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Air

EMISSION TEST EVALUATION OF A CREMATORY AT WOODLAWN CEMETERY IN THE BRONX, NY

VOLUME I OF III

MRI

Emission Test Evaluation of a Crematory at Woodlawn Cemetery in the Bronx, NY

Final Test Report Volume I

For U.S. Environmental Protection Agency
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EPA Contract No. 68-D-98-027
Work Assignment No. 2-08
MRI Project No. 4951-08

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DISCLAIMER

This report presents the results of a single test program at a single cremation facility. It should not be assumed that these results would characterize emissions at other cremation facilities without further study.

Preface

This document was prepared by Midwest Research Institute (MRI) for the U.S. Environmental Protection Agency (EPA) and the Crematory Association of North American (CANA). This collaborative test was performed under EPA Contract No. 68-D-98-027, Work Assignment No. 2-08 and under CANA Project No. 305587. Mr. Foston Curtis was the EPA Work Assignment Manager and Mr. Paul Rahill was the CANA representative.

In this draft test report, MRI presents a description of the source tested, the sampling and analysis procedures, quality assurance and quality control activities, reporting and data reduction activities, sample and data handling procedures, and schedule, for the test program. This report is contained in three volumes consisting of 1300 pages.

The test program was conducted in MRI's Applied Engineering Division under the leadership of Mr. James Surman, Work Assignment Leader. Mr. John Hosenfeld, Program Manager, provided oversight to technical and administrative aspects of this work assignment.

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Section 1. Introduction

1.1 Background

EPA is required to set emission standards for the "other solid waste incinerators" (OSWI) category referenced under Section 129(a)(1)(E) of the amended Clean Air Act. This category currently contains pathological waste incinerators and human crematories. A representative human crematory, located at the Woodlawn Cemetery in the Bronx, New York, was tested in support of setting these emission standards. Testing was conducted in collaboration with the Cremation Association of North America (CANA).

Although emissions data are available from tests at another facility, the unit tested was not controlled and the body containers (caskets) may not have been representative. Thus, the Woodlawn facility, which involves a representative human crematory having emission controls, was selected for baseline ("best controlled similar unit") emissions testing. Additionally, this test project would help determine the effects of secondary chamber temperature on emission levels.

1.2 Scope

This EPA work assignment was conducted in collaboration with the Cremation Association of North America (CANA) and results of testing for both parties are combined in this report. Emissions testing for polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) and process monitoring was conducted under the EPA work assignment. In conjunction with EPA testing, emissions testing for total particulate matter (PM), hydrogen chloride (HCl), cadmium (Cd), mercury (Hg), lead (Pb), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and carbon monoxide (CO), and visual observation of opacity was conducted for CANA.

Testing was conducted for three conditions, where secondary chamber temperature was varied at 1,400°, 1,600°, and 1,800°F per test. Each test consisted of three sampling runs at the scrubber inlet and outlet simultaneously with similar container materials, as available, being used for all runs. Each sampling run covered an entire cycle of about 2 hours.

1.3 Project Personnel

The following individuals are the key personnel in the management and execution of this test project:

The EPA Work Assignment Manager (WAM) was

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The primary contact assisting MRI, EPA, and Woodlawn Cemetery, as Facility Test Site Coordinator, on this test project was

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The MRI Work Assignment Leader (WAL) for this test project was

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1.4 Report Organization

The results of testing are presented in the following sections of this document. Section 2 provides process information. Section 3 provides test results and Section 4 provides a description of sampling, analysis, and process data collection. Finally, Section 5 provides a summary of QA/QC results.

Section 2.
Source Description

2.1 Process Description

The crematory at Woodlawn Cemetery is located in a lower level adjacent to the basement of the Woolworth Chapel. Four cremation incinerator units of the same design are operated and vented to the common chimney located on a side of the steeple. A schematic of the unit tested is presented in Figure 2-1. A retort is preheated prior to introducing the body container for cremation. Typical cremation takes approximately 2 hours. Following a cremation, the cooldown, removal of the remains, and preheating for the next cremation takes approximately 1 hour.

The cremation incinerator unit retort consists of a primary combustion chamber where cremation occurs and a secondary chamber where the products of combustion from the primary chamber are incinerated further to reduce emissions. The external dimensions of the retort are approximately 15 feet long by 5 feet wide by 6 feet high. The burner in the primary chamber is rated at approximately 0.6 MMBTU/hr, and the burner in the secondary chamber is rated at approximately 1.0 MMBTU/hr. A forced air blower (approximately 400-600 scfm) supplies air to both burners and chambers.

Combustion gases and products are vented through refractory-lined ductwork above the retort to a wet scrubber with spray chambers using unmodified water (i.e., not caustic or acidic). Gases from the scrubber pass through a short section of duct with a damper to the chimney. Uncontrolled emissions were measured in the horizontal, circular section of duct immediately upstream from the scrubber. Ports were installed for the tests. Controlled emissions were measured in the short horizontal, circular section of duct between the scrubber and chimney. A new section with ports and without the damper was installed for the tests. The damper is used to isolate the unit from the chimney and the other three units when it is not in use. This unit is considered to be typical for cremation incinerators, and the scrubber, or a similar device, may be a candidate for maximum achievable control technology.

2.2 Control Equipment

Combustion gas passes through a wet scrubber prior to entering the chimney. Entrained particulate matter and other pollutants exiting the secondary combustion chamber are removed in the scrubber. The horizontal, cylindrical, stainless steel scrubber unit is approximately 48 inches long with a 36-inch diameter and uses unmodified city

water (i.e., not a caustic or acidic solution). Water spray nozzles are located across the top of the cylinder, and drains remove water from the bottom of the cylinder.

A temporary platform was erected which ran alongside the scrubber to allow for sampling at the scrubber inlet and outlet. The scrubber inlet was sampled in the 72-inch long horizontal circular duct leading into the scrubber. The scrubber outlet was sampled in the 30-inch long horizontal circular duct connected directly to the scrubber. This was a temporary duct installed to replace the original duct for the test. The number of traverse points and sampling time at each point was identical for both inlet and outlet locations.

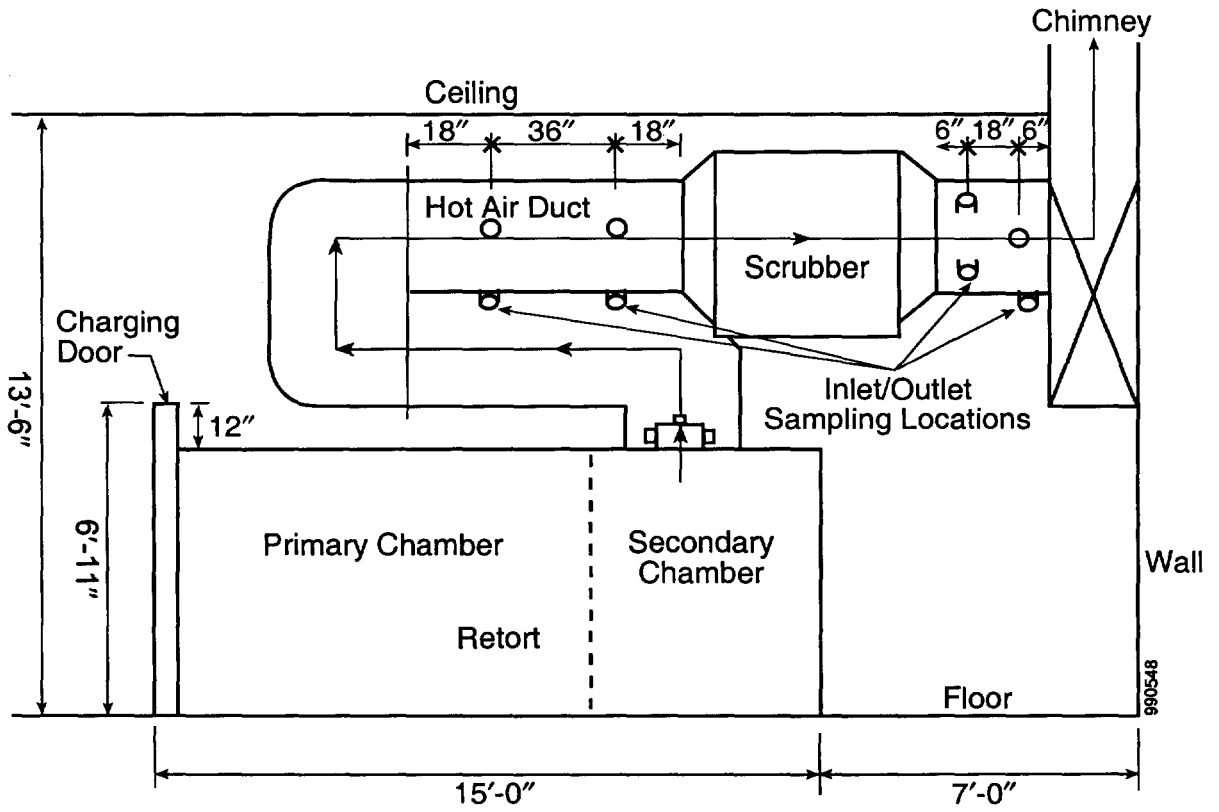

Figure 2-1. Cremation Incinerator Unit

Section 3.
Test Project Description

3.1 Objectives and Test Matrix

The purpose of this collaborative test project was to obtain uncontrolled and controlled emission data from a crematory at the Woodlawn Cemetery to assist EPA in developing emission standards under Section 129 of the Clean Air Act. The specific objectives were to:

- Measure polychlorinated dibenzodioxin (PCDD) and polychlorinated dibenzofuran (PCDF), total particulate matter (PM), hydrogen chloride (HCl), cadmium (Cd), mercury (Hg), lead (Pb), sulfur dioxide (SO_2), oxides of nitrogen (NO_X), and carbon monoxide (CO) emissions simultaneously at the inlet and outlet of the wet scrubber along with observations of opacity at the chimney during three operating conditions where the secondary combustion chamber temperature would be varied

- Monitor and record primary and secondary chamber temperatures, presence of outdoor ambient odors, charge weights, body container descriptions, batch cycle times, fuel flow rates, outdoor ambient temperatures, outdoor relative humidity, and outdoor barometric pressure during each test run.

Testing for the pollutants specified in the work assignment and also those contracted by CANA was done during three operating or test conditions where the secondary chamber was maintained at approximately 1,400°, 1,600°, and 1,800°F for each condition. The retort was heated to operating temperature before testing. Testing for each run was started when the retort door was closed following insertion of the body container. Testing for each run was stopped when the operator determined that cremation was completed. Sampling was not conducted during any portion of a warm-up or cool-down period.

The test matrix, which includes the number of samples or sample component sets collected during each run for either uncontrolled or controlled emissions, is presented in Table 3-1. The target pollutants are listed in Table 3-2. Measured emission parameters were identical at the scrubber inlet and outlet locations. Opacity readings were taken outside at the chimney during all three tests. All sample analysis for target pollutants, except HCl, were performed at MRI's laboratories in Kansas City, Missouri. Samples to be analyzed for HCl were transferred to Galbraith Laboratories, Inc., in Knoxville, Tennessee, for analysis. ETS, Inc. of Roanoke, Virginia, performed the EPA instrumental

analyzer methods for CO_2, O_2, SO_2, NO_X, and CO as well as opacity observations. Process operating data were collected by CANA during each test run.

3.2 Test Schedule

Testing began June 11 and continued through June 17, 1999. Table 3-3 presents the test run times. Testing was preceded by preliminary velocity measurements. Once preliminary measurements were completed and final preparations were in progress, the site coordinator and other personnel were notified of run start times.

3.3 Field Test Changes and Problems

3.3.1 Sampling

Problems encountered in the field fell into three main categories: probes, thermocouples, and sample recovery. They are discussed below. Sampling data sheets and computer generated MM5 data are found in Appendices C and D.

Probes

Even with water-cooled probes, the extreme temperatures at the scrubber inlet caused some probes to heat and warp, thereby rendering them useless for any subsequent runs. This did not affect results, but would have resulted in the unavailability of probes for subsequent runs if no preventative measures were taken. This problem was solved by conducting inlet sampling in the uppermost port so that probes were oriented on a downward slope to maintain cooling water at the tip thereby preventing heat warpage. One additional port had to be installed in order to perform all inlet sampling on a downward slope. Problems with sample collection as a result of using water-cooled probes in the high temperature environment are summarized below:

- The additional port was installed after the fourth run. Only two trains were operated during Run 4 in the two available ports (metals and PCDD/PCDF trains). The M26A train was not used for HCl, and particular matter sampling was conducted with the metals train.

- During Run 4, sampling at the inlet continued during port changes at the outlet. This resulted in longer sampling times at the inlet than at the outlet. For all subsequent runs sampling at the inlet was halted until port changes at the outlet were completed to obtain simultaneous inlet/outlet sample collection. The effect

of non-simultaneous testing is that results obtained from the inlet during Run 4 are somewhat larger than the outlet results.

- During the last two runs of regular testing (Runs 8 and 9), no M26A trains were used for sample collection at the outlet in order to conserve usable water-cooled probes. Particulate matter for these runs was collected on the metals train. Particulate matter results were not compromised by using a different train sample collection, however, no HCl samples could be collected as a result.

- Some trains at the scrubber inlet location (Run 1 M26A train, Run 2 M29 train, Run 2 M23 train, Run 3 M26A train, and Run 5 M23 train) did not pass final leak check from the nozzle, but did pass from the sample transfer line. This appeared to be caused by extreme temperatures loosening the nozzle-to-probe liner connection. Since O_2, CO_2, and moisture results were nearly identical for all trains within a given run, results from these trains appear to be uncompromised and representative of stack conditions.

The PCDD/PCDF outlet trains for Runs 5 and 10 did not pass final leak check. These results are considered to be unusable and are therefore not reported.

Thermocouples

During Run 1, the probe thermocouple on the PCDD/PCDF train at the scrubber inlet location shorted out. This was replaced after the end of the run with the result that no probe temperature data was available for the second half of the run. However, based on stack temperature and filter box temperature, this is not expected to have affected results.

During Run 3, the XAD thermocouple on the PCDD/PCDF train started to fail, giving high temperature readings in spite of frequent applications of ice. It was replaced during port change and readings thereafter were well within method requirements. Data were not affected, since the high temperature readings were not a reflection of actual temperatures thought to have been experienced at the XAD inlet.

Sample Recovery

The recovery and QA rinses of the Run 1 PCDD/PCDF inlet and outlet sampling trains were not collected according to the test plan (see analysis memo in Appendix A). The recovery rinses for the semivolatile front-half (PCDD/PCDF FH) outlet were inadvertently placed into the SV FH inlet sample bottles. This was easily corrected by analyzing the recovery rinses labeled for the inlet with the outlet train samples and designating a new number for the inlet train rinses to prevent mix up during analysis. The QA rinse from the PCDD/PCDF front-half outlet was inadvertently placed into the inlet

sample bottle which already contained the inlet back-half QA rinses. A new sample bottle was used to collect the remaining PCDD/PCDF front-half rinses of the inlet train. This resulted in partial collection of inlet and outlet train QA rinses and a third sample containing some rinses from each train.

The final QA toluene soak (3rd of 3) from the Run 4, PCDD/PCDF outlet train was inadvertently placed in the corresponding recovery rinse sample bottle instead. This would not affect sample results, but would lengthen sample concentration time during analysis and could potentially result in a lower QA rinse result.

3.3.2 Analytical

Samples were analyzed according to the Site Specific Test Plan and Quality Assurance Project Plan with no problems or changes.

3.4 Summary of Test Results

Testing was performed to gather emissions data from a crematory to assist in developing emissions standards under Section 129 of the Clean Air Act. Results of testing at the Unit 4 crematory in the Woolworth Chapel at Woodlawn Cemetery are presented here. Summary test data is presented in Table 3-4 with more detailed summaries in all the following tables. The calculation of removal efficiencies are not appropriate to this test since scrubber inlet amounts are so low.

3.4.1 Modified Method 5 and Particulate Matter Results

Data obtained from sampling trains are summarized in Tables 3-5 through 3-7. Each sampling train provided data on gas velocity, temperature, pressure, O_2, CO_2, and volumetric flow rates. As flagged in the tables, some trains at the scrubber inlet location did not pass final leak check from the nozzle, but did pass from the sample transfer line.

CO_2 and O_2 results indicate some inleakage was occurring between the inlet and outlet sampling locations. This evidence of inleakage is supported by the higher dry standard volumetric gas flow rates (averages of flow rates measured by all trains at a location) measured at the outlet location.

The variability in dry standard volumetric gas flow rate results is not due to equipment calibration or probe orientation with duct walls during sampling. Sampling locations were not ideal for obtaining consistent flow data. The Method 23 inlet train was nearest to the

last duct bend after the secondary combustion chamber, and the Method 23 outlet train was located nearest to the scrubber outlet. More turbulent flow expected at these locations may explain the higher flow results obtained with the Method 23 trains. Because flow was different at each traverse point at any given time across each sampling cross-section and flow varied at each of those points during the course of a run, consistent flow results could not be obtained among the trains used at the inlet or the outlet during any run.

Results of testing for total particulate matter are presented in Table 3-8. As indicated from the data, inlet and outlet concentrations for each run were very similar, regardless of condition thereby indicating that the scrubber had little, or no effect on particulate matter removal. Data from particulate matter testing are found in Appendix H.

3.4.2 Hydrogen Chloride Analysis Results

Hydrogen chloride emission results are presented in Table 3-9 in units of both grams per minute and pounds per hour. While, emissions appear to be lower at the scrubber outlet than at the inlet for Condition 1, the HCl concentrations are too low at the inlet relative to the outlet locations for removal efficiencies to be meaningful. HCl data are included in Appendix E.

3.4.3 Metals Analysis Results

Metals results, blank corrected results and emission rates are shown in Tables 3-10 through 3-12. Cadmium and lead emissions tend to increase with secondary combustion chamber temperature increase; mercury emissions were less affected by temperature than the other two metals. The increase in metals emissions with increasing temperatures is not uncommon, however, the amount of cadmium and lead charged during each run may also have contributed. The metals narrative report with analysts' results are included in Appendix F.

3.4.4 Dioxin and Furan Results

Dioxin and furan results are provided in Tables 3-13 through 3-24, grouped by condition. Tables 3-13 through 3-16 provide results for Condition 1 testing, Tables 3-17 through 3-20 provide results for Condition 2 testing, and Tables 3-21 through 3-24 provide results for Condition 3 testing. Results for each condition are presented first by total amount found within a given homologue, next by the 2,3,7,8-substituted compounds, then by the corresponding equivalent toxicity of 2,3,7,8-tetrachloro-dibenzo-dioxin for inlet and outlet. The dioxin and furan narrative report is included in Appendix G. It should be noted

that Run 1 inlet results are low by a factor of 10 compared to Runs 2 and 3. As is commonly observed, data show a trend for increased dioxin/furan amounts at the outlet compared with the inlet. There is also a trend for increased dioxin/furan amounts as SCC temperatures are increased.

3.4.5 Results of O_2, CO_2, SO_2, NO_x, and CO Analysis and Opacity Observations

Continuous instrumental analyzers were used for the duration of a cremation to measure scrubber inlet and outlet emissions of O_2, CO_2, SO_2, NO_x, and CO. A concurrent visible emissions evaluation for opacity was also performed at the chimney outlet. Results of continuous instrumental analyzers monitoring and opacity observations are presented in Table 3-25.

The Run 5 cremation in Unit 4 started 30 minutes before the end of a cremation in Unit 1. For the first 30 minutes of Run 5, therefore, visible emissions recorded may not reflect the true visible emissions from Unit 4 only.

The SO_2, NO_x, and CO instrumental analyzers occasionally recorded gas concentration spikes that exceeded their span. At the end of the test program, the linearity of the analyzers at higher concentrations was demonstrated by using a calibration gas above the highest one-minute average spike measured during the test program. Calibration gas was introduced at the sampling probe, and linearity was demonstrated to meet the accuracy and calibration error requirements of Methods 6C, 7E, and 10 in Appendix A of 40 *CFR* 60. Data from the post-test linearity checks are contained in Appendix J.

3.4.6 Process Data

Process test data and a summary of body/container characteristics are provided in Tables 3-26 and 3-27, respectively. Process data collection forms are found in Appendix B. As denoted in the process data Table 3-26, no ambient odors were noticeable near the crematory. However, a slight foul odor could be observed by passersby near the down draft of the stack during the first 2 to 3 minutes.

Table 3-1. Test Matrix—Summary of Emission Sampling and Analytical Parameters and Methods per Test Run

Sampling location	Sampling or measurement time	Test method and sample size	Emission parameters	Total number of samples or sample component sets per run & location	Preparation method	Analytical method
Scrubber inlet or outlet duct	One full operating cycle (approximately 2 hours)	40 *CFR* 60, Appendix A, Method 23, ≥2.4 m^3	Dioxins and furans	1 set emission samples and 1 set QA samples	Solvent extraction	HRGC/HRMS (SW-846, Method 8290)
		40 *CFR* 60, Appendix A, Method 29, ≥2m^3	Metals (Cd, Hg, and Pb)	1	Method 29 microwave and hotplate digestion	GFAAS (SW-846, Methods 7000A, 7131A, and 7421; and CVAAS (SW-846, Method 7470A)
		40 *CFR* 60, Appendix A, Method 26A, ≥2m^3	Particulate matter	1	Desiccation	Gravimetric
			HCl	1	NA	IC (Method 26A)
		40 *CFR* 60, Appendix A, Method 2	Velocity, pressure, temperature, volumetric flow rate	NA	NA	Pitot tube, thermocouple
		40 *CFR* 60, Appendix A, Methods 3 and 3B, ≥20L	CO_2 and O_2 (Molecular weight; and emission rate correction factor for dioxins and furans)	3	NA	Orsat
		40 *CFR* 60, Appendix A, Method 4, ≥2-2.4 m^3	Moisture	3	NA	Gravimetric
		40 *CFR* 60, Appendix A, Method 3A	CO_2 and O_2 (to normalize SO_2, NO_x, and CO results)	1 continuous	Particulate matter and moisture removal	NDIR for CO_2 Micro-fuel cell for O_2
		40 *CFR* 60, Appendix A, Method 6C	SO_2	1 continuous	Particulate matter and moisture removal	UV spectrophotometry
		40 *CFR* 60, Appendix A, Method 7E	NO_x	1 continuous	Particulate matter and moisture removal	Chemiluminescense
		40 *CFR* 60, Appendix A, Method 10	CO	1 continuous	Particulate matter and moisture removal	Gas filter correlation NDIR
Scrubber outlet	One full operating cycle (approximately 2 hours)	40 *CFR* 60, Appendix A, Method 9	Opacity	1 data set continued every 15 seconds	NA	Visual observation

Table 3-2. List of Target Analytes

Compound or Group	CAS No.
Dioxin/Furans:	
2,3,7,8-TCDD	1746-01-6
Total TCDD	41903-57-5
2,3,7,8-TCDF	51207-31-9
Total TCDF	55722-27-5
1,2,3,7,8-PeCDD	40321-76-4
Total PeCDD	36088-22-9
1,2,3,7,8-PeCDF	57117-41-6
2,3,4,7,8-PeCDF	57117-31-4
Total PeCDF	30402-15-4
1,2,3,4,7,8-HxCDD	39227-28-6
1,2,3,6,7,8-HxCDD	57653-85-7
1,2,3,7,8,9-HxCDD	19408-74-3
Total HxCDD	34465-46-8
1,2,3,4,7,8-HxCDF	70648-26-9
1,2,3,6,7,8-HxCDF	57117-44-9
1,2,3,7,8,9-HxCDF	72918-21-9
2,3,4,6,7,8-HxCDF	60851-34-5
Total HxCDF	55684-94-1
1,2,3,4,6,7,8-HpCDD	35822-46-9
Total HpCDD	37871-00-4
1,2,3,4,6,7,8-HpCDF	67562-39-4
1,2,3,4,7,8,9-HpCDF	55673-89-7
Total HpCDF	38998-75-3
OCDD	3268-87-9
OCDF	39001-02-0
Metals:	
Cadmium	7440-43-9
Lead	7439-92-1
Mercury	7439-97-6
Other Pollutants:	
Sulfur dioxide	7446-09-5
Oxides of nitrogen (NO_x)	
Carbon monoxide	630-08-0
Hydrogen chloride	7647-01-0
Particulate matter (per Method 5)	

Table 3-3. Stack Sampling Run Times

Run Number	Date	Stack Sampling Intervals (in minutes per 24-hour clock) (PM/HCl/Cl2)	(Metals)	(Semivolatiles)
1	6/11/99			
Inlet		15:20 - 16:20	15:21 - 16:21	15:20 - 16:20
		17:00 - 18:00	17:01 - 18:01	17:00 - 18:00
Outlet		15:22 - 16:22	15:20 - 16:20	15:21 - 16:21
		17:02 - 18:02	17:00 - 18:00	17:01 - 1801
2	6/12/99			
Inlet		11:45 - 12:45	11:46 - 12:46	11:45 - 12:45
		13:10 - 14:10	13:11 - 14:11	13:10 - 14:10
Outlet		11:47 - 12:47	11:45 - 12:45	11:46 - 12:46
		13:12 - 14:12	13:10 - 14:10	13:11 - 14:11
3	6/13/99			
Inlet		09:06 - 10:06	09:07 - 10:07	09:06 - 10:06
		10:29 - 11:29	10:30 - 11:30	10:29 - 11:29
Outlet		09:08 - 10:08	09:06 - 10:06	09:07 - 10:07
		10:31 - 11:31	10:29 - 11:29	10:30 - 11:30
4	6/13/99			
Inlet			16:05 - 18:35	16:05 - 18:35
Outlet		16:07 - 17:07	16:05 - 17:05	16:06 - 17:06
		17:27 - 18:27	17:25 - 18:25	17:26 - 18:26
5	6/14/99			
Inlet		15:50 - 16:50	15:51 - 16:51	15:50 - 16:50
		17:20 - 18:20	17:21 - 18:21	17:20 - 18:20
Outlet		15:52 - 16:52	15:50 - 16:50	15:51 - 16:51
		17:22 - 18:22	17:20 - 18:20	17:21 - 18:21
6	6/15/99			
Inlet		10:45 - 11:45	10:46 - 11:46	10:45 - 11:45
		12:11 - 13:11	12:12 - 13:12	12:11 - 13:11
Outlet		10:47 - 11:47	10:45 - 11:45	10:46 - 11:46
		12:13 - 13:13	12:11 - 13:11	12:12 - 13:12
7	6/15/99			
Inlet		17:50 - 18:50	17:51 - 18:51	17:50 - 18:50
		19:10 - 20:10	19:11 - 20:11	19:10 - 2010
Outlet		17:52 - 18:52	17:50 - 18:50	17:51 - 18:51
		19:12 - 20:12	19:10 - 20:10	19:11 - 20:11
8	6/16/99			
Inlet		15:40 - 16:40	15:41 - 16:41	15:40 - 16:40
		16:48 - 18:18	16:49 - 18:19	16:48 - 18:18
Outlet			15:40 - 16:40	15:41 - 16:41
			16:48 - 18:18	16:49 - 18:19
9	6/17/99			
Inlet		10:05 - 11:05	10:06 - 11:06	10:05 - 11:05
		11:18 - 12:18	11:19 - 12:19	11:18 - 12:18
Outlet			10:05 - 11:05	10:06 - 11:06
			11:18 - 12:18	11:19 - 12:19
10	6/17/99			
Inlet				16:02 - 17:02
				17:06 - 18:06
Outlet				16:02 - 17:02
				17:06 - 18:06

Table 3-4. Summary Test Data

Run No.	Body Description	Container Description	Average SCC Temp °F	Particulate Matter Conc (corr to 7% O2) (gr/dscf)		HCl (lb/hr)		Metals (g/hr) Inlet			Metals (g/hr) Outlet			PCDD/PCDF Homologue (ng/min)	
				Inlet	Outlet	Inlet	Outlet	Cd	Pb	Hg	Cd	Pb	Hg	Inlet	Outlet
1	157 lb, not embalmed, white plastic sheet	15 lb; white fiberboard, chipboard bottom	1425	0.016	0.019	0.029	0.012	0.004	0.06	0.30	0.003	0.05	0.20	6.5	206
2	163 lb, not embalmed, white plastic sheet	85 lb; white fiberboard & chipboard, wooden inserts	1475	0.013	0.012	0.032	0.011	0.002	0.02	0.003	0.003	0.03	0.006	97	325
3	182 lb, not embalmed, white plastic pouch, metal found in remains	10 lb; brown fiberboard, no wood	1450	0.015	0.017	0.095	0.076	0.014	0.21	0.51	0.013	0.20	0.23	86	482
Condition 1 Test Average			**1450**	**0.015**	**0.016**	**0.053**	**0.033**	**0.006**	**0.10**	**0.27**	**0.006**	**0.09**	**0.15**	**82** [a]	**338**
4	199 lb, not embalmed, light white plastic pouch	10 lb; brown fiberboard, no wood	1660	0.032	0.032	-	0.11	0.032	0.39	0.82	0.029	0.49	0.71	76	527
5	180 lb, embalmed	100 lb; ptcl board casket; fabric lining, plastic fiber stuffing, white plastic sheet	1656	0.029	0.029	0.074	0.097	0.032	0.21	0.14	0.025	0.17	0.07	146	-
6	188 lb, not embalmed, white plastic sheets	30 lb; fiberboard with pine base, chipboard bottom	1645	0.038	0.040	0.21	0.23	0.091	0.37	0.02	0.059	0.21	0.01	194	701
Condition 2 Test Average			**1654**	**0.033**	**0.034**	**0.14**	**0.15**	**0.052**	**0.32**	**0.33**	**0.038**	**0.29**	**0.26**	**139**	**614**
7	140 lb, embalmed, cloth sheet	100 lb; ptcl board casket; fabric lining, plastic fiber stuffing, white plastic sheet	1845	0.112	0.115	0.43	0.39	0.13	0.99	0.240	0.08	0.82	0.160	221	697
8	200 lb, not embalmed, white plastic pouch	10 lb; brown fiberboard, no wood	1838	0.051	0.052	0.16	-	0.17	0.47	0.014	0.11	0.33	0.012	187	254
9	105 lb, not embalmed, white plastic pouch	10 lb; brown fiberboard, no wood	1838	0.040	0.037	0.19	-	0.03	0.32	0.005	0.03	0.16	0.007	167	319
Condition 3 Test Average			**1840**	**0.068**	**0.068**	**0.26**	**0.39**	**0.11**	**0.59**	**0.086**	**0.07**	**0.44**	**0.060**	**192**	**423**

[a] Includes inlet Run 10 result of 140 ng/min.

Table 3-5. Summary Modified Method 5 Sampling Data—Condition 1

		Sampling time (min)	Gas volume (dscm)	Orsat Analysis Oxygen (%)	Orsat Analysis CO2 (%)	Water (%)	Avg. Stack Temp. (F)	Iso-kinetic (%)	Stack velocity (act. ft/min)	Stack flow rate (dscft/min)	Stack flow rate (dscm/min)
Run 1											
Inlet	M29	120	1.269	10.0	6.9	13.5	1294	102.3	505	326	9
	M26A [a]	120	1.652	10.0	6.9	13.6	1272	102.7	649	424	12
	M23	120	1.884	10.0	6.9	13.4	1310	96.4	804	515	15
	Average =			10.0	6.9	13.5	1292		653	422	12
Outlet	M29	120	0.684	11.4	6.1	22.8	503	100.3	171	331	9
	M26A	120	0.879	11.4	6.1	23.9	526	100.8	227	423	12
	M23	120	1.316	11.4	6.1	23.1	530	104.6	329	616	17
	Average =			11.4	6.1	23.3	520		242	457	13
Run 2											
Inlet	M29 [a]	120	1.628	10.4	6.6	14.9	1234	103.6	632	414	12
	M26A	120	1.478	10.4	6.6	15.3	1253	100.4	601	388	11
	M23 [a]	120	1.739	10.4	6.6	15.1	1238	98.6	712	465	13
	Average =			10.4	6.6	15.1	1242		648	422	12
Outlet	M29	120	1.009	11.4	6.1	28.5	526	105.5	266	464	13
	M26A	120	1.109	11.4	6.1	24.7	514	101.4	286	531	15
	M23	120	1.385	11.5	6.0	25.1	528	101.8	362	660	19
	Average =			11.4	6.1	26.1	523		305	552	16
Run 3											
Inlet	M29	120	1.456	9.3	7.5	15.5	1261	100.8	593	379	11
	M26A [a]	120	1.383	9.3	7.5	15.4	1225	100.7	553	362	10
	M23	120	1.983	9.3	7.5	14.9	1238	101.0	793	518	15
	Average =			9.3	7.5	15.3	1241		646	420	12
Outlet	M29	120	0.898	10.0	7.1	24.2	509	101.1	230	431	12
	M26A	120	1.098	10.0	7.1	20.7	521	97.5	282	547	15
	M23	120	1.592	10.1	7.0	25.1	516	102.1	412	758	21
	Average =			10.0	7.1	23.3	515		308	579	16
Run 10											
Inlet	M23	120	1.766	10.5	6.9	14.0	1199	99.0	698	469	13
Outlet	M23 [b]	-	-	-	-	-	-	-	-	-	-

M29 = Multiple metals sampling train. M26A = Particulate/HCl sampling train. M23 = PCDD/PCDF sampling train.

[a] Failed final leak check from nozzle, but passed from sample transfer line.

[b] Failed final leak check.

Table 3-6. Summary Modified Method 5 Sampling Data—Condition 2

		Sampling time (min)	Gas volume (dscm)	Orsat Analysis Oxygen (%)	Orsat Analysis CO2 (%)	Water (%)	Avg. Stack Temp. (F)	Iso-kinetic (%)	Stack velocity (act. ft/min)	Stack flow rate (dscft/min)	Stack flow rate (dscm/min)
Run 4											
Inlet	M29	150	1.844	8.7	7.7	17.3	1432	102.6	666	379	11
	M26A	-	-	-	-	-	-	-	-	-	-
	M23	150	2.730	8.7	7.7	17.5	1509	103.5	1,020	556	16
	Average =			8.7	7.7	17.4	1471		843	468	14
Outlet	M29	120	1.049	9.3	7.4	26.9	574	104.3	287	487	14
	M26A	120	1.123	9.3	7.4	28.2	557	105.6	305	516	15
	M23	120	1.476	9.4	7.4	28.2	619	105.8	426	679	19
	Average =			9.3	7.4	27.8	583		339	561	16
Run 5											
Inlet	M29	120	1.813	8.1	9.0	15.3	1409	100.2	816	477	14
	M26A	120	1.448	8.1	9.0	15.3	1308	100.5	614	380	11
	M23 [a]	120	2.263	8.1	9.0	15.9	1480	101.8	1,048	586	17
	Average =			8.1	9.0	15.5	1399		826	481	14
Outlet	M29	120	1.025	9.7	7.9	24.5	610	101.2	293	492	14
	M26A	120	1.261	9.7	7.9	24.4	631	101.4	367	603	17
	M23	-	-	-	-	-	-	-	-	-	-
	Average =			9.7	7.9	24.5	621		330	548	16
Run 6											
Inlet	M29	120	1.822	9.0	8.1	14.8	1443	99.4	835	483	14
	M26A	120	1.451	9.0	8.1	15.5	1241	99.8	597	383	11
	M23	120	2.126	8.9	7.9	15.4	1498	100.2	1,001	559	16
	Average =			9.0	8.0	15.2	1394		811	475	14
Outlet	M29	120	0.970	10.6	7.0	24.3	605	100.9	275	465	13
	M26A	120	1.101	10.6	7.0	25.3	628	101.9	321	524	15
	M23	120	1.786	10.6	7.0	24.9	634	99.4	535	875	25
	Average =			10.6	7.0	24.8	622		377	621	18

M29 = Multiple metals sampling train. M26A = Particulate/HCl sampling train. M23 = PCDD/PCDF sampling train.

[a] Failed final leak check from nozzle, but passed from sample transfer line.

Table 3-7. Summary Modified Method 5 Sampling Data—Condition 3

		Sampling time (min)	Gas volume (dscm)	Orsat Analysis Oxygen (%)	Orsat Analysis CO2 (%)	Water (%)	Avg. Stack Temp. (F)	Iso-kinetic (%)	Stack velocity (act. ft/min)	Stack flow rate (dscft/min)	Stack flow rate (dscm/min)
Run 7											
Inlet	M29	120	1.626	7.1	9.8	15.2	1572	100.0	795	428	12
	M26A	120	1.458	7.1	9.8	15.3	1496	100.0	687	384	11
	M23	120	1.926	7.1	9.8	16.6	1647	102.1	973	497	14
	Average =			7.1	9.8	15.7	1572		818	436	12
Outlet	M29	120	0.782	8.4	8.6	27.2	621	101.0	234	375	11
	M26A	120	0.982	8.4	8.6	27.5	657	99.0	312	481	14
	M23	120	1.473	8.4	8.6	28.1	677	103.4	460	691	20
	Average =			8.4	8.6	27.6	652		335	516	15
Run 8											
Inlet	M29	150	2.104	7.6	8.2	16.2	1626	100.0	848	443	13
	M26A	150	1.681	7.6	8.2	17.2	1542	101.0	653	351	10
	M23	150	2.386	7.6	8.2	16.8	1694	101.4	988	496	14
	Average =			7.6	8.2	16.7	1621		830	430	12
Outlet	M29	150	1.311	8.9	7.4	27.3	675	97.0	344	527	15
	M26A	-	-	-	-	-	-	-	-	-	-
	M23	150	1.826	8.9	7.3	27.0	703	101.4	467	701	20
	Average =			8.9	7.4	27.2	689		406	614	18
Run 9											
Inlet	M29	120	1.831	7.8	8.2	15.1	1553	99.0	889	486	14
	M26A	120	1.407	7.8	8.2	15.6	1462	100.0	653	372	11
	M23	120	1.943	7.8	8.2	16.6	1629	101.0	980	507	14
	Average =			7.8	8.2	15.8	1548		841	455	13
Outlet	M29	120	0.994	9.2	7.3	26.8	671	100.0	311	482	14
	M26A	-	-	-	-	-	-	-	-	-	-
	M23	120	1.402	9.2	7.3	28.7	667	108.8	414	625	18
	Average =			9.2	7.3	27.8	669		363	554	16

M29 = Multiple metals sampling train. M26A = Particulate/HCl sampling train. M23 = PCDD/PCDF sampling train.

Table 3-8. Particulate Matter Test Results

	Condition 1					
	INLET			OUTLET		
Parameter	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Amount found in probe rinse (g)	0.0223	0.0223	0.0186	0.0121	0.0112	0.0122
Amount found on filter (g)	0.0246	0.0121	0.0200	0.0143	0.0093	0.0206
Total particulate weight (g)	0.0469	0.0344	0.0386	0.0264	0.0205	0.0328
Total particulate weight (grains)	0.7238	0.5309	0.5957	0.4074	0.3164	0.5062
Gas sample volume (dscf)	58.330	52.208	48.839	31.039	39.148	38.785
Oxygen concentration (%)	10.0	10.4	9.3	11.4	11.4	10.0
Particulate concentration - corrected to 7% O_2 (gr/dsdf)	0.016	0.013	0.015	0.019	0.012	0.017
Condition Avg (gr/dscf, corr 7%O2)	**0.015**			**0.016**		
	Condition 2					
	INLET			OUTLET		
Parameter	Run 4	Run 5	Run 6	Run 4	Run 5	Run 6
Amount found in probe rinse (g)	0.0596	0.0389	0.0513	0.0172	0.0203	0.0215
Amount found on filter (g)	0.0580	0.0504	0.0560	0.0512	0.0478	0.0541
Total particulate weight (g)	0.1176	0.0893	0.1073	0.0684	0.0681	0.0756
Total particulate weight (grains)	1.8148	1.3781	1.6559	1.0556	1.0509	1.1667
Gas sample volume (dscf)	65.139	51.120	51.243	39.673	44.517	38.898
Oxygen concentration (%)	8.7	8.1	9.0	9.3	9.7	10.6
Particulate concentration - corrected to 7% O_2 (gr/dsdf)	0.032	0.029	0.038	0.032	0.029	0.040
Condition Avg (gr/dscf, corr 7%O2)	**0.033**			**0.033**		
	Condition 3					
	INLET			OUTLET		
Parameter	Run 7	Run 8	Run 9	Run 7	Run 8	Run 9
Amount found in probe rinse (g)	0.2005	0.1118	0.0744	0.0543	0.0423	0.0203
Amount found on filter (g)	0.1713	0.0777	0.0459	0.1793	0.0934	0.0502
Total particulate weight (g)	0.3718	0.1895	0.1203	0.2336	0.1357	0.0705
Total particulate weight (grains)	5.7378	2.9244	1.8565	3.6050	2.0942	1.0880
Gas sample volume (dscf)	51.487	59.368	49.676	34.696	46.302	35.088
Oxygen concentration (%)	7.1	7.6	7.8	8.4	8.9	9.2
Particulate concentration - corrected to 7% O_2 (gr/dsdf)	0.112	0.051	0.040	0.115	0.052	0.037
Condition Avg (gr/dscf, corr 7%O2)	**0.068**			**0.067**		

Table 3-9. Hydrogen Chloride Emission Results

Run No.		Chloride conc. (mg/L)	Impinger volume (L)	Quantity found (mg)	Stack gas sample volume (dscm)	HCl conc. (mg/dscm)	HCl conc. (ppm)	Stack flow (dscm/min)	HCl emission (g/min)	HCl emission (lb/h)
1	Inlet	53.5	0.5537	29.6	1.652	17.9	11.9	12	0.22	0.029
	Outlet	10.0	0.6185	6.19	0.879	7.04	4.65	12	0.087	0.012
2	Inlet	60.9	0.5147	31.3	1.478	21.2	14.0	11	0.24	0.032
	Outlet	9.4	0.6390	6.01	1.109	5.42	3.58	15	0.084	0.011
3	Inlet	189.9	0.5054	96.0	1.383	69.4	45.9	10	0.71	0.095
	Outlet	66.2	0.6154	40.7	1.098	37.1	24.5	15	0.57	0.076
4	Inlet	-	-	-	-	-	-	-	-	-
	Outlet	90.6	0.6638	60.1	1.123	53.5	35.4	15	0.83	0.11
5	Inlet	138.6	0.5191	71.95	1.448	49.69	32.9	11	0.56	0.074
	Outlet	83.2	0.6340	52.7	1.261	41.8	27.7	17	0.73	0.097
6	Inlet	389.1	0.5192	202.0	1.451	139.2	92.1	11	1.6	0.21
	Outlet	199.2	0.6160	122.7	1.101	111.5	73.7	15	1.7	0.23
7	Inlet	786.1	0.5273	414.5	1.458	284.3	188	11	3.2	0.43
	Outlet	325.9	0.6153	200.5	0.982	204.2	135	14	2.9	0.39
8	Inlet	349.4	0.5720	199.9	1.681	118.9	78.6	10	1.2	0.16
	Outlet	-	-	-	-	-	-	-	-	-
9	Inlet	345.5	0.5223	180.4	1.407	128.2	84.8	11	1.5	0.19
	Outlet	-	-	-	-	-	-	-	-	-

Table 3-10. Metal Emission Results—Condition 1

Metal	INLET						OUTLET					
	Cd		Pb		Hg		Cd		Pb		Hg	
	Measured	Blank Corred	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Corred	Measured	Blank Correct	Measured	Blank Correct
Run 1												
Rinse and filter, ug	8.4	8.0	150	149	< 0.400	0.400	4.44	4.08	61.6	60.8	< 0.400	0.400
HNO3 impinger, ug	0.348	0.348	1.63	0.81	35.9	35.9	0.169	0.169	1.56	0.74	49.4	49.4
Fourth impinger, ug	NA	NA	NA	NA	5.17	5.17	NA	NA	NA	NA	23.5	23.500
KMnO4 impinger, ug	NA	NA	NA	NA	24.3	24.3	NA	NA	NA	NA	8.79	8.79
HCl rinse, ug	NA	NA	NA	NA	611	611	NA	NA	NA	NA	154	154
Total, ug	8.7	8.4	152	150	547	547	4.61	4.2	63.2	61.5	236	236
Concentration, ug/dscm		6.6		118		336		6.2		89.9		345
Emissions, g/hr		0.004		0.06		0.24		0.003		0.05		0.2
Run 2												
Rinse and filter, ug	3.36	3.00	39.4	38.6	< 0.400	0.400	3.76	3.40	37.2	36.4	< 0.400	0.400
HNO3 impinger, ug	1.13	1.13	2.23	1.41	< 4.97	4.97	0.211	0.211	1.66	0.835	< 5.14	5.14
Fourth impinger, ug	NA	NA	NA	NA	< 0.196	0.196	NA	NA	NA	NA	< 0.195	0.195
KMnO4 impinger, ug	NA	NA	NA	NA	1.22	1.22	NA	NA	NA	NA	< 1.00	1.00
HCl rinse, ug	NA	NA	NA	NA	< 1.00	1.00	NA	NA	NA	NA	< 1.00	1.00
Total, ug	4.49	4.13	41.6	40.0	7.79	7.79	3.97	3.61	38.9	37.2	7.74	7.74
Concentration, ug/dscm		2.54		24.6		4.78		3.58		36.9		7.67
Emissions, g/hr		0.0018		0.018		0.0034		0.0028		0.029		0.0060
Run 3												
Rinse and filter, ug	29.6	29.2	458	457	0.776	0.776	15.6	15.2	236	235	0.440	0.440
HNO3 impinger, ug	0.649	0.649	2.21	1.39	50.4	50.4	0.608	0.608	10.40	9.60	28.4	28.4
Fourth impinger, ug	NA	NA	NA	NA	8.25	8.25	NA	NA	NA	NA	8.47	8.47
KMnO4 impinger, ug	NA	NA	NA	NA	889	889	NA	NA	NA	NA	176	176
HCl rinse, ug	NA	NA	NA	NA	180	180	NA	NA	NA	NA	74.0	74.0
Total, ug	30.2	29.9	460	459	1128	1128	16.2	15.8	246	245	287	287
Concentration, ug/dscm		20.5		315		775		17.6		273		320
Emissions, g/hr		0.014		0.21		0.51		0.013		0.20		0.23
Blank												
Rinse and filter, ug	0.360		0.820		<0.400							
HNO3 impinger, ug	<0.067		0.825		<3.00							
Fourth impinger, ug	N/A		N/A		<0.200							
KMnO4 impinger, ug	N/A		N/A		<0.800							
HCl rinse, ug	N/A		N/A		<1.00							

Table 3-11. Metal Emission Results—Condition 2

Metal	INLET						OUTLET					
	Cd		Pb		Hg		Cd		Pb		Hg	
	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct
Run 4												
Rinse and filter, ug	88.0	88.0	1080	1079	0.488	0.488	36.4	36.0	604	603	0.664	0.664
HNO3 impinger, ug	0.644	0.644	2.39	1.57	143	143	0.748	0.748	5.34	4.52	52.9	52.9
Fourth impinger, ug	NA	NA	NA	NA	5.84	5.84	NA	NA	NA	NA	10.2	10.2
KMnO4 impinger, ug	NA	NA	NA	NA	1770	1770	NA	NA	NA	NA	589	589.0
HCl rinse, ug	NA	NA	NA	NA	376	376	NA	NA	NA	NA	239	239
Total, ug	88.6	88.6	1082	1080	2295	2295	37.1	36.8	609	608	892	892
Concentration, ug/dscm		48.1		586		1245		35.1		579		850
Emissions, g/hr		0.032		0.39		0.82		0.029		0.49		0.71
Run 5												
Rinse and filter, ug	70.0	69.6	444	443	< 0.400	0.400	31.0	30.6	205	204	< 0.400	0.400
HNO3 impinger, ug	0.339	0.339	1.53	0.71	15.4	15.4	0.325	0.325	2.16	1.34	< 5.32	5.32
Fourth impinger, ug	NA	NA	NA	NA	5.97	5.97	NA	NA	NA	NA	2.12	2.12
KMnO4 impinger, ug	NA	NA	NA	NA	249	249	NA	NA	NA	NA	77.1	77.1
HCl rinse, ug	NA	NA	NA	NA	38.5	38.5	NA	NA	NA	NA	2.79	2.79
Total, ug	70.3	70.0	446	444	309	309	31.3	31.0	207	206	87.7	87.7
Concentration, ug/dscm		38.6		245		171		30.2		201		85.6
Emissions, g/hr		0.032		0.21		0.14		0.025		0.17		0.072
Run 6												
Rinse and filter, ug	198	198	804	803	< 0.400	0.400	73.0	72.6	254	253	< 0.400	0.400
HNO3 impinger, ug	0.366	0.366	1.9	1.1	32.8	32.8	0.644	0.644	3.91	3.09	< 5.13	5.13
Fourth impinger, ug	NA	NA	NA	NA	1.20	1.20	NA	NA	NA	NA	0.537	0.537
KMnO4 impinger, ug	NA	NA	NA	NA	7.79	7.79	NA	NA	NA	NA	< 1.00	1.00
HCl rinse, ug	NA	NA	NA	NA	≤ 1.00	1.00	NA	NA	NA	NA	< 1.00	1.00
Total, ug	198	198	806	804	43.2	43	73.6	73.3	258	256	8.07	8.07
Concentration, ug/dscm		109		441		24		75.6		264		8.32
Emissions, g/hr		0.091		0.37		0.02		0.059		0.21		0.0065
Blank		(Run 4, inlet only)		(Run 4, inlet only)		(Run 4, inlet only)						
Rinse and filter, ug	0.360	<0.100	0.820	1.36	<0.400	<0.400						
HNO3 impinger, ug	<0.067		0.825		<3.00							
Fourth impinger, ug	N/A		N/A		<0.200							
KMnO4 impinger, ug	N/A		N/A		<0.800							
HCl rinse, ug	N/A		N/A		<1.00							

Table 3-12. Metal Emission Results—Condition 3

Metal	INLET						OUTLET					
	Cd		Pb		Hg		Cd		Pb		Hg	
	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct	Measured	Blank Correct
Run 7												
Rinse and filter, ug	286	286	2230	2229	1.78	1.78	99.0	98.6	976	975	0.836	0.836
HNO3 impinger, ug	0.130	0.130	1.04	0.22	288	288	0.222	0.222	2.06	1.24	70.6	70.6
Fourth impinger, ug	NA	NA	NA	NA	5.12	5.12	NA	NA	NA	NA	< 2.06	2.06
KMnO4 impinger, ug	NA	NA	NA	NA	157	157	NA	NA	NA	NA	108	108
HCl rinse, ug	NA	NA	NA	NA	94.8	94.8	NA	NA	NA	NA	2.83	2.83
Total, ug	286	286	2231	2229	547	547	99.2	98.9	978	976	184	184
Concentration, ug/dscm		176		1371		336		126.4		1249		236
Emissions, g/hr		0.13		0.99		0.24		0.083		0.82		0.16
Run 8												
Rinse and filter, ug	448	448	1270	1269	1.14	1.14	166	166	480	479	< 0.400	0.400
HNO3 impinger, ug	1.55	1.55	6.16	5.34	27.7	27.7	0.667	0.667	2.53	2.53	12.3	12.3
Fourth impinger, ug	NA	NA	NA	NA	1.77	1.77	NA	NA	NA	NA	1.36	1.36
KMnO4 impinger, ug	NA	NA	NA	NA	7.15	7.15	NA	NA	NA	NA	2.60	2.60
HCl rinse, ug	NA	NA	NA	NA	< 1.00	1.00	NA	NA	NA	NA	< 1.00	1.00
Total, ug	450	449	1276	1275	38.8	38.8	167	167	483	482	17.7	17.7
Concentration, ug/dscm		213		606		18.4		127		367		13.5
Emissions, g/hr		0.17		0.47		0.014		0.11		0.33		0.0121
Run 9												
Rinse and filter, ug	73.0	72.6	696	695	< 0.400	0.400	31.6	31.6	195	194	< 0.400	0.400
HNO3 impinger, ug	0.232	0.232	1.44	0.62	< 5.33	5.33	0.383	0.383	1.39	0.57	< 5.52	5.52
Fourth impinger, ug	NA	NA	NA	NA	< 2.10	2.10	NA	NA	NA	NA	< 0.192	0.192
KMnO4 impinger, ug	NA	NA	NA	NA	< 1.00	1.00	NA	NA	NA	NA	1.02	1.02
HCl rinse, ug	NA	NA	NA	NA	< 1.00	1.00	NA	NA	NA	NA	< 1.00	1.00
Total, ug	73.2	72.9	697	696	9.83	9.83	32.0	32.0	196	195	8.13	8.13
Concentration, ug/dscm		39.8		380		5.37		32.2		196		8.18
Emissions, g/hr		0.033		0.32		0.0045		0.027		0.16		0.0069
Blank							(Run 8, outlet only)		(Run 8, outlet only)		(Run 8, outlet only)	
Rinse and filter, ug	0.360		0.820		<0.400		<0.100		0.740		<0.400	
							(Run 9, outlet only)		(Run 9, outlet only)		(Run 9, outlet only)	
Rinse and filter, ug							<0.100		0.600		<0.400	
HNO3 impinger, ug	<0.067		0.825		<3.00							
Fourth impinger, ug	N/A		N/A		<0.200							
KMnO4 impinger, ug	N/A		N/A		<0.800							
HCl rinse, ug	N/A		N/A		<1.00							

Table 3-13. PCDD/PCDF Homologue Emissions—Condition 1

	INLET				OUTLET		
Analyte	**Run 1**	**Run 2**	**Run 3**	**Run 10**	**Run 1**	**Run 2**	**Run 3**
Sample volume (dscm)	*1.884*	*1.739*	*1.983*	*1.766*	*1.316*	*1.385*	*1.592*
Stack flow rate (dscm/min)	*15*	*13*	*15*	*13*	*17*	*19*	*21*
Total Dioxins (pg)							
TCDD	29.6	550	207	223	1150	6670	6970
PeCDD	13.4	877	898	574	1450	7490	12300
HxCDD	67.4	1380	2330	1620	1610	3850	8470
HpCDD	73.4	907	2290	2370	1480	954	2460
OCDD	156	540	883	2400	1010	530	526
Total amount (pg)	339.8	4254	6608	7187	6700	19494	30726
Total amount (ng)	0.3398	4.254	6.608	7.187	6.700	19.494	30.726
Concentration (ng/dscm)	0.1804	2.446	3.332	4.070	5.091	14.08	19.30
Emission rate (ng/min)	2.7	32	50	53	87	267	405
Total Furans (pg)							
TCDF	200	1850	1030	2546	2710	2190	2550
PeCDF	119	1430	1040	2150	1310	788	1150
HxCDF	108	2860	1530	3330	2120	694	1120
HpCDF	30.7	2150	911	2990	2450	317	846
OCDF	14.7	485	221	875	674	237	178
Total amount (pg)	472	8775	4732	11891	9264	4226	5844
Total amount (ng)	0.472	8.775	4.732	11.891	9.264	4.226	5.844
Concentration (ng/dscm)	0.251	5.046	2.386	6.733	7.040	3.051	3.671
Emission rate (ng/min)	3.8	66	36	88	120	58	77
Total Dioxin/Furans							
Concentration (ng/dscm)	0.431	7.492	5.719	10.803	12.131	17.13	22.97
Emission rate (ng/min)	6.5	97	86	140	206	325	482

Note: a "<" sign indicates analyte not observed above the detection limit.

Table 3-14. 2,3,7,8-Substituted PCDD/PCDF Emissions - Condition 1

	INLET				OUTLET		
Analyte	Run 1	Run 2	Run 3	Run 10	Run 1	Run 2	Run 3
Sample volume (dscm)	*1.884*	*1.739*	*1.983*	*1.766*	*1.316*	*1.385*	*1.592*
Stack flow rate (dscm/min)	*15*	*13*	*15*	*13*	*17*	*19*	*21*
2,3,7,8-SubstitutedDioxins (pg)							
2,3,7,8-TCDD	< 2.6	9.17	< 7.75	< 13.6	< 9.75	< 26.7	12.7
1,2,3,7,8-PeCDD	< 5.18	< 43	45.2	< 58.5	44.2	222	240
1,2,3,4,7,8-HxCDD	< 4.46	55.6	59.5	81.8	55.7	147	176
1,2,3,6,7,8-HxCDD	6.19	99.2	124	118	117	322	565
1,2,3,7,8,9-HxCDD	5.22	71.9	85.5	83.8	88.4	321	682
1,2,3,4,6,7,8-HpCDD	39	465	800	1080	737	557	1350
1,2,3,4,6,7,8,9-OCDD	156	540	883	2400	1010	530	526
Total amount (pg)	219	1284	2005	3836	2062	2126	3552
Total amount (ng)	0.219	1.284	2.005	3.836	2.062	2.126	3.552
Concentration (ng/dscm)	0.116	0.738	1.011	2.172	1.567	1.535	2.231
Emission rate (ng/min)	1.7	10	15	28	27	29	47
2,3,7,8-Substituted Furans (pg)							
2,3,7,8-TCDF	9.77	85.2	40	98.6	74.3	112	53.4
1,2,3,7,8-PeCDF	7.24	67.6	55.2	117	51.2	51.9	41.2
2,3,4,7,8-PeCDF	13.5 [b]	190	131 [b]	271 [b]	146	99 [b]	119 [b]
1,2,3,4,7,8-HxCDF	< 10.9	306	126	280	224	89.2	108
1,2,3,6,7,8-HxCDF	11.4	262	144	312	191	80.9	99.7
2,3,4,6,7,8-HxCDF	16	483	250	549	397	117	188
1,2,3,7,8,9-HxCDF	6.47	211	100	162	144	96.1	64.6
1,2,3,4,6,7,8-HpCDF	< 29.2	1380	414	1570	1500	169	516
1,2,3,4,7,8,9-HpCDF	4.85	193	108	266	227	99.7	74.5
1,2,3,4,6,7,8,9-OCDF	14.7	485	221	875	674	237	178
Total amount (pg)	124	3663	1589	4501	3629	1152	1442
Total amount (ng)	0.124	3.663	1.589	4.501	3.629	1.152	1.442
Concentration (ng/dscm)	0.0658	2.106	0.8014	2.548	2.757	0.8316	0.9060
Emission rate (ng/min)	1.0	27	12	33	47	16	19
Total 2,3,7,8-substituted dioxin/furan							
Concentration (ng/dscm)	0.182	2.845	1.812	4.720	4.324	2.366	3.137
Emission rate (ng/min)	2.7	37	27	61	74	45	66

Note: a "<" symbol indicates analyte not observed above the detection limit.

[b] Field Surrogate recovery low.

Table 3-15. 2,3,7,8-TCDD Equivalent Results—Condition 1, Inlet

Analyte	Toxicity Equivalence Factor [a]	Run 1 Inlet Amount (ng)	Run 1 Inlet Conc. (ng/dscm)	Run 2 Inlet Amount (ng)	Run 2 Inlet Conc. (ng/dscm)	Run 3 Inlet Amount (ng)	Run 3 Inlet Conc. (ng/dscm)	Run 10 Inlet Amount (ng)	Run 10 Inlet Conc. (ng/dscm)
Sample volume (dscm)			*1.884*		*1.739*		*1.983*		*1.766*
Stack flow rate (dscm/min)			*15*		*13*		*15*		*13*
Dioxins									
2,3,7,8-TCDD	1	< 0.0026	< 0.0014	0.00917	0.00527	< 0.00775	< 0.00391	< 0.0136	< 0.00770
1,2,3,7,8-PeCDD	0.5	< 0.00259	< 0.00137	< 0.022	< 0.012	0.0226	0.0114	< 0.0293	< 0.0166
1,2,3,4,7,8-HxCDD	0.1	< 0.000446	< 0.000237	0.00556	0.00320	0.00595	0.00300	0.00818	0.00463
1,2,3,6,7,8-HxCDD	0.1	0.00062	0.00033	0.00992	0.00570	0.0124	0.00625	0.0118	0.00668
1,2,3,7,8,9-HxCDD	0.1	0.000522	0.000277	0.00719	0.00413	0.00855	0.00431	0.00838	0.00475
1,2,3,4,6,7,8-HpCDD	0.01	0.00039	0.00021	0.00465	0.00267	0.00800	0.00403	0.01080	0.006116
1,2,3,4,6,7,8,9-OCDI	0.001	0.000156	0.0000828	0.000540	0.000311	0.000883	0.000445	0.002400	0.001359
Total		0.0073	0.0039	0.059	0.034	0.0661	0.0333	0.0844	0.0478
Furans									
2,3,7,8-TCDF	0.1	0.000977	0.000519	0.00852	0.00490	0.0040	0.0020	0.00986	0.00558
1,2,3,7,8-PeCDF	0.05	0.000362	0.000192	0.00338	0.00194	0.00276	0.00139	0.00585	0.00331
2,3,4,7,8-PeCDF	0.5	0.00675[b]	0.00358	0.0950	0.0546	0.0655[b]	0.0330	0.136[b]	0.0767
1,2,3,4,7,8-HxCDF	0.1	< 0.00109	< 0.000579	0.0306	0.0176	0.0126	0.00635	0.0280	0.0159
1,2,3,6,7,8-HxCDF	0.1	0.00114	0.000605	0.0262	0.0151	0.0144	0.00726	0.0312	0.0177
2,3,4,6,7,8-HxCDF	0.1	0.0016	0.00085	0.0483	0.0278	0.0250	0.0126	0.0549	0.0311
1,2,3,7,8,9-HxCDF	0.1	0.000647	0.000343	< 0.0211	< 0.0121	0.0100	0.00504	0.0162	0.00917
1,2,3,4,6,7,8-HpCDF	0.01	< 0.000292	< 0.000155	0.01380	0.007936	0.00414	0.00209	0.01570	0.008890
1,2,3,4,7,8,9-HpCDF	0.01	0.0000485	0.0000257	0.00193	0.00111	0.00108	0.000545	0.00266	0.00151
1,2,3,4,6,7,8,9-OCDI	0.001	0.0000147	0.00000780	0.000485	0.000279	0.000221	0.000111	0.000875	0.000495
Total		0.0129	0.00686	0.2493	0.14337	0.1397	0.0704	0.30	0.17
Total Dioxin/Furan Equivalent									
Emission rate (ng/min)			0.16		2.3		1.6		2.8

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

[b] Field Surrogate recovery low.

Table 3-16. 2,3,7,8-TCDD Equivalent Results—Condition 1, Outlet

Analyte	Toxicity Equivalence Factor [a]	Run 1 Outlet Amount (ng)	Run 1 Outlet Conc. (ng/dscm)	Run 2 Outlet Amount (ng)	Run 2 Outlet Conc. (ng/dscm)	Run 3 Outlet Amount (ng)	Run 3 Outlet Conc. (ng/dscm)
Sample volume (dscm)			*1.316*		*1.385*		*1.592*
Stack flow rate (dscm/min)			*17*		*19*		*21*
Dioxins							
2,3,7,8-TCDD	1	< 0.00975	< 0.00741	< 0.0267	< 0.0193	0.0127	0.00798
1,2,3,7,8-PeCDD	0.5	0.0221	0.0168	0.111	0.0801	0.120	0.0754
1,2,3,4,7,8-HxCDD	0.1	0.00557	0.00423	0.0147	0.0106	0.0176	0.0111
1,2,3,6,7,8-HxCDD	0.1	0.0117	0.00889	0.0322	0.0232	0.0565	0.0355
1,2,3,7,8,9-HxCDD	0.1	0.00884	0.00672	0.0321	0.0232	0.0682	0.0428
1,2,3,4,6,7,8-HpCDD	0.01	0.00737	0.00560	0.00557	0.00402	0.01350	0.008480
1,2,3,4,6,7,8,9-OCDD	0.001	0.001010	0.0007675	0.000530	0.000383	0.000526	0.000330
Total		0.0663	0.0504	0.2228	0.1609	0.289	0.1815
Furans							
2,3,7,8-TCDF	0.1	0.00743	0.00565	0.0112	0.00809	0.00534	0.00335
1,2,3,7,8-PeCDF	0.05	0.00256	0.00195	0.00260	0.00187	0.00206	0.00129
2,3,4,7,8-PeCDF	0.5	0.0730	0.0555	0.050[b]	0.036	0.0595[b]	0.0374
1,2,3,4,7,8-HxCDF	0.1	0.0224	0.0170	0.00892	0.00644	0.0108	0.00678
1,2,3,6,7,8-HxCDF	0.1	0.0191	0.0145	0.00809	0.00584	0.00997	0.00626
2,3,4,6,7,8-HxCDF	0.1	0.0397	0.0302	0.0117	0.00845	0.0188	0.0118
1,2,3,7,8,9-HxCDF	0.1	0.0144	0.0109	0.00961	0.00694	0.00646	0.00406
1,2,3,4,6,7,8-HpCDF	0.01	0.01500	0.01140	0.00169	0.00122	0.00516	0.00324
1,2,3,4,7,8,9-HpCDF	0.01	0.00227	0.00172	0.000997	0.000720	0.000745	0.000468
1,2,3,4,6,7,8,9-OCDF	0.001	0.000674	0.000512	0.000237	0.000171	0.000178	0.000112
Total		0.1965	0.1493	0.105	0.075	0.1190	0.0748
Total Dioxin/Furan Equivalent							
Emission rate (ng/min)			3.4		4.5		5.4

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

[b] Field Surrogate recovery low.

Table 3-17. PCDD/PCDF Homologue Emissions—Condition 2

	INLET			OUTLET		
Analyte	**Run 4**	**Run 5**	**Run 6**	**Run 4**	**Run 5**	**Run 6**
Sample volume (dscm)	*2.73*	*2.263*	*2.216*	*1.476*	-	*1.786*
Stack flow rate (dscm/min)	*16*	*17*	*16*	*19*	-	*25*
Total Dioxins (pg)						
TCDD	316	625	560	10900	-	7710
PeCDD	713	983	1240	11700	-	12400
HxCDD	1660	1580	2120	6510	-	9580
HpCDD	1400	1130	1760	1600	-	3250
OCDD	672	617	1060	613	-	968
Total amount (pg)	4761	4935	6740	31323	-	33908
Total amount (ng)	4.761	4.935	6.740	31.323	-	33.908
Concentration (ng/dscm)	1.744	2.181	3.042	21.22	-	18.99
Emission rate (ng/min)	28	37	49	403	-	475
Total Furans (pg)						
TCDF	2030	5880	5540	5940	-	8960
PeCDF	1570	3790	5710	2000	-	4170
HxCDF	2540	3241	5780	1120	-	2025
HpCDF	1660	1320	2630	355	-	821
OCDF	384	215	487	198	-	190
Total amount (pg)	8184	14446	20147	9613	-	16166
Total amount (ng)	8.184	14.446	20.147	9.613	-	16.166
Concentration (ng/dscm)	2.998	6.384	9.092	6.513	-	9.052
Emission rate (ng/min)	48	109	145	124	-	226
Total Dioxin/Furans						
Concentration (ng/dscm)	4.742	8.564	12.133	27.734	-	28.04
Emission rate (ng/min)	76	146	194	527	-	701

Note: a "<" sign indicates analyte not observed above the detection limit.

Table 3-18. 2,3,7,8-Substituted PCDD/PCDF Emissions - Condition 2

	INLET			OUTLET		
Analyte	Run 4	Run 5	Run 6	Run 4	5	Run 6
Sample volume (dscm)	*2.73*	*2.263*	*2.216*	*1.476*	*-*	*1.786*
Stack flow rate (dscm/min)	*16*	*17*	*16*	*19*	*-*	*25*
2,3,7,8-SubstitutedDioxins (pg)						
2,3,7,8-TCDD	< 6.48	25.3	39.5	38.2	-	47
1,2,3,7,8-PeCDD	< 46.1	< 102	123	300	-	330
1,2,3,4,7,8-HxCDD	68.8	98.6	122	204	-	261
1,2,3,6,7,8-HxCDD	112	138	161	468	-	606
1,2,3,7,8,9-HxCDD	78.9	103	136	447	-	504
1,2,3,4,6,7,8-HpCDD	605	575	826	867	-	1440
1,2,3,4,6,7,8,9-OCDD	672	617	1060	613	-	968
Total amount (pg)	1589	1659	2468	2937	-	4156
Total amount (ng)	1.589	1.659	2.468	2.937	-	4.156
Concentration (ng/dscm)	0.5822	0.7331	1.113	1.990	-	2.327
Emission rate (ng/min)	9.3	12	18	38	-	58
2,3,7,8-Substituted Furans (pg)						
2,3,7,8-TCDF	73	214	302	165	-	242
1,2,3,7,8-PeCDF	66	215	343	84.2	-	163
2,3,4,7,8-PeCDF	211 [b]	450	680	222 [b]	-	490
1,2,3,4,7,8-HxCDF	253	312	553	110	-	214
1,2,3,6,7,8-HxCDF	224	339	603	114	-	235
2,3,4,6,7,8-HxCDF	428	459	784	175	-	408
1,2,3,7,8,9-HxCDF	162	146	284	86.9	-	118
1,2,3,4,6,7,8-HpCDF	966	707	1410	240	-	522
1,2,3,4,7,8,9-HpCDF	168	121	287	83.5	-	93.2
1,2,3,4,6,7,8,9-OCDF	384	215	487	198	-	190
Total amount (pg)	2935	3178	5733	1479	-	2675
Total amount (ng)	2.935	3.178	5.733	1.479	-	2.675
Concentration (ng/dscm)	1.075	1.404	2.587	1.002	-	1.498
Emission rate (ng/min)	17	24	41	19	-	37
Total 2,3,7,8-substituted dioxin/furan						
Concentration (ng/dscm)	1.657	2.137	3.701	2.992	-	3.825
Emission rate (ng/min)	27	36	59	57	-	96

Note: a "<" symbol indicates analyte not observed above the detection limit.

[b] Field Surrogate recovery low.

Table 3-19. 2,3,7,8-TCDD Equivalent Results—Condition 2, Inlet

Analyte	Toxicity Equivalence Factor [a]	Run 4 Inlet Amount (ng)	Run 4 Inlet Conc. (ng/dscm)	Run 5 Inlet Amount (ng)	Run 5 Inlet Conc. (ng/dscm)	Run 6 Inlet Amount (ng)	Run 6 Inlet Conc. (ng/dscm)
Sample volume (dscm)			*2.73*		*2.263*		*2.216*
Stack flow rate (dscm/min)			*16*		*17*		*16*
Dioxins							
2,3,7,8-TCDD	1	0.00648	0.00237	0.0253	0.0112	0.0395	0.0178
1,2,3,7,8-PeCDD	0.5	0.0231	0.00844	0.0510	0.0225	0.0615	0.0278
1,2,3,4,7,8-HxCDD	0.1	0.00688	0.00252	0.00986	0.00436	0.0122	0.00551
1,2,3,6,7,8-HxCDD	0.1	0.0112	0.00410	0.0138	0.00610	0.0161	0.00727
1,2,3,7,8,9-HxCDD	0.1	0.00789	0.00289	0.0103	0.00455	0.0136	0.00614
1,2,3,4,6,7,8-HpCDD	0.01	0.00605	0.00222	0.00575	0.00254	0.00826	0.00373
1,2,3,4,6,7,8,9-OCDI	0.001	0.000672	0.000246	0.000617	0.000273	0.001060	0.0004783
Total		0.0622	0.02279	0.1166	0.0515	0.1522	0.0687
Furans							
2,3,7,8-TCDF	0.1	0.0073	0.0027	0.0214	0.00946	0.0302	0.0136
1,2,3,7,8-PeCDF	0.05	0.0033	0.0012	0.0108	0.00475	0.0172	0.00774
2,3,4,7,8-PeCDF	0.5	0.106[b]	0.0386	0.225	0.0994	0.340	0.153
1,2,3,4,7,8-HxCDF	0.1	0.0253	0.00927	0.0312	0.0138	0.0553	0.0250
1,2,3,6,7,8-HxCDF	0.1	0.0224	0.00821	0.0339	0.0150	0.0603	0.0272
2,3,4,6,7,8-HxCDF	0.1	0.0428	0.0157	0.0459	0.0203	0.0784	0.0354
1,2,3,7,8,9-HxCDF	0.1	0.0162	0.00593	0.0146	0.00645	0.0284	0.0128
1,2,3,4,6,7,8-HpCDF	0.01	0.00966	0.00354	0.00707	0.00312	0.01410	0.006363
1,2,3,4,7,8,9-HpCDF	0.01	0.00168	0.000615	0.00121	0.000535	0.00287	0.00130
1,2,3,4,6,7,8,9-OCDI	0.001	0.000384	0.000141	0.000215	0.0000950	0.000487	0.000220
Total		0.235	0.0859	0.391	0.1729	0.627	0.283
Total Dioxin/Furan Equivalent							
Emission rate (ng/min)			1.7		3.8		5.6

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

[b] Field Surrogate recovery low.

Table 3-20. 2,3,7,8-TCDD Equivalent Results - Condition 2, Outlet

Analyte	Toxicity Equivalence Factor [a]	Run 4 Outlet Amount (ng)	Run 4 Outlet Conc. (ng/dscm)	Run 5 Outlet Amount (ng)	Run 5 Outlet Conc. (ng/dscm)	Run 6 Outlet Amount (ng)	Run 6 Outlet Conc. (ng/dscm)
Sample volume (dscm)			*1.476*		-		*1.786*
Stack flow rate (dscm/min)			*19*		-		*25*
Dioxins							
2,3,7,8-TCDD	1	0.0382	0.0259	-	-	0.047	0.026
1,2,3,7,8-PeCDD	0.5	0.150	0.102	-	-	0.165	0.0924
1,2,3,4,7,8-HxCDD	0.1	0.0204	0.0138	-	-	0.0261	0.0146
1,2,3,6,7,8-HxCDD	0.1	0.0468	0.0317	-	-	0.0606	0.0339
1,2,3,7,8,9-HxCDD	0.1	0.0447	0.0303	-	-	0.0504	0.0282
1,2,3,4,6,7,8-HpCDD	0.01	0.00867	0.00587	-	-	0.01440	0.008063
1,2,3,4,6,7,8,9-OCDD	0.001	0.000613	0.000415	-	-	0.000968	0.000542
Total		0.309	0.210	-	-	0.364	0.204
Furans							
2,3,7,8-TCDF	0.1	0.0165	0.0112	-	-	0.0242	0.0135
1,2,3,7,8-PeCDF	0.05	0.00421	0.00285	-	-	0.00815	0.00456
2,3,4,7,8-PeCDF	0.5	0.111 [b]	0.0752	-	-	0.245	0.137
1,2,3,4,7,8-HxCDF	0.1	0.0110	0.00745	-	-	0.0214	0.0120
1,2,3,6,7,8-HxCDF	0.1	0.0114	0.00772	-	-	0.0235	0.0132
2,3,4,6,7,8-HxCDF	0.1	0.0175	0.0119	-	-	0.0408	0.0228
1,2,3,7,8,9-HxCDF	0.1	0.00869	0.00589	-	-	0.0118	0.00661
1,2,3,4,6,7,8-HpCDF	0.01	0.00240	0.00163	-	-	0.00522	0.00292
1,2,3,4,7,8,9-HpCDF	0.01	0.000835	0.000566	-	-	0.000932	0.000522
1,2,3,4,6,7,8,9-OCDF	0.001	0.000198	0.000134	-	-	0.000190	0.000106
Total		0.184	0.1245	-	-	0.381	0.213
Total Dioxin/Furan Equivalent							
Emission rate (ng/min)			6.3		-		10.4

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

[b] Field Surrogate recovery low.

Table 3-21. PCDD/PCDF Homologue Emissions—Condition 3

	INLET			OUTLET		
Analyte	**Run 7**	**Run 8**	**Run 9**	**Run 7**	**Run 8**	**Run 9**
Sample volume (dscm)	*1.926*	*2.104*	*1.831*	*1.473*	*2.386*	*1.402*
Stack flow rate (dscm/min)	*14*	*13*	*14*	*20*	*14*	*18*
Total Dioxins (pg)						
TCDD	407	921	690	7750	6630	3300
PeCDD	914	1960	1570	8440	8390	4670
HxCDD	2270	3860	2490	6130	6580	3790
HpCDD	3300	3430	2210	2290	2330	1440
OCDD	3370	2150	1240	920	898	649
Total amount (pg)	10261	12321	8200	25530	24828	13849
Total amount (ng)	10.261	12.321	8.200	25.530	24.828	13.849
Concentration (ng/dscm)	5.328	5.856	4.478	17.33	10.41	9.878
Emission rate (ng/min)	75	76	63	347	146	178
Total Furans (pg)						
TCDF	5070	5110	4180	14500	10200	5830
PeCDF	4235	4120	3130	6400	4270	2550
HxCDF	5450	4980	3810	3590	2740	1790
HpCDF	3930	2980	2170	1160	1130	729
OCDF	1390	706	343	126	165	112
Total amount (pg)	20075	17896	13633	25776	18505	11011
Total amount (ng)	20.075	17.896	13.633	25.776	18.505	11.011
Concentration (ng/dscm)	10.42	8.506	7.446	17.50	7.756	7.854
Emission rate (ng/min)	145.9	111	104	350	109	141
Total Dioxin/Furans						
Concentration (ng/dscm)	15.75	14.362	11.924	34.83	18.16	17.732
Emission rate (ng/min)	221	187	167	697	254	319

Note: a "<" sign indicates analyte not observed above the detection limit.

Table 3-22. 2,3,7,8-Substituted PCDD/PCDF Emissions—Condition 3

Analyte	INLET Run 7	INLET Run 8	INLET Run 9	OUTLET Run 7	OUTLET Run 8	OUTLET Run 9
Sample volume (dscm)	*1.926*	*2.104*	*1.831*	*1.473*	*2.386*	*1.402*
Stack flow rate (dscm/min)	*14*	*13*	*14*	*20*	*14*	*18*
2,3,7,8-SubstitutedDioxins (pg)						
2,3,7,8-TCDD	23.4	12.4	17.6	64	58.1	< 27.8
1,2,3,7,8-PeCDD	< 92.5	105	92	310	324	171
1,2,3,4,7,8-HxCDD	121	160	110	198	220	111
1,2,3,6,7,8-HxCDD	171	266	174	399	439	256
1,2,3,7,8,9-HxCDD	124	178	125	303	336	200
1,2,3,4,6,7,8-HpCDD	1500	1680	1050	1090	1160	708
1,2,3,4,6,7,8,9-OCDD	3370	2150	1240	920	898	649
Total amount (pg)	5402	4551	2809	3284	3435	2123
Total amount (ng)	5.402	4.551	2.809	3.284	3.435	2.123
Concentration (ng/dscm)	2.805	2.163	1.534	2.229	1.440	1.514
Emission rate (ng/min)	39	28	21	45	20	27
2,3,7,8-Substituted Furans (pg)						
2,3,7,8-TCDF	155	116	136	384	326	161
1,2,3,7,8-PeCDF	188	143	150	233	192	109
2,3,4,7,8-PeCDF	464[b]	544	411	629	517	290[b]
1,2,3,4,7,8-HxCDF	495	440	342	326	260	171
1,2,3,6,7,8-HxCDF	527	459	383	332	286	182
2,3,4,6,7,8-HxCDF	930	845	757	494	465	305
1,2,3,7,8,9-HxCDF	240	217	195	98	107	67.9
1,2,3,4,6,7,8-HpCDF	2140	1610	1150	835	796	474
1,2,3,4,7,8,9-HpCDF	333	290	180	64	78.9	50.9
1,2,3,4,6,7,8,9-OCDF	1390	706	343	126	165	112
Total amount (pg)	6862	5370	4047	3521	3193	1923
Total amount (ng)	6.862	5.370	4.047	3.521	3.193	1.923
Concentration (ng/dscm)	3.563	2.552	2.210	2.390	1.338	1.371
Emission rate (ng/min)	50	33	31	48	19	25
Total 2,3,7,8-substituted dioxin/furan						
Concentration (ng/dscm)	6.368	4.715	3.744	4.620	2.778	2.886
Emission rate (ng/min)	89	61	52	92	39	52

Note: a "<" symbol indicates analyte not observed above the detection limit.

[b] Field Surrogate recovery low.

Table 3-23. 2,3,7,8-TCDD Equivalent Results - Condition 3, Inlet

Analyte	Toxicity Equivalence Factor [a]	Run 7 Inlet Amount (ng)	Run 7 Inlet Conc. (ng/dscm)	Run 8 Inlet Amount (ng)	Run 8 Inlet Conc. (ng/dscm)	Run 9 Inlet Amount (ng)	Run 9 Inlet Conc. (ng/dscm)
Sample volume (dscm)			*1.926*		*2.104*		*1.831*
Stack flow rate (dscm/min)			*14*		*13*		*14*
Dioxins							
2,3,7,8-TCDD	1	0.0234	0.0121	0.0124	0.00589	0.0176	0.00961
1,2,3,7,8-PeCDD	0.5	0.0463	0.0240	0.0525	0.0250	0.0460	0.0251
1,2,3,4,7,8-HxCDD	0.1	0.0121	0.00628	0.0160	0.00760	0.0110	0.00601
1,2,3,6,7,8-HxCDD	0.1	0.0171	0.00888	0.0266	0.0126	0.0174	0.00950
1,2,3,7,8,9-HxCDD	0.1	0.0124	0.006438	0.0178	0.00846	0.0125	0.00683
1,2,3,4,6,7,8-HpCDD	0.01	0.01500	0.007788	0.01680	0.007985	0.01050	0.005735
1,2,3,4,6,7,8,9-OCD	0.001	0.003370	0.001750	0.002150	0.001022	0.001240	0.0006772
Total		0.1296	0.0673	0.1443	0.0686	0.1162	0.0635
Furans							
2,3,7,8-TCDF	0.1	0.0155	0.00805	0.0116	0.00551	0.0136	0.00743
1,2,3,7,8-PeCDF	0.05	0.00940	0.00488	0.00715	0.00340	0.00750	0.00410
2,3,4,7,8-PeCDF	0.5	0.232 [b]	0.120	0.272	0.129	0.206	0.112
1,2,3,4,7,8-HxCDF	0.1	0.0495	0.0257	0.0440	0.0209	0.0342	0.0187
1,2,3,6,7,8-HxCDF	0.1	0.0527	0.0274	0.0459	0.0218	0.0383	0.0209
2,3,4,6,7,8-HxCDF	0.1	0.0930	0.0483	0.0845	0.0402	0.0757	0.0413
1,2,3,7,8,9-HxCDF	0.1	0.0240	0.0125	0.0217	0.0103	0.0195	0.0106
1,2,3,4,6,7,8-HpCDF	0.01	0.02140	0.01111	0.01610	0.007652	0.01150	0.006281
1,2,3,4,7,8,9-HpCDF	0.01	0.00333	0.00173	0.00290	0.00138	0.00180	0.000983
1,2,3,4,6,7,8,9-OCD	0.001	0.001390	0.0007217	0.000706	0.000336	0.000343	0.000187
Total		0.502	0.261	0.507	0.241	0.408	0.223
Total Dioxin/Furan Equivalent							
Emission rate (ng/min)			4.6		4.0		4.0

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

Table 3-24. 2,3,7,8-TCDD Equivalent Results - Condition 3, Outlet

Analyte	Toxicity Equivalence Factor [a]	Run 7 Outlet Amount (ng)	Run 7 Outlet Conc. (ng/dscm)	Run 8 Outlet Amount (ng)	Run 8 Outlet Conc. (ng/dscm)	Run 9 Outlet Amount (ng)	Run 9 Outlet Conc. (ng/dscm)
Sample volume (dscm)			*1.473*		*2.386*		*1.402*
Stack flow rate (dscm/min)			*20*		*14*		*18*
Dioxins							
2,3,7,8-TCDD	1	0.064	0.043	0.0581	0.0244	0.0278	0.0198
1,2,3,7,8-PeCDD	0.5	0.155	0.105	0.162	0.0679	0.0855	0.0610
1,2,3,4,7,8-HxCDD	0.1	0.0198	0.0134	0.0220	0.00922	0.0111	0.00792
1,2,3,6,7,8-HxCDD	0.1	0.0399	0.0271	0.0439	0.0184	0.0256	0.0183
1,2,3,7,8,9-HxCDD	0.1	0.0303	0.0206	0.0336	0.0141	0.0200	0.0143
1,2,3,4,6,7,8-HpCDD	0.01	0.01090	0.007400	0.01160	0.004862	0.00708	0.00505
1,2,3,4,6,7,8,9-OCDD	0.001	0.000920	0.000625	0.000898	0.000376	0.000649	0.000463
Total		0.321	0.218	0.332	0.1392	0.1777	0.1268
Furans							
2,3,7,8-TCDF	0.1	0.0384	0.0261	0.0326	0.0137	0.0161	0.0115
1,2,3,7,8-PeCDF	0.05	0.0117	0.00791	0.00960	0.00402	0.00545	0.00389
2,3,4,7,8-PeCDF	0.5	0.315	0.214	0.259	0.108	0.145 [b]	0.103
1,2,3,4,7,8-HxCDF	0.1	0.0326	0.0221	0.0260	0.0109	0.0171	0.0122
1,2,3,6,7,8-HxCDF	0.1	0.0332	0.0225	0.0286	0.0120	0.0182	0.0130
2,3,4,6,7,8-HxCDF	0.1	0.0494	0.0335	0.0465	0.0195	0.0305	0.0218
1,2,3,7,8,9-HxCDF	0.1	0.0098	0.0067	0.0107	0.00448	0.00679	0.00484
1,2,3,4,6,7,8-HpCDF	0.01	0.00835	0.00567	0.00796	0.00334	0.00474	0.00338
1,2,3,4,7,8,9-HpCDF	0.01	0.00064	0.00043	0.000789	0.000331	0.000509	0.000363
1,2,3,4,6,7,8,9-OCDF	0.001	0.000126	0.0000855	0.000165	0.0000692	0.000112	0.0000799
Total		0.499	0.339	0.421	0.177	0.245	0.174
Total Dioxin/Furan Equivalent							
Emission rate (ng/min)			11		4.4		5.4

Note: a "<" sign indicates analyte not observed above the detection limit.

[a] 1989 EPA Factors.

[b] Field Surrogate recovery low.

Table 3-25. Summary CEMS and Opacity of Results

Analyte	Secondary Chamber Temperature: 1400 F							
	Run 1		Run 2		Run 3		Average	
	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet
Oxygen (%dv)	9.78	11.36	10.43	11.85	9.22	10.37	9.81	11.19
Carbon dioxide (%dv)	6.92	6.13	6.50	5.81	7.56	6.88	6.99	6.27
Sulfur dioxide (ppmdv)	9.17	8.54	1.45	0.00	16.66	14.60	9.09	7.71
Nitrogen oxides (ppmdv)	132.35	119.59	110.62	97.42	96.31	84.87	113.09	100.63
Carbon monoxide (ppmdv)	1.91	1.42	2.99	2.41	1.78	1.38	2.23	1.74
Visible emissions (% opacity)								
max. 6-min. value	0.00		0.00		3.75		1.25	
run average	0.00		0.00		0.33		0.11	

	Secondary Chamber Temperature: 1600 F							
	Run 4		Run 5		Run 6		Average	
	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet
Oxygen (%dv)	8.56	9.31	8.25	9.79	8.90	10.50	8.57	9.87
Carbon dioxide (%dv)	7.76	7.29	8.76	7.68	7.80	6.88	8.11	7.28
Sulfur dioxide (ppmdv)	17.62	16.19	20.03	16.79	15.18	12.48	17.61	15.15
Nitrogen oxides (ppmdv)	113.18	102.92	176.69	140.46	88.23	75.09	126.03	106.16
Carbon monoxide (ppmdv)	0.16	0.19	0.15	0.04	0.68	0.58	0.33	0.27
Visible emissions (% opacity)								
max. 6-min. value	0.00		7.71		0.00		2.57	
run average	0.00		0.99		0.00		0.33	

	Secondary Chamber Temperature: 1800 F							
	Run 7		Run 8		Run 9		Average	
	inlet	outlet	inlet	outlet	inlet	outlet	inlet	outlet
Oxygen (%dv)	7.24	8.78	7.53	8.94	7.71	9.48	7.49	9.07
Carbon dioxide (%dv)	9.55	8.37	8.21	7.34	8.16	7.07	8.64	7.59
Sulfur dioxide (ppmdv)	48.46	38.96	33.71	26.84	17.68	16.12	33.28	27.31
Nitrogen oxides (ppmdv)	128.09	113.18	79.62	70.97	85.29	73.86	97.67	86.00
Carbon monoxide (ppmdv)	15.73	10.50	1.49	1.48	0.00	0.46	5.74	4.15
Visible emissions (% opacity)								
max. 6-min. value	6.04		13.96		12.50		10.83	
run average	0.78		0.92		0.72		0.81	

Table 3-26. Process and Test Data

Run No.	Date	Average SCC Temp. °F	Gas Volume Burned during Test (Ft^3)	Barometric Pressure (in. Hg)	Outdoor Air Temperature (°F)	Outdoor Relative Humidity (%)	Presence of Odors
1	6/11/99	1425	2885	30.20	75	39.6	None
2	6/12/99	1475	3030	30.23	78	54.8	None
3	6/13/99	1450	3435	30.09	70	85.6	None
4	6/13/99	1660	2820	30.02	77	73.4	None
5	6/14/99	1656	ND	29.78	77	69.3	None
6	6/15/99	1645	ND	29.91	81	40.0	None
7	6/15/99	1845	2680	29.90	79	40.1	ND
8	6/16/99	1838	3810	29.95	71	44.1	None
9	6/17/99	1838	ND	29.95	65	72.0	ND
10	6/17/99	1470	1845	29.97	65	69.6	None

ND indicates that no data was available.

Table 3-27. Summary of Body and Container Characteristics

Run No.	Date	Body Weight (lb)	Container Weight (lb)	Body Embalmed? (Y/N)	Body Description	Container Type	Body Wrappings, Container Contents
1	6/11/99	157	15	no	78 year old male, lean build	White fiberboard, chipboard bottom	No clothes, white plastic sheet
2	6/12/99	163	85	no	70 year old female	White fiberboard, wooden inserts, chipboard on sides, bottom, and top	No clothes, cloth sheet, white plastic sheets
3	6/13/99	182	10	no	91 year old male	Brown fiberboard, no wood	Light white plastic pouch, note on box "no jewelry", shoulder joint, eyeglass rims, partials, and unknown metal found in remains
4	6/13/99	199	10	no	55 year old male	Brown fiberboard, no wood	Light white plastic pouch
5	6/14/99	180	100	yes	74 year old male, lean build	Cloth covered casket, particle board sides, bottom and top, fabric lining, plastic fiber stuffing, white plastic sheet	Body dressed in a suit, leather shoes
6	6/15/99	188	30	no	76 year old male	Fiberboard with pine base, chipboard bottom	White plastic sheets
7	6/15/99	140	100	yes	65 year old male	Cloth covered casket, particle board sides, bottom and top, fabric lining, plastic fiber stuffing, white plastic sheet	Body dressed in hospital gown, cloth sheet
8	6/16/99	200	10	no	88 year old female	Brown fiberboard, no wood	Light white plastic pouch, surgical gloves
9	6/17/99	105	10	no	88 year old male	Brown fiberboard, no wood	Light white plastic pouch
10	6/17/99	132	10	no	58 year old female	Brown fiberboard, no wood	Light white plastic pouch

Section 4.
Sampling, Analytical, and Process Data Collection Procedures

The sampling, analysis, and process data collection procedures used for this test project are described in this section. The published methods and MRI Standard Operating Procedures (SOPs) used are cited. Details providing clarification and any modifications to or deviations from the published methods are presented in this section. Otherwise, the cited methods were followed.

4.1 Sampling Procedures

The samples collected required the use of four (4) sampling systems at both sampling locations:

- EPA Method 23 isokinetic sampling train for PCDDs and PCDFs, along with an EPA Method 3B integrated gas sampling train for carbon dioxide (CO_2) and oxygen (O_2).
- EPA Method 29 isokinetic sampling train for metals (Cd, Hg, and Pb), along with an EPA Method 3B integrated gas sampling train.
- EPA Method 26A isokinetic sampling train for PM and HCl, along with an EPA Method 3B integrated gas sampling train.
- EPA Instrumental Analyzer Methods 6C, 7E, and 10 sampling and analytical system for SO_2, NO_X, and CO. Method 3A instrumentation was also added for CO_2 and O_2 data collection for normalizing the SO_2, NO_X, and CO results if needed.

The following methods were employed in the use and operation of these sampling trains and systems.

4.1.1 Sample and Velocity Traverses

Method 1 in Appendix A of 40 *CFR* 60 (basis for MRI SOP MRI-8401) was used to establish traverse (sampling) points at the test locations for the traversing sampling trains.

However, the use of a total of 12 traverse points (6 on a diameter) instead of the 24 specified in Method 1 for the known proximity of flow disturbances at the test locations was performed as planned.

A check for absence of cyclonic flow was not conducted at the test locations prior to the start of sampling or during the test project. If any cyclonic flow conditions were found at the test locations during process operation, it would likely change in intensity throughout a cycle as velocity and temperature fluctuated and would have to be checked throughout a complete cycle. Also, the unit was not designed to provide emission measurement test locations and could not be modified without significant changes in design if cyclonic flow problems were found.

4.1.2 Determination of Gas Velocity and Volumetric Flow Rates

Method 2 in Appendix A of 40 *CFR* 60 (basis for SOP MRI-8402) was used to measure gas velocities and volumetric flow rates with Type S pitot tubes that are components of the traversing sampling trains. Pitot tubes meeting the dimensional specifications in the method were used. However, the pitot tube coefficients were adjusted for blockage in the gas stream caused by the probe assemblies used during sampling. An average adjusted coefficient for each such pitot tube was calculated in a spreadsheet using procedures cited in Method 2.

An aneroid barometer calibrated against a mercury barometer was used to measure atmospheric pressure at the sampling locations.

4.1.3 Determination of Dry Gas Molecular Weight and Emission Rate Correction Factors

Method 3B in Appendix A of 40 *CFR* 60 (basis for SOP MRI-8406) was used to collect multi-point, integrated gas bag samples simultaneously with the traversing/ isokinetic sampling for determination of dry gas molecular weight. The integrated gas sampling apparatus used to collect the samples is a component of each traversing sampling train. Integrated gas samples were extracted at a constant rate from the exhaust of a traversing sampling train just upstream from the outlet of the dry gas meter outlet orifice. MRI has determined through investigation that the impinger contents of all trains used did not cause interferences (e.g., loss of carbon dioxide) during sample collection. Also, in less than one minute after the start of traversing/isokinetic sampling, the entire traversing train is purged with sampled gas, and integrated gas sampling can begin. Sampling was conducted at a constant rate throughout the run while the traversing/isokinetic sampling

was in progress. Each integrated gas sampling apparatus was leak checked before and after each test run.

4.1.4 Determination of Moisture Content

Method 4 in Appendix A of 40 *CFR* 60, incorporated as part of Methods 23, 26A, and 29, was used to determine the moisture (water vapor) content of the gas stream. Moisture collected during sampling was determined gravimetrically from the difference between the initial and final weights of all of the impingers in a train, including the resin cartridge, where used.

4.1.5 Sampling for PCDDs and PCDFs

Method 23 in Appendix A of 40 *CFR* 60 (basis for SOP MRI-8404) was used to collect samples for dioxin and furan analysis. Clarifications of and modifications to the method are included in the following discussion.

Quartz glass nozzles and probe liners were used in water-cooled probes. The internal surface of the compression fittings used for connecting nozzles to probe liners are permanently coated with abrasion-resistant Teflon® to prevent sample gas contact with the stainless steel, and the connections are positioned within the water-cooled section of each probe.

Heat traced, ½-inch O.D. with ⅛- inch wall Teflon® tubing was used as a sample transfer line (STL) between the probe liner outlet and the filter holder inlet in all of the trains because the proximity of adjacent test ports and other obstructions would not allow sampling with trains assembled in the normal manner. A glass coupling was used to connect the STL tubing to the probe liner outlet while the other end of the tube was connected directly to the filter holder inlet. The STL was maintained at 248±25°F during sampling. Samples were recovered from the STL in the same manner as for the probe, as specified in Method 23.

No cyclone/flask assembly was necessary in front of the filter holder to prevent overloading the filter. Filter supports in the filter holders were Teflon®-coated, stainless steel screening. Quartz fiber filters having the same specifications described in the method were used. Each cartridge (sorbent trap) was loaded with approximately 65 grams of XAD-2 resin.

Two silica gel impingers were used in each train. This was done to minimize any need to swap those components during a test run.

Sample recovery procedures followed those specified in the method, i.e., using acetone and methylene chloride for rinsing train components. The toluene QA rinses were also analyzed for dioxins and furans. The condensate collected in the impingers was not recovered. All samples were stored and shipped cold at water ice temperature.

4.1.6 Sampling for Metals

Method 29 in Appendix A of 40 *CFR* 60 (basis for SOP MRI-8405) was used to collect samples for metals analysis. Clarifications of and modifications to the method are also included in the following discussion.

Quartz glass nozzles and probe liners were used in water-cooled probes. The internal surface of the compression fittings used for connecting nozzles to probe liners are permanently coated with abrasion-resistant Teflon® to prevent sample gas contact with the stainless steel, and the connections are positioned within the water-cooled section of each probe.

Heat traced, ½-inch O.D. with ⅛- inch wall Teflon® tubing was used as a sample transfer line (STL) between the probe liner outlet and the filter holder inlet in all of the trains because the proximity of adjacent test ports and other obstructions would not allow sampling with trains assembled in the normal manner. A glass coupling was used to connect the STL tubing to the probe liner outlet while the other end of the tube was connected directly to the filter holder inlet. The STL was maintained at 248±25°F during sampling. Samples were recovered from the STL in the same manner as for the probe, as specified in Method 29.

No cyclone/flask assembly was necessary in front of the filter holder to prevent overloading the filter. Filter supports in the filter holders were 100% Teflon®. Quartz fiber filters having the same specifications described in the method were used.

Two silica gel impingers were used in each train. This was done to minimize any need to swap those components during a test run.

Sample recovery procedures followed those specified in the method. Adequate quantities of recovery reagents used during recovery were saved for analysis for blank correction purposes. All samples were stored cold at water ice temperature at the test site (not required by the method), but were shipped and stored at the laboratory at room temperature.

4.1.7 Sampling for Particulate Matter and HCl

Method 26A in Appendix A of 40 *CFR* 60 was used to collect samples for total particulate matter and HCl analysis. Clarifications of and modifications to the method are included in the following discussion.

Quartz glass nozzles and probe liners were used in water-cooled probes. The internal surface of the compression fittings used for connecting nozzles to probe liners are permanently coated with abrasion-resistant Teflon® to prevent sample gas contact with the stainless steel, and the connections are positioned within the water-cooled section of each probe.

Heat traced, ½-inch O.D. with ⅛- inch wall Teflon® tubing was used as a sample transfer line (STL) between the probe liner outlet and the filter holder inlet in all of the trains because the proximity of adjacent test ports and other obstructions would not allow sampling with trains assembled in the normal manner. A glass coupling was used to connect the STL tubing to the probe liner outlet while the other end of the tube was connected directly to the filter holder inlet. The STL was maintained at 248±25 °F during sampling. Samples were recovered from the STL in the same manner as for the probe as referred to in Method 26A and specified in Method 5 in Appendix A of 40 *CFR* 60.

No cyclone/flask assembly was necessary in front of the filter holder to prevent overloading the filter. Filter supports in the filter holders were 100% Teflon®. Quartz fiber filters having the same specifications described in Method 5 were used.

Two silica gel impingers were used in each train. This was done to minimize any need to swap those components during a test run. One additional empty impinger was inserted between the last acidic impinger and the first caustic impinger. Material recovered from that impinger was treated as if from a caustic impinger.

4.1.8 Sampling and Analysis for CO_2, O_2, CO, NO_x, and SO_2

Methods 3A, 6C, 7E, and 10 in Appendix A of 40 *CFR* 60 were used to sample and analyze for CO_2, O_2, CO, NO_X, and SO_2. Clarifications of and modifications to the methods are included in the following discussion.

All calibration gases were certified by EPA Protocol 1.

Gas was extracted through stainless steel probes (not water-cooled) fitted with calibration valves at their outlets. The valve directs sampled gas through a heated glass-fiber filter and a heated Teflon® sample transfer line to an ice-cooled condenser

conditioner for moisture removal. Conditioned sample passes through an unheated Teflon® sample line to a gas sampling and distribution manifold system. The system contains a pump for distributing sample to the analyzers.

The SO_2 analyzer used was a Western Research Model 721AT photometric instrument using a nondispersive ultraviolet analyzer operating on the principle of differential absorption. The NO_X analyzer systems used was a Thermo Electron Model 10AR chemiluminescent NO/NO_X analyzer with associated vacuum and bypass pumps. The CO analyzer used was a Thermo Electron Model 48 gas filter correlation instrument using a nondispersive infrared analyzer with gas filter correlation. The CO_2 analyzer used was a Horiba Model PIR-2000 NDIR instrument. The O_2 analyzer used was a Teledyne Model 320A chemical cell instrument.

A Campbell Scientific Model CR10WP multi-channel system operating at a rate of 60 Hz was used for data acquisition with data storage at 1-minute average values.

All operating, calibration, and QC procedures and QC performance criteria specified in the methods were used. CO analyzers were operated in accordance with applicable procedures specified in Methods 6C and 10. Calibration of the CO analyzers was conducted with the zero and the high level gases, and two mid-level gases were used during the calibration error test.

At the beginning of each test day, the NO_x, SO_2, O_2, and CO_2 monitors on the sampling system were zeroed using zero nitrogen, and spanned using a certified calibration gas with a concentration of 80% to 100% of the instrument span. Following calibration, a mid-range gas (40% to 60% of the instrument span) was introduced into each monitor. The mid-range response did not exceed 2% of the instrument span, as required by EPA reference Method 6C.

The CO monitor was zeroed using zero nitrogen and spanned using a known concentration of CO in nitrogen. Following calibration, the CO monitor was challenged with two additional gas concentrations corresponding to approximately 60% and 30% of instrument span. All calibration gases were EPA Protocol 1 certified.

After calibrating the SO_2, NO_x, O_2, and CO_2 monitors, calibration gas was introduced remotely through the probe to verify the absence of sampling system bias. The bias error did not did not exceed 5% of the instrument span, as required by EPA Method 6C.

After each test run, zero nitrogen and either a mid- or high-range calibration gas were introduced remotely through the sampling train system to each monitor to check for calibration drift error. In accordance with Method 6C, the calibration drift did not exceed 3% of the instrument span for all valid test runs.

4.1.9 Visible Emissions Determination

All visible emissions readings were performed using EPA Method 9 procedures contained in USEPA 40 *CFR* 60, Appendix A. Appendix E of this report contains the raw field data for the tests.

Evaluations of visible emissions from the crematorium stack were made by an observer who was certified in accordance with Section 3.12.1, Subsection 1.3 of the *Quality Assurance Handbook for Air Pollution Measurements Systems: Volume III* (EPA-600/4-77-027b, August 1977). Appendix E contains the observer's certification.

The observer stood at a distance that provided a clear view of the emissions with the sun oriented in the 140° sector to his back. In addition, the observer made observations from a position at which the line of vision was approximately perpendicular to the plume direction. For more detailed information on the observer position, see Appendix E.

Opacity observations were made at the point of greatest opacity in the portion of the plume where condensed water vapor was not present. Opacity was read at 15-sec intervals, and readings were made to the nearest 5% opacity with a minimum of 24 observations being recorded. Readings were taken against a clearly visible background which gave the highest degree of contrast. See Appendix E for more detailed information on the observations.

4.2 Analytical Procedures

The analytical methodology and procedures used by MRI for this project were standardized methods and EPA approved procedures. The analytical methods used on this project are described below. The MRI SOPs pertaining to the methods are cited.

4.2.1 Analysis for PCDDs and PCDFs

The sample components recovered from the Method 23 trains (i.e., XAD-2 resin and filter) were combined and extracted in the laboratory using Soxhlet extraction according to MRI SOP CS154. The procedure for extraction involved placing the XAD-2 resin and filter samples in the Soxhlet apparatus, spiking with $^{13}C_{12}$ PCDD/PCDF internal quantitation standards, and extracting with toluene for a minimum of 16 hours.

The train rinses were extracted with methylene chloride using a separatory funnel. Following extraction, the methylene chloride was concentrated to a volume of 1 to 5 mL

and combined with the corresponding XAD-2/filter extract for each train. The combined extract was split, with one-half analyzed for dioxins and furans, and one-half archived. The sample split for dioxins and furans was taken through the remaining clean-up steps in Method 23 modified per MRI SOP CS154, concentrated to 10 μL with the addition of a recovery standard, and provided for analysis by HRGC/HRMS.

Extracts were analyzed for dioxins and furans by SOP MRI-5405 based on the procedures specified in Method 8290, "Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography / High-Resolution Mass Spectrometry (HRGC/HRMS)," in "Test Methods for Evaluating Solid Waste, Physical/Chemical (SW-846)." The target analyte amounts, surrogate and internal standard recoveries were quantitated according to Method 23. No modifications of these procedures were necessary.

4.2.2 Analysis for Metals

The sample components recovered from the Method 29 trains (i.e., rinses, filter, and impinger contents) were digested, combined, and analyzed according to the procedures specified in Method 29. Method 29 incorporates analytical methods published in "Test Methods for Evaluating Solid Waste, Physical/Chemical (SW-846)." The SW-846 methods and MRI SOPs used for analysis are:

- Method 7000A and MRI SOP ASF-602 for graphite furnace atomic absorption spectroscopy (GFAAS) with Method 7131A for cadmium and Method 7421 for lead, and
- Method 7470A with MRI SOPs ASF-420 (preparation) and ASF-603 (analysis) for cold vapor atomic absorption spectroscopy (CVAAS) for mercury.

No modifications of these procedures were necessary.

4.2.3 Analysis for Particulate Matter and HCl

The sample components recovered from the Method 26A train front half rinses and filters were evaporated, desiccated, and weighed, as appropriate for particulate matter determination, according to the procedures specified in Method 5 in Appendix A of 40 *CFR* 60. The same sample components recovered from the Method 29 trains for Run 4 inlet, and Runs 8 and 9 outlet were treated in the same manner. M29 train front half acetone rinses preceded the nitric acid rinses. Following analysis for particulate matter, acetone rinse residues and filters were submitted for metals analysis.

The impinger contents recovered from the Method 26A trains were analyzed by ion chromatography (IC) using the procedures specified in Method 26A. The contents of the first three impingers were combined and analyzed for chloride to determine HCl emissions. Analysis of the fourth through sixth impingers (caustic solution) was not within the scope of work for this project. No modifications of these procedures were required.

4.3 Process Data

Process operating parameters necessary to characterize process conditions were monitored and recorded during each test run. Data were recorded manually about every 15 min to provide a record depicting process operations. Parameters logged were secondary chamber temperatures, body container description and weight, body weight (gross weight less container tare weight), batch cycle time, any noticeable changes or fluctuations during each cycle, and fuel flow (consumption) rate. Additionally, presence or lack of any ambient odors, outdoor ambient temperature and relative humidity were noted and documented during each run.

Section 5.
Quality Assurance (QA)/Quality Control (QC) Activities

The QA/QC requirements and emission measurement and data quality criteria for this test project are summarized in this section. The QC procedures and acceptance criteria specified in the EPA methods and MRI SOPs were used. The procedures included, but were not limited to, (1) sampling equipment calibrations, (2) procedural elements of the methods such as leak checks, proper traversing, placement of sampling probes, verification of the integrity of metering systems prior to the start of sampling, etc., and (3) the use of QC samples and analytical approaches such as reagent blank samples, method blanks, matrix spike samples, duplicate analysis, and surrogate spiking. The performance and results of all QC procedures were recorded on appropriate forms, data sheets, field logs, and laboratory notebooks, as appropriate.

5.1 Equipment Calibration

QC procedures, acceptability limits for sampling equipment calibrations, and calibration results are presented in Table 5-1. Calibration data sheets and equipment condition checklists used during calibration are provided in Appendix I. Equipment used for analysis of samples was calibrated according to the procedures in the approved standard methods and manufacturers' manuals.

5.2 Emission Measurement and Data Quality Criteria

Specific QC procedures were followed to ensure the continuous production of useful and valid data. Table 5-2 presents a summary of specific criteria for assessing overall emission measurement and data quality along with the results of these determinations.

5.2.1 Blank, Spikes, and Toluene Rinse Results

The results for chloride matrix spikes and relative percent difference for duplicate analysis are summarized in Table 5-3. The results for the metals laboratory reagent and field blanks are summarized in Table 5-4. The metals matrix spikes, spiked laboratory reagents, and reference material results are presented in Table 5-5. The chloride and metals data quality objectives as specified in Table 5-2 were met.

The PCDD/PCDF blank results are summarized in Table 5-6. The PCDD/PCDF Lab Control Spike met the objective as presented in Table 5-7. The PCDD/PCDF toluene rinse results are summarized in Table 5-8.

5.2.2 Surrogate PCDD/PCDF Recoveries

Surrogate recoveries are presented in Table 5-10. Lab surrogates were acceptable for all train samples. Field surrogates were generally acceptable for all train samples with the exception of ^{13}C-2,3,4,7,8-PeCDF, which showed recoveries below the 70% objective. For the toluene rinse samples, the lab surrogates were generally acceptable. Low recoveries were observed in Runs 6 to 9 for several compounds. Field surrogates were not spiked into the toluene rinse samples.

5.2.3 Audit Sample Results

Results of the EPA audit samples are presented in Tables 5-11, 5-12, and 5-13 for chloride, metals, and PCDD/PCDF, respectively.

5.3 Data Audit

The data audit was conducted to evaluate the analytical data generated during this work assignment. The quality of the analytical data was evaluated against the quality objectives for the measurement process, which were presented in the QAPP and the specified test methods. The analytical data generated by MRI for this work assignment were audited by the QAU. The MRI data met the data quality and measurement criteria for this work assignment as noted in Tables 5-1 and 5-2.

5.4 Data Assessment

An assessment of the overall quality of the data generated for this work assignment was conducted. The data assessment included a review of the sample collection data, preparation and analysis data, including calibration, surrogate recoveries, laboratory control spike sample, and precision measurements. The data generated by MRI for this report are traceable and of known and acceptable quality.

Table 5-1. Calibration Procedures and QC Criteria for Sampling Equipment

Parameter	Calibration technique	Reference standard	Acceptance limit	Frequency	Criteria met?
1. Sampling nozzle	Measure 3 diameters to nearest 0.001 in. and average measurements	Micrometer	Difference between high and low measurements, ≤ 0.004 in.	Prior to sampling	Yes
2. Metering system–volume	Compare with calibrated critical orifices, 40 *CFR* 60, Appendix A, Method 5, Section 7.2	Calibrated critical orifice	Difference between individual calibration factor values and average value, ≤ ±0.02	Prior to test series	Yes
			≤ ±5% of initial calibration factor	After test series	Yes
3. Gas meter temperature	Compare to mercury-in-glass thermometer	ASTM thermometer	≤ ±5°F difference from reference	Before and after test series	Yes
4. Gas stream (stack) temperature sensor (thermocouple)	Heated block monitored with potentiometer thermocouple system	NIST traceable potentiometer thermocouple system	Difference of ≤ ±1.5% of minimum absolute stack temperature from absolute reference temperature (unsaturated gas streams); ≤ ±1°F difference from reference (saturated gas streams)	Before and after test series	Yes
5. Final impinger outlet temperature sensor (thermocouple)	Compare to mercury-in-glass thermometer	ASTM thermometer	≤ ±2°F difference from reference	Before and after test series	Yes—Note 1
6. Filter temperature sensor (thermocouple)	Compare to mercury-in-glass thermometer	ASTM thermometer	≤ ±5°F difference from reference	Before and after test series	Yes
7. Aneroid barometer	Compare to mercury barometer	Mercury column barometer	≤ ±0.1 in. Hg difference from reference	Before and after test series	Yes
8. Type S pitot tube	Measure dimensions according to 40 *CFR* 60, Appendix A, Method 2 for baseline coefficient of 0.84	Micrometer and angle finder	Meets dimensional criteria specified in Method 2, Section 4.1 and Figures 2-2 and 2-3.	Before and after test series	Yes

Note 1: XAD thermocouple #XAD-4 went bad during Run 3. It was replaced with TC #91-11 during the run.

Table 5-2. Criteria for Emission Measurement and Data Quality

Test parameters	Matrix	Method of determination	Frequency	Accuracy objective	Precision objective	Criteria met?
Dioxin/Furan	Method 23 train samples	Field surrogates (spiked in lab during preparation of XAD for sampling trains)	Each field sample and blank	70% to 130% recovery	NA	Yes—Note 1
		Lab surrogates (internal quantitation standards)	Each field sample and blank	40% to 130% recovery (for tetra-hexa) 25% to 130% recovery (for hepta-octa)	NA	Yes—Note 2
		Laboratory reagent blank	One XAD/filter	Levels less than lowest calibration standard	NA	Yes—Note 3
		Laboratory control sample (blank reagents spiked with independent standards of native Dioxin/Furan)	One spiked XAD/filter	50% to 150% recovery	NA	Yes
		Independent (second source) check standard (EPA or certified Dioxin/Furan reference standards)	After initial calibration	80% to 120% difference	NA	Yes—Note 4

Note 1—As indicated in Table 5-10, sample surrogate recoveries were low for 13C 2,3,4,7,8-PeCDF.
Note 2—As indicated in Table5-10, IQS toluene rinse surrogate recoveries were low for various 13C compounds for Runs 6, 8, 9, and 10.
Note 3—Criteria met for all 2,3,7,8 isomers in both method blanks with the exception of OCDD.
Note 4—Criteria met for all 2,3,7,8 isomers except for 1,2,3,7,8-PeCDF and 2,3,4,7,8-PeCDF in both spike checks and OCDF in the Batch 2 spike check.

Table 5-2 (Continued)

Test parameters	Matrix	Method of determination	Frequency	Accuracy objective	Precision objective	Criteria met?
Metals	Method 29 train samples	Analysis of train sample components prepared from field reagent blanks	Once to demonstrate system control (no gross contamination) and to determine blank correction values	NA	NA	Yes
		QC check standard (certified standard, independent of working calibration standards)	After each initial calibration	90% to 110% accuracy (GFAAS); 90% to 110% accuracy (CVAAS)	NA	Yes
		Spiked lab reagent blanks simulating front-half and back-half train components	Two control spikes for each component (or combined components) at least 10X the estimated detection limit	65% to 135% recovery or analyzed by standard addition	<40% RPD	Yes
Particulate matter	Method 26A filter & front half rinses	Balance calibration check with ASTM Class 1 weights	Prior to and after all tare weighings and gravimetric determinations	±0.2 mg of standard weights approximating object being weighed	Two weighings, 6 hr apart must agree within 0.5 mg	Yes
Chloride	Method 26A impinger contents	Duplicate analysis	Each sample	NA	<5% RPD, otherwise repeat duplicate analysis	Yes
		Spiked matrix samples (0.1N H_2SO_4)	2 samples (1 matrix)	90% to 110% accuracy	NA	Yes

Table 5-2 (Continued)

Test parameters	Matrix	Method of determination	Frequency	Accuracy objective	Precision objective	Criteria met?
Moisture (water vapor)	Impinger contents	Balance calibration check with calibration weight	Prior to initial and final gravimetric determinations and whenever balance drift is apparent	±0.1g	NA	Yes
Moisture pressure temperature velocity	Gas stream being measured	Secondary technical review of field test data and equipment calibration records relative to EPA Methods 1-5	Ongoing during testing	Validated by meeting posttest equipment calibration tolerances	NA, but multiple test runs may be used as indication of overall operation variability	Yes
SO_2, NO_X, and CO, plus CO_2 and O_2, by instrumental analyzer on site	Flue gas	Analyzer calibration error check with zero, mid-range, and high-range calibration gases	After system setup each day and more often when needed	≤±2% of span for the difference between system response and calibration gas value for any of the calibration gases	NA	Yes
		Sampling system bias check with zero and either of the upscale calibration gases	After the calibration error check, during calibration drift tests, and more often when needed	≤±5% of span for the difference between analyzer response for the initial calibration error check and system response for the initial bias check for either of the calibration gases	NA	Yes
		Response time determination	During the initial bias check each day; determines when acceptable data begins to be recorded	NA	NA	Yes
		Zero and calibration drift tests	Repeat the bias check after each run or more often if needed	≤±5% of span for the difference between analyzer response for the initial calibration error check and system response for the final bias check for either of the calibration gases	≤±3% of span for the difference between final and initial system responses for either of the calibration gases	Yes
O_2, CO_2, and CO by Orsat	Gas bag samples	Analysis of ambient air	Once prior to bag sample analysis	±0.2 percent by volume for ambient air oxygen	Method 3B criteria	Yes
		Triplicate analysis of bag samples	Each bag sample	NA	Method 3B criteria	Yes

Table 5-3. Chloride Duplicate Analysis and Matrix Spike Results

	Result (mg/mL)	Duplicate (mg/mL)	RPD (%)	Spike (%)	Spike Duplicate (%)
Run No.			INLET		
1	53.9	53.1	1%		
2	61.0	60.8	0.3%		
3	185.1	194.7	5%		
5 [a]	130.1	146.9	12%		
5	152.4	125.0	20%		
6 [a]	410.8	340.8	19%	91%	94%
6	421.5	383.3	9%	105%	106%
7	789.8	782.4	1%		
8	349.7	349.1	0.2%		
9	350.1	340.8	3%		
			OUTLET		
1	10.0	10.0	0%		
2	9.4	9.4	0%		
3	65.2	67.2	3%		
4	89.8	91.3	2%		
5	83.4	83.0	0.5%		
6	193.4	205.0	6%		
7	324.0	327.8	1%		
Blank	<1.0	<1.0	NA		
Audit 1071	14.2	14.1	1%		
Audit 1072	13.3	13.3	0%		

[a] Reanalyzed due to high relative percent difference.

Table 5-4. Metals Field and Reagent Blank Results

Description	Cd (µg)	Pb (µg)	Hg (µg)
Field Reagent Blank			
Rinse and filter, µg[a]	0.360	0.820	<0.400
Rinse and filter, µg[b]	<0.100	1.36	<0.400
Rinse and filter, µg[c]	<0.100	0.740	<0.400
Rinse and filter, µg[d]	<0.100	0.600	<0.400
HNO_3 impingers, µg	<0.067	0.825	<3.00
Fourth impinger, µg	NA	NA	<0.200
$KMnO_4$ impingers, µg	NA	NA	<0.800
HCl rinse, µg	NA	NA	<1.00
Method Blank, Front Half	< 0.100	0.580	< 0.400
Method Blank, Back Half	< 0.050	0.200	< 5.00

A "<" flag indicates a result less than the detection limit, corrected for any digestion, dilution and aliquot factors.
NA = Not applicable
[a] Reagent blank for Runs 1-3 and 5-9 at Inlet plus Runs 1-7 at Outlet
[b] Reagent blank for Run 4 at Inlet (B23 = Beaker 23 containing field reagent blank samples 2049/1051)
[c] Reagent blank for Run 8 at Outlet (B24 = Beaker 24 containing field reagent blank samples 2049/2051)
[d] Reagent blank for Run 9 at Outlet (B25 = Beaker 25 containing field reagent blank sample 2049)

Table 5-5. Metals Spike and Check Standard Results

	Cadmium			Lead			Mercury		
	Recovery (%)	Duplicate Recovery (%)	RPD (%)	Recovery (%)	Duplicate Recovery (%)	RPD (%)	MS (%)	MSD (%)	RPD (%)
Reagent Blank Spike									
Front Half	125.0%	121.0%	3.3%	104.4%	107.4%	2.8%	101.0%	101.0%	0.0%
Back Half	92.0%	91.0%	1.1%	94.8%	93.4%	1.5%	-	-	-
Matrix Spike	-	-	-	-	-	-	102.4%	100.0%	2.4%
	-	-	-	-	-	-	103.2%	104.2%	1.0%
	-	-	-	-	-	-	102.8%	102.4%	0.4%
	-	-	-	-	-	-	103.6%	100.6%	2.9%
Standard Reference Material									
QC Filter	106.0	-	-	103.4	-	-	-	-	-

RPD = Relative percent difference.
MS/MSD = Matrix spike/ matrix spike duplicate.
A "-" symbol indicates "not applicable".

Table 5-6. Dioxin/Furan Blank Results (total pg)

Description	Method Blank b1	Method Blank b2
Isomer		
2,3,7,8-Substituted Dioxins (pg)		
2378TCDD	U(1.66 EMPC)	U(1.44 EMPC)
12378PECDD	U(.746)	U(.866)
123478HXCDD	2.03	U(.907)
123678HXCDD	0.995	U(.905)
123789HXCDD	0.887	U(.859)
1234678HPCDD	10.4	7.28
12346789OCDD	69.1	71.3
2,3,7,8-Substituted Furans (pg)		
2378TCDF	U(.483)	3.31
12378PECDF	U(.394)	U(.645 EMPC)
23478PECDF	U(.416)	U(.466)
123478HXCDF	U(.741 EMPC)	U(.587)
123678HXCDF	U(.459)	U(.562)
234678HXCDF	U(.522)	U(.64)
123789HXCDF	0.651	U(.727)
1234678HPCDF	3.21	U(1.55 EMPC)
1234789HPCDF	U(.681 EMPC)	U(.757)
12346789OCDF	U(5.69 EMPC)	1.79
Dioxin Homologs (pg)		
Total TCDD	1.3	20.9
Total PeCDD	U(.746)	1.08
Total HxCDD	5.22	U(.89)
Total HpCDD	18.4	13.9
12346789OCDD	69.1	71.3
Furan Homologs (pg)		
Total TCDF	U(.483)	6.0
Total PeCDF	U(.405)	U(.454)
Total HxCDF	1.36	U(.621)
Total HpCDF	8.25	U(.664)
12346789OCDF	U(5.69 EMPC)	1.79

EMPC - Estimated Maximum Possible Concentration

Table 5-7. Dioxin/Furan Lab Control Spike and Independent Check Standard Results

	Spike Level (Total pg)	LCS b1	% Recovery	LCS b2	% Recovery	Spike Check b1	% Recovery	Spike Check b2	% Recovery
2,3,7,8-Substituted Dioxins									
2378TCDD	200	179	89.5	166	83.0	191	95.5	172	86.0
12378PECDD	1000	903	90.3	828	82.8	953	95.3	873	87.3
123478HXCDD	1000	896	89.6	847	84.7	965	96.5	890	89.0
123678HXCDD	1000	909	90.9	861	86.1	998	99.8	912	91.2
123789HXCDD	1000	885	88.5	845	84.5	975	97.5	892	89.2
1234678HPCDD	1000	958	95.8	888	88.8	959	95.9	895	89.5
12346789OCDD	2000	2100	105	1740	87.0	1900	95.0	1750	87.5
2,3,7,8-Substituted Furans									
2378TCDF	200	176	88.0	171	85.5	189	94.5	178	89.0
12378PECDF	1000	720	72.0	648	64.8	740	74.0	674	67.4
23478PECDF	1000	787	78.7	769	76.9	785	78.5	770	77.0
123478HXCDF	1000	860	86.0	874	87.4	940	94.0	891	89.1
123678HXCDF	1000	911	91.1	885	88.5	957	95.7	912	91.2
234678HXCDF	1000	896	89.6	895	89.5	951	95.1	911	91.1
123789HXCDF	1000	869	86.9	945	94.5	1090	109.0	912	91.2
1234678HPCDF	1000	1050	105	953	95.3	1050	105.0	983	98.3
1234789HPCDF	1000	885	88.5	801	80.1	949	94.9	885	88.5
12346789OCDF	2000	1600	80.0	1430	71.5	1730	86.5	1470	73.5

Table 5-8. Toluene Rinse Dioxin/Furan Results—Inlet

	CONDITION 1					CONDITION 2			CONDITION 3		
Field ID	1012	1023	2012	3012	10012	4012	4012	6012	7012	8012	9012
Description	Run 1a	Run 1 b	Run 2	Run 3	Run 10	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9
Extract ID	42838 (b1)	42839 (b1)	42841 (b1)	42843 (b1)	42926 (b2)	42845 (b1)	42847 (b1)	42918 (b2)	42920 (b2)	42922 (b2)	42924 (b2)
MS File	G09V34.RPT	G09V35.RPT	G09V37.RPT	G09V39.RPT	G14V11.RPT	G09V314.RPT	G09V316.RPT	G13V59.RPT	G13V511.RPT	G13V513.RPT	G13V515.RPT
Isomer											
2,3,7,8-Substituted Dioxins (pg)											
2378TCDD	U(.503)	U(.496)	U(.702 EMPC)	U(.45)	U(.728)	U(.407)	U(.507)	0.809	U(.431)	U(.384)	U(1.13) J
12378PECDD	U(1.21 EMPC)	U(.498)	U(3.7 EMPC)	U(.724 EMPC)	U(1.39) J	U(5.23 EMPC)	U(.513 EMPC)	3.65	1.56	1.9	U(1.4) J
123478HXCDD	U(.808 EMPC)	U(.421)	5.16	U(.815 EMPC)	5.69 J	4.91	0.558	5.42	U(1.87 EMPC)	3.46	2.24 (J)
123678HXCDD	U(1.47 EMPC)	U(.335)	8.35	1.47	J(8.63 EMPC) J	8.24	0.651	U(6.54 EMPC)	3	U(5.89 EMPC)	U(2.91 EMPC) J
123789HXCDD	U(1.23 EMPC)	U(.318)	6.9	U(1.51 EMPC)	J(14.1 EMPC) J	6.65	U(.935 EMPC)	U(11.9 EMPC)	U(3.97 EMPC)	8.56	3.63 J
1234678HPCDD	18.8	3.13	43.6	13.1	101	46.2	5.42	34.8	U(15.1 EMPC)	84.5	23.5
12346789OCDD	102	27.3	72.4	36.7	391	82.4	15.9	86.3	76.7	350	61.6
2,3,7,8-Substituted Furans (pg)											
2378TCDF	U(2.46 EMPC)	U(.62 EMPC)	U(6.06 EMPC)	0.842	1.19	6.93	1.07	4.07	2.07	U(.997 EMPC)	U(1.76 EMPC) J
12378PECDF	U(1.63 EMPC)	0.37	4.82	U(.593 EMPC)	2.14	4.61	U(.928 EMPC)	5.51	2.71	1.28	U(2.65 EMPC)
23478PECDF	U(2.73 EMPC)	U(.771 EMPC)	14.2	1.6	5.76	14.2	1.39	9.63	5.6	4.14	U(5.64 EMPC)
123478HXCDF	U(3 EMPC)	U(.585 EMPC)	22.5	1.98	U(18.9 EMPC)J	22.6	U(1.67 EMPC)	U(14.8 EMPC)J	7.67	U(13.4 EMPC)J	5.2(J)
123678HXCDF	3.2	U(.571 EMPC)	19.8	2.1	14.4(J)	19.8	U(1.87 EMPC)	14.7(J)	U(8.31 EMPC)	13(J)	U(6.16 EMPC)J
234678HXCDF	3.57	U(.808 EMPC)	40.9	U(3.47 EMPC)	232(J)	36.2	U(2.32 EMPC)	71.9(J)	29.1	U(136 EMPC)J	42.7(J)
123789HXCDF	U(1.62 EMPC)	U(.28)	20.2	1.45	56.7(J)	19.4	0.954	35.4(J)	U(8.48 EMPC)	U(31.6 EMPC)J	U(9.38 EMPC)J
1234678HPCDF	11.1	2.33	97.6	U(8.94 EMPC)	195(J)	87.7	4.44	48.6(J)	38.7	106(J)	U(27.4 EMPC)J
1234789HPCDF	1.81	U(.479 EMPC)	21	2.45	11.9(J)	20.9	0.985	12.3(J)	5.62	7.27(J)	3.47(J)
12346789OCDF	10	1.87	60.6	8.13	34.6	58.4	1.9	19.8	15.6	20.9	7.27
Dioxin Homologs (pg)											
Total TCDD	2.41	U(.496)	25.5	0.996	1.08	21.4	U(.507)	5.59	0.736	1.47	U(1.13)
Total PeCDD	2.98	U(.498)	35.2	U(.472)	13.8	37.1	U(.482)	23.7	4.17	13.5	U(1.4)
Total HxCDD	11.4	0.889	91.6	17.3	89.8	78.1	6.67	49.9	29.7	67.5	5.96
Total HpCDD	38.1	5.33	79.8	29.4	200	81.4	9.98	62.3	28.7	146	44.1
12346789OCDD											
Furan Homologs (pg)											
Total TCDF	34.6	7.05	93.1	5.17	8.12	95.8	6.84	39.9	32.8	8.21	16.4
Total PeCDF	12.5	2.24	83.5	3.19	26.8	90.2	2.9	42.3	27	18.5	15.1
Total HxCDF	22.4	2.46	217	16.4	367	193	8.22	179	83.5	59.6	52.3
Total HpCDF	20.5	2.38	164	2.22	308	154	5.45	123	78.3	180	11
12346789OCDF	10	1.87	60.6	8.13	34.6	58.4	1.9	19.8	15.6	20.9	7.27

J--Value calculated from a 13C IQS with recovery outside.
EMPC--Estimated Maximum Possible Concentration

Table 5-9. Toluene Rinse Dioxin/Furan Results—Outlet

	CONDITION 1			CONDITION 2		CONDITION 3		
Field ID	1036	2036	3036	4036	6036	7036	8036	9036
Description	Run 1	Run 2	Run 3	Run 4	Run 6	Run 7	Run 8	Run 9
Extract ID	42840 (b1)	42842 (b1)	42844 (b1)	42846 (b1)	42919 (b2)	42921 (b2)	42923 (b2)	42925 (b2)
MS File	G09V36.RPT	G09V38.RPT	G09V310.RPT	G09V315.RPT	G13V510.RPT	G13V512.RPT	G13V514.RPT	G13V516.RPT
Isomer								
2,3,7,8-Substituted Dioxins (pg)								
2378TCDD	U(.384)	U(.646 EMPC	U(.347)	U(.461)	U(.411)	U(.339)	U(.508)	U(.378)
12378PECDD	1.71	U(2.88 EMPC	U(.353)	U(1.91 EMPC)	U(.47)	U(.793 EMPC	U(1.26 EMPC)	U(.605)
123478HXCDD	U(2.54 EMPC	3.84	U(.286)	U(2.69 EMPC)	U(.509)	U(.826 EMPC	U(1.79 EMPC)	U(.713)
123678HXCDD	U(4.21 EMPC	4.6	U(.583 EMPC)	U(3.14 EMPC)	0.727	1.68	U(3.11 EMPC)	U(.712)
123789HXCDD	4.51	U(5.43 EMPC	U(.74 EMPC)	3.62	U(.483)	1.62	U(6.69 EMPC)	U(.676)
1234678HPCDD	39.6	18.3	3.73	12.3	4.02	11.7	13	U(3.2 EMPC)
12346789OCDD	72.5	68.3	14.3	62	18.2	41	43.7	16.7
2,3,7,8-Substituted Furans (pg)								
2378TCDF	U(.952 EMPC	U(6.02 EMPC	U(.294)	1.89	U(.293)	U(.499 EMPC	U(.552 EMPC)	U(.363)
12378PECDF	1.57	2.05	U(.166)	1.08	U(.276 EMPC)	0.584	U(.572 EMPC)	U(.223)
23478PECDF	3.67	3.38	U(.256)	U(.213)	U(.458 EMPC)	1.12	U(1.49 EMPC)	U(.235)
123478HXCDF	7.46	4.88	0.296	2.59	U(.572)	U(1.85 EMPC	U(2.41)J	U(1.15) J
123678HXCDF	7.16	4.02	U(.331 EMPC)	U(2.2 EMPC)	U(.547)	U(1.87 EMPC	U(2.3)J	U(1.1) J
234678HXCDF	17.0	5.73	U(.495 EMPC)	U(3.5 EMPC)	U(1.36 EMPC)	U(5.81 EMPC	19.2(J)	U(1.78 EMPC) J
123789HXCDF	9.09	6.29	U(.235)	3.06	U(.708)	U(1.91 EMPC	U(15 EMPC)J	U(1.42) J
1234678HPCDF	60.4	10.8	U(2.13 EMPC)	6.34	1.93	8.33	8.52(J)	U(2.75 EMPC)
1234789HPCDF	16.4	9.74	U(.261)	U(5.45 EMPC)	U(.389)	1.53	U(1.82 EMPC)J	U(.466)
12346789OCDF	57.7	28.7	1.69	17.5	0.75	4.88	2.22	U(.551 EMPC)
Dioxin Homologs (pg)								
Total TCDD	U(.384)	2.77	U(.347)	3.24	U(.411)	U(.339)	U(.508)	U(.378)
Total PeCDD	3.32	9.44	1.06	8.33	U(.47)	0.559	2.27	U(.605)
Total HxCDD	24.1	24.5	2.31	16	0.715	4.57	10.9	U(.7)
Total HpCDD	73.0	28.1	6.67	17.8	6.59	22.6	22.8	U(.47)
12346789OCDD								
Furan Homologs (pg)								
Total TCDF	12.8	16.2	0.776	6.63	U(.293)	U(.322)	3.46	U(.363)
Total PeCDF	22	9.85	0.505	5.48	0.698	6.23	0.814	0.392
Total HxCDF	71.5	26.6	1.46	5.69	U(.605)	4.23	18.6	U(1.21)
Total HpCDF	109	20.7	U(.247)	8.12	1.97	11.1	16.8	U(1.44)
12346789OCDF	57.7	28.7	1.69	17.5	0.75	4.88	2.22	U(.551 EMPC)

Table 5-10. Dioxin/Furan Surrogate Recoveries (%)

			INLET TRAINS									
Description	Method Blank b1	Method Blank b2	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10
Lab Surrogates (IQS)												
13C2378TCDF	88.4	78.4	86.8	88.1	82.9	76.6	75.4	78.8	73.8	75.6	83.1	77.4
13C2378TCDD	88.6	85.4	87.6	93.4	87.0	90.4	87.3	90.9	82	82.2	91.9	90.1
13C12378PeCDF	123	98.1	124	124	118	101	97.5	101	99.1	101	107	103
13C12378PeCDD	93.3	81.6	101	103	97.6	85.2	89.2	95.3	82.1	92.3	92.6	88.9
13C123678HxCDF	112	99.5	91.6	102	88.9	106	94.5	102	86.9	91.9	78.7	99.7
13C123678HxCDD	113	107	103	113	103	114	107	108	98.8	102	110	110
13C1234678HpCDF	123	99.5	97.5	116	99.8	108	95.9	105	82.2	93.2	71.6	99.6
13C1234678HpCDD	120	102	111	123	111	115	109	110	99.6	101	103	113
13C12OCDD	121	110	114	128	113	120	107	112	106	90.8	93.9	119
Field Surrogates												
37CL2378TCDD	97.6	93.8	97.4	97.2	96.1	91.8	90.7	91.7	93.8	95.3	92.2	90.3
13C23478PeCDF	66.8(J)	65.6(J)	67.8(J)	72.2	68.0 (J)	65.7(J)	72.4	75.0	66.3(J)	76.4	71.5	69.9 (J)
13C123478HxCDF	93.9	98.0	96.7	96.6	96.4	96.0	92.4	94.4	92.0	93.8	88.9	91.7
13C123478HxCDD	88.8	91.6	90.5	89.2	92.4	89.9	88.6	90.5	92.1	89.0	86.0	88.0
13C1234789HpCDF	89.0	94.3	95.0	96.3	90.6	94.4	93.6	91.5	105	96.3	124	103

			OUTLET TRAINS							
Description	Method Blank b1	Method Blank b2	Run 1	Run 2	Run 3	Run 4	Run 6	Run 7	Run 8	Run 9
Lab Surrogates (IQS)										
13C2378TCDF	88.4	78.4	85.2	89.9	84.1	78.9	77.0	77.8	75.8	73.5
13C2378TCDD	88.6	85.4	88.5	92.1	86.5	91.8	87.4	88.4	85.7	83.1
13C12378PeCDF	123	98.1	115	121	115	103	95.9	104	99.9	99.3
13C12378PeCDD	93.3	81.6	98.1	100	94.2	93.6	86.8	97.2	97.9	89.7
13C123678HxCDF	112	99.5	99.9	94.6	91.1	102	96.3	101	84.9	84.9
13C123678HxCDD	113	107	109	108	103	111	107	110	103	105
13C1234678HpCDF	123	99.5	108	112	97.8	105	103	102	76.7	83.4
13C1234678HpCDD	120	102	116	119	111	110	113	108	96.7	98.4
13C12OCDD	121	110	117	123	115	114	114	102	79.1	89.9
Field Surrogates										
37CL2378TCDD	97.6	93.8	97.4	95.4	95.1	91.3	94.3	92.6	89.9	94.4
13C23478PeCDF	66.8(J)	65.6(J)	71.9	68.9(J)	66.6(J)	68.2(J)	76.6	71.4	70.1	69.1(J)
13C123478HxCDF	93.9	98.0	99.4	98.8	97.2	95.8	96.3	97.2	91.6	96.8
13C123478HxCDD	88.8	91.6	90.8	88.0	87.4	90.7	93.4	91.3	86.2	85.3
13C1234789HpCDF	89.0	94.3	95.7	93.5	95.4	95.9	96.2	90.7	111	110

J- Recovery outside the method criteria
Field surrogates 70%-130%
IQS 40%-130% tetra-hexa, 25%-130% hepta-octa
NA- Not applicable

Table 5-10 (Continued)

INLET TOLUENE RINSES													
Description	Run 1	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8	Run 9	Run 10	LCS b1	LCS b2
Lab Surrogates (IQS)													
13C2378TCDF	89.5	72.3	76.5	83.9	84.3	69.2	78.2	84.1	85.9	37.1 (J)	75.3	92.8	77.4
13C2378TCDD	90.2	72.4	75.3	82.6	84.2	67.8	76.4	93.5	80.5	39.1 (J)	51.6	94.2	84.5
13C12378PeCDF	127	110	109	114	128	94.1	94.1	107	94.9	48.2	66.0	136 (J)	96.8
13C12378PeCDD	98.1	92.1	91.9	92.9	109	76.1	52.1	86.7	50.5	33.5 (J)	28.1 (J)	109	86.3
13C123678HxCDF	105	91.8	88.4	93	91.5	78.7	23.7(J)	42.4	10.7(J)	11.8(J)	ND (J)	117	84.7
13C123678HxCDD	113	103	98.6	105	107	90.0	52.4	87.9	45.3	35.9 (J)	25.6 (J)	117	93.7
13C1234678HpCDF	125	116	106	112	103	102	24.3(J)	42.8	9.53(J)	13.3(J)	6.81(J)	130	86.9
13C1234678HpCDD	125	118	111	120	111	110	84.1	106	77.5	49.5	48.1	128	90.3
13C12OCDD	125	122	114	126	118	112	103	114	97.0	53.5	68.2	127	94.2
Field Surrogates													
37CL2378TCDD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	97.1	95.7
13C23478PeCDF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	73.2	73.9
13C123478HxCDF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	91.6	98.1
13C123478HxCDD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	88.4	90.7
13C1234789HpCDF	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	88.7	90.6

OUTLET TOLUENE RINSES									
Description	Run 1	Run 2	Run 3	Run 4	Run 6	Run 7	Run 8	Run 9	Audit Sample
Lab Surrogates (IQS)									
13C2378TCDF	81.3	85.9	81.7	75.6	65.4	83.6	89.1	92.7	74.8
13C2378TCDD	81	82.4	81.2	79.1	75.1	91.9	88.8	99.4	86.0
13C12378PeCDF	115	113	112	105	92.3	107	104	117	93.3
13C12378PeCDD	94.5	91.8	90.4	92.1	82.8	88.9	52.5	76.9	87.1
13C123678HxCDF	89	93.5	93.2	87.4	47.6	55.7	12.3(J)	26.8 (J)	90.3
13C123678HxCDD	97.4	105	103	100	89.1	103	46.8	71.6	106
13C1234678HpCDF	109	112	104	105	48.5	55.7	11.1(J)	28.0	89.3
13C1234678HpCDD	110	114	116	113	92.7	111	87.3	101	96.8
13C12OCDD	115	117	121	115	92.4	113	107	117	100
Field Surrogates									
37CL2378TCDD	NA	NA	NA	NA	NA	NA	NA	NA	95.0
13C23478PeCDF	NA	NA	NA	NA	NA	NA	NA	NA	74.5
13C123478HxCDF	NA	NA	NA	NA	NA	NA	NA	NA	94.9
13C123478HxCDD	NA	NA	NA	NA	NA	NA	NA	NA	91.9
13C1234789HpCDF	NA	NA	NA	NA	NA	NA	NA	NA	104

J- Recovery outside the method criteria
Field surrogates 70%-130%
IQS 40%-130% tetra-hexa, 25%-130% hepta-octa
NA- Not applicable

Table 5-11. Chloride Analysis Results for EPA Audit Samples

Audit Sample ID	Chloride (ug/mL)	Pass/Fail
J2017-1071	64.9	Pass
J2572-1072	69.3	Pass

Table 5-12. Metals Analysis Results for EPA Audit Samples

Audit sample ID	Sample description	Cd conc.	Pb conc.	Hg (ng/mL)	Pass/Fail
M29-019/Blank	Blank filter (ug)	< 0.10	0.280	–	Pass
M29-019/FL-112	Spiked filter (Multi-metals low level, ug)	11.2	51.0	–	Pass
M29-019/MMA-124[a]	Spiked solution (Multi-metals extra low level, ug/mL)	0.00980	0.0494	–	Pass
M29-019/Hg-117[b]	Spike solution (Mercury low level, ng/mL)	–	–	< 0.20	Pass

Note: All sample results greater than the detection limit have been rounded to three significant figures.

A "<" flag indicates a result less than the detection limit, corrected for any digestion and dilution factors.

[a] This sample represents a 1,000-fold dilution of the original solution.

[b] This sample represents a 10,000-fold dilution of the original solution.

Table 5-13. Dioxin/Furan Audit Sample Results (total pg)

Description	Performance Audit Sample M23-028 (XAD)	Pass/Fail
Isomer		
2,3,7,8-Substituted Dioxins (pg)		
2378TCDD	185	pass
12378PECDD	179	pass
123478HXCDD	169	pass
123678HXCDD	175	pass
123789HXCDD	169	pass
1234678HPCDD	355	pass
12346789OCDD	390	pass
2,3,7,8-Substituted Furans (pg)		
2378TCDF	168	pass
12378PECDF	127	pass
23478PECDF	158	pass
123478HXCDF	175	pass
123678HXCDF	179	pass
234678HXCDF	180	pass
123789HXCDF	437	pass
1234678HPCDF	380	pass
1234789HPCDF	393	pass
12346789OCDF	282	pass
Dioxin Homologs (pg)		
Total TCDD	452	pass
Total PeCDD	599	pass
Total HxCDD	876	pass
Total HpCDD	562	pass
12346789OCDD		
Furan Homologs (pg)		
Total TCDF	360	pass
Total PeCDF	448	pass
Total HxCDF	1020	pass
Total HpCDF	755	pass
12346789OCDF	282	pass