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CHARACTERIZATION OF HAZARDOUS WASTE INCINERATION RESIDUALS

by

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NOTICE

FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of solid and hazardous wastes. These materials, if improperly dealt with, can threaten both public health and the environment. Abandoned waste sites and accidental release of toxic and hazardous substances to the environment also have important environmental and public health implications. The Hazardous Waste Engineering Research Laboratory assists in providing an authoritative and defensible engineering basis for assessing and solving these problems. Its products support the policies, programs, and regulations of the Environmental Protection Agency, the permitting and other responsibilities of State and local governments and the needs of both large and small business in handling their wastes responsibly and economically.

This report describes an effort to comprehensively characterize the chemical composition of all effluents (other than air emissions) from treatment facilities which incinerate hazardous waste, and will be useful to the user community and its regulators. For further information, please contact the Alternative Technologies Division of the Hazardous Waste Engineering Research Laboratory.

Thomas R. Hauser, Director
Hazardous Waste Engineering Research Laboratory

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SECTION 1

INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

Under the amendments to the Resource Conservation and Recovery Act (RCRA) that were passed in 1985, the Environmental Protection Agency (EPA) is required to ban the land disposal of many hazardous wastes unless it can be proved that such wastes can be safely disposed of to the land. Incineration has proved to be an effective method for the destruction of many hazardous wastes. The Office of Solid Wastes and Emergency Response (OSWER) is considering establishing the criterion that the achievement of residue quality equivalent to that from effective incineration will be required before a waste or residue will be allowed to be disposed of into the land.

EPA's Office of Research and Development (ORD) has characterized stack gas emissions from hazardous waste incinerators under a previously conducted field testing program to support OSWER's regulation development process. This testing, conducted at eight full-scale operating incinerators, was directed at assessing the incinerators' ability to achieve the required destruction and removal efficiency (DRE) of 99.99 percent. Some analysis of bottom ash, flyash, and scrubber discharge liquid was conducted. However, in order to assist OSWER in establishing a standard for residue quality, there existed a need to conduct more comprehensive chemical characterization of incinerator bottom and flyash at a greater number of hazardous waste incineration facilities.

In addition to meeting a residue quality criterion to be established by OSWER, facilities that treat, store, or dispose of hazardous waste (TSDFs) will be subject to existing pretreatment discharge standards established by the Office of Water (OW) or such standards as may be developed by OW in the future. Therefore, there exists a need for comprehensive data on the chemical characteristics of any wastewater that may be discharged from a hazardous waste incineration facility.

The objective of this project was to provide EPA data on the characteristics of both solid and liquid discharges from hazardous waste incineration facilities. Samples were collected from 10 sites, and then analyzed in the laboratory for volatiles, semivolatiles, and metals. This report summarizes those findings.

1.2 SITE SELECTION

Acurex recommended to EPA candidate incineration facilities from which samples could be procured during a site visit. Roughly 30 candidate facilities were identified from lists of previously tested facilities, EPA's database, RCRA notification and permit lists, and manufacturers' installation lists. Not all candidate facilities participated in the sampling program due to a combination of site availability, incinerator operational status, types of waste being incinerated, and budget constraints.

During the site selection process, emphasis was placed on facilities that incinerate solid waste, generate ash, use air pollution control devices, and facilities which were previously tested for air emissions and thermal destruction performance. A total of 10 sites were tested in this program comprising a broad range of hazardous waste incinerator design and current operating practice. Table 1 summarizes the incinerator configurations encountered.

Most operating hazardous waste incinerators use rotary kilns with liquid injection; six of the ten facilities tested operate with rotary kilns. All six rotary kiln sites also burned liquid wastes downstream of the rotary combustor. Typically, smaller incinerator facilities use fixed hearth designs. Three fixed hearth incinerators were tested in this program. Typically, fluidized bed incinerators are not widely used in the industry. Only one fluidized bed incinerator was tested in this program.

Most, but not all, operating hazardous waste incinerators quench ash before discharge from the system. Since APCE using wet collection methods predominates among incinerator sites, most additional ash is collected in effluent water from a scrubber or wet ESP. With increased regulation of effluent water disposal, however, it is possible for dry ash collection systems to become more popular for future systems and retrofits. Air pollution control equipment among the 10 tested facilities ranged from uncontrolled to primarily wet controls. Excluding two sites with no control devices, all sites had a quench system, a scrubber, and all but one used recycled water with caustic or ammonia added for pH control. A couple of sites with low pressure wet scrubbers also employed wet electrostatic precipitators.

The hazardous waste incinerators sampled for this study appear to be representative of those found in the general population with one exception. The two sites (with fixed hearth incinerators) that employed no active APCE may produce a nonrepresentative incinerator ash due to the lack of APCE.

TABLE 1. HAZARDOUS WASTE INCINERATOR CONFIGURATIONS AND WASTE IDs

Site No. Incinerator type	1 Rotary kiln with secondary combustor in parallel with a liquid waste-fired boiler	2 Rotary kiln with secondary combustor in parallel with a liquid injection combustor	3 Rotary kiln with secondary combustor	4 Fluidized bed incinerator	5 Fixed hearth (2 separate incineration systems)	6 Fixed hearth	7 Fixed hearth with secondary combustor	8 Rotary kiln with (secondary) liquid injection combustor. Drums also conveyed through combustor	9 Rotary kiln with secondary combustor	10 Rotary kiln with secondary combustor
EPA Waste Identification No.	D001 F001 F002 F003 F005	D001 D008	D001 F001 F002 F003 F005	None	D001 F001 F002 F003 F005	D001 F003 F005	D001 F001 F002 F003 F005	D001 F001 D002 F002 D006 F003 D007 F005 D008 U002 D009	D001 F001 F002 F003 F005	D001 F001 F002 F003 F005
Incinerator ash quench	X	X	X				X	X (rotary kiln only)	X	X (But no ash during testing)
Secondary combustion chamber with liquid waste injection							X		X	X
Hot gas cyclones	X			X						
Quench	X	X	X	X			X	X	X	X
Scrubber + demister	X	X	X	X			X	X	X	X
Acid absorbers		X								X
Waste heat recovery boiler	X (liquid-waste fired)		X							
Wet ESP's			X					X		
No control device (Constraints on fuel and firing rates)					X	X				
Selective material reburning							X	X (drums and residue)		

Sites are identified throughout this report by number. After receiving approval from EPA, the selected sites were contacted to obtain access for the sampling program, determine site-specific sampling information, and determine facility availability. All site visits and sampling were conducted during September, October, and November 1985.

1.3 APPROACH

A generic sampling and analysis protocol was prepared that addressed all liquid and solid input and output streams of a generic incineration facility. This document was prepared in August 1985 and was issued under separate cover. Sampling and analytical activities identified in this protocol conformed to established EPA liquid and solid sampling and analysis procedures, and were tailored to each facility on a site-specific basis. Site-specific sampling details are discussed in Section 2.

Typically, samples were collected during a nominal 3- to 4-hour period of incinerator operation. Composite samples for analysis were generally produced in the field or laboratory by combining a series of grab samples taken from each tested stream during the sampling period. Where appropriate, the composites reflected the relative flowrates of the streams involved.

In general, sample containers consisted of Teflon-capped amber glass jars. VOA vials with Teflon-lined lids were prepared in the field for storing samples for volatile organic analyses. A portion of the collected liquid samples was stored in a plastic bottle and preserved with nitric acid for priority pollutant metals. Containers were filled essentially to capacity, chilled, and tightly capped to prevent the loss of volatile components. Table 2 summarizes the sample collection containers.

TABLE 2. SAMPLE COLLECTION CONTAINERS[a]

Analysis Parameter	Container	Preservative
Liquids for:		
Volatile organic compounds	VOA vial (40 ml) with Teflon-lined lid[b]	None
Base neutral/acid organic compounds	Amber glass bottle (2L) with Teflon-lined lid	None
Priority pollutant metals	Plastic bottle (2L)	Nitric acid
Solids and Sludges for:		
Volatile organic compounds	Amber glass wide-mouth bottle (500 ml)	None
Base neutral/acid organic compounds	Amber glass wide-mouth bottle (500 ml)	None
Leachable priority pollutant metals	Amber glass wide-mouth bottle (500 ml)	None

[a]All samples stored on ice
[b]No air space present in the VOA vials

Appropriate labels were affixed to the sample containers after collection. The samples were then packed in ice and shipped to the Acurex Chemistry Laboratory for analysis.

Laboratory analysis of the composite samples consisted of determining volatile organic compounds, base/neutral and acid extractable organic compounds (semivolatiles), plus priority pollutant metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc) by atomic adsorption in accordance with "Test Methods for Evaluating Solid Waste," EPA publication SW-846, Second Edition, revised April 1984. The solid residue samples were subjected to the EP II toxicity leaching procedure to generate an aqueous leachate which was analyzed for priority pollutant metals. The solid residue samples were also subjected to the draft Toxicity Characteristic Leaching Procedure (TCLP), provided by EPA's Office of Solid Waste and dated December 20, 1985. The TCLP generates a leachate which was analyzed by GC/MS for volatile organics, base/neutral and acid extractable organics, and priority pollutant metals. Additional POHCs beyond those normally sought were identified and quantified for site no. 1, a site licensed to incinerate PCB contaminated materials. All analytical methods are summarized in Table 3. Tables 4, 5, and 6 list those specific compounds sought in the analyses. A summary of the samples collected and analyses performed is shown in Table 7.

A project QA/QC plan, prepared in accordance with EPA's "Interim Guidelines and Specification for Preparing Quality Assurance Project Plans," QAMS-005/80, December 29, 1980, was issued under separate cover in November 1985. A summary of QA/QC results, including the results of a system audit by EPA's QA contractor, is given in Appendix A.

TABLE 3. ANALYTICAL PROCEDURES

Measurement Parameter	Sample Type	Analytical Method[a]		
		Sample Workup	Sample Introduction	Analysis
Volatile organic priority pollutants[b]	Solids, sludges, and aqueous liquids	NA	5030	8240
	Organic liquids	Dilution (if needed)	Direct injection	8240
	Solid discharges	TCLP	5030 (extract)	8240
Semivolatile organic priority pollutants[c]	Solids and sludges	3550	Direct injection	8270
	Organic liquids	Dilution (if needed)	Direct injection	8270
	Aqueous liquids	3520	Direct injection	8270
	Solid discharges	TCLP followed by 3520 of extract	Direct injection	8270
Priority pollutant metals[d]	Solids	3010 or 3020	NA	7000 series
	Sludges	3050	NA	7000 series
	Organic liquids	3030	NA	7000 series
	Aqueous liquids	NA	NA	7000 series
	Solid discharges	1310	NA	7000 series
		TCLP	NA	7000 series

[a]All method numbers refer to SW-846, second edition; NA denotes not applicable.
[b]See Table 4 for specific compounds.
[c]See Table 5 for specific compounds and their detection limits.
[d]See Table 6 for specific metals and their analytical methods.

TABLE 4. VOLATILE ORGANICS SOUGHT IN GC/MS ANALYSIS AND THEIR DETECTION LIMITS (μg/L)

Chlorinated aliphatics		Chlorinated ethers	
Chloromethane	5	2-Chloroethyl vinyl ether	2
Methylene Chloride	3		
Chloroform	4	Aromatic hydrocarbons	
Tetrachloromethane	3		
Chloroethane	4	Benzene	3
1,1-Dichloroethane	3	Toluene	3
1,2-Dichloroethane	4	Ethyl benzene	3
1,1,1-Trichloroethane	3	Xylenes	3
1,1,2-Trichloroethane	3	Styrene	3
1,1,2,2-Tetrachloroethane	3		
1,2-Dichloropropane	3	Chlorinated aromatics	
Vinyl chloride	4		
1,1-Dichloroethylene	4	Chlorobenzene	3
1,2-Dichloroethylene	4		
Trichloroethylene	3	Others	
Tetrachloroethylene	3		
1,3-Dichloropropene	2	Acetone	5
Bromomethane	3	Carbon disulfide	4
Bromodichloromethane	3	2-Butanone	3
Dibromochloromethane	3	Vinyl acetate	3
Bromoform	3	2-Hexanone	4
		4-methyl-2-pentanone	2

TABLE 5. SEMIVOLATILE ORGANICS SOUGHT IN THE GC/MS ANALYSIS AND THEIR DETECTION LIMITS (μg/L)

Acenaphthene	3	4,6-Dinitro-o-cresol	20
Acenaphthylene	1	2,4-Dinitrophenol	20
Aniline	8	2,4-Dinitrotoluene	10
Anthracene	1	2,6-Dinitrotoluene	5
Benzidine	20	Di-n-octyl phthalate	2
Benzo(a)anthracene	1	1,2-Diphenylhydrazine (as azobenzene)	NA
Benzo(a)pyrene	1		
Benzo(b)fluoranthene	1	Fluoranthene	1
Benzo(k)fluoranthene	1	Fluorene	1
Benzo(ghi)perylene	5	Hexachlorobenzene	2
Benzoic acid	20	Hexachlorobutadiene	4
Benzyl alcohol	6	Hexachlorocyclopentadiene	5
Bis(2-chloroethoxy)methane	2	Hexachloroethane	3
Bis(2-chloroethyl)ether	2	Indeno(1,2,3-cd)pyrene	5
Bis(2-chloroisopropyl)ether	3	Isophorone	1
Bis(2-ethylhexyl)phthalate	5	2-Methylnaphthalene	3
4-Bromophenyl phenyl ether	3	2-Methylphenol	5
Butyl benzyl phthalate	11	4-Methylphenol	5
4-Chloroaniline	3	Naphthalene	1
p-Chloro-m-cresol	2	2-Nitroaniline	25
2-Chloronaphthalene	2	3-Nitroaniline	25
2-Chlorophenol	1	4-Nitroaniline	25
4-Chlorophenyl phenyl ether	1	Nitrobenzene	1
Chrysene	1	2-Nitrophenol	5
Dibenzo(a,h)anthracene	1	4-Nitrophenol	20
Dibenzofuran	1	N-nitrosodi-n-propylamine	5
1,2-Dichlorobenzene	1	N-nitrosodimethylamine	NA
1,3-Dichlorobenzene	1	N-nitrosodiphenylamine	5
1,4-Dichlorobenzene	1	Pentachlorophenol	5
3,3'-Dichlorobenzidine	40	Phenanthrene	1
2,4-Dichlorophenol	2	Phenol	4
Diethyl phthalate	2	Pyrene	1
2,4-Dimethylphenol	4	1,2,4-Trichlorobenzene	1
Dimethyl phthalate	2	2,4,5-Trichlorophenol	5
Di-n-butyl phthalate	2	2,4,6-Trichlorophenol	5

TABLE 6. ANALYSIS METHOD FOR METALS DETERMINATION

Metal	Method[a]
Antimony	7041
Arsenic	7060
Beryllium	7090
Cadmium	7130
Chromium	7190
Copper	7210
Lead	7240
Mercury	7470, 7471
Nickel	7520
Selenium	7740
Silver	7760
Thallium	7840
Zinc	7950

[a]Method numbers refer to SW-846, second edition.

TABLE 7. SUMMARY OF SAMPLES COLLECTED AND ANALYSES PERFORMED FOR 10 HAZARDOUS WASTE INCINERATION FACILITIES

		Analyses					
Stream description	Site numbers	Volatiles	Semivolatiles	Priority pollutant metals	EP II procedure	Draft TCLP	PCB identity[a]
Input Streams							
APCE aqueous supply	8	X	X	X			
Aqueous or low-Btu waste	1 and 5	X	X	X			
Coating waste solids	7	X	X	X			
Chloroprene catalyst sludge	2	X	X	X			
CS tear gas powder	4	X	X	X			
DCB coke solids	2	X	X	X			
Drum feed liquids	3	X	X	X			
Drum feed solids	3 and 9	X	X	X			
Lacquer chips	6	X	X	X			
Lacquered cardboard waste	5	X	X	X			
Latex coagulum solids	7	X	X	X			
Liquid injected waste fuels	1, 3, 5 to 10	X	X	X			
PCB-contaminated dirt	1	X	X	X			
PCB liquid waste	1	X	X	X			X
Unused automotive paint	2	X	X	X			
Vacuum filter solids	2	X	X	X			
Output Streams							
APCE aqueous effluent	1 to 4, 7 to 10	X	X	X			X
Boiler tube soot blowdown	3	X	X	X	X	X	
Cyclone ash	1 and 4	X	X	X	X	X	
Incinerator bottom ash	5 to 8	X	X	X	X	X	
Waste water treatment facility discharge water	7						
Rotary kiln ash	1 to 3, 8, 9	X	X	X	X	X	X
Stack condensate	4						

[a]Site 1 only.
APCE = Air pollution control equipment
CS = O-chlorobenzelmalonitrile
TCB = 1,4-Dichlorobutene-2

SECTION 2

RESULTS

The results presented here are organized by site. For each site a process schematic is included. This schematic shows at a glance which process streams were sampled (those with numbers only). Process operating conditions and flowrates during the test period are also summarized. A sample summary table showing the streams sampled, sample date, RCRA identification numbers, and analyses performed is given for each site. The analytical results are organized by type of analysis: volatile, metals, etc. Both concentrations and mass flowrates are reported. Residual flowrates are based on the estimated overall process rates at each site. If a particular volatile or semivolatile pollutant is <u>not</u> listed in the analytical results tables, then that compound was not detected (at the nominal detection limits) in any of the samples. The nominal detection limits reported for volatile and semivolatile analyses are the average of the individual pollutant detection limits for a given sample.

Selenium and thallium data at all sites should be considered suspect, owing to the fact that the QA/QC checks for these two metals did not meet the QA objectives (see Appendix A).

2.1 SITE 1

2.1.1 Facility Description

The incinerator design features both a liquid injection waste-fired boiler and a rotary kiln incinerator with an afterburner. The gas stream from the two incinerators is combined and passes through a gas scrubber and the exhaust stack. A flow schematic of the system is shown in Figure 1.

Solid wastes, including PCB-contaminated ballast, capacitors, and dirt, can be received and reduced in size by a totally enclosed shredder, if required, and augered into a 7-ft diameter by 34-ft long rotary kiln. The ash discharged from the kiln drops onto a water-submerged conveyor and is emptied into a 55-gal drum. The hot combustion gases from the kiln flow into a hot cyclone for particulate removal.

Off gases from the hot cyclone flow into an afterburner, or thermal oxidation unit, consisting of primary and secondary combustion units, and are quenched and cleaned in a venturi scrubber before being passed through a demister and out the stack.

Ash discharged from the kiln and hot cyclone is disposed of in a hazardous waste landfill. Scrubber water is recycled directly out of the demister and from the lagoon.

2.1.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: September 16 and 17, 1985
- Process observations:
  - -- Ash from the rotary kiln and hot cyclone is disposed of at an offsite hazardous waste landfill
  - -- Scrubber effluent disposed of in an onsite lagoon

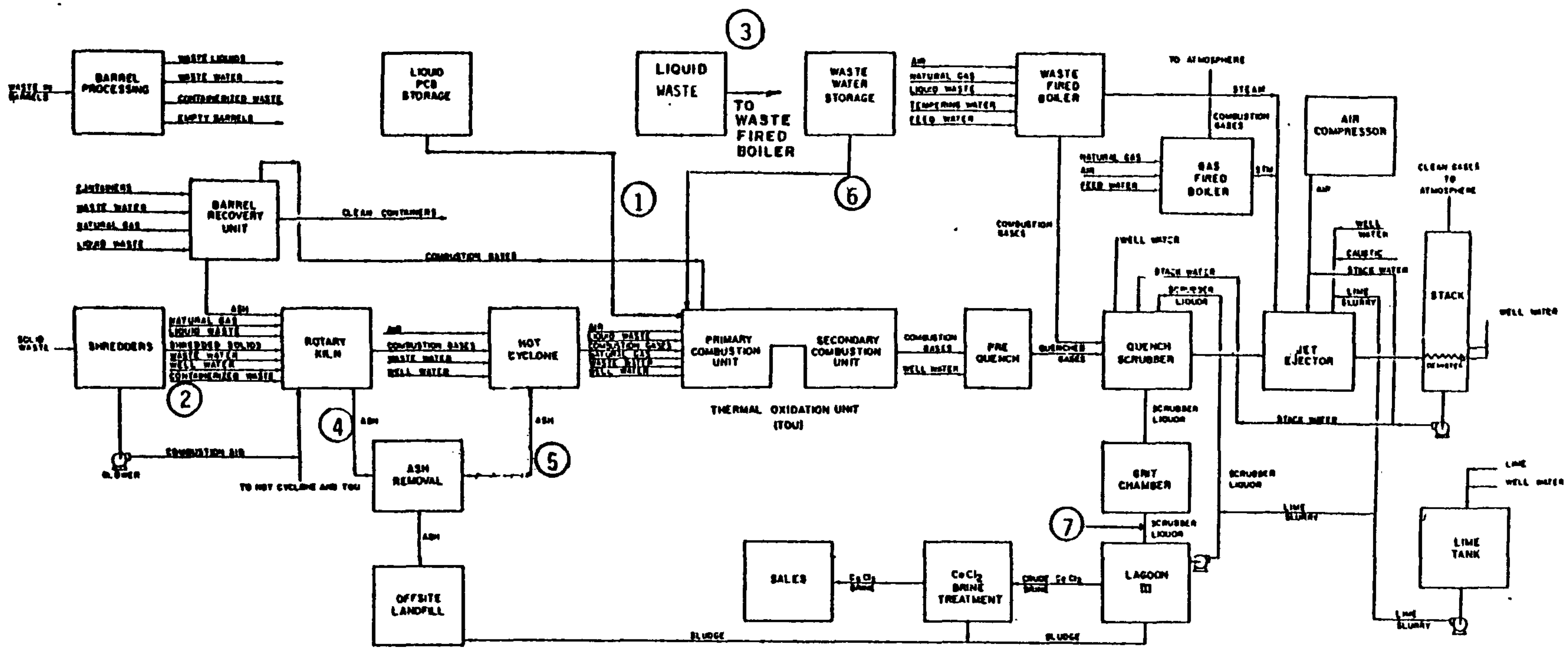


Figure 1. Site 1 incinerator schematic.

- Process conditions:
  - -- Kiln exit temperature during test 1950 to 2250°F
  - -- Hot cyclone temperature of 2000 to 2300°F
  - -- Scrubber liquid temperature of 190 to 205°F
- Estimated influent and effluent flows during test:
  - -- Aqueous waste water flow 53 lb/min
  - -- PCB liquid flow 81 lb/min
  - -- Kiln solids (dirt) feedrate 53 lb/min
  - -- Kiln ash collected in fifty 55-gal drums per day
  - -- Cyclone ash collected in seven 55-gal drums per day
  - -- Scrubber effluent generation rate 100 gal/min

A summary of all samples collected at this site and the analyses performed is presented in Table 8.

2.1.3 Analytical Results

Volatile Organics

As shown in Table 9, the volatile organics in the influent streams all appear to be commonly used industrial solvents, with 1,1,1-trichloroethane and tetrachloroethylene the principal chlorinated compounds and toluene and xylenes the principal nonchlorinated compounds.

The volatile organic concentrations discharged in the kiln ash, stream no. 4, and scrubber effluent, stream no. 7, were all less than 1 mg/kg of ash and 5 mg/L of scrubber effluent except for 34 mg/kg of 2-Butanone (also known as MEK or methyl ethyl ketone) detected in the kiln ash.

TABLE 8. SITE 1 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID numbers	Sampling date	Analyses performed[a]	Comments
1	PCB liquid waste	902425	Not RCRA	9/17/85	2,PCB	Combined with 902426 and 902428
1	PCB liquid waste	902426	Not RCRA	9/17/85	2,PCB	Combined with 902425 and 902428
3	Liquid waste (fired in boiler)	902427	b	9/17/85		
1	PCB liquid waste	902428	Not RCRA	9/17/85	2,PCB	Combined with 902425 and 902426
1	PCB liquid waste	902429	Not RCRA	9/17/85	3	
1	PCB liquid waste	902430	Not RCRA	9/17/85		
5	Cyclone ash	902431		9/17/85		
4	Kiln ash	902432		9/17/85	1,2,3, 4,5,PCB	
2	Dirt	902434	Not RCRA	9/17/85	1,2,3	
6	Aqueous waste	902435	c	9/17/85	2	
6	Aqueous waste	902436	c	9/17/85		
6	Aqueous waste	902437	c	9/17/85	3	
6	Aqueous waste	902438	c	9/17/85	1	
7	Scrubber effluent	902439		9/17/85		
7	Scrubber effluent	902440		9/17/85	3	
7	Scrubber effluent	902441		9/17/85	2,PCB	
7	Scrubber effluent	902442		9/17/85	1	
1	PCB liquid waste	902443	Not RCRA	9/17/85	1	
6	Aqueous waste	902444	c	9/17/85	1	

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]D001, F001, F002, F003, F005.

[c]Water decanted from EPA RCRA wastes D001, F001, F002, F003, F005.

TABLE 9. SITE 1 VOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	1		6		2			4		7			4
Stream description	PCB liquid waste		Aqueous waste		PCB-contaminated dirt			Kiln ash		Scrubber effluent			Kiln ash
Stream flowrate in kg/s	0.61		0.4		0.4			0.19		6.3			
Sample number	902443		902438		902434			902432		902442			902432
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	5		5		1			1		5			1
Priority Pollutants													
Methylene chloride	1500	910	ND	<2	22	88	920	ND	<0.2	ND	<30	<30	20
1,1-Dichloroethene	40	24	32	13	ND	<0.4	38	ND	<0.2	ND	<30	<30	ND
1,1-Dichloroethane	ND	<3	18	7	ND	<0.4	<11	ND	<0.2	ND	<30	<30	ND
Chloroform	ND	<3	47	19	ND	<0.4	<22	ND	<0.2	ND	<30	<30	3
1,2-Dichloroethane	ND	<3	1800	720	ND	<0.4	720	ND	<0.2	ND	<30	<30	ND
1,1,1-Trichloroethane	8800	5400	ND	<2	ND	<0.4	5400	ND	<0.2	ND	<30	<30	ND
1,1,2,2-Tetrachloroethane	190	120	ND	<2	ND	<0.4	120	ND	<0.2	ND	<30	<30	ND
Trichloroethene	730	440	16	6	ND	<0.4	450	ND	<0.2	ND	<30	<30	ND
1,1,2-Trichloroethane	250	150	130	52	ND	<0.4	200	ND	<0.2	ND	<30	<30	ND
Benzene	220	130	ND	<2	ND	<0.4	130	ND	<0.2	ND	<30	<30	2
Tetrachloroethene	3400	2100	ND	<2	4	1.6	2100	ND	<0.2	ND	<30	<30	ND
Toluene	1200	730	12	5	3	1.2	740	ND	<0.2	ND	<30	<30	6
Chlorobenzene	290	180	ND	<2	ND	<0.4	180	ND	<0.2	ND	<30	<30	ND
Ethylbenzene	380	230	ND	<2	ND	<0.4	230	ND	<0.2	ND	<30	<30	ND
All other priority pollutants	ND	<3	ND	<2	ND	<0.4	<5	ND	<0.2	ND	<30	<30	ND
Nonpriority Pollutants													
Acetone	420	260	980	390	36	14	660	ND	<0.2	ND	<30	<30	ND
2-Butanone	240	150	290	120	ND	<0.4	260	34	6.6	ND	<30	<40	ND
4-Methyl-2-pentanone	910	550	140	56	15	6	620	ND	<0.2	ND	<30	<30	ND
Total xylenes	1800	1100	ND	<2	ND	<0.4	1100	ND	<0.2	ND	<30	<30	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by detection limit in Table 4.

The volatile organics detected in the TCLP leachate included methylene chloride (20 µg/L), chloroform (3 µg/L), benzene (2 µg/L), and toluene (6 µg/L).

Semivolatile Organics

As shown in Table 10, the quantity of semivolatile organics predominates in the PCB liquid waste primarily due to 1,2,4-trichlorobenzene with a concentration of about 60 parts per thousand. Aqueous waste, stream no. 6, contains semivolatile organics in concentrations less than 20 ppm by weight. Only one semivolatile organic, bis(2-ethylhexyl) phthalate, was detected in the PCB-contaminated dirt at a concentration of 720 µg/kg (or less than 1 ppm by weight). Phthalates in concentrations of less than 1 ppm are normally considered as a contaminant from plasticizers in the laboratory and in the field.

The outlet semivolatile organics in the kiln ash, stream no. 4, and scrubber effluent, stream no. 7, were all less than the nominal detection level of 100 µg/kg (0.1 ppm by weight) and 10 µg/L (0.01 ppm by weight), respectively, except for bis(2-ethylhexyl) phthalate detected at 12 µg/L in scrubber effluent. These values are generally indicative of a high destruction efficiency incinerator.

Only one semivolatile organic, bis(2-ethylhexyl) phthalate at 56 µg/L, was detected in the TCLP leachate at a concentration of greater than 2 µg/L.

TABLE 10. SITE 1 SEMIVOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	1		6		2			4		7			4
Stream description	PCB liquid waste		Aqueous waste		PCB-contaminated dirt			Kiln ash		Scrubber effluent			Kiln ash
Stream flowrate in kg/s	0.61		0.4		0.4			0.19		6.3			
Sample number	902425, 26, 28		902435		902434			902432		902441			902432
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	20		0.6		0.2			0.1		0.01			2
Priority Pollutants													
1,2,4-Trichlorobenzene	58,000	35,000	4.3	1.7	ND	<0.1	35,000	ND	<0.02	ND	<0.1	<0.1	ND
Hexachloroethane	270	160	ND	<0.2	ND	<0.1	160	ND	<0.02	ND	<0.1	<0.1	ND
Bis(2-chloroethyl)ether	ND	<10	11	4.4	ND	<0.1	<17	ND	<0.02	ND	<0.1	<0.1	ND
1,2-Dichlorobenzene	1,100	670	1.7	0.7	ND	<0.1	670	ND	<0.02	ND	<0.1	<0.1	ND
1,3-Dichlorobenzene	230	140	ND	<0.2	ND	<0.1	140	ND	<0.02	ND	<0.1	<0.1	ND
1,4-Dichlorobenzene	1,200	730	ND	<0.2	ND	<0.1	730	ND	<0.02	ND	<0.1	<0.1	ND
Hexachlorobutadiene	210	130	1.7	0.7	ND	<0.1	130	ND	<0.02	ND	<0.1	<0.1	ND
Isophorone	ND	<10	13	5.2	ND	<0.1	<17	ND	<0.02	ND	<0.1	<0.1	ND
Naphthalene	340	210	0.66	0.3	ND	<0.1	210	ND	<0.02	ND	<0.1	<0.1	ND
Phenol	240	150	ND	<0.2	ND	<0.1	150	ND	<0.02	ND	<0.1	<0.1	ND
Bis(2-ethylhexyl)phthalate	200	120	0.72	0.3	0.28	0.1	120	ND	<0.02	0.012	0.1	0.1	56
Benzyl butyl phthalate	290	180	ND	<0.2	ND	<0.1	180	ND	<0.02	ND	<0.1	<0.1	ND
Di-n-butyl phthalate	170	100	ND	<0.2	ND	<0.1	100	ND	<0.02	ND	<0.1	<0.1	ND
Phenanthrene	78	50	ND	<0.2	ND	<0.1	50	ND	<0.02	ND	<0.1	<0.1	ND
All other priority pollutants	ND	<10	ND	<0.2	ND	<0.1	<12	ND	<0.02	ND	<0.1	<0.1	ND
Nonpriority pollutants													
2-Methylphenol	ND	<10	17,000	6.8	ND	<0.1	<19	ND	<0.02	ND	<0.1	<0.1	ND
4-Methylphenol	ND	<10	4,600	1.8	ND	<0.1	<14	ND	<0.02	ND	<0.1	<0.1	ND
2-Methylnaphthalene	940	570	ND	<0.2	ND	<0.1	570	ND	<0.02	ND	<0.1	<0.1	ND
Benzyl alcohol	ND	<10	4,400	1.8	ND	<0.1	<14	ND	<0.02	ND	<0.1	<0.1	ND
Dibenzofuran	32	20	ND	<0.2	ND	<0.1	20	ND	<0.02	ND	<0.1	<0.1	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

Priority Pollutant Metals

The input waste and output streams were all analyzed for the 13 priority pollutant metals (see Table 11). Unlike organics, the priority pollutant metals present in the input waste streams should be present in an equal mass quantity in the combined output streams (including exhaust gas). Most of the output should be in the kiln ash, stream no. 4, and the scrubber effluent stream no. 7. Ideally, a metals mass balance could be constructed to account for all priority pollutant input metals within a few percent.

The three input streams, PCB liquid waste, aqueous waste, and PCB-contaminated dirt, did not contain detectable levels (at 1 mg/L, 0.01 mg/L, and 1 mg/kg, respectively) of antimony, beryllium, selenium, silver, and thallium, and of mercury at a factor of 20 less. The two output streams, kiln ash and scrubber effluent, did not contain detectable levels of beryllium and thallium at an ash detection level of 1 mg/kg and an effluent detection limit of 0.01 mg/L.

The scrubber effluent is recycled, and so experiences a build-up of the 13 priority pollutant metals. Cadmium, chromium, and lead all exceed the EP toxicity limits. Lead is present in a concentration of more than 100 times the allowable EP toxicity concentration.

TABLE 11. SITE 1 PRIORITY POLLUTANT METALS

	Input						Total input	Output				Total output	Toxicity EP	Toxicity TCLP
Stream number	1		6		2			4		7			4	4
Stream description	PCB liquid waste		Aqueous waste		PCB-contaminated dirt			Kiln ash		Scrubber effluent			Kiln ash	Kiln ash
Stream flowrate in g/s	610		400		400			190		6300				
Sample number	902429		902437		902434			902432		902440			902432	902432
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals														
Antimony	<1	<0.6	<0.01	<0.004	<1	0.4	<1	2	0.39	0.1	0.6	1	<0.05	0.04
Arsenic	3	1.8	0.11	0.044	4	1.6	3.5	4	0.77	0.2	1.3	2	0.23	<0.01
Beryllium	<1	<0.6	<0.01	<0.004	<1	<0.4	<1	<1	0.19	<0.01	<0.1	<0.3	<0.01	<0.01
Cadmium	<2	<1.2	0.24	0.096	<2	<0.8	<2.1	<2	0.39	3.5[a]	22	22	<0.01	<0.01
Chromium	<1	<0.6	1.9	0.76	26	10	12	120	23	11[b]	69	92	0.1	0.22
Copper	150	91	40	16	28	11	120	6900	300	550	3500	4800	8.6	16
Lead	<1	<0.6	1.5	0.60	50	20	21	220	42	860[c]	5400	5500	2.3	3.5
Mercury	<0.05	<0.0	<0.005	<0.002	<0.05	<0.02	<0.05	<0.05	<0.01	0.06	0.4	0.4	<0.001	<0.001
Nickel	<2	<1.2	1.9	0.76	<2	<0.8	<2.8	190	37	<0.02	0.1	37	0.49	0.45
Selenium	<1	<0.6	<0.01	<0.004	<1	<0.4	<1	<1	<0.19	0.09	0.6	<0.8	<0.05	0.02
Silver	<1	<0.6	<0.01	<0.004	<1	<0.4	<1	11	2.1	<0.01	<0.1	2.2	<0.01	<0.01
Thallium	<1	<0.6	<0.01	<0.004	<1	<0.4	<1	<1	<0.19	<0.01	<0.1	<0.3	<0.01	<0.02
Zinc	17	10.0	39	16	180	72	98	160	31	950	6000	6000	0.14	0.42

[a]Exceeds EP toxicity limit of 1 mg/L
[b]Exceeds EP toxicity limit of 5 mg/L
[c]Exceeds EP toxicity limit of 5 mg/L

The kiln ash, stream no. 4, was subjected to two different leaching procedures, EP toxicity leaching procedure and Toxicity Characteristic Leaching Procedure (TCLP), to produce a leachate approximating that produced in a landfill. Neither of the leachates had component concentrations exceeding EP toxicity limits. The TCLP leachate concentration of lead, copper, chromium, and zinc was 1.5 to 3 times the concentration of the EP toxicity leachate. The EP toxicity leachate concentration for arsenic was at least 20 times greater than the TCLP leachate concentration. The nickel concentration for the two leachates was nearly the same while all others were indeterminate due to one or both concentrations being less than detectable limits.

PCBs

Table 12 presents the PCB analyses. Since the PCB-contaminated dirt was only slightly contaminated, a decision was made to analyze only the PCB liquid waste, kiln ash, and scrubber effluent for PCBs. The two PCB species detected were PCB-1242 and PCB-1260. Total concentration of the PCB contaminated waste is just over 12 percent by weight (and is obviously a transformer oil). PCB-1242 was detected in the kiln ash at 1400 ppb by weight and in the scrubber effluent at 44 ppb by weight. PCB-1260 was only detected in the scrubber effluent at a concentration of 105 ppb by weight.

2.2 SITE 2

2.2.1 Facility Description

The incinerator design features both a single-stage liquid injection incinerator and a rotary kiln incinerator with a natural gas fired afterburner. Each of the two incinerators has a water quench system and a cyclone which acts to remove particulate matter and droplets entrained in the

TABLE 12. SITE 1 PCBs

	Input		Output				Total output
Stream number	1		4		7		
Stream description	PCB liquid waste		Kiln ash		Scrubber effluent		
Sample number	902425, 26, 28		902432		902441		
	Concentration in mg/L	Rate in m g/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s
<u>PCB Species</u>							
1242	35,000	21,000	1.4	0.3	0.044	0.3	0.5
1260	90,000	55,000	ND	<0.01	0.105	0.7	0.7

exhaust gas. After exiting the cyclones, the gas streams combine and pass through a common absorber system, ID fan, and stack (see Figure 2).

During our visit, a liquid chloroprene catalyst sludge was fed continuously to both the liquid injection incinerator and the rotary kiln from waste feed storage tanks. The rotary kiln incinerator was also intermittently fed solid waste composed of DCB coke waste, vacuum filter cakewaste, and waste paint. These solid wastes were fed to the kiln in drums. The residence time of the solids in the kiln typically ranges from 1 to 4 hr. Ash is removed from the kiln by a water sluice system and pumped into a clarifier.

The common absorber system is a three-stage scrubber system for HCl removal. Inflow water is fed into the third stage of the scrubber, the quench, and the kiln ash sluice system. Part of the effluent from the third stage is recirculated to the second stage, and the effluent from the second stage is recirculated to the first stage. The effluent from the scrubber system is combined with effluent from the quench and clarifier before being discharged to a neutralizer unit in another part of the plant.

2.2.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: September 19 and 20, 1985
- Process observations:
  - -- Incinerator ash classified as EPA D008 and disposed of in an offsite hazardous waste landfill
  - -- Clarifier blowdown processed at onsite waste water treatment facility prior to deep well injection

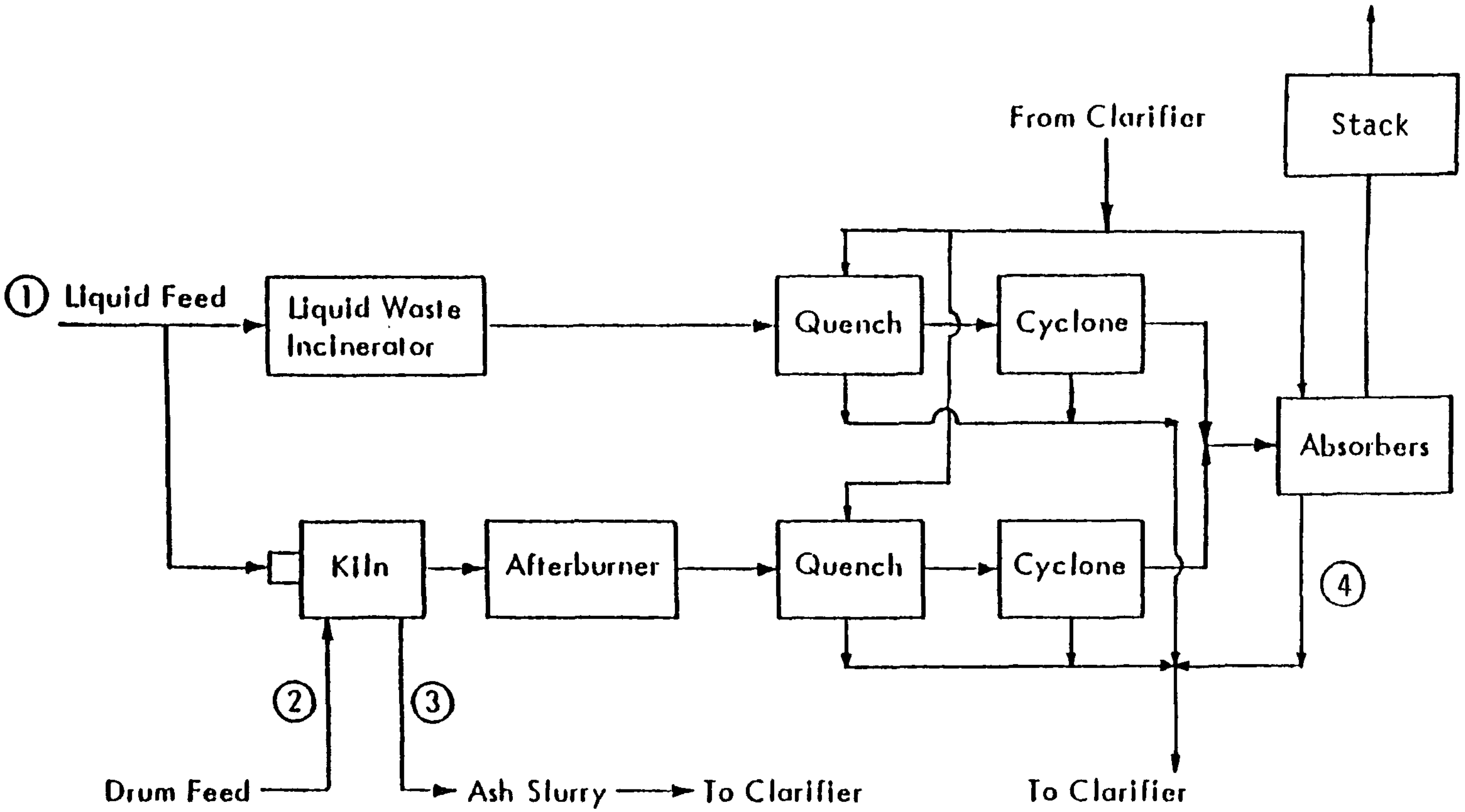


Figure 2. Site 2 incinerator schematic.

-- Make-up water is chlorinated process water from onsite power facilities

-- System rated at 40 million Btu/hr:

  - Rotary kiln -- 11 million Btu/hr
  - Afterburner -- 3 million Btu/hr
  - Liquid injection incinerator -- 26 million Btu/hr

- Process conditions:

  -- Kiln temperature 800°C with 750° to 800°C outlet

  -- Afterburner temperature range 967° to 1000°C

  -- Liquid injection incinerator temperatue 1000°C

  -- Venturi scrubbers operated at 160-in. water column differential pressure

  -- System exhaust 5- to 13-percent oxygen

- Estimated influent and effluent flows during test:

-- CD cat sludge liquid injection	500 lb/hr
-- Automotive paint	60 lb/hr
-- DCB coke solids	1,200 lb/hr
-- Vacuum filter solids	1,200 lb/hr
-- Kiln ash at sluice	50 lb/hr
-- Scrubber effluent	1,100 gal/min
-- Clarifier blowdown	15,000 lb/hr

A summary of all samples collected at this site and the analyses performed is presented in Table 13.

TABLE 13. SITE 2 PROCESS STREAM SAMPLES

Stream number	Stream description	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
4	First stage scrubber effluent	902447		9/20/85	2	
4	First stage scrubber effluent	902448		9/20/85	1	Combined with 902450 and 902461
4	First stage scrubber effluent	902449		9/20/85		
4	First stage scrubber effluent	902450		9/20/85	1	Combined with 902448 and 902461
1	Tank farm nitrile					Not sampled at site's request
1	Chloroprene catalyst sludge	902452	D001	9/20/85	2	
1	Chloroprene catalyst sludge	902453	D001	9/20/85		
1	Chloroprene catalyst sludge	902454	D001	9/20/85		
1	Chloroprene catalyst sludge	902455	D001	9/20/85		
2	DCB coke solids	902456	D001	9/20/85	1,2,3	From dichlorobutene snythesis
2	Vacuum filter solids	902457	D001	9/20/85	1,2,3	
2	Automotive paint	902458	D001	9/20/85	1,2,3	Unused but requiring disposal
3	Kiln ash at sluice	902459	D008	9/20/85	1,2,3,4,5	
4	First stage scrubber effluent	902460		9/20/85	3	
4	First stage scrubber effluent	902461		9/20/85	1	Combined with 902448 and 902450
1	Chloroprene catalyst sludge	902462	D001	9/20/85	3	
1	Chloroprene catalyst sludge	902463	D001	9/20/85	1	
1	Chloroprene catalyst sludge	902464	D001	9/20/85		

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 - TCLP followed by analyses 1, 2, and 3.

2.2.3 Analytical Results

Volatile Organics

As shown in Table 14, volatile organics detected in the automotive paint (stream no. 2) totaled about 264 g/L or approximately 26 percent by weight of the paint. Toluene accounted for about 7 percent of the paint. Toluene was also detected in the filter solids at a concentration of about 1 percent. Both liquid and solid input streams at this site were complex organic matrices preventing the identification of compounds having concentration less than 0.01 percent by weight.

The outlet volatile organic concentrations in the kiln ash, stream no. 3, and the scrubber effluent, stream no. 4, were all less than 0.1 g/kg (100 ppm by weight) and 50 µg/L (50 ppb by weight), respectively, except that chloroform was detected in the scrubber effluent at 4100 µg/L. Since the scrubber water is chlorinated, it is very likely that the chloroform is associated with chlorinating the water and not the hazardous waste incinerator.

Twelve volatile organics were detected in the TCLP leachate at concentrations ranging from a 3 µg/L for benzene and dichloroethane to 1700 µg/L for toluene. (Again, these organics were not detected in the ash sample at the detection limit of 100 ppm by weight.)

Semivolatile Organics

Inlet streams contained the expected amount of semivolatile compounds, as shown in Table 15. The wet kiln ash contained seven detected semivolatile organics in concentrations ranging from 200 to 610 µg/kg. Pyrene, fluoranthene, phenanthrene, phenol, and benzo(b)fluoranthene were not detected in the input streams, and are thus likely to be products of

TABLE 14. SITE 2 VOLATILE ORGANICS

	Input								Total input	Output				Total output	TCLP
Stream number	1		2		2		2			3		4			3
Stream description	Chloroprene catalyst sludge		Automotive paint		DCR coke solids		Vacuum filter solids			Kiln ash at sluice		Scrubber effluent			Kiln ash at sluice
Stream flowrate in kg/s	0.063		0.0076		0.15		0.15			0.0063		69			
Sample number	902463		902458		902456		902457			902459		902448, 50, 61			902459
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in ug/L
Detection Limit Factor[a]	100		100		100		100			100		0.050			1
Priority Pollutants															
Methylene chloride	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	14
Chloroform	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	4.1	280,000	280,000	4
1,2-Dichloroethane	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	3
Trichloroethene	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	7
Benzene	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	3
Tetrachloroethene	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	6
Toluene	ND	<6	73,000	520	ND	<15	9,700	1,500	2,000	ND	<1	ND	<3,500	<3,500	1700
Ethylbenzene	ND	<6	14,000	110	ND	<15	ND	<15	<140	ND	<1	ND	<3,500	<3,500	25
All other priority pollutants	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	ND
Nonpriority Pollutants															
Acetone	ND	<6	95,000	720	ND	<15	ND	<15	<75	ND	<1	ND	<3,500	<3,500	590
4-Methyl-2-pentanone	ND	<6	ND	<1	ND	<15	ND	<15	<37	ND	<1	ND	<3,500	<3,500	47
2-Butanone	ND	<6	42,000	320	ND	<15	ND	<15	<35	ND	<1	ND	<3,500	<3,500	280
Total xylenes	ND	<6	40,000	300	ND	<15	500	76	<40	ND	<1	ND	<3,500	<3,500	80

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table.
Note: all less than values should be multiplied by corresponding detection limits in Table 4.

TABLE 15. SITE 2 SEMIVOLATILE ORGANICS

	Input								Total input	Output				Total output	TCLP
Stream number	1		2		2		2			3		4			3
Stream description	Chloroprene catalyst sludge		Automotive paint		DCB coke solids		Vacuum filter solids			Kiln ash at sluice		Scrubber effluent			Kiln ash
Stream flowrate in kg/s	0.063		0.0076		0.15		0.15			0.0063		69			
Sample number	902452		902458		902456		902457			902459		902447			902459
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	4		20		0.1		5			0.1		0.010			2
Priority Pollutants															
Acenaphthene	ND	<0.3	ND	<0.2	ND	<0.02	16	2	<3	ND	<0.001	ND	<1	<1	ND
1,2,4-Trichlorobenzene	ND	<0.3	ND	<0.2	0.23	0.03	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
1,2-Dichlorobenzene	ND	<0.3	ND	<0.2	0.34	0.05	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
2,4-Dinitrotoluene	ND	<0.3	ND	<0.2	ND	<0.02	30	5	5	ND	<0.001	ND	<1	<1	ND
Fluoranthene	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	0.61	0.004	ND	<1	<1	ND
Naphthalene	ND	<0.3	1,000	7.6	ND	<0.02	110	17	24	ND	<0.001	ND	<1	<1	ND
N-nitrosodiphenylamine	1800	1100	ND	<0.2	ND	<0.02	ND	<1	110	ND	<0.001	ND	<1	<1	ND
Phenol	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	1	0.35	0.002	0.033	2	2	ND
Bis(2-ethylhexyl)phthalate	ND	<0.3	520	3.9	0.27	0.04	65	10	14	0.31	0.002	0.032	2	2	24
Benzyl butyl phthalate	ND	<0.3	ND	<0.2	0.16	0.02	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
Di-n-butyl phthalate	ND	<0.3	ND	<0.2	0.65	0.1	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
Benzo(a)anthracene	210	130	ND	<0.2	ND	<0.02	ND	<1	14	ND	<0.001	ND	<1	<1	ND
Benzo(b)fluoranthene	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	0.2	0.001	ND	<1	<1	ND
Chrysene	ND	<0.3	ND	<0.2	ND	<0.02	8.5	1	<2	0.2	0.001	ND	<1	<1	ND
Fluorene	ND	<0.3	ND	<0.2	ND	<0.02	20	3	3	ND	<0.001	ND	<1	<1	ND
Phenanthrene	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	0.48	0.003	ND	<1	<1	ND
Pyrene	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	0.66	0.004	ND	<1	<1	ND
All other priority pollutants	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
Nonpriority Pollutants															
Benzoic acid	ND	<0.3	ND	<0.2	0.32	0.05	ND	<1	<1	ND	<0.001	ND	<1	<1	ND
4-Methylphenol	ND	<0.3	ND	<0.2	ND	<0.02	ND	<1	<1	ND	<0.001	0.015	1	1	ND
2-Methylnaphthalene	ND	<0.3	ND	<0.2	ND	<0.02	600	91	91	ND	<0.001	ND	<1	<1	ND
Benzyl alcohol	200	130	ND	<0.2	ND	<0.02	ND	<1	14	ND	<0.001	ND	<1	<1	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table.
Note: all less than values should be multiplied by corresponding detection limits in Table 5.

incomplete combustion or were introduced with the quench water. The other two detected semivolatiles were present in the input waste streams. The scrubber effluent contained only two detected semivolatile organics, phenol and bis(2-ethylhexyl) phthalate, each at approximately 30 µg/L. These two were also detected in the kiln ash sample.

Only bis(2-ethylhexyl)phthalate was detected in the kiln ash leachate from the TCLP. Frequently, the presence of bis(2-ethylhexyl)phthalate is associated with contamination but, in this case, it was in the automotive paint at a relatively high concentration (0.05 percent), and therefore may not have been completely destroyed.

Priority Pollutant Metals

Table 16 presents the results of the analyses for priority pollutant metals. Antimony, arsenic, beryllium, and cadmium were generally not detected in the input streams and were in low concentrations or not detected in the output streams as well. The vacuum filter solids had relatively high levels of nickel, zinc, copper, lead, chromium, and mercury. Measurable levels of selenium, lead, silver, and mercury were also found in the other three input streams.

Output concentrations, as expected, were highest in the kiln ash ranging from 640 mg/kg for zinc to 7300 mg/kg for nickel. Lower concentration metals such as lead (100 mg/kg), mercury (2.2 mg/kg), silver (8 mg/kg), and selenium (6 mg/kg) exceed EP leachate toxicity limits. With the exception of nickel, present at a concentration of 23 mg/L, the sludge was found to be essentially void of priority pollutant metals.

The EP and TCLP leachates from the kiln ash generally have metal concentrations less than detection limits (nominally 0.01 mg/L, but as low as

TABLE 16. SITE 2 PRIORITY POLLUTANT METALS

	Input								Total input	Output				Total output	Toxicity	
															EP	TCLP
Stream number	1		2		2		2			3		4			3	3
Stream description	Chloroprene catalyst sludge		Automotive paint		DCB coke solids		Vacuum filter solids			Kiln ash at sluice		Scrubber effluent			Kiln ash	Kiln ash
Stream flowrate in kg/s	0.063		0.0076		0.15		0.15			0.0063		69				
Sample number	902462		902458		902456		902457			902459		902460			902459	902459
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals																
Antimony	<0.01	<0.001	<0.01	<0.0001	<1	<0.2	4	0.6	<0.8	6	0.04	<0.01	<1	<1	<0.01	<0.01
Arsenic	<0.01	<0.001	<0.01	<0.0001	<1	<0.2	<1	<0.2	<0.3	2	0.01	<0.01	<1	<1	<0.01	<0.01
Beryllium	<0.01	<0.001	<0.01	<0.0001	<2	<0.3	<2	<0.3	<0.6	<2	<0.01	<0.01	<1	<1	<0.01	<0.01
Cadmium	<0.01	<0.001	<0.01	<0.0001	<1	<0.2	<1	<0.2	<0.3	<1	<0.01	<0.01	<1	<1	<0.01	<0.01
Chromium	0.16	0.01	<0.05	<0.0004	<2	<0.3	150	23	23	110	0.69	<0.05	<3	<4	0.09	0.1
Copper	0.28	0.018	<0.04	<0.0003	10	<1.5	560	85	85	840	5.3	<0.04	<3	<8	3.7	7.9
Lead	<0.01	<0.001	0.5	0.0038	<1	<0.2	250	38	38	100	0.63	<0.01	<1	<1	<0.01	<0.01
Mercury	<0.001	<0.0001	<0.001	<0.00001	0.2	0.03	2.2	0.3	<0.4	1.5	0.01	0.013	1	<1	<0.001	<0.001
Nickel	17	1.1	0.12	0.0009	580	88	6,100	920	1000	7,300	46	23	1600	1600	6.9	6
Selenium	2	0.13	<0.01	<0.0001	<1	<0.2	<1	<0.2	<0.4	6	0.04	<0.01	<1	<1	0.2	0.05
Silver	0.03	0.002	11	0.083	<1	<0.2	<1	<0.2	<0.4	8	0.05	<0.02	<1	<1	0.05	<0.01
Thallium	0.8	0.05	<0.01	<0.0001	<1	<0.2	<1	<0.2	<0.4	<1	<0.01	1.3	90	90	<0.01	<0.02
Zinc	0.23	0.014	0.25	0.0019	25	3.8	2,000	300	310	640	4	0.02	1	5	1.8	2

0.001 mg/L for mercury), and agree to within 15 percent. Three exceptions include copper, selenium, and silver.

2.3 SITE 3

2.3.1 Facility Description

This two-level facility includes a large materials handling building, tank farm for liquid waste storage, specially designed feed system for 55-gal drums, rotary kiln, mixing chamber, secondary combustion chamber, extensive air and water pollution control, a 200-ft discharge stack, and necessary accessory equipment. A schematic of this facility is shown in Figure 3.

Although tank truck unloading is provided, most of the industrial wastes are hauled to the materials handling building in well-labeled 55-gal drums. After sorting, liquid wastes are pumped through pipes to the tank farm; nonpumpable wastes (oily rags, sludges, etc.) are fed directly into the kiln by a semiautomatic feed system that recovers the drum if possible. Otherwise, drum and contents are dropped into the kiln.

A burner in the slowly rotating kiln burns liquid wastes pumped from the tank farm. The minimum temperature is 2000°F. Burned out drums and ash drop from the kiln into a water quench chamber and are carried on a conveyor to trucks that take the residue to a storage area. The iron in the residue, which is from the steel drums, is picked up with a magnet and recycled like scrap metal.

Gas and smoke flow from the kiln through a mixing chamber and into a secondary combustion chamber to complete the burning process. The resulting gas stream then enters the air pollution control system that includes a series of water sprays that cool and clean the gas stream with up to 1400 gal of water per minute.

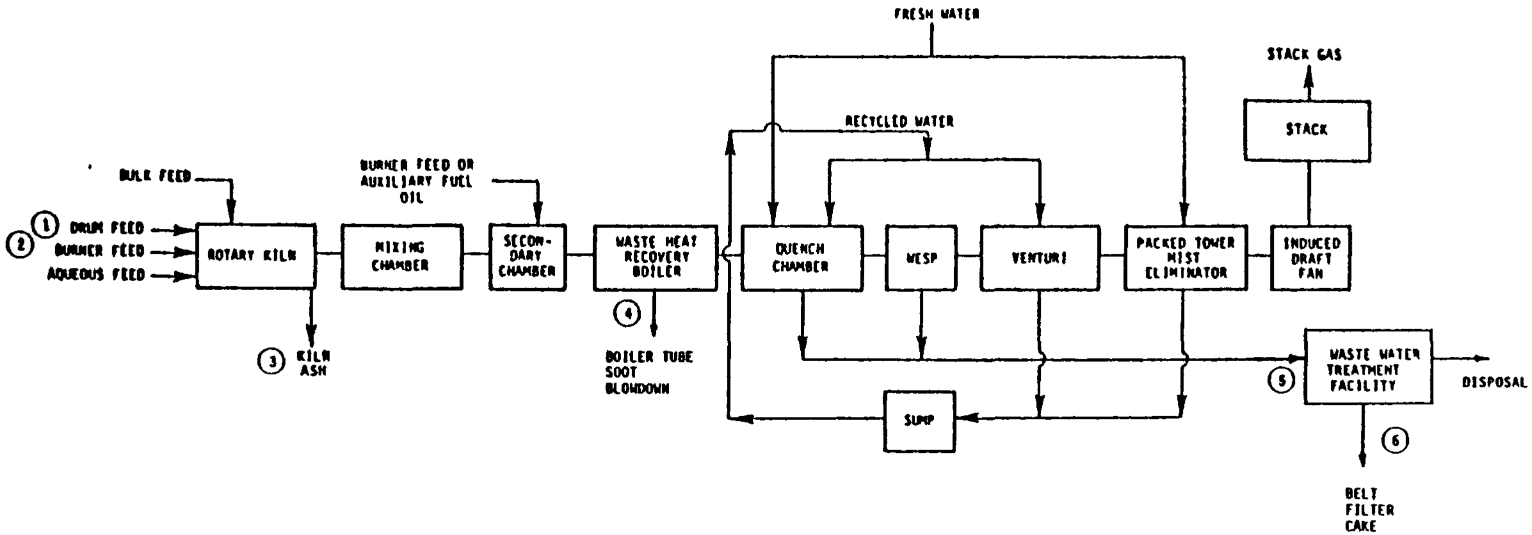


Figure 3. Site 3 incinerator schematic.

A 500-hp fan draws the gas stream through the air pollution control train and forces it up the 200-ft stack. Meanwhile, dirty water from the air pollution control system is neutralized with lime and pumped to the onsite wastewater treatment facility. The wastewater sludge is hauled to a secure landfill because it contains small amounts of heavy metals.

This facility operates 24 hours a day, 7 days a week, except for about four 10-day shutdown periods each year for maintenance. Only the waste produced by the corporation is processed at this facility.

2.3.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: September 23 and 24, 1985
- Process conditions:
  - -- Stack gas O_2 concentration 14 percent on a wet basis
  - -- Stack gas CO_2 concentration 5 percent on a wet basis
- Estimated influent and effluent flows during test:
  - -- APCE effluent flow 2 million gal/day
  - -- Wastewater treatment facility generates 4 wet tons of sludge/day
  - -- Ash generation rate of 5 tons/day
  - -- Average system capacity is 90 million Btu/hr and 500 drums/day

A summary of all samples collected at this site and the analyses performed is presented in Table 17.

TABLE 17. SITE 3 PROCESS STREAM SAMPLES

Stream number	Stream description	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
1	Drum feed (solids)	902466	D001	9/24/85	1,2,3	
2	Liquid waste fuel	902467	b	9/24/85	2,3	Combined with 902467, 68, 69, 70
2	Liquid waste fuel	902468	b	9/24/85	2,3	Combined with 902467, 68, 69, 70
2	Liquid waste fuel	902469	b	9/24/85	2,3	Combined with 902467, 68, 69, 70
2	Liquid waste fuel	902470	b	9/24/85	2,3	Combined with 902467, 68, 69, 70
2	Liquid waste fuel	902472	b	9/24/85		
1	Drum feed (liquid)	902475	D001	9/24/85		
2	Liquid waste fuel	902478	b	9/24/85	1	
3	Kiln ash from drag conveyor	902479		9/24/85	1,2,3,4,5	
4	Boiler tube soot blowdown	902481		9/24/85	1,2,3,4,5	
6	Belt filter cake	902482		9/24/85	1,2,3,4,5	
5	APCE effluent water	902483		9/24/85	2	
5	APCE effluent water	902484		9/24/85		
5	APCE effluent water	902485		9/24/85	3	
5	APCE effluent water	902486		9/24/85	1	Combined with 902487
5	APCE effluent water	902487		9/24/85	1	Combined with 902486

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]EPA ID Numbers D001, F001, F002, F003, F005

2.3.3 Analytical Results

Volatile Organics

As shown in Table 18, the liquid waste fuel, stream no. 2, contained high levels of volatile organics. The combined concentration of all detected organic solvents in the liquid waste was approximately 500 g/L (50 percent). The three detected organics in the drum feed solids included toluene, ethylbenzene, and xylenes.

Output streams were essentially void of volatile organics. Only the kiln ash and the belt filter cake were found to have volatile organics with concentrations ranging from about 1 to 4 ppm. The belt filter cake represents primarily the particulate captured in the APCE effluent water. Volatile organics detected in the belt filter cake are attributed primarily to flue gas particulate because effluent water (stream no. 5) was found to be void of volatile organic compounds.

TCLP analyses were performed on kiln ash and boiler tube soot leachates. Kiln ash leachate included carbon disulfide (900 µg/L), toluene (27 µg/L), methylene chloride (23 µg/L), xylenes (15 µg/L), and ethylbenzene (2 µg/L). Analysis of boiler tube soot leachate revealed chloromethane (50 µg/L), bromomethane (9 µg/L), and toluene (10 µg/L). These organics were not found in the soot sample (stream no. 4) because the analytical detection limit was too high. Since chloromethane and bromomethane were not detected in any incinerator input streams, their presence in the leachates may be attributed to byproducts of combustion or the result of contaminated APCE effluent water.

TABLE 18. SITE 3 VOLATILE ORGANICS

	Input				Total input	Output								Total output	TCLP	
Stream number	1		2			3		4		5		6			3	4
Stream description	Drum feed solids		Liquid waste fuel			Kiln ash		Boiler tube soot		APCE effluent water		Belt filter cake[a]			Kiln ash	Boiler tube soot
Stream flowrate in kg/s	1.9		0.76			0.053		0.010		87		0.042				
Sample number	902466		902478			902479		902481		902486, 87		902482			902479	902481
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[b]	100		100			0.5		100		0.001		0.5			1	1
Priority Pollutants																
Chloromethane	ND	<190	ND	<76	<270	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	50
Bromomethane	ND	<190	ND	<76	<270	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	9
Methylene chloride	ND	<190	9,800	7,400	7,400	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	23	ND
1,1-Dichloroethane	ND	<190	46,000	35,000	35,000	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
1,1,1-Trichloroethane	ND	<190	29,000	22,000	22,000	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
1,1,2-Trichloroethane	ND	<190	47,000	36,000	36,000	ND	<0.03	ND	<1	ND	<0.1	2	0.08	<1	ND	ND
Tetrachloroethene	ND	<190	200	150	<340	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
Toluene	28,000	54,000	52,000	39,000	93,000	2.5	0.13	ND	<1	ND	<0.1	4.4	0.18	<1	27	10
Ethylbenzene	200	390	4,500	3,400	3,800	0.5	0.03	ND	<1	ND	<0.1	1.2	0.05	<1	2	ND
All other priority pollutants	ND	<190	ND	<76	<270	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
Nonpriority Pollutants																
Acetone	ND	<190	160,000	120,000	120,000	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
Carbon disulfide	ND	<190	ND	<76	<270	2.8	0.15	ND	<1	ND	<0.1	ND	<0.02	<1	900	ND
2-Butanone	ND	<190	100,000	76,000	76,000	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
4-Methyl-2-pentanone	ND	<190	30,000	23,000	23,000	ND	<0.03	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
Styrene	ND	<190	ND	>76	<270	4.3	0.23	ND	<1	ND	<0.1	ND	<0.02	<1	ND	ND
Total xylenes	700	1,400	17,000	13,000	14,000	1.5	0.08	ND	<1	ND	<0.1	2.3	0.1	<1	15	ND

[a]Belt filter cake is physically removed from APCE effluent water, and therefore its flowrates are not included in the total output flowrates.
[b]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table.
Note: all less than values should be multiplied by corresponding detection limits in Table 4.

Semivolatile Organics

As shown in Table 19, several semivolatile organics were detected in both input streams. Concentrations of priority pollutants in the liquid waste fuel was substantially higher than that of the drum feed solids (pproximately 1.2 versus 0.005 percent by weight).

Output samples included kiln ash, stream no. 3, boiler tube soot, stream no. 4, APCE effluent water, stream no. 5, and belt filter cake, stream no. 6. Kiln ash had detectable levels of bis(3-ethylhexyl)phthalate (4400 µg/L), phenol (3000 µg/L), as well as lower levels of other phthalates, fluoranthene, naphthalene, and 2-methylnaphthalene, most of which were present in the input streams. The only semivolatile detected in the boiler tube soot was bis(2-ethylhexyl) phthalate (400 µg/L). The APCE effluent water did not contain any semivolatile compounds; however, the belt filter cake was found to have several semivolatile organic compounds. Concentrations however, were in ppb to low ppm levels. Half of the detected organics, bis(2-ethylhexyl)phthalate (2400 µg/L), diethyl phthalate (470 µg/L). phenol (260 µg/L), di-n-butyl phthalate (140 µg/L), and naphthalene (130 µg/L), were detected in the input. The other five organics, pyrene, fluoranthene, phenanthrene, di-n-octyl phthalate, and chrysene, were not detected in the input streams and are likely products of incomplete combustion.

TCLP leachates were generated for three samples -- kiln ash, boiler tube soot, and belt filter cake. Phenol (116 µg/L) and diethyl phthalates (6 to 30 µg/L) were detected in the kiln ash and boiler tube soot leachates. No semivolatile organics were detected in the belt filter cake leachate.

	Input				Total input	Output								Total output	TCLP		
Stream number	1		2			3		4		5		6			3	4	6
Stream description	Drum feed solids		Liquid waste fuel			Kiln ash		Boiler tube soot		APCE effluent water		Belt filter cake[a]			Kiln ash	Boiler tube soot	Belt filter cake
Stream flowrate in kg/s	1.9		0.76			0.053		0.010		87		0.042					
Sample number	902466		902467,68,69,70			902479		902481		902483		902482			902479	902481	902482
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in µg/L	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[b]	0.1		20			0.1		0.1		10		0.100			2	2	2
Priority Pollutants																	
Fluoranthene	ND	<0.2	ND	<15	<15	0.61	0.03	ND	<0.001	ND	<1	0.36	0.015	<1	ND	ND	ND
Isophorone	ND	<0.2	350	260	260	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
Naphthalene	0.23	0.4	62	47	47	0.17	<0.01	ND	<0.001	ND	<1	0.13	0.005	<1	ND	ND	ND
Phenol	4.7	9.1	460	350	360	3	0.16	ND	<0.001	ND	<1	0.26	0.011	<1	116	ND	ND
Bis(2-ethylhexyl)phthalate	13	25	86	65	90	4.4	0.23	0.4	0.004	ND	<1	2.4	0.101	<1	ND	30	ND
Benzyl butyl phthalate	ND	<0.2	ND	<15	<15	0.28	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
Di-n-butyl phthalate	430	0.8	ND	<15	<15	0.41	<0.02	ND	<0.001	ND	<1	0.14	0.006	<1	ND	ND	ND
Di-n-octyl phthalate	ND	<0.2	ND	<15	<15	0.76	<0.04	ND	<0.001	ND	<1	0.16	0.007	<1	ND	ND	ND
Diethyl phthalate	ND	<0.2	11,000	8,300	8,300	ND	<0.01	ND	<0.001	ND	<1	0.47	0.02	<1	6	ND	ND
Dimethyl phthalate	28	54	18	14	68	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
Chrysene	ND	<0.2	ND	<15	<15	ND	<0.01	ND	<0.001	ND	<1	0.13	0.005	<1	ND	ND	ND
Phenanthrene	ND	<0.2	ND	<15	<15	ND	<0.01	ND	<0.001	ND	<1	0.34	0.014	<1	ND	ND	ND
Dibenzo(a,h)anthracene	ND	<0.2	ND	<15	<15	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
Pyrene	ND	<0.2	ND	<15	<15	ND	<0.01	ND	<0.001	ND	<1	0.63	0.026	<1	ND	ND	ND
All other priority pollutants	ND	<0.2	ND	<15	<15	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
Nonpriority Pollutants																	
Benzoic acid	1.6	3.1	ND	<15	<18	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
2-Methylphenol	0.94	1.8	ND	<15	<17	ND	<0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND
2-Methylnaphthalene	0.22	0.4	ND	<15	<15	0.12	0.01	ND	<0.001	ND	<1	ND	<0.004	<1	ND	ND	ND

[a]Belt filter cake is physically removed from APCE effluent water, and therefore its flowrates are not included in the total output flowrates.
[b]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note all less than values should be multiplied by corresponding detected limits in Table 5.

Priority Pollutant Metals

From Table 20, the two input waste streams, drum feed solids and liquid waste fuel, contained approximately 750 mg/kg and 500 mg/kg of zinc. Concentrations of all other priority pollutant metals were generally below 10 ppm.

Output concentrations in the kiln ash and boiler soot ash generally saw much higher concentrations than in the input streams. Boiler tube soot generally had the highest concentrations, which might be expected due to metals erosion from boiler tubes. For the kiln ash and boiler tube soot, zinc was present in the highest concentration with chromium, lead, copper, and nickel being substantially lower. APCE effluent water contained relatively dilute concentrations of priority pollutant metals as expected due to the high water flow. Zinc and thallium were present in the highest concentration (16 mg/L each) with lead being present at a relatively high 2.6 mg/L. Priority pollutant metals, as expected, were generally detected at a higher level in the belt filter cake than in the APCE effluent water. High levels of zinc (5000 mg/kg) and lead (3100 mg/kg) were both detected with lower levels of antimony (440 mg/kg), chromium (180 mg/kg), copper (160 mg/kg) and the remaining metals.

The EP and TCLP leachates for the three solid residuals, kiln ash, boiler tube soot, and belt filter cake, are generally within a factor of two or less for comparable samples. The boiler tube soot EP leachate exceeds the EP toxicity limit for cadmium (8.6 mg/L), while the TCLP leachate exceeds the limit for cadmium (6.7 mg/L) as well as selenium (1.4 mg/L). The belt filter cake EP and TCLP leachate each exceed toxicity limits for cadmium

TABLE 20. SITE 3 PRIORITY POLLUTANT METALS

	Input				Total input	Output								Total output	Toxicity					
															EP			TCLP		
Stream number	1		2			3		4		5		6			3	4	6	3	4	6
Stream description	Drum feed solids		Liquid waste fuel			Kiln ash		Boiler tube soot		APCE effluent water		Belt filter cake[a]			Kiln ash	Boiler tube soot	Belt filter cake	Kiln ash	Boiler tube soot	Belt filter cake
Stream flowrate in kg/s	1.9		0.76			0.053		0.010		87		0.042								
Sample number	902466		902467,68,69,70			902479		902481		902485		902482			902479	902481	902482	902479	902481	902482
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals																				
Antimony	<1	<2	10	8	8	18	0.95	190	1.9	0.61	53	440	18	56	0.06	<0.01	0.08	<0.01	<0.01	0.18
Arsenic	<1	<2	<1	<1	<3	3	0.16	14	0.14	<0.01	<0.9	11	0.5	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	<2	<4	<1	<1	<5	<7	<0.37	6	0.06	<0.01	<0.9	<7	<0.3	<1	<0.01	<0.01	<0.01	<0.01	0.08	<0.01
Cadmium	<1	<2	1	<1	<3	<1	<0.05	61	0.61	0.04	3.5	41	1.7	4	<0.01	8.6[b]	1.5[b]	<0.01	6.7[b]	1.8[b]
Chromium	3	6	<3	<2	6	660	35	1800	18	0.1	8.7	180	7.6	61	0.03	0.03	0.03	0.06	0.36	<0.02
Copper	10	19	7	5	25	400	21	780	7.8	0.26	23	160	6.7	52	0.02	31	1.6	0.09	21	1.7
Lead	6	12	5	4	15	610	32	5000	50	2.6	230	3100	130	310	0.04	4.4	28[c]	<0.01	4.5	16[c]
Mercury	<0.1	<0.2	1.2	1	1	<0.1	<0.01	0.2	0.02	0.013	1.1	15	0.6	1	<0.001	<0.001	0.003	<0.001	<0.001	0.008
Nickel	11	21	<2	<2	21	240	13	4700	47	0.17	15	130	5.5	75	0.79	20	0.36	0.8	13	0.55
Selenium	<1	<2	<4	<3	<5	13	0.68	13	0.13	<0.01	<0.9	15	0.6	<2	0.17	<1	0.2	0.4	1.4[b]	0.04
Silver	4	8	13	10	18	4	0.21	190	1.9	0.04	3.5	70	2.9	6	0.02	0.09	<0.01	0.05	0.05	<0.01
Thallium	<1	<2	8	6	6	7	0.37	9	0.09	16	1400	2	0.1	1400	<0.01	0.7[d]	<0.01	<0.02	<0.02	<0.02
Zinc	720	1400	460	350	1700	21000	1100	32000	320	16	1400	5000	210	2800	27	1400	230	43	1200	300

[a]Belt filter cake is physically removed from APCE effluent water, and therefore its flowrates are not included in the total output flowrates.
[b]Exceeds EP Toxicity limit of 1 mg/L.
[c]Exceeds EP Toxicity limit of 5 mg/L.
[d]True value likely to be much lower, because of interferences during analysis.

(1.5 mg/L and 1.8 mg/L, respectively) and lead (28 mg/L and 16 mg/L, respectively).

2.4 SITE 4

2.4.1 Facility Description

The incinerator facility features three separate incinerators, namely a fluidized bed combustor, a chain grate incinerator, and a rotary kiln incinerator. Only the fluidized bed incinerator is discussed since the other two incinerators were not in operation during the site sampling visit. A schematic of this incinerator is shown in Figure 4.

The facility normally receives irritant and/or explosive material which is excess to current requirements, not completely consumed in use, or present as a contaminant. The fluidized bed combustor design allows for the incineration of those wastes that are powders, granular material, and pumpable liquids or slurries. The liquids can be pumped into the 13-ft inside diameter refractory-lined fluidized bed combustor. Powders and granular material are pneumatically transported into the combustor using an eductor powered by high-pressure nitrogen, steam, or air to create a draft that draws the powdery material into a 2-in. diameter feedline and transport the material into a hot bed of silica sand. The fluidized bed combustor is initially charged with 60,000 lb of fine silica sand. Additional sand is occasionally added to replace sand elutriated during normal usage.

A hot cyclone separates most of the elutriated sand and ash from the fluidized bed off-gases which are then quenched and scrubbed by a low-pressure wet venturi before being released to the atmosphere through a stack common to all three incinerators.

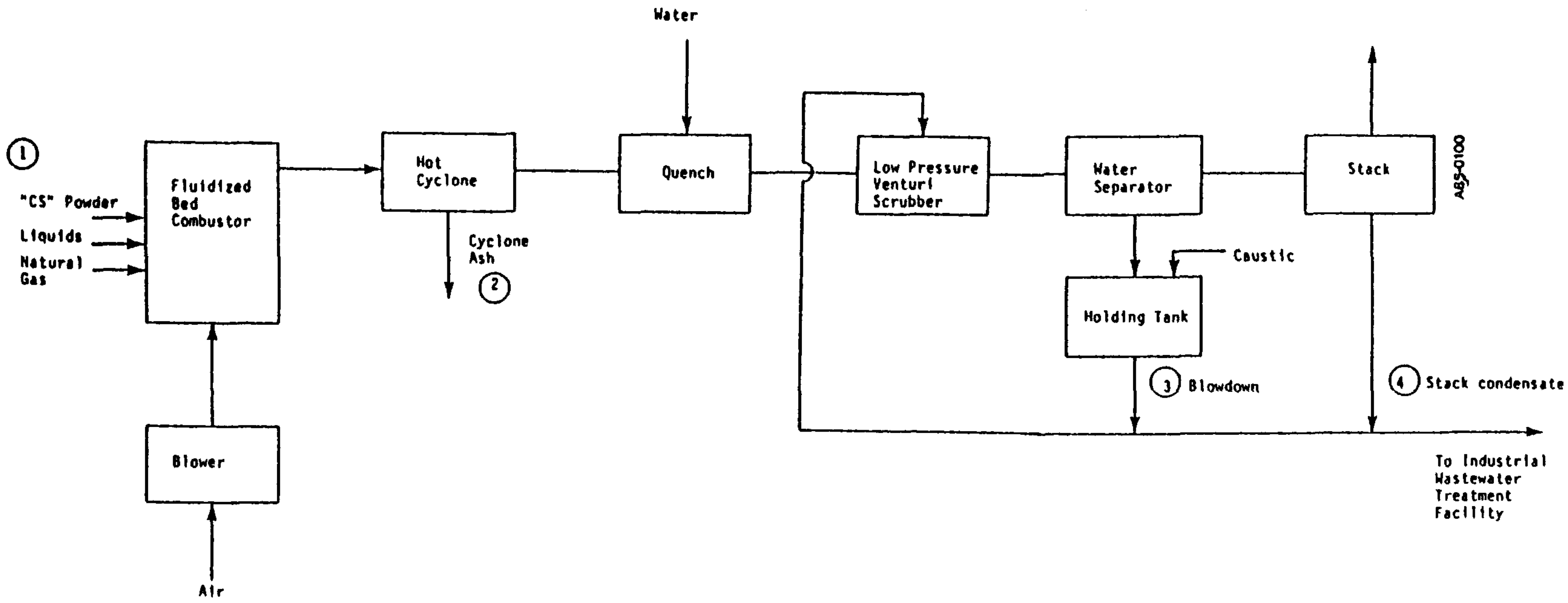


Figure 4. Site 4 incinerator schematic.

2.4.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: September 23 and 24, 1985
- Process observations:
  - -- Cyclone ash, always tested prior to disposal, generally does not exhibit the characteristic of EP toxicity and thus can be landfilled in a Class II landfill
  - -- Natural gas burned as primary fuel in fluid bed combustor
  - -- Eductor powered by steam during test but normally powered by nitrogen or compressed air
  - -- CS tear gas feedline periodically cleaned with steam since some melting of CS occurs in feedline during normal operation. Normal procedure is to purge feedline with steam after feeding an 80-lb drum of CS
  - -- Bed material used during test was previously used when burning a flame retardant chemical
- Process conditions:
  - -- Bed temperature, middle and high locations, average 1650°F
  - -- Freeboard temperature, average 1550°F
  - -- Fluidizing airflow 3,000 scfm
  - -- Bed pressure drop 80 in. of water
  - -- Windbox pressure 80 in. of water
  - -- Bed initially charged with 60,000 lb of flintshot sand (approximately 30 mesh) from Ottawa Industrial Sand Company
  - -- Scrubber holding tank pH maintained at about 7

-- Superficial velocity through bed approximately 1.5 ft/sec during test

-- Stack gas oxygen concentration about 15.8 percent on a dry basis

- Estimated influent and effluent flows during test:

  -- CS tear gas injection rate 2 lb/min

  -- Cyclone collected ash and sand flow rate 0.2 lb/min

  -- Scrubber holding tank blowdown estimated at 35 gal/min

  -- Stack condensate measured as 0.2 gal/min

A summary of all samples collected at this site and the analyses performed is presented in Table 21. The stack condensate was not mixed with the scrubber effluent since the stack is also used by other incinerators.

2.4.3 Analytical Results

This facility at the time of the test was incinerating CS tear gas (o-chlorobenzalmalononitrile) in a fluidized bed incinerator. This serves as an example of a special type of incinerator being used to dispose of a unique waste.

Volatile Organics

As shown in Table 22, the relatively high-purity CS tear gas contained no volatile organics at a concentration of greater than 100 ppm by weight. The volatiles detected in the cyclone ash and scrubber effluent in concentrations ranging from 1 to 30 ppm might be (a) products of incomplete combustion, or (b) contaminants in the scrubber makeup water. Since the dry-collected cyclone ash contained the same five volatiles detected in the scrubber effluent, the possibility of the volatiles being PICs is suspected. From visual observations, the cyclone ash appeared to be almost completely flintshot sand.

TABLE 21. SITE 4 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
1	CS tear gas powder	902645	None	9/23/85	1,2,3	
3	Scrubber holding tank drain	902646	None	9/23/85	1	
3	Scrubber holding tank drain	902647	None	9/23/85	NA	
3	Scrubber holding tank drain	902648	None	9/23/85	2	
3	Scrubber holding tank drain	902649	None	9/23/85	3	
4	Stack condensate	902650	None	9/23/85	NA	Not representative
4	Stack condensate	902651	None	9/23/85	NA	Not representative
4	Stack condensate	902652	None	9/23/85	NA	Not representative
4	Stack condensate	902653	None	9/23/85	NA	Not representative
4	Stack condensate	902654	None	9/23/85	NA	
4	Stack condensate	902655	None	9/23/85	NA	
4	Stack condensate	902656	None	9/23/85	NA	
4	Stack condensate	902657	None	9/23/85	NA	
3	Scrubber holding tank drain	902658	None	9/23/85	NA	Upstream of recycle pump
3	Scrubber holding tank drain	902659	None	9/23/85	NA	Upstream of recycle pump
	30 mesh flintshot sand	902660	None	9/23/85	NA	Ottawa Industrial Sand Co.
2	Cyclone ash (from test)	902661	None	9/23/85	1,2,3,4,5	
2	Cyclone ash (pre-test)	902662	None	9/23/85	NA	
3	Scrubber holding tank drain	902663	None	9/23/85	1	
4	Stack condensate	902664	None	9/23/85	NA	

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

TABLE 22. SITE 4 VOLATILE ORGANICS

	Input		Output				Total output	TCLP
Stream number	1		2		3			2
Stream description	CS tear gas		Cyclone ash		Scrubber drain			Cyclone ash
Stream flowrate in kg/s	0.015		0.0015		2.2			
Sample number	902645		902661		902646			902661
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	100		0.5		0.5			1
<u>Priority Pollutants</u>								
Trans-1,2-Dichloroethene	ND	<1.5	1.1	0.016	0.6	1.3	1.3	ND
1,2-Dichloroethane	ND	<1.5	ND	<0.007	32	71	71	ND
1,1,1-Trichloroethane	ND	<1.5	3.7	0.055	6.8	15	15	ND
Trichloroethene	ND	<1.5	5.4	0.081	14	31	31	ND
Tetrachloroethene	ND	<1.5	16	0.24	1.2	2.6	2.9	ND
Toluene	ND	<1.5	6.4	0.096	5	11	11	ND
All other priority pollutants	ND	<1.5	ND	<0.007	ND	<1.1	<1.1	ND
<u>Nonpriority Pollutants</u>								
Total xylenes	ND	<1.5	ND	<0.007	1.2	2.6	2.6	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

Semivolatile Organics

As shown in Table 23, no semivolatile organics were detected in input, output, and TCLP leachates for this tested facility. Nominal detection limits of 10,000 μg/kg (10 ppm by weight) were used for the CS tear gas, 10 μg/kg (10 ppb) for cyclone ash, 10 μg/L (10 ppb) for scrubber effluent, and 2 μg/L (2 ppb) for TCLP leachate of cyclone ash. The detection limits all appear quite reasonable for this application and clearly indicate no priority pollutant semivolatile organics in any of the samples.

Priority Pollutant Metals

Table 24 lists the priority pollutant metals results for this site. The CS tear gas contained only silver (4 mg/kg) and nickel (3 mg/kg) in detectable quantities. Output streams would likely contain at least nickel and silver from the CS tear gas. Although the cyclone ash appeared to be a high silica sand (from the fluidized bed) some metals were detected in concentrations ranging from 7 ppm for chromium to 200 ppm for zinc. Silver and nickel from the tear gas were also detected in the cyclone ash. The scrubber effluent blowdown had only one metal, zinc (0.27 mg/L), with a concentration above 0.06 mg/L. The EP and TCLP leachate results showed generally good agreement. The three detected metals in the highest concentrations, zinc, nickel, and chromium, were present in nearly equal concentrations in the EP and TCLP leachates.

2.5 SITE 5

2.5.1 Facility Description

This site has two incinerators which are located at a commercial facility designed primarily to burn liquid wastes, but also with the capability to accept solid wastes in small quantities. Wastes come primarily

TABLE 23. SITE 4 SEMIVOLATILE ORGANICS

	Input		Output				Total output	TCLP
Stream number	1		2		3			2
Stream description	CS tear gas		Cyclone ash		Scrubber drain			Cyclone ash
Stream flowrate in kg/s	0.015		0.0015		2.2			
Sample number	902645		902661		902646			902661
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	10		0.01		0.01			2
Priority Pollutants								
All	ND	<0.15	ND	<0.000015	ND	<0.02	<0.02	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

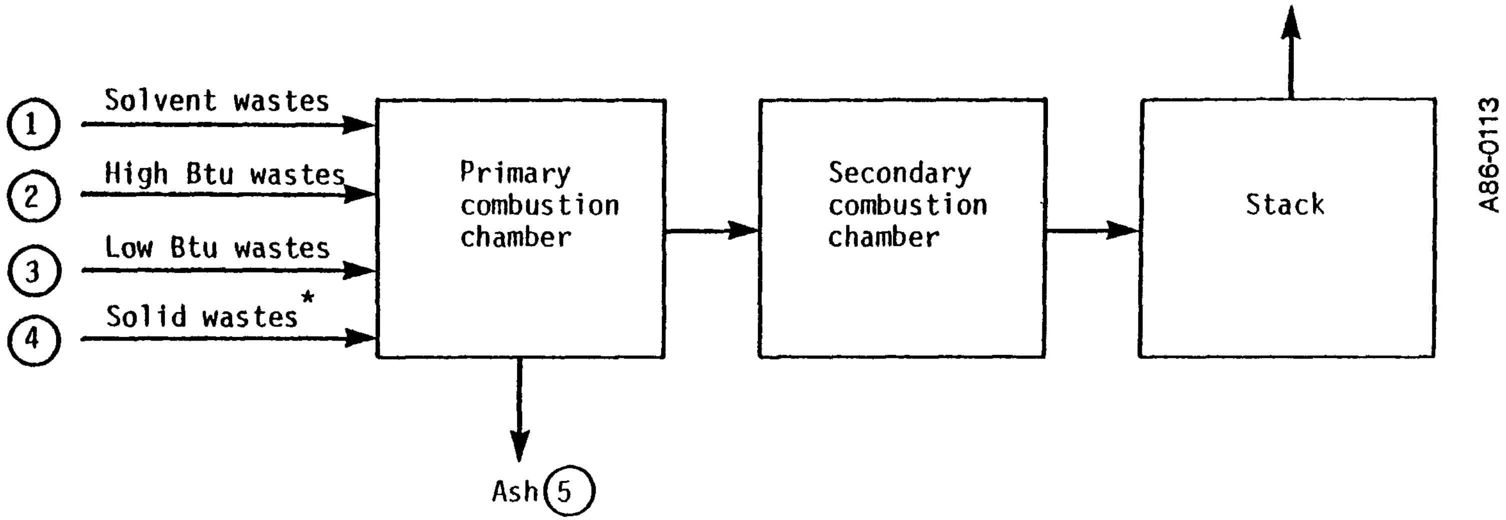
TABLE 24. SITE 4 PRIORITY POLLUTANT METALS

	Input		Output				Total output	Toxicity EP	Toxicity TCLP
Stream number	1		2		3			2	2
Stream description	CS tear gas		Cyclone ash		Scrubber drain			Cyclone ash	Cyclone ash
Stream flowrate in kg/s	0.015		0.0015		2.2				
Sample number	902645		902661		902649			902661	902661
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals									
Antimony	<1	<0.01	<1	<0.001	<0.01	<0.02	<0.02	<0.01	<0.01
Arsenic	<1	<0.07	<1	<0.001	<0.01	<0.02	<0.02	<0.01	<0.01
Beryllium	<2	<0.30	<2	<0.003	<0.01	<0.02	<0.02	<0.01	<0.01
Cadmium	<1	<0.01	<1	<0.001	<0.01	<0.02	<0.02	<0.01	<0.01
Chromium	<2	<0.30	7	0.010	0.06	0.13	0.14	0.03	0.03
Copper	<4	<0.60	<4	<0.006	<0.04	<0.08	0.09	<0.01	0.02
Lead	<1	<0.01	<1	<0.001	<0.01	<0.02	<0.02	<0.01	<0.01
Mercury	<0.1	<0.00	<0.1	<0.000	<0.001	<0.002	<0.002	<0.001	<0.001
Nickel	3	0.04	25	0.037	0.05	0.11	0.14	0.18	0.22
Selenium	<1	<0.09	<1	<0.001	<0.01	<0.02	<0.02	<0.01	<0.01
Silver	4	0.06	120	0.181	<0.02	<0.04	<0.22	<0.01	<0.01
Thallium	<5	<0.07	<1	<0.001	0.02	0.04	0.04	<0.01	<0.02
Zinc	<4	<0.06	200	0.302	0.27	0.59	0.89	2.2	2.6

from the furniture manufacturing industry. The units each consist of two, horizontally oriented, cylindrical refractory lined combustion chambers (primary and secondary) situated one above the other. Combustion gases exit through a stack at one end of the secondary chamber. A schematic diagram of the system is shown in Figure 5.

Liquid wastes are delivered to the plant in tank trucks and stored in one of eight main storage tanks 12,500 to 20,000 gal each. Two types of liquid wastes, organic and aqueous, are normally incinerated at the facility. The bulk liquid wastes are categorized as solvents, high-Btu wastes, or low-Btu wastes, with one or more storage tanks for each category. A reprocessed oil is used as fuel oil when necessary and is stored in one of the eight storage tanks. Waste chemicals are also received at the plant in 55-gal drums which are stored inside the building. When scheduled for incineration, those drums are emptied into a small holding tank that is equipped with an exhaust hood. The liquid wastes can then be pumped from the base of the tank directly into either incinerator. Capacity of that tank is approximately 630 gal.

Waste liquids are fed to the primary combustion chamber using air-atomized injectors (a total of four are available). Flowrates are established by adjusting manually operated values. For the small incinerator, an ECP 1500T, the primary combustion chamber is approximately 10 ft long and has an outside diameter of 8 ft. The firing end has an opening about 60 in. wide with a variable opening height depending upon the position of an adjustable shutter which is used to regulate the natural draft of combustion air. The unit is rated at 9.5×10^6 Btu/hr, with a normal operating temperature of 1700 to 2100°F in both chambers. The secondary



*Small incinerator only

Figure 5. Site 5 incinerator schematic.

chamber is identical to the primary except that it is only 7 ft in diameter. A burner and blower can add additional heat to the secondary chamber. The periodic use of the blower alone to add more combustion air for temperature control is quite common. Typical retention times are 2 to 3 sec.

The solids periodically hand-fed into the small incinerator typically include lacquer chips, filters, and rags all from the furniture manufacturing industry. Since the primary combustion chamber has a fixed hearth, solids with high ash content typically reduce the allowable continuous operating time.

The larger incinerator, an ECP 2500T, has slightly larger and longer primary and secondary combustion chambers; on a volume basis those chambers are slightly more than twice as large as those on the ECP 1500T. The larger incinerator has a sealed primary combustion chamber so no solids can be fed. The secondary chamber also incorporates a burner and blower to control the chamber temperature.

The exhaust stacks (which are also refractory lined) extend to a height of 20 ft above the secondary combustion chamber. Combustion gases exiting the stack typically average about 1450°F. At the beginning of a typical week's operation, ash which has accumulated on the bottom of the primary chamber from the previous week's operation is manually removed and stored in an outdoor concrete holding bay. The ash is later drummed and sent to a hazardous waste landfill.

Since the incinerators lack typical add-on devices for control of particulates and HCl emissions, particulate emissions are normally controlled by control of waste inerts (ash) and combustion airflow (turbulence) in the primary combustion chamber, while HCl emissions are normally controlled by limiting facility acceptance of chlorinated wastes and burning a variety of wastes to effectively blend wastes in the combustor.

This facility is reportedly undergoing voluntary closure proceedings because the owner needs to add APCE or to reduce operations.

2.5.2 Operating and Sampling Information

The following operating information was collected for this site:

- Date of site visit: September 26, 1985
- Process observations:
  - -- Both incinerators temporarily shutdown while facility underwent minor piping modifications
  - -- Ash samples removed from shutdown incinerators (ash can be sampled only if systems are shutdown)
  - -- Ash from small and large incinerators drummed and sent to a hazardous waste landfill for disposal
  - -- Incinerators not extensively instrumented
- Process conditions:
  - -- Stack gas oxygen concentration about 10 percent on a dry basis
  - -- Stack flow in small incinerator 2900 scfm
  - -- Stack flow in large incinerator 4600 scfm
  - -- Permit conditions require secondary combusion chamber temperatures greater than 1600°F
- Estimated influent and effluent flows during test:
  - -- Large incinerator ash generated at an estimated rate of 7 ft^3/week
  - -- Estimated stream flows were not available at this site

A summary of all samples collected at this site and the analyses performed is presented in Table 25.

2.5.3 Analytical Results

Since no stream flowrates were available at this site, only concentrations are reported in the results tables.

Volatile Organics

Volatile organics results from this incineration facility are shown in Table 26. Solvent wastes, stream no. 1, with a total volatile organic concentration of 180 g/L included several common solvents in concentrations greater than 10,000 mg/L. High-Btu wastes contain about 70 g/L of volatile organics. Low-Btu liquid wastes usually contain a high percentage of water. Organics detected at a concentration greater than 120 mg/L included only acetone, tetrachloroethane, and toluene. Lacquer-coated cardboard (from paint spray booths) contained only toluene (280 mg/L) at a level greater than 100 mg/L. The exact quantity and/or ratio of these input streams to produce the residual ash streams were not obtained since all records were sent to the state. The input streams were collected after the residuals had been produced, but were still felt to be representative of wastes consumed earlier (to produce the residuals).

The two output streams no. 5, small incinerator ash and large incinerator ash, each contained no organics at a 100 mg/kg nominal detection limit. Since the small incinerator was not as turbulent as the large incinerator, organics at less than 100 ppm may have been present.

The TCLP leachates for the two incinerator ashes indicate that the large incinerator ash leachate is free of organics, while the small incinerator ash leachate contains methylene chloride (180 µg/L), 2-butanone (25 µg/L), as

TABLE 25. SITE 5 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analysis performed[a]	Comments
5	Large incinerator ash	903059		9/25/85	1,2,3,4,5	Removed from incinerator
5	Small incinerator ash	903060		9/25/85	1,2,3,4,5	Removed from incinerator
5	Small incinerator ash	9 03061		9/25/85	5	From ash pile
4	Lacquered cardboard waste	903062	None	9/25/85	1,2,3	Fed in sheet form
1	Mixed solvent wastes	903063	b	9/25/85		
1	Mixed solvent wastes	903064	b	9/25/85	3	
1	Mixed solvent wastes	903065	b	9/25/85		
1	Mixed solvent wastes	903066	b	9/25/85	1,2	
1	Mixed solvent wastes	903067	b	9/25/85		
2	Mixed high Btu liquid wastes	903068	b	9/25/85		
2	Mixed high Btu liquid wastes	903069	b	9/25/85	3	
2	Mixed high Btu liquid wastes	903070	b	9/25/85		
2	Mixed high Btu liquid wastes	903071	b	9/25/85	1,2	
2	Mixed high Btu liquid wastes	903072	b	9/25/85		
2	High Btu liquid wastes A	903073	b	9/25/85		
2	High Btu liquid wastes A	903074	b	9/25/85		
2	High Btu liquid wastes B	903075	b	9/25/85		
2	High Btu liquid wastes B	903076	b	9/25/85		
2	High Btu liquid wastes C	903077	b	9/25/85		
2	High Btu liquid wastes C	903078	b	9/25/85		
2	High Btu liquid wastes D	903079	b	9/25/85		
2	High Btu liquid wastes D	903080	b	9/25/85		
3	Mixed low Btu liquid wastes	903081	None	9/25/85		
3	Mixed low Btu liquid wastes	903082	None	9/25/85	3	
3	Mixed low Btu liquid wastes	903083	None	9/25/85		
3.	Mixed low Btu liquid wastes	903084	None	9/25/85	1,2	
3	Mixed low Btu liquid wastes	903085	None	9/25/85		
3	Low Btu liquid waste C1	903086	None	9/25/85		
3	Low Btu liquid waste C1	903087	None	9/25/85		
3	Low Btu liquid waste C2	903088	None	9/25/85		
3	Low Btu liquid waste C2	903089	None	9/25/85		

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]Primarily from furniture manufacturing industry with EPA numbers D001, F001, F002, F003, and F005. Not to exceed 1.5 percent ash and 1 percent chlorine by weight.

TABLE 26. SITE 5 VOLATILE ORGANICS

	Input				Output		TCLP	
Stream number	1	2	3	4	5	5	5	4
Stream description	Solvent wastes	High-Btu liquid wastes	Low-Btu liquid wastes	Lacquer-coated cardboard	Large incin. ash	Small incin. ash	Large incin. ash	Small incin. ash
Sample number	903066	903071	903084	903062	903059	903060	903059	903061
	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[a]	120	120	120	100	100	100	1	1
Priority Pollutants								
Bromomethane	790	1,200	ND	ND	ND	ND	ND	ND
Methylene chloride	15,000	7,100	ND	ND	ND	ND	ND	180
1,2-dichloroethane	ND	ND	ND	ND	ND	ND	ND	8
1,2-dichlorobenzene	ND	4,000	ND	ND	ND	ND	ND	ND
1,1,1-trichloroethane	ND	830	ND	ND	ND	ND	ND	3
Trichloroethane	ND	3,600	ND	ND	ND	ND	ND	ND
Tetrachloroethane	1,200	570	870	ND	ND	ND	ND	ND
Toluene	26,000	24,000	690	280	ND	ND	ND	7
Ethyl benzene	ND	2,100	ND	ND	ND	ND	ND	ND
All other priority pollutants	ND	ND	ND	ND	ND	ND	ND	ND
Nonpriority Pollutants								
Acetone	34,000	17,000	2,500	ND	ND	ND	ND	ND
2-Butanone	100,000	12,000	ND	ND	ND	ND	ND	25
4-Methyl-2-Pentanone	580	ND	ND	ND	ND	ND	ND	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

well as low levels of 1,2-dichloroethane (8 μg/L), toluene, (7 μg/L), and 1,1,1-trichloroethane (3 μg/L).

Semivolatile Organics

As shown in Table 27, semivolatile organics were detected in most of the input streams but not the output streams. Solvent wastes, stream no. 1, contained approximately 4 g/L of semivolatiles, while high-Btu liquid wastes contained approximately 115 g/L of semivolatile organics. Low-Btu liquid wastes contained no semivolatile organics above 100 mg/L, while lacquer-coated cardboard contained bis(2-ethylhexyl) phthalate at 9.7 g/kg but no other semivolatiles above 5 mg/kg.

The output streams from each incinerator contained no semivolatiles at a detection limit of 100 μg/kg. The TCLP leachates were similarly free of semivolatile organics except for 46 μg/L of benzoic acid in the small incinerator ash, possibly associated with incomplete oxidation of toluene.

Priority Pollutant Metals

As shown in Table 28, priority pollutant metal analyses were performed on four input streams, two output residual streams, plus EP toxicity and TCLP leachates for each of the residuals. The first input stream, solvent wastes, is characterized by a very high chromium level and relatively high lead and zinc levels. High-Btu and low-Btu liquid wastes contained chromium, lead, and zinc. Lacquer-coated cardboard, which has a high-ash content and was fed only into the small incinerator, had relatively high levels of zinc (570 mg/kg), chromium (110 mg/kg), and silver (30 mg/kg). Because this site serviced the furniture manufacturing industry (as well as other industries), it is assumed that several of the priority pollutant metals were originally metal oxides from paint pigments.

TABLE 27. SITE 5 SEMIVOLATILE ORGANICS

	Input				Output		TCLP	
Stream number	1	2	3	4	5	5	5	5
Stream description	Solvent wastes	High-Btu liquid wastes	Low-Btu liquid wastes	Lacquer-coated cardboard	Large incin. ash	Small incin. ash	Large incin. ash	Small incin. ash
Sample number	903066	903071	903084	903062	903059	903060	903059	903061
	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[a]	100	100	100	5	0.1	0.1	2	2
<u>Priority Pollutants</u>								
2-Chlorophenol	ND	450	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	210	ND	ND	ND	ND	ND	ND	ND
Naphthalene	790	140	ND	ND	ND	ND	ND	ND
Phenol	790	101,000	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	2,000	700	ND	9,700	ND	ND	ND	ND
Dimethyl phthalate	ND	12,000	ND	ND	ND	ND	ND	ND
Phenanthrene	80	ND	ND	ND	ND	ND	ND	ND
All other priority pollutants	ND	ND	ND	ND	ND	ND	ND	ND
<u>Nonpriority Pollutants</u>								
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	46
2-Methylphenol	270	370	ND	ND	ND	ND	ND	ND
4-Methylphenol	410	370	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	680	180	ND	ND	ND	ND	ND	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

TABLE 28. SITE 5 PRIORITY POLLUTANT METALS

	Input				Output		Toxicity			
							EP		TCLP	
Stream number	1	2	3	4	5	5	5	5	5	5
Stream description	Solvent wastes	High-Btu liquid wastes	Low-Btu liquid wastes	Lacquer-coated cardboard	Large incin. ash	Small incin. ash	Large incin. ash	Small incin. ash	Large incin. ash	Small incin. ash
Sample number	903064	903069	903082	903062	903059	903060	903059	903060	903059	903061
	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg	Concentration in mg/kg
Priority Pollutant Metals										
Antimony	2	<1	<1	<1	3	<1	<0.01	<0.01	<0.01	0.1
Arsenic	6	<1	<1	<1	9	<1	0.12	0.12	0.1	0.54
Beryllium	<1	<1	<1	<2	<2	<2	<0.01	<0.01	<0.01	<0.01
Cadmium	3	3	<1	<1	2	<1	<0.01	<0.01	<0.01	<0.01
Chromium	4,300	30	11	110	520	100	0.98	0.03	0.2	2.7
Copper	6	6	7	10	500	40	<0.01	0.02	0.11	0.07
Lead	93	51	38	<1	1,800	<1	<0.01	<0.01	<0.01	<0.01
Mercury	<0.05	0.15	<0.05	<0.1	<0.1	<0.1	<0.001	<0.001	<0.001	<0.001
Nickel	7	<4	<4	3	34	3	0.03	0.04	0.02	0.27
Selenium	<1	<1	<1	<1	8	<1	<0.01	<0.1	0.03	0.12
Silver	<1	<1	<1	30	16	54	<0.01	<0.01	<0.01	<0.01
Thallium	<1	<1	<1	5	<1	6	<0.01	<0.01	<0.02	<0.02
Zinc	310	170	65	570	1,300	200	0.14	0.31	0.17	0.17

The two incinerator ashes appear to differ quite substantially. The small incinerator ash has metal concentrations inline with those for the lacquer-coated cardboard, except zinc (200 mg/kg) is substantially lower and copper (40 mg/kg) is substantially higher. With the exception of chromium (520 mg/L), the large incinerator ash appears more concentrated than the solvent waste and high-Btu waste streams. Concentrations of lead (1800 mg/kg), zinc (1300 mg/kg), and copper (500 mg/kg) are especially high. The leachates do not exceed the EP Toxicity and TCLP limits. The low concentration of lead in the large incinerator ash (<0.01 mg/L) is somewhat surprising given the ash concentration of 1800 mg/kg. Differences between the large incinerator ash EP and TCLP leachates appear slight. A direct comparison between the small incinerator ash EP and TCLP leachates should not be attempted since the samples were collected from different sampling points (see Table 25).

2.6 SITE 6

2.6.1 Facility Description

The incinerator sampled is a commercial facility designed primarily to burn liquid wastes, but also with the capability to accept solid wastes, hand fed in small quantities. It is almost identical to the incinerators at Site 5. The unit consists of two, horizontally oriented, cylindrical combustion chambers (primary and secondary) situated one above the other. Combustion gases exit through a stack at one end of the secondary chamber. A schematic diagram of the system is shown in Figure 6.

Liquid wastes are delivered to the plant primarily in 55-gal steel drums. Especially high Btu liquids are typically emptied into a small batch tank near the incinerator and emptied prior to incinerator shutdown. Another special tank is continuously agitated and used for hard to pump sludge-like liquids; other liquids may be added to thin the continuously agitated waste liquid. The remaining wastes are generally organic or aqueous and stored in separate storage tanks.

Waste liquids are fed to the primary combustion chamber using air-atomized injectors (a total of five are available). Flowrates are established by adjusting manually operated valves. The primary combustion chamber is approximately 10-ft long and has an outside diameter of 8 ft. The firing end has an opening about 60-in. wide with a variable height depending on the position of an adjustable shutter which is used to regulate the natural draft of combustion air. The unit is rated at 9.5×10^6 Btu/hr, with a normal operating temperature of 1800 to 2100°F in the primary chamber and 1700 to 2100°F in the secondary chamber. The secondary chamber is identical to the primary except that it is only 7 ft in diameter. Both chambers are refractory lined. Typical retention times are 2 to 3 sec.

The solids periodically hand fed into the small incinerator typically include lacquer chips, filters, and rags all from the furniture manufacturing industry. Since the primary combustion chamber has a fixed hearth with no online ash removal capability, solids with high ash content typically reduce the allowable continuous operating time.

The exhaust stack (which is also refractory lined) extends to a height of 20 ft above the secondary combustion chamber. Combustion gases exiting the stack typically average about 1450°F. At the beginning of a typical week's operation, ash which has accumulated on the bottom of the primary chamber from the previous week's operation is manually removed and stored in

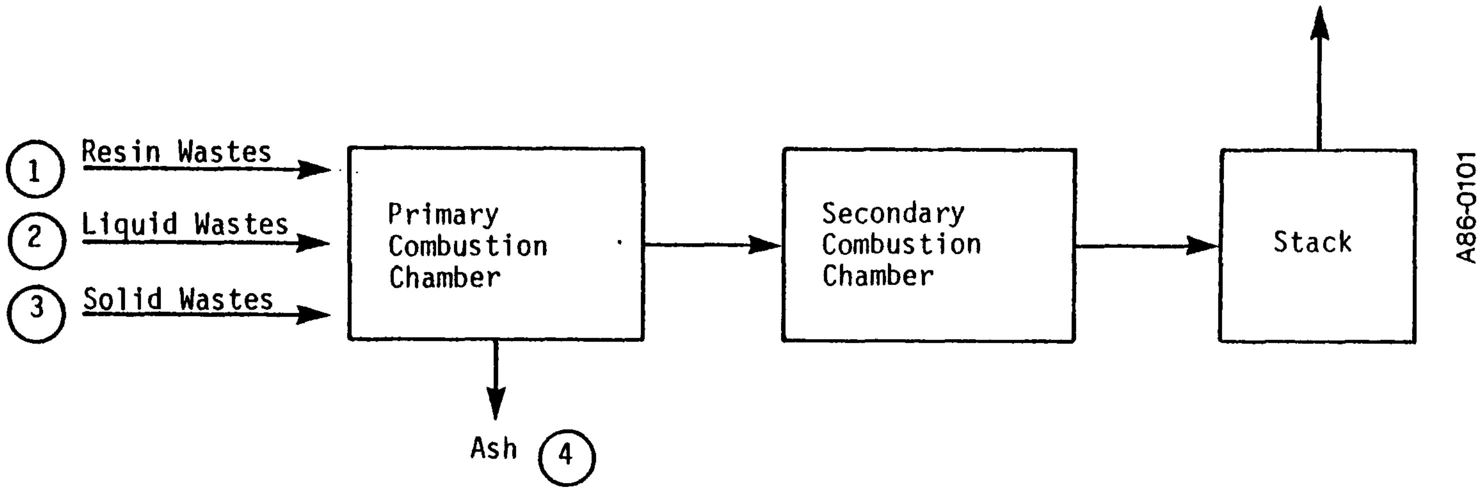


Figure 6. Site 6 incinerator schematic.

a concrete holding bay. The ash is sent to a landfill for hazardous waste for final disposal.

Since the incinerator lacks typical add-on devices for control of particulates and HCl emissions, particulates emissions are normally controlled by control of waste inerts (ash) and combustion airflow (turbulance) in the primary combustion chamber, while HCl emissions are normally controlled by limiting facility acceptance of chlorinated wastes and burning a variety of wastes to effectively blend wastes in the combustor. This commercial incinerator facility receives wastes from the furniture manufacturing industry and others.

2.6.2 Operating and Sampling Information

The following operating information was collected for this site:

- Date of site visit: September 27, 1985
- Process observations:
  - -- Incinerator ash disposed offsite in a hazardous waste landfill
  - -- HCl emissions controlled by limiting acceptance of chlorinated wastes and waste blending
  - -- Sampled ash generated during previous 48 hours
- Process conditions:
  - -- Primary combustion chamber maintained at 2000°F
  - -- Secondary combustion chamber maintained at 1750°F
  - -- Nominal exhaust airflow 3000 scfm
- Estimated influent and effluent flows:
  - -- Ash cleanout immediately prior to arrival at site yielded estimated 15,000 lb

-- Liquids fed during previous 48 hours as follows:

Resins	725 gal
Continuously agitated waste liquid (CAWL)	715 gal
Inks, reducers, stains, etc.	1155 gal
Navy Otto fuel	2255 gal
Tank cleanings, Otto fuel, water	3410 gal

-- 52,000 lb of solids fed during previous 48 hours, primarily lacquer dust, lacquer chips, and rags

A summary of all samples collected at this site and the analyses performed is presented in Table 29. Several input liquid streams were combined (in proportion to volumetric feedrates) prior to analysis to form one homogeneous liquid waste fuel sample.

2.6.3 Analytical Results

Volatile Organics

As shown in Table 30, seven common solvents appeared in the liquid waste composite fuel sample -- toluene, 2-hexanone, xylenes, 2-butanone, acetone, ethylbenzene, and 4-methyl-2-pentanone. The solids fed into the system were predominantly lacquer chips or shavings, although the site operator called a similar looking sample "toluene chips." When analyzed, these chips contained only toluene at a concentration greater than 100 ppm (the detection limit of the analysis).

The incinerator ash samples removed from an ash pile were composited in the laboratory and analyzed. Although the ash samples appeared dry, the ash pile had previously been sprayed to prevent smouldering. At the time of sampling, however, the ash samples were near ambient temperature. Volatile organics were not detected in the incinerator ash at a concentration of

TABLE 29. SITE 6 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
4	Incinerator ash	903090		9/27/85	1,2,3,4,5	Combined with 903090 and 92
4	Incinerator ash	903091		9/27/85	1,2,3,4,5	Combined with 903091 and 92
4	Incinerator ash clinker	903092		9/27/85	1,2,3,4,5	Combined with 903090 and 91
1	Liquid resin waste	903093	b	9/27/85	2	Combined 903093, 98, 103, 109, 114
1	Liquid resin waste	903094	b	9/27/85	3	Combined 903094, 99, 105, 108, 113
1	Liquid resin waste	903095	b	9/27/85	1	Combined 903095, 100, 106, 110, 115
1	Liquid resin waste	903096	b	9/27/85		
2	CAWL[c]	903097	b	9/27/85		
2	CAWL	903098	b	9/27/85	2	Combined 903093, 98, 103, 109, 114
2	CAWL	903099	b	9/27/85	3	Combined 903094, 99, 105, 108, 113
2	CAWL	903100	b	9/27/85	1	Combined 903095, 100, 106, 110, 115
2	CAWL	903101	b	9/27/85		
1	Liquid resin waste	903102	b	9/27/85		
2	Tank #1 liquid waste	903103	b	9/27/85	2	Combined 903093, 98, 103, 109, 114
2	Tank #1 liquid waste	903104	b	9/27/85		
2	Tank #1 liquid waste	903105	b	9/27/85	3	Combined 903094, 99, 105, 108, 113
2	Tank #1 liquid waste	903106	b	9/27/85	1	Combined 903095, 100, 106, 110, 115
2	Tank #1 liquid waste	903107	b	9/27/85		
2	Tank #6 liquid waste	903108	b	9/27/85	3	Combined 903094, 99, 105, 108, 113
2	Tank #6 liquid waste	903109	b	9/27/85	2	Combined 903093, 98, 103, 109, 114
2	Tank #6 liquid waste	903110	b	9/27/85	1	Combined 903095, 100, 106, 110, 115
2	Tank #6 liquid waste	903111	b	9/27/85		
2	Tank #1 liquid waste	903112	b	9/27/85		
2	Tank #7 liquid waste	903113	b	9/27/85	3	Combined 903094, 99, 105, 108, 113
2	Tank #7 liquid waste	903114	b	9/27/85	2	Combined 903093, 98, 103, 109, 114
2	Tank #7 liquid waste	903115	b	9/27/85	1	Combined 903095, 100, 106, 110, 115
2	Tank #7 liquid waste	903116	b	9/27/85		
3	Lacquer dust	903117	None	9/27/85	1,2,3	Combined 903117 through 25
3	Toluene solids	903118	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903119	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903120	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903121	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903122	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903123	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903124	None	9/27/85	1,2,3	Combined 903117 through 25
3	Lacquer chips	903125	None	9/27/85	1,2,3	Combined 903117 through 25
1	Liquid resin waste	903126	b	9/27/85		

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]D001, F003, F005.

[c]CAWL - continuously agitated waste liquids

TABLE 30. SITE 6 VOLATILE ORGANICS

	Input				Total input	Output		TCLP
Stream number	1 + 2		3			4		4
Stream description	Liquid waste fuel		Lacquer chips			Incinerator ash		Incinerator ash
Stream flowrate in kg/s	0.18		0.14			0.039		
Sample number	903095, 100, 106, 110, 115		903117 through 903125			903090, 91, 92		903090, 91, 92
	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	100		100			100		1
<u>Priority Pollutants</u>								
Methylene chloride	ND	<18	ND	<14	<32	ND	<4	550
Benzene	ND	<18	ND	<14	<32	ND	<4	10
Tetrachloroethene	ND	<18	ND	<14	<32	ND	<4	3
Toluene	32000	5800	350	48	5800	ND	<4	790
Ethylbenzene	2600	470	ND	<14	480	ND	<4	38
All other priority pollutants	ND	<18	ND	<14	<32	ND	<4	ND
<u>Nonpriority Pollutants</u>								
Acetone	5200	940	ND	<14	940	ND	<4	950
2-Butanone	7100	1300	ND	<14	1300	ND	<4	91
2-Hexanone	14000	2500	ND	<14	2500	ND	<4	ND
4-Methyl-2-pentanone	1600	290	ND	<14	290	ND	<4	ND
Total xylenes	9800	1800	ND	<14	1800	ND	<4	75

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

greater than 100 ppm. The TCLP leachate analyses, however, yielded eight volatile organics -- acetone, toluene, methylene chloride, 2-butanone, xylenes, ethylbenzene, benzene, and tetrachloroethene. This type of incinerator has been previously tested for thermal destruction performance. High DREs were measured suggesting low level PICs and POHCs in the ash residue.

Semivolatile Organics

Table 31 summarizes the results for semivolatile organics. The total concentration of semivolatile organics was slightly higher in the lacquer chips, stream no. 3, than in the composited liquid waste fuels, stream 1 plus 2. Bis(2-ethylhexyl)phthalate was present in the composite lacquer chip sample at a concentration of 74,000 mg/kg with a few other semivolatiles present at less than 10 mg/kg.

The incinerator ash, with a nominal detection limit of 100 ppb by weight, contained 16 semivolatile organic compounds. Four of these compounds were detected in concentrations less than 1 mg/kg, an additional eight were less than 10 mg/kg, and four were at concentrations of 10 mg/kg or greater.

Priority Pollutant Metals

As shown in Table 32, two composite input, one composite ash residual, and the ash residual's EP toxicity and TCLP leachates were analyzed for the presence of 13 priority pollutant metals.

The liquid waste fuel contained a high level of zinc, chromium, and copper (40 to 320 ppm). Lead, cadmium, and thallium were detected at low levels (4 to 13 ppm). Analysis of the lacquer chips yielded results similar

TABLE 31. SITE 6 SEMIVOLATILE ORGANICS

	Input				Total input	Output		TCLP
Stream number	1 + 2		3			4		4
Stream description	Liquid waste fuels		Lacquer chips			Incinerator ash		Incinerator ash
Stream flowrate in kg/s	0.18		0.14			0.039		
Sample number	903093, 98, 103, 09, 114		903117 through 903125			903090, 91, 92		903090, 91, 92
	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	20		5			0.1		2
Priority Pollutants								
Acenaphthene	ND	<4	ND	<1	<4	0.26	0.01	ND
1,2,4-Trichlorobenzene	ND	<4	ND	<1	<4	10	0.39	10
Fluoranthene	ND	<4	ND	<1	<4	0.23	0.01	ND
Isophorone	200	36	ND	<1	36	1.1	0.04	20
Naphthalene	380	69	15	2	71	6.8	0.27	8
2-Nitrophenol	ND	<4	ND	<1	<4	ND	<0.003	60
4-Nitrophenol	ND	<4	ND	<1	<4	ND	<0.003	90
Phenol	50,000	9,000	ND	<1	9,000	1.7	0.07	30
Bis(2-ethylhexyl)phthalate	3700	670	74,000	10,000	11,000	500	20	ND
Benzyl butyl phthalate	120	22	6	1	22	5	0.2	ND
Di-n-butyl phthalate	2000	360	7	1	360	39	1.5	14
Di-n-octyl phthalate	ND	<4	ND	<1	<4	2.5	0.1	ND
Dimethyl phthalate	66	12	ND	<1	12	31	1.2	580
Anthracene	ND	<4	ND	<1	<4	0.15	0.01	ND
Phenanthrene	ND	<4	ND	<1	<4	1.3	0.05	ND
Pyrene	ND	<4	ND	<1	<4	0.34	0.01	ND
All other priority pollutants	ND	<4	ND	<1	<4	ND	<0.003	ND
Nonpriority pollutants								
Benzoic acid	ND	<4	ND	<1	<4	2.4	0.09	ND
2-Methylnaphthalene	170	31	ND	<1	31	6.2	0.24	4

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

TABLE 32. SITE 6 PRIORITY POLLUTANT METALS

	Input				Total input	Output		Toxicity: EP	Toxicity: TCLP
Stream number	1 + 2		3			4		4	4
Stream description	Liquid waste fuels		Lacquer Chips			Incinerator ash		Incinerator ash	Incinerator ash
Stream flowrate in kg/s	0.18		0.14			0.039			
Sample number	903094, 99, 105, 108, 113		903117 through 903125			903090, 91, 92		903090, 91, 92	903090, 91, 92
	Concentration in mg/L	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals									
Antimony	0.25	0.045	<1	<0.13	<0.2	<1	<0.04	0.07	0.06
Arsenic	0.23	0.041	<1	<0.13	<0.2	8	0.32	<0.01	<0.01
Beryllium	<0.01	<0.001	<2	<0.27	<0.3	<2	<0.08	<0.01	<0.01
Cadmium	5.4	1	<1	<0.13	1	<1	<0.04	0.04	<0.01
Chromium	85	15	15	2	17	110	4.3	0.03	<0.02
Copper	43	7.8	<4	<0.54	7.8	120	4.7	1.9	0.64
Lead	4.2	0.76	<1	<0.13	0.8	1300	51	3.3	12
Mercury	0.003	0.0005	0.3	0.04	0.04	<0.1	<0.004	<0.001	<0.001
Nickel	2.1	0.38	6	0.81	1.2	22	0.87	0.33	0.49
Selenium	0.5	0.09	<1	<0.13	<2.2	12	0.47	0.03	0.02
Silver	0.06	0.01	35	48	4.8	21	0.83	<0.04	<0.01
Thallium	13	2.3	17	2.3	4.7	<1	<0.04	0.05	<0.02
Zinc	320	58	1000	140	190	810	32	16	9.5

to the results for lacquer-coated cardboard at site 5, except lead was not detected. Zinc was present at 1000 mg/kg, silver at 35 mg/kg, thallium at 17 mg/kg, and chromium at 15 mg/L.

Incinerator ash, as expected, generally showed more concentrated metal values for lead, zinc, copper, and chromium.

In reviewing the EP toxicity and TCLP leachate analyses, the results from each test generally agreed within a factor of 3. Lead, while being slightly below the toxicity limit for EP toxicity leachate, exceeded the limit in the TCLP leachate. Zinc was also present at a relatively high concentration, 16 mg/L in the EP toxicity leachate and 9.5 mg/L in the TCLP leachate.

2.7 SITE 7

2.7.1 Facility Description

This incinerator design features a two-stage combustion chamber, a quench section, a venturi scrubber, and water separator (see Figure 7).

High-Btu liquid organic wastes and low-Btu wastes (which on occasion are highly aqueous) are stored in separate 9000-gal storage tanks. These wastes are continuously fed into the primary combustion chamber through separate lines. Solid waste is inserted into the chamber using a ram at an approximate rate of one 45-lb batch every 5 min. Combustion air and fuel oil (as necessary) are also admitted into the chamber to control the combustion temperature. Ash is removed from the chamber periodically by a long stroke of the feed ram to push ash from the floor of the chamber onto a water submerged ash conveyor which empties the ash into an ash bin. Ash is recycled back through the incinerator if combustible material is detected in the ash by the incinerator operator.

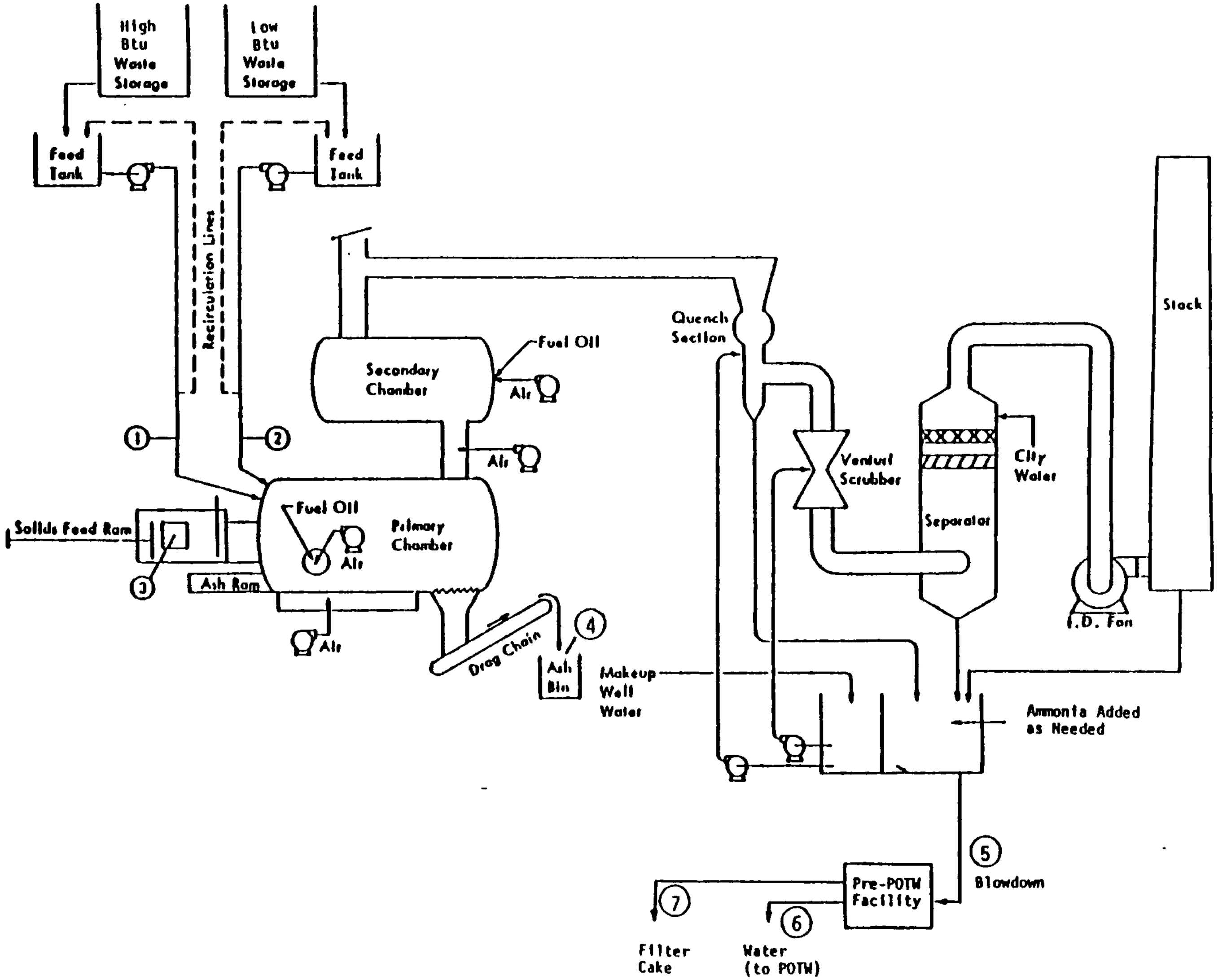


Figure 7. Site 7 incinerator schematic.

The combustion gases exit the primary combustion chamber and enter a secondary chamber where additional fuel oil (as necessary) and combustion air are admitted to maintain desired operating conditions. After leaving the second chamber, the gases are quenched and passed through a venturi scrubber for particulate and HCl removal. The gases then travel up through a water separator and exit the process through the stack. The stack has an expanded bottom section and includes pad demisters.

Water for the quench and venturi scrubber is recirculated from a holding tank. Makeup to the holding tank is provided by well water. Effluent waters from the quench, water separator, and stack are channeled into the holding tank. The holding tank is periodically blown down to prevent an excessive build-up of solids, salts, and metals in the tank and/or water. The blowdown is treated in an onsite water treatment facility. A filter cake sludge from that facility is stabilized with lime and transported to a hazardous waste landfill for disposal while the water is discharged to the city's industrial sewer for eventual treatment at a POTW. The cleansed blowdown water is not recirculated.

2.7.2 <u>Operating and Sampling Information</u>

The following operating information was collected for this site:

- Dates of site visit: October 22 and 23, 1985
- Process observations:
  - -- Quenched incinerator ash taken to a hazardous waste landfill for final disposal
  - -- Relatively dewatered solids from the pre-POTW filter press are stabilized with lime prior to disposal in a hazardous waste landfill

- -- The treated water from the pre-POTW is released to the industrial sewer since continued reuse would result in a build-up of heavy metals

- Process conditions:
  - -- Primary combustion chamber maintained at 1820 to 1915°F
  - -- Secondary combustion chamber maintained at 1840 to 1900°F
  - -- Lower combustion chamber pressure maintained at near minus 1 in. of water
  - -- Scrubber holding tank maintained at near pH 7 with ammonia
  - -- Stack gas concentration of oxygen during liquid waste incineration varied from about 12 percent to slightly more than 13 percent
  - -- Venturi scrubber pressure drop approximately 23 in. of water
  - -- Stack gas flow of 8500 to 9000 acfm at 150°F
  - -- Quench water flow 111 gal/min
  - -- Venturi water flow 70 gal/min

- Estimated influent and effluent flows during day of test:

-- High-Btu liquid waste	517 lb/hr
-- Low-Btu liquid waste	333 lb/hr
-- Solids	
• Latex coagulum (plus corncobs)	150 lb/hr
• Coating waste (plus corncobs)	128 lb/hr
• Magnesium scrap shavings in oil	6 lb/hr
• Lab packs	9 lb/hr
• Hospital wastes	162 lb/hr
-- Fuel oil	17.7 gal/hr

-- Scrubber holding tank blowdown 7 gal/min

-- Pre-POTW discharge to sewer 15 lb/min

-- Dewatered solids from pre-POTW 1.5 yd^3/day

-- Incinerator ash 3 yd^3/day

A summary of all samples collected at this site and the analyses performed is presented in Table 33.

For safety reasons, the magnesium scrap shavings from a machine shop and the hospital waste, which included infectious wastes, were not sampled. Lab packs, which typically include spent or unwanted laboratory chemicals in glassware, placed in small cardboard drums or boxes, overpacked with an adsorbent such as vermiculite, and sealed, were also not sampled due to the difficulty of obtaining a representative sample. Corncob powder was regularly added to some material at this site. Since the "solid" feed system pushes material onto a fixed hearth, corncob powder is added to some difficult-to-pump material to absorb free liquid.

2.7.3 Analytical Results

Volatile Organics

As shown in Table 34, approximately 12 g/kg (1.2 percent) of the sampled solids contained volatiles, primarily xylenes, 2-butanone, toluene, and ethylbenzene. Surprisingly, the high-Btu liquids contained less volatiles but still had relatively high concentrations of toluene, acetone, styrene, and 1,1,1-trichloroethane. Low-Btu liquids had only three detected organics, all at relatively high concentrations.

Bottom ash had no detectable volatiles exceeding 100 ppm. Volatiles at the 35 ppm level or less for this incinerator have been reported in an earlier report. APCE effluent, basically blowdown from the quench plus

TABLE 33. SITE 7 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
6	Pre-POTW discharge water	902666		10/23/85		
6	Pre-POTW discharge water	902667		10/23/85		
6	Pre-POTW discharge water	902668		10/23/85		
2	Low-Btu liquid waste	902669	b	10/23/85	2	
2	Low-Btu liquid waste	902670	b	10/23/85	1	Combined 902670, 71, 81, 85, 91
2	Low-Btu liquid waste	902671	b	10/23/85	1	Combined 902670, 71, 81, 85, 91
1	High-Btu liquid waste	902672	b	10/23/85	2	Combined with 902679
1	High-Btu liquid waste	902673	b	10/23/85	1	Combined 902673, 80, 84, 90
5	Scrubber holding tank blowdown	902674		10/23/85	2	
5	Scrubber holding tank blowdown	902675		10/23/85	1	Combined 902675, 78, 82, 87, 92
3	Latex coagulum plus sorbent	902676	D001	10/23/85	1,2,3	Sorbent is corncob dust
1	High-Btu liquid waste	902677	b	10/23/85		Container failure in transit
5	Scrubber holding tank blowdown	902678		10/23/85	1	Combined 902675, 78, 82, 87, 92
1	High-Btu liquid waste	902679	b	10/23/85	2	Combined with 902672
1	High-Btu liquid waste	902680	b	10/23/85	1	Combined 902673, 80, 84, 90
2	Low-Btu liquid waste	902681	b	10/23/85	1	Combined 902670, 71, 81, 85, 91
5	Scrubber holding tank blowdown	902682		10/23/85	1	Combined 902675, 78, 82, 87, 92
6	Pre-POTW discharge water	902683		10/23/85		
1	High-Btu liquid waste	902684	b	10/23/85	1	Combined 902673, 80, 84, 90
2	Low-Btu liquid waste	902685	b	10/23/85	1	Combined 902670, 71, 81, 85, 91
3	Coating waste plus sorbent	902686	D001	10/23/85	1,2,3	Sorbent is corncob dust
5	Scrubber holding tank blowdown	902687		10/23/85	1	Combined 902675, 78, 82, 87, 92
6	Pre-POTW discharge water	902689		10/23/85		
1	High-Btu liquid waste	902690	b	10/23/85	1	Combined 902673, 80, 84, 90
2	Low-Btu liquid waste	902691	b	10/23/85	1	combined 902670, 71, 81, 85, 91
5	Scrubber holding tank blowdown	902692		10/23/85	1	Combined 902675, 78, 82, 87, 92
6	Pre-POTW discharge water	902693		10/23/85		
2	Low-Btu liquid waste	902694	b	10/23/85	3	From 902669
7	Pre-POTW discharge filter cake	902695		10/23/85		
7	Pre-POTW discharge filter cake	902696		10/23/85		
6	Pre-POTW discharge water	902697		10/23/85		From 902666
5	Scrubber holding tank blowdown	902698		10/23/85	3	From 902674
4	Quenched incinerator ash	902699		10/23/85	1,2,3,4,5	
4	Quenched incinerator ash	902700		10/23/85		
3	Magnesium scrap	--	D001	--	--	Not sampled
3	Lab packs	--	D001	--	--	Not sampled
3	Hospital waste	--	--	--	--	Not sampled

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]D001, F001, F002, F003, F005.

TABLE 34. SITE 7 VOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	3		1		2			4		5			4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Bottom ash		APCE effluent			Bottom ash
Stream flowrate in kg/s	0.035		0.065		0.042			0.043		0.0073			
Sample number	902676 & 86		902673, 80, 84, 90		902670, 71, 81, 85, 91			902699		902675, 78, 82, 87, 92			902699
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	100		100		100			100		0.5			1
Priority Pollutants													
Methylene chloride	ND	<4	ND	<7	ND	<4	<14	ND	<4	ND	<0.004	<4	150
Chloroform	ND	<4	150	10	ND	<4	<17	ND	<4	ND	<0.004	<4	17
1,1,1-Trichloroethane	ND	<4	1,900	120	ND	<4	120	ND	<4	ND	<0.004	<4	77
Trichloroethene	ND	<4	990	64	ND	<4	64	ND	<4	8.4	0.062	<4	17
Benzene	ND	<4	ND	<7	ND	<4	<14	ND	<4	ND	<0.004	<4	3
Toluene	20,000	700	6,300	410	2,400	100	1,200	ND	<4	ND	<0.004	<4	61
Ethylbenzene	14,000	490	180	12	16,000	670	1,200	ND	<4	ND	<0.004	<4	10
All other priority pollutants	ND	<4	ND	<7	ND	<4	<14	ND	<4	ND	<0.004	<4	ND
Nonpriority Pollutants													
Acetone	ND	<4	3,100	200	ND	<4	200	ND	<4	ND	<0.004	<4	110
2-Butanone	35,000	1,200	ND	<7	ND	<4	1,200	ND	<4	ND	<0.004	<4	140
2-Hexanone	1,100	39	ND	<7	ND	<4	<50	ND	<4	ND	<0.004	<4	ND
4-Methyl-2-pentanone	12,000	420	820	53	ND	<4	470	ND	<4	ND	<0.004	<4	62
Styrene	ND	<4	2,200	140	ND	<4	140	ND	<4	ND	<0.004	<4	ND
Total xylenes	43,000	1,500	730	48	51,000	2,100	3,700	ND	<4	ND	<0.004	<4	28

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

scrubber recirculation tank, had only one detectable volatile, trichloroethene at 8400 µg/L. Methylene chloride, benzene, and toluene in a combined concentration of near 10 ppb by weight have been reported for this stream under a separate test program. The TCLP leachate had 11 detected volatiles. Such leachate values would support volatile concentrations in ash residuals at ppm levels. Incinerator residuals, which did not appear to be completely burned, were routinely recycled back, through the incinerator.

Semivolatile Organics

Several organics were detected in the input and output streams below 300 ppm (see Table 35). Naphthalene at 100 ppm by weight was the only detected semivolatile organic in the composited solids feed sample. The high-Btu liquids contained a high concentration of naphthalene plus other common semivolatile organics. Low-Btu liquids contained some similar semivolatile organics.

Bottom ash contained several semivolatiles but all in concentrations at or below 150 ppm by weight. Detected above the 1 ppm level include bis(2-ethylhexyl) phthalate (150,000 µg/kg), isophorone (11,000 µg/kg), benzyl butyl phthalate and di-n-butyl phthalate (7000 µg/kg each). The semivolatile organics concentration for this stream was reported at 570,000 µg/kg during our previous test program.

APCE effluent blowdown included only two low concentration compounds, phenol (100 µg/L) and di-n-butyl phthalate (22 µg/L).

The TCLP bottom ash leachate analysis results indicate only isophorone, aniline, and phenol in concentrations ranging from 6 to 60 µg/L.

TABLE 35. SITE 7 SEMIVOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	3		1		2			4		5			4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Bottom ash		APCE effluent			Bottom ash
Stream flowrate in kg/s	0.035		0.065		0.042			0.043		0.0073			
Sample number	902676 & 86		902672 & 79		902669			902699		902674			902699
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	100		20		0.6			0.1		0.02			2
<u>Priority Pollutants</u>													
1,2,4-Trichlorobenzene	ND	<4	ND	<1	0.78	0.03	<5	ND	<0.004	ND	<0.0001	<0.004	ND
Hexachlorobenzene	ND	<4	ND	<1	19	0.8	<6	ND	<0.004	ND	<0.0001	<0.004	ND
p-Chloro-m-cresol	ND	<4	ND	<1	0.84	0.04	<5	ND	<0.004	ND	<0.0001	<0.004	ND
1,2-Dichlorobenzene	ND	<4	30	2	ND	<0.03	<5	ND	<0.004	ND	<0.0001	<0.004	ND
1,4-Dichlorobenzene	ND	<4	ND	<1	0.9	0.04	<5	ND	<0.004	ND	<0.0001	<0.004	ND
3,3-Dichlorobenzidine	ND	<4	ND	<1	1.6	0.07	<5	ND	<0.004	ND	<0.0001	<0.004	ND
Isophorone	ND	<4	48	3	3.4	0.14	<7	11	0.47	ND	<0.0001	0.47	62
Naphthalene	100	4	290	19	12	0.5	23	0.75	0.031	ND	<0.0001	0.031	ND
Nitrobenzene	ND	<4	38	<2	ND	<0.03	<6	ND	<0.004	ND	<0.0001	<0.004	ND
N-Nitrosodiphenylamine	ND	<4	ND	<1	ND	<0.03	<5	1.5	0.063	ND	<0.0001	0.063	ND
Phenol	ND	<4	ND	<1	ND	<0.03	<5	ND	<0.004	0.1	0.0007	<0.004	6
Bis(2-ethylhexyl)phthalate	ND	<4	ND	<1	3.5	0.15	<5	150	6.4	ND	<0.0001	6.4	ND
Benzyl butyl phthalate	ND	<4	ND	<1	3.1	0.13	<5	7	300	ND	<0.0001	0.3	ND
Di-n-butyl phthalate	ND	<4	ND	<1	2.6	0.11	<5	7	300	0.022	0.0002	0.3	ND
Diethyl phthalate	ND	<4	100	7	ND	<0.03	<10	ND	<0.004	ND	<0.0001	<0.004	ND
Phenanthrene	ND	<4	28	2	ND	<0.03	<5	ND	<0.004	ND	<0.0001	<0.004	ND
All other priority pollutants	ND	<4	ND	<1	ND	<0.03	<5	ND	<0.004	ND	<0.0001	<0.004	ND
<u>Nonpriority pollutants</u>													
2-Methylnaphthalene	ND	<4	60	4	5.7	0.24	<8	0.3	0.012	ND	<0.0001	0.012	ND
Aniline	ND	<4	ND	<1	ND	<0.03	<5	ND	<0.004	ND	<0.0001	<0.004	20
Benzyl alcohol	ND	<4	38	2	ND	<0.03	<6	ND	<0.004	ND	<0.0001	<0.004	ND
4-Chloroaniline	ND	<4	ND	<1	2.1	0.09	<5	ND	<0.004	ND	<0.0001	<0.004	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

Priority Pollutant Metals

As shown in Table 36, concentrations of metals greater than 100 ppm were observed in only two sampled input streams, the solid feed (stream No. 3) and the low-Btu liquids (stream No. 1). High lead and chromium concentrations of 650 and 130 ppm were measured in the solid feed. Only zinc with a concentration of 610 ppm was detected in the low-Btu liquids. For the streams not sampled, the priority pollutant metals concentration was also likely be to low. For example, lab packs would generate "ash" from vermiculite (hydrated magnesium-aluminum-iron silicate), cardboard, glassware, and contents. The magnesium scrap shavings in oil would, of course, generate magnesium oxide which is not a priority pollutant metal. As with lab packs, hospital wastes would likely generate most "ash" from cardboard, glassware, and perhaps vermiculite, if used.

Output streams were either high in metals (such as bottom ash) or low (such as APCE effluent). Bottom ash was especially high in copper, zinc, nickel, lead, and chromium. The APCE effluent's highest level metal was zinc followed by lead. The leachates for bottom ash appear to be under both the EP and TCLP limits for metals. Zinc appears high (>50 mg/L), but the two leachates generally agree within a factor of three.

2.8 SITE 8

2.8.1 Facility Description

The incinerator consists of a large, nearly rectangular combustion chamber and a rotary kiln as shown schematically in Figure 8.

There are four major waste feed streams into the incinerator. Liquid organic waste is fed continuously at the end opposite the rotary kiln, below

TABLE 36. SITE 7 PRIORITY POLLUTANT METALS

	Input						Total input	Output				Total output	Toxicity	
													EP	TCLP
Stream number	3		1		2			4		5			4	4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Bottom ash		APCE effluent			Bottom ash	Bottom ash
Stream flowrate in kg/s	0.035		0.065		0.042			0.043		0.0073				
Sample number	902676 & 86		902672 & 79		902694			902699		902698			902699	902699
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
<u>Priority Pollutant Metals</u>														
Antimony	<1	<0.035	<0.03	0.002	<0.03	<0.0012	<0.03	49	2.1	1.7	0.012	2.1	<0.01	0.02
Arsenic	2	0.07	0.6	0.039	22	0.92	1	12	0.51	0.06	0.00044	0.51	<0.06	<0.01
Beryllium	<1	<0.035	<0.01	0.001	<0.01	<0.0004	<0.03	<1	<0.04	<0.01	<0.00007	<0.04	<0.01	<0.01
Cadmium	<1	<0.035	0.7	0.046	0.18	0.0075	<0.08	<1	<0.04	0.08	0.00058	<0.04	<0.01	<0.01
Chromium	130	4.6	2.2	0.14	8.7	0.36	5.1	120	5.1	0.28	0.002	5.1	<0.03	<0.02
Copper	2	0.07	2.1	0.14	10	0.42	0.62	2000	85	0.64	0.0047	85	13	11
Lead	650	23	9.1	0.59	16	0.67	24	160	6.8	2.6	0.019	6.8	0.11	0.5
Mercury	<0.05	<0.001	0.025	0.002	0.01	0.0004	0.002	0.25	<0.01	<0.005	<0.00003	<0.01	<0.001	<0.001
Nickel	7	0.24	2.5	0.16	0.83	0.035	0.44	650	28	0.75	0.0055	28	13	4
Selenium	<4	<0.14	<1	0.065	<1	<0.042	<0.24	19	0.81	0.6	0.0044	0.81	<0.05	0.02
Silver	3	0.10	0.54	0.035	0.06	0.0025	0.14	9	0.38	0.05	0.00036	0.38	<0.01	<0.01
Thallium	11	0.38	0.25	0.016	0.2	0.0083	0.4	4	0.17	0.16	0.0012	0.17	<0.01	<0.02
Zinc	4	0.14	16	1	610	26	27	850	36	6.7	0.049	36	65	98

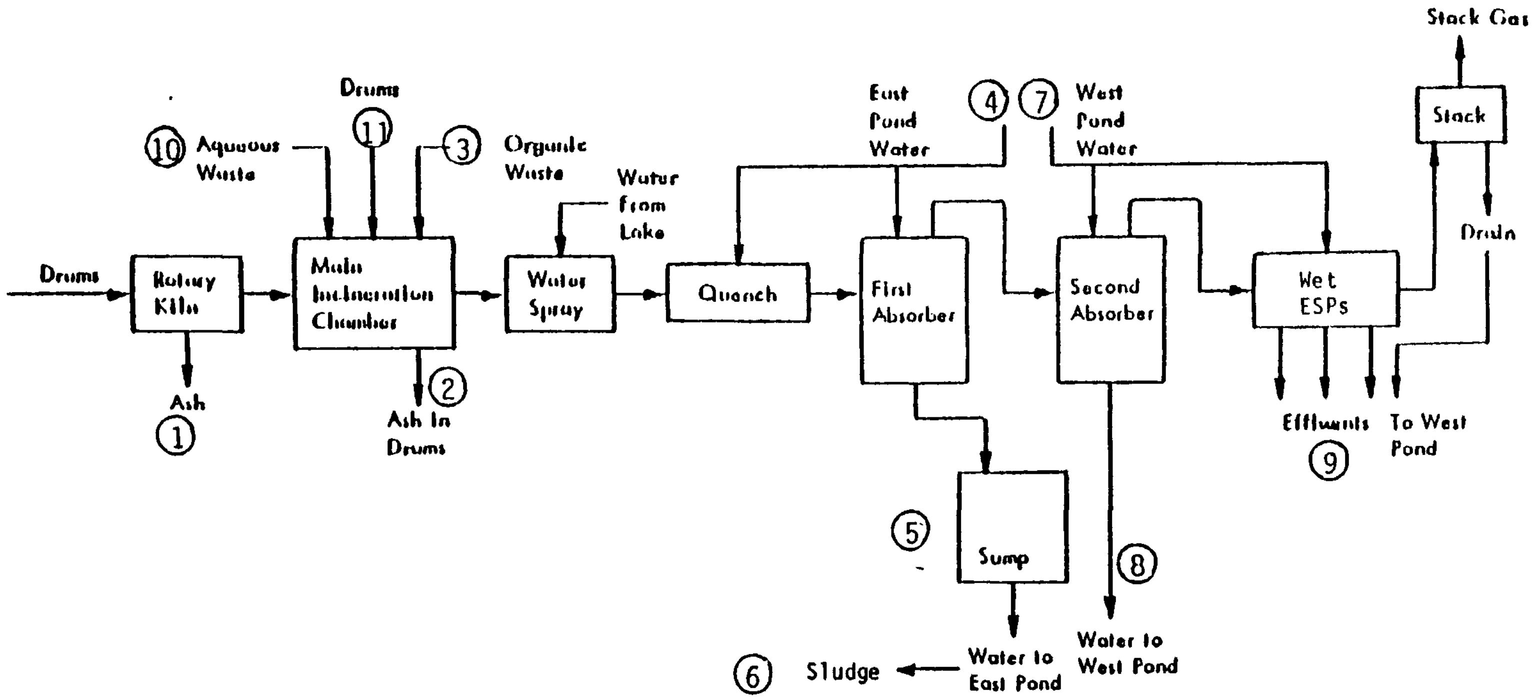


Figure 8. Site 8 incinerator schematic.

the gas exhaust duct that is near the top of that end of the chamber. Aqueous waste is fed when available into the combustion chamber just above the liquid organic waste flame. The other two waste feeds are wastes normally contained in steel drums. Depending on the waste characteristics, some drums are sliced into sections and the drums and contents are conveyed into the rotary kiln. Other drums are placed in groups of four on metal "sleds" and are conveyed upright through the combustion chamber, remaining in the chamber for about 4 hours. Normally, these latter drums are sliced and recycled back through the kiln after passing through the combustion chamber to further incinerate residue collected in the bottom of the drum. Approximately 150 drums per day are incinerated; however, with drum "recycling," the number of drums fed to the chamber and kiln per hour normally averages four and seven, respectively. Auxiliary fuel is not used under normal operating conditions at this plant.

Gases exiting the combustion chamber pass through a water quench section and two packed scrubbers in series with caustic addition to adjust pH. The gases then pass through two two-stage wet ESPs and induced draft fans in parallel that discharge into a demister and then are released through a tall stack. All liquid effluents are regularly recycled to the two ponds, with makeup provided by nearby lake water. Thus, the only nongaseous effluent regularly removed from the incinerator system is the ash discharged from the rotary kiln. As currently configured, however, bottom ash is periodically removed from the combustion chamber during shutdowns for preventive maintenance. The ash, less large ferrous pieces, is taken for final disposal to a hazardous waste landfill.

Also, the ponds experience a build-up of salts and sludge. Approximately once a year, high salt content water from the east pond is pumped into a holding pond. That water is incrementally shipped to a facility offsite for treatment and disposal. The settled solids in sludge form are removed from the ponds periodically and placed in another holding pond. Although operations to date have not required disposal of that sludge, the sludge will soon be hauled to a hazardous waste landfill.

This hazardous waste incinerator handles bulk liquids as well as liquids, sludges, and solids in a variety of commonly used containers, including steel drums and aerosol cans. Some items, such as some packaged consumer products, may not meet the RCRA definition of hazardous, but are incinerated as a cost-effective disposal option. The incinerator capacity exceeds 50 million Btu/hr.

2.8.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: October 24 and 25, 1985
- Process observations:
  - -- Large ferrous pieces of metal removed from ash prior to disposal
  - -- Kiln ash and bottom ash both transported to a hazardous waste landfill for final disposal
  - -- Process water in holding pond removed to an offsite hazardous material treatment facility for disposal
  - -- Sludge in sludge holding pond not yet emptied but will also be taken to a hazardous waste landfill for final disposal

-- Bottom ash emptied with front-end loader during preventive maintenance shutdowns

- Process conditions:
  -- The pH of the east pond is maintained at 7.5, while the west pond is maintained at 7
  -- Nominal 4- to 8-sec gas residence time in main combustion chamber
  -- Main combustion chamber exit temperature maintained at 2075°F during sampling
  -- Historical stack gas data yielded average flue gas oxygen concentration of 10.5 percent on a dry gas basis
- Estimated influent and effluent flows during test:
  -- Quench flow 2500 gal/min
  -- Flow to scrubber no. 1 2500 gal/min
  -- Flow to scrubber no. 2 plus wet ESPs 750 gal/min with 650 gal/min flowing to scrubber no. 2, and 90 to 100 gal/min flowing to the wet ESPs
  -- Liquid fuel feedrate varied from 40 to 117 lb/min during test with an average rate of 90 lb/min
  -- Bottom ash generated at a rate of 8 yd^3/week
  -- Quenched kiln ash generated at a rate of 6 yd^3/day and weighed 1.3 tons/yd^3
  -- Direct feedwater flow 270 gal/min, but configuration did not allow sampling
  -- Excluding reruns, four 55-gal drums/hr were fed directly into the incinerator and six 55-gal drums/hr into the rotary kiln

A summary of all samples collected at this site and the analyses performed is presented in Table 37.

2.8.3 Analytical Results

The streams not sampled at the site's request included (a) feedwater containing 20 percent paint pigments (toxic metals), 10 percent NaOH, and 1 to 3 percent acetone, toluene, and xylene, and (b) drummed solids and liquids which were obtained from many sources and are more difficult to generalize, but typically included solvents and toxic metals.

Volatile Organics

Analytical results appear in Table 38. The liquid waste fuel contains many typical solvents, so it appears reasonable that 13 organics were detected. The highly recycled scrubber water from two ponds showed six of seven detected organics as higher in the inlet than outlet. All detected volatiles were 5 ppm or lower.

The kiln ash and incinerator bottom ash were both found to contain volatile organics, although the level of organics in the kiln ash is not particularly expected. Nine volatiles were detected in the kiln ash with toluene at 120 ppm by weight being followed in concentration by 4-methyl-2-pentanone (29 ppm), xylenes (15 ppm), and several other common solvents.

Bottom ash, which was obtained at the first shutdown after the test, was determined to contain only toluene at 2.1 ppm. The nominal detection limit for the ash sample was 500 μg/kg.

TCLP leachates for the kiln ash and bottom ash each had detectable levels of volatiles. Kiln ash volatiles, including toluene (170 μg/L),

TABLE 37. SITE 8 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
3	Liquid waste fuel	902702	b	10/25/85	2,3	Combined with 902703
3	Liquid waste fuel	902703	b	10/25/85	2,3	Combined with 902702
3	Liquid waste fuel	902704	b	10/25/85	1	Combined 902704, 05, 06
3	Liquid waste fuel	902705	b	10/25/85	1	Combined 902704, 05, 06
3	Liquid waste fuel	902706	b	10/25/85	1	Combined 902704, 05, 06
4	Quench plus scrubber no. 1 supply	902707		10/25/85	2	
4	Quench plus scrubber no. 1 supply	902708		10/25/85	3	
4	Quench plus scrubber no. 1 supply	902709		10/25/85	1	Combined 902709, 10, 11
4	Quench plus scrubber no. 1 supply	902710		10/25/85	1	Combined 902709, 10, 11
4	Quench plus scrubber no. 1 supply	902711		10/25/85	1	Combined 902709, 10, 11
5	Quench plus scrubber no. 1 sump	902712		10/25/85	2	
5	Quench plus scrubber no. 1 sump	902713		10/25/85	3	
5	Quench plus scrubber no. 1 sump	902714		10/25/85	1	Combined 902714, 15, 16
5	Quench plus scrubber no. 1 sump	902715		10/25/85	1	Combined 902714, 15, 16
5	Quench plus scrubber no. 1 sump	902716		10/25/85	1	Combined 902714, 15, 16
7	Scrubber no. 2 and ESP supply	902717		10/25/85	2,3	Combined with 902718
7	Scrubber no. 2 and ESP supply	902718		10/25/85	2,3	Combined with 902717
7	Scrubber no. 2 and ESP supply	902719		10/25/85	1	Combined 902719, 20, 21
7	Scrubber no. 2 and ESP supply	902720		10/25/85	1	Combined 902719, 20, 21
7	Scrubber no. 2 and ESP supply	902721		10/25/85	1	Combined 902719, 20, 21
8	Scrubber no. 2 return	902722		10/25/85	2	Combined 902722, 27, 28
8	Scrubber no. 2 return	902723		10/25/85	3	Combined 902723, 27, 28
8	Scrubber no. 2 return	902724		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
8	Scrubber no. 2 return	902725		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
8	Scrubber no. 2 return	902726		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
9	ESP return	902727		10/25/85 10/25/85	2 3	Combined 902722, 27, 28 Combined 902723, 27, 28
9	ESP return	902728		10/25/85 10/25/85	2 3	Combined 902722, 27, 28 Combined 902723, 27, 28
9	ESP return	902729		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
9	ESP return	902730		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
9	ESP return	902731		10/25/85	1	Combined 902724, 25, 26, 29, 30, 31
1	Quenched kiln ash	902732		10/25/85	1,2,3,4,5	Combined with 902733
1	Quenched kiln ash	902733		10/25/85	1,2,3,4,5	Combined with 902732
6	East pond sludge	902734		10/25/85		
2	Incinerator bottom ash, east end	902766		10/31/85	1,2,3,4,5	Combined with 902767
2	Incinerator bottom ash, west end	902767		10/31/85	1,2,3,4,5	Combined with 092766
10	Direct feedwater	--	c	--	--	c
11	Drummed solids and liquids	--	d	--	--	d

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]Blended liquid waste fuel. EPA numbers include D001, D003, D007, D008, F001, F002, F003, and F005.

[c]Not sampled. EPA numbers D001, D002, D006, D007, D008. Twenty percent paint pigments, 10 percent NaOH, 1 to 3 percent acetone, toluene, and xylene.

[d]Not sampled. Majority of drums at least D001. Other EPA numbers include D003, D006, D007, D008, D009, F002, F003, F005, and U002. Some drums nonhazardous.

TABLE 38. SITE 8 VOLATILE ORGANICS

	Input		Output														Total output	TCLP	
			Quench + scrubber #1					Scrubber #2 + wet ESPs											
Stream number	3		4		5			7		8			1		2			1	2
Stream description	Liquid waste fuel		Supply		Sump		Net	Supply		Return		Net	Kiln ash		Bottom ash			Kiln ash	Bottom ash
Stream flowrate in kg/s	0.68		310		310			47		47			0.085		0.11				
Sample number	902704 to 06		902709 to 11		902714 to 16			902719 to 21		902724 to 26, 29 to 31			902732, 33		902766, 67			902732, 33	902766, 67
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[a]	100		0.5		0.5			0.5		0.5			0.5		0.5			1	1
<u>Priority Pollutants</u>																			
Chloromethane	ND	<68	1.8	570	2.5	790	220	0.55	26	ND	<24	<24	1.7	0.14	ND	<0.06	220	ND	ND
Methylene chloride	6,600	4,500	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	90	26
trans-1,2-Dichloroethene	ND	<68	ND	<160	ND	<160	<160	0.6	28	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	ND
1,1,1-Trichloroethane	10,000	6,800	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	6.2	0.53	ND	<0.06	<180	22	ND
Benzene	ND	<68	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	3	2
Trichloroethene	4,700	3,200	ND	<160	ND	<160	<160	3.6	170	ND	<24	<24	5.3	0.45	ND	<0.06	<180	ND	ND
Tetrachloroethene	17,000	12,000	5.2	1600	ND	<160	<160	1.1	52	ND	<24	<24	3.6	0.31	ND	<0.06	<180	4	ND
Toluene	43,000	29,000	4.2	1300	ND	<160	<160	ND	<24	ND	<24	<24	120	0.21	2.1	0.24	<180	170	13
Chlorobenzene	1,100	750	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	2.5	0.21	ND	<0.06	<180	2	ND
Ethylbenzene	43,000	29,000	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	7.6	0.65	ND	<0.06	<180	12	ND
All other priority pollutants	ND	<68	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	ND
<u>Nonpriority Pollutants</u>																			
Acetone	86,000	59,000	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	ND
2-Butanone	110,000	75,000	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	49	ND
2-Hexanone	9,100	6,200	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	ND
4-Methyl-2-pentanone	32,000	22,000	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	29	2.5	ND	<0.06	<180	150	ND
Styrene	12,000	8,200	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	ND
Carbon disulfide	ND	<68	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	ND	<0.04	ND	<0.06	<180	ND	4
Total xylenes	73,000	50,000	ND	<160	ND	<160	<160	ND	<24	ND	<24	<24	15	1.3	ND	<0.06	<180	57	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

4-methyl-2-pentanone (150 μg/L), and methylene chloride (90 μg/L), had higher concentrations than bottom ash volatiles which included methylene chloride (26 μg/L) and toluene (13 μg/L).

Semivolatile Organics

Semivolatile organics, as shown in Table 39, were detected in high concentrations in the liquid waste fuel.

Except for benzoic acid detected at a level of 260 ppb in the quench plus scrubber #1 sump, no semivolatile organics were detected in the scrubber supply or return water.

As with the volatiles, relatively high levels of semivolatiles were detected in the kiln ash; phenol was detected at 400 ppm followed by 2-methylnaphthalene at 15 ppm and five others in the 1 to 2 ppm range. No semivolatiles were detected in the bottom ash.

Kiln ash and bottom ash TCLP leachates were analyzed for semivolatiles and both were determined to only contain phenol at 1800 and 120 μg/L, respectively, at a nominal detection limit of 2 μg/L. Phenol was detected in the kiln ash at 400 ppm, so its presence in the leachate is not surprising. The bottom ash, however, did not have a detected level of phenol, and the phenol level in the leachate suggests that the bottom ash phenol concentration should also be in the ppm range or greater.

Priority Pollutant Metals

Priority pollutant metals analyses are shown in Table 40. The two unsampled waste streams were noted to contain cadmium, chromium, lead, and mercury. Chromium, lead, and zinc appear to be the higher concentration metals in the liquid waste fuel. Although an unsuccessful attempt was made to create a metals mass balance for the system, it can be seen that the

TABLE 39. SITE 8 SEMIVOLATILE ORGANICS

	Input		Output														Total Output	TCLP	
			Quench + scrubber #1					Scrubber #2 + wet ESPs											
Stream number	3		4		5			7		8			1		2			1	2
Stream description	Liquid waste fuel		Supply		Sump		Net	Supply		Return		Net	Kiln ash		Bottom ash			Kiln ash	Bottom ash
Stream flowrate in kg/s	0.68		310		310			47		47			0.085		0.11				
Sample number	902702, 03		902709 to 11		902712			902717, 18		902722 to 28			902732, 33		902766, 67			902732, 33	902766, 67
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in µg/L	Concentration in µg/L
Detection Limit Factor[a]	20		0.02		0.02			0.02		0.02			0.5		0.1			2	2
<u>Priority Pollutants</u>																			
Isophorone	6,800	4,600	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	2.5	0.21	ND	<0.01	<7	ND	ND
Naphthalene	590	400	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	2.3	0.2	ND	<0.01	<7	ND	ND
Phenol	38	26	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	400	34	ND	<0.01	<7	1800	120
Benzyl butyl phthalate	2,000	1,400	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	ND	<0.04	ND	<0.01	<7	ND	ND
Diethyl phthalate	32	22	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	ND	<0.04	ND	<0.01	<7	ND	ND
Phenanthrene	ND	<14	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	0.9	0.08	ND	<0.01	<7	ND	ND
Pyrene	ND	<14	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	1.3	0.11	ND	<0.01	<7	ND	ND
All other priority pollutants	ND	<14	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	ND	<0.04	ND	<0.01	<7	ND	ND
<u>Nonpriority Pollutants</u>																			
Benzoic acid	19	13	ND	<6	0.26	82	82	ND	<1	ND	<1	<1	ND	<0.04	ND	<0.01	82	ND	ND
2-Methylphenol	ND	<14	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	1	0.09	ND	<0.01	<7	ND	ND
2-Methylnaphthalene	110	75	ND	<6	ND	<6	<6	ND	<1	ND	<1	<1	15	1.3	ND	<0.01	<7	ND	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

TABLE 40. SITE 8 PRIORITY POLLUTANT METALS

	Input		Output															Total output	Toxicity			
			Quench + scrubber #1					Scrubber #2 + wet ESPs											EP		TCLP	
Stream number	3		4		5			7		8			1		2				1	2	1	2
Stream description	Liquid waste fuel		Supply		Sump		Net	Supply		Return		Net	Kiln ash		Bottom ash				Kiln ash	Bottom ash	Kiln ash	Bottom ash
Stream flowrate in kg/s	0.68		310		310			47		47			0.085		0.11							
Sample number	902702, 03		902708		902713			902717, 18		902723 to 28			902732, 33		902766, 67				902732, 33	902766, 67	902732, 33	902766, 67
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals																						
Antimony	<1	<1	4.1	1,300	2.4	700	0	0.16	7.5	0.31	15	7	240	20	32	3.6	31	0.49	<0.05	0.36	<0.01
Arsenic	3	2	0.4	130	0.3	94	0	<0.1	<4.7	<0.1	<4.7	0	11	0.9	27	3.1	4	<0.06	0.22	0.02	<0.01
Beryllium	<1	<1	<0.01	<3	0.01	3	0	<0.01	<0.4	<0.01	<0.4	0	<1	<0.1	<1	<0.1	<0.2	<0.01	<0.01	<0.01	<0.01
Cadmium	<1	<1	2.8	880	1.5	470	0	0.18	8.5	0.28	13	5	36	3.1	3	0.3	8	0.12	0.03	0.19	<0.01
Chromium	28	19	3.8	1,200	1.9	600	0	0.2	9.4	1	47	38	250	21	110	12	72	<0.03	0.63	<0.02	0.28
Copper	<1	<1	2.2	690	1.2	380	0	0.43	20	1.1	52	32	2900	250	14	1.6	280	0.33	0.09	1.8	0.05
Lead	25	17	31	9,800	6	1,900	0	2.1	99	7	330	230	1600	136	280	32.8	400	0.11	<0.07	<0.01	<0.01
Mercury	0.1	0.07	<0.005	<2	<0.005	<2	0	<0.005	<0.2	<0.005	<0.2	0	0.1	0.009	<0.05	<0.006	<0.01	<0.001	<0.001	<0.001	<0.001
Nickel	7	5	1.5	470	0.9	280	0	0.05	2.3	<0.03	1.4	0	100	8.6	15	1.7	10	0.42	<0.03	0.71	<0.01
Selenium	<4	<3	0.6	190	2.1	660	470	0.2	9.4	0.3	14	5	<40	<3.4	8	0.9	480	<0.05	<0.05	0.04	<0.01
Silver	<1	<1	0.15	47	0.13	41	0	0.03	1.4	<0.01	0.4	0	3	0.3	<1	<0.1	<0.3	<0.01	<0.01	<0.01	<0.01
Thallium	6	4	1.6	500	0.47	150	0	0.07	3.3	0.03	1.4	0	3	0.3	4	0.5	1	<0.01	<0.01	0.18	<0.02
Zinc	190	130	0.55	170	0.43	130	0	0.43	20	1.6	75	55	2500	210	2200	250	520	12	8.5	35	20

scrubber supply and/or return streams had sufficiently high concentrations of cadmium, chromium, lead, and selenium to be near or above the EP toxicity limit.

As expected, kiln ash and bottom ash each have total priority pollutant metal concentrations above 2000 ppm. The kiln ash, which is perhaps not subjected to as high a temperature and would likely be generated from larger size material than the bottom ash, has higher concentrations of copper (2900 mg/kg versus 14 mg/kg), zinc (2500 mg/kg versus 2200 mg/kg), lead (1600 mg/kg versus 280 mg/kg), cadmium (250 mg/kg versus 110 mg/kg), antimony (240 mg/kg versus 32 mg/kg), etc. For this site, the EP and TCLP leachates for the kiln ash and bottom ash did not exceed toxicity limits.

2.9 SITE 9

2.9.1 Facility Description

A facility schematic is shown in Figure 9. This facility is designed to incinerate a variety of solid and liquid wastes. Although all wastes are ultimately incinerated, there are onsite receiving and staging areas to ensure constant flow to the incinerator under various waste loads.

Solid wastes are normally received prepackaged in burnable containers and are fed at only one location -- the feed end of the rotary kiln. Occasionally a steel drum is fed. The containerized solid wastes are mechanically conveyed to the rotary kiln air lock and dropped into the kiln. Under normal operation, blended high-Btu and blended low-Btu liquid wastes are fed to the rotary kiln, but only blended high-Btu liquid waste is fed to the secondary combustion chamber. Destruction of wastes takes place in the 11-ft diameter by 35-ft long rotary kiln and more than 4000-ft^3 secondary

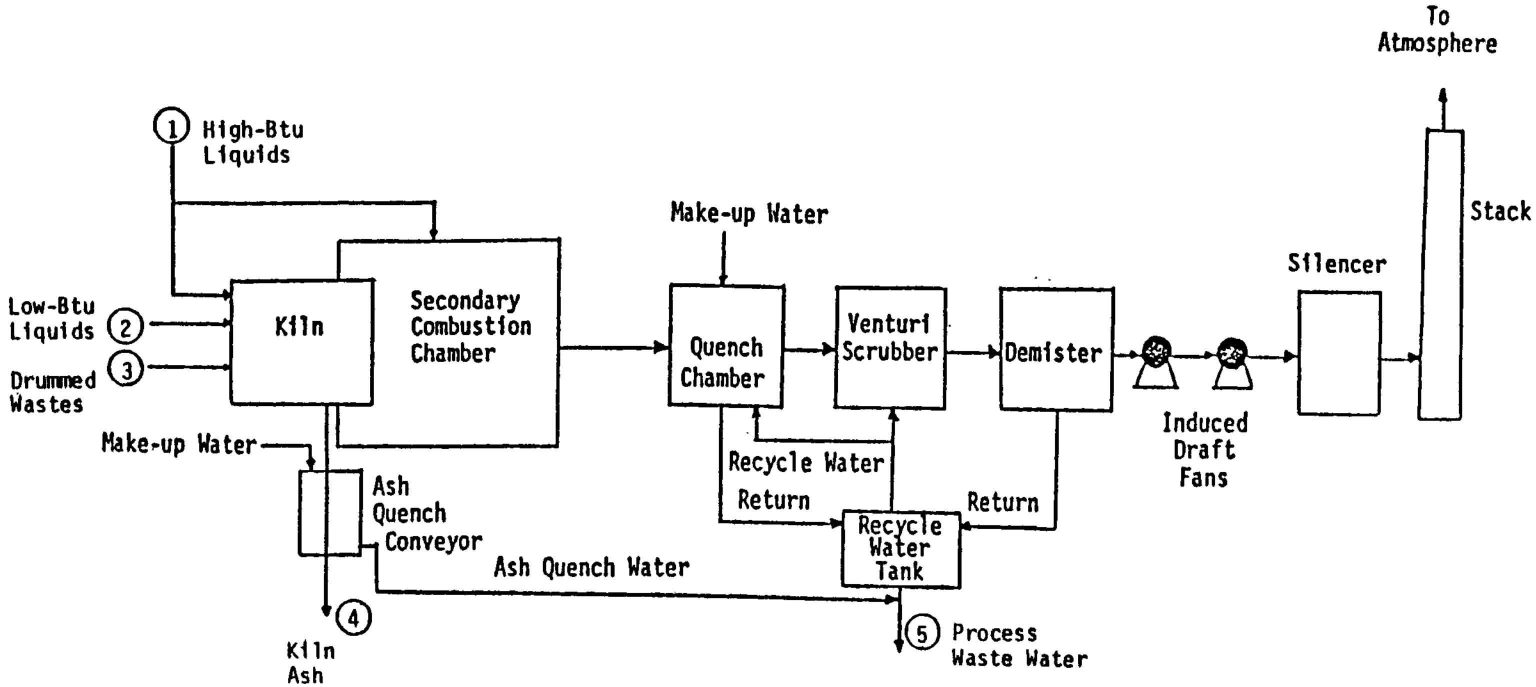


Figure 9. Site 9 incinerator schematic.

combustion chamber. The rotary kiln provides controlled agitation of the solid wastes to ensure good exposure for combustion and thorough burnout. As the kiln rotates, the burned out ash travels through the kiln and falls onto a water-submerged drag chain conveyor which periodically removes the ash from the trough and discharges it into a lugger box. The ash is sold to a processor for silver recovery.

The hot gases from the rotary kiln pass through a mixing chamber and into the secondary combustion chamber. High-Btu waste liquids are burned in the secondary combustion chamber to provide additional retention time at a higher temperature to ensure complete combustion of the kiln gases. Flue gas leaving the secondary combustion chamber enters the emission control portion of the process where particulates and acid gases are removed in a three-step process: a quench chamber, a variable-throat venturi scrubber, and a variable spin vane cyclonic liquid-gas separator. The gases proceed to two induced draft fans in series, through a silencer for noise supression, and out through a free-standing, nearly 200-ft stack. The fans maintain a negative pressure throughout the incinerator system.

2.9.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: October 31, 1985, and November 1, 1985
- Process observations:
  - Ferrous metals are removed from the kiln ash and the residue is sold to a processor for silver recovery
  - Process wastewater flow is treated by an industrial wastewater treatment plant prior to release to a river

- Process conditions:
  - -- Kiln temperature maintained at 1450 to 1500°F with one excursion to 1550°F
  - -- Secondary combustion chamber temperature maintained at 1700°F with excursions to 1750°F
- Estimated influent and effluent flows during test:
  - -- Blended high-Btu liquid fuel flowrate 92 lb/min
  - -- Blended low-Btu liquid fuel flowrate 16 lb/min
  - -- Solid waste feedrate 59 lb/min with 8 different types of solid wastes having been fed
  - -- Process wastewater flow to industrial wastewater treatment plant 560 gpm
  - -- Kiln ash generation rate approximately 280 lb/hr

A summary of all samples collected at this site and the analyses performed is presented in Table 41.

2.9.3 Analytical Results

Volatile Organics

As shown in Table 42, the high-Btu and low-Btu liquid waste streams plus the solids feed waste stream all contain high levels of widely used industrial solvents, especially acetone and toluene.

The kiln ash generation rate for this system appeared relatively low or perhaps the ash handling system was substantially oversized. The ash conveyor was operated approximately 10 minutes an hour with the conveyor trough receiving a continuous makeup and blowdown of quench water. No volatiles were detected in this kiln ash at a level above 500 µg/kg, which suggests a better combustion efficiency than experienced at some other

TABLE 41. SITE 9 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
3	Gel residue	902741	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902742	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902743	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902744	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902745	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902746	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902747	D001	10/31/85	1,2,3	Combined 902741 thru 48
3	Filter press residue	902748	D001	10/31/85	1,2,3	Combined 902741 thru 48
5	Scrubber holding tank blowdown	902749		11/1/85	2	
5	Scrubber holding tank blowdown	902750		11/1/85	3	
5	Scrubber holding tank blowdown	902751		11/1/85	1	
5	Scrubber holding tank blowdown	902752		11/1/85		
2	Low-Btu blended liquid waste	902753	b	11/1/85	2	
2	Low-Btu blended liquid waste	902754	b	11/1/85		
2	Low-Btu blended liquid waste	902755	b	11/1/85	3	
2	Low-Btu blended liquid waste	902756	b	11/1/85	1	
2	Low-Btu blended liquid waste	902757	b	11/1/85		
1	High-Btu blended liquid waste	902758	b	11/1/85	2	
1	High-Btu blended liquid waste	902759	b	11/1/85		
1	High-Btu blended liquid waste	902760	b	11/1/85	3	
1	High-Btu blended liquid waste	902761	b	11/1/85	1	
1	High-Btu blended liquid waste	902762	b	11/1/85		
4	Quenched kiln ash	902763		11/1/85	1,2,3,4,5	Combined with 902764
4	Quenched kiln ash	902764		11/1/85	1,2,3,4,5	Combined with 902763
	Water trip blank	902765		11/1/85	1	

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]EPA numbers D001, F001, F002, F003, and F005.

TABLE 42. SITE 9 VOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	3		1		2			4		5			4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Kiln ash		APCE effluent			Kiln ash
Stream flowrate in kg/s	0.44		0.7		0.12			0.035		35			
Sample number	902741 to 48		902761		902756			902763, 64		902751			902763, 64
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	0.5		100		100			0.5		0.5			1
Priority Pollutants													
Methylene chloride	ND	<0.2	15,000	10,000	15,000	1,900	12,000	ND	<0.02	ND	<18	<18	100
Chloroform	ND	<0.2	ND	<70	ND	<12	<80	ND	<0.02	ND	<18	<18	13
1,1-Dichloroethane	ND	<0.2	690	480	ND	<12	480	ND	<0.02	ND	<18	<18	ND
1,1,1-Trichloroethane	ND	<0.2	15,000	10,500	16,000	2,000	12,000	ND	<0.02	ND	<18	<18	ND
1,2-Dichloropropane	2.2	1	680	480	600	74	550	ND	<0.02	ND	<18	<18	ND
Trichloroethene	ND	<0.2	4,200	2,900	5,000	620	3,600	ND	<0.02	ND	<18	<18	ND
Tetrachloroethene	ND	<0.2	460	320	500	60	380	ND	<0.02	ND	<18	<18	ND
Toluene	90	40	100,000	70,000	110,000	13,000	84,000	ND	<0.02	ND	<18	<18	ND
Chlorobenzene	ND	<0.2	1,500	1,000	1,600	600	1,200	ND	<0.02	ND	<18	<18	ND
Ethylbenzene	2.8	1.2	8,300	5,800	10,000	1,200	7,000	ND	<0.02	ND	<18	<18	ND
All other priority pollutants	ND	<0.2	ND	<70	ND	<12	<80	ND	<0.02	ND	<18	<18	ND
Nonpriority Pollutants													
Acetone	840	370	220,000	150,000	240,000	30,000	180,000	ND	<0.02	ND	<18	<18	67
4-Methyl-2-pentanone	ND	<0.23	25,000	17,000	28,000	3,500	21,000	ND	<0.02	ND	<18	<18	ND
Total xylenes	3.3	1.5	22,000	15,000	23,000	2,900	18,000	ND	<0.02	ND	<18	<18	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 4.

sites using rotary kilns. Also, no volatiles were detected in the APCE effluent blowdown to the industrial wastewater treatment plant. Providing that the makeup water is clean, the relatively high blowdown rate is likely to keep any PICs or POHCs below detectable levels.

Kiln ash TCLP leachate was analyzed for volatiles. With no volatiles having been discovered in the kiln ash, it is somewhat surprising to find three common solvents, methylene chloride (100 μg/L), acetone (67 μg/L) and chloroform (13 μg/L) in the leachate.

Semivolatile Organics

As shown in Table 43, only a few semivolatiles were detected in the input streams while none were detected in the outlet, including the TCLP leachate for the kiln ash. Isophorone at 1000 ppm was the only semivolatile detected in the composited solids feed sample. For the high-Btu liquids, di-n-butyl phthalate (4300 mg/L), 4-methylphenol (2000 mg/L) and 2-methylnaphthalene (460 mg/L) were three of the eight semivolatiles detected but the only ones at a concentration of greater than 100 mg/L. Low-Btu liquids only had four detected semivolatiles, di-n-butyl phthalate (500 mg/L), 4-methylphenol (280 mg/L), phenol (160 mg/L), and isophorone (56 mg/L).

Priority Pollutant Metals

The analyses for priority pollutant metals are shown in Table 44. In general, the input streams appear to have low concentrations of metals (less than 20 ppb). In comparison, several other sites had metals at substantially higher levels in the feed. Since this site has its ash processed for silver, it is surprising to see silver barely detected in one of the three input samples.

TABLE 43. SITE 9 SEMIVOLATILE ORGANICS

	Input						Total input	Output				Total output	TCLP
Stream number	3		1		2			4		5			4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Kiln ash		APCE effluent			Kiln ash
Stream flowrate in kg/s	0.44		0.7		0.12			0.035		35			
Sample number	902741 to 48		902758		902753			902763 & 64		902749			902763, 64
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in µg/L
Detection Limit Factor[a]	20		20		20			0.1		0.02			2
Priority Pollutants													
Isophorone	1000	440	ND	<14	56	7	450	ND	<0.004	ND	<1	<1	ND
Naphthalene	ND	<9	32	22	ND	<2	<31	ND	<0.004	ND	<1	<1	ND
Phenol	ND	<9	24	17	160	20	<46	ND	<0.004	ND	<1	<1	ND
Bis(2-ethylhexyl)phthalate	ND	<9	82	57	ND	<2	<68	ND	<0.004	ND	<1	<1	ND
Di-n-butyl phthalate	ND	<9	4300	3000	500	62	3100	ND	<0.004	ND	<1	<1	ND
Diethyl phthalate	ND	<9	78	55	ND	<2	<66	ND	<0.004	ND	<1	<1	ND
Phenanthrene	ND	<9	44	30	ND	<2	<41	ND	<0.004	ND	<1	<1	ND
All other priority pollutants	ND	<9	ND	<14	ND	<2	<25	ND	<0.004	ND	<1	<1	ND
Nonpriority Pollutants													
4-Methylphenol	ND	<9	2000	1400	280	35	1400	ND	<0.004	ND	<1	<1	ND
2-Methylnaphthalene	ND	<9	460	320	ND	<2	320	ND	<0.004	ND	<1	<1	ND

[a]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 5 and retain units from this table. Note: all less than values should be multiplied by corresponding detection limits in Table 5.

TABLE 44. SITE 9 PRIORITY POLLUTANT METALS

	Input						Total input	Output				Total output	Toxicity EP	Toxicity TCLP
Stream number	3		1		2			4		5			4	4
Stream description	Solids feed		High Btu liquids		Low Btu liquids			Kiln Ash		APCE Effluent			Kiln ash	Kiln ash
Stream flowrate in kg/s	0.44		0.70		0.12			0.035		35				
Sample number	902741 to 48		902760		902755			902763 & 64		902750			902763, 64	902763, 64
	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/kg	Rate in mg/s	Concentration in mg/L	Rate in mg/s	Rate in mg/s	Concentration in mg/L	Concentration in mg/L
Priority Pollutant Metals														
Antimony	<1	<0.44	0.6	0.42	0.8	0.099	<1	<0.8	<0.03	<0.03	<1.1	<1.1	<0.01	0.02
Arsenic	<1	<0.44	0.2	0.14	<0.1	<0.012	<0.6	2	0.07	<0.1	<3.5	<3.6	<0.06	<0.01
Beryllium	<1	<0.44	<0.01	<0.007	<0.01	<0.001	<0.4	<1	<0.03	<0.01	<0.4	<0.4	<0.01	<0.01
Cadmium	<1	<0.44	0.02	0.014	0.02	0.002	<0.5	<1	<0.03	<0.01	<0.4	<0.4	<0.01	<0.01
Chromium	6	2.7	11	7.7	0.76	0.094	10	29	1	0.27	9.5	11	0.08	<0.02
Copper	2	0.89	1.8	1.3	0.93	0.11	2.3	120	4.2	0.46	16	20	<0.02	0.67
Lead	7	3.1	2.3	1.6	0.24	0.03	4.7	490	17	0.38	13	31	<0.07	0.5
Mercury	<0.05	<0.02	<0.005	<0.003	<0.005	<0.001	<0.02	<0.05	<0.002	<0.005	<0.2	<0.2	<0.001	<0.001
Nickel	<2	0.89	2.5	1.7	0.5	0.062	2.7	21	0.74	0.07	2.5	3.2	2	0.49
Selenium	<4	<1.8	<0.5	<0.35	<0.5	<0.062	<2.2	<4	<0.14	<0.1	<3.5	<3.7	<0.05	<0.01
Silver	<1	0.44	<0.01	<0.007	0.02	0.002	<0.4	9	0.32	0.61	22	22	0.09	<0.01
Thallium	11	4.9	0.53	0.37	1.1	0.14	5.4	6	0.21	0.31	11	11	<0.01	<0.02
Zinc	17	7.6	0.72	0.5	<0.09	<0.011	8.1	44	1.6	0.16	5.6	7.2	0.67	1.9

The kiln ash, as expected, exhibits an increased concentration for most metals, especially lead (490 ppm), chromium (120 ppm), zinc (44 ppm), and cadmium (29 ppm). The APCE effluent blowdown, likely due to a high blowdown rate, has a low metals concentration. Based on mass flows, more silver appears in the blowdown water than in the kiln ash.

The EP toxicity and TCLP leachates for the kiln ash provide extremely low concentrations for most of the metals. This may be associated with the makeup of the kiln ash or the water washing the ash receives when it is removed from the incinerator system.

2.10 SITE 10

2.10.1 Facility Description

A schematic of this process is shown in Figure 10. The facility incinerates solid wastes in a rotary kiln and liquid wastes in the rotary kiln and a secondary combustion chamber. The rotary kiln is 6-1/2 ft in diameter and 22-ft long, while the secondary combustion chamber is 7-1/2 ft in diameter and 24-ft high. Hot gases from the rotary kiln are heated to at least 1900°F in the secondary combustion chamber to ensure complete combustion.

Flue gas leaving the secondary combustion chamber enters the emission control section of the process where particulates and acid gases are removed in a four-step process: a quench chamber, a low-pressure venturi scrubber, a liquid-gas separator, and an acid absorber. An induced draft fan downstream of the liquid-gas separator maintains a negative pressure in the front half of the system and forces the cooled gases through the acid absorber and into the exhaust stack.

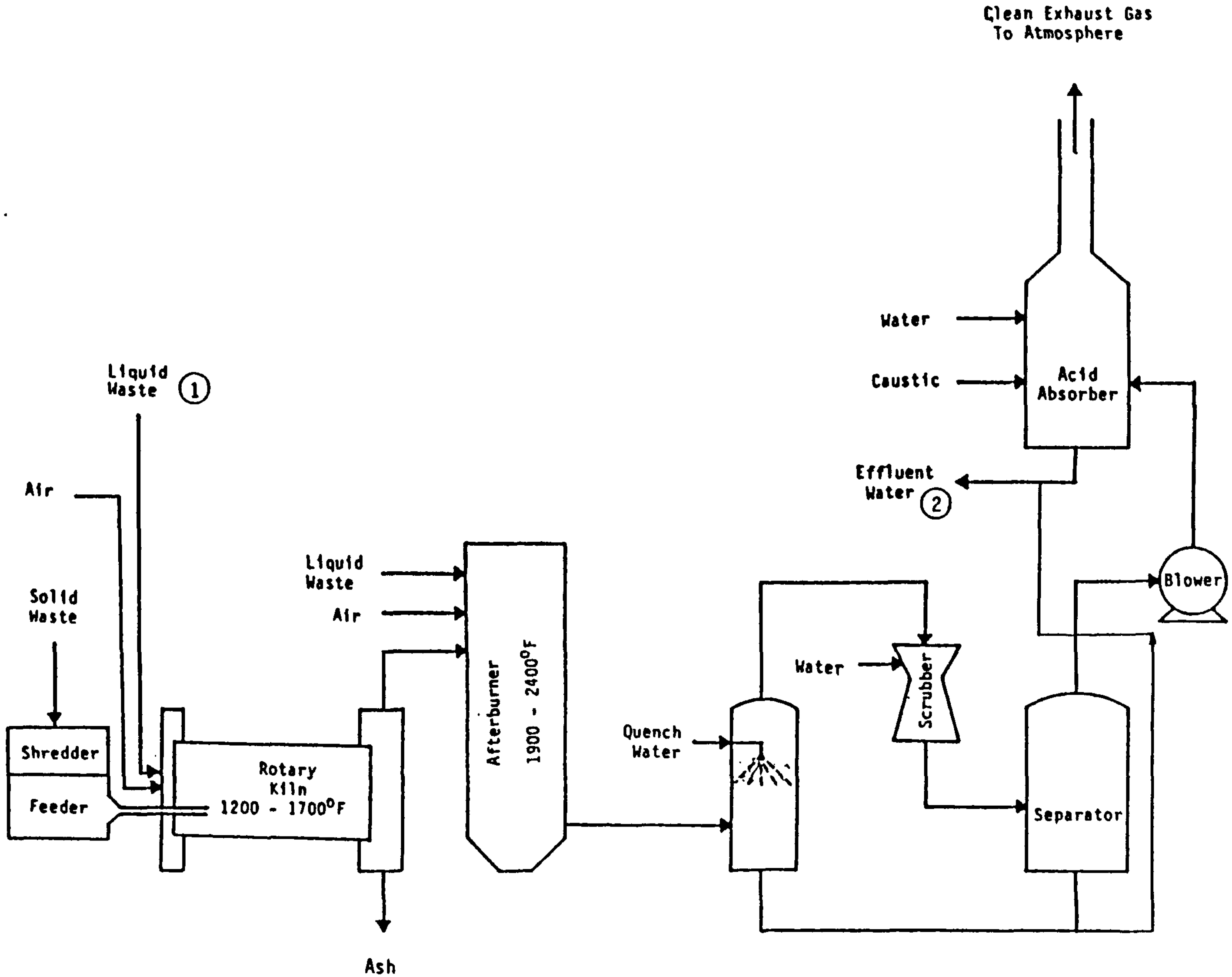


Figure 10. Site 10 incinerator schematic.

2.10.2 Operating and Sampling Information

The following operating information was collected for this site:

- Dates of site visit: November 4 and 5, 1985
- Process observations:
  - -- Solids feed system not operational during test, so no ash generated
- Process conditions:
  - -- Kiln maintained at 1325°F
  - -- Afterburner chamber maintained at 2230°F
  - -- Venturi scrubber pressure drop 24 in. of water
  - -- Kiln airflow 240 scfm
  - -- Afterburner airflow 635 scfm
  - -- Quench water flow 790 lb/min
  - -- Venturi water flow 1090 lb/min
  - -- Absorber water flow 1310 lb/min
  - -- Recirculation water maintained at pH of 7.2
  - -- Stack oxygen concentration 9 percent on a dry basis
- Estimated influent and effluent flows during test:
  - -- Liquid waste flow to kiln 256 lb/hr
  - -- Liquid waste flow to afterburner 398 lb/hr
  - -- Recycle effluent blowdown 7.4 gal/min
  - -- Absorber effluent blowdown 8.2 gal/min

A summary of all samples collected at this site and the analyses performed is presented in Table 45.

TABLE 45. SITE 10 PROCESS STREAM SAMPLES

Stream number	Stream name	Sample ID number	EPA ID number	Sampling date	Analyses performed[a]	Comments
1	Liquid waste feed	901998	b	11/5/85	3	
1	Liquid waste feed	901999	b	11/5/85	2	
1	Liquid waste feed	902000	b	11/5/85	1	
2	Scrubber effluent	902001		11/5/85	2	
2	Scrubber effluent	902002		11/5/85	3	
2	Scrubber effluent	902003		11/5/85		
2	Scrubber effluent	902333		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902334		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902335		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902336		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902337		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902338		11/5/85	1	Combined 902333 thru 39
2	Scrubber effluent	902339		11/5/85	1	Combined 902333 thru 39
	Water trip blank	902340		11/5/85	1	

[a]Key: 1 = Volatile analyses.
2 = Semivolatile and base neutral acid analyses.
3 = Thirteen priority pollutant metals.
4 = EP Toxicity extraction procedure followed by analysis 3.
5 = TCLP followed by analyses 1, 2, and 3.

[b]EPA numbers D001, F001, F002, F003, and F005.

2.10.3 Analytical Results

Unfortunately, the solids feed system was not operational during the gathering of incinerator system input and output samples at this site. Hence, this site as tested did not fully meet the site selection criteria but does demonstrate possible expected performance for sites with rotary kilns temporarily not incinerating solid hazardous wastes. As tested, this facility had only one liquid input stream and one output stream.

Volatile Organics

As shown in Table 46, common solvent volatile organics were only detected in the liquid waste fuel with toluene (about 7 percent), acetone (about 5 percent), and xylenes (about 2.6 percent) occurring in concentrations above 10,000 mg/L. No volatiles were detected in the APCE effluent blowdown.

Semivolatile Organics

Many common semivolatile organics were detected in the liquid waste fuel (see Table 47). Those present above 10,000 µg/L (10 ppm) included 2-methylnaphthalene (1,100,000 µg/L), phenanthrene (74 µg/L), fluorene (44,000 µg/L), 1,2,4-trichlorobenzene (40,000 µg/L), naphthalene (38,000 µg/L), pyrene (29,000 µg/L), fluoranthene (22,000 µg/L), and 1,4-dichlorobenzene. Only two semivolatiles were detected in the APCE effluent blowdown, bis(2-ethylhexyl)phthalate (43 ppb) and diethyl phthalate (30 ppb).

Priority Pollutant Metals

Priority pollutant metal concentrations are shown in Table 48. Based on results from other sites, the concentrations of priority pollutant metals at site 10 without solids feed is relatively low.

TABLE 46. SITE 10 VOLATILE ORGANICS

	Input		Output	
Stream number	1		2	
Stream description	Liquid Waste Fuel		APCE effluent	
Stream flowrate in kg/s	0.082		0.98	
Sample number	902000		902333 through 39	
	Concen- tration in mg/L	Rate in mg/s	Concen- tration in mg/L	Rate in mg/s
Nominal Detection Limit	100		0.5	
Priority Pollutants				
Methylene chloride	4000	300	ND	<0.5
Chloroform	9600	790	ND	<0.5
1,1,1-Trichloroethane	6700	550	ND	<0.5
Benzene	6700	550	ND	<0.5
Toluene	71000	5800	ND	<0.5
Ethylbenzene	5100	420	ND	<0.5
All other priority pollutants	ND	<8	ND	<0.5
Nonpriority Pollutants				
Acetone	49000	4000	ND	<0.5
4-Methyl-2-pentanone	1700	140	ND	<0.5
Total xylenes	26000	2100	ND	<0.5

TABLE 47. SITE 10 SEMIVOLATILE ORGANICS

	Input		Output	
Stream number	1		2	
Stream description	Liquid waste fuel		APCE effluent	
Stream flowrate in kg/s	0.082		0.98	
Sample number	901999		902001	
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s
Nominal Detection Limit	1		0.01	
Priority Pollutants				
Acenaphthene	9	0.7	ND	<0.01
1,2,4-Trichlorobenzene	40	3.3	ND	<0.01
2-Chloronaphthalene	2.1	0.2	ND	<0.01
1,2-Dichlorobenzene	9	0.7	ND	<0.01
1,4-Dichlorobenzene	17	1.4	ND	<0.01
Fluoranthene	22	1.8	ND	<0.01
Naphthalene	38	3.1	ND	<0.01
Phenol	5	0.4	ND	<0.01
Bis(2-ethylhexyl)phthalate	6	0.5	0.043	0.04
Di-n-butyl phthalate	4	0.3	ND	<0.01
Diethyl phthalate	ND	<0.1	0.03	0.03
Benzo(a)pyrene	8.4	0.7	ND	<0.01
Anthracene	4	0.3	ND	<0.01
Fluorene	44	3.6	ND	<0.01
Phenanthrene	74	6.1	ND	<0.01
Pyrene	29	2.4	ND	<0.01
All other priority pollutants	ND	<0.1	ND	<0.01
Nonpriority pollutants				
4-Methylphenol	2.1	0.2	ND	<0.01
2-Methylnaphthalene	1100	91	ND	<0.01
4-Chloroaniline	7	0.6	ND	<0.01
Dibenzofuran	8	0.7	ND	<0.01

TABLE 48. SITE 10 PRIORITY POLLUTANT METALS

	Input		Output	
Stream number	1		2	
Stream description	Liquid waste fuel		APCE effluent	
Stream flowrate in kg/s	0.82		0.98	
Sample number	901998		902002	
	Concentration in mg/L	Rate in mg/s	Concentration in mg/L	Rate in mg/s
<u>Priority Pollutant Metals</u>				
Antimony	<0.03	<0.002	0.13	0.13
Arsenic	<0.1	<0.008	<0.1	<0.1
Beryllium	<0.01	<0.001	<0.01	<0.01
Cadmium	<0.01	<0.001	<0.01	<0.01
Chromium	0.18	0.015	0.28	0.27
Copper	<0.02	<0.002	0.05	0.05
Lead	0.1	0.008	0.1	0.1
Mercury	<0.005	<0.004	<0.005	<0.005
Nickel	0.18	0.015	0.48	0.47
Selenium	0.2	0.016	0.2	0.2
Silver	0.03	0.002	<0.01	<0.01
Thallium	<0.08	<0.007	0.03	0.03
Zinc	<0.09	<0.007	0.11	0.11

SECTION 3

DATA ANALYSIS

In this program the residual streams at 10 incinerator sites were sampled. The samples were then analyzed for volatiles, semivolatiles, and metals. An analysis of the analytical data is given below.

3.1 VOLATILE AND SEMIVOLATILE ORGANICS

Liquid, aqueous, and solid waste fuels all generally contained relatively common volatile and semivolatile organics. Acetone, 2-butanone (MEK), ethylbenzene, methylene chloride, toluene, tetrachloroethane, trichloroethane, and xylenes (combined ortho-, meta-, and para-) were the volatiles typically present in the highest concentrations in most fuel samples. Semivolatile organics were not detected in concentrations as high as the common volatiles. Bis(2-ethylhexyl)phthalate, isophorone, naphthalene, and phenol were detected as major semivolatiles in the waste feeds at roughly half the tested sites. Benzyl-butyl phthalate, diethyl phthalate, dimethyl phthalate, 2-methylnaphthalene, N-nitrosodiphenylamine, and 1,2,4-trichlorobenzene were detected at significant levels at just a few sites.

Site 1 incinerated a special waste high in PCBs typically present in Aroclor and other transformer oils, while Site 4 incinerated CS tear gas (O-chlorobenzalmalononitrile). These sites demonstrate that incinerator inlet streams can be well-defined and limited to one or two special feeds.

More typical, though, were the many other incinerators with generic solvents present in the inlet streams.

A total of 19 distinct volatile organics and 24 distinct semivolatile organics were detected in the ash residual samples. Those present in the highest concentrations are shown in Table 49 while the data results are summarized in Table 50. Even the low volatiles concentrations in the ash reported in these tables would generally not be expected. However, these levels might be due to the ash adsorbing volatiles from quench water (Sites 1, 2, 3, 7, 8, and 9), flue gas, or air; products of incomplete combustion (PICs) (especially possible with Site 4) or early ash quenching before complete ash burnout (possible with Sites 3 and 8); or poor air/waste mixing (sites with fixed hearth incinerators). Except for Site 4 where the feed material was a relatively pure chemical, o-chlorobenzalmalononitrile, the volatile organics found generally appear in the waste feed. The cyclone

TABLE 49. ORGANICS IN ASH

	Highest concentration in ppm
Volatiles (19 total detected)	
Toluene	120
2-butanone	34
4-methyl-2-pentanone	29
Tetrachloroethane	16
Semivolatiles (24 total detected)	
Bis(2-ethylhexyl)phthalate	500
Phenol	400
Di-n-butylphthalate	39
2-methylnaphthalene	15

TABLE 50. CONCENTRATION OF VOLATILE AND SEMIVOLATILE ORGANICS IN INCINERATOR ASH RESIDUALS AND THEIR TCLP LEACHATE

Site number Stream description	1 Kiln ash	2 Kiln ash	3 Kiln ash	3 Boiler ash	4 Cyclone ash	5 Small incinerator bottom ash	6 Incinerator bottom ash	7 Incinerator bottom ash	8 Kiln ash	8 Incinerator bottom ash	9 Kiln ash
	Concentration[a,b,c]										
	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)	(mg/kg)/(µg/L)
Volatile organics[d]											
Detection Limit Factor[f]	1 / 1	100 / 1	0.5 / 1	0.1 / 1	0.5 / 1	100 / 1	100 / 1	100 / 1	0.5 / 1	0.5 / 1	/
Chloromethane	-- / --	-- / --	-- / --	-- / 50	-- / --	-- / --	-- / --	-- / --	1.7 / --	-- / --	/
Bromomethane	/	/	/	-- / 9	/	/	/	/	/	/	/
Methylene chloride	-- / 20	-- / 14	-- / 23	/	/	-- / 180	-- / 550	-- / 150	-- / 90	-- / 26	-- / 100
Trans-1,2-dichloroethene	-- / --	-- / --	-- / --	-- / --	1.1 / --	-- / --	-- / --	-- / --	-- / --	-- / --	/
Chloroform	-- / 3	-- / 4	/	/	/	/	/	-- / 17	/	/	-- / 13
1,2-dichloroethane	/	-- / 3	/	/	/	-- / 8	/	/	/	/	/
1,1,1-trichloroethane	-- / --	-- / --	-- / --	-- / --	3.7 / --	-- / 3	-- / --	-- / 77	6.2 / 22	-- / --	/
Trichloroethene	-- / --	-- / 7	2.5 / --	-- / --	5.4 / --	-- / --	-- / --	-- / 17	5.3 / --	-- / --	/
Benzene	-- / 2	-- / 3	/	/	/	/	-- / 10	-- / 13	-- / 3	-- / 2	/
Tetrachloroethene	-- / --	-- / 6	-- / --	-- / --	16 / --	-- / --	-- / 3	-- / --	3.6 / 4	-- / --	/
Toluene	-- / 6	-- / 1700	-- / 27	-- / 10	6.4 / --	-- / 7	-- / 790	-- / 61	120 / 170	2.1 / 13	/
Chlorobenzene	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	2.5 / 2	-- / --	/
Ethylbenzene[e]	-- / --	-- / 25	0.5 / 2	-- / --	-- / --	-- / --	-- / 38	-- / 10	7.6 / 12	-- / --	/
Acetone	/	-- / 590	/	/	/	/	-- / 950	-- / 110	/	/	-- / 67
Carbon disulfide	-- / --	-- / --	2.8 / 900	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 4	/
2-butanone	34 / --	-- / 280	-- / --	-- / --	-- / --	-- / 25	-- / 91	-- / 110	-- / 49	-- / --	/
4-methyl-2-pentanone	-- / --	-- / 47	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 140	29 / 150	-- / --	/
Styrene	-- / --	-- / --	4.3 / --	-- / --	-- / --	-- / --	-- / --	-- / 62	-- / --	-- /	/
Total xylenes	-- / --	-- / 80	1.5 / 15	-- / --	-- / --	-- / --	-- / 75	-- / 28	15 / 57	-- /	/
Semivolatile Organics[d]											
Detection Limit Factor[f]	0.1 / 2	0.1 / 2	0.1 / 2	0.1 / 2	0.01 / 2	0.1 / 2	0.1 / 2	0.1 / 2	0.5 / 2	0.1 / 2	0.5 / 2
Acenaphthene	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	0.26 / --	-- / --	-- / --	-- / --	-- / --
1,2,4-Trichlorobenzene	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	10 / 10	-- / --	-- / --	-- / --	-- / --
Fluoranthene	-- / --	0.61 / --	-- / --	-- / --	-- / --	-- / --	0.23 / --	-- / --	-- / --	-- / --	-- / --
Isophorone	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	1.1 / 20	11 / 62	2.9 / --	-- / --	-- / --
Naphthalene	-- / --	-- / --	0.17 / --	-- / --	-- / --	-- / --	6.8 / 8	0.75 / --	2.3 / --	-- / --	-- / --
2-Nitrophenol	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 60	-- / --	-- / --	-- / --	-- / --
4-Nitrophenol	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 90	-- / --	-- / --	-- / --	-- / --
N-Nitrosodiphenylamine	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	1.5 / --	-- / --	-- / --	-- / --
Phenol	-- / --	0.35 / --	3 / 116	-- / --	-- / --	-- / --	1.7 / 30	-- / 6	400 / 1800	-- / 120	-- / --
Bis(2-ethylhexyl)phthalate	-- / 56	0.31 / 24	4.4 / --	0.4 / 30	-- / --	-- / --	500 / --	150 / --	-- / --	-- / --	-- / --
Benzyl butyl phthalate	-- / --	-- / --	0.28 / --	-- / --	-- / --	-- / --	5 / --	7 / --	-- / --	-- / --	-- / --
Di-n-butyl phthalate	-- / --	-- / --	0.41 / --	-- / --	-- / --	-- / --	39 / 14	7 / --	-- / --	-- / --	-- / --
Di-n-octyl phthalate	-- / --	-- / --	0.76 / --	-- / --	-- / --	-- / --	2.5 / --	-- / --	-- / --	-- / --	-- / --
Diethyl phthalate	-- / --	-- / --	-- / 6	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --
Dimethyl phthalate	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	31 / 580	-- / --	-- / --	-- / --	-- / --
Benzo(b)fluoranthene	-- / --	0.2 / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --
Chrysene	-- / --	0.2 / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --
Anthracene[e]	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	0.15 / --	-- / --	-- / --	-- / --	-- / --
Phenanthrene	-- / --	0.48 / --	-- / --	-- / --	-- / --	-- / --	1.3 / --	-- / --	0.9 / --	-- / --	-- / --
Pyrene	-- / --	0.66 / --	-- / --	-- / --	-- / --	-- / --	0.34 / --	-- / --	1.3 / --	-- / --	-- / --
Benzoic acid	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 46	2.4 / --	-- / --	-- / --	-- / --	-- / --
2-Methylphenol	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	1 / --	-- / --	-- / --
2-Methylnaphthalene	-- / --	-- / --	0.12 / --	-- / --	-- / --	-- / --	6.2 / 4	0.3 / --	15 / --	-- / --	-- / --
Aniline	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / --	-- / 20	-- / --	-- / --	-- / --
Comments: Wet or Dry Ash	Wet	Wet	Wet	Wet	Dry	Dry	Dry	Wet	Wet	Dry	Wet

[a]Ash concentration / TCLP leachate concentration.
[b]-- means not detected, hence less than nominal detection limit.
[c]Volatile organics data for TCLP leachate not available.
[d]RCRA Appendix VIII unless otherwise noted.
[e]Not RCRA Appendix VIII compound.
[f]To obtain actual detection limits, multiply this factor times the individual detection limit values in Table 4 and retain units from this table.

ash from Site 4 shows several compounds that would appear to be PICs. Because the cyclone ash at Site 4 was periodically emptied and allowed to free fall through air during the cyclone draining procedure, it is possible that the volatiles observed were adsorbed while the ash was in the cyclone and/or during the free fall through air upon draining.

Most detected compounds are less than 10 ppm. Most sites quench ash with water. Especially if a rotary kiln discharges ash and unburned material too quickly, it is possible for some of the organics to not be subjected to high enough temperatures for complete combustion (thus, the appearance of the organics in the analyses); also, the quench water may experience a buildup of these organic compounds and contaminate the ash (c.f., wet and dry ash from Site 8).

Incinerators with rotary kilns would be expected to more thoroughly incinerate organics than incinerators with fixed hearths since the tumbling action of the rotary kiln continuously agitates the solid materials and exposes unburned material to very high temperatures.

This expectation is not fully supported by the sample averages shown in Figure 11 since the kiln ash volatile average is shown as being higher than the bottom ash average. The bottom ash average would be increased, however, if values were deleted for Site 5's large incinerator (since that incinerator burned only liquid waste) and Site 8's bottom ash (since that ash was predominantly generated from liquid waste).

Boiler ash and cyclone ash each consist of small particles exposed to high temperatures and oxygen for a sufficiently long period for expected high organic burnout. Although the cyclone ash volatiles are somewhat high,

Figure 11 generally supports the expected good burnout and low organics ash content.

A total of nine volatile and five semivolatile organics were detected in the various APCE effluents as shown in Table 51. Site 4 effluent appears to have either been contaminated with approximately 60 ppm of volatile organics or the incinerator produced those items as PICs followed by adsorption into APCE effluent water. Since the cyclone ash for this facility also contained volatiles, it appears the two cases support the presence of volatiles as PICs. Sites 1 and 8 practice extensive water recirculation although all other sites with APCE recirculate effluent to a certain extent before discharging water to an onsite treatment facility. Sites 1 and 8 are expected to have higher than average volatiles and semivolatiles as the data relatively supports (the detection limit for Site 1 volatiles, in retrospect, was set too high and is hypothesized to contain several volatiles in the near ppm range).

A draft toxicity characteristic leaching procedure (TCLP) using the EPA draft protocol revised December 1985 was used to obtain extracts from the residual ash samples. Those samples were analyzed for semivolatile organics and for volatile organics. Organics extracted, as shown in Table 50, were analyzed with uniform detection limits of 1 μg/L (1 ppb) for volatiles and 2 μg/L (2 ppb) for semivolatiles. Average leachable volatiles and semivolatiles for each type of ash, shown in Figure 12, were less than 1000 μg/L or 1 ppm. Organics with highest concentrations are summarized in Table 52.

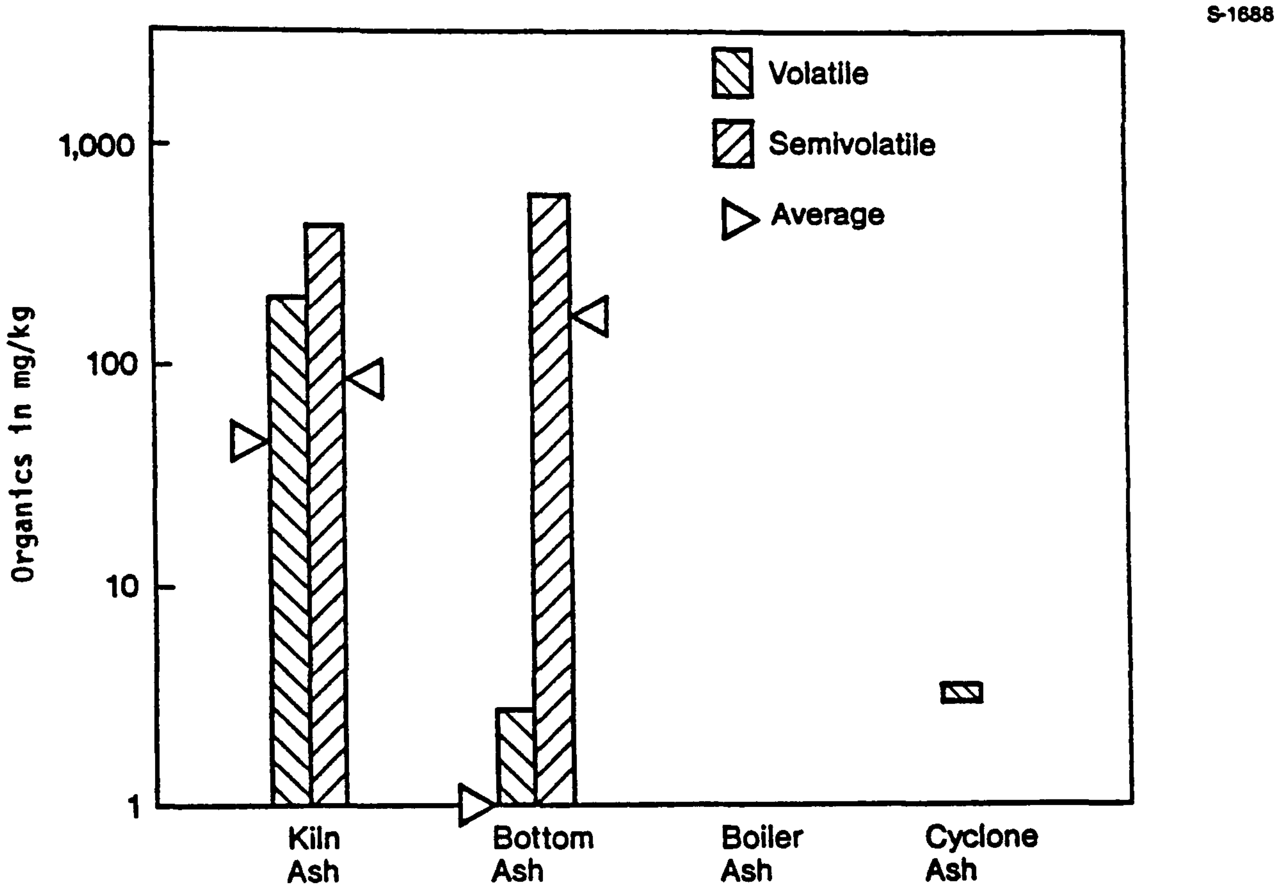


Figure 11. Total and average organic concentrations in ash.

TABLE 51. CONCENTRATION OF VOLATILE AND SEMIVOLATILE ORGANICS IN INCINERATOR APCE EFFLUENTS, IN mg/L[a]

Site number	1	2	3	4	7	8	9	10
<u>Volatile organics</u>								
Nominal detection limit	5	0.05	0.001	0.5	0.5	0.5	0.5	0.5
Chloromethane	--	--	--	--	--	2.5	--	--
Trans-1,2-dichloroethene	--	--	--	0.6	--	0.6	--	--
Chloroform	--	4.1	--	--	--	--	--	--
1,2-dichloroethane	--	--	--	32.0	--	--	--	--
1,1,1-trichloroethane	--	--	--	6.8	--	--	--	--
Trichloroethene	--	--	--	14.0	8.4	3.6	--	--
Tetrachloroethene	--	--	--	1.2	--	5.2	--	--
Toluene	--	--	--	5.0	--	4.2	--	--
Total xylenes	--	--	--	1.2	--	--	--	--
<u>Semivolatile organics</u>								
Nominal detection limit	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01
Phenol	--	0.033	--	--	0.100	--	--	0.043
Bis(2-ethylhexyl)phthalate	0.012	0.032	--	--	--	--	--	--
Di-n-butyl phthalate	--		--	--	0.022	--	--	--
Diethyl phthalate	--		--	--	--	--	--	0.030
Benzoic acid	--		--	--	--	0.260	--	--

[a]-- means not detected, hence less than nominal detection limit.
[b]Values in table represent highest individual concentrations from more than one sample.
[c]RCRA Appendix VIII unless otherwise noted.
[d]Not RCRA Appendix VIII compound.

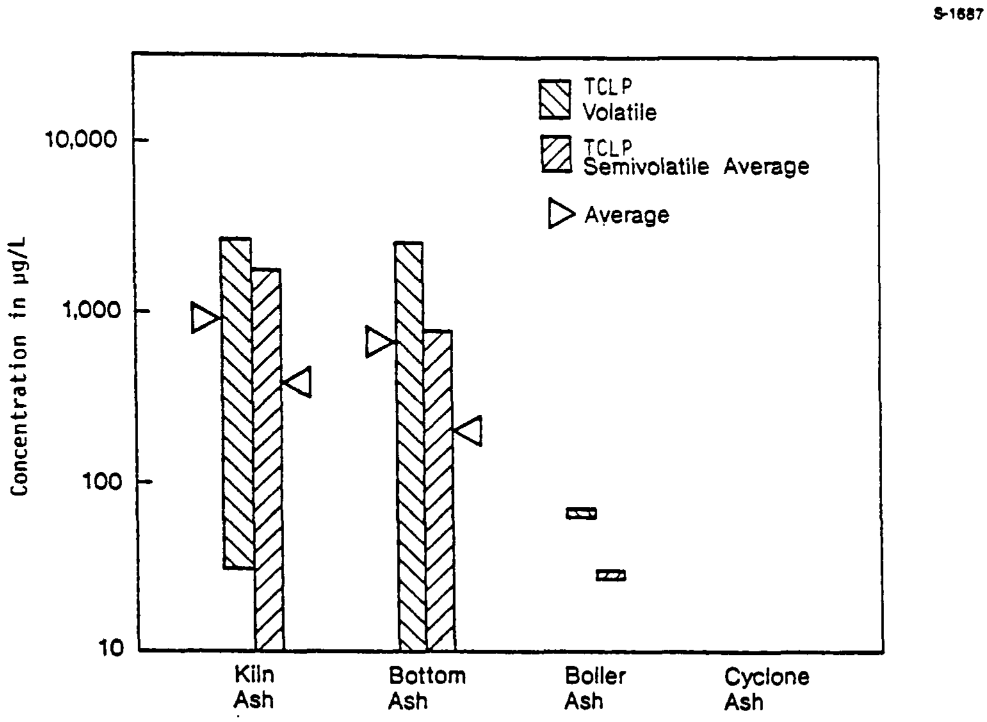


Figure 12. Total and average organic concentrations in TCLP leachates.

TABLE 52. TCLP LEACHATE ORGANICS

	Highest concentration in µg/L
Volatiles	
Toluene	1700
Acetone	950
Carbon disulfide	900
Methytlene chloride	550
2-butanone	280
Semivolatiles	
Phenol	1800
Dimethyl phthalate	580

3.2 PRIORITY POLLUTANT METALS

Concentration of priority pollutant metals varied dramatically between the different input waste streams at the 10 sites. Site 10's input stream had the lowest metals concentrations, with total metals less than 0.7 mg/L. Liquid waste fuel at Site 8 had nearly 230 mg/L of metals with a zinc concentration of 190 mg/L. Higher metal concentrations were found in the solvent wastes at Site 5 with chromium at 4300 mg/L, zinc at 310 mg/L, and lead at 93 mg/L. The highest metals concentrations were detected in the vacuum filter solids at Site 2 with just over 9000 mg/kg, composed of nickel (6100 mg/kg) and zinc (2000 mg/kg). Although a number of generic solvents appear in the wastes burned at the 10 sites, the metals concentration drastically varies, most likely, with the application or with the process generating the waste.

Data for the nine sites producing a solid residual are displayed in Table 53. Figure 13 shows the ranges of priority pollutant metals experienced. Boiler ash (from Site 3) has the highest concentration of metals; the small ash particle size at this site presents a high surface to mass ratio which favors metals condensation. Highest concentrations for each metal are shown in Table 54.

Ash generated from the incineration of wastes was subjected to both the EP toxicity test procedure and toxicity characteristic leaching procedure for metals. The metal concentrations presented in Table 53 indicate that only 1 metals measurement of the EP leachate out of 84 exceeded the maximum concentration of contaminants for characteristics of EP toxicity (standards

TABLE 53. CONCENTRATION OF PRIORITY POLLUTANT METALS IN INCINERATOR RESIDUALS

Site number	1	2	3	3	4	5
Stream description	Kiln ash	Kiln ash	Kiln ash	Boiler ash	Cyclone ash	Large incinerator bottom ash
	Concentration[a]					
	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)
Antimony	2 /<0.05 / 0.04	6 /<0.01 /<0.01	18 / 0.06 /<0.01	190 /<0.01 /<0.01	<1 /<0.01 /<0.01	3 /<0.01 /<0.01
Arsenic	4 / 0.23 /<0.01	2 /<0.01 /<0.01	3 /<0.01 /<0.01	14 /<0.01 /<0.01	<1 /<0.01 /<0.01	9 / 0.12 / 0.10
Beryllium	<1 /<0.01 /<0.01	<2 /<0.01 /<0.01	<7 /<0.01 /<0.01	6 /<0.01 / 0.08	<2 /<0.01 /<0.01	<2 /<0.01 /<0.01
Cadmium	<2 /<0.01 /<0.01	<1 /<0.01 /<0.01	<1 /<0.01 /<0.01	61 / 8.6 / 6.7	<1 /<0.01 /<0.01	2 /<0.01 /<0.01
Chromium	120 / 0.10 / 0.22	110 / 0.09 / 0.10	660 / 0.03 / 0.06	1800 / 0.03 / 0.36	7 / 0.03 / 0.03	520 / 0.98 / 0.20
Copper	6900 / 8.6 / 16	840 / 3.7 / 7.9	400 / 0.02 / 0.09	780 / 31 /21	<4 /<0.01 / 0.02	500 /<0.01 / 0.11
Lead	220 / 2.3 / 3.5	100 /<0.01 /<0.01	610 / 0.04 /<0.01	5000 / 4.4 / 4.5	<1 /<0.01 /<0.01	1800 /<0.01 /<0.01
Mercury	<0.05 /<0.001/<0.001	1.5 /<0.001/<0.001	<0.1 /<0.001/<0.001	0.2 /<0.001/<0.001	<0.1 /<0.001/<0.001	<0.1 /<0.001/<0.001
Nickel	190 / 0.49 / 0.45	7300 / 6.9 / 6	240 / 0.79 /13	4700 / 20 /13	25 / 0.18 / 0.22	34 / 0.03 / 0.02
Selenium	<1 /<0.05 / 0.02	6 / 0.2 / 0.05	13 / 0.17 / 1.4	13 / <1 / 1.4	<1 /<0.01 /<0.01	8 /<0.01 / 0.03
Silver	11 /<0.01 /<0.01	8 / 0.05 /<0.01	4 / 0.02 / 0.05	190 / 0.09 / 0.05	120 /<0.01 /<0.01	16 /<0.01 /<0.01
Thallium	<1 /<0.01 /<0.02	<1 /<0.01 /<0.02	7 /<0.01 /<0.02	9 / 0.7[b] /<0.02	<1 /<0.01 /<0.02	<1 /<0.01 /<0.02
Zinc	160 / 0.14 / 0.42	640 / 1.8 / 2	21000 / 27 /300	32000 / 1400 /1200	200 / 2.2 / 2.6	1300 / 0.14 / 0.17
Comments						
Wet or Dry Ash	Wet	Wet	Wet	Wet	Dry	Dry

Site number	5	6	7	8	8	9
Stream description	Small incinerator bottom ash	Incinerator bottom ash	Incinerator bottom ash	Kiln ash	Incinerator bottom ash	Kiln ash
	Concentration[a]					
	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)	(mg/kg)/(mg/L)/(mg/L)
Antimony	<1 /<0.01 / 0.10	<1 / 0.07 / 0.06	49 /<0.01 / 0.02	240 / 0.49 / 0.36	32 /<0.05 /<0.01	<0.8 /<0.01 / 0.02
Arsenic	<1 / 0.12 / 0.54	8 /<0.01 /<0.01	12 /<0.06 /<0.01	11 /<0.06 / 0.02	27 / 0.22 /<0.01	2 /<0.06 /<0.01
Beryllium	<2 /<0.01 /<0.01	<2 /<0.01 /<0.01	<1 /<0.01 /<0.01	<1 /<0.01 /<0.01	<1 /<0.01 /<0.01	<1 /<0.01 /<0.01
Cadmium	<1 /<0.01 /<0.01	<1 / 0.04 /<0.01	<1 /<0.01 /<0.01	36 / 0.12 / 0.19	3 / 0.03 /<0.01	<1 /<0.01 /<0.01
Chromium	100 / 0.03 / 2.7	110 / 0.03 /<0.02	120 /<0.03 /<0.02	250 /<0.03 /<0.02	110 / 0.63 / 0.28	29 / 0.08 /<0.02
Copper	40 / 0.02 / 0.07	120 / 1.9 / 0.64	2000 / 13 /11	2900 / 0.33 / 1.8	14 / 0.09 / 0.05	120 /<0.02 / 0.67
Lead	<1 /<0.01 /<0.01	1300 / 3.3 /12	160 / 0.11 / 0.50	1600 / 0.11 /<0.01	280 /<0.07 /<0.01	490 /<0.07 /<0.50
Mercury	<0.1 /<0.001/<0.001	<0.1 /<0.001/<0.001	0.25 /<0.001/<0.001	0.1 /<0.001/<0.001	<0.05 /<0.001/<0.001	<0.05 /<0.001/<0.001
Nickel	3 / 0.04 / 0.27	22 / 0.33 / 0.49	650 / 13 / 4.0	100 / 0.42 / 0.71	15 /<0.03 /<0.01	21 / 2 / 0.49
Selenium	<1 / <0.1 / 0.12	12 / 0.03 / 0.02	19 /<0.05 / 0.02	<40 /<0.05 / 0.04	8 /<0.05 /<0.01	<4 /<0.05 /<0.01
Silver	54 /<0.01 /<0.01	21 /<0.01 /<0.01	9 /<0.01 /<0.01	3 /<0.01 /<0.01	<1 /<0.01 /<0.01	9 / 0.09 /<0.01
Thallium	6 /<0.01 /<0.02	<1 / 0.05 /<0.02	4 /<0.01 /<0.02	3 /<0.01 / 0.18	4 /<0.01 /<0.02	6 /<0.01 /<0.02
Zinc	200 / 0.31 / 0.17	810 / 16 / 9.5	850 / 65 /98	2500 / 12 /35	2200 / 8.5 /20	44 / 0.67 / 1.9
Comments						
Wet or Dry Ash	Dry	Dry	Wet	Wet	Dry	Wet

[a]Sample concentration / EP leachate concentration / TCLP leachate concentration

[b]Thallium EP leachate concentration for Site 3 boiler ash measured as 0.7 but probably less due to interference.

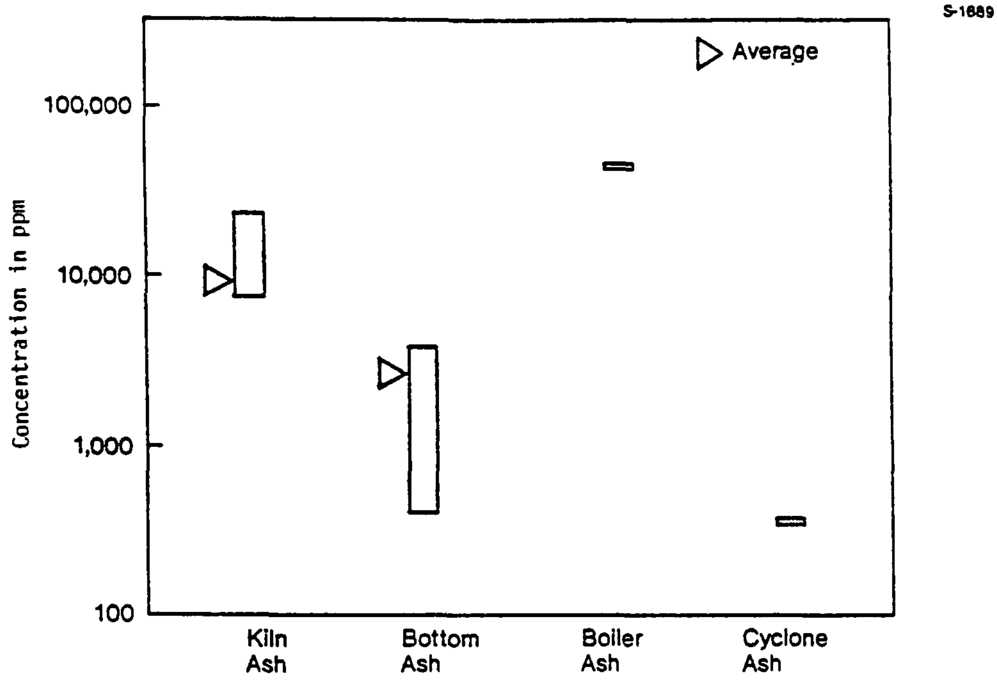


Figure 13. Total and average priority pollutant metals concentrations in ash.

TABLE 54. METALS IN ASH

	Highest concentration in ppm
Antimony	190
Arsenic	27
Beryllium	6
Cadmium	61
Chromium	1,800
Copper	6,900
Lead	5,000
Mercury	1.5
Nickel	7,300
Selenium	19
Silver	190
Thallium	9
Zinc	32,000

are set forth in Table 4 of 40 CFR 261.24), hence only the boiler ash at Site 3, due to cadmium being 8.6 mg/L versus an allowable standard of 1 mg/L, would be considered a hazardous waste for metals if not already listed in 40 CFR Subpart D. The TCLP leachate, if subjected to the same standards, would have 3 measurements out of 84 exceeding an allowable concentration. Site 3 boiler ash would exceed the standards for cadmium at 6.7 mg/L and selenium at 1.4 mg/L versus an allowable standard of 1 mg/L for each. Site 6 ash would exceed the standard for lead at 12 mg/L versus an allowable 5 mg/L.

Table 55 presents the highest metal concentrations experienced in the two leachates. Zinc is the metal with the highest concentrations for 8 of the 12 EP toxicity ash leachates and 7 of the 12 TCLP ash leachates. Figure 14 shows the range of total priority pollutant metals concentrations in leachates for the four types of ash. Leachate concentrations are highest for boiler ash. Kiln ash leachate would be expected to have more metals than bottom ash leachate, but one very low zinc concentration apparently skewed the EP toxicity kiln ash data substantially.

Leachate concentrations (in mg/L) are expected to be about 20 times less than ash reported values (in mg/kg) for 100 percent soluble metals. Although several metals in ash concentrations are less than detectable limits and cannot be further evaluated, solubility generally ranged from 1 to 10 percent. Metal concentrations greater than 1000 mg/kg of ash included chromium (Site 3), copper (Sites 1, 7, and 8), lead (Sites 3, 5, 6, and 8), nickel (Sites 2 and 3), and zinc (Sites 3 and 8).

TABLE 55. HIGHEST METALS CONCENTRATIONS IN ASH LEACHATE IN mg/L

	EP		
	Toxicity limit	Concentration	TCLP Concentration
Antimony	--	0.49	0.36
Arsenic	5	0.23	0.54
Beryllium	--	<0.01	0.08
Cadmium	1	8.6	6.7
Chromium	5	0.98	0.36
Copper	--	31	21
Lead	5	4.4	12
Mercury	0.2	<0.001	<0.001
Nickel	--	20	13
Selenium	1	0.17	1.4
Silver	5	0.09	0.05
Thallium	--	0.05	0.18
Zinc	--	1400	1200

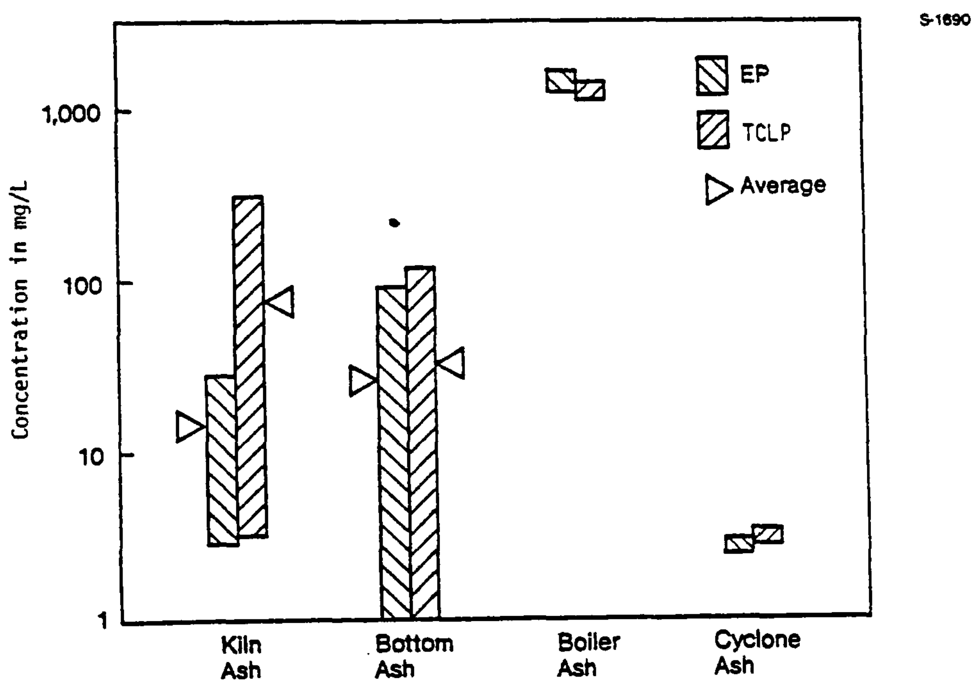


Figure 14. Total and average metals concentrations in ash leachate.

These high concentrations in the ash did not always yield a good mass balance. Outputs were greater than inputs by a factor of 10 for chromium (Site 3), copper (Site 1), and lead (Site 6) and by a factor of 100 for copper (Site 7). Since process data were not gathered for Site 5 and all streams were not sampled for Sites 7 and 8, mass balance statements cannot be accurately made for those sites. To improve the representativeness of the ash samples and better close a mass balance would require sampling and analysis of other streams.

Most of the leachate measurements for antimony, arsenic, beryllium, cadmium, lead, selenium, silver, and thallium yielded measurements less than detectable limits of nominally 0.1 to 0.05 mg/L of leachate. All mercury leachate measurements were less than 0.001 mg/L of leachate.

APCE water effluents were analyzed for priority pollutant metals and the results are shown in Table 56. Two sites which most effectively limit discharging a wastewater effluent, Sites 1 and 8, have the highest concentration of metals, 2375 mg/L and 51 mg/L, respectively. By applying the EP toxicity limits, the effluent for Site 1 would be considered hazardous for cadmium (3.5 mg/L), chromium (11 mg/L), and lead (860 mg/L), while the effluent from Site 8 would be considered hazardous for cadmium (2.8 mg/L), lead (31 mg/L), and selenium (2.1 mg/L).

Sites 4 and 10, which incinerate low metals content wastes, have only 0.4 mg/L and 1.4 mg/L, respectively, of priority pollutant metals in their APCE effluents. Sites with an apparent low recirculation rate, such as Site 9, also appear to have a low metals concentration in the APCE effluent (2.3 mg/L).

TABLE 56. CONCENTRATIONS OF PRIORITY POLLUTANT METALS IN APCE AQUEOUS EFFLUENTS, IN mg/L

Site number	1	2	3	4	7	8[a]	9	10
Antimony	0.1	<0.01	0.61	<0.01	1.7	4.1	<0.03	0.13
Arsenic	0.2	<0.01	<0.01	<0.01	0.06	0.4	<0.1	<0.1
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Cadmium	3.5	<0.01	0.04	<0.01	0.08	2.8	<0.01	<0.01
Chromium	11	<0.05	0.1	0.06	0.28	3.8	0.27	0.28
Copper	550	<0.04	0.26	<0.04	0.64	2.2	0.46	0.05
Lead	860	<0.01	2.6	<0.01	2.6	31	0.38	0.1
Mercury	0.06	0.013	0.013	<0.001	<0.005	<0.005	<0.005	<0.005
Nickel	<0.02	23	0.17	0.05	0.75	1.5	0.07	0.48
Selenium	0.09	<0.01	<0.01	<0.01	0.6	2.1	<0.1	0.2
Silver	<0.01	<0.02	0.04	<0.02	0.05	0.15	0.61	<0.01
Thallium	<0.01	1.3	16	0.02	0.16	1.6	0.31	0.03
Zinc	950	0.02	16	0.27	6.7	1.6	0.16	0.11
Total	2380	24.3	35.7	0.4	13.6	51.3	2.26	1.38

[a]Highest values used for aqueous effluent recirculated from two cooling ponds.

3.3 COMPARISON OF EP TOXICITY TEST PROCEDURE AND TOXICITY CHARACTERISTIC LEACHING PROCEDURE

A limited comparison was made of the analytical results for priority pollutant metals obtained from residual ash leachates extracted by the EP toxicity test procedure and toxicity characteristic leaching procedure. In this comparison, the following assumptions were made:

- Comparison is only for metals, since analyses were not performed for the six total herbicides and pesticides associated with EPA hazardous waste numbers D012 through D017;
- Only data sets which included a metals concentration greater than or equal to 0.2 mg/L were included;
- Data with non-detected concentrations were assumed to be at the minimum detection level for that metal;
- The small incinerator ash for Site 5 was excluded since leachates were not generated from the same ash sample.

Data sets, as shown in Table 57, are plotted in Figures 15 and 16. Sufficient data does not exist to make a definitive metals-by-metals comparison of the relative solubility between the two leachate-producing methods. This is especially true for beryllium, mercury, silver, and thallium since none had detected concentrations in either leachate of 0.2 mg/L minimum. Based on one data set for antimony and cadmium, the EP toxicity leachate contained about a third more metals than the TCLP leachate. Based on two data sets for arsenic, however, the TCLP leachate concentration was about 0.2 mg/L while the EP toxicity leachate contained less than 0.01 mg/L. All five lead data sets had equal or higher concentrations in the TCLP leachate than in the EP toxicity leachate.

TABLE 57. PRIORITY POLLUTANT METAL LEACHATE CONCENTRATION DATA SETS, IN (mg/L)/(mg/L)[a,b]

Site number	Ash description	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Zinc
1	Kiln ash		0.23/<0.01[b]		0.10/0.22	8.6/16	2.3/3.5	0.49/0.45		0.14/0.42
2	Kiln ash					3.7/7.9		6.9/6	0.2/0.05	1.8/2
3	Kiln ash							0.79/13	0.17/1.4	27/300
3	Boiler ash			8.6/6.7	0.03/0.36	31/21	4.4/4.5	20/13	<1/1.4	1400/1200
4	Cyclone ash							0.18/0.22		2.2/2.6
5	Large incinerator bottom ash				0.98/0.20					
5	Small incinerator bottom ash									
6	Bottom ash					1.9/0.64	3.3/12	0.33/0.49		16/9.5
7	Bottom ash					13/11	0.11/0.50	13/4		65/98
8	Kiln ash	0.49/0.36	0.22/<0.01			0.33/1.8		0.42/0.71		12/35
8	Bottom ash				0.63/0.28					8.5/20
9	Kiln ash					<0.02/0.67	<0.07/0.50	2/0.49		0.67/1.9

[a]See text for data restrictions; no data included for beryllium, mercury, silver, and thallium.
[b]EP toxicity leachate concentration data/TCLP leachate concentration data.

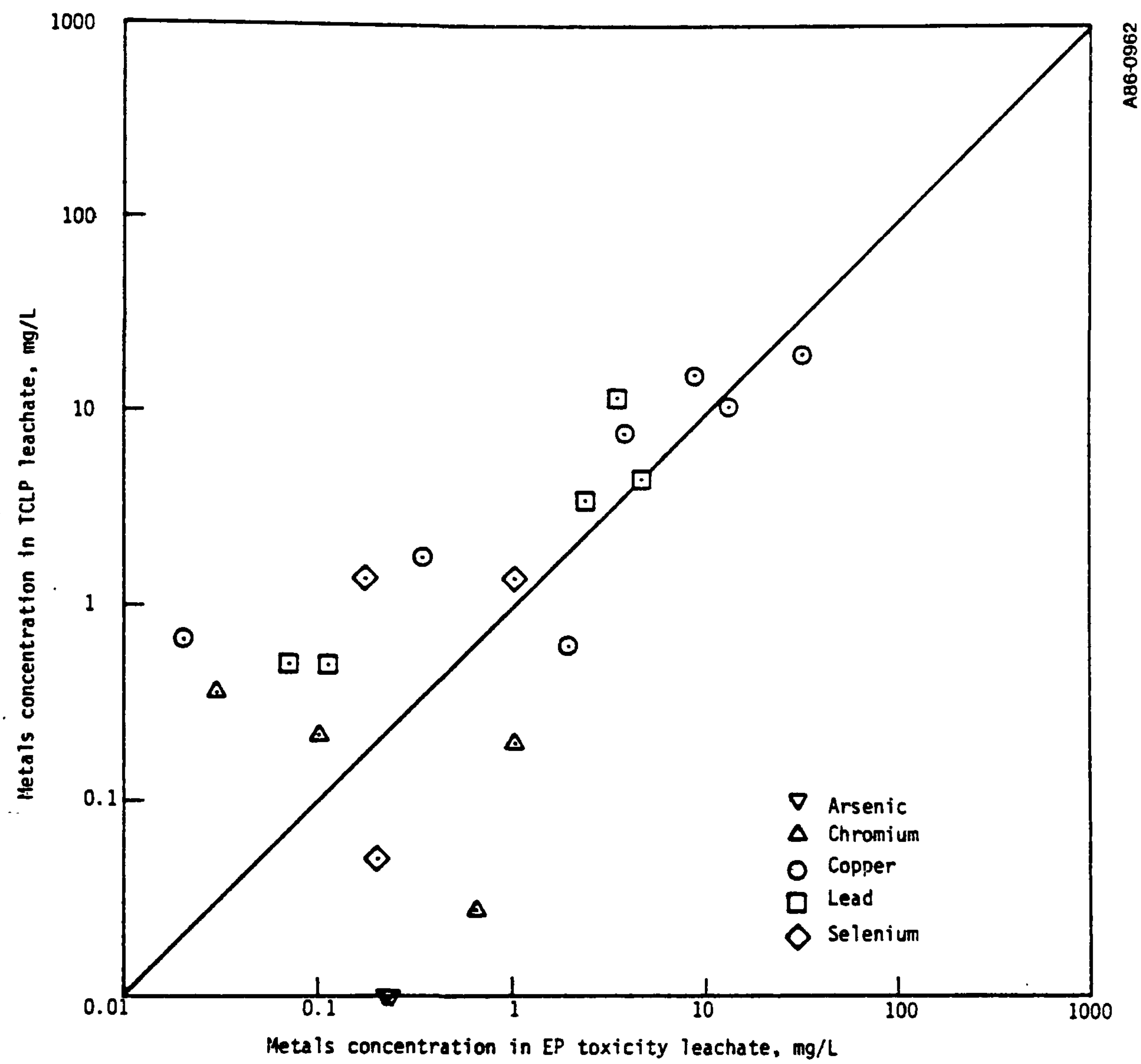


Figure 15. EP versus TCLP leachate comparison for arsenic, chromium, copper, lead, and selenium.

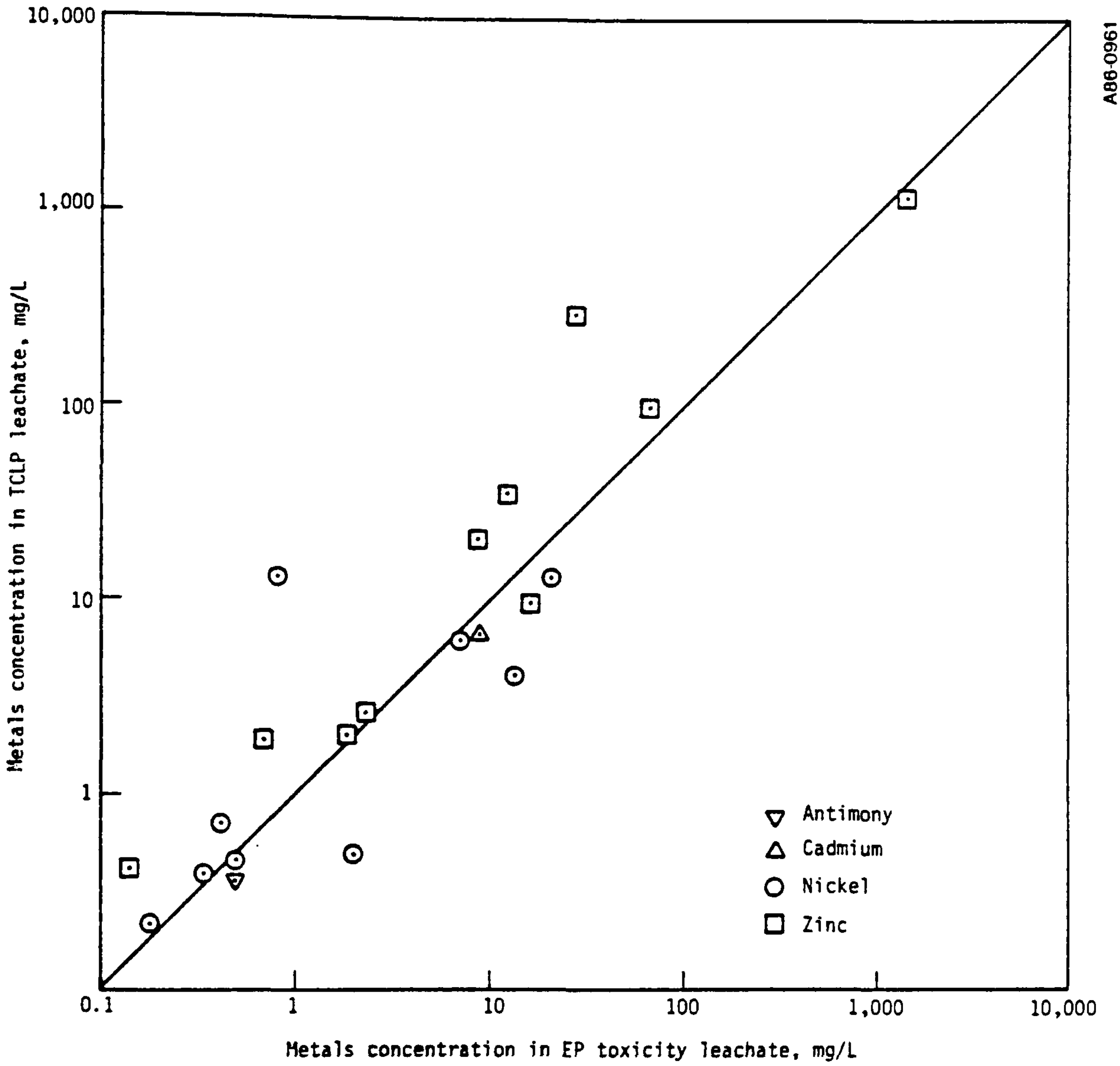


Figure 16. EP versus TCLP leachate comparison for antimony, cadmium, nickel, and zinc.

The other metals, chromium, copper, nickel, selenium, and zinc, each had data sets which showed some higher metals concentration in the EP toxicity leachate and other data sets with higher metals concentrations in the TCLP leachate. As shown in Figures 15 and 16, the estimated average curve predicts equal solubility of metals in both the EP toxicity and the TCLP leachates.

SECTION 4

CONCLUSIONS

Before using the data in this report to establish residue quality criteria for land disposal of hazardous wastes, a number of questions need to be considered concerning the representativeness, validity, and sample size of the data collected under this program:

- Are the 10 sites sampled representative of the whole population of hazardous waste incinerators, in terms of incinerator or APCE type?
- Are the hazardous waste fuels at these sites representative of those typically burned at other sites? Also, at the sites tested, are the fuels burned during our visit typical of those burned at other times?
- How does the age and mode of operation of the 10 facilities tested compare with other hazardous waste incinerators?
- Are the analyses of the solid and liquid residues from the tested facilities accurate and therefore valid data?

Of the 10 sites tested, 6 were rotary kilns. 3 were fixed hearth, and 1 was a fluidized bed design. This distribution is fairly representative of the present incinerator population. However, the 10 incinerators sampled in this program represent only 4 to 5 percent of the current U.S. population of hazardous waste incinerators. All sites had wet APCE systems (with the exception of 2 sites which had no controls but did have fuel and firing constraints). None of the sites tested had dry APCE.

The wastes burned at all hazardous waste incinerators vary greatly from one site to the next. Some incinerators are dedicated to a manufacturing plants' wastes, while others accept wastes from most anyone. Both kinds of incinerators were tested in this program (five of each type). The types of wastes burned at these sites varied greatly; however, it is felt that a representative sample of waste types was burned for this program (with the possible exception of chlorinated wastes). It is unknown whether, at the sites tested, the wastes burned during our visit were typical of those burned at other times.

Many of the incinerators tested were rather old, and sometimes did not use state-of-the-art equipment and controls. This fact may or may not influence the effectiveness of control equipment.

With the possible exception of two metals, selenium (Se) and thallium (Tl), the analyses performed on the solid and liquid residues met all accuracy. precision, and completeness objectives set up at the start of the program. We, therefore, feel that the analytical results are accurate and form a valid data base on incinerator residue quality.

APPENDIX A

QA/QC RESULTS

Acurex prepared a QA plan for this project in August 1985 and issued a revised plan in November 1985. QA/QC results in each major area of the plan are discussed below.

Sampling Procedures and Sample Custody

Sampling and sample custody procedures, as outlined in the "Generic Sampling and Analysis Protocol" dated August 1985 and in the revised QA plan, were followed very closely at each site. Only 3 persons were used to obtain samples at the 10 sites, thus minimizing potential sampling procedure errors. Each person was specifically trained on what sampling and sample custody procedures to follow, and on what sample custody records to keep.

Analytical Procedures and Instrument Calibration

The analytical instrument calibration procedures and frequency, outlined in the November 1985 QA plan, were rigorously followed. Also, in this plan, was a summary of the analytical procedures employed in this study. Most procedures are taken from SW-846, second edition.

Data Validation

All data have been reviewed and validated by the sampling person, the chemistry analyst, the analytical laboratory technical manager, the project engineer, and the project manager. Details on validation procedures are included with the QA plan.

Technical Systems Audit

On November 22, 1985, EPA/HWERL's QA contractor, S-CUBED, performed a technical systems audit of this study. All sampling had been completed by this date; thus, only the analytical portion of the project could be audited in any detail. The results of this audit are summarized in a separate report.

Surrogate Recoveries

Surrogate recovery objectives are listed in Table A-1. Surrogates were added only to those samples analyzed by a purge and trap technique; hence, recoveries are only reported for those samples. Surrogates were not added to samples analyzed by direct injection. Surrogate results are reported with the chemistry labortory data in Appendix C.

A total of 47 volatile organic analyses were performed with surrogates added. Surrogate recoveries were within an acceptable range for 118 of the 141 individual surrogate recoveries, for a completeness of 84 percent.

A total of 55 semivolatile organic analyses were performed with surrogates added. Surrogate recoveries were within an acceptable range for 298 of the 330 individual surrogate recoveries for a completeness of 90 percent.

Check Sample, Method Blank, and Trip Blank Results

Two sets (1 volatile, 1 semivolatile, and 1 metal sample per set) of check samples were submitted for analysis. All check samples were provided by EPA/EMSL-Cincinnati, Ohio. Each sample not only had an EPA ID number, but also an Acurex sample ID number. These samples are summarized in Table A-2.

TABLE A-1. SURROGATE RECOVERY OBJECTIVES

Surrogate compounds	Type of compound	Acceptable recovery ranges (percent)
1,2-dichloroethane-d_4	Volatile	77 to 120
Toluene-d_8		86 to 119
4-bromofluorobenzene		85 to 121
2-fluorophenol	Semivolatile	23 to 107
Phenol-d_5		15 to 96
Nitrobenzene-d_5		41 to 120
2-fluorobiphenyl		44 to 119
2,4,6-tribromophenol		20 to 105
p-terphenyl-d_{14}		33 to 128

TABLE A-2. CHECK SAMPLES

Check sample no.	EPA ID no.	Acurex sample no.	Date submitted for analysis	Analysis performed
1	WP 1079, Conc 2	903359	9/19/85	Volatiles
2	WP 482, Conc 3	903360	9/19/85	Semivolatiles
	WP 881, Conc 1	903361		
3	WP 481, Conc 2	903362	9/19/85	Metals
4	WP 483, Conc 1	903128	11/19/85	Volatiles
5	WP 482, Conc 1	903129	11/19/85	Semivolatiles
	WP 881, Conc 2	903130		
6	WP 475, Conc 6	903127	11/19/85	Metals

Tables A-3 through A-8 compare the analytical results on the six samples to their true values. Table A-9 presents a summary of the accuracy and completeness objectives from these measurements.

Method blank results are reported with the chemistry laboratory data in Appendix C. All method blank corrections were either small or nonexistent.

Trip blanks were analyzed for volatiles for sites 9 and 10 only. In both cases, no volatiles were detected at a nominal detection level of 500 μg/L.

Field and Laboratory Duplicate Sample Results

Duplicate samples were analyzed at sites 1, 2, 4, 8, and 9. The analytical results for these samples are shown in Tables A-10 through A-23. The precision objectives for volatiles, semivolatiles, and metals are 50, 50, and 20 percent relative standard deviation (RSD), respectively. Although a precision objective was not formulated for PCBs, a duplicate analysis was performed and is reported with Site 1.

A summary of completeness objectives for duplicate analyses is shown in Table A-24.

QA/QC Discussion

A review of the QA/QC analytical data results in the following conclusions as far as data quality is concerned:

- The selenium levels in the two metal check samples and in the Site 8 duplicate analysis do not meet the QA accuracy and precision objectives. This leads to the conclusion that the selenium analyses in the main report are suspect data ("outliers").

TABLE A-3. CHECK SAMPLE NO. 1

Organic compound	True value (µg/L)	Analytically determined value (µg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
Chloromethane	6.5	12	+85	X	
Chloroethane	9.4	14	+49	X	
Methylene Chloride	15.8	13	-18	X	
1,1-Dichloroethylene	11.3	8	-29	X	
Trans-1,2-Dichloroethylene	45.0	49	+9	X	
Carbontetrachloride	15.0	6	-60		X
Bromodichloromethane	18.0	10	-44	X	
1,1,2-Trichloroethane	15.8	15	-5	X	

[a]QA accuracy objective is -50, +100 percent of true value.

- Duplicate thallium analyses at Sites 2 and 9 do not meet the QA precision objectives. We have, therefore, labeled as suspect the thallium analyses.
- The reported phthalate values for the two check samples are, in most cases, lower than the true values. It is unclear as to why the reported values are lower.
- The discrepancies in the results of the duplicate analyses of Table A-17 have been attributed to the fact that the sampling times of the two field duplicates differed by over 5-1/2 hours, and the incinerator may not have been at steady state.

TABLE A-4. CHECK SAMPLE NO. 2

Semivolatile compound	True value (µg/L)	Analytically determined value (µg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
1,4-Dichlorobenzene	24.8	13	-48	X	
Bis (2-chloroisopropyl)ether	38.8	30	-23	X	
Hexachloroethane	30.0	15	-50	X	
Nitrobenzene	76.5	56	-27	X	
Naphthalene	24.8	19	-23	X	
Dimethyl phthalate	40.0	15	-62		X
Acenaphthene	19.5	15	-23	X	
Fluorene	51.2	42	-18	X	
4-Chlorophenyl phenyl ether	76.7	63	-18	X	
4-Bromphenyl phenyl ether	41.5	36	-13	X	
Anthracene	40.0	37	-8	X	
Fluoranthene	29.8	24	-19	X	
Butyl benzyl phthalate	51.3	21	-59		X
Chrysene	69.9	71	+2	X	
Bis (2-e hyl hexyl) phthalate	29.1	24	-18	X	
Benzo (b) fluoranthene	40.0	37	-8	X	
Benzo (a) pyrene	24.9	21	-16	X	
Dibenzo (a,h) anthracene	40.7	38	-7	X	
Benzo (g,h,i) perylene	80.4	70	-12	X	
2-Chlorophenol	30	23	-23	X	
2-Nitrophenol	50	45	-10	X	
Phenol	100	74	-26	X	
2,4-Dimethylphenol	30	22	-27	X	
2,4-Dichlorophenol	50	39	-22	X	
2,4,6-Trichlorophenol	25	18	-28	X	
4-Chloro-3-methylphenol	75	66	-12	X	
2-Methyl-4,6-dinitrophenol	250	510	+104		X
Pentachlorophenol	75	78	+4	X	
4-Nitrophenol	50	54	+8	X	

[a]QA accuracy objective is -50, +100 percent of true value.

TABLE A-5. CHECK SAMPLE NO. 3

Metal	True value (mg/L)	Analytically determined value (mg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
As	235	410	+74		X
Be	235	230	-2	X	
Cd	39	40	+3	X	
Cr	261	320	+23	X	
Cu	339	110	-68		X
Pb	435	500	+15	X	
Hg	8.7	7	-21	X	
Ni	207	190	-8	X	
Se	50	30	-40		X
Zn	418	320	-23	X	

[a]QA accuracy objective is ±30 percent of true value.

TABLE A-6. CHECK SAMPLE NO. 4

Organic compound	True value (μg/L)	Analytically determined value (μg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
1,2-Dichloroethane	2.0	<1	NA		X
Chloroform	12.0	12	0	X	
1,1,1-Trichloroethane	1.4	1.6	+14	X	
1,1,2-Trichloroethylene	2.9	3.1	+7	X	
Carbontetrachloride	2.6	2.7	+4	X	
1,1,2,2-Tetrachloroethylene	1.6	1.2	-25	X	
Bromodichloromethane	2.0	<1	NA		X
Dibromochloromethane	2.6	2.2	-15	X	
Bromoform	2.9	1.7	-41	X	

[a]QA accuracy objective is -50, +100 percent of true value.

TABLE A-7. CHECK SAMPLE NO. 5

Semivolatile	True value (µg/L)	Analytically determined value (µg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
Bis 2-chloroethyl ether	48.2	42	-15	X	
1,3-Dichlorobenzene	52.0	28	-46	X	
1,2-Dichlorobenzene	24.7	14	-43	X	
Nitrosodipropylamine	34.8	22	-37	X	
Isophorone	76.7	56	-30	X	
Bis (2-chloroethoxy)methane	48.6	36	-26	X	
1,2,4-Trichlorobenzene	25.3	14	-45	X	
Hexachlorobutadiene	49.6	14	-71		X
2-Chloronaphthalene	25.4	16	-37	X	
2,6-Dinitrotoluene	76.5	70	-8	X	
2,4-Dinitrotoluene	73.8	68	-8	X	
Diethyl phthalate	25.1	<1	NA		X
Hexachlorobenzene	35.7	24	-32	X	
Phenanthrene	40.2	34	-15	X	
Dibutyl phthalate	24.9	<1	NA		X
Pyrene	60.2	72	+20	X	
Benzo (a) anthracene	73.9	68	-8	X	
Dioctyl phthalate	43.9	30	-32	X	
Benzo (k) fluoranthene	45.7	78	+71	X	
2-Chlorophenol	300	220	-27	X	
2-Nitrophenol	250	200	-20	X	
Phenol	250	190	-24	X	
2,4-Dimethylphenol	150	130	-13	X	
2,4-Dichlorophenol	250	190	-24	X	
2,4,6-Trichlorophenol	250	200	-20	X	
4-Chloro-3-methylphenol	225	220	-2	X	
2-Methyl-4,6-dinitrophenol	750	1000	+33	X	
Pentachlorophenol	375	350	-7	X	
4-Nitrophenol	250	280	+12	X	

[a]QA accuracy objective is -50, +100 percent of true value.

TABLE A-8. CHECK SAMPLE NO. 6

Parameter	True value (mg/L)	Analytically determined value (mg/L)	Accuracy (percent)	Meets QA accuracy objective[a] Yes	No
As	300	270	-10	X	
Be	900	940	+4	X	
Cd	70	60	-14	X	
Cr	250	250	0	X	
Cu	350	290	-17	X	
Pb	400	200	-50		X
Hg	8.0	8	0	X	
Ni	300	210	-30	X	
Se	50	70	+40		X
Zn	400	110	-70		X

[a]QA accuracy objective is ±30 percent of true value

TABLE A-9. SUMMARY OF CHECK SAMPLE ACCURACY AND COMPLETENESS

	Accuracy		Completeness		
Analysis	Number of measurements meeting accuracy objective	Total number of measurements	Completeness (percent)	Completeness QA objective	Meet QA completeness objective?
Volatiles	14	17	82	70	Yes
Semivolatiles	52	58	90	70	Yes
Priority pollutant metals	14	20	70	90	No

TABLE A-10. SITE 1 FIELD DUPLICATE FOR VOLATILE ORGANICS

Priority pollutant	Pollutant concentration in Acurex sample ID: 902438 (mg/L)	902444 (mg/L)	Precision (percent RSD)	Meets QA precision objective: Yes	No
1,1-Dichloroethene	28	32	7	X	
1,1-Dichloroethane	14	18	13	X	
Chloroform	37	47	12	X	
1,2-Dichloroethane	1200	1800	20	X	
Trichloroethene	12	16	14	X	
1,1,2-Trichloroethane	93	130	17	X	
Toluene	8	12	20	X	
All other priority pollutants	<5	<5	0	X	

TABLE A-11. SITE 1 LABORATORY DUPLICATE OF ACUREX SAMPLE 902435 FOR SEMIVOLATILE ORGANICS

Priority pollutant	Pollutant concentration: First analysis (μg/L)	Second analysis (μg/L)	Precision (percent RSD)	Meet QA precision objective: Yes	No
1,2,4-Trichlorobenzene	4,300	4,400	1	X	
Bis(2-chloroethyl)ether	11,000	11,000	0	X	
1,2-Dichlorobenzene	1,700	1,600	3	X	
Hexachlorobutadiene	1,700	1,600	3	X	
Isophorone	13,000	13,000	0	X	
Naphthalene	660	720	4	X	
Bis(2-ethylhexyl)phthalate	720	<600	100		X
All other priority pollutants	<600	<600	0	X	

TABLE A-12. SITE 1 LABORATORY DUPLICATE OF ACUREX SAMPLE 902437 FOR PRIORITY POLLUTANT METALS

Priority pollutant	Pollutant concentration		Precision (percent RSD)	Meet QA precision objective	
	First analysis (mg/L)	Second analysis (mg/L)		Yes	No
Antimony	<0.01	<0.01	0	X	
Arsenic	0.11	0.11	0	X	
Beryllium	<0.01	<0.01	0	X	
Cadmium	0.24	0.31	13	X	
Chromium	1.9	1.9	0	X	
Copper	40	37	4	X	
Lead	1.5	1.5	0	X	
Mercury	<0.005	<0.005	0	X	
Nickel	1.9	1.9	0	X	
Selenium	<0.01	<0.01	0	X	
Silver	<0.01	<0.01	0	X	
Thallium	<0.01	<0.01	0	X	
Zinc	39	39	0	X	

TABLE A-13. SITE 1 LABORATORY DUPLICATE OF ACUREX COMPOSITE SAMPLE 902425, 26, AND 28 FOR PCBs

PCB Specie	Specie concentration		Precision (percent RSD)
	First analysis (μg/mL)	Second analysis (μg/mL)	
1242	35,000	31,000	6
1260	90,000	90,000	0

TABLE A-14. SITE 2 LABORATORY DUPLICATE OF ACUREX COMPOSITE SAMPLE 902448, 50, AND 61 FOR VOLATILE ORGANICS

Priority pollutant	Pollutant concentration: First analysis (μg/L)	Pollutant concentration: Second analysis (μg/L)	Precision (percent RSD)	Meet QA precision objective: Yes	Meet QA precision objective: No
Chloroform	4100	4100	0	X	
All other priority pollutants	<50	<50	0	X	

TABLE A-15. SITE 2 LABORATORY DUPLICATE OF ACUREX SAMPLE 902447 FOR SEMIVOLATILE ORGANICS

Priority pollutant	Pollutant concentration: First analysis (μg/L)	Pollutant concentration: Second analysis (μg/L)	Precision (percent RSD)	Meet QA precision objective: Yes	Meet QA precision objective: No
Phenol	33	28	8	X	
Bis(2-ethylhexyl)phthalate	32	12	45	X	
All other priority pollutants	<10	<10	0	X	

TABLE A-16. SITE 2 LABORATORY DUPLICATE OF ACUREX SAMPLE 902460 FOR PRIORITY POLLUTANT METALS

Priority pollutant	Pollutant concentration: First analysis (mg/L)	Pollutant concentration: Second analysis (mg/L)	Precision (percent RSD)	Meet QA precision objective: Yes	Meet QA precision objective: No
Antimony	<0.01	<0.01	0	X	
Arsenic	<0.01	<0.01	0	X	
Beryllium	<0.01	<0.01	0	X	
Cadmium	<0.01	<0.01	0	X	
Chromium	<0.05	<0.05	0	X	
Copper	<0.04	<0.04	0	X	
Lead	<0.01	<0.01	0	X	
Mercury	0.013	0.012	4	X	
Nickel	23	22	2	X	
Selenium	<0.01	<0.01	0	X	
Silver	<0.02	<0.02	0	X	
Thallium	1.3	4.2	53		X
Zinc	0.02	0.02	0	X	

TABLE A-17. SITE 4 FIELD DUPLICATE FOR VOLATILE ORGANICS

Priority pollutant	Pollutant concentration in Acurex sample ID: 902646 (μg/L)	Pollutant concentration in Acurex sample ID: 902663 (μg/L)	Precision (percent RSD)	Meet QA precision objective: Yes	Meet QA precision objective: No
Trans-1,2-Dichloroethene	600	<500	100		X
1,2-Dichloroethane	32,000	<500	100		X
1,1,1-Trichloroethane	6,800	<500	100		X
Trichloroethene	14,000	<500	100		X
Tetrachloroethene	1,200	<500	100		X
Toluene	5,000	6,400	12	X	
All other priority pollutants	<500	<500	0	X	

TABLE A-18. SITE 8 LABORATORY DUPLICATE OF ACUREX COMPOSITE SAMPLE 902714, 15, AND 16 FOR VOLATILE ORGANICS

Priority pollutant	Pollutant concentration		Precision (percent RSD)	Meet QA precision objective	
	First analysis (µg/L)	Second analysis (µg/L)		Yes	No
Chloromethane	2500	750	54		X
All other priority pollutants	<500	<500	0	X	

TABLE A-19. SITE 8 LABORATORY DUPLICATE OF ACUREX SAMPLE 902712 FOR SEMIVOLATILE ORGANICS

Priority pollutant	Pollutant concentration		Precision (percent RSD)	Meet QA precision objective	
	First analysis (µg/L)	Second analysis (µg/L)		Yes	No
All priority pollutants	<20	<20	0	X	

TABLE A-20. SITE 8 LABORATORY DUPLICATE OF ACUREX SAMPLE 902713 FOR PRIORITY POLLUTANT METALS

Priority pollutant	Pollutant concentration First analysis (mg/L)	Pollutant concentration Second analysis (mg/L)	Precision (percent RSD)	Meet QA precision objective Yes	Meet QA precision objective No
Antimony	2.41	2.1	7	X	
Arsenic	0.3	0.2	20	X	
Beryllium	<0.01	<0.01	0	X	
Cadmium	1.5	1.5	0	X	
Chromium	1.9	2.0	3	X	
Copper	1.2	1.2	0	X	
Lead	6.0	6.3	2	X	
Mercury	<0.005	<0.005	0	X	
Nickel	0.90	0.75	9	X	
Selenium	2.1	3.3	22		X
Silver	0.13	0.18	16	X	
Thallium	0.47	0.47	0	X	
Zinc	0.43	0.53	10	X	

TABLE A-21. SITE 9 LABORATORY DUPLICATE OF ACUREX SAMPLE 902751 FOR VOLATILE ORGANICS

Priority pollutant	Pollutant concentration First analysis (µg/L)	Pollutant concentration Second analysis (µg/L)	Precision (percent RSD)	Meet QA precision objective Yes	Meet QA precision objective No
All priority pollutants	<500	<500	0	X	

TABLE A-22. SITE 9 LABORATORY DUPLICATE OF ACUREX SAMPLE 902749 FOR SEMIVOLATILE ORGANICS

Priority pollutant	Pollutant concentration		Precision (percent RSD)	Meet QA precision objective	
	First analysis (µg/L)	Second analysis (µg/L)		Yes	No
All priority pollutants	<20	<20	0	X	

TABLE A-23. SITE 9 LABORATORY DUPLICATE OF ACUREX SAMPLE 902750 FOR PRIORITY POLLUTANT METALS

Priority pollutant	Pollutant concentration		Precision (percent RSD)	Meet QA precision objective	
	First analysis (mg/L)	Second analysis (mg/L)		Yes	No
Antimony	<0.03	<0.03	0	X	
Arsenic	<0.1	<0.1	0	X	
Beryllium	<0.01	<0.01	0	X	
Cadmium	<0.01	<0.01	0	X	
Chromium	0.27	0.21	13	X	
Copper	0.46	0.46	0	X	
Lead	0.38	0.38	0	X	
Mercury	<0.005	<0.005	0	X	
Nickel	0.07	0.07	0	X	
Selenium	<0.1	<0.1	0	X	
Silver	0.61	0.61	0	X	
Thallium	0.31	<0.01	100		X
Zinc	0.16	0.16	0	X	

TABLE A-24. SUMMARY OF DUPLICATE SAMPLE PRECISION AND COMPLETENESS

Analysis	Measurements per sample	Total number of samples	Total number of measurements	Number of measurements not meeting QA precision objective	Completeness (percent)	Meet QA completeness objective	
						Yes	No
Volatile organic compounds	27	5	135	6	96	X	
Semivolatile organic compounds	57	4	228	1	99	X	
Priority pollutant metals	13	4	52	3	94	X	

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT

The Office of Solid Waste and Emergency Response (OSWER-EPA) is considering establishing a criterion for disposal of waste or residue into the land. This criterion is based on the achievement of residue quality equivalent to that from effective incineration. The purpose of this study was to provide data on the quantities and characteristics of solid and liquid discharges from hazardous waste incineration facilities. A total of 10 facilities were sampled comprising major incineration designs and flue gas treatment devices. All inlet and outlet liquid and solid streams were sampled and subjected to extensive analyses for organic and inorganic pollutant concentrations. Laboratory analyses for solid discharge streams also included leachate evaluations using standard EPA toxicity tests for metals and a draft TCLP toxicity procedure for volatile and semivolatile organics and metals. Monitored data on incinerator facility operation was then used to determine the discharge rates of dectected pollutants.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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