

United States  
Environmental Protection  
Agency

Office Of Air Quality  
Planning And Standards  
Research Triangle Park, NC 27711

EPA-454/R-00-038a  
September 2000

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Air

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# **Source Characterization For Sewage Sludge Incinerators**

## **Executive Summary Report**

**Metropolitan Sewer District (MSD)  
Mill Creek Wastewater Treatment Plant  
Cincinnati, Ohio**

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EMISSIONS REPORT - VOLUME I OF III - METROPOLITAN SEWER DISTRICT (MSD) -  
MILL CREEK WASTEWATER TREATMENT PLANT, CINCINNATI, OHIO"  
EPA -454/R-00-038b - September 2000**

Please delete and replace the following text contained in the report.

Page 1-1      1.0 INTRODUCTION  
                 1.1 SUMMARY OF TEST PROGRAM

Delete the first and second paragraphs starting with: "The Clean Air Act Amendments"

Replace the second paragraph as follows:

This test report summarizes testing of a multiple hearth incinerator at the Metropolitan Sewer District (MSD) Mill Creek Wastewater Treatment Plant in Cincinnati, Ohio in July, 1999. The emissions data collected in this program will be used to provide information for EPA's Office of Water (OW) to determine the need for further emissions standards in the Section CFR 503 - Subpart E, Standards for Incineration of Sewage Sludge.

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**Please delete and replace the following text contained in the report.**

**Page 6            1.0 OVERVIEW**

**Delete the second paragraph starting with: “This executive summary report summarizes”**

**Replace the second paragraph as follows:**

**This executive summary report summarizes testing of a multiple hearth incinerator at the Metropolitan Sewer District (MSD) Mill Creek Wastewater Treatment Plant in Cincinnati, Ohio in July, 1999. The emissions data collected in this program will be used to provide information for EPA’s Office of Water (OW) to determine the need for further emissions standards in the Section CFR 503 - Subpart E, Standards for Incineration of Sewage Sludge.**

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For Review and Approval

Project No. G474001-02

Name	Initials	Date
Originator J Ferg	JAF	9/7/00
Concurrence		
Approved K Riggs	KR	9/12/00

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September 12, 2000

Mr. C. E. (Gene) Riley  
U.S. Environmental Protection Agency  
Emission Measurement Center  
MD-19  
Research Triangle Park, NC 27711

Dear Gene:

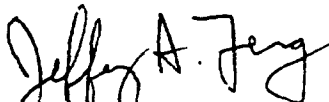
**Contract No. 68-D-99-009  
Work Assignment 2-01  
Executive Summary Report**

Enclosed for your use are 12 copies of the final Executive Summary Report (ESR) for Work Assignment 2-01 Source Characterization for Sewage Sludge Incinerator Emissions. The WordPerfect electronic file has also been transmitted to you.

The final DQA report will be forwarded to you next week. Battelle anticipates that this delivery will complete Work Assignment 2-01.

If you have any immediate questions on the enclosed ESR, please call me at 614-424-5970.

Sincerely,



Jeffery A. Ferg  
WA 2-01 Work Assignment Leader  
Atmospheric Science and Applied Technology

JAF:dlm

Enclosures

cc: Ms. Kathy Weant  
Ms. Sandra Clark

SOURCE CHARACTERIZATION FOR SEWAGE SLUDGE INCINERATORS

EXECUTIVE SUMMARY REPORT

METROPOLITAN SEWER DISTRICT (MSD)  
MILL CREEK WASTEWATER TREATMENT PLANT  
CINCINNATI, OHIO

Prepared for:

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U.S. ENVIRONMENTAL PROTECTION AGENCY  
Office of Air and Radiation  
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Research Triangle Park, North Carolina 27711

September 2000

#### **EPA DISCLAIMER**

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### **ACKNOWLEDGMENTS**

This report was prepared under Contract No. 68-D-99-009, Work Assignment WA 2-01, by Battelle and its subcontractor ETS, Inc. under the sponsorship of the U.S. Environmental Protection Agency. Mr. Eugene Crumpler was the EPA Program Manager and Mr. C. E. (Gene) Riley was the Work Assignment Manager. Their support on this test program was much appreciated. We would also like to acknowledge the assistance provided by the Hamilton County Metropolitan Sewer District and its employees, in particular Mr. Michael W. Heitz, who served as the MSD on-site coordinator for this test program.



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## **1.0 OVERVIEW**

The U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards (OAQPS) is required to establish standards, which consist of general requirements, pollutant characterization, and emission limits for sewage sludge disposal by incineration. These standards are necessary to protect public health and the environment from any adverse effect of a pollutant during the incineration of sewage sludge. In order for EPA to assess control technologies and the associated strategies for cost-effective development and/or use, data on emissions from sewage sludge incinerators are needed. While some emission data exist for sewage sludge incinerators, data on toxic polychlorinated biphenyls (PCBs) from this source type are scarce.

This executive summary report summarizes testing of a multiple hearth incinerator at the Metropolitan Sewer District (MSD) Mill Creek Wastewater Treatment Plant in Cincinnati, Ohio in July, 1999. The emission data collected in this test program will be used by OAQPS and EPA's Office of Water (OW) to support a decision about further data gathering efforts in support of Maximum Achievable Control Technology (MACT) standards for sewage sludge incinerators.

### **1.1 TEST OBJECTIVES**

The PCB and D/F emissions data collected from the MSD sewage sludge incinerator in this test program will be used by EPA's OAQPS and OW to:

- (1) Conduct a comprehensive assessment of the risk to human health of the emissions of dioxin/furan/toxic PCBs from sewage sludge incinerators. This assessment is to determine if regulations on these emissions are required to reduce any unacceptable risk.
- (2) Establish an emissions data base for toxic PCB and D/F emissions from sewage sludge incinerators.

## **1.2 PROCESS DESCRIPTION**

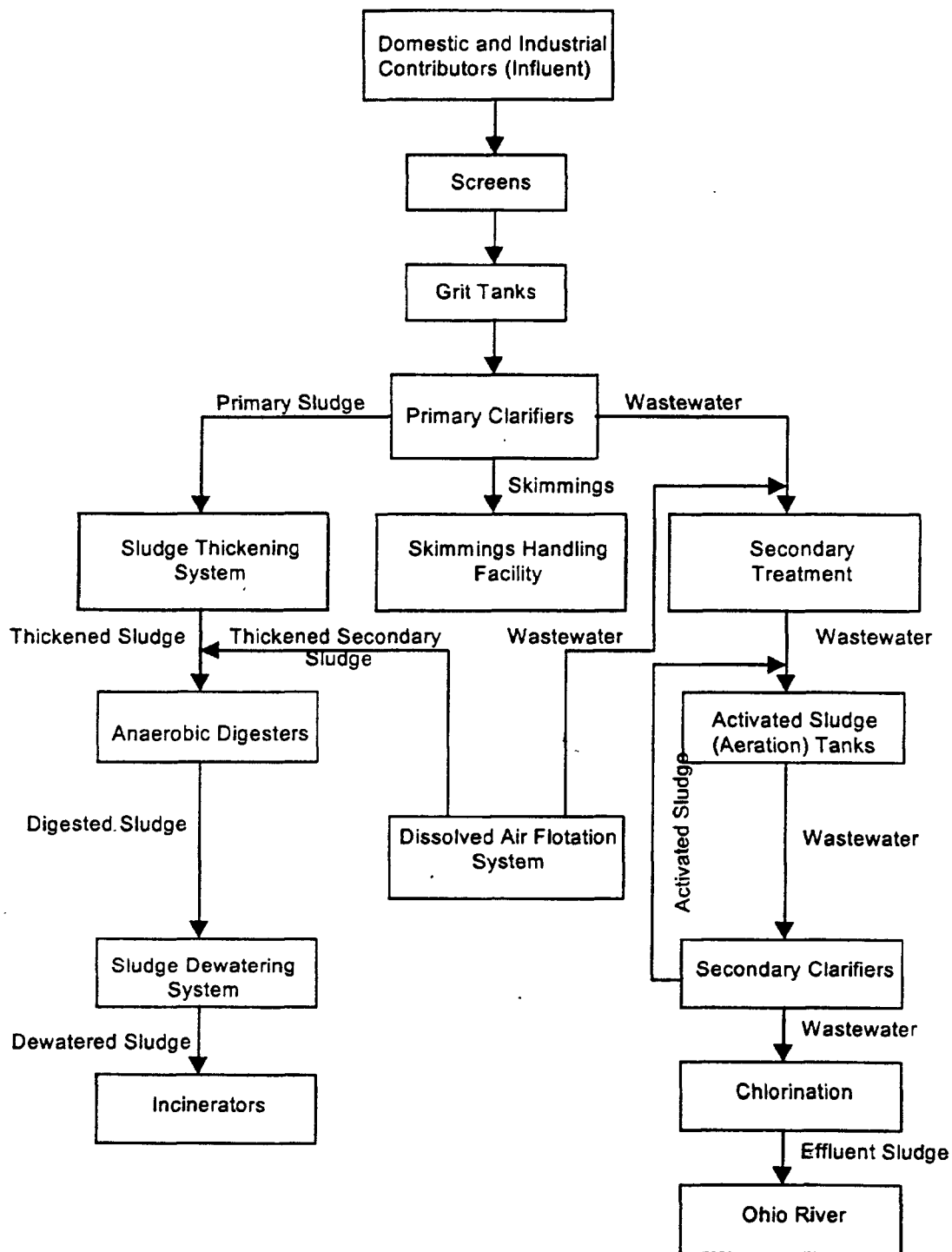
The Mill Creek Wastewater Treatment Plant is a municipal wastewater treatment plant designed to process 120 to 180 million gallons per day (MGD) of wastewater. Most of the wastewater received at the treatment plant comes from sanitary sources, with approximately 20 to 25 percent from industrial sources. The sludge generated from wastewater treatment is incinerated on site in six multiple hearth incinerators. Normally, three incinerators incinerate a combined total of 100 dry tons of sludge per day. The incinerators operate 24 hours a day. Natural gas and digester gas are used as auxiliary fuels. Emissions from each incinerator are controlled by a venturi scrubber, followed by a three-tray impingement conditioning tower with a chevron style stainless steel demister, and exit through an individual stack. Figure 1-1 details the process flow diagram for the facility.

## **1.3 TEST PROGRAM**

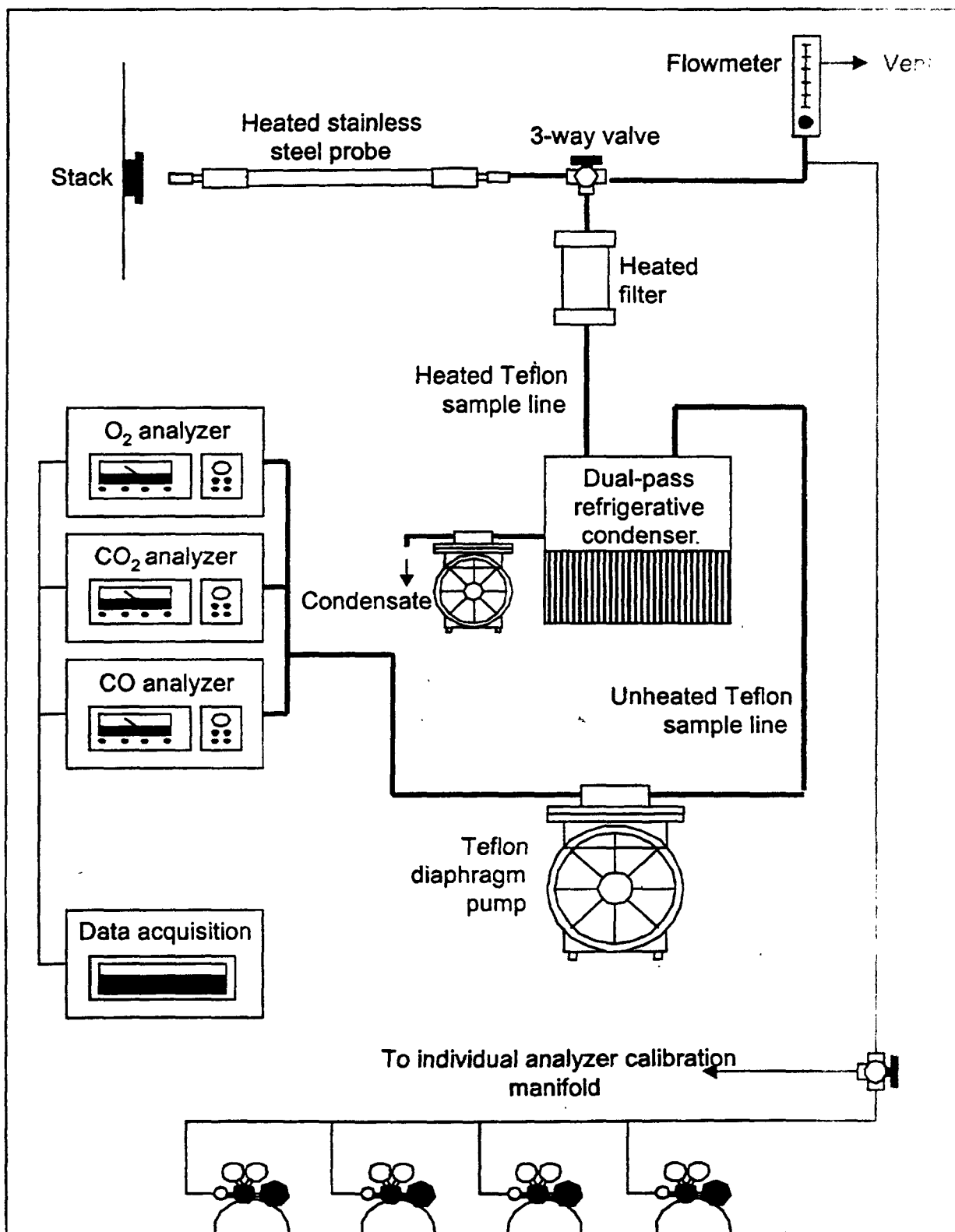
In this test program, emissions from Incinerator No. 6 were collected and analyzed for PCB, D/F, and polycyclic aromatic hydrocarbons (PAH). Carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>), and total hydrocarbon (THC) emissions from the incinerator were continuously monitored throughout the test. Figure 1-2 shows the continuous sampling system.

Process samples consisting of sludge feed and scrubber water into and out of the venturi control system were also collected. Both sludge feed and scrubber water samples were analyzed for PCB, D/F, chlorine (Cl<sub>2</sub>), and percent solids. The temperature and pH of the scrubber water were measured at the time of sample collection. Ultimate/proximate analysis of the sludge feed was also conducted.

A matrix of the type and location of the samples collected is presented in Table 1-1.



**Figure 1-1. Schematic Diagram of Mill Creek Wastewater Treatment Plant Process**



**Figure 1-2. Continuous Sampling System for Instrumental Methods  
(EPA Methods 3A and 10)**

Table 1-1. Test Matrix

Sampling Location/ Matrix	No. of Runs	Sample Type	Sampling Method	Sampling Org.	Sample Run Time (min)	Analytical Method	Analytical Laboratory
Outlet Stack	3 <sup>b</sup>	Toxic PCBs	M-0010 <sup>a,b</sup>	ETS	360	Draft PCB Emissions <sup>c</sup>	Battelle
	3 <sup>b</sup>	D/Fs	M-0010 <sup>b</sup>	ETS	360	M-8290 <sup>d</sup>	Battelle
	3 <sup>b</sup>	PAHs	M-0010 <sup>b</sup>	ETS	360	CARB 429 <sup>e</sup>	Quanterra
	Continuous	CO	M 10 <sup>f</sup>	ETS	360	NDIR	NA
	Continuous	O <sub>2</sub> /CO <sub>2</sub>	M 3A <sup>g</sup>	ETS	360	Chemical Cell/ NDIR	NA
	Continuous	THC	M25A	MSD	360	Flame Ionization	NA
Sludge Feed	6 Grab Samples (1 per hour)	Toxic PCBs	Composite of 60 min grabs	Battelle	360	Draft PCB Sludge <sup>h</sup>	Battelle
		D/Fs	Composite of 60 min grabs	Battelle	360	M-8290	Battelle
		Chlorine	Composite of 60 min grabs	Battelle	360	M-4500 G <sup>i</sup>	U.S. EPA T & E
		Total % Solids	Composite of 60 min grabs	Battelle	360	M-2540 B <sup>j</sup>	U.S. EPA T & E
		Ultimate/Proximate	Composite of 60 min grabs	Battelle	360	ASTM D3172, D5373	CT&E
Scrubber Water	Inlet and Outlet 6 Grab Samples Each (1 per hour)	Toxic PCBs	Composite of 60 min grabs	Battelle	360	Draft PCB Water <sup>k</sup>	Battelle
		D/Fs	Composite of 60 min grabs	Battelle	360	M-8290	Battelle
		Chlorine	Composite of 60 min grabs	Battelle	360	M-4500 G	U.S. EPA T & E
		Total % Solids	Composite of 60 min grabs	Battelle	360	M-2540 B	U.S. EPA T & E
		pH/Temp	60 min grabs	Battelle	360	M-4500-H <sup>l</sup>	Battelle

a SW-846, Method 0010, Modified Method 5 Sampling Train.

b Three M-0010 runs total at outlet stack, single M-0010 run will generate sample for coplanar PCB, D/F, and PAH analysis.

c Draft Analytical Method for Determination of Toxic Polychlorinated Biphenyl Emissions from Sewage Incinerator Stationary Sources Using Isotope Dilution High Resolution Gas Chromatography/High Resolution Mass Spectrometry.

d SW-846, Method 8290, Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High Resolution Gas Chromatography / High Resolution Mass Spectrometry (HRGC / HRMS).

e Air Resources Board, Method 429, Determination of Polycyclic Aromatic Hydrocarbons (PAH) Emissions from Stationary Sources.

f 40CFR60, Appendix A, Method 10, Determination of Carbon Monoxide Emissions from Stationary Sources.

g 40CFR60, Appendix A, Method 3A, Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources.

h Draft Method, Determination of Toxic Polychlorinated Biphenyls in Sewage Sludge Using Isotope Dilution High Resolution Gas Chromatography / High Resolution Mass Spectrometry.

i Standard Methods for Examination of Water and Wastewater, Method 4500 G, DPD Colorimetric Method.

j Standard Methods for Examination of Water and Wastewater, Method 2540 B, Total Solids Dried at 103-105°C.

k Draft Method, Determination of Toxic Polychlorinated Biphenyls in Sewage Incinerator Scrubber Water Using Isotope Dilution High Resolution Gas Chromatography / High Resolution Mass Spectrometry.

l Standard Methods for Examination of Water and Wastewater, Method 4500 H, pH Value.

## **1.4 SUMMARY OF CONTENT**

This executive summary report consists of the following sections:

Section 1.0 provides an overview of the test program. This section includes the general purpose and background of the test program, a brief overview of the facility and process tested and the test matrix.

Section 2.0 provides a summary of test results. This section includes CEM results; analytical results for PCBs, D/Fs, and PAHs for emission, scrubber water, and sludge feed samples; and inorganic analysis results for scrubber water and sludge feed samples

Section 3.0 contains a discussion of the data quality and the QA objectives that were met

Section 4.0 presents conclusions about the test results by media and analyte.

Additional information and detail is contained in both the Emissions Test Report and the Data Quality Assessment Report documents.

## **2.0 SUMMARY AND DISCUSSION OF TEST RESULTS**

### **2.1 AIR EMISSIONS MEASUREMENTS**

The test results for air emissions are provided for toxic PCBs in Tables 2-1 through 2-4, for D/Fs in Tables 2-5 through 2-7, and for PAHs in Tables 2-8 and 2-9.

The toxic PCB, D/F, and PAH results for Runs 2 and 3 are almost identical for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for all the analytes. As a result, emission concentrations for Run 4 are approximately half of the emission concentrations for Runs 2 and 3 for all three analyte classes.

Analyte loss may have occurred during sampling, during sample handling and transport or prior to spiking the Run 4 sample with pre-extraction internal standards. This time period is based on a comparison of the pre-field surrogate spike recoveries to the pre-extraction internal standard recoveries. Recoveries of the pre-field surrogate spikes for Run 4 back half samples were approximately half of the recoveries for Run 2 and 3 back half samples for all PCB, D/F, and PAH field surrogate spikes, whereas recoveries of the spiked pre-extraction PCB, D/F, and



PAH internal standards were comparable and generally acceptable across all three runs. Any losses in the pre-field surrogate spikes that may have occurred in sample extraction or cleanup of the Run 4 back half sample would have also been reflected in similar losses of the spiked pre-extraction internal standards. Since the pre-extraction internal standard results are acceptable for Run 4 and consistent with the other two runs, this result suggests that the field surrogate spike and analyte losses likely occurred prior to extraction of the Run 4 emission samples.

Another indicator that analyte losses occurred prior to sample extraction is that the PCB, D/F, and PAH concentrations in the samples follow the same pattern as the pre-field surrogate spikes in that all measured back half analytes were approximately one half or less for the Run 4 sample. In addition, analyte concentrations for the Run 4 front half sample were somewhat lower than the Run 2 and 3 front half samples. This suggests that analyte levels may not have been consistent during sampling due to some type of matrix interference inherent in incineration systems. Prior experience with municipal and medical waste incineration have exhibited similar low pre-field surrogate standard recoveries — the cause of which is as yet unknown.

#### **2.1.1 Toxic PCB Results**

The toxic PCB results in ng/dscm are summarized in Tables 2-1 and 2-2. Toxic PCB results for Runs 2 and 3 are almost identical for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for all the analytes. Possible loss of PCBs may have occurred in the field as indicated by lower pre-field surrogate recoveries for Run 4 (as discussed in Section 4.1). The PCB data have been reviewed extensively, and no reason can be found for the data differential. Alternatively, these lower Run 4 concentrations may be an accurate reflection of a change in incinerator emissions on the third day of sampling. Table 2-3 presents toxic PCB results in World Health Organization (WHO) Toxic Equivalencies which are an estimate of the concentration of 2,3,7,8-TCDD which would produce an equivalent toxicity as the PCB. The Toxic Equivalent Factors (TEFs) for the toxic PCBs are presented in Table 2-4.

**Table 2-1. Toxic PCB Results - Stack Gas Concentrations (ng/dscm, as measured)**

PCB Congener	Concentration (ng/dscm, as measured) <sup>a</sup>		
	Run 2	Run 3	Run 4
3,3',4,4'-tetrachlorobiphenyl (TCB) (PCB-77) <sup>b</sup>	15.6	10.7	4.27
2,3,3',4,4'-pentachlorobiphenyl (PeCB) (PCB-105)	2.67	2.45	0.945
2,3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-114)	0.389	0.340	0.137
2,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-118)	5.72	5.27	2.21
2',3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-123)	0.121	0.111	0.038
3,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-126)	0.700	0.584	0.210
2,3,3',4,4',5-hexachlorobiphenyl (HxCB) (PCB-156)	0.645	0.565	0.213
2,3,3',4,4',5'-hexachlorobiphenyl (HxCB) (PCB-157)	0.221	0.179	0.079
2,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-167)	0.388	0.337	0.136
3,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-169)	0.559	0.467	0.141
2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB) (PCB-170)	1.08	0.966	0.437
2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-180)	2.69	2.37	0.856
2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-189)	0.095	0.076	0.044

<sup>a</sup> ng/dscm; nanogram per dry standard cubic meter.

Standard conditions: temperature - 20°C; pressure - 1 atm (760 mm Hg).

<sup>b</sup> Back half extracts diluted with additional internal standard and re-analyzed to bring the reported concentrations within the calibration range (see Section 6.1.3.1).

**Table 2-2. Toxic PCB Results - Stack Gas Concentrations (ng/dscm, adjusted to 7% O<sub>2</sub>)**

PCB Congener	Concentration (ng/dscm, adjusted to 7% O <sub>2</sub> )		
	Run 2	Run 3	Run 4
3,3',4,4'-tetrachlorobiphenyl (TCB) (PCB-77) <sup>b</sup>	30.6	18.8	7.92
2,3,3',4,4'-pentachlorobiphenyl (PeCB) (PCB-105)	5.22	4.32	1.75
2,3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-114)	0.762	0.598	0.254
2,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-118)	11.2	9.27	4.10
2',3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-123)	0.237	0.195	0.070
3,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-126)	1.37	1.03	0.389
2,3,3',4,4',5-hexachlorobiphenyl (HxCB) (PCB-156)	1.26	0.994	0.395
2,3,3',4,4',5'-hexachlorobiphenyl (HxCB) (PCB-157)	0.433	0.315	0.146
2,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-167)	0.760	0.593	0.252
3,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-169)	1.09	0.822	0.261
2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB) (PCB-170)	2.11	1.70	0.810
2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-180)	5.26	4.18	1.59
2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-189)	0.186	0.134	0.082

\* ng/dscm; nanogram per dry standard cubic meter, adjusted to 7% oxygen.

Standard conditions: temperature - 20°C; pressure - 1 atm (760 mm Hg).

<sup>b</sup> Back half extracts diluted with additional internal standard and re-analyzed to bring the reported concentrations within the calibration range (see Section 6.1.3.11).

**Table 2-3. Toxic PCB Results - WHO Toxic Equivalent Stack Gas Concentrations  
(ng/dscm, adjusted to 7% O<sub>2</sub>)**

PCB Congener	WHO Toxic Equivalencies (ng/dscm, adjusted to 7% O <sub>2</sub> )			
	WHO TEFs	Run 2	Run 3	Run 4
3,3',4,4'-tetrachlorobiphenyl (TCB) (PCB-77) <sup>(b)</sup>	1.0E-04	3.06E-03	1.88E-03	7.92E-04
2,3,3',4,4'-pentachlorobiphenyl (PeCB) (PCB-105)	1.0E-04	5.23E-04	4.32E-04	1.75E-04
2,3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-114)	5.0E-04	3.81E-04	2.99E-04	1.27E-04
2,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-118)	1.0E-04	1.12E-03	9.27E-04	4.10E-04
2',3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-123)	1.0E-04	2.37E-05	1.95E-05	7.04E-06
3,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-126)	0.1	1.37E-01	1.03E-01	3.89E-02
2,3,3',4,4',5-hexachlorobiphenyl (HxCB) (PCB-156)	5.0E-04	6.31E-04	4.97E-04	1.97E-04
2,3,3',4,4',5'-hexachlorobiphenyl (HxCB) (PCB-157)	5.0E-04	2.16E-04	1.57E-04	7.32E-05
2,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-167)	1.0E-05	7.60E-06	5.93E-06	2.52E-06
3,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-169)	0.01	1.09E-02	8.22E-03	2.51E-03
2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB) (PCB-170)	1.0E-04	2.11E-04	1.70E-04	8.10E-05
2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-180)	1.0E-05	5.26E-05	4.18E-05	1.59E-05
2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-189)	1.0E-04	1.86E-05	1.34E-05	8.15E-06

<sup>a</sup> ng/dscm; nanogram per dry standard cubic meter, adjusted to 7% oxygen.

<sup>b</sup> Back half extracts diluted with additional internal standard and re-analyzed to bring the reported concentrations within the calibration range (see Section 6.1.3.11).

<sup>c</sup> WHO TEFs - World Health Organization, Toxic Equivalent Factors.

Standard conditions: temperature - 20°C; pressure - 1 atm (760 mm Hg).

**Table 2-4. World Health Organization Toxic Equivalent Factors (TEFs) for Determining Toxic PCB TEQs**

Congeners			
Type of Compound	IUPAC No.	Structure	TEF
Non-ortho	77	3,3',4,4'-tetrachlorobiphenyl (TCB)	0.0001
	126	2,3,3',4'5-pentachlorobiphenyl (PeCB)	0.1
	169	3,3',4,4',5,5'-hexachlorobiphenyl (HxCB)	0.01
Mono-ortho	105	2,3',3',4,4'-pentachlorobiphenyl (PeCB)	0.0001
	114	2,3,4,4',5-pentachlorobiphenyl (PeCB)	0.0005
	118	2,3',4,4',5-pentachlorobiphenyl (PeCB)	0.0001
	123	2,3,3',4,4',5-hexachlorobiphenyl (PeCB)	0.0001
	156	2,3,3',4,4',5'-hexachlorobiphenyl (HxCB)	0.0005
	157	2,3,3',4,4',5'-hexachlorobiphenyl (HxCB)	0.0005
	167	2,3',4,4',5,5'-hexachlorobiphenyl (HxCB)	0.00001
	189	2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB)	0.0001
Di-ortho	170	2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB)	0.0001
	180	2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB)	0.00001

\* IUPAC = International Union of Pure and Applied Chemistry.

Note: World Health Organization (WHO) TEFs for human risk assessment based on the conclusions of the WHO consultation in Stockholm, Sweden, 15-18 June 1997 (Van der Berg et al., 1998).

### **2.1.2 Dioxin/Furan (D/F) Results**

The D/F results are summarized in Tables 2-5 through 2-7. A detailed discussion of the QA/QC results associated with these D/F data appears in Section 3.2. D/F results for Runs 2 and 3 are almost identical for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for all the analytes. These lower Run 4 concentrations may be due to analyte loss or an accurate reflection of a change in incinerator emissions on the third day of sampling. The D/F data have been reviewed extensively, and no reason can be found for the data differential.

### **2.1.3 PAH Results**

The PAH results are summarized in Tables 2-8 and 2-9. A detailed discussion of the QA/QC results associated with these PAH data appears in Section 4.1.3. PAH results for Runs 2 and 3 are somewhat similar for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for most of the analytes. These lower Run 4 concentrations may be due to analyte loss or an accurate reflection of a change in incinerator emissions on the third day of sampling. The PAH data have been reviewed extensively, and no definitive reason can be found for the data differential (see Section 4.1).

Table 2-5. D/F Results - Stack Gas Concentrations (ng/dscm, as measured)

Congener	Concentration (ng/dscm, as measured)		
	Run 2	Run 3	Run 4
<b>Dioxins</b>			
2,3,7,8-TCDD #	0.098	0.067	0.034
Total TCDD	3.02	3.53	0.719
1,2,3,7,8-PCDD	0.017	0.013	(0.005)
Total PCDD	0.706	0.658	0.187
1,2,3,4,7,8-HxCDD	0.015	0.015	0.006
1,2,3,6,7,8-HxCDD	0.038	0.040	0.013
1,2,3,7,8,9-HxCDD	0.039	0.035	0.018
Total HxCDD	0.606	0.584	0.324
1,2,3,4,6,7,8-HpCDD	0.204	0.202	0.093
Total HpCDD	0.459	1.45	0.237
Octa CDD	0.317	0.303	0.140
Total CDD Based on given numbers:	5.11	6.53	1.61
<b>Furans</b>			
2,3,7,8-TCDF #	1.58	1.24	0.533
Total TCDF	5.61	4.88	2.57
1,2,3,7,8-PCDF	0.195	0.150	0.068
2,3,4,7,8-PCDF	0.389	0.283	0.123
Total PCDF	4.93	3.67	1.54
1,2,3,4,7,8-HxCDF	0.226	0.177	0.092
1,2,3,6,7,8-HxCDF	0.081	0.067	0.035
2,3,4,6,7,8-HxCDF	0.126	0.097	0.051
1,2,3,7,8,9-HxCDF	ND < 0.003	ND < 0.003	ND < 0.003
Total HxCDF	1.13	0.880	0.410
1,2,3,4,6,7,8-HpCDF	0.224	0.185	0.103
1,2,3,4,7,8,9-HpCDF	0.023	0.017	0.009
Total HpCDF	0.329	0.261	0.137
Octa CDF	0.090	0.082	0.041
Total CDF Based on given numbers:	12.1	9.77	4.69
Total CDD + CDF Based on given numbers:	17.2	16.3	6.30

\* ng/dscm; nanogram per dry standard cubic meter.

Standard conditions, pressure and temperature defined as 1 atm (760 mm Hg) and 20°C.

Note: (Below Detection Limit) values listed in parentheses; ND = Non Detect, value is detection limit.

# = value from confirmation column. Non Detect and (Below Detection Limit) values not included in totals.

Table 2-6. D/F Results - Stack Gas Concentrations (ng/dscm, adjusted to 7% O<sub>2</sub>)

Concentration (ng/dscm, adjusted to 7% O <sub>2</sub> )			
Concentration	Run 2	Run 3	Run 4
<b>Dioxins</b>			
2,3,7,8-TCDD	0.209	0.118	0.063
Total TCDD	5.92	6.22	1.33
1,2,3,7,8-PCDD	0.033	0.023	(0.009)
Total PCDD	1.38	1.16	0.348
1,2,3,4,7,8-HxCDD	0.029	0.026	0.011
1,2,3,6,7,8-HxCDD	0.074	0.069	0.024
1,2,3,7,8,9-HxCDD	0.076	0.062	0.030
Total HxCDD	1.19	1.03	0.600
1,2,3,4,6,7,8-HpCDD	0.399	0.357	0.172
Total HpCDD	0.899	2.560	0.439
Octa CDD	0.621	0.424	0.259
Total CDD	10.0	11.4	2.97
<b>Furans</b>			
2,3,7,8-TCDF	3.10	2.17	0.988
Total TCDF	11.00	8.58	4.76
1,2,3,7,8-PCDF	0.382	0.264	0.124
2,3,4,7,8-PCDF	0.762	0.496	0.228
Total PCDF	9.66	6.45	2.85
1,2,3,4,7,8-HxCDF	0.442	0.313	0.169
1,2,3,6,7,8-HxCDF	0.159	0.116	0.065
2,3,4,6,7,8-HxCDF	0.247	0.171	0.095
1,2,3,7,8,9-HxCDF	ND < 0.0059	ND < 0.0053	ND < 0.0056
Total HxCDF	2.20	1.55	0.760
1,2,3,4,6,7,8-HpCDF	0.437	0.324	0.189
1,2,3,4,7,8,9-HpCDF	0.043	0.030	0.017
Total HpCDF	0.642	0.459	0.252
Octa CDF	0.176	0.146	0.078
Total CDF	23.7	17.2	8.71
Total CDD + CDF	33.7	28.6	11.7

\* ng/dscm; nanogram per dry standard cubic meter, adjusted to 7% oxygen. Standard conditions, pressure and temperature defined as 1 atm (760 mm Hg) and 20°C.

Note: (Below Detection Limit) values listed in parentheses.

Non Detects and (Below Detection Limit) values not included in totals.

ND = Non detect, value is detection limit.



Table 2-7. D/F Results - TEQ Stack Gas Concentrations (ng/dscm, adjusted to 7% O<sub>2</sub>)

Congener	2,3,7,8-TCDD Toxic Equivalence Factor	Concentration ng/dscm adjusted to 7% O <sub>2</sub>		
		Run 2	Run 3	Run 4
Dioxins				
2,3,7,8-TCDD	1.000	0.209	0.118	0.063
Total TCDD				
1,2,3,7,8-PCDD	0.500	0.017	0.012	(0.005)
Total PCDD				
1,2,3,4,7,8-HxCDD	0.100	0.003	0.003	0.001
1,2,3,6,7,8-HxCDD	0.100	0.007	0.007	0.002
1,2,3,7,8,9-HxCDD	0.100	0.008	0.006	0.003
Total HxCDD				
1,2,3,4,6,7,8-HpCDD	0.010	0.004	0.004	0.002
Total HpCDD				
Octa CDD	0.001	0.00062	0.00053	0.00026
2,3,7,8-TEQ Total CDD		0.249	0.151	0.071
Furans				
2,3,7,8-TCDF	0.100	0.310	0.218	0.099
Total TCDF				
1,2,3,7,8-PCDF	0.050	0.019	0.013	0.006
2,3,4,7,8-PCDF	0.500	0.381	0.248	0.114
Total PCDF				
1,2,3,4,7,8-HxCDF	0.100	0.044	0.031	0.017
1,2,3,6,7,8-HxCDF	0.100	0.016	0.012	0.007
2,3,4,6,7,8-HxCDF	0.100	0.025	0.017	0.010
1,2,3,7,8,9-HxCDF	0.100	ND<0.0006	ND<0.0005	ND<0.0006
Total HxCDF				
1,2,3,4,6,7,8-HpCDF	0.010	0.004	0.003	0.002
1,2,3,4,7,8,9-HpCDF	0.010	0.000	0.000	0.000
Total HpCDF				
Octa CDF	0.001	0.000	0.000	0.000
2,3,7,8-TEQ Total CDF		0.799	0.542	0.255
2,3,7,8-TEQ Total CDD + CDF		1.05	0.693	0.326

\* ng/dscm; nanogram per dry standard cubic meter, adjusted to 7% oxygen. Standard conditions, pressure and temperature defined as 1 atm (760 mm Hg) and 20°C.

Note: (Below Detection Limit) values listed in parentheses. Non Detects and (Below Detection Limit) values not included in totals.

Table 2-8. PAH Results - Stack Gas Concentrations (ng/dscm, as measured)

Compound	Concentration (ng/dscm, as measured)		
	Run 2	Run 3	Run 4
Acenaphthene	109	83.6	15.5
Acenaphthylene	{1160}D	{1290}E	{155}
Anthracene	{144}	{52.7}	55.5
Benzo(a)anthracene	93.0	251	49.0
Benzo(b)fluoranthene	828	662	159
Benzo(k)fluoranthene	759	361	93.7
Benzo(g,h,i)perylene	233	134	50.7
Benzo(a)pyrene	75.2	34.1	NQ*
Chrysene	2390 E	{1340}E	288
Dibenzo(a,h)anthracene	71.8	48.9	12.5
Fluoranthene	2700 E	{2340}	557
Fluorene	1030	1090	77.6
Indeno(1,2,3-cd)pyrene	244	166	44.2
Naphthalene	{309000}D,E	{245000}D,E	{126000}D,E
Phenanthrene	{22600}D,E	{21200}D,E	{4780}E
Pyrene	1810 E	1560 E	292

\* ng/dscm = nanogram per dry standard cubic meter. Standard conditions, pressure and temperature defined as 1 atm (760 mm Hg) and 20°C.

Note: Estimated Maximum Possible Concentration (EMPC) values listed in brackets.

D based on dilution.

E Exceeds calibration range.

NQ\* d<sub>12</sub>-benzo(a)pyrene recovery in Sample Run 4 was too low to quantify the compound. Maximum concentration of the compound is estimated by quantitation of benzo(e)pyrene at 161 ng/dscm.

Table 2-9. PAH Results - Stack Gas Concentrations (ng/dscm, adjusted to 7% O<sub>2</sub>)

Compound	Concentration (ng/dscm, adjusted to 7% O <sub>2</sub> )		
	Run 2	Run 3	Run 4
Acenaphthene	214	147	28.8
Acenaphthylene	{2280}D	{2260}E	{288}
Anthracene	{281}	{92.8}	103
Benzo(a)anthracene	182	441	90.7
Benzo(b)fluoranthene	1620	1160	294
Benzo(k)fluoranthene	1490	636	174
Benzo(g,h,i)perylene	455	236	94.0
Benzo(a)pyrene	147	60.0	NQ*
Chrysene	4690 E	{2350}E	534
Dibenzo(a,h)anthracene	141	86.0	23.2
Fluoranthene	5290 E	{4110}	1030
Fluorene	2010	1920	144
Indeno(1,2,3-cd)pyrene	478	292	21.9
Naphthalene	{605000}D,E	{431000}D,E	{233000}D,E
Phenanthrene	{44400}D,E	{37300}D,E	{8850}E
Pyrene	3540 E	2750 E	542

\* ng/dscm = nanogram per dry standard cubic meter, adjusted to 7% oxygen. Standard conditions, pressure and temperature defined as 1 atm (760 mm Hg) and 20°C.

Note: Estimated Maximum Possible Concentration {EMPC} values listed in brackets.

D based on dilution.

E Exceeds calibration range.

NQ\* d<sub>12</sub>-benzo(a)pyrene recovery in Sample Run 4 was too low to quantify the compound.

Maximum concentration of the compound is estimated by quantitation of benzo(e)pyrene at 96.1 ng/dscm.

#### 2.1.4 Continuous Emission Monitoring Data

Average daily results from continuous emission monitoring of carbon monoxide (CO), total hydrocarbons (THC), carbon dioxide (CO<sub>2</sub>), and oxygen (O<sub>2</sub>) are provided in Table 2-10. Plots of individual CO and THC data are provided in Figures 2-1, 2-2, and 2-3 for Runs 2, 3, and 4, respectively. The CO data scale appears along the left side of the plot, with the THC data points plotted hourly along the bottom and scaled on the right-hand side of each figure.

**Table 2-10. CEM Daily Results**

CEM	Daily Test Run Averages			
	Run 2	Run 3	Run 4	Average
CO <sup>a</sup> , ppm <sub>dv</sub>	1380	1170	1130	1230
THC <sup>b</sup> , ppm <sub>dv</sub>	70.6	54.2	37.5	54.1
CO <sub>2</sub> <sup>a</sup> , % v	5.16	5.50	5.07	5.24
O <sub>2</sub> <sup>a</sup> , % v	13.7	13.0	13.4	13.4

<sup>a</sup> CO, CO<sub>2</sub>, and O<sub>2</sub> analyzer data calibration corrected from 1-minute averages during the 360 minute sampling run.

<sup>b</sup> THC analyzer data calibration corrected from the arithmetic average of hourly reported values from MSD during the sampling runs.

CO, CO<sub>2</sub>, and O<sub>2</sub> emission concentrations appear to be relatively constant across the three runs. The THC concentrations for Run 4 are much lower than the THC concentrations for Run 2 and 3.

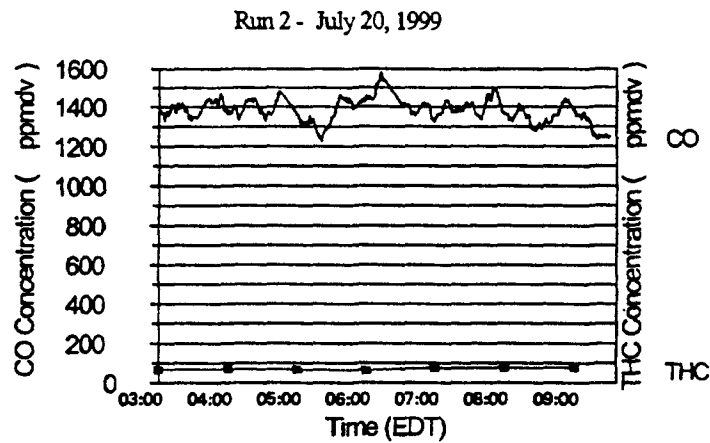


Figure 2-1. CO and THC Daily Test Results - Run 2

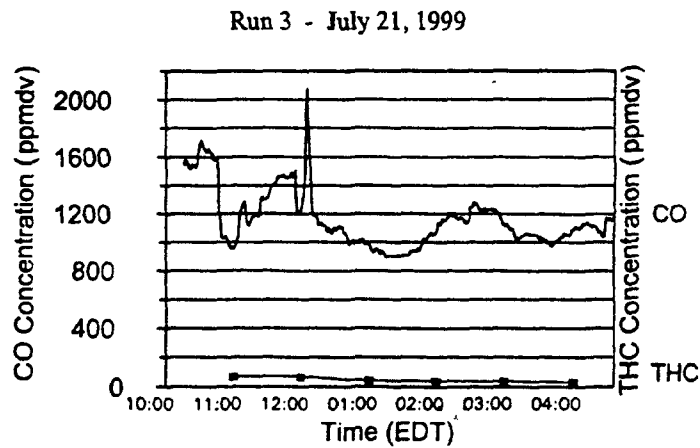


Figure 2-2. CO and THC Daily Test Results - Run 3

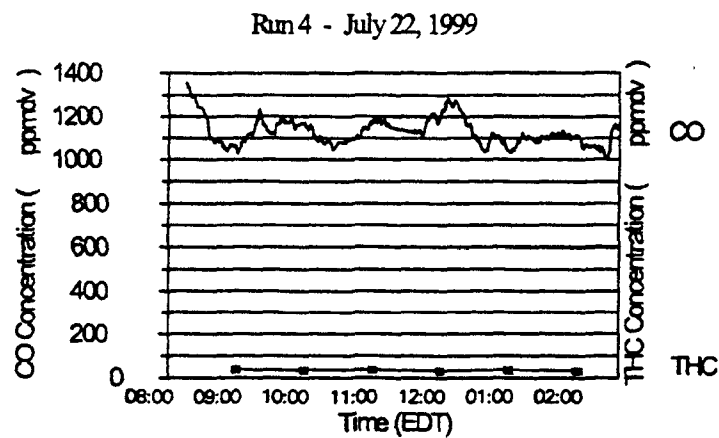


Figure 2-3. CO and THC Daily Test Results - Run 4

## **2.2 PROCESS SAMPLE MEASUREMENTS**

Test results for scrubber water and sewage sludge feed which were collected during the MM5 sampling runs are presented in this section.

### **2.2.1 Scrubber Water Organic Results**

#### **2.2.1.1 Toxic PCB Comparison of Scrubber Water In Versus Scrubber Water Out**

Table 2-11 presents the PCB comparison between the inlet and outlet scrubber water samples for Runs 2, 3, and 4, respectively. In general, the PCB concentrations in the inlet scrubber water samples are slightly lower than PCB concentrations in the outlet scrubber water samples, although this result varies from run to run and from PCB congener to PCB congener.

The PCB concentrations in the inlet scrubber water samples were generally consistent throughout the three runs.

The PCB concentrations in the three outlet scrubber water samples are comparable. The Run 3 sample was re-analyzed after a laboratory error using the archived sample.

#### **2.2.1.2 D/F Results for Scrubber Water**

D/F concentrations for scrubber water samples are presented in Table 2-12. The comparison of D/F concentrations in inlet versus outlet scrubber water samples suggests that outlet concentrations are higher than inlet concentrations since most D/F congeners were not detected in the inlet water samples. However, the detection limit for the inlet scrubber water samples in many cases is higher than the concentration found in the outlet scrubber water samples, so an evaluation of inlet versus outlet concentrations is difficult to make. As shown, most D/F concentrations in all three inlet scrubber water samples were below detection limits. The D/F concentrations in the outlet scrubber water samples were generally comparable across the three runs in that D/F congeners found at higher levels in one run (compared to other D/F congeners) were found at the same relatively higher levels in the other two runs as well.

Table 2-11. Run 2, Run 3, and Run 4 Toxic PCB Results - Comparison of Inlet Versus Outlet Scrubber Water

PCB Congener	Concentration (ng/L, as measured)					
	Run 2		Run 3		Run 4	
	July 20, 1999		July 21, 1999		July 22, 1999	
	In	Out	In	Out	In	Out
3,3',4,4'-tetrachlorobiphenyl (TCB) (PCB-77)	0.158	4.18	0.166	3.63	0.138	2.52
2,3,3',4,4'-pentachlorobiphenyl (PeCB) (PCB-105)	0.690	0.946	0.491	1.87	0.504	0.854
2,3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-114)	0.233	0.157	0.068	0.155	0.045	0.124
2,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-118)	1.20	1.68	1.06	3.52	1.06	1.62
2',3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-123)	0.177	0.086	0.032	0.065	0.018	0.050
3,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-126)	0.024	0.135	0.007	0.118	0.004	0.098
2,3,3',4,4',5-hexachlorobiphenyl (HxCB) (PCB-156)	0.243 #	0.249 #	0.085 #	0.413 #	0.080 #	0.236 #
2,3,3',4,4',5'-hexachlorobiphenyl (HxCB) (PCB-157)	0.166 #	0.119 #	0.285 #	0.110 #	0.020 #	0.083 #
2,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-167)	0.186	0.158	0.044	0.164	0.036	0.125
3,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-169)	0.027	0.113	0.006	0.081	(0.002)	0.098
2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB) (PCB-170)	0.105	0.264	0.080	0.414	0.078	0.298
2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-180)	0.338	0.686	0.190	1.00	0.177	0.653
2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-189)	0.029	0.030	0.009	0.024	{0.005}	0.044

\* Re-analyzed result.

Note: # Values from second column confirmation.

(Below Detection Limit) values listed in parentheses.

Estimated Possible Concentration (EMPC) values listed in brackets.

Table 2-12. D/F Results - Comparison of Inlet Versus Outlet Scrubber Water

Congener	Scrubber Water Concentrations (ug/L measured)					
	Run 2		Run 3		Run 4	
	In	Out	In	Out	In	Out
<b>Dioxin</b>						
2,3,7,8-TCDD	ND<0.013	0.009 #	ND<0.003	0.013 #	ND<0.008	0.014 #
Total TCDD	ND<0.029	0.475	(0.002)	0.821	ND<0.017	0.277
1,2,3,7,8-PCDD	ND<0.027	ND<0.005	ND<0.007	ND<0.013	ND<0.023	ND<0.004
Total PCDD	ND<0.046	0.046	ND<0.012	0.057	ND<0.039	{0.066}
1,2,3,4,7,8-HxCDD	ND<0.013	0.002	ND<0.002	ND<0.004	ND<0.006	0.003
1,2,3,6,7,8-HxCDD	ND<0.013	0.003	ND<0.002	ND<0.004	ND<0.006	0.006
1,2,3,7,8,9-HxCDD	ND<0.013	{0.003}	ND<0.002	ND<0.004	ND<0.006	0.006
Total HxCDD	ND<0.029	{0.029}	ND<0.005	0.054	ND<0.004	0.102
1,2,3,4,6,7,8-HpCDD	ND<0.033	{0.011}	ND<0.004	0.025	ND<0.012	0.032
Total HpCDD	ND<0.099	0.027	ND<0.013	0.053	ND<0.037	0.074
Octa CDD	0.040	0.030	0.012	0.059	0.016	0.047
Total CDD	0.040	0.578	0.012	1.040	0.016	0.500
<b>Furans</b>						
2,3,7,8-TCDF	ND<0.009	0.181 #	ND<0.002	0.222 #	ND<0.005	0.256 #
Total TCDF	0.092	0.824	(0.002)	1.120	ND<0.015	0.866
1,2,3,7,8-PCDF	ND<0.018	0.014	ND<0.004	0.025	ND<0.011	0.025
2,3,4,7,8-PCDF	ND<0.011	0.029	ND<0.002	0.045	ND<0.005	0.053
Total PCDF	ND<0.035	0.316	ND>0.006	0.493	ND<0.019	0.495
1,2,3,4,7,8-HxCDF	ND<0.014	0.012	ND<0.002	0.016	ND<0.006	0.025
1,2,3,6,7,8-HxCDF	ND<0.013	0.005	ND<0.002	0.007	ND<0.0006	0.011
2,3,4,6,7,8-HxCDF	ND<0.017	{0.006}	ND<0.002	0.013	ND<0.007	0.017
1,2,3,7,8,9-HxCDF	ND<0.014	ND<0.002	ND<0.002	ND<0.005	ND<0.008	ND<0.002
Total HxCDF	ND<0.053	0.048	ND<0.002	0.080	ND<0.025	0.113
1,2,3,4,6,7,8-HpCDF	ND<0.009	0.012	0.001	0.020	ND<0.003	0.025
1,2,3,4,7,8,9-HpCDF	ND<0.035	ND<0.003	ND<0.005	ND<0.008	ND<0.013	ND<0.003
Total HpCDF	ND<0.079	0.017	(0.004)	0.029	(0.003)	{0.035}
Octa CDF	ND<0.047	0.006	ND<0.006	0.010	ND<0.016	0.008
Total CDF	0.092	1.21	0.001	1.73	0.000	1.48
Total CDD + CDF	0.132	1.79	0.013	2.78	0.016	1.98

Note: (Below Detection Limit) values listed in parentheses and Estimated Maximum Possible Concentration (EMPC) values listed in brackets.

ND = Non Detect, value is detection limit.

# = value from second column confirmation.

Non Detects and (Below Detection Limit) values not included in totals.



### 2.2.2 Sewage Sludge Organic Results

Sewage sludge samples were analyzed for PCBs and D/Fs. Sewage sludge feed was sampled and analyzed for PCBs and D/Fs consistent with the scrubber water. Results for sewage sludge feed are presented in Table 2-13 for PCBs and in Table 2-14 for D/Fs. In general, PCB and D/F concentrations in the sludge feed are comparable across the three runs. However, an overall higher (20 percent above the mean) sewage sludge D/F concentration was measured in Run 4.

### 2.2.3 Scrubber Water and Sewage Sludge Inorganic Results

Table 2-15 provides analytical results for inorganic parameters (chlorine, total percent solids, temperature, and pH) in scrubber water samples. No significant differences are apparent between inlet and outlet, or across the three runs, for these parameters in the scrubber water.

**Table 2-15. Chlorine, Percent Solids, Temperature, and pH Results - Comparison of Inlet Versus Outlet Scrubber Water**

Measurement	Run 2		Run 3		Run 4	
	In	Out	In	Out	In	Out
Chlorine (mg/L)						
- Free	0.01	0.03	0.05	0.05	0.03	0.01
- Total	ND < 0.01	0.05	0.08	0.03	0.05	0.02
Total Percent Solids (%)	0.146	0.154	0.129	0.142	0.146	0.158
Temperature (°F)	87	116	87	120	87	123
pH*	7.37	6.49	7.48	6.57	7.43	6.51

\* Temperature and pH were calculated as an average of six grab samples collected during each of the 360 minute sampling runs.

Note: ND = Non Detect, value is detection limit.

Table 2-13. Toxic PCB Results for Sewage Sludge

PCB Congener	Concentration (ng/g dry)		
	Run 2	Run 3	Run 4
3,3',4,4'-tetrachlorobiphenyl (TCB) (PCB-77)	40.9	41.1	45.4
2,3,3',4,4'-pentachlorobiphenyl (PeCB) (PCB-105)	7.01	7.39	7.29
2,3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-114)	0.691	0.674	0.738
2,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-118)	12.2	13.5	12.9
2',3,4,4',5-pentachlorobiphenyl (PeCB) (PCB-123)	0.231	0.276	0.241
3,3',4,4',5-pentachlorobiphenyl (PeCB) (PCB-126)	1.12	1.21	1.48
2,3,3',4,4',5-hexachlorobiphenyl (HxCB) (PCB-156)	1.77 #	1.88 #	1.88 #
2,3,3',4,4',5'-hexachlorobiphenyl (HxCB) (PCB-157)	0.472 #	0.565 #	0.536 #
2,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-167)	0.878	0.968	0.959
3,3',4,4',5,5'-hexachlorobiphenyl (HxCB) (PCB-169)	0.453	0.601	0.656
2,2',3,3',4,4',5-heptachlorobiphenyl (HpCB) (PCB-170)	2.53	2.57	2.78
2,2',3,4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-180)	6.00	6.78	6.71
2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB) (PCB-189)	0.181	0.198	0.218

Note: # Values from second column confirmation.

Table 2-14. D/F Results for Sewage Sludge

Congener	Concentration (ng/g, dry)		
	Run 2	Run 3	Run 4
<b>Dioxins</b>			
2,3,7,8-TCDD	(0.003) #	(0.003) #	(0.005) #
Total TCDD	0.068	0.083	0.095
1,2,3,7,8-PCDD	ND <0.015	ND <0.017	ND <0.017
Total PCDD	0.030	0.023	0.030
1,2,3,4,7,8-HxCDD	ND <0.005	ND <0.005	0.008
1,2,3,6,7,8-HxCDD	0.015	0.018	0.031
1,2,3,7,8,9-HxCDD	0.027	0.024	0.040
Total HxCDD	0.128	0.135	0.020
1,2,3,4,6,7,8-HpCDD	0.229	0.281	0.384
Total HpCDD	0.431	0.520	0.702
Octa CDD	2.51	2.69	3.69
Total CDD	3.17	3.45	4.53
<b>Furans</b>			
2,3,7,8-TCDF	0.021 #	0.024 #	0.035 #
Total TCDF	0.076	0.096	0.120
1,2,3,7,8-PCDF	ND <0.008	ND <0.008	0.013
2,3,4,7,8-PCDF	0.008	0.009	0.013
Total PCDF	0.030	0.095	0.163
1,2,3,4,7,8-HxCDF	0.014	0.019	0.030
1,2,3,6,7,8-HxCDF	ND <0.005	0.006	0.010
2,3,4,6,7,8-HxCDF	0.006	0.008	0.013
1,2,3,7,8,9-HxCDF	ND <0.006	ND <0.007	ND <0.007
Total HxCDF	0.098	0.117	0.171
1,2,3,4,6,7,8-HpCDF	0.132	0.159	0.222
1,2,3,4,7,8,9-HpCDF	ND <0.012	ND <0.013	ND <0.013
Total HpCDF	0.239	0.284	0.377
Octa CDF	0.313	0.340	0.441
Total CDF	0.756	0.932	1.27
Total CDD + CDF	3.92	4.38	5.80

Note: (Below Detection Limit) values listed in parentheses.

ND = Non Detect, value is detection limit.

# = Value from second column confirmation.

Non Detects and (Below Detection Limit) values not included in totals.

Chlorine and percent solids results for sewage sludge samples are presented in Table 2-16. Again, results across the three runs appear generally comparable. However, in two instances the free chlorine values exceed the reported total chlorine values. The explanation for this is indeterminant.

Ultimate/proximate analysis was also performed on the sludge feed samples to determine thermal properties. Results from the ultimate/proximate analysis are presented in Tables 2-17 and 2-18. As shown, ultimate/proximate results are consistent for all three runs.

**Table 2-16. Chlorine and Percent Solids Results for Sewage Sludge**

Measurement	Run 2	Run 3	Run 4
Chlorine (mg/kg)			
- Free	18.5	4.84	17.1
- Total	ND < 0.5	4.84	4.29
Total Percent Solids (%)	23.5	20.0	20.4

Note: ND = Not detected, value is detection limit.

**Table 2-17. Ultimate Analysis Results for Sewage Sludge**

Ultimate Measurement	Dry Basis, %		
	Run 2	Run 3	Run 4
Hydrogen	4.95	4.93	5.16
Nitrogen	4.76	4.51	4.91
Oxygen	12.5	15.1	13.5
Carbon	38.2	37.0	39.3
Sulphur	1.33	1.33	1.35
Ash	38.3	37.1	35.7

**Table 2-18. Proximate Analysis Results for Sewage Sludge**

Proximate Measurement	Run 2		Run 3		Run 4	
	As Received	Dry Basis	As Received	Dry Basis	As Received	Dry Basis
Moisture, %	76.2	--	79.1	--	78.3	--
Volatile Matter, %	13.9	58.3	12.2	58.7	13.0	60.0
Fixed Carbon, %	0.80	3.39	0.89	4.26	0.93	4.29
Sulphur, %	0.32	1.33	0.28	1.33	0.29	1.35
BTU Content (BTU/lb)	1630	6850	1480	7100	1590	7300

### 3.0 DISCUSSION OF DATA QUALITY

#### 3.1 QA OBJECTIVES

The seven steps of the DQO process described in the QAPP are summarized and reviewed below. The objectives of the data collection effort have not changed, thus the specified DQOs are still applicable.

##### Step 1. State the Problem

The objective of the data collection effort was to characterize the concentration of D/Fs, toxic PCBs, and PAHs in air emissions, sewage sludge, and scrubber water.

##### Step 2. Identify the Decision

No specific decision was to be made based on these data. Rather, the results of this test program provide preliminary information regarding levels of pollutants and associated health risks. In combination with additional future data collection efforts, EPA may assess the need for regulations on sewage sludge incinerator emissions. The results from Run 4 have been evaluated, and this run has been determined to not be a statistical outlier.

### **Step 3. Identify the Inputs to the Decision**

Measurements of analytes were obtained from stack emissions, sewage sludge, and scrubber water. See Table 1-1 in Section 1 for a concise description of all data collected. The data collected are consistent with the objective specified in Step 1.

### **Step 4. Define the Boundaries of the Study**

Budget constraints implied restrictions on the quantity of data to be collected, namely three days of sampling from one incinerator under one test condition without duplicate sampling trains. The DQA assessed if this design was adequate or if more resources were necessary in future tests in order to meet the characterization objective.

### **Step 5. Develop a Decision Rule**

The DQA sought to statistically answer the question "Was Run 4 an outlier?" by formally testing if the Run 4 air emissions measurements were statistically significantly different from the Run 2 and 3 air emissions measurements for the following compounds: toxic polychlorinated biphenyls (PCBs), dioxins/furans (D/F), and polyaromatic hydrocarbons (PAHs). Note that there is no one definition of an outlier. Various methods may be devised to test this question under diverse definitions. *Here, we will conclude that Run 4 was an outlier if the Run 4 concentration of the measured analytes was significantly different from the average of the Run 2 and 3 concentrations.*

### **Step 6. Specify Tolerable Limits on Decision Errors**

The determination of whether or not Run 4 was an outlier was formally tested using an analysis of variance (ANOVA) of the standardized stack air emission PCB, D/F and PAH data, as well as of the CEM data.

The ANOVA model used for the PCB, D/F and PAH analyses was

$$z_{ij} = \alpha_i + \varepsilon_{ij} \quad (1)$$

where  $z_{ij}$  is the standardized measurement for the  $i^{\text{th}}$  run and the  $j^{\text{th}}$  compound,  $\alpha_i$  is the mean for the  $i^{\text{th}}$  run, and  $\varepsilon_{ij}$  is the error term. The error terms are assumed to be independent across compounds and normally distributed within each run.

As mentioned above, we concluded that Run 4 was an outlier provided the mean concentration of the measured analytes was significantly different than the average of the Run 2 and 3 mean concentrations. That is, we tested the null hypothesis  $H_0: (\alpha_2 + \alpha_3)/2 = \alpha_4$  versus the alternative hypothesis  $H_1: (\alpha_2 + \alpha_3)/2 \neq \alpha_4$ . According to our definition of an outlier, these hypotheses were equivalent to  $H_0$ : Run 4 was not an outlier and  $H_1$ : Run 4 was an outlier.

Residuals from the model were used to visually inspect the normality assumption for the errors.

## 3.2 DATA EVALUATION

### 3.2.1 Data Quality

Table 3-1, reproduced from the Emissions Test Report, illustrates the data quality, as measured by precision, accuracy, and completeness. In almost all cases, the performance targets were met. The DQA concluded that Run 4 mean concentrations of measured analytes were a statistical outlier on the basis of an analysis of variance test.

### 3.2.2 Data Quantity

The quantity of data collected was determined by budgetary constraints. While the goal of data collection was characterization of the mean concentrations, no limits on the acceptable variability of these means were specified. Computation of the relative standard error (RSE) of the mean, defined as RSD divided by the square root of the sample size, was carried out along with a study examining the reduction in RSE with an increase in the number of days of sampling. Calculation of the RSE, and its reduction with an increase in the number of days of sampling, was carried out under two possible scenarios:

**Table 3-1. Overall Program QA/QC Results**

QC Type/ Parameter	Analyte	Program Targets <sup>(a)</sup>	Achieved Result <sup>(a)</sup>
Precision	D/Fs	< 50% RSD	< 50% for all 2,3,7,8 isomers but 2,3,7,8-TCDD and 1,2,3,7,8-PCDD
	PAHs	< 50% RSD	Not met on any analyte, range 62.30-144.86% RSD. Corrected recoveries for Run 4 would put all < 50% except perylene and benzo(a)pyrene
	Toxic PCBs	< 50% RSD	< 50% for all but PCB-169 126, -77
Accuracy <sup>(b)</sup>	D/Fs	40% - 135%	Met (79-134%) except for 3 analytes
	PAHs	50% - 150%	All within range except as specified on Quanterra's report, and surrogate spike in field blanks.
	Toxic PCBs	70% - 130%	84-128% except for PCB-114
Completeness	D/Fs	100%	100%
	PAHs	100%	100%
	Toxic PCBs	100%	100%

<sup>(a)</sup> For emission testing only.

<sup>(b)</sup> Based on recovery of laboratory spikes for emission samples.

**Scenario 1:** Run 4 data represents actual temporal variability and should be incorporated in order to unbiasedly estimate the true variability in pollutant concentration means.

**Scenario 2:** Run 4 data resulted from some inconsistency in data collection and may not represent actual pollutant data. As such, the variability of the pollutant concentration means probably should be estimated based only on the data from Runs 2 and 3.

No maximum allowable relative standard error (RSE) was specified in the DQOs. For example, suppose estimation of mean PCB-77 is of primary interest and it is desired to estimate



this mean with 20 percent precision. Based on Scenario 1, such precision would require nine days of sampling. Perhaps nine days of sampling would be too costly and 25 percent precision would be sufficient. Then only six days of sampling would be required. The present level of effort (three days of sampling) yields 34.3 percent precision.

### **3.3 SUMMARY OF TEST REPORT DATA ANALYSIS**

In the following, the three test runs are referred to as Runs 2, 3, and 4. The main findings of the DQA are:

- There may have been a process “shift” starting around noon of the day of Run 3. Prior to the shift, higher pollutant levels were observed in emissions and lower levels in sewage sludge feed samples. After the shift, lower levels were observed in emissions and higher levels in the sludge.
- It is possible that no “shift” occurred, but that there were matrix interference problems with the data collection during Run 4. This issue is also discussed in the Emissions Test Report. Conclusive evidence has not been found to distinguish between a change in the process and a problem with the sample data collection (low pre-field surrogate standard recoveries caused by matrix interferences).
- The data collected were of the appropriate type for characterization of the mean pollutant concentrations: multiple direct measurements of the quantities of interest.
- As shown in Table 3-1, the data are of adequate precision, accuracy, and completeness, indicating that the quality of the data collected was adequate for characterization of the mean pollutant levels. Note, however, that these estimates are highly variable, being derived from only three sampling runs.

Additional discussion of the test report data is contained in the separate Data Quality Assessment Report, developed as part of this work assignment.

## **4.0 CONCLUSIONS**

### **4.1 AIR EMISSIONS MEASUREMENTS**

The organic PCB, D/F, and PAH results for Runs 2 and 3 are almost identical for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for all the analytes. As a result, emission concentrations for Run 4 are approximately half of the emission concentrations for Runs 2 and 3 for all three analyte classes.

Analyte loss may have occurred during sampling, during sample handling and transport, or prior to spiking the Run 4 sample with pre-extraction internal standards. This time period is based on a comparison of the pre-field surrogate spike recoveries to the pre-extraction internal standard recoveries. Recoveries of the pre-field surrogate spikes for Run 4 back half samples were approximately half of the recoveries for Runs 2 and 3 back half samples for all PCB, D/F, and PAH field surrogate spikes, whereas recoveries of the spiked pre-extraction PCB, D/F, and PAH internal standards were comparable and generally acceptable across all three runs. Any losses in the pre-field surrogate spikes that may have occurred in sample extraction or cleanup of the Run 4 back half sample would have also been reflected in similar losses of the spiked pre-extraction internal standards. Since the pre-extraction internal standard results are acceptable for Run 4 and consistent with the other two runs, this result suggests that the field surrogate spike and analyte losses likely occurred prior to extraction of the Run 4 emission samples.

Another indicator that analyte losses occurred prior to sample extraction is that the PCB, D/F, and PAH concentrations in the samples follow the same pattern as the pre-field surrogate spikes in that all measured back half analytes were approximately one half or less for the Run 4 sample. In addition, analyte concentrations for the Run 4 front half sample were somewhat lower than the Runs 2 and 3 front half samples. This suggests that analyte levels may not have been consistent during sampling rather than a loss of analyte from the collected sample.

After review of sampling and analysis records, a definite explanation for the lower Run 4 emission concentrations could not be determined. Possible causes of the lower Run 4 concentrations and/or lower pre-field surrogate spikes that were considered include the following:

- Pre-field Surrogate Spike Performed Improperly. This does not seem possible in that the PCB, D/F, and PAH spikes were done independently (three separate solutions) and the same spiking error would have had to be made three times on the same XAD-2 resin. The laboratory logbooks do not reflect any problem with the pre-field surrogate spiking of the XAD-2 resin.
- Analytes Not Collected Consistently During Sampling. In Run 4, PCB, D/F, and PAH compounds in the gas stream may not have been collected consistently by the MM5 sampling train. This event would affect both the Run 4 front half and back half samples and is substantiated by emission concentrations for the Run 4 front half samples which are somewhat lower than emission concentrations for the Run 2 and front half samples.
- XAD-2 Resin Lost After Sampling. During sample recovery, XAD-2 resin could have been lost from the XAD-2 resin cartridge. Field logs do not indicate any problem with the XAD-2 resin cartridge during Run 4 sample recovery so this is probably not the case.
- Temperature of XAD-2 Not Maintained During Sampling. The XAD-2 resin cartridge must be maintained at 20°C or lower temperature to avoid decomposition or volatilization of organic compounds. If the MM5 sampling train or XAD-2 resin portion thereof was exposed to ultraviolet light, high temperature, or other forms of energy, this might account for the low levels. A check of the field data sheet showed that the XAD-2 trap temperature was maintained below the required 20°C throughout Run 4. A review of the field log does not indicate any problems in recovering the MM5 sampling train at the completion of Run 4.
- XAD-2 Temperature Not Maintained During Sample Transportation. A review of the laboratory sample check-in record book shows that the Run 4 samples were received within the allowable  $\leq 4^{\circ}\text{C}$ . The temperatures of the coolers storing the XAD-2 resin traps as received from the test team for transport to Columbus were also within this limit.
- XAD-2 Temperature Not Maintained During Storage Prior to Extraction. All air emission samples were stored in the same locked refrigerated storage unit in the laboratory prior to extraction. The temperature control records for this period do not indicate any elevated temperatures.
- Emissions Concentrations During Run 4 Were Actually Lower. Lower Run 4 concentrations may be an accurate reflection of a change in incinerator emissions on the third day of sampling. This cause, however, does not explain why the field surrogate spike recoveries were low.
- Run 4 XAD-2 Resin Lost Prior to Transfer to Soxhlet Extractor. This event would result in a volume loss of analytes including the pre-field surrogate spikes. However, laboratory record books do not collaborate such an event.

- Incorrect Sample Volume Used in Calculations. If an incorrect sample volume was used to calculate emission concentrations in ug/dscm, Run 4 emission concentrations could be affected. This would affect both front and back half results for Run 4. A check of field data reduction does not indicate any calculation error.
- Improper Spiking of Laboratory Internal or Recovery Standards. An incorrect amount of internal or recovery standards could have been added to the Run 4 samples. However, since native PCB concentrations are quantified against pre-extraction internal standards and PCB pre-field surrogate spikes are quantified against the pre-analysis recovery standard, this cause would require incorrect spiking on multiple occasions which is unlikely.
- Matrix Interference Resulting in Low Standard Recoveries. Incineration systems have been known to produce matrix interferences from unknown causes. These could explain the low pre-field surrogate spike recoveries and resultant emissions.

#### 4.1.1 Toxic PCBs

Toxic PCB results for Runs 2 and 3 are almost identical for most of the analytes. The back half emission concentrations for Run 4 are 50 to 60 percent lower than the back half emission concentrations for Runs 2 and 3 for all the analytes. Possible loss of PCBs may have occurred in the field as indicated by lower pre-field surrogate recoveries for Run 4. Internal standard recoveries give an indication of how well analytes were extracted from the medium and retained during extract cleanup. For the front half air samples, recoveries of all internal standards were within the method specified limits of 30-150 percent and ranged from 35-77 percent. Internal standard recoveries in the back half air samples were also within the 30-150 percent limits and ranged from 49-84 percent. These internal standard recoveries indicate analytes were well recovered during laboratory extraction and were retained during the extract cleanup process.  $^{13}\text{C}_{12}$ -PCB-81 and  $^{13}\text{C}_{12}$ -PCB-111 were added as cleanup standards in processing the front half air samples and as pre-sampling surrogate standards spiked into XAD resin before shipping to the field in the back half air samples. Method-specified recovery ranges for these standards were from 10-150 percent for  $^{13}\text{C}_{12}$ -PCB-81 and 20-130 percent for  $^{13}\text{C}_{12}$ -PCB-111. Recovery of the cleanup standards in the front half air samples were within the limits and ranged from 53-65 percent for  $^{13}\text{C}_{12}$ -PCB-81 and from 41-57 percent for  $^{13}\text{C}_{12}$ -PCB-111 indicating that analytes were well retained through the extract cleanup procedures. Recoveries of the pre-sampling surrogates

in the back half air samples were also within the limits and ranged from 21-61 percent for PCB-81 and from 28-52 percent for  $^{13}\text{C}_{12}$ -PCB-111. The pre-sampling surrogate recoveries indicate how well analytes are retained from field sampling through laboratory analysis. While all the pre-sampling surrogate recoveries were within the target recovery range, the pre-sampling surrogate recoveries in Run 4 (21 percent, 28 percent) were approximately half of the recoveries for the surrogates in Runs 2 and 3 (51-61 percent). Since all internal standard recoveries for Runs 2, 3, and 4 were acceptable and similar between the three runs (indicating that laboratory extraction and cleanup were not a source of analyte loss), the low pre-sampling surrogate recovery in Run 4 suggests loss of this standard during sampling, handling, and/or transport to the laboratory prior to the sample extraction process. A discussion of what might have resulted in the lower Run 4 results is provided in Section 4.1 above. Since PCB concentrations are not corrected for pre-sampling surrogate recoveries, the lower PCB emission concentrations in Run 4 may be attributed to these possible analyte losses. If the concentrations for Runs 2, 3 and 4 are adjusted for the pre-sampling surrogate concentrations as shown in Table 4-1, then the results between the three runs agree well within the <50 percent RSD precision QA/QC requirement for the analytes with actual RSDs ranging from 5-24 percent.

**Table 4-1. Back Half Air PCB Data Corrected for Pre-sampling Surrogate Recovery**

ANALYTES	RUN 2 (pg/sample)	RUN 3 (pg/sample)	RUN 4 (pg/sample)	AVERAGE (pg/sample)	STANDARD DEVIATION	RSD (%)
PCB-77	171000	117600	114200	134267	31857	24
PCB-123	1256	1172	930	1119	169	15
PCB-118	60800	56400	55800	57667	2730	5
PCB-114	4120	3640	3480	3747	333	9
PCB-105	28200	26200	23600	26000	2307	9
PCB-126	7660	6420	5660	6580	1010	15
PCB-167	4160	3640	3500	3767	348	9
PCB-156	6860	6080	5380	6107	740	12
PCB-157	2360	1932	2040	2111	223	11
PCB-169	6040	5140	3680	4953	1191	24
PCB-180	29000	26000	22400	25800	3305	13
PCB-170	11660	10540	11520	11240	610	5
PCB-189	1016	818	1110	981	149	15

E = Estimated value since calibration range exceeded.

#### 4.1.2 D/Fs

The D/F results are summarized in Tables 2-5 through 2-7 in Section 2. A discussion of the QA/QC results associated with these D/F data is summarized below. The initial calibration met the requirement for response factors having less than 20 percent relative standard deviation (RSD) for native analytes and less than 35 percent RSD for labeled analytes (actual range = <13 percent for native analytes and < 19 percent for labeled analytes). The continuing calibrations met the requirement for response factors being within 20 percent of the initial calibration response factors for native analytes and being within 30 percent of the initial calibration response factors for labeled analytes for all D/F but for the native OCDF. Native OCDF response factors in the middle and last of the three continuing calibrations which bracketed the emission sample analyses were higher than the 20 percent criteria which is derived from Method 8290.

Internal standard recoveries give an indication of how well analytes were extracted from the medium and retained during extract cleanup. For the front half air samples, recoveries of all internal standards were within the method specified limits of 40-135 percent and ranged from 54-98 percent. Internal standard recoveries in the back half air samples were also within the 40-135 percent limits and ranged from 47-95 percent. These internal standard recoveries indicate analytes were well recovered during laboratory extraction and were retained during the extract cleanup process. Since all internal standard recoveries for Runs 2, 3, and 4 were acceptable and similar between the three runs (indicating that laboratory extraction and cleanup were not a source of analyte loss), the low pre-sampling surrogate recovery for D/F in Run 4 suggests loss of this standard during sampling, handling, and/or transport to the laboratory prior to the sample extraction process.

#### 4.1.3 PAHs

The PAH results are summarized in Tables 2-8 and 2-9 in Section 2.0. A discussion of the QA/QC results associated with these PAH data appears in summary below. Acceptable recoveries (64-124 percent) for the recovery standards were established in the FH and BH samples. These data suggest that there were no significant sample matrix effects on the native acenaphthene and pyrene in the resulting sample extracts for GC/MS analysis. However, the

possible sample matrix effect on other relatively more reactive target PAH compounds cannot be discounted.

Quantitative recoveries (>70 percent) of all the internal standards except benzo[a]pyrene-d<sub>12</sub> and perylene-d<sub>12</sub> were obtained in the FH samples. Recoveries of benzo[a]pyrene-d<sub>12</sub> and perylene-d<sub>12</sub> ranged from 17 to 22 percent and from 18-32 percent, respectively. The low recoveries of these two internal standards could be explained by either loss through the sample preparation process and/or through sample matrix effects. The internal standards benzo[a]pyrene-d<sub>12</sub> and perylene-d<sub>12</sub> are relatively more reactive PAH compounds as compared to other internal standards. Thus, it is assumed that the sample matrix effects could contribute significantly to the loss experienced by these two internal standards. Surrogate standards were not used in the FH samples, thus no recovery data were reported.

Acceptable recoveries (>50 percent) of 10 out of 14 internal standards were obtained in the BH samples. The four internal standards with low recoveries in the BH samples were acenaphthylene-d<sub>8</sub>, benz[a]anthracene-d<sub>12</sub>, benzo[a]pyrene-d<sub>12</sub>, and perylene-d<sub>12</sub>. These four internal standards are relatively more reactive as compared to other remaining internal standards. As described above, the loss of the internal standards was possibly due to the combination of sample preparation loss and sample matrix effects. Matrix effect variations between the FH and BH samples could be explained by more internal standards being located in the BH samples with lower than 50 percent recovery. For the same reason discussed before, the internal standard benzo[k]fluoranthene-d<sub>12</sub>, was used for the quantification of benzo[e]pyrene level. Low recoveries (13-24 percent) were obtained for the surrogate standard (field spike) in the BH samples. The loss of the surrogate standards are believed to be from either field handling or sample matrix effects. Acceptable recovery standard results were obtained in the BH samples, ranging from 64-87 percent. PAH Results for Runs 2 and 3 are somewhat similar for most of the analytes.

#### **4.1.4 Continuous Emission Monitoring**

Average daily results from continuous emission monitoring of carbon monoxide (CO) total hydrocarbons (THC), carbon dioxide (CO<sub>2</sub>), and oxygen (O<sub>2</sub>) are provided in Table 2-10. Plots of individual CO and THC data are provided in Figures 2-1, 2-2, and 2-3 for Runs 2, 3, and

4, respectively. The CO data scale appears along the left side of the plot with the THC data points plotted hourly along the bottom and scaled on the right-hand side of each figure. Run 2 THC levels were the highest encountered during the test program with Run 4 THC levels the lowest, at roughly half the Run 2 concentration. These variations do not appear to reflect significant process changes in incinerator operation according to the process data collected.

## **4.2 PROCESS SAMPLE ORGANIC MEASUREMENTS**

Test results for scrubber water and sewage sludge feed which were collected during the MM5 sampling runs are presented in this section. Detailed PCB and D/F analytical data for these matrices are provided in Section 2 and Appendix E and F, respectively of the Emissions Test Report.

Scrubber water samples collected at the inlet and outlet of the scrubber were analyzed for PCB and D/F.

### **4.2.1 Toxic PCB Comparison of Scrubber Water In Versus Scrubber Water Out**

Table 2-11 presents the PCB comparison between the inlet and outlet scrubber water samples for Run 2, 3, and 4 respectively. In general, the PCB concentrations in the inlet scrubber water samples are slightly lower than PCB concentrations in the outlet scrubber water samples although this result varies from run to run and from PCB congener to PCB congener. The PCB concentrations in the three outlet scrubber water samples are comparable. The Run 3 outlet sample was re-analyzed after a laboratory error using the archived sample.

### **4.2.2 D/F Results for Scrubber Water**

D/F concentrations for scrubber water samples are presented in Table 2-12. The comparison of D/F concentrations in inlet versus outlet scrubber water samples in Table 2-12 suggests that outlet concentrations are higher than inlet concentrations since most D/F congeners were not detected in the inlet water samples. However, the detection limit for the inlet scrubber water samples in many cases is higher than the concentration found in the outlet scrubber water



samples so an evaluation of inlet versus outlet concentrations is difficult to make. As shown in Table 2-12, most D/F concentrations in all three inlet scrubber water samples were below detection limits. The D/F concentrations in the outlet scrubber water samples were generally comparable across the three runs in that D/F congeners found at higher levels in one run (compared to other D/F congeners) were found at the same relatively higher levels in the other two runs.

#### **4.2.3 Sewage Sludge Organic Results**

Sewage sludge samples were analyzed for PCB and D/F. Sewage sludge feed was sampled and analyzed for PCBs and D/Fs consistent with the scrubber water. Results for sewage sludge feed are presented in Table 2-13 for PCBs and in Table 2-14 for D/Fs. In general, PCB and D/F concentrations in the sludge feed are comparable across the three runs.

### **4.3 PROCESS SAMPLE INORGANIC MEASUREMENTS**

#### **4.3.1 Scrubber Water**

Table 2-15 provides analytical results for inorganic parameters (chlorine, total percent solids, temperature, and pH) in scrubber water samples. No significant differences are apparent between inlet and outlet, or across the three runs, for these parameters in the scrubber water.

#### **4.3.2 Sewage Sludge**

Chlorine and percent solids results for sewage sludge samples are presented in Table 2-16. Again, results across the three runs appear generally comparable. However, in several instances the free chlorine values exceed the reported total chlorine values. The explanation for this is indeterminant.

Ultimate/proximate analysis was also performed on the sludge feed samples to determine thermal properties. Results from the ultimate/proximate analysis are presented in Tables 2-17 and 2-18. As shown, ultimate/proximate results are consistent for all three runs.

<b>TECHNICAL REPORT DATA</b> <i>(Please read Instructions on reverse before completing)</i>		
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16. ABSTRACT <p>The Clean Air Act Amendments of 1990 require the U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards (OAQPS) to establish standards of performance for sewage sludge incineration. These standards are necessary to protect public health and the environment from any adverse effects of pollutant emissions from sewage sludge incineration. The regulations will contain general regulatory requirements, pollutant characterization, and emission limits. To assess control technologies as well as associated strategies for cost-effective standards, EPA requires data on PCB, D/F, and PAH emissions from sewage sludge incinerators. While some emission data exist for sewage sludge incinerators, data on coplanar polychlorinated biphenyls (PCBs) from sewage sludge incinerators are very limited.</p> <p>The test report summarizes testing of a multiple hearth incinerator at the Metropolitan Sewer District (MSD) Mill Creek Wastewater Treatment Plant in Cincinnati, Ohio in July, 1999. The emission data collected in this test program will be used by EPA/OAQPS and EPA's Office of Water (OW) to support a decision about further data gathering efforts in support of MACT standards for sewage sludge incinerators. During the testing, a second EPA contractor monitored and recorded the process and emission control system operating parameters, and prepared Section 4.0, Process Description And Operation of the report. The report consist of five documents: Executive Summary Report; Volume I-Main Report; Volume II-Appendices A-J; Volume III-Appendices K-P; and a Data Quality Assessment Report.</p>		
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