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SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

PEI Associates, Inc. "BDAT Incineration of CERCLA SARMS at the John Zink Company Test Facility (Final Project Report)." Technical report prepared for U.S. EPA, ORD, HWERL, Cincinnati, OH. 375 pp. November 1987.

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SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Thermal Treatment - Rotary Kiln
Media:	Soil/Generic
Document Reference:	PEI Associates, Inc. "BDAT Incineration of CERCLA SARMS at the John Zink Company Test Facility (Final Project Report)." Technical report prepared for U.S. EPA, ORD, HWERL, Cincinnati, OH. 375 pp. November 1987.
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Site Name:	BDAT SARM-Manufactured Waste (Non-NPL)
Location of Test:	ORD-Edison, NJ

BACKGROUND: This report presents the results of a treatability study of rotary kiln incineration of a synthetic "Superfund soil" bearing a wide range of chemical contaminants typically occurring at Superfund sites. This surrogate soil is referred to as a synthetic analytical reference matrix (SARM), and was composed of clay, sand, silt, topsoil, and gravel. Two concentrations of contaminants were added to this material to produce SARM I and SARM II; volatile and semivolatile organics (3000 ppm in SARM II and 30,000 ppm in SARM I), and metals (1000 ppm in SARM I and II). **OPERATIONAL INFORMATION:** Three 4-hour test burns were conducted on each SARM at the John Zink pilot plant facility in Tulsa, Oklahoma using a rotary kiln incineration system capable of handling 1000 lb/hr of low BTU solids. The runs were conducted on September 16-18, 1987. The temperature and feed rates were reasonably close to the goals of 1800° F in the kiln, 2000° F in the secondary chamber, and nominal feed rates of 1000 lb/hr. Excess air was maintained at about 3% in the kiln and about 5% in the secondary. Emissions of O_2, CO_2, and CO were steady throughout the tests. **PERFORMANCE:** The contaminant concentrations in the ash, scrubber water, and flue gas were measured to evaluate the performance of the treatment. Little or no volatiles were measured in the ash, except for acetone and phthalate, and these appear to be due to sample contamination. Metal concentrations in the ash were unexpectedly low (50 to 80% lower than in the feed). As expected, cadmium was at least 99.9% lower in the ash, due to volatilization. Only arsenic concentrations increased in the ash (more than double the concentrations in the feed). The scrubber water was essentially free of all organics, and contained only low ppm concentrations of metals. Critical emission parameters (oxygen, HCl, and CO) were within RCRA allowable limits. The DRE performance standard of 99.99%

NOTE: Quality assurance of data may not be appropriate for all uses.

was achieved for the designed critical principal volatile organic contaminants for each SARM type. The DRE for the principal semi-volatile organic contaminants show that anthracene was effectively destroyed. DRE data for bis(2-ethylhexyl)phthalate showed three runs meeting the 99.99% criteria.

The document discusses QA/QC procedures in detail.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W01-Halogenated Aromatic Compounds	108-90-7	Chlorobenzene
W03-Halogenated Phenols, Cresols and Thiols	87-86-5	Pentachlorophenol
W04-Halogenated Aliphatic Solvents	107-06-2	1,2-Dichloroethane
	127-18-4	Tetrachloroethene
W07-Heterocyclics and Simple Aromatics	100-41-4	Ethylbenzene
	100-42-5	Styrene
	1330-20-7	Xylenes
W08-Polynuclear Aromatics	120-12-7	Anthracene
W09-Other Polar Organic Compounds	67-64-1	Acetone
	117-81-7	Bis(2-ethylhexyl)phthalate
W10-Halogenated Non-Polar Aromatic Compounds	7440-02-0	Nickel
	7440-47-3	Chromium
	7440-50-8	Copper
W11-Halogenated Non-Polar Aromatic Compounds	7439-92-1	Lead
	7440-43-9	Cadmium
	7440-66-6	Zinc

NOTE: Quality assurance of data may not be appropriate for all uses.

980-TS1-RT-EU2V

DRAFT

BDAT INCINERATION OF CERCLA SARMS AT THE JOHN ZINK COMPANY TEST FACILITY (FINAL PROJECT REPORT)

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
HAZARDOUS WASTE ENVIRONMENTAL RESEARCH LABORATORY
ALTERNATIVE TECHNOLOGIES DIVISION
CINCINNATI, OHIO

November 1987

THIS REPORT HAS BEEN PREPARED IN CONNECTION WITH THE DEVELOPMENT OF BDAT FOR THE LAND DISPOSAL RESTRICTION RULES. THIS REPORT IS A PRESENTATION OF DATA. EPA'S ASSESSMENT OF WHETHER DATA REPRESENT TREATMENT BY BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT) WILL BE PROVIDED IN THE TECHNICAL BACKGROUND DOCUMENT FOR CERCLA SOIL/DEBRI WASTES.

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SECTION 1

INTRODUCTION

The Hazardous and Solid Waste Amendments (HSWA) of 1984 prohibit the continued land disposal of untreated hazardous wastes beyond specified dates. The statute requires EPA to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized". The legislation sets forth a series of deadlines at which times further disposl of particular waste types is prohibited if the Agency has not set treatment standards under Section 3004(m) or determined, based on a case-specific petition, that there will be no migration of hazardous constituents for as long as the wastes remain hazardous.

In addition to addressing future land disposal of specific listed wastes, the HSWA land disposal restrictions address the disposal of soil and debris from CERCLA site response actions as well. Sections 3004(d)(3) and (e)(3) state that the soil/debris waste material resulting from a Superfund financed response action or an enforcement authority response action implemented under Sections 104 and 106 of CERCLA, respectively, will be subject to the land ban beginning November 8, 1988.

Because soil/debris waste often differs significantly from other types of hazardous waste, the U.S. EPA is developing specific Section 3004(m) standards or levels for treatment of these types of Superfund wastes. The standards will establish Best Demonstrated and Available Treatment (BDAT) levels through the evaluation of five readily available treatment technologies; namely, soil washing, chemical treatment (KPEG), thermal desorption, incineration, and stabilization/fixation. After November 8, 1988, Superfund wastes in compliance with these regulations may be deposited in land disposal units; wastes not in compliance will be banned from land disposal unless a variance is issued.

This report details part of the initial work conducted from June to November 1987 under Phase I of EPA's Superfund BDAT research program. In this segment of the program, a surrogate Superfund soil bearing a wide range of chemical contaminants typically occurring at Superfund sites was subjected to treatment by rotary kiln incineration. A complete series of test burns was conducted, a battery of process and emission samples were collected and analyzed, and the results are reported herein.

The surrogate soil is referred to throughout the text as SARM, which is an acronym for Synthetic Analytical Reference Matrix. It was prepared for this test series under EPA Contract No. 68-03-3413, Work Assignment No. 7. More than 27,000 pounds of SARM were treated by incineration during this study.

The SARM was composed of clay, sand, silt, topsoil, and gravel as outlined below:

Percent by volume	
Clay	30% (75% Kaolinite, 25% Bentonite)
Sand	20%
Silt	25%
Topsoil	20%
Gravel	5%

Chemicals were added to the soil at two levels to produce SARM-I and SARM-II; the target contaminant levels for each SARM are shown in Table 1-1. Total organic contaminants were expected to be present at high and low levels (targeted at approximately 30,000 ppm and 3,000 ppm) as shown in the table. Metals were targeted at a total level of 1000 ppm in both SARM samples.

The BDAT incineration testing was conducted at the John Zink pilot plant facility in Tulsa, Oklahoma using a rotary kiln incineration system capable of handling 1000 lb/h of low-Btu solids. EPA provided more than 12,000 pounds of each SARM soil in order to conduct three 4-hour test burns (runs) on each SARM. Approximately one week prior to start up of the test burns, the soils were delivered to J. Zink in 48 55-gallon steel drums, each containing 500-600 pounds of SARM I or SARM II.

TABLE 1-1. TARGET CONTAMINANT LEVELS FOR SYNTHETIC SOILS (SARMs) TO BE USED AS WASTE FEED FOR INCINERATION, ppm

Contaminant	SARM I	SARM II
Volatiles		
Ethylbenzene	3,200	320
Xylene	8,200	820
Tetrachloroethylene	600	60
Chlorobenzene	400	40
Acetone	6,800	680
1,2-Dichloroethane	600	60
Styrene	1,000	100
	20,800	2,080
Semivolatiles		
Anthracene	6,500	650
Bis(2-ethylhexyl)phthalate	2,500	250
Pentachlorophenol	1,000	100
	10,000	1,000
Metals		
Lead	280	280
Zinc	450	450
Cadmium	20	20
Arsenic	10	10
Copper	190	190
Nickel	30	30
Chromium	30	30
	1,000	1,000

SECTION 2

SUMMARY OF RESULTS

The results obtained for the test burns of SARM I and II are summarized in this section. Details on the process equipment and operating conditions, the sampling and analytical procedures, and quality assurance procedures and results, can be found in succeeding chapters. Calculations, field and laboratory data reports, etc. are located in the appendices.

2.1 CRITICAL TEST BURN PARAMETERS

The most important parameter studied was the degree to which the SARMs were treated by incineration as measured by the Toxic Contaminant Leaching Procedure or TCLP. TCLP values for both the untreated and treated SARMS are compared and discussed in Section 2.4. In addition to TCLP, the following chemical parameters were monitored throughout the test burns:

Stack Gases

- Volatiles (ethylbenzene,* xylene,* tetrachloroethylene, chlorobenzene, acetone, 1,2-dichlorethane, and styrene)

- Semivolatiles (anthracene,* bis(2-ethylhexyl)phthalate,* pentachlorphenol, and dioxins)

- Metals (lead,* zinc,* cadmium, arsenic, copper, nickel, and chromium)

- Particulate*

- HCl*

- O_2, CO, and CO_2

---

* Critical parameter, per QAPP.

Waste Feed

Volatiles (same as above)
Semivolatiles (same as above)
Metals (same as above)

Ash

Volatiles (same as above)
Semivolatiles (same as above)
Metals (same as above)

Scrubber Wastes

Volatiles (same as above)
Semivolatiles (same as above)

Monitoring results for these chemical measurements are summarized in Sections 2.3 and 2.5 through 2.8. Operating conditions throughout the tests are discussed in Section 2-2.

2.2 SUMMARY OF OPERATING CONDITIONS

Three 4-hour test runs were conducted on each SARM, for a total of six runs. The runs were conducted two per day over the 3-day period of September 16-18, 1987. Runs 1, 2, and 3 were conducted using SARM-I (high organics, low metals) and Runs 4, 5, and 6 were conducted using SARM-II (low organics, low metals). Equipment operations were normal throughout each run.

Table 2-1 summarizes the process operating data collected during each test run, as well as the average values for each test (i.e., for each group of three runs). Overall, the data in Table 2-1 show that the temperatures and feed rates achieved were reasonably close to the goals (i.e., 1800°F in the kiln, 2000°F in the secondary, and nominal feed rate goal of 1000 lb/h). Excess air was maintained at about 3 percent in the kiln and about 5 percent in the secondary during both tests. Emissions of O_2, CO_2, and CO were steady throughout, with CO remaining at less than 10 ppm at all times except for a few brief excursions of 45 to 90 ppm, lasting for 1 to 5 minutes.

A total of 13,932 lb of SARM-I and 13,460 lb of SARM-II were incinerated over a course of 3 days involving 29 hours and 22 minutes of testing.

See Appendix B for detailed field data sheets recording process data at 30- to 40-minute intervals throughout each run.

TABLE 2-1. SUMMARY OF PROCESS OPERATING DATA

Location/Parameter	SARM-I				SARM-II			
	Run 1	Run 2	Run 3	Avg.	Run 4	Run 5	Run 6	Avg.
FEED								
Time elapsed, h:min	4:23	3:45	4:54	4:21	4:06	4:12	4:02	4:07
Amount fed, lb	4640	3939	5353	4644	4392	4561	4507	4487
Feed rate, lb/h	1059	1050	1092	1067	1071	1086	1118	1092
KILN								
Temperature, °F	1795	1776	1760	1777	1749	1784	1780	1771
O_2, %	3.3	4.7	2.5	3.5	2.6	3.3	2.4	2.8
SECONDARY								
Temperature, °F	2004	1997	1995	1999	1985	2004	2005	1998
O_2, %	4.1	6.0	4.6	4.9	4.1	5.4	5.2	4.9
SCRUBBER								
Flow, % max.	72	70	76	73	72	72	70	71
Blowdown, % max.	0	0	0	0	0	0	0	0
ΔP venturi, in. w.g.	23.0	24.8	23.9	23.9	26.2	23.3	23.3	24.[illegible]
STACK								
O_2, %	5.8	6.3	6.1	6.1	5.1	5.9	5.3	5.4
CO_2, %	10.1	9.6	10.2	10.0	10.9	10.4	11.1	10.[illegible]
CO, ppm	<10	<10	<10	<10	<10[a]	<10[b]	<10	<10

[a] On three occasions, CO spiked to 90, 69, and 69 ppm for about 1 min each occurrence.

[b] On two occasions, CO spiked to 45 ppm briefly (less than 5 min each).

2.3 PROCESS SAMPLE DATA

Tables 2-2, 2-3, and 2-4 present the results of chemical analyses (i.e., total waste analyses) of the waste feed, ash and scrubber water samples collected during each test run. EPA SW 846 Methods were used to develop these analytical values for total waste composition. Samples analyzed for semi-volatiles and metals were collected as composites over the course of each test; samples analyzed for volatiles were collected as discrete samples at the beginning, middle, and end of each run, and composited at the time of analysis.

2.3.1 Feed Analyses (Table 2-2)

The waste feed analyses show that the target concentrations for most of the contaminants were reasonably well achieved. Some of the volatile compounds were present at levels lower than desired, but this was anticipated. Pentachlorophenol values were much lower than expected; in fact, pentachlorophenol was found in measurable quantities in only one of six SARM feed samples analyzed. Semi-volatile surrogate recovery data (Section 5.0 and Appendix C) for 2-fluorophenol and d5-phenol are within expected limits of the methodology used which would seem to preclude poor extraction recoveries as the reason for the non-detectable values.

2.3.2 Ash Analyses (Table 2-3)

The volatile compounds styrene, tetrachloroethylene, and chlorobenzene were not detected in any of the ash samples. Measurable quantities of ethylbenzene, and xylene were found in the ash of both SARMs and 1,2-dichloroethane was found in the ash of SARM II, but the amounts were small (in the low part-per-billion range) and typically at levels within 2 to 3 times the method detection limit. Acetone was found in the ash samples of all runs for both SARMs at significant levels ranging from 190 to 790 μg/kg; these levels are 24 to 99 times higher than the method detection level (8 μg/kg).

On the average, the concentrations of acetone and phthalate found in the ash of SARM I are similar to those found in the ash of SARM-II, even though the input waste feed levels for these compounds were roughly 10 times higher in SARM-I than in SARM II. This is suggestive of sample contamination, and the data should be interpreted with caution. Significant quantities of phthalate were also found in several of the method blanks, and phthalates are known to be commonly encountered contaminants in sample analysis.

TABLE 2-2. TOTAL WASTE ANALYSIS FOR SARM FEED[a]

Parameter	Method detection limit	SARM I			SARM II		
		Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
VOLATILES, mg/kg							
Ethylbenzene	7.0	3600	2400	4000	240	84	330
Xylene	5.0	5800	4000	6000	120	150	520
Tetrachloroethylene	4.0	b	260	350	29	8.5	36
Chlorobenzene	6.0	340	240	360	22	6.9	30
Acetone	8.0	3300	6000	2700	680	570	270
1,2-Dichloroethane	3.0	450	140	340	13	3.5	28
Styrene	3.0	770	580	810	51	16	67
SEMIVOLATILES, mg/kg							
Anthracene	6.0	6200	8500	5300	480	420	440
Bis(2-ethylhexyl) phthalate	44.0	2800	3300	2200	290	270	ND[c]
Pentachlorophenol	3.3	ND[c]	630	ND[c]	ND[c]	ND[c]	ND[c]
METALS, mg/kg							
Lead	4.2	261	296	292	328	301	302
Zinc	0.12	451	551	526	548	508	158
Cadmium	0.12	26	25	26	26	26	26
Arsenic	0.04	17	17	20	19	19	18
Copper	0.42	244	267	261	282	250	255
Nickel	0.30	28	30	27	30	28	28
Chromium	0.30	24	33	39	30	27	27
AVG. FEED RATE							
lb/h		1060	1062	1092	1071	1086	1118
kg/h		482	483	496	487	497	508
MOISTURE CONTENT							
Dean Stark Distillation % H_2O only			19.6			22.9	

[a] For target concentrations, see Table 1-1.

[b] Analytical result rejected for QA reasons. See Section 5.2 for explanation.

[c] None detected.

TABLE 2-3. TOTAL WASTE ANALYSIS FOR SARM ASH

Parameter	Method detec-tion limit	SARM I			SARM II		
		Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
VOLATILES, μg/kg							
Ethylbenzene	7.0	ND[a]	19	ND	8	ND	13
Xylene	5.0	ND	34	ND	11	6	20
Tetrachloroethylene	4.0	ND	ND	ND	ND	ND	ND
Chlorobenzene	6.0	ND	ND	ND	ND	ND	ND
Acetone	8.0	440	420	630	190	210	790
1,2-Dichloroethane	3.0	ND	ND	ND	ND	5	10
Styrene	3.0	ND	ND	ND	ND	ND	ND
SEMIVOLATILES, μg/kg							
Anthracene	37	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	63	1600	540	740	950	710	1300
Pentachlorophenol	370	ND	ND	ND	ND	ND	ND
METALS, mg/kg							
Lead	4.2	56	98	107	146	75	88
Zinc	0.12	217	227	250	252	199	237
Cadmium	0.12	<0.2	<0.2	<0.2	0.2	<0.2	<0.2
Arsenic	0.04	38	36	44	46	39	37
Copper	0.42	111	132	159	125	106	162
Nickel	0.30	12	15	11	12	9.1	12
Chromium	0.30	10	14	12	12	7	10
VOLATILE PICs, μg/kg							
2-Butanone	25	35	ND	ND	14[b]	ND	ND
Methylene chloride	2.8	2.9	5.4	4.2	ND	ND	ND
2-Chloroethylvinyl ether	5.0	70	ND	ND	ND	ND	ND

[a] ND = Not detected.

[b] Estimated value less than method detection limit.

TABLE 2-4. TOTAL WASTE ANALYSIS FOR SCRUBBER WATER

Parameter	Method detection limit	SARM I			SARM II			Influent[a]
		Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	
VOLATILES, μg/liter								
Ethylbenzene	7.0	ND[b]	ND	ND	ND	ND	ND	ND
Xylene	5.0	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	4.0	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	6.0	ND	ND	ND	ND	ND	ND	ND
Acetone	8.0	ND	17	12	ND	ND	ND	ND
1,2-Dichloroethane	3.0	ND	ND	ND	ND	ND	ND	ND
Styrene	3.0	ND	ND	ND	ND	ND	ND	ND
SEMIVOLATILES, μg/liter								
Anthracene	ND	ND	ND	ND	ND	ND	ND	
Bis(2-ethylhexyl) phthalate	3	ND	5	2.3	5	ND	9	
Pentachlorophenol	0.4	8	4	ND	ND	ND	ND	
METALS, μg/ml								
Lead	0.105	1.8	1.5	2.3	2.2	2.0	4.8	NA[c]
Zinc	0.003	2.1	4.4	1.8	2.9	1.7	3.3	NA
Cadmium	0.003	2.4	4.1	1.9	3.6	2.0	5.8	NA
Arsenic	0.001	0.15	0.26	0.15	0.27	0.18	0.41	NA
Copper	0.011	0.6	0.53	0.48	0.56	0.59	1.1	NA
Nickel	0.008	0.32	0.76	0.27	0.36	<0.04	0.27	NA
Chromium	0.008	2.4	4.1	1.9	3.6	2.0	5.8	NA
OTHER COMPOUNDS DETECTED, μg/liter								
Chloroform	1.6	5.7	5.6	4.8	4.2	5.9	8.6	7.1
Bromodichloromethane	2.2	ND	ND	ND	ND	ND	2.4	2.7

[a] Sample of scrubber water collected prior to the start of testing. Analyzed for organic content only.

[b] ND = Not detected

[c] NA - Not analyzed.

Compound	Average feed conc. mg/kg	Ash conc., mg/kg			
		First run	Second run	Third run	Average
Acetone					
SARM I	4000	0.440	0.420	0.630	0.497
SARM II	506	0.190	0.210	0.790	0.397
Bis(2-ethylhexyl) phthalate					
SARM I	2767	1.600	0.540	0.740	0.960
SARM II	186	0.950	0.710	1.300	0.987

The metals data for the ash samples are also interesting. Prior to the testing, it was anticipated that most of the metals concentrations in the ash would be elevated compared to the waste feed due to combined effects of retention of metals in the ash and losses of water and organics from the feed during the incineration process; cadmium levels in the ash, however, were expected to be low due to volatilization of the metal in the kiln at the high operating temperature of 1800°F. As expected, cadmium levels in the ash were quite low, at least 99.9 percent lower than the waste feed levels. Surprisingly, all of the other heavy metal levels except for arsenic were also lower in the ash (e.g., on the order 50 to 80 percent lower) than in the waste feed. On the other hand, arsenic levels in the ash were more than double those of the feed levels, across the board. An explanation for these unexpected results is being sought.

2.3.3 Scrubber Water Analyses (Table 2-4)

Scrubber water analyses indicate that it was essentially free of all organics from the SARM I and II feeds, except acetone, which appeared in Runs 2 and 3 at low ppb levels, and bis(2-ethylhexyl)phthalate which appeared in 4 of the 6 runs, also at low ppb levels. In both cases, the amounts detected were only 2 to 3 times the method detection limits. Pentachlorophenol was also detected in the scrubber water from two of the three runs on SARM I, at 4 and 8 μg/liter, levels which are 10 to 20 times higher than the MDL. Two

volatile compounds--chloroform and bromodichloromethane--were detected at low ppb levels in the influent scrubber water (prior to any SARM testing) and throughout the test runs. All of the metals were detected in the scrubber water at low ppm levels for both SARMs.

2.4 TREATMENT EFFICIENCY AS MEASURED BY TCLP

Toxic Characteristic Leaching Procedure (TCLP) test results are given in Table 2-5 for the untreated and treated SARMS.

(Discussion to be added when data are available.)

2.5 EMISSION TEST RESULTS

Table 2-6 summarizes the sample and analytical methodology used for this test program. In summary, single modified Method 5 (semi-volatile organics) and EPA Method 12 (metals) sample trains were run simultaneously over a 3- to 4-hour period during the incineration of SARM I and II. Additionally, the volatile organic sample train (VOST) was used to collect volatile samples during the runs and continuous emission monitors (CEMS) were used to continuously monitor gas stream composition for oxygen, carbon dioxide, and carbon monoxide content. All samples were collected after the venturi scrubbing system to determine the concentrations and mass rates of the pollutants listed in Table 2-6.

Stack samples for the semi-volatile organics were collected on XAD-2 resin. The XAD-2, filter, and probe rinse residue were solvent extracted and the concentrated extracts were analyzed by GC/MS. Prior to the organics analysis, probe rinse and filter samples were analyzed gravimetrically to determine particulate concentration per EPA Method 5 procedures. An aliquot from the 0.1 NaOH impinger of each MM5 train was also analyzed for chloride content (as HCL) using ion chromatography.

Metals samples were collected using an EPA Method 12 sample train. This train is identical to the standard EPA Method 5 train except that 0.1 N HNO_3 (nitric acid) is added to the impinger and used as the sample nozzle and probe rinse reagent. Analysis for the listed metals was accomplished by combining the probe rinse and filter fraction into a single sample and digesting each sample using appropriate procedures in SW 846. Analyses were per-

TABLE 2-5. TCLP VALUES,[a]
mg/liter

	SARM I		SARM II	
	Untreated[b] (waste feed)	Treated[b] (ash)	Untreated[c] (waste feed)	Treated[d] (ash)
	Run 1	Run 1	Run 4	Run 4
VOLATILES				
Ethylbenzene	49.7	0.65	7.31	0.19
Xylene (Total)	84.6	1.05	15.8	0.23
Tetrachloroethylene	3.59	0.04 l	0.68	0.10 μ
Chlorobenzene	6.47	0.04 l	0.79	0.10 μ
Acetone	282	0.74	26.1	0.14
1,2-Dichloroethane	18.9	0.10 μ	0.48	0.10 μ
Styrene	2.10	0.11	0.58	0.10 μ
SEMIVOLATILES				
Anthracene				
Bis(2-ethylhexyl) phthalate				
Pentachlorophenol				
METALS				
Lead	0.46	0.15 μ	1.74	0.15 μ
Zinc	7.96	0.03 μ	13.5	0.49
Cadmium	0.62	0.01 μ	0.77	0.01 μ
Arsenic	0.15 μ	0.15 μ	0.15 μ	0.15 μ
Copper	1.31	0.02 μ	4.12	0.26
Nickel	0.34	0.04 μ	0.65	0.05
Chromium	0.01 μ	0.01 μ	0.07	0.04

μ = Detection limit.
l = Less than detection limit; estimated value.

[a] Data generated by Lee Wan Associates, Atlanta, Georgia, under EPA Contract No. 68-03-3393.

[b] Waste feed: Sample No. ZSARM-I-1-F, Seal No. 8303 and 8304.

[c] Ash (unquenched): Sample No. ZSARM-I-1-A, Seal No. 8331 and 8332.

[d] Waste feed: Sample No. ZSARM-II-4-F, Seal No. 8369.

[e] Ash (unquenched): Sample No. ZSARM-II-4-A, Seal No. 8368.

TABLE 2-6. SUMMARY OF STACK GAS SAMPLE AND ANALYTICAL PROCEDURES (SARM I AND II TEST BURNS)

Sample Identification	Parameter	Sample Method	Analytical Method	No. of Samples
Stack Gas (after scrubbing system)	°POHCS - Volatiles Ethylbenzene Xylene Chlorobenzene Acetone 1,2-Dichloroethane Styrene Tetrachloroethylene	S012 (VOST protocol)	GC/MS (VOST)	18 pairs
	- Semi-volatiles Anthracene Pentachlorophenol Bis(2-ethylhexyl)phtalate	Modified Method 5	GC/MS SW 846-8270	6
	°Particulate	EPA Method 5	Gravimetric (EPA 5)	6
	°HCl	EPA Method 5	Ion chromatography (EPA 300.0)	6
	°Metals	EPA Method 12	SW 846 (ICP/AA)	6
	°Volumetric Gas Flow - Temperature - Moisture content	EPA Methods 1-4	---	-
	°CO	EPA Method 10	NDIR	continuous
	°CO_2	EPA Method 3A	NDIR	continuous
	°O_2	EPA Method 3A	Zirconium cell	continuous

formed by either Atomic Absorption (AA) or Inductively Coupled Plasma Spectroscopy (ICP).

Volatile organic samples were collected using the VOST sample train. This train consists of paired sorbent traps using Tenax and Tenax-Charcoal traps in series. Three sample pairs were collected over each sample period. Analysis was conducted by GC/MS.

During each test, flue gas flow rate, temperature, and moisture content were measured using EPA Method 1 through 4 procedures. Additionally, CEM's were used to continuously record O_2, CO_2, and CO concentrations during each test period. The following subsections detail the results of the sample program.

2.5.1 Critical Emission Parameters Results Summary

Tables 2-7 and 2-8 summarize the critical emission parameters for the SARM I and SARM II test burns. In summary, the data show:

- Particulate concentrations corrected to 7 percent O_2 were below the RCRA allowable limit of 0.08 gr/dscf for each SARM type.
- Measured HCL emission rates in lb/h were considerably less than the RCRA allowable of 4.0 lb/h for each SARM type.
- The average stack gas concentration of CO was less than 23 ppm during each test.
- The DRE performance standard of 99.99 percent was achieved for the designated critical volatile POHC's for each SARM type. The DRE data for the semi-volatile POHCs show that anthracene was effectively destroyed since the amount in each emission was less than the method detection limit (μg/sample) resulting in DRE's of greater than 99.99 percent. DRE data for bis(2-ethylhexyl)phthalate showed three of zinc sample runs meeting the 99.99 percent criteria. Sample contamination (background level) problems make these data suspect as discussed in Subsection 2.5.4.

Overall, the sampling and analysis were conducted as described in the QAPP for this project and no major field sampling problems were encountered which could significantly impact test results.

2.5.2. Summary of Flue Gas Conditions

Table 2-9 summarizes flue gas data as measured during this test program. The modified Method 5 and metal sample trains were run simultaneously at the same location using isokinetic and cross-sectional traverse sample techniques.

TABLE 2-7. RESULTS FOR CRITICAL EMISSION PARAMETERS - SARM I

Parameter	Test No. 1	Test No. 2	Test No. 3	Average
Test date (1987)	9/16	9/16	9/17	
Test time (24-h)	1020-1413	1625-2030	1041-1409	
SARM I feed rate, lb/h	1060	1062	1092	1071
Total ethylbenzene feed rate, lb/h	3.4	2.3	3.7	3.1
Total xylene feed rate, lb/h	5.5	3.8	5.5	4.9
Total anthracene feed rate, lb/h	5.8	8.0	4.9	6.2
Total bis(2-ethylhexyl) phthalate feed rate, lb/h	2.6	3.1	2.0	2.6
Exhaust gas data				
Volumetric flow, dscfm	1466	1342	1427	1412
O_2, %[a]	5.4	5.8	5.4	5.5
CO_2, %[a]	10.8	10.4	10.6	10.6
CO, ppm (dry)[a]	<10	<10	<10	<10
Particulate concentration, gr/dsct @ 7% O_2	0.014	0.015	0.011	0.013
Emission rates, lb/h				
Particulate	0.19	0.19	0.145	0.175
HCl	0.05	0.05	0.03	0.04
Ethylbenzene	2.9×10^{-5}	1.4 x 10-5	6.0×10^{-5}	3.4×10^{-5}
Xylene	3.3×10^{-5}	3.1×10^{-5}	8.0×10^{-5}	4.8×10^{-5}
Anthracene	ND[b]	ND	ND	ND
Bis(2-ethylhexyl) phthalate	2.5×10^{-4}	1.5×10^{-5}	6.6×10^{-4}	3.3×10^{-4}

(continued)

TABLE 2-7 (continued)

Parameter	Test No. 1	Test No. 2	Test No. 3	Average
Exhaust gas data continued.				
DRE, %[c]				
Ethylbenzene	99.999	99.999	99.998	99.999
Xylene	99.999	99.999	99.998	99.999
Anthracene	>99.99	>99.99	>99.99	>99.99
Bis (2-ethylhexyl) phthalate	99.990	99.999	99.967	99.985

[a] Dry basis, determined as average values from O_2, CO_2, and CO continuous monitors.

[b] ND = None detected.

[c] Destruction removal efficiency = $\frac{\text{lb/h in} - \text{lb/h out}}{\text{lb in}} \times 100$

TABLE 2-8. RESULTS FOR CRITICAL EMISSION PARAMETERS - SARM II

Parameter	Test No. 1	Test No. 2	Test No. 3	Average
Test date (1987)	9/17	9/18	9/18	
Test time (24-h)	1655-2015	0944-1308	1350-1718	
SARM I feed rate, lb/h	1071	1086	1118	1092
Total ethylbenzene feed rate, lb/h	0.22	0.08	0.30	0.2
Total xylene feed rate, lb/h	0.11	0.14	0.47	0.24
Total anthracene feed rate, lb/h	0.45	0.39	0.39	0.41
Total bis(2-ethylhexyl) phthalate feed rate, lb/h	0.27	0.25	ND[a]	0.17
Exhaust gas data				
Volumetric flow, dscfm	1352	1456	1413	1407
O_2, %[b]	5.1	5.6	5.4	5.4
CO_2, %[b]	11.0	10.8	11.1	11.0
CO, ppm (dry)[b]	<10	<10	<10	<10
Particulate concentration, gr/dsct @ 7% O_2	0.007	0.006	0.005	0.006
Emission rates, lb/h				
Particulate	0.09	0.08	0.07	0.08
HCl	0.02	0.02	0.01	0.02
Ethylbenzene	5.3×10^{-6}	3.7×10^{-6}	3.2×10^{-6}	4.1×10^{-6}
Xylene	8.9×10^{-6}	1.3×10^{-5}	8.9×10^{-6}	1.0×10^{-5}
Anthracene	ND[b]	ND	ND	ND
Bis(2-ethylhexyl) phthalate	2.1×10^{-5}	1.0×10^{-3}	6.2×10^{-5}	3.6×10^{-4}

(continued)

TABLE 2-8 (continued)

Parameter	Test No. 1	Test No. 2	Test No. 3	Average
Exhaust gas data continued.				
DRE, %[c]				
Ethylbenzene	99.998	99.995	99.999	99.998
Xylene	99.992	99.990	99.998	99.996
Anthracene	>99.99	>99.99	>99.99	>99.99
Bis (2-ethylexyl) phthalate	99.992	99.600	-	99.796

[a] ND = None detected.

[b] Dry basis, determined as average values from O_2, CO_2, and CO continuous monitors.

[c] Destruction removal efficiency = $\frac{\text{lb/h in - lb/h out}}{\text{lb in}} \times 100$

TABLE 2-9. SUMMARY OF FLUE GAS CONDITIONS

SARM I									
Run No.	Date (1987) and Time (24 hours)	Sample Type	Volumetric Flow Rate[a] acfm	Volumetric Flow Rate[a] dscfm	Temperature °F	Moisture Content, %	Gas Composition[b] O_2%	Gas Composition[b] CO_2%	Gas Composition[b] CO-ppm
SAI-SV-1	9/16; 1020-1413	Part./HCl/semi-volatiles	3387	1407	180	48.8	5.4	10.8	< 12
SAI-M-1	9/16; 1020-1245	Metals	3610	1525	180	47.9	5.4	10.8	< 12
SAI-SV-2	9/16; 1625-2030	Part./HCl/semi-volatiles	3403	1327	180	51.9	5.8	10.4	< 10
SAI-M-2	9/16; 1628-1955	Metals	3352	1357	180	50.1	5.8	10.4	< 10
SAI-SV-3	9/17; 1041-1409	Part./HCl/semi-volatiles	3512	1377	181	52.0	5.4	10.6	< 17
SAI-M-3	9/17; 1044-1324	Metals	3767	1477	181	52.0	5.4	10.6	< 17
SAII-SV-1	9/17; 1655-2015	Part./HCl/semi-volatiles	3439	1340	181	52.3	5.1	11.0	< 23
SAII-M-1	9/17; 1700-1936	Metals	3479	1364	181	52.0	5.1	11.0	< 23
SAII-SV-2	9/18; 0944-1308	Part./HCl/semi-volatiles	3693	1443	181	52.4	5.6	10.8	< 16
SAII-M-2	9/18; 0933-1234	Metals	3701	1469	180	51.7	5.6	10.8	< 16
SAII-SV-3	9/18; 1350-1718	Part./HCl/semi-volatiles	3761	1415	181	54.1	5.4	11.1	< 11
SAII-M-3	9/18;1337-1639	Metals	3659	1411	182	53.0	5.4	11.1	< 11

[a]Volumetric gas flow rate in actual cubic feet per minute (actm) at stock conditions and dry standard cubic feet per minute (dscfm) at 68°F, 29.92 in Hg, and zero percent moisture.

[b]Gas composition data represents the average value obtained from CEMs for each test period.

Flue gas flow rates were consistent throughout the test program ranging between 3300 and 3800 acfm (1300 to 1500 dscfm). Flue gas temperature averaged about 180°F with moisture contents of between 48 and 54 percent by volume. Since the gas stream appeared saturated and contained water droplets, two moisture determinations were made: the first involved volumetrically determining the amount of water collected during each test and the second determination involved calculating the moisture content using the vapor pressure of water at the measured stack temperature and pressure. In each case, the lower value was reported as specified in EPA Method 4. During three of the twelve sample runs (SAI-M-1 and 3 and SAII-SV-1), the silica gel impinger broke under high vacuum as a result of the large quantities of water collected in the impinger section of the sample training. Sampling was discontinued, the broken impinger changed, and sampling resumed after the appropriate system leak-checks were performed. Because a portion of the silica gel was lost and could not be weighed, the volumetrically determined moisture contents for the runs are biased somewhat low. No significant bias in emission results is believed to have occurred as a result of this problem.

Gas composition data were continuously recorded throughout each test using continuing emission monitors for O_2, CO_2, and CO. The strip charts were reduced to 15 minute averages and reported values represent the average value obtained over the 4 hour burn period. The gas composition data show O_2 content ranging between 5.1 and 5.8 percent; CO_2 ranging between 10 and 11 percent; and CO values of less than 20 ppm (dry basis). It should be noted that during five of the six SARM burns excursions in CO concentration of between 45 and 90 ppm were observed typically lasting less than 5 minutes.

2.5.3 Particulate and HCl Emission Data

Tables 2-10 and 2-11 summarize the particulate and HCl emissions data from this test program. Concentrations are expressed in grains per dry standard cubic feet (gr/dscf) and mass rate data in lb/h. The product of the flue gas flow rate and concentration yields the mass emission rate. Volumetric flow rates (in dscfm) as measured by each individual sample train were averaged and the resulting average value (see Tables 2-7 and 2-8) for each test period was used in calculating mass rates.

For the SARM I burns, the particulate concentration corrected to 7 percent O_2 averaged 0.0133 gr/dscf with a corresponding average mass rate of

TABLE 2-10. PARTICULATE EMISSIONS DATA

Test No.	Concentration as measured, gr/dscf	Concentration corrected to 7% O_2 gr/dscf	Mass rate, lb/h
°SARM I			
SAI-SV-1	0.0156	0.014	0.19
SAI-SV-2	0.0166	0.015	0.19
SAI-SV-3	0.0123	0.011	0.145
Average	0.0148	0.0133	0.175
° SARM II			
SAII-SV-1	0.0079	0.007	0.09
SAII-SV-2	0.0061	0.006	0.08
SAII-SV-3	0.0056	0.005	0.07
Average	0.0065	0.006	0.08

TABLE 2-11. HCl EMISSION DATA

Test No.	Concentration gr/dscf	Mass Rate lb/h
°SARM I		
SAI-SV-1	.004	0.05
SAI-SV-2	.0045	0.05
SAI-SV-3	.003	0.03
Average	0.0038	0.043
° SARM II		
SAII-SV-1	.0016	0.02
SAII-SV-2	.0014	0.02
SAII-SV-3	.0009	0.01
Average	0.0013	0.017

approximately .175 lb/h. HCl concentrations averaged 0.0038 gr/dscf with an average mass rate of 0.043 lb/h. For the SARM II burns, the average corrected particulate concentration was 0.0065 gr/dscf with an average mass rate of 0.08 lb/h. HCl concentrations averaged 0.0013 gr/dscf with an average mass rate of 0.017 lb/h.

It should be noted that run SAI-SV-1 was conducted at a non-isokinetic sample condition (approximately 85 percent) which would tend to bias particulate measurements on the high side. Based on the relative consistency between concentration measurements, no significant bias in particulate measurements is believed to have occurred. All other sample runs were conducted within the isokinetic sample specifications (between 90 and 110 percent) detailed in EPA Method 5.

2.5.4 POHC Emission Data and Destruction Removal Efficiency (DRE)

Tables 2-12 through 2-17 summarize the volatile and semi-volatile organic feed and mass emission data as well as the DRE for each compound. Also included for informational purposes are the Method Detection Limits (MDL) for the feed and stack samples. Individual compound feed rates were determined using the waste composition and incinerator feed rate data detailed in Sections 2.2. and 2.3. For the volatile organic data, (Tables 2-12 through 2-14), concentrations in nanograms per liter (ng/l) represent the average concentration determined from the three VOST samples collected during each SARM burn. Mass rates were then calculated using the average concentration and volumetric flow rate data for each test.

Per the QAPP for this project, ethylbenzene and xylene were chosen as critical parameters to evaluate incinerator performance in effectively destroying volatile organic compounds. For the SARM I tests, ethylbenzene stack gas concentrations ranged between 2.7 and 11.3 ng/l with corresponding mass emission rates of between 1.4×10^{-5} and 6.0×10^{-5} lb/h. For the SARM II tests, stack gas concentrations ranged between 0.6 and 1.0 ng/l with corresponding mass emission rates of between 3.2×10^{-6} and 5.3×10^{-6} lb/h. Overall, the DRE's for ethylbenzene were greater than 99.99 percent for each run. SARM I xylene stack gas concentrations ranged between 5.8 and 15.1 ng/l with corresponding mass emission rates of between 3.1×10^{-5} and 8.0×10^{-5} lb/h, respectively. SARM II xylene concentrations ranged between 1.7 and 2.5 ng/l with corresponding mass emission rates of between 8.9×10^{-6} and 1.3 x

TABLE 2-12. SUMMARY OF VOLATILE ORGANIC FEED RATE DATA

	SARM I						SARM II					
Test No.	1		2		3		1		2		3	
Feed Rate lb/h	1060		1062		1092		1071		1086		1118	
Analyte	Concentration ppm	Feed[a] rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h
Ethylbenzene[b]	3600	3.4	2400	2.3	4000	3.7	240	0.22	84	0.08	330	0.3
Xylene[b]	5800	5.5	4000	3.8	6000	5.5	120	0.11	150	0.14	520	0.47
Tetrachloroethylene	ND	-	260	0.24	350	0.32	29	0.03	8.5	0.01	36	0.03
Chlorobenzene	340	0.32	240	0.23	360	0.33	22	0.02	6.9	0.01	30	0.03
Acetone	3300	3.1	6000	5.6	2700	2.5	680	0.6	570	0.5	270	0.24
1,2-Dichloroethane	450	0.42	140	0.13	340	0.31	13	0.01	3.5	0.003	28	0.03
Styrene	770	0.73	580	0.55	810	0.74	51	0.05	16	0.015	67	0.06

[a] Feed rate = $\frac{\text{Total SARM Feed Rate (lb/h)}}{\text{Analyte concentration (ppm)}}$

[b] Critical parameters per QAPP.

Minimum Method Detection Limits: (Total ppm)

- Ethylbenzene 7.0
- Xylene 5.0
- Tetrachloroethylene 4.0
- Chlorobenzene 6.0
- Acetone 8.0
- 1,2-Dichloroethane 3.0
- Styrene 3.0

TABLE 2-13. SUMMARY OF VOLATILE ORGANIC STACK GAS CONCENTRATION AND MASS RATE DATA

	SARM I						SARM II					
Test No.	1		2		3		1		2		3	
Analyte	ng/l[a]	lb/h	ng/l	lb/h	ng/l	lb/h	ng/l	lb/h	ng/l	lb/h	ng/l	lb/h
Ethyl-benzene	5.4	2.9×10^{-5}	2.7	1.4×10^{-5}	11.3	6.0×10^{-5}	1.0	5.3×10^{-6}	0.7	3.7×10^{-6}	0.6	3.2×10^{-6}
Xylene	6.3	3.3×10^{-5}	5.8	3.1×10^{-5}	15.1	8.0×10^{-5}	1.7	8.9×10^{-6}	2.5	1.3×10^{-5}	1.7	8.9×10^{-6}
Tetrachlo-roethylene	0.04	2.1×10^{-7}	0.25	1.3×10^{-6}	1.7	9.0×10^{-6}	0.1	5.3×10^{-7}	0.2	1.1×10^{-6}	0.5	2.6×10^{-6}
Chloro-benzene	0.8	4.2×10^{-6}	0.3	1.6×10^{-6}	3.3	1.7×10^{-5}	0.17	8.9×10^{-7}	0.23	1.2×10^{-6}	0.2	1.1×10^{-6}
Acetone	5.8	3.1×10^{-5}	3.9	2.1×10^{-5}	5.1	2.7×10^{-5}	ND[b]	---	ND[b]	---	0.4	2.1×10^{-6}
1,2-Dich-loroethane	ND[b]	---	0.25	1.3×10^{-6}	1.3	6.9×10^{-6}	ND[b]	---	ND[b]	---	0.1	5.3×10^{-7}
Styrene	3.4	1.8×10^{-5}	1.7	9.0×10^{-6}	20.3	1.1×10^{-4}	4.0	2.1×10^{-5}	0.2	1.1×10^{-6}	0.3	1.6×10^{-6}

[a] Concentration in nanograms per liter (ng/l).
[b] None detected.

Minimum Method Detection Limit (MDL):

	Total Nanograms
- Ethylbenzene:	2.0
- Xylene:	4.0
- Perchloroethane:	1.0
- Chlorobenzene:	0.7
- Acetone:	5.0
- 1,2-Dichloroethane:	1.0
- Styrene:	2.0

TABLE 2-14. SUMMARY OF VOLATILE ORGANIC DRE DATA

	SARM I									SARM II								
Test No.	1			2			3			1			2			3		
Analyte	Feed rate lb/h	Mass emission rate lb/h	DRE[a] %	Feed rate lb/h	Mass emission rate lb/h	DRE %	Feed rate lb/h	Mass emission rate lb/h	DRE %	Feed rate lb/h	Mass emission rate lb/h	DRE %	Feed rate lb/h	Mass emission rate lb/h	DRE %	Feed rate lb/h	Mass emission rate lb/h	DRE %
Ethylbenzene	3.4	2.9×10^{-5}	99.999	2.3	1.4×10^{-5}	99.999	3.7	6.0×10^{-5}	99.998	0.22	5.3×10^{-6}	99.998	0.08	3.7×10^{-6}	99.995	0.3	3.2×10^{-6}	99.999
Xylene	5.5	3.3×10^{-5}	99.999	3.8	3.1×10^{-5}	99.999	5.5	8.0×10^{-5}	99.998	0.11	8.9×10^{-6}	99.992	0.14	1.3×10^{-5}	99.990	0.47	8.9×10^{-6}	99.998
Tetrachloro-ethylene	ND[b]	2.1×10^{-7}	---	0.24	1.3×10^{-6}	99.999	0.32	9.0×10^{-6}	99.997	0.03	5.3×10^{-7}	99.998	0.01	1.1×10^{-6}	99.989	0.03	2.6×10^{-6}	99.991
Choloro-benzene	0.32	4.2×10^{-6}	99.998	0.23	1.6×10^{-6}	99.999	0.33	1.7×10^{-5}	99.995	0.02	8.9×10^{-7}	99.996	0.01	1.2×10^{-6}	99.988	0.03	1.1×10^{-6}	99.996
Acetone	3.1	3.1×10^{-5}	99.999	5.6	2.1×10^{-5}	99.999	2.5	2.7×10^{-5}	99.999	0.6	ND	---	0.05	ND	---	0.24	2.1×10^{-6}	99.999
1,2-Dichloro-benzene	0.42	ND	---	0.13	1.3×10^{-6}	99.999	0.31	6.9×10^{-6}	99.998	0.01	ND	---	0.003	ND	---	0.03	5.3×10^{-7}	99.998
Styrene	0.73	1.8×10^{-5}	99.998	0.55	9.0×10^{-6}	99.998	0.74	1.1×10^{-4}	99.985	0.05	2.1×10^{-5}	99.958	0.015	1.1×10^{-6}	99.993	0.06	1.6×10^{-6}	99.997

[a] $\% \text{ DRE} = \frac{\text{lb/h(in)} - \text{lb/h (out)}}{\text{lb/h (in)}} \times 100$

[b] None detected.

TABLE 2-15. SUMMARY OF SEMI-VOLATILE ORGANIC FEED RATE DATA

	SARM I						SARM II					
Test No.	1		2		3		1		2		3	
Feed Rate, lb/h	1060		1062		1092		1071		1086		1118	
Analyte	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h	Concentration ppm	Feed rate lb/h
Anthracene[b]	6200	5.8	8500	8.0	5300	4.85	480	0.45	420	0.39	440	0.39
Pentachlorophenol	ND[c]	---	630	0.59	ND[c]	----	ND[c]	----	ND[c]	----	ND[c]	----
Bis(2-ethyl-hexyl)phthalate[b]	2800	2.6	3300	3.1	2200	2.0	290	0.27	270	0.25	ND	----

[a] Feed rate (lb/h) = $\frac{\text{Concentration (ppm)}}{\text{Total SRM Feed Rate (lb/h)}}$

[b] Critical parameters per QAPP.

[c] None detected.

Minimum Detection Limit (MDL-ppm):

Anthracene: 6
Pentachlorophenol: 3.3
Bis(2-ethylhexyl)phthalate: 44.0

TABLE 2-16. SUMMARY OF SEMI-VOLATILE ORGANIC STACK GAS CONCENTRATION AND MASS RATE DATA

	SARM I						SARM II					
Test No.	1		2		3		1		2		3	
Analyte	Concentration μg/m³	Mass rate lb/h	Concentration μg/m³	Mass rate lb/h	Concentration μg/m³	Mass rate lb/h	Concentration μg/m³	Mass rate lb/h	Concentration μg/m³	Mass rate lb/h	Concentration μg/m³	Mass rate lb/h
Anthracene	ND[a]	----	ND	----	ND	----	ND	----	ND	----	ND	----
Pentachloro-	ND	----	ND	----	ND	----	1.5	7.6×10^{-6}	ND	----	ND	----
Bis(2-ethylhexyl) phthalate	46.2	2.5×10^{-4}	3.0	1.5×10^{-5}	124.2	6.6×10^{-4}	4.2	2.1×10^{-5}	190.5	1.0×10^{-3}	11.3	6.2×10^{-5}

[a] None detected.

MDL (total μg/sample):	
Anthracene:	0.4 - 2.9 μg
Pentachlorophenol:	0.3 μg
Bis(2-ethylhexyl)-phthalate	0.4 μg

TABLE 2-17. SUMMARY OF SEMIVOLATILE ORGANIC DRE DATA

	SARM I									SARM II								
Test No.	1			2			3			1			2			3		
Analyte	Feed rate lb/h	Mass rate lb/h	DRE %	Feed rate lb/h	Mass rate lb/h	DRE %	Feed rate lb/h	Mass rate lb/h	DRE %	Feed rate lb/h	Mass rate lb/h	DRE %	Feed rate lb/h	Mass rate lb/h	DRE %	Feed rate lb/h	Mass rate lb/h	DRE %
Anthracene	5.6	ND[a]	>99.99	8.0	ND	>99.99	0.45	ND	>99.99	0.39	ND	>99.99	0.39	ND	>99.99	0.39	ND	>99.99
Pentachloro-phenol	ND	ND	---	0.59	ND	>99.99	ND	ND	---	ND	7.6×10^{-6}	---	ND	ND	---	ND	ND	---
Bis(2-ethyl-hexyl) phthalate	2.6	2.5×10^{-4}	99.990	3.1	1.5×10^{-5}	99.999	2.0	6.6×10^{-4}	99.967	0.27	2.1×10^{-5}	99.992	0.25	1.0×10^{-3}	99.600	ND	6.2×10^{-5}	--

[a] None detected.

10^{-5} lb/h. The calculated DRE's for xylene were at least 99.99 percent for each test period.

Analyses for volatile organic compounds including perchloroethane, chlorobenzene, acetone, 1,2-dichloroethane, and styrene were also conducted. With the exception of those samples (either feed or stack gas in which compound concentrations were below the MDL) DRE's of at least 99.99 percent were achieved. Note that the calculated DRE for styrene was less than 99.99 percent for SARM I run number 3 and SARM II run number 1. However, the overall DRE average for each SARM level is 99.99 percent for this compound.

All samples contained at least one analyte at a level five times the detection limits reported in the tables. Levels of analyte ranged from the detection limit to more than 100 times the detection limit. In view of the extremely high surrogate recoveries encountered for bromoflurobenzene (see Section 5.0, Appendix C), values for the late-eluting compounds (most especially ethylbenzene, styrene, and the xylenes) may be high by the factor about 100% exhibited by the bromoflurobenzene. Since response factors remain stable (as demonstrated by the initial calibration check at the beginning of the day and an additional calibration check as the end of the day) and, in general, the blanks do not exhibit these inflated surrogate compound recoveries, the occurrence of elevated surrogate compound recoveries in the course of the performance of VOST analyses must be considered a matrix effect. The classic means of demonstrating the operation of a matrix effect, namely, repeated analysis of the same sample, repeated preparation and analysis of the same sample, and occurrence of the matrix effect throughout all analyses of the sample, cannot be performed in the VOST assay, since the VOST sample consists only of a single set of sampling tubes and the compounds which are desorbed from the sampling tubes are analyzed in the initial analysis. No VOST sample can be re-analyzed. VOST samples are know to contain high levels of water, since stack emissions contain high levels of water. Large quantities of water introduced into a chromatographic analysis and/or into a mass spectrometer will distort the chromatography and will cause relative signal levels for the compounds to be distorted. Additional components of the stack gases such as various acids can also have the effect of perturbing the chromatography, and stack emissions are often highly acidic.

The Method 5040 QC (VOST) measures were executed with acceptable results, but sample surrogate recoveries are often seen to be above the 50-150% criterion for acceptability of the method. No corrections were applied to the stack emission results to account for inflated surrogate compound recoveries; particularly for ethylbenzene, styrene, and xylenes. Uncorrected ethylbenzene and xylene emission results and subsequent DRE's were at least 99.99 percent making corrections unnecessary. If styrene emissions from SARM I test 3 and SARM II test 1 are corrected for the inflated surrogate recoveries, DRE's of at least 99.99 percent would be achieved.

Tables 2-15 through 2-17 summarize the semi-volatile organic feed, mass rate, and DRE data. Minimum method detection limits are also shown. Analyte feed rates were determined by dividing the measured concentration (ppm) by the SARM feed rate in lb/h. Note that only one of six SARM feed samples contained pentachlorophenol at detectable levels, therefore, development of DRE data for this compound is not possible. Also, the quantity of bis(2-ethylhexyl)phthalate found in SARM II run 3 was below the method detection limit.

Non-detectable levels of anthracene and pentachlorophenol were observed in all modified method 5 samples with the exception of SARM II run 1 in which a pentachlorophenol concentration of 1.5 $\mu g/m^3$ and mass rate of 7.6×10^{-6} lb/h were observed. Since non-detectable levels of pentachlorphenol were observed for corresponding SARM feed for this run, this result is considered an outlier and is less than 2 times the method detection limit thus making this value suspect. The DRE's for anthracene are all greater than 99.99 percent based on the feed rate data and non-detectable stack gas concentration. For the one test for which pentachlorophenol feed data are available (SARM I, run 2), a DRE of greater than 99.99 percent was achieved based on the non-detectable level in the corresponding stack gas sample. The DRE data for bis(2-ethylhexyl)phthalate show that 3 of 5 sample runs achieved at least a 99.99 percent DRE. Results for bis(2-ethylhexyl)phthalate must be interpreted with caution, however. Blanks which were analyzed show the presence of this compound, with the filter blank, XAD-2 blank, and train blanks showing the presence of bis(2-ethylhexyl)phthalate at levels which range from a factor of approximately 30 times the detection limit to 65 times the detection limit. Contamination by this compound thus is observed to occur readily.

However, the levels of this compound in the actual emission samples is an additional factor of 50 to 70 times above the levels observed in the blanks. A correction factor of 45 μg (representing the blank value obtained from analysis of the field train blank) was applied to each run.

2.5.5 Metals Emission Data

Table 2-18 summarizes the concentration and mass rate data for the following metals: arsenic, cadmium, chromium, copper, lead, nickel, and zinc. Concentrations are expressed in micrograms per cubic meter ($\mu g/m^3$) and mass rates in lb/h. The volumetric flow rate measured by the metals train during each test period was used in calculating the mass emission rates.

2.5.6 Continuous Emission Monitor Data

Tables 2-19 through 2-24 summarize the CEM data for O_2, CO_2, and CO during each test burn. These data remained relatively consistent throughout each sample period with short-term (less than 5 minutes) excursions in CO concentration as noted in the tables. During the CO excursions, the O_2 content of the stack gas typically dropped to near zero percent for less than 1 minute.

2.5.7 Dioxin/Furans Analytical Data

The determination of tetra-, penta-, hexa-, and octachlorodibenzodioxins (PCDDs) and dibenzofurans (PCDFs) was performed on feed, ash, and scrubber water samples following the analytical methodology of EPA Method 8280 (SW-846, Third Edition).

The results for the analysis of the dioxin/furan samples are shown in Tables 2-25 to 2-27. No levels of dioxins or furans above the Method detection limit were observed in any of the samples, while all surrogate compound recoveries were within the limits specified by Method 8280 (SW-846, Third Edition).

TABLE 2-18. SUMMARY OF METALS EMISSION DATA

SARM I							
Run	1		2		3		3 Test average
Metal	μg/m³	lb/h	μg/m³	lb/h	μg/m³	lb/h	lb/h
Arsenic	19.3	.0001	23.3	.0001	11.5	.00006	.0001
Cadmium	2051	.012	1411	.007	2595	.014	.0110
Chromium	80.6	.0005	69.8	.0004	60.1	.0003	.0004
Copper	217	.001	274	.001	303	.002	.0014
Lead	840	.005	1018	.005	1074	.006	.0053
Nickel	362	.002	52	.0003	38	.0002	.0009
Zinc	454	.003	311	.002	490	.003	.0023
SARM II							
Run	4		5		6		
Arsenic	6.3	.00003	6.0	.00003	9.8	.00005	.00004
Cadmium	1353	.007	1347	.007	1016	.005	.0066
Chromium	35.2	.0002	20.3	.0001	15.4	.00008	.00012
Copper	104	.0005	51	.0003	38.8	.0002	.00034
Lead	415	.002	374	.002	351	.002	.002
Nickel	45	.0002	33	.0002	27	.0001	.00018
Zinc	185	.0009	129	.0007	70	.0004	.00068

TABLE 2-19. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM I
TEST NUMBER 1

Time Period (24h)	Net time, (minutes)	Average concentration O_2, %	CO_2%	CO, ppm	Comments
1030	15	6.6	10.1	10	
1045	15	5.8	10.5	10	
1100	15	6.2	10.1	10	
1115	15	5.8	10.9	10	
1130	15	5.5	10.7	10	
1145	15	5.3	11.6	10	
1200	15	5.5	11.0	10	
1215	15	5.1	11.0	10	
1230	15	5.3	10.7	10	
1245	15	5.5	11.0	10	
1300	15	5.3	11.2	10	
1315	15	4.7	11.2	10	
1330	15	4.7**	11.0	10*	
1345	15	4.7	11.0	45	*Peaked off scale for 1 min. **Dropped to zero for 1 min.
1400	15	5.0	11.0	2.5	
1415	15	5.0	10.5	10	
1430	15	5.8	10.1	10	
		5.4	10.8	11.6	

TABLE 2-20. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM I
TEST NUMBER 2

Time Period (24h)	Net time, (minutes)	Average concentration O_2, %	CO_2%	CO, ppm	Comments
1630	15	6.6	9.3	10	
1645	15	6.9*	9.5*	10*	
1700	15	6.9	9.5	10	* Stop at 1700 re-start at 1745
1800	15	6.3	9.3	10	
1815	15	6.1	9.7	10	
1830	15	5.5	10.9	10	
1845	15	4.7	11.2	10	
1900	15	5.3	11.2	10	
1915	15	5.1	11.2	10	
1930	15	5.3	10.7	10	
1945	15	5.5	10.5	10	
2000	15	5.5	10.9	10	
2015	15	5.8**	10.7**	10**(a)	** Stopped test at 2030 water in line
2030	15	5.5	10.7	10	(a) Peak at 2016
		5.8	10.4	10	

TABLE 2-21. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM I
TEST NUMBER 3

Time Period (24h)	Net time, (minutes)	Average concentration			Comments
		O_2, %	CO_2%	CO, ppm	
1050	15	7.1	9.1	10	
1105	15	6.3	9.9	10	
1120	15	5.5**	10.5	10*	
1135	15	4.7	11.2	45	* Peaked off scale at 1134, 1401, and 1407 ** Dropped to zero at 1134 and 1401
1150	15	5.3	11.4	10	
1205	15	5.5	10.9	10	
1220	15	6.3	9.8	10	
1235	15	6.0	10.1	10	
1250	15	5.5	10.3	10	
1305	15	4.5	11.8	10	
1320	15	6.3	10.3	10	
1335	15	5.5**	11.1	10*	
1350	15	4.2	10.9	45	
1405	15	4.5	10.9	10*	
1420	15	4.2	11.2	45	
		5.4	10.6	17.0	

TABLE 2-22. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM II
TEST NUMBER 4

Time Period (24h)	Net time, (minutes)	Average concentration O_2, %	CO_2%	CO, ppm	Comments
1715	15	6.3	9.2	10	
1730	15	5.7	10.0	10	
1745	15	5.3	10.9	10	
1800	15	4.2	11.6	10	
1815	15	3.7	12.0	10	
1830	15	3.4[a]	12.3	92*	[a] Dropped to zero at 1819 and 1828
					* spike at 1819 and off scale at 1828
1845	15	5.0	11.4	10	
1900	15	5.5	10.9	10	
1915	15	5.8	11.1	10	
1930	15	5.3	10.3	10	
1945	15	5.3[b]	10.7	69**	[b] Dropped to zero at 1931
					** spike at 1931 and off scale at 1945
2000	15	5.5	10.9	10	
2015	15	5.3	11.4	10	
2030	15	5.5[c]	10.9	45***	[c] Dropped to zero ar 202B
					*** spike at 2028 and off scale at 2028
		5.1	11.0	22.6	

TABLE 2-23. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM II
TEST NUMBER 5

Time Period (24h)	Net time, (minutes)	Average concentration			Comments
		O_2, %	CO_2%	CO, ppm	
0945	15	6.3	9.9	10	
1000	15	5.4[a]	10.4	12.4*	[a] Dropped to 22
					* Spike at 0946
1015	15	5.2	11.0	10	
1030	15	4.9	11.5	10	
1045	15	5.2	11.3	10	
1100	15	5.7	10.6	10	
1115	15	5.4	11.5	10	
1130	15	5.4[b]	10.2	26**	[b] Dropped to 15
					** Spike at 1129
1145	15	5.7	10.6	10	
1200	15	6.3	10.6	10	
1215	15	5.4[c]	10.4	45***	c Dropped to zero
					*** Spike at 1208
1230	15	5.6	11.0	10	
1245	15	5.7	11.0	10	
1300	15	5.4[d]	11.1	45****	[d] Dropped to zero
					**** Spike at 1250
1315	15	5.7	10.8	10	
		5.6	10.8	15.9	

TABLE 2-24. SUMMARY OF CONTINUOUS EMISSION MONITOR DATA
SARM II
TEST NUMBER 6

Time Period (24h)	Net time, (minutes)	Average concentration			Comments
		O_2, %	CO_2%	CO, ppm	
1415	15	5.4	11.1	10	
1430	15	5.4	11.3	10	
1445	15	5.7	10.6	10	
1500	15	5.2	11.5	10	
1515	15	5.2	11.5	10	
1530	15	5.2	11.5	10	
1545	15	5.4	10.8	10	
1600	15	5.6	10.8	10	
1615	15	5.7	11.1	10	
1630	15	5.4	11.3	10	
1645	15	5.4	11.0	10	
1700	15	5.3	10.8	10	
1715	15	4.9	11.0	10	
		5.4	11.1	10.9	

TABLE 2-25. DIOXIN/FURAN RESULTS NG/G FEED

Analyte	Reagent blank A710018-Blank 37031	ZSARM 1-2-F A710003-07-A 37034	ZSARM-II-5-F A710003-08-A 37035
Total TCDD	<0.2	<0.6	<0.6
Total TCDF	<0.2	<0.5	<0.5
Total PCDD	<0.2	<0.4	<0.5
Total PCDF	<0.2	<0.4	<0.4
Total HxCDD	<0.5	<1.0	<1.1
Total HxCDF	<0.4	<0.9	<0.8
Total HpCDD	<0.6	<0.6	<0.6
Total HpCDF	<0.4	<0.8	<1.1
Total OCDD	<1.6	<1.6	<2.2
Total OCDF	<0.7	<1.6	<1.7

NOTE: All Surrogate recoveries are within method prescribed limits. Each value listed represents the method detection limit (MDL) for that particular dioxin and sample. All values are less than the MDL.

TABLE 2-26. DIOXIN/FURAN RESULTS NG/G ASH

Analyte	Reagent blank A710003-Blank 37022	ZSARM 1-2-A A710003-04-A 37020	ZSARM-II-5-A A710003-05-A 37021
Total TCDD	<0.2	<0.2	<0.2
Total TCDF	<0.1	<0.1	<0.1
Total PCDD	<0.2	<0.2	<0.2
Total PCDF	<0.2	<0.1	<0.1
Total HxCDD	<0.4	<0.3	<0.3
Total HxCDF	<0.3	<0.2	<0.2
Total HpCDD	<0.5	<0.4	<0.4
Total HpCDF	<0.3	<0.3	<0.3
Total OCDD	<0.6	<0.5	<0.6
Total OCDF	<0.5	<0.4	<0.5

NOTE: All Surrogate recoveries are within method prescribed limits. Each value listed represents the method detection limit (MDL) for that particular dioxin and sample. All values are less than the MDL.

TABLE 2-27. DIOXIN/FURAN SCRUBBER RESULTS
(ng/liter)

Analyte	Reagent blank A710003-Blank 37017	ZSARM 1-2-S A710003-01A 37018	ZSARM-II-5-S A710003-02-A 37019
Total TCDD	<2	<2	<1
Total TCDF	<1	<1	<1
Total PCDD	<2	<2	<1
Total PCDF	<1	<1	<1
Total HxCLD	<3	<3	<3
Total HxCDF	<2	<2	<2
Total HpCDD	<4	<4	<4
Total HpCDF	<2	<2	<2
13C-OCDD	<5	<4	<4
13C-OCDF	<4	<4	<4

NOTE: All Surrogate recoveries are within method prescribed limits. Each value listed represents the method detection limit (MDL) for that particular dioxin and sample. All values are less than the MDL.

SECTION 3

DESCRIPTION OF INCINERATOR AND PROCESS OPERATION

3.1 INCINERATOR DESCRIPTION

The John Zink Co. incineration test facility, which was used for this test series, is located in Tulsa, Oklahoma. The test facility is composed of several modular components which can be assembled in a variety of configurations. Although the test facility is outdoors, it operates during wet or dry weather. Minimum system input is 2×10^6 Btu/h, maximum is 3×10^6 Btu/h.

The rotary kiln system configuration which was used for this test is shown in Figure 3-1. It consisted of a rotary kiln fitted with an auxiliary natural gas fuel burner, screw conveyor for feeding solids, and a continuous ash removal system; the kiln was followed by a secondary combustion chamber fitted with a natural gas burner, a cyclone separator for large solids, a quench section, an adjustable venturi scrubber, and an induced-draft blower. For this test, the rotary kiln was positioned for co-current operation, i.e., solids/ash travel in the same direction as the gas. In addition to this equipment, a tertiary afterburner, required by the Oklahoma State Department of Health for final thermal treatment of the combustion system's flue gas, followed the air pollution control equipment. All source testing, process monitoring, and sampling for the BDAT program were conducted upstream of this tertiary unit.

The sample ports used for stack testing purposes were located in the flue between the venturi scrubber and the afterburner (Sample Ports B of Figure 3-1). The ports were 4 inches in diameter, located on a vertical, 12-inch I.D. flue about 15 feet above ground; John Zink Co. supplied scaffolding for the equipment used to conduct stack tests at this location. A

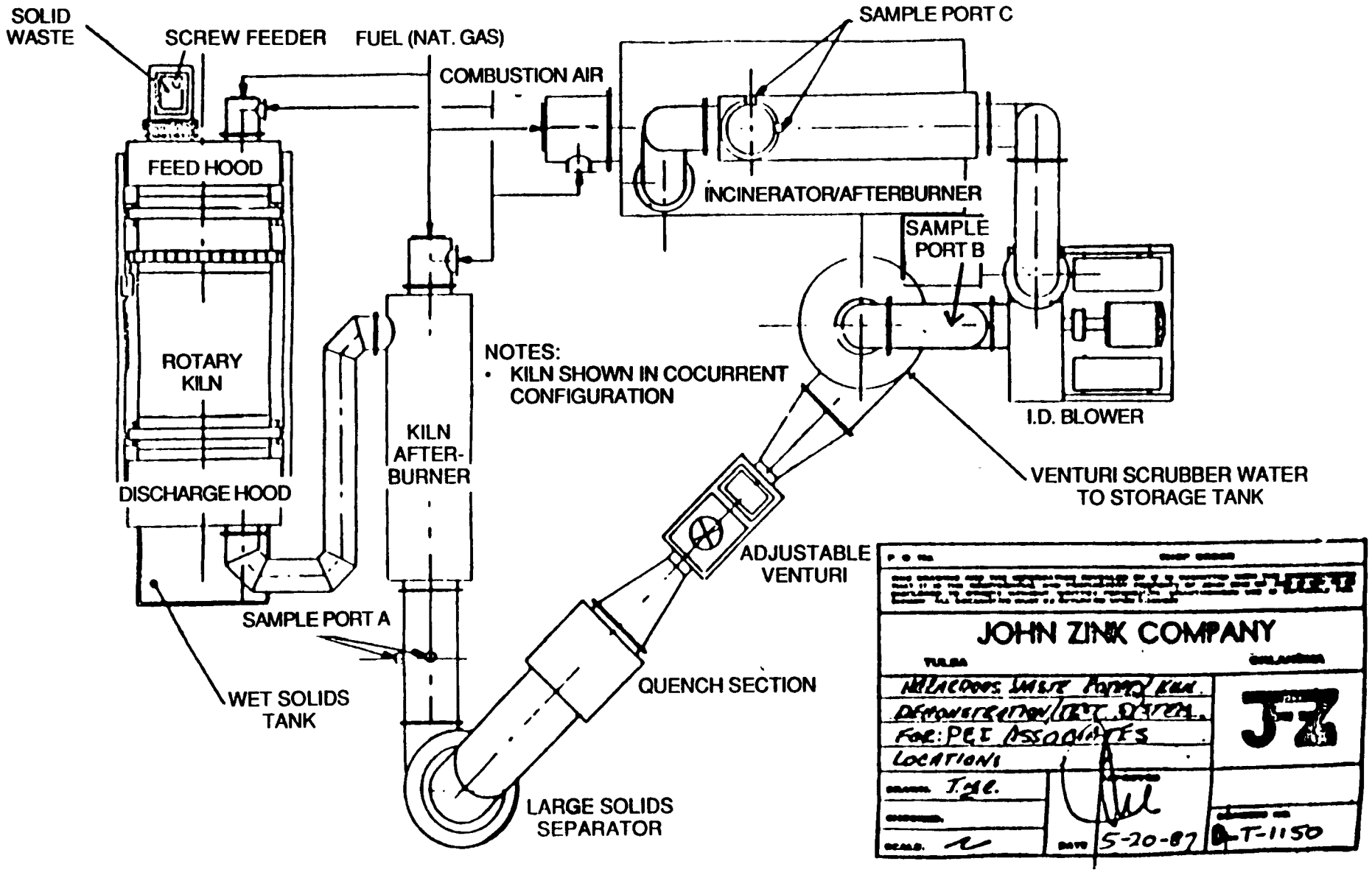


Figure 3-1. Rotary kiln incinerator configuration for solids.

conference room, indoor storage/work area, lab space, ice machines, and electricity located at the test site were available throughout the test. The 55-gallon drums of SARM were staged for feeding from the hazardous waste storage pad located adjacent to the test equipment. Drums were transported to the feed screw conveyor using a hydraulic drum lifter; once the drums had been emptied of feed material they were used to contain the ash which was ultimately sent for disposal to U.S. Pollution Control, Inc.'s Lone Mountain RCRA landfill in Oklahoma.

John Zink provided standard system performance monitoring consisting of continuous monitoring of temperature, gas flow, and O_2 through the kiln and secondary chamber, plus continuous monitoring of CO, CO_2, and NO_X in stack gases exiting the afterburner. PEI collected process samples of feed, ash, and scrubber wastes throughout the testing for subsequent analysis, as well as stack gas emission samples for volatiles (VOST), semivolatiles (MM5), metals (EPA Method 12), HCl (EPA Method 5), particulate (EPA Method 5), CO, CO_2, and O_2 throughout each test burn.

SECTION 4

SAMPLE LOCATIONS AND TEST METHODS USED

4.1 SAMPLING LOCATIONS AND EQUIPMENT OPERATION SPECIFICATIONS

Figures 4-1 and 4-2 show the rotary kiln system configuration and associated sampling and monitoring points for the SARM test burns. Three test runs were performed on each SARM.

4.2 PROCESS SAMPLING PROCEDURES (WASTE FEED, ASH, AND SCRUBBER WATER)

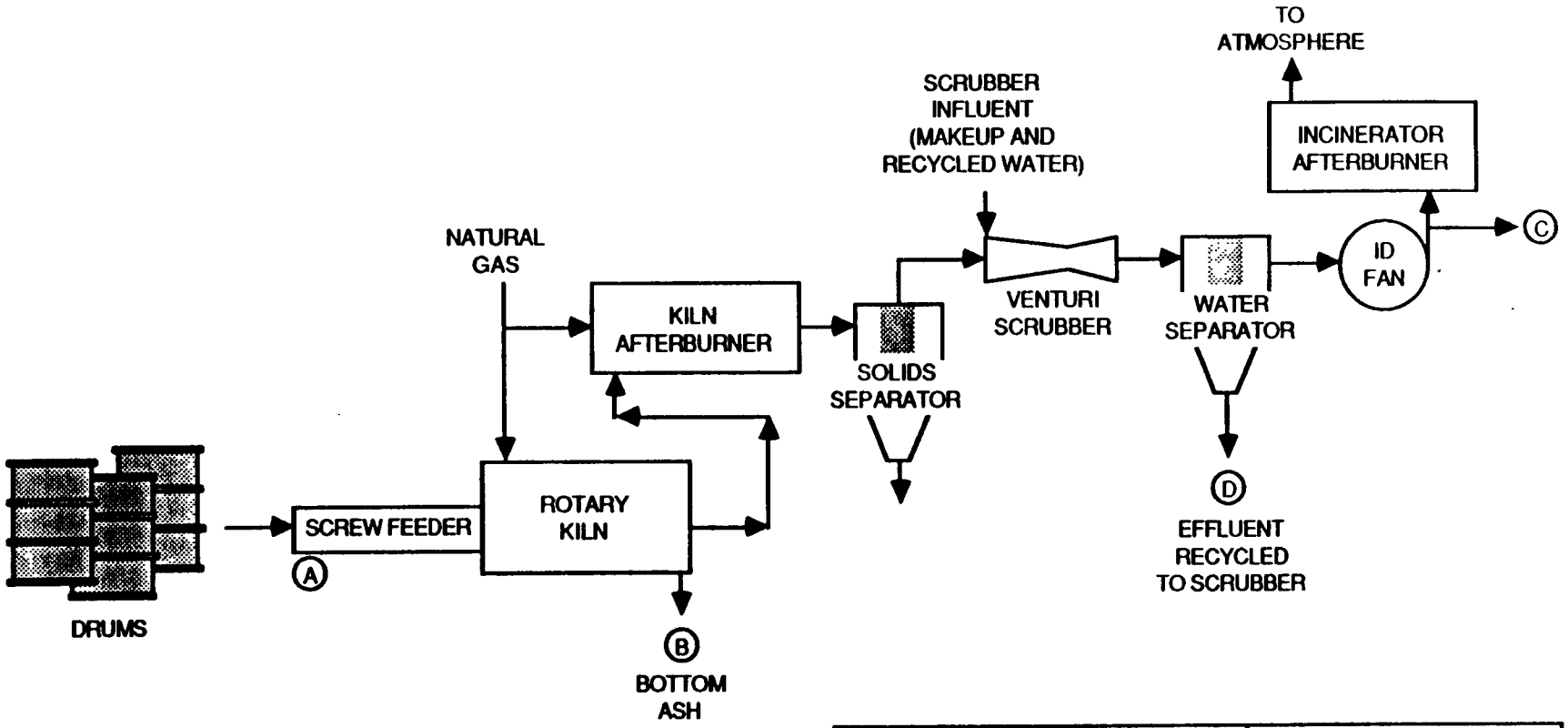
Table 4-1 presents the sampling plan and methodology followed for collecting the feed, ash, and scrubber water samples. Basic sample collection procedures followed were those described in Sampling and Analysis Methods for Hazardous Waste Combustion, Arthur D. Little, Inc. EPA-600/8-84-002, February 1984. This reference was added as a revision to the 2nd Edition of SW-846.

4.2.1 Waste Feed Sampling

Feed samples were collected from the screw feed hopper at the beginning, middle, and end of each run and composited into a 5-gallon metal container which was covered between sampling events. Samples were collected using metal scoops which were wiped clean between samples. Grab samples for volatiles were collected at the same time and placed in appropriate containers immediately. The composite was mixed using the scoop, and aliquots were placed in appropriate sample containers (see Table 4-1) for analysis. Samples were labeled and placed in coolers with vermiculite and ice for shipment to the laboratory for analysis.

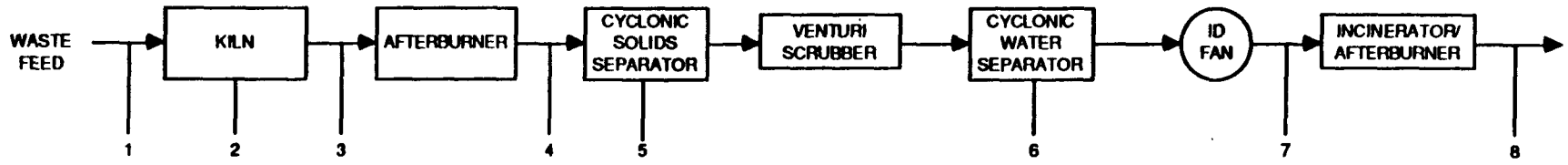
4.2.2 Bottom Ash Samples

One composite sample of bottom ash was collected during each SARM test run. The ash was sampled at the beginning, middle, and end of each run directly from the rotary kiln (prior to the quench), placed in a 5-gallon



SAMPLE ID	SITE DESCRIPTION	SAMPLE DESCRIPTION
A	Drums	Waste Feed
B	Ash Bin	Bottom Ash
C	Sample Ports	Stack Gas
D	Water Separator	Scrubber Effluent

Figure 4-1. The John Zink Company rotary kiln incineration system and feed and residuals sampling sites for SARM I and II.



SAMPLING POINT	PARAMETER											
	WASTE FEEDRATE	WASTE FEED	FUEL FEEDRATE	AIR FEEDRATE	ASH	SCRUBBER WATER	CONTINUOUS MONITORS CO_2, O_2, CO, T	VOLUME FLOW	VOST, MM5 (VOLATILES, SEMIVOLATILES AND METALS)	M5 (PARTICULATE AND HCl)	T	P
1	X	X	X	X								
2					X							
3			X	X							X	
4											X	
5					X							
6						X						
7							X	X	X	X	X	X
8[a]							X				X	

T: Temperature
P: Pressure
[a]: Monitoring by John Zink for state permit requirements.

Figure 4-2. Operating parameters monitored by John Zink/PEI during SARM test burns.

TABLE 4-1. PROCESS SAMPLING LOCATIONS, EQUIPMENT, AND METHODS

Sampling stream identification	Access	Analytical parameter	Sampling container	General procedure/frequency	Reference methods	Sampling responsibility
Solid feed	Hopper (screw feed)	Semivolatiles Volatiles Metals TCLP	8-oz glass bottles 40-ml VOA vial (Teflon septum lid) 4-oz plastic jar ½-gal glass bottles	Subsamples collected at beginning, middle, and end of each 4-h test period; composited into one sample with aliquots taken for each analytical parameter (volatile samples were not composited)	S007 P003	PEI
Ash	Hopper	Semivolatiles Volatiles Metals TCLP	8-oz glass bottles 40-ml VOA vial 4-oz plastic jar ½-gal glass bottles	Subsamples collected at beginning, middle, and end of each 4-h test period; composited into one sample with aliquots taken for each analytical parameter (volatile samples were not composited)	S007 P003	PEI
Scrubber water	Tap	Semivolatiles Volatiles Metals	1-gal glass bottle 40-ml VOA vial 1-liter plastic bottle	Subsamples collected at beginning, middle, and end of each 4-h test period; composited into one sample with aliquots taken for each analytical parameter (volatile samples were not composited)	S004 P001	PEI

metal container, mixed, and allowed to cool briefly before it was placed in the final sample containers for shipment to the laboratory.

4.2.3 Scrubber Water Samples

Prior to the start of testing, one sample of influent scrubber water was taken for analysis to determine background levels. Following one composite scrubber sample was collected for semivolatiles and metals and three discrete samples were collected for volatiles during each test run. Aliquots were collected at the beginning, middle, and end of each run from a tap in the scrubber recycle system. The aliquots taken for semivolatiles and metals were composited in a 1-gallon glass container which was covered between sampling events; aliquots of the composite were subsequently placed in appropriate containers for analysis, as outlined in Table 4-1. Samples taken for volatiles were placed in 40-ml VOA vials with septum lids, with care taken to eliminate all headspace in the vials. Samples were then labeled and placed in coolers packed with vermiculite and ice for shipment for analysis.

4.3 STACK GAS SAMPLING PROCEDURES

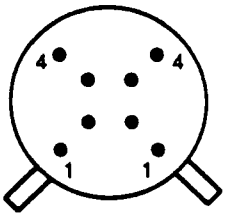
This section discusses the specific sampling procedures used for the stack gas monitoring portion of this test program.

4.3.1 Sample Location

All emission sampling was conducted after the venturi scrubber control system immediately after the ID blower and prior to the tertiary fume incinerator, as shown in Figure 4-1. Figure 4-3 depicts in more detail the actual sample location and ports used to extract air emission samples. Two sample ports, 90 degrees off-center, were located more than 8 duct diameters downstream and upstream from the nearest flow disturbance in the 12-inch I.D. round duct. Eight sample points, four per port, were used to traverse the cross-sectional area of the duct for the particulate/HCL/semivolatile and metals sample runs. Two additional sample ports located a few feet downstream from the particulate ports (See Figure 4-3) were used for the VOST and CEM sample probes.

TRAVERSE POINT NO.	DISTANCE FROM OUTSIDE OF NIPPLE, in.
1	8 1/2
2	10 1/2
3	16 1/2
4	18 1/4

CROSS SECTION



12 in. i.d.
7 1/2 in. NIPPLE LENGTH

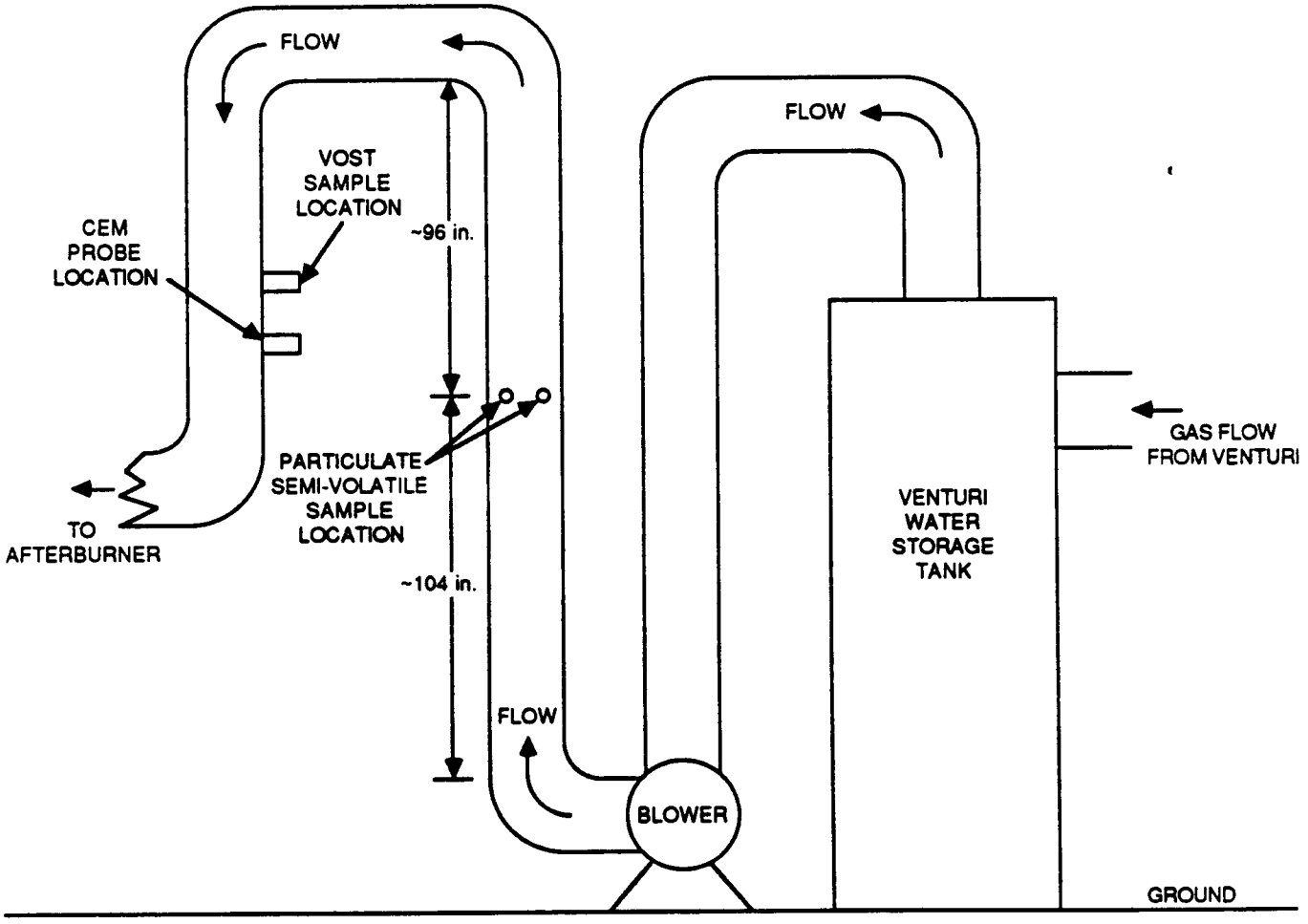


Figure 4-3. Stack gas sample location.

4.3.2 Sample Procedures

Both high- and low-level contaminated soils were incinerated during this test program. The same basic emission sampling and analytical methodology was applied for both waste types as outline in Table 4-2.

A modified Method 5 (MM5) sampling train (EPA-600/8-84-002, Method S008) was used to measure semivolatile POHCs [anthracene, pentachlorophenol, bis(2-ethylhexyl)phthalate], particulate, and HCl emissions. Triplicate, integrated 3-hour sample runs were conducted by traversing the cross-sectional area of the stack. Samples were collected isokinetically according to the procedures of EPA Method 5 (40 CFR 60, Appendix A). Gas stream flow rate, temperature, and moisture content were measured in conjunction with the MM5 sampling.

The MM5 sampling train consisted of a stainless steel nozzle, a heated glass-line probe, a heated glass-fiber particulate filter, a water-cooled condenser, an XAD-2 sorbent trap, and a series of impingers. The filter and a methylene chloride rinse of the nozzle, probe, and connecting glassware were recovered and analyzed for particulate content according to EPA Method 5 procedures. The XAD-2 sorbent trap and a methylene chloride rinse of the connecting glassware between the filter and the sorbent trap was recovered and analyzed for the designated POHCs. The recovered filter and the residue from the probe rinse were analyzed for POHCs after completion of the particulate analysis.

Initially, the first impinger in the train was empty, and condensate collected was recovered for POHC analysis by rinsing the impinger with methylene chloride. The second and third impingers each contained 100 ml of 0.1 NaOH solution; both were recovered and analyzed for HCl content. The fourth impinger contained approximately 400 g of silica gel for moisture removal.

Volatile organic emissions (ethylbenzene, xylene, 1,2-dichloroethane, tetrachloroethylene, acetone, chlorobenzene, and styrene) were measured according to the Volatile Organic Sampling Train (VOST) protocol (EPA-600/8-84-007) with improvements that were developed through a recent field validation study.* The sampling train consisted of a heated glass probe, a pair of

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* Validation of the Volatile Organic Sampling Train (VOST) Protocol, Field Validation Phase. EPA 600/S4-80-014, April 1986.

TABLE 4-2. EMISSION SAMPLE LOCATION, EQUIPMENT, AND METHODS

Sampling stream identification	Access	Analytical parameter	Sampling equipment	General procedure/frequency	Reference methods
Stack gas (after scrubber and prior to fume incinerator)	Ports	Semivolatiles	Modified Method 5 train	Triplicate integrated 3-h sample run	S008 EPA 5
		Particulate			
		HCl			
		Volatiles	VOST	Triplicate single-point sample pairs - 40 minutes per pair	S012 VOST protocol
		Metals	EPA 12 sample train	Triplicate integrated 2-h sample run	EPA 12
		Carbon monoxide (CO)	NDIR-continuous monitor	Continuous for each test run	EPA 10
		Oxygen (O_2)/ carbon dioxide (CO_2)	Continuous emission monitors	Continuous for each test run	EPA 3A

water-cooled condensers, and a pair of sorbent traps in series. The first sorbent trap contained approximately 1.6 g of Tenax GC; the second contained approximately 1 g of Tenax GC and 1 g of activated charcoal. Each sample was collected at a constant rate of 0.5 liter per minute over a 40-minute period. Three 40-minute samples were collected during each 3-hour test run. Condensate collected in the sampling train was recovered after each 3-hour test run and analyzed for volatile POHC content.

Metals were collected using an EPA Method 12 sample train. This train consisted of a heated glass-line probe, a heated filter, and a series of impingers containing 0.1 N HNO_3 (nitric acid). Samples were collected isokinetically by traversing the cross-section area of the stack. Probe rinse, filter, and impinger solution fractions were combined and digested into a single sample and analyzed for the following metals: lead, zinc, cadmium, arsenic, copper, nickel, and chromium. This sample train was run concurrent with the MM5 sample train with a total test time of 2 hours for each run.

Carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) concentrations measured continuously throughout the test periods by continuous emission monitors (CEM's). A sample tap downstream from the MM5 sample location was used to locate the CEM sample probe. The sampling was performed according to EPA Method 10 for CO, and EPA Method 3A for CO_2 and O_2.

Appendix D contains more detailed descriptions of the sampling and analytical procedures used for collecting the stack gas samples.

SECTION 5

QUALITY ASSURANCE PROCEDURES AND RESULTS

The procedures described in the Quality Assurance Project Plan were followed for all field sampling and analyses. The following sections describe the quality assurance procedures and the results obtained.

5.1 FIELD SAMPLING QUALITY ASSURANCE

Routine reference method quality control procedures were followed throughout the test program These included, but were not limited to, the following:

- Calibration of field sampling equipment. Sampling equipment was calibrated according to the procedures of the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III," EPA 600/4-72-027B, August 1977. The calibration data are summarized in Table 5-1. Calibration guidelines are described in more detail in Appendix E.

- Onsite audits of dry gas meters, thermocouples, and digital indicators (See Appendix B).

- Train configuration and calculation checks.

- Onsite quality control checks of the sampling train and leak checks of the pitot tube and Orsat line.

- Use of designated equipment and reagents.

The sampling equipment and procedures met all the guidelines established in the reference methods to achieve accurate test results.

5.2 CONTINUOUS EMISSION MONITORS

The following quality assurance procedures pertain to the use of the carbon dioxide, oxygen, and carbon monoxide continuous emission monitors:

- Use of designated sampling equipment and procedures. The CEM's met all performance requirements of EPA Methods 3A and 10. All components in the sampling system were either 316 stainless steel (probes) or Teflon (sampling line and pump diaphragms).

TABLE 5-1. FIELD EQUIPMENT CALIBRATION DATA

Equipment	ID No.	Calibrated against	Allowable error	Actual error	Within allowable limits	Comments
Meter box	FT-3	Wet test meter	Y ±0.02Y ΔH @ ±0.15 (Y ± 0.05Y post-test)	0.007 0.13 0.008	X X X	
		Critical orifice	Y ±0.05Y ΔH @ ±0.15	0.008 -0.04	X X	Checked on si prior to test
	FB-3			0.001 0.0 0.027 0.014 0.03	X X X X X	Checked on si prior to test
Pitot tube	504 376	Geometric specifications	a		X X X X	Visually insp ted on site
Digital indicator	FT-3	Millivolt signals	±0.5%	0.0-0.18%	X	Check on sit prior to te calibration ranges
Stack thermocouple	409 103	ASTM-3F	±2°F	+1°F +1°F	X X	
VOST Meter console	VB-4	Bubble Meter	Y ± 0.05Y post-test	-0.034	X	
Impinger thermocouple	I-13 I-14	ASTM-3F	±2°F	0.0°F 0.0°F	X X	
Balance	Mettler	Type S weights	±0.5g	0.0 g	X	
Barometer	No. 408	NBS-traceable	±0.10 in.Hg	0.01 in.Hg	X	
Dry gas thermo-	FT-3 FB-3	ASTM-3F	±5°F	+1°F +0°F +1°F +2°F	X X X X	Inlet Outlet Inlet Outlet
	VB-4	ASTM-3F	±5°F	+3°F	X	Inlet

[a]See Appendix E.

- System leak checks and integrity checks. Prior to the start of the first test, the entire sampling system from the probe to the analyzer inlet was leak-checked by plugging the probe inlet and evacuating the system to 15 in. Hg. The vacuum was observed for 5 minutes to ensure that the system was leak-free.

  System integrity and bias were measured by injecting calibration gases through a three-way valve at the probe outlet and comparing the response obtained to the response obtained when the gas was introduced directly to the analyzer. System integrity test results are listed on the data sheets in Appendix B. System bias was in all cases less than 2 percent of scale.

- Pre- and post-test calibrations. At the beginning and end of each test, each analyzer was calibrated with three standards in the analytical range and zero nitrogen. The calibration data were reduced by linear regression analysis and the linear equations were used for data reduction. Calibration data are summarized in Tables 5-2, 5-3, and 5-4.

Pre-test calibration data was used to calculate gaseous concentrations from all test blocks. In most cases, post-test calibrations drifted by less than 2 percent from pre-test values.

5.3 LABORATORY QUALITY ASSURANCE

The laboratory quality assurance procedures outlined in the Quality Assurance Plan were followed for each type of analysis. Quality assurance measures included replicate analyses, analyses of spiked samples, reagent and field sampling train blanks, and reference standards (where applicable). All analyses for the process and stack gas samples were conducted by Radian Corporation following procedures describe in the appropriate analytical methods as described in the QAPP for this project. The following sections describe the results of these measures by analysis type. The laboratory report for this project is contained in Appendix C.

5.3.1 Volatile Organics

Process samples analyzed for volatile organics included waste feed, scrubber water, and ash. Quality assurance included matrix spikes and matrix spike duplicates for each , as required by Method 8240. The laboratory reports in Appendix C indicate that data were acceptable based on EPA contract limits and the specifications of Method 8240. One value reported as ND (non-detectable) for tetrachloroethylene in the SARM I waste feed of Run 1 was

TABLE 5-2. CO ANALYZER CALIBRATION DATA

Test No.	Standard concentration, pmm	Analyzer response, % of scale		Drift, % of span	Linear regression equation	Correlation coefficient
		Pretest	Post-test			
SAI-CO-1	0	0.3	0.2	-0.1	$CO\ ppm = \frac{CD-.4748}{.2114}$	0.9999
	22	5.0	4.8	-0.2		
SAI-CO-2	250	54.0	54.0	0.0		
	453.1	95.9	94.5	-1.4		
SAI-CO-3	0	0	0	0	$Copper = \frac{CD - .1852}{.2163}$	0.9999
	22	4.8	4.5	-0.3		
SAII-CO-1	250	55.0	54.2	-0.8		
	453.1	97.8	97.0	-0.8		
SAII-CO-2	0	0	0	0	$Copper = \frac{CD - .1852}{.2176}$	0.9999
	22	4.9	4.2	-0.7		
SAII-CO-3	250	55.8	54.2	-1.6		
	453.1	98.3	96.3	-2.0		

TABLE 5-3. CO_2 ANALYZER CALIBRATION DATA

Test No.	Standard concen-tration, %	Analyzer response, % of scale		Drift, % of span	Linear regression equation	Correlation coefficient
		Pretest	Post-test			
SAI-CO_2-1	0	4.0	4.0	0.0	$CO_2\% = \frac{CD - 3.9906}{5.254}$	0.9996
	+.01	26.0	26.0	0.0		
SAI-CO_2-2	7.98	44.5	45.0	+0.5		
	16.09	89.0	92.5	+3.5		
SAI-CO_2-3	0	3.2	5.0	+1.8	$CO_2\% = \frac{CD - 3.375}{5.4843}$	0.9996
	4.01	26.5	28.2	+1.7		
SAII-CO_2-1	7.98	45.8	48.0	+2.2		
	16.09	92.0	95.0	+3.0		
SAII-CO_2-2	0	4.2	4.3	+0.1	$CO_2\% = \frac{CD - 4.2157}{5.5498}$	0.9996
	4.01	27.5	27.5	0.0		
SAII-CO_2-3	7.98	47.0	46.5	-0.5		
	16.09	94.0	92.0	-2.0		

TABLE 5-4. O_2 ANALYZER CALIBRATION DATA

Test No.	Standard concentration, %	Analyzer response, % of scale		Drift, % of span	Linear regression equation	Correlation coefficient
		Pretest	Post-test			
SAI-O_2-1	0	11.5	11.0	-0.5	$O_2\% = \frac{CD - 12.575}{3.694}$	0.9590
	4.09	28.6	27.3	-1.3		
SAI-O_2-2	8.08	43.3	41.0	-2.3		
	15.09	67.6	63.3	-4.3		
SAI-O_2-3	0	11.2	11.2	0.0	$O_2\% = \frac{CD - 12.181}{3.7592}$	0.9992
	4.09	28.3	26.8	-1.5		
SAII-O_2-1	8.08	43.5	40.4	-3.1		
	15.09	68.2	64.0	-4.2		
SAII-O_2-2	0	11	11	0.0	$O_2\% = \frac{CD - 12.3408}{3.6184}$	0.9980
	4.08	28.2	28.2	0.0		
SAII-O_2-3	8.08	42.8	42.8	0.0		
	15.09	66.0	67.8	+1.8		

rejected as a reporting error--the value is apparently confused with that reported for trichloroethylene. Tables 5-5 through 5-8 summarize the volatile surrogate recoveries and matrix spike data (including duplicates) for the process samples.

For stack samples analyzed by the VOST procedure, quality assurance included field, laboratory, and trip blank analyses, surrogate spikes, and daily and weekly instrument calibration per the VOST protocol. Table 5-9 summarizes the surrogate recovery data and Tables 5-10 and 5-11 summarize the system blank and other pertinent field and laboratory blank check data. The method blanks show surrogate recoveries ranging from 45 percent for bromofluorobenzene to 108 percent for d8-toluene. Field blanks show a range of 81 percent for d8-toluene to 206 percent for bromofluorobenzene. Most of these recoveries are within the acceptable ranges stated in Method 8240. Actual sample surrogate recoveries showed exaggerated ranges in some cases. The presence of large quantities of water on the sampling tubes may therefore be inferred, indicating a matrix effect on these samples. The field blank data show non-detectable levels of volatile analytes.

5.3.2 Semi-Volatile Organics

Analyses for semi-volatiles organics were conducted by Method 8270. Process sample quality assurance included surrogate and matrix spike recoveries and replicate analyses on specific samples. Tables 5-12 through 5-17 summarize these data. For stack samples analyzed by Method 8270, quality assurance included blank train and reagent blank analysis as well as surrogate spike recoveries for each sample. Tables 5-16 and 5-17 summarize these data. Note that a blank train value of 45 μg of bis(2-ethyhexyl) phthalate was recorded (Table 5-17), thus each emission sample was corrected for this value.

5.3.3 Metals

Quality assurance for metals included matrix spike recoveries and duplicates for the process and stack samples as well as Method 12 blank data. Tables 5-18 through 5-22 summarize these data.

5.3.4 Particulate and HCl

One filter and one sample of methylene chloride probe rinse were submitted for particulate analysis as blanks. The filter blank yielded a total particulate value of 0.1 mg. The blank level for the methylene chloride was

TABLE 5-5. VOLATILE ORGANIC SURROGATE RECOVERIES FOR PROCESS SAMPLES

Feed Extract	SARM I			SARM II			SARM I 1 matrix	SARM II 1 matrix
Surrogates	1	2	3	1	2	3	spike	spike duplicate
d4-1,2 Dichloro-ethane	106	96	110	97	95	106	107	108
d8-Toluene	103	96	101	96	96	102	102	103
Bromoflurobenzene	106	103	103	102	100	104	106	104
Bottom Ash								
d4-1,2 Dichloro-ethane	91	95	90	101	122	121	111	106
d8-Toluene	101	105	105	108	101	102	105	103
Bromofluorobenzene	99	100	89	100	96	100	102	100
Scrubber Water								
d4-1,2 Dichloro-ethane	108	100	94	103	92	96	109	113
d8-Toluene	105	96	103	98	98	94	97	94
Bromofluorobenzene	105	106	107	108	106	107	104	102

TABLE 5-6. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION) FOR FEED EXTRACT

Matrix Spike = 100 (μg/kg)	Determined Concentration (μg/kg) ZSARM-I-1-F 0906102B	ZSARM-I-1-F MS 0906102C	ZSARM-I-1-F MSD 0906102D	Spike recovery	Spike recovery duplicate	Relative percent difference
Acetone	220	330	340	110	120	9
1,2-Dichloroethane	30	160	170	130	140	7
Tetrachloroethane	36	140	140	104	104	0
Chlorobenzene	22	130	140	108	118	9
Ethlybenzene	240	390	400	150	160	6
Styrene	50	160	170	110	120	9
Total xylenes	380	540	550	160	170	6

ND = Not detected.

TABLE 5-7. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION) FOR BOTTOM ASH

Matrix Spike = 100 (µg/kg)	Determined Concentration (µg/kg) ZSARM-I-1-A 0906104B	ZSARM-I-1-A MS 0906104C	ZSARM-I-1-A MSD 0906104D	Spike recovery	Spike recovery duplicate	Relative percent difference
Acetone	440	1600	1100	1160	660	55
1,2-Dichloroethane	ND	160	130	160	130	21
Tetrachloroethane	ND	110	120	110	120	9
Chlorobenzene	ND	110	110	110	110	0
Ethlybenzene	ND	140	140	140	140	0

TABLE 5-8. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION FOR SCRUBBER WATER

Matrix Spike = 100 (µg/kg)	Determined Concentration (µg/kg) ZSARM-I-1-F 0906103B	ZSARM-I-1-F MS 0906103CR	ZSARM-I-1-F MSD 0906103D	Spike recovery	Spike recovery duplicate	Relative percent difference
Acetone	ND	50	54	50	54	8
1,2-Dichloroethane	ND	110	120	110	120	9
Tetrachloroethane	ND	85	96	85	96	12
Chlorobenzene	ND	92	100	92	100	8
Ethlybenzene	ND	85	98	85	98	14
Styrene	ND	85	96	85	96	14
Total xylenes	ND	49	56	49	56	13

ND = Not detected.

TABLE 5-9. VOST SURROGATE PERCENT RECOVERIES

Sample I.D.	p-Bromofluro-benzene	d4-1,2-Dichloro-ethane	d8-Toluene
SAI-V-1-A OWA870271	585	158	393
SAI-V-1-B OWA870272	258	112	155
SAI-V-I-C OWA870273	212	104	139
SAI-V-II-A OWA870274	223	93	139
SAI-V-II-B OWA870275	219	94	131
SAI-V-III-A OWA870299	257	101	141
SAI-V-III-B OWA870300	281	101	134
SAI-V-III-C OWA870301	279	141	103
SAII-V-I-A OWA870302	199	91	117
SAII-V-I-B OWA870303	220	108	110
SAII-V-I-C OWA870304	203	103	109
SAII-V-II-A OWA870316	245	84	171
SAII-V-II-B OWA870317	267	79	155
SAII-V-II-C OWA879318	197	85	157
SAII-V-III-A OWA870319	264	94	148

(continued)

TABLE 5-9 (continued)

Sample I.D.	p-Bromofluro-benzene	d4-1,2-Dichloro-ethane	d8-Toluene
SAII-V-III-B OWA870320	203	88	148
SAII-V-II-C OWA870321	260	89	158
SAI-V-I CONDENSATE OWA870276	220	92	127
SAI-V-II CONDENSATE OWA870277	207	88	124
SAI-V-III CONDENSATE OWA870305	211	102	94
SAII-V-1 CONDENSATE OWA870322	279	96	158
SAII-V-2 CONDENSATE OWA870323	292	97	166
SAII-V-III OWA870324	299	98	169
SAI-V-I-2 FIELD BLANK OWA870325	206	95	154
SAII-V-1 FIELD BLANK OWA870326	119	101	81
SAII-V-3 FIELD BLANK OWA870327	101	94	95
METHOD BLANK 1 OWA870270	45	105	69
METHOD BLANK 2 OWA870298	87	108	78

TABLE 5-10. SYSTEM BLANK DATA FOR VOST ANALYSES (NG)

Analytes	Estimated Limits of Detection	28A Method Blank # 1	29A Method Blank # 2
Acetone	5.0	ND	ND
1,2-Dichlorethane	1.0	ND	ND
Perchloroethylene	1.1	ND	ND
Chlorobenzene	0.7	ND	ND
Ethylbenzene	1.8	ND	ND
Styrene	1.6	ND	ND
Total Xylenes	3.8	ND	ND

ND = Not detected.

TABLE 5-11. SYSTEM BLANK DATA FOR VOST ANALYSES (NG)

Compound	Method Detection Limit	25 SAI-V-1-2 Field Blank	26 SAII-V-1 Field Blank	27 SAII-V-3 Field Blank
Acetone	5.0	ND	ND	ND
1,2-Dichlorethane	1.0	ND	ND	ND
Perchloroethylene	1.0	1	1	ND
Chlorobenzene	0.7	ND	ND	ND
Ethylbenzene	2.0	ND	ND	ND
Styrene	2.0	ND	ND	ND
Total Xylenes	4.0	a	ND	ND

a = Tube broken
ND = Not detected at specified Method Detection Limit.

TABLE 5-12. SEMIVOLATILES SURROGATE PERCENT RECOVERIES

Sample I.D.	2-Fluoro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl
Scrubber Water						
ZSARM-I-1-S F872139	75	84	72	98	114	101
ZSARM-I-2-S F872142	86	101	69	90	64	94
ZSARM-I-3-S F872143	86	96	94	95	97	109
ZSARM-II-4-S F872144	82	96	67	89	105	92
ZSARM-II-5-S F872145	64	78	91	87	87	95
ZSARM-11-6-S FB872146	48	61	92	87	77	90
ZSARM-I-1-S (MATRIX SPIKE) F872147	74	93	77	91	48	95
ZSARM-I-1-S (MATRIX SPIKE DUPLICATE) F872148	85	91	69	91	55	91
METHOD BLANK F872138	48	73	79	87	69	102
ZSARM-I-1-INF F872149	77	88	103	88	87	88
Bottom Ash						
ZSARM-I-1-A F872151	24	46	84	80	12	91
ZSARM-I-2-A F872154	9	39	65	77	13	89
ZSARM-I-3-A F872155	25	55	79	84	30	93

(continued)

TABLE 5-12 (continued)

Sample I.D.	2-Fluoro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl
Bottom Ash Cont.						
ZSARM-II-4-A F872156	2	10	82	86	ND	99
ZSARM-II-5-A F872157	4	13	64	75	ND	94
ZSARM-II-6-A F872158	15	40	79	79	ND	91
ZSARM-I-1-A (MATRIX SPIKE) F872159	5	38	69	73	ND	82
ZSARM-I-1-A (MATRIX SPIKE DUPLICATE) F872160	7	25	74	73	ND	85
METHOD BLANK FB872150	79	90	88	86	84	93
Feed Extract						
ZSARM-I-1-F F872167	91	96	93	115	24	107
ZSARM-I-2-F F872168	88	91	90	110	119	103
ZSARM-I-3-F F872169	89	94	93	118	122	107
ZSARM-II-4-F F872164	80	92	94	105	102	98
ZSARM-II-5-F F872165	85	91	90	112	112	101
ZSARM-II-6-F F872166	89	87	92	109	121	109
ZSARM-I-1-F (MATRIX SPIKE) FB872170	78	78	73	107	137	106

(continued)

TABLE 5-12 (continued)

Sample I.D.	2-Fluoro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl
Feed Extract cont.						
ZSARM-I-1-F (MATRIX SPIKE DUPLICATE) F872171	84	85	84	109	142	101
METHOD BLANK F872163	83	90	92	112	114	97

TABLE 5-13. SEMIVOLATILES MATRIX SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR FEED

Matrix Spike = 100 (µg/kg)	Determined Concentration (µg/kg)					
	ZSARM-I-1-F F872167	ZSARM-I-1-F MS F872170	ZSARM-I-1-F MSD F872171	Spike recovery	Spike recovery duplicate	Relative percent difference
Pentachlorophenol	ND	116	138	116	138	17
Anthracene	74	210	215	136	141	4
Bis(2-ethylhexyl)-phthalate	33	134	139	101	106	5

ND = Not detected.

TABLE 5-14. SEMIVOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR ASH

Matrix Spike = 100 (µg/kg)	Determined Concentration (µg/kg)					
	ZSARM-I-1-A F872151	ZSARM-I-1-A MS F872159	ZSARM-I-1-A MSD F872160	Spike recovery	Spike recovery duplicate	Relative percent difference
Pentachlorophenol	ND	ND	ND	0	0	0
Anthracene	ND	90	87	90	87	3
Bis(2-ethylhexyl)-phthalate	13	200	126	187	113	49

ND = Not detected.

TABLE 5-15. SEMIVOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR SCRUBBER WATER

Matrix Spike = 100 (µg/kg)	Determined Concentration (µg/kg)					
	ZSARM-I-1-F F872139	ZSARM-I-1-F MS F872149	ZSARM-I-1-F MSD F872148	Spike recovery	Spike recovery duplicate	Relative percent difference
Pentachlorophenol	8	74	80	66	72	9
Anthracene	ND	89	84	89	84	6
Bis(2-ethylhexyl)-phthalate	ND	123	118	123	118	4

ND = Not detected.

TABLE 5-16. SYSTEM BLANK DATA FOR SEMIVOLATILE ANALYSES
(TOTAL μg)

	Pentachlorophenol	Anthracene	Bis(2-ethylhexyl)-phthalate
Estimated Limits of Detection	5	0.4	0.7
METHOD BLANK F872138	7	ND	ND
METHOD BLANK F872150	ND	ND	13
METHOD BLANK F872163	ND	ND	ND
REAGENT BLANK MeC12 F872178	ND	ND	ND
REAGENT BLANK FILTER F872179	ND	ND	29
REAGENT BLANK XAD-2 F872182	ND	ND	43
FIELD TRAIN BLANK F872193	ND	ND	45
METHOD BLANK TRAIN F872185	ND	ND	40

ND = Not detected.

TABLE 5-17. SEMIVOLATILES SURROGATE PERCENT RECOVERIES

Sample I.D.	2-Fluro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl	d10-Antracene
SAI-SV-1 F872183	77	85	88	95	91	93	83
SAI-SV-2 F872186	62	54	66	97	101	88	44
SAI-SV-3 FB72187	68	57	68	97	104	99	55
SAII-SV-1 F872190	64	58	55	90	122	100	84
SAII-SV-2 F872191	65	64	63	93	111	91	79
SAII-SV-3 F872192	69	52	57	96	113	88	92

TABLE 5-18. PEI WASTE FEED SPIKE RECOVERIES

Analyte	Analysis Type	Method Detection Limit (μg/g)*	Sample used for Spikes P7-09-023-19 (μg/g)	Amount Spiked in (μg/g)	Matrix Spike P7-09-023-25a (μg/g)	Matrix Spike Recovery P7-09-023-25a (% recovery)	Matrix Spike Duplicate P7-08-023-26a (μg/g)	M S Duplicate Recovery P7-09-023-26a (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.040	16.9	20.0	28.8	78	30.3	82	5
Chromium	ICAP	0.300	24.2	100.0	115	93	121	97	5
Zinc	ICAP	0.120	451	800.0	1200	96	1280	102	6
Lead	ICAP	4.200	261	300.0	543	97	587	105	8
Cadmium	ICAP	0.120	26.3	100.0	118	93	121	96	3
Nickel	ICAP	0.300	27.5	100.0	117	92	120	94	3
Copper	ICAP	0.420	244	600.0	804	95	836	99	4

MDL = Method Detection Limit
* Assuming 5 g samples in 100 ml total volume.
(a) Relative Percent Difference = (MS - MSD)/(0.5* (MMS + MSD).

TABLE 5-19. PEI ASH SPIKE RECOVERIES

Analyte	Analysis Type	Method Detection Limit (µg/g)*	Sample used for Spikes P7-09-023-10a (µg/g)	Amount Spiked in (µg/g)	Matrix Spike P7-09-023-16a (µg/g)	Matrix Spike Recovery P7-09-023-16a (% recovery)	Matrix Spike Duplicate P7-08-023-17a (µg/g)	M S Duplicate Recovery P7-09-023-17a (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.040	37.7	20.0	55.9	97	61.5	107	10
Chromium	ICAP	0.300(a)	9.8	100.0	101	92	101	92	0
Zinc	ICAP	0.120	217	1000.0	1130	93	1170	96	3
Lead	ICAP	4.200	56.2	600.0	610	93	604	92	1
Cadmium	ICAP	0.120	<1.48	100.0	87.7	88	87.6	88	0
Nickel	ICAP	0.300	11.8	100.0	102	91	103	92	1
Copper	ICAP	0.420	111	500.0	604	99	585	96	3

MDL = Method Detection Limit
* Assuming 5 g samples in 100 ml total volume.
(a) Amount shown is a default value, but agrees with the amount found in the undiluted sample.
(b) Relative Percent Difference = (MS - MSD)/(0.5* (MMS + MSD).

TABLE 5-20. PEI SCRUBBER WATER SPIKE RECOVERIES

Analyte	Analysis Type	Method Detection Limit (μg/ml)*	Sample used for Spikes P7-09-023-01a (μg/ml)	Amount Spiked in (μg/ml)	Matrix Spike P7-09-023-07a (μg/ml)	Matrix Spike Recovery P7-09-023-07a (% recovery)	Matrix Spike Duplicate P7-08-023-08a (μg/ml)	MS Duplicate Recovery P7-09-023-08a (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.001	0.150	0.500	0.700	100	0.760	117	8
Chromium	ICAP	0.008	0.530	2.500	3.60	119	3.39	112	6
Zinc	ICAP	0.003	2.14	7.500	10.9	113	11.1	115	2
Lead	ICAP	0.105(a)	1.75	7.500	9.51	86	9.83	89	3
Cadmium	ICAP	0.003	2.35	15.000	19.3	111	18.6	107	4
Nickel	ICAP	0.015	0.320	2.500	2.96	105	2.93	104	1
Copper	ICAP	0.011(a)	0.595	3.750	4.32	87	4.26	86	2

MDL = Method Detection Limit
(a) Amount shown is a default value, but agrees with the amount found in the undiluted sample.
(b) Relative Percent Difference = (MS - MSD)/(0.5* (MMS + MSD).

TABLE 5-21. PEI METHOD SPIKE RECOVERIES METHOD 12 TRAIN SAMPLES

Analyte	Analysis Type	Method Detection Limit (µg)*	Amount Spiked in µg	Method Spike (total µg)	Method Spike Recovery (% recovery)	Method Spike Duplicate (total µg)	MS Duplicate Recovery (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.200	10.0	9.5	95	9.80	98	3
Chromium	ICAP	1.50	500.0	448	90	439	88	2
Zinc	ICAP	0.600	1000.0	868	87	857	86	1
Lead	ICAP	21.0	500.0	435	87	434	87	0
Cadmium	ICAP	0.600	500.0	441	88	435	87	2
Nickel	ICAP	1.50	500.0	441	88	434	87	2
Copper	ICAP	2.10	500.0	476	95	463	93	3

MDL = Method Detection Limit
* Assuming 100 ml total volume.
(a) Relative Percent Difference = (MS - MSD)/(0.5* (MMS + MSD).

TABLE 5-22. SUMMARY OF METHOD 12 BLANK ANALYSIS DATA

Analyte	Analysis type	Method detection limit	Sample 6750-A nitric blank P7-09-023-34a (total μg)	Sample 6750-B filter blank P7-09-023-35a (total μg)	Sample method blank P7-09-023-36a (total μg)
Arsenic	GF AAS	0.200	0.300	NA	<0.200
Chromium	ICAP	1.50	<1.50	NA	<1.50
Zinc	ICAP	0.600	5.50	NA	3.00
Lead	ICAP	21.0	<21.0	NA	<21.0
Cadmium	ICAP	0.600	<0.600	NA	<0.600
Nickel	ICAP	1.50	<1.50	NA	3.20
Copper	ICAP	2.10	<2.10	NA	<2.10

NA = Not available.

.003 mg/g. Total particulate catch ranged between 40 and 100 mg and no blank corrections were applied. For the HCl analysis, quality assurance included matrix spikes, duplicate analysis, and reagent blank analyses. Table 5-23 summarizes these data. Note that the 0.1 N NaOH blank analysis was inclusive because of nitric interference.

5.3.5 Dioxin/Furans

Quality assurance for analysis of dioxin included system performance and calibration checks, blank and duplicate matrix spike analyses. These data are summarized in Tables 5-24 through 5-26.

TABLE 5-23 CHLORIDE ANALYSIS QUALITY CONTROL RESULTS

Description	ppm	Comments
Reagent blank	-	Nitric interferences
Method blank #1	ND	
Method blank #2	ND	
Matrix spike	15.8	98.1% recovery
Matrix spike duplicate	15.1	93.8% recovery
Check sample #1 9.09 ppm	9.1	99.89% agreement
Check sample #2 9.09 ppm	9.0	99.01% agreement

TABLE 5-24. DIOXIN/FURAN RESULTS SCRUBBER SURROGATE RECOVERIES, %

Analyte	Reagent blank A710003-blank 37017	ZSARM 1-2-S A710003-01A 37018	ZSARM-II-5-S A710003-02A 37019
13C-2,3,7,8-TCDD	86	84	88
13C-2,3,7,8-TCDF	91	92	97
13C-1,2,3,7,8-PCDD	91	92	94
13C-1,2,3,7,8-PCDF	91	89	94
13C-1,2,3,6,7,8-HxCDD	89	87	72
13C-1,2,3,4,7,8-HxCDF	91	94	101

TABLE 5-25. DIOXIN/FURAN RESULTS FEED
SURROGATE RECOVERIES, %

Surrogate	Reagent blank A710018 37031	ZSARM 1-2-F A710003-07A 37034	ZSARM-II-5-F A710003-08A 37035
13C-2,3,7,8-TCDD	86	71	78
13C-2,3,7,8-TCDF	89	68	80
13C-1,2,3,7,8-PCDD	89	95	91
13C-1,2,3,7,8-PCDF	86	82	87
13C-1,2,3,6,7,8-HxCDD	80	77	76
13C-1,2,3,4,7,8-HxCDF	78	76	92

TABLE 5-26. DIOXIN/FURAN RESULTS ASH
SURROGATE RECOVERIES, %

Analyte	Reagent blank A710003-3540-BL 37022	ZSARM 1-2-A A710003-04A 37020	SARM-II-5-A A710003-05A 37021
13C-2,3,7,8-TCDD	83	86	86
13C-2,3,7,8-TCDF	89	94	98
13C-1,2,3,7,8-PCDD	92	94	93
13C-1,2,3,7,8-PCDF	89	93	91
13C-1,2,3,6,7,8-HxCDD	74	86	86
13C-1,2,3,4,7,8-HxCDF	88	96	94

APPENDIX A

COMPUTER PRINTOUTS AND EXAMPLE CALCULATIONS

°Particulate, HCl, Semivolatiles

NOMENCLATURE FOR SEMI-VOLATILE DESTRUCTION AND REMOVAL EFFICIENCY CALCULATIONS

DRE = POHC destruction and removal efficiency, %

FR = SARM I or II feed rate, lb/h

P_C = POHC concentration in MM5 sample, gr/dscf

PER = POHC emission rate, lb/h

PFR = POHC feed rate, lb/ h

PF = POHC concentration in SARM feed, wt. percent (lb/lb)

PM_s = POHC mass in MM5 sample, μg

Q_{sstd} = Stack volumetric flow rate, dscfm

SV = Sample volume, dscf

EXAMPLE CALCULATIONS

1) SARM Waste Feed Rate, (FR) lb/h

(as determined for each individual run - see Section 2)

2) POHC Feed Rate, (PFR), lb/h

$$PFR = PF \div FR$$

3) POHC Concentration in MM5 Sample (PC), gr/dscf

$$Pc = P_{m_s} (\mu g) \times \frac{10^{-6}\ g}{\mu g} \times \frac{15.43\ gr}{g} \div SV\ (dscf)$$

4) POHC Emission Rate (PER), lb/h

$$PER = P_c \frac{(gr)}{dscf} \times Q_{sstd} \times \frac{60\ min}{n} \times \frac{g}{15.43\ gr} \times \frac{lb}{453.6\ g}$$

5) POHC DRE

$$DRE = \frac{PFR\ (lb/h) - PER\ (lb/h)}{PFR\ (lb/h)} \times 100$$

SUMMARY OF SEMI-VOLATILE CONCENTRATION AND MASS RATE CALCULATIONS
SARM I

Test No.	1			2			3			Average	
Sample Volume (dscf)	141.243			107.367			123.672			----	
Volumetric Flow (dscfm)	1466			1342			1427			1412	
Analyte	Total µg	gr/ dscf	lb/h	Total µg	gr/ dscf	lb/h	Total µg	gr/ dscf	lb/h	gr/ dscf	lb/h
Anthracene	ND[a]	----	----	ND	----	----	ND	----	----	----	----
Pentachlorophenol	ND	----	----	ND	----	----	ND	----	----	----	----
Bis(2-ethylhexyl) phtlate	185	2×10^{-5}	2.5×10^{-4}	9	1.3×10^{-6}	1.5×10^{-5}	435	5.4×10^{-5}	6.6×10^{-4}	2.5×10^{-5}	3.0×10^{-4}

[a] None detected

Method Detection Limit (Total µg)

Antracene:	0.4-2.9 µg
Pentachlorophenol:	0.3 µg
Bis(2-ethylhexyl)-: phtlate	0.4 µg

SUMMARY OF SEMI-VOLATILE CONCENTRATION AND MASS RATE CALCULATIONS
SARM II

Test No.	1			2			3			Average	
Sample Volume (dscf)	117.072			121.379			113.876			----	
Volumetric Flow (dscfm)	1352			1456			1413			1407	
Analyte	Total µg	gr/ dscf	lb/h	Total µg	gr/ dscf	lb/h	Total µg	gr/ dscf	lb/h	gr/ dscf	lb/h
Anthracene	ND[a]	----	----	ND	----	----	ND	----	----	----	----
Pentachlorophenol	5	6.6×10^{-7}	7.6×10^{-6}	ND	----	----	ND	----	----	----	----
Bis(2-ethylhexyl) phtlate	14	1.8×10^{-6}	2.1×10^{-5}	655	8.3×10^{-5}	1.0×10^{-3}	38[b]	5.1×10^{-6}	6.2×10^{-5}	3.0×10^{-5}	3.6×10^{-4}

[a] None detected

[a] Below MDL (44.0 µg/sample).

F E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....[illegible] CO.
Sampling location .....QUENCH OUTLET
Test time (start-stop) 1020-1413

Date 9/16/87
Run number SAI-SV-1

Sample type .....PART./HCL SEMI-VOLS.
Bar. pressure (in-HG) 29.15
Static pressure (in-H2O) .....+3.6
Filter number(s) .....[illegible]
Stack inside dia. (in) 12
Pitot tube coeff. 84
Total H2O collected (ml) 2855.3
Percent O2 by volume (dry) ...5.4

Leakage (cu-ft) 0.0
Meter calibration factor 999
Data interval (min) 30
Nozzle dia. 309
Meter box number .....[illegible]
Number of traverse points 8
Percent CO2 by volume (dry) ..10.8
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	327.947					
30.0	357.380	1.500	2.93	179	82	91
60.0	382.050	1.100	2.16	181	89	84
90.0	408.887	1.400	2.48	181	91	90
120.0	433.531	1.100	2.20	180	101	94
135.0	447.000	1.000	2.05	180	110	109
150.0	458.400	0.900	1.83	181	105	105
165.0	470.200	0.950	1.50	180	105	100
180.0	480.128	1.000	1.30	180	102	97
180.0	152.181	1.110	2.06	180	98	95

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J. ZINK CO.
TEST: SAI-SV-1 / QUENCH OUTLET

TEST DATE: 9/16/87
TEST TIME: 1020-1413

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	8
Y	.....	Meter calibration factor	0.999
DN	.....	Sampling nozzle dia (in)	0.309
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	2.06
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	152.181
TM	.....	Average gas meter temperature (deg F)	96.6
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	141.243
VLC	.....	Total H2O collected in impingers and silica gel (ml)	2855.3
VWC	.....	Volume of water vapor at standard conditions (scf)	134.399
BWC	.....	Percent moisture by volume (saturation check made)	48.76
FMD	.....	Mole fraction of dry gas	0.51
PCO2	.....	Percent CO2 by volume (dry	10.800
PO2	.....	Percent O2 by volume (dry)	5.400
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	83.800
MD	.....	Molecular weight - dry stack gas	29.94

TEST RESULTS

MWS	.....	Molecular weight - stack gas	24.12
PB	.....	Barometric pressure (in-HG)	29.15
PSI	.....	Static pressure of stack gas (in-H2O)	7.600
PS	.....	Stack pressure - absolute (in-HG	29.41
TS	.....	Average stack temperature (deg F	180
VH	.....	Average square root of velocity head (in-H2O)	1.054
VS	.....	Average stack gas velocity (fps)	71.9
AS	.....	Stack area (sq in)	113
QS	.....	Actual stack flow rate (acfm)	3,387
QSSTD	.....	Stack flow rate - dry (scfm)	1,407
ISO	.....	Percent isokinetic	84.1
MN	.....	FILTERABLE PARTICULATE, MG	142.8 ✓
CS	.....	FILTERABLE PARTICULATE, GR/DSCF	0.0156
EMR	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.188
MN	.....	TOTAL CHLORIDES AS HCL, MG	36.6 ✓
CS	.....	TOTAL CHLORIDES AS HCL, GR DSCF	3.9994E-03
EMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.048

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....J. ZINK CO.
Sampling location .....QUENCH OUTLET
Test time (start-stop) 1625-2030

Date 9/16/87
Run number SAI-SV-2

Sample type .....PART./HCL/SEMI-VOLS.
Bar. pressure (in-HG) 29.11
Static pressure (in-H2O) .....+4.0
Filter number(s) 8730047
Stack inside dia. (in) 12
Pitot tube coeff. 84
Total H2O collected (ml) 2507.4
Percent O2 by volume (dry ...5.8

Leakage (cu-ft) 07
Meter calibration factor 999
Data interval (min) 22.2
Nozzle dia. 25
Meter box number FT3
Number of traverse points 9
Percent CO2 by volume (dry) ..10.4
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	480.776					
22.5	493.230	1.050	0.88	177	100	99
45.0	506.500	1.200	1.00	179	96	97
67.5	521.500	1.100	1.25	179	95	92
90.0	535.664	0.980	1.12	181	100	91
112.5	551.080	1.200	1.37	181	96	97
135.0	566.781	1.200	1.37	181	101	95
157.5	581.580	1.000	1.15	181	101	96
180.0	596.738	1.100	1.26	181	102	97
180.0	116.362	1.102	1.15	181	100	95

F E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J. ZINK CO.
TEST: SAI-SV-2 / QUENCH OUTLET

TEST DATE: 9/16/87
TEST TIME: 1625-2030

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	8
Y	.....	Meter calibration factor	0.999
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.18
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	116.292
TM	.....	Average gas meter temperature (deg F)	97.5
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	107.367
VLC	.....	Total H2O collected in impingers and silica gel (ml) (at saturation)	2461.2
VWC	.....	Volume of water vapor at standard conditions (scf) (at saturation)	115.874
BWO	.....	Percent moisture by volume (at saturation)	51.91
FMD	.....	Mole fraction of dry gas	0.48
PCO2	.....	Percent CO2 by volume (dry)	10.400
PO2	.....	Percent O2 by volume (dry)	5.800
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	83.800
MD	.....	Molecular weight - dry stack gas	29.99

TEST RESULTS

PAGE NO: 2
RUN NO: SAI-SV-2

MWS	.....	Molecular weight - stack gas	23.72
PB	.....	Barometric pressure (in-HG)	29.11
PSI	.....	Static pressure of stack gas (in-H2O)	4.000
PS	.....	Stack pressure - absolute (in-HG)	29.40
TS	.....	Average stack temperature (deg F)	180
VH	.....	Average square root of velocity head (in-H2O)	1.050
VS	.....	Average stack gas velocity (fps)	72.2
AE	.....	Stack area (sq in)	113
QE	.....	Actual stack flow rate (acfm)	3,403
QSSTD	.....	Stack flow rate - dry (scfm)	1,3[illegible]
ISO	.....	Percent isokinetic	102.6
MN	.....	FILTERABLE PARTICULATE, MG	115.6 ✓
CE	.....	FILTERABLE PARTICULATE, GR/DSCF	0.0166
PMR	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.189
MN	.....	TOTAL CHLORIDES AS HCL, MG	31.1 ✓
CS	.....	TOTAL CHLORIDES AS HCL, GR/DSCF	4.4[illegible]E-[illegible]
PMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.051

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....J. ZINK CO.
Sampling location .....QUENCH OUTLET
Test time (start-stop) 1041-1439

Date 9/17/87
Run number SAI-SV-3

Sample type .....PART.HCL/SEMI-VOLS.
Bar. pressure (in-HG) 29.37
Static pressure (in-H2O) .....+4.0
Filter number(s) 8730154
Stack inside dia. (in) 12
Pitot tube coeff. 84
Total H2O collected (ml) 2739.5
Percent O2 by volume (dry) ...5.4

Leakage (cu-ft) 0.0
Meter calibration factor 999
Data interval (min) 22.5
Nozzle dia. 25
Meter box number FT2
Number of traverse points 8
Percent CO2 by volume (dry) ..10.6
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	velocity head (in H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp deg. F) inlet	outlet
0.0	597.654					
22.5	611.250	1.000	1.09	178	84	82
45.0	627.500	1.400	1.53	176	87	87
67.5	642.370	1.300	1.42	181	91	88
90.0	658.655	1.300	1.38	182	94	88
112.5	673.700	1.100	1.21	183	92	91
135.0	688.480	1.100	1.22	182	95	91
157.5	703.830	1.200	1.35	179	98	94
180.0	718.546	1.000	1.11	181	98	96
180.0	120.892	1.182	1.29	181	92	89

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J. ZINK CO.
TEST: SAI-SV-3 / QUENCH OUTLET

TEST DATE: 9/17/87
TEST TIME: 1041-1409

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	8
Y	.....	Meter calibration factor	0.999
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.29
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	120.852
TM	.....	Average gas meter temperature (deg F)	90.6
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	114.046
VLC	.....	Total H2O collected in impingers and silica gel (ml) (at saturation)	2626.8
VWC	.....	Volume of water vapor at standard conditions (scf) (at saturation)	123.672
BWO	.....	Percent moisture by volume (at saturation)	52.02
FMD	.....	Mole fraction of dry gas	0.48
PCO2	.....	Percent CO2 by volume (dry)	10.600
PO2	.....	Percent O2 by volume (dry)	5.400
PCO	.....	Percent CO by volume (dry)	0.000
PNC	.....	Percent N2 by volume (dry)	84.000
MD	.....	Molecular weight - dry stack gas	29.91

TEST RESULTS

MWS	.....	Molecular weight - stack gas	27.71
PB	.....	Barometric pressure (in-HG)	29.37
PSI	.....	Static pressure of stack gas (in-H2O)	4.000
PS	.....	Stack pressure - absolute (in-HG)	29.66
TS	.....	Average stack temperature (deg F)	181
VH	.....	Average square root of velocity head (in-H2O)	1.088
VS	.....	Average stack gas velocity (fps)	74.5
AS	.....	Stack area (sq in)	113
QS	.....	Actual stack flow rate (acfm)	2,512
QSSTD	.....	Stack flow rate - dry (scfm)	1,377
ISO	.....	Percent isokinetic	106.0
MN	.....	FILTERABLE PARTICULATE, MG	90.9
CS	.....	FILTERABLE PARTICULATE, GR/DSCF	0.0122
PMR	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.145
MN	.....	TOTAL CHLORIDES AS HCL, MG	21.3
CS	.....	TOTAL CHLORIDES AS HCL, GR/DSCF	2.8818E-02
PMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.034

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....J. ZINK CO.
Sampling location .....QUENCH OUTLET
Test time (start-stop) 1655-2015

Date 5/17/87
Run number SAII-SV-1

Sample type .....PART/HCL/SEMI-VOLS.
Bar. pressure (in-HG) 29.37
Static pressure (in-H2O) .....+4.0
Filter number(s) 8730068
Stack inside dia. (in) 12
Pitot tube coeff. 84
Total H2O collected (ml) 2495
Percent O2 by volume (dry) ...5.1

Leakage (cu-ft) 0.0
Meter calibration factor 999
Data interval (min) 22.5
Nozzle dia. 25
Meter box number F73
Number of traverse points 6
Percent CO2 by volume (dry) ..11
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	719.948					
22.5	733.670	0.900	1.01	180	104	102
45.0	748.810	1.100	1.24	178	105	102
67.5	763.191	1.000	1.13	181	106	102
90.0	778.873	1.200	1.35	182	107	102
112.5	794.190	1.200	1.35	181	102	101
135.0	809.450	1.100	1.22	181	101	98
157.5	825.450	1.300	1.45	182	100	96
172.1	835.270	1.300	1.45	181	99	94
172.1	115.322	1.134	1.28	181	103	100

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J. ZINK CO.
TEST: SAII-SV-1 / QUENCH OUTLET

TEST DATE: 9/17/87
TEST TIME: 1655-2015

TT	.....	Net time of test (min)	172.1
NP	.....	Net sampling points	8
Y	.....	Meter calibration factor	1.995
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.28
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	115.322
TM	.....	Average gas meter temperature (deg F)	101.3
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	106.717
VLC	.....	Total H2O collected in impingers and silica gel (ml) (at saturation)	2456.6
VWC	.....	Volume of water vapor at standard conditions (scf) (at saturation)	117.072
BWO	.....	Percent moisture by volume (at saturation)	52.31
FMD	.....	Mole fraction of dry gas	0.48
PCO2	.....	Percent CO2 by volume (dry)	11.000
PO2	.....	Percent O2 by volume (dry)	5.100
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	83.900
MD	.....	Molecular weight - dry stack gas	29.96

TEST RESULTS

MWS	.....	Molecular weight - stack gas	23.71
PB	.....	Barometric pressure (in-HG)	29.37
PSI	.....	Static pressure of stack gas (in-H2O)	4.000
PS	.....	Stack pressure - absolute (in-HG)	29.66
TS	.....	Average stack temperature (deg F)	181
VH	.....	Average square root of velocity head (in-H2O)	1.065
VS	.....	Average stack gas velocity (fps)	73.0
AS	.....	Stack area (sq in)	117
QS	.....	Actual stack flow rate (acfm)	3,439
QSSTD	.....	Stack flow rate - dry (scfm)	1,340
ISO	.....	Percent isokinetic	106.6
MN	.....	FILTERABLE PARTICULATE, MG	54.5 ✓
CS	.....	FILTERABLE PARTICULATE, GR/DSCF	7.8545E-02
PMR	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.091
MN	.....	TOTAL CHLORIDES AS HCL, MG	11.0 ✓
CS	.....	TOTAL CHLORIDES AS HCL, GR/DSCF	1.5905E-02
PMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.018

P E I ASSOCIATES, INC.

E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....L. [illegible] CO.
Sampling location .....QUENCH OUTLET
Test time start-stop 1944-1303

Date .....[illegible]
Run number SAII-EV-2

Sample type .....PART.HCL/SEMI-VOLS.
Bar. pressure (in-HG) 29.5
Static pressure (in-H2O) .....+4.0
Filter number s .....[illegible]
Stack inside dia. in .....[illegible]
Pitot tube coeff. .....[illegible]
Total HCl collected mg .....[illegible]
Percent O2 by volume (dry) ...5.0

Leakage (cu-ft) 0.0
Meter calibration factor .....[illegible]
Data interval min .....[illegible]
Nozzle dia. .....[illegible]
Meter box number FT3
Number of traverse points 8
Percent CO2 by volume (dry ..10.6
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	835.386					
22.5	849.410	1.300	1.16	179	66	65
45.0	863.400	1.200	1.08	181	69	65
67.5	876.021	1.200	1.06	181	72	67
90.0	888.913	1.200	0.99	181	74	68
112.5	903.150	1.300	1.17	181	72	69
135.0	918.053	1.400	1.27	180	76	71
157.5	932.950	1.400	1.27	183	78	72
180.0	947.728	1.400	1.27	182	77	73
180.0	112.342	1.311	1.16	181	73	69

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J. ZINK CO.
TEST: SAII-SV-2 / QUENCH OUTLET

TEST DATE: 9/18/97
TEST TIME: 0944-1308

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	8
Y	.....	Meter calibration factor	0.999
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.84[illegible]
PM	.....	Average orifice pressure drop (in-H2O)	1.1[illegible]
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	112.342
TM	.....	Average gas meter temperature (deg F)	70.9
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	110.77[illegible]
VLC	.....	Total H2O collected in impingers and silica gel (ml) (at saturation)	2578.1
VWC	.....	Volume of water vapor at standard conditions (scf (at saturation)	121.77[illegible]
BWC	.....	Percent moisture by volume (at saturation)	52.37
FMD	.....	Mole fraction of dry gas	0.48
PCO2	.....	Percent CO2 by volume (dry)	10.800
PO2	.....	Percent O2 by volume (dry)	5.60[illegible]
PCO	.....	Percent CO by volume (dry)	0.[illegible]
PN2	.....	Percent N2 by volume (dry)	8[illegible].60[illegible]
MD	.....	Molecular weight - dry stack gas	29.[illegible]

TEST RESULTS

MWS	.....	Molecular weight - stack gas	23.69
PB	.....	Barometric pressure (in-HG)	29.50
PSI	.....	Static pressure of stack gas (in-H2O)	4.000
PS	.....	Stack pressure - absolute (in-HG)	29.79
TS	.....	Average stack temperature (deg F)	181
VH	.....	Average square root of velocity head (in-H2O)	1.145
VS	.....	Average stack gas velocity (fps)	78.4
AS	.....	Stack area (sq in)	113
QS	.....	Actual stack flow rate (acfm)	3,693
QSSTD	.....	Stack flow rate - dry, std (dscfm)	1,443
ISO	.....	Percent isokinetic	98.[illegible]
MN	.....	FILTERABLE PARTICULATE, MG	43.4 ✓
CS	.....	FILTERABLE PARTICULATE, GR/DSCF	6.0677E-03
PMF	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.075
MN	.....	TOTAL CHLORIDES AS HCL, MG	10.2 ✓
CS	.....	TOTAL CHLORIDES AS HCL, GR/DSCF	1.4259E-03
PMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.018

F E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....J.INN CO
Sampling location .....QUENCH OUTLET
Test time (start-stop) 1350-1718

Date 9/18/87
Run number SAII-SV-3

Sample type .....PART/HCL/SEMI-VOLS.
Bar. pressure (in-HG) 29.5
Static pressure (in-H2O) .....+4.0
Filter number(s) 8730045
Stack inside dia. (in) 12
Pitot tube coeff. 84
Total H2O collected (ml) 2855
Percent O2 by volume (dry) ...5.4

Leakage (cu-ft) 0.0
Meter calibration factor 999
Data interval (min) 22.5
Nozzle dia. 25
Meter box number FT3
Number of traverse points 8
Percent CO2 by volume (dry) ..11.1
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	947.944					
22.5	962.540	1.350	1.23	182	75	75
45.0	977.790	1.400	1.27	181	78	73
67.5	992.871	1.450	1.32	181	81	75
90.0	1007.436	1.300	1.19	181	84	77
112.5	1022.210	1.400	1.28	181	80	78
135.0	1036.815	1.300	1.19	181	82	78
157.5	1050.800	1.200	1.11	181	85	79
180.0	1065.244	1.400	1.29	182	87	80
180.1	117.700	1.349	1.24	181	82	77

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: J.ZINK CO
TEST: SAII-SV-3 / QUENCH OUTLET

TEST DATE: 9/18/87
TEST TIME: 1350-1718

TT	.....	Net time of test (min)	180.0
NF	.....	Net sampling points	8
Y	.....	Meter calibration factor	0.999
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.24
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	117.700
TM	.....	Average gas meter temperature (deg F)	79.2
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	117.876
VLC	.....	Total H2O collected in impingers and silica gel (ml)	2355.[illegible]
VWC	.....	Volume of water vapor at standard conditions (scf)	134.385
BWO	.....	Percent moisture by volume	54.17
FMD	.....	Mole fraction of dry gas	0.46
PCO2	.....	Percent CO2 by volume (dry)	11.100
PO2	.....	Percent O2 by volume (dry)	5.400
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	83.500
MD	.....	Molecular weight - dry stack gas	29.99

TEST RESULTS

MWS	.....	Molecular weight - stack gas	23.50
PB	.....	Barometric pressure (in-HG)	29.50
PSI	.....	Static pressure of stack gas (in-H2O)	4.000
PS	.....	Stack pressure - absolute (in-HG)	29.79
TS	.....	Average stack temperature (deg F)	181
VH	.....	Average square root of velocity head (in-H2O)	1.161
VS	.....	Average stack gas velocity (fps)	79.8
AS	.....	Stack area (sq in)	117
QS	.....	Actual stack flow rate (acfm)	3,761
QSSTD	.....	Stack flow rate - dry (scfm)	1,415
ISI	.....	Percent isokinetic	103.1
MN	.....	FILTERABLE PARTICULATE, MG	41.3 ✓
CS	.....	FILTERABLE PARTICULATE, GR/DSCF	5.5961E-03
PMR	.....	FILTERABLE PARTICULATE Emission rate, lb/hr	0.068
MN	.....	TOTAL CHLORIDES AS HCL, MG	6.9 ✓
CS	.....	TOTAL CHLORIDES AS HCL, GR/DSCF	9.349E-04
PMR	.....	TOTAL CHLORIDES AS HCL Emission rate, lb/hr	0.011

Nomenclature and Dimensions

A_s = cross-sectional area of stack, ft^2

B_{ws} = proportional by volume of water vapor in the gas stream, dimensionless

C_p = pitot tube coefficient, dimensionless

% CO = percent of carbon monoxide by volume, dry basis

% CO_2 = percent of carbon dioxide by volume, dry basis

M_d = dry molecular weight, lb/lb-mole

M_s = molecular weight of stack gas (wet basis), lb/lb-mole

% N_2 = percent of nitrogen by volume, dry basis

% O_2 = percent of oxygen by volume, dry basis

ΔP = velocity head of stack gas, in. H_2O

P_s = absolute stack gas pressure, in.Hg

Q_s = volumetric flow rate, wet basis, stack conditions

$Q_{s_{std}}$ = volumetric flow rate, dry basis, standard conditions

T_s = average temperature of stack gas, °R

V_s = stack gas velocity at stack conditions, fps

Note: Standard conditions = 68°F and 29.92 in.Hg.

Fxample Calculations for Particulate Emissions

1. Volume of dry gas samples corrected to standard conditions. Note: V_m must be corrected for leakage if any leakage rates exceed L_a.

$$V_{m_{std}} = 17.65 \times V_m \times Y \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

2. Volume of water vapor at standard conditions, ft^3.

$$V_{w_{std}} = 0.04707 V_{1_c}$$

3. Moisture content in stack gas.

$$B_{ws} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}}$$

4. Dry molecular weight of stack gas.

$$M_d = 0.440\ (\%\ CO_2) + 0.320\ (\%\ O_2) + 0.280\ (\%\ N_2 + \%\ CO)$$

5. Molecular weight of stack gas.

$$M_s = M_d\ (1-B_{ws}) + 18\ B_{ws}$$

6. Stack velocity at stack conditions, fps.

$$V_s = 85.49\ Cp \left(\sqrt{\Delta P}\right)\ avg. \sqrt{\frac{T_s}{P_s\ M_s}}$$

7. Stack gas volumetric flow rate at stack conditions, cfm.

$$Q_s = 60 \times V_s \times A_s$$

(continued)

Example Calculations for Particulate Emissions (continued)

8. Dry stack gas volumetric flow rate at standard conditions, cfm.

$$Q_{s_{std}} = 17.65\ Q_s \frac{P_s}{T_s} \left(1-B_{ws}\right)$$

9. Concentration in gr/dscf.

$$C's = (0.01543) \frac{M_n}{V_{m_{std}}}$$

10. Particulate mass emission rate, lb/h.

$$pmr = \frac{C's}{7000} \times Q_{s_{std}} \times 60$$

11. Isokinetic variation.

$$I = \frac{100\ T_s \left[0.002669\ V_{l_c} + \frac{V_m}{T_m}\ Y \left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{60\ \theta\ V_s\ P_s\ A_n}$$

12. Particulate concentration correction to 7% O_2:

$$\text{gr/dscf @ 7\% } O_2 = \text{measured gr/dscf} \left(\frac{21-7}{21-\%\ O_2}\right)$$

SAMPLE CALCULATIONS FOR HCl EMISSIONS

1. Volume of dry gas sample corrected to standard conditions (68°F, 29.92 in.Hg, and zero percent moisture)

$$VM_{std} = \text{(see MM5 Computer Data Sheet)}$$

2. Concentration of Cl^- in sample, gr/dscf

$$C_{Cl^-} = (0.01543) \frac{Mn}{V_{mstd}}$$

where Mn = total chloride in sample, mg

3. HCl Mass Emission Rate, lb/h

$$Pmr = C_{HCl} \times Q_{sstd} \times \frac{60 \text{ min}}{h} \times \frac{g}{15.43 \text{ gr}} \times \frac{lb}{453.6 \text{ g}}$$

°VOLATILES

Example Calculations for Volatile Organics (POHC's)

POHC Feed Rates, lb/h

POHC feed rate, lb/h = PC ÷ FR

where

F.R. = measured feed rate of SARM I or II, lb/h
PC = POHC compound concentration expressed as a weight fraction (lb/lb)

VOST Sample Data

$$V_{std} = V_m \times Y \times 17.647 \times \frac{Pb}{T_m}$$

where

V_{std} = sample volume at standard conditions, liters at 20°C, 760 mm Hg (68°F, 29.92 in.Hg)

V_m = volume metered, liters

Y = dry gas meter calibration factor

Pb = barometric pressure, in.HG

T_m = meter gas temperature, °R

17.647 = conversion to standard conditions, 528°R/29.92 in.Hg

POHC conc. ng/liter = total ng in sample/V_{std}

POHC emission rate lb/h = ng/liter X 10^{-9} g/ng X $\frac{1 lb}{453.6 g}$ X 28.317 liters /ft³

x Q_{std}, dscfm X 60 m/h

$$\% \text{ DRE} = \frac{\text{lb/h feed} - \text{lb/h emission rate}}{\text{lb/h feed}} \times 100$$

CALCULATION OF VOST SAMPLE CONCENTRATIONS
SARM I

CALCULATION OF VOST SAMPLE CONCENTRATIONS
SARM I

Compound ID	Samples Nos. and Volumes, dNl																							
	1A 21.016		1B 19.357		1C 18.659		Run 1 average		2A 19.887		2B 19.125		2C[a] 18.896		Run 2 average		3A 20.432		3B 19.207		3C 19.283		Run 3 average	
	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l
Acetone	ND[b]	--	120	6.2	210	11.3	110	5.8	76	3.8	75	3.9	Tube broke		76	3.9	67	3.3	110	5.7	120	6.2	99	5.1
Cholorobenzene	28	1.3	13	0.7	7	0.4	16	0.8	9	0.5	2	0.1	--	--	5.5	0.3	60	2.9	130	6.8	6	0.3	65	3.3
1,2-Dichloro-ethane	ND	--	ND	--	ND	--	ND	--	10	0.5	ND		--	--	5	0.25	16	0.8	17	0.9	45	2.3	26	1.3
Ethylbenzene	230	10.9	74	3.8	29	1.6	111	5.4	97	4.9	7	0.4	--	--	52	2.7	120	5.9	170	8.9	370	19.2	220	11.3
Styrene	130	6.2	53	2.7	22	1.2	68	3.4	40	2.0	24	1.3	--	--	32	1.7	340	16.6	760	39.6	90.0	4.7	397	20.3
Perchloroe-thylene	ND	--	ND	--	2	0.11	0.7	0.04	9	0.5	ND	--	--	--	4.5	0.25	24	1.2	29	1.5	48	2.5	34	1.7
Xylene	230	10.9	83	4.3	71	3.8	128	6.3	190	9.6	37	1.9	--	--	114	5.8	180	8.8	180	9.4	520	27.0	293	15.1

[a] Tube broken in shpiment, sample void.

[b] ND = Non-detectable (See Section 2.0 for Detection Limit Data)

CALCULATION OF VOST SAMPLE CONCENTRATIONS
SARM II

CALCULATION OF VOST SAMPLE CONCENTRATIONS
SARM II

	Samples Nos. and Volumes, dNl																							
Compound ID	1A 19.471		1B 19.875		1C 20.142		Run 1 average		2A 21.653		2B 20.724		2C[a] 19.229		Run 2 average		3A 20.497		3B 20.590		3C 18.303		Run 3 average	
	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l	ng	ng/l
Acetone	ND	--	ND	--	ND	--	ND	--	ND	--	ND	--	ND	--	ND	--	13	0.6	ND	--	11	0.6	8	0.4
Cholorobenzene	ND	--	10	0.5	ND	--	3.3	.17	4	0.2	9	0.4	2	.10	5	.23	5	0.24	2	0.1	6	0.3	4.3	0.2
1,2-Dichloro-ethane	ND	--	ND	--	ND	--	ND	--	ND	--	ND	--	ND	--			ND	--	2	0.1	2	0.1	1.3	0.1
Ethylbenzene	12	0.6	47	2.4	ND	--	20	1.0	14	0.7	20	1.0	6	0.3	13	0.7	16	0.8	7	0.3	12	0.7	12	0.6
Styrene	ND	--	240	12.1	ND	--	80	4.0	7	0.3	ND	--	3	0.2	3.3	0.2	7	0.3	3	0.2	6	0.3	5.3	0.3
Perchloroe-ethylene	2	0.1	3	0.2	ND	--	1.7	0.1	7	0.3	5	0.2	3	0.2	5	0.2	21	1.0	6	0.3	5	0.3	11	0.5
Xylene	17	0.9	82	4.1	ND	--	33	1.7	47	2.2	78	3.8	30	1.6	52	2.5	49	2.4	18	0.9	35	1.9	34	1.7

CALCULATION OF VOST MASS EMISSION RATES
SARM II

CALCULATION OF VOST MASS EMISSION RATES
SARM II

	SAMPLES NOS.														
Compound ID	1A ng/l	1B ng/l	1C ng/l	average ng/l	Run 1[a] average lb/h	2A ng/l	2B ng/l	2C ng/l	average ng/l	Run 2[a] average lb/h	3A ng/l	3B ng/l	3C ng/l	average ng/l	Run 3[a] average lb/h
Acetone	ND	ND	ND	--	--	ND	ND	ND	--	--	0.6	ND	0.6	0.4	2.1×10^{-6}
Cholorobenzene	ND	0.5	ND	0.17	8.9×10^{-7}	0.2	0.4	0.1	0.23	1.2×10^{-6}	0.24	0.1	0.3	0.2	1.1×10^{-6}
1,2-Dichloro-ethane	ND	ND	ND	--	--	ND	ND	ND	--	--	ND	0.1	0.1	0.1	5.3×10^{-7}
Ethylbenzene	0.6	2.4	ND	1.0	5.3×10^{-6}	0.7	1.0	0.3	0.7	3.7×10^{-6}	0.8	0.3	0.7	0.6	3.2×10^{-6}
Styrene	ND	12.1	ND	4.0	2.1×10^{-5}	0.3	ND	0.2	0.2	1.1×10^{-6}	0.3	0.2	0.3	0.3	1.6×10^{-6}
Perchloroe-ethylene	0.1	0.2	ND	0.1	5.3×10^{-7}	0.3	0.2	0.2	0.2	1.1×10^{-6}	1.0	0.3	0.3	0.5	2.6×10^{-6}
Xylene	0.9	4.1	ND	1.7	8.9×10^{-6}	2.2	3.8	1.6	2.5	1.3×10^{-5}	2.4	0.9	1.9	1.7	8.9×10^{-6}

[a] Average exhaust gas flow rate = 1407 dscfm.

CALCULATION OF VOST MASS EMISSION RATES
SARM I

CALCULATION OF VOST MASS EMISSION RATES
SARM I

	SAMPLES NOS.														
Compound ID	1A ng/l	1B ng/l	1C ng/l	average ng/l	Run 1[a] average lb/h	2A ng/l	2B ng/l	2C ng/l	average ng/l	Run 2[a] average lb/h	3A ng/l	3B ng/l	3C ng/l	average ng/l	Run 3[a] average lb/h
Acetone	ND	6.2	11.3	5.8	3.1×10^{-5}	3.8	3.9	--	3.9	2.1×10^{-5}	3.3	5.7	6.2	5.1	2.7×10^{-5}
Cholorobenzene	1.3	0.7	0.4	0.8	4.2×10^{-6}	0.5	0.1	--	0.3	1.6×10^{-6}	2.9	6.8	0.3	3.3	1.7×10^{-5}
1,2-Dichloro-ethane	ND	ND	ND	--	--	0.5	ND	--	0.25	1.3×10^{-6}	0.8	0.9	2.3	1.3	6.9×10^{-6}
Ethylbenzene	10.9	3.8	1.6	5.4	2.9×10^{-5}	4.9	0.4	--	2.7	1.4×10^{-5}	5.9	8.9	19.2	11.3	6.0×10^{-5}
Styrene	6.2	2.7	1.2	3.4	1.8×10^{-5}	2.0	1.3	--	1.7	9×10^{-6}	16.6	39.6	4.7	20.3	1.1×10^{-4}
Perchloroe-ethylene	ND	ND	0.11	0.04	2.1×10^{-7}	0.5	ND	--	0.25	1.3×10^{-6}	1.2	1.5	2.5	1.7	9.0×10^{-6}
Xylene	10.9	4.3	3.8	6.3	3.3×10^{-5}	9.6	1.9	--	5.8	3.1×10^{-5}	8.8	9.4	27.0	15.1	8.0×10^{-5}

[a] Average exhaust gas flow rate = 1412 dscfm.

$$\text{lb/h} = \mu\text{g/l} \times 10^{-9}\ \text{g/ug} \times \frac{1\ \text{lb}}{454\text{g}} \times \frac{28.317\ \text{L}}{\text{ft}^3} \times Q \times 60\ \text{min/h}$$

METALS

[illegible] ASSOCIATES, INC.
[illegible]

FIELD DATA

Plant .....[illegible]
Sampling location .....QUENCH OUTLET
Test time (start-stop) .....[illegible]-1245

Date .....[illegible]
Run number .....[illegible]

Sample type .....METALS
Bar. pressure (in-Hg) 29.15
Static pressure (in-H2O) .....[illegible]
Filter number .....[illegible]
Stack inside dia. (in) .....[illegible]
Pitot tube coeff. .....[illegible]
Time (min) collected (t) .....[illegible]
Percent CO2 by volume (dry) 5.4

Leakage (cu-ft) .....[illegible]
Meter calibration factor .....[illegible]
Data interval (min) .....[illegible]
Nozzle dia. .....[illegible]
Meter box number .....[illegible]
Number of the area points .....[illegible]
Percent CO2 by volume (dry) .....[illegible]
Percent O2 by volume (dry) .....[illegible]

Sample flow (cfm)	Gas meter reading (cu-ft)	Velocity head (in. H2O)	Orifice press-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp. (deg. F) inlet	outlet
[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]

[illegible]

TEST RESULTS

PLANT: [illegible]
TEST: [illegible]

TEST DATE: [illegible]
TEST TIME: [illegible]

[illegible]	.....	Net time of test (min)	[illegible]
[illegible]	.....	Net sampling points	[illegible]
	.....	Meter calibration factor	[illegible]
[illegible]	.....	Sampling nozzle dia (in)	[illegible]
[illegible]	.....	Pitot tube coefficient	[illegible]
[illegible]	.....	Average orifice pressure drop (in-H2O)	[illegible]
[illegible]	.....	Volume of dry gas sampled at meter conditions (cuft)	[illegible]
[illegible]	.....	Average gas meter temperature (deg F)	[illegible]
[illegible]	.....	Volume of dry gas sampled at standard conditions (scf)	[illegible]
[illegible]	.....	Total H2O collected in impingers and silica gel (ml)	[illegible]
[illegible]	.....	Volume of water vapor at standard conditions (scf)	[illegible]
BWO	.....	Percent moisture by volume (saturation check made)	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent CO2 by volume (dry)	[illegible]
[illegible]	.....	Percent O2 by volume (dry)	[illegible]
[illegible]	.....	Percent CO by volume (dry)	[illegible]
[illegible]	.....	Percent N2 by volume (dry)	[illegible]
[illegible]	.....	Molecular weight of dry stack gas	[illegible]

TEST RESULTS

PAGE NO: 2
RUN NO: [illegible]

MWS	.....	Molecular weight - stack gas	24.2[illegible]
PB	.....	Barometric pressure (in-HG)	[illegible]
PSI	.....	Static pressure of stack gas (in-H2O)	[illegible]
PS	.....	Stack pressure - absolute (in-HG)	29.41
TS	.....	Average stack temperature (deg F)	[illegible]
VH	.....	Average square root of velocity head (in-H2O)	1.125
VS	.....	Average stack gas velocity (fps)	76.[illegible]
AS	.....	Stack area (sq ft)	[illegible]
QS	.....	Actual stack flow rate (acfm)	[illegible]
QSSTD	.....	Stack flow rate - dry (acfm)	1.525
ISO	.....	Percent isokinetic	84.[illegible]

[illegible]

[illegible]

[illegible]

Plant [illegible]
Sampling location [illegible]
Test time start-stop [illegible]

Date [illegible]
Run number [illegible]

Sample type [illegible] METALS
Bar. pressure [illegible]
Static pressure [illegible]
Filter number [illegible]
Stack inside diam. [illegible]
Pitot tube coeff. [illegible]
Total H2O collected [illegible]
Percent CO2 by volume [illegible]

Leakage [illegible]
Meter calibration factor [illegible]
Data [illegible]
Nozzle [illegible]
Meter [illegible] number [illegible]
Number of traverse points [illegible]
Percent CO2 by volume [illegible]
Percent CO by volume [illegible]

Sample [illegible]	Gas meter [illegible]	Velocity [illegible]	Orifice [illegible]	Stack [illegible]	[illegible]	[illegible]
[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.050	1.07	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.75	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible] ASSOCIATES, INC.
EMISSION TEST REPORT

TEST RESULTS

PLANT: [illegible]
TEST: [illegible] / [illegible] OUTLET

TEST DATE: [illegible]
TEST TIME: [illegible]

[illegible]	.....	Net time of test, min	[illegible]
[illegible]	.....	Net sampling volume	[illegible]
[illegible]	.....	Meter box orifice factor	[illegible]
[illegible]	.....	Sampling nozzle diameter	[illegible]
[illegible]	.....	Pitot tube coefficient	[illegible]
[illegible]	.....	Average orifice pressure drop, in-H2O	[illegible]
[illegible]	.....	Volume of dry gas sampled at meter conditions, [illegible]	[illegible]
[illegible]	.....	Average meter temperature, deg F	[illegible]
[illegible]	.....	Volume of dry gas sampled at standard conditions, scf	[illegible]
[illegible]	.....	Total mass collected in impinger and silica gel, mg	[illegible]
[illegible]	.....	Volume of water vapor at standard conditions, scf	[illegible]
[illegible]	.....	Percent moisture by volume saturation check rate	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent CO2 by volume, dry	[illegible]
[illegible]	.....	Percent O2 by volume, dry	[illegible]
[illegible]	.....	Percent CO by volume, dry	[illegible]
[illegible]	.....	Percent N2 by volume, dry	[illegible]
[illegible]	.....	Molecular weight of dry stack gas	[illegible]

TEST RESULTS

PAGE NO: [illegible]
RUN NO: [illegible]

[illegible]	.....	Molecular weight - stack gas	[illegible]
[illegible]	.....	Barometric pressure in-HG	[illegible]
[illegible]	.....	Static pressure of stack gas in-H2O	[illegible]
[illegible]	.....	Stack pressure - absolute in-HG	[illegible]
[illegible]	.....	Average stack temperature deg F	[illegible]
[illegible]	.....	Average square root of velocity head in-H2O	[illegible]
[illegible]	.....	Average stack gas velocity fps	[illegible]
[illegible]	.....	Stack pressure in	[illegible]
[illegible]	.....	Actual stack flow rate acfm	[illegible]
[illegible]	.....	Stack flow rate - dry acfm	[illegible]
[illegible]	.....	Percent isokinetic	[illegible]

[illegible] ASSOCIATES, INC.

[illegible]

FIELD DATA

Plant .....[illegible] CO.
Sampling location .....[illegible]
Test time start-stop .....[illegible]

Date .....[illegible]
Run number .....[illegible]

Sample type .....METALS
Barometric pressure (in-Hg) .....[illegible]
Static pressure (in-H2O) .....[illegible]
Filter number .....[illegible]
Stack inside dia (in) .....[illegible]
Pitot tube coeff. .....[illegible]
Total H2O collected (ml) .....[illegible]
Percent H2O by volume (%) .....[illegible]

Leakage (cu-ft) .....[illegible]
Meter calibration factor .....[illegible]
Data interval (min) .....[illegible]
Nozzle dia. .....[illegible]
Meter box number .....[illegible]
Number of traverse points .....[illegible]
Percent CO2 by volume (%) .....[illegible]
Percent O2 by volume (%) .....[illegible]

Sample time (hr)	Gas meter reading (cu-ft)	Velocity head (in-H2O)	Orifice press-diff (in-H2O)	Stack temp (deg F)	Dry gas meter temp (deg F) inlet	outlet
	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]

[illegible]

TEST RESULTS

PLANT: [illegible]
TEST: [illegible]

TEST DATE: [illegible]
TEST TIME: [illegible]

TT	.....	Net time of test [illegible]	[illegible]
NP	.....	Net sampling points	[illegible]
[illegible]	.....	Meter [illegible]	[illegible]
[illegible]		Sampling nozzle [illegible]	[illegible]
[illegible]	.....	Pitot tube coefficient	[illegible]
PM	.....	Average orifice pressure drop [illegible]	[illegible]
	.....	Volume of dry gas sampled at meter conditions [illegible]	[illegible]
TM	.....	Average gas meter temperature [illegible]	[illegible]
VMSTD	.....	Volume of dry gas sampled at standard conditions [illegible]	[illegible]
[illegible]	.....	Total H2O collected in impingers and silica gel [illegible] at saturation	[illegible]
VWC	.....	Volume of water vapor at standard conditions [illegible] at saturation	[illegible]
[illegible]	.....	Percent moisture by volume at saturation	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent CO2 by volume dry	[illegible]
[illegible]	.....	Percent O2 by volume dry	[illegible]
[illegible]	.....	Percent CO by volume dry	[illegible]
[illegible]	.....	Percent N2 by volume dry	[illegible]
MD	.....	Molecular weight of dry [illegible]	[illegible]

TEST RESULTS

PAGE NO. [illegible]
RUN NO. [illegible]

MWS	.....	Molecular weight - stack gas	[illegible]
PB	.....	Barometric pressure in-HG	[illegible]
PSI	.....	Static pressure of stack gas in-H2O	4.[illegible]
PS	.....	Stack pressure - absolute in-HG	[illegible].66
TS	.....	Average stack temperature deg F	[illegible]
[illegible]	.....	Average square root of [illegible] in-H2O	[illegible]
VS	.....	Average stack gas velocity fps	[illegible]
AS	.....	Stack area sq in	[illegible]
CS	.....	Actual stack flow rate acfm	[illegible]
[illegible]	.....	Stack [illegible] acfm	[illegible]
[illegible]	.....	Percent isokinetic	[illegible]

[illegible]

[illegible]

[illegible]

Plant [illegible]

Date [illegible]

Run number [illegible]

Sampling location [illegible]

Test time [illegible]

Sample type [illegible]

Barometric pressure [illegible]

Static pressure [illegible]

Filter number [illegible]

[illegible]

Pitot tube coefficient [illegible]

Total H2O collected [illegible]

Percent CO2 by volume [illegible]

Percent O2 by volume [illegible]

Leakage [illegible]

Meter calibration factor [illegible]

Data interval [illegible]

Nozzle diameter [illegible]

Meter box number [illegible]

Number of traverse points [illegible]

Percent CO2 by volume [illegible]

Percent O2 by volume [illegible]

Sample time (min)	Gas meter reading (ft³)	Velocity head (in. H2O)	Orifice pressure drop (in. H2O)	Stack temp. (deg F)	Dry gas meter temp. inlet	Dry gas meter temp. outlet
[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	86.574	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible] ASSOCIATES, INC.

[illegible]

TEST RESULTS

PLANT: [illegible] CO.
TEST: [illegible] QUENCH OUTLET

TEST DATE: [illegible]
TEST TIME: [illegible]

[illegible]	.....	Net time of test [illegible]	[illegible]
[illegible]	.....	Net sampling points	[illegible]
	.....	Meter calibration [illegible]	[illegible]
[illegible]	.....	Sampling nozzle [illegible]	[illegible]
[illegible]	.....	Pitot tube coefficient	[illegible]
[illegible]	.....	Average orifice pressure drop [illegible]	[illegible]
[illegible]	.....	Volume of dry gas sampled at meter conditions [illegible]	[illegible]
[illegible]	.....	Average [illegible]	[illegible]
[illegible]	.....	Volume of dry gas sampled at standard conditions [illegible]	[illegible]
[illegible]	.....	Total [illegible] impingers and silica gel [illegible]	[illegible]
[illegible]	.....	[illegible] water vapor at standard conditions [illegible] at saturation	[illegible]
[illegible]	.....	Percent moisture by volume at saturation	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent [illegible] by volume [illegible]	[illegible]
[illegible]	.....	Percent [illegible] by volume [illegible]	[illegible]
[illegible]	.....	Percent [illegible] by volume [illegible]	[illegible]
[illegible]	.....	Percent [illegible] by volume [illegible]	[illegible]
[illegible]	.....	Molecular weight [illegible]	[illegible]

[illegible]	Molecular weight - stack gas	[illegible]
[illegible]	Barometric pressure (in-Hg)	[illegible]
[illegible]	Static pressure of stack gas (in-H2O)	[illegible]
[illegible]	Stack pressure - absolute (in-Hg)	[illegible]
[illegible]	Average stack temperature (deg F)	[illegible]
[illegible]	Average stack gas velocity (feet/sec)	[illegible]
[illegible]	Average total gas volume (cfm)	[illegible]
[illegible]	Stack area (sq ft)	[illegible]
[illegible]	Actual stack flow rate (acfm)	[illegible]
[illegible]	Stack flow rate - std (scfm)	[illegible]
[illegible]	Percent isokinetic	[illegible]

[illegible] ASSOCIATES, INC.

EMISSION TEST REPORT

FIELD DATA

Plant .....[illegible]

Sampling location .....[illegible] OUTLET

Test time [illegible] .....[illegible]

Date .....[illegible]

Run number .....[illegible]

Sample type .....[illegible]

Barometric pressure .....[illegible]

Static pressure .....[illegible]

Filter number [illegible]

Stack orifice dia. in .....[illegible]

Pitot tube coeff .....[illegible]

Total HCl collected [illegible] .....[illegible]

Percent CO2 [illegible] .....[illegible]

Leakage rate .....[illegible]

Meter calibration factor .....[illegible]

Data interval min .....[illegible]

Nozzle dia. .....[illegible]

Meter box number .....[illegible]

Number of traverse points .....[illegible]

Percent O2 [illegible] .....[illegible]

Percent [illegible] .....[illegible]

Sample time min	Gas meter reading cu. ft.	Gas meter cu. ft.	Orifice pressure drop in. H2O	Stack temp. deg. F	Gas meter temp. inlet deg. F	Gas meter temp. outlet deg. F
[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible]

[illegible]

TEST RESULTS

PLANT: [illegible]
TEST: [illegible] QUENCH OUTLET

TEST DATE: [illegible]
TEST TIME: [illegible]

[illegible]	.....	Net time of test (min)	[illegible]
[illegible]	.....	Net sampling points	[illegible]
	.....	Meter calibration factor	[illegible]
[illegible]	.....	Sampling nozzle dia (in)	[illegible]
[illegible]	.....	Pitot tube [illegible]	[illegible]
PM	.....	Average orifice pressure drop (in H2O)	[illegible]
[illegible]	.....	Volume of dry gas sampled at meter conditions (cu ft)	[illegible]
[illegible]	.....	Average gas meter temperature (deg F)	[illegible]
[illegible]	.....	Volume of dry gas sampled at standard conditions (scf)	[illegible]
[illegible]	.....	Total H2O collected in impingers and silica gel (ml) at saturation	[illegible]
VWC	.....	Volume of water vapor at standard conditions (scf) at saturation	[illegible]
[illegible]	.....	Percent moisture by volume at saturation	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent CO2 by volume (dry)	[illegible]
[illegible]	.....	Percent CO by volume (dry)	[illegible]
[illegible]	.....	Percent CO by volume (dry)	[illegible]
[illegible]	.....	Percent NO by volume (dry)	[illegible]
[illegible]	.....	Molecular weight of dry stack gas	[illegible]

TEST RESULTS

PAGE NO: 2
RUN NO: [illegible]

MWS	.....	Molecular weight - stack gas	[illegible]
PB	.....	Barometric pressure (in-HG	[illegible]
PSC	.....	Static pressure of stack gas (in-H2O	[illegible]
PD	.....	Stack pressure - absolute (in-HG)	[illegible]
TS	.....	Average stack temperature (deg F	[illegible]
VH	.....	Average square root of velocity head (in-H2O	[illegible]
VS	.....	Average stack gas velocity (fps)	[illegible]
AS	.....	Stack area (sq in)	[illegible]
CS	.....	Actual stack flow rate (acfm)	[illegible]
DSSTD	.....	Stack flow rate - dry (scfm)	[illegible]
ISO	.....	Percent isokinetic	[illegible]

[illegible]		[illegible]	[illegible]
[illegible]	.....	Net sampling points	6
		Meter calibration factor	[illegible]
[illegible]	.....	Sampling nozzle dia. in A-51	[illegible]
[illegible]		Pitot tube coefficient	[illegible]
[illegible]	.....	Average orifice pressure drop in H2O	[illegible]
[illegible]	.....	Volume of dry gas sampled at meter conditions (cu ft)	[illegible]
[illegible]	.....	Average gas meter temperature (deg F)	[illegible]
[illegible]	.....	Volume of dry gas sampled at standard conditions (dcf)	75.45[illegible]
[illegible]	.....	Total H2O collected in impingers and silica gel (ml) at saturation	[illegible]
[illegible]	.....	Volume of water vapor at standard conditions (scf) at saturation	[illegible]
[illegible]	.....	Percent moisture by volume at saturation	[illegible]
[illegible]	.....	Mole fraction of dry gas	[illegible]
[illegible]	.....	Percent CO2 by volume (dry)	[illegible]
[illegible]	.....	Percent O2 by volume (dry)	[illegible]
[illegible]	.....	Percent CO by volume (dry)	[illegible]
[illegible]	.....	Percent N2 by volume (dry)	[illegible]
[illegible]	.....	Molecular weight of dry stack gas	[illegible]

TEST RESULTS

PAGE NO: [illegible]
[illegible]

[illegible]	.....	Molecular weight of stack A-51	[illegible]
[illegible]	.....	Barometric pressure (in Hg)	[illegible]

[illegible] ASSOCIATES, INC.

EMISSIONS TEST REPORT

FIELD DATA

Plant .....[illegible] COMP CO

Sampling location .....QUENCH OUTLET

Test time [illegible] .....[illegible]

Date .....[illegible]

Run number .....[illegible]

Sample type .....[illegible]

Barometric pressure (in-Hg) .....[illegible]

Static pressure (in-H2O) .....[illegible]

Filter number [illegible] .....[illegible]

Stack inside diam (in) .....[illegible]

Pitot tube coeff .....[illegible]

Total H2O collected (ml) .....[illegible]

Percent CO2 by volume (dry) .....[illegible]

Leakage (cu-ft) .....[illegible]

Meter calibration factor .....[illegible]

Data interval (min) .....[illegible]

Nozzle diam .....[illegible]

Meter box number .....[illegible]

Number of traverse points .....[illegible]

Percent O2 by volume (dry) .....[illegible]

Percent CO by volume (dry) .....[illegible]

Sample time (hr)	Gas meter reading (cu ft)	Velocity head (in-H2O)	Orifice pressure (in-H2O)	Stack temp (deg F)	Dry gas meter temp (deg F) inlet	Dry gas meter temp (deg F) outlet
[illegible]	[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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[illegible] ASSOCIATES, INC.

EMISSIONS TEST REPORT

TEST RESULTS

[illegible]

TEST DATE [illegible]

[illegible]	[illegible]	Stack pressure - [illegible]	[illegible]
[illegible]	[illegible]	Average stack temperature, deg F	[illegible]
[illegible]	[illegible]	Average square root of velocity head, in-H2O	[illegible]
[illegible]	[illegible]	Average stack gas velocity, fps	[illegible]
[illegible]		Stack area, [illegible]	[illegible]
[illegible]	[illegible]	Actual stack flow rate, acfm	[illegible]
[illegible]	[illegible]	Stack flow rate - dry, [illegible]	[illegible]
[illegible]	[illegible]	Percent isokinetic	[illegible]

Rt1

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	Sample Volume, dscf			Volumetric Flow, dscfm		
	73.183	68.341	82.863	1525	1357	1477

	ug Per Sample			Concentration, ug/m3				Emission Rate, lb/h			
	Runs			Runs			Avg.	Runs			Avg.
Metals	SAI-M-1	SAI-M-2	SAI-M-3	M-1	M-2	M-3		M-1	M-2	M-3	
ARSENIC	40	45	27	19.300	23.250	11.505	18.018	.00011	.00012	.00006	.00010
CADMIUM	4250	2730	6090	2050.6	1410.5	2595.1	2018.7	.01171	.00717	.01436	.01108
CHROMIUM	167	135	141	80.576	69.751	60.084	70.137	.00046	.00035	.00033	.00038
COPPER	450	530	710	217.12	273.84	302.55	264.50	.00124	.00139	.00167	.00144
LEAD	1740	1970	2520	839.53	1017.8	1073.8	977.07	.00480	.00517	.00594	.00530
NICKEL	750	100	89	361.87	51.667	37.925	150.49	.00207	.00026	.00021	.00085
ZINC	940	602	1150	453.54	311.04	490.04	418.21	.00259	.00158	.00271	.00229

	Sample Volume, dscf			Volumetric Flow, dscfm		
	78.283	76.53	75.456	1364	1469	1411

	ug Per Sample			Concentration, ug/m3				Emission Rate, lb/h			
	Runs			Runs			Avg.	Runs			Avg.
Metals	SAII-M-1	SAII-M-2	SAII-M-3	M-1	M-2	M-3		M-1	M-2	M-3	
ARSENIC	14	13	21	6.3148	5.9980	9.8271	7.3800	.00003	.00003	.00005	.00004
CADMIUM	3000	2920	2170	1353.2	1347.3	1015.5	1238.6	.00691	.00741	.00537	.00657
CHROMIUM	78	44	33	35.182	20.301	15.443	23.642	.00018	.00011	.00008	.00012
COPPER	230	110	83	103.74	50.753	38.840	64.445	.00053	.00028	.00021	.00034
LEAD	920	810	750	414.97	373.72	350.97	379.89	.00212	.00206	.00186	.00201
NICKEL	100	71	57	45.106	32.759	26.673	34.846	.00023	.00018	.00014	.00018
ZINC	410	280	150	184.93	129.19	70.193	128.10	.00094	.00071	.00037	.00068

APPENDIX B

FIELD DATA SHEETS

PROCESS FIELD DATA SHEETS

1-2

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-I-1
DATE: 9/16/87
TIME BEGIN WASTE FEED: 9 45 AM
TIME BEGIN TESTING: 10 15 AM
TIME STOP WASTE FEED 2 08 PM (4hr 23 min)
TOTAL WAMT FED 4640 lb (~1080 lb/hr)

TEST CONDITIONS:
Flue Gas Oxygen 3-5 %
Blowdown Rate 0 gpm
Venturi Scrubber 30 in. WG
Feed Rate 1000 lb/hr
Incinerator Temp. 1800 °F Kiln
2000 °F Secondary

Kiln Rotation speed 0.35, ~45 min retention

PARAMETER	TIME									
	9 45	10 15	10 50	11 40	12 10	12 40	1 10	1 40	2 20	AVG
KILN										
Temperature, °F	1824	1764	1798	1808	1828	1764	1823	1792	1865	1795
Combustion Air, inches WG	~~1.2~~ 0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	3.8	
O2, % ~~Feed Rate Indicator, lb~~	3.7	2.6	3.4	3.2	3.4	4.8	3.0	2.5	2.9	3.3
KILN AFTERBURNER										
Temperature, °F	2012	1942	2004	2017	2038	1994	2017	2019	1997	2004
Combustion Air, inches WG	4.5	6.0	6.8	6.7	6.7	6.7	6.7	6.7	6.7	
Continuous Oxygen, %	4.2	5.0	4.4	3.8	4.0	4.8	4.0	2.9	4.4	4.1
Continuous CO, ppm										
~~Continuous CO2, %~~	8									
SCRUBBER										
Scrubber flow, % max. (12.46 gpm max)	78	72	72/78	72/72	72/72	72/70	72/70	71/70	72/70	
Blowdown, % max.	0	0	0	0	0	<	0	0	0	
Δ P Venturi, in. WG	26.5	21.5	21.5	-	23.5	22.5	21.5	23.5	23.5	23.0
STACK (behind ID fan)										
Oxygen, %	5.5	8.0	5.8	5.5	-	5.5	5.3	-	5.2	5.8
CO ppm ~~Combustibles, %~~ CO2, %	<10 9	<10 9.5	<10 10.5	<10 10.7	-	<10 11.0	<10 11.2	-	<10 9.0	<10 10.1

NOTES:

DRUM #	FULL WGT lbs	EMPTY WGT lbs	NET WGT lbs	Time Start Feed	Time Complete Feed	Net (Δ) Feed Time
SARM-I-26	633	54	579	9:45	10.15	30 min.
SARM-I-21	645	54	591	10.15	10:45	30 min
SARM-I-25	660	68	592	10 45	11:20	35 min
SARM-I-15	613	60	553	11:20	12.00	40 min
SARM-I-17	670	89	581	12:00	12.32	32 min
SARM-I-23	638	61	577	12.32	1:04	32 min
SARM-I 16	640	65	575	1:04	1:36	32 min
SARM-I-24	650	58	592	1:36	2:08	37

UE

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-I-2
DATE: 9/16/87
TIME BEGIN WASTE FEED: 4 11 pm
TIME BEGIN TESTING: ~4 30

TEST CONDITIONS:
Flue Gas Oxygen 8-5 %
Blowdown Rate 0 gpm
Venturi Scrubber 30 in. WG

Feed Rate 1000 lb/hr nominal
Incinerator Temp. 1800 °F KILN
2000 °F SECONDARY

Avg. Feed Rate Overall ~~1135 lb/h~~ 3939 lb/3.15h = 1050 lb/h
7:55 - backfiring at feed - flames
igniting - 3 shotgun type blasts (SARM-I-14)

Kiln Rotation 0.35 rpm (45 min retention)

PARAMETER	TIME										AVG
pm	4 11	4 40	4 55	5 45	5 55	6 42	7 45	8 25			
KILN											
Temperature, °F	1782	1789	Ash dump jammed		1809	1745	1781	1757	Cold kiln burn	Start feeding	1776
Combustion Air, inches WG	1.5	1.2		Ash dump working	1.2	1.4	1.5	1.5			
O_2, % ~~Feed Rate Indicator, lb~~	9.2	5.4			3.6	3.5	2.3	4.0			4.7
KILN AFTERBURNER											
Temperature, °F	2008	2002	Ash dump jammed. Sludge in drum	Ash dump working	2002	1996	1990	1982			1997
Combustion Air, inches WG	6.5	5.7			5.5	5.4	5.3	5.3			
Continuous Oxygen, %	4.2	6.0			5.5	4.6	5.1	5.5			6.0
Continuous CO, ppm											
Contionuous CO2, %											
SCRUBBER											
Scrubber flow, % max. (10.46 gpm max)	70	-	Stop feed for clean up. Work in sludge feed	Resumed feed again	—		—	—	Weight of test drum reached limit		70
Blowdown, % max.	0	0			0		0	0			0
Δ P Venturi, in. WG	23.5	26.5			26.5	26.0	23.0	23.5			24.8
STACK											
Oxygen, %	9.1	-			6.3	4.7	5.3	5.8	8.5 gpm		6.3
CO ppm ~~Combustibles, %~~	40	-			<10	<10	<10	<10			<10
CO_2, %	(6.7)	-		9.5	8.9	11.2	10.7	10.7			9.6

NOTES:

DRUM #	FULL WGT (lbs)	EMPTY WGT LBS	NET WGT FED lbs	Time Start Feed	Time Complete Feed	Net Time Feed
SARM-I 3	632	59	573	4 11 pm	4 45	34
SARM-I-4	586	55	531	4 45 pm	5 45	30
SARM-I-10	630	56	574	6 05	6 32	27
SARM-I-11	641	48	593	6 32	7 12	40
SARM-I-12	618	53	565	7 12	7 43	31
SARM-I-14	635	63	572	7 43	8 15	32
SARM-I-13	638	57 B-4	581 - 50* = 531	8 15	8 46	31
SARM-I-18	655	- Cancelled - 3939 Total lb feed		Feed Run Time 3h 45 min total		

* about 50 lb of #13 was not fed, left over in scoop pail to be fed at beginning of next run

= 1600° on kiln

SAMP- 2 composited at 2 15pm

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-I-3
DATE: 9/17/87
TIME BEGIN WASTE FEED: 10:16
TIME BEGIN TESTING: 10:40

TEST CONDITIONS:

Flue Gas Oxygen	3-5	%	Feed Rate	1000	lb/hr
Blowdown Rate	0	gpm	Incinerator Temp.	1800	°F Kiln
Venturi Scrubber	30	in. WG		2000	°F Secondary

CO_2 spike at ~11:30
O_2 dropped off

START

11:30 - 2 fume explosions at feed
1:00 - 2 " " " "

Kiln Rotation speed 0.35 rpm
(45 min retention

PARAMETER	TIME									
	10:19	11:00	11:30	11:45-50	12:30	1:00	1:30	2:00	2:30	AVG
KILN										
Temperature, °F, thermocouple	1767	1776	1760	1770	1725	1767	-	1770	1760	1760
Combustion Air, inches WG	1.5	1.9	2.0	2.7	1.6	1.5	1.7	1.7	2.0	
Oxygen, % ~~Feed Rate Indicator, lb~~	5.9	7.3	0.8	1.2	2.3	0	2.5	1.0	1.5	2.5
KILN AFTERBURNER										
Temperature, °F	1960	1995	2002	1993	1980	2011	2002	2006	2008	1995
Combustion Air, inches WG	4.2	4.5	4.2	4.7	5.0	4.0	4.0	4.0	4.0	
Continuous Oxygen, %	6.8	7.5	3.6	4.7	5.3	2.3	4.0	3.7	3.7	4.6
Continuous CO, ppm										
Contionuous CO2, %										
SCRUBBER										
Scrubber flow, % max. (12.46 gpm max)	76/76		—		—					76
Blowdown, % max.	0	0	-		—					0
Δ P Venturi, in. WG	23.5	24.0	20.0	—	24	25	26	24.3	24.3	23.9
STACK										
Oxygen, %	8.0	6.3	-	5.5	6.3	5.5	6.3	5.0		6.1
CO, ppm	<10	<10	-	<10	<10	<10	<10	<10	—	<10
~~Combustibles, %~~ CO_2, %	9.0	9.9		10.5	9.9	10.3	10.3	10.5	11.2	10.2

NOTES:

Drum #	Full wgt lbs	Empty wgt lbs	Net wgt Feed lbs	Time Start feed	Time End Feed	Net Feed Time	Feed Rate lbs/hr
~50lbs of effluent #12							
SARM-I-18	653	70	583+50-633	10:16	10:54	38	999
SARM I-20	713	67	646	10:54	11:20	26	1490
SARM-I-22	651	59	592	11:20	11:53	33	1076
SARM-I-5*	610	66	544	11:53	12:22	30	1088
SARM-I-6	633	58	575	12:22	12:55	33	1046
SARM-I-8	612	58	554	12:55	1:25	30	1108
SARM-I-9	673	53	620	1:25	2:02	37	1005
SARM-I-2	641	59	582	2:02	2:38	36	970
SARM-I-7	660	53	607	2:38	3:10	32	1138
			5353	Run Time elapsed 4h, 54 min			

AVG 10

338 rev/min

* CO spike ~90 for 1 min @ 6:25 p
CO spikes 7:31 + 7:45 @ ~69 ppm 1 min each

Check kiln temp
1700 °F
Thermo couple 1706 °F
7:00 pm 1750
1750
8 pm 1750
1742

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-II-4
DATE: 9/17/87
TIME BEGIN WASTE FEED: 4:44 pm
TIME BEGIN TESTING: 5:05 pm
TIME STOP TESTING 8:20 pm

TEST CONDITIONS:

Flue Gas Oxygen	3-5	%	Feed Rate	1000	lb/hr
Blowdown Rate	0	gpm	Incinerator Temp.	1800	°F kiln
Venturi Scrubber	30	in. WG		2000	°F [illegible]

Avg. Feed Rate: 4392 lb/4.1 h = 1071 lb/h

PARAMETER pm	TIME 5:00	5:30	6:00	6:30	7:00 p	7:30 p	8:00	8:30	AVG	
KILN										
Temperature, °F	1777	1770	1736	1706	1753	1739	1742	1770	1749	
Combustion Air, inches WG	1.5	1.3	1.8	2.1	2.1	2.2	2.5	2.5		
Oxygen, % ~~Feed Rate Indicator, lb~~	6.5	3.2	2.0	0.5	3.0	0.5	3.0	2.0	2.6	
KILN AFTERBURNER										
Temperature, °F	2001	2004	1989	1993	1959	1980	1962	1990	1985	
Combustion Air, inches WG	3.0	2.8	2.5	4.0	2.5	2.5	2.7	2.8		
Continuous Oxygen, %	7.4	4.5	3.4	1.5	5.2	2.5	5.0	3.5	4.1	
Continuous CO, ppm										
Contionuous CO2, %										
SCRUBBER										
Scrubber flow, % max. (12.46 gpm max)	74/76	70	—						7.2	
Blowdown, % max.	0	0	0	0	0	0	0	0	0	
Δ P Venturi, in. WG	28.5	29	27	26.2	25.0	24.5	25.0	24.6	26.2	
STACK										
Oxygen, %	6.3	5.3	4.2	3.6	5.5	5.3	5.3	5.5	5.1	
CO, ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10*	
~~Combustibles~~, % CO2, %	9.2	11.2	11.8	12.2	10.9	10.5	10.9	10.9	10.9	

NOTES:

DRUM #	FULL WGT lbs	EMPTY WGT lbs	NET WGT lbs	TIME START FEED	TIME STOP FEED	NET FEED TIME	FEED RATE lbs/hr
SARM-II-15B	635	61	574	4:44 pm	5:24	40	861
SARM-II-10B	599	55	544	5:24	5:46	22	1484
SARM-II-2	540	56	484	5:46	6:10	24	1210
SARM-II-16B	487	54	433	6:10	6:39	29	896
SARM-II-10A	642	61	581	6:39	7:15	36	968
SARM-II-3	634	56	578	7:15	7:43	28	1239
SARM-II-14A	612	67	545	7:43	8:16	33	991
SARM-II-11B	710	57	653	8:16	8:50	34	1152
			4392 lb				Avg 1100

* 12:15pm 45ppm CO spike
12 30 <10 ppm

12:00 noon Temp at Stack 176°F
Temp before Venturi 1653°F

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-II-5
DATE: 9-18-87
TIME BEGIN WASTE FEED: 9:00 AM
TIME BEGIN TESTING: 9 -

TEST CONDITIONS:
Flue Gas Oxygen 3-5 %
Blowdown Rate 0 gpm
Venturi Scrubber 30 in. WG

Feed Rate 1000 lb/hr
Incinerator Temp. 1800 °F Kiln
2000 °F SECONDARY

FEED RATE 4561 lb/4.2 h = 1086 lb/h

WEATHER: HEAVY RAIN 8-10; 10-12 light rain + drizzle

PARAMETER	TIME									
	7 10 A	9	10 20	10 50	11 20	11 55	12 28	1 00 P	AVG	
KILN Temperature, °F	1776	1754	1774	1778	1801	1784	1804	1779	1784	
Combustion Air, inches WC	[illegible]	[illegible]	2.5	2.5	2.5	2.5	2.5	2.4		
Oxygen % Feed ~~Rate Indicator, lb~~	5.5	[illegible]	3.0	2.5	3.0	3.3	1.9	3.0	3.3	
KILN AFTERBURNER Temperature, °F	2009	-	2014	2010	2003	1983	2007	2000	2004	
Combustion Air, inches WC	[illegible]	[illegible]	3.1	[illegible]	3.1	3.1	3.0	3.0		
Continuous Oxygen, %	6 -	[illegible]	4.5	6.0	3.5	6.7	5.8	5.4	5.4	
Continuous CO, ppm										
Contionuous CO2, %						**				
SCRUBBER Scrubber flow, % max.	70	72	72	74/74	72	72	75		72	
Blowdown, % max.	0	0	0	0	0	0		0	0	
Δ P Venturi, in. WG	[illegible]	23.5	24.3	25.0	24.0	25	23.8	23.5	23.3	
STACK Oxygen, %	—	6.3	5.2	6.0	6.5	—	5.6	5.7	5.9	
ppm CO	—	<10	<10	<10	<10	—	<10*	<10*	<10	
~~Combustibles~~, % CO_2 %		9.9	11.1	9.9	9.5	—	11.0	11.0	10.4	

at feed end. Excluded [illegible] sample
no fugitive losses while burning [illegible], but this is
not [illegible] Does [illegible] in respiration

NOTES:

DRUM #	LBS FULL	LBS EMPTY	NET WGT FED	TIME START FEED	END FEED	NET FEED TIME	FEED [illegible] LB/[illegible]
SARM-II-6	625	54	571	9:00 am	9 38	38	902
-16A	781	62	719	9 38	10 10	32	[illegible]
-12A	599	62	537	10 10	10 39	29	1111
-8	638	61	577	10 39	11 14	35	95[illegible]
15A	606	60	546	11 14	11 45	31	1057
11A	543	67	476	11 46	12 14	29	985
5	634	59	575	12 14	12 44 P	30	115[illegible]
14B	615	55	560	12 44 P	1 12 P	28	120[illegible]
			4561				

* CO spike 12 50/P 45 ppm averaged for 5 min

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-II-6
DATE: 9-18-87
TIME BEGIN WASTE FEED: 1:12 PM
TIME BEGIN TESTING: 1:51 PM

TEST CONDITIONS:
Flue Gas Oxygen 3-5 %
Blowdown Rate 0 gpm
Venturi Scrubber 30 in. WG
Feed Rate 1000 lb/hr
Incinerator Temp. 1800 °F Kiln
2000 °F Secondary

TIME STOP TESTING 5:18
TOTAL TIME FEED 4 hr 2 min.
AVG FEED RATE OVERALL 4507/4.03 = 1118 lb/h

PARAMETER	TIME 1:30 P	2:00	2:45	3:20	3:45	4:15	4:45	5:15	AVG
KILN									
Temperature, °F	1799	1784	1787	1784	1769	1781	1773	1764	1780
Combustion Air, inches WC	2.5	2.5	2.6	2.5	2.6	2.6	2.6	2.6	~~—~~
Oxygen % ~~Feed Rate Indicator~~, lb	3.0	3.2	2.7	2.0	3.3	2.0	1.2	2.0	2.4
KILN AFTERBURNER									
Temperature, °F	2005	2010	2010	2006	1999	2000	2005	2005	2005
Combustion Air, inches WC	3.0	3.1	3.1	3.0	3.0	3.0	3.0	3.0	—
Continuous Oxygen, %	5.5	5.3	3.6	4.6	5.3	6.5	5.6	5.5	5.2
Continuous CO, ppm									
Contionuous CO2, %									
SCRUBBER									
Scrubber flow, % max.	—	70	70	—	70	70	70	—	70
Blowdown, % max.	0	0	0	0	0	0	0		0
Δ P Venturi, in. WG	23.0	24.0	23.0	23.5	—	23	23	23.5	23.3
STACK									
Oxygen, %	—	5.7	5.7	5.3	5.4	5.0	5.4	4.9	5.3
CO ppm ~~Combustibles~~, % CO2	—	<10 11.1	<10 10.6	<10 12.0	<10 10.8	<10 11.5	<10 11	<10 11	<10 11.1

NOTES:

DRUM # SARM-II-	FULL WGT lbs	EMPTY WGT lbs	NET WGT lbs	Time Start feed	Time Stop feed	Net Feed Time	Feed Rate lb/hr
SARM-II-13B	675	76	599	1:12	1:46	34	1057
II-7	593	58	535	1:46	2:16	30	1070
II-17	604	61	543	2:16	2:45	29	1123
II-	619	71	548	2:45	3:17	32	1028
II-13B	574	61	513	3:17	3:41	24	1283
II-4	620	65	555	3:41	4:13	32	104[illegible]
II-13A	702	64	638	4:13	4:44	31	1[illegible]
II-9	628	52	576	4:44	5:14	30	1[illegible]5
			4507 total				112[illegible]

SARM TEST BURN
JOHN ZINK ROTARY KILN INCINERATOR

TEST NO.: SARM-I-1
DATE: 9/16/87
TIME BEGIN WASTE FEED: _____
TIME BEGIN TESTING: _____

TEST CONDITIONS:

Flue Gas Oxygen	_____	%	Feed Rate	_____	lb/hr
Blowdown Rate	0	gpm	Incinerator Temp.	_____	°F
Venturi Scrubber	_____	in. WG	Residence Time		

PARAMETER	TIME									
KILN										
Temperature, °F										
Combustion Air, inches WC	-2.5									
Continuous O2 % ~~Feed Rate Indicator, lb~~	6.9									
KILN AFTERBURNER										
Temperature, °F										
Combustion Air, inches WC	-4.9									
Continuous Oxygen, %	3.8									
Continuous CO, ppm										
Contionuous CO2, %										
SCRUBBER										
Scrubber flow, % max.										
Blowdown, % max.	0									
Δ P Venturi, in. WG	40 w2									
STACK										
Oxygen, %										
Combustibles, %										

test for 9/15 aborted - seal had to be replaced

NOTES:

DRUM #	FULL WGT (incl. lid) lbs	Time Feed Start	EMPTY WGH	Time Feed Stop
SARM-I-26	633			
SARM-I-21	645			
SARM-I-25	660			
SARM-I-15	613			
SARM-I-17	670			
SARM-I-23	638			
SARM-I-16	640			
SARM-I-24	650			

STACK TEST FIELD DATA SHEETS

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant John Zink Co. - Tulsa

Date 9/14/87

Sampling location Scrubber Outlet

Inside of far wall to outside of nipple 19½"

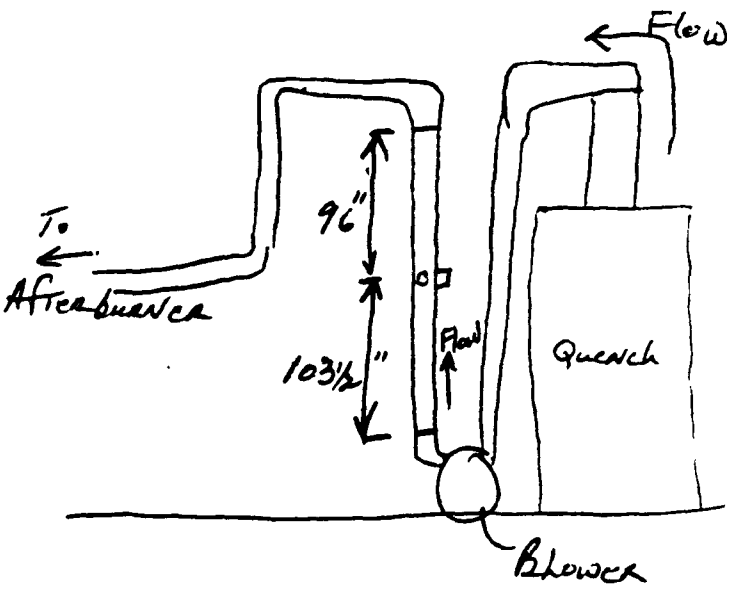
Inside of near wall to outside of nipple (nipple length) 7½"

Stack I.D. 12"

Nearest upstream disturbance 8 dd

Nearest downstream disturbance 8.6 dd

Calculated by CB



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	NIPPLE LENGTH	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	.067	12	≈0.804	7½"	8½"
2	0.25	↓	3	↓	10½"
3	0.75	↓	9	↓	16.5"
4	0.93	↓	11.2	↓	18¼"

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City J. Zink Co. - Tulsa Date 9/14/87

Sampling Location Scrubber Outlet Clock Time 1600

Run No. PV-1 Operator CB - [illegible]

Barometric Pressure, in.Hg 29.38 Static Pressure, in.H_2O +3.6

Moisture, % _____ Molecular wt., Dry _____ Pitot Tube, Cp .84

Stack Dimension, in. Diameter or Side 1 12" Side 2 _____

FIELD DATA

	TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔP_s), in.H_2O	STACK TEMP., °F
Active 3.7	A-1	.80	120
	2	.75	111
	3	.67	108
	4	.62	120
	B 1	.60	100
	2	.55	98
3.5	3	.57	96
	4	.62	96

Ave. Δp = .65 $T_{s_{ave}}$ = 106°F

CALCULATIONS

$M_s = Mc \times (1 - \frac{H_2O}{100}) + 18 (\frac{H_2O\ \%}{100})$

$M_s = (\qquad) \times (1 - \frac{\qquad}{100}) + 18 (\frac{\qquad}{100})$

$M_s =$

$T_s =$ °F = °R = (°F + 460)

$P_s = P_b + \frac{S.P.}{13.6} = (\qquad) + \frac{\qquad}{13.6}$

$P_s =$ in.Hg

$\sqrt{\Delta P} =$

$V_s = 85.49 \times Cp \times \sqrt{\Delta P} \times \sqrt{\frac{T_s, °R}{P_s \times M_s}}$

$V_s = 85.49 \times (\qquad) \times (\qquad) \times \sqrt{\frac{\qquad}{\qquad \times \qquad}}$

$V_s =$ ft/s

$A_s =$ ft²

$Q_s = V_s \times A_s \times \frac{60\ s}{m}$

$Q_s = \qquad \times \qquad \times 60$

$Q_s =$ acfm

$Q_{s_{std}} = Q_s \times 17.647 \times \frac{P_s}{T_s} \times (1 - \frac{H_2O\ \%}{100})$

$Q_{s_{std}} = \qquad \times 17.647 \times \frac{\qquad}{\qquad} \times (1 - \frac{\qquad}{100})$

$Q_{s_{std}} =$ dscfm

180
460
64

FIELD AUDIT REPORT: DRY GAS METER
BY CRITICAL ORIFICE

DATE: 9/14/87 CLIENT: USEPA-HWERL

BAROMETRIC PRESSURE (P_{bar}): 29.38 in.Hg METER BOX NO. FB-3

ORIFICE NO. 7 PRETEST Y: .981 ΔH@ 1.89 in.H_2O

ORIFICE K FACTOR: 5.013×10^{-4} AUDITOR: SB

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft^3	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run Ø min.
2.10	595.7	94	94	103	104	100	18:24:90
	611.1	94		96	97		(18.415)

Dry gas meter V_m, ft^3	$V_{m_{std}}$, ft^3	$V_{m_{act}}$, ft^3	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
15.4	14.332	13.862	.967	1.4 ✓	1.92	+0.03 ✓

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} = \qquad ft^3$$

$$V_{m_{act}} = \frac{1203(\ \emptyset\ )(\ K\ )(P_{bar})}{(T_a + 460)^{1/2}} = \qquad ft^3$$

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = \qquad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pretest Y}}{\text{Pretest Y}} \times 100 =$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\emptyset}{Y\ (V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = \qquad \text{in.}H_2O$$

Audit Y must be in the range, pretest Y ±0.05 Y.
Audit ΔH@ must be in the range pretest ΔH@ ±0.15 inches H_2O.

FIELD AUDIT REPORT: DRY GAS METER
BY CRITICAL ORIFICE

DATE: 9/14/87 CLIENT: USEPA-HWERL

BAROMETRIC PRESSURE (P_{bar}): 29.38 in.Hg METER BOX NO. FT-3

ORIFICE NO. 3 PRETEST Y: .999 ΔH@ 1.64 in.H_2O

ORIFICE K FACTOR: 5.436×10^{-4} AUDITOR: CB

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft³	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run θ min.
2.03 @ 20"Hg	309.8	94	94	94	97	94	15:04:45
	323.0	94		91	93		15.074

Dry gas meter V_m, ft³	$V_{m_{std}}$, ft³	$V_{m_{act}}$, ft³	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
13.2	12.416	12.305	.991	0.8 ✓	1.60	-.04 ✓

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} = \quad ft^3$$

(V_m = 13.2, ΔH = 2.03, T_m = 94)

$$V_{m_{act}} = \frac{1203(\theta)(K)(P_{bar})^{1/2}}{(T_a + 460)} = \quad ft^3$$

(θ = 15.04, K = 5.436×10^{-4}, P_{bar} = 29.38, T_a = 94)

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = \quad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pretest Y}}{\text{Pretest Y}} \times 100 =$$

($V_{m_{act}}$ = 12.305)

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\theta}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = \quad in.H_2O$$

Audit Y must be in the range, pretest Y ±0.05 Y.
Audit ΔH@ must be in the range pretest ΔH@ ±0.15 inches H_2O.

THERMOCOUPLE DIGITAL INDICATOR
AUDIT DATA SHEET

Date 4/14/87 Indicator No. FI-3 Operator CB

Test Point No.	Millivolt signal*	Equivalent temperature, °F*	Digital indicator temperature reading, °F	Difference, %
1 STACK		100	98	0.36 ✓
2		200	199	0.15 ✓
3		300	299	0.13 ✓
4		400	398	0.23 ✓

Percent difference must be less than or equal to 0.5%.

Percent difference:

$$\frac{(\text{Equivalent temperature °R} - \text{Digital indicator temperature reading °R})(100\%)}{(\text{Equivalent temperature °R})}$$

Where °R = °F + 460°F

* These values are to be obtained from the calibration data sheet for the calibration device.

°PARTICULATE

°SEMI-VOLATILES

°METALS

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
J. Zink Co. Tulsa, OKL	9/16/87	Quench Outlet	Part, Hcl, Semi-Vols.

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAISV1	CB	75	~~29.50~~ 29.15	+26	8730060	12	84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (S)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Heated Glass	309		55		FT3	164	999	21	0.018			300	250		30

Pre-Test @ 17" Hg = .016 cfm .004

Pitot L.C @ 7" H_2O (+)-α (-)-α

Pitot ...
Therm 103
Imp I-14
ORSAT 31

□-Change to 3 hr, test ⇒ 15 min/pt.

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F Steam	XAZ °F
	0	1020	327.947										
A1	30.		357.38	1.50	2.93	* 2.93	179	82	81	15.	266	86	
2	60.	*	382.05	1.10	2.16	2.16	181	89	84	15.	269	108	62
3	90.	**	408.887	1.40	2.78	2.78	181	91	90	19.	278	106	
4	120.	1245	433.521	1.10	2.20	2.20	180	101	94	19.	277	118	→ 67
	□												
A1	135 ~~150.~~	1326	447.00	1.00	2.05	2.05	180	110	109	20.	275	106	→ 68
2	150 ~~180.~~		458.40	.90	1.83	1.83	181	105	105	17.	276	109	→ 64
3	165 ~~210.~~		470.2	.95	1.92	1.50	180	95	100	21.	280	111	→ 69
4	182 ~~240.~~	1413	480.128	1.00	2.05	2.30	180	102	97	22.0	275	108	→ 68
							~~180~~						

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant J. ZINK Co. Sample date 9/16/87

Sample location Scrubber Outlet Recovery date 9/16/87

Run No. 5AI-SV-1 Recovered by DS

Filter No(s). 8730060

XAD-2 sorbent trap No. 5AI-SV-1

350
500
754 ml. - NaOH Imp.
858 ml Condensate
495
25
1932
200
2732

MOISTURE

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	____ g	____ g	____ g	____ g	931.7 g
Initial volume wt.	391.9 g	590.6 g	583.4 g	486.4 g	808.4 g
Net volume wt.	____ g	____ g	____ g	____ g	123.3 g
Description of impinger contents	____	____	____	____	____% spent

Total moisture 2855.3 g

2732
123.3
2855.3

RECOVERED SAMPLE

Filter container number(s) 6755-B Sealed ✓

Description of particulate on filter - Rust color -

Probe rinse Container No. 6755-A $MeCl_2$ Blank Container No. 6751-A

Back rinse Container No. 6756-A " Blank Container No. "

Condensate Container No. 6757-A / 6805 A

Impinger Contents Container No. 6758-A 6804-A NaOH Blank Container No. 6752-A

Liquid Levels marked ✓ Samples stored and locked ✓

Remarks FILTER BLNK: 6751-A

* $MeCl_2$ Rinsed into Sample Cont # 6805 (Condensate Only)

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

EMISSION TESTING FIELD DATA

pitot - .6
therm 404
Imp I-1
ORSAT 310

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
J. ZINK CO. TULSA OKL	9/16/87	Quench outlet	Metals

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN Hg)	STATIC PRESS (IN H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAJM-1	JN	75	~~46.35~~ 29.15	+3.6	8710222	12	0.84		0 F 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO.	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' glass	3.3		55		PB3	1.89	98.1	11	0.000	0.044		300	250		30

Stop test @ 83.7 min.

pretest leak check 0.002 @ 17" Hg.

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1020	617.429									
B-1	30		646.784	1.30	3.11	3.11	180	85	83	4.	262	66
2	60.		676.02	1.30	3.13	3.13	180	93	87	5.	227	72
3	83.7	1245	696.819	1.20	2.95	2.95	181	110	92	9.	258	79
~~4~~	~~120.~~											
A-1	47 ~~60.~~											
2	105 ~~180.~~											
3	112.5 ~~210.~~											
4	120 ~~240.~~											

Res

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant John Zink Co. - Tulsa Sample date 9/16/87

Sample location Scrubber Outlet Recovery date 9/16/87

Run number SAI-M-1 Recovered by DS

Filter number(s) 87/0222

MOISTURE

Impingers		Silica gel	
Final volume (wt)	ml (g)	Final wt	890.2 g
Initial volume (wt)	583.7; 592.6; 510.5 ml (g)	Initial wt	827.3/850.2 g
Net volume (wt)	ml (g)	Net wt	40.0 g
Description of impinger water			% spent

218
438
672 ml Condensate
1328

Total moisture ~~1348~~ ① g + Silica Gel
1328 + 40 + 60 ⇒ ↑ insured

RECOVERED SAMPLE

Filter container number(s) 6753-B Sealed ✓

Description of particulate on filter - Rust color -

Acetone probe rinse container no.	NA	Liquid level marked	NA
Acetone blank container no.	NA	Liquid level marked	NA
0.1 N HNO_3 probe rinse container no.	6753-A	Liquid level marked	✓
Impinger contents container no.	① 6754-A ② 6803A	Liquid level marked	✓
0.1 N HNO_3 blank container no.	6750-A	Liquid level marked	✓

Samples stored and locked

Remarks Filter Blank: #6750-B

LABORATORY CUSTODY

Received by Date

Remarks

① 1st Silica Gel wt not added (Imp. broke)

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Tiche Finl Co.	8/26/87	Rework Outlet	Part, HCl, Form Vols.

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
STATION 2	(9)	86	29.1	-1.07	873 0047	12	.84		10 of

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3 Heated Glass	.25		5.5 48.0		873	1.64	.999	22	.007	.9465		300	275		

L.C. Vol. adj. = 535.734

Pre-Test L.C @ 20" Hg ⇒ 0.011 cfm

Pitot L.C
(+) α
(−) α

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	XAD
	0	1625	480.376										
A1	22.5		493.23	1.05	.88	.88	177	100	99	6.	274	113	59
2	45.0		506.50	1.2	1.00	1.00	179	96	97	7.	278	105	61
3	67.5		521.60	1.1	1.25	1.25	179	98	92	10.	280	97	63
4	90.0	1840	535.664	.98	1.12	1.12	181	100	91	12.	274	92	66°
		Rotor 1900											
B1	112.5		551.08	1.20	1.37	1.37	181	98	97	14.	280	75	58
2	135.		566.78	1.20	1.37	1.37	181	101	95	16.	274	77	62
3	157.5		581.58	1.0	1.15	1.15	181	101	96	17.	275	72	60°
4	180.	2030	596.738	1.1	1.26	1.26	181	102	97	18.0	275	69	58

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Zinc
Sample location Outlet
Run No. SAI[redacted]K 2
Filter No(s). 873 0047
XAD-2 sorbent trap No. SAI[redacted]-2 SV

Sample date 9/16/87
Recovery date 9/1/87
Recovered by DS

MOISTURE

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	___ g	___ g	___ g	___ g	1072.3 g
Initial volume wt.	400.2 g	486.2 g	587.4 g	581.9 g	831.9 g
Net volume wt.	___ g	___ g	___ g	___ g	240.4 g
Description of impinger contents	___	___	___	___	___ % spent

Total moisture 2507.4 g

~~375~~
~~500~~
3775
495
497
400
240.4 SV
2507.4

RECOVERED SAMPLE

Filter container number(s) 6808-B Sealed ✓
Description of particulate on filter Light Tan

Probe rinse
Container No. 6808 A MeCl2 Blank Container No. 6751 A

Coal Back rinse
Container No. 6809 A " Blank Container No. "

Condensate Container No. 6810 A / 6826 A

Impinger Contents
Container No. 6811 A NaOH Blank Container No. 6752 A

Liquid Levels marked ✓ Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by _____ Date _____

Remarks _____

EMISSION TESTING LD L....

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
LTI. ZINK CO. TULSA OK	9/16/80	QUENCH OUTLET	METALS

pilot therm Imp I-14

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAI-NR	JN CO	86	29.11	+4.9	8791 9732	12	.84		0 F

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR .0024	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3 Heated Glass	.25		5.5 48		F83	1.89	9.81	6	.009	[redacted]	NA	250	250	NA	15

pre exit leak check 0.002 at 16" Hg

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1628	697.158									
A1	15.		706.17	1.00	1.01	1.01	178	104	102	2.	268	75
2	30.		715.16	1.1	1.12	1.12	179	108	103	1.	271	79
3	45.		723.66	1.05	1.07	1.07	178	106	102	2.	274	84
4	60.	1814	733.284	1.00	1.35	1.35	179	106	100	2.	280	92
	Notes	1846										
A 1	75.	1902	742.60	.95	1.28	1.28	180	104	100	3.	278	86
2	90.		753.09	1.2	1.62	1.62	182	105	99	4.	280	84
3	105.		763.40	1.1	1.49	1.49	182	106	98	5.	278	75
4	120.	1955	773.235	1.25	1.69	1.69	181	105	98	6.0	280	84

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Zinc Sample date 9/17/87

Sample location Quench Outlet Recovery date 9/17/87

Run number SAI-M-2 Recovered by DB

Filter number(s) 87/0132

MOISTURE

Impingers			Silica gel		
Final volume (wt)	1425	ml (g)	Final wt	1058.8	g
Initial volume (wt)	~~677.6; 644.9; 477.2~~ 200	ml (g)	Initial wt	826.8	g
Net volume (wt)	1225	ml (g)	Net wt	232.0	g
Description of impinger water	Clear			100	% spent

1225
232
1457

Total moisture 1457.0 g

RECOVERED SAMPLE

Filter container number(s) 6806 B Sealed ✓

Description of particulate on filter Rusty Color

Acetone probe rinse container no.	NA	Liquid level marked	
Acetone blank container no.	NA	Liquid level marked	
0.1 N HNO_3 probe rinse container no.	6806 A	Liquid level marked	✓
Impinger contents container no.	~~6807 A~~ 6807 A	Liquid level marked	✓
0.1 N HNO_3 blank container no.	6750-A	Liquid level marked	✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Tinker Air Force Base, Oklahoma City	4/17/87	Quench Outlet	Particulate, HCl, Formaldehyde

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (in. Hg)	STATIC PRESS (in. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
6A, 5, 6, 7, 8	(CB)	75	29.31	-4.0	8739954	12	.84		0 of

Pitot L.C. -.01 for

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (s)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK in. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Heated Glass	.245		4.8		BT3	1.64	.999	22	0.014	1.902	.84	250	250		

Pre-Test @ 20" Hg ⇒ 0.017 cfm

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	RAD
	0	1041	597.654										
A1	22.5		611.25	1.00	1.09	1.09	178	84	83	10	273	92	254°
2	45		627.50	1.4	1.53	1.53	178	87	83	15.5	274	84	257°
3	67.5		643.37	1.3	1.42	1.42	181	91	85	19.0	277	89	260°
4	90.0	1218	658.655	1.3	1.44	1.38	182	94	88	21.0	278	84	259°
	Update 1225												
B1	112.5		673.70	1.1	1.21	1.21	183	92	91	19.0	279	88	264°
2	135		688.48	1.1	1.22	1.22	182	95	91	21.0	279	81	261°
3	157.5		703.82	1.3	1.44	1.35	179	98	94	22.0	277	77	263°
4	180.0	1409	718.546	1.0	1.11	1.11	181	98	96	21	278	81	266°F

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant J. ZINK CO
Sample location OUTLET
Run No. SAI SV-3
Filter No(s). 8730054
XAD-2 sorbent trap No. SAI SV-3

Sample date 9/17/87
Recovery date 9/17/87
Recovered by [illegible]

MOISTURE

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	____ g	____ g	____ g	____ g	850.1 g 906.9
Initial volume wt.	393.8 g	492.1 g	594.3 g	583.6 g	806.3 g 865.2
Net volume wt.	____ g	____ g	____ g	____ g	43.8 g 41.
Description of impinger contents	____	____	____	____	____% spent

500
390
500
350
515
400
417
43.8
2739.5

Total moisture 2739.5 g

RECOVERED SAMPLE

Filter container number(s) 6817 B Sealed ✓
Description of particulate on filter TAN

Probe rinse Container No. 6817 A MeCl2 Blank Container No. 6751 A
Back rinse Container No. 6818 A MeCl2 Blank Container No. 6751 A
Coil Rinse
Condensate Container No. 6819 A / 6820 A / 6830 A
Impinger Contents Container No. 6825 A NaOH Blank Container No. 6752 A
Liquid Levels marked ✓ Samples stored and locked ✓
Remarks

LABORATORY CUSTODY

Received by ____ Date ____
Remarks ____

EMISSION TESTING ...D DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
J. Zink Co. Tulsa, OKL	9/17/87	Quench Outlet	Metals

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAI-M-3	JN-CB	75	29.37	+4.00	87/0013	12	84		10 of 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	.25		48		FB3	1.89	.981	10	.000	.0024	NA	250	250		

Pre-test @ 17" Hg ⇒ 0.0 cfm
Pitot L.C. -B2

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1044	773.367									
B1	15.		784.35	1.4	1.82	1.82	178	84	83	1.0	270	79
2	30.		795.07	1.3	1.70	1.70	179	90	82	2.5	275	74
3	45.		806.30	1.4	1.85	1.85	179	97	83	4.0	275	72
4	60.	1144	817.366	1.3	1.73	1.73	182	98	87	5.0	277	78
	Restart	1224										
A1	75.		829.05	1.5	1.99	1.99	181	94	90	4.0	275	72
2	90.		840.10	1.3	1.73	1.73	182	99	90	4.0	274	77
3	105.		850.92	1.2	1.61	1.61	183	105	94	5.0	277	79
4	120.	1324	862.995	1.5	2.01	2.01	180	108	95	7.0	276	72

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Zink Sample date 9/17/87

Sample location Outlet Recovery date 9/17/87

Run number SAI-M-[illegible] Recovered by DS

Filter number(s) 8710113

MOISTURE

Impingers			Silica gel		
Final volume (wt)		ml (g)	Final wt		g
Initial volume (wt)	579.7 602.1	ml (g)	Initial wt	512.0 794.2	g
Net volume (wt)	1930	ml (g)	Net wt	?	g
Description of impinger water				100 % spent	

Silica Gel Broken

500
595
500
415
930

Total moisture 1930 + S.Gel + 100 assumed g

RECOVERED SAMPLE

Filter container number(s) 6812 B Sealed ✓

Description of particulate on filter TAN

Acetone probe rinse container no.		Liquid level marked	
Acetone blank container no.		Liquid level marked	
0.1 N HNO_3 probe rinse container no.	6812 A	Liquid level marked	✓
Impinger contents container no.	~~6813 A~~	Liquid level marked	✓
0.1 N HNO_3 blank container no.	~~6829 A~~ 6750 A	Liquid level marked	✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

I...SSI TES IG LD A

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Frank Thulsa, OK	9/17/87	Quench Outlet	Part; HCl; Semi Vol.

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	SARM II - Low Level FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAE-541	[illegible]	90	29.37	+2.0	8730068	12	84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	250		48		FT3	164	.997			.002		250	275		225

1 se-test L.C. @ 21 "Hg ⇒ 0.011 cfm
Pitot L.C. ⇒ ok

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	XAD °F
	0	1655	719.948										
A1	22.5		733.67	.90	1.01	1.01	180	104	102	6.	278	100	→ 66
2	45.0		748.81	1.1	1.24	1.24	178	105	102	8.	274	96	→ 61
3	67.5		763.18	1.0	1.13	1.13	181	106	102	8.	273	88	→ 59
4	90.0	1833	778.873	1.2	1.35	1.35	182	107	102	10.	274	83	→ 60
	[illegible]	1847											
B1	112.5		794.19	1.2	1.35	1.35	181	102	101	11.0	273	79	→ 59
2	135.0		809.45	1.1	1.22	1.22	181	101	98	12.0	274	75	→ 55
3	157.5		825.15	1.3	1.45	1.45	182	100	96	13.	272	70	→ 57
4	172 ~~[illegible]~~	2015	835.270	1.3	1.45	1.45	181	99	94	15.	275	70	→ 60

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant I Zink. Co.
Sample location Outlet
Run No. SA II-SV-1
Filter No(s). 8730068
XAD-2 sorbent trap No. SA II SV-1

Sample date 9/17/87
Recovery date 9/17+18/87
Recovered by DS

MOISTURE

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	____ g	____ g	____ g	____ g	892.2 g ✓ BR
Initial volume wt.	____ g	____ g	____ g	____ g	867.2 g 850.7
Net volume wt.	____ g	____ g	____ g	____ g	25.0 g
Description of impinger contents	____	____	____	____ *	____ % spent

Total moisture 2470 + 25 (assumed) g without broke silica gel. ⇒ 2495 CA 9/22

25
500
380
510
500
500
55
2470

RECOVERED SAMPLE

Filter container number(s) 6821 B Sealed ____

Description of particulate on filter ____

Probe rinse Container No. 6821 A MeCl2 Blank Container No. 6751A

Coil Back rinse Container No. 6822 A MeCl2 Blank Container No. 6751A

Condensate Container No. 6823 A / 6828 A

Impinger Contents Container No. 6824 A NaOH Blank Container No. 6752A

Liquid Levels marked ✓ Samples stored and locked ✓

Remarks ____

LABORATORY CUSTODY

Received by ____ Date ____

Remarks ____

E...SIC.. PES G .D I A

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Zink - Tulsa, Ok.	9/17/87	Quench Outlet	Metals

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN Hg)	STATIC PRESS (IN H_2O)	SARM II - Low Level FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAII-A1	[illegible]	90	2937	+4.0	8769196	12	84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	259		48		F.B3	1.89	.981	5	.099	.0024		250	250		15

Pre-test @ 17" Hg ⇒ 0.0 cfm
Pitot LC ⇒ OK

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_o), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1700	863.190									
A1	15.		873.20	.97	1.31	1.31	178	106	104	1.	280	79
2	30.		883.54	1.1	1.49	1.49	178	111	103	2.	270	87
3	45.		894.50	1.2	1.63	1.63	179	113	103	2.	272	79
4	60.	1800	904.855	1.05	1.43	1.43	181	111	103	2.	275	78
	[illegible]	1836										
B1	75.		916.26	1.3	1.76	1.76	182	105	100	3.	272	79
2	90.		927.35	1.2	1.62	1.62	182	105	98	2.	270	74
3	105.		938.40	1.2	1.62	1.62	181	106	98	3.	269	69
4	120.	1936	949.724	1.3	1.75	1.75	183	105	97	3.	271	69

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant FINK Sample date 9/17/87

Sample location Quench Outlet Recovery date 9/17/87

Run number SA II M-[redacted]1 Recovered by DS/JN

Filter number(s) 8710106

MOISTURE

Impingers			Silica gel		
Final volume (wt)		ml (g)	Final wt	863.2 g	928.8
Initial volume (wt)	597.8 594.7	ml (g)	Initial wt	~~842.3~~	881.5
Net volume (wt)		ml (g)	Net wt	20.9 g	47.3
Description of impinger water				% spent	

500
468
500
365
47.3
1901.2

Total moisture 1901.2 g

RECOVERED SAMPLE

Filter container number(s) 6814 B Sealed ✓

Description of particulate on filter TAN

Acetone probe rinse container no.		Liquid level marked	
Acetone blank container no.		Liquid level marked	
0.1 N HNO_3 probe rinse container no.	6814 A	Liquid level marked	✓
Impinger contents container no.	6814 / 6815 A	Liquid level marked	✓ / ✓
0.1 N HNO_3 blank container no.	6[illegible]-DA	Liquid level marked	✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Birk, Tulsa, OKL	8/18/87	Quench Outlet	Part, HCl, Semi-VOC

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SATURD	(GB)	65	29.5	-1.0	873095	12	.84		(0,F)

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (B)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
31 Glass	.250		52		FB	1.44	.999	15	.0003	.00017		300	250		2.25

Pre Test @ 18" Hg ⇒ 0.004 cfm

Pitot L.C. ⇒ OK

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (ΔP_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	XAd
	0	0944	835.386										
A 1	22.5		849.41	1.3	1.16	1.16	179	66	65	8.	252	61	→ 3
a	45.0		863.40	1.2	1.08	1.08	181	69	65	7.	261	63	→ 5
3	67.5	*1052	876.021	1.2	1.08	1.08	181	72	67	7.	266	64	→ 55
4	90.0	1125	888.918	1.3	.99	.99	181	74	68	10.	269	64	→ 56
	Leak	1133											
B 1	112.5		903.15	1.3	1.17	1.17	181	72	69	10.	271	63	→ 53
2	135.0		918.05	1.4	1.27	1.27	180	76	71	12.	272	57	→ 55
3	157.5		932.95	1.4	1.27	1.27	183	78	72	14.	275	56	→ 56
4	180.0	1308	947.728	1.4	1.27	1.27	182	77	73	14.	274	66	→ 61%

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Zink
Sample location Outlet
Run No. SA II SV-2
Filter No(s). 8730051
XAD-2 sorbent trap No. SA II SV-2

Sample date 9/18/87
Recovery date 9/18/87
Recovered by DS

MOISTURE

525
420
500
500
387
365
36.6
2723.6

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	____ g	____ g	____ g	____ g	858.2 g 857.3
Initial volume wt.	____ g	____ g	____ g	____ g	843.7 g 835.7
Net volume wt.	____ g	____ g	____ g	____ g	14.5 g 22.1
Description of impinger contents	____	____	____	____	____% spent

Total moisture 2723.6 g

RECOVERED SAMPLE

Filter container number(s) 6831 B Sealed ✓
Description of particulate on filter Brown

Probe rinse Container No. 6831 A MeCl2 Blank Container No. 6751 A

Back rinse Container No. 6832 A MeCl2 Blank Container No. 6751 A

Condensate Container No. 6833 A / 6834 A / 6851 A

Impinger Contents Container No. 6835 A NaOH Blank Container No. 6751 A

Liquid Levels marked ✓ Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

[illegible] TES[illegible]G [illegible]D A

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Rink, Tuksay, ORL	9/18/87	Quench Outlet	Metals

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN Hg)	STATIC PRESS (IN H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
3	[illegible]	66	29.50	-1.49	87 0232	12	.84		70 F 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	.33		52		FT3/44	1.89	7	20.9	.993	NA	300	275			15

Pre-test L.C. @ 19" Hg ⇒ 0.001 cfm

Pitot L.C. ⇒ OK

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	0933	949.934									
A-1	15.		959.69	1.3	1.37	1.37	178	65	65	1.	280	54
2	30.		969.58	1.3	1.37	1.37	182	65	65	2.	279	54
3	45.		979.64	1.4	1.48	1.48	180	76	66	3.	275	55
4	60.	1033	988.559	1.1	1.17	1.17	180	79	69	3.	268	56
	[illegible]	1134										
B 1	75		998.74	1.4	1.49	1.49	182	77	69	3.5	270	54
2	90.		1009.12	1.4	1.50	1.50	181	77	70	3.5	281	57
3	105.		1019.16	1.3	1.40	1.40	179	82	71	4.0	279	56
4	120.	1234	1029.359	1.4	1.51	1.51	181	83	73	4.	274	62

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Fink Sample date 9/18/87

Sample location Quench Outlet Recovery date 9/18/87

Run number SA II M-2 Recovered by DS

Filter number(s) 8710232

MOISTURE

Impingers			Silica gel			
Final volume (wt)		ml (g)	Final wt	875.4	g	940.7
Initial volume (wt)		ml (g)	Initial wt	852.2	g	903.2
Net volume (wt)		ml (g)	Net wt	23.2	g	37.5
Description of impinger water					% spent	

500
495
500
45
37.5
23.2
98.7

Total moisture 1898.7 g

RECOVERED SAMPLE

Filter container number(s) 6836 B Sealed ✓

Description of particulate on filter TAN

Acetone probe rinse container no.		Liquid level marked	
Acetone blank container no.		Liquid level marked	
0.1 N HNO_3 probe rinse container no.	6836 A	Liquid level marked	✓
Impinger contents container no.	~~6848 A~~ 6837 A	Liquid level marked	✓/✓
0.1 N HNO_3 blank container no.	6850 A	Liquid level marked	✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Zinke Tulsa, OK	9/18/87	Cyclone Outlet	Part., HCl, Semi-VOC

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (in. Hg)	STATIC PRESS (in. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
SAM-3V-3	[illegible]	64	29.50	+.6	8730945	12	.84		0, F

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK (in. Hg)	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	.259		52		FT3	1.64	.999	1.0	0.006	.0017	.84	275	275		225

POST

A- Chng. imp/s. Gel

Pre-test @ 17" Hg ⇒ 0.001 cfm

Pitot Cp ⇒ .84

7 8 9 10	11 12 13 14	15 16 17 18	19 20 21 22 23 24	25 26 27 28 29	30 31 32 33 34 35 36 37	38 39 40 41	42 43 44	45 46 47	48 49 50 51	52 53 54	55 56 57
TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED / ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1350	947.944								
A1	22.5		962.54	1.35	1.23 / 1.23	182	75	75	7.	270	66
2	45.0		977.39	1.40	1.27 / 1.27	181	78	73	8.	279	65
3	67.5*		992.871	1.45	1.33 / 1.33	181	81	75	9.	277	64
4	90.0	1527	1007.436	1.2	1.19 / 1.19	181	84	77	9.	280	65
	Leak	1542	[redacted]								
B1	112.5		1022.210	1.4	1.28 / 1.28	181	80	78	10.	270	64
2	135.0		1036.815	1.3	1.19 / 1.19	181	82	78	10.	275	66
3	157.5		1050.80	1.2	1.11 / 1.11	181	85	79	11.	276	65*
4	180.0	1718	1065.644	1.4	1.29 / 1.29	182	87	80	11.	270	66

XAD Temp

→61

→59

→59

→62

→61

→60

→59

→61

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant ZINC
Sample location Outlet
Run No. SA II SV-3
Filter No(s). 8730045
XAD-2 sorbent trap No. SA II SV-3

Sample date 9/18/87
Recovery date 9/18/87
Recovered by DS

MOISTURE

	1st impinger	2nd impinger	3rd impinger	4th impinger	Silica gel
Final volume wt.	____ g	____ g	____ g	____ g	905.3 g 814.7
Initial volume wt.	____ g	____ g	____ g	____ g	881.8 g 792.4
Net volume wt.	____ g	____ g	____ g	____ g	____ g
Description of impinger contents	____	____	____	____	____% spent

500
390
100
390
500
500
75

Total moisture 2855 g

RECOVERED SAMPLE

Filter container number(s) 6841 B Sealed ✓
Description of particulate on filter - Light Beige color -

Probe rinse Container No. 6841 A Me Cl2 Blank Container No. 6751 A

Back rinse (coil) Container No. 6842 A Me Cl2 Blank Container No. 6751 A

Condensate Container No. 6838 A / 6840 A / 6852 A

Impinger Contents Container No. 6843 A NaOH Blank Container No. 6757 A

Liquid Levels marked ✓ Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by ____ Date ____

Remarks

EMISSION TESTING ...LD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
Zink Tulsa, OKL	4/18/87	Quench Outlet	Metals

RUN NO.	OPERATOR	AMB TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
3A-M-3	CB	66	295	+4.9	8710131	12	.84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3' Glass	.259		52		FB3	1.89	.981	6	.000	.992		275	275	.44	15

Pre-Test @ 13"Hg ⇒ 0.0 cfm
Pitot LC ⇒ ok

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1337	30.000									
A-1	15.		39.38	1.3	1.39	1.39	182	76	73	1.	275	66
2	30.		49.40	1.3	1.39	1.39	182	80	73	2.	270	64
3	45.		59.76	1.4	1.50	1.50	181	83	74	2.	277	63
4	60.	1437	69.100	1.1	1.19	1.19	181	86	76	2.	273	64
	Reduct →	1539	.	.	.	.				.		
B-1	75.		80.00	1.5	1.62	1.62	182	81	77	2.	280	61
2	90.		90.420	1.4	1.51	1.51	181	82	77	3.	277	61
3	105.		99.67	1.1	1.19	1.19	181	87	78	3.	281	64
4	120.	1639	109.416	1.2	1.31	1.31	182	88	78	3.	282	66

LEAD SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Zink Sample date 9/15/87

Sample location Cutter Recovery date 9/18/87

Run number SA II M-3 Recovered by DS

Filter number(s) 87-0131

MOISTURE

Impingers			Silica gel	No. 1	No. 2
Final volume (wt)		ml (g)	Final wt	846.1 g	862.9
Initial volume (wt)	200	ml (g)	Initial wt	821.6 g	842.2
Net volume (wt)		ml (g)	Net wt	24.5 g	20.7
Description of impinger water				% spent	

30
500
500
700
335

Total moisture 1889.5 + 20.7 ⇒ 1910.2 (cp) 9/22

RECOVERED SAMPLE

Filter container number(s) 6844 B Sealed ✓

Description of particulate on filter Light Beige

Acetone probe rinse container no.	NA	Liquid level marked	
Acetone blank container no.	NA	Liquid level marked	
0.1 N HNO_3 probe rinse container no.	6844 A	Liquid level marked	✓
Impinger contents container no.	6845 A / 6846 A	Liquid level marked	✓ / ✓
0.1 N HNO_3 blank container no.	6750 A	Liquid level marked	✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by Date

Remarks

°VOLATILES

VOST SAMPLING DATA

Date 9-18-87 Location John Zink, Tulsa, Ok Run No. SAII-V-3C Operator G. Howard

Test Condition SARM-II Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 836 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 17.5 in.Hg vacuum

Barometric Pressure (P_b) 29.52 in.Hg Ambient Temperature 70 °F Probe Purged 12 minutes at 0.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	14:50	50.695	34	2.0	125	67	269		
10	15:00	56.35	34	3.0	126	63	278		
20	15:10	61.18	34	3.0	129	64	275		
30	15:20	66.23	34	3.5	128	67	281		
40	15:30	71.278	34	4.0	128	68	275		
	V_m	20.583	✓	Avg.	127.2	✓			

Post-Test Leak Check 0.0 in.Hg/min at 9.5 in.Hg Vacuum Trap Pair Label No. SAII-V-3C

Flow Direction Marked? ✓ Condensate Recovered? ✓ VOA Label Nos. SAII-V-3 condensate

Total Volume of Condensate in Vials, 14.0 ml Remaining Condensate 33.0 mls Total Condensate Vol. 47.0 ml

Traps and Vial Stored in Can No. 3 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg/min @ 18.0 "Hg vacuum

Corresponding Blank Nos. SAII-V-3FB pr. #833 leak check 0.0 @ 15.0 "Hg

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 18.303 liters ✓ kll

VOST SAMPLING DATA

Date 9-16-87 Location JOHN ZINK, TULSA, OK. Run No. SA1-V-1a Operator G Howard

Test Condition Sarm I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 851 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) 29.15 in.Hg Ambient Temperature 75 °F Probe Purged 12 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	10:22	69.235	34	3.0	96	62	266		
10	10:32	75.17	34	2.0	~~10~~99	57	271		
20	10:42	80.85	34	2.0	103	59	265		
30	10:52	86.49	34	2.0	108	62	281		
40.0	11:02	92.200	34	2.0	113	64	278		
	V_m	22.965 ✓		Avg.	103.8 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 4.5 in.Hg Vacuum Trap Pair Label No. SA1&V-1a

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. _____

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 1 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 " Hg/min @ 18.0 "Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, °R}$ = 21.016 liters ✓ RH

VOST SAMPLING DATA

Date 9-16-87 Location JOHN Zink; Tulsa, OK Run No. SAI-V-1b Operator G. Howard

Test Condition SARM I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 847 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 14.0 in.Hg vacuum

Barometric Pressure (P_b) 29.13 in.Hg Ambient Temperature 78 °F Probe Purged 20 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	11:25	92.288	34	2.0	112	64	281		
10	11:35	98.0	33	2.0	114	62	287		
20	11:45	103.3	33	2.0	118	63	285		
30	11:55	108.62	33	2.0	121	64	284		
40.0	12:05	103.965	33	2.0	124	68	279		
	V_m	21.677 ✓		Avg.	117.8 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 5.0 in.Hg Vacuum Trap Pair Label No. SAI-V-1b

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 1 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg/min. @ 18.0 "Hg

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.357 liters ✓ KM

VOST SAMPLING DATA

Date 9-16-87 Location John Zink, Tulsa Ok Run No. SAI-V-1C Operator _____

Test Condition SARM. I Sampling Train No. _____ Meter Console No. _____ Y-Factor 1.003

Trap Nos. 850 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) 29.13 in.Hg Ambient Temperature 80 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	13:02	14.141	33	3.0	125	68	281		
10	13:12	19.03	33	5.0	129	63	280		
20	13:22	24.55	34	5.5	132	64	269		
30	13:32	30.00	34	5.5	133	65	286		
40	13:42	35.500	34	5.5	134	68	286		
V_m		21.359 ✓		Avg.	130.6 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 7.0 in.Hg Vacuum Trap Pair Label No. SAI-V-1C

Flow Direction Marked? ✓ Condensate Recovered? ✓ VOA Label Nos. SAI-V-1 CONDENSATE

Total Volume of Condensate in Vials, 14 ml Remaining Condensate 28 mls Total Condensate Vol. 42.0 ml

Traps and Vial Stored in Can No. 1 on Ice? ✓ Culture Tubes and Can Purged With N_2? _____

Comments:

Probe Leak Check Data: 0.0"Hg/min. @ 18.0"Hg

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 18.659 liters ✓ P.H

VOST SAMPLING DATA

Date 9-16-87 Location John Zink; Tulsa, Okla Run No. SAI-V-2a Operator G. Howard

Test Condition SARM I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 830 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 14.5 in.Hg vacuum

Barometric Pressure (P_b) 29.15 in.Hg Ambient Temperature 80 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rotameter setting	Sampling train vacuum, in.Hg	Dry gas meter temperature, °F	Primary condenser exit temp., °F	Probe temperature, °F		
0	16:23	35.544	34	2.0	121	68	276		
10	16:33	41.35	34	2.0	122	60	272		
20	16:43	46.51	34	3.0	127	64	273		
30	16:53	52.50	34	3.5	130	63	279		
—	17:49	58.092	34	4.0	125	68	275		
	V_m	22.548	✓	Avg.	125.0	✓			

Post-Test Leak Check 0.0 in.Hg/min at 8.0 in.Hg Vacuum Trap Pair Label No. SAI-V-2a

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 1 on Ice? _____ Culture Tubes and Can Purged With N_2? _____

Comments: Test interrupted at 32.0 minutes - dgm 53.628
- resume testing @ 17:41

Probe Leak Check Data: 0.0 "Hg/min @ 18.0 "Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters $\times Y \times 17.647 \times \frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.887 liters ✓ RH

VOST SAMPLING DATA

Date 9-16-87 Location John Zink; Tulsa, Ok Run No. SAI-V-2b Operator G. Howard

Test Condition SARM I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 828 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 16.6 in.Hg vacuum

Barometric Pressure (P_b) 29.15 in.Hg Ambient Temperature 79 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	18.07	58.176	33	2.0	~~7~~	68	~~68~~ 2		
10	18.17	63.75	33	2.0	127	68	286		
20	18.27	69.48	33	2.0	130	63	266		
30	18.37	75.27	33	2.0	132	64	268		
40.0	18.47	80.073	33	2.5	134	62	271		
	V_m	21.897 √		Avg.	130.75 √				

Post-Test Leak Check 0.0 in.Hg/min at 6.5 in.Hg Vacuum Trap Pair Label No. SAI-V-2b

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 1 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0"Hg/min. @ 18.0"Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.125 liters √ RTB

VOST SAMPLING DATA

Date 9-16-87 Location John Zink, Tulsa, Ok Run No. SAI-V-2C Operator G. Howard

Test Condition SARM-I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 829 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 17.0 in.Hg vacuum

Barometric Pressure (P_b) 29.15 in.Hg Ambient Temperature 78 °F Probe Purged 17 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	19:08	80.082	33	72.0	135	67	281		
10	19.18	85.61	33	3.0	136	65	269		
20	19.28	91.50	33	3.5	135	66	269		
30	19.38	96.31	33	4.0	134	67	271		
40.0	19.48	101.880	33	4.0	136	68	266		
	V_m	21.798 ✓		Avg.	135.2 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 7.0 in.Hg Vacuum Trap Pair Label No. SAI-V-2C

Flow Direction Marked? ✓ Condensate Recovered? ✓ VOA Label Nos. SAI-V-2 condensate

Total Volume of Condensate in Vials, 14 ml Remaining Condensate 25.6 mls Total Condensate Vol. 39.6 ml

Traps and Vial Stored in Can No. 1 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg/min @ 18.0 "Hg vacuum

Corresponding Blank Nos. SAI-V-12FB pi # 823 leak check - 0.0 @ 16.0 "Hg @ 20:00

1) $V_{std} = V_m, \text{ liters} \times Y \times 17.647 \times \frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}} = 18.896$ liters ✓ KH

25
14.6
39.6

VOST SAMPLING DATA

Date 9-17-87 Location John Zink, Tulsa, Ok. Run No. SAI-V-3a Operator G. Howard

Test Condition SARM-I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 826 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 17.0 in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg Ambient Temperature 80 °F Probe Purged 12 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	10:40	01.933	33	>2.0	104	68	269		
10	10:50	07.67	33	2.0	107	61	270		
20	11:00	13.21	33	2.0	110/112	60	278		
30	11:10	18.90	33	3.0	116	62	277		
40	11:20	24.423	33	3.5	122	63	275		
	V_m	22.490	✓	Avg.	112.2	✓			

Post-Test Leak Check 0.0 in.Hg/min at 8.0 in.Hg Vacuum Trap Pair Label No. SAI-V-3a

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. _____

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg min. @ 18.0 "Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 20.432 liters ✓

VOST SAMPLING DATA

Date 9-17-87 Location John Zink; Tulsa, Ok Run No. SAI-V-3b Operator G. Howard

Test Condition SARM I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 824 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg Ambient Temperature 80 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	11:38	24.468	33	72.0	123	68	279		
10	11:48	30.00	33	2.0	128	66	271		
20	11:58	35.51	33	2.0	132	64	275		
30	12:08		33	2.0	136	65	280		
40.0	12:18	46.348	33	2.0	142	68	282		
	V_m	21.880	✓	Avg.	132.2	✓			

Post-Test Leak Check 0.0 in.Hg/min at 5.5 in.Hg Vacuum Trap Pair Label No. SAI-V-3b

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0" Hg/min @ 18.0" Hg vacuum

Corresponding Blank Nos.

*) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.207 liters ✓ RH

VOST SAMPLING DATA

Date 9-17-87 Location John Zink; Tulsa, Ok Run No. SAI-V-3c Operator G. Howard

Test Condition SARM-I Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 825 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 14.5 in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg Ambient Temperature 80 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	12:40	46.428	33	2.5	140	~~27~~ 67	271		
10	12:50	51.75	33	3.0	141	66	276		
20	13:00	56.98	33	3.5	143	64	279		
30	13:10	61.85	33	4.5	145	66	284		
40.0	13:20	68.810	35	5.0	148	67	274		
V_m		22.382	✓	Avg.	~~143.2~~	143.4 RH			

Post-Test Leak Check 0.0 in.Hg/min at 7.0 in.Hg Vacuum Trap Pair Label No. SAI-V-3c

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, 14 ml Remaining Condensate 28 mls Total Condensate Vol. 42.0 ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0" Hg/min. @ 18.0" Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{in.Hg}}{T_m, °R}$ = ~~19.284~~ liters 19.283 RH

25
17
42
14
28

VOST SAMPLING DATA

Date 9-17-87 Location John Zink, 9 Run No. SAII-V-1a Operator G. Howard

Test Condition Sasm-II Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.005

Trap Nos. 827 From Can No. — Pretest Leak Check 0.0 in.Hg/min at 16.0 in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg RH Ambient Temperature 80 °F Probe Purged 10 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rotameter setting	Sampling train vacuum, in.Hg	Dry gas meter temperature, °F	Primary condenser exit temp., °F	Probe temperature, °F		
0	16:55	68.864	34	2.0	138	65	281		
10	17:05	75.00	34	2.0	140	63	278		
20	17:15	80.01	34	2.0	142	62	277		
30	17:25	85.57	34	2.0	146	63	285		
40.0	17:35	91.420	34	2.5	145	68	277		
V_m		22.556 ✓		Avg.	142.2 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 5.0 in.Hg Vacuum Trap Pair Label No. SAII-V-1a

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0" Hg/min. @ 18.0" Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = ~~19.411~~ liters 19.471 RH

VOST SAMPLING DATA

Date 9 17 87 Location John Zink, Tulsa, Ok Run No. SAII-V-1b Operator [illegible]

Test Condition SARM-II Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 820 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 14.0 in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg Ambient Temperature 83 °F Probe Purged 15 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	18:00	91.867	33	2.0	144	69	275		
10	18:10	97.30	34	4.0	146	66	280		
20	18:20	102.58	34	4.0	148	63	285		
30	18:30	110.0	35	4.5	148	68	279		
40	18:40	115.082	35	4.5	150	69	275		
	V_m	23.215 ✓		Avg.	147.2 ✓				

Post-Test Leak Check 0.0 in.Hg/min at 5.5 in.Hg Vacuum Trap Pair Label No. SAII-V-1b

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0"Hg/min @ 18.0"Hg

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.875 liters ✓ K1b

VOST SAMPLING DATA

Date 9-17-87 Location Johns Zink, Tulsa Ok Run No. SAII-V-1C Operator G. Howard

Test Condition SARM-II Sampling Train No. 1-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 818 From Can No. - Pretest Leak Check 0.0 in.Hg/min at 1[illegible] in.Hg vacuum

Barometric Pressure (P_b) 29.37 in.Hg Ambient Temperature 80 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter temperature, °F	Primary condenser exit temp., °F	Probe temperature, °F		
0	18:58	15.135	34	3.5	143	68	271		
10	19:08	21.00	34	4.0	143	65	280		
20	19:18	26.48	34	4.0	143	65	277		
30	19:28	32.81	34	4.0	142	66	276		
40	19:38	38.476	34	4.0	141	68	275		
	V_m	23.341	✓	Avg.	142.4	✓			

Post-Test Leak Check 0.0 in.Hg/min at 7.0 in.Hg Vacuum Trap Pair Label No. SAII-V-1C

Flow Direction Marked? ✓ Condensate Recovered? ✓ VOA Label Nos. SAII-V-1 condensate

Total Volume of Condensate in Vials, 14 ml Remaining Condensate 24 mls Total Condensate Vol. 38 ml

Traps and Vial Stored in Can No. 2 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg/min @ 18.0 "Hg vacuum

Corresponding Blank Nos. SAII-V-1FB #340 0.0 @ 15.0

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, °R}$ = 20.142 liters ✓ RH

VOST SAMPLING DATA

Date 9.12.84 Location [illegible] Run No. [illegible] Operator [illegible]

Test Condition M.M.T. Sampling Train No. [illegible] Meter Console No. [illegible] Y-Factor 1.03

Trap Nos. [illegible] From Can No. _____ Pretest Leak Check _____ in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) 29.50 in.Hg Ambient Temperature _____ °F Probe Purged ____ minutes at _____ liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	[illegible]	28.445	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]									
V_m		22.825	✓	Avg.	90.4	✓			

Post-Test Leak Check _____ in.Hg/min at [illegible] in.Hg Vacuum Trap Pair Label No. [illegible]

Flow Direction Marked? [illegible] Condensate Recovered? _____ VOA Label Nos. _____

Total Volume of Condensate in Vials, _____ ml Remaining Condensate _____ mls Total Condensate Vol. _____ ml

Traps and Vial Stored in Can No. _____ on Ice? _____ Culture Tubes and Can Purged With N_2? _____

Comments: [illegible]

Probe Leak Check Data: [illegible]

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 21.653 liters ✓ KAI

VOST SAMPLING DATA

Date _____ Location _____ Run No. _____ Operator _____

Test Condition _____ Sampling Train No. _____ Meter Console No. _____ Y-Factor _____

Trap Nos. _____ From Can No. _____ Pretest Leak Check _____ in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) _____ in.Hg Ambient Temperature _____ °F Probe Purged 15 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	[illegible]	21.25	[illegible]	[illegible]	98	64	283		
	11:01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			
[illegible]	11:21	[illegible]	[illegible]	[illegible]	125	66	272		
22	[illegible]	[illegible]			[illegible]	64	[illegible]		
	V_m	22.345 ✓		Avg.	103	✓			

Post-Test Leak Check _____ in.Hg/min at _____ in.Hg Vacuum Trap Pair Label No. _____

Flow Direction Marked? _____ Condensate Recovered? _____ VOA Label Nos. _____

Total Volume of Condensate in Vials, _____ ml Remaining Condensate _____ mls Total Condensate Vol. _____ ml

Traps and Vial Stored in Can No. _____ on Ice? _____ Culture Tubes and Can Purged With N_2? _____

Comments:

Probe Leak Check Data:

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 20.724 liters ✓ KH

POST SAMPLING DATA

Date 9-18-87 Location John Zink, Tulsa, OK Run No. SAII-V-2C Operator G. Howard

Test Condition SARM 11 Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 838 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 16.0 in.Hg vacuum

Barometric Pressure (P_b) 29.5 in.Hg Ambient Temperature 70 °F Probe Purged 16 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	11:50	83.671	34	3.5	111	62	275		
10	12:00	88.00	34	5.0	111	67	274		
20	12:10	93.80	34	6.0	114	64	275		
30	12:20	97.95	34	7.5	114	66	277		
40	12:30	104.780	36	9.0	116	62	278		
	V_m	21.109	✓	Avg.	113.2	✓			

Post-Test Leak Check 0.0 in.Hg/min at 10.0 in.Hg Vacuum Trap Pair Label No. SAII-V-2C

Flow Direction Marked? ✓ Condensate Recovered? ✓ VOA Label Nos. AII-V-2 CONDENS

Total Volume of Condensate in Vials, 14 ml Remaining Condensate 42 mls Total Condensate Vol. 56.0 ml

Traps and Vial Stored in Can No. _____ on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0 "Hg/min. @ 18.0" Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 19.229 liters ✓

VOST SAMPLING DATA

Date 9-18-87 Location John Zink; Tulsa, Ok Run No. SAII-V-3a Operator G. Howard

Test Condition SARM-II Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 835 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 15.0 in.Hg vacuum

Barometric Pressure (P_b) 29.50 in.Hg Ambient Temperature 70 °F Probe Purged 12 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rota-meter setting	Sampling train vacuum, in.Hg	Dry gas meter tempera-ture, °F	Primary condens-er exit temp., °F	Probe tempera-ture, °F		
0	12:54	04.895	34	3.0	113	68	272		
10	13:04	10.2	34	4.0	114	67	278		
20	13:14	16.32	34	4.0	114	66	275		
30	1324	21.80	34	4.0	115	56	280		
40.0	13:34	27.475	34	4.0	120	58	279		
	V_m	22.580 ✓		Avg.	115.2	✓			

Post-Test Leak Check 0.0 in.Hg/min at 8.5 in.Hg Vacuum Trap Pair Label No. SAII-V-3a

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. _____

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. — on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0" Hg/min @ 18.0" Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, \text{ °R}}$ = 20.497 liters ✓ KTB

VOST SAMPLING DATA

Date 9-18-87 Location John Zink; Tulsa, Ok Run No. SAII-V-3b Operator G Howard

Test Condition SARM-II Sampling Train No. V-2 Meter Console No. VB-2 Y-Factor 1.003

Trap Nos. 832 From Can No. _____ Pretest Leak Check 0.0 in.Hg/min at 17.0 in.Hg vacuum

Barometric Pressure (P_b) 29.50 in.Hg Ambient Temperature 70 °F Probe Purged 18 minutes at 1.0 liters/min

Sampling time, min.	Clock time (24-h)	Meter volume reading, liter	Rotameter setting	Sampling train vacuum, in.Hg	Dry gas meter temperature, °F	Primary condenser exit temp., °F	Probe temperature, °F		
0	13:55	27.590	34	>2.0	119	63	275		
10	14:05	33.85	34	>2.0	121	65	278		
20	14:15	39.80	34	>2.0	124	65	280		
30	14:25	45.20	34	>2.0	124	68	277		
40	14:35	50.603	34	>2.0	130	64	275		
	V_m	23.013	✓	Avg.	123.6	✓			

Post-Test Leak Check 0.0 in.Hg/min at 5.0 in.Hg Vacuum Trap Pair Label No. SAII-V-3b

Flow Direction Marked? ✓ Condensate Recovered? — VOA Label Nos. —

Total Volume of Condensate in Vials, — ml Remaining Condensate — mls Total Condensate Vol. — ml

Traps and Vial Stored in Can No. 3 on Ice? ✓ Culture Tubes and Can Purged With N_2? ✓

Comments:

Probe Leak Check Data: 0.0"Hg/min. @ 18.0"Hg vacuum

Corresponding Blank Nos.

1) $V_{std} = V_m$, liters x Y x 17.647 x $\frac{P_b, \text{ in.Hg}}{T_m, °R}$ = 20.590 liters ✓ RH

CEM DATA SHEETS AND EXAMPLE
STRIP CHART DATA

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	Johnzinc	Pollutant	CO
Location	Outlet	Monitor	Bendix
Date	9/16/87	Span	0-500 ppm
Operator	D. Scheffel	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SAI CO-1 & 2	Tamb, deg. F	

Cal. gas conc.,	Chart divisions 0850 Pretest	Post-test 2100	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	0.3	0.2	-0.8	0.2	-0.1
22	5.0	4.8	21.4	0.1	-0.2
250 A	54.0	54	253.2	0.7	+0.5
453.1	95.9	94.5	451.4	0.4	-1.4

COMMENTS: $CO_{ppm} = \frac{CD - .4748}{.2114}$ Corr Coef = 0.9999

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	John Zinc	Pollutant	CO_2
Location	Outlet	Monitor	Infrared Ind.
Date	9/16/87	Span	0-20%
Operator	D. Scheffel	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SA I-CO_2-1&2	Tamb, deg. F	

Cal. gas conc.,	Chart divisions C0900 Pretest	Post-test 2045	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	4.0	4.0	0.2	1.2	0
4.01	26.0	26.0	4.19	1.1	0
7.98	44.5	45	7.71	1.7	+0.5
16.09	89.0	92.5	16.18	0.6	+3.5

COMMENTS: $CO_2\% = \frac{CD - 3.9906}{5.254}$ Cal Coef 0.9996

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

$$\text{Analyzer cal error} = \frac{[\text{Cal. gas conc.} - \text{conc. predicted}] \times 100}{\text{High cal. gas conc.}}$$

$$\text{Drift} = \frac{[\text{Post-test} - \text{pretest}] \times 100}{\text{Chart div. span}}$$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	John Zinc	Pollutant	O_2
Location	Outlet	Monitor	Datatest
Date	9/16/87	Span	0-25%
Operator	D. Scheffel	Chart scale	0-100
PN		Pbar, in.Hg	
Run No.		Tamb, deg. F	

Cal. gas conc.,	Chart divisions @ 0900 Pretest	Post 2045 test	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	11.5	11	-0.3	~~0.4~~ 2.0	-0.5
4.09	28.6	27.3	4.34	~~0.4~~ 1.7	-1.3
8.08	43.3	41	8.32	1.6	-2.3
15.09	67.6	63.3	14.9	1.3	-4.3

COMMENTS: O_2 % = $\frac{CD - 12.575}{3.694}$ Cor coef 0.9590

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted]} \times 100}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest]} \times 100}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

CO CEM DATA SHEET

SAI CO-1

Date 9/16/87 PN

P_{bar} Operator

Ambient Temperature Location

CRF CO = CD - .4748 / .2114 Pre-Test

Time	Zero set	Chart reading	CO conc., ppm		
START 015 - 1030		0	<10	→ 0-500 ppm Scale	
1045		0	<10	2% Accuracy ± 10 ppm	
1100		0	<10		
1115		0	<10		
1130		0	<10		
1145		0	<10		
1200		0	<10		
1215		0	<10		
1230		0	<10		
1245		0	<10		
1300		0	<10		
1315		0	<10		
1330		0	<10		
1345		10	45	Peaked off scale for 1 min.	
1400		1	2.5		
1415		0	<10		
1430		0	<10		
		Avg =	11.6		

CO_2 CEM DATA SHEET SAI CO_2-1

Date 9/16/87 PN

P_{bar} Operator

Ambient Temperature Location

CRF $CO_2 = \frac{CD - 3.9906}{5.254}$

Time		Chart reading	CO_2 conc., %		
5 SAI 1015-1030		57	10.1		
1045		59	10.5		
1100		57	10.1		
1115		61	10.9		
1130		60	10.7		
1145		65	11.6		
1200		62	11.0		
1215		62	11.0		
1230		60	10.7		
1245		62	11.0		
1300		63	11.2		
1315		63	11.2		
1330		62	11.0		
1345		62	11.0		
1400		62	11.0		
1415		59	10.5		
1430		57	10.1		
		Avg =	10.8		

O_2 CEM DATA SHEET SAI O_2 - 1

Date 9/16/87 PN

P_{bar} Operator

Ambient Temperature Location

CRF $O_2\% = \frac{(2) - 12.575}{3.694}$

START Time		Chart reading	O_2 conc., %		
1015 - 1030		37	6.6		
1045		34	5.8		
1100		35.5	6.2		
1115		34	5.8		
1130		33	5.5		
1145		32	5.3		
1200		33	5.5		
1215		31.5	5.1		
1230		32	5.3		
1245		33	5.5		
1300		32	5.3		
1315		30	4.7		
1330		30	4.7		
* 1345		30	4.7	Dropped to 0 for 1 min.	
1400		31	5.0		
1415		31	5.0		
1430		34	5.8		
		Avg =	5.4		

CO CEM DATA SHEET SAI CO-2

Date 9/16/87 PN

P_{bar} Operator DS

Ambient Temperature Location

CRF $CO_{ppm} = \frac{CD - .4748}{.2114}$ pre-test

	Time		Chart reading	CO conc., ppm		
START	1615-1630		0	<10		
	1645		0	<10		
Stop	1700		0	<10		
R START	1745-1800		0	<10.		
	1815		0	<10		
	1830		0	<10		
	1845		0	<10		
	1900		0	<10		
	915		0	<10		
	1930		0	<10		
	1945		0	<10		
	2000		0	<10		
	2015		0	<10		
	2030		0	<10	PEAK @ 2016	

Stopped test @ 2030 - water in line - Condenser overflow - May change post results - Emptied condenser, line air out.

CO_2 CEM DATA SHEET SAI CO_2 -2

Date 9/16/87 PN

P_{bar} Operator DS

Ambient Temperature Location OUTLET

CRF CO_2 % = $\frac{CD - 3.9906}{5.254}$ pre-test

	Time		Chart reading	CO_2 conc., %		
START 1615-	1630		53	9.3		
	1645		54	9.5		
stop	1700		54	9.5		
START 1745-	1800		53	9.3		
	1815		55	9.7		
	1830		61	10.9		
	1845		63	11.2		
	1900		63	11.2		
	1915		63	11.2		
	1930		60	10.7		
	1945		59	10.5		
	2000		61	10.9		
	2015		60	10.7		
	2030		60	10.7		
			Avg =	10.4		

O2 CEM DATA SHEET SAE O2-2

Date 9/12/87 PN

P_{bar} Operator DB

Ambient Temperature Location

CRF $O_2\% = \frac{CD - 12.575}{3.694}$ pre-test

	Time		Chart reading	O2 conc., %		
INTOR:	1615-1630		37	6.6		
	1645		38	6.9		
STOP	1700		38	6.9		
RESTART						
	1745-1800		36	6.3		
	1815		35	6.1		
	1830		33	5.5		
	1845		30	4.7		
	1900		32	5.3		
	1915		31.5	5.1		
	1930		32	5.3		
	1945		33	5.5		
	2000		33	5.5		
	2015		34	5.8		
	2030		33	5.5		
			Avg =	5.8		

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	Zinc	Pollutant	CO
Location	Outlet	Monitor	Bendix
Date	9/17/87	Span	0-500 ppm
Operator	D Scheffel	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SAI CO-3 ; SAII-CO-1	Tamb, deg. F	

Cal. gas conc.,	Chart divisions @0825 Pretest	Post-test 20	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	0	0	-0.9	-0.2	0
22	4.8	4.5	21.3	-0.2	-0.3
250.1	55	54.2	253.4	+0.7	-0.8
453.1	97.8	97.0	451.3	-0.4	-0.8

COMMENTS: $CO_{ppm} = \frac{CD - .1852}{.2163}$ Cor. Coef = 0.9999

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	ZNC	Pollutant	CO_2
Location	OUTLET	Monitor	INFRARED IND.
Date	9/17/87	Span	0-20%
Operator	D. Scheffel	Chart scale	0-100
PN		Pbar, in.Hg	
Run No.	SA I-CO_2-3; SA II-CO_2-1	Tamb, deg. F	

Cal. gas conc.,	Chart divisions 0835 Pretest	Post-test 2041	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	3.2	5	-.03	-0.2	+1.8
4.01	26.5	28.2	4.22	+1.3	+1.7
7.98	45.8	48	7.74	-1.5	+2.2
16.09	92	95	16.16	+0.4	+3.0

COMMENTS: CO_2 % = $\frac{CD - 3.375}{5.4843}$ Cor Coef = 0.9996

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	ZINC	Pollutant	O_2
Location	OUTLET	Monitor	DATA TEST
Date	9/17/87	Span	0-25 %
Operator	D. Scheffel	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SA I-O_2-3; SA II-O_2-1	Tamb, deg. F	

Cal. gas conc.,	Chart divisions Pretest	Post-test	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	11.2	11.2	-0.26	-1.7	0
4.09	28.3	26.8	4.29	+1.3	-1.5
8.08	43.5	40.4	8.33	+1.7	-3.1
15.09	68.2	64	14.9	-1.2	-4.2

COMMENTS: O_2 % = $\frac{CD - 12.181}{3.7592}$ Corr coef = 0.9992

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

CO CEM DATA SHEET SAI CO-3

Date 9/17/87 PN

P_{bar} Operator DS

Ambient Temperature Location OUTLET

CRF CO ppm = $\frac{CD - .1852}{.2163}$ pre-test

Time		Chart reading	CO conc., ppm		
START 1035 — 1050		0	<10		
1105		0	<10		
1120		0	<10		
1135		10	45	* Peak off scale ~1139	
1150		0	<10		
1205		0	<10		
1220		0	<10		
1235		0	<10		
1250		0	<10		
1305		0	<10		
1320		0	<10		
1335		0	<10		
1350		10	45	Peak off scale @ 1401	
1405		0	<10		
1420		10	45	Peak off scale @ 1407	
		Avg =	17.0		

CO2 CEM DATA SHEET SAI CO2 -3

Date 9/17/87 PN

P_{bar} Operator DS

Ambient Temperature Location OUTLET

CRF CO_2 % = CD − 3.375 / 5.4843 pre-test

START Time		Chart reading	CO_2 conc., %		
035 – 1050		53	9.1		
1105		57.5	9.9		
1120		61	10.5		
1135		65	11.2		
1150		66	11.4		
1205		63	10.9		
1220		57	9.8		
1235		59	10.1		
1250		60	10.3		
1305		68	11.8		
1320		60	10.3		
1335		64	~~11.4~~ 11.1		
1350		63	10.9		
1405		63	10.9		
1420		65	11.2		
		Avg =	10.10		

O_2 CEM DATA SHEET SAI O_2-3

Date 9/17/87 PN

P_{bar} Operator DB

Ambient Temperature Location Outlet

CRF $O_2\% = \frac{CD - 12.181}{3.7592}$ pre-test

≤ DRT Time		Chart reading	O_2 conc., %		
1035-1050		39	7.1		
1105		36	6.3		
1120		33	5.5		
1135		30	4.7	Dropped to zero @ 1134	
1150		32	5.3		
1205		33	5.5		
1220		36	6.3		
1235		34	6.0		
1250		33	5.5		
1305		29	4.5		
1320		36	6.3		
1335		33	5.5		
1350		28	4.2	Dropped to zero @ 1401	
1405		29	4.5		
1420		28	4.2		
		Avg =	5.4		

CO CEM DATA SHEET SAII CO-1

Date 9/17/87 PN

P_{bar} Operator DS

Ambient Temperature Location

CRF $CO_{ppm} = \frac{CO - .1852}{.2163}$ pre-test

Time		Chart reading	CO conc., ppm		
AFT 700 - 1715		0	<10		
1730		0	<10		
1745		0	<10		
1800		0	<10		
1815		0	<10		
1830		20	92	Spike @ 1814 & 1828	offscale
1845		0	<10		
1900		0	<10		
1915		0	<10		
1930		0	<10		
1945		15	69	Spike @ 1931 & 1945	offscale
2000		0	<10		
2015		0	<10		
2030		10	45	Spike @ 2028	offscale
		Avg =	22.6		

CO_2 CEM DATA SHEET SA II CO_2-1

Date 9/17/87 PN

P_{bar} Operator DS

Ambient Temperature Location Outlet

CRF CO_2 % = CD − 3.375 / 5.4843

Time		Chart reading	CO_2 conc., %		
1715		54	9.2		
1730		58	10.0		
1745		63	10.9		
1800		67	11.6		
1815		69	12.0		
1830		71	12.3		
1845		66	11.4		
1900		63	10.9		
1915		64	11.1		
1930		60	10.3		
1945		62	10.7		
2000		63	10.9		
2015		66	11.4		
2030		63	10.9		
		Avg =	11.0		

= AR 1100

O2 CEM DATA SHEET SAII O_2 - 1

Date 9/17/87 PN

P_{bar} Operator DB

Ambient Temperature Location OUTLET

CRF O_2 % = CD − 12.181 / 3.7592

	Time		Chart reading	O_2 conc., %		
START 1700	1715		36	6.3		
	1730		33.5	5.7		
	1745		32	5.3		
	1800		28	4.2		
	1815		26	3.7		
	1830		25	~~[illegible]~~ 3.4	Dropped to Zero - 1819 + 1820	
	1845		31	5.0		
	1900		33	5.5		
	1915		34	5.8		
	1930		32	5.3		
	1945		32	5.3	Dropped to Zero 1931	
	2000		33	5.5		
	2015		32	5.3		
	2030		33	5.5	Dropped to Zero 2028	
			Avg =	5.1		

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	Zink	Pollutant	CO
Location	Outlet	Monitor	Bendix
Date	9/15/87	Span	0-500
Operator	DJ	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SAII-CO-2 and 3	Tamb, deg. F	

Cal. gas conc.,	Chart divisions Pretest	Post-test	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	0	0	-1.4	-0.3	0
22	4.9	4.2	21.1	-0.2	-0.7
250.1	55.5	54.2	255.1	+1.1	-1.6
453.1	98.3	96.3	450.4	-0.6	-2.0

COMMENTS: $CO_{ppm} = \frac{CD - .3054}{.2176}$ Cal Corr = 0.9999

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	ZINK	Pollutant	CO_2
Location	OUTLET	Monitor	Infrared
Date	9/18/87	Span	0-20%
Operator	DS	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SAII-CO_2-2:3	Tamb, deg. F	

Cal. gas conc.,	Chart divisions Pretest 0905	Post-test 1730	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	4.2	4.3	0.0	0	+0.1
4.01	27.5	27.5	4.2	+1.1	0
7.98	47	46.5	7.71	-1.7	-0.5
16.09	94	92	16.18	+0.6	-2.0

COMMENTS: CO_2 % = $\frac{CD - 4.2157}{5.5498}$ Corr Coef = 0.9996

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

DAILY CEM CALIBRATION AND PERFORMANCE EVALUATION

Plant	Fink	Pollutant	O_2
Location	Outlet	Monitor	Datatest
Date	9/18/87	Span	0-25%
Operator	DS	Chart scale	0-100
PN	3724-7	Pbar, in.Hg	
Run No.	SA II-O_2-2i3	Tamb, deg. F	

Cal. gas conc.,	Chart divisions Pretest (0915)	Post-test (1120)	Concentration predicted by equation*	Analyzer cal. error, % of span	Drift, % of span
0	11	11	-0.37	-2.4	0
4.09	28.2	28.2	4.38	1.9	0
8.08	42.8	42.8	8.41	+2.2	0
15.09	66.0	67.8	14.8	-1.7	+1.8

COMMENTS: $O_2\% = \frac{CD - 12.3408}{3.6184}$ corr coef = 0.998

* Perform linear regression of pretest chart divisions vs cal. gas concentrations to determine following equation:

Conc., _____ = chart divisions x (_____) + (_____)
Correlation coef. = _____

Analyzer cal error = $\frac{\text{[Cal. gas conc. - conc. predicted] x 100}}{\text{High cal. gas conc.}}$

Drift = $\frac{\text{[Post-test - pretest] x 100}}{\text{Chart div. span}}$

Minimum detectable limit = _____ or _____% of span

Zero drift = _____% of span

Cal. drift = _____% of span

CO CEM DATA SHEET SAII CO-2

Date 9/18/87 PN

P_{bar} Operator DS

Ambient Temperature Location Outlet

CRF CO ppm = CO −.3034 / .2176 pre-test

	Time		Chart reading	CO conc., ppm		
FAIL 930 –	0945		0	<10		
	1000		3	12.4	Spike @ 0946	45 CO
	1015		0	<10		
	1030		0	<10		
	1045		0	<10		
	1100		0	<10		
	1115		0	<10		
	1130		6	26	Spike @ 1129	96 CO
	1145		0	<10		
	1200		0	<10		
	1215		10	45	Spike @ 1208	off scale
	1230		0	<10		
	1245		0	<10		
	1300		10	45	Spike @ 1250	off scale
ND	1315		0	<10		
			Avg =	15.9		

CO_2 CEM DATA SHEET SA II CO_2-2

Date 9/18/87 PN

P_{bar} Operator D. Schuffel

Ambient Temperature Location Outlet

CRF $CO_2\% = \frac{CD - 4.2157}{5.5499}$ pre-test

	Time		Chart reading	CO_2 conc., %		
S. ART 0930-	0945		59	9.9		
	1000		62	10.4		
	1015		65	11.0		
	1030		68	11.5		
	1045		67	11.3		
	1100		63	10.6		
	1115		68	11.5		
	1130		61	10.2		
	1145		63	10.6		
	1200		63	10.6		
	1215		62	10.4		
	1230		65	11.0		
	1245		65	11.0		
END	1300		66	11.1		
	1315		64	10.8		
			Avg =	10.8		

O2 CEM DATA SHEET SA II O_2-2

Date 9/18/87 PN

P_{bar} Operator DSchuffel

Ambient Temperature Location Outlet

CRF O_2 % = $\frac{CD - 12.3408}{3.6184}$ pre-test

	Time		Chart reading	O_2 conc., %		
START 0920 -	0945		35	6.3		
	1000		32	5.4	Dropped to 22 LD	
	1015		31	5.2		
	1030		30	4.9		
	1045		31	5.2		
	1100		33	5.7		
	1115		32	5.4		
	1130		32	5.4	Dropped to 15 LD @ 1129	
	1145		33	5.7		
	1200		35	6.3		
	1215		32	5.4	Dropped to Zero @ 1218	
	1230		32.5	5.6		
	1245		33	5.7		
	1300		32	5.4	Dropped to Zero @ 1250	
END	1315		33	5.7		
			Avg =	5.6		

CO CEM DATA SHEET SAII CO-3

Date 9/18/87 PN

P_{bar} Operator DS

Ambient Temperature Location

CRF CO ppm = $\frac{CD - .3034}{.2176}$ pre-test

Time		Chart reading	CO conc., ppm		
START 1400 — 1415		0	<10		
1430		0	<10		
1445		0	<10		
1500		0	<10		
1515		0	<10		
1530		0	<10		
1545		0	<10		
1600		0	<10		
1615		0	<10		
1630		0	<10		
1645		0	<10		
1700		0	<10		
1715		0	<10		
		Avg =	10.0		

CO_2 CEM DATA SHEET SAII CO_2-3

Date 9/18/87 PN

P_{bar} Operator DB

Ambient Temperature Location Outlet

CRF $CO_2\% = \frac{CD - 4.2157}{5.5498}$ pre-test

Time		Chart reading	CO_2 conc., %		
TARE 1400-1415		66	11.1		
1430		67	11.3		
1445		63	10.6		
1500		68	11.5		
1515		68	11.5		
1530		68	11.5		
1545		64	10.8		
1600		64	10.8		
1615		66	11.1		
1630		67	11.3		
1645		65	11.0		
1700		64	10.8		
1715		65	11.0		
		Avg =	11.1		

O_2 CEM DATA SHEET SA II O_2-3

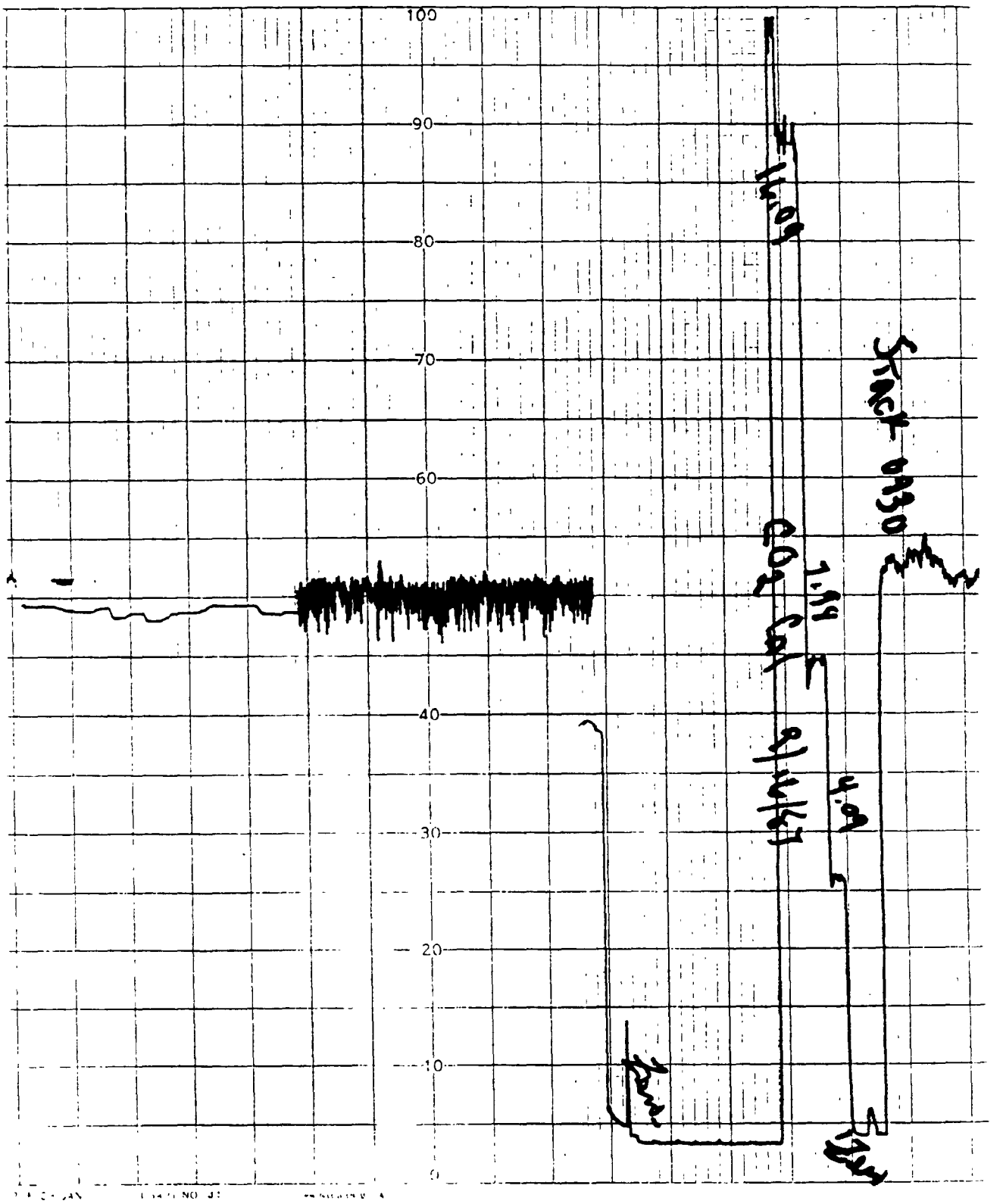
Date 9/18/87 PN

P_{bar} Operator DS

Ambient Temperature Location OUTLET

CRF $O_2\% = \frac{4D - 12.3468}{3.6184}$ pre-test

Time		Chart reading	O_2 conc., %		
SWR 1400 - 1415		32	5.4		
1430		32	5.4		
1445		33	5.7		
1500		31	5.2		
1515		31	5.2		
1530		31	5.2		
1545		32	5.4		
1600		32.5	5.6		
1615		33	5.7		
1630		32	5.4		
1645		32	5.4		
1700		31.5	5.3		
1715		30	4.9		
		Avg =	5.4		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30
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10
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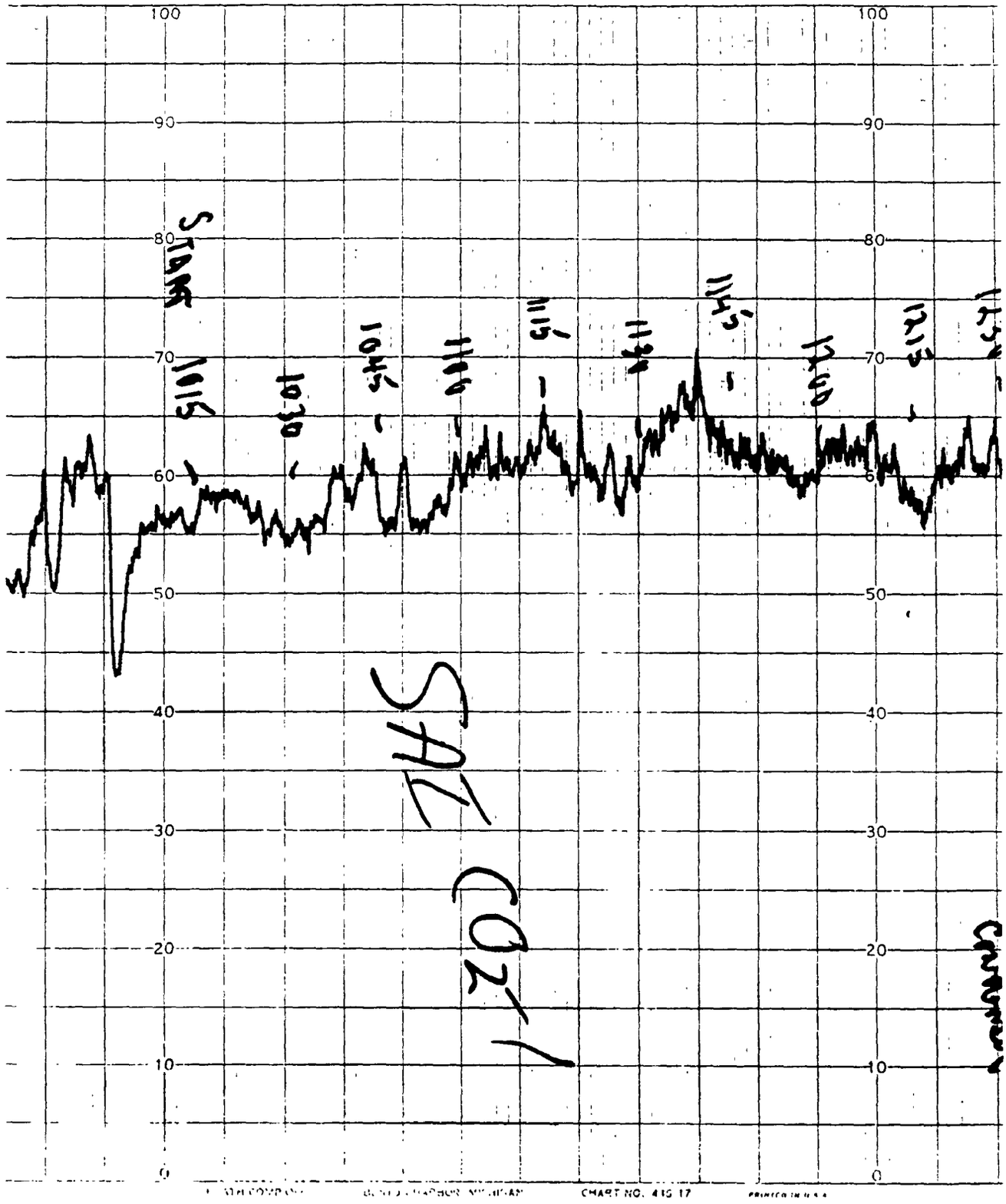
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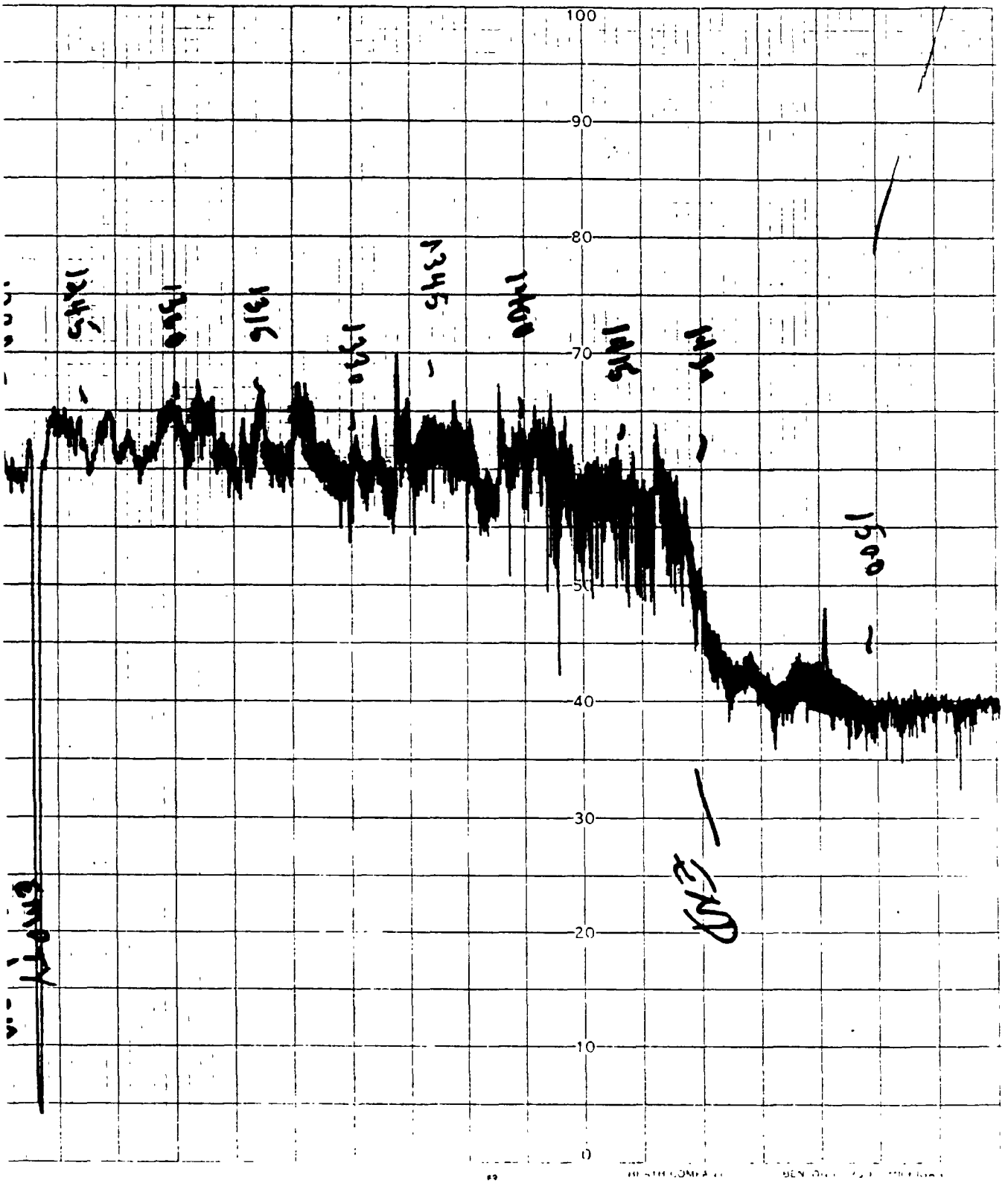
90
80
70
60
50
40
30
20
10
0
START
1015
1030
1045
1100
1115
1130
1145
1200
1215
1230
SAT CO2 1
CHART NO. 415 17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30
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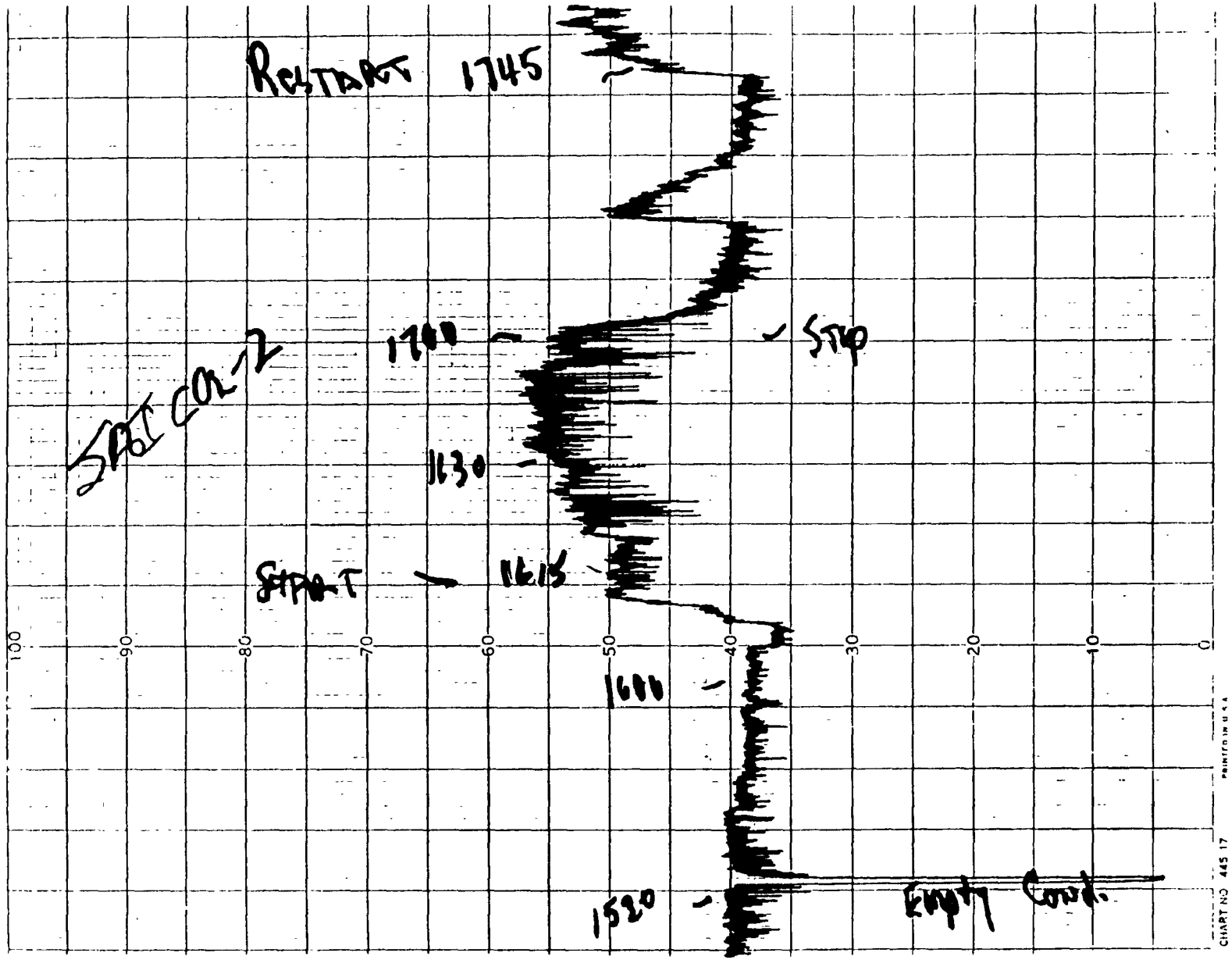
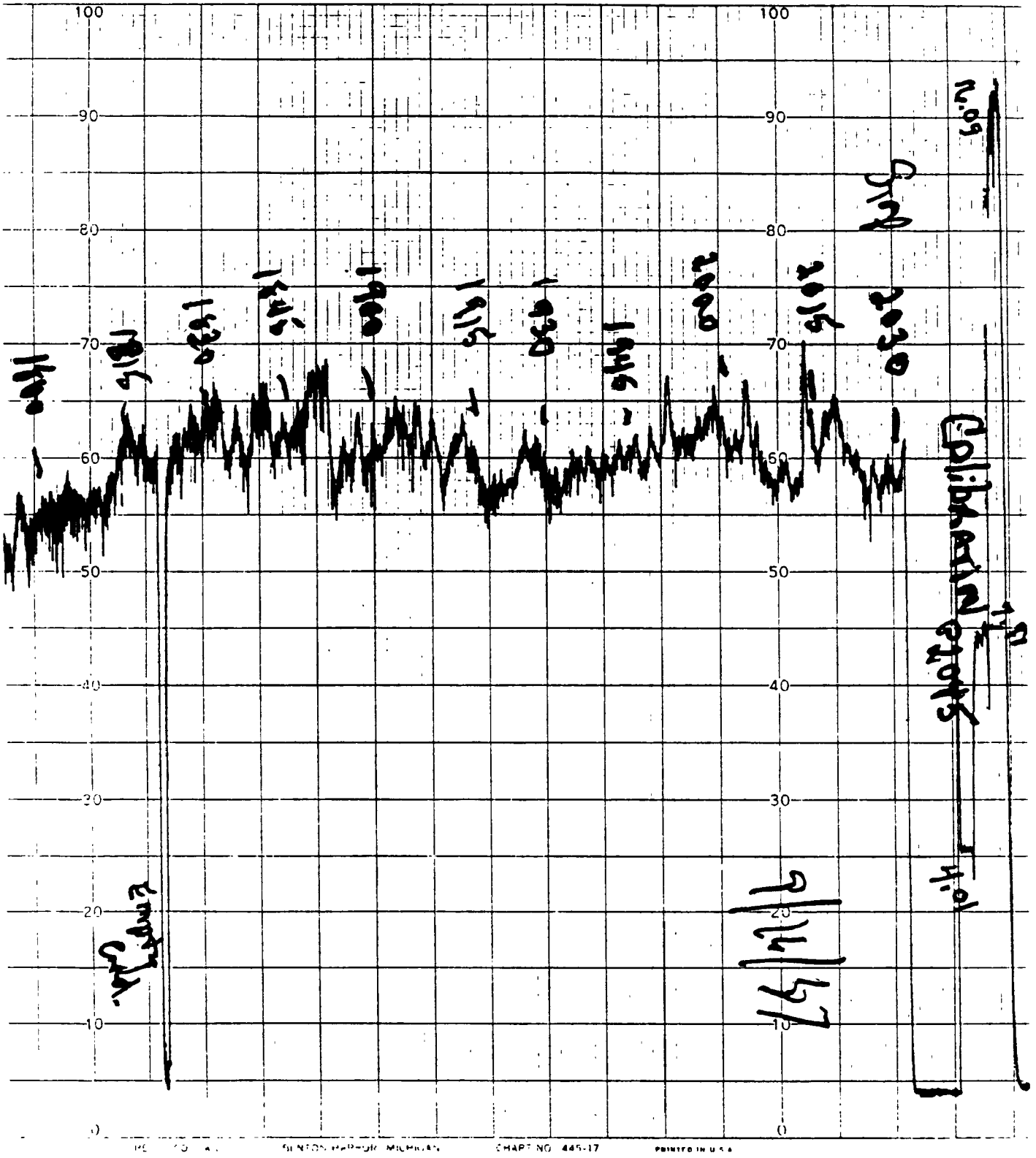

RESTART 1745
SPEC COL-2
1700
STOP
1630
START
1615
1600
1520
Empty Cond.
100
90
80
70
60
50
40
30
20
10
0
CHART NO 445 17
PRINTED IN U.S.A.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60
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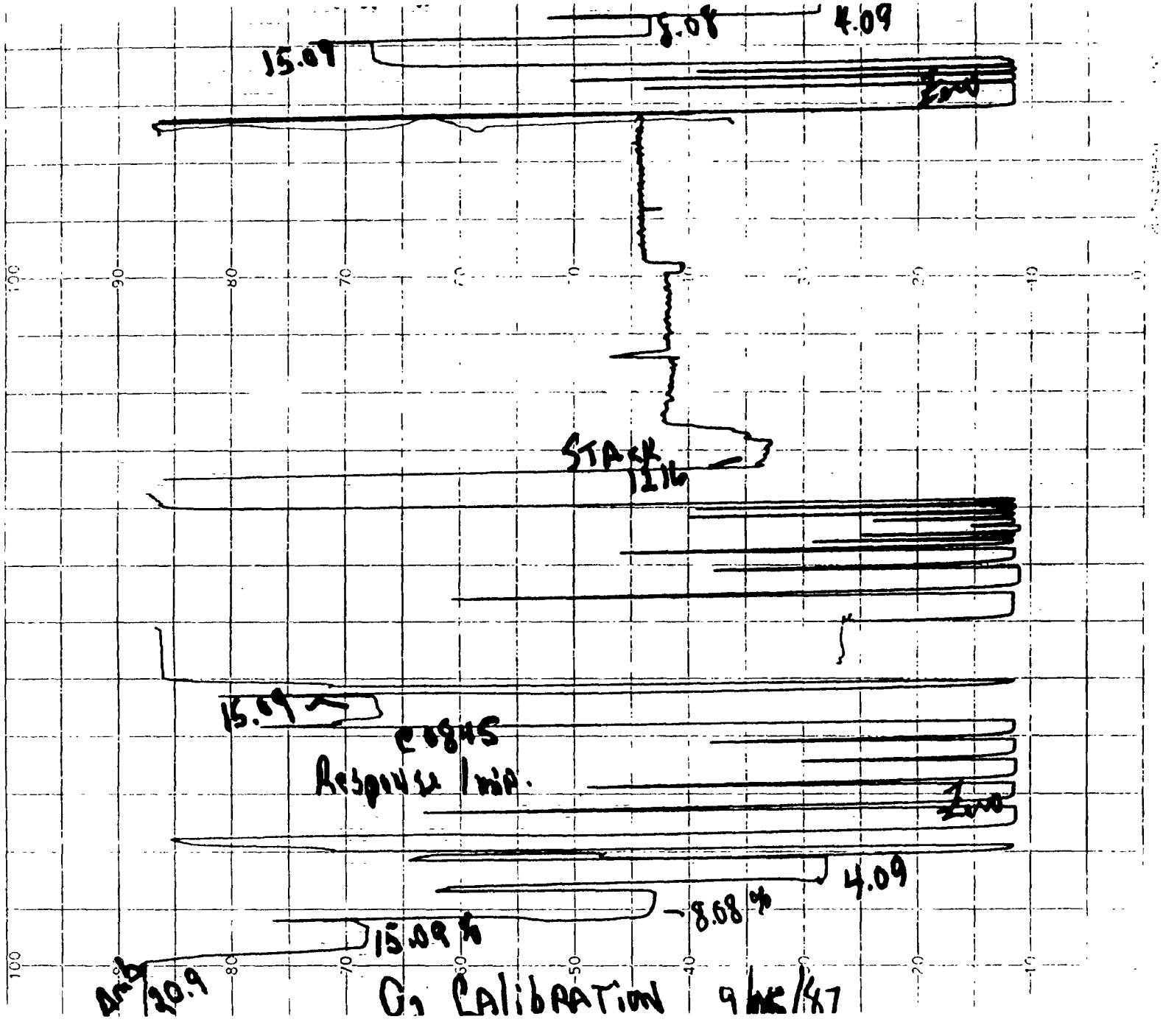
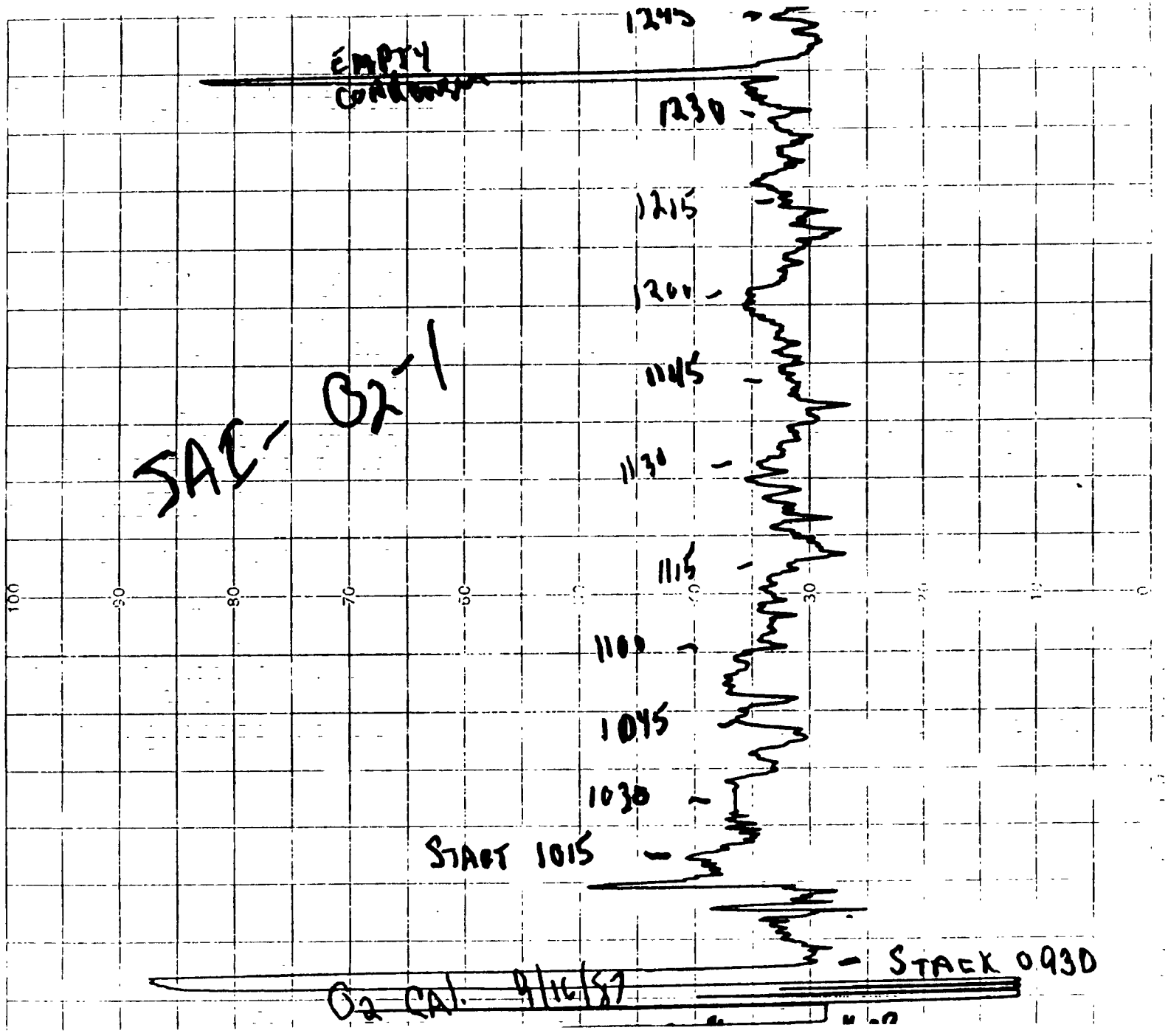
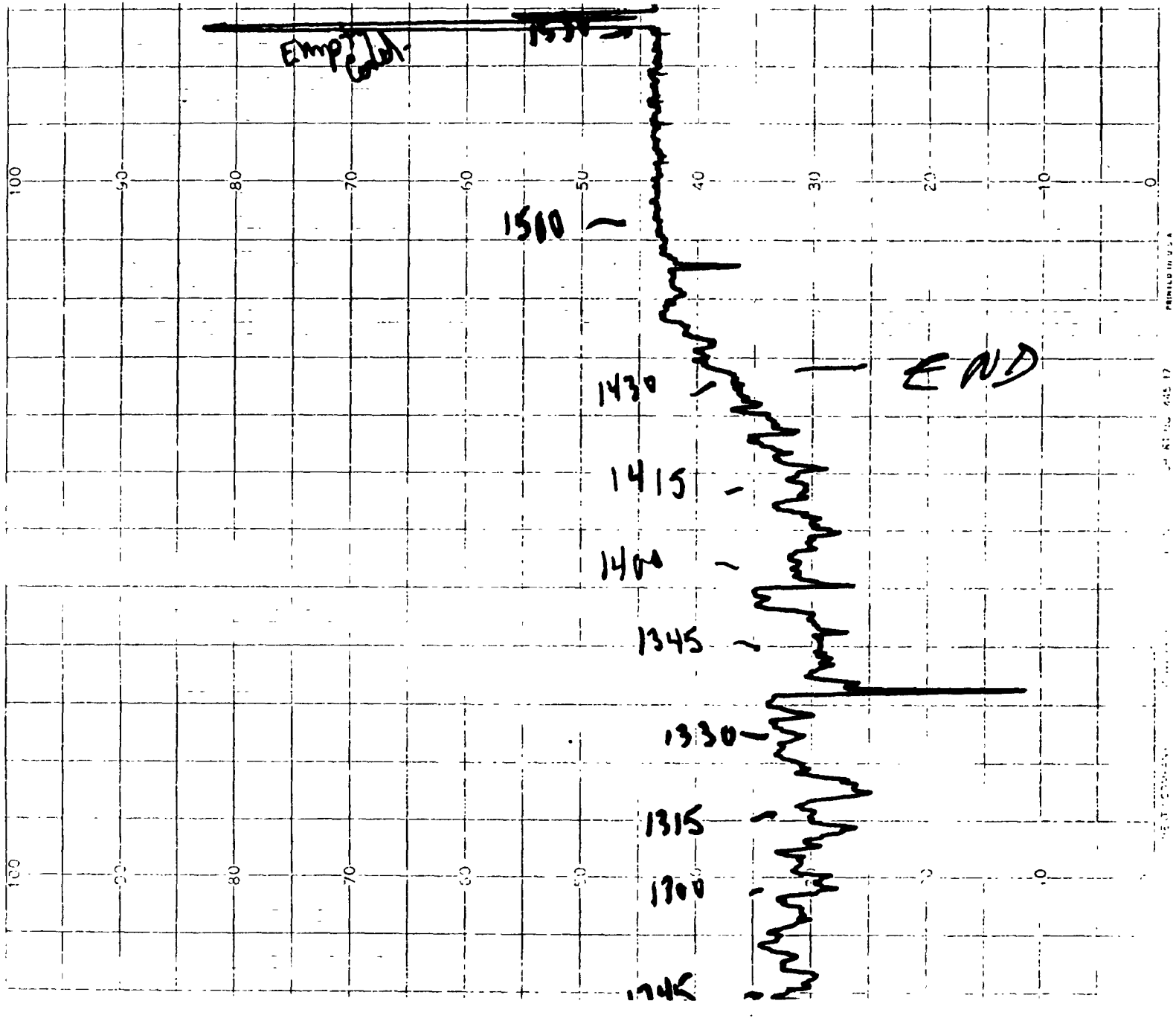
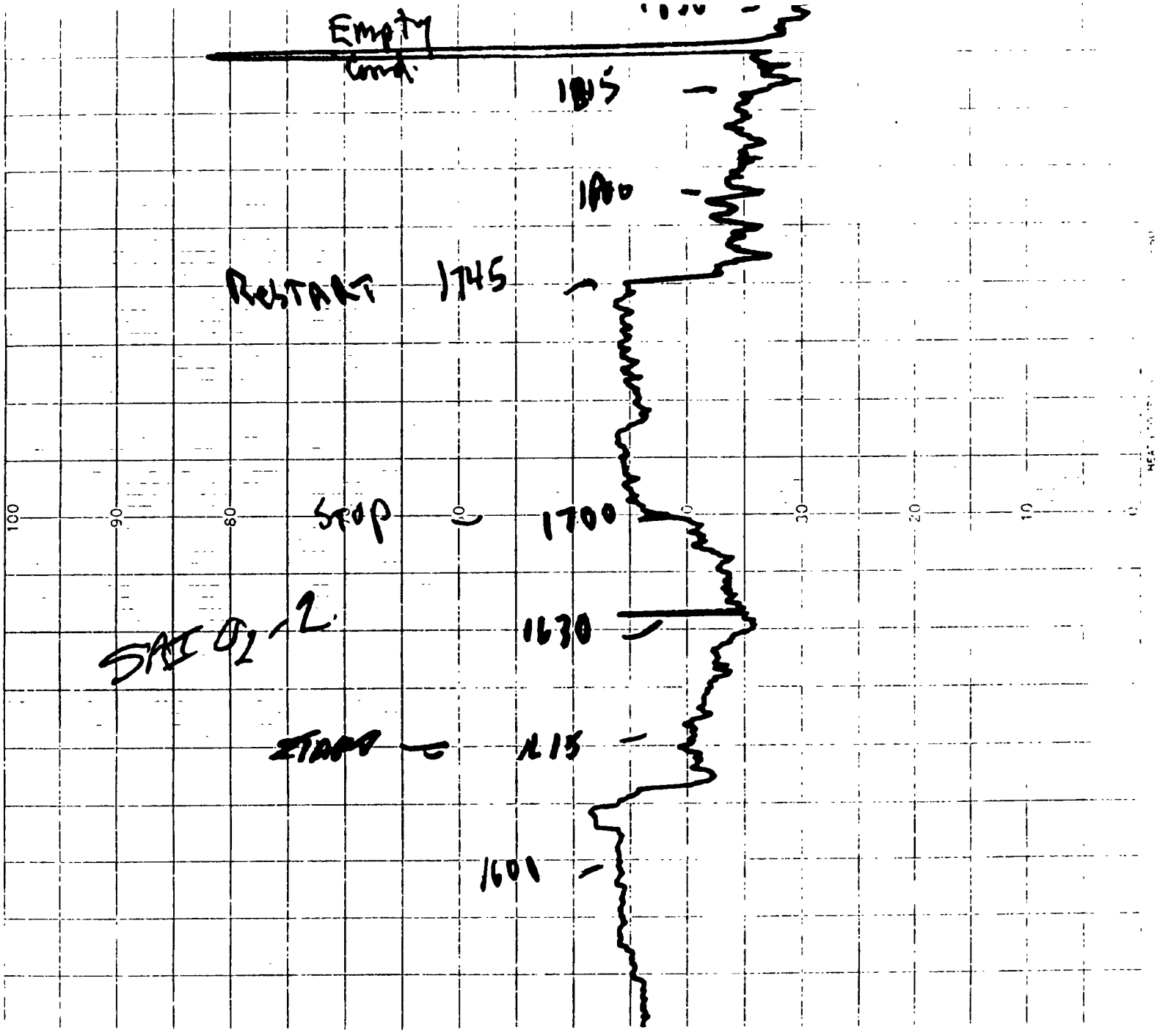
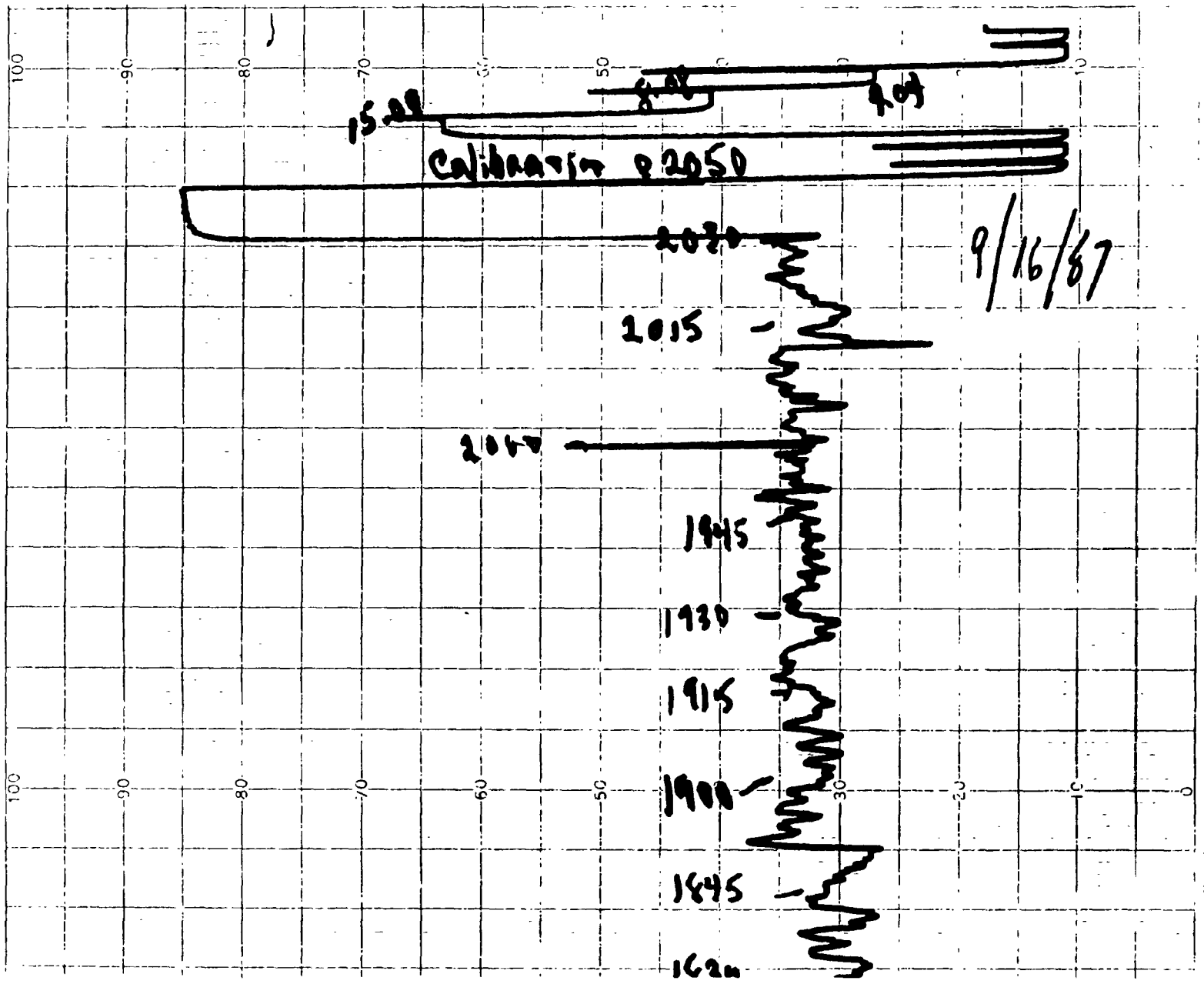

15.09
8.08
4.09
Zero
STACK
1216
15.09
@ 0845
Response 1 min.
Zero
4.09
8.08 %
15.09 %
Amb 20.9
O2 Calibration 9/ /87



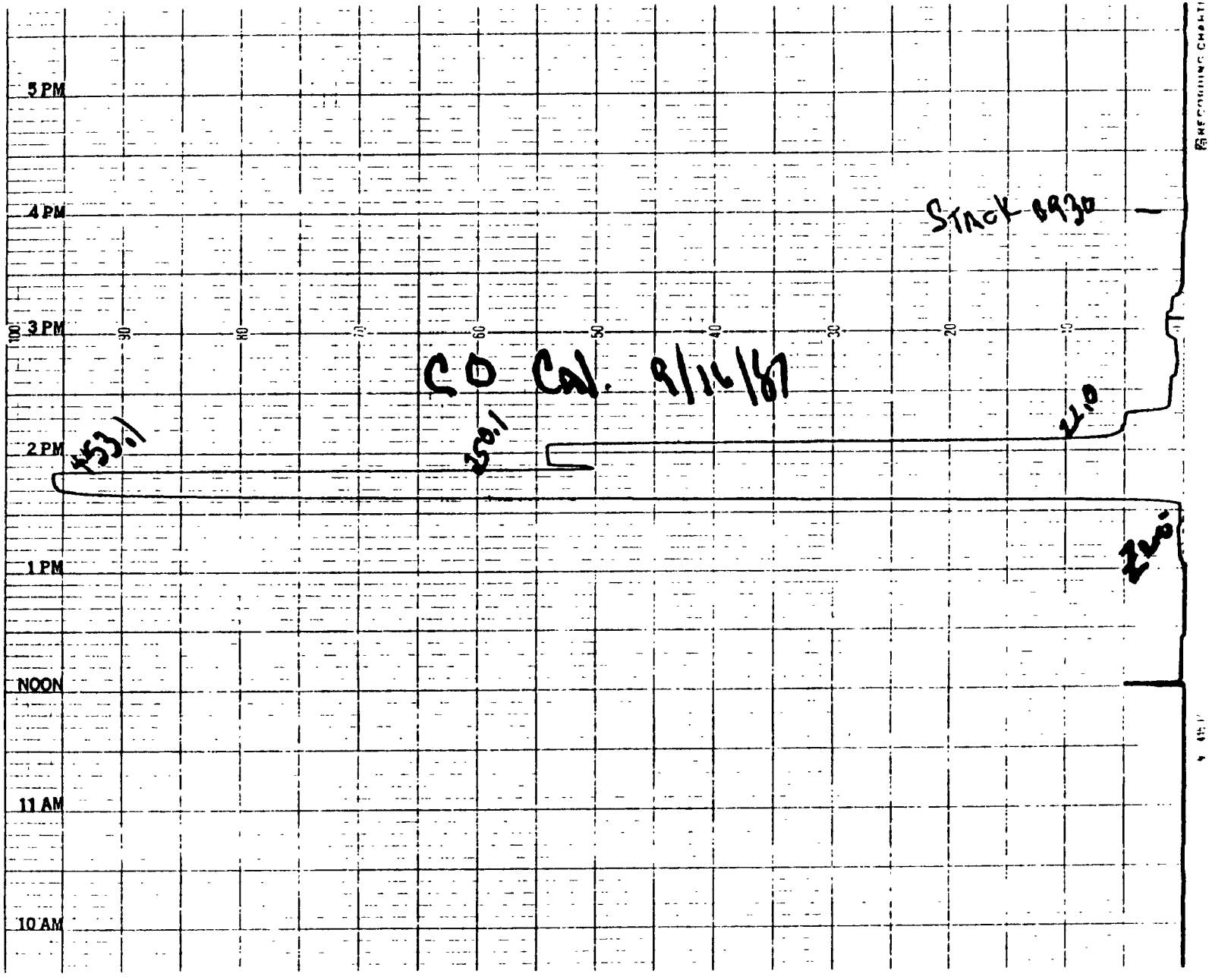
SAI - O2-1
EMPTY
1245
1230
1215
1200
1145
1130
1115
1100
1045
1030
START 1015
STACK 0930
O2 CAL. 9/16/87
100
90
80
70
60
30

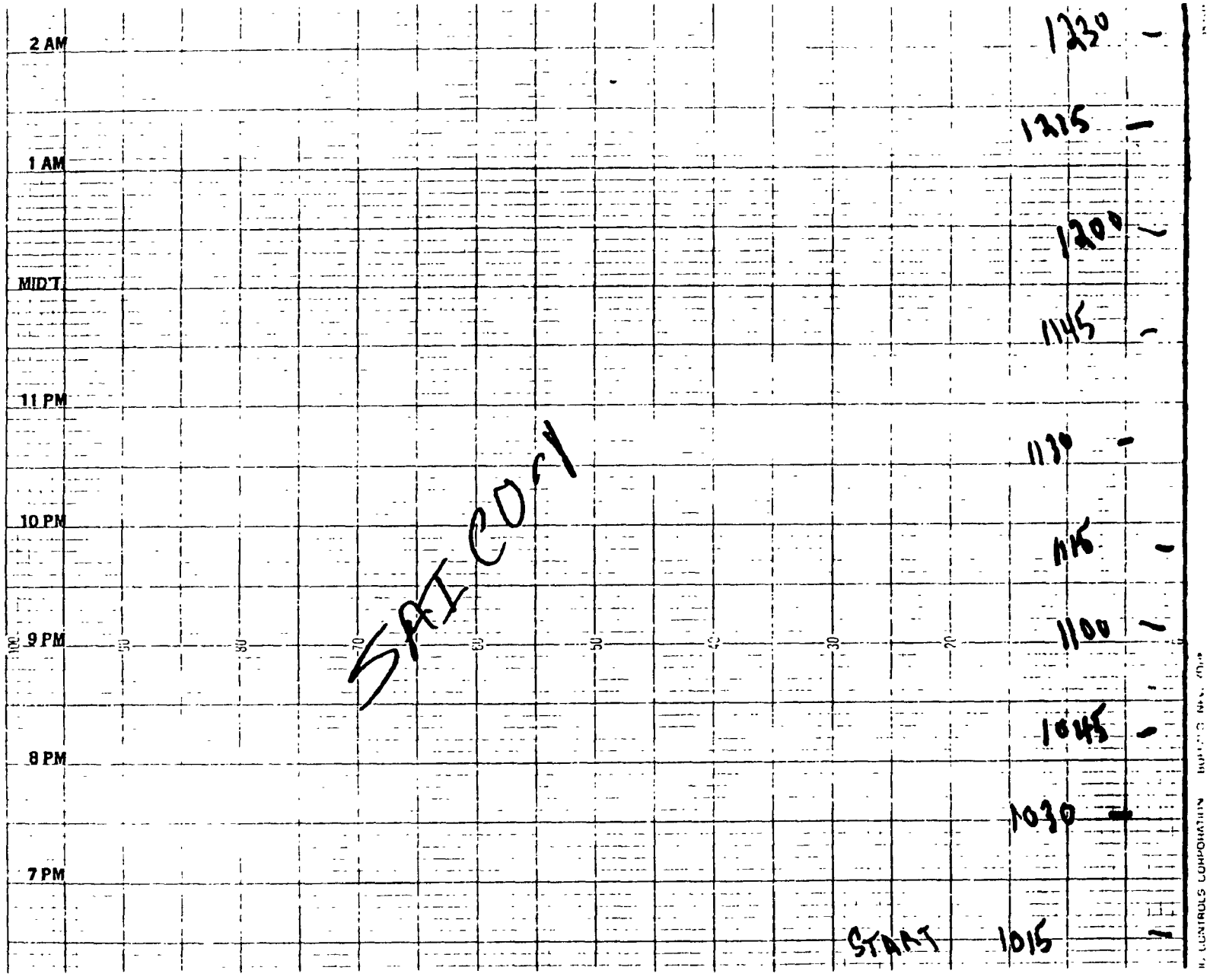

Empty Cold
1500
1430
1415
1400
1345
1330
1315
1300
END
100
90
80
70
60
50
40
30
20
10
0

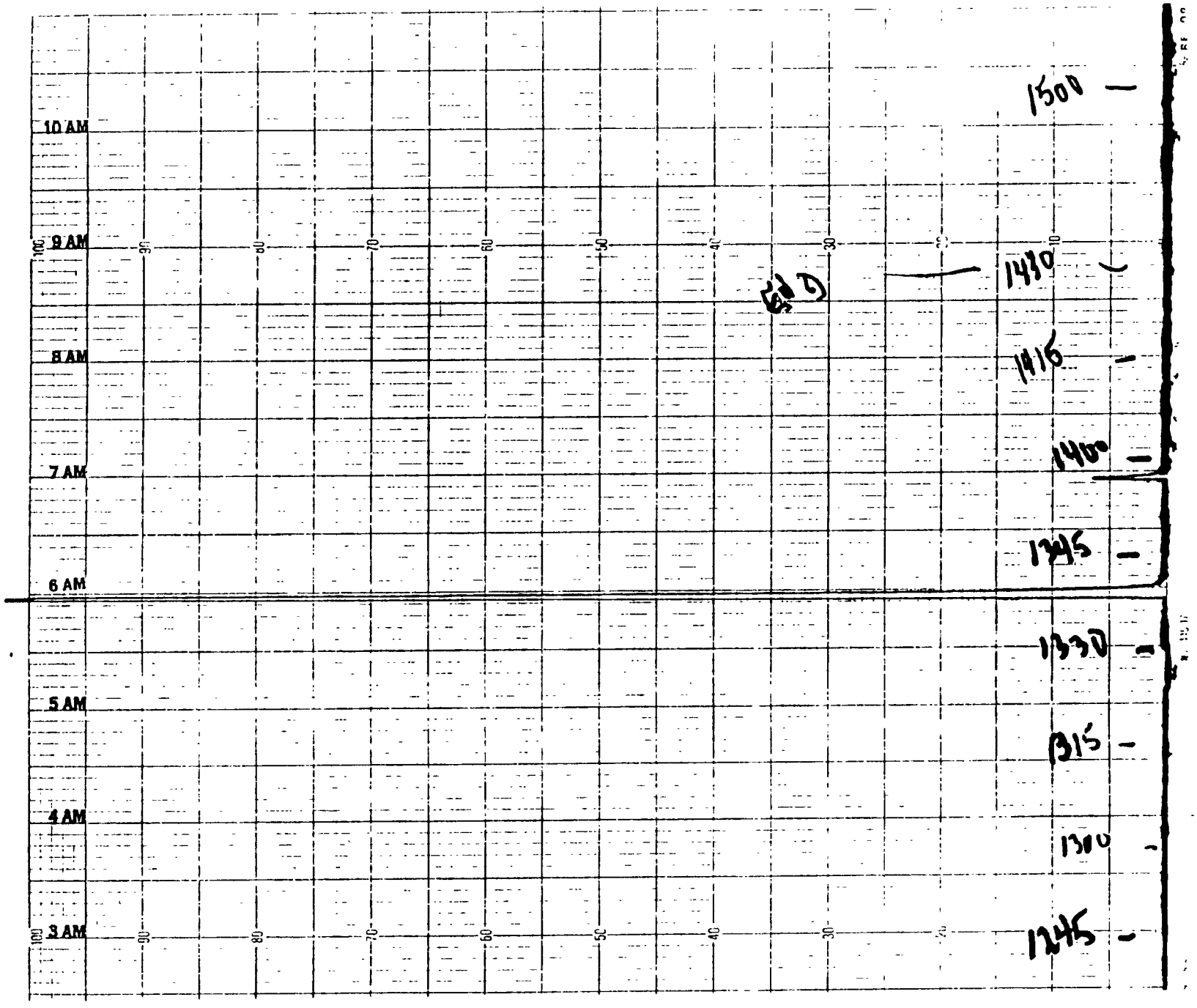

Empty
Cond.
1815
1800
RESTART 1745
STOP 1700
1630
SAI O2 - 2
1615
1601
100
90
80
30
20
10

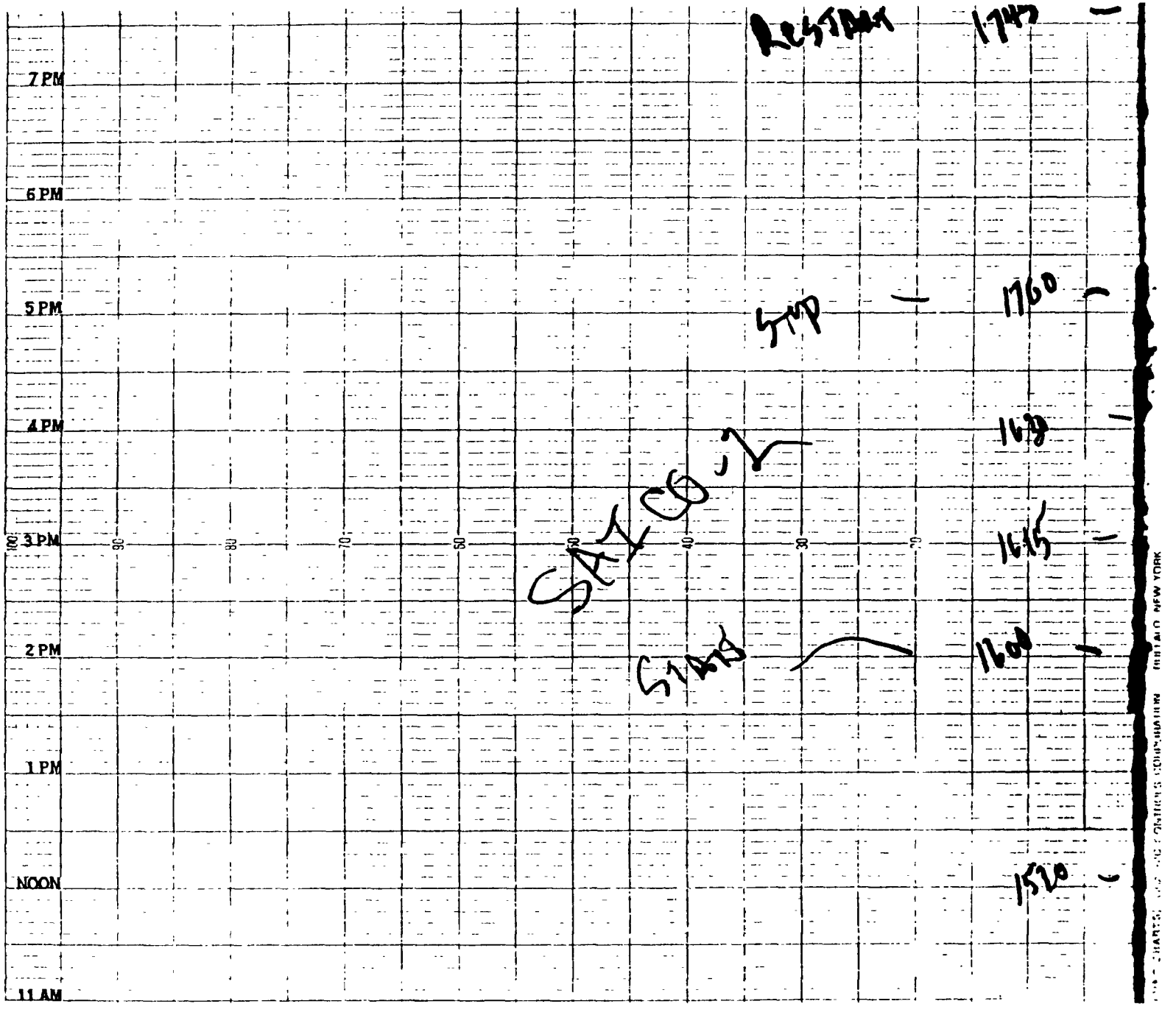


Calibration @ 2050
9/16/87
2030
2015
2000
1945
1930
1915
1900
1845
1620


5 PM
4 PM
3 PM
2 PM
1 PM
NOON
11 AM
10 AM
100
90
80
70
60
50
40
30
20
10
CO Cal. 9/16/87
Stack 0930
453.1
50.1
2.0
2.0

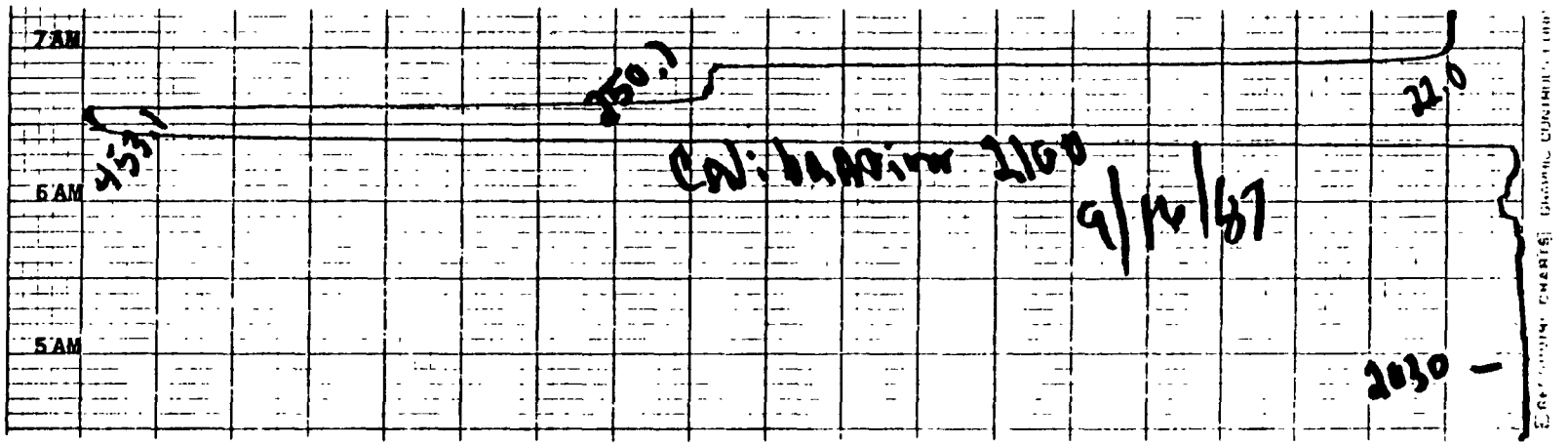

2 AM
1 AM
MID'T
11 PM
10 PM
9 PM
8 PM
7 PM
100
90
80
70
60
50
40
30
20
1230
1215
1200
1145
1130
1115
1100
1045
1030
START 1015
SAI COPY


10 AM
9 AM
8 AM
7 AM
6 AM
5 AM
4 AM
3 AM
100
90
80
70
60
50
40
30
20
10
1500
1430
1415
1400
1345
1330
1315
1300
1245


7 PM
6 PM
5 PM
4 PM
3 PM
2 PM
1 PM
NOON
11 AM
100
90
80
70
60
50
40
30
20
RESTART
1745
STOP
1760
1638
1615
1600
1520
SAICO
START

4 AM
3 AM
2 AM
1 AM
MDT
11 PM
10 PM
9 PM
8 PM
100
90
80
70
60
50
40
30
20
10
2015
2000
1945
1930
1915
1900
1845
1830
1815
1800

4 AM
3 AM
2 AM
1 AM
MDT
11 PM
10 PM
9 PM
100
90
80
70
60
50
40
30
20
10
0
2015
2000
1945
1930
1915
1900
1845
1830
1816


7 AM
6 AM
5 AM
453.1
250.1
22.0
2030
9/16/87

APPENDIX C

LABORATORY DATA AND ANALYSIS REPORT

RADIAN
CORPORATION

DEN: 87-233-006-02

ANALYTICAL RESULTS FOR BDAT INCINERATION TESTS OF CERCLA SARM WASTES AT THE JOHN ZINK COMPANY TEST FACILITY

Prepared For:

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PEI Associates, Inc.
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Cincinnati, Ohio 45246

Prepared By:

Radian Corporation
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P.O. Box 201088
Austin, Texas 78720-1088

November 17, 1987

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1.0 OVERVIEW

This report contains the results of the analyses for volatiles, VOST, semivolatiles, particulates, modified method five (MM5), dioxins/furans, metals, Method 12, and chloride performed on samples collected by PEI at the John Zink pilot plant facility in Tulsa, Oklahoma using a rotary kiln incineration system capable of handling 1000 lb/h of low-Btu solids. Under this work assignment, incineration was evaluated as a "Best Demonstrated Available Technology" (BDAT) treatment technology for CERCLA wastes prior to land disposal. Because Superfund wastes differ markedly from site to site, EPA prepared two synthetic soil samples containing a prescribed list of contaminants for BDAT testing. The soil samples were referred to as Standard Analytical Reference Matrices, or SARMS. This sampling and analysis program was accomplished under a subcontract from EPA/HWERL Cincinnati, Ohio subcontract No. 750-87, EPA contract No. 68-03-3389. The volatile organic compounds were analyzed according to EPA Method 8240, SW-846, 3rd ed. The VOST (<100°C) emission samples were analyzed according to Method 5040, SW-846, semivolatiles by EPA Method 8270, dioxins/furans by EPA Method 8280, and semivolatile compound (> 100°C) stack emissions by Modified Method Five method. The metals were analyzed according to EPA Method 6010 (ICP) and Method 7060 (GF AAS). All metal samples were prepared by Method 3050, SW-846. Metal stack emission samples were analyzed according to EPA Method 12. Particulate samples were analyzed according to EPA Method 5. Chloride emission samples were analyzed by EPA method 300 (IC).

2.0 SAMPLE DESCRIPTION

The sample coding and status report can be found in Tables 2-1, 2-2, 2-3, 2-4, and 2-5. The samples were accompanied by a chain of custody record which was signed by the Radian sample custodian upon inspection of the samples. The samples were logged in to the Radian computerized Sample and Analysis Management system and transferred to a secured facility for storage. Copies of the chain of custody forms are provided as Attachment 1.

TABLE 2-1. VOA SAMPLE CODING AND STATUS SUMMARY

Client ID	Radian Number	Radian FRN	Date Received	Date Analyzed
Scrubber Water				
ZSARM-I-1-INF	S7-09-061-01B	0906101B	9-19-87	9-24-87
ZSARM-I-1-S	S7-09-061-03B	0906103B	9-19-87	9-24-87
ZSARM-I-1-S-MS	S7-09-061-03C	0906103CR	9-19-87	9-25-87
ZSARM-I-1-S-MSD	S7-09-061-03D	0906103D	9-19-87	9-25-87
ZSARM-I-3-S	S7-09-061-05B	0906105B	9-19-87	9-24-87
ZSARM-I-2-S	S7-09-061-08B	0906108B	9-19-87	9-25-87
ZSARM-II-4-S	S7-09-061-11B	0906111B	9-19-87	9-24-87
ZSARM-II-5-S	S7-09-062-02B	0906202B	9-19-87	9-24-87
ZSARM-II-6-S	S7-09-062-05A	0906205B	9-19-87	9-25-87
Feed Extract				
ZSARM-I-1-F	S7-09-061-02B	0906102B	9-19-87	9-27-87
ZSARM-I-1-F-MS	S7-09-061-02C	0906102C	9-19-87	9-27-87
ZSARM-I-1-F-MSD	S7-09-061-02D	0906102D	9-19-87	9-27-87
ZSARM-I-3-F	S7-09-061-06B	0906106B	9-19-87	9-27-87
ZSARM-I-2-F	S7-09-061-09B	0906109B	9-19-87	9-27-87
ZSARM-II-4-F	S7-09-061-12B	0906112B	9-19-87	9-27-87
ZSARM-II-5-F	S7-09-062-03B	0906203B	9-19-87	9-27-87
ZSARM-II-6-F	S7-09-062-06B	0906206B	9-19-87	9-27-87
Bottom Ash				
ZSARM-I-1-A	S7-09-061-04B	0906104B	9-19-87	9-25-87
ZSARM-I-1-A-MS	S7-09-061-04C	0906104C	9-19-87	9-26-87
ZSARM-I-1-A-MSD	S7-09-061-04D	0906104D	9-19-87	9-26-87
ZSARM-I-3-A	S7-09-061-07B	0906107B	9-19-87	9-25-87
ZSARM-I-2-A	S7-09-061-10B	0906110B	9-19-87	9-26-87
ZSARM-II-4-A	S7-09-062-01B	0906201B	9-19-87	9-26-87
ZSARM-II-5-A	S7-09-062-04B	0906204B	9-19-87	9-26-87
ZSARM-II-6-A	S7-09-062-07B	0906207B	9-19-87	9-26-87
Reagent Blank	S7-09-061-13B	0906113A	9-19-87	9-24-87
Reagent Blank	S7-09-062-08B	0906208B	9-19-87	9-25-87

TABLE 2-2. VOST SAMPLE CODING AND STATUS SUMMARY

Client ID	Radian Number	Radian FRN	Date Received	Date Analyzed
SAI-V-1-A	S7-09-025-01A	OWA870271	9-19-87	9-25-87
SAI-V-1-B	S7-09-025-02A	OWA870272	9-19-87	9-25-87
SAI-V-1-C	S7-09-025-03A	OWA870273	9-19-87	9-25-87
SAI-V-2-A	S7-09-025-04A	OWA870274	9-19-87	9-25-87
SAI-V-2-B	S7-09-025-05A	OWA870275	9-19-87	9-25-87
SAI-V-2-C	S7-09-025-06A	Sample Lost		
SAI-V-3-A	S7-09-025-07A	OWA870299	9-19-87	9-29-87
SAI-V-3-B	S7-09-025-08A	OWA870300	9-19-87	9-29-87
SAI-V-3-C	S7-09-025-09A	OWA870301	9-19-87	9-29-87
SAII-V-1-A	S7-09-025-10A	OWA870302	9-19-87	9-29-87
SAII-V-1-B	S7-09-025-11A	OWA870303	9-19-87	9-29-87
SAII-V-1-C	S7-09-025-12A	OWA870304	9-19-87	9-29-87
SAII-V-2-A	S7-09-025-13A	OWA870316	9-19-87	9-29-87
SAII-V-2-B	S7-09-025-14A	OWA870317	9-19-87	10-1-87
SAII-V-2-C	S7-09-025-15A	OWA870318	9-19-87	10-1-87
SAII-V-3-A	S7-09-025-16A	OWA870319	9-19-87	10-1-87
SAII-V-3-B	S7-09-025-17A	OWA870320	9-19-87	10-1-87
SAII-V-3-C	S7-09-025-18A	OWA870321	9-19-87	10-1-87
SAI-V-1-Condensate	S7-09-025-19A	OWA870276	9-19-87	9-25-87
SAI-V-2-Condensate	S7-09-025-20A	OWA870277	9-19-87	9-25-87
SAI-V-3-Condensate	S7-09-025-21A	OWA870305	9-19-87	9-29-87
SAII-V-1-Condensate	S7-09-025-22A	OWA870322	9-19-87	10-1-87
SAII-V-2-Condensate	S7-09-025-23A	OWA870323	9-19-87	10-1-87
SAII-V-3-Condensate	S7-09-025-24A	OWA870324	9-19-87	10-1-87
SAI-V-1-2-Field Blank	S7-09-025-25A	OWA870325	9-19-87	10-1-87
SAII-V-1-Field Blank	S7-09-025-26A	OWA870326	9-19-87	10-1-87
SAII-V-3-Field Blank	S7-09-025-27A	OWA870327	9-19-87	10-1-87
Method Blank #1	S7-09-025-28A	OWA870270	9-19-87	9-25-87
Method Blank #2	S7-09-025-29A	OWA870298	9-19-87	9-29-87

TABLE 2-3. SEMI-VOLATILE/MM5 SAMPLE CODING AND STATUS SUMMARY

Client ID	Radian Number	Radian FRN	Date Received	Date Extracted	Date Analyzed
(Scrubber Water)					
ZSARM-I-1-S	P7-09-024-01A	F872139	9-19-87	9-24-87	10-5-87
ZSARM-I-2-S	P7-09-024-02A	F872142	9-19-87	9-24-87	10-6-87
ZSARM-I-3-S	P7-09-024-03A	F872143	9-19-87	9-24-87	10-6-87
ZSARM-II-4-S	P7-09-024-04A	F872144	9-19-87	9-24-87	10-6-87
ZSARM-II-5-S	P7-09-024-05A	F872145	9-19-87	9-24-87	10-6-87
ZSARM-II-6-S	P7-09-024-06A	F872146	9-19-87	9-24-87	10-6-87
ZSARM-I-1-S-MS	P7-09-024-07A	F872147	9-19-87	9-24-87	10-6-87
ZSARM-I-1-S-MSD	P7-09-024-08A	F872148	9-19-87	9-24-87	10-6-87
Method Blank	P7-09-024-09A	F872138	9-19-87	9-24-87	10-5-87
ZSARM-I-1-INF	P7-09-024-40A	F872149	9-19-87	9-24-87	10-6-87
(Ash)					
ZSARM-I-1-A	P7-09-024-10A	F872151	9-19-87	9-25-87	10-6-87
ZSARM-I-2-A	P7-09-024-11A	F872154	9-19-87	9-25-87	10-7-87
ZSARM-I-3-A	P7-09-024-12A	F872155	9-19-87	9-25-87	10-7-87
ZSARM-II-4-A	P7-09-024-13A	F872156	9-19-87	9-25-87	10-7-87
ZSARM-II-5-A	P7-09-024-14A	F872157	9-19-87	9-25-87	10-7-87
ZSARM-II-6-A	P7-09-024-15A	F872158	9-19-87	9-25-87	10-7-87
ZSARM-I-1-A-MS	P7-09-024-16A	F872159	9-19-87	9-25-87	10-7-87
ZSARM-I-1-A-MSD	P7-09-024-17A	F872160	9-19-87	9-25-87	10-7-87
Method Blank	P7-09-024-18A	F872150	9-19-87	9-25-87	10-6-87
(Feed)					
ZSARM-I-1-F	P7-09-024-19A	F872167	9-19-87	10-1-87	10-8-87
ZSARM-I-2-F	P7-09-024-20A	F872168	9-19-87	10-1-87	10-8-87
ZSARM-I-3-F	P7-09-024-21A	F872169	9-19-87	10-1-87	10-8-87
ZSARM-II-4-F	P7-09-024-22A	F872164	9-19-87	10-1-87	10-8-87
ZSARM-II-5-F	P7-09-024-23A	F872165	9-19-87	10-1-87	10-8-87
ZSARM-II-6-F	P7-09-024-24A	F872166	9-19-87	10-1-87	10-8-87
ZSARM-I-1-F-MS	P7-09-024-25A	F872170	9-19-87	10-1-87	10-8-87
ZSARM-I-1-F-MSD	P7-09-024-26A	F872171	9-19-87	10-1-87	10-8-87
Method Blank	P7-09-024-27A	F872163	9-19-87	10-1-87	10-8-87
SAI-V-1	P7-09-024-28A	F872183	9-19-87	10-6-87	10-13-87
SAI-SV-2	P7-09-024-29A	F872186	9-19-87	10-6-87	10-13-87
SAI-SV-3	P7-09-024-30A	F872187	9-19-87	10-6-87	10-13-87
SAII-SV-1	P7-09-024-31A	F872190	9-19-87	10-6-87	10-14-87
SAII-SV-2	P7-09-024-32A	F872191	9-19-87	10-6-87	10-14-87
SAII-SV-3	P7-09-024-33A	F872192	9-19-87	10-6-87	10-14-87
Method Blank	P7-09-024-39A	F872185	9-19-87	10-6-87	10-13-87
Reagent Blank MeCl2	P7-09-024-34A	F872178	N/A	10-12-87	10-12-87
Reagent Blank NaOH	P7-09-024-35A	Sample Lost			
Reagent Blank Filter	P7-09-024-36A	F872179	N/A	10-8-87	10-12-87
Reagent Blank XAD-2	P7-09-024-37A	F872182	N/A	10-7-87	10-13-87
Field Train Blank	P7-09-024-38A	F872193	N/A	10-6-87	10-14-87

TABLE 2-4. SAMPLE CODING AND STATUS REPORT (DIOXINS/FURANS)

Sample Type	Client ID	Radian Number	Date Received	Date Analyzed
Feed	ZSARM-I-2-F	A710003-07-A 37034	9-29-87	10-26-87
	ZSARM-II-5-F	A710003-08-A 37035	9-29-87	10-26-87
Ash	ZSARM-I-2-A	A710003-04-A 37020	9-29-87	10-26-87
	ZSARM-II-5-A	A710003-05-A 37021	9-29-87	10-26-87
Scrubber Water	ZSARM-I-2-S	A710003-01-A 37018	9-29-87	10-26-87
	ZSARM-II-5-S	A710003-02-A 37019	9-29-87	10-26-87

TABLE 2-5. METALS/METHOD 12 CODING AND STATUS SUMMARY

Scrubber Water Samples Client Number	Radian Number	Date Received	Date Analyzed
ZARM I 1-S	P7-09-023-1a	9/21/87	10/13/87
ZARM I 2-S	P7-09-023-2a	9/21/87	10/13/87
ZARM I 3-S	P7-09-023-3a	9/21/87	10/13/87
ZARM II 4-S	P7-09-023-4a	9/21/87	10/13/87
ZARM II 5-S	P7-09-023-5a	9/21/87	10/13/87
ZARM II 6-S	P7-09-023-6a	9/21/87	10/13/87
ZARM I 1-S MS	P7-09-023-7a	9/21/87	10/13/87
ZARM I 1-S MS dup.	P7-09-023-8a	9/21/87	10/13/87
Scrubber Water Method Blank	P7-09-023-9a	9/21/87	10/13/87
ZSARM-I-1-INF	P7-09-023-37a	9/21/87	10/13/87
Ash Samples Client Number	**Radian Number**	**Date Received**	**Date Analyzed**
ZARM I 1-A	P7-09-023-10a	9/21/87	10/13/87
ZARM I 2-A	P7-09-023-11a	9/21/87	10/13/87
ZARM I 3-A	P7-09-023-12a	9/21/87	10/13/87
ZARM II 4-A	P7-09-023-13a	9/21/87	10/13/87
ZARM II 5-A	P7-09-023-14a	9/21/87	10/13/87
ZARM II 6-A	P7-09-023-15a	9/21/87	10/13/87
ZARM I 1-A MS	P7-09-023-16a	9/21/87	10/13/87
ZARM I 1-A MS dup.	P7-09-023-17a	9/21/87	10/13/87
Ash Method Blank	P7-09-023-18a	9/21/87	10/13/87
Waste Feed Samples Client Number	**Radian Number**	**Date Received**	**Date Analyzed**
ZARM I 1-F	P7-09-023-19a	9/21/87	10/13/87
ZARM I 2-F	P7-09-023-20a	9/21/87	10/13/87
ZARM I 3-F	P7-09-023-21a	9/21/87	10/13/87
ZARM II 4-F	P7-09-023-22a	9/21/87	10/13/87
ZARM II 5-F	P7-09-023-23a	9/21/87	10/13/87
ZARM II 6-F	P7-09-023-24a	9/21/87	10/13/87
ZARM I 1-F MS	P7-09-023-25a	9/21/87	10/13/87
ZARM I 1-F MS dup.	P7-09-023-26a	9/21/87	10/13/87
Waste Feed Method Blank	P7-09-023-27a	9/21/87	10/13/87
Method 12 Train Samples Client Number	**Radian Number**	**Date Received**	**Date Analyzed**
SAI-M-1 (3 components)	P7-09-023-28a	9/21/87	10/13/87
SAI-M-2 (3 components)	P7-09-023-29a	9/21/87	10/13/87
SAI-M-3 (3 components)	P7-09-023-30a	9/21/87	10/13/87
SAII-M-1 (3 components)	P7-09-023-31a	9/21/87	10/13/87
SAII-M-2 (3 components)	P7-09-023-32a	9/21/87	10/13/87
SAII-M-3 (3 components)	P7-09-023-33a	9/21/87	10/13/87
Container # 6750-A	P7-09-023-34a	9/21/87	10/13/87

3.0 ANALYTICAL METHODOLOGY

3.1 Volatiles

All samples analyzed for volatile organics were analyzed by gas chromatography/mass spectrometry (GC/MS) in the full scan mode, following the methodology of Method 8240, SW-846, Third Edition. The instrumental conditions shown in Table 3-1 were used on a Finnigan-MAT 5100 or a Finnigan-MAT 4000 for analysis of samples by Method 8240. Analyte identification was performed using retention times and reference mass spectra from the analysis of standards; quantitative analysis was performed by the method of response factors relative to the closest-eluting of three internal standards. The response factors were generated from a five-point calibration curve. The three quantitation standards were:

- bromochloromethane
- 1,4-difluorobenzene
- d_5-chlorobenzene.

Surrogate compounds added to each sample prior to analysis which were used to assess purging and trapping efficiency were:

- d_4-dichloroethane
- d_8-toluene bromofluorobenzene.

The calibration standard mixtures contained the following compounds:

- ethylbenzene
- xylenes (total)
- tetrachloroethylene
- chlorobenzene
- acetone
- 1,2-dichloroethane
- styrene.

Scrubber water samples were purged per Method 8240. Ash samples were purged as an aqueous slurry. Sludge feed samples were prepared by methanol extraction, according to Method 8240 (SW-846, Third Edition), and a dilution of the methanol extract was purged. System blanks were prepared and

TABLE 3-1. OPERATING CONDITIONS, FINNIGAN-MAT 4000 AND FINNIGAN-MAT 5100

Ionization Mode	Electron ionization
Electron Energy	70 eV, nominal
Resolution Unit	
Mass Range	40 to 300 amu
Scan Mode	Linear, 3 sec/cycle
Manifold Temperature	80°C
Ion Source Temperature	200°C
Interface Temperature	220°C
Gas Chromatograph Column	6 ft x 1/8 in, 1% SP-1000 on Carbopak B, 60/80 mesh
Carrier Gas	Helium
Carrier Flow Rate	30 mL/min
GC Program	Initial hold of 3 min at 45°C; 45°C to 220°C at 10°/min; hold at 220°C for 18 min
Injector:	Tekmar LSC 2 Purge and Trap Unit
Purge Time	11 min
Desorption Time	4 min
Desorption Temperature	180°C
Bakeout Time	12 min
Bakeout Temperature	220°C

analyzed with these samples. At least one blank was analyzed per day of analysis. In addition, a set of matrix spikes and matrix spike duplicates was prepared and analyzed for each matrix type as part of the QA/QC for this part of the program. A detailed description of all QA/QC performed is presented in Section 5.1.

3.2 VOST

All emissions samples for Volatile Organic Sampling Train (VOST) analysis were analyzed by gas chromatography/mass spectrometry according to EPA Method 5040, SW-846, Third Edition. The instrumental conditions shown in Table 3-2 were used on a Finnigan OWA for these analyses. Analyte identification and quantification were performed using response factors and retention times relative to standard compounds. A five-point calibration curve was generated initially. The internal standard used in Method 5040 is d_6-benzene; hexafluorobenzene was also added for possible use as an internal standard in the event matrix interferences precluded the use of d_6-benzene.

Blanks that were prepared and analyzed with the field samples included laboratory blanks and field blanks. Laboratory blanks consisted of Tenax®/Tenax® charcoal tubes which were cleaned and prepared for use in the field. However, the laboratory blanks are sealed and stored in a special refrigerator, and analyzed in conjunction with the field samples. A field blank consists of a set of sampling tubes which have been prepared and shipped to the field. These sampling tubes are opened and placed into a sampling train which does not then draw gas. The sampling tubes are removed from the train and returned to the laboratory to be analyzed with the other samples. Both types of blanks are required to document the nature of any contamination problems with field samples. Matrix spikes and matrix spike duplicates are not part of EPA Method 5040 (SW-846, Third Edition), so none of these determinations were performed with the VOST samples. Three surrogate compounds were added to each set of sampling tubes prior to analysis to assess efficiency of the combined process of desorption and purge and trap. These compounds were:

- d_4-1,2-dichloroethane
- d_8-toluene
- bromofluorobenzene

TABLE 3-2. OPERATING CONDITIONS FOR VOST ANALYSIS USING THE FINNIGAN OWA

GC Column	30 m DB-624 megabore fused silica capillary
Carrier Gas	Helium
Carrier Gas Flow Rate	15 mL/min with 15 mL/min makeup
GC Program	$5^{o}C$ for 2 min, then $6^{o}C$/min to $200^{o}C$, hold at $200^{o}C$ for 10 min
Electron Energy	70 eV, nominal
Resolution	Unit
Mass Range	35 -250 amu
Scan Cycle	1 sec/cycle
Interface Oven Temperature	$200^{o}C$
Injector Temperature	$100^{o}C$
Manifold Temperature	$100^{o}C$
Tekmar LSC-2	
Analytical Trap	EPA Method 601
Purge Time	10.0 min
Purge Flow	40 mL/min, helium
Desorb Time	4.0 min
Desorb Temperature	$180^{o}C$
Bakeout Time	15.0 min
Bakeout Temperature	$200^{o}C$

A complete description of all QA/QC performed with the VOST analyses is presented in Section 5.2.

3.3 Semi-Volatiles

All PEI semi-volatile extracts were analyzed by gas chromatography/-mass spectrometry following Method 8270 (SW-846, Third Edition). A Finnigan-MAT 4500 using the conditions shown in Table 3-3 was used to perform these analyses. Quantitative analysis was performed using retention time standards and response factors generated from the mean of a five-point calibration. The six internal standards used for determination of retention times and quantitative analysis were:

- d_4-dichlorobenzene
- d_8-naphthalene
- d_{10}-acenaphthene
- d_{10}-phenanthrene
- d_{12}-chrysene
- d_{12}-perylene.

Target analyte identification was determined from both retention times and by the match of three major ions from the mass spectrum of the analyte with the ions in the mass spectral library. The compounds of interest for the analysis were:

- anthracene
- bis (2-ethylhexyl) phthalate
- pentachlorophenol.

All semi-volatile extracts were prepared following the extraction procedures outlined in EPA SW-846, Third Edition. With the extraction procedures, a mixture of six surrogate compounds was added to each sample prior to extraction to assess extraction efficiency. These surrogate compounds were:

- d_5-phenol
- 2-fluorophenol
- d_5-nitrobenzene
- 2-fluorobiphenyl
- 2,4,6-tribromophenol
- d_{14}-terphenyl.

TABLE 3-3. OPERATING CONDITIONS, FINNIGAN-MAT 4500

Ionizer Temperature	150°C
Injection Port Temperature	280°C
Manifold Temperature	95°C
Transfer Line Oven Temperature	270°C
Electron Energy	70 eV, nominal I
Ionization Mode	Electron Ionization
Resolution	Unit
Mass Range	35-450 amu
Scan Time	1 sec/cycle
Column	30 m DB-5 fused silica capillary, 0.32 mm ID, 1.0 u film thickness
Column Head Pressure	8 psi
Carrier Gas	Helium
Injection Mode	Splitless 0.6 min, then 10:1 split
Interface to MS	Direct Coupling
Injection Volume	1 uL of sample extract
GC Program	Hold at 35°C for 4 min, then program at 10°/min to 270°C; hold until elution of peaks ceases

A detailed description of all QA/QC performed during the analysis of the semi-volatile extracts is presented in Section 5.3.

3.4 Particulate/Modified Method 5/Chloride

Particulates, semivolatile compounds, and chloride collected by the Modified Method 5 sampling train were determined by the analytical procedures of EPA Method 5 (SW-846, Third Edition), EPA Method 8270 (SW-846, Third Edition), and EPA Method 300 (SW-846, Third Edition), respectively.

Each Modified Method 5 train filter was conditioned in a weighing room maintained at less than 50% relative humidity. Each probe residue/solvent rinse was evaporated at room temperature in a fume hood. The samples were protected from air particulate matter in a special designed drying shield. All filters and dried probe residues were constant weighed using a calibrated analytical balance.

All PEI Modified Method 5 train samples were analyzed by gas chromatography/mass spectrometry following Method 8270 (SW-846, Third Edition). A Finnigan-MAT 4500 using the conditions shown in Table 3-3 was used to perform these analyses. To prepare the samples, the XAD-2® resin and the methylene chloride rinse of the connecting glassware and the first impinger were combined in a Soxhlet extractor and extracted for 16 hours. A mixture of surrogate compounds was added to each sample during the preparation process to assess extraction efficiency. Each XAD-2® resin sample was spiked with the following surrogate compounds:

- d_{10}-anthracene
- 2-fluorobiphenyl
- 2,4,6-tribromophenol.

The condensate and NaOH impinger solutions from each train were combined and spiked with the following surrogate compounds:

- d_{10}-anthracene
- d_{14}-terphenyl
- d_5-phenol.

Extraction of the condensate/impinger solutions was performed under both acidic and basic conditions. After particulate analysis, the residue from the probe rinse was dissolved in methylene chloride, combined with the particulate filter in the Soxhlet extractor, and extracted for 16 h. Each filter and probe residue was spiked with the following surrogate compounds:

- d_{10}-anthracene
- 2-fluorophenol
- d_5-nitrobenzene.

All extracts were combined and concentrated to 1 mL final volume in a Kuderna-Danish concentrator for GC/MS analysis. Quantitative analysis was performed using retention time standards and response factors generated from the mean of a five-point calibration. The six internal standards used for determination of retention times and quantitative analysis were:

- d_4-dichlorobenzene
- d_8-naphthalene
- d_{10}-acenaphthene
- d_{10}-phenanthrene
- d_{12}-chrysene
- d_{12}-perylene.

Target analyte identification was determined from both retention times and by the match of the three major ions from the mass spectrum of the analyte with the ions in the mass spectral library. The compounds of interest for the analysis were:

- anthracene
- bis (2-ethyl hexyl)phthalate
- pentachlorophenol.

A detailed description of all QA/QC performed during the analysis of the semi-volatile Modified Method 5 train components is presented in Section 5.4. A small aliquot was obtained from both the train condensates and NaOH impinger solutions and analyzed for chloride by ion chromatography according to EPA Method 300 (SW-846, Third Edition).

3.5 Dioxins/Furans

The determination of tetra-, penta-, hexa-, and octachlorodibenzodioxins (PCDDs) and dibenzofurans (PCDFs) was performed following the analytical methodology of EPA Method 8280 (SW-846, Third Edition). A Hewlett-Packard 5985/87 using the conditions shown in Table 3-4 was used to perform these analyses. The analytical procedure employed high resolution capillary gas chromatography/low resolution mass spectrometry using the Selected Ion Monitoring technique. Quantitative analysis was performed using a recovery standard, ^{13}C-1,2,3,4-tetrachlorodibenzodioxin. The following internal standards are added at the start of the sample preparation process to assess extraction efficiency:

- ^{13}C-2,3,7,8-tetrachlorodibenzodioxin
- ^{13}C-2,3,7,8-tetrachlorodibenzofuran
- ^{13}C-1,2,3,7,8-pentachlorodibenzodioxin
- ^{13}C-1,2,3,7,8-pentachlorodibenzofuran
- ^{13}C-1,2,3,6,7,8-hexachlorodibenzodioxin
- ^{13}C-1,2,3,4,7,8-hexachlorodibenzofuran
- ^{13}C-1,2,3,4,6,7,8-heptachlorodibenzodioxin
- ^{13}C-1,2,3,4,6,7,8-heptachlorodibenzofuran
- ^{13}C-octachlorodibenzodioxin
- ^{13}C-octachlorodibenzofuran.

Target analyte identification relies upon establishing retention time windows for the analytes at each level of chlorination using a specific retention time standard, as well as the presence of all of the characteristic ions listed in Table 2 of Method 8280 (SW-846, Third Edition) for each class of PCDD and PCDF and the fragment ion (M-COCl) for confirmation of the identification. The maximum intensity of each of the specified characteristic ions must coincide within 2 scans or 2 sec. The relative intensities of the selected isotopic ions within the molecular ion cluster of a homologous series of PCDDs or PCDFs must lie within the range specified in Table 3 of Method 8280 (SW-846, Third Edition). A single response factor is used for the compounds at each level of chlorination, so a single standard is used at each

TABLE 3-4. HEWLETT-PACKARD 5985 OPERATING CONDITIONS

Source Temperature	200°C
Ionization Mode	Electron Ionization
Electron Energy	70 eV, nominal
Resolution	Unit
Interface Temperature	275°C
Scan Mode	Selected Ion Monitoring
GC Column	60 m x 0.32 mm ID J&W DB-5 fused silica capillary 1.0 u-film thickness
Carrier Gas	He @ 15 psi
Injector	Cool on-column (35°C)
Interface	Direct source coupling
GC Temperature Program	Initial hold of 0.5 min, then 35-200°C at 3°C/min, then 200-310°C at 4°C/min
Injection Volume	1 uL

level of chlorination to determine the response factors. The following compounds are components of the calibration standard:

- 2,3,7,8-tetrachlorodibenzodioxin
- 2,3,7,8-tetrachlorodibenzofuran
- 1,2,3,7,8-pentachlorodibenzodioxin
- 1,2,3,4,7-pentachlorodibenzodioxin
- 1,2,3,7,8-pentachlorodibenzodioxin
- 2,3,4,7,8-pentachlorodibenzofuran
- 1,2,3,4,7,8-hexachlorodibenzodioxin
- 1,2,3,6,7,8-hexachlorodibenzodioxin
- 1,2,3,7,8,9-hexachlorodibenzodioxin
- 1,2,3,4,7,8-hexachlorodibenzofuran
- 1,2,3,6,7,8-hexachlorodibenzofuran
- 1,2,3,7,8,9-hexachlorodibenzofuran
- 1,2,3,4,6,7,8-heptachlorodibenzodioxin
- 1,2,3,4,6,7,8-heptachlorodibenzofuran
- 1,2,3,4,7,8,9-heptachlorodibenzofuran
- octachlorodibenzodioxin
- octachlorodibenzofuran.

All dioxin/furan extracts were prepared following the extraction/-purification procedures of Method 8280 (SW-846, Third Edition). A detailed description of all QA/QC performed during the analysis of the dioxin/furan extracts is presented in Section 5.5.

3.6 Metals/Method 12

The feed, ash, scrubber water, and Method 12 samples were analyzed for metals using ICPES and graphite furnace atomic absorption techniques. Prior to analysis, samples were subjected to the acid digestion procedures as described in Method 3050 (SW-846, Third Edition) and EPA Method 12. Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) was used for the analysis of chromium, zinc, lead, cadmium, nickel, and copper. The basis of chemical analysis by ICP-AES is the measurement of the atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs.

Characteristic atom-line emission spectra are produced by a radio frequency spectrometer. These samples were analyzed using a sequential type ICP-PES (a computer-controlled slow scan monochromator). The monochromator isolates the atomic lines of interest and the intensities are multiplied by the photomultiplier.

Furnace atomic absorption spectrophotometry was used to analyze samples for arsenic by the procedure outlined in Method 7060, SW-846 . An aliquot of each sample was dried, charred and atomized in a graphite furnace. Light from a metal-specific hollow cathode tube is passed through the resulting vapor containing ground-state atoms. The decrease in the spectral intensity across the vapor is proportional to the concentration of the metal being determined. A detailed description of the QA/QC performed during the analysis is presented in Section 5.6.

4.0 RESULTS AND DISCUSSION

4.1 Volatiles

The results of the analyses of the volatile samples for the selected organic compounds are shown in Tables 4-1 through 4-3. Scrubber water showed only the presence of small quantities of acetone in two of the samples. No analyte was detected at a level of five times greater than the detection limit. Bottom ash (Table 4-2), which was purged as a water slurry, showed the presence of acetone, 1,2-dichloroethane, ethylbenzene, and xylenes. Only acetone was present at a level five times greater than the detection limit in all of the samples. Total xylenes were observed at a level greater than five times the detection limit in only one sample. All other compounds observed were present at significantly lower levels in the bottom ash. The sludge feeds (analyzed as methanol extracts) showed very high levels of all of the target compounds (Table 4-3), and required extensive dilution to avoid saturation of peaks in the chromatogram and in the mass spectrum.

TABLE 4-1. VOLATILE RESULTS FOR PEI ASSOCIATES - SCRUBBER WATER (ug/L)

Analyte	Method Detection Limit	02 ZSARM-II-5-S	05 ZSARM-II-6-S	01 ZSARM-I-1-INF	03 ZSARM-I-1-S	05 ZSARM I-3-S	08 ZSARM-I-2-S	11 ZSARM-II-4-5
acetone	8.0	ND	ND	ND	ND	12	17	ND
1,2-dichloroethane	3.0	ND	ND	ND	ND	ND	ND	ND
tetrachloroethene	4.0	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	6.0	ND	ND	ND	ND	ND	ND	ND
ethylbenzene	7.0	ND	ND	ND	ND	ND	ND	ND
styrene	3.0	ND	ND	ND	ND	ND	ND	ND
total xylenes	5.0	ND	ND	ND	ND	ND	ND	ND

ND = not detected at specified detection limit

TABLE 4-2. VOLATILE RESULTS FOR PEI ASSOCIATES - BOTTOM ASH (ug/kg)

Analyte	Method Detection Limit	01 ZSARM-II-4-A	04 ZSARM-II-5-A	07 ZSARM-II-6-A	04 ZSARM-I-1-A	07 ZSARM-I-3-A	10 ZSARM-I-2-A
acetone	8.0	190	210	790	440	630	420
1,2-dichloroethane	3.0	ND	5	10	ND	ND	ND
tetrachloroethene	4.0	ND	ND	ND	ND	ND	ND
chlorobenzene	6.0	ND	ND	ND	ND	ND	ND
ethylbenzene	7.0	8	ND	13	ND	ND	19
styrene	3.0	ND	ND	ND	ND	ND	ND
total xylenes	5.0	11	6	20	ND	ND	34

ND = not detected at specified detection limit

TABLE 4-3. VOLATILE RESULTS FOR PEI ASSOCIATES - FEED EXTRACTS (ug/kg)

	Method Detection Limit	02 ZSARM-I-1-F (1:12500dil) (0.82g)	03 ZSARM-II-5-F (1:625dil) (4.0g)	06 ZSARM-II-6-F (1:1250dil) (0.83g)	09 ZSARM-I-2-F (1:12500dil) (4.0g)	06 ZSARM-I-3-F (1:12500dil) (0.85g)	12 ZSARM II-4- (1:125 (4.0g
acetone	8.0	3300000	570000	270000	6000000	2700000	68000
1,2-dichloroethane	3.0	450000	3500	28000	140000	340000	1300
tetrachloroethene	4.0	ND	8500	36000	260000	350000	2900
chlorobenzene	6.0	340000	6900	30000	240000	360000	2200
ethylbenzene	7.0	3600000	84000	330000	2400000	4000000	24000
styrene	3.0	770000	16000	67000	580000	810000	5100
total xylenes	5.0	5800000	150000	520000	4000000	6000000	12000

ND = not detected at specified detection limit

All samples were analyzed within the holding times required by Method 8240 (SW-846, Third Edition). GC/MS analysis was performed the same day as the methanol extraction.

4.2 VOST

The results for the VOST analysis of incinerator stack emissions are shown in Table 4-4. One sample could not be analyzed because the sampling tube arrived broken. Only one sample did not show the presence of any analytes at a detectable level. All of the other samples contained at least one analyte at a level five times the detection limit. Levels of analyte observed ranged from the detection limit to more than one hundred times the detection limit. In view of the extremely high surrogate recoveries encountered for bromofluorobenzene, values for the late-eluting compounds (most especially ethylbenzene, styrene, and the xylenes) may be high by the factor above 100% exhibited by the bromofluorobenzene. Since response factors remain stable (as demonstrated by the initial calibration check at the beginning of the day and an additional calibration check at the end of the day) and, in general, the blanks do not exhibit these inflated surrogate compound recoveries, the occurrence of elevated surrogate compound recoveries in the course of the performance of VOST analyses must be considered a matrix effect. The classic means of demonstrating the operation of a matrix effect, namely, repeated analysis of the same sample, repeated preparation and analysis of the same sample, and occurrence of the matrix effect throughout all analyses of the sample, cannot be performed in the VOST assay, since the VOST sample consists only of a single set of sampling tubes and the compounds which are desorbed from the sampling tubes are analyzed in the initial analysis. No VOST sample can be re-analyzed. VOST samples are known to contain high levels of water, since stack emissions contain high levels of water. Large quantities of water introduced into a chromatographic analysis and/or into a mass spectrometer will distort the chromatography and will cause relative signal levels for the compounds to be distorted. Additional components of the stack gases such as various acids can also have the effect of perturbing the chromatography, and stack emissions are often highly acidic.

TABLE 4-4. VOST RESULTS OF INCINERATOR STACK EMISSIONS (nanograms)

Compound Compound	Method Detection Limit (ng)	01 SAI-V-1-A	02 SAI-V-1-B	03 SAI-V-1-C	04 SAI-V-2-A	05 SAI-V-2-B	06 SAI-V-2-C	07 SAI-V-3-A	08 SAI-V-3-B	09 SAI V-3
acetone acetone	5.0	ND	120	210	76	75	*	67	110	12
1,2-dichl1,2-dichloroethane	1.0	ND	ND	ND	10	ND		16	17	4
perchloroperchloroethylene	1.0	ND	ND	2	9	ND		24	29	4
chlorobenchlorobenzene	0.7	28	13	7	9	2		60	130	
ethylbenzethylbenzene	2.0	230	74	29	97	7		120	170	37
styrene styrene	2.0	130	53	22	40	24		340	760	9
total xyltotal xylenes	4.0	230	83	71	190	37		180	180	52

Compound Compound	Method Detection Limit (ng)	10 SAII-V-1-A	11 SAII-V-1-B	12 SAII-V-1-C	13 SAII-V-2-A	14 SAII-V-2-B	15 SAII-V-2-C	16 SAII-V-3-A	17 SAII-V-3-B	18 SA V-3
acetone acetone	5.0	ND	ND	ND	ND	ND	ND	13	ND	
1,2-dichl1,2-dichloroethane	1.0	ND	ND	ND	1	ND	ND	ND	2	
perchloroperchloroethylene	1.0	2	3	ND	7	5	3	21	6	
chlorobenchlorobenzene	0.7	ND	10	ND	4	9	2	5	2	
ethylbenzethylbenzene	2.0	12	47	ND	14	20	6	16	7	
styrene styrene	2.0	ND	240	ND	7	1	3	7	3	
total xyltotal xylenes	4.0	17	82	ND	47	78	30	49	18	

Compound Compound	Method Detection Limit	25 SAI-V-1-2 FIELD BLANK	26 SAII-V-1 FIELD BLANK	27 SAII-V-3 FIELD BLANK
acetone acetone	5.0	ND	ND	ND
1,2-dichl1,2-dichloroethane	1.0	ND	ND	ND
perchloroperchloroethylene	1.0	1	1	ND
chlorobenchlorobenzene	0.7	ND	ND	ND
ethylbenzethylbenzene	2.0	ND	ND	ND
styrene styrene	2.0	ND	ND	ND
total xyltotal xylenes	4.0	4	ND	ND

*tube bro*tube broken

The Method 5040 QC measures were executed with acceptable results, but sample surrogate recoveries are often seen to be above the 50-150% criterion for acceptability of the method.

4.3 Semi-Volatiles

The results for the analysis of semi-volatile sample extracts are shown in Table 4-5. In analogy to the Volatiles assays, only low levels of analytes (many of them not more than five times the method detection limit) are observed in scrubber water and bottom ash. Relatively low levels of analytes are also observed in Condensate/Back Methylene Chloride samples. High levels of analytes, ranging in the millions of ug/kg for some of the analytes, are observed in the feed extracts. Results for bis (2-ethylhexyl) phthalate must be interpreted with caution, however. Blanks which were analyzed (Table 5-9) show the presence of this compound, with the filter blank, XAD-2® blank, and train blanks showing the presence of bis (2- ethylhexyl) phthalate at levels which range from a factor of approximately 30 times the detection limit to 65 times the detection limit. Obviously significant quantities of bis (2-ethylhexyl) phthalate are detected upon analysis of any of the blanks which incorporate train components. Contamination by this compound thus is observed to occur readily, and perhaps a higher criterion for credibility for the concentration of this compound than a factor of five times the method detection limit should be considered. If blanks exhibit the presence of the compound at a level of sixty times the detection limit, then perhaps a criterion of one hundred times would be more credible than five times the method detection limit.

4.4 Particulate/Modified Method 5/Chloride

The results for the analysis of particulate are shown in Table 4-6. Particulate weights in grams are reported for the filter and the condensate. As expected, the weight of particulate is far higher on the filter than in the condensate. The results for the Modified Method 5 samples are shown in Table 4-5, with the other semivolatile data. Pentachlorophenol is observed in one

TABLE 4-5. SEMIVOLATILE RESULTS FOR PEI ASSOCIATES - SCRUBBER WATER, ASH AND FEED EXTRACTS/MM5

Scrubber Water (ug/L)

Analyte	Estimated Instrument Det Limit	01 ZSARM-I-1-S	02 ZSARM-I-2-S	03 ZSARM-I-3-S	04 ZSARM-II-4-S	05 ZSARM-II-5-S	06 ZSARM-II-6-S	4(ZSAF I-1-
pentachlorophenol	0.4	8	4	ND	ND	ND	ND	N(
anthracene	ND	ND	ND	ND	ND	ND	ND	N(
bis(2-ethylhexyl)phthalate	3	ND	5	2.3	5	ND	9	N(

Bottom Ash (ug/kg)

Analyte	Estimated Instrument Det Limit	10 ZSARM-I-1-A	11 ZSARM-I-2-A	12 ZSARM-I-3-A	13 ZSARM-II-4-A	14 ZSARM-II-5-A	15 ZSARM-II-6-A
pentachlorophenol	370	ND	ND	ND	ND	ND	ND
anthracene	37	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl)phthalate	63	1600	540	740	950	710	1300

Feed Extracts (ug/kg)

Analyte	Estimated Instrument Det Limit	19 ZSARM-I-1-F (1:10 dil)	20 ZSARM-I-2-F (1:10 dil)	21 ZSARM-I-3-F (1:10 dil)	22 ZSARM-II-4-F	23 ZSARM-II-5-F	24 ZSARM-II-6-F
pentachlorophenol	3300	ND	630,000	ND	ND	ND	ND
anthracene	6000	6,200,000	8,500,000	5,300,000	480,000	420,000	440,000
bis(2-ethylhexyl)phthalate	44,000	2,800,000	3,300,000	2,200,000	290,000	270,000	ND

TABLE 4-5. CONCLUDED

MM5
XAD-2, Condensate/Back MeCl2 (total ug)

Analyte	Target Det Limit	28 SAI-SV-1	29 SAI-SV-2	31 SAII-SV-1
pentachlorophenol	.2	ND	ND	5
anthracene	2.9	ND	ND	ND
bis(2-ethylhexyl)phthalate	.3	230	54	59

MM5
XAD-2 Condensate/Back MeCl2 (total ug)

Analyte	Target Det Limit	30 SAI-SV-3	32 SAII-SV-2	33 SAII-SV-3
pentachlorophenol	.5	ND	ND	ND
anthracene	.4	ND	ND	ND
bis(2-ethylhexyl)phthalate	.4	480	700	38

TABLE 4-6. PARTICULATE RESULTS

Client ID	Radian Number	Particulate Weights (grams) Filter	Condensate
SAI-SV-1	P7-09-024-SP-28A	0.1327	0.0101
SAI-SV-2	P7-09-024-SP-29A	0.1081	0.0075
SAI-SV-3	P7-09-024-SP-30A	0.0843	0.0066
SAII-SV-1	P7-09-024-SP-31A	0.0501	0.0045
SAII-SV-2	P7-09-024-SP-32A	0.0367	0.0067
SAII-SV-3	P7-09-024-SP-33A	0.0389	0.0024

sample at a level greater than five times the detection limit, but no anthracene is found in any of the train samples. Bis(2-ethyl hexyl)phthalate is observed at very high levels in all of the samples, occurring at factors of several hundred times the detection limit. The peak has been identified accurately by both retention time and mass spectrum, but the results should be interpreted with caution and a knowledge of the field history and treatment of the samples, since this compound is a very common contaminant. Levels observed in field blanks were far lower than the values obtained for the field samples, but the field samples could still be dealing with some contamination which occurred in the field.

The results for the analysis of the aliquots from the Modified Method 5 samples are presented in Table 4-7. The chloride values ranged from 1.7 to 20 mg for the condensates and impingers. The measured chloride per train ranged from 6.9 (SAII-SV-3) to 36.6 (SAI-SV-I) total milligrams.

4.5 Dioxins/Furans

The results for the analysis of the dioxin/furan samples are shown in Tables 4-8 to 4-10. No levels of dioxins or furans above the Method detection limit were observed in any of the samples, while all surrogate compound recoveries were within the limits specified by Method 8280 (SW-846, Third Edition).

4.6 Metals/Method 12

The results for the analysis of the metals in waste feed, ash, and scrubber water are shown in Tables 4-11 to 4-13, respectively. The metal results of the analysis by Method 12 of the stack emissions are given in Table 4-14.

5.0 QA/QC

TABLE 4-7. PEI CHLORIDE ANALYSIS
SAMPLE RESULTS

Date	Field #	Work Order	Sample #	Description	ppm	Total Vol.	mg
10/8/87	SAI-SV-1	P709026	01A	condensate	14.6	1410	20.59
10/8/87	SAI-SV-1	P709026	02A	impinger	8.9	1800	16.02
10/7/87	SAI-SV-2	P709026	03A	condensate	14.3	1370	19.59
10/7/87	SAI-SV-2	P709026	04A	impinger	11.3	1020	11.53
10/7/87	SAI-SV-3	P709026	05A	condensate	8.4	2200	18.48
10/7/87	SAI-SV-3	P709026	06A	impinger	5.1	560	2.86
10/7/87	SAII-SV-1	P709026	07A	condensate	4.2	1555	6.53
10/7/87	SAII-SV-1	P709026	08A	impinger	4.4	1005	4.42
10/7/87	SAII-SV-2	P709026	09A	condensate	2.1	2380	5.00
10/7/87	SAII-SV-2	P709026	10A	impinger	1.0	520	5.20
10/8/87	SAII-SV-3	P709026	11A	condensate	2.3	2270	5.22
10/8/87	SAII-SV-3	P709026	12A	impinger	2.5	670	1.68

TABLE 4-8. DIOXIN/FURAN RESULTS ng/g
FEED

Analyte	Reagent blank A710018-Blank 37031	ZSARM 1-2-F A710003-07-A 37034	ZSARM-II-5-F A710003-08-A 37035
Total TCDD	<0.2	<0.6	<0.6
Total TCDF	<0.2	<0.5	<0.5
Total PCDD	<0.2	<0.4	<0.5
Total PCDF	<0.2	<0.4	<0.4
Total HxCDD	<0.5	<1.0	<1.1
Total HxCDF	<0.4	<0.9	<0.8
Total HpCDD	<0.6	<0.6	<0.6
Total HpCDF	<0.4	<0.8	<1.1
Total OCDD	<1.6	<1.6	<2.2
Total OCDF	<0.7	<1.6	<1.7

NOTE: All Surrogate recoveries are within method prescribed limits.

TABLE 4-9. DIOXIN/FURAN RESULTS ng/g
ASH

Analyte	Reagent blank A710003-3540 blank 37022	ZSARM 1-2-A A710003-04-A 37020	ZSARM-II-5-A A710003-05A 37021
Total TCDD	<0.2	<0.2	<0.2
Total TCDF	<0.1	<0.1	<0.1
Total PCDD	<0.2	<0.2	<0.2
Total PCDF	<0.2	<0.1	<0.1
Total HxCDD	<0.4	<0.3	<0.3
Total HxCDF	<0.3	<0.2	<0.2
Total HpCDD	<0.5	<0.4	<0.4
Total HpCDF	<0.3	<0.3	<0.3
Total OCDD	<0.6	<0.5	<0.6
Total OCDF	<0.5	<0.4	<0.5

NOTE: All Surrogate recoveries are within method prescribed limits.

TABLE 4-10. DIOXIN/FURAN RESULTS ng/L
SCRUBBER

Analyte	Reagent blank A710003-blank 37017	ZSARM 1-2-S A710003-01A 37018	ZSARM-II-5-S A710003-02A 37019
Total TCDD	<2	<2	<1
Total TCDF	<1	<1	<1
Total PCDD	<2	<2	<1
Total PCDF	<1	<1	<1
Total HxCLD	<3	<3	<3
Total HxCDF	<2	<2	<2
Total HpCDD	<4	<4	<4
Total HpCDF	<2	<2	<2
13C-OCDD	<5	<4	<4
13C-OCDF	<4	<4	<4

NOTE: All Surrogate recoveries are within method prescribed limits.

TABLE 4-11. PEI WASTE FEED SAMPLE RESULTS

Analyte	Analysis Type	Method Detection Limit (total ug)	MDL assuming 5 gram sample (ug/g)	Sample ZARM I 1-F P7-09-023 -19a (ug/g)	Sample ZARM I 2-F P7-09-023 -20a (ug/g)	Sample ZARM I 3-F P7-09-023 -21a (ug/g)	Sample ZARM II 4-F P7-09-023 -22a (ug/g)	Sample ZARM II 5-F P7-09-023 -23a (ug/g)	Sample ZARM II 6-F P7-09-023 -24a (ug/g)	Sample ZARM I 1-F MS P7-09-023 -25a (ug/g)	Sample ZARM I 1-F MS Duplicate P7-09-023 -26a (ug/g)	Sampl Metho Blank P7-09-0 -27a (total
Arsenic	GF AAS	0.200	0.040	16.9	17.2	19.7	19.1	19.3	17.8	28.8	30.3	0.3
Chromium	ICAP	1.50	0.300	24.2	32.8	30.6	30.1	27.3	26.6	115	121	< 1.5
Zinc	ICAP	0.600	0.120	451	551	526	548	508	158	1200	1280	3.
Lead	ICAP	21.0	4.20	261	296	292	328	301	302	543	587	< 21.
Cadmium	ICAP	0.600	0.120	26.3	25.4	26.0	26.5	25.6	25.8	118	121	< 0.60
Nickel	ICAP	1.50	0.300	27.5	29.8	26.8	29.5	27.6	28.1	117	120	< 1.5
Copper	ICAP	2.10	0.420	244	267	261	282	250	255	804	836	< 2.1

Analyte	Analysis Type	Method Detection Limit (ug/mL)	Comments	Sample P7-09-023 -19a (ug/mL)	Sample P7-09-023 -20a (ug/mL)	Sample P7-09-023 -21a (ug/mL)	Sample P7-09-023 -22a (ug/mL)	Sample P7-09-023 -23a (ug/mL)	Sample P7-09-023 -24a (ug/mL)	Sample P7-09-023 -25a (ug/mL)	Sample P7-09-023 -26a (ug/mL)	Sampl P7-09-(-27a (ug/mL
Arsenic	GF AAS	0.002	All samples brought to 100 mL fina volume. All samples (except the blank) used 5 grams of dry solid. (Reported ug/g per dry weight.	0.886	0.858	0.992	0.959	1.040	0.904	1.450	1.520	0.(
Chromium	ICAP	0.015		1.270	1.640	1.540	1.510	1.470	1.350	5.810	6.060	< MDI
Zinc	ICAP	0.006		23.620	27.520	26.490	27.530	27.380	8.030	60.690	64.370	0.(
Lead	ICAP	0.210		13.680	14.810	14.690	16.470	16.210	15.320	27.370	29.420	< MDI
Cadmium	ICAP	0.006		1.380	1.270	1.310	1.330	1.380	1.310	5.940	6.080	< MDI
Nickel	ICAP	0.015		1.440	1.490	1.350	1.480	1.490	1.430	5.900	6.020	< MDI
Copper	ICAP	0.021		12.790	13.370	13.120	14.160	13.450	12.950	40.540	41.930	< MDI

MDL = Method Detection Limit

TABLE 4-12. PEI ASH SAMPLE RESULTS

Analyte	Analysis Type	Method Detection Limit (total ug)	MDL assuming 5 gram sample (ug/g)	Sample ZARM I 1-A P7-09-023 -10a (ug/g)	Sample ZARM I 2-A P7-09-023 -11a (ug/g)	Sample ZARM I 3-A P7-09-023 -12a (ug/g)	Sample ZARM II 4-A P7-09-023 -13a (ug/g)	Sample ZARM II 5-A P7-09-023 -14a (ug/g)	Sample ZARM II 6-A P7-09-023 -15a (ug/g)	Sample ZARM I 1-A MS P7-09-023 -16a (ug/g)	Sample ZARM I 1-A MS duplicate P7-09-023 -17a (ug/g)
Arsenic	GF AAS	0.200	0.040	37.7	36.1	43.8	45.5	38.6	37.4	55.9	61.5
Chromium	ICAP	1.500	0.300	(a) 9.80	13.5	(a) 11.9	11.8	6.90	(a) 9.60	101	101
Zinc	ICAP	0.600	0.120	217	227	250	252	199	237	1130	1170
Lead	ICAP	21.000	4.20	56.2	97.8	(a) 107	146	75.1	(a) 88.3	610	604
Cadmium	ICAP	0.600	0.120	< 1.48	< 1.50	< 1.49	(a) 3.20	< 1.48	< 1.45	87.7	87.6
Nickel	ICAP	1.500	0.300	11.8	14.8	11.4	12.0	9.12	12.3	102	103
Copper	ICAP	2.100	0.420	111	132	159	125	106	162	604	585

Analyte	Analysis Type	Method Detection Limit (ug/mL)	Comments	Sample P7-09-023 -10a (ug/mL)	Sample P7-09-023 -11a (ug/mL)	Sample P7-09-023 -12a (ug/mL)	Sample P7-09-023 -13a (ug/mL)	Sample P7-09-023 -14a (ug/mL)	Sample P7-09-023 -15a (ug/mL)	Sample P7-09-023 -16a (ug/mL)	Sampl P7-09-0 -17a (ug/mL)
Arsenic	GF AAS	0.002	All samples brought to 100 mL final volume. All samples (except the blank) used 5 grams of dry solid. (Reported ug/g per dry weight.)	1.920	1.800	2.200	2.320	1.960	1.940	2.810	3.110
Chromium	ICAP	0.015		(a)0.500	0.675	(a)0.600	0.600	0.350	(a)0.500	5.063	5.100
Zinc	ICAP	0.006		11.075	11.338	12.550	12.863	10.100	12.263	56.588	59.250
Lead	ICAP	0.210		2.863	4.875	(a)5.388	7.438	3.813	(a)4.575	30.688	30.513
Cadmium	ICAP	0.006		< MDL	< MDL	< MDL	(a)0.163	< MDL	< MDL	4.413	4.425
Nickel	ICAP	0.015		0.600	0.738	0.575	0.613	0.463	0.638	5.113	5.212
Copper	ICAP	0.021		5.638	6.600	7.998	6.350	5.400	8.375	30.388	29.563

MDL = Method Detection Limit

(a) amount shown is a default value, but agrees with the amount

TABLE 4-13. PEI SCRUBBER WATER SAMPLE RESULTS

Analyte	Analysis Type	Method Detection Limit (ug/mL)*	Sample ZARM I 1-S P7-09-023 -01a (ug/mL)	Sample ZARM I 2-S P7-09-023 -02a (ug/mL)	Sample ZARM I 3-S P7-09-023 -03a (ug/mL)	Sample ZARM II 4-S P7-09-023 -04a (ug/mL)	Sample ZARM II 5-S P7-09-023 -05a (ug/mL)	Sample ZARM II 6-S P7-09-023 -06a (ug/mL)	Sample ZARM I 1-S MS P7-09-023 -07a (ug/mL)	Sample ZARM I 1-S MS Duplicate P7-09-023 -08a (ug/mL)	Sample Method Blank P7-09-023 -09a (ug/mL)
Arsenic	GF AAS	0.001	0.150	0.260	0.150	0.270	0.180	0.405	0.700	0.760	0.004
Chromium	ICAP	0.008	0.530	0.863	0.505	0.610	0.535	0.835	3.60	3.39	0.020
Zinc	ICAP	0.003	2.14	4.40	1.81	2.92	1.66	3.34	10.9	11.1	< 0.003
Lead	ICAP	0.105	(a) 1.75	1.52	2.25	2.23	2.02	4.82	9.51	9.83	< 0.105
Cadmium	ICAP	0.003	2.35	4.13	1.89	3.57	2.03	5.77	19.3	18.6	< 0.003
Nickel	ICAP	0.008	0.320	0.76	0.265	0.360	< 0.075	0.265	2.96	2.93	7.49
Copper	ICAP	0.011	(a) 0.595	(a) 0.530	(a) 0.475	(a) 0.550	(a) 0.585	1.14	4.32	4.26	0.540

MDL = Method Detection Limit

(a) Amount shown is a default value, but agrees with the amount found in the undiluted sample.

*For samples concentrated from 200 to 100 ml.

Table 4-14. PEI METHOD 12 TRAIN SAMPLE RESULTS

Analyte	Analysis Type	Method Detection Limit (total ug)	Sample ZARM I M-1 P7-09-023 -28a (total ug)	Sample ZARM I M-2 P7-09-023 -29a (total ug)	Sample ZARM I M-3 P7-09-023 -30a (total ug)	Sample ZARM II M-1 P7-09-023 -31a (total ug)	Sample ZARM II M-2 P7-09-023 -32a (total ug)	Sample ZARM II M-3 P7-09-023 -33a (total ug)	Sample 6750-A Nitric Blank P7-09-023 -34a (total ug)	Sample 6750-B Filter Blank P7-09-023 -35a (total ug)	Sample Method Blank P7-09-023 -36a (total ug)
Arsenic	GF AAS	0.200	40.3	44.7	27.2	13.7	13.3	21.3	0.300	NA	< 0.200
Chromium	ICAP	1.50	167	135	141	78.0	43.8	32.8	< 1.50	NA	< 1.50
Zinc	ICAP	0.600	940	602	1150	411	284	148	5.50	NA	3.00
Lead	ICAP	21.0	1740	1970	2520	923	811	750	< 21.0	NA	< 21.0
Cadmium	ICAP	0.600	4250	2730	6090	3000	2920	2170	< 0.600	NA	< 0.600
Nickel	ICAP	1.50	750	103	89.0	101	70.6	57.1	< 1.50	NA	3.20
Copper	ICAP	2.10	447	525	708	(a) 225	108	83.0	< 2.10	NA	< 2.10

Analyte	Analysis Type	Method Detection Limit (ug/mL)	Sample P7-09-023 -28a (ug/mL)	Sample P7-09-023 -29a (ug/mL)	Sample P7-09-023 -30a (ug/mL)	Sample P7-09-023 -31a (ug/mL)	Sample P7-09-023 -32a (ug/mL)	Sample P7-09-023 -33a (ug/mL)	Sample P7-09-023 -34a (ug/mL)	Sample P7-09-023 -35a (ug/mL)(c)	Sample P7-09-023 -36a (ug/mL)
Arsenic	GF AAS	0.002	0.403	0.447	0.272	0.137	0.133	0.213	0.003	0.439	< MDL
Chromium	ICAP	0.015	1.670	1.350	1.410	0.780	0.438	0.328	< MDL	< MDL	< MDL
Zinc	ICAP	0.006	9.400	6.020	11.530	4.110	2.838	1.484	0.055	0.141	0.030
Lead	ICAP	0.210	17.380	19.700	25.180	9.234	8.110	7.500	< MDL	< MDL	< MDL
Cadmium	ICAP	0.006	42.510	27.320	60.850	29.970	29.204	21.677	< MDL	< MDL	< MDL
Nickel	ICAP	0.015	7.500	1.030	0.890	1.008	0.706	0.571	< MDL	< MDL	0.032
Copper	ICAP	0.021	4.470	5.250	7.080	(a) 2.247	1.084	0.830	< MDL	< MDL	< MDL

MDL = Method Detection Limit
NA = Not Available

5.1 Volatiles

5.1.1 Instrument Calibration and Tuning

The volatile samples were analyzed according to the QA/QC procedures outlined in Method 8240, SW-846, Third Edition. The mass calibration and the instrument tune were verified daily by using perfluorotributylamine. The acceptability of a tune to meet QC criteria for bromofluorobenzene (Method 8240) was demonstrated daily prior to the initiation of any analyses.

5.1.2 System Performance

System performance was demonstrated initially with a five-point calibration. A minimum average response factor of 0.3 (0.25 for bromoform) was obtained for the System Performance Check Compounds (SPCCs) specified in Method 8240:

- chloromethane
- 1,1-dichloroethane
- bromoform
- 1,1,2,2-tetrachloroethane
- chlorobenzene.

The minimum response factor criterion was demonstrated every 12 hours for the duration of the volatiles analyses.

5.1.3 Analyte Calibration

The initial five-point calibration of 5, 10, 50, 100, and 200 ug/L standards, used for generating response factors, demonstrated a percent relative standard deviation (% RSD) of less than 30 for all of the calibration check compounds (CCCs) shown below:

- 1,1-dichloroethene
- chloroform
- 1,2-dichloropropane
- toluene
- ethylbenzene
- vinyl chloride.

This criterion for correspondence of values within 30% RSD was demonstrated every twelve hours for the duration of the volatiles analyses for this program.

5.1.4 Surrogate Recovery

To monitor the efficiency of the purge and trap operation, each sample was spiked with three surrogate compounds before analysis, as specified in Method 8240, SW-846, Third Edition. These compounds are:

- d_4-1,2-dichloroethane
- d_8-toluene
- bromofluorobenzene.

Actual surrogate recoveries are listed in Tables 5-1. All recoveries were between 90-122%, within acceptable QA/QC limits.

5.1.5 Blanks

At least one daily system/reagent blank was analyzed to check for background contamination or contamination of the analytical system. All of the method blank data can be found in Table 5-2. No contamination was found in any of the blanks; no corrections were made for contamination in the blanks.

5.1.6 Duplicate Matrix Spike Analyses

A sample from each matrix was used to perform duplicate matrix spike analyses. Each sample was spiked with 100 ng of each of the following matrix spike compounds according to Method 8240, SW-846, Third Edition:

- acetone
- 1,2-dichloroethane
- tetrachloroethene
- chlorobenzene
- ethylbenzene
- styrene
- total xylenes

TABLE 5-1. VOLATILE SURROGATES PERCENT RECOVERIES: SCRUBBER WATER, ASH, AND FEED

Scrubber Water

Surrogates	02 ZSARM-II-5-S	05 ZSARM-II-6-S	01 ZSARM-I-1-INF	03 ZSARM-I-1-S	03 ZSARM-I-1-S-MS	03 ZSARM-I-1-S-MSD	05 ZSARM I-3-S	08 ZSARM-I-2-S	11 ZSARM-II-4-5
d4-1,2-dichloroethane	92	96	96	108	109	113	94	100	103
d8-toluene	98	94	102	105	97	94	103	96	98
Bromofluorobenzene	106	107	105	105	104	102	107	106	108

Bottom Ash

Surrogates	01 ZSARM-II-4-A	04 ZSARM-II-5-A	07 ZSARM-II-6-A	04 ZSARM-I-1-A	04 ZSARM-I-1-A-MS	04 ZSARM-I-1-A-MSD	07 ZSARM-I-3-A	10 ZSARM-I-2-A
d4-1,2-dichloroethane	101	122	121	91	111	106	90	95
d8-toluene	108	101	102	101	105	103	105	105
Bromofluorobenzene	100	96	100	99	102	100	89	100

Feed Extract

Surrogates	03 ZSARM-II-5-F	06 ZSARM-II-6-F	02 ZSARM-I-1-F	02 ZSARM-I-1-F-MS	02 ZSARM-I-1-F-MSD	06 ZSARM-I-3-F	09 ZSARM-I-2-F	12 ZSARM-II-4-F
d4-1,2-dichloroethane	95	106	106	107	108	110	96	97
d8-toluene	96	102	103	102	103	101	96	96
Bromofluorobenzene	100	104	106	106	104	103	103	102

Blanks

Surrogates	08 REAGENT BLANK	13 REAGENT BLANK
d4-1,2-dichloroethane	93	91
d8-toluene	102	107
Bromofluorobenzene	99	106

TABLE 5-2. VOLATILE SYSTEM BLANK ANALYSIS RESULTS FOR PEI ASSOCIATES (ug/L)

Analyte	Method Detection Limit	8 REAGENT BLANK	13 REAGENT BLANK
acetone	8.0	ND	ND
1,2-dichloroethane	3.0	ND	ND
tetrachloroethene	4.0	ND	ND
chlorobenzene	7.0	ND	ND
ethylbenzene	7.0	ND	ND
styrene	3.0	ND	ND
total xylenes	5.0	ND	ND

ND = not detected at specified detection limit

Tables 5-3 - 5-5 show the accuracy and precision of these analyses.

5.2 VOST Analyses

5.2.1 Instrument Calibration and Tuning

The VOST samples were analyzed according to the QA/QC procedures outlined in Method 5040, SW-846, Third Edition. Acceptability of the instrument tune was verified daily by the analysis of 50 ng of bromofluorobenzene. No analyses were initiated until an acceptable tune according to the criteria of Method 8240 (SW-846, Third Edition) had been demonstrated.

5.2.2 System Performance

System performance was established initially using a five-point calibration to ensure a minimum average response factor of 0.3 (0.15 for acetone) for the System Performance Check Compounds (SPCCs):

- acetone
- 1,2-dichloroethane
- tetrachloroethylene
- chlorobenzene
- ethylbenzene
- styrene
- xylene (total).

Since Method 5040 does not specify SPCCs, the analytical target compounds were selected as SPCCs. The minimum response factor of 0.3 (0.15 for acetone) was demonstrated daily.

5.2.3 Analyte Calibration

The initial five-point calibration of 20, 50, 100, 250, and 500 ng, used for generating response factors, also demonstrated a percent relative standard deviation (% RSD) of less than 30 for all of the target compounds:

TABLE 5-3. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION) FOR BOTTOM ASH

Matrix Spike = 100 ug/kg	Determined Concentration (ug/kg)					
	ZSARM-I-1-A 0906104B	ZSARM-I-1-A MS 0906104C	ZSARM-I-1-A MSD 0906104D	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
acetone	440	1600	1100	1160	660	55
1,2-dichloroethane	ND	160	130	160	130	21
tetrachloroethene	ND	110	120	110	120	9
chlorobenzene	ND	110	110	110	110	0
ethylbenzene	ND	140	140	140	140	0

TABLE 5-4. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION) FOR SCRUBBER WATER

Matrix Spike = 100 ug/L	Determined Concentration (ug/L)					
	ZSARM-I-1-S 0906103B	ZSARM-I-1-S MS 0906103CR	ZSARM-I-1-S MSD 0906103D	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
acetone	ND	50	54	50	54	8
1,2-dichloroethane	ND	110	120	110	120	9
tetrachloroethene	ND	85	96	85	96	12
chlorobenzene	ND	92	100	92	100	8
ethylbenzene	ND	85	98	85	98	14
styrene	ND	85	96	85	96	14
total xylenes	ND	49	56	49	56	13

ND = not detected.

TABLE 5-5. VOLATILES SPIKE RECOVERY (ACCURACY) AND RELATIVE PERCENT DIFFERENCE (PRECISION) FOR FEED EXTRACT

Matrix Spike = 100 ug/kg	Determined Concentration (ug/kg)					
	ZSARM-I-1-F 09061028	ZSARM-I-1-F MS 0906102C	ZSARM-I-1-F MSD 09061020	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
acetone	220	330	340	110	120	9
1,2-dichloroethane	30	160	170	130	140	7
tetrachloroethene	36	140	140	104	104	0
chlorobenzene	22	130	140	108	118	9
ethylbenzene	240	390	400	150	160	6
styrene	50	160	170	110	120	9
total xylenes	380	540	550	160	170	6

ND = not detected

- acetone
- 1,2-dichloroethane
- tetrachloroethylene
- chlorobenzene
- ethylbenzene
- m-, p-xylene
- o-xylene
- styrene.

This criterion was demonstrated daily for the duration of the VOST analyses.

5.2.4 Surrogate Recovery

To monitor desorption/purge and trap efficiency, each sample was spiked with three surrogate compounds immediately before analysis. These compounds are listed below:

- d_4-1,2-dichloroethane
- d_8-toluene
- bromofluorobenzene

Actual recoveries are listed in Table 5-6. The Method Blanks (Laboratory Blanks of VOST tubes) show surrogate recoveries which range from 45% for bromofluorobenzene to 108% for d_8-toluene. Field Blanks show a range of 81% for d_8-toluene to 206% for bromofluorobenzene. Most of these recoveries are within the acceptable range as determined by Method 8240 (SW-846, Third Edition). However, actual sample surrogate recoveries show the following ranges:

bromofluorobenzene	141% - 585%
d_4-1,2-dichloroethane	79% - 158%
d_8-toluene	94% - 393%.

The sample which showed the very high surrogate recoveries also exhibited poor chromatography on the megabore column: both of the internal standard peaks were wide and diffuse. The presence of large quantities of water on the sampling tubes may be inferred, illustrating a matrix effect on this sample.

TABLE 5-6. VOST SURROGATE PERCENT RECOVERIES

Sample I.D.	p-Bromofluorobenzene	d4-1,2-Dichloroethane	d8-Toluene
SAI-V-1-A OWA870271	585	158	393
SAI-V-I-B OWA870272	258	112	155
SAI-V-I-C OWA870273	212	104	139
SAI-V-II-A OWA870274	223	93	139
SAI-V-II-B OWA870275	219	94	131
SAI-V-III-A OWA870299	257	101	141
SAI-V-III-B OWA870300	281	101	134
SAI-V-III-C OWA870301	279	141	103
SAII-V-I-A OWA870302	199	91	117
SAII-V-I-B OWA870303	220	108	110
SAII-V-I-C OWA870304	203	103	109
SAII-V-II-A OWA870316	245	84	171
SAII-V-II-B OWA870317	267	79	155
SAII-V-II-C OWA879318	197	85	153

TABLE 5-6. CONCLUDED

Sample I.D.	p-Bromofluorobenzene	d4-1,2-Dichloroethane	d8-Toluene
SAII-V-III-A OWA870319	264	94	148
SAII-V-III-B OWA870320	203	88	148
SAII-V-III-C OWA870321	260	89	158
SAI-V-1 CONDENSATE OWA870276	220	92	127
SAI-V-II CONDENSATE OWA870277	207	88	124
SAI-V-III CONDENSATE OWA870305	211	102	94
SAII-V-1 CONDENSATE OWA870322	279	96	158
SAII-V-2 CONDENSATE OWA870323	292	97	166
SAII-V-III OWA870324	299	98	169
SAI-V-I-2 FIELD BLANK OWA870325	206	95	154
SAII-V-1 FIELD BLANK OWA870326	119	101	81
SAII-V-3 FIELD BLANK OWA870327	101	94	95
METHOD BLANK 1 OWA870270	45	105	69
METHOD BLANK 2 OWA870298	87	108	78

5.2.5 Blanks

Daily laboratory blanks, consisting of clean sampling tubes which had not been sent to the field, were analyzed to check for background contamination. The results are shown in Table 5-7. No significant contamination was observed on the sampling tubes. Results for the field blank analyses are reported with the data for the field samples.

5.2.6 Duplicate Matrix Spike Analyses

Since duplicate matrix spike analyses are not required according to the protocol of Method 5040 (SW-846, Third Edition) and since the ability to perform these analyses is dependent upon the supply of a given sample in triplicate from the field, no duplicate matrix spike analyses could be performed because the samples were not supplied for spiking.

5.3 Semi-Volatiles

5.3.1 Instrument Calibration and Tuning

All semi-volatile extracts were analyzed using the QA/QC procedures outlined in Method 8270, SW-846, Third Edition, without significant modification. The tune of the mass spectrometer used for these analyses was verified by demonstrating an acceptable mass spectrum of decafluorotriphenylphosphine every twelve hours. Acceptable chromatography was verified daily by examination of the shape of the chromatographic peaks produced by benzidine and pentachlorophenol.

5.3.2 System Performance

System performance was verified daily beginning with the initial five- point calibration by demonstrating that system performance check compounds (SPCCs) had response factors greater than 0.05 using the 50 ug/mL calibration standard. The System Performance Check Compounds are:

TABLE 5-7. SYSTEM BLANK DATA FOR VOST ANALYSES (NG)

ANALYTE	ESTIMATED LIMITS OF DETECTION	28A METHOD BLANK #1	29A METHOD BLANK #2
Acetone	5.0	ND	ND
1,2-dichloroethane	1.0	ND	ND
Perchloroethylene	1.1	ND	ND
Chlorobenzene	0.7	ND	ND
Ethylbenzene	1.8	ND	ND
Styrene	1.6	ND	ND
Total Xylenes	3.8	ND	ND

- N-Nitrosodi-n-propylamine
- hexachlorocyclopentadiene
- 2,4-dichlorophenol
- 4-nitrophenol.

5.3.3 Continuing Analyte Calibration

In the course of generating a five-point calibration for this program, response factors for the calibration check compounds (CCCs) were verified to have less than 30% relative standard deviation (RSD) over the calibration range. The calibration check compounds (CCCs) were:

- phenol
- 1,4-dichlorobenzene
- 2-nitrophenol
- 2,4-dichlorophenol
- hexachlorobutadiene
- 4-chloro-3-methylphenol
- acenaphthene
- 2,4,6-trichlorophenol
- N-nitroso-di-N-phenylamine
- pentachlorophenol
- fluoranthene
- di-n-octyl phthalate
- benzo(a)pyrene

The analysis of the Calibration Check Compounds was repeated every twelve hours to verify that the response factors were within 30% of the mean generated in the five-point calibration curve.

5.3.4 Surrogate Recoveries

Surrogate recoveries were determined for all of the semi-volatile samples, blanks, and matrix spikes. Surrogate recoveries are shown in Table 5-8.

TABLE 5-8. SEMIVOLATILES SURROGATE PERCENT RECOVERIES

Sample I.D	2-Fluoro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluoro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl
Scrubber Water						
ZSARM-I-1-S F872139	75	84	72	98	114	101
ZSARM-I-2-S F872142	86	101	69	90	64	94
ZSARM-I-3-S F872143	86	96	94	95	97	109
ZSARM-II-4-S F872144	82	96	67	89	105	92
ZSARM-II-5-S F872145	64	78	91	87	87	95
ZSARM-II-6-S F872146	48	61	92	87	77	90
ZSARM-I-1-S MS F872147	74	93	77	91	48	95
ZSARM-I-1-S MSD 872148	85	91	69	91	55	91
METHOD BLANK F872138	48	73	79	87	69	102
ZSARM-I-1-INF F872149	77	88	103	88	87	88
Bottom Ash						
ZSARM-I-1-A F872151	24	46	84	80	12	91
ZSARM-I-2-A F872154	9	39	65	77	13	89
ZSARM-I-3-A F872155	25	55	79	84	30	93
ZSARM-II-4-A F872156	2	10	82	86	ND	99
ZSARM-II-5-A F872157	4	13	64	75	ND	94
ZSARM-II-6-A F872158	15	40	79	79	ND	91

TABLE 5-8. CONTINUED

Sample I.D	2-Fluoro-phenol	d5-Phenol	d5-Nitro-Benzene	2-Fluoro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl
ZSARM-I-1-A MS F872159	5	38	69	73	ND	82
ZSARM-I-1-A MSD F872160	7	25	74	73	ND	85
METHOD BLANK F872150	79	90	88	86	84	93
Feed Extract						
ZSARM-I-1-F F872167	91	96	93	115	24	107
ZSARM-I-2-F F872168	88	91	90	110	119	103
ZSARM-I-3-F F872169	89	94	93	118	122	107
ZSARM-II-4-F F872164	80	92	94	105	102	98
ZSARM-II-5-F F872165	85	91	90	112	112	101
ZSARM-II-6-F F872166	89	87	92	109	121	109
ZSARM-I-1-F MS F872170	78	78	73	107	137	106
ZSARM-I-1-F MSD F872171	84	85	84	109	142	101
METHOD BLANK F872163	83	90	92	112	114	97

TABLE 5-8. CONCLUDED

Sample I.D	2-Fluoro-phenol	d5-Phenol	d5-Nitro-benzene	2-Fluoro-biphenyl	2,4,6-Tri-bromophenol	d14-Terphenyl	d10-Anthracene
SAI-SV-1 F872183	77	85	88	95	91	93	83
SAI-SV-2 F872186	62	54	66	97	101	88	44
SAI-SV-3 F872187	68	57	68	97	104	99	55
SAII-SV-1 F872190	64	58	55	90	122	100	84
SAII-SV-2 F872191	65	64	63	93	111	91	79
SAII-SV-3 F872192	69	52	57	96	113	88	92
Reagent Blanks							
Reagent Blank MeCl2 F872178	ND	ND	ND	ND	ND	ND	NR
Reagent Blank Filter F872179	69	ND	69	ND	ND	ND	84
Reagent Blank XAD-2 F872182	ND	ND	ND	90	20	ND	100
Field Train Blank F872193	64	68	53	95	98	96	102
Method Blank Train F872185	50	57	52	35	78	90	71

ND = Not Detected

5.3.5 Blanks

At least one extraction blank was generated for each sample set. No target analytes were detected in any of the blanks. Results of the analyses of blanks are shown in Table 5-9.

5.3.6 Duplicate Matrix Spike Analyses

A sample from each matrix type was used to perform duplicate matrix spike analyses. Prior to extraction, samples were spiked with a mixture containing the following compounds:

- anthracene
- bis (2-ethylhexyl) phthalate
- pentachlorophenol.

The accuracy and precision of these analyses is reported in Tables 5-10, 5-11, and 5-12.

5.4 Particulate/Modified Method 5/Chloride

5.4.1 Instrument Tuning and Calibration

All particulate samples were weighed on an analytical balance. The balance was checked at each use with a set of NBS certified Class S weights.

All Modified Method 5 extracts were analyzed using the QA/QC procedures outlined in Method 8270 (SW-846, Third Edition), without significant modification. The tune of the mass spectrometer used for these analyses was verified by demonstrating an acceptable mass spectrum of decafluorotri- phenylphosphine every twelve hours. Acceptable chromatography was verified daily by examination of the shape of the chromatographic peaks produced by benzidine and pentachlorophenol.

TABLE 5-9. SYSTEM BLANK DATA FOR SEMIVOLATILE ANALYSES (ug/L)

	pentachlorophenol	anthracene	bis(2-ethylhexyl)phthalate
Estimated Limits of Detection	5	0.4	0.7
METHOD BLANK F872138	7	ND	ND
METHOD BLANK F872150	ND	ND	13
METHOD BLANK F872163	ND	ND	ND
REAGENT BLANK MeCl2 F872178	ND	ND	ND
REAGENT BLANK FILTER F872179	ND	ND	29
REAGENT BLANK XAD-2 F872182	ND	ND	43
FIELD TRAIN BLANK F872193	ND	ND	45
METHOD BLANK TRAIN F872185	ND	ND	40

ND = Not Detected

TABLE 5-10. SEMIVOLTILES MATRIX SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR ASH

Matrix Spike = 100 ug/g	Determined Concentration (ug/ml)					
	ZSARM-I-1-A F872151	ZSARM-I-1-A MS F872159	ZSARM-I-1-A MSD F872160	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
Pentachlorophenol	ND	ND	ND	0	0	0
Anthracene	ND	90	87	90	87	3
Bis(2-ethylhexyl)phthalate	13	200	126	187	113	49

TABLE 5-11. SEMIVOLATILES MATRIX SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR FEED

Matrix Spike = 100 ug/g	Determined Concentration (ug/g)					
	ZSARM-I-1-F F872167	ZSARM-I-1-F MS F872170	ZSARM-I-1-F MSD F872171	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
Pentachlorophenol	ND	116	138	116	138	17
Anthracene	74	210	215	136	141	4
Bis(2-ethylhexyl)phthalate	33	134	139	101	106	5

TABLE 5-12. SEMIVOLATILES MATRIX SPIKE RECOVERY (ACCURACY) AND RELATIVE DIFFERENCE (PRECISION) FOR SCRUBBER WATER

Matrix Spike = 100ug/ml	Determined Concentration (ug/ml)					
	ZSARM-I-1-S F872139	ZSARM-I-1-S MS F872147	ZSARM-I-1-S MSD F872148	SPIKE RECOVERY	SPIKE RECOVERY DUPLICATE	RELATIVE PERCENT DIFFERENCE
Pentachlorophenol	8	74	80	66	72	9
Anthracene	ND	89	84	89	84	6
Bis(2-ethylhexyl)phthalate	ND	123	118	123	118	4

All chloride analyses were performed on a Dionex Model 16 ion chromatograph. All standards were prepared from ACS reagent-grade chemicals. A multipoint calibration curve was prepared and a linear regression analysis performed to determine the best-fit linear calibration fit for the chloride ion.

5.4.2 System Performance

System performance was verified daily beginning with the initial five-point calibration by demonstrating that System Performance Check Compounds (SPCCs) had response factors grater than 0.05 using the 50 ug/mL calibration standard. The System Performance Check Compounds are:

- N-nitrosodi-n-propylamine
- hexachlorocyclopentadiene
- 2,4-dichlorophenol
- 4-nitrophenol.

5.4.3 Continuing Analyte Calibration

In the course of generating a five-point calibration for this program, response factors for the Calibration Check Compounds (CCCs) were verified to have less than 30% relative standard deviation (RSD) over the calibration range. The Calibration Check Compounds which were used were:

- phenol
- 1,4-dichlorobenzene
- 2-nitrophenol
- 2,4-dichlorophenol
- hexachlorobutadiene
- 4-chloro-3-methylphenol
- acenaphthene
- 2,4,6-trichlorophenol
- N-nitroso-di-N-Phenylamine
- pentachlorophenol
- fluoranthene
- di-n-octyl phthalate
- benzo(a)pyrene

The analysis of the Calibration Check Compounds was repeated every twelve hours to verify that the response factors were within 30% of the mean generated in the five-point calibration curve.

On each analysis day for chloride by ion chromatography a multipoint calibration curve was prepared. A check sample was analyzed each day with the results shown in Table 5-13. Check sample values agreed within 99 percent of the true chloride concentrations.

5.4.4 Surrogate Compound Recoveries

Surrogate recoveries were determined for all of the Modified Method 5 samples and blanks. Surrogate recoveries are shown in Table 5-8.

5.4.5 Blanks

For the set of Modified Method 5 samples, the following blanks were generated and analyzed:

- Methylene Chloride Reagent Blank
- Filter Reagent Blank
- XAD-2® Reagent Blank
- Method Train Blank
- Field Train Blank.

Results of the analyses of blanks are shown in Table 5-9. All of the blanks associated with components of the sampling train showed levels of bis(2-ethyl hexyl) phthalate at a level of at least 40 times the detection limit. The presence of the phthalate at this high level suggests a systematic contamination in the train with plasticizers. However, the level of the bis(2-ethyl hexyl) phthalate in the samples analyzed is an additional factor of 50-70 times the level observed in the blanks.

TABLE 5-13. CHLORIDE CONTROL CHECK AND MATRIX SPIKE RECOVERY DATA

Date	Work Order	Sample #	Description	ppm	Comments
10/8/87	P709026	13A	reagent blank	-	nitric interferences
10/7/87	P709026	14A	method blank #1	ND	
10/8/87	P709026	15A	method blank #2	ND	
10/8/87	P709026	16A	Matrix Spike	15.8	98.1% recovery
10/8/87	P709026	17A	Matrix Spike Duplicate	15.1	93.8% recovery
10/7/87	*	*	Check Sample #1 9.09 ppm	9.1	99.89% agreement
10/8/87	*	*	Check Sample #2 9.09 ppm	9.0	99.01 % agreement

Blank method chloride results are shown in Table 5-13. A method blank was a prepared and analyzed each day. A reagent field blank was analyzed; however, a nitrate ion interference prevented the determination of chloride. A check of the reagent blank documentation, disclosed that nitric acid had been added to the sample prior to aliquoting for metals sample preparation.

5.4.6 Duplicate Matrix Spike Analyses

Because additional train samples were not available for analysis, duplicate matrix spike analyses were not performed for the Modified Method 5 extracts. Two matrix spike chloride samples were analyzed by ion chromatography. The chloride method recoveries (93.8 and 98.1%) are shown in Table 5-13.

5.5 Dioxins/Furans

5.5.1 Instrument Tuning and Calibration

The GC/MS instrumentation was tuned to meet the isotopic ratio criteria listed in Table 3 (Method 8280, SW-846, Third Edition) for polychlorinated dibenzodioxins and dibenzofurans. Once tuning and mass calibration procedures were completed, a column performance check mixture containing a mixture of PCDD and PCDF isomers was analyzed to check retention windows for each of the homologues, to verify that the GC resolution of 2,3,7,8- tetrachlorodibenzodioxin and 1,2,3,4-tetrachlorodibenzodioxin was adequate, and that the relative ion abundance criteria listed in Method 8280 for PCDDs and PCDFs were acceptable. The chromatographic peak separation between 2,3,7,8-tetrachlorodibenzodioxin and 1,2,3,4-tetrachlorodibenzodioxin showed a valley of <25%. Adequate sensitivity for Method 8280 was verified by achieving a minimum signal-to-noise ratio of 50:1 for the ion of mass 320 of 2,3,7,8-tetrachlorodibenzodioxin obtained from injection of the 200 ng/mL calibration standard. The concentration levels for the calibration samples were 200, 500, 1000, 2000, and 5000 ng/mL. Triplicate determinations of

response factors for each calibration standard were performed; the percent relative standard deviations were within 15%. All dioxin/furan extracts were analyzed using the QA/QC procedures outlined in Method 8280 (SW-846, Third Edition), without significant modification. The continuing stability of the calibration was verified every twelve hours of operation.

5.5.2 System Performance

System performance was verified daily by analysis of the 500 ng/mL calibration standard with all analytes within 30% of the mean values established by the initial analyses of the calibration standard solutions. GC column performance was demonstrated initially and verified prior to analysis of any samples in the twelve-hour period. The GC column performance solution was analyzed under the same chromatographic and mass spectrometric conditions used for other samples and standards. The components of the GC column performance solution are:

- tetrachlorodibenzodioxins
  1,3,6,8; 1,2,8,9; 2,3,7,8; 1,2,3,4; 1,2,3,7; 1,2,3,9
- pentachlorodibenzodioxin
  1,2,4,6,8; 1,2,3,8,9
- hexachlorodibenzodioxin
  1,2,3,4,6,9; 1,2,3,4,6,7
- heptachlorodibenzodioxin
  1,2,3,4,6,7,8; 1,2,3,4,6,7,9
- octachlorodibenzodioxin
  1,2,3,4,6,7,8,9
- tetrachlorodibenzofuran
  1,3,6,8; 1,2,8,9
- pentachlorodibenzodioxin
  1,3,4,6,8; 1,2,3,8,9
- hexachlorodibenzofuran
  1,2,3,4,6,8; 1,2,3,4,8,9
- heptachlorodibenzofuran
  1,2,3,4,6,7,8; 1,2,3,4,7,8,9
- octachlorodibenzofuran
  1,2,3,4,6,7,8,9 5.5.3

5.5.3 Continuing Analyte Calibration

In the course of generating a fifteen-point calibration for this program, response factors for the entire range of calibration compounds exhibited a percent relative standard deviation less than 15%. The daily calibration check with the 500 ng/mL calibration standard showed that the measured response factors were within 30% of the mean values established by the initial analyses of the calibration standard calibration solutions.

5.5.4 Blanks

A reagent blank was generated with each matrix in this sample set. No target analytes were detected at or above their detection limits. The results of the analyses of the Reagent Blanks are shown in Table 5-14 (ash), 5-15 (feed), and 5-16 (scrubber water).

5.5.5 Duplicate Matrix Spike Analyses

Since a surrogate analog of dioxins and furans at each level of chlorination was spiked into each sample, duplicate matrix spike analyses were not performed.

5.6 Metals/Method 12

5.6.1 Instrument Calibration and System Performance

All elements except arsenic were analyzed by ICPES. All metal standards were prepared from certified standards and ACS reagent chemicals. The samples were diluted to minimize interferences from elements such as iron and aluminum. In general, samples were diluted so that iron and aluminum levels were below 50 ppm. The reported numbers from the ICPES analyses were chosen so as to minimize interferences, but at a level as far above the method detection limits as possible. An instrumental detection limit study was

TABLE 5-14. DIOXIN/FURAN RESULTS
ASH SURROGATE RECOVERIES (%)

Surrogate	Reagent Blank A710003-3540-BL 37022	ZSARM 1-2-A ASH A710003-04A 37020	ZSARM-II-5-A ASH A710003-05A 37021
13C-2,3,7,8-TCDD	83	86	86
13C-2,3,7,8-TCDF	89	94	98
13C-1,2,3,7,8-PCDD	92	94	93
13C-1,2,3,7,8-PCDF	89	93	91
13C-1,2,3,6,7,8-HxCDD	74	86	86
13C-1,2,3,4,7,8-HxCDF	88	96	94
13C-1,2,3,4,6,7,8-HpCDD	77	87	74
13C-1,2,3,4,6,7,8-HpCDF	76	83	73
13C-OCDD	75	81	65
13C-OCDF	78	84	70

TABLE 5-15. DIOXIN/FURAN RESULTS
FEED SURROGATE RECOVERIES (%)

Surrogate	Reagent blank A710018 37031	ZSARM 1-2-F A710003-07-A 37034	ZSARM-II-5-F A710003-08A 37035
13C-2,3,7,8-TCDD	86	71	78
13C-2,3,7,8-TCDF	89	68	80
13C-1,2,3,7,8-PCDD	89	95	91
13C-1,2,3,7,8-PCDF	86	82	87
13C-1,2,3,6,7,8-HxCDD	80	77	76
13C-1,2,3,4,7,8-HxCDF	78	76	92
13C-1,2,3,4,6,7,8-HpCDD	70	74	53
13C-1,2,3,4,6,7,8-HpCDF	70	79	61
13C-OCDD	61	58	50

TABLE 5-16. DIOXIN/FURAN RESULTS
SCRUBBER WATER SURROGATE RECOVERIES, (%)

Surrogate	Reagent blank A710003-blank 37017	ZSARM 1-2-S A710003-01A 37018	ZSARM-II-5-S A710003-02A 37019
13C-2,3,7,8-TCDD	86	84	88
13C-2,3,7,8-TCDF	91	92	97
13C-1,2,3,7,8-PCDD	91	92	94
13C-1,2,3,7,8-PCDF	91	89	94
13C-1,2,3,6,7,8-HxCDD	89	87	72
13C-1,2,3,4,7,8-HxCDF	91	94	101
13 C-1,2,3,4,6,7,8-HpCDD	85	85	85
13C-1,2,3,4,6,7,8-HpCDF	81	85	82
13C-OCDD	79	83	76
13C-OCDF	84	87	84

performed and the results are presented in Table 5-17. Method detection limits are given in Tables 5-18 (Feed), 5-19 (Ash), and 5-20 (Scrubber Water) for each element. Method detection limit values are given for the undiluted samples. It should be noted that most of the samples were diluted before analysis and to obtain an accurate MDL for each element, the reported MDL must be multiplied by the sample dilution.

The arsenic analysis was done by graphite furnace atomic absorption spectrophotometry. A blank and 4 upscale calibration points were used for each calibration. Instrumental detection limits are shown in Table 5-17.

5.6.2 Blanks

Method blanks were analyzed with feed, ash, and scrubber water samples. No problems were encountered for feed and ash blanks; however, the method blank for scrubber water contained nickel and copper. More copper is present in this method blank than in any of the samples. This contamination problem is related to this particular blank.

5.6.3 Interference Check/Control Samples

Interference check samples were analyzed at least twice per day analysis day to insure that there were no interference problems. An independent control sample was analyzed after the calibration and after every ten samples, water blanks were analyzed after every ten samples, and standard additions were made and analyzed for 10% of the samples. For a given analysis, all quality control was within 10% and all interference check samples were within 20% or the analysis was redone. Recoveries of 80 to 120% were obtained for all standard additions. For AAS analysis an independent control sample was analyzed with the calibration standards and after 10 to 15 samples, and after the last sample of a given analysis run. If the control sample was not within 20% of the reported value, the samples were reanalyzed.

TABLE 5-17

Minimum Detection Limits for Metals By ICPES/Graphite AA

	259.94 Fe	396.15 Al	197.20 As	205.55 Cr	213.86 Zn	220.35 Pb	226.50 Cd	231.60 Ni	327.40 Cu
Day 1 Results	0.039	0.06	1.097	0.038	0.022	0.708	0.040	0.137	0.179
	0.042	0.09	1.110	0.039	0.019	0.710	0.039	0.132	0.181
	0.038	0.03	1.059	0.044	0.021	0.678	0.040	0.124	0.188
	0.043	0.04	1.048	0.043	0.019	0.732	0.038	0.130	0.179
	0.045	0.07	1.069	0.052	0.024	0.759	0.038	0.121	0.170
	0.045	0.05	0.995	0.033	0.018	0.771	0.038	0.122	0.170
	0.046	0.01	1.206	0.046	0.019	0.735	0.037	0.123	0.178
σ_{n-1}	0.003	0.03	0.066	0.006	0.002	0.032	0.001	0.006	0.006
Day 3 Results	0.039	0.06	1.119	0.044	0.015	0.699	0.043	0.133	0.148
	0.041	0.03	1.028	0.043	0.016	0.724	0.041	0.135	0.162
	0.039	0.02	1.060	0.043	0.015	0.704	0.044	0.134	0.153
	0.038	0.04	1.141	0.049	0.017	0.765	0.040	0.140	0.139
	0.042	0.05	1.014	0.039	0.017	0.688	0.039	0.133	0.138
	0.039	0.01	1.084	0.043	0.018	0.736	0.041	0.134	0.153
	0.040	-0.01	1.153	0.042	0.014	0.690	0.042	0.135	0.151
σ_{n-1}	0.0014	0.024	0.055	0.003	0.0014	0.028	0.002	0.0024	0.008
Day 5 Results	0.039	0.01	1.047	0.044	0.014	0.706	0.037	0.137	0.186
	0.038	0.01	1.084	0.032	0.015	0.684	0.044	0.135	0.193
	0.038	0.04	1.053	0.048	0.015	0.668	0.039	0.128	0.203
	0.040	0.03	1.065	0.045	0.018	0.309	0.041	0.142	0.199
	0.039	0.06	1.100	0.044	0.014	0.725	0.040	0.132	0.197
	0.039	0.05	0.981	0.033	0.015	0.753	0.036	0.130	0.204
	0.036	0.05	1.063	0.050	0.016	0.674	0.041	0.132	0.193
σ_{n-1}	0.013	0.02	0.038	0.007	0.0014	0.151	0.003	0.005	0.006
mean $\sigma(n-1)$x3	0.002	0.03	0.053	0.005	0.002	0.070	0.002	0.005	0.007
= MDL	0.006	0.09	0.159	0.015	0.006	0.210	0.006	0.015	0.021
Alt. Method -	0.009	0.14	0.231	0.012	0.005	0.151	0.010	0.030	0.047

TABLE 5-17 CONTINUED

AA-MDL FOR AS

Day 1	.0058	Day 2	.0063	Day 3	.0048
	.0047		.0055		.0044
	.0054		.0050		.0048
	.0047		.0050		.0036
	.0047		.0055		.0040
	.0050		.0050		.0044
	.0039		.0046		.0050
σ_{n-1}	.0006		.0006		.0005

mean σ_{n-1} .006 method Detection Limit = 3 x $\bar{X}$ σ_{n-1} = .0018
Alternate Method = .0023

Table 5-18. DUPLICATE MATRIX SPIKE RECOVEREIS FOR METALS IN FEED

Analyte	Analysis Type	Method Detection Limit (ug/g) *	Sample used for Spikes P7-09-023-19a (ug/g)	Amount Spiked in ug/g	Matrix Spike P7-09-023-25a (ug/g)	Matrix Spike Recovery P7-09-023-25a (% recovery)	Matrix Spike Duplicate P7-09-023-26a (ug/g)	MS Duplicate Recovery P7-09-023-26a (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.040	16.9	20.0	28.8	78%	30.3	82%	5%
Cadmium	ICAP	0.300	24.2	100.0	115	93%	121	97%	5%
Zinc	ICAP	0.120	451	800.0	1200	96%	1280	102%	6%
Lead	ICAP	4.200	261	300.0	543	97%	587	105%	8%
Chromium	ICAP	0.120	26.3	100.0	118	93%	121	96%	3%
Nickel	ICAP	0.300	27.5	100.0	117	92%	120	94%	3%
Copper	ICAP	0.420	244	600.0	804	95%	836	99%	4%

MDL = Method Detection Limit

Assuming 5 g samples in 100 mL total volume.

Relative Percent Difference = (MS - MSD)/(0.5*(MSMS + MSD).

Table 5-19. DUPLICATE MATRIX SPIKE RECOVERIES FOR METALS IN ASH

Analyte	Analysis Type	Method Detection Limit (ug/g) *	Sample used for Spikes P7-09-023-10a (ug/g)	Amount Spiked in ug/g	Matrix Spike P7-09-023-16a (ug/mL)	Matrix Spike Recovery P7-09-023-16a (% recovery)	Matrix Spike Duplicate P7-09-023-17a (ug/mL)	MS Duplicate Recovery P7-09-023-17a (% recovery)	Relative Percent Difference (b)
Arsenic	GF AAS	0.040	37.7	20.0	55.9	97%	61.5	107%	10%
Chromium	ICAP	0.300	(a) 9.8	100.0	101	92%	101	92%	0%
Zinc	ICAP	0.120	217	1000.0	1130	93%	1170	96%	3%
Lead	ICAP	4.200	56.2	600.0	610	93%	604	92%	1%
Cadmium	ICAP	0.120	< 1.48	100.0	87.7	88%	87.6	88%	0%
Nickel	ICAP	0.300	11.8	100.0	102	91%	103	92%	1%
Copper	ICAP	0.420	111	500.0	604	99%	585	96%	3%

MDL = Method Detection Limit

* assuming 5 g samples in 100 mL total volume.

(a) Amount shown is a default value, but agrees with the amount found in the undiluted sample.

(b) Relative Percent Difference = (MS - MSD)/(0.5*(MSMS + MSD).

Table 5-20. DUPLICATE MATRIX SPIKE RECOVERIES FOR METALS IN SCRUBBER WATER

Analyte	Analysis Type	Method Detection Limit (ug/mL)*	Sample used for Spikes P7-09-023-01 (ug/mL)	Amount Spiked in ug/mL	Matrix Spike P7-09-023-07a (ug/mL)	Matrix Spike Recovery P7-09-023-07a (% recovery)	Matrix Spike Duplicate P7-09-023-08a (ug/mL)	MS Duplicate Recovery P7-09-023-08a (% recovery)	Relative Percent Difference (b)
Arsenic	GF AAS	0.001	0.150	0.500	0.700	108%	0.760	117%	8%
Chromium	ICAP	0.008	0.530	2.500	3.60	119%	3.39	112%	6%
Zinc	ICAP	0.003	2.14	7.500	10.9	113%	11.1	115%	2%
Lead	ICAP	0.105	(a) 1.75	7.500	9.51	86%	9.83	89%	3%
Cadmium	ICAP	0.003	2.35	15.000	19.3	111%	18.6	107%	4%
Nickel	ICAP	0.015	0.320	2.500	2.96	105%	2.93	104%	1%
Copper	ICAP	0.011	(a) 0.595	3.750	4.32	87%	4.26	86%	2%

*MDL = Method Detection Limit

(a) Amount shown is a default value, but agrees with the amount found in the undiluted sample.

(b) Relative Percent Difference = (MS - MSD)/(0.5*(MS + MSD).

5.6.4 Duplicate Matrix Analysis

A matrix spike and a matrix spike duplicate were prepared for feed, ash, scrubber water, and Method 12 metal samples. The matrix spike/matrix spike duplicate recoveries and relative percent difference are given in Tables 5-18 (Feed), 5-19 (Ash), 5-20 (Scrubber Water), and 5-21 (Method 12). The maximum relative percent difference for all samples was 10 percent.

Table 5-21. DUPLICATE MATRIX SPIKE RECOVERIES FOR METHOD 12 METALS
METHOD 12 TRAIN SAMPLES

Analyte	Analysis Type	Method Detection Limit (ug) *	Amount Spiked in ug	Method Spike (total ug)	Method Spike Recovery (% recovery)	Method Spike Duplicate (total ug)	MS Duplicate Recovery (% recovery)	Relative Percent Difference (a)
Arsenic	GF AAS	0.200	10.0	9.50	95%	9.80	98%	3%
Chromium	ICAP	1.50	500.0	448	90%	439	88%	2%
Zinc	ICAP	0.600	1000.0	868	87%	857	86%	1%
Lead	ICAP	21.0	500.0	435	87%	434	87%	0%
Cadmium	ICAP	0.600	500.0	441	88%	435	87%	2%
Nickel	ICAP	1.50	500.0	441	88%	434	87%	2%
Copper	ICAP	2.10	500.0	476	95%	463	93%	3%

MDL = Method Detection Limit
* assuming 100 mL total volume.
(a) Relative Percent Difference = (MS - MSD)/(0.5*(MS + MSD))

ATTACHMENT 1

CORPORATION
8501 Mo-Pac Blvd.
PO. Box 201088
Austin, TX 78720-1088

Chain of Custody Record

PROJECT: PEI ASSOCIATES

SITE: TULSA OKLAHOMA

COLLECTOR:

Analyses: VOA

SAMPLE I.D.	TYPE	DATE/TIME	VOA	REMARKS
ZSARM-I-1-INF ×	3-40mL VOA Bottles	liq	Seal # 8302 ✓	
ZARM-I-1-~~X~~F 9/21	5-40mL VOA Bottles	sludge	Seal # 8312 ✓	need MS/MSD
ZSARM-I-1-S ×	5-40mL VOA Bottles	liq	Seal # 8316 ✓	need MS/MSD
ZSARM-I-1-A ✓	5-40mL VOA Bottles	soil	Seal # 8325 ✓	need MS/MSD
ZSARM-I-3-S ×	2-40mL VOA Bottles		Seal #8336 ✓	
ZSARM-I-3-F X	3-40mL VOA Bottles		Seal #8339 ✓	
ZSARM-I-3-A X	3-40mL VOA Bottles		Seal #8342 ✓	
ZSARM-I-2-S ✓	3-40mL VOA Bottles		Seal # 8345 ✓	
ZSARM-I-2-F ✓	3-40mL VOA Bottles		Seal # 8348 ✓	

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Margaret Wilson	9/23/87	11:00	[illegible] 9/24/87 10:11				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RECEIVED FOR LABORATORY BY:	DATE	TIME	REMARKS

2 of 3

RADIAN
CORPORATION
501 Mo-Pac Blvd.
P.O. Box 201088
Austin, TX 78720-1088

Chain of Custody Record

Analyses

PROJECT PEI Associates

SITE TULSA OKLAHOMA

COLLECTOR

SAMPLE I.D.	TYPE	DATE/TIME	VOA	REMARKS
SARM-I-2-A X	3-40mL VOA Bottles		Seal # 8351 ✓	
SARM-II-4-5 X	3-40mL VOA Bottles		Seal # 8361 ✓	
SARM-II-4-F X	3-40mL VOA Bottles		Seal # 8364 ✓	
SARM-II-4-A X	3-40mL VOA Bottles		Seal # 8367 ✓	
SARM-II-5-S X	3-40mL VOA Bottles		Seal # 8372 ✓	
SARM-II-5-F X	3-40mL VOA Bottles		Seal # 8375 ✓	
SARM-II-5-A X	3-40mL VOA Bottles		Seal # 8378 ✓	
ARM-II-6-S X	3-40mL VOA Bottles		Seal # 8381 ✓	
ARM-II-6-F X	3-40mL VOA Bottles		Seal # ~~8384~~ 8382 ✓	

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Margaret Wilson	9/23/87	11:00	9/24/87 [signature] 10:5				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RECEIVED FOR LABORATORY BY:	DATE	TIME	REMARKS

25848

RADIAN CORPORATION
8501 Mo-Pac Blvd.
P.O. Box 201088
Austin, TX 78720-1088

Chain of Custody Record

Analyses

PROJECT PEI Associates

SITE Tulsa OKLAHOMA

COLLECTOR

SAMPLE I.D.	TYPE	DATE/TIME	VOA	REMARKS
7ARM-II-6-A X	3-40 mL VOA Bottles		Seal # 8387 ✓	

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Margaret Wilson	9/23/87	11:00	9/24/87 Lo Pet Kosman 10:20				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RECEIVED FOR LABORATORY BY:	DATE	TIME	REMARKS

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT Radian PN

2. SENDER	3. CARRIER	4. RECEIVER
Signature C Bruffy / [illegible]	Company Fed Ex	Courier from Depot
Date 9/21/87	Signature	Signature
Sent From PEI Ass.	Date	Date
11499 Chester	B/L No. 4384928295	LAB CUSTODIAN
Cinti, Ohio 45246		Signature
		Date
		Condition upon
		Receipt

5. SHIPMENT DESCRIPTION

Number of Packages 4

Sealed (yes or no) yes

Types of Containers cookers

Condition prior to Shipment good

Seal No.	Seal Intact?	Seal No.	Seal Intact?
7126	7123		
7125	7127		
7122			
7124			
7108			

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
See list attached to letter				
Check Bruffy / [illegible]				

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT Radian PN

2. SENDER	3. CARRIER	4. RECEIVER
Signature C Bouffay / RR	Company Fed Ex	Courier from Depot
Date 7/21/87	Signature	Signature
Sent From PEI Ass.	Date	Date
11499 Chester	B/L No. 4384428245	LAB CUSTODIAN
[illegible] Ohio 45246		Signature
		Date
		Condition upon
		Receipt

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages 4	7126	7127		
Sealed (yes or no) yes	7125	7127		
Types of Containers [illegible]	7122			
Condition prior to Shipment good	7124			
	7108			

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
[illegible]				
Attached				
to letter				

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT [illegible] PN

2. SENDER	3. CARRIER	4. RECEIVER
Signature C Bruffey / ER	Company [illegible]	Courier from Depot
Date [illegible]	Signature	Signature
Sent From [illegible]	Date	Date
[illegible]	B/L No. [illegible]	LAB CUSTODIAN
[illegible]		Signature
		Date
		Condition upon
		Receipt

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages 4	7126	7127		
Sealed (yes or no) [illegible]	7125	7127		
Types of Containers [illegible]	7122			
Condition prior to Shipment good	7124			
	7128			

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
[illegible]				
[illegible]				
[illegible]				

PEI ASSOCIATES, INC.

SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT Joan Zink PN 3724-7

2. SENDER	3. CARRIER	4. RECEIVER
Signature [illegible]	Company [illegible] Express	Courier from Depot
Date 9/10/87	Signature	Signature
Sent From Joan Zink	Date	Date
6401 S Peoria	B/L No. 420209204	LAB CUSTODIAN
Tulsa Oklahoma		Signature Margaret Wilson
74105		Date 9/21/87
		Condition upon good
		Receipt Radian Corp.

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages 2				
Sealed (yes or no) YES	8329			
Types of Containers Glass & Nalgene Unitized	8330			
packed w/ vermiculite in coolers				
Condition prior to Shipment				

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
2Sarm-I-1-INF 1 Gal	Liquid	8300		
" 1 L	"	8301		
" 3 40ml	"	8302		VOA
~~[illegible]~~	~~Solid~~	~~8303~~		
~~[illegible]~~	~~[illegible]~~	8304		
2Sarm-I-1-F 1 8oz	Solid	8305		
" 1 8oz	"	8306		
" 1 8oz	"	8307		
" 1 8oz	"	8308		
2Sarm-I-1-F 4 oz.	"	8309		
" 4 oz	"	~~8310~~ 8310		
" 4 oz.	"	~~8311~~ 8311		
" 5 40ml	"	~~8312~~ 8312		VOA
2Sarm I-1-S 1 Gal	Liquid	8313		
" 1 Gal	"	8314		
" 1 Gal	"	8315		
" 5 40ml	"	8316		VOA
" 1 8oz.	"	8317		

(2

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT [illegible] Zink PN 3724-7

2. SENDER	3. CARRIER	4. RECEIVER
Signature [illegible]	Company Federal Express	Courier from Depot
Date 9/16/87	Signature	Signature
Sent From J Zink	Date 9/16/87	Date
4401 S Peoria	B/L No.	LAB CUSTODIAN
Tulsa Oklahoma		Signature Margaret Wilson
74105		Date 9/21/87
		Condition upon good
		Receipt
		Radian Corp.

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages				
Sealed (yes or no)				
Types of Containers				
Condition prior to Shipment				

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
✓ [illegible] 1 Liter	Liquid	5315		
✓ [illegible] 1 Liter	"	5319		
✓ [illegible] 1 Liter	"	5320		
✓ [illegible] 1 [illegible]	Solid	5321		
✓ "	"	5322		
✓ "	"	5323		
✓ "	"	5324		
✓ " 5 40 ml	"	5325		VOA
✓ " 1 4oz	"	5326		
✓ "	"	5327		
✓ "	"	5328		

SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT JOHN ZINK (PEI ASSOCIATES INC) **PN** 3724-7

2. SENDER

Signature [illegible]

Date 9/17/87

Sent From JOHN ZINK
4801 S. PEORIA
TULSA, OKLAHOMA

3. CARRIER

Company FEDERAL EXPRESS

Signature

Date 9/18/87

B/L No. 420 214 023

4. RECEIVER

Courier from Depot

Signature

Date

LAB CUSTODIAN

Signature Margaret Wilson

Date 9/21/87

Condition upon Receipt good

Radian Corp.

5. SHIPMENT DESCRIPTION

Number of Packages 1

Sealed (yes or no) YES. PALE

Types of Containers GLASS [illegible] BALLOON IN COOLERS.

Condition prior to Shipment

Seal No.	Seal Intact?	Seal No.	Seal Intact?
8353			

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
ZSAAM-II-4-S #1-GAL	LIQUID	YES	8359	
" #1-LITER	"	"	8360	
" #3-40ml	"	"	8361	VOA
ZSAAM-II-4-F #1-8oz	SOLID	"	8362	
" #1-4oz	"	"	8363	
" #3-40ml	"	"	8364	VOA
ZSAAM-II-4-A #1-8oz	"	"	8365	
" #1-4oz	"	"	8366	
" #3-40ml	"	"	8367	VOA
ZSAAM-II-5-S #1 GAL	LIQUID	"	8370	
" #1 LITER	"	"	8371	
" #3 40ml	"	"	8372	VOA
ZSAAM-II-5-F #1-8oz	SOLID	"	8373	
" #1-4oz	"	"	8374	
" #3-40ml	"	"	8375	VOA
ZSAAM-II-5-A #1-8oz	"	"	8376	
" #1-4oz	"	"	8377	
" #3-40ml	"	"	8378	VOA

PEI ASSOCIATES, INC.
SAMPLE SHIPPING/RECEIVING RECORD

1. NAME OF ESTABLISHMENT John Zink (Pei Associates.) PN 3724-7

2. SENDER	3. CARRIER	4. RECEIVER
Signature Lavinia W. Barrett	Company FED X	Courier from Depot
Date 9/18/87	Signature	Signature
Sent From John Zink	Date 9/18/87	Date
TULSA OKLAHOMA	B/L No. 420 214 623	LAB CUSTODIAN
		Signature Margaret Wilson
		Date 9/21/87
		Condition upon good
		Receipt
		Radian Corp

5. SHIPMENT DESCRIPTION

	Seal No.	Seal Intact?	Seal No.	Seal Intact?
Number of Packages 1				
Sealed (yes or no)	8354			
Types of Containers GLASSWARE IN COOLER				
Condition prior to Shipment				

6. CONTENTS

Sample I.D. No.	Type of Sample	Sealed (yes or no)	Seal No. if any	Condition (damaged, loss of liquid, etc.)
✓ 2ARM-II-6-B, #1-LAL	LIQUID	YES	8377	
✓ 2 " , #1-LIRR	"	"	8380	
✓ " 3-40ml	"	"	8381	VOA
✓ 2ARM-II-6-F, #1-4OZ	SOLID	"	8382	VOA
✓ " , #1-4OZ	"	"	8383	REVERSED SEALS
✓ , #3-40ml	"	"	8384	
✓ 2ARM-II-B-A, #1-8OZ	"	"	8385	
✓ " #1-4OZ	"	"	8386	
✓ " , 3-40ml	"	"	8387	VOA

APPENDIX D

STACK GAS SAMPLING AND ANALYTICAL PROCEDURES

DETERMINATION OF PARTICULATE, SEMIVOLATILE POHC, AND HCL EMISSIONS

The following procedures are used to measure particulate, semivolatile organic, and HCl emissions. The sampling train is a modified Method 5 sampling train as described in Method S008.*

SAMPLING APPARATUS

The sampling train, which is shown in Figure D-1, consists of the following:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Probe - Borosilicate glass with a heating system capable of maintaining a minimum gas temperature of 250°F at the exit end during sampling.

Impingers - Five impingers are connected in series with glass ball joints. The third, fourth, and fifth impingers are of the Greenburg-Smith design, modified by replacing the tip with a ½-in.-i.d. glass tube extending to ½ in. from the bottom of the flask. The first impinger is a 500 ml collection jar attached to the XAD-2 trap.

XAD-2 Resin Module - Pyrex glass with a resin capacity of approximately 25 g of XAD-2 with a glass frit on the outlet end and glass wool packed at the inlet end.

Metering System - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2 percent accuracy, and related equipment to maintain an isokinetic sampling rate and to determine sample volume. The dry gas meter is made by Rockwell, and the fiber vane pump is made by Gast.

Barometer - Aneroid barometer capable of measuring atmospheric pressures to ±0.1 in.Hg.

Recirculation Pump - Thomas submersible water pump to cool sample gas prior to resin module.

Pitot Tube - A Type S pitot tube, which meets all geometric standards, attached to measure stack gas velocity pressure.

Temperature Gauge - A Chromel/Alumel Type K thermocouple (or equivalent) attached to the probe to monitor stack gas temperature within 1°C (2°F) by the use of a digital readout.

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* Sampling and Analysis Methods for Hazardous Waste Combustion. EPA-600/8-84-002. February 1984.

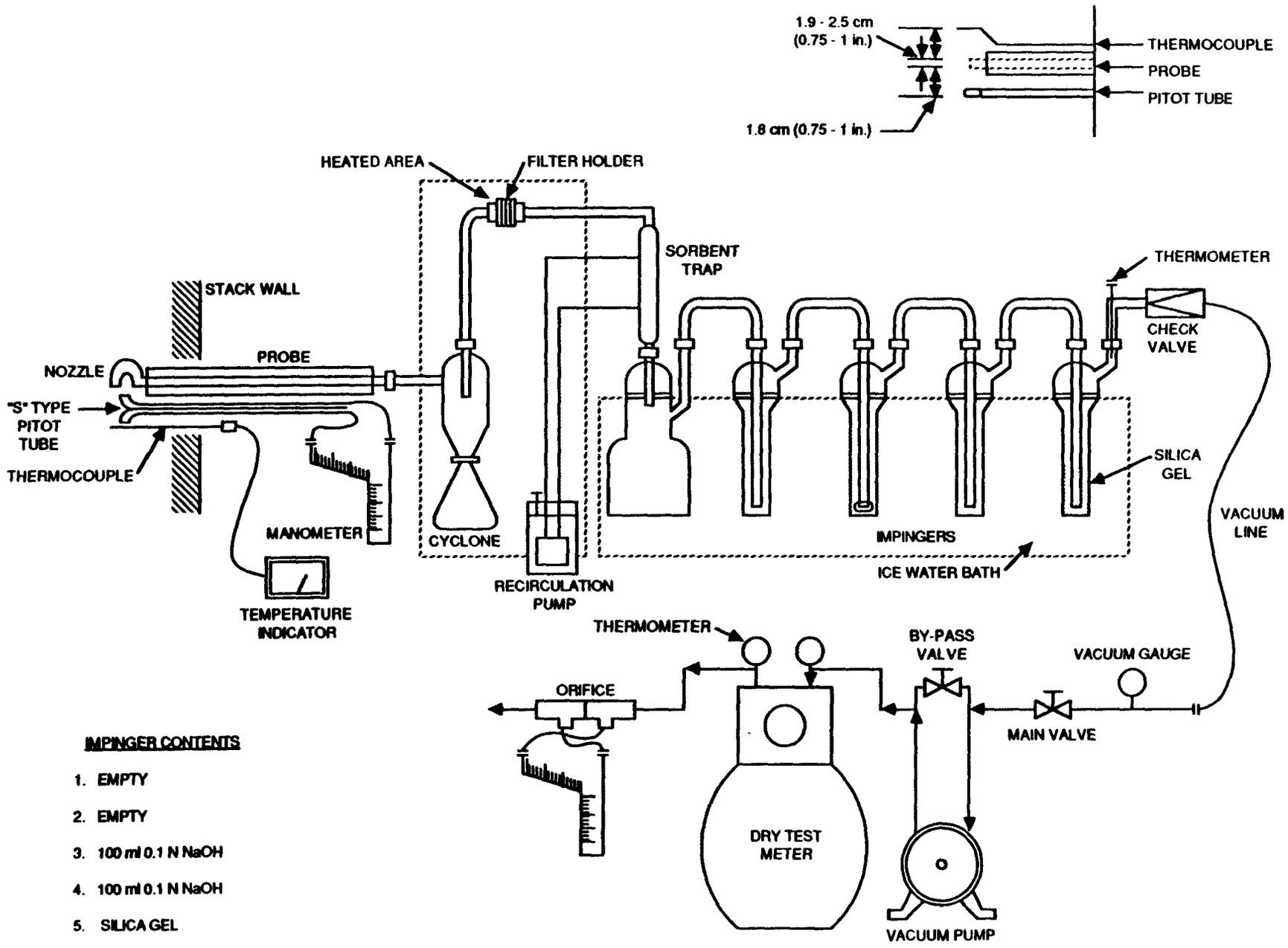

Figure D-1. Modified Method 5 sampling train.

Filter - A glass-fiber filter placed between the probe and resin module to remove any particulate in the sample gas.

EQUIPMENT PREPARATION

The probe, impingers, and all glassware used during the sampling and recovery are prepared according to procedures described in the Manual of Analytical Methods for Analysis of Pesticides in Human and Environmental Samples. These procedures consist of a soapy-water wash, a distilled-water rinse followed by a methanol rinse and methylene chloride rinse, and oven drying. After drying, all open areas of each component are sealed with aluminum foil to prevent contamination.

The XAD-2 resin is purchased in a precleaned state; i.e., the resin has been prepared according to EPA Level 1 specifications.* This cleanup involves two washings with distilled water and two soxhlet extractions with methylene chloride and methanol. After an acceptable blank level is obtained, the XAD-2 resin is stored in methylene chloride in an amber glass bottle until just prior to use. Approximately 1 week before the test, the resin is dried and packed into the glass sorbent module. The module is capped with glass caps and wrapped in aluminum foil to protect the resin from light.

SAMPLING PROCEDURE

Samples are collected isokinetically according to the procedures of EPA Method 5.* Sample train components are assembled in the sample preparation

* IERL-RTP, Procedures Manual: Level 1 Environmental Assessments. EPA-600/7-78-201. October 1978.

area, as shown in Figure D-1. The first impinger (condensate jar) and second impinger were initially empty. The third and fourth impingers were each charged with 100 ml of 0.1 NaOH solution for HCl collection. The fifth impinger was filled with silica gel. Each impinger was weighed prior to assembly so that the total moisture collected could be determined. The sampling train was leak checked at the sampling site prior to each test run by plugging the inlet to the nozzle and pulling a 15-in.Hg vacuum, and at the conclusion of the test by plugging the inlet to the nozzle and pulling a vacuum equal to the highest vacuum reached during the test run.

During sampling, crushed ice was placed around the impingers, and cooling water was circulated through the condenser coil to maintain the XAD-2 module inlet temperature at 68°F or less. Stack gas and sampling train data were recorded at each traverse point and whenever significant changes are observed in stack flow conditions. Isokinetic sampling rates were set throughout the sampling period with the aid of a programmable calculator.

SAMPLE RECOVERY PROCEDURES

At the completion of the test, the sample was capped and transported to the sample recovery area. Figure D-2 is a schematic of the sample recovery procedures. The samples are recovered as follows:

Container No. 1 - The particulate filter is removed and placed in a glass petri dish.

Container No. 2 - The nozzle, probe, and connecting glassware between the probe and filter were rinsed with methylene chloride. A nylon brush is used to ensure complete removal of particulate matter. Amber glass jars with Teflon-lined caps are used to recover the rinse.

* 40 CFR 60, Appendix A, Reference Method 5. July 1, 1987.

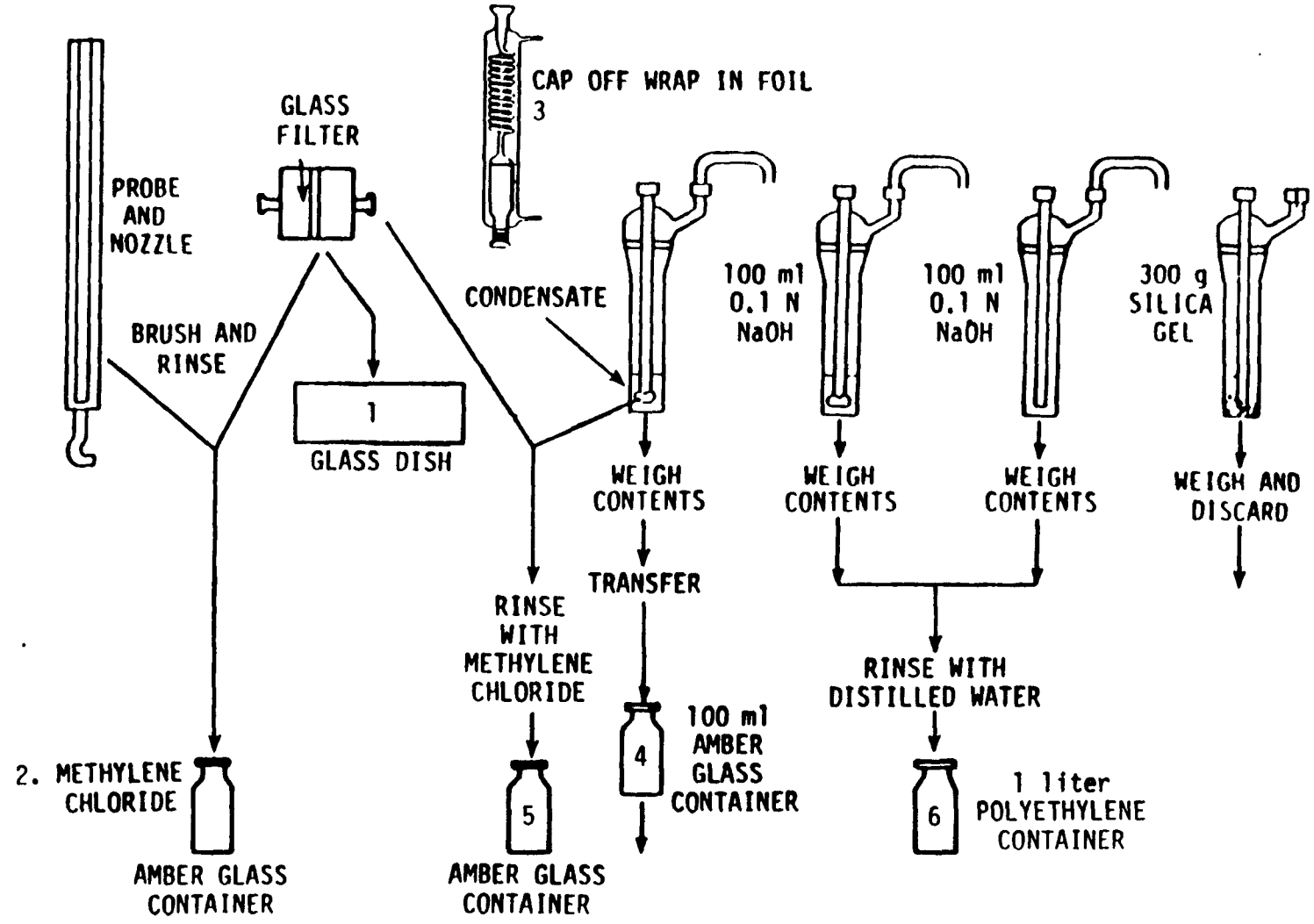

Figure D-2. Recovery procedure Modified Method 5 sampling train.

Container No. 3 - The XAD-2 sorbent trap was removed from the train, capped with glass ball-joint caps, and wrapped in aluminum foil. The sorbent trap was stored on ice until returned to the laboratory.

Container No. 4 - After it was weighed, the condensate collected in the first impinger was transferred to a 100-ml amber glass jar.

Container No. 5 - The connecting glassware between the filter and the sorbent module and the first impinger is rinsed with methylene chloride and the rinse is stored in an amber glass jar.

Container No. 6 - After each impinger was weighed, the NaOH solution was recovered into a polyethylene container. Each impinger was rinsed wit distilled water, and the rinse was added to the same container.

Container No. 7 - At least 200 ml of methylene chloride was collected in an amber glass jar for particulate blank analysis.

Container No. 8 - One unused filter was labeled for particulate blank analysis.

Container No. 9 - With each set of samples, one unused XAD-2 sorbent trap was labeled for blank organic analysis.

Container No. 10 - With each set of samples, one 100-ml portion of methylene chloride was collected in an amber glass jar for blank organic analysis.

Container No. 11 - With each set of samples, 200-ml portions of NaOH solution was collected for blank HCl analysis.

The silica gel impinger is weighed and the silica gel is discarded.

ANALYTICAL PROCEDURES

All analyses for the project were performed by Radian Corporation. See Appendix C for methods and procedures.

DETERMINATION OF VOLATILE POHC EMISSIONS

VOLATILE ORGANIC SAMPLING TRAIN (VOST) PROTOCOL

Sampling Apparatus

The sampling train, which was assembled by PEI personnel, meets the general design specifications of Method S012* and the VOST Protocol.**

The sampling train is shown in Figure D-3. It consists of:

Probe - Stainless steel sheath and glass liner with a heating system capable of maintaining an exit-end gas temperature of 130°C (266°F).

Particulate Filter - A plug of glass wool placed in the front of the probe.

Four-way Valve - Stainless steel or Teflon four-way valve.

Condensers - Glass coil condensers with water jacket to cool the sample gas stream to 20°C (68°F) or less before it enters the first sorbent trap.

Sorbent Traps - Borosilicate glass with dimensions of 1.6-cm (0.63-in.) o.d. by 12.7 cm (5 in.) with both ends necked down to 6.3-mm (¼-in.) o.d. Traps are shown in Figure D-4. The first trap contains a minimum of 1.6 g of Tenax TC and the second contains a minimum of 1 g of Tenax TC and 1 g of activated charcoal.

Flask - Borosilicate glass with 250-ml volume and screw cap bored to accept 6.3-mm (¼-in.) o.d. tubing. Teflon-backed silicone gaskets are used to make a leak-free seal.

Drying Tube - Teflon container holding approximately 100 g of silica gel.

Metering System - Vacuum gauges, leak-free diaphragm pump, calibrated rotameter, singer dry-gas meter measuring 1 liter/revolution with ±2 percent accuracy for flow rates between 0.25 and 1.0 liter/min.

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* Sampling and Analysis Methods for Hazardous Waste Combustion. EPA-600/8-84-002. February 1984.

** Protocol for the Collection and Analysis of Volatile POHC's Using VOST. EPA-600/8-84-007. March 1984, as improved by recommendations in Validation of the Volatile Organic Sampling Train (VOST) Protocol, Field Validation Phase, EPA 600/S4-80-014. April 1986.

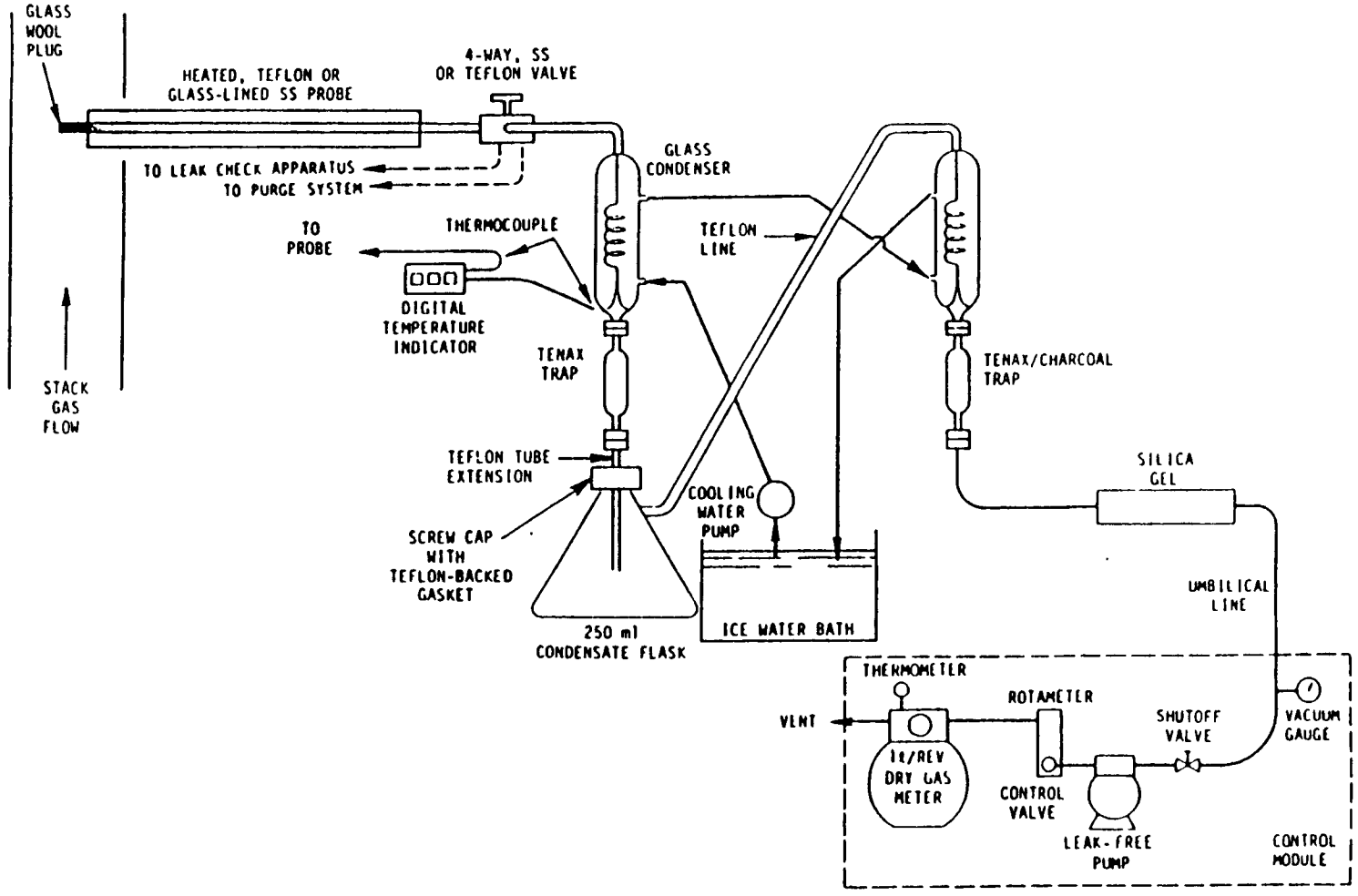

Figure D-3. Schematic of volatile organic sampling train (VOST).

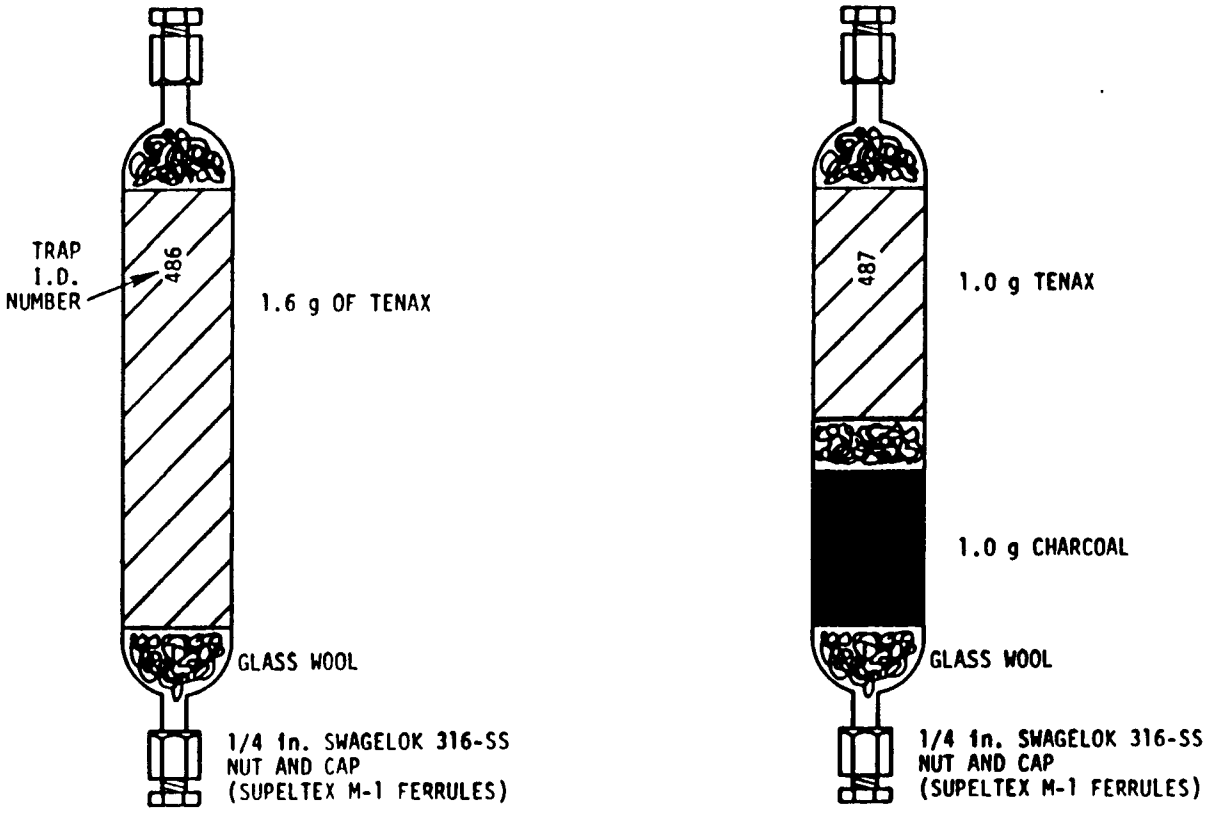

Figure D-4. Sorbent trap configurations.

Trap Blank Check Apparatus

Thermal Desorption Unit - Modified Supelco high-capacity gas purifier oven. A temperature controller was used to control oven temperature and a thermocouple was used to monitor it.

Purge and Trap Unit - Tekmar Model LSC-2 with all Teflon transfer lines replaced with 1.6-mm (1/16-in.) o.d. stainless steel tubing. The analytical trap consisted of a 15-cm-long section of Tenax, 3.7-cm section of silica gel, and a 3.7-cm section of charcoal.

Analyzer - Perkin Elmer Model 990 gas chromatograph with a flame ionization detector (GC/FID). The GC column is a 6 ft x 1/8 in. o.d. stainless steel column packed with 1 percent SP-1000 on Carbopak B.

Analytical Apparatus

The analytical system used in these tests is in accordance with Method S012 and the VOST Protocol.

Thermal Desorption Unit - Modified Supelco high-capacity, gas-purifier oven ("clamshell" oven). A temperature controller was used to control oven temperature, and a thermocouple was used to monitor it.

Purge and Trap Unit - Tekmar Model LSC-2 with all Teflon transfer lines replaced with 1.6-mm (1/16-in.) o.d. stainless steel tubing. The analytical trap consisted of a 15-cm long section of Tenax, 3.7-cm section of silica gel, and 3.7-cm section of charcoal.

GC/MS System - Finnigan Model 4023 with quadrupole mass spectrometer. The separation column is 1.848-m (6-ft) by 2-mm i.d. glass, packed with 1 percent SP-1000 on Carbopak B (60/80 mesh). The mass spectrometer scans from 35 to 335 m/e every 2 seconds when methanolic standards are used, and from 20 to 335 m/e when gaseous standards are used. The GC/MS interface is an all-glass jet separator. The data acquisition and processing system that controls the mass spectrometer consists of a Data General Nova 3 computer with Perkin-Elmer/Wangco 10 mega-byte dual-disk drive running Finnigan Incos software.

Reagent and Materials Preparation

Tenax - 2,6-Diphenylene oxide polymer (35/60 mesh) Soxhlet extracted for 24 hours with glass-distilled methanol (Burdick and Jackson pesticide residue grade or equivalent). After extraction, the Tenax was transferred to a clean ceramic evaporating dish and dried for 4 hours under an infrared lamp. The Tenax and evaporating dish were then placed in a vacuum oven at 50°C and 20 in.Hg vacuum for 6 hours to complete drying. Finally, the Tenax was transferred to a clean amber glass bottle with a Teflon-lined screw cap and placed in a glass aquarium containing activated charcoal.

Charcoal - Petroleum-based charcoal (SKC Lot 208, Calgon-Type GW20X50, or equivalent) was prepared by heating to 190°C in a vacuum oven under a slow nitrogen purge according to the following procedures:

1) Charcoal was placed in a cylindrical metal container opened at the top and connected to a source of charcoal-filtered nitrogen at the bottom.

2) Nitrogen purge flow was set at 50 ml/min.

3) The charcoal and metal container were placed in a vacuum oven set at 190°C and approximately 5 in.Hg vacuum for 6 hours.

Glassware and Teflon Parts - All glass parts (traps, culture tubes, flasks, and condensers), Teflon fittings, and sample-exposed connecting lines were cleaned with a nonionic detergent (Alcojet) and rinsed thoroughly with charcoal-filtered deionized water. The parts were then oven-dried at 110°C for 8 hours. All parts were then wrapped in aluminum foil and stored in sealed glass aquariums containing activated charcoal.

Metal Parts - Sorbent trap end-plugs and stainless steel unions (used to connect the traps to the sampling train) were ultrasonically cleaned for 15 minutes in a hot nonionic detergent solution, then rinsed with charcoal-filtered deionized water, air-dried, and finally heated in a muffle furnace at 400°C for 2 hours. Cleaned parts were stored in amber glass bottles, which were placed in sealed glass aquariums containing activated charcoal.

Glass Wool - Pyrex wool filtering fiber was Soxhlet-extracted for 16 hours with glass-distilled methanol, placed in a clean ceramic evaporating dish, and dried under an infrared lamp in an exhaust hood for 4 hours. The glass wool and dish were then placed in a vacuum oven and heated at 110°C and 20 in.Hg vacuum for 6 hours. The cleaned glass wool was then stored in amber glass bottles with Teflon-lined screw caps until it was used.

Water - Charcoal-filtered, deionized water was used for trap leak checking prior to blank analysis. Water used for analytical steps was further treated by boiling for 15 minutes.

Nitrogen - For purging sorbent traps during thermal conditioning, nitrogen was passed through an inline gas purifier containing 5A° molecular sieve and activated charcoal. The charcoal bed was replaced with each new nitrogen cylinder.

Analytical Trap - The analytical trap consisted of the following components: Tenax (60/80 mesh), chromatographic grade or equivalent; silica gel, Davison Chemical (35/CU mesh), Grade 15 or equivalent; charcoal, petroleum-based (SKC Lot 104 or 208, Calgon Type GW20X50, or equivalent).

Stock Standard Solution - The stock standard solutions were prepared weekly from pure standard material by diluting with glass-distilled methanol.

Bromofluorobenzene (BFB) Tuning Check Standard - A solution of 50 µg/ml BFB in methanol was prepared and 1 µl of this standard was injected on column each day for the MS tuning check.

Internal Standard - A known concentration of D_6-Benzene and hexafluorobenzene was prepared in methanol, such that a 4-µl on-trap injection produced an amount on column in the range of the amount of the target compounds.

Assembly and Conditioning of VOST Sorbent Traps

Sorbents are loaded into the glass tube by use of a modified rifle shell loader. Tenax tubes are loaded with 1.6 grams of Tenax, and Tenax/charcoal tubes are loaded with 1.0 gram of each sorbent. A small section of Teflon tubing is used to help transfer the sorbent from the loader into the sorbent tube. Sorbent beds are held in placed by glass wool plugs. Sorbent tube ends are sealed with a Swagelok stainless steel cap and Supeltex M-1 ferrule. Each sorbent trap has a unique numeric code etched on the glass. Each assembled sorbent tube is stored in a clean glass culture tube with a Teflon-lined screw cap. All culture tubes are stored in sealed glass aquariums containing activated charcoal.

Once assembled, the sorbent traps are conditioned by passing nitrogen (30 ml/min) through the trap for 28 hours. Traps are heated in an oven at 190°C during conditioning. After conditioning the traps are returned to a culture tube and stored in a friction-top metal container, which also contains activated charcoal. Both the culture tubes and the metal can are purged with nitrogen to remove air contaminants before the traps are placed into them.

Blank Checking Procedure

Each set of traps is blank checked to ensure that the tubes contained less than 5 ng of the target compounds or any other contaminant. The target compounds include the designated POHC's and acetone, benzene, and hexane.

The following procedures are used to blank-check each pair of sorbent traps:

1) A pair of traps is connected with the charcoal side of the Tenax/charcoal tube connected to the inlet carrier gas. The traps are connected by stainless steel unions.

2) With the outlet of the paired traps (Tenax tube sampling inlet) still capped, the system is leak-checked at approximately 30 psig, either by immersing the traps in a pan of distilled water and observing the water for bubbles or by checking around the fittings with a thermal conductivity gas leak detector (e.g., GOW-MAC®). Any leaks are corrected.

3) The outlet of the paired traps is connected to the Tekmar purge and trap system. The traps are then placed in the oven and desorbed for 10 minutes.

4) After desorption, the sample collected in the purge and trap apparatus is injected into the GC.

5) To minimize contamination, carrier gas flow is maintained at all times and traps are disconnected by the following procedure:

   a) After cooling, the outlet of the paired traps is capped.

   b) The union between the traps is disconnected and both ends are capped.

   c) The outlet of the Tenax/charcoal tube is disconnected and capped.

6) Traps are immediately placed back in their respective culture tubes, which are taped together to keep the paired traps as a unit.

Sample Collection Procedure

The VOST train is assembled at the exit stack, as shown in Figure D-3. During sample collection, the end caps of the sorbent traps are placed back into the culture tubes in which the traps were stored.

The heated glass probe is leak-checked at the beginning of each test day by connecting a vacuum gauge, a shutoff valve, and a charcoal tube device to the inlet of the probe. The four-way valve is turned to the leak-check/probe-purge position and a 250-mmHg vacuum is pulled by use of a probe purge pump (Figure D-5). Any leak rate in excess of 2.5 mmHg/min in the vacuum gauge is unacceptable. At the completion of the leak check, the valve or the probe leak check device is opened to allow charcoal-filtered air to enter the probe and return pressure to ambient.

The remainder of the sampling train is leak-checked by turning the four-way valve to the leak-check/probe-purge setting, closing the control valve on the leak-check system (Figure D-6), and pulling a vacuum of at least 250-mmHg (10 in.Hg) with the sampling pump.

The control valve on the control module is closed to isolate the traps and condensers from the pump, and the leak rate is measured. At the completion of the leak check, the leak-check system control valve is opened to allow charcoal-filtered ambient air to enter the train.

At the completion of the leak check, the probe is positioned at the desired sampling point in the gas stream; the probe purge pump (Figure D-5) is activated, and the probe is purged with stack gas for 10 minutes at a rate of 0.5 liter per minute.

Immediately prior to the sampling, the dry gas meter volume is recorded and the time clock is set at zero. The four-way valve is then turned to the sample position and the sample pump is started. Sample flow rate is adjusted to a constant sampling rate, and sampling is continued until a total volume of not more than 20 liters is collected. The sampling run is terminated by closing the sample pump control valve and turning off the pump. The final

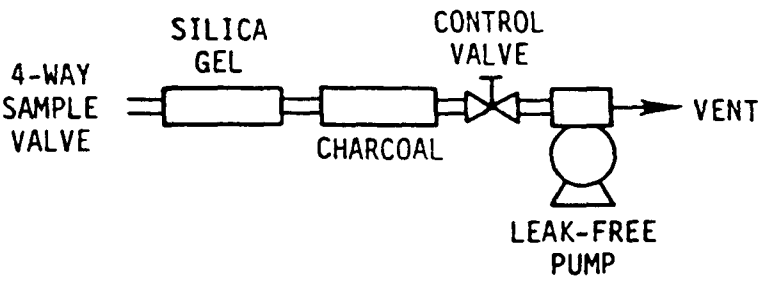

Figure D-5. Probe purge system.

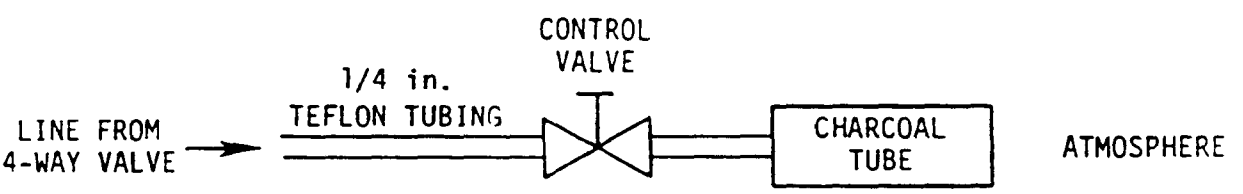

Figure D-6. Leak check system.

dry gas meter reading is then recorded, and the four-way valve is turned to the leak-check/purge position.

The post-test leak check is conducted similarly to the pretest leak check, but the vacuum is set at the highest vacuum attained during the run.

The traps are then disconnected, capped, placed in the culture tubes, sealed, and labeled. All traps are placed in the culture tubes with point of entry nearest the screw cap. The culture tubes are then purged with charcoal-filtered nitrogen and sealed. The culture tubes are then placed back into metal cans. The metal can is also purged with nitrogen prior to sealing at the end of the test day.

At the end of a test run (3 to 6 sorbent samples), any condensate collected in the flask is recovered as follows: The condensate is poured from the flask into 7-ml glass vials with Teflon lined septa and screw caps. Other sizes of vials can be used so that, if possible, two completely full glass vials are collected (one is a spare). The volume of any remaining condensate is measured and this portion is discarded.

Several blank sorbent traps are collected during the test series. The field blanks are collected by connecting the sorbent traps to the sampling train, leak-checking the train, and then disconnecting the traps. Trip blanks are traps carried to the field but left sealed in their culture tubes until analyzed. If designated by the project plan, ambient field blanks are collected by uncapping a pair of sorbent tubes and laying them near the sampling site for the amount of time required to assemble a pair of tubes in the sampling train, and lab blanks are traps prepared and blank checked at the same time as the sample traps, but left stored in the laboratory custody room until analyzed with the lot of field samples.

All samples are transported in an ice-chilled cooler and refrigerated in the laboratory until analysis.

Analytical Procedure

Analysis was performed by Radian Corp. See Appendix C for methods and procedures.

DETERMINATION OF METAL EMISSIONS

An EPA Reference Method 12 sample train, which meets design specifications established by the U.S. Environmental Protection Agency, was used to determine emissions of select metals for this test program.* This train was be assembled by PEI personnel and consists of the following items:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Probe - Borosilicate glass with a heating system capable of maintaining a gas temperature of approximately 121°C (250°F) at the exit end during sampling.

Pitot tube - Type-S pitot tube that meets all geometric standards. It was attached to the probe to monitor stack gas velocity.

Thermocouple - Type-K thermocouple capable of measuring stack gas temperatures within 2 percent. It was attached to the probe.

Filter holder - Pyrex glass with heating system capable of maintaining a filter temperature of approximately 121°C (250°F)

Draft gauge - An inclined manometer made by Dwyer with a range of 0 to 10 in. H_2O.

Impingers - Four impingers connected in series with glass ball joints. The second impinger was of the Greenburg-Smith design. The first, third, and fourth impingers were also of the Greenburg-Smith design, but modified by replacing the tip with a ½-in. i.d. glass tube extending to ½-in. from the bottom of the flask.

Metering system - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2 percent accuracy, and related equipment to maintain an isokinetic sampling rate and to determine sample volume. The dry gas meter is made by Rockwell and the fiber vane pump is made by Gast.

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* 40 CFR 60, Appendix A, Reference Method 12, July 1987.

Barometer - Aneroid type to measure atmospheric pressures to within ±2.5 mmHg (±0.1 in.Hg).

SAMPLING PROCEDURES

Glass fiber filters* (3-in. diameter) were desiccated for at least 24 hours and weighed to the nearest 0.1 mg on an analytical balance. One hundred ml of 0.1 N HNO_3 was placed in each of the first two impingers; the third impinger will initially be empty; and the fourth impinger, containing approximately 300 to 400 g of silica gel, was be placed next in series. The train will be set up with the probe as shown in Figure D-8. The sampling train was leak checked at the sampling site prior to each test run by plugging the inlet to the nozzle and pulling a 15-in.Hg vacuum, and at the conclusion of the test by plugging the inlet to the nozzle and pulling a vacuum equal to the highest vacuum reached during the test run.

The pitot tube and lines were leak checked at the test site prior to and at the conclusion of each test run. The check was made by blowing into the impact opening of the pitot tube until 3 or more inches of water was recorded on the manometer and then capping the impact opening and holding it for 15 seconds to assure it is leak free. The static pressure side of the pitot tube was leak checked using the same procedure, except suction was used to obtain the 3-in.H_2O manometer reading. Crushed ice was placed around the impingers to keep the temperature of the gases leaving the last impinger at 20°C (68°F) or less.

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* Whatman Reeve Angel 934AH.

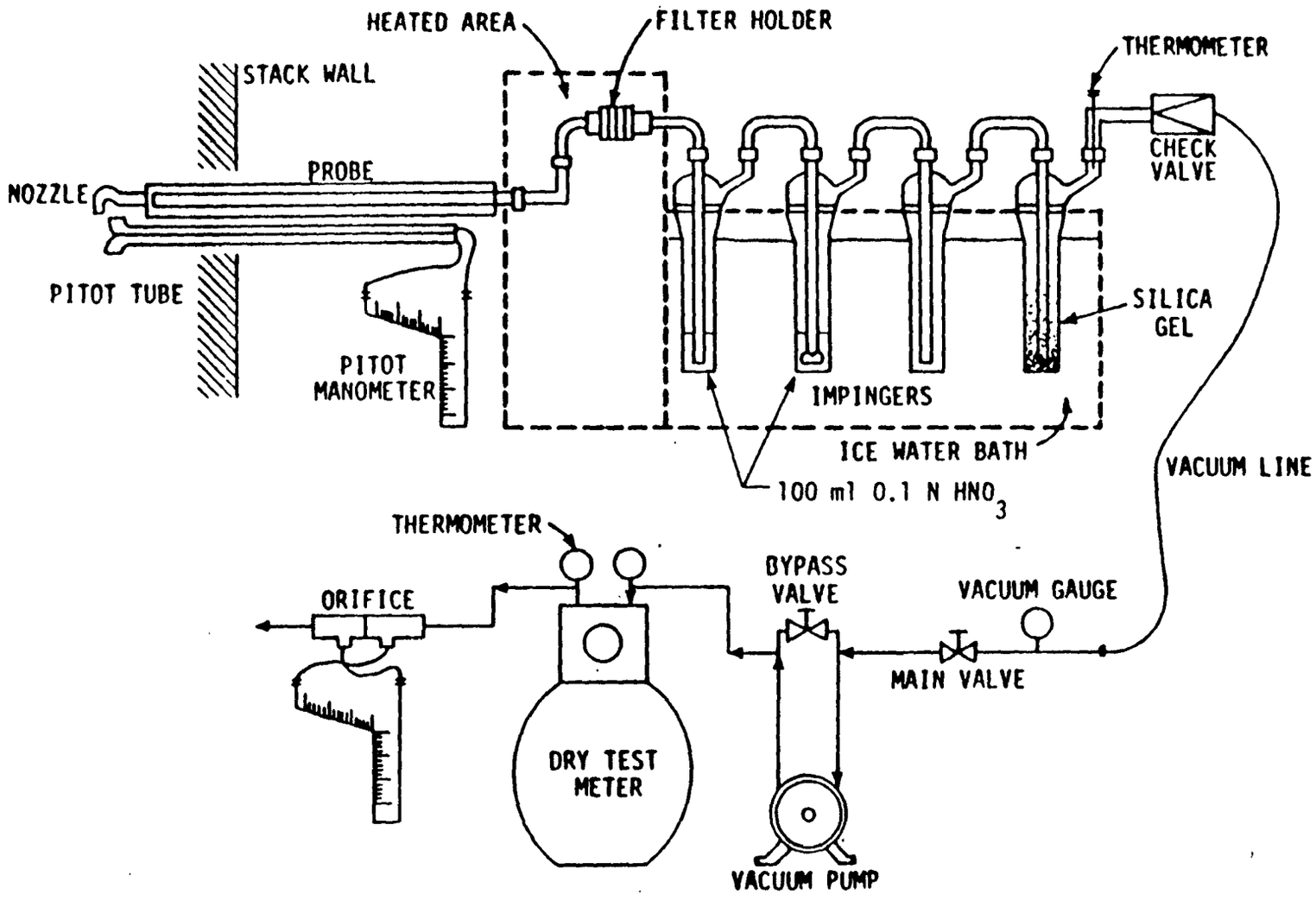

Figure D-8. Metals sampling train.

During sampling, stack gas and sampling train data was recorded at each sampling point and when significant changes in stack flow conditions occurred. Isokinetic sampling rates was set throughout the sampling period with the aid of a programmable calculator. All sampling data was recorded on the Particulate Field Data Sheet.

Sample Recovery Procedures

The sampling train was moved carefully from the test site to the designated sample recovery site. Each impinger was weighed after the test to determine the amount of moisture present. Sample fractions was recovered as follows:

Container No. 1 - The filter was removed from its holder and placed in a petri dish, sealed, and labeled.

Container No. 2 - An unused filter was taken as a blank.

Container No. 3 - Loose particulate and 0.1 N HNO_3 washings from all sample-exposed surfaces prior to the filter was placed in a polyethylene container, which was then be sealed and labeled. Particulate was removed from the probe with the aid of a brush and HNO_3 rinsing. The liquid level was marked after the container is sealed.

Container No. 4 - A minimum of 500 ml of HNO_3 was taken for the blank analysis. The blank was obtained and treated in a similar manner as the HNO_3 rinse.

Container No. 5 - 0.1 N HNO_3 and condensate in the impinger section of the sampling train was placed in a polyethylene container. The impingers and connecting glassware were rinsed with 0.1 N HNO_3, and this rinse was added to the container. The container was sealed and labeled, and the liquid level was marked.

The silica gel from the fourth impinger was weighed, and this value was recorded with other pertinent data on the Sample Recovery and Integrity Sheet.

Metals Analysis

Analyses for the indicated metals was accomplished by procedures described in SW846: Methods 3050 for digestion and preparation of samples and Methods 7060 for arsenic (Atomic ABsorption) and 6010 for the remaining metals (Inductively-Coupled Plasma (ICP) Spectroscopy) (see Appendix C).

DETERMINATION OF CARBON MONOXIDE, CARBON DIOXIDE, AND OXYGEN CONTENT BY CONTINUOUS EMISSION MONITOR

Carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) concentrations were measured continuously throughout the test periods. The sampling procedures were those of EPA Method 10 for CO, and Method 3A for O_2 and CO_2. A schematic of the sampling system is shown in Figure D-9.

The CEM sampling system consisted of a stainless steel probe with an in-stack glass wool particulate filter, a three-way ball valve at the probe exit for calibration gas introduction, a stainless steel condenser for moisture removal, a Teflon sampling line, and a Teflon diaphragm or stainless steel bellow pump to supply the analyzer sampling manifold. The CO and CO_2 analyzers are NDIR detectors. The O_2 analyzer is an electrochemical cell detector. All analyzers were calibrated at the beginning and end of each test run with three gas standards in the analytical range and zero nitrogen. Span and zero checks were be conducted at the midpoint of each test run. Calibration data were reduced by means of a linear regression analysis, and the linear equation was used to quantitate stack gas concentrations. The output from the analyzers was continuously recorded on analog-type strip-chart recorders for a permanent record.

In conducting these tests, PEI performed all calibration and quality assurance tests required by the EPA Methods.

The following is a description of the analyzers that will be used and the reference method performance specifications.

CARBON MONOXIDE

A Beckman Model 8501-5CA continuous nondispersive infrared (NDIR) analyzer will be used to measure CO. The following list compares the Beckman NDIR

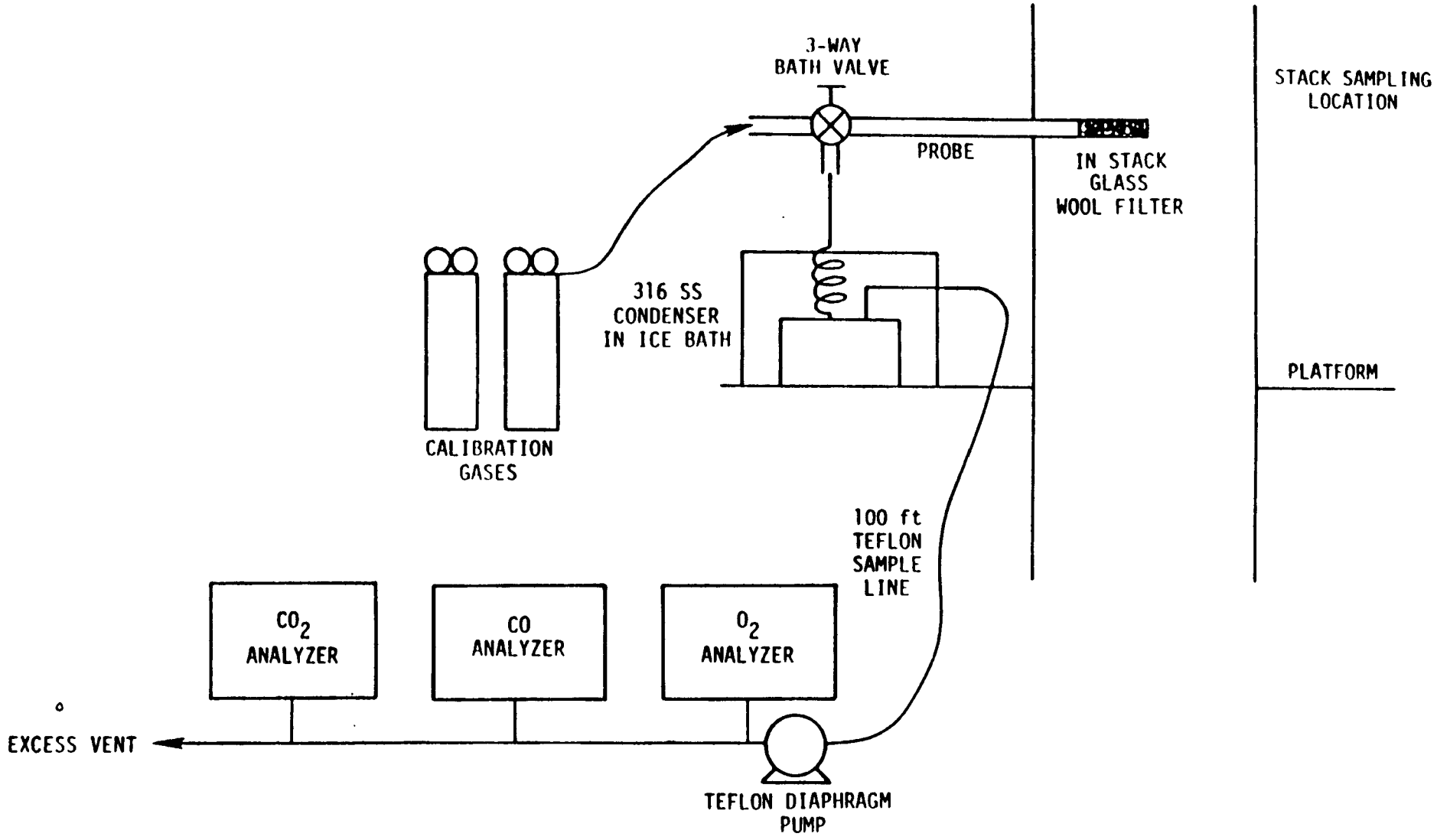

Figure D-9. CEM Sampling System for CO, CO_2, and O_2.

performance parameters with the minimum performance specifications given in EPA Method 10.

Parameter	EPA Method 10 minimum specification	Bendix NDIR, manufacturer's performance specification
Detector type	NDIR	NDIR
Analytical range	0 to 1000 ppm	Available ranges: 0 to 50, 250, 500, and 1000 ppm
Minimum detectable ppm	20	0.5 ppm in 0 to 50 range
Calibration requirement	0, 30, 60, and 90% of span	PEI will use Method 10 criteria
Linearity	±2% of span	±1% of span
Precision	±2% of span	±1% of span
Noise	±1% of span	±0.5% of span
Zero drift	±10% of scale	±1% for 24 h
Span drift	±10% of scale	±1% for 24 h
Response time	30 s to 90% of full response	Electronic response time 0.7 s to 90% of scale
Interference ratio		
CO_2	1000 to 1	40,000 to 1
H_2O	1000 to 1	20,000 to 1

PEI will measure the actual performance of the analyzer on site during initial setup.

OXYGEN

A Data Test Corporation Model 303 zirconia cell detector was used to measure oxygen. The CO_2 analyzer was an Anarad model NDIR analyzer. The O_2 analyzer was operated in the 0 to 25 percent range and was calibrated with zero nitrogen and gas standards of 8, 15, and 21 percent oxygen. The CO_2 analyzer was operated in the 0 to 20 percent range and calibrated with gas standards at 4, 8, and 16 percent. The following is a list of EPA Method 3A performance specifications. The analyzers were tested on site to ensure that all performance specifications are met.

METHOD 3A PERFORMANCE CRITERIA

Parameter	Specification
Analyzer type	Not specified
Range	So that average stack gas concentration is 20 to 90% of span (4 to 19% for 21% span)
Minimum detectable concentration	2% of span (0.4% O_2 or CO_2 for 21% span)
Calibration gases	20 to 30%, 50 to 60%, and 80 to 90% of span
Analyzer calibration error	±2% for all calibration gases
Sensitivity	Detect ±0.5% change in concentration
Zero and span drift	±2% of span per run
Accuracy	±5% of Method 3 value or 0.2% O_2 or CO_2, whichever is greater

PROCESS SAMPLING PROCEDURES (WASTE FEED, ASH, AND SCRUBBER WATER)

Basic sample collection procedures followed those described in Sampling and Analysis Methods for Hazardous Waste Combustion, Arthur D. Little, Inc. EPA-600/8-84-002, February 1984. This reference was added as a revision to the 2nd Edition of SW-846. Analysis followed applicable procedures described in SW-846.

Waste Feed Sampling

Feed samples were collected from the screw feed hopper once an hour during each run and composited into a 5-gallon metal container which was covered between sampling events. Samples were collected using disposable scoops. Hourly volatile grab samples were taken and placed in appropriate containers immediately. The composite was mixed using the scoop, and aliquots will be placed in appropriate sample containers for analysis. Samples

were labeled and placed in coolers with vermiculite and ice for shipment to the laboratory for analysis.

Bottom Ash Samples

One composite sample of bottom ash was collected during each SARM test run. The ash was sampled from the dewatered ash bin after it is removed from the rotary kiln ash quench box. This ash is removed continuously by a paddle wheel and dumped into the dewatered ash bin. A sample of ash was collected from this dewatered ash container using disposable scoops once each hour following the start of each run, and placed in a separate 5-gallon metal container which was covered between sampling events. Hourly volatile grabe samples were taken and placed in appropriate containers immediately. The composite was mixed, and from this individual aliquots was taken and placed in appropriate sample containers for analysis.

3.2.3 Scrubber Water Samples

One scrubber blowdown sample was collected uring each test run. Aliquots were collected once an hour as the blowdown leaves the recycling chamber and before it reaches the waste scrubber water storage tank. Hourly volatile grab samples were taken and placed in appropriate containers immediately. The aliquots were composited in a 1-gallon glass container which was covered between sampling events. Aliquots of the composite were placed in appropriate containers for analysis. Samples were labeled and then placed in coolers packed with vermiculite and ice for shipment and analysis.

3.2.4 Sample Identification

Each sample collected during the incineration testing was assigned a unique alpha-numeric sampel identification number. The coded number identified the facility, whether the sample is SARM I or SARM II feed, scrubber

effluent, or incinerator residue (ash), and which of the three replicate Zink runs it came from.

Example Sample ID Number: ZSARM-I-1-A

In the example identification number given above, the first seven digits (ZSARM-I) specify the sample is from the John Zink incinerator (Z) buring SARM-I. The next digit (1) signifies that the sample was taken during the first test run. The last digit signifies the sampling location from Figure 3-1 (A refers to the screw feeder).

Sample Containers

In the determination of organics and metals, containers can introduce either positive or negative errors by 1) contributing contaminants through leaching or surface desorption, and 2) depleting concentrations through adsorption. Therefore, particular attention must be given to the collection and treatment of a sample prior to its analysis.

Preparation and Handling of Process Sample Containers for Volatile Organic Analysis--

Standard 40-ml, screw-cap, glass VOA* vials with Teflon-faced silicone septa were used for both liquid and solid matrices. The vials and septa were washed with soap and water and rinsed with distilled deionized water. After the vials and septa had been thoroughly cleaned, they were placed in an oven and dried at 105°C for approximately 1 hour.

During sample collection, liquids and solids were gently introduced into the vials to reduce any agitation that might drive off volatile compounds.

*Volatile organics analysis.

Liquid scrubber water samples were poured into vials without introducing any air bubbles within the vial during the process. Should bubbling result from overly aggressive pouring, the sample will be poured out and the vial refilled. Each VOA vial was filled until there was a meniscus higher than the lip of the vial. The screw-top lid with the septum (Teflon side toward the sample) was then tightened onto the vial. After the lid is tightened, the vial was inverted and tapped to check for air bubbless. If any air bubbles were present, the sample was retaken. Two VOA vials were filled per sample location and interval. The scrubber water was cooled by passing it through a coil of teflon tubing submerged in a ice-water bath prior to filling the vial.

The VOA vials for solid waste feed and ash samples were filled to the extent possible. During the filling process, the vials were tapped slightly to eliminate as much free air space as possible. Two vials were filled per sample location and interval.

The VOA vials were filled and immediately labeled at the point at which the sample was collected. They were not filled near a running motor or any type of exhaust system because discharged fumes and vapors can contaminate the samples. The two vials from each sampling location were then placed in separate sealed plastic bags to prevent cross-contamination between samples. VOA samples from SARM I and SARM II were kept in separate coolers packed with vermiculite and plastic-wrapped ice. Samples of scrubbed water and ash were kept in separate coolers. Since VOA samples also may become contaminated by diffusion of volatile organics into the vial through the septum during shipment and storage, a VOA trip blank prepared from distilled deionized water was placed in each cooler containing the scrubber water throughout the sampling, storage, and shipping process.

Preparation and Handling of Process Sample Containers for Semivolatile Analysis

Glass wide-mouth jars with screw-top covers and Teflon liners were used to collect samples for determination of semivolatile organics compounds. They were prewashed with soap and water and rinsed with methanol (or isopropanol).

One gallon of scrubber water and 250-mls of wate feed and ash were placed in the glass wide-mouth bottles. Sample containers were filled carefully to prevent any portion of the collected sample from coming in contact with the sampler's gloves and thereby causing contamination. Samples were collected or stored in the presence of exhaust fumes.

Preparation and Handling of Process Sample Containers for Metals Analyses

Two 4-ounce and one 1-liter plastic wide mouth jars with screw top lids wre used to contain process samples of waste feed, ash, and scrubber water for metals analysis. The containers were prewashed with soap and water and acid rinsed with a non-chromate product such as NoChromix. After filling, the aqueous scrubber water samples were acidified with nitric acid to a pH of less than 2 as a preservation step; the solid waste feed and gas samples were not acidified. All containers were labeled and placed in coolers with vermiculite for shipment to the laboratory.

Preparation and Handling of Process Sample Containers for TCLP Analyses

Half-gallon wide mouth glass jars with screw top plastic lids and Teflon liners were used to contain process samples of waste feed and bottom ash for TCLP analysis. The containers were precleaned with soap and water followed by an acid rinse using a non-chromate product such as NoChromix. The containers were filled as full as possible to minimize head space losses of volatiles. They were labeled and placed in coolers with ice (wrapped in plastic) for shipment of U.S. EPA.

Cleaning and Storage of Lab Glassware

In the analysis of samples containing contaminants in the parts-per-million range, the preparation of clean glassware is mandatory. Failure to do so can lead to a myriad of problems in the interpretation of the final chromatograms resulting from extraneous peaks caused by contamination. Particular care must be taken with glassware such as Soxhlet extractors, Kuderna-Danish evaporative concentrators, sampling-train components, or any other glassware coming in contact with an extract that will be evaporated to a lesser volume. The process of concentrating the compounds of interest in this operation may similarly concentrate the contaminant and thereby seriously distort the results.

The basic cleaning steps are:

1. Removal of surface residuals immediately after use.
2. Hot soaking to loosen and flotate most particulate matter.
3. Hot-water rinse to flush away flotated particulates.
4. Soaking with an oxidizing agent to destroy traces of organic compounds.
5. Hot-water rinse to flush away materials loosened by soaking in a deep penetrant.
6. Distilled-water rinse to remove metallic deposits from the tap water.
7. Methanol rinse to flush off any final traces of organic materials and to remove the water.
8. Flushing the item immediately before use with some of the same solvent that will be used in the analysis.

Each of these eight fundamental steps are discussed in their order of appearance.

1. As soon as possible after glassware (i.e., beakers, pipets, flasks, or bottles) has come in contact with sample or standards, it should

be methanol-flushed before it is placed in a hot detergent soak bath. If this is not done, the soak bath may serve to contaminate all other glassware placed therein.

2. The hot soak bath consists of a suitable detergent in water of 50°C or higher. The detergent--powder or liquid--should be entirely synthetic and not have a fatty acid base. Very few areas of the country have water with sufficently low hardness to avoid the formation of some hard-water scum due to the reaction of calcium and magnesium salts with a fatty-acid soap. This hard-water scum or curd would have a particular affinity for many chlorinated compounds, and being almost entirely water-insoluble, it would deposit as a thin film on all glassware in the bath.

   Many suitable detergents are available on the wholesale and retail market. Most of the common liquid dishwashing detergents sold at retail are satisfactory, but they are more expensive than other comparable industrial products. Alconox, manufactured by Alconox, Inc., New York, in powder or tablet form, is marketed by several laboratory supply firms. Sparkleen, another powdered product, is distributed by Fisher Scientific Company.

3. No comments required.

4. The most common and highly effective oxidizing agent for removal of traces of organic compounds is the traditional chromic acid solution made up of H_2SO_4 and potassium or sodium dichromate. For maximum efficiency, the soak solution should be hot (40° to 50°C). Rigid safety precautions must be observed in the handling of this solution. Prescribed safety gear should include safety goggles, rubber glvoes, and an apron. The bench area where this operation is conducted should be covered with flurocarbon sheeting because spattering will disintergrate any unprotected surfaces.

   The great potential hazards associated with the use of a chromic sulfuric acid mixture have been well publicized. Current commerically available substitutes possess the advantage of safety in handling, and claims indicate that these biodegradable concentrates have a cleaning strength equal to that of chromic acid solution. They are alkaline (equivalent to approximately 0.1 N NaOH upon dilution) are are claimed to remove dried blood, silicone greases, traces, etc. They will not attack glass or have a corrosive effect on skin or clothing. One such product, "Chem Solv 2157," is manufactured by Mallinckrodt and available through laboratory supply firms. Another comparable product, "Detex," is a product of Borer-Chemie, Solothurn, Switzerland.

5, 6, and 7. No comments required.

8. Between the time the glassware is washed and its next use, it could pick up some contamination from either the air or direct contact. The practice of flushing the item immediately before its use with some of the same solvent that will be used in the analysis helps to ensure agains this.

The drying and storage of the cleaned glassware are critical to preventing the nullifying of the beneficial effects of the cleaning. Pegboard drying is not recommended because contaminants can be introduced to the interior of the cleaned vessels. Neoprene-coated metal racks are suitable for such items as beakers, flasks, chromatographic tubes, and any glassware that can be inverted and suspended to dry. Small articles such as stirring rods, glass stoppers, and bottle caps can be wrapped in aluminum foil and oven-dried for a short time if oven space is available. Under no circumstances should such small items be left in the open without protective covering. Clean glassware can easily be recontaminated by a dust cloud raised by the daily sweeping of the laboratory floor.

Process Sample Preservation

The required containers, preservation procedures, and holding times for the aqueous scrubber water samples are presented in Table D-1. In accordance with generally accepted practice, solids such as the waste feed and ash will be placed in glass containers with Teflon-line caps and cooled to 4°C without jeopardizing the sample. Toxicity Characteristic Leaching Procedure (TCLP) samples must be obtained as separate samples; no preservatives are added, and samples are stored and shipped at 4°C.

Scoops and dippers or thiefs were used to prepare all process samples. Gallon glass jars and 5-gallon metal pails were used for compositing purposes prior to placement of sample aliquots in final sample containers to analysis. Separate containers were used for each run so that no decontamination of the compositing vessels was required in the field.

TABLE D-1. REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR AQUEOUS SAMPLES

Measurement parameter	Container[a]	Preservation[b]	Maximum holding times[c]
Purgeable organics (EPA Method 8240)	G Teflon-lined septum	Cool to 4°C, protect from light[d]	14 days
Extractable organics (EPA Method 8250)	G Teflon-lined cap	Cool to 4°C,[d] protect from light	7 days until extraction, 40 days after extraction
Metals	P,G	HNO_3 to pH <2	6 months

[a] Polyethylene (P) or glass (G).

[b] Sample should be preserved immediately upon sample collection.

[c] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. All data obtained beyond the maximum holding times will be flagged.

[d] Add 0.08% $Na_2S_2O_3$ if residual chlorine may be present in aqueous samples.

Reference: BDAT Generic QAPP

APPENDIX E

EQUIPMENT CALIBRATION PROCEDURES AND RESULTS

CALIBRATION PROCEDURES AND RESULTS

All of the manual stack sample equipment used was calibrated according to the procedures outlined in "Quality Assurance Handbook for Air Pollution Measurement Sytems, Volume III" EPA-600/4-77-927b.

NOZZLE DIAMETER

The nozzles were calibrated by making three separate measurements using different inside diameters and calculating the average. If a deviation of more than 0.002 inch was found, the nozzle was either discarded or reamed out and remasured. A micrometer was used for measuring. These calibration data are shown in Figure E-1.

PITOT TUBE CALIBRATION

The pitot tube used in sampling was constructed by PEI Associates, Inc., and met all requirements of EPA Mehtod 2, Section 4.1.* Therefore, a baseline coefficent of 0.84 was assigned to each pitot tube. See Figures E-2 and E-3 for alignment requirements of Method 2, and Figures E-4 and E-5 for actual inspection data of the pitot tubes used during the test program.

* 40 CFR 60, Appendix A, Reference Method 2, July 1987.

NOZZLE CALIBRATION

Date 9/15/87 Calibrated by 93

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
MM5 (#5-107)	.308	.308	.311	.003 ✓	.309
Metals (#5-100)	.315	.312	.311	.004 ✓	.313

where:

$D_{1,2,3,}$ = nozzle diameter measured on a different diameter, in. Tolerance = measure within 0.001 in.

ΔD = maximum difference in any two measurements, in. Tolerance = 0.004 in.

D_{avg} = average of D_1, D_2, and D_3.

Figure E-1. Nozzle calibration data.

NOZZLE CALIBRATION

Date 9-16-87 Calibrated by G. Nuzzard

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
4-120	0.25	~~0.25~~ 0.248	0.251	0.003	0.250
4-105	0250	0.251	0.250	0.001	0.250

where:

$D_{1,2,3,}$ = nozzle diameter measured on a different diameter, in. Tolerance = measure within 0.001 in.

ΔD = maximum difference in any two measurements, in. Tolerance = 0.004 in.

D_{avg} = average of D_1, D_2, and D_3.

Figure E-1 continued. Nozzle calibration data.

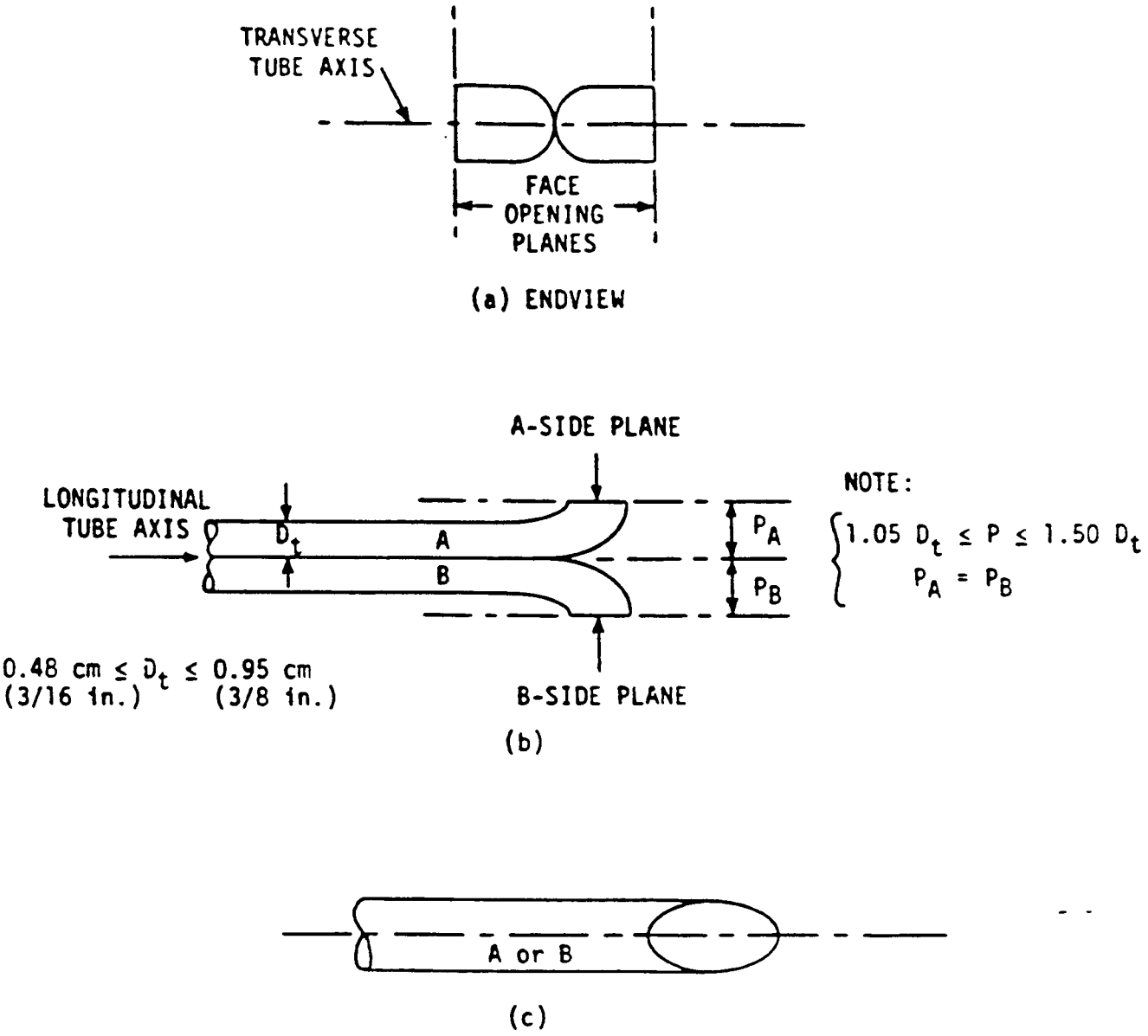

Figure E-2. Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

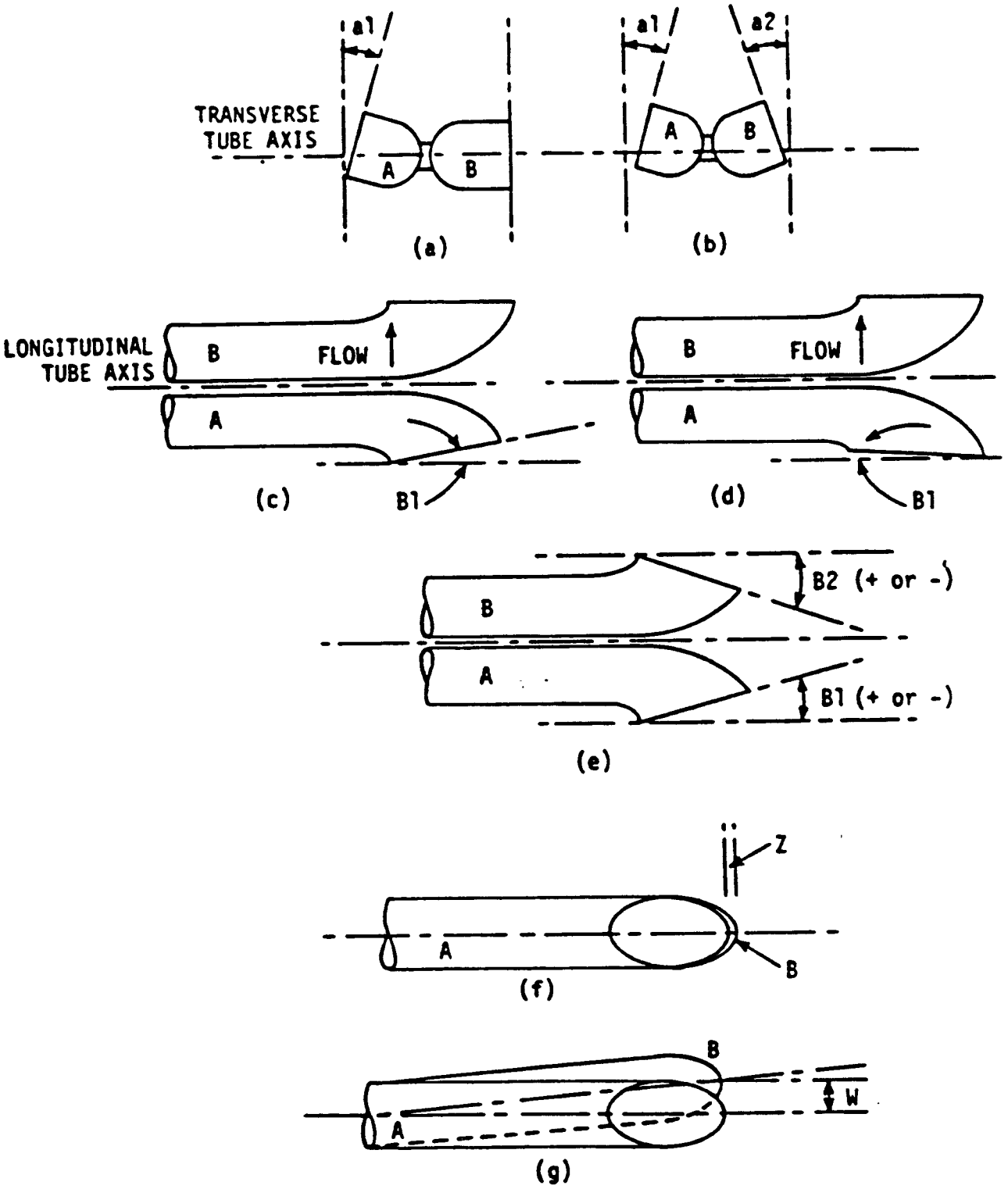

Figure E-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp so long as a_1 and a_2 <10°, B_1 and B_2 <5°, z <0.32 (1/8 in.) and w <0.08 cm (1/32 in.).

PITOT TUBE INSPECTION DATA SHEET

Pitot Tube No. 504 3' Date 12-22-86 Inspector G Thress

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
0°	1°	1°	1°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
0.375	.996	0.394	0.563
$0.185 \leq P_t < 0.380$	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
3°	0°	0.052	0.000
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.502	0.494	0.008	✓
$1.05\ D_t < P_1 < 1.50\ D_t$	$1.05\ D_t < P_2 < 1.50\ D_t$		

Lower line in each table is limits for meeting specifications.

Figure E-4. Pitot tube inspection data sheet.

PITOT TUBE INSPECTION DATA SHEET

Pitot Tube No. 376 Date 12-22-86 Inspector G Thress

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
0°	0°	2°	1°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
.375	.836	.394	.563
$0.185 \leq P_t < 0.380$	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
0°	1°	0.105	0.0175
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.420	.416	.004	✓
$1.05\ D_t < P_1 < 1.50\ D_t$	$1.05\ D_t < P_2 < 1.50\ D_t$		

Lower line in each table is limits for meeting specifications.

Figure E-5. Pitot tube inspection data sheet.

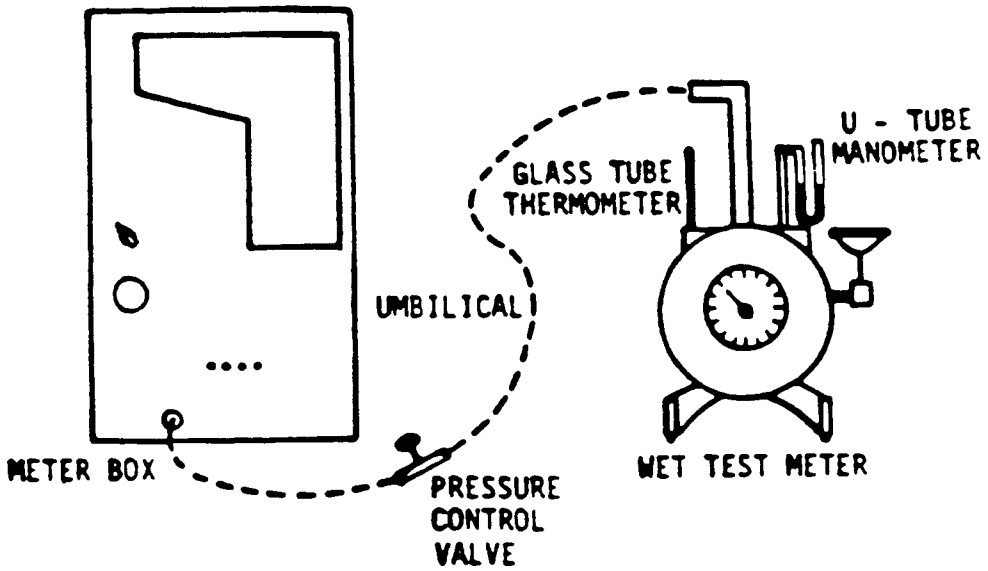

Figure E 6 Calibration setup.

DATE _____ METER BOX NO. _____

BAROMETRIC PRESSURE, P_b = _____ in. Hg. DRY GAS METER NO. _____

Orifice manometer setting ΔH in. H_2O	Gas volume wet test meter V_w, ft^3	Gas volume dry gas meter V_d, ft^3	Wet test meter t_w, °F	Dry gas meter Inlet t_{di}, °F	Dry gas meter Outlet t_{do}, °F	Dry gas meter Average t_d, °F	Time θ, min	γ	$\Delta H@$
0.5	5								
1.0	5								
1.5	10								
2.0	10								
3.0	10								
4.0	10								

Average _____

ΔH	$\frac{\Delta H}{13.6}$	γ $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@$ $\frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w} \right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

γ = Ratio of accuracy of wet test meter to dry test meter. Tolerance = ± 0.01
$\Delta H@$ = Orifice of pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in H_2). Tolerance = ±0.15.

Figure E-7. Calibration data sheet.

PARTICULATE SAMPLING METER BOX INITIAL CALIBRATION

DATE: 9-3-86 METER BOX NO. FT-3

CALIBRATOR: G.K. Howard BAROMETRIC PRESSURE (P_b) 29.56 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓ @ 7.8" H_2O

Negative (within 3 in. Hg of absolute): 0.000 cfm* 27.5 in. Hg

*Not to exceed 0.005 cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_1 °F	Dry gas meter: Outlet T_o °F	Dry gas meter: Average T_d °F	Duration of test θ min	Vacuum setting in Hg	Y	ΔHθ in H_2O
0.5	5.0	022.543	72	80	75	77.75	$11\frac{48.34}{60}$	10 0	1.006	1.573
		027 362	72	80	76					
1.0	10.0	028.141	72	81	76	79.25	$16\frac{49.46}{60}$	10.0	1.001	1.593
		038.240	72	83	77					
1.5	10.0	039.153	72	84	77	81.0	$13\frac{48.86}{60}$	10.0	1.000	1.606
		049.283	72	85	78					
2.0	17.0	050305	72	85	78	82.5	$20\frac{54.51}{60}$	10.0	1.002	1.693
		067.613	72	87	80					
3.0	12.0	068.376	72	87	80	84	$11\frac{57.25}{60}$	10.0	.994	1.661
		680.635	72	88	81					
4.0	10.0	081.954	72	88	81	84.75	$8\frac{42.72}{60}$	10.0	.991	1.692
		092.186	72	89	81					
								Average	.999	1.636

Y must not deviate by more than ±0.02 Y.
ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	Y: $\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5.0)(29.56)(537.75)}{(5.019)(29.597)(532)}$	$\frac{(0.0317)(0.5)}{(29.56)(537.75)}\left[\frac{(532)(11.806)}{(5.0)}\right]^2$
1.0	$\frac{(10.0)(29.56)(539.25)}{(10.099)(29.634)(532)}$	$\frac{(0.0317)(1.0)}{(29.56)(539.25)}\left[\frac{(532)(16.829)}{(10.0)}\right]^2$
1.5	$\frac{(10.0)(29.56)(541.0)}{(10.130)(29.670)(532)}$	$\frac{(0.0317)(1.5)}{(29.56)(541.0)}\left[\frac{(532)(13.814)}{(10.0)}\right]^2$
2.0	$\frac{(17.0)(29.56)(542.5)}{(17.218)(29.707)(532)}$	$\frac{(0.0317)(2.0)}{(29.56)(542.5)}\left[\frac{(532)(20.91)}{(17.0)}\right]^2$
3.0	$\frac{(12.0)(29.56)(544.0)}{(12.259)(29.781)(532)}$	$\frac{(0.0317)(3.0)}{(29.56)(544.0)}\left[\frac{(532)(11.859)}{(12.0)}\right]^2$
4.0	$\frac{(10.0)(29.56)(544.75)}{(10.252)(29.854)(532)}$	$\frac{(0.0317)(4.0)}{(29.56)(544.75)}\left[\frac{(532)(8.712)}{(10.0)}\right]^2$

Figure E-8. Particulate sampling meter box initial calibration.

PARTICULATE SAMPLING METER BOX INITIAL CALIBRATION

DATE: 12-23-86 METER BOX NO. FB-3

CALIBRATOR: J. Neese BAROMETRIC PRESSURE (P_b) 29.70 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓

Negative (within 3 in. Hg of absolute): 0.000 cfm* 28.0 in. Hg

*Not to exceed 0.005 cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_1 °F	Dry gas meter: Outlet T_o °F	Dry gas meter: Average T_d °F	Duration of test θ min	Vacuum setting in Hg	γ	ΔHθ in H_2O
0.5	5	583.233 588.433	69 69	81 82	73 74	77.5	12:45.47	10	.976	1.81
1.0	10	588.821 599.224	69 69	82 85	74 76	79.25	18:24.00	10	.978	1.88
1.5	10	599.509 609.903	69 69	85 87	76 77	81.25	14:58.20	10	.981	1.86
2.0	10	610.224 620.609	69 69	87 88	77 78	82.5	13:00.52	10	.983	1.86
3.0	10.1	621.022 631.498	69 69	88 88	78 78	83	10:57.87	10	.982	1.94
4.0	10	631.827 642.175	69 69	88 89	78 79	83.5	9:26.74	10	.983	1.96
								Average	.981	1.89

γ must not deviate by more than ±0.02 γ.
ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	γ: $\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5)(29.70)(537.5)}{(5.200)(29.74)(529)}$	$\frac{(.0317)(0.5)}{(29.70)(537.5)}\left[\frac{(529)(12.76)}{(5)}\right]^2$
1.0	$\frac{(10)(29.70)(539.25)}{(10.403)(29.77)(529)}$	$\frac{(.0317)(1.0)}{(29.70)(539.25)}\left[\frac{(529)(18.4)}{(10)}\right]^2$
1.5	$\frac{(10)(29.70)(541.25)}{(10.394)(29.81)(529)}$	$\frac{(.0317)(1.5)}{(29.70)(541.25)}\left[\frac{(529)(14.97)}{(10)}\right]^2$
2.0	$\frac{(10)(29.70)(542.5)}{(10.385)(29.85)(529)}$	$\frac{(.0317)(2.0)}{(29.70)(542.5)}\left[\frac{(529)(13.01)}{(10)}\right]^2$
3.0	$\frac{(10.1)(29.70)(543)}{(10.476)(29.92)(529)}$	$\frac{(.0317)(3.0)}{(29.70)(543)}\left[\frac{(529)(10.96)}{(10.1)}\right]^2$
4.0	$\frac{(10)(29.70)(543.5)}{(10.348)(29.99)(529)}$	$\frac{(.0317)(4.0)}{(29.70)(543.5)}\left[\frac{(529)(9.45)}{(10)}\right]^2$

Figure E-8 continued. Particulate sampling meter box initial calibration.

POST-TEST CALIBRATION

DATE: 9-21-87

BAROMETRIC PRESSURE (P_{bar}): 29.42 in. Hg

PLANT: J. Zink

PROJECT MANAGER: C. Bruffey

METER BOX NO. FT-3

PRETEST Y: .999 ΔH@: 1.64

PROJECT NO. 3724-7

CALIBRATOR: J. Neese

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_{di} °F	Dry gas meter: Outlet T_{di} °F	Dry gas meter: Average T_d °F	Vacuum setting ** in. Hg	Duration of run θ min	Y	ΔH@
1.2	10	92.418	71.5	74	72	73.25	21	14:51.91	.984	1.51
		102.584	71.5	74	73					
1.2	10	102.584	71.5	74	73	74	21	14:51.20	.988	1.51
		112.724	71.5	75	74					
1.2	11	118.774	71.5	77	74	75.5	21	16:26.22	1.000	1.52
		129.817	71.5	77	74					
								Post-test average***	.991	1.51

Y	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(10)(29.42)(533.25)}{(10.166)(29.51)(531.5)}$	$\frac{(.0317)(1.2)}{(29.42)(533.25)}\left[\frac{(531.5)(14.87)}{(10)}\right]^2$
$\frac{(10)(29.42)(534)}{(10.140)(29.51)(531.5)}$	$\frac{(.0317)(1.2)}{(29.42)(534)}\left[\frac{(531.5)(14.85)}{(10)}\right]^2$
$\frac{(11)(29.42)(535.5)}{(11.043)(29.51)(531.5)}$	$\frac{(.0317)(1.2)}{(29.42)(535.5)}\left[\frac{(531.5)(16.44)}{(11)}\right]^2$

*To be the average ΔH used during the test series.
**To be the highest vacuum used during the test series.
***Post-test Y must be within the range, pre-test Y ±0.05Y
Post-test ΔH@ must be within the range, pre-test ΔH@ ±0.15

Figure E-8 continued. Particulate sampling meter box post -test calibration.

PARTICULATE SAMPLING METER BOX
POST-TEST CALIBRATION

DATE: 9-21-87 METER BOX NO. FB-3

BAROMETRIC PRESSURE (P_{bar}): 29.40 in. Hg PRETEST Y: .981 ΔH@: 1.89

PLANT: J. Zink PROJECT NO. 3724-1

PROJECT MANAGER: C. Bruffey CALIBRATOR: J. Neese

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_{di} °F	Dry gas meter: Outlet T_{di} °F	Dry gas meter: Average T_d °F	Vacuum setting ** in. Hg	Duration of run θ min	γ	ΔH@
1.3	16	143.039	71	85	74	80.75	5	25.44.59	.955	1.89
		160.037	71	87	77					
1.3	10	160.037	71	87	77	82	5	16:09.54	.956	1.90
		170.676	71	87	77					
1.3	10	170.676	71	87	77	82.25	5	16:04.04	.955	1.88
		181.333	71	88	77					
								Post-test average***	.955	1.89

γ	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(16)(29.40)(540.75)}{(16.998)(29.50)(531)}$	$\frac{(.0317)(1.3)}{(29.40)(540.75)}\left[\frac{(531)(25.74)}{(16)}\right]^2$
$\frac{(10)(29.40)(542)}{(10.639)(29.50)(531)}$	$\frac{(.0317)(1.3)}{(29.40)(542)}\left[\frac{(531)(16.16)}{(10)}\right]^2$
$\frac{(10)(29.40)(542.75)}{(10.657)(29.50)(531)}$	$\frac{(.0317)(1.3)}{(29.40)(542.75)}\left[\frac{(531)(16.07)}{(10)}\right]^2$

*To be the average ΔH used during the test series.
**To be the highest vacuum used during the test series.
***Post-test γ must be within the range, pre-test γ ±0.05γ
Post-test ΔH@ must be within the range, pre-test ΔH@ ±0.15

Figure E-9 continued. Particulate sampling meter box post-test calibration.

THERMOCOUPLES

The thermocouples were calibrated by comparison against an ASTM-3F thermometer at approximately 10°F intervals between 50 and 180°F. The thermocouples read within ± 2°F of the reference thermometer throughout the entire range. The thermocouple was checked at ambient temperature at the test site to verify the calibration. Calibration data are presented in Figures E-10 through E-13.

DIGITAL INDICATOR FOR THERMOCUPLE READOUTA

A digital indicator was calibrated by feeding a series of millivolt signals to the input, and comparing the indicator reading with the reading the signal should have generated. Error did not exceed 0.5 percent when the temperatures were expressed in degrees Rankine. Calibration data are shown in Figure E-14.

DRY GAS THERMOCOUPLES

The dry gas thermocouples were calibrated by comparison against an ASTM-3F thermometer at approximately 32°F, at ambient temperature, and at approximately 110°F. The thermocouples agreed within 5°F of the reference thermometer. The thermocouples were checked at ambient tmeprature prior to the test series to verify calibration. Calibration data are included in Figures E-15 and E-16.

TRIP BALANCE

The electronic mettler balance was calibrated by comparing it with Class-S standard weights, and it agreed within 0.5 gram. Calibration data are shown in Figure E-17.

METHOD 4 THERMOCOUPLE CALIBRATION DATA SHEET

Date: 9/4/87 Thermocouple No.: 409

Calibrator: R. [illegible] Reference: ASTM Thermometer

Correction factor: _____

Reference point No.	Recommended temperature, °F	Reference thermometer temperature, °F*	Thermocouple temperature, °F	Difference, °F**
1	50	50	50	0
2	60	60	60	0
3	70	70	70	0
4	80	80	80	0
5	90	90	90	0
6	100	100	100	0
7	110	110	110	0
8	120	120	120	0
9	130	130	130	0
10	140	140	140	0
11	150	150	149	1
12	160	160	161	1
13	170	170	171	1
14	180	180	181	1

*Reference thermometer must be ASTM.

**Difference must be less than or equal to ±2°F over entire range.

Figure E-10. Method 4 thermocouple calibration data sheet.

DRY GAS METER AND ORIFICE METER

Figure E-6 was the setup used for the initial and post-test calibration. A wet-test meter with a 2-cubic-feet-per-minute capacity and ± 1 percent accuracy was used. The pump was run for approximately 15 minutes at an orifice manometer setting of 0.5 in.H_2O to heat up the pump and wet the interior surface of the wet-test meter. The information in Figure E-7 (example calculation sheet) was gathered for the initial calibration and then the ratio of accuracy of the wet-test meter to the dry-test meter and the ΔH@ were calculated.

POST-TEST METER CALIBRATION CHECK

A post-test meter calibration check was made on the meter box used during the test to check its accuracy against its last calibration check. This post-test calibration must be within ± 5 percent of the initial calibration. The initial calibration was performed as described in APTD-0576. The post-test calibration was performed using the same the initial calibration. Three calibration runs were made using the average orifice setting obtained during each test run and with the vacuum set at the maximum value obtained during each test run. After running the post-test calibration check all three runs were within the ± 5 percent range allowed by EPA Method 5.*

The initial and post-test meter box calibration data are resented in Figures E-8 and E-9.

* 40 CFR 60, Appendix A, Reference Method 5, July 1987.

METHOD 4 THERMOCOUPLE CALIBRATION DATA SHEET

Date: 1-14-85 Thermocouple No.: 103

Calibrator: [illegible] Reference: ASTM-3F

Correction factor: _____

Reference point No.	Recommended temperature, °F	Reference thermometer temperature, °F*	Thermocouple temperature, °F	Difference, °F**
1	50	50	49	1
2	60	60	59	1
3	70	70	69	1
4	80	80	79	1
5	90	90	89	1
6	100	100	99	1
7	110	110	109	1
8	120	120	119	1
9	130	130	130	0
10	140	140	139	1
11	150	150	149	1
12	160	160	160	0
13	170	170	170	0
14	180	180	180	0

*Reference thermometer must be ASTM.

**Difference must be less than or equal to ±2°F over entire range.

Figure E-11. Method 4 thermocouple calibration data sheet.

IMPINGER THERMOCOUPLE
CALIBRATION DATA SHEET

Date: 12-31-86 Thermocouple No: I-13

Calibrator: G Thress Reference: ASTM

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	72	72	0
2	2	32	32	0

'Source: 1) Ambient
2) Ice bath

''Difference must be less than 2 deg. F at both points

Figure E-12. Impinger thermocouple calibration data sheet.

IMPINGER THERMOCOUPLE
CALIBRATION DATA SHEET

Date: 1/15/87 Thermocouple No: I-14

Calibrator: C. Clark Reference: ASTM-3F

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	73	73	0
2	2	32	32	0

'Source: 1) Ambient
2) Ice bath

''Difference must be less than 2 deg. F at both points

Figure E-13. Impinger thermocouple calibration data sheet.

THERMOCOUPLE DIGITAL INDICATOR
CALIBRATION DATA SHEET

DATE: 9-2-86 INDICATOR NO: FT-3

OPERATOR: G. Howard SERIAL NO: 8517

CALIBRATION DEVICE NO: 2 MANUFACTURER: OMEGA

TEST POINT NO#	MILLIVOLT SIGNAL	EQUIVALENT TEMPERATURE, deg. F	DIGITAL INDICATOR TEMPERATURE READING, deg. F	DIFFERENCE %
1	-0.692	0	0	0
2	1.520	100	101	.179
3	3.819	200	201	.152
4	6.092	300	301	.132
5	8.314	400	399	.116
6	10.560	500	500	0
7	22.251	1000	1000	0
8	29.315	1300	1299	.057
9	36.156	1600	1597	.146
10	42.732	1900	1897	.127

Percent difference must be less than of equal to 0.5%

Percent difference:

$$\frac{(\text{Equivalent temperature, deg. R} - \text{Digital indicator temperature, deg. R})(100\%)}{(\text{Equivalent temperature, deg. R})}$$

Where, deg. R = deg. F + 460

Figure E-14. Thermocouple digital indicator calibration data sheet.

DRY GAS THERMOCOUPLE
CALIBRATION DATA SHEET

Date: 9-2-86 Thermocouple No: FT-3

Calibrator: G. Howard Reference: ASTM-3F

INLET

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	72	72	0
2	2	32	32	0
3	3	144	145	1

OUTLET

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	71	71	0
2	2	32	32	0
3	3	144	144	0

'Source: 1) Ambient
2) Ice bath
3) Water bath

''Difference must be less than 5 deg. F at both points

Figure E-15. Dry gas thermocouple calibration data sheet.

DRY GAS THERMOCOUPLE
CALIBRATION DATA SHEET

Date: 12-23-86 Thermocouple No: FB-3

Calibrator: J. Neese Reference: ASTM-3F

INLET

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	72	73	1
2	2	32	32	0
3	3	124	124	0

OUTLET

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	72	70	2
2	2	32	32	0
3	3	124	124	0

'Source: 1) Ambient
2) Ice bath
3) Water bath

''Difference must be less than 5 deg. F at both points

Figure E-16. Dry gas thermocouple calibration data sheet.

TRIP BALANCE CALIBRATION DATA SHEET

Balance No.	Date	Calibrator	Mass determined for					
			5 g	Error	50 g	Error	100 g	Error
194	3/20/87	J. Neese	5.3	0.3	50.1	0.1	100.1	0.1
198	3/20/87	J. Neese	5.1	0.1	50.0	0.0	100.0	0.0
418	3/20/87	J. Neese	5.1	0.1	50.2	0.2	100.1	0.1
199	3/20/87	J. Neese	5.0	0.0	50.0	0.0	100.0	0.0
419	3/20/87	J. Neese	5.0	0.0	50.0	0.0	100.0	0.0
Mettler	3/20/87	J. Neese	4.9	0.1	49.9	0.1	99.9	0.1

Error must not exceed 0.5 grams at each point.

Figure E-17. Trip balance calibration data sheet.

BAROMETER

The field barometer was calibrated to within 0.1 in.Hg of an NBS-traceable mercury-in-glass barometer before the test series. It was checked against the reference barometer after each series to determine if it read within 0.2 in.Hg. The barometer read within the allowable limits each time. Calibration data are included in Figure E-18.

VOST DRY GAS METER

The dry gas meter for the VOST sampling train was calibrated against a 500-ml bubble meter at a flow rate of 1 liter/min. After the bubble meter is connected to the gas meter inlet, the meter is operated for 5 minutes to stabilize flow. After warmup, three separate calibrations are made with a total metered volume of 5 liters and at least seven bubble meter flow rate readings. Bubble meter readings are acceptable if the ratio of the shortest time to the longest time is greater than 0.95. The meter calibration factors for all three runs must agree within ± 0.02 Y. The calibration data for the meter used in this test are shown in Figure E-19.

BAROMETER CALIBRATION LOG

BAROMETER NO.	408	409	406	410	409	406	409
PRETEST	HWERL 3724-7	Goodyear 5538	Pressing Sandwich SENCO 5546	Plumwelt	5517	Ohio Rime 3745	Aristech
BAROMETER READING	29.44	29.49	29.41	29.52	29.55	29.56	29.58
REFERENCE BAROMETER READING	29.43	29.48	29.41	29.51	29.56	29.55	29.58
DIFFERENCE*	0.01	0.01	.00	.01	.01	.01	.00
DATE	8-10-87	8-11-87	8-12-87	8-13-87	8-18-87	8-18-87	8/27/87
CALIBRATOR	J Meese	J Meese	R. Kolde	R. Kolde	R. Kolde	R. Kolde	R. Kolde

POST-TEST

				AM	PM		
BAROMETER READING	29.49	29.55	29.56	29.57	29.40	29.52	
REFERENCE BAROMETER READING	29.48	29.56	29.55	29.57	29.41	29.52	
DIFFERENCE**	-.01	0.01	.01	.00	0.01	0.00	
DATE	9/22/87	8-18-87	8-18-87	8/26/87	8/26/87	9/2/87	
CALIBRATOR	CB	R. Kolde	R. Kolde	R. Kolde	D. Schaffer	J. Howard	

*Barometer is adjusted so that difference does not exceed 0.05 in. Hg.
**Barometer is not adjusted. If difference exceed 0.10 in. Hg, inform project manager immediately.

Figure E-18. Barometer calibration log.

DRY GAS METER POST-TEST CALIBRATION
(LOW FLOW <1 LITER/MINUTE)

DATE: 10/20/92 METER CONSOLE NO: VB-4 PRETEST Y: .978

PLANT: ~~[illegible]~~ Zink (CB) 11/12 NOMINAL FLOW RATE: .25 LITERS/MINUTE

PROJECT MANAGER: ~~J. Pechaska~~ (CB) BUBBLE METER NO: 511 ROTO. SETTING: 15

CALIBRATION BY: R. Kolde PROJECT NO: ~~843-71~~ 3724-7 (CB) 11/12

RUN #1

BUBBLE METER CONDITIONS		DRY GAS METER CONDITIONS	
volume (Vbm):	.1 liters	volume initial(Vmi):	70.000 liters
temp. (Tbm):	74 deg. F	volume final(Vmf):	75.000 liters
bubble meter times (seconds) (time,bm)		temp. initial(Tdgmi):	100 deg. F
1: 26.45 sec.	5: 26.49 sec.	temp. final(Tdgmf):	104 deg. F
2: 27.00 sec.	6: 26.95 sec.	temp. avg.(Tdgm):	102 deg. F
3: 27.05 sec.	7: 27.15 sec.	time,dgm	21.31.81 min.
4: 27.37 sec.	Avg: 27.04 sec.	calculated y=	1.005

RUN #2

BUBBLE METER CONDITIONS		DRY GAS METER CONDITIONS	
volume (Vbm):	.1 liters	volume initial(Vmi):	75.500 liters
temp. (Tbm):	74 deg. F	volume final(Vmf):	80.500 liters
bubble meter times (seconds) (time,bm)		temp. initial(Tdgmi):	104 deg. F
1: 26.96 sec.	5: 27.30 sec.	temp. final(Tdgmf):	106 deg. F
2: 27.00 sec.	6: 26.92 sec.	temp. avg.(Tdgm):	105 deg. F
3: 27.16 sec.	7: 27.00 sec.	time,dgm	21.53.60 min.
4: 27.26 sec.	Avg: 27.09 sec.	calculated y=	1.026

RUN #3

BUBBLE METER CONDITIONS		DRY GAS METER CONDITIONS	
volume (Vbm):	.1 liters	volume initial(Vmi):	81.000 liters
temp. (Tbm):	74 deg. F	volume final(Vmf):	86.000 liters
bubble meter times (seconds) (time,bm)		temp. initial(Tdgmi):	106 deg. F
1: 27.00 sec.	5: 27.[illegible] sec.	temp. final(Tdgmf):	106 deg. F
2: 27.12 sec.	6: 27.31 sec.	temp. avg.(Tdgm):	106 deg. F
3: 27.40 sec.	7: 27.14 sec.	time,dgm	21.25.65 min.
4: 27.17 sec.	Avg: 27.19 sec.	calculated y=	1.002

$$Qbm = \frac{(Vbm)(60)}{(avg.\ time,bm)} \qquad Qdgm = \frac{(Vmf-Vmi)(Tbm+460)}{(avg.\ Tdgm+460)(time,dgm)}$$

$$Y = \frac{Qbm}{Qdgm}$$

AVERAGE POST-TEST Y= 1.011

Figure E-19. Dry gas meter post-test calibration (low flow approximately 1 liter minute)