to PCDDs and PCDFs by assigning 2,3,7,8-TCDD toxicity equivalence factors (TEF) to each of the 2,3,7,8-isomers and homolog groups. The product of the mass of a given isomer and its respective TEF is considered to be the equivalent mass of 2,3,7,8-TCDD which would have the same toxic effect. This equivalence calculation was performed on the data in hand using the TEFs presented at the USEPA Risk Assessment Forum in October 1986. The results of these calculations are summarized in Table 9. When this is done, it is seen that the two tetrachloro isomers, 2,3,7,8-TCDD and 2,3,7,8-TCDF have the greatest toxic impact of all the isomers and homolog groups. The higher chlorinated species, although most prevalent on a mass basis, play a lesser role from the standpoint of toxicity.

Table 7. Results of the **Dioxin Homolog Analysis** Test on the Unit 2 Incinerator at the Pope/Douglas Waste to Energy Facility (July 23 and 24, 1987).

Homolog	Run 1	Run 2	Run 3
Concentration (ng/dsm^3)			
TCDD	3.4	5.8	3.1
PeCDD	10.4	13.4	9.3
HxCDD	25.4	27.5	21.8
HpCDD	40.6	44.8	31.9
OCDD	45.3	52.1	35.8
TCDF	15.6	22.1	14.1
PeCDF	19.8	29.7	19.3
HxCDF	27.3	33.2	22.7
HpCDF	23.4	27.5	17.7
OCDF	11.9	14.2	8.2
Emission Rate (10^{-8} g/sec)			
TCDD	1.1	2.0	1.0
PeCDD	3.4	4.5	3.0
HxCDD	8.4	9.3	7.1
HpCDD	13.3	15.2	10.4
OCDD	14.9	17.6	11.6
TCDF	5.1	7.5	4.6
PeCDF	6.5	10.0	6.3
HxCDF	9.0	11.2	7.4
HpCDF	7.7	9.3	5.8
OCDF	3.9	4.8	2.7

Table 8. Results of the Dioxin 2,3,7,8-Isomer Analysis Test on the Unit 2 Incinerator at the Pope/Douglas Waste to Energy Facility (July 23 and 24, 1987).

Isomer	Run 1	Run 2	Run 3
Concentration (ng/dsm^3)			
2,3,7,8-TCDD	.11	.10	.061
1,2,3,7,8-PeCDD	.44	.57	.28
1,2,3,4,7,8-HxCDD	.86	.86	.64
1,2,3,6,7,8-HxCDD	2.8	3.0	2.3
1,2,3,7,8,9-HxCDD	1.6	1.4	1.0
1,2,3,4,6,7,8-HpCDD	21.3	23.5	16.9
2,3,7,8-TCDF	3.4	.57	.42
1,2,3,7,8-PeCDF	1.7	2.3	1.8
2,3,4,7,8-PeCDF	1.9	3.0	1.7
1,2,3,4,7,8-HxCDF	2.5	2.6	2.3
1,2,3,6,7,8-HxCDF	3.3	3.8	3.6
1,2,3,7,8,9-HxCDF	.72	.70	.67
2,3,4,6,7,8-HxCDF	5.4	5.7	5.3
1,2,3,4,6,7,8-HpCDF	12.2	15.5	10.1
1,2,3,4,7,8,9-HpCDF	2.9	2.9	2.0
Emission Rate (10^{-8} g/sec)			
2,3,7,8-TCDD	.036	.034	.020
1,2,3,7,8-PeCDD	.15	.19	.091
1,2,3,4,7,8-HxCDD	.28	.29	.21
1,2,3,6,7,8-HxCDD	.92	1.01	.74
1,2,3,7,8,9-HxCDD	.53	.47	.32
1,2,3,4,6,7,8-HpCDD	7.00	7.95	5.49
2,3,7,8-TCDF	1.12	.19	.14
1,2,3,7,8-PeCDF	.56	.78	.58
2,3,4,7,8-PeCDF	.62	1.01	.55
1,2,3,4,7,8-HxCDF	.82	.88	.74
1,2,3,6,7,8-HxCDF	1.09	1.29	1.17
1,2,3,7,8,9-HxCDF	.24	.24	.22
2,3,4,6,7,8-HxCDF	1.78	1.93	1.72
1,2,3,4,6,7,8-HpCDF	4.01	5.24	3.28
1,2,3,4,7,8,9-HpCDF	.95	.98	.65

Table 9. Results of the Dioxin Determination on the Unit 2 Incinerator at the Pope/Douglas Waste to Energy Facility Presented in 2,3,7,8-TCDD Equivalents.

		2,3,7,8-TCDD Equivalents		
	TEF	Run 1	Run 2	Run 3
Concentration	**(ng/dsm^3)**			
2,3,7,8-TCDD	1	.11	.10	.061
Other TCDDs	.01	.033	.057	.030
2,3,7,8-PeCDD	.5	.22	.29	.14
Other PeCDDs	.005	.050	.064	.045
2,3,7,8-HxCDD	.04	.21	.21	.16
Other HxCDDs	.0004	.0081	.0089	.0071
2,3,7,8-HpCDD	.001	.021	.024	.017
Other HpCDDs	.00001	.00019	.00021	.00015
2,3,7,8-TCDF	.1	.34	.057	.042
Other TCDFs	.001	.012	.022	.014
2,3,7,8-PeCDF	.1	.36	.53	.35
Other PeCDFs	.001	.016	.024	.016
2,3,7,8-HxCDF	.01	.12	.128	.12
Other HxCDFs	.0001	.0016	.0020	.0011
2,3,7,8-HpCDF	.001	.015	.018	.012
Other HpCDFs	.00001	.000083	.000091	.000056
Total		1.52	1.54	1.02
Emission Rate (10^{-8}g/sec)				
2,3,7,8-TCDD	1	.036	.034	.020
Other TCDDs	.01	.011	.020	.0098
2,3,7,8-PeCDD	.5	.075	.095	.046
Other PeCDDs	.005	.016	.022	.015
2,3,7,8-HxCDD	.04	.069	.071	.051
Other HxCDDs	.0004	.0027	.0030	.0023
2,3,7,8-HpCDD	.001	.0070	.0080	.0055
Other HpCDDs	.00001	.000063	.000073	.000049
2,3,7,8-TCDF	.1	.112	.019	.014
Other TCDFs	.001	.0040	.0073	.0045
2,3,7,8-PeCDF	1	.109	.179	.113
Other PeCDFs	.001	.0054	.0082	.0052
2,3,7,8-HxCDF	.01	.039	.043	.039
Other HxCDFs	.0001	.00051	.00069	.00036
2,3,7,8-HpCDF	.001	.0050	.0062	.0039
Other HpCDFs	.00001	.000027	.000031	.000019
Total		.4917	.5165	.3296

TEF = Toxicity equivalence factor

2.3.10 Supplemental Results

Although outside the scope of its contract, Interpoll Labs performed several additional measurements at the request of HDR or MPCA personnel. These measurements included static pressure determinations at the inlet and outlet of each of the two waste heat boilers to allow calculations of the differential pressure across the boilers. These results are shown in Table 10.

The second set of measurements consisted of a verification of the homogenity of the exhaust gas stream at the outlet of the waste heat boilers on both units. This series of measurements was performed to ensure the representiveness of the data derived from the CCGM system, since the sample gas stream for the system was extracted at this point in the flow system on both incinerators. The results of these tests, shown in Table 11, demonstrate the areal uniformity in gas composition at this point in each of the two incinerator trains flow systems.

Table 10. Summary of the Results of the Static Pressure Measurements Performed on the Unit 1 and 2 Waste Heat Boilers.

Date	Unit	Test/Run	Pressure (IN.WC,)		
			Inlet	Outlet	Differential
7-23-87	1	1/1	-1.5	-2.6	1.1
7-23-87	1	1/2	-1.8	-3.2	1.4
7-23-87	1	1/3	-1.7	-3.0	1.3
7-24-87	2	2/1	-2.1	-3.2	1.1
7-24-87	2	2/2	-2.2	-3.4	1.2
7-25-87	2	2/3	-2.0	-3.2	1.2
7-25-87	2	2/4	-2.2	-3.7	1.5
7-26-87	2	2/5	-2.0	-3.7	1.7

Note: The static pressure measurements presented above were made by Interpoll laboratories personnel outside the scope of this contract at the request of HDR personnel.

Table 11. Combustion Gas Stratification Test Performed at the Unit 1 and 2 Incinerator Outlet Test Sites.

Traverse Point	Oxygen Concentration (% v/v, dry)	
	Unit 1	Unit 2
A-1	14.7	12.8
A-2	14.8	12.8
A-3	14.8	12.8
A-4	14.8	12.8
A-5	14.8	12.9
A-6	14.8	12.8
A-7	14.8	12.8
A-8	14.8	12.7
A-1	14.8	12.6
A-2	14.8	12.7
A-3	14.9	12.7
A-4	14.8	12.8
A-5	14.8	12.8
A-6	14.8	12.8
A-7	14.7	12.6
A-8	14.7	12.7

Note: The above tests were performed at these locations at the request of the MPCA to ensure that combustion gases were not stratified at the point in the flow system where the slip stream was to be extracted for the Continuous Emission Monitor System (CEM). The above tests were performed prior to continuous emission monitoring on the two units. A Teledyne Model 320P Oxygen Analyzer was used for the determinations.

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition results (Orsat and moisture) are presented first followed by the computer printout of the particulate, sulfur dioxide, hydrogen chloride, oxides of nitrogen, visible emissions, lead, beryllium, arsenic, mercury, VOCs and PCDDs and PCDFs determinations. Preliminary measurements including test port locations are given in the appendices.

The results have been calculated on a Sperry PC Computer using programs written in Extended BASIC specifically for source testing calculations. EPA-published equations have been used as the basis of the calculation techniques in these programs.

The particulate emission rate has been calculated using the product of the concentration times flow method (as recommended by the EPA).

3.1 Results of Orsat and Moisture Analyses

Test No. 1
Unit 1 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

Date of run	Run 1 07-21-87	Run 2 07-21-87	Run 3 07-21-87
Dry basis (orsat)			
carbon dioxide.....	6.45	6.30	6.80
oxygen.....	13.80	13.90	13.35
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.75	79.80	79.85
Wet basis (orsat)			
carbon dioxide.....	5.61	5.59	5.98
oxygen.....	12.01	12.34	11.75
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	69.42	70.83	70.26
water vapor.....	12.96	11.24	12.01
Dry molecular weight.....	29.58	29.56	29.62
Wet molecular weight.....	28.08	28.26	28.23
Specific gravity.....	0.970	0.976	0.975
Water mass flow.....(LB/HR)	2775	2505	2700

FD	1.101	1.111	1.110

Test No. 2
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

Date of run	Run 1 07-22-87	Run 2 07-22-87	Run 3 07-22-87
Dry basis (orsat)			
carbon dioxide.....	6.80	7.50	6.20
oxygen.....	13.35	12.90	14.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.85	79.60	79.80
Wet basis (orsat)			
carbon dioxide.....	5.84	6.56	5.29
oxygen.....	11.47	11.29	11.96
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	68.60	69.65	68.14
water vapor.....	14.09	12.50	14.61
Dry molecular weight.....	29.62	29.72	29.55
Wet molecular weight.....	27.98	28.25	27.86
Specific gravity.....	0.967	0.976	0.963
Water mass flow.....(LB/HR)	3119	2694	3144

FO	1.110	1.067	1.113

Test No. 3
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	07-22-87	07-22-87	07-22-87
Dry basis (orsat)			
carbon dioxide.....	6.80	7.50	6.20
oxygen.....	13.35	12.70	14.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.85	79.80	79.80
Wet basis (orsat)			
carbon dioxide.....	5.92	6.49	5.33
oxygen.....	11.63	10.99	12.04
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	69.55	69.08	68.62
water vapor.....	12.89	13.43	14.01
Dry molecular weight.....	29.62	29.71	29.55
Wet molecular weight.....	28.12	28.14	27.93
Specific gravity.....	0.971	0.972	0.965

FO	1.110	1.093	1.113

Test No. 5
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

Date of run	Run 1 07-22-87	Run 2 07-22-87	Run 3 07-22-87
Dry basis (orsat)			
carbon dioxide.....	6.05	6.60	6.40
oxygen.....	14.10	13.60	13.75
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.85	79.80	79.85
Wet basis (orsat)			
carbon dioxide.....	5.25	5.66	5.47
oxygen.....	12.23	11.67	11.74
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	69.28	68.45	68.19
water vapor.....	13.24	14.23	14.61
Dry molecular weight.....	29.53	29.60	29.57
Wet molecular weight.....	28.00	27.95	27.88
Specific gravity.....	0.967	0.965	0.963

FO	1.124	1.106	1.117

Test No. 6
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1
Date of run	07-22-87
Dry basis (orsat)	
carbon dioxide.....	6.05
oxygen.....	14.10
carbon monoxide.....	0.00
nitrogen.....	79.85
Wet basis (orsat)	
carbon dioxide.....	5.29
oxygen.....	12.32
carbon monoxide.....	0.00
nitrogen.....	69.76
water vapor.....	12.64
Dry molecular weight.....	29.53
Wet molecular weight.....	28.07
Specific gravity.....	0.970

Test No. 8
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	07-23-87	07-23-87	07-24-87
Dry basis (orsat)			
carbon dioxide.....	6.25	6.40	6.50
oxygen.....	14.05	13.80	13.75
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.70	79.80	79.75
Wet basis (orsat)			
carbon dioxide.....	5.47	5.61	5.66
oxygen.....	12.30	12.10	11.97
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	69.76	69.97	69.43
water vapor.....	12.47	12.32	12.94
Dry molecular weight.....	29.56	29.58	29.59
Wet molecular weight.....	28.12	28.15	28.09
Specific gravity.....	0.971	0.972	0.970

FO

1.096	1.109	1.100

Test No. 9
Unit 2 Incinerator Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1
Date of run	07-23-87
Dry basis (orsat)	
carbon dioxide.....	6.25
oxygen.....	14.05
carbon monoxide.....	0.00
nitrogen.....	79.70
Wet basis (orsat)	
carbon dioxide.....	5.39
oxygen.....	12.11
carbon monoxide.....	0.00
nitrogen.....	68.70
water vapor.....	13.80
Dry molecular weight.....	29.56
Wet molecular weight.....	27.97
Specific gravity.....	0.966

3.2 Results of Particulate Loading Determinations

Test No. 1
Unit 1 Incinerator Stack

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	07-21-87	07-21-87	07-21-87
Time run start/end.....(HRS)	1055/1159	1235/1338	1425/1529
Static pressure.....(IN.WC)	-0.21	-0.21	-0.21
Cross sectional area (SQ.FT)	6.87	6.87	6.87
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	162.0	137.0	144.0
desiccant.....(GRAMS)	27.0	23.0	31.0
total.....(GRAMS)	189.0	160.0	175.0
Total particulate material..			
.....collected(grams)	0.0568	0.0677	0.0557
Gas meter coefficient.....	1.0002	1.0002	1.0002
Barometric pressure..(IN.HG)	28.70	28.70	28.70
Avg. orif.pres.drop..(IN.WC)	3.41	3.50	3.54
Avg. gas meter temp..(DEF-F)	88.5	100.0	100.5
Volume through gas meter....			
at meter conditions...(CF)	64.29	65.31	66.34
standard conditions.(DSCF)	59.87	59.58	60.48
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.425	.425	.425
Avg.stack gas temp ..(DEG-F)	415	418	412
Volumetric flow rate.....			
actual.....(ACFM)	13193	13779	13815
dry standard.....(DSCFM)	6646	7055	7055
Isokinetic variation.....(%)	104.8	98.3	99.7
Particulate concentration...			
actual.....(GR/ACF)	0.00737	0.00897	0.00725
dry standard.....(GR/DSCF)	0.01464	0.01753	0.01421
Particle mass rate...(LB/HR)	0.83	1.06	0.86

Test No. 2
Unit 2 Incinerator Stack

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	07-22-87	07-22-87	07-22-87
Time run start/end.....(HRS)	1235/1340	1415/1520	1600/1706
Static pressure.....(IN.WC)	-0.20	-0.20	-0.20
Cross sectional area (SQ.FT)	6.87	6.87	6.87
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	127.0	122.0	132.0
desiccant.....(GRAMS)	35.0	15.0	32.0
total.....(GRAMS)	162.0	137.0	164.0
Total particulate material..			
.....collected(grams)	0.0813	0.0711	0.0593
Gas meter coefficient.....	1.0002	1.0002	1.0002
Barometric pressure..(IN.HG)	28.51	28.51	28.51
Avg. orif.pres.drop..(IN.WC)	2.10	2.10	1.98
Avg. gas meter temp..(DEF-F)	90.3	94.2	94.0
Volume through gas meter....			
at meter conditions...(CF)	50.69	49.53	49.54
standard conditions.(DSCF)	46.59	45.20	45.21
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.377	.377	.377
Avg.stack gas temp ..(DEG-F)	415	425	417
Volumetric flow rate.....			
actual.....(ACFM)	13734	13518	13377
dry standard.....(DSCFM)	6781	6721	6553
Isokinetic variation.....(%)	101.6	99.4	102.0
Particulate concentration...			
actual.....(GR/ACF)	0.01329	0.01206	0.00991
dry standard.....(GR/DSCF)	0.02693	0.02427	0.02024
Particle mass rate...(LB/HR)	1.57	1.40	1.14

Test No. 7
Unit 2 Incinerator Stack

3.3 Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	07-23-87	07-23-87	07-23-87
Time run start/end.....(HRS)	1041/1146	1154/1254	1302/1402
Barometric pressure..(IN.HG)	28.44	28.44	28.44
Meter temperature....(DEG-F)	88.92	94.50	98.25
Meter correction coefficient	0.9962	0.9962	0.9962
Volume through gas meter....			
at meter conditions...(CF)	47.100	47.400	47.820
standard conditions..(SCF)	43.094	42.932	43.021
Total sampling time....(MIN)	65.0	60.0	60.0
Moisture content.....(%V/V)	12.62	14.47	16.48
Milliequivalents of SO4 in..			
gas sample.....	5.5200	7.0800	7.4000
Sulfur dioxide concentration			
(GR/DSCF).....	0.0633	0.0815	0.0850
(MG/DSCM).....	145	187	195
(PPM-DRY).....	54	70	73
(PPM-WET).....	48	60	61
SO2 Emission rate....(LB/HR)	3.78	4.87	5.08

Test No. 7
Unit 2 Incinerator Stack

3.4 Results of HCl Determinations

	Run 1	Run 2	Run 3
Date of run	07-23-87	07-23-87	07-23-87
Time run start/end.....(HRS)	1041-1146	1154-1254	1302-1402
Barometric pressure..(IN.HG)	28.44	28.44	28.44
Meter temperature....(DEG-F)	88.92	94.50	98.25
Meter correction coefficient	0.9962	0.9962	0.9962
Volume through gas meter.... at meter conditions...(CF)	47.100	47.400	47.820
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	12.62	14.47	16.48
Volumetric flow rate (DSCFM)	6972	6972	6972
HCl in sample.....(mG)	262.25	282.82	339.38
HCl concentration.....			
(GR/DSCF).....	0.0939	0.1016	0.1217
(MG/DSCM).....	214.98	232.71	278.68
(PPM-DRY).....	141.80	153.50	183.82
(PPM-WET).....	123.91	131.29	153.52
HCl emission rate....(LB/HR)	5.61	6.07	7.27

HCl = Hydrogen chloride

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.5 Results of Oxides of Nitrogen Determinations

Test No. 4
Unit 2 Incinerator Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 1A	Run 1B	Run 1C	Run 1D
Date of run.....	07-22-87	07-22-87	07-22-87	07-22-87
Time of run.....(HRS)	1240	1255	1310	1325
Flask number.....	13	14	15	16
Volume of flask.....(ML)	2060	2048	2045	2067
Data: time of sampling				
flask temperature..(DEG-F)	88.00	98.00	95.00	95.00
bar. press.....(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.....(IN.HG)	27.90	27.80	27.70	27.95
flask abs. press...(IN.HG)	0.60	0.70	0.80	0.55
Data: Time of Flask Opening				
flask temperature..(DEG-F)	74.00	74.00	74.00	74.00
lab. bar. press....(IN.HG)	29.05	29.05	29.05	29.05
flask static press.(IN.HG)	-1.85	-2.00	-2.20	-1.40
flask abs. press...(IN.HG)	27.20	27.05	26.85	27.65
Volume gas sampled....(DSML)	1789	1763	1740	1829
Nitrate in gas sample...(uG)	670.0	666.0	586.0	819.0
NO2 in gas sample.....(uG)	497.1	494.2	434.8	607.7
NOx Concentration				
(GR/DSCF).....	0.1214	0.1225	0.1092	0.1452
(MG/DSCM).....	278	280	250	332
(PPM-DRY).....	145	147	131	174
NOX Emission rate....(LB/HR)	7.06	7.12	6.35	8.44

Test No. 4
Unit 2 Incinerator Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 2A	Run 2B	Run 2C	Run 2D
Date of run.....	07-22-87	07-22-87	07-22-87	07-22-87
Time of run.....(HRS)	1420	1435	1450	1505
Flask number.....	17	18	19	20
Volume of flask.....(ML)	2054	2045	2069	2060
Data: time of sampling				
flask temperature..(DEG-F)	93.00	94.00	94.00	94.00
bar. press.....(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.....(IN.HG)	28.05	28.00	28.05	28.10
flask abs. press...(IN.HG)	0.45	0.50	0.45	0.40
Data: Time of Flask Opening				
flask temperature..(DEG-F)	74.00	74.00	74.00	74.00
lab. bar. press....(IN.HG)	29.05	29.05	29.05	29.05
flask static press.(IN.HG)	-2.35	-1.80	-0.80	-0.65
flask abs. press...(IN.HG)	26.70	27.25	28.25	28.40
Volume gas sampled....(DSML)	1760	1786	1878	1883
Nitrate in gas sample...(uG)	766.0	867.0	764.0	683.0
NO2 in gas sample.....(uG)	568.4	643.3	566.9	506.8
NOx Concentration				
(GR/DSCF).....	0.1411	0.1574	0.1319	0.1176
(MG/DSCM).....	323	360	302	269
(PPM-DRY).....	169	188	158	141
NOX Emission rate....(LB/HR)	8.13	9.07	7.60	6.77

Test No. 4
Unit 2 Incinerator Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 3A	Run 3B	Run 3C	Run 3D
Date of run.....	07-22-87	07-22-87	07-22-87	07-22-87
Time of run.....(HRS)	1605	1620	1635	1650
Flask number.....	21	22	23	55
Volume of flask.....(ML)	2068	2031	2056	2086
Data: time of sampling				
flask temperature..(DEG-F)	89.00	90.00	89.00	90.00
bar. press.....(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.....(IN.HG)	28.00	27.95	28.05	27.80
flask abs. press...(IN.HG)	0.50	0.55	0.45	0.70
Data: Time of Flask Opening				
flask temperature..(DEG-F)	74.00	74.00	74.00	74.00
lab. bar. press....(IN.HG)	29.05	29.05	29.05	29.05
flask static press.(IN.HG)	-2.25	-0.70	-0.65	-2.40
flask abs. press...(IN.HG)	26.80	28.35	28.40	26.65
Volume gas sampled....(DSML)	1776	1843	1876	1768
Nitrate in gas sample...(uG)	672.0	665.0	654.0	719.0
NO2 in gas sample.....(uG)	498.6	493.4	485.3	533.5
NOx Concentration				
(GR/DSCF).....	0.1227	0.1170	0.1130	0.1319
(MG/DSCM).....	281	268	259	302
(PPM-DRY).....	147	140	135	158
NOX Emission rate....(LB/HR)	6.89	6.57	6.35	7.41

3.6 Results of Opacity Observations

Test No. 1
Unit 1 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	47.50
5	0.0223	40.83
10	0.0458	11.67
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 3.21	Avg OD 0.0144	Time average

Observer: R. Rosenthal
Cert. Date: 04-23-87
Date of Observation: 07-21-87
Time of Observation: 1055-1155

Test No. 1
Unit 1 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	89.17
5	0.0223	10.00
10	0.0458	0.83
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 0.58	Avg OD 0.0026	Time average

Observer: R. Rosenthal
Cert. Date: 04-23-87
Date of Observation: 07-21-87
Time of Observation: 1240-1340

Test No. 1
Unit 1 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	100.00
5	0.0223	0.00
10	0.0458	0.00
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 0.00	Avg OD 0.0000	Time average

Observer: R. Downs
Cert. Date: 04-23-87
Date of Observation: 07-21-87
Time of Observation: 1426-1526

Test No. 2
Unit 2 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	80.83
5	0.0223	15.83
10	0.0458	3.33
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 1.12	Avg OD 0.0051	Time average

Observer: R. Downs
Cert. Date: 04-23-87
Date of Observation: 07-22-87
Time of Observation: 1225-1325

Test No. 2
Unit 2 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	63.33
5	0.0223	32.50
10	0.0458	2.50
15	0.0706	1.67
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00
Avg Opac 2.13	Avg OD 0.0096	Time average

Observer: R. Downs
Cert. Date: 04-23-87
Date of Observation: 07-22-87
Time of Observation: 1415-1515

Test No. 2
Unit 2 Incinerator Stack

Results of Opacity Observations ---------- EPA Method 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0.0000	92.90
5	0.0223	6.70
10	0.0458	0.40
15	0.0706	0.00
20	0.0969	0.00
25	0.1249	0.00
30	0.1549	0.00
35	0.1871	0.00
40	0.2219	0.00
45	0.2596	0.00
50	0.3010	0.00
55	0.3468	0.00
60	0.3979	0.00
65	0.4559	0.00
70	0.5229	0.00
75	0.6021	0.00
80	0.6690	0.00
85	0.8239	0.00
90	1.0000	0.00
95	1.3010	0.00
99	2.0000	0.00

Avg Opac 0.38 Avg OD 0.0017 Time average

Observer: R. Downs
Cert. Date: 04-23-87
Date of Observation: 07-22-87
Time of Observation: 1600-1700

Test No. 3
Unit 2 Incinerator Stack

3.7 Results of Lead Determinations----------Method 12

	Run 1	Run 2	Run 3
Date of run	07-22-87	07-22-87	07-22-87
Time run start/end.....(HRS)	1235-1540	1415-1520	1600-1706
Barometric pressure..(IN.HG)	28.51	28.51	28.51
Meter temperature....(DEG-F)	92.30	97.00	94.70
Meter correction coefficient	0.9962	0.9962	0.9962
Volume through gas meter....			
at meter conditions...(CF)	49.940	49.080	48.780
standard conditions (DSCF)	45.568	44.395	44.305
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	12.89	13.43	14.01
Volumetric flow rate (DSCFM)	6879	6723	6718
Lead in sample.....(uG)	540.00	1100.00	420.00
Lead concentration.....			
(GR/DSCF).....	0.0002	0.0004	0.0001
(MG/DSCM).....	0.42	0.88	0.34
Lead emission rate...(LB/HR)	0.011	0.022	0.008

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 3
Unit 2 Incinerator Stack

3.8 Results of Beryllium Determinations----------Method 104

	Run 1	Run 2	Run 3
Date of run	07-22-87	07-22-87	07-22-87
Time run start/end.....(HRS)	1235-1540	1415-1520	1600-1706
Barometric pressure..(IN.HG)	28.51	28.51	28.51
Meter temperature....(DEG-F)	92.30	97.00	94.70
Meter correction coefficient	0.9962	0.9962	0.9962
Volume through gas meter....			
at meter conditions...(CF)	49.940	49.080	48.780
standard conditions (DSCF)	45.568	44.395	44.305
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	12.89	13.43	14.01
Volumetric flow rate (DSCFM)	6879	6723	6718
Beryllium in sample.....(uG)	3.000<	3.000<	3.000<
Beryllium concentration.....			
(GR/10^3DSCF).....	0.0010<	0.0010<	0.0010<
(uG/DSCM).....	2.33<	2.39<	2.39<
Beryllium emission rate.....			
(10^{-3}LB/HR).....	0.06<	0.06<	0.06<

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 5
Unit 2 Incinerator Stack

3.9 Results of Arsenic Determinations---------- Method 108

	Run 1	Run 2	Run 3
Date of run	07-22-87	07-22-87	07-22-87
Time run start/end.....(HRS)	1750-1853	1910-2015	2100-2203
Barometric pressure..(IN.HG)	28.51	28.51	28.51
Meter temperature....(DEG-F)	95.40	95.90	96.10
Meter correction coefficient	0.9962	0.9962	0.9962
Volume through gas meter....			
at meter conditions...(CF)	48.380	48.640	48.700
standard conditions (DSCF)	43.882	44.080	44.119
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	13.24	14.23	14.61
Volumetric flow rate (DSCFM)	6737	6650	6664
As in sample.....(uG)	0.82	0.62	0.74
As concentration.....			
(GR/10^{3}DSCF).....	0.0003	0.0002	0.0003
(uG/DSCM).....	0.66	0.50	0.59
As emis. rate....(10^{-3}LB/HR)	0.02	0.01	0.01

As = Arsenic

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Test No. 9
Unit 2 Incinerator Stack

3.10 Results of Mercury Determinations----------Method 101A

	Run 1
Date of run	07-23-87
Time run start/end.....(HRS)	1638-1840
Barometric pressure..(IN.HG)	28.44
Meter temperature....(DEG-F)	90.90
Meter correction coefficient	0.9962
Volume through gas meter....	
at meter conditions...(CF)	0.000
standard conditions (DSCF)	35.342
Total sampling time....(MIN)	120
Moisture content.....(%V/V)	13.80
Volumetric flow rate (DSCFM)	0
Mercury in sample.....(uG)	65.50
Hg concentration.....	
(GR/10^{3}DSCF).....	0.0286
(uG/DSCM).....	65.50
Hg emis. rate....(10^{-3}LB/HR)	1.62

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

Note: Results above are based on the total of both solid and gaseous mercury emissions. Gaseous mercury emissions accounted for 98% of total emissions.

3.11 Results of VOC Determinations

RESEARCH TRIANGLE LABORATORIES
METHOD 25 TABLE OF RESULTS

Name: Interpoll ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample Number	Sample Description	Concentrations (ppmC) CO+CH4	CO2	Noncon-densibles	Conden-sibles	TGNMO	Mass Conc. (mgC/cu.m)
0	Field Blank	6	2244	24	24	49	24
1	Test#9-Run#1	8	16455	40	47	87	43
2	Test#9-Run#2	8	8997	15	31	46	23
3	Test#9-Run#3	9	7327	25	197	222	110

RESEARCH TRIANGLE LABORATORIES
METHOD 25 DATA REPORT

Name: Interpoll

ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample # 0 Field Blank

TANK new 92:
Volume (cu.m) = 0.004438

	Pressure (mm Hg)	Temp. (K)
Presampling	3.6	299.8
Postsampling	722.4	299.8
Final	948.0	299.2

Volume Sampled (dscm) = 0.004107

TRAP IC

COLLECTION VESSEL:
Volume (cu.m) = 0.002443

	Pressure (mm Hg)	Temp. (K)
Final	1133.0	319.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	239.5	196.7
Blank (ppmC)	3.8	
Blank Area (area units)		4626

Areas:

CO + CH4	992	1,050	1,108
CO2	406,780	406,550	406,330
Noncondensibles	7,253	8,677	8,822
Condensibles	8,300	8,504	7,212

Concentrations (ppmC):

		%RSD
CO + CH4	5.7948	5.5238
CO2	2243.7120	0.0553
Noncondensibles	24.3567	23.9206
Condensibles	24.1473	9.7893
TGNMO	48.5040	

(= 24.1550 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES
METHOD 25 DATA REPORT

Name: Interpoll

ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample # 1 Test#9-Run#1

TANK new 93:
Volume (cu.m) = 0.004552

	Pressure (mm Hg)	Temp. (K)
Presampling	6.1	300.9
Postsampling	697.0	301.5
Final	958.0	299.2

Volume Sampled (dscm) = 0.004026

TRAP IK

COLLECTION VESSEL:
Volume (cu.m) = 0.002443

	Pressure (mm Hg)	Temp. (K)
Final	1205.0	319.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	245.1	189.5
Blank (ppmC)	3.8	
Blank Area (area units)		3411

Areas:

CO + CH4	1,248	1,470	1,257
CO2	2,882,000	2,887,400	2,888,600
Noncondensibles	8,960	8,795	8,742
Condensibles	14,944	14,896	11,785

Concentrations (ppmC):

		%RSD
CO + CH4	7.5547	9.4833
CO2	16454.9800	0.1218
Noncondensibles	39.9798	2.0972
Condensibles	46.6975	13.9849
TGNMO	86.6773	

(= 43.1653 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES
METHOD 25 DATA REPORT

Name: Interpoll

ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample # 2 Test#9-Run#2

TANK new 94:
Volume (cu.m) = 0.004569

	Pressure (mm Hg)	Temp. (K)
Presampling	3.6	301.5
Postsampling	674.1	302.0
Final	907.0	299.2

Volume Sampled (dscm) = 0.003915

TRAP IM COLLECTION VESSEL:
Volume (cu.m) = 0.002443

	Pressure (mm Hg)	Temp. (K)
Final	1127.0	318.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	245.3	195.9
Blank (ppmC)	3.8	
Blank Area (area units)		3411

Areas:

CO + CH4	1,494	1,638	1,415
CO2	1,615,600	1,616,900	1,615,300
Noncondensibles	5,129	6,772	4,803
Condensibles	10,272	9,461	9,502

Concentrations (ppmC):

		%RSD
CO + CH4	8.4383	7.4599
CO2	8996.5000	0.0526
Noncondensibles	15.0371	48.9271
Condensibles	30.6509	5.1840
TGNMO	45.6880	

(= 22.7526 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES
METHOD 25 DATA REPORT

Name: Interpoll ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample # 3 Test#9-Run#3

TANK new 95:
Volume (cu.m) = 0.004553

	Pressure (mm Hg)	Temp. (K)
Presampling	3.6	302.6
Postsampling	674.1	303.2
Final	946.0	300.2

Volume Sampled (dscm) = 0.003887

TRAP IW COLLECTION VESSEL:
Volume (cu.m) = 0.002443

	Pressure (mm Hg)	Temp. (K)
Final	1176.0	319.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	243.1	195.6
Blank (ppmC)	3.8	
Blank Area (area units)		3411

Areas:

CO + CH4	1,724	1,537	1,585
CO2	1,252,300	1,249,300	1,248,600
Noncondensibles	6,530	6,829	7,127
Condensibles	54,808	54,393	54,059

Concentrations (ppmC):

		%RSD
CO + CH4	9.4679	6.0124
CO2	7326.9830	0.1572
Noncondensibles	24.8965	8.7340
Condensibles	196.6983	0.7014
TGNMO	221.5948	

(= 110.3542 mgC/cu.m)

RESEARCH TRIANGLE LABORATORIES
METHOD 25 SAMPLE CALCULATION

Note: All pressure values have been converted when necessary to mm Hg and all temperature values to Kelvin.

Name: Interpoll ID #87-100-279 Date: 7/31/87 - 8/3/87

Sample # 1 Test#9-Run#1

DATA

Tank new 93:
Volume (cu.m) = 0.004552

	Pressure (mm Hg)	Temp. (K)
Presampling	6.1	300.9
Postsampling	697.0	301.5
Final	958.0	299.2

Trap IK

Collection Vessel:
Volume (cu.m) = 0.002443

	Pressure (mm Hg)	Temp. (K)
Final	1205.0	319.2

Calibration Data:

	CO2	Backflush
Response Factor (area units/ppmC)	245.1	189.5
Blank (ppmC)	3.8	
Blank Area (area units)		3411

Areas:

CO + CH4	1,248	1,470	1,257
CO2	2,882,000	2,887,400	2,888,600
Noncondensibles	8,960	8,795	8,742
Condensibles	14,944	14,896	11,785

CALCULATIONS

Measured Concentrations, corrected for blank:

Cm(CO+CH4) = Area(CO+CH4)/RF(CO2)
= 1248 /245 = 5.1
= 1470 /245 = 6.0
= 1257 /245 = 5.1

Cm(CO2) = Area(CO2)/RF(CO2)
= 2882000 /245 = 11758.5
= 2887400 /245 = 11780.5
= 2888600 /245 = 11785.4

Cm(Noncondensibles) = [Area(Noncondensibles) - Blank Area(NMO)]/RF(NMO)
= (8960 - 3411)/190 = 29.3
= (8795 - 3411)/190 = 28.4
= (8742 - 3411)/190 = 28.1

Cm(Condensibles) = Area(Condensibles)/RF(CO2) - Blank(CO2)
= 14944 /245 - 3.8 = 57.2
= 14896 /245 - 3.8 = 57.0
= 11785 /245 - 3.8 = 44.3

Pressure-Temperature Ratio, Q(i) = P(i)/T(i):

postsampling tank: Q(1) = 696.976 / 301.4833 = 2.311823
presampling tank: Q(2) = 6.095994 / 300.9278 = 2.025733E-02
final tank: Q(3) = 958 / 299.15 = 3.202407
final CV: Q(4) = 1205 / 319.15 = 3.775654

Volume Sampled (dscm) = 0.386 x Tank Volume x [Q(1)-Q(2)]
= 0.386 x .004552 x [2.3118 - 0.0203]
= 0.004026

Averages and % Relative Standard Deviations (%RSD) of Cm's are calculated.
(%RSD of C = %RSD of Cm)

Calculated Concentrations:

C(CO+CH4) = Q(3)/[Q(1)-Q(2)] x Cm(CO+CH4)
= 3.2024/(2.3118 - 0.0203) x 5.4 = 7.6

C(CO2) = Q(3)/[Q(1)-Q(2)] x Cm(CO2)
= 3.2024/(2.3118 - 0.0203) x 11774.8 = 16455.0

C(Noncondensibles) = Q(3)/[Q(1)-Q(2)] x Cm(Noncondensibles)
= 3.2024/(2.3118 - 0.0203) x 28.6 = 40.0

C(Condensibles)
= Volume(CV)/Volume(Tank) x Q(4)/[Q(1)-Q(2)] x Cm(Condensibles)
= 0.002443/0.004552 x 3.7757/(2.3118 - 0.0203) x 52.8 = 46.7

Total Gaseous Non-Methane Organics(TGNMO)=C(Noncondensibles)+C(Condensibles)
= 40.0 + 46.7
= 86.7

Mass Concentration = 0.498 x TGNMO
= 0.498 x 86.7 = 43.2

3.12 Results of PCDDs and PCDFs Determinations

Test No. 8
Unit 2 Incinerator Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5132-(01-04)
Date of run	07-23-87
Time run start/end.....(HRS)	
PCDD homolog distribution...	
TCDD.....(ng)	<.052
PeCDD.....(ng)	<.050
HxCDD.....(ng)	<.053
HpCDD.....(ng)	.49
OCDD.....(ng)	1.2
PCDF homolog distribution...	
TCDF.....(ng)	<.039
PeCDF.....(ng)	<.061
HxCDF.....(ng)	<.032
HpCDF.....(ng)	<.13
OCDF.....(ng)	<.18

Test No. 8
Unit 2 Incinerator Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5132-(06-09)	(11-14)	(16-19)
Date of run	07-23-87	07-23-87	07-24-87
Time run start/end.....(HRS)	915/1330	1530/1945	800/1215
PCDD homolog distribution...			
TCDD.....(ng)	12.3	21.5	11.1
PeCDD.....(ng)	37.6	49.5	33.2
HxCDD.....(ng)	91.5	102	77.8
HpCDD.....(ng)	146	166	114
OCDD.....(ng)	164	194	129
PCDF homolog distribution...			
TCDF.....(ng)	56.2	81.9	50.5
PeCDF.....(ng)	71.2	110	68.9
HxCDF.....(ng)	98.2	123	81.1
HpCDF.....(ng)	84.3	102	63.2
OCDF.....(ng)	43.0	52.7	29.4

Test No. 8
Unit 2 Incinerator Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Field Blank
Sample log number	5132-(01-04)
Date of run	07-23-87
Time run start/end.....(HRS)	
PCDD Isomer distribution....	
2,3,7,8-TCDD.....(ng)	<.052
1,2,3,7,8-PeCDD.....(ng)	<.0091
1,2,3,4,7,8-HxCDD.....(ng)	<.019
1,2,3,6,7,8-HxCDD.....(ng)	<.026
1,2,3,7,8,9-HxCDD.....(ng)	<.036
1,2,3,4,6,7,8-HpCDD...(ng)	.26
PCDF Isomer distribution....	
2,3,7,8-TCDF.....(ng)	<.018
1,2,3,7,8-PeCDF.....(ng)	<.034
2,3,4,7,8-PeCDF.....(ng)	<.021
1,2,3,4,7,8-HxCDF.....(ng)	<.034
1,2,3,6,7,8-HxCDF.....(ng)	<.030
1,2,3,7,8,9-HxCDF.....(ng)	<.019
2,3,4,6,7,8-HxCDF.....(ng)	<.037
1,2,3,4,6,7,8-HpCDF...(ng)	<.13
1,2,3,4,7,8,9-HpCDF...(ng)	<.052

Test No. 8
Unit 2 Incinerator Stack

Results of PCDD and PCDF HRGC/HRMS Analysis----------

	Run 1	Run 2	Run 3
Sample log number	5132-(06-09)	(11-14)	(16-19)
Date of run	07-23-87	07-23-87	07-24-87
Time run start/end.....(HRS)	915/1330	1530/1945	800/1215
PCDD Isomer distribution....			
2,3,7,8-TCDD.....(ng)	.40	.37	.22
1,2,3,7,8-PeCDD.....(ng)	1.6	2.1	1.4
1,2,3,4,7,8-HxCDD.....(ng)	3.1	3.2	2.3
1,2,3,6,7,8-HxCDD.....(ng)	10.1	11.0	8.4
1,2,3,7,8,9-HxCDD.....(ng)	5.7	5.2	3.6
1,2,3,4,6,7,8-HpCDD...(ng)	77.0	87.4	60.6
PCDF Isomer distribution....			
2,3,7,8-TCDF.....(ng)	12.4	2.1	1.5
1,2,3,7,8-PeCDF.....(ng)	6.2	8.6	6.5
2,3,4,7,8-PeCDF.....(ng)	7.0	11.0	6.2
1,2,3,4,7,8-HxCDF.....(ng)	9.0	9.7	8.1
1,2,3,6,7,8-HxCDF.....(ng)	11.7	14.0	13.0
1,2,3,7,8,9-HxCDF.....(ng)	2.6	2.6	2.4
2,3,4,6,7,8-HxCDF.....(ng)	19.3	21.0	19.0
1,2,3,4,6,7,8-HpCDF...(ng)	43.9	57.6	36.21
1,2,3,4,7,8,9-HpCDF...(ng)	10.4	10.8	7.0

Test No. 8
Unit 2 Incinerator Stack

Results of PCDD and PCDF Determinations----SW846 Method 0010

	Run 1	Run 2	Run 3
Date of run	07-23-87	07-23-87	07-24-87
Time run start/end.....(HRS)	915/1330	1530/1945	800/1215
Static pressure.....(IN.WC)	0.05	0.05	0.05
Cross sectional area (SQ.FT)	6.87	6.87	6.87
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condensate trap.....(ML)	351.0	360.0	278.0
impingers.....(GRAMS)	0.0	0.0	0.0
desiccant.....(GRAMS)	34.0	31.0	121.0
total.....(GRAMS)	385.0	391.0	399.0
Mass of TTE in sample...(ng)	5.56	5.71	2.02
Gas meter coefficient.....	1.0002	1.0002	1.0002
Barometric pressure..(IN.HG)	28.44	28.51	28.50
Avg. orif.pres.drop..(IN.WC)	0.98	1.05	0.96
Avg. gas meter temp..(DEF-F)	88.2	96.8	85.3
Volume through gas meter....			
at meter conditions...(CF)	138.65	144.56	136.74
standard conditions.(DSCF)	127.23	130.95	126.41
standard conditions.(DSCM)	3.600	3.705	3.577
Total sampling time....(MIN)	240.00	240.00	240.00
Nozzle diameter.....(IN)	.311	.311	.311
Avg.stack gas temp ..(DEG-F)	425	438	430
Volumetric flow rate.....			
actual.....(ACFM)	14045	14597	14010
dry standard.....(DSCFM)	6972	7174	6890
Isokinetic variation.....(%)	99.1	99.2	99.7
TTE concentration..(ng/DSM3)	1.52	1.54	1.02
TTE emission rate.....(10^{-8}g/sec)	.492	.517	.330

TTE = total 2,3,7,8 TCDD equivalents

Toxicity Equivalence Factors (TEFs) used in the calculation of the above TTEs are those currently recommended by "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs)", J.S. Bellin and D.G. Barnes, USEPA Risk Assessment Forum, October 1986.

3.13 Results of Continuous Combustion Parameters Monitoring

(Performed by Interpoll Labs)

7/21/87 - **Unit 1**

Time (HRS)	Temp. 1 (°F)	Temp. 2 (°F)	O_2 (% v/v)	CO_2 (% v/v)	CO (ppm)
1115	-*	1931	13.0	8.8	6
1130	-*	1889	10.5	10.0	5
1145	1380	1983	12.5	8.0	80
1200	1536	1909	13.0	8.4	15
1215	1413	1917	-**	8.5	5
1230	1538	1845	-**	7.7	15
1245	1309	1797	14.5	7.6	10
1300	1472	1743	15.0	7.3	25
1315	1583	1771	14.0	6.8	15
1330	1666	1842	13.0	8.3	5
1345	-***	1855	13.0	7.5	5
1400	-***	1955	12.0	9.6	5
1415	-***	1937	12.5	7.5	5
1430	1649	1988	13.0	8.0	3
1445	1645	1870	14.5	7.0	12
1500	1582	1864	12.5	8.7	10
1515	1452	1831	13,5	7.3	40
1530	-***	1986	10.5	9.0	10

*Temperature probe damaged - replaced 1135 HRS

**Power outage

***Refuse on the incline grate collided with the thermocouple and partially shorted the output millivoltage.

7/22/87 - **Unit 2**

Time (HRS)	Temp. 1 (°F)	Temp. 2 (°F)	O_2 (% v/v)	CO_2 (% v/v)	CO (ppm)
1245	1618	1717	12.0	8.1	20
1300	-***	1757	12.5	8.2	15
1315	-***	1761	13.0	8.3	10
1330	-***	1757	13.5	8.0	15
1345	-***	1740	13.5	7.5	15
1400	1630	1765	12.5	8.7	10
1415	-***	1713	13.0	8.0	10
1430	-***	1886	12.0	8.5	10
1445	1664	1903	12.0	8.5	8
1500	1730	1827	12.0	8.8	8
1515	1640	1723	13.5	8.0	8
1530	1547	1678	15.0	7.0	12
1545	1460	1542	16.0	5.4	85
1600	1870	1522	15.5	6.0	35
1615	1926	1582	15.0	6.0	25
1630	1674	1673	14.0	6.5	15
1645	1686	1417	16.0	5.0	350
1700	1601	1687	13.0	6.0	35
1715	1047	1827	12.5	8.0	10
1730	1009	1893	12.0	8.3	8
1745	1468	1621	15.5	7.0	20
1800	1625	1894	13.5	7.0	12
1815	1722	1907	13.5	7.5	8
1830	1746	1940	13.0	7.0	10
1845	1613	1719	13.0	7.0	15
1900	1723	2006	12.5	8.0	15
1915	1845	2084	12.5	8.5	5
1930	1690	1924	14.0	7.5	7
1945	1511	1775	15.5	5.5	13
2000	1702	1615	14.5	5.7	15
2015	1707	2015	12.5	7.0	8
2030	1755	2012	13.5	7.0	6
2045	1831	1932	14.0	7.0	6
2100	1630	1767	15.0	5.9	8
2115	-***	1687	14.0	6.3	18
2130	-***	1985	11.5	8.3	9
2145	-***	1928	13.5	8.5	6
2200	-***	2015	11.5	8.9	6

7/23/87 - **Unit 2**

Time (HRS)	Temp. 1 (°F)	Temp. 2 (°F)	O_2 (% v/v)	CO_2 (% v/v)	CO (ppm)
0930	-***	2034	13.0	9.0	10
0945	1244	2027	12.5	8.0	8
1000	976	1876	13.0	7.9	10
1015	786	1578	14.5	7.5	8
1030	1327	1487	13.0	8.5	9
1045	-***	1857	14.5	7.0	8
1100	1080	1857	14.5	7.0	9
1115	853	1881	15.0	6.5	9
1130	826	1841	14.5	7.0	9
1145	734	1659	15.0	5.5	70
1200	398	1956	14.0	8.0	9
1215	835	1852	12.5	8.5	10
1230	907	1658	15.0	5.0	20
1245	1131	1679	15.5	5.5	10
1300	826	1868	14.0	7.5	7
1315	1061	1894	13.5	7.5	8
1330	1022	1846	13.5	7.0	8
1345	1052	1966	14.0	6.5	7
1400	1018	1842	15.0	6.0	7
1415	1137	1844	14.5	6.5	6
1430	1184	1839	14.5	6.5	6
1445	1116	1717	14.5	6.5	7
1500	1182	1820	15.0	6.0	50
1515	1183	1755	14.0	6.5	8
1530	1241	1795	14.0	6.5	6
1545	1261	1804	14.5	6.5	9
1600	1644	1944	13.0	8.0	16
1615	1787	1958	13.0	8.0	5
1630	1540	1919	13.5	7.0	5
1645	1446	1897	13.5	7.0	5
1700	1541	1800	14.5	6.0	7
1715	1493	1875	14.0	7.0	40
1730	1399	2009	12.5	8.3	7
1745	1535	1976	13.5	7.5	4
1800	1717	1959	13.0	8.0	4
1815	1477	1773	14.5	6.5	6
1830	1398	1827	14.8	6.0	5
1845	1375	1764	14.5	6.3	5
1900	1450	1913	14.5	7.0	4
1915	1722	2000	12.5	8.0	3
1930	1674	1986	13.5	7.0	2
1945	1630	1770	14.0	6.5	48

7/24/87 - **Unit 2**

Time (HRS)	Temp. 1 (^{o}F)	Temp. 2 (^{o}F)	O_2 (% v/v)	CO_2 (% v/v)	CO (ppm)
0815	1647	1939	12.0	8.3	7
0830	1738	1846	12.5	9.0	6
0845	1747	1802	15.0	7.0	7
0900	1677	1838	14.5	7.0	6
0915	1654	1816	15.0	6.3	6
0930	1612	1788	15.5	6.5	17
0945	1657	1797	14.0	6.5	7
1000	1639	1823	13.5	7.0	6
1015	1675	1839	14.0	7.0	6
1030	1678	1830	14.0	6.5	6
1045	1647	1833	14.0	7.0	6
1100	1618	1860	14.0	7.0	6
1115	1653	1829	15.0	6.5	6
1130	1634	1839	14.0	6.5	6
1145	1612	1815	14.5	6.5	6
1200	1617	1835	14.5	7.0	6
1215	1611	1798	15.0	6.3	6

interpoll

INTERPOLL INC.
4500 BALL ROAD N.E.
CIRCLE PINES, MINNESOTA 55014
612/786-6020

December 29, 1987

Radian Corporation
P. O. Box 13000
Research Triangle Park, NC 27709

Attention: Mike Vancil
Chemical Engineer

RE: Pope/Douglas Waste to Energy Facility
Alexandria, Minnesota

Dear Mike:

Per your request of this date, I am enclosing one copy of Interpoll Laboratories Report No. 7-2394, excluding the appendices. We would appreciate it if you would give Interpoll Laboratories credit for the work in any report you may prepare.

If you have any questions regarding this report, please feel free to contact me.

Sincerely,

INTERPOLL LABORATORIES

Perry Lonnes, Ph.D.
President

PL/kp
Enclosures