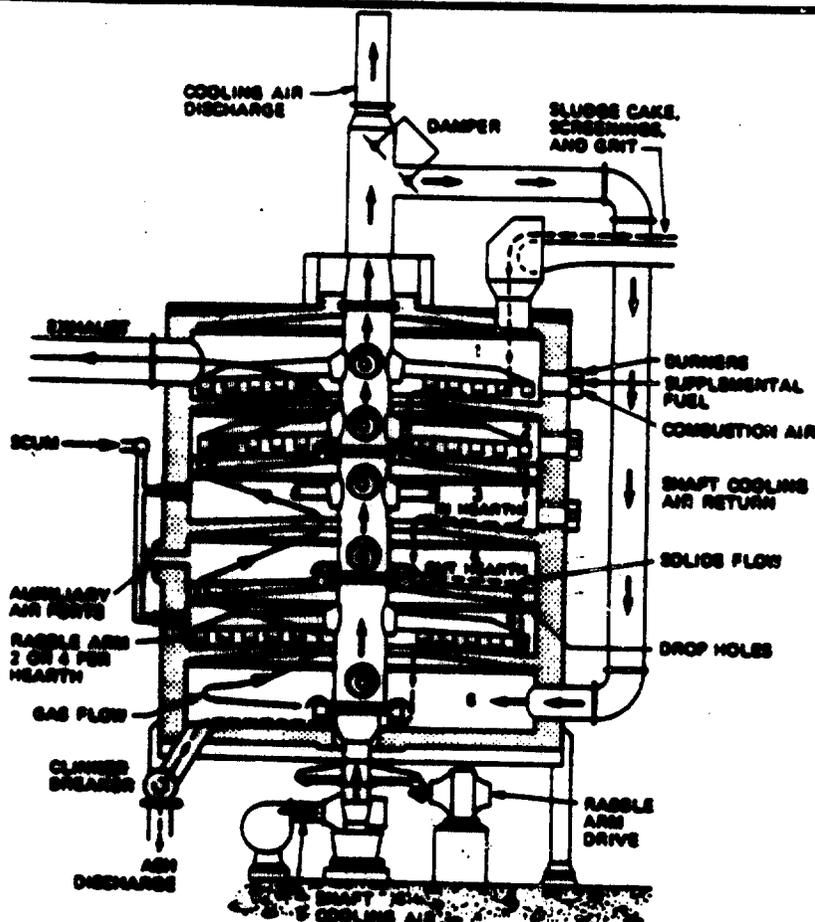


2-5

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

Document No. P-E081-500

Non-Criteria Emissions Monitoring Program for the Envirotech Nine-Hearth Sewage Sludge Incinerator at the Metropolitan Wastewater Treatment Facility



FINAL REPORT

Prepared for:

**Metropolitan Waste Control Commission
Twin Cities Area
St. Paul, Minnesota
October 1986**

ERT

A RESOURCE ENGINEERING COMPANY

A RESOURCE ENGINEERING COMPANY

496 E. BRYAN ROAD, CONCORD, MASSACHUSETTS 01742

EAS-6418

Environmental and Engineering Services
October 24, 1986

Mr. James Brown
Engineering Department
Metropolitan Waste Control Commission
350 Metro Square Building
7th and Robert Streets
Saint Paul, MN 55101

Subject: Final Report Submittal - Non-Criteria Emissions Monitoring
Program - MWTTP Facility, St. Paul, Minnesota (ERT Document
E081-500)

Dear Jim:

As discussed in our telephone conversation earlier this afternoon, please find enclosed three (3) copies of the Final Report document referenced above. An additional ten (10) copies, per your request, will be forwarded to your office next week.

The enclosed Final Report document entitled, "Non-Criteria Emissions Monitoring Program for the Envirotech Nine-Hearth Sewage Sludge Incinerator at the Metropolitan Wastewater Treatment Facility" represents a revised version of the Draft Report document submitted earlier this month.

The enclosed document has been revised in accordance with MWCC comments provided in your letters of 10/6/86 and 10/20/86. Please note that we have made every effort to address each of the reviewer's comments and incorporate the requisite revisions into the Final Report as appropriate. In some instances, however, we were unable to oblige the reviewer's request and have opted to address these items separately outside the context of the report. We will respond to these issues collectively in writing and will forward our response to your office within the next 1-2 weeks.

I trust the enclosed document is commensurate with your expectations. Should you have any questions or comments upon review of the enclosed document, please do not hesitate to call me directly.

Sincerely,

Gary I. Hunt
Program Manager
Senior Air Quality Scientist

GTH/sc

Enclosures

cc: P. Fennelly, ERT
R. Graziano, ERT
J. Lauria, Malcolm-Pirnie

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GLOSSARY OF TECHNICAL TERMS AND NOMENCLATURE

Parameter	Definition
T	= Time
VM	= Dry Gas Meter in Cubic Feet
TS	= Temperature of Stack °F
TMI	= Temperature of Meter in
TMO	= Temperature of Meter out
PST	= Stack Static Pressure inches H ₂ O
DN	= Nozzle Diameter
VMSTD	= Volume of Dry Gas Sampled at Standard Conditions
DSCF	= Dry Standard Cubic Feet
VW	= Volume of water collected
%M	= Percent Moisture
lb/lb Mole	= Molecular weight of stack gas
AS	= Stack Area
VS	= Stack Gas Velocity
AFPM	= Actual Feet Per Minute
DSCFM	= Dry Standard Cubic Feet Per Minute
ACFM	= Actual Cubic Feet Per Minute
M	= Meter
M ³	= Cubic Meter
mg	= Milligram
ng	= Nanogram
µg	= Microgram
ml	= Milliliter
lpm	= Liter per minute
L	= Liter
lb	= Pound
oz	= Ounces
µl	= Microliter
v/v	= Volume per volume
in Hg	= Inches of Mercury

GLOSSARY (Continued)

Parameter	Definition
in H ₂ O	= Inches of water
act	= Actual
avg	= Average
std	= Standard
O ₂	= Oxygen
CO	= Carbon Monoxide
CO ₂	= Carbon Dioxide
N ₂	= Nitrogen
PPMV	= Parts per million by volume
PPBV	= Parts per billion by volume
THC	= Total HydroCarbons
Kg	= Kilogram
KPa	= Kilo Pascal
DDI	= Distilled Deionized Water
MPa	= Millapascal

1. INTRODUCTION

1.1 Project Background

ERT, A Resource Engineering Company of Concord, Massachusetts, was retained by Malcolm Pirnie, Inc. of White Plains, New York, to assist them in the conduct of a combined Odor Control Engineering Study/Non-Criteria Emissions Monitoring Program for the Metropolitan Waste Control Commission (MWCC) situated in the Twin Cities, Minnesota, area. The actual program was conducted at the Metropolitan Wastewater Treatment Facility to fulfill obligations set forth in the facility air operating permit (Permit No. 879-85-0-2) issued in April 1985. The objectives of the non-criteria emissions monitoring, which was designed and implemented wholly by ERT, were to assess the presence and significance of selected non-criteria pollutants potentially present in flue gas emissions released from the nine-hearth sewage sludge incinerators contained in the sludge treatment process at the site. It was further anticipated that the data product from this program would supplement existing emissions monitoring data from the Metropolitan Wastewater Treatment Plant (MWWTP) reported by the Environmental Protection Agency in July of 1986 as part of The National Dioxin Study [1].

1.2 Project Scope of Work

The program work scope consisted of sampling and analysis for a preselected list of chemical parameters potentially contained in incinerator flue gas emissions from the MWCC treatment facility as follows:

- Particulates
- Heavy Metals
- Semivolatile Organics (miscellaneous)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Chlorinated Phenols

- Chlorinated Benzenes
- Polychlorinated Biphenyls (PCBs)
- Polychlorinated Dibenzodioxins (PCDDs)
- Polychlorinated Dibenzofurans (PCDFs)
- Volatile Organics
- Total Hydrocarbons (continuous)
- Carbon Monoxide (continuous)
- Oxygen (continuous)

The selection of these parameters was based upon a comprehensive literature review conducted by ERT at the outset of the program and contained in the Project Test Plan prepared in May 1986.

The emissions monitoring program described herein consisted of three sampling sessions, for each of the above parameters, while incinerators #7 and #8 were maintained under identical representative "steady-state" operating conditions.

Section 2 of this document contains a summary of emissions monitoring data for each of the aforementioned chemical categories. Section 3 provides a formal discussion and interpretation of these program results. Particular emphasis has been placed on a comparison of these test results to data collected earlier at this facility, as well as data contained in the open literature pertinent to emissions from other multiple-hearth sewage incineration facilities.

Section 4 provides a description of the MWCC Twin Cities facility with a detailed description of the Envirotech incinerators themselves, as well as the operating parameters selected to establish "steady-state" conditions during the testing program.

Summaries of the pertinent sampling and analysis protocols are contained in Sections 5 and 6, respectively. More detailed sampling and analysis protocols are provided in the Program Test Plan entitled "Non-Criteria Emission Sampling and Analysis Test Plan for the Envirotech Nine-Hearth Sewage Sludge Incinerator," May 1986 (ERT Document E-081-200).

A summary of program quality control data is provided in Section 7. This includes results of all field blanks, collocated samples, field surrogate spikes, method blanks, and laboratory matrix spikes.

Additional supporting information provided in the appendices to this report includes the following: Field Data Sheets (Appendix A), Continuous Emissions Monitoring (CO, O₂, THC) Calibration Data (Appendix B), Continuous Emissions Monitoring Data (CO, O₂, THC) 3-Minute Averages (Appendix C), Chain of Custody Records (Appendix D), ERT Analytical Data Reports (Appendix E), Justification for Technical Approach to Monitoring PCDDs/PCDFs (Appendix F), Technical Work Scope for PCDDs/PCDFs (Appendix G), ENSECO-CAL Labs PCDDs/PCDFs Data Sheets (Appendix H), ERT's Field Notes Summary (Appendix I) and MWCC Operations Data for the MWWTP (Appendix J).

2. SUMMARY OF RESULTS

2.1 Introduction

Three days of flue gas monitoring were conducted using the #7 and #8 incinerators at the MWWTTP. Measurements were collected for each of the parameters and chemical classes listed previously in Section 1. This includes continuous emissions monitoring for CO, O₂ and total hydrocarbons (THC), ORSAT analyses for a series of fixed gas species (O₂, CO, CO₂, N₂), as well as average flue gas concentrations for a series of preselected heavy metals, volatile and semivolatile "target" compounds. Continuous emissions monitoring data are provided for each of three test series conducted during the calendar period May 20-22, 1986.

Data collected during each of three sampling sessions are provided for each of the following monitoring categories: volatile organics (EPA HSL list and additional components), semivolatile organics (EPA HSL List, PCBs, chlorobenzenes, and chlorophenols), and selected heavy metals. In addition, results are provided for three sets of PCDDs/PCDFs flue gas samples collected during the course of two sampling sessions in the #8 incinerator.

It is ERT's understanding that all of the flue gas data contained in this section were collected while the #7 and #8 incinerator units were operating under "steady-state" or representative operating conditions as defined in Section 4 of this report. The responsibility for establishing and maintaining each operating parameter within the corresponding numerical guidelines was assumed by MWCC personnel. These operating parameters and associated numerical guidelines were established in May of 1986 under joint agreement by MWCC, MPCA, ERT and Malcolm Pirnie.

Results for each of the aforementioned monitoring categories are summarized in the discussion to follow.

2.2 Particulate Emissions

Flue gas particulate emissions were collected from the #7 incinerator, at the stack exit employing an EPA Method 5 sampling train. Each of three sampling sessions were conducted during the calendar period May 20-21, 1986 (see field monitoring test schedule provided in Table 5-1). Each sample was collected under isokinetic flow conditions over an elapsed period of 3 hours while the #7 incinerator was operating under "steady-state" load conditions. A summary of pertinent stack test data for each of the three sampling sessions is provided in Table 2-1. This includes particulate emissions expressed as grains/dscf corrected to 12% CO₂ as well as other pertinent test data collected during each of the three test series. These results are also applicable to the trace metals data to follow which were generated from analyses of the particulate samples from each of these three test series. As shown in Table 2-1, particulate concentrations of 0.024, 0.036 and 0.030 gr/dscf were measured for Runs 1, 2 and 3, respectively. Particulate emission rates are provided in units of lb/hr, as well as gr/dscf.

Particulate analysis was conducted gravimetrically from the particulate catch. The acetone washes were transferred to tared beakers and dried at ambient pressure in a hood. After removal of the acetone the beakers were dessicated over Drierite® and weighed to a constant weight of ±.5 mg. The particulate filters were also dessicated to constant weight in the same manner. The acetone washes were blank corrected by taking an acetone blank sample and conducting the drydown following the same procedure as the acetone washes.

It should be noted that these results do not include the back half analysis of the impinger water. This extra analysis was not requested until the second test was initiated. ERT collected and recovered the impinger waters from Runs 2 and 3 and saved these samples. Analysis has not been performed because of the out-of-scope cost associated with the task. Fixed gas analyses shown in Table 2-1 for O₂, CO, CO₂ and

TABLE 2-1
 STACK #7 TEST DATA SUMMARY
 METHOD 5 TEST SERIES FOR PARTICULATES AND TRACE METALS

STACK EXHAUST GAS RESULTS
 PLANT: MWCC, MALCOLM PIRNIE
 LOCATION: ST. PAUL, MINNESOTA

RUN NUMBER	*****	M5-1	M5-2	M5-3
DATE OF RUN	*****	5-20-86	5-21-86	5-21-86
CLOCK TIME: INITIAL	*****	1343	820	1310
CLOCK TIME: FINAL	*****	1643	1130	1630
AVG. STACK TEMPERATURE	DEGREES F	98	106	104
AVG. SQUARE DELTA P	INCHES H2O	1.24	1.44	1.35
NOZZLE DIAMETER	INCHES	0.19	0.19	0.19
BAROMETRIC PRESSURE	IN. HG.	29.45	29.30	29.30
SAMPLING TIME	MIN.	180	180	180
SAMPLE VOLUME	CUBIC FEET	145.28	156.66	149.62
AVG. METER TEMP.	DEGREES F	84	87	90
AVG. DELTA H	IN. H2O	2.04	2.42	2.55
DGM CALIB. FACTOR (Y)	*****	1.00	0.99	0.99
WATER COLLECTED	MILLILITERS	65.0	109.5	95.3
CO 2	PERCENT	5.1	5.4	4.9
O 2	PERCENT	14.3	13.8	14.5
CO	PERCENT	0.0	1.2	2.7
N 2	PERCENT	80.6	79.6	77.9
STACK AREA	SQUARE INCHES	707	707	707
STATIC PRESSURE	INCHES WG.	0.36	0.35	0.25
PITOT COEFFICIENT	*****	0.84	0.84	0.84
SAMPLE VOLUME DRY	DSCF	140.05	147.38	140.14
WATER AT STD.	SCF	3.1	5.2	4.4
MOISTURE	PERCENT	2.1	3.4	3.0
MOLE FRACTION DRY GAS	*****	0.98	0.97	0.97
MOLECULAR WT. DRY	LB/LB MOLE	29.39	30.09	30.74
EXCESS AIR	PERCENT	204.92	169.49	182.03
MOLECULAR WT. WET	LB/LB MOLE	29.14	29.68	30.35
STACK GAS PRESSURE	INCHES HG.	29.48	29.33	29.32
STACK VELOCITY	AFPM	4304	5001	4628
VOLUMETRIC FLOWRATE, DRY STD.	DSCFM	19277	21690	20211
VOLUMETRIC FLOWRATE, ACTUAL	ACFM	21131	24553	22723
ISOKINETIC RATIO	PERCENT	106	99	96
MASS AIR FLOW RATE	LBS/MINUTE	1446	1627	1516

CALCULATIONS FOR GRAIN LOADING AND EMISSION RATES

FRONT HALF TOTAL	mg	92.9	150.3	110.5
PARTICULATE	gr/dscf	0.010	0.016	0.012
PARTICULATE	lb/hr	1.688	2.920	2.100
Particulate	gr/dscf*	0.024	0.036	0.029

*Corrected to 12% CO₂

TABLE 2-1 (Continued)
 STACK # 7 TEST DATA SUMMARY
 METHOD 5 TEST SERIES FOR PARTICULATES AND TRACE METALS

Calculations for Grain Loading and Emission Rates

		M5-1	M5-2	M5-3
Particulates	lb/ton D.S.	2.78×10^{-4}	4.80×10^{-4}	3.45×10^{-4}
Particulates	lb/dscf*	3.4×10^{-6}	5.1×10^{-6}	4.1×10^{-6}

* Corrected to 12% CO₂

N₂ are the result of ORSAT analyses performed during each test series and not actual continuous emissions monitoring which are presented in a subsequent portion of this section.

2.3 Trace Metals

Particulate samples identified in Table 2-1 were submitted for the analyses of a preselected listing of heavy metals. Flue gas physical and chemical data presented for the particulate emissions in Table 2-1 are also applicable to the trace metals measurements presented here. Trace metal analyses were conducted on the combined front half rinse/particulate filter catch from each of the three test series in accordance with the protocols stipulated in Section 6 of this report. A summary of these results including analytical flue gas concentrations in total μg , $\mu\text{g}/\text{m}^3$ and emission rates in grams/hr are provided in Tables 2-2, 2-3, and 2-4 for Runs 1, 2, and 3, respectively. Please note that the values provided in Tables 2-2, 2-3 and 2-4 have been corrected using the appropriate laboratory method blank.

2.4 Continuous Emissions Monitoring Data (CO, O₂, THC)

Carbon monoxide (CO), oxygen (O₂) and total hydrocarbons (THC) were monitored in the #8 incinerator flue gas on a continuous basis on each of the 3 test days, May 20-22, 1986. A complete set of results for each of these parameters expressed as 3-minute averages for the duration of each sampling session (Run) is provided in Appendix C. CO and THC data are expressed in units of ppm (v/v) while O₂ data are expressed as percent (v/v). THC data are provided as referenced to the propane calibrant gas. In order to enhance the relevance of the CEM data to each test series, the data in Appendix C were further reduced to reflect the actual concentrations present during each of the sampling sessions. These data, presented as average concentrations for each of the test runs or sampling sessions,

TABLE 2-2
TRACE METALS DATA SUMMARY
FLUE GAS EMISSIONS - RUN 1 STACK #7

ERT No: 35512

DATE SAMPLED: 05/20/86

FIELD ID: 1-M5-PF-B163

SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RESULTS ug/FILTER (a)	DETECTION LIMIT ug/FILTER	ug/DSCM (b)	GRAMS/HR
ANTIMONY	14	5.0	3.5	0.13
BARIUM	13	5.0	3.3	0.12
BERYLLIUM	BDL	5.0	1.3	--
BORON	BDL	42.8(c)	11	--
CADMIUM	1100	5.0	280	10
CHROMIUM	310	5.0	78	2.8
COBALT	BDL	5.0	1.3	--
COPPER	410	5.0	100	3.7
LEAD	1300	5.0	330	12
MANGANESE	71	5.0	18	0.64
MOLYBDENUM	12	5.0	3.0	0.11
NICKEL	120	5.0	30	1.1
SELENIUM	43	5.0	11	0.39
SILVER	15	5.0	3.8	0.14
STRONTIUM	BDL	5.0	1.3	--
TIN	880	5.0	220	8.0
VANADIUM	5.4	5.0	1.4	0.05
ZINC	5200	5.0	1300	47

- NOTES:
- (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT.
 - (b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 3.963 DSCM (140.05 DSCF). SEE TABLE 2-1.
 - (c) ELEVATED DETECTION LIMIT REFLECTS MEASURABLE QUANTITIES OBSERVED IN THE METHOD BLANK.

TABLE 2-3
TRACE METALS DATA SUMMARY
FLUE GAS EMISSIONS - RUN 2 STACK #7

ERT No: 35514 DATE SAMPLED: 05/21/86
FIELD ID: 2-M5-PF-B179 SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RESULTS	DETECTION LIMIT		GRAMS/HR
	ug/FILTER(a)	ug/FILTER	ug/DSCM(b)	
ANTIMONY	21	5.0	4.2	0.21
BARIUM	18	5.0	4.3	0.18
BERYLLIUM	BDL	5.0	1.2	--
BORON	BDL	42.8(c)	10	--
CADMIUM	2500	5.0	600	25
CHROMIUM	300	5.0	72	3.0
COBALT	34	5.0	8.2	0.34
COPPER	860	5.0	210	8.6
LEAD	2000	5.0	480	20
MANGANESE	46	5.0	11	0.46
MOLYBDENUM	11	5.0	2.6	0.11
NICKEL	340	5.0	82	3.4
SELENIUM	81	5.0	19	0.81
SILVER	25	5.0	6.0	0.25
STRONTIUM	5.9	5.0	1.4	0.059
TIN	89	5.0	21	0.89
VANADIUM	8.1	5.0	1.9	0.081
ZINC	11000	5.0	2600	110

- NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT.
- (b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.171 DSCM (147.38 DSCF). SEE TABLE 2-1.
- (c) ELEVATED DETECTION LIMIT REFLECTS MEASURABLE QUANTITIES OBSERVED IN THE METHOD BLANK.

is provided in Table 2-5. In this manner the CEM data more appropriately reflect actual average concentrations present in the incinerator flue gas during a contemporaneous sampling session for one of the other parameters. Please note that ERT has assumed for the purposes of this report that CEM data while collected in the #8 incinerator stack are similarly applicable to other flue gas data collected in the #7 incinerator unit as well. This is consistent with our understanding contained in the Program Test Plan that two incinerators maintained under equivalent "steady-state" operating conditions would result in comparable flue gas emissions. Table 2-6 contains the average daily operating conditions for incinerators #7 and #8 during the sample program.

2.5 Polychlorinated Dibenzodioxins (PCDDs)/Polychlorinated Dibenzofurans (PCDFs)

Flue gas samples designated as Runs MM5-1A and MM5-2A/2B were collected on May 20 and May 21, respectively, and submitted to ENSECO-CAL Labs for the analyses of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Samples were extracted from the 4-inch sampling ports of the #8 incinerator using a Modified Method 5 sampling train. As noted previously in Table 5-1, Run 1A was conducted over a 6-hour sampling period (360 minutes) on May 20, 1986, while Runs 2A and 2B were conducted contemporaneously over 8.5-hour (510 min) and 9.0-hour (540 min) sampling intervals, respectively, on May 21, 1986. Analyses were conducted for a preselected "target" list of PCDDs/PCDFs congeners as follows: mono through octa PCDDs (Cl_1 - Cl_8), mono through octa PCDFs (Cl_1 - Cl_8), 2,3,7,8-TCDD and 2,3,7,8-TCDF. Results for these PCDDs/PCDFs congeners and congener categories are provided in units of ng/dscm in Tables 2-7 and 2-8. Please note that all results reflect method and field blank corrected values. The data provided in these tables were generated using ENSECO-CAL

TABLE 2-5
CONTINUOUS EMISSIONS MONITORING DATA
(CO, O₂, THC) - AVERAGE CONCENTRATIONS^a
FOR EACH TEST SERIES
STACK #8

May 20, 1986

Run Time	- SMM5-1 - 1245-1630	Run Time	- MM5-1 - 1139-1754
CO	= 4445 PPM 4220 PPM ^a	CO	= 4530 PPM 4350 PPM ^a
O ₂	= 13.4%	O ₂	= 13.1%
THC	= 7.3 PPM ^b	THC	= 7.3 PPM ^b

May 21, 1986

Run Time	- M5+SMM5-2 - 0818-1130	Run Time	- M5+SMM5-3 - 1309-1630
CO	= 2990 PPM 2830 PPM ^a	CO	= 2400 PPM 2280 PPM ^a
O ₂	= 15.2%	O ₂	= 11.1%
THC	= 10.4 PPM ^b	THC	= 6.4 PPM ^b

May 22, 1986

Run Time	- MM5-2A - 1139-2100	Run Time	- MM5-2B - 1139-2200
CO	= 2705 PPM 2560 PPM ^a	CO	= 2700 PPM 2555 PPM ^a
O ₂	= 9.3%	O ₂	= 9.3%
THC	= 11.1 PPM ^b	THC	= 11.0 PPM ^b

a. Concentrations reflect time weighted averages for each respective sample period. All values are corrected for the volume of CO₂ removed from sample as determined by ORSAT analysis.

b. Value reported as propane.

TABLE 2-6
OPERATING DATA ON SLUDGE AND SCUM FEED TO INCINERATORS
FOR NON-CRITERIA EMISSION TEST OF MAY 20-22, 1986

Parameter	Inc. 7 May 20	Inc. 8 May 20	Inc. 8 May 21	Inc. 8 May 22
Sludge Feed Rate				
Dry Tons Per Hour	3.04	2.98	3.18	2.83
Wet Tons Per Hour	7.59	7.44	7.60	7.53
Scum Feed Rate				
Gallons Per Hour	32	32	24	33
Pounds Per Hour	200	200	150	230
Heat Value, Btu/lb. D.S.				
Sludge	7,050	7,050	7,400	7,400
Scum	13,800	13,800	15,800	16,000
Heat Input, MMBtu/Hour				
Sludge	43	42	47	42
Scum	3	3	3	4
Total	46	45	50	46
Ratio of Gravity Thickened Primary Sludge to Thermally Conditioned Sludge				
Volume Basis	3.8	3.8	4.0	4.0
Mass Basis	1.4	1.4	1.6	1.5
Sludge Volatile Solids, %	67	67	67	68
Cake Solids Content, %	40.1	40.1	41.8	37.6

Note:

1. Sludge cake samples for analyses were composited from hourly grab samples.
2. D.S. = Dry Solids
3. MMBtu = 1,000,000 Btu

TABLE 2-7
 SUMMARY OF PCDDs/PCDFs EMISSIONS DATA - MAMTP FACILITY STACK # 8
 (CL₄ - CL₈ PCDDs and PCDFs)

Test Run	Gas Volume Sampled dscm ^b	Concentration Ng/dscm ^c									
		Furans (PCDFs)		Dioxins (PCDDs)		Dioxins (PCDFs)		Dioxins (PCDFs)			
		TeKa	PeKa	Hexa	Hepta	Octa	TeKa	PeKa	Hexa	Hepta	Octa
1A	7.473	0.71	0.09	MD (<0.06)	MD (<0.09)	MD (<0.33)	MD (<0.03)	MD (<0.06)	MD (<0.07)	MD (<0.43)	MD (<1.5)
2A ^a	13.174	2.00	0.31	0.04	0.04	0.11	MD (<0.02)	MD (<0.02)	MD (<0.04)	MD (<0.30)	MD (<1.1)
2B ^a	11.566	2.0	0.60	0.13	0.10	MD (<0.07)	MD (<0.03)	MD (<0.02)	MD (<0.03)	MD (<0.48)	MD (<1.3)
2 A/B (Avg)	-	2.0	0.46	0.09	0.07	0.09	MD (<0.03)	MD (<0.02)	MD (<0.04)	MD (<0.39)	MD (<1.3)

- a. Collocated sampling trains - Results provided here for Runs 2A/B reflect precision of combined sampling and analysis scheme.
- b. Gas sample volume as provided in Table 2-8.
- c. Concentrations calculated at actual stack oxygen concentrations as provided in Tables 2-5 and 2-8.

TABLE 2-8
 SUMMARY OF PCDDs/PCDFs EMISSIONS DATA - MMWTP FACILITY STACK #8
 (Cl₁ - Cl₃ PCDDs and PCDFs, 2,3,7,8-TCDD AND 2,3,7,8-TCDF)

Test Run	Gas Volume Sampled desc ^b	Concentration Ng/DSCMC							
		Furans (PCDFs)		2,3,7,8-TCDD		Dioxins (PCDDs)			
		MONO	DI	TRI	2,3,7,8-TCDD	MONO	DI	TRI	
1A	7.473	ND (<0.02)	ND (<0.34)	0.03	ND (<0.02)	ND (<0.04)	1.9	0.07	
2A ^a	13.174	0.19	ND (<0.40)	0.78	ND (<0.01)	ND (<0.08)	2.4	0.13	
2B ^a	11.566	0.19	ND (<0.50)	0.84	ND (<0.01)	ND (<0.07)	ND	0.17	
2 (Avg)	-	0.19	ND (<0.45)	0.81	ND (<0.01)	ND (<0.08)	2.2	0.15	

- Collocated sampling trains - Results provided here for Runs 2A/B reflect precision of combined sampling and analysis scheme.
- Gas sample volume as provided in Table 2-8.
- Concentrations calculated at actual stack oxygen concentrations as provided in Tables 2-5 and 2-8.

Lab's data report provided in Appendix H of this report in conjunction with the stack test data provided in Table 2-8. Additional quality control data pertinent to these analyses including laboratory spike data, and field applied surrogate recovery data are provided in Section 7, entitled "Quality Assurance/Quality Control Data." Stack test summary data pertinent to the PCDDs/PCDFs sampling runs are provided in Table 2-9. This includes pertinent physical and chemical parameters of the #8 incinerator flue gas monitored during each of the PCDDs/PCDFs test series employing the Modified Method 5 train. Comparison of these data to the stack test data summarized earlier in Table 2-1 provides a direct measure of equivalency between the two incinerator units (#7 and #8) in simultaneous operation during the MWWTP test program. This applies in particular to a comparison of the following test parameters: stack temperature ($^{\circ}\text{F}$), fixed gas analyses (CO , CO_2 , O_2 , N_2), stack velocity (afpm), volumetric flow rate (dscfm) and mass air flow (lb/minute).

2.6 Semivolatile Organics

Three sets of flue gas samples designated as SMM5-1, SMM5-2 and SMM5-3 were collected during the calendar period of May 20 and May 21, 1986. SMM5-1, collected on May 20, 1986, and SMM5-2 and 3, collected on May 21, 1986, were submitted to the ERT laboratory in Concord, Massachusetts, to undergo analyses for semivolatile organics. As noted in Table 5-1, these samples were taken in either the #8 or #7 incinerator employing a modified EPA Method 5 train on each of the two test days. All samples were collected under isokinetic flow conditions. Again, as noted in Table 5-1 each of the three runs was conducted over a 3-hour sampling period (180 minutes) while the incinerator was maintained at "steady-state" operating conditions. Stack test summary data pertinent to the semivolatile organics' sampling runs are provided in Table 2-10. This includes pertinent physical and chemical parameters of the incinerator flue gas monitored during each test series.

TABLE 2-9
 STACK #8 TEST DATA SUMMARY - PCDDs/PCDFs
 MODIFIED METHOD 5 TEST SERIES

STACK EXHAUST GAS RESULTS
 PLANT: MWCC, MALCOLM FIRNIE
 LOCATION: ST PAUL, MINNESOTA

RUN NUMBER	*****	MMS-1	MMS-2A	MMS-2B
DATE OF RUN	*****	5-20-86	5-22-86	5-22-86
CLOCK TIME: INITIAL	*****	1133	1138	1137
CLOCK TIME: FINAL	*****	1753	2101	2200
AVG. STACK TEMPERATURE	DEGREES F	108	105	105
AVG. SQUARE DELTA P	INCHES H2O	1.32	1.44	1.51
NOZZLE DIAMETER	INCHES	0.17	0.19	0.19
BAROMETRIC PRESSURE	IN. HG.	29.45	29.25	29.25
SAMPLING TIME	MIN.	360	540	510
SAMPLE VOLUME	CUBIC FEET	277.49	498.01	439.12
AVG. METER TEMP.	DEGREES F	84	97	93
AVG. DELTA H	IN. H2O	2.00	2.88	2.83
DGM CALIB. FACTOR (Y)	*****	0.99	1.00	0.99
WATER COLLECTED	MILLILITERS	255.1	692.7	618.6
CO 2	PERCENT	5.0	5.4	5.4
CO	PERCENT	14.6	14.0	14.0
N 2	PERCENT	0.0	1.7	1.7
STACK AREA	SQUARE INCHES	80.4	78.9	78.9
STATIC PRESSURE	INCHES WG.	707	707	707
PITOT COEFFICIENT	*****	0.30	0.41	0.56
SAMPLE VOLUME DRY	DSCF	0.84	0.84	0.84
WATER AT STD.	SCF	263.90	465.25	408.46
MOISTURE	PERCENT	12.0	32.7	29.2
MOLE FRACTION DRY GAS	*****	4.4	6.6	6.7
MOLECULAR WT. DRY	LB/LB MOLE	0.96	0.93	0.93
EXCESS AIR	PERCENT	29.38	29.42	29.42
MOLECULAR WT. WET	LB/LB MOLE	220.36	194.97	194.97
STACK GAS PRESSURE	INCHES HG.	28.89	28.67	28.66
STACK VELOCITY	AFPM	29.47	29.28	29.29
VOLUMETRIC FLOWRATE, DRY STD.	DSCFM	4643	5087	5333
VOLUMETRIC FLOWRATE, ACTUAL	ACFM	19963	21347	22356
ISOKINETIC RATIO	PERCENT	22795	24976	26181
MASS AIR FLOW RATE	LBS/MINUTE	109	106	90
		1497	1601	1677

TABLE 2-10
 STACK #7 & 8 TEST DATA SUMMARY
 MODIFIED METHOD 5 TEST SERIES FOR SEMIVOLATILE ORGANICS

STACK EXHAUST GAS RESULTS
 PLANT: MWCC, MALCOLM PIRNIE
 LOCATION: ST PAUL, MINNESOTA

RUN NUMBER	*****	SMMS-1	SMMS-2	SMMS-3
DATE OF RUN	*****	5-20-86	5-21-86	5-21-86
CLOCK TIME: INITIAL	*****	1246	817	1310
CLOCK TIME: FINAL	*****	1630	1130	1630
AVG. STACK TEMPERATURE	DEGREES F	98	106	104
AVG. SQUARE DELTA P	INCHES H2O	1.34	1.37	1.29
NOZZLE DIAMETER	INCHES	0.19	0.19	0.19
BAROMETRIC PRESSURE	IN. HG.	29.45	29.30	29.30
SAMPLING TIME	MIN.	180	180	180
SAMPLE VOLUME	CUBIC FEET	158.26	160.16	153.60
AVG. METER TEMP.	DEGREES F	88	89	88
AVG. DELTA H	IN. H2O	2.68	2.71	2.50
DGM CALIB. FACTOR (Y)	*****	1.00	1.00	1.00
WATER COLLECTED	MILLITERS	95.1	267.9	113.4
CO 2	PERCENT	5.1	5.4	4.9
O 2	PERCENT	14.3	13.8	14.5
CO	PERCENT	0.0	1.2	2.7
N 2	PERCENT	80.6	82.0	82.8
STACK AREA	SQUARE INCHES	707	707	707
STATIC PRESSURE	INCHES WG.	0.30	0.25	0.12
PITOT COEFFICIENT	*****	0.84	0.84	0.84
SAMPLE VOLUME DRY	DSCF	151.07	152.00	145.74
WATER AT STD.	SCF	4.5	12.6	5.3
MOISTURE	PERCENT	2.9	7.7	3.5
MOLE FRACTION DRY GAS	*****	0.97	0.92	0.96
MOLECULAR WT. DRY	LB/LB MOLE	29.39	30.09	30.74
EXCESS AIR	PERCENT	204.92	169.49	182.03
MOLECULAR WT. WET	LB/LB MOLE	29.06	29.16	30.29
STACK GAS PRESSURE	INCHES HG.	29.47	29.32	29.31
STACK VELOCITY	AFPM	4659	4800	4437
VOLUMETRIC FLOWRATE, DRY STD.	DSCFM	20692	19889	19272
VOLUMETRIC FLOWRATE, ACTUAL	ACFM	22869	23566	21786
ISOKINETIC RATIO	PERCENT	104	107	107
MASS AIR FLOW RATE	LBS/MINUTE	1552	1492	1445

As noted previously, the flue gas train components for each run noted in Table 5-2 were combined to create a single sample for analyses. Each combined sample representing vapor phase and particulate associated semivolatile organics was submitted for analyses. As noted in Section 6, this consisted of analyses for a preselected list of semivolatile organics identified during the literature survey conducted at the outset of the program. It was agreed that the semivolatile "target" compound list would include the EPA Hazardous Substances listing, as well as selected positional isomers of polychlorinated benzenes, polychlorinated phenols and polychlorinated biphenyls (PCBs). Results for the EPA Hazardous Substances list are provided in Table 2-11, reported in units of $\mu\text{g}/\text{m}^3$. Please note that all reported values reflect correction with the corresponding method blank. In a similar manner, results for all non-HSL semivolatile "target" compounds are provided in Table 2-12. All values are method blank corrected and are provided in units of $\mu\text{g}/\text{m}^3$. Results in Table 2-12 include data for selected chlorinated benzene isomers, chlorinated phenol isomers, and polychlorinated biphenyl isomers not already contained in the EPA HSL list noted in Section 6. (These constituents were selected on the premise that they have been historically identified as potential precursors involved in the formation of PCDDs and PCDFs.) Lastly, results are provided in Table 2-12 for those semivolatile components identified in flue gas samples that were not identified as "target" compounds as listed in Tables 2-11, and 2-12 and Section 6. Results are again provided in units of $\mu\text{g}/\text{m}^3$ and have been corrected using the appropriate method blank values. Please note that the results provided in Table 2-13 represent "approximate" concentrations for the components listed because standard reference materials for non-"target" compounds were not readily available during the conduct of the analytical

TABLE 2-11

SEMIVOLATILE ORGANICS DATA SUMMARY
 FLUE GAS EMISSIONS DATA FOR EPA HAZARDOUS
 SUBSTANCE LISTING - RUNS 1, 2, AND 3

ERT No: 35505, 35507, 35508 DATES SAMPLED: 05/20/86 & 05/21/86

FIELD ID's: SMMS-1, 2, & 3 SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RUN SMMS-1		RUN SMMS-2		RUN SMMS-3	
	RESULTS ug/SAMPLE(a)	ug/DSCN(b)	RESULTS ug/SAMPLE(a)	ug/DSCN(c)	RESULTS ug/SAMPLE (a)	ug/DSCN(d)
NAPHTHALENE	20	4.7	11	2.6	11	2.7
ACENAPHTHYLENE	<10	<2.3	<10	<2.3	<10	<2.4
ACENAPHTHENE	<10	<2.3	<10	<2.3	<10	<2.4
FLUORENE	<10	<2.3	<10	<2.3	<10	<2.4
PHENANTHRENE	<10	<2.3	<10	<2.3	<10	<2.4
ANTHRACENE	<10	<2.3	<10	<2.3	<10	<2.4
FLUORANTHENE	<10	<2.3	<10	<2.3	<10	<2.4
PYRENE	<10	<2.3	<10	<2.3	<10	<2.4
BENZ(A)ANTHRACENE	<10	<2.3	<10	<2.3	<10	<2.4
CHRYSENE	<10	<2.3	<10	<2.3	<10	<2.4
BENZOFLUORANTHENES	<10	<2.3	<10	<2.3	<10	<2.4
BENZO(A)PYRENE	<10	<2.3	<10	<2.3	<10	<2.4
INDENO(1,2,3-C)PYRENE	<10	<2.3	<10	<2.3	<10	<2.4
BIBENZ(AH)ANTHRACENE	<10	<2.3	<10	<2.3	<10	<2.4
BENZO(BH)PERYLENE	<10	<2.3	<10	<2.3	<10	<2.4
PHENOL	<10	<2.3	<10	<2.3	12	2.9
2-CHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2-METHYLPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
4-METHYLPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2,4-DIMETHYLPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2-NITROPHENOL	160	37	70	16	54	13
2,4-DICHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
4-CHLORO-3-METHYLPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2,4,6-TRICHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2,4,5-TRICHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2,4-DINITROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
4-NITROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
4,6-DINITRO-2-METHYLPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
PENTACHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
BENZOIC ACID	<10	<2.3	<10	<2.3	<10	<2.4
N-NITROSDIMETHYLAMINE	<10	<2.3	<10	<2.3	<10	<2.4
ANILINE	<10	<2.3	<10	<2.3	<10	<2.4
BIS(2-CHLOROETHYL)ETHER	<10	<2.3	<10	<2.3	<10	<2.4
DI-N-OCTYLPHTHALATE	<10	<2.3	<10	<2.3	<10	<2.4

TABLE 2-11 (Continued)

PARAMETER	RUN SHWS-1		RUN SHWS-2		RUN SHWS-3	
	RESULTS ug/SAMPLE(a)	ug/DSCN(b)	RESULTS ug/SAMPLE(a)	ug/DSCN(c)	RESULTS ug/SAMPLE (a)	ug/DSCN(d)
1,3-DICHLOROBENZENE	<10	<2.3	<10	<2.3	<10	<2.4
1,4-DICHLOROBENZENE	49	11	41	9.5	58	14
BENZYL ALCOHOL	<10	<2.3	<10	<2.3	<10	<2.4
1,2-DICHLOROBENZENE	12	2.8	39	9.1	25	6.1
BIS(2-CHLOROISOPROPYL) ETHER	<10	<2.3	<10	<2.3	<10	<2.4
N-NITROBIS(1-N-PROPYLAMINE	<10	<2.3	<10	<2.3	<10	<2.4
HEXACHLOROETHANE	<10	<2.3	<10	<2.3	<10	<2.4
NITROBENZENE	<10	<2.3	<10	<2.3	<10	<2.4
ISOPHORONE	<10	<2.3	<10	<2.3	<10	<2.4
BIS(2-CHLOROETHOXY) METHANE	<10	<2.3	<10	<2.3	<10	<2.4
1,2,4-TRICHLOROBENZENE	<10	<2.3	<10	<2.3	<10	<2.4
4-CHLORANILINE	<10	<2.3	<10	<2.3	<10	<2.4
HEXACHLOROBTADINE	<10	<2.3	<10	<2.3	<10	<2.4
2-METHYLNAPHTHALINE	<10	<2.3	<10	<2.3	<10	<2.4
HEXACHLOROCYCLOPENTADINE	<10	<2.3	<10	<2.3	<10	<2.4
2-CHLORONAPHTHALINE	<10	<2.3	<10	<2.3	<10	<2.4
2-NITROANILINE	<10	<2.3	<10	<2.3	<10	<2.4
DIMETHYLPHTHALATE	<10	<2.3	<10	<2.3	<10	<2.4
3-NITROANILINE	<10	<2.3	<10	<2.3	<10	<2.4
DIBENZOFURAN	<10	<2.3	<10	<2.3	<10	<2.4
2,4-DINITROTOLUENE	<10	<2.3	<10	<2.3	<10	<2.4
2,6-DINITROTOLUENE	<10	<2.3	<10	<2.3	<10	<2.4
DIETHYL PHTHALATE	<10	<2.3	34	7.9	68	16.5
4-CHLOROPHENYLPHENYL ETHER	<10	<2.3	<10	<2.3	<10	<2.4
4-NITROANILINE	<10	<2.3	<10	<2.3	<10	<2.4
N-NITROBISPHENYLAMINE	<10	<2.3	<10	<2.3	<10	<2.4
4-BROMOPHENYLPHENYL ETHER	<10	<2.3	<10	<2.3	<10	<2.4
HEXACHLOROBENZENE	<10	<2.3	<10	<2.3	<10	<2.4
DI-N-BUTYL PHTHALATE	<10	<2.3	<10	<2.3	<10	<2.4
BENZIDINE	<10	<2.3	<10	<2.3	<10	<2.4
BUTYL BENZYL PHTHALATE	12	2.8	<10	<2.3	<10	<2.4
3,3-DICHLOROBENZIDINE	<10	<2.3	<10	<2.3	<10	<2.4
BIS(2-ETHYLHEXYL)PHTHALATE	35	8.2	<10	<2.3	22	5.3

NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT.

(b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.275 DSCN (151.07 DSCF). SEE TABLE 2-9.

(c) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.302 DSCN (152.00 DSCF). SEE TABLE 2-9.

(d) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.124 DSCN (145.74 DSCF). SEE TABLE 2-9.

TABLE 2-12
 SEMIVOLATILE ORGANICS DATA SUMMARY
 FLUE GAS EMISSIONS DATA FOR NON-HSL "TARGET"
 COMPOUNDS - RUNS 1, 2, AND 3

ERT No: 33505, 33507, 33508 DATES SAMPLED: 05/20/86 & 05/21/86

FIELD ID's: SNWS-1, 2, & 3 SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RUN SNWS-1		RUN SNWS-2		RUN SNWS-3	
	RESULTS ug/SAMPLE (a)	ug/DSCM(b)	RESULTS ug/SAMPLE(a)	ug/DSCM(c)	RESULTS ug/SAMPLE (a)	ug/DSCM(d)
1-METHYLNAPHTHALENE	<10	<2.3	<10	<2.3	<10	<2.4
PENTACHLOROBENZENE	<10	<2.3	<10	<2.3	<10	<2.4
1,2,4,5-TETRACHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
1,2,3,5-TETRACHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
1,2,3,4-TETRACHLOROPHENOL	<10	<2.3	<10	<2.3	<10	<2.4
2-NITRONAPHTHALENE	<10	<2.3	<10	<2.3	<10	<2.4
BIPHENYL	<10	<2.3	<10	<2.3	<10	<2.4
MONOCHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
DICHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
TRICHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
TETRACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
PENTACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
HEXACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
HEPTACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
OCTACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
NONACHLOROBIPHENYLS (TOTAL)	<10	<2.3	<10	<2.3	<10	<2.4
DECACHLOROBIPENYL	<10	<2.3	<10	<2.3	<10	<2.4

NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT

(b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.275 DSCM (151.07 DSCF). SEE TABLE 2-9.

(c) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.302 DSCM (152.00 DSCF). SEE TABLE 2-9.

(d) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.124 DSCM (145.74 DSCF). SEE TABLE 2-9.

TABLE 2-13

**SEMI-VOLATILE ORGANICS DATA SUMMARY
FLUE GAS EMISSIONS DATA FOR ADDITIONAL NON-
"TARGET" COMPOUNDS - RUNS 1, 2, AND 3**

ERT No: 35505, 35507, 35508 DATES SAMPLED: 05/20/86 & 05/21/86

FIELD ID's: SHMS-1, 2, & 3 SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RUN SHMS-1		RUN SHMS-2		RUN SHMS-3	
	RESULTS ug/SAMPLE (a)	ug/DSCM(b)	RESULTS ug/SAMPLE(a)	ug/DSCM(c)	RESULTS ug/SAMPLE (a)	ug/DSCM(d)
TETRADECANE	3800	890	--	--	--	--
DODECANOIC ACID	2700	630	4200	980	650	160
4,4-DIMETHYL-2-PENTENE	--	--	16000	3700	--	--
2,3-DIMETHYLCYCLOBUTANOL	--	--	24000	5600	--	--

- NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT
- (b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.275 DSCM (151.07 DSCF). SEE TABLE 2-9.
- (c) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.302 DSCM (152.00 DSCF). SEE TABLE 2-9.
- (d) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 4.124 DSCM (145.74 DSCF). SEE TABLE 2-9.

program. As noted in Section 6, concentrations for these constituents were calculated as referenced to the closest eluting internal standard during GC/MS analyses.

2.7 Volatile Organics

During each PCDDs/PCDFs test series, volatile organics were collected contemporaneously employing a Volatile Organic Sampling Train (VOST). As noted in Tables 5-1 and 5-2, two VOST runs of 60 minutes in duration and two VOST runs of 50 minutes in duration were conducted during each of the three test series. As noted in Table 5-1, these samples were collected from the #8 incinerator while it was maintained under "steady-state" operating conditions. Differential sample volumes were collected to avoid "overload" of sorbent tubes and resulting "breakthrough" and data quality problems. Flow rates for Runs 1A and 1B, 2A and 2B were preset at 0.25 liter/minute while Runs 3A, 3B, 4A and 4B were set at 0.1 liter/minute. Additionally, THC measurements collected on a continuous basis during each VOST run provided an additional "real time" criteria for estimating optimum sample collection volumes and test run durations for each VOST sample. A total of 22 samples were collected during the course of the aforementioned test series. Of these a total of 8 VOST samples were selected for actual GC/MS analyses. This listing included four flue gas samples and four associated field-biased blanks as follows: B-208 Run 1B (ERT ID No. 35486), B-201 Field Blank (ERT ID No. 35310), B-206-Field Blank (ERT ID No. 35484), B-212 Field Blank (ERT ID No. 35490), B-214 Run 2B (ERT ID No. 35492), B-216 Run 3A (ERT ID No. 34494), B-220 Run 4A (ERT ID No. 35498) and B-222 Field Blank (ERT ID No. 35500). Each sorbent cartridge was submitted for analyses of the volatile organic "target" compound listing identified in the project test plan and again in Section 6 of this report. Analyses were conducted employing thermal desorption in conjunction with combined gas chromatography/mass spectrometry.

Results for analyses of the EPA Hazardous Substances Listing (HSL) of volatile organics are provided in Table 2-14. These results which reflect method blank and field-biased blank corrected values are reported in units of $\mu\text{g}/\text{m}^3$. In a similar manner, results for all non-HSL "target" compounds as well as all additional non-"target" volatiles are provided in Table 2-15. Results for the latter category again represent "approximate" concentrations for the non-target compounds listed because standard reference materials were not readily available during the conduct of the analytical program. Concentrations for these components were calculated as referenced to the closest eluting internal standard during GC/MS analyses.

TABLE 2-14

VOLATILE ORGANICS DATA SUMMARY
 FLUE GAS EMISSIONS DATA FOR EPA HAZARDOUS
 SUBSTANCE LISTING - RUNS 1B, 2B, 3A, AND 4A

ERT Nos: 33406, 33492, 33494, 33498

DATES SAMPLED: 05/20/86 THRU 05/22/86

FIELD ID: B200, B214, B216, B220

SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RUN 1-B		RUN 2-B		RUN 3-A		RUN 4-A	
	RESULTS ng/SAMPLE(a)	ug/BSCH(b)	RESULTS ng/SAMPLE(a)	ug/BSCH(c)	RESULTS ng/SAMPLE (a)	ug/BSCH(d)	RESULTS ng/SAMPLE (a)	ug/BSCH(e)
CHLOROETHANE	140	8.4	<50	<3.3	54	11	<50	<10
BROMOETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
VINYL CHLORIDE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
CHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
METHYLENE CHLORIDE	19000	1100	9100	600	6100	1200	18000	3700
ACETONE	490	30	<50	<3.3	120	24	160	33
CARBON DISULFIDE	1100	66	350	23	250	50	210	44
1,1-DICHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
1,1-DICHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
TRANS-1,2-DICHLOROETHENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
CHLOROFORM	110	6.6	110	7.3	<50	<9.9	<50	<10
1,2-DICHLOROETHANE	460	28	330	22	120	24	<50	<10
2-BUTANONE	<50	<3.0	54	3.6	<50	<9.9	170	35
1,1,1-TRICHLOROETHANE	<50	<3.0	340	22	<50	<9.9	<50	<10
CARBON TETRACHLORIDE	<50	<3.0	74	4.9	<50	<9.9	63	13
VINYL ACETATE	<50	<3.0	<50	<3.3	100	20	<50	<10
BROMODICHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	130	27
1,2-DICHLOROPROPANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
TRANS-1,3-DICHLOROPROPENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
TRICHLOROETHENE	60	3.6	120	7.9	<50	<9.9	<50	<10
DIBROMODICHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
1,1,2-TRICHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
BENZENE	510	31	77	5.1	57	11	<50	<10
CIS-1,3-DICHLOROPROPENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
2-CHLOROETHYL VINYL ETHER	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
BROMOFORM	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
2-HEXANONE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
4-METHYL-2-PENTANONE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
TETRACHLOROETHENE	170	10	450	30	60	12	<50	<10
1,1,2,2-TETRACHLOROETHANE	<50	<3.0	<50	<3.3	<50	<9.9	70	16
TOLUENE	<50	<3.0	54	3.7	<50	<9.9	<50	<10
CHLOROBENZENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
ETHYL BENZENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
STYRENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
TOTAL XYLENES	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10

NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE FIELD-BASED AND LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT.

(b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.01640 BSCH (16.60 LITERS).

(c) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.01512 BSCH (15.12 LITERS).

(d) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.00504 BSCH (5.04 LITERS).

(e) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.00482 BSCH (4.82 LITERS).

TABLE 2-15

VOLATILE ORGANICS DATA SUMMARY
 FLUE GAS EMISSIONS DATA FOR NON-HSL "TARGET" COMPOUNDS
 AND ADDITIONAL "TARGET" COMPOUNDS - RUNS 1B, 2B, 3A, AND 4A

ERT No: 35486, 35492, 35494, 35498

DATES SAMPLED: 05/20/86 THRU 05/22/86

FIELD ID: B200, B214, B216, B220

SAMPLING SITE: TWIN CITIES, MN

PARAMETER	RUN 1-B		RUN 2-B		RUN 3-A		RUN 4-A	
	RESULTS ng/SAMPLE (a)	ug/BSCH(b)	RESULTS ng/SAMPLE(a)	ug/BSCH(c)	RESULTS ng/SAMPLE (a)	ug/BSCH(d)	RESULTS ng/SAMPLE (a)	ug/BSCH(e)
NON-HSL "TARGET" COMPOUNDS								
CYCLOPENTANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
CYCLOHEXANE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
1,2-DIBROMETHYLENE	<50	<3.0	<50	<3.3	<50	<9.9	<50	<10
3-HEPTANE	<130	<7.8	<130	<8.6	<130	<26	<130	<27
2,6-DIMETHYL-4-HEPTANONE	<130	<7.8	<130	<8.6	700	140	<130	<27
NON - "TARGET" COMPOUNDS								
2-ETHYL-4-METHYL-1,3-DIOXOLANE	2200	130	850	56	--	--	97	20
NITROMETHANE	--	--	420	28	--	--	--	--
2-PROPENITRILE	2200	130	560	37	200	56	--	--
CYCLOHEXENE	160	9.6	130	8.6	48	9.5	40	8.3
2,2'-DIYBIS-PROPANE	230	14	170	11	93	18	90	19
TETRAHYDROFURAN	--	--	190	13	--	--	--	--
2,4(3H,5H)-FURANDIONE	--	--	76	5.0	--	--	72	15
1,4-DICHLOROBENZENE	--	--	190	13	--	--	46	9.5
2,5-DIMETHYL-1,4-DIOXANE	250	15	260	17	--	--	--	--
2,4-DIMETHYLOCTANE HEPTANE	320	19	20	1.3	--	--	--	--
METHYL ESTER FORMIC ACID	1900	110	--	--	--	--	120	25
DIMETHOXYETHANE	1900	110	--	--	2400	476	2700	560
UREA	300	18	--	--	--	--	--	--
2-(FORMYLOXY)-1-PHENYLETHANONE	16	--	--	--	--	--	--	--
BENZONITRILE	--	--	--	--	--	--	--	--
BENZALDEHYDE	--	--	--	--	--	--	500	100
ETHANOL	--	--	--	--	--	--	200	41
1,1-DICHLORO-1-NITROETHANE	--	--	--	--	770	153	--	--
TRICHLOROMETHANE	--	--	--	--	30	7.5	--	--
CHLOROFLUOROMETHANE	--	--	--	--	79	16	--	--
							120	25

NOTES: (a) VALUES PROVIDED HERE HAVE BEEN CORRECTED USING THE APPROPRIATE FIELD-BASED AND LABORATORY METHOD BLANK. ANALYTICAL RESULTS WERE TAKEN FROM THE ERT ANALYTICAL DATA REPORT PROVIDED IN APPENDIX E OF THIS DOCUMENT.

(b) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.01660 BSCH (16.60 LITERS).

(c) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.01512 BSCH (15.12 LITERS).

(d) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.00504 BSCH (5.04 LITERS).

(e) VALUES PROVIDED HERE ARE BASED UPON A TOTAL SAMPLE VOLUME OF 0.00482 BSCH (4.82 LITERS).

3. DISCUSSION OF RESULTS

3.1 Introduction

The discussion to follow will focus on an interpretation of the emissions monitoring data contained in Section 2 in an attempt to ascribe additional relevance to this information. Particular attention has been focused on the organics data and most notably the PCDDs/PCDFs emissions values which were an integral component of the MWCC monitoring program. Our approach to assessing the significance of the emissions monitoring data collected during the present program will include a comparison of the present data with emissions data from other multiple hearth sewage sludge incinerators. This comparison will make use of each of the following types of historical information:

- Emissions data for multiple hearth incinerators at other municipal wastewater/sewage treatment facilities in the United States. This historical data base was compiled as a direct result of the literature survey conducted at the outset of the present program.
- Historical emissions data for the MWCC treatment facility collected during the conduct of a 1985 EPA sponsored monitoring program. This data contained in the Radian Report [1] focuses primarily on PCDDs/PCDFs emissions from the MWCC facility.

In the process of assessing the significance of our emissions data we have made use of the emissions monitoring data contained in Section 2 of this report as well as the associated quality control data contained in Section 7. This data in concert with the literature survey contained in the project test plan and the incinerator description and operating conditions provided in Section 4 of this report will provide the basis for the discussion to follow.

3.2 Volatile Organics

Results for analyses of the EPA Hazardous Substances Listing (HSL) are provided in Table 2-14. Results for both non-HSL volatiles as well as all additional non "target" volatile organics are provided in Table 2-15.

As shown in Table 2-14, the flue gas emissions contain a variety of volatile organics with concentrations ranging from the lower limit of detection ($3-10 \mu\text{g}/\text{m}^3$) up to an upper limit of $44 \mu\text{g}/\text{m}^3$. The only notable exception to this is methylene chloride which persists in each of the samples at concentrations ranging from $600 \mu\text{g}/\text{m}^3$ (Run 2B) to $3700 \mu\text{g}/\text{m}^3$ (Run 4A). (These emissions for methylene chloride which represent blank corrected data should be regarded as minimum values owing to the potential for analyte breakthrough at these high concentrations during the sample collection process).

3.2.1 Chlorinated Organics

The majority of those constituents which appeared in two or more of the runs can be categorized as chlorinated aliphatics which are in ERT's experience commonly found in industrial effluents and in turn in wastewater influents to sewage treatment facilities throughout the United States [4.5]. This includes methylene chloride ($600-3700 \mu\text{g}/\text{m}^3$), 1,2-dichloroethane ($22-35 \mu\text{g}/\text{m}^3$), and tetrachloroethylene ($10-30 \mu\text{g}/\text{m}^3$) which appeared in all of the four runs examined and chloromethane ($8-11 \mu\text{g}/\text{m}^3$), chloroform ($6-7 \mu\text{g}/\text{m}^3$), 1,1,1-trichloroethane ($13-22 \mu\text{g}/\text{m}^3$), and trichloroethene ($4-8 \mu\text{g}/\text{m}^3$) which appeared in two of the four runs examined. Since little data can be identified in the open literature pertinent to chlorinated aliphatic emissions from sewage sludge incinerators, no direct comparisons can be made between these data and emissions from other wastewater treatment facilities. As noted earlier, however, it is not

uncommon to find a variety of chlorinated aliphatic solvents in wastewater influents to a treatment facility such as this one. [5]

Chlorinated solvents potentially contained in industrial wastewaters received at the facility, if not completely removed during the treatment process and chlorinated solvents formed during chlorinated treatment processes, will of course provide the basis for chlorinated aliphatics present in flue gas emissions from the on-site incinerator. Chlorinated solvents, such as those identified here, are in fact the topic of investigation in a project that ERT is presently conducting at a municipal wastewater treatment facility in Fields Point, Rhode Island. Volatile solvents that have consistently appeared in plant wastewaters have included 1,1,1 trichloroethane, methylene chloride, trichloroethene and tetrachloroethylene [4].

Additionally, in one or more instances the flue gas emissions contained measurable levels of the following "target" and non "target" chlorinated organics: carbon tetrachloride ($5 \mu\text{g}/\text{m}^3$) in Run 2B, 1,4 dichlorobenzene ($13 \mu\text{g}/\text{m}^3$) in Run 2B and ($10 \mu\text{g}/\text{m}^3$) in Run 4A, 1,1-dichloro-1-nitromethane ($8 \mu\text{g}/\text{m}^3$) in Run 3A and chlorodifluoromethane ($25 \mu\text{g}/\text{m}^3$) in Run 4A. Again no direct significance can be ascribed to these data owing to the paucity of emissions data in the open literature. It is worthy of note, however, that dichlorobenzene which appeared in Runs 2B and 4A is a semivolatile organic "target" compound which appeared consistently in the flue gas emissions data provided in Table 2-11. The appearance of the p-dichlorobenzene isomer as a volatile organic here provides further confirmation of the data provided in Table 2-11 for each of the three semivolatile organic sampling runs. In fact, the concentration data for p-dichlorobenzene in Runs 2B ($13 \mu\text{g}/\text{m}^3$) and 4A ($10 \mu\text{g}/\text{m}^3$) provided here are in excellent agreement with the data generated using the preferred monitoring methodology as shown in Table 2-11. In the latter instance

1,4-dichlorobenzene concentrations ranging from 10-14 $\mu\text{g}/\text{m}^3$ were reported during each of the three semivolatile sampling runs. 1,4-dichlorobenzene which is widely used as a disinfectant, deodorant and chemical intermediate [6] is a known precursor to PCDDs/PCDFs under combustion source conditions [7]. Dichlorobenzene isomers were also identified as contaminants in the sludge feed to the incinerator during previous testing conducted by Radian at this facility in 1985 [1]. The data provided here are consistent with these observations.

3.2.2 Volatile Organics - Nonchlorinated (Aliphatic Ketones, Esters, Aromatics)

As shown in Tables 2-14 and 2-15, a number of nonchlorinated volatile organics were also present in flue gas emissions from the MWCC facility. Again the majority of those constituents which appeared in two or more of the four runs can be categorized as aliphatics, aliphatic ketones, aliphatic esters, or aromatics. Again it has been ERT's experience that many of these components are commonly found in industrial discharges and hence influents to the wastewater treatment facility. This includes acetone (24-33 $\mu\text{g}/\text{m}^3$) and benzene (5-31 $\mu\text{g}/\text{m}^3$) which appeared in three of four samples examined, vinyl acetate (20-27 $\mu\text{g}/\text{m}^3$) which appeared in two of four samples, and toluene (4 $\mu\text{g}/\text{m}^3$) and 2-butanone (4 $\mu\text{g}/\text{m}^3$), which each appeared in one of four samples examined. Lastly, carbon disulfide (23-66 $\mu\text{g}/\text{m}^3$) which is an organosulfur or mercaptan species persisted in all of the four runs examined. No particular significance can be ascribed to these data, however, since we were unable to identify any historical emissions data for these components as part of our literature survey. Furthermore, volatile organic emissions were not specifically addressed during previous monitoring programs conducted at this facility.

3.3 Semivolatile Organics

As shown in Section 2 each of three sets of flue gas samples were analyzed for a series of semivolatile organic "target" compounds comprised of both the EPA Hazardous Substances Listing (HSL) as well as a series of additional non-HSL compounds. The latter category included polychlorinated biphenyls (PCBs), as well as additional chlorinated benzene and chlorinated phenol isomers. The results of these analyses are provided collectively in Tables 2-11 and 2-12. A brief discussion of the significance of these measurements are provided in the text to follow.

3.3.1 EPA Hazardous Substances Listing (HSL)

As shown previously in Table 2-11 each of three sets of flue gas samples were analyzed for a variety of semivolatile organics identified collectively as the EPA hazardous substances listing (HSL). Included in this listing are a representative listing of polynuclear aromatic hydrocarbons (PAHs), substituted phenolics, substituted anilines, chlorinated aromatics, nitro substituted aromatics, and phthalate esters potentially contained in industrial discharges that may enter the MWCC treatment system as wastewater influents. The results of these analyses as shown in Table 2-11 indicate that the HSL listing of semivolatile organics are virtually absent from flue gas emissions associated with the MWCC sewage sludge incinerator. With the exception of naphthalene ($2.6-4.7 \mu\text{g}/\text{m}^3$), 2-nitrophenol ($13-37 \mu\text{g}/\text{m}^3$), 1,4-dichlorobenzene ($9.5-19 \mu\text{g}/\text{m}^3$), and 1,2-dichlorobenzene ($2.8-9.1 \mu\text{g}/\text{m}^3$) which appeared in each of the three test runs, diethyl phthalate ($7.9-17 \mu\text{g}/\text{m}^3$) and bis(2-ethyl(hexyl)phthalate ($5.3-8.2 \mu\text{g}/\text{m}^3$) which appeared in two of three runs and phenol ($2.9 \mu\text{g}/\text{m}^3$), and butyl benzyl phthalate ($2.8 \mu\text{g}/\text{m}^3$) which appeared in one test each none of the remaining HSL compounds appeared in flue gas emissions during the MWCC monitoring program.

Again little can be said about the significance of these measured values owing to the general lack of comparative emissions data in the open literature as well as the absence of such information from the existing data base for this facility. However, despite these shortcomings some discussion of the semivolatile organic emissions data at least in a qualitative sense will be addressed here.

Naphthalene which appears in each of the three test runs is a polynuclear aromatic hydrocarbon which is commonly found in flue gas emissions from stationary incineration sources, particularly those associated with the combustion of fossil fuels.

Phthalate esters which appear in each of the three test series are industrial plasticizers commonly found in influent wastewaters to sewage treatment facilities. In fact the results of an EPA sponsored research program released in 1982 indicated that phthalate esters were frequently found in the influent wastewaters of 40 treatment facilities examined [5]. During the aforementioned study a total of 287 samples were examined. Bis(2-ethylhexyl) phthalate appeared in 265 or 92% of the samples examined, diethyl phthalate appeared in 151 or 53% of the samples examined and butylbenzyl phthalate appeared in 165 or 57% of the samples examined. Such trends could of course account for the persistence of phthalate esters found here in flue gas emissions from the MWCC sewage sludge incinerator. While these data provide some qualitative justification for the appearance of phthalate plasticizers in MWCC incinerator emissions little can be said about the quantitative significance of these measurements. This is again precipitated by the unavailability of flue gas emissions data for phthalate esters in the readily accessible open literature.

3.3.2 Chlorinated Benzenes/Chlorinated Phenols

In accordance with the project test plan each of the three sets of flue gas samples was examined for the presence of each of the five positional isomer categories of chlorinated phenols and each of the six positional isomer categories of chlorinated benzenes. These categories were selected on the basis of their historical significance as known precursors to polychlorinated dibenzodioxins (PCDDS) and polychlorinated dibenzofurans (PCDFS)[7]. Each of the three sample sets were examined for a series of specific chlorinated phenol and chlorinated benzene isomers contained in the EPA HSL listing as well as a series of additional isomers acting as surrogates for those positional isomer categories not represented on the EPA HSL listing. As shown in Tables 2-11 and 2-12 with the exception of the dichlorobenzene positional isomer class none of the remaining isomer categories were in evidence during each of the three flue gas sampling sessions. As discussed previously the persistence of the dichlorobenzene isomer class in each of the three flue gas samples is corroborated both qualitatively and quantitatively by the results of the volatile organic measurements shown in Table 2-14. The 1,2 and 1,4 dichlorobenzene isomers which are not uncommon to POTW wastewater influents (23% and 17% of samples examined in 1982 EPA survey, respectively) are commercially available as disinfectants, deodorants and chemical intermediates[6]. Additionally, chlorinated benzenes are known precursors under combustion conditions to both polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzodioxins (PCDDS)[7]. Furthermore, the persistence of the dichlorobenzene isomers in flue gas emissions from the MWCC incinerator in conjunction with previous results of sludge feed analyses contained in the 1986 EPA/Radian report[1] suggest that these constituents may have their origin in the sludge feed to the incinerator.

3.3.3 Polychlorinated Biphenyls (PCBs)

Analyses were conducted for polychlorinated biphenyls (PCBs) as each of the ten positional isomer categories (Cl_1 - Cl_{10}). As shown in Table 2-12 none of the ten positional isomer PCB categories were in evidence during any of the three flue gas sampling sessions ($<2.4 \mu\text{g}/\text{m}^3$). These results may be particularly significant in light of the fact that much of the historical emissions data base for wastewater treatment facilities has focused on PCBs contained in flue gas emissions from multiple hearth sewage sludge incinerators.

In fact, a review of the available literature indicates that extensive PCB emissions testing programs have been performed at a number of sewage treatment facilities throughout the United States. Two Municipal Sewage Sludge Incinerators were stack tested in 1976 as part of an overall program to develop methods for determining PCB emissions from incinerators and capacitor and transformer filling plants[8]. One of these plants, the Blue River Facility of Kansas City, Missouri, received waste comprised of significant quantities of industrial waste. The second test was at the facility of the city of Mission, Kansas, which receives mostly domestic waste. Both incinerators operate under induced draft and employ a wet scrubber for air pollution control. The Mission, Kansas Facility utilizes a four-hearth Multiple Hearth Incinerator while the type of unit at the Blue River Facility was not identified. Operational data, including PCB input rates, furnace temperatures and destruction efficiencies were not given. PCB concentrations in the stack gas were presented and totaled 305,308,287 and $98 \mu\text{g}/\text{m}^3$ for the four test runs at the Blue River Facility and 3.80 and $3.70 \mu\text{g}/\text{m}^3$ for two test runs at the Mission Incinerator.

The New Bedford Municipal Sewage Sludge Incinerator was tested for PCB destruction efficiency on February 9 and March 1 and 3, 1977[9]. Samples were collected from the incinerator flue gas, the sewage sludge feed, the incinerator ash, the

precooler and scrubberwater feeds and the scrubber water effluent. Total PCB concentrations in the flue gas spanned from 3-10.6 $\mu\text{g}/\text{m}^3$ during the three test series.

Subsequent testing conducted at the New Bedford POTW in 1984 resulted in no measurable levels of PCBs in flue gas emissions from the same multiple hearth sewage sludge incinerator[10]. Detection limits for each of the ten PCB positional isomer categories ranged from 2 $\mu\text{g}/\text{m}^3$ for the mono thru tri categories to 5 $\mu\text{g}/\text{m}^3$ for the tetra thru hepta categories to an upper limit of 13 $\mu\text{g}/\text{m}^3$ for the octa thru decachlorobiphenyl congener classes[10].

3.4 Polychlorinated Dibenzodioxins (PCDDS)/Polychlorinated Dibenzofurans (PCDFS)

PCDDS and PCDFS were monitored during each of two sampling sessions. The results of these measurements were provided previously in Section 2 of this report. The total tetra thru octa PCDDS/PCDFS data are provided in Table 2-7, while results for the mono thru tri PCDDS/PCDFS isomer categories as well as the 2,3,7,8-TCDD and 2,3,7,8-TCDF isomers are provided in Table 2-8. By and far the results provided here are predominated by the presence of the PCDFS over the PCDDS. For instance the TCDF congener class and in particular the 2,3,7,8-TCDF isomer appears in each of the three samples examined. Run 1A is characterized further by the presence of the tri (0.03 ng/m^3) and penta (0.09 ng/m^3) PCDF congener classes, while the two contemporaneous sample runs 2A/2B are characterized by the presence of the mono (0.02-0.19 ng/m^3), tri (0.03-0.84 ng/m^3), penta (0.09-0.60 ng/m^3), hexa (0.04-0.13 ng/m^3), hepta (0.04-0.10 ng/m^3) and octa (0.07-0.33 ng/m^3) PCDFs congener classes.

Conversely, with the exception of the di and tri congener categories none of the other PCDD congener classes are represented in either of the two test series. The di PCDD congener category appears in Runs 1 and 2A/2B at concentrations

of 1.9 and 2.2 (avg) ng/m^3 , respectively, while the tri PCDD category appears in Runs 1 and 2A/2B at concentrations of 0.07 and 0.16 (avg) ng/m^3 , respectively. It is particularly noteworthy that the TCDD congener class as well as the 2,3,7,8-TCDD isomer were not in evidence during either of the two test series. Detection limits for the 2,3,7,8-TCDD isomer of 0.01 and 0.02 ng/m^3 were achieved during Runs 1 and 2A/2B, respectively. Detection limits for the TCDD congener class ranging from 0.02 to 0.03 ng/m^3 were achieved as shown in Table 2-7 for each of the two test series.

By comparison the existing PCDDs/PCDFs emissions data for this facility is generally in good qualitative and quantitative agreement with the results provided here in Tables 2-7 and 2-8. More specifically the emissions data contained in the 1986 Radian/EPA report demonstrates the predominance of the PCDF congeners over the corresponding PCDDs congener classes. A summary of the Radian/EPA PCDDs/PCDFs emissions monitoring data for this facility is contained in Table 3-1[1]. Note in particular the predominance of PCDF congeners in Run 01 and to a lesser degree in Runs 05 and 03. Similarly, note the virtual absence of PCDDs congeners from Run 03 and to a lesser degree from Run 05 and Run 01. With the exception of data for the TCDD, and Octa PCDD congener classes the Radian/EPA 1986 data is in good agreement with the concentrations noted during the present program as shown in Tables 2-7 and 2-8. More specifically the 2,3,7,8-TCDD isomer is not in evidence in any of the samples examined in either of the two monitoring programs. Detection limits for the most part are directly comparable ranging from 0.01 to 0.02 ng/m^3 during the present program to 0.012 to 0.06 ng/m^3 during the 1985 EPA sponsored monitoring program. Total tetra and octa PCDDs in evidence during the EPA/Radian test program did not appear during the present program. Measurement of the octa PCDD isomer during the present program at concentrations comparable to those achieved during the EPA sponsored program was prohibited.

TABLE 3-1
 SUMMARY OF PCDDS/PCDFS EMISSIONS DATA FOR
 MWCC SEWAGE SLUDGE INCINERATOR - EPA/RADIAN 1986 (1)

Dioxin/Furan Isomer	Isomer Concentration in Flue Gas (ng/dscm)			
	Run 01	Run 03	Run 05	Avg.
DIOXINS				
2378 TCDD	ND(1.15E-02)	ND(6.00E-02)	ND(1.15E-02)	.00E-00
Other TCDD	1.92E-01	ND(6.00E-02)	2.87E-02	7.37E-02
Penta-CDD	ND(1.92E-02)	ND(4.50E-02)	ND(5.75E-02)	.00E+00
Hexa-CDD	ND(1.85E-01)	ND(1.02E-01)	ND(8.62E-03)	.00E-00
Hepta-CDD	1.15E-01	ND(6.75E-02)	ND(4.02E-02)	3.85E-02
Octa-CDD	3.08E-01	1.75E-01	1.72E-01	2.18E-01
Total PCDD	6.15E-01	1.75E-01	2.01E-01	3.31E-01
FURANS				
2378 TCDF	7.31E-01	2.50E-01	4.02E-01	4.61E-01
Other TCDF	7.50E+00	1.52E+00	2.67E+00	3.90E+00
Penta-CDF	2.08E+00	ND(4.50E-02)	7.18E-01	9.32E-01
Hexa-CDF	8.46E-01	ND(5.75E-02)	ND(2.13E-01)	2.82E-01
Hepta-CDF	ND(2.38E-01)	ND(7.25E-02)	ND(2.01E-02)	.00E+00
Octa-CDF	3.85E-02	ND(1.25E-02)	ND(1.72E-02)	1.29E-02
Total PCDF	1.12E+01	1.77E+00	3.79E+00	5.59E-00

NOTE: Isomer concentrations shown are at as-measured oxygen conditions.

ND = not detected (detection limit in parentheses).
 ng = 1.0E-09g
 8760 operating hours per year

however, by the presence of positive interferences in the laboratory method blank. Hence detection limits achieved during each of the two test programs are not directly comparable.

Additional significance can be ascribed to the PCDDS/PCDFS emissions data contained in Tables 2-7 and 2-8 from a direct comparison to data from other stationary combustion sources. Since test data from other sewage sludge incinerators is limited it might prove useful to examine the MWCC emissions data in light of PCDDS/PCDFS emissions peculiar to other stationary combustion sources here in North America. The values provided here for both 2,3,7,8-TCDD and total TCDD indicate that emissions from the MWCC incinerator are significantly lower than values reported in flue gas emissions from a variety of other stationary combustion sources [7]. This includes all of the source categories presently under investigation as part of the EPA National Dioxin Strategy - Tier IV Combustion Sources. Additionally, the MWCC PCDDs PCDFs emissions data are significantly lower than PCDDS/PCDFS emissions data characteristic of municipal refuse incinerators situated throughout the United States and Canada. A summary of this PCDDS/PCDFS emission data sorted by congener category (Cl_4 - Cl_9) for such facilities is provided in Table 3-2. As shown the MWCC emissions data are markedly lower than the concentrations typical of the cross-section of municipal refuse incinerators shown here.

3.5 Trace Metals

Trace metals data for each of the three test series are provided in Tables 2-2, 2-3, and 2-4. While the majority of the "target" metals appear in one or more of the samples examined, only a select number of these appear consistently in significant concentrations in the flue gas. For the purposes of our discussion here, only those species which appear in each of the three samples examined at concentrations in excess of 10 ug/m^3 will be addressed. The metal species which satisfy

TABLE 3-2
SUMMARY OF ALL NORTH AMERICAN DATA BY FACILITY AVERAGE

Country	Site	Run	PCOF CONTAINER (kg/200L)			PCOF CONTAINER (kg/200L)			PA - 10 CF	PA - 10 CF	MVA Particulate PCOF + PA (mg) PCOF Container (g)	Ref.
			PCOF	PCOF	PCOF	PCOF	PCOF	PCOF				
Average of All Published Data by Individual Facility												
Non-Burn Facilities												
GEORGIA, U.S.		2.11	0.23	2.11	2.09	4.10	6.57	17.16				
CONNECTICUT, U.S.		12.67	6.27	4.33	16.33	7.97	2.93	22.70				
MISSISSIPPI, U.S.		46.00	200.25	200.25	600.75	461.25	100.50	2571.13				
MA, CANADA		3.57	1.67				3.57					
ONTARIO, CANADA		0.06	0.06	0.06	0.10	0.19	0.20					
MINNESOTA, CANADA		21.20	97.20	307.11	197.20	85.61	700.20					
QUEBEC, CANADA		4.06	14.06	15.46	12.23	1.70	40.10					
PENNSYLVANIA, U.S.		158.00	5.43	430.33	790.00	270.33	112.03	1770.50				
Refuse Derived Fuel Facilities												
MINN., CANADA		617.20		200.00	207.20	242.20	105.25	2002.75				
ALABAMA, U.S.		15.73	0.41	122.64	112.05	102.12	0.65	202.75				
DEL. DEL., U.S.		55.04	2.05	20.20	200.00	253.20	115.00	737.62				
MA, CANADA		20.00	5.00				20.00					
Controlled Air Facilities												
PEI, CANADA		3.25		10.00	17.23	27.00	41.20	90.75				
LAKE CHARLES, CANADA		4.24		47.00	100.23	46.16	1.20	100.62				
MA, (Little Rock)		4.75	1.20				4.75					

AVERAGE OF ALL NORTH AMERICAN FACILITIES - ALL TECHNOLOGIES - BY FACILITY AVERAGE

Average =	66.05	1.76	100.16	100.25	100.15	46.07	200.79	163.74	370.95	500.73	241.93	80.46	10.25	1233.41	1025.20
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these criteria and persist in the incinerator flue gas emissions include zinc (1300-2600 ug/m³), cadmium (280-600 ug/m³), lead (280-480 ug/m³), tin (16-220 ug/m³), copper (100-210 ug/m³), chromium (18-78 ug/m³), nickel (16-82 ug/m³), and to a lesser extent selenium (11-19 ug/m³).

Since little is known about historical heavy metal emissions from this facility, we have attempted to ascribe some relevance to the present data by direct comparison to emissions data contained in the open literature.

In a manner consistent with the observations of others who have characterized heavy metals contained in sewage sludge incinerator flue gases, our samples are predominated by the more volatile metal species zinc, cadmium, and lead which are typically enriched on particles contained in the flue gas (12, 13, 14). To a lesser extent, each of the samples contained significant concentrations of tin, copper, and chromium, and to a lesser degree nickel and selenium. The appearance of these species in flue gas emissions from multiple-hearth sewage sludge incinerators is not uncommon, however, as these species are typically contained in dewatered sewage sludge provided as feed material to the incinerator. A number of other investigators have, in fact, reported on the persistence of the metals identified here in sewage sludge throughout the United States (5, 12-15).

In fact, a 1982 survey can be cited here which reports on elemental emissions (ug/m³) from each of four sewage sludge incineration systems. (Three multiple-hearth units and one fluidized bed system). A direct comparison of our data to emissions data for each of these facilities is provided in Table 3-3. To facilitate the comparison of data, results are provided from the literature citation only for those 8 species identified earlier in our discussion as present in significant concentrations.

TAB. 3-3

COMPARISON OF MACC ELEMENTAL EMISSIONS DATA ($\mu\text{g}/\text{m}^3$)
 FOR SELECTED PARAMETERS WITH ENVIRONMENTAL EMISSIONS FROM
 OTHER SEWAGE SLUDGE INCINERATORS (14)

Element	Flue Gas Concentration - $\mu\text{g}/\text{m}^3$				MCC Facility $\mu\text{g}/\text{m}^3$
	Site O (14)	Site P (14)	Site Q (14)	Site R (14)	
Lead (Pb)	510	1170	114	2140	360 - 480
Zinc (Zn)	810	1840	87	1830	2100 - 2600
Cadmium (Cd)	42	34	7	1890	280 - 600
Chromium (Cr)	97	480	14	230	18 - 78
Copper (Cu)	85	810	14	520	100 - 210
Tin (Sn)	180	1230	30	790	16 - 220
Selenium (Se)	~45	20	18	26	11 - 19
Nickel (Ni)	<22	125	<22	<22	16 - 82

As shown in Table 3-3, the data reported here, both average concentrations and ranges, are comparable in some instances to the corresponding flue gas concentrations for the 4 facilities examined.

In other instances the MWWTP data is lower than the literature values provided, such as in the case of lead, chromium and tin. In the case of zinc and cadmium the MWWTP emissions are much higher than the corresponding flue gas concentrations for the majority of the facilities examined. This is particularly true in a direct comparison of our data to emissions data peculiar to other multiple hearth sludge incinerators.

4. INCINERATOR DESCRIPTION AND OPERATING CONDITIONS

The emissions monitoring program was conducted using two of the available multiple-hearth sewage sludge incinerators at the MWWTP. Each of the two incinerators selected, #7 and #8, were maintained at representative "steady-state" operating conditions during each test series. The discussion to follow in Section 4.1 contains a description of the incinerators, including the heat recovery and associated air pollution control systems. Section 4.3 provides a definition of "steady-state" or representative system operations as defined by numerical criteria for each of the preselected parameters determined to be critical to incinerator operations.

4.1 Incinerator Description

The two incinerators (#7 and #8) tested were identical Envirotech nine-hearth sewage sludge incinerators installed at the plant in 1983. A schematic of the incinerator and its heat recovery and air pollution control systems is shown in Figure 4-1. Table 4-1 lists some of the more important design parameters of the incinerator.

Conditioned primary and secondary sludge with a solids content of 30 to 40 percent by weight is fed to hearth 1 of each incinerator at an average feed rate of ≥ 2.5 DTPH (≥ 7.5 WTPH). The design capacity of the incinerator is 3.39 dry Mg (3.75 dry tons) per hour. The sludge typically has a volatiles content of 72 percent by weight and a heating value of 24.4 J/g (10,500 Btu/lb) of volatiles. The upper hearths are used for drying of the sludge cake, the middle hearths are used for burning, and the bottom hearths are used for ash cooling.

An auxiliary fuel system consisting of natural gas-fired burners is available to provide supplemental heat when necessary. However, efforts by plant personnel to minimize energy usage usually result in these burners being used only during incinerator startup. The incinerators were firing

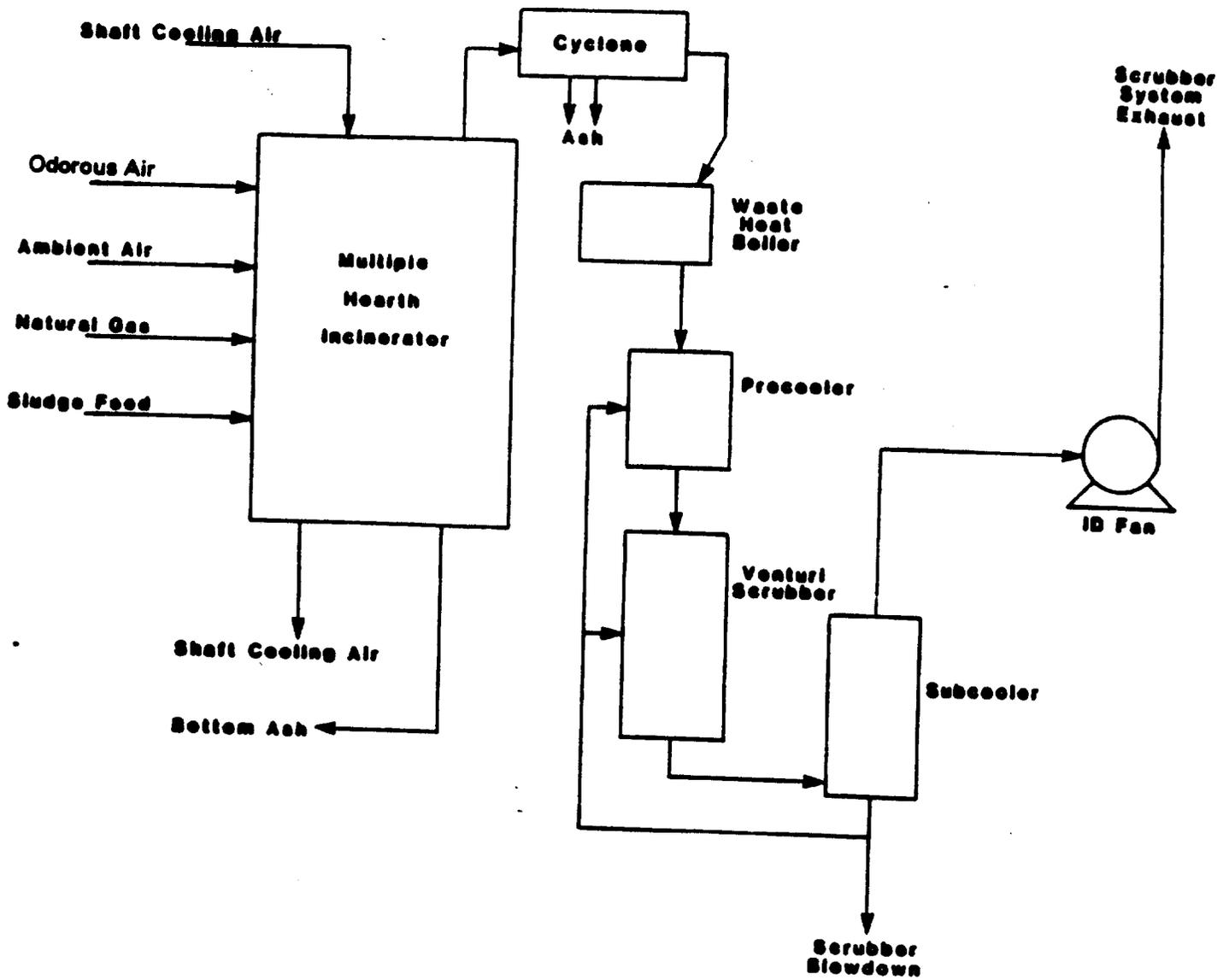


Figure 4-1 Schematic Diagram of Typical MWWTP Incinerator and Associated Air Pollution Control Equipment

TABLE 4-1
INCINERATOR AND SLUDGE DESIGN PARAMETERS
FOR TYPICAL INCINERATOR

<u>Design Parameter</u>	<u>Value</u>
<u>Incinerator</u>	
1. Manufacturer	● Envirotech
2. Number of Hearths	● 9
3. Sludge burning capacity	● 3.75 tons/hr (dry)
4. Exhaust gas volume	● 82,000 acfm @ 1,200°F
5. Bottom ash production	● 28 tons/day (typical) 34 tons/day (maximum)
6. Auxiliary fuel	● Natural gas (startup only)
<u>Sludge Feed</u>	
1. Sludge type	● Conditioned and dewatered primary and secondary sludge
2. Solids content	● 30% to 40%

primary scum from the wastewater treatment process, at a feed rate of approximately 33 gph each during the test program. (Secondary scum was transferred to the flotation thickeners.) Combustion air for the incinerators consists of ambient air and odorous air collected from ventilation systems on various wastewater treatment plant processes, including thermal conditioning. A shaft cooling air system is used to prevent overheating of the rabble arm shaft. The shaft cooling air exhaust is vented directly to the atmosphere via a stack separate from that used for the incinerator air pollution control system. None of the shaft cooling air exhaust is recycled for use as combustion air.

The incinerators are typically operated to maintain a temperature of 870°C (1,600°F) on Hearth No. 3 (fourth hearth from the top). The temperature is controlled by a microprocessor-based system that varies the combustion air intake dampers. The percent oxygen in the incinerator exhaust gas is typically 12 to 15 percent.

Under normal feed rate conditions each incinerator produces about 23 mg (25 tons) per day of bottom ash, which is pneumatically conveyed to silos for storage. The ash is ultimately loaded onto trucks or rail cars and hauled away for land disposal.

4.2 Heat Recovery and Air Pollution Control Systems

The incinerator exhaust gas train consists of a quad cyclone, a waste heat recovery boiler, a wet scrubber system, an induced draft fan, and an exhaust stack. The heat recovery and air pollution control system components are described below.

4.2.1 Quad Cyclone

The quad cyclone is used for large particulate removal prior to the waste heat boiler system. The cyclone has a rated gas flow capacity of 38.7 m³/s @ 650°C (82,000 acfm @

1,200°F) and typically operates at a pressure drop of 1.2 kPa (5 inches of water). The rated particulate removal efficiency of the cyclone is 72 percent. Uncontrolled particulate emissions entering the cyclone are estimated to be approximately 617 mg (680 tons) per year.

4.2.2 Waste Heat Recovery Boiler

The waste heat boiler recovers the heat from the incinerator offgas to produce steam. The nominal steam capacity of the boiler is 8200 kg/hr @ 2.8 MPa (17,000 lb/hr steam @ 400 psig). The steam is used in the thermal conditioning process and for other auxiliary equipment (e.g., steam turbines). Waste heat boiler offgas is sent to the wet scrubber system at a temperature of about 230°C (490°F).

4.2.3 Wet Scrubber System

The wet scrubber system consists of a precooler, a venturi scrubber, and a packed tower subcooler with demister. Subcooler exhaust is discharged to a stack. In the precooler, blowdown water from the subcooler is sprayed into the gas stream to provide cooling from about 23° to 80°C (490° to 180°F). The design precooler water flow rate is 136 m³/hr (600 gpm). Precooler exhaust gas enters the venturi scrubber, which is operated at a pressure drop of about 5.0 to 7.5 kPa (25 to 30 inches of water). Blowdown water from the subcooler is injected at the venturi scrubber throat at a design rate of 114 m³/hr (500 gpm). Design gas flow through the venturi scrubber is about 16.5 m³/s @ 80°C (35,000 acfm @ 180°F), and the water:gas ratio is on the order of 1.3 m³ per 1000 m³ (10 gallons per 1,000 acf). The rated particulate matter removal efficiency of the venturi scrubber is 99 percent. Gas exits the scrubber at about 80°C (160°F) and is sent to the subcooler, which consists of a three-tray packed tower with demister. Fresh makeup water (wastewater treatment plant

effluent) is added to the subcooler at a design rate of 454 m³/hr (2,000 gpm). Actual water flow rates and gas flow rates during normal operation are generally 50 to 80 percent of the design rates. The offgas temperature from the subcooler is about 20°C (70°F). Blowdown water from the subcooler is partially recycled to the precooler and venturi scrubber, with the remainder sent to a drain. The solids content of the subcooler blowdown streams is estimated to be on the order of 40 mg solids/liter (3.4 x 10⁻⁴ lb solids/gal).

Offgas from the subcooler is discharged to a stack using an induced draft fan. The exhaust stack diameter is 0.8 m (2.5 feet), and the stack discharge is 27 m (90 feet) above ground.

4.3 Representative ("Steady-State") Operating Conditions

It was jointly agreed by MPCA, MWCC, ERT and Malcolm Pirnie during a May 7, 1986, Technical Advisory Panel Meeting (TAP) that the two incinerators to be identified for the testing program would be operated at preselected "steady-state" conditions throughout the course of the monitoring program. This would include establishing and maintaining preset numerical operating guidelines for a series of parameters critical to the control of "steady-state" operations. It was the consensus of MWCC and MPCA personnel that these would include the parameters and corresponding numerical operating criteria provided in Table 4-2.

4.3.1 Incinerator Operating Conditions During This Program (May 20-22, 1986)

Incinerator operating conditions during the non-criteria emissions monitoring program were found to be consistent with the representative operating criteria offered earlier in Table 4-2. To illustrate this point please refer to the sludge and scum feed data summarized in Table 2-6 as well as Table 4-3 which provides a comparison of typical long-term

TABLE 4-2
 REPRESENTATIVE OR "STEADY STATE"
 INCINERATOR OPERATING CONDITIONS -
 A SUMMARY OF CRITICAL OPERATING PARAMETERS &
 NUMERICAL CRITERIA

<u>Parameter</u>	<u>Numerical Operating Criteria</u>
Sludge Feed Rate	2.5DTPH \pm 0.25
Scum Feed Rate	35 GPH \pm 5
Hearth #3 Temp	1600°F \pm 100°
Hearth #0 Temp	1000°F min
(actual range will be 1000 - 1200°F)	
Venturi Scrubbers	30" water
Exhaust Gas Quality	Within MPCA Permit Guidelines (>20% opacity will warrant shutdown)
Bypass Dampers	Closed Position

Table 4-3

Comparison of Metro Plant Sludge Incinerator
Operating Data During Non-Criteria Emission
Test and During Long-Term Operation

Parameter	Long-Term Operation					Non-Criteria Emission Tes
	Annual Average	Monthly		Daily		
		Min.	Max.	Min.	Max.	
Sludge Solids, %						
Total	34	32	36	25	44	37-42
Volatile	72	-	-	50	81	67-68
Sludge Feed, DTPH	2.6	2.2	3.0	1.8	3.7	2.8-3.2
Stack Oxygen, % (1)	14	12	16	-	-	-
Opacity, %	9	7	13	4	20	-
Temperature, deg. F.						
Hearth 0	1120	1080	1160	1000	1400	1210-1250
Hearth 1	1140	-	-	1000	1400	1140-1230
Hearth 2	1450	-	-	1200	1600	1410-1490
Hearth 3	1600	-	-	1200	1700	1600-1620
Hearth 4	1000	-	-	600	1300	910-980
Subcooler	68	60	75	55	80	63-74
Flue Gas Flow, dscfm (1)	19,000	14,000	23,000	-	-	-
Sludge Heat Value, Btu/lb.D.S. (2)	7,400	-	-	5,200	8,200	7050-7400
Gravity/Decant Ratio (3)						
Volume Basis	4	-	-	1.0	8	3.8-4.0
Mass Basis	2	-	-	0.6	4	1.4-1.6
Venturi Pressure Drop, in.w.c.	28	26	30	-	-	29-30
Scum Feed Rate, gph	25	20	30	0	70	24-33

Notes:

1. Based on 17 stack tests during 1985 and 1986. Stack oxygen and flue gas are not continuously measured.
2. Based on analyses of two samples per month.
3. Ratio of gravity thickened primary sludge to thermally conditioned (decant) sludge.

operating data for the Metro Plant Sludge Incinerator to operations data recorded during the present program.

Some general observations pertinent to these data as derived from an MWCC report on the subject of operating conditions (see Appendix J) are provided below:

1. Sludge cake was drier than average but within the range of conditions normally encountered.
2. Sludge feed rate was slightly higher than average but within the normal operating range.
3. Opacity during non-criteria emissions test was about 5%, which is lower than average but within the normal operating range.
4. Incinerator temperature profiles were well within the normal range. Hearth O temperature was above average, because the cake was drier than average. The non-criteria emission test operating conditions were "normal", though not "average".
5. Sludge heat content was normal during the non-criteria emission test.
6. Sludge mixture was normal during the non-criteria emission test.
7. Scrubber operating conditions were normal during the non-criteria emission test.

Based upon the data provided here in Table 2-6 and Table 4-3 and the historical data provided in Appendix J, in conjunction with the experience of MWCC plant personnel the following conclusions can be offered.

1. Operating conditions were consistent with those contained in Table 4-2.
2. Operating conditions fell within the normal range experienced during the past year.
3. Operating conditions were representative of normal sludge incinerator operation.

5. FLUE GAS SAMPLING PROCEDURES

As outlined in Section 1, ERT collected a variety of flue gas samples from the #7 and #8 incinerators while they were maintained under "steady-state" conditions. Separate and discrete samples were collected for particulates/heavy metals, volatile organics, semivolatile organics and PCDDs/PCDFs. In addition, continuous emissions monitoring was conducted contemporaneously for total hydrocarbons (THC), carbon monoxide (CO), and oxygen (O₂). The actual sampling protocols employed were consistent with those specified in the document entitled "Non-Criteria Emissions Sampling and Analysis Test Plan for the Envirotech Nine-Hearth Sewage Sludge Incinerator," May 1986 (ERT Document E-081-200).

A discussion of the field monitoring program including the actual test schedule, and a brief synopsis of the sample collection procedures with modifications necessitated during the conduct of the field program, is provided in the section to follow.

5.1 Field Test Schedule and Sample Inventory

Three sets of flue gas samples were collected during the calendar period of May 20 through May 22, 1986. As noted earlier, flue gas samples were collected from either the #7 or #8 incinerator unit. A summary of the actual field test schedule including parameters monitored and the duration of each sampling session is provided in Table 5-1.

A complete listing of flue gas sample types and numbers collected during the conduct of the field monitoring program is provided in Table 5-2.

Flue gas samples were collected using a particulate filter followed sequentially by an XAD-2 sorbent cartridge so as to represent vapor-phase and particulate associated PCDDs/PCDFs combined. One 6-hour test was conducted on Day 1, while two simultaneous 9-hour tests were collected on Day 3 of the test

TABLE 5-1
FIELD MONITORING PROGRAM - MWWTP TEST SCHEDULE

<u>Run No.</u>	<u>Date</u>	<u>Incinerator</u>	<u>Test Parameter</u>	<u>Sample Duration</u>
M5-1	5-20-86	7	Particulates trace metals	180 min.
Fixed Gas	5-20-86	7	CO ₂ -O ₂ -CO	180 min.
SMM5-1	5-20-86	7	Semivolatile organics	180 min.
MM5-1	5-20-86	8	PCDDs/PCDFs	360 min.
VOST	5-20-86	8	Volatile organics	2-60 min.
CEM	5-20-86	8	CO-O ₂ -THC	540 min. ^a
M5-2+3	5-21-86	7	Particulates trace metals	180/180 min.
Fixed Gas	5-21-86	7	CO ₂ -O ₂ -CO	180 min.
SMM5-2&3	5-21-86	8	Semivolatile organics	180/180 min.
VOST	5-21-86	8	Volatile organics	2-60 min.
CEM	5-21-86	8	CO-O ₂ -THC	510 min. ^a
MM5-2A	5-22-86	8	PCDDs/PCDFs	510 min.
MM5-2B	5-22-86	8	PCDDs/PCDFs	540 min.
VOST	5-22-86	8	Volatile organics	2-60 min.
CEM	5-22-86	8	CO-O ₂ -THC	600 min. ^a

Note:

^aMinutes shown indicate total monitoring for each day.

TABLE 5-2
SUMMARY OF FLUE GAS SAMPLING AND ANALYSIS

<u>Test Parameters</u>	<u>Sample Method</u>	<u>Sample Code</u>	<u>No. of Samples Collected</u>	<u>No. of Samples Analyzed</u>	<u>Analysis Method</u>
Fixed Gas	EPA Method 3		3	3	ORSAT
Total Hydrocarbons	EPA Method 25A		Continuous		FID Continuous
Carbon Monoxide Oxygen	Instack probe and Filter		Continuous Continuous		NDIR Analyzer
<u>Particulates/Metals</u>					
Particulate ^{a,b}	EPA Method 5	-M5-PF	4	4	Gravimetric
Metals	EPA Method 5	-M5-PF	4	4	ICAP
Front Half Rinse ^{a,b}	EPA Method 5	-M5-FH	4	4	Gravimetric
<u>Semivolatile Organics</u>					
Particulate ^{a,b}	EPA Method 5	-SMMS-PF	4	4	GC/MS
Front Half Rinse ^{a,b}	EPA Method 5	-SMMS-FH	4	4	GC/MS
XAD-2 Resin ^{a,b}	EPA Method 5	-SMMS-XR	4	4	GC/MS
Flue Gas Condensate ^b	EPA Method 5	-SMMS-CD	3	3	GC/MS
	EPA Method 5	-SMMS-IMP 2/3	3	3	GC/MS
<u>PCDDs/PCDFs</u>					
Particulate ^{a,b}	EPA Modified Method 5	-MMS-PF	5	5	GC/MS
Front Half Rinse ^{a,b}	EPA Modified Method 5	-MMS-FH	5	5	GC/MS
XAD-2 Resin ^{a,b}	EPA Modified Method 5	-MMS-XR	5	5	GC/MS
Flue Gas Condensate ^b	EPA Modified Method 5	-MMS-CD	5	5	GC/MS
	EPA Modified Method 5	-MMS-IMP 2/3	5	5	GC/MS
<u>Volatile Organics</u>					
Volatiles	VOST	-POMC-A,B	22	8	GC/MS

^aIncludes Field Biased Blank.

^bSamples from each individual train were appropriately combined and analyzed as one sample.
8797P PB 081-500

program (see Table 5-1). All samples were collected employing the 4-inch (ID) ports in the #8 incinerator stack as shown in Figure 5-1. Each flue gas sample was collected using a total of 12 points along two perpendicular stack diameters as shown in Figure 5-2. In the case of the PCDDs/PCDFs runs collected on Days 1 and 3, the 12 points were collected during elapsed periods of 360 minutes (6 hours) and 540 minutes (9 hours), respectively.

5.2 Sample Shipment and Chain-of-Custody Procedure

ERT maintained strict control of all samples collected from each sample train. Each recovered sample was affixed with a preprinted sample identification label to ensure that the required information was entered in the field. A unique identification number was assigned to each sample upon collection.

This unique identifier for each sample with other accompanying information was then transferred to a chain-of-custody form. The purpose of this procedure is to document the identity of the sample and its handling from its first existence as a sample until analysis and data reduction are completed. This custody record traces a sample from its collection through all transfers of custody until it is transferred to the analytical laboratory.

Appendix D contains all chain-of-custody records obtained from this program.

5.3 PCDDs/PCDFs Sampling Train

An EPA Modified Method 5 particulate train was employed for the collection of polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzo-p-dioxins (PCDDs), in accordance with the ASME protocol entitled "Sampling for the Determination of Chlorinated Organic Compounds in Stack Emissions" provided in Appendix A of the aforementioned Program Test Plan.

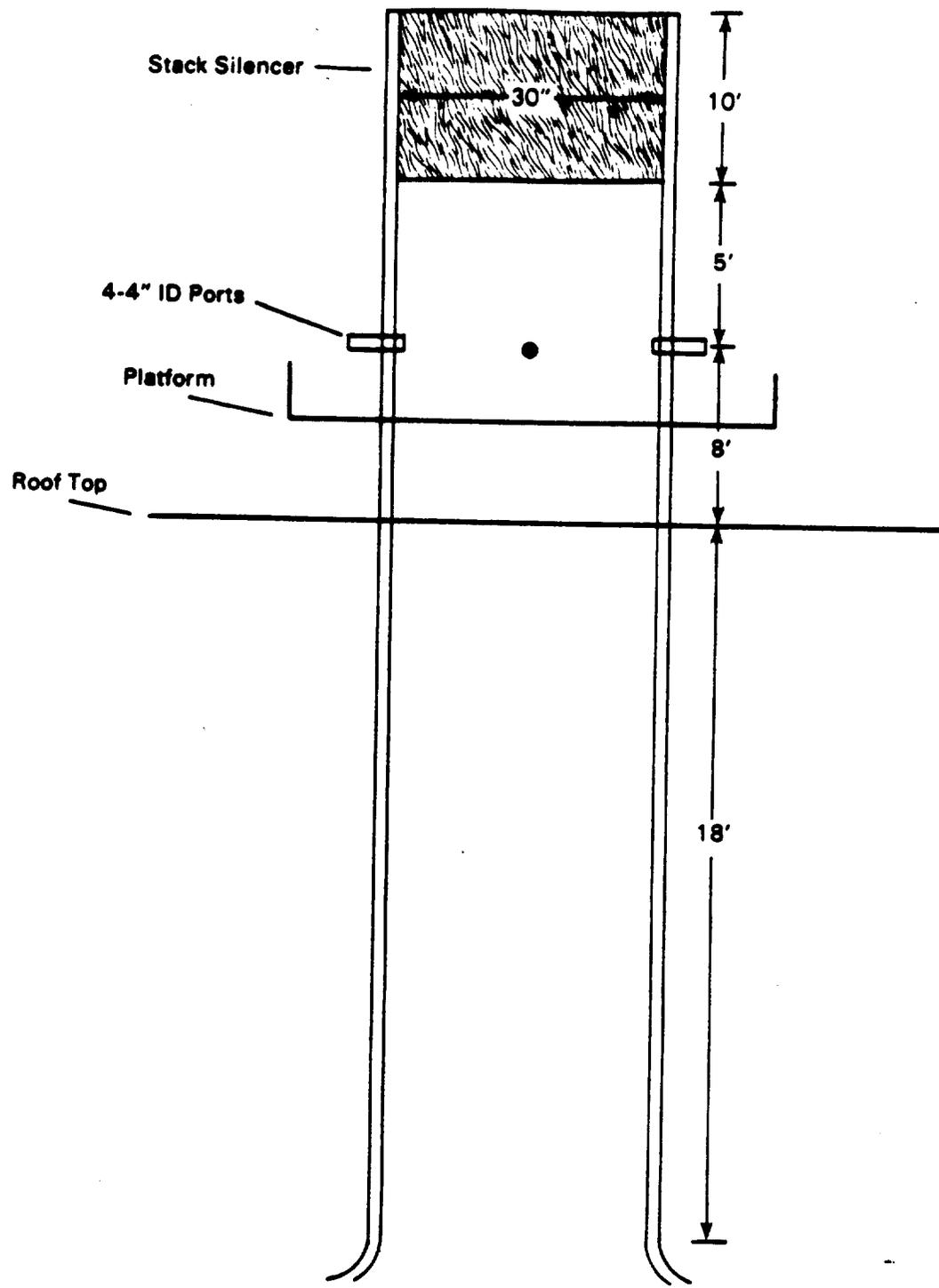
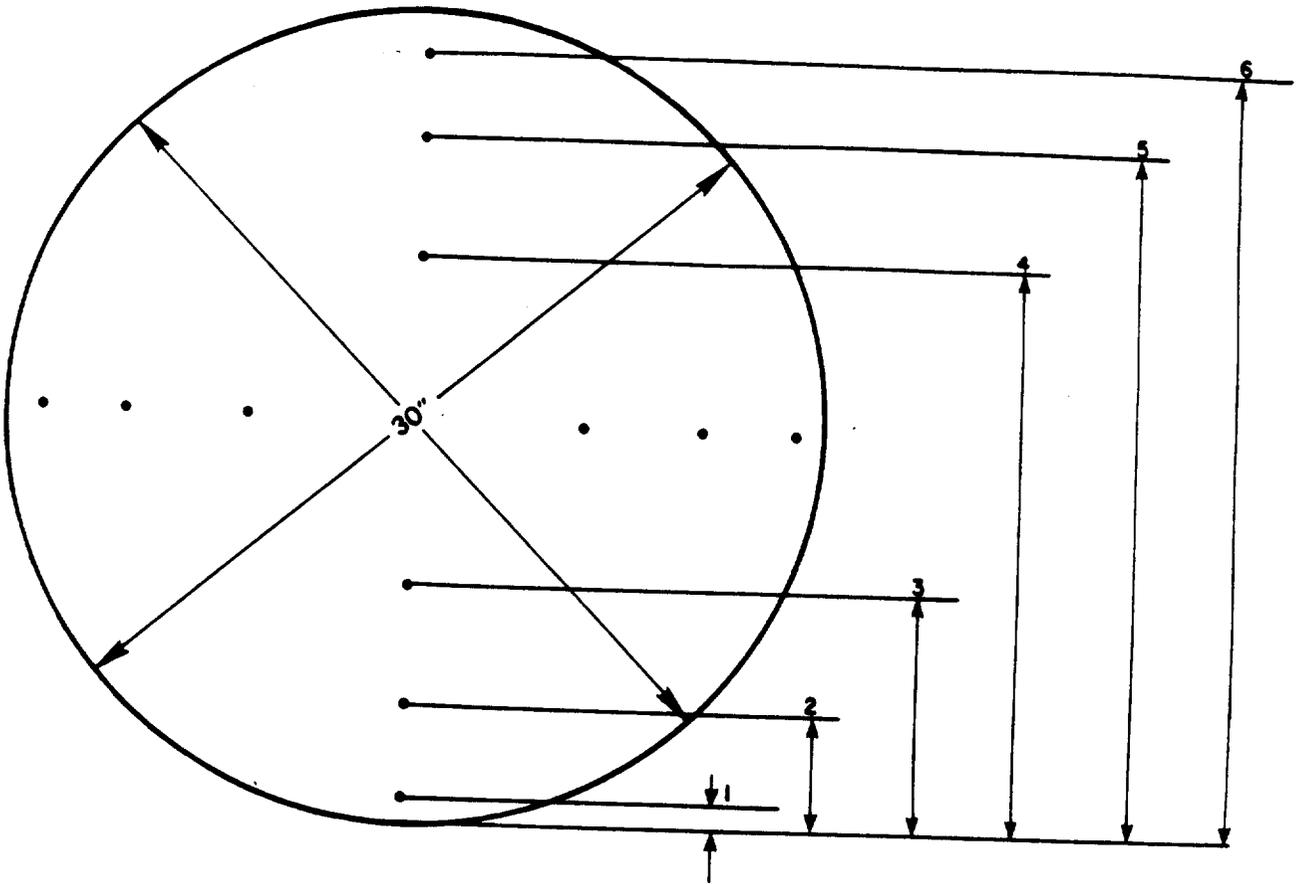


Figure 5-1 Schematic of Sampling Location



Traverse Point	Distance % of Diameter	Actual Distance	Traverse Point	Distance % of Diameter	Actual Distance
1	4.4	1.3	4	70.4	21.1
2	14.6	4.4	5	85.4	25.6
3	29.6	8.9	6	95.6	28.7

Figure 5-2 Traverse Point Locations

The sample train consisted of a glass-lined, heat-traced probe with a stainless steel button hook nozzle and attached thermocouple and pitot tubes. After the probe, the gas passed through a heated glass filter (Reeve Angel 934 AH filter paper). Downstream of the heated filter, the sample gas passed through a water-cooled module then through a sorbent module containing approximately 25 g of XAD-2 resin. The XAD module, which was kept at a temperature below 70°F, was followed by a series of four impingers. The first and second impingers contained approximately 100 gms of DDI water, the third was empty and the fourth contained a known weight of silica gel. The impingers were followed by a pump, dry gas meter, and a calibrated orifice.

Prior to conducting each field test, the XAD-2 resin cartridge was spiked with a surrogate mixture containing Cl^{37} 2,3,7,8-TCDD and C^{13} 1,2,3,4-TCDD at a concentration of 1000 picograms and 3000 picograms, respectively. The surrogate spiking mixture was provided to ERT by California Analytical Laboratories. The results of these surrogate analyses which provide a measure of accuracy for the combined sampling and analysis scheme are provided in Section 7 of this report.

A blank train was set up on site and disassembled and recovered in the same fashion as the actual sampling train in order to provide appropriate blank corrections.

Recovery procedures for each of the PCDDs/PCDFs sampling trains were as follows:

1. Remove the sampling train to the predetermined recovery area.
2. Note the condition of the train (e.g., impinger color, filter condition, etc.).
3. Disassemble the filter housing and transfer the filter to its original glass petri dish. Seal the container with Teflon tape and label the sample as: -MM5/PF. Run number precedes all sample codes (e.g., 1-MM5/PF).

4. Rinse the front half of the train three times with 1:1 hexane and acetone. Seal the amber glass container and label the sample as: MM5/FH.
5. Weigh and record the weight gained for each impinger.
6. Pour the condensate in the first impinger into a precleaned amber glass bottle. Rinse the impinger three times with 1:1 acetone/hexane. Seal the container and label the sample as: MM5-CD.
7. Weigh and record the weight gain of the second and third impingers and transfer each to a precleaned amber glass container. Rinse and recover the impingers with DI-H₂O. Seal the containers and label the samples as: MM5-IMP-2 and MM5-IMP-3.
8. Weigh and record the weight gained by the silica gel impinger.
9. Examine all containers to ensure that they are properly sealed and labeled and that the liquid levels are marked.
10. Transfer the XAD-2 resin from the trap to its original container. Rinse the condenser coil, resin chamber, and condensate impinger into the XAD amber glass container. Seal and label it as: X-MM5/XR.
11. Be sure all containers are properly sealed, labeled, and the liquid level marked. Log all samples on the Sample Packing Sheet.

5.4 Volatile Organic Sampling Train (VOST)

Volatile organics were collected from the #8 incinerator unit on each of the three test days. Each of the three daily sampling sessions consisted of two 60-minute runs collected during a total elapsed sampling period of 3 hours. All samples were collected using the EPA-sanctioned Volatile Organic Sampling Train (VOST) as shown in Figure 5-3. All samples were collected with the probe inserted in the 4-inch-diameter sampling port(s) as shown in Figure 5-1.

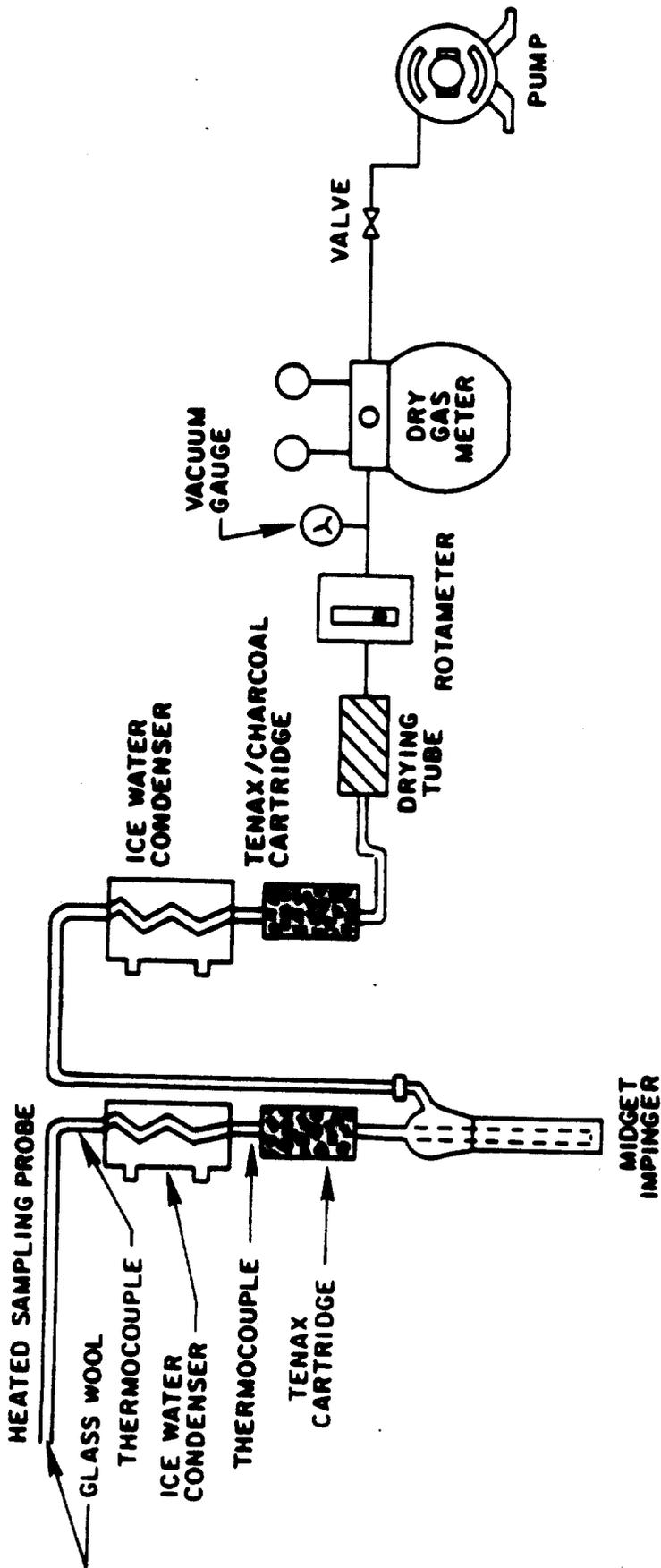


Figure 5-3 Schematic of Volatile Organic Sampling Train

The train consisted of a heated glass-lined probe with a glass wool plug to remove particulate, followed by an assembly of condensers and organic resin traps. The first condenser cooled the gas stream and condensed the water vapor present. The flue gas and condensed moisture then passed through a cartridge containing 1.5 grams of Tenax resin (60/80 mesh). No condensate was collected in the first impinger. The second condenser and trap containing Tenax/charcoal (50/50) served as a backup for compounds with low breakthrough volumes. Following the second Tenax trap was a drying tube for residual moisture removal.

As required in the VOST protocol, the probe was located in the stack at a point of average stack velocity. Sample temperatures were monitored at the outlet of the sample probe and the inlet to the Tenax cartridge through the use of thermocouples. The gas temperature through the probe was maintained above 130°C to prevent the premature condensation of the volatile components. The temperature of the gas when it passed through the resin cartridges was maintained at less than 20°C. The sample gas volume through the resin traps was maintained at 0.25 liter per minute for 60 minutes for two runs. A slow-VOST low-volume sample was collected on two additional runs at 0.10 liter per minute to ensure that the collection tubes would not become oversaturated. The total sample volume for each set of tubes did not exceed 20 liters.

The samples collected for each VOST run consisted of a Tenax cartridge, and a backup cartridge containing Tenax and charcoal. The sealed sorbent cartridges were stored in containers packed with activated charcoal.

Method and field blanks of the sorbent resins were collected in conjunction with each of the four runs. During the sampling program, the reagent and sorbent resin samples associated with this train were maintained off site to minimize the potential for sample contamination from the ambient air. All of the resin cartridges and other samples associated with this train were stored and transported at a temperature of 4°C

to prevent contamination and minimize degradation of the Tenax sorbent polymer.

5.5 Particulate and Semivolatile Organic Emissions

An EPA Modified Method 5 train was used to simultaneously collect particulate and semivolatile organic pollutants in the flue gas from incinerator unit 7. A sampling and velocity traverse was performed along two diameters of the stack. A total of 12 sampling points, determined in accordance with EPA Method 1, were sampled at 15 minutes per point, yielding a total sample time of 180 minutes for each of the three separate runs (see Figure 5-2). Sampling was isokinetic (± 10 percent) with flue gas parameters measured at every sampling point. The sampling train consisted of a heated, glass-lined probe with a stainless steel button-hook nozzle and attached thermocouple and pitot tubes. The sampled gas passed through the probe assembly to a heated glass fiber filter (Reeve Angel 934 AH). The filter holder was maintained at 248°F , $\pm 25^{\circ}\text{F}$ throughout the test period. Downstream of the heated filter, the sample gas passed through a water cooled module, then through a sorbent module containing a known amount of XAD-2 resin. The XAD-2 module was sequentially followed by four impingers. The first impinger was modified with a short stem for collection of condensate. The second contained 100 ml of DDI water, the third impinger was empty and the final impinger contained a known amount of desiccant. The impingers were followed by a pump, dry gas meter and calibrated orifice.

A leak check of the entire sampling train was conducted prior to, and at the conclusion of, each sampling run; and before and after changing or disconnecting any components of the train during the run. Leak checks before the test run, and after changing any constituent, were conducted at 15 in. Hg vacuum to ensure a leak rate of not more than 0.02 cfm. Leak checks conducted at the end of a run, and prior to making any component changes or disconnections to facilitate recovery,

were at or above the highest vacuum obtained during the run. The pitot tube assembly was also leak checked prior to and after each sampling run to ensure validity of the velocity data. Cyclonic flow angles were also checked prior to the initiation of sampling.

Recovery activities for this system included the following:

1. Remove sample train to a predetermined recovery area.
2. Note the condition of the train (e.g., impinger color, filter condition, etc.).
3. Disassemble the filter housing and transfer and filter to its original petri dish. Seal the container with Teflon tape and label the samples as: -SMM5/PF. Run number precedes all sample codes (e.g., 1-SMM5/PF).
4. Rinse the front half of the train three times with 1:1 hexane and acetone. Seal the amber glass container and label the samples as: -SMM5/FH.
5. Measure the volume of condensate in the first impinger with a precleaned, glass, graduated cylinder. Add 30 percent of the total sample volume of hexane (e.g., condensate = 100 ml, add 30 ml hexane). Release pressure buildup in the amber glass container several times before sealing. Label the sample as: -SMM5/CD.
6. Measure volumes of second and third impingers. Rinse the impingers with DDI water. Seal in a glass container and label it as: -SMM5/Imp. 2 and 3.
7. Weigh and record the weight gained by the silica gel impinger.
8. Transfer the XAD-2 resin from the trap to its original container. Rinse the condenser coil, resin chamber, and condensate impinger into the XAD amber glass container. Seal and label it as: -SMM5/XR.
9. Be sure all containers are properly sealed, labeled, and the liquid level marked. Log all samples in on the SAMPLE PACKING SHEET.

5.6 Particulate and Trace Metals Emissions

An EPA Method 5 train was used to simultaneously collect particulate and trace metals in the flue gas. This sampling train was set up and operated on incinerator unit 7, operating under identical process conditions as the unit selected for the PCDDs/PCDFs and volatile organics. EPA Reference Method 5 sampling procedures were followed. A total of 12 points along two stack diameters were sampled for 15 minutes per point for a total sample duration of 180 minutes for each of the three runs. See Figures 5-1 and 5-2 for locations of sampling ports and stack traverse points, respectively.

The sampling train consisted of a heated, stainless steel probe with a stainless steel button-hook nozzle, attached thermocouple and pitot tubes. The sampled gas passes through the probe assembly to a heated glass fiber filter (Reeve Angel 934 AH). The filter holder was maintained at $248^{\circ}\text{F} \pm 25^{\circ}\text{F}$ throughout the test period. Downstream of the heated filter, the gas passed through a series of four ice-cooled impingers to effect the removal of entrained moisture. The first and second impingers contained 100 ml DI water each to provide for the collection of the flue gas condensate. The third impinger was empty and the final impinger contained a known amount of desiccant. The impingers were followed by a pump, a dry gas meter and calibrated orifice.

Leak checks of the entire sampling train were conducted prior to and at the conclusion of each sampling run, and before and after changing or disconnecting any components of the train during the run. Leak checks before the test run and after changing any components were conducted at 15 in. Hg vacuum to ensure a leak rate of not more than 0.02 cfm. Leak checks conducted at the end of a run, and prior to making any component changes or disconnecting them to facilitate recovery, were at or above the highest vacuum obtained during the run. The pitot tube assembly was also leak checked prior to and after each sampling run to ensure validity of the velocity data.

Recovery activities for the EPA Method 5 train were:

1. Remove sample train to a predetermined recovery area.
2. Note the condition of the train (e.g., desiccant color, filter condition, etc.).
3. Disassemble the filter housing and transfer the filter to its original petri dish. Seal the container and label the sample as:-M5-PF.
4. Rinse the front half of the train (nozzle, liner, and filter assembly) three times with acetone. Seal the polyethylene container and label the samples as:-M5-FH.
5. Measure and record the volume of condensate in the impingers. Rinse with DIH_2O into a polyethylene container and label the sample as:-M5-BH.
6. Record the weight gained by the silica gel impinger.

5.7 Continuous Emissions Monitoring (CO , O_2 , THC) and Fixed Gases

Flue gas emissions were monitored on a continuous basis for total hydrocarbons (THC), carbon monoxide (CO), and oxygen (O_2). Further details on sampler operation, flue gas conditioning and calibration for each of the three gas categories are provided in the discussion to follow.

5.7.1 Total Hydrocarbons (THC)

Total hydrocarbons were monitored on a continuous basis employing a Beckman Model 400 Total Hydrocarbon Analyzer. Flue gas samples were extracted from the 4-inch sampling port of the #8 incinerator during each of the three daily sampling sessions identified earlier. Flue gas samples were collected using a heated stainless steel probe situated at a point of average concentration along the stack diameter. The stainless steel probe was followed by a heated glass fiber filter for

particulate removal. A schematic of the THC monitoring system which is in compliance with the requisites of EPA Method 25-A is shown in Figure 5-4. The THC analyzer was calibrated with a zero and three span gases of 20, 50 and 90% of full scale prior to and at the completion of each test. These calibration procedures are consistent with EPA procedures contained in 40 CFR Part 60. Calibration data pertinent to the THC measurements and an NBS traceable certification for the propane calibrant gases are provided in Appendix B. A complete set of THC measurements corrected for instrument drift are provided as 3-minute averages in Appendix C. Cumulative averages for each of the daily sampling sessions are summarized in Section 2.

5.7.2 Carbon Monoxide Monitoring (CO)

Carbon monoxide was monitored on a continuous basis employing an Anarad AR 411R Non-Dispersive Infrared (NDIR) analyzer. Flue gas samples were extracted from a 4-inch sampling port located in the #8 incinerator stack during each of three daily sampling sessions. Flue gas samples were collected using a stainless steel probe situated at a point of average concentration along the stack diameter. The sample collection system was fitted with a gas conditioning system to permit removal of particulates, moisture, and carbon dioxide. The CO monitor was calibrated with zero and three additional span gases prior to and at the completion of each sampling session. Calibration data pertinent to the CO measurements including an NBS traceable certification for the calibrant gases are provided in Appendix B. A complete set of CO measurements corrected for instrument signal non-linearity are provided in Appendix C on the basis of 3-minute averages. Cumulative averages for each of the daily sampling sessions are summarized in Section 2.

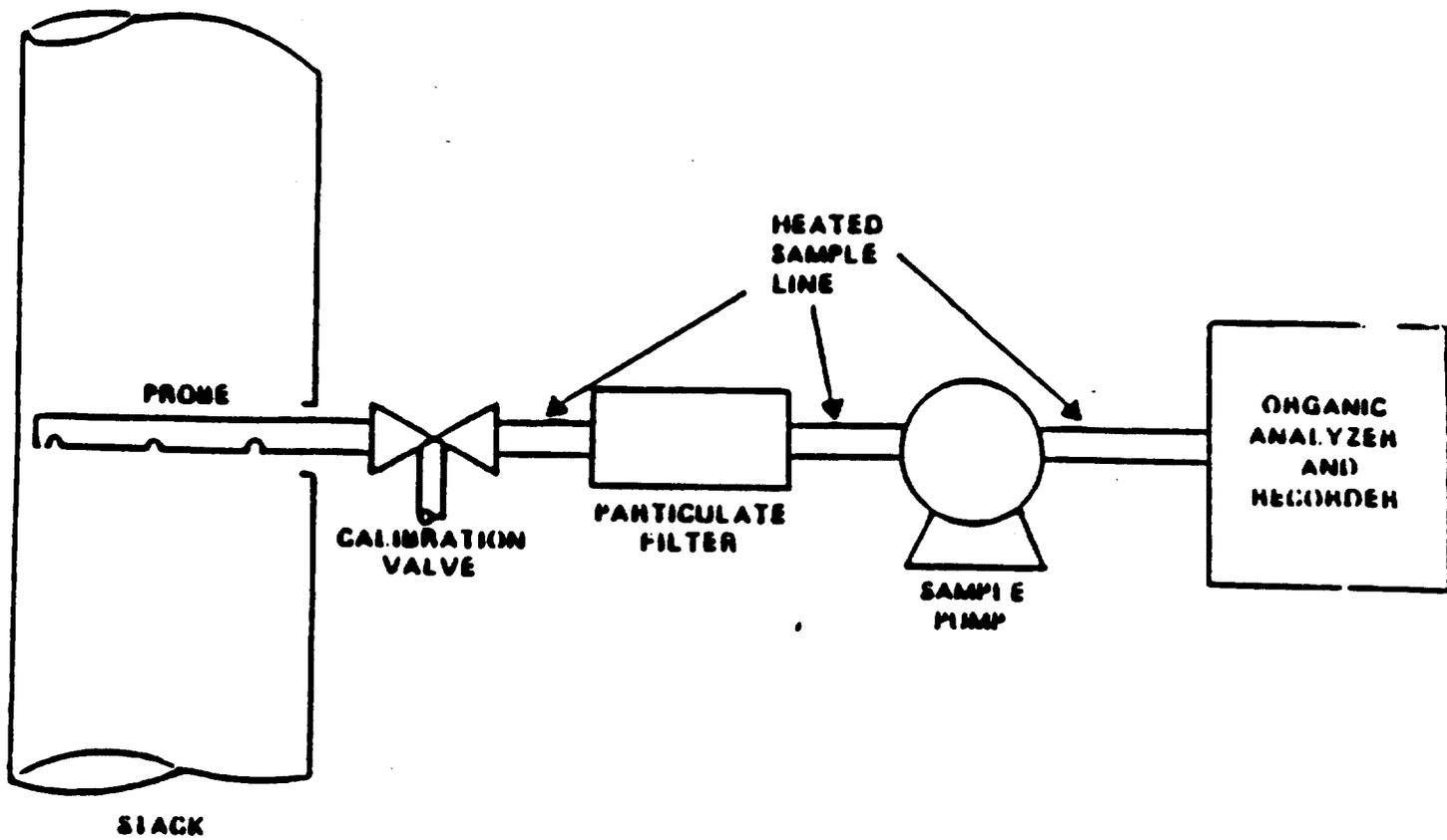


Figure 5-4 Schematic of the Total Hydrocarbon Monitoring System

5.7.3 Percent Oxygen Monitoring (O_2)

Percent oxygen was monitored on a continuous basis employing a Beckman Model 741 polarographic oxygen analyzer. Flue gas samples were extracted from the same 4-inch sampling port located in the #8 incinerator stack during each of three daily sampling sessions. Flue gas samples were collected using a stainless steel probe situated at a point of average concentration along the stack diameter. The sample collection system was fitted with a gas conditioning system to permit removal of particulate and moisture. The O_2 monitor was calibrated with ultra pure nitrogen (zero) and ambient air (span) prior to and at the completion of each sampling session. Calibration data pertinent to the O_2 measurements are provided in Appendix B. A complete set of O_2 measurements are provided in Appendix C on the basis of 3-minute averages. Cumulative averages for each of the daily sampling sessions are summarized in Section 2.

5.8 Fixed Gas Analysis (O_2 , CO_2 , N_2)

Integrated bag samples were collected during each of the three tests for the determination of fixed gases (O_2 , CO_2 , N_2). These samples were obtained through the use of the sampling system depicted in Figure 5-5. Flue gas samples were extracted using each of the 12 sample points simultaneously with the Method 5 sample train. The sample collection system consisted of a stainless steel probe equipped with a glass wool plug to remove particulate matter, followed by a glass condenser unit for moisture removal, a Tedlar bag, leak-free pump and rotameter. Upon completion of the sample run, the bag was analyzed by use of an Orsat analyzer for the respective fixed gases in accordance with EPA Method 3.

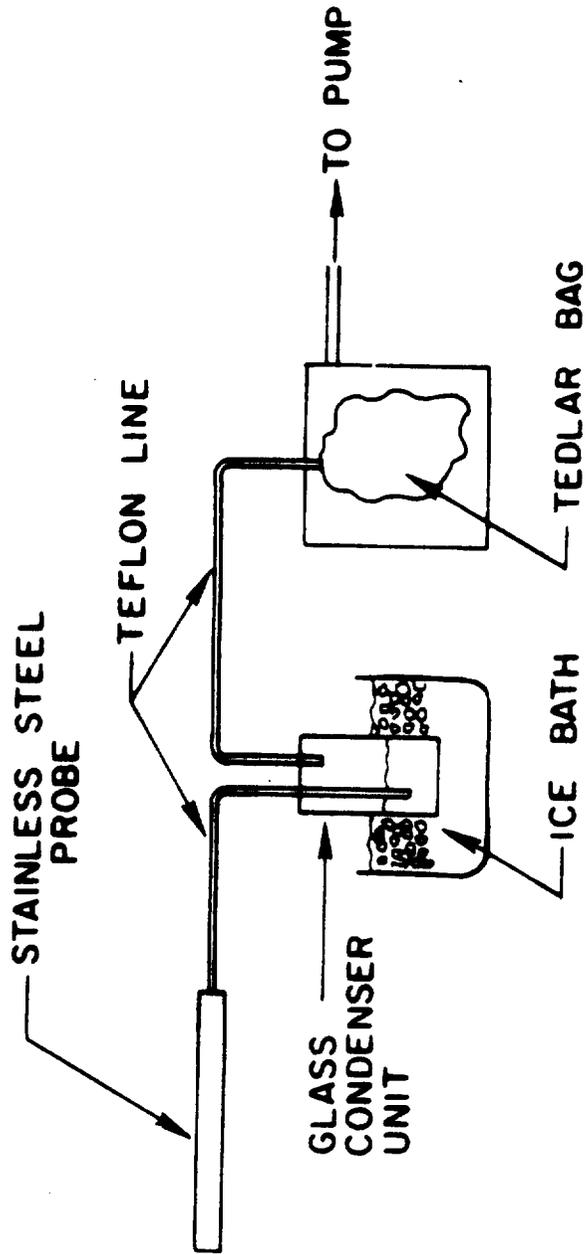


Figure 5-5 Integrated Gas Sampling Train

6. ANALYTICAL PROTOCOLS

6.1 Introduction/Overview

All samples, with the exception of those designated for PCDDs/PCDFs analyses, were returned to the ERT laboratory in Concord, Massachusetts for subsequent analyses. PCDDs/PCDFs samples, conversely, were transported to ENSECO-CAL Labs in Sacramento, California for subsequent analyses. All samples were transported on ice under strict chain-of-custody procedures per instructions contained in Section 7 of the Project Test Plan entitled "Non-Criteria Emissions Sampling and Analysis Test Plan for the Envirotech Nine-Hearth Sewage Sludge Incinerator," May 1986 (ERT Document E-081-200).

As noted in Tables 5-1 and 5-2, three complete sets of flue gas samples were collected for analyses of the following parameters: particulates, semivolatile organics, trace metals, and PCDDs/PCDFs. Additionally, 12 separate sample sets were collected for volatile organics.

In general, sample preparation and analyses procedures were consistent with the protocols contained in the Project Test Plan referenced earlier in this section.

The discussion to follow will provide a brief synopsis of each of the respective analytical procedures including both sample preparation and instrumental analyses. Particular emphasis will be placed on any modifications made to the protocols outlined in the Project Test Plan in the conduct of the actual analyses. A listing of the "target" compounds contained in each of the analyses categories will also be provided.

6.2 Trace Metals

6.2.1 "Target" Compound Listing

As discussed in Section 3 of the Project Test Plan, the "target" compound listing contained a series of heavy metals

previously identified in flue gas emissions from other municipal sewage sludge incinerators. It was anticipated that these same analytes had the greatest potential of being contained in flue gas emissions from the MWWTP facility. A complete listing of the target heavy metals identified is provided in Table 6-1. Please note that in the conduct of the present program, mercury (Hg) and arsenic (As) were not included in the analytical work scope. This adjustment was made prior to the commencement of the field program with the endorsement of the Minnesota Pollution Control Agency (MPCA).

6.2.2 Analytical Procedures

Metals analyses were conducted on each of three sets of flue gas samples obtained from the Method 5 train identified in Tables 5-1 and 5-2. In each instance the front half or probe rinse was combined with the corresponding particulate filter prior to commencement of the sample preparation sequence.

Preparative procedures included the extraction of an aliquot (50%) in a mixture of nitric and hydrochloric acids. During digestion the samples were sonicated at 10-minute intervals to ensure total extraction of entrained particulates. Resultant extracts were subsequently filtered to remove filter media and extraneous particulate prior to metals quantitation by Inductively Coupled Argon Plasma (ICAP). All data are provided corrected using the corresponding method blank in units of $\mu\text{g}/\text{m}^3$. Refer to Tables 2-2, 2-3, and 2-4 for trace metals data from Test Runs 1, 2, and 3, respectively. Quality control data pertinent to these analyses are provided in Section 7.

6.3 Polychlorinated Dibenzodioxins (PCDDs)/Polychlorinated Dibenzofurans (PCDFs)

6.3.1 "Target" Compound Listing

Based upon the aforementioned literature survey in conjunction with previous testing in 1985 at the MWWTP facility,

TABLE 6-1
HEAVY METALS "TARGET" COMPOUND LISTING
MWWTP EMISSIONS MONITORING PROGRAM

Antimony (Sb)
Beryllium (Be)
Lead (Pb)
Vanadium (V)
Manganese (Mn)
Molybdenum (Mo)
Tin (Sn)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Nickel (Ni)
Zinc (Zn)
Selenium (Se)
Silver (Ag)
Boron (B)
Barium (Ba)
Cobalt (Co)
Strontium (Sr)

it was agreed that the PCDDs/PCDFs "target" compound listing would include each of the eight PCDDs/PCDFs positional isomer categories as well as the customary 2,3,7,8-TCDD and 2,3,7,8-TCDF isomers. A complete listing of these target congeners and congener classes is provided in Table 6-2.

6.3.2 Sample Summary Listing

A total of five flue gas samples were submitted for analyses to ENSECO-CAL. Each sample was comprised of a series of components which were composited to create a single sample. A summary listing of the five samples submitted for analyses is provided in Table 6-3. This includes sample identification numbers, sample codes and corresponding descriptions for each component in a sample set.

6.3.3 Analytical Procedures

Each of three sets of actual flue gas samples and two sets of field-biased blanks were submitted to ENSECO-CAL Labs for analysis of the PCDDs/PCDFs congeners listed.

Analytical protocols employed were consistent with those contained in the draft ASME protocols entitled, "Analytical Procedures to Assay Stack Effluent Samples and Residual Combustion Products for Polychlorinated Dibenzodioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF)" (Draft, September 19, 1984). It was further understood that CAL would make use of modifications contained in their methods manual entitled, "Total and/or 2,3,7,8- Substituted Dioxin and Furan Analyses."

Sample preparation protocols proceeded as outlined in Figure 1 of the Project Test Plan. As noted, the individual components from each sampling train (particulate filter, front half rinse condensate extract, impinger extracts, and XAD-2 resin cartridge) were combined such that a single sample extract resulted for each sampling train. The particulate filter was placed in the Soxhlet extractor thimble along with

TABIE 6-2
PCDDs/PCDFs
"TARGET" CONGENER LISTING

PCDDs

Mono CDDS (Total)
Di CDDS (Total)
Tri CDDS (Total)
Tetra CDDS (Total)
Penta CDDS (Total)
Hexa CDDS (Total)
Hepta CDDS (Total)

Octa CDD
2,3,7,8-TCDD

PCDFs

Mono CDFS (Total)
Di CDFS (Total)
Tri CDFS (Total)
Tetra CDFS (Total)
Penta CDFS (Total)
Hexa CDFS (Total)
Hepta CDFS (Total)

Octa CDF
2,3,7,8-TCDF

TABLE 6-3

PCDDs/PCDFs FLUE GAS SAMPLE LISTING
 ENSHCO-CAI, LABS

Sample Description	Sample Code	Run 1A	ERT Sample Number		
			2A	2B	FBB-1 FBB-2
Particulate Filter	PCDD-X ^a -MM5-PF	B-166	169	161	B-172 164
Front Half Rinse ^b	PCDD-X ^a -MM5-FH	PCDD-1A-MM5-FH	PCDD-2A-MM5-FH	PCDD-2B-MM5-FH	PCDD-1-MM5-FH PCDD-2-MM5-FH
Impinger Catch #2 and #3	PCDD-X ^a -MM5-IMP 2 & 3	PCDD-1A-MM5-IMP	PCDD-2A-MM5-IMP	PCDD-2B-MM5-IMP	PCDD-1-MM5-IMP-B PCDD-2-MM5-IMP 2 & 3 B
Condensate ^c	PCDD-X ^a -MM5-CD	PCDD-1A-MM5-CD	PCDD-2A-MM5-CD	PCDD-2B-MM5-CD	PCDD-1-MM5-CD PCDD-2-MM5-CDB
XAD-2 Resin Trap	PCDD-X ^a -MM5-XR	1526	1516	1527	1533 1522
Condensate ^c #2	PCDD-X ^a -MM5-CD2		PCDD-2A-MM5-CD2	PCDD-2B-MM5-CD2	

^a Where X denotes run number.

^b Remarks on KRT chain-of-custody forms indicate rinse solvent for appropriate sample. For example, front half rinse means 1:1 (v/v) acetoane/hexane.

^c Condensate was emptied from the sample trains part way through the run, thus creating two condensate samples for runs 2A and 2B. "Condensate" and "Condensate 2" may be combined for each sample run.

the contents of the corresponding XAD-2 sorbent trap. Both the front half probe rinse and the back half rinse were placed in the solvent reservoir of the soxhlet extractor. The condensate and impinger (2 and 3) aqueous samples were combined and extracted with methylene chloride. (Ph adjustments were made in a manner consistent with CAL's analytical protocol entitled, "Total and/or 2,3,7,8- Substituted Dioxin and Furan Analyses."

Each of these solvent extracts were then combined and transferred to the solvent reservoir of the soxhlet extraction apparatus. Each sample was extracted for a period of 8-12 hours. The balance of the analytical scheme proceeded in accordance with CAL's standard operating procedures referenced above. This included analyses of all extracts for the PCDDs/PCDFs congeners listed in Table 6-2 employing combined gas chromatography/mass spectrometry (GC/MS).

Results for each of the three test runs are provided in Tables 2-6 and 2-7. This includes values in units of ng/dscm (m^3) for each of the eight PCDD and PCDF positional isomer categories, as well as 2,3,7,8-TCDD and 2,3,7,8-TCDF. Flue gas concentrations provided in Tables 2-6 and 2-7 were generated using ENSECO-CAL's data report provided in Appendix H in conjunction with stack test data provided in Table 2-8.

Refer to Appendix G for a copy of the actual technical work scope issued to ENSECO-CAL as part of their subcontract with ERT.

6.4 Volatile Organics

6.4.1 "Target" Compound Listing

Volatile organic "target" compounds as defined in the Project Test Plan (literature survey, Section 3) included a comprehensive listing of components defined as the EPA Hazardous Substances Listing (HSL). It was believed that this approach would provide us with a listing of the more commonly occurring organic solvents potentially contained in industrial

discharges and ultimately in wastewater influent to the MWWTP facility. The EPA Hazardous Substances Listing is provided in Table 6-4. Additional organic solvents not contained in the EPA HSL that were selected as "target" compounds are also listed in Table 6-4.

6.4.2 Analytical Protocols

Primary Tenax sorbent cartridges were submitted to ERT's Concord, Massachusetts laboratory to undergo analyses for each of 35 EPA HSL components listed in Table 6-4 as well as the 6 additional non-HSL compounds noted. Analyses were conducted using thermal desorption in conjunction with combined gas chromatography/ mass spectrometry (GC/MS).

Thermal desorption analyses were conducted using a Nutech Model 340 interfaced to a Finnigan OWA 1030B GC/MS system. GC/MS calibration procedures and operating conditions were consistent with those stipulated in the Project Test Plan. Detection limits of 50 ng were achieved for the majority of the "target" compounds identified earlier. Each of eight sorbent tubes were submitted for analyses including four flue gas samples and four field-biased blanks. Results are provided in Tables 2-13 for the EPA HSL listing, while Table 2-14 contains a summary of results for non-HSL "target" compounds and other non-"target" volatiles identified in each sorbent sample. All results which are provided in units of $\mu\text{g}/\text{m}^3$ (ng/l) have been corrected using the appropriate field-biased and laboratory method blanks.

Also, please note that each of the GC/MS total ion chromatograms were reviewed visually with the aid of an automated peak searching program (Biller-Biemann) for the presence of non-target volatile compounds. All non-target compounds detected at a level above the method detection limit (50 ng) up to a limit of 20 compounds were reported and tentative identifications attempted based on an EPA/NBS MS library search. Quantitative data are provided for those

TABLE 6-4
VOLATILE ORGANICS
"TARGET" COMPOUND LISTING
EPA HAZARDOUS SUBSTANCES LISTING

<u>Parameter</u>	<u>CAS Number</u>
Chloromethane	74-87-3
Bromomethane	74-83-9
Vinyl Chloride	75-01-4
Chloroethane	75-00-3
Methylene Chloride	75-09-2
Acetone	67-64-1
Carbon Disulfide	75-15-0
1,1-Dichloroethene	75-35-4
1,1-Dichloroethane	75-35-3
trans-1,2-Dichloroethene	156-60-5
Chloroform	67-66-3
1,2-Dichloroethene	107-06-2
2-Butanone	78-93-3
1,1,1-Trichloroethane	71-__-6
Carbon Tetrachloride	56-23-5
Vinyl Acetate	108-05-4
Bromodichloromethane	75-27-4
1,1,2,2-Tetrachloroethane	79-34-5
1,2-Dichloropropane	78-87-5
trans-1,3-Dichloropropene	10061-01-5
Trichloroethene	79-01-6
Dibromochloromethane	124-48-1
1,1,2-Trichloroethane	79-00-5
Benzene	71-43-2
cis-1,3-Dichloropropene	10061-01-5
2-Chloroethyl Vinyl Ether	110-75-8
Bromoform	75-25-2
2-Hexanone	591-78-6
4-methyl-2-pentanone	108-10-1
Tetrachloroethene	127-18-4
Toluene	108-88-3
Chlorobenzene	108-90-7
Ethyl Benzene	100-41-4
Styrene	100-42-5
Total Xylenes	

TABLE 6-4 (Continued)

<u>Parameter</u>	<u>CAS Number</u>
<u>Non-HSL Listing</u>	
Cyclohexane	
Cyclopentane	
Ethylbutyl Ketone	
Di-isobutyl Ketone	
Ethyl Dibromide	

Hazardous Substances Listing (HSL) U.S. EPA Contract Laboratory Program.
Statement of work for organic analysis. 7/85 revision.

compounds based on a response factor equal to 1.0 using the total area response for the non-target compound and the nearest eluting internal standard. Analytical results for these compounds are provided in Appendix E of this report. Flue gas concentrations in units of $\mu\text{g}/\text{m}^3$ for these compounds are again provided in Table 2-14.

6.5 Semivolatile Organics

6.5.1 "Target" Compound Listing

Semivolatile organic "target" compounds as defined in the project test plan included a comprehensive listing of components identified as the EPA Hazardous Substances List (HSL). This listing as shown in Table 6-5 contains constituents from each of the compound classes identified in the project test plan (Section 3 Literature Survey) as well as a variety of other semivolatiles generally regarded as hazardous by the EPA. Included in this listing are a variety of polynuclear aromatic hydrocarbons (PAHs) commonly associated with stationary combustion source emissions as well as positional isomers of chlorinated phenols and chlorinated benzenes, known to be precursors of polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzodioxins (PCDDs). While the EPA HSL List (see Table 6-5) contains a number of these chlorinated phenol and chlorinated benzene isomer categories not all of them are represented. Accordingly, an additional series of these were also selected as semivolatile "target" compounds as listed in Table 6-6. Table 6-6 also contains other non-HSL semivolatile organics such as the polychlorinated biphenyls (PCBs) selected as "target" compounds for the flue gas monitoring program.

TABLE 6-5
SEMIVOLATILE "TARGET" COMPOUND LISTING
EPA HAZARDOUS SUBSTANCES LISTING (HSL)^a

<u>No.</u>	<u>Compound</u>	<u>No.</u>	<u>Compound</u>
7	Naphthalene	43	1,2-Dichlorobenzene
8	Acenaphthalene	44	Bis(2-chloroisopropyl) ether
9	Acenaphthene	45	N-Nitroso-di-n-propylamine
10	Fluorene	46	Hexachloroethane
11	Phenanthrene	47	Nitrobenzene
12	Anthracene	48	Isophorone
13	Fluoranthene	49	Bis(2-chloroethoxy) methane
14	Pyrene	50	1,2,4-Trichlorobenzene
15	Benz(a)anthracene	51	4-Chloroaniline
16	Chrysene	52	Hexachlorobutadiene
17	Benzofluoranthenes	53	2-Methylnaphthalene
18	Benzo(a)pyrene	54	Hexachlorocyclopentadiene
19	Indeno(1,2,3,cd)pyrene	55	2-Chloronaphthalene
20	Dibenzo(ah)anthracene	56	2-Nitroaniline
21	Benzo(ghi)perylene	57	Dimethyl phthalate
22	Phenol	58	3-Nitroaniline
23	2-Chlorophenol	59	Dibenzofuran
24	2-Methylphenol	60	2,4-Dinitrotoluene
25	4-Methylphenol	61	2,6-Dinitrotoluene
26	2,4-Dimethylphenol	62	Diethyl phthalate
27	2-Nitrophenol	63	4-Chlorophenylphenyl ether
28	2,4-Dichlorophenol	64	4-Nitroaniline
29	4-Chloro-3-Methylphenol	65	N-Nitrosodiphenylamine
30	2,4,6-Trichlorophenol	66	4-Bromophenylphenylether
31	2,4,5-Trichlorophenol	67	Hexachlorobenzene
32	2,4-Dinitrophenol	68	Di-n-butyl phthalate
33	4-Nitrophenol	69	Benzidine
34	4,6-Dinitro-2-methylphenol	70	Butyl benzyl phthalate
35	Pentachlorophenol	71	3,3'-Dichlorbenzidine
36	Benzoic Acid	72	Bis(2-ethylhexyl)phthalate
37	N-Nitrosodimethylamine	73	Di-n-octyl phthalate
38	Aniline		
39	Bis(2-chloroethyl) ether		
40	1,3-Dichlorobenzene		
41	1,4-Dichlorobenzene		
42	Benzyl alcohol		

^aHazardous Substances Listing (HSL) U.S. EPA Contract Laboratory Program. Statement of work for organic analysis. 7/85 revision.

TABLE 6-6
SEMIVOLATILE "TARGET" COMPOUND LISTING
ADDITIONAL NON-HSL COMPOUNDS

1-Methyl Naphthalene
Pentachlorobenzene
1,2,4,5-Tetrachlorophenol
1,2,3,5-Tetrachlorophenol
1,2,3,4-Tetrachlorophenol
2-Nitronaphthalene
Biphenyl

Polychlorinated Biphenyls (PCBs)

Monochlorobiphenyls (Total)
Dichlorobiphenyls (Total)
Trichlorobiphenyls (Total)
Tetrachlorobiphenyls (Total)
Pentachlorobiphenyls (Total)
Hexachlorobiphenyls (Total)
Heptachlorobiphenyls (Total)
Octachlorobiphenyls (Total)
Nonachlorobiphenyls (Total)
Decachlorobiphenyl

6.5.2 Analytical Protocols

Each of five sets of Modified Method 5 (MM5) train samples were submitted under chain-of-custody to the ERT Laboratory in Concord, MA for subsequent analyses. This includes three flue gas samples and two associated field blank trains. A complete listing of the components in each sample set noting ERT identification numbers and sample codes are contained in Appendix E of this report.

Each flue gas sample set was composited to create a single sample per procedures outlined in the project test plan (Figure 5-1). A brief synopsis of these protocols is provided below. The individual components from each sampling train (particulate filter, front half rinse, condensate extract, impinger extracts and XAD-2 resin cartridge) were combined such that a single sample extract resulted for each sampling train. The particulate filter was placed in the Soxhlet extraction thimble along with the contents of the corresponding XAD-2 sorbent trap. Both the front half probe rinse and the back half rinse were placed in the solvent reservoir of the soxhlet extractor. The condensate and aqueous impinger (2/3) samples were combined and extracted with methylene chloride. Each of these solvent extracts were then combined and transferred to the solvent reservoir of the extraction apparatus. A surrogate cocktail containing predetermined quantities (70-200 µg) of a series of isotopically labeled or halogenated semivolatiles was then placed in the extraction thimble. (The surrogate cocktail contained 2-fluorophenol, phenol-d₅, 2,4,6-tribromophenol, nitrobenzene-d₅, 2-fluorobiphenyl and benzo(a)pyrene-d₁₂).

Each composite sample was then extracted for a period of 16-24 hours. The extract was divided two-to-one at this point, with each fraction being dried over sodium sulfate and concentrated separately. The larger fraction was concentrated to 1 ml and submitted for analysis, and the smaller fraction concentrated to 0.5 ml and archived. Internal standards of 1,4-dichlorobenzene-d₄, chrysene-d₁₂, naphthalene-d₈,

perylene-d₁₂, acenaphthene-d₁₀, and phenanthrene-d₁₀ were added to the concentrated extract.

Each extract was then analyzed for the aforementioned "target" compound list provided in Tables 6-5 and 6-6 employing combined gas chromatography/mass spectrometry (GC/MS). Component identification and quantitation procedures for the EPA HSL listing were consistent with those outlined in EPA method 625. Instrument calibration for all single analytes was provided using three serial dilutions of a stock solution prepared from reference materials. This included analysis of the EPA HSL compounds listed in Table 6-5 as well as the additional non-HSL compounds listed in Table 6-6.

In the case of positional isomer classes such as chlorinated phenols, chlorinated benzenes, and polychlorinated biphenyls (PCBs) instrument calibration was provided using a single representative isomer from each isomer class. Polychlorinated biphenyls, for example, were quantitated as the ten (10) respective positional isomer categories employing the representative congeners listed in Table 6-7.

The results of these analyses are provided in Tables 2-10 and 2-11. All of these results which are provided in units of $\mu\text{g}/\text{m}^3$ have been corrected using the appropriate field-biased and laboratory method blanks. Results for the corresponding quality control analyses are provided in Section 7 of this report. The "raw" analytical data are provided in Appendix E of this report.

Also, please note that each of the GC/MS total ion chromatograms were reviewed visually with the aid of an automated peak searching program, (Biller-Biemann) for the presence of non-target semivolatile compounds. All non-target compounds detected at a level above the method detection limit (10 μg total) up to a limit of 20 compounds were reported and tentative identifications attempted based on an EPA/NBS MS library search. Quantitative data are provided for these compounds based on a response factor equal to 1.0 using the total area response for the non-target compound and the nearest

TABLE 6-7
 POSITIONAL ISOMER ANALYSES FOR PCBs -
 IDENTIFICATION OF REFERENCE MATERIALS

<u>Isomer</u>	<u>Congener Group</u>	<u>Quantitative Ion</u>
2-Cl	Cl ₁	188
2,3-Cl ₂	Cl ₂	222
2,4,5-Cl ₃	Cl ₃	256
2,2',4,6-Cl ₄	Cl ₄	292
2,2',3,4,5'-Cl ₅	Cl ₅	326
2,2',4,4',5,6'-Cl ₆	Cl ₆	360
2,2',3,4',5,6,6'-Cl ₇	Cl ₇	394
2,2',3,3',4,5',6,6'-Cl ₈	Cl ₈	430
2,2',3,3',4,4',5,5',6,6'-Cl ₁₀	Cl ₉ , Cl ₁₀	464, 498

eluting internal standard. Analytical results for these compounds are provided in Appendix E of this report. Flue gas concentrations in units of $\mu\text{g}/\text{m}^3$ are again provided in Table 2-12.

7. QUALITY CONTROL DATA

7.1 Overview

Quality control measures implemented during the conduct of this program were consistent with those outlined in the aforementioned Project Test Plan. These included the use of a number of discrete measures to monitor the quality of field associated activities as well as subsequent laboratory analyses. These included the following elements: field-biased blanks, collocated field samples (PCDDs/PCDFs only), field surrogate spikes (PCDDs/PCDFs only), method blanks, laboratory control spikes, and laboratory surrogate spikes. A brief discussion of each of these measures, including results for each of the respective quality control categories, is provided in the subsequent portions of this section.

7.2 Trace Metal Analysis

A single spiked glass fiber filter accompanied the sample set through the complete analytical scheme. The filter was fortified with a spiking matrix containing each of the 18 trace metal parameters comprising the program "target" compound list. The results of these analyses including quantities applied (μg), quantities recovered (μg) and percent recovery data are provided in Table 7-1.

7.3 Semivolatile Organics

7.3.1 Laboratory Fortification/Spike Samples

Two laboratory fortified XAD-2 sorbent cartridges accompanied the Modified Method 5 train samples through the laboratory regime for the analyses of semivolatile organics. Each of the two sorbent cartridges was fortified with predetermined quantities of a representative mixture of those

TABLE 7-1
 TRACE METAL QUALITY CONTROL DATA
 RESULTS OF FORTIFIED FILTER ANALYSES
 (ERT SAMPLE No. LF 86 0448)

<u>Parameter</u>	<u>µg</u>		<u>% Recovery</u>
	<u>Applied</u>	<u>Observed</u>	
Antimony	30	22.7	76
Barium	30	25.1	84
Beryllium	30	19.2	64
Boron	30	24.7	82
Cadmium	30	24.8	82
Chromium	30	25.7	86
Cobalt	30	23.4	78
Copper	30	26.8	89
Lead	30	23.7	79
Manganese	30	23.8	79
Molybdenum	30	23.5	78
Nickel	30	24.1	80
Selenium	30	22.5	75
Silver	30	25.3	84
Strontium	30	27.5	92
Tin	30	49.8	166
Vanadium	30	25.1	84
Zinc	30	28.2	94

semivolatile "target" compounds identified previously in Section 6. The results of these analyses, including quantities applied (μg), measured values (μg) and percent recovery data, are contained in Table 7-2.

7.3.2 Surrogate Spike Data

Each program sample consisting of a particulate filter and a sorbent cartridge was fortified with a surrogate cocktail just prior to commencing the sample preparatory scheme. It was anticipated that these components would assess the behavior of actual components present in individual program samples during the analytical regime. The surrogate cocktail contained six individual components, either halogenated or isotopically labeled compounds, preselected to be representative in chemical properties of those semivolatile target compounds listed in Section 6. Nominally 100-200 μg of each surrogate was applied to the XAD-2 sorbent cartridge just prior to Soxhlet extraction. The results of these analyses including quantities (μg) applied, measured values, percent recovery data and associated statistics ($\bar{X}, S_{\bar{X}}$) are provided in Table 7-3.

7.4 Volatile Organics

7.4.1 Laboratory Fortification/Spike Samples

Two laboratory fortified Tenax sorbent cartridges accompanied the VOST samples through the laboratory regime for analyses of volatile organics. Each of the two sorbent cartridges was fortified with predetermined quantities of a representative mixture of five volatile components selected from the target compound listing identified previously in Section 6. The results of these analyses, including quantities applied (μg), measured values (μg) and percent recovery data, are contained in Table 7-4.

TABLE 7-2

SEMIVOLATILE ORGANIC QUALITY CONTROL DATA
RESULTS OF FORTIFIED SORBENT CARTRIDGE ANALYSES

Parameter	ERT Sample No. L.F. 860 477			ERT Sample No. L.F. 860 476			\bar{X}
	μg	μg	%	μg	μg	%	
4-Chloro-3-methylphenol	277	218	79	277	212	77	78
4-Nitrophenol	230	153	67	230	145	63	65
2-Chlorophenol	235	148	63	235	168	71	67
Phenol	211	120	57	211	137	65	61
Pentachlorophenol	205	144	70	205	178	86	78
1,2,4-Trichlorobenzene	210	213	102	210	241	115	109
2,4-Dinitrotoluene	180	145	80	180	139	77	79
1,4-Dichlorobenzene	209	169	81	209	190	91	86
Pyrene	229	248	108	229	247	108	108
Naphthalene	185	151	81	185	161	87	84
Di-N-Butylphthalate	237	215	91	237	209	88	90
Acenaphthalene	202	187	93	202	196	97	95
2-chlorobiphenyl	284	272	96	284	294	103	100
Decachlorobiphenyl	211	376	178	211	369	175	177

TABLE 7-3
SEMIVOLATILE ORGANIC QUALITY CONTROL DATA
RESULTS OF SURROGATE SPIKING

SPT Sample No.	LF 060 417		35500		36714		35504		35505		35506		35507		LF 060/6	
	µg Observed	µg Added														
2-Fluorophenol	107	90	66	66	32	32	96	65	44	30	87	59	<10	<6.0	111	77
Phenol IS	70	46	66	66	21	33	33	67	23	31	34	48	<9.0	<14	50	72
2,4,6-Tribromopheno	194	200	126	126	32	196	101	100	102	102	175	90	13	6.5	246	127
Mitobenzene IS	96	74	77	77	91	74	74	77	61	64	68	71	86	90	79	82
2-Fluorobiphenyl	103	87	84	84	80	70	70	76	79	77	120	80	82	80	94	91
Benzo(a)pyrene	92	69	75	75	<11	65	65	71	<10	71	67	73	<10	<11	72	70

TABLE 7-4
 VOLATILE ORGANIC QUALITY CONTROL DATA - RESULTS OF
 FORTIFIED SORBENT CARTRIDGE ANALYSIS

<u>Parameter</u>	<u>ERT Sample No. LF 860 453</u>			<u>ERT Sample No. LF 860 457</u>		
	<u>ng</u>	<u>ng</u>	<u>%</u>	<u>ng</u>	<u>ng</u>	<u>%</u>
	<u>Applied</u>	<u>Observed</u>	<u>Recovery</u>	<u>Applied</u>	<u>Observed</u>	<u>Recovery</u>
1,1-Dichloroethene	150	113	73	150	150	100
Trichloroethene	150	84	56	150	123	82
Benzene	150	106	71	150	153	102
Toluene	150	101	68	150	117	78
Chlorobenzene	150	61	42	150	79	53
						<u>X̄</u>
						87
						69
						87
						73
						48

7.4.2 Surrogate Spike Data

Each solid sorbent cartridge was fortified with a surrogate cocktail just prior to analyses. It was anticipated that these components would assess the behavior of actual components present in individual program samples during the analytical scheme. The surrogate cocktail contained four individual components as follows: 1,2-dichloroethane-D₄, benzene-D₆, toluene-D₈, bromofluorobenzene (BFB) nominally, 150 ng of each surrogate was applied to the Tenax sorbent cartridge just prior to the thermal desorption sequence. The results of these analyses, including quantities (ng) applied, measured values (ng), percent recovery data and associated statistics ($\bar{X}, S_{\bar{X}}$), are provided in Table 7-5.

7.5 Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs)

7.5.1 Introduction/Overview

Flue gas samples were submitted to ENSECO-CAL Labs for analyses of selected PCDDs/PCDFs isomers. Quality control protocols pertinent to these measurements, as noted earlier, included specific field and laboratory measures. Quality control measures pertinent to the field monitoring program included the use of field-biased blanks, collocated sampling trains and isotopically labeled TCDD isomers which were applied under field conditions. Analytical quality control measures were consistent with those outlined in the Project Test Plan and contained in the ENSECO-CAL Quality Assurance Manual (January 1986, Version 3.3). These measures included at a minimum the use of laboratory method blanks and laboratory matrix spikes. For a complete listing of QA/QC requisites pertinent to these analyses, please refer to the ENSECO-CAL Work Scope provided in Appendix G of this report. The results of these and other critical quality control analyses are provided in the discussion to follow.

TABLE 7-5
VOLATILE ORGANIC QUALITY CONTROL DATA - RESULTS OF
SURROGATE SPIKING ANALYSIS

Field ID No.	ERT Lab No.	ng Applied All Parameters	1,2-Dichloroethane-D4		Benzene-D6		Toluene-D8		Bromofluorobenzene (BFB)	
			ng Observed	% Recovery	ng Observed	% Recovery	ng Observed	% Recovery	ng Observed	% Recovery
B-201	35310	150	125	83	166	111	70	46	179	119
B-206	35484	150	138	92	176	117	52	34	276	184
B-208	35486	150	172	114	126	84	141	94	194	129
B-212	35490	150	128	86	194	129	152	101	247	165
B-214	35492	150	163	109	144	96	206	137	195	130
B-216	35494	150	128	86	140	93	199	136	142	94
B-220	35498	150	106	70	142	94	203	136	224	149
B-222	35500	150	142	95	149	99	33	22	104	70
--	LF860453	150	127	85	116	77	146	97	109	72
--	LF860457	150	263	175	247	165	187	125	169	112
				10		10		10		10
				99.5		106.5		92.8		106.4
				29.4		25.7		44.1		49.5

N =
X̄ =
S_X =

7.5.2 Field-Biased Blanks

Two sets of field-biased blanks, one per each of the two PCDDs/PCDFs sampling sessions, were submitted for analyses. No measurable levels above the stated analytical detection limit were noted in either of the samples examined. The results of these analyses as provided to ERT by ENSECO-CAL Labs are contained in Appendix H of this report.

7.5.3 Field Surrogate Data

Each PCDDs/PCDFs sampling train was fortified in the field with a surrogate mixture provided to ERT by ENSECO-CAL Labs. The surrogate cocktail, which contained Cl^{37} -2,3,7,8-TCDD and Cl_{13} -1,2,3,4-TCDD at concentrations of 1,000 picograms and 3,000 picograms, respectively, was applied directly to the XAD-2 sorbent cartridge just prior to commencement of the respective flue gas sampling session. The results of these analyses including quantities applied (pg), quantities observed, percent recovery data and associated statistical data ($X.S_x$) are provided in Table 7-6.

As shown, percent recovery data for Cl^{37} -2,3,7,8-TCDD and Cl_{13} -1,2,3,4-TCDD resulted in means (\bar{X}) of 114% and 79% for each of the two analytes, respectively. These values are commensurate with existing EPA guidelines which suggest acceptable recovery efficiency data in the range of 70-120% for the combined sampling and analysis scheme. The latter values, however, reflect recovery data collected using an actual spiked flue gas matrix (2,3).

The surrogate data reported here are also consistent with the target surrogate recovery range of 50-120% reported for labeled TCDDs by Radian Corporation during previous PCDDs/PCDFs flue gas monitoring at the MWWTP facility (1). In the case of the previous Radian monitoring campaign, the surrogate recovery data reflect the analytical measurements only and not the combined sampling and analysis scheme as is the case here.

TABLE 7-6
 PCDDs/PCDFs QUALITY CONTROL DATA -
 RESULTS OF FIELD APPLIED SURROGATE SPIKES
 (Cl³⁷-2,3,7,8-TCDD and C₁₃-1,2,3,4-TCDD)

<u>ERT Sample</u>	<u>CAI. Lab I.D.</u>	<u>Cl³⁷-2,3,7,8-TCDD (1000 pg Applied) % Recovery</u>	<u>C₁₃-1,2,3,4-TCDD (3000 pg Applied) % Recovery</u>
FBB-1	24894-2C	106	82
FBB-2	24894-18C	106	68
Run 1A	24894-1C	112	77
Run 2A	24894-10C	127	74
Run 2B	24894-11C	117	96
		N = 5	5
		X = 114	79
		S _x = 8.8	11

a. Surrogate recovery data reflect accuracy of combined sampling and analysis scheme. The surrogate spiking mixture which contained 1000 pg of Cl³⁷-2,3,7,8-TCDD and 3000 pg of C₁₃-1,2,3,4-TCDD was placed in the sorbent cartridge of each of the respective sampling trains prior to commencement of each sampling session.

7.5.4 Collocated Sampler Data

Collocated samplers were operated during Run 2 using the #8 incinerator unit to provide a measure of precision for the combined sampling and analysis scheme. The results of these analyses including measured values for each of the designated PCDDs/PCDFs isomer categories and sampler precision expressed as a percent deviation between the two data sets are summarized in Table 7-7. As shown, the precision of the combined sampling and analysis scheme for the majority of the congener categories represented ranges from 1 to 25% expressed as a percent difference between two measured values. This is particularly true for each of the following positional isomers or isomer categories: 2,3,7,8-TCDF, mono CDFs, tri CDFs, tri CDDS and CDFs. Precision data for the remaining categories for which measured values are reported range from 46% up to a maximum of 69%. Present EPA guidelines suggest a data precision goal of $\pm 50\%$ for collocated flue gas sampler data. The majority of the values reported here are consistent with these guidelines.

7.5.5 Laboratory Method Blanks

A single laboratory method blank was prepared and accompanied the three PCDDs/PCDFs sample sets through the complete analytical scheme. Analytical results for this sample (CAL ID #24894 MB) are contained in Appendix H of this report, which contains ENSECO-CAL Labs PCDDs/PCDFs data sheets. As noted in the ENSECO-CAL report, with the exception of the hepta-CDD and octa-CDD classes no measurable quantities of any of the PCDDs/PCDFs congeners were reported above analytical lower limits of detection. Measurable quantities of hepta CDD (2.5 Ng) and octa CDD (10.0 Ng) were applied as correction factors for each of the respective program samples as stated in the ENSECO-CAL report. This naturally resulted in elevated detection limits for the hepta CDD and octa CDD congener classes in actual program samples.

TABLE 7-7
PCDDS/PCDFS QUALITY CONTROL DATA
RESULTS OF COLLOCATED FLUE GAS SAMPLES^a (Run 2A/2B)

<u>Congener</u>	<u>NG/DSCM</u>			<u>% a, d</u> <u>Difference</u>
	<u>Run 2A^b</u>	<u>Run 2B^c</u>	<u>\bar{X}</u>	
<u>PCDFS</u>				
Tetra CDFS (Total)	2.00	2.03	2.02	1.5
Penta CDFS (Total)	0.31	0.58	0.45	47
Hexa CDFS (Total)	0.04	0.13	0.09	69
Hepta CDFS (Total)	0.04	0.10	0.07	60
Octa CDFS (Total)	0.11	0.07	0.09	57
Mono CDFS (Total)	0.19	0.19	0.19	0.0
Tri CDFS (Total)	0.78	0.84	0.81	7.1
2,3,7,8-TCDF	0.27	0.30	0.29	10
<u>PCDDS</u>				
Di CDDS (Total)	2.40	1.94	2.17	24
Tri CDDS (Total)	0.13	0.17	0.15	24

- a. Results provided here for Runs 2A/2B reflect precision of combined sampling and analysis scheme. Precision of measured values and not ND are reported here for simplicity. In instances where only a single measured value (> detection limit) is reported the detection limit for the second value has been selected to calculate the % difference.
- b. Values provided based upon a sample collection volume of 13.17 DSCM (m³).
- c. Values provided based upon a sample collection volume of 11.57 DSCM (m³).

d.
$$\% D = \left(\frac{X_1 - X_2}{X_1} \right) \times 100$$

7.5.6 Laboratory Matrix Spikes

A pair of laboratory matrix spikes accompanied the flue gas sample sets throughout the complete PCDDs/PCDFs analytical scheme. The spiking cocktail contained representative PCDDs/PCDFs isomers from each of the "target" congener categories identified earlier in Section 6. Analytical results for these samples (CAL ID #24894 MBNS) are contained in Appendix H of this report. A summary of these results including quantities applied (Ng), quantities observed (Ng) and percent recovery data for each of the PCDDs/PCDFs congeners are provided in Tables 7-8 and 7-9.

TABLE 7-8
 PCDDS/PCDFS QUALITY CONTROL DATA
 RESULTS OF LABORATORY MATRIX SPIKE
 (CAL ID NO. 24894 MBNS)

<u>Congener</u>	<u>Ng</u>		<u>% Recovery</u>
	<u>Applied</u>	<u>Observed</u>	
<u>PCDFS</u>			
2,3,7,8-TCDF	10.0	11.7	117
1,2,3,7,8-PCDF	10.0	9.4	94
1,2,3,4,7,8-HEXCDF	10.0	11.5	115
1,2,3,4,6,7,8-HEPTACDF	10.0	9.5	95
OCTA CDF	50.0	62.3	125
<u>PCDDS</u>			
2,3,7,8-TCDD	10.0	12.1	121
1,2,3,7,8-PCDD	10.0	6.4	64
1,2,3,4,7,8-HEX CDD	10.0	12.3	123
1,2,3,4,6,7,8-HEPTA CDD	10.0	15.5	155
OCTA CDD	50.0	65.2	130

TABLE 7-9
 PCDDs/PCDFs QUALITY CONTROL DATA
 RESULTS OF LABORATORY MATRIX SPIKE
 (CAL ID NO. 24894 MBNS)

<u>Congener</u>	<u>Ng</u>		<u>% Recovery</u>
	<u>Applied</u>	<u>Observed</u>	
<u>PCDFs</u>			
2,3,7,8-TCDF	10.0	7.3	73
2,8-DCDF	10.0	--- ^a	a
<u>PCDDs</u>			
2,3,7,8-TCDD	10.0	8.5	85
2-MCDD	10.0	1.1	11
2,7-DCDD	10.0	2.5	25
1,2,4-TRI CDD	10.0	3.6	36

^aChemical interference precluded quantitation of this isomer.

8. REFERENCES

- [1] Final Draft Test Report - Site O3 Sewage Sludge Incinerator SSI-B National Dioxin Study. Tier 4: Combustion Sources Prepared by Radian Corporation for U.S. EPA July 3, 1986 (EPA Contract No. 68-03-3148).
- [2] Taylor, M.L., Tiernan, T.O., Garrett, J.H., Van Ness, G.F., and Solch, J.G., "Assessments of Incineration Processes as Sources of Supertoxic Chlorinated Hydrocarbons: Concentrations of Polychlorinated Dibenzo-p-dioxins/Dibenzo-furans and Possible Precursor Compounds in Incinerator Effluents", Chapter 8-Chlorinated Dioxins and Dibenzofurans in the Total Environment, Butterworth Publishers, Woburn, MA
- [3] Cooke, M. DeRoos, F., and Rising, B., 1984. "Hot Flue Gas Spiking and Recovery Study for Tetrachlorodibenzo-dioxins (TCDD) Using Method 5 and SASS Sampling with a Simulated Incinerator", EPA Report, Research Triangle Park, NC 27711.
- [4] Rhode Island Toxics Integration Project Final Report Prepared by Versar Inc. for Rhode Island Department of Environmental Management January, 1986.
- [5] Fate of Priority Pollutants, in Publicly Owned Treatment Works. Final Report Volume I prepared by Burns and ROE Industrial Services for U.S. EPA Washington D.C. EPA 440/1-82/303 September, 1982.
- [6] Clayton, G. and Clayton F. (Eds) 1981 Patty's Industrial Hygiene and Toxicology Volume 2B Toxicology. Third revised edition, John Wiley and Sons, New York.
- [7] National Dioxin Study Tier 4 - Combustion Sources Initial Literature Review and Testing Options Prepared by Radian Corporation for U.S. EPA OAQPS RTP, N.C. EPA-450/4-84-014b, October 1984.
- [8] Haile, C.L., and E. Baladi. Methods for Determining the Total Polychlorinated Biphenyl Emissions from Incineration and Capacitor and Transformer Filling Plants. EPA-600/4-77-048, U.S. Environmental Protection Agency, Office of Research and Development, Research Triangle Park, N.C. November 1977.
- [9] Piispanen, W., R. W. Cass, R.M. Bradway, and A.S. Werner. PCB Compounds Emanating from the New Bedford Municipal Wastewater Incinerator. Final Report Prepared by GCA/Technology Division, Bedford, MA., under EPA Contract No. 68-01-3154, Task Order No. 24, September 1977.

- [10] McInnes, R.G., Hall, J.M., Hunt G.T. and White M.O.
"Sampling and Analysis Program at the New Bedford
Municipal Sewage Sludge Incinerator" Final Report
Prepared by GCA Technology. Division for U.S. EPA RTP
1985 GCA TR-84-103-G
- [11] McInnes, R.G. and Hunt, G.T., "Critical Criteria in the
Development of a Toxic Air Emissions Inventory for
Municipal Solid Waste Incinerators" Paper presented at
Spring 1986 meeting of New England Section of Air
Pollution Control Association. Providence, Rhode
Island April 1986.
- [12] Gerstle, R.W. and Albrinck D.N. "Atmospheric Emissions of
Metals from Sewage Sludge Incinerators". Jour Air Poll
Cont 32 (11), pp. 1119-1123 1982.
- [13] Dewling, R.T., Manganelli R.M. and Baer GT "Fate and
Behavior of Selected Heavy Metals in Incinerated
Sludge" Jour WPCF 52(10), pp 2552-2557, 1980.
- [14] Bennett, R.L. and Knapp K.T. "Characterization of
Particulate Emissions from Municipal Wastewater Sludge
Incinerators". Environ Sci Technol, 16 (12), pp
831-836, 1982.
- [15] Greenberg, R.R., Zoller W.H. and Gordon G.E. "Atmospheric
Emissions of Elements on Particles from the Parkway
Sewage-Sludge Incinerator". Environ Sci Technol, 15
(1), pp. 64-70, 1981.

APPENDIX A
FIELD DATA SHEETS

**METHOD 5
DATA SHEETS**

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-20-86
 Run No. L-MS-PF
 Sample Recovered by S Miller
 Sample Box No. EN 513-2

Client MP
 WO No. _____
 Plant MASS

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>A-163</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	
			Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1</u>	<u>23</u>	<u>100</u>	<u>27</u>
<u>2</u>	<u>124</u>	<u>100</u>	<u>24</u>
<u>3</u>	<u>14</u>	<u>0</u>	<u>14</u>
Total Imp. Gain			<u>11</u> g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>340.7</u>	<u>301.0</u>	<u>39.7</u>
_____	<u>447.0</u>	<u>409.7</u>	<u>14.3</u>
_____	_____	_____	_____
_____	_____	_____	_____
Total Si. Gel Gain			<u>54.0</u> g
Total Moisture			<u>65.0</u> g

PARTICULATE TEST FIELD DATA - EET

Plant: Delta Waste Control Center (Manufacturing Process) 2936
 Date: 7/24/86
 Test Location: Stack 8
 Run Number: 275
 Stack Diameter inches: 30
 Duct Dimensions in x in: _____
 Start Time: 8:20
 Operator: S. Miller

Morale Size & Number: 485 3D
 Material Weighed: _____
 BWO: _____
 FILTER DATA
 NUMBER: B-179 TARE: _____ FINAL WT: _____

IMPINGER VOLUMES	TIME	CO ₂	O ₂	CO
1	100			
2	150			
3	0			
SHICA GEL				
2/17				

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD ΔP in. wg	ORIFICE METER ΔH in. wg	GAS METER VOLUME FT ³	STACK	PROBE	IMPINGER	ORGANIC MODULE	OVEN	GAS METER		PUMP VACUUM in. Hg	√ΔP
										IN	OUT		
A 1	0	1.3	1.5	670.106	91		62		271	71	77.8	2	114
2	15	2.2	2.6	680.15	100		66		268	75	88	5	118
3	30	2.3	2.7	702.65	88		65		264	77	76.8	5	115
4	45	2.2	2.8	716.52	83		68		263	80	91.5	5	118
5	60	2.2	2.9	722.25	81		68		257	80	77.0	4	116
6	75	2.2	2.8	745.92	79		68		252	79	78.0	4	118
Stop	90		8.25	757.226	790								
D 1	0	2.2	2.7	751.807	89		68		271	80	85.0	4	118
2	15	2.1	2.6	772.8	91		68		262	85	119.2	4.5	118
3	30	2.1	2.6	781.6	89		68		267	84	78.0	4	118
4	45	1.6	2.0	800.1	84		68		262	73	92.0	4	126
5	60	2.3	2.9	811.0	87		68		277	80	76.0	4	115
6	75	2.4	3.0	822.0	96		68		271	82	97.0	5	118
Stop	90		8.05	836.768	870								
			8.05		870								
AVERAGE			2.42	186.662	89.15								114

Total Volume: 186.662

PARTICULATE CLEAN-UP SHEET

Date 5-11-80
 Run No. 2-MS-AF
 Sample Recovered by _____
 Sample Box No. 57

Client MP
 WO No. _____
 Plant RWSS

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>1-09</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	
			Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Vol.</u>	<u>Initial Vol.</u>	<u>Net Vol.</u>	
<u>1</u>	<u>100</u>	<u>100</u>	<u>0</u>	45 ml Rinse
<u>2</u>	<u>145</u>	<u>100</u>	<u>45</u>	
<u>3</u>	<u>15</u>	<u>0</u>	<u>15</u>	
			Total Imp. Gain	<u>60.0</u> ml

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>411.2</u>	<u>361.7g</u>	<u>49.5</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Si. Gel Gain <u>49.5</u> g
			Total Moisture <u>109.5</u> g

PARTICULATE TEST SHEET

Plant Picota Waste Control Corp Barometric Pressure 29.70
 Date 5/24/66 Static Pressure _____
 Test Location Stack 8 Stack Pressure _____
 Run Number 2 MC Probe Number _____
 Stack Diameter inches 30 Pilot Coefficient .84
 Duct Dimensions in x in _____ Pilot Number _____
 Start Time _____ Meter BC Number 42
 Operator S. Miller Orifice Coefficient _____

INPUMPER VOLUMES	TIME	CO ₂	O ₂	CO
AGG				
100				
0				
SILICA GEL				
343F				

FILTER DATA		
NUMBER	TARE	FINAL WT
5-171		

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD AP in. wg	ORIFICE METER AQ in. wg	GAS METER VOLUME FT ³	STACK	PROBE	INPUMPER	ORGANIC MODULE	OVEN	GAS METER		PUMP VACUUM in Hg	VAP
										IN	OUT		
B-6	0	4.1	5.0	837.420	100		68		264		81	82	202
5	16	3.6	4.6	857.024	99		68		270		84	85	19
5	16	2.1	2.6		99		68		270		84	85	145
4	30	2.4	2.8	869.3	89		68		273		80	81	155
3	45	1.7	2.3	882.4	85		68		265		85	86	13
2	60	1.2	1.5	894.9	85		67		265		85	86	101
1	75	1.1	1.3	905.4	85		68		264		85	86	104
Stack	90		2.25	914.205	80.5						80.9	81	8.14
A-6	0	1.5	1.9	914.499	100		68		257		82	83	102
5	15	1.7	2.1	926	101		68		264		81	82	120
4	30	1.4	1.8	938	102		68		259		85	86	118
3	45	1.9	2.4	949	85		68		269		84	85	138
2	60	2.0	2.5	962	85		68		270		84	85	141
1	75	1.9	2.4	975	86		68		267		84	85	135
Stack	90		2.55	987.334	80.8						84	85	1.1
Average													BACK 1.35

1310
 1215
 1145
 1035
 945
 870
 800
 740
 690
 650
 620
 600
 580
 560
 540
 520
 500
 480
 460
 440
 420
 400
 380
 360
 340
 320
 300
 280
 260
 240
 220
 200
 180
 160
 140
 120
 100
 80
 60
 40
 20
 0

2020/ 2021/ 2022/ 2023/ 2024/ 2025/ 2026/ 2027/ 2028/ 2029/ 2030/ 2031/ 2032/ 2033/ 2034/ 2035/ 2036/ 2037/ 2038/ 2039/ 2040/ 2041/ 2042/ 2043/ 2044/ 2045/ 2046/ 2047/ 2048/ 2049/ 2050/ 2051/ 2052/ 2053/ 2054/ 2055/ 2056/ 2057/ 2058/ 2059/ 2060/ 2061/ 2062/ 2063/ 2064/ 2065/ 2066/ 2067/ 2068/ 2069/ 2070/ 2071/ 2072/ 2073/ 2074/ 2075/ 2076/ 2077/ 2078/ 2079/ 2080/ 2081/ 2082/ 2083/ 2084/ 2085/ 2086/ 2087/ 2088/ 2089/ 2090/ 2091/ 2092/ 2093/ 2094/ 2095/ 2096/ 2097/ 2098/ 2099/ 2100/

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-21-86
 Run No. 2 MS-11
 Sample Recovered by _____
 Sample Box No. 12

Client MSD
 WO No: _____
 Plant MSD

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>B-171</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1</u>	<u>90</u>	<u>100</u>	<u>-10</u>
<u>2</u>	<u>139</u>	<u>100</u>	<u>39</u>
<u>3</u>	<u>12</u>	<u>0</u>	<u>12</u>
			Total Imp. Gain <u>41</u> g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>396.1 g</u>	<u>343.8</u>	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Si. Gel Gain <u>52.3</u> g
			Total Moisture <u>45.3</u> g

PCDD/PCDF
DATA SHEETS

PARTICULATE TEST FIELD DATA SHEET

Plant: Minnesota Light Manufacturing Pressure: 2945
 Date: 5-20-82 Static Pressure: +2.6
 Test Location: STACK # 8 Stack Pressure: 0.84
 Run Number: AMMS- Probe Number: 1
 Stack Diameter inches: 30 Pilot Coefficient: 0.84
 Dust Emissions in a in: 30 Pilot Number: 1
 Start Time: 11:33 Meter No. Number: 166 #2
 Operator: 230 Orifice Coefficient: 0.84

Filter Data
 NUMBER: 8-166 TAPE: FRIAL WT:
 FILTER IDEN: WGT:

HAD JET IN: TIME: CO:
 HAD JET OUT: TIME: CO:
 SHEET NO:

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD ΔP in. wg	ORIFICE METER ΔH in. wg	GAS METER VOLUME FT ³	STACK	PROBE	TEMPERATURES °F			GAS METER IN	GAS METER OUT	PUMP MAXIMUM in. Hg	ΔP
							MMPINGER	ORGANIC MODULE	OVEN				
A-1	0	1.1	1.25	401.717	105	-	56	-	225	71	72	5	1.04
	15	1.1	1.25	412.9	105	-	54	-	240	75	85	5	1.04
	30	1.70	2.00	420.1	105	-	54	-	220	75	87	6	1.30
	45	1.70	2.00	431.6	105	-	54	-	220	75	88	7	1.30
	60	2.30	2.60	442	105	-	54	-	205	76	91	10	1.51
	75	2.40	2.70	455.5	108	-	54	-	220	77	91	10	1.44
	90	2.10	2.50	470.6	108	-	54	-	220	77	92	9.5	1.34
	105	1.80	2.10	483.4	109	-	54	-	225	79	93	10	1.34
	120	1.80	2.10	498.1	109	-	56	-	225	80	92	10	1.37
	135	1.90	2.20	506.1	105	-	54	-	225	80	91	10	1.30
	150	1.70	1.90	516.9	105	-	54	-	225	74	74	10	1.30
	165	1.70	1.90	530.7	106	-	54	-	225	74	74	10	1.30
STOP	180			539.8						82.4			
BZ	0	1.90	2.20	539.840	106	-	54	-	227	77	82	10	1.37
	15	1.40	1.70	551.4	106	-	54	-	225	75	90	11	1.54
	30	1.80	2.00	564.0	106	-	54	-	240	71	95	12	1.34
	45	1.70	2.00	576.9	108	-	54	-	172	80	112	11	1.30
	60	2.00	2.2	588.7	107	-	54	-	259	80	93	11	1.41
AVERAGE													

1133

12:19

3

1433

1438

2.09

14.4

1.34

SAL POINT	CLOCK TIME	VELOCITY HEAD SP in wg	ORIFICE METER DIAM in wg	GAS METER VOLUME FT ³	STACK	PHOBE	TAMPINGER	ORGANIC MATERIAL	OVEN	GAS METER		PUMP VALVING in Hg	VAP
										IN	OUT		
	75	2.00	2.20	603	108				200	18	73	11	1.41
4	90	1.30	1.85	614.0	110				235	77	80	9	1.14
	105	1.50	1.70	623.1	110				230	75	88	9	1.22
5	120	1.70	1.90	633	110				225	78	84	10	1.30
	135	1.70	1.90	645	111				220	78	82	10	1.30
6	150	1.70	1.90	655.7	107				220	82	88	11	1.30
	165	2.10	2.30	667.8	107				256	81	90	11	1.45
STOP	180			679.212									
			1.11	277.49	109					79	87		1.30
			2.0										1.32

1753

PCDD-II

PARTICULATE CLEAN-UP SHEET

Date 5-20-86
Run No. 1A-mms-PF
Sample Recovered by _____
Sample Box No. _____

Client M. Hermann F.R.V.E
WO No. _____
Plant HWSS

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash

Lab No. _____ Residue: _____ mg

Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>B766</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Vol.</u>	<u>Initial Vol.</u>	<u>Net Vol.</u>
<u>1</u>	<u>336.0</u>	<u>280.4</u>	<u>55.6</u>
<u>2+3</u>	<u>400.9</u>	<u>279.5</u>	<u>120.9</u>

Total Imp. Gain 176.5 ml

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1</u>	<u>335.0</u>	<u>280.7g</u>	<u>54.2</u>
<u>2</u>	<u>382.7</u>	<u>358.8g*</u>	<u>23.9</u>

Total Si. Gel Gain 78.6 g

Total Moisture 255.1 g

* changed silica gel

XAD RESIN TRAP # 1526

6 Hr test

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5/20/86
 Run No. LA-MME-Blank
 Sample Recovered by R.G.
 Sample Box No. _____

Client _____
 WO No. _____
 Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>172</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	
			Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1</u>	_____	_____	_____
<u>2+3</u>	<u>374.8</u>	<u>274.6</u>	_____
_____	_____	_____	_____
			Total Imp. Gain _____ g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Si. Gel Gain _____ g
			Total Moisture _____ g

XAD RESIN TRAP # 1533

PARTICULATE TEST FIELD DATA SHEET

DATE	TIME	CO.	CO.
5-22-86	14:00		
TEST LOCATION	SHICA GEL		
RUN NUMBER	372		

Job No. & Name: 3D-185
 Identifier: W-414
 Filter Data: 1516
 Filter No.: 1516
 Filter Weight: 1516

Plant: MUSCC
 Date: 5-22-86
 Test Location: #8 Stack
 Run Number: 21115-100
 Stack Diameter inches: .84
 Dust Dimensions in in: 30" Ø
 Start Time: 11:58
 Operator: LSB

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD ΔP in wg	ORIFICE METER ΔH in wg	GAS METER VOLUME FT ³	STACK	PROBE	IMPINGER	ORGANIC MODULE	OVEN	GAS METER		PUMP VACUUM in Hg	ΔP
										IN	OUT		
1	0	1.70	2.40	842.850	103		59		250	110	100	1.30	
	15	3.50	3.50	855.1	103		60		250	108	100	1.58	
2	30	3.50	3.50	871.0	104		54		247	108	100	1.58	
	45	3.70	3.70	886.4	107		49		250	118	100	1.30	
3	60	1.70	1.50	901.2	106		49		249	118	100	1.30	
	75	2.00	1.70	915.3	106		47		250	111	100	1.41	
4	90	2.80	3.90	928.7	106		47		249	111	100	1.47	
	105	1.90	2.65	945.3	105		49		240	110	100	1.87	
5	120	3.00	4.20	959.1	105		50		250	109	100	1.73	
	135	2.50	3.50	976.1	105		50		245	109	100	1.58	
	150	1.60	2.25	991.8	105		52		250	110	100	1.30	
	165	1.50	2.70	1003.7	105		50		250	110	100	1.51	
	180			1017.419									
1	0	1.90	2.10	1017.419	105		48		240	109	100	1.51	
	15	1.70	2.30	1030.1	105		48		244	104	100	1.50	
2	30	2.80	3.90	1043.6	106		49		240	102	100	1.67	
	45	1.70	2.60	1051.5	105		51		249	100	100	1.34	
	60	2.10	2.90	1074.0	105		50		250	111	100	1.51	
AVERAGE													

Leak Check: 0.009 CFM @ 17" H₂O
 Date: 5/22/86

S Point	CLOCK TIME	VELOCITY HEAD SP in wg	ORIFICE METER 2.11 in wg	GAS METER VOLUME FT ³	STACK	PRG...	IMPINGER	ORGANIC MEDIUM	OVEN	GAS METER		PUMP CALIBRATION in 19	√ΔP
										IN	OUT		
	15	2.10	2.90	1087.4	105		57		257	70	76	15	1.96
4	40	1.80	2.50	1105	105		50		150	70	76	14	1.57
	105	1.7	2.3	1117.2	105		50		250	70	76	14	1.57
5	120	2.1	2.9	1142.8	102		50		250	70	110	16	1.97
	135	2.6	3.6	1142.8	102		50		250	89	89	15	1.57
6	150	1.9	2.6	1157.1	102		49		246	89	89	15	1.57
	165	2.2	2.9	1171.1	102		49		246	90	118	17	1.97
5000	180		(2.2)	1185.612	103								1.97
1	0	2.0	2.80	1185.6	104		46		250	70	119	15	1.97
	15	1.5	2.10	1199.0	104		49		250	90	111	15	1.57
2	30	2.1	3.00	1202.0	104		49		248	90	113	15	1.57
	45	2.1	3.00		106		52		245	91	111	17	1.97
3	60	2.1	3.00	1241.5	109		56		245	91	110	17	1.57
	75	1.5	2.10		109		56		245	91	110	16	1.57
4	90	1.9	2.70	1246.955	109		56		250	80	80	14	1.77
	105	1.9	2.70		105		54		245	51	81	17	1.97
5	120	2.2	3.3	1292.5	105		54		245	83	110	17	1.97
	135	2.2	3.3	1309	105		54		250	84	110	17	1.97
6	150	2.2	3.3	1324.1	105		52		250	84	110	17	1.97
5000	165	2.1	3.2	1337.1	105		50		250	84	110	17	1.97
5000	180			1340.840					250	84	110	17	1.97
1	0		2.886	4980.1	104								1.97
2	15												
3	30												
4	45												

1846
1850

1921
Change Bible
1943
5000
2100

Final Lead Check 0005 / 0005 CK

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-22-86
 Run No. 2A-11125-1000
 Sample Recovered by _____
 Sample Box No. NEW 1302

Client MWCC
 WO No. _____
 Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash

Lab No. _____ Residue: _____ mg

Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>B-169</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>	
_____	_____	<u>100</u>	_____	Bottle weight CD-279.5 - 552.5 = 273 281.1 282.4 CD-281.9 409.7
_____	_____	<u>100</u>	_____	
_____	_____	_____	_____	
			Total Imp. Gain	<u>2243.9</u> g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>461.3</u>	<u>369.7</u>	_____
_____	<u>380.6</u>	<u>347.6</u>	_____
_____	<u>510.1</u>	<u>461.5g</u>	_____
			Total Si. Gel Gain <u>193.2</u> g

Total Moisture 2437.1 g

TEMPERATURE

LE POINT	CLOCK TIME	VELOCITY HEAD 2P in wg	ORIFICE METER 21 in wg	GAS METER VOLUME FT ³	STACK	PHG	IMPINGER	ORGANIC MODURE	OVEN	GAS METER		PUMP CALORIM in 1/4	√ΔP
										IN	OUT		
	15	2.1	2.6	218	95	250	61		250	88	108	11	181
4	90	1.4	1.7	230.5	96	250	58		250	88	107	9	178
5	105	1.7	2.0	241	95	250	56		250	85	107	10	171
	120	1.7	2.0	253.1	95	250	54		250	86	107	10	171
	130	2.1	2.1	268	96	250	53		250	85	107	10	171
6	150	1.7	2.1	276	95	250	51		250	83	107	10	171
	165	2.5	3.0	292	95	250	58		250	85	107	10	171
	180			304.539									
1	0	2.0	2.5	304.539	96	250	59		250	83	96	12	194
	15	1.2	1.5	317	97	250	52		250	81	106	10	195
2	30	3.0	3.0	328	96	250	53		250	85	107	10	171
	45	3.0	3.0	343	97	250	57		250	87	107	10	171
3	60	2.0	2.5	357	99	250	53		250	86	106	15	192
	75	2.0	2.5	372.00	98	250	57		250	86	107	14	194
4	90	2.5	3.0	387.919	97	250	59		250	87	107	15	194
	105	2.0	2.5	396.7	97	250	56		250	86	107	15	194
5	120	2.2	2.8	402.855	97	250	52		250	81	97	17	198
	135	2.2	2.8	418	97	250	52		250	82	99	17	198
6	150	2.6	3.2	427	97	250	48		250	82	97	18	198
	165		3.2	439.117									
7	180			443.5									
1	0												1.55
2	15												
3	30												
4	45												
5	60												

17.46 2500

17.50 2500

18.21 2500

18.42 2500

18.63 2500

18.84 2500

19.05 2500

19.26 2500

19.47 2500

19.68 2500

19.89 2500

20.10 2500

20.31 2500

20.52 2500

20.73 2500

20.94 2500

21.15 2500

21.36 2500

21.57 2500

21.78 2500

21.99 2500

22.20 2500

22.41 2500

22.62 2500

22.83 2500

23.04 2500

23.25 2500

23.46 2500

23.67 2500

23.88 2500

17.46 2500

17.50 2500

18.21 2500

18.42 2500

18.63 2500

18.84 2500

19.05 2500

19.26 2500

19.47 2500

19.68 2500

19.89 2500

20.10 2500

20.31 2500

20.52 2500

20.73 2500

20.94 2500

21.15 2500

21.36 2500

21.57 2500

21.78 2500

21.99 2500

22.20 2500

22.41 2500

22.62 2500

22.83 2500

23.04 2500

23.25 2500

23.46 2500

23.67 2500

23.88 2500

SAMP POINT	CLOCK TIME	VELOCITY HEAD ΔP in wg	ORIFICE METER ΔP in wg	GAS METER VOLUME FT ³	STACK	PROBE	TEMPERATURES °F	OVEN	GAS METER		PUMP VACUUM in Hg	$\sqrt{\Delta P}$
									IN	OUT		
	75	2.1	2.6	218	95	250	61	251	88	105	11	3 r. 45
4	90	1.4	1.7	230.5	96	250	58	250	88	101	9	
	105	1.7	2.0	241	95	250	56	250	85	101	10	
5	120	1.7	2.0	253	95	250	54	250	86	101	10	3 r. 66
	135	3.2	3.9	266	96	250	53	250	85	99	15	
6	150	1.7	2.1	276	95	250	57	250	83	99	10	
	165	2.5	3.0	290	95	250	58	250	85	105	10	
STOP	180			304.531								
1	0	2.0	2.5	309.531	96	250	59	250	87	96	12	
	15	1.2	1.5	317	97	250	52	252	87	106	10	
2	30	3.5	4.2	328	96	250	53	250	85	101	15	
	45	3.7	4.4	343	97	250	57	246	87	106	15	3 r. 63
3	20	3.7	4.4	357	99	250	53	248	86	106	15	3 r. 63
	75	2.0	2.5	372.00	98	250	59	250	86	101	14	
4	90	2.5	3.0	382.911	97	250	57	240	77	81	15	
	105	2.5	3.0	367	97	250	56	225	78	96	15	
5	120	2.8	3.3	407.855	97	250	52	260	81	97	17	
	135	2.8	3.3	418	97	250	52	255	82	97	17	
6	150	2.6	3.2	427	97	250	48	236	82	97	18	
STOP	165	2.5	3.0	435	95	250	44	270	81	95	18	
STOP				437.882								
1	0											
	15											
2	30											
	45											
3	60											

* STOP Due to unable to maintain ΔH

18:40 STOP

18:21 STOP
 Change silencer
 5000
 5000
 5000

5000
 5000
 5000

10/11/11

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-22-96
Run No. 28-11115-PCDD
Sample Recovered by
Sample Box No. 2 (1025)

Client WACC
WO No.
Plant

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
Cyclone & Flask Acetone Wash

Lab No. Residue: mg
Lab No. Residue: mg

Filter No.	Lab No.	Weight	
3-161		mg	Total Filter Particulate mg
		mg	
		mg	
		mg	Front Half Total mg

MOISTURE

Impinger No.	Final Weight	Initial Weight	Net Weight
1st		100 (100)	
2nd 3rd		100	

Total Imp. Gain 481.2 g

Bottle wt 281.2g and billing 481.5
Bottle weight
CD 524.2 - 279.2 =
23 388.0 280.1
CD2 409.5 281.2

SILICA GEL

Container No.	Final Weight	Initial Weight	Net Weight
	384.3	328.6g	
	377.4	334.4g	
	478.0	441.3g	

Total Si. Gel Gain 137.4 g

Total Moisture 618.6 g

A-1522

PC 11

BLANK

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-22-80
Run No. 211015-1100
Sample Recovered by _____
Sample Box No. _____

Client DUCC
WO No. _____
Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash Lab No. _____ Residue: _____ mg
Cyclone & Flask Acetone Wash Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>0164</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1</u>	<u>374.5</u>	<u>278.6</u>	_____
<u>2</u>	<u>377.6</u>	<u>280.2</u>	_____
_____	_____	_____	_____
Total Imp. Gain			_____ g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
Total Si. Gel Gain			_____ g

XAD TRAP # 1522

Total Moisture _____ g

SEMI-VOLATILE
DATA SHEETS

PARTICULATE TEST FIELD DATA SHEET

AD-1514

Plant: _____ Barometric Pressure: 29.75
 Date: 5-20-86 Static Pressure: _____
 Test Location: Stack #7 Stack Pressure: _____
 Run Number: 1-500MS- Probe Number: _____
 Stack Diameter in inches: 30 Pilot Coefficient: 0.84
 duct Dimensions in x x in: _____ Pilot Number: _____
 Start Time: 12:46 Meter BC Number: New RAC
 Operator: GL Orifice Coefficient: _____

Module Size & Number: _____
 Adjuster Weighed: _____
 FRESH DATA (AD-1514)
 NUMBER: _____ TARE: _____
 SERIAL WT: _____
 SHIM: _____
 GEL: _____
 39.7 313.6

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD AP in. w.g.	ORIFICE METER AQ in. w.g.	GAS METER VOLUME FT ³	STACK	PROBE	IMPINGER	ORGANIC MODULE	OVEN	GAS METER		PUMP VACUUM in. Hg	VAP Wt. %
										IN	OUT		
B-6	0	2.0	2.8	569.114	100	250	.58		250	60	69	11	1.41
5	15	1.8	2.8	582.1	97	250	.46		260	12	94	10	1.39
4	30	1.5	2.2	394.6	97	250	.48		255	77	100	9	1.22
15:00 MS	45			408.305									
14:00 MS		2.7	3.5	408.305	99	250	.47		250	72	72	15	1.69
15	60	2.2	3.1	426.1	97	250	.50		250	92	104	13	1.48
16	75	0.8	1.1	437.6	97	250	.52		252	84	104	6	2.22
Stop	90			446.975									
17:00 MS													
A-1	0	1.0	1.5	446.475	98	250	.59		250	82	80	8	1
2	15	1.9	2.8	457.0	97	250	.51		250	80	95	13	1.38
3	30	2.6	3.8	470.3	97	250	.53		250	85	100	17	1.61
4	45	2.1	3.1	486.0	98	250	.52		250	88	108	16	1.45
5	60	1.4	2.6	501.5	91	250	.52		250	90	110	14	1.58
6	75	1.7	2.5	512.7	104	250	.58		250	90	108	12	1.30
Stop	90			527.875									
				558.259	X=97.5	X=250	X=51.75		X=250	X=88.08			X=1.34

17:00 MS
 18:00 MS
 19:00 MS
 20:00 MS
 21:00 MS
 22:00 MS
 23:00 MS
 24:00 MS
 25:00 MS
 26:00 MS
 27:00 MS
 28:00 MS
 29:00 MS
 30:00 MS
 31:00 MS
 32:00 MS
 33:00 MS
 34:00 MS
 35:00 MS
 36:00 MS
 37:00 MS
 38:00 MS
 39:00 MS
 40:00 MS
 41:00 MS
 42:00 MS
 43:00 MS
 44:00 MS
 45:00 MS
 46:00 MS
 47:00 MS
 48:00 MS
 49:00 MS
 50:00 MS
 51:00 MS
 52:00 MS
 53:00 MS
 54:00 MS
 55:00 MS
 56:00 MS
 57:00 MS
 58:00 MS
 59:00 MS
 60:00 MS

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-22-86
 Run No. 14115
 Sample Recovered by GL
 Sample Box No. 1000 (121)

Client MCC
 WO No. _____
 Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>R168</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	
			Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1st</u>	<u>54</u>	<u>0</u>	<u>54</u>
<u>2nd</u>	<u>105</u>	<u>100</u>	<u>5</u>
_____	_____	_____	_____

Total Imp. Gain 59 g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>349.7</u>	<u>313.6</u>	<u>36.1</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Si. Gel Gain 36.1 g

Total Moisture 95.1 g

✓

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-20-76
Run No. 15291
Sample Recovered by ASD/CC
Sample Box No. _____

Client _____
WO No. _____
Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>15-177</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Imp. Gain _____ g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Si. Gel Gain _____ g

Total Moisture _____ g

PARTICULATE TEST FIELD DATA EET

Plant Metro Waste Control Corp 7930
 Date 5/21/66 Stack # 8
 Test Location Stack # 8
 Run Number 2-30005
 Stack Diameter inches 30"
 Duct Dimensions in x in 8" x 8"
 Start Time 8:17 am Meter No. Number # 52030
 Operator GL Orifice Coefficient

Match Site & Number 187
 Match test Weight XAD-1530
 Filter Data
 NUMBER 8-125 TARE FINAL WT
 ANALYST
 DATE
 TIME
 PUMP CALIBRATION No.
 SHPCA CELL
 38791/3/71

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD ΔP in. wg	ORIFICE METER ΔH in. wg	GAS METER VOLUME FT ³	STACK	PROBE	IMPINGER	ORGANIC MODULE	OVEN	GAS METER		PUMP CALIBRATION No. (H)	ΔP
										IN	OUT		
B-1	0	1.8	2.3	527.968	108	250	50		250	64	64	10	1.54
2	15	2.0	2.8	542	101	250	52		250	75	95	12	1.41
3	30	1.8	2.5	556	107	250	50		250	78	100	11	1.54
4	45	2.4	3.5	568	107	250	50		250	80	102	15	1.55
5	60	2.3	3.4	582	107	250	44		250	80	104	17	1.41
6	75	2.0	2.8	547	106	250	52		250	84	110	15	1.41
STOP	90			609.316									$\bar{X} = 1.493$
A-6	0	2.0	2.8	609.346	107	250	54		250	82	84	15	1.41
5	15	2.2	3.5	624	108	250	54		250	86	102	22	1.48
4	30	2.1	3.0	634	108	250	60		250	86	102	18	1.41
3	45	1.5	2.2	652	108	250	50		250	84	100	13	1.32
2	60	1.4	2.0	666	102	250	47		250	84	100	12	1.48
1	75	1.2	1.7	677	101	250	66		250	82	76	11	1.30
STOP	90			688.125									$\bar{X} = 1.31$
				160.157	$\bar{X} = 106$	$\bar{X} = 250$	$\bar{X} = 53.5$		$\bar{X} = 250$	$\bar{X} = 88.5$			$\bar{X} = 1.41$

8:17
 9:47
 1000
 1600 ft³/15 min

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-21-86
 Run No. 25000
 Sample Recovered by 555 56
 Sample Box No. _____

Client _____
 WO No. _____
 Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>5</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	
			Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1st</u>	<u>329</u>	<u>280.5</u>	<u>48.5</u>
<u>2nd 3rd</u>	<u>378</u>	<u>200</u>	<u>178.0</u>
_____	_____	_____	_____

*Rinsed w/ 1.1 Acetone
 and added to Amber
 bottle before wt
 was taken*

Total Imp. Gain 227.5 g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>357.8</u>	<u>347.4</u>	<u>40.4</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Total Si. Gel Gain 227.5 g

Total Moisture 267.9 g

✓
METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5/21/86
Run No. 1243 SMMS-BLANK
Sample Recovered by R.G.
Sample Box No. _____

Client MWCC
WO No. _____
Plant Metro Plant

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>174</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Imp. Gain _____ g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Si. Gel Gain _____ g

Total Moisture _____ g

XAD. Resin #
1535

PARTICULATE TEST FIELD DATA EET

Plant Name: Highland Co. Barometric Pressure: -29.30
 Date: 5/21/85 Static Pressure: 0.12
 Test Location: Stack #8 Stack Pressure: _____
 Run Number: 3-5MMS Probe Number: 64
 Stack Diameter inches: 30" Pilot Coefficient: _____
 duct Dimensions in in: _____ Pilot Number: 3030
 Start Time: 13:10 Meter BC Number: _____
 Operator: GL Orifice Coefficient: _____

WASH WATER	TIME	CO.	CO.
70			
LOW			
0			
SILICA GEL			
8.2.5			

Mouth Size & Number: 1/8" 30
 Airflow Weigh: _____
 BWG: XPD-1523
 FILTER DATA
 NUMBER: 176 TARE: _____ FINAL WT: _____
 _____ TARE: _____ FINAL WT: _____
 _____ TARE: _____ FINAL WT: _____

SAMPLE POINT	CLOCK TIME	VELOCITY HEAD ΔP in. wg	ORIFICE METER OUT in. wg	GAS METER VOLUME FT ³	STACK	PROBE	TEMPERATURES °F			PUMP CALORIM #. 100	√ΔP	
							INPINGER	ORGANIC MODULE	OVEN			
A-1	0	2.5	3.6	682.500	104	250	68	250	75	75	21	1.50
STOP	6:24			701.605								
2	16:01	1.7	2.4	704.605	105	250	73	250	80	80	13	1.50
3	30	2.1	3.1	717.6	104	250	64	250	84	100	20	1.75
4	45	1.5	2.2	731.2	105	250	62	250	86	104	15	1.22
5	60	1.4	2.0	744	105	250	61	250	85	103	15	1.18
6	75	1.4	2.0	755	105	250	62	250	85	103	15	1.16
STOP	90			766.289								
6	0	1.4	2.0	766.500	100	250	70	250	80	80	16	1.18
5	15	2.0	2.7	782	105	250	72	250	84	100	21	1.11
4	30	1.1	1.4	799	105	250	69	250	84	98	11	1.05
3	45	2.0	3.3	804	105	250	67	250	82	96	21	1.11
2	60	1.7	2.7	817.	105	250	64	250	82	95	21	1.30
1	75	1.6	2.6	830.	105	250	64	250	82	95	21	1.26
STOP	90			842.015								
AVERAGE		X=1.29	X=2.5	153.595	X=104				X=88.33			

13:10
13:26

13:30
STOP

14:15
STOP

15:03

16:30

Total Leak Rate: 10.004 CFM @ 15" H₂O
 Date Check: _____

METHOD 8 - PARTICULATE CLEAN-UP SHEET

Date 5-21-85
 Run No. 3
 Sample Recovered by BSD/G.L.
 Sample Box No. _____

Client MWCC - ...
 WO No. _____
 Plant _____

PARTICULATE - FRONT HALF

Nozzle & Probe Acetone Wash
 Cyclone & Flask Acetone Wash

Lab No. _____ Residue: _____ mg
 Lab No. _____ Residue: _____ mg

<u>Filter No.</u>	<u>Lab No.</u>	<u>Weight</u>	
<u>3176</u>	_____	_____ mg	Total Filter Particulate _____ mg
_____	_____	_____ mg	
_____	_____	_____ mg	
_____	_____	_____ mg	Front Half Total _____ mg

MOISTURE

<u>Impinger No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
<u>1st</u>	<u>70ml</u>	<u>0</u>	<u>70ml</u>
<u>2nd 3rd</u>	<u>100ml</u>	<u>100</u>	<u>0ml (70ml Rinse)</u>
_____	_____	_____	_____
			Total Imp. Gain <u>70ml</u> g

SILICA GEL

<u>Container No.</u>	<u>Final Weight</u>	<u>Initial Weight</u>	<u>Net Weight</u>
_____	<u>388.7</u>	<u>345.3</u>	<u>43.4</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
			Total Si. Gel Gain <u>43.4</u> g
			Total Moisture <u>113.4</u> g

VOLATILE ORGANIC SAMPLE TRAIN
DATA SHEETS

Run 1A

VOST DAT ORN

tube entry - 45

PLANT NAME MMW-insulators, Massapequa, Mass.

DATE 5-20-86

SAMPLE LOCATION Stack # 8

OPERATOR B. Vaclavet

SAMPLE NO.: TRAP 1 B-204 TRAP 2 B-205

BAROMETRIC PRESSURE 29.85 mm Hg (in. Hg)

PROBE LENGTH 3 (ft)

PROBE MATERIAL glass

PROBE HEATER SETTING 150°C

DRY GAS METER NO. 32016

METER CALIBRATION FACTOR (Y) 1.02

SAMPLE POINT LOCATION

LEAK CHECK: INITIAL 0.04/in FINAL 1.02 REMARKS STACK TEMPERATURE AT 105°F, NO VACUUM

* X is on inlet side

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l.	SAMPLE RATE Setting lpm	SAMPLE FLOW RATE SETTING lpm	SAMPLE VOLUME METERED ΔV_m ft ³	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1345	88.67	0.25		0.00 3.92		77 81	21 70
15	1400	92.40	0.25		3.75	-5	78 82	20 68
30	1415	96.42	0.25		4.02	12.5	78 82	20 68
45	1430	100.44	0.25		4.02	12.5	77 81	20 68
60	1445	104.35	0.25		5.91	0%	77 81	20 68
TOTAL		TOTAL 15.60			ΔV_m AVG. 3.92	MAX. DEV. 2.5	AVG. 79.4 81.4	MAX. TEMP. 70

(%) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \right] \times 100$ Sample No.

Run 1B

VOST DAT 0000

PLANT NAME Minneapolis Waste Water Treatment Plant DATE 5-20-86

SAMPLE LOCATION STACK # 8 OPERATOR R. Vachon

SAMPLE NO.: TRAP 1 B-208 TRAP 2 B-209 BAROMETRIC PRESSURE 29.45 mm Hg (in. Hg)

PROBE LENGTH 3 (ft) PROBE MATERIAL glass

PROBE HEATER SETTING 1500C DRY GAS METER NO. 32016

METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION

LEAK CHECK: INITIAL 0.01/m FINAL 0.02/m REMARKS Stack Temp ~ 105°F; X in inlet side of Teena tube

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l.	SAMPLE VOLUME m ³	SAMPLE FLOW RATE SETTING lpm	SAMPLE FLOW RATE SETTING cfm	SAMPLE VOLUME METERED ft ³	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1515	4.89	—	0.25	—	4.23	—	—	—
15	1530	9.10	4.21	0.25	—	—	-0.5	26 79	20 68
30	1545	13.25	4.15	0.25	—	—	-2.0	26 79	20 68
45	1600	17.54	4.29	0.25	—	—	+1.4	27 81	20 68
60	1615	21.80	4.26	0.25	—	—	+0.7	27 81	20 68
TOTAL		16.91	AV _M AVG. 4.23				MAX. DEV. -2.0	AVG. 27.5	MAX. TEMP. 20
60								80	20 68

(%) Percent deviation (s) = $\left[\frac{AV_M - AV_{M\text{AVG}}}{AV_{M\text{AVG}}} \right] \times 100$ Sample No. _____

45-50 in. glass tube

VOST DAT DIRI

Run 2A

PLANT NAME MUSS, INCINERATOR DATE 5-21-86

SAMPLE LOCATION Stack # 8 OPERATOR G. Kachert

SAMPLE NO.: TRAP 1 B-210 B TRAP 2 B-211 BAROMETRIC PRESSURE 7130 mm Hg (in. Hg)

PROBE LENGTH m (ft) PROBE MATERIAL glass

PROBE HEATER SETTING 150°C DRY GAS METER NO. 32016

METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION _____

LEAK CHECK: INITIAL 0.02/1m FINAL 0.01/1m REMARKS 1 on end of TenAnt tube

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l. ft	SAMPLE FLOW RATE SETTING lpm	SAMPLE VOLUME METERS ³ AV _m	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	8:16	22.13	0.25	—	—	—	—
15	8:31	26.03	0.25	3.90	-1.5	24 75	20 68
30	8:46	30.06	0.25	4.08	12.0	26 79	20 68
45	9:01	34.01	0.25	3.95	0	28 82	20 68
60	9:16	38.93	0.25	3.92	0.2	29 84	20 68
TOTAL		158		AV _m AVG. 3.95	MAX. DEV. 12.0	AVG. 27 80	MAX. TEMP. 20 68

(1) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \right] \times 100$ Sample No. _____

VOST DAT / ORN

Run 2B

PLANT NAME MWSS INCINERATOR DATE 5-21-86
 SAMPLE LOCATION Stack #8 OPERATOR B. Vachero
 SAMPLE NO.: TRAP 1 B 214 TRAP 2 B 215
 PROBE LENGTH m (ft) 3
 PROBE HEATER SETTING 150°C
 BAROMETRIC PRESSURE 27.30 mm Hg (in. Hg)
 PROBE MATERIAL glass
 DRY GAS METER NO. 32016
 METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION
 LEAK CHECK: INITIAL 0.04pm FINAL 0.04pm REMARKS X on inlet to TENAX

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l.	SAMPLE RATE SETTING lpm	SAMPLE FLOW RATE SETTING cfm	SAMPLE VOLUME METERED ft ³	PERCENT DEVIATION % ±	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	930	38.14	0.25		—	—	—	—
15	945	42.05	0.25		3.91	-0.8	31 88	21 70
30	1000	46.05	0.25		4.00	+1.5	32 90	20 68
45	1015	50.00	0.25		3.95	+0.2	32 90	18 64
60	1030	59.91	0.25		3.91	-0.8	32 90	16 61
TOTAL		15.77			ΔV _m AVG. 9.94	MAX. DEV. 1.5	AVG. 32 90	MAX. TEMP. 21 70

(1) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \right] \times 100$ Sample No.

VOST DATA FORM

Run 3A

PLANT NAME MUSS DATE 5-21-86
 SAMPLE LOCATION Stack #8 OPERATOR B. Vachert
 SAMPLE NO.: TRAP 1 B-216 TRAP 2 B-217 BAROMETRIC PRESSURE 730 mm Hg (in. Hg)
 PROBE LENGTH 3 (ft) PROBE MATERIAL Flux
 PROBE HEATER SETTING 150 DRY GAS METER NO. 32016
 METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION _____

LEAK CHECK: INITIAL 0.0 l/min FINAL _____
 REMARKS Pressure reduced from pressure reading
0.1 l/min ≈ 23 on flowmeter scale (glass)

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l. ft ³	SAMPLE FLOW RATE SETTING lpm	SAMPLE FLOW RATE SETTING cfm	SAMPLE VOLUME METERED ΔV _m ft ³	PERCENT DEVIATION % ±	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1345	57.34	0.1		—	—	—	—
10	1345 1328	58.34 58.50	0.1		1.05	+0.6	30	86
20	1345 1331	59.36	0.1		0.97	-7.0	30	86
30	1345 1350	60.50	0.1		1.14	+9.0	30	86
40	1345 1400	61.45	0.1		0.95	-9.0	30	86
50	1400 1410	62.56	0.1		1.11	+6.0	30	86
TOTAL		TOTAL			ΔV _m AVG.	MAX. DEV.	AVG.	MAX. TEMP.
50		5.72			1.044	9.0	30	86

* Sampling stopped @ 1324 because of high stack velocities. VOST 70 min sealed from probe.
 Resumed sampling @ 1331 after changing larger screen.

(%) Percent deviation (s) = $\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \times 100$ Sample No. _____

Run 3B

VOST DAT/ 1984

PLANT NAME MWSS DATE 5-21-86

SAMPLE LOCATION Stack #8 OPERATOR R. Vandebeek

SAMPLE NO.: TRAP 1 B-218 TRAP 2 B-219 BAROMETRIC PRESSURE 27.80 mm Hg (in. Hg)

PROBE LENGTH 3 (ft) PROBE MATERIAL GLASS

PROBE HEATER SETTING 150°C DRY GAS METER NO. 32016

METER CALIBRATION FACTOR (Y) 102 SAMPLE POINT LOCATION _____

LEAK CHECK: INITIAL 0.09 f/m FINAL _____

REMARKS _____

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l. ft ³	SAMPLE FLOW RATE SETTING lpm	SAMPLE FLOW RATE SETTING cfm	SAMPLE VOLUME METERED ΔV_m ft ³	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1452 1452	67.67	0.1		-	-	-	-
10	1505	68.75	0.1		1.08	-0.4	29 84	16 61
20	1515	69.86	0.1		1.11	+2.4	29 84	17 63
30	1525	70.95	0.1		1.09	+0.5	29 84	16 61
40	1535	71.53	0.1		0.98	-9.6	29 84	16 61
50	1445	72.09	0.1		1.16	+7.0	29 84	16 61
TOTAL		5.42			ΔV_m AVG. 1.084	MAX. DEV. -9.6	AVG. 29 84	MAX. TEMP. 17 63

(1) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \right] \times 100$ Sample No. _____

Run 4A

VOST DAT/ DIM

PLANT NAME MURC DATE 5-22-86

SAMPLE LOCATION stack #8, incinerator OPERATOR R. Unherot

SAMPLE NO.: TRAP 1, B-220 TRAP 2 B-221 BAROMETRIC PRESSURE 29.25 mm Hg (in. Hg)

PROBE LENGTH 3 (ft) PROBE MATERIAL glass

PROBE HEATER SETTING 150°C DRY GAS METER NO. 32016

METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION

LEAK CHECK: INITIAL 0.09/m FINAL

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l. ft ³	SAMPLE FLOW RATE SETTING lpm	SAMPLE FLOW RATE SETTING cfm	SAMPLE VOLUME METERED ΔV_m ft ³	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1411	73.28	0.1		-	-	-	-
10	1421	74.34	0.1		0.96	-3.0	27 81	20 68
20	1431	75.29	0.1		0.95	-4.0	28 82	20 68
30	1441	76.28	0.1		0.97	0.0	29 84	20 68
40	1451	77.26	0.1		0.98	-1.0	29 84	20 68
50	1501	78.35	0.1		1.09	10.0	30 86	20 68
TOTAL		TOTAL			ΔV_m AVG.	MAX. DEV.	AVG.	MAX. TEMP.
50		4.97			0.99	10.0	29 83	20 68

(%) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ AVG.}}{\Delta V_m \text{ AVG.}} \right] \times 100$ Sample No. _____

VOST DATA FORM

Rm 4B

PLANT NAME MUCC DATE 5-22-86
 SAMPLE LOCATION Stack #8, Incinerator OPERATOR R. Vachert
 SAMPLE NO.: TRAP 1 B-224 TRAP 2 B-225 BAROMETRIC PRESSURE 27.25 mm Hg (in. Hg)
 PROBE LENGTH m (ft) 3 PROBE MATERIAL GLASS
 PROBE HEATER SETTING 150°C DRY GAS METER NO. 32016
 METER CALIBRATION FACTOR (Y) 1.02 SAMPLE POINT LOCATION _____
 LEAK CHECK: INITIAL _____ FINAL _____ REMARKS _____

SAMPLING TIME (min)	CLOCK TIME (24 hr)	SAMPLE VOLUME l. ft	SAMPLE FLOW RATE SETTING lpm cfm	SAMPLE VOLUME MEASURED ΔV_m ft ³	PERCENT DEVIATION %	DRY GAS METER TEMP. °C (°F)	TRAP TEMPERATURE °C (°F)
0	1520	78.59	0.1	—	—	—	—
10	1530	79.57	0.1	0.98	-1.0	29 84	19 66
20	1540	80.55	0.1	0.98	-2.0	27 84	19 66
30	1550	81.54	0.1	0.99	0.0	29 84	18 64
40	1600	82.47	0.1	0.93	+6.0	29 84	18 64
50	1610	83.56	0.1	1.09	+10.0	29 84	19 66
TOTAL		497		4.97 0.994	+10.0	27	19
50				AVG. ΔV_m	MAX. DEV.	AVG.	MAX. TEMP.

(1) Percent deviation (%) = $\left[\frac{\Delta V_m - \Delta V_m \text{ avg.}}{\Delta V_m \text{ avg.}} \right] \times 100$ Sample No. _____

APPENDIX B
CONTINUOUS EMISSIONS MONITORING
CALIBRATION DATA
(CO, O₂, THC)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

SITE: Mess: Metro Plant INITIAL CAL: CAL DRIFT: _____
 LOCATION: St Paul, Minn ZERO SOURCE: Ultrasonic Nz/H₂ Gas
 ANALYZER S/N: AR-411-2339 SPAN GAS BOTTLE S/N: ANL-12064
 RECORDER S/N: GM/EKI-13223 (green pen) ANL-12064
 DATE: 5-10-86 TIME: 0800 ANL-1015

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO	zero	0	0	0	—
~20%	494.2	10.5	525	525	+6.2%
~50%	1003	20.8	1040	1040	+3.7%
~90%	4032	64.0	3200	4150	+2.9%

REMARKS: Analyser response not linear, — see correction curve for correction
from "chart ppm to corrected ppm" (1 SPD = 50 H₂C)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

SITE: INWCC Metro Plant INITIAL CAL: CAL DRIFT: ✓
 LOCATION: St Paul, Minn ZERO SOURCE: Ultra pure N₂
 ANALYZER S/N: 2339 SPAN GAS BOTTLE S/N: ABL 18624
 RECORDER S/N: EFT-13263 (Green par) ABL 12054
 DATE: 5-20-86 TIME: 1230 ABL 1015

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO	250	0	0	0	—
~20%	494.2	11.5	575	515	+16.3%
~50%	1003	22.5	1125	1125	+12.2%
~90%	4032	63.0	3150	4050	+0.4%

REMARKS: Analyzer response not linear, - see correction curve for correction
from "chart ppm" to "corrected ppm" (1 CD = 51 ppm)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

SITE: MCCS Sinter Plant INITIAL CAL: CAL DRIFT: _____
 LOCATION: St Paul Mine ZERO SOURCE: Older Gas N₂ H₂ Tank
 ANALYZER S/N: AR-411-2339 SPAN GAS BOTTLE S/N: ARL-1015
 RECORDER S/N: EKT-1363 (General) ARL-1015
 DATE: 5-21-86 TIME: 0715 ARL-1015

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO	zero	0	0	0	—
~20%	494.2	9.9	495	495	-0.2%
~50%	1003	20.0	1000	1000	-0.3%
~90%	4032	57.2	2860	3600	-10.7%

REMARKS: Analyser response is not linear - see correction curve
(1 CD = 50 ppm)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

SITE: MWDCC - Mirabe Plant
 LOCATION: St Paul, MN
 ANALYZER S/N: AR-411-2339
 RECORDER S/N: ESR-13263 (Green)
 DATE: 5-21-86 TIME: 1707
 INITIAL CAL: CAL DRIFT: ✓
 ZERO SOURCE: OP N₂ - 16.5 liter
 SPAN GAS BOTTLE S/N: VAL-12024
VAL-12021
VAL-12015

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO					
	250	0	0	0	-
~20%	417.2	11	550	550	+ 11.1%
~50%	1003	23	1150	1150	+ 14.7%
~90%	4032	65	3250	4200	+ 4.2%

REMARKS: Analyser response not linear -- see calibration curve
(1 CD = 50 ppm)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

SITE: Inoce Indeo Plant INITIAL CAL: CAL DRIFT: _____
 LOCATION: St Paul, Minn ZERO SOURCE: O₂, N₂, HC Gas
 ANALYZER S/N: AR-411-2339 SPAN GAS BOTTLE S/N: HAL-1205+
 RECORDER S/N: EKT-1303 (green pen) HAL-1205+
 DATE: 0830 TIME: 5:22:86 HAL-1205

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO	250	0	0	0	-
~20%	494.2	10	500	500	+1.2%
~50%	1003	20	1000	1000	-0.2%
~90%	4032	58	2900	3650	-9.5%

REMARKS: Analyzer response not linear - see correction curve
(LED = 50 ppm)

CALIBRATION DATA FOR THE ANARAD MODEL AR-411 CARBON MONOXIDE ANALYZER

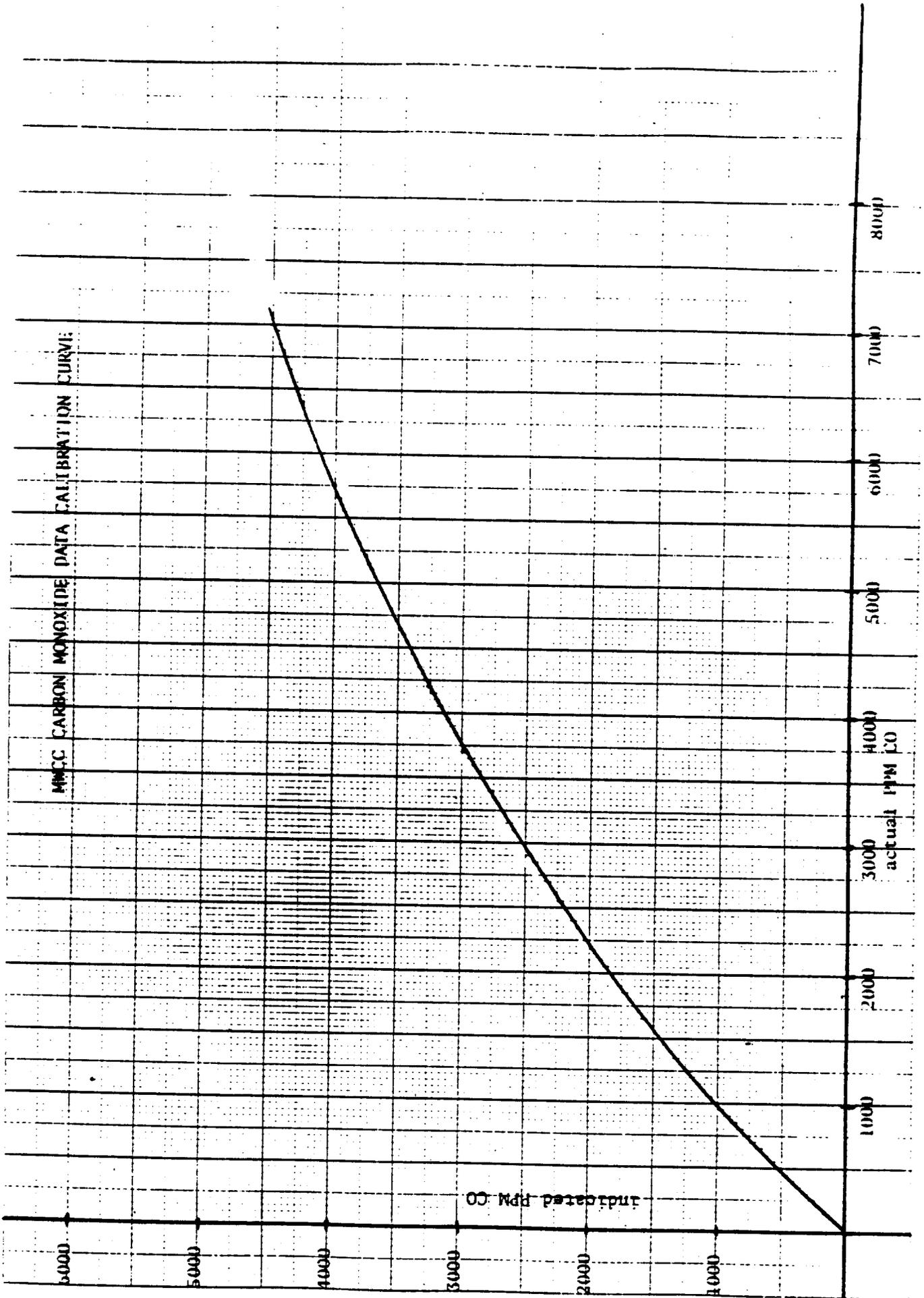
SITE: Indus Motor Plant
 LOCATION: St Paul, Minn
 ANALYZER S/N: AR-411-2339
 RECORDER S/N: EFT-132631 (Green Pen)
 DATE: 5-23-86 TIME: 2025
 INITIAL CAL: CAL DRIFT: ✓
 ZERO SOURCE: OP N₂ - 1K (Green)
 SPAN GAS BOTTLE S/N: APL-1004
APL-1005
APL-1015

	source ppm	chart divisions	chart ppm	corrected ppm	% diff.
ZERO	0				
~20%	2950	1/2	25	-25	-0.5% FS
~50%	414.2	10.0	500	500	+1.2%
~90%	1003	20.5	1025	1025	+2.2%
	4032	60.0	3000	3820	-5.8%

REMARKS: Analyzer response not linear - see construction

(ICD = 50 ppm)

MMCC CARBON MONOXIDE DATA CALIBRATION CURVE



CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: MOORE Industrial Plant INITIAL CAL: CAL DRIFT:
 LOCATION: St Paul, Miss ZERO SOURCE: Of N₂ = HC Flow
 ANALYZER S/N: ERT-628 SPAN GAS BOTTLE S/N: PHL-15055
 RECORDER S/N: ERT-20082 (Propane) PHL-12157
 DATE: 5-10-82 TIME: 0800 PHL-7310

	source ppm	chart divisions (20D effect)	chart ppm	% diff.
ZERO	zero	2.0	0	0
~20%	10.04	11.8	9.8	-2.1%
~50%	50.44	53.0	51.0	+1.1%
~90%	80.12	84.0	82.0	+2.5%

REMARKS: (1 SD = 1 ppm) (Subtract 3 ppm for 20D effect)

CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: INWCC Inshore Plant
 LOCATION: St Paul, Minn
 ANALYZER S/N: ERT-628
 RECORDER S/N: ERT-20082
 DATE: 5-30-86 TIME: 1830

INITIAL CAL: CAL DRIFT: ✓
 ZERO SOURCE: OP N₂ - HS flask
 SPAN GAS BOTTLE S/N: ABL-15359
Propane in N₂ ABL-12153
ABL-1310

	source ppm	chart divisions (2.0 offset)	chart ppm	% diff.
ZERO	zero	2.0	0	-
~20%	10.04	10.1	8.1	-17.3%
~50%	50.44	48.5	46.5	-7.8%
~90%	80.12	78.0	76.0	-5.1%

REMARKS: (1.00 = 1 ppm) = (subtract 2 ppm for 2.00 zero offset)

CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: St. Paul, Minn. INITIAL CAL: CAL DRIFT: _____
 LOCATION: St. Paul, Minn. ZERO SOURCE: of N₂ - H₂CO₂
 ANALYZER S/N: ERT-628 SPAN GAS BOTTLE S/N: 6A2-13361
 RECORDER S/N: ERT-20032 propane in N₂ 6A2-13361
 DATE: 5-24-86 TIME: 0715 6A2-13361

	source ppm	chart divisions (2 divisions)	chart fpm	% diff.
ZERO	ZERO	2.2	0.2	+0.0%
~20%	10.04	12.0	10.0	-0.4%
~50%	50.94	52.2	50.2	-0.5%
~90%	80.12	82.0	80.0	-0.1%

REMARKS: (1 div = 1 fpm) (subtract 2 fpm for zero offset)

CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: Muroc Metho Plant
 LOCATION: St Paul Mine
 ANALYZER S/N: EKT-628
 RECORDER S/N: EKT-20032
 DATE: 5-21-86 TIME: 1645

INITIAL CAL: CAL DRIFT:
 ZERO SOURCE: OP N₂ - HC Gas
 SPAN GAS BOTTLE S/N: EEC-1500351
RAU-12110
RAU-12110

	source ppm	chart divisions	chart ppm	% diff.
ZERO	0	3.5	1.5	+1.5% B
~20%	10.04	11.5	9.5	-5.4%
~50%	50.44	48.5	46.5	-7.8%
~90%	80.12	77.5	75.5	-5.8%

REMARKS: (1 ch = 1 ppm) (subtract 3 ppm for 2 SD zero offset)

CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: M.W.C.C. Metric Plant
 LOCATION: Sta. Road, Minna
 ANALYZER S/N: EKT-628
 RECORDER S/N: EKT-10032
 DATE: 5-22-86 TIME: 0920

INITIAL CAL: CAL DRIFT:
 ZERO SOURCE: UF N₂ - HC filter
 SPAN GAS BOTTLE S/N: HA-15287
 (prepare in N₂) VAL-17181
VAL-17910

	source ppm	chart divisions	chart ppm	% diff.
ZERO	zero	2.0	0	-
~20%	10.04	12.0	10.0	-0.4%
~50%	50.44	53.5	51.5	+2.1%
~90%	80.12	84.0	82.0	+2.3%

REMARKS: (1 cal = 1 ppm) (subtract 2 ppm for zero offset)

CALIBRATION DATA FOR THE BECKMAN 400 TOTAL HYDROCARBON ANALYZER

SITE: Lawrence Medco Plant
 LOCATION: Sa Red, Ind
 ANALYZER S/N: EKT-628
 RECORDER S/N: EKT-20632
 DATE: 5-23-82 TIME: 2015

INITIAL CAL: CAL DRIFT: ✓
 ZERO SOURCE: UF N₂ HC (100)
 SPAN GAS BOTTLE S/N: BAAL-15385
 (propene in N₂) BAAL-12100
BAAL-7110

	source ppm	chart divisions	chart ppm	% diff.
ZERO	zero	2.0	0.0	—
~20%	10.04	12.0	10.0	-0.9%
~50%	50.44	53.0	51.0	+1.1%
~90%	80.12	82.0	80.0	-0.1%

REMARKS: (1 CD = 1 ppm) (subtract 2 ppm for zero offset)

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: Musco Minto Plant DATE: 5/22/83 TIME: 0800
 LOCATION: St Paul, Minn INITIAL CAL: CAL DRIFT:
 ANALYZER S/N: EKI-16855 SPAN CAL SOURCE: Air/O₂ Air
 RECORDER S/N: EKI-13063 - (Real Pen) ZERO CAL SOURCE: O₂ N₂

source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO			
0	1.0	0.25	17.0%
~20% FS	—————		
~50% FS	—————		
~90% FS	89.2	22.3	+6.6%

REMARKS: 1 CD = 0.25% O₂

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: Mudce Medio Plant DATE: 5/20/86 TIME: 1300
 LOCATION: D+ Paul Miller INITIAL CAL: CAL DRIFT:
 ANALYZER S/N: EKT-16255 SPAN CAL SOURCE: Air/Oxygen Mix
 RECORDER S/N: EKT-13203 (Krd Pen) ZERO CAL SOURCE: OP N₂

source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO			
~20% FS	0	0	-
~50% FS			
~90% FS			
	30.9	32.0	30.5 -1.9%

REMARKS: 1 CD = 0.25% O₂

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: Maxx Metric Plant DATE: 5-21-86 TIME: 0712
 LOCATION: On Plant Main INITIAL CAL: CAL DRIFT:
 ANALYZER S/N: EKT-16855 SPAN CAL SOURCE: Highst b.c.
 RECORDER S/N: EKT-13243 (Red Pen) ZERO CAL SOURCE: VS 12

	source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO	29.0	0.3	0.2	+0.8%FS
~20% FS	—————			
~50% FS	—————			
~90% FS	30.9	86.4	21.6	+3.3%

REMARKS: 1 CD = 0.25% O₂

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: Murphy's Metro Plant DATE: 5-21-86 TIME: _____
 LOCATION: On Pool, Midd INITIAL CAL: _____ CAL DRIFT: ✓
 ANALYZER S/N: ERT-16855 SPAN CAL SOURCE: Analyst A
 RECORDER S/N: ERT-13263 (Red Pen) ZERO CAL SOURCE: 100% N₂

source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO	10	10	
~20% FS	20	20	
~50% FS	30	30	
~90% FS	40	40	

NO FINAL
 CALS COMPLETED
 for O₂ on
 5-21-86

REMARKS: _____

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: Source Water Plant DATE: 5-12-86 TIME: 0830
 LOCATION: St Paul, Minn INITIAL CAL: CAL DRIFT:
 ANALYZER S/N: EKI-16855 SPAN CAL SOURCE: Amhval Air
 RECORDER S/N: EKI-13263 (Ksd Per) ZERO CAL SOURCE: OF N₂

source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO			
~20% FS	0	0	—
~50% FS			
~90% FS			
20.9	83.6	20.9	0

REMARKS: (1 Chart Division = 0.25% O₂)

CALIBRATION DATA FOR THE BECKMAN 741 OXYGEN ANALYZER

SITE: MCCOY Motor Plant DATE: 5-2-88 TIME: 2:35
 LOCATION: Sit Pad, Minn INITIAL CAL: CAL DRIFT: ✓
 ANALYZER S/N: EKT-16265 SPAN CAL SOURCE: Airbag + Pin
 RECORDER S/N: EKT-13263 (Red Pen) ZERO CAL SOURCE: OF N₂

	source %O ₂	chart divisions	chart %O ₂	% diff.
ZERO	20.0	0	0	-
~20% FS	—	—	—	—
~50% FS	—	—	—	—
~90% FS	20.9	80.0	20.0	-4.3%

REMARKS: (1'CD = 0.25% O₂)



Scott Specialty Gases

PLUMSTEADVILLE, PA. 18949 PHONE: (215) 766-8861 TWX: 510-665-9344

METRO WASTE CONTROL COMM.
 METRO PLANT
 2400 CHILDS ROAD
 ATTN: JIM BROWN
 ST. PAUL, MN 55106

Date: 5/8/86
 Our Project No.: 917129
 Your P.O. No.: 56310

Gentlemen:

Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl. No. <u>AAL-9864</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Carbon Monoxide	494.2 PPM
Nitrogen	Balance

Cyl. No. <u>AAL-12054</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Carbon Monoxide	1003 PPM
Nitrogen	Balance

Cyl. No. <u>AAL-1015</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Carbon Monoxide	4032 PPM
Nitrogen	Balance

Cyl. No. <u>AAL-15389</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Propane	10.04 PPM
Air	Balance

Analyst *Thomas V. Huber*

Approved By *J. Shapiro*

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

ANALYTICAL REPORT - cont'd

PAGE #2

Date: 5/8/86

Our Project No.: 917189

Your P.O. No.: 56310

Cyl. No. <u>AAL-12959</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Propane	50.44 PPM
Air	Balance

Cyl. No. <u>AAL-7310</u>	Analytical Accuracy <u>+2%</u>
Component	Concentration
Propane	80.12 PPM
Air	Balance

Cyl. No. _____	Analytical Accuracy _____
Component	Concentration

Cyl. No. _____	Analytical Accuracy _____
Component	Concentration

Cyl. No. _____	Analytical Accuracy _____
Component	Concentration

Cyl. No. _____	Analytical Accuracy _____
Component	Concentration

Analyst Thomas W. Hubers

Approved By J. Shapiro

APPENDIX C
CONTINUOUS EMISSIONS MONITORING DATA

Continuous Emissions Monitoring Data Summary

Values listed below are the average of the 3-minute averages for each respective sampling run.

May 20, 1986

Run Time	-	SMM5-1 1245-1630	Run Time	-	MM5-1 1139-1754
<u>CO</u>	=	4445 PPM 4220 PPM ^a	<u>CO</u>	=	4530 PPM 4305 PPM ^a
<u>O₂</u>	=	13.4%	<u>O₂</u>	=	13.1%
<u>THC</u>	=	7.3 PPM ^b	<u>THC</u>	=	7.3 PPM ^b

May 21, 1986

Run Time	-	M5+SMM5-2 0818-1130	Run Time	-	M5+SMM5-3 1309-1630
<u>CO</u>	=	2990 PPM 2830 PPM ^a	<u>CO</u>	=	2400 PPM 2280 PPM ^a
<u>O₂</u>	=	15.2%	<u>O₂</u>	=	11.1%
<u>THC</u>	=	10.4 PPM ^b	<u>THC</u>	=	6.4 PPM ^b

May 22, 1986

Run Time	-	MM5-2A 1139-2100	Run Time	-	MM5-2B 1139-2200
<u>CO</u>	=	2705 PPM 2560 PPM ^a	<u>CO</u>	=	2700 PPM 2555 PPM ^a
<u>O₂</u>	=	9.3%	<u>O₂</u>	=	9.3%
<u>THC</u>	=	11.1 PPM ^b	<u>THC</u>	=	11.0 PPM ^b

Note: a. Corrected for volume of CO₂ removed from sample as determined by ORSAT Analysis.
b. Value reported as propane.

MWCC CARBON MONOXIDE DATA
 DATE: MAY 20, 1986

TIME	PPM CO								
900	2750	1100	2300	1300	3850	1500	4550	1700	4750
903	2750	1103	-	1303	3850	1503	4550	1703	4750
906	2750	1106	-	1306	3800	1506	4550	1706	4750
909	2450	1109	-	1309	3800	1509	4550	1709	4750
912	2450	1112	-	1312	3800	1512	4550	1712	4750
915	2450	1115	2850	1315	3800	1515	4550	1715	4750
918	2450	1118	2850	1318	3700	1518	4550	1718	4750
921	2600	1121	2900	1321	3800	1521	4550	1721	4750
924	2600	1124	2900	1324	3700	1524	4550	1724	4750
927	2600	1127	3250	1327	3700	1527	4650	1727	4750
930	2600	1130	3250	1330	3800	1530	4650	1730	5450
933	2600	1133	3550	1333	3800	1533	5450	1733	5300
936	2650	1136	3550	1336	3800	1536	5900	1736	5300
939	2600	1139	3500	1339	3800	1539	6550	1739	5750
942	2600	1142	-	1342	3800	1542	6450	1742	5750
945	2500	1145	-	1345	3850	1545	5900	1745	5750
948	2650	1148	-	1348	3850	1548	5900	1748	5750
951	2650	1151	-	1351	3850	1551	5300	1751	5300
954	2400	1154	3850	1354	3850	1554	5300	1754	5200
957	2300	1157	4250	1357	3850	1557	5300	1757	4550
1000	2400	1200	4250	1400	3850	1600	5300	1800	4550
1003	2300	1203	4250	1403	3950	1603	5300	1803	4550
1006	2300	1206	4350	1406	3950	1606	5450	1806	4550
1009	2300	1209	4350	1409	3550	1609	5300	1809	4550
1012	2300	1212	4250	1412	3800	1612	5300	1812	4550
1015	2300	1215	4350	1415	3950	1615	5450		
1018	2300	1218	4350	1418	3550	1618	4750		
1021	2250	1221	4350	1421	3850	1621	5300		
1024	2250	1224	4350	1424	3850	1624	4750		
1027	2250	1227	3850	1427	4250	1627	5300		
1030	2250	1230	3850	1430	4250	1630	5300		
1033	2250	1233	4350	1433	4250	1633	4750		
1036	2250	1236	4350	1436	4250	1636	4650		
1039	2250	1239	3850	1439	4250	1639	4750		
1042	2600	1242	4350	1442	4250	1642	4750		
1045	2600	1245	4250	1445	4250	1645	4750		
1048	2600	1248	3850	1448	4250	1648	4750		
1051	2250	1251	4250	1451	4150	1651	4750		
1054	1950	1254	4250	1454	4550	1654	4750		
1057	1950	1257	3850	1457	4550	1657	4750		

AVERAGE CO VALUE FOR: RUN #: SMMS-1
 DATE: 5-20-86
 START: 1245
 END: 1630

AVERAGE CO VALUE FOR: RUN #: MM5-1
 DATE: 5-20-86
 START: 1139
 END: 1754

AVERAGE ANALYZER
 RESPONSE: 4445 PPM

AVERAGE ANALYZER
 RESPONSE: 4530 PPM

ACTUAL AVERAGE
 CO VALUE (*): 4220 PPM

ACTUAL AVERAGE
 CO VALUE (*): 4305 PPM

(*) CORRECTED FOR THE VOLUME OF CO2 REMOVED FROM SAMPLE AS DETERMINED BY ORSAT ANALYSIS

MWCC CARBON MONOXIDE DATA
 DATE: MAY 21, 1986

TIME	PPM CO								
		1000	3250	1200	2900	1400	2600	1600	1600
		1003	3150	1203	2900	1403	2600	1603	1600
		1006	3250	1206	2900	1406	2600	1606	1600
		1009	2900	1209	3300	1409	2300	1609	1600
		1012	2900	1212	3300	1412	2300	1612	1600
		1015	2900	1215	3700	1415	2300	1615	1650
		1018	2900	1218	3700	1418	2300	1618	1650
		1021	2900	1221	3700	1421	1950	1621	1650
824	1700	1024	2900	1224	3700	1424	1950	1624	1650
827	2250	1027	2950	1227	4050	1427	1950	1627	1950
830	2600	1030	2900	1230	4050	1430	1950	1630	2050
833	2850	1033	2650	1233	4050	1433	1950	1633	1950
836	2850	1036	2650	1236	4050	1436	1950	1636	1950
839	2850	1039	2950	1239	4550	1439	1950	1639	1950
842	2900	1042	2950	1242	4650	1442	1950	1642	1950
845	2900	1045	2950	1245	4550	1445	1950	1645	2250
848	2900	1048	2950	1248	4050	1448	2300	1648	2250
851	2900	1051	3300	1251	4550	1451	2300	1651	2250
854	2900	1054	2950	1254	4450	1454	2250	1654	2250
857	2900	1057	3250	1257	4450	1457	2250	1657	2250
900	2900	1100	2850	1300	4450	1500	2250	1700	2250
903	2950	1103	3250	1303	4450	1503	2250	1703	2850
906	2900	1106	2850	1306	4350	1506	2250	1706	2500
909	2900	1109	2850	1309	4350	1509	2250		
912	2850	1112	3150	1312	4350	1512	2200		
915	3250	1115	3850	1315	3950	1515	1900		
918	3250	1118	3150	1318	4450	1518	1900		
921	3250	1121	2750	1321	4450	1521	1900		
924	3250	1124	2750	1324	4450	1524	1900		
927	3250	1127	2750	1327	4450	1527	1900		
930	3150	1130	2750	1330	4450	1530	1900		
933	3150	1133	2750	1333	3950	1533	1850		
936	3150	1136	2450	1336	3950	1536	1850		
939	3250	1139	2750	1339	2900	1539	1850		
942	3250	1142	2750	1342	2600	1542	1850		
945	3250	1145	2500	1345	2600	1545	1850		
948	3250	1148	2450	1348	2600	1548	1850		
951	3250	1151	2500	1351	2600	1551	1850		
954	3250	1154	2600	1354	2600	1554	1850		
957	3250	1157	2850	1357	2900	1557	1850		

AVERAGE CO VALUE FOR: RUN #: M5+SMMS-2
 DATE: 5-21-86
 START: 0818
 END: 1130

AVERAGE CO VALUE FOR: RUN #: M5+SMMS-3
 DATE: 5-21-86
 START: 1309
 END: 1630

AVERAGE ANALYZER RESPONSE: 2990 PPM

 ACTUAL AVERAGE CO VALUE (*): 2830 PPM

AVERAGE ANALYZER RESPONSE: 2400 PPM

 ACTUAL AVERAGE CO VALUE (*): 2280 PPM

(*) CORRECTED FOR THE VOLUME OF CO2 REMOVED FROM SAMPLE AS DETERMINED BY ORSAT ANALYSIS

MWCC CARBON MONOXIDE DATA
DATE: MAY 22, 1986

TIME	PPM CO								
1000	1200	1200	3800	1400	2300	1600	-	1800	2300
1003	1150	1203	4050	1403	2200	1603	-	1803	2650
1006	1100	1206	4050	1406	2200	1606	1700	1806	3250
1009	1050	1209	4050	1409	2200	1609	1750	1809	4350
1012	1000	1212	4150	1412	2100	1612	1900	1812	3400
1015	1000	1215	4150	1415	2100	1615	1850	1815	4350
1018	950	1218	4250	1418	2200	1618	1900	1818	4450
1021	950	1221	4250	1421	2200	1621	1950	1821	3600
1024	900	1224	4050	1424	2200	1624	1950	1824	2850
1027	900	1227	4250	1427	2200	1627	2200	1827	2900
1030	850	1230	4050	1430	2200	1630	2250	1830	3300
1033	1750	1233	4250	1433	2200	1633	2250	1833	3850
1036	1950	1236	4250	1436	2100	1636	2050	1836	4350
1039	1500	1239	4350	1439	2050	1639	1950	1839	4350
1042	1250	1242	4350	1442	2050	1642	1750	1842	3550
1045	1200	1245	4450	1445	2050	1645	1750	1845	3150
1048	1650	1248	4450	1448	2100	1648	1750	1848	3250
1051	2450	1251	4450	1451	2100	1651	2100	1851	4050
1054	2500	1254	4550	1454	2200	1654	2900	1854	3500
1057	2300	1257	4550	1457	2100	1657	2600	1857	2450
1100	2300	1300	4550	1500	2200	1700	3050	1900	2600
1103	2500	1303	4550	1503	2050	1703	3800	1903	3300
1106	2950	1306	4650	1506	2600	1706	3050	1906	3150
1109	3250	1309	4650	1509	2400	1709	3150	1909	2300
1112	3300	1312	4450	1512	2450	1712	3250	1912	2100
1115	3300	1315	3550	1515	3050	1715	2300	1915	1950
1118	3500	1318	3050	1518	2750	1718	2100	1918	1900
1121	3700	1321	2750	1521	2300	1721	2050	1921	1850
1124	3800	1324	3550	1524	2100	1724	2250	1924	1850
1127	3600	1327	4350	1527	2100	1727	2200	1927	1750
1130	3550	1330	2750	1530	2100	1730	3050	1930	1700
1133	3800	1333	2750	1533	2050	1733	4150	1933	1700
1136	3800	1336	2950	1536	2250	1736	2850	1936	1700
1139	3950	1339	2400	1539	2050	1739	2300	1939	1750
1142	3850	1342	2750	1542	1950	1742	2900	1942	1750
1145	3800	1345	4150	1545	1950	1745	2450	1945	1850
1148	3700	1348	3850	1548	1850	1748	2050	1948	1850
1151	3600	1351	2750	1551	1750	1751	2200	1951	1750
1154	3700	1354	2500	1554	-	1754	2200	1954	1750
1157	3700	1357	2400	1557	-	1757	2200	1957	1750

AVERAGE CO VALUE FOR: RUN #: MM5-2A
DATE: 5-22-86
START: 1139
END: 2100

AVERAGE CO VALUE FOR: RUN #: MM5-2B
DATE: 5-22-86
START: 1139
END: 2200

AVERAGE ANALYZER
RESPONSE: 2705 PPM

AVERAGE ANALYZER
RESPONSE: 2700 PPM

ACTUAL AVERAGE
CO VALUE (*): 2560 PPM

ACTUAL AVERAGE
CO VALUE (*): 2555 PPM

(*) CORRECTED FOR THE VOLUME OF CO2 REMOVED FROM SAMPLE AS DETERMINED BY ORSAT ANALYSIS

MWCC CARBON MONOXIDE DATA
DATE: MAY 22, 1986
(CONTINUED)

TIME	PPM CO
2000	1750
2003	1700
2006	1650
2009	1650
2012	1600
2015	1600
2018	1550
2021	1550
2024	1550
2027	1600
2030	1600
2033	1550
2036	1550
2039	1550
2042	1600
2045	1600
2048	1600
2051	1600
2054	1600
2057	1650
2100	1650
2103	1700

MWCC TOTAL HYDROCARBON DATA
 DATE: MAY 20, 1986

TIME	PPM THC								
900	6	1100	6	1300	7	1500	10	1700	7
903	6	1103	6	1303	6	1503	7	1703	8
906	6	1106	-	1306	6	1506	6	1706	6
909	6	1109	-	1309	7	1509	6	1709	6
912	6	1112	-	1312	7	1512	6	1712	6
915	6	1115	6	1315	7	1515	6	1715	6
918	6	1118	6	1318	7	1518	6	1718	6
921	6	1121	6	1321	6	1521	6	1721	7
924	6	1124	6	1324	6	1524	7	1724	6
927	6	1127	6	1327	6	1527	10	1727	6
930	7	1130	7	1330	6	1530	6	1730	6
933	6	1133	6	1333	7	1533	9	1733	10
936	6	1136	6	1336	6	1536	10	1736	10
939	6	1139	6	1339	6	1539	10	1739	10
942	6	1142	6	1342	7	1542	10	1742	10
945	5	1145	7	1345	7	1545	11	1745	9
948	6	1148	7	1348	6	1548	10	1748	10
951	6	1151	7	1351	6	1551	10	1751	10
954	7	1154	6	1354	6	1554	10	1754	10
957	7	1157	7	1357	6	1557	10	1757	10
1000	2	1200	7	1400	6	1600	10	1800	10
1003	6	1203	10	1403	7	1603	11	1803	10
1006	2	1206	6	1406	7	1606	10	1806	6
1009	2	1209	6	1409	6	1609	10		
1012	6	1212	6	1412	6	1612	10		
1015	6	1215	6	1415	6	1615	10		
1018	6	1218	6	1418	6	1618	9		
1021	6	1221	6	1421	6	1621	7		
1024	6	1224	7	1424	6	1624	6		
1027	6	1227	7	1427	6	1627	6		
1030	6	1230	7	1430	6	1630	10		
1033	6	1233	7	1433	7	1633	10		
1036	6	1236	6	1436	6	1636	7		
1039	6	1239	6	1439	6	1639	6		
1042	7	1242	6	1442	5	1642	11		
1045	6	1245	6	1445	6	1645	10		
1048	6	1248	6	1448	6	1648	10		
1051	6	1251	7	1451	6	1651	7		
1054	2	1254	10	1454	6	1654	6		
1057	6	1257	7	1457	6	1657	6		

AVERAGE THC VALUE FOR: RUN #: SMM5-1
 DATE : 5-20-86
 START: 1245
 END : 1630

AVERAGE THC (AS PROPANE): 7.3 PPM

AVERAGE THC VALUE FOR: RUN #: MMS-
 DATE: 5-20-
 START: 1139
 END: 1754

AVERAGE THC (AS PROPANE): 7.3 PPM

MWCC TOTAL HYDROCARBON DATA
 DATE: MAY 21, 1986

TIME	PPM THC								
800	10	1000	10	1200	10	1400	6	1600	6
803	10	1003	10	1203	10	1403	7	1603	6
806	7	1006	15	1206	10	1406	7	1606	6
809	10	1009	12	1209	11	1409	6	1609	6
812	10	1012	10	1212	11	1412	6	1612	6
815	10	1015	10	1215	11	1415	6	1615	6
818	10	1018	11	1218	11	1418	6	1618	6
821	10	1021	10	1221	11	1421	6	1621	6
824	10	1024	10	1224	10	1424	6	1624	6
827	10	1027	10	1227	15	1427	6	1627	6
830	10	1030	11	1230	19	1430	6	1630	7
833	10	1033	10	1233	15	1433	6		
836	11	1036	11	1236	24	1436	6		
839	10	1039	11	1239	24	1439	6		
842	10	1042	11	1242	24	1442	6		
845	11	1045	11	1245	24	1445	6		
848	11	1048	13	1248	19	1448	6		
851	11	1051	-	1251	15	1451	6		
854	10	1054	11	1254	14	1454	6		
857	11	1057	10	1257	15	1457	6		
900	10	1100	10	1300	15	1500	6		
903	10	1103	10	1303	15	1503	6		
906	10	1106	10	1306	15	1506	7		
909	10	1109	9	1309	15	1509	7		
912	10	1112	9	1312	11	1512	6		
915	10	1115	10	1315	11	1515	6		
918	11	1118	14	1318	7	1518	6		
921	10	1121	11	1321	7	1521	7		
924	10	1124	12	1324	7	1524	6		
927	11	1127	-	1327	7	1527	6		
930	11	1130	-	1330	7	1530	6		
933	11	1133	7	1333	6	1533	6		
936	11	1136	10	1336	6	1536	6		
939	11	1139	11	1339	6	1539	6		
942	9	1142	7	1342	6	1542	6		
945	11	1145	10	1345	6	1545	6		
948	10	1148	10	1348	6	1548	6		
951	11	1151	10	1351	6	1551	6		
954	11	1154	10	1354	6	1554	6		
957	11	1157	10	1357	6	1557	6		

AVERAGE THC VALUE FOR: RUN #: M5+SMM5-2
 DATE : 5-21-86
 START: 0818
 END : 1130

AVERAGE THC VALUE FOR: RUN #: M5+
 DATE: 5-21-
 START: 1309
 END: 1630

AVERAGE THC (AS PROPANE): 10.4 PPM

AVERAGE THC (AS PROPANE): 6.4 PPM

MWCC TOTAL HYDROCARBON DATA
 DATE: MAY 22, 1986

TIME	PPM THC								
1000	24	1200	15	1400	11	1600	6	1800	10
1003	24	1203	15	1403	7	1603	6	1803	10
1006	24	1206	24	1406	7	1606	6	1806	10
1009	-	1209	20	1409	6	1609	6	1809	15
1012	-	1212	19	1412	6	1612	6	1812	19
1015	-	1215	19	1415	6	1615	6	1815	15
1018	-	1218	19	1418	6	1618	6	1818	24
1021	-	1221	19	1421	10	1621	6	1821	19
1024	-	1224	24	1424	7	1624	6	1824	15
1027	-	1227	19	1427	6	1627	7	1827	10
1030	19	1230	19	1430	6	1630	10	1830	10
1033	19	1233	19	1433	11	1633	10	1833	15
1036	20	1236	24	1436	6	1636	7	1836	15
1039	10	1239	24	1439	10	1639	7	1839	19
1042	7	1242	24	1442	7	1642	6	1842	19
1045	6	1245	24	1445	7	1645	6	1845	15
1048	6	1248	24	1448	6	1648	6	1848	11
1051	6	1251	24	1451	6	1651	6	1851	15
1054	6	1254	24	1454	10	1654	10	1854	20
1057	6	1257	30	1457	11	1657	7	1857	11
1100	11	1300	24	1500	6	1700	10	1900	10
1103	11	1303	30	1503	6	1703	11	1903	11
1106	15	1306	30	1506	11	1706	15	1906	15
1109	15	1309	24	1509	10	1709	10	1909	11
1112	19	1312	20	1512	6	1712	10	1912	10
1115	19	1315	15	1515	11	1715	10	1915	7
1118	19	1318	10	1518	10	1718	10	1918	6
1121	19	1321	10	1521	10	1721	10	1921	6
1124	24	1324	10	1524	6	1724	10	1924	6
1127	24	1327	19	1527	6	1727	10	1927	6
1130	19	1330	15	1530	6	1730	10	1930	6
1133	24	1333	10	1533	6	1733	15	1933	6
1136	24	1336	11	1536	7	1736	15	1936	6
1139	24	1339	11	1539	6	1739	10	1939	6
1142	20	1342	10	1542	6	1742	11	1942	6
1145	20	1345	15	1545	6	1745	11	1945	6
1148	15	1348	20	1548	6	1748	11	1948	6
1151	15	1351	11	1551	6	1751	11	1951	6
1154	15	1354	10	1554	6	1754	10	1954	6
1157	15	1357	11	1557	6	1757	7	1957	6

AVERAGE THC VALUE FOR: RUN #: MM5-2A
 DATE : 5-22-86
 START: 1139
 END : 2100

AVERAGE THC VALUE FOR: RUN #: MM5
 DATE: 5-22
 START: 1139
 END: 2200

AVERAGE THC (AS PROPANE): 11.1 PPM

AVERAGE THC (AS PROPANE): 11.0 PPM

MWCC TOTAL HYDROCARBON DATA
DATE: MAY 22, 1986
(CONTINUED)

TIME	PPM THC
2000	6
2003	6
2006	6
2009	6
2012	6
2015	6
2018	7
2021	6
2024	6
2027	6
2030	6
2033	6
2036	6
2039	6
2042	6
2045	6
2048	6
2051	6
2054	6
2057	6
2100	6
2103	6
2106	6
2109	6
2112	7
2115	7

MWCC PERCENT OXYGEN DATA
 DATE: MAY 20, 1986

TIME	%O2								
900	15.8	1100	14.3	1300	14.5	1500	13.0	1700	11.3
903	15.8	1103	-	1303	14.5	1503	13.0	1703	11.5
906	15.8	1106	-	1306	14.5	1506	13.0	1706	11.3
909	15.8	1109	-	1309	14.3	1509	12.8	1709	11.3
912	15.8	1112	-	1312	14.3	1512	13.0	1712	11.3
915	15.8	1115	12.3	1315	14.3	1515	13.0	1715	11.3
918	15.8	1118	13.5	1318	14.3	1518	13.0	1718	11.3
921	16.0	1121	14.3	1321	14.3	1521	11.8	1721	11.3
924	16.0	1124	14.8	1324	14.3	1524	12.0	1724	12.5
927	16.0	1127	14.8	1327	14.3	1527	12.0	1727	11.5
930	16.0	1130	14.8	1330	14.3	1530	12.0	1730	12.3
933	15.8	1133	14.8	1333	14.3	1533	12.5	1733	11.3
936	16.3	1136	14.5	1336	14.3	1536	12.5	1736	11.3
939	16.0	1139	14.5	1339	14.3	1539	12.5	1739	11.3
942	16.3	1142	-	1342	14.3	1542	12.5	1742	11.3
945	15.5	1145	-	1345	14.5	1545	12.5	1745	11.0
948	15.5	1148	-	1348	14.5	1548	12.5	1748	11.0
951	14.5	1151	-	1351	14.8	1551	12.3	1751	11.0
954	14.5	1154	12.5	1354	14.8	1554	12.3	1754	11.0
957	14.3	1157	13.3	1357	14.8	1557	12.3	1757	10.8
1000	14.3	1200	13.3	1400	14.8	1600	12.3	1800	9.8
1003	14.3	1203	14.5	1403	14.8	1603	12.3	1803	9.8
1006	14.3	1206	14.5	1406	14.8	1606	12.3	1806	9.8
1009	14.3	1209	14.5	1409	14.5	1609	12.3	1809	9.8
1012	14.3	1212	14.5	1412	14.8	1612	12.3	1812	9.8
1015	14.3	1215	14.5	1415	14.8	1615	12.3		
1018	14.3	1218	14.8	1418	14.8	1618	12.3		
1021	14.0	1221	14.5	1421	14.5	1621	12.3		
1024	14.0	1224	14.8	1424	14.5	1624	12.3		
1027	14.0	1227	14.5	1427	13.3	1627	12.3		
1030	14.0	1230	14.8	1430	13.3	1630	12.3		
1033	14.0	1233	14.5	1433	13.3	1633	12.3		
1036	14.0	1236	14.8	1436	13.3	1636	12.3		
1039	14.0	1239	14.8	1439	13.3	1639	12.3		
1042	15.3	1242	14.5	1442	13.3	1642	11.3		
1045	15.3	1245	14.5	1445	13.3	1645	11.3		
1048	15.3	1248	14.5	1448	13.0	1648	11.3		
1051	15.3	1251	14.5	1451	13.0	1651	11.3		
1054	14.3	1254	14.5	1454	13.0	1654	11.3		
1057	14.3	1257	14.5	1457	13.0	1657	11.3		

AVERAGE O2 VALUE FOR: RUN #: SMMS-1
 DATE :5-20-86
 START:1245
 END :1630

AVERAGE O2 VALUE FOR: RUN #: MMS-1
 DATE:5-20-86
 START:1139
 END:1754

AVERAGE PERCENT O2: 13.4 %

AVERAGE PERCENT O2: 13.1 %

MWCC PERCENT OXYGEN DATA
 DATE: MAY 21, 1986

TIME	%O2								
		1000	15.5	1200	14.3	1400	12.0	1600	9.5
		1003	15.3	1203	14.5	1403	12.0	1603	9.5
		1006	15.3	1206	14.5	1406	12.0	1606	9.8
		1009	15.5	1209	14.5	1409	12.0	1609	9.8
		1012	15.5	1212	14.5	1412	12.0	1612	9.8
		1015	15.5	1215	14.5	1415	12.0	1615	9.8
		1018	15.5	1218	14.5	1418	12.0	1618	9.8
		1021	15.5	1221	14.5	1421	12.0	1621	9.8
824	13.0	1024	15.5	1224	14.8	1424	12.0	1624	11.0
827	14.3	1027	15.5	1227	14.5	1427	11.0	1627	11.0
830	14.3	1030	15.5	1230	14.8	1430	12.0	1630	11.0
833	14.3	1033	15.5	1233	14.8	1433	11.0	1633	11.0
836	14.3	1036	15.8	1236	14.8	1436	11.0	1636	11.0
839	14.3	1039	15.8	1239	14.5	1439	11.0	1639	11.0
842	15.3	1042	15.8	1242	14.5	1442	11.0	1642	11.0
845	15.3	1045	15.8	1245	14.5	1445	11.0	1645	11.0
848	15.5	1048	15.8	1248	14.5	1448	11.0	1648	11.0
851	15.5	1051	15.8	1251	14.5	1451	11.0	1651	11.0
854	15.5	1054	15.8	1254	14.3	1454	11.0	1654	11.0
857	15.5	1057	15.5	1257	14.3	1457	11.0	1657	11.0
900	15.5	1100	15.3	1300	14.3	1500	11.0	1700	11.0
903	15.5	1103	15.3	1303	14.0	1503	10.8	1703	12.0
906	16.0	1106	15.3	1306	14.0	1506	10.8	1706	12.0
909	15.5	1109	14.0	1309	14.0	1509	10.8		
912	15.5	1112	14.0	1312	12.8	1512	10.8		
915	15.3	1115	15.0	1315	13.0	1515	9.5		
918	15.3	1118	15.0	1318	13.0	1518	9.5		
921	15.3	1121	13.8	1321	13.0	1521	9.5		
924	15.3	1124	13.8	1324	13.0	1524	9.5		
927	15.3	1127	13.8	1327	13.0	1527	10.5		
930	15.3	1130	13.8	1330	13.0	1530	9.5		
933	15.0	1133	14.0	1333	13.0	1533	10.5		
936	15.0	1136	14.0	1336	13.0	1536	10.5		
939	15.3	1139	13.8	1339	11.8	1539	9.5		
942	15.3	1142	14.0	1342	13.0	1542	9.5		
945	15.3	1145	14.0	1345	13.0	1545	9.5		
948	15.3	1148	14.0	1348	12.0	1548	9.5		
951	15.3	1151	14.0	1351	12.0	1551	9.5		
954	15.3	1154	14.3	1354	12.0	1554	9.5		
957	15.3	1157	14.3	1357	12.0	1557	9.5		

AVERAGE O2 VALUE FOR: RUN #: M5+SMM5-2
 DATE : 5-21-86
 START: 0818
 END : 1130

AVERAGE O2 VALUE FOR: RUN #: M5+SMM5-
 DATE: 5-21-86
 START: 1309
 END: 1630

AVERAGE PERCENT O2: 15.2 %

AVERAGE PERCENT O2: 11.1 %

MWCC PERCENT OXYGEN DATA
 DATE: MAY 22, 1986

TIME	%O2								
1000	15.3	1200	9.5	1400	9.5	1600	8.3	1800	9.8
1003	15.3	1203	9.5	1403	9.5	1603	8.3	1803	9.8
1006	15.3	1206	9.5	1406	9.5	1606	8.3	1806	9.8
1009	15.3	1209	9.5	1409	9.5	1609	8.3	1809	11.0
1012	15.3	1212	9.5	1412	9.5	1612	8.3	1812	9.8
1015	15.3	1215	9.3	1415	9.5	1615	8.3	1815	9.8
1018	15.3	1218	9.3	1418	9.8	1618	8.3	1818	11.0
1021	15.3	1221	9.3	1421	9.8	1621	8.5	1821	9.8
1024	15.3	1224	9.3	1424	9.8	1624	8.5	1824	9.8
1027	15.3	1227	9.3	1427	9.8	1627	8.5	1827	10.0
1030	15.3	1230	9.3	1430	9.8	1630	8.5	1830	9.8
1033	14.3	1233	9.5	1433	9.8	1633	8.5	1833	9.8
1036	11.0	1236	9.5	1436	9.8	1636	8.8	1836	9.8
1039	10.0	1239	9.5	1439	9.8	1639	8.8	1839	10.8
1042	10.0	1242	9.5	1442	9.8	1642	8.5	1842	9.8
1045	10.0	1245	9.8	1445	10.0	1645	8.8	1845	9.8
1048	11.0	1248	9.8	1448	10.0	1648	8.8	1848	9.8
1051	11.3	1251	9.8	1451	9.0	1651	8.8	1851	9.5
1054	11.3	1254	9.8	1454	10.0	1654	10.0	1854	9.5
1057	10.0	1257	10.0	1457	9.0	1657	9.0	1857	9.5
1100	10.3	1300	10.0	1500	8.8	1700	8.8	1900	9.3
1103	10.3	1303	10.0	1503	8.8	1703	10.0	1903	9.3
1106	11.3	1306	10.3	1506	8.8	1706	10.0	1906	9.3
1109	10.3	1309	10.3	1509	8.8	1709	10.0	1909	9.3
1112	11.3	1312	9.8	1512	8.8	1712	10.0	1912	8.0
1115	10.3	1315	8.5	1515	9.8	1715	10.0	1915	8.0
1118	10.3	1318	9.8	1518	8.5	1718	8.5	1918	8.0
1121	10.3	1321	9.8	1521	8.5	1721	9.8	1921	8.0
1124	11.3	1324	9.5	1524	8.5	1724	8.5	1924	9.3
1127	10.0	1327	9.8	1527	8.5	1727	9.8	1927	9.3
1130	10.0	1330	8.5	1530	8.5	1730	8.5	1930	9.3
1133	10.0	1333	8.3	1533	8.3	1733	9.5	1933	9.3
1136	10.0	1336	9.5	1536	8.3	1736	9.5	1936	9.3
1139	10.0	1339	8.3	1539	8.3	1739	9.5	1939	9.5
1142	10.0	1342	9.5	1542	8.3	1742	9.5	1942	9.5
1145	9.8	1345	9.5	1545	8.3	1745	9.3	1945	9.8
1148	9.8	1348	9.5	1548	8.3	1748	8.0	1948	9.8
1151	9.8	1351	8.5	1551	8.0	1751	9.3	1951	9.5
1154	9.8	1354	8.3	1554	8.0	1754	9.3	1954	9.5
1157	9.8	1357	8.5	1557	8.3	1757	9.8	1957	9.5

AVERAGE O2 VALUE FOR: RUN #: MM5-2A
 DATE :5-22-86
 START:1139
 END :2100

AVERAGE O2 VALUE FOR: RUN #: MM5-2B
 DATE:5-20-86
 START:1139
 END:2200

AVERAGE PERCENT O2: 9.3 %

AVERAGE PERCENT O2: 9.3 %

MWCC PERCENT OXYGEN DATA
DATE: MAY 22, 1986
(CONTINUED)

TIME	%O2
2000	9.8
2003	9.5
2006	9.5
2009	9.8
2012	9.5
2015	9.5
2018	9.8
2021	9.8
2024	9.5
2027	9.5
2030	9.8
2033	9.5
2036	9.8
2039	9.5
2042	9.5
2045	9.8
2048	9.8
2051	9.5
2054	9.8
2057	9.8
2100	9.8
2103	9.8

APPENDIX D
CHAIN OF CUSTODY RECORDS

CHAIN OF CUSTODY RECORD

Client/Project Name Mableton Fenie		Project Location Mableton Fenie, St. Paul, Minnesota		ANALYSES		
Project No. E081		Field Logbook No.				
Sampler: P. Packard		Chain of Custody Title No.				
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS	
1-S005-PH	5-20			1st Blank	1st Blank - 1/1, 5	
2-S005-PH	5-21			2nd Blank	SCOURALATILES	
3-S005-PH	5-21			3rd Blank		
4-S005-1st Blank	5-20			1st Blank		
2-S005-2nd Blank	5-21			2nd Blank		
2-S005-3rd Blank	5-21			3rd Blank		
2-S005-4th Blank	5-21			4th Blank		
4-S005-1st Blank	5-20			1st Blank		
Relinquished by: (Signature) <i>Packard</i>		Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)		5-21	12:05			
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)						
Relinquished by: (Signature)		Date	Time	Received for Laboratory: (Signature)	Date	Time
Relinquished by: (Signature)				<i>M. J. ...</i>	5-21	10:15
Sample Disposal Method:		Disposed of by: (Signature)		Date	Time	
SAMPLE COLLECTOR		ANALYTICAL LABORATORY				No 5846
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910						

CHAIN OF CUSTODY RECORD

Client/Project Name Makono Prairie		Project Location MNCL-10000, Seward, Minnesota			
Project No. E081		Field Logbook No.			
Sample: (Signature) <i>[Signature]</i>		Chain of Custody Tape No.			
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
1-SM05-FB-0177	5/17/84			Sewer Filter Block	
1-SM05-FB-0178	5/17/84			Sewer Filter Block, Run 1	
2-SM05-FB-0175	5/17/84			Sewer Filter Block, Run 2	
3-SM05-FB-0176	5/17/84			Sewer Filter Block, Run 3	
4-SM05-FB-0179	5/17/84			Sewer Filter Block, Run 4	
1-MS-FB-0173	5/17/84			Sanitary Filter Block, Run 1	
2-MS-FB-0174	5/17/84			Sanitary Filter Block, Run 2	
3-MS-FB-0175	5/17/84			Sanitary Filter Block, Run 3	
Relinquished by: (Signature) <i>[Signature]</i>		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		Date	Time	Received for Laboratory: (Signature) <i>[Signature]</i>	
Sample Disposal Method:		Disposed of by: (Signature)		Date	Time
SAMPLE COLLECTOR		ANALYTICAL LABORATORY		ERT	
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910				No 5845	

CHAIN OF CUSTODY RECORD

Client/Project Name Malcolm Pirnie		Project Location Well, St. Paul, Minnesota		ANALYSES			
Project No. E081		Field Logbook No.					
Sampler (Signature) <i>[Signature]</i>		Chain of Custody Tape No.					
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS	Date	Time
1-SM-5-CD	5/2/05			Seawater	54 ml	5/2/05	10:00
1-SM-5-Tap	5/2/05			Tap 2+3 catch	170 ml	5/2/05	10:00
2-SM-5-CL	5/2/05			Seawater		5/2/05	10:00
3-SM-5-DM	5/2/05			Tap 2+3 catch		5/2/05	10:00
3-SM-5-CD	5/2/05			Seawater		5/2/05	10:00
3-SM-5-Tap	5/2/05			Tap 2+3 catch		5/2/05	10:00
1-SM-5-FNB	5/2/05			Final Half Blank		5/2/05	10:00
1-NS-FNB	5/2/05			Final Half Blank		5/2/05	10:00
Relinquished by: (Signature) <i>[Signature]</i>		Date		Time		Received by: (Signature)	
Relinquished by: (Signature)		Date		Time		Received by: (Signature)	
Relinquished by: (Signature)		Date		Time		Received for Laboratory: (Signature) <i>[Signature]</i>	
Sample Disposal Method:		Date		Time		Disposed of by: (Signature)	
SAMPLE COLLECTOR				ANALYTICAL LABORATORY			
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910				ERT			
				No 5844			

CHAIN OF CUSTODY RECORD

Client/Project Name: **MALDEN FIRE** Project Location: **1000-1000 St. Paul, Minnesota**

Project No.: **E081** Field Logbook No.:

Sampler: (Signature) *G. Jacobson* Chain of Custody Tape No.:

Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
1-5005-XR-510					
1-5005-XR-511					
2-5005-XR-52					
2-5005-XR-53					
3-5005-XR-523					
1-MS-AD-24					

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
<i>G. Jacobson</i>	7/2/81	1005			

Relinquished by: (Signature) _____ Date _____ Time _____

Relinquished by: (Signature) _____ Date _____ Time _____

Relinquished by: (Signature) _____ Date _____ Time _____

Sample Disposal Method: _____ Disposed of by: (Signature) _____ Date _____ Time _____

SAMPLE COLLECTOR

Environmental Research and Technology, Inc.
 696 Virginia Road
 Concord, MA 01742
 617-369-8910

ANALYTICAL LABORATORY

ERT

No. **5843**

CHAIN OF CUSTODY RECORD

Client/Project Name Molecular Profile		Project Location Muse. ST, Real W. Massachusetts		ANALYSES		
Project No. E-051		Field Logbook No.				
Sampler: <i>(Signature)</i> R. Packard		Chain of Custody Tape No.				
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS	
1-M5-FH	5-20			Groundwater Top 1 Half Rose	Archeo. Soil	
2-M5-FH	5-21			Lead battery, no label, box 2		
3-M5-FH	5-21			Lead battery, no label, box 3		
2-M5-mpa1	5-21			100% acetate, box 2	100% acetate #1	
2-M5-mpa2	5-21			100% acetate, box 2	100% acetate #2	
3-M5-mpa1	5-21			100% acetate, box 3	100% acetate #1	
3-M5-mpa2	5-21			100% acetate, box 3	100% acetate #2	
Relinquished by: <i>(Signature)</i> R. Packard		Date	Time	Received by: <i>(Signature)</i>	Date	Time
Relinquished by: <i>(Signature)</i>		Date	Time	Received by: <i>(Signature)</i>	Date	Time
Relinquished by: <i>(Signature)</i>		Date	Time	Received for Laboratory: <i>(Signature)</i> M. Kelly	Date	Time
Sample Disposal Method:		Disposed of by: <i>(Signature)</i>		Date	Date	Time
SAMPLE COLLECTOR		ANALYTICAL LABORATORY		ERT		No
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910						5841

CHAIN OF CUSTODY RECORD

Client/Project Name Malcomn Prairie		Project Location St Paul, Minnesota		ANALYSES	
Project No. E081		Field Logbook No.			
Sample: <i>(Signature)</i> J. Schubert		Chain of Custody Tape No.			
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
B-205	5-20-86	↓			
B-207	↓	↓			
B-209	↓	↓			
B-211	5-21-86	↓			
B-213	↓	↓			
B-215	↓	↓			
B-217	↓	↓			
B-219	↓	↓			
Relinquished by: <i>(Signature)</i> J. Schubert		Date	Time	Received by: <i>(Signature)</i>	
Relinquished by: <i>(Signature)</i>		5/21/86	1:05	Received by: <i>(Signature)</i>	
Relinquished by: <i>(Signature)</i>		Date	Time	Received for Laboratory: <i>(Signature)</i>	
Relinquished by: <i>(Signature)</i>				Received for Laboratory: <i>(Signature)</i>	
Sample Disposal Method:		Date	Time	Disposed of by: <i>(Signature)</i>	
Sample Disposal Method:				Disposed of by: <i>(Signature)</i>	
SAMPLE COLLECTOR		ANALYTICAL LABORATORY			
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910		ERT			
		No		5851	

CHAIN OF CUSTODY RECORD

Client/Project Name M. Adams Private		Project Location S. Road, Massachusetts		ANALYSES		
Project No. E081		Field Logbook No.				
Sampler: (Signature) H. Vachon		Chain of Custody Type No.				
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS	
B-220	5-28-88	↓			1" marks	
B-222	↓	↓			No salt of	
B-224	↓	↓			TERRA TUBES	
B-221	5-28-88	↓			1" marks	
B-223	↓	↓			cont. of TERRA	
B-225	↓	↓			checked tubes	
Relinquished by: (Signature) H. Vachon		Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)		5/28/88	12:5			
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)		Date	Time	Received for Laboratory: (Signature)	Date	Time
Sample Disposal Method:		Disposed of by: (Signature)		M. Adams		
SAMPLE COLLECTOR		ANALYTICAL LABORATORY		ERT		No 5852
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910						

CHAIN OF CUSTODY RECORD

Client/Project Name MALOMAS PIRNIE		Project Location St. Paul, Minnesota		ANALYSES	
Project No. E081		Field Logbook No.			
Sample: (Signature) <i>R. V. ...</i>		Chain of Custody Tape No.			
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
B-201	5-20-86	↓		POST MORTAL TUBE	"X" is marked
B-206	↓	↓		Block - Field	1. Handwritten
B-208	↓	↓		RUN 1B	sub with rock
B-210	5-21-86			RUN 2A	
B-212				Blank - Field	
B-214				RUN 2B	
B-216				RUN 3A	
B-218				RUN 3B	
Relinquished by: (Signature) <i>R. V. ...</i>		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		Date	Time	Received for Laboratory: (Signature) <i>M. ...</i>	
Sample Disposal Method:		Disposed of by: (Signature)		Date	
SAMPLE COLLECTOR		ANALYTICAL LABORATORY		ERT	
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910				No: 5854	

Received June 27, 1986

California Environmental Laboratories, Inc.
2544 Industrial Blvd.
West Sacramento, California 95691
916 370-1991

24894

Date Received : 5-20-86
Date Due :
Project ID :
EPA Date, PMA Lot : 5-181
P.O. Number :
Delivered by : FCO, P. 513314334
Storage Location :
Logged in by : J-918

ENVIRONMENTAL RESEARCH TECHNOLOGIES, INC.
2544 INDUSTRIAL BLVD
WEST SACRAMENTO, CALIF.
95691

Richard Graziano
217 369-8910

THE FOLLOWING SAMPLES WERE RECEIVED UNDER CHAIN OF CUSTODY IN 1-PK. NUMBER 24-86
BOTTLES: 17, PLASTIC FILTERS: 51 AND XAD RESIN TRAP: 51 TO BE ANALYZED FOR:

Lab ID	Ext. ID	Client's Label Info	EPA Tag No., EPA Label	Date	Comments
24894-001		PCDD-1A-MMS-XR-1526	XAD-TRAP #1526	5-20-86	RECEIVED
24894-002		PCDD-1-MMS-XR-B-1533	BLANK TRAIN- #1533	5-20-86	RECEIVED
24894-003		PCDD-1A-MMS-CD		5-20-86	RECEIVED
24894-004		PCDD-1A-MMS-IMP 2&3		5-20-86	RECEIVED
24894-005		PCDD-1-MMS-CD-B	BLANK TRAIN	5-20-86	RECEIVED
24894-006		PCDD-1-MMS-IMP 2&3B	BLANK TRAIN	5-20-86	RECEIVED
24894-007		PCDD-1-MMS-PF-B	BLANK #B-172	5-20-86	FILTERS
24894-008		PCDD-1A-MMS-PF	#B-166	5-20-86	FILTERS
24894-009		PCDD-1A-MMS-FRONT END		5-20-86	RECEIVED
24894-010		PCDD-2A-MMS-FH		5-22-86	RECEIVED
24894-011		PCDD-2B-MMS-FH		5-22-86	RECEIVED
24894-012		2A-MMS-PCDD-CD		5-22-86	RECEIVED
24894-013		2B-MMS-PCDD-CD		5-22-86	RECEIVED
24894-014		PCDD-2A-MMS-IMP 2&3		5-22-86	RECEIVED
24894-015		PCDD-2B-MMS-IMP 2&3		5-22-86	RECEIVED
24894-016		2A-MMS-PF	#B-169	5-22-86	FILTERS
24894-017		2B-MMS-PF	#B-161	5-22-86	FILTERS
24894-018		MMS-PF BLANK	#B-164	5-22-86	FILTERS
24894-019		PCDD-2-MMS-FHB		5-22-86	RECEIVED
24894-020		PCDD-2-MMS-IMP 2&3B		5-22-86	RECEIVED
24894-021		PCDD-2-MMS-CDB		5-22-86	RECEIVED

Continued next page.

Samples not destroyed in testing are retained a maximum of thirty (30) days unless otherwise requested.

Supervisor: MJM

Date Approved:

Notebook:

CHAIN OF CUSTODY RECORD

Client/Project Name McCain Foods		Project Location Mel, St. Paul, Minnesota		ANALYSES	
Project No. E-081		Field Logbook No.			
Sampler: (Signature) <i>Richard [Signature]</i>		Chain of Custody Tape No.			
Sample No. / Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
R-21-100-11-10-10	5/22/69	8:45		Front Half Rinse	1:1 Acetone - Rinse Rinse
R-21-100-11-10-10	5/22/69			Front Half Rinse	1:1 Acetone - Rinse Rinse
R-21-100-11-10-10	5/22/69			Front Half Rinse	1:1 Acetone - Rinse Rinse
R-21-100-11-10-10	5/22/69			Rinse Container	1:1 Acetone - Rinse Rinse
R-21-100-11-10-10	5/22/69			Rinse Container	1:1 Acetone - Rinse Rinse
R-21-100-11-10-10	5/22/69			Rinse Tray 23 Catch	DI H ₂ O Rinse - normal
R-21-100-11-10-10	5/22/69			Rinse Tray 23 Catch	DI H ₂ O Rinse - normal
R-21-100-11-10-10	5/22/69			Rinse - Back to Filter	Filter 4/169
Relinquished by: (Signature) <i>Richard [Signature]</i>		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		5/22/69	8:45	[Signature]	
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		Date	Time	Received for Laboratory: (Signature)	
Relinquished by: (Signature)		Date	Time	Disposed of by: (Signature)	
Relinquished by: (Signature)		5-24-69	10-30	[Signature]	
Sample Disposal Method:					
SAMPLE COLLECTOR		ANALYTICAL LABORATORY			
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910		ERT			
		No. 5817			

CHAIN OF CUSTODY RECORD

Client/Project Name Alcohol Probe		Project Location Mex, St Paul Minnesota		ANALYSES	
Project No. E-081		Field Logbook No.			
Sampler (Signature) <i>Richard Geyman</i>		Chain of Custody Tape No.			
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
Run 20-MS-PR-5-2/26				Run 20-Residue Filter	Filter # 161
Run 2-MS-PR-5-2/26				Run 2-Residue Filter Blank	Filter # 164
Run 2-MS-PR-5-2/26				Run 2-Field HLF Control Blank	1:1 Acetone Hexane Rinse
Run 2-MS-PR-5-2/26				Run 2-Inject 2-3 Blank	DI H ₂ O Rinse
Run 2-MS-PR-5-2/26				Run 2-Inject 1-2 Blank	DI H ₂ O Rinse
Run 2-MS-PR-5-2/26				Run 2-XAD Blank	# 1520
Run 2-MS-PR-5-2/26				Run 2-XAD	# 1516
Run 2-MS-PR-5-2/26				Run 2-XAD	# 1527
Relinquished by: (Signature) <i>Richard Geyman</i>		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)			8:45	Received by: (Signature)	
Relinquished by: (Signature)				Received by: (Signature)	
Relinquished by: (Signature)				Received for Laboratory: (Signature) <i>Philip Geyman</i>	
Sample Disposal Method:		Disposed of by: (Signature)		Date	Time
				5/24/66	10:30
SAMPLE COLLECTOR		ANALYTICAL LABORATORY		ERT	
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910				No 5818	

CHAIN OF CUSTODY RECORD

Client/Project Name Maledon Prairie		Project Location Musc ST. Paul Minnesota		ANALYSES	
Project No. E-081		Field Logbook No.			
Sampler: (Signature) <i>Richard Ferguson</i>		Chain of Custody Tape No.			
Sample No./ Identification	Date	Time	Lab Sample Number	Type of Sample	REMARKS
1:1 Acetone Rinse	5/24/06	8:45	Front Half Rinse Blank	Blank	1:1 Acetone Rinse Rinse
1:1 Acetone Rinse	5/24/06	8:45	Front Half Rinse	Blank	1:1 Acetone Rinse Rinse
1:1 Acetone Rinse	5/24/06	8:45	Blank #2	Blank	1:1 Hexam Acetone Rinse
1:1 Acetone Rinse	5/24/06	8:45	Connect #2	Blank	1:1 Hexam Acetone Rinse
Relinquished by: (Signature) <i>Richard Ferguson</i>		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)		5/24/06	8:45		
Relinquished by: (Signature)		Date	Time	Received by: (Signature)	
Relinquished by: (Signature)					
Sample Disposal Method:		Date	Time	Received for Laboratory: (Signature) <i>Richard Ferguson</i>	
SAMPLE COLLECTOR		Disposed of by: (Signature)		Date	Time
Environmental Research and Technology, Inc. 696 Virginia Road Concord, MA 01742 617-369-8910				5/24/06	10:30
ANALYTICAL LABORATORY				Date	Time
				ERT	
				No.	5861

APPENDIX E
ERT ANALYTICAL DATA REPORTS

- HEAVY METALS
- VOLATILE ORGANICS
- SEMIVOLATILE ORGANICS

METAL ANALYSES ON FILTERS

Summary of Analytical Results

Method Blank Results

Quality Control Check Sample Results

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
METALS SCAN

ERT NO : 35512
FLD ID : 1-MS-PF-B163

DATE SAMPLED : 05/20/86
SAMPLING SITE : TWIN CITIES, MN

PARAMETER	RESULT ug/filter	DETECTION LIMIT ug/filter
ANTIMONY	14	5.0
BARIUM	13	5.0
BERYLLIUM	BDL	5.0
BORON	BDL	5.0
CADMIUM	1100	5.0
CHROMIUM	310	5.0
COBALT	BDL	5.0
COPPER	410	5.0
LEAD	1300	5.0
MANGANESE	71	5.0
MOLYBDENUM	12	5.0
NICKEL	120	5.0
SELENIUM	43	5.0
SILVER	15	5.0
STRONTIUM	BDL	5.0
TIN	900	5.0
VANADIUM	5.4	5.0
ZINC	5200	5.0

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
METALS SCAN

ERT NO : 35514
FLD ID : 2-M5-PF-B179

DATE SAMPLED : 05/21/86
SAMPLING SITE : TWIN CITIES, MN

PARAMETER	RESULT ug/filter	DETECTION LIMIT ug/filter
ANTIMONY	21	5.0
BARIUM	18	5.0
BERYLLIUM	BDL	5.0
BORON	BDL	5.0
CADMIUM	2500	5.0
CHROMIUM	300	5.0
COBALT	34	5.0
COPPER	860	5.0
LEAD	2000	5.0
MANGANESE	46	5.0
MOLYBDENUM	11	5.0
NICKEL	340	5.0
SELENIUM	81	5.0
SILVER	25	5.0
STRONTIUM	5.9	5.0
TIN	110	5.0
VANADIUM	8.1	5.0
ZINC	11000	5.0

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
METALS SCAN

ERT NO : 35518
FLD ID : 3-M5-PF-B171

DATE SAMPLED : 05/21/86
SAMPLING SITE : TWIN CITIES, MN

PARAMETER	RESULT ug/filter	DETECTION LIMIT ug/filter
ANTIMONY	15	5.0
BARIUM	6.4	5.0
BERYLLIUM	BDL	5.0
BORON	BDL	5.0
CADMIUM	1700	5.0
CHROMIUM	72	5.0
COBALT	BDL	5.0
COPPER	600	5.0
LEAD	1100	5.0
MANGANESE	35	5.0
MOLYBDENUM	5.2	5.0
NICKEL	64	5.0
SELENIUM	74	5.0
SILVER	12	5.0
STRONTIUM	BDL	5.0
TIN	85	5.0
VANADIUM	5.9	5.0
ZINC	9000	5.0

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
PRIORITY POLLUTANT METALS

ERT NUMBER 35314
ID MB860402

PARAMETER	ANALYTICAL RESULTS ug/filter	DETECTION LIMIT ug/filter
ANTIMONY	BDL	5.0
BARIUM	BDL	5.0
BERYLLIUM	BDL	5.0
BORON	42.8	5.0
CADMIUM	BDL	5.0
CHROMIUM	BDL	5.0
COBALT	BDL	5.0
COPPER	BDL	5.0
LEAD	BDL	5.0
MANGANESE	BDL	5.0
MOLYBDENUM	BDL	5.0
NICKEL	BDL	5.0
SELENIUM	BDL	5.0
SILVER	BDL	5.0
STRONTIUM	BDL	5.0
TIN	21	5.0
VANADIUM	BDL	5.0
ZINC	5.5	5.0

SEMI-VOLATILE ORGANIC COMPOUND ANALYSES ON MM5 TRAINS

Summary of Analytical Results

Non-EPA 625/HSL Target Compounds (Quantitated) Results

NON-Target Compound Results

Method Blank Results

Quality Control Sample Results

ERT ANALYTICAL LABORATORY
MALCOLM PIRNIE
FIELD IDENTIFICATION

ERT NO:	35504	35505	35506	35507	35508
SAMPLE TYPE:	RUN 1	RUN 1	RUN 2,3	RUN 2	RUN 3
	FIELD BIAS BLANK		FIELD BIAS BLANK		

FRONT 1/2 RINSE	1-SMMS- FHB	1-SMMS- FH	2-SMMS- FH BLANK	2-SMMS- FH	3-SMMS- FH
FILTER	1-SMMS- FBB B177	1-SMMS- PF B168	2-SMMS- PFBB B174	2-SMMS- PF B175	3-SMMS- PF B176
XAD	1-SMMS- XRB 1529	1-SMMS- XR 1514	2-SMMS- XRB 1535	2-SMMS- XR 1530	3-SMMS- XR 1523
CONDENSATE	1-SMMS- IMP 1B	1-SMMS- CD	2-SMMS- IMP 1BK	2-SMMS- CD	3-SMMS- CD
IMP 2,3 CATCH	1-SMMS- IMP 2BK	1-SMMS- IMP 2,3	2-SMMS- IMP 2BK	2-SMMS- IMP 2,3	3-SMMS- IMP 2,3

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SEMI-VOLATILE COMPOUNDS ON MMS TRAIN

ERT NO 35508
FLD ID FH,PF,XR,CD,IMP2&3
DATE ANALYZED 07/03/86

CLIENT MALCOMN PIRNIE
SAMPLING SITE TWIN CITIES, MN
DATE SAMPLED 05/20/86

PARAMETER	RESULT	PARAMETER	RESULT
	total ug		total ug
NAPHTHALENE	11	1,3-DICHLOROBENZENE	<10
ACENAPHTHYLENE	<10	1,4-DICHLOROBENZENE	58
ACENAPHTHENE	<10	BENZYL ALCOHOL	<10
FLUORENE	<10	1,2-DICHLOROBENZENE	25
PHENANTHRENE	<10	BIS(2-CHLOROISOPROPYL)ETHER	<10
ANTHRACENE	<10	N-NITROSODI-N-PROPYLAMINE	<10
FLUORANTHENE	<10	HEXACHLOROETHANE	<10
PYRENE	<10	NITROBENZENE	<10
BENZ(A)ANTHRACENE	<10	ISOPHORONE	<10
CHRYSENE	<10	BIS(2-CHLOROETHOXY)METHANE	<10
BENZOFUORANTHENES	<10	1,2,4-TRICHLOROBENZENE	<10
BENZO(A)PYRENE	<10	4-CHLOROANILINE	<10
INDENO(123CD)PYRENE	<10	HEXACHLOROBUTADIENE	<10
DIBENZ(AH)ANTHRACENE	<10	2-METHYLNAPHTHALENE	<10
BENZO(GHI)PERYLENE	<10	HEXACHLOROCYCLOPENTADIENE	<10
PHENOL	12	2-CHLORONAPHTHALENE	<10
2-CHLOROPHENOL	<10	2-NITROANILINE	<10
2-METHYLPHENOL	<10	DIMETHYLPHTHALATE	<10
4-METHYLPHENOL	<10	3-NITROANILINE	<10
2,4-DIMETHYLPHENOL	<10	DIBENZOFURAN	<10
2-NITROPHENOL	54	2,4-DINITROTOLUENE	<10
2,4-DICHLOROPHENOL	<10	2,6-DINITROTOLUENE	<10
4-CHLORO-3-METHYLPHENOL	<10	DIETHYL PHTHALATE	68
2,4,6-TRICHLOROPHENOL	<10	4-CHLOROPHENYLPHENYL ETHER	<10
2,4,5-TRICHLOROPHENOL	<10	4-NITROANILINE	<10
2,4-DINITROPHENOL	<10	N-NITROSODIPHENYLAMINE	<10
4-NITROPHENOL	<10	4-BROMOPHENYLPHENYL ETHER	<10
4,6-DINITRO-2-METHYLPHENOL	<10	HEXACHLOROBENZENE	<10
PENTACHLOROPHENOL	<10	DI-N-BUTYL PHTHALATE	<10
BENZOIC ACID	<10	BENZIDINE	<10
N-NITROSODIMETHYLAMINE	<10	BUTYL BENZYL PHTHALATE	<10
ANILINE	<10	3,3-DICHLOROBENZIDINE	<10
BIS(2-CHLOROETHYL)ETHER	<10	BIS(2-ETHYLHEXYL)PHTHALATE	22
DI-N-OCTYLPHTHALATE	<10		

SURROGATE RECOVERY, %

2-FLUOROPHENOL	32	PHENOL, DS	21
2,4,6-TRIBROMOPHENOL	32	NITROBENZENE, DS	91
2-FLUOROBIPHENYL	80	BENZO(A)PYRENE, D12	<11

NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SEMI-VOLATILE COMPOUNDS ON MMS TRAIN

ERT NO 36714
FLD ID MB860411
DATE ANALYZED 07/02/86

CLIENT MALCOMN PIRNIE
SAMPLING SITE TWIN CITIES, MN
DATE SAMPLED 06/27/86

PARAMETER	RESULT total ug	PARAMETER	RESULT total ug
NAPHTHALENE	<10	1,3-DICHLOROBENZENE	<10
ACENAPHTHYLENE	<10	1,4-DICHLOROBENZENE	<10
ACENAPHTHENE	<10	BENZYL ALCOHOL	<10
FLUCRENE	<10	1,2-DICHLOROBENZENE	<10
PHENANTHRENE	<10	BIS(2-CHLOROISOPROPYL)ETHER	<10
ANTHRACENE	<10	N-NITROSODI-N-PROPYLAMINE	<10
FLUORANTHRENE	<10	HEXACHLOROETHANE	<10
PYRENE	<10	NITROBENZENE	<10
BENZ(A)ANTHRACENE	<10	ISOPHORONE	<10
CHRYSENE	<10	BIS(2-CHLOROETHOXY)METHANE	<10
BENZOFLUORANTHENES	<10	1,2,4-TRICHLOROBENZENE	<10
BENZO(A)PYRENE	<10	4-CHLOROANILINE	<10
INDENO(123CD)PYRENE	<10	HEXACHLOROBUTADIENE	<10
DIBENZ(AH)ANTHRACENE	<10	2-METHYLNAPHTHALENE	<10
BENZO(GHI)PERYLENE	<10	HEXACHLOROCYCLOPENTADIENE	<10
PHENOL	<10	2-CHLORONAPHTHALENE	<10
2-CHLOROPHENOL	<10	2-NITROANILINE	<10
2-METHYLPHENOL	<10	DIMETHYLPHTHALATE	<10
4-METHYLPHENOL	<10	3-NITROANILINE	<10
2,4-DIMETHYLPHENOL	<10	DIBENZOFURAN	<10
2-NITROPHENOL	<10	2,4-DINITROTOLUENE	<10
2,4-DICHLOROPHENOL	<10	2,6-DINITROTOLUENE	<10
4-CHLORO-3-METHYLPHENOL	<10	DIETHYL PHTHALATE	<10
2,4,6-TRICHLOROPHENOL	<10	4-CHLOROPHENYLPHENYL ETHER	<10
2,4,5-TRICHLOROPHENOL	<10	4-NITROANILINE	<10
2,4-DINITROPHENOL	<10	N-NITROSODIPHENYLAMINE	<10
4-NITROPHENOL	<10	4-BROMOPHENYLPHENYL ETHER	<10
4,6-DINITRO-2-METHYLPHENOL	<10	HEXACHLOROBENZENE	<10
PENTACHLOROPHENOL	<10	DI-N-BUTYL PHTHALATE	<10
BENZOIC ACID	<10	BENZIDINE	<10
N-NITROSODIMETHYLAMINE	<10	BUTYL BENZYL PHTHALATE	<10
ANILINE	<10	3,3-DICHLOROBENZIDINE	<10
BIS(2-CHLOROETHYL)ETHER	<10	BIS(2-ETHYLHEXYL)PHTHALATE	<10
DI-N-OCTYLPHTHALATE	<10		

SURROGATE RECOVERY, %

2-FLUOROPHENOL	65	PHENOL, D5	47
2,4,6-TRIBROMOPHENOL	101	NITROBENZENE, D5	77
2-FLUOROBIPHENYL	76	BENZO(A)PYRENE, D12	71

NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SEMI-VOLATILE COMPOUNDS ON MMS TRAIN

ERT NO 35504 CLIENT MALCCMN PIRNIE
FLD ID : FHB, FBB, XRB, IM1, IM2 SAMPLING SITE TWIN CITIES, MN
DATE ANALYZED 07/02/86 DATE SAMPLED 05/20/86

PARAMETER	RESULT	PARAMETER	RESULT
	total ug		total ug
NAPHTHALENE	<10	1,3-DICHLOROBENZENE	<10
ACENAPHTHYLENE	<10	1,4-DICHLOROBENZENE	<10
ACENAPHTHENE	<10	BENZYL ALCOHOL	<10
FLUORENE	<10	1,2-DICHLOROBENZENE	<10
PHENANTHRENE	<10	BIS(2-CHLOROISOPROPYL)ETHER	<10
ANTHRACENE	<10	N-NITROSDI-N-PROPYLAMINE	<10
FLUORANTHENE	<10	HEXACHLOROETHANE	<10
PYRENE	<10	NITROBENZENE	<10
BENZ(A)ANTHRACENE	<10	ISOPHORONE	<10
CHRYSENE	<10	BIS(2-CHLOROETHOXY)METHANE	<10
BENZOFLUORANTHENES	<10	1,2,4-TRICHLOROBENZENE	<10
BENZO(A)PYRENE	<10	4-CHLOROANILINE	<10
INDENO(123CD)PYRENE	<10	HEXACHLOROBUTADIENE	<10
DIBENZ(AH)ANTHRACENE	<10	2-METHYLNAPHTHALENE	<10
BENZO(CHI)PERYLENE	<10	HEXACHLOROCYCLOPENTADIENE	<10
PHENOL	<10	2-CHLORONAPHTHALENE	<10
2-CHLOROPHENOL	<10	2-NITROANILINE	<10
2-METHYLPHENOL	<10	DIMETHYLPHTHALATE	<10
4-METHYLPHENOL	<10	3-NITROANILINE	<10
2,4-DIMETHYLPHENOL	<10	DIBENZOFURAN	<10
2-NITROPHENOL	<10	2,4-DINITROTOLUENE	<10
2,4-DICHLOROPHENOL	<10	2,6-DINITROTOLUENE	<10
4-CHLORO-3-METHYLPHENOL	<10	DIETHYL PHTHALATE	<10
2,4,6-TRICHLOROPHENOL	<10	4-CHLOROPHENYLPHENYL ETHER	<10
2,4,5-TRICHLOROPHENOL	<10	4-NITROANILINE	<10
2,4-DINITROPHENOL	<10	N-NITROSODIPHENYLAMINE	<10
4-NITROPHENOL	<10	4-BROMOPHENYLPHENYL ETHER	<10
4,6-DINITRO-2-METHYLPHENOL	<10	HEXACHLOROBENZENE	<10
PENTACHLOROPHENOL	<10	DI-N-BUTYL PHTHALATE	<10
BENZOIC ACID	<10	BENZIDINE	<10
N-NITROSODIMETHYLAMINE	<10	BUTYL BENZYL PHTHALATE	<10
ANILINE	<10	3,3-DICHLOROBENZIDINE	<10
BIS(2-CHLOROETHYL)ETHER	<10	BIS(2-ETHYLHEXYL)PHTHALATE	<10
DI-N-OCTYLPHTHALATE	<10		

SURROGATE RECOVERY, %

2-FLUOROPHENOL	30	PHENOL, DS	33
2,4,6-TRIBROMOPHENOL	102	NITROBENZENE, DS	64
2-FLUOROBIPHENYL	77	BENZO(A)PYRENE, D12	71

NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SEMI-VOLATILE COMPOUNDS ON MMS TRAIN

ERT NO 35505
FLD ID FH,PF,XR,CD,IMP:
DATE ANALYZED 07/02/86

CLIENT MALCOMN PIRNIE
SAMPLING SITE TWIN CITIES, MN
DATE SAMPLED 05/20/86

PARAMETER	RESULT total ug	PARAMETER	RESULT total ug
NAPHTHALENE	20	1,3-DICHLOROBENZENE	<10
ACENAPHTHYLENE	<10	1,4-DICHLOROBENZENE	49
ACENAPHTHENE	<10	BENZYL ALCOHOL	<10
FLUORENE	<10	1,2-DICHLOROBENZENE	12
PHENANTHRENE	<10	BIS(2-CHLOROISOPROPYL)ETHER	<10
ANTHRACENE	<10	N-NITROSODI-N-PROPYLAMINE	<10
FLUORANTHENE	<10	HEXACHLOROETHANE	<10
PYRENE	<10	NITROBENZENE	<10
BENZ(A)ANTHRACENE	<10	ISOPHORONE	<10
CHRYSENE	<10	BIS(2-CHLOROETHOXY)METHANE	<10
BENZOFUORANTHENES	<10	1,2,4-TRICHLOROBENZENE	<10
BENZO(A)PYRENE	<10	4-CHLOROANILINE	<10
INDENO(123CD)PYRENE	<10	HEXACHLOROBUTADIENE	<10
DIBENZ(AH)ANTHRACENE	<10	2-METHYLNAPHTHALENE	<10
BENZO(GHI)PERYLENE	<10	HEXACHLOROCYCLOPENTADIENE	<10
PHENOL	<10	2-CHLORONAPHTHALENE	<10
2-CHLOROPHENOL	<10	2-NITROANILINE	<10
2-METHYLPHENOL	<10	DIMETHYLPHTHALATE	<10
4-METHYLPHENOL	<10	3-NITROANILINE	<10
2,4-DIMETHYLPHENOL	<10	DIBENZOFURAN	<10
2-NITROPHENOL	160	2,4-DINITROTOLUENE	<10
2,4-DICHLOROPHENOL	<10	2,6-DINITROTOLUENE	<10
4-CHLORO-3-METHYLPHENOL	<10	DIETHYL PHTHALATE	<10
2,4,6-TRICHLOROPHENOL	<10	4-CHLOROPHENYLPHENYL ETHER	<10
2,4,5-TRICHLOROPHENOL	<10	4-NITROANILINE	<10
2,4-DINITROPHENOL	<10	N-NITROSODIPHENYLAMINE	<10
4-NITROPHENOL	<10	4-BROMOPHENYLPHENYL ETHER	<10
4,6-DINITRO-2-METHYLPHENOL	<10	HEXACHLOROBENZENE	<10
PENTACHLOROPHENOL	<10	DI-N-BUTYL PHTHALATE	<10
BENZOIC ACID	<10	BENZIDINE	<10
N-NITROSODIMETHYLAMINE	<10	BUTYL BENZYL PHTHALATE	12
ANILINE	<10	3,3-DICHLOROBENZIDINE	<10
BIS(2-CHLOROETHYL)ETHER	<10	BIS(2-ETHYLHEXYL)PHTHALATE	35
DI-N-OCTYLPHTHALATE	<10		

SURROGATE RECOVERY, %

2-FLUOROPHENOL	<6.8	PHENOL, D5	<14
2,4,6-TRIBROMOPHENOL	<5.2	NITROBENZENE, D5	98
2-FLUOROBIPHENYL	120	BENZO(A)PYRENE, D12	<11

NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
SEMI-VOLATILE COMPOUNDS ON MM5 TRAIN

ERT NO 35506 CLIENT MALCOMN PIRNIE
 FLD ID FH, PFB, XRB, IM1, IM2 SAMPLING SITE TWIN CITIES, MN
 DATE ANALYZED 07/02/86 DATE SAMPLED 05/20/86

PARAMETER	RESULT total ug	PARAMETER	RESULT total ug
NAPHTHALENE	<10	1,3-DICHLOROBENZENE	<10
ACENAPHTHYLENE	<10	1,4-DICHLOROBENZENE	<10
ACENAPHTHENE	<10	BENZYL ALCOHOL	<10
FLUORENE	<10	1,2-DICHLOROBENZENE	<10
PHENANTHRENE	<10	BIS(2-CHLOROISOPROPYL)ETHER	<10
ANTHRACENE	<10	N-NITROSODI-N-PROPYLAMINE	<10
FLUORANTHENE	<10	HEXACHLOROETHANE	<10
PYRENE	<10	NITROBENZENE	<10
BENZ(A)ANTHRACENE	<10	ISOPHORONE	<10
CHRYSENE	<10	BIS(2-CHLOROETHOXY)METHANE	<10
BENZOFUORANTHENES	<10	1,2,4-TRICHLOROBENZENE	<10
BENZO(A)PYRENE	<10	4-CHLOROANILINE	<10
INDENO(123CD)PYRENE	<10	HEXACHLOROBUTADIENE	<10
DIBENZ(AH)ANTHRACENE	<10	2-METHYLNAPHTHALENE	<10
BENZO(GHI)PERYLENE	<10	HEXACHLOROCYCLOPENTADIENE	<10
PHENOL	<10	2-CHLORONAPHTHALENE	<10
2-CHLOROPHENOL	<10	2-NITROANILINE	<10
2-METHYLPHENOL	<10	DIMETHYLPHTHALATE	<10
4-METHYLPHENOL	<10	3-NITROANILINE	<10
2,4-DIMETHYLPHENOL	<10	DIBENZOFURAN	<10
2-NITROPHENOL	<10	2,4-DINITROTOLUENE	<10
2,4-DICHLOROPHENOL	<10	2,6-DINITROTOLUENE	<10
4-CHLORO-3-METHYLPHENOL	<10	DIETHYL PHTHALATE	<10
2,4,6-TRICHLOROPHENOL	<10	4-CHLOROPHENYLPHENYL ETHER	<10
2,4,5-TRICHLOROPHENOL	<10	4-NITROANILINE	<10
2,4-DINITROPHENOL	<10	N-NITROSODIPHENYLAMINE	<10
4-NITROPHENOL	<10	4-BROMOPHENYLPHENYL ETHER	<10
4,6-DINITRO-2-METHYLPHENOL	<10	HEXACHLOROBENZENE	<10
PENTACHLOROPHENOL	<10	DI-N-BUTYL PHTHALATE	<10
BENZOIC ACID	<10	BENZIDINE	<10
N-NITROSODIMETHYLAMINE	<10	BUTYL BENZYL PHTHALATE	<10
ANILINE	<10	3,3-DICHLOROBENZIDINE	<10
BIS(2-CHLOROETHYL)ETHER	<10	BIS(2-ETHYLHEXYL)PHTHALATE	<10
DI-N-OCTYLPHTHALATE	<10		

SURROGATE RECOVERY, %

2-FLUOROPHENOL	59	PHENOL, D5	48
2,4,6-TRIBROMOPHENOL	90	NITROBENZENE, D5	71
2-FLUOROBIPHENYL	80	BENZO(A)PYRENE, D12	73

NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
SEMI-VOLATILE ORGANIC COMPOUNDS ON MMS TRAIN

CLIENT MALCOMN FIRNIE

ERT NUMBER LF860476
DATE FORTIFIED 6/27/86
DATE ANALYZED 7/2/86

PARAMETER -----	SURROGATE % RECOVERED -----
2-FLUOROPHENOL	77%
PHENOL D-6	72%
2,4,6-TRIBROMOPHENOL	127%
NITROBENZENE D-5	82%
2-FLUOROBIPHENYL	91%
BENZO(a)PYRENE	78%

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
SEMI-VOLATILE ORGANIC COMPOUNDS

ERT NO LF860476
DATE FORTIFIED 6/27/86
DATE ANALYZED 7/2/86

PARAMETER -----	FORTIFICATION % RECOVERY -----
4-CHLORO-3-METHYLPHENOL	77
4-NITROPHENOL	63
2-CHLOROPHENOL	71
PHENOL	65
PENTACHLOROPHENOL	86
1,2,4-TRICHLOROBENZENE	115
2,4-DINITROTOLUENE	77
1,4-DICHLOROBENZENE	91
PYRENE	108
NAPHTHALENE	87
DI-N-BUTYLPHTHALATE	88
ACENAPHTHALENE	97
2-CHLOROBIPHENYL	103
DECACHLOROBIPHENYL	175

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
SEMI-VOLATILE ORGANIC COMPOUNDS ON MMS TRAIN

CLIENT MALCOMN PIRNIE

ERT NUMBER: LF860477
DATE FORTIFIED: 6/27/86
DATE ANALYZED: 7/2/86

PARAMETER -----	SURROGATE % RECOVERED -----
2-FLUOROPHENOL	66%
PHENOL D-6	66%
2,4,6-TRIBROMOPHENOL	126%
NITROBENZENE D-3	77%
2-FLUOROBIPHENYL	84%
BENZO(a)PYRENE	75%

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
NON-EPA 605/HSL TARGET COMPOUNDS QUANTITATED

CLIENT MALCOLM PIRNIE
DETECTION LIMIT 10 ug

ERT NO:	35505	35507	35508
PARAMETER	-----	-----	-----
1-METHYLNAPHTHALENE	BDL	BDL	BDL
PENTACHLOROBENZENE	BDL	BDL	BDL
TETRACHLOROPHENOLS	BDL	BDL	BDL
2-NITRONAPHTHALENE	BDL	BDL	BDL
BIPHENYL	BDL	BDL	BDL
ALL CHLORINATED PCB CONGENERS	BDL	BDL	BDL

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
NON-EPA 625 HSL TARGET COMPOUNDS QUANTITATED

CLIENT MALCOMN PIRNIE
DETECTION LIMIT: 10 ug

ERT NO: 36714
ID: MB860411

PARAMETER

1-METHYLNAPHTHALENE	BDL
PENTACHLOROBENZENE	BDL
TETRACHLOROPHENOLS	BDL
2-NITRONAPHTHALENE	BDL
BIPHENYL	BDL
ALL CHLORINATED PCB CONGENERS	BDL

VOLATILE ORGANIC COMPOUND ANALYSES ON TENAX

Summary of Analytical Results

Non-EPA 624/HSL Target Compounds (Quantitated) Results

NON-Target Compound Results

Method Blank Results

Quality Control Sample Results

ERT ANALYTICAL LABORATORY
 SUMMARY OF ANALYTICAL RESULTS
 VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35310
 FLD ID : B-201
 DATE ANALYZED : 6/23/86

CLIENT : MALCOMM PIRNIE
 SAMPLING SITE : TWIN CITIES, MN
 DATE SAMPLED : 05/16/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	BDL	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	BDL
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	BDL	BENZENE	BDL
ACETONE	BDL	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	BDL	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	BDL	TETRACHLOROETHENE	BDL
1,2-DICHLOROETHANE	BDL	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	BDL	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	BDL	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	83
BENZENE, D6	111
TOLUENE, D8	46
BROMOFLUOROBENZENE	119

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
 NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35484
FLD ID : 8-206
DATE ANALYZED : 6/24/86

CLIENT : MALCOMN PIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/20/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE ✓	BDL	TRANS-1,3-DICHLOROPROPENE ✓	BDL
BROMOMETHANE ✓	BDL	TRICHLOROETHENE ✓	BDL
VINYL CHLORIDE ✓	BDL	DIBROMOCHLOROMETHANE ✓	BDL
CHLOROETHANE ✓	BDL	1,1,2-TRICHLOROETHANE ✓	BDL
METHYLENE CHLORIDE ✓	BDL	BENZENE ✓	BDL
ACETONE ✓	BDL	CIS-1,3-DICHLOROPROPENE ✓	BDL
CARBON DISULFIDE ✓	BDL	2-CHLOROETHYL VINYL ETHER ✓	BDL
1,1-DICHLOROETHENE ✓	BDL	BROMOFORM ✓	BDL
1,1-DICHLOROETHANE ✓	BDL	2-HEXANONE ✓	BDL
TRANS-1,2-DICHLOROETHENE ✓	BDL	4-METHYL-2-PENTANONE ✓	BDL
CHLOROFORM ✓	BDL	TETRACHLOROETHENE ✓	BDL
1,2-DICHLOROETHANE ✓	BDL	1,1,2,2-TETRACHLOROETHANE ✓	160
2-BUTANONE ✓	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE ✓	BDL	CHLOROBENZENE ✓	BDL
CARBON TETRACHLORIDE ✓	BDL	ETHYL BENZENE ✓	BDL
VINYL ACETATE	BDL	STYRENE	BDL
BROMODICHLOROMETHANE ✓	BDL	TOTAL XYLENES ✓	190
1,2-DICHLOROPROPANE ✓	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	92
BENZENE, D6	117
TOLUENE, D8	34
BROMOFLUOROBENZENE	184

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO 35486
FLD ID B-208
DATE ANALYZED : 6/24/86

CLIENT : MALCOMN PIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/20/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	140	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	60
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	19000	BENZENE	510
ACETONE	490	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	1100	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	110	TETRACHLOROETHENE	170
1,2-DICHLOROETHANE	460	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	BDL	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	BDL	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	114
BENZENE, D6	84
TOLUENE, D8	94
BROMOFLUOROBENZENE	129

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
 SUMMARY OF ANALYTICAL RESULTS
 VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35490
 FLD ID : B-212
 DATE ANALYZED : 6/23/86

CLIENT : MALCOMN PIRNIE
 SAMPLING SITE : TWIN CITIES, MN
 DATE SAMPLED : 05/21/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	BDL	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	BDL
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	BDL	BENZENE	BDL
ACETONE	66	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	BDL	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	BDL	TETRACHLOROETHENE	BDL
1,2-DICHLOROETHANE	BDL	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	BDL	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	66	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	86
BENZENE, D6	129
TOLUENE, D8	101
BROMOFLUOROBENZENE	165

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
 NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO 35492
FLD ID : B-214
DATE ANALYZED : 6/24/86

CLIENT : MALCOMN PIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/21/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	BDL	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	120
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	9100	BENZENE	77
ACETONE	BDL	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	350	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	110	TETRACHLOROETHENE	450
1,2-DICHLOROETHANE	330	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	54	TOLUENE	56
1,1,1-TRICHLOROETHANE	340	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	74	ETHYL BENZENE	BDL
VINYL ACETATE	BDL	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	109
BENZENE, D6	96
TOLUENE, D8	137
BROMOFLUOROBENZENE	130

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35494
FLD ID : B-216
DATE ANALYZED : 6/23/86

CLIENT : MALCOMN PIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/21/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	54	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	BDL
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	6100	BENZENE	57
ACETONE	190 -	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	250	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	BDL	TETRACHLOROETHENE	60
1,2-DICHLOROETHANE	120	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	BDL	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	170 -	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	86
BENZENE, D6	93
TOLUENE, D8	130
BROMOFLUOROBENZENE	94

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35498
FLD ID : B-220
DATE ANALYZED : 6/23/86

CLIENT : MALCOMM FIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/22/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	BDL	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	BDL
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	18000	BENZENE	49
ACETONE	160	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	210	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	BDL	TETRACHLOROETHENE	78
1,2-DICHLOROETHANE	170	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	63	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	130	STYRENE	BDL
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	BDL
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	70
BENZENE, D6	94
TOLUENE, D8	136
BROMOFLUOROBENZENE	149

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS ON TENAX

ERT NO : 35500
FLD ID : B-222
DATE ANALYZED : 6/23/86

CLIENT : MALCOMN PIRNIE
SAMPLING SITE : TWIN CITIES, MN
DATE SAMPLED : 05/22/86

PARAMETER	RESULT ng/tube	PARAMETER	RESULT ng/tube
CHLOROMETHANE	BDL	TRANS-1,3-DICHLOROPROPENE	BDL
BROMOMETHANE	BDL	TRICHLOROETHENE	BDL
VINYL CHLORIDE	BDL	DIBROMOCHLOROMETHANE	BDL
CHLOROETHANE	BDL	1,1,2-TRICHLOROETHANE	BDL
METHYLENE CHLORIDE	67	BENZENE	BDL
ACETONE	BDL	CIS-1,3-DICHLOROPROPENE	BDL
CARBON DISULFIDE	BDL	2-CHLOROETHYL VINYL ETHER	BDL
1,1-DICHLOROETHENE	BDL	BROMOFORM	BDL
1,1-DICHLOROETHANE	BDL	2-HEXANONE	BDL
TRANS-1,2-DICHLOROETHENE	BDL	4-METHYL-2-PENTANONE	BDL
CHLOROFORM	BDL	TETRACHLOROETHENE	BDL
1,2-DICHLOROETHANE	BDL	1,1,2,2-TETRACHLOROETHANE	BDL
2-BUTANONE	BDL	TOLUENE	BDL
1,1,1-TRICHLOROETHANE	BDL	CHLOROBENZENE	BDL
CARBON TETRACHLORIDE	BDL	ETHYL BENZENE	BDL
VINYL ACETATE	BDL	STYRENE	240
BROMODICHLOROMETHANE	BDL	TOTAL XYLENES	130
1,2-DICHLOROPROPANE	BDL		

SURROGATE RECOVERY, %

1,2-DICHLOROETHANE, D4	95
BENZENE, D6	99
TOLUENE, D8	22
BROMOFLUOROBENZENE	70

BDL = BELOW DETECTION LIMIT, 50.00 ng/tube
NA = NOT ANALYZED

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
VOLATILE ORGANIC COMPOUNDS

ERT NO LF860453
ID LAB FORTIFICATION
DATE ANALYZED 6/23/86

PARAMETER	% RECOVERY
1,1-DICHLOROETHENE	73
TRICHLOROETHENE	56
BENZENE	71
TOLUENE	68
CHLOROBENZENE	42

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
QUALITY CONTROL CHECK SAMPLES
VOLATILE ORGANIC COMPOUNDS

ERT NO: LF860457
ID: LAB FORTIFICATION
DATE ANALYZED: 6/24/86

PARAMETER	% RECOVERY
1,1-DICHLOROETHENE	100
TRICHLOROETHENE	82
BENZENE	102
TOLUENE	78
CHLOROBENZENE	53

ERT ANALYTICAL LABORATORY
 SUMMARY OF ANALYTICAL RESULTS
 NON-EPA 624/HSL TARGET COMPOUNDS QUANTITATED

CLIENT: MALCOMN PIRNIE
 UNITS: ng/tube

ERT NO:	35484	35486	35490
ID:	B-206	B-208	B-212

PARAMETER				DETECTION LIMIT
-----	-----	-----	-----	-----
CYCLOPENTANE	BDL	BDL	BDL	50
CYCLOHEXANE	BDL	BDL	BDL	50
1,2-DIBROMOETHYLENE	BDL	BDL	BDL	50
3-HEPTANONE	2200	BDL	BDL	125
2,6-DIMETHYL-4-HEPTANONE	17000	210	BDL	125

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
NON-EPA 624/HSL TARGET COMPOUNDS QUANTITATED

CLIENT MALCOMN PIRNIE
UNITS ng/tube

ERT NO:	35492	35494	35498
ID:	B-214	B-216	B-220

PARAMETER				DETECTION LIMIT
-----	-----	-----	-----	-----
CYCLOPENTANE	BDL	BDL	BDL	50
CYCLOHEXANE	BDL	BDL	BDL	50
1,2-DIBROMOETHYLENE	BDL	BDL	BDL	50
3-HEPTANONE	BDL	BDL	BDL	125
2,6-DIMETHYL-4-HEPTANONE	BDL	700	BDL	125

ERT ANALYTICAL LABORATORY
SUMMARY OF ANALYTICAL RESULTS
NON-EPA 624/HSL TARGET COMPOUNDS QUANTITATED

CLIENT: MALCOMN PIRNIE
UNITS: ng/tube

ERT NO: 35500
ID: B-222

PARAMETER		DETECTION LIMIT
-----	-----	-----
CYCLOPENTANE	BDL	50
CYCLOHEXANE	BDL	50
1,2-DIBROMOETHYLENE	BDL	50
3-HEPTANONE	1500	125
2,6-DIMETHYL-4-HEPTANONE	8600	125

SUMMARY OF ANALYTICAL RESULTS
NON-TARGET COMPOUNDS
VOLATILE ORGANICS

CLIENT: MALCOM PIRNIE
ERT NUMBER: 35492
CLIENT ID: B-214

TENTATIVE ID	SCAN #	BASE PEAK (M/Z)	CONC. (NG/TUBE)
2-ETHYL-4-METHYL-1,3-DIOXOLANE	448	87	850
UNKNOWN	622	105	340
NITROMETHANE	54	61	420
2-PROPENENITRILE	151	53	560
CYCLOHEXENE	335	67	130
2-2'-OXYBIS-PROPANE	389	45	170
TETRAHYDROFURAN	223	42	190
2,4(3H,5H)-FURANDIONE	498	100	76
1,4-DICHLOROBENZENE	757	146	190
UNKNOWN	840	77	160
2,5-DIMETHYL-1,4-DIOXANE	484	42	260
UNKNOWN	706	69	20

SUMMARY OF ANALYTICAL RESULTS
NON-TARGET COMPOUNDS
VOLATILE ORGANICS

CLIENT: MALCOM PIRNIE
ERT NUMBER: 35486
CLIENT ID: B-208

<u>TENTATIVE ID</u>	<u>SCAN #</u>	<u>BASE PEAK (M/Z)</u>	<u>CONC. (NG/TUBE)</u>
2-PROPENENITRILE	159	53	
2-ETHYL-4-METHYL-1,3-DIOXOLANE	447	87	5100
UNKNOWN	529	87	2200
2-4-DIMETHYLOCTANE HEPTANE	621	43	310
UNKNOWN	49	52	320
METHYL ESTER FORMIC ACID	82	60	870
DIMETHOXYMETHANE	203	45	1900
UNKNOWN	267	49	1900
CYCLOHEXENE	338	67	89
2,2'-OXYBIS-PROPANE	389	45	160
UREA	104	60	230
UNKNOWN	323	43	300
2,5-DIMETHYL-1,4-DIOXANE	483	42	7.3
UNKNOWN	501	100	250
UNKNOWN	760	146	82
2-(FORMYLOXY)-1-PHENYLETHANONE	871	77	42
UNKNOWN	598	57	16
UNKNOWN	709	69	9.8
UNKNOWN	818	57	8.1
			53

SUMMARY OF ANALYTICAL RESULTS
NON-TARGET COMPOUNDS
VOLATILE ORGANICS

CLIENT: MALCOM PIRNIE
ERT NUMBER: 35498
CLIENT ID: B-220

TENTATIVE ID	SCAN #	BASE PEAK (M/Z)	CONC. (NG/TUBE)
DIMETHOXYMETHANE	189	45	2700
BENZONITRILE	626	103	500
BENZALDEHYDE	644	77	200
CHLORODIFLUOROMETHANE	43	51	120
METHYL ESTER FORMIC ACID	59	60	120
UNKNOWN	81	45	380
UNKNOWN	126	45	750
CYCLOHEXENE	337	67	40
2,2'-OXYBIS-PROPANE	391	45	90
2-ETHYL-4-METHYL-1,3-DIOXOLANE	473	87	97
2,4(3H,5H)-FURANDIONE	499	146	72
UNKNOWN	548	57	33
UNKNOWN	811	57	11
1,4-DICHLOROBENZENE	755	146	46

SUMMARY OF ANALYTICAL RESULTS
NON-TARGET COMPOUNDS
VOLATILE ORGANICS

CLIENT: MALCOM PIRNIE
ERT NUMBER: 35494
CLIENT ID: B-216

TENTATIVE ID	SCAN #	BASE PEAK (M/Z)	CONC. (NG/TUBE)
ETHANOL	137	45	770
DIMETHOXYMETHANE	194	45	2400
UNKNOWN	47	52	110
UNKNOWN	58	202	58
UNKNOWN	84	60	480
2-PROPENENITRILE	165	53	280
UNKNOWN	207	46	17
1,1-DICHLORO-1-NITROETHANE	296	97	38
CYCLOHEXENE	338	67	48
2,2'-OXYBIS-PROPANE	390	45	93
UNKNOWN	485	57	28
TRICHLOROMETHANE	238	83	79
UNKNOWN	668	106	11
UNKNOWN	852	57	21

APPENDIX F
JUSTIFICATION FOR TECHNICAL APPROACH PROPOSED FOR
THE MEASUREMENT OF POLYCHLORINATED DIBENZODIOXINS (PCDDS)
AND POLYCHLORINATED DIBENZOFURANS (PCDFS)
PRESENTED AT MAY 7, 1986 TAP MEETING
MWCC TREATMENT FACILITY
ST. PAUL, MINNESOTA

Non-Criteria Emissions Monitoring Program
Technical Approach for the Measurement
of Polychlorinated Dibenzodioxins (PCDDs) and
Polychlorinated Dibenzofurans (PCDFs)
(ERT Project E-081 May 1986)

Background

A non-criteria emissions test program is presently scheduled to take place in May of 1986 at a municipal sewage sludge treatment facility operated by the Metropolitan Waste Control Commission (MWCC) in St. Paul Minnesota. The emissions test program is comprised of monitoring for a variety of organic and inorganic parameters in an effort to provide a baseline or initial characterization of incinerator flue gas emissions at the facility. As is customary in emissions monitoring programs of this type, the project work scope contains provisions for monitoring of toxic organic emissions, including polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Previous PCDD/PCDF testing conducted at the MWCC facility in 1985 by Radian Corporation and sponsored by the EPA provided results that at the present time have not been fully accepted by the MPCA and other interested parties. As a consequence, it is the intention of the present monitoring PCDD/PCDF program to provide data to both supplement the existing EPA data and perhaps allay some of the reservations that the MWCC and MPCA may have about the existing EPA data. Accordingly, ERT's approach to the PCDD/PCDF monitoring issue will address each of these objectives, while at the same time provide a data product of verifiable quality.

Scope Summary

ERT will collect two sets of flue gas samples while the incinerator is operating under normal or "steady state" load conditions. One run per previous discussions with MPCA will consist of an extended 12 hour sampling period, while the second run will consist of two (2) collocated sampling trains scheduled to operate for a 6 hour sampling interval. In all instances, the samples collected will represent the combined particulate and vapor phases present in the flue gas emissions. All samples, per the discussion contained in the ERT Test Plan, will be collected using the ASME Sampling Train specified by the U.S. EPA for use in the National Dioxin Strategy - Tier IV Combustion Source Investigation. All samples will be transferred to California Analytical Laboratories (CAL) in Sacramento, California, to undergo PCDD/PCDF analyses. So as to provide data consistent with the existing EPA test data on the MWCC unit, as well as the majority of the state-of-the-art PCDD/PCDF data in the open literature analyses will be provided for tetra through octa PCDDs and PCDFs. Quality control measures peculiar to this testing program will include the use of field blanks, isotopically labeled surrogate compounds (applied to the sample collection system as a measure of accuracy for the combined sampling and analysis system), a pair of collocated samples collected simultaneously (as a measure of precision), and duplicate analyses of the extended 12 hour sampling run (as a measure of precision for the laboratory analyses scheme). The discussion to follow will further outline and substantiate ERT's approach to the PCDD/PCDF monitoring program, including field sample collection, analytical requirements, including anticipated detection limits (pg/m^3), and quality assurance/quality control measures. Particular attention has been focused on those issues raised by written comments, and in previous discussions with MPCA personnel.

Sample Collection

ERT has opted to collect a total of five samples for PCDDs/PCDFs. These will consist of three actual flue gas samples and two field blanks, resulting in a total of six actual samples for analyses, as specified in the existing Work Scope and Test Plan. All samples will be collected using the ASME sampling train specified by EPA which actually is a Method 5 particulate train modified to contain a polymeric sorbent cartridge for the collection of gaseous components. In response to our discussions with MPCA, ERT has opted to extend one of the sampling runs to an interval of 12 hours in an attempt to optimize flue gas detection limits. ERT selected this approach in lieu of the alternative of using the EPA Source Assessment Sampling System (SASS), as suggested by MPCA for the collection of larger sample volumes. It has been ERT's experience that the SASS train is not suitable for this sort of monitoring primarily because of difficulties in establishing and maintaining isokinetic sample flow rates, as well as difficulties in traversing the stack diameter, hence, resulting in non-representative flue gas samples. Furthermore, the SASS train is not presently sanctioned by the EPA for use in programs of this nature.

In response to comments received on method precision, ERT has selected to operate two (2) collocated sampling trains during the second PCDDs/PCDFs sampling run. These will be operated simultaneously for a period of approximately 6 hours. It is anticipated that these samples will provide a measure of precision for the combined sampling and analysis scheme. A total sample volume of 8 m^3 is projected for each of these samples.

Additionally, per comments received from MPCA in direct response to the existing Radian/EPA data, ERT will make use of two isotopically labeled surrogate compounds as a means to measure both the accuracy (retention efficiency) and the precision of the entire sample collection and analysis scheme. ERT is recommending that the two surrogate compounds be placed directly in the glass sorbent trap just prior to commencement of sample collection. The surrogate cocktail will consist of C_{13}^{37} - 2,3,7,8-TCDD and C_{13} - 1,2,3,4-TCDD. It is recommended that spiking levels of 3X and 10X the anticipated detection limits for native 2,3,7,8-TCDD (30 pg/m^3 , see Table 1) be used for the two surrogates, respectively.

This corresponds to spiking levels of $60\text{--}90 \text{ pg/m}^3$ for the C_{13}^{37} -2,3,7,8-TCDD and 300 pg/m^3 for the C_{13} - 1,2,3,4-TCDD. ERT realizes that these levels of sensitivity for TCDD are higher than those provided by the existing EPA/Radian data set, and also that the recommended spiking levels are higher than those requested by Ed Crowley of MPCA in his April 14, 1986 letter to Jim Brown of MWCC. However, after a series of conversations involving ERT technical staff and key technical members of EPA/RTP actively involved in the National Dioxin Strategy for Tier IV combustion sources, it was concluded that spiking levels of 2-3 times the anticipated lower detection limit (LDL) is more appropriate and technically sound than spiking at or near the LDL to assess the recovery efficiency of the sample collection and analysis system. ERT agrees with this recommendation and, therefore, has incorporated it into the technical Work Scope.

Analytical Measurements

As discussed previously, each of five field samples will undergo analyses for PCDDs/PCDFs (tetra through octa). As requested by MPCA, the 12 hour extended sampling run will be split into two identical portions immediately after extraction so as to provide a measure of precision specific to the analytical regime.

Anticipated detection limits (pg/m^3) for each of the respective PCDDs/PCDFs congener classes are provided in Table 1. Please note that these detection limits correspond to both the 6 hour samples, as well as the 12 hour extended sampling run, since the latter sample will be divided in two parts at the outset of the analytical scheme. Also, please note that the values provided here are conservative ones. In actual practice lower limits of sensitivity may be achievable as dictated primarily by matrix complexity, background interferences, and field and laboratory derived contamination. In some instances, the LDLs provided in Table 1 are somewhat higher than those achieved by the EPA/Radian data (2,3,7,8-TCDD $38 \text{ pg}/\text{m}^3$ vs. $10 \text{ pg}/\text{m}^3$) and in other instances, those provided here are lower than those reported by EPA/Radian. This is particularly true in the case of some of the higher molecular weight homologues. In any case, the anticipated conservative detection limits for this program, as well as those likely to be achieved in practice will not surpass the lower limit of detection of $10 \text{ pg}/\text{m}^3$ reported by EPA/Radian for 2,3,7,8-TCDD. Furthermore, the LDLs for the TCDDs/TCDFs in particular will most probably not satisfy the MPCA objectives to provide actual measured values for these congener classes, particularly if actual emission values are well below the existing EPA/Radian LDL of $10 \text{ pg}/\text{m}^3$. ERT, however, does not feel that detection limits far below $10 \text{ pg}/\text{m}^3$ are fully warranted and justified for combustion source monitoring. In our conversations during the past several weeks with members of EPA/RTP, they agreed with this conclusion. It has been ERT's observation on this issue that such LDLs are in fact commensurate with existing or proposed air quality guidelines for PCDDs/PCDFs in ambient atmosphere. A number of these are shown in Table 2. In our opinion, it does not appear practical or prudent to impose what are recognized to be stringent ambient air quality guidelines on emissions from stationary combustion sources. Certainly even an LDL of $30 \text{ pg}/\text{m}^3$ for TCDD when extrapolated via dispersion modeling to a maximum ground level ambient concentration can be expected to fall well below guidelines (AALs) such as those offered in Table 2.

TABLE 1

CALIFORNIA REGULATIONS
**MINIMUM DETECTABLE LEVEL FOR
 PCDD/PCDF ANALYSIS BY GC/MS FROM STACK EMISSIONS**

<u>Chemical</u>	<u>Minimum Picograms Detectable</u>	<u>Volume Air Sampled m³</u>	<u>Minimum Detectable Level in Stack pg/m³</u>
2,3,7,8 TCDD	300	8	37.5
Other TCDD	300	8	37.5
2,3,7,8 TCDF	300	8	37.5
Other TCDF	300	8	37.5
Penta CDD	1,000	8	125.0
Penta CDF	1,000	8	125.0
Hexa CDD	1,000	8	125.0
Hexa CDF	1,000	8	125.0
Hepta CDD	2,000	8	250.0
Hepta CDF	2,000	8	250.0
Octa CDD	5,000	8	625.0
Octa CDF	5,000	8	625.0

Volume of air samples calculation.

$$0.25 \text{ ft}^3/\text{min} \times 360 \text{ minutes} + 35.3147 = 7.6 \sim 8$$

TABLE 2 Dioxin Guidelines for MSW Incineration

Acceptable Ambient Concentrations Adopted
by Selected State and Municipal Regulatory Agencies (4-6)

<u>Agency</u>	<u>Parameter</u>	<u>Concentration</u>
New York DEC	TCDDS (Total)	0.092 pg/m ³
Mass DEQE	PCDDS/PCDFS (total)	1.1 pg/m ³ (Particulate)
		2.2 pg/m ³ (Gaseous)
Philadelphia	-	35 pg/m ³

APPENDIX G
TECHNICAL WORK SCOPE PROVIDED TO ENSECO-CAL LABORATORIES
BY ERT
FOR THE ANALYSES OF PCDDS/PCDFS

Technical Work Scope
PCDDS/PCDFS Analyses of Flue Gas Samples
Non-Criteria Emissions Monitoring Program
MWCC Sewage Sludge Incinerator

Sample Summary Listing

A total of five flue gas samples have been submitted for analyses. Each sample is comprised of a series of components which will be composited to create a single sample. A summary listing of the five samples submitted for analyses are provided in Table 1. This includes sample identification numbers, sample codes and corresponding descriptions for each component in a sample set.

Analytical Protocols

Analytical protocols to be employed should be consistent with those contained in the draft ASME protocols (copy enclosed) entitled, Analytical Procedures to Assay Stack Effluent Samples and Residual Combustion Products for Polychlorinated Dibenzodioxins (PCDD) and Polychlorinated Dibenzofurans (PCDF) (Draft, September 18, 1984). It is further understood that CAL may make use of modifications contained in their methods manual entitled, Total and/or 2, 3, 7, 8 - Substituted Dioxin and Furan Analyses. Such modifications can be implemented provided they have been sanctioned by the U.S. EPA for use in the analyses of flue gas samples for PCDDS and PCDFS.

Sample preparation protocols should proceed as outlined in the schematic provided as Figure 1. As noted, the individual components from each sampling train (particulate-filter, front half rinse, condensate extract, impinger extracts, and XAD-2 resin cartridge) will be combined such that a single sample extract results for each sampling train. The particulate filter is placed in the soxhlet extractor thimble along with

the contents of the corresponding XAD-2 sorbent trap. Both the front half probe rinse and the back half rinse are placed in the solvent reservoir of the soxhlet extractor. The condensate and impinger (2 and 3) aqueous samples are combined and extracted with methylene chloride. (PH adjustments should be made in a manner consistent with CAL's analytical protocol entitled, Total and/or 2, 3, 7, 8 - Substituted Dioxin and Furan Analyses). (The samples that remain after completion of the extraction procedures should be returned to their respective containers and placed in storage for future reference. These samples should be retained until the analytical data has been received and approved by ERT.)

Each of these solvent extracts are then combined and transferred to the solvent reservoir of the soxhlet extraction apparatus. The surrogate spiking mixture is placed in the soxhlet thimble that contains the particulate filter and the contents of the XAD-2 sorbent cartridge. Each sample should be extracted for a period of 8-12 hours. The balance of the analytical scheme should proceed in accordance with CAL's Standard Operating Procedures referenced above. This includes the analysis of all extracts for mono through octa chlorodibenzodioxins and mono through octa chlorodibenzofurans employing combined gas chromatography/mass spectrometry (GC/MS).

Results

Results are to be provided for each of the isomer categories listed in Table 2. This includes values for each of the eight PCDD and PCDF positional isomer categories, as well as 2, 3, 7, 8-TCDD and 2, 3, 7, 8-TCDF. Results should be provided in units of total picograms (pg) for each of these categories in each program sample. It is assumed that all reported data points will reflect method blank corrected values. It is our understanding that at a minimum (at the worst) the lower limits of detection stated in Table 2 will be achieved for each of the respective isomer categories. (In

conversations with CAL technical staff, it was brought to our attention that detection limits lower than those provided in Table 2 can probably be achieved in practice.)

Quality Control Requirements

Quality control measures should be consistent with those contained in CAL's Quality Assurance Manual (January 1986, Version 3.3, copy attached). These should include, at a minimum, the use of laboratory method blanks, laboratory fortified spikes, laboratory performance check samples, and isotopically labeled surrogates and internal standards in each sample. Please note that in addition, the XAD-2 sorbent cartridge from each sample train has been fortified in the field with a surrogate mixture of Cl³⁷-2,3,7,8-TCDD and C¹³-1,2,3,4-TCDD, at concentrations of 1,000 picograms and 3,000 picograms, respectively.

Additional quality control requirements should include the use of formal chain of custody and document control procedures. At a minimum, these should include the following types of document control: custody records, sample tracking records, analyst logbook pages, computerized raw data summaries, and instrument logbook pages. In summary, sufficient information should be provided so as to permit ERT personnel to derive the data points provided by CAL, as well as verify sample handling and integrity.

Summary of Reporting Requirements and Deliverables

A summary of the reporting requirements, deliverables, and other supplementary information, to be provided as part of the contractor's obligations, are as follows:

- Total pg quantities in each sample reported for each of the isomer categories listed in Table 2. This applies to all method blanks, field blanks, field samples, and laboratory derived quality control samples.
- Results of all quality control analyses, including spikes, replicates, and performance check/evaluation samples. Spiked sample data should include ng applied, ng recovered, as well as % recovery data.
- Results of performance evaluation samples recently completed by CAL as offered in Section V of the CAL QA Manual.
- Results of all field surrogate analyses to include quantities of $^{37}\text{Cl}_4$ - 2,3,7,8 TCDD and C^{13} -1,2,3,4-TCDD applied and recovered from each and every program sample. Recovery data (%) for the surrogate compounds should also be provided. Similar results for laboratory introduced surrogate compounds should also be provided.
- Results of all of the daily performance check samples pertinent to the set of samples submitted for analysis. The performance check solution and the calibration solution data are needed to demonstrate GC and MS resolution, sensitivity, response factor reproducibility, as well as mass range calibration.
- Copies of actual selected ion current profiles (SICPS) and raw and background subtracted spectra pertinent to each sample.
- Copies of all calibrant response factor calculations, plotted concentration calibration curves and computer derived quantitation reports.

- A chronological list of all analyses performed including the data system file name, ERT sample number for each sample blank, concentration calibration solution, and performance check solution. This shall include all labeled peaks for PCDD/PCDF isomers, as well as the internal standards and surrogates.
- The accompanying document control and chain of custody package should include original sample tags, custody records, sample tracking records, analyst logbook pages, computer printouts, raw data summaries, and instrument logbook pages.

TABLE 1
FLUE GAS SAMPLE LISTING

Sample Description	Sample Code	Run 1A	ERT Sample Number		
			2A	2B	FBB-1 FBB-2
Particulate Filter	PCDD-X ^a -MM5-PP	B-166	169	161	B-172 164
Front Half Rinse ^b	PCDD-X ^a -MM5-FH	PCDD-1A- MM5-FH	PCDD-2A- MM5-FH	PCDD-2B- MM5-FH	PCDD-1- MM5-FH PCDD-2- MM5-FHB
Impinger Catch #2 and #3	PCDD-X ^a -MM5-IMP 2 & 3	PCDD-1A- MM5-IMP	PCDD-2A- MM5-IMP	PCDD-2B- MM5-IMP	PCDD-1- MM5-IMP-B PCDD-2- MM5-IMP 2 & 3 B
Condensate ^c	PCDD-X ^a -MM5-CD	PCDD-1A- MM5-CD	PCDD-2A- MM5-CD	PCDD-2B- MM5-CD	PCDD-1- MM5-CD PCDD-2- MM5-CDB
XAD-2 Resin Trap	PCDD-X ^a -MM5-XR	1526	1516	1527	1533 1522
Condensate ^c #2	PCDD-X ^a -MM5-CD2		PCDD-2A- MM5-CD2	PCDD-2B- MM5-CD2	

^a Where X denotes run number.

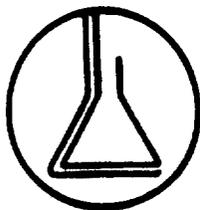
^b Remarks on ERT chain-of-custody forms indicate rinse solvent for appropriate sample. For example, front half rinse means 1:1 (v/v) acetoane/hexane.

^c Condensate was emptied from the sample trains part way through the run, thus creating two condensate samples for runs 2A and 2B. "Condensate" and "Condensate 2" may be combined for each sample run.

TABLE 2
 CALIFORNIA ANALYTICAL LAB'S MINIMUM
 DETECTABLE LEVELS FOR PCDDS/PCDFS

<u>Isomer Category</u>	<u>Quantity in Picograms (pg)</u>
Mono CDD	-
Mono CDF	-
Di CDD	-
Di CDF	-
Tri CDD	-
Tri CDF	-
2,3,7,8 TCDD	300
Other TCDD	300
2,3,7,8 TCDF	300
Other TCDF	300
Penta CDD	1,000
Penta CDF	1,000
Hexa CDD	1,000
Hexa CDF	1,000
Hepta CDD	2,000
Hepta CDF	2,000
Octa CDD	5,000
Octa CDF	5,000

APPENDIX H
ENSECO-CAL LABORATORIES
PCDDS/PCDFS DATA SHEETS



California Analytical Laboratories, Inc.
2544 Industrial Boulevard • West Sacramento, CA 95691 • (916) 372-1393

August 7, 1986
Lab No. 24394
Received: 5/24/86
Project: E-081

Richard Graziano
Environmental Research & Tech
696 Virginia Road
Concord, MA 01742

Twenty-seven samples were received under chain of custody in various containers to be analyzed for mono-octa chlorodioxins and furans.

<u>CAL I.D.</u>	<u>Sample I.D.</u>
24394-1	PCDD-1A-MM5-XR-1525 XAD TRAP #1525
-2	PCDD-1-MM5-XR-B-1533 BLANK TRAIN #1533
-3	PCDD-1A-MM5-CD
-4	PCDD-1A-MM5-IMP 2&3
-5	PCDD-1-1MM5-CD-B BLANK TRAIN
-5	PCDD-1-MM5-IMP 2&3B BLANK TRAIN
-7	PCDD-1-MM5-PF-B BLANK #B-172
-3	PCDD-1A-MM5-PF #B-166
-9	PCDD-1A-MM5-FRONT END
-10	PCDD-2A-MM5-FH
-11	PCDD-2B-MM5-FH
-12	2A-MM5-PCDD-CD
-13	2B-MM5-PCDD-CD
-14	PCDD-2A-MM5-IMP 2&3
-15	PCDD-2B-MM5-IMP 2&3
-16	2A-MM5-PF #B-169
-17	2B-MM5-PF #B-161
-28	MM5-PF BLANK #B-164
-19	PCDD-2-MM5-FHB
-20	PCDD-2-MM5-IMP 2&3B
-21	PCDD-2-MM5-CDB
-22	PCDD-2-MM5-XRB XAD BLANK #1522
-23	PCDD-2A-MM5-XR XAD TRAP #1516
-24	2B-MM5-XR XAD TRAP #1527
-25	PCDD-1-MM5-FHB BLANK
-26	PCDD-2A-MM5-CD#2
-27	PCDD-2B-MM5-CD#2

RESULTS

Samples were composited and analyzed per your letter of June 13, 1986. We did have a low level of hepta and octa dioxin present in the method blank, forcing us to report the low levels in the samples as MPC values (maximum possible concentration). It was not possible to run a duplicate or native spike analysis because of the nature of the samples, so only a method blank spike was analyzed and reported.

Michael J. Mille
Michael J. Mille, PhD
Vice President

jb

This report is for the sole and exclusive use of the client to whom it is addressed.

Quantities not destroyed in testing are retained a maximum of thirty (30) days unless otherwise requested.

California Analytical Laboratories, Inc.

POLYCHLORINATED DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: RUN 1A Date Analyzed: 7/25/86 Column: DB-5

CAL ID: 24894-1C Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
tetra (total)	5.3	-
penta	0.65	-
hexa	ND	0.45
hepta	ND	0.69
octa	ND	2.5
DIOXINS		
tetra (total)	ND	0.19
penta	ND	0.45
hexa	ND	0.55
hepta	MPC	3.2
octa	MPC	11.3

ND = Not Detected

MPC - Maximum Possible Concentration; See Cover Letter

PREPARED BY: *DS*

APPROVED BY: *ADVA*

DATE: 8/7/86

California Analytical Laboratories, Inc.

MONO THRU TETRA
DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: RUN 1A Date Analyzed: 7/29/86 Column: SP-2331
CAL ID: 24894-1C Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
2,3,7,8-TCDF	0.94	-
Mono (total)	ND	0.12
Di (total)	ND	2.5
Tri (total)	0.25	-
DIOXINS		
2,3,7,8-TCDD	ND	0.11
Mono (total)	ND	0.31
Di (total)	14.4	-
Tri (total)	0.55	-

ND = Not Detected

PREPARED BY: *[Signature]*

APPROVED BY: *bsm*

DATE: 8/3/86

California Analytical Laboratories, Inc.

POLYCHLORINATED DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: RUN 2A

Date Analyzed: 7/25/86 Column: DB-5

CAL ID: 24894-10C

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
tetra (total)	26.3	-
penta	4.1	-
hexa	0.56	-
hepta	0.50	-
octa	1.4	-
DIOXINS		
tetra (total)	ND	0.24
penta	ND	0.22
hexa	ND	0.50
hepta	MPC	3.9
octa	MPC	15.0

ND = Not Detected

MPC - Maximum Possible Concentration; See Cover Letter

PREPARED BY: 

APPROVED BY: 

DATE: 8/7/86

California Analytical Laboratories, Inc.

MONO THRU TETRA
DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: RUN 2A

Date Analyzed: 7/29/86 Column: SP-2331

CAL ID: 24894-10C

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
2,3,7,8-TCDF	3.6	-
Mono (total)	2.5	-
Di (total)	ND	5.3
Tri (total)	10.3	-
DIOXINS		
2,3,7,8-TCDD	ND	0.14
Mono (total)	ND	1.1
Di (total)	31.6	-
Tri (total)	1.7	-

ND = Not Detected

PREPARED BY: *B*

APPROVED BY: *ASM*

DATE: *7/26*

California Analytical Laboratories

A DIVISION OF
ENSECO

California Analytical Laboratories, Inc.

POLYCHLORINATED DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: FBB-1

Date Analyzed: 7/25/86 Column: DB-5

CAL ID: 24894-2C

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
tetra (total)	ND	0.11
penta	ND	0.56
hexa	ND	0.21
hepta	ND	0.42
octa	ND	1.5
DIOXINS		
tetra (total)	ND	0.11
penta	ND	0.45
hexa	ND	0.48
hepta	MPC	2.0
octa	MPC	6.3

ND - Not Detected

MPC - Maximum Possible Concentration; See Cover Letter

PREPARED BY: DR

APPROVED BY: [Signature]

DATE: 8/6/86

California Analytical Laboratories

A DIVISION OF
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MONO THRU TETRA
DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: FBB-1

Date Analyzed: 7/29/86 Column: SP-2331

CAL ID: 24894-2C

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
2,3,7,8-TCDF	ND	0.13
Mono (total)	ND	0.15
Di (total)	ND	7.6
Tri (total)	ND	0.14
DIOXINS		
2,3,7,8-TCDD	ND	0.14
Mono (total)	ND	0.37
Di (total)	ND	2.2
Tri (total)	ND	0.098

ND = Not Detected

PREPARED BY: JS

APPROVED BY: BSM

DATE: 8/3/86

California Analytical Laboratories, Inc.

POLYCHLORINATED DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: FBB-2

Date Analyzed: 7/25/86 Column: DB-5

CAL ID: 24894-18C

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
tetra (total)	ND	0.14
penta	ND	0.52
hexa	ND	0.43
hepta	ND	0.70
octa	ND	2.0
DIOXINS		
tetra (total)	ND	0.24
penta	ND	0.65
hexa	ND	0.70
hepta	MPC	2.9
octa	MPC	11.0

ND = Not Detected

MPC - Maximum Possible Concentration; See Cover Letter

PREPARED BY: DA

APPROVED BY: 1/12/1

DATE: 8/7/86

California Analytical Laboratories, Inc.

MONO THRU TETRA
DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: FBB-2 Date Analyzed: 7/29/86 Column: SP-2331
CAL ID: 24894-18C Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
2,3,7,8-TCDF	ND	0.23
Mono (total)	ND	0.43
Di (total)	ND	4.9
Tri (total)	ND	0.42
DIOXINS		
2,3,7,8-TCDD	ND	0.20
Mono (total)	ND	0.81
Di (total)	ND	0.50
Tri (total)	ND	0.26

ND = Not Detected

PREPARED BY: DB

APPROVED BY: BSM

DATE: 8/2/86

SURROGATE RECOVERIES FOR 37C1-2378-TCDD
AND 13C1-1234-TCDD

TICKET NO. 24894

CAL ID	CLIENT ID	%RECOVERY 37C1-2378-TCDD	%RECOVERY 13C-1234-TCDD
24894-2C	FBB-1	106%	82%
24894-18C	FBB-2	106%	68%
24894-1C	RUN 1A	112%	77%
24894-10C	RUN 2A	127%	74%
24894-11C	RUN 2B	117%	96%

PREPARED BY: *DB*

APPROVED BY: *WJM*

DATE: 8/7/86

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QUALITY CONTROL SUMMARY

CASE NO: 24894

EPA ID: METHOD BLANK NATIVE SPIKE

CAL ID: 24894MBNS

FURANS	ng/g Found in Sample	ng/g Spiked	ng/g Found in NS Sample	NS % Recovery
2,3,7,8-TCDF	ND	10.0	11.7	117%
penta (12378)	ND	10.0	9.4	94%
hexa (123478)	ND	10.0	11.5	115%
hepta (1234678)	ND	10.0	9.5	95%
octa (total)	ND	50.0	62.3	125%
DIOXINS				
2,3,7,8-TCDD	ND	10.0	12.1	121%
penta (12378)	ND	10.0	6.4	64%
hexa (123478)	ND	10.0	12.3	123%
hepta (1234678)	ND	10.0	15.5	155%
octa (total)	ND	50.0	65.2	130%

PREPARED BY:

APPROVED BY:

DATE: 8/7/96



California Analytical Laboratories, Inc.

POLYCHLORINATED DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: METHOD BLANK Date Analyzed: 7/25/86 Column: DB-5

CAL ID: 24894MB

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
tetra (total)	ND	0.058
penta	ND	0.23
hexa	ND	0.13
hepta	ND	0.56
octa	ND	3.0
DIOXINS		
tetra (total)	ND	0.060
penta	ND	0.19
hexa	ND	0.28
hepta	2.5	-
octa	10.0	-

ND = Not Detected

PREPARED BY: DS

APPROVED BY: MM

DATE: 8/7/86

California Analytical Laboratories

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California Analytical Laboratories, Inc.

MONO THRU TETRA
DIOXIN/FURAN ANALYSIS

TICKET NO. 24894

CLIENT ID: METHOD BLANK Date Analyzed: 7/25/86 Column: SP-2331

CAL ID: 24894MB

Weight: EXTRACT

FURANS	AMOUNT FOUND (ng/extract)	DETECTION LIMIT (ng/extract)
2,3,7,8-TCDF	ND	0.045
Mono (total)	ND	0.028
Di (total)	ND	3.6
Tri (total)	ND	0.034
DIOXINS		
2,3,7,8-TCDD	ND	0.035
Mono (total)	ND	0.093
Di (total)	ND	0.10
Tri (total)	ND	0.034

ND - Not Detected

PREPARED BY: DB

APPROVED BY: BSM

DATE: 7/29/86

California Analytical Laboratories

A DIVISION OF
ENSECO

APPENDIX I
ERT FIELD NOTES SUMMARY

(Memo from R. Graziano to Jeff Lauria May 30, 1986)



ENVIRONMENTAL RESEARCH & TECHNOLOGY INC

MEMORANDUM

TO: Jeff Lauria MEMO NO.:

FROM: Richard Graziano FILE: E081-800

SUBJECT: Non-Criteria Emissions Test DATE: May 30, 1986
Program of the MWCC Metro Plant
St. Paul, Minnesota

The following is a synopsis of daily events that transpired during the sampling program the week of May 18-23, 1986.

Sunday, May 18, 1986

All field crew members departed Boston for St. Paul, Minnesota.

Monday, May 19, 1986

Field crew arrived on-site. Equipment was set up on stack #7 and 8. MWCC personnel removed sections of the hand rails on stack 7 and 8 to accommodate ERT's sample trains. A staff meeting was held at Ms. Joanne Hart's request with the shift operations managers to discuss the incinerators operation during this program and also what ERT's test schedules will be. Sludge feed to the incinerators will be started at 7:00 am Tuesday. The 3 am shift will ensure the incinerators are ready. Natural gas readings will be recorded hourly. Roll press, feed rates, etc. will be recorded by designated plant personnel.

The semi-volatile and the particulate/trace metals trains were set up on unit #7. The CEM system, VOST and simultaneous Dioxin trains were set up on unit #8.

The Dioxin resin traps could not be set out until the spiking process was conducted on Tuesday morning. Also, no preliminary velocity and temperature profiles were performed due to the incinerators being down. This would be conducted Tuesday morning.

Tuesday, May 20, 1986

All ERT personnel arrived on-site. Surrogate spiking of the Dioxin sample trains resin traps was conducted at Administration Building recovery and storage area.

Velocity and temperature profiles were performed on stacks 7 and 8. The Dioxin trains were set up and initial leak check conducted. There were delay problems in starting the test due to the initial leak checks. These problems were resolved and the tests were started by late morning.

Two hours into the Dioxin run, Dioxin train 1-B sample pump malfunctioned resulting in the loss of that sample train. A meeting was held with plant operations personnel to discuss Wednesday's sampling program. Incinerator #8 will be used for the remainder of the test program; #7 incinerator will be on standby.

It was noted that the flue gas plume was quite clean during the test program. C. McGinsley of McGinsley Associates also was aware of the unusually clean plume.

All runs were completed and recovered. Sample trains were set up for testing on Wednesday.

Wednesday, May 21, 1986

Conducted 2-3 hour semivolatiles runs, 2-3 hour particulate/trace metals runs, 2 VOST runs and CEM's.

A decision was made between Jim Brown and Steve Greenwood that we will continue test on #8 stack if scum feed were to go down again during the test. Sampling was put on hold for approximately 10 minutes due to excessively high velocities. This was due to the 100% opening of dampers on #3 hearth.

* MPCA observer arrived on-site to witness sampling. She required that back half analysis be conducted on the particulate train #2 and 3. (This is out-of-scope.) Recovered samples and set up for Dioxin test.

Thursday, May 22, 1986

ERT was on site and ready to conduct the simultaneous 12-hour Dioxin test. Testing was put on hold for 3 1/2 hours due to sludge hopper feed problems. ERT remained set up on #8 stack because it would have taken 3-4 hours to transfer to #7 stack. 10-hour Dioxin test was started late morning.

Ed. Crowley, MPCA, arrived on site and we discussed dropping the 12-hour test and conducting a 10-hour test due to down time which we agreed upon.

Sample trains were shut down after 9 1/2 hours of sampling due to a high pressure drop in one of the trains. All samples were recovered and stored.

Friday, May 23, 1986

All equipment was packed for return to ERT. Dioxin samples were Federal Expressed to Cal Labs in California.

In general, ERT would like to thank the MWCC Metro Plant personnel for assistance in moving equipment, providing additional electrical power, and flood lights for the Thursday evening tests. Their response to our needs was greatly appreciated.


Richard Graciano

/jm

APPENDIX J
MWCC LETTER TO MALCOLM PIRNIE

(Bryce J. Pickart to
Jeff Lauria August 12, 1986)



August 12, 1986

Dr. Jeff Lauria
Malcolm Pirnie, Inc.
2 Corporate Park Drive
Box 751
White Plains, New York 10602

Subject: Metro Plant Non-Criteria Emissions Test
Project No. 85-56-318

Dear Dr. Lauria:

I previously sent you copies of pertinent operating logs and strip charts covering the May 20-22, 1986, non-criteria emissions tests on the Metro Plant sludge incinerators. Also sent at that time were copies of the operating log and strip chart for a similar period in February, 1986, to demonstrate that the operating conditions during the non-criteria emissions test were representative of normal operating conditions.

Table 1 presents information on sludge and scum feed rates and characteristics for the non-criteria emission test period. This should provide you with the remaining operating data that you need to evaluate the test results.

In your June 3, 1986, letter to MWCC, you requested a brief opinion/comparison statement regarding test conditions and normal operating conditions. As expressed in your letter, parameters of concern are:

1. Sludge feed solids (percent)
2. Sludge feed rate (dry pounds per hour)
3. Stack oxygen (percent)
4. Opacity (percent)
5. Temperature profiles (°F)
6. Air flows (shaft cooling, sludge and burner combustion) (cfm)
7. Sludge BTU content (BTU/lb)

Table 2 compares long-term sludge incinerator operating data (May 1985 to June 1986) with operating conditions during the non-criteria emission test. General observations:

1. Sludge cake was drier than average but within the range of conditions normally encountered.
2. Sludge feed rate was slightly higher than average but within the normal operating range.

Dr. Jeff Lauria
Page 2
August 12, 1986

3. Stack oxygen content that you gave us for non-criteria emission test as preliminary data for review appears to be questionable for Run 3 on May 21 and for both runs on May 22. Our mode of operation to use excess air for combustion hearth cooling results in stack oxygen content of 12-16%. Please check your data.
4. Opacity during non-criteria emissions test was about 5%, which is lower than average but within our normal operating range.
5. Incinerator temperature profiles were well within the normal range. Hearth O temperature was above average, because the cake was drier than average. The operating data for February, 1986, that was submitted to you earlier, demonstrates that there are extended periods when hearth O temperature exceeds 1200 deg. F. The non-criteria emission test operating conditions were "normal", though not "average".
6. Sludge heat content was normal during the non-criteria emission test.
7. Sludge mixture was normal during the non-criteria emission test.
8. Scrubber operating conditions were normal during the non-criteria emission test.

Conclusions regarding operating conditions during the sludge incinerator non-criteria emission test are as follows:

1. Operating conditions were consistent with the approved test plan.
2. Operating conditions fell within the normal range experienced during the past year.
3. Operating conditions were representative of normal sludge incinerator operation.

If you have any questions please call.

Sincerely,

Bryce J. Pickart

Bryce J. Pickart, P.E.
Process Assurance Manager

BJP:hw

cc: Lou Bartscher
Joanne Hart
Nadim Shamat

Steve Greenwood
Jim Brown
Helen Boyer

Robert Polta

Table 2. Comparison of Metro Plant Sludge Incinerator Operating Data During Non-Criteria Emission Test and During Long-Term Operation

Parameter	Long-Term Operation					Non-Criteria Emission Test
	Annual Average	Monthly		Daily		
		Min.	Max.	Min.	Max.	
Sludge Solids, %						
Total	34	32	36	25	44	37-42
Volatile	72	-	-	50	81	67-68
Sludge Feed, DTPH	2.6	2.2	3.0	1.8	3.7	2.8-3.2
Stack Oxygen, % (1)	14	12	16	-	-	-
Opacity, %	9	7	13	4	20	-
Temperature, deg. F.						
Hearth 0	1120	1080	1160	1000	1400	1210-1250
Hearth 1	1140	-	-	1000	1400	1140-1230
Hearth 2	1450	-	-	1200	1600	1410-1490
Hearth 3	1600	-	-	1200	1700	1600-1620
Hearth 4	1000	-	-	600	1300	910-980
Subcooler	68	60	75	55	80	63-74
Flue Gas Flow, dscfm (1)	19,000	14,000	23,000	-	-	-
Sludge Heat Value, Btu/lb.D.S. (2)	7,400	-	-	5,200	8,200	7050-7400
Gravity/Decant Ratio (3)						
Volume Basis	4	-	-	1.0	8	3.8-4.0
Mass Basis	2	-	-	0.6	4	1.4-1.6
Venturi Pressure Drop, in.w.c.	28	26	30	-	-	29-30
Scum Feed Rate, gph	25	20	30	0	70	24-33

Notes:

1. Based on 17 stack tests during 1985 and 1986. Stack oxygen and flue gas are not continuously measured.
2. Based on analyses of two samples per month.
3. Ratio of gravity thickened primary sludge to thermally conditioned (decant) sludge.

TABLE 3. METROPOLITAN PLANT SLUDGE INCINERATOR STACK TEST RESULTS (1986)

Parameter	3/6/1986	5/28/1986	6/4/1986	6/18/1986
	No. 8	No. 8	No. 10	No. 7
Air Emissions				
Particulates, lb.ton D.S.	0.86	1.08	0.91	1.15
Opacity, %	11	13	11	5
Odor Conc., odor units	103	273	133	290
Odor Rate, o.u./minute	2,400,000	5,600,000	2,400,000	6,400,000
Gas Flow Rate, dscfm	22,600	20,500	18,000	22,200
Temperature, deg. F.				
Hearth 0	1140	1060	1230	1240
Hearth 1	1150	1100	1200	1190
Hearth 2	1380	1370	1490	1580
Hearth 3	1600	1640	1610	1600
Hearth 4	990	1150	840	910
Breech	1100	1050	1190	1210
Precooler	500	410	490	490
Venturi	110	120	120	140
Subcooler	60	75	71	70
Pressure Drop, in. w.c.				
Venturi	30	30	30	30
Subcooler	5	3	3	5
Water Flow, gpm				
Precooler	270	240	290	290
Venturi	270	290	300	300
Subcooler	1600	1800	1800	1400
Dampers, % Open				
Hearth 2	0	0	0	16
Hearth 3	54	60	49	36
Hearth 8	12	10	10	11
Sludge Feed Rate				
Dry Ton/Hour	2.38	2.61	2.86	2.76
Wet Ton/Hour	7.25	7.52	7.52	7.56
Scum Feed Rate, gph	67	24	45	56
Auxiliary Burners	0	0	0	0
Gas Analysis, % V/V				
Carbon Dioxide	5.2	4.9	6.4	5.5
Oxygen	14.9	15.1	13.4	14.4
Moisture Content	3.2	4.8	3.2	3.4

METROPOLITAN PLANT SLUDGE INCINERATOR STACK COMPLIANCE TEST RESULTS

Parameter	8/1/1985 No. 7	8/14/1985 No. 8	8/28/1985 No. 9	5/24/1985 No. 10
Air Emissions				
Particulates, lb/ton D.S.	0.99	0.82	1.1	0.78
Odor Conc., odor units	153	671	208	41
Odor Rate, o.u./minute	3,300,000	15,000,000	3,800,000	700,000
Opacity, %	5	5	8	5
Temperature, deg. F.				
Hearth 0	1110	1140	1210	1010
Hearth 1	1080	1170	1180	1050
Hearth 2	1500	1420	1460	1360
Hearth 3	1610	1600	1610	1540
Hearth 4	1160	1130	1240	840
Breech	1050	1150	1190	1000
Precooler	500	500	520	500
Venturi	140	120	140	130
Subcooler	75	73	75	70
Pressure Drop, in. w.c.				
Venturi	33	30	28	30
Subcooler	4	4	3	3
Water Flow, gpm				
Precooler	300	310	300	250
Venturi	250	250	300	250
Subcooler	1400	NA	NA	1000
Dampers, % Open				
Hearth 3	42	51	63	12
Hearth 7	5	0	5	0
Hearth 8	12	11	15	5
Sludge Feed Rate				
Dry Ton/Hour	2.66	3.07	2.70	2.55
Wet Ton/Hour	7.8	8.5	8.3	8.6
Auxiliary Burners				
	0	2 (HO, Run 1)	0	2 (H4)
Gas Analysis, % V/V				
Carbon Dioxide	5.4	5.7	6.7	5.4
Oxygen	14.4	14.2	12.9	14.2
Moisture Content	4.7	4.5	4.6	4.2
Gas Flow Rate, dscfm				
	21,700	21,800	18,200	17,500

TABLE 9. METROPOLITAN PLANT SLUDGE INCINERATOR STACK TEST RESULTS

Parameter	5/30/1985 No. 8	6/26/1985 No. 9	7/11/1985 No. 8	7/25/1985 No. 8	8/8/1985 No. 8	8/23/1985 No.
Air Emissions						
Particulates, lb/ton D.S.	0.63	1.19	1.49	0.86	0.55	0.72
Odor Conc., odor units	24	71	44	45	19	150
Odor Rate, o.u./minute	500,000	1,100,000	900,000	800,000	400,000	3,200,000
Temperature, deg. F.						
Hearth 0	1060	1110	1200	1230	1020	1000
Hearth 1	1120	1100	1200	1240	1100	1050
Hearth 2	1410	1420	1400	1490	1440	1500
Hearth 3	1610	1560	1600	1600	1530	1640
Hearth 4	1100	1300	840	560	1050	1050
Breech	1030	1030	1200	1240	1000	1020
Precooler	510	500	490	480	480	550
Venturi	140	140	120	120	120	140
Subcooler	95	72	77	76	72	75
Pressure Drop, in. w.c.						
Venturi	30	30	25	30	25	30
Subcooler	5	3	4	4	4	4
Water Flow, gpm						
Precooler	300	350	240	240	250	240
Venturi	250	270	250	250	290	250
Subcooler	1000	1500	1700	1900	NA	1400
Dampers, % Open						
Hearth 3	43	56	40	13	22	50
Hearth 7	0	0	0	5	5	6
Hearth 8	11	10	9	10	10	10
Sludge Feed Rate						
Dry Ton/Hour	3.0	2.1	2.3	2.4	2.3	2.2
Wet Ton/Hour	8.3	6.8	6.8	7.0	7.1	7.0
Auxiliary Burners						
	0	0	0	0	0	0
Gas Analysis, % V/V						
Carbon Dioxide	5.0	5.4	5.5	6.1	4.9	5.0
Oxygen	16.2	14.4	14.5	14.0	15.3	14.0
Moisture Content						
	7.7	3.7	4.5	4.1	4.0	4.0
Gas Flow Rate, dscfm						
	20,800	15,100	20,400	18,700	19,900	21,300

* Tests were conducted by MWCC Quality Control Department. Odor panel members were

TABLE 9. METROPOLITAN PLANT SLUDGE INCINERATOR STACK TEST RESULTS

Parameter	10/22/1985 No. 9	10/30/1985 No. 9	11/7/1985 No. 9
Air Emissions			
Particulates, lb/ton D.S.	0.83	0.46	0.60
Odor Conc., odor units	143	256	261
Odor Rate, o.u./minute	2,700,000	3,600,000	4,000,000
Temperature, deg. F.			
Hearth 0	1280	1200	1210
Hearth 1	1270	1210	1170
Hearth 2	1510	1450	1450
Hearth 3	1600	1600	1600
Hearth 4	1180	1490	1280
Breech	1250	1150	1200
Precooler	520	500	490
Venturi	110	120	140
Subcooler	71	65	64
Pressure Drop, in. w.c.			
Venturi	30	30	25
Subcooler	3	2	3
Water Flow, gpm			
Precooler	330	300	350
Venturi	250	250	240
Subcooler	1200	1600	1400
Dampers, % Open			
Hearth 3	57	40	55
Hearth 7	4	2	0
Hearth 8	10	12	9
Sludge Feed Rate			
Dry Ton/Hour	3.4	3.5	2.8
Wet Ton/Hour	10.3	10.7	8.0
Auxiliary Burners			
	0	0	1
Gas Analysis, % V/V			
Carbon Dioxide	7.4	8.1	6.9
Oxygen	12.4	11.5	12.8
Moisture Content	4.0	3.4	3.4
Gas Flow Rate, dscfm			
	18,800	13,900	15,500

Control Department. Odor panel members were