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Planning and Standards
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Final Report

Manual Testing and Continuous Emissions Monitoring Lime Kiln No. 4 Baghouse Inlet and Stack Dravo Lime Company Saginaw, Alabama

Office of Air Quality
Clean Air
OAQPS
Planning and Standards

FINAL REPORT

MANUAL TESTING AND CONTINUOUS EMISSIONS MONITORING LIME KILN NO. 4 BAGHOUSE INLET AND STACK

DRAVO LIME COMPANY
SAGINAW, ALABAMA

EPA Contract No. 68-D-98-004
Work Assignment No. 3-03

Prepared for:

Mr. Michael L. Toney (MD-19)
Work Assignment Manager
SCGA, EMC, OAQPS
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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Submitted by

PACIFIC ENVIRONMENTAL SERVICES, INC.
5001 S. Miami Blvd., Suite 300
Post Office Box 12077
Research Triangle Park, NC 27709-2077
(919) 941-0333
FAX (919) 941-0234

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77 West Jackson Boulevard, 12th Floor
Chicago, IL 60604-3590

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Emission Standards Division (ESD) is investigating the lime manufacturing industry to identify and quantify hazardous air pollutants (HAPs) emitted from lime kilns. ESD requested that EPA's Emissions, Monitoring and Analysis Division (EMAD) conduct the required testing. EMAD issued a work assignment to Pacific Environmental Services, Inc. (PES) to conduct "screening" tests to collect emissions data as specified in the ESD test request. The planning and initial preparation activities of the program were conducted through EPA Contract No. 68-D7-0002, Work Assignment No. 0/005. Remaining preparation, testing, and generation of the Draft Final Report were completed under EPA Contract No. 68-D7-0002, Work Assignment No. 1/007. Generation of the Final Report, incorporating EPA's comments on the Draft Final Report, was completed under EPA Contract No. 68-D-98-004, Work Assignment No. 3-03.

The primary objective was to characterize HAP emissions from Lime Kiln No. 4 at Dravo Lime Company's facility located in Saginaw, Alabama. The "screening"tests were conducted to quantify the uncontrolled and controlled air emissions of hydrogen chloride (HCl), total hydrocarbons (THC), and polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs). The basic test methods employed were US EPA Test Methods 1 (sample point location), 2 (velocity and volumetric flow), 3A (oxygen and carbon dioxide concentration), 4 (moisture content), 23 (PCDDs/PCDFs), 25A (total hydrocarbon concentration), and 26A (hydrogen chloride). Simultaneous testing was performed at the inlet to the baghouse and at the stack. Additional analyses of the HCl train reagents were conducted to quantify the content of ammonia (NH_4) and aluminum, calcium, magnesium, potassium, and sodium cations. Cybelle M. Brockman of Research Triangle Institute (RTI), Durham, North Carolina recorded plant operational data during testing. This work was conducted under a separate work assignment issued to RTI by EPA ESD.

PES used four subcontractors for this effort: Air Pollution Characterization and Control Inc. (APCC), of Toland, Connecticut; Triangle Laboratories, Inc. (TLI), of Durham, North Carolina; Research Triangle Institute, and Atlantic Technical Services, Inc. (ATS), of Chapel Hill, North Carolina. APCC was tasked with the quantification of HCl, oxygen, carbon dioxide, and THC concentrations at the baghouse inlet and stack using Continuous Emission Monitors (CEMs). During testing at the facility previous to Dravo (four lime kilns were tested during the same mobilization), the CEM system was contaminated with a process liquor which rendered the HCl analyzer inoperable. Extensive onsite repairs were made to the CEM sampling system and to the HCl analyzer. At the direction of the WAM, PES used EPA Method 26A for HCl quantification instead of the Draft Method 322 so the HCl data could be collected. TLI provided analytical services for the analysis of the PCDDs/PCDFs. RTI provided analytical services for the analysis of the HCl, NH_4, and additional cations, and ATS provided technical support for

preparation of the Quality Assurance Project Plan (QAPP), Site Specific Test Plan (SSTP), for reduction of the test data, and for preparation of the Draft Final Report.

The field testing program organization and major lines of communication are presented in Figure 1.1. The PES Project Manager (PM) communicated directly with the EPA Work Assignment Manager and coordinated all of the on-site testing activities.

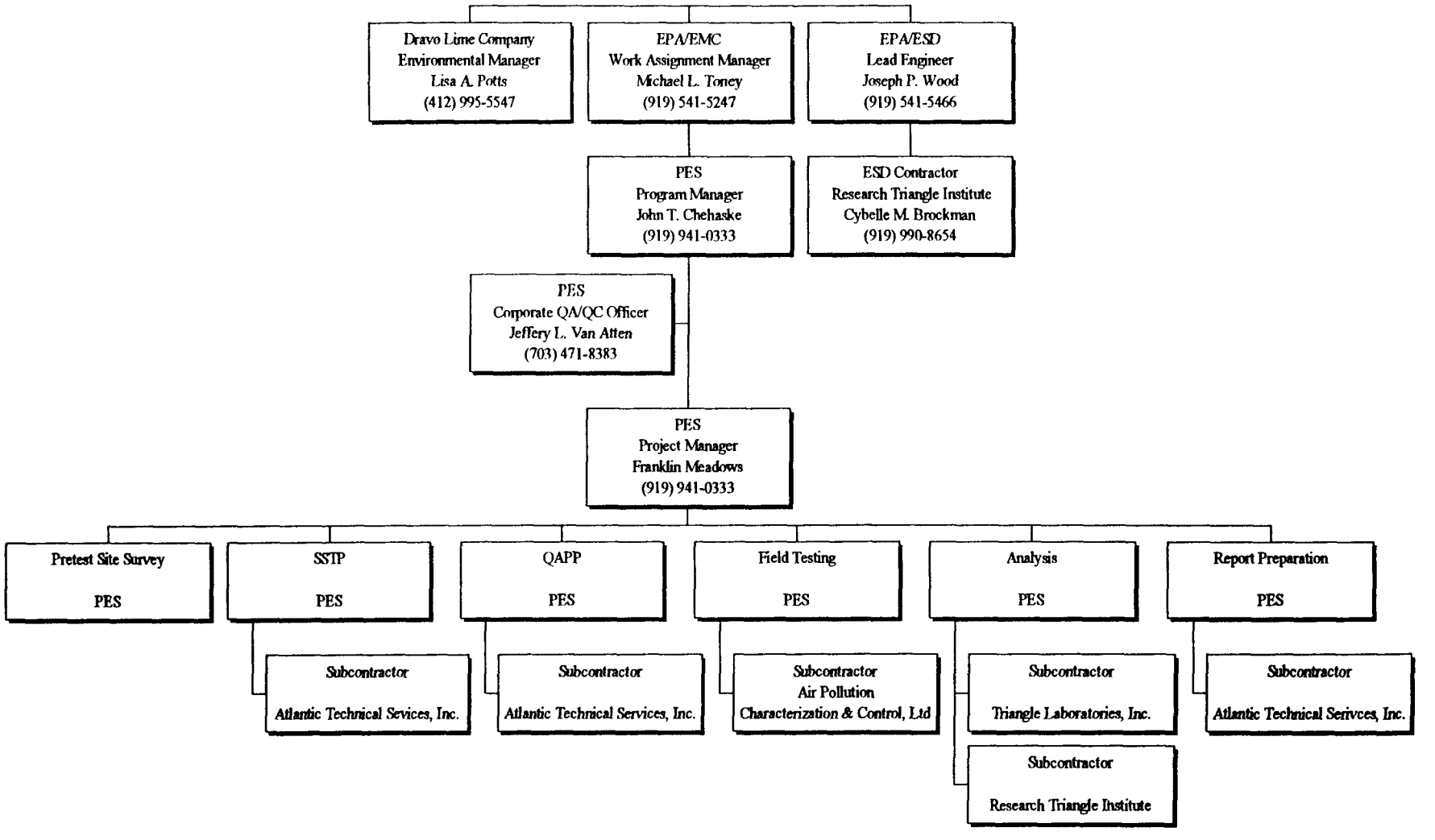


Figure 1.1 Key Personnel and Responsibility for Field Testing at Dravo Lime Company - Saginaw, Alabama

2.0 SUMMARY OF RESULTS

This section provides summaries of the testing conducted at the Dravo Lime Company in Saginaw, Alabama. The following text and tables summarize the dates and times of the sampling runs, the parameters of the baghouse inlet and stack gas streams, and the concentrations and mass emission rates of the target pollutants.

2.1 EMISSIONS TEST LOG

All testing at Dravo Lime Company's Kiln No. 4 was conducted on March 28, 1998. Table 2.1 presents the emissions test log. The test log summarizes the run number designations, target pollutants, run times, and down time durations. One Method 23 sampling run was conducted simultaneously at the baghouse inlet and the stack locations. After the Method 23 runs were completed, three pair of Method 26A sampling runs were completed. Each pair of Method 26A runs consisted of one run and the inlet location and one run at the outlet.

The inlet sample line was contaminated at the facility tested previously to Dravo, therefore no CEM data was collected at the baghouse inlet location. CEM data consisting of O_2, CO_2, and THC concentrations were collected at the outlet location during the Method 23 sampling runs. Repairs to the HCl analyzer were completed during the afternoon of March 28. The analyzer was calibrated, and system QA/QC checks were conducted. Instrumental HCl data was collected starting shortly before the end of the second Method 26A sampling run. HCl data was collected for slightly less than two hours at the stack location. No instrumental HCl data was collected at the baghouse inlet location.

2.2 PCDDs/PCDFs TEST RESULTS

PES employed EPA Method 23 for the measurement of PCDDs and PCDFs. The results of the PCDD/PCDF testing are presented in Tables 2.2 through 2.4. PCDDs/PCDFs results are presented as 1) actual concentrations and mass emission rates, 2) concentrations adjusted to 7 percent (%) O_2, and 3) concentrations adjusted to 7 % O_2 and 2378 tetra-chlorinated dibenzo-*p*-dioxin (TCDD) toxic equivalent basis. Due to the process upset described previously, no CEM data was available for the quantification of O_2 and CO_2 content at the baghouse inlet. Therefore, O_2 and CO_2 concentrations of 10.6 and 19.2 % were assumed based upon the outlet values. These concentrations should be representative of the concentrations of the diluents at the inlet location. Adjustment of the congeners to a 2378 toxic equivalent basis was conducted using the Toxic Equivalency Factor (TEF) values developed by the NATO Committee on the Challenges of Modern Society, August 1988.

TABLE 2.1

EMISSIONS TEST LOG
DRAVO LIME COMPANY - SAGINAW, ALABAMA
MARCH 28, 1998

Run No.	Pollutant	Run Time	Downtime, Minutes
Kiln No. 4 Baghouse Inlet			
I-M23-4	PCDDs/PCDFs	1042-1355	13
I-M26A-4	HCl	1430-1530	0
I-M26A-5*	HCl, NH_4, and Cations	1635-1735	0
I-M26A-6	HCl	1801-1901	0
Kiln No. 4 Baghouse Outlet			
O-M23-4	PCDDs/PCDFs	1044-1346	2
O-M3A-4	O_2, CO_2	1040-1340	0
O-M25A-4	THC	1040-1340	0
O-M26A-4	HCl	1432-1532	0
O-M26A-5*	HCl, NH_4, and Cations	1638-1738	0
O-M26A-6	HCl	1802-1902	0
O-M322-4	HCl (GFC/IR)	1725-1910	15

* At the request of the WAM, the impinger solutions of the second inlet and outlet runs were analyzed to determine the catches of ammonia and cations (aluminum, calcium, maganesium, potassium, and sodium)

The Method 23 sample fractions consisted of a sample train front-half solvent rinse, a particulate filter, a back-half solvent rinse, and an XAD®-2 sorbent resin module. During analysis, each of the sample fractions was extracted, concentrated, combined, and analyzed using a Gas Chromatograph with a Mass Spectrometer detector (GC/MS), according to the procedures outlined in Method 23. During analysis, the combined sample extract was separated with a DB-5 capillary column. Where the results of that analysis indicated the presence of 2378-TCDF congeners, the analysis was confirmed using a DB-225 capillary column.

The results of the analyses indicated the presence of several congeners that were qualified as Estimated Maximum Possible Concentrations, or EMPCs. From time to time during the Method 23 analyses, a peak elutes at the position expected for a particular congener, but the peak fails validation based on the theoretical split of chlorine isotopes. That is to say that the number of Cl^{35} isotopes and the number of Cl^{37} isotopes attached to the PCDDs/PCDFs congeners should agree with the Cl^{35}/Cl^{37} ratio found in nature. For each congener, this ratio must agree within 15%. If the mass ratio of chlorine isotopes does not agree with the natural chlorine isotope ratio, then the peak is flagged as an EMPC.

The values presented as "Total PCDDs" are the sum of the "12346789 OCDD" polychlorinated dibenzo-p-dioxin and all of the dioxins labeled "Total"; "Total PCDFs" values are the sum of the "12346789 OCDF" polychlorinated dibenzofuran and all of the furans labeled "Total". "Total PCDDs + Total PCDFs" values are the sum of the "Total PCDDs" and "Total PCDFs" values. Values that have been qualified as being EMPC have been included in the sums. Concentrations and emission rates based on or including EMPC values are denoted by braces ({ }).

2.3 HYDROGEN CHLORIDE, AMMONIA, AND CATIONS TEST RESULTS

The results of the Method 26A are presented in Tables 2.5 and 2.6 for the Kiln No. 4 baghouse inlet. Table 2.5 summarizes the baghouse inlet flue gas parameters, and Table 2.6 summarizes the concentrations and emission rates of the target pollutants. The impinger catches from the second Method 26A sampling run (I-M26A-5) were analyzed to determine the catch weights of ammonia (as NH_4), aluminum, calcium, maganesium, potassium, and sodium in addition to chlorides. Table 2.6 presents two mass emission rates for chlorides, as HCl and as Cl. The target parameter during analysis is the concentration of chlorine ions in the impinger catches; therefore, the calculated in-stack concentration of HCl and Cl is the same. The mass emission rate of HCl is slightly greater because the formula weight of HCl is slightly more than that of Cl (36.47 lb/lb-mol vs. 34.45 lb/lb-mol). Stack gas parameters and mass emission rates for the Method 26A sampling runs conducted at the outlet are presented in Tables 2.7 and 2.8.

2.4 CONTINUOUS EMISSION MONITORS

As stated previously, limited CEMs data for HCl and THC were collected at the baghouse outlet only. THC, O_2, and CO_2 concentrations were monitored during the Method 23 sampling

run, while the instrumental HCl monitoring was performed during the third Method 26A (run O-M26A-6). The THC and HCl results are presented in Table 2.9. The concurrent Method 26A (run O-M26A-6) air stream moisture and flow rate data were used to calculate the HCl emission rate, while the concurrent Method 23 outlet (run O-M23-4) air stream moisture and flow rate were used to calculate the emission rate of THC.

Proposed Method 322 calls for the analysis of a matrix spike for HCl so that the integrity of the sampling and analysis system for HCl can be ascertained. After calibration of the HCl sampling system with the appropriate standards, the flue gas is sampled to determine the baseline concentration of the HCl. After the baseline concentration is established, a known quantity of HCl is injected into the sampling system, and the analyzer should report the concentration of the HCl in the effluent stream plus the contribution of the HCl from the matrix spike injection. The allowable tolerance for the matrix spike is ± 30% from the predicted value. During the matrix spike procedures conducted on the sampling system at Dravo Lime Company, the spikes were never measured by the analyzer, which is to say that the baseline HCl concentrations recorded by the analyzer did not change when the HCl spike gas was introduced into the system.

The probable cause for the failure of the matrix spike procedure was the presence of finely divided lime dust which was collected on the heated filter in the CEM stack interface module. The caustic lime dust had the effect of neutralizing the acidic HCl that was added to the sampling system during the matrix spike injection. During normal sampling of the stack gas, HCl was detected because the HCl and lime dust were in a state of equilibrium in the effluent gas. However, the addition of HCl into the matrix may have forced a response in the equilibrium condition which resulted in the absorption of additional HCl by the lime dust. Based on this theory, the results of the HCl testing are most likely representative of the HCl concentrations in the effluent gas streams, or should any bias exist, are most likely biased low.

TABLE 2.2

PCDDs/PCDFs SAMPLING AND STACK GAS PARAMETERS
KILN NO. 4 BAGHOUSE INLET AND OUTLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	I-M23-4	O-M23-4
Date	03/28/98	03/28/98
Total Sampling Time, minutes	180	180
Average Sampling Rate, dscfm [a]	0.710	0.745
Sample Volume:		
dscf [b]	127.805	134.157
dscm [c]	3.619	3.799
Average Exhaust Gas Temperature, °F	472	348
O_2 Concentration, % by Volume [d]	10	10.6
CO_2 Concentration, % by Volume [d]	20	19.2
Moisture, % by Volume [e]	4.5	4.5
Exhaust Gas Volumetric Flow Rate:		
acfm [f]	162,000	131,000
dscfm [a]	80,100	80,300
dscmm [g]	2,270	2,270
Isokinetic Sampling Ratio, %	100.1	103.0

[a] Dry standard cubic feet per minute at 68° F (20° C) and 1 atm.

[b] Dry standard cubic feet at 68° F (20° C) and 1 atm.

[c] Dry standard cubic meters at 68° F (20° C) and 1 atm.

[d] In-stack oxygen and carbon dioxide concentrarions assumed to due to CEM malfunction.

[e] Estimated.

[f] Actual cubic feet per minute at exhaust gas conditions.

[g] Dry standard cubic meters per minute at 68° F (20° C) and 1 atm.

TABLE 2.3

PCDDs/PCDFs CONCENTRATIONS AND EMISSION RATES
KILN NO. 4 BAGHOUSE INLET AND OUTLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

CONGENER	CONCENTRATION [a] (ng/dscm, as measured)		EMISSION RATE [b] (µg/hr)	
	I-M23-4	O-M23-4	I-M23-4	O-M23-4
DIOXINS:				
2378 TCDD	(0.000829)	(0.00105)	(0.113)	(0.144)
Total TCDD	0.00553	(0.00105)	0.752	(0.144)
12378 PeCDD	(0.00111)	(0.00158)	(0.150)	(0.215)
Total PeCDD	{0.000829}	(0.00158)	{0.113}	(0.215)
123478 HxCDD	(0.00166)	(0.00211)	(0.226)	(0.287)
123678 HxCDD	(0.00138)	(0.00184)	(0.188)	(0.251)
123789 HxCDD	(0.00138)	(0.00184)	(0.188)	(0.251)
Total HxCDD	0.00276	{0.00237}	0.376	{0.323}
1234678 HpCDD	0.00221	{0.00263}	0.301	{0.359}
Total HpCDD	0.00553	{0.00263}	0.752	{0.359}
12346789 OCDD	0.0111	0.0132	1.50	1.80
Total PCDDs	**{0.0257}**	**(0.0208)**	**{3.50}**	**(2.84)**
FURANS:				
2378 TCDF	0.0387	(0.00132)	5.27	(0.180)
Total TCDF	0.718	0.0447	97.8	6.10
12378 PeCDF	0.0111	(0.00105)	1.50	(0.144)
23478 PeCDF	0.0111	(0.00105)	1.50	(0.144)
Total PeCDF	0.105	0.00263	14.3	0.359
123478 HxCDF	0.00276	(0.00132)	0.376	(0.180)
123678 HxCDF	0.00221	(0.00132)	0.301	(0.180)
234678 HxCDF	0.00221	(0.00158)	0.301	(0.215)
123789 HxCDF	(0.00111)	(0.00158)	(0.150)	(0.215)
Total HxCDF	0.0138	0.00211	1.88	0.287
1234678 HpCDF	0.00193	(0.00184)	0.263	(0.251)
1234789 HpCDF	(0.00193)	(0.00263)	(0.263)	(0.359)
Total HpCDF	0.00193	(0.00211)	0.263	(0.287)
12346789 OCDF	(0.00553)	(0.00263)	(0.752)	(0.359)
Total PCDFs	**(0.845)**	**(0.0542)**	**(115)**	**(7.40)**
Total PCDDs + PCDFs	**(0.870)**	**(0.0750)**	**(118)**	**(10.2)**

[a] Nanogram per dry standard cubic meter at 20°C and 1 atm.

[b] Micrograms per hour.

( ) Not Detected. Value shown is the detection limit and is included in totals.

{} Estimated Maximum Possible Concentration. EMPC values are included in totals.

TABLE 2.4

PCDDs/PCDFs CONCENTRATIONS AND 2378-TCDD TOXIC EQUIVALENT CONCENTRATIONS ADJUSTED TO 7 PERCENT OXYGEN
KILN NO. 4 BAGHOUSE INLET AND OUTLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

CONGENER	CONCENTRATION [a] (ng/dscm, adjusted to 7 percent O_2)		2378-TCDD Toxicity Equivalence Factor	2378 TOXIC EQUIVALENCIES (ng/dscm, adjusted to 7 percent O_2)	
	I-M23-4	O-M23-4		I-M23-4	O-M23-4
DIOXINS:					
2378 TCDD	(0.00106)	(0.00142)	1.000	(0.00106)	(0.00142)
Total TCDD	0.00705	(0.00142)			
12378 PeCDD	(0.00141)	(0.00213)	0.500	(0.000705)	(0.00107)
Total PeCDD	{0.00106}	(0.00213)			
123478 HxCDD	(0.00211)	(0.00284)	0.100	(0.000211)	(0.000284)
123678 HxCDD	(0.00176)	(0.00249)	0.100	(0.000176)	(0.000249)
123789 HxCDD	(0.00176)	(0.00249)	0.100	(0.000176)	(0.000249)
Total HxCDD	0.00352	(0.00320)			
1234678 HpCDD	0.00282	(0.00355)	0.010	0.0000282	(0.0000355)
Total HpCDD	0.00705	(0.00355)			
12346789 OCDD	0.0141	(0.0178)	0.001	0.0000141	(0.0000178)
Total PCDDs	**{0.0328}**	**(0.0281)**	**Total PCDDs TEQ**	**(0.00237)**	**(0.00332)**
FURANS:					
2378 TCDF	0.0493	(0.00178)	0.100	0.00493	(0.000178)
Total TCDF	0.916	0.0604			
12378 PeCDF	0.0141	(0.00142)	0.050	0.000705	(0.0000710)
23478 PeCDF	0.0141	(0.00142)	0.500	0.00705	(0.000710)
Total PeCDF	0.134	0.00355			
123478 HxCDF	0.00352	(0.00178)	0.100	0.000352	(0.000178)
123678 HxCDF	0.00282	(0.00178)	0.100	0.000282	(0.000178)
234678 HxCDF	0.00282	(0.00213)	0.100	0.000282	(0.000213)
123789 HxCDF	(0.00141)	(0.00213)	0.100	(0.000141)	(0.000213)
Total HxCDF	0.0176	0.00284			
1234678 HpCDF	0.00247	(0.00249)	0.010	0.0000247	(0.0000249)
1234789 HpCDF	(0.00247)	(0.00355)	0.010	(0.0000247)	(0.0000355)
Total HpCDF	0.00247	(0.00284)			
12346789 OCDF	(0.00705)	(0.00355)	0.001	(0.00000705)	(0.00000355)
Total PCDFs	**(1.08)**	**(0.0732)**	**Total PCDFs TEQ**	**(0.0138)**	**(0.00180)**
Total PCDDs + PCDFs	**(1.11)**	**(0.101)**	**Total TEQ**	**(0.0162)**	**(0.00513)**

[a] Nanogram per dry standard cubic meter at 20°C and 1 atm and corrected to 7 percent oxygen.

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

TABLE 2.5

HCL AND AMMONIA SAMPLING AND STACK GAS PARAMETERS
KILN NO. 4 BAGHOUSE INLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	I-M26A-4	I-M26A-5	I-M26A-6	Average
Date	03/28/98	03/28/98	03/28/98	
Total Sampling Time, minutes	60	60	60	
Average Sampling Rate, dscfm [a]	0.537	0.531	0.536	0.534
Sample Volume:				
dscf [b]	32.197	31.844	32.149	32.063
dscm [c]	0.912	0.902	0.910	0.908
Average Exhaust Gas Temperature, °F	488	497	516	501
O_2 Concentration, % by Volume	10 *	10 *	10 *	-
CO_2 Concentration, % by Volume	20 *	20 *	20 *	-
Moisture, % by Volume	4.7	4.5	4.8	4.7
Exhaust Gas Volumetric Flow Rate:				
acfm [d]	147,400	159,700	165,400	157,500
dscfm [a]	71,300	76,700	77,700	75,200
dscmm [e]	2,019	2,170	2,200	2,130
Isokinetic Sampling Ratio, %	103.9	103.7	103.4	103.6

[a] Dry standard cubic feet per minute at 68° F (20° C) and 1 atm.
[b] Dry standard cubic feet at 68° F (20° C) and 1 atm.
[c] Dry standard cubic meters at 68° F (20° C) and 1 atm.
[d] Actual cubic feet per minute at exhaust gas conditions.
[e] Dry standard cubic meters per minute at 68° F (20° C) and 1 atm.
* Estimated oxygen and carbon dioxide values, based upon values observed at outlet location.

TABLE 2.6

HCL, AMMONIA, AND CATIONS CONCENTRATIONS AND EMISSION RATES KILN NO. 4 BAGHOUSE INLET DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	I-M26A-4	I-M26A-5	I-M26A-6	Average
Date	03/28/98	03/28/98	03/28/98	
Clock Time, 24-hr clock	1430-1530	1635-1735	1801-1901	
Chlorides as HCl				
ppmvd [a]	1.72	3.02	2.58	2.44
lb/hr [b]	0.696	1.32	1.14	1.05
Chlorides as Cl				
ppmvd [a]	1.72	3.02	2.58	2.44
lb/hr [b]	0.677	1.28	1.11	1.02
Ammonia				
ppmvd [a]	5.54	8.19	7.31	7.01
lb/hr [b]	1.11	1.77	1.60	1.49
Aluminum, Al				
ppmvd [a]	#N/A	(0.0119)	#N/A	(0.0119)
lb/hr [b]	#N/A	(0.00382)	#N/A	(0.00382)
Calcium, Ca				
ppmvd [a]	#N/A	0.0965	#N/A	0.0965
lb/hr [b]	#N/A	0.0462	#N/A	0.0462
Magnesium, Mg				
ppmvd [a]	#N/A	0.0204	#N/A	0.0204
lb/hr [b]	#N/A	0.00593	#N/A	0.00593
Potassium, K				
ppmvd [a]	#N/A	0.00649	#N/A	0.00649
lb/hr [b]	#N/A	0.00303	#N/A	0.00303
Sodium, Na				
ppmvd [a]	#N/A	0.0556	#N/A	0.0556
lb/hr [b]	#N/A	0.0153	#N/A	0.0153

[a] Parts Per Million by Volume Dry.

[b] Pounds per hour.

( ) Not Detected. Detection limit values enclosed in parentheses ( ).

#N/A The impinger catches from the first and the third runs were not analyzed for cation content.

TABLE 2.7

HCL AND AMMONIA SAMPLING AND STACK GAS PARAMETERS
KILN NO. 4 BAGHOUSE OUTLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	O-M26A-4	O-M26A-5	O-M26A-6	Average
Date	03/28/98	03/28/98	03/28/98	
Total Sampling Time, minutes	60	60	60	
Average Sampling Rate, dscfm [a]	0.735	0.730	0.743	0.736
Sample Volume:				
dscf [b]	44.116	43.822	44.602	44.180
dscm [c]	1.249	1.241	1.263	1.251
Average Exhaust Gas Temperature, °F	352	349	358	353
O_2 Concentration, % by Volume	10.6	10.6	10.6	10.6
CO_2 Concentration, % by Volume	19.2	19.2	19.2	19.2
Moisture, % by Volume	4.8	4.5	5.1	4.8
Exhaust Gas Volumetric Flow Rate:				
acfm [d]	131,000	130,000	132,000	131,000
dscfm [a]	80,100	79,700	79,900	79,900
dscmm [e]	2,270	2,260	2,260	2,260
Isokinetic Sampling Ratio, %	101.8	101.6	103.2	102.2

[a] Dry standard cubic feet per minute at 68° F (20° C) and 1 atm.

[b] Dry standard cubic feet at 68° F (20° C) and 1 atm.

[c] Dry standard cubic meters at 68° F (20° C) and 1 atm.

[d] Actual cubic feet per minute at exhaust gas conditions.

[e] Dry standard cubic meters per minute at 68° F (20° C) and 1 atm.

TABLE 2.8

HCL, AMMONIA, AND CATIONS CONCENTRATIONS AND EMISSION RATES KILN NO. 4 BAGHOUSE OUTLET DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	O-M26A-4	O-M26A-5	O-M26A-6	Average
Date	03/28/98	03/28/98	03/28/98	
Clock Time, 24-hr clock	1432-1532	1638-1738	1802-1902	
Chlorides as HCl				
ppmvd [a]	1.39	1.65	2.07	1.70
lb/hr [b]	0.633	0.745	0.938	0.772
Chlorides as Cl				
ppmvd [a]	1.39	1.65	2.07	1.70
lb/hr [b]	0.615	0.724	0.912	0.750
Ammonia				
ppmvd [a]	7.86	7.87	9.43	8.38
lb/hr [b]	1.77	1.76	2.12	1.88
Aluminum, Al				
ppmvd [a]	#N/A	0.0116	#N/A	0.0116
lb/hr [b]	#N/A	0.00388	#N/A	0.00388
Calcium, Ca				
ppmvd [a]	#N/A	0.141	#N/A	0.141
lb/hr [b]	#N/A	0.0700	#N/A	0.0700
Magnesium, Mg				
ppmvd [a]	#N/A	0.0264	#N/A	0.0264
lb/hr [b]	#N/A	0.007967	#N/A	0.007967
Potassium, K				
ppmvd [a]	#N/A	(0.00238)	#N/A	(0.00238)
lb/hr [b]	#N/A	(0.00116)	#N/A	(0.00116)
Sodium, Na				
ppmvd [a]	#N/A	0.0250	#N/A	0.0250
lb/hr [b]	#N/A	0.00712	#N/A	0.00712

[a] Parts Per Million by Volume Dry.

[b] Pounds per hour.

( ) Not Detected. Detection Limit values enclosed in parentheses ().

#N/A The impinger catches from the first and the third runs were not analyzed for cation content.

TABLE 2.9

HCL AND THC CONCENTRATIONS AND EMISSION RATES
KILN NO. 4 BAGHOUSE OUTLET
DRAVO LIME COMPANY - SAGINAW, ALABAMA

Run No.	M25A-O-4	M322-O-4
Date	03/28/98	03/28/98
Clock Time, 24-hr clock	1040-1340	1725-1910
Total Sampling Time, minutes	180	90
O_2 Concentration, % by Volume	10.6	10.6 [a]
CO_2 Concentration, % by Volume	19.2	19.2 [a]
Moisture, % by Volume	4.5 [b]	5.1 [c]
Volumetric Flow Rate, dscfm [d]	80,300	79,900
Hydrogen Chloride:		
Formula Weight, lb/lb-mole	36.47	36.47
Concentration, ppmvw [e]	- [i]	7.1
Concentration, ppmvd [f]	- [i]	7.5
Concentration, ppmvd @ 7% O_2 [g]	- [i]	10.1
Emission Rate, lb/hr [h]	- [i]	3.4
Total Hydrocarbons (as methane):		
Formula Weight, lb/lb-mole	16.04	16.04
Concentration, ppmvw [e]	6.3	- [i]
Concentration, ppmvd [f]	6.6	- [i]
Concentration, ppmvd @ 7% O_2 [g]	8.9	- [i]
Emission Rate, lb/hr [h]	1.3	- [i]
Total Hydrocarbons (as propane):		
Formula Weight, lb/lb-mole	44.08	44.08
Concentration, ppmvw [e]	2.1	- [i]
Concentration, ppmvd [f]	2.2	- [i]
Concentration, ppmvd @ 7% O_2 [g]	3.0	- [i]
Emission Rate, lb/hr [h]	1.2	- [i]

[a] Diluent concentrations estimated based upon data collected during sampling run M25A-O-4
[b] Moisture concentration based upon data collected during sampling run M23-O-4
[c] Moisture concentration based upon data collected during sampling run M26A-O-6
[d] Dry standard cubic feet per minute at 68° F (20° C) and 1 atm.
[e] Parts per million by volume wet.
[f] Parts per million by volume dry.
[g] Parts per million by volume dry corrected to 7% O_2
[h] Pounds per hour.
[i] No data was acquired during the test period.

3.0 PROCESS DESCRIPTION

Kiln No. 4 at Dravo Lime Company is an inclined rotating kiln. Limestone is charged at the back end of the kiln through a preheater and tumbles toward the front end of the kiln via gravity and the rotating motion of the kiln. Combustion air and fuel, which consists of pulverized coal and coke, enter at the front end of the kiln. Combustion products are removed from the kiln by an induced draft (ID) fan and pulled through the preheater and a series of multiclones and are discharged to the atmosphere through a reverse-air baghouse and the stack. Ambient air is introduced at the inlet to the preheater when the exhaust gas temperature at this location exceeds a certain temperature.

Process data were recorded by the ESD contractor during testing. The data were recorded from computer screens in the kiln control room; the recorded data were measured with instruments already in place and used by the plant for process control of the kilns. A summary of process operations during the testing is presented in Table 4.1. Individual recordings of process parameters may be found in the appendix.

Except for opacity, the recorded process parameters varied only slightly during testing - as indicated by the low values of percent relative standard deviation (% RSD) in Table 1. The % RSD for opacity was high because of the 40 percent opacity recording at 2:43 pm; as seen in Table 2, this opacity recording was extremely high compared to previous recordings, and those that followed. The start-up of Method 26 testing (which occurred around this time) may have interfered with the opacity monitor. No other process anomalies occurred during testing.

The plant does not measure the pressure drop across the baghouse (one of the process parameters listed in the test plan for recording). The plant does measure the static pressure downstream of the fan (just prior to the baghouse); the static pressure at this location was recorded during testing and had an average value of 8.3 inches of water. The testing crew took five measurements of the static pressure at the outlet test location (just downstream of the baghouse); the measurements were taken during Method 23 and 26 testing (one measurement per run) and during the velocity traverse. The five measurements ranged from -0.47 to -0.53 inches of water; the average was -0.50 inches of water. The pressure drop from downstream of the fan to the outlet test location was 7.8 inches of water. A typical value of the pressure drop across the baghouse was not reported in the plant's questionnaire or mentioned during the pre-test site survey.

During testing, Kiln No. 4 produced a high calcium lime from limestone which was quarried on-site. The plant does not measure limestone feed rate or lime production rate. Plant

personnel were asked whether or not they knew the production during testing, and they replied no. Consequently, the production level during testing is not known.

Little information is available to determine if values of the other recorded parameters were typical of normal operation. The only relevant parameters reported in the plant's questionnaire were the exhaust temperature at the exit of the kiln (2000 degrees Fahrenheit [°F]), the inlet temperature to the baghouse (435 °F), the ratio of coal and coke to lime (0.20 tons of coal and coke per ton of lime), and the design capacity of the kiln (900 tons of lime per day). The reported temperatures are consistent with those recorded during testing. The average coal and coke feed rate during testing was 6.20 tons per hour, which was below the range of coal feed rates cited during the pre-test site survey (6.4 to 6.6 tons of coal per hour). Based on the average coal and coke feed rate during testing, and the reported coal and coke to lime ratio, the plant produced approximately 31 tons of lime per hour during testing. This translates into approximately 744 tons of lime per day (assuming the kiln operates 24 hours per day), which is less than the design capacity of 900 tpd reported in the plant's questionnaire.

TABLE 3.1

SUMMARY OF OPERATING PARAMETERS

Parameter	Mean	% RSD	Minimum	Maximum
Fuel Feed Rate, tph	6.20	2.19	5.96	6.54
Kiln Speed, rpm	1.37	0.714	1.36	1.38
Preheater Inlet Temperature, °F	2002	0.4371	1985	2025
Baghouse Inlet Temperature, °F	466	1.09	460	482
Baghouse Static Pressure, in. H_2O	8.3	7.0	7.1	9.3
Stack Gas Opacity	5.4	16	4.3	8

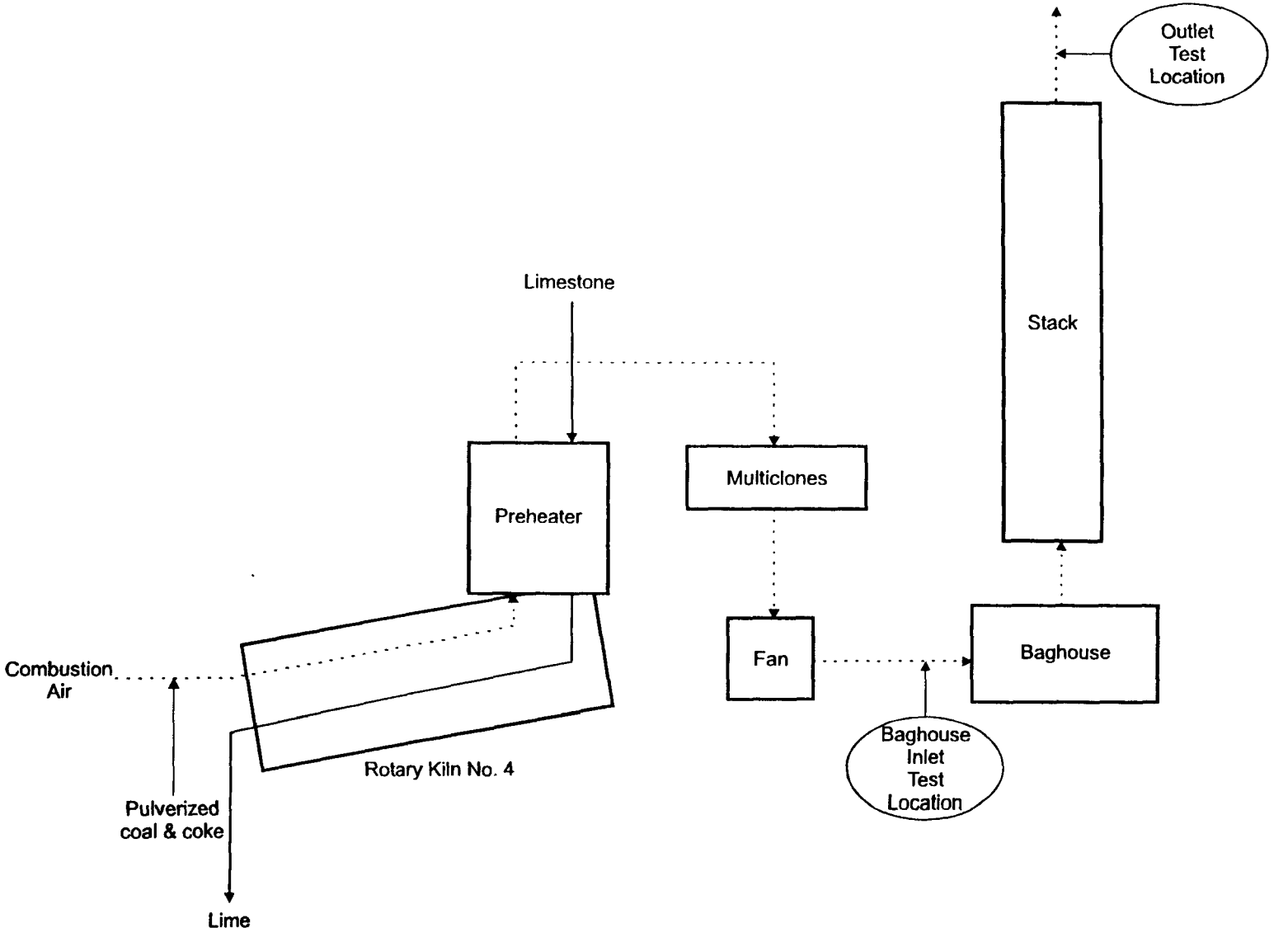


Figure 3.1 Kiln No. 4 Process Flow Schematic, Dravo Lime Company - Saginaw Alabama

4.0 SAMPLING LOCATIONS

As stated previously, source sampling was conducted to determine uncontrolled and controlled emissions of HCl, PCDDs/PCDFs, cations, and total hydrocarbons from Lime Kiln No. 4 located at Dravo Lime Company's Saginaw, Alabama facility. Testing was conducted at the inlet of the baghouse and at the Kiln No. 4 stack. Descriptions and schematic diagrams of the test locations are presented below.

4.1 KILN NO. 4 BAGHOUSE INLET

The Kiln No. 4 baghouse inlet measurement site was located in an 84-inch inside diameter (ID) round, vertical duct, 38 inches (0.5 duct diameters) downstream of the nearest flow disturbance (90° bend) and 300 inches (3.6 duct diameters) upstream of the fan inlet.

According to EPA Method 1 criteria, this site required 24 sample traverse points. Only one sample port was available for isokinetic testing, and because of a lack of clearance for the Method 23 sampling train behind the port, isokinetic sampling was conducted at a single point in the center of the duct. Prior to the test, a velocity traverse was conducted through the port which indicated a uniform velocity profile. The center point of the duct approximated the average air stream velocity. A schematic of the sampling location is depicted in Figure 4.1.

4.2 KILN NO. 4 BAGHOUSE OUTLET

The baghouse stack measurement site was located in an 83.25-inch inside diameter (ID) round, vertical duct, 432 inches (5.2 duct diameters) downstream of the nearest flow disturbance (breeching) and 617 inches (7.4 duct diameters) upstream of the nearest flow disturbance (the exhaust to the atmosphere). Only two ports were available for testing. Because the Method 322 sampling probe occupied one of the test ports, the Method 23 sampling was performed using only one port. According to EPA Method 1 criteria, this site required a total of 12 sample traverse points; because only one axis was used, the 12 points were located along one of the perpendicular diameters. Figure 4.2 shows a simplified schematic of the inlet measurement site and Figure 4.3 shows the sample traverse point locations.

A check for the presence of non-parallel flow was conducted as specified in Section 2.4 of EPA Method 1. The results of the cyclonic flow check showed an average yaw angle (α) of 2.2 degrees which was well within the Method 1 criterion of 20 degrees; therefore, the sampling location was considered suitable for isokinetic sampling.

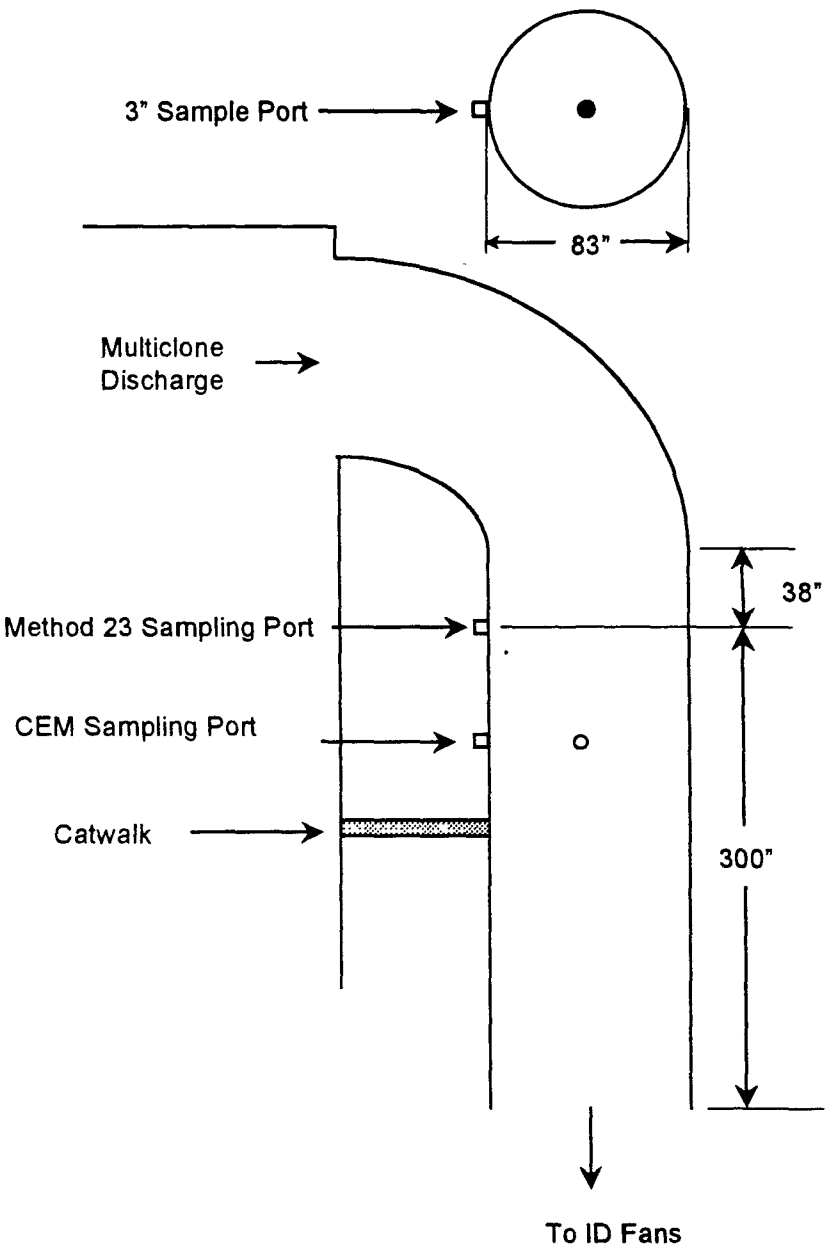


Figure 4.1 Kiln No. 4 Baghouse Inlet Test Location, Dravo Lime Company - Saginaw, Alabama

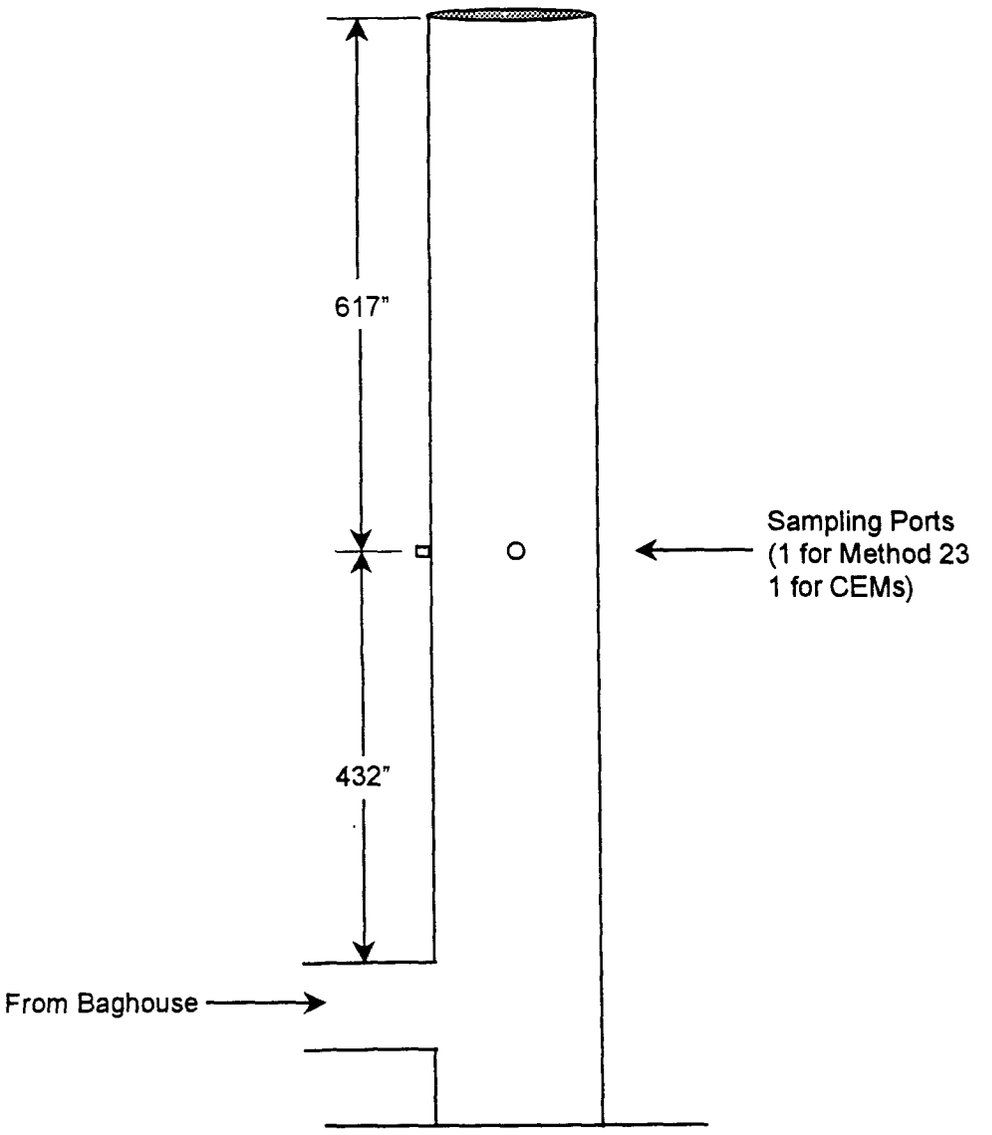
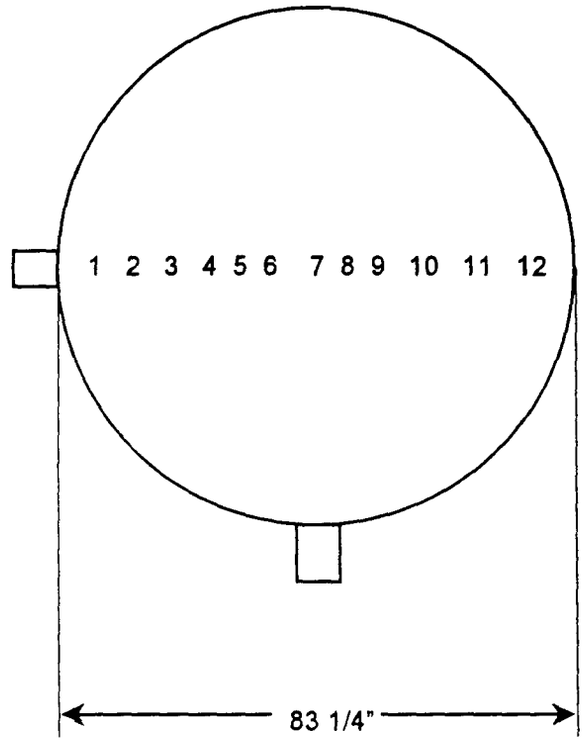


Figure 4.2 Kiln No. 4 Baghouse Outlet Test Location, Dravo Lime Company - Saginaw, Alabama



Traverse Point No.	Distance From Inside Wall (in.)
1	1.7
2	5.6
3	9.8
4	14.7
5	20.8
6	29.6
7	53.6
8	62.4
9	68.5
10	73.4
11	77.7
12	81.5

Figure 4.3 Kiln No. 4 Baghouse Outlet Sample Point Locations, Dravo Lime Company - Saginaw, Alabama

5.0 SAMPLING AND ANALYTICAL PROCEDURES

Source sampling was performed at the baghouse inlet and the Kiln No. 4 stack to determine the concentrations and mass emission rates of PCDDs/PCDFs, HCl, and total hydrocarbons. Table 5.1 presents a summary of the sampling and analytical methods that were used to quantify the target compounds. The following text provides brief descriptions of the sampling and analysis procedures that were employed.

TABLE 5.1

SUMMARY OF SAMPLING METHODS
DRAVO LIME COMPANY - SAGINAW, ALABAMA

Test Method	Parameter	Measurement Principle
EPA Method 1	Sample Point Location	Linear Measurement
EPA Method 2	Velocity and Flow	Differential Pressure, Thermocouple
EPA Method 3A	Oxygen, Carbon Dioxide	Paramagnetic and NDIR Continuous Analyzers
EPA Method 4	Moisture	Gravametric
EPA Method 23	PCDDs/PCDFs	Gas Chromatograph / Mass Spectrometry
EPA Method 26A	HCl, Ammonia	Ion Chromatograph
EPA Method 26A	Aluminum, Calcium, Maganesium, Potassium, Sodium	Inductively Coupled Plasma / Atomic Emission Spectroscopy
Proposed Method 322	HCl	Gas Filter Correlation / Infra Red

5.1 LOCATION OF MEASUREMENT SITES AND SAMPLE/VELOCITY TRAVERSE POINTS

EPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to establish velocity and sample traverse point locations at the baghouse outlet. The process ductwork and locations of measurement sites and traverse points are discussed in Section 4.0 of this document.

5.2 DETERMINATION OF STACK GAS VOLUMETRIC FLOW RATE

EPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to determine exhaust gas velocity. A Type S Pitot tube, constructed according to Method 2 criteria and having an assigned coefficient of 0.84, was connected to an inclined-vertical manometer and used to measure the velocity pressure (Δp). The stack gas temperature was also recorded at each traverse point using a Type K thermocouple. The average gas velocity was calculated from the average square root of the velocity pressure, average stack gas temperature, air stream molecular weight, and absolute outlet pressure. The volumetric flow rate is the product of velocity and the cross-sectional area of the duct/outlet at the sampling location.

5.3 DETERMINATION OF STACK GAS OXYGEN AND CARBON DIOXIDE CONTENT

The CEM system was housed in the APCC Environmental Monitoring Laboratory positioned near the baghouse outlet. Stack gas was drawn from the outlet through a heated Teflon® sample line (320 °F nominal) and sample conditioning system (except the THC sample) to remove moisture from the gas stream. A leakless Teflon® diaphragm pump then drew the sample through an unheated dry Teflon® sample line and pumped it through a manifold under slightly positive pressure with a bypass to the atmosphere. CO_2 and O_2 samples were continuously drawn from this manifold to their respective analyzers. A heated sample was introduced directly to the THC analyzer. All CEM data was recorded using a Tracor/Westronics 3000 automatic digital data logger. All data was monitored by a Tracor/Westronics 3000 digital data logger which recorded using its integral color printer. Trends were monitored using the strip chart mode with averages printed digitally for 5-minute intervals and/or the test period. Emissions data was "sampled" by the data logger at 5-second intervals. Figure 5.1 shows a schematic of the system.

EPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)," was used to determine the O_2 and CO_2 concentrations at the baghouse outlet location. A Horiba CMA 321 analyzer was used to monitor O_2 and CO_2 concentrations. Oxygen was measured using the paramagnetic analytical technique. The analyzer was operated on a range of 0 - 25 percent and calibrated using zero nitrogen and oxygen-in-nitrogen calibration standards of 11.1 and 20.2 percent. CO_2 was

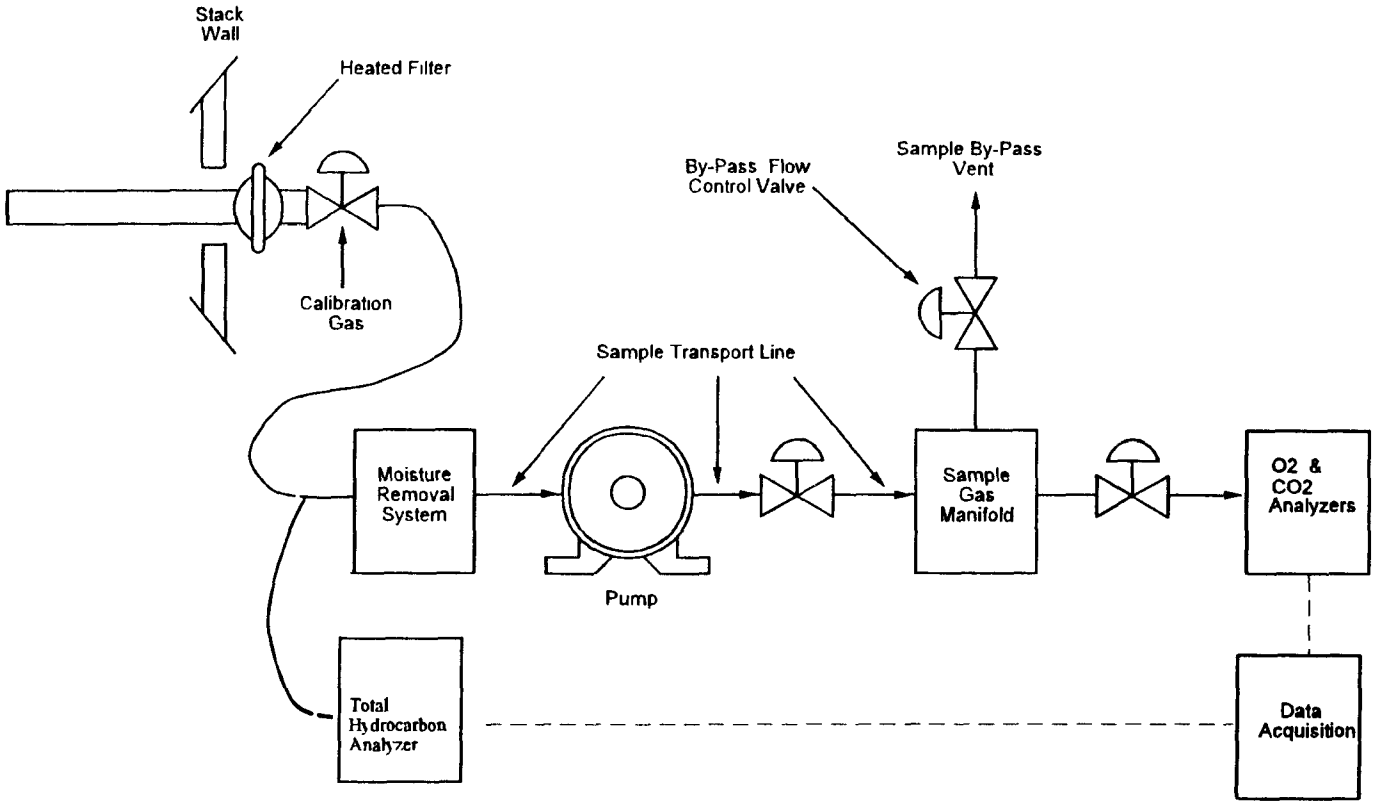


Figure 5.1 CEMs Sampling and Analysis System

measured using the principle of infra-red absorption. The analyzer was operated on a range of 0 - 40 % by volume and calibrated with carbon dioxide standards of 11.0 and 20.4 %. Radiation absorbed by CO_2 in the sample cell produces a capacitance change in the detector which is proportional to the CO_2 concentration. Calibration gas standards were prepared according to the EPA Traceability Protocol.

5.4 DETERMINATION OF STACK GAS MOISTURE CONTENT

EPA Method 4, "Determination of Moisture Content in Stack Gases," was used to determine the air stream moisture content. EPA Method 4 was performed in conjunction with each EPA Method 23 and Method 26A test run. At the baghouse inlet single-point isokinetic sampling was conducted. At the baghouse outlet multi-point, isokinetic sampling was conducted. Condensed moisture was determined by recording pre-test and post-test weights of the impingers, reagents, and silica gel. Due to weighing problems for run I-M23-4 at the baghouse inlet, no condensed moisture weight is available; for calculation purposes, the moisture percent measured by the Method 23 run at the outlet (O-4) was used as an estimate for the moisture percent for run I-M23-4.

5.5 DETERMINATION OF PCDDs/PCDFs

EPA Method 23, "Determination of Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources," was used to collect dioxins and furans at each location. In addition, the proposed rules amending Method 23 as published in the Federal Register, Volume 60, No. 104, May 31, 1995 were incorporated. These proposed rules correct existing errors in the method, eliminate the methylene chloride rinse, and clarify the quality assurance requirements of the method.

At the baghouse outlet, a multi-point integrated sample was extracted isokinetically from the traverse points shown in Section 4.0; at each traverse point, sampling was performed for 15 minutes for a total run time of 180 minutes. At the baghouse inlet, the single sampling point was sampled for 180 minutes, with readings taken every 10 minutes.

The EPA Method 23 samples were extracted through a glass nozzle, a heated glass-lined probe, a precleaned and heated glass fiber filter, a water cooled condenser coil and an adsorbent trap containing approximately 40 g of XAD®-2 adsorbent resin. The EPA Method 23 sampling train is shown in Figure 5.2.

TLI prepared the filters and adsorbent traps and performed the analyses. The samples were extracted and analyzed according to EPA Method 23 and the above mentioned proposed rules amendment. The sample components (filter, XAD®, and rinses) were Soxhlet extracted and combined. The sample was then split with half being archived and the other half analyzed. Analysis was performed on a high resolution Gas Chromatograph with a high resolution Mass Spectrometer detector.

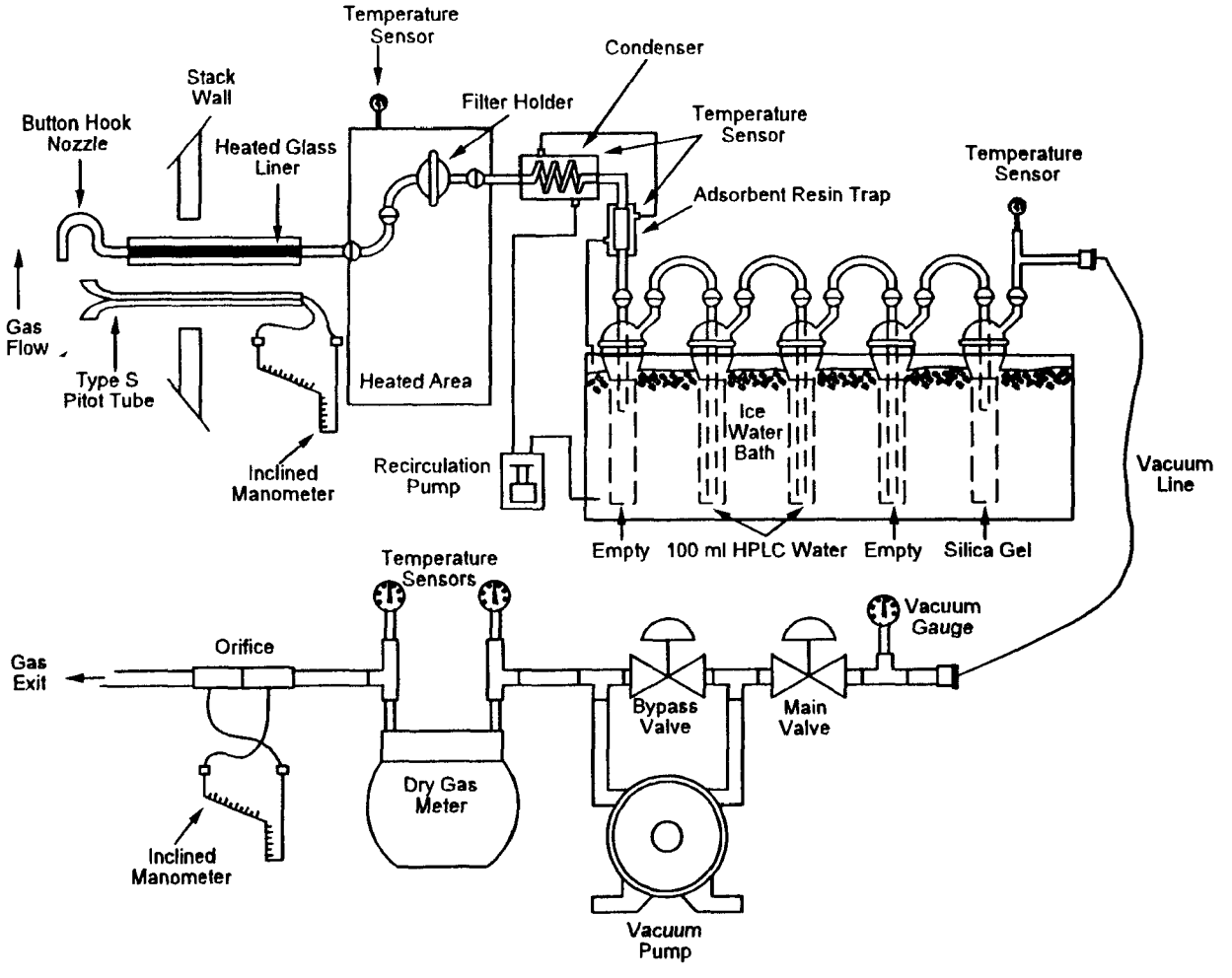


Figure 5.2 EPA Method 23 Sampling Train

5.6 DETERMINATION OF TOTAL HYDROCARBONS

EPA Method 25A, "Determination of Total Gaseous Organic Concentration using a Flame Ionization Analyzer," was used to determine total hydrocarbon concentrations at the Kiln No. 4 stack. A VIG Industries Total Hydrocarbon Analyzer, which utilizes a flame ionization detector (FID), was used to measure hydrocarbons. Approximately 5.0 liters per minute (lpm) of sample gas was drawn from the source through a heated Teflon® sample line. The sample gas was drawn through a heated filter and valves by a heated pump. The sample gas was introduced into the FID chamber and any hydrocarbons in the sample were ionized by a hydrogen flame. The flame was positioned between two charged plates, and the associated electric field induces the migration of the ions towards the charged plates. The ion migration resulted in the genera- tion of a current directly proportional to the amount of hydrocarbons present in the sample.

The analyzer was calibrated using methane calibration gas standards. THC concentrations are in presented on a methane basis. In addition THC concentrations have been presented as propane multiplying the methane result by a factor of three.

5.7 DETERMINATION OF HYDROGEN CHLORIDE, AMMONIA, AND CATIONS

EPA Method 26A "Determination of Hydrogen Chloride Emissions from Stationary Sources," was used to measure the chloride and ammonia concentrations in the gas streams at the baghouse inlet and outlet locations. In addition, the impinger contents from the second run at each location were analyzed for the following cations - aluminum, calcium, potassium, magnesium, and sodium.

A sample was extracted isokinetically through a glass nozzle, probe liner, a Quartz fiber filter maintained at greater than 250°F, and a series of impingers. The first and second impingers were each charged with 100 milliliters of 0.1 N sulfuric acid, the third and fourth impingers were each charged with 100 milliliters of 0.1 N sodium hydroxide, and the fifth impinger contained a known mass, approximately 200 grams, of silica gel. A schematic of this train is presented in Figure 5.3.

Pre- and post-test leak checks were conducted on the Method 26A sampling train to guard against dilution of the collection sample with ambient air. Prior to testing, the train was leak checked at a system vacuum of at least fifteen inches of mercury, and after each test, the train was leak checked at the highest system vacuum observed during the test. The maximum acceptable leakage rate is 0.02 cfm, and all leak checks that were performed met this criteria.

After each test, the impinger contents were recovered, placed into labeled polypropylene sample bottles, and transported to the analytical laboratory for chlorides, ammonia, and cations content analysis. The impinger solutions were recovered and analyzed by ion chromatography for the ammonia and chlorides, and ICP for the cations (aluminum, calcium, magnesium, potassium, and sodium). The samples were analyzed by the Center for Environmental Measurement and Quality Assurance of the Research Triangle Institute located in Research Triangle Park, North Carolina.

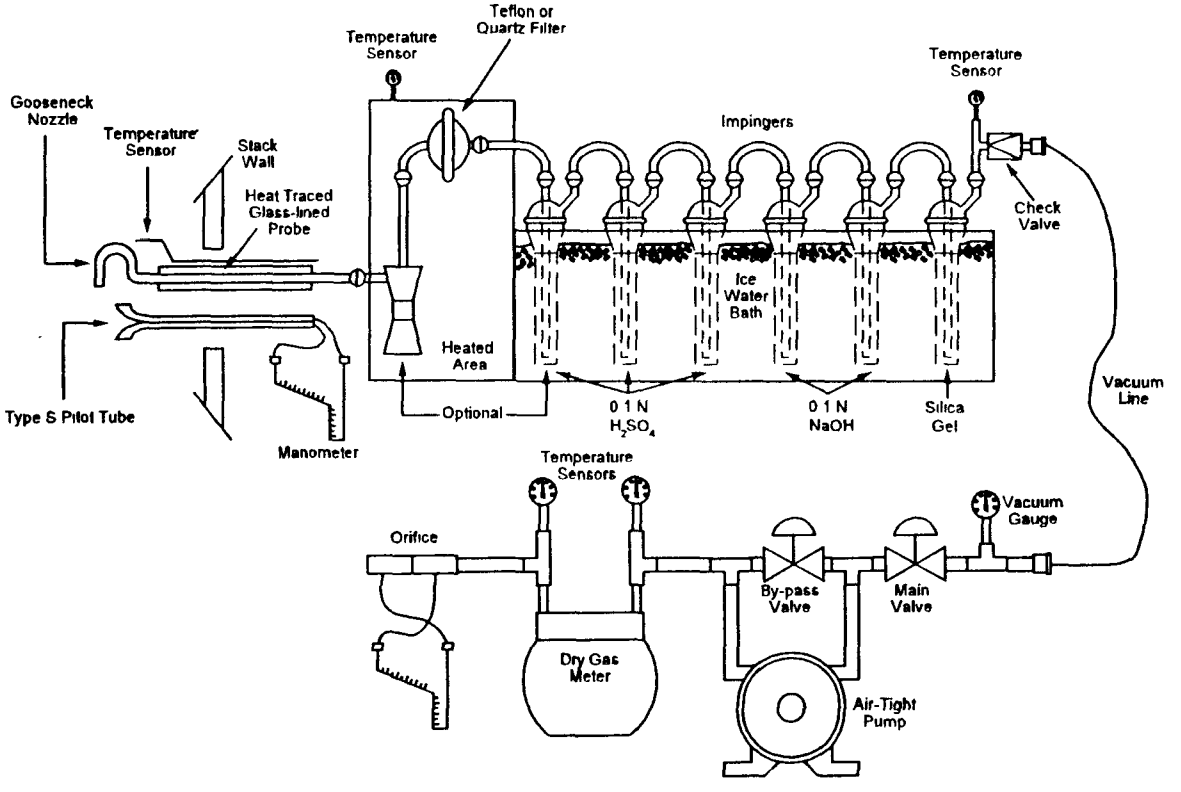


Figure 5.3 EPA Method 26A Sampling Train

5.7 DETERMINATION OF HCL (INSTRUMENTAL METHOD)

Proposed EPA Method 322, "Measurement of Hydrogen Chloride Emissions from Portland Cement Kilns by GFC/IR," was used to monitor HCl emissions at the stack. The stack gas sample was extracted from the sampling location and transported to the HCl analyzer (a Perkin Elmer (PE) MCS-100) through a heated sample probe, heated sample line, and a heated sample pump. Sampling components were maintained at a minimum temperature of 375°F. A heated three-way valve was attached to the probe assembly to allow for sampling of stack gas or for the introduction of HCl calibration standards. The sample exited the pump and passed through a heated rotameter and into the analyzer containing the gas filter correlation infrared spectrometer (GFC/IR). Hydrogen chloride in the sample cell attenuates an infrared light source. The intensity of the attenuated beam is measured by a detector positioned at the end of the cell. The amount of HCl in the sample gas stream is related to the amount of light attenuated. A schematic of this system is presented in Figure 5.4.

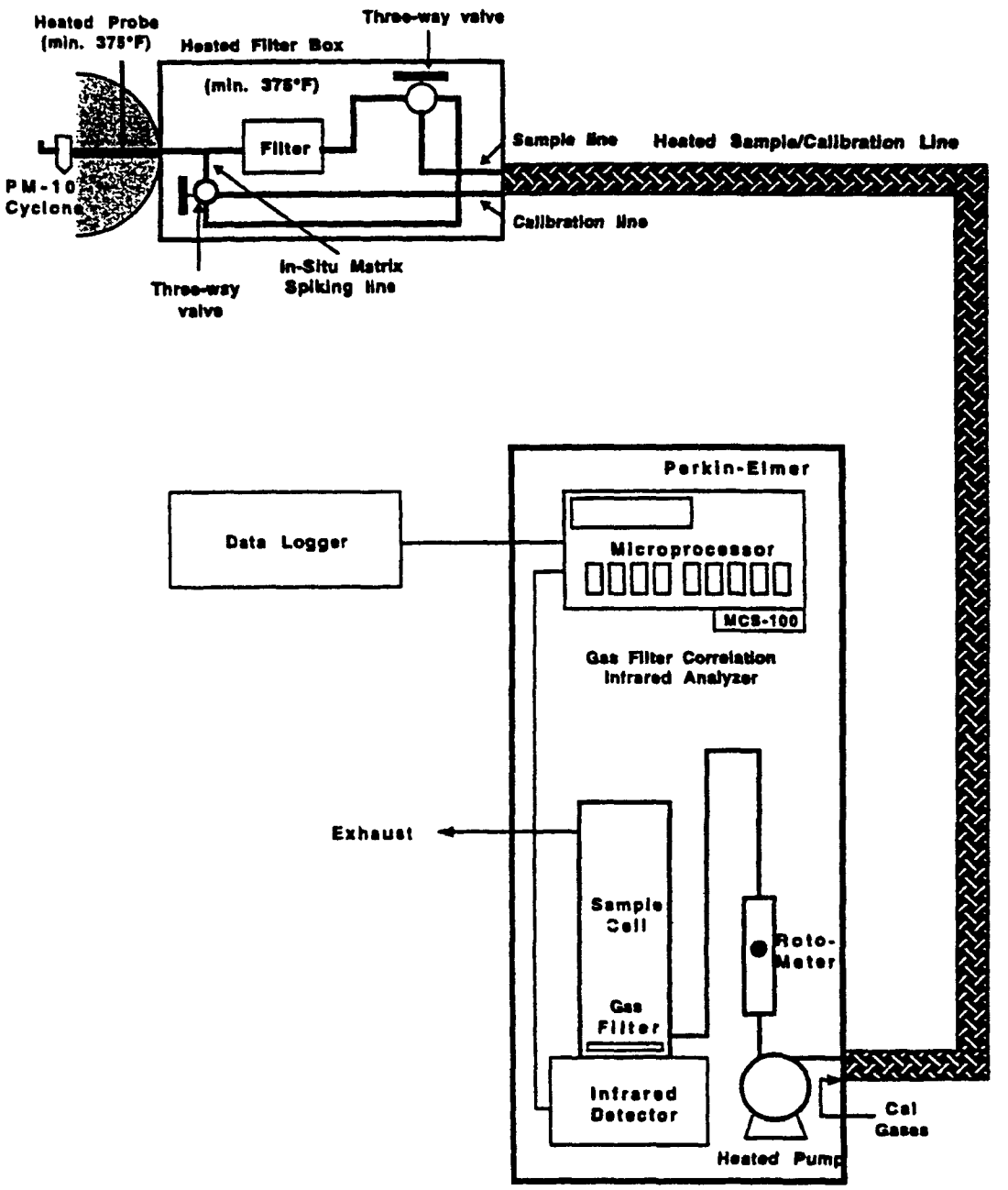


Figure 5.4 Proposed EPA Method 322 CEM Sampling System

6.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND RESULTS

This section describes the specific QA/QC procedures employed by PES in performing this series of tests. The procedures contained in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods," EPA/600/R-94/038c, and in the reference test methods served as the basis for performance for all testing and related work activities in this project.

6.1 CALIBRATION OF APPARATUS

The preparation and calibration of source sampling equipment is essential in maintaining data quality. Brief descriptions of the calibration procedures used by PES follow.

6.1.1 Barometers

PES used aneroid barometers which are calibrated against a station pressure value, corrected for elevation, reported by a nearby National Weather Service Station.

6.1.2 Temperature Sensors

Bimetallic dial thermometers and Type K thermocouples were calibrated using the procedure described in Calibration Procedure 2a of EPA/600/R-94/038c. Each temperature sensor was calibrated over the expected range of use against an ASTM 3C or 3F thermometer. Table 6.1 summarizes the type of calibrations performed, the acceptable levels of variance, and the results. Digital thermocouple displays were calibrated using a thermocouple simulator having a range of 0-2400°F.

6.1.3 Pitot Tubes

Type S pitot tubes constructed to EPA Method 2 specifications were used. Pitot tubes meeting these specifications are assigned to a baseline coefficient to 0.84 and need not be calibrated. The dimensional criteria and results for each pitot tube used are summarized in Table 6.2.

TABLE 6.1

SUMMARY OF TEMPERATURE SENSOR CALIBRATION DATA

Temp. Sensor I.D.	Usage	Temperature, °R		Difference (%)	Criteria (%)
		Reference	Sensor		
4E	Stack Gas	534	534	0.0%	<±1.5%
		498	498	0.0%	<±1.5%
		663	662	-0.15%	<±1.5%
		799	800	0.13%	<±1.5%
7D	Stack Gas	500	501	0.20%	<±1.5%
		534	534	0.0%	<±1.5%
		666	665	-0.15%	<±1.5%
		800	801	0.12%	<±1.5%
MB-10	Dry Gas Meter Inlet	493	494	0.20%	<±1.5%
		536	536	0.0%	<±1.5%
		666	665	-0.15%	<±1.5%
	Outlet	492	494	0.40%	<±1.5%
		536	537	0.19%	<±1.5%
		666	665	-0.15%	<±1.5%
RMB-15	Dry Gas Meter Inlet	493	495	0.40%	<±1.5%
		534	534	0.0%	<±1.5%
		668	670	0.30%	<±1.5%
	Outlet	493	493	0.0%	<±1.5%
		534	535	0.19%	<±1.5%
		668	668	0.0%	<±1.5%

TABLE 6.2

SUMMARY OF PITOT TUBE DIMENSIONAL DATA

Measurement	Criteria	Results	
		Pitot Tube Identification	
		4E	7D
α_1	<10°	0	3
α_2	<10°	1	3
β_1	<5°	1	1
β_2	<5°	3	1
γ	-	0	1
θ	-	1	0
A	-	0.973	0.931
Z	≤ 0.125 in.	0	0.016
W	≤ 0.03125 in.	0.017	0.0
D_t	$0.1875'' \leq D_t \leq 0.375''$	0.375	0.375
$A/2D_t$	$1.05\ D_t \leq A \leq 1.50\ D_t$	1.30	1.24
	Acceptable	Yes	Yes
	Assigned Coefficient	0.84	0.84

6.1.4 Differential Pressure Gauges

PES used Dwyer inclined/vertical manometers to measure differential pressures. The differential pressures measurements included velocity pressure, static pressure, and meter orifice pressure. Manometers were selected with sufficient sensitivity to accurately measure pressures over the entire range of expected values. Manometers are primary standards and require no calibration.

6.1.5 Dry Gas Meters and Orifices

The EPA Method 23 and Method 26A dry gas meters and orifices were calibrated in accordance with Sections 5.3.1 and 5.3.2 of EPA Method 5. This procedure involves direct comparison of the metered volume passed through the dry gas meter to a reference dry test meter. The reference dry test meter is calibrated annually using a wet test meter. Before its initial use in the field, the metering system was calibrated over the entire range of operation, as specified in EPA Method 5. After field use, a calibration check of the metering system was performed at a single intermediate setting based on the previous field test. Acceptable tolerances for the dry gas meter correction factor (γ) and orifice calibration factor ($\Delta H_@$) are ± 0.02 and ± 0.20 from average, respectively. The calibration check of the dry gas meter correction factor must agree within 5 percent of the correction factor generated during the annual calibration. The results for the gas meters and orifices used in this test program are summarized in Table 6.3.

TABLE 6.3

SUMMARY OF DRY GAS METER AND ORIFICE CALIBRATION DATA

Meter No.	Dry Gas Meter Correction Factor (γ)				Reference Orifice Pressure ($\Delta H_@$, in. H_2O)		
	Pre-test	Post-test	% Diff.	EPA Criteria	Average	Range	EPA Criteria
MB-10	1.021	0.985	-3.6	± 5%	1.72	1.59 - 1.79	1.72 ± 0.20
RMB-15	1.000	1.002	0.2	± 5%	1.56	1.56 - 1.56	1.56± 0.20

6.2 ON-SITE MEASUREMENTS

The on-site QA/QC activities include:

6.2.1 Measurement Sites

Prior to sampling, the stack and inlet duct were checked dimensionally to determine measurement site locations, location of velocity and sample test ports, inside stack/duct dimensions, and sample traverse point locations. Inside stack/duct dimensions were checked

through both traverse axes to ensure uniformity of the stack/duct inside diameter. The inside stack/duct dimensions, wall thickness, and sample port depths were measured to the nearest 1/16 inch.

6.2.2 Velocity Measurements

All velocity measurement apparatus were assembled, leveled, zeroed, and leak-checked prior to use and at the end of each determination. The static pressure was determined at a single point near the center of the stack or duct cross-section.

6.2.3 Method 3A (Stack Gas Composition) / Method 25A

The field QA/QC activities for Method 3A and Method 25A included the use of EPA Protocol calibration gases during pretest calibration error tests, system bias checks, and response time tests; and post-test zero and calibration drift determinations. Table 6.4 lists the calibration gas cylinder numbers, concentrations, and expiration dates. Calibration error tests, system bias checks, calibration drift checks, and response time checks are shown in Appendix D. All pre- and post-test calibrations and bias checks were well within the method specifications.

TABLE 6.4

SUMMARY OF CALIBRATION GAS CYLINDERS

Cylinder Number	Contents	Expiration Date
A018685	10.7 ppm HCl in nitrogen	08-26-98
A018704	26.0 ppm HCl in nitrogen	08-12-98
A018749	37.6 ppm HCl in nitrogen	08-25-98
A017718	101 ppm HCl in nitrogen	08-12-98
CC79006	29.97 ppm CH_4 in nitrogen	11/4/97
SX-27307	51.1 ppm CH_4 in nitrogen	08-20-99
CC46103	84.8 ppm CH_4 in nitrogen	3/5/97
CC84096	10.99 % CO2 in $N_2/O_2/CO_2$	03-02-01
CC84096	11.05 % O2 in $N_2/O_2/CO_2$	03-02-01
CC60029	20.2 % CO2 in $N_2/O_2/CO_2$	04-03-99
CC60029	20.4 % O2 in $N_2/O_2/CO_2$	04-03-99

6.2.4 Moisture

The EPA Method 23 and Method 26A sampling trains were used to determine the flue gas moisture content. During sampling, the exit gas of the last impinger was maintained below 68°F to ensure complete condensation of flue gas water vapor. The total moisture was determined gravimetrically using an electronic platform balance with 0.1 gram sensitivity. The XAD® adsorbent module from the EPA Method 23 sampling train was also weighed and its weight included in the moisture catch.

6.2.5 Method 23 and Method 26A

Table 6.5 summarizes the EPA Method 23 and Method 26A critical field sampling QA/QC measurements made and the EPA's acceptability criteria. All pre- and post-test sample train leaks met the acceptance criteria. The isokinetic sampling rates for all runs deviated by no more than 4% from 100%, thereby meeting the method criteria of 90-110%.

Due to plant operational issues, a field blank for the EPA Method 23 sample train was not collected.

6.2.6 EPA Proposed Method 322

The HCl sampling and analysis system was calibrated with a zero gas and three upscale gas standards, corresponding to 10.7, 26, and 37.6 ppm HCl in nitrogen. The response of the analyzer was within 7.5% of span, as specified by the method, for all calibration standards with the exception of the high-level gas. The calibration error for the high-level gas was 11.8% of span, which means that HCl concentrations in this range of the calibration curve would be over-estimated by approximately 12%. However, the average concentration during the sampling run was 7.1 ppm HCl, which is in the region of the calibration curve that was well characterized. The response of the sampling system to the 10.7 ppm HCl standard was within 3% of the instrument span.

As stated previously, the HCl sampling system did not respond to the injection of the HCl spike gases. The effect of this failure is described in Section 2 of this document. Because of the failure of the matrix spikes, the HCl data collected at this facility is most likely biased low.

6.3 LABORATORY ANALYSES

6.3.1 EPA Method 23 PCDDs/PCDFs

Prior to the field testing program, TLI prepared PES' XAD®-2 adsorbent traps and precleaned the glass fiber filters. TLI's laboratory QA/QC program consisted of adding isotopically labeled standards to each sample at various stages of the project to determine recovery efficiencies. The following types of standards were used:

Surrogate Standards were spiked in the TLI laboratory on the XAD®-2 resin prior to the field sampling program. Recovery efficiencies for these surrogate compounds provided a measure of the sample collection efficiency and an indication of any analytical matrix effects.

Internal Standards were spiked in the TLI laboratory after the field sampling program and prior to sample extraction. Recovery efficiencies for these compounds were used in quantifying the actual PCDDs/PCDFs isomers measured in the samples.

Alternate Standards were spiked in the TLI laboratory after the field sampling program and prior to sample extraction. Recovery of these compounds indicated the extraction efficiencies.

Recovery Standards were added in the laboratory after extraction just prior to GC/MS analysis.

TABLE 6.5

SUMMARY OF EPA METHODS 23 AND 26A FIELD SAMPLING QA/QC DATA

Site	Run No.	Pre-Test Leak Rate (acfm)	Post-Test Leak Rate (acfm)	EPA Criteria (acfm)	Isokinetic Sampling Ratio (%)	EPA Criteria (%)
Kiln 4 Baghouse Inlet	I-M23-4	0.001 @ 15" Hg	0.0__ @ __" Hg	0.02	100.4	90-110%
	I-M26A-4	0.002 @ 15" Hg	0.002 @ 17" Hg	0.02	103.9	90-110%
	I-M26A-5	0.001 @ 15" Hg	0.0__ @ __" Hg	0.02	103.7	90-110%
	I-M26A-6	0.001 @ 17" Hg	0.001 @ 16" Hg	0.02	103.4	90-110%
Kiln 4 Baghouse Outlet	O-M23-4	0.003 @ 20" Hg	0.004@ 12" Hg	0.02	103.0	90-110%
	O-M26A-4	0.005 @ 15" Hg	0.003 @ 15" Hg	0.02	101.8	90-110%
	O-M26A-5	0.005 @ 15" Hg	0.002 @ 05" Hg	0.02	101.6	90-110%
	O-M26A-6	0.003 @ 15" Hg	0.002 @ 12" Hg	0.02	103.2	90-110%

Table 6.6 summarizes the recovery efficiencies for the various standards and the respective quality control limits. The recovery efficiencies for the XAD® blank and samples were all within the method QC limits. Refer to TLI's case narrative for their discussion of any quality control anomalies.

One of the Method 23 sample handling requirements is to keep the samples under ice. The field sample recovery technician during this effort, Michael D. Maret, personally packed the XAD resin traps with ice packs and personally delivered the samples to TLI on April 1, 1998. This statement is made in rebuttal to the TLI custodian lab report; TLI was informed of this discrepancy but has not responded as of the time of the preparation of this final report.

6.3.2 EPA Method 26A Hydrogen Chloride, Ammonia, and Cations

Tables 6.7 and 6.8 summarize the QC results from the Method 26A laboratory analyses performed by Research Triangle Institute. All QC results are within generally accepted criteria, with the exception of the sodium (Na) duplicate results as shown in Table 6.8. However, because of the low concentration of Na (less than twice the detection limit), it is considered to be within the variability of the instrument.

The field blank results are presented in Table 6.9. Note that the Ca, Mg, and Na results are of significant magnitude (> 50% of sample) in comparison to the sample catches. Refer to Appendix B.2 for a comparison of the blank and sample catches. This could indicate that the sample catches do not represent the amount of Ca, Mg, and Na native to the air stream.

TABLE 6.6

SUMMARY OF EPA METHOD 23 STANDARDS RECOVERY EFFICIENCIES

	Percent Recovery				QC Limits
	TLI M23 Blank	M23-I-4	M23-O-4	RB 1-4	
FULL SCREEN ANALYSIS					
Internal Standards					
2,3,7,8-TCDF	65.8	60.6	79.7	66.0	40-130%
2,3,7,8-TCDD	67.9	53.7	64.1	59.9	40-130%
1,2,3,7,8-PeCDF	68.6	63.2	70.7	62.5	40-130%
1,2,3,7,8-PeCDD	99.4	69.5	68.3	76.1	40-130%
1,2,3,6,7,8-HxCDF	68.1	72.2	80.5	81.6	40-130%
1,2,3,6,7,8-HxCDD	78.7	70.5	95.3	97.6	40-130%
1,2,3,4,6,7,8-HpCDF	83.7	65.5	74.4	82.8	25-130%
1,2,3,4,6,7,8-HpCDD	92.5	68.4	87.2	101	25-130%
1,2,3,4,6,7,8,9-OCDD	83.0	40.3	93.8	115	25-130%
Surrogate Standards					
2,3,7,8-TCDD	87.9	88.9	91.8	83.8	70-140%
2,3,4,7,8-PeCDF	106	96.0	89.7	101	70-140%
1,2,3,4,7,8-HxCDF	108	92.2	93.4	82.5	70-140%
1,2,3,4,7,8-HxCDD	114	93.2	83.8	82.5	70-140%
1,2,3,4,7,8,9-HpCDF	90.1	76.0	104	95.2	70-140%
Alternate Standards					
1,2,3,7,8,9-HxCDF	84.5	76.1	87.0	87.7	40-130%
2,3,4,6,7,8-HxCDF	81.8	75.6	86.1	89.1	40-130%
CONFIRMATION ANALYSIS					
Internal Standards					
2,3,7,8-TCDF	69.2	56.1	75.5	*	40-130%

* Confirmation analysis was not necessary on these samples since no TCDF's were detected in the full screen analysis.

TABLE 6.7

SUMMARY OF EPA METHOD 26A ANION SPIKES AND DUPLICATE ANALYSIS

Sample ID	Cl^-	NH_4^-
Recovery Efficiency, %		
QA-MED	99.0	na[a]
QA-LOW	99.0	na[a]
QA-MED	100.0	na[a]
EPA-3909 [b]	103.4	na[a]
NH_4 QA-1	na[a]	96.9
NH_4 QA-2	na[a]	93.6
EPA-3177 [b]	na[a]	91.4
M26A-I-6-A SPIKE	100.4	na[a]
M26A-O-6-A SPIKE	na[a]	96.6
Duplicate Analysis [c]		
M26A-O-2-A	0.043 mg/L	na[a]
M26A-O-2-A DUPLICATE	0.044 mg/L	na[a]
Percent Difference	2.3	na[a]
M26A-O-1-A	na[a]	0.019 mg/L
M26A-O-1-A DUPLICATE	na[a]	0.018 mg/L
Percent Difference	na[a]	5.3

[a] na = not applicable
[b] Quality assurance samples prepared by the EPA.
[c] Duplicate analyses were performed by the laboratory on samples collected at another lime kiln facility during the same mobilization.

TABLE 6.8

SUMMARY OF EPA METHOD 26A CATION SPIKES AND DUPLICATE ANALYSIS

Sample ID	K^+	Ca^+	Mg^+	Na^+	Al^+
Recovery Efficiency, %					
M26A-O-2A SPIKE*	85.0	91.8	96.2	96.4	104
Duplicate Analysis					
M26A-O-5-A DUP	< 4.8 µg	277 µg	32.3 µg	40.4 µg	15.1 µg
M26A-O-5-A	< 4.8 µg	291 µg	33.1 µg	29.6 µg	16.1 µg
Percent Difference	0.0	-4.8	-2.4	36.5	-6.2

* The matrix spike was performed by the laboratory on a sample collected at another lime kiln facility during the same mobilization.

TABLE 6.9

SUMMARY OF EPA METHOD 26A FIELD BLANK ANALYSIS

Analyte	M26A-FB-2-A Catch
Cl^-	0.41 mg
NH_4^-	0.20 mg
K^+	< 3.5 µg
Ca^+	80.8 µg
Mg^+	10.2 µg
Na^+	27.0 µg
Al^+	< 11 µg

APPENDIX A

RAW FIELD DATA

Appendix A.1

Raw Field Data - Kiln No. 4 Baghouse Inlet

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant: DRAVO, SAGINAW, AL - KILN #4

Date: 3-28-98

Sampling Location: INLET TO BAGHOUSE

Inside of Far Wall to Outside of Nipple: 3.5" + 84"

Inside of Near Wall to Outside of Nipple (Nipple Length): 3.5"

Stack I.D.: 84"

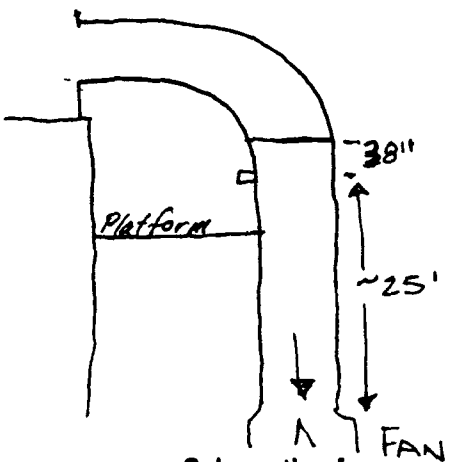
Distance Downstream from Flow Disturbance (Distance B):

_____ inches / Stack I.D. = _____ dd

Distance Upstream from Flow Disturbance (Distance A):

_____ inches / Stack I.D. = _____ dd

Calculated By: P. SIEGEL



Schematic of Sampling Location

Traverse Point Number	Fraction of Length	Length (inches)	Product of Columns 2 & 3 (To nearest 1/8")	Nipple Length (inches)	Traverse Point Location (Sum of Col. 4 & 5)
1	.021	84"	1.764	3.5	5 1/4
2	.067		5.628		9 1/8
3	.118		9.912		13 3/8
4	.177		14.868		18 3/8
5	.250		21.0		24 1/2
6	.356		29.904		33 3/8
7	.644		54.096		57 5/8
8	.750		63		66.5
9	.823		69.132		72.5/8
10	.882		74.088		77.5/8
11	.933	78.372	~~81.872~~		81.7/8
12	.979	82.236	~~85.736~~		85 3/4

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant: DRAVO - SAGINAW, KILN 4 Date: 3-28-98
Sampling Location: INLET TO BAGHOUSE Clock Time: 9:30
Run #: Preliminary Velocity Operators: PSIEGEL
Barometric Pressure, in. Hg: 29.5 Static Pressure, in. H_2O: -30" H_2O
Moisture, %: _____ Molecular wt., Dry: _____ Pitot Tube, Cp: 0.84
Stack Dimension, in. Diameter or Side 1: 84" Side 2: _____
Wet Bulb, °F: _____ Dry Bulb, °F: _____

Traverse Point Number	Velocity Head in. H_2O	Stack Temp. °F
1	0.95 *	NO TEMP
2	0.63 *	RECORDED
3	0.64 *	—
4	0.85	385
5	0.88	405
6	0.85	436
7	0.88	465
8	0.86	471
9	0.88	477
10	0.86	467
11	0.88	466
12	0.87	461
	$\overline{\sqrt{\Delta P}}$ =	$\overline{Ts}$ = 448

used in Calcs

$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + (0.28 \times \%N_2)$

$Md = (0.44 \times 12) + (0.32 \times 9) + (0.28 \times 79)$

$Md = 30.28$

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

$Ms = (\quad) \times (1 - \frac{}{100}) + 18 (\frac{}{100})$

$Ms = 29.67$

$\overline{Ts} = 448$ °F = 908 °R (°F + 460)

$Ps = Pb + \frac{S.P.}{13.6} = (29.5) + \frac{-30}{13.6}$

$Ps = 27.29$ in. Hg

$\overline{\sqrt{\Delta P}} =$

$Vs = 85.49 \times Cp \times \overline{\sqrt{\Delta P}} \times \sqrt{\frac{Ts\,(°R)}{Ps \times Ms}}$

$Vs = 85.49 \times (\quad) \times (\quad) \times \sqrt{\quad}$

$Vs =$ ft/s

$As =$ ft^2

$Qs = Vs \times As \times 60$ s/m

$Qs = \quad \times \quad \times 60$

$Qs =$ acfm

$Qs_{std} = Qs \times 17.647 \times \frac{Ps}{Ts} \times (1 - \frac{\%H_2O}{100})$

$Qs_{std} = \quad \times 17.647 \times \frac{}{} \times (1 - \frac{}{100})$

$Qs_{std} =$ dscfm

* High negative pressure (-30" H_2O) made it difficult to get good measurement

FIELD DATA SHEET

Y = 1.021 avg

Plant: DRAVO - SAGINAW, KILN 4 **Sample Type:** M23 **Operator:** P. SIEGEL **Nozzle ID:** 0.25 **Thermocouple #:** 4-E

Sampling Location INLET TO BAGHOUSE **Pbar:** 29.5 **Ps:** ~~-20~~ PT3 -30" H2O **Assumed Bws:** 5% **Filter #:**

Run Number: I-M23-4 **Date:** 3-28-98 **CO2:** 12 **O2:** ~~9~~ **Meter Box #:** M810 **Y:** 1.016 **ΔH@:** 1.94

Pretest Leak Rate: 0.001 cfm @ 15 in. Hg. **Probe Length/Type:** 5' Glass **Pitot #:** 4E **Post-Test Leak Rate:** <0.02 cfm @ >16 in. Hg. ewr

Pretest Leak Check: Pitot: ✓ **Orsat:** **Stack Diameter:** 7' = 84" **As:** 38.485 ft² **Post-Test Leak Check: Pitot:** **Orsat:**

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft³	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O Desired	Actual	Stack Temp. (Ts)	Temperature Condenser °F ~~Probe~~	Filter	Impinger Temp. °F	Dry Gas Meter Temp. Inlet (Tm in °F)	Outlet (Tm out °F)	Pump Vacuum (in. Hg)
0	0	10:42	643.526										
	10	10:52	650.89	0.93	2.21	2.2	467	55	234	65	97	95	10
	20	11:02	658.43	0.87	2.07	2.1	467	55	233	64	97	95	10
	30	11:12	665.74	0.86	2.05	2.05	465	56	237	63	97	94	12
	40	11:22	673.18	0.86	2.06	2.06	461	57	235	65	97	95	14
	50	11:37	680.57	0.84	2.00	2.00	464	48	238	66	96	94	15.5
	60	11:47	687.98	0.88	2.09	2.09	464	54	226	68	95	94	9
	70	11:57	695.33	0.85	2.04	2.04	459	57	235	66	100	96	11
	80	12:07	702.92	0.84	2.03	2.03	460	59	238	67	104	99	13.5
	90	12:17	710.516	0.86	2.07	2.07	463	59	238	69	102	99	15.5
	100	12:31	718.05	0.88	2.11	2.11	464	55	232	69	101	99	9
	110	12:41	725.58	0.88	2.08	2.08	477	51	233	65	102	99	10
	120	12:51	733.02	0.88	2.12	2.12	462	51	236	63	102	99	13.5
	130	13:01	740.42	0.90	2.12	2.12	483	53	237	64	102	100	15
	140	13:15	748.00	0.84	1.97	1.97	485	56	239	64	102	100	15.5
	150	13:25	755.33	0.88	2.04	2.04	496	63	228	69	100	100	9
	160	13:35	762.84	0.89	2.09	2.09	490	62	240	63	105	102	11.5
	170	13:45	770.41	0.88	2.08	2.08	485	53	238	61	104	102	13.5
	180	13:55	778.299	0.86	2.01	2.01	484	53	241	62	101	101	15

TESTING WAS PERFORMED AT A SINGLE POINT, CENTER OF THE DUCT, ISOKINETICALLY.

THIS WAS DONE BECAUSE OF PORT LOCATION AND UNIFORM VELOCITY ACROSS DUCT.

134.773
-.324
-.315
-.338

ΔVm= 133.796 $\overline{\sqrt{\Delta p}}$= 0.9333 $\overline{\Delta H}$= 2.07 Ts= 472 Tm= 99

.5
1@17
77.930
8.254
2@16
35
p 90.0
1@17
6@15
0.516
10.831
:21
p 135
02 @17
44.337
44.675
001 @15
:10

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Delano Lime		Run No.: ~~R01~~ M23-1-4
Date: 3/26/98	Sample Box No.:	Job No.: R012-002
Sample Location: Baghouse Inlet - Kiln 4		
Sample Type: US EPA Method 23		
Sample Recovery Person: MMM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents 103-4	Initial Volume, ml	Weight, grams Initial	Final	Net
XAD	XAD Resin	-		307.4	
1	K.O.	0	~~495.0~~	574.0	
2	H_2O	100	~~603.1~~	712.5	
3	MT	0	~~514.4~~	598.1	
4	Si Gel	-	~~925.7~~	~~307.4~~	
Total					

Comments: No prelim. wts due to balance incl-function

K = 2.25

FIELD DATA SHEET

Y = 1.021 avg

Plant: DRAVO - SAGINAW KILN 4
Sampling Location INLET TO BAGHOUSE
Run Number: I-26A-4 Date: 3-28-98
Pretest Leak Rate: 0.002 cfm @ 15 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: ____

Sample Type: 26A Operator: P. SIEGEL
Pbar: 29.5 Ps: ~~-20~~ PT3 -30" H_2O
CO2: 12 O2: 9
Probe Length/Type: 5' Glass Pitot #: 4-E
Stack Diameter: 7' = 84" As: 38.485

Nozzle ID: 0.217 Thermocouple #: 4-E
Assumed Bws: 5 Filter #: ____
Meter Box #: MB1D Y: 1.015 ΔH@: 1.94
Post-Test Leak Rate: 0.002 cfm @ 17 in. Hg.
Post-Test Leak Check: Pitot: ____ Orsat: ____

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft^3	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in °F)	Outlet (Tm out °F)	
0	0	14:30	778.699										
	5	14:35	781.60	0.85	1.15	1.15	470		231	66	101	100	12
	10	14:40		0.87	1.15	1.15	489		233	64	97	98	12
	15	14:45	787.23	0.83	1.11	1.11	481		234	68	100	99	12
	20	14:50	789.99	0.84	1.11	1.11	494		240	69	99	98	12
	25	14:55	792.80	0.84	1.11	1.11	493		238	67	99	98	12
	30	15:00	795.61	0.83	1.09	1.09	495		241	68	98	97	13
	35	15:05	798.42	0.84	1.11	1.11	494		241	68	98	97	14
	40	15:10	801.99	0.84	1.14	1.14	467		240	68	98	97	15
	45	15:15	804.02	0.83	1.09	1.09	494		240	66	98	97	15
	50	15:20	806.79	0.80	1.05	1.05	497		241	67	99	98	16
	55	15:25	809.48	0.81	1.07	1.07	495		240	67	99	98	16
	60	15:30	812.441	0.78	1.03	1.03	494		238	67	99	98	16.5

TESTING WAS PERFORMED AT SINGLE POINT, CENTER OF DUCT, ISOKINETICALLY.

ΔVm = 33.742 $\overline{\sqrt{\Delta p}}$ = 0.9110 $\overline{\Delta H}$ = 1.10 $\overline{Ts}$ = 488 $\overline{Tm}$ = 98

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Draw Lime		Run No.: M26A-I-4
Date: 3/28/98	Sample Box No.:	Job No.: R012-002
Sample Location: Baghouse Inlet		
Sample Type: US EPA Method 26A		
Sample Recovery Person: MDM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1	0.1 N H_2SO_4	100	708.2	726.6	
2	0.1 N H_2SO_4	100	716.0	721.7	
3	0.1 N NaOH	100	723.6	724.9	
4	0.1 N NaOH	100	692.2	690.2	
5	Si Gel	-	916.0	926.2	
Total					

Comments:

FIELD DATA SHEET

K=2.25

Y=1.021 ows

Plant: DRAVO - SAGINAW, KILN 4
Sampling Location INLET TO BAGHOUSE
Run Number: I-26A-5 Date: 3-28-98
Pretest Leak Rate: 0.001 cfm @ 15 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: ____

Sample Type: M26A Operator: P. SIEGEL
Pbar: 29.5 Ps: PTS -20 -30" H_2O
CO2: 12 O2: 9
Probe Length/Type: 5' Glass Pitot #: 4E
Stack Diameter: 7' = 84" As: 38.485

Nozzle ID: 0.217 Thermocouple #: 4E
Assumed Bws: 5 Filter #: ____
Meter Box #: MB10 Y: 1.016 ΔH@: 1.94
Post-Test Leak Rate: <0.02 cfm @ >14 in. Hg.
Post-Test Leak Check: Pitot: OWS Orsat: ____

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft^3	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in°F)	Outlet (Tm out°F)	
0	0	16:35	812.774										
	5	16:40	815.70	0.80	1.04	1.04	497		233	61	93	94	8
	10	16:45	818.41	0.81	1.06	1.06	492		234	60	93	94	8
	15	16:50	821.19	0.81	1.07	1.07	489		238	58	94	94	8
	20	16:55	823.94	0.83	1.08	1.08	499		239	54	94	94	8.5
	25	17:00	826.67	0.83	1.08	1.08	496		240	53	95	94	9
	30	17:05		0.82	1.07	1.07	497		239	53	96	94	9.5
	35	17:10	832.11	0.84	1.09	1.09	505		240	53	96	94	10
	40	17:15	834.81	0.80	1.04	1.04	502		239	53	95	93	10.5
	45	17:20	837.56	0.80	1.04	1.04	496		240	53	95	93	11
	50	17:25	840.31	0.83	1.08	1.08	498		239	54	96	94	12
	55	17:30	843.11	0.82	1.07	1.07	498		240	55	96	94	13
	60	17:35	845.912	0.85	1.11	1.11	500		239	54	96	94	14

TESTING WAS CONDUCTED AT SINGLE POINT, CENTER OF DUCT, ISOKINETICALLY.

ΔVm= 33.138 $\overline{\sqrt{\Delta p}}$= .9055 $\overline{\Delta H}$= 1.07 $\overline{Ts}$= 497 $\overline{Tm}$= ____

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Primo Lime		Run No.: M26A-I-5
Date: 3/28/96	Sample Box No.:	Job No.: R012-002
Sample Location: Baghouse Inlet		
Sample Type: US EPA Method 26A		
Sample Recovery Person: MDM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1			707.3	724.2	
2			721.7	726.6	
3			725.6	796.3	
4			694.4	694.2	
5			940.3	949.9	
Total					

Comments:

FIELD DATA SHEET

Y = 1.021 eus

Plant: DRAVO - SAGINAW, KILN 4
Sampling Location INLET TO BAGHOUSE
Run Number: I-26A-6 Date: 3-28-98
Pretest Leak Rate: 0.001 cfm @ 17 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: ____

Sample Type: M26A Operator: P. SIEGEL
Pbar: 29.5 Ps: -30 "H_2O
CO2: 12 O2: 9
Probe Length/Type: 5' Glass Pitot #: 4E
Stack Diameter: 7' = 84" As: 38.485 ft^2

Nozzle ID: 0.217 Thermocouple #: 4E
Assumed Bws: 5 Filter #: ____
Meter Box #: MB10 Y: 1.016 ΔH@: 1.94
Post-Test Leak Rate: 0.001 cfm @ 16 in. Hg.
Post-Test Leak Check: Pitot: ____ Orsat: ____

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft^3	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in °F)	Outlet (Tm out °F)	
0	0	18:01	846.269										
	5	18:06	849.17	0.89	1.15	1.15	509		230	67	95	96	8.5
	10	18:11	851.93	0.84	1.08	1.08	516		231	66	96	96	8.5
	15	18:16		0.83	1.07	1.07	513		233	69	96	96	8.5
	20	18:21	PTS	0.84	1.08	1.08	512		237	67	96	95	9.5
	25	18:26	860.15	0.82	1.06	1.06	511		242	68	96	95	10
	30	18:31	862.85	0.82	1.05	1.05	515		237	69	96	95	10.5
	35	18:36	865.62	0.86	1.11	1.11	514		238	67	96	95	11
	40	18:41	868.32	0.85	1.09	1.09	514		240	66	96	95	12
	45	18:46	871.08	0.87	1.11	1.11	518		241	66	96	95	13
	50	18:51	873.97	0.96	1.23	1.23	522		239	65	97	96	15
	55	18:56	876.81	0.9	1.14	1.14	529		245	66	99	97	15.5
	60	19:01	879.825	0.86	1.10	1.10	521		243	67	99	97	16

TESTING WAS CONDUCTED AT SINGLE POINT, CENTER OF DUCT, ISOKINETICALLY.

ΔVm= ____ $\overline{\sqrt{\Delta p}}$= ____ $\overline{\Delta H}$= ____ $\overline{Ts}$= ____ $\overline{Tm}$= ____

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Pravo Lime		Run No.: M26A-I-6
Date: 3/28/98	Sample Box No.:	Job No.: A012-002
Sample Location: Baghouse Inlet		
Sample Type: US EPA Method 26A		
Sample Recovery Person:		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1			729.0	748.3	
2			706.4	712.0	
3			724.2	725.4	
4			720.7	721.1	
<			895.3	903.0	
Total					

Comments:

Appendix A.2

Raw Field Data - Kiln No. 4 Baghouse Outlet

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant: Dravo - Alabama

Date: 3-28-98

Sampling Location: Baghouse Outlet - Kiln 4

Inside of Far Wall to Outside of Nipple: 90"

Inside of Near Wall to Outside of Nipple (Nipple Length): 6 3/4

Stack I.D.: 83 1/4

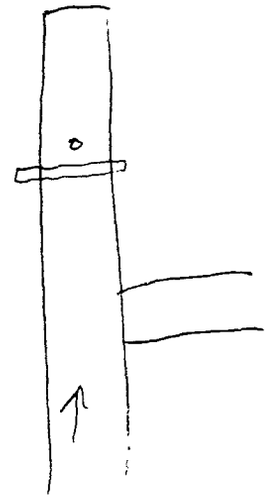
Distance Downstream from Flow Disturbance (Distance B):

2' 4 3/2 inches / Stack I.D. = 5.1 dd

Distance Upstream from Flow Disturbance (Distance A):

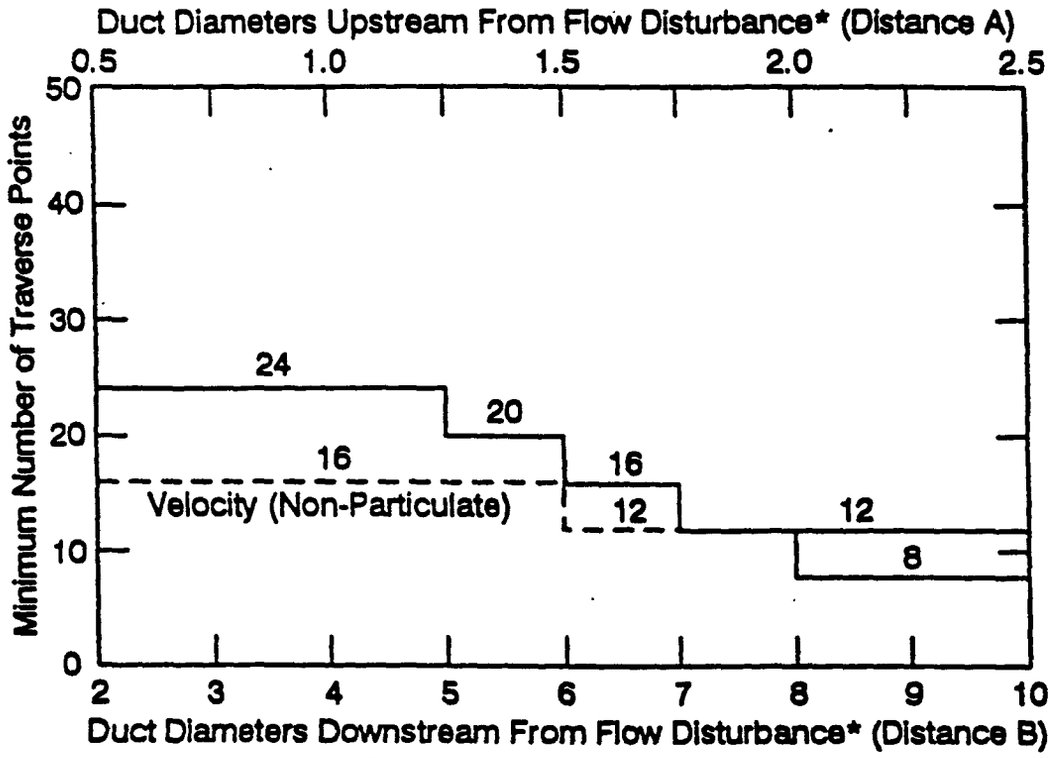
5'5" 6.17 inches / Stack I.D. = 7.4 dd

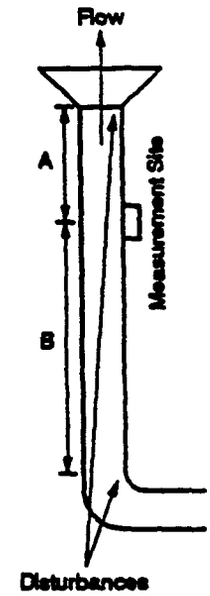
Calculated By: TA/GC



Schematic of Sampling Location

Traverse Point Number	Fraction of Length	Length (inches)	Product of Columns 2 & 3 (To nearest 1/8")	Nipple Length (inches)	Traverse Point Location (Sum of Col. 4 & 5)
1	0.021	83 1/4	1.7	6 3/4	8 1/2
2	0.067		5.6		12 3/8
3	0.118		9.8		16 1/2
4	0.177		14.7		21 1/2
5	0.250		20.8		27 1/2
6	0.356		29.6		36 3/8
7	0.644		53.6		60 3/8
8	0.750		62.4		69 1/4
9	0.823		68.5		75 1/4
10	0.882		73.4		80 1/8
11	0.933		77.7		84 1/2
12	0.979		81.5		88 1/4





LOCATION OF TRAVERSE POINTS IN CIRCULAR DUCTS
(Fraction of Stack Diameter from Inside Wall to Traverse Point)

Traverse Point Number on a Diameter	Number of Traverse Points on a Diameter				
	4	6	8	10	12
1	0.067	0.044	0.032	0.026	0.021
2	0.250	0.146	0.105	0.082	0.067
3	0.750	0.296	0.194	0.146	0.118
4	0.933	0.704	0.323	0.226	0.177
5		0.854	0.677	0.342	0.250
6		0.956	0.806	0.658	0.356
7			0.895	0.774	0.644
8			0.968	0.854	0.750
9				0.918	0.823
10				0.974	0.882
11					0.933
12					0.979

GAS VELOCITY ,CYCLONIC, AND VOLUMETRIC FLOW RATE

Plant:	Bravo - Alabama	Date:	3-28-98
Sample Location:	Baghouse Outlet	Clock Time:	0848
Run No.:	Run 4	Operators:	TA/GG
Pbar, in. Hg:	29.5	Static Pressure, in. H_2O:	-.50
Moist, %:	5.0%	Pitot Tube, Cp:	.84
Stack Dimension, in. Dia. 1:	83.25	Dia. 2:	
Wet Bulb, °F:		Dry Bulb, °F:	

Traverse Point Number	Velocity Head, in. H_2O	Stack Temp, °F	Cyclonic Flow Angle, %	Directon of Angle
1	.93	352	7	CW
2	.92	352	5	CW
3	.90	352	0	—
4	.86	353	2	CW
5	.76	353	2	CW
6	.67	354	0	—
7	.66	355	5	CC
8	.73	354	2	CC
9	.82	354	3	CC
10	.80	353	0	—
11	.68	353	0	—
12	.48	348	0	—

	sq.rt. dp	Stack Temp	Angle, °
Average	.8728	353	2.2
	.7675		

$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + (0.28 \times \%N_2)$

$Md = (0.44 \times \quad) + (0.32 \times \quad) + (0.28 \times \quad)$

$Md =$

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

$Ms = (\quad) \times (1 - \frac{\quad}{100}) + 18 (\frac{\quad}{100})$

$Ms =$

$\overline{Ts} = \quad °F = \quad °R \ (°F + 460)$

$Ps = Pb + \frac{S.P.}{13.6} = (\quad) + \frac{\quad}{13.6}$

$Ps = \quad$ in. Hg

$\overline{\sqrt{\Delta P}} =$

$Vs = 85.49 \times Cp \times \overline{\sqrt{\Delta P}} \times \sqrt{\frac{Ts\ (°R)}{Ps \times Ms}}$

$Vs = 85.49 \times (\quad) \times (\quad) \times \sqrt{\quad}$

$Vs = \quad$ ft/s

$As = \quad ft^2$

$Qs = Vs \times As \times 60$ s/m

$Qs = \quad \times \quad \times 60$

$Qs = 137,089$ acfm

$Qs_{std} = Qs \times 17.647 \times \frac{Ps}{Ts} \times (1 - \frac{\% H_2O}{100})$

$Qs_{std} = \quad \times 17.647 \times \frac{\quad}{\quad} \times (1 - \frac{\quad}{100})$

$Qs_{std} = 83,311$ dscfm

1344 vic

Y = 1.000 cuts

FIELD DATA SHEET

Plant: Dravo - Alabama
Sampling Location Baghouse Outlet - kiln 4
Run Number: 0-4 **Date:** 3-28-98
Pretest Leak Rate: .003 cfm @ 20 in. Hg.
Pretest Leak Check: Pitot: ✓ **Orsat:** —

Sample Type: M-23 **Operator:** TA/GG
Pbar: 29.5 **Ps:** -.51
CO2: 12 **O2:** 9
Probe Length/Type: 7' Glass **Pitot #:** 7D
Stack Diameter: 83.25 **As:**

Nozzle ID: .25 **Thermocouple #:** 7D
Assumed Bws: .05 **Filter #:** NA
Meter Box #: RMB 15 **Y:** .955 **ΔH@:** 1.92
Post-Test Leak Rate: .004 cfm @ 12 in. Hg.
Post-Test Leak Check: Pitot: ✓ **Orsat:** —

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft³	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O Desired	Actual	Stack Temp. (Ts)	Temperature °F Probe	Filter	Impinger Temp. °F	Dry Gas Meter Temp. Inlet (Tm in °F)	Outlet (Tm out °F)	Pump Vacuum (in. Hg)	Trap
0	0	1044	488.630											
1			—	.87	2.4	2.4	349	252	246	60	83	83	7	55
	15	1058	~~511.5~~ 495	.87	2.4	2.4	351	252	253	57	84	83	7	55
2			507.2	.81	2.2	2.2	351	252	253	57	84	83	7	55
	30	1113	513.2	.81	2.2	2.2	348	253	255	58	86	83	7	54
STOP 1132 1136 3			518.7	.81	2.2	2.2	348	250	259	59	88	83	7	54
	45	1129	524.9	.81	2.2	2.2	348	248	259	59	88	83	7	
4			530.2	.74	2.0	2.0	347	250	255	59	92	86	7	54
	60	1147	536.2	.74	2.0	2.0	348	251	257	59	92	86	7	
5			551.9	.68	1.9	1.9	347	252	256	59	91	87	7	50
	75	1202	557.0	.69	1.9	1.9	349	247	255	56	90	85	7	50
6			~~561.9~~	.55	1.5	1.5	348	245	256	55	91	85	7	
STOP 1219 1222	90	1217	567.9	.55	1.5	1.5	351	250	258	52	92	88	7	50
7			~~570.5~~ 8	.59	1.6	1.6	348	247	249	52	92	91	7	
	105	1237	570.5	.58	1.6	1.6	348	247	250	52	92	91	7	
8			579.2	.73	2.0	2.0	348	252	255	52	90	87	7	50
	120	1252	588.6	.73	2.0	2.0	348	251	252	52	90	87	7	
9			593.6	.78	2.1	2.1	349	250	253	53	90	87	7	52
	135	1307	598.7	.78	2.1	2.1	348	253	255	52	90	87	7	
10			603.6	.78	2.1	2.1	346	250	254	52	90	87	7	52
	150	1326	608.6	.78	2.1	2.1	346	251	256	52	90	87	7	
11				.68	1.9	1.9	347	252	253	52	93	88	7	55
	165	1341	618.6	.69	1.9	1.9	349	255	252	52	93	88	7	
12			—	.73	2.0	2.0	349	255	252	52	93	88	7	55
	180	1346	629.252	.73	2.0	2.0	349	253	253	52	94	89	7	

ΔVm= ~~140.622~~ 140.622 $\overline{\sqrt{\Delta p}}$= .8517 $\overline{\Delta H}$= 1.99 $\overline{Ts}$= 348 $\overline{Tm}$= 88

ACFM 133,407
DSCFM 81.822 @ 5%

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Drano Lime		Run No.: M23-0-4
Date: 3/28/98	Sample Box No.:	Job No.: 12012-002
Sample Location: Baghouse Outlet		
Sample Type: US EPA Method 23		
Sample Recovery Person: MDM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents (Lin. Inubated)	Initial Volume, ml	Weight, grams Initial	Final	Net
XAD	XAD resin	-	786.1	792.1	6.0
1	KCl	0	495.2	586.5	101.3
2	H_2O	100	683.1	681.1	(2.0)
3	MT	0	519.4	521.0	1.6
4	Si Gel	-	925.7	953.2	27.5
					134.4
Total					

Comments: ~~No Prelim Wts due to Balance Malfunction~~

FIELD DATA SHEET

Y = 1.000 ems

Plant: Dravo - Alabama
Sample Type: M-26A Operator: JA/GG
Nozzle ID: .250 Thermocouple #: 7D
Sampling Location Baghouse Outlet - Kiln 4
Pbar: 29.5 Ps: -.53
Assumed Bws: .05 Filter #: NA - Teflon
Run Number: 0-26A-4 Date: 3-25-98
CO2: 12 O2: 9
Meter Box #: RmB15 Y: .995 ΔH@: 1.92
Pretest Leak Rate: .005 cfm @ 15 in. Hg.
Probe Length/Type: 7' Glass Pitot #: 7D
Post-Test Leak Rate: .003 cfm @ 15 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: —
Stack Diameter: 83.25 As:
Post-Test Leak Check: Pitot: ✓ Orsat: —

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft³	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in °F)	Outlet (Tm out °F)	
0	0	1432	629.490										
1	5	1437	635.1	.90	2.5	2.5	347	250	250	57	91	90	10
2	10	1442	638.0	.90	2.5	2.5	352	250	251	57	90	90	10
3	15	1447	643.6	.80	2.2	2.2	352	247	250	55	90	90	10
4	20	1452	645.8	.75	2.1	2.1	352	246	250	54	91	91	10
5	25	1457	649.8	.67	1.7	1.7	353	246	250	54	92	90	10
6	30	1502	653.3	.55	1.5	1.5	351	252	260	54	94	91	7
7	35	1507	656.6	.55	1.5	1.5	352	242	267	56	96	91	7
8	40	1512	660.3	.75	2.1	2.1	352	255	255	57	96	91	10
9	45	1517	664.3	.75	2.1	2.1	353	250	255	56	99	93	16
10	50	1522	668.5	.73	2.1	2.1	353	250	251	57	97	92	10
11	55	1527	672.5	.73	2.1	2.1	353	250	251	57	97	92	10
12	60	1532	676.103	.71	2.0	2.0	351	251	252	57	97	92	8

ΔVm= 46.613 $\overline{\sqrt{\Delta p}}$= .8536 $\overline{\Delta H}$= 2.03 $\overline{Ts}$= 352 $\overline{Tm}$= 93

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Pizano Lime		Run No.: MZGA-0-4
Date: 3/20/98	Sample Box No.:	Job No.: R012-002
Sample Location: Baghouse Outlet		
Sample Type: US EPA Method 26A		
Sample Recovery Person: MBM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1	0.1 N H_2SO_4		732.4	755.2	
2	0.1 N H_2SO_4		708.9	719.4	
3	0.1 N NaOH		719.2	719.8	
4	0.1 N NaOH		705.9	705.8	
5	Si Gel.	-	882.2	895.2	
Total					

Comments:

FIELD DATA SHEET

Y = 1.000 ows

Plant: Draw - Alabama
Sampling Location: Baghouse Outlet - Kiln 4
Run Number: 0-26A-5 Date: 3-28-98
Pretest Leak Rate: .005 cfm @ 15 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: —

Sample Type: M-26A Operator: TA/GG
Pbar: 29.5 Ps: -.47
CO2: 12 O2: 9
Probe Length/Type: 7' Glass Pitot #: 7D
Stack Diameter: 83.25 As:

Nozzle ID: .250 Thermocouple #: 7D
Assumed Bws: .05 Filter #: Teflon
Meter Box #: BAR .5 Y: .995 ΔH@: 1.92
Post-Test Leak Rate: .002 cfm @ 5 in. Hg.
Post-Test Leak Check: Pitot: ✓ Orsat: —

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft³	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in °F)	Outlet (Tm out °F)	
0	0	1638	676.340										
1	5	1643	680.0	.85	2.4	2.4	347	250	251	57	93	93	3
2	10	1648	684.8	.85	2.4	2.4	349	250	249	55	92	92	3
3	15	1653	689.0	.79	2.2	2.2	347	245	250	56	91	90	3
4	20	1658	692.8	.75	2.1	2.1	349	249	256	54	93	90	3
5	25	1703	696.8	.68	1.9	1.9	349	249	251	54	97	91	2
6	30	1708	700.1	.55	1.5	1.5	350	246	253	54	99	92	2
7	35	1713	703.5	.55	1.5	1.5	350	249	253	56	100	93	2
8	40	1718	707.2	.68	1.9	1.9	349	253	260	56	100	93	2
9	45	1723	711.2	.75	2.1	2.1	350	250	255	56	100	93	3
10	50	1728	715.3	.75	2.1	2.1	350	250	254	57	101	93	3
11	55	1733	718.9	.72	2.0	2.0	350	251	253	57	102	94	3
12	60	1738	722.838	.72	2.0	2.0	350	251	253	58	102	94	3

ΔVm = 46.498 $\overline{\sqrt{\Delta p}}$ = .8469 $\overline{\Delta H}$ = 2.01 $\overline{Ts}$ = 350 $\overline{Tm}$ = 95

132,747 ACF
80,956 DSCF

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Olau Lime		Run No.: M26A - 05
Date: 3/26/98	Sample Box No.:	Job No.: 2012 - 002
Sample Location: Baghouse Outlet		
Sample Type: US EPA Method 26A		
Sample Recovery Person: MMM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1	0.1 H_2SO_4	100	718.4	741.1	
2	0.1 H_2SO_4	100	688.5	695.2	
3	0.1 NaOH	100	617.9	618.1	
4	0.1 NaOH	100	707.1	709.2	
5	Si Gel	-	941.2	953.8	
Total					

Comments:

FIELD DATA SHEET

Y = 1.000 Gas

Plant: Dravo - Alabama
Sampling Location: Baghouse Outlet - Kiln 4
Run Number: 0-26A-6 Date: 3-20-98
Pretest Leak Rate: .003 cfm @ 15 in. Hg.
Pretest Leak Check: Pitot: ✓ Orsat: —

Sample Type: M-26A Operator: TA/GG
Pbar: 29.5 Ps: -.47
CO2: 12 O2: 9
Probe Length/Type: 7' Glass Pitot #: 7D
Stack Diameter: 83.25 As:

Nozzle ID: .250 Thermocouple #: 7D
Assumed Bws: .05 Filter #: Teflon
Meter Box #: BMB 15 Y: .975 ΔH@: 1.92
Post-Test Leak Rate: .002 cfm @ 12 in. Hg.
Post-Test Leak Check: Pitot: ✓ Orsat: —

Traverse Point Number	Sampling Time (min)	Clock Time (24-hour clock)	Gas Meter Reading (Vm) ft³	Velocity Head (Δp) in H2O	Orifice Pressure Differential (ΔH) in H2O		Stack Temp. (Ts)	Temperature °F		Impinger Temp. °F	Dry Gas Meter Temp.		Pump Vacuum (in. Hg)
					Desired	Actual		Probe	Filter		Inlet (Tm in °F)	Outlet (Tm out °F)	
0	0	1802	722.940										
1	5	1807	727.0	.90	2.5	2.5	354	244	240	60	92	89	10
2	10	1812	731.0	.90	2.5	2.5	356	249	254	55	92	89	10
3	15	1817	735.2	.85	2.4	2.4	357	247	252	49	92	89	10
4	20	1822	739.2	.75	2.1	2.1	358	246	253	51	92	89	10
5	25	1827	743.0	.68	1.9	1.9	358	245	256	51	92	89	10
6	30	1832	746.9	.68	1.9	1.9	358	250	259	53	92	89	10
7	35	1837	750.2	.55	1.5	1.5	358	253	257	53	93	89	10
8	40	1842	754.2	.60	1.7	1.7	359	249	260	53	93	89	10
9	45	1847	758.2	.75	2.1	2.1	359	245	259	53	94	88	10
10	50	1852	761.9	.75	2.1	2.1	359	241	259	53	94	88	10
11	55	1857	766.0	.72	2.0	2.0	362	243	259	53	94	88	10
12	60	1902	769.904	.72	2.0	2.0	362	242	256	53	94	88	10

ΔVm= _____ $\overline{\sqrt{\Delta p}}$= _____ $\overline{\Delta H}$= _____ $\overline{Ts}$= _____ $\overline{Tm}$= _____

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Pennsy-Lime		Run No.: M26A-0-6
Date: 3/20/98	Sample Box No.:	Job No.: 1012-002
Sample Location: Baghouse Outlet		
Sample Type: US EPA Method 26		
Sample Recovery Person: MM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1	0.1 N H_2SO_4		723.6	750.3	
2	0.1 N H_2SO_4		718.4	725.7	
3	0.1 N NaOH		695.4	697.8	
4	0.1 N NaOH		628.8	632.8	
5	Si Gel.		926.1	936.2	
6			~~926.1~~		
Total					

Comments:

MULTI-METALS SAMPLE RECOVERY DATA

Plant: Drake Lime		Run No.: M29A - Pb-2
Date: 3/28/98	Sample Box No.:	Job No.: R012 - 002
Sample Location: Baghouse Outlet		
Sample Type: US EPA Method 29A		
Sample Recovery Person: MPM		

Container	Description	Volume, ml	Sealed/Level Marked
Front Half			
1	Filter No.(s)		
2	Acetone Rinse		
3	Nitric Rinse		
Back Half			
4	Nitric Rinse - Imp. 1,2,3, + Back 1/2 Filter		
5A	Nitric Rinse - Impinger No. 4		
5B	KMNO4/H2O Rinse - Impingers 5 & 6		
5C	HCl Rinse - Impingers 5 & 6		

Moisture Data

Impinger No.	Contents	Initial Volume, ml	Weight, grams		
			Initial	Final	Net
1	0.1 N H_2SO_4		696.5	696.7	
2	0.1 N H_2SO_4		688.4	688.2	
3	0.1 N NaOH		619.1	619.1	
4	0.1 N NaOH		723.6	723.6	
5	Sil Gel		953.8	953.1	
Total					

Comments:

Table A-2
HCl Emission Measurementsa Lime Kiln
Dravo Lime Company
Saginaw, Alabama
3/28/98

Time	Date	Inlet/Outlet	HCl ppmW	THC ppmW	O2 %	CO2 %
Kiln No. 4			avs	avs		
10:40-10:55	3/28/98	Outlet	n/a	7.0	10.8	19.6
10:55-11:10	3/28/98	Outlet	n/a	6.8	10.6	19.8
11:10-11:25	3/28/98	Outlet	n/a	6.6	10.6	19.2
11:25-11:40	3/28/98	Outlet	n/a	6.9	10.6	18.9
11:40-11:55	3/28/98	Outlet	n/a	6.6	10.5	19.0
11:55-12:10	3/28/98	Outlet	n/a	6.5	10.6	18.9
12:10-12:25	3/28/98	Outlet	n/a	6.4	10.6	19.1
12:25-12:40	3/28/98	Outlet	n/a	6.2	10.5	19.4
12:40-12:55	3/28/98	Outlet	n/a	5.9	10.5	19.2
12:55-13:10	3/28/98	Outlet	n/a	5.8	10.5	19.1
13:10-13:25	3/28/98	Outlet	n/a	5.6	10.5	19.0
13:25-13:40	3/28/98	Outlet	n/a	5.7	10.5	19.0
Average			**n/a**	**6.3**	**10.6**	**19.2**
Kiln No. 4						
17:25-17:40	3/28/98	Outlet	7.8	n/a	n/a	n/a
17:40-17:55	3/28/98	Outlet	6.8	n/a	n/a	n/a
17:55-18:10	3/28/98	Outlet	6.9	n/a	n/a	n/a
18:10-18:25	3/28/98	Outlet	7.3	n/a	n/a	n/a
18:25-18:40	3/28/98	Outlet	6.9	n/a	n/a	n/a
18:55-19:10	3/28/98	Outlet	6.6	n/a	n/a	n/a
Average			**7.1**			

APPENDIX B

LABORATORY ANALYTICAL DATA

Appendix B.1

Method 23 Analytical Report

TRIANGLE LABS

CASE NARRATIVE

Analysis of Samples for the Presence of

Polychlorinated Dibenzo-*p*-Dioxins and Dibenzofurans by

High-Resolution Chromatography / High-Resolution Mass Spectrometry

Method 23 (6/93)

Date:	April 21, 1998
Client ID:	Pacific Environmental Services
P.O. Number:	104-98-0159
TLI Project Number:	45399

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Rev. 11/19/97

Triangle Laboratories, Inc.
801 Capitola Drive
Durham, NC 27713-4411
919-544-5729
P.O. Box 13485
Research Triangle Park, NC 27709-3485
Fax # 919-544-5491

Overview

The sample(s) and associated QC samples were extracted and analyzed according to procedures described in Method 23 (6/93). Any particular difficulties encountered during the sample handling by Triangle Laboratories will be discussed in the QC Remarks section below. This report contains results only from the Method 23 dioxin/furan analyses of the M23 sample(s).

Quality Control Samples

A laboratory method blank, identified as the TLI M23 Blank, was prepared along with the samples.

Quality Control Remarks

This release of this particular set of Pacific Environmental Services analytical data by Triangle Laboratories was authorized by the Quality Control Chemist who has reviewed each sample data package following a series of inspections/reviews. When applicable, general deviations from acceptable QC requirements are identified below and comments are made on the effect of these deviations upon the validity and reliability of the results. Specific QC issues associated with this particular project are:

Sample receipt: Twelve M23 sample(s) were received from Pacific Environmental Services in good condition on April 01, 1998 at ambient temperature and stored in a refrigerator at 4 °C. On the sample labeled M23-0-1-2, acetone was marked through and toluene was written above it. On the sample labeled M23-0-1-3, toluene was marked through and acetone was written above it. Neither of these labels agreed with the clients' chain of custody.

Sample Preparation Laboratory: None

Mass Spectrometry: None

Data Review: Sample M23-O-1 indicated low internal standard recoveries. However, the signal-to-noise ratio is above ten-to-one in all cases and all standards are valid for quantitation. TCDF was the only analyte detected in this sample and is below Target Detection Limit (TDL).

Other Comments: No 2,3,7,8-substituted target analytes were detected in the TLI Blank above the target detection limit (TDL).

The analytical data presented in this report are consistent with the guidelines of EPA Method 23 (6/93). Any exceptions have been discussed in the QC Remarks section of this case narrative with emphasis on their effect on the data. Should Pacific Environmental Services have any questions or comments regarding this data package, please feel free to contact our Project Scientist, Rose West, at 919/544-5729 ext. 270.

For Triangle Laboratories, Inc.,

Released by

Girgis Mikhael

Girgis Mikhael
Report Preparation Chemist

The total number of pages in the data package is : 381 .

TRIANGLE LABS

TRIANGLE LABORATORIES, INC.

LIST OF CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

American Association for Laboratory Accreditation. Accredidation pending. Certificate Number 0226-01. Accreditation for technical competence in Environmental Testing.(Including Waste Water, Sol/Haz Waste, Pulp/Paper, and Air Matrices) Parameters are AOX/TOX, and Dioxin/Furan. Method 1613 for Drinking Water.

State of Alabama, Department of Environmental Management. Expires December 31, 1998. Laboratory I.D. # 40950. Dioxin in drinking water.

State of Alaska, Department of Environmental Conservation. Expires December 21, 1998. Certificate number OS-00397. Dioxin in drinking water.

State of Arizona, Department of Health Services. Expires May 26, 1998. Certificate #AZ0423. Drinking Water for Dioxin, Dioxin in WW and S/H Waste.

State of Arkansas, Department of Pollution Control and Ecology. Expires February 18, 1999. Pulp/paper, soil, water, and Hazardous Waste for Dioxin/Furan; AOX/TOX, Volatiles, Semi-volatiles, and Metals.

State of California, Department of Health Services. Expires August 31, 1999. Certificate #1922. Selected Metals in Waste Water; Volatiles, Semi-volatiles, and Dioxin/furan in WW and Sol/Haz Waste. Dioxin in drinking water.

State of Connecticut, Department of Health Services. Expires September 30, 1999. Registration # PH-0117. Dioxin in drinking water.

Delaware Health and Social Services. Expires December 31, 1998. Certificate #NC 140. Dioxin in drinking water.

Florida Department of Health and Rehabilitative Services. Expires June 30, 1998. Dioxin in DW. Drinking Water ID HRS# 87424. Metals, Extractable Organics (GC/MS), Pesticides/PCB's (GC) and Volatiles (GC/MS) in Environmental Samples. Environmental water ID HRS# E87411.

Revised 3/2/98 RM
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Hawaii Department of Health. Expires March 1, 1999. Dioxin in drinking water. "Accepted" status for regulatory purposes .

Idaho Department of Health and Welfare. Expires December 31, 1998. Dioxin in drinking water.

State of Kansas, Department of Health and Environment. Expires January 31, 1999. Environmental Analyses/Non portable Water and Solid and Hazardous Waste. Method 1613 for drinking water. ID #'s - Drinking water and/or pollution control - E-215. Solid or Hazardous Waste - E-1209.

Commonwealth of Kentucky, Department for Environmental Protection. Expires December 31, 1998. ID#90060. Dioxin in drinking water.

Maryland Department of Health and Mental Hygiene. Expires September 30, 1998. Certification #235. Drinking water by Method 1613A.

State of Michigan, Department of Public Health. Expires June 3, 1998. Drinking water by Method 1613.

Mississippi State Department of Health. No expiration date. Dioxin in drinking water.

Montana Department of Health and Environmental Services. Expires December 31, 1998. Dioxin in drinking water.

State of New Jersey, Department of Environmental Protection and Energy. Expires June 30, 1998. ID #67851. BNAs and Volatiles. Dioxin in drinking water.

State of New Mexico, Environment Department. Recertification pending. Dioxin in drinking water.

New York State Department of Health. Expires April 1, 1998. ID #11026. Environmental Analyses of non-potable Water, Solid and Hazardous Waste. Method 1613 in DW.

State of North Carolina, Department of Environment Health and Natural Resources Expires August 31, 1999. Certificate # 37751. Dioxin in drinking water.

State of North Carolina, Department of Environment, Health, and Natural Resources, Division of Environmental Management. Expires December 31, 2000. Certificate # 485. Metals, pesticides & PCBs, semi-volatiles and volatiles; TCLP.

North Dakota State Department of Health and Consolidated Laboratories. Expires December 31, 1998. Certificate # R-076. Effective October 4, 1993. Dioxin in drinking water.

Revised 3/2/98 RM
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-6-

State of West Virginia, Department of Health. Expires December 31, 1998. Certificate No. 9923(C). Dioxin in drinking water.

State of Wisconsin, Department of Natural Resources. Expires August 31, 1998. Laboratory ID Number 999869530. Certification for the following categories of Organics: Purgeable, Base/Neutral, Acid, PCBs, and Dioxin. Expires November 14, 1999. Laboratory ID 999869530. Dioxin in drinking water.

PHARMACEUTICAL

Drug Enforcement Agency (DEA). Expires November 30, 1998. Registration number RT01195835. Controlled substance registration for schedules 1,2,3,3N,4,5.

N.C. Department of Human Resources. Expires October 31, 1998. Registration number NC-PT 0000 0031. North Carolina controlled substances registration. Application submitted for renewal.

Food & Drug Administration (FDA) Registration. Expires June 1998. ID #'s 001500 1053481. Annual registration of drug establishment. Annual registration of drug establishment.

OTHER

Clinical Laboratory Improvement Amendments (CLIA) Registration. Expires May 30, 1999. ID # 34D0705123. Department of Health & Human Services, Health Care Financing Administration.

U.S. EPA Large Quantity Hazardous Waste Generator. No expiration date. EPA ID #NCD982156879. Permit indicates that the laboratory is a large generator of hazardous waste.

North Carolina General License for Radiation Protection. No. expiration date. License No. 032-875-OG. The general license applies only to radioactive material contained in devices which have been manufactured and labeled in accordance with specific requirements.

TRIANGLE LABS

DOCUMENT CONTROL

Triangle Laboratories, Inc.
801 Capitola Drive
Durham, NC 27713-4411
919-544-5729

P.O. Box 13485
Research Triangle Park, NC 27709-3485
Fax # 919-544-5491

541

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PACIFIC ENVIRONMENTAL SERVICES, INC.

Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Chain of Custody Record

Project Num	Project Name
r012.002	US EPA Lime Kiln Screening - Alabama Lime

mplers: Abernathy, Gay, Maret, Phoenix, Siegal

Date	Time	Field Sample ID	Sample Description	PCDD's	PCDF's						Remarks
3/23/98		M23-I-1-1	Container No. 1 - Filter	•	•						
3/23/98		M23-I-1-2	Container No. 2 - Train Acetone Rinse	•	•						
3/23/98		M23-I-1-3	Container No. 3 - Train Toluene Rinse	•	•						
3/23/98		M23-I-1-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/24/98		M23-I-2-1	Container No. 1 - Filter	•	•						
3/24/98		M23-I-2-2	Container No. 2 - Train Acetone Rinse	•	•						
3/24/98		M23-I-2-3	Container No. 3 - Train Toluene Rinse	•	•						
3/24/98		M23-I-2-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/26/98		M23-I-3-1	Container No. 1 - Filter	•	•						
3/26/98		M23-I-3-2	Container No. 2 - Train Acetone Rinse	•	•						
3/26/98		M23-I-3-3	Container No. 3 - Train Toluene Rinse	•	•						
3/26/98		M23-I-3-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/28/98		M23-I-4-1	Container No. 1 - Filter	•	•						
3/28/98		M23-I-4-2	Container No. 2 - Train Acetone Rinse	•	•						
3/28/98		M23-I-4-3	Container No. 3 - Train Toluene Rinse	•	•						
3/28/98		M23-I-4-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/23/98		M23-O-1-1	Container No. 1 - Filter	•	•						
3/23/98		M23-O-1-2	Container No. 2 - Train Acetone Rinse	•	•						
3/23/98		M23-O-1-3	Container No. 3 - Train Toluene Rinse	•	•						

4/1/98

COPY

PACIFIC ENVIRONMENTAL SERVICES, INC.

Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Chain of Custody Record

Project Num: r012.002

Project Name: US EPA Lime Kiln Screening - Alabama Lime

Samplers: Abernathy, Gay, Maret, Phoenix, Siegal

Date	Time	Field Sample ID	Sample Description	PCDD's	PCDF's						Remarks
3/23/98		M23-O-1-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/24/98		M23-O-2-1	Container No. 1 - Filter	•	•						
3/24/98		M23-O-2-2	Container No. 2 - Train Acetone Rinse	•	•						
3/24/98		M23-O-2-3	Container No. 3 - Train Toluene Rinse	•	•						
3/24/98		M23-O-2-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/26/98		M23-O-3-1	Container No. 1 - Filter	•	•						
3/26/98		M23-O-3-2	Container No. 2 - Train Acetone Rinse	•	•						
3/26/98		M23-O-3-3	Container No. 3 - Train Toluene Rinse	•	•						
3/26/98		M23-O-3-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/28/98		M23-O-4-1	Container No. 1 - Filter	•	•						
3/28/98		M23-O-4-2	Container No. 2 - Train Acetone Rinse	•	•						
3/28/98		M23-O-4-3	Container No. 3 - Train Toluene Rinse	•	•						
3/28/98		M23-O-4-4	Container No. 4 - XAD Sorbent Resin	•	•						
3/23/98		M23-FB-1-1	Container No. 1 - Filter	•	•						FIELD BLANK 1
3/23/98		M23-FB-1-2	Container No. 2 - Train Acetone Rinse	•	•						FIELD BLANK 1
3/23/98		M23-FB-1-3	Container No. 3 - Train Toluene Rinse	•	•						FIELD BLANK 1
3/23/98		M23-FB-1-4	Container No. 4 - XAD Sorbent Resin	•	•						FIELD BLANK 1
3/24/98		M23-FB-2-1	Container No. 1 - Filter	•	•						FIELD BLANK 2
3/24/98		M23-FB-2-2	Container No. 2 - Train Acetone Rinse	•	•						FIELD BLANK 2

PACIFIC ENVIRONMENTAL SERVICES, INC.

Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Chain of Custody Record

Project Num	Project Name
r012.002	US EPA Lime Kiln Screening - Alabama Lime

Samplers: Abernathy, Gay, Maret, Phoenix, Siegal

Date	Time	Field Sample ID	Sample Description	PCDD's	PCDF's						Remarks
3/24/98		M23-FB-2-3	Container No. 3 - Train Toluene Rinse	•	•						FIELD BLANK 2
3/24/98		M23-FB-2-4	Container No. 4 - XAD Sorbent Resin	•	•						FIELD BLANK 2
3/26/98		M23-FB-3-1	Container No. 1 - Filter	•	•						FIELD BLANK 3
3/26/98		M23-FB-3-2	Container No. 2 - Train Acetone Rinse	•	•						FIELD BLANK 3
3/26/98		M23-FB-3-3	Container No. 3 - Train Toluene Rinse	•	•						FIELD BLANK 3
3/26/98		M23-FB-3-4	Container No. 4 - XAD Sorbent Resin	•	•						FIELD BLANK 3
3/27/98		M23-RB-1	Container No. 1 - Filter	•	•						REAGENT BLANK
3/27/98		M23-RB-2	Container No. 2 - Train Acetone Rinse	•	•						REAGENT BLANK
3/27/98		M23-RB-3	Container No. 3 - Train Toluene Rinse	•	•						REAGENT BLANK
3/27/98		M23-RB-4	Container No. 4 - XAD Sorbent Resin	•	•						REAGENT BLANK

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for lab by: (Signature)	REMARKS
	1594 4/1/98	R. Davis	

TRIANGLE LABORATORIES, INC. -- LOG IN RECORD/CHAIN OF CUSTODY

Custody Seal : Absent
Chain of Custody : Present
Sample Tags : Absent
Sample Tag Numbers: Not Listed on Chain of Custody
SMO Forms : N/A

Sample Seals: Absent
Container...: Intact

TLI Project Number 45399
Client: PES03 - Pacific Environmental Services

Date Received 04/01/98 By Mark Stevens

Carrier and Number

Ice Chest/Box NO COOLANT

Book 204 Page 92

TLI Number.. mR/H:CPM.	Client Sample ID..... Client COC ID.....*	Matrix Location.....	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	DISPOSED Date/Init
204-92-1A	M23-I-1-1 M23-I-1-1	FILTER C02	MW 4/2/98	Used							
204-92-1B	M23-I-1-2 M23-I-1-2	ACETONE RINSE C02									
204-92-1C	M23-I-1-3 M23-I-1-3	TOLUENE RINSE C02									
204-92-1D	M23-I-1-4 M23-I-1-4	XAD C02									
204-92-2A	M23-I-2-1 M23-I-2-1	FILTER C02									
204-92-2B	M23-I-2-2 M23-I-2-2	ACETONE RINSE C02									
204-92-2C	M23-I-2-3 M23-I-2-3	TOLUENE RINSE C02									
204-92-2D	M23-I-2-4 M23-I-2-4	XAD C02									
204-92-3A	M23-I-3-1 M23-I-3-1	FILTER C02									
204-92-3B	M23-I-3-2 M23-I-3-2	ACETONE RINSE C02									
204-92-3C	M23-I-3-3 M23-I-3-3	TOLUENE RINSE C02									
204-92-3D	M23-I-3-4 M23-I-3-4	XAD C02									
204-92-4A	M23-I-4-1 M23-I-4-1	FILTER C02									
204-92-4B	M23-I-4-2 M23-I-4-2	ACETONE RINSE C02	MW 4/2/98	used							

Receiving Remarks: ON SAMPLE LABEL:M23-O-1-2, ACETONE WAS MARKED THROUGH AND TOLUENE WRITTEN ABOVE IT; TOLUENE WAS MARKED THROUGH WITH ACETONE WRITTEN ABOVE FOR SAMPLE M23-O-1-3; NEITHER AGGREED WITH CLIENT'S COC.

Archive Remarks:

TRIANGLE LABORATORIES, INC. -- LOG IN RECORD/CHAIN OF CUSTODY

Custody Seal : Absent	Sample Seals: Absent	TLI Project Number 45399	Book
Chain of Custody : Present	Container...: Intact	Client: PES03 - Pacific Environmental Services	204
Sample Tags : Absent			
Sample Tag Numbers: Not Listed on Chain of Custody			
SMO Forms : N/A		Date Received 04/01/98 By Mark Stowe	Page
Ice Chest/Box NO COOLANT		Carrier and Number	92

TLI Number.. mR/H:CPM.	Client Sample ID..... .....Client COC ID.....*	.....Matrix Location.....	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	DISPOSED Date/Init
204-92-4C	M23-I-4-3 M23-I-4-3	TOLUENE RINSE C02	JH 4/2/97	used							
204-92-4D	M23-I-4-4 M23-I-4-4	XAD C02									
204-92-5A	M23-O-1-1 M23-O-1-1	FILTER C02									
204-92-5B	M23-O-1-2 M23-O-1-2	TOLUENE RINSE C02									
204-92-5C	M23-O-1-3 M23-O-1-3	ACETONE RINSE C02									
204-92-5D	M23-O-1-4 M23-O-1-4	XAD C02									
204-92-6A	M23-O-2-1 M23-O-2-1	FILTER C02									
204-92-6B	M23-O-2-2 M23-O-2-2	ACETONE RINSE C02									
204-92-6C	M23-O-2-3 M23-O-2-3	TOLUENE RINSE C02									
204-92-6D	M23-O-2-4 M23-O-2-4	XAD C02									
204-92-7A	M23-O-3-1 M23-O-3-1	FILTER C02									
204-92-7B	M23-O-3-2 M23-O-3-2	ACETONE RINSE C02									
204-92-7C	M23-O-3-3 M23-O-3-3	TOLUENE RINSE C02									
204-92-7D	M23-O-3-4 M23-O-3-4	XAD C02	JH 4/2/97	used							

Receiving Remarks: ON SAMPLE LABEL:M23-O-1-2, ACETONE WAS MARKED THROUGH AND TOLUENE WRITTEN ABOVE IT; TOLUENE WAS MARKED THROUGH WITH ACETONE WRITTEN ABOVE FOR SAMPLE M23-O-1-3; NEITHER AGGREED WITH CLIENT'S COC.

Archive Remarks:

TRIANGLE LABORATORIES, INC. -- LOG IN RECORD/CHAIN OF CUSTODY

Custody Seal : Absent
Chain of Custody : Present
Sample Tags : Absent
Sample Tag Numbers: Not Listed on Chain of Custody
SMO Forms : N/A

Sample Seals: Absent
Container...: Intact

TLI Project Number 45399
Client: PES03 - Pacific Environmental Services

Date Received 04/01/98 By [illegible]

Carrier and Number

Ice Chest/Box NO COOLANT

Book 204 Page 92

TLI Number.. mR/H:CPM.	Client Sample ID..... Client COC ID.....*	Matrix Location.....	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	DISPOSED Date/Init
204-92-8A	M23-O-4-1 M23-O-4-1	FILTER C02	JH 4/2/98	used							
204-92-8B	M23-O-4-2 M23-O-4-2	ACETONE RINSE C02									
204-92-8C	M23-O-4-3 M23-O-4-3	TOLUENE RINSE C02									
204-92-8D	M23-O-4-4 M23-O-4-4	XAD C02									
204-92-9A	M23-FB-1-1 M23-FB-1-1	FILTER C02									
204-92-9B	M23-FB-1-2 M23-FB-1-2	ACETONE RINSE C02									
204-92-9C	M23-FB-1-3 M23-FB-1-3	TOLUENE RINSE C02									
204-92-9D	M23-FB-1-4 M23-FB-1-4	XAD C02									
204-92-10A	M23-FB-2-1 M23-FB-2-1	FILTER C02									
204-92-10B	M23-FB-2-2 M23-FB-2-2	ACETONE RINSE C02									
204-92-10C	M23-FB-2-3 M23-FB-2-3	TOLUENE RINSE C02									
204-92-10D	M23-FB-2-4 M23-FB-2-4	XAD C02									
204-92-11A	M23-FB-3-1 M23-FB-3-1	FILTER C02									
204-92-11B	M23-FB-3-2 M23-FB-3-2	ACETONE RISE C02	JH 4/2/98	used							

Receiving Remarks: ON SAMPLE LABEL:M23-O-1-2, ACETONE WAS MARKED THROUGH AND TOLUENE WRITTEN ABOVE IT; TOLUENE WAS MARKED THROUGH WITH ACETONE WRITTEN ABOVE FOR SAMPLE M23-O-1-3; NEITHER AGGREED WITH CLIENT'S COC.

Archive Remarks:

TRIANGLE LABORATORIES, INC. -- LOG IN RECORD/CHAIN OF CUSTODY

Custody Seal : Absent	Sample Seals: Absent	TLI Project Number 45399	Book
Chain of Custody : Present	Container...: Intact	Client: PES03 - Pacific Environmental Services	204
Sample Tags : Absent			
Sample Tag Numbers: Not Listed on Chain of Custody			
SMO Forms : N/A		Date Received 04/01/98 By Mark Stone	Page
Ice Chest/Box NO COOLANT		Carrier and Number	92

TLI Number.. mR/H:CPM.	Client Sample ID..... Client COC ID.....*	Matrix Location.....	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	To LAB Date/Init	To STORAGE Date/Init	DISPOSED Date/Init
204-92-11C	M23-FB-3-3 M23-FB-3-3	TOLUENE RINSE C02	MH 4/2/98	used							
204-92-11D	M23-FB-3-4 M23-FB-3-4	XAD C02									
204-92-12A	M23-RB-1 M23-RB-1	FILTER C02									
204-92-12B	M23-RB-2 M23-RB-2	ACETONE RINSE C02									
204-92-12C	M23-RB-3 M23-RB-3	TOLUENE RINSE C02									
204-92-12D	M23-RB-4 M23-RB-4	XAD C02	MH 4/2/98	used							

Receiving Remarks: ON SAMPLE LABEL:M23-O-1-2, ACETONE WAS MARKED THROUGH AND TOLUENE WRITTEN ABOVE IT; TOLUENE WAS MARKED THROUGH WITH ACETONE WRITTEN ABOVE FOR SAMPLE M23-O-1-3; NEITHER AGGREED WITH CLIENT'S COC.

Archive Remarks:

TRIANGLE LABORATORIES, INC.
SAMPLE TRACKING AND PROJECT MANAGEMENT FORM

----------ADMINISTRATIVE INFORMATION----------

TLI Proj#: 45399-	Samples: 12	TurnAround.: 21 Day(s)
Prod Code: D23451	Matrix.: M23	Hold Time..: 30 Day(s)
DetectLim: 0.05 ng	Type...: A	Start Date.: 04/02/98
	Recvd..: 04/01/98	Ship By....: 04/21/98
		DWL Due Dt.: 04/09/98

Analyte List.: Tetra-Octa CDDs/CDFs

Method.....: Method 23: T-O, Toluene Combined
Client Proj..: r012.002/Lime Kiln
Client.....: Pacific Environmental Services (PES03)
P.O. No.....: 104-98-0159 Collect Dt/Tm: SeeCOC
Contact.....: Mike Maret Phone.....: 919-941-0333
Proj. Mgr....: Rose West Fax.....: 919-941-0234
Sample Origin: AL

----------SPECIAL INSTRUCTIONS / QA REQUIREMENTS----------

Prep Project: 04228
Prespike Standard: USF-CS
Prespike Amount..: 4.0ng
Extraction Exp...: 04/22/98

----------REPORTING REQUIREMENTS----------

Reporting Format: Report Option II

See MILES for Instructions/Communications.

Completed by: Rose V. West DATE: 4-2-98

Reviewed by: RVW DATE: 4-2-98 (PMGT0197)

PROJECT COMMUNICATION TRACKING FORM

TLI Project Number: 45399

Use this form to record all exchanges of information between production units as well as personnel handling this project. Decisions, corrective actions and recommendations must also appear on this tracking document.

Date	Name	Comment / Decision / Resolution / Action / Observation
04/03/98	TLW	003 - Grey Solid & filter in thimble already.
		PES03-Pacific Environmental Services M23-I-3-4 Project:45399 204-92-3D US EPA Lime Kiln Screening - Alabama Lime - R012.002 Pacific Environmental Services, Inc. Research Triangle Park, North Carolina Run No. M23-I-3 Container No. M23-I-3-4 XAD sorbent module Triangle Laboratories, Inc. TLI PROJECT #04228 DATE [illegible] SPIKE USF-C & USF-S SPIKED [illegible] PREPED [illegible] AC PACIFIC ENVIRONMENTAL
		White XAD White glasswool. No Odor TLW 04/03/98
		004 - Brown solid & filter in thimble already.
		PES03-Pacific Environmental Services M23-I-4-4 Project:45399 204-92-4D US EPA Lime Kiln Screening - Alabama Lime - R012.002 Pacific Environmental Services, Inc. Research Triangle Park, North Carolina Run No. M23-I-1 Container No. M23-I-4-4 XAD sorbent module Triangle Laboratories, Inc. TLI PROJECT #04228 03-17-98 USF-C & USF-S [illegible] AC [illegible] ENVIRONMENTAL
		White XAD White glasswool. No Odor. TLW 04/03/98

005- White filter already in Thimble.

PES03-Pacific Environmental Services
M23-O-1-4
Project: 45399
204-92-5D

US EPA Lime Kiln Screening - Alabama Lime - R012.002
Pacific Environmental Services, Inc.
Research Triangle Park, North Carolina
Run No. M23-O-1
Container No. M23-O-1-4 XAD sorbent module

Triangle Laboratories, Inc.
TLI PROJECT #04228
DATE: 03-17-98
SPIKE: USF-C & USF-S
SPIKER_____
PREPED BY AC
PACIFIC ENVIRONMENTAL

white XAD
white glasswool.
No odor. TLW 04/03/98

006- white filters already in Thimble.

PES03-Pacific Environmental Services
M23-O-2-4
Project: 45399
204-92-6D

US EPA Lime Kiln Screening - Alabama Lime - R012.002
Pacific Environmental Services, Inc.
Research Triangle Park, North Carolina
Run No. M23-O-2
Container No. M23-O-2-4 XAD sorbent module

Triangle Laboratories, Inc.
TLI PROJECT #04228
DATE: 03-17-98
SPIKE: USF-C & USF-S
SPIKER_____
PREPED BY AC
PACIFIC ENVIRONMENTAL

white XAD
white glasswool.
No odor. TLW 04/03/98

000-

Triangle Laboratories, Inc.
TLI PROJECT #04228
DATE: 03-17-98 TLI BLANK
SPIKE: USF-C & USF-S
SPIKER_____
PREPED BY AC
PACIFIC ENVIRONMENTAL

Dry white XAD. No odor.
TLW 04/03/98

PROJECT COMMUNICATION TRACKING FORM

page ___ of ___

TLI Project Number: 45399

Use this form to record all exchanges of information between production units as well as personnel handling this project. Decisions, corrective actions and recommendations must also appear on this tracking document.

Date	Name	Comment / Decision / Resolution / Action / Observation
4/2/98		204-92-12A,D filter is white, XAD is white (sample #12)
		204-92-11 A,D filter is white, XAD is white (sample #11)
		204-92-10A,D filter is white, XAD is white (Sample #10)
		204-92-8A, D filter is gray XAD is white (sample #8)
		204-92-9A, D filter is white, XAD is white (sample #9)
		204-92-7A, D filter is gray, XAD is white (sample #7)
		204-92-6A, D filter is flesh/white, XAD is white (sample #6)
		4/2/98
		204-92-5A, D filter light gray/white XAD white (sample #5)
		204-92-3A, D filter gray powder (on filter), XAD white (sample #3)
		4/2/98

PROJECT COMMUNICATION TRACKING FORM

page ___ of ___

TLI Project Number: 45399-

Use this form to record all exchanges of information between production units as well as personnel handling this project. Decisions, corrective actions and recommendations must also appear on this tracking document.

Date	Name	Comment / Decision / Resolution / Action / Observation
2/98	JW	Sample 204-92-5A-D, 204-92-6A-D, 204-92-10A-D and 204-92-11A-D, 204-92-12A-D Didn't have and Extract added into the thimble before we add the samples from the bags.
		- Sample 204-92-1A - Contained filter with gray powder residue and a gray powder solid. The filter and solid was combine with solid gray extract in the thimble.
		Sample 204-92-2A Contained a filter with gray powder residue, also contained a gray powder solid. The filter and powder was combined with the solid extract

Date: 04/03/98
Time: 11:41

TRIANGLE LABORATORIES, INC.
Wet Lab MM5/PUF Observations
Project: 45399

Sample #	crd	TLI_Number..	Customer.Sample.Id.....	F. No	XAD Color.....	Filter Color.....	Glass Wool Color.....	PUF Color.....	Odor.....	Air Q.No.	Entered.By.....	Date....	Time....	S
000		TLI Blank	TLI M23 Blank	0	WHITE	NA	NA	NA	NONE	04228	WHIGHAM	04/03	10:59	F
001		204-92-1A-D	M23-I-1	1	WHITE	GREY	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
002		204-92-2A-D	M23-I-2	1	WHITE	GREY	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
003		204-92-3A-D	M23-I-3	1	WHITE	GREY	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
004		204-92-4A-D	M23-I-4	1	WHITE	BROWN	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
005		204-92-5A-D	M23-O-1	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
006		204-92-6A-D	M23-O-2	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
007		204-92-7A-D	M23-O-3	1	WHITE	GREY	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
008		204-92-8A-D	M23-O-4	1	WHITE	GRAY	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
009		204-92-9A-D	M23-FB-1	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
010		204-92-10A-D	M23-FB-2	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
011		204-92-11A-D	M23-FB-3	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
012		204-92-12A-D	M23-RB-1-4	1	WHITE	WHITE	WHITE	NA	NONE	04228	WHIGHAM	04/03	10:59	F
013		TLI LCS	TLI LCS	0	WHITE	NA	NA	NA	NONE	NA	WHIGHAM	04/03	10:59	F
014		TLI LCSD	TLI LCSD	0	WHITE	NA	NA	NA	NONE	NA	WHIGHAM	04/03	10:59	F

*** End of Report ***

TRIANGLE LABORATORIES, INC.

Dioxin Sample Preparation Tracking & Management Form

Project: 45399 Client: Pacific Environmental Services (PES03)

Solvent(s)/Acid(s): Toluene / _____ / _____ Method: Method 23: T-O, Toluene Combined Matrix: XAD

Lot Numbers: V560 KVPH-P / _____ / _____ Extraction Date: 04/03/98

IS Spike: 40 µl conc: 0.1000 ng/µl

SS Spike: ___ µl conc: __.___ ng/µl

MS Spike: 0 µl conc: 0.0000 ng/µl

LCS Spike: 0 µl conc: 0.0000 ng/µl

OPR Spike: 20 µl conc: 0.01 ng/µl

							TLW	TLW	TLW	SBM	Chemist
							60146	5670J	5814F	5863B	Spike #
							USF-I	USF-MX	USF-CS	USF-A	ID
							12/01/98	12/01/98	11/29/98	11/6/98	Expir
							04/03/98	04/03/98	04/03/98	4/4/98	Date
							11:10am	11:10am	11:10am	10:35	Time
							0.1 ng/µl	0.01 ng/µl	0.1 ng/µl	0.1 ng/µl	Conc.
							40 µl	40 µl	40 µl	40 µl	Vol.
#.crd	TLI SAMPLE ID	CLIENT SAMPLE ID	GROSS WEIGHT Before	GROSS WEIGHT After	SAMPLE SIZE ~~g / ml~~						Any Left
	TLI Blank	TLI M23 Blank	—	—	1		SBM			SBM	yes/no
01	204-92-1A-D	M23-I-1	—	—	1		SBM			SBM	yes/no
02	204-92-2A-D	M23-I-2	—	—	1		SBM			SBM	yes/no
03	204-92-3A-D	M23-I-3	—	—	1		SBM			SBM	yes/no
4	204-92-4A-D	M23-I-4	—	—	1		SBM			SBM	yes/no
5	204-92-5A-D	M23-O-1	—	—	1		SBM			SBM	yes/no
6	204-92-6A-D	M23-O-2	—	—	1		SBM			SBM	yes/no
7	204-92-7A-D	M23-O-3	—	—	1		SBM			SBM	yes/no
8	204-92-8A-D	M23-O-4	—	—	1		SBM			SBM	yes/no
9	204-92-9A-D	M23-FB-1	—	—	1		SBM			SBM	yes/no

ross weight of sample container + sample befo e/after aliquot removal.

Comments: Supelco Supelpak 2 (Lot # P1111) used for TLI LCS, LCSD. Prepre pred blank (# 04228) used for TLI blank. TLW 04/02/98

Initials: _____ Date: __/__/__

t of both SPIKER AND OBSERVER must be entered. XXXXX = Gross Weight not provided for WATER Samples.

REV 05/27/97 (PSTMF 7)

TRIANGLE LABORATORIES, INC.

Dioxin Sample Preparation Tracking & Management Form

Project: 45399

Client: Pacific Environmental Services (PES03)

Solvent(s)/Acid(s): Toluene / _____ / _____

Lot Numbers: V560 KVPH-P / _____ / _____

Methbd: Method 23: T-O, Toluene Combined Matrix: XAD

Extraction Date: 04/03/98

IS Spike: 40 µl conc: 0.1000 ng/µl

SS Spike: ____ µl conc: __.____ ng/µl

MS Spike: 0 µl conc: 0.0000 ng/µl

LCS Spike: 0 µl conc: 0.0000 ng/µl

OPR Spike: 20 µl conc: 0.01 ng/µl

S#.crd	TLI SAMPLE ID / CLIENT SAMPLE ID	GROSS WEIGHT Before	GROSS WEIGHT After	SAMPLE SIZE ~~g/ml~~					
					TLW	TLW	TLW	SBM	Chemist
					6014G	5670J	5814F	5863B	Spike #
					USF-I	USF-MX	USF-CS	USF-A	* ID
					12/04/98	12/01/98	11/24/98	11/6/98	* Expi
					04/03/98	04/03/98	04/03/98	4/4/98	* Date
					11:10a.m.	11:19a.m.	11:21a.m.	:	* Time
					0.1 ng/µl	0.01 ng/µl	0.1 ng/µl	0.1 ng/µl	* Conc
					40 µl	40 µl	40 µl	40 µl	* Vol
010	204-92-10A-D / M23-FB-2	—	—	1	SBM			SBM	Any Le yes/
011	204-92-11A-D / M23-FB-3	—	—	1	SBM			SBM	Any Le yes/
012	204-92-12A-D / M23-RB-1-4	—	—	1	SBM			SBM	Any Le yes/
013	TLI LCS / TLI LCS	—	—	1	SBM	SBM	SBM	SBM	Any L yes/
014	TLI LCSD / TLI LCSD	—	—	1	SBM	SBM	SBM	SBM	Any L yes/
									Any L yes/
									Any I yes/
									Any I yes/
									Any yes
									Any yes

ross weight of sample container + sample before/after aliquot removal.

mments: Supelco Supelpak 2 (Lot # P1111) used for TLI LCS, LCSD. Preprepared Blank (# 04228) sed for TLI blank TLW 04/02/98

Initials: _____ Date: __/__/

of both SPIKER AND OBSERVER must be entered.

XXXXX = Gross Weight not provided for WATER Sam

REV 05/27/97 (PSTM

TRIANGLE LABORATORIES, INC.
DIOXIN SAMPLE EXTRACTION and CLEANUP TRACKING FORM
TLI Project No.: 45399

Ext S#.crd and TLI Number	1	2	3	4a	5	4b	6	4a	7	8	9
000 TLI Blank	TLW 04/03/98	SDH 4/4/98	JDP 4.5.98	—	—	JDP 4/4/98	JDP 4/4/98	JDP 4/5/98	JDP 4.5.98	CPH/AMW 4/6/98	LE 4/6/98
001 204-92-1A-D				JDP 4.4.98	JDP 4.4.98						
002 204-92-2A-D				JDP 4.4.98							4/7/98 LE
003 204-92-3A-D				JDP 4.4.98	JDP 4.4.98						
004 204-92-4A-D				—	—						
005 204-92-5A-D				—	—						
006 204-92-6A-D				—	—						
007 204-92-7A-D				—	—						LE 4/7/98
008 204-92-8A-D				—	—						
009 204-92-9A-D	TLW 04/03/98			—	—					CPH/AMW 4/6/98	

Enter the procedure number below into the box at the top of each column to signify the step performed.
Initial and date each sample for each numbered procedure performed.

#..	....PROCEDURE....	SOP.#.	.v..	DETAILS (circle)
1)	EXTRACTION			Time On __ : __ Time Off __ : __
				Soxhlet / Jar / Sep Funnel / Steam Dist / Cont LL / ASE / Waste Dilution
2)	SPIKE AFTER EXT'N			
3)	ADD TRIDECANE			Lot# TRI 115.71
4)	ROTOVAP	124	1	40mL / 1 10mL / a Dryness → Samples 001, 002, 003; Parts 1A2 combine.
5)	COMBINE			
6)	DIV/LIP. DETERM.			20%/80% 50%/50% 5mL/20mL Other_____
7)	SOLVENT EXCHANGE			Iso-Octane Lot# C77164 Heptane Lot#_____
8)	CLEANUP		V.5	DSP 260 / DSP 225 / DSP 115 / DSP 215 / DSP 267 / Other_____
9)	TRANSFER	272	2	
10)	ADDITIONAL CLEANUP			Mod. DSP 260 / DSP 225 / DSP 115 / DSP 215 / DSP 267 / DSP260(10g)
11)	FINAL TRANSFER			

Comments: _____

TRIANGLE LABORATORIES, INC.

DIOXIN SAMPLE EXTRACTION and CLEANUP TRACKING FORM

TLI Project No.: 45399

Ext S#.crd and TLI Number	1	2	3	4a	5	4b	6	4a	7	8	9
010 204-92-10A-D	TLW 04/03/98	SM 4/4/98	JMP 4.5.98	—	—	JMP 4.14.98	JMP 4.15.98	JMP 4.15.98	JMP 4.15.98	CP/AMW 4/6/98	[illegible]
011 204-92-11A-D				—	—						
012 204-92-12A-D				—	—						
013 TLI LCS				—	—						
014 TLI LCSD	TLW 04/03/98			—	—					CP/AMW 4/6/98	[illegible]

Enter the procedure number below into the box at the top of each column to signify the step performed.
Initial and date each sample for each numbered procedure performed.

#.. ....PROCEDURE....	SOP.#.	.v..	DETAILS (circle)
1) EXTRACTION	____	____	Time On __ : __ Time Off __ : __
			(Soxhlet) / Jar / Sep Funnel / Steam Dist / Cont LL / ASE / Waste Dilution
2) SPIKE AFTER EXT'N			
3) ADD TRIDECANE			Lot# TRI 1.5.71
4) ROTOVAP	124	6	40mL (b) 10mL (a) Dryness
5) COMBINE	____	____	
6) (DIV)/LIP. DETERM.	____	____	20%/80% (50%/50%) 5mL/20mL Other____
7) SOLVENT EXCHANGE			Iso-Octane Lot# 977164 Heptane Lot#____
8) CLEANUP		V.5	(DSP 260) / DSP 225 / DSP 115 / DSP 215 / DSP 267 / Other ____
9) TRANSFER	272	2	
10) ADDITIONAL CLEANUP		____	Mod. DSP 260 / DSP 225 / DSP 115 / DSP 215 / DSP 267 / DSP260(10g)
11) FINAL TRANSFER	____	____	

Comments: _____

Rev 11/25/97 (PSTMI

TRIANGLE LABORATORIES, INC.
Transfer Chain-of-Custody Form
Project 45399

Transfer From: DWLH5 To: DMS5

	Initials..	Date.....	Time...
Released by:	[illegible]	4/7/98	11:18
Accepted by:	[illegible]	4/8/98	8:30

MILES.ID.....		TLI_No.....	Cust.Id.....
45399-	-000	TLI Blank	TLI M23 Blank
45399-	-001	204-92-1A-D	M23-I-1
45399-	-002	204-92-2A-D	M23-I-2
45399-	-003	204-92-3A-D	M23-I-3
45399-	-004	204-92-4A-D	M23-I-4
45399-	-005	204-92-5A-D	M23-O-1
45399-	-006	204-92-6A-D	M23-O-2
45399-	-007	204-92-7A-D	M23-O-3
45399-	-008	204-92-8A-D	M23-O-4
45399-	-009	204-92-9A-D	M23-FB-1
45399-	-010	204-92-10A-D	M23-FB-2
45399-	-011	204-92-11A-D	M23-FB-3
45399-	-012	204-92-12A-D	M23-RB-1-4
45399-	-013	TLI LCS	TLI LCS
45399-	-014	TLI LCSD	TLI LCSD

XfrCOC (Rev 11/01/94)

Additional comments or instructions:

TRIANGLE LABORATORIES, INC.

Method: Method 23: T-O, Toluene Combined — HR GC/HRMS ANALYSIS

Required Detection Limit: 0.05 ng — PROJECT: 45399

SAMPLE INFORMATION — RS Conc 20 µl ● 100.0 PG/µl

S#.crd	TLI / SAMPLE ID / CLIENT SAMPLE ID	1ST COLUMN GC/MS FILENAME COLUMN: DB5	CONFIRM	2ND COLUMN CONFIRM FILENAME COLUMN: DB225	USP-RS VOLUME SOLN ID	USP-RS INIT. DATE	ANALYSIS COMMENTS
000	TLI Blank / TLI M23 Blank	US80780	Y	P981305	20 ul G038A	(AA) 4/9/98	
001	204-92-1A-D / M23-I-1	W981017	Y	P981306			
002	204-92-2A-D / M23-I-2	W981018	Y	P981307			
003	204-92-3A-D / M23-I-3	T981957	Y	P981308			
004	204-92-4A-D / M23-I-4	T981958	Y	P981309			
005	204-92-5A-D / M23-O-1	T981959	Y	P981310			
006	204-92-6A-D / M23-O-2	T981960	Y	P981311			
007	204-92-7A-D / M23-O-3	S982305	Y	P981312			
008	204-92-8A-D / M23-O-4	S982306	Y	P981313			
009	204-92-9A-D / M23-FB-1	S982307	N	P981318			
010	204-92-10A-D / M23-FB-2	S982308	Y	P981319			
011	204-92-11A-D / M23-FB-3	S982309	Y	P981320	20 ul G038A	RAB 4/9/98	

Comments: Sample 005 appears to have been double spiked based on observed volume. Mom 4/15/98

Type: A

Spike File: SPMIT204

Amt of Extract: 50%

REV 03/07/95 (PSTMF

TRIANGLE LABORATORIES, INC.

Method: Method 23: T-O, Toluene Combined — HR GC/HRMS ANALYSIS

Required Detection Limit: 0.05 ng — PROJECT: 45399

SAMPLE INFORMATION — RS Conc 20 µl @ 100.0 PG/µl

.crd	TLI / SAMPLE ID / CLIENT SAMPLE ID	1ST COLUMN GC/MS FILENAME COLUMN:	CONFIRM	2ND COLUMN CONFIRM FILENAME COLUMN: DB225	USF-RS VOLUME SOLN ID	USF-RS INIT. DATE	ANALYSIS COMMENTS
2	204-92-12A-D / M23-RB-1-4	5982310		P981321	20 ul 6038A	KAS 4/9/98	
3	TLI LCS / TLI LCS	5982311	—	—	↓	↓	
4	TLI LCSD / TLI LCSD	5982312	—	—	20 ul 6038A	KAS 4/9/98	

Comments: _____

Type: A

Spike File: SPMIT204

Amt of Extract: 50%

REV 03/07/95 (PSTMF 6)

Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
705	DB5	5638441	T02	2.0uL	US	NDB5US

DL
Signature

4/18/98
Date

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
~~5982300~~			~~45499~~	~~205-89-5A~~	6	~~5804089572~~	~~Auto~~		~~MS 4/17/98~~	
5982301			45464	OPR	0	OPR Water	↓		↓	
5982302			↓	TU Blank	1	TU Water Blank	↓		↓	
~~5982303~~			~~45464~~	~~205-58-1A~~	2	~~Sandy Pond~~	~~Auto~~		~~MS 4/17/98~~	Not run 1/from 4/17/9
5982297	4/18/98	1:31	45464	OPR	0	OPR Water	Auto	6.7 ES	DL 4/18/98	
298	↓	2:25	↓	Blank	1	TU Water Blank	↓	5.1 ES	↓	very low IS recovery
299	4/18/98	3:11	45464	205-58-1A	2	Sandy Pond	↓	5.7 ES	↓	
300			45470	205-64-1A	2	POS-Entry Point Sample	↓		↓	
~~5982301~~			~~45470~~	~~205-74-1A~~	2	~~184402-01~~	~~Auto~~		~~DL 4/18/98~~	not run 1/from 4/18/9
5982302	4/18/98	8:27	—	6062A	—	Rtchk	Rtchk	11%	DL 4/18/98	
5982303	↓	9:28	—	5964B	—	8290/1613 Concal 10	MO #3	5.2 ES	DL 4/18/98	good for 8290CT-0 +1 DL
5982304	↓	10:33	—	6038D	—	RS100	Auto	4.2 ES	DL 4/18/98	clean
5982305	4/18/98	11:26	45399	204-92-7A-1	7	M23-0-3	Auto	6.1 ES	DL 4/18/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 7:53 (was good 1613 EDD only)
ConCal Due: _____

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5982305 → 315
(1 sample)

Triangle Laboratories, Inc.
Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
705	DB5	5638441	702	2.0ml	US	NDBSUS

DL
Signature

4/18/98
Date

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
S982306	4/18/98	12:12	45399	204-92-8A-D	8	M23-0-4	AUTO	6.9 ES	DL 4/18/98	
S982307		12:58		-9A-D	9	M23-FB-1		6.6 ES		
S982308		13:44		-10A-D	10	M23-FB-2		5.7 ES		
S982309		14:27		-11-A-D	11	M23-FB-3		5.3 ES		
S982310		15:16		204-92 -12A-D	12	M23-RB-1-4		5.6 ES		
S982311		1602		TU LCS	13	TU LCS		4.9 ES		
S982312		1648	45399	TU LCSD	14	TU LCSD		4.8 ES		
S982313		1734	45403	TU Blank	0	TU solid blank		8.7 ES		
S982314		1820		204-96-1	1	Soil bt sample #1		1.1 ES		
S982315	4/18/98	1906	45403	204-96-2	2	Soil sample # 2	AUTO	6.7 ES	DL 4/18/98	
S982316	4/18/98	1950	45403	204-96-3	3	Basement NW sample #1	Auto	6.6 ES	ML 4/18/98	
S982317	4/18/98	2041	—	5969B	—	8290 concal 10.0	M-2 #3	6.7 ES	ML 4/18/98	Good ending only
S982318	4/18/98	2136	—	6062A	—	Retention window check	RTCHK	13%	ML 4/18/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 21:28
ConCal Due:

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Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
70T	DB5	7631535	TC2	2.0 µl	US	NDBSUS

DLe
Signature

4/17/98
Date

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
T981940	4/17/98	16:22	91591	Mick Carbon 1	7	"Mick's Carbon" Sample #1	AUTO	4.4 ±5	DLe 4/17/98	
T981941		17:09		2	8	#2		3.9 ±5		
T981942		17:55		3	9	#3		4.3 ±5		
T981943		18:42		4	10	#4		4.3 ±5		
T981944	4/17/98	19:28	91591	Mick Carbon 5	11	"Mick's Carbon" Sample #5	AUTO	4.7 ±5	DL 4/17/98	
T981945		20:28	—	6062A	—	Rtchk	Rtchk	17%	BB 4/17/98	
T981946		21:18	—	5969B	—	8290/16B Concal	m-o #3	5.9 ±5	BB 4/17/98	9000 8290 BB 4/17
T981947		22:18	—	6030C	—	RS100	auto	6.3 ±5	BB 4/17/98	
~~948~~	~~4/17/98~~		~~45460~~	TC2 Blank	0	~~TC2 MZ3 Blank~~				
949				205-54-3	3	980125 = methol Blank				
950				205-54-1	1	980123 = line1				
951				205-54-2	2	980134 = line2				
~~T981952~~			~~454601~~	TC2LCS	4	TC2 LCS	auto		BB 4/17/98	Needle bent at s of run LMM 4/17

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: _____
ConCal Due: _____

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Triangle Laboratories, Inc.
Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
70T	DB-5	7631535	T02	20ul	US	HDBSUS

Brenda Borofede — Signature
4/18/98 — Date

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
~~T981953~~			~~45460r1~~	~~T02LCSD~~	5	T02 LCSD	auto		~~BB 4/18/98~~	not used mm 4/18
T981951	4/18/98	1:34	45460r1	Blank	0	TLI M23 Blank	Auto	6.7 BS	mm 4/18/98	
52	4/18/98	2:20		205-54-3	3	980125= Method Blank		5.8 BS		
53	4/18/98	3:06		205-54-1	1	980123: Cal 1		6.7 BS		
54	4/18/98	3:53		205-54-2	2	980124= Cal 2		6.5 ES		
55	4/18/98	4:40		LCS	4	LCS		6.6 ES		
56	4/18/98	05:26	45460r1	LCSD	5	LCSD		6.1 ES		
T981957	4/18/98	06:13	45399	204-92-3A-D	3	M23-I-3	Auto	6.4 ES	mm 4/18/98	
58	4/18/98	06:59		204-92-4A-D	4	M23-I-4		9.4 ES		
59	4/18/98	7:46		204-92-5A-D	5	M23-O-1		6.1 ES		
T981960	4/18/98	8:32	45399	204-92-6A-D	6	M23-O-2	Auto	6.2 ES	mm 4/18/98	
T981961	4/18/98	9:56	—	6062A	—	Rtchk	Rtchk	16%	DL 4/18/98	
T981962	4/18/98	10:44	—	5969B	—	8290/1613 Cal 10	MU #3	4.3 ES	DL 4/18/98	HxCDD, OCDD out DL 4/18

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 9:15
ConCal Due:

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1.03

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
7DU	DB-5	7586437	TD2	2.0 µl	NDB5US	NDB5US

Signature: [illegible] Date: 4/15/98

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
U980763	4/15/98	455	45381B	204-74-10	5	DPG 445	U4091	2.9 E7	KS 4/15/98	
U980764	4/15/98	542	45381B	204-74-11	6	DPG 473	U4091	3.1 E7	KS 4/15/98	
U980765	4/15/98	6:27	45381B	204-74-12	7	DPG 474	U4091	4.8 E7	KS 4/15/98	
U980766	4/15/98	7:33	45381B	LCS	8	LCS	U4091	2.0 E7	[illegible] 4/15/98	
U980767	4/15/98	8:22	45381B	TLI LCSD	9	TLI LCSD	U4091	3.5 E7	DL 4/15/98	
U980768	4/15/98	9:11	—	5969B	—	8240 concal 10	MU #3	3.2 E7	DL 4/15/98	good endmy cal
U980769	4/15/98	10:52	—	5994	—	Rt-chk	Rt-chk	18%	DL 4/15/98	
U980770	4/15/98	12:04	—	5969B	—	8240 concal 10	MU #3	3.3 E7	DL 4/15/98	[illegible]
U980771	4/15/98	13:11	—	5969B	—	8240 concal 10	MU #3	2.8 E7	DL 4/15/98	~~[illegible]~~ good 8240 [illegible]
U980772	4/15/98	14:17	—	6038C	—	RS10D	U4091	2.1 E7	DL 4/15/98	clean DL 4/15/98
U980773	4/15/98	15:12	45473	205-67-1	1	25893-001	U4091	6.4 E7	DL 4/15/98	
U980774	4/15/98	15:59	45473	LCSD	3	TLI LCSD	U4091	4.7 E7	DL 4/15/98	
U980775	4/15/98	1646	45381A	204-74-1	1	DPG 044	U4091	2.5 E7	DL 4/15/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 11:06
ConCal Due: 10:0pm

B

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Triangle Laboratories, Inc.
F Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
70W	DB-5	7586437	702	2.0 µl	NDBSMS	NDBSMS
				Signature		4/15/93 Date

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
U980776	04/15/98	1732	45381A	204-74-2	2	DPG 903	U4091	2.0 E7	ML 04/15/93	
U980777	04/15/93	1819	45381A	204-74-3	3	DPG 073	U4091	2.8 E7	ML 04/15/93	
U980778	04/15/93	1914	45381A	204-74-4	4	DPG 073	U4091	2.9 E7	ML 04/15/93	
U980779	04/15/93	2001	45381A	204-74-5	5	DPG 074	U4091	2.8 E7	ML 04/15/93	
U980780	04/15/98	2048	45399	TLI Blank	0	TLI MLS Blank	U4091	3.0 E7	ML 04/15/98	
U980781	04/15/93	2153	—	5969B	—	8290 Concal 10.0	M-0 #3	3.3 E7	ML 04/15/93	Good background and
U980782	04/15/93	2322	—	5969B	—	8290 Concal 10.0	M-0 #3	3.1 E7	ML 04/15/98	Tetrac SD above [illegible]
U980783	04/16/93	0:25	—	5969B	—	8290 Concal 10.0	M-0 #3	3.7 E7	ML 04/16/93	NG [illegible]
~~U980784~~	~~4/16/98~~		—	~~5969B~~	—	~~8290 CONCL 10~~	M-0 #3		~~WK 4/16/98~~	NOT USED WK 4/16/98
U980785	4/16/98		—	5969B	—	8290 CON 10	M-0 #3		WK 4/16/98	WRONG VOLUME WK 4/16/98
U980786	4/16/98	13:29	—	5969B	—	8290 CONCL 10	M-0 #3	3.7 E7	WK 4/16/98	
U980787	4/16/98		—	5969B	—	8290 CONC 10	M-0 #3		WK 4/16/98	
U980788	4/16/98		—	5969B	—	8290/1613/MIT	M-0 #3		WK 4/16/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 10:00pm
ConCal Due: _____

Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
VG TOW	DB5	8677115	TOL	2 ul	NDB5U8	NDA5

Signature: [illegible]

Date: 4/15/98

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
W981009	4/15/98		—	5994	—	RT CHK	Rch		Lok 4/15/98	
W981010	4/15/98		—	5969B	—	8290/1613/MIT CC 10	M-0 #3		MAS 4/15/98	
W981011	4/15/98		—	5969B	—	8290/1613/MIT CC 10	W-0 #7		MAS 4/16/98	
W981012	4/16/98	11:12	—	5961A	—	8290/1613A CONCAL 10	M-0 #3	0.7 FF	Lok 4/16/98	Good Lok 4/
W981013	4/16/98	12:24	—	6062A	—	RT CHK	Rch	16%	Lok 4/16/98	
W981014	4/16/98	13:24	—	6038C	—	RS-1 ON	W402	7.4 ES	Lok 4/16/98	
W981015	4/16/98	14:24	45404	204-97-1A	2	DSN 001	W402	2.1 ES	Lok 4/16/98	
W981016	4/16/98	15:17	45409	205-3-1A	2	98-3496	W402	1.1 ES	Lok 4/16/98	
W981017	4/16/98	16:19	45399	204-92-1A-D	1	M23-I-1	W402	2.5 ES	Lok 4/16/98	
W981018	4/16/98		45399	204-92-1A-D	2	M23-I-2	W4021		MAS 4/16/98	
W981019	4-17-98		—	5969B	—	8290/1613/MIT CONCAL	M-0 #3		GG 4-17-98	
W981020	4-17-98		—	5969B	—	8290/1613/MIT CONCAL 10	M-0 #3		GG 4-17-98	
W981021	4-17-98		—	5969B	—	8290/1613/MIT CONCAL 10	M-0 #3		GG 4-17-98	

* Transcribed from chromatographic data

** Dated initials required

ConCal Due: 22:30 pm MAS 4/16/98

ConCal Due: _____

Triangle Laboratories, Inc.
Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
70P	DB225	7609925	TT1	20ul	DB225	DB225

Signature: Bernard J. Glasmann
Date: 4/16/98

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
P981300	4/16/98	8:17	—	5994	—	RTCHK	RTCHK	11%	BJG 4/16/98	Good BJG 4/16/98
P981301	4/16/98	9:14	—	5787	—	TETRA Cont/5.0	Tetra 5.0	2.8 ES	BJG 4/16/98	NG IS > 30%
P981302	4/16/98	13:10	—	5787	—	TETRA Cont 5.0	Tetra 5.0	4.0 ES	4/16/98	Good BJG 4/16/98
P981303	4/16/98	14:05	—	6062A	—	RTCHK	RTCHK	13%	BJG 4/16/98	Good BJG 4/16/98
P981304	4/16/98	14:55	—	6038C	—	RS-100	P4141	2.3 ES	BJG 4/16/98	Clean BJG 4/16/98
P981305	4/16/98	1542	45399	TC1 BLANK	0	TC1 M23 BLANK	P4141	2.9 ES	BJG 4/16/98	
P981306	4/16/98	1630	45399	204-92-1A-D	1	M23-I-1	P4141	2.7 ES	BJG 4/16/98	
P981307	4/16/98	1812	45399	204-92-2A-D	2	M23-I-2	P4141	4.5 ES	ML 4/16/98	
P981308	4/16/98	1858	45399	204-92-3A-D	3	M23-I-3	P4141	4.4 ES	ML 4/16/98	
P981309	4/16/98	1951	45399	204-92-4A-D	4	M23-I-4	P4141	6.2 ES	ML 4/16/98	
P981310	4/16/98	2038	45399	204-92-5A-D	5	~~M23-I-1~~ EE ML 4/16/98 M23-D-1	P4141	4.3 ES	ML 4/16/98	
P981311	4/16/98	2124	45399	204-92-6A-D	6	M23-D-2	P4141	3.7 ES	ML 4/16/98	
P981312	4/16/98	2212	45399	204-92-7A-D	7	M23-D-3	P4141	3.8 ES	ML 4/16/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: 11:50 pm KAJ 4/14/98
ConCal Due: _____

Triangle Laboratories, Inc.
Run Log

Instrument ID	Column Type	Column ID	Plot Name	Inj. Vol.	Acquisition	G/C
70P	DB225	7609225	T11	2.0 µl	DB225	DB225

Signature: [illegible]
Date: 4/16/98

Filename	Date*	Time*	Project #	Sample#	No.	Client Sample ID	Syr	332	Operator/Date	Comments**
P981313	04/16/98	2300	45473	205-67-1	1	25893-001	P4141	7.2 E4	ML 04/16/98	
P981314	04/16/98	23:58	—	5787	—	Tetra Concl 5.0	Tetra 5.0	3.0 E1	ML 04/16/98	Good F&B KB 4/17
P981315	4/17/98	01:09	—	6062A	—	RTCHK	RTCHK	10%	KB 4/17/98	Good KB 4/17/98
P981316	4/17/98	154	—	6038C	—	RS-100	P4141	2.2 E1	KB 4/17/98	Clean KB 4/17/98
P981317	4/17/98	241	45399	204-92-8A-D	8	M23-0-4	P4141	24 ES	KB 4/17/98	
P981318	4/17/98	329	45399	204-92-9A-D	9	M23-FB-1	P4141	30 ES	KB 4/17/98	
P981319	4/17/98	418	45399	204-92-10A-D	10	M23-FB-2	P4141	2.3 ES	KB 4/17/98	
P981320	4/17/98	05:04	45399	204-92-11-D	11	M23-FB-3	P4141	2.5 ES	KB 4/17/98	
P981321	4/17/98	05:49	45399	204-92-12A-D	12	M23-RB-1-4	P4141	2.6 ES	Jm 4/17/98	

* Transcribed from chromatographic data
** Dated initials required

ConCal Due: _____
ConCal Due: _____

srvr1/qa/forms/hrunlog.doc (02/05/97)

TRIANGLE LABS

SAMPLE DATA

Triangle Laboratories, Inc.
801 Capitola Drive
Durham, NC 27713-4411
919-544-5729
P.O. Box 13485
Research Triangle Park, NC 27709-3485
Fax # 919-544-5491

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	U980780	W981017	W981018	T981957
Sample ID	TLI M23 Blank	M23-I-1	M23-I-2	M23-I-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/15/98	04/16/98	04/16/98	04/18/98
Instrument	U	W	W	T
Matrix	XAD	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet
Analytes				
2378-TCDD	(0.002)	(0.03)	(0.04)	(0.003)
12378-PeCDD	(0.002)	(0.05)	(0.07)	(0.004)
123478-HxCDD	(0.003)	(0.06)	(0.09)	(0.007)
123678-HxCDD	(0.002)	(0.06)	(0.08)	(0.007)
123789-HxCDD	(0.002)	(0.06)	(0.08)	(0.007)
1234678-HpCDD	(0.003)	(0.09)	(0.1)	(0.01)
OCDD	0.01 J	(0.1)	{0.29}	{0.03} JB
2378-TCDF	{0.004}J	0.05 B	1.5	0.02 B
12378-PeCDF	(0.002)	(0.03)	0.21	(0.003)
23478-PeCDF	(0.002)	(0.04)	0.21	(0.003)
123478-HxCDF	(0.002)	(0.04)	0.10 J	{0.007}J
123678-HxCDF	(0.002)	(0.04)	{0.05} J	{0.004}J
234678-HxCDF	(0.002)	(0.04)	(0.06)	(0.004)
123789-HxCDF	(0.002)	(0.05)	(0.07)	(0.005)
1234678-HpCDF	(0.002)	(0.06)	{0.05} J	0.009 J
1234789-HpCDF	(0.002)	(0.08)	(0.1)	(0.008)
OCDF	(0.003)	(0.1)	(0.1)	(0.02)
TOTAL TCDD	(0.002)	(0.03)	0.25	0.01
TOTAL PeCDD	(0.002)	(0.05)	{0.11}	(0.004)
TOTAL HxCDD	(0.002)	(0.06)	0.07	(0.007)
TOTAL HpCDD	(0.003)	(0.09)	(0.1)	(0.01)
TOTAL TCDF	{0.004}	0.09	12.1	0.11
TOTAL PeCDF	(0.002)	{0.06}	2.7	0.02
TOTAL HxCDF	(0.002)	(0.04)	0.33	0.01
TOTAL HpCDF	(0.002)	(0.06)	{0.05}	0.009
Other Standards Percent Recovery Summary (% Rec)				
37Cl-TCDD	87.9	83.3	84.7	84.9
Other Standards Percent Recovery Summary (% Rec)				
13C12-PeCDF 234	106	89.3	88.8	94.9
13C12-HxCDF 478	108	78.3	81.0	87.6
13C12-HxCDD 478	114	75.5	75.6	90.8
13C12-HpCDF 789	90.1	83.6	85.1	68.1
Other Standards Percent Recovery Summary (% Rec)				
13C12-HxCDF 789	84.5	82.4	90.3	80.1
13C12-HxCDF 234	81.8	114	78.2	94.0
Internal Standards Percent Recovery Summary (% Rec)				
13C12-2378-TCDF	65.8	71.2	73.1	76.6
13C12-2378-TCDD	67.9	78.1	74.0	71.7

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	U980780	W981017	W981018	T981957
Sample ID	TLI M23 Blank	M23-I-1	M23-I-2	M23-I-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/15/98	04/16/98	04/16/98	04/18/98
Instrument	U	W	W	T
Matrix	XAD	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet
Internal Standards Percent Recovery Summary (% Rec)				
13C12-PeCDF 123	68.6	68.5	64.9	72.6
13C12-PeCDD 123	99.4	71.8	68.3	80.1
13C12-HxCDF 678	68.1	119	87.9	101
13C12-HxCDD 678	78.7	115	93.0	93.2
13C12-HpCDF 678	83.7	115	100.0	99.8
13C12-HpCDD 678	92.5	116	107	101
13C12-OCDD	83.0	103	95.4	65.6

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	T981958	T981959	T981960	S982305
Sample ID	M23-I-4	M23-O-1	M23-O-2	M23-O-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/18/98	04/18/98	04/18/98	04/18/98
Instrument	T	T	T	S
Matrix	M23	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet
Analytes				
2378-TCDD	(0.003)	(0.01)	(0.006)	(0.006)
12378-PeCDD	(0.004)	(0.02)	(0.009)	(0.009)
123478-HxCDD	(0.006)	(0.02)	(0.01)	(0.01)
123678-HxCDD	(0.005)	(0.02)	(0.01)	(0.01)
123789-HxCDD	(0.005)	(0.02)	(0.01)	(0.009)
1234678-HpCDD	0.008 J	(0.03)	0.01 J	(0.01)
OCDD	0.04 JB	(0.05)	{0.03} JB	(0.02)
2378-TCDF	0.34	{0.02} B	0.03 B	{0.007}JB
12378-PeCDF	0.04 J	(0.01)	(0.006)	(0.006)
23478-PeCDF	0.04 J	(0.01)	(0.006)	(0.006)
123478-HxCDF	0.01 J	(0.01)	(0.008)	(0.006)
123678-HxCDF	0.008 J	(0.01)	(0.007)	(0.006)
234678-HxCDF	0.008 J	(0.01)	(0.009)	(0.007)
123789-HxCDF	(0.004)	(0.01)	(0.01)	(0.008)
1234678-HpCDF	0.007 J	(0.02)	{0.01} J	(0.01)
1234789-HpCDF	(0.007)	(0.02)	(0.02)	(0.01)
OCDF	(0.02)	(0.04)	(0.03)	(0.01)
TOTAL TCDD	0.02	0.03	0.08	(0.006)
TOTAL PeCDD	{0.003}	(0.02)	0.03	(0.009)
TOTAL HxCDD	0.01	(0.02)	(0.01)	(0.01)
TOTAL HpCDD	0.02	(0.03)	0.01	(0.01)
TOTAL TCDF	2.6	{0.02}	0.25	{0.007}
TOTAL PeCDF	0.38	{0.01}	0.02	(0.006)
TOTAL HxCDF	0.05	(0.01)	{0.007}	(0.007)
TOTAL HpCDF	0.007	(0.02)	{0.01}	(0.01)
Other Standards Percent Recovery Summary (% Rec)				
37Cl-TCDD	88.9	92.6	87.1	96.7
Other Standards Percent Recovery Summary (% Rec)				
13C12-PeCDF 234	96.0	107	98.8	102
13C12-HxCDF 478	92.2	91.3	91.0	97.4
13C12-HxCDD 478	93.2	99.4	95.9	96.5
13C12-HpCDF 789	76.0	84.8	82.2	95.2
Other Standards Percent Recovery Summary (% Rec)				
13C12-HxCDF 789	76.1	38.5 V	66.8	62.9
13C12-HxCDF 234	75.6	39.2 V	73.2	65.3
Internal Standards Percent Recovery Summary (% Rec)				
13C12-2378-TCDF	60.6	22.9 V	57.4	54.8
13C12-2378-TCDD	53.7	22.3 V	54.3	49.0

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	T981958	T981959	T981960	S982305
Sample ID	M23-I-4	M23-O-1	M23-O-2	M23-O-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/18/98	04/18/98	04/18/98	04/18/98
Instrument	T	T	T	S
Matrix	M23	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet

Internal Standards Percent Recovery Summary (% Rec)

13C12-PeCDF 123	63.2	25.6	V	54.4	55.4
13C12-PeCDD 123	69.5	31.3	V	62.6	59.7
13C12-HxCDF 678	72.2	35.4	V	74.0	63.9
13C12-HxCDD 678	70.5	36.3	V	71.9	72.6
13C12-HpCDF 678	65.5	33.7		67.7	54.3
13C12-HpCDD 678	68.4	38.7		77.0	65.5
13C12-OCDD	40.3	25.1		47.7	63.1

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	S982306	S982307	S982308	S982309
Sample ID	M23-O-4	M23-FB-1	M23-FB-2	M23-FB-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/18/98	04/18/98	04/18/98	04/18/98
Instrument	S	S	S	S
Matrix	M23	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet
Analytes				
2378-TCDD	(0.004)	(0.003)	(0.004)	(0.003)
12378-PeCDD	(0.006)	(0.005)	(0.005)	(0.005)
123478-HxCDD	(0.008)	(0.005)	(0.006)	(0.005)
123678-HxCDD	(0.007)	(0.005)	(0.006)	(0.005)
123789-HxCDD	(0.007)	(0.004)	(0.006)	(0.005)
1234678-HpCDD	{0.01} J	(0.005)	(0.006)	(0.006)
OCDD	0.05 JB	(0.006)	(0.009)	(0.008)
2378-TCDF	0.02 JB	(0.002)	0.005 JB	(0.002)
12378-PeCDF	(0.004)	(0.004)	(0.004)	(0.004)
23478-PeCDF	(0.004)	(0.004)	(0.004)	(0.004)
123478-HxCDF	(0.005)	(0.003)	(0.004)	(0.004)
123678-HxCDF	(0.005)	(0.003)	(0.004)	(0.003)
234678-HxCDF	(0.006)	(0.004)	(0.004)	(0.004)
123789-HxCDF	(0.006)	(0.004)	(0.004)	(0.004)
1234678-HpCDF	(0.007)	(0.004)	(0.005)	(0.005)
1234789-HpCDF	(0.01)	(0.005)	(0.006)	(0.006)
OCDF	(0.01)	(0.004)	(0.006)	(0.006)
TOTAL TCDD	(0.004)	(0.003)	(0.004)	(0.003)
TOTAL PeCDD	(0.006)	(0.005)	(0.005)	(0.005)
TOTAL HxCDD	{0.009}	(0.005)	(0.006)	(0.005)
TOTAL HpCDD	{0.01}	(0.005)	(0.006)	(0.006)
TOTAL TCDF	0.17	(0.002)	0.005	(0.002)
TOTAL PeCDF	0.01	(0.004)	(0.004)	(0.004)
TOTAL HxCDF	0.008	(0.004)	(0.004)	(0.004)
TOTAL HpCDF	(0.008)	(0.005)	(0.005)	0.008
Other Standards Percent Recovery Summary (% Rec)				
37Cl-TCDD	91.8	93.5	92.1	93.8
Other Standards Percent Recovery Summary (% Rec)				
13C12-PeCDF 234	89.7	106	107	99.6
13C12-HxCDF 478	93.4	90.4	84.6	83.7
13C12-HxCDD 478	83.8	92.9	85.0	90.3
13C12-HpCDF 789	104	110	82.6	85.4
Other Standards Percent Recovery Summary (% Rec)				
13C12-HxCDF 789	87.0	84.9	85.6	88.0
13C12-HxCDF 234	86.1	87.4	87.6	87.6
Internal Standards Percent Recovery Summary (% Rec)				
13C12-2378-TCDF	79.7	74.4	70.4	63.8
13C12-2378-TCDD	64.1	63.1	66.2	63.4

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

04/21/98

Data File	S982306	S982307	S982308	S982309
Sample ID	M23-O-4	M23-FB-1	M23-FB-2	M23-FB-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/18/98	04/18/98	04/18/98	04/18/98
Instrument	S	S	S	S
Matrix	M23	M23	M23	M23
Extraction Type	Soxhlet	Soxhlet	Soxhlet	Soxhlet
Internal Standards Percent Recovery Summary (% Rec)				
13C12-PeCDF 123	70.7	70.1	72.1	64.2
13C12-PeCDD 123	68.3	83.6	95.3	74.3
13C12-HxCDF 678	80.5	72.8	96.7	84.5
13C12-HxCDD 678	95.3	91.7	104	97.8
13C12-HpCDF 678	74.4	80.5	102	82.6
13C12-HpCDD 678	87.2	106	133	99.2
13C12-OCDD	93.8	119	114	104

Data File	S982310
Sample ID	M23-RB-1-4
Units	ng
Extraction Date	04/03/98
Analysis Date	04/18/98
Instrument	S
Matrix	M23
Extraction Type	Soxhlet

Analytes	
2378-TCDD	(0.003)
12378-PeCDD	(0.004)
123478-HxCDD	(0.004)
123678-HxCDD	(0.004)
123789-HxCDD	(0.004)
1234678-HpCDD	(0.004)
OCDD	(0.005)
2378-TCDF	(0.002)
12378-PeCDF	(0.003)
23478-PeCDF	(0.003)
123478-HxCDF	(0.003)
123678-HxCDF	(0.003)
234678-HxCDF	(0.003)
123789-HxCDF	(0.003)
1234678-HpCDF	(0.003)
1234789-HpCDF	(0.004)
OCDF	(0.004)
TOTAL TCDD	(0.003)
TOTAL PeCDD	(0.004)
TOTAL HxCDD	(0.004)
TOTAL HpCDD	(0.004)
TOTAL TCDF	(0.002)
TOTAL PeCDF	(0.003)
TOTAL HxCDF	(0.003)
TOTAL HpCDF	(0.004)

Other Standards Percent Recovery Summary (% Rec)	
37Cl-TCDD	83.8

Other Standards Percent Recovery Summary (% Rec)	
13C12-PeCDF 234	101
13C12-HxCDF 478	82.5
13C12-HxCDD 478	82.5
13C12-HpCDF 789	95.2

Other Standards Percent Recovery Summary (% Rec)	
13C12-HxCDF 789	87.7
13C12-HxCDF 234	89.1

Internal Standards Percent Recovery Summary (% Rec)	
13C12-2378-TCDF	66.0
13C12-2378-TCDD	59.9

TRIANGLE LABORATORIES OF RTP, INC.
Sample Result Summary for Project 45399
Method MIT2 Analysis (DB-5)

Data File	S982310
Sample ID	M23-RB-1-4
Units	ng
Extraction Date	04/03/98
Analysis Date	04/18/98
Instrument	S
Matrix	M23
Extraction Type	Soxhlet

Internal Standards Percent Recovery Summary (% Rec)

13C12-PeCDF 123	62.5
13C12-PeCDD 123	76.1
13C12-HxCDF 678	81.6
13C12-HxCDD 678	97.6
13C12-HpCDF 678	82.8
13C12-HpCDD 678	101
13C12-OCDD	115

{Estimated Maximum Possible Concentration}, (Detection Limit).

TRIANGLE LABORATORIES, INC.
Sample Result Summary for Project 45399
Method 23X (DB-225)

04/20/98

Data File	P981305	P981306	P981307	P981308
Sample ID	TLI M23 Blank	M23-I-1	M23-I-2	M23-I-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/16/98	04/16/98	04/16/98	04/16/98
Instrument	P	P	P	P
Matrix	XAD	M23	M23	M23
Extraction Type				
Analytes				
2378-TCDF	(0.005)	{0.007}JB	0.51	{0.007}JB
Internal Standards Percent Recovery Summary (% Rec)				
13C12-2378-TCDF	69.2	80.4	73.5	79.7

TRIANGLE LABORATORIES, INC.
Sample Result Summary for Project 45399
Method 23X (DB-225)

04/20/98

Data File	P981309	P981310	P981311	P981312
Sample ID	M23-I-4	M23-O-1	M23-O-2	M23-O-3
Units	ng	ng	ng	ng
Extraction Date	04/03/98	04/03/98	04/03/98	04/03/98
Analysis Date	04/16/98	04/16/98	04/16/98	04/16/98
Instrument	P	P	P	P
Matrix	M23	M23	M23	M23
Extraction Type				
Analytes				
2378-TCDF	0.14	(0.01)	0.01 JB	(0.007)
Internal Standards Percent Recovery Summary (% Rec)				
13C12-2378-TCDF	56.1	21.4 V	54.0	60.0

TRIANGLE LABORATORIES, INC.
Sample Result Summary for Project 45399
Method 23X (DB-225)

04/20/98

Data File	P981317	P981319
Sample ID	M23-O-4	M23-FB-2
Units	ng	ng
Extraction Date	04/03/98	04/03/98
Analysis Date	04/17/98	04/17/98
Instrument	P	P
Matrix	M23	M23
Extraction Type		
Analytes		
2378-TCDF	(0.005)	(0.005)
Internal Standards Percent Recovery Summary (% Rec)		
13C12-2378-TCDF	75.5	73.7

{Estimated Maximum Possible Concentration}, (Detection Limit).

Method 8290 Sample Calculations:

Analyte Concentration

The concentration or amount of any analyte is calculated using the following expression.

$$C_{(\sigma)} = \frac{A_\sigma * Q_\beta}{A_\beta * RRF_{(\sigma)} * W}$$

Where:

$C_{(\sigma)}$	=	concentration or amount of a given analyte
A_σ	=	integrated current for the characteristic ions of the analyte
A_β	=	integrated current of the characteristic ions of the corresponding internal standard
Q_β	=	amount of internal standard added to the sample before extraction
$RRF_{(\sigma)}$	=	mean analyte relative response factor from the initial calibration
W	=	sample weight or volume

Detection Limits

The detection limit reported for a target analyte that is not detected or presents an analyte response that is less than 2.5 times the background level is calculated by using the following expression. The area of the analyte is replaced by the noise level measured in a region of the chromatogram clear of genuine GC signals multiplied by an empirically determined factor. The detection limits represent the maximum possible concentration of a target analyte that could be present without being detected.

$$DL_{(\sigma)} = \frac{2 * 2.5 * (F * H) * Q_\beta}{A_\beta * RRF_{(\sigma)} * W}$$

Where:

$DL_{(\sigma)}$	=	estimated detection limit for a target analyte
2.5	=	minimum response required for a GC signal
F	=	an empirical number that approximates the area to height ratio for a GC signal. (F = 3.7 for all dioxin/furan analyses)
H	=	height of the noise
A_β	=	integrated current of the characteristic ions of the corresponding internal standard
Q_β	=	amount of internal standard added to the sample before extraction
$RRF_{(\sigma)}$	=	mean analyte relative response factor from the initial calibration
W	=	sample weight or volume

Data Flags

In order to assist with data interpretation, data qualifier flags are used on the final reports. Please note that all data qualifier flags are subjective and are applied as consistently as possible. Each flag has been reviewed by two independent Chemists and the impact of the data qualifier flag on the quality of the data discussed above. The most commonly used flags are:

A **'B'** flag is used to indicate that an analyte has been detected in the laboratory method blank as well as in an associated field sample. The 'B' flag is used only when the concentration of analyte found in the sample is less than 20 times that found in the associated blank. This flag denotes possible contribution of background laboratory contamination to the concentration or amount of that analyte detected in the field sample.

An **'E'** flag is used to indicate a concentration based on an analyte to internal standard ratio which exceeds the range of the calibration curve. Values which are outside the calibration curve are estimates only.

An **'I'** flag is used to indicate labeled standards have been interfered with on the GC column by coeluting, interferent peaks. The interference may have caused the standard's area to be overestimated. All quantitations relative to this standard, therefore, may be underestimated.

A **'J'** flag is used to indicate a concentration based on an analyte to internal standard ratio which is below the calibration curve. Values which are outside the calibration curve are estimates only.

A **'PR'** flag is used to indicate that a GC peak is poorly resolved. This resolution problem may be seen as two closely eluting peaks without a reasonable valley between the peak tops, overly broad peaks, or peaks whose shapes vary greatly from a normal distribution. The concentrations or amounts reported for such peaks are most likely overestimated.

A **'Q'** flag is used to indicate the presence of QC ion instabilities caused by quantitative interferences.

An **'RO'** flag is used to indicate that a labeled standard has an ion abundance ratio that is outside of the acceptable QC limits, most likely due to a coeluting interference. This may have caused the percent recovery of the standard to be overestimated. All quantitations versus this standard, therefore, may be underestimated.

An **'S'** flag indicates that the response of a specific PCDD/PCDF isomer has exceeded the normal dynamic range of the mass spectrometer detection system. The corresponding signal is saturated and the reported analyte concentration is a 'minimum estimate'. When the 'S' qualifier is used in the reporting of 'totals', there is saturation of one (not

necessarily from a specific isomer) or more saturated signals for a given class of compounds.

A 'U' flag is used to indicate that a specific isomer cannot be resolved from a large, co-eluting interferent GC peak. The specific isomer is reported as not detected as a valid concentration cannot be determined. The calculated detection limit, therefore, should be considered an underestimated value.

A 'V' flag is used to indicate that, although the percent recovery of a labeled standard may be below a specific QC limit, the signal-to-noise ratio of the peak is greater than ten-to-one. The standard is considered reliably quantifiable. All quantitations derived from the standard are considered valid as well.

An 'X' flag is used to indicate that a pentachlorodibenzofuran (PCDF) peak has eluted at the same time as the associated diphenyl ether (DPE) and that the DPE peak intensity is at least ten percent of the total PCDF peak intensity. Total PCDF values are flagged 'X' if the total DPE contribution to the total PCDF value is greater than ten percent. All PCDF peaks that are significantly influenced by the presence of DPE peaks are either reported as "estimated maximum possible concentration (EMPC) values without regard to the isotopic abundance ratio, or are included in the detection limit value depending on the analytical method.

Method 23 Sample Calculations:

Analyte Concentration

The concentration or amount of any analyte is calculated using the following expression.

$$Amt_{(\sigma)} = \frac{A_\sigma * Q_\beta}{A_\beta * RRF_{(\sigma)} * W}$$

Where:

$Amt_{(\sigma)}$	=	amount of a given analyte, expressed in nanograms (ng) or picograms (pg).
A_σ	=	integrated current for the characteristic ions of the analyte
A_β	=	integrated current of the characteristic ions of the corresponding internal standard
Q_β	=	amount of internal standard added to the sample before extraction
$RRF_{(\sigma)}$	=	mean analyte relative response factor from the initial calibration
W	=	sample weight or volume (W = 1.0 for Method 23 samples)

Detection Limits

The detection limit reported for a target analyte that is not detected or presents an analyte response that is less than 2.5 times the background level is calculated by using the following expression. The area of the analyte is replaced by the noise level measured in a region of the chromatogram clear of genuine GC signals multiplied by an empirically determined factor. The detection limits represent the maximum possible concentration of a target analyte that could be present without being detected.

$$DL_{(\sigma)} = \frac{2 * 2.5 * (F * H) * Q_\beta}{A_\beta * RRF_{(\sigma)} * W}$$

Where:

$DL_{(\sigma)}$	=	estimated detection limit for a target analyte, expressed in ng or pg
2.5	=	minimum response required for a GC signal
F	=	an empirical number that approximates the area to height ratio for a GC signal. (F = 3.7 for all dioxin/furan analyses)
H	=	height of the noise
A_β	=	integrated current of the characteristic ions of the corresponding internal standard
Q_β	=	amount of internal standard added to the sample before extraction
$RRF_{(\sigma)}$	=	mean analyte relative response factor from the initial calibration
W	=	sample weight or volume

Pacific Environmental Services

TLI Project: **45399** Method 23 PCDD/PCDF Analysis (a)
Client Sample: **TLI M23 Blank** Analysis File: **U980780**

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	XAD	Date Received:	/ /	Spike File:	SPMIT204
TLI ID:	TLI Blank	Date Extracted:	04/03/98	ICal:	UF51058
		Date Analyzed:	04/15/98	ConCal:	U980771
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-5	Analyst:	ML	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDD	ND	0.002				—
1,2,3,7,8-PeCDD	ND	0.002				—
1,2,3,4,7,8-HxCDD	ND	0.003				—
1,2,3,6,7,8-HxCDD	ND	0.002				—
1,2,3,7,8,9-HxCDD	ND	0.002				—
1,2,3,4,6,7,8-HpCDD	ND	0.003				—
1,2,3,4,6,7,8,9-OCDD	0.01			0.86	38:23	J
2,3,7,8-TCDF	EMPC		0.004			J
1,2,3,7,8-PeCDF	ND	0.002				—
2,3,4,7,8-PeCDF	ND	0.002				—
1,2,3,4,7,8-HxCDF	ND	0.002				—
1,2,3,6,7,8-HxCDF	ND	0.002				—
2,3,4,6,7,8-HxCDF	ND	0.002				—
1,2,3,7,8,9-HxCDF	ND	0.002				—
1,2,3,4,6,7,8-HpCDF	ND	0.002				—
1,2,3,4,7,8,9-HpCDF	ND	0.002				—
1,2,3,4,6,7,8,9-OCDF	ND	0.003				—

Totals	Amt. (ng)	Number	DL	EMPC	Flags
Total TCDD	ND		0.002		—
Total PeCDD	ND		0.002		—
Total HxCDD	ND		0.002		—
Total HpCDD	ND		0.003		—
Total TCDF	EMPC			0.004	
Total PeCDF	ND		0.002		—
Total HxCDF	ND		0.002		—
Total HpCDF	ND		0.002		—

MIT2_PSR v1.04, LARS 6.11.00

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Printed: 13:40 04/20/98

TLI Project: 45399
Client Sample: TLI M23 Blank

Method 23 PCDD/PCDF Analysis (a)
Analysis File: U980780

Internal Standards	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	2.6	65.8	40%-130%	0.77	23:21	—
$^{13}C_{12}$-2,3,7,8-TCDD	2.7	67.9	40%-130%	0.81	24:07	—
$^{13}C_{12}$-1,2,3,7,8-PeCDF	2.7	68.6	40%-130%	1.48	27:32	—
$^{13}C_{12}$-1,2,3,7,8-PeCDD	4.0	99.4	40%-130%	1.50	28:38	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	2.7	68.1	40%-130%	0.50	31:15	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	3.1	78.7	40%-130%	1.23	31:57	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	3.3	83.7	25%-130%	0.39	34:04	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	3.7	92.5	25%-130%	1.00	35:03	—
$^{13}C_{12}$-1,2,3,4,6,7,8,9-OCDD	6.6	83.0	25%-130%	0.87	38:22	—

Surrogate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,4,7,8-PeCDF	4.2	106	40%-130%	1.46	28:17	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	4.3	108	40%-130%	0.49	31:10	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	4.6	114	40%-130%	1.22	31:53	—
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	3.6	90.1	25%-130%	0.42	35:30	—

Other Standard	Amt. (ng)	% Recovery	QC Limits	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	3.5	87.9	40%-130%	24:08	—

Alternate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	3.4	84.5	40%-130%	0.50	32:30	—
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	3.3	81.8	40%-130%	0.50	31:46	—

Recovery Standards	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.82	23:55	—
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.20	32:16	—

Data Reviewer: WDNT 04/20/98

MIT2_PSR v1.04, LARS 6.11.0

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Printed: 13:40 04/20/98

Initial ....Date...

Data Review By: WDN 4/20/98 Calculated Noise Area: 4.07

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of U980780B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF				0.65-0.89						0.844-1.086			
304-306	DC	NL		0:00	RO	0.62	15.06			0.000			
				23:22	RO	0.45	32.25	14.03	31.51	1.001	2378-TCDF	AN	J
304-306			1	Peak			32.25						
13C12-TCDF				0.65-0.89						0.957-1.043			
316-318	DC	NL		0:00	RO	1.96	6.21			0.000			
	DC	WL		22:13		0.76	318.34			0.951			
				22:54		0.87	121.02	56.22	64.80	0.981			
				23:21		0.77	27,052.70	11,732.50	15,320.20	1.000	13C12-2378-TCDF	ISO	
				23:49	RO	0.99	69.14	38.57	39.06	1.020			
316-318			3	Peaks			27,242.86						

---------- Above: TCDF / TCDD Follows ----------

TCDD				0.65-0.89						0.878-1.050			
320-322	DC	NL		0:00	RO	0.63	4.90			0.000			
	DC	SN		23:20	RO	3.39	8.18			0.968			
D	D	SN		24:08	RO	0.43	18.85			1.001	2378-TCDD	AN	
	DC	SN		24:21	RO	1.36	2.60			1.010			
	DC	SN		24:30	RO	1.70	2.16			1.016			
320-322			0	Peaks			0.00						
37Cl-TCDD										0.917-1.083			
328	DC	NL		0:00			1.39			0.000			
				22:37			17.02	17.02		0.938			
				24:08			18,717.10	18,717.10		1.001	37Cl-TCDD	CLS	
328			2	Peaks			18,734.12						
13C12-TCDD				0.65-0.89						0.917-1.083			
332-334	DC	NL		0:00	RO	2.10	13.54			0.000			
				22:53	RO	1.12	104.54	66.07	59.06	0.949			
				23:55		0.82	28,009.20	12,615.40	15,393.80	0.992	13C12-1234-TCDD	RS1	
				24:07		0.81	21,268.95	9,538.45	11,730.50	1.000	13C12-2378-TCDD	IS1	
				24:29		0.79	318.23	140.18	178.05	1.015			
332-334			4	Peaks			49,700.92						

---------- Above: TCDD / PeCDF Follows ----------

PeCDF				1.32-1.78						0.917-1.068			
340-342	DC	NL		0:00	RO	0.84	4.33			0.000			
	DC	SN		25:29	RO	2.89	5.38			0.926			
	DC	SN		25:48	RO	0.72	3.36			0.937			
	DC	SN		26:05	RO	0.47	3.64			0.947			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
	DC	SN		26:26	RO	0.16	1.07			0.960			
	DC	SN		26:39	RO	0.57	5.74			0.968			
	DC	SN		26:49		1.43	1.65			0.974			
	DC	SN		26:58	RO	0.43	2.50			0.979			
	DC	SN		27:10	RO	0.52	5.91			0.987			
	DC	SN		28:11		1.73	4.61			1.024			
	DC	SN		28:17	RO	2.08	5.99			1.027	23478-PeCDF	AN	
	DC	SN		28:25		1.50	4.95			1.032			
	DC	SN		29:14	RO	0.99	4.95			1.062			
	DC	SN		29:20	RO	0.72	2.50			1.065			
340-342			0	Peaks			0.00						
13C12-PeCDF				1.32-1.78						0.855-1.145			
352-354	DC	NL		0:00		1.46	3.27			0.000			
				26:38		1.49	515.16	308.00	207.16	0.967			
				27:10		1.34	43.38	24.88	18.50	0.987			
				27:32		1.48	21,926.89	13,102.30	8,824.59	1.000	13C12-PeCDF 123	IS2	
				27:51		1.53	168.38	101.84	66.54	1.012			
				28:17		1.46	22,359.52	13,285.30	9,074.22	1.027	13C12-PeCDF 234	SUR1	
				28:38		1.66	44.32	27.66	16.66	1.040			
				29:16		1.58	65.71	40.27	25.44	1.063			
352-354			7	Peaks			45,123.36						
---------- Above: PeCDF / PeCDD Follows ----------													
PeCDD				1.32-1.78						0.928-1.022			
356-358	DC	NL		0:00	RO	0.69	1.83			0.000			
	DC	SN		26:55	RO	0.59	5.26			0.940			
D	D	SN		27:32	RO	1.08	15.14			0.962			
	DC	SN		27:39		1.72	3.13			0.966			
D	D	SN		28:17		1.77	15.90			0.988			
	DC	SN		28:36	RO	2.08	3.70			0.999	12378-PeCDD	AN	
	DC	SN		29:05	RO	0.93	4.28			1.016			
	DC	WH		29:22	RO	0.36	2.37			1.026			
	DC	WH		29:38	RO	1.17	6.70			1.035			
356-358			0	Peaks			0.00						
13C12-PeCDD				1.32-1.78						0.860-1.140			
368-370	DC	NL		0:00	RO	0.98	2.39			0.000			
				27:32		1.64	28.72	17.85	10.87	0.962			
				28:38		1.50	16,427.29	9,847.36	6,579.93	1.000	13C12-PeCDD 123	IS3	
				28:46		1.53	1,424.21	860.99	563.22	1.005			
				29:00	RO	3.03	13.36	15.88	5.24	1.013			
368-370			4	Peaks			17,893.58						
---------- Above: PeCDD / HxCDF Follows ----------													
HxCDF				1.05-1.43						0.959-1.047			
374-376	DC	NL		0:00		1.30	10.44			0.000			
	DC	SN		31:11		1.07	8.09			0.998	123478-HxCDF	AN	
	DC	SN		31:53	RO	0.71	4.15			1.020			
	DC	SN		31:56	RO	0.25	3.16			1.022			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
		DC	SN	32:04	RO	0.34	1.64			1.026			
		DC	SN	32:07	RO	2.02	2.93			1.028			
		DC	SN	32:11	RO	3.67	2.53			1.030			
		DC	SN	32:29	RO	0.73	6.20			1.039	123789-HxCDF		AN
	D	D	SN	32:31		1.11	11.58			1.041			
		DC	WH	32:55	RO	0.42	3.54			1.053			
374-376			0	Peaks			0.00						
13C12-HxCDF				0.43-0.59						0.872-1.128			
384-386		DC	NL	0:00	RO	1.27	11.01			0.000			
				30:10		0.45	211.83	66.19	145.64	0.965			
				30:18		0.47	252.65	80.95	171.70	0.970			
				31:10		0.49	19,894.83	6,563.63	13,331.20	0.997	13C12-HxCDF 478		SUR2
				31:15		0.50	22,345.35	7,415.55	14,929.80	1.000	13C12-HxCDF 678		IS4
				31:46		0.50	24,229.50	8,099.80	16,129.70	1.017	13C12-HxCDF 234		ALT2
				32:30		0.50	19,282.44	6,456.14	12,826.30	1.040	13C12-HxCDF 789		ALT1
384-386			6	Peaks			86,216.60						

---------- Above: HxCDF / HxCDD Follows ----------

HxCDD				1.05-1.43						0.955-1.014			
390-392		DC	NL	0:00	RO	0.83	9.45			0.000			
	D	D	SN	31:10	RO	1.95	13.75			0.975			
	D	D	SN	31:16	RO	2.30	13.53			0.979			
		DC	SN	31:47	RO	3.01	9.61			0.995			
		DC	WH	32:30	RO	8.36	4.75			1.017			
390-392			0	Peaks			0.00						
13C12-HxCDD				1.05-1.43						0.969-1.031			
402-404		DC	NL	0:00	RO	1.03	15.99			0.000			
				31:22		1.17	76.16	40.99	35.17	0.982			
				31:53		1.22	15,985.15	8,798.58	7,186.57	0.998	13C12-HxCDD 478		SUR3
				31:57		1.23	19,092.35	10,538.10	8,554.25	1.000	13C12-HxCDD 678		IS5
				32:16		1.20	24,384.70	13,317.20	11,067.50	1.010	13C12-HxCDD 789		RS2
402-404			4	Peaks			59,538.36						

---------- Above: HxCDD / HpCDF Follows ----------

HpCDF				0.88-1.20						0.995-1.047			
408-410		DC	NL	0:00	RO	2.42	4.92			0.000			
		DC	SN	34:06	RO	2.70	6.94			1.001	1234678-HpCDF		AN
		DC	SN	35:27		1.08	3.32			1.041			
		DC	SN	35:36	RO	3.00	4.75			1.045			
		DC	WH	35:43	RO	2.77	3.53			1.048			
408-410			0	Peaks			0.00						
13C12-HpCDF				0.37-0.51						0.941-1.117			
418-420		DC	NL	0:00	RO	0.60	9.13			0.000			
				34:04		0.39	16,774.71	4,735.81	12,038.90	1.000	13C12-HpCDF 678		IS6
				35:30		0.42	12,127.45	3,608.54	8,518.91	1.042	13C12-HpCDF 789		SUR4
418-420			2	Peaks			28,902.16						

```
Compound/
M_Z.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

                    ---------------------- Above: HpCDF / HpCDD Follows ---------------------

HpCDD                                0.88-1.20                                        0.975-1.005
424-426          DC  NL   0:00 RO  0.36          1.61                                    0.000
                 DC  WL  34:03 RO  2.59         10.38                                    0.971
                 DC  SN  34:38 RO  4.74          2.33                                    0.988
424-426                0 Peaks                   0.00

13C12-HpCDD                          0.88-1.20                                        0.971-1.029
436-438          DC  NL   0:00 RO  1.38         13.63                                    0.000
                        34:21 RO  1.30         80.62         51.37          39.52  0.980
                        35:03     1.00     16,382.49      8,187.87       8,194.62  1.000 13C12-HpCDD 678 IS7
436-438                2 Peaks             16,463.11

                    ---------------------- Above: HpCDD / Octa-CDD and CDF Follows ----------

OCDF                                 0.76-1.02                                        0.896-1.104
442-444          DC  NL   0:00     0.97          4.97                                    0.000
                 DC  SN  34:34 RO  1.05          1.78                                    0.901
                 DC  SN  34:39 RO  0.72          4.16                                    0.903
                        35:03 RO  1.89         10.05         10.07           5.32  0.914
                 DC  SN  35:29 RO  1.15          6.41                                    0.925
                 DC  SN  35:37 RO  1.35          3.74                                    0.928
                 DC  SN  35:48 RO  1.10          4.16                                    0.933
                 DC  SN  35:54 RO  0.63          6.99                                    0.936
                 DC  SN  36:54 RO  2.02          3.59                                    0.962
                 DC  SN  38:51 RO  0.35          1.34                                    1.013
                 DC  SN  40:39 RO  2.08          1.49                                    1.060
                 DC  SN  40:46 RO  1.91          1.08                                    1.063
                 DC  SN  40:55 RO  1.18          2.91                                    1.066
442-444                1 Peak                   10.05

OCDD                                 0.76-1.02                                        0.896-1.104
458-460          DC  NL   0:00 RO  2.18          2.10                                    0.000
                        38:23     0.86         37.20         17.20          20.00  1.000 OCDD                AN   J
458-460                1 Peak                   37.20

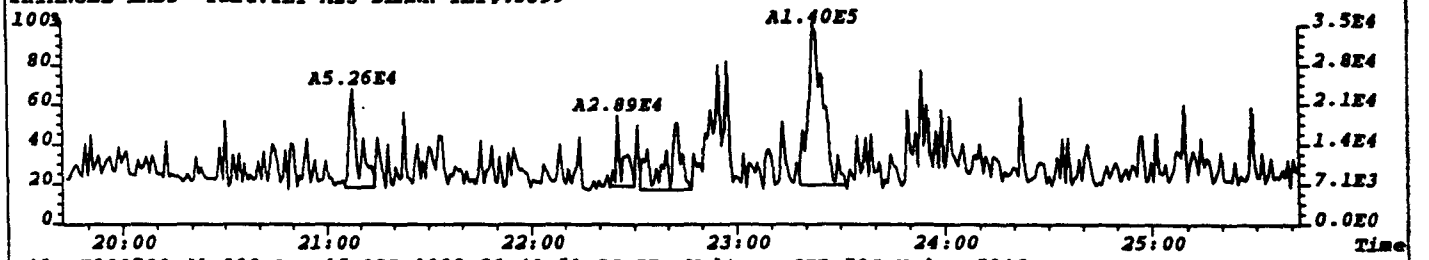
13C12-OCDD                           0.76-1.02                                        0.995-1.004
470-472          DC  NL   0:00 RO  2.50          1.91                                    0.000
                        38:22     0.87     22,056.70     10,248.60      11,808.10  1.000 13C12-OCDD          IS8
470-472                1 Peak             22,056.70


Column Description............  "Why" Code Description.........  QC Log Desc.........

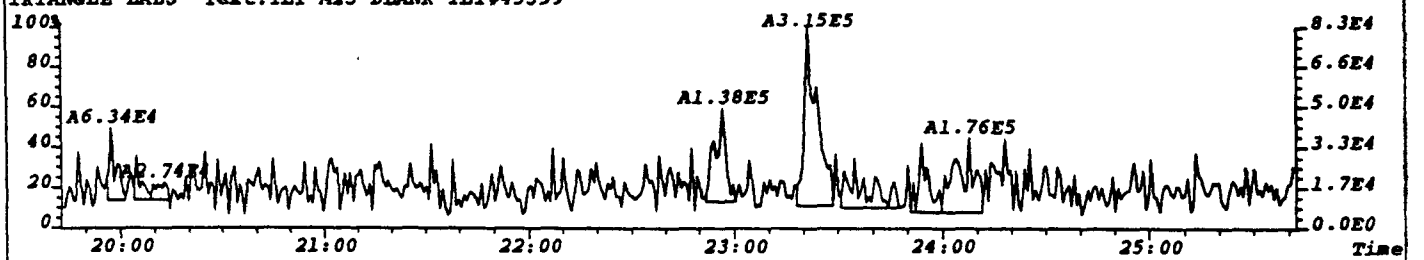
M_Z   -Nominal Ion Mass(es)      WL-Below Retention Time Window   A-Peak Added
..RT. -Retention Time (mm:ss)    WH-Above Retention Time Window   K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions       SN-Below Signal to Noise Level   D-Peak Deleted
OK    -RO=Ratio Outside Limits   <M-Below Method Detection Limit  T-Time Changed
Rel.RT-Relative Retention Time   NL-Channel Specific Noise Level  M-Peak Area Changed
                                                                  N-Name Changed
                                                                  X-Ether Interference

*** End of Report ***
```

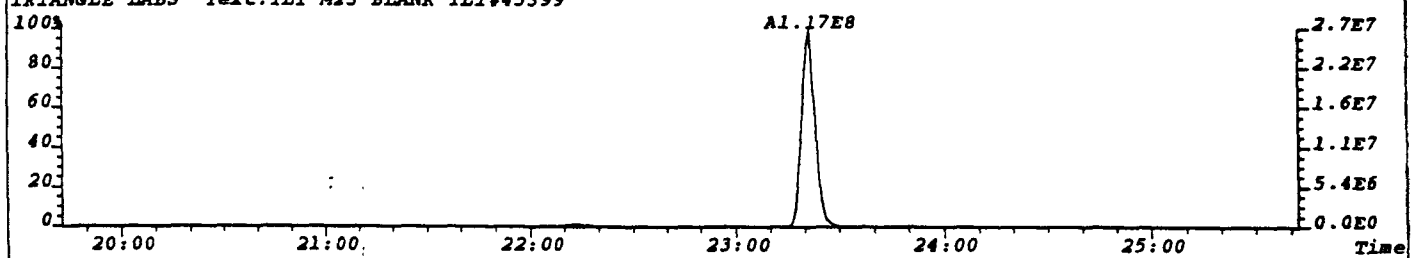
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3276
303.9016 F:2 BSUB(256,30,-3.0) PKD(9,5,3,0.10%,13104.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



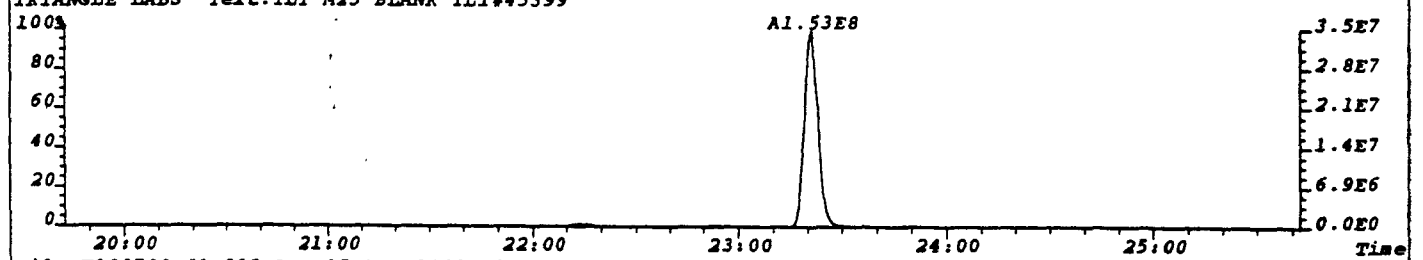
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:5246
305.8987 F:2 BSUB(256,30,-3.0) PKD(9,5,3,0.10%,20984.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



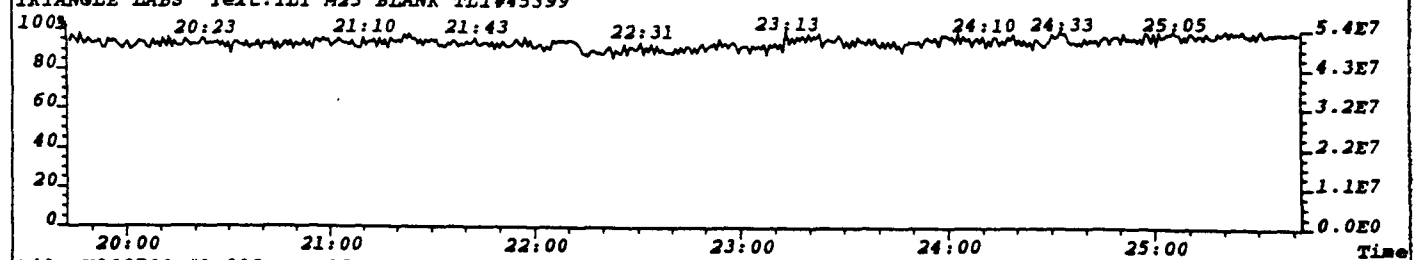
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3441
315.9419 F:2 BSUB(256,30,-3.0) PKD(9,5,3,0.10%,13764.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



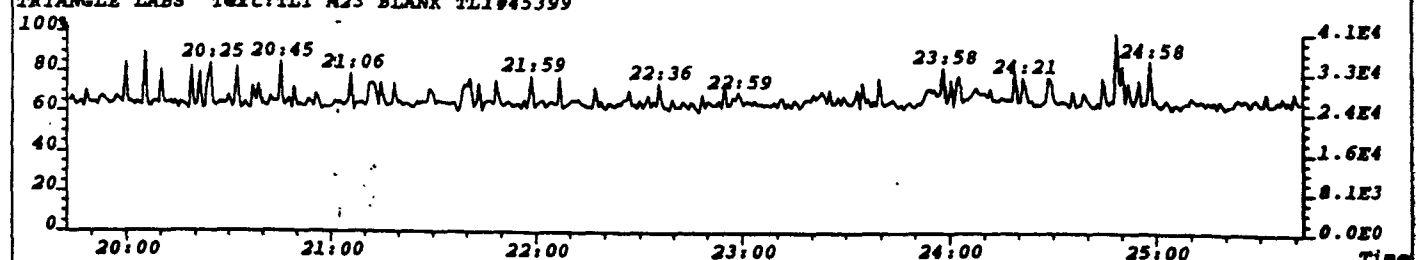
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1753
317.9389 F:2 BSUB(256,30,-3.0) PKD(9,5,3,0.10%,7012.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



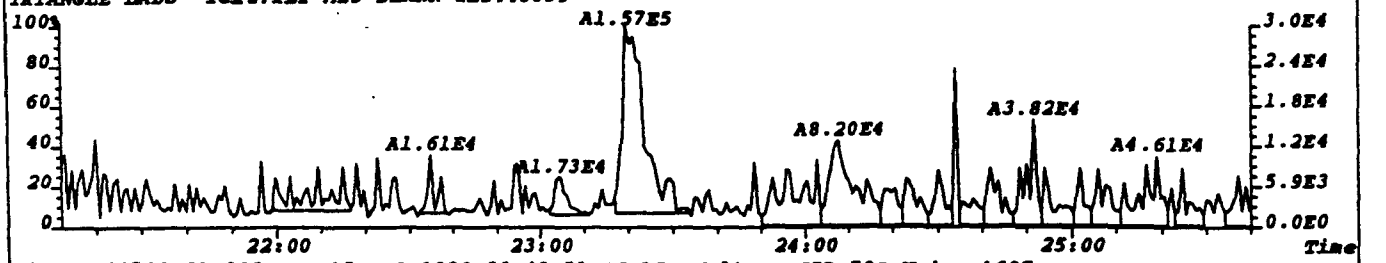
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



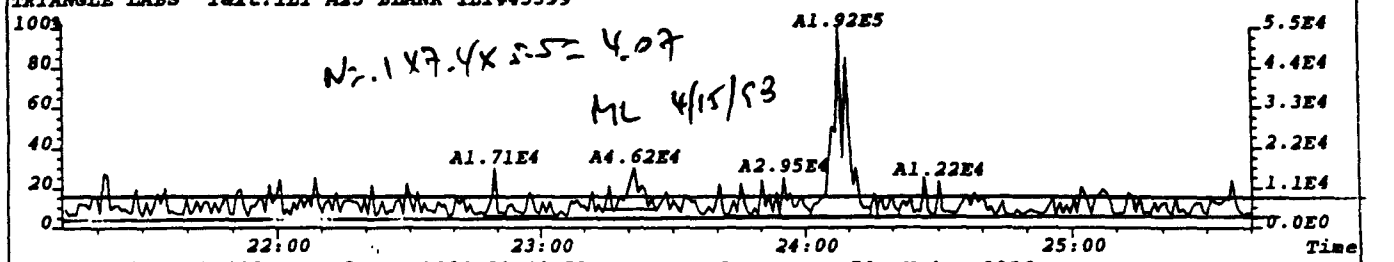
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
375.8364 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1065
319.8965 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,4260.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399

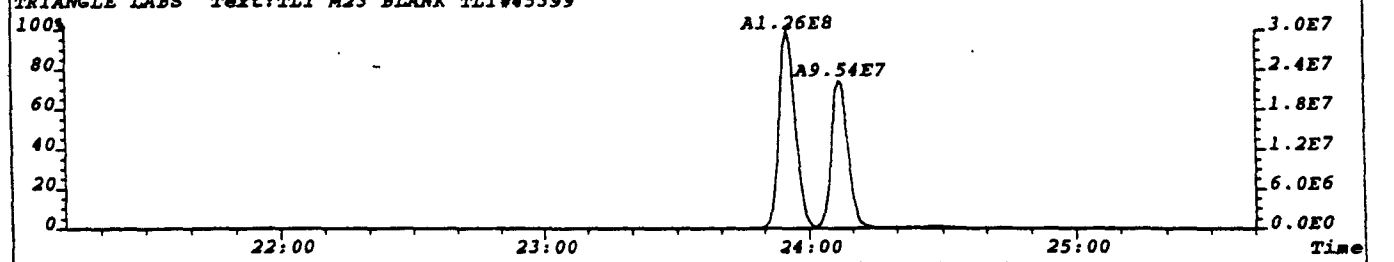


File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1687
321.8936 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,6748.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399

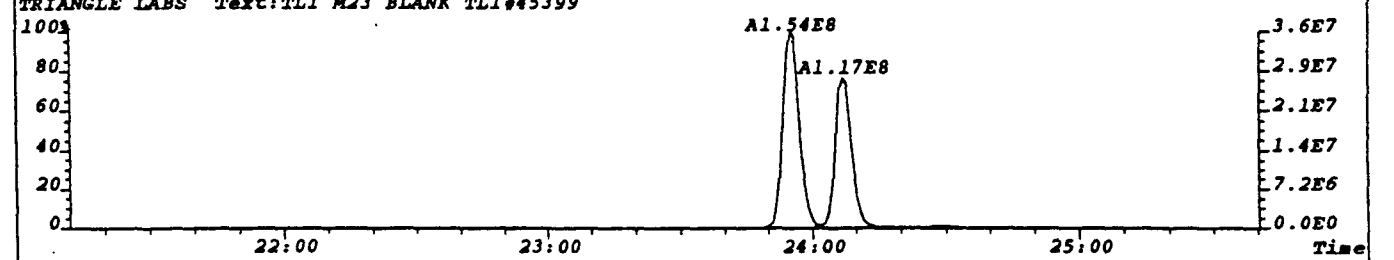


N=.147.4x 5.5= 4.07
ML 4/15/98

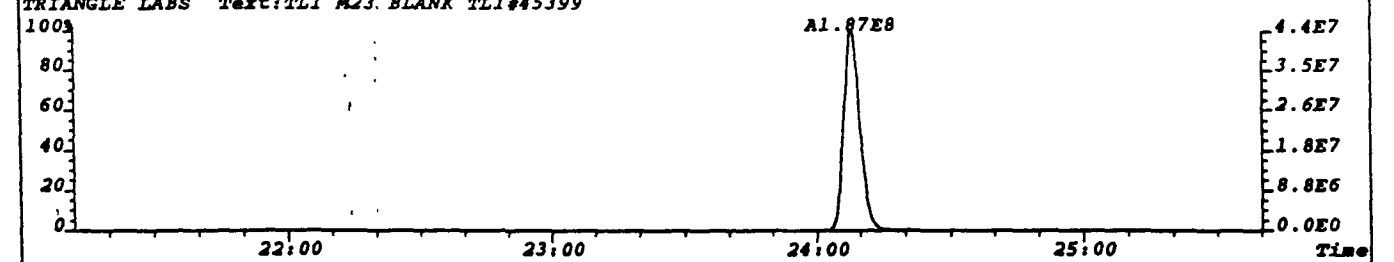
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:8036
331.9368 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,32144.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



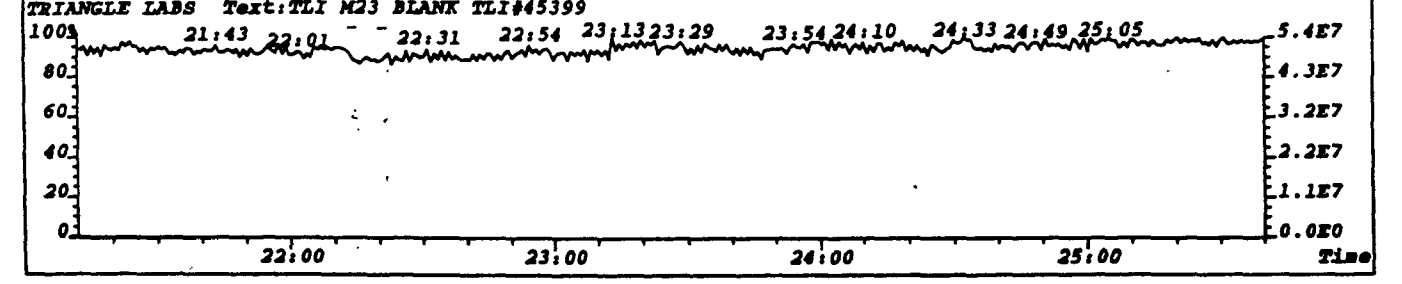
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3827
333.9338 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,15308.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



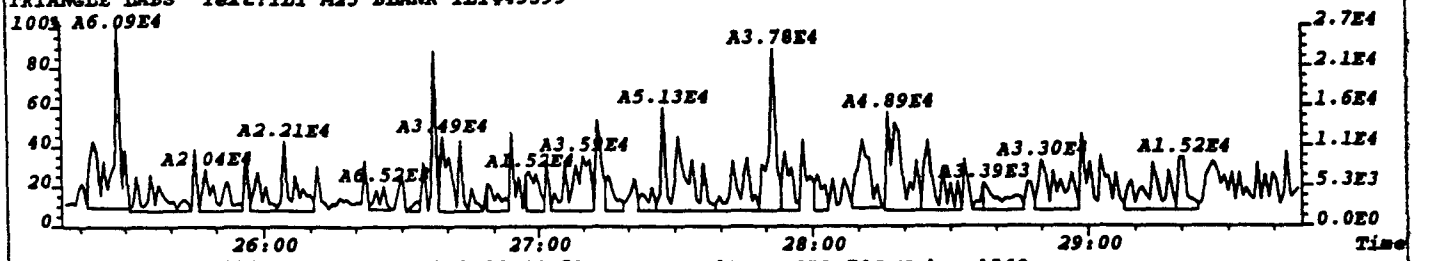
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:696
327.8847 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,2784.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1317
339.8597 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,5268.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



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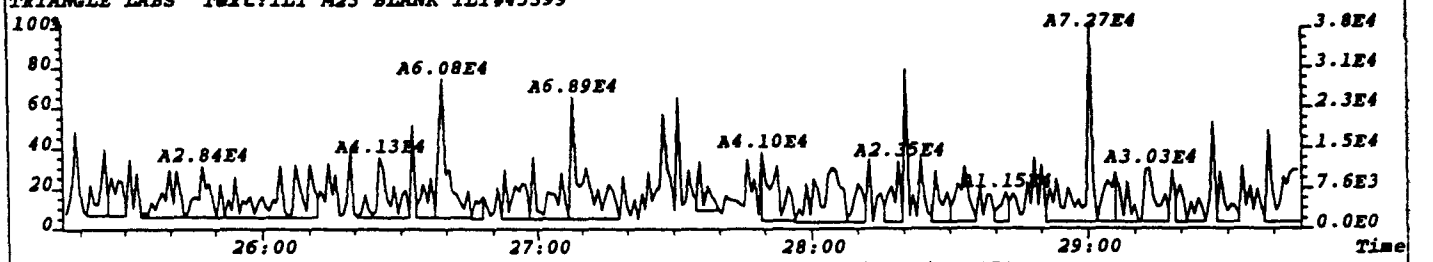
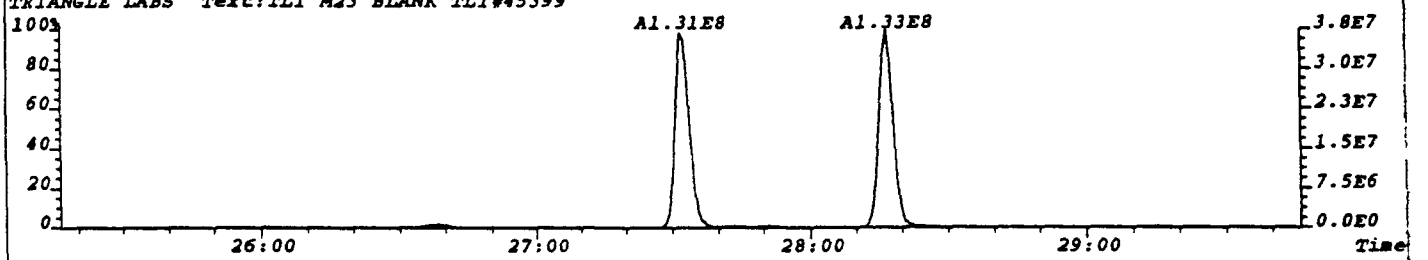
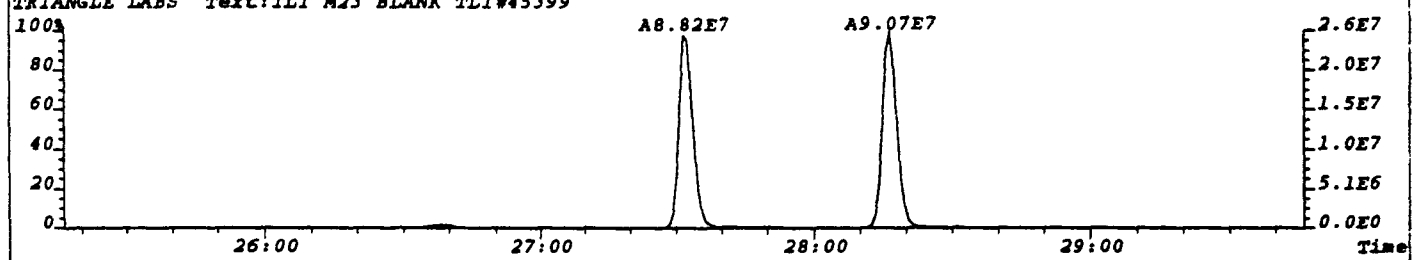
341.8567 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,6272.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



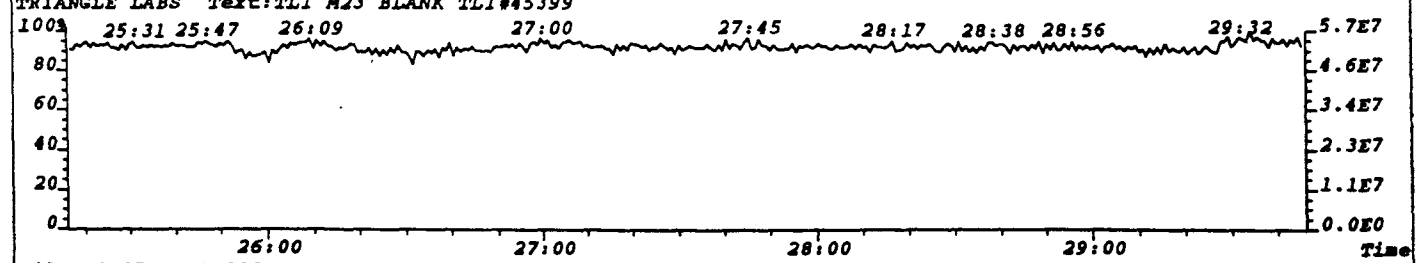
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:971
351.9000 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,3884.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



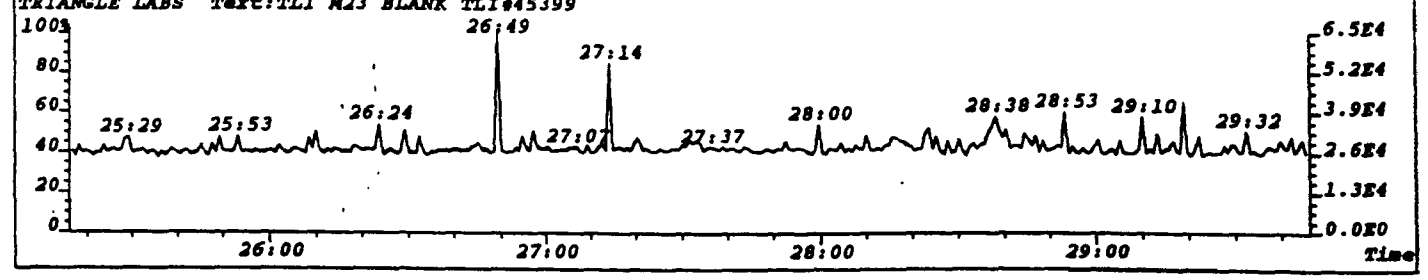
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:666
353.8970 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,2664.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



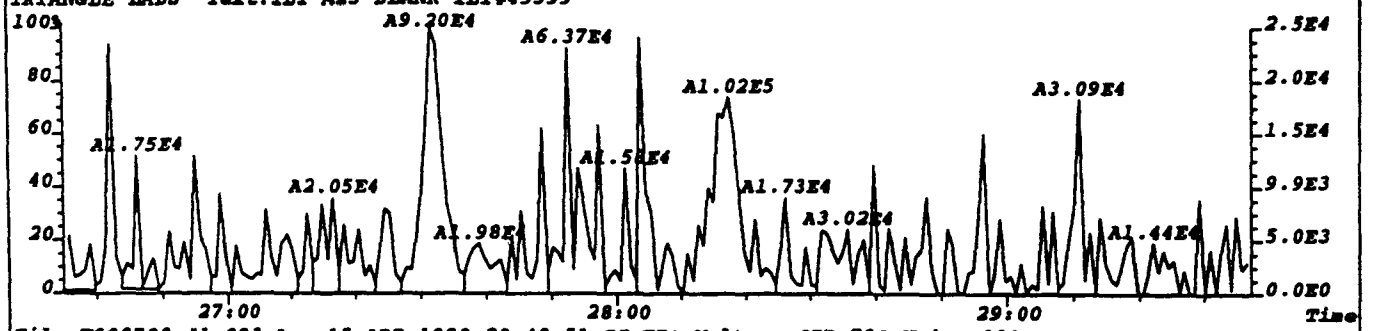
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



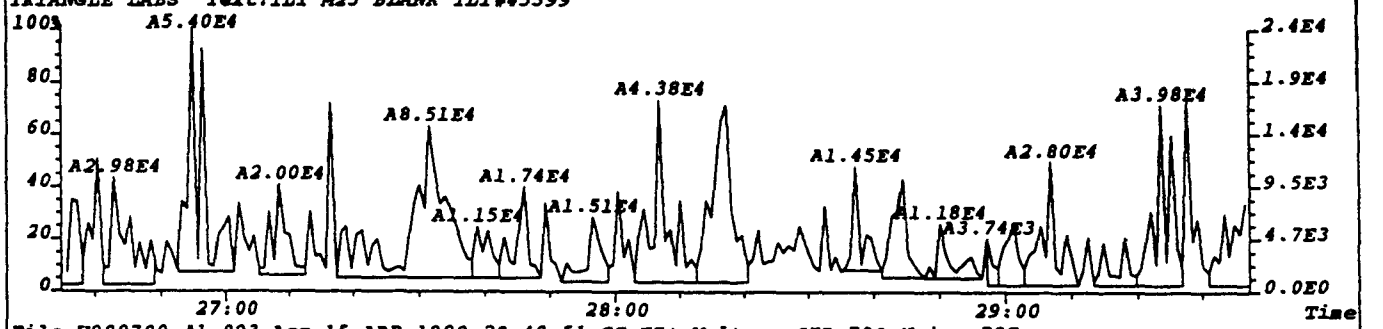
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
409.7974 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



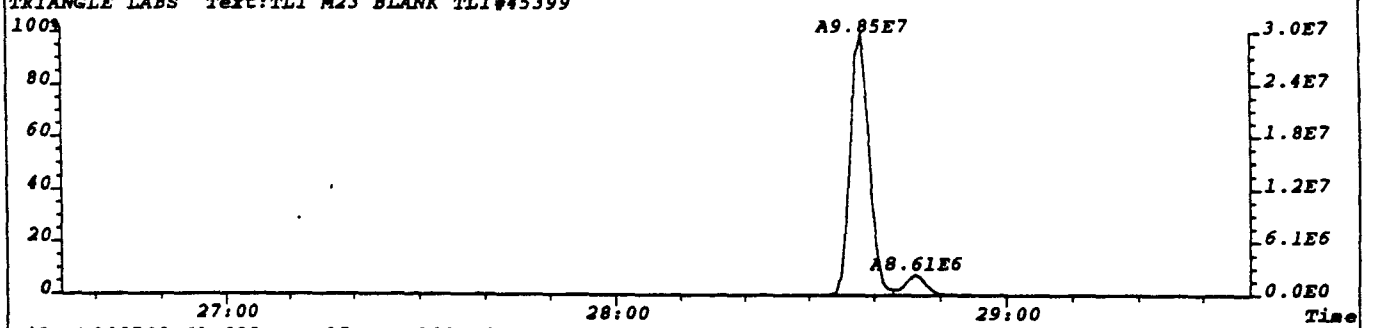
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:555
355.8546 F:2 BSUB(256,30,-3.0) PKD(5,5,3,0.05%,2220.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



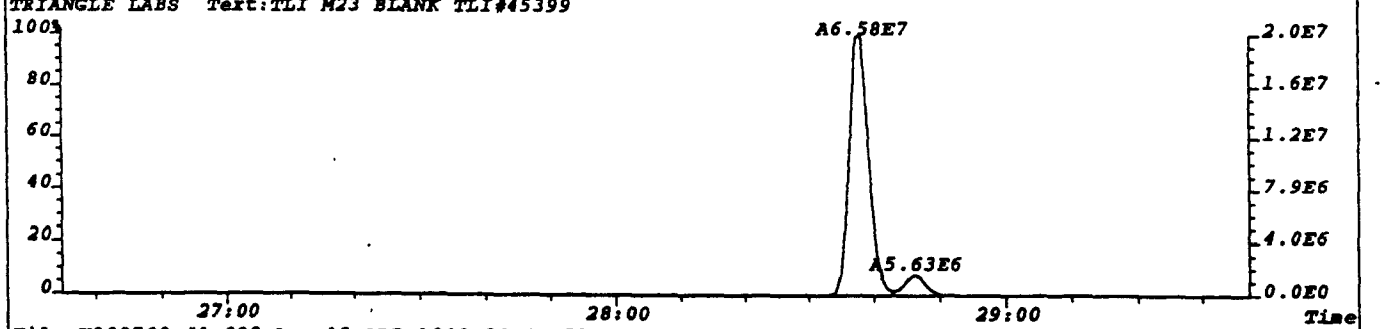
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:801
357.8516 F:2 BSUB(256,30,-3.0) PKD(5,5,3,0.05%,3204.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



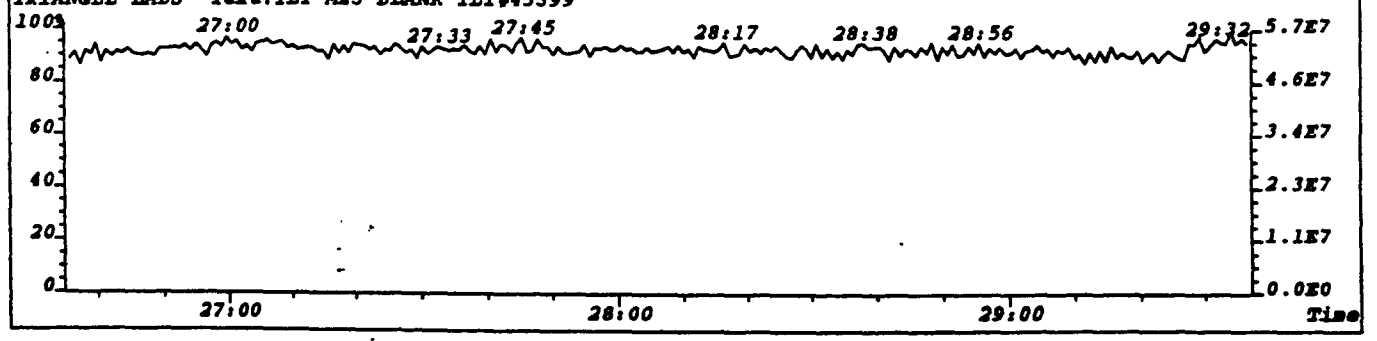
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:727
367.8949 F:2 BSUB(256,30,-3.0) PKD(5,5,3,0.05%,2908.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



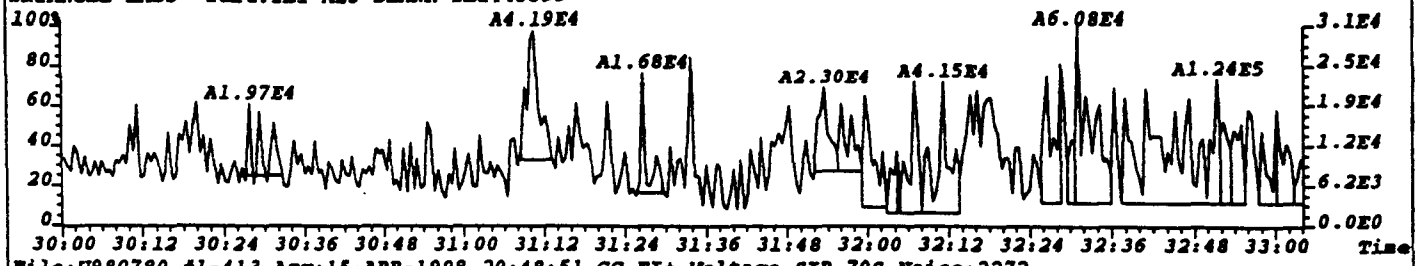
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:740
369.8919 F:2 BSUB(256,30,-3.0) PKD(5,5,3,0.05%,2960.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



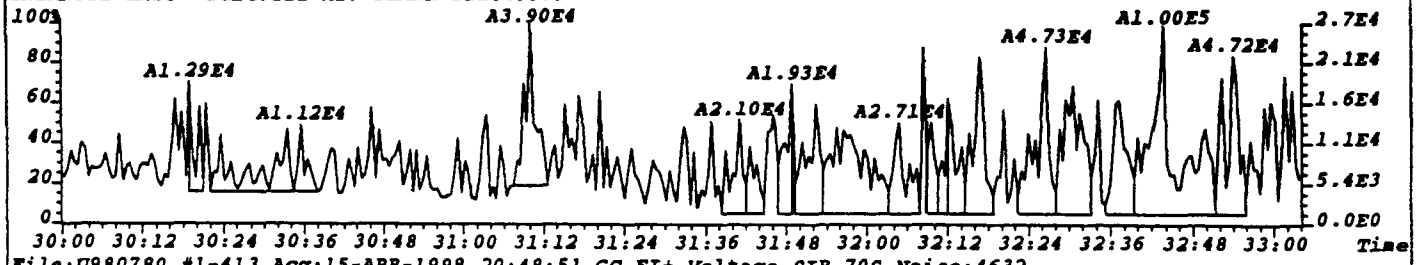
File:U980780 #1-893 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



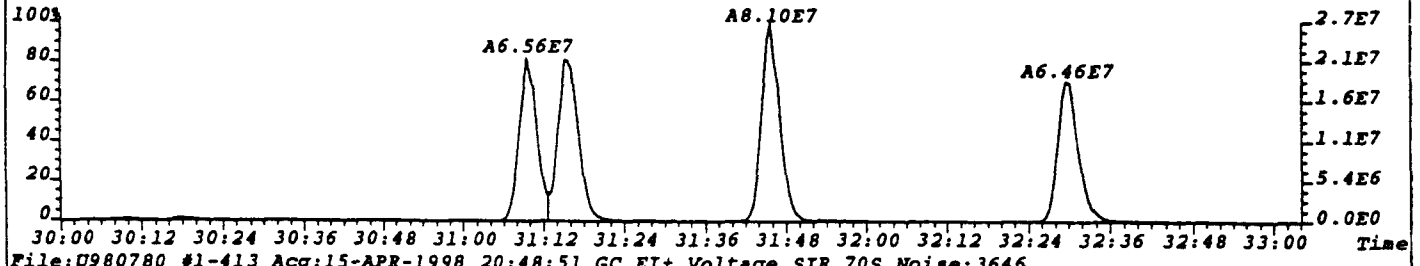
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:2952
373.8208 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,11808.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



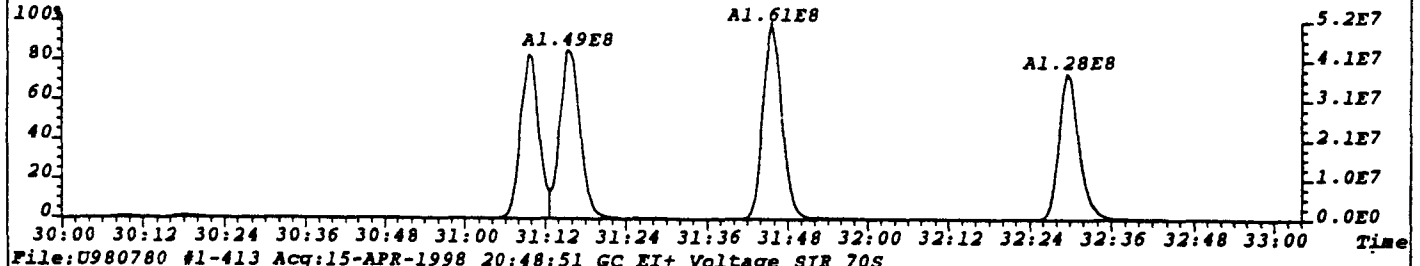
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:2272
375.8178 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,9088.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



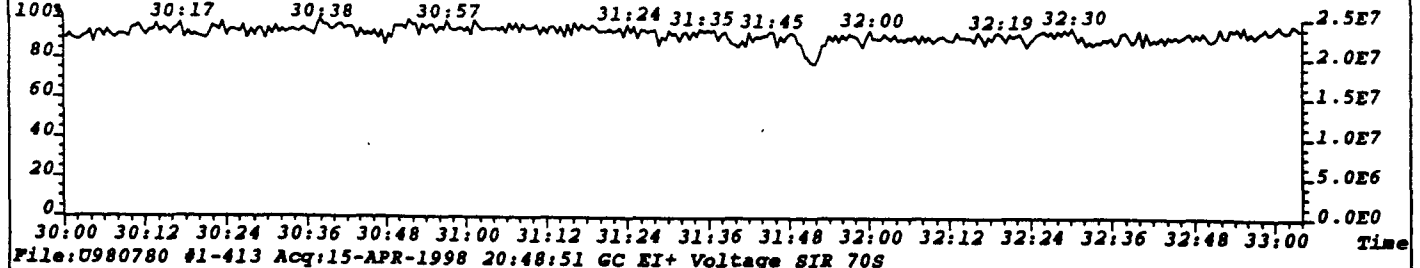
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:4632
383.8639 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,18528.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



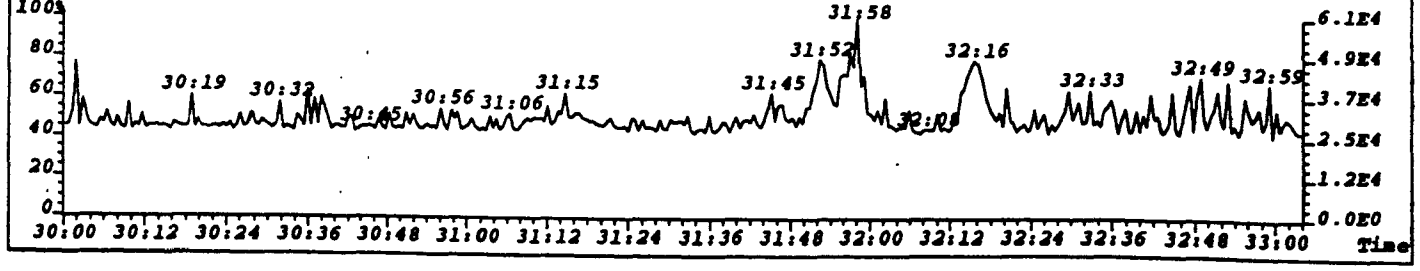
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3646
385.8610 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,14584.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
445.7555 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



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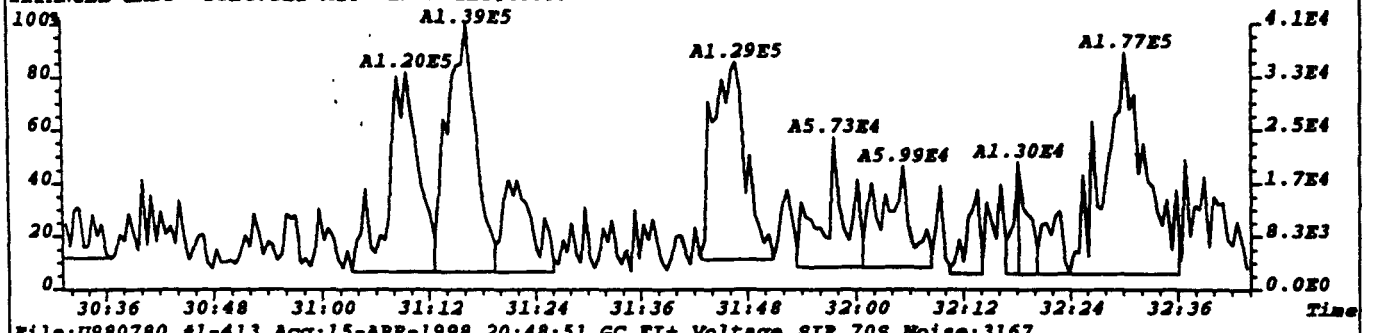
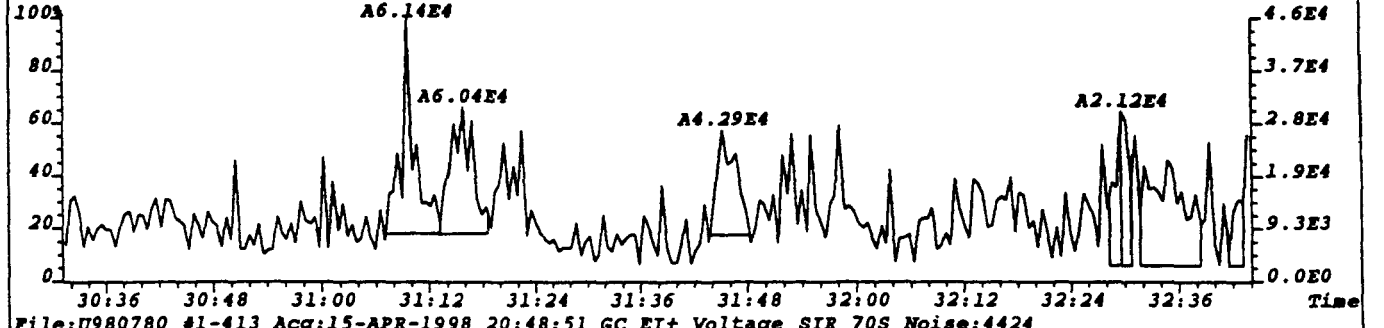
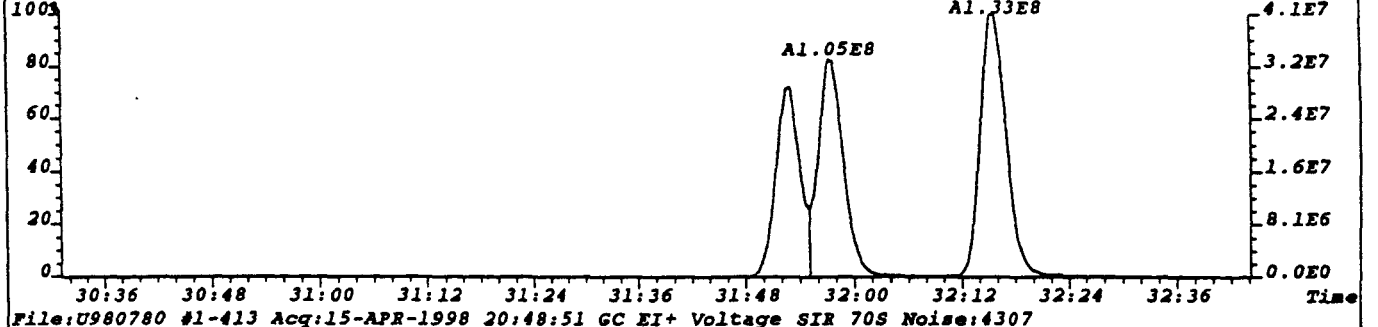
389.8156 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,10456.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



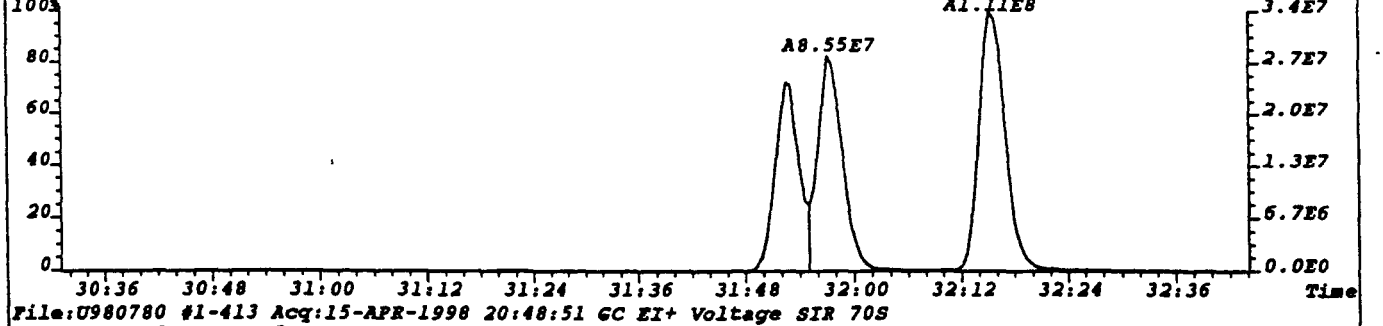
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3167
391.8127 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,12668.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



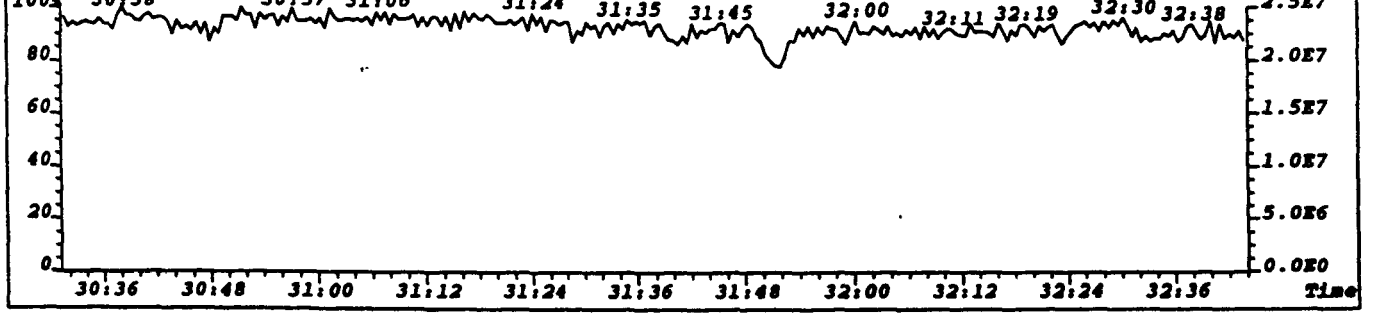
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:4424
401.8558 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,17696.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



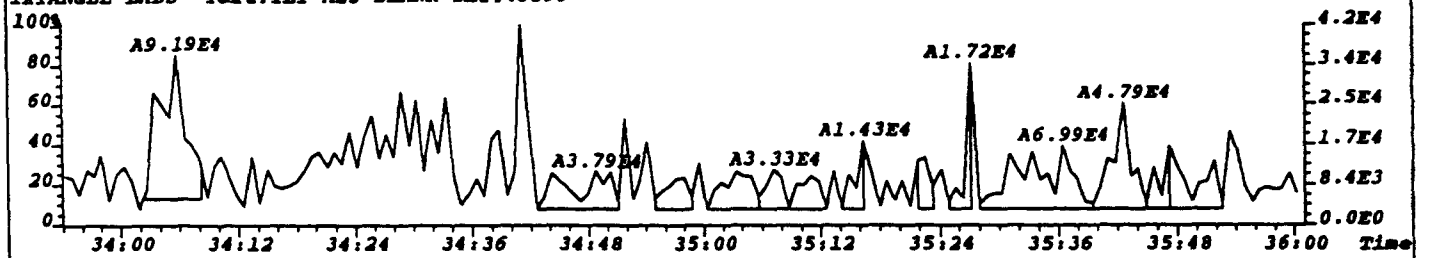
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:4307
403.8529 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,17228.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



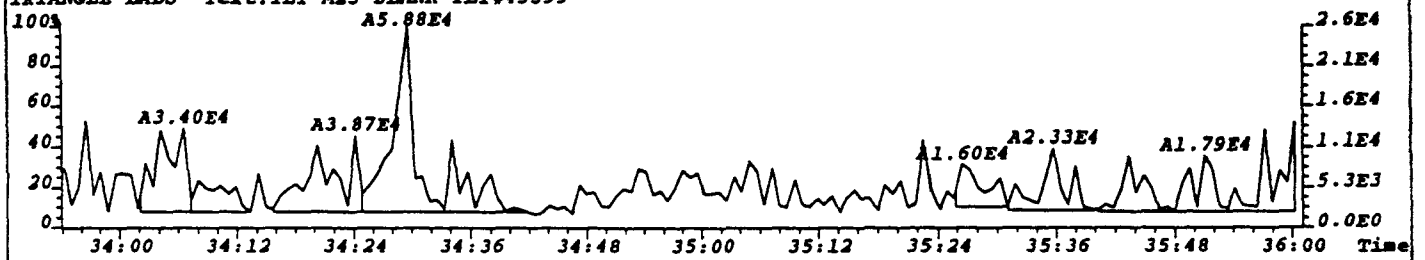
File:U980780 #1-413 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



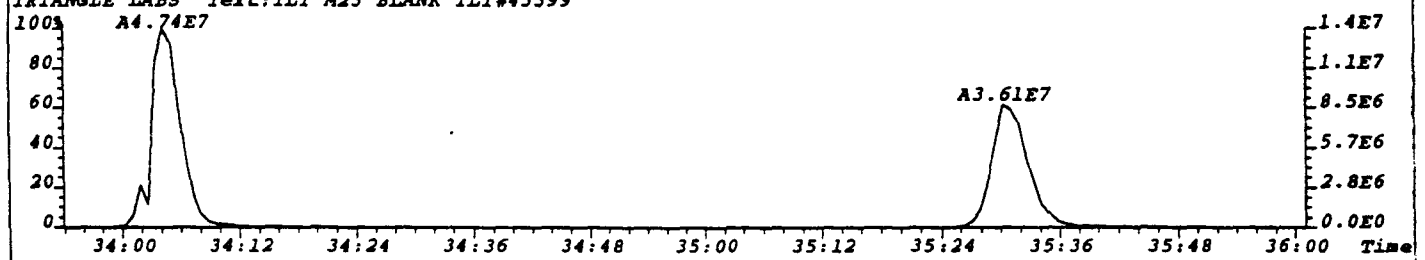
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:2920
407.7818 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,11680.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



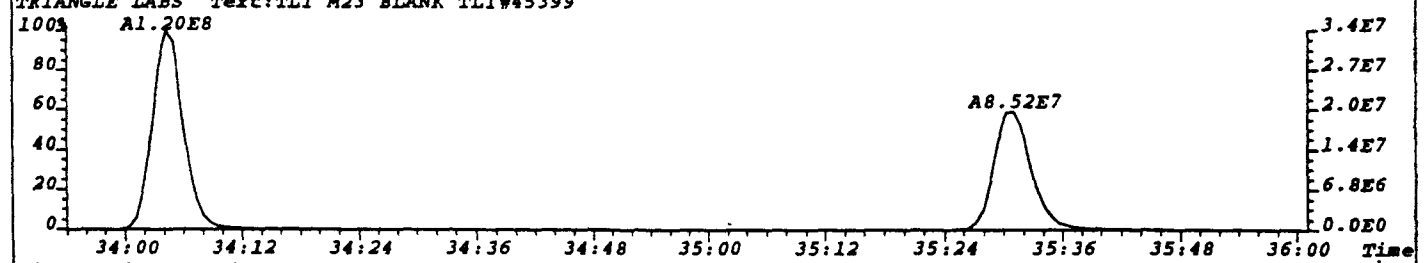
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1203
409.7789 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,4812.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



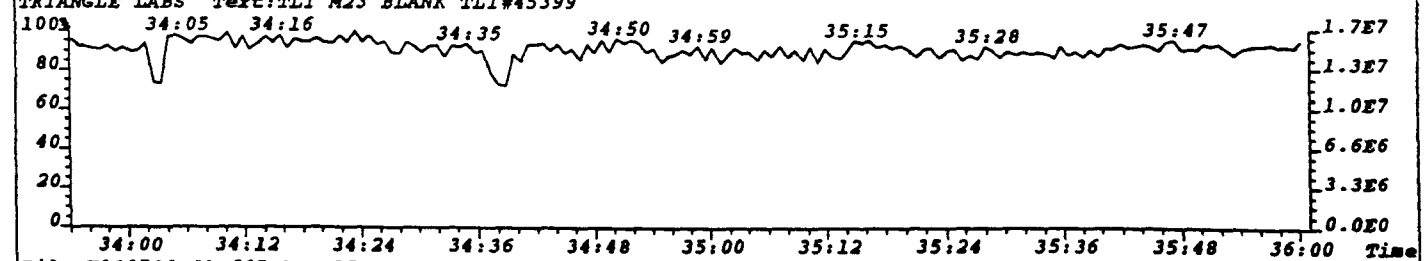
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1898
417.8253 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,7592.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



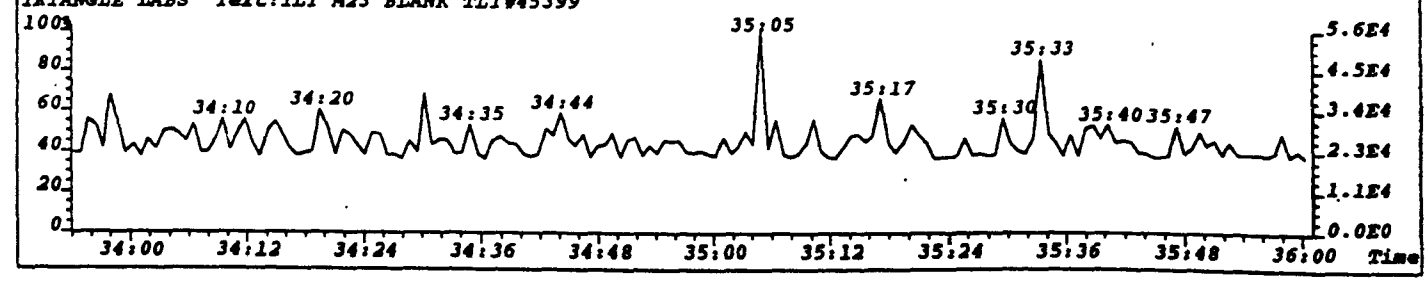
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3168
419.8220 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,12672.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



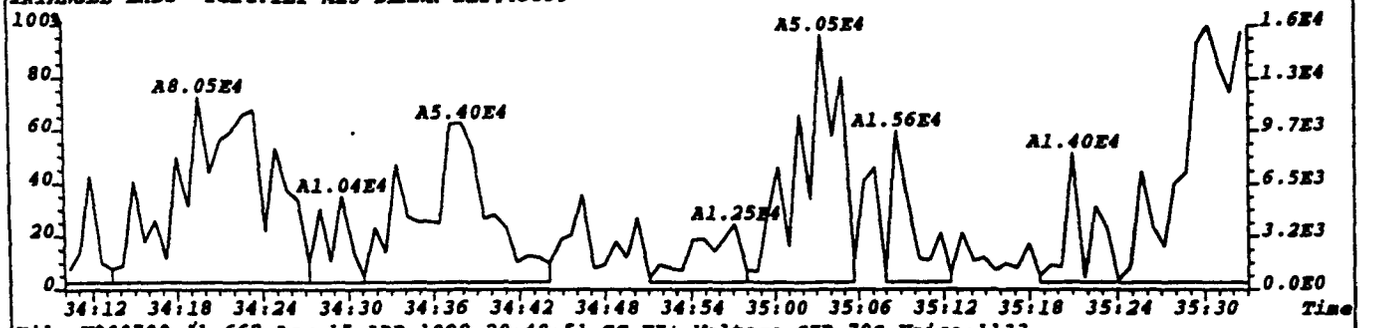
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
479.7165 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:409
423.7766 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,1636.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



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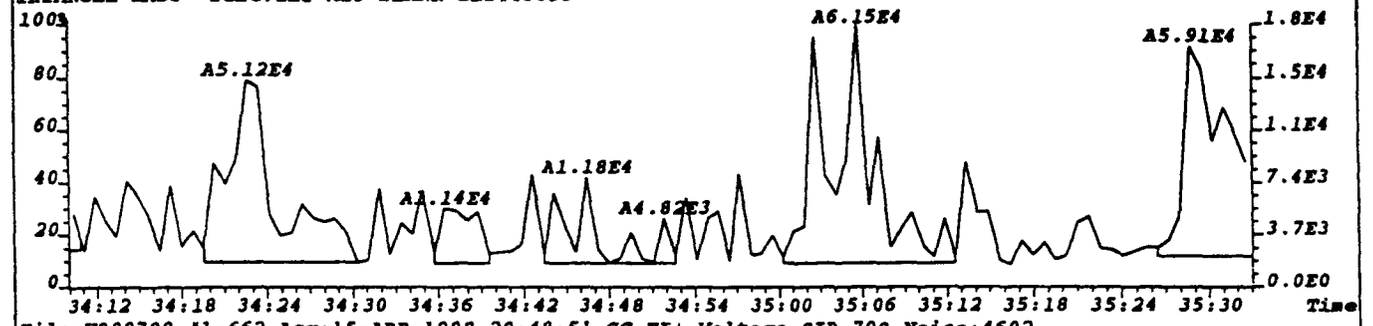
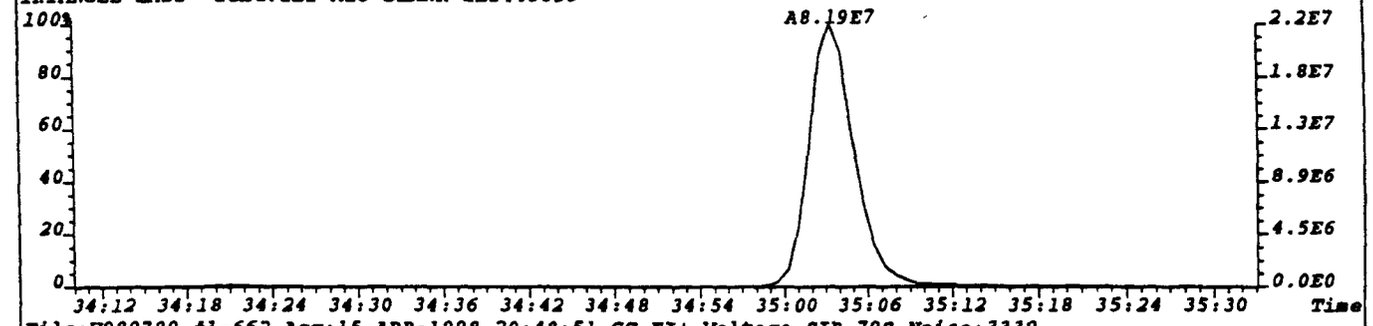
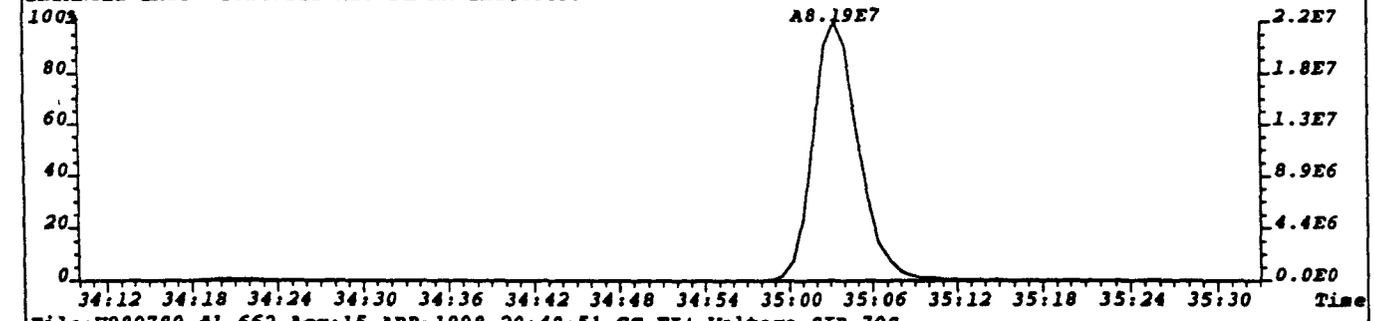
425.7737 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,4532.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



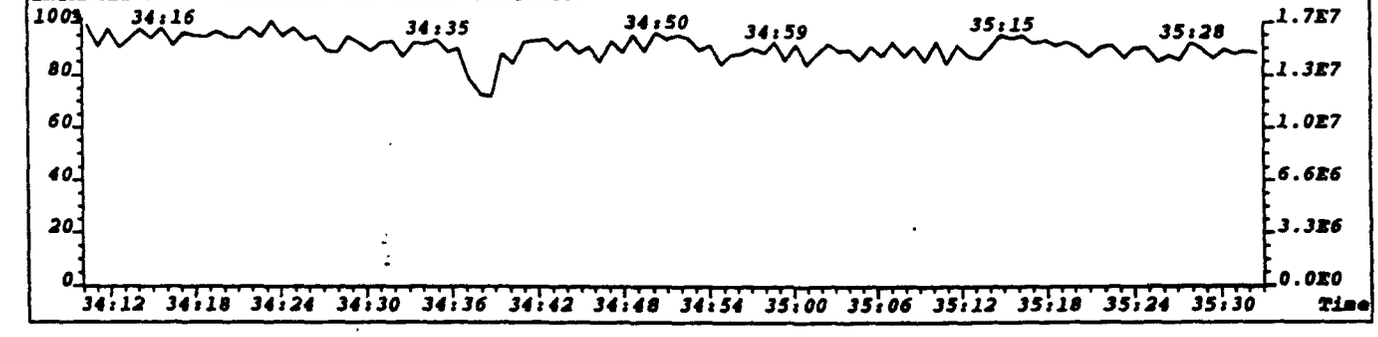
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:4602
435.8169 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,18408.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



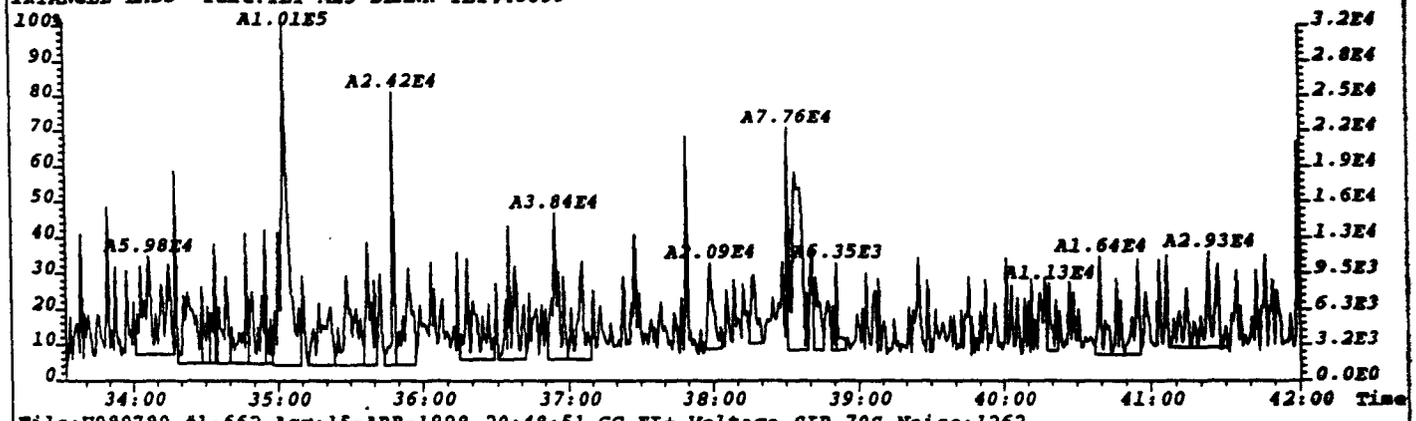
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:3339
437.8140 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,13356.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1226
441.7428 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,4904.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



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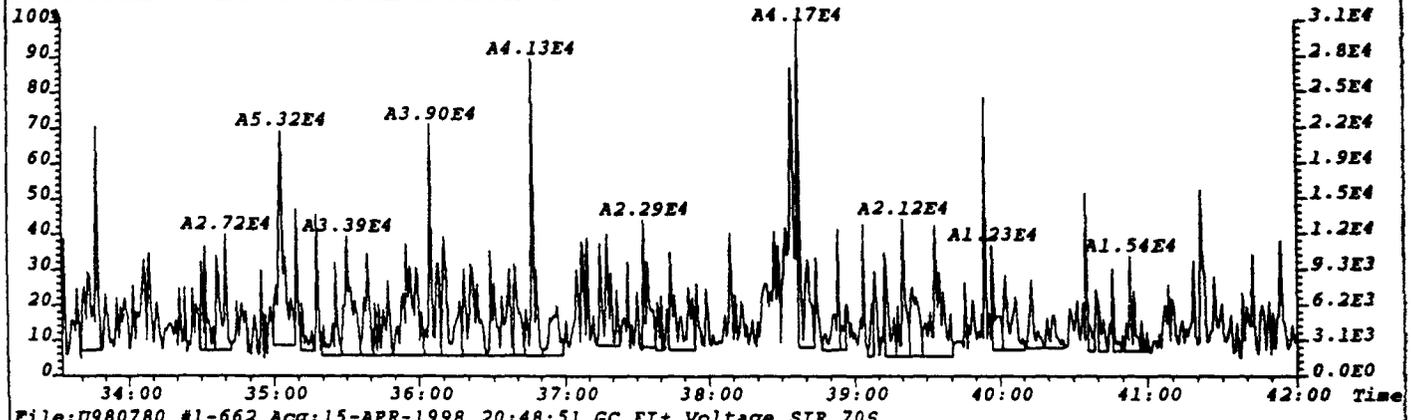
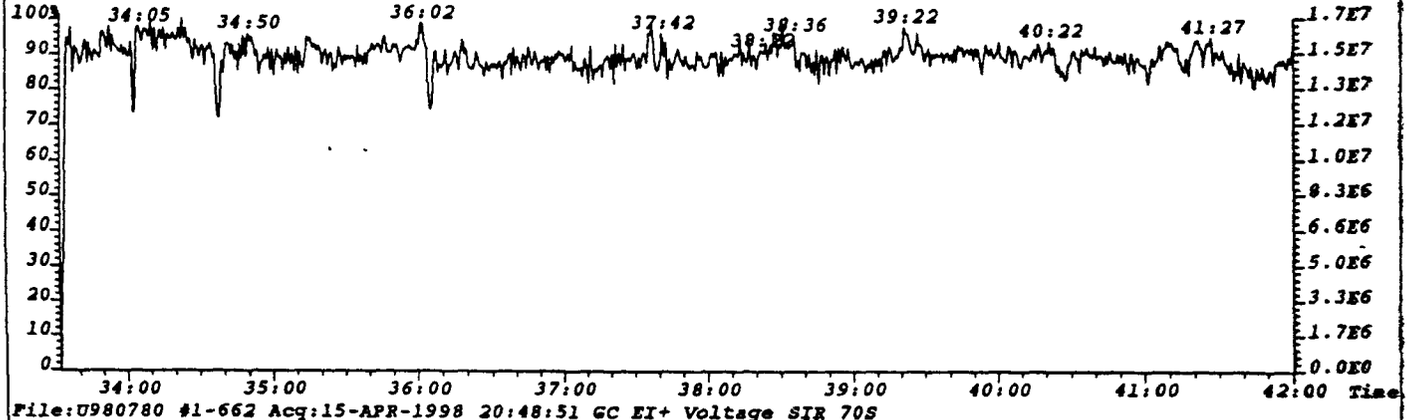
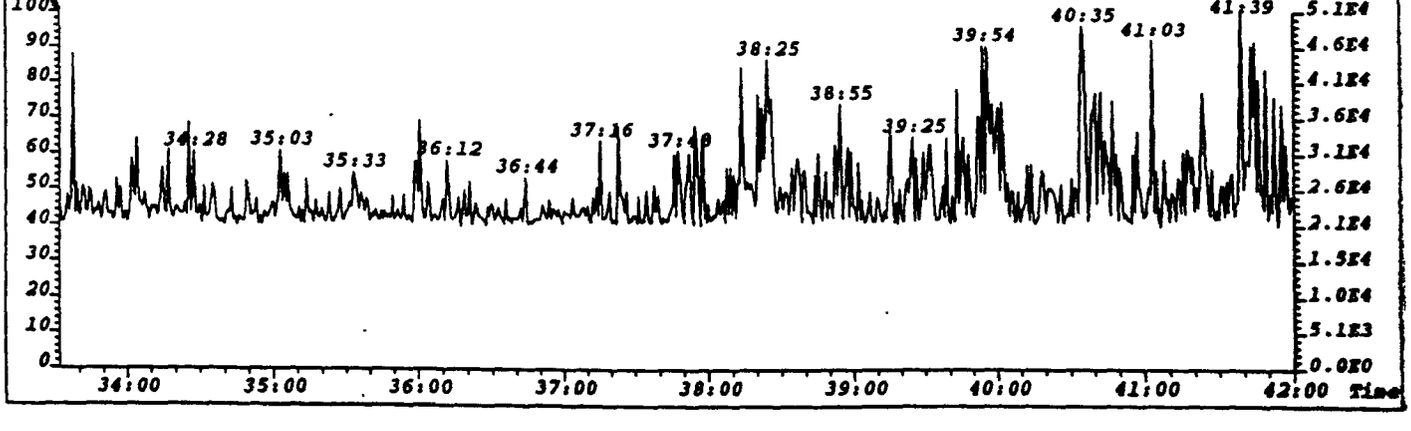
443.7399 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,5048.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



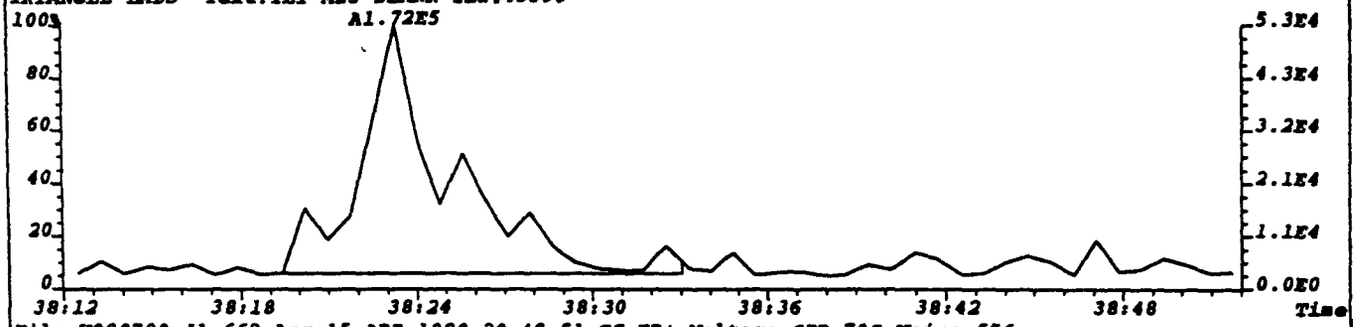
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



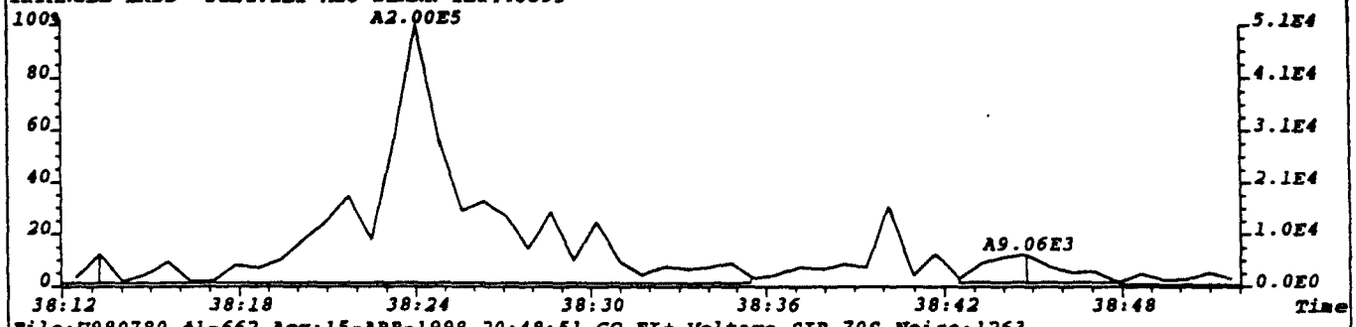
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
513.6775 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:1211
457.7377 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,4844.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:556
459.7348 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,2224.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



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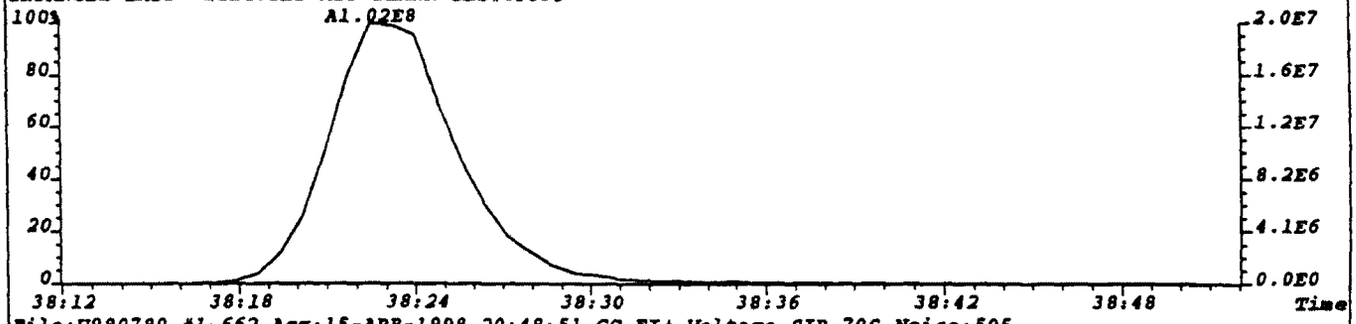
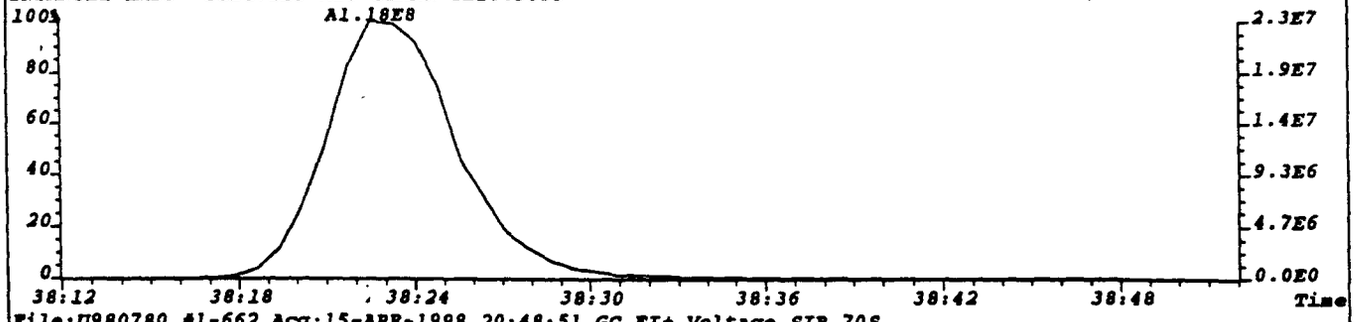
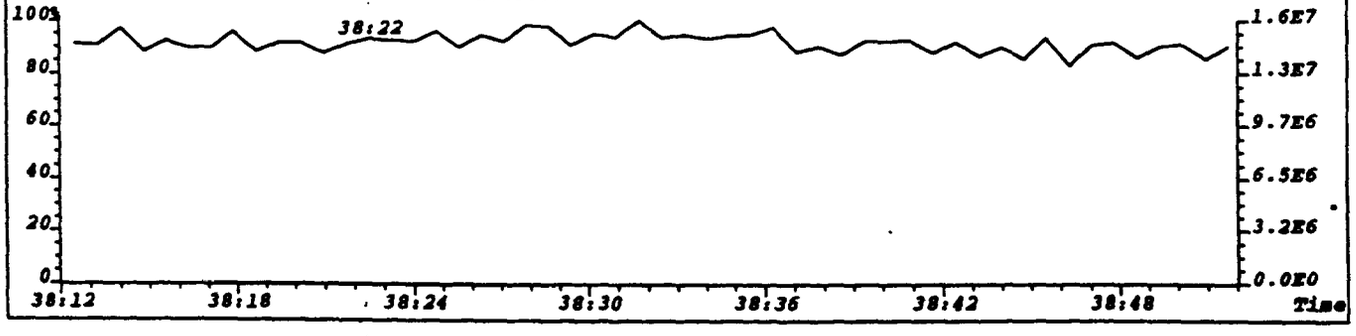
469.7779 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,5052.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



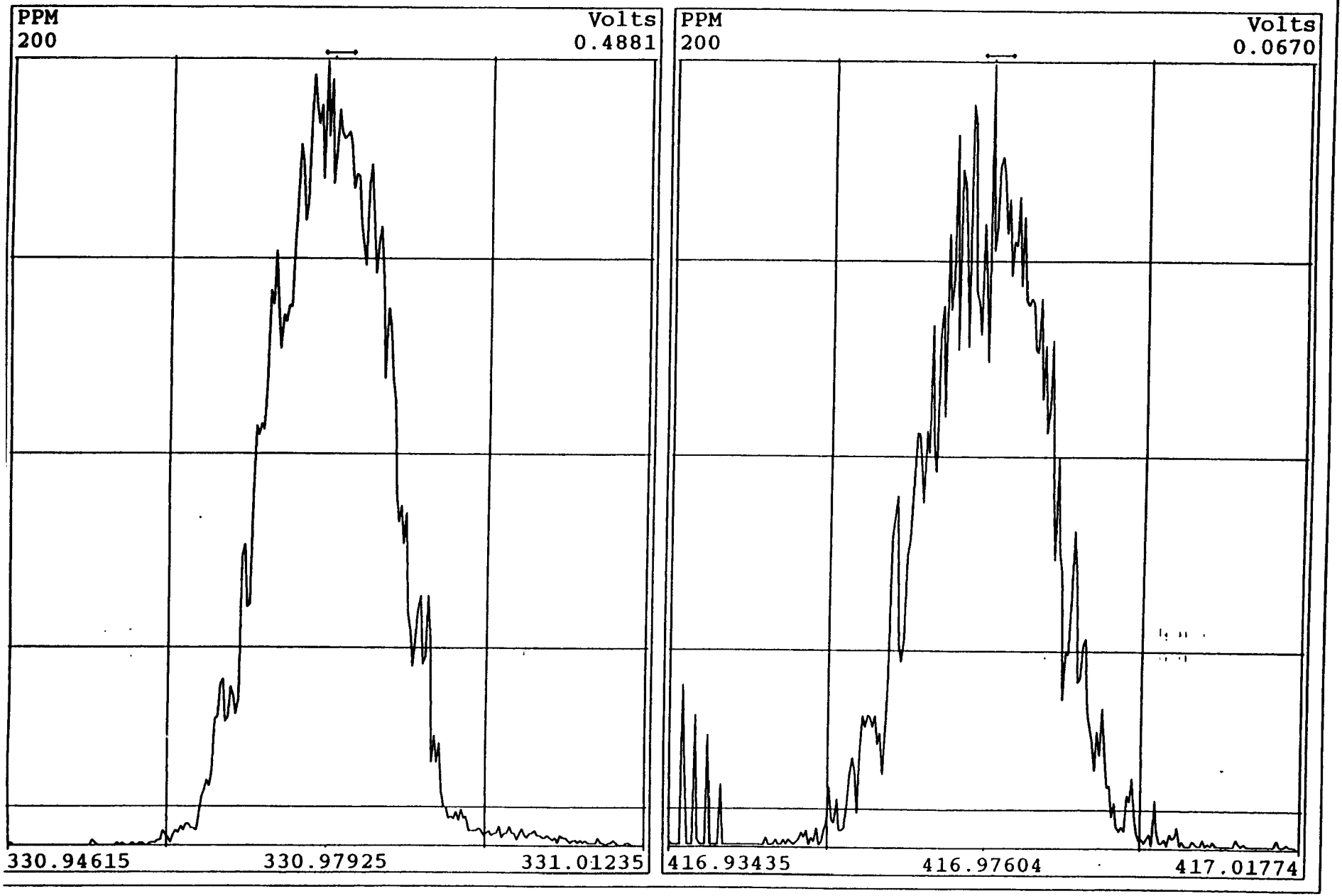
File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S Noise:505
471.7750 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.10%,2020.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:U980780 #1-662 Acq:15-APR-1998 20:48:51 GC EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



Peak Locate Examination:15-APR-1998:20:47 File:U980780
Experiment:NDB5US Function:2 Reference:PFK



Pacific Environmental Services

TLI Project: 45399 — Method 23 TCDD/TCDF Analysis (DB-225)

Client Sample: TLI M23 Blank — Analysis File: P981305

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	XAD	Date Received:	/ /	Spike File:	SPC2NF04
TLI ID:	TLI Blank	Date Extracted:	04/03/98	ICal:	PF24098
		Date Analyzed:	04/16/98	ConCal:	P981302
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-225	Analyst:	BJG	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDF	ND	0.005				—

Internal Standard	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	2.8	69.2	40%-130%	0.75	22:23	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.78	21:17	—

Data Reviewer: KC 04/20/98

C2NF_PSR v2.02, LARS 6.11.0

Triangle Laboratories, Inc.®
801 Capitola Drive • Durham, North Carolina 27713
Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 21:27 04/20/9

Initial ....Date...

Data Review By: K 4/20/98 Calculated Noise Area: 0.13

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of P981305B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF						0.65-0.89				0.790-1.102			
304-306	DC	NL		0:00	RO	1.00	0.14			0.000			
304-306			0 Peaks				0.00						
13C12-TCDF						0.65-0.89				0.955-1.045			
316-318	DC	NL		0:00	RO	1.13	0.14			0.000			
	DC	WL		20:58		0.88	0.81			0.937			
	DC	WL		21:14		0.75	2.19			0.949			
				22:23		0.75	257.47	110.10	147.37	1.000	13C12-2378-TCDF	ISO	
	DC	SN		23:02	RO	1.40	0.27			1.029			
	DC	WH		24:25		0.87	2.62			1.091			
316-318			1 Peak				257.47						

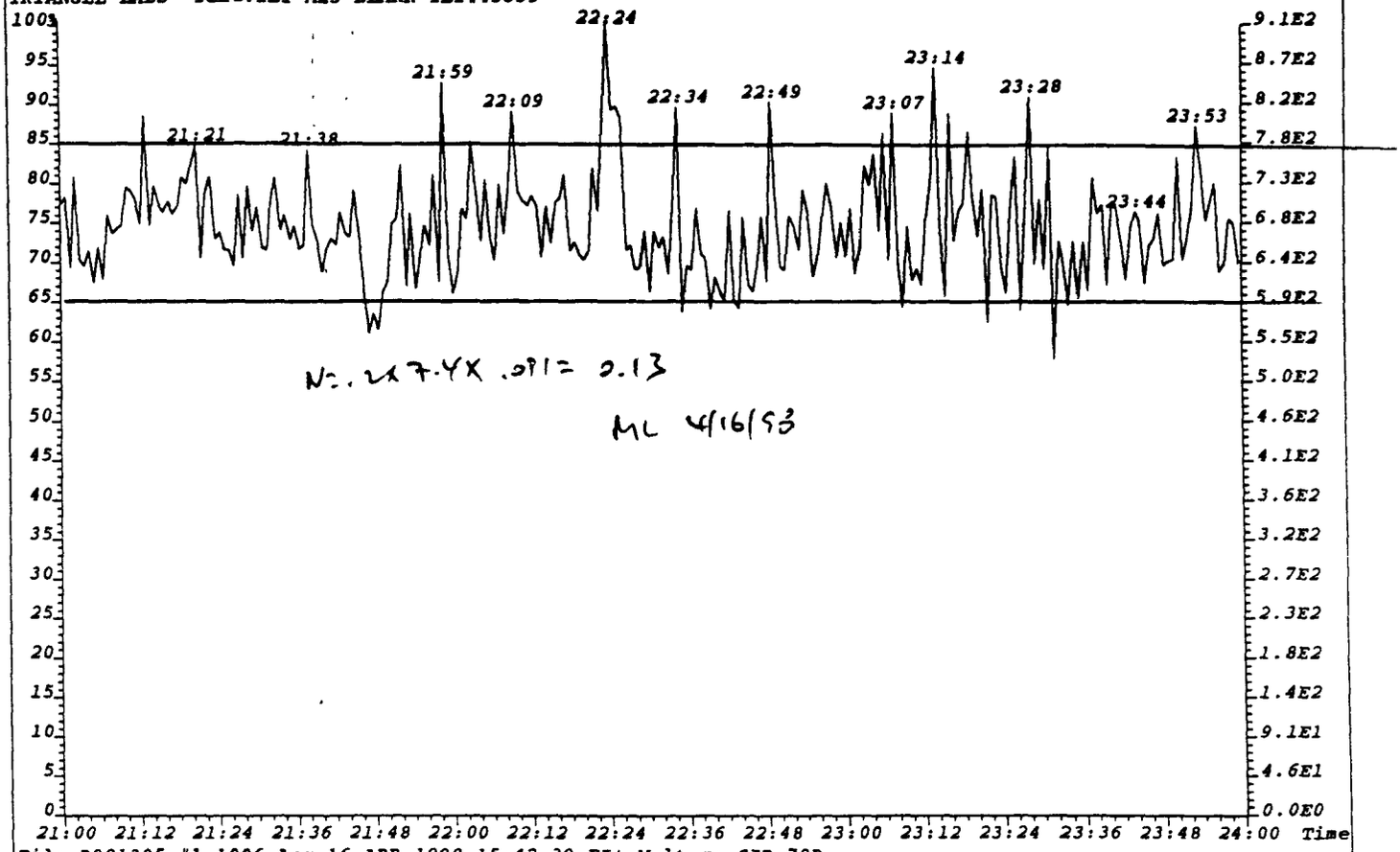
---------- Above: TCDF / TCDD Follows ----------

13C12-TCDD						0.65-0.89				0.905-1.095			
332-334	DC	NL		0:00	RO	1.22	0.16			0.000			
				19:54	RO	1.04	0.42	0.25	0.24	0.948			
				21:00		0.78	181.15	79.63	101.52	1.000	13C12-2378-TCDD	IS1	
				21:17		0.78	276.72	121.27	155.45	1.013	13C12-1234-TCDD	RS1	
				22:00		0.75	1.45	0.62	0.83	1.048			
332-334			4 Peaks				459.74						

Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

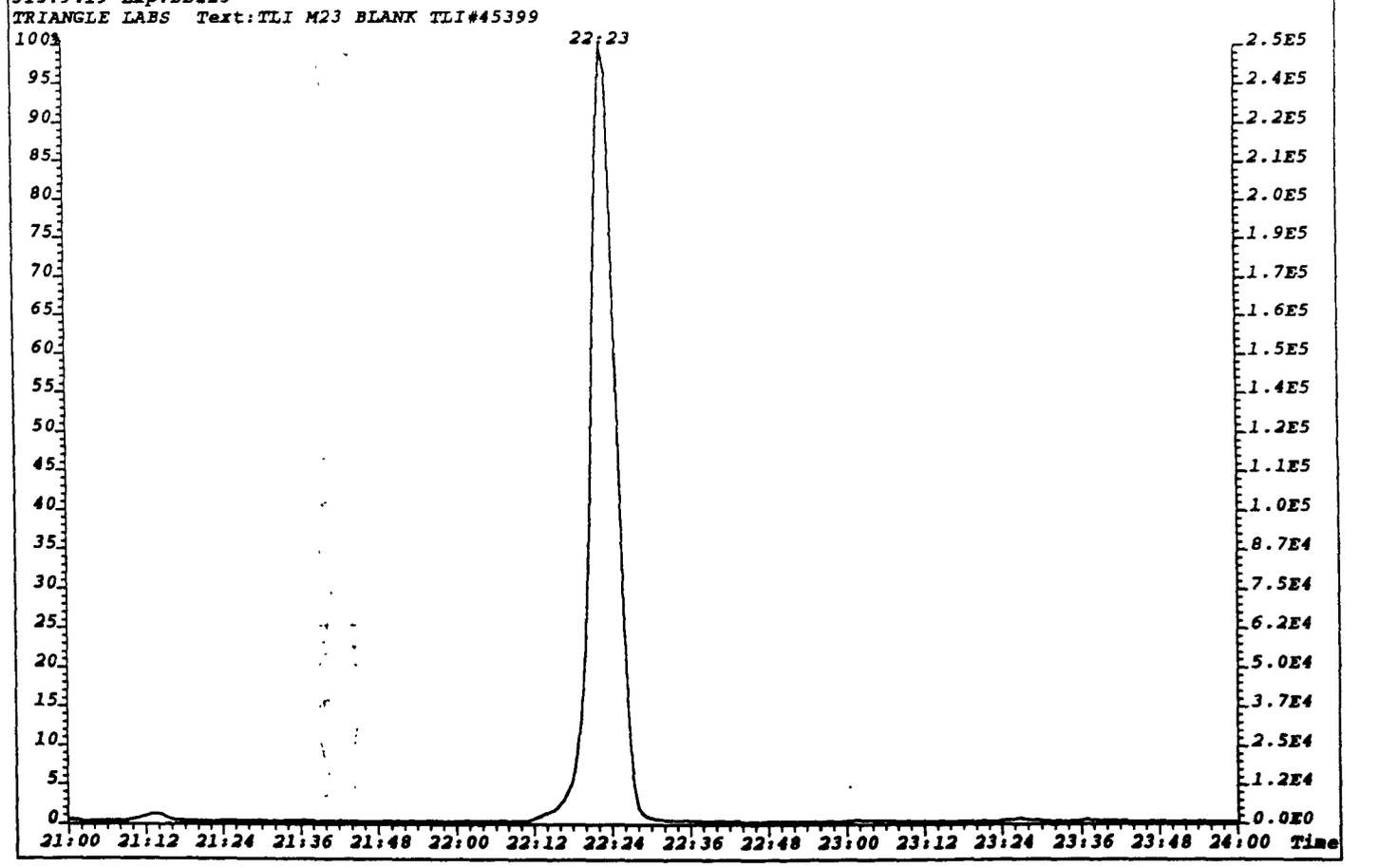
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



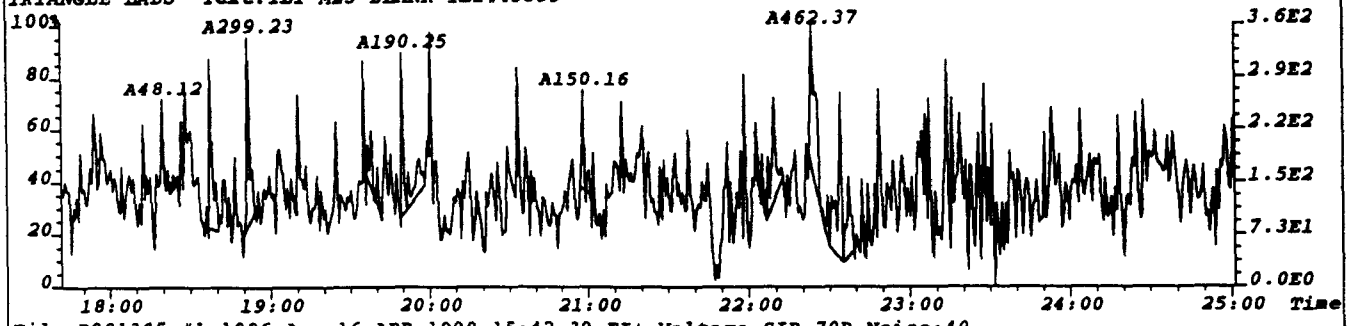
N=.247.4X .091= 0.13

ML 4/16/98

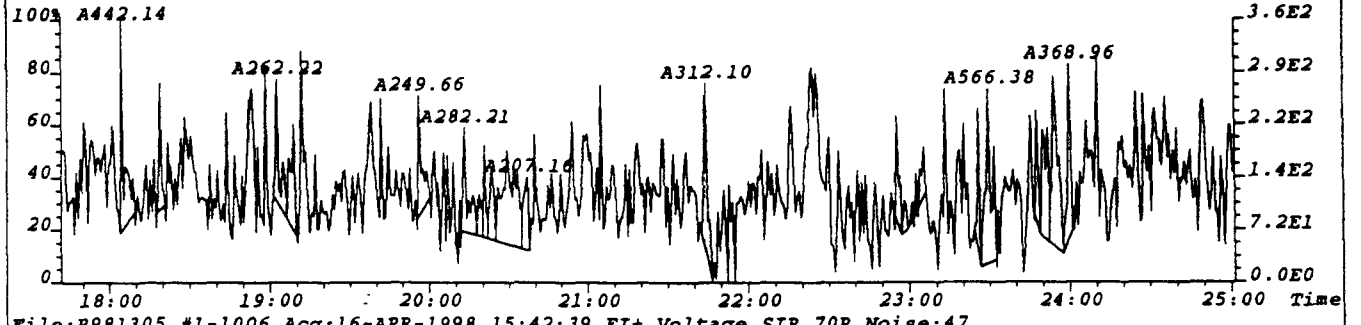
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



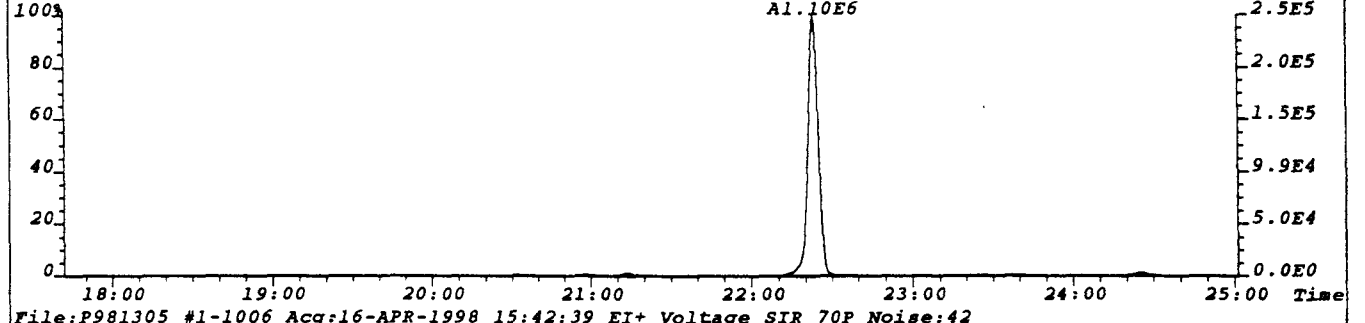
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:41
303.9016 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,164.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



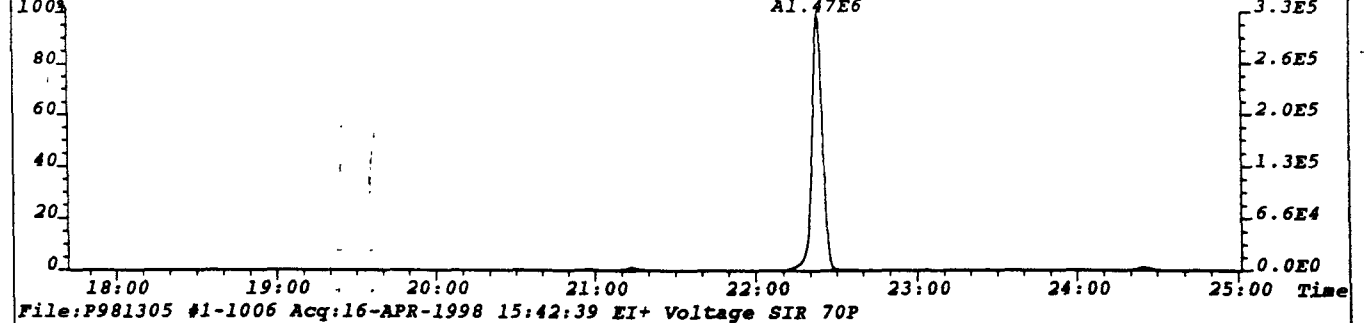
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:40
305.8987 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,160.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



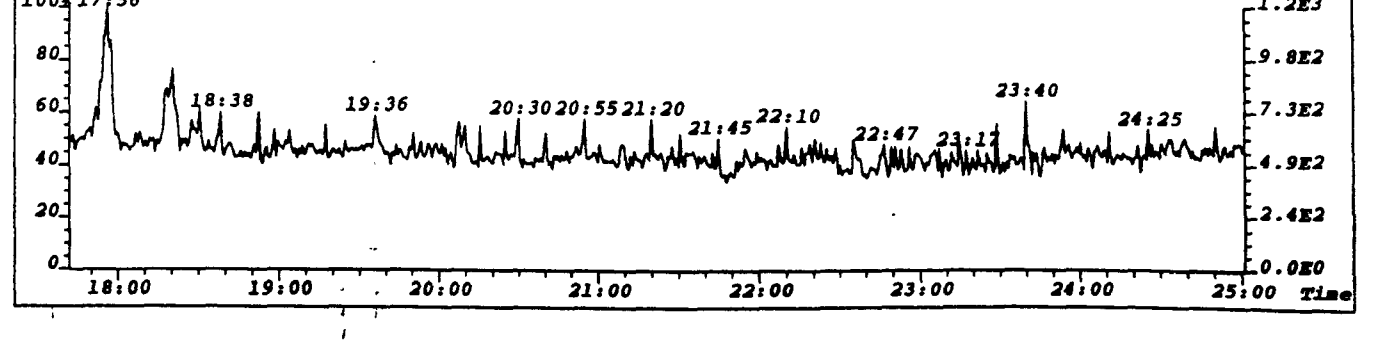
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:47
315.9419 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,188.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



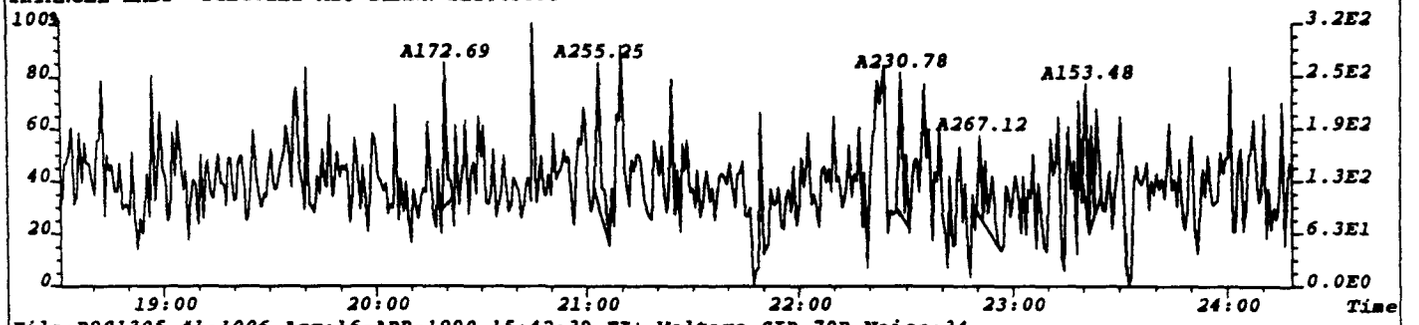
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:42
317.9389 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,168.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



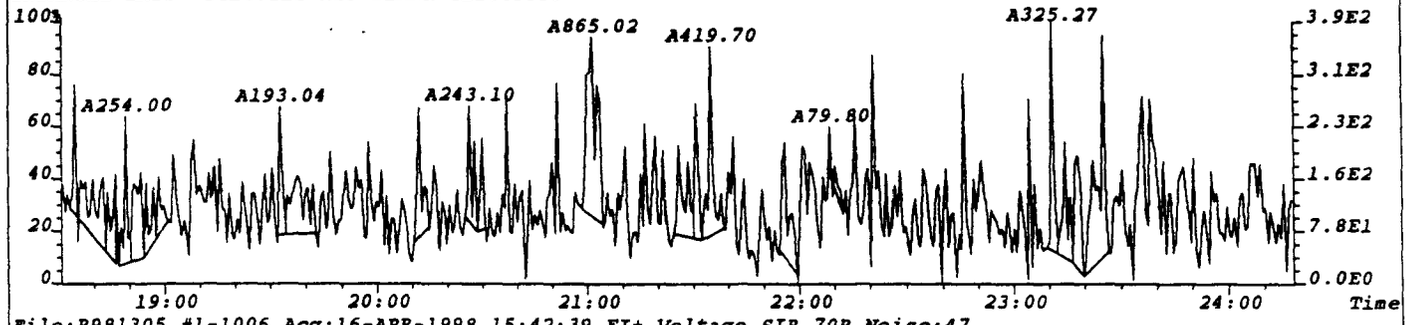
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
375.8364 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



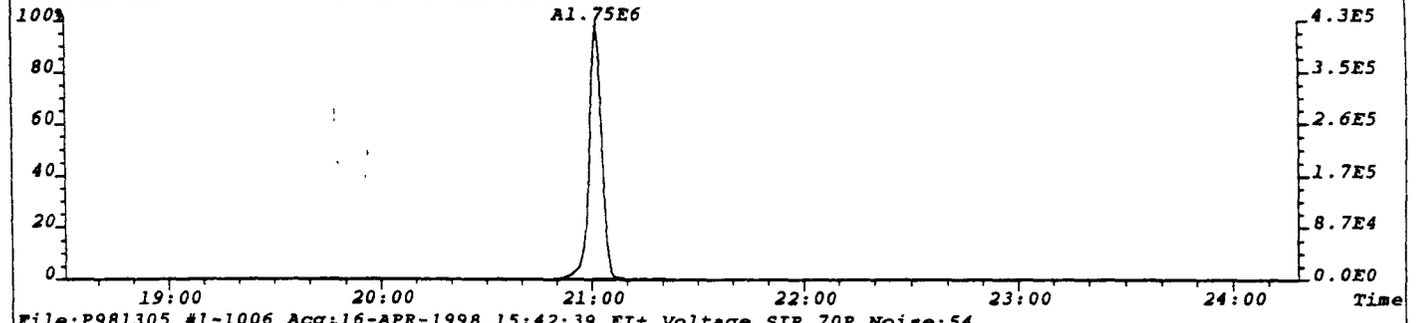
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:40
319.8965 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,160.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



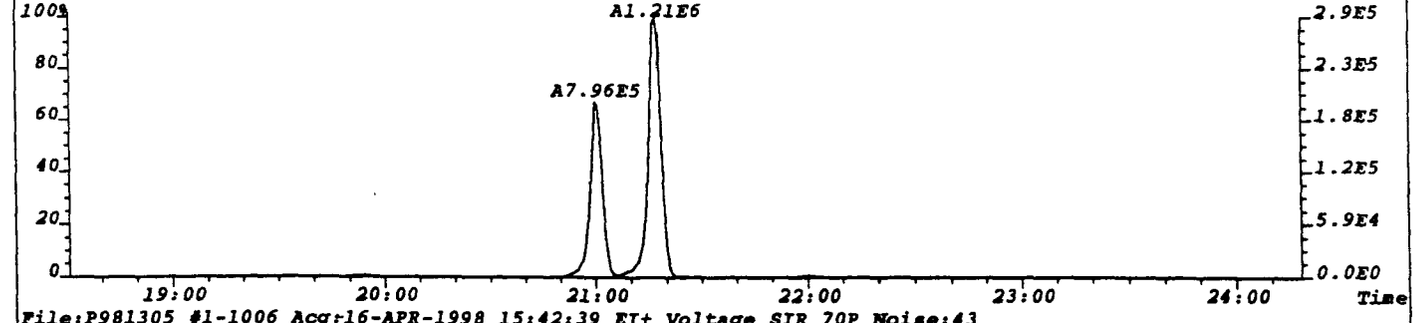
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:34
321.8936 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,136.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



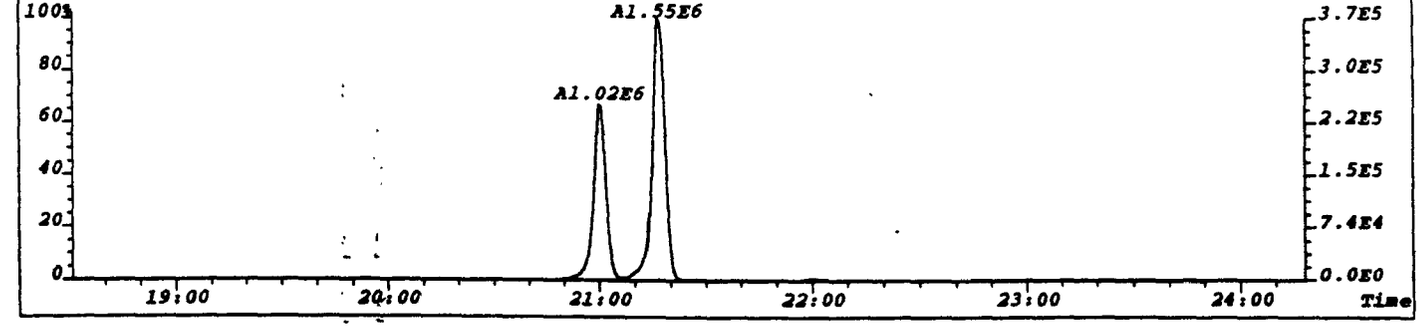
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:47
327.8847 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,188.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



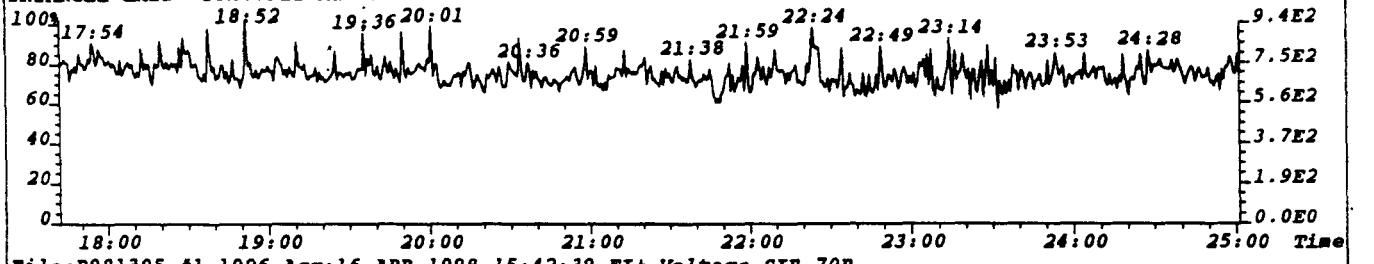
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:54
331.9368 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,216.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



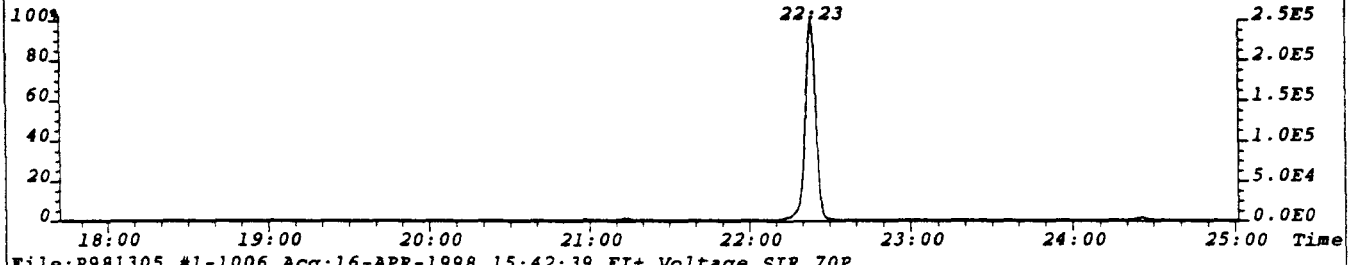
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P Noise:43
333.9338 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,172.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



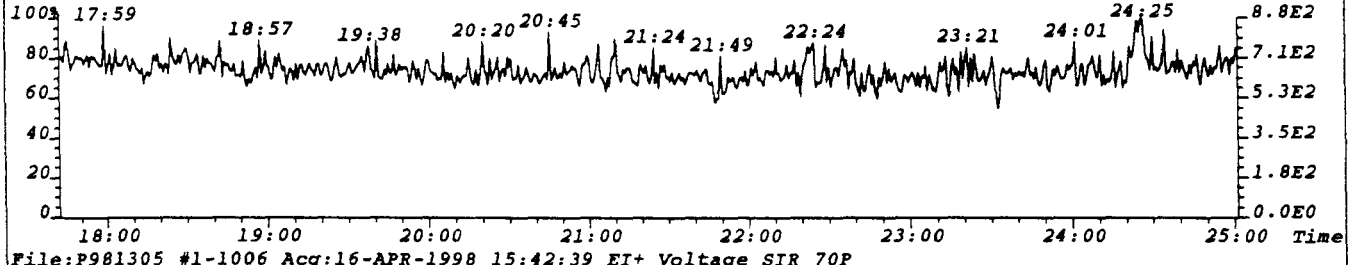
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



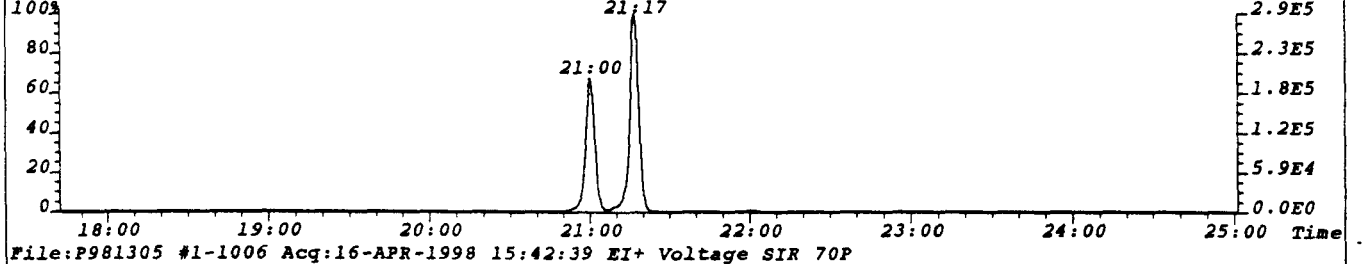
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



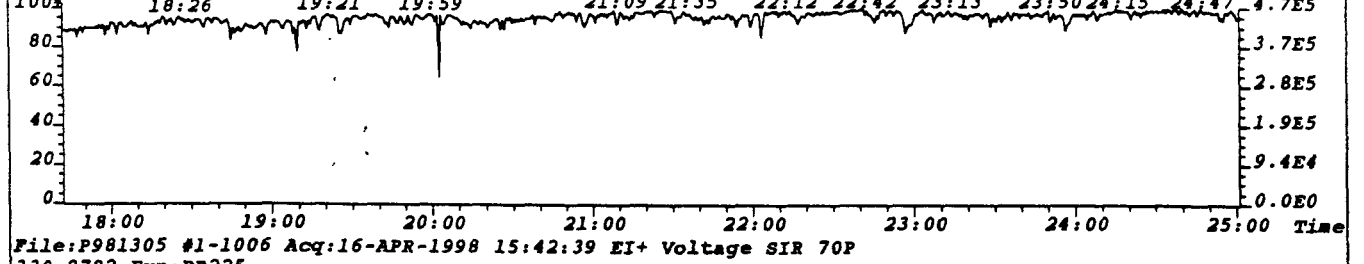
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
319.8965 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



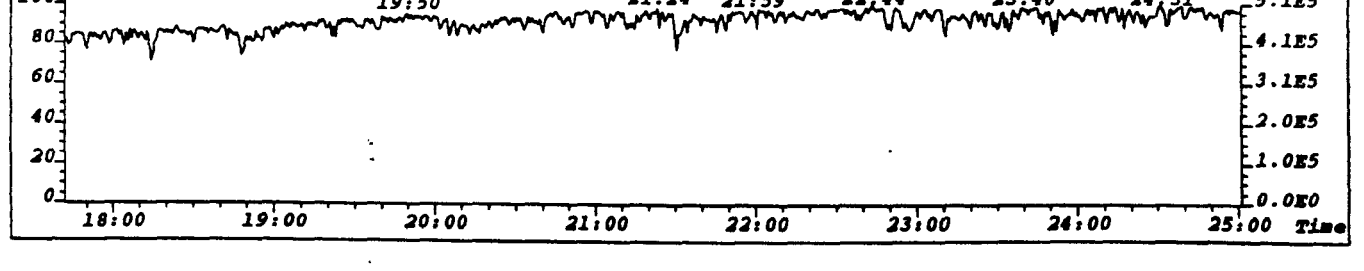
File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
331.9368 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399

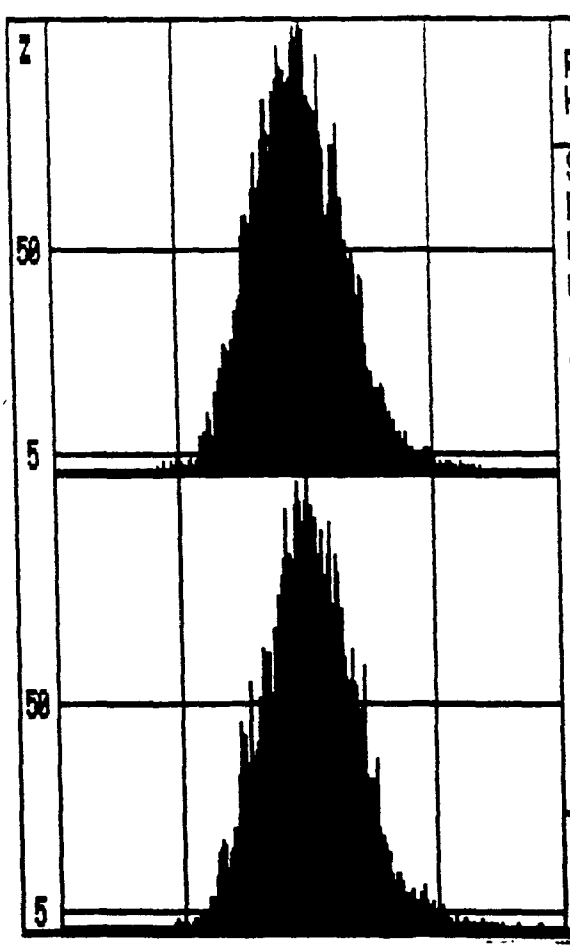


File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
292.9825 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399



File:P981305 #1-1006 Acq:16-APR-1998 15:42:39 EI+ Voltage SIR 70P
330.9792 Exp:DB225
TRIANGLE LABS Text:TLI M23 BLANK TLI#45399





Ref. mass 292.9825 Peak top
Height .07 volts Span 200 ppm

System file name	DB225
Data file name	A:P981305
Resolution	10000
Group number	1
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 300.9761

A	292.9825	J	330.9792
B	303.9016	K	331.9368
C	305.8987	L	333.9338
D	315.9419	M	375.8364
E	317.9389		
F	319.8965		
G	321.8936		
H	327.8847		
I	330.9792		

Channel I 330.9792 Peak top
Height .07 volts Span 200 ppm

Pages 77 through 159 from the Triangle Laboratories, Inc. analytical report have been excluded by PES since these pages present results for samples collected at another lime kiln facility during the same mobilization.

Pacific Environmental Services

TLI Project: 45399 — Method 23 PCDD/PCDF Analysis (a)
Client Sample: M23-I-4 — Analysis File: T981958

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	M23	Date Received:	04/01/98	Spike File:	SPMIT204
TLI ID:	204-92-4A-D	Date Extracted:	04/03/98	ICal:	TF51308
		Date Analyzed:	04/18/98	ConCal:	T981946
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-5	Analyst:	HLM	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDD	ND	0.003				___
1,2,3,7,8-PeCDD	ND	0.004				___
1,2,3,4,7,8-HxCDD	ND	0.006				___
1,2,3,6,7,8-HxCDD	ND	0.005				___
1,2,3,7,8,9-HxCDD	ND	0.005				___
1,2,3,4,6,7,8-HpCDD	0.008			1.00	36:49	J__
1,2,3,4,6,7,8,9-OCDD	0.04			0.84	40:23	JB_
2,3,7,8-TCDF	0.34			0.80	25:26	___
1,2,3,7,8-PeCDF	0.04			1.52	29:25	J__
2,3,4,7,8-PeCDF	0.04			1.43	30:07	J__
1,2,3,4,7,8-HxCDF	0.01			1.28	32:52	J__
1,2,3,6,7,8-HxCDF	0.008			1.40	32:58	J__
2,3,4,6,7,8-HxCDF	0.008			1.14	33:27	J__
1,2,3,7,8,9-HxCDF	ND	0.004				___
1,2,3,4,6,7,8-HpCDF	0.007			0.90	35:49	J__
1,2,3,4,7,8,9-HpCDF	ND	0.007				___
1,2,3,4,6,7,8,9-OCDF	ND	0.02				___

Totals	Amt. (ng)	Number	DL	EMPC	Flags
Total TCDD	0.02	2		0.04	___
Total PeCDD	EMPC			0.003	___
Total HxCDD	0.01	2			___
Total HpCDD	0.02	2			___
Total TCDF	2.6	14		2.6	___
Total PeCDF	0.38	10		0.46	___
Total HxCDF	0.05	5			___
Total HpCDF	0.007	1			___

MIT2_PSR v1.04, LARS 6.11.00

Triangle Laboratories, Inc.®
801 Capitola Drive • Durham, North Carolina 27713

Printed: 15:39 04/20/98

Pacific Environmental Services

TLI Project: **45399** Method 23 PCDD/PCDF Analysis (a)
Client Sample: **M23-I-4** Analysis File: **T981958**

Internal Standards	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	2.4	60.6	40%-130%	0.75	25:23	—
$^{13}C_{12}$-2,3,7,8-TCDD	2.1	53.7	40%-130%	0.81	26:07	—
$^{13}C_{12}$-1,2,3,7,8-PeCDF	2.5	63.2	40%-130%	1.45	29:24	—
$^{13}C_{12}$-1,2,3,7,8-PeCDD	2.8	69.5	40%-130%	1.51	30:26	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	2.9	72.2	40%-130%	0.50	32:58	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	2.8	70.5	40%-130%	1.22	33:38	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	2.6	65.5	25%-130%	0.43	35:48	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	2.7	68.4	25%-130%	1.02	36:49	—
$^{13}C_{12}$-1,2,3,4,6,7,8,9-OCDD	3.2	40.3	25%-130%	0.86	40:22	—

Surrogate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,4,7,8-PeCDF	3.8	96.0	40%-130%	1.46	30:06	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	3.7	92.2	40%-130%	0.50	32:52	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	3.7	93.2	40%-130%	1.21	33:34	—
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	3.0	76.0	25%-130%	0.42	37:18	—

Other Standard	Amt. (ng)	% Recovery	QC Limits	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	3.6	88.9	40%-130%	26:09	—

Alternate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	3.0	76.1	40%-130%	0.50	34:12	—
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	3.0	75.6	40%-130%	0.51	33:26	—

Recovery Standards	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.81	25:56	—
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.20	33:56	—

Data Reviewer: WZN 04/20/98

MIT2_PSR v1.04, LARS 6.11.00

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801 Capitola Drive • Durham, North Carolina 27713

Printed: 15:20 4/20/98

Initial ....Date...

Data Review By: WDM 4/20/98 Calculated Noise Area: 0.18

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of T981958B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF				0.65-0.89						0.868-1.077			
304-306	DC	NL		0:00	RO	1.29	0.42			0.000			
				22:09		0.79	31.91	14.04	17.87	0.873			
				22:41		0.80	15.39	6.85	8.54	0.894			
				22:56		0.78	9.97	4.38	5.59	0.903			J
				23:20		0.81	113.69	50.76	62.93	0.919			
				23:39		0.78	58.73	25.69	33.04	0.932			
				24:04		0.79	54.12	23.82	30.30	0.948			
				24:21		0.78	51.26	22.54	28.72	0.959			
				24:39		0.80	42.33	18.81	23.52	0.971			
				24:59		0.79	39.68	17.49	22.19	0.984			
				25:14		0.76	18.34	7.93	10.41	0.994			
				25:26		0.80	70.71	31.46	39.25	1.002	2378-TCDF	AN	
				25:52		0.79	24.89	10.95	13.94	1.019			
				26:04		0.71	11.35	4.73	6.62	1.027			
				26:18	RO	0.93	2.41	1.27	1.36	1.036			J
				27:10		0.73	2.13	0.90	1.23	1.070			J
304-306			15	Peaks			546.91						
13C12-TCDF				0.65-0.89						0.961-1.039			
316-318	DC	NL		0:00	RO	1.35	0.35			0.000			
				24:58		0.89	2.55	1.20	1.35	0.984			
				25:23		0.75	676.36	290.19	386.17	1.000	13C12-2378-TCDF	ISO	
				25:51		0.86	3.27	1.51	1.76	1.018			
316-318			3	Peaks			682.18						

---------- Above: TCDF / TCDD Follows ----------

TCDD				0.65-0.89						0.896-1.045			
320-322	DC	NL		0:00	RO	1.17	0.21			0.000			
				23:33		0 80	1.73	0.77	0.96	0.902			J
				23:56	RO	0.48	0.69	0.30	0.62	0.916			J
				24:57	RO	0.61	1.70	0.74	1.21	0.955			J
	DC	SN		25:12	RO	0.24	0.23			0.965			
	DC	SN		25:23	RO	2.18	0.30			0.972			
	DC	SN		25:35	RO	0.31	0.28			0.980			
D	D	SN		25:58	RO	0.90	0.53			0.994			
				26:03	RO	0.95	0.74	0.40	0.42	0.997	-		J
D	D	SN		26:09	RO	0.51	0.85			1.001	2378-TCDD	AN	
	DC	SN		26:17	RO	1.05	0.35			1.006			
				26:29		0.82	0.93	0.42	0.51	1.014			J
320-322			5	Peaks			5.79						

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
37Cl-TCDD										0.924-1.076			
328	DC	NL		0:00			0.13			0.000			
				24:46			2.29	2.29		0.948			
				26:09			428.41	428.41		1.001	37Cl-TCDD	CLS	
				26:32			2.38	2.38		1.016			
328			3	Peaks			433.08						
13C12-TCDD					0.65-0.89					0.924-1.076			
332-334	DC	NL		0:00	RO	1.98	0.83			0.000			
				25:56		0.81	753.51	337.35	416.16	0.993	13C12-1234-TCDD	RS1	
				26:07		0.81	463.61	206.91	256.70	1.000	13C12-2378-TCDD	IS1	
				26:28		0.89	7.87	3.71	4.16	1.013			
332-334			3	Peaks			1,224.99						

---------- Above: TCDD / PeCDF Follows ----------

PeCDF					1.32-1.78					0.926-1.063			
340-342	DC	NL		0:00	RO	0.86	0.20			0.000			
	DC	WL		27:13	RO	0.45	1.07			0.926			
				27:24	RO	1.25	7.42	4.51	3.61	0.932			J
				28:24		1.35	4.88	2.80	2.08	0.966			J
				28:33		1.46	23.55	13.98	9.57	0.971			
				28:42		1.62	5.29	3.27	2.02	0.976			J
				28:52		1.51	2.64	1.59	1.05	0.982			J
				29:02	RO	1.25	2.22	1.35	1.08	0.988			J
				29:07		1.34	2.71	1.55	1.16	0.990			J
	A			29:19		1.33	1.12	0.64	0.48	0.997			J
	M			29:25		1.52	7.11	4.29	2.82	1.001	12378-PeCDF	AN	J
				29:34	RO	1.31	2.68	1.63	1.24	1.006			J
				29:42		1.49	5.06	3.03	2.03	1.010			J
				30:07		1.43	6.78	3.99	2.79	1.024	23478-PeCDF	AN	J
				30:14		1.48	3.54	2.11	1.43	1.028			J
	DC	SN		30:28	RO	1.20	0.39			1.036			
	DC	SN		30:33		1.33	0.35			1.039			
				31:05	RO	1.91	0.84	0.63	0.33	1.057			J
340-342			14	Peaks			75.84						
13C12-PeCDF					1.32-1.78					0.864-1.136			
352-354	DC	NL		0:00	RO	1.22	0.18			0.000			
				28:30		1.35	1.67	0.96	0.71	0.969			
				29:24		1.45	588.63	348.18	240.45	1.000	13C12-PeCDF 123	IS2	
				29:40		1.44	5.46	3.22	2.24	1.009			
				30:06		1.46	567.36	336.42	230.94	1.024	13C12-PeCDF 234	SUR1	
				31:03		1.54	1.60	0.97	0.63	1.056			
352-354			5	Peaks			1,164.72						

---------- Above: PeCDF / PeCDD Follows ----------

PeCDD					1.32-1.78					0.936-1.021			
356-358	DC	NL		0:00	RO	1.00	0.18			0.000			
	A			28:37	RO	0.73	0.31	0.19	0.26	0.940			J
	DC	SN		29:08	RO	0.38	0.16			0.957			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
	D	D	SN	29:22		1.59	0.75			0.965			
		DC	SN	29:31	RO	1.26	0.39			0.970			
		DC	SN	29:42		1.77	0.36			0.976			
		DC	SN	29:56		1.40	0.48			0.984			
	D	D	SN	30:08		1.48	0.82			0.990			
	D	D	SN	30:27	RO	1.16	0.61			1.001	12378-PeCDD	AN	
		DC	SN	30:34	RO	1.18	0.21			1.004			
		DC	WH	31:11	RO	6.33	0.08			1.025			
356-358			1	Peak			0.31						
13C12-PeCDD				1.32-1.78						0.869-1.131			
368-370		DC	NL	0:00	RO	1.25	0.16			0.000			
				30:26		1.51	358.85	215.94	142.91	1.000	13C12-PeCDD 123	IS3	
				30:35		1.44	36.59	21.61	14.98	1.005			
368-370			2	Peaks			395.44						

---------- Above: PeCDD / HxCDF Follows ----------

HxCDF				1.05-1.43						0.963-1.045			
374-376		DC	NL	0:00	RO	1.00	0.38			0.000			
				31:54		1.10	0.63	0.33	0.30	0.968			J
				32:03		1.07	2.21	1.14	1.07	0.972			J
		DC	SN	32:12		1.37	0.45			0.977			
		DC	SN	32:21	RO	1.00	0.31			0.981			
				32:52		1.28	1.55	0.87	0.68	0.997	123478-HxCDF	AN	J
				32:58		1.40	1.20	0.70	0.50	1.000	123678-HxCDF	AN	J
		DC	SN	33:05		1.35	0.40			1.004			
				33:27		1.14	0.90	0.48	0.42	1.015	234678-HxCDF	AN	J
374-376			5	Peaks			6.49						
13C12-HxCDF				0.43-0.59						0.879-1.121			
384-386		DC	NL	0:00	RO	1.09	0.17			0.000			
				31:53		0.51	3.36	1.14	2.22	0.967			
				32:02		0.57	2.16	0.78	1.38	0.972			
				32:52		0.50	426.02	141.90	284.12	0.997	13C12-HxCDF 478	SUR2	
				32:58		0.50	480.37	160.93	319.44	1.000	13C12-HxCDF 678	IS4	
				33:26		0.51	474.12	160.01	314.11	1.014	13C12-HxCDF 234	ALT2	
				33:49	RO	0.33	1.10	0.37	1.11	1.026			
				33:55	RO	0.66	1.12	0.49	0.74	1.029			
				34:12		0.50	370.48	123.09	247.39	1.037	13C12-HxCDF 789	ALT1	
384-386			8	Peaks			1,758.73						

---------- Above: HxCDF / HxCDD Follows ----------

HxCDD				1.05-1.43						0.958-1.013			
390-392		DC	NL	0:00	RO	0.90	0.33			0.000			
				32:52		1.32	0.58	0.33	0.25	0.977			J
	K			33:03		1.42	0.46	0.27	0.19	0.983			J
		DC	SN	33:58	RO	0.61	0.31			1.010	123789-HxCDD	AN	
		DC	SN	34:01	RO	0.27	0.07			1.011			
		DC	WH	34:12	RO	0.64	0.38			1.017			
390-392			2	Peaks			1.04						

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Compound/
M_Z.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

13C12-HxCDD                     1.05-1.43                                    0.970-1.030
402-404          DC  NL   0:00 RO  0.77          0.36                              0.000
                         33:03 RO  0.70          0.90          0.50          0.71  0.983
                         33:34     1.21        280.38        153.47        126.91  0.998 13C12-HxCDD 478 SUR3
                         33:38     1.22        359.75        197.68        162.07  1.000 13C12-HxCDD 678 IS5
                         33:56     1.20        506.53        276.20        230.33  1.009 13C12-HxCDD 789 RS2
                         34:22 RO  0.82          0.96          0.53          0.65  1.022
                         34:25 RO  0.50          0.89          0.49          0.98  1.023
402-404                6 Peaks               1,149.41

                 --------------------- Above: HxCDD / HpCDF Follows --------------------

HpCDF                           0.88-1.20                                    0.996-1.047
408-410          DC  NL   0:00     1.09          0.23                              0.000
        M                35:49     0.90          0.59          0.28          0.31  1.000 1234678-HpCDF   AN   J
408-410                1 Peak                    0.59

13C12-HpCDF                     0.37-0.51                                    0.944-1.112
418-420          DC  NL   0:00 RO  1.15          0.19                              0.000
                         35:48     0.43        245.39         73.79        171.60  1.000 13C12-HpCDF 678 IS6
                 DC  SN  36:13 RO  0.17          0.49                              1.012
                         37:18     0.42        134.79         40.11         94.68  1.042 13C12-HpCDF 789 SUR4
418-420                2 Peaks                 380.18

                 --------------------- Above: HpCDF / HpCDD Follows --------------------

HpCDD                           0.88-1.20                                    0.976-1.005
424-426          DC  NL   0:00 RO  1.50          0.16                              0.000
                         36:05     0.90          0.55          0.26          0.29  0.980                       J
        K                36:49     1.00          0.40          0.20          0.20  1.000 1234678-HpCDD   AN  J
424-426                2 Peaks                    0.95

13C12-HpCDD                     0.88-1.20                                    0.973-1.027
436-438          DC  NL   0:00     1.13          0.32                              0.000
                         36:49     1.02        210.51        106.11        104.40  1.000 13C12-HpCDD 678 IS7
                         37:14 RO  0.86          0.61          0.31          0.36  1.011
436-438                2 Peaks                 211.12

                 --------------------- Above: HpCDD / Octa-CDD and CDF Follows ----------

OCDF                            0.76-1.02                                    0.901-1.099
442-444          DC  NL   0:00     0.82          0.20                              0.000
                 DC  WL  35:41 RO  0.50          0.13                              0.884
                 DC  WL  35:57 RO  1.67          0.11                              0.891
                 DC  WL  36:02 RO  0.57          0.08                              0.893
                 DC  SN  40:35 RO  1.37          0.36                              1.005 OCDF            AN
442-444                0 Peaks                    0.00

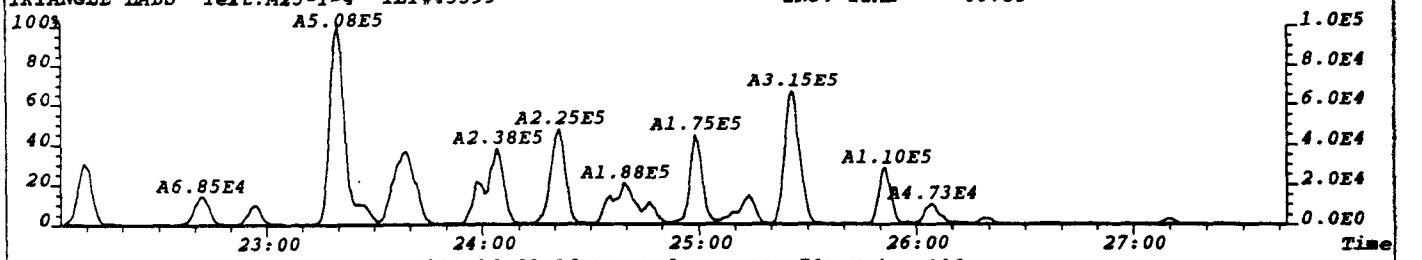
OCDD                            0.76-1.02                                    0.901-1.099
458-460          DC  NL   0:00     1.00          0.20                              0.000
                         40:02 RO  0.23          1.44          0.68          2.90  0.992
                         40:23     0.84          1.03          0.47          0.56  1.000 OCDD            AN   J
```

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
458-460			2 Peaks				2.47						
13C12-OCDD				0.76-1.02						0.996-1.004			
470-472	DC	NL		0:00	RO	1.10	0.19			0.000			
				40:22		0.86	167.16	77.42	89.74	1.000	13C12-OCDD	IS8	
	DC	WH		40:46	RO	0.44	0.64			1.010			
470-472			1 Peak				167.16						

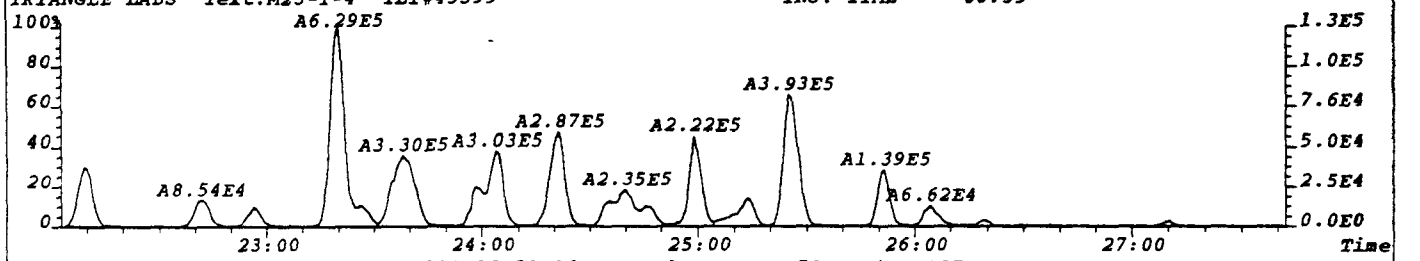
Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

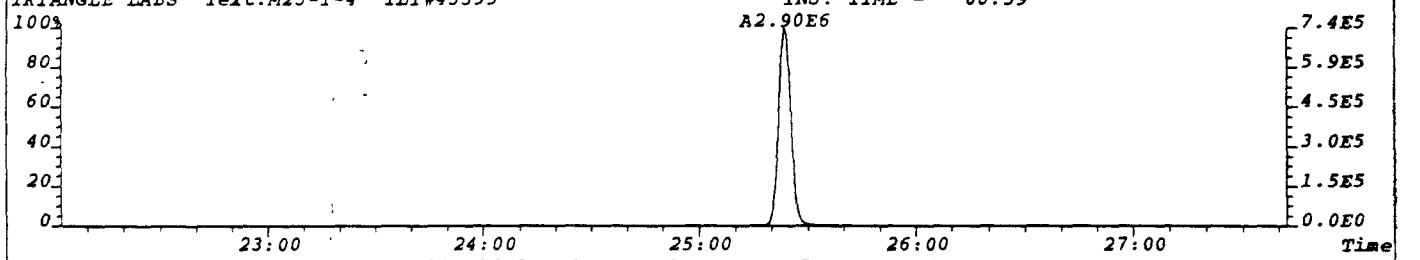
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:156
303.9016 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,624.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



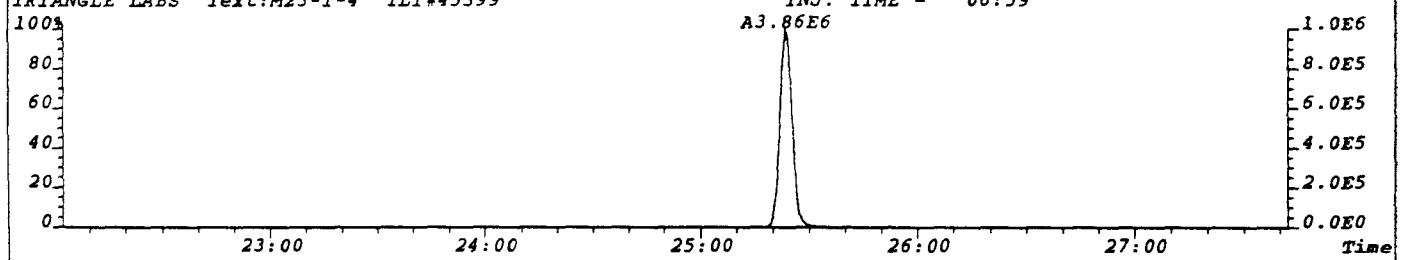
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:118
305.8987 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,472.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



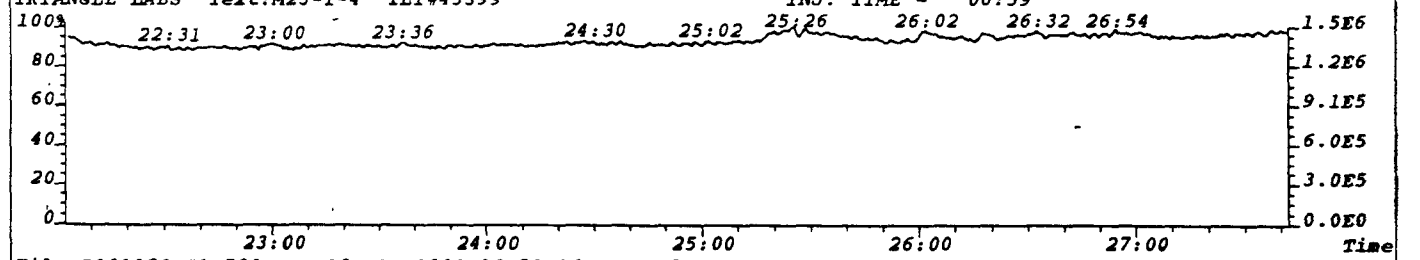
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:137
315.9419 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,548.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



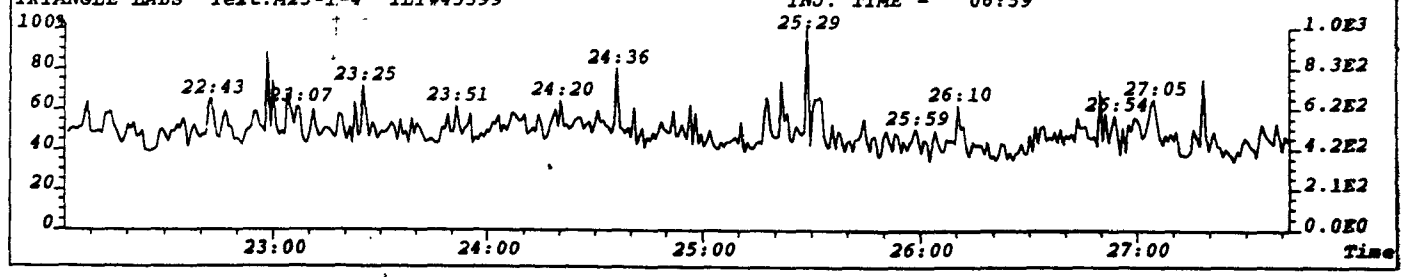
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:99
317.9389 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,396.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



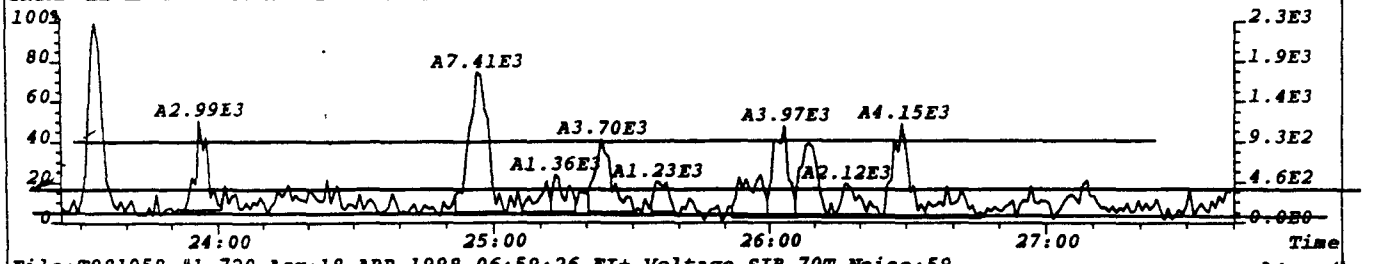
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
375.8364 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59

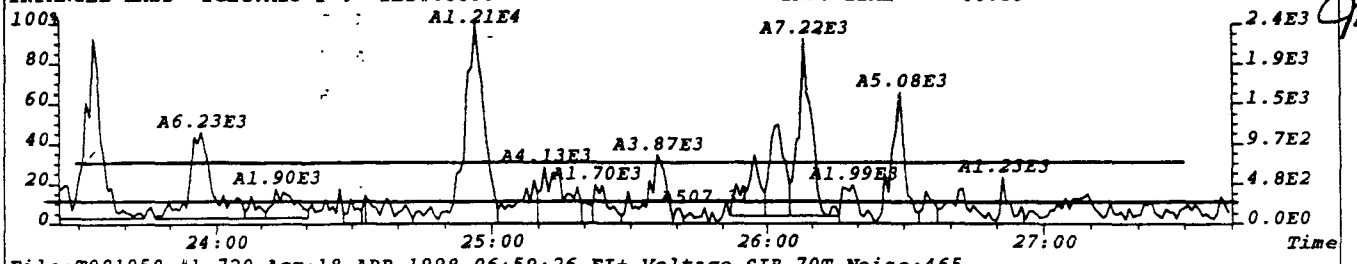


File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:71
319.8965 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,284.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59

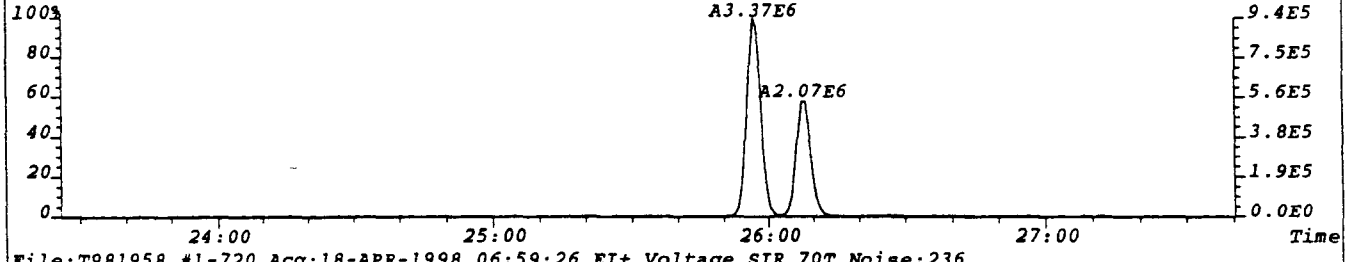


File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:59
321.8936 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,236.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59

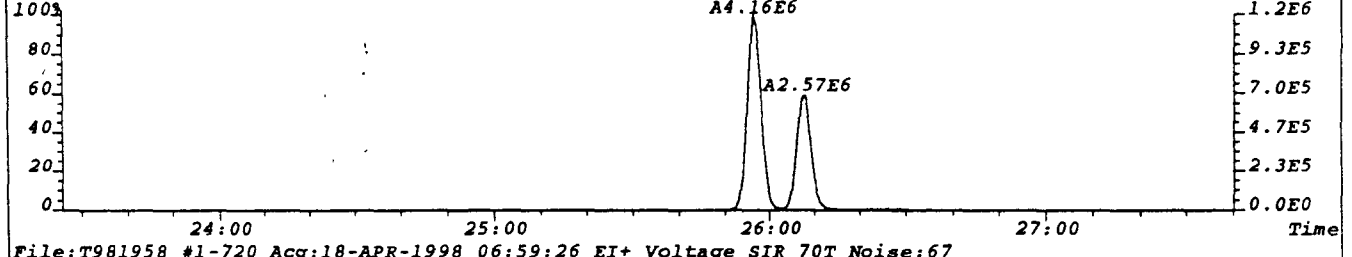
N=(.10)(7.4)(.24)=.18 JM 4.18.98



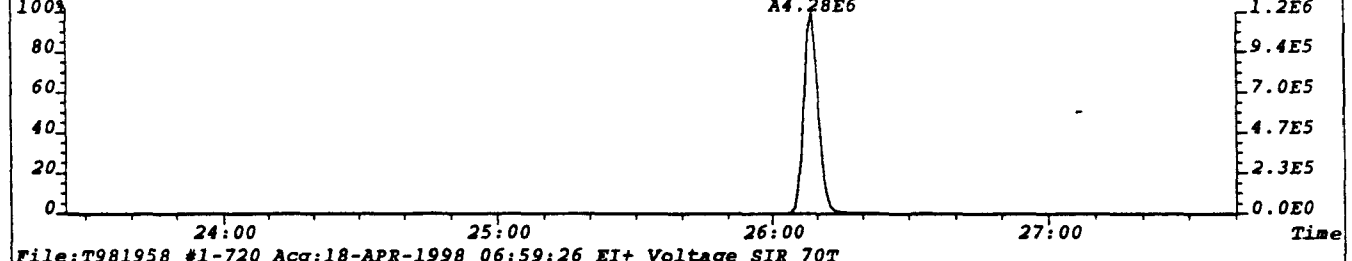
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:465
331.9368 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,1860.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



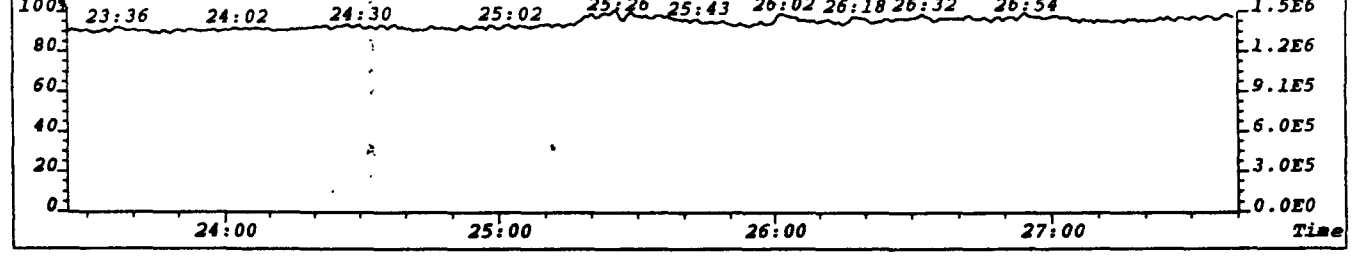
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:236
333.9338 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,944.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



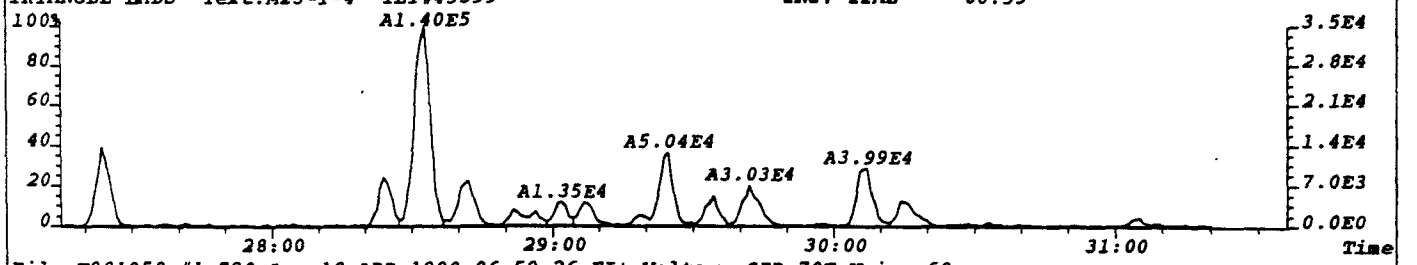
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:67
327.8847 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,268.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



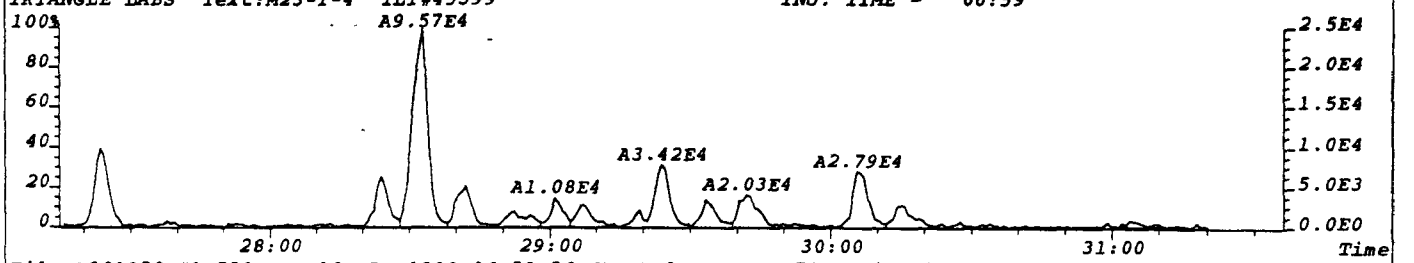
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



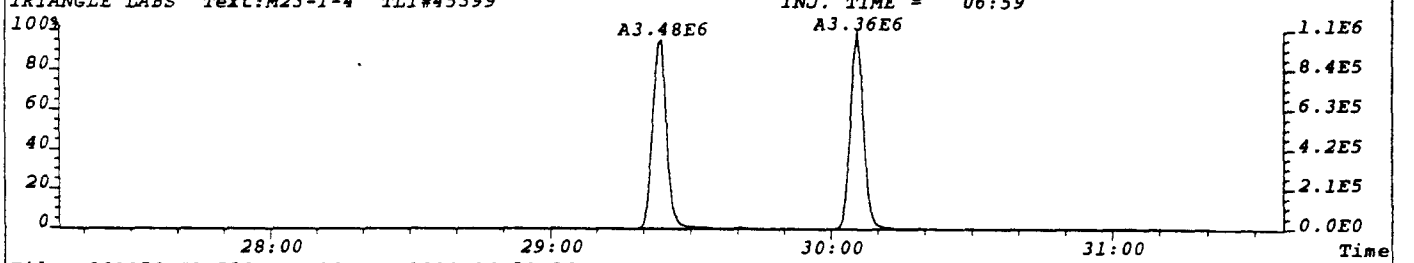
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:60
339.8597 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,240.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



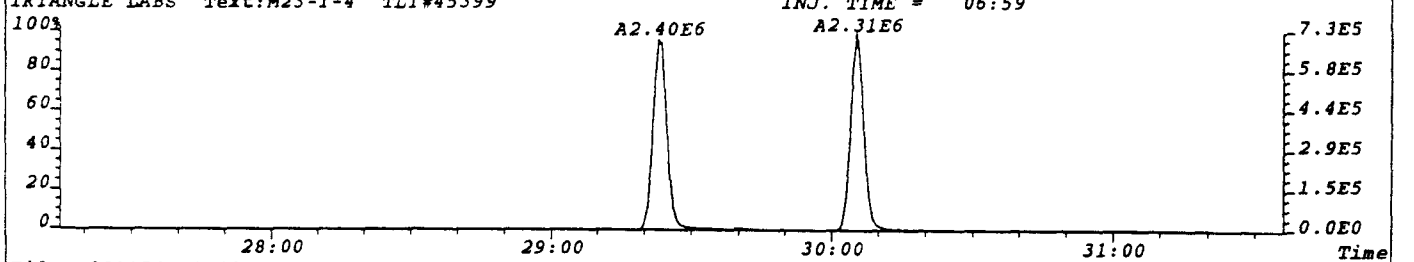
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:68
341.8567 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,272.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



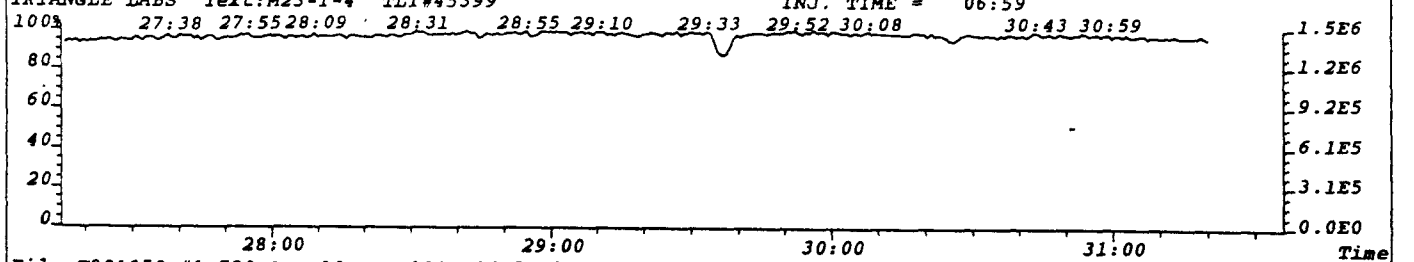
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:56
351.9000 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,224.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



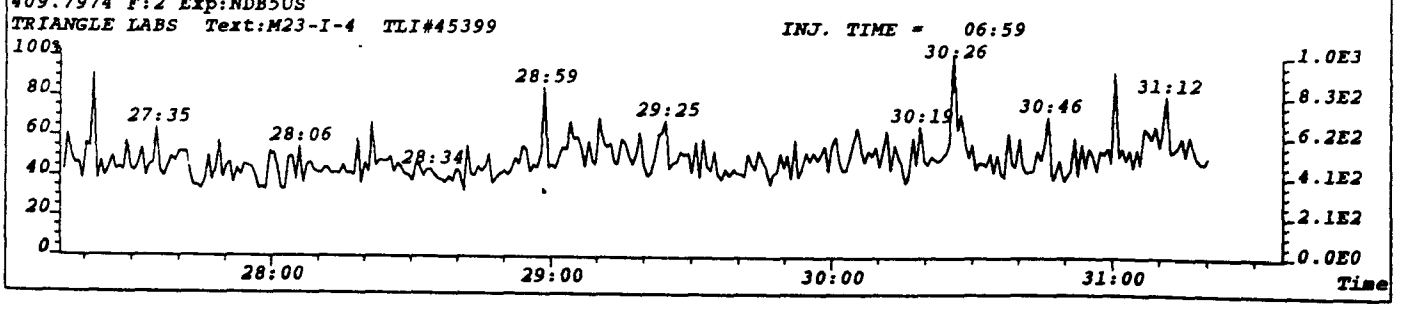
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:47
353.8970 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,188.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



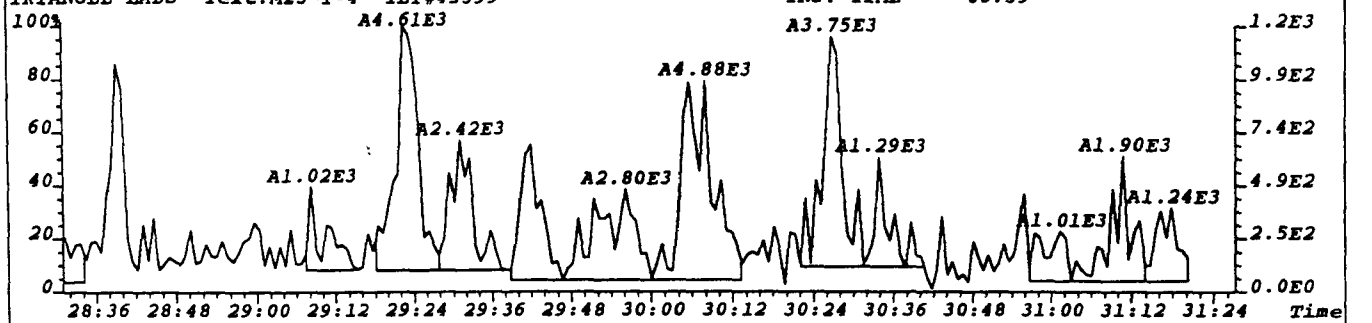
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



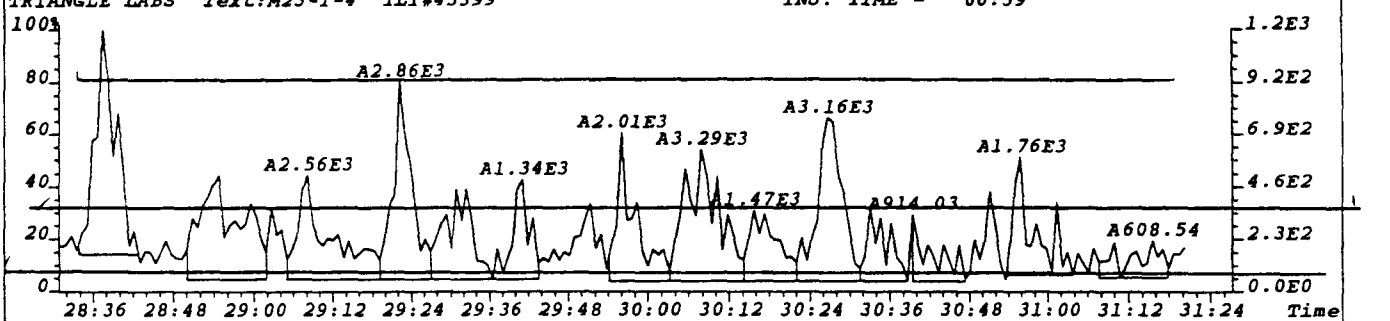
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
409.7974 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



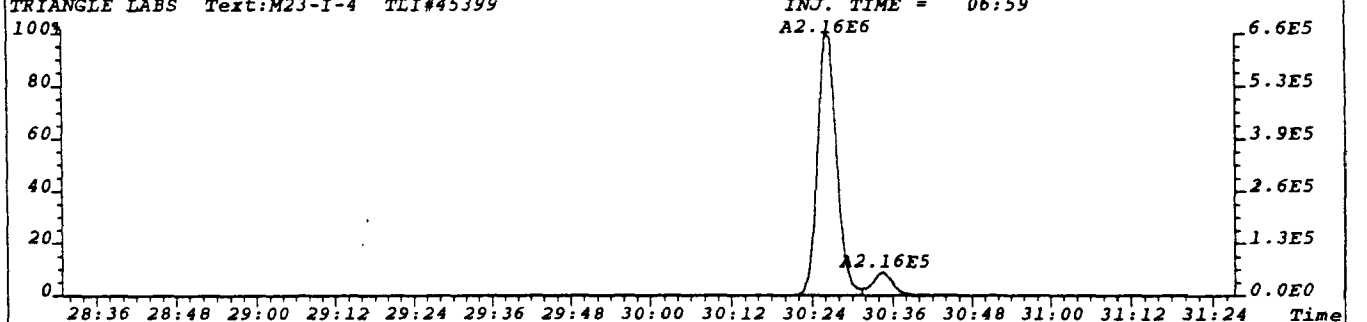
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:56
355.8546 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,224.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



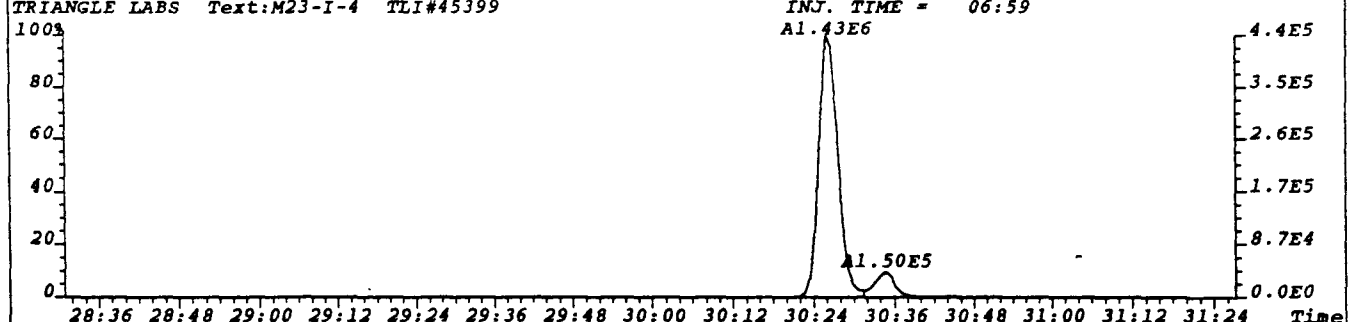
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:53
357.8516 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,212.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



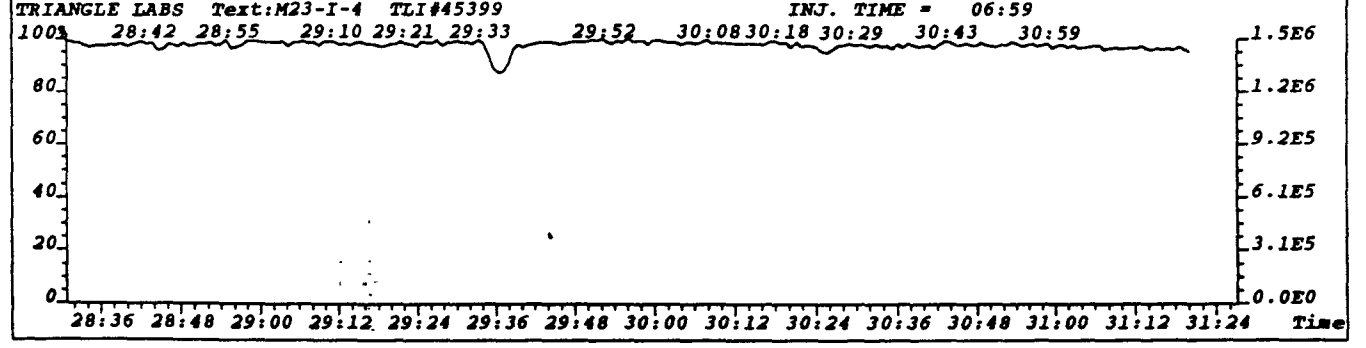
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:49
367.8949 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,196.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



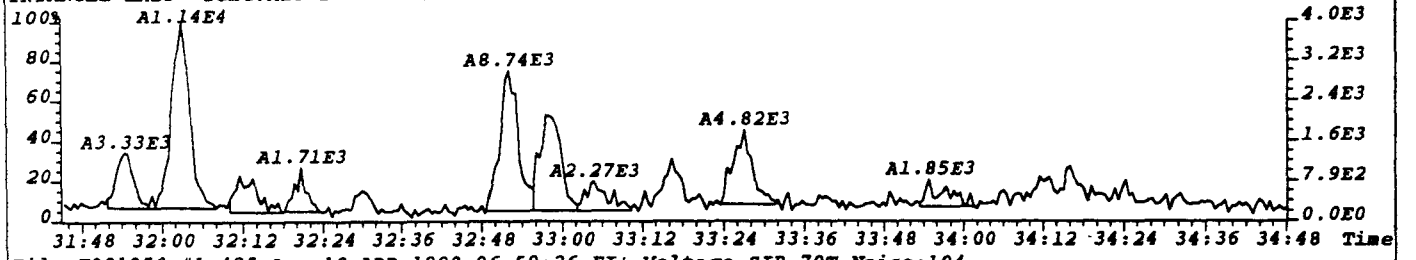
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:42
369.8919 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,168.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



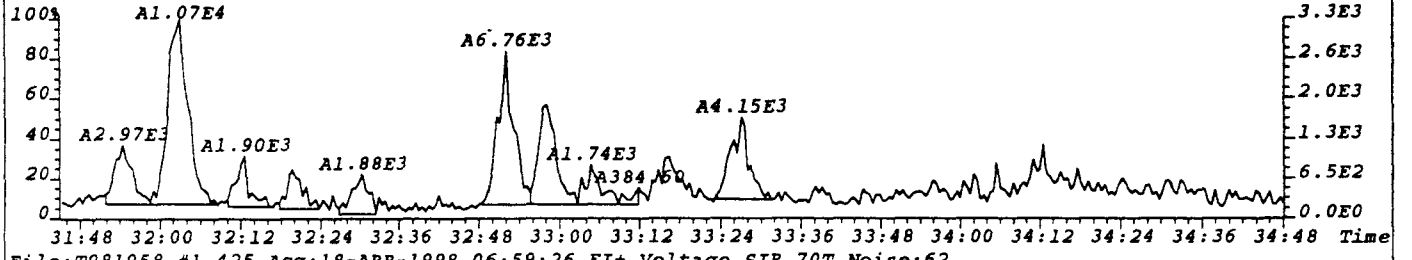
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



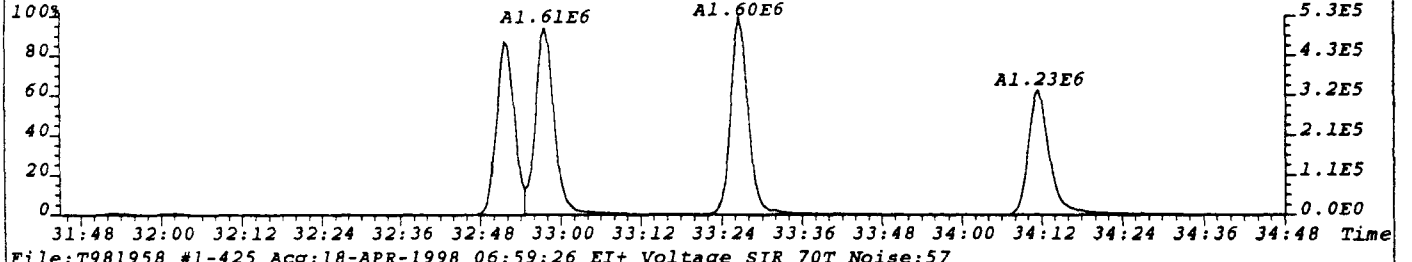
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:105
373.8208 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,420.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



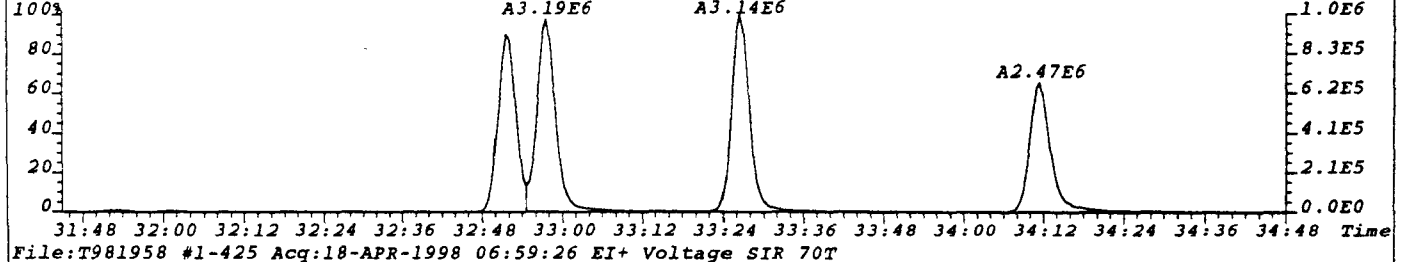
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:104
375.8178 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,416.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



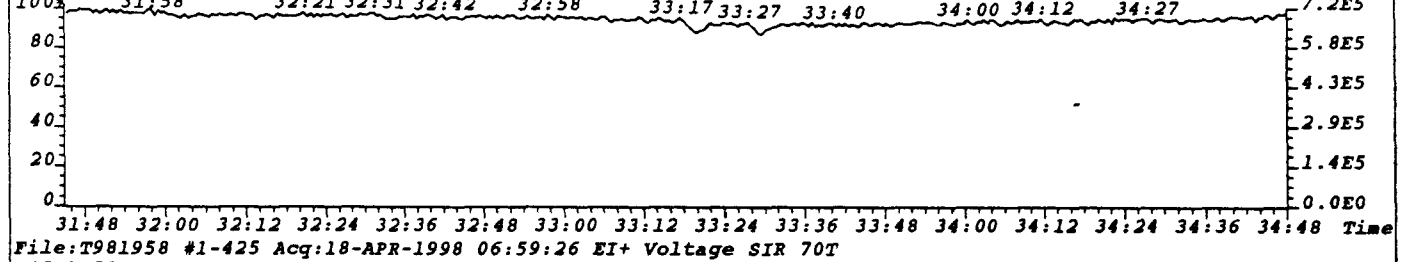
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:62
383.8639 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,248.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



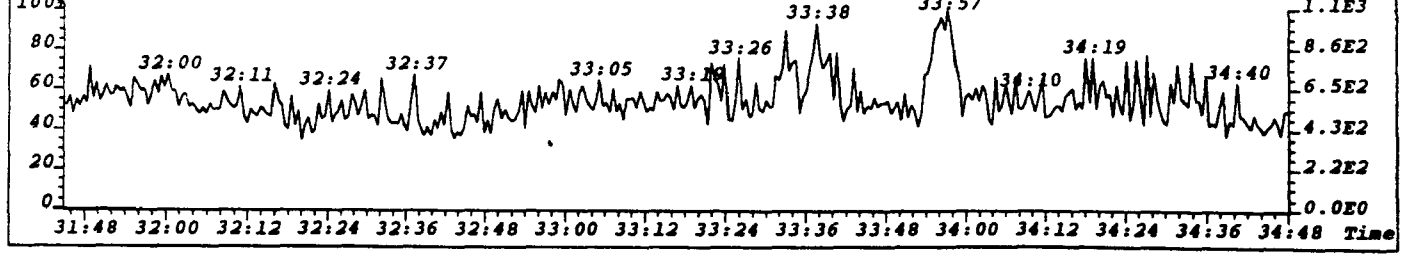
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:57
385.8610 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,228.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



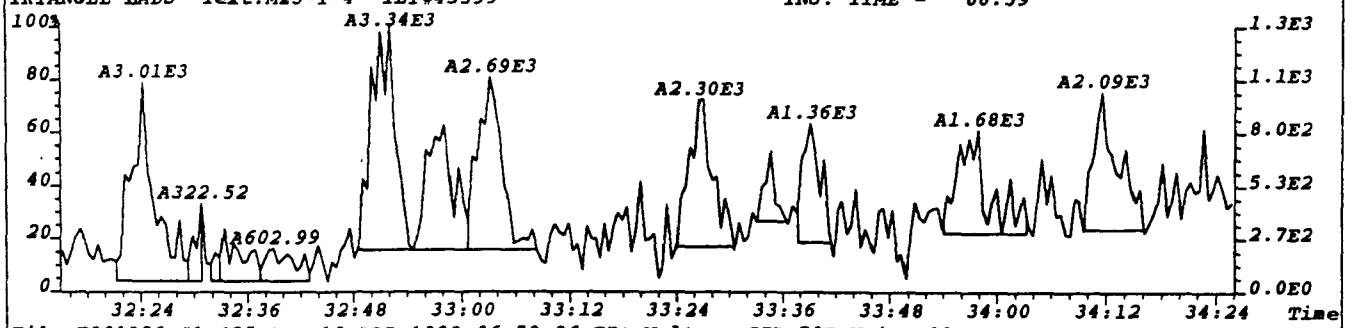
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



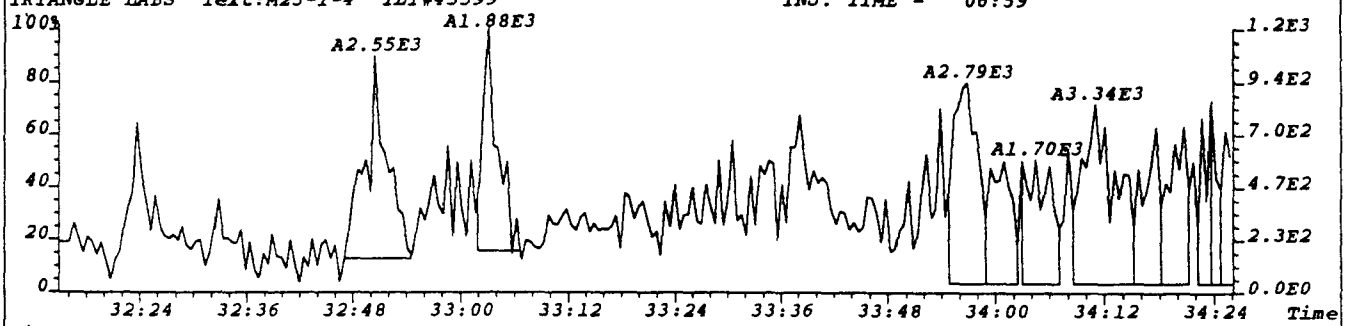
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
445.7555 F:3 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



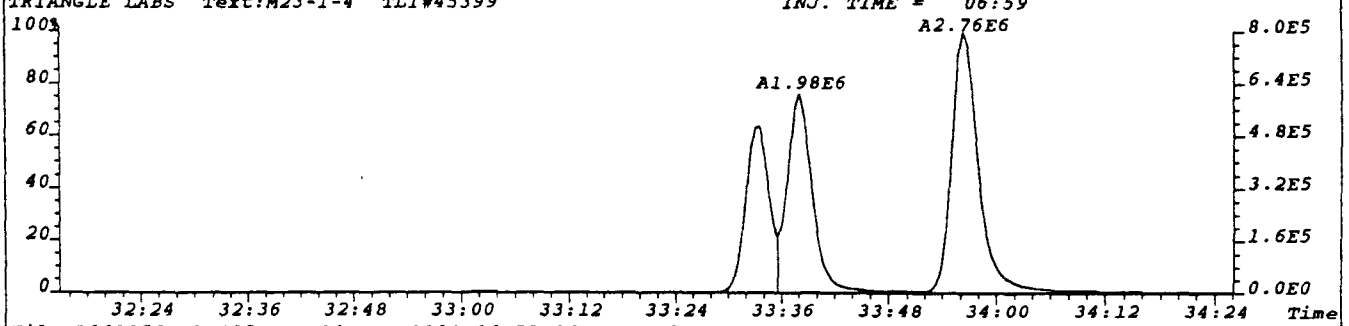
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:89
389.8156 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,356.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



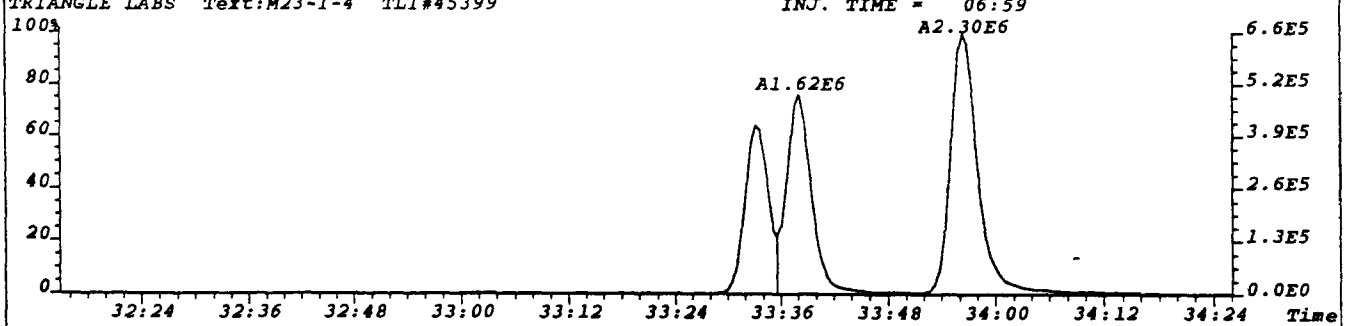
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:99
391.8127 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,396.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



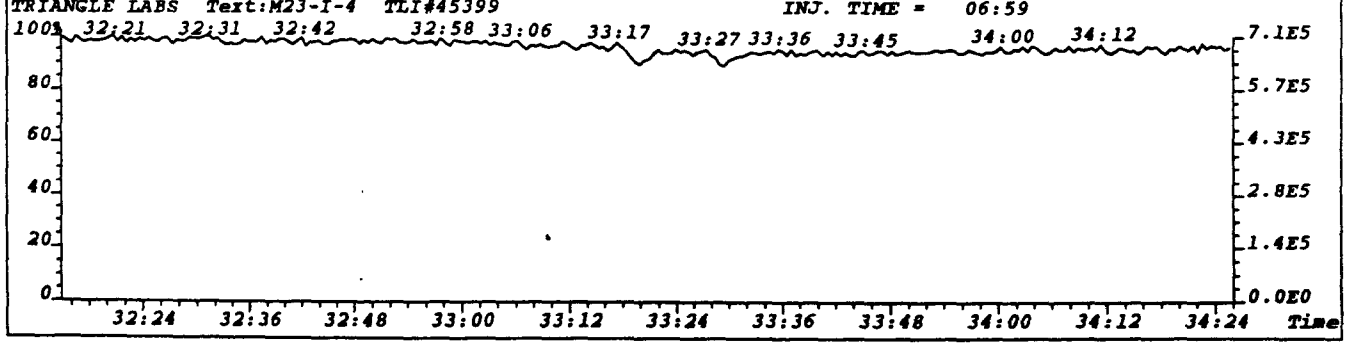
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:101
401.8558 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,404.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



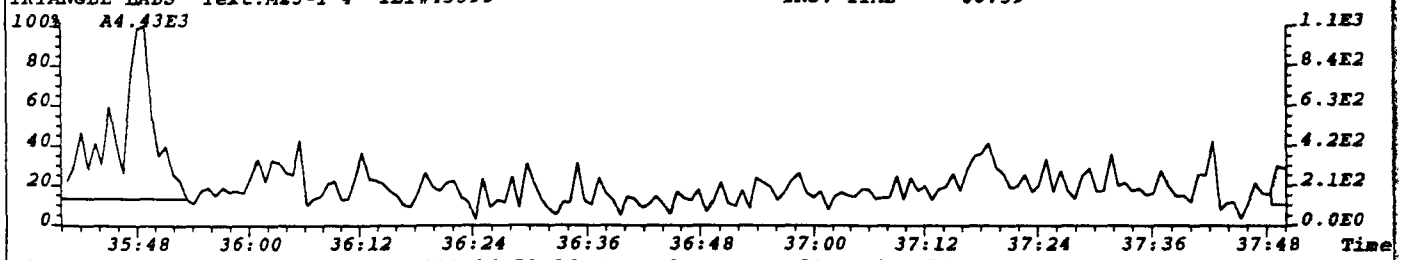
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:131
403.8529 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,524.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



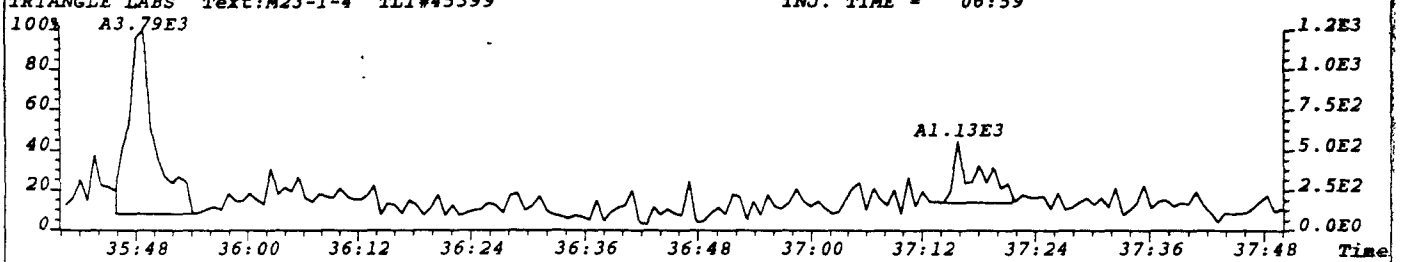
File:T981958 #1-425 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



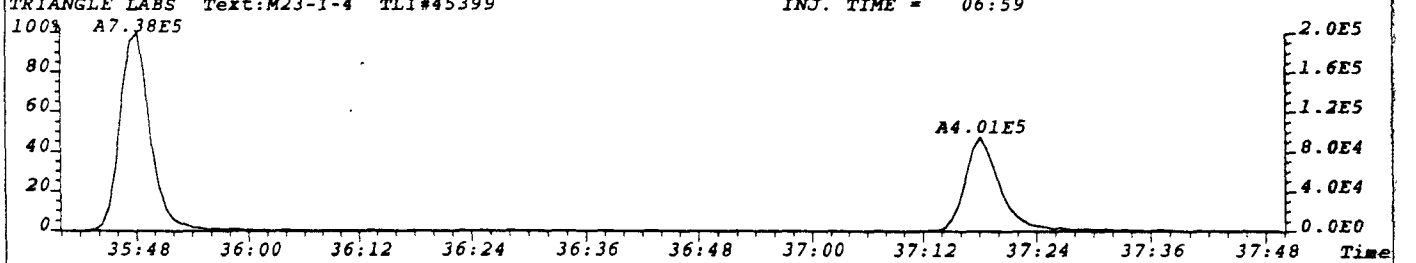
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:61
407.7818 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,244.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



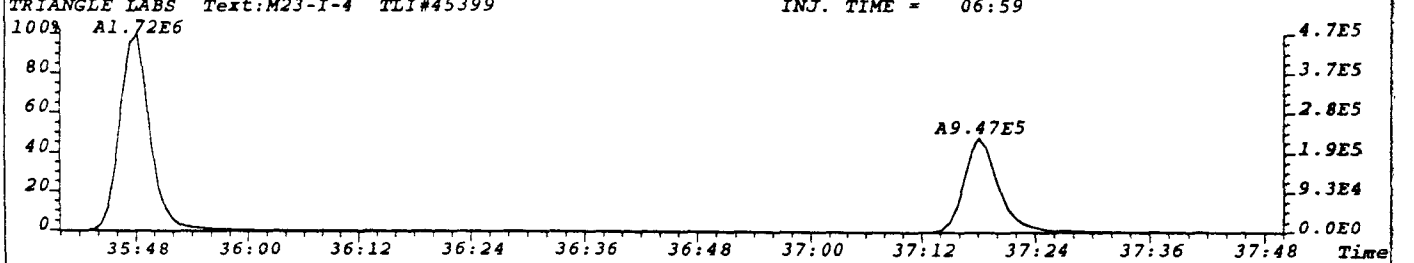
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:55
409.7789 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,220.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



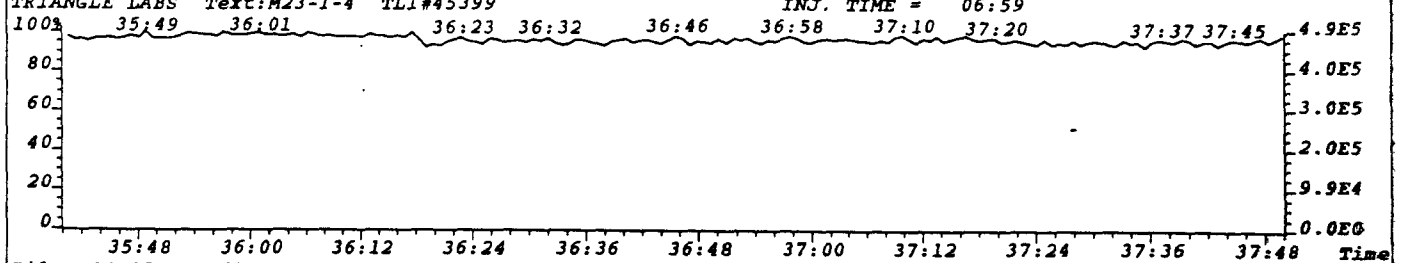
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:74
417.8253 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,296.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



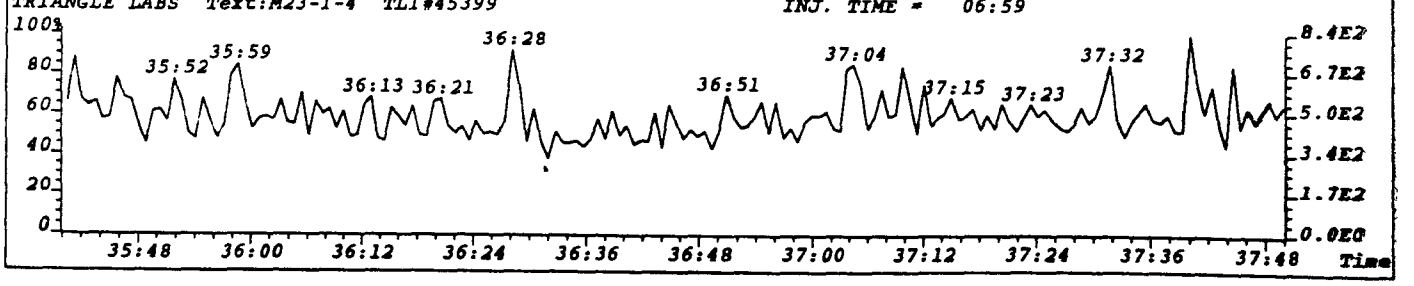
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:66
419.8220 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,264.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



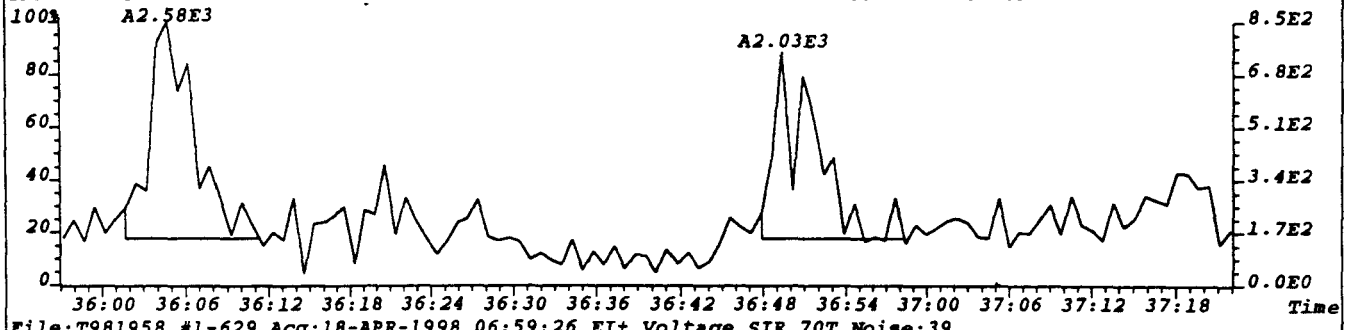
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



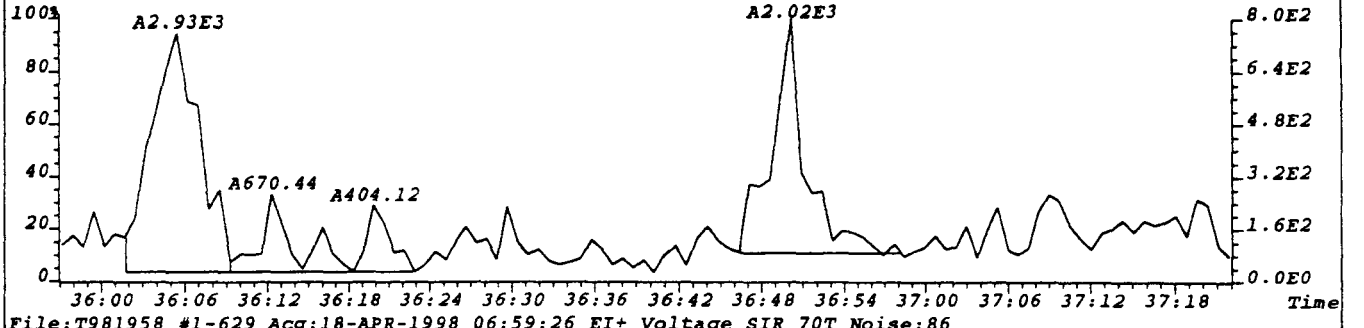
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
479.7165 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



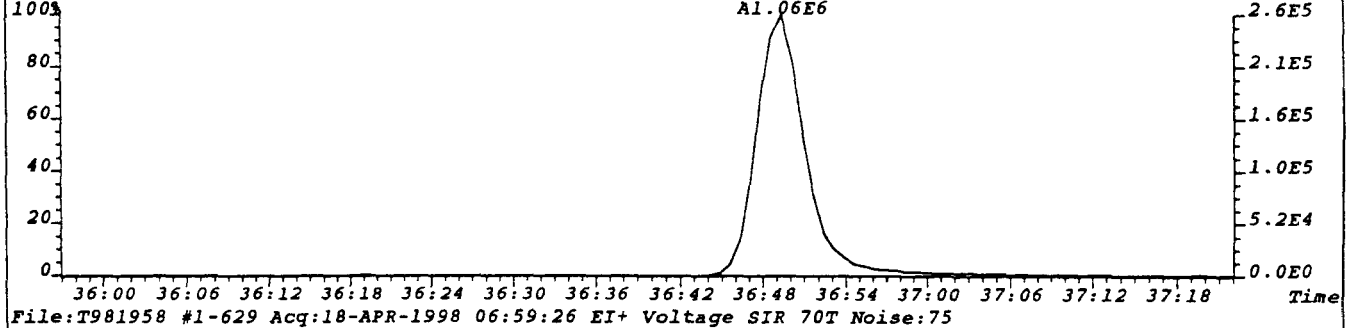
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:62
423.7766 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,248.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



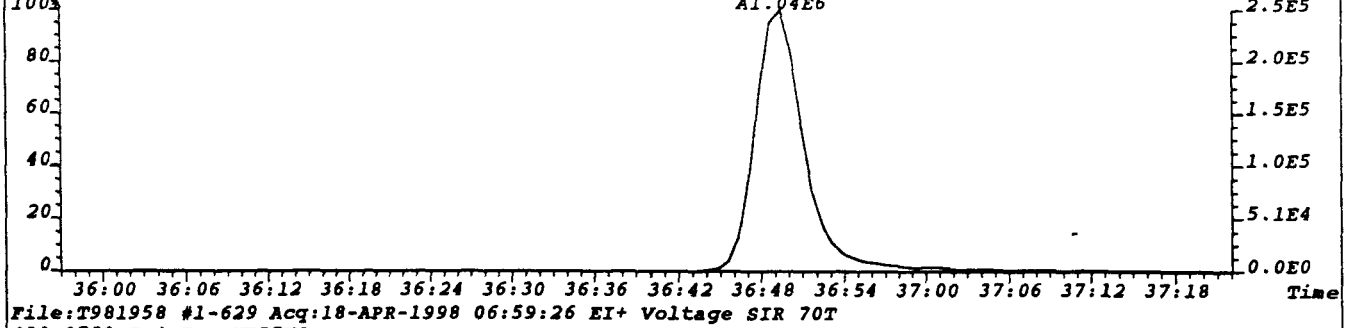
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:39
425.7737 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



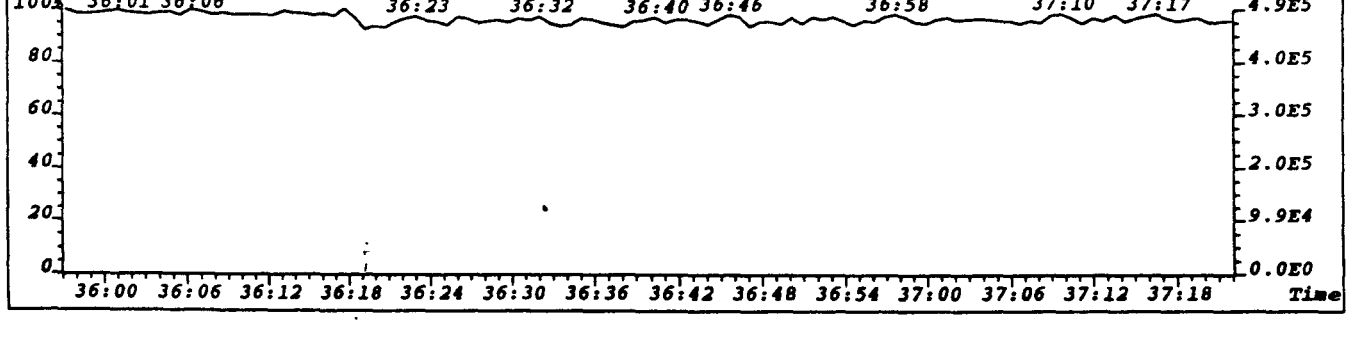
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:86
435.8169 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,344.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



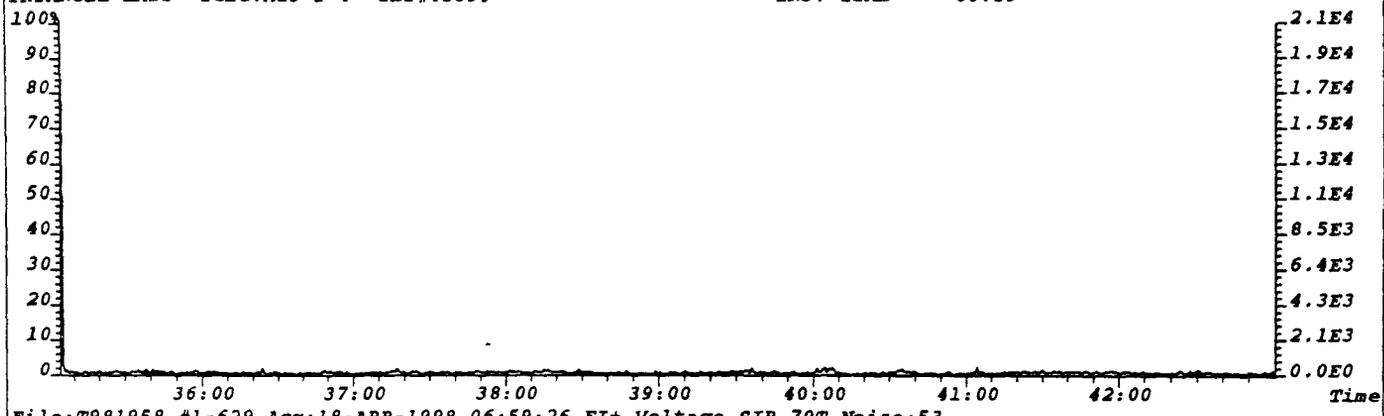
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:75
437.8140 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,300.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



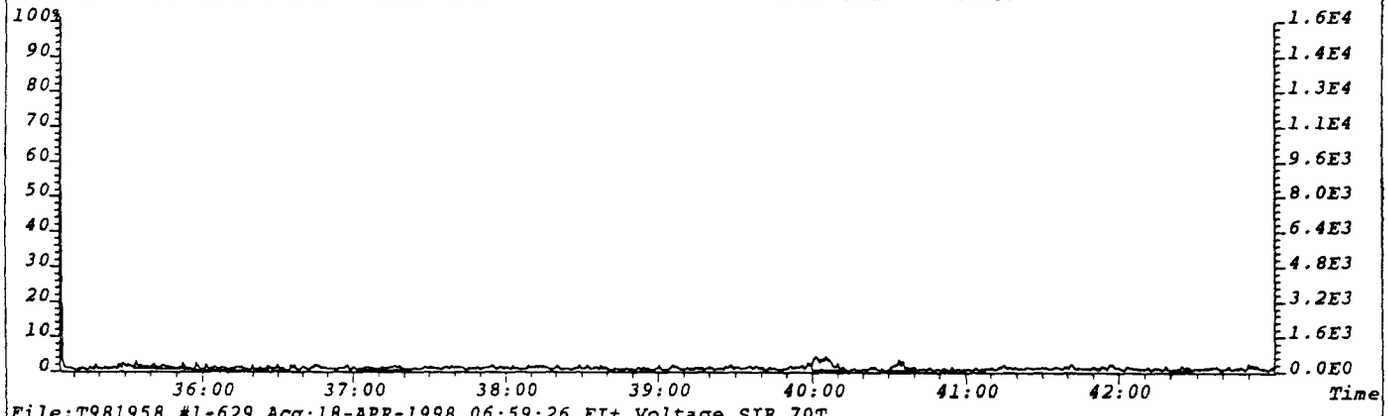
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



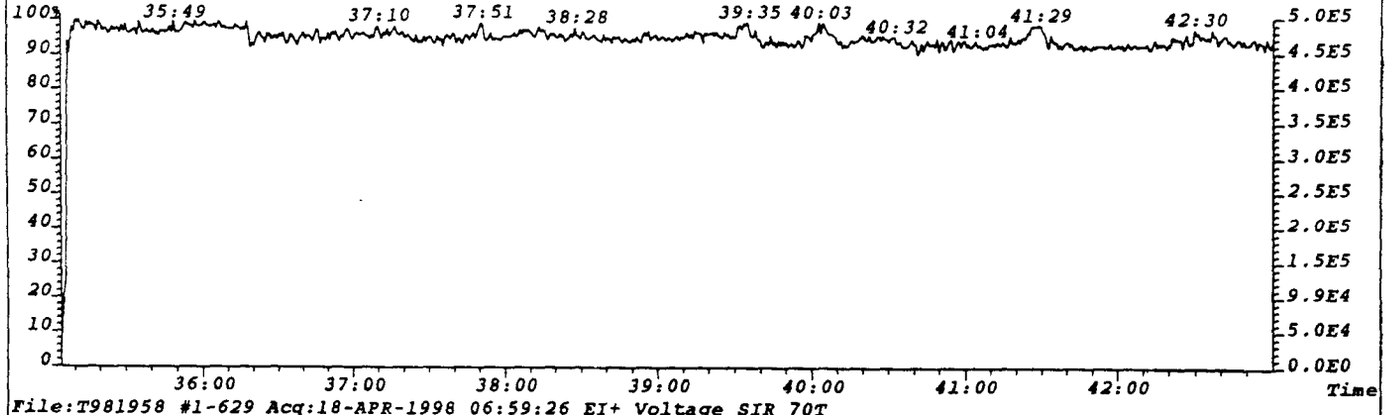
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:44
441.7428 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



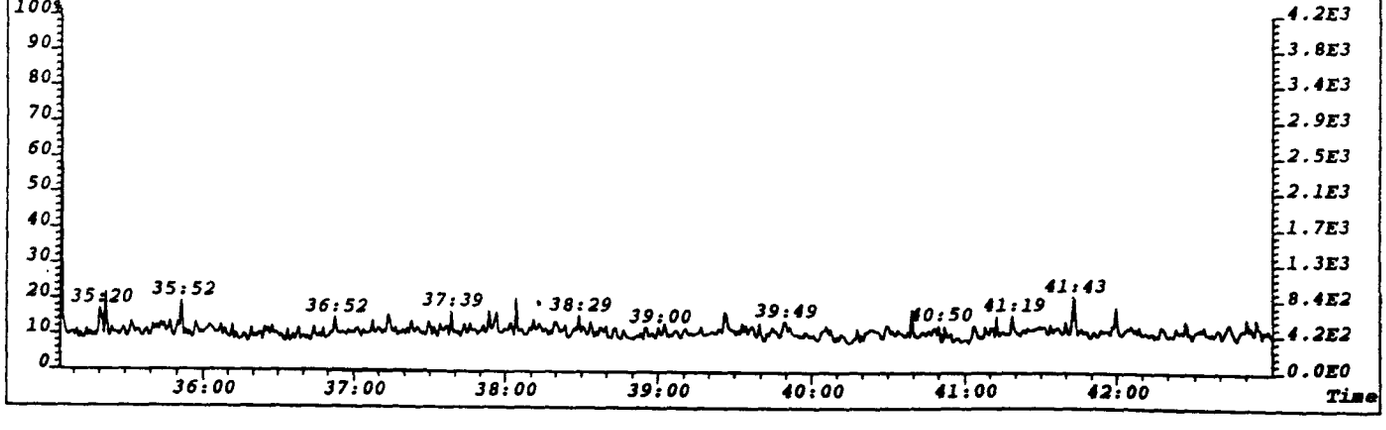
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:53
443.7399 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,212.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



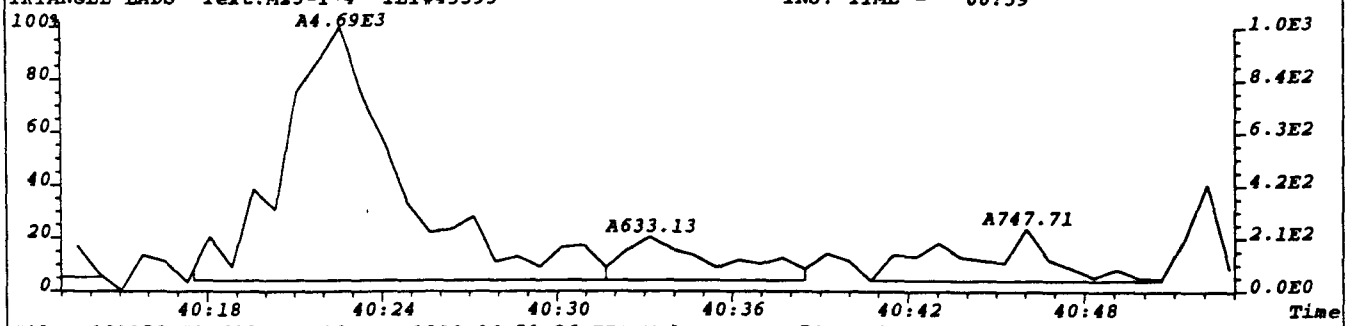
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



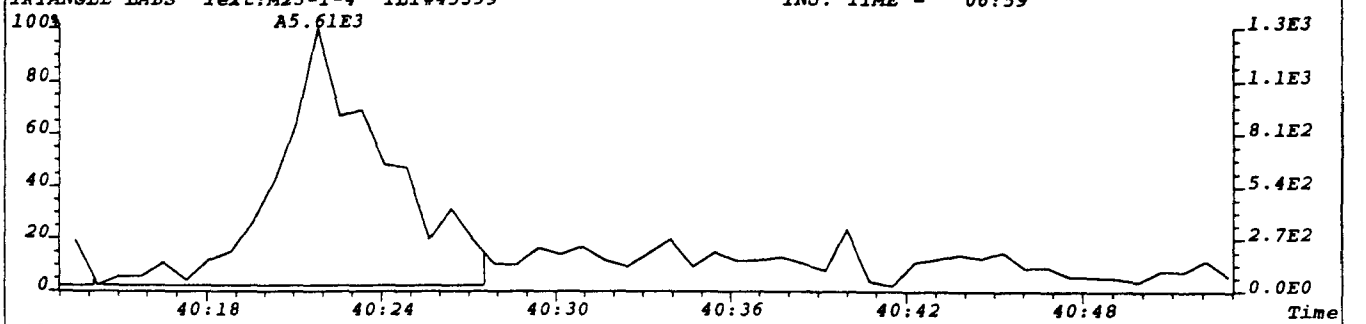
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
513.6775 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



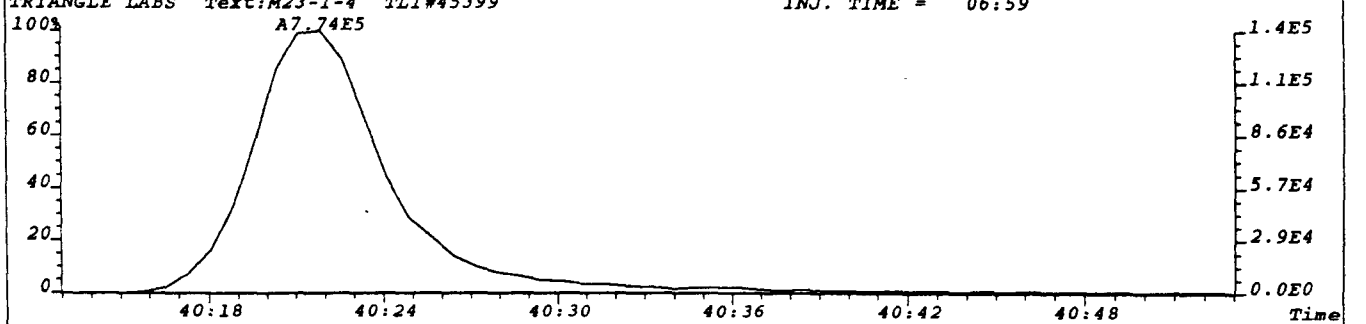
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:48
457.7377 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,192.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



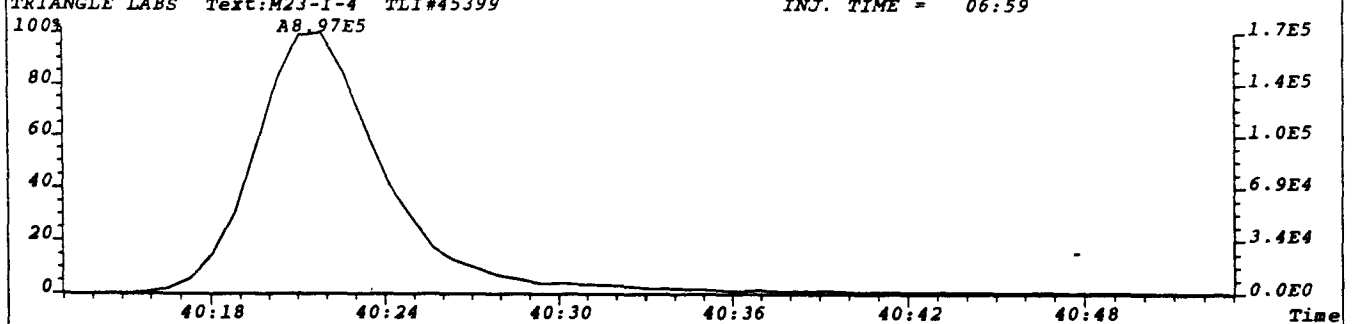
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:50
459.7348 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,200.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



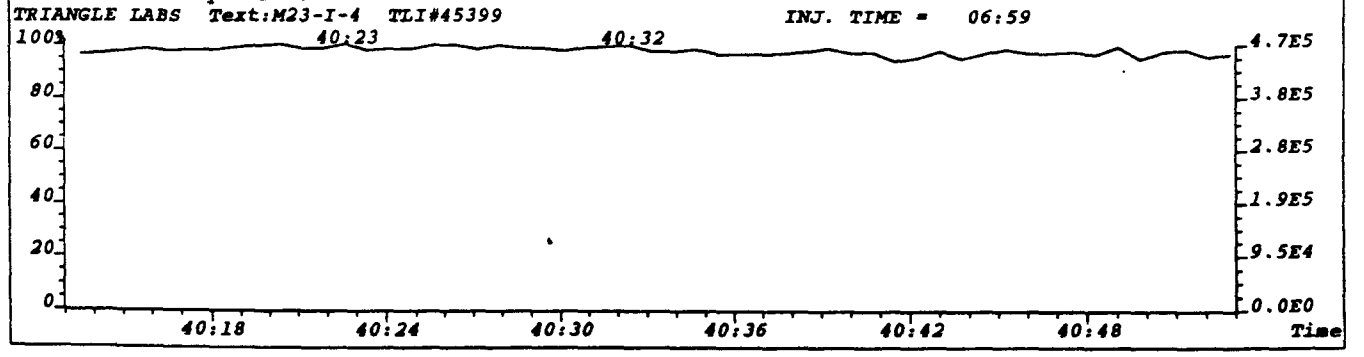
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:57
469.7779 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,228.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59

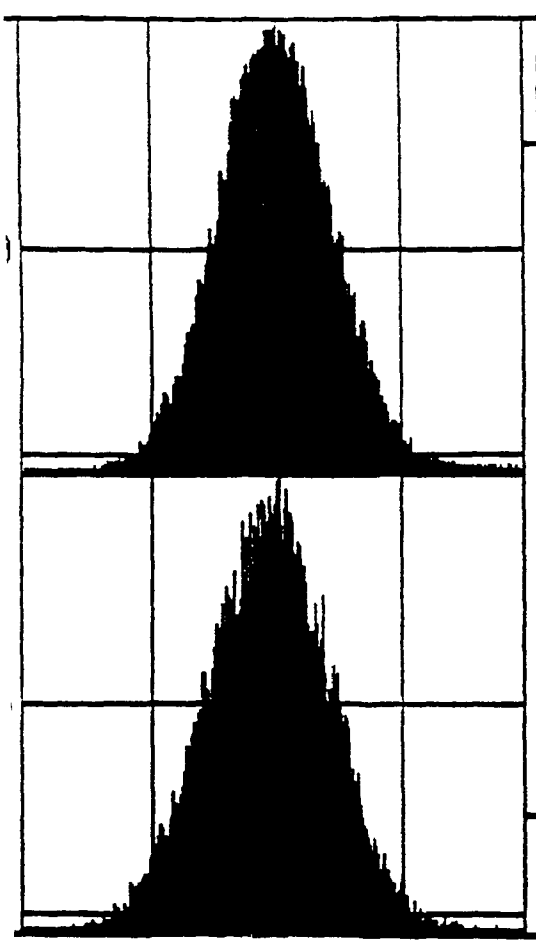


File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T Noise:49
471.7750 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,196.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59



File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:M23-I-4 TLI#45399 INJ. TIME = 06:59





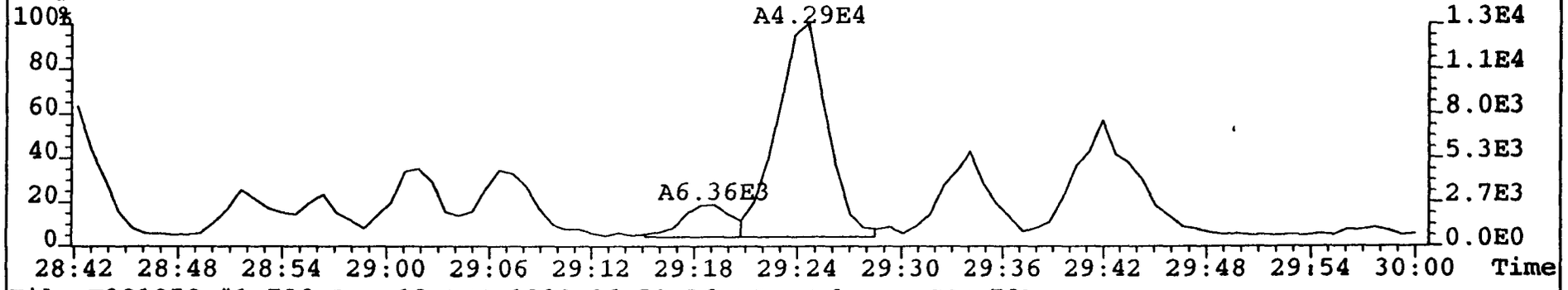
Channel I 330.9792 Peak top
Height .70 volts Span 200 ppm

System file name	ND85US
Data file name	A:T981948
Resolution	10000
Group number	2
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 416.9760

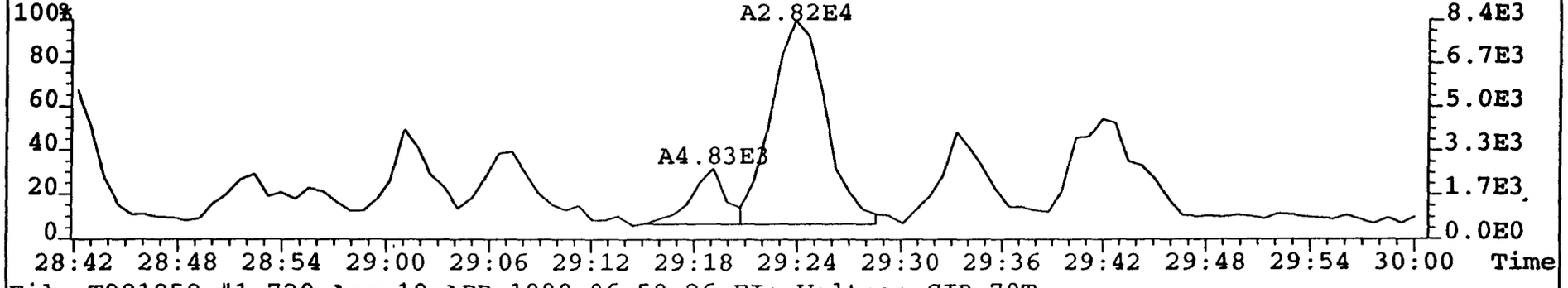
A	293	J	331	S	368
B	304	K	332	T	370
C	306	L	334	U	376
D	316	M	340	V	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

Ref. mass 416.9760 Peak top
Height .17 volts Span 200 ppm

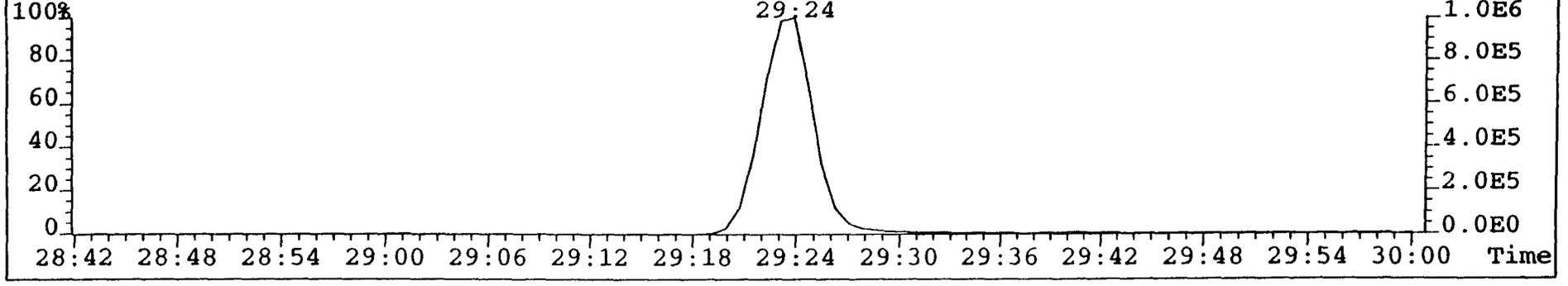
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
339.8597 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»

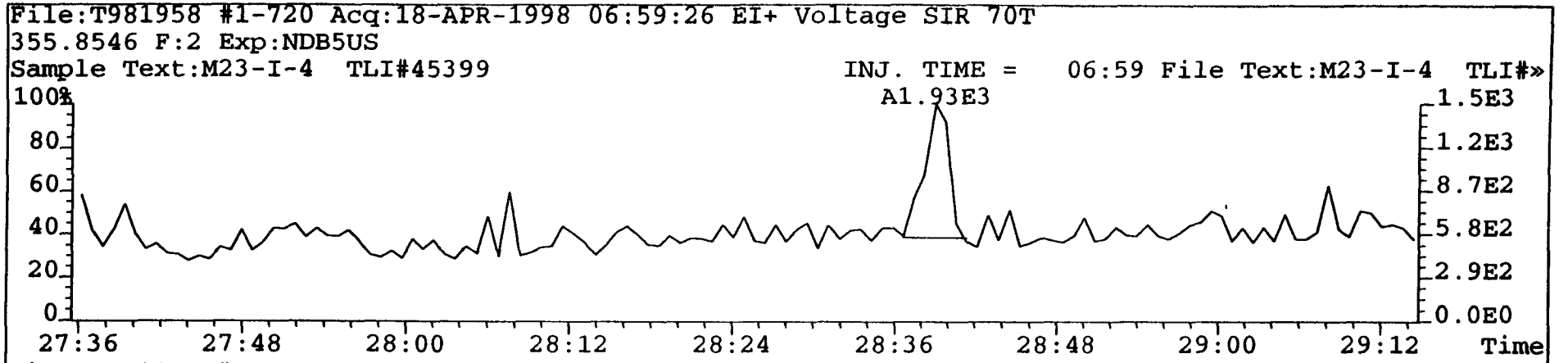


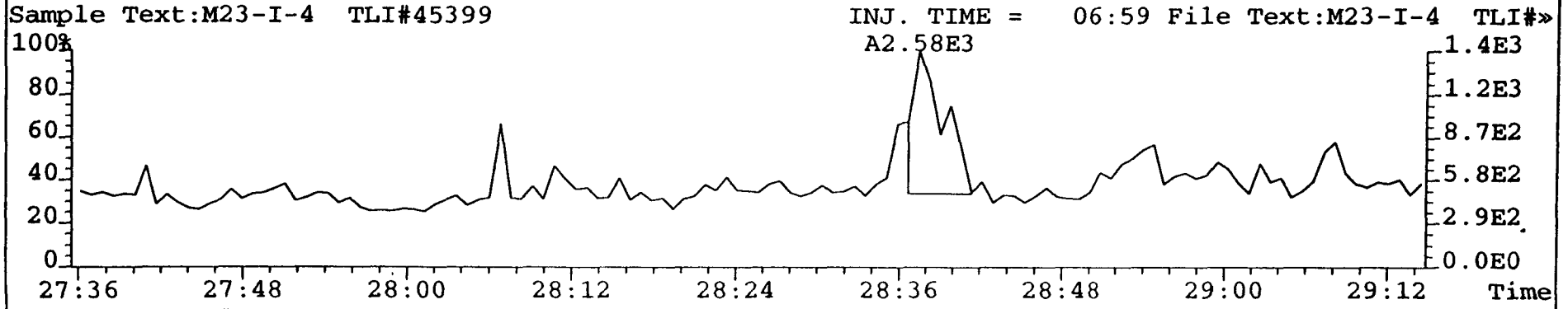
File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
341.8567 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»

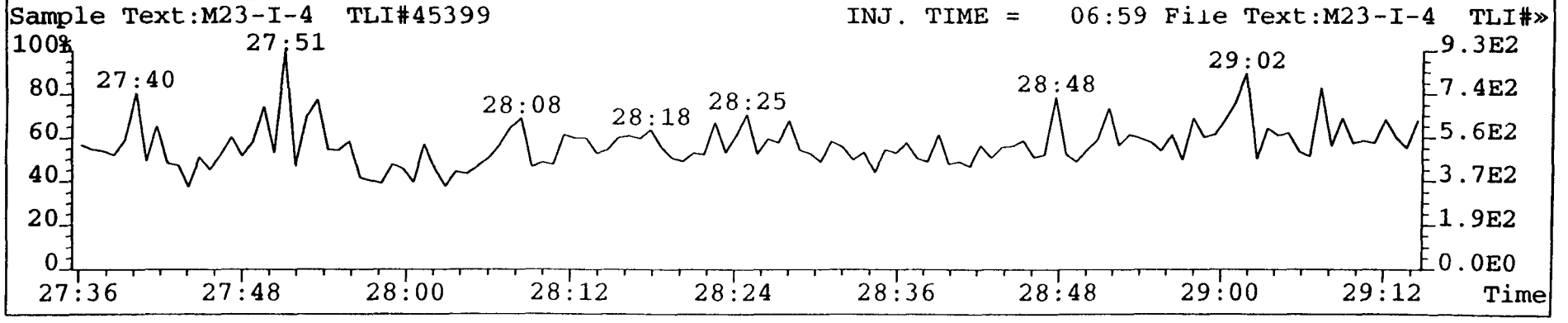


File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
351.9000 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»

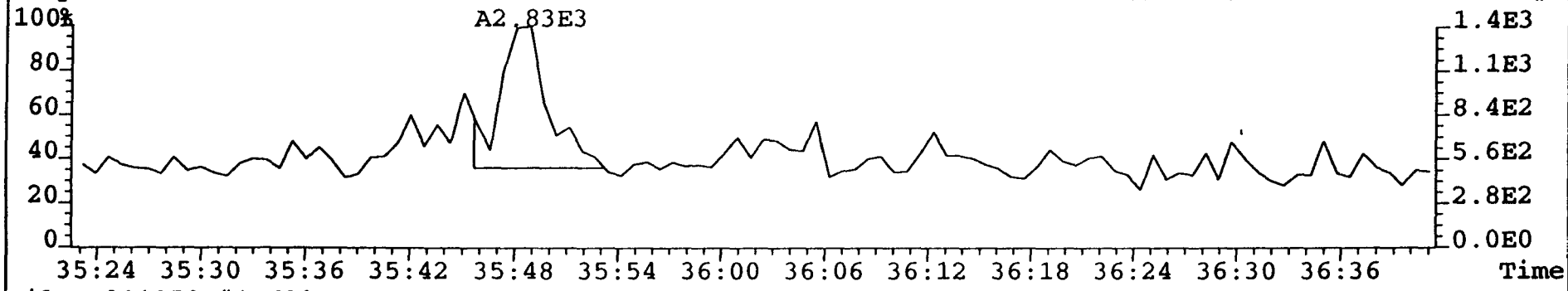



File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
355.8546 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399
INJ. TIME = 06:59 File Text:M23-I-4 TLI#»
A1.93E3
100%
80
60
40
20
0
1.5E3
1.2E3
8.7E2
5.8E2
2.9E2
0.0E0
27:36
27:48
28:00
28:12
28:24
28:36
28:48
29:00
29:12
Time

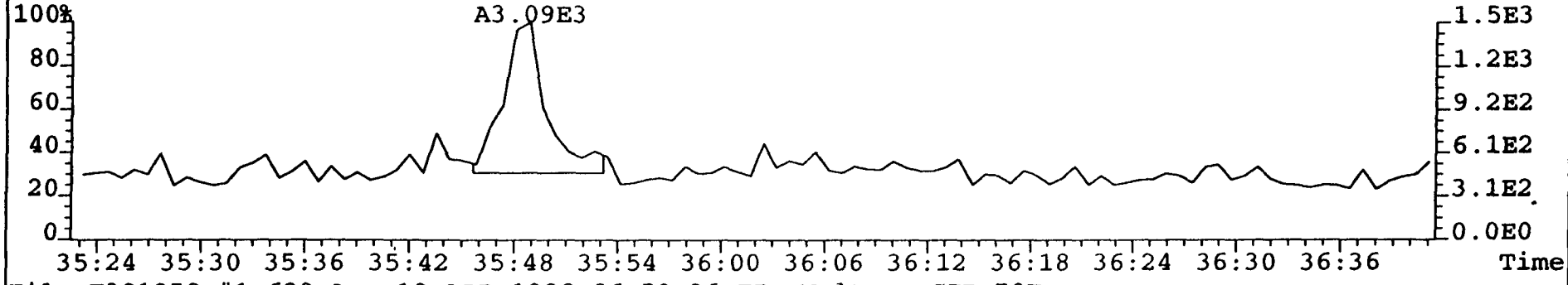

File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
357.8516 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399
INJ. TIME = 06:59 File Text:M23-I-4 TLI#»
A2.58E3
100%
80
60
40
20
0
1.4E3
1.2E3
8.7E2
5.8E2
2.9E2
0.0E0
27:36
27:48
28:00
28:12
28:24
28:36
28:48
29:00
29:12
Time


File:T981958 #1-720 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
367.8949 F:2 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399
INJ. TIME = 06:59 File Text:M23-I-4 TLI#»
27:40
27:51
28:08
28:18
28:25
28:48
29:02
100%
80
60
40
20
0
9.3E2
7.4E2
5.6E2
3.7E2
1.9E2
0.0E0
27:36
27:48
28:00
28:12
28:24
28:36
28:48
29:00
29:12
Time

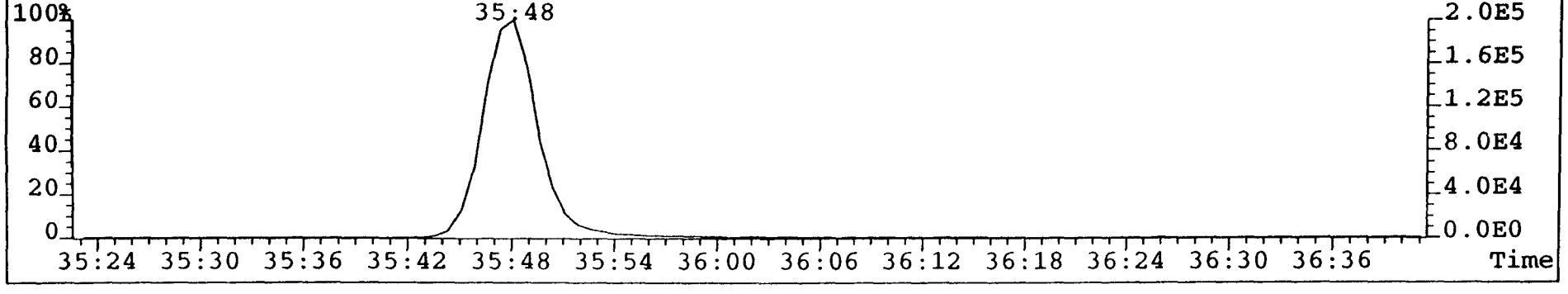
File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
407.7818 F:4 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»



File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
409.7789 F:4 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»



File:T981958 #1-629 Acq:18-APR-1998 06:59:26 EI+ Voltage SIR 70T
417.8253 F:4 Exp:NDB5US
Sample Text:M23-I-4 TLI#45399 INJ. TIME = 06:59 File Text:M23-I-4 TLI#»



Pacific Environmental Services

TLI Project: **45399** Method 23 TCDD/TCDF Analysis (DB-225)
Client Sample: **M23-I-4** Analysis File: **P981309**

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	M23	Date Received:	04/01/98	Spike File:	SPC2NF04
TLI ID:	204-92-4A-D	Date Extracted:	04/03/98	ICal:	PF24098
		Date Analyzed:	04/16/98	ConCal:	P981302
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-225	Analyst:	ML	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
',3,7,8-TCDF	0.14			0.76	22:24	—

Internal Standard	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	2.2	56.1	40%-130%	0.77	22:23	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.81	21:17	—

Data Reviewer: _____ 04/20/98

C2NF_PSR v2.02, LARS 6.11.00

'iangle Laboratories, Inc.®
)1 Capitola Drive • Durham, North Carolina 27713
ıone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 21:28 04/20/98

Initial ....Date...

Data Review By: K 4/20/98 Calculated Noise Area: 0.13

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of P981309B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF					0.65-0.89					0.790-1.102			
304-306	DC	NL		0:00	RO	1.11	0.16			0.000			
				17:51		0.75	13.77	5.92	7.85	0.797			
				18:51		0.74	39.31	16.66	22.65	0.842			
				18:58		0.77	10.91	4.75	6.16	0.847			
				19:06		0.72	13.26	5.55	7.71	0.853			
				19:17		0.74	7.82	3.32	4.50	0.862			
				19:33		0.75	6.14	2.63	3.51	0.873			
				19:43		0.75	8.51	3.64	4.87	0.881			
				19:52		0.74	2.78	1.18	1.60	0.888			
				20:01		0.74	29.63	12.61	17.02	0.894			
				20:08		0.73	3.56	1.50	2.06	0.899			
				20:11		0.83	4.08	1.85	2.23	0.902			
				20:32		0.67	11.74	4.72	7.02	0.917			
				20:37		0.89	6.84	3.22	3.62	0.921			
				20:59		0.76	19.32	8.35	10.97	0.937			
				21:04		0.77	1.63	0.71	0.92	0.941			J
				21:14		0.73	13.90	5.87	8.03	0.949			
				21:28		0.77	9.50	4.14	5.36	0.959			
				21:40		0.81	0.85	0.38	0.47	0.968			J
				21:52		0.74	5.21	2.21	3.00	0.977			
				22:17		0.79	4.50	1.99	2.51	0.996			
				22:24		0.76	14.01	6.06	7.95	1.001	2378-TCDF	AN	
				22:37		0.85	4.64	2.13	2.51	1.010			
				22:57		0.71	3.11	1.29	1.82	1.025			
				23:05		0.74	10.99	4.67	6.32	1.031			
				23:50		0.70	3.08	1.27	1.81	1.065			
				24:32		0.70	0.75	0.31	0.44	1.096			J
304-306				26 Peaks			249.84						
13C12-TCDF					0.65-0.89					0.955-1.045			
316-318	DC	NL		0:00	RO	1.10	0.18			0.000			
	DC	WL		20:59		0.72	0.91			0.937			
				22:23		0.77	394.06	171.22	222.84	1.000	13C12-2378-TCDF	IS0	
				23:03	RO	1.37	0.48	0.37	0.27	1.030			
	DC	WH		24:26		0.77	5.49			1.092			
316-318				2 Peaks			394.54						

---------- Above: TCDF / TCDD Follows ----------

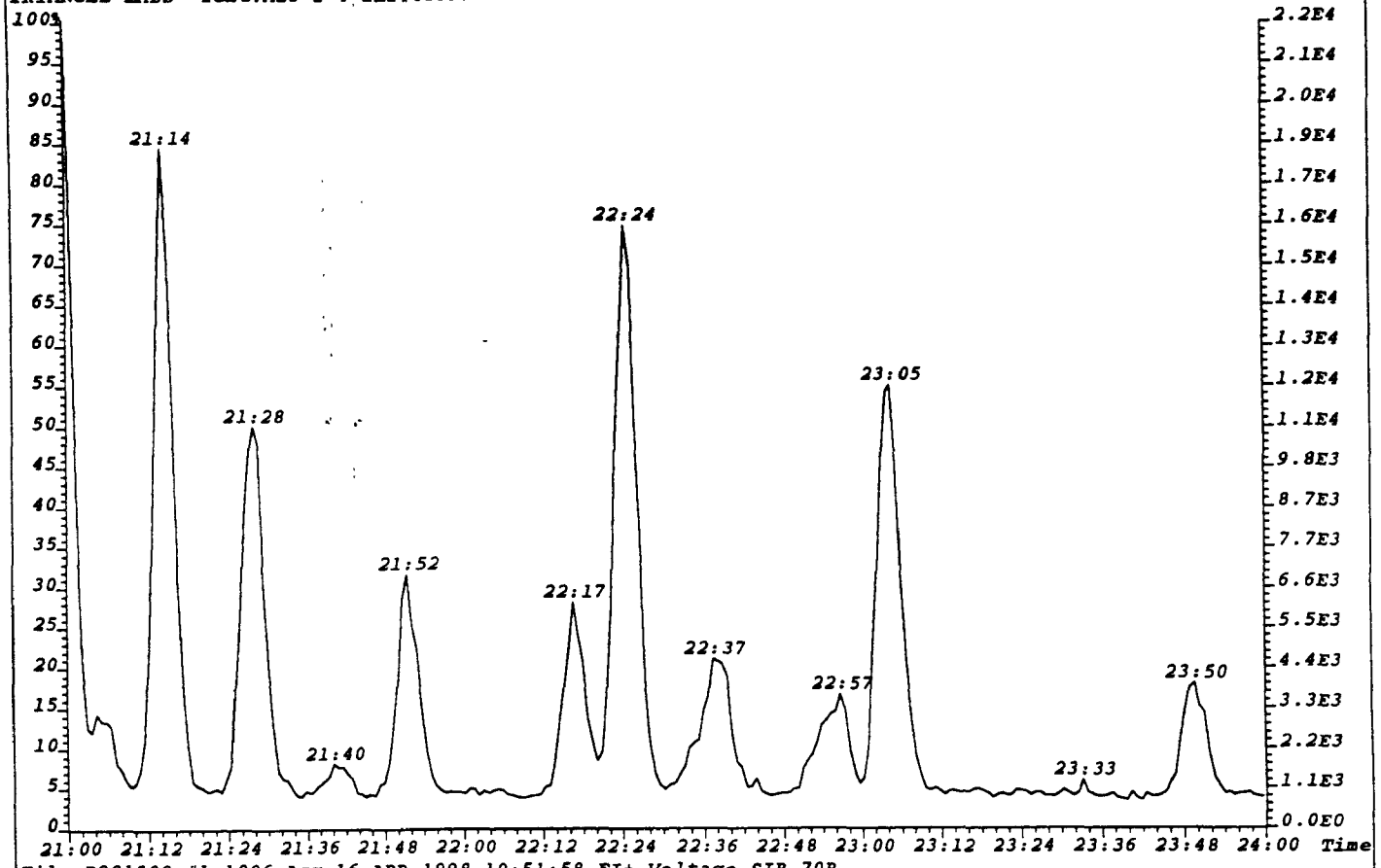
13C12-TCDD					0.65-0.89					0.905-1.095			
332-334	DC	NL		0:00	RO	1.50	0.14			0.000			
				19:53		0.80	0.54	0.24	0.30	0.946			
				21:01		0.78	290.21	127.00	163.21	1.000	13C12-2378-TCDD	IS1	

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
				21:17		0.81	522.68	233.35	289.33	1.013	13C12-1234-TCDD	RS1	
				22:00	RO	0.91	2.02	1.04	1.14	1.047			
332-334			4 Peaks				815.45						

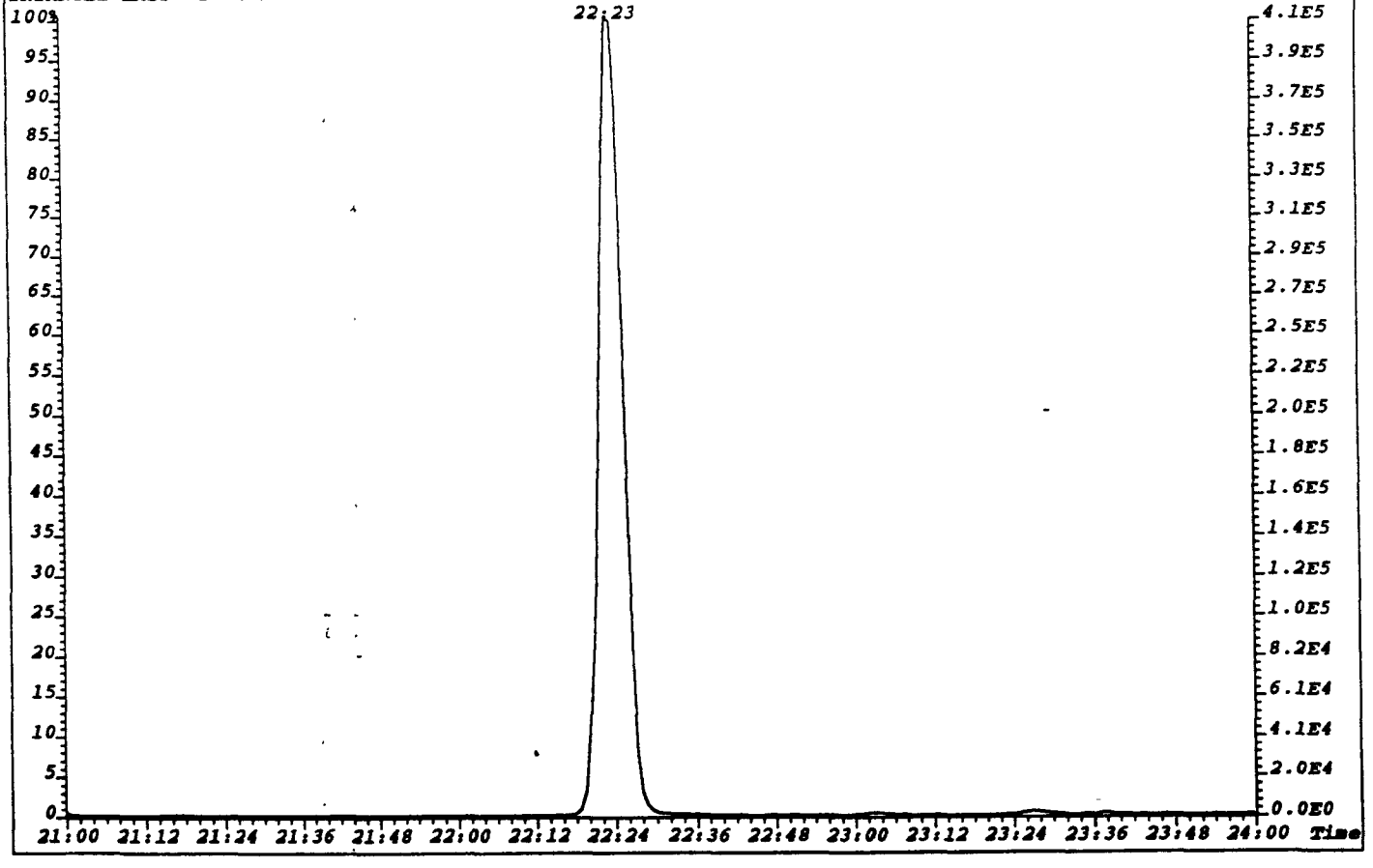
Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

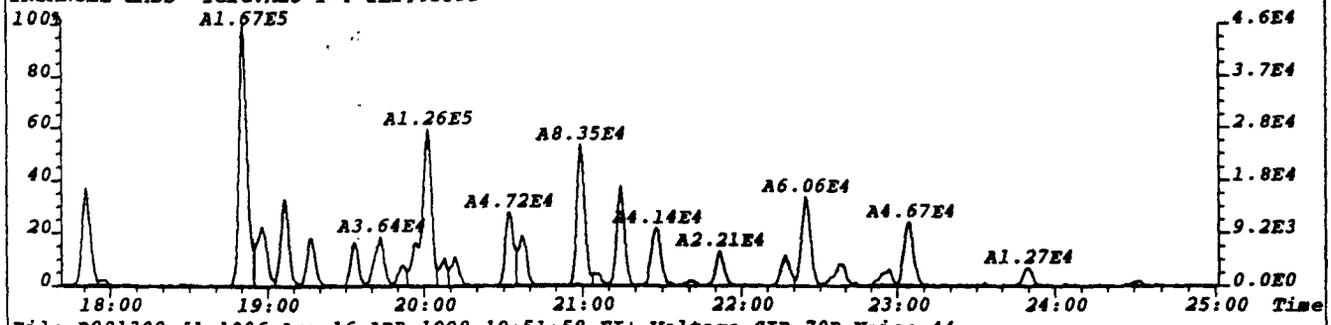
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



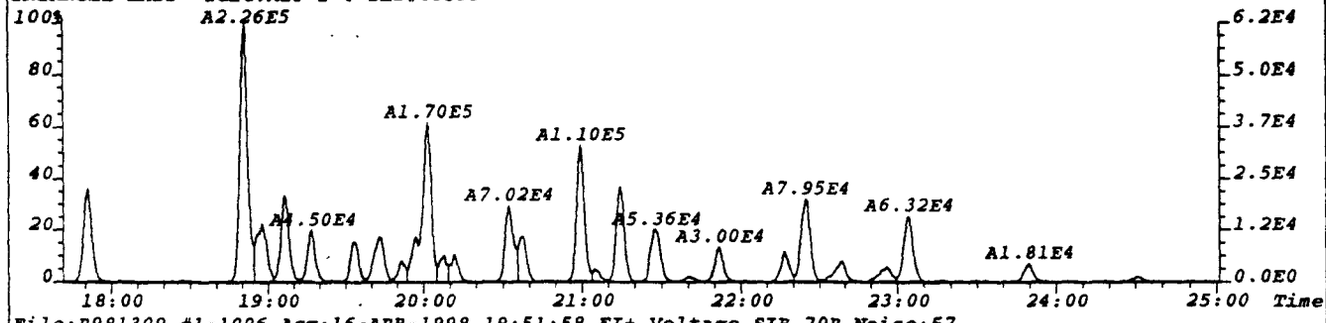
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



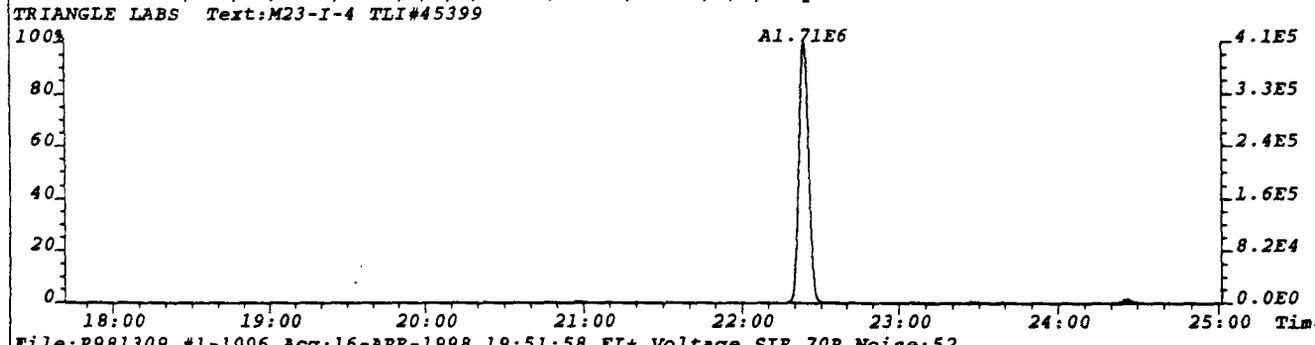
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:48
303.9016 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,192.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



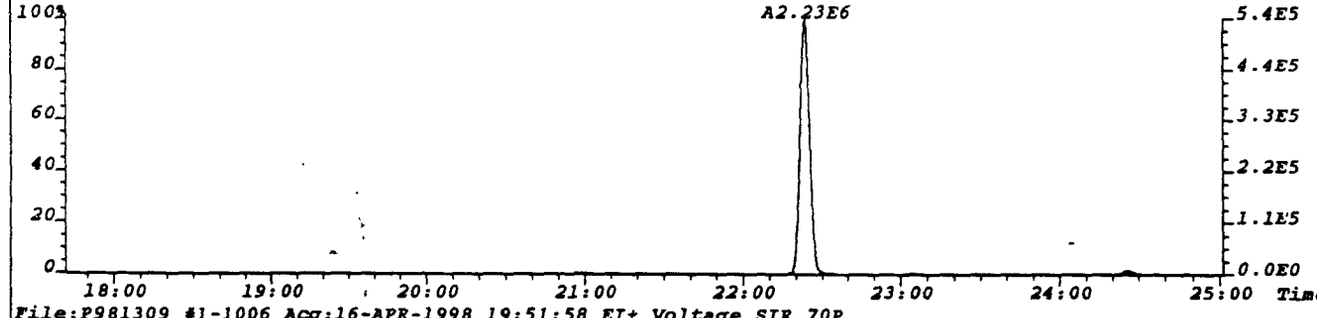
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:44
305.8987 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,176.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



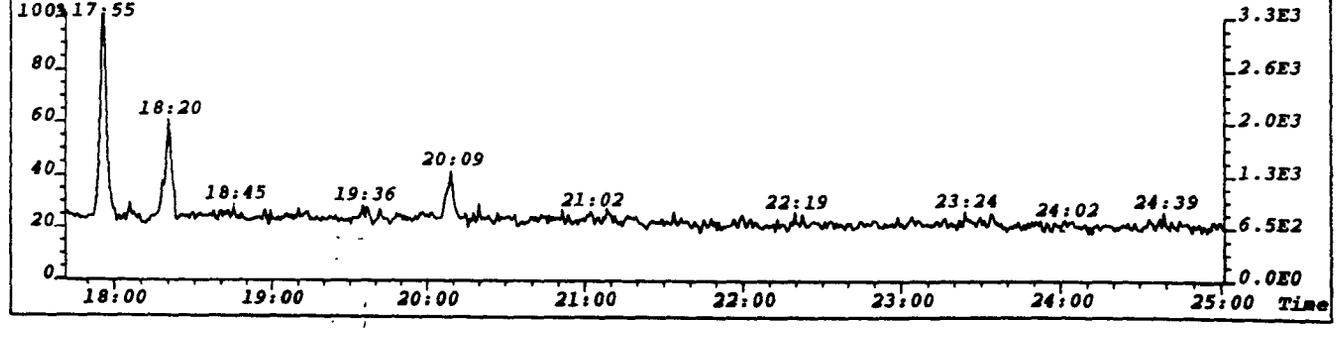
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:57
315.9419 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,228.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



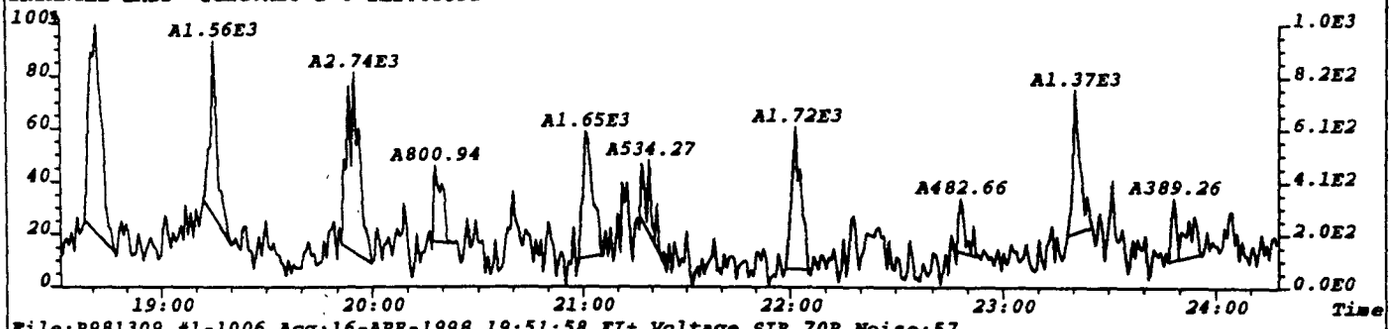
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:52
317.9389 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,208.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



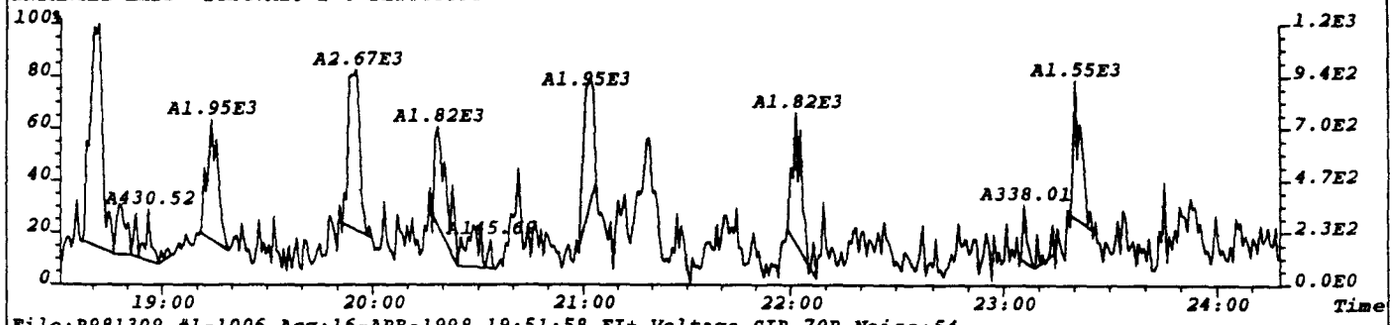
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
375.8364 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



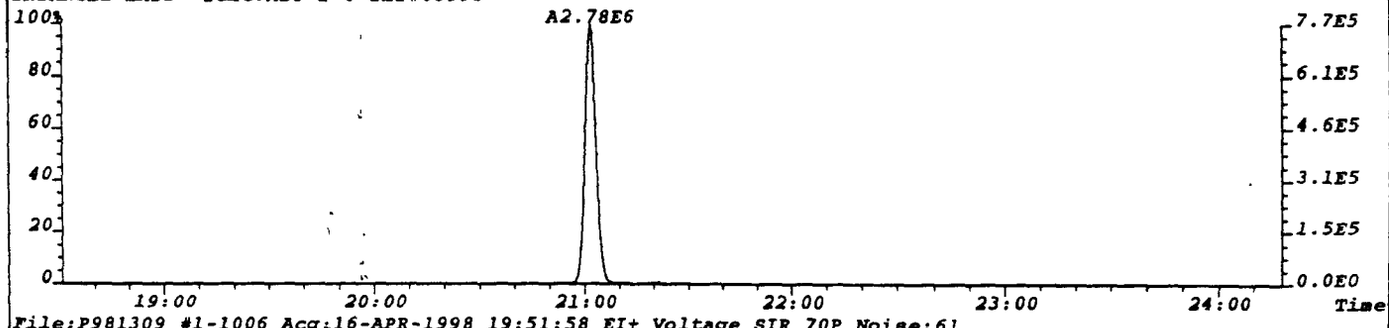
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:51
319.8965 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,204.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



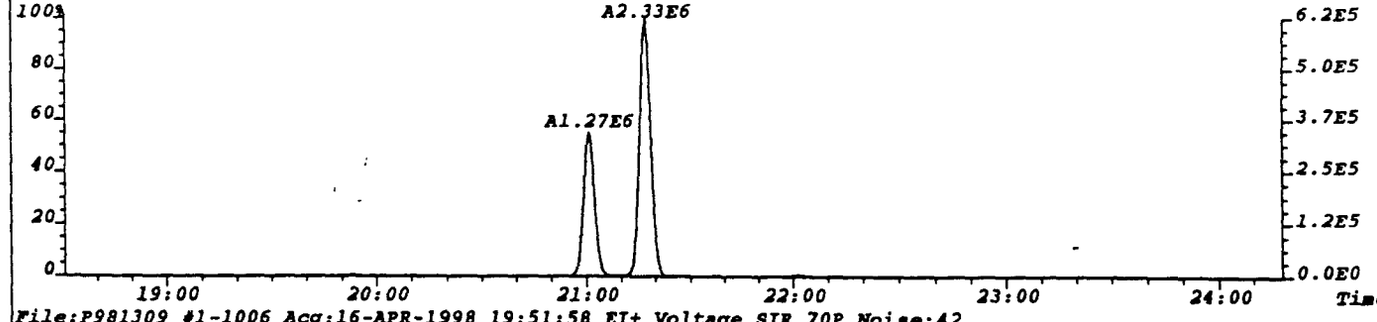
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:57
321.8936 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,228.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



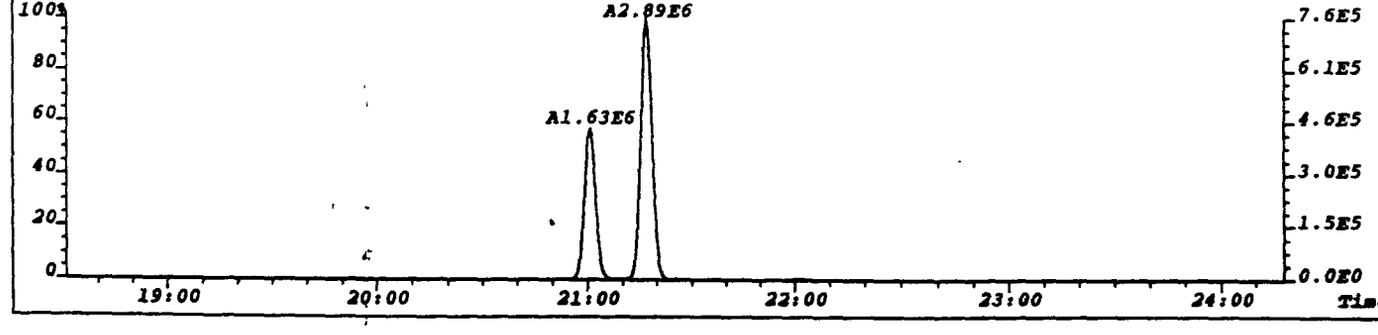
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:54
327.8847 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,216.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



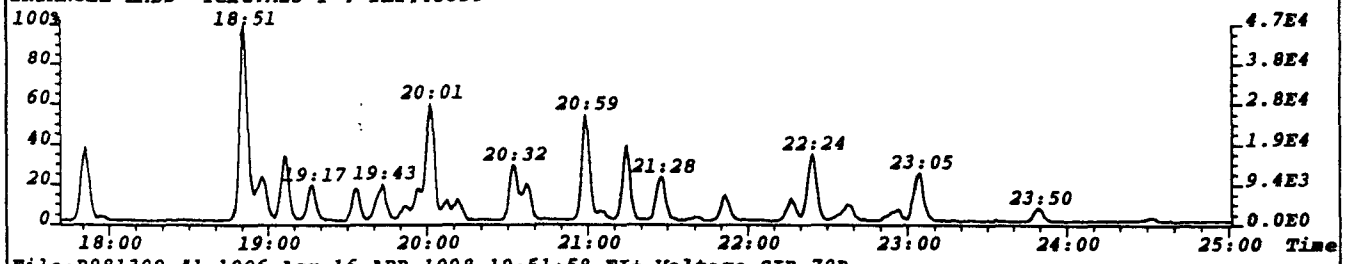
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:61
331.9368 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,244.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



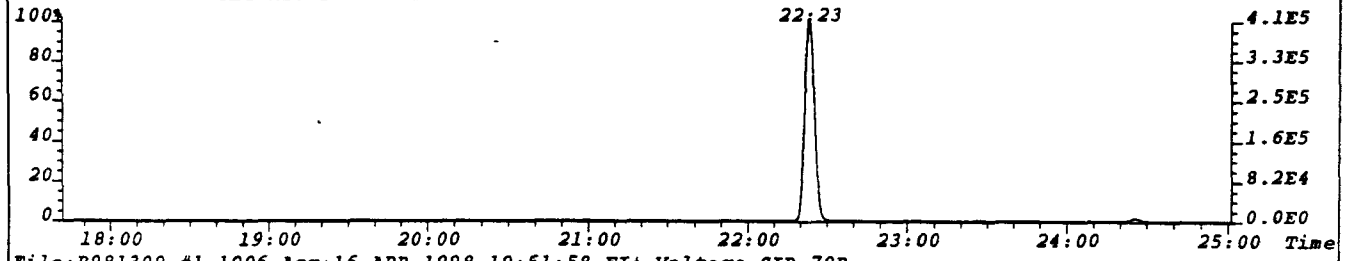
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P Noise:42
333.9338 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,168.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



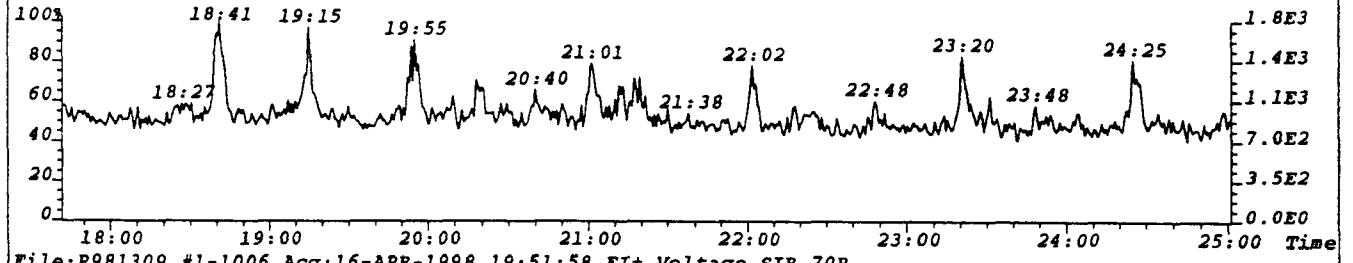
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



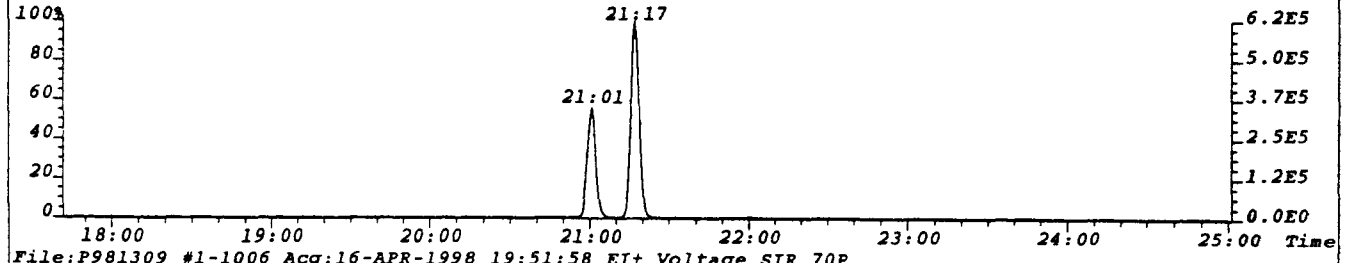
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



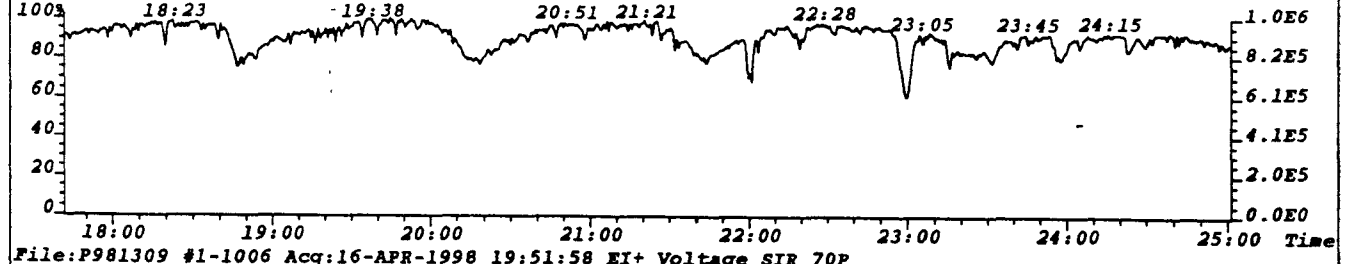
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
319.8965 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



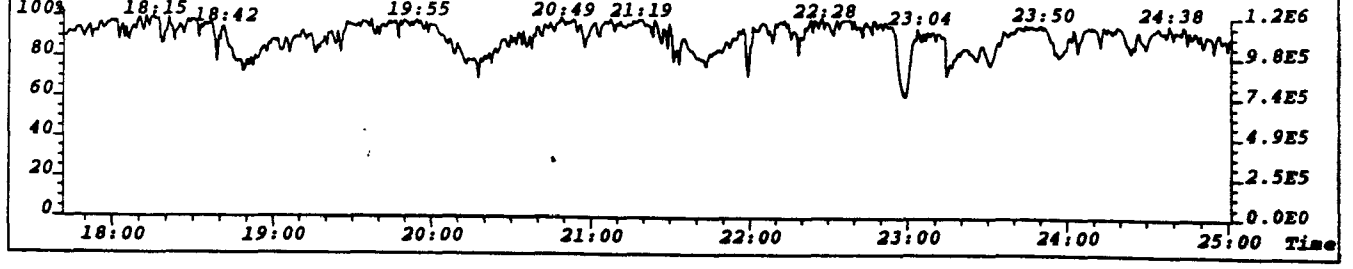
File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
331.9368 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
292.9825 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



File:P981309 #1-1006 Acq:16-APR-1998 19:51:58 EI+ Voltage SIR 70P
330.9792 Exp:DB225
TRIANGLE LABS Text:M23-I-4 TLI#45399



Pages 188 through 268 from the Triangle Laboratories, Inc. analytical report have been excluded by PES since these pages present results for samples collected at another lime kiln facility during the same mobilization.

Pacific Environmental Services

TLI Project: 45399
Client Sample: M23-O-4

Method 23 PCDD/PCDF Analysis (a)
Analysis File: S982306

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	M23	Date Received:	04/01/98	Spike File:	SPMIT204
TLI ID:	204-92-8A-D	Date Extracted:	04/03/98	ICal:	SF51078
		Date Analyzed:	04/18/98	ConCal:	S982303
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-5	Analyst:	DL	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDD	ND	0.004				
1,2,3,7,8-PeCDD	ND	0.006				
1,2,3,4,7,8-HxCDD	ND	0.008				
1,2,3,6,7,8-HxCDD	ND	0.007				
1,2,3,7,8,9-HxCDD	ND	0.007				
1,2,3,4,6,7,8-HpCDD	EMPC		0.01			J
1,2,3,4,6,7,8,9-OCDD	0.05			0.95	40:44	JB
2,3,7,8-TCDF	0.02			0.69	25:18	JB
1,2,3,7,8-PeCDF	ND	0.004				
2,3,4,7,8-PeCDF	ND	0.004				
1,2,3,4,7,8-HxCDF	ND	0.005				
1,2,3,6,7,8-HxCDF	ND	0.005				
2,3,4,6,7,8-HxCDF	ND	0.006				
1,2,3,7,8,9-HxCDF	ND	0.006				
1,2,3,4,6,7,8-HpCDF	ND	0.007				
1,2,3,4,7,8,9-HpCDF	ND	0.01				
1,2,3,4,6,7,8,9-OCDF	ND	0.01				

Totals	Amt. (ng)	Number	DL	EMPC	Flags
Total TCDD	ND		0.004		
Total PeCDD	ND		0.006		
Total HxCDD	EMPC			0.009	
Total HpCDD	EMPC			0.01	
Total TCDF	0.17	8		0.20	
Total PeCDF	0.01	1		0.02	
Total HxCDF	0.008	1			
Total HpCDF	ND		0.008		

MIT2_PSR v1.04, LARS 6.11.02

Triangle Laboratories, Inc.®
301 Capitola Drive • Durham, North Carolina 27713
Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 11:08 04/21/98

Pacific Environmental Services

TLI Project: 45399 — Method 23 PCDD/PCDF Analysis (a)

Client Sample: M23-O-4 — Analysis File: S982306

Internal Standards	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	3.2	79.7	40%-130%	0.72	25:15	—
$^{13}C_{12}$-2,3,7,8-TCDD	2.6	64.1	40%-130%	0.79	25:58	—
$^{13}C_{12}$-1,2,3,7,8-PeCDF	2.8	70.7	40%-130%	1.55	29:11	—
$^{13}C_{12}$-1,2,3,7,8-PeCDD	2.7	68.3	40%-130%	1.47	30:13	—
C_{12}-1,2,3,6,7,8-HxCDF	3.2	80.5	40%-130%	0.50	32:45	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	3.8	95.3	40%-130%	1.20	33:28	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	3.0	74.4	25%-130%	0.42	35:46	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	3.5	87.2	25%-130%	1.01	36:52	—
$^{13}C_{12}$-1,2,3,4,6,7,8,9-OCDD	7.5	93.8	25%-130%	0.87	40:44	—

Surrogate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,4,7,8-PeCDF	3.6	89.7	40%-130%	1.50	29:53	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	3.7	93.4	40%-130%	0.50	32:40	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	3.4	83.8	40%-130%	1.21	33:24	—
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	4.2	104	25%-130%	0.43	37:23	—

Other Standard	Amt. (ng)	% Recovery	QC Limits	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	3.7	91.8	40%-130%	25:59	—

Alternate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	3.5	87.0	40%-130%	0.50	34:04	—
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	3.4	86.1	40%-130%	0.50	33:16	—

Recovery Standards	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.80	25:47	—
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.20	33:48	—

Data Reviewer: GM 04/21/98

MIT2_PSR v1.04, LARS 6.11.02

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Printed: 11:08 04/21/98

Initial ....Date...

Data Review By: GM 4/21/98 Calculated Noise Area: 0.19

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of S982306B.dbf
04/21/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF						0.65-0.89				0.873-1.075			
304-306		DC	NL	0:00	RO	2.25	0.21			0.000			
				22:09		0.78	5.26	2.31	2.95	0.877			J
				22:39		0.88	2.84	1.33	1.51	0.897			J
				22:55		0.80	1.33	0.59	0.74	0.908			J
				23:15		0.88	8.74	4.08	4.66	0.921			J
				23:36		0.88	5.31	2.48	2.83	0.935			J
				23:58		0.79	5.47	2.42	3.05	0.949			J
				24:13		0.85	3.50	1.61	1.89	0.959			J
	M			24:33	RO	1.01	2.73	1.56	1.54	0.972			J
				24:51	RO	0.98	1.98	1.10	1.12	0.984			J
				25:06	RO	1.05	1.04	0.62	0.59	0.994			J
				25:18		0.69	3.66	1.49	2.17	1.002	2378-TCDF	AN	J
304-306			11	Peaks			41.86						
13C12-TCDF						0.65-0.89				0.960-1.040			
316-318		DC	NL	0:00	RO	1.00	0.25			0.000			
		DC	WL	24:14	RO	0.96	0.81			0.960			
				24:51	RO	0.59	2.00	0.87	1.47	0.984			
				25:15		0.72	644.64	269.10	375.54	1.000	13C12-2378-TCDF	ISO	
				25:41	RO	1.10	1.91	1.19	1.08	1.017			
316-318			3	Peaks			648.55						

---------- Above: TCDF / TCDD Follows ----------

TCDD						0.65-0.89				0.899-1.046			
320-322		DC	NL	0:00	RO	1.20	0.18			0.000			
	D	d	SN	23:27		0.86	0.54			0.903			
		DC	SN	23:39	RO	1.22	0.16			0.911			
		DC	SN	24:15	RO	0.17	0.05			0.934			
		DC	SN	24:23	RO	2.00	0.11			0.939			
		DC	SN	25:16	RO	2.33	0.21			0.973			
320-322			0	Peaks			0.00						
37Cl-TCDD										0.923-1.077			
328		DC	NL	0:00			0.12			0.000			
				24:37			2.57	2.57		0.948			
				25:59			347.08	347.08		1.001	37Cl-TCDD	CLS	
				26:22			0.27	0.27		1.015			
				26:39			0.36	0.36		1.026			
328			4	Peaks			350.28						
13C12-TCDD						0.65-0.89				0.923-1.077			
332-334		DC	NL	0:00	RO	2.73	0.19			0.000			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
				24:48		0.87	1.78	0.83	0.95	0.955			
				25:47		0.80	563.57	249.74	313.83	0.993	13C12-1234-TCDD	RS1	
				25:58		0.79	398.20	175.28	222.92	1.000	13C12-2378-TCDD	IS1	
				26:17		0.76	5.33	2.31	3.02	1.012			
332-334				4 Peaks			968.88						
---------- Above: TCDD / PeCDF Follows ----------													
PeCDF				1.32-1.78					0.928-1.063				
340-342	DC	NL		0:00	RO	0.75	0.15			0.000			
				27:12	RO	1.00	0.72	0.44	0.44	0.932			J
	DC	SN		28:12	RO	0.86	0.31			0.966			
				28:21		1.59	1.40	0.86	0.54	0.971			J
	DC	SN		28:50	RO	0.39	0.20			0.988			
	DC	SN		29:06	RO	0.37	0.12			0.997			
	DC	SN		29:21	RO	0.92	0.38			1.006			
D	d	SN		29:54	RO	0.94	0.49			1.025	23478-PeCDF	AN	
	DC	SN		30:02	RO	4.30	0.26			1.029			
	DC	SN		30:22	RO	0.90	0.15			1.041			
	DC	SN		30:30	RO	0.47	0.13			1.045			
	DC	SN		30:45	RO	0.50	0.07			1.054			
340-342				2 Peaks			2.12						
13C12-PeCDF				1.32-1.78					0.863-1.137				
352-354	DC	NL		0:00	RO	1.00	0.15			0.000			
				28:20		1.33	1.77	1.01	0.76	0.971			
	DC	SN		28:47	RO	0.54	0.35			0.986			
				29:11		1.55	428.94	260.76	168.18	1.000	13C12-PeCDF 123	IS2	
				29:28		1.32	2.18	1.24	0.94	1.010			
				29:53		1.50	373.83	224.49	149.34	1.024	13C12-PeCDF 234	SUR1	
				30:52	RO	0.94	0.79	0.48	0.51	1.058			
352-354				5 Peaks			807.51						
---------- Above: PeCDF / PeCDD Follows ----------													
PeCDD				1.32-1.78					0.937-1.022				
356-358	DC	NL		0:00	RO	0.80	0.13			0.000			
	DC	SN		29:11		1.77	0.36			0.966			
	DC	SN		30:13	RO	1.10	0.18			1.000	12378-PeCDD	AN	
356-358				0 Peaks			0.00						
13C12-PeCDD				1.32-1.78					0.868-1.132				
368-370	DC	NL		0:00	RO	1.13	0.15			0.000			
	DC	SN		29:09		1.44	0.39			0.965			
				30:13		1.47	229.78	136.91	92.87	1.000	13C12-PeCDD 123	IS3	
				30:21		1.43	19.46	11.46	8.00	1.004			
368-370				2 Peaks			249.24						
---------- Above: PeCDD / HxCDF Follows ----------													
HxCDF				1.05-1.43					0.963-1.048				
374-376	DC	NL		0:00		1.33	0.21			0.000			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
		DC	SN	31:41	RO	0.91	0.18			0.967			
				31:51		1.29	0.71	0.40	0.31	0.973			J
	D	d	SN	32:40	RO	1.00	0.45			0.997	123478-HxCDF	AN	
		DC	SN	32:45	RO	1.00	0.40			1.000	123678-HxCDF	AN	
		DC	SN	33:05	RO	2.50	0.09			1.010			
		DC	SN	33:16		1.05	0.39			1.016	234678-HxCDF	AN	
374-376			1	Peak			0.71						
13C12-HxCDF						0.43-0.59				0.878-1.122			
384-386		DC	NL	0:00	RO	0.89	0.27			0.000			
				31:42	RO	0.66	1.98	0.87	1.31	0.968			
				31:50	RO	0.66	1.51	0.66	1.00	0.972			
				32:40		0.50	284.12	94.61	189.51	0.997	13C12-HxCDF 478	SUR2	
				32:45		0.50	299.43	100.38	199.05	1.000	13C12-HxCDF 678	IS4	
		DC	SN	32:58	RO	0.35	0.33			1.007			
		DC	SN	33:06	RO	0.15	0.21			1.011			
				33:16		0.50	316.87	105.51	211.36	1.016	13C12-HxCDF 234	ALT2	
		DC	SN	33:27	RO	1.84	0.29			1.021			
		DC	SN	33:35	RO	0.63	0.29			1.025			
		DC	SN	33:42	RO	1.60	0.15			1.029			
				34:04		0.50	257.28	85.88	171.40	1.040	13C12-HxCDF 789	ALT1	
				34:18	RO	0.23	0.74	0.25	1.10	1.047			
384-386			7	Peaks			1,161.93						

---------- Above: HxCDF / HxCDD Follows ----------

HxCDD						1.05-1.43				0.958-1.014			
390-392		DC	NL	0:00		1.20	0.22			0.000			
		DC	SN	32:03		1.25	0.09			0.958			
				32:39	RO	1.65	0.58	0.43	0.26	0.976			J
		DC	SN	32:50		1.26	0.43			0.981			
		DC	WH	33:59	RO	0.67	0.07			1.015			
		DC	WH	34:03	RO	1.67	0.13			1.017			
		DC	WH	34:06	RO	2.17	0.13			1.019			
390-392			1	Peak			0.58						
13C12-HxCDD						1.05-1.43				0.970-1.030			
402-404		DC	NL	0:00		1.33	0.21			0.000			
				32:51		1.18	0.98	0.53	0.45	0.982			
				33:24		1.21	197.91	108.18	89.73	0.998	13C12-HxCDD 478	SUR3	
				33:28		1.20	256.92	140.31	116.61	1.000	13C12-HxCDD 678	IS5	
				33:48		1.20	291.70	159.10	132.60	1.010	13C12-HxCDD 789	RS2	
		DC	SN	34:04	RO	0.28	0.20			1.018			
		DC	SN	34:12	RO	1.67	0.34			1.022			
402-404			4	Peaks			747.51						

---------- Above: HxCDD / HpCDF Follows ----------

HpCDF						0.88-1.20				0.997-1.051			
408-410		DC	NL	0:00	RO	1.36	0.22			0.000			
	D	d	SN	35:47		1.05	1.23			1.000	1234678-HpCDF	AN	
		DC	SN	36:23	RO	0.77	0.20			1.017			

```
Compound/
M_Z.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

               DC  SN  36:29 RO  2.43          0.14                                1.020
               DC  SN  36:36 RO  1.57          0.14                                1.023
               DC  SN  36:40 RO  1.50          0.24                                1.025
408-410              0 Peaks                   0.00

13C12-HpCDF                     0.37-0.51                                   0.944-1.112
418-420        DC  NL   0:00 RO  0.95          0.27                                0.000
                       35:46     0.42        183.77         54.11        129.66  1.000 13C12-HpCDF 678 IS6
                       37:23     0.43        153.17         45.69        107.48  1.045 13C12-HpCDF 789 SUR4
418-420              2 Peaks                  336.94

              --------------------- Above: HpCDF / HpCDD Follows --------------------

HpCDD                           0.88-1.20                                   0.976-1.005
424-426        DC  NL   0:00 RO  0.77          0.20                                0.000
       MK              36:53 RO  1.42          0.49          0.34          0.24  1.000 1234678-HpCDD   AN   J
424-426              1 Peak                    0.49

13C12-HpCDD                     0.88-1.20                                   0.973-1.027
436-438        DC  NL   0:00     1.07          0.29                                0.000
                       36:52     1.01        188.22         94.75         93.47  1.000 13C12-HpCDD 678 IS7
436-438              1 Peak                   188.22

              --------------------- Above: HpCDD / Octa-CDD and CDF Follows ----------

OCDF                            0.76-1.02                                   0.902-1.098
442-444        DC  NL   0:00     1.00          0.20                                0.000
               DC  SN  38:02     0.83          0.11                                0.934
               DC  SN  39:36     0.85          0.24                                0.972
               DC  SN  40:55     0.91          0.21                                1.005
442-444              0 Peaks                   0.00

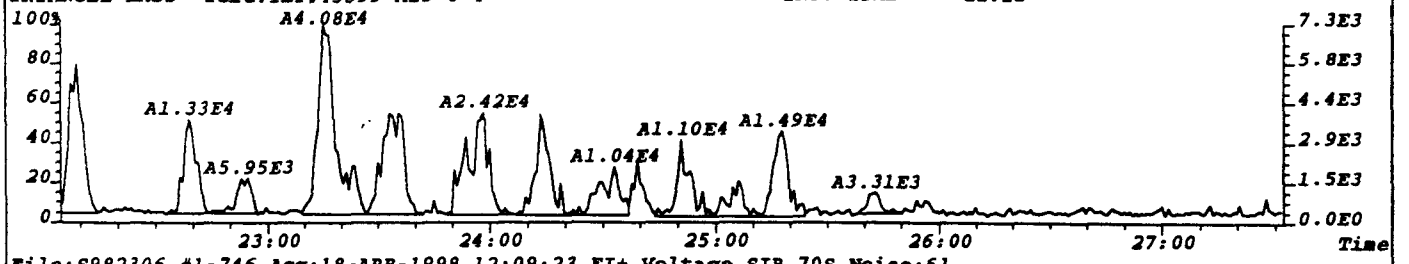
OCDD                            0.76-1.02                                   0.902-1.098
458-460        DC  NL   0:00     0.88          0.15                                0.000
       MK              40:44     0.95          1.85          0.90          0.95  1.000 OCDD            AN   J
458-460              1 Peak                    1.85

13C12-OCDD                      0.76-1.02                                   0.996-1.004
470-472        DC  NL   0:00     1.00          0.16                                0.000
                       40:44     0.87        274.79        127.71        147.08  1.000 13C12-OCDD      IS8
470-472              1 Peak                   274.79
```

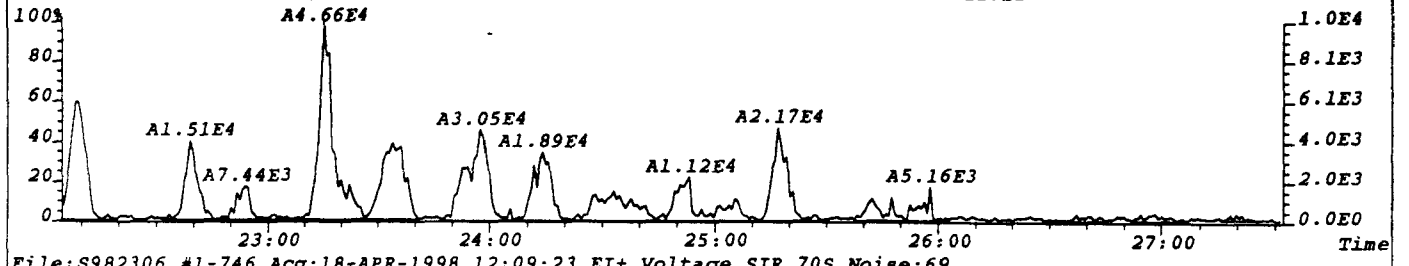
Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

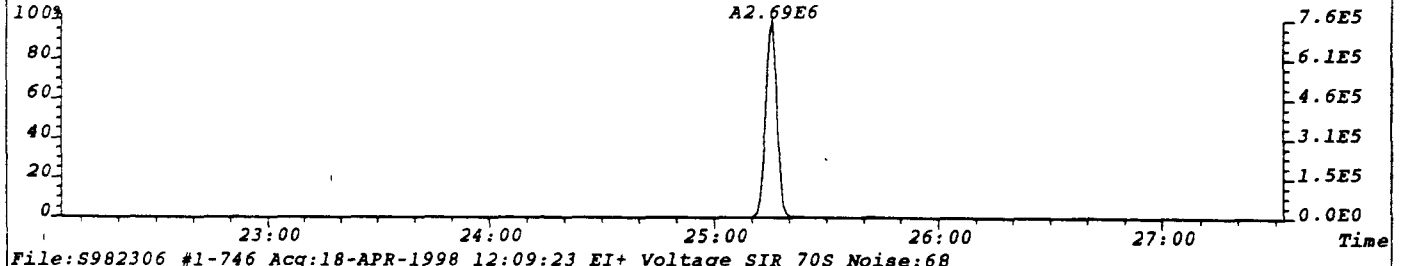
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:133
303.9016 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,532.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



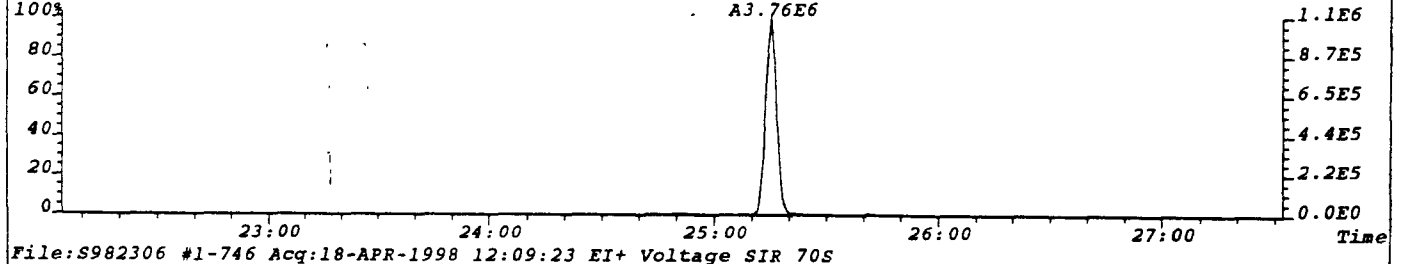
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:61
305.8987 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,244.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



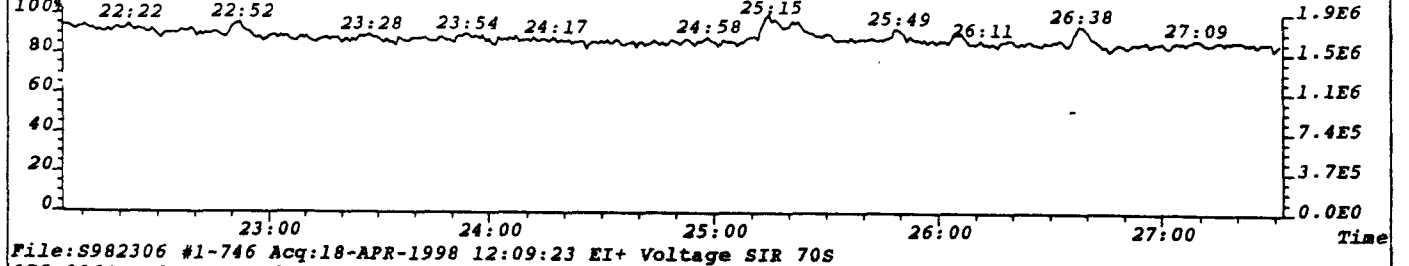
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:69
315.9419 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,276.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



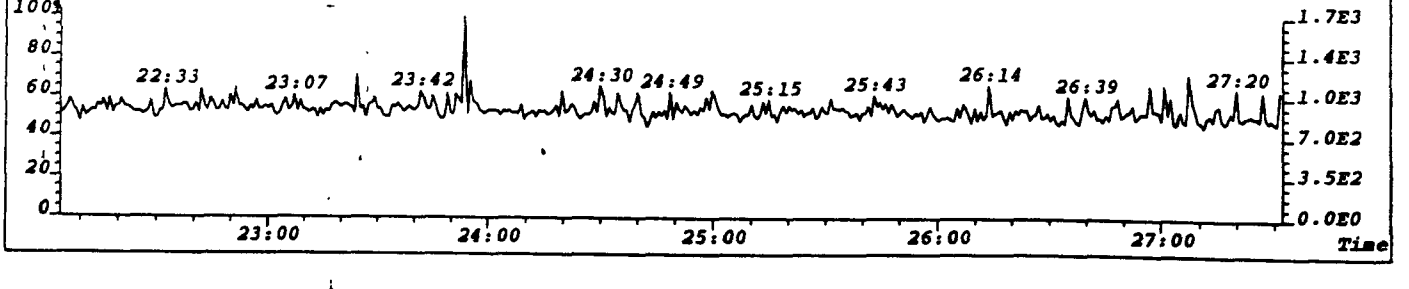
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:68
317.9389 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,272.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



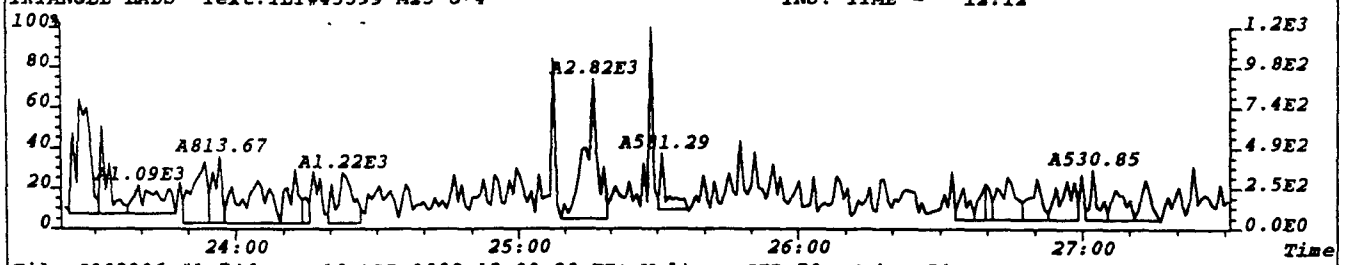
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



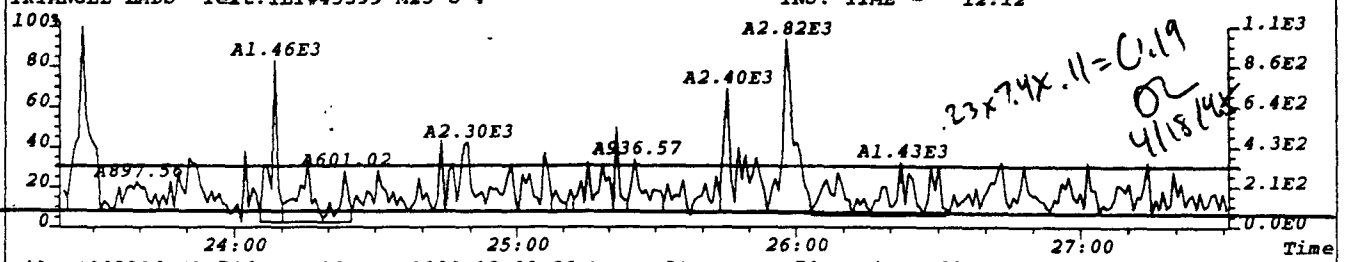
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
375.8364 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



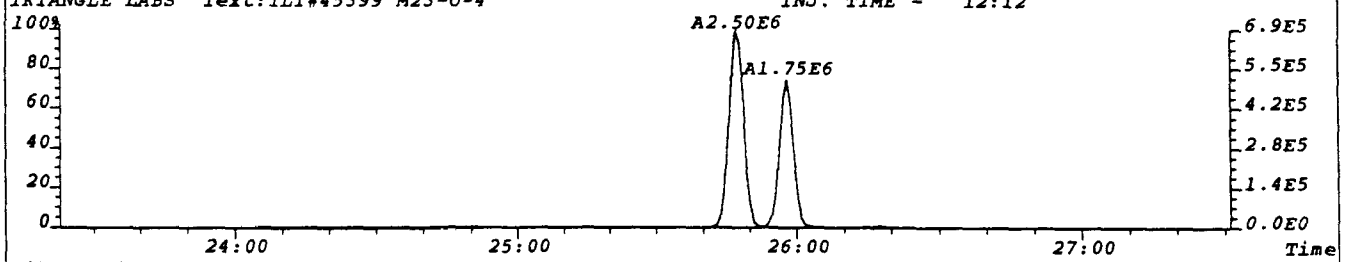
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:61
319.8965 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,244.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



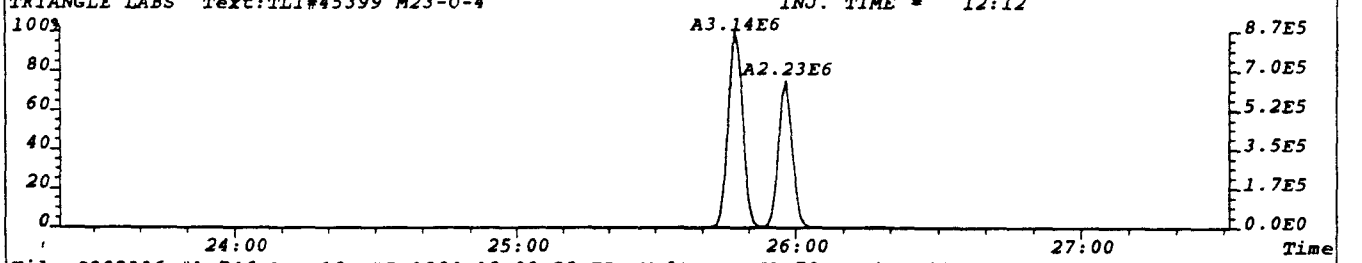
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:50
321.8936 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,200.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



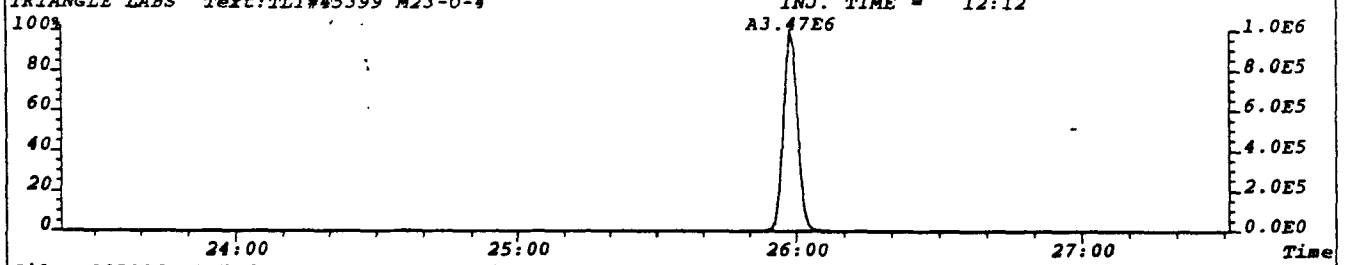
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:152
331.9368 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,608.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



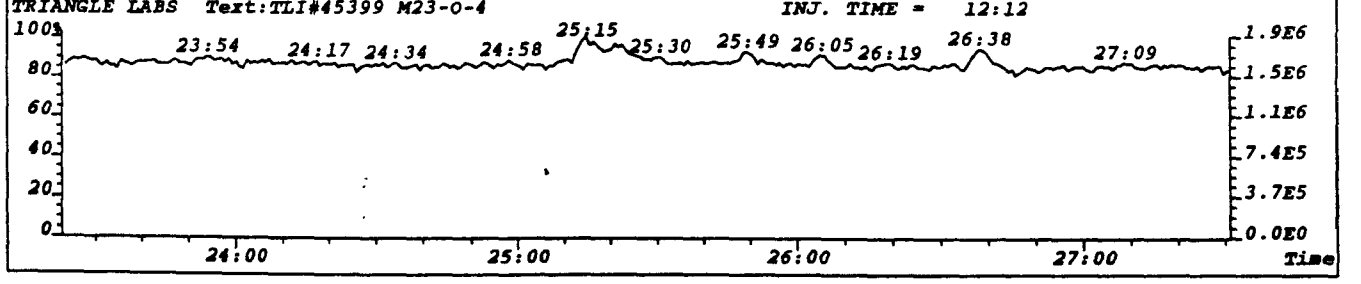
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:56
333.9338 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,224.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



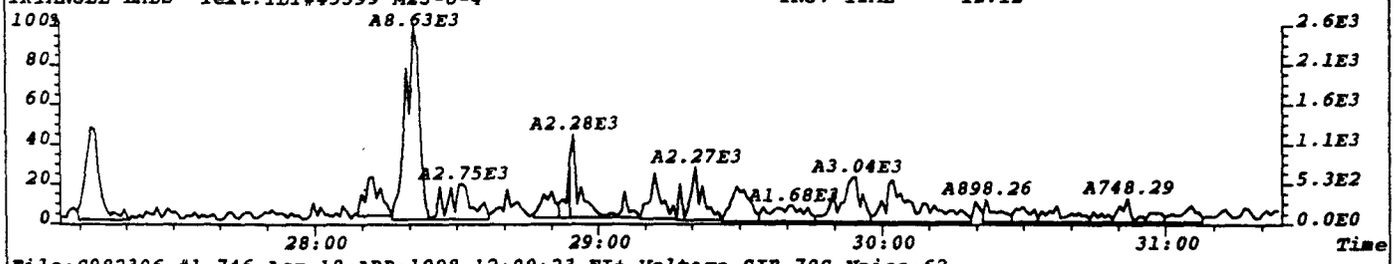
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:58
327.8847 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,232.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



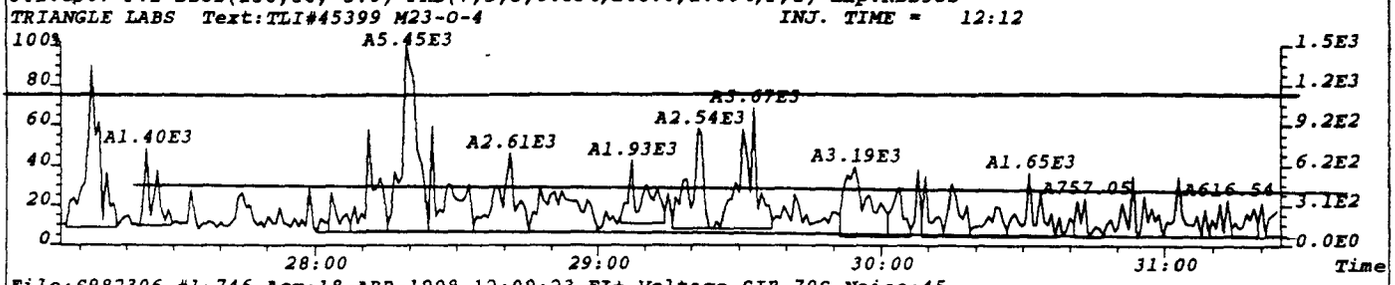
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



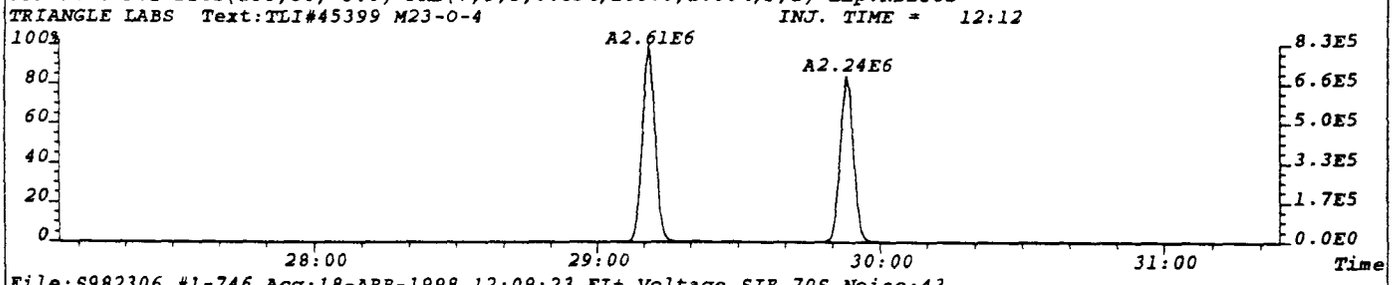
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:46
339.8597 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,184.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



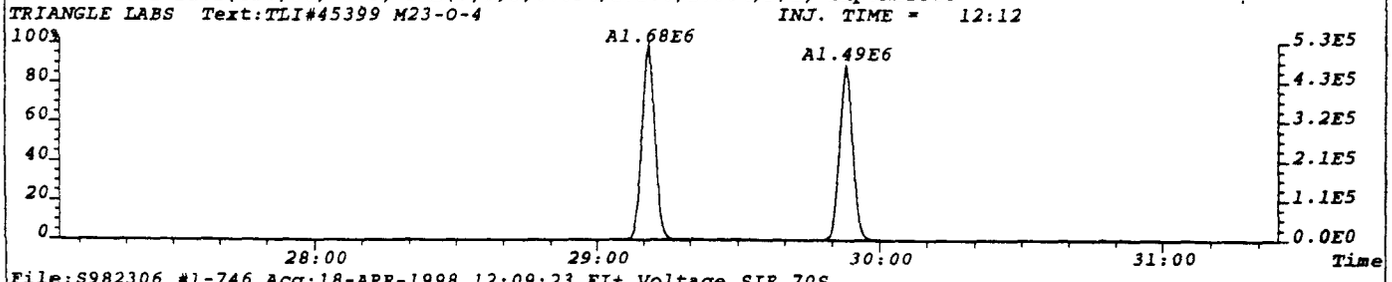
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:62
341.8567 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,248.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



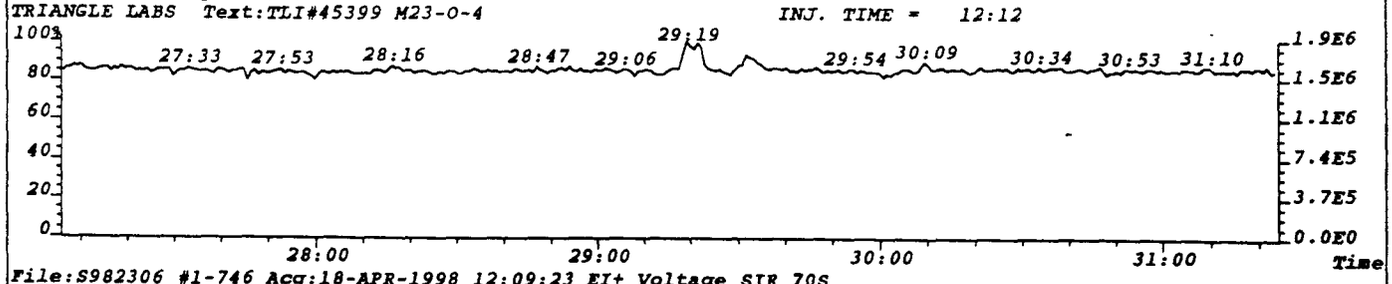
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:45
351.9000 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,180.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



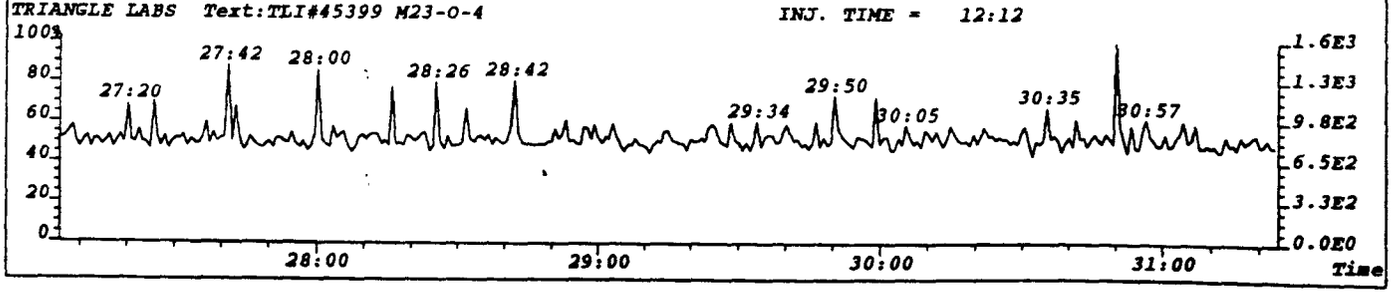
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:43
353.8970 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,172.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



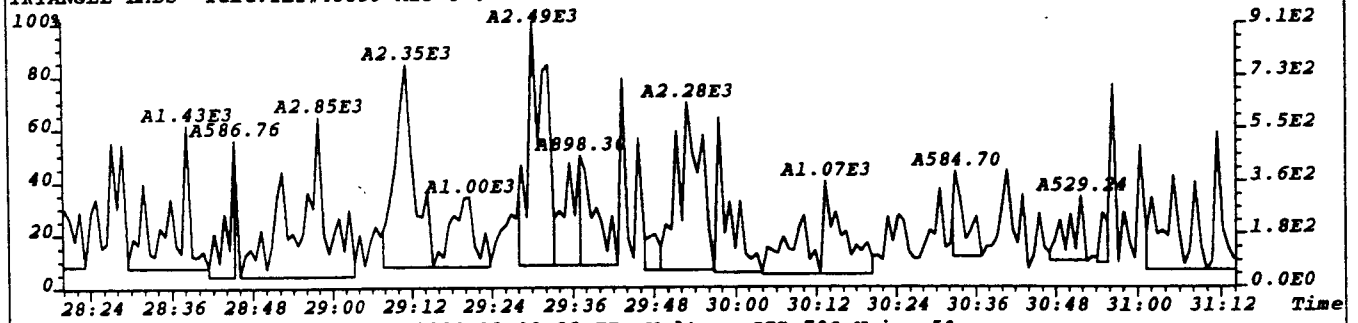
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



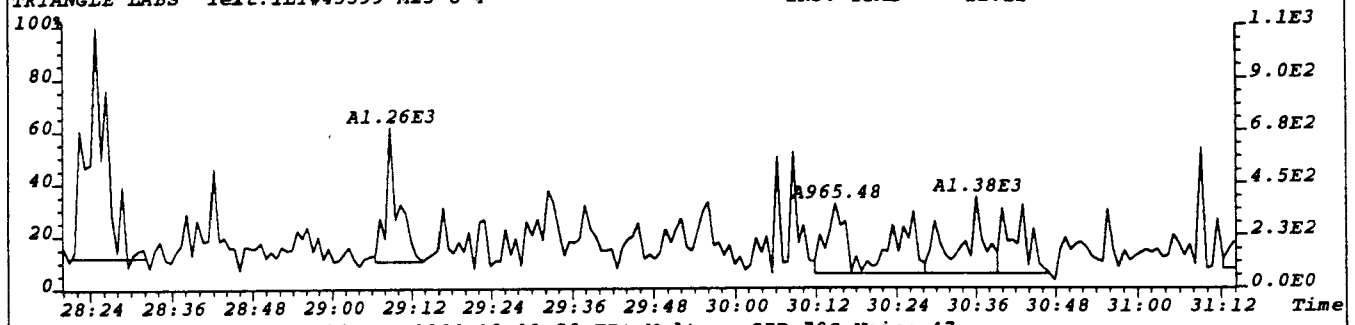
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
409.7974 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



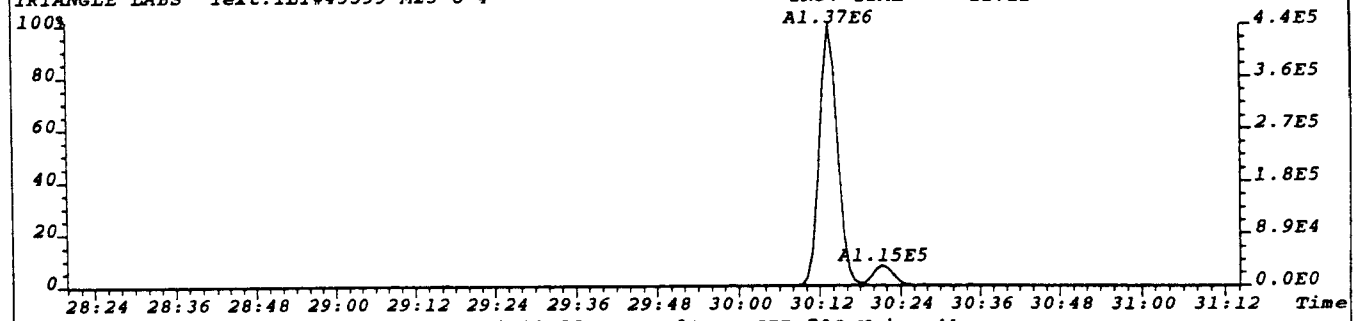
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:42
355.8546 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,168.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



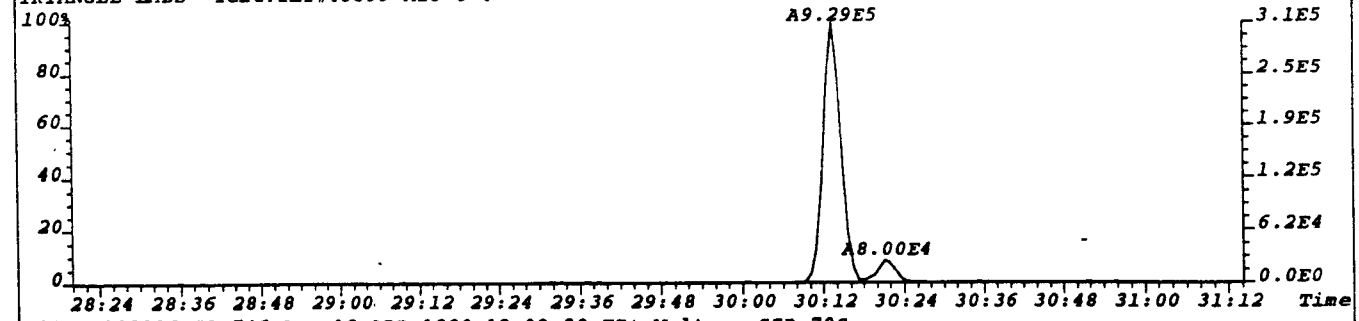
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:50
357.8516 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,200.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



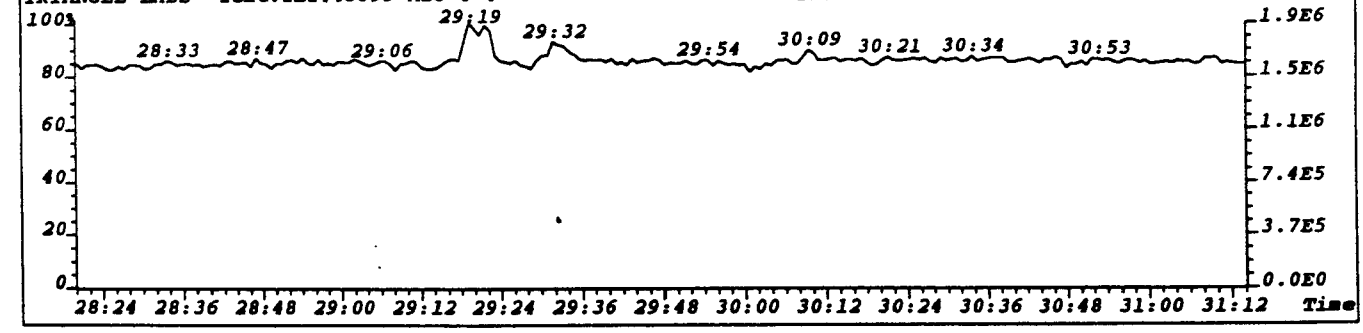
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:47
367.8949 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,188.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



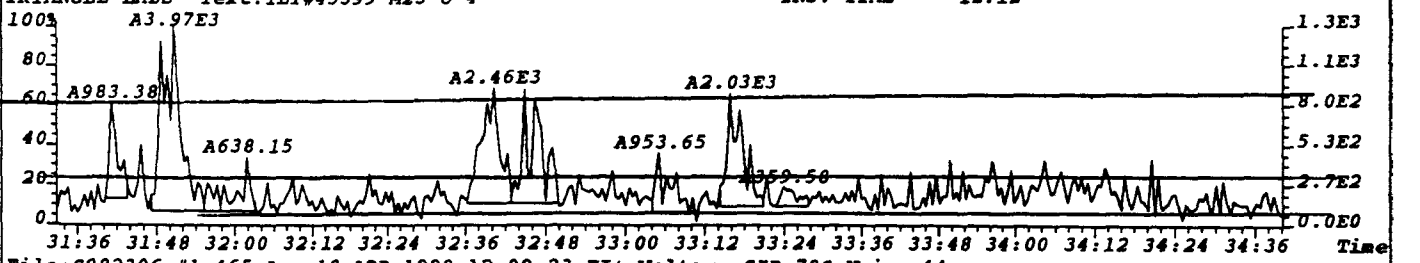
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:41
369.8919 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,164.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



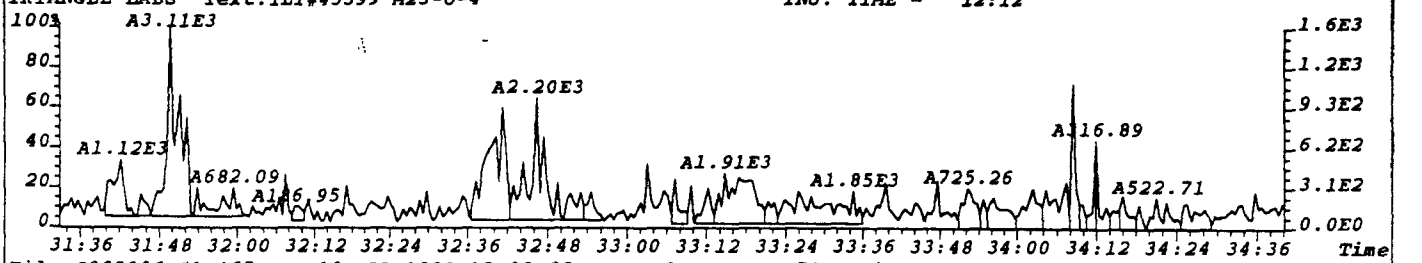
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



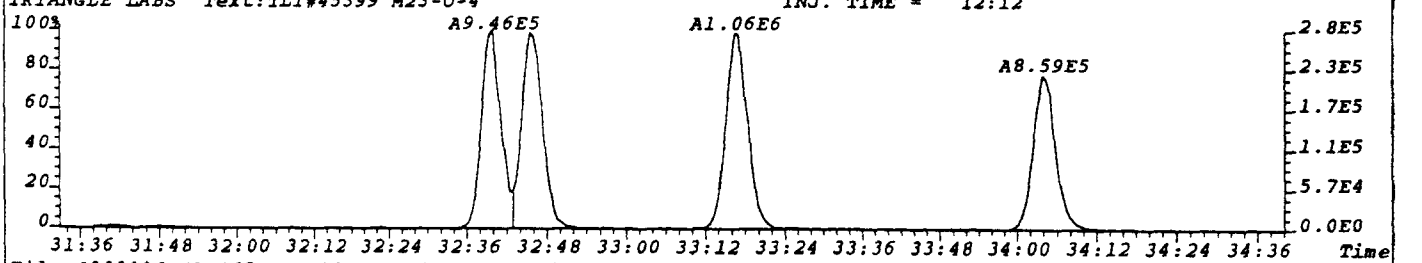
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:58
373.8208 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,232.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



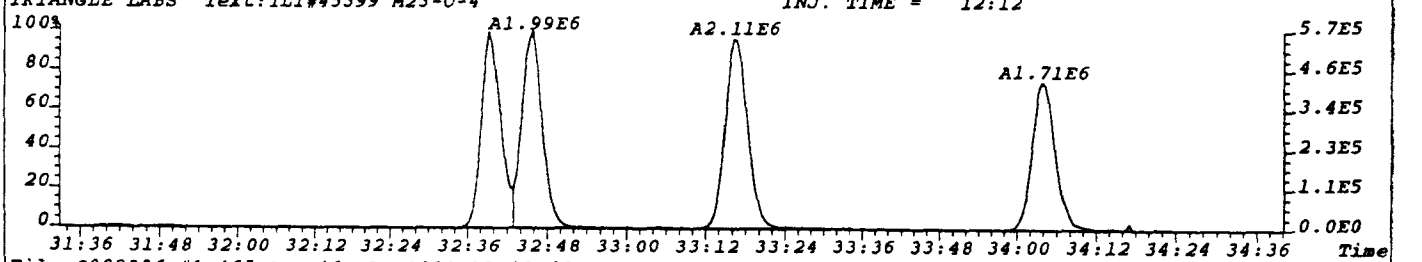
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:44
375.8178 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



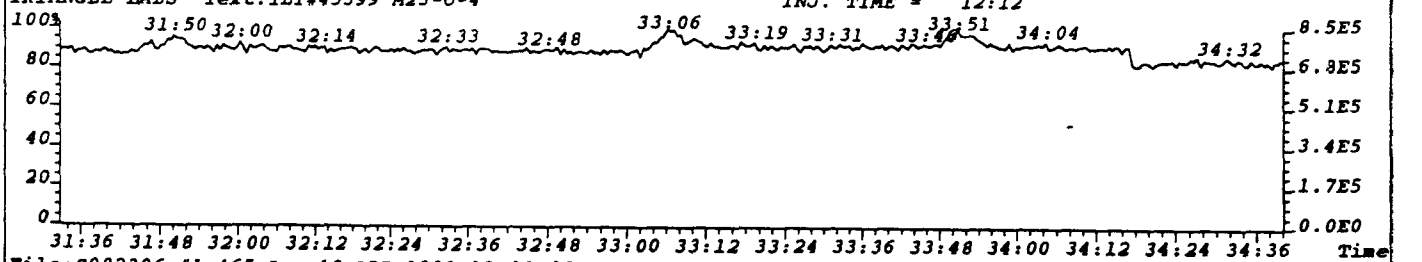
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:80
383.8639 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,320.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



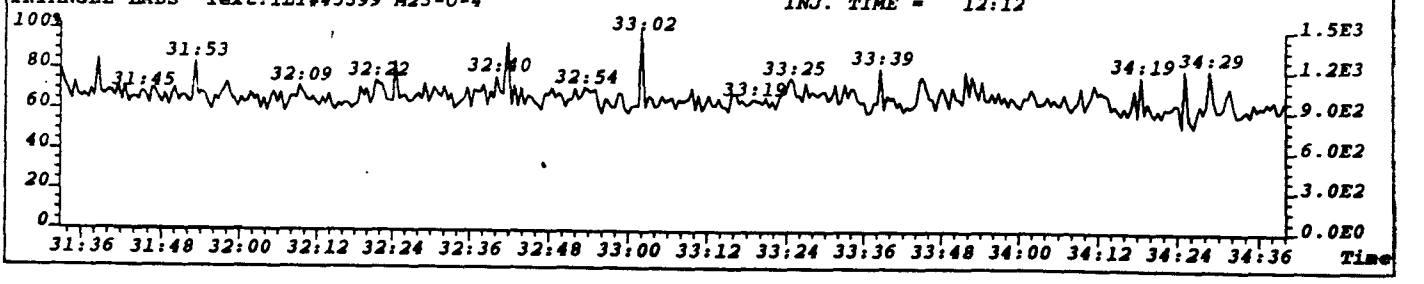
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:89
385.8610 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,356.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



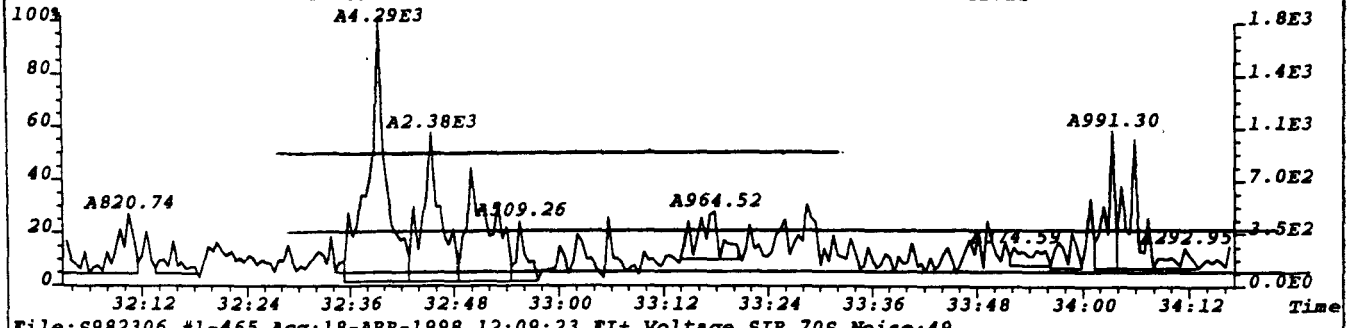
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



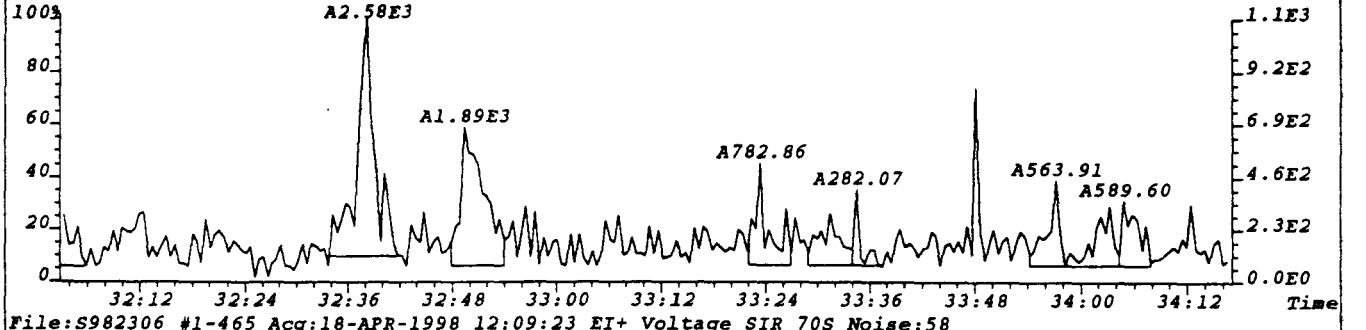
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
445.7555 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



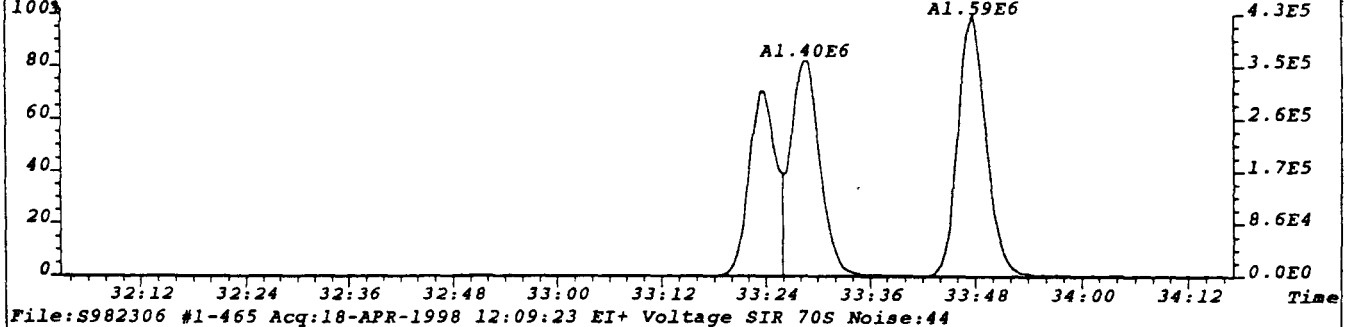
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:61
389.8156 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,244.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



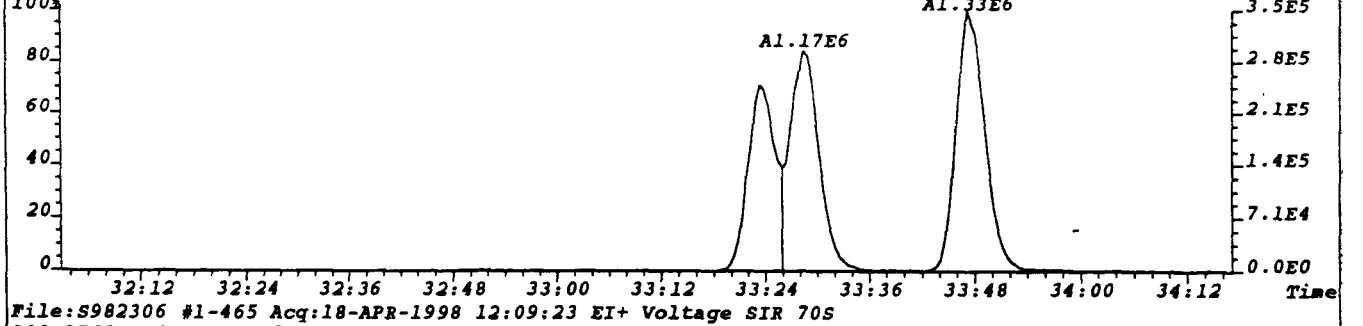
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:49
391.8127 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,196.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



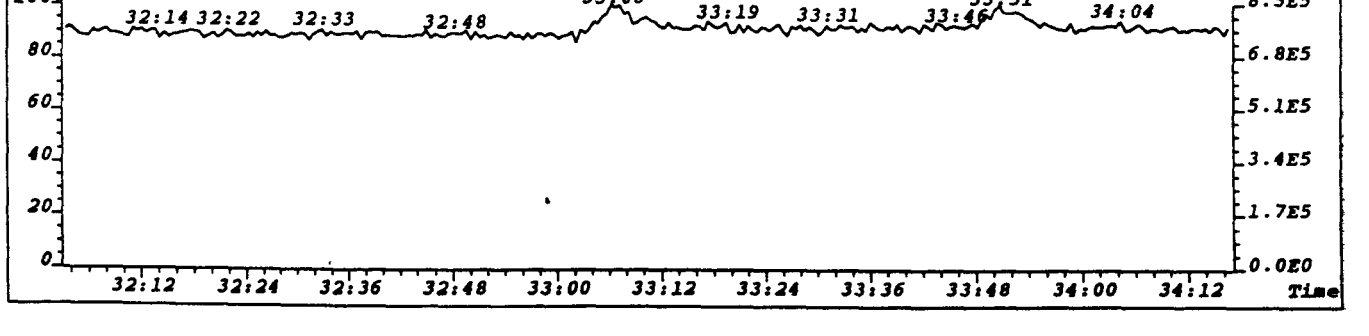
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:58
401.8558 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,232.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



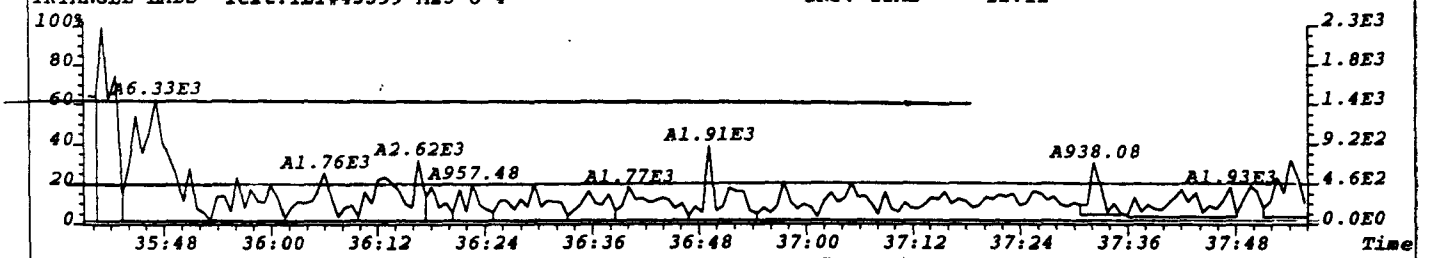
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:44
403.8529 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



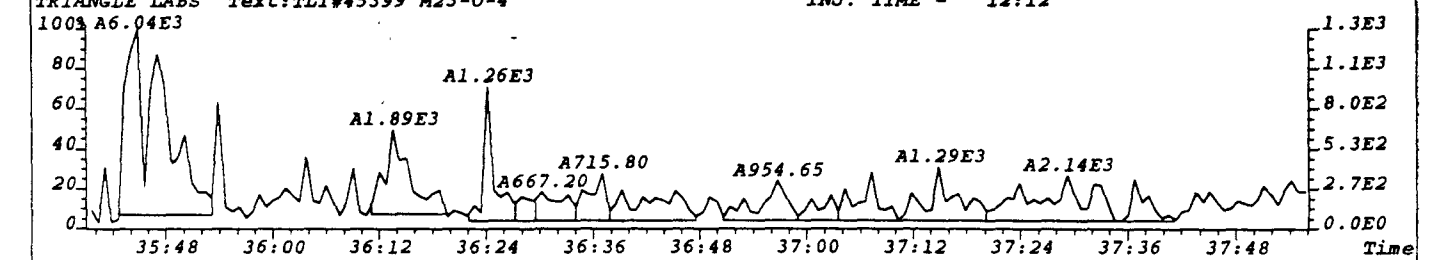
File:S982306 #1-465 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



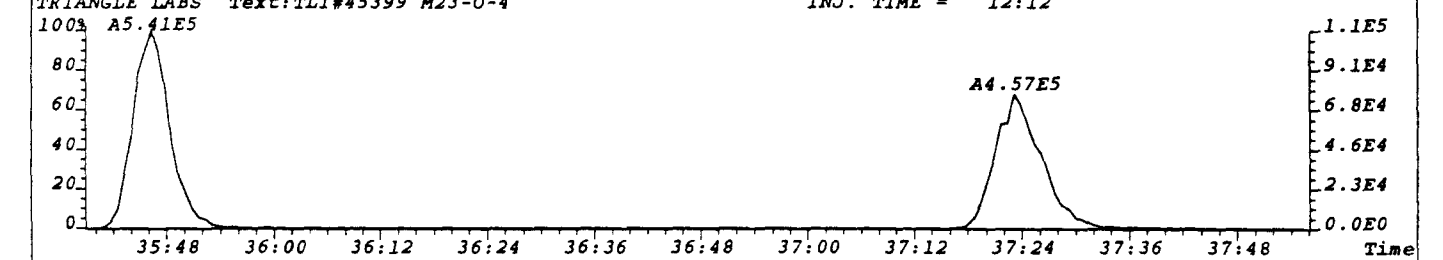
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:75
407.7818 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,300.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



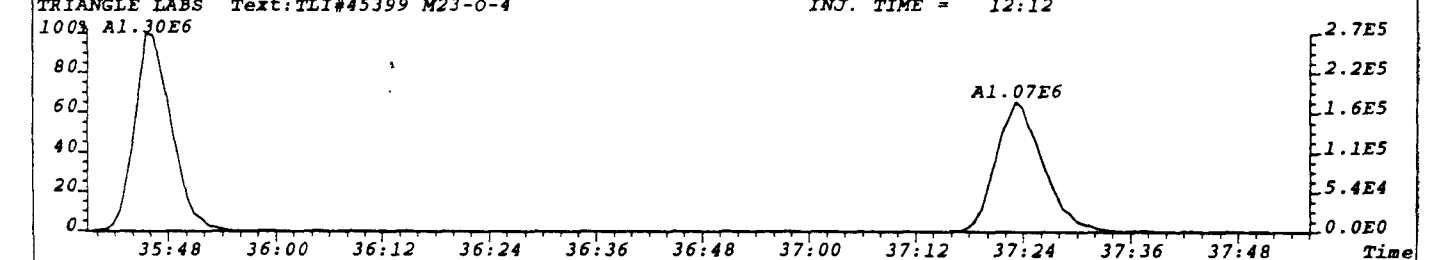
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:57
409.7789 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,228.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



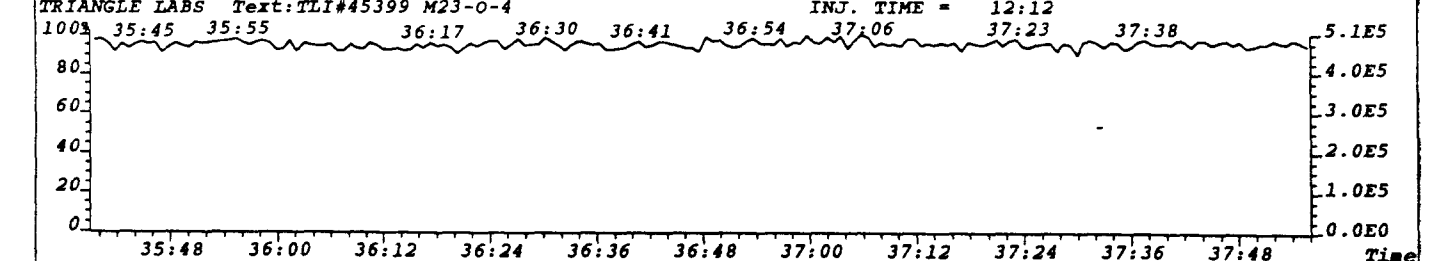
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:89
417.8253 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,356.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



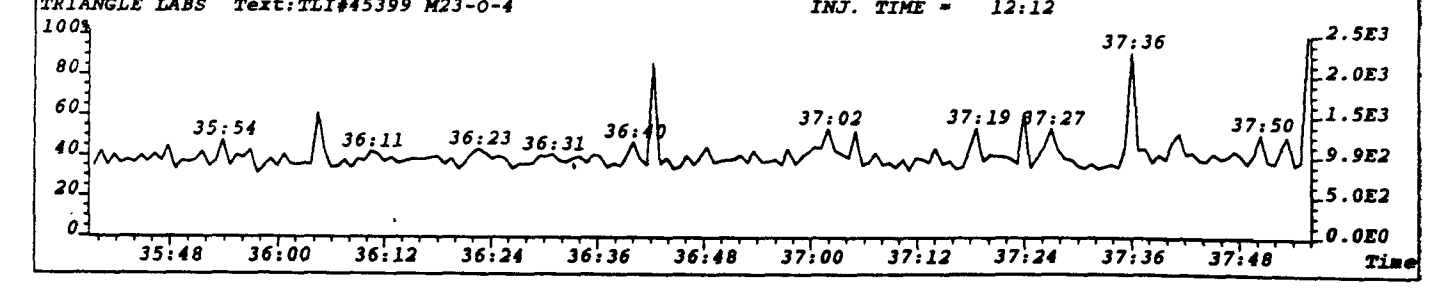
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:96
419.8220 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,384.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



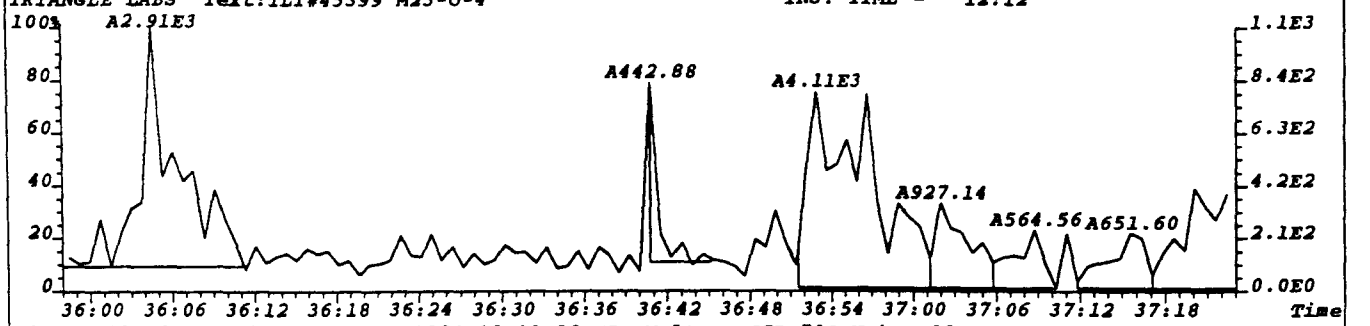
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



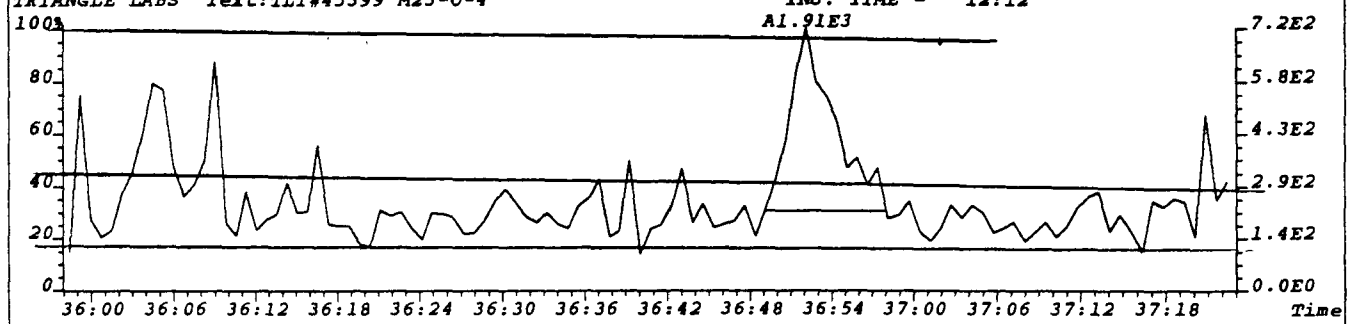
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
479.7165 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



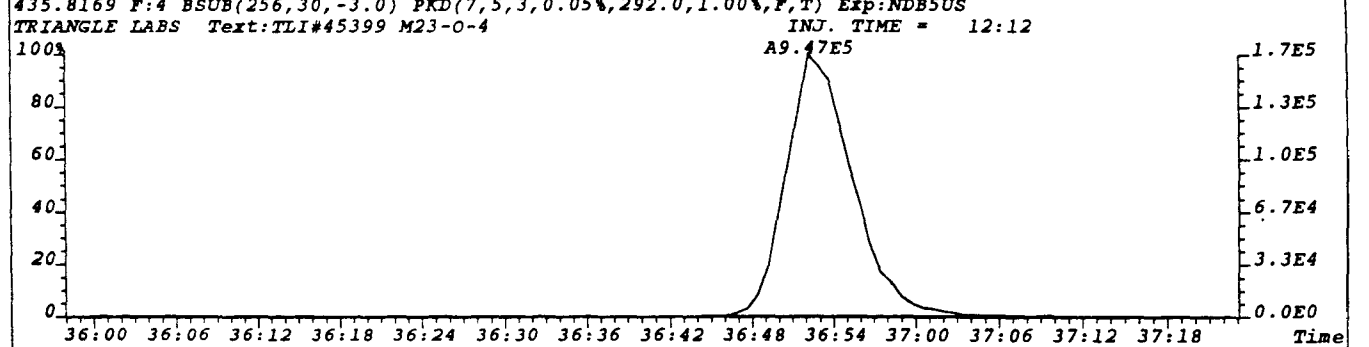
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:51
423.7766 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,204.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



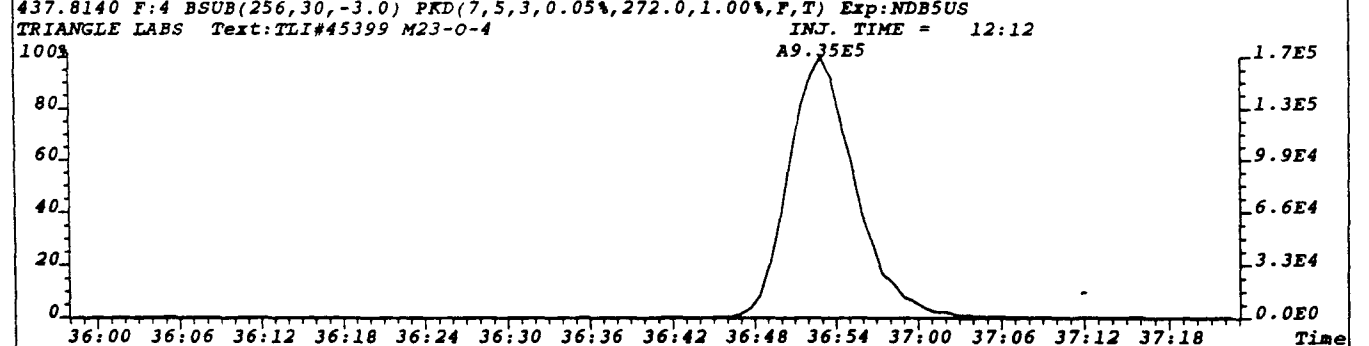
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:66
425.7737 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,264.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



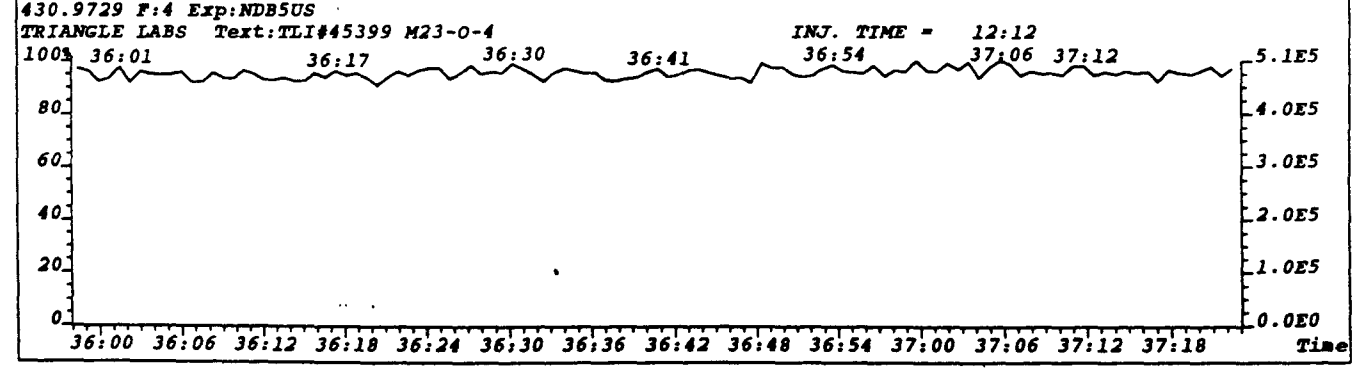
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:73
435.8169 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,292.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:68
437.8140 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,272.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-O-4 INJ. TIME = 12:12



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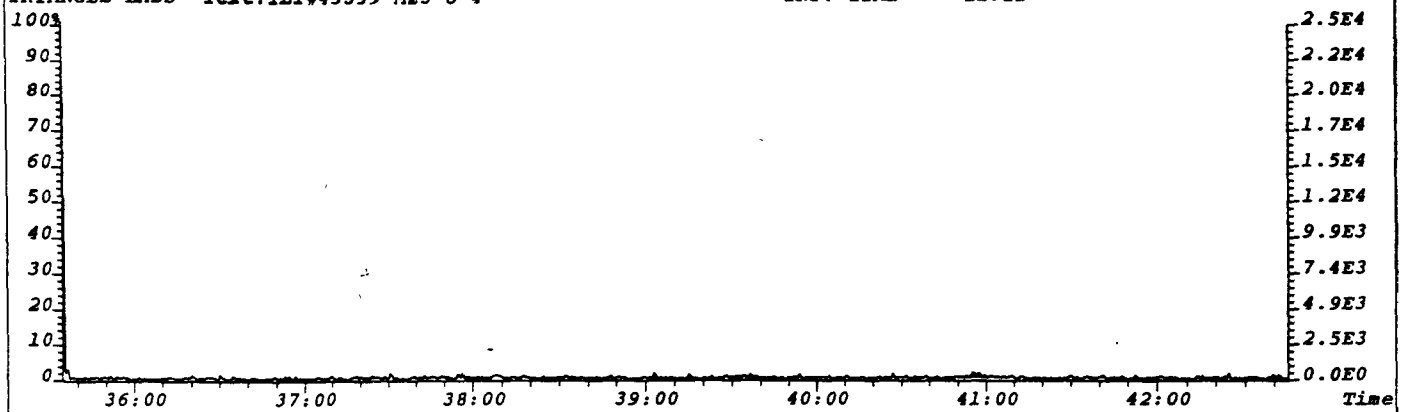
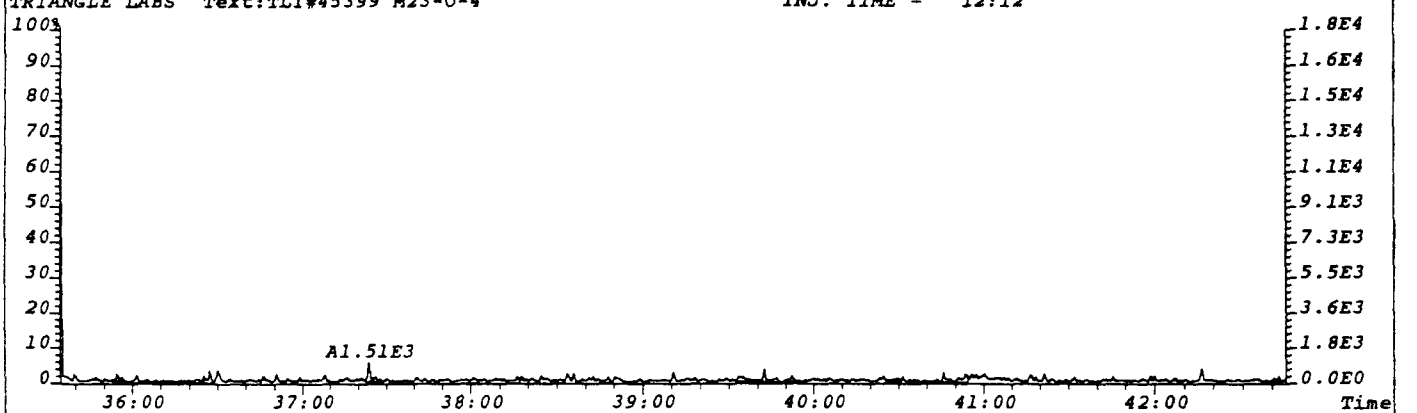
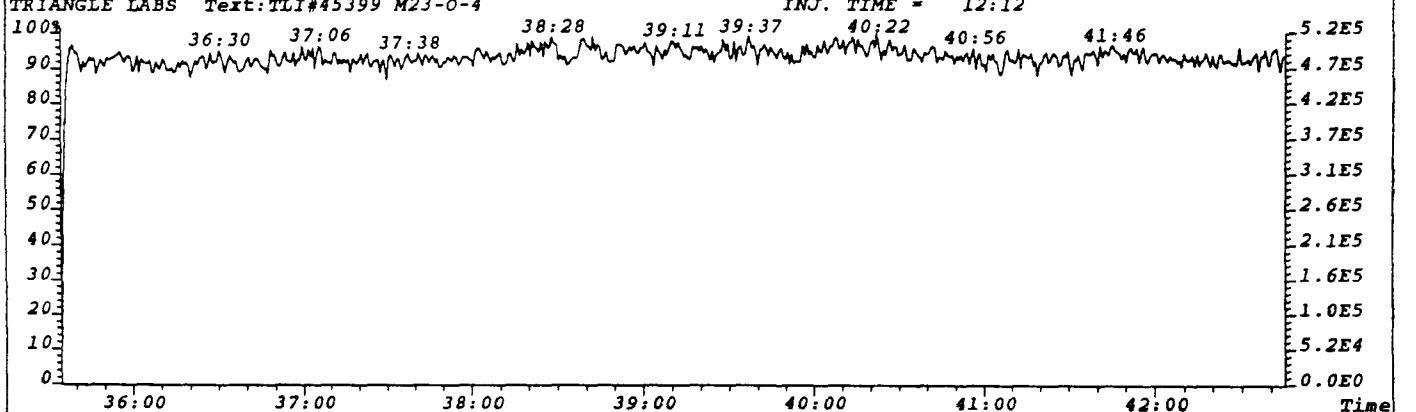
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:52
441.7428 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,208.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:50
443.7399 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,200.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



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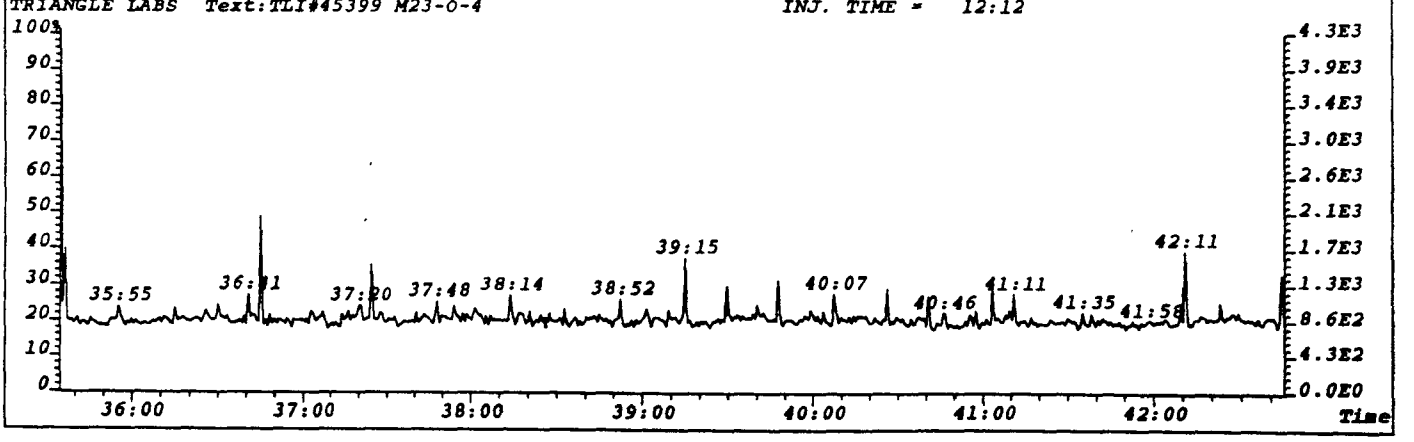
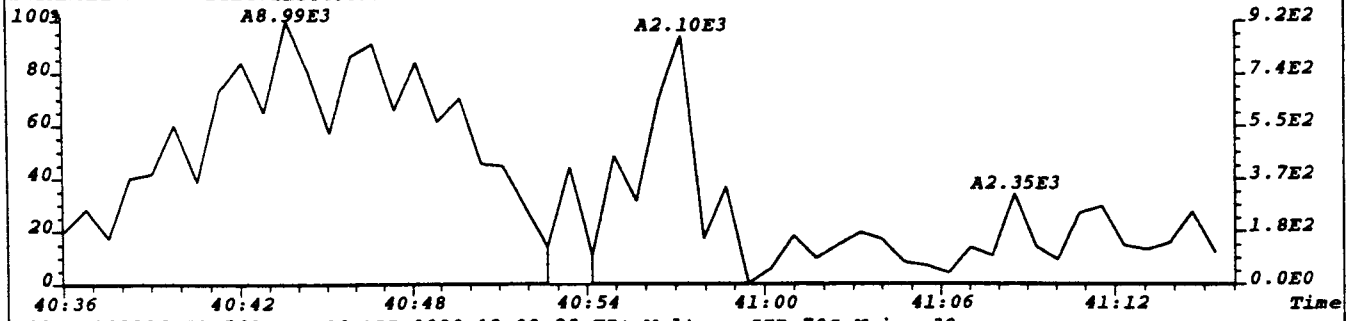
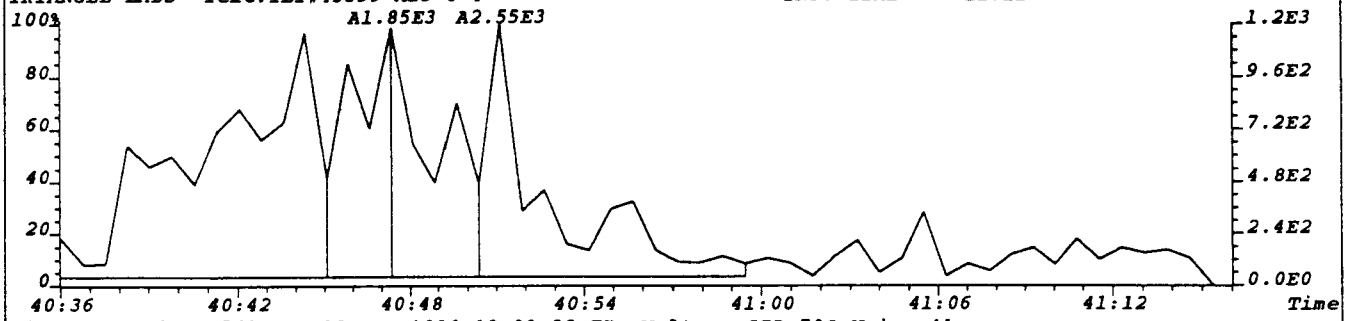
513.6775 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



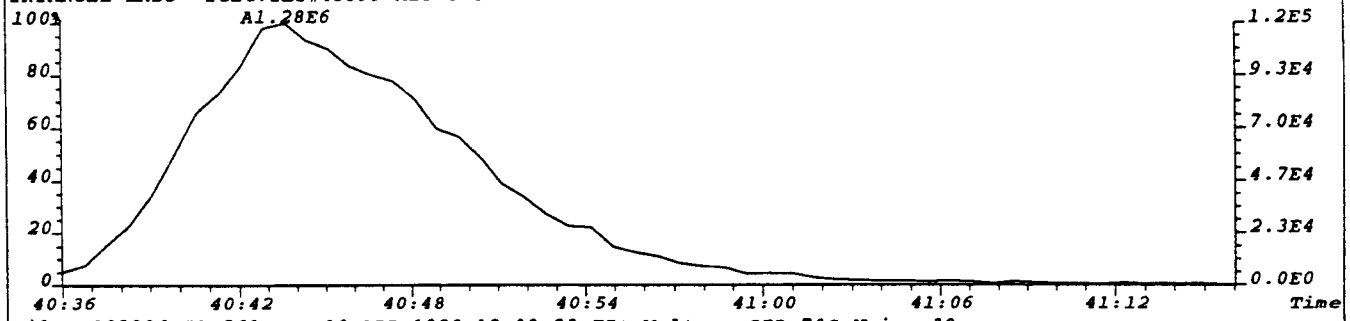
File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:37
457.7377 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,148.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:39
459.7348 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S Noise:41
469.7779 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,164.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



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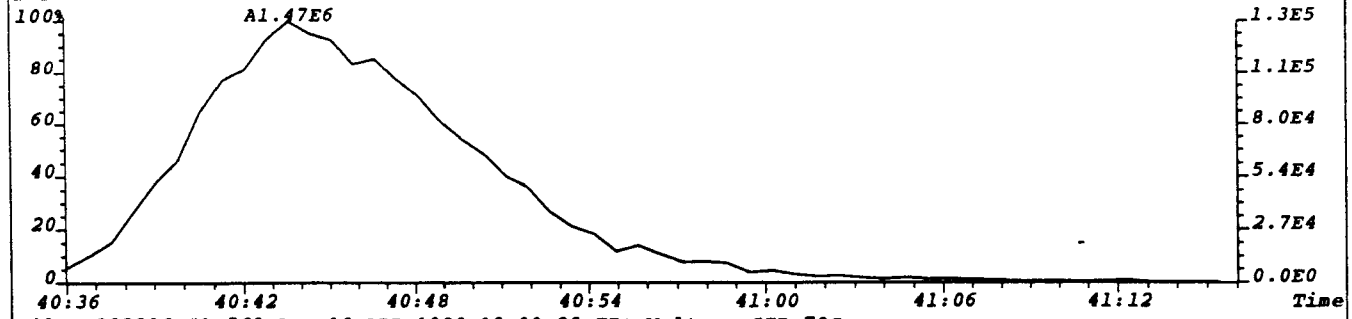
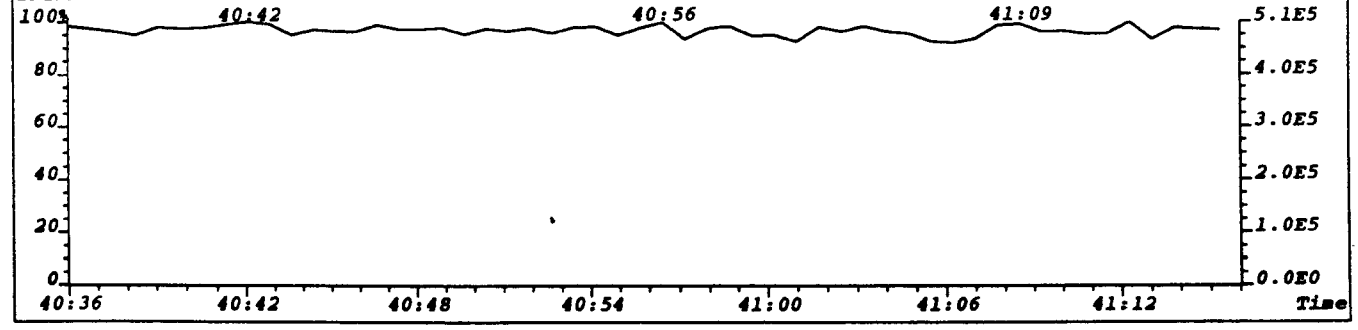
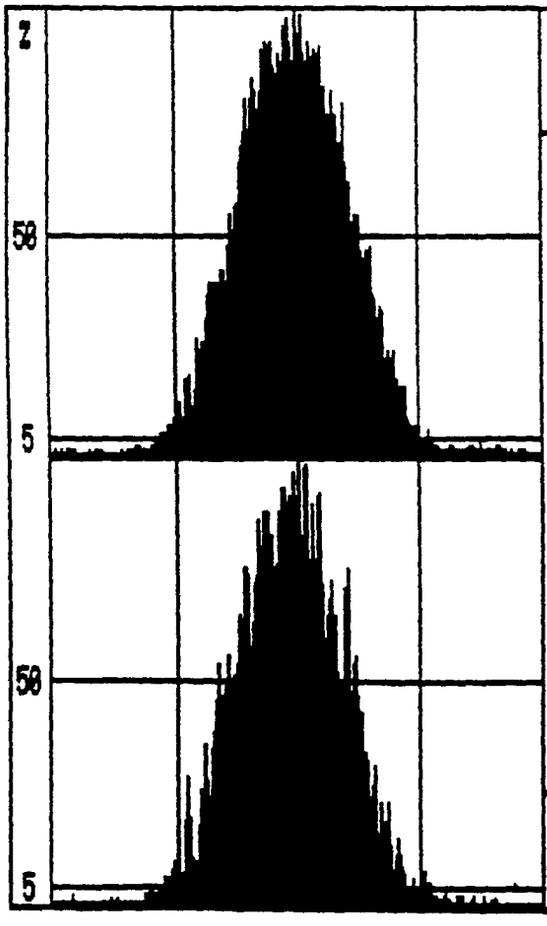
471.7750 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-0-4 INJ. TIME = 12:12



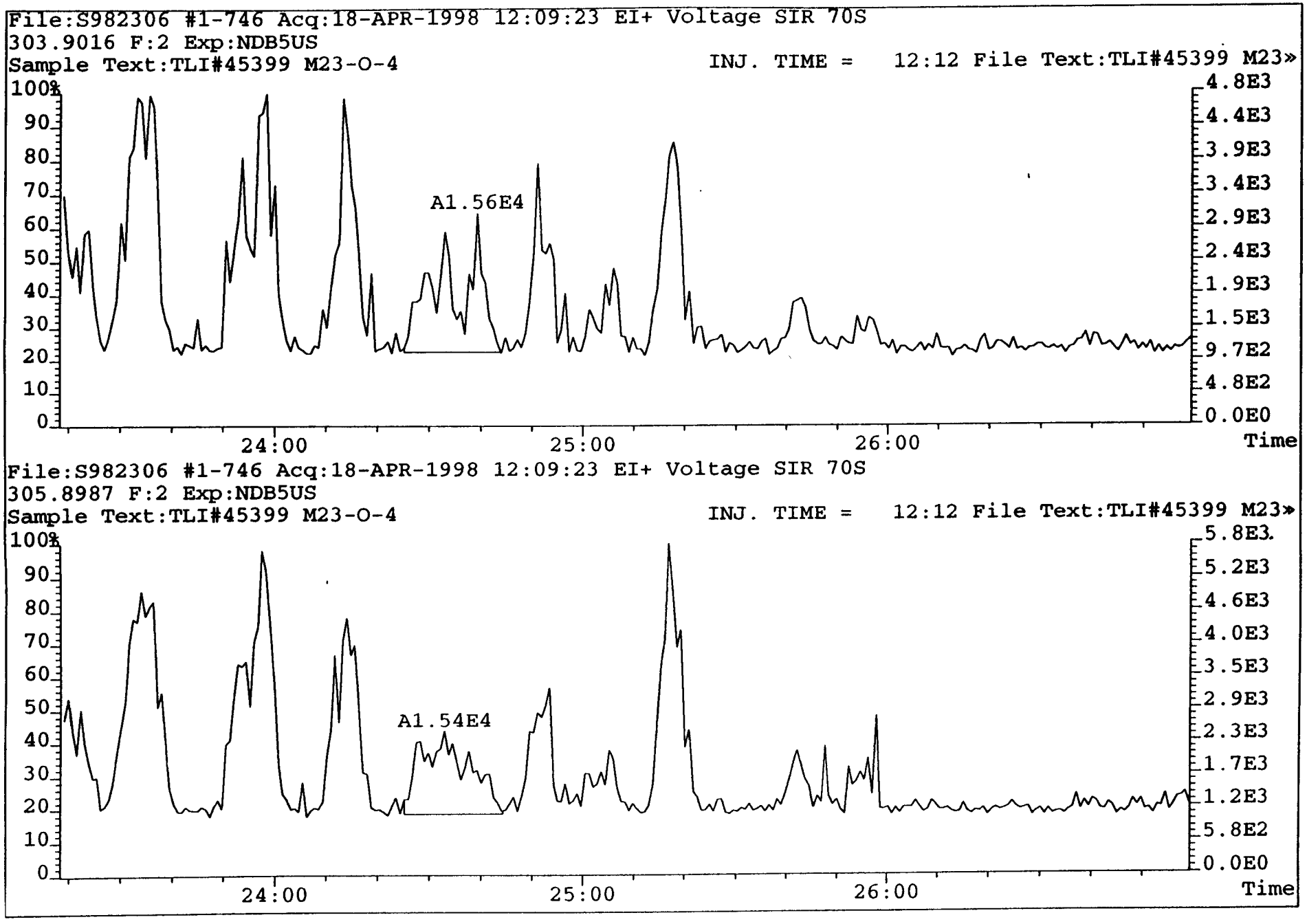


Channel I 330.9792 Peak top
Height .33 volts Span 200 ppm

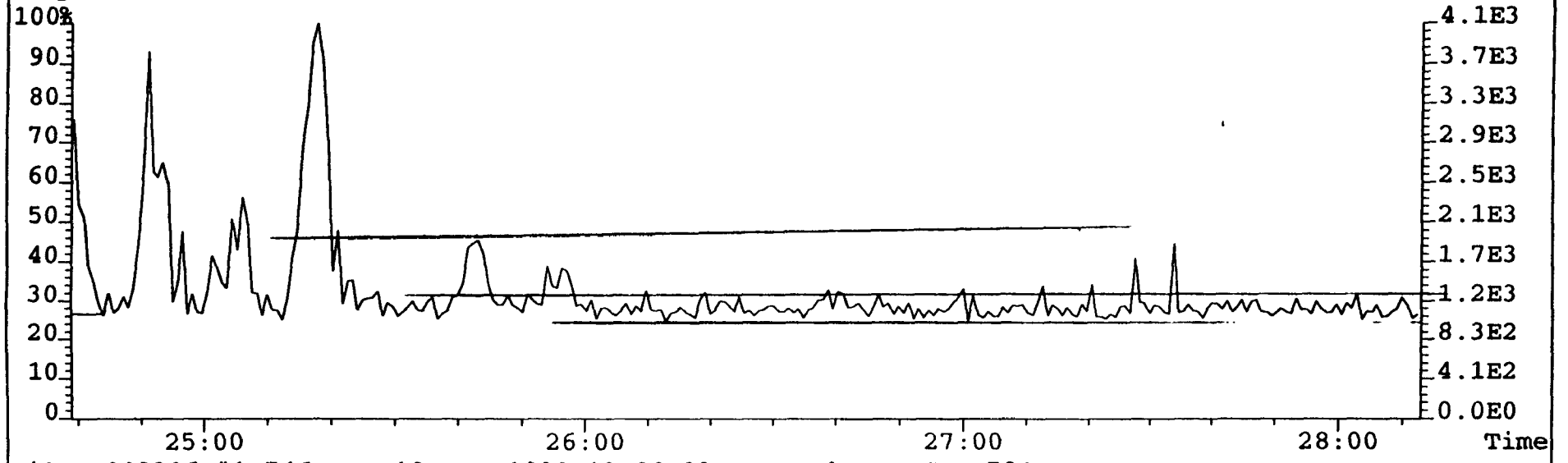
System file name ND85US
Data file name A:S982304
Resolution 10000
Group number 2
Ionization mode EI+
Switching VOLTAGE
Ref. masses 292.9825, 416.9760

A	293	J	331	S	368
B	304	K	332	T	370
C	306	L	334	U	376
D	316	M	340	V	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

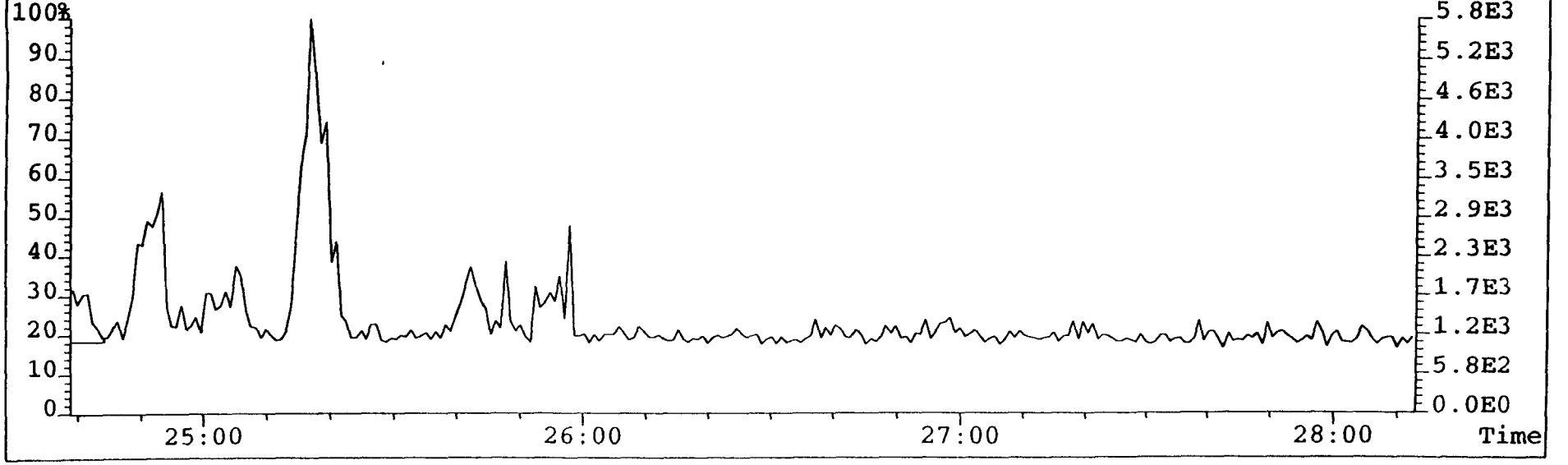
Ref. mass 416.9760 Peak top
Height .00 volts Span 200 ppm

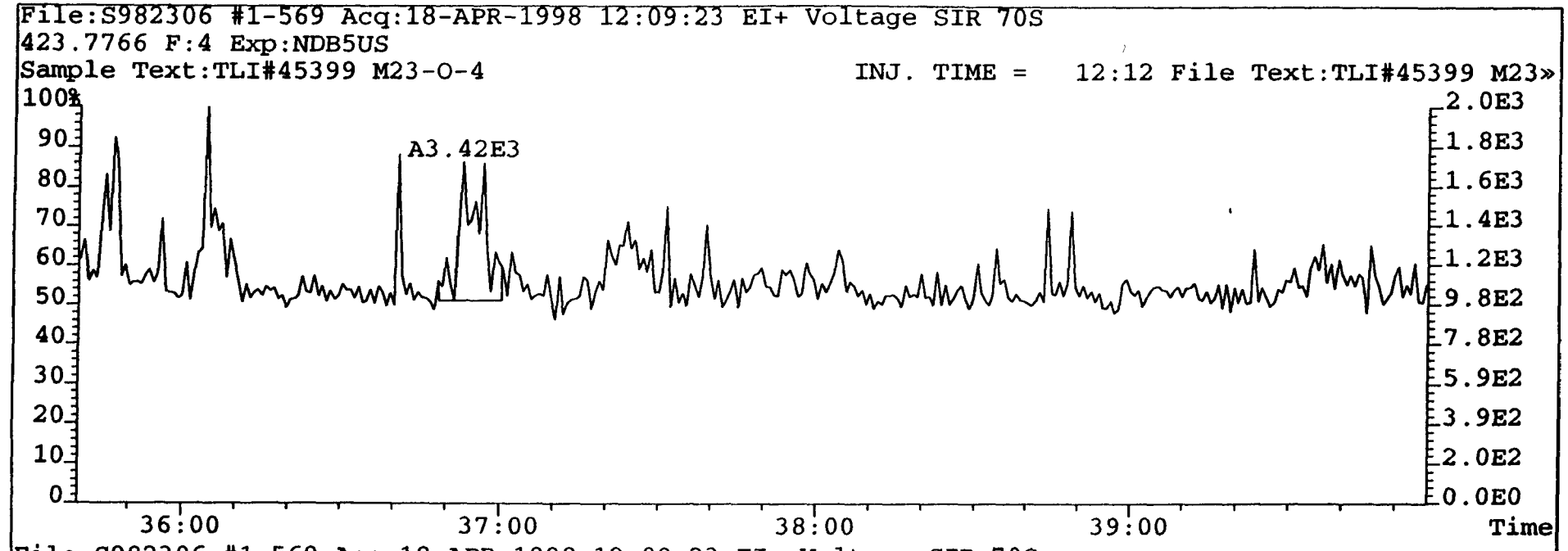

File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
303.9016 F:2 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4
INJ. TIME = 12:12 File Text:TLI#45399 M23»
A1.56E4
100%
90
80
70
60
50
40
30
20
10
0
4.8E3
4.4E3
3.9E3
3.4E3
2.9E3
2.4E3
1.9E3
1.5E3
9.7E2
4.8E2
0.0E0
24:00
25:00
26:00
Time
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
305.8987 F:2 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4
INJ. TIME = 12:12 File Text:TLI#45399 M23»
A1.54E4
100%
90
80
70
60
50
40
30
20
10
0
5.8E3
5.2E3
4.6E3
4.0E3
3.5E3
2.9E3
2.3E3
1.7E3
1.2E3
5.8E2
0.0E0
24:00
25:00
26:00
Time

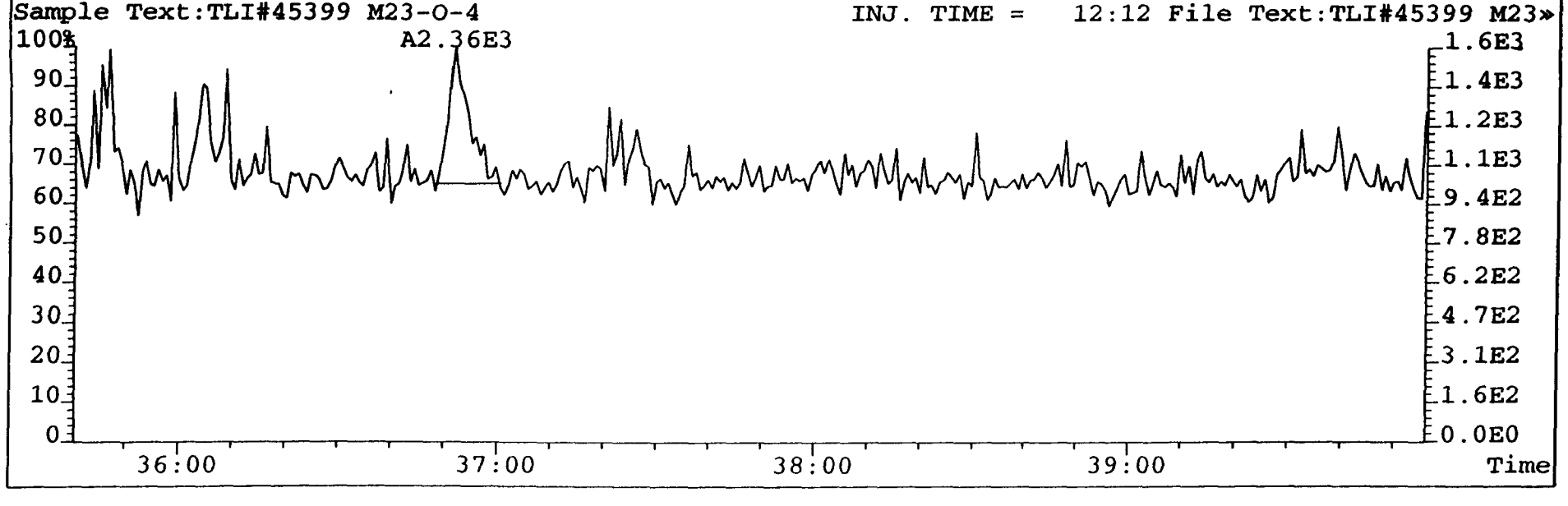
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
303.9016 F:2 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4 INJ. TIME = 12:12 File Text:TLI#45399 M23»



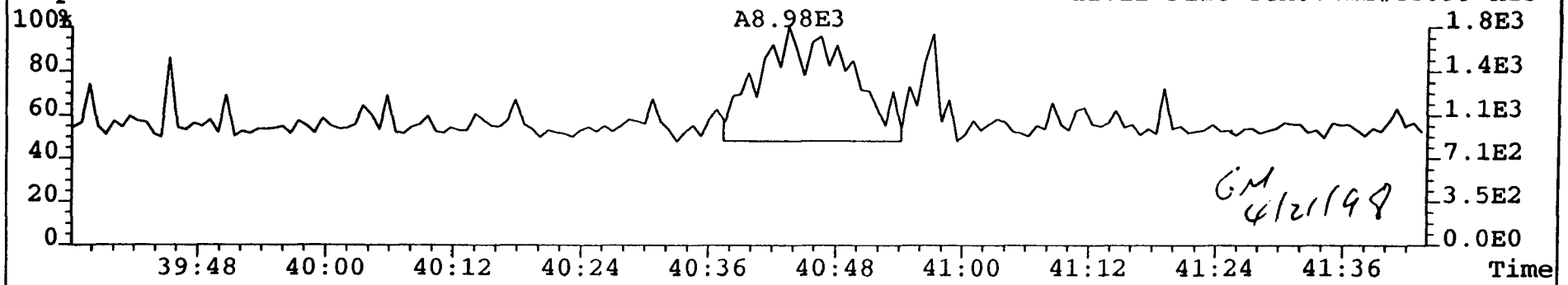
File:S982306 #1-746 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
305.8987 F:2 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4 INJ. TIME = 12:12 File Text:TLI#45399 M23»




File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
423.7766 F:4 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4
INJ. TIME = 12:12 File Text:TLI#45399 M23»
A3.42E3
100%
90
80
70
60
50
40
30
20
10
0
2.0E3
1.8E3
1.6E3
1.4E3
1.2E3
9.8E2
7.8E2
5.9E2
3.9E2
2.0E2
0.0E0
36:00
37:00
38:00
39:00
Time

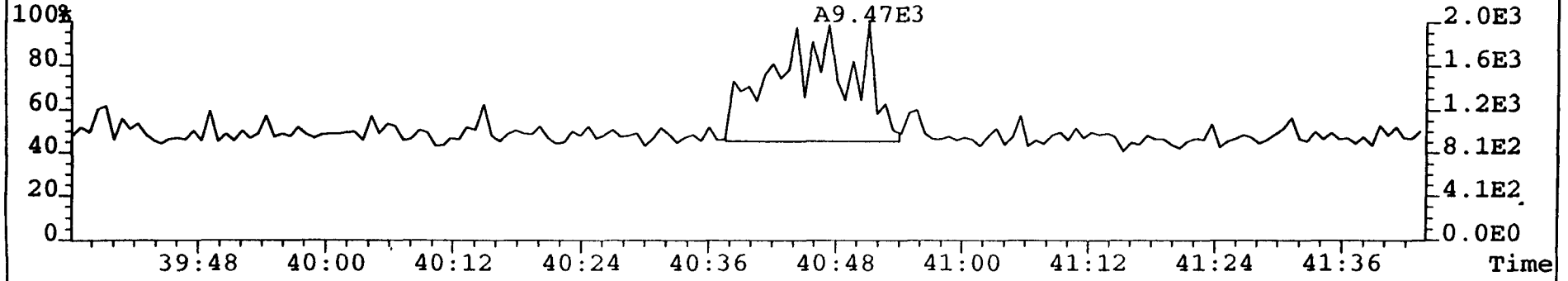

File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
425.7737 F:4 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4
INJ. TIME = 12:12 File Text:TLI#45399 M23»
A2.36E3
100%
90
80
70
60
50
40
30
20
10
0
1.6E3
1.4E3
1.2E3
1.1E3
9.4E2
7.8E2
6.2E2
4.7E2
3.1E2
1.6E2
0.0E0
36:00
37:00
38:00
39:00
Time

File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
457.7377 F:4 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4 INJ. TIME = 12:12 File Text:TLI#45399 M23»

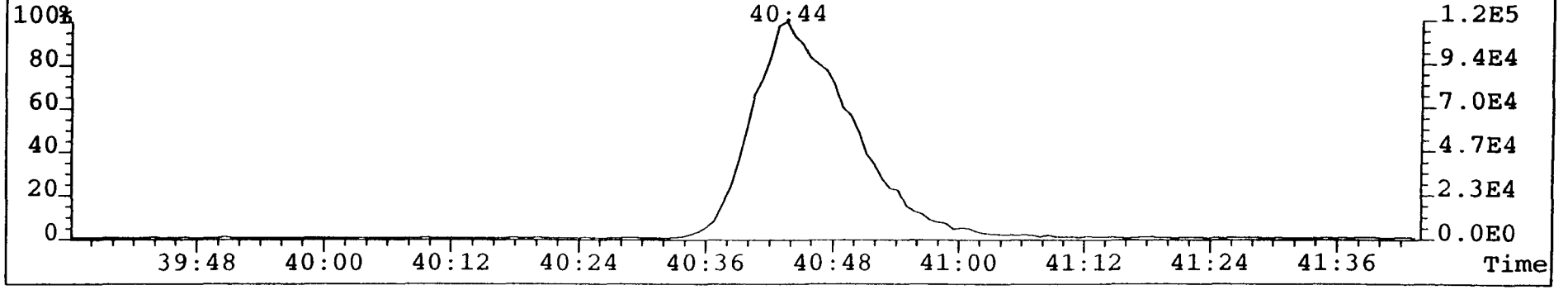


GM 4/21/98

File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
459.7348 F:4 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4 INJ. TIME = 12:12 File Text:TLI#45399 M23»



File:S982306 #1-569 Acq:18-APR-1998 12:09:23 EI+ Voltage SIR 70S
469.7779 F:4 Exp:NDB5US
Sample Text:TLI#45399 M23-O-4 INJ. TIME = 12:12 File Text:TLI#45399 M23»



Pacific Environmental Services

TLI Project: **45399** Method 23 TCDD/TCDF Analysis (DB-225)
Client Sample: **M23-O-4** Analysis File: **P981317**

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	M23	Date Received:	04/01/98	Spike File:	SPC2NF04
TLI ID:	204-92-8A-D	Date Extracted:	04/03/98	ICal:	PF24098
		Date Analyzed:	04/17/98	ConCal:	P981314
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-225	Analyst:	KB	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDF	ND	0.005				—

Internal Standard	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	3.0	75.5	40%-130%	0.76	22:23	—

Recovery Standard	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.80	21:16	—

Data Reviewer: KC 04/20/98

C2NF_PSR v2.02, LARS 6.11.00

Triangle Laboratories, Inc.®
801 Capitola Drive • Durham, North Carolina 27713

Printed: 21:29 04/20/98

Initial ....Date...

Data Review By: K 4/20/98 Calculated Noise Area: 0.11

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of P981317B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF						0.65-0.89				0.789-1.101			
304-306	DC	NL		0:00	RO	0.90	0.18			0.000			
				17:51		0.85	1.26	0.58	0.68	0.797			
	DC	SN		17:57	RO	3.00	0.04			0.802			
				18:50		0.66	1.33	0.53	0.80	0.841			
				18:59	RO	1.05	0.39	0.23	0.22	0.848			J
				19:06	RO	1.02	0.94	0.54	0.53	0.853			J
				19:17	RO	1.07	0.25	0.15	0.14	0.862			J
				19:33		0.85	0.50	0.23	0.27	0.873			J
				19:42		0.71	0.72	0.30	0.42	0.880			J
				20:01	RO	0.63	0.99	0.43	0.68	0.894			J
	DC	SN		20:06	RO	0.17	0.02			0.898			
	DC	SN		20:11	RO	0.47	0.18			0.902			
	DC	SN		20:31	RO	0.25	0.18			0.917			
				20:59	RO	0.42	0.34	0.15	0.36	0.937			J
				21:14		0.81	0.56	0.25	0.31	0.949			J
	DC	SN		22:15	RO	0.50	0.07			0.994			
	DC	SN		22:24	RO	1.78	0.16			1.001	2378-TCDF	AN	
304-306			10	Peaks			7.28						
13C12-TCDF						0.65-0.89				0.955-1.045			
316-318	DC	NL		0:00	RO	1.20	0.18			0.000			
	DC	WL		20:59	RO	0.58	0.44			0.937			
				22:23		0.76	225.41	97.46	127.95	1.000	13C12-2378-TCDF	IS0	
				23:02	RO	1.25	0.28	0.20	0.16	1.029			
	DC	WH		24:25		0.68	2.82			1.091			
316-318			2	Peaks			225.69						

---------- Above: TCDF / TCDD Follows ----------

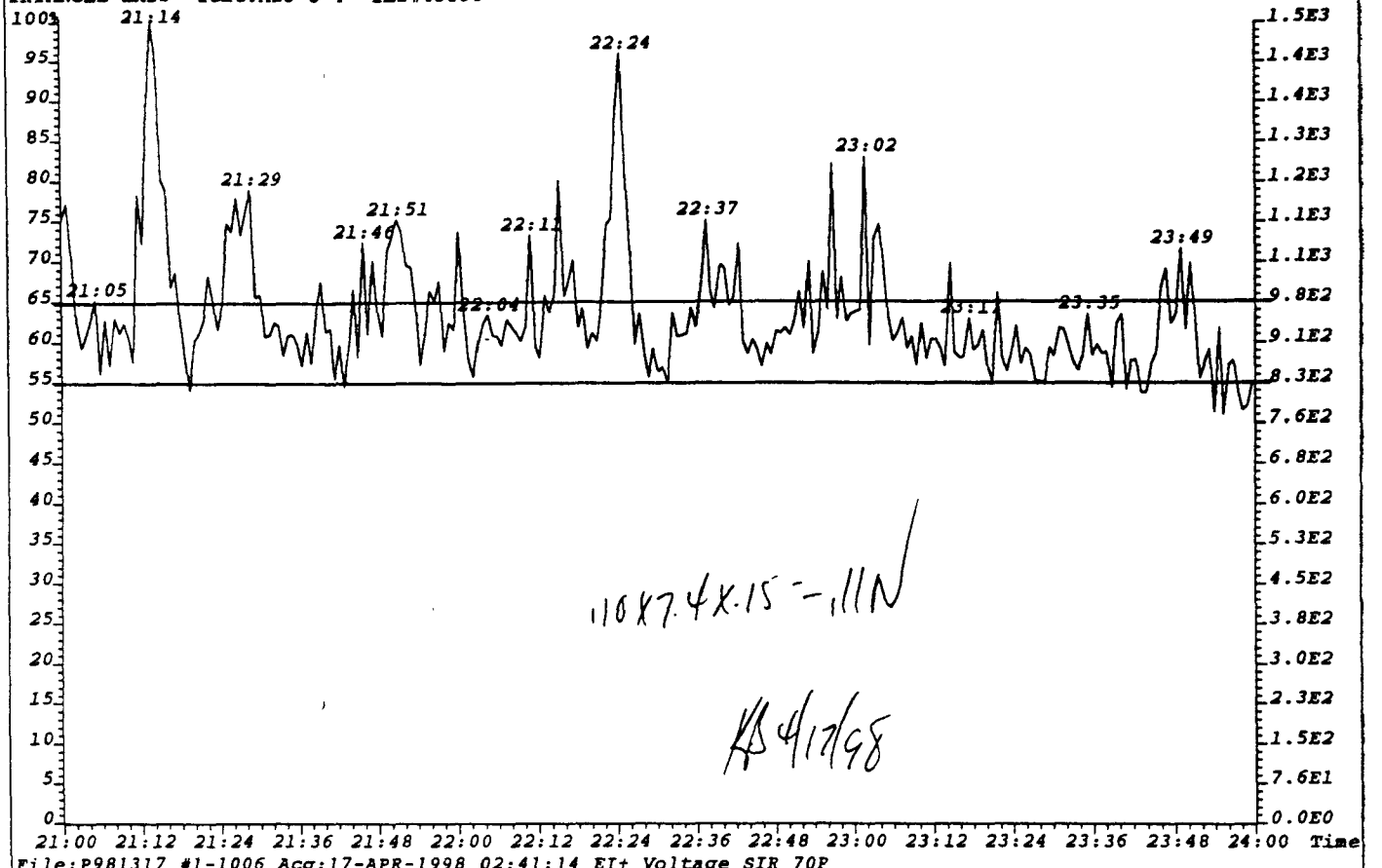
13C12-TCDD						0.65-0.89				0.905-1.095			
332-334	DC	NL		0:00	RO	1.22	0.16			0.000			
				19:53	RO	1.42	0.34	0.27	0.19	0.947			
				21:00		0.79	154.37	67.90	86.47	1.000	13C12-2378-TCDD	IS1	
				21:16		0.80	222.13	98.53	123.60	1.013	13C12-1234-TCDD	RS1	
				22:00	RO	0.97	1.08	0.59	0.61	1.048			
332-334			4	Peaks			377.92						

Compound/
M_Z.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

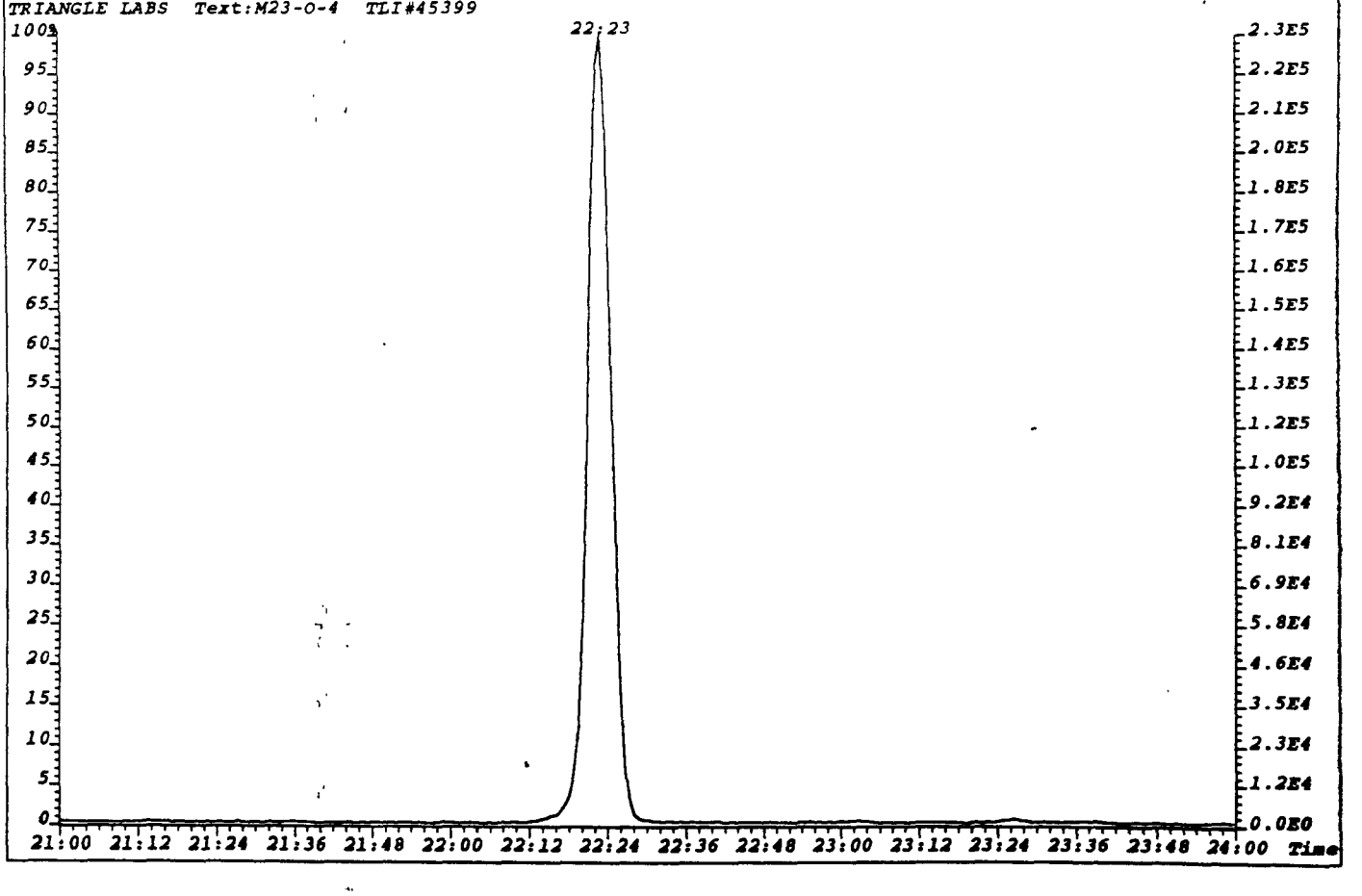
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:M23-0-4 TLI#45399



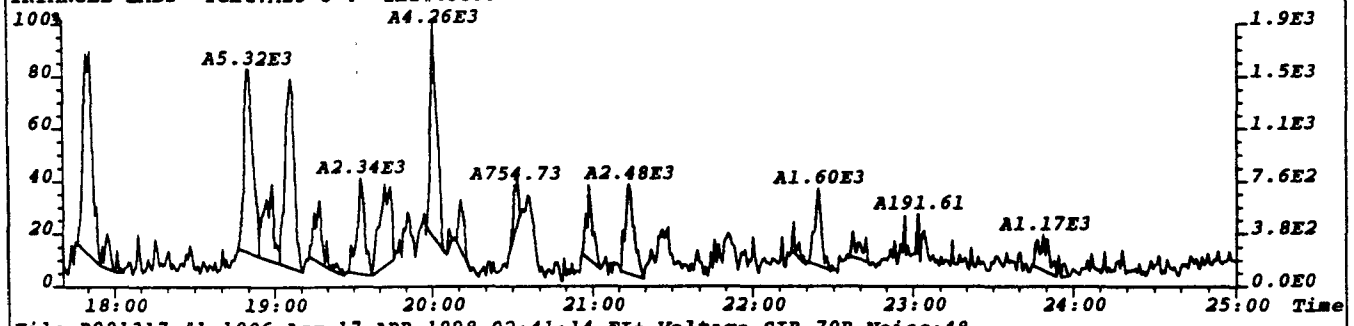
110X7.4X.15 = .111N

KS 4/17/98

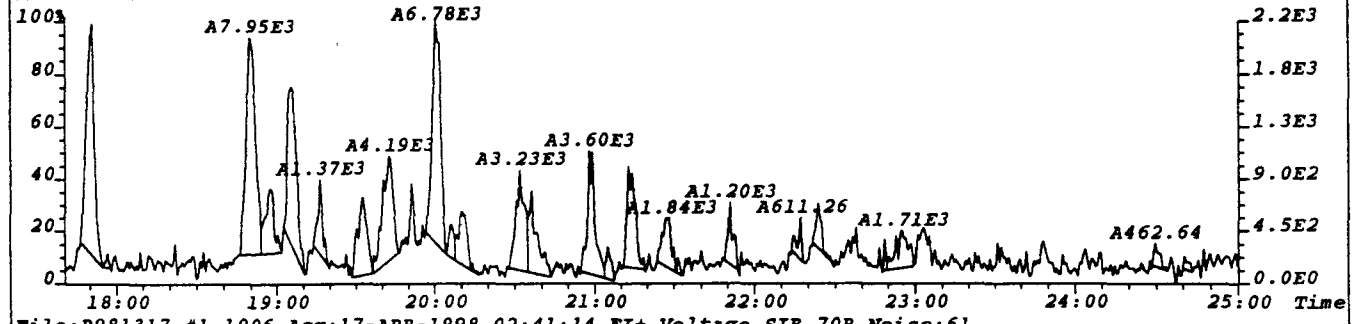
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:M23-0-4 TLI#45399



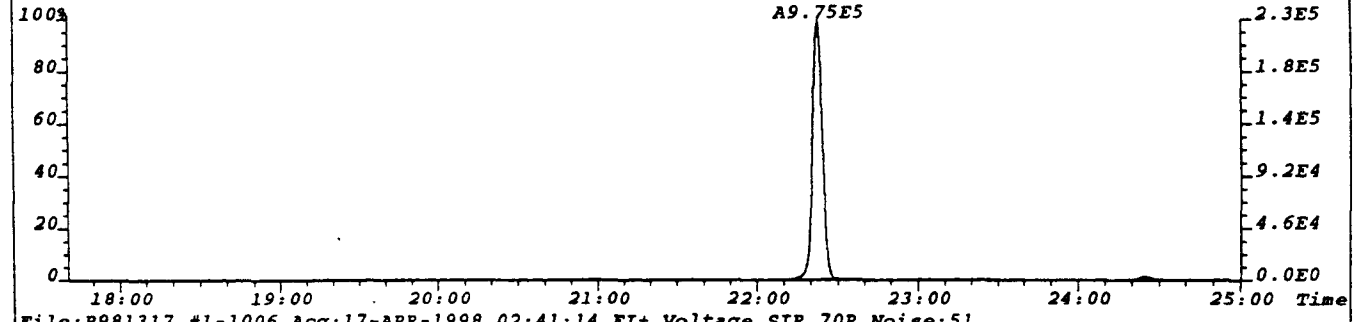
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:46
303.9016 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,184.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



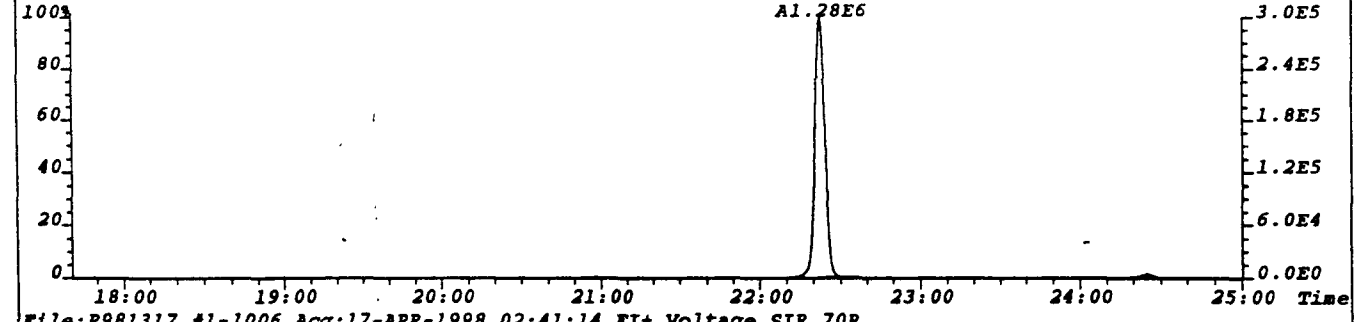
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:48
305.8987 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,192.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



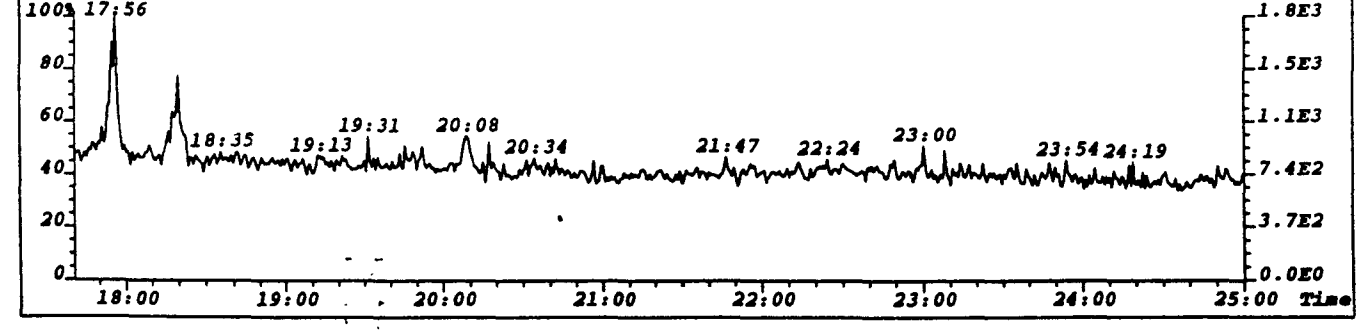
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:61
315.9419 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,244.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



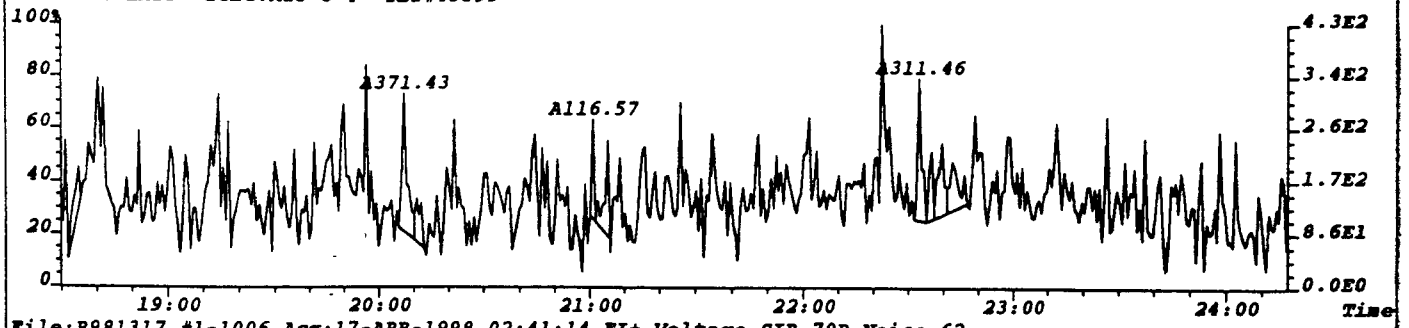
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:51
317.9389 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,204.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



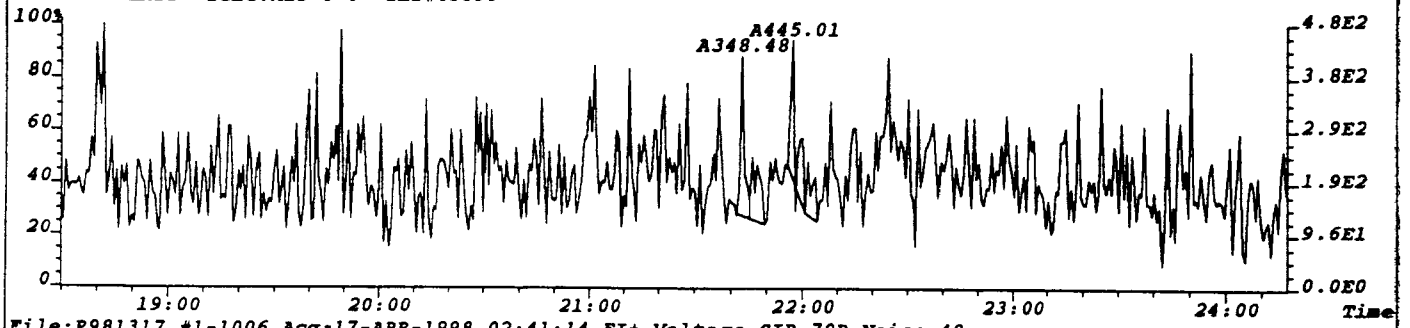
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
375.8364 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



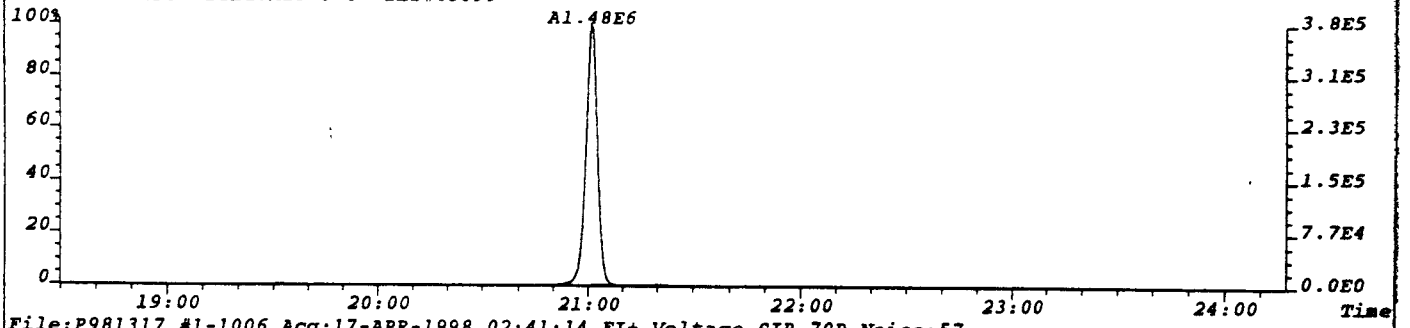
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:44
319.8965 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,176.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



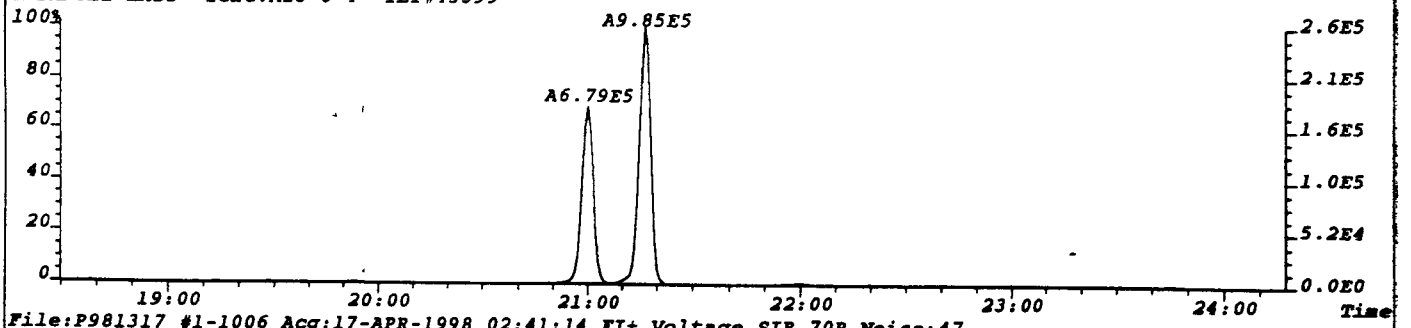
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:62
321.8936 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,248.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



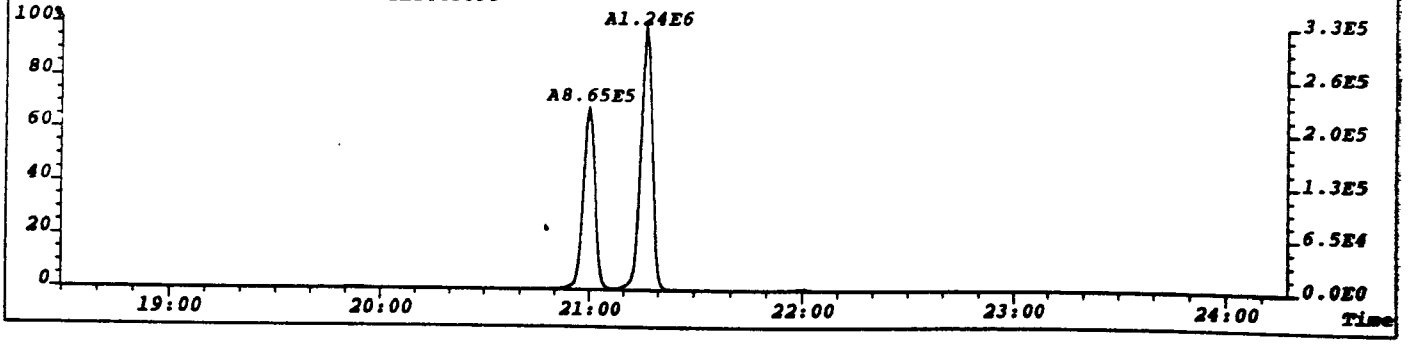
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:48
327.8847 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,192.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



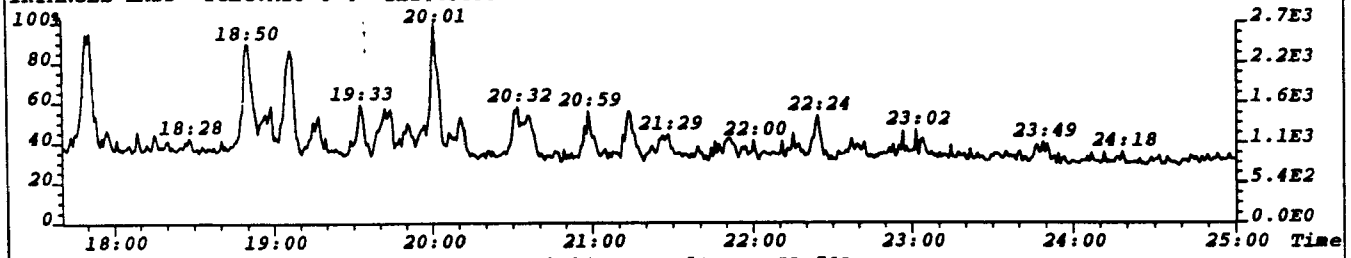
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:57
331.9368 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,228.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



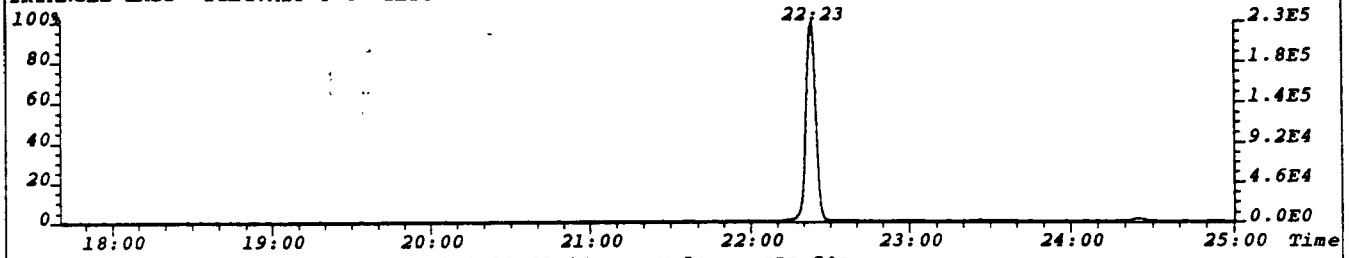
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P Noise:47
333.9338 BSUB(256,30,-3.0) PKD(5,3,1,0.10%,188.0,0.00%,F,F) Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



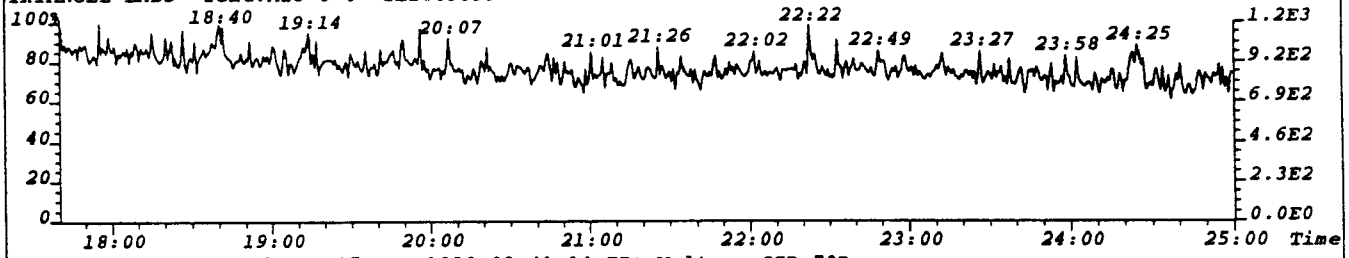
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
303.9016 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



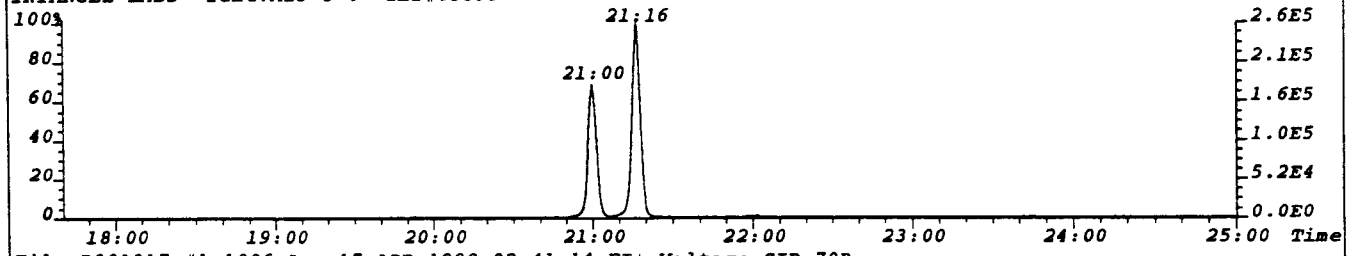
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
315.9419 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



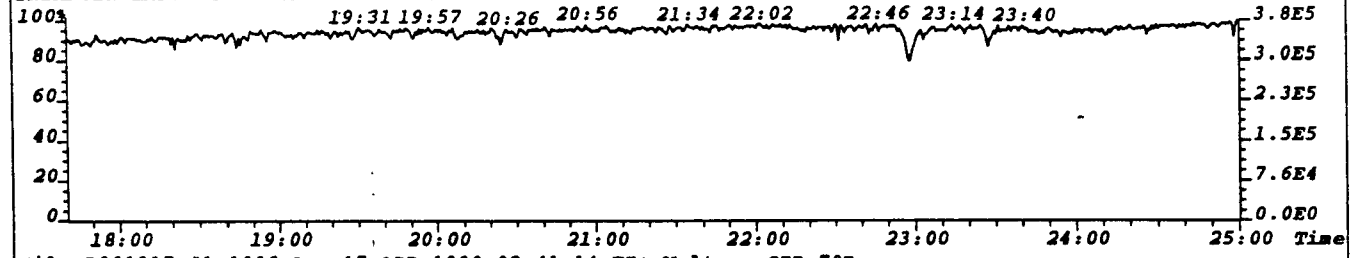
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
319.8965 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



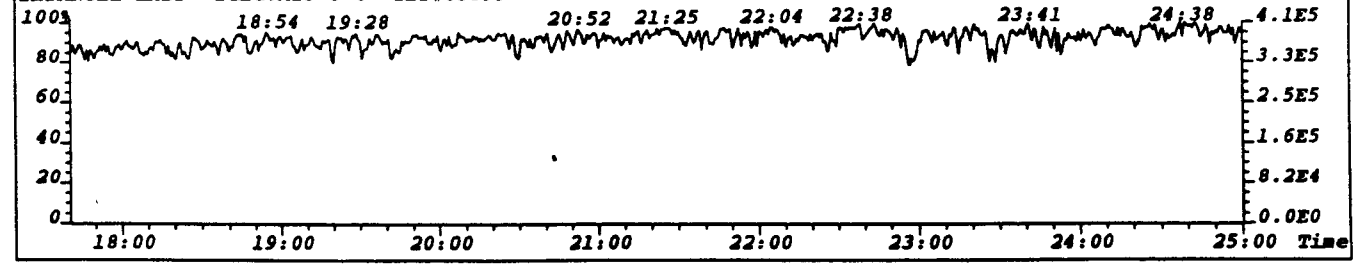
File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
331.9368 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399

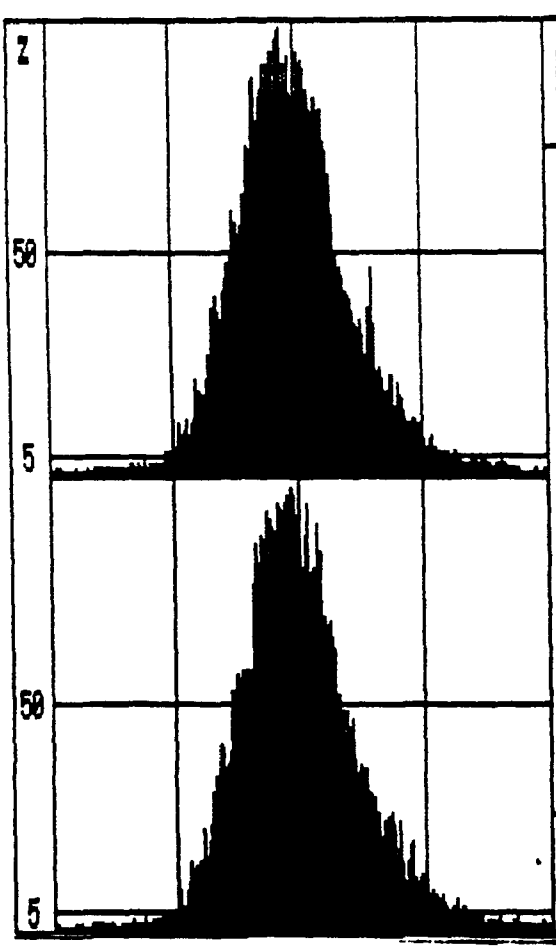


File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
292.9825 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399



File:P981317 #1-1006 Acq:17-APR-1998 02:41:14 EI+ Voltage SIR 70P
330.9792 Exp:DB225
TRIANGLE LABS Text:M23-O-4 TLI#45399





Ref. mass 292.9825 Peak top
Height .06 volts Span 200 ppm

System file name	D8225
Data file name	A:P971317
Resolution	10000
Group number	1
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 380.9761

A	292.9825	J	330.9792
B	303.9016	K	331.9368
C	305.8987	L	333.9338
D	315.9419	M	375.8364
E	317.9389		
F	319.8965		
G	321.8936		
H	327.8847		
I	330.9792		

Channel I 330.9792 Peak top
Height .06 volts Span 200 ppm

Pages 298 through 357 from the Triangle Laboratories, Inc. analytical report have been excluded by PES since these pages present results for samples collected at another lime kiln facility during the same mobilization.

Pacific Environmental Services

TLI Project: 45399
Client Sample: M23-RB-1-4

Method 23 PCDD/PCDF Analysis (a)
Analysis File: S982310

Client Project:	r012.002/Lime Kiln				
Sample Matrix:	M23	Date Received:	04/01/98	Spike File:	SPMIT204
TLI ID:	204-92-12A-D	Date Extracted:	04/03/98	ICal:	SF51078
		Date Analyzed:	04/18/98	ConCal:	S982303
Sample Size:	1.000	Dilution Factor:	n/a	% Moisture:	n/a
Dry Weight:	n/a	Blank File:	U980780	% Lipid:	n/a
GC Column:	DB-5	Analyst:	DL	% Solids:	n/a

Analytes	Amt. (ng)	DL	EMPC	Ratio	RT	Flags
2,3,7,8-TCDD	ND	0.003				—
1,2,3,7,8-PeCDD	ND	0.004				—
1,2,3,4,7,8-HxCDD	ND	0.004				—
1,2,3,6,7,8-HxCDD	ND	0.004				—
1,2,3,7,8,9-HxCDD	ND	0.004				—
1,2,3,4,6,7,8-HpCDD	ND	0.004				—
1,2,3,4,6,7,8,9-OCDD	ND	0.005				—
2,3,7,8-TCDF	ND	0.002				
1,2,3,7,8-PeCDF	ND	0.003				—
2,3,4,7,8-PeCDF	ND	0.003				—
1,2,3,4,7,8-HxCDF	ND	0.003				—
1,2,3,6,7,8-HxCDF	ND	0.003				—
2,3,4,6,7,8-HxCDF	ND	0.003				—
1,2,3,7,8,9-HxCDF	ND	0.003				—
1,2,3,4,6,7,8-HpCDF	ND	0.003				—
1,2,3,4,7,8,9-HpCDF	ND	0.004				—
1,2,3,4,6,7,8,9-OCDF	ND	0.004				—

Totals	Amt. (ng)	Number	DL	EMPC	Flags
Total TCDD	ND		0.003		
Total PeCDD	ND		0.004		—
Total HxCDD	ND		0.004		—
Total HpCDD	ND		0.004		—
Total TCDF	ND		0.002		
Total PeCDF	ND		0.003		—
Total HxCDF	ND		0.003		—
Total HpCDF	ND		0.004		—

MIT2_PSR v1.04, LARS 6.11.00

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801 Capitola Drive • Durham, North Carolina 27713
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Printed: 20:28 04/20/98

TLI Project: 45399
Client Sample: M23-RB-1-4

Method 23 PCDD/PCDF Analysis (a)
Analysis File: S982310

Internal Standards	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,7,8-TCDF	2.6	66.0	40%-130%	0.71	25:14	—
$^{13}C_{12}$-2,3,7,8-TCDD	2.4	59.9	40%-130%	0.80	25:57	—
$^{13}C_{12}$-1,2,3,7,8-PeCDF	2.5	62.5	40%-130%	1.57	29:10	—
$^{13}C_{12}$-1,2,3,7,8-PeCDD	3.0	76.1	40%-130%	1.48	30:13	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	3.3	81.6	40%-130%	0.50	32:44	—
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	3.9	97.6	40%-130%	1.21	33:27	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	3.3	82.8	25%-130%	0.42	35:44	—
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	4.0	101	25%-130%	1.01	36:52	—
$^{13}C_{12}$-1,2,3,4,6,7,8,9-OCDD	9.2	115	25%-130%	0.85	40:42	—

Surrogate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-2,3,4,7,8-PeCDF	4.0	101	40%-130%	1.53	29:52	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	3.3	82.5	40%-130%	0.50	32:38	—
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	3.3	82.5	40%-130%	1.20	33:22	—
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	3.8	95.2	25%-130%	0.43	37:22	—

Other Standard	Amt. (ng)	% Recovery	QC Limits	RT	Flags
$^{37}Cl_4$-2,3,7,8-TCDD	3.4	83.8	40%-130%	25:58	—

Alternate Standards (Type A)	Amt. (ng)	% Recovery	QC Limits	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	3.5	87.7	40%-130%	0.51	34:03	—
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	3.6	89.1	40%-130%	0.50	33:15	—

Recovery Standards	Ratio	RT	Flags
$^{13}C_{12}$-1,2,3,4-TCDD	0.79	25:46	—
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	1.19	33:47	—

Data Reviewer: Ku 04/20/98

MIT2_PSR v1.04, LARS 6.11.0

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Phone: (919) 544-5729 • Fax: (919) 544-5491

Printed: 20:28 04/20/98

Initial ....Date...

Data Review By: K 4/20/98 Calculated Noise Area: 0.10

The Total Area for each peak with an ion abundance ratio outside ratio limits has been recalculated according to method requirements.

Page No. 1 Listing of S982310B.dbf
04/20/98 Matched GC Peaks / Ratio / Ret. Time

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
TCDF				0.65-0.89						0.873-1.075			
304-306	DC	NL		0:00	RO	1.23	0.23			0.000			
304-306		0	Peaks				0.00						
13C12-TCDF				0.65-0.89						0.960-1.040			
316-318	DC	NL		0:00	RO	1.00	0.28			0.000			
	DC	WL		23:15	RO	1.46	0.42			0.921			
	DC	WL		24:12		0.71	12.07			0.959			
				24:31		0.88	1.05	0.49	0.56	0.972			
				24:50		0.71	3.00	1.25	1.75	0.984			
				25:14		0.71	434.08	180.06	254.02	1.000	13C12-2378-TCDF	ISO	
				25:40		0.86	1.90	0.88	1.02	1.017			
316-318		4	Peaks				440.03						

---------- Above: TCDF / TCDD Follows ----------

TCDD				0.65-0.89						0.899-1.046			
320-322	DC	NL		0:00	RO	0.90	0.18			0.000			
	DC	SN		23:26	RO	4.00	0.04			0.903			
	DC	SN		23:34	RO	0.43	0.07			0.908			
	DC	SN		23:43		0.67	0.10			0.914			
	DC	SN		23:53	RO	0.40	0.05			0.920			
	DC	SN		24:12		0.83	0.11			0.933			
	DC	SN		24:26	RO	0.18	0.07			0.942			
D	d	SN		24:46	RO	1.00	0.39			0.954			
	DC	SN		25:30	RO	1.20	0.09			0.983			
	DC	SN		25:44	RO	3.75	0.07			0.992			
	DC	SN		25:59	RO	0.37	0.16			1.001	2378-TCDD	AN	
320-322		0	Peaks				0.00						
37Cl-TCDD										0.923-1.077			
328	DC	NL		0:00			0.13			0.000			
				24:35			1.40	1.40		0.947			
	DC	SN		25:07			0.12			0.968			
				25:58			240.64	240.64		1.001	37Cl-TCDD	CLS	
				26:10			0.28	0.28		1.008			
				27:27			0.16	0.16		1.058			
328		4	Peaks				242.48						
13C12-TCDD				0.65-0.89						0.923-1.077			
332-334	DC	NL		0:00	RO	1.27	0.27			0.000			
				24:46	RO	0.94	1.54	0.82	0.87	0.954			
				25:46		0.79	458.13	202.61	255.52	0.993	13C12-1234-TCDD	RS1	
				25:57		0.80	302.52	134.10	168.42	1.000	13C12-2378-TCDD	IS1	

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
				26:17		0.89	4.44	2.09	2.35	1.013			
332-334			4	Peaks			766.63						

---------- Above: TCDD / PeCDF Follows ----------

PeCDF					1.32-1.78					0.928-1.063			
340-342	DC	NL		0:00	RO	1.00	0.13			0.000			
	DC	SN		29:20		1.75	0.11			1.006			
	DC	SN		29:30	RO	0.17	0.12			1.011			
	DC	SN		29:39	RO	0.50	0.05			1.017			
	DC	SN		29:45	RO	0.60	0.10			1.020			
	DC	SN		29:54	RO	0.73	0.13			1.025	23478-PeCDF		AN
	DC	SN		30:08	RO	0.38	0.05			1.033			
340-342			0	Peaks			0.00						
13C12-PeCDF					1.32-1.78					0.863-1.137			
352-354	DC	NL		0:00	RO	1.11	0.16			0.000			
				28:19		1.51	18.55	11.15	7.40	0.971			
				28:47	RO	1.80	0.89	0.63	0.35	0.987			
				29:10		1.57	308.06	188.06	120.00	1.000	13C12-PeCDF 123		IS2
				29:20	RO	0.89	1.28	0.78	0.88	1.006			
				29:27		1.34	2.78	1.59	1.19	1.010			
				29:52		1.53	301.10	182.19	118.91	1.024	13C12-PeCDF 234		SUR1
				30:14	RO	1.09	0.41	0.25	0.23	1.037			
				30:49	RO	1.00	0.92	0.56	0.56	1.057			
352-354			8	Peaks			633.99						

---------- Above: PeCDF / PeCDD Follows ----------

PeCDD					1.32-1.78					0.937-1.022			
356-358	DC	NL		0:00	RO	1.00	0.13			0.000			
	DC	SN		29:37	RO	2.00	0.13			0.980			
	DC	SN		29:49	RO	1.22	0.18			0.987			
356-358			0	Peaks			0.00						
13C12-PeCDD					1.32-1.78					0.868-1.132			
368-370	DC	NL		0:00	RO	0.89	0.13			0.000			
				29:07	RO	1.00	0.48	0.29	0.29	0.964			
				29:17	RO	2.74	0.59	0.63	0.23	0.969			
				30:13		1.48	208.19	124.24	83.95	1.000	13C12-PeCDD 123		IS3
				30:20		1.44	17.71	10.45	7.26	1.004			
	DC	SN		30:45	RO	2.11	0.23			1.018			
368-370			4	Peaks			226.97						

---------- Above: PeCDD / HxCDF Follows ----------

HxCDF					1.05-1.43					0.963-1.048			
374-376	DC	NL		0:00	RO	0.90	0.16			0.000			
	DC	SN		31:50	RO	2.00	0.16			0.973			
	DC	SN		32:15	RO	0.67	0.04			0.985			
	DC	SN		32:20	RO	0.33	0.02			0.988			
	DC	SN		33:02	RO	1.50	0.04			1.009			

Compound/ M_Z....	QC.Log	Omit	Why	..RT.	OK	Ratio	Total.Area...	Area.Peak.1..	Area.Peak.2..	Rel.RT	Compound.Name..	ID..	Flags.
	DC	SN		33:05		1.38	0.19			1.011			
	DC	WH		34:34	RO	0.40	0.04			1.056			
	DC	WH		34:38	RO	3.50	0.04			1.058			
374-376			0	Peaks			0.00						
13C12-HxCDF				0.43-0.59						0.878-1.122			
384-386	DC	NL		0:00	RO	0.87	0.23			0.000			
				31:40	RO	0.60	3.47	1.37	2.30	0.967			
				31:47		0.54	6.79	2.39	4.40	0.971			
				32:38		0.50	254.40	84.46	169.94	0.997	13C12-HxCDF 478	SUR2	
				32:44		0.50	303.42	101.46	201.96	1.000	13C12-HxCDF 678	IS4	
	DC	SN		32:58	RO	0.23	0.18			1.007			
	DC	SN		33:01	RO	0.27	0.09			1.009			
	DC	SN		33:03	RO	0.18	0.18			1.010			
				33:15		0.50	327.85	109.60	218.25	1.016	13C12-HxCDF 234	ALT2	
				33:29	RO	0.42	0.56	0.19	0.45	1.023			
	DC	SN		33:32	RO	0.69	0.20			1.024			
				34:03		0.51	259.19	87.04	172.15	1.040	13C12-HxCDF 789	ALT1	
				34:22	RO	0.67	0.32	0.14	0.21	1.050			
384-386			8	Peaks			1,156.00						

---------- Above: HxCDF / HxCDD Follows ----------

HxCDD				1.05-1.43						0.958-1.014			
390-392	DC	NL		0:00		1.29	0.16			0.000			
	DC	SN		32:26	RO	3.00	0.04			0.970			
	DC	SN		32:34	RO	1.00	0.07			0.974			
D	d	SN		32:38	RO	1.00	0.25			0.976			
	DC	SN		32:43	RO	2.13	0.18			0.978			
	DC	SN		32:49		1.20	0.22			0.981			
	DC	SN		32:58	RO	0.60	0.05			0.986			
	DC	SN		33:03	RO	0.70	0.13			0.988			
	DC	SN		33:09	RO	0.75	0.05			0.991			
	DC	SN		33:17	RO	2.44	0.20			0.995			
390-392			0	Peaks			0.00						
13C12-HxCDD				1.05-1.43						0.970-1.030			
402-404	DC	NL		0:00	RO	1.56	0.20			0.000			
				32:50	RO	1.46	1.57	1.02	0.70	0.982			
				33:22		1.20	199.35	108.74	90.61	0.998	13C12-HxCDD 478	SUR3	
				33:27		1.21	262.94	143.85	119.09	1.000	13C12-HxCDD 678	IS5	
				33:47		1.19	291.63	158.76	132.87	1.010	13C12-HxCDD 789	RS2	
				34:01		1.39	0.86	0.50	0.36	1.017			
				34:13	RO	1.94	0.38	0.33	0.17	1.023			
402-404			6	Peaks			756.73						

---------- Above: HxCDD / HpCDF Follows ----------

HpCDF				0.88-1.20						0.997-1.051			
408-410	DC	NL		0:00	RO	0.81	0.26			0.000			
	DC	SN		35:50	RO	2.75	0.08			1.003			
D	d	SN		35:55		0.90	0.40			1.005			

```
Compound/
M_2.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

408-410                0 Peaks                  0.00

13C12-HpCDF                     0.37-0.51                                    0.944-1.112
418-420          DC  NL   0:00 RO  0.93         0.22                              0.000
                         35:44     0.42       204.45        60.09       144.36  1.000 13C12-HpCDF 678 IS6
                         36:07 RO  0.95         0.32         0.21         0.22  1.011
                         37:22     0.43       155.83        46.84       108.99  1.046 13C12-HpCDF 789 SUR4
418-420                3 Peaks                360.60

                 --------------------- Above: HpCDF / HpCDD Follows --------------------

HpCDD                           0.88-1.20                                    0.976-1.005
424-426          DC  NL   0:00 RO  1.25         0.16                              0.000
                 DC  SN  36:13 RO  4.50         0.04                              0.982
                 DC  SN  37:02 RO  0.67         0.08                              1.005
424-426                0 Peaks                  0.00

13C12-HpCDD                     0.88-1.20                                    0.973-1.027
436-438          DC  NL   0:00     1.14         0.30                              0.000
                         36:04     0.94         2.41         1.17         1.24  0.978
                         36:52     1.01       217.46       109.39       108.07  1.000 13C12-HpCDD 678 IS7
436-438                2 Peaks                219.87

                 --------------------- Above: HpCDD / Octa-CDD and CDF Follows ----------

OCDF                            0.76-1.02                                    0.902-1.098
442-444          DC  NL   0:00     1.00         0.16                              0.000
                 DC  WL  36:37 RO  0.75         0.19                              0.900
                 DC  SN  37:50 RO  0.75         0.13                              0.930
                 DC  SN  37:55 RO  3.50         0.04                              0.932
                 DC  SN  38:01 RO  1.67         0.17                              0.934
                 DC  SN  38:38 RO  0.40         0.04                              0.949
                 DC  SN  38:43 RO  2.00         0.09                              0.951
                 DC  SN  38:50 RO  0.19         0.06                              0.954
                 DC  SN  39:08 RO  0.71         0.11                              0.962
                 DC  SN  39:15 RO  0.10         0.02                              0.964
                 DC  SN  39:18 RO  0.31         0.08                              0.966
442-444                0 Peaks                  0.00

OCDD                            0.76-1.02                                    0.902-1.098
458-460          DC  NL   0:00     1.00         0.16                              0.000
                 DC  SN  40:41 RO  6.50         0.04                              1.000 OCDD            AN
                 DC  SN  40:54 RO  0.75         0.06                              1.005
                 DC  SN  40:54 RO  0.43         0.06                              1.005
                 DC  SN  41:06 RO  0.50         0.08                              1.010
                 DC  SN  41:12 RO  0.50         0.02                              1.012
458-460                0 Peaks                  0.00

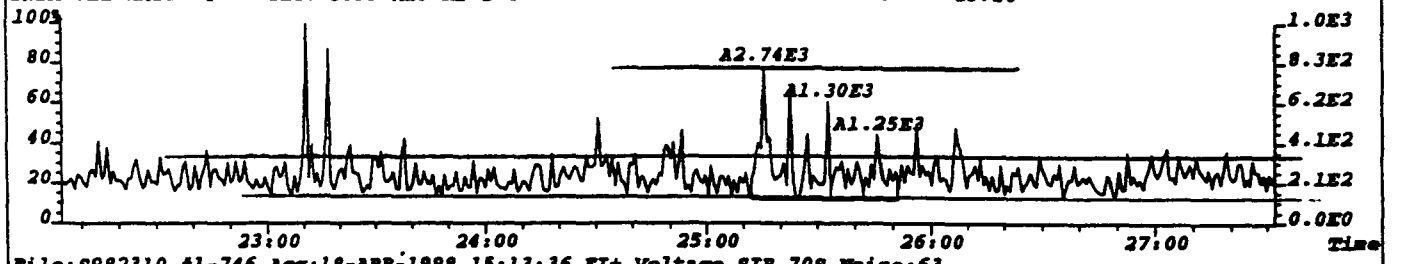
13C12-OCDD                      0.76-1.02                                    0.996-1.004
470-472          DC  NL   0:00 RO  1.13         0.15                              0.000
                         40:42     0.85       337.69       154.89       182.80  1.000 13C12-OCDD      IS8
470-472                1 Peak                 337.69
```

Compound/
M_Z.... QC.Log Omit Why ..RT. OK Ratio Total.Area... Area.Peak.1.. Area.Peak.2.. Rel.RT Compound.Name.. ID.. Flags.

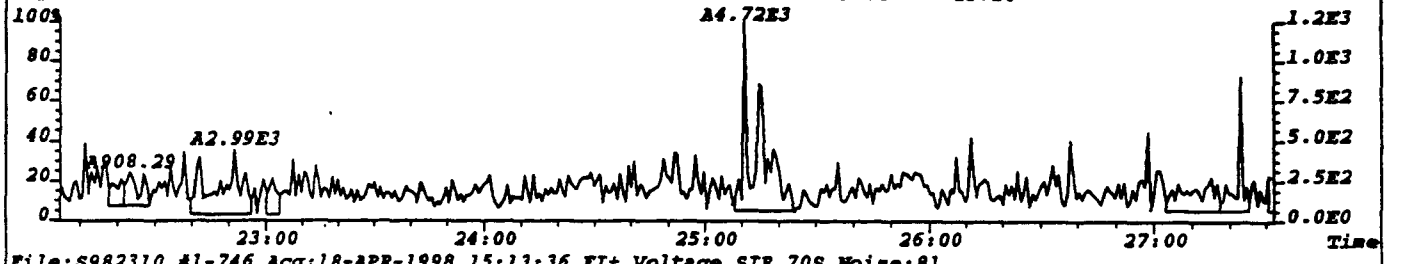
Column Description.....	"Why" Code Description.....	QC Log Desc.....
M_Z -Nominal Ion Mass(es)	WL-Below Retention Time Window	A-Peak Added
..RT. -Retention Time (mm:ss)	WH-Above Retention Time Window	K-Peak Kept
Rat.1 -Ratio of M/M+2 Ions	SN-Below Signal to Noise Level	D-Peak Deleted
OK -RO=Ratio Outside Limits	<M-Below Method Detection Limit	T-Time Changed
Rel.RT-Relative Retention Time	NL-Channel Specific Noise Level	M-Peak Area Changed
		N-Name Changed
		X-Ether Interference

*** End of Report ***

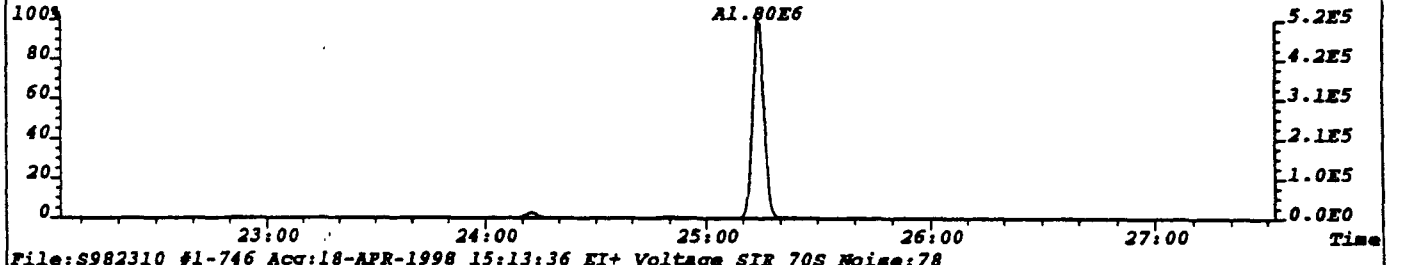
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:78
303.9016 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,312.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



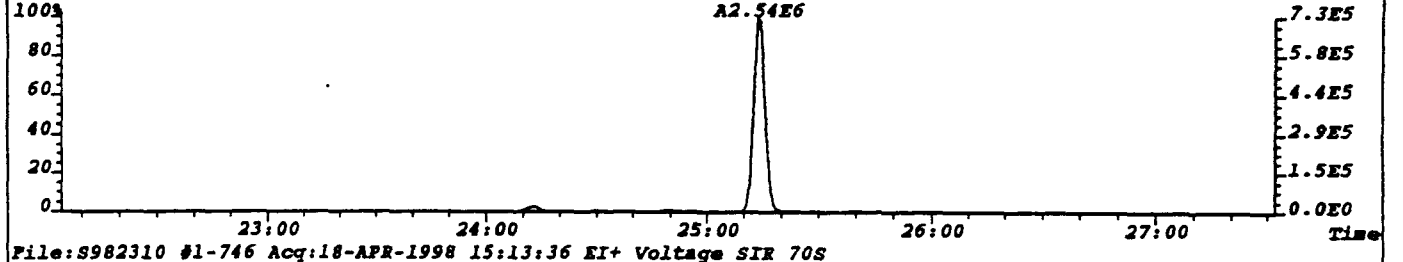
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:63
305.8987 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,252.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



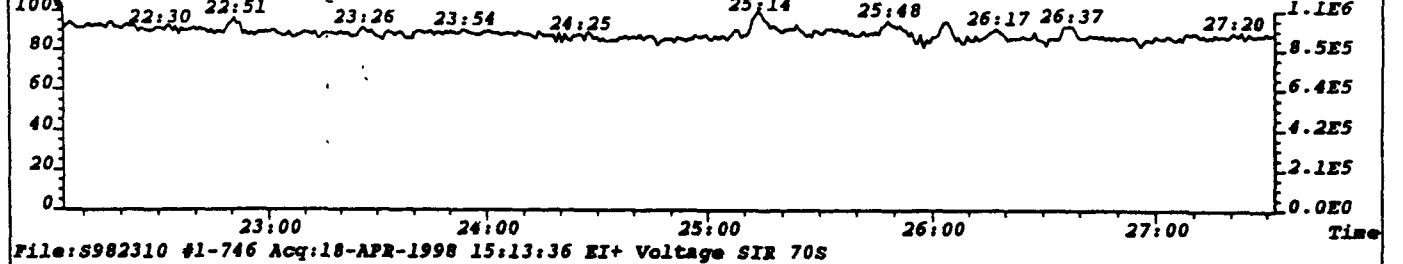
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:81
315.9419 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,324.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



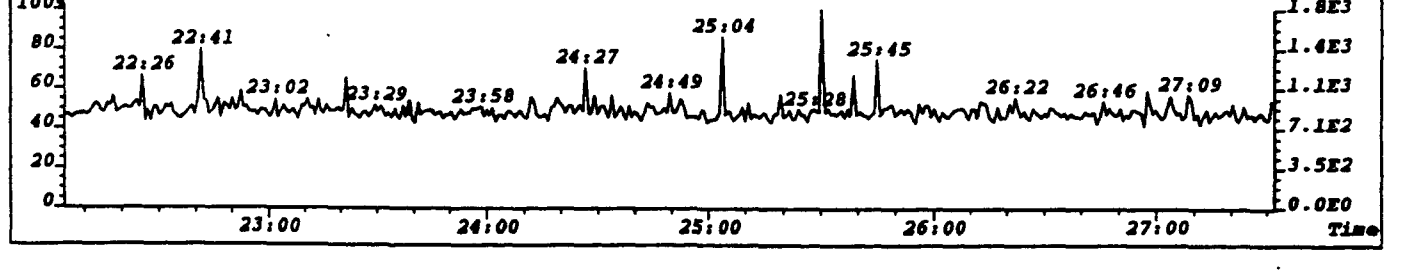
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:78
317.9389 F:2 BSUB(256,30,-3.0) PKD(9,5,5,0.05%,312.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



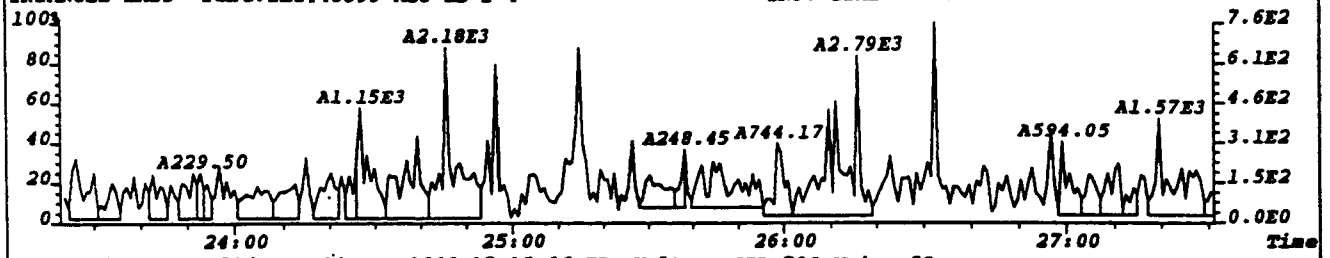
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



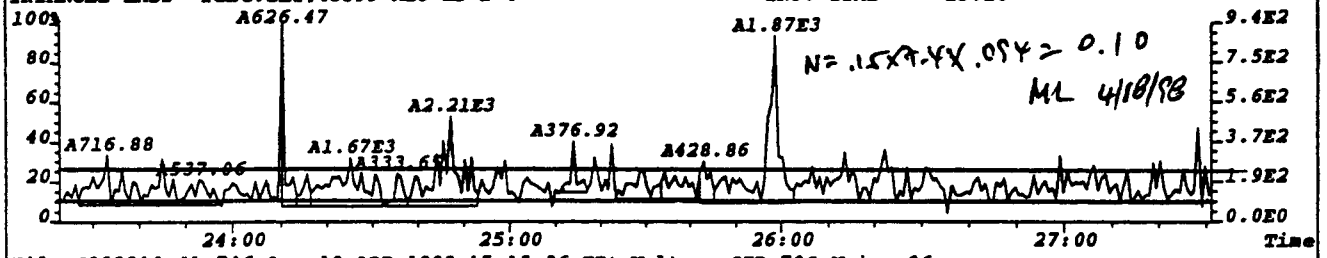
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
375.8364 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



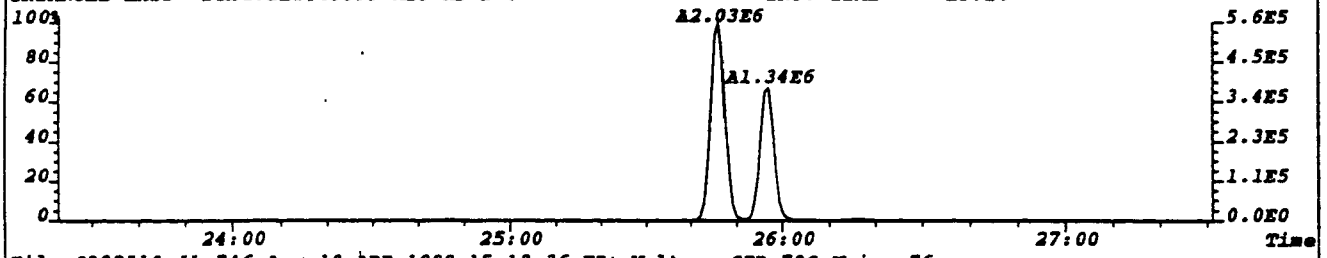
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:43
319.8965 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,172.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



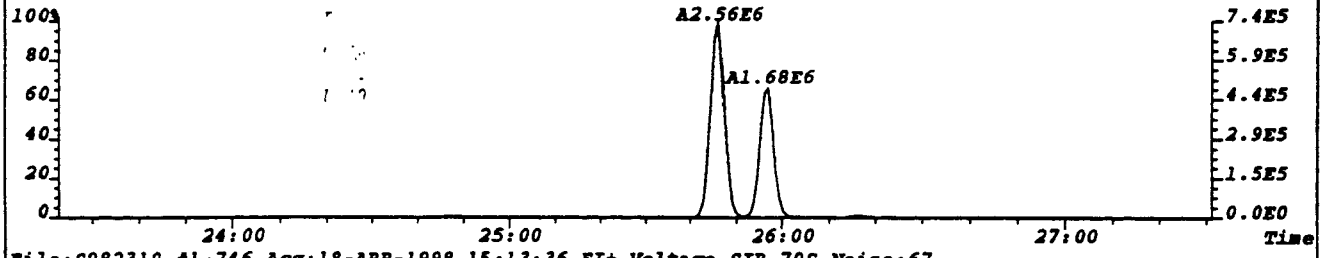
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:52
321.8936 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,208.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:96
331.9368 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,384.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16

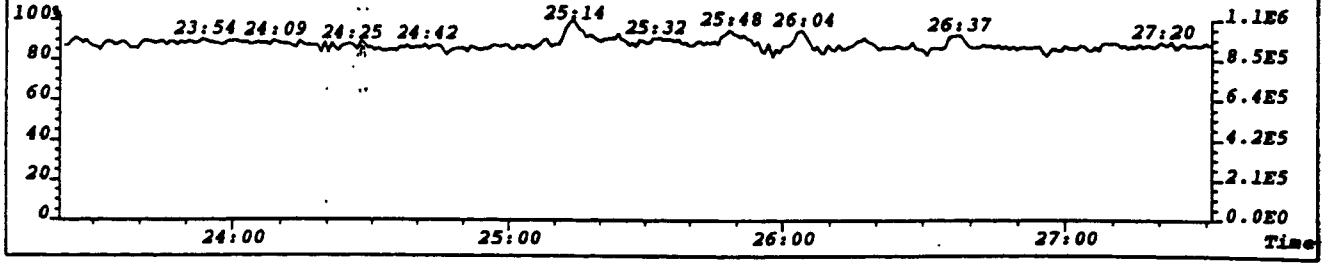


File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:76
333.9338 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,304.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16

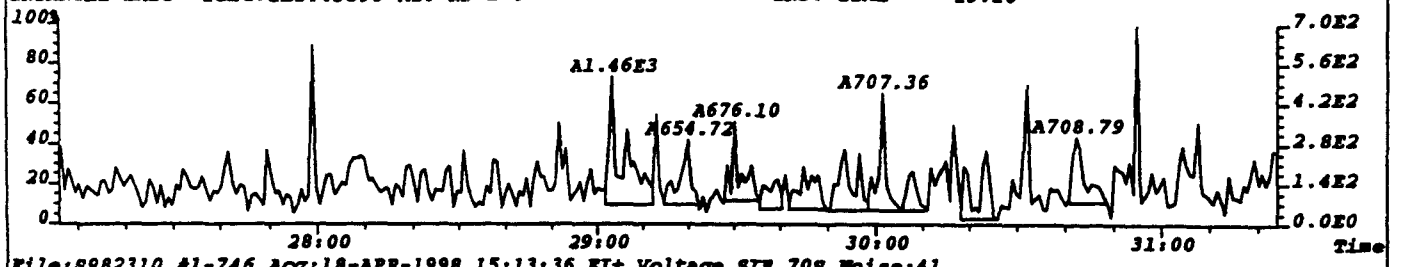


File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:67
327.8847 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,268.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16

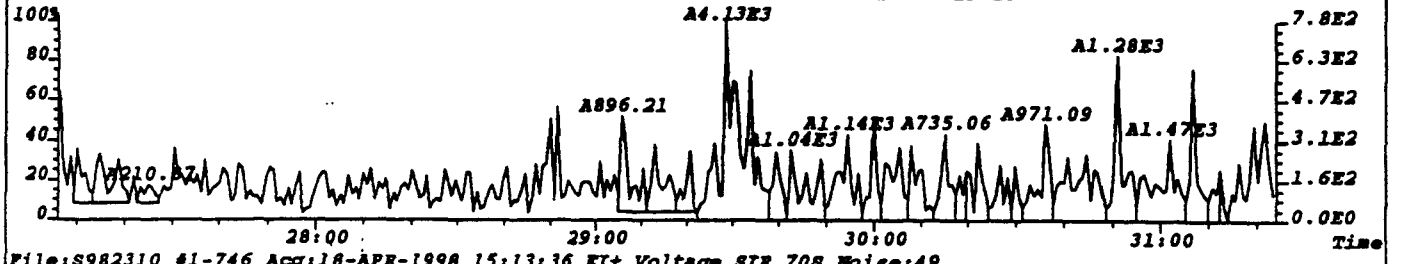
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



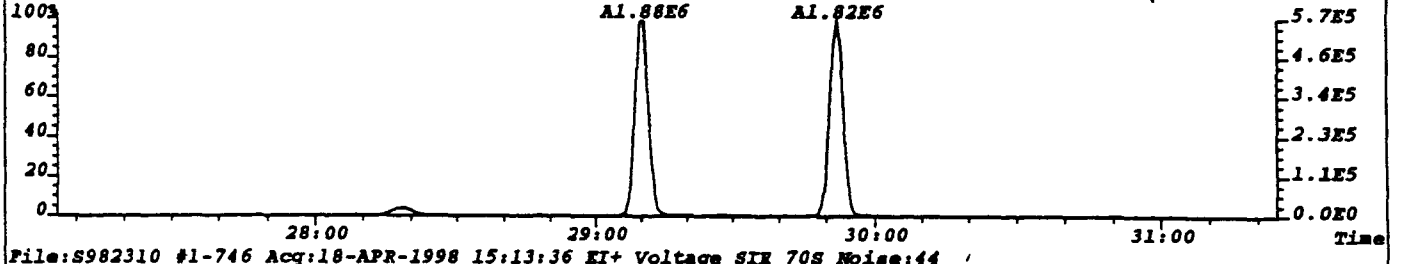
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:39
339.8597 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



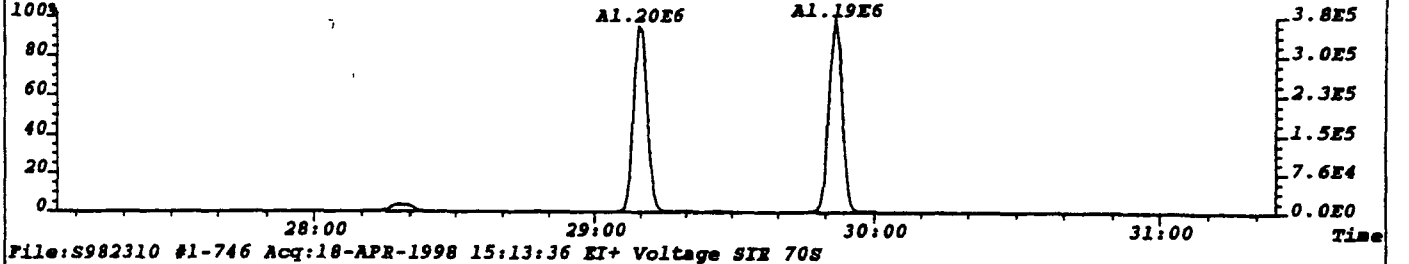
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:41
341.8567 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,164.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



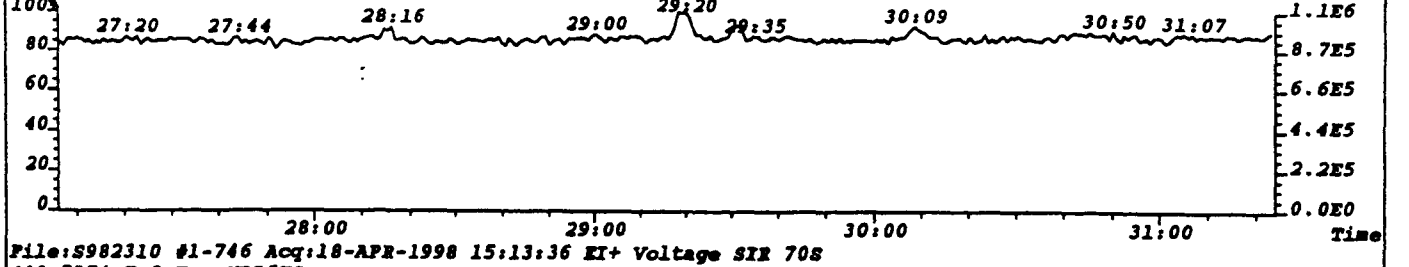
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:49
351.9000 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,196.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



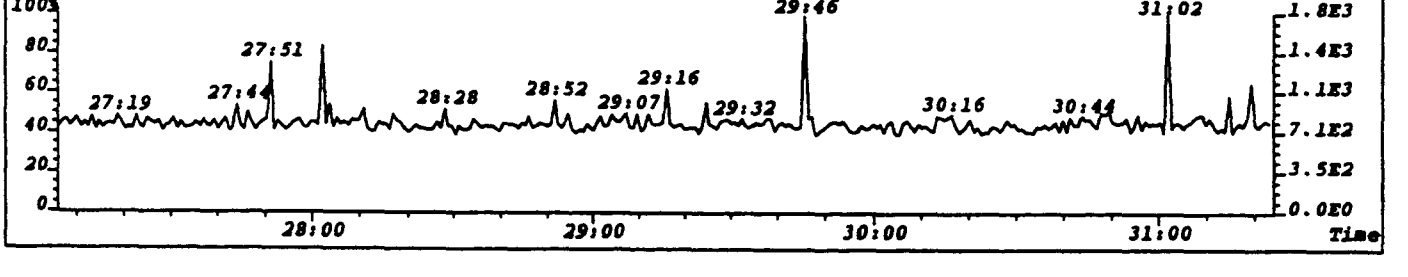
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:44
353.8970 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



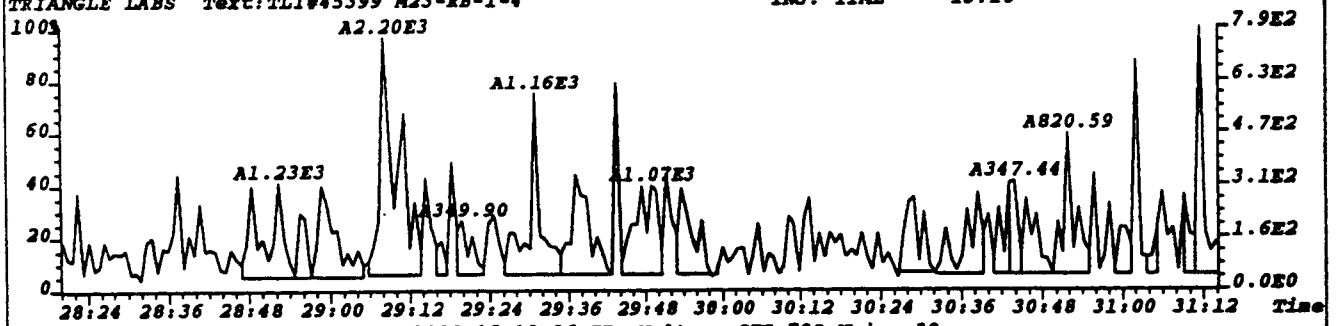
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



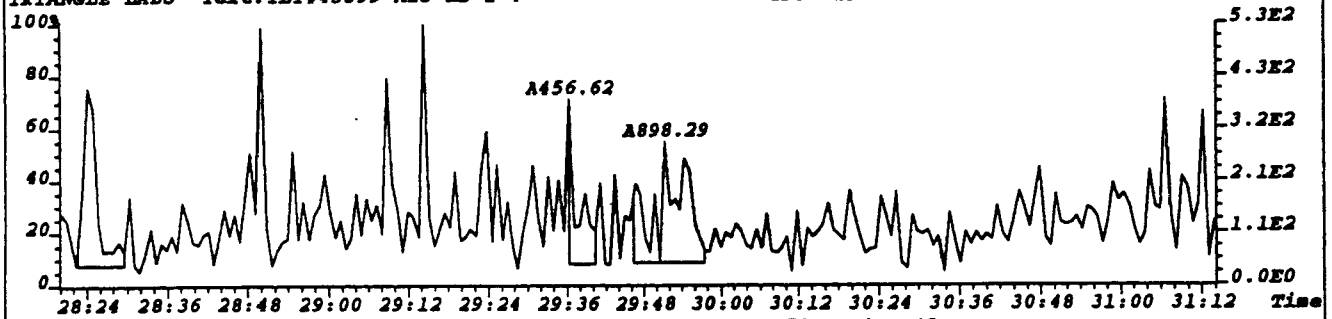
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
409.7974 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



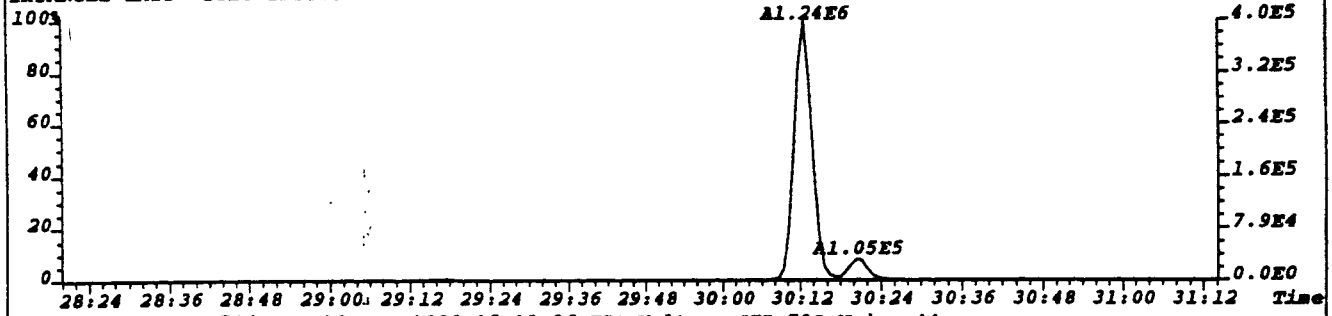
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:38
355.8546 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,152.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



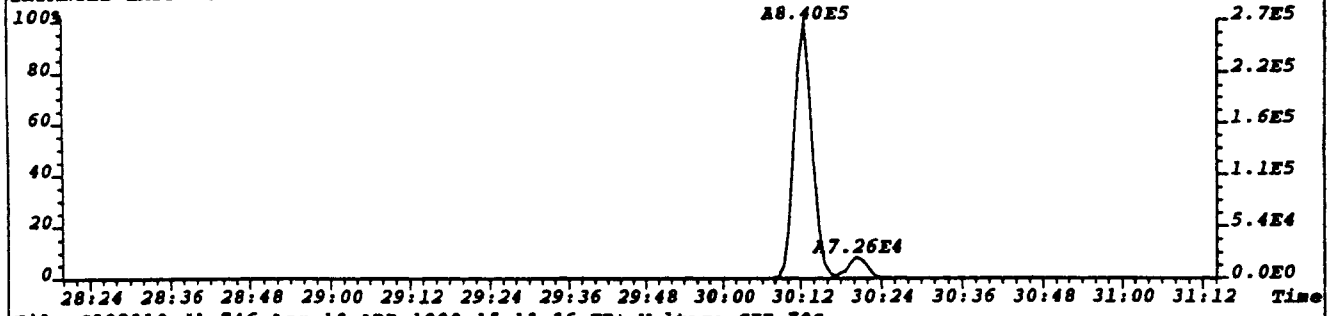
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:39
357.8516 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



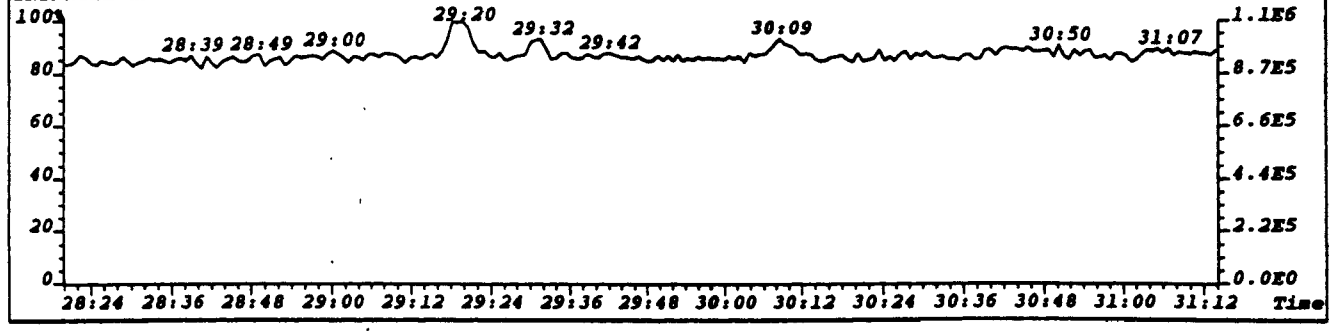
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:42
367.8949 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,168.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



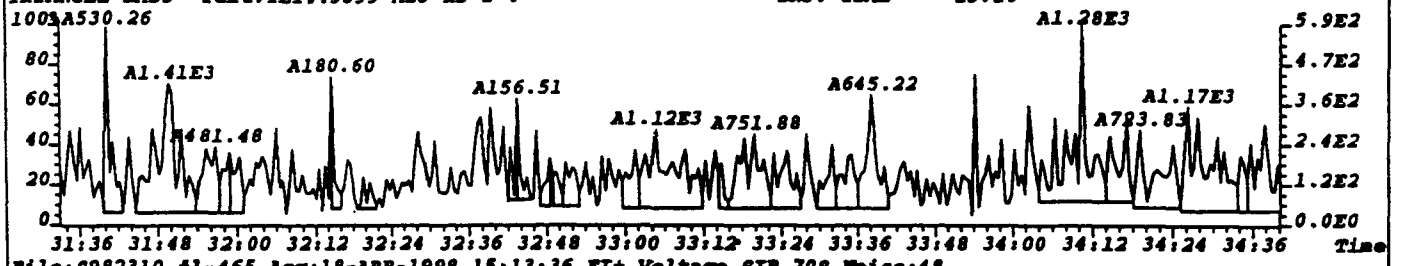
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:44
369.8919 F:2 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



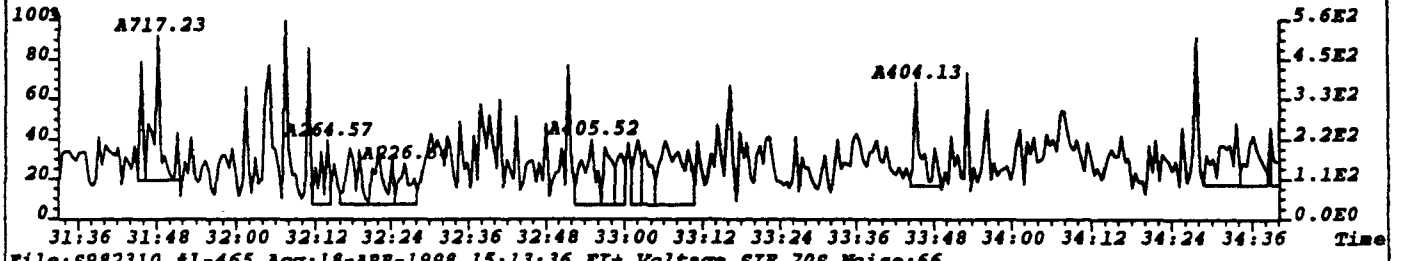
File:S982310 #1-746 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
330.9792 F:2 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



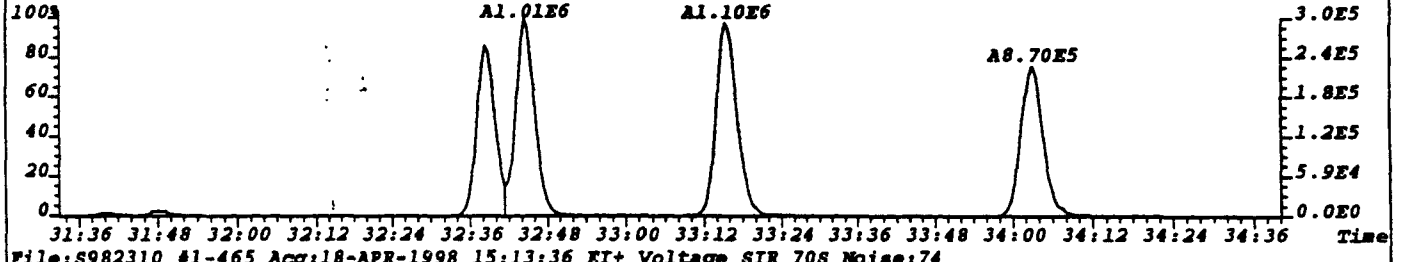
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:44
373.8208 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



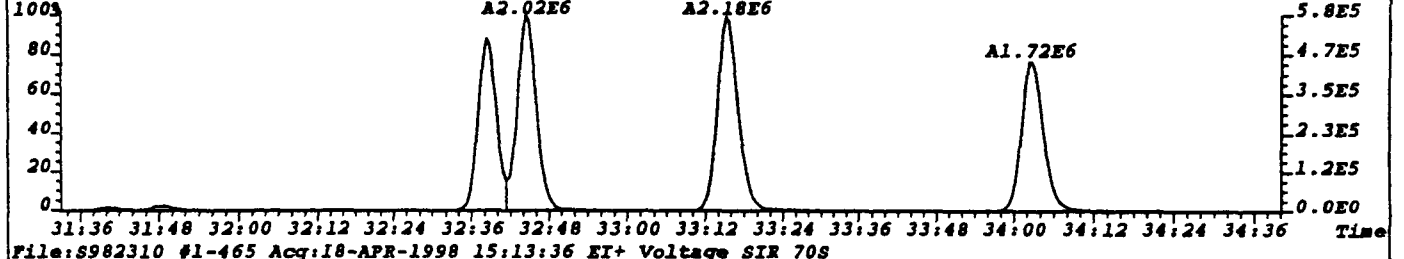
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:48
375.8178 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,192.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



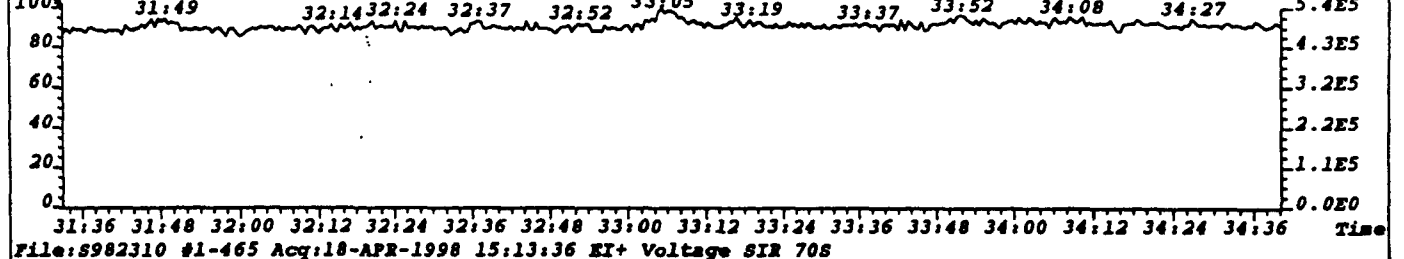
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:66
383.8639 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,264.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



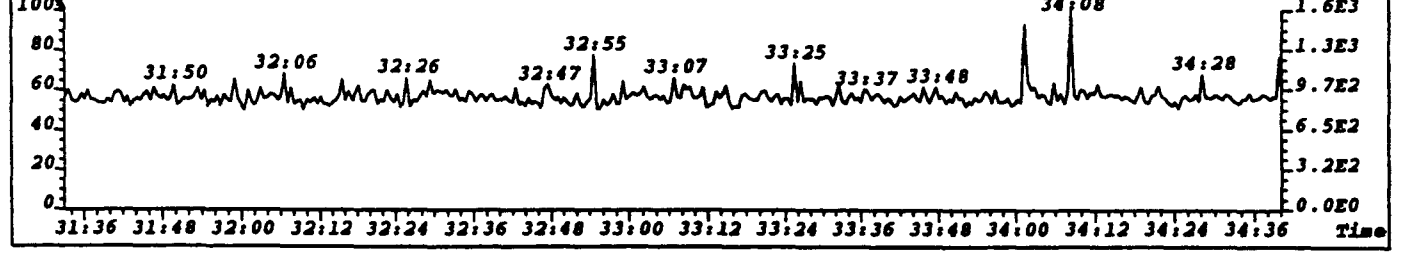
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:74
385.8610 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,296.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



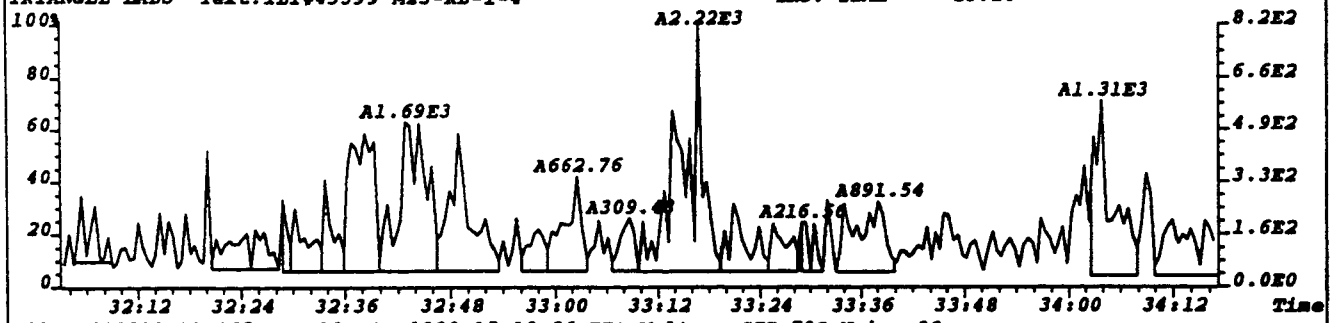
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



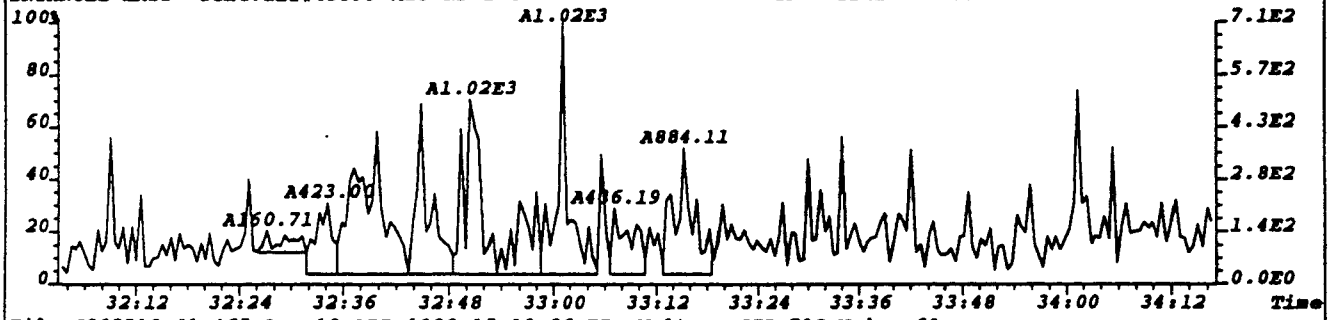
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
445.7555 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



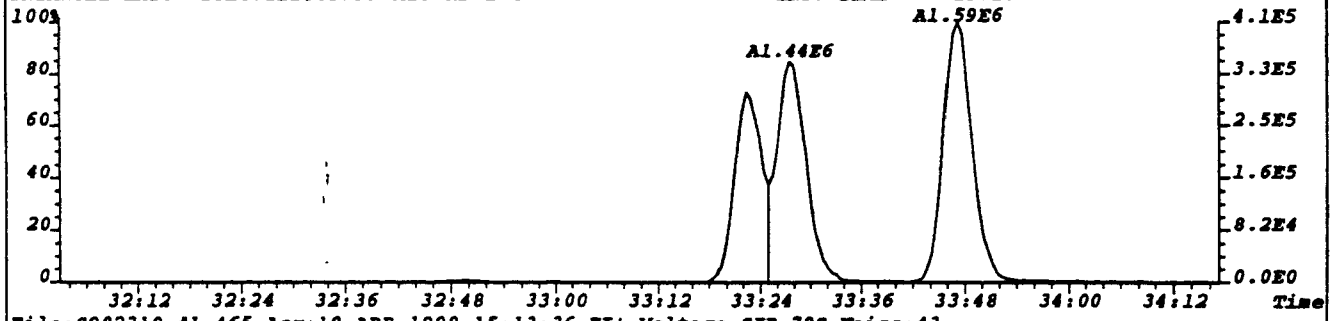
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:44
389.8156 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,176.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



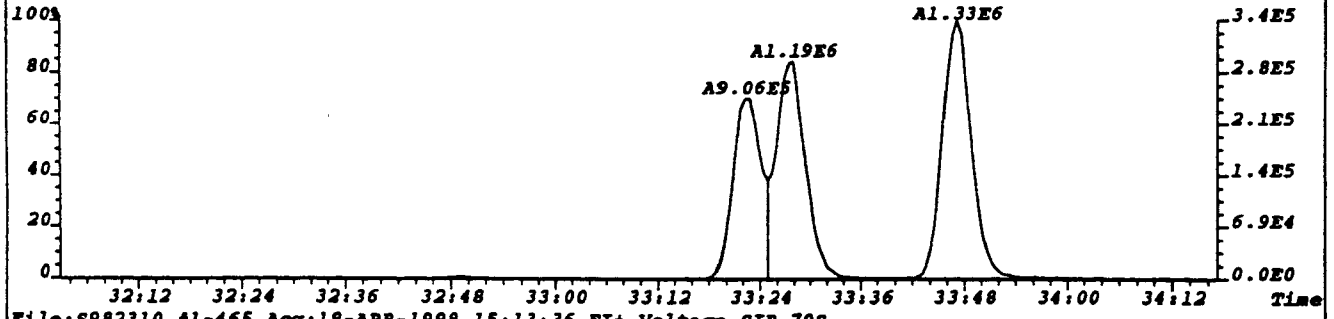
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:36
391.8127 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,144.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



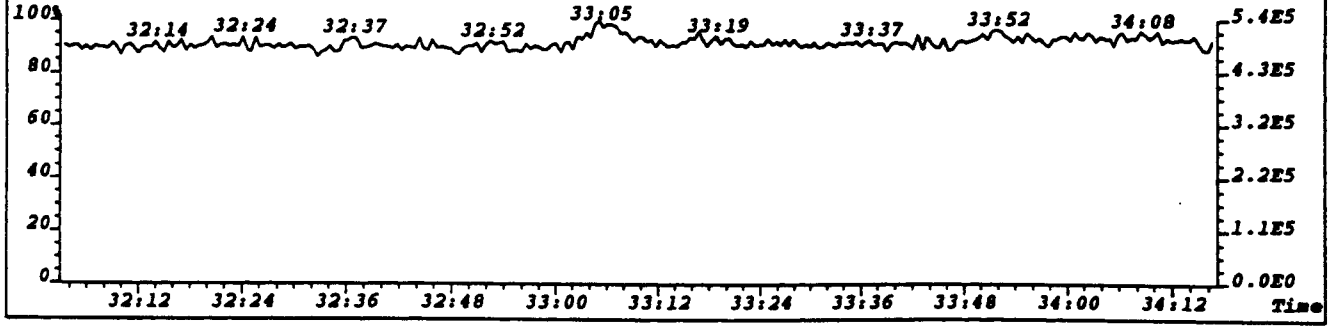
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:68
401.8558 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,272.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



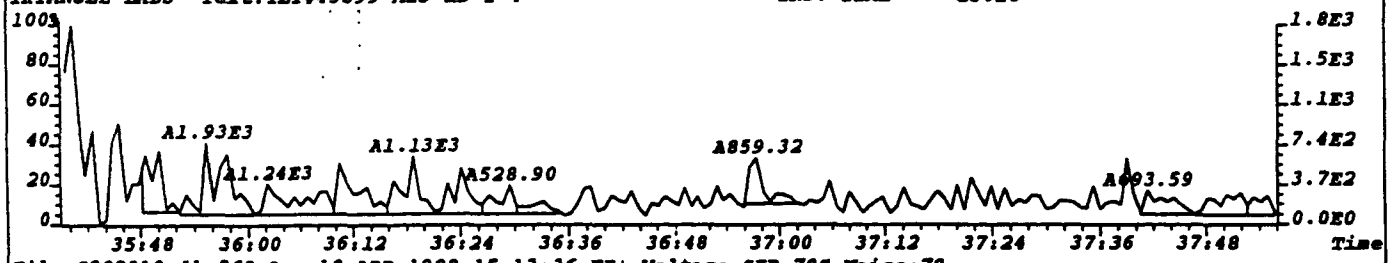
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:43
403.8529 F:3 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,172.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



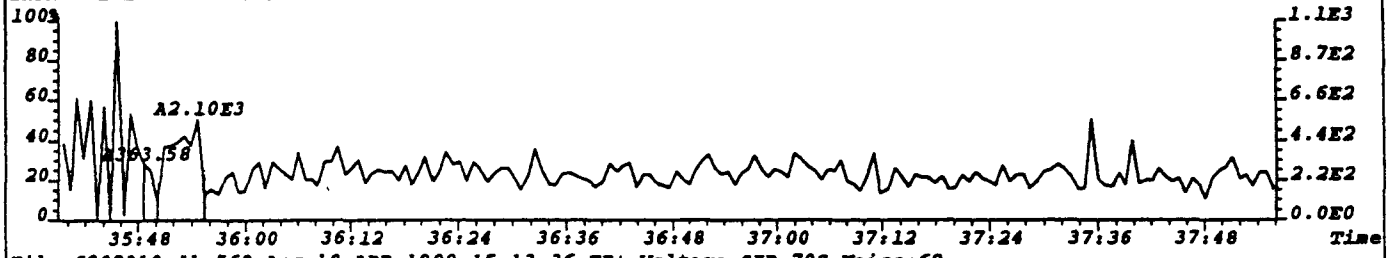
File:S982310 #1-465 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
392.9760 F:3 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



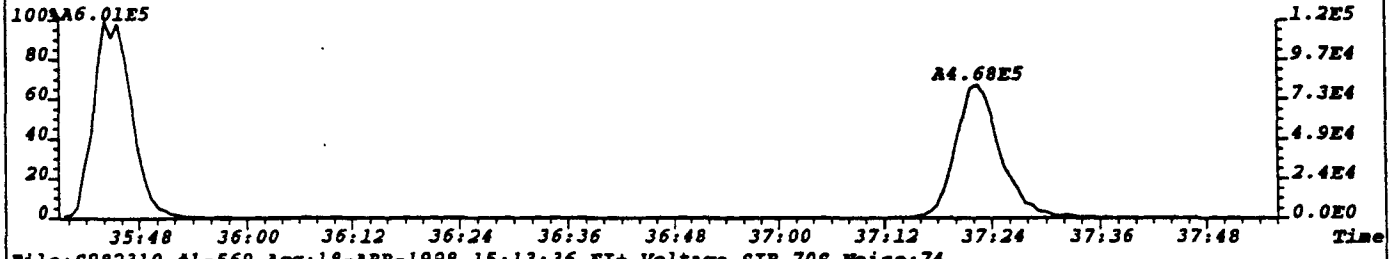
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:64
407.7818 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,256.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



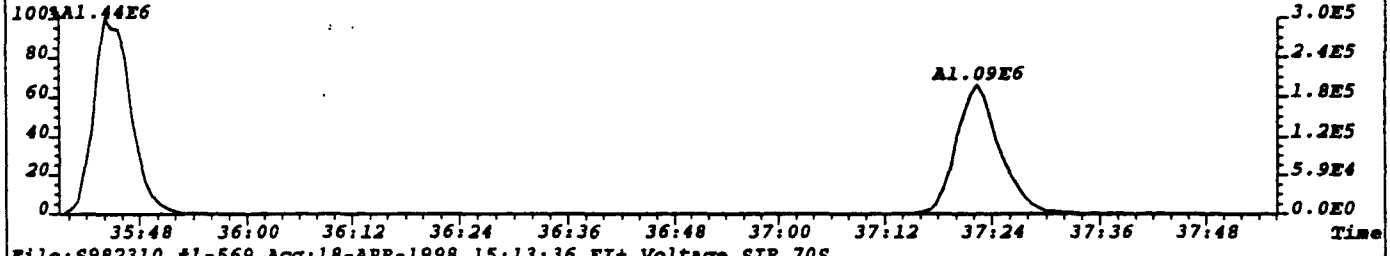
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:79
409.7789 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,316.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



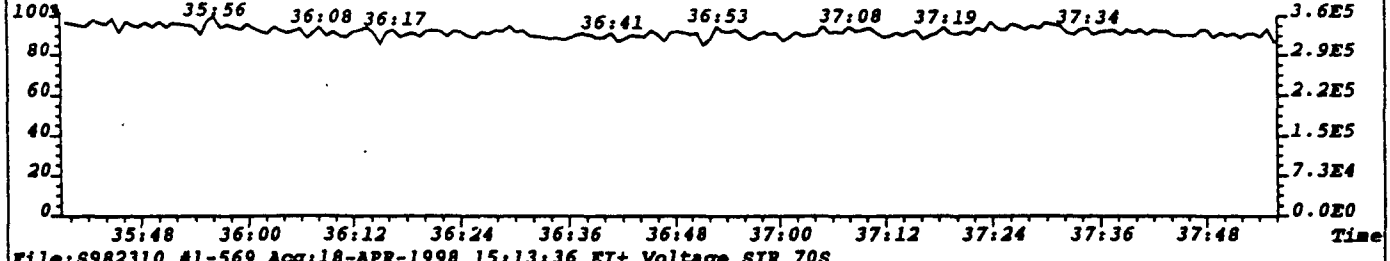
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:69
417.8253 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,276.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



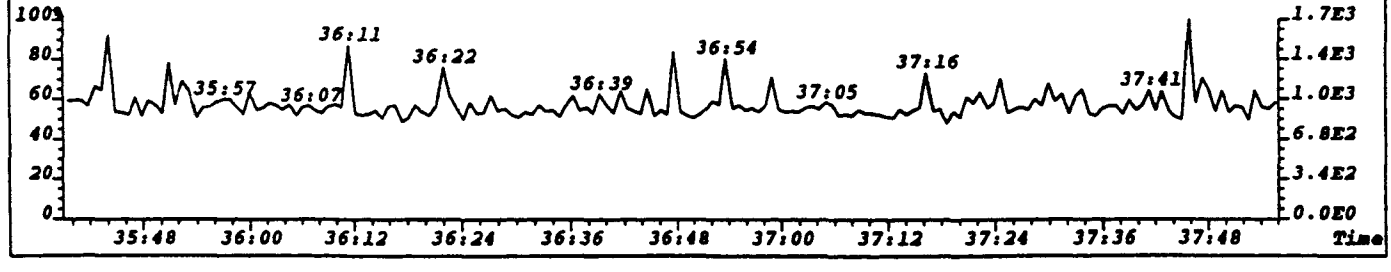
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:74
419.8220 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,296.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



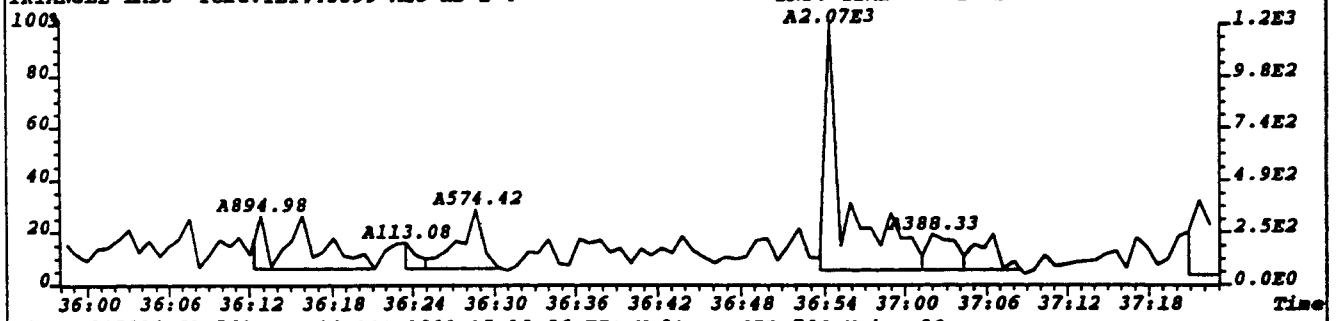
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



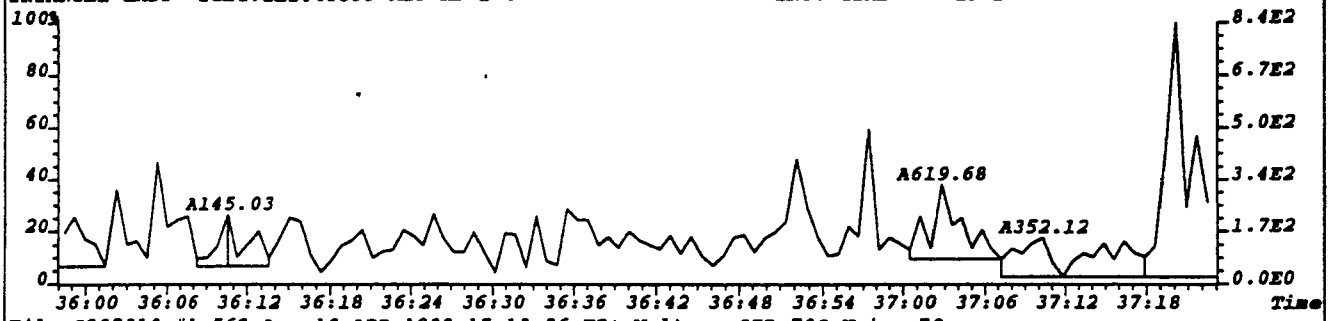
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
479.7165 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



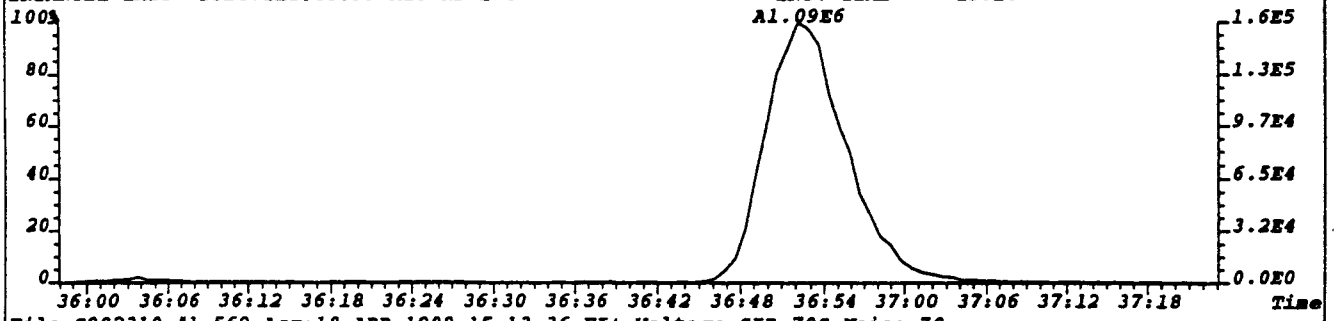
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:51
423.7766 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,204.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



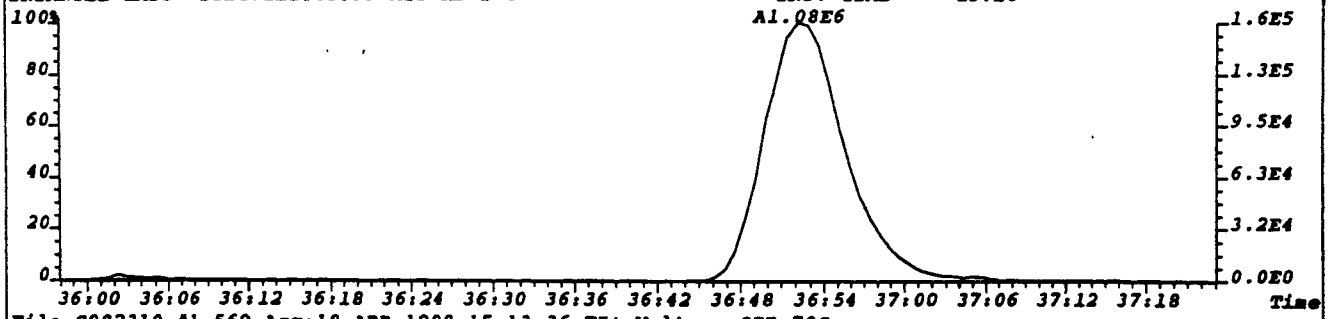
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:39
425.7737 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



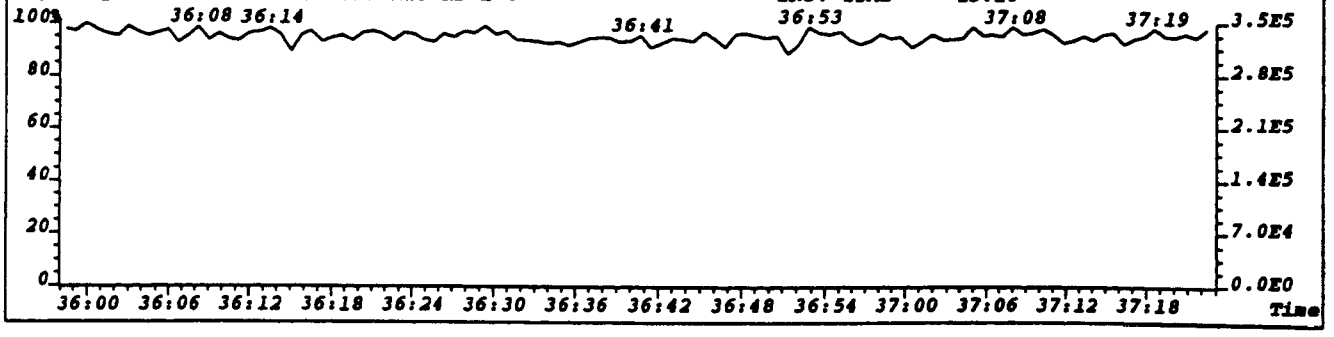
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:78
435.8169 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,312.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



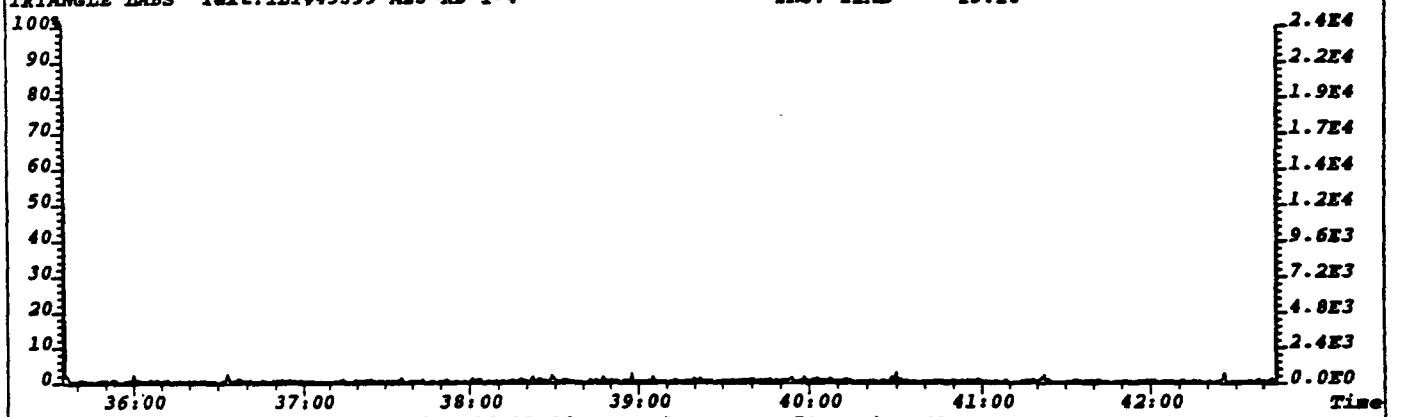
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:70
437.8140 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,280.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



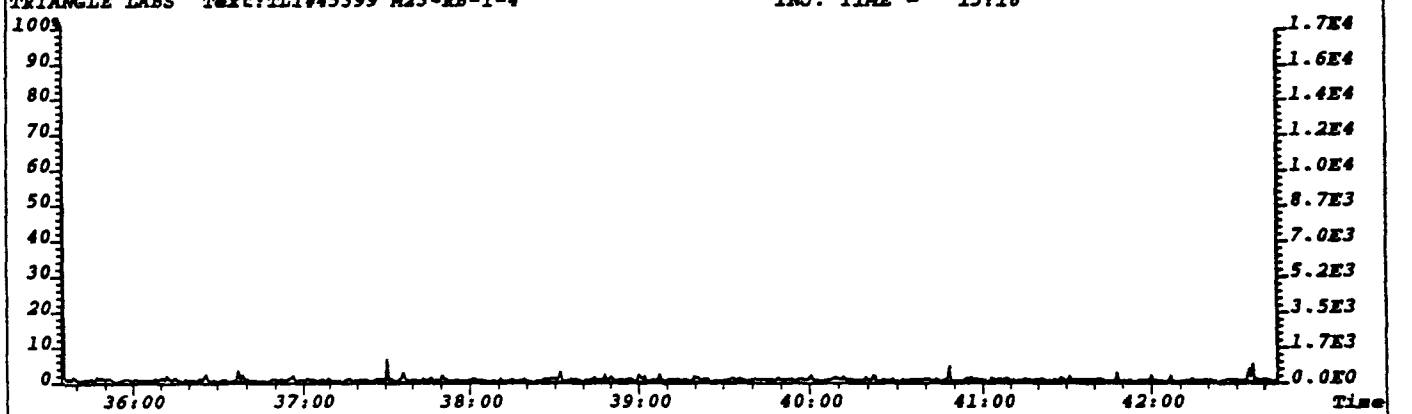
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



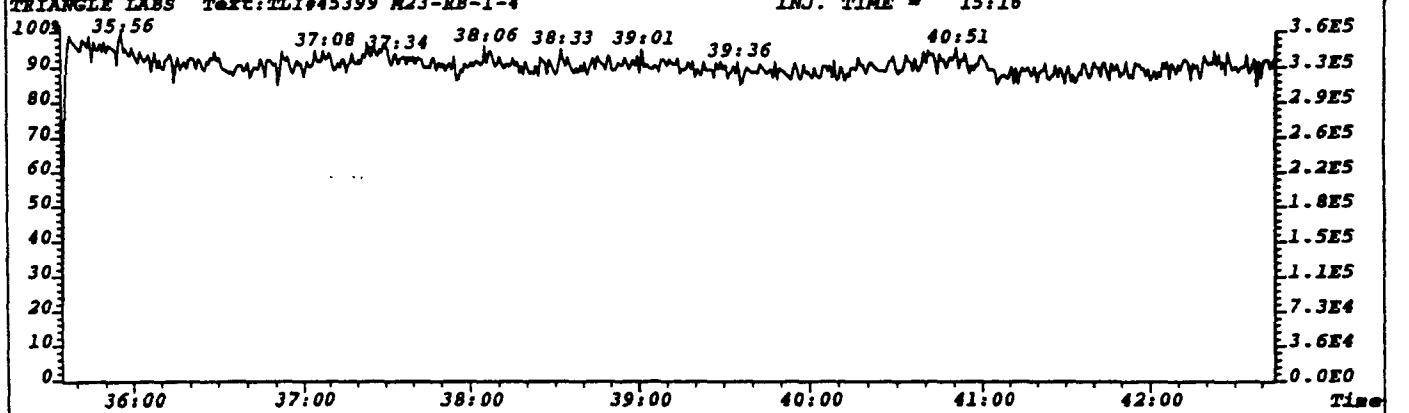
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:41
441.7428 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,164.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:41
443.7399 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,164.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
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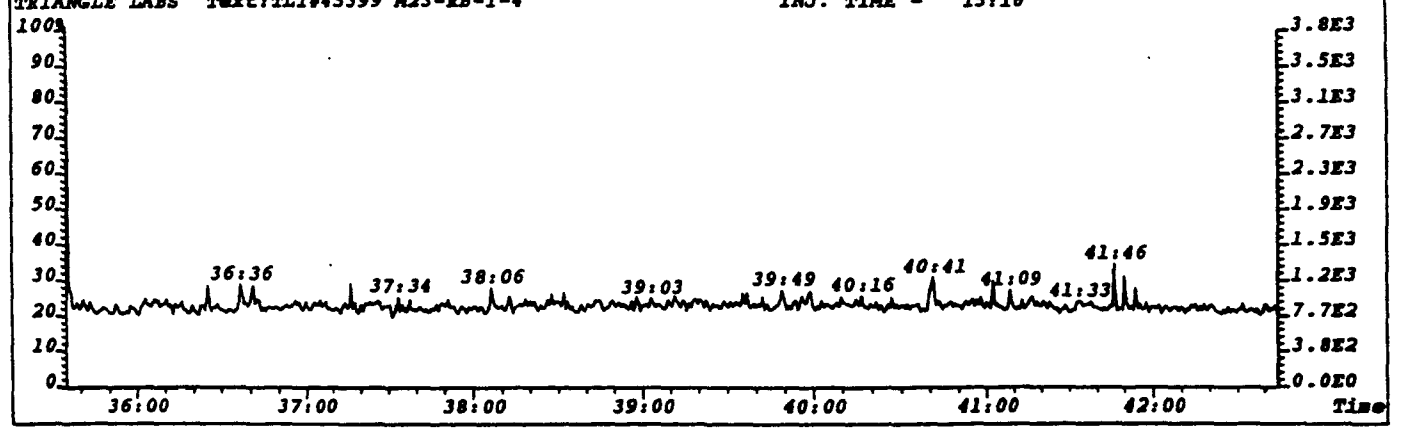
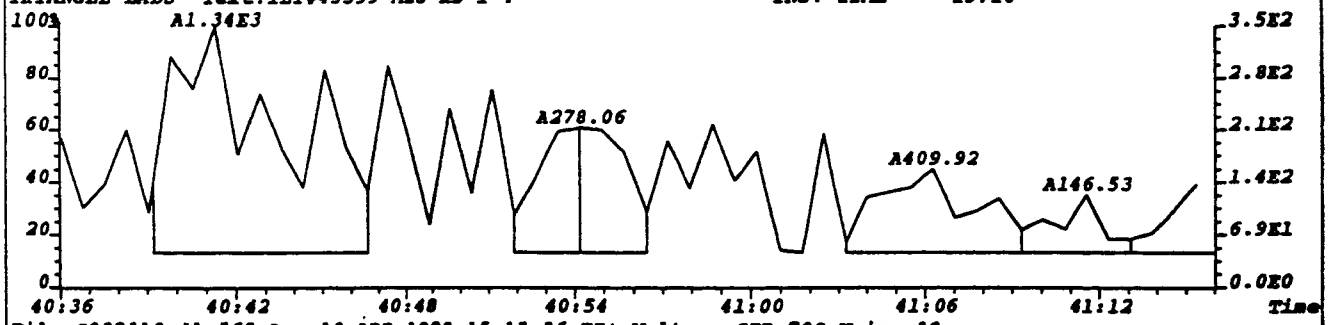
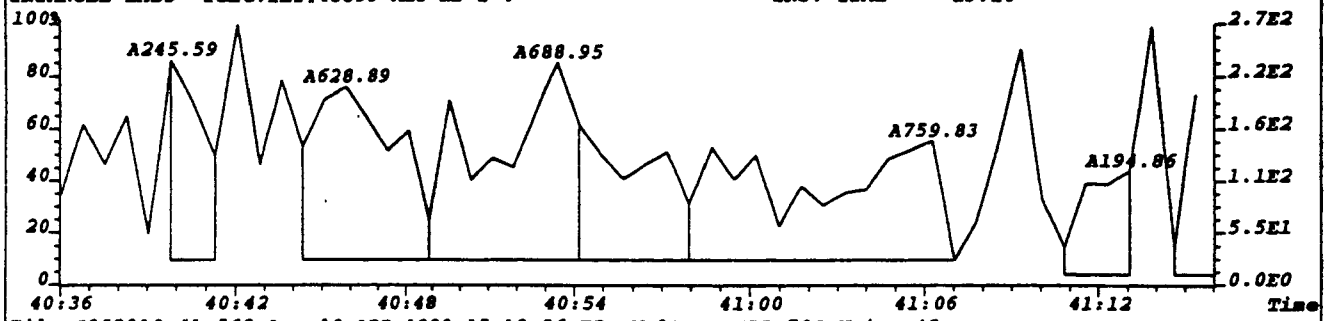


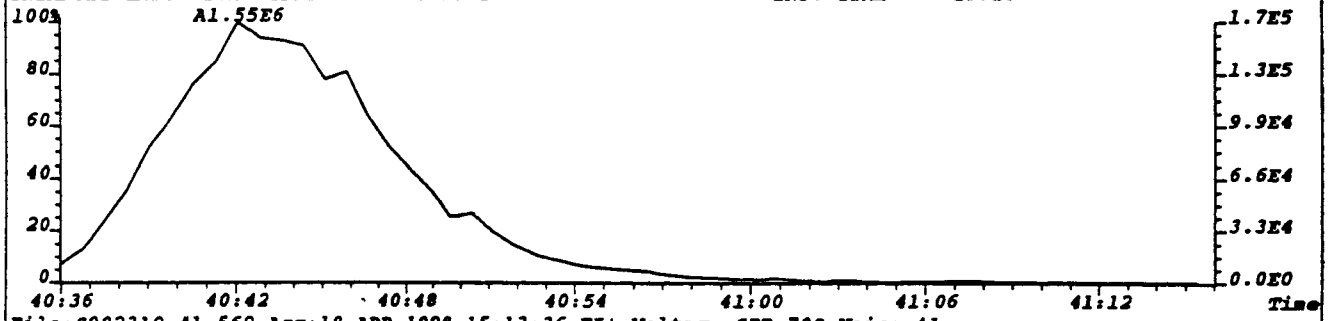
File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:39
457.7377 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,156.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:38
459.7348 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,152.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:43
469.7779 F:4 BSUB(256,30,-3.0) PKD(7,5,3,0.05%,172.0,1.00%,F,T) Exp:NDB5US
TRIANGLE LABS Text:TLI#45399 M23-RB-1-4 INJ. TIME = 15:16



File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S Noise:41
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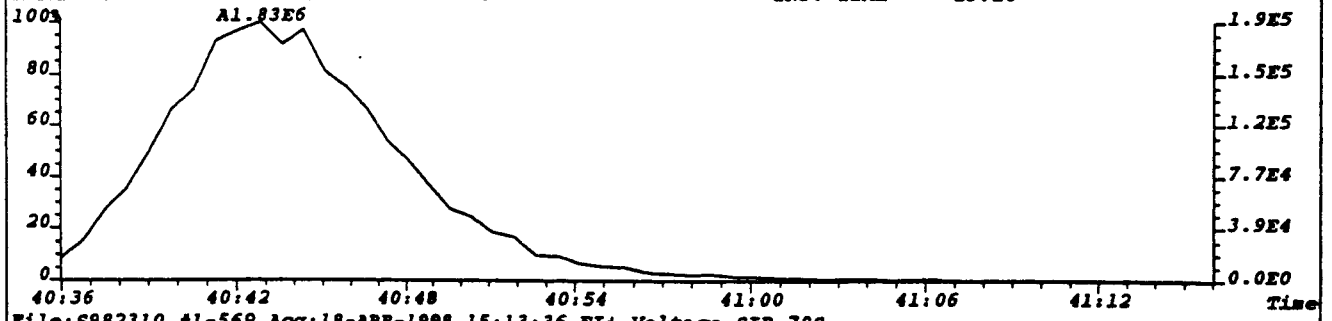

File:S982310 #1-569 Acq:18-APR-1998 15:13:36 EI+ Voltage SIR 70S
430.9729 F:4 Exp:NDB5US
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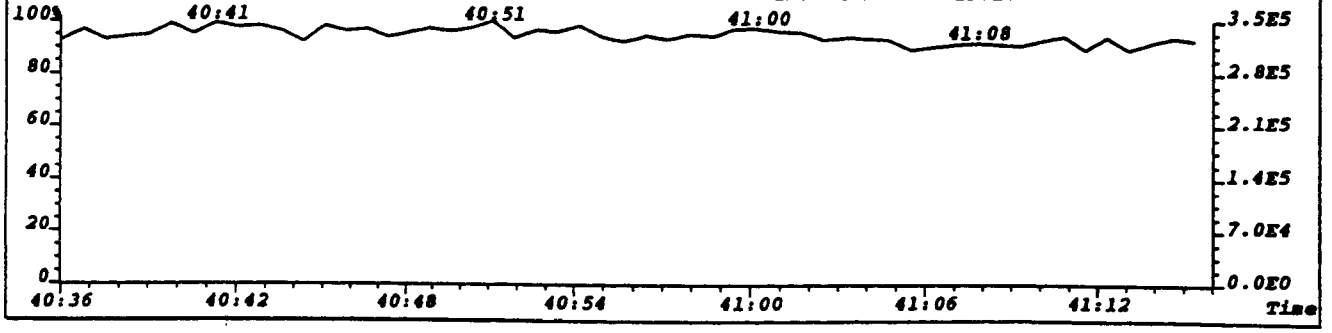

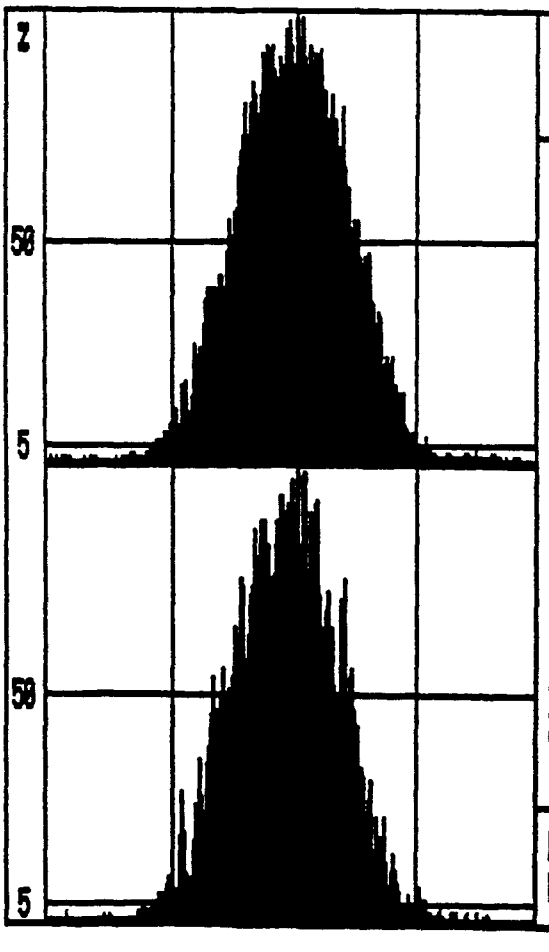

Channel I 330.9792 Peak top
Height .33 volts Span 200 ppm

System file name	MOBUS
Data file name	R:S982304
Resolution	10000
Group number	2
Ionization mode	EI+
Switching	VOLTAGE
Ref. masses	292.9825, 416.9760

A	293	J	331	S	368
B	304	K	332	T	370
C	306	L	334	U	376
D	316	M	340	V	410
E	318	N	342		
F	320	O	352		
G	322	P	354		
H	328	Q	356		
I	331	R	358		

Ref. mass 416.9760 Peak top
Height .08 volts Span 200 ppm

TRIANGLE LABS

CALIBRATION DATA

Triangle Laboratories, Inc.
801 Capitola Drive
Durham, NC 27713-4411
919-544-5729

P.O. Box 13485
Research Triangle Park, NC 27709-3485
Fax # 919-544-5491

Initial Calibration Summary for UF51058

Analysis Date....: 01/05/98 Method.....: MIT2
Instrument.....: U

Analytes	RF	SD	%RSD	RT	RT/LO	RT/HI	Ratio1	Ratio2	N
Total MCDF	0.000	0.000	100%		4:35	18:35			0
Total MCDD	0.000	0.000	100%		5:18	19:18			0
Total DCDF	0.000	0.000	100%		11:35	19:35			0
Total DCDD	0.000	0.000	100%		12:18	20:18			0
Total TriCDF	0.000	0.000	100%		15:35	22:35			0
Total TriCDD	0.000	0.000	100%		17:18	23:18			0
1368-TCDF	1.298	0.073	6%	21:26	23:35	30:35	0.745		6
2378-TCDF	1.240	0.132	11%	24:36			0.743		6
TOTAL TCDF	1.240	0.132	11%				0.744		6
1368-TCDD	0.715	0.032	4%	22:46	24:18	31:18	0.776		6
1379-TCDD	0.360	0.021	6%	23:10			0.786		6
2378-TCDD	1.240	0.160	13%	25:19			0.787		6
TOTAL TCDD	1.240	0.160	13%				0.781		6
12378-PeCDF	1.051	0.090	9%	28:33	24:32	32:32	1.526		6
23478-PeCDF	1.019	0.078	8%	29:14			1.530		6
TOTAL PeCDF	1.035	0.084	8%				1.528		6
12378-PeCDD	1.333	0.125	9%	29:34	25:34	33:34	1.580		6
TOTAL PeCDD	1.333	0.125	9%				1.580		6
123478-HxCDF	1.007	0.074	7%	32:01	28:06	36:06	1.283		6
123678-HxCDF	1.253	0.089	7%	32:07			1.245		6
234678-HxCDF	0.985	0.082	8%	32:36			1.262		6
123789-HxCDF	0.870	0.047	5%	33:22			1.263		6
TOTAL HxCDF	1.029	0.071	7%				1.262		6
123478-HxCDD	0.765	0.051	7%	32:43	28:47	36:47	1.257		6
123678-HxCDD	0.976	0.079	8%	32:47			1.211		6
123789-HxCDD	0.941	0.068	7%	33:06			1.234		6
TOTAL HxCDD	0.894	0.064	7%				1.232		6
1234678-HpCDF	1.410	0.098	7%	35:00	30:59	38:59	1.060		6
1234789-HpCDF	1.096	0.071	6%	36:31			1.049		6
TOTAL HpCDF	1.253	0.084	7%				1.055		6
1234678-HpCDD	0.995	0.051	5%	36:01	32:00	40:00	1.028		6
TOTAL HpCDD	0.995	0.051	5%				1.028		6
OCDF	1.377	0.070	5%	39:47	35:34	43:34	0.891		6
OCDD	1.108	0.080	7%	39:35	35:34	43:34	0.836		6

Other Standards	RF	SD	%RSD	RT	RT/LO	RT/HI	Ratio1	Ratio2	N
37Cl-TCDD	1.001	0.056	6%	25:19	23:18	27:18			6
13C12-PeCDF 234	0.966	0.010	1%	29:14	26:32	30:32	1.498		6
13C12-HxCDF 478	0.825	0.042	5%	32:01			0.509		6
13C12-HxCDF 234	0.902	0.043	5%	32:35			0.508		6
13C12-HxCDF 789	0.695	0.042	6%	33:21			0.504		6
13C12-HxCDD 478	0.732	0.024	3%	32:42			1.214		6
13C12-HpCDF 789	0.802	0.016	2%	36:30	32:59	38:59	0.431		6

Internal Standards	RF	SD	%RSD	RT	RT/LO	RT/HI	Ratio1	Ratio2	N
13C12-2378-TCDF	1.467	0.053	4%	24:35	23:35	25:35	0.755		6
13C12-2378-TCDD	1.118	0.049	4%	25:18	23:18	27:18	0.807		6
13C12-PeCDF 123	1.142	0.075	7%	28:32	24:32	32:32	1.478		6
13C12-PeCDD 123	0.590	0.045	8%	29:34	25:34	33:34	1.506		6
13C12-HxCDF 678	1.346	0.038	3%	32:06	28:06	36:06	0.506		6
13C12-HxCDD 678	0.995	0.017	2%	32:47	31:47	33:47	1.216		6
13C12-HpCDF 678	0.822	0.013	2%	34:59	32:59	38:59	0.434		6
13C12-HpCDD 678	0.726	0.011	2%	36:00	35:00	37:00	1.018		6
13C12-OCDD	0.545	0.038	7%	39:34	37:34	41:34	0.861		6

Recovery Standards	RF	SD	%RSD	RT	RT/LO	RT/HI	Ratio1	Ratio2	N
13C12-1234-TCDD	1.000	0.000	0%	25:08			0.812		6
13C12-HxCDD 789	1.000	0.000	0%	33:05			1.210		6

*** End of Report ***

iangle Laboratories, Inc.® Analytical Services Division
1 Capitola Drive • Durham, North Carolina 27713
one: (919) 544-5729 • Fax: (919) 544-5491

Continuing Calibration for U980771

Analysis Date....: 04/15/98
Operator.....: DL
Init Calibration.: UF51058
ICal Date.....: 01/05/98

Method.....: MIT2
Instrument..: U
Std.Conc....: 10.00

Analyte Summary

Name	RF	Ratio 1&2	RT Lo/High	RT	Rel. RT	ICal RF	Delta RF	%D
Total MCDF	0.000		3:22 17:22			0.000	0.000	100.0%
Total MCDD	0.000		4:08 18:08			0.000	0.000	100.0%
Total DCDF	0.000		10:22 18:22			0.000	0.000	100.0%
Total DCDD	0.000		11:08 19:08			0.000	0.000	100.0%
Total TriCDF	0.000		14:22 21:22			0.000	0.000	100.0%
Total TriCDD	0.000		16:08 22:08			0.000	0.000	100.0%
1368-TCDF	1.285	0.76	19:43 25:22	19:55	0.8524	1.298	-0.013	-1.0%
2378-TCDF	1.227	0.77		23:23	1.0007	1.240	-0.013	-1.1%
TOTAL TCDF	1.227	0.76				1.240	-0.013	-1.1%
1368-TCDD	0.702	0.79	21:12 25:20	21:24	0.8867	0.715	-0.013	-1.9%
1379-TCDD	0.321	0.78		21:50	0.9047	0.360	-0.039	-10.8%
2378-TCDD	1.125	0.78		24:09	1.0007	1.240	-0.115	-9.3%
TOTAL TCDD	1.125	0.78				1.240	-0.115	-9.3%
12378-PeCDF	1.081	1.51	25:16 29:26	27:34	1.0006	1.051	0.030	2.9%
23478-PeCDF	1.056	1.49		28:18	1.0272	1.019	0.037	3.6%
TOTAL PeCDF	1.069	1.50				1.035	0.034	3.2%
12378-PeCDD	1.250	1.61	26:35 29:17	28:39	1.0000	1.333	-0.083	-6.2%
TOTAL PeCDD	1.250	1.61				1.333	-0.083	-6.2%
123478-HxCDF	1.210	1.26	30:00 32:44	31:10	0.9968	1.007	0.203	20.2%
123678-HxCDF	1.267	1.24		31:17	1.0005	1.253	0.014	1.1%
234678-HxCDF	1.053	1.28		31:46	1.0160	0.985	0.068	6.9%
123789-HxCDF	1.031	1.30		32:30	1.0394	0.870	0.161	18.5%

Final

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Date: 04/15/98 TRIANGLE LABORATORIES OF RTP, INC.

Continuing Calibration for U980771

TOTAL HxCDF	1.140	1.27				1.029	0.111	10.8%
123478-HxCDD	0.878	1.21	30:31 32:24	31:53	0.9979	0.765	0.113	14.8%
123678-HxCDD	0.916	1.22		31:58	1.0005	0.976	-0.060	-6.1%
123789-HxCDD	0.910	1.22		32:16	1.0099	0.941	-0.031	-3.3%
TOTAL HxCDD	0.901	1.21				0.894	0.007	0.8%
1234678-HpCDF	1.377	1.06	33:54 35:41	34:05	1.0005	1.410	-0.033	-2.3%
1234789-HpCDF	1.115	1.06		35:31	1.0426	1.096	0.019	1.7%
TOTAL HpCDF	1.246	1.06				1.253	-0.007	-0.6%
1234678-HpCDD	1.008	1.02	34:10 35:13	35:04	1.0005	0.995	0.013	1.3%
TOTAL HpCDD	1.008	1.02				0.995	0.013	1.3%
OCDF	1.279	0.91	34:23 42:23	38:34	1.0048	1.377	-0.098	-7.1%
OCDD	1.001	0.87	34:23 42:23	38:24	1.0004	1.108	-0.107	-9.6%

Other Standard Summary

Name	RF	Ratio 1&2	RT Lo/High	RT	Rel. RT	ICal RF	Delta RF	%D
37Cl-TCDD	0.972		22:08 26:08	24:09	1.0007	1.001	-0.029	-2.9%
13C12-PeCDF 234	0.932	1.47	23:33 31:33	28:17	1.0266	0.966	-0.034	-3.5%
13C12-HxCDF 478	1.005	0.51		31:10	0.9968	0.825	0.180	21.9%
13C12-HxCDF 234	0.977	0.50		31:46	1.0160	0.902	0.075	8.3%
13C12-HxCDF 789	0.834	0.49		32:30	1.0394	0.695	0.139	20.0%
13C12-HxCDD 478	0.939	1.20		31:53	0.9979	0.732	0.207	28.3%
13C12-HpCDF 789	0.866	0.42	32:04 38:04	35:31	1.0426	0.802	0.064	8.0%

Internal Standard Summary

Name	RF	Ratio 1&2	RT Lo/High	RT	Rel. RT	ICal RF	Delta RF	%D
13C12-2378-TCDF	1.484	0.76	22:22 24:22	23:22	1.0000	1.467	0.017	1.2%
13C12-2378-TCDD	1.121	0.81	22:08 26:08	24:08	1.0000	1.118	0.003	0.2%
13C12-PeCDF 123	1.085	1.49	23:33 31:33	27:33	1.0000	1.142	-0.057	-5.0%

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Printed: 14:20 04/15/98

Continuing Calibration for U980771

13C12-PeCDD 123	0.607	1.46	24:39 32:39	28:39	1.0000	0.590	0.017	2.8%
13C12-HxCDF 678	1.289	0.51	27:16 35:16	31:16	1.0000	1.346	-0.057	-4.3%
13C12-HxCDD 678	1.043	1.23	30:57 32:57	31:57	1.0000	0.995	0.048	4.8%
13C12-HpCDF 678	0.879	0.43	32:04 38:04	34:04	1.0000	0.822	0.057	6.9%
13C12-HpCDD 678	0.741	1.06	34:03 36:03	35:03	1.0000	0.726	0.015	2.1%
13C12-OCDD	0.569	0.88	38:12 38:32	38:23	1.0000	0.545	0.024	4.3%

Recovery Standard Summary

Name	RF	Ratio 1&2	RT Lo/High	RT	Rel. RT	ICal RF	Delta RF	%D
13C12-1234-TCDD	1.000	0.82		23:56	0.9917	1.000	0.000	0.0%
13C12-HxCDD 789	1.000	1.20		32:15	1.0094	1.000	0.000	0.0%

QC Front End Check: 1.5693

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Appendix B.2

Method 26A Analytical Reports

TECHNICAL REPORT

Client: Pacific Environmental Services, Inc.

Purchase Order No.: 104-98-0175

RTI Project No.: 7048-03E

Date: April 23, 1998

By

Kate K. Luk
Research Triangle Institute
Post Office Box 12194
3040 Cornwallis Road
Research Triangle Park, NC 27709

(919) 541-6569

Submitted to:

Frank Phoenix
Pacific Environmental services, Inc.
5001 South Miami Blvd., Suite 300
RTP, NC 27709-2077

RTI

INTRODUCTION

Six impinger samples were received under Purchase No. 104-98-0175 on April 9, 1998 for K, Ca, Mg, Na, and Al analyses .

ANALYSIS

The samples were analyzed as follows:

Digestion Method - None

Instrumentation - Leemans Plasma Spec ICP and V.G. Plasma Quad P2 ICP/MS

Measurement Method - ICP/ AES

QA/QC - Duplicates, spikes, blanks, and calibration check solutions were used

RESULTS

See Tables 1-4

COMMENTS

No problems encountered.

SAMPLE CUSTODY

Samples will be kept for 3 months after report is delivered.

RTI Project No.: 7048-03E

Samples: Impinger Samples
Company: PES (P.O.# 104-98-0175)
Analyte: Trace metals
Method of Analysis: ICP
Sample Received Date: 4-9-98
Analysis Date: 4-16-98
Report Date: 4-23-98

Table 1. Results for Impinger Samples

Sample	Total Volume mL	K ug	Ca ug	Mg ug	Na ug	Al ug
M26A-I-2-A	371	8.87	150	30.1	151	< 20
M26A-O-2-A	493	78.9	233	45.8	119	< 27
M26A-FB-1-A(inlet)	241	< 4.3	63.6	12.5	75.0	< 13
M26A-I-5-A	227	9.51	145	18.6	47.9	< 12
M26A-O-5-A	269	< 4.8	291	33.1	29.6	16.1
M26A-FB-2-A(inlet)	197	< 3.5	80.8	10.2	27.0	< 11

Detection Limit : K - 0.018 ug/mL
Ca - 0.003 ug/mL
Mg - 0.001 ug/mL
Na - 0.065 ug/mL
Al - 0.054 ug/mL

RTI Project No.: 7048-03G

Samples: QC for Impinger Samples
Company: PES (P.O.# 104-98-0175)
Analyte: Trace metals
Method of Analysis: ICP
Sample Received Date: 4-9-98
Analysis Date: 4-16-98
Report Date: 4-23-98

Table 2. Calibration Check Sample

Sample	K ug/mL Measured	Ca ug/mL Measured	Mg ug/mL Measured	Na ug/mL Measured	Al ug/mL Measured
QC	0.0432	2.05	2.06	2.10	10.1
QC Epected	0.0500	2.00	2.00	2.00	10.0
QC	0.0497	1.01	10.0	5.12	20.1
QC Expected	0.0500	1.00	10.0	5.00	20.0

Table 3. Results of Blank and Spike Analysis

Sample	K, ug/mL Measured	Ca, ug/mL Measured	Mg, ug/mL Measured	Na, ug/mL Measured	Al, ug/mL Measured
RTI-Blk	< 0.018	< 0.003	< 0.001	< 0.065	< 0.054
M26-O-2A SPK	0.340	0.459	4.81	2.41	5.22
SPK Expected	0.400	0.500	5.00	2.50	5.00
% SPK Recovery	85.0	91.8	96.2	96.4	104

Table 4. Results of Duplicate Analysis

Sample	K, ug Measured	Ca, ug Measured	Mg, ug Measured	Na, ug Measured	Al, ug Measured
M26-O-5-A DUP	< 4.8	277	32.3	40.4	15.1

TECHNICAL REPORT

Client: Pacific Environmental Services

Purchase Order No.: 104-98-0175

RTI Project No.: 91C-7048-03E

Date: April 21, 1998

By

Eva D. Hardison
Research Triangle Institute
Post Office Box 12194
3040 Cornwallis Road
Research Triangle Park, NC 27709

(919) 541-5926

Submitted to:

Frank Phoenix
Pacific Environmental Services
5001 South Miami Blvd., Suite 300
Research Triangle Park, NC 27709

RTI

INTRODUCTION

Seven impinger samples were received under Purchase Order No. 104-98-0175 on April 9, 1998 for analysis of chloride and ammonium ions.

ANALYSIS

The samples were analyzed on a Dionex Model DX-500 Ion Chromatograph using conductivity detection and data reduction by Dionex PeakNet software. Chloride ion was analyzed using a Dionex AS12A anion separator column and ammonium ion was analyzed using a Dionex CS12 cation separator column. Quality control samples prepared by RTI and quality assurance samples prepared by the Environmental Protection Agency (EPA) were used to verify the calibrations. A sample matrix spike and a duplicate were also analyzed.

RESULTS

See spreadsheets.

COMMENTS

No problems were encountered.

SAMPLE CUSTODY

Samples will be kept for 3 months after the report is delivered.

Analysis of Impinger Absorbing Solutions for Cl and NH4
Pacific Environmental Services
PES P.O.# 104-98-0175
RTI Project No. 91C-7048-03E

Sample Receipt Date: 4/9/98
Sample Analysis Date: 4/15/98; 4/20/98
Report Date: 4/20/98

Sample ID	Cl, ug/mL	DF	Vol, mL	Cl, mg	as HCl mg	NH4, ug/mL	DF	Vol, mL	NH4, mg
M26A-I-4-A	0.102	100	226	2.31	2.38	0.670	25	226	3.79
M26A-I-5-A	0.177	100	227	4.02	4.14	0.976	25	227	5.54
M26A-I-6-A	0.153	100	226	3.46	3.56	0.883	25	226	4.99
M26A-O-4-A	0.107	100	239	2.56	2.63	1.232	25	239	7.36
M26A-O-5-A	0.112	100	269	3.01	3.10	1.089	25	269	7.32
M26A-O-6-A	0.163	100	236	3.85	3.96	1.514	25	236	8.93
M26A-FB-2-A	0.021	100	197	0.41		0.041	25	197	0.20

QA/QC for
Analysis of Impinger Absorbing Solutions for Cl and NH4
Pacific Environmental Services

Sample Receipt Date: 4/9/98
Sample Analysis Date: 4/15/98; 4/20/98
Report Date: 4/20/98

Sample ID		Cl, exp. mg/L	Cl, found mg/L	% Rec.	NH4, exp. mg/L	NH4, found mg/L	% Rec.
QA/QC:							
QA-MED		0.500	0.495	99.0	NA	NA	
QA-LOW		0.200	0.198	99.0	NA	NA	
QA-MED		0.495	0.495	100.0	NA	NA	
EPA-3909		0.502	0.519	103.4	NA	NA	
NH4 QA-1		NA	NA		5.000	4.844	96.9
NH4 QA-2		NA	NA		0.500	0.468	93.6
EPA-3177		NA	NA		0.444	0.406	91.4
Spikes:							
M26-I-6-A 1/100 DIL			0.153				
Spike		0.553	0.555	100.4			
M26A-O-6-A 1/25 DIL						1.514	
Spike					2.514	2.428	96.6
Duplicates:							
M26A-O-2-A	1/100 DIL		0.043				
M26A-O-2-A DUP	1/100 DIL		0.044				
M26A-O-1-A	1/25 DIL					0.019	
M26A-O-1-A DUP	1/25 DIL					0.018	

APPENDIX C

COMPUTER SUMMARIES AND EXAMPLE CALCULATIONS

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**
	MEASURED DATA	
γ	Meter Box Correction Factor	1.021
ΔH	Avg Meter Orifice Pressure, in. H_2O	2.07
P_{bar}	Barometric Pressure, inches Hg	29.50
V_m	Sample Volume, ft^3	133.796
T_m	Average Meter Temperature, °F	99.08
P_{static}	Stack Static Pressure, inches H_2O	-30.00
T_s	Average Stack Temperature, °F	472
CO_2	Carbon Dioxide content, % by volume	19.2
O_2	Oxygen content, % by volume	10.6
N_2	Nitrogen content, % by volume	70.2
C_p	Pitot Tube Coefficient	0.84
$\Delta p^{1/2}$	Average Square Root Δp, (in. $H_2O)^{1/2}$	0.9333
Θ	Sample Run Duration, minutes	180
D_n	Nozzle Diameter, inches	0.250
	CALCULATED DATA	
A_n	Nozzle Area, ft^2	0.00034
$V_{m(std)}$	Standard Meter Volume, dscf	127.805
$V_{m(std)}$	Standard Meter Volume, dscm	3.619
P_s	Stack Pressure, inches Hg	27.29
B_{ws}	Estimated Moisture, % by volume	4.50
V_{wstd}	Standard Water Vapor Volume, ft^3	6.022
$1-B_{ws}$	Dry Mole Fraction	0.955
M_d	Molecular Weight (d.b.), lb/lb•mole	31.50
M_s	Molecular Weight (w.b.), lb/lb•mole	30.89
V_s	Stack Gas Velocity, ft/s	70.5
A	Stack Area, ft^2	38.48
Q_a	Stack Gas Volumetric flow, acfm	162,732
Q_s	Stack Gas Volumetric flow, dscfm	80,260
$Q_{s(cmm)}$	Stack Gas Volumetric flow, dscmm	2,273
I	Isokinetic Sampling Ratio, %	99.9

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**
	EMISSIONS DATA	
	DIOXINS:	
	2378 TCDD	
ng	Catch, ng	(0.003)
ng/dscm	Concentration, ng/dscm, as measured	(0.000829)
µg/hr	Emission Rate, µg/hr	(0.113)
	Total TCDD	
ng	Catch, ng	0.02
ng/dscm	Concentration, ng/dscm, as measured	0.00553
µg/hr	Emission Rate, µg/hr	0.754
	12378 PeCDD	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00111)
µg/hr	Emission Rate, µg/hr	(0.151)
	Total PeCDD	
ng	Catch, ng	{0.003}
ng/dscm	Concentration, ng/dscm, as measured	{0.000829}
µg/hr	Emission Rate, µg/hr	{0.113}
	123478 HxCDD	
ng	Catch, ng	(0.006)
ng/dscm	Concentration, ng/dscm, as measured	(0.00166)
µg/hr	Emission Rate, µg/hr	(0.226)
	123678 HxCDD	
ng	Catch, ng	(0.005)
ng/dscm	Concentration, ng/dscm, as measured	(0.00138)
µg/hr	Emission Rate, µg/hr	(0.188)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**

EMISSIONS DATA -Continued

DIOXINS - Continued

	123789 HxCDD	
ng	Catch, ng	(0.005)
ng/dscm	Concentration, ng/dscm, as measured	(0.00138)
µg/hr	Emission Rate, µg/hr	(0.188)
	Total HxCDD	
ng	Catch, ng	0.01
ng/dscm	Concentration, ng/dscm, as measured	0.00276
µg/hr	Emission Rate, µg/hr	0.377
	1234678 HpCDD	
ng	Catch, ng	0.008
ng/dscm	Concentration, ng/dscm, as measured	0.00221
µg/hr	Emission Rate, µg/hr	0.301
	Total HpCDD	
ng	Catch, ng	0.02
ng/dscm	Concentration, ng/dscm, as measured	0.00553
µg/hr	Emission Rate, µg/hr	0.754
	OCDD	
ng	Catch, ng	0.04
ng/dscm	Concentration, ng/dscm, as measured	0.0111
µg/hr	Emission Rate, µg/hr	1.51
	Total PCDD	
ng	Catch, ng	{0.093}
ng/dscm	Concentration, ng/dscm, as measured	{0.0257}
µg/hr	Emission Rate, µg/hr	{3.50}

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**
	EMISSIONS DATA - Continued	
	FURANS	
	2378 TCDF	
ng	Catch, ng	0.14
ng/dscm	Concentration, ng/dscm, as measured	0.0387
µg/hr	Emission Rate, µg/hr	5.28
	Total TCDF	
ng	Catch, ng	2.6
ng/dscm	Concentration, ng/dscm, as measured	0.718
µg/hr	Emission Rate, µg/hr	98.0
	12378 PeCDF	
ng	Catch, ng	0.04
ng/dscm	Concentration, ng/dscm, as measured	0.0111
µg/hr	Emission Rate, µg/hr	1.51
	23478 PeCDF	
ng	Catch, ng	0.04
ng/dscm	Concentration, ng/dscm, as measured	0.0111
µg/hr	Emission Rate, µg/hr	1.51
	Total PeCDF	
ng	Catch, ng	0.38
ng/dscm	Concentration, ng/dscm, as measured	0.105
µg/hr	Emission Rate, µg/hr	14.3
	123478 HxCDF	
ng	Catch, ng	0.01
ng/dscm	Concentration, ng/dscm, as measured	0.00276
µg/hr	Emission Rate, µg/hr	0.377

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**
	EMISSIONS DATA - Continued	
	Furans - Continued	
	123678 HxCDF	
ng	Catch, ng	0.008
ng/dscm	Concentration, ng/dscm, as measured	0.00221
µg/hr	Emission Rate, µg/hr	0.301
	234678 HxCDF	
ng	Catch, ng	0.008
ng/dscm	Concentration, ng/dscm, as measured	0.00221
µg/hr	Emission Rate, µg/hr	0.301
	123789 HxCDF	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00111)
µg/hr	Emission Rate, µg/hr	(0.151)
	Total HxCDF	
ng	Catch, ng	0.05
ng/dscm	Concentration, ng/dscm, as measured	0.0138
µg/hr	Emission Rate, µg/hr	1.88
	1234678 HpCDF	
ng	Catch, ng	0.007
ng/dscm	Concentration, ng/dscm, as measured	0.00193
µg/hr	Emission Rate, µg/hr	0.264
	1234789 HpCDF	
ng	Catch, ng	(0.007)
ng/dscm	Concentration, ng/dscm, as measured	(0.00193)
µg/hr	Emission Rate, µg/hr	(0.264)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Inlet

	RUN NUMBER	**I-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1042-1355**
	EMISSIONS DATA - Continued	
	Furans - Continued	
	Total HpCDF	
ng	Catch, ng	0.007
ng/dscm	Concentration, ng/dscm, as measured	0.00193
µg/hr	Emission Rate, µg/hr	0.264
	OCDF	
ng	Catch, ng	(0.02)
ng/dscm	Concentration, ng/dscm, as measured	(0.00553)
µg/hr	Emission Rate, µg/hr	(0.754)
	Total PCDF	
ng	Catch, ng	(3.057)
ng/dscm	Concentration, ng/dscm, as measured	(0.845)
µg/hr	Emission Rate, µg/hr	(115)
	Total PCDD + PCDF	
ng	Catch, ng	(3.15)
ng/dscm	Concentration, ng/dscm, as measured	(0.870)
µg/hr	Emission Rate, µg/hr	(119)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 26A - HCl
Kiln No. 4 Baghouse Inlet

	RUN NUMBER	I-M26A-4	I-M26A-5	I-M26A-6	
	RUN DATE	3/28/98	3/28/98	3/28/98	Average
	RUN TIME	1430-1530	1635-1735	1801-1901	
	MEASURED DATA				
P_{static}	Stack Static Pressure, inches H_2O	-30.00	-30.00	-30.00	-30.00
γ	Meter Box Correction Factor	1.021	1.021	1.021	1.021
P_{bar}	Barometric Pressure, inches Hg	29.50	29.50	29.50	29.50
V_m	Sample Volume, ft^3	33 742	33.138	33.556	33.479
$\Delta p^{1/2}$	Average Square Root Δp, (in $H_2O)^{1/2}$	0.9110	0.9055	0.9280	0.9148
ΔH	Avg Meter Orifice Pressure, in. H_2O	1.10	1.07	1 11	1 09
T_m	Average Meter Temperature, °F	98.3	94 4	96.1	96.3
T_s	Average Stack Temperature, °F	488	497	516	501
V_{lc}	Condensate Collected, ml	33.6	31.9	34.2	33.2
CO_2	Carbon Dioxide content, % by volume	19.20	19.20	19.20	19.2
O_2	Oxygen content, % by volume	10.60	10.6	10.60	10.6
N_2	Nitrogen content, % by volume	70 2	70.2	70.2	70.2
C_p	Pitot Tube Coefficient	0 84	0.84	0.84	0.84
Θ	Sample Run Duration, minutes	60	60	60	60
D_n	Nozzle Diameter, inches	0.217	0.217	0.217	0.217
	CALCULATED DATA				
A_n	Nozzle Area, ft^2	0.000257	0.000257	0.000257	0.000257
$V_{m(std)}$	Standard Meter Volume, ft^3	32.197	31.844	32.149	32.063
$V_{m(std)}$	Standard Meter Volume, m^3	0.912	0 902	0.910	0.908
Q_m	Average Sampling Rate, dscfm	0.537	0.531	0.536	0.534
P_s	Stack Pressure, inches Hg	27.29	27.29	27.29	27.29
B_{ws}	Moisture, % by volume	4.7	4 5	4.8	4.7
V_{wstd}	Standard Water Vapor Volume, ft^3	1 582	1 502	1.610	1.564
$1-B_{ws}$	Dry Mole Fraction	0.953	0 955	0.952	0.953
M_d	Molecular Weight (d.b.), lb/lb•mole	31.50	31 50	31 50	31.50
M_s	Molecular Weight (w.b.), lb/lb•mole	30.86	30.89	30.85	30.87
V_s	Stack Gas Velocity, ft/s	69.4	69.3	71.8	70.2
A	Stack Area, ft^2	38.48	38.48	38.48	38.48
Q_a	Stack Gas Volumetric flow, acfm	147,378	160,007	165,684	157,689
Q_s	Stack Gas Volumetric flow, dscfm	71,314	76,841	77,822	75,326
Q_s	Stack Gas Volumetric flow, dscmm	2,019	2,176	2,204	2,133
I	Isokinetic Sampling Ratio, %	103.7	103.5	103.2	103.5

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 26A - HCl
Kiln No. 4 Baghouse Inlet

	RUN NUMBER	I-M26A-4	I-M26A-5	I-M26A-6	
	RUN DATE	3/28/98	3/28/98	3/28/98	Average
	RUN TIME	1430-1530	1635-1735	1801-1901	
	EMISSIONS DATA				
	Chlorides as HCl				
	Target Catch, mg	2.38	4.14	3.56	3.36
F_{Wt}	Formula Weight, lb/lb-mol	36.47	36.47	36.47	36.47
C_{ppmvd}	Concentration, ppm by volume	1.72	3.02	2.58	2.44
E_{HCl}	Emission Rate, lb/hr	0.696	1.32	1.14	1.05
	Chlorides as Cl				
	Target Catch, mg	2.31	4.02	3.46	3.26
F_{Wt}	Formula Weight, lb/lb-mol	35.45	35.45	35.45	35.45
C_{ppmvd}	Concentration, ppm by volume	1.72	3.02	2.58	2.44
E_{Cl}	Emission Rate, lb/hr	0.677	1.28	1.11	1.023
	Ammonia				
	Target Catch, mg	3.79	5.54	4.99	4.77
F_{Wt}	Formula Weight, lb/lb-mol	18 04	18.04	18.04	18.04
C_{ppmvd}	Concentration, ppm by volume	5.54	8.19	7.31	7.01
E_{NH4}	Emission Rate, lb/hr	1.11	1.77	1.60	1.49
	Aluminum, Al				
	Target Catch, ug	#N/A	(12)	#N/A	(12)
F_{Wt}	Formula Weight, lb/lb-mol	26.98	26.98	26.98	26.98
C_{ppmvd}	Concentration, ppm by volume	#N/A	(0.0119)	#N/A	(0.0119)
E_{Al}	Emission Rate, lb/hr	#N/A	(0.00383)	#N/A	(0.00383)
	Calcium, Ca				
	Target Catch, ug	#N/A	145	#N/A	145
F_{Wt}	Formula Weight, lb/lb-mol	40 08	40.08	40.08	40.08
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0965	#N/A	0.0965
E_{Ca}	Emission Rate, lb/hr	#N/A	0.0463	#N/A	0.0463
	Magnesium, Mg				
	Target Catch, ug	#N/A	18.6	#N/A	18.6
F_{Wt}	Formula Weight, lb/lb-mol	24.31	24.31	24.31	24.31
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0204	#N/A	0.0204
E_{Mg}	Emission Rate, lb/hr	#N/A	0.00594	#N/A	0.00594
	Potassium, K				
	Target Catch, ug	#N/A	9.51	#N/A	9.51
F_{Wt}	Formula Weight, lb/lb-mol	39.10	39.10	39.10	39.10
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.00649	#N/A	0.00649
E_K	Emission Rate, lb/hr	#N/A	0.00304	#N/A	0.00304
	Sodium, Na				
	Target Catch, ug	#N/A	47.9	#N/A	47.9
F_{Wt}	Formula Weight, lb/lb-mol	22.99	22.99	22.99	22.99
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0556	#N/A	0.0556
E_{Na}	Emission Rate, lb/hr	#N/A	0.0153	#N/A	0.0153

( ) - Not Detected

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	**O-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1044-1346**
	MEASURED DATA	
γ	Meter Box Correction Factor	1.000
ΔH	Avg Meter Orifice Pressure, in. H_2O	1.99
P_{bar}	Barometric Pressure, inches Hg	29.50
V_m	Sample Volume, ft^3	140.622
T_m	Average Meter Temperature, °F	88.2
P_{static}	Stack Static Pressure, inches H_2O	-0.51
T_s	Average Stack Temperature, °F	348
V_{lc}	Condensate Collected, ml	134.4
CO_2	Carbon Dioxide content, % by volume	19.2
O_2	Oxygen content, % by volume	10.6
N_2	Nitrogen content, % by volume	70.2
C_p	Pitot Tube Coefficient	0.84
$\Delta p^{1/2}$	Average Square Root Δp, (in. $H_2O)^{1/2}$	0.8517
Θ	Sample Run Duration, minutes	180.0
D_n	Nozzle Diameter, inches	0.250
	CALCULATED DATA	
A_n	Nozzle Area, ft^2	0.00034
$V_{m(std)}$	Standard Meter Volume, dscf	134.157
$V_{m(std)}$	Standard Meter Volume, dscm	3.799
P_s	Stack Pressure, inches Hg	29.46
B_{ws}	Moisture, % by volume	4.5
V_{wstd}	Standard Water Vapor Volume, ft^3	6.326
$1-B_{ws}$	Dry Mole Fraction	0.955
M_d	Molecular Weight (d.b.), lb/lb•mole	31.50
M_s	Molecular Weight (w.b.), lb/lb•mole	30.89
V_s	Stack Gas Velocity, ft/s	57.6
A	Stack Area, ft^2	37.80
Q_a	Stack Gas Volumetric flow, acfm	130,734
Q_s	Stack Gas Volumetric flow, dscfm	80,274
$Q_{s(cmm)}$	Stack Gas Volumetric flow, dscmm	2,273
I	Isokinetic Sampling Ratio, %	103.0

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	**O-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1044-1346**
	EMISSIONS DATA	
	DIOXINS:	
	2378 TCDD	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00105)
µg/hr	Emission Rate, µg/hr	(0.144)
	Total TCDD	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00105)
µg/hr	Emission Rate, µg/hr	(0.144)
	12378 PeCDD	
ng	Catch, ng	(0.006)
ng/dscm	Concentration, ng/dscm, as measured	(0.00158)
µg/hr	Emission Rate, µg/hr	(0.215)
	Total PeCDD	
ng	Catch, ng	(0.006)
ng/dscm	Concentration, ng/dscm, as measured	(0.00158)
µg/hr	Emission Rate, µg/hr	(0.215)
	123478 HxCDD	
ng	Catch, ng	(0.008)
ng/dscm	Concentration, ng/dscm, as measured	(0.00211)
µg/hr	Emission Rate, µg/hr	(0.287)
	123678 HxCDD	
ng	Catch, ng	(0.007)
ng/dscm	Concentration, ng/dscm, as measured	(0.00184)
µg/hr	Emission Rate, µg/hr	(0.251)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	O-M23-4
	RUN DATE	3/28/98
	RUN TIME	1044-1346
	EMISSIONS DATA -Continued	
	DIOXINS - Continued	
	123789 HxCDD	
ng	Catch, ng	(0.007)
ng/dscm	Concentration, ng/dscm, as measured	(0.00184)
µg/hr	Emission Rate, µg/hr	(0.251)
	Total HxCDD	
ng	Catch, ng	{0.009}
ng/dscm	Concentration, ng/dscm, as measured	{0.00237}
µg/hr	Emission Rate, µg/hr	{0.323}
	1234678 HpCDD	
ng	Catch, ng	{0.01}
ng/dscm	Concentration, ng/dscm, as measured	{0.00263}
µg/hr	Emission Rate, µg/hr	{0.359}
	Total HpCDD	
ng	Catch, ng	{0.01}
ng/dscm	Concentration, ng/dscm, as measured	{0.00263}
µg/hr	Emission Rate, µg/hr	{0.359}
	OCDD	
ng	Catch, ng	0.05
ng/dscm	Concentration, ng/dscm, as measured	0.0132
µg/hr	Emission Rate, µg/hr	1.80
	Total PCDD	
ng	Catch, ng	(0.079)
ng/dscm	Concentration, ng/dscm, as measured	(0.0208)
µg/hr	Emission Rate, µg/hr	(2.84)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	**O-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1044-1346**

EMISSIONS DATA - Continued

FURANS

	2378 TCDF	
ng	Catch, ng	(0.005)
ng/dscm	Concentration, ng/dscm, as measured	(0.00132)
µg/hr	Emission Rate, µg/hr	(0.180)
	Total TCDF	
ng	Catch, ng	0.17
ng/dscm	Concentration, ng/dscm, as measured	0.0447
µg/hr	Emission Rate, µg/hr	6.10
	12378 PeCDF	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00105)
µg/hr	Emission Rate, µg/hr	(0.144)
	23478 PeCDF	
ng	Catch, ng	(0.004)
ng/dscm	Concentration, ng/dscm, as measured	(0.00105)
µg/hr	Emission Rate, µg/hr	(0.144)
	Total PeCDF	
ng	Catch, ng	0.01
ng/dscm	Concentration, ng/dscm, as measured	0.00263
µg/hr	Emission Rate, µg/hr	0.359
	123478 HxCDF	
ng	Catch, ng	(0.005)
ng/dscm	Concentration, ng/dscm, as measured	(0.00132)
µg/hr	Emission Rate, µg/hr	(0.180)

( ) Not Detected. Value shown is the detection limit and is included in totals.

[ ] Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	**O-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1044-1346**
	EMISSIONS DATA - Continued	
	Furans - Continued	
	123678 HxCDF	
ng	Catch, ng	(0.005)
ng/dscm	Concentration, ng/dscm, as measured	(0.00132)
µg/hr	Emission Rate, µg/hr	(0.180)
	234678 HxCDF	
ng	Catch, ng	(0.006)
ng/dscm	Concentration, ng/dscm, as measured	(0.00158)
µg/hr	Emission Rate, µg/hr	(0.215)
	123789 HxCDF	
ng	Catch, ng	(0.006)
ng/dscm	Concentration, ng/dscm, as measured	(0.00158)
µg/hr	Emission Rate, µg/hr	(0.215)
	Total HxCDF	
ng	Catch, ng	0.008
ng/dscm	Concentration, ng/dscm, as measured	0.00211
µg/hr	Emission Rate, µg/hr	0.287
	1234678 HpCDF	
ng	Catch, ng	(0.007)
ng/dscm	Concentration, ng/dscm, as measured	(0.00184)
µg/hr	Emission Rate, µg/hr	(0.251)
	1234789 HpCDF	
ng	Catch, ng	(0.01)
ng/dscm	Concentration, ng/dscm, as measured	(0.00263)
µg/hr	Emission Rate, µg/hr	(0.359)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 23 - PCDDs/PCDFs
Kiln # 4 Baghouse Outlet

	RUN NUMBER	**O-M23-4**
	RUN DATE	**3/28/98**
	RUN TIME	**1044-1346**
	EMISSIONS DATA - Continued	
	Furans - Continued	
	Total HpCDF	
ng	Catch, ng	(0.008)
ng/dscm	Concentration, ng/dscm, as measured	(0.00211)
µg/hr	Emission Rate, µg/hr	(0.287)
	OCDF	
ng	Catch, ng	(0.01)
ng/dscm	Concentration, ng/dscm, as measured	(0.00263)
µg/hr	Emission Rate, µg/hr	(0.359)
	Total PCDF	
ng	Catch, ng	(0.206)
ng/dscm	Concentration, ng/dscm, as measured	(0.0542)
µg/hr	Emission Rate, µg/hr	(7.40)
	Total PCDD + PCDF	
ng	Catch, ng	(0.285)
ng/dscm	Concentration, ng/dscm, as measured	(0.0750)
µg/hr	Emission Rate, µg/hr	(10.2)

( ) Not Detected. Value shown is the detection limit and is included in totals.

{ } Estimated Maximum Possible Concentration. EMPC values are included in totals.

Summary of Stack Gas Parameters and Test Results
Air Emissions Screening Test
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 26A - HCl
Kiln No. 4 Baghouse Outlet
Page 1 of 2

	RUN NUMBER RUN DATE RUN TIME	O-M26A-4 3/28/98 1432-1532	O-M26A-5 3/28/98 1638-1738	O-M26A-6 3/28/98 1802-1902	Average
	MEASURED DATA				
P_{static}	Stack Static Pressure, inches H_2O	-0.53	-0.47	-0.47	-0.49
γ	Meter Box Correction Factor	1.000	1.000	1.000	1.000
P_{bar}	Barometric Pressure, inches Hg	29.50	29.50	29.50	29.50
V_m	Sample Volume, ft^3	46.613	46.498	46.964	46.692
$\Delta p^{1/2}$	Average Square Root Δp, (in. $H_2O)^{1/2}$	0.8536	0.8467	0.8567	0.8523
ΔH	Avg Meter Orifice Pressure, in. H_2O	2.03	2.01	2.06	2.03
T_m	Average Meter Temperature, °F	92.6	94.9	90.8	92.8
T_s	Average Stack Temperature, °F	352	349	358	353
V_{lc}	Condensate Collected, ml	46.9	44.3	50.5	47.2
CO_2	Carbon Dioxide content, % by volume	19.20	19.20	19.20	19.2
O_2	Oxygen content, % by volume	10.60	10.6	10.60	10.6
N_2	Nitrogen content, % by volume	70.2	70.2	70.2	70.2
C_p	Pitot Tube Coefficient	0.84	0.84	0.84	0.84
Θ	Sample Run Duration, minutes	60	60	60	60
D_n	Nozzle Diameter, inches	0.250	0.250	0.250	0.250
	CALCULATED DATA				
A_n	Nozzle Area, ft^2	0.000341	0.000341	0.000341	0.000341
$V_{m(std)}$	Standard Meter Volume, ft^3	44.116	43.822	44.602	44.180
$V_{m(std)}$	Standard Meter Volume, m^3	1.249	1.241	1.263	1.251
Q_m	Average Sampling Rate, dscfm	0.735	0.730	0.743	0.736
P_s	Stack Pressure, inches Hg	29.46	29.47	29.47	29.46
B_{ws}	Moisture, % by volume	4.8	4.5	5.1	4.8
V_{wstd}	Standard Water Vapor Volume, ft^3	2.208	2.085	2.377	2.223
$1-B_{ws}$	Dry Mole Fraction	0.952	0.955	0.949	0.952
M_d	Molecular Weight (d.b.), lb/lb•mole	31.50	31.50	31.50	31.50
M_s	Molecular Weight (w.b.), lb/lb•mole	30.85	30.88	30.81	30.85
V_s	Stack Gas Velocity, ft/s	57.9	57.3	58.4	57.9
A	Stack Area, ft^2	37.80	37.80	37.80	37.80
Q_a	Stack Gas Volumetric flow, acfm	131,380	130,038	132,462	131,293
Q_s	Stack Gas Volumetric flow, dscfm	80,103	79,736	79,877	79,905
Q_s	Stack Gas Volumetric flow, dscmm	2,268	2,258	2,262	2,263
I	Isokinetic Sampling Ratio, %	101.8	101.6	103.2	102.2

Summary of Stack Gas Parameters and Test Results
Air Emissions Screening Test
Dravo Lime Company - Saginaw, Alabama
US EPA Test Method 26A - HCl
Kiln No. 4 Baghouse Outlet

	RUN NUMBER	O-M26A-4	O-M26A-5	O-M26A-6	
	RUN DATE	3/28/98	3/28/98	3/28/98	Average
	RUN TIME	1432-1532	1638-1738	1802-1902	
	EMISSIONS DATA				
	Chlorides as HCl				
	Target Catch, mg	2.63	3.10	3.96	3.23
F_{Wt}	Formula Weight, lb/lb-mol	36.47	36.47	36.47	36.47
C_{ppmvd}	Concentration, ppm by volume	1.39	1.65	2.07	1.70
E_{HCl}	Emission Rate, lb/hr	0.633	0.745	0.938	0.772
	Chlorides as Cl				
	Target Catch, mg	2.56	3.01	3.85	3.14
F_{Wt}	Formula Weight, lb/lb-mol	35.45	35.45	35.45	35.45
C_{ppmvd}	Concentration, ppm by volume	1.39	1.65	2.07	1.70
E_{Cl}	Emission Rate, lb/hr	0.615	0.724	0.912	0.750
	Ammonia				
	Target Catch, mg	7.36	7.32	8.93	7.87
F_{Wt}	Formula Weight, lb/lb-mol	18.04	18.04	18.04	18.04
C_{ppmvd}	Concentration, ppm by volume	7.86	7.87	9.43	8.38
E_{NH4}	Emission Rate, lb/hr	1.77	1.76	2.12	1.88
	Aluminum, Al				
	Target Catch, ug	#N/A	16.1	#N/A	16.1
F_{Wt}	Formula Weight, lb/lb-mol	26.98	26.98	26.98	26.98
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0116	#N/A	0.0116
E_{Al}	Emission Rate, lb/hr	#N/A	0.00388	#N/A	0.00388
	Calcium, Ca				
	Target Catch, ug	#N/A	291	#N/A	291
F_{Wt}	Formula Weight, lb/lb-mol	40.08	40.08	40.08	40.08
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.141	#N/A	0.141
E_{Ca}	Emission Rate, lb/hr	#N/A	0.0700	#N/A	0.0700
	Magnesium, Mg				
	Target Catch, ug	#N/A	33.1	#N/A	33.1
F_{Wt}	Formula Weight, lb/lb-mol	24.31	24.31	24.31	24.31
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0264	#N/A	0.0264
E_{Mg}	Emission Rate, lb/hr	#N/A	0.00797	#N/A	0.00797
	Potassium, K				
	Target Catch, ug	#N/A	(4.8)	#N/A	(4.8)
F_{Wt}	Formula Weight, lb/lb-mol	39.10	39.10	39.10	39.10
C_{ppmvd}	Concentration, ppm by volume	#N/A	(0.00238)	#N/A	(0.00238)
E_K	Emission Rate, lb/hr	#N/A	(0.00116)	#N/A	(0.00116)
	Sodium, Na				
	Target Catch, ug	#N/A	29.6	#N/A	29.6
F_{Wt}	Formula Weight, lb/lb-mol	22.99	22.99	22.99	22.99
C_{ppmvd}	Concentration, ppm by volume	#N/A	0.0250	#N/A	0.0250
E_{Na}	Emission Rate, lb/hr	#N/A	0.00712	#N/A	0.00712

( ) - Not Detected

Example Calculations
Dravo Lime Company - Saginaw, Alabama
US EPA Method 23-PCDD/PCDF
(Using Data from Run O-4)

Note: Discrepancies may exist between the computer generated reported results, which use more significant figures, and the values manually calculated from the displayed values.

1. Volume of dry gas sampled corrected to standard conditions of 68°F, 29.92 in. Hg, ft^3.

$$V_{m(std)} = 17.64\, V_m Y \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{460 + t_m} \right)$$

$$V_{m(std)} = (17.64)(140.622)(1.000) \left(\frac{29.5 + \frac{1.992}{13.6}}{460 + 88.17} \right)$$

$$V_{m(std)} = 134.157 \text{ dscf}$$

2. Volume of dry gas sampled corrected to standard conditions of 68°F, 29.92 in. Hg, m^3.

$$V_{m(std)m^3} = V_{m(std)}(0.028317)$$

$$V_{m(std)m^3} = (134.157)(0.028317)$$

$$V_{m(std)m^3} = 3.799 \text{ dscm}$$

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

$$V_{w(std)} = 0.04707\, V_{lc}$$

$$V_{w(std)} = (0.04707)(134.4)$$

$$V_{w(std)} = 6.326 \text{ scf}$$

4. Moisture content in stack gas.

$$B_{ws} = \frac{V_{w(std)}}{\left(V_{m(std)} + V_{w(std)}\right)}$$

$$B_{ws} = \frac{6.326}{134.157 + 6.326}$$

$$B_{ws} = 0.0450$$

5. Dry molecular weight of stack gas, lb/lb-mol.

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO)$$

$$M_d = 0.44(19.2) + 0.32(10.6) + 0.28(70.2 + 0)$$

$$M_d = 31.50 \text{ lb/lbmol}$$

6. Molecular weight of stack gas, lb/lb-mol.

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

$$M_s = 31.50(1 - 0.0450) + 18(0.0450)$$

$$M_s = 31.50(0.9550) + 18(0.0450)$$

$$M_s = 30.0825 + 0.810$$

$$M_s = 30.89 \text{ lb/lbmol}$$

7. Absolute stack gas pressure, in. Hg.

$$P_s = P_{bar} + \frac{P_{static}}{13.6}$$

$$P_s = 29.5 + \frac{(-0.51)}{13.6}$$

$$P_s = 29.46 \text{ inches Hg}$$

8. Stack velocity at stack conditions, fps.

$$v_s = 85.49\ C_p \left(\sqrt{\Delta P}\right)_{avg} \sqrt{\frac{t_s + 460}{M_s\ P_s}}$$

$$v_s = (85.49)(0.84)(0.8517) \sqrt{\frac{(348.3 + 460)}{(30.89)(29.46)}}$$

$$v_s = 57.64 \text{ fps}$$

9. Isokinetic Variation.

$$\%I = \frac{\left(V_{m(std)}\right)\left(t_s + 460\right)(17.32)}{\left(v_s\right)\left(D_n^2\right)(\theta)\left(P_s\right)\left(1 - B_{ws}\right)}$$

$$\%I = \frac{(134.157)\ (348.3 + 460)\ (17.32)}{(57.64)\ (0.250)^2\ (180)\ (29.46)\ (1 - 0.0450)}$$

$$\%I = 103.0$$

10. Stack gas volumetric flow rate at stack conditions, acfm.

$$Q_s = (60)\ (A)\ (v_s)$$

$$Q_s = (60)\ (37.80)\ (57.64)$$

$$Q_s = 130{,}734 \text{ acfm}$$

11. Dry stack gas volumetric flow rate at standard conditions, dscfm.

$$Q_{s(std)} = 17.64\ Q_s \frac{P_s}{(t_s + 460)} \left(1 - B_{ws}\right)$$

$$Q_{s(std)} = (17.64)\ (130{,}734) \left(\frac{29.46}{348.3 + 460}\right) (1 - 0.0450)$$

$$Q_{s(std)} = 80{,}274 \text{ dscfm}$$

12. Dry stack gas volumetric flow rate at standard conditions, dscmm.

$$Q_{s(std)m^3/min} = Q_{s(std)}\ 0.028317$$

$$Q_{s(std)m^3/min} = (80{,}274)\ (0.028317)$$

$$Q_{s(std)m^3/min} = 2{,}273 \text{ dscmm}$$

13. Pollutant (2378 TCDD) concentration, ng/dscm.

$$\text{ng/dscm} = \frac{\text{ng}}{V_{m(std)m^3}}$$

$$\text{ng/dscm} = \frac{< 0.004}{3.799}$$

$$\text{ng/dscm} = < 0.00105 \text{ ng/dscm}$$

14. Pollutant (2378 TCDD) concentration, ng/dscm adjusted to 7 percent oxygen.

$$\text{ng/dscm@7\%O}_2 = (\text{ng/dscm}) \frac{(20.9 - 7)}{(20.9 - \%O_2)}$$

$$\text{ng/dscm@7\%O}_2 = (< 0.00105) \frac{13.9}{(20.9 - 10.6)}$$

$$\text{ng/dscm@7\%O}_2 = < 0.00142 \text{ ng/dscm@7\%O}_2$$

15. Pollutant (2378 TCDD) emission rate, μg/hr.

$$\mu\text{g/hr} = \frac{(60)\ (\text{ng})\ (Q_{s(std)})}{(10^3)\ (V_{m(std)})}$$

$$\mu\text{g/hr} = \frac{(60)\ (< 0.004)\ (80{,}274)}{(10^3)\ (134.157)}$$

$$\mu\text{g/hr} = < 0.144\ \mu\text{g/hr}$$

APPENDIX D

CALIBRATION DATA

4E

PACIFIC ENVIRONMENTAL SERVICES, INC.

4700 Duke Drive,
Suite 150
Mason, Ohio 45040
Phone: (513) 398-2556
Fax (513) 398-3342
www.pes.com

Pitot Tube Number: 4E

Date: 12/23/97

Effective Length: 49"

Calibrated By: S. Simon

Pitot Tube Openings Damaged? YES [NO]

Pitot Tube Assembly Level? [YES] NO

α_1 = 0 °(< 10°)

α_2 = 1 °(< 10°)

β_1 = 1 °(< 5°)

β_2 = 3 °(< 5°)

Y = 0 θ = 1 A = 0.973

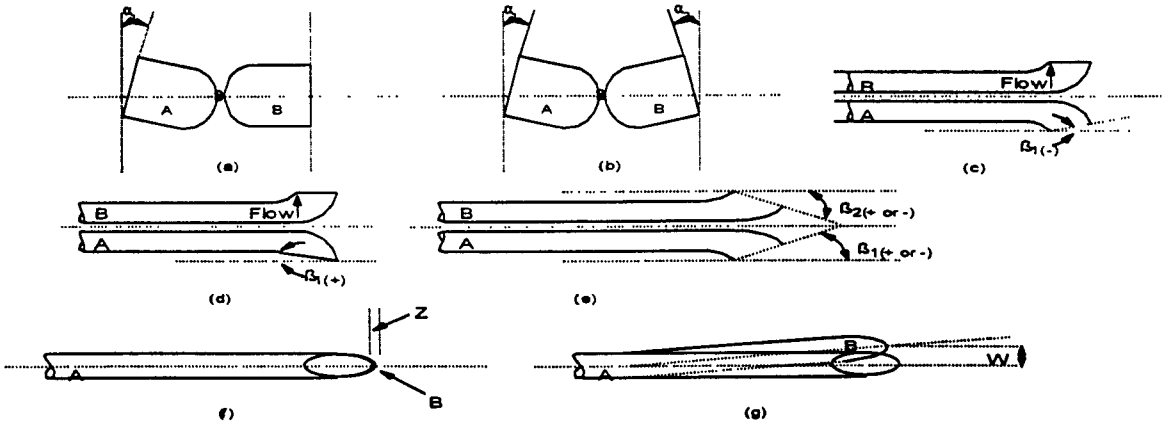
z = A sin γ = 0 cm (in.) 0.32 cm (< 1/8 in.)

w = A sin θ = 0.0170 cm (in.) 0.08 cm (< 1/32 in.)

P_A = 0.487 cm (in.)

P_β = 0.486 cm (in.)

D_t = 0.375 cm (in.)



The types of face-opening misalignment shown above will not affect the baseline value of Cp(s) so long as α_1 and α_2 is less than or equal to 10°, β_1 and β_2 is less than or equal to 5°, z is less than or equal to 0.32 cm (1/8 in.), and w is less than or equal to 0.08 cm(1/32 in.) (reference 11.0 in Section 16.0)

Assigned Pitot Coefficient, C_p: 0.84

PACIFIC ENVIRONMENTAL SERVICES, INC.

4700 Duke Drive,
Suite 150
Mason, Ohio 45040
Phone: (513) 398-2556
Fax (513) 398-3342
www.pes.com

Pitot Tube Number: 7D Date: 12/23/97

Effective Length: 84.5" Calibrated By: S. Simon

Pitot Tube Openings Damaged? YES [NO]

Pitot Tube Assembly Level? [YES] NO

α_1 = 3 °(< 10°) α_2 = 3 °(< 10°)

β_1 = 1 °(< 5°) β_2 = 1 °(< 5°)

Y = 1 θ = 0 A = 0.931

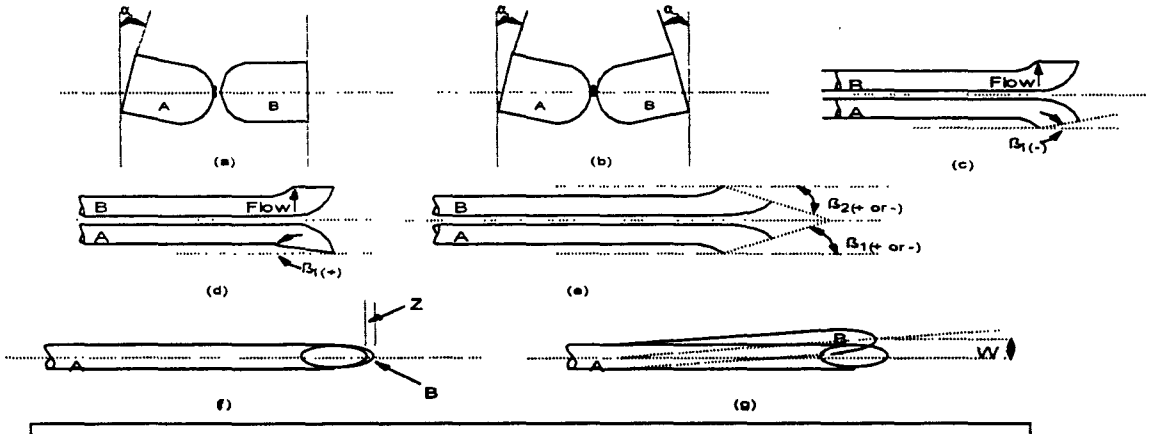
$z = A \sin \gamma$ = 0.016 cm (in.) 0.32 cm (< 1/8 in.)

$w = A \sin \theta$ = 0 cm (in.) 0.08 cm (< 1/32 in.)

P_A = 0.466 cm (in.)

P_β = 0.465 cm (in.)

D_t = 0.375 cm (in.)



The types of face-opening misalignment shown above will not affect the baseline value of Cp(s) so long as α_1 and α_2 is less than or equal to 10°, β_1 and β_2 is less than or equal to 5°, z is less than or equal to 0.32 cm (1/8 in.), and w is less than or equal to 0.08 cm(1/32 in.) (reference 11.0 in Section 16.0).

PACIFIC ENVIRONMENTAL SERVICES,INC.

4700 Duke Drive,
Suite 150
Mason, Ohio
Phone: (513) 398-2556
Fax: (513) 3983342
www.pes.com

TEMPERATURE SENSOR CALIBRATION DATA FOR STACK THERMOCOUPLES

THERMOCOUPLE NUMBER: 4E

DATE: 12/23/97

BAROMETRIC PRES.(In.Hg): 29.52

REFERENCE:
Mercury-in-glass: ASTM-3F

Other:

AMBIENT TEMP. °F: 74

CALIBRATOR: G.Gay

Reference point number	Source[a] (Specify)	Reference Thermometer Temperature,°F	Thermocouple Potentiometer Temperature,°F	Temperature Difference,[b] %
1	Ambient Air	74	74	0.00
2	Cold Bath	38	38	0.00
3	Hot Bath	203	202	0.15
4	Hot Oil	339	340	0.13

[a]Type of calibration used.

[b]$\frac{(\text{ref. temp.}°F+460)-(\text{test thermometer temp.}°F+460)}{\text{ref temp.}°F+460} \times 100$ $100 \leq 1.5\%$

Comments:

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Suite 150
Mason, Ohio
Phone: (513) 398-2556
Fax: (513) 3983342
www.pes.com

TEMPERATURE SENSOR CALIBRATION DATA FOR STACK THERMOCOUPLES

THERMOCOUPLE NUMBER: 7D **DATE:** 12/23/97

BAROMETRIC PRES.(In.Hg): 29.52 **REFERENCE:**
Mercury-in-glass: ASTM-3F

Other:

AMBIENT TEMP. °F: 74 **CALIBRATOR:** G. Gay

Reference point number	Source[a] (Specify)	Reference Thermometer Temperature,°F	Thermocouple Potentiometer Temperature,°F	Temperature Difference,[b] %
1	Ambient Air	74	74	0.00
2	Cold Bath	40	41	0.20
3	Hot Bath	206	205	0.15
4	Hot Oil	340	341	0.13

[a]Type of calibration used.

[b]$\frac{(\text{ref. temp,°F}+460)-(\text{test thermometer temp,°F}+460)}{\text{ref temp,°F}+460}$ X100 100≤1.5%

Comments:

TEMPERATURE SENSOR CALIBRATION FORM

DGM-IN

Temperature Sensor No. MB-10 Sensor Type K-TC Length 8"
Ambient Temp. °F 76 Barometric Pressure, "Hg 29.61"
Reference Temp. Sensor: _____

Date	Ref. Point No.	Temp. Source	Temp. °F		Temp. Diff. %	Within Limits Y/N	Calibrated By
			Ref. Sensor	Test Sensor			
3-20-98	1	ICE H_2O	33	34			
"	2	AMB. AIR	76	76	0		
"	3	BOIL H_2O	206	205			
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						

$$\% \text{ Temp. Diff} = \frac{(\text{Ref. Temp} + 460) - (\text{Test Temp.} + 460)}{(\text{Ref. Temp.} + 460)} \times 100 \leq 1.5\ \%$$

TEMPERATURE SENSOR CALIBRATION FORM

DGM-007

Temperature Sensor No. MB-10 Sensor Type K-TC Length 12"
Ambient Temp. °F 76 Barometric Pressure, "Hg 29.61"
Reference Temp. Sensor: _____

Date	Ref. Point No.	Temp. Source	Temp. °F		Temp. Diff. %	Within Limits Y/N	Calibrated By
			Ref. Sensor	Test Sensor			
3-20-98	1	ICE H2O	32	34	.406	Y	WB
"	2	AMB, AIR	76	77	.186	Y	WB
"	3	BOIL H2O	206	208	.150	Y	WB
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						

$$\% \text{ Temp. Diff} = \frac{(\text{Ref. Temp} + 460) - (\text{Test Temp.} + 460)}{(\text{Ref. Temp.} + 460)} \times 100 \leq 1.5\ \%$$

TEMPERATURE SENSOR CALIBRATION FORM

Temperature Sensor No. RMB-15 DGM-1D Sensor Type K-TC Length 1'
Ambient Temp. °F 74 Barometric Pressure, "Hg 30.24"
Reference Temp. Sensor: _____

Date	Ref. Point No.	Temp. Source	Temp. °F		Temp. Diff. %	Within Limits Y/N	Calibrated By
			Ref. Sensor	Test Sensor			
3-18-98	1	ICE H2O	33	35	.406	Y	KWB
"	2	AMB. AIR	74	74	0	Y	KWB
"	3	Boil. H2O	208	210	.279	Y	KWB
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						

$$\% \text{ Temp. Diff} = \frac{(\text{Ref. Temp} + 460) - (\text{Test Temp.} + 460)}{(\text{Ref. Temp.} + 460)} \times 100 \leq 1.5\ \%$$

TEMPERATURE SENSOR CALIBRATION FORM

Temperature Sensor No. RMB-15 DCM-OUT Sensor Type K-TC Length 2'
Ambient Temp. °F 74 Barometric Pressure, "Hg 30.24"
Reference Temp. Sensor: _____

Date	Ref. Point No.	Temp. Source	Temp. °F		Temp. Diff. %	Within Limits Y/N	Calibrated By
			Ref. Sensor	Test Sensor			
3-18-98	1	ICE H_2O	33	33	0	Y	WB
"	2	AMB AIR	74	75	.187	Y	WB
"	3	BOIL. H_2O	208	208	0	Y	WB
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						
	1						
	2						
	3						

$$\% \text{ Temp. Diff} = \frac{(\text{Ref. Temp} + 460) - (\text{Test Temp.} + 460)}{(\text{Ref. Temp.} + 460)} \times 100 \leq 1.5\ \%$$

From: **"Paul Siegel" <PSIEGEL@cin.pes.com>**
Organization: **Pacific Environmental Services**
To: **Estewart@rtp.pes.com**
Date sent: **Wed, 5 Aug 1998 21:04:52 -0500**
Subject: **Alabama Lime Kiln Testing**
Priority: **normal**

Mr. Stewart,

All pre and post leak-checks performed during the Alabama lime kiln testing program were less than 0.020 cubic feet during a one minute period. All pre-test leak-checks were conducted under a minimum of 15 inches of vacuum. All post-test leak-checks were conducted at a vacuum rate of 1 inch greater than the highest vacuum measured during the sample run. If you have any questions or need any additional comments, please call or e-mail.

Paul Siegel

PACIFIC ENVIRONMENTAL SERVICES, INC.
Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Initial Dry Gas Meter Calibration Form (English Units)

Date: 9/1/97 Calibrator: Tom McDonald Meter Box No.: MB-10

P_{bar}, in Hg 30.16 Reference Meter Correction Factor: 1.0049 (8/28/96)

ΔH = 0.5		Dry Gas Meter MB-10								
	Trial Duration	Gas Volume			Meter Temperatures					
Trial	(min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	19	994.409	1001.982	7.573	74	78	76	73	75	74
2	19	1001.982	1009.513	7.531	77	80	78.5	75	77	76
3	19	1009.513	1017.050	7.537	80	81	80.5	77	78	77.5

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H_2O)
1	600.523	608.185	7.662	72	74	73	1.019	1.71
2	608.185	615.801	7.616	74	76	75	1.019	1.74
3	615.801	623.430	7.629	76	77	76.5	1.021	1.74

ΔH = 0.75		Dry Gas Meter MB-10								
	Trial Duration	Gas Volume			Meter Temperatures					
Trial	(min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	15	17.220	24.350	7.130	80	82	81	78	79	78.5
2	15	24.350	31.563	7.213	82	83	82.5	79	79	79
3	15	31.563	38.780	7.217	82	83	82.5	79	81	80

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H_2O)
1	623.622	630.833	7.211	77	77	77	1.020	1.82
2	630.833	638.141	7.308	78	78	78	1.021	1.77
3	638.141	645.425	7.284	78	78.5	78.25	1.018	1.79

ΔH = 1.0		Dry Gas Meter MB-10								
	Trial Duration	Gas Volume			Meter Temperatures					
Trial	(min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	10	38.946	44.490	5.544	81	83	82	80	80	80
2	10	44.490	50.050	5.560	83	84	83.5	80	80	80
3	10	50.050	55.585	5.535	84	84	84	80	80	80

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H_2O)
1	645.614	651.22	5.606	78	78	78	1.019	1.79
2	651.220	656.829	5.609	78	78	78	1.018	1.78
3	656.829	662.435	5.606	78	78	78	1.023	1.78

PACIFIC ENVIRONMENTAL SERVICES, INC.
Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

ΔH = 2.0		Dry Gas Meter MB-10								
	Trial	Gas Volume			Meter Temperatures					
Trial	Duration (min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	10	55.868	63.519	7.651	84	86	85	81	81	81
2	10	63.519	71.182	7.663	86	86	86	81	81	81
3	10	71.182	78.845	7.663	86	87	86.5	81	81	81

	Reference Meter						Meter Box	Reference
	Gas Volume			Meter Temperature			Correction	Orifice Press
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	Factor γ	$\Delta H_@$ (in. H_2O)
1	662.729	670.472	7.743	78	78	78	1.021	1.87
2	670.472	678.244	7.772	78	78	78	1.025	1.86
3	678.244	686.010	7.766	78	78	78	1.024	1.86

ΔH = 4.0		Dry Gas Meter MB-10								
	Trial	Gas Volume			Meter Temperatures					
Trial	Duration (min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	8	79.058	86.620	7.562	85	88	86.5	81	82	81.5
2	8	86.620	94.185	7.565	87	89	88	82	82	82
3	8	94.185	101.754	7.569	89	89	89	82	82	82

	Reference Meter						Meter Box	Reference
	Gas Volume			Meter Temperature			Correction	Orifice Press
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	Factor γ	$\Delta H_@$ (in. H_2O)
1	686.208	693.895	7.687	78	78	78	1.023	2.44
2	693.895	701.558	7.663	78	78	78	1.021	2.45
3	701.558	709.244	7.686	78	78	78	1.025	2.43

Calibration Results

ΔH	γ	$\Delta H_@$
0.50	1.020	1.73
0.75	1.020	1.79
1.0	1.020	1.78
2.0	1.023	1.86
4.0	1.023	2.44

Dry Gas Meter MB-10 on 09/01/97

Meter Box Calibration Factor	**1.021**
Meter Box Reference Orifice Pressure	**1.92**

PACIFIC ENVIRONMENTAL SERVICES, INC.

Central Park West
5001 South Miami Boulevard, P.O. Box 12077
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Posttest Dry Gas Meter Calibration Form (English Units)

Pretest Calibration Factor 1.021
System Vacuum Setting, (in Hg) 16
Reference Meter Correction Factor 1.0077
Date: 5/2/98 P_{bar}, in Hg 29.94 Calibrator: D. Holzschuh Meter Box No. MB-10

ΔH = 1.41		Dry Gas Meter								
Trial	Duration (min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inle (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	Final, Outlet (°F)	Avg. Outlet (°F)
1	15	902.1	912.624	10.524	75	76	75.5	74	74	74
2	8	912.624	917.993	5.369	76	76	76	74	74	74
3	8	917.493	923.154	5.661	76	76	76	74	74	74

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H2O)
1	320.645	331.244	10.601	75	75	75	1.011	1.59
2	331.244	336.545	5.301	72	73	72.5	0.996	1.79
3	336.545	341.865	5.32	73	73	73	0.947	1.78

[redacted]

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Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Initial Dry Gas Meter Calibration Form (English Units)

Date: 10/13/97 Calibrator: MMD Meter Box No.: RMB-15

P_{bar}, in Hg 29.86 Reference Meter Correction Factor: 1.0077 (10/5/97)

ΔH = 0.5

Trial	Trial Duration (min)	Dry Gas Meter RMB-15 Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperatures Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	15	48.833	54.722	5.889	73	77	75	72	75	73.5
2	13	54.722	59.821	5.099	78	80	79	74	75	74.5
3	12	59.821	64.544	4.723	80	83	81.5	76	77	76.5

Trial	Reference Meter Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperature Initial (°F)	Final (°F)	Avg. (°F)	Meter Box Correction Factor γ	Reference Orifice Press $\Delta H_@$ (in. H_2O)
1	34.044	39.829	5.785	70	70	70	0.997	1.86
2	39.829	44.843	5.014	71	70	70.5	1.001	1.86
3	44.843	49.463	4.620	71	71	71	0.999	1.86

ΔH = 0.75

Trial	Trial Duration (min)	Dry Gas Meter RMB-15 Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperatures Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	8	69.524	73.327	3.803	74	74	74	77	75	76
2	21	73.327	83.322	9.995	77	83	80	76	77	76.5
3	13	83.322	89.571	6.249	78	82	80	78	74	76

Trial	Reference Meter Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperature Initial (°F)	Final (°F)	Avg. (°F)	Meter Box Correction Factor γ	Reference Orifice Press $\Delta H_@$ (in. H_2O)
1	54.365	58.108	3.743	72	72	72	0.996	1.91
2	58.108	67.912	9.804	72	73	72.5	0.997	1.91
3	67.912	74.036	6.124	73	73	73	0.995	1.88

ΔH = 1.0

Trial	Trial Duration (min)	Dry Gas Meter RMB-15 Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperatures Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	19	89.777	100.214	10.437	82	86	84	79	80	79.5
2	8	100.214	104.614	4.400	85	87	86	81	81	81
3	16	104.614	113.404	8.790	85	88	86.5	82	83	82.5

Trial	Reference Meter Gas Volume Initial (ft^3)	Final (ft^3)	Net (ft^3)	Meter Temperature Initial (°F)	Final (°F)	Avg. (°F)	Meter Box Correction Factor γ	Reference Orifice Press $\Delta H_@$ (in. H_2O)
1	74.254	84.44	10.186	73	73	73	0.997	1.92
2	84.440	88.743	4.303	73	73	73	1.002	1.91
3	88.743	97.302	8.559	73	73	73	1.000	1.92

PACIFIC ENVIRONMENTAL SERVICES, INC.
Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

ΔH = 2.0	Dry Gas Meter RMB-15									
	Trial Duration	Gas Volume			Meter Temperatures					
Trial	(min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	9	13.863	20.884	7.021	87	91	89	83	83	83
2	7	20.884	26.372	5.488	90	92	91	84	84	84
3	7	26.372	31.871	5.499	90	93	91.5	84	84	84

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H_2O)
1	97.749	104.591	6.842	73	73	73	1.001	1.90
2	104.591	109.929	5.338	73	73	73	1.002	1.89
3	109.929	115.281	5.352	73	74	73.5	1.002	1.88

ΔH = 4.0	Dry Gas Meter RMB-15									
	Trial Duration	Gas Volume			Meter Temperatures					
Trial	(min)	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial, Inlet (°F)	Final, Inlet (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	inal, Outle (°F)	Avg. Outlet (°F)
1	6.5	32.371	39.484	7.113	92	94	93	85	85	85
2	15.5	39.484	56.484	17.000	93	97	95	87	87	87

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft^3)	Final (ft^3)	Net (ft^3)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H_2O)
1	15.775	22.732	6.957	73	74	73.5	1.004	1.92
2	22.732	39.287	16.555	73	73	73	1.005	1.92

Calibration Results

ΔH	γ	$\Delta H_@$	
0.50	0.999	1.86	
0.75	0.996	1.90	
1.0	1.000	1.92	
2.0	1.002	1.89	
4.0	1.004	1.92	<— Two Trial Average

Dry Gas Meter RMB-15 on 10/13/97

Meter Box Calibration Factor	**1.000**
Meter Box Reference Orifice Pressure	**1.90**

PACIFIC ENVIRONMENTAL SERVICES, INC.

Central Park West
5001 South Miami Boulevard, P.O. Box 12077
Research Triangle Park, North Carolina 27709-2077
(919) 941-0333 FAX: (919) 941-0234

Posttest Dry Gas Meter Calibration Form (English Units)

Pretest Calibration Factor 1.000
System Vacuum Setting, (in Hg) 12
Reference Meter Correction Factor 1.0077
Date: 5/2/98 P_{bar}, in Hg 29.94 Calibrator: D. Holzschuh Meter Box No. MB-15

ΔH = 1.41		Dry Gas Meter								
Trial	Duration (min)	Initial (ft³)	Final (ft³)	Net (ft³)	Initial, Inlet (°F)	Final, Inle (°F)	Avg. Inlet (°F)	Initial, Outlet (°F)	Final, Outlet (°F)	Avg. Outlet (°F)
1	8	776.09	781.709	5.619	71	73	72	69	70	69.5
2	8	781.709	787.439	5.730	73	73	73	70	71	70.5
3	11	787.439	795.344	7.905	73	73	73	71	71	71

	Reference Meter						Meter Box Correction Factor	Reference Orifice Press
	Gas Volume			Meter Temperature				
Trial	Initial (ft³)	Final (ft³)	Net (ft³)	Initial (°F)	Final (°F)	Avg. (°F)	γ	$\Delta H_@$ (in. H2O)
1	343.209	348.9	5.691	72	72	72	1.015	1.56
2	348.9	354.597	5.697	72	72	72	0.998	1.56
3	354.597	362.414	7.817	72	72	72	0.993	1.56

[redacted]

REFERENCE METER CALIBRATION
ENGLISH REFERENCE METER UNITS

Barometric Pressure 29.82
Meter Yw 1.00000
K (deg R/inches Hg) 17.64

DGM Serial # 6841495
Date 10/5/97

Filename: F:\DATAFILE\CALIBRAT\CAL_MENU.DSK\DGM_REF.
Revised: 06/08/95

Time (min)	Pressure (in. H20)	Dry Gas Meter (DGM) Meter Readings Initial	Final	Volume (cubic feet)	Temperature Initial (deg F)	Final (deg F)	Wet Test Meter (WTM) Meter Readings Initial	Final	Volume (cubic feet)	Temp (deg F)	DGM Coefficient Yds	Coefficient Variation Yds-(Avg.Yds)	Flow Rate (CFM)
20.50	-8.000	742.719	768.193	25.474	78.0	79.0	671.890	697.180	25.290	77.0	1.016	0.002	1.208
5.00	-8.000	768.193	774.402	6.209	79.0	79.0	697.180	703.325	6.145	77.0	1.013	0.000	1.204
13.00	-8.000	774.402	790.575	16.173	79.0	79.0	703.325	719.309	15.984	77.0	1.012	-0.002	1.204
									Max Yds - Min Yds =0.003626886 Must be no greater than 0.030				
									Average Yds =1.013636253 Must be between 0.95 to 1.05				
8.50	-5.400	790.575	798.821	8.246	79.0	79.0	719.309	727.485	8.176	77.0	1.009	0.001	0.942
27.50	-5.400	798.821	825.423	26.602	79.0	80.0	727.485	753.809	26.324	77.0	1.008	0.000	0.938
26.50	-5.400	825.423	850.983	25.560	80.0	81.0	753.809	779.025	25.216	77.0	1.006	-0.001	0.932
									Max Yds - Min Yds =0.002262496 Must be no greater than 0.030				
									Average Yds =1.007525980 Must be between 0.95 to 1.05				
14.00	-3.800	850.983	861.899	10.916	81.0	81.0	779.025	789.820	10.795	77.0	1.006	0.001	0.755
15.50	-3.800	861.899	873.960	12.061	81.0	82.0	789.820	801.740	11.920	77.0	1.006	0.001	0.753
12.50	-3.800	953.219	962.970	9.751	86.0	86.0	879.651	889.205	9.554	78.0	1.004	-0.001	0.747
									Max Yds - Min Yds =0.002245979 Must be no greater than 0.030				
									Average Yds =1.005164785 Must be between 0.95 to 1.05				
23.50	-2.400	962.970	976.611	13.641	86.0	87.0	889.205	902.599	13.394	78.0	1.003	-0.001	0.557
17.50	-2.400	976.611	986.740	10.129	87.0	87.0	902.599	912.545	9.946	78.0	1.004	0.000	0.556
15.00	-2.400	986.740	995.413	8.673	87.0	88.0	912.545	921.069	8.524	78.0	1.006	0.002	0.556
									Max Yds - Min Yds =0.002785363 Must be no greater than 0.030				
									Average Yds =1.004591811 Must be between 0.95 to 1.05				
32.00	-1.600	995.413	1008.596	13.183	88.0	89.0	921.069	934.025	12.956	78.0	1.006	-0.002	0.396
35.00	-1.600	1008.596	1022.986	14.390	89.0	89.0	934.025	948.175	14.150	78.0	1.007	0.000	0.395
15.00	-1.600	1022.986	1029.158	6.172	89.0	90.0	948.175	954.255	6.080	78.0	1.010	0.002	0.396
									Max Yds - Min Yds =0.004205886 Must be no greater than 0.030				
									Average Yds =1.007822494 Must be between 0.95 to 1.05				

Overall Average Yds =1.007748265

I certify that the above Dry Gas Meter was calibrated in accordance with E.P.A. Method 5 , paragraph 7.1 ;CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature _____ Date 10-5-97

REFERENCE METER CALIBRATION
ENGLISH REFERENCE METER UNITS

DGM Serial # 6841495
Date 8/28/96

Filename: F:\DATAFILE\CALIBRAT\CAL_MENU.DSK\DGM_REF.
Revised: 06/08/95

Barometric Pressure 29.73
Meter Yw 1.00000
K (deg R/inches Hg) 17.64

Time (min)	Pressure (in. H20)	Dry Gas Meter (DGM) Meter Readings Initial	Final	Volume (cubic feet)	Temperature Initial (deg F)	Final (deg F)	Wet Test Meter (WTM) Meter Readings Initial	Final	Volume (cubic feet)	Temp (deg F)	DGM Coefficient Yds	Coefficient Variation Yds-(Avg.Yds)	Flow Rate (CFM)
6.00	-6.60	374.451	381.901	7.450	73.0	76.0	496.572	503.987	7.415	77.0	1.007	-0.004	1.207
24.00	-6.60	381.901	411.424	29.523	74.0	76.0	503.987	533.471	29.484	77.0	1.011	0.000	1.200
8.00	-6.60	411.424	421.233	9.809	76.0	76.0	533.471	543.279	9.808	77.0	1.015	0.004	1.197
											Max Yds - Min Yds =0.007489914	Must be no greater than 0.030	
											Average Yds =1.011058546	Must be between 0.95 to 1.05	
10.00	-4.00	421.233	430.675	9.442	76.0	77.0	543.279	552.761	9.482	77.0	1.013	0.009	0.926
35.00	-4.00	430.675	464.147	33.472	77.0	77.0	552.761	585.965	33.204	77.0	1.002	-0.003	0.926
16.50	-4.00	464.147	479.992	15.845	77.0	78.0	585.965	601.625	15.660	77.0	0.999	-0.006	0.927
											Max Yds - Min Yds =0.014197179	Must be no greater than 0.030	
											Average Yds =1.004786738	Must be between 0.95 to 1.05	
12.50	-2.80	479.992	489.698	9.706	78.0	78.0	601.625	611.270	9.645	77.0	1.003	0.002	0.754
14.00	-2.80	489.698	500.594	10.896	78.0	78.0	611.270	622.061	10.791	77.0	0.999	-0.002	0.753
58.50	-2.80	500.594	546.063	45.469	78.0	79.0	622.061	667.125	45.064	77.0	1.001	0.000	0.752
											Max Yds - Min Yds = 0.00338145	Must be no greater than 0.030	
											Average Yds =1.000808891	Must be between 0.95 to 1.05	
16.50	-1.60	574.496	583.672	9.176	79.0	79.0	695.390	704.530	9.140	77.0	1.004	0.000	0.541
42.00	-1.60	590.619	614.123	23.504	80.0	80.0	711.429	734.785	23.356	77.0	1.003	0.000	0.543
66.50	-1.60	614.123	651.520	37.397	80.0	81.0	734.785	771.901	37.116	77.0	1.003	0.000	0.545
											Max Yds - Min Yds =0.000835063	Must be no greater than 0.030	
											Average Yds =1.003302205	Must be between 0.95 to 1.05	
15.00	-1.00	651.520	657.572	6.052	81.0	82.0	771.901	777.994	6.093	78.0	1.016	0.011	0.396
13.50	-1.00	657.572	663.065	5.493	82.0	82.0	777.994	783.400	5.406	78.0	0.994	-0.010	0.390
35.00	-1.00	663.065	677.274	14.209	82.0	82.0	783.400	797.515	14.115	78.0	1.003	-0.001	0.393
											Max Yds - Min Yds =0.021724294	Must be no greater than 0.030	
											Average Yds =1.004344616	Must be between 0.95 to 1.05	

Overall Average Yds =1.004860199

I certify that the above Dry Gas Meter was calibrated in accordance with E.P.A. Method 5 , paragraph 7.1 ;CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature [illegible] Date [illegible]

Table C-1
Montevallo and Saginaw Calibration Table

Montevallo CALIBRATION ERROR TEST(METHOD 6C-6.3) 3/23/98

Kiln #4 Initial Outlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	0.4	0.4	0.80%
LOW RANGE	10.7	10.7	0	0.00%
MID RANGE	26	27.7	1.7	3.40%
HIGH RANGE	37.6	38.2	0.6	1.20%

Kiln #4 Final Outlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	1.1	1.1	2.20%
LOW RANGE	10.7	10.8	0.1	0.20%
MID RANGE	26	27.8	1.8	3.60%
HIGH RANGE	37.6	37.5	0.1	0.20%

Kiln #4 Initial Inlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	0.3	0.3	0.60%
LOW RANGE	10.7	8.3	2.4	4.80%
MID RANGE	26	27.4	1.4	2.80%
HIGH RANGE	37.6	38.1	0.5	1.00%

Kiln #4 Final Inlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	1.2	1.2	2.40%
LOW RANGE	10.7	10.2	0.5	1.00%
MID RANGE	26	26.9	0.9	1.80%
HIGH RANGE	37.6	38.3	0.7	1.40%

Montevallo CALIBRATION ERROR TEST(METHOD 6C-6.3) 3/24/98

Kiln #3 Initial Outlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	0.8	0.8	1.60%
LOW RANGE	10.7	10.9	0.2	0.40%
MID RANGE	26	26.3	0.3	0.60%
HIGH RANGE	37.6	37.5	0.1	0.20%

Kiln #3 Final Outlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	1.1	1.1	2.20%
LOW RANGE	10.7	11.4	0.7	1.40%
MID RANGE	26	28.5	2.5	5.00%
HIGH RANGE	37.6	38.9	1.3	2.60%

Kiln #3 Initial Inlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	0.8	0.8	1.60%
LOW RANGE	10.7	10.9	0.2	0.40%
MID RANGE	26	26.3	0.3	0.60%
HIGH RANGE	37.6	37.5	0.1	0.20%

Kiln #3 Final Inlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	1.7	1.7	3.40%
LOW RANGE	10.7	10.7	0	0.00%
MID RANGE	26	25.5	0.5	1.00%
HIGH RANGE	37.6	37.2	0.4	0.80%

Saginaw CALIBRATION ERROR TEST(METHOD 6C-6.3) 3/26/98

Kiln #4 Initial Outlet

	ACTUAL CONC	RESPONSE	DIFFEFENCE	% OF SPAN
ZERO GAS	0	0	0	0.00%
LOW RANGE	10.7	12.5	1.8	3.60%
MID RANGE	26	24.9	1.1	2.20%
HIGH RANGE	37.6	37.6	0	0.00%

Kiln #4 Final Outlet

	ACTUAL CONC	RESPONSE	DIFFERENCE	% OF SPAN
ZERO GAS	0	2.5	2.5	5.00%
LOW RANGE	10.7	12.2	1.5	3.00%
MID RANGE	26	29.5	3.5	7.00%
HIGH RANGE	37.6	43.5	6.9	11.80%

Table C-5
Saginaw Kiln #4
Continuous Emissions Monitoring Data Sheet
EPA Methods 3A, 6C, 7E, 10, and 25A
28-Mar-98

INLET Analyzer	Range		Gas Conc.	Pre Test Sys. Cal.	Cal. Bias % of Span	Post Test Sys. Cal.	Cal. Bias % of Span	Drift % of Span
Oxygen	0-25%	zero	0.0	0.4	1.6%	0.4	1.6%	0.0%
		upscale	11.1	11.3	0.8%	11.3	0.8%	0.0%
Carbon Dioxide	0-40%	zero	0.0	0.2	0.5%	0.2	0.5%	0.0%
		upscale	11.0	10.7	-0.8%	10.7	-0.8%	0.0%
Total Hydrocarbon	0-100ppm	zero	0.0	2.9	2.9%	0.4	0.4%	2.5%
		upscale	51.1	53.1	2.0%	53.5	2.4%	-0.4%
					±5%		±5%	±3%

Analyzer Calibration Check

Analyzer	Gas Conc.	Response	Error
O2 High	20.2	20.1	-0.40%
O2 Mid	11.1	11.4	1.20%
O2 zero	0.0	0.4	1.60%
CO2 High	20.4	20.3	-0.25%
CO2 Mid	11.0	10.8	-0.47%
CO2 zero	0.0	0.2	0.50%
THC High	84.8	83.5	-1.30%
THC Mid	51.1	53.1	2.00%
THC High	30.0	32.2	2.21%
THC zero	0.0	2.9	2.90%

Scott Specialty Gases

Shipped From: 1290 COMBERMERE STREET
TROY MI 48083
Phone: 248-585-2950 Fax: 248-589-2134

CERTIFICATE OF ANALYSIS

PACIFIC ENVIRONMENTAL SERVICES
JOHN POWELL
C/O AIR POLUTION C & C LT
60 INDUSTRIAL PARK RD W.
TOLLAND CT 06084

PROJECT #: 05-23193-001
PO#: 104-98-0125
ITEM #: 0502243202 5A
DATE: 2/25/98

CYLINDER #: A018685
FILL PRESSURE: 2000 PSI

ANALYTICAL ACCURACY: +/-5%
PRODUCT EXPIRATION: 8/26/1998

BLEND TYPE : CERTIFIED WORKING STD

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
HYDROGEN CHLORIDE	10.	PPM	10.7	PPM
NITROGEN		BALANCE		BALANCE

CERTIFIED WORKING STANDARD

ANALYST: Bob Pahl

Scott Specialty Gases

Shipped From: 1290 COMBERMERE STREET
TROY MI 48083
Phone: 248-589-2950 Fax: 248-589-2134

CERTIFICATE OF ANALYSIS

PACIFIC ENVIRONMENTAL SERVICES
JOHN POWELL
C/O AIR POLUTION C & C LT
60 INDUSTRIAL PARK RD W.
TOLLAND CT 06084

PROJECT #: 05-23193-002
PO#: 104-98-0125
ITEM #: 0502243202 5A
DATE: 2/13/98

CYLINDER #: A018704
FILL PRESSURE: 2000 PSI

ANALYTICAL ACCURACY: +/-5%
PRODUCT EXPIRATION: 8/12/1998

BLEND TYPE : CERTIFIED WORKING STD

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
HYDROGEN CHLORIDE	25.	PPM	26.0	PPM
NITROGEN		BALANCE		BALANCE

CERTIFIED WORKING STANARD

ANALYST: Sarah Reinter

Scott Specialty Gases

Shipped From: 1290 COMBERMERE STREET
TROY MI 48083
Phone: 248-589-2950 Fax: 248-589-2134

CERTIFICATE OF ANALYSIS

PACIFIC ENVIRONMENTAL SERVICES
JOHN POWELL
C/O AIR POLUTION C & C LT
60 INDUSTRIAL PARK RD W.
TOLLAND CT 06084

PROJECT #: 05-23193-003
PO#: 104-98-0125
ITEM #: 0502243202 5A
DATE: 2/25/98

CYLINDER #: A018749
FILL PRESSURE: 2000 PSI

ANALYTICAL ACCURACY: +/-5%
PRODUCT EXPIRATION: 8/25/1998

BLEND TYPE : CERTIFIED WORKING STD

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
HYDROGEN CHLORIDE	40.	PPM	37.6	PPM
NITROGEN		BALANCE		BALANCE

CERTIFIED WORKING STANDARD

ANALYST: _____

Scott Specialty Gases

Shipped From: 1290 COMBERMERE STREET
TROY MI 48083
Phone: 248-589-2950 Fax: 248-589-2134

CERTIFICATE OF ANALYSIS

PACIFIC ENVIRONMENTAL SERVICES
JOHN POWELL
C/O AIR POLUTION C & C LT
60 INDUSTRIAL PARK RD W.
TOLLAND CT 06084

PROJECT #: 05-23193-004
PO#: 104-98-0125
ITEM #: 05022430 5A
DATE: 2/12/98

CYLINDER #: A017718
FILL PRESSURE: 2000 PSI

ANALYTICAL ACCURACY: +/-5%
PRODUCT EXPIRATION: 8/12/1998

BLEND TYPE : CERTIFIED WORKING STD

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
HYDROGEN CHLORIDE	100.	PPM	101.	PPM
NITROGEN		BALANCE		BALANCE

CERTIFIED WORKING STANDARD

ANALYST:

Airgas

Airgas S[redacted]

325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6927
FAX: (203) 250-6942

CERTIFICATE OF ANALYSIS

Date: 11/4/97

Record Number: 3350

Customer Name: Airgas Cheshire

Purchase Order #: 127383

Grade of Product: Primary Standard

Cylinder Number:	Component	Required Concentration	Actual Concentration
CC79006	Methane	30 ppm	29.97 ppm
	Nitrogen	Balance	Balance

Uncertainty Of Analytical Result 1 %

Approval Signature

✓ CP.

Matheson Gas Products
World Leader in Specialty Gases & Equipment

CERTIFICATE OF ANALYSIS CALMAT DAILY STANDARD

CUSTOMER: ABCO Welding and Industrial Supply
CYLINDER #: EX-27307
CYLINDER PRESSURE: 2000 psig
ANALYSIS DATE: 8/20/96
EXPIRATION DATE: 8/20/99

REFERENCE: 109-51846
CALMAT DAILY: 2

COMPONENT: Methane

CONC: 51.1 ppm

COMPONENT:

CONC:

COMPONENT:

CONC:

BALANCE GAS: Nitrogen

REFERENCE STANDARDS

COMPONENT:	Methane
REFERENCE #:	SRM-2750
CYLINDER #:	SX-20007

CERTIFICATION METHOD

COMPONENT:	Methane
METHOD #:	1-1405-04-T1
INSTRUMENT:	HP-5730A
SERIAL #:	2151A92413
MEASUREMENT PRINC:	GC-FID
LAST CALIBRATION:	8/20/96

THIS CERTIFICATION WAS PERFORMED ACCORDING TO STANDARD OPERATING PROCEDURES AND IS TRACEABLE TO AN NIST STANDARD.

ANALYST Thomas J Purdon DATE 2/24/97

1680 Enterprise Parkway
Twinsburg, Ohio 44087
Phone: (216) 425-4408
Toll Free: (800) 428-9427

Airgas

Airgas Specialty Ga

325 McCauslend Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX: (203) 250-6842

CERTIFICATE OF ANALYSIS

Date : 03-5-97 Record Number: 1987

Customer Name: NORTHEAST AIRGAS CHESHIRE
Address:

Purchase Order #: 98537

Grade of Product: Primary Standard

Cylinder Number:	Component	Required Concentration	Actual Concentration
CC46103	METHANE NITROGEN	85 PPM BALANCE	84.8 PPM BALANCE

Uncertainty of Analytical Result : ± 1%

Approval Signature

Airgas

Airgas Specialty Gases

325 McCausland Court
Cheshire, CT 06410
Phone: (203) 250-6827
FAX: (203) 250-0842

Certificate of Analysis: E.P.A. Protocol Gas Mixture

Rec#	4149		
Cylinder No :	CC84096	Purchase Order #	139680
Cylinder Pressure:	2000	Expiration Date:	3/2/01
Certification Date	3/2/98	Laboratory:	Cheshire, CT

Reference Standard Information:

Type	Component	Cyl. Number	Concentration
GMIS	Carbon Dioxide	CC34977	14.08 %
GMIS	Oxygen	CC19914	20.98 %

Instrumentation:

Instrument/Model/Serial No.	Analytical Principle
Rosemount/NGA2000/Rack#1	NDIR
Servomex/244/701/488	Parmagnetic

Analytical Methodology does not require correction for analytical interferences.

Certified Concentrations:

Component	Concentration	Accuracy	Procedure
Carbon Dioxide	10.99 %	+/- 2%	G1
Oxygen	11.05 %	+/- 2%	G1
Nitrogen	Balance		

Analytical Results:

1st Component: Carbon Dioxide

1st Analysis Date: 2/16/98

R	3.259	S	2.896	Z	0.305	Conc	10.900 %
S	2.942	Z	0.256	R	3.305	Conc	10.956 %
Z	0.265	R	3.298	S	2.946	Conc	11.065 %
						AVG:	10.987 %

2nd Component: Oxygen

1st Analysis Date: 3/2/98

R	173.630	S	91.150	Z	1.460	Conc	11.060 %
S	91.230	Z	1.420	R	173.610	Conc	11.000 %
Z	1.890	R	173.630	S	91.270	Conc	11.032 %
						AVG:	11.051 %

Certification performed in accordance with "EPA Traceability Protocol (Jan. 1998)" using the assay procedures listed.

Do not use cylinder below 150 psig.

Approved for Release

NATIONAL SPECIALTY GASES

630 UNITED DRIVE
DURHAM, NC
27713
(919)544-3772

CERTIFICATE OF ANALYSIS : EPA PROTOCOL MIXTURES

REFERENCE #:	88-46838	CYLINDER #:	CC60029	CYL. PRESSURE:	2000 PSIG	P.O. #:	18778
EXP. DATE:	4/3/99	LAST ANALYSIS DATE:	4/3/96	CUSTOMER:	CONNECTICUT AIRGAS		

METHOD: ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS-SEPTEMBER 1993:G-1 THIS STANDARD SHOULD NOT BE USED WHEN ITS GAS PRESSURE IS BELOW 1.0 MEGAPASCALS (150 PSIG).

COMPONENT:	CARBON DIOXIDE	COMPONENT:	OXYGEN
STANDARD		STANDARD	
SRM #	1675B	SRM #:	2659A
CYL. #:	CLM 6481	CYL. #	CLM 6717
CONC:	14.01 %	CONC:	20.72 %
INSTRUMENT:	ROSEMOUNT NDIR	INSTRUMENT:	BECKMAN PARAMAGNETIC
MODEL #:	880	MODEL #:	755
SERIAL #:	2000418	SERIAL #:	1001419
LAST CAL.:	3/21/96	LAST CAL.:	4/1/96
MEAN CONC.:	20.2% +/- 0.2 %	MEAN CONC:	20.4% +/- 0.2 %
REPLICATE CONC.		REPLICATE CONC.	
DATE: 4/3/96	DATE:	DATE: 4/3/96	DATE:
20.2 %		20.4 %	
20.1 %		20.4 %	
20.2 %		20.5 %	

BALANCE GAS: NITROGEN

REPLICATE DATA						REPLICATE DATA						REPLICATE DATA					
DATE: 4/3/96						DATE: 4/3/96											
Z	0	R	14.1	C	20.3	Z	0	R	394	C	390						
R	14.0	Z	0	C	20.1	R	394	Z	0	C	392						
Z	0	C	20.3	R	14.1	Z	0	C	390	R	394						

Z= ZERO C=CANDIDATE R=REFERENCE

ANALYST: Mark H. K.

APPROVED BY: Laura Gharbus

THIS REPORT STATES ACCURATELY THE RESULTS OF THE INVESTIGATION MADE UPON THE MATERIAL SUBMITTED TO THE ANALYTICAL LABORATORY. EVERY EFFORT HAS BEEN MADE TO DEVELOP EFFECTIVELY THE INFORMATION REQUESTED; HOWEVER, IN CONNECTION WITH THIS REPORT, NATIONAL SPECIALTY GASES SHALL HAVE NO LIABILITY IN EXCESS OF ITS ESTABLISHED CHARGE FOR THE SERVICE.
ASSAYED AT: NATIONAL SPECIALTY GASES, 630 UNITED DRIVE, DURHAM, NC 27713. (919)544-3772

APPENDIX E

PARTICIPANTS

PROJECT PARTICIPANTS

Name	Affiliation	Responsibility
Michael L. Toney	USEPA, Emission Measurement Center	Work Assignment Manager
Franklin Meadows	Pacific Environmental Services, Inc.	Project Manager
Frank J. Phoenix	Pacific Environmental Services, Inc.	Task Manager
Troy Abernathy	Pacific Environmental Services, Inc.	Site Leader/Console Operator
Paul Siegel	Pacific Environmental Services, Inc.	Site Leader/Console Operator
Gary Gay	Pacific Environmental Services, Inc.	Sampling Technician
Mike Maret	Pacific Environmental Services, Inc.	Sampling Technician/Sample Recovery
Cybelle Brockman	Research Triangle Institute	Process Data Recorder
Eric Dithrich[1]	APCC	CEM Team Leader
Terry Thomasson[1]	APCC	CEM Sampling Technician

[1] Subcontractor to Pacific Environmental Services, Inc.

APPENDIX F

PROCESS DATA

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Analysis / Environmental Engineering Program

December 14, 1998

TO: Joseph Wood, ESD/MICG (MD-13)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

FROM: Cybele Brockmann, RTI

SUBJECT: Process data recorded during emissions testing at Dravo's plant in Saginaw, Alabama, March 28, 1998.

REFERENCE: Information Gathering and Analysis for the Lime Manufacturing Industry NESHAP
EPA Contract 68-D6-0014
ESD Project 95/06
RTI Project 7035-027

Attached is a finalized process description and summary of process data recorded during emissions testing at Dravo's plant in Saginaw, Alabama March 28, 1998. The memo was finalized based on comments received by Lisa Potts, environmental manager for Dravo Lime Company.[1]

3040 Cornwallis Road • Post Office Box 12194 • Research Triangle Park, North Carolina 27709-2194 USA
Telephone 919 990-8603 • Fax 919 990-8600

1.0 Process Description

The following is a brief process description of Kiln 4. See the attached pre-test site survey memo for a more detailed process description.

Figure 1 is a schematic of Kiln 4. The kiln is an inclined rotating kiln. Limestone enters at the back end of the kiln (the highest point of incline) through a preheater, and tumbles toward the front end of the kiln via gravity and the rotating motion of the kiln. Combustion air and fuel, which consists of pulverized coal and coke, enter at the front end of the kiln. Combustion exhaust exits at the back end of the kiln through the preheater.

Exhaust from the preheater passes through multiclones, a fan, a reverse-air baghouse, and a stack, from which it is discharged to the atmosphere. As noted in the pre-test site survey, ambient air is mixed in with the exhaust at the inlet to the preheater when the exhaust temperature at this location exceeds a certain temperature.

2.0 Process Monitoring

Kiln 4 was tested on March 28, 1998. Process data were recorded during testing. The data were recorded from computer screens in the kiln control room; the recorded data were measured with instruments already in place and used by the plant for process control of the kilns.

Table 1 is a statistical summary of the process data recorded during testing. Table 2 displays all of process data recorded during testing. Except for opacity, the recorded process parameters varied only slightly during testing - as indicated by the low values of percent relative standard deviation (% RSD) in Table 1. The % RSD for opacity was high because of the 40 percent opacity recording at 2:43 pm; as seen in Table 2, this opacity recording was extremely high compared to previous recordings, and those that followed. The start-up of Method 26 testing (which occurred around this time) may have interfered with the opacity monitor. No other process anomalies occurred during testing.

The plant does not measure the pressure drop across the baghouse (one of the process parameters listed in the test plan for recording). The plant does measure the static pressure downstream of the fan (just prior to the baghouse); the static pressure at this location was recorded during testing and had an average value of 8.3 inches of water. The testing crew took five

measurements of the static pressure at the outlet test location (just downstream of the baghouse); the measurements were taken during Method 23 and 26 testing (one measurement per run) and during the velocity traverse. The five measurements ranged from -0.47 to -.53 inches of water; the average was - 0.50 inches of water. The pressure drop from downstream of the fan to the outlet test location was 7.8 inches of water. A typical value of the pressure drop across the baghouse was not reported in the plant's questionnaire or mentioned during the pre-test site survey.

During testing, kiln 4 produced a high calcium lime from limestone which was quarried on-site. The plant does not measure limestone feed rate or lime production rate. Plant personnel were asked whether or not they knew the production during testing and they replied no. Consequently, the production level during testing is not known.

Little information is available to determine if values of the other recorded parameters were typical of normal operation. The only relevant parameters reported in the plant's questionnaire were the exhaust temperature at the exit of the kiln (2000 degrees Fahrenheit [° F]), the inlet temperature to the baghouse (435 ° F), the ratio of coal and coke to lime (0.20 tons of coal and coke per ton of lime), and the design capacity of the kiln (900 tons of lime per day).[2] The reported temperatures are consistent with those recorded during testing. The average coal and coke feed rate during testing was 6.20 tons per hour, which was below the range of coal feed rates cited during the pre-test site survey (6.4 to 6.6 tons of coal per hour). Based on the average coal and coke feed rate during testing, and the reported coal and coke to lime ratio, the plant produced approximately 31 tons of lime per hour during testing; this translates into approximately 744 tons of lime per day (assuming the kiln operates 24 hours per day), which is less than the design capacity of 900 tpd reported in the plant's questionnaire.[3]

Table 1. Statistical Summary of Recorded Data for Kiln 4 at Dravo's Plant in Saginaw, AL.

Recorded 3/28/98 from 10:40 am to 7:00 pm	Mean	% RSD	Minimum	Maximum	# Recordings
Coal/coke, tph	6.20	2.19	5.96	6.54	28.00
Kiln speed, rpm	1.37	0.714	1.36	1.38	28
Inlet Temperature to preheater, deg F	2002	0.4371	1985	2025	28
Inlet Temperature to baghouse, deg F	466	1.09	460	482	28
opacity, %*	5.4	16	4.3	8	28.0
Static pressure at inlet to baghouse, "H20	8.3	7.0	7.1	9.3	23

tph = tons per hour
rpm = rotations per minute
%RSD = relative standard deviation as a percentage of the mean
*Opacity statistics do not include 40% opacity measurement at 2:43 pm

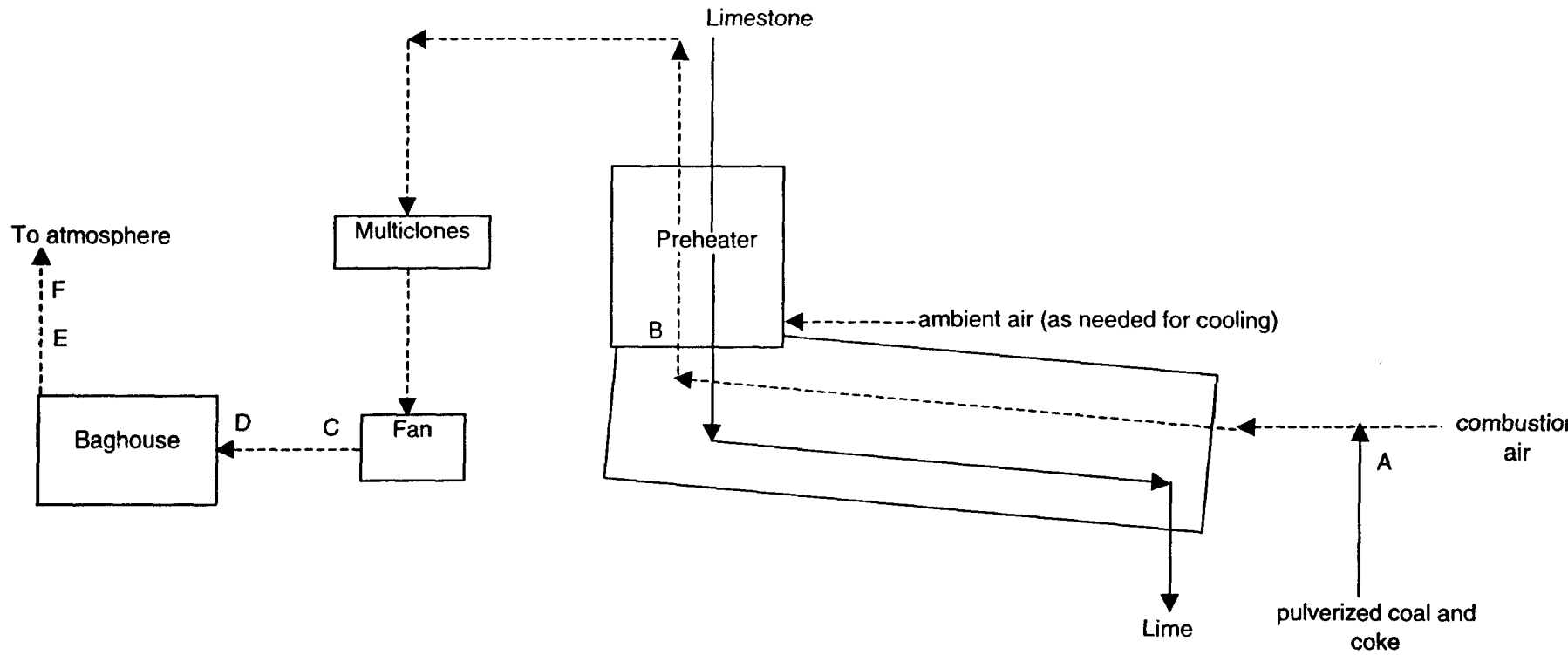
Table 2. Process Data Collected from Kiln 4 at Dravo's Saginaw Plant on 3-28-98.

Time	Lime Produced	Coal/coke, tph	Kiln rpm	Inlet T to preheater, deg F	Inlet T to bh, deg F	opacity, %	Static pressure at inlet to bh, "H20
10:40 AM	HICAL	6.24	1.36	2000	464	4.3	
10:56 AM	HICAL	6.28	1.36	2001	466	4.3	
11:10 AM	HICAL	6.20	1.36	2001	461	4.3	
11:25 AM	HICAL	6.21	1.36	1997	464	4.3	9
11:40 AM	HICAL	6.28	1.36	1998	463	4.6	7.9
11:55 AM	HICAL	6.22	1.36	2000	461	4.6	7.8
12:10 PM	HICAL	6.18	1.36	1998	463	5.1	
12:25 PM	HICAL	6.21	1.36	1998	463	5.1	7.6
12:40 PM	HICAL	6.19	1.36	2004	460	5.1	9
12:55 PM	HICAL	6.23	1.36	2002	462	5.1	7.8
1:10 PM	HICAL	6.19	1.36	2007	460	5.4	8.4
1:25 PM	HICAL	6.20	1.36	2010	462	5.4	9.3
1:40 PM	HICAL	6.21	1.36	2011	467	5.1	8.9
1:58 PM	HICAL	6.21	1.38	2025	464	5.4	
2:43 PM	HICAL	6.02	1.38	2001	466	40.0	8.8
3:01 PM	HICAL	6.22	1.38	1992	467	5.4	8.2
3:16 PM	HICAL	6.16	1.38	2002	465	5.4	7.1
3:30 PM	HICAL	5 96	1.38	1999	461	5.4	8.3
4:39 PM	HICAL	6.01	1.38	2002	465	5.4	7.8
4:55 PM	HICAL	6.52	1.38	1989	465	6.4	7.7
5:10 PM	HICAL	5.98	1.38	2012	469	6.7	8.1
5:25 PM	HICAL	6.35	1.38	1985	466	5.4	8.6
5:40 PM	HICAL	6.23	1.38	2011	470	6.0	8.3
5:58 PM	HICAL	6.20	1.36	1987	470	5.4	7.5
6:15 PM	HICAL	6.30	1.36	2012	472	6.0	8.3
6:30 PM	HICAL	6 13	1.36	1989	472	8.1	9
6:46 PM	HICAL	6.54	1.36	2007	476	6.4	8.7
7:00 PM	HICAL	5.98	1.36	2006	482	6.0	8.6

At 2:43 PM, Method 26 was getting started and may have interfered with the opacity monitor (resulting in the high reading). The average and % RSD for opacity do not include the opacity reading at 2:43 pm

Acronyms

rpm = rotations per minute
tph = tons per hour
T = temperature
deg F = degrees Fahrenheit
P = pressure
bh = baghouse
HICAL = high calcium lime
Blank cells mean data were not recorded



A = Coal/coke feed rate measurement
B = Temperature measurement at inlet to preheater
C = Static pressure measurement
D = Temperature measurement at inlet to baghouse and inlet testing
E = Opacity Measurement
F = Outlet testing
dashed lines are gas flows
solid lines are material flows

Figure 1. Kiln 4 at Dravo's Saginaw, AL plant

References

1. Docket item II-D-174. Letter, A. Potts, Dravo Lime Company, to J. Wood, EPA:OAQPS:ESD:MICG, November 2, 1998, Comments on the Draft Report of the Process Description and Operation for Dravo's Saginaw, Alabama Facility.

2. Docket item. II-D-42 Letter and attachment, R. Henry, Dravo Corporation, Dravo Lime Company, to J. Wood, EPA:MICG, October 30, 1995, enclosing response to NLA/EPA voluntary questionnaire for Longview plant.

3. Reference 2.

APPENDIX G

TEST METHODS

Appendix G.1

EPA Method 1

Method 1 - Sample and Velocity Traverses for Stationary Sources

1. PRINCIPLE AND APPLICABILITY

1.1 Principle. To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas.

1.2 Applicability. This method is applicable to flowing gas streams in ducts, stacks, and flues. The method cannot be used when: (1) flow is cyclonic or swirling (see Section 2.4), (2) a stack is smaller than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) in cross-sectional area, or (3) the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance.

The requirements of this method must be considered before construction of a new facility from which emissions will be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator, U.S. Environmental Protection Agency.

2. PROCEDURE

2.1 Selection of Measurement Site. Sampling or velocity measurement is performed at a site located at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame. If necessary, an alternative location may be selected, at a position at least two stack or duct diameters

downstream and a half diameter upstream from any flow disturbance. For a rectangular cross section, an equivalent diameter (D_e) shall be calculated from the following equation, to determine the upstream and downstream distances:

$$D_e = \frac{2LW}{(L + W)}$$

Eq. 1-1

Where
L = Length and W = width.

An alternative procedure is available for determining the acceptability of a measurement location not meeting the criteria above. This procedure,
determination of gas flow angles at the sampling points and comparing the results with acceptability criteria, is described in Section 2.5.

2.2 Determining the Number of Traverse Points.

2.2.1 Particulate Traverses. When the eight- and two-diameter criterion can be met, the minimum number of traverse points shall be: (1) twelve, for circular or rectangular stacks with diameters (or equivalent diameters) greater than 0.61 meter (24 in.); (2) eight, for circular stacks with diameters between 0.30 and 0.61 meter (12 and 24 in.); and (3) nine, for rectangular stacks with equivalent diameters between 0.30 and 0.61 meter (12 and 24 in.).

When the eight- and two-diameter criterion cannot be met, the minimum number of traverse points is determined from Figure 1-1. Before referring to the figure, however, determine the distances from the chosen measurement site to the nearest upstream and downstream disturbances, and divide each distance by the stack

diameter or equivalent diameter, to determine the distance in terms of the number of duct diameters. Then, determine from Figure 1-1 the minimum number of traverse points that corresponds: (1) to the number of duct diameters upstream; and (2) to the number of diameters downstream. Select the higher of the two minimum numbers of traverse points, or a greater value, so that for circular stacks the number is a multiple of 4, and for rectangular stacks, the number is one of those shown in Table 1-1.

2.2.2 Velocity (Non-Particulate) Traverses. When velocity or volumetric flow rate is to be determined (but not particulate matter), the same procedure as that used for particulate traverses (Section 2.2.1) is followed, except that Figure 1-2 may be used instead of Figure 1-1.

2.3 Cross-Sectional Layout and Location of Traverse Points.

2.3.1 Circular Stacks. Locate the traverse points on two perpendicular diameters according to Table 1-2 and the example shown in Figure 1-3. Any equation (for examples, see Citations 2 and 3 in the Bibliography) that gives the same values as those in Table 1-2 may be used in lieu of Table 1-2.

For particulate traverses, one of the diameters must be in a plane containing the greatest expected concentration variation, e.g., after bends, one diameter shall be in the plane of the bend. This requirement becomes less critical as the distance from the disturbance increases; therefore, other diameter locations may be used, subject to the approval of the Administrator.

In addition, for stacks having diameters greater than 0.61 m (24 in.), no traverse points shall be within 2.5 centimeters (1.00 in.) of the stack walls; and for stack diameters equal to or less than 0.61 m (24 in.), no traverse points shall be located within 1.3 cm (0.50 in.) of the stack walls. To meet these criteria, observe the procedures given below.

2.3.1.1 Stacks With Diameters Greater Than 0.61 m (24 in.). When any of the traverse points as located in Section 2.3.1 fall within 2.5 cm (1.00 in.) of the stack walls, relocate them away from the stack walls to: (1) a distance of 2.5 cm (1.00 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger. These relocated traverse points (on each end of a diameter) shall be the "adjusted" traverse points.

Whenever two successive traverse points are combined to form a single adjusted traverse point, treat the adjusted point as two separate traverse points, both in the sampling (or velocity measurement) procedure, and in recording the data.

2.3.1.2 Stacks With Diameters Equal To or Less Than 0.61 m (24 in.). Follow the procedure in Section 2.3.1.1, noting only that any "adjusted" points should be relocated away from the stack walls to: (1) a distance of 1.3 cm (0.50 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger.

2.3.2 Rectangular Stacks. Determine the number of traverse points as explained in Sections 2.1 and 2.2 of this method. From Table 1-1, determine the grid configuration. Divide the stack cross-section into as many equal rectangular elemental areas as traverse points, and then locate a traverse point at the centroid of each equal area according to the example in Figure 1-4.
If the tester desires to use more than the minimum number of traverse points, expand the "minimum number of traverse points" matrix (see Table 1-1) by adding the extra traverse points along one or the other or both legs of the matrix; the final matrix need not be balanced. For example, if a 4 x 3 "minimum number of points" matrix were expanded to 36 points, the final matrix could be 9 x 4 or 12 x 3, and would not necessarily have to be 6 x 6. After constructing the final matrix, divide the stack cross-section into as many equal rectangular, elemental areas as traverse points, and locate a traverse point at the centroid of each equal area. The situation of traverse points being too close to the stack walls is not expected to arise with rectangular stacks. If this problem should ever arise, the Administrator must be contacted for resolution of the matter.

2.4 Verification of Absence of Cyclonic Flow. In most stationary sources, the direction of stack gas flow is essentially parallel to the stack walls. However, cyclonic flow may exist (1) after such devices as cyclones and inertial demisters following venturi scrubbers, or (2) in stacks having tangential inlets or other duct configurations which tend to induce swirling; in these instances, the presence or absence of cyclonic flow at the sampling location must be determined. The following techniques are acceptable for this determination. Level and zero the manometer. Connect a Type S pitot tube to the manometer. Position the Type S pitot tube at each traverse point, in succession, so that the planes of the face openings of the pitot tube are perpendicular to the stack cross-

sectional plane; when the Type S pitot tube is in this position, it is at "0° reference." Note the differential pressure (Δp) reading at each traverse point. If a null (zero) pitot reading is obtained at 0° reference at a given traverse point, an acceptable flow condition exists at that point. If the pitot reading is not zero at 0° reference, rotate the pitot tube (up to ±90° yaw angle), until a null reading is obtained. Carefully determine and record the value of the rotation angle (α) to the nearest degree. After the null technique
has been applied at each traverse point, calculate the average of the absolute values of α; assign α values of 0° to those points for which no rotation was required, and include these in the overall average. If the average value of α is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology, subject to the approval of the Administrator, must be used to perform accurate sample and velocity traverses. The alternative procedure described in Section 2.5 may be used to determine the rotation angles in lieu of the procedure described above.

2.5 Alternative Measurement Site Selection Procedure. This alternative applies to sources where measurement locations are less than 2 equivalent or duct diameters downstream or less than one-half duct diameter upstream from a flow disturbance. The alternative should be limited to ducts larger than 24 in. in diameter where blockage and wall effects are minimal. A directional flow-sensing probe is used to measure pitch and yaw angles of the gas flow at 40 or more traverse points; the resultant angle is calculated and compared with acceptable criteria for mean and standard deviation.

NOTE: Both the pitch and yaw angles are measured from a line passing through the traverse point and parallel to the stack axis. The pitch angle is the angle of the gas flow component in the plane that INCLUDES the traverse line and is parallel to the stack axis. The yaw angle is the angle of the gas flow component in the plane PERPENDICULAR to the traverse line at the traverse point and is measured from the line passing through the traverse point and parallel to the stack axis.

2.5.1 Apparatus.

2.5.1.1 Directional Probe. Any directional probe, such as United Sensor Type DA Three-Dimensional Directional Probe, capable of measuring both the pitch and yaw angles of gas flows is acceptable.

(**NOTE:** Mention of trade name or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.) Assign an identification number to the directional probe, and permanently mark or engrave the number on the body of the probe. The pressure holes of directional probes are susceptible to plugging when used in particulate-laden gas streams. Therefore, a system for cleaning the pressure holes by "back-purging" with pressurized air is required.

2.5.1.2 Differential Pressure Gauges. Inclined manometers, U-tube manometers, or other differential pressure gauges (e.g., magnehelic gauges) that meet the specifications described in Method 2, Section 2.2.

NOTE: If the differential pressure gauge produces both negative and positive readings, then both negative and positive pressure readings shall be calibrated at a minimum of three points as specified in Method 2, Section 2.2.

2.5.2 Traverse Points. Use a minimum of 40 traverse points for circular ducts and 42 points for rectangular ducts for the gas flow angle determinations. Follow Section 2.3 and Table 1-1 or 1-2 for the location and layout of the traverse points. If the measurement location is determined to be acceptable according to the criteria in this alternative procedure, use the same traverse point number and locations for sampling and velocity measurements.

2.5.3 Measurement Procedure.

2.5.3.1 Prepare the directional probe and differential pressure gauges as recommended by the manufacturer. Capillary tubing or surge tanks may be used to dampen pressure fluctuations. It is recommended, but not required, that a pretest leak check be conducted. To perform a leak check, pressurize or use suction on the impact opening until a reading of at least 7.6 cm (3 in.) H_2O registers on the differential pressure gauge, then plug the impact opening. The pressure of a leak-free system will remain stable for at least 15 seconds.

2.5.3.2 Level and zero the manometers. Since the manometer level and zero may drift because of vibrations and temperature changes, periodically check the level and zero during the traverse.

2.5.3.3 Position the probe at the appropriate locations in the gas stream, and rotate until zero deflection is indicated for the yaw angle pressure gauge. Determine and record the yaw angle. Record the pressure gauge readings for the pitch angle, and determine the pitch angle from the calibration curve. Repeat this procedure for each traverse point. Complete a "back-purge" of the pressure lines and the impact openings prior to measurements of each traverse point.

A post-test check as described in Section 2.5.3.1 is required. If the criteria for a leak-free system are not met, repair the equipment, and repeat the flow angle measurements.

2.5.4 Calculate the resultant angle at each traverse point, the average resultant angle, and the standard deviation using the following equations. Complete the calculations retaining at least one extra significant figure beyond that of the acquired data. Round the values after the final calculations.

2.5.4.1 Calculate the resultant angle at each traverse point:

$$R_i = \text{arc cosine}[(\text{cosine}Y_i)(\text{cosine}P_i)]$$

Eq. 1-2

Where:

R_i = resultant angle at traverse point i, degree.
Y_i = yaw angle at traverse point i, degree.
P_i = pitch angle at traverse point i, degree.

2.5.4.2 Calculate the average resultant for the measurements:

$$\overline{R} = \frac{\Sigma R_i}{n}$$

Eq. 1-3

Where:

R_{avg} = average resultant angle, degree.
n = total number of traverse points.

2.5.4.3 Calculate the standard deviations:

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} (R_i - \overline{R})^2}{(n-1)}}$$

Eq. 1-4

Where:

S_d = standard deviation, degree.

2.5.5 The measurement location is acceptable if $R_{avg} \leq 20°$ and $S_d \leq 10°$.

2.5.6 Calibration. Use a flow system as described in Sections 4.1.2.1 and 4.1.2.2 of Method 2. In addition, the flow system shall have the capacity to generate two test-section velocities: one between 365 and 730 m/min (1200 and 2400 ft/min) and one between 730 and 1100 m/min (2400 and 3600 ft/min).

2.5.6.1 Cut two entry ports in the test section. The axes through the entry ports shall be perpendicular to each other and intersect in the centroid of the test section. The ports should be elongated slots parallel to the axis of the test section and of sufficient length to allow measurement of pitch angles while maintaining the pitot head position at the test-section centroid. To facilitate alignment of the directional probe during calibration, the test section should be constructed of plexiglass or some other transparent material. All calibration measurements should be made at the same point in the test section, preferably at the centroid of the test section.

2.5.6.2 To ensure that the gas flow is parallel to the central axis of the test section, follow the procedure in Section 2.4 for cyclonic flow determination to measure the gas flow angles at the centroid of the test section from two test ports located 90° apart. The gas flow angle measured in each port must be ±2° of 0°. Straightening vanes should be installed, if necessary, to meet this criterion.

2.5.6.3 Pitch Angle Calibration. Perform a calibration traverse according to the manufacturer's recommended protocol in 5° increments for angles from -60° to +60° at one velocity in each of the two ranges specified above. Average the pressure ratio values obtained for each angle in the two flow ranges, and plot a

calibration curve with the average values of the pressure ratio (or other suitable measurement factor as recommended by the manufacturer) versus the pitch angle. Draw a smooth line through the data points. Plot also the data values for each traverse point. Determine the differences between the measured datavalues and the angle from the calibration curve at the same pressure ratio. The difference at each comparison must be within 2° for angles between 0° and 40° and within 3° for angles between 40° and 60°.

2.5.6.4 Yaw Angle Calibration. Mark the three-dimensional probe to allow the determination of the yaw position of the probe. This is usually a line extending the length of the probe and aligned with the impact opening. To determine the accuracy of measurements of the yaw angle, only the zero or null position need be calibrated as follows: Place the directional probe in the test section, and rotate the probe until the zero position is found. With a protractor or other angle measuring device, measure the angle indicated by the yaw angle indicator on the three-dimensional probe. This should be within 2° of 0°. Repeat this measurement for any other points along the length of the pitot where yaw angle measurements could be read in order to account for variations in the pitot markings used to indicate pitot head positions.

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Table 1-1. CROSS-SECTION LAYOUT FOR RECTANGULAR STACKS

Number of traverse points	Matrix layout
9	3x3
12	4x3
16	4x4
20	5x4
25	5x5
30	6x5
36	6x6
42	7x6
49	7x7

TABLE 1-2
LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS
(Percent of stack diameter from inside wall to traverse point)

Traverse Point Number on a Diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.4	67.7	34.2	25.0	20.1	16.9	14.6	112.9	11.6	10.5
6			95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8				96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10					97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2

14							98.2	91.5	85.4	79.6	73.8	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

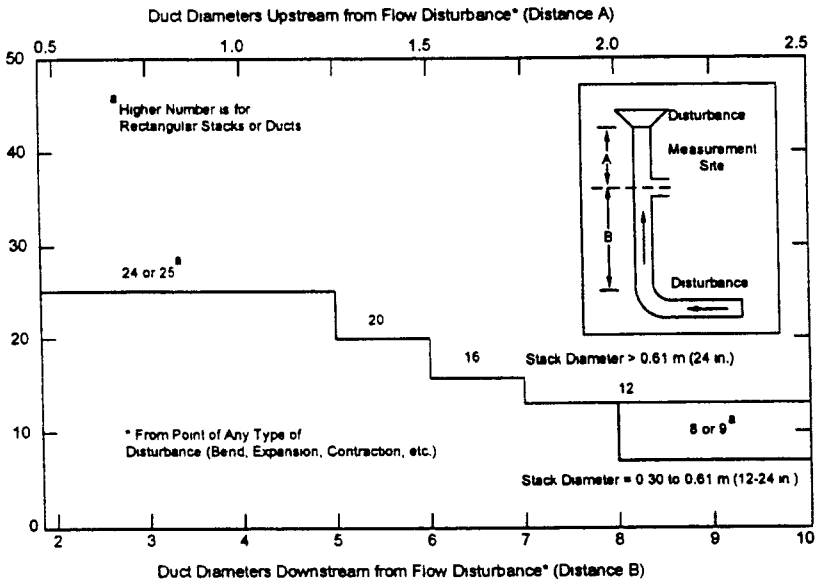

Figure 1-1. Minimum number of traverse points for particulate traverses.

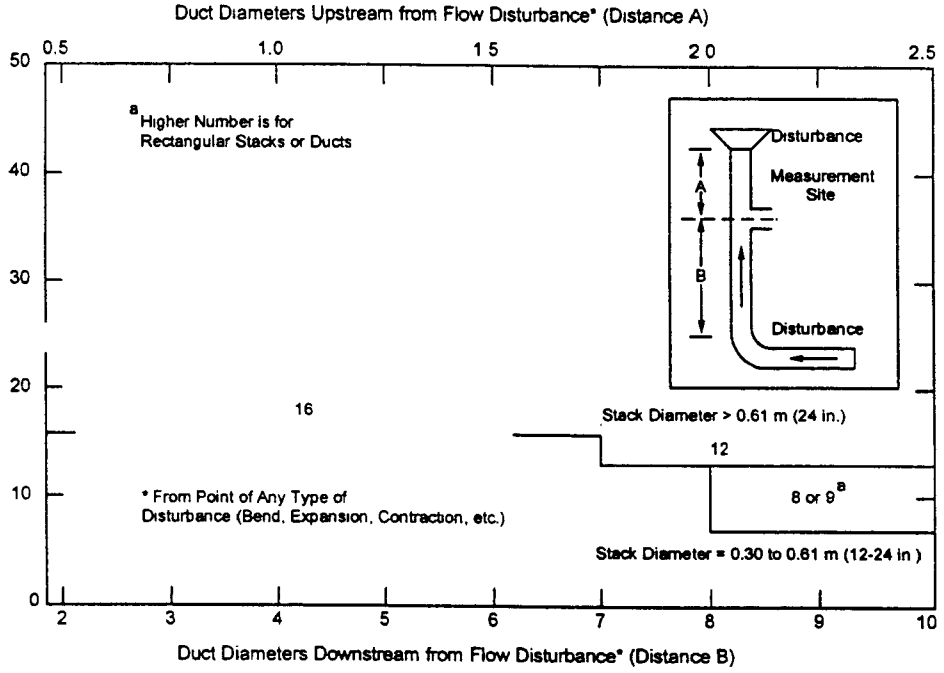

Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses.

Traverse Point	Distance % of diameter
1	4.4
2	14.7
3	29.5
4	70.5
5	85.3
6	95.6

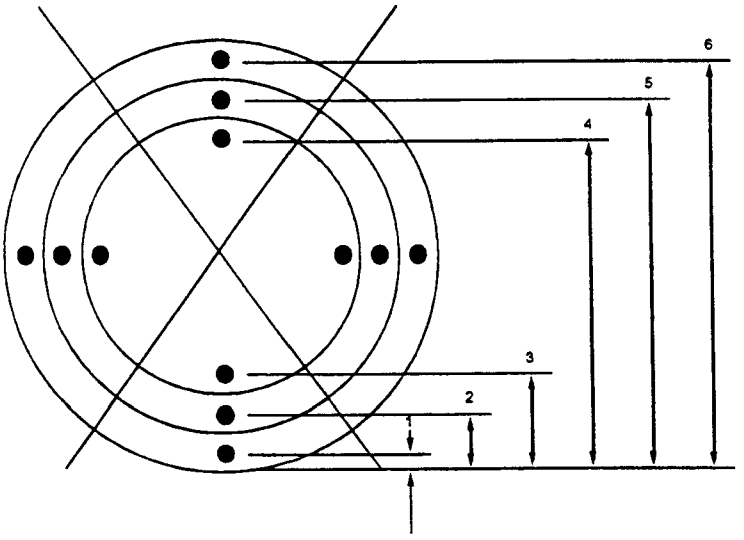

Figure 1-3. Example showing circular stack cross section divided into 12 equal areas, with location of traverse points indicated.

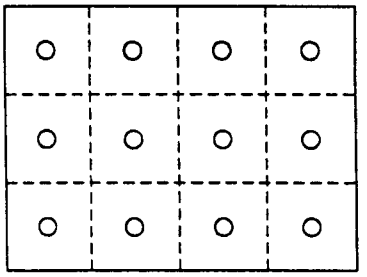

Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with a traverse point at centroid of each area.

STACK SAMPLING CYCLONIC FLOW

General

Conventional sampling procedures are not applicable to stacks with cyclonic flow due to the presence of non-axial flow components. This appendix describes a method for sampling stacks with cyclonic flow; i.e. flow with tangential velocity components. Cyclonic flow may exist after cyclones, tangential inlets, or other configurations that may tend to induce swirling.

Several different approaches have been devised to minimize the biasing effects of non-axial flow. The method discussed in this appendix utilizes the alignment approach to reduce or eliminate the bias produced by misalignment of the sampling nozzle and pitot tubes with the path of the particles. Sampling results obtained with this method must be reviewed for possible inherent bias (see section entitled Accuracy Considerations) to determine acceptability for any purpose.

Accuracy Considerations

As discussed in Chapter 5, small (light) particles tend to follow the flow stream while large (heavy) particles tend to be affected more by their own inertia than by the flow stream. Due to the effects of the cyclonic condition and centrifugal action, components of radial velocity should be imparted to large particles, while small particles continue to follow the flow stream. If the sampling ports are sufficiently downstream of the onset of cyclonic flow (at least two stack diameters), large particles should have moved to the vicinity of the stack wall and no longer have radial velocity components. For this reason, this method does not consider components of radial velocity, and the term "total velocity vector" refers to the resultant of the vertical (parallel to the stack axis) velocity vector and the tangential velocity vector.

Although sampling by the alignment approach is done in the direction of flow of the stack gas at each sample point, bias may still be produced if the path of the particles is not in the direction of flow. Small particles follow the flow stream and large particles at the stack wall have no radial velocity components so the only source of bias should be large particles near the stack wall that may not be moving in the direction of flow, i.e. unequal tangential velocity components. An indication of the distribution of large and small particles may be obtained by comparing the probe wash and cyclone catch to the filter and impinger catch. Large particles that do not follow the flow stream should be caught in the probe and cyclone, while small particles should be caught on the filter and in the impingers. Such comparison may yield

information on possible bias in the sample since bias is produced by large particles, but should not be considered to be an accurate determination of particle size distribution. If the large particles were not moving in the direction of flow in the stack, the large/small particle proportion in the sampling train may not be the same as in the stack. If all particles are moving parallel to the direction of flow, no bias should be produced.

If the pollutant is or behaves as a gas, no bias is produced by particles moving in directions other than parallel to the flow stream. This method provides an accurate determination of velocity and flow rate, which are requirements of gaseous sampling (Chapter 6). The larger the proportion of the total catch that behaves as a gas (filter and impingers), the greater the confidence in the sample being without bias.

Determining Cyclonic Flow

The existence of cylconic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angles is greater than 20°, cyclonic flow exists to such an extent that special sampling procedures are necessary.

The direction of flow is determined by locating the pitot tube null position at each sample point. The pitot tube null position at a sample point is determined by rotating the pitot tubes around the axis of the probe until a zero manometer reading is obtained. Advance knowledge of the direction of the tangential flow component is helpful for the initial rotation of the pitot tubes since the plane through the pitot tubes must be perpendicular to the total velocity vector to obtain a null reading on the manometer. The angle between the plane through the pitot tubes in the null position and the stack cross-sectional plane is equal in magnitude to the flow angle; the magnitude of the angle may be measured with the pitot tubes in the null position or after the pitot tubes have been rotated 90° into the flow stream for velocity measurement. A magnetic protractor-level is a convenient angle measuring device; scribe marks on the sample box with a pointer on the probe (or vice-versa) may be satisfactory if proper alignment with the axis of the stack and the plane of the pitot tubes is maintained.

In some cases of cyclonic flow, the flow angle may be greater than 90° at some sample points, indicating flow back into the stack at those particular sample points. If the flow angle is greater than 90°, it is recorded as 90° so that sample points with negative velocity are considered to have no vertical velocity ($\cos 90° = 0$). The existence of sample points with negative velocity may be determined with the pitot tubes aligned with the flow stream; the manometer deflection will indicate the direction of flow.

Sampling Procedure

Standard isokinetic sampling procedures (Chapters 4 and 5) are followed except for adjustment of the sampling time and pitot tube and nozzle orientation at each sample point.

Preliminary Velocity Traverse and Calculations

Knowledge of the flow angles at all sampling points is necessary to insure that the total sample time and total sample volume is adequate; therefore, flow angles are normally measured during the preliminary velocity traverse. The complete set of angles should be measured in as short a duration of time as possible in case the position of the flow cyclone in the stack is changing with time. After the measurement of flow angles is complete, a base sampling time for each sampling point is selected. The actual sampling time at each sample point is the base sampling time multiplied by the cosine of the flow angle at that sample point.

All preliminary procedures and calculations are performed with preliminary data as measured in the direction of flow similar to standard isokinetic sampling procedures. The actual sampling time at each sample point (base time x $\cos \alpha$) is used in preliminary calculations. As discussed earlier, if zero or negative flow exists at any sample point, the flow angle is recorded as 90° and the actual sampling time at that sample point is zero ($\cos 90° = 0$). The base time should be large enough so that the total sample volume is adequate and that the sampling time at the sample point with the shortest actual sampling time is long enough to record data. Appendix D contains data forms for recording angles and sampling times along with forms for standard stack sampling.

Sampling

Sampling is performed with the nozzle and pitot tubes oriented in the direction of flow at each sampling point with isokinetic conditions maintained according to the ΔP measured in the flow stream. As discussed in the section on Accuracy Considerations, radial velocity components are not considered since large particles should have no radial velocity components. Since large particles should be concentrated near the stack wall, the accuracy of sampling at the outer points is of particular importance. The precalculated sampling time at each sampling point is the base time multiplied by the cosine of the flow angle. For instance, if the base sampling time is four minutes and the flow angle is 60° at one sample point, the actual sampling time at that sample point is two minutes ($\cos 60° = 0.5$). It is suggested that sampling at each sample point be started at some increment of a minute or that a timer be used for each sample point to avoid confusion with various odd minutes and seconds. The flow may be stopped for short

periods between sample points, but the off-time must not be so long that the sample could be contaminated by particles entering the sampling train while the flow is stopped.

In some cases of cyclonic flow, some sample points may have negative flow or flow back into the stack (flow angle > 90°) rather than out the stack. These sampling points are treated as points with zero flow and zero actual sampling time. This situation may cause the results to be biased high if some of the pollutant sampled at the sample points with positive flow is also present at the sample points with negative flow. Two separate samples may produce more accurate results in such a case - one sample for positive flow and one sample for negative flow with the numerical difference being the emission rate.

The field check of percent isokinetic is made using actual parameters measured during sampling; velocity is used as measured in the flow stream and time is the sum of the adjusted (actual) sampling times for the separate sample points. The isokinetic check could also be performed by calculating the vertical velocity component at each sample point and using the total base time as explained in the section on Data Reduction, but this approach is considered too cumbersome for field use.

Data Reduction

Data reduction procedures must account for the differences between the total velocity vectors (defined by α and ΔP) and the exiting components of these vectors. Since the average exiting velocity must be used to calculate stack flow rate (ACFM or SCFM), effective stack height, and, in turn, allowable emission rate and standard effective stack height, data reduction procedures must average only the vertical components of the total velocity vectors. Different data reduction approaches may yield correct results; the data reduction procedures discussed in this section are based on adjustment of individual ΔP readings to correspond to vertical velocity components. Standard data reduction procedures are discussed in Chapter 8 and only the adjustments to the input data necessary to apply the standard procedures are discussed here.

Each field ΔP reading (as measured in the flow stream) is multiplied by the square of the cosine of the flow angle (α) corresponding to each ΔP reading. Data reduction input ΔP is ($\cos^2 \alpha$) (field ΔP). Input sample time per sample point is the total base sampling time per sample point and the total sampling time input is the total base time (base time) (number of sample points). All other parameters are input as measured. The data sheets in Appendix D should be helpful in organizing cyclonic flow data.

CYCLONIC FLOW FIELD CALCULATION SHEET

Company Name _____ Date _____

Address _____ Tester _____

Sampling Location _____ Base Test Time _____

Sample Point	Angle ϕ	Test Time	Run #		Run #		Run #	
			Δp	$\cos\phi\ (\sqrt{\Delta p})$	Δp	$\cos\phi\ (\sqrt{\Delta p})$	Δp	$\cos\phi\ (\sqrt{\Delta p})$

Test Time = $\cos\phi$ (Base Time)

$$\text{Avg. } \Delta p_v = \left(\frac{\Sigma \cos\phi \sqrt{\Delta p}}{n}\right)^2$$

Average Δp_v _____ Average Δp_v _____ Average Δp_v _____

F-1003 b

Appendix G.2

EPA Method 2

Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

1. PRINCIPLE AND APPLICABILITY

1.1 Principle. The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube.

1.2 Applicability. This method is applicable for measurement of the average velocity of a gas stream and for quantifying gas flow.

This procedure is not applicable at measurement sites that fail to meet the criteria of Method 1, Section 2.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; Section 2.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, U.S. Environmental Protection Agency, must be employed to make accurate flow rate determinations; examples of such alternative procedures are: (1) to install straightening vanes; (2) to calculate the total volumetric flow rate stoichiometrically, or (3) to move to another measurement site at which the flow is acceptable.

2. APPARATUS

Specifications for the apparatus are given below. Any other apparatus that has been demonstrated (subject to approval of the Administrator) to be capable of meeting the specifications will be considered acceptable.

2.1 Type S Pitot Tube. Pitot tube made of metal tubing (e.g., stainless steel) as shown in Figure 2-1. It is recommended that the external tubing diameter (dimension D_t, Figure 2-2b) be between 0.48 and 0.95 cm (3/16 and 3/8 inch). There shall be an equal distance from the base of each leg of the pitot tube to its face-opening plane (dimensions P_A and P_B, Figure 2-2b); it is recommended that this distance be between 1.05 and 1.50 times the external tubing diameter. The face openings of the pitot tube shall, preferably, be aligned as shown in Figure 2-2; however, slight misalignments of the openings are permissible (see Figure 2-3).

The Type S pitot tube shall have a known coefficient, determined as outlined in Section 4. An identification number shall be assigned to the pitot tube; this

number shall be permanently marked or engraved on the body of the tube. A standard pitot tube may be used instead of a Type S, provided that it meets the specifications of Sections 2.7 and 4.2; note, however, that the static and impact pressure holes of standard pitot tubes are susceptible to plugging in particulate-laden gas streams. Therefore, whenever a standard pitot tube is used to perform a traverse, adequate proof must be furnished that the openings of the pitot tube have not plugged up during the traverse period; this can be done by taking a velocity head (Δp) reading at the final traverse point, cleaning out the impact and static holes of the standard pitot tube by "back-purging" with pressurized air, and then taking another Δp reading. If the Δp readings made before and after the air purge are the same (±5 percent), the traverse is acceptable. Otherwise, reject the run. Note that if Δp at the final traverse point is unsuitably low, another point may be selected. If "back-purging" at regular intervals is part of the procedure, then comparative Δp readings shall be taken, as above, for the last two back purges at which suitably high Δp readings are observed.

2.2 Differential Pressure Gauge. An inclined manometer or equivalent device. Most sampling trains are equipped with a 10-in. (water column) inclined-vertical manometer, having 0.01-in. H_2O divisions on the 0- to 1-in. inclined scale, and 0.1-in. H_2O divisions on the 1- to 10-in. vertical scale. This type of manometer (or other gauge of equivalent sensitivity) is satisfactory for the measurement of Δp values as low as 1.3 mm (0.05 in.) H_2O. However, a differential pressure gauge of greater sensitivity shall be used (subject to the approval of the Administrator), if any of the following is found to be true: (1) the arithmetic average of all Δp readings at the traverse points in the stack is less than 1.3 mm (0.05 in.) H_2O; (2) for traverses of 12 or more points, more than 10 percent of the individual Δp readings are below 1.3 mm (0.05 in.) H_2O; (3) for traverses of fewer than 12 points, more than one Δp reading is below 1.3 mm (0.05 in.) H_2O. Citation 18 in the Bibliography describes commercially available instrumentation for the measurement of low-range gas velocities.

As an alternative to criteria (1) through (3) above, the following calculation may be performed to determine the necessity of using a more sensitive differential pressure gauge:

$$T = \frac{\sum_{i=1}^{n} \sqrt{\Delta p_i + K}}{\sum_{i=1}^{n} \sqrt{\Delta p_i}}$$

Where:

Δp_i = Individual velocity head reading at a traverse point, mm (in.) H_2O.

n = Total number of traverse points.

K = 0.13 mm H_2O when metric units are used and 0.005 in. H_2O when English units are used.

If T is greater than 1.05, the velocity head data are unacceptable and a more sensitive differential pressure gauge must be used.

NOTE: If differential pressure gauges other than inclined manometers are used (e.g., magnehelic gauges), their calibration must be checked after each test series. To check the calibration of a differential pressure gauge, compare Δp readings of the gauge with those of a gauge-oil manometer at a minimum of three points, approximately representing the range of Δp values in the stack. If, at each point, the values of Δp as read by the differential pressure gauge and gauge-oil manometer agree to within 5 percent, the differential pressure gauge shall be considered to be in proper calibration. Otherwise, the test series shall either be voided, or procedures to adjust the measured Δp values and final results shall be used, subject to the approval of the Administrator.

2.3 Temperature Gauge. A thermocouple, liquid-filled bulb thermometer, bimetallic thermometer, mercury-in-glass thermometer, or other gauge capable of measuring temperature to within 1.5 percent of the minimum absolute stack temperature. The temperature gauge shall be attached to the pitot tube such that the sensor tip does not touch any metal; the gauge shall be in an interference-free arrangement with respect to the pitot tube face openings (see Figure 2-1 and also Figure 2-7 in Section 4). Alternative positions may be used if the pitot tube-temperature gauge system is calibrated according to the procedure of Section 4. Provided that a difference of not more than 1 percent in the average velocity measurement is introduced, the temperature gauge need not be attached to the pitot tube; this alternative is subject to the approval of the Administrator.

2.4 Pressure Probe and Gauge. A piezometer tube and mercury- or water-filled U-tube manometer capable of measuring stack pressure to within 2.5 mm (0.1 in.) Hg. The static tap of a standard type pitot tube or one leg of a Type S pitot tube with the face opening planes positioned parallel to the gas flow may also be used as the pressure probe.

2.5 Barometer. A mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm (0.1 in.) Hg. See **NOTE** in Method 5, Section 2.1.9.

2.6 Gas Density Determination Equipment. Method 3 equipment, if needed (see Section 3.6), to determine the stack gas dry molecular weight, and Reference Method 4 or Method 5 equipment for moisture content determination; other methods may be used subject to approval of the Administrator.

2.7 Calibration Pitot Tube. When calibration of the Type S pitot tube is necessary (see Section 4), a standard pitot tube for a reference. The standard pitot tube shall, preferably, have a known coefficient, obtained either (1) directly from the National Bureau of Standards, Route 70 S, Quince Orchard Road, Gaithersburg, Maryland, or (2) by calibration against another standard pitot tube with an NBS-traceable coefficient. Alternatively, a standard pitot tube designed according to the criteria given in Sections 2.7.1 through 2.7.5 below and illustrated in Figure 2-4 (see also Citations 7, 8, and 17 in the Bibliography) may be used. Pitot tubes designed according to these specifications will have baseline coefficients of about 0.99 ± 0.01.

2.7.1 Hemispherical (shown in Figure 2-4) ellipsoidal, or conical tip.

2.7.2 A minimum of six diameters straight run (based upon D, the external diameter of the tube) between the tip and the static pressure holes.

2.7.3 A minimum of eight diameters straight run between the static pressure holes and the centerline of the external tube, following the 90-degree bend.

2.7.4 Static pressure holes of equal size (approximately 0.1 D), equally spaced in a piezometer ring configuration.

2.7.5 Ninety-degree bend, with curved or mitered junction.

2.8 Differential Pressure Gauge for Type S Pitot Tube Calibration. An inclined manometer or equivalent. If the single-velocity calibration technique is employed (see Section 4.1.2.3), the calibration differential pressure gauge shall be readable to the nearest 0.13 mm (0.005 in.) H_2O. For multivelocity calibrations, the gauge shall be readable to the nearest 0.13 mm (0.005 in.) H_2O for Δp values between 1.3 and 25 mm (0.05 and 1.0 in.) H_2O, and to the nearest 1.3 mm (0.05 in.) H_2O for Δp values above 25 mm (1.0 in.) H_2O. A special, more sensitive gauge will be required to read Δp values below 1.3 mm (0.05 in.) H_2O (see Citation 18 in the Bibliography).

3. PROCEDURE

3.1 Set up the apparatus as shown in Figure 2-1. Capillary tubing or surge tanks installed between the manometer and pitot tube may be used to dampen Δp fluctuations. It is recommended, but not required, that a pretest leak-check be conducted as follows: (1) blow through the pitot impact opening until at least

7.6 cm (3 in.) H_2O velocity pressure registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3 in.) H_2O. Other leak-check procedures, subject to the approval of the Administrator, may be used.

3.2 Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse. Record all necessary data as shown in the example data sheet (Figure 2-5).

3.3 Measure the velocity head and temperature at the traverse points specified by Method 1. Ensure that the proper differential pressure gauge is being used for the range of Δp values encountered (see Section 2.2). If it is necessary to change to a more sensitive gauge, do so, and remeasure the Δp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in Section 3.1 above, to validate the traverse run.

3.4 Measure the static pressure in the stack. One reading is usually adequate.

3.5 Determine the atmospheric pressure.

3.6 Determine the stack gas dry molecular weight. For combustion processes or processes that emit essentially CO_2, O_2, CO, and N_2, use Method 3. For processes emitting essentially air, an analysis need not be conducted; use a dry molecular weight of 29.0. For other processes, other methods, subject to the approval of the Administrator, must be used.

3.7 Obtain the moisture content from Reference Method 4 (or equivalent) or from Method 5.

3.8 Determine the cross-sectional area of the stack or duct at the sampling location. Whenever possible, physically measure the stack dimensions rather than using blueprints.

4. CALIBRATION

4.1 Type S Pitot Tube. Before its initial use, carefully examine the Type S pitot tube in top, side, and end views to verify that the face openings of the tube are aligned within the specifications illustrated in Figure 2-2 or 2-3. The pitot tube shall not be used if it fails to meet these alignment specifications.

After verifying the face opening alignment, measure and record the following dimensions of the pitot tube: (a) the external tubing diameter (dimension D_t, Figure 2-2b); and (b) the base-to-opening plane distances (dimensions P_A and P_B, Figure 2-2b). If D_t is between 0.48 and 0.95 cm (3/16 and 3/8 in.), and if P_A and P_B are equal and between 1.05 and 1.50 D_t, there are two possible options: (1) the pitot tube may be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, or (2) a baseline (isolated tube) coefficient value of 0.84 may be assigned to the pitot tube. Note, however, that if the

pitot tube is part of an assembly, calibration may still be required, despite knowledge of the baseline coefficient value (see Section 4.1.1).

If D_t, P_A, and P_B are outside the specified limits, the pitot tube must be calibrated as outlined in Sections 4.1.2 through 4.1.5 below.

4.1.1 Type S Pitot Tube Assemblies. During sample and velocity traverses, the isolated Type S pitot tube is not always used; in many instances, the pitot tube is used in combination with other source-sampling components (thermocouple, sampling probe, nozzle) as part of an "assembly." The presence of other sampling components can sometimes affect the baseline value of the Type S pitot tube coefficient (Citation 9 in the Bibliography); therefore an assigned (or otherwise known) baseline coefficient value may or may not be valid for a given assembly. The baseline and assembly coefficient values will be identical only when the relative placement of the components in the assembly is such that aerodynamic interference effects are eliminated. Figures 2-6 through 2-8 illustrate interference-free component arrangements for Type S pitot tubes having external tubing diameters between 0.48 and 0.95 cm (3/16 and 3/8 in.). Type S pitot tube assemblies that fail to meet any or all of the specifications of Figures 2-6 through 2-8 shall be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, and prior to calibration, the values of the intercomponent spacings (pitot-nozzle, pitot-thermocouple, pitot-probe sheath) shall be measured and recorded.

NOTE: Do not use any Type S pitot tube assembly which is constructed such that the impact pressure opening plane of the pitot tube is below the entry plane of the nozzle (see Figure 2-6B).

4.1.2 Calibration Setup. If the Type S pitot tube is to be calibrated, one leg of the tube shall be permanently marked A, and the other, B. Calibration shall be done in a flow system having the following essential design features:

4.1.2.1 The flowing gas stream must be confined to a duct of definite cross-sectional area, either circular or rectangular. For circular cross sections, the minimum duct diameter shall be 30.5 cm (12 in.); for rectangular cross sections, the width (shorter side) shall be at least 25.4 cm (10 in.).

4.1.2.2 The cross-sectional area of the calibration duct must be constant over a distance of 10 or more duct diameters. For a rectangular cross section, use an equivalent diameter, calculated from the following equation, to determine the number of duct diameters:

$$D_e = \frac{2LW}{(L + W)}$$

Eq. 2-1

Where:

D_e = Equivalent diameter.
L = Length.
W = Width.

To ensure the presence of stable, fully developed flow patterns at the calibration site, or "test section," the site must be located at least eight diameters downstream and two diameters upstream from the nearest disturbances.

NOTE: The eight- and two-diameter criteria are not absolute; other test section locations may be used (subject to approval of the Administrator), provided that the flow at the test site is stable and demonstrably parallel to the duct axis.

4.1.2.3 The flow system shall have the capacity to generate a test-section velocity around 915 m/min (3,000 ft/min). This velocity must be constant with time to guarantee steady flow during calibration. Note that Type S pitot tube coefficients obtained by single-velocity calibration at 915 m/min (3,000 ft/min) will generally be valid to ±3 percent for the measurement of velocities above 305 m/min (1,000 ft/min) and to ±5 to 6 percent for the measurement of velocities between 180 and 305 m/min (600 and 1,000 ft/min). If a more precise correlation between C_p and velocity is desired, the flow system shall have the capacity to generate at least four distinct, time-invariant test-section velocities covering the velocity range from 180 to 1,525 m/min (600 to 5,000 ft/min), and calibration data shall be taken at regular velocity intervals over this range (see Citations 9 and 14 in the Bibliography for details).

4.1.2.4 Two entry ports, one each for the standard and Type S pitot tubes, shall be cut in the test section; the standard pitot entry port shall be located slightly downstream of the Type S port, so that the standard and Type S impact openings will lie in the same cross-sectional plane during calibration. To facilitate alignment of the pitot tubes during calibration, it is advisable that the test section be constructed of plexiglas or some other transparent material.

4.1.3 Calibration Procedure. Note that this procedure is a general one and must not be used without first referring to the special considerations presented in Section 4.1.5. Note also that this procedure applies only to single-velocity calibration. To obtain calibration data for the A and B sides of the Type S pitot tube, proceed as follows:

4.1.3.1 Make sure that the manometer is properly filled and that the oil is free from contamination and is of the proper density. Inspect and leak-check all pitot lines; repair or replace if necessary.

4.1.3.2 Level and zero the manometer. Turn on the fan, and allow the flow to stabilize. Seal the Type S entry port.

4.1.3.3 Ensure that the manometer is level and zeroed. Position the standard pitot tube at the calibration point (determined as outlined in Section 4.1.5.1), and align the tube so that its tip is pointed directly into the flow. Particular care should be taken in aligning the tube to avoid yaw and pitch angles. Make sure that the entry port surrounding the tube is properly sealed.

4.1.3.4 Read Δp_{std}, and record its value in a data table similar to the one shown in Figure 2-9. Remove the standard pitot tube from the duct, and disconnect it from the manometer. Seal the standard entry port.

4.1.3.5 Connect the Type S pitot tube to the manometer. Open the Type S entry port. Check the manometer level and zero. Insert and align the Type S pitot tube so that its A side impact opening is at the same point as was the standard pitot tube and is pointed directly into the flow. Make sure that the entry port surrounding the tube is properly sealed.

4.1.3.6 Read Δp_s, and enter its value in the data table. Remove the Type S pitot tube from the duct, and disconnect it from the manometer.

4.1.3.7 Repeat Steps 4.1.3.3 through 4.1.3.6 above until three pairs of Δp readings have been obtained.

4.1.3.8 Repeat Steps 4.1.3.3 through 4.1.3.7 above for the B side of the Type S pitot tube.

4.1.3.9 Perform calculations, as described in Section 4.1.4 below.

4.1.4 Calculations.

4.1.4.1 For each of the six pairs of Δp readings (i.e., three from side A and three from side B) obtained in Section 4.1.3 above, calculate the value of the Type S pitot tube coefficient as follows:

$$C_{p(s)} = C_{p(std)} \sqrt{\frac{\Delta p_{std}}{\Delta p_s}}$$

Eq. 2-2

Where:

$C_{p(s)}$ = Type S pitot tube coefficient.

$C_{p(std)}$ = Standard pitot tube coefficient; use 0.99 if the coefficient is unknown and the tube is designed according to the criteria of Sections 2.7.1 to 2.7.5 of this method.

Δp_{std} = Velocity head measured by the standard pitot tube, cm (in.) H_2O.

Δp_s = Velocity head measured by the Type S pitot tube, cm (in.) H_2O.

4.1.4.2 Calculate $\overline{C}_p$ (side A), the mean A-side coefficient, and $\overline{C}_p$ (side B), the

mean B-side coefficient; calculate the difference between these two average values.

4.1.4.3 Calculate the deviation of each of the three A-side values of $C_{p(s)}$ from $\overline{C}_p$ (side A), and the deviation of each B-side values of $C_{p(s)}$ from $\overline{C}_p$ (side B). Use the following equation:

$$\text{Deviation} = C_{p_{(s)}} - \overline{C}_p(\text{A or B})$$

Eq. 2-3

4.1.4.4 Calculate σ, the average deviation from the mean, for both the A and B sides of the pitot tube. Use the following equation:

$$\sigma(\text{side A or B}) = \frac{\sum_{1}^{3} \left| C_{p(s)} - \overline{C}_p(\text{A or B}) \right|}{3}$$

Eq. 2-4

4.1.4.5 Use the Type S pitot tube only if the values of σ (side A) and σ (side B) are less than or equal to 0.01 and if the absolute value of the difference between $\overline{C}_p$ (A) and $\overline{C}_p$ (B) is 0.01 or less.

4.1.5 Special Considerations.

4.1.5.1 Selection of Calibration Point.

4.1.5.1.1 When an isolated Type S pitot tube is calibrated, select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The Type S pitot coefficients so obtained, i.e., $\overline{C}_p$ (side A) and $\overline{C}_p$ (side B), will be valid, so long as either: (1) the isolated pitot tube is used; or (2) the pitot tube is used with other components (nozzle, thermocouple, sample probe) in an arrangement that is free from aerodynamic interference effects (see Figures 2-6 through 2-8).

4.1.5.1.2 For Type S pitot tube-thermocouple combinations (without sample probe), select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The coefficients so obtained will be valid so long as the pitot tube-thermocouple combination is used by itself or with other components in an interference-free arrangement (Figures 2-6 and 2-8).

4.1.5.1.3 For assemblies with sample probes, the calibration point should be

located at or near the center of the duct; however, insertion of a probe sheath into a small duct may cause significant cross-sectional area blockage and yield incorrect coefficient values (Citation 9 in the Bibliography). Therefore, to minimize the blockage effect, the calibration point may be a few inches off-center if necessary. The actual blockage effect will be negligible when the theoretical blockage, as determined by a projected-area model of the probe sheath, is 2 percent or less of the duct cross-sectional area for assemblies without external sheaths (Figure 2-10a), and 3 percent or less for assemblies with external sheaths (Figure 2-10b).

4.1.5.2 For those probe assemblies in which pitot tube-nozzle interference is a factor (i.e., those in which the pitot-nozzle separation distance fails to meet the specification illustrated in Figure 2-6A), the value of $C_{p(s)}$ depends upon the amount of free-space between the tube and nozzle, and therefore is a function of nozzle size. In these instances, separate calibrations shall be performed with each of the commonly used nozzle sizes in place. Note that the single-velocity calibration technique is acceptable for this purpose, even though the larger nozzle sizes (>0.635 cm or 1/4 in.) are not ordinarily used for isokinetic sampling at velocities around 915 m/min (3,000 ft/min), which is the calibration velocity; note also that it is not necessary to draw an isokinetic sample during calibration (see Citation 19 in the Bibliography).

4.1.5.3 For a probe assembly constructed such that its pitot tube is always used in the same orientation, only one side of the pitot tube need be calibrated (the side which will face the flow). The pitot tube must still meet the alignment specifications of Figure 2-2 or 2-3, however, and must have an average deviation (σ) value of 0.01 or less (see Section 4.1.4.4.)

4.1.6 Field Use and Recalibration.

4.1.6.1 Field Use.

4.1.6.1.1 When a Type S pitot tube (isolated or in an assembly) is used in the field, the appropriate coefficient value (whether assigned or obtained by calibration) shall be used to perform velocity calculations. For calibrated Type S pitot tubes, the A side coefficient shall be used when the A side of the tube faces the flow, and the B side coefficient shall be used when the B side faces the flow; alternatively, the arithmetic average of the A and B side coefficient values may be used, irrespective of which side faces the flow.

4.1.6.1.2 When a probe assembly is used to sample a small duct, 30.5 to 91.4 cm (12 to 36 in.) in diameter, the probe sheath sometimes blocks a significant part of the duct cross-section, causing a reduction in the effective value of $C_{p(s)}$. Consult Citation 9 in the Bibliography for details. Conventional pitot-sampling probe assemblies are not recommended for use in ducts having inside diameters smaller than 30.5 cm (12 in.) (see Citation 16 in the Bibliography).

4.1.6.2 Recalibration.

4.1.6.2.1 Isolated Pitot Tubes. After each field use, the pitot tube shall be

carefully reexamined in top, side, and end views. If the pitot face openings are still aligned within the specifications illustrated in Figure 2-2 or 2-3, it can be assumed that the baseline coefficient of the pitot tube has not changed. If, however, the tube has been damaged to the extent that it no longer meets the specifications of the Figure 2-2 or 2-3, the damage shall either be repaired to restore proper alignment of the face openings, or the tube shall be discarded.

4.1.6.2.2 Pitot Tube Assemblies. After each field use, check the face opening alignment of the pitot tube, as in Section 4.1.6.2.1; also, remeasure the intercomponent spacings of the assembly. If the intercomponent spacings have not changed and the face opening alignment is acceptable, it can be assumed that the coefficient of the assembly has not changed. If the face opening alignment is no longer within the specifications of Figure 2-2 or 2-3, either repair the damage or replace the pitot tube (calibrating the new assembly, if necessary). If the intercomponent spacings have changed, restore the original spacings, or recalibrate the assembly.

4.2 Standard Pitot Tube (if applicable). If a standard pitot tube is used for the velocity traverse, the tube shall be constructed according to the criteria of Section 2.7 and shall be assigned a baseline coefficient value of 0.99. If the standard pitot tube is used as part of an assembly, the tube shall be in an interference-free arrangement (subject to the approval of the Administrator).

4.3 Temperature Gauges. After each field use, calibrate dial thermometers, liquid-filled bulb thermometers, thermocouple-potentiometer systems, and other gauges at a temperature within 10 percent of the average absolute stack temperature. For temperatures up to 405°C (761°F), use an ASTM mercury-in-glass reference thermometer, or equivalent, as a reference; alternatively, either a reference thermocouple and potentiometer (calibrated by NBS) or thermometric fixed points, e.g., ice bath and boiling water (corrected for barometric pressure) may be used. For temperatures above 405°C (761°F), use an NBS-calibrated reference thermocouple-potentiometer system or an alternative reference, subject to the approval of the Administrator.

If, during calibration, the absolute temperature measured with the gauge being calibrated and the reference gauge agree within 1.5 percent, the temperature data taken in the field shall be considered valid. Otherwise, the pollutant emission test shall either be considered invalid or adjustments (if appropriate) of the test results shall be made, subject to the approval of the Administrator.

4.4 Barometer. Calibrate the barometer used against a mercury barometer.

5. CALCULATIONS

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

5.1 Nomenclature.

A = Cross-sectional area of stack, m^2 (ft^2).

B_{ws} = Water vapor in the gas stream (from Method 5 or Reference Method 4), proportion by volume.

C_p = Pitot tube coefficient, dimensionless.

K_p = Pitot tube constant,

$$34.97 \frac{m}{sec} \left[\frac{(g/g\text{-mole})(mmHg)}{(^\circ K)\ (mmH_2O)} \right]^{1/2}$$

for the metric system.

$$85.49 \frac{ft}{sec} \left[\frac{lb/lb\text{-mole})\ (in.Hg)}{(^\circ R)\ (in.H_2O)} \right]^{1/2}$$

for the English system.

M_d = Molecular weight of stack gas, dry basis (see Section 3.6), g/g—mole (lb/lb-mole).

M_s = Molecular weight of stack gas, wet basis, g/g-mole (lb/lb-mole).

$$= M_d(1 - B_{ws}) + 18.0B_{ws}$$

Eq. 2-5

P_{bar} = Barometric pressure at measurement site, mm Hg (in. Hg).

P_g = Stack static pressure, mm Hg (in. Hg).

P_s = Absolute stack pressure, mm Hg (in. Hg),

$$= P_{bar} + P_g$$

Eq. 2-6

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

Q_{sd} = Dry volumetric stack gas flow rate corrected to standard conditions, dsm^3/hr (dscf/hr).

t_s = Stack temperature, °C (°F).

T_s = Absolute stack temperature, °K (°R).

$$= 273 + t_s$$

Eq. 2-7

for metric.

$$= 460 + t_s$$

Eq. 2-8

for English.

T_{std} = Standard absolute temperature, 293°K (528°R).

v_s = Average stack gas velocity, m/sec (ft/sec).

Δp = Velocity head of stack gas, mm H_2O (in. H_2O).

3,600= Conversion factor, sec/hr.

18.0 = Molecular weight of water, g/g-mole (lb/lb-mole).

5.2 Average Stack Gas Velocity.

$$v_s = K_p C_p \left(\sqrt{\Delta p}\right)_{avg} \sqrt{\frac{T_{s\,(avg)}}{P_s M_s}}$$

Eq. 2-9

5.3 Average Stack Gas Dry Volumetric Flow Rate.

$$Q_{sd} = 3,600(1 - B_{ws}) v_s A \frac{T_{std}}{T_{s\,(avg)}} \frac{P_s}{P_{std}}$$

Eq. 2-10

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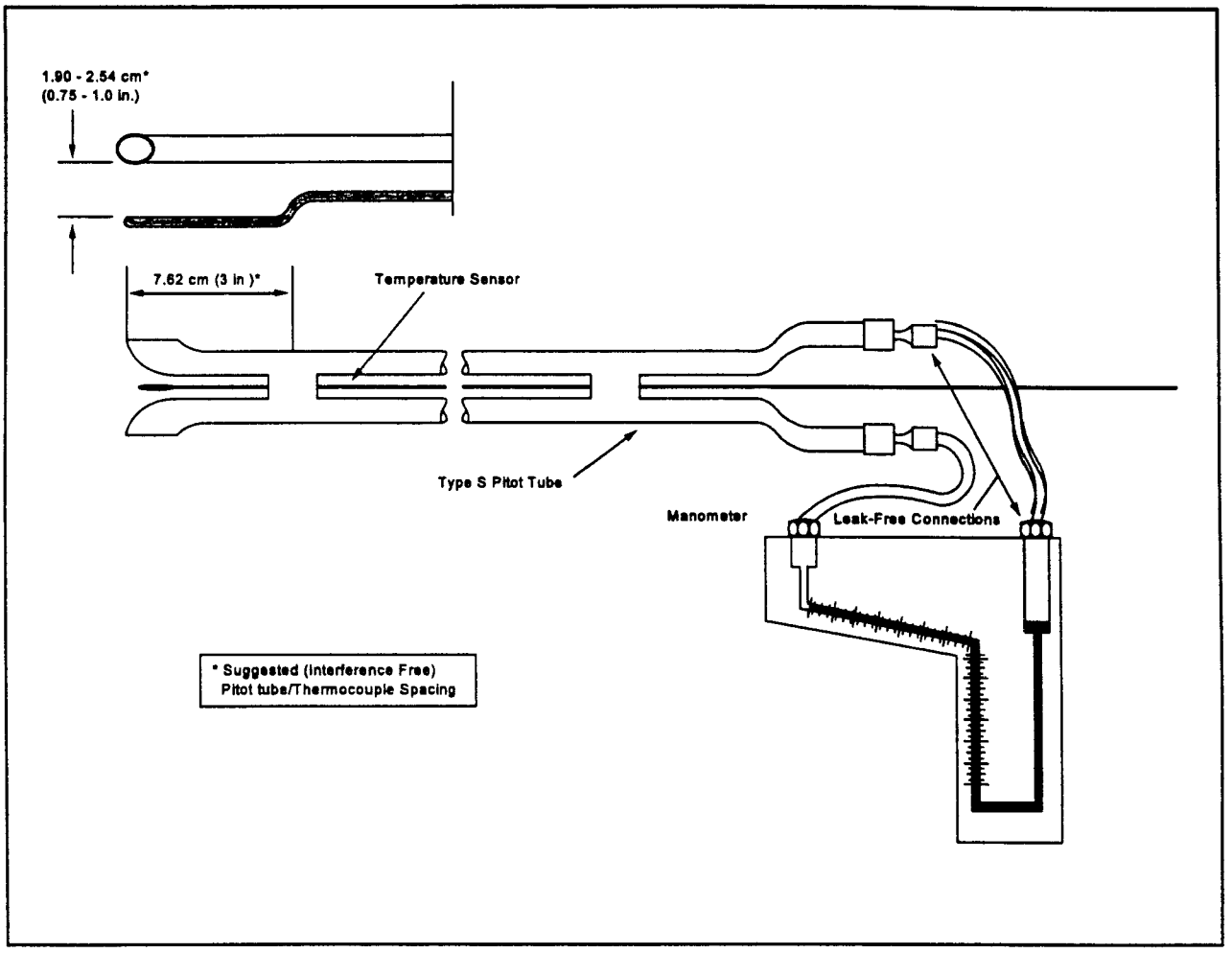


Figure 2-1. Type S pitot tube manometer assembly.

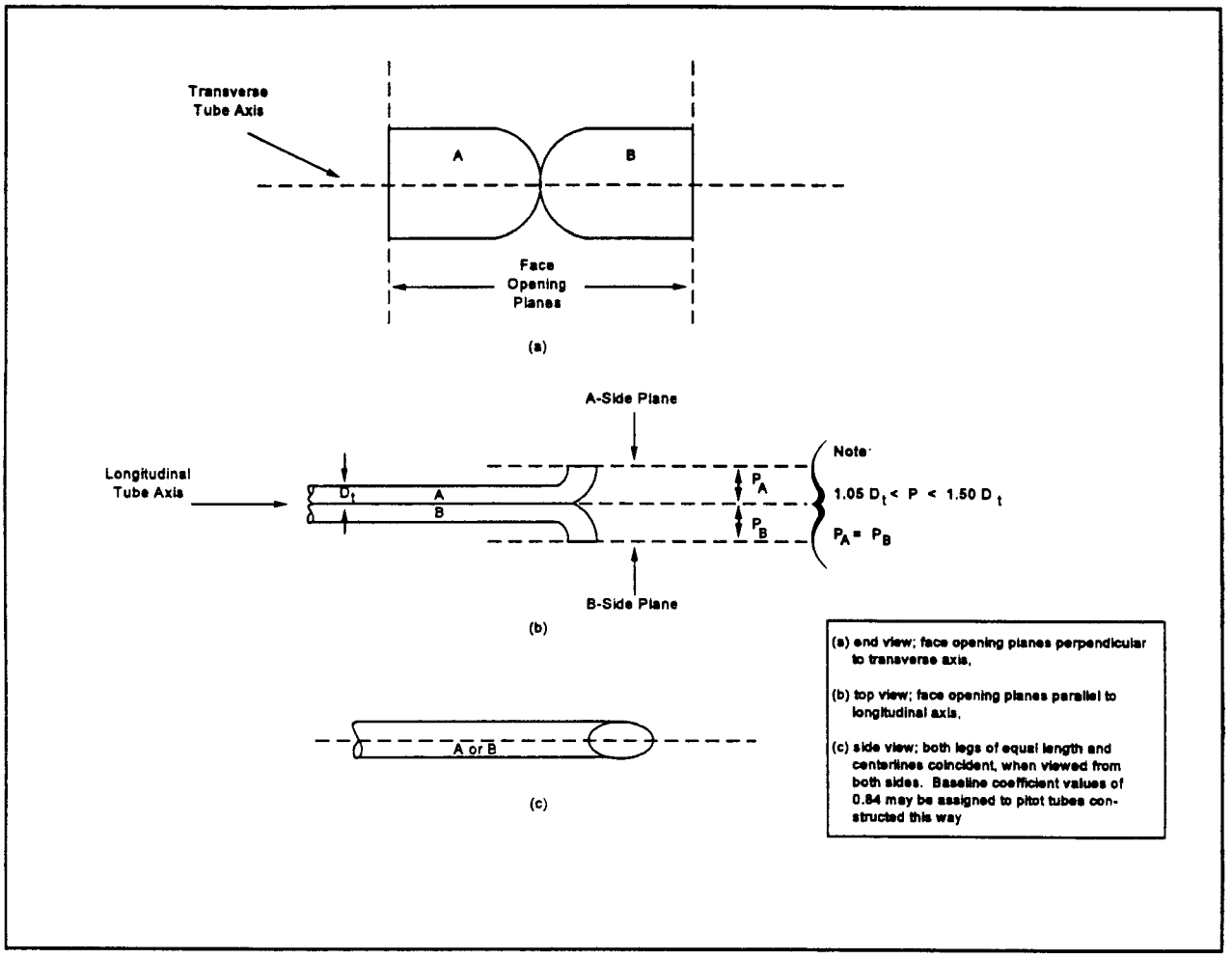


Figure 2-2. Properly constructed Type S pitot tube.

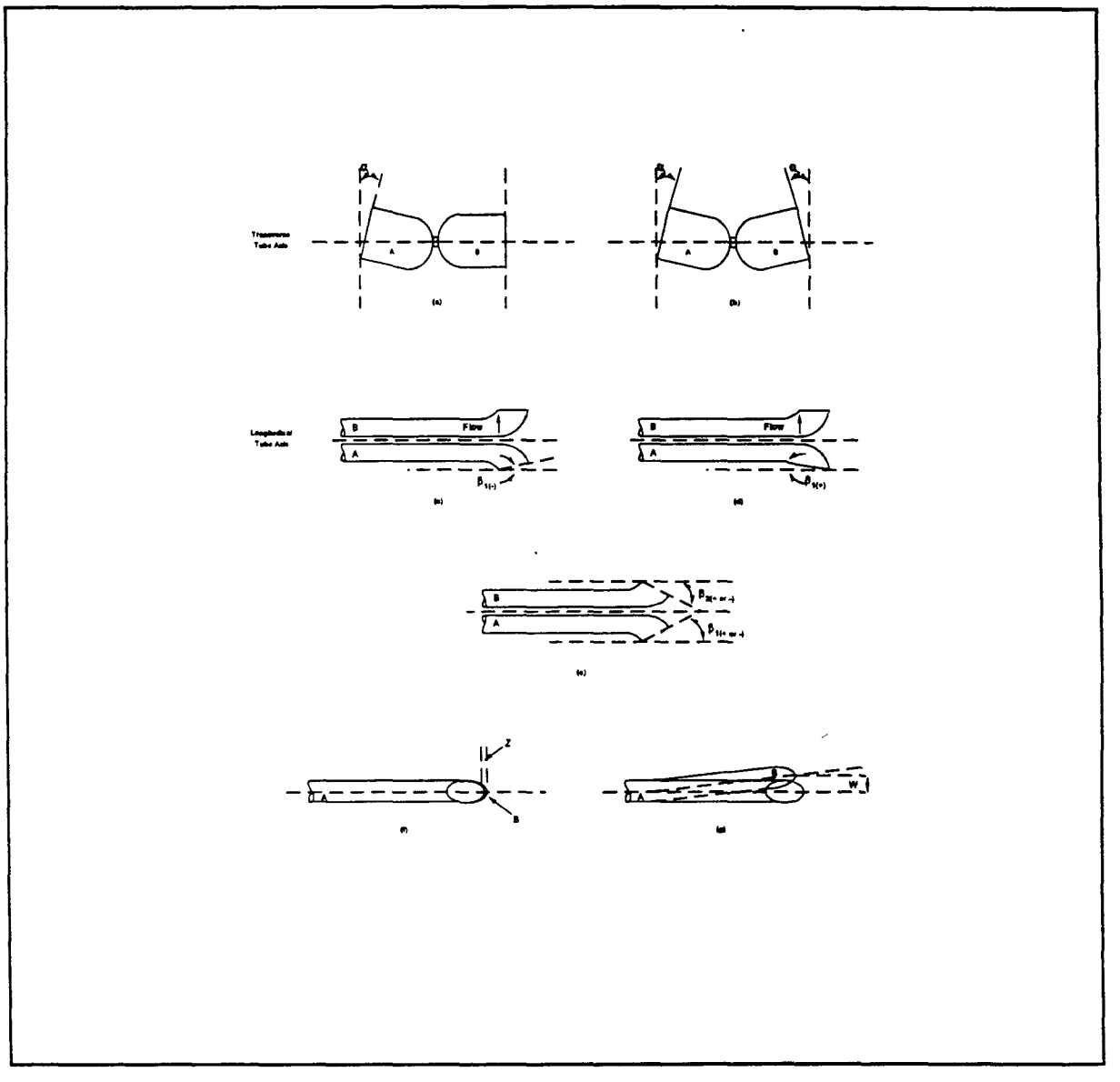


Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp(s) so long as α^1 and α^2 $\leq 10°$, β^1 and β^2 $\leq 5°$, z ≤ 0.32 cm (1/8 in.) and w ≤ 0.08 cm (1/32 in.) (citation 11 in Bibliography).

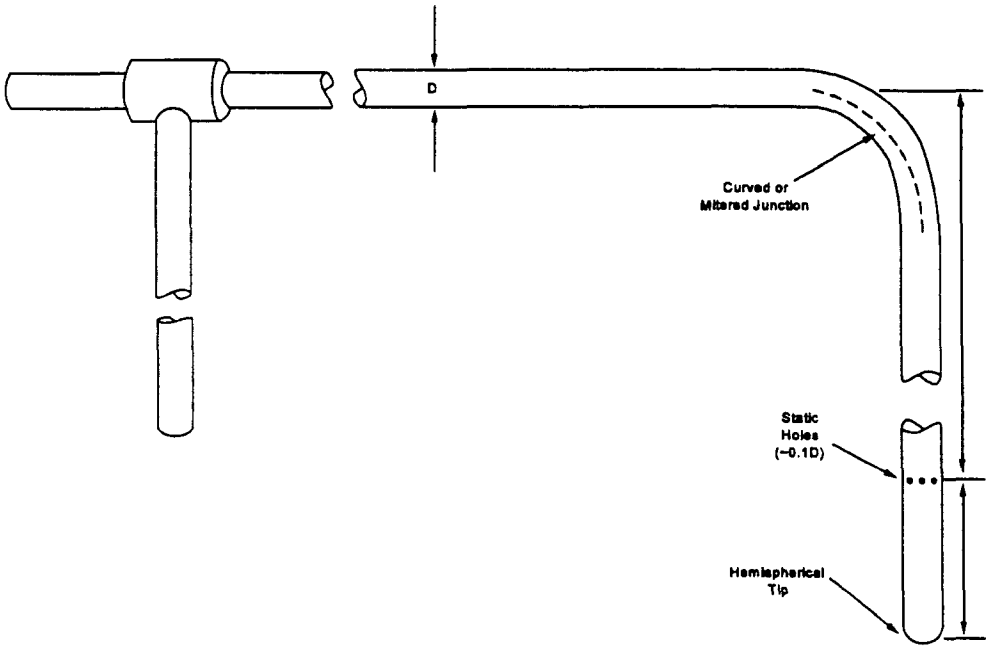


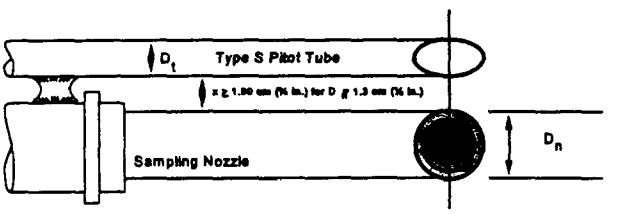
Figure 2-4. Standard pitot tube design specifications.

PLANT _____
DATE _____ RUN NO. _____STACK DIA. OR
DIMENSIONS, m (in.) _____ BAROMETRIC PRESS., mm Hg
(in. Hg) _____CROSS SECTIONAL AREA, m^2 (ft^2)_____
OPERATORS _____
PITOT TUBE I.D. NO. _____
AVG. COEFFICIENT, Cp = _____
LAST DATE CALIBRATED _____

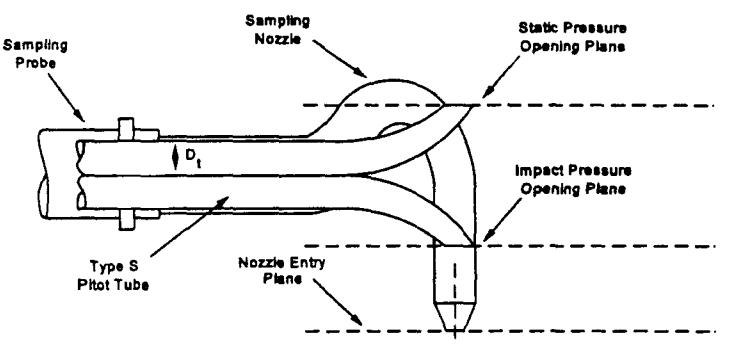
SCHEMATIC OF STACK
CROSS SECTION

Traverse Pt. No.	Vel. Hd., Δp mm (in.) H_2O	Stack Temperature		P_g mm Hg (in.Hg)	$(\Delta p)^{1/2}$
		T_s, °C (°F)	T_s, °K (°R)		
		Average			

Figure 2-5. Velocity traverse data.



A Bottom View, showing minimum pitot tube-nozzle separation.



B Side View; to prevent pitot tube from interfering with gas flow streamlines approaching the nozzle, the impact pressure opening plane of the pitot tube shall be even with or above the nozzle entry plane

Figure 2-6. Proper pitot tube-sampling nozzle configuration to prevent aerodynamic interference; button-hook type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

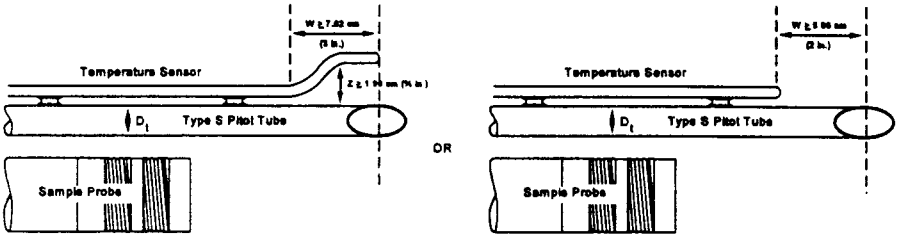


Figure 2-7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

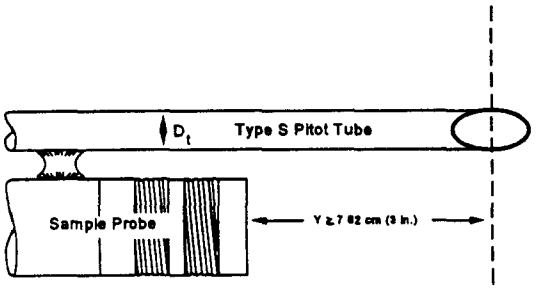


Figure 2-8. Minimum pitot-sample probe separation needed to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

PITOT TUBE IDENTIFICATION NUMBER: _____ DATE: _____CALIBRATED BY: _
_____

	"A" SIDE CALIBRATION			
RUN NO.	ΔP_{std} cm H_2O (in H_2O)	$\Delta P_{(s)}$ cm H_2O (in H_2O)	$C_{p(s)}$	Deviation $C_{p(s)}$ - C_p(A)
1				
2				
3				
		$C_{p,avg}$ (SIDE A)		

	"B" SIDE CALIBRATION			
RUN NO.	ΔP_{std} cm H_2O (in H_2O)	$\Delta P_{(s)}$ cm H_2O (in H_2O)	$C_{p(s)}$	Deviation $C_{p(s)}$ - C_p(B)
1				
2				
3				
		$C_{p,avg}$ (SIDE B)		

$$\text{Average Deviation} = \sigma_{(A\,or\,B)} = \frac{\sum_{i=1}^{3} \left| C_{p(s)} - \overline{C}_{p(A\,or\,B)} \right|}{3} \leftarrow \text{Must Be} \leq 0.01$$

$$\left| \overline{C}_p(\text{SideA}) - \overline{C}_p(\text{SideB}) \right| \leftarrow \text{Must Be} \leq 0.01$$

Figure 2-9. Pitot tube calibration data.

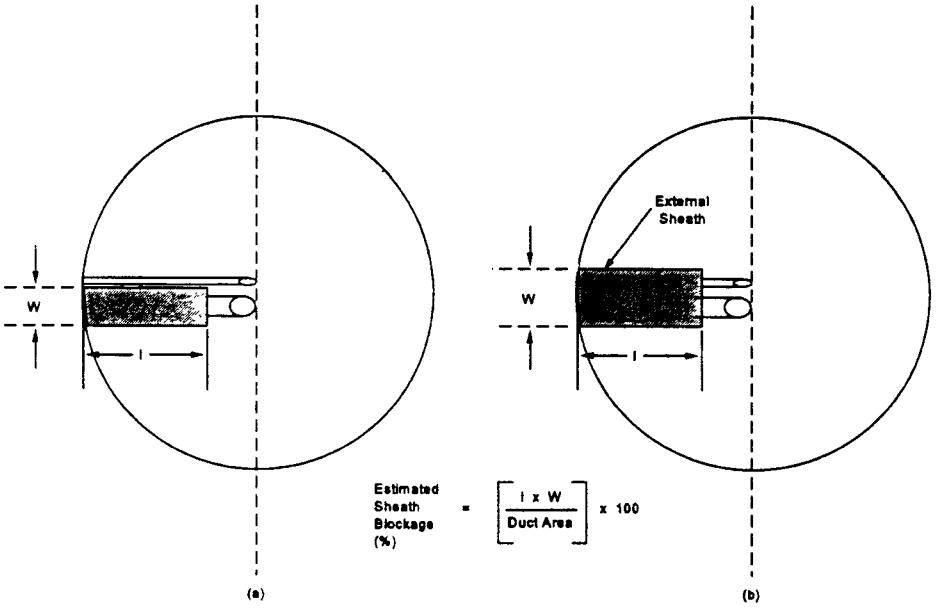


Figure 2-10. Projected-area models for typical pitot tube assemblies.

Appendix G.3

EPA Method 3A

Method 3A - Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method is applicable to the determination of oxygen (O_2) and carbon dioxide (CO_2) concentrations in emissions from stationary sources only when specified within the regulations.

1.2 Principle. A sample is continuously extracted from the effluent stream: a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O_2 and CO_2 concentration(s). Performance specifications and test procedures are provided to ensure reliable data.

2. RANGE AND SENSITIVITY

Same as in Method 6C, Sections 2.1 and 2.2, except that the span of the monitoring system shall be selected such that the average O_2 or CO_2 concentration is not less than 20 percent of the span.

3. DEFINITIONS

3.1 Measurement System. The total equipment required for the determination of the O_2 or CO_2 concentration. The measurement system consists of the same major subsystems as defined in Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.

3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, Response Time, and Calibration Curve. Same as in Method 6C, Sections 3.2 through 3.8, and 3.10.

3.3 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

4. MEASUREMENT SYSTEM PERFORMANCE SPECIFICATIONS

Same as in Method 6C, Sections 4.1 through 4.4.

5. APPARATUS AND REAGENTS

5.1 Measurement System. Any measurement system for O_2 or CO that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:

5.1.1 Sample Probe. A leak-free probe of sufficient length to traverse the sample points.

5.1.2 Sample Line. Tubing to transport the sample gas from the probe to the moisture removal system. A heated sample line is not required for systems that measure the O_2 or CO_2 concentration on a dry basis, or transport dry gases.

5.1.3 Sample Transport Line, Calibration Valve Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as in Method 6C, Sections 5.1.3 through 5.1.9, and 5.1.11, except that the requirements to use stainless steel, Teflon, and nonreactive glass filters do not apply.

5.1.4 Gas Analyzer. An analyzer to determine continuously the O_2 or CO_2 concentration in the sample gas stream. The analyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) shall be provided at the analyzer. The requirements for measuring and controlling the analyzer for measuring and controlling the analyzer flow rate are not applicable if data are presented that demonstrate the analyzer is insensitive to flow variations over the range encountered during the test.

5.2 Calibration Gases. The calibration gases for CO_2 analyzers shall be CO_2 in N_2 or CO_2 in air. Alternatively, CO_2/SO_2, O_2/SO_2, or $O_2/CO_2/SO_2$ gas mixtures in N_2 may be used. Three calibration gases, as specified in Sections 5.3.1 through 5.3.4 of Method 6C, shall be used. For O_2 monitors that cannot analyze zero gas, a calibration gas concentration equivalent to less than 10 percent of the span may be used in place of zero gas.

6. MEASUREMENT SYSTEM PERFORMANCE TEST PROCEDURES

Perform the following procedures before measurement of emissions (Section 7).

6.1 Calibration Concentration Verification. Follow Section 6.1 of Method 6C, except if calibration gas analysis is required, use Method 3 and change the acceptance criteria for agreement among Method 3 results to 5 percent (or 0.2 percent by volume, whichever is greater).

6.2 Interference Response. Conduct an interference response test of the analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if

changes are made in the instrumentation that could alter the interference response (e.g., changes in the type of gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, Response Time, and Sampling System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.

7. EMISSION TEST PROCEDURE

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 3.

7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as that used during the response time test. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. The sampling time per run shall be the same as for tests conducted using Method 3 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.

7.3 Zero and Calibration Drift Test. Follow Section 7.4 of Method 6C.

8. QUALITY CONTROL PROCEDURES

The following quality control procedures are recommended when the results of this method are used for an emission rate correction factor, or excess air determination. The tester should select one of the following options for validating measurement results:

8.1 If both O_2 and CO are measured using Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the O_2 and CO measurement results.

8.2 If only O_2 is measured using Method 3A, measurements of the sample stream CO concentration should be obtained at the sample by-pass vent discharge using an Orsat or Fyrite analyzer, or equivalent. Duplicate samples should be obtained concurrent with at least one run. Average the duplicate Orsat or Fyrite analysis results for each run. Use the average CO_2 values for comparison with the O_2 measurements in accordance with the procedures described in Section 4.4 of Method 3.

8.3 If only CO_2 is measured using Method 3A, concurrent measurements of the sample stream CO_2 concentration should be obtained using an Orsat or Fyrite analyzer as described in Section 8.2. For each run, differences greater than 0.5 percent between the Method 3A results and the average of the duplicate Fyrite analysis should be investigated.

9. EMISSION CALCULATION

9.1 For all CO_2 analyzers, and for O_2 analyzers that can be calibrated with zero gas, follow Section 8 of Method 6C, except express all concentrations as percent, rather than ppm.

9.2 For O_2 analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{gas} = \frac{C_{ma} - C_{oa}}{C_m - C_o} (\bar{C} - C_m) + C_{ma} \qquad \text{Eq. 3A-1}$$

Where:

C_{gas} = Effluent gas concentration, dry basis, percent.

C_{ma} = Actual concentration of the upscale calibration gas, percent.

C_{oa} = Actual concentration of the low-level calibration gas, percent.

C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.

C_o = Average of initial and final system calibration bias check responses for the low level gas, percent.

$\bar{C}$ = Average gas concentration indicated by the gas analyzer, dry basis, percent.

10. BIBLIOGRAPHY

Same as in Bibliography of Method 6C.

Appendix G.4

EPA Method 4

Method 4 - Determination of Moisture Content in Stack Gases

1. PRINCIPLE AND APPLICABILITY

1.1 Principle. A gas sample is extracted at a constant rate from the source; moisture is removed from the sample stream and determined either volumetrically or gravimetrically.

1.2 Applicability. This method is applicable for determining the moisture content of stack gas.

1.2.1 Two procedures are given. The first is a reference method, for accurate determinations of moisture content (such as are needed to calculate emission data). The second is an approximation method, which provides estimates of percent moisture to aid in setting isokinetic sampling rates prior to a pollutant emission measurement run. The approximation method described herein is only a suggested approach; alternative means for approximating the moisture content, e.g., drying tubes, wet bulb-dry bulb techniques, condensation techniques, stoichiometric calculations, previous experience, etc., are also acceptable.

1.2.2 The reference method is often conducted simultaneously with a pollutant emission measurement run; when it is, calculation of percent isokinetic, pollutant emission rate, etc., for the run shall be based upon the results of the reference method or its equivalent; these calculations shall not be based upon the results of the approximation method, unless the approximation method is

shown, to the satisfaction of the Administrator, U.S. Environmental Protection Agency, to be capable of yielding results within 1 percent H_2O of the reference method.

1.2.3 **Note:** The reference method may yield questionable results when applied to saturated gas streams or to streams that contain water droplets. Therefore, when these conditions exist or are suspected, a second determination of the moisture content shall be made simultaneously with the reference method, as follows: Assume that the gas stream is saturated. Attach a temperature sensor [capable of measuring to within 1°C (2°F)] to the reference method probe. Measure the stack gas temperature at each traverse point (see Section 2.2.1) during the reference method traverse; calculate the average stack gas temperature. Next, determine the moisture percentage, either by: (1) using a psychrometric chart and making appropriate corrections if stack pressure is different from that of the chart, or (2) using saturation vapor pressure tables. In cases where the psychrometric chart or the saturation vapor pressure tables are not applicable (based on evaluation of the process), alternative methods, subject to the approval of the Administrator, shall be used.

2. REFERENCE METHOD

The procedure described in Method 5 for determining moisture content is acceptable as a reference method.

2.1 **Apparatus.** A schematic of the sampling train used in this reference method is shown in Figure 4-1. All components shall be maintained and calibrated according to the procedures in Method 5.

2.1.1 Probe. Stainless steel or glass tubing, sufficiently heated to prevent water condensation, and equipped with a filter, either in-stack (e.g., a plug of glass wool inserted into the end of the probe) or heated out-stack (e.g., as described in Method 5), to remove particulate matter. When stack conditions permit, other metals or plastic tubing may be used for the probe, subject to the approval of the Administrator.

2.1.2 Condenser. See Method 5, Section 2.1.7, for a description of an acceptable type of condenser and for alternative measurement systems.

2.1.3 Cooling System. An ice bath container and crushed ice (or equivalent), to aid in condensing moisture.

2.1.4 Metering System. Same as in Method 5, Section 2.1.8, except do not use sampling systems designed for flow rates higher than 0.0283 m^3/min (1.0 cfm). Other metering systems, capable of maintaining a constant sampling rate to within 10 percent and determining sample gas volume to within 2 percent, may be used, subject to the approval of the Administrator.

2.1.5 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm (0.1 in.) Hg. See **NOTE** in Method 5, Section 2.1.9.

2.1.6 Graduated Cylinder and/or Balance. To measure condensed water and moisture caught in the silica gel to within 1 ml or 0.5 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. These balances are suitable for use here.

2.2 Procedure. The following procedure is written for a condenser system (such as the impinger system described in Section 2.1.7 of Method 5) incorporating volumetric analysis to measure the condensed moisture, and silica gel and gravimetric analysis to measure the moisture leaving the condenser.

2.2.1 Unless otherwise specified by the Administrator, a minimum of eight traverse points shall be used for circular stacks having diameters less than 0.61 m (24 in.), a minimum of nine points shall be used for rectangular stacks
having equivalent diameters less than 0.61 m (24 in.), and a minimum of twelve traverse points shall be used in all other cases. The traverse points shall be located according to Method 1. The use of fewer points is subject to the approval of the Administrator. Select a suitable probe and probe length such that all traverse points can be sampled. Consider sampling from opposite sides
of the stack (four total sampling ports) for large stacks, to permit use of shorter probe lengths. Mark the probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point. Place known volumes of water in the first two impingers. Weigh and record the weight of the silica gel to the nearest 0.5 g, and transfer the silica gel to the fourth impinger; alternatively, the silica gel may first be transferred to the impinger, and the weight of the silica gel plus impinger recorded.

2.2.2 Select a total sampling time such that a minimum total gas volume of 0.60 scm (21 scf) will be collected, at a rate no greater than 0.021 m^3/min (0.75 cfm). When both moisture content and pollutant emission rate are to be determined, the moisture determination shall be simultaneous with, and for the same total length of time as, the pollutant emission rate run, unless otherwise specified in an applicable subpart of the standards.

2.2.3 Set up the sampling train as shown in Figure 4-1. Turn on the probe heater and (if applicable) the filter heating system to temperatures of about 120°C (248°F), to prevent water condensation ahead of the condenser; allow time for the temperatures to stabilize. Place crushed ice in the ice bath container. It is recommended, but not required, that a leak check be done, as follows: Disconnect the probe from the first impinger or (if applicable) from the filter holder. Plug the inlet to the first impinger (or filter holder), and pull a 380 mm (15 in.) Hg vacuum; a lower vacuum may be used, provided that it is not exceeded during

the test. A leakage rate in excess of 4 percent of the average sampling rate or 0.00057 m^3/min (0.02 cfm), whichever is less, is unacceptable. Following the leak check, reconnect the probe to the sampling train.

2.2.4 During the sampling run, maintain a sampling rate within 10 percent of constant rate, or as specified by the Administrator. For each run, record the data required on the example data sheet shown in Figure 4-2. Be sure to record the dry gas meter reading at the beginning and end of each sampling time increment and whenever sampling is halted. Take other appropriate readings at each sample point, at least once during each time increment.

2.2.5 To begin sampling, position the probe tip at the first traverse point. Immediately start the pump, and adjust the flow to the desired rate. Traverse the cross section, sampling at each traverse point for an equal length of time. Add more ice and, if necessary, salt to maintain a temperature of less than 20°C (68°F) at the silica gel outlet.

2.2.6 After collecting the sample, disconnect the probe from the filter holder (or from the first impinger), and conduct a leak check (mandatory) as described in Section 2.2.3. Record the leak rate. If the leakage rate exceeds the allowable rate, the tester shall either reject the test results or shall correct the sample volume as in Section 6.3 of Method 5. Next, measure the volume of the moisture condensed to the nearest ml. Determine the increase in weight of the silica gel (or silica gel plus impinger) to the nearest 0.5 g. Record this information (see example data sheet, Figure 4-3), and calculate the moisture percentage, as described in 2.3 below.

2.2.7 A quality control check of the volume metering system at the field site is suggested before collecting the sample following the procedure in Method 5, Section 4.4.

2.3 Calculations. Carry out the following calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

2.3.1 Nomenclature.

B_{ws} = Proportion of water vapor, by volume, in the gas stream.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P_m = Absolute pressure (for this method, same as barometric pressure) at the dry gas meter, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 (mm Hg)(m^3)/(g-mole)(°K) for metric units and 21.85 (in. Hg)(ft^3)/(lb-mole)(°R) for English units.

T_m = Absolute temperature at meter, °K (°R).

T_{std} = Standard absolute temperature, 293°K (528°R).

V_m = Dry gas volume measured by dry gas meter, dcm (dcf).

ΔV_m = Incremental dry gas volume measured by dry gas meter at each traverse point, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

$V_{wc(std)}$ = Volume of water vapor condensed, corrected to standard conditions, scm (scf).

$V_{wsg(std)}$ = Volume of water vapor collected in silica gel, corrected to standard conditions, scm (scf).

V_f = Final volume of condenser water, ml.

V_i = Initial volume, if any, of condenser water, ml.

W_f = Final weight of silica gel or silica gel plus impinger, g.

W_i = Initial weight of silica gel or silica gel plus impinger, g.

Y = Dry gas meter calibration factor.

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).

2.3.2 Volume of Water Vapor Condensed.

$$V_{wc(std)} = (V_f - V_i)\rho_w \frac{RT_{std}}{P_{std} M_w} = K_1 (V_f - V_i) \qquad \text{Eq. 4-1}$$

Where:

K_1 = 0.001333 m^3/ml for metric units,

= 0.04707 ft^3/ml for English units.

2.3.3 Volume of Water Collected in Silica Gel.

$$V_{wsg(std)} = \frac{(W_f - W_i)\ RT_{std}}{P_{std} M_w} = K_2 (W_f - W_i) \qquad \text{Eq. 4-2}$$

Where:

K_2 = 0.001335 m^3/g for metric units,

= 0.04715 ft^3/g for English units.

2.3.4 Sample Gas Volume.

$$V_{m(std)} = V_m Y \frac{(P_m)(T_{std})}{(P_{std})(T_m)} = K_3 Y \frac{V_m P_m}{T_m} \qquad \text{Eq. 4-3}$$

Where:

K_3 = 0.3858 °K/mm Hg for metric units,

= 17.64 °R/in. Hg for English units.

NOTE: If the post-test leak rate (Section 2.2.6) exceeds the allowable rate, correct the value of V_m in Equation 4-3, as described in Section 6.3 of Method 5.

2.3.5 Moisture Content.

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}} \qquad \text{Eq. 4-4}$$

NOTE: In saturated or moisture droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one using a value based upon the saturated conditions (see Section 1.2), and another based upon the results of the impinger analysis. The lower of these two values of B_{ws} shall be considered correct.

2.3.6 Verification of Constant Sampling Rate. For each time increment, determine the ΔV_m. Calculate the average. If the value for any time increment differs from the average by more than 10 percent, reject the results, and repeat the run.

3. APPROXIMATION METHOD

The approximation method described below is presented only as a suggested method (see Section 1.2).

3.1 Apparatus. See Figure 4-4.

3.1.1 Probe. Stainless steel or glass tubing, sufficiently heated

to prevent water condensation and equipped with a filter (either in-stack or heated out-stack) to remove particulate matter. A plug of glass wool, inserted into the end of the probe, is a satisfactory filter.

3.1.2 Impingers. Two midget impingers, each with 30-ml capacity, or equivalent.

3.1.3 Ice Bath. Container and ice, to aid in condensing moisture in impingers.

3.1.4 Drying Tube. Tube packed with new or regenerated 6- to 16-mesh indicating-type silica gel (or equivalent desiccant), to dry the sample gas and to protect the meter and pump.

3.1.5 Valve. Needle valve, to regulate the sample gas flow rate.

3.1.6 Pump. Leak-free, diaphragm type, or equivalent, to pull the gas sample through the train.

3.1.7 Volume Meter. Dry gas meter, sufficiently accurate to measure the sample volume to within 2 percent, and calibrated over the range of flow rates and conditions actually encountered during sampling.

3.1.8 Rate Meter. Rotameter, to measure the flow range from 0 to 3 liters/min (0 to 0.11 cfm).

3.1.9 Graduated Cylinder. 25-ml.

3.1.10 Barometer. Mercury, aneroid, or other barometer, as described in Section 2.1.5 above.

3.1.11 Vacuum Gauge. At least 760-mm (30-in.) Hg gauge, to be used for the sampling leak check.

3.2 Procedure.

3.2.1 Place exactly 5 ml water in each impinger. Leak check the

sampling train as follows: Temporarily insert a vacuum gauge at or near the probe inlet; then, plug the probe inlet, and pull a vacuum of at least 250 mm (10 in.) Hg. Note the time rate of change of the dry gas meter dial; alternatively, a rotameter (0 to 40 cc/min) may be temporarily attached to the dry gas meter outlet to determine the leakage rate. A leak rate not in excess of 2 percent of the average sampling rate is acceptable. **NOTE:** Carefully release the probe inlet plug before turning off the pump.

3.2.2 Connect the probe, insert it into the stack, and sample at a constant rate of 2 liters/min (0.071 cfm). Continue sampling until the dry gas meter registers about 30 liters (1.1 ft^3) or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter readings as required by Figure 4-5.

3.2.3 After collecting the sample, combine the contents of the two impingers, and measure the volume to the nearest 0.5 ml.

3.3 **Calculations.** The calculation method presented is designed to estimate the moisture in the stack gas; therefore, other data, which are only necessary for accurate moisture determinations, are not collected. The following equations adequately estimate the moisture content, for the purpose of determining isokinetic sampling rate settings.

3.3.1 Nomenclature.

B_{wm} = Approximate proportion by volume of water vapor in the gas stream leaving the second impinger, 0.025.

B_{ws} = Water vapor in the gas stream, proportion by volume.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P_m = Absolute pressure (for this method, same as barometric pressure) at the dry gas meter, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 [(mm Hg)(m^3)]/[(g-mole)(°K)] for metric units and 21.85 [(in. Hg)(ft^3)]/[(lb-mole)(°R)] for English units.

T_m = Absolute temperature at meter, °K (°R).

T_{std} = Standard absolute temperature, 293°R (528°R).

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents, ml.

V_m = Dry gas volume measured by dry gas meter, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, dscm (dscf).

Y = Dry gas meter calibration factor.

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).

3.3.2 Volume of Water Vapor Collected.

$$V_{wc} = \frac{(V_f - V_i)\rho_w R T_{std}}{P_{std} M_w} = K_1 (V_f - V_i) \qquad \text{Eq. 4-5}$$

Where:

K_1 = 0.001333 m^3/ml for metric units,

= 0.04707 ft^3/ml for English units.

3.3.3 Gas Volume.

$$V_{m(std)} = V_m \left(\frac{P_m}{P_{std}} \right) \left(\frac{T_{std}}{T_m} \right) = K_2 \; V_m \frac{P_m}{T_m} \qquad \text{Eq. 4-6}$$

Where:

K_2 = 0.03858 °K/mm Hg for metric units,

= 17.64 °R/in. Hg for English units.

3.3.4 Approximate Moisture Content.

$$B_{ws} = \frac{V_{wc}}{V_{wc}+V_{m(std)}} + B_{wm} = \frac{V_{wc}}{V_{wc}+V_{m(std)}} + (0.025) \qquad \text{Eq. 4-7}$$

4. CALIBRATION

4.1 For the reference method, calibrate the metering system, temperature gauges, and barometer according to Sections 5.3, 5.5, and 5.7, respectively, of Method 5. The recommended leak check of the metering system (Section 5.6 of Method 5) also applies to the reference method. For the approximation method, use the procedures outlined in Section 5.1.1 of Method 6 to calibrate the metering system, and the procedure of Method 5, Section 5.7, to calibrate the barometer.

5. BIBLIOGRAPHY

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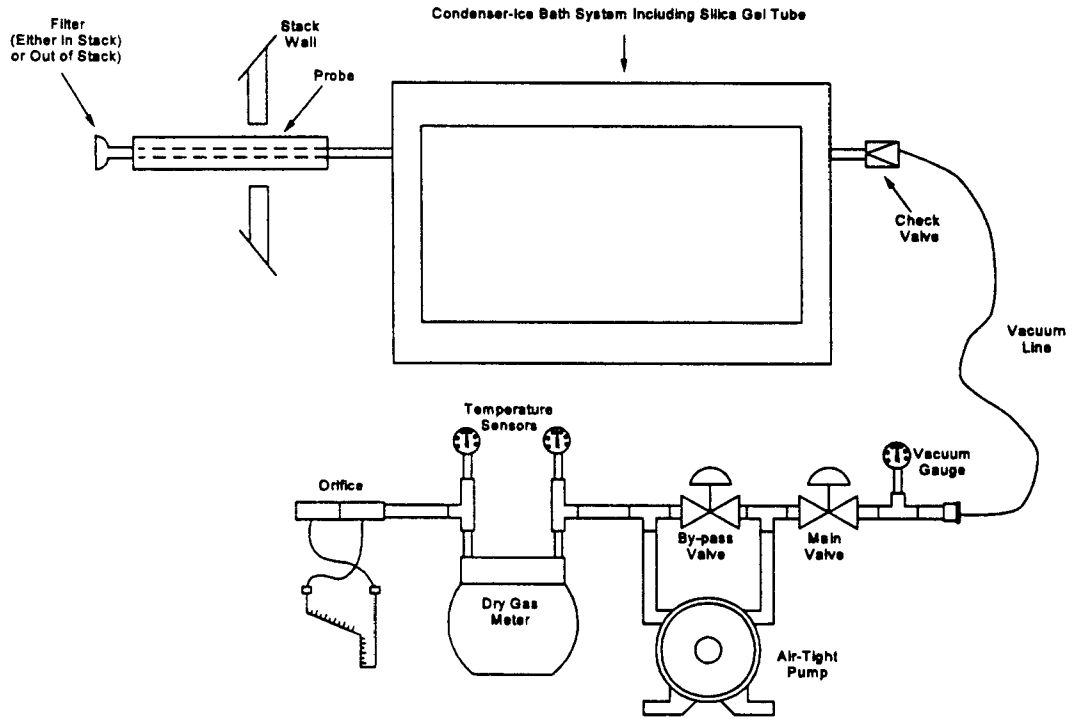

Figure 4-1. Moisture sampling train reference method.

Figure 4-2. Field Moisture Determination Reference Method.

Plant _____
Location _____
Operator _____
Date _____
Run No. _____
Ambient temperature _____
Barometric pressure _____
Probe Length _____

SCHEMATIC OF STACK CROSS SECTION

Traverse Pt. No.	Sampling Time (θ), min	Stack Temperature °C (°F)	Pressure differential across orifice meter ΔH mm (in.) H_2O	Meter Reading gas sample volume m^3 (ft^3)	ΔV_m m^3 (ft^3)	Gas sample temperature at dry gas meter		Temperature of gas leaving condenser or last impinger °C(°F)
						Inlet Tm_{in} °C(°F)	Outlet Tm_{out} °C(°F)	
Average								

Figure 4-3. Analytical data - reference method.

	Impinger volume, ml	Silica gel weight, g
Final	_____	_____
Initial	_____	_____
Difference	_____	_____

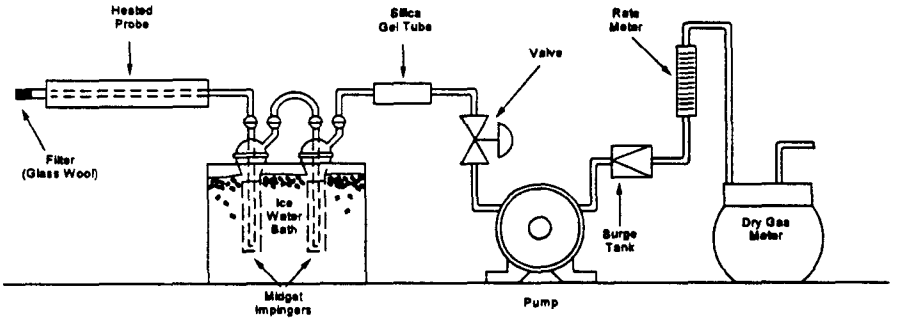

Figure 4-4. Moisture Samping Train - Approximation Method.

Figure 4-5. Field Moisture Determination - Approximation Method.

Location_____Comments:
Test_____
Date_____
Operator_____
Barometric pressure_____

Clock Time	Gas volume through meter, (V_m), m^3 (ft^3)	Rate meter setting m^3/min (ft^3/min)	Meter temperature ° C (° F)

Appendix G.5

EPA Method 23

6560-50

ENVIRONMENTAL PROTECTION AGENCY
40 CFR Part 60

[AD-FRL-]
STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES
Appendix A , Test Method 23

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed Rule.

SUMMARY: This rule amends Method 23, entitled "Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources," to correct existing errors in the method, to eliminate the methylene chloride rinse of the sampling train, and to clarify the quality assurance requirements of the method.

DATES: Comments. Comments must be received on or before _____ (90 days after publication in the FEDERAL REGISTER].

Public Hearing. If anyone contacts EPA requesting to speak at a public hearing by _____ (two weeks after publication in the FEDERAL REGISTER), a public hearing will be held on _____ (four weeks after publication in the FEDERAL REGISTER), beginning at 10:00 a.m. Persons interested in attending the hearing should call Ms. Lala Cheek at (919) 541-5545 to verify that a hearing will be held.

Request to Speak at Hearing. Persons wishing to present

oral testimony must contact EPA by _____ (two weeks after publication in the FEDERAL REGISTER).

ADDRESSES: Comments. Comments should be submitted (in duplicate if possible) to Public Docket No. A-94-2 at the following address: U. S. Environmental Protection Agency , Air and Radiation Docket and Information Center, Mail Code: 6102, 401 M Street, SW, Washington, DC 20460. The Agency requests that a separate copy also be sent to the contact person listed below. The docket is located at the above address in Room M-1500 Waterside Mall (ground floor), and may be inspected from 8:30 a.m. to Noon and 1:00 to 3:00 PM, Monday through Friday. The proposed regulatory text and other materials related to this rulemaking are available for review in the docket or copies may be mailed on request from the Air Docket by calling 202-260-7548. A reasonable fee may be charged for copying docket materials.

Public Hearing. If anyone contacts EPA requesting a public hearing, it will be held at EPA's Emission Measurement Laboratory, Research Triangle Park, North Carolina. Persons interested in attending the hearing or wishing to present oral testimony should notify Ms. Lala Cheek (MD-19), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5545.

Docket: A Docket, A-94-22, containing materials relevant to this rulemaking, is available for public inspection and copying between 8:30 a.m. and Noon and 1:00 and 3:00 p.m., Monday through Friday, in at EPA's Air Docket Section (LE-131), Room M-1500 Waterside Mall (ground floor) 401 M Street, S.W., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Gary McAlister, Emission Measurement Branch (MD-19), Emissions, Monitoring, and Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone (919) 541-1062.

SUPPLEMENTARY INFORMATION:

The proposed regulatory text of the proposed rule is not included in this Federal Register notice, but is available in Docket No. A-94-22 or by written or telephone request from the Air Docket (see ADDRESSES). If necessary, a limited number of copies of the Regulatory Text are available from the EPA contact persons designated earlier in this notice. This Notice with the proposed regulatory language is also available on the Technology Transfer Network (TTN), one of EPA's electronic bulletin boards. TTN provides information and technology exchange in various areas of air pollution control. The service is free except for the cost of the phone call. Dial (919) 541-5742 for up to a 14400

bps modem. If more information on TTN is needed, call the HELP line at (919) 541-5384.

I. SUMMARY

Method 23 was promulgated along with the New Source Performance Standard for municipal waste combustors (Subpart Ea). As promulgated, the method contained some errors. This action would correct those errors and would clarify some of the existing quality assurance requirements. In addition, the current procedure requires rinsing of the sampling train with two separate solvents which must be analyzed separately. Based on data the Agency has collected since promulgation of Method 23, we believe that one of these rinse steps and the resulting sample fraction can be eliminated. This could save as much as $2000 per test run in analytical costs.

II. THE RULEMAKING

This rulemaking does not impose emission measurement requirements beyond those specified in the current regulations nor does it change any emission standard. Rather, the rulemaking would simply amend an existing test method associated with emission measurement requirements in the current regulations that would apply irrespective of this rulemaking.

III. ADMINISTRATIVE REQUIREMENTS

A. Public Hearing

A public hearing will be held, if requested, to discuss the proposed amendment in accordance with section 307(d)(5)of the Clean Air Act. Persons wishing to make oral presentations should contact EPA at the address given in the ADDRESSES section of this preamble. Oral presentations will be limited to 15 minutes each. Any member of the public may file a written statement with EPA before, during, or within 30 days after the hearing. Written statements should be addressed to the Air Docket Section address given in the ADDRESSES section of this preamble.

A verbatim transcript of the hearing and written statements will be available for public inspection and copying during normal working hours at EPA's Air Docket Section in Washington, DC (see ADDRESSES section of this preamble).

B. Docket

The docket is an organized and complete file of all the information considered by EPA in the development of this rulemaking. The docket is a dynamic file, since material is added throughout the rulemaking development. The docketing system is intended to allow members of the public and industries involved to identify and locate documents readily so that they may effectively participate in the rulemaking process. Along

with the statement of basis and purpose of the proposed and promulgated test method revisions and EPA responses to significant comments, the contents of the docket, except for interagency review materials, will serve as the record in case of judicial review [Section 307(d)(7)(A)].

C. Executive Order 12291 Review

Under Executive Order 12291, EPA is required to judge whether a regulation is a "major rule" and, therefore, subject to the requirements of a regulatory impact analysis. This rulemaking does not impose emission measurement requirements beyond those specified in the current regulations, nor does it change any emission standard. The Agency has determined that this regulation would result in none of the adverse economic effects set forth in Section 1 of the Order as grounds for finding the regulation to be a "major rule." The Agency has, therefore, concluded that this regulation is not a "major rule" under Executive Order 12291.

D. Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) of 1980 requires the identification of potentially adverse impacts of Federal regulations upon small business entities. The RFA specifically requires the completion of an analysis in those instances where

small business impacts are possible. This rulemaking does not impose emission measurement requirements beyond those specified in the current regulations, nor does it change any emission standard. Because this rulemaking imposes no adverse economic impacts, an analysis has not been conducted.

Pursuant to the provision of 5 U.S.C. 605(b), I hereby certify that the promulgated rule will not have an impact on small entities because no additional costs will be incurred.

E. Paperwork Reduction Act

This rule does not change any information collection requirements subject to Office of Management and Budget review under the Paperwork Reduction Act of 1980, 44 U.S.C. 3501 *et seq*.

F. Statutory Authority

The statutory authority for this proposal is provided by sections 111 and 301(a) of the Clean Air Act, as amended: 42 U.S.C., 7411 and 7601(a).

LIST OF SUBJECTS

Air pollution control, municipal waste combustors, polychorinated dibenzo-p-dioxins, sources.

Date The Administrator

It is proposed that 40 CFR Part 60 be amended as follows:

1. The authority citation for Part 60 continues to read as follows: Authority: Clean Air Act (42 U.S.C. 7401 [et seq.], as amended by Pub. L 101-549).

2. Replace test Method 23 of Appendix A, with the following:

Method 23 - Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method is applicable to the determination of emissions of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from municipal waste combustors. Calibration standards are selected for regulated emission levels for municipal waste combustors.

1.2 Principle. A sample is withdrawn isokinetically from the gas stream and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle and vapor fraction. The PCDD's and PCDF's are extracted from the sample, separated by high resolution gas chromatography (HRGC), and measured by high

resolution mass spectrometry (HRMS).

2. APPARATUS

2.1 Sampling. A schematic of the sampling train is shown in Figure 23-1. Sealing greases shall not be used in assembling the train. The train is identical to that described in Section 2.1 of Method 5 of this appendix with the following additions:

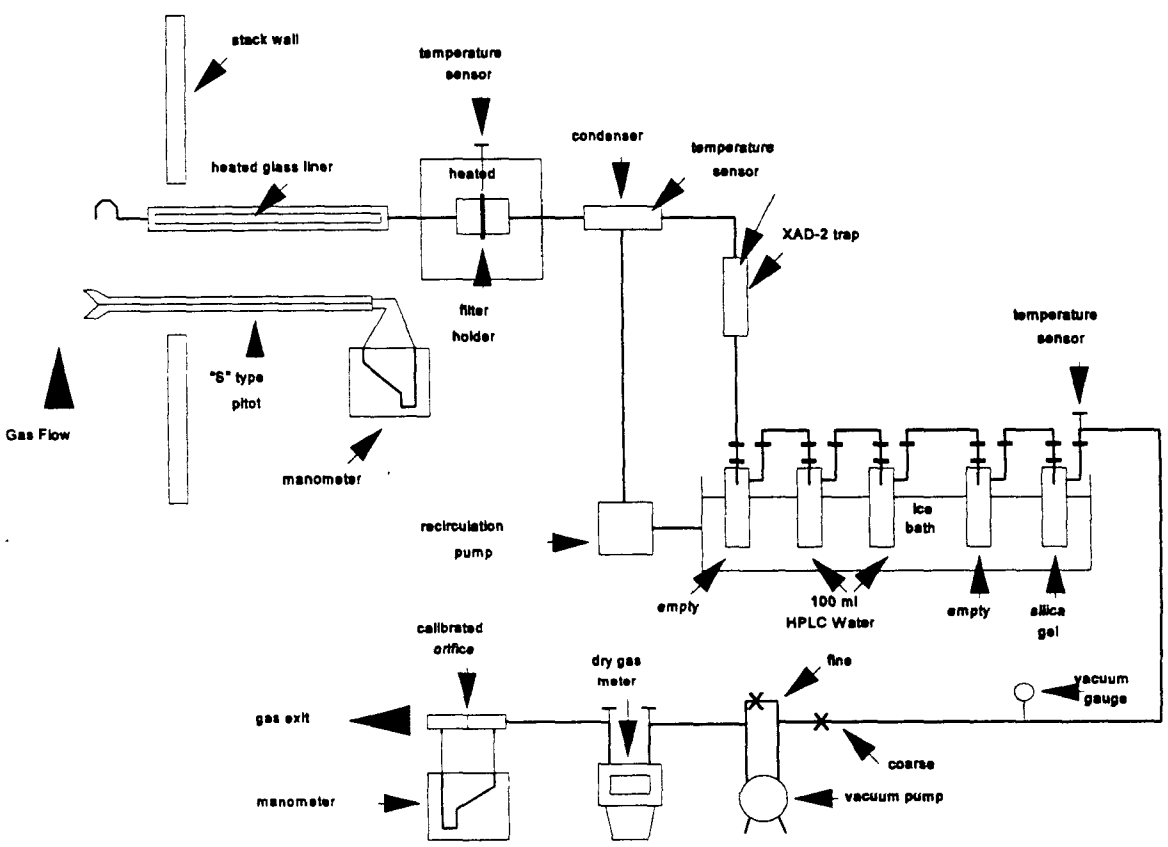

Figure 23.1 Sampling Train

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (1/2 in. OD with 1/8 in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at $\geq$120°C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23-2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at $\leq$20°C (68°F).

2.1.4 Adsorbent Module. Glass container to hold up to 40 grams of resin adsorbent. A schematic diagram is shown in Figure 23-2. Other physical configurations of the water-jacketed resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. A coarse glass frit is included to retain the adsorbent in the water-jacketed sorbent module.

2.1.5 Probe Liner. The probe liner shall be made of glass and a Teflon ferrule or Teflon coated O-ring shall be used to make the seal at the nozzle end of the probe.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train and sorbent module.

2.2.2 Wash Bottles. Teflon, 500-mL.

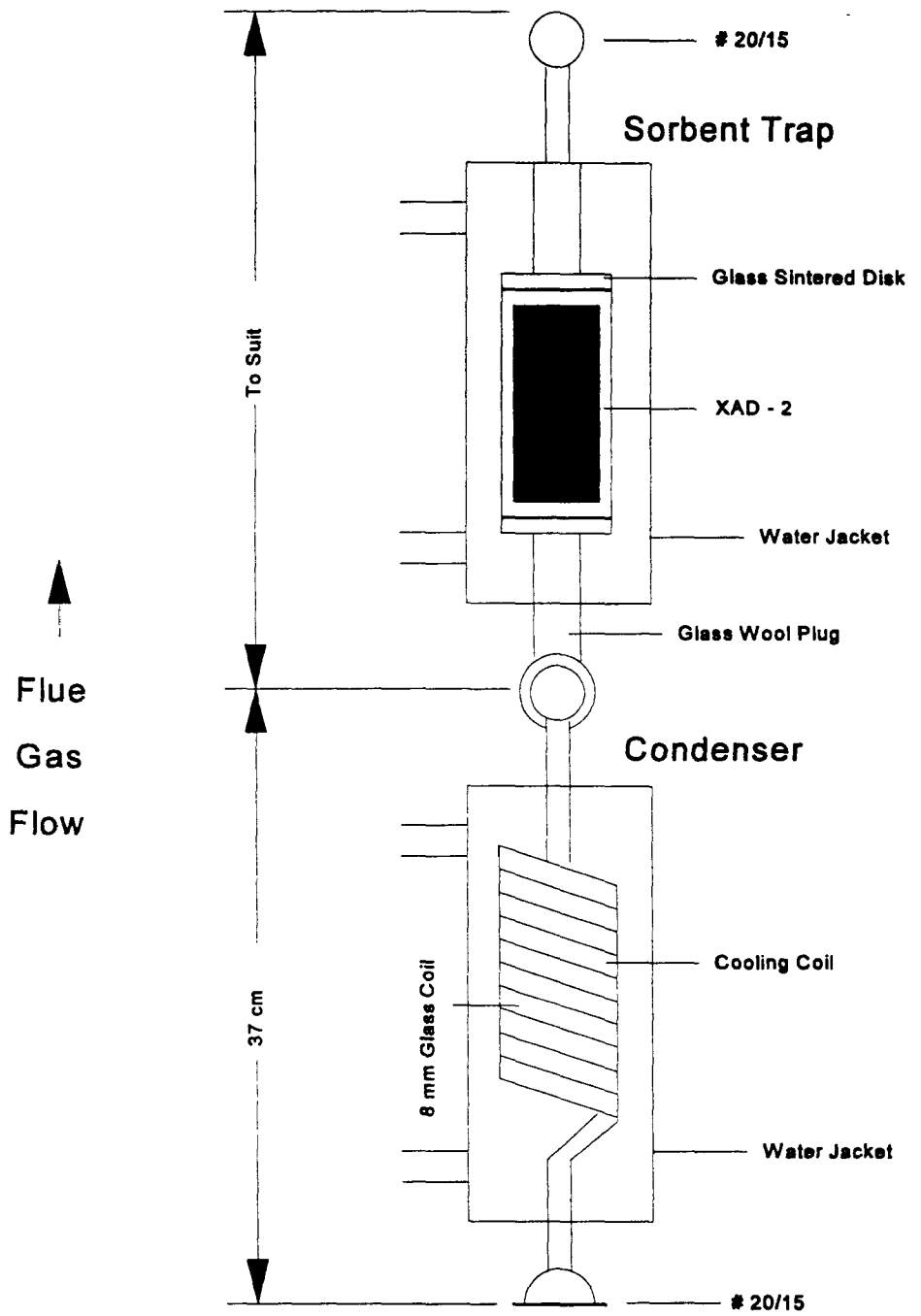

Figure 23.2 Condenser and Adsorbent Trap

2.2.3 Probe Liner, Probe Nozzle, and Filter Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, glass petri dish, or Teflon baggie.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed (Do not use to wrap or ship filter samples, because it may react with particulate matter).

2.2.7 Metal Storage Container. Air tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-mL with 2-mL graduations.

2.2.9 Glass Sample Storage Containers. Amber glass bottles for sample glassware washes, 500- or 1000-mL, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Containers. 125- and 250-mL flint glass bottles with Teflon-lined caps.

2.3.2 Test Tubes. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 x 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-mL.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF-121 or equivalent.

2.3.8 Kuderna-Danish Concentrator Apparatus.

2.3.9 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.10 Separatory Funnels. Glass, 2-liter.

2.3.11 Gas Chromatograph. Consisting of the following components:

2.3.11.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±10°C and performing programmed increases in temperature at rates of at least 40°C/min.

2.3.11.2 Temperature Gauges. To monitor column oven, detector, and exhaust temperatures ±1°C.

2.3.11.3 Flow Systems. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.11.4 Capillary Columns. A fused silica column, 60 x 0.25 mm inside diameter (ID), coated with DB-5 and a fused silica column, 30 m x 0.25 mm ID coated with DB-225. Other column systems may be substituted provided that the user is able to demonstrate, using calibration and performance checks, that the column system is able to meet the specifications of Section 6.1.2.2.

2.3.12 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.13 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.14 Analytical Balance. To measure within 0.1 mg.

3. REAGENTS

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986-71 (Reapproved 1978) (incorporated by reference - see §60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus,

charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean nitrogen (N_2) stream. Store the filters in a glass petri dishes and seal with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD-2 resin. Thoroughly cleaned before initial use. Do not reuse resin. If precleaned XAD-2 resin is purchased from the manufacturer, the cleaning procedure described in Section 3.1.2.1 is not required.

3.1.2.1 Cleaning. Procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-coarse frit is used for extraction of XAD-2. The frit is recessed 10-15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial Rinse: Place resin in a beaker,

	rinse once with HPLC water, and discard water. Refill beaker with water, let stand overnight, and discard water.
Water	Extract with HPLC water for 8 hours.
Methanol	Extract with methanol for 22 hours.
Methylene Chloride	Extract with methylene chloride for 22 hours.
Methylene Chloride	Extract with methylene chloride for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source for large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40°C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles, but

not so excessive as to cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual methylene chloride ($MeCl_2$) as well as PCDDs and PCDFs prior to use. The analyst may opt to omit this check for precleaned XAD-2.

3.1.2.3.1 $MeCl_2$ Residue Extraction. Weigh a 1.0 g sample of dried resin into a small vial, add 3 mL of toluene, cap the vial, and shake it well.

3.1.2.3.2 $MeCl_2$ Residue Analysis. Inject a 2 μl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft x 1/8 in stainless steel containing 10 percent OV-101™ on 100/120 Supelcoport.

Carrier Gas: Helium at a rate of 30 mL/min.

Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.

Injection Port Temperature: 250°C.

Detector Temperature: 305°C.

Oven Temperature: 30°C for 4 min; programmed to rise at 40°C/min until it reaches 250°C; return to 30°C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injecting

4.0 µl of methylene chloride into 100 mL of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.3.3 PCDD and PCDF Check. Extract the adsorbent sample as described in Section 5.1. Analyze the extract as described in Section 5.3. If any of the PCDDs or PCDFs (tetra through hexa) are present at concentrations above the target detection limits (TDLs), the adsorbent must be recleaned by repeating the last step of the cleaning procedure. The TDLs for the various PCDD/PCDF congeners are listed in Table 1.

3.1.2.4 Storage. After cleaning, the adsorbent may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in glass adsorbent modules tightly sealed with glass stoppers. It must be used within 4 weeks of cleaning. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110°C oven, and stored in a methylene chloride-washed glass container with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene

chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 **Silica Gel.** Indicating type, 6 to 16 mesh. If previously used, dry at 175° C (350°F) for two hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 **Chromic Acid Cleaning Solution.** Dissolve 20 g of sodium dichromate in 15 mL of water, and then carefully add 400 mL of concentrated sulfuric acid.

3.1.7 **HPLC Water.**

3.2 **Sample Recovery.**

3.2.1 **Acetone.** Pesticide quality.

3.2.2 **Toluene.** Pesticide quality.

3.3 **Analysis.**

3.3.1 **Potassium Hydroxide.** ACS grade, 2-percent (weight/volume) in water.

3.3.2 **Sodium Sulfate.** Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 **Sulfuric Acid.** Reagent grade.

3.3.4 **Sodium Hydroxide.** 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 **Hexane.** Pesticide grade.

3.3.6 **Methylene Chloride.** Pesticide grade.

3.3.7 **Benzene.** Pesticide grade.

3.3.8 **Ethyl Acetate.**

3.3.9 **Methanol.** Pesticide grade.

3.3.10 **Toluene.** Pesticide grade.

3.3.11 **Nonane.** Pesticide grade.

3.3.12 **Cyclohexane.** Pesticide Grade.

3.3.13 **Basic Alumina.** Activity grade 1, 100-200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130°C. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 **Silica Gel.** Bio-Sil A, 100-200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180°C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50°C for 10 minutes, then increase the temperature gradually to 180°C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 **Silica Gel Impregnated with Sulfuric Acid.** Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the

solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 **Silica Gel Impregnated with Sodium Hydroxide.** Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 **Carbon/Celite.** Combine 10.7 g of AX-21 carbon with 124 g of Celite 545 in a 250-mL glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 **Nitrogen.** Ultra high purity.

3.3.19 **Hydrogen.** Ultra high purity.

3.3.20 **Internal Standard Solution.** Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Internal Standards" in 10 mL of nonane.

3.3.21 **Surrogate Standard Solution.** Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Surrogate Standards" in 10 mL of nonane.

3.3.22 **Recovery Standard Solution.** Prepare a stock standard

solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Recovery Standards" in 10 mL of nonane.

4. PROCEDURE

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers and analysts should be trained and experienced with the procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in Section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps shall be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD-2. Follow the XAD-2 with glass wool and tightly cap both ends of the trap. Add 40 μl of the surrogate standard solution (Section 3.3.21) to each trap for a sample that will be split prior to analysis or 20 μl of the

surrogate standard solution (Section 3.3.21) to each trap for samples that will not be split for analysis (Section 5.1). After addition of the surrogate standard solution, the trap must be used within 14 days. Keep the spiked sorbent under refrigeration until use.

4.1.1.3 Sampling Train. It is suggested that all components be maintained according to the procedure described in APTD-0576.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in air tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in the fifth impinger just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container or Teflon baggie. Do not mark filter with ink or any other contaminating substance.

4.1.2 Preliminary Determinations. Same as Section 4.1.2 Method 5.

4.1.3 Preparation of Sampling Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until sampling is about to begin. Wrap sorbent module with aluminum foil to shield from radiant heat of sun light. (NOTE:

Do not use sealant grease in assembling the train.)

4.1.3.2 Place approximately 100 mL of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus the fifth impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the sampling train as shown in Figure 23-1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD-2 adsorbent resin temperature never exceed 50°C because thermal decomposition and breakthrough of surrogate standards will occur. During testing, the XAD-2 temperature must not exceed 20°C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, Section 4.1.4.

4.1.5 Sampling Train Operation. Same as Method 5, Section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon

as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area. Cleanup personnel shall wash their hands prior to sample recovery.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Do not place the filter in aluminum foil. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the

container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container with Teflon tape.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by brushing while rinsing three times with acetone and then, by rinsing the probe three times with toluene. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of toluene for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Impinger Water. Measure the liquid in the first four impingers to within 1 mL by using a graduated cylinder or by weighing it to within 0.5 g by using a balance. Record the

volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Discard the liquid after measuring and recording the volume or weight.

4.2.5 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal.

5. ANALYSIS

All glassware shall be cleaned as described in Section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction. The analyst may choose to split the sample extract after the completion of sample extraction procedures. One half of the sample can then be archived. Sample preparation procedures are given for using the entire sample and for splitting the sample.

5.1.1 Extraction System. Place an extraction thimble (Section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the

extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD-2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See Section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD-2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD-2 glass wool plug to the thimble.

5.1.4 Container No. 2 (Acetone and Toluene). Concentrate the sample to a volume of about 1-2 mL using a Kuderna-Danish concentrator apparatus, followed by N_2 blow down at a temperature of less than 37°C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the sampling train probe and nozzle. Add the concentrate to the

filter and the XAD-2 resin in the Soxhlet apparatus described in Section 5.1.1.

5.1.5 Extraction. For samples that are to be split prior to analysis add 40 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from Section 5.1.4. Alternatively, 20 µl of the internal standard solution (Section 3.3.20) for samples that are <u>not</u> to be split prior to analysis. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD-2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Add additional toluene to fill the reservoir approximately 2/3 full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-mL rinses to the rotary evaporator. Concentrate the extract to approximately 10 mL. If decided to split the sample, store one half for future use, and analyze the other half according to the procedures in Sections 5.2 and 5.3. In either case, use a nitrogen evaporative

concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 mL of hexane.

5.2 Sample Cleanup and Fractionation.

The following sample cleanup and fractionation procedures are recommended. Alternative procedures may be utilized providing acceptable identification criteria (Section 5.3.2.5) and quantification criteria (Section 5.3.2.6) are met.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm x 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 mL of hexane and discard. Add the sample extract, dissolved in 5 mL of hexane to the column with two additional 5-mL rinses. Elute the column with an additional 90 mL of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 mL using the nitrogen evaporative concentrator (Section 2.3.9).

5.2.2 Basic Alumina Column. Shorten a 25-mL disposable Pasteur pipette to about 16 mL. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 mL of 0.5 percent methylene chloride in hexane followed by 120 mL of 35

percent methylene chloride in hexane. Discard the first 120 mL of eluate. Collect the second 120 mL of eluate and concentrate it to about 0.5 mL using the nitrogen evaporative concentrator. Transfer this extract with hexane to "13 mL tubes".

5.2.3 AX-21 Carbon/Celite 545 Column. Remove the bottom 0.5 in. from the tip of a 2-mL disposable Pasteur pipette. Insert a glass fiber filter disk or glass wool plug in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/Celite™ mixture to form a 2 cm column (the 0.6 mL mark column. Top with a glass wool plug. In some cases AX-21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Pre-elute the column with 5 mL toluene, followed by 1 mL of a 50:50 methylene chloride/cyclohexane mixture, followed by 5 mL of hexane. Load in sequence, the sample extract in 1 mL hexane, 2x0.5 mL rinses in hexane, 2 mL of 50 percent methylene chloride in hexane and 2 mL of 50 percent benzene in ethyl acetate and discard the eluates. Invert the column and elute in the reverse direction with 13 mL of toluene. Collect this eluate. Concentrate the eluate in a nitrogen evaporator at 45°C to about 1 mL. Transfer the concentrate to a Reacti-vial using a toluene rinses and concentrate to near dryness (less than 20 μl) using a stream of N_2. Store extracts at room temperature,

shielded from light, until the analysis is performed.

5.3 **Analysis.** Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in Sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the recovery standard solution from Table 2 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB-5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If 2,3,7,8-TCDF is detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB-225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that it can be demonstrated using calibration and performance checks that the column system is able to meet the specifications of Section 6.1.2.

5.3.1 **Gas Chromatograph Operating Conditions.** The recommended conditions are shown in Table 4.

5.3.2 **High Resolution Mass Spectrometer.**

5.3.2.1 **Resolution.** 10,000 resolving power or 100 ppm mass/mass.

5.3.2.2 **Ionization Mode.** Electron impact.

5.3.2.3 **Source Temperature 250°C.**

5.3.2.4 **Monitoring Mode.** Selected ion monitoring. A list of

the various ions to be monitored is presented in Table 5.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M+2 or M+2/M+4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges (±15%) for the identification of chlorine-containing compounds are given in Table 6. If the ion-abundance ratio ranges are the outside those in Table 6, the source has the option of using the results if the concentration is determined using procedures in Section 9.3 or redoing the analysis to eliminate the unacceptable ion-abundance ratio.

2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard or surrogate standard.

3. The monitored ions, shown in Table 5 for a given analyte, shall reach their maximum within 2 seconds of each other.

4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.

5. The signal to noise ratio for all monitored ions must be greater than 2.5.

6. The confirmation of 2, 3, 7, 8-TCDF shall satisfy all of the above identification criteria.

7. Any PCDF coeluting (±2 s) with a peak in the corresponding PCDPE channel, of intensity 10% or greater compared to the analyte peak is evidence of a positive interference, the source may opt keep the value to calculate CDD/CDF concentration or conduct a complete reanalysis in an effort to remove or shift the interference. If a reanalysis is conducted, all values from the reanalyzed sample will be used for CDD/CDF concentration calculations.

8. Set the mass spectrometer lock channels as specified in Table 5. Monitor the quality control check channels specified in Table 5 to verify instrument stability during the analysis. If the signal varies by more than 25 percent from the average response, results for all isomers at corresponding residence time shall be invalid. The source has the options of conducting additional cleanup procedures on the other portion of the sample for split samples or diluting the original sample or following other procedures recommended by the Administrator. When a complete reanalysis is conducted, all concentration calculations shall be based on the reanalyzed sample.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$-2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$-1,2,3,4-TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard. When no peak is detected, the noise level, as measured by the intensity of the noise in a clear zone of the chromatogram, is used to calculate the detection limit. Tables 7, 8, and 9 summarize the quantification relationships for the unlabeled analytes, internal standards and surrogate standards, respectively.

6. CALIBRATION

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 3. The relative standard deviation for the mean response factor from each of the

unlabeled analytes (Table 3) and of the internal and surrogate standards shall be less than or equal to the values in Table 6. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 10. The ion abundance ratios shall be within the control limits in Table 5.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject 2 μl of solution Number 3 from Table 3. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 10. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 6.

6.1.2.2 Column Separation Check. Inject 2 μl of a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8-TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series. Perform a similar resolution check on the confirmation column to document the resolution between

2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 5. Monitor the quality control check channels specified in Table 5 to verify instrument stability during the analysis.

7. QUALITY CONTROL

7.1 Sampling Train Collection Efficiency Check. Add 40 μl of the surrogate standards in Table 2 for samples split for analysis or 20 μl of the surrogate standards for sample <u>not</u> split for analysis to the adsorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon-labeled PCDDs and PCDFs representing the tetra- through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards shall be between 40 to 130 percent for the tetra- through hexachlorinated compounds while the range is 25 to 130 percent for the hepta- and octachlorinated homologues.

7.3 Surrogate Standard Recoveries. The five surrogate compounds in Table 3 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate

recoveries are measured relative to the internal standards and are a measure of the sampling train collection efficiency. They are not used to measure the native PCDD's and PCDF's. All surrogate standard recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery (on a homolog group basis). Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

7.5 Detection Limits. Calculate the detection limits using the equation in Section 9.8. If the detection limits meet the Target Detection Limits (TDLs) in Table 1, then they are considered acceptable. If the TDLs are not met, the impact of the detection limits shall be calculated using the procedures in Section 9.9. If the maximum potential value of the sum of the summed detection limits is less then 50 percent of the emission standard, the detection limits are acceptable. If the value is

greater than 50 percent of the emission standard, then the analysis and/or sampling and analysis must be repeated until acceptable detection limits are obtained.

8. QUALITY ASSURANCE

8.1 Applicability. When the method is used to analyze samples to demonstrate compliance with a source emission regulation, an audit sample must be analyzed, subject to availability.

8.2 Audit Procedure. Analyze an audit sample with each set of compliance samples. The audit sample contains tetra through octa isomers of PCDD and PCDF. Concurrently analyze the audit sample and a set of compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation. The same analyst, analytical reagents, and analytical system shall be used both for the compliance samples and the EPA audit sample.

8.3 Audit Sample Availability. Audit samples will be supplied only to enforcement agencies for compliance tests. Audit samples may be obtained by writing:

Source Test Audit Coordinator (MD-77B)
Quality Assurance Division
Atmospheric Research and Exposure Assessment Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

or by calling the Source Test Audit Coordinator (STAC) at (919)

541-7834. The audit sample request must be made at least 30 days prior to the scheduled compliance sample analysis.

8.4 Audit Results. Calculate the audit sample concentration according to the calculation procedure provided in the audit instructions included with the audit sample. Fill in the audit sample concentration and the analyst's name on the audit response form included with the audit instructions. Send one copy to the EPA Regional Office or the appropriate enforcement agency and a second copy to the STAC. The EPA Regional office or the appropriate enforcement agency will report the results of the audit to the laboratory being audited. Include this response with the results of the compliance samples in relevant reports to the EPA Regional Office or the appropriate enforcement agency.

9. CALCULATIONS

Same as Method 5, Section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.

A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A_{csi} = Integrated ion current of the two ions characteristic of

surrogate compound i in the calibration standard.

A_i = Integrated ion current of the two ions characteristic of compound i in the sample.

A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.

A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.

C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.

DL = Detection limit, pg/sample.

DL_{hs} = Detection limit for each homologous series, pg/sample.

DL_{sum} = Sum of all isomers times the corresponding detection limit, ng/m^3.

H_{ai} = Summed heights of the noise at the retention time of the analyte in the two analyte channels.

m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.

m^*_{ci} = Mass of labeled compound i in the calibration standard injected into the analyzer, pg.

m^*_i = Mass of internal standard i added to the sample, pg.

m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m_s = Mass of surrogate compound in the sample to be analyzed, pg.

m_{si} = Mass of surrogate compound i in the calibration standard, pg.

RRF_i = Relative response factor for compound i.

RRF_{rs} = Recovery standard response factor.

RRF_s = Surrogate compound response factor.

$V_{m(std)}$ = Metered volume of sample run, dscm.

1000 = pg per ng.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n} \frac{A_{cij}\ m^*_{ci}}{A^*_{cij}\ m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m^*_i\ A_i}{A^*_i\ RRF_i\ V_{m_{std}}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A^*_{ci}\ m_{rs}}{A_{rs}\ m^*_{ci}} \qquad \text{Eq. 23-3}$$

9.5 **Recovery of Internal Standards (R^*).**

$$R^* = \frac{A^*_i\ m_{rs}}{A_{rs}\ RF_{rs}\ m^*_i} \times 100\% \qquad \text{Eq. 23-4}$$

9.6 **Surrogate Compound Response Factor.**

$$RRF_s = \frac{A^*_{ci}\ m_{si}}{A_{csi}\ m^*_{ci}} \qquad \text{Eq. 23-5}$$

9.7 **Recovery of Surrogate Compounds (R_s).**

$$R_s = \frac{A_{si}\ m^*_i}{A^*_i\ RRF_s\ m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 **Detection Limit (DL).** The detection limit can be calculated based on either the height of the noise or the area of

the noise using one of the two equations.

Detection limit using height for the DB-225 column. Three and one half times the height has been empirically determined to give area.

$$DL = \frac{2.5\ (3.5 \times H_{ai})\ m_i^*}{A_{ci}^*\ RRF_i} \qquad \text{Eq. 23-7}$$

Detection limit using height for the DB-5 column. Five times the height has been empirically determined to give area.

$$DL = \frac{2.5\ (5 \times H_{ai})\ m_i^*}{A_{ci}^*\ RRF_i} \qquad \text{Eq. 23-8}$$

Detection limit using area of the noise.

$$DL = \frac{2.5\ A_{ai}\ m_i^*}{A_{ci}^*\ RRF_i} \qquad \text{Eq. 23-9}$$

9.9 **Summed Detection Limits.** Calculate the maximum potential value of the summed detection limits. If the isomer (group of unresolved isomers) was not detected, use the value calculated for the detection limit in Section 9.8 above. If the isomer (group of unresolved isomers) was detected, use the value (target

detection limit) from Table 1.

$$DL_{sum} = (13\ DL_{TCDD} + 16\ DL_{TCDF} + 12\ DL_{PeCDD} + 14\ DL_{PeCDF} + 7\ DL_{HxCDD} + 12\ DL_{HxCDF} + 2\ DL_{HpCDD} + 4\ DL_{HpCDF} + DL_{OCDD} + DL_{OCDF})\ /\ 1000\ V_{m(std)} \qquad \text{Eq.23-10}$$

Note: The number of isomers used to calculate the summed detection limit represent the total number of isomers typically separated and not the actual number of isomers for each series.

9.10 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_T = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-11}$$

Any PCDDs or PCDFs that are reported as not detected (below the DL) shall be counted as zero for the purpose of calculating the total concentration of PCDDs and PCDFs in the sample.

10. BIBLIOGRAPHY

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6. Personnel communications with R. L. Harless of U.S. EPA and Triangle Laboratory staff.

TABLE 23-1. TARGET DETECTION LIMITS (TDLs)

ANALYTE	TDL (pg/Sample Train)
TCDD/TCDF	50
PeCDD/PeCDF	250
HxCDD/HxCDF	250
HpCDD/HpCDF	250
OCDD/OCDF	500

TABLE 23-2. COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS*

ANALYTE	CONCENTRATION (pg/μL)
Internal Standards	
$^{13}C_{12}$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100
$^{13}C_{12}$-OCDD	100
$^{13}C_{12}$-2,3,7,8-TCDF	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards	
$^{37}Cl_4$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100
Recovery Standards	

$^{13}C_{12}$-1,2,3,4-TCDD	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100

*Calibration levels are specific for samples at the MWC compliance standard level.

TABLE 23-3. COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

COMPOUND	CONCENTRATIONS (pg/µl)				
SOLUTION NO.	1	2	3	4	5
UNLABELED ANALYTES					
2,3,7,8-TCDD	0.5	1	5	50	100
2,3,7,8-TCDF	0.5	1	5	50	100
1,2,3,7,8-PeCDD	2.5	5	25	250	500
1,2,3,7,8-PeCDF	2.5	5	25	250	500
2,3,4,7,8-PeCDF	2.5	5	25	250	500
1,2,3,4,7,8-HxCDD	2.5	5	25	250	500
1,2,3,6,7,8-HxCDD	2.5	5	25	250	500
1,2,3,7,8,9-HxCDD	2.5	5	25	250	500
1,2,3,4,7,8-HxCDF	2.5	5	25	250	500
1,2,3,6,7,8-HxCDF	2.5	5	25	250	500
1,2,3,7,8,9-HxCDF	2.5	5	25	250	500
2,3,4,6,7,8-HxCDD	2.5	5	25	250	500
1,2,3,4,6,7,8-HpCDD	2.5	5	25	250	500
1,2,3,4,6,7,8-HpCDF	2.5	5	25	250	500
1,2,3,4,7,8,9-HpCDF	2.5	5	25	250	500
OCDD	5	10	50	500	1000
OCDF	5	10	50	500	1000
INTERNAL STANDARDS					
$^{13}C_{12}$-2,3,7,8-TCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100
$^{13}C_{12}$-OCDD	100	100	100	100	100

$^{13}C_{12}$-2,3,7,8-TCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100

TABLE 23-3. (Continued)

COMPOUND	CONCENTRATION (pg/µl)				
SOLUTION NO.	1	2	3	4	5
SURROGATE STANDARDS					
$^{37}Cl_4$-2,3,7,8-TCDD	60	80	100	120	140
$^{13}C_{12}$-2,3,4,7,8-PeCDF	60	80	100	120	140
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	60	80	100	120	140
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	60	80	100	120	140
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	60	80	100	120	140
RECOVERY STANDARDS					
$^{13}C_{12}$-1,2,3,4-TCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 23-4. RECOMMENDED GC OPERATING CONDITIONS

Column Type	DB-5	DB-225
Length (m)	60	30
i.d. (mm)	0.25	0.25
Film Thickness (μm)	0.25	0.25
Carrier Gas	Helium	Helium
Carrier Gas Flow (mL/min)	1-2	1-2
Injection Mode	<-- splitless -->	
Valve Time (min)	2.5	2.5
Initial Temperature (° C)	150	130
Initial Time (min)	0.5	2.5
Rate 1 (deg. C/min)	60	50
Temperature 2 (deg. C)	170	170
Rate 2 (deg. C/min)	3	4
Final Temperature (deg. C)	300	250

TABLE 23-5. ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD's AND PCDF's

DESCRIPTOR NUMBER	ACCURATE MASS	ION TYPE	ELEMENTAL COMPOSITION	ANALYTE
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M+2	$C_{12}H_4{}^{35}Cl_3Cl^{37}O$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF(S)
	317.9389	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF(S)
	319.8965	M	$C_{12}H_4{}^{35}Cl_4O_2$	TCDD
	321.8936	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD(S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD(S)
	333.9339	M+2	$^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD(S)
	339.8597	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF
	341.8567	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF(S)
	353.8970	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF(S)
	355.8546	M+2	$C_{12}H_3{}^{35}Cl_3{}^{37}ClO_2$	PeCDD
	357.8516	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD(S)
	369.8919	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD(S)
	375.8364	M+2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M+2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE
3	373.8208	M+2	$C_{12}H_235Cl_5{}^{37}ClO$	HxCDF
	375.8178	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	$^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF(S)
	385.8610	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF(S)
	389.8157	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK

	401.8559	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD(S)
	403.8529	M+4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD(S)
	445.7555	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK

TABLE 23-5. (Continued)

DESCRIPTOR NUMBER	ACCURATE MASS	ION TYPE	ELEMENTAL DESCRIPTION	ANALYTE
	407.7818	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF(S)
	389.8157	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD(S)
	403.8529	M+4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD(S)
	445.7555	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
	407.7818	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF(S)
	419.8220	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF(S)
	423.7766	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD(S)
	437.8140	M+4	$^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD(S)
	479.7165	M+4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M+2	$^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD(S)

	471.7750	M+4	$^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD(S)
	513.6775	M+4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

The following nuclidic masses were used:

H = 1.007825 O = 15.994914 C = 12.000000 ^{35}Cl = 34.968853

^{13}C = 13.003355 ^{37}Cl = 36.965903 F = 18.9984

S = Labeled Standard

QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 23-6. ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD's AND PCDF's

Number of Chlorine Atoms	Ion Type	Theoretical Ratio	Control Limits	
			Lower	Upper
4	M/M+2	0.77	0.65	0.89
5	M+2/M+4	1.55	1.32	1.78
6	M+2/M+4	1.24	1.05	1.43
6[a]	M/M+2	0.51	0.43	0.59
7[b]	M?M+2	0.44	0.37	0.51
7	M+2/M+4	1.04	0.88	1.20
8	M+2/M+4	0.89	0.76	1.02

TABLE 23-7. UNLABELED ANALYTES QUANTIFICATION RELATIONSHIPS

ANALYTE	INTERNAL STANDARD USED
2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD
Other TCDD's	$^{13}C_{12}$-2,3,7,8-TCDD
1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,7,8-PeCDD
Other PeCDD's	$^{13}C_{12}$-1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
Other HxCDD's	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
Other HpCDD's	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
OCDD	$^{13}C_{12}$-OCDD
2,3,7,8-TCDF	$^{13}C_{12}$-2,3,7,8-TCDF
Other TCDF's	$^{13}C_{12}$-2,3,7,8-TCDF
1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
Other PeCDF's	$^{13}C_{12}$-1,2,3,7,8-PeCDF
1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
Other HxCDF's	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF

1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
OCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF

TABLE 23-8. INTERNAL STANDARDS QUANTIFICATION RELATIONSHIPS

INTERNAL STANDARD	STANDARD USED DURING PERCENT RECOVERY DETERMINATION
$^{13}C_{12}$-2,3,7,8-TCDD	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-OCDD	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-2,3,7,8-TCDF	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,4-TCDD
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,7,8,9-HxCDD

TABLE 23-9. SURROGATE STANDARDS QUANTIFICATION RELATIONSHIPS

SURROGATE STANDARD	STANDARD USED DURING PERCENT RECOVERY DETERMINATION
$^{37}Cl_4$-2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD
$^{13}C_{12}$-2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF

TABLE 23-10. MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

COMPOUND	RELATIVE RESPONSE FACTORS	
	INITIAL CALIBRATION (RSD)	DAILY CALIBRATION (% DIFFERENCE)
UNLABELED ANALYTES		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
SURROGATE STANDARDS		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF		
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD		
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF		
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF		

(Figure 1)

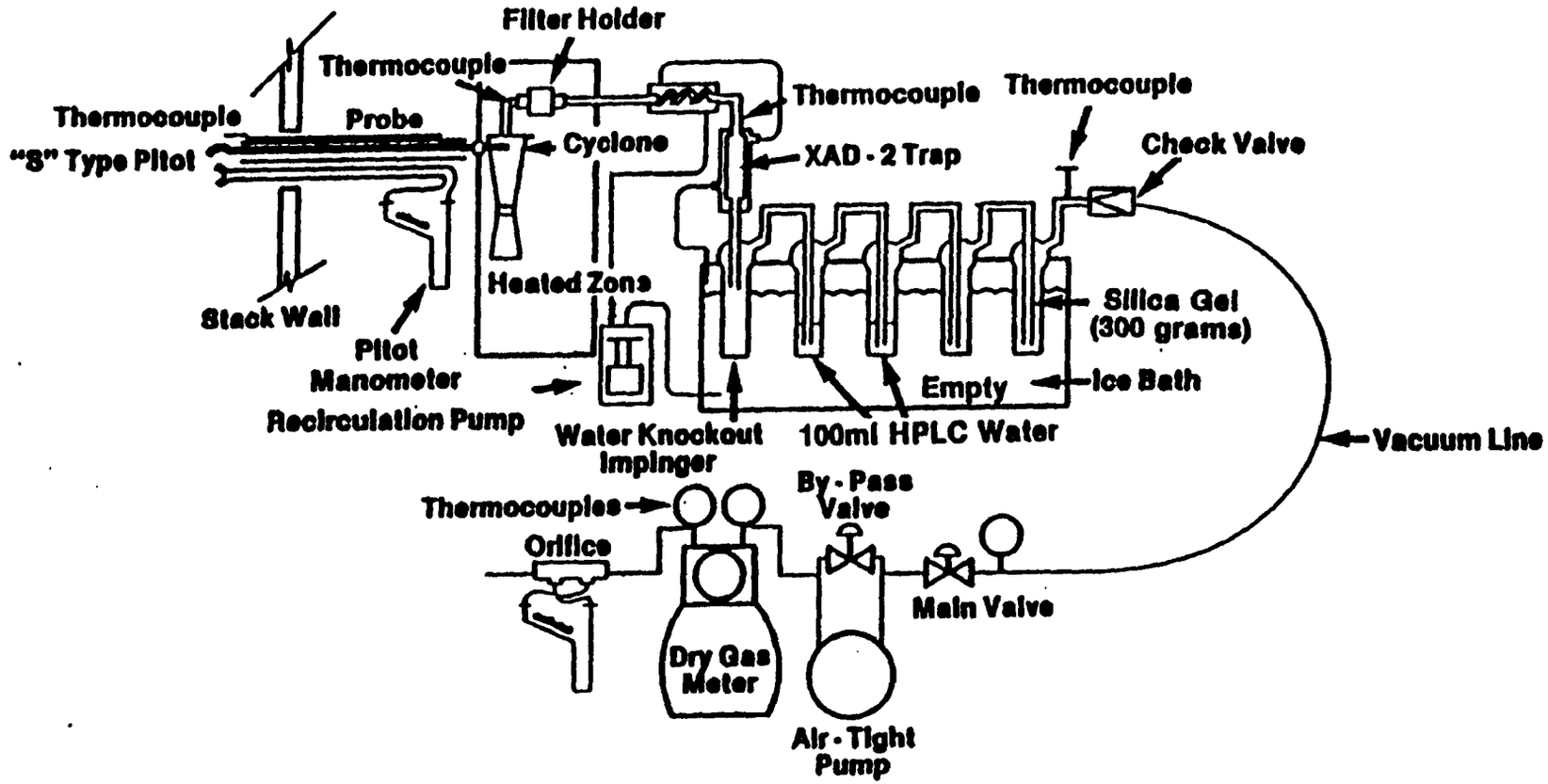

Figure 5-1. CDD/CDF Sampling Train Configuration

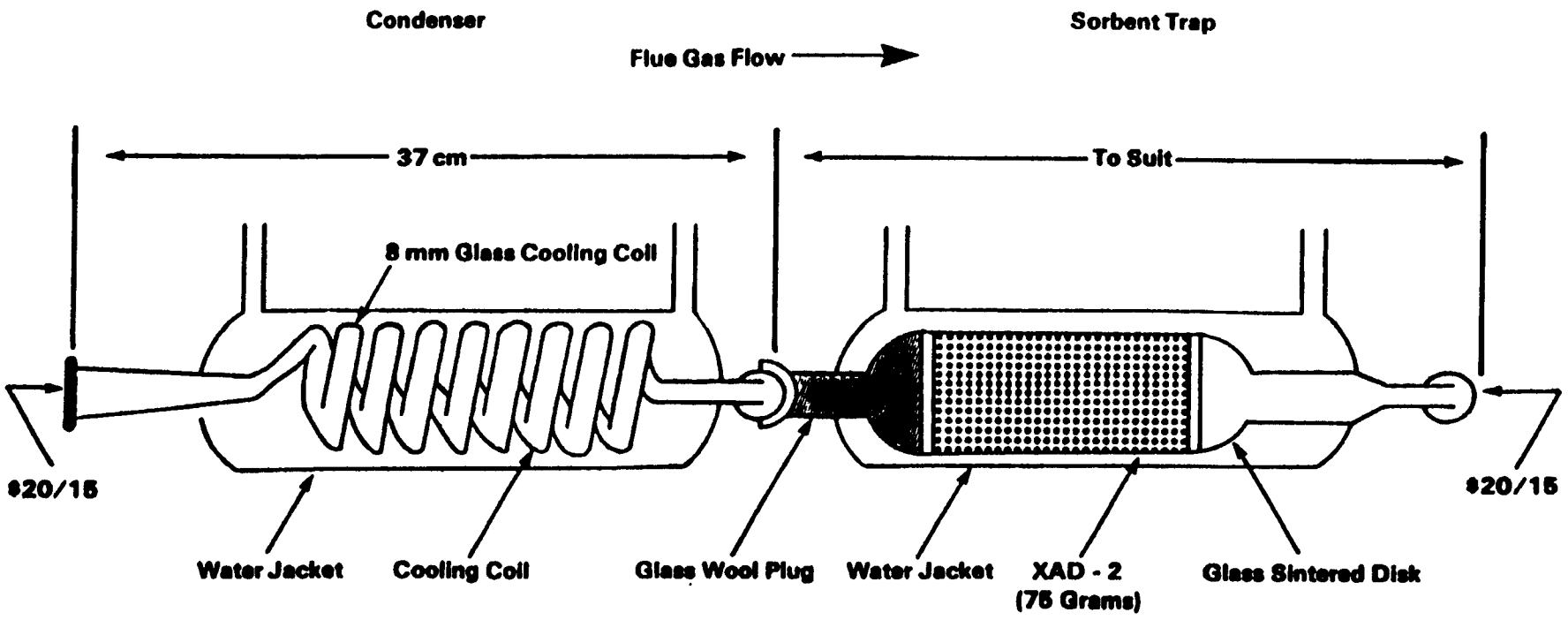

FIGURE 2. CONDENSER AND SORBENT TRAP FOR COLLECTION OF GASEOUS PCDDs AND PCDFs

(Figure 2)

Appendix G.6

EPA Method 25A

Appendix G.6

EPA Method 25A

METHOD 25A-DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

1. Applicability and Principle

1.1 Applicability. This method applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.2 Principle. A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

2. Definitions

2.1 Measurement Systems. The total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

2.1.1 Sample Interface. That portion of the system that is used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer from the effects of the stack effluent.

2.1.2 Organic Analyzer. That portion of the system that senses organic concentration and generates an output proportional to the gas concentration.

2.2 Span Value. The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

2.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.

2.4 Zero Drift. The difference in the measurement system response to a zero level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

2.5 **Calibration drift.** The difference in the measurement system response to a midlevel calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair or adjustment took place.

2.6 **Response Time.** The time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

2.7 **Calibration Error.** The difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas.

3. **Apparatus.**

A schematic of an acceptable measurement system is shown in Figure 25A-1. The essential components of the measurement system are described below:

3.1 **Organic Concentration Analyzer.** A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications in this method.

3.2 **Sample Probe.** Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

3.3 **Sample Line.** Stainless steel or Teflon * tubing to transport the sample gas to the analyzer. The sample line should be heated, if necessary, to prevent condensation in the line.

3.4 **Calibration Valve Assembly.** A three way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

3.5 **Particulate Filter.** An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

* Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

3.6 **Recorder.** A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute, Note: This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

4. **Calibration and Other Gases.**

Gases used for calibrations, fuel, and combustion air (if required) are

contained in compressed gas cylinders. Preparation of calibration gases shall be done according to the procedure in Protocol No. 1, listed in Citation 2 of Bibliography. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (i.e., organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems, may be used with prior approval of the Administrator.

Calibration gases usually consist of propane in air or nitrogen and are determined in terms of the span value. Organic compounds other than propane can be used following the above guidelines and making the appropriate corrections for response factor.

4.1 **Fuel.** A 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

4.2 **Zero Gas.** High purity air with less than 0.1 parts per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

4.3 **Low-level Calibration Gas.** An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

4.4 **Mid-level Calibration Gas.** An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

4.5 **High-level Calibration Gas.** An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

5. **Measurement System Performance Specifications**

5.1 **Zero Drift.** Less than ±3 percent of the span value.

5.2 **Calibration Drift.** Less than ±3 percent of span value.

5.3 **Calibration Error.** Less than ±5 percent of the calibration gas value.

6. **Pretest Preparations**

6.1 **Selection of Sampling Site.** The location of the sampling site is generally specified by the applicable regulation or purpose of the test; i.e., exhaust stack, inlet line, etc. The sample port shall be located at least 1.5 meters or 2 equivalent diameters upstream of the gas discharge to the atmosphere.

6.2 **Location of Sample Probe.** Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

6.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing the sample interface and the organic analyzer. Make the system operable.

FIA equipment can be calibrated for almost any range of total organics concentrations. For high concentrations of organics (>1.0 percent by volume as propane) modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

6.4 Calibration Error Test. Immediately prior to the test series, (within 2 hours of the start of the test) introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level responses. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 7.3). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

6.5 Response Time Test. Introduce Zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

7. Emission Measurement Test Procedure

7.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particular, note on the recording chart periods of process interruption or cyclic operation.

7.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until after both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement

system. Alternatively, recalibrate the test measurement system as in Section 6.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

8. Organic Concentration calculations

Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by the integration of the output recording over the period specified in the applicable regulation. If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A-1.

$$C_c = KC_{meas} \qquad \text{Eq. 25A-1}$$

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.

K = 2 for ethane.

K = 3 for propane.

K = 4 for butane.

K = Appropriate response factor for other organic calibration gases.

9. Bibliography

1. Measurement of Volatile Organic Compounds-Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/2-78-041. June 1978. p. 46-54.

2. Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol No. 1). U.S. Environmental Protection Agency,

   Environmental Monitoring and Support Laboratory. Research Triangle Park, NC. June 1978.

3. Gasoline Vapor Emission Laboratory Evaluation-Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75-GAS-6. August 1975.

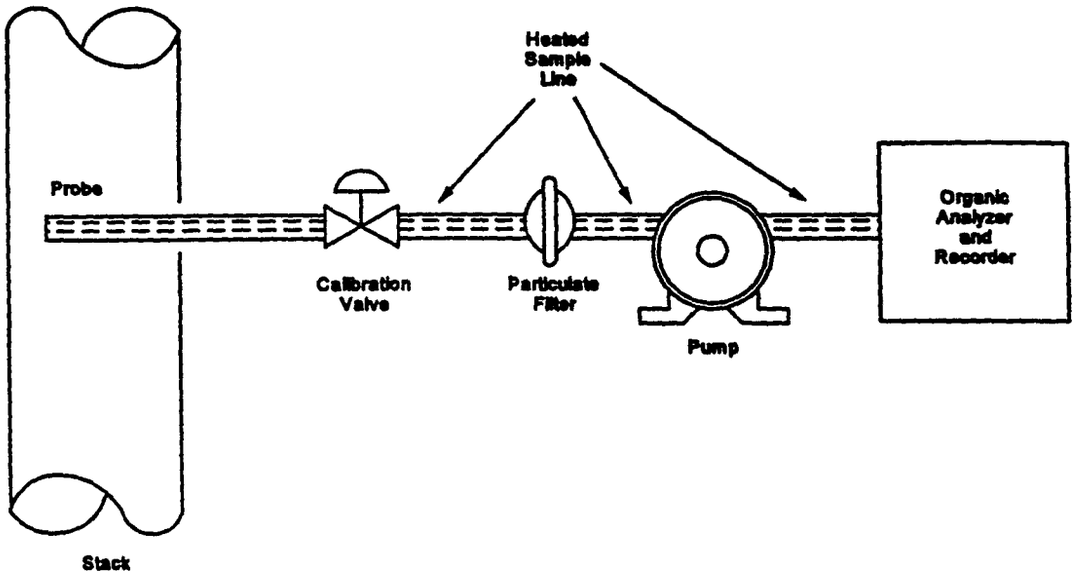

Figure 25A-1. Organic Concentration Measurement System.

Appendix G.7

EPA Method 26A

Method 26A - Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources - Isokinetic Method

1. APPLICABILITY, PRINCIPLE, INTERFERENCES, PRECISION, BIAS, AND STABILITY

1.1 Applicability. This method is applicable for determining emissions of hydrogen halides (HX) [hydrogen chloride (HCl), hydrogen bromide (HBr), and hydrogen fluoride (HF)] and halogens (X_2) [chlorine (Cl_2) and bromine (Br_2)] from stationary sources. This method collects the emission sample isokinetically and is therefore particularly suited for sampling at sources, such as those controlled by wet scrubbers, emitting acid particulate matter (e.g., hydrogen halides dissolved in water droplets). [Note: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.]

1.2 Principle. Gaseous and particulate pollutants are withdrawn isokinetically from the source and collected in an optional cyclone, on a filter, and in absorbing solutions. The cyclone collects any liquid droplets and is not necessary if the source emissions do not contain them; however, it is preferable to include the cyclone in the sampling train to protect the filter from any moisture present. The filter collects other particulate matter including halide salts. Acidic and alkaline

absorbing solutions collect the gaseous hydrogen halides and halogens, respectively. Following sampling of emissions containing liquid droplets, any halides/halogens dissolved in the liquid in the cyclone and on the filter are vaporized to gas and collected in the impingers by pulling conditioned ambient air through the sampling train. The hydrogen halides are solubilized in the acidic solution and form chloride (Cl^-), bromide (Br^-), and fluoride (F^-) ions. The halogens have a very low solubility in the acidic solution and pass through to the alkaline solution where they are hydrolyzed to form a proton (H^+), the halide ion, and the hypohalous acid (HClO or HBrO). Sodium thiosulfate is added to the alkaline solution to assure reaction with the hypohalous acid to form a second halide ion such that 2 halide ions are formed for each molecule of halogen gas. The halide ions in the separate solutions are measured by ion chromatography (IC). If desired, the particulate matter recovered from the filter and the probe is analyzed following the procedures in Method 5. [Note: If the tester intends to use this sampling arrangement to sample concurrently for particulate matter, the alternative Teflon^R probe liner, cyclone, and filter holder should not be used. The Teflon^R filter support must be used. The tester must also meet the probe and filter temperature requirements of both sampling trains.]

1.3 Interferences. Volatile materials, such as chlorine dioxide (ClO_2) and ammonium chloride (NH_4Cl), which produce halide ions upon dissolution during sampling are potential interferents. Interferents for the halide measurements are the halogen gases which disproportionate to a hydrogen halide and an hypohalous acid upon dissolution in water. The use of acidic rather than neutral or basic solutions for collection of the hydrogen halides greatly reduces the dissolution of any halogens passing through this solution. The simultaneous presence of both HBr and Cl_2 may cause a positive bias in the HCl result with a corresponding negative bias in the Cl_2 result as well as affecting the HBr/Br_2 split. High concentrations of nitrogen oxides (NO_x) may produce sufficient nitrate (NO_3^-) to interfere with measurements of very low Br^- levels.

1.4 Precision and Bias. The method has a possible measurable negative bias below 20 ppm HCl perhaps due to reaction with small amounts of moisture in the probe and filter. Similar bias for the other hydrogen halides is possible.

1.5 Sample Stability. The collected Cl^- samples can be stored for up to 4 weeks for analysis for HCl and Cl_2.

1.6 Detection Limit. The in-stack detection limit for HCl is approximately 0.02 μg per liter of stack gas; the analytical detection limit for HCl is 0.1 μg/ml. Detection limits for the

other analyses should be similar.

2. APPARATUS

2.1 Sampling. The sampling train is shown in Figure 26A-1; the apparatus is similar to the Method 5 train where noted as follows:

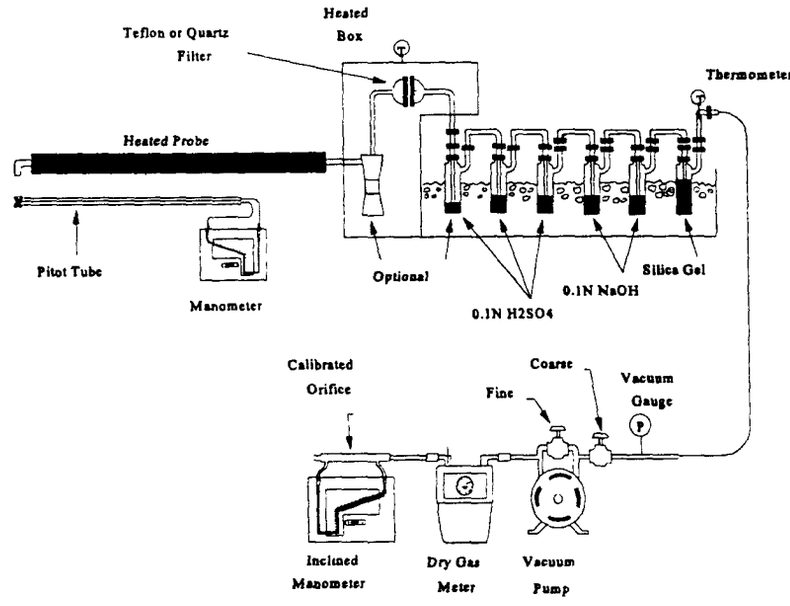

Figure 26A-1. Sampling Train

2.1.1 Probe Nozzle. Borosilicate or quartz glass; constructed and calibrated according to Method 5, Sections 2.1.1 and 5.1, and coupled to the probe liner using a Teflon[R] union; a stainless steel nut is recommended for this union. When the stack temperature exceeds 210°C (410°F), a one-piece glass nozzle/liner assembly must be used.

2.1.2 Probe Liner. Same as Method 5, Section 2.1.2, except metal liners shall not be used. Water-cooling of the stainless steel sheath is recommended at temperatures exceeding 500°C. Teflon[R] may be used in limited applications where the minimum stack temperature exceeds 120 °C (250 °F) but never exceeds the temperature where Teflon[R] is estimated to become unstable (approximately 210 °C).

2.1.3 Pitot Tube, Differential Pressure Gauge, Filter Heating System, Metering System, Barometer, Gas Density Determination Equipment. Same as Method 5, Sections 2.1.3, 2.1.4, 2.1.6, 2.1.8, 2.1.9, and 2.1.10.

2.1.4 Cyclone (Optional). Glass or Teflon[R] . Use of the cyclone is required only when the sample gas stream is saturated with moisture; however, the cyclone is recommended to protect the filter from any moisture droplets present.

2.1.5 Filter Holder. Borosilicate or quartz glass, or

Teflon[R] filter holder, with a Teflon[R] filter support and a sealing gasket. The sealing gasket shall be constructed of Teflon[R] or equivalent materials. The holder design shall provide a positive seal against leakage at any point along the filter circumference. The holder shall be attached immediately to the outlet of the cyclone.

2.1.6 Impinger Train. The following system shall be used to determine the stack gas moisture content and to collect the hydrogen halides and halogens: five or six impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. The first impinger shown in Figure 26A-1 (knockout or condensate impinger) is optional and is recommended as a water knockout trap for use under high moisture conditions. If used, this impinger should be constructed as described below for the alkaline impingers, but with a shortened stem, and should contain 50 ml of 0.1 N H_2SO_4. The following two impingers (acid impingers which each contain 100 ml of 0.1 N H_2SO_4) shall be of the Greenburg-Smith design with the standard tip (Method 5, Section 2.1.7). The next two impingers (alkaline impingers which each contain 100 ml of 0.1 N NaOH) and the last impinger (containing silica gel) shall be of the modified Greenburg-Smith design (Method 5, Section 2.1.7). The condensate, acid, and alkaline impingers shall contain known

quantities of the appropriate absorbing reagents. The last impinger shall contain a known weight of silica gel or equivalent desiccant. Teflon[R] impingers are an acceptable alternative.

2.1.7 Ambient Air Conditioning Tube (Optional). Tube tightly packed with approximately 150 g of fresh 8 to 20 mesh sodium hydroxide-coated silica, or equivalent, (Ascarite II[R] has been found suitable) to dry and remove acid gases from the ambient air used to remove moisture from the filter and cyclone, when the cyclone is used. The inlet and outlet ends of the tube should be packed with at least 1-cm thickness of glass wool or filter material suitable to prevent escape of fines. Fit one end with flexible tubing, etc. to allow connection to probe nozzle following the test run.

2.2 Sample Recovery. The following items are needed:

2.2.1 Probe-Liner and Probe-Nozzle Brushes, Wash Bottles, Glass Sample Storage Containers, Petri Dishes, Graduated Cylinder or Balance, and Rubber Policeman. Same as Method 5, Sections 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, and 2.2.7.

2.2.2 Plastic Storage Containers. Screw-cap polypropylene or polyethylene containers to store silica gel. High-density polyethylene bottles with Teflon screw cap liners to store impinger reagents, 1-liter.

2.2.3 Funnels. Glass or high-density polyethylene, to aid

in sample recovery.

2.3 Analysis. For analysis, the following equipment is needed:

2.3.1 Volumetric Flasks. Class A, various sizes.

2.3.2 Volumetric Pipettes. Class A, assortment, to dilute samples to calibration range of the ion chromatograph (IC).

2.3.3 Ion Chromatograph. Suppressed or nonsuppressed, with a conductivity detector and electronic integrator operating in the peak area mode. Other detectors, a strip chart recorder, and peak heights may be used.

3. REAGENTS

Unless otherwise indicated, all reagents must conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS reagent grade). When such specifications are not available, the best available grade shall be used.

3.1 Sampling.

3.1.1 Water. Deionized, distilled water that conforms to American Society of Testing and Materials (ASTM) Specification D 1193-77, Type 3.

3.1.2 Acidic Absorbing Solution, 0.1 N Sulfuric Acid (H_2SO_4). To prepare 1 L, slowly add 2.80 ml of concentrated H_2SO_4 to about 900 ml of water while stirring, and adjust the final

volume to 1 L using additional water. Shake well to mix the solution.

3.1.3 Alkaline Absorbing Solution, 0.1 N Sodium Hydroxide (NaOH). To prepare 1 L, dissolve 4.00 g of solid NaOH in about 900 ml of water and adjust the final volume to 1 L using additional water. Shake well to mix the solution.

3.1.4 Filter. Teflon[R] mat (e.g., Pallflex[R] TX40HI45) filter. When the stack gas temperature exceeds 210 °C (410 °F) a quartz fiber filter may be used.

3.1.5 Silica Gel, Crushed Ice, and Stopcock Grease. Same as Method 5, Sections 3.1.2, 3.1.4, and 3.1.5, respectively.

3.1.6 Sodium Thiosulfate, ($Na_2S_2O_3 3 \cdot 5\ H_2O$).

3.2 Sample Recovery.

3.2.1 Water. Same as Section 3.1.1.

3.2.2 Acetone. Same as Method 5, Section 3.2.

3.3 Sample Analysis.

3.3.1 Water. Same as Section 3.1.1.

3.3.2 Reagent Blanks. A separate blank solution of each absorbing reagent should be prepared for analysis with the field samples. Dilute 200 ml of each absorbing solution (250 ml of the acidic absorbing solution, if a condensate impinger is used) to the same final volume as the field samples using the blank sample of rinse water. If a particulate determination is conducted,

collect a blank sample of acetone.

3.3.3 Halide Salt Stock Standard Solutions. Prepare concentrated stock solutions from reagent grade sodium chloride (NaCl), sodium bromide (NaBr), and sodium fluoride (NaF). Each must be dried at 110°C for 2 or more hours and then cooled to room temperature in a desiccator immediately before weighing. Accurately weigh 1.6 to 1.7 g of the dried NaCl to within 0.1 mg, dissolve in water, and dilute to 1 liter. Calculate the exact Cl^- concentration using Equation 26A-1.

$$\mu g\ Cl^-/ml = g\ of\ NaCl \times 10^3 \times 35.453/58.44 \qquad \text{Eq. 26A-1}$$

In a similar manner, accurately weigh and solubilize 1.2 to 1.3 g of dried NaBr and 2.2 to 2.3 g of NaF to make 1-liter solutions. Use Equations 26A-2 and 26A-3 to calculate the Br^- and F^- concentrations.

$$\mu g\ Br^-/ml = g\ of\ NaBr \times 10^3 \times 79.904/102.90 \qquad \text{Eq. 26A-2}$$

$$\mu g\ F^-/ml = g\ of\ NaF \times 10^3 \times 18.998/41.99 \qquad \text{Eq. 26A-3}$$

Alternately, solutions containing a nominal certified concentration of 1000 mg/L NaCl are commercially available as convenient stock solutions from which standards can be made by appropriate volumetric dilution. Refrigerate the stock standard solutions and store no longer than 1 month.

3.3.4 Chromatographic Eluent. Same as Method 26, Section 3.2.4.

4. PROCEDURE

Because of the complexity of this method, testers and analysts should be trained and experienced with the procedures to ensure reliable results.

4.1 Sampling.

4.1.1 Pretest Preparation. Follow the general procedure given in Method 5, Section 4.1.1, except the filter need only be desiccated and weighed if a particulate determination will be conducted.

4.1.2 Preliminary Determinations. Same as Method 5, Section 4.1.2.

4.1.3 Preparation of Sampling Train. Follow the general procedure given in Method 5, Section 4.1.3, except for the following variations:

Add 50 ml of 0.1 N H_2SO_4 to the condensate impinger, if used. Place 100 ml of 0.1 N H_2SO_4 in each of the next two impingers. Place 100 ml of 0.1 N NaOH in each of the following two impingers. Finally, transfer approximately 200-300 g of preweighed silica gel from its container to the last impinger. Set up the train as in Figure 26A-1. When used, the optional cyclone is inserted between the probe liner and filter holder and located in the heated filter box.

4.1.4 Leak-Check Procedures. Follow the leak-check

procedures given in Method 5, Sections 4.4.1 (Pretest Leak-Check), 4.1.4.2 (Leak-Checks During the Sample Run), and 4.1.4.3 (Post-Test Leak-Check).

4.1.5 Train Operation. Follow the general procedure given in Method 5, Section 4.1.5. Maintain a temperature around the filter and (cyclone, if used) of greater than 120 °C (248 °F). For each run, record the data required on a data sheet such as the one shown in Method 5, Figure 5-2. If the condensate impinger becomes too full, it may be emptied, recharged with 50 ml of 0.1 N H_2SO_4, and replaced during the sample run. The condensate emptied must be saved and included in the measurement of the volume of moisture collected and included in the sample for analysis. The additional 50 ml of absorbing reagent must also be considered in calculating the moisture. After the impinger is reinstalled in the train, conduct a leak-check as described in Method 5, Section 4.1.4.2.

4.1.6 Post-Test Moisture Removal (Optional). When the optional cyclone is included in the sampling train or when moisture is visible on the filter at the end of a sample run even in the absence of a cyclone, perform the following procedure. Upon completion of the test run, connect the ambient air conditioning tube at the probe inlet and operate the train with the filter heating system at least 120 °C (248 °F) at a low flow

rate (e.g., ΔH = 1 in. H_2O) to vaporize any liquid and hydrogen halides in the cyclone or on the filter and pull them through the train into the impingers. After 30 minutes, turn off the flow, remove the conditioning tube, and examine the cyclone and filter for any visible moisture. If moisture is visible, repeat this step for 15 minutes and observe again. Keep repeating until the cyclone is dry. [Note: It is critical that this is repeated until the cyclone is completely dry.]

4.2 Sample Recovery. Allow the probe to cool. When the probe can be handled safely, wipe off all the external surfaces of the tip of the probe nozzle and place a cap loosely over the tip. Do not cap the probe tip tightly while the sampling train is cooling down because this will create a vacuum in the filter holder, drawing water from the impingers into the holder. Before moving the sampling train to the cleanup site, remove the probe, wipe off any silicone grease, and cap the open outlet of the impinger train, being careful not to lose any condensate that might be present. Wipe off any silicone grease and cap the filter or cyclone inlet. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the first impinger and the filter holder, disconnect it at the filter holder and let any condensed water drain into the first impinger. Wipe off any silicone grease and cap the filter

holder outlet and the impinger inlet. Ground glass stoppers, plastic caps, serum caps, Teflon[R] tape, Parafilm[R], or aluminum foil may be used to close these openings. Transfer the probe and filter/impinger assembly to the cleanup area. This area should be clean and protected from the weather to minimize sample contamination or loss. Inspect the train prior to and during disassembly and note any abnormal conditions. Treat samples as follows:

4.2.1 Container No. 1 (Optional; Filter Catch for Particulate Determination). Same as Method 5, Section 4.2, Container No. 1.

4.2.2 Container No. 2 (Optional; Front-Half Rinse for Particulate Determination). Same as Method 5, Section 4.2, Container No. 2.

4.2.3 Container No. 3 (Knockout and Acid Impinger Catch for Moisture and Hydrogen Halide Determination). Disconnect the impingers. Measure the liquid in the acid and knockout impingers to ±1 ml by using a graduated cylinder or by weighing it to ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Quantitatively transfer this liquid to a leak-free sample storage container. Rinse these impingers and connecting glassware including the back portion of the filter

holder (and flexible tubing, if used) with water and add these rinses to the storage container. Seal the container, shake to mix, and label. The fluid level should be marked so that if any sample is lost during transport, a correction proportional to the lost volume can be applied. Retain rinse water and acidic absorbing solution blanks and analyze with the samples.

4.2.4 Container No. 4 (Alkaline Impinger Catch for Halogen and Moisture Determination). Measure and record the liquid in the alkaline impingers as described in Section 4.2.3. Quantitatively transfer this liquid to a leak-free sample storage container. Rinse these two impingers and connecting glassware with water and add these rinses to the container. Add 25 mg of sodium thiosulfate per ppm halogen-dscm of stack gas sampled. [Note: This amount of sodium thiosulfate includes a safety factor of approximately 5 to assure complete reaction with the hypohalous acid to form a second Cl^- ion in the alkaline solution.] Seal the container, shake to mix, and label; mark the fluid level. Retain alkaline absorbing solution blank and analyze with the samples.

4.2.5 Container No. 5 (Silica Gel for Moisture Determination). Same as Method 5, Section 4.2, *Container No. 3.*

4.2.6 Container Nos. 6 through 9 (Reagent Blanks). Save portions of the absorbing reagents (0.1 N H_2SO_4 and 0.1 N NaOH)

equivalent to the amount used in the sampling train; dilute to the approximate volume of the corresponding samples using rinse water directly from the wash bottle being used. Add the same ratio of sodium thiosulfate solution used in container No. 4 to the 0.1 N NaOH absorbing reagent blank. Also, save a portion of the rinse water alone and a portion of the acetone equivalent to the amount used to rinse the front half of the sampling train. Place each in a separate, prelabeled sample container.

4.2.7 Prior to shipment, recheck all sample containers to ensure that the caps are well-secured. Seal the lids of all containers around the circumference with Teflon[R] tape. Ship all liquid samples upright and all particulate filters with the particulate catch facing upward.

4.3 Sample Preparation and Analysis. Note the liquid levels in the sample containers and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results.

4.3.1 Container Nos. 1 and 2 and Acetone Blank (Optional; Particulate Determination). Same as Method 5, Section 4.3.

4.3.2 Container No. 5. Same as Method 5, Section 4.3 for silica gel.

4.3.3 Container Nos. 3 and 4 and Absorbing Solution and Water Blanks. Quantitatively transfer each sample to a volumetric flask or graduated cylinder and dilute with water to a final volume within 50 ml of the largest sample.

4.3.3.1 The IC conditions will depend upon analytical column type and whether suppressed or nonsuppressed IC is used. Prior to calibration and sample analysis, establish a stable baseline. Next, inject a sample of water, and determine if any Cl^-, Br^-, or F^- appears in the chromatogram. If any of these ions are present, repeat the load/injection procedure until they are no longer present. Analysis of the acid and alkaline absorbing solution samples requires separate standard calibration curves; prepare each according to Section 5.2. Ensure adequate baseline separation of the analyses.

4.3.3.2 Between injections of the appropriate series of calibration standards, inject in duplicate the reagent blanks and the field samples. Measure the areas or heights of the Cl^-, Br^-, and F^- peaks. Use the average response to determine the concentrations of the field samples and reagent blanks using the linear calibration curve. If the values from duplicate injections are not within 5 percent of their mean, the duplicate injection shall be repeated and all four values used to determine the average response. Dilute any sample and the blank with equal

volumes of water if the concentration exceeds that of the highest standard.

4.4 Audit Sample Analysis. Audit samples must be analyzed subject to availability.

5. CALIBRATION

Maintain a laboratory log of all calibrations.

5.1 Probe Nozzle, Pitot Tube, Dry Gas Metering System, Probe Heater, Temperature Gauges, Leak-Check of Metering System, and Barometer. Same as Method 5, Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, and 5.7, respectively.

5.2 Ion Chromatograph. To prepare the calibration standards, dilute given amounts (1.0 ml or greater) of the stock standard solutions to convenient volumes, using 0.1 N H_2SO_4 or 0.1 N NaOH, as appropriate. Prepare at least four calibration standards for each absorbing reagent containing the three stock solutions such that they are within the linear range of the field samples. Using one of the standards in each series, ensure adequate baseline separation for the peaks of interest. Inject the appropriate series of calibration standards, starting with the lowest concentration standard first both before and after injection of the quality control check sample, reagent blanks, and field samples. This allows compensation for any instrument drift occurring during sample analysis. Determine the peak

areas, or height, of the standards and plot individual values versus halide ion concentrations in μg/ml. Draw a smooth curve through the points. Use linear regression to calculate a formula describing the resulting linear curve.

6. QUALITY CONTROL

Same as Method 5, Section 4.4.

7. QUALITY ASSURANCE

7.1 Applicability. When the method is used to demonstrate compliance with a regulation, a set of two audit samples shall be analyzed.

7.2 Audit Procedure. The currently available audit samples are chloride solutions. Concurrently analyze the two audit samples and a set of compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation. The same analyst, analytical reagents, and analytical system shall be used both for compliance samples and the Environmental Protection Agency (EPA) audit samples.

7.3 Audit Sample Availability. Audit samples will be supplied only to enforcement agencies for compliance tests. Audit samples may be obtained by writing the Source Test Audit Coordinator (MD-77B), Quality Assurance Division, Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Laboratory, Research Triangle Park, NC 27711 or by

calling the Source Test Audit Coordinator (STAC) at (919) 541-7834. The request for the audit samples should be made at least 30 days prior to the scheduled compliance sample analysis.

7.4 Audit Results. Calculate the concentrations in mg/dscm using the specified sample volume in the audit instructions. Include the results of both audit samples, their identification numbers, and the analyst's name with the results of the compliance determination samples in appropriate reports to the EPA regional office or the appropriate enforcement agency. (**NOTE:** Acceptability of results may be obtained immediately by reporting the audit results in mg/dscm and compliance results in total μg HCl/sample to the responsible enforcement agency.) The concentrations of the audit samples obtained by the analyst shall agree within 10 percent of the actual concentrations. If the 10 percent specification is not met, reanalyze the compliance samples and audit samples, and include initial and reanalysis values in the test report. Failure to meet the 10 percent specification may require retests until the audit problems are resolved.

8. CALCULATIONS

Retain at least one extra decimal figure beyond those contained in the available data in intermediate calculations, and

round off only the final answer appropriately.

8.1 Nomenclature. Same as Method 5, Section 6.1. In addition:

1 B_{X^-} = Mass concentration of applicable absorbing solution blank, μg halide ion (Cl^-, Br^-, F^-)/ml, not to exceed 1 μg/ml which is 10 times the published analytical detection limit of 0.1 μg/ml. (It is also approximately 5 percent of the mass concentration anticipated to result from a one hour sample at 10 ppmv HCl.)

C = Concentration of hydrogen halide (HX) or halogen (X_2), dry basis, mg/dscm.

m_{HX} = Mass of HCl, HBr, or HF in sample, ug.

m_{X2} = Mass of Cl_2 or Br_2 in sample, ug.

S_{X^-} = Analysis of sample, ug halide ion (Cl^-, Br^-, F^-)/ml.

V_s = Volume of filtered and diluted sample, ml.

8.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. See data sheet (Figure 5-2 of Method 5).

8.3 Dry Gas Volume. Calculate $V_{m(std)}$ and adjust for leakage, if necessary, using the equation in Section 6.3 of Method 5.

8.4 Volume of Water Vapor and Moisture Content. Calculate

the volume of water vapor $V_{w(std)}$ and moisture content B_{ws} from the data obtained in this method (Figure 5-2 of Method 5); use Equations 5-2 and 5-3 of Method 5.

8.5 Isokinetic Variation and Acceptable Results. Use Method 5, Sections 6.11 and 6.12.

8.6 Acetone Blank Concentration, Acetone Wash Blank Residue Weight, Particulate Weight, and Particulate Concentration. For particulate determination.

8.7 Total μg HCl, HBr, or HF Per Sample.

$$m_{HX} = K\ V_s\ (S_{X^-} - B_{X^-}) \qquad \text{Eq. 26A-4}$$

where: K_{HCl} = 1.028 (μg HCl/μg-mole)/(μg Cl^-/μg-mole).

K_{HBr} = 1.013 (μg HBr/μg-mole)/(μg Br^-/μg-mole).

K_{HF} = 1.053 (μg HF/μg-mole)/(μg F^-/μg-mole).

8.8 Total μg Cl_2 or Br_2 Per Sample.

$$m_{X2} = V_s\ (S_{X^-} - B_{X^-}) \qquad \text{Eq. 26A-5}$$

8.9 Concentration of Hydrogen Halide or Halogen in Flue Gas.

$$C = K\ m_{HX,X2}/V_{m(std)} \qquad \text{Eq. 26A-6}$$

where: $K = 10^{-3}$ mg/μg

8.10 Stack Gas Velocity and Volumetric Flow Rate. Calculate the average stack gas velocity and volumetric flow rate, if needed, using data obtained in this method and the equations in Sections 5.2 and 5.3 of Method 2.

9. BIBLIOGRAPHY

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Appendix G.8

EPA Proposed Method 322

(PROPOSED) TEST METHOD 322 - MEASUREMENT OF HYDROGEN CHLORIDE EMISSIONS FROM PORTLAND CEMENT KILNS BY GFCIR

1.0 Applicability and Principle

1.1 Applicability. This method is applicable to the determination of hydrogen chloride (HCl) concentrations in emissions from portland cement kilns. This is an instrumental method for the measurement of HCl using an extractive sampling system and an infrared (IR) gas-filter correlation (GFC) analyzer. This method is intended to provide the cement industry with a direct interface instrumental method. A procedure for analyte spiking is included for quality assurance. This method is considered to be self-validating provided that the requirements in section 9 of this method are followed.

1.2 Principle. A gas sample is continuously extracted from a stack or duct over the test period using either a source-level hot/wet extractive subsystem or a dilution extractive subsystem. A nondispersive infrared gas filter correlation (NDIR-GFC) analyzer is specified for the measurement of HCl in the sample. The total measurement system is comprised of the extractive subsystem, the analyzer, and the data acquisition subsystem. Test system performance specifications are included in this method to provide for the collection of accurate, reproducible data.

1.3 Test System Operating Range. The measurement range (span) of the test system shall include the anticipated HCl concentrations of the effluent and spiked samples. The range should be selected so that the average of the effluent measurements is between 25 and 75 percent of span. If at any time during a test run, the effluent concentration exceeds the span value of the test system, the run shall be considered invalid.

2.0 Summary of Method

2.1 Sampling and Analysis. Kiln gas is continuously extracted from the stack or duct using either a source level, hot/wet extractive system, or an in-situ dilution probe or heated out-of-stack dilution system. The sample is then directed by a heated sample line maintained above 350°F to a GFC analyzer having a range appropriate to the type of sampling system. The gas filter correlation analyzer incorporates a gas cell filled with HCl. This gas cell is periodically moved into the path of an infrared measurement beam of the instrument to filter out essentially all of the HCl absorption wavelengths. Spectral filtering provides a reference from which the HCl concentration of the sample can be determined. Interferences are minimized in the analyzer by choosing a spectral band over which compounds such as CO_2 and H_2O either do not absorb significantly or do not match the spectral pattern of the HCl infrared absorption.

2.2 Operator Requirements. The analyst must be familiar with the specifications and test procedures of this method and follow them in order to obtain reproducible and accurate data.

3.0 Definitions

3.1 Measurement System. The total equipment required for the determination of gas concentration. The measurement system consists of the following major subsystems:

3.1.1 Sample Interface. That portion of a system used for one or more of the following: sample acquisition, sample transport, sample conditioning, or protection of the analyzers from the effects of the stack gas.

3.1.2 Gas Analyzer. That portion of the system that senses the gas to be measured and generates an output proportional to its concentration.

3.1.3 Data Recorder. A strip chart recorder, analog computer, or digital recorder for recording measurement data from the analyzer output.

3.2 Span. The upper limit of the gas concentration measurement range displayed on the data recorder.

3.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas (i.e., N_2).

3.4 Analyzer Calibration Error. The difference between the gas concentration exhibited by the gas analyzer and the known concentration of the calibration gas when the calibration gas is introduced directly to the analyzer.

3.5 Sampling System Bias. The sampling system bias is the difference between the gas concentrations exhibited by the measurement system when a known concentration gas is introduced at the outlet of the sampling probe and the known value of the calibration gas.

3.6 Response Time. The amount of time required for the measurement system to display 95 percent of a step change in gas concentration on the data recorder.

3.7 Calibration Curve. A graph or other systematic method of establishing the relationship between the analyzer response and the actual gas concentration introduced to the analyzer.

3.8 Linearity. The linear response of the analyzer or test system to known calibration inputs covering the concentration range of the system.

3.9 Interference Rejection. The ability of the system to reject the effect of interferences in the analytical measurement processes of the test system.

4.0 Interferences

4.1 Sampling System Interferences. An important consideration in measuring HCl using an extractive measurement system is to ensure that a representative kiln gas sample is delivered to the gas analyzer. A sampling system interferant is a factor that inhibits an analyte from reaching the analytical instrumentation. Condensed water vapor is a strong sampling system interferant for HCl and other water soluble compounds.

"Cold spots" in the sampling system can allow water vapor in the sample to condense resulting in removal of HCl from the sample stream. The extent of HCl sampling system bias depends on concentrations of potential interferants, moisture content of the gas stream, temperature of the gas stream, temperature of sampling system components, sample flow rate, and reactivity of HCl with other species in the gas stream. For measuring HCl in a wet gas stream, the temperatures of the gas stream and sampling system components and the sample flow rate are of primary importance. In order to prevent problems with condensation in the sampling system, these parameters must be closely monitored.

4.1.1 System Calibration Checks. Performing these calibration checks where HCl calibration gas is injected through the entire system both before and after each test run demonstrates the integrity of the sampling system and capability of the analyzer for measuring this water soluble and otherwise unstable compound under ideal conditions (i.e., HCl in N_2).

4.1.2 Analyte Spiking Checks. For analyte spiking checks, HCl calibration gas is quantitatively added to the sample stream at a point upstream of the particulate filter and all other sample handling components both before and after each test run. The volume of HCl spike gas should not exceed 10 percent of the total sample volume so that the sample matrix is relatively unaffected. Successfully performing these checks demonstrates the integrity of the sampling system for measuring this water soluble and reactive compound under actual sample matrix conditions. Successfully performing these checks also demonstrates the adequacy of the interference rejection capability of the analyzer. (See section 9.3 of this method.)

4.2 Analytical Interferences. Analytical interferences are reduced by the GFC spectroscopic technique required by the method. The accuracy of HCl measurements provided by some GFC analyzers is known to be sensitive to the moisture content of the sample. This must be taken into account in order to acquire accurate results. These analyzers must be calibrated for the specific moisture content of the samples.

5.0 Safety

This method may involve sampling at locations having high positive or negative pressures, or high concentrations of hazardous or toxic pollutants, and cannot address all safety problems encountered under these diverse sampling conditions. It is the responsibility of the tester(s) to ensure proper safety and health practices, and to determine the applicability of regulatory limitations before performing this test method. Because HCl is a respiratory irritant, it is advisable to limit exposure to this compound.

6.0 Equipment and Supplies

Note: Mention of company or product names does not constitute endorsement by the U. S. Environmental Protection Agency.

6.1 Measurement System. Use any GFC measurement system for HCl that meets the specifications of this method. All sampling system components must be maintained above the kiln gas temperature, when possible, or at least 350°F. The length of sample transport line should be minimized and sampling rate should be as high as possible to minimize adsorption of HCl. The essential components of the measurement system are described in sections 6.1.1 through 6.1.12.

6.1.1 Sample Probe. Glass, stainless steel, Hastalloy™, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to a minimum of 350°F to prevent condensation. Dilution extractive systems must use a dilution ratio such that the average diluted concentrations are between 25 to 75 percent of the selected measurement range of the analyzer.

6.1.2 Calibration Valve Assembly. Use a heated, three-way valve assembly, or equivalent, for selecting either sample gas or introducing calibration gases to the measurement system or introducing analyte spikes into the measurement system at the outlet of the sampling probe before the primary particulate filter.

6.1.3 Particulate Filter. A coarse filter or other device may be placed at the inlet of the probe for removal of large particulate (10 microns or greater). A heated (Balston® or equivalent) filter rated at 1 micron is necessary for primary particulate removal, and shall be placed immediately after the heated probe. The filter/filter holder shall be maintained at 350°F or a higher temperature. Additional filters at the inlet of the gas analyzer may be used to prevent accumulation of particulate material in the measurement system and extend the useful life of components. All filters shall be fabricated of materials that are nonreactive with HCl. Some types of glass filters are known to react with HCl.

6.1.4 Sample Transport Lines. Stainless steel or polytetrafluoroethylene (PTFE) tubing shall be heated to a minimum temperature of 350°F (sufficient to prevent condensation and to prevent HCl and NH_3 from combining into ammonium chloride in the sampling system) to transport the sample gas to the gas analyzer.

6.1.5 Sample Pump. Use a leak-free pump to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The pump components that contact the sample must be heated to a temperature greater than 350°F and must be constructed of a material that is nonreactive to HCl.

6.1.6 Sample Flow Rate Control. A sample flow rate control valve and rotameter, or equivalent, must be used to maintain a constant sampling rate within ±10 percent. These components must be heated to a temperature greater than 350°F. (<u>Note</u>: The tester may elect to install a back-pressure regulator to maintain

the sample gas manifold at a constant pressure in order to protect the analyzer(s) from over-pressurization, and to minimize the need for flow rate adjustments.)

6.1.7 Sample Gas Manifold. A sample gas manifold, heated to a minimum of 350°F, is used to divert a portion of the sample gas stream to the analyzer and the remainder to the by-pass discharge vent. The sample gas manifold should also include provisions for introducing calibration gases directly to the analyzer. The manifold must be constructed of material that is nonreactive to the gas being sampled.

6.1.8 Gas Analyzer. Use a nondispersive infrared analyzer utilizing the gas filter correlation technique to determine HCl concentrations. The analyzer shall meet the applicable performance specifications of section 8.0 of this method. (Note: Housing the analyzer in a clean, thermally-stable, vibration free environment will minimize drift in the analyzer calibration.) The analyzer (system) shall be designed so that the response of a known calibration input shall not deviate by more than ±3 percent from the expected value. The analyzer or measurement system manufacturer may provide documentation that the instrument meets this design requirement. Alternatively, a known concentration gas standard and calibration dilution system meeting the requirements of Method 205 of appendix M to part 51 of this chapter, "Verification of Gas Dilution Systems for Field Calibrations" (or equivalent procedure), may be used to develop a multi-point calibration curve over the measurement range of the analyzer.

6.1.9 Gas Regulators. Single stage regulator with cross purge assembly that is used to purge the CGA fitting and regulator before and after use. (This purge is necessary to clear the calibration gas delivery system of ambient water vapor after the initial connection is made, or after cylinder changeover, and will extend the life of the regulator.) Wetted parts are 316 stainless steel to handle corrosive gases.

6.1.10 Data Recorder. A strip chart recorder, analog computer, or digital recorder, for recording measurement data. The data recorder resolution (i.e., readability) shall be 0.5 percent of span. Alternatively, a digital or analog meter having a resolution of 0.5 percent of span may be used to obtain the analyzer responses and the readings may be recorded manually. If this alternative is used, the readings shall be obtained at equally-spaced intervals over the duration of the sampling run. For sampling run durations of less than 1 hour, measurements at 1-minute intervals or a minimum of 30 measurements, whichever is less restrictive, shall be obtained. For sampling run durations greater than 1 hour, measurements at 2-minute intervals or a minimum of 96 measurements, whichever is less restrictive, shall be obtained.

6.1.11 Mass Flow Meters/Controllers. A mass flow meter having the appropriate calibrated range and a stated accuracy of

±2 percent of the measurement range is used to measure the HCl spike flow rate. This device must be calibrated with the major component of the calibration spike gas (e.g., nitrogen) using an NIST traceable bubble meter or equivalent. When spiking HCl, the mass flow meter/controller should be thoroughly purged before and after introduction of the gas to prevent corrosion of the interior parts.

6.1.12 System Flow Measurement. A measurement device or procedure to determine the total flow rate of sample gas within the measurement system. A rotameter, or mass flow meter calibrated relative to a laboratory standard to within ±2 percent of the measurement value at the actual operating temperature, moisture content, and sample composition (molecular weight) is acceptable. A system which ensures that the total sample flow rate is constant within ±2 percent and which relies on an intermittent measurement of the actual flow rate (e.g., calibrated gas meter) is also acceptable.

6.2 HCl Calibration Gases. The calibration gases for the gas analyzer shall be HCl in N_2. Use at least three calibration gases as specified below:

6.2.1 High-Range Gas. Concentration equivalent to 80 to 100 percent of the span.

6.2.2 Mid-Range Gas. Concentration equivalent to 40 to 60 percent of the span.

6.2.3 Zero Gas. Concentration of less than 0.25 percent of the span. Purified ambient air may be used for the zero gas by passing air through a charcoal filter or through one or more impingers containing a solution of 3 percent H_2O_2.

6.2.4 Spike Gas. A calibration gas of known concentration (typically 100 to 200 ppm) used for analyte spikes in accordance with the requirements of section 9.3 of this method.

7.0 Reagents and Standards

7.1 Hydrogen Chloride. Hydrogen Chloride is a reactive gas and is available in steel cylinders from various commercial gas vendors. The stability is such that it is not possible to purchase a cylinder mixture whose HCl concentration can be certified at better than ±5 percent. The stability of the cylinder may be monitored over time by periodically analyzing cylinder samples. The cylinder gas concentration must be verified within 1 month prior to the use of the calibration gas. Due to the relatively high uncertainty of HCl calibration gas values, difficulties may develop in meeting the performance specifications if the mid-range and high-range calibration gases are not consistent with each other. Where problems are encountered, the consistency of the test gas standards may be determined: (1) by comparing analyzer responses for the test gases with the responses to additional certified calibration gas standards, (2) by reanalysis of the calibration gases in accordance with sections 7.2.1 or 7.2.2 of this method, or (3) by other procedures subject to the approval of EPA.

7.2 Calibration Gas Concentration Verification. There are two alternatives for establishing the concentrations of calibration gases. Alternative No. 1 is preferred.

7.2.1 Alternative No. 1. The value of the calibration gases may be obtained from the vendor's certified analysis within 1 month prior to the test. Obtain a certification from the gas manufacturer that identifies the analytical procedures and date of certification.

7.2.2 Alternative No. 2. Perform triplicate analyses of the gases using Method 26 of appendix A to part 60 of this chapter. Obtain gas mixtures with a manufacturer's tolerance not to exceed ±5 percent of the tag value. Within 1 month of the field test, analyze each of the calibration gases in triplicate using Method 26 of appendix A to part 60 of this chapter. The tester must follow all of the procedures in Method 26 (e.g., use midget impingers, heated Pallflex TX40H175 filter (TFE-glass mat), etc. if this analysis is performed. Citation 3 in section 13 of this method describes procedures and techniques that may be used for this analysis. Record the results on a data sheet. Each of the individual HCl analytical results for each calibration gas shall be within 5 percent (or 5 ppm, whichever is greater) of the triplicate set average; otherwise, discard the entire set and repeat the triplicate analyses. If the average of the triplicate analyses is within 5 percent of the calibration gas manufacturer's cylinder tag value, use the tag value; otherwise, conduct at least three additional analyses until the results of six consecutive runs agree within 5 percent (or 5 ppm, whichever is greater) of the average. Then use this average for the cylinder value.

7.3 Calibration Gas Dilution Systems. Sample flow rates of approximately 15 L/min are typical for extractive HCl measurement systems. These flow rates coupled with response times of 15 to 30 minutes will result in consumption of large quantities of calibration gases. The number of cylinders and amount of calibration gas can be reduced by the use of a calibration gas dilution system in accordance with Method 205 of appendix M to part 51 of this chapter, "Verification of Gas Dilution Systems for Field Instrument Calibrations." If this option is used, the tester shall also introduce an undiluted calibration gas approximating the effluent HCl concentration during the initial calibration error test of the measurement system as a quality assurance check.

8.0 Test System Performance Specifications

8.1 Analyzer Calibration Error. This error shall be less than ±5 percent of the emission standard concentration or ±1 ppm, (whichever is greater) for zero, mid-, and high-range gases.

8.2 Sampling System Bias. This bias shall be less than ±7.5 percent of the emission standard concentration or ±1.5 ppm (whichever is greater) for zero and mid-range gases.

8.3 Analyte Spike Recovery. This recovery shall be between

70 to 130 percent of the expected concentration of spiked samples calculated with the average of the before and after run spikes.

9.0 Sample Collection, Preservation, and Storage

9.1 Pretest. Perform the procedures of sections 9.1.1. through 9.1.3.3 of this method before measurement of emissions (procedures in section 9.2 of this method). It is important to note that after a regulator is placed on an HCl gas cylinder valve, the regulator should be purged with dry N_2 or dry compressed air for approximately 10 minutes before initiating any HCl gas flow through the system. This purge is necessary to remove any ambient water vapor from within the regulator and calibration gas transport lines; the HCl in the calibration gas may react with this water vapor and increase system response time. A purge of the system should also be performed at the conclusion of a test day prior to removing the regulator from the gas cylinder. Although the regulator wetted parts are corrosion resistant, this will reduce the possibility of corrosion developing within the regulator and extend the life of the equipment.

9.1.1 Measurement System Preparation. Assemble the measurement system by following the manufacturer's written instructions for preparing and preconditioning the gas analyzer and, as applicable, the other system components. Introduce the calibration gases in any sequence, and make all necessary adjustments to calibrate the analyzer and the data recorder. If necessary, adjust the instrument for the specific moisture content of the samples. Adjust system components to achieve correct sampling rates.

9.1.2 Analyzer Calibration Error. Conduct the analyzer calibration error check in the field by introducing calibration gases to the measurement system at any point upstream of the gas analyzer in accordance with sections 9.1.2.1 and 9.1.2.2 of this method.

9.1.2.1 After the measurement system has been prepared for use, introduce the zero, mid-range, and high-range gases to the analyzer. During this check, make no adjustments to the system except those necessary to achieve the correct calibration gas flow rate at the analyzer. Record the analyzer responses to each calibration gas. Note: A calibration curve established prior to the analyzer calibration error check may be used to convert the analyzer response to the equivalent gas concentration introduced to the analyzer. However, the same correction procedure shall be used for all effluent and calibration measurements obtained during the test.

9.1.2.2 The analyzer calibration error check shall be considered invalid if the difference in gas concentration displayed by the analyzer and the concentration of the calibration gas exceeds ±5 percent of the emission standard concentration or ±1 ppm, (whichever is greater) for the zero, mid-, or high-range calibration gases. If an invalid calibration

is exhibited, cross-check or recertify the calibration gases, take corrective action, and repeat the analyzer calibration error check until acceptable performance is achieved.

9.1.3 Sampling System Bias Check. For nondilution extractive systems, perform the sampling system bias check by introducing calibration gases either at the probe inlet or at a calibration valve installed at the outlet of the sampling probe. For dilution systems, calibration gases for both the analyzer calibration error check and the sampling system bias check must be introduced prior to the point of sample dilution. For dilution and nondilution systems, a zero gas and either a mid-range or high-range gas (whichever more closely approximates the effluent concentration) shall be used for the sampling system bias check.

9.1.3.1 Introduce the upscale calibration gas, and record the gas concentration displayed by the analyzer. Then introduce zero gas, and record the gas concentration displayed by the analyzer. During the sampling system bias check, operate the system at the normal sampling rate, and make no adjustments to the measurement system other than those necessary to achieve proper calibration gas flow rates at the analyzer. Alternately introduce the zero and upscale gases until a stable response is achieved. The tester shall determine the measurement system response time by observing the times required to achieve a stable response for both the zero and upscale gases. Note the longer of the two times and note the time required for the measurement system to reach 95 percent of the step change in the effluent concentration as the response time.

9.1.3.2 For nondilution systems, where the analyzer calibration error test is performed by introducing gases directly to the analyzer, the sampling system bias check shall be considered invalid if the difference between the gas concentrations displayed by the measurement system for the sampling system bias check and the known gas concentration standard exceeds ±7.5 percent of the emission standard or ±1.5 ppm, (whichever is greater) for either the zero or the upscale calibration gases. If an invalid calibration is exhibited, take corrective action, and repeat the sampling system bias check until acceptable performance is achieved. If adjustment to the analyzer is required, first repeat the analyzer calibration error check, then repeat the sampling system bias check.

9.1.3.3 For dilution systems (and nondilution systems where all calibration gases are introduced at the probe), the comparison of the analyzer calibration error results and sampling system bias check results is not meaningful. For these systems, the sampling system bias check shall be considered invalid if the difference between the gas concentrations displayed by the analyzer and the actual gas concentrations exceed ±7.5 percent of the emission standard or ±1.5 ppm, (whichever is greater) for either the zero or the upscale calibration gases. If an invalid

calibration is exhibited, take corrective action, and repeat the sampling system bias check until acceptable performance is achieved. If adjustment to the analyzer is required, first repeat the analyzer calibration error check.

9.2 Emission Test Procedures

9.2.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to Method 26 of appendix A to part 60 of this chapter.

9.2.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the sampling system bias check. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. Field test experience has shown that conditioning of the sample system is necessary for approximately 1-hour prior to conducting the first sample run. This conditioning period should be repeated after particulate filters are replaced and at the beginning of each new day or following any period when the sampling system is inoperative. Experience has also shown that prior to adequate conditioning of the system, the response to analyte spikes and/or the change from an upscale calibration gas to a representative effluent measurement may be delayed by more than twice the normal measurement system response time. It is recommended that the analyte spikes (see section 9.3 of this method) be performed to determine if the system is adequately conditioned. The sampling system is ready for use when the time required for the measurement system to equilibrate after a change from a representative effluent measurement to a representative spiked sample measurement approximates the calibration gas response time observed in section 9.1.3.1 of this method.

9.2.3 Sample Duration. After completing the sampling system bias checks and analyte spikes prior to a test run, constant rate sampling of the effluent should begin. For each run, use only those measurements obtained after all residual response to calibration standards or spikes are eliminated and representative effluent measurements are displayed to determine the average effluent concentration. At a minimum, this requires that the response time of the measurement system has elapsed before data are recorded for calculation of the average effluent concentration. Sampling should be continuous for the duration of the test run. The length of data collection should be at least as long as required for sample collection by Method 26 of part 60 of this chapter. One hour sampling runs using this method have provided reliable data for cement kilns.

9.2.4 Validation of Runs. Before and after each run, or if adjustments are necessary for the measurement system during the run, repeat the sampling system bias check procedure described in section 9.1.3 of this method. (Make no adjustments to the measurement system until after the drift checks are completed.)

Record the analyzer's responses.

9.2.4.1 If the post-run sampling system bias for either the zero or upscale calibration gas exceeds the sampling system bias specification, then the run is considered invalid. Take corrective action, and repeat both the analyzer calibration error check procedure (section 9.1.2 of this method) and the sampling system bias check procedure (section 9.1.3 of this method) before repeating the run.

9.2.4.2 If the post-run sampling system bias for both the zero and upscale calibration gas are within the sampling system bias specification, then construct two 2-point straight lines, one using the pre-run zero and upscale check values and the other using the post-run zero and upscale check values. Use the slopes and y-intercepts of the two lines to calculate the gas concentration for the run in accordance with equation 1 of this method.

9.3 Analyte Spiking—Self-Validating Procedure. Use analyte spiking to verify the effectiveness of the sampling system for the target compounds in the actual kiln gas matrix. Quality assurance (QA) spiking should be performed before and after each sample run. The spikes may be performed following the sampling system bias checks (zero and mid-range system calibrations) before each run in a series and also after the last run. The HCl spike recovery should be within ±30 percent as calculated using equations 1 and 2 of this method. Two general approaches are applicable for the use of analyte spiking to validate a GFC HCl measurement system: (1) two independent measurement systems can be operated concurrently with analyte spikes introduced to one of the systems, or (2) a single measurement system can be used to analyze consecutively, spiked and unspiked samples in an alternating fashion. The two-system approach is similar to Method 301 of this appendix and the measurement bias is determined from the difference in the paired concurrent measurements relative to the amount of HCl spike added to the spiked system. The two-system approach must employ identical sampling systems and analyzers and both measurement systems should be calibrated using the same mid- and high-range calibration standards. The two-system approach should be largely unaffected by temporal variations in the effluent concentrations if both measurement systems achieve the same calibration responses and both systems have the same response times. (See Method 301 of this appendix for appropriate calculation procedures.) The single measurement system approach is applicable when the concentration of HCl in the source does not vary substantially during the period of the test. Since the approach depends on the comparison of consecutive spiked and unspiked samples, temporal variations in the effluent HCl concentrations will introduce errors in determining the expected concentration of the spiked samples. If the effluent HCl concentrations vary by more than ±10 percent (or ±5 ppm,

whichever is greater) during the time required to obtain and equilibrate a new sample (system response time), it may be necessary to: (1) use a dual sampling system approach, (2) postpone testing until stable emission concentrations are achieved, (3) switch to the two-system approach [if possible] or, (4) rely on alternative QA/QC procedures. The dual-sampling system alternative uses two sampling lines to convey sample to the gas distribution manifold. One of the sample lines is used to continuously extract unspiked kiln gas from the source. The other sample line serves as the analyte spike line. One GFC analyzer can be used to alternately measure the HCl concentration from the two sampling systems with the need to purge only the components between the common manifold and the analyzer. This minimizes the time required to acquire an equilibrated sample of spiked or unspiked kiln gas. If the source varies by more than ±10 percent or ±5 ppm, (whichever is greater) during the time it takes to switch from the unspiked sample line to the spiked sample line, then the dual-sampling system alternative approach is not applicable. As a last option, (where no other alternatives can be used) a humidified nitrogen stream may be generated in the field which approximates the moisture content of the kiln gas. Analyte spiking into this humidified stream can be employed to assure that the sampling system is adequate for transporting the HCl to the GFC analyzer and that the analyzer's water interference rejection is adequate.

9.3.1 Spike Gas Concentration and Spike Ratio. The volume of HCl spike gas should not exceed 10 percent of the total sample volume (i.e., spike to total sample ratio of 1:10) to ensure that the sample matrix is relatively unaffected. An ideal spike concentration should approximate the native effluent concentration, thus the spiked sample concentrations would represent approximately twice the native effluent concentrations. The ideal spike concentration may not be achieved because the native HCl concentration cannot be accurately predicted prior to the field test, and limited calibration gas standards will be available during the field test. Some flexibility is available by varying the spike ratio over the range from 1:10 to 1:20. Practical constraints must be applied to allow the tester to spike at an anticipated concentration. Thus, the tester may use a 100 ppm calibration gas and a spike ratio of 1:10 as default values where information regarding the expected HCl effluent concentration is not available prior to the tests. Alternatively, the tester may select another calibration gas standard and/or lower spike ratio (e.g., 1:20) to more closely approximate the effluent HCl concentration.

9.3.2 Spike Procedure. Introduce the HCl spike gas mixture at a constant flow rate (±2 percent) at less than 10 percent of the total sample flow rate. (For example, introduce the HCl spike gas at 1 L/min (±20 cc/min) into a total sample flow rate of 10 L/min). The spike gas must be preheated before

introduction into the sample matrix to prevent a localized condensation of the gas stream at the spike introduction point. A heated sample transport line(s) containing multiple transport tubes within the heated bundle may be used to spike gas up through the sampling system to the spike introduction point. Use a calibrated flow device (e.g., mass flow meter/controller) to monitor the spike flow rate. Use a calibrated flow device (e.g., rotameter, mass flow meter, orifice meter, or other method) to monitor the total sample flow rate. Calculate the spike ratio from the measurements of spike flow and total flow. (See equation 2 and 3 in section 10.2 of this method.)

9.3.3 Analyte Spiking. Determine the approximate effluent HCl concentrations by examination of preliminary samples. For single-system approaches, determine whether the HCl concentration varies significantly with time by comparing consecutive samples for the period of time corresponding to at least twice the system response time. (For analyzers without sample averaging, estimate average values for two to five minute periods by observing the instrument display or data recorder output.) If the concentration of the individual samples varies by more than ±10 percent relative to the mean value or ±5 ppm, (whichever is greater), an alternate approach may be needed.

9.3.3.1 Adjust the spike flow rate to the appropriate level relative to the total flow by metering spike gas through a calibrated mass flow meter or controller. Allow spike flow to equilibrate within the sampling system for at least the measurement system response time and a steady response to the spike gas is observed before recording response to the spiked gas sample. Next, terminate the spike gas flow and allow the measurement system to sample only the effluent. After the measurement system response time has elapsed and representative effluent measurements are obtained, record the effluent unspiked concentration. Immediately calculate the spike recovery.

9.3.3.2 If the spike recovery is not within acceptable limits and a change in the effluent concentration is suspected as the cause for exceeding the recovery limit, repeat the analyte spike procedure without making any adjustments to the analyzer or sampling system. If the second spike recovery falls within the recovery limits, disregard the first attempt and record the results of the second spike.

9.3.3.3 Analyte spikes must be performed before and after each test run. Sampling system bias checks must also be performed before and after each test run. Depending on the particular sampling strategy and other constraints, it may be necessary to compare effluent data either immediately before or immediately after the spike sample to determine the spike recovery. Either method is acceptable provided a consistent approach is used for the test program. The average spike recovery for the pre- and post-run spikes shall be used to determine if spike recovery is between 70 and 130 percent.

10.0 Data Analysis and Emission Calculations

The average gas effluent concentration is determined from the average gas concentration displayed by the gas analyzer and is adjusted for the zero and upscale sampling system bias checks, as determined in accordance with section 9.2.3 of this method. The average gas concentration displayed by the analyzer may be determined by integration of the area under the curve for chart recorders, or by averaging all of the effluent measurements. Alternatively, the average may be calculated from measurements recorded at equally spaced intervals over the entire duration of the run. For sampling run durations of less than 1-hour, average measurements at 2-minute intervals or less, shall be used. For sampling run durations greater than 1-hour, measurements at 2-minute intervals or a minimum of 96 measurements, whichever is less restrictive, shall be used. Calculate the effluent gas concentration using equation 1.

$$C_{gas} = \frac{(m_i + m_f)\left[\frac{(C_{avg} - b_c)}{m_c}\right] + (b_i + b_f)}{2} \qquad \text{(Eq. 1)}$$

where:

b_c = Y-intercept of the calibration least-squares line.

b_f = Y-intercept of the final bias check 2-point line.

b_i = Y-intercept of the initial bias check 2-point line.

C_{gas} = Effluent gas concentration, as measured, ppm.

C_{avg} = Average gas concentration indicated by gas analyzer, as measured, ppm.

m_c = Slope of the calibration least-squares line.

m_f = Slope of the final bias check 2-point line.

m_i = Slope of the initial bias check 2-point line.

The following equations are used to determine the percent recovery (%R) for analyte spiking:

$$\%R = (S_M/C_E) \times 100 \qquad \text{(Eq. 2)}$$

where:

S_M = Mean concentration of duplicate analyte spiked samples (observed).

C_E = Expected concentration of analyte spiked samples (theoretical).

$$C_E = C_S(Q_S/Q_T) + S_U(1-Q_S/Q_T) \qquad \text{(Eq. 3)}$$

where:

C_S = Concentration of HCl spike gas (cylinder tag value).

Q_S = Spike gas flow rate.

Q_T = Total sample flow rate (effluent sample flow plus spike flow).

S_U = Native concentration of HCl in unspiked effluent samples.

Acceptable recoveries for analyte spiking are ±30 percent.

11.0 Pollution Prevention

Gas extracted from the source and analyzed or vented from the system manifold shall be either scrubbed, exhausted back into the stack, or discharged into the atmosphere where suitable dilution can occur to prevent harm to personnel health and welfare or plant or personal property.

12.0 Waste Management

Gas standards of HCl are handled as according to the instructions enclosed with the materials safety data sheets.

13.0 References

1. Peeler, J.W., Summary Letter Report to Ann Dougherty, Portland Cement Association, June 20, 1996.

2. Test Protocol, Determination of Hydrogen Chloride Emissions from Cement Kilns (Instrumental Analyzer Procedure) Revision 4; June 20, 1996.

3. Westlin, Peter R. and John W. Brown. Methods for Collecting and Analyzing Gas Cylinder Samples. Source Evaluation Society Newsletter. 3(3):5-15. September 1978.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

The United States Environmental Protection Agency (EPA) Emission Standards Division (ESD) is investigating the lime manufacturing industry to identify and quantify hazardous air pollutants (HAPs) emitted from lime kilns. ESD requested that EPA's Emissions, Monitoring and Analysis Division (EMAD) conduct the required testing. EMAD issued a work assignment to Pacific Environmental Services, Inc. (PES) to conduct a screening test to collect air emissions data as specified in the ESD test request. The primary objective of the testing program was to characterize HAP emissions from one lime kiln at the Dravo Lime Company's facility located in Saginaw, Alabama. Based on the pollutant concentrations and emission rates calculated from the results of the screening tests, the kiln may be selected by EPA for further testing.

The tests were conducted to quantify the uncontrolled and controlled air emissions of hydrogen chloride (HCl), total hydorcarbons (THC), and polychlorinated dibenzo-*p*-dioxins and polyclorinated dibenzofurans (PCDDs/PCDFs). Emissions from the kiln were controlled by a baghouse. Testing was conducted at the baghouse inlet and at the stack. Inlet and stack runs were conducted simultaneously. Oxygen (O_2) and carbon dioxide (CO_2) were also monitored at each location.

During the testing program another EPA contractor monitored and recorded process and emission control system operating parameters, and prepared Section 3.0 of this report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTIONS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COASTI Field/Group
Baghouse Dioxins/Furans Hazardous Air Pollutants Hydrogen Chloride Total Hydrocarbons		
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