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FINAL REPORT
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Assessment of Combustion Sources That Emit Polychlorinated Dioxins and Furans, Polycyclic Aromatic Hydrocarbons, and Other Toxic Compounds

State of California
AIR RESOURCES BOARD
Research Division

**Assessment of Combustion Sources That Emit Polychlorinated
Dioxins and Furans, Polycyclic Aromatic Hydrocarbons,
and Other Toxic Compounds**

**Final Report
Contract No. A832-124**

Prepared for:

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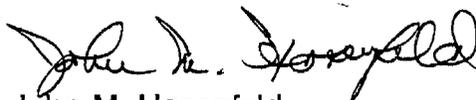
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PREFACE

Midwest Research Institute has prepared this document for project requirements of both Phase I and Phase II for the California Air Resources Board (ARB) project "Assessment of Combustion Sources That Emit Polychlorinated Dioxins and Furans, Polycyclic Aromatic Hydrocarbons, and Other Toxic Compounds."

This document was prepared by the Engineering and Environmental Technology Department of Midwest Research Institute (MRI) for the ARB, Mr. Ralph Propper, ARB Project Manager, under the direction of Mr. John M. Hosenfeld, MRI Project Leader. Mr. Dan March was the field sampling task leader. Dr. Andrès Romeu and Ms. Marilyn Whitacre were responsible for the semivolatile organics analysis (PCDDs/PCDFs and PAHs), Ms. Eileen McClendon was responsible for the metals analysis. Ms. Pam Murowchick performed the test results calculations and provided the spreadsheets for this report. Mr. Dennis Hooton was the quality assurance coordinator. Additional contributions were made by the following individuals: Mr. Bob Gulick (CEMs sampling and graphs); Mr. Dennis Wallace and Mr. Paul Gorman (technical advisors); Ms. Elizabeth Page and Mr. Greg Maynard (Phase I report).

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NOMENCLATURE

dscm	Dry standard cubic meter at 20°C, 760 mm Hg (68°F, 29.92 in. Hg)
°F	Degrees, Fahrenheit
PAH	Polynuclear aromatic hydrocarbons
PCDD	Polychlorinated dibenzo- <i>p</i> -dioxins (tetra-octa)
PCDF	Polychlorinated dibenzofurans (tetra-octa)
μg	Microgram (10 ⁻⁶ g)
ng	Nanogram (10 ⁻⁹ g)

SECTION 1

INTRODUCTION

1.1 PROJECT SCOPE

The State of California, through its Air Resources Board (ARB) has the authority and responsibility for identifying airborne compounds and substances to be considered as toxic air contaminants (TACs) and for evaluating the need to develop regulations for the control of these contaminants. The ARB is now developing an assessment of those combustion sources that emit polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polycyclic aromatic hydrocarbons (PAHs), and other toxic substances. The impetus of this program arises from the classification of PCDD and PCDF as TACs by the ARB, pursuant to the provisions of AB 1807. The ARB has identified potential PCDD and PCDF source categories that currently exist in the State of California.

One important part in the sequence of determining the impact of TACs on the Californian environment is to determine TAC emissions from the waste oil recycling, drum reconditioning, and wire reclamation industries. In order to assess fully the impact of toxic air contaminants, it is necessary to quantify TACs from those selected emission sources. In addition, ARB is interested in expanding its knowledge of wood burning stoves and the presence of PAHs and PCDDs/PCDFs in the soot residue.

MRI is under contract to ARB to complete the "Assessment of Combustion Sources That Emit PCDDs and PCDFs, PAHs, and Other Toxic Compounds." The project is divided in two phases with the following key elements, actions, and deliverables:

Phase I—Source Identification and Screening Criteria

- Develop a methodology to identify and screen potential sources for emissions of PCDDs, PCDFs, and other toxic compounds.
- Identify sampling and analytical methods.
- Prepare an interim report.

- Modify the interim report to include additional guidance from ARB on priorities to be addressed in Phase II.

Phase II—Source Selection and Testing

- Test the selected sources to determine emissions.
- Complete analysis of each sample for PCDDs/PCDFs and other TACs.
- Identify conditions possibly affecting the formation of PCDDs/PCDFs and TACs.
- Identify potential control measures and operational or combustion modifications necessary to reduce TACs.
- Prepare a final report.

1.2 BACKGROUND DISCUSSION

As early as the late 1970s, concerns were raised in Europe about the emissions of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs) from waste incineration processes. During the past 10 years, these concerns have generated a substantive amount of research throughout North America and Western Europe on the mechanisms of PCDD/PCDF formation in waste combustion processes and on procedures that can be used to control those emissions. Much of the research focused on PCDD/PCDF emissions from municipal waste combustors (MWCs). These research studies have covered theoretical evaluations of the kinetics and thermodynamics of combustion reactions, bench-scale research, and emission testing of full-scale MWC facilities. In general, the research has demonstrated that PCDDs/PCDFs are emitted from MWCs and that they can be emitted at levels that are considered to have an adverse effect on public health. The research also has led to some understanding, or at least hypotheses, about PCDD/PCDF formation/destruction mechanisms in waste combustion systems. However, no general agreement has been reached on the relative contribution of these mechanisms to PCDD/PCDF emissions from full-scale systems.

Over the past 10 years, a substantive amount of research has been conducted on the formation and destruction of PCDDs/PCDFs in waste combustion systems. As a result of this research, a wide variety of reaction mechanisms has been proposed to explain PCDD/PCDF emissions from waste combustion processes (primarily MWCs). Although the number of proposed mechanisms is quite large, they can be divided into three general groups based on the part of the process from which the PCDDs/PCDFs are postulated to be derived—the waste

feed, the high temperature combustion zone, and cooler zones downstream from the combustor.

One of the earliest theories of the source of PCDD/PCDF emissions in MWCs was that they were actually present in the waste feed and escaped destruction in the combustion process. PCDDs were observed in the MWC refuse samples with more PCDDs going into the incinerator than coming out of the stack, although the ash analysis was not performed.¹⁰ However, there is no information on whether the feed material of the wire reclamation, waste oil, or drum reconditioning industries in the present study contains PCDDs/PCDFs. The emphasis is, moreover, on the controlling of stack emissions.

The second process component that has been proposed as a source of PCDDs/PCDFs is the combustion zone itself. Most of the research published to date has been directed toward proposing formation/destruction mechanisms which are not understood at this time. Hypotheses that postulate a variety of precursor compounds have been proposed. Proposed precursors include related chlorinated aromatic species, such as chlorobenzenes and chlorinated phenols, and nonchlorinated, structurally similar species, such as lignin, in combination with inorganic chlorine. Various reaction mechanisms also have been proposed. These mechanisms include both gas phase homogeneous reactions and surface reactions in the bed or on suspended particles. None of the specified hypotheses that have been postulated have been confirmed by the research conducted to date. Consequently, the discussion below presents key findings relevant to selection of process parameters to consider for these subject industries rather than a detailed summary of the various hypotheses.

1. The theoretical work by Shaub and Tsang suggested that at temperatures greater than 920°C (1700°F) in the presence of oxygen, the destruction of PCDDs/PCDFs was much more likely than formation.¹ This finding was confirmed in bench scale work by Miller et al., in temperature ranges of 600° to 1000°C (1100° to 1800°F) and residence times as low as 0.5 sec.² Consequently, a relationship between secondary chamber temperature and residence time and PCDD/PCDF emissions is not expected.
2. Reactions on surfaces, particularly in oxygen-starved, cool spots may be important.
3. The formation of complex chlorinated organics in thermal systems can be achieved with almost any type of fuel when in the presence of chlorine. Pyrolysis of two chlorophenols at temperatures of about 400°C (750°F) yielded almost all 210 congeners of PCDDs and PCDFs, and complex aromatics can be formed from simple aliphatics.^{2,3} Consequently, the specific chemical makeup of the waste relative to

precursors probably is of minimal importance, providing a source of chlorine is present.

4. One recent study suggested that the S/Cl ratio in the feed may be a key factor in PCDD/PCDF formation.⁴

By far the most research has been conducted over the past 4 years on PCDD/PCDF formation in low temperature zones downstream of the combustion zone. Much of the work that has led to an understanding of factors which promote this formation comes from laboratory scale experiments, but the formation has been demonstrated across boilers and high temperature ESPs. Although the specific mechanism of formation is not defined fully, research has defined some of the parameters which affect PCDD/PCDF formation as summarized below.

1. Optimum temperature for fly ash catalyzed PCDD/PCDF formation is about 300°C (570°F). Little formation appears to occur below 250°C (480°F), and above 350°C (660°F) destruction processes dominate.^{1,5,6,9}
2. Oxygen is a key parameter to PCDD/PCDF formation. When fly ash is exposed to an O₂-free carrier gas, no formation is found. In the presence of oxygen, PCDD/PCDF concentrations on the fly ash may increase 10 to 20 times.^{6,7}
3. At temperatures of 300°C (570°F), the time required in laboratory experiments to approach equilibrium (steady-state) conditions is about 6 to 8 hr. Consequently, the time over which fly ash is exposed to 250° to 350°C (450° to 700°F) temperatures is likely to be important.
4. Copper appears to be an important catalyst in the formation of PCDDs/PCDFs, and the quantity of carbon in the ash also may be important.^{8,9}
5. Recent experiments found formation to be related to gas moisture content,⁸ although a review of MSW data shows that flue gas moisture levels after combustion is complete are not related to PCDDs/PCDFs concentration.¹⁰

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SECTION 2

PROJECT SUMMARY

The ARB is interested in determining the emission level from a series of facilities that may have the potential to produce by-product emissions of toxic air contaminants (TACs). These TACs include dioxins and furans, PAHs, and metals. The present study examined the waste oil users, drum reconditioners, and wire reclamation facilities as possible sources of these TACs. The waste oil users were manufacturing facilities that used the waste oil as fuel for heating their rotary kilns. Inlet and outlet sampling was conducted across the baghouse fabric filters at each site. In contrast, the drum reconditioner facilities were sampled to determine the emissions from a drum burning operation. There was no APCD, although that industry refers to the installed afterburner as such a device. Outlet sampling only was conducted at these two facilities. The wire reclamation facility removes coating from wire by means of burning and only samples of ash were collected.

The results of the waste oil users indicate that there was a decrease in dioxin and furan emissions across the APCD. A similar trend was seen in the PAH emissions. The metals analysis indicated removal across the APCD for one facility, but the other exhibited no distinct trend. The drum reconditioners had dioxin and furan levels higher than the waste oil users. The wire reclamation ash was submitted to ARB for analysis.

In order to place the TAC levels found in this study in some perspective, the data were compared to cement kiln data. The dioxin and furan data from the waste oil users were about two orders of magnitude lower than that from the cement kilns. The metals data showed no apparent difference between the two sources. The drum reconditioners have dioxin and furan and metals emissions that are comparable to the cement kiln data.

SECTION 3

SOURCE IDENTIFICATION AND SCREENING

3.1 IDENTIFICATION OF COMBUSTION SOURCES

The ARB provided a list of potential test facilities for recycled oil users, drum reconditioners, and wire reclaimers. The list identified 8 to 24 facilities in each of the three categories with contact names, phone numbers, and addresses for most facilities. MRI explored the possibility of augmenting this list by using trade association membership lists as potential test facilities. The local air pollution control districts were contacted and asked to supply potential test sites.

A primary goal of the Phase I study was to identify best candidate test sites among waste oil recycling, drum reconditioning, and wire reclamation facilities for the purpose of evaluating the potential for PCDD/PCDF emissions, as well as emissions of polynuclear aromatic hydrocarbons (PAHs) and metals from these three source categories. The two overriding concerns that formed the basis for identifying these sites were: (a) whether the facility had the potential to emit significant quantities of PCDDs/PCDFs (i.e., whether a facility was likely to represent "worst case" PCDD/PCDF emissions for the particular industry category), and (b) whether the facility was equipped with "best" air pollution control systems for that industry category.

Preliminary information collected from the local air pollution control districts was insufficient to evaluate the facilities with respect to these concerns. Consequently, a questionnaire was developed for collecting information directly from the facilities through a combined mail/telephone survey. The two major subsections below discuss the criteria used to formulate the questionnaire and describe the final questionnaire.

3.2 DEVELOPMENT OF QUESTIONNAIRE

3.2.1 Criteria Used for Questionnaire Development

The questionnaire was designed to address the following three questions for each waste oil recycling, drum reconditioning, and wire reclamation facility:

1. Does the facility have the potential for emitting relatively high concentrations of PCDDs/PCDFs (and possibly other trace organics) in comparison to other facilities in the same industry category?
2. Is the air pollution control system likely to provide substantial reduction in PCDD/PCDF emissions relative to control systems at other facilities within the industry category?
3. Is sampling of PCDD/PCDF emissions technically and logistically feasible at the facility?

Because the theory of PCDD/PCDF formation and control is not fully understood and because information on these three industry categories is quite sparse, the questionnaire was not designed to provide quantitative answers to these three questions. Rather it was designed to collect as much information as possible that would allow relative comparisons of the facilities within each category. The three subsections below identify the key information that forms the basis for addressing each of the questions, along with a brief discussion of why the information is important.

An initial phone survey of potential test facilities was conducted to obtain preliminary information that would assist in developing questions specific to the three industry sources. In addition, a brief literature search was conducted to add any other pertinent questions to the list being developed. From these discussions, a master questionnaire was developed for this study. The questionnaire was submitted to the ARB for comments. The ARB's comments were used to refine the questionnaire, and from this, individual questionnaires for each source category were developed.

Once the questionnaires were completed, the ARB supplied MRI with a cover letter explaining to each facility the purpose for this information-gathering questionnaire. MRI then sent a questionnaire, MRI's letter, and the ARB's cover letter in a Federal Express packet to each facility.

3.2.2 Questionnaires

Separate questionnaires were developed for each of the three industry categories—wire reclamation facilities, waste oil recyclers, and drum reconditioners. Each questionnaire requested general facility contact information, detailed information on the combustion system that can be used to evaluate the potential for PCDD/PCDF formation, summary information about the air pollution control system, and detailed information related to sampling access and stack gas characteristics that can be used to facilitate test planning.

3.3 COLLECTION OF SOURCE INFORMATION

A preliminary phone screen was conducted by contacting each facility. The plant manager or environmental coordinator identified at each facility were questioned about this facility. Each facility was informed of the purpose of the phone call and the focus of the survey was explained. Each facility was asked a few questions that were central to the goal of the study. Specifically, each facility was asked if it had an air pollution control device (APCD), if it indeed did fit into the assigned category and if the contact person was willing to talk with MRI about the facility.

Since one objective of the study is to evaluate APCDs, any facility that did not have at least one control device was automatically rejected. Once the status of the plant APCD was established, a packet containing the appropriate facility questionnaires, ARB letter of authorization, and MRI's letter of introduction were mailed to all facilities that had passed the initial screen and a few which had some interesting features that made them potential test sites. Each facility was subsequently called to ensure that the questionnaire had arrived, to answer any questions about the questionnaire, to set up a time for MRI to call back, and to set a deadline for replies.

In an attempt to normalize questionnaire responses, MRI set up a system to complete each questionnaire over the phone. The facilities were asked to complete all applicable questions, and then during an interactive phone conversation, MRI would fill in our copy of the questionnaire. This system worked very well in two respects. First, MRI was able to ensure that the more important questions were answered in a consistent manner from facility to facility. Second, the MRI interviewers became more confident with the material, were able to draw out more complete information about the facilities, and were able to subjectively determine the level of facility cooperation.

3.4 ASSESSMENT OF QUESTIONNAIRE INFORMATION

A total of 40 facilities were contacted in the initial phone screen, and 30 facilities were mailed a questionnaire. Seven wire reclamation, seven waste oil, and four drum facilities provided more or less complete information in response to the questionnaires. During the conduct of the phone survey, several interesting discussions occurred.

Several contacts were either reluctant or unable to confirm the existence of an APCD. This was due as much to resistance to possible further regulation as to lack of knowledge of APCDs. One facility claimed to have a stack gas chiller. Upon further conversation, the chiller was discovered to be a crude scrubber. During the phone screen, some facilities were judged to no longer fit into the original category due to a change of fuel or a change in business. Several facilities had changed from recycled oil as a fuel to diesel or natural gas. The most common concern was

over environmental regulations governing recycled oil. Some facilities were discovered to use waste oil only as a makeup fuel, and one facility was not a stationary source at all, but a locomotive.

A few facility contacts were openly hostile. One individual refused to speak with any representative of the State government unless forced to by a court order. Several contacts asked the contact name and phone number of the ARB Work Assignment Manager, and some requested documentation of the validity of MRI's request. Most contacts were helpful or at least resigned to cooperating with the survey.

The descriptions noted in the following sections were compiled from an assessment made of the information obtained from the questionnaire.

3.4.1 Recycled Waste Oil Facilities

3.4.1.1 Operating Facilities

Seven facilities that burn recycled waste oil were surveyed for this study. The majority of the facilities burn 100% waste oil, while two facilities burn a mixture of waste oil and virgin fuel. Combustion zone temperatures vary over a range from 325° to in excess of 1500°F. Due to the likely presence of chlorine-containing corrosion inhibitors in the waste motor oil, a potential exists for dioxin and furan formation reactions. Particulate matter control is necessary, and air emissions are controlled by several types of devices. These air pollution control devices are cyclones, scrubbers, fabric filters, and afterburners.

3.4.1.2 Sampling Characteristics and Test Feasibility

The waste oil facilities offer a variety of air pollution control devices. Two facilities have fabric filters while the remaining facilities have scrubber control and one is equipped with an afterburner. Combustion zone temperatures range above 1600°F for three of the companies, but one facility has a combustion zone temperature of only 325°F.

3.4.2 Drum Reconditioners

3.4.2.1 Operating Characteristics

The drum reconditioning facilities recondition drums that contain residues ranging from food grade products, such as soda, juice, and fruit, to chemicals, such

as adhesives, paints, concrete curing agents, lubricants, and greases. The facilities are fueled by natural gas and operate at temperatures ranging from 1100° to 1700°F. Each facility is equipped with an afterburner which is fueled by natural gas. Two of the facilities have waste heat recovery systems, and another facility had plans to install a similar system in the near future. Again, these facilities are small and have limited staffing. Information about the operating and design specifications for each facility was difficult to obtain.

3.4.2.2 Sampling Characteristics and Test Feasibility

Fortunately, the drum reconditioning facilities lend themselves as acceptable test sites. Combustion zone temperatures are higher than those found in the wire reclamation facilities, and the combustion air is generally forced air. Each of the four facilities has an afterburner. One facility operates its afterburner at 1700°F and would be able to store enough feed for 6 hr of testing for 3 days. Another facility did not have sampling ports but would be able to have sufficient drums for 3 days of testing.

3.4.3 Wire Reclamation Facilities

3.4.3.1 Operating Characteristics

The wire reclamation facilities are generally small facilities which operate on a demand basis only. The facilities recover wire from electric motor stators and lead-covered power cable and are fueled with natural gas. Due to the small loads at these facilities, they are not equipped with waste heat recovery systems. Air emissions are controlled by afterburners which are fueled by natural gas and operate between 1500° and 2000°F. Due to the small size of these facilities and their sporadic operating schedules, they are not usually staffed with knowledgeable technical personnel.

3.4.3.2 Sampling Characteristics and Test Feasibility

The short and intermittent nature of the firing schedule at wire reclamation facilities does not lend itself to 6 hr of testing for 3 days. None of the facilities has sampling ports, scaffolding, and safety equipment, and electricians are not available. It is important to note that these facilities are potential sources of dioxins and furans, since the combustion zone temperatures are well below the temperatures required for destruction of dioxin and furan compounds. Also, with the exception of one facility, the afterburners at each facility operate at less than 1600°F. Temperatures greater than 1600°F are required to minimize dioxin and furan formation reactions.

No information was obtained concerning the amount of air supplied to the combustion zone and the afterburner.

3.5 SPECIAL STUDY—SOOT FROM RESIDENTIAL WOOD BURNING STOVES

Polycyclic aromatic hydrocarbons (PAHs) are emitted from combustion sources which include residential wood burning fire stoves. The ARB had recently commissioned a study (Atkinson, 1988) of PAHs in the ambient air around known industrial sources including an area impacted by residential wood smoke. Ambient air samples were collected during the high wood usage months of February and March in Mammoth Lakes, California. One important goal of that ambient air measurement study was to identify and quantify the volatile PAH and PAH derivatives, as well as the particle-associated species. The study found that of the PAHs determined, only retene (1-methyl-7-isopropylphenanthrene) was a useful marker compound for coniferous wood burning.

The purpose of the present study is to determine the extent of PAHs in the soot of the wood-burning stoves. Possible correlations may exist between the PAH concentration in the soot and the ambient air as measured in the Atkinson study. A simplified approach was developed to identify homes with wood burning stoves and to collect a sample of the soot. It was assumed that the stoves and chimneys have to be cleaned periodically because of the buildup of soot from the burning of coniferous wood. A list of possible chimney sweeps in the Lake Tahoe and Sacramento areas was obtained from the *Yellow Pages*. A local chimney sweep was identified from several provided and contact was made.

In the Tahoe area, the season for chimney cleanout is late July to early August which is just prior to the start of the heating season at that elevation. Generally, about four to six full cords of coniferous wood are burned by each house during the heating season which means that a sufficient amount of soot could be obtained from the chimney during cleanout. In contrast, the Sacramento area has both hard and coniferous wood burning stoves and fireplaces.

Preliminary discussions were held with local chimney cleaning companies for MRI to collect about 200 g of soot during the cleanout of the stoves. The soot samples were to be collected from the chimney flues during the mechanical cleanout with wire brushes. Data collection included the sampling date, descriptive manufacturer's information on the stove, wood burned, and burning regime. In the Sacramento area, the wood burned was predominantly hardwood, i.e., oak (50%-90%), and softwood, i.e., fir and cedar (10%-50%). In the Tahoe area, all wood burned was softwood, i.e., pine and fir (100%). The wood ash samples were submitted to the ARB for analysis.

SECTION 4

PHASE II SAMPLING AND ANALYSIS PROGRAM

At the Phase I review meeting, detailed discussions of the findings were held. In light of the current needs of ARB, it was determined that information and data needed to be obtained from all three types of facilities. The scope of the information requested was also expanded to include inlet sampling to assess removal efficiencies. However, budget constraints focused the work on conducting inlet and outlet sampling on two waste oil user facilities, outlet sampling on two drum reconditioner facilities, and collecting samples of ash from a wire reclamation facility.

Following completion of the site selection process in Phase I, site visits were conducted at the facilities represented by the three categories.

4.1 GENERAL TEST PROGRAM DESCRIPTION

A series of three test burns was to be conducted at each of the waste oil users and drum reconditioning facilities. Specifically, the tests were to determine:

- PCDD/PCDF concentrations and emissions prior to and after any air pollution control device, if appropriate.
- PAH concentrations and emissions prior to and after any APCD.
- Metals concentrations and emissions (Ag, As, Ba, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn) prior to and after any APCD.
- Continuous emissions for CO, SO₂, NO_x, O₂, and CO₂.

The test protocol for sample collection and analysis is summarized in Table 4-1. Appendix A contains the details about the sampling and analysis methods used, including any modifications to the methods. The stack emissions were measured using appropriate ARB methods supplemented by EPA methods as appropriate, e.g., Method 1-4 and CEM methods.

Table 4-1. SUMMARY OF SAMPLING AND ANALYSIS PARAMETERS AND METHODS

Sample	Sample location	Sampling frequency for each run	Sampling method	Sample size ^a	Analytical parameters	Preparation method	Analytical method
Stack gas	Stack	180 min	ARB Methods ^b 428 and 429	≥ 1 dscm	PCDDs, PCDFs, and PAHs	Solvent extraction	GC/MS ARB Methods 428 and 429
		180 min	ARB Method 436 ^c	≥ 1 dscm	Metals	Acid digestion	ICP (SW 846-6010) ^d ; GFAA (SW 846-7000 series) and CVAA (SW 846-7470- 7471) as needed
		Continuous	EPA Method 10	NA	CO	NA	NDIR
		Continuous	EPA Method 3E	NA	CO ₂	NA	NDIR
		Continuous	EPA Method 3E	NA	O ₂	NA	NDIR
		Continuous	EPA Method 7E	NA	NO _x	NA	Chemiluminescent
		Continuous	EPA Method 6C	NA	SO ₂	NA	Ultraviolet

^a Exact volume on gas sampled was dependent on isokinetic sampling rate.

^b PCDDs, PCDFs, and PAHs: according to California Air Resources Board (ARB) Methods 428 and 429, as modified (Appendix A).

^c Total Ag, As, Ba, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, and Zn: according to proposed California ARB Method 436, as modified (Appendix A).

^d SW 846: U.S. EPA Manual, Test Methods for Evaluating Solid Waste, Third Edition.

Sampling Train Summary. Each run included sampling of inlet and outlet emissions with two different sampling trains, i.e., a combined train for semivolatiles (SV) (i.e., PCDDs/PCDFs and PAHs) and a multiple metals (MM) train. The SV train that included an XAD-2 resin trap per ARB Methods 428 and 429 was used to determine emissions of PCDDs/PCDFs and PAHs. The second train (MM) that included two nitric acid/hydrogen peroxide and two acidified potassium-permanganate impingers and the ARB Method 436 were used to determine metals emissions. Data on inlet and outlet measurements of moisture content, duct/stack temperature, and velocity were obtained. The average flow rate, measured by the trains, for each location identified by run number was obtained and was used to calculate emissions of PCDDs and PCDFs, PAHs, and metals.

Dioxin and Furan Emissions. The SV train samples were analyzed using ARB Method 428 for PCDDs/PCDFs and the 2,3,7,8-substituted TCDDs/TCDFs on all samples collected from both the inlet and outlet locations. In conjunction with the gas sample volumes, the concentrations and emission rates of dioxins and furans in the stack gas were calculated. Using ARB's 2,3,7,8-TCDD/TCDF toxic equivalency factors, each 2,3,7,8-substituted TCDD/TCDF congener was converted to its 2,3,7,8-TCDD/TCDF equivalent, and the total 2,3,7,8-TCDD/TCDF equivalent concentration and emission rate were determined.

Polycyclic Aromatic Hydrocarbon Emissions. The SV train samples were also analyzed using ARB Method 429 for PAHs on all samples collected at both inlet and outlet locations. The concentrations were determined for 17 PAHs, and the emission rates were calculated.

Metals Emissions. Three portions of the multiple metals train that were analyzed included (a) filter, probe rinse residue, HNO₃; (b) condensate and nitric acid/peroxide impingers; and (c) potassium permanganate/sulfuric acid impingers (Hg only).

Continuous Emission Measurements. During the semivolatile and metals emission sampling, continuous measurements were made at the inlet and outlet locations for CO, SO₂, NO_x, O₂, and CO₂. Summary data are provided for those measurements that include the average emissions during the sampling run. Computer-generated graphs of the real-time measurements are included.

4.2 RECYCLED WASTE OIL FACILITIES

4.2.1 Site A

4.2.1.1 Process Description

Site A produces high purity filtration materials from diatomaceous earth. A surface mine located on property adjacent to the plant supplies raw material for the process. The facility uses diesel fuel to fire its dryers and kiln. The use of recycled waste oil as a fuel had been discontinued just prior to conducting sampling for this test program. However, the facility graciously offered to use recycled waste oil as a fuel during the test program.

This facility operates on a schedule of 10 days of operation followed by 4 days of maintenance. The facility operates three 8-hr shifts per day during manufacturing periods and one shift during maintenance periods. This schedule is kept throughout the year.

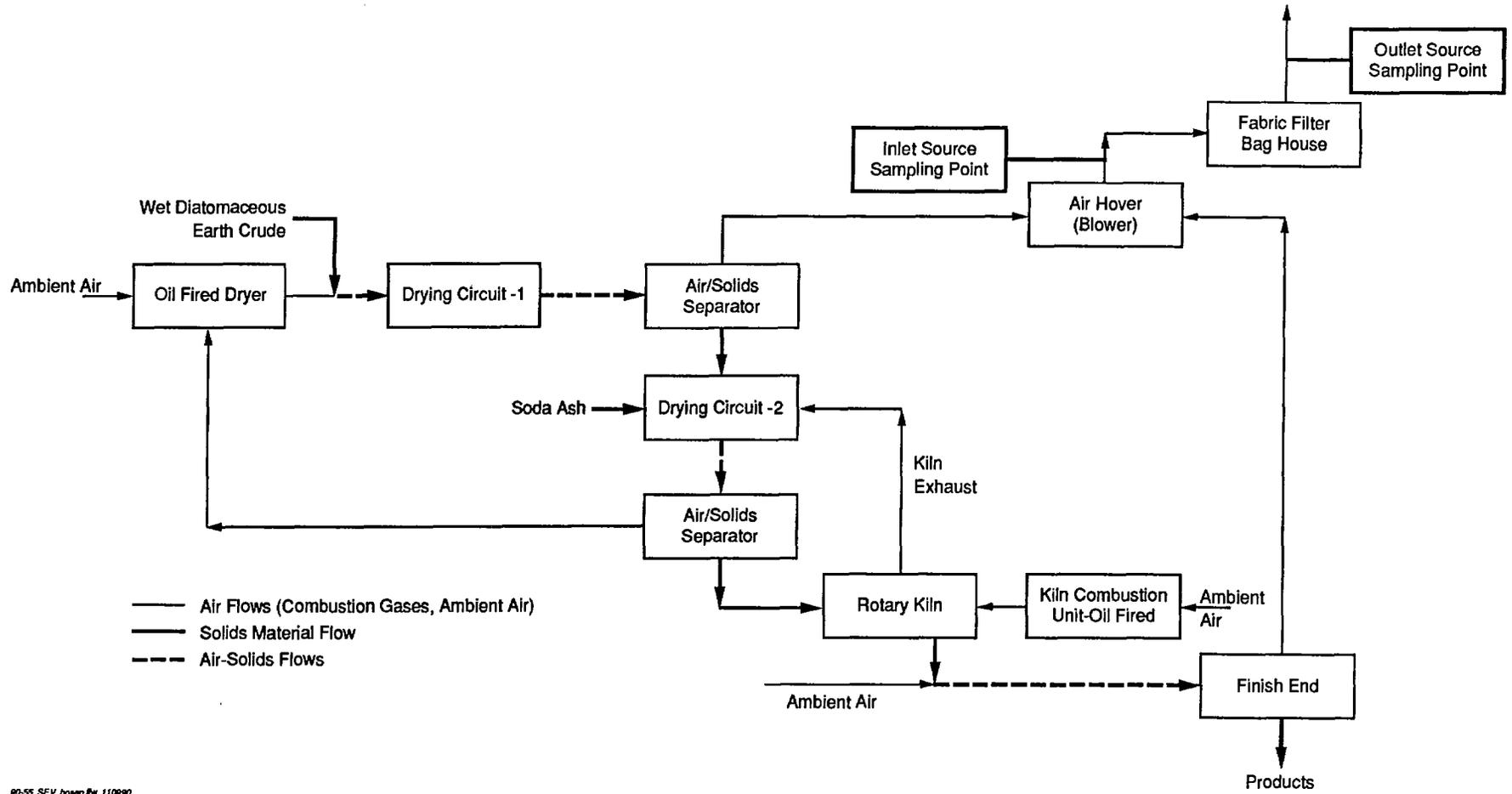
Wet diatomaceous earth is introduced to an oil-fired dryer which heats the diatomaceous earth to remove all moisture. The dried earth is air-separated, and material of designated mesh size for the specific product line is directed to the waste oil-fired rotary kiln. Processed materials from the kiln are air-separated by size and weight, and then are directed to the shipping department where they are packaged in 50-lb bags. Oversized materials are directed to the combustion gas baghouse. A schematic of Site A is included as Figure 4-1.

Combustion gases from the rotary kiln and particulate separation of the dried diatomaceous earth are directed to an eight cell fabric filter baghouse. The exhaust was sampled from an 8-ft high, 17-in x 24.5-in rectangular vertical stack located on top of the baghouse with the top of the stack 36 ft from the ground. Gases entering the baghouse are at approximately +200°F, and never greater than 250°F. Materials captured in the baghouse are recycled back through the process.

4.2.1.2 Sampling

Test program samples were collected before the entrance to the baghouse and from one of the exit stacks of the eight-cell baghouse. Operating conditions for Site A are presented in Table 4-2. Inlet samples were collected between the induced draft (i.d.) fan and the baghouse. The inlet sample location was in a curved duct section directly above and after the fan. This location was not consistent with sampling procedures specified by ARB Method 1, but there was no alternative location. The exit stack of Baghouse Cell No. 1 was the outlet sample location. This site was an acceptable sampling location based on ARB Method 1.

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Site A Process Diagram

Figure 4-1

TABLE 4-2. SITE A - PROCESS OPERATING CONDITIONS

Parameter	Units	Run 1	Run 2	Run 3
Waste oil feed rate to kiln	gal/min	2.5	2.4	2.5
Waste oil feed rate to furnace	gal/min	1.5	1.8	1.9
Kiln temperature	°F	1,581	1,492	1,625
Combustion air flowrate	ft ³ /min	5,100	4,900	5,300
Process feed rate	tons/hr	7.25	7.00	6.75
Baghouse temperature	°F	207	220	224
Baghouse pressure drop	inWC	3.1	3.4	3.8

Sampling at Site A was conducted at the beginning of a 10-day operation schedule. During Run 1 and part of Run 2, the facility was having minor start-up problems. The main problem was the temperature of the rotary kiln. The kiln temperature fluctuated enough that product from the kiln was of a size less uniform than usual. This caused some clogging of the air separation systems. When clogging occurred, an access door to the product exit tubes was opened and excess material was removed. This was an infrequent occurrence, and only once was the upset enough to cause a disruption in sampling. All other problems were considered minor enough that sampling was continued on the premise that these were normal occurrences which produced normal emissions.

Sampling at the inlet to and outlet from the baghouse was performed by a combination of ARB Methods 428 and 429. This combination of methods was approved by CARB before this test program began. Basically, the difference is in the recovery of the sample from the trains and how the sample was split for analysis. Analytical deviations are presented in Appendix A. Sampling Methods 428 and 429 were combined into one train. The trains were washed using acetone, then methylene chloride, and then toluene to recover samples. This was the only sample recovery method deviation. Metal samples were collected using ARB Method 436.

The inlet sampling train experienced a severe sample loading problem on the filter which resulted in a sampling method deviation. Particulate matter loading in the gas stream to the baghouse was so concentrated that the particulate filter became clogged to the point that an excessive vacuum built up in the sampling system. The vacuum was so great that isokinetic sampling could not be maintained, and sampling was halted. All three tests conducted at Site A experienced this problem. Sample times ranged from 36 to 60 min for the three tests. Samples that were collected are representative of conditions in the duct for those time periods. The volume of material collected was so great that no analytical minimum volume limit was exceeded. This problem is typical of inlet sampling, i.e., prior to air pollution control devices. No other sampling deviations occurred.

4.2.1.3 Analysis Results—Site A

Data on inlet and outlet measurements of moisture content, duct/stack temperature, and velocity are provided in Table 4-3. The average flow rates, measured by the trains, identified by run number and location are also given. These rates were used to calculate PCDDs and PCDFs, PAHs, and metals emissions. It should be emphasized that the stack sampled was the No. 1 cell of an eight-cell baghouse.

TABLE 4-3. SITE A - INLET AND OUTLET SUMMARY DATA

	Sampling time (min)	Gas volume sampled (dscm)	Moisture content (% vol)	Average stack temp (C)	Stack velocity (m/sec)	Stack flow rate (dscm/min)
<u>Run 1</u>						
MM-Inlet	60	1.118	11.8	97	25.2	1,268
SV-Inlet	42	0.656	17.5	100	24.4	1,138
MM-Outlet	180	2.705	13.3	89	19.0	200
SV-Outlet	180	3.623	13.7	89	17.9	188
<u>Run 2</u>						
MM-Inlet	36	0.649	15.0	105	26.1	1,230
SV-Inlet	36	0.609	17.9	105	26.3	1,197
MM-Outlet	180	2.444	16.5	91	17.8	178
SV-Outlet	180	4.169	11.1	91	18.8	201
<u>Run 3</u>						
MM-Inlet	36	0.649	15.2	104	25.8	1,223
SV-Inlet	36	0.599	15.9	104	26.1	1,223
MM-Outlet	180	2.421	13.9	94	18.8	193
SV-Outlet	180	3.763	13.7	94	16.2	167

MM = Multiple metals sampling train, ie. method 436 train.

SV = Semivolatile sampling train, ie. combined method 428 and 429 train.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse.
The emissions calculated are only from this one stack.

Dioxin and Furan Emissions. Table 4-4 presents the dioxin and furan results by homologs, while Table 4-5 presents the 2,3,7,8-substituted data. In conjunction with the gas sample volumes, the concentrations and emission rates of dioxins and furans in the stack gas were calculated and are provided in these tables.

In Table 4-6, using ARB's 2,3,7,8-TCDD/TCDF toxic equivalency factors, each 2,3,7,8-substituted TCDD/TCDF congener was converted to its 2,3,7,8-TCDD/TCDF equivalent, and the total 2,3,7,8-TCDD/TCDF equivalent concentration and emission rate were determined.

Polycyclic Aromatic Hydrocarbon Emissions. Table 4-7 presents the concentrations found for 17 PAHs and their calculated emission rates.

Metals Emissions. Table 4-8 presents the concentrations and emission rates for the 12 metals of interest.

Continuous Emission Measurements. During the semivolatile and metals emission sampling, continuous measurements were conducted at the inlet and outlet locations for CO, SO₂, NO_x, O₂, and CO₂. Summary data for those measurements are presented in Table 4-9. Computer-generated graphs of the real-time measurements are included in Appendix B.

Additional Information. Although it was not a requirement of the survey, analysis results of the waste oil were obtained from the facility in order to provide some perspective on the waste fuel composition. Analysis summary is provided in Appendix C.

4.2.2 Site B

4.2.2.1 Process Description

Site B produces magnesium oxide which is used in the manufacturing of refractory firebrick and related materials. Ore is excavated from nearby mines and processed in high-temperature reducing kilns to form magnesium oxide. Recycled waste oil is used to fire the rotary kilns.

Raw magnesium ore is combined with water and mixed in a pug mill prior to introduction to the oil-fired kiln. The material is in a wet paste form when it enters the kiln. Processed material falls out the exit end of the kiln into cooling trays and then onto a belt which conveys it to a storage bin. A schematic of Site B is included as Figure 4-2.

TABLE 4-4. SITE A - DIOXIN/FURAN RESULTS FOR MM5-SV SAMPLES

Analyte	Blank Inlet	Blank Outlet	Run 1		Run 2		Run 3	
			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sample volume (dscm)			0.656	3.623	0.609	4.169	0.599	3.763
Stack flow rate (dscm/m)			1,138	188	1,197	201	1,223	167
Concentration CO2 (%)			1.8	2.2	3.2	2.3	3.4	2.3
<u>Dioxins (pg)</u>								
TCDD		564	302	409	320	355	354	283
PeCDD		270	241	330	243	103	194	54.1
HxCDD		281	338	769	312	271	336	116
HpCDD		181	249	495	272	235	181	135
OCDD		715	324	483	391	283	295	238
Total (pg)		2,011	1,454	2,486	1,538	1,247	1,360	826
Total (ng/dscm)	3.24 ^b	0.522 ^b	2.22	0.686	2.53	0.299	2.27	0.220
Total (ng/dscm @ 12% CO2)	13.9	2.76	14.8	3.74	9.47	1.56	8.01	1.15
Total (lb/hr)	5.08E-07	1.28E-08	3.34E-07	1.71E-08	4.00E-07	7.95E-09	3.67E-07	4.85E-09
<u>Furans (pg)</u>								
TCDF		2,110	6,540	3,460	3,900	1,560	1,880	1,260
PeCDF		1,800	559	1,040	888	653	492	421
HxCDF		431	411	966	314	335	144	187
HpCDF		69.8	192	612	204	184	127	95.4
OCDF		58.4	61.1	130	50.3	2.93 ^a	2.9 ^a	37.2
Total (pg)		4,469	7,763	6,208	5,356	2,735	2,646	2,001
Total (ng/dscm)	7.19 ^b	1.16 ^b	11.8	1.71	8.80	0.656	4.42	0.532
Total (ng/dscm @ 12% CO2)	30.8	6.14	78.9	9.35	33.0	3.42	15.6	2.77
Total (lb/hr)	1.13E-06	2.84E-08	1.78E-06	4.26E-08	1.39E-06	1.74E-08	7.15E-07	1.17E-08
<u>Total Dioxins and Furans</u>								
Conc. (ng/dscm @ 12% CO2)	44.7	8.91	93.7	13.1	42.5	4.98	23.6	3.92
Emission rate (lb/hr)	1.64E-06	4.12E-08	2.12E-06	5.97E-08	1.79E-06	2.54E-08	1.08E-06	1.66E-08
<u>Surrogate recovery (%)</u>								
13C-2,3,7,8-TCDF		106	97	101	121	100	109	125
13C-2,3,7,8-TCDD		103	97	96	111	97	92	124
13C-1,2,3,7,8-PeCDF		100	113	110	117	94	93	124
13C-1,2,3,7,8-PeCDD		97	102	100	119	95	97	129
13C-1,2,3,4,7,8-HxCDF		128	139	149	142	120	129	152
13C-1,2,3,6,7,8-HxCDD		114	105	98	114	108	101	127
13C-1,2,3,4,6,7,8-HpCDF		114	141	128	145	124	122	152
13C-1,2,3,4,6,7,8-HpCDD		98	118	125	120	121	127	162
13C-12-OCDD		98	101	117	118	111	118	144
37Cl-2,3,7,8-TCDD ^c		95	94	98	94	93	94	92
13C-2,3,4,7,8-PeCDF ^c		94	90	93	95	95	97	99
13C-1,2,3,6,7,8-HxCDF ^c		77	71	71	75	81	72	75
13C-1,2,3,4,7,8-HxCDD ^c		93	91	108	101	96	103	101
13C-1,2,3,4,7,8,9-HpCDF ^c		85	94	93	86	88	91	99

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

b. Blank train "emissions" calculated using average flow rates from each location.

c. Field surrogates spiked into XAD prior to sample collection.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-5. SITE A - 2,3,7,8-SUBSTITUTED DIOXIN/FURAN FOR MM5-SV SAMPLES

Analyte	Blank		Run 1		Run 2		Run 3	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sample volume (dscm)			0.656	3.623	0.609	4.169	0.599	3.763
Stack flow rate (dscm/m)			1,138	188	1,197	201	1,223	167
Concentration CO2 (%)			1.8	2.2	3.2	2.3	3.4	2.3
<u>Dioxins (pg)</u>								
2,3,7,8-TCDD		33.4 a	26.6	34.2	21.5	27.0 a	9.2 a	10.9 a
1,2,3,7,8-PeCDD		36.6	26.2 a	51.6 a	22.4 a	12.3 a	13.9	8.45 a
1,2,3,4,7,8-HxCDD		21 a	28.6 a	53	29.6 a	24.0 a	20.4	10.8 a
1,2,3,6,7,8-HxCDD		26.8	34.6	66	31 a	32.5	12.8 a	15
1,2,3,7,8,9-HxCDD		18.5	34.0 a	77	43.0 a	28.0 a	12.0 a	10.7 a
1,2,3,4,6,7,8-HpCDD		99.1	127	257	143	103	98.8	71.9
1,2,3,4,6,7,8,9-OCDD		715	324	483	391	283	295	238
Total (pg)		923	557	996	618	464	462	366
Total (ng/dscm)	1.49	0.239 b	0.849	0.275	1.01	0.111	0.771	0.0973
Total (ng/dscm @ 12% CO2)	6.37	1.27	5.66	1.50	3.81	0.581	2.72	0.507
Total (lb/hr)	2.33E-07	5.86E-09	1.28E-07	6.84E-09	1.61E-07	2.96E-09	1.25E-07	2.15E-09
<u>Furans (pg)</u>								
2,3,7,8-TCDF		339	171	552	187	216	151	129
1,2,3,7,8-PeCDF		165	81.8	197	85.9	100 a	59	46.2
2,3,4,7,8-PeCDF		110	65.8	213	77	79.1	52.2	43.1
1,2,3,4,7,8-HxCDF		111	122	332	108	108	69.1	55.9
1,2,3,6,7,8-HxCDF		58.4	59.1	146 a	51.7	56.3	16.5 a	25.4
2,3,4,6,7,8-HxCDF		24.2	6.6	115	37.8 a	42.2	11.2 a	20.7
1,2,3,7,8,9-HxCDF		3.42 a	5.39	31.4	2.34 a	5.02 a	1.52 a	1.63 a
1,2,3,4,6,7,8-HpCDF		68.1	131	399	139	125	92.6	69.1
1,2,3,4,7,8,9-HpCDF		7.44 a	17.2	51.8	15.2	18.9 a	13.1	5.70 a
1,2,3,4,6,7,8,9-OCDF		58.4	61.1	130 a	50.3	65.4 a	15.9 a	37.2
Total (pg)		940	721	2,029	734	721	482	434
Total (ng/dscm)	1.51	0.243	1.10	0.560	1.21	0.173	0.805	0.115
Total (ng/dscm @ 12% CO2)	6.48	1.29	7.33	3.06	4.52	0.903	2.840	0.602
Total (lb/hr)	2.37E-07	5.96E-09	1.65E-07	1.39E-08	1.91E-07	4.60E-09	1.30E-07	2.55E-09
<u>Total 2,3,7,8-substituted dioxin/furan</u>								
Conc. (ng/dscm @ 12% CO2)	12.8	2.6	13.0	4.55	8.33	1.48	5.56	1.11
Emission rate (lb/hr)	4.70E-07	1.18E-08	2.93E-07	2.08E-08	3.52E-07	7.56E-09	2.55E-07	4.70E-09

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

b. Blank train "emissions" calculated using average flow rates from each location.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-6. SITE A - 2,3,7,8-TCDD EQUIVALENTS RESULTS

Pollutant	ARB equiv. factor	Run 1						Run 2						Run 3								
		Inlet			Outlet			Inlet			Outlet			Inlet			Outlet					
		Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =			
Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)		
CO2																						
TCDD	1	28.6	0.0405	0.0405	34.2	0.0094	0.0094	21.5	0.0353	0.0353	27.0	0.0065	0.0065	9.2	0.0154	0.0154	10.9	0.0029	0.0029	0.0029	0.0029	
1,2,3,7,8-PeCDF	1	28.2	0.0399	0.0399	51.8	0.0142	0.0142	22.4	0.0368	0.0368	12.3	0.0030	0.0030	13.9	0.0232	0.0232	8.45	0.0022	0.0022	0.0022	0.0022	
1,2,3,7,8-PeCDD	0.03	28.6	0.0436	0.0013	53	0.0146	0.0004	29.6	0.0486	0.0015	24.0	0.0058	0.0002	20.4	0.0341	0.0010	10.8	0.0029	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	34.0	0.0518	0.0016	66	0.0182	0.0005	31	0.0509	0.0015	32.5	0.0078	0.0002	12.8	0.0214	0.0006	15	0.0040	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDD	0.03	34.0	0.0518	0.0016	77	0.0213	0.0006	43.0	0.0706	0.0021	28.0	0.0067	0.0002	12.0	0.0200	0.0006	10.7	0.0028	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	127	0.1936	0.0058	257	0.0709	0.0021	143	0.2348	0.0070	103	0.0247	0.0007	98.8	0.1849	0.0049	71.9	0.0191	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDD	0.03	324	0.4939	0.0148	483	0.1333	0.0040	391	0.6420	0.0193	283	0.0679	0.0020	295	0.4925	0.0148	238	0.0632	0.0011	0.0011	0.0011	
2,3,7,8-TCDF	1	171	0.2607	0.2607	552	0.1524	0.1524	187	0.3071	0.3071	218	0.0518	0.0518	151	0.2521	0.2521	129	0.0343	0.0343	0.0343	0.0343	
2,3,7,8-TCDF	1	81.8	0.1247	0.1247	197	0.0544	0.0544	85.9	0.1411	0.1411	100	0.0240	0.0240	59	0.0985	0.0985	46.2	0.0123	0.0123	0.0123	0.0123	
2,3,7,8-TCDF	1	65.8	0.1003	0.1003	213	0.0588	0.0588	77	0.1264	0.1264	79.1	0.0190	0.0190	52.2	0.0871	0.0871	43.1	0.0115	0.0115	0.0115	0.0115	
1,2,3,7,8-PeCDF	0.03	122	0.1880	0.0058	332	0.0918	0.0027	108	0.1773	0.0053	108	0.0259	0.0008	69.1	0.1154	0.0035	55.9	0.0149	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	59.1	0.0901	0.0027	146	0.0403	0.0012	51.7	0.0849	0.0025	56.3	0.0135	0.0004	33.0	0.0551	0.0017	25.4	0.0067	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	6.6	0.0101	0.0003	115	0.0317	0.0010	37.8	0.0621	0.0019	42.2	0.0101	0.0003	22.4	0.0374	0.0011	20.7	0.0055	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	5.39	0.0082	0.0002	31.4	0.0087	0.0003	2.34	0.0038	0.0001	5.02	0.0012	0.00004	1.52	0.0025	0.0001	1.63	0.0004	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	131	0.1997	0.0060	399	0.1101	0.0033	139	0.2282	0.0068	125	0.0300	0.0009	92.6	0.1546	0.0046	69.1	0.0184	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	17.2	0.0262	0.0008	51.8	0.0143	0.0004	15.2	0.0250	0.0008	18.9	0.0045	0.0001	13.1	0.0219	0.0007	5.70	0.0015	0.0000	0.0000	0.0000	
1,2,3,7,8-PeCDF	0.03	61.1	0.0931	0.0028	130	0.0359	0.0011	50.3	0.0826	0.0025	65.4	0.0157	0.0005	15.9	0.0265	0.0008	37.2	0.0099	0.0000	0.0000	0.0000	
2,3,7,8-TCDD																						
2,3,7,8-TCDD concentration (ng/dscm) =				0.5883			0.2985			0.6760			0.0933			0.5093					0.087	
2,3,7,8-TCDD equivalent concentration @ 12% CO2 (ng/dscm) =				3.92			1.63			2.54			0.487			1.80					0.35	
2,3,7,8-TCDD equivalent (lb/yr) =				8.86E-08			7.12E-09			1.07E-07			2.48E-09			8.24E-08					1.50E-08	

† samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

the detection limit value. "Totals" calculated using half the detection limit.

TABLE 4-7. SITE A - PAHs EMISSIONS RESULTS FOR MM5-SV SAMPLES

	Run 1		Run 2		Run 3		Blank Inlet	Blank Outlet
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet		
Sample volume (dscm)	0.656	3.623	0.609	4.169	0.599	3.763		
Stack flow rate (dscm/m)	1138	188	1197	201	1223	167		
Concentration CO2 (%)	1.8	2.2	3.2	2.3	3.4	2.3		
PAHs (ug)								
Naphthalene	173	457	149	446	241	555		20.5
Acenaphthylene	14.3	61	18.9	53.5	15.7	70.7		0.1 a
Acenaphthene	5.61	28.9	8.62	27.9	9.03	35.4		0.102
Fluorene	17.5	66.1	22.4	62.3	23.5	77.2		0.278
Phenanthrene	22.2	59.7	27.7	50.4	31.2	66.3		0.342
Anthracene	25.6	70.9	2.03	4.16	4.38	7.94		0.381
Fluoranthene	3.49	3.65	4.48	2.65	7.05	7.52		0.173
Pyrene	3.49	2.97	4.11	2.53	6.32	6.67		0.179
Retene	0.1 a	0.389	0.538	0.272	0.664	0.63		0.1 a
Benz(a)anthracene	1.7	0.218	1.96	0.216	2.74	0.23		0.175
Chrysene	1.65	0.306	1.89	0.268	2.69	0.161		0.172
Benzo(b)fluoranthene	0.352	0.164	0.544	0.1 a	0.84	0.1 a		0.1 a
Benzo(k)fluoranthene	0.352	0.164	0.508	0.1 a	0.679	0.1 a		0.1 a
Benzo(a)pyrene	0.45	0.381	0.497	0.245	0.769	0.256		0.229
Indeno(1,2,3-cd)pyrene	0.1 a	0.1 a	0.187	0.1 a	0.305	0.1 a		0.1 a
Dibenz(a,h)anthracene	0.1 a	0.1 a	0.1 a	0.1 a	0.1	0.1 a		0.1 a
Benzo(ghi)perylene	0.473	0.1 a	1.18	0.1 a	1.01	0.1 a		0.1 a
Total PAHs (ug)	270	752	245	651	348	829	23.2	23.2
Total PAHs (ug/dscm)	412	208	402	156	581	220	37.4	6.03
Total PAHs (ug/dscm @ 12%)	2,749	1,132	1,506	815	2,050	1,149	160	31.9
Total PAHs (lb/hr)	0.0621	0.00516	0.0636	0.00415	0.0940	0.00486	0.00587	0.000148
FIELD SURROGATES RECOVERY								
D10-1-Methylnapthalene	55%	70%	73%	60%	38%	66%		56%
D12-Perylene	72%	80%	91%	91%	86%	86%		96%
LAB SURROGATES RECOVERY								
D8-Naphthalene	34%	42%	51%	27%	8%	37%		29%
D10-Acenaphthene	69%	70%	77%	69%	66%	71%		72%
D10-Fluorene	77%	75%	82%	76%	77%	78%		80%
D10-Phenanthrene	84%	88%	89%	92%	88%	95%		85%
D10-Anthracene	79%	81%	83%	85%	79%	82%		83%
D10-Fluoranthene	87%	86%	88%	94%	86%	95%		86%
D10-Pyrene	86%	92%	87%	93%	85%	95%		89%
D12-Benz(a)anthracene	72%	91%	90%	97%	88%	98%		90%
D12-Chrysene	76%	94%	90%	98%	90%	100%		92%
D12-Benzo(a)pyrene	69%	88%	94%	96%	88%	96%		98%

Note: Outlet samples were collected from the stack of number 1-cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

(a): Values shown are the detection limits which were calculated as 2.5 times the baseline noise level.

TABLE 4-B. SITE A - ANALYSIS RESULTS FOR MM5-MM (METALS) TRAIN

	Ag	As	Ba	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Se	Zn
Run 1												
Inlet												
Rinse and filter, ug	243	<181	1153	<15.7	554	<38.2	<1.29	246	94.7	1,349	795	1,655
Nitric acid impingers, ug	<1.63	<8.29	3.94	1.48	12.1	<1.54	<1.08	24.9	4.48	6.12	3.00	33.1
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	2.38	NA	NA	NA	NA	NA
Total, ug	243	<189	1,157	<17.2	566	<39.7	<4.75	271	99.1	1,355	798	1,688
Concentration, ug/dscm	217	<169	1,035	<15.4	507	<35.5	<4.25	242	88.7	1,212	714	1,510
Emissions, lb/hr	0.0365	<0.0284	0.174	<0.00258	0.0850	<0.00596	<0.000713	0.0406	0.0149	0.203	0.120	0.253
Outlet												
Rinse and filter, ug	<1.24	37.8	2.50	52.9	16.7	15.1	0.120	16.0	95.0	56.5	65.1	<6.29
Nitric acid impingers, ug	<1.63	<8.29	2.14	4.60	29.6	<1.54	<1.21	12488	5.24	9.69	27.1	41.8
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	1.71	NA	NA	NA	NA	NA
Total, ug	0	37.8	4.64	57.5	46.3	15.1	<3.04	12,504	100.2	66.2	92.2	<48.1
Concentration, ug/dscm	0	14.0	1.72	21.3	17.1	5.59	<1.12	4,622	37.0	24.5	34.1	<17.8
Emissions, lb/hr	0	0.000370	0.0000454	0.000562	0.000000	0.000148	<0.0000297	0.122	0.000980	0.000647	0.000902	<0.000471
Run 2												
Inlet												
Rinse and filter, ug	122	<163	1151	21.6	527	<34.2	<1.21	257	137	1329	825	1686
Nitric acid impingers, ug	<1.63	<8.29	2.16	6.98	3.76	3.02	<0.918	25.5	2.84	6.73	<2.24	46.5
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	<0.612	NA	NA	NA	NA	NA
Total, ug	122	<171	1,153	28.5	531	<37.2	<2.74	283	140	1,336	825	1,733
Concentration, ug/dscm	188	<263	1,776	44.0	818	<57.4	<1.01	436	216	2,059	1,272	2,670
Emissions, lb/hr	0.0306	<0.0429	0.289	0.00716	0.133	<0.00933	<0.0000267	0.0709	0.0351	0.335	0.207	0.434
Outlet												
Rinse and filter, ug	33.3	95.6	2.04	43.5	<1.32	32.6	0.168	13.1	58.1	42.3	55.3	<62.9
Nitric acid impingers, ug	<1.63	<8.29	1.50	3.68	3.22	6.31	<1.53	316	11.7	15.3	5.94	111
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	0.531	NA	NA	NA	NA	NA
Total, ug	33.3	95.6	3.54	47.20	<4.54	38.9	<2.23	329	69.8	57.6	61.2	<174
Concentration, ug/dscm	13.6	39.1	1.45	19.31	<1.86	15.9	<0.912	135	28.5	23.6	25.1	<71.2
Emissions, lb/hr	0.000321	0.000921	0.0000341	0.000455	<0.0000437	0.000375	<0.0000215	0.00317	0.000672	0.000555	0.000590	<0.00168
Run 3												
Inlet												
Rinse and filter, ug	145	<157	1162	29.0	563	<33.1	2.91	265	138	1467	814	2788
Nitric acid impingers, ug	<1.63	<8.29	1.05	1.18	2.70	<1.54	<0.966	13.8	7.25	3.47	<2.24	10.1
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	<0.482	NA	NA	NA	NA	NA
Total, ug	145	<165	1,163	30.2	565	<34.6	<4.36	279	145	1,470	814	2,799
Concentration, ug/dscm	224	<254	1,793	46.5	871	<53.3	<6.71	429	224	2,265	1,255	4,312
Emissions, lb/hr	0.0362	<0.0411	0.290	0.00752	0.141	<0.00862	<0.00109	0.0694	0.0363	0.366	0.203	0.698
Outlet												
Rinse and filter, ug	<1.23	33.3	2.68	12.5	<1.32	9.13	0.0862	4.55	91.4	55.2	45.4	<6.29
Nitric acid impingers, ug	2.49	<8.29	1.83	3.89	71.0	<1.54	<1.99	53333	3.47	21.7	65.1	24.1
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	<0.202	NA	NA	NA	NA	NA
Total, ug	<3.72	<41.6	4.51	16.4	71.0	<10.7	<2.28	53,337	94.9	76.9	111	<30.4
Concentration, ug/dscm	<1.54	<17.2	1.86	6.78	29.3	<4.42	<0.941	22,031	39.2	31.8	45.6	<12.6
Emissions, lb/hr	<0.0000392	<0.000436	0.0000475	0.000173	0.000748	<0.000113	<0.0000240	0.562	0.00100	0.000811	0.00117	<0.000322
Blank train												
Rinse and filter, ug	<1.24	29.0	1.29	7.43	<1.32	1.96	0.0838	0.842	86.3	55.0	21.6	<6.29
Impingers 1-6, ug	<1.63	<8.29	0.371	0.332	1.02	<1.54	<0.259	12.1	<0.542	2.14	<2.24	11.0
Total, ug	<2.67	<37.3	1.66	7.76	<2.34	<3.50	<0.343	12.9	86.3	57.1	<23.8	<17.3

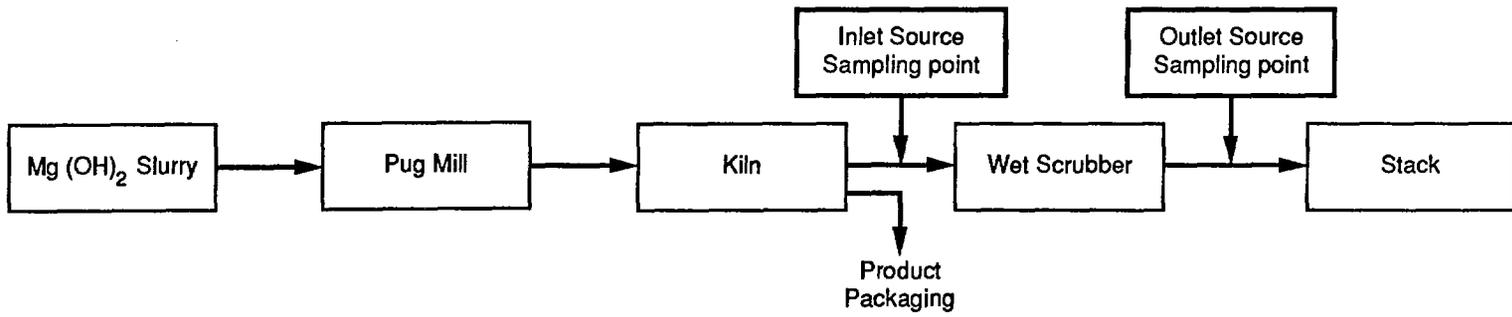
4-14

NA = Not applicable.

Note: The outlet samples were collected from the stack of cell-1 of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-9. SITE A -- CONTINUOUS EMISSION MEASUREMENTS

Run	Inlet		O ₂	CO ₂	CO	SO ₂	NO _x	12% CO ₂			
								CO	SO ₂	NO _x	
Run 1	Inlet	Avg	19.0	1.8	196.1	3.3	30.5	1421.6	21.3	197.4	
		Max	20.4	2.6	216.7	3.9	35.0	2798.6	29.1	271.5	
		Min	.0	.8	169.0	2.7	27.0	956.4	17.0	147.6	
	Outlet	Avg	17.9	2.2	173.9	32.1	19.3	959.1	171.0	106.2	
		Max	19.6	2.8	200.5	136.8	22.0	1244.1	608.0	119.4	
		Min	16.3	1.7	150.1	14.8	15.6	724.7	87.5	75.6	
	Run 2	Inlet	Avg	17.3	3.2	247.3	5.1	27.0	947.1	20.1	103.2
			Max	18.2	3.8	282.0	9.4	32.0	1656.3	59.0	169.5
			Min	16.5	1.8	216.7	.4	24.0	724.4	1.4	83.9
Outlet		Avg	20.8	2.3	198.2	62.3	21.1	1025.8	311.8	109.3	
		Max	21.4	3.0	234.4	166.5	25.3	1256.5	688.2	130.9	
		Min	19.5	1.9	167.5	21.2	19.1	788.2	120.0	88.4	
Run 3		Inlet	Avg	17.1	3.4	269.0	9.1	25.0	965.5	32.7	90.0
			Max	17.6	4.5	332.4	22.9	27.0	1590.1	78.0	113.2
			Min	16.0	2.1	223.6	3.8	11.0	728.9	11.9	57.8
	Outlet	Avg	20.1	2.3	226.7	55.7	22.0	1185.6	271.5	115.3	
		Max	22.6	3.1	279.9	252.7	24.1	1503.2	981.4	132.4	
		Min	17.4	1.9	184.1	20.4	15.3	851.8	118.8	76.5	



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Site B Process Diagram

Figure 4-2

Combustion air enters the lower end of the kiln where waste oil is fired. The gas passes countercurrent through the kiln heating the magnesium ore to approximately 2300°F in a reducing atmosphere. The combustion gas exits the high end of the kiln into an expanded vertical section of ductwork that was part of a previous air pollution control device (APCD). This section is insulated and equipped with sampling ports and was the inlet sampling location. The combustion gas is ducted to a countercurrent wet scrubber. Seawater is sprayed in to reduce the temperature. Fresh well water is piped into the scrubber to flow over multiple perforated plates to absorb acid gases. A demister pad after the scrubber removes excess water. The gas stream is directed up through an i.d. fan and into a combined 140-ft, 30-in diameter emission stack which serves all the kilns. The outlet sampling location from Kiln A was located prior to the junction with the combined stack.

Site B operates on a continuous basis approximately 50 weeks/year. Three shifts per day operate several similar rotary kilns. Operating conditions for Site B are presented in Table 4-10.

4.2.2.2 Sampling

The facility operated in a normal fashion during the test program except for the normal water spray on the exhaust i.d. fan. A fresh water spray is normally directed onto the fan to prevent carbonate build-up from the seawater. This spray was turned off to reduce entrained water in the emission gas. Run 6 exhibited some high carbon monoxide concentrations and lower combustion gas temperatures indicative of upset conditions. Sampling was suspended until conditions returned to normal. All other tests were conducted under stable operating conditions.

Sampling was conducted in a manner identical to that at Site A for organics and metals. Runs 4 and 5 had curtailed inlet metal sampling times due to shattering of the quartz nozzles from thermal shock. The nozzles shattered when removed from the approximately 900°F stack. Since no other nozzles of exactly the same size were available to replace them as per ARB Method 5, sampling was suspended. Runs 4 and 5 were for one-half the prescribed 3-hr test period in ARB Method 436, i.e., one traverse of the stack. The quantity of material collected after one traverse was sufficient to meet analytical requirements. After Run 5, MRI had expended its supply of quartz nozzles for the water-cooled inlet probe so a stainless steel nozzle was used instead.

During Run 5, moisture broke through the MRI gas conditioning system and entered the sulfur dioxide (SO₂) monitor for the inlet location. This prevented obtaining data from the inlet SO₂ Continuous Emission Monitor (CEM), and no SO₂ data are available for the first half of the test for the inlet location. At the half-way point of the test, when the stack sampling trains were switching ports, the monitor

TABLE 4-10. SITE B - PROCESS OPERATING CONDITIONS

Parameter	Units	Run 4	Run 5	Run 6
Waste oil feed rate	gal/hr	254	262	524
Atomizer pressure #1	psi	330	340	333
Atomizer pressure #2	psi	330	340	333
Kiln temperature	°F	3,381	3,384	3,370
Mg(OH) ₂ input	lb/hr	15.0	15.0	15.0
MgO	ton/hr	7.5	7.4	6.8
Venturi inlet temperature	°F	930	935	944
Venturi outlet temperature	°F	151	151	150
Venturi pressure drop	inWC	28.3	30.0	30.0

was not yet repaired. Rather than have no inlet data for the entire test, the SO₂ monitor for the outlet was switched over to analyze the inlet gas sample for the second half of the test period. No other sampling deviations occurred at Site B.

4.2.2.3 Analysis Results—Site B

Data on inlet and outlet measurements of moisture content, duct/stack temperature, and velocity are provided in Table 4-11. The average flow rates, measured by the trains, identified by run number and location, are also given, and were used to calculate PCDDs and PCDFs, PAHs, and metals emissions.

Dioxin and Furan Emissions. Table 4-12 presents the dioxin and furan results by homologs, while Table 4-13 presents the 2,3,7,8-substituted data. In conjunction with the gas sample volumes, the concentrations and emission rates of dioxins and furans in the stack gas were calculated and provided in these tables.

In Table 4-14, using ARB's 2,3,7,8-TCDD/TCDF toxic equivalency factors, each 2,3,7,8-substituted TCDD/TCDF congener was converted to its 2,3,7,8-TCDD/TCDF equivalent, and the total 2,3,7,8-TCDD/TCDF equivalent concentration and emission rate were determined.

Polycyclic Aromatic Hydrocarbon Emissions. Table 4-15 presents the concentrations found for 17 PAHs and their calculated emission rates.

Metals Emissions. Table 4-16 presents the concentrations and emissions for the 12 metals of interest.

Continuous Emission Measurements. During the semivolatile and metals emission sampling, continuous measurements were conducted at the inlet and outlet locations for CO, SO₂, NO_x, O₂, and CO₂. Summary data for those measurements are presented in Table 4-17. Computer generated graphs of the real time measurements are included in Appendix B.

Additional Information. Although it was not a requirement of the survey, analysis results of the waste oil were obtained from the facility in order to provide some perspective on the waste fuel composition. Analysis summary is provided in Appendix C.

TABLE 4-11. SITE B - INLET AND OUTLET SUMMARY DATA

	Sampling time (min)	Gas volume sampled (dscm)	Moisture content (% vol)	Average stack temp (C)	Stack velocity (m/sec)	Stack flow rate (dscm/min)
<u>Run 4</u>						
MM-Inlet	96	0.933	34.1	480	19.8	342
SV-Inlet	192	2.057	34.8	480	19.9	340
MM-Outlet	192	3.830	9.2	46	19.4	446
SV-Outlet	192	2.142	9.2	45	19.3	446
<u>Run 5</u>						
MM-Inlet	93	2.221	32.0	501	20.2	352
SV-Inlet	192	2.834	32.7	506	20.6	353
MM-Outlet	192	3.961	8.7	45	20.0	466
SV-Outlet	192	2.119	8.9	44	19.0	443
<u>Run 6</u>						
MM-Inlet	180	4.207	28.5	502	21.0	385
SV-Inlet	192	2.903	32.8	510	20.6	351
MM-Outlet	192	3.866	8.4	45	19.5	455
SV-Outlet	192	2.153	8.7	44	19.3	450

MM = Multiple metals sampling train, ie. method 436 train.

SV = Semivolittle sampling train, ie. combined method 428 and 429 train.

TABLE 4-12. SITE B - DIOXIN/FURAN RESULTS FOR MM5-SV SAMPLES

Analyte	Blank Inlet	Blank Outlet	Run 4		Run 5		Run 6	
			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sample volume (dscm)			2.057	2.142	2.834	2.119	2.903	2.153
Stack flow rate (dscm/m)			340	446	353	443	351	450
Concentration CO2 (%)			12.4	10.4	5.6	10.4	7.8	10.3
Dioxins (pg)								
TCDD		215	2,170	662	3,780	759	2,060	597
PeCDD		3.4 ^a	2,540	336	6,800	328	2,790	230
HxCDD		122	5,790	296	18,100	449	9,740	240
HpCDD		31.6	6,000	163	18,900	410	10,600	108
OCDD		162	5,730	288	12,200	1,070	6,360	311
Total (pg)		534	22,230	1,745	59,780	3,016	31,550	1,486
Total (ng/dscm)	0.206 ^b	0.250 ^b	10.8	0.815	21.1	1.423	10.9	0.690
Total (ng/dscm @ 12% CO2)	0.287	0.289	10.5	0.940	45.2	1.642	16.7	0.804
Total (lb/hr)	9.46E-09	1.47E-08	4.86E-07	4.81E-08	9.85E-07	8.34E-08	5.05E-07	4.11E-08
Furans (pg)								
TCDF		128	15,800	2,620	50,600	3,060	18,500	1,510
PeCDF		127	9,640	915	43,900	1120	17,600	423
HxCDF		34.3	4,730	263	23,900	419	8,230	94.4
HpCDF		27.2	3,270	124	16,500	64.3	9,810	57.5
OCDF		17.6	916	49.1	3,790	108	2,500	39.2
Total (pg)		334	34,356	3,971	138,690	4,771	56,640	2,124
Total (ng/dscm)	0.129 ^b	0.156 ^b	16.7	1.85	48.9	2.25	19.5	0.987
Total (ng/dscm @ 12% CO2)	0.179	0.181	16.2	2.14	105	2.60	30.0	1.15
Total (lb/hr)	5.92E-09	9.22E-09	7.51E-07	1.09E-07	2.29E-06	1.32E-07	9.06E-07	5.87E-08
Total Dioxins and Furans								
Conc. (ng/dscm @ 12% CO2)	0.466	0.470	26.6	3.08	150	4.24	48.7	1.95
Emission rate (lb/hr)	1.54E-08	2.40E-08	1.24E-06	1.57E-07	3.27E-06	2.15E-07	1.41E-06	9.98E-08
Surrogate recovery (%)								
13C-2,3,7,8-TCDF		106	94	77	81	95	119	112
13C-2,3,7,8-TCDD		97	89	72	98	87	99	98
13C-1,2,3,7,8-PeCDF		96	86	71	92	87	105	100
13C-1,2,3,7,8-PeCDD		99	86	65	106	82	101	93
13C-1,2,3,4,7,8-HxCDF		122	109	83	113	113	130	122
13C-1,2,3,6,7,8-HxCDD		103	89	64	97	93	101	102
13C-1,2,3,4,6,7,8-HpCDF		105	108	92	97	93	108	107
13C-1,2,3,4,6,7,8-HpCDD		99	107	89	110	97	117	117
13C-12-OCDD		94	100	78	107	80	98	92
37Cl-2,3,7,8-TCDD ^c		96	94	91	94	98	98	97
13C-2,3,4,7,8-PeCDF ^c		95	96	90	103	94	98	98
13C-1,2,3,6,7,8-HxCDF ^c		78	79	73	76	75	73	79
13C-1,2,3,4,7,8-HxCDD ^c		96	106	100	107	99	108	104
13C-1,2,3,4,7,8,9-HpCDF ^c		85	97	93	98	96	97	96

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

b. Blank train "emissions" calculated using average flow rates from each location.

c. Field surrogates spiked into XAD prior to sample collection.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-13. SITE B - 2,3,7,8-SUBSTITUTED DIOXIN/FURAN FOR MM5-SV SAMPLES

Analyte	Blank	Blank	Run 4		Run 5		Run 6	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sample volume (dscm)			2.057	2.142	2.834	2.119	2.903	2.153
Stack flow rate (dscm/m)			340	446	353	443	351	450
Concentration CO2 (%)			12.4	10.4	5.6	10.4	7.8	10.3
<u>Dioxins (pg)</u>								
2,3,7,8-TCDD		8.26 a	81.6 a	16.4 a	139	26.4 a	20 a	21.4 a
1,2,3,7,8-PeCDD		3.92 a	201	27.0 a	491	25.4 a	194	13.1
1,2,3,4,7,8-HxCDD		17.2 a	248 a	27.0 a	787	27.4 a	327	17.3 a
1,2,3,6,7,8-HxCDD		5 a	508	28.8 a	1,940	39.1	1,050	20.3
1,2,3,7,8,9-HxCDD		7.11	482	35.8 a	1,860	37.9	875	16.6
1,2,3,4,6,7,8-HpCDD		31.6	3,350	84.6	10,000	228	5,680	56.2
1,2,3,4,6,7,8,9-OCDD		162	5,730	288	12,200	1070	6,360	311
Total (pg)		218	10,436	440	27,417	1415	14,496	437
Total (ng/dscm)	0.0839	0.102 b	5.07	0.205	9.67	0.668	4.993	0.203
Total (ng/dscm @ 12% CO2)	0.117	0.118	4.91	0.237	20.73	0.771	7.68	0.236
Total (lb/hr)	3.86E-09	6.02E-09	2.28E-07	1.21E-08	4.52E-07	3.91E-08	2.32E-07	1.21E-08
<u>Furans (pg)</u>								
2,3,7,8-TCDF		37.4	2,980	501	6,740	519	4,080	277
1,2,3,7,8-PeCDF		18.6 a	669	84.4	2,170	86.6	929	35.6 a
2,3,4,7,8-PeCDF		10.8	886	83.9	4,070	96.6	1,900	40.6
1,2,3,4,7,8-HxCDF		17.4 a	1,290	78.5	6,830	118	2,970 a	39.1
1,2,3,6,7,8-HxCDF		7.92	504	41	2,360	49.1	350	18.5
2,3,4,6,7,8-HxCDF		5.64 a	614	25.8	3,260	45.4	1,750	13 a
1,2,3,7,8,9-HxCDF		4.56 a	212	4.4 a	2,780 a	18.10 a	822	6.2 a
1,2,3,4,6,7,8-HpCDF		20.9	2,000	86.5	18,140 a	153.0 a	5,100	46.2
1,2,3,4,7,8,9-HpCDF		5.91	309	17.5 a	4,240 a	31.5 a	1,450	10.4
1,2,3,4,6,7,8,9-OCDF		17.6	916	49.1	3,790	108	2,500	39.2
Total (pg)		124	10,380	961	41,800	1,124	20,366	498
Total (ng/dscm)	0.0476	0.058	5.05	0.449	14.7	0.530	7.02	0.231
Total (ng/dscm @ 12% CO2)	0.066	0.067	4.88	0.518	31.6	0.612	10.8	0.270
Total (lb/hr)	2.19E-09	3.41E-09	2.27E-07	2.65E-08	6.89E-07	3.11E-08	3.26E-07	1.38E-08
<u>Total 2,3,7,8-substituted dioxin/furan</u>								
Conc. (ng/dscm @ 12% CO2)			9.79	0.755	52.3	1.383	18.5	0.506
Emission rate (lb/hr)			4.55E-07	3.86E-08	1.14E-06	7.02E-08	5.58E-07	2.59E-08

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

b. Blank train "emissions" calculated using average flow rates from each location.

TABLE 4-14. SITE B - 2,3,7,8-TCDD EQUIVALENTS RESULTS

ARB equiv. factor	Run 4						Run 5						Run 6						
	Inlet			Outlet			Inlet			Outlet			Inlet			Outlet			
	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	Sample volume (dscm) =	Stack flow rate (dscm/m)	Concentration CO2 (%) =	
	2.057	340	12.4	2.142	446	10.4	2.834	353	5.6	2.119	443	10.4	2.803	351	7.8	2.803	351	7.8	
	Total	Equiv.		Total	Equiv.		Total	Equiv.		Total	Equiv.		Total	Equiv.		Total	Equiv.		
	(pg)	(ng/dscm)	(ng/dscm)																
DD	1	81.6 *	0.0397	0.0397	16.4 *	0.0077	0.0077	139	0.0490	0.0490	26.4 *	0.0125	0.0125	20 *	0.0069	0.0069	21.4 *	0.0099	0.0099
CDD	0.03	248 *	0.1206	0.0036	27.0 *	0.0126	0.0004	787	0.2777	0.0083	27.4 *	0.0129	0.0004	327	0.1126	0.0034	17.3 *	0.0080	0.0080
CDD	0.03	508	0.2470	0.0074	28.8 *	0.0134	0.0004	1,940	0.6845	0.0205	39.1	0.0185	0.0006	1,050	0.3617	0.0109	20.3	0.0094	0.0094
CDD	0.03	482	0.2343	0.0070	35.8 *	0.0167	0.0005	1,860	0.6563	0.0197	37.9	0.0179	0.0005	875	0.3014	0.0090	18.6	0.0077	0.0077
HpCDD	0.03	3,350	1.6286	0.0489	84.6	0.0395	0.0012	10,000	3.5286	0.1059	228	0.1076	0.0032	5,680	1.9566	0.0587	56.2	0.0261	0.0261
	0.03	5,730	2.7856	0.0836	288	0.1345	0.0040	12,200	4.3049	0.1291	1070	0.5050	0.0152	6,360	2.1908	0.0657	311	0.1444	0.1444
DF	1	2,980	1.4487	1.4487	501	0.2339	0.2339	6,740	2.3783	2.3783	519	0.2449	0.2449	4,080	1.4054	1.4054	277	0.1287	0.1287
DF	1	669	0.3252	0.3252	84.4	0.0394	0.0394	2,170	0.7657	0.7657	86.6	0.0409	0.0409	929	0.3200	0.3200	35.6	0.0165	0.0165
DF	1	886	0.4307	0.4307	83.9	0.0392	0.0392	4,070	1.4361	1.4361	96.6	0.0456	0.0456	1,900	0.6545	0.6545	40.6	0.0189	0.0189
CDF	0.03	1,290	0.6271	0.0188	78.5	0.0366	0.0011	6,830	2.4100	0.0723	118	0.0557	0.0017	2,970 *	1.0231	0.0307	39.1	0.0182	0.0182
CDF	0.03	504	0.2450	0.0074	41	0.0191	0.0006	2,360	0.8327	0.0250	49.1	0.0232	0.0007	350	0.1206	0.0036	18.5	0.0086	0.0086
CDF	0.03	614	0.2985	0.0090	25.8	0.0120	0.0004	3,260	1.1503	0.0345	45.4	0.0214	0.0006	1,750	0.6028	0.0181	13 *	0.0060	0.0060
CDF	0.03	212	0.1031	0.0031	4.4 *	0.0021	0.00006	2,780 *	0.9809	0.0294	18.10 *	0.0085	0.0003	822	0.2832	0.0085	6.2 *	0.0029	0.0029
tpCDF	0.03	2,000	0.9723	0.0292	86.5	0.0404	0.0012	18,140	6.4008	0.1920	153.0 *	0.0722	0.0022	5,100	1.7588	0.0527	46.2	0.0215	0.0215
tpCDF	0.03	309	0.1502	0.0045	17.5 *	0.0082	0.0002	4,240 *	1.4961	0.0449	31.5 *	0.0149	0.0004	1,450	0.4995	0.0150	10.4	0.0048	0.0048
	0.03	916	0.4453	0.0134	49.1	0.0229	0.0007	3,790	1.3373	0.0401	108	0.0510	0.0015	2,500	0.8612	0.0258	39.2	0.0182	0.0182
2,3,7,8-TCDD																			
concentration (ng/dscm) =			2.5562			0.3326			5.3909			0.3692			2.7368				0.1
2,3,7,8-TCDD equivalent																			
concentration @ 12% CO2 (ng/dscm) =			2.47			0.384			11.6			0.426			4.21				0
limit (b/hr) =			1.15E-07			1.96E-08			2.52E-07			2.16E-08			1.27E-07				1.04E

the detection limit value. "Totals" calculated using half the detection limit.



TABLE 4-15. SITE B - PAHs EMISSIONS RESULTS FOR MM5-SV SAMPLES

	Run 4		Run 5		Run 6		Blank Inlet	Blank Outlet
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet		
Sample volume (dscm)	2.057	2.142	2.834	2.119	2.903	2.153		
Stack flow rate (dscm/m)	340	446	353	443	351	450		
Concentration CO2 (%)	12.4	10.4	5.6	10.4	7.8	10.3		
<u>PAHs (ug)</u>								
Naphthalene	199	168	229	156	200	132		13.4
Acenaphthylene	8.26	3.42	10.6	1.07	8.17	0.739		0.404
Acenaphthene	0.1 a	0.648	0.632	0.563	0.43	0.1 a		1.18
Fluorene	2.76	1.66	3.76	1.34	2.05	0.1 a		2.55
Phenanthrene	20.4	12	33	13.6	22.6	8.24		0.366
Anthracene	1.68	0.405	2.02	0.23	0.355	11.1		0.251
Fluoranthene	6.89	3.08	11.1	3.31	7.64	1.89		0.164
Pyrene	2.95	1.1	4.05	1.26	1.45	0.523		0.197
Retene	0.319	0.104	0.963	0.157	0.713	0.132		0.1 a
Benz(a)anthracene	1.16	0.195	0.889	0.218	0.252	0.182		0.179
Chrysene	1.01	0.295	1.84	0.338	1.01	0.231		0.167
Benzo(b)fluoranthene	0.305	0.0725	0.642	0.1 a	0.468	0.1 a		0.1 a
Benzo(k)fluoranthene	0.305	0.0725	0.642	0.1 a	0.468	0.1 a		0.1 a
Benzo(a)pyrene	0.23	0.252	0.295	0.25	0.242	0.216		0.248
Indeno(1,2,3-cd)pyrene	0.1 a	0.1 a	0.1 a	0.1 a	0.1	0.1 a		0.1 a
Dibenz(a,h)anthracene	0.1 a	0.1 a	0.1 a	0.1 a	0.1	0.1 a		0.1 a
Benzo(ghi)perylene	0.1 a	0.1 a	0.1 a	0.1 a	0.1	0.1 a		0.1 a
Total PAHs (ug)	246	192	300	179	246	156	19.7	19.7
Total PAHs (ug/dscm)	119	89	106	84	85	72	7.59	9.22
Total PAHs (ug/dscm @ 12% CO	116	103	227	97	130	84.4	10.6	10.7
Total PAHs (lb/hr)	0.00537	0.00528	0.00494	0.00495	0.00394	0.00431	0.000349	0.000544
<u>FIELD SURROGATE RECOVERY</u>								
D10-1-Methylnaphthalene	46%	55%	69%	73%	59%	66%		74%
D12-Perylene	46%	55%	52%	39%	76%	20%		59%
<u>LAB SURROGATE RECOVERY</u>								
D8-Naphthalene	22%	29%	35%	39%	28%	46%		33%
D10-Acenaphthene	52%	69%	74%	84%	77%	76%		80%
D10-Fluorene	54%	75%	77%	89%	86%	81%		88%
D10-Phenanthrene	58%	83%	83%	95%	96%	85%		95%
D10-Anthracene	56%	77%	77%	81%	85%	69%		79%
D10-Fluoranthene	57%	82%	73%	92%	96%	84%		95%
D10-Pyrene	59%	83%	73%	90%	96%	84%		92%
D12-Benz(a)anthracene	52%	80%	64%	93%	97%	74%		87%
D12-Chrysene	54%	83%	64%	97%	103%	82%		95%
D12-Benzo(a)pyrene	48%	80%	56%	80%	85%	49%		52%

Note(a): Values shown are the detection limits which were calculated as 2.5 times the baseline noise level.

TABLE 4-16. SITE B - ANALYSIS RESULTS FOR MM5-MM (METALS) TRAIN

	Ag	As	Ba	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Se	Zn
Run 4												
<u>Inlet</u>												
Rinse and filter, ug	<135	333	438	178	331	4,227	NA	907	1,789	9,531	1,004	55,946
Nitric acid impingers, ug	<1.63	<8.29	1.05	1.60	1.67	2.86	3.21	1.69	2.67	3.55	10.4	13.4
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	1.13	NA	NA	NA	NA	NA
Total, ug	<137	333	439	178	332	4,229	4.34	908	1,791	9,535	1,015	55,959
Concentration, ug/dscm	<147	357	470	191	356	4,533	4.65	974	1,920	10,219	1,087	59,978
Emissions, lb/hr	<0.00664	0.0161	0.0213	0.00863	0.0161	0.205	0.000210	0.0440	0.0869	0.462	0.0492	2.71
<u>Outlet</u>												
Rinse and filter, ug	<21.5	101	18.2	38.4	493	44.2	NA	60.6	2,044	106	5,364	53.0
Nitric acid impingers, ug	<1.63	<8.29	1.74	0.921	1.81	1.84	<2.27	8.40	2.60	39.1	2.83	11.4
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	6.90	NA	NA	NA	NA	NA
Total, ug	<23.1	101	19.9	39.4	495	46.1	<9.17	69.0	2,046	145	5,367	64.4
Concentration, ug/dscm	<8.03	26.4	5.20	10.3	129	12.0	<2.39	18.0	534	37.8	1,401	16.8
Emissions, lb/hr	<0.000356	0.00156	0.000307	0.000606	0.00763	0.000710	<0.000141	0.00106	0.0315	0.00223	0.0827	0.000992
Run 5												
<u>Inlet</u>												
Rinse and filter, ug	<702	779	536	392	<389	9,310	NA	1,451	1,967	14,287	2,026	78,210
Nitric acid impingers, ug	<1.63	<8.29	1.78	2.84	1.02	6.28	4.55	7.21	4.17	4.54	15.1	19.1
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	4.60	NA	NA	NA	NA	NA
Total, ug	<704	779	538	395	<390	9,316	9.15	1,458	1,971	14,292	2,041	78,229
Concentration, ug/dscm	<317	351	242	178	<176	4,195	4.12	656	888	6,435	919	35,222
Emissions, lb/hr	<0.0148	0.0163	0.0113	0.00829	<0.00818	0.195	0.000192	0.0306	0.0413	0.300	0.0428	1.64
<u>Outlet</u>												
Rinse and filter, ug	<21.5	51.4	21.4	82.3	652	24.9	NA	79.4	3,495	106	5,391	49.0
Nitric acid impingers, ug	<1.63	<8.29	2.08	0.917	2.66	1.94	<2.53	2.74	2.18	4.63	4.23	15.1
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	6.37	NA	NA	NA	NA	NA
Total, ug	<23.1	<59.7	23.5	83.3	655	26.8	<8.90	82.1	3,497	111	5,395	64.0
Concentration, ug/dscm	<6.83	<15.1	5.94	21.0	165	6.77	<2.25	20.7	883	27.9	1,362	16.2
Emissions, lb/hr	<0.00359	<0.000929	0.000366	0.00130	0.0102	0.000417	0.000138	0.00128	0.0544	0.00172	0.0840	0.000997
Run 6												
<u>Inlet</u>												
Rinse and filter, ug	<877	1,483	877	605	<486	16,401	NA	2,747	3,765	24,703	2,612	175,612
Nitric acid impingers, ug	<1.63	<8.29	2.38	1.81	2.28	2.90	7.60	2.22	3.34	7.63	34.9	20.7
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	6.70	NA	NA	NA	NA	NA
Total, ug	<879	1,483	879	607	<488	16,404	14.30	2,749	3,768	24,711	2,647	175,633
Concentration, ug/dscm	<209	352	209	144	<116	3,899	3.40	654	896	5,874	629	41,748
Emissions, lb/hr	<0.0106	0.0180	0.0106	0.00735	<0.00591	0.199	0.000173	0.0333	0.0456	0.299	0.0320	2.13
<u>Outlet</u>												
Rinse and filter, ug	<21.4	69.5	23.5	125	731	62.1	NA	112	3,468	137	7,492	58.3
Nitric acid impingers, ug	<1.63	<8.29	1.56	1.31	2.17	2.08	<2.07	18.5	1.88	4.00	3.43	9.41
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	11.9	NA	NA	NA	NA	NA
Total, ug	<23.0	<77.8	25.1	126	733	64.2	<14.0	130	3,470	141	7,495	67.7
Concentration, ug/dscm	<5.95	<20.1	6.49	32.6	190	16.6	<3.62	33.7	898	36.6	1,939	17.5
Emissions, lb/hr	<0.000358	<0.00121	0.000391	0.00196	0.0114	0.00100	<0.00217	0.00203	0.0540	0.00220	0.117	0.00105
Blank train												
Rinse and filter, ug	<2.15	29.3	1.31	8.06	<1.05	1.99	NA	0.767	84.0	54.2	22.5	<6.29
Impingers 1-6, ug	4.47	<8.29	1.32	<0.18	2.46	<1.54	<1.23	0.280	0.963	1.84	<2.24	4.84
Total, ug	<6.62	<37.6	2.63	8.06	<3.51	<3.53	<1.23	1.047	84.9	56.0	22.5	<11.13

NA = Not applicable. For Hg, this fraction was not analyzed due to holding time exceedance. Total mercury emissions are therefore conservative.

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TABLE 4-17. SITE B -- CONTINUOUS EMISSION MEASUREMENTS

								12% CO ₂		
Run 4	Inlet		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
		Avg	4.8	12.4	2538.4	405.1	880.1	2494.0	393.7	851.7
		Max	6.9	14.8	3966.4	533.2	1160.0	4598.9	518.2	1045.9
		Min	3.9	10.2	1252.2	278.8	700.0	1030.0	281.3	680.8
	Outlet									
		Avg	6.8	10.4	2029.0	117.5	822.1	2342.3	135.6	948.1
		Max	8.5	10.5	2111.9	152.9	980.9	2601.5	175.4	1122.1
		Min	4.7	9.6	1452.3	83.6	698.6	1666.8	97.4	809.2
Run 5	Inlet		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
		Avg	13.9	5.6	1746.8	80.4	530.8	3915.7	199.9	1215.9
		Max	15.6	8.7	3060.7	106.6	953.0	7283.9	241.4	1684.2
		Min	10.0	2.0	783.2	44.9	206.0	1453.1	130.0	613.4
	Outlet									
		Avg	7.5	10.4	2001.1	38.4	541.3	2314.5	44.4	625.0
		Max	8.0	10.5	2138.7	57.5	1043.6	2553.7	66.3	1198.4
		Min	7.0	10.1	147.8	25.6	242.8	169.6	29.7	288.8
Run 6	Inlet		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
		Avg	10.8	7.9	1919.1	254.9	579.9	2878.7	382.4	881.0
		Max	13.0	8.5	4856.0	525.1	1096.0	7295.9	782.8	1844.6
		Min	9.5	7.0	272.9	129.5	247.0	409.9	199.0	368.2
	Outlet									
		Avg	7.2	10.3	1762.5	92.3	668.2	2046.3	107.1	774.2
		Max	7.7	10.5	2011.9	137.7	1314.2	2399.9	160.7	1552.2
		Min	7.0	10.1	14.9	66.1	205.9	17.7	76.9	243.4

4.3 DRUM RECONDITIONING FACILITIES

4.3.1 Site C

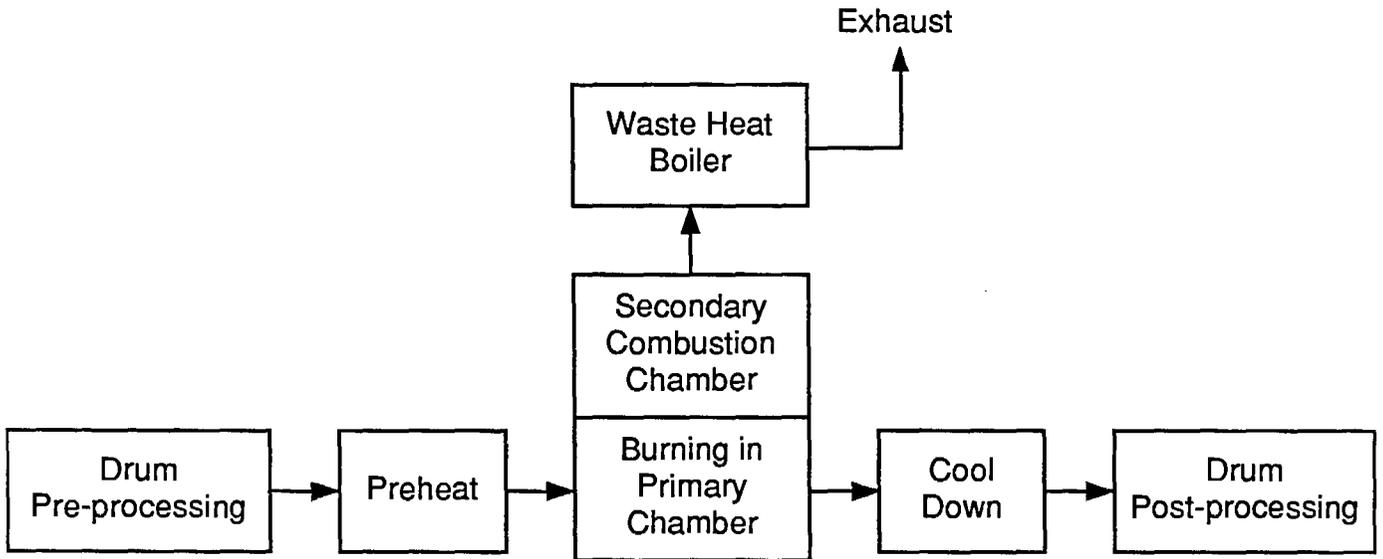
4.3.1.1 Process Description

Site C reconditions 55-gal steel drums for a variety of clients. Drums are first heat-treated to remove exterior paint, residual contents, and the interior coating. Then the drums are shot-blasted to exposed bare steel as a base surface. Finally, the drums are given an interior coating and an exterior coat of paint. The facility has an inventory of its own drums, but all drums processed during the testing program were owned by clients who requested quick reconditioning of their drums. A schematic of Site C is presented in Figure 4-3.

This facility operates on a quick turnaround basis, with virtually no advance warning. A vast majority of reconditioned drums are requested on a same day or next day basis. All the drums used during this test program were delivered to the facility in truck trailers, and the trailers were unloaded directly onto the production line. Generally, the facility operates one 8- to 10-hr shift per day. The heat-treating system could be turned on and be operational in approximately 30 min. Operating conditions for Site C are presented in Table 4-18.

All drums processed during this test program were of the open top variety rather than closed top drums with a bung hole. Barrels were opened, the lid removed, and each drum was turned upside down directly in front of the mouth of the kiln. Drums with too much residue were emptied into a receptacle for disposal before introduction to the kiln. A drum lid was placed atop each drum before it entered the kiln. The rate of drums fed into the kiln was judged by the secondary combustion chamber (SCC) exit temperature. Since the amount of natural gas to the kiln was constant, fluctuations in SCC exit temperature were due to drums and their contents. The SCC exit temperature was measured at the point the combustion gas exited the SCC on its way to the "APCD," i.e., afterburner. The SCC exit temperature was mandated by the AQMD permit and was set at 1700°F.

At Site C, drums entered a preheat zone of 25 ft before the hot zone. The hot zone had six natural gas flame jets on each side over approximately 30 ft. A cool-down zone of approximately 40 ft followed the hot zone. Combustion gas exited the top of the center of hot zone and were ducted to the SCC. At this point, 99% pure oxygen was injected to the system. Oxygen served to reduce the amount of combustion air required by the system. This reportedly resulted in overall cost savings by reducing maintenance and replacement costs for the i.d. fan and reduced wear of refractory brick. The SCC had three natural gas burners at the exit aligned 120° to each other and perpendicular to the flow of the gas stream. The combustion gas stream passed through a heat exchanger to recover heat in the form of steam. Steam was produced but not used by the facility; it was vented to



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Site C: Drum Reconditioner Process Diagram

Figure 4-3

TABLE 4-18. SITE C - PROCESS OPERATING CONDITIONS

Parameter	Units	Run 7	Run 8	Run 9
Burner atomizer feed pressure	psi	5	5	5
Burner temperature	°F	1,600	1,536	1,563
Secondary chamber temperature	°F	1,664	1,728	1,725
Air velocity/O ₂	psi	8	8	8
Waste heat boiler steam pressure	psi	78	95	80

the atmosphere. Combustion gas passed from the WHB through an i.d. fan and out the 28-ft-tall, 18-in diameter stack.

4.3.1.2 Sampling

The facility operated in a normal fashion during the test program. Workdays started at 6 a.m. and generally ended at 2:30 p.m. Run 8, however, ended at 10:30 a.m., when the facility ran out of work for the day. A majority of the drums processed had contained industrial chemicals. Very few containing food or other substances were processed. Table 4-19 lists the contents of drums processed during selected periods of Runs 7, 8, and 9.

Sampling was conducted only at the outlet of the stack. Organics and metals trains were run each day as were CEMs. During the recovery of the filter from the Run 9 metals train, some of the particulate matter may not have been completely recovered. This particulate matter loss was estimated by the field sampling crew chief to be less than 1% of the total filter particulate collected. Thus the reported metals results for Run 8 may be lower than actual concentrations. During Run 9, sampling was suspended while the facility fixed a drum jam in the drum burner. No other sampling deviations occurred.

4.3.1.3 Analysis Results—Site C

Data on outlet measurements of moisture content, duct/stack temperature, and velocity were obtained are provided in Table 4-20. The average flow rates, measured by the trains, identified by run number and location, are also given, and was used to calculate PCDDs and PCDFs, PAHs, and metals emissions.

Dioxin and Furan Emissions. Table 4-21 presents the dioxin and furan results by homologs while Table 4-22 presents the 2,3,7,8-substituted data. In conjunction with the gas sample volumes, the concentrations and emission rates of dioxins and furans in the stack gas were calculated and are presented in these tables.

In Table 4-23, using ARB's 2,3,7,8-TCDD/TCDF toxic equivalency factors, each 2,3,7,8-substituted TCDD/TCDF congener was converted to its 2,3,7,8-TCDD/TCDF equivalent, and the total 2,3,7,8-TCDD/TCDF equivalent concentration and emission rate were determined.

Polycyclic Aromatic Hydrocarbon Emissions. Table 4-24 presents the concentrations found for 17 PAHs, and the emission rates were also calculated.

Metals Emissions. Table 4-25 presents the concentrations and emissions for the 12 metals of interest.

Table 4-19. DRUMS RECONDITIONED DURING SAMPLING - SITE C

Contents

Butanol, Ethanol, Cellulose Solvents
White Paint
Arbek Lo VOC Stain
White Lacquer Primer
Struct Stuco Finish
Clear Sanding Sealer
Solvent Stain Base
Satin Stain White
Pitch Sealer
Rustic Medium Stain
Acrylic Flat White
Putty VOC 2.23
Contact Adhesive w/Toluene, Hexane and Acetane
Ebony Black
Extender, Epoxy Resin, Inorganic Pigments, Aromatics Paint
High Solids AAR Solvent Type Spray Grade Adhesive
Paint Additive - Xylene
Ink Solution - Flammable Liquid D001
Metallic Silver Paint
Orange Paint
AQ/GM Metallic Gold Paint
Burger King Red Paint
Surfactant, Wetting Agent Detergent Soln
Foam Control Agent Drew Plus L-475
Colloid 697
Foammaster w/Petroleum Derivative
Rheology Modifier
Waste Silvent EPAN
Manganese Chloride Flakes
Wood Stain - Dark
Sealer
Precoate Sealer
Banana Puree
Paint and Water
Gantree ES-225 CoPolymer
New Shell Red Industrial Enamel
Resin Solution UN1866
Whole Sliced Strawberries
Isopropanol
Anti Skinning Agent w/Methyethyl Ketoxime
Acetone
Polypropylene Glycol
Cosperse 70 Dispersing & Grinding Aid Contains Mineral Spirits

TABLE 4-20. SITE C - OUTLET SUMMARY DATA

	Sampling time (min)	Gas volume sampled (dscm)	Moisture content (% vol)	Average stack temp (C)	Stack velocity (m/sec)	Stack flow rate (dscm/min)
<u>Run 7</u>						
MM-Outlet	162	3.807	17.2	306	43.5	181
SV-Outlet	162	2.021	17.9	295	40.3	170
<u>Run 8</u>						
MM-Outlet	96	2.167	13.0	339	42.9	178
SV-Outlet	108	1.266	14.1	313	40.9	175
<u>Run 9</u>						
MM-Outlet	186	4.172	16.1	282	40.3	177
SV-Outlet	186	2.315	15.6	301	41.4	177

MM = Multiple metals sampling train, ie. method 436 train.

SV = Semivolatile sampling train, ie. combined method 428 and 429 train.

TABLE 4-21. SITE C - DIOXIN/FURAN RESULTS FOR MM5-SV SAMPLES

Analyte	Blank train	Run 7 Outlet	Run 8 Outlet	Run 9 Outlet
Sample volume (dscm)		2.021	1.266	2.315
Stack flow rate (dscm/m)		170	175	177
Concentration CO ₂ (%)		4.1	4.2	3.5
<u>Dioxins (pg)</u>				
TCDD	204	89,200	56,400	47,600
PeCDD	51.1	97,200	51,700	54,300
HxCDD	173	195,000	82,600	114,000
HpCDD	3,830	107,000	42,700	70,300
OCDD	42,400	45,300	18,400	34,700
Total (pg)	46,658	533,700	251,800	320,900
Total (ng/dscm)	25.0 ^b	264	199	139
Total (ng/dscm @ 12% CO ₂)	76.2	773	568	475
Total (lb/hr)	5.75E-07	5.94E-06	4.60E-06	3.25E-06
<u>Furans (pg)</u>				
TCDF	4.24 ^a	462,000	257,000	296,000
PeCDF	4.24 ^a	224,000	162,000	167,000
HxCDF	11.4	127,000	55,900	73,900
HpCDF	174	68,000	23,900	45,200
OCDF	239	6.72 ^a	2.30 ^a	4.94 ^a
Total (pg)	430	881,000	498,800	582,100
Total (ng/dscm)	0.230 ^b	436	394	251
Total (ng/dscm @ 12% CO ₂)	0.703	1,276	1126	862
Total (lb/hr)	5.30E-09	9.80E-06	9.12E-06	5.89E-06
<u>Total Dioxins and Furans</u>				
Conc. (ng/dscm @ 12% CO ₂)	76.9	2,049	1,694	1,337
Emission rate (lb/hr)	5.80E-07	1.57E-05	1.37E-05	9.13E-06
<u>Surrogate recovery (%)</u>				
13C-2,3,7,8-TCDF	110	119	121	118
13C-2,3,7,8-TCDD	112	99	100	105
13C-1,2,3,7,8-PeCDF	98	112	112	116
13C-1,2,3,7,8-PeCDD	103	103	104	118
13C-1,2,3,4,7,8-HxCDF	129	144	121	141
13C-1,2,3,6,7,8-HxCDD	123	111	94	110
13C-1,2,3,4,6,7,8-HpCDF	129	106	97	114
13C-1,2,3,4,6,7,8-HpCDD	124	121	98	123
13C-12-OCDD	133	112	95	99
37Cl-2,3,7,8-TCDD ^c	88	94	99	103
13C-2,3,4,7,8-PeCDF ^c	91	88	94	95
13C-1,2,3,6,7,8-HxCDF ^c	73	75	73	64
13C-1,2,3,4,7,8-HxCDD ^c	94	99	104	106
13C-1,2,3,4,7,8,9-HpCDF ^c	82	91	97	87

- a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.
 b. Blank train "emissions" calculated using average flow rates from each location.
 c. Field surrogates spiked into XAD prior to sample collection.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-22. SITE C - 2,3,7,8-SUBSTITUTED DIOXIN/FURAN FOR MM5-SV SAMPLES

Analyte	Blank train	Run 7 Outlet	Run 8 Outlet	Run 9 Outlet
Sample volume (dscm)		2.021	1.266	2.315
Stack flow rate (dscm/m)		170	175	177
Concentration CO2 (%)		4.1	4.2	3.5
<u>Dioxins (pg)</u>				
2,3,7,8-TCDD	15.5	20.2 a	540	496
1,2,3,7,8-PeCDD	5.16 a	5,250	2,630	2,890
1,2,3,4,7,8-HxCDD	13.6 a	6,720	2,950	3,860
1,2,3,6,7,8-HxCDD	32.5	14,700	6,440	9,280
1,2,3,7,8,9-HxCDD	9.60 a	15,600	7,610	9,550
1,2,3,4,6,7,8-HpCDD	1,990	51,000	20,600	34,200
1,2,3,4,6,7,8,9-OCDD	42,400	45,300	18,400	34,700
Total (pg)	44,452	138,580	59,170	94,976
Total (ng/dscm)	23.8	68.6	46.7	41.0
Total (ng/dscm @ 12% CO2)	72.6	201	134	141
Total (lb/hr)	5.48E-07	1.54E-06	1.08E-06	9.61E-07
<u>Furans (pg)</u>				
2,3,7,8-TCDF	7.86 a	94,500	71,300 a	66,500
1,2,3,7,8-PeCDF	4.94 a	18,600	9,680	11,800
2,3,4,7,8-PeCDF	3.72 a	28,900 a	16,000	20,000 a
1,2,3,4,7,8-HxCDF	6.51	34,500	14,700	20,900
1,2,3,6,7,8-HxCDF	4.33	15,900	6,390	8,430
2,3,4,6,7,8-HxCDF	2.4 a	18,800	7,990	11,500
1,2,3,7,8,9-HxCDF	4.10 a	4,440	1,640	2,760
1,2,3,4,6,7,8-HpCDF	49.4	46,100	17,300	30,100
1,2,3,4,7,8,9-HpCDF	6.64	5,340	1,680	3,850
1,2,3,4,6,7,8,9-OCDF	239	13,200 a	3,780 a	9,500 a
Total (pg)	317	259,230	112,920	170,590
Total (ng/dscm)	0.170	128	89.2	73.7
Total (ng/dscm @ 12% CO2)	0.518	375	255	253
Total (lb/hr)	3.91E-09	2.88E-06	2.06E-06	1.73E-06
<u>Total 2,3,7,8-substituted dioxin/furan</u>				
Conc. (ng/dscm @ 12% CO2)	73.1	576	388	393
Emission rate (lb/hr)	5.52E-07	4.43E-06	3.15E-06	2.69E-06

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

TABLE 4-23. SITE C - 2,3,7,8-TCDD EQUIVALENTS RESULTS

Analyte	ARB equiv. factor	Run 7			Run 8			Run 9		
		Outlet			Outlet			Outlet		
		Sample volume (dscm) =	2.021	Sample volume (dscm) =	1.266	Sample volume (dscm) =	2.315			
		Stack flow rate (dscm/m)	170	Stack flow rate (dscm/m)	175	Stack flow rate (dscm/m)	177			
Concentration CO2 (%) =	4.1	Concentration CO2 (%) =	4.2	Concentration CO2 (%) =	3.5					
		Total (pg)	Equiv. (ng/dscm)	Total (pg)	Equiv. (ng/dscm)	Total (pg)	Equiv. (ng/dscm)			
Dioxins										
2,3,7,8-TCDD	1	20.2 ^a	0.01	0.01	540	0.43	0.43	496	0.21	0.21
1,2,3,7,8-PeCDD	1	5,250	2.60	2.60	2,630	2.08	2.08	2,890	1.25	1.25
1,2,3,4,7,8-HxCDD	0.03	6,720	3.33	0.10	2,950	2.33	0.07	3,860	1.67	0.05
1,2,3,6,7,8-HxCDD	0.03	14,700	7.27	0.22	6,440	5.09	0.15	9,280	4.01	0.12
1,2,3,7,8,9-HxCDD	0.03	15,600	7.72	0.23	7,610	6.01	0.18	9,550	4.13	0.12
1,2,3,4,6,7,8-HpCDD	0.03	51,000	25.24	0.76	20,600	16.27	0.49	34,200	14.77	0.44
OCDD	0.03	45,300	22.41	0.67	18,400	14.53	0.44	34,700	14.99	0.45
Furans										
2,3,7,8-TCDF	1	94,500	46.76	46.76	71,300	56.32	56.32	66,500	28.73	28.73
1,2,3,7,8-PeCDF	1	18,600	9.20	9.20	9,680	7.65	7.65	11,800	5.10	5.10
2,3,4,7,8-PeCDF	1	28,900 ^a	14.30	14.30	16,000	12.64	12.64	20,000	8.64	8.64
1,2,3,4,7,8-HxCDF	0.03	34,500	17.07	0.51	14,700	11.61	0.35	20,900	9.03	0.27
1,2,3,6,7,8-HxCDF	0.03	15,900	7.87	0.24	6,390	5.05	0.15	8,430	3.64	0.11
2,3,4,6,7,8-HxCDF	0.03	18,800	9.30	0.28	7,990	6.31	0.19	11,500	4.97	0.15
1,2,3,7,8,9-HxCDF	0.03	4,440	2.20	0.07	1,640	1.30	0.04	2,760	1.19	0.04
1,2,3,4,6,7,8-HpCDF	0.03	46,100	22.81	0.68	17,300	13.67	0.41	30,100	13.00	0.39
1,2,3,4,7,8,9-HpCDF	0.03	5,340	2.64	0.08	1,680	1.33	0.04	3,850	1.66	0.05
OCDF	0.03	13,200 ^a	6.53	0.20	3,780	2.99	0.09	9,500	4.10	0.12
Total 2,3,7,8-TCDD equivalent concentration (ng/dscm) =			69.65		53.50		41.86			
Total 2,3,7,8-TCDD equivalent concentration @ 12% CO2 (ng/dscm) =			204		153		144			
Emission (lb/hr) =			1.57E-06		1.24E-06		9.80E-07			

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

TABLE 4-24. SITE C – PAHs EMISSIONS RESULTS FOR MM5-SV SAMPLES

	Run 7	Run 8	Run 9	Blank train
Sample volume (dscm)	2.021	1.266	2.315	
Stack flow rate (dscm/m)	170	175	177	
Concentration CO2 (%)	4.1	4.2	3.5	
<u>PAHs (ug)</u>				
Naphthalene	15.1	24.1	20.9	12.4
Acenaphthylene	0.1 a	0.576	0.343	0.1 a
Acenaphthene	0.1 a	0.233	0.306	0.153
Fluorene	0.319	0.899	0.627	0.301
Phenanthrene	0.767	1.78	1.57	0.317
Anthracene	0.907	0.1 a	0.1 a	0.1 a
Fluoranthene	0.257	0.501	0.417	0.145
Pyrene	0.115	0.48	0.294	0.152
Retene	0.1 a	0.112	0.1 a	0.1 a
Benz(a)anthracene	0.1 a	0.185	0.162	0.181
Chrysene	0.1 a	0.221	0.185	0.15
Benzo(b)fluoranthene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(k)fluoranthene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(a)pyrene	0.1 a	0.232	0.194	0.198
Indeno(1,2,3-cd)pyrene	0.1 a	0.1 a	0.1 a	0.1 a
Dibenz(a,h)anthracene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(ghi)perylene	0.1 a	0.1 a	0.1 a	0.1 a
Total PAHs (ug)	18.6	29.9	25.7	14.8
Total PAHs (ug/dscm)	9.19	23.6	11.1	13.51
Total PAHs (ug/dscm @ 12% CO2)	26.9	67.5	38.1	58.6
Total PAHs (lb/hr)	0.000207	0.000547	0.000260	0.000205
<u>FIELD SURROGATE RECOVERY</u>				
D10-1-Methylnaphthalene	34%	32%	79%	65%
D12-Perylene	49%	79%	74%	74%
<u>LAB SURROGATE RECOVERY</u>				
D8-Naphthalene	17%	42%	58%	36%
D10-Acenaphthene	50%	71%	84%	75%
D10-Fluorene	62%	76%	88%	76%
D10-Phenanthrene	72%	81%	91%	77%
D10-Anthracene	66%	80%	86%	75%
D10-Fluoranthene	73%	82%	90%	75%
D10-Pyrene	75%	82%	91%	78%
D12-Benz(a)anthracene	57%	88%	85%	76%
D12-Chrysene	68%	87%	92%	80%
D12-Benzo(a)pyrene	55%	88%	79%	79%

Note(a): Values shown are the detection limits which were calculated as 2.5 times the baseline noise levels.

TABLE 4-25. SITE C - ANALYSIS RESULTS FOR MM5-MM (METALS) TRAIN

	Ag	As	Ba	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Se	Zn
Run 7												
Rinse and filter, ug	126	890	490	355	415	146	NA	114	18,653	1,648	21,976	27.9
Nitric acid impingers, ug	13.4	<8.29	16.4	1.34	13.1	<1.54	927	140	1.98	16.3	NA	15.8
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	103	NA	NA	NA	NA	NA
Total, ug	140	890	507	356	428	146	1030	254	18,654	1,664	21,976	43.7
Concentration, ug/dscm	36.8	234	133	93.5	113	38.5	271	66.7	4,900	437	5,773	11.5
Emissions, lb/hr	0.000880	0.00560	0.00319	0.00224	0.00269	0.000921	0.00648	0.00160	0.117	0.0105	0.138	0.000275
Run 8												
Rinse and filter, ug	30.3	337	93.9	107	148	48.8	NA	38.7	7,257	228	8,370	<6.29
Nitric acid impingers, ug	<1.63	<8.29	35.0	0.970	5.51	<1.54	66.2	4.80	1.64	9.52	41.9	12.5
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	14.9	NA	NA	NA	NA	NA
Total, ug	30.3	337	129	108	153	48.8	81.1	43.5	7,258	238	8,411	<18.8
Concentration, ug/dscm	14.0	155	59.5	49.7	70.7	22.5	37.4	20.1	3,350	110	3,882	<8.68
Emissions, lb/hr	0.000329	0.00366	0.00140	0.001170	0.00167	0.000530	0.000881	0.000473	0.0789	0.00258	0.0914	<0.000208
Run 9												
Rinse and filter, ug	101	1,736	419	251	<10.5	280	NA	63.0	20,208	176	13,006	21.7
Nitric acid impingers, ug	<1.63	<8.29	38.1	1.24	5.03	1.71	2540	4.38	1.54	22.3	22.3	18.0
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	471	NA	NA	NA	NA	NA
Total, ug	101	1,736	457	252	<15.5	282	3011	67.4	20,210	199	13,028	39.6
Concentration, ug/dscm	24.3	416	110	60.5	<3.72	67.5	722	16.1	4,844	47.6	3,123	9.50
Emissions, lb/hr	0.000568	0.00974	0.00256	0.00142	0.0000870	0.00158	0.0169	0.000378	0.113	0.00111	0.0731	0.000222
Blank train												
Rinse and filter, ug	<2.15	34.7	1.39	8.17	<1.05	2.20	NA	0.896	85.6	54.5	25.4	<6.29
Nitric acid impingers, ug	<1.63	<8.29	0.913	0.197	1.45	<1.54	<1.33	0.669	0.573	8.07	<2.24	1.63
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	<0.411	NA	NA	NA	NA	NA
Total, ug	<3.78	<43.0	2.30	8.37	<2.50	<3.74	<1.74	1.564	86.1	62.6	25.4	<7.92

NA = Not applicable. For Hg, this fraction was not analyzed due to holding time exceedance. Total mercury emissions are therefore conservative.

Continuous Emission Measurements. During the semivolatile and metals emission sampling, continuous measurements were conducted at the inlet and outlet locations for CO, SO₂, NO_x, O₂, and CO₂. Summary data for those measurements are presented in Table 4-26. Computer-generated graphs of the real time measurements are included in Appendix B.

4.3.2 Site D

4.3.2.1 Process Description

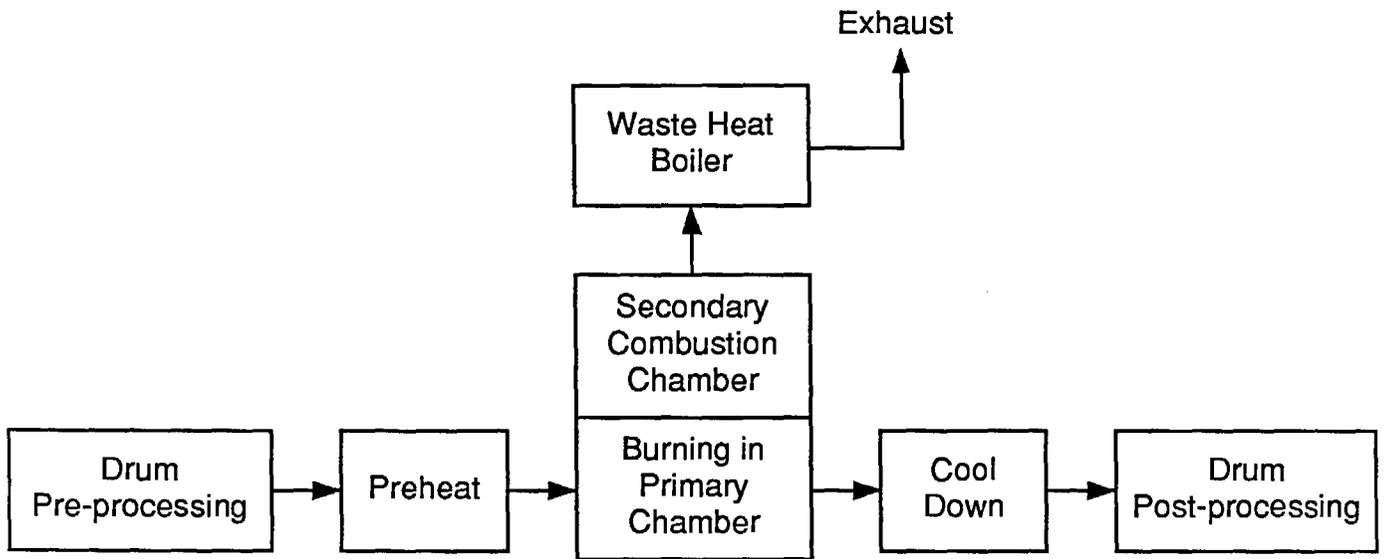
Site D also reconditions 55-gal steel drums for a variety of clients. Drums are first heat-treated to remove exterior paint, residual contents, and the interior coating. Then the drums are shot-blasted to exposed bare steel as a base surface. Finally, the drums are given an interior coating and an exterior coat of paint. The facility has an inventory of its own drums and a combination of client drums and Site D drums were used during this test program. A schematic of Site D is presented in Figure 4-4.

This facility operates on a quick turnaround basis, with little or no advance warning. A majority of reconditioned drums are requested on a same day or next day basis. Some of the drums used during this test program were delivered to the facility in truck trailers, and the trailers were unloaded directly onto the production line. Other drums from the facility's inventory were used. Generally, the facility operates one 8- to 10-hr shift per day. The heat-treating system could be turned on and be operational in approximately 30 min. Operating conditions for Site D are presented in Table 4-27.

All drums processed during this test program were of the open top variety rather than closed top drums with a bung hole. Barrels were opened, the lid removed, and each drum was turned upside down directly in front of the mouth of the kiln. Drums with too much residue were emptied into a receptacle for disposal before introduction to the kiln. A drum lid was placed atop each drum before it entered the kiln. The rate of drums fed into the kiln was judged by the secondary combustion chamber (SCC) exit temperature. Since the amount of natural gas to the kiln was constant, fluctuations in SCC exit temperature were due to drums and their contents. The SCC exit temperature was measured at the point the combustion gas exited the SCC on its way to the APCD. The SCC exit temperature was mandated by the AQMD permit and was set at 1700°F.

TABLE 4-26. SITE C -- CONTINUOUS EMISSION MEASUREMENTS

Run		O ₂	CO ₂	CO	SO ₂	NO _x	12% CO ₂		
							CO	SO ₂	NO _x
Run 7									
	Avg	16.1	4.1	5.3	4.8	48.6	16.7	12.2	143.0
	Max	20.5	6.1	180.2	138.7	120.3	355.7	383.5	411.3
	Min	11.9	.6	-6.2	-3.4	.6	-23.5	-67.4	3.2
Run 8									
	Avg	17.1	4.2	12.0	8.5	48.8	34.2	24.2	139.2
	Max	19.5	5.1	18.0	28.5	60.6	54.0	94.2	198.1
	Min	15.1	3.3	8.7	2.6	33.6	22.2	6.8	81.0
Run 9									
	Avg	18.3	3.5	9.5	13.2	38.3	33.4	44.8	135.0
	Max	20.7	5.0	152.7	69.7	55.5	429.1	175.7	276.2
	Min	15.6	2.1	4.9	5.5	21.7	15.8	20.1	79.1



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Site D: Drum Reconditioner Process Diagram

Figure 4-4

TABLE 4-27. SITE D - PROCESS OPERATING CONDITIONS

Parameter	Units	Run 10	Run 11	Run 12
Burner temperature	°F	1,150	1,163	1,204
Secondary chamber temperature	°F	1,784	1,758	1,750
Air flow pressure	psi	1	1	1

At Site D, drums entered a preheat zone of 25 ft before the hot zone. The hot zone had six natural gas flame jets on each side over approximately 30 ft. A cool-down zone of approximately 45 ft followed the hot zone. Combustion gas exited the top of the center of hot zone and were ducted to the SCC. The SCC had four natural gas burners at the exit aligned 90° to each other and perpendicular to the flow of the gas stream. The combustion gas then passed through an i.d. fan and out the 26-ft, 24-in x 27-in rectangular stack.

4.3.2.2 Sampling

The facility operated in a normal fashion during the test program. Workdays started at 5 a.m. and generally ended at 1:30 p.m. Run 10, however, ended at 1 p.m., when the facility ran out of work for the day. Sampling time for Run 10 was 30 min short for this reason. A majority of the drums processed had contained industrial chemicals. The rest had contained food or other substances. Table 4-28 lists the contents of drums processed during selected periods of Runs 10, 11, and 12.

Sampling was conducted only at the outlet of the stack. Organics and metals trains were run each day as were CEMs.

4.3.2.3 Analysis Results—Site D

Data on outlet measurements of moisture content, stack temperature, and velocity are provided in Table 4-29. The average flow rates, measured by the trains, identified by run number and location, are also given, and were used to calculate PCDDs and PCDFs, PAHs, and metals emissions.

Dioxin and Furan Emissions. Table 4-30 presents the dioxin and furan results by homologs, while Table 4-31 presents the 2,3,7,8-substituted data. In conjunction with the gas sample volumes, the concentrations and emission rates of dioxins and furans in the stack gas were calculated and are provided in these tables.

In Table 4-32, using ARB's 2,3,7,8-TCDD/TCDF toxic equivalency factors, each 2,3,7,8-substituted TCDD/TCDF congener was converted to its 2,3,7,8-TCDD/TCDF equivalent, and the total 2,3,7,8-TCDD/TCDF equivalent concentration and emission rate was determined.

Polycyclic Aromatic Hydrocarbon Emissions. Table 4-33 presents the concentrations found for 17 PAHs, and the emission rates were also calculated.

Metals Emissions. Table 4-34 presents the concentrations and emissions for the 12 metals of interest.

Table 4-28. DRUMS RECONDITIONED DURING SAMPLING - SITE D

Contents

Resin Solution

Nutra Zirconium 18%

Anti Skinning Agent with Methylethyl Ketoxime

Linseed Oil

Grapefruit Oil

A Linseed Oil Product

Lubricating Oil

Salad Dressing

Grape Juice Concentrate

Surfactant

Mayonnaise

Carsonon N-9

Amway

Xylene

Hazardous Waste (not specified)

Silcolube

Valvoline

Freon Cleaning Agent

Castrol GTX Motor Oil

Diethanol Amine

TABLE 4-29. SITE D - OUTLET SUMMARY DATA

	Sampling time (min)	Gas volume sampled (dscm)	Moisture content (% vol)	Average stack temp (C)	Stack velocity (m/sec)	Stack flow rate (dscm/min)
<u>Run 10</u>						
MM-Outlet	150	2.505	7.0	286	29.5	361
SV-Outlet	150	1.373	8.3	285	28.8	348
<u>Run 11</u>						
MM-Outlet	180	3.037	7.6	284	28.3	347
SV-Outlet	180	1.605	5.4	284	27.8	350
<u>Run 12</u>						
MM-Outlet	180	3.002	6.8	284	27.8	346
SV-Outlet	180	1.698	5.4	285	27.8	351

MM = Multiple metals sampling train, ie. method 436 train.

SV = Semivolatile sampling train, ie. combined method 428 and 429 train.

TABLE 4-30. SITE D - DIOXIN/FURAN RESULTS FOR MM5-SV SAMPLES

Analyte	Blank train	Run 10 Outlet	Run 11 Outlet	Run 12 Outlet
Sample volume (dscm)		1.373	1.605	1.698
Stack flow rate (dscm/m)		348	350	351
Concentration CO ₂ (%)		2.8	2.8	2.8
<u>Dioxins (pg)</u>				
TCDD	197	6,080	4,290	3,770
PeCDD	100	4,680	3,450	2,680
HxCDD	108	7,770	6,610	3,420
HpCDD	1,790	6,530	4,170	2,790
OCDD	11,900	5,620	5,380	5,120
Total (pg)	14,095	30,680	23,900	17,780
Total (ng/dscm)	9.04 ^b	22.3	14.9	10.5
Total (ng/dscm @ 12% CO ₂)	38.8	95.8	63.8	44.9
Total (lb/hr)	4.18E-07	1.03E-06	6.89E-07	4.86E-07
<u>Furans (pg)</u>				
TCDF	28.8	10,500	6,740	6,740
PeCDF	35.6	5,070	3,040	3260
HxCDF	55.2	2,370	1,190	885
HpCDF	98.8	2,730	950	773
OCDF	181	2.48 ^a	3.52 ^a	5.56 ^a
Total (pg)	399	20,671	11,922	11,661
Total (ng/dscm)	0.256 ^b	15.1	7.43	6.87
Total (ng/dscm @ 12% CO ₂)	1.10	64.5	31.8	29.4
Total (lb/hr)	1.19E-08	6.93E-07	3.44E-07	3.19E-07
<u>Total Dioxins and Furans</u>				
Conc. (ng/dscm @ 12% CO ₂)	39.9	160	95.7	74.3
Emission rate (lb/hr)	4.30E-07	1.72E-06	1.03E-06	8.05E-07
<u>Surrogate recovery (%)</u>				
13C-2,3,7,8-TCDF	94	106	97	89
13C-2,3,7,8-TCDD	90	92	90	82
13C-1,2,3,7,8-PeCDF	87	96	83	77
13C-1,2,3,7,8-PeCDD	89	97	86	78
13C-1,2,3,4,7,8-HxCDF	109	120	114	100
13C-1,2,3,6,7,8-HxCDD	100	100	93	92
13C-1,2,3,4,6,7,8-HpCDF	104	105	100	95
13C-1,2,3,4,6,7,8-HpCDD	95	110	100	94
13C-12-OCDD	105	105	87	89
37Cl-2,3,7,8-TCDD ^c	94	100	89	94
13C-2,3,4,7,8-PeCDF ^c	86	89	89	93
13C-1,2,3,6,7,8-HxCDF ^c	73	68	68	76
13C-1,2,3,4,7,8-HxCDD ^c	95	101	99	104
13C-1,2,3,4,7,8,9-HpCDF ^c	74	87	83	96

- a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.
- b. Blank train "emissions" calculated using average flow rates from each location.
- c. Field surrogates spiked into XAD prior to sample collection.

Note: Outlet samples were collected from the stack of number 1 cell of an 8-cell baghouse. The emissions calculated are only from this one stack.

TABLE 4-31. SITE D - 2,3,7,8-SUBSTITUTED DIOXIN/FURAN FOR MM5-SV SAMPLES

Analyte	Blank train	Run 10 Outlet	Run 11 Outlet	Run 12 Outlet
Sample volume (dscm)		1.373	1.605	1.698
Stack flow rate (dscm/m)		348	350	351
Concentration CO2 (%)		2.8	2.8	2.8
<u>Dioxins (pg)</u>				
2,3,7,8-TCDD	18.2 a	26.4 a	8.16 a	10.4 a
1,2,3,7,8-PeCDD	7.8 a	217	157	117
1,2,3,4,7,8-HxCDD	7.84 a	252 a	192	124 a
1,2,3,6,7,8-HxCDD	32.5	574	424	261
1,2,3,7,8,9-HxCDD	4.78 a	700	512	306
1,2,3,4,6,7,8-HpCDD	1,100	3,360	2,130	1,490
1,2,3,4,6,7,8,9-OCDD	11,900	5,620	5,380	5,120
Total (pg)	13,052	10,610	8,799	7,361
Total (ng/dscm)	8.37	7.73	5.48	4.34
Total (ng/dscm @ 12% CO2)	35.9	33.1	23.5	18.6
Total (lb/hr)	3.88E-07	3.56E-07	2.54E-07	2.01E-07
<u>Furans (pg)</u>				
2,3,7,8-TCDF	20.2 a	2,230	1,350	1,330
1,2,3,7,8-PeCDF	10.4 a	314	184	195
2,3,4,7,8-PeCDF	3.6 a	560 a	310 a	280
1,2,3,4,7,8-HxCDF	15.4 a	809	418	337
1,2,3,6,7,8-HxCDF	8.67	293	158	160 a
2,3,4,6,7,8-HxCDF	7.49	526 a	244 a	210 a
1,2,3,7,8,9-HxCDF	3.3 a	116	39.6 a	43.1
1,2,3,4,6,7,8-HpCDF	53.6 a	1,750	648	473
1,2,3,4,7,8,9-HpCDF	4.16 a	263	62.1	67.2
1,2,3,4,6,7,8,9-OCDF	181	770 a	304 a	298 a
Total (pg)	252	6,703	3,267	3,058
Total (ng/dscm)	0.162	4.88	2.04	1.80
Total (ng/dscm @ 12% CO2)	0.694	20.9	8.72	7.72
Total (lb/hr)	7.50E-09	2.25E-07	9.42E-08	8.36E-08
<u>Total 2,3,7,8-substituted dioxin/furan</u>				
Conc. (ng/dscm @ 12% CO2)	36.6	54.0	32.2	26.3
Emission rate (lb/hr)	3.95E-07	5.80E-07	3.48E-07	2.85E-07

a. None detected. value shown is the detection limit. "Totals" calculated using half the detection limit.

TABLE 4-32. SITE D - 2,3,7,8-TCDD EQUIVALENTS RESULTS

Analyte	ARB equiv. factor	Run 10			Run 11			Run 12		
		Outlet			Outlet			Outlet		
		Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)	Total (pg)	(ng/dscm)	Equiv. (ng/dscm)
		Sample volume (dscm) =	1.373		Sample volume (dscm) =	1.605		Sample volume (dscm) =	1.698	
		Stack flow rate (dscm/m)	348		Stack flow rate (dscm/m)	350		Stack flow rate (dscm/m)	351	
		Concentration CO2 (%) =	2.8		Concentration CO2 (%) =	2.8		Concentration CO2 (%) =	2.8	
Dioxins										
2,3,7,8-TCDD	1	26.4 ^a	0.0192	0.0192	8.16 ^a	0.0051	0.0051	10.4 ^a	0.0061	0.0061
1,2,3,7,8-PeCDD	1	217	0.1580	0.1580	157	0.0978	0.0978	117	0.0689	0.0689
1,2,3,4,7,8-HxCDD	0.03	252 ^a	0.1835	0.0055	192	0.1196	0.0036	124 ^a	0.0730	0.0022
1,2,3,6,7,8-HxCDD	0.03	574	0.4181	0.0125	424	0.2642	0.0079	261	0.1537	0.0046
1,2,3,7,8,9-HxCDD	0.03	700	0.5098	0.0153	512	0.3190	0.0096	306	0.1802	0.0054
1,2,3,4,6,7,8-HpCDD	0.03	3,360	2.4472	0.0734	2,130	1.3271	0.0398	1,490	0.8775	0.0263
OCDD	0.03	5,620	4.0932	0.1228	5,380	3.3520	0.1006	5,120	3.0153	0.0905
Furans										
2,3,7,8-TCDF	1	2,230	1.6242	1.6242	1,350	0.8411	0.8411	1,330	0.7833	0.7833
1,2,3,7,8-PeCDF	1	314	0.2287	0.2287	184	0.1146	0.1146	195	0.1148	0.1148
2,3,4,7,8-PeCDF	1	560 ^a	0.4079	0.4079	310 ^a	0.1931	0.1931	280	0.1649	0.1649
1,2,3,4,7,8-HxCDF	0.03	809	0.5892	0.0177	418	0.2604	0.0078	337	0.1985	0.0060
1,2,3,6,7,8-HxCDF	0.03	293	0.2134	0.0064	158	0.0984	0.0030	160 ^a	0.0942	0.0028
2,3,4,6,7,8-HxCDF	0.03	526 ^a	0.3831	0.0115	244 ^a	0.1520	0.0046	210 ^a	0.1237	0.0037
1,2,3,7,8,9-HxCDF	0.03	116	0.0845	0.0025	39.6 ^a	0.0247	0.0007	43.1	0.0254	0.0008
1,2,3,4,6,7,8-HpCDF	0.03	1,750	1.2746	0.0382	648	0.4037	0.0121	473	0.2786	0.0084
1,2,3,4,7,8,9-HpCDF	0.03	263	0.1916	0.0057	62.1	0.0387	0.0012	67.2	0.0396	0.0012
OCDF	0.03	770 ^a	0.5608	0.0168	304 ^a	0.1894	0.0057	298 ^a	0.1755	0.0053
Total 2,3,7,8-TCDD equivalent concentration (ng/dscm) =				2.5355			1.3434			1.2850
Total 2,3,7,8-TCDD equivalent concentration @ 12% CO2 (ng/dscm) =				10.9			5.76			5.51
Emission (lb/hr) =				1.17E-07			6.22E-08			5.97E-08

a. Includes the detection limit value. "Totals" calculated using half the detection limit.

TABLE 4-33. SITE D – PAHs EMISSIONS RESULTS FOR MM5-SV SAMPLES

	Run 10	Run 11	Run 12	Blank train
Sample volume (dscm)	1.373	1.605	1.698	
Stack gas rate (dscm/m)	348	350	351	
Concentration CO2 (%)	2.8	2.8	2.8	
<u>PAHs (ug)</u>				
Naphthalene	21.3	13.5	17.9	10.7
Acenaphthylene	0.1 a	0.1 a	0.226	0.107
Acenaphthene	0.276	0.245	0.428	0.188
Fluorene	0.503	0.445	0.658	0.266
Phenanthrene	0.739	0.611	1.35	0.402
Anthracene	0.1 a	0.1 a	0.1 a	0.1 a
Fluoranthene	0.305	0.192	0.417	0.157
Pyrene	0.257	0.168	0.333	0.152
Retene	0.1 a	0.1 a	0.236	0.1 a
Benz(a)anthracene	0.206	0.154	0.205	0.159
Chrysene	0.175	0.149	0.1 a	0.165
Benzo(b)fluoranthene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(k)fluoranthene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(a)pyrene	0.21	0.125	0.1 a	0.201
Indeno(1,2,3-cd)pyrene	0.1 a	0.1 a	0.1 a	0.1 a
Dibenz(a,h)anthracene	0.1 a	0.1 a	0.1 a	0.1 a
Benzo(ghi)perylene	0.1 a	0.1 a	0.1 a	0.1 a
Total PAHs (ug)	24.8	16.4	22.6	13.2
Total PAHs (ug/dscm)	18.0	10.21	13.3	13.3
Total PAHs (ug/dscm @ 12% CO2)	77.3	43.8	56.9	85.5
Total PAHs (lb/hr)	0.000830	0.000473	0.000617	0.000409
<u>FIELD SURROGATE RECOVERY</u>				
D10-1-Methylnaphthalene	66%	73%	98%	92%
D12-Perylene	63%	50%	92%	77%
<u>LAB SURROGATE RECOVERY</u>				
D8-Naphthalene	41%	48%	55%	59%
D10-Acenaphthene	69%	80%	91%	94%
D10-Fluorene	71%	80%	91%	93%
D10-Phenanthrene	73%	81%	91%	90%
D10-Anthracene	70%	70%	91%	82%
D10-Fluoranthene	71%	80%	90%	89%
D10-Pyrene	73%	81%	91%	92%
D12-Benz(a)anthracene	66%	72%	93%	84%
D12-Chrysene	70%	78%	96%	91%
D12-Benzo(a)pyrene	66%	67%	101%	83%

Note(a): Values shown are the detection limits which were calculated as 2.5 times the baseline noise levels.

TABLE 4-34. SITE D - ANALYSIS RESULTS FOR MM5-MM (METALS) TRAIN

	Ag	As	Ba	Cd	Cr	Cu	Hg	Mn	Ni	Pb	Se	Zn
Run 10												
Rinse and filter, ug	33.9	402	41.0	337	58.1	759	NA	20.6	5,340	81.9	2,378	<6.29
Nitric acid impingers, ug	<1.63	<8.29	2.48	1.04	3.13	2.73	16.2	3.58	1.37	22.4	3.43	16.9
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	3.36	NA	NA	NA	NA	NA
Total, ug	33.865	402	43.5	338	61.2	761	19.6	24.1	5,341	104	2,382	<23.2
Concentration, ug/dscm	13.5	161	17.4	135	24.4	304	7.81	9.64	2,132	41.7	951	<9.26
Emissions, lb/hr	0.000646	0.00767	0.000830	0.00644	0.00117	0.0145	0.000373	0.000460	0.102	0.00199	0.0454	<0.000441
Run 11												
Rinse and filter, ug	25.5	239	35.7	336	<10.5	361	NA	13.0	5,971	92.2	1,339	<6.29
Nitric acid impingers, ug	<1.63	<8.29	4.05	1.27	3.62	4.29	7.30	5.17	1.88	24.1	3.41	20.6
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	2.68	NA	NA	NA	NA	NA
Total, ug	25.45	239	39.7	337	<14.1	365	9.98	18.1	5,972	116	1,342	<26.9
Concentration, ug/dscm	8.38	78.7	13.1	111	<4.64	120	3.29	5.97	1,967	38.3	442	<8.86
Emissions, lb/hr	0.000385	0.00361	0.000601	0.00510	<0.000213	0.00551	0.000151	0.000274	0.0903	0.00176	0.0203	<0.000406
Run 12												
Rinse and filter, ug	53.4	186	23.2	257	<10.5	292	NA	10.9	3,862	87.3	529	<6.29
Nitric acid impingers, ug	<1.63	<8.29	2.19	0.401	2.74	<1.54	4.40	4.23	0.807	17.1	2.49	7.15
KMnO4 impingers, ug	NA	NA	NA	NA	NA	NA	<0.668	NA	NA	NA	NA	NA
Total, ug	53.425	186	25.3	257	<13.2	292	4.40	15.1	3,863	104	532	<13.4
Concentration, ug/dscm	17.8	62.0	8.44	85.7	<4.41	97.4	1.47	5.02	1,287	34.8	177	<4.48
Emissions, lb/hr	0.000814	0.00284	0.000386	0.00392	<0.000202	0.00446	0.0000671	0.000230	0.0589	0.00159	0.00811	0.000205
Blank train												
Rinse and filter, ug	<2.15	38.6	1.39	7.89	<1.05	2.04	NA	1.03	84.5	54.4	28.0	<6.29
Impingers 1-6, ug	<1.63	<8.29	0.525	0.185	1.01	<1.54	NA	0.388	<0.542	2.24	<2.24	2.87
Total, ug	<3.78	<46.9	1.91	8.07	<2.06	<3.58	0.000	1.42	84.5	56.6	28.0	<9.16

NA = Not applicable. For Hg, this fraction was not analyzed due to holding time exceedance. Total mercury emissions are therefore conservative.

Continuous Emission Measurements. During the semivolatile and metals emission sampling, continuous measurements were conducted at the inlet and outlet locations for CO, SO₂, NO_x, O₂, and CO₂. Summary data for those measurements are presented in Table 4-35. Computer-generated graphs of the real time measurements are included in Appendix B.

4.4 WIRE RECLAMATION FACILITY

4.4.1 Facility Description

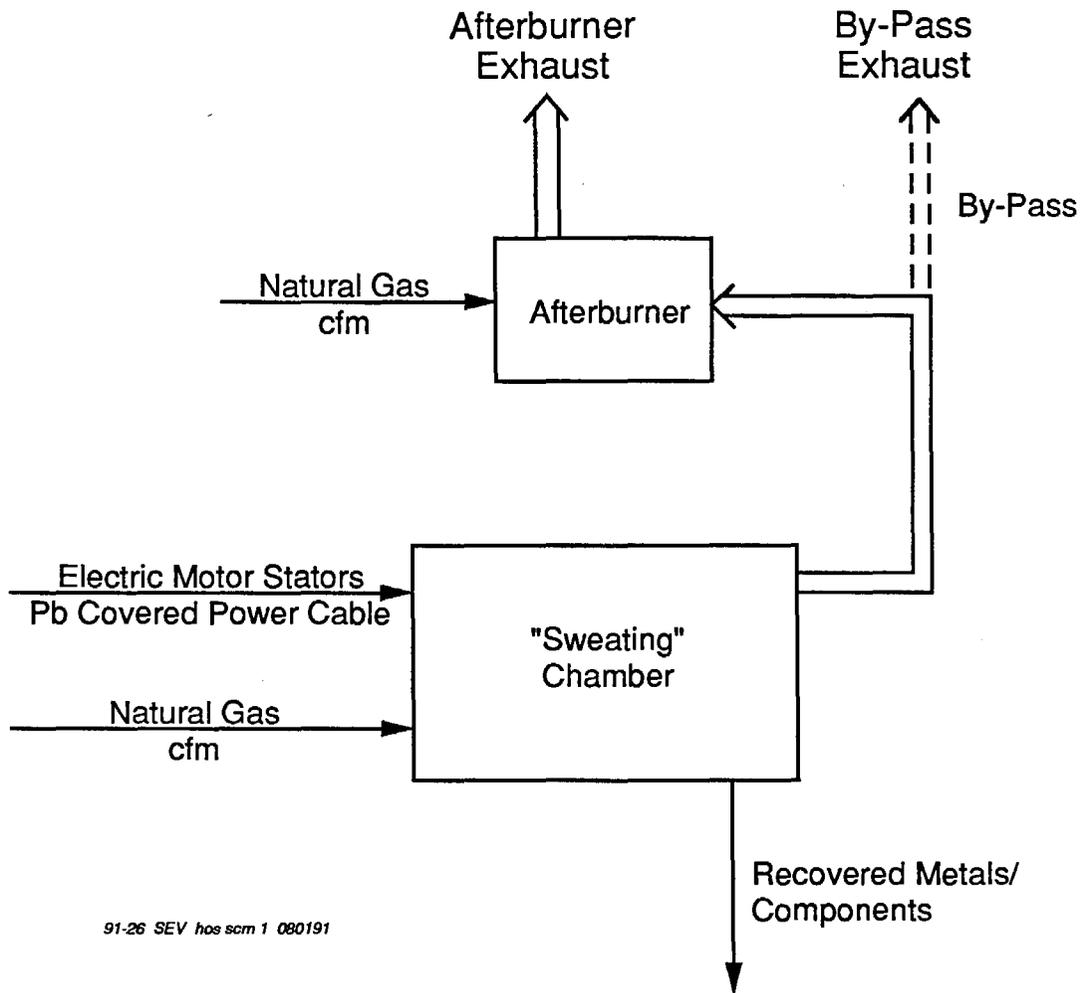
The wire reclamation facility sampled was a small facility which operated on a demand basis only. The facility recovers wire from electric motor stators and lead-covered power cable and is fueled with natural gas (Figure 4-5). Due to the small loads at this facility, it was not equipped with waste heat recovery systems. Air emissions are controlled by afterburners which are fueled by natural gas and operate between 1500° and 2000°F.

4.4.2 Sampling

This facility only had samples of ash collected after the wire had been processed, i.e., any coating removed. The plant processed several kinds of wire on the pallets sampled. These wire types included copper wire coated with various materials such as plastic coating (about 1% of the wire by weight), aluminum (about 30%), and paper/cloth (about 20%). After the completion of three separate burns, each ash sample was collected from the residue remaining after the burning of coated wire. Grab samples of the coating residue ash were collected from the pallet containing the now bare wire. These ash samples were collected from the pallet after the material had cooled enough to be safely handled. A total of three samples were collected and then submitted to ARB for analysis.

TABLE 4-35. SITE D -- CONTINUOUS EMISSION MEASUREMENTS

							12% CO ₂		
Run 10		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
	Avg	18.3	2.9	9.0	.2	28.8	40.2	.2	121.0
	Max	20.6	4.2	29.7	4.1	51.5	239.2	14.1	202.6
	Min	15.9	1.5	7.4	-3.5	.9	25.2	-17.6	6.5
Run 11		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
	Avg	17.2	2.8	10.0	4.0	15.8	42.5	16.0	71.7
	Max	20.4	4.4	70.5	43.7	45.0	229.5	168.1	360.0
	Min	10.9	.0	6.6	-.5	3.2	.0	-2.9	13.6
Run 12		O ₂	CO ₂	CO	SO ₂	NO _x	CO	SO ₂	NO _x
	Avg	19.0	2.8	7.2	1.1	24.2	30.9	4.5	102.8
	Max	22.2	3.6	9.0	15.3	42.1	42.8	61.6	168.6
	Min	13.1	2.4	3.5	-1.2	15.2	14.8	-4.6	62.4



Site E: Wire Reclamation Process Diagram

Figure 4-5

