

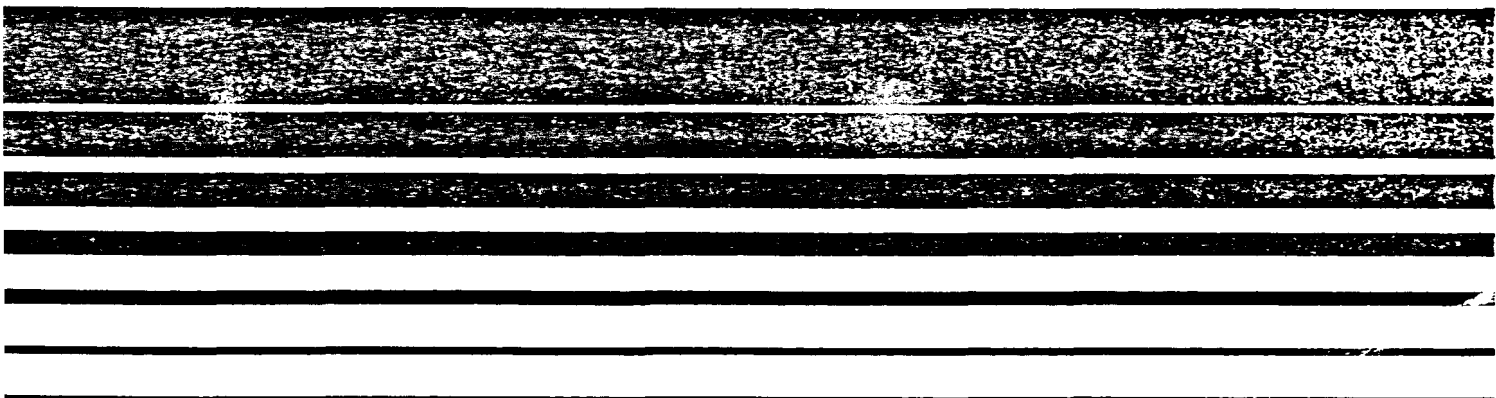
Air



Petroleum Refineries Waste Water Treatment Systems

Emission Test Report

**Phillips Petroleum
Company
Sweeny Refinery
Sweeny, Texas**



Contract No. 68-02-3545
Work Assignment 14
EMB Report No. 83 WWS 4

EPA Task Manager

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EMISSION TEST REPORT
PETROLEUM REFINERY WASTEWATER
TREATMENT SYSTEM
PHILLIPS PETROLEUM COMPANY
SWEENEY, TEXAS

Contractor

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March 1984

GLOSSARY OF TERMS

EMB - Emission Measurement Branch
EPA - Environmental Protection Agency
NSPS - New Source Performance Standard
Phillips - Phillips Petroleum Company
IAF - Induced Air Flotation
VOC - Volatile Organic Carbon
COD - Chemical Oxygen Demand
TOC - Total Organic Carbon
TCO - Total Chromatographic Organics
FID - Flame Ionization Detector
GC - Gas Chromatograph
MS - Mass Spectrometer
THC - Total Hydrocarbon
OVA - Organic Vapor Analyzer
TCD - Thermal Conductivity Detection
VOA - Void of Air
QA - Quality Assurance
QC - Quality Control
As C_3H_8 - Based on Propane Standard
ppm - Parts per million
scfm - Standard cubic feet per minute

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1. INTRODUCTION

Under Section 111 of the Clean Air Act, the Environmental Protection Agency is required to develop standards of performance for stationary sources that have been determined to contribute significantly to air pollution. EPA is conducting a study to develop standards that would limit volatile organic compound emissions from new wastewater treatment systems in petroleum refineries. Under contract to the Emission Measurement Branch, EPA, TRW Environmental Operations personnel conducted a testing program at the wastewater treatment system at Phillips Petroleum Company's Sweeny Refinery in Sweeny, Texas, during September 19-23, 1983.

The purpose of this test program was to provide estimates of the organic release rates from the induced air flotation (IAF) units. This information is necessary to estimate uncontrolled emission rates from uncovered flotation devices for potential emission reduction and cost effectiveness calculations.

The IAF system at the Sweeny Refinery consists of two parallel units. Each IAF is covered and is equipped with inspection doors. An air or inert purge is not used to ventilate the IAF head space. For test purposes, a ventilation air stream was purged through the head space of each unit, with the inspection doors being sealed as tightly as possible. The ventilation air stream was measured to estimate the organic release rate that would have occurred if the flotation device had been uncovered. This approach was used to estimate uncovered unit emissions because of the difficulty in measuring a dispersed-source fugitive emission. It is assumed that the dominant factors affecting organic emission rates are the water characteristics and the physical turbulence caused by bubbling air through the water, and that meteorological factors such as air temperature and wind speed are secondary parameters.

However, the results of these tests do not necessarily represent the emissions from the IAF units under normal operation when an air purge stream is not used and the inspection doors are closed.

Tests were conducted to determine the mass flow rate and the organic species composition of the added ventilation air from the two IAF units. During these measurements, samples of wastewater were collected from the IAF influents and effluents and from the CPI separator influents and effluents to characterize the liquid stream.

These samples were analyzed for chemical oxygen demand (COD), total organic carbon (TOC), total chromatographical organics (TCO), and oil and grease content using standard methods for water analysis.

The results of these tests are presented in Section 2. A description of the process and the operation during the test period is given in Section 3. The sampling locations and the sampling and analytical procedures are discussed in Sections 4 and 5, respectively. The appendices to this report contain example calculations, field data, test logs and a list of project participants.

2. SUMMARY AND DISCUSSION OF RESULTS

This section details the results of the testing and analysis at the Sweeny Refinery wastewater treatment units. The overall refinery waste water treatment system is illustrated in Figure 3-1 and the sampling locations are indicated in Figures 4-1 to 4-3. Table 2-1 presents a summary of the periods during which continuous hydrocarbon monitoring was performed at the indicated sample locations. Table 2-2 presents a summary of the periods during which integrated gas samples were collected, velocity or flow rate measurements were measured and when liquid samples were collected from each location. The results are discussed separately for the dual tank IAF water systems and the process water analyses.

2.1 IAF SYSTEM

A summary of the daily average total hydrocarbon mass flow rates in the dual IAF exhaust air is presented in Table 2-3. The total hydrocarbon measurement does not exclude methane. The hydrocarbon mass flow in the IAF ventilation air ranged from 0.36 lb/hr to 0.93 lb/hr for unit #1 and 0.34 lb/hr to 0.80 lbs/hr for unit #2 (24-hour average basis) over the five days of testing. The average mass flow was 0.56 lb/hr (24-hour basis) for the complete IAF system. The average mass flow for each IAF unit was 0.60 lb/hr and 0.52 lb/hr (24-hour basis) for unit #1 and #2, respectively. The test results on a one-hour average basis for each day of testing are presented in Tables 2-4 to 2-8 for unit #1 and in Tables 2-10 to 2-13 for unit #2. The average total hydrocarbon concentration based on equivalents of propane is presented for each one-hour period. Propane was chosen as the calibration species because it is a stable compound and calibration mixtures are easily acquired and stored. For the organic species expected at refineries, the response of

Table 2-1. SAMPLING LOG OF CONTINUOUS HYDROCARBON MONITORING:
SAMPLING LOCATIONS AT THE PHILLIPS PETROLEUM REFINERY - SWEENEY, TEXAS

Test day	Sample location	Time sampled	Duration sampled (hr)
9/19/83	IAF-Outlet #1	1700-2400	7
9/20/83	IAF-Outlet #1	0001-2400	24
9/20/83	IAF-Outlet #2	1700-2400	7
9/21/83	IAF-Outlet #1	0000-2400	24
9/21/83	IAF-Outlet #2	0000-1100	11
9/21/83	IAF-Outlet #2	1200-2400	12
9/22/83	IAF-Outlet #1	0000-2400	24
9/22/83	IAF-Outlet #2	0900-2400	15
9/23/83	IAF-Outlet #1	0000-1330	13

Table 2-2. DAILY TIME TABLE OF SAMPLING ACTIVITIES AT
PHILLIPS PETROLEUM REFINERY - SWEENEY, TEXAS

(Time) Location/Date		0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
IAF-OUTLET #1	9/19												
							(1700 - 2400)						
IAF-OUTLET #1	9/20												
					○		○			□	□		○
					○					○			○
										△—△	△—△		
IAF-INLET #1	9/20				○								
					○								
IAF-OUTLET #2	9/20												
					○		○			○		○	□
					○								
A'	9/20				○		○			○			○
					○								○
CPI(1)	9/20											○(1)	○

(1)CPI includes CPI inlet 1,2,3; CPI outlet 2,3.

Legend

(0000-0000) (Method 25A-TCH)
 □ (Velocity)
 ○ (Liquid Composite)
 ○ (Liquid VOA)
 △ (Method 18-Gas Bag)
 ⬢ (Grab Sample)

Table 2-2. Continued

(Time) Location/Date		0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
IAF-OUTLET #1	9/21	<hr/>											
		(0001 - 2400)											
IAF-INLET #1	9/21				□				□				
			○			○			○		○		
IAF-OUTLET #2	9/21	<hr/>											
		(UPSET) (1220 - 2400)											
A'	9/21				□				□				
			○		○			○			○		
CPI(1)	9/21		○										
			○										
CPI(1)	9/21				◇(1)						(1)		
					○						○		

(1) CPI includes CPI inlet 1,2,3; CPI outlet 1,2,3.

Legend

(0000-0000)	(Method 25A-TCH)
□	(Velocity)
○	(Liquid Composite)
○	(Liquid VOA)
△	(Method 18-Gas Bag)
◇	(Grab Sample)

Table 2-2. Continued

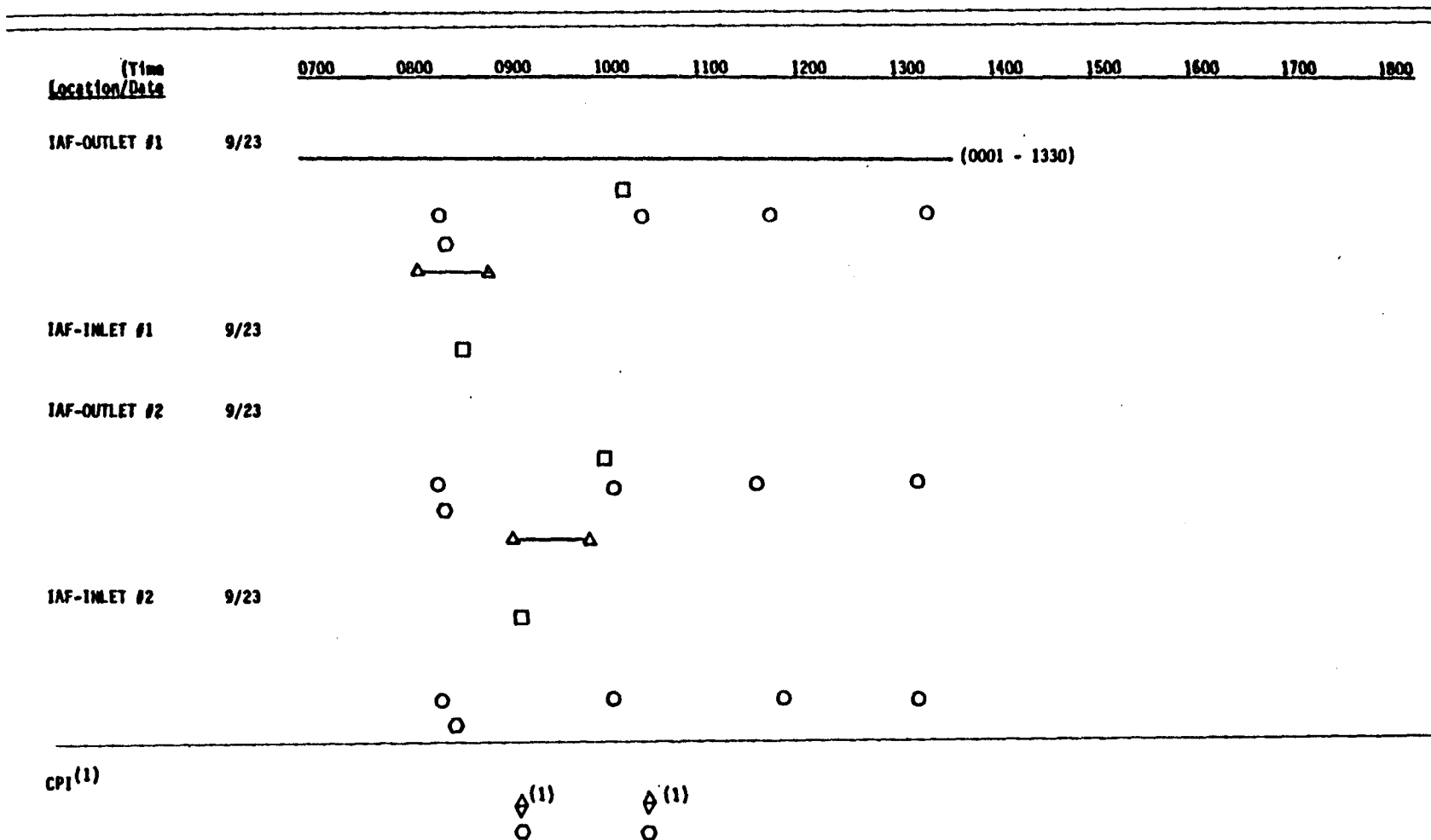
(Time) Location/Date		0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
IAF-OUTLET #1	9/22	(0001 - 2400)											
				○ ○ △—△		○			○		○ △—△	○	
IAF-INLET #1	9/22		□										
IAF-OUTLET #2	9/22	(0900 - 2400)											
				□ ○ ○ △—△		○			○ △—△		○ ○	○	
IAF-INLET #2	9/22			□									
CPI ⁽¹⁾				○ ○ ⊖ ⁽¹⁾ ○		○			○			○ ○	
											⊖ ⁽¹⁾ ○		

(1) CPI includes CPI inlet 1,2,3; CPI outlet 2,3.

Legend

(0000-0000) (Method 25A-TCH)
 □ (Velocity)
 ○ (Liquid Composite)
 ○ (Liquid VOA)
 △ (Method 18-Gas Bag)
 ⊖ (Grab Sample)

Table 2-2. Concluded



(1) CPI includes CPI inlet 1,2,3; CPI outlet 2,3.

Legend

(0000-0000) (Method 25A-TCH)
 □ (Velocity)
 ○ (Liquid Composite)
 ○ (Liquid VOA)
 △ (Method 18-Gas Bag)
 ◇ (Grab Sample)

Table 2-3. DAILY EMISSION RATE AVERAGES AT THE IAF OUTLET
SAMPLE LOCATION ON TEST DAYS 9/19/83 to 9/23/83
PHILLIPS PETROLEUM FACILITY - SWEENY, TEXAS

Test day	Average daily emission rate (lb/hr as C ₃ H ₈)	
	IAF #1	IAF #2
9/19/83	0.51	a
9/20/83	0.47	0.34
9/21/83	0.71	0.54
9/22/83	0.93	0.80
9/23/83	0.36	0.42

^aIAF #2 not on-line for monitoring on 9/19/83.

Table 2-4. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #1 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENY, TEXAS
TEST DAY 9/19/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
1700 ^b	1492	62.5	0.60
1800	1537	62.5	0.61
1900	1320	62.5	0.53
2000	1291	62.5	0.52
2100	1250	62.5	0.50
2200	1061	62.5	0.42
2300	1054	62.5	0.42
2400	1091	62.5	0.44
Average			0.51

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

^bBegin test period with Beckman 402 analyzer on-line at the IAF #1 (South) sample location.

Table 2-5. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #1 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENEY, TEXAS
TEST DAY 9/20/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1075	61.3	0.42
0200	1057	61.3	0.41
0300	1021	61.3	0.40
0400	1028	61.3	0.40
0500	1078	61.3	0.42
0600	1161	61.3	0.46
0700	1236	61.3	0.48
0800	1081	61.3	0.42
0900	905	61.3	0.35
1000	1040	61.3	0.41
1100	1199	61.3	0.47
1200	1262	61.3	0.50
1300	1138	61.3	0.45
1400	1313	61.3	0.52
1500	1834	61.3	0.72
1600	1577	61.3	0.62
1700	1201	61.3	0.47
1800	1182	61.3	0.46
1900	1142	61.3	0.45
2000	1142	61.3	0.45
2100	1176	61.3	0.46
2200	1299	61.3	0.51
2300	1178	61.3	0.46
2400	1297	61.3	0.51
Average			0.47

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

Table 2-6. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT
THE IAF #1 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENEY, TEXAS
TEST DAY 9/21/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1845	64.6	0.76
0200	1969	64.6	0.81
0300	2035	64.6	0.84
0400	2052	64.6	0.85
0500	1974	64.6	0.82
0600	1952	64.6	0.81
0700	1918	64.6	0.79
0800	1877	64.6	0.78
0900	1637	64.6	0.68
1000	1695	64.6	0.70
1100	1625	64.6	0.67
1200	1521	64.6	0.63
1300	1387	64.6	0.57
1400	1508	64.6	0.62
1500	1458	64.6	0.60
1600	1990	64.6	0.82
1700	2022	64.6	0.84
1800	1928	64.6	0.80
1900	1681	64.6	0.70
2000	1434	64.6	0.59
2100	1244	64.6	0.51
2200	1249	64.6	0.52
2300	1322	64.6	0.55
2400	1772	64.6	0.73
Average			0.71

^aConcentration is average value for continuous readings across the hour
(0-55 minutes) based on 5-minute readings.

Table 2-7. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT
THE IAF #1 OUTLET SAMPLE LOCATIONS - PHILLIPS PETROLEUM, SWEENY, TEXAS
TEST DAY 9/22/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1754	65.4	0.74
0200	2224	65.4	0.93
0300	2533	65.4	1.06
0400	2619	65.4	1.10
0500	2834	64.5	1.19
0600	3111	65.4	1.30
0700	3002	65.4	1.26
0800	2924	65.4	1.22
0900	3358	65.4	1.41
1000	2485	65.4	1.04
1100	2067	65.4	0.87
1200	2271	65.4	0.95
1300	2378	65.4	1.00
1400	2087	65.4	0.87
1500	2190	65.4	0.92
1600	2124	65.4	0.89
1700	1979	65.4	0.83
1800	1618	65.4	0.68
1900	1648	65.4	0.69
2000	1478	65.4	0.62
2100	1159	65.4	0.49
2200	1791	65.4	0.75
2300	2073	65.4	0.87
2400	1560	65.4	0.65
Average			0.93

^aConcentration is average value for continuous readings across the hour
(0-55 minutes) based on 5-minute readings.

Table 2-8. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #1 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENEY, TEXAS
TEST DAY 9/23/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1468	53.6	0.50
0200	1158	53.6	0.40
0300	1139	53.6	0.39
0400	913	53.6	0.31
0500	865	53.6	0.30
0600	677	53.6	0.23
0700	996	53.6	0.34
0800	1025	53.6	0.35
0900	1199	53.6	0.41
1000	1053	53.6	0.36
1100 ^b	2118	26.9	0.36
1200 ^c	2613	26.9	0.45
1300 ^d	3090	2.4	0.05
e			
Average			0.36
(Reduced Rate)			0.40
(No Flow Induced)			0.05

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

^bAir flow through IAF reduced 50%.

^cSampling with 30 min. 50% and 30 min. no flow through IAF system.

^dNo induced air flow through IAF system.

^eEnd of test period at IAF #1 (South) sample location.

Table 2-9. FLOW MONITORING RESULTS: IAF #1 FLOW MEASUREMENTS AT THE
INLET AND OUTLET GASEOUS SAMPLE LOCATIONS - PHILLIPS PETROLEUM, SWEENEY, TEXAS

Sample location	Date	Time	Temperature (°F)	Actual volumetric flowrate (ACFM)	Standard volumetric flowrate (SCFM)
Inlet	9/19/83	—	—	—	62.5 ^a
	9/20/83	1540-1613	94	64.5	61.3
	9/21/83	1003-1033	60	58.2	60.3
	9/21/83	1425-1455	70	67.9	69.0
	9/22/83	858- 938	65	77.4	79.4
	9/22/83	1637-1657	75	51.1	51.4
	9/23/83	854- 916	68	52.5	53.6
Inlet	9/23/83	1056-1236 ^b	76	26.8	26.9
Outlet	9/20/83	1136-1236	99	18.4	17.4
	9/20/83	1436-1451	101	16.1	15.1
	9/21/83	1127-1142	85	28.5	28.2
	9/21/83	1550-1610	92	27.8	27.1
	9/22/83	1100-1115	102	31.0	29.7
	9/22/83	1521-1536	110	29.4	27.8
	9/23/82	1000-1015	103	33.5	32.1
Outlet ^c	9/23/83	1242-1328	120	2.6	2.4

^aFlow not measured on initial test day (9/19/83), therefore, used average of remaining test days.

^bMonitoring reduced flow (50%) through IAF; not included in 9/19/83 flow average.

^cMonitoring no flow condition through IAF.

Table 2-10. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #2 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENEY, TEXAS
TEST DAY 9/20/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
1700 ^b	1154	48.4	0.36
1800	1025	48.4	0.32
1900	1074	48.4	0.33
2000	1118	48.4	0.35
2100	1135	48.4	0.35
2200	1197	48.4	0.37
2300	1042	48.4	0.32
2400	1152	48.4	0.36
Average			0.34

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

^bBegin test period with Beckman 400 analyzer on-line at the IAF #2 (North) sample location.

Table 2-11. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #2 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENY, TEXAS
TEST DAY 9/21/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1448	49.6	0.46
0200	1356	49.6	0.43
0300	1525	49.6	0.48
0400	1525	49.6	0.48
0500	1571	49.6	0.50
0600	1546	49.6	0.49
0700	1634	49.6	0.52
0800	1559	49.6	0.49
0900	1739	49.6	0.55
1000	1834	49.6	0.58
1100 ^b	—	—	—
1200	1420	49.6	0.45
1300	1610	49.6	0.51
1400 ^b	—	—	—
1500	2319	49.6	0.74
1600	2692	49.6	0.85
1700	2642	49.6	0.84
1800	1917	49.6	0.61
1900	1696	49.6	0.54
2000	1643	49.6	0.52
2100	1449	49.6	0.46
2200	1387	49.6	0.44
2300	1359	49.6	0.43
2400	1794	49.6	0.57
Average			0.54

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

^bContinuous analyzer (Beckman 400) flamed out and recalibration required; therefore, sample off-line.

Table 2-12. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #2 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENY, TEXAS
TEST DAY 9/22/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	2015	50.8	0.66
0200	2348	50.8	0.76
0300	2744	50.8	0.89
0400	3121	50.8	1.02
0500	3549	50.8	1.15
0600	3760	50.8	1.22
0700	3805	50.8	1.24
0800	3595	50.8	1.17
0900	3240	50.8	1.05
1000	3428	50.8	1.11
1100	2960	50.8	0.96
1200	2716	50.8	0.88
1300	2981	50.8	0.97
1400	2694	50.8	0.88
1500	2892	50.8	0.94
1600	2777	50.8	0.90
1700	1937	50.8	0.63
1800	1373	50.8	0.45
1900	1173	50.8	0.38
2000	993	50.8	0.32
2100	1011	50.8	0.33
2200	1483	50.8	0.48
2300	1443	50.8	0.47
2400	1300	50.8	0.42
Average			0.80

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

Table 2-13. CONTINUOUS EMISSION RESULTS: HYDROCARBON MONITORING AT THE IAF #2 OUTLET SAMPLE LOCATION - PHILLIPS PETROLEUM, SWEENY, TEXAS
TEST DAY 9/23/83

Time	Concentration ^a (ppm as C ₃ H ₈)	Flow (SCFM)	Emission rate (lbs/hr as C ₃ H ₈)
0100	1274	63.0	0.51
0200	1106	63.0	0.45
0300	1055	63.0	0.43
0400	957	63.0	0.42
0500	1054	63.0	0.42
0600	674	63.0	0.27
0700	837	63.0	0.34
0800	948	63.0	0.38
0900	1250	63.0	0.50
1000	1278	63.0	0.52
1100 ^b	2576	26.9	0.44
1200 ^c	2651	26.9	0.46
1300 ^d	2934	2.4 ^e	0.04
Average			0.42
		(Reduced Rate)	0.45
		(No Induced Flow)	0.04

^aConcentration is average value for continuous readings across the hour (0-55 minutes) based on 5-minute readings.

^bAir flow through IAF system reduced 50%.

^cSampling with 30 min. 50% and 30 min. no flow through IAF system.

^dNo air flow through IAF system.

^eEnd of test period at IAF #2 (North) sample location.

the carbon content. While the concentration results are on a propane basis and are not equal to the true hydrocarbon concentration, the calculated mass flow rates are equivalent to true hydrocarbon mass flow rates. The average volumetric flow rate result that was used for calculation of the mass flow is also given for each day of monitoring. A single value is used for each day because the ventilation blowers operated at constant speed and no changes were made to the ventilation configuration. The average volumetric flow rate results are presented in Table 2-9 for unit #1 and Table 2-14 for unit #2.

The integrity of the closed system across the IAF units was checked by measuring inlet and outlet flow rates. Problems with sealing the units were evident and the difference in the flow rate measurement was filtration lost in the system. Monitored rates across the test day determined that 65-85 percent of the inlet flow exited the system via the fabricated outlet duct.

The results of the analysis of integrated gas samples of the IAF unit #1 and unit #2 exhaust air are presented in Tables 2-15 and 2-16. The species analyses were obtained using two field gas chromatographic systems and were intended to generally identify the major components and their approximate concentrations. Calibrations standards were available for C1 to C5, benzene and m-xylene, so the results for these compounds can be calculated directly. Hexane, heptane, and p-xylene are calculated as equivalents of the nearest carbon number calibration species. Other peaks were also grouped with the closest eluting calibration species for computation. Since a benzene standard was used to establish a specific retention time for that compound, it can be concluded that the peak occurring at that time was benzene. However, these are some compounds found at refineries that tend to elute near benzene (such as methylcyclopentane and cyclohexane) and would be indistinguishable with the analytical systems employed. However, since clear identification of toluene and xylene was present, it is probable that at least part of the concentrations attributed to benzene was actually benzene. Additional descriptions of the chromatographic techniques are given in Section 5.

On 8/19/83, a test was performed to observe the off-gasing effect caused by the purge air across the system. The first check was decreasing the flow rate by one-half. The result was essentially as expected, the

Table 2-14. FLOW MONITORING RESULTS: IAF #2 FLOW MEASUREMENTS AT THE INLET AND OUTLET
GASEOUS SAMPLE LOCATIONS - PHILLIPS PETROLEUM, SWEENEY, TEXAS

Sample location	Date	Time	Temperature (°F)	Actual volumetric flowrate (ACFM)	Standard volumetric flowrate (SCFM)
Inlet	9/20/83	1813-1843	78	49.5	48.4
	9/21/83	830- 905	58	47.5	49.3
	9/21/83	1507-1537	71	49.3	49.9
	9/22/83	948-1028	68	54.1	55.2
	9/22/83	1611-1631	77	46.4	46.5
	9/23/83	934- 954	72	62.2	63.0
<hr/>					
Outlet	9/21/83	1355-1410	88	21.0	20.7
	9/21/83	1620-1635	89	21.7	21.3
	9/22/83	1122-1137	98	21.0	20.2
	9/22/83	1543-1558	102	22.9	21.9
	9/23/83	1020-1035	102	24.2	23.2

Table 2-15. GAS CHROMATOGRAPH RESULTS FROM THE SAMPLE LOCATION
AT IAF #1 (PHILLIPS SOUTH UNIT) PHILLIPS PETROLEUM, SWEENEY, TEXAS

DATE	9/20/83	9/20/83	9/21/83	9/21/83
TIME	1500	1645	1100	1430
RUN NO.	1	2	3	4
ANALYTICAL RESULTS (ppmv as compound)				
C-1	87.2	57.7	65.1	57.5
C-2	4.9	—	4.3	6.0
C-3	6.7	4.2	3.9	4.7
C-4	18.4	11.7	15.2	1.1
C-5	20.4	17.6	20.3	3.9
Hexane	145.3	85.9	110.0	63.6
Benzene	161.1	99.0	135.2	95.1
Heptane	25.9	16.8	37.0	21.1
Toluene	139.4	95.2	94.1	67.0
m-Xylene	45.4	34.2	33.3	21.1
o-Xylene	20.7	12.4	10.3	8.5
TOTAL HYDROCARBON ^a (ppmv as compound)	675.4	434.7	528.7	349.6
CONTINUOUS MONITOR DATA				
Hydrocarbon Level (ppmv as C ₃ H ₈)	1834	1577	1625	1508
Emission Rate (lb/hr)	0.72	0.62	0.67	0.62

(continued)

Table 2-15. Concluded

DATE	9/22/83	9/22/83	9/23/83
TIME	0930	1430	0915
RUN NO.	5	6	7
ANALYTICAL RESULTS (ppmv as compound)			
C-1	218.2	197.5	115.7
C-2	6.2	5.7	4.0
C-3	5.6	6.0	2.7
C-4	21.2	15.5	4.6
C-5	52.4	16.2	10.5
Hexane	352.2	213.5	41.3
Benzene	353.4	201.1	60.9
Heptane	—	78.7	20.2
Toluene	217.4	140.2	53.7
m-Xylene	118.4	62.4	26.2
o-Xylene	43.2	18.9	10.0
TOTAL HYDROCARBON (ppmv as compound)	1388.2	955.7	349.8
CONTINUOUS MONITOR DATA			
Hydrocarbon Level (ppmv as C ₃ H ₈)	3358	2087	1199
Emission Rate (lb/hr)	1.41	0.87	0.41

^aTotal includes unidentified hydrocarbon responsive to GC/FID.

Table 2-16. GAS CHROMATOGRAPH RESULTS FROM THE SAMPLE LOCATION
AT IAF #2 (PHILLIPS NORTH UNIT) PHILLIPS PETROLEUM, SWEENY, TEXAS

DATE	9/21/83	9/21/83	9/22/83	9/22/83	9/23/83
TIME	0930	1545	1050	1550	1015
RUN NO.	3 ^a	4	5	6	7
ANALYTICAL RESULTS (ppmv as compound)					
C-1	58.7	78.6	226.2	167.2	93.0
C-2	4.2	7.5	7.3	3.8	3.4
C-3	4.4	5.9	5.6	3.6	2.2
C-4	17.5	22.6	21.5	8.6	3.5
C-5	21.5	10.5	59.5	7.7	8.9
Hexane	128.5	133.7	292.5	109.7	33.1
Benzene	134.3	171.8	287.0	122.4	53.4
Heptane	35.9	46.6	113.1	50.2	20.3
Toluene	84.0	116.5	178.2	96.5	52.2
m-Xylene	26.1	43.9	73.9	46.9	26.1
o-Xylene	8.1	13.6	20.0	14.5	8.5
TOTAL HYDROCARBON ^b (ppmv as compound)	523.2	651.2	1284.8	631.1	251.2
CONTINUOUS MONITOR DATA					
Hydrocarbon Level (ppmv as C ₃ H ₈)	1739	2319	3428	2892	1278
Emission Rate (lb/hr)	0.55	0.74	1.11	0.94	0.52

^aIAF #2 not monitored on 9/20/83 during Run No. 1 and Run No. 2.

^bTotal includes unidentified hydrocarbon responsive to GC/FID.

concentrations in the exhaust air doubled. Unit #1 concentration changed from 1,000 ppm to 2,100 ppm and unit #2 concentration changed from 1,200 ppm to 2,500 ppm. The second check was a no flow situation with the inlet blower system off. The no flow situation was monitored for one hour. The results were identical in both units. The concentration dropped to 1,000 ppm; but increased to 3,000 ppm as the headspace concentration in the IAF units forced the mass concentration through the outlet exhaust vent.

The general results of the species analysis are relatively consistent. The major components were methane and C6 to C8 components. The results of these analyses can be used to calculate a non-methane hydrocarbon emission rate, but these calculations were not performed for this report.

2.2 PROCESS WATER ANALYSES

Tables 2-17 through 2-21 provide the process water analysis for the composite and grab samples taken during the hydrocarbon (air) monitoring.

Designated samples (item, location) were analyzed for the following parameters:

- TOC (total organic carbon);
- COD (chemical oxygen demand);
- oil and grease; and
- TCO (total chromatographable organics/hydrocarbon speciation (C₇-C₃₀) and VOA by purge and trap GC/FID.

All analytical parameters are reported in milligrams per liter (ppmw), except purge and trap values which are given in parts per billion (ppbw).

The most critical factors in the measurement of the process water parameters were the collection of representative samples at the site location and obtaining a representative aliquot for analysis in the laboratory. In most cases the samples involved two-phase oil/water mixtures which contributed to the non-homogeneity of the samples and to the variation in the sample values.

The sampling points at Phillips were dictated by the physical layout and available sample locations. The samples were collected from streams at elevated temperatures, stored on ice, and shipped to the TRW laboratory. Sample preservatives were not utilized in preference to

TABLE 2-17. LIQUID ANALYSES FOR PROCESS SAMPLES ON TEST DAY 9/20/83
PHILLIPS PETROLEUM - SWEENEY, TEXAS

	TRW No.	COD mg/l	Oil/grease mg/l	TOC mg/l
<u>Liquid Composite and Grab Samples</u>				
IAF #2-out-D	5404	539.3	40.6	
IAF #1-out-C	5405	628.4	150.1	
IAF-inlet-A'	5406-A'	4221.8	3059.5	
CPI-3-in (1700)	5407	2061.4	1065.1	
CPI-2-out (1700)	5408	681.2	69.6	
CPI-2-out (1700)	5410	2267.1	121.0	
CPI-3-in (1700)	5412	2810.7	339.9	
<u>Void of Air Samples</u>				
CPI-2-out (1813)	5366			502.5
IAF #2-out-C (1830)	5367			308.5
CPI-3-in (1700)	5368			205
IAF-in-A (1830)	5369			478.5
IAF #2-out-C (1030)	5370			107
CPI-2-in (1700)	5371			664.5
IAF-in-A (1030)	5372			358
CPI-1-in (1700)	5373			478.5
CPI-3-out (1700)	5374			204
IAF #2-out-D (1830)	5375			138
IAF #1-out-C (1030)	5376			229.5

TABLE 2-18. LIQUID ANALYSES FOR PROCESS SAMPLES ON TEST DAY 9/21/83
PHILLIPS PETROLEUM - SWEENEY, TEXAS

	TRW No.	COD mg/l	Oil/grease mg/l	TOC mg/l
<u>Liquid Composite and Grab Samples</u>				
CPI-3-out (0930)	5409	1991.0	269.6	
CPI-2-in (0945)	5411	2149.1	267.4	
CPI-1-in (0945)	5413	2697.8	687.7	
IAF-in-A'	5414	1476.6	126.0	
IAF #2-out-D	5415	2300.7	34.2	
IAF #1-out-C	5416	1369.5	58.0	
CPI-2-inlet (0945)	5417	1042.7	40.5	
CPI-1-out (0930)	5418	2114.8	168.3	
CPI-3-out (0930)	5419	2395.0	209.4	
<u>Void of Air Samples</u>				
CPI-1-in (1600)	5353			310
CPI-3-in (1600)	5354			259
CPI-2-in (1600)	5355			250
CPI-2-out (1600)	5357			157.5
CPI-3-out (1600)	5358			198
CPI-1-out (1600)	5359			549
CPI-2-inlet (0945)	5361			36
IAF #2-out-D (1445)	5365			218.5
IAF #1-out-C (0855)	5377			129.5
CPI-1-inlet (0945)	5378			155.5
IAF-in-A (0855)	5379			237
IAF #2-out-D (0855)	5380			226.5
CPI-2-outlet (0930)	5381			223.5
CPI-3-outlet (0930)	5382			194.5
CPI-3-inlet (0945)	5383			451.5
IAF #1-out-C (1445)	5384			242
IAF-in-A' (1445)	5385			278
CPI-1-outlet (0930)	5386			262.5

TABLE 2-19. LIQUID ANALYSES FOR PROCESS SAMPLES ON TEST DAY 9/22/83
PHILLIPS PETROLEUM - SWEENEY, TEXAS

	TRW No.	COD mg/l	Oil/grease mg/l	TOC mg/l
<u>Liquid Composite and Grab Samples</u>				
CPI #3-outlet (0930)	5420	3000.5	232.5	
IAF-in-A'	5421	2941.7	262.8	
IAF-#1-out-C	5422	1312.9	152.3	
CPI-#1-inlet (0940)	5423	1811.2	32.1	
CPI-#1-outlet (0930)	5424	3400.2	705.3	
CPI-#3-inlet (0940)	5425	2290.5	31.7	
CPI-#2-inlet (0940)	5426	2065.1	34.8	
CPI-#2-outlet (0940)	5427	5045.2	4293.6	
IAF-#2-out-D	5428	1140.3	74.4	
<u>Void of Air Samples</u>				
CPI-#3-outlet (0920)	5348			192.5
IAF-#2-out-D (0920)	5349			410
CPI-#2-outlet (1600)	5350			80
CPI-#2-inlet (1600)	5351			199.5
CPI-#2-inlet (0930)	5352			302.5
IAF-#1-out-C (0920)	5356			366
IAF-#1-out-C (1600)	5360			688.5
IAF-in-A' (0920)	5362			531.5
CPI-#1-outlet (0920)	5363			146.5
CPI-#2-outlet (0920)	5364			194.5
CPI-#1-inlet (1600)	5387			166
IAF-in-A' (1600)	5388			274
CPI-#3-outlet (1600)	5389			242.5
IAF-#2-out-D (1600)	5390			335
CPI-#1-outlet (1600)	5391			396
CPI-#3-inlet (1600)	5392			210.5
CPI-#1-inlet (0930)	5393			297
CPI-#3-inlet (0930)	5394			208

TABLE 2-20. LIQUID ANALYSES FOR PROCESS SAMPLES ON TEST DAY 9/23/83
PHILLIPS PETROLEUM - SWEENEY, TEXAS

	TRW No.	COD mg/l	Oil/grease mg/l	TOC mg/l
<u>Liquid Composite and Grab Samples</u>				
CPI-#3-outlet (1000)	5429	1503.3	469.4	
IAF-in-A'	5430	160.9	250.0	
CPI-#1-inlet (0930)	5431	1604.4	107.4	
CPI-#2-inlet (0930)	5432	29194	10617	
CPI-#3-outlet (1000)	5433	1352.2	90.0	
CPI-#3-inlet (0930)	5434	1135.2	48.3	
CPI-#1-outlet (1000)	5435	2230.3	405.6	
CPI-#2-outlet (0930)	5436	2354.4	336.2	
IAF-#2-out-D	5437	1927.6	21.2	
IAF-#1-out-C	5438	1910.7	26.6	
<u>Void of Air Samples</u>				
CPI-#3-in (1000)	5395			204.5
CPI-#1-outlet (1000)	5396			105
IAF-in-A' (0900)	5397			224.5
CPI-#2-outlet (1000)	5398			444.5
IAF-#2-out-D (0900)	5399			248
IAF-#1-out-C (0900)	5400			225.5
CPI-#3-outlet (1000)	5401			251
CPI-#1-in (1000)	5402			107
CPI-#2-in (1000)	5403			153.5

Table 2-21. C₁ TO C₇ SPECIATION BY GC/FID PURGE AND TRAP
PHILLIPS PETROLEUM, SWEENEY, TEXAS

TRW no.	Sample no.	Date taken	Run	Compound	Concentration (in ppb)
5372	Phillips-A'-VOA-1030	9/20/83	1	C ₆ H ₆	2100
				C ₆ H ₅ CH ₃	2160
			2	C ₆ H ₆	2040
				C ₆ H ₅ CH ₃	2010
5369	Phillips-A'-VOA-1830	9/20/83	1	C ₆ H ₆	2470
				C ₆ H ₅ CH ₃	2700
			2	C ₆ H ₆	2280
				C ₆ H ₅ CH ₃	2410
5370	Phillips-C-VOA-1030	9/20/83	1	C ₆ H ₆	535
				C ₆ H ₅ CH ₃	545
			2	C ₆ H ₆	522
				C ₆ H ₅ CH ₃	495
5367	Phillips-C-VOA-1830	9/20/83	1	C ₆ H ₆	1940
				C ₆ H ₅ CH ₃	2270
			2	C ₆ H ₆	1790
				C ₆ H ₅ CH ₃	2110
5375	Phillips-D-VOA-1830	9/20/83	1	C ₆ H ₆	1850
				C ₆ H ₅ CH ₃	2190
			2	C ₆ H ₆	1740
				C ₆ H ₅ CH ₃	2020
5368	Phillips-CPI #3-IN-VOA-1700	9/20/83	1	C ₆ H ₆	1080
				C ₆ H ₅ CH ₃	1970
			2	C ₆ H ₆	1130
				C ₆ H ₅ CH ₃	2480

(continued)

Table 2-21. Continued

TRW no.	Sample no.	Date taken	Run	Compound	Concentration (in ppb)
5379	Phillips-VOA-IAFA'-0855	9/21/83	1	C ₆ H ₆	2270
				C ₆ H ₅ CH ₃	3020
			2	C ₆ H ₆	2080
				C ₆ H ₅ CH ₃	2600
			3	C ₆ H ₆	1770
				C ₆ H ₅ CH ₃	2350
5377	Phillips-VOA-IAF-C-0855	9/21/83	1	C ₆ H ₆	1910
				C ₆ H ₅ CH ₃	2500
			2	C ₆ H ₆	1890
				C ₆ H ₅ CH ₃	2460
5384	Phillips-VOA-IAF-C-1445	9/21/83	1	C ₆ H ₆	2090
				C ₆ H ₅ CH ₃	2500
			2	C ₆ H ₆	1870
				C ₆ H ₅ CH ₃	2350
5381	Phillips-VOA-CPI #2-OUTLET	9/21/83	1	C ₆ H ₆	7060
				C ₆ H ₅ CH ₃	7950
			2	C ₆ H ₆	5442
				C ₆ H ₅ CH ₃	6240
			3	C ₆ H ₆	5060
				C ₆ H ₅ CH ₃	5890
			4	C ₆ H ₆	4390
				C ₆ H ₅ CH ₃	4890
5382	Phillips-VOA-CPI #3-OUTLET	9/21/83	1	C ₆ H ₆	794
				C ₆ H ₅ CH ₃	1530
			2	C ₆ H ₆	697
				C ₆ H ₅ CH ₃	1370

(continued)

Table 2-21. Concluded

TRW no.	Sample no.	Date taken	Run	Compound	Concentration (in ppb)
2-30	5360	Phillips-C-VOA-1600	9/22/83	1	C ₆ H ₆ 1450
					C ₆ H ₅ CH ₃ 2090
			2		C ₆ H ₆ 1380
					C ₆ H ₅ CH ₃ 2030
	5363	Phillips-CPI #1-VOA-OUT-0920	9/22/83	1	C ₆ H ₆ 1760
					C ₆ H ₅ CH ₃ 1920
			2		C ₆ H ₆ 1390
					C ₆ H ₅ CH ₃ 1370
	5392	Phillips-CPI #3-INLET-VOA-1600	9/22/83	1	C ₆ H ₆ 447
					C ₆ H ₅ CH ₃ 1170
			2		C ₆ H ₆ 334
					C ₆ H ₅ CH ₃ 764
	5389	Phillips-CPI #3-OUTLET-VOA-1600	9/22/83	1	C ₆ H ₆ 537
					C ₆ H ₅ CH ₃ 884
			2		C ₆ H ₆ 488
					C ₆ H ₅ CH ₃ 840
	5399	Phillips-D-VOA-0900	9/23/83	1	C ₆ H ₆ 636
					C ₆ H ₅ CH ₃ 943
			2		C ₆ H ₆ 601
					C ₆ H ₅ CH ₃ 942
	5396	Phillips-CPI #1-OUT-VOA-1000	9/23/83	1	C ₆ H ₆ 2170
					C ₆ H ₅ CH ₃ 2340
			2		C ₆ H ₆ 2120
					C ₆ H ₅ CH ₃ 2290

immediate analysis (24-48 hours) due to the expected elevated levels of hydrocarbons in the streams. Upon arrival at the laboratory, all samples were homogenized prior to analysis. However, the two-phased system and the cooling of the sampling affected the homogeneity of the samples. All samples were brought to room temperature and shaken vigorously before samples were removed. In addition, due to the high levels of the parameters being measured, the size of the sample aliquots were small which also contributed to the variability from sample to sample.

Process water samples for test day 9/22/83 were used for an analysis on the integrity check on sampling methods. Table 2-22 provides the results comparing liquid VOA and composite sample. Table 2-23 provides the results comparing liquid VOA and grab samples.

Table 2-22. GAS CHROMATOGRAPH RESULTS FROM LIQUID VOA AND
COMPOSITE SAMPLES AT IAF SAMPLE LOCATIONS - 9/22/83
PHILLIPS PETROLEUM - SWEENEY, TEXAS

SAMPLE LOCATION:	IAF IN-A'	IAF IN-A'	IAF#1 OUT-C	IAF#1 OUT-C	IAF#2 OUT-D	IAF#2 OUT-D
TYPE SAMPLE:	Composite	VOA	Composite	VOA	Composite	VOA
TIME:		0920		0920		0920
<u>Purge & Trap Analysis (mg/l)</u>						
Benzene ^a	0.80	1.81	1.22	1.58	1.19	1.52
Toluene ^a	1.44	2.62	1.70	2.53	1.91	2.21
<u>Extraction Analysis (mg/l)</u>						
Benzene	0.85	- ^b	<0.50	- ^b	<0.50	- ^b
Toluene	0.72	-	0.77	-	0.66	-
C-9	22.27	-	40.96	-	44.14	-
C-10	5.38	-	8.54	-	9.02	-
C-10	10.30	-	18.07	-	19.16	-
C-11	1.24	-	1.66	-	1.72	-
C-12	0.98	-	0.86	-	<0.50	-
C-13	<0.50	-	<0.50	-	<0.50	-
C-14	<0.50	-	<0.50	-	<0.50	-
C-15	<0.50	-	<0.50	-	<0.50	-
C-16	<0.50	-	<0.50	-	<0.50	-
C-17	1.48	-	1.22	-	<0.50	-
C-18	4.02	-	3.20	-	1.64	-
C-19	6.10	-	4.71	-	2.25	-
<u>TOC^c</u>						
	1017	-	678	-	427	-
	954	-	737	-	419	-

^a Purge and trap results for benzene and toluene are preferred over the extraction results, because of the potential for losing benzene and toluene during the extraction and concentration steps associated with the extraction method.

^b Extraction analysis performed on composite and grab samples only.

^c Duplicate analysis performed.

Table 2-23. GAS CHROMATOGRAPH RESULTS FROM LIQUID VOA AND GRAB SAMPLES
AT CPI SAMPLE LOCATIONS - 9/22/83, PHILLIPS PETROLEUM - SWEENEY, TEXAS

SAMPLE LOCATION:	CPI#1 OUT	CPI#1 OUT	CPI#2 OUT	CPI#2 OUT	CPI#3 OUT	CPI#3 OUT	CPI#1 IN	CPI#1 IN	CPI#2 IN	CPI#2 IN	CPI#3 IN
TYPE SAMPLE:	GRAB	VOA	GRAB	VOA	GRAB	VOA	GRAB	VOA	GRAB	VOA	GRAB
TIME:	0930	0920	0930	0920	0930	0920	0940	0930	0940	0930	0940
<u>Purge & Trap</u>											
<u>Analysis (mg/l)</u>											
Benzene ^a	2.480	1.580	0.008	8.920	1.270	0.863	0.284	0.891	0.423	0.199	0.522
Toluene ^a	2.920	1.650	0.070	8.350	0.114	1.170	1.850	1.470	0.091	0.044	0.146
<u>Extraction</u>											
<u>Analysis (mg/l)</u>											
Benzene	0.75	- ^b	0.75	- ^b	0.56	- ^b	<0.50	- ^b	1.62	- ^b	2.77
Toluene	1.68	-	1.20	-	0.70	-	<0.40	-	<0.40	-	<0.40
C-8	<0.50	-	<0.50	-	0.46	-	<0.50	-	<0.50	-	<0.50
C-9	-	-	-	-	-	-	<0.50	-	<0.50	-	<0.50
C-10	-	-	<0.50	-	<0.50	-	<0.50	-	<0.50	-	<0.50
C-11	-	-	-	-	<0.50	-	<0.50	-	<0.60	-	<0.50
C-12	<0.50	-	-	-	0.65	-	<0.50	-	<0.50	-	<0.50
C-13	<0.50	-	<0.50	-	2.26	-	<0.50	-	<0.50	-	<0.50
C-14	<0.50	-	<0.50	-	0.67	-	<0.50	-	<0.50	-	<0.50
C-15	<0.50	-	<0.50	-	0.59	-	<0.50	-	<0.50	-	<0.50
C-16	<0.50	-	<0.50	-	<0.50	-	<0.50	-	<0.50	-	<0.50
C-17	1.44	-	1.11	-	2.13	-	<0.50	-	<0.50	-	<0.50
C-18	4.12	-	3.20	-	4.00	-	<0.50	-	<0.50	-	<0.50
C-19	5.60	-	4.40	-	5.51	-	<0.50	-	<0.50	-	<0.50
<u>TOC^c</u>											
	871	-	179	-	1116	-	773	-	912	-	1005
	961	-	195	-	1007	-	788	-	802	-	902

^a Purge and trap results for benzene and toluene are preferred over the extraction results, because of the potential for losing benzene and toluene during the extraction and concentration steps associated with the extraction method.

^b Extraction analysis performed on composite and grab samples only.

^c Duplicate analysis performed.

3. PROCESS DESCRIPTION

3.1 PLANT DESCRIPTION

The Phillips refinery in Sweeny has a crude throughput capacity of 175,000 barrels per calendar day (b/cd). The Effluent Guidelines Division of the Environmental Protection Agency (EPA) places Phillips in refinery subcategory C which includes refineries producing petroleum products by the use of topping, cracking, and petrochemical operation. Phillips has recently added new process units which enable the refinery to process sour, heavier crudes. These new process units include an atmospheric crude distillation unit, a distillate hydrodesulfurization unit, an atmospheric residuum desulfurization (ARDS) unit, a heavy oil cracking unit, and sulfur recovery facilities. Additional wastewater treatment facilities were added to handle wastewater produced by these new units. The induced air flotation systems tested at Sweeny were part of the new wastewater treatment facilities.

The charge rates for the units listed above are given in Table 3-1. These charge rates are for the days on which emissions testing was conducted. Design charge rates for each unit are also provided in the table.

3.2 REFINERY WASTEWATER SYSTEM

The refinery wastewater system at Phillips consists of two separate oil separation facilities. Wastewater generated in the older sections of the refinery is first treated by dual API separators which are followed by air flotation systems. The air flotation systems are converted API separators which have been equipped with air diffusers. Wastewater generated by the new process units is treated in three corrugated plate interceptor (CPI) type separators which are followed by two IAF systems. Effluent from the old and new wastewater systems is then combined before

Table 3-1. UNIT CHARGE RATES DURING TEST PERIOD

Process unit (unit #1)	Unit charge (barrels/day unless noted)					Design rate
	9-19	9-20	9-21	9-22	9-23	
Crude (25.1)	105,600	105,600	105,600	116,700		130,000
Hydrodesulfurization (25.2)	28,800	28,000	28,000	31,495		50,000
Atmos. residuum desulfurization (26.1)	Down	Down	Down	50,610	72,000	75,000
H ₂ purification (26.2)	105 MMCFD ^a	104.6 MMCFD	110 MMCFD	122 MMCFD		192 MMCFD
Heavy oil cracking (27.1)	43,200	43,200	43,200	47,688		50,000
Wet gas (27.2)	22,200	22,000	22,320	23,592		27,500
Sulfur (28.2)	201 LT/D ^b	63 LT/D	71 LT/D	190 LT/D		35 LT/D

^aMMCFD - million cubic feet per day.^bLT/D - long ton per day.

being further treated by biological processes. The wastewater treatment system serving the new process units will be described in further detail below.

3.2.1 New Wastewater Treatment Facilities

Wastewater in each of the new process units is collected in a process drain system. Water from the unit drains flows to a separate junction box associated with individual process units. Wastewater is pumped from the junction boxes to the CPI separators.

As shown in Figure 3-1, wastewater from each unit is designated to one CPI. However, the CPI's are interconnected allowing the flow to equalize between the three units. The CPI's were manufactured by Pielkenroad of Houston, Texas and are completely closed tanks. Each CPI has an observation port which allows for visual inspection of the unit.

Wastewater flow to the CPI's is intermittent and dependent on water flow to the junction boxes. The junction boxes are equipped with level control devices which trigger the pumps when the boxes become full. Therefore, surges in wastewater flow to the CPI separator occur regularly.

In addition to process unit wastewater, wastewater from other sources is treated by the CPI separators. Wastewater from the contaminated water ponds, catalyst disposal area, alkyl sludge ponds, and oily solids area is also pumped to the CPI's.

Wastewater from the three CPI separators converges into a flash mix tank. The flash mix tank is a concrete structure that is completely covered. An uncovered overflow tank is located next to the flash mix tank and can be used to handle extreme surges in wastewater flow. The purpose of the flash mix tank is to control the pH level of the wastewater and to serve as a mixing tank for chemical coagulant addition. The addition of coagulant enhances oil and suspended solids removal in the IAF systems.

From the flash mix tank, wastewater splits into two parallel IAF systems. The IAF's were installed by U.S. Filter and are designed to treat 1100 gallons per minute of wastewater. Each IAF is 32 feet long and 8 feet, one inch wide. By design, wastewater retention time would be 4 minutes in the IAF.

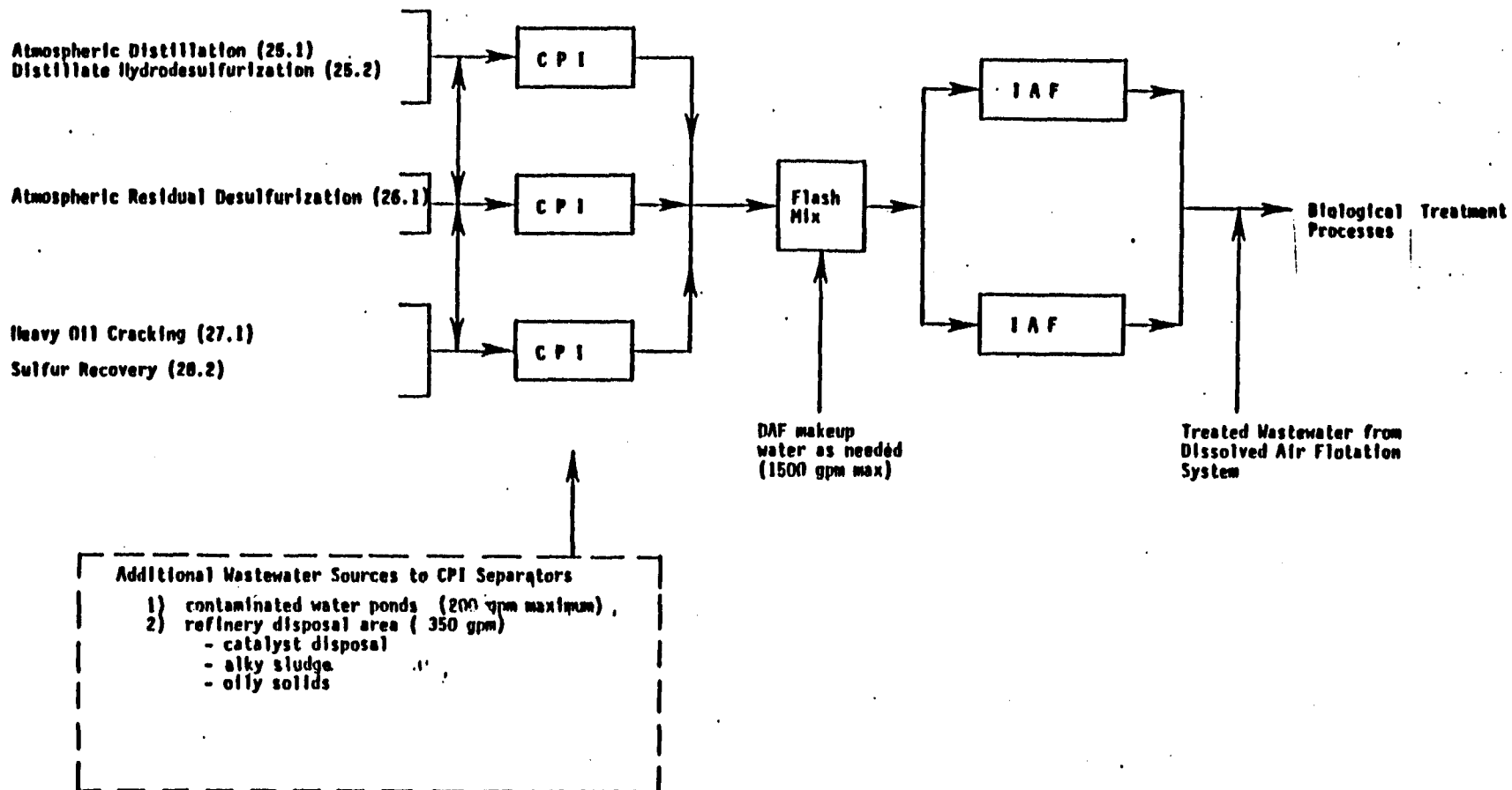


Figure 3-1. Wastewater treatment system for new process units.

Figure 3-2 shows a U.S. Filter "Hydrocell" IAF similar to that used at Phillips. Figure 3-3 shows the flow pattern of water in each cell of the unit and also the mechanism by which air is introduced into the system. The Hydrocell has four flotation cells, plus inlet and outlet compartments. In the Hydrocell IAF, a portion of the treated wastewater is recycled through the distribution header to each air induction assembly. The recycled water draws air or gas into the liquid by means of the venturi effect. The Hydrocell does not use external blowers or pressurized gas to produce aeration.

Skimmer mechanisms located in each cell remove floating oil and suspended solids. Water level is controlled in the outlet compartment by a pneumatic level controller. Five inspection doors are located on each side of the unit to allow for observation of IAF operation. The inspection doors remain closed during normal IAF operation.

The two IAF systems at Phillips were designated as the North and South units. Observations made during the test period found that the operation of the two systems varied. The water level in the South unit remained consistently higher than the North unit. The South unit appeared to be more effective in skimming floating oil and solids from the surface of the cells. The water level in the North unit was too low to allow for proper skimming. Therefore, a substantial sludge layer developed on the surface of the water. Periodically, this sludge layer would rise to a level where skimming was possible.

The North unit was also experiencing problems draining the sludge collected in the side launders. For this reason, a steam line was placed in one side launder to prevent clogging by the sludge. This caused the temperature inside the North unit to be slightly higher than the South unit.

3.2.2 Additional Wastewater Treatment Facilities

Effluent from the IAF systems combines with effluent from the DAF system of the older wastewater treatment facilities. This wastewater then enters a series of aerated ponds. Following the aerated ponds, biological treatment is accomplished by rotating biological contactors (RBC). The RBC units are followed by a clarifier, two stabilization ponds, and filters. Effluent from the filters is discharged to the Linville Bayou.

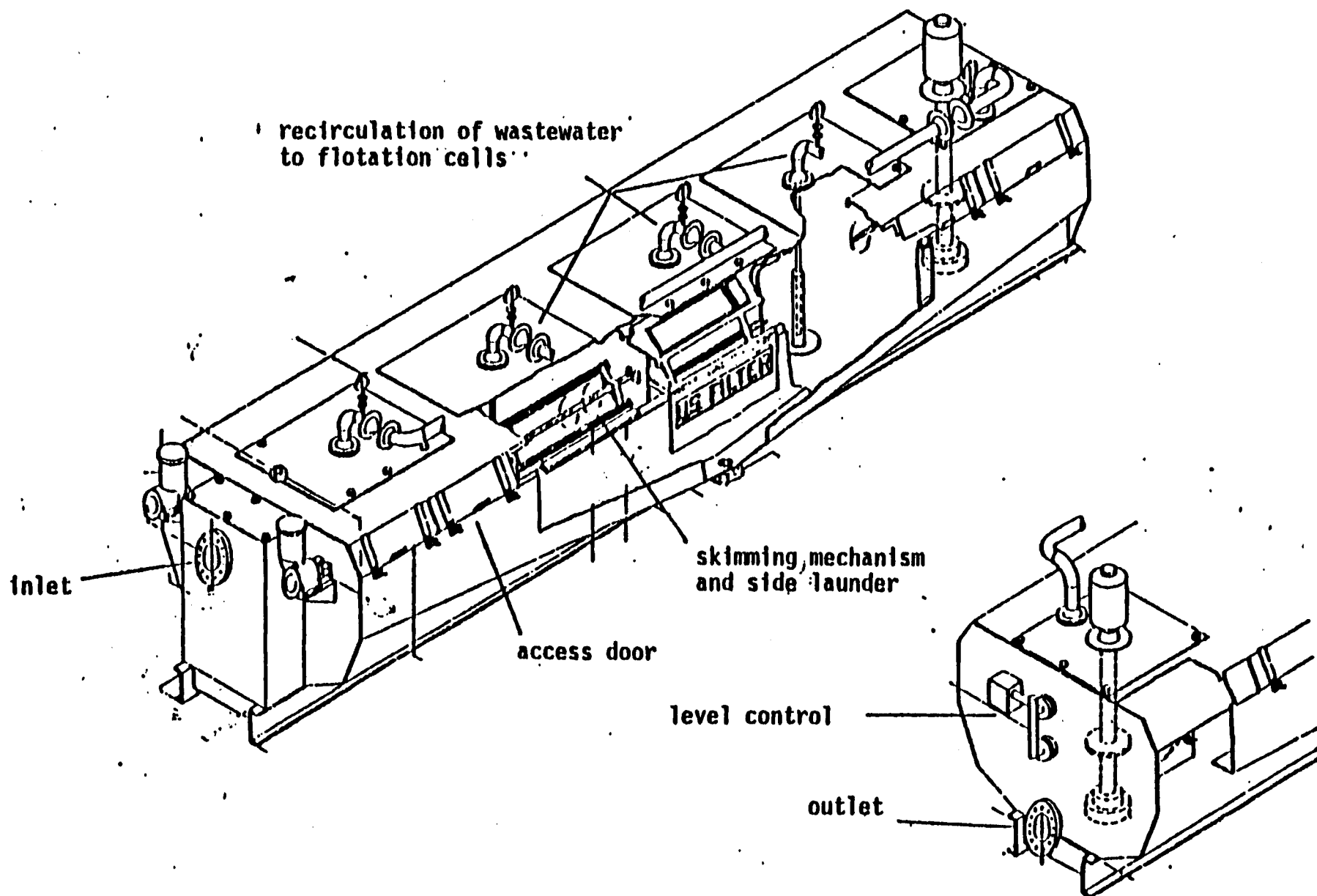


Figure 3-2. Induced Air Flotation System, "Hydrocell" designed by U.S. Filter.
(Source: U.S. Filter Fluid System Corporation - Flotation General Catalog)

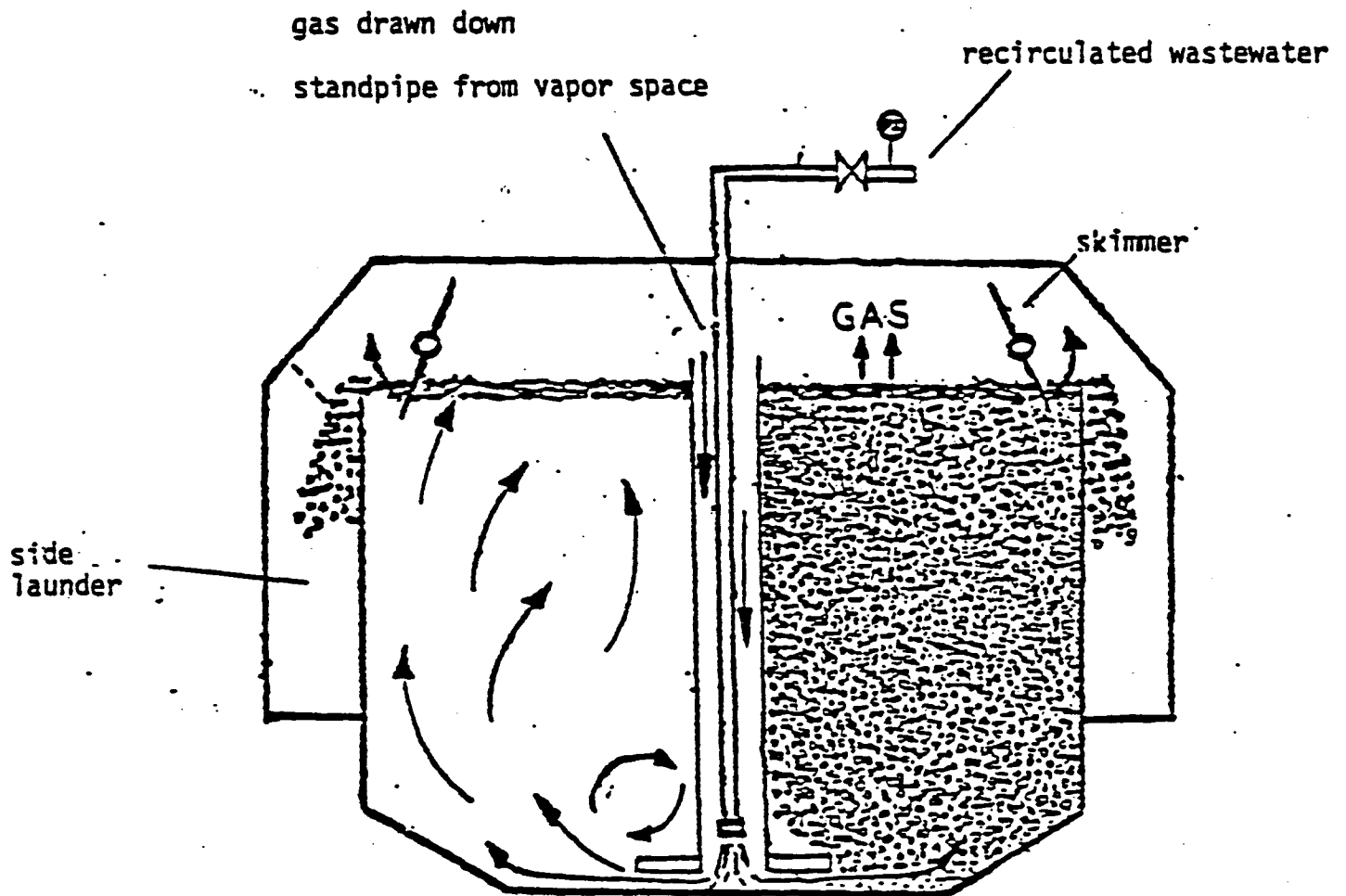


Figure 3-3. Flow pattern of gas and water in IAF system cell.
 (Source: U.S. Filter Fluid Systems Corp., Flotation General Catalog)

Auxillary wastewater facilities have been mentioned above. These include the contaminated water ponds, catalyst disposal area, alkyl sludge ponds, and oily solids ponds. These facilities store waste from specialized areas of the refinery and produce small quantities of wastewater. For example, spent catalyst fines are sent to the catalyst disposal area. The catalyst fines settle out, leaving the surface water to be drawn off and treated by the newer wastewater facilities.

3.3 MONITORING OF WASTEWATER TREATMENT FACILITIES

Phillips monitors a number of pollutant parameters to insure compliance with the refinery NPDES (National Pollution Discharge Elimination System) permit. Among the parameters monitored are: total organic carbon (TOC), pH, ammonia, sulfides, oil and grease, fluorides, and chromium. Data regarding these parameters were not acquired from Phillips during the test. However, the test plan required that samples be drawn to measure TOC and oil and grease concentrations to and from the IAF systems.

During the test period, monitoring of wastewater flow to the IAF systems was accomplished by observing instrument readings in the control room of the wastewater treatment facility. Flow meters in the control room provided estimates of flow to each of the CPI separators. Because flow to the separators was intermittent, the meters often were reading "0." Table 3-2 summarizes the flow readings observed during the test period. The flow rates were calculated by recording the meter reading at an instantaneous time and correcting by a factor given by Phillips for each meter. Applying the correction factor to the instantaneous reading gave measurements in gallon per minute (gpm). Readings were taken as often as possible, usually every one to two hours during each day of testing.

The data shown in Table 3-2 do not provide an accurate estimation of wastewater flow to the IAF systems. A stripchart in the control room recorded flow from the flash mix tank to the IAF. Again, instantaneous readings were recorded on the chart and these readings often indicated zero flow. The stripchart reading generally coincided with the flow reading for the CPI separators.

Table 3-2. ESTIMATED WASTEWATER FLOW RATES TO
CPI SEPARATORS DURING TEST PERIOD

Wastewater flow in gallons per minute (GPM)					
Date	Time	Estimated flow to separators			Total flow
		CPI-1	CPI-2	CPI-3	
9-20-83	0900	345	304	291	940
	1025	331	274	260	865
	1035	331	262	281	874
	1045	0	0	0	-
	1100	0	0	0	-
	1125	331	274	281	886
	1140	0	0	0	-
	1205	0	0	0	-
	1450	552	0	114	666
	1513	0	0	0	-
	1530	0	0	0	-
	1715	345	274	459	1078
9-21-83	0900	276	192	177	645
	0901	621	411	364	1396
	0925	276	0	187	463
	0930	538	425	406	1369
	0935	593	438	416	1447
	1030	276	178	177	631
	1105	331	205	135	671
	1145	552	643	364	1519
	1325	290	192	0	482
	1705	1035	247	20	1302
9-22-83	0900	207	0	0	207
	0925	621	480	21	1122
	0930	276	192	21	489
	0935	207	0	0	207
	0945	179	0	0	179
	1015	621	480	135	1236
	1215	759	589	239	1587
	1450	152	0	0	152
	1455	621	493	125	1239
	1604	442	219	0	661
	1610	731	589	291	1611
	1655	179	0	0	179
9-23-83	0925	0	0	0	-
	0945	0	0	0	-
	1130	0	0	0	-
	1240	552	356	125	1033
	1205	552	370	52	974
	1325	538	562	270	1370
	1330	593	562	270	1425

As mentioned above, the water level in the IAF systems was monitored throughout the test. Visual inspection of the water level in each IAF was made periodically on each day of testing. The submersion depth of the skimmer bars was used as a reference point to determine changes in water level. In general, these water levels remained consistent in each IAF during the test period. Operators at Phillips adjusted the water levels on the initial day of testing to insure proper operation of the units during the test. Only slight fluctuations were observed.

3.4 PROCESS UPSETS AND IRREGULARITIES DURING TEST

Consistent fluctuations in the concentration of VOC recorded by the continuous monitoring equipment were noted throughout the test period. One possible explanation for these fluctuations is the intermittent flow of oily wastewater to the CPI separators. As noted above, oil wastewater is pumped to the CPI separators from junction boxes located in each process unit. Pumping is dependent on the amount of wastewater generated in the process units. According to plant personnel, when the pumps are engaged, normal pumping times are roughly 17 to 20 minutes in duration. This time interval agrees with peak wastewater flows recorded on stripcharts in the control room. Further, peak VOC concentrations also appeared to coincide with these time intervals.

Water levels remained constant in the IAF systems despite fluctuation in the flow to the CPI separators. Flow to the IAF systems could be supplemented by effluent from the IAF system located in the older treatment system. Therefore, fluctuations in quantity of wastewater in the IAF's were not observed. However, the quality of oily wastewater could fluctuate due to the intermittent flow from the CPI separators.

During the first three days of testing (9-19 to 9-21), the atmospheric residuum desulfurization (ARDS) units was not being charged. Preparation activities to bring this unit back on line began at approximately midnight on September 22. Plant records indicate that full operations of this unit began at 04:20 of that day.

3.5 ADDITIONAL NOTES REGARDING WASTEWATER TREATMENT SYSTEM

- Wastewater generated by desalter in Unit 25.1 is treated by the older wastewater treatment system. This was due to an effort to hasten startup of the new crude unit. The new wastewater treatment system was not complete when the unit was first charged.

- According to Phillips personnel, Units 25, 27, and 28 would have the highest potential for producing wastewater high in VOC content. Unit 26 (ARDS) would have lowest VOC potential of the new units.
- Major maintenance procedures in process units are carried out during mid-evening shifts. Large quantities of wastewater may be produced during this time period (3:00 p.m. to 11:00 p.m.) due to routine maintenance practices.
- Total wastewater flow from the refinery is approximately 3850 gpm. This flow is measured as the flow rate to the rotating biological contactors.

4. LOCATION OF SAMPLE POINTS

This section presents a description of the sampling locations within the process at Phillips Petroleum in Sweeny, Texas. An explanation is provided of the sample point maintained at the gaseous sampling location for continuous monitoring, gas bag sampling, and flow measurement. Figure 3-1 presents a diagram of the petroleum wastewater system with the IAF treatment process units and sample locations.

4.1 GASEOUS SAMPLE LOCATIONS

The gaseous sample locations at the IAF #1 and IAF #2 outlets were fabricated to provide a measurable gaseous flow through the IAF units. Figure 4-1 provides a schematic of the IAF system and shows the configuration of the blower system to introduce a ventilation air to the IAF unit's headspace. Figure 4-2 illustrates the fabricated ductwork and the sampling location at the outlet of IAF #1 and IAF #2.

In attempt to create a closed system so that only the outlet ventilation air would have to be measured, weatherstripping and tape was used to seal the inspection doors. However, since some doors had to be accessible for maintenance and adjustment of the unit, a closed system could not be continually attained.

4.2 WATER SAMPLE LOCATIONS

The process water sample locations were the same as those used by Phillips to collect plant process water samples. Figure 4-3 provides a diagram of the sample locations within the process.

Figure 4-1 provides a schematic of the sample locations at the IAF units. The sample location IAF-A' was the common process line feeding both IAF #1 and IAF #2 (see Figure 4-3). IAF-C and IAF-D sample locations were maintained at the recirculation pump to the two separate units.

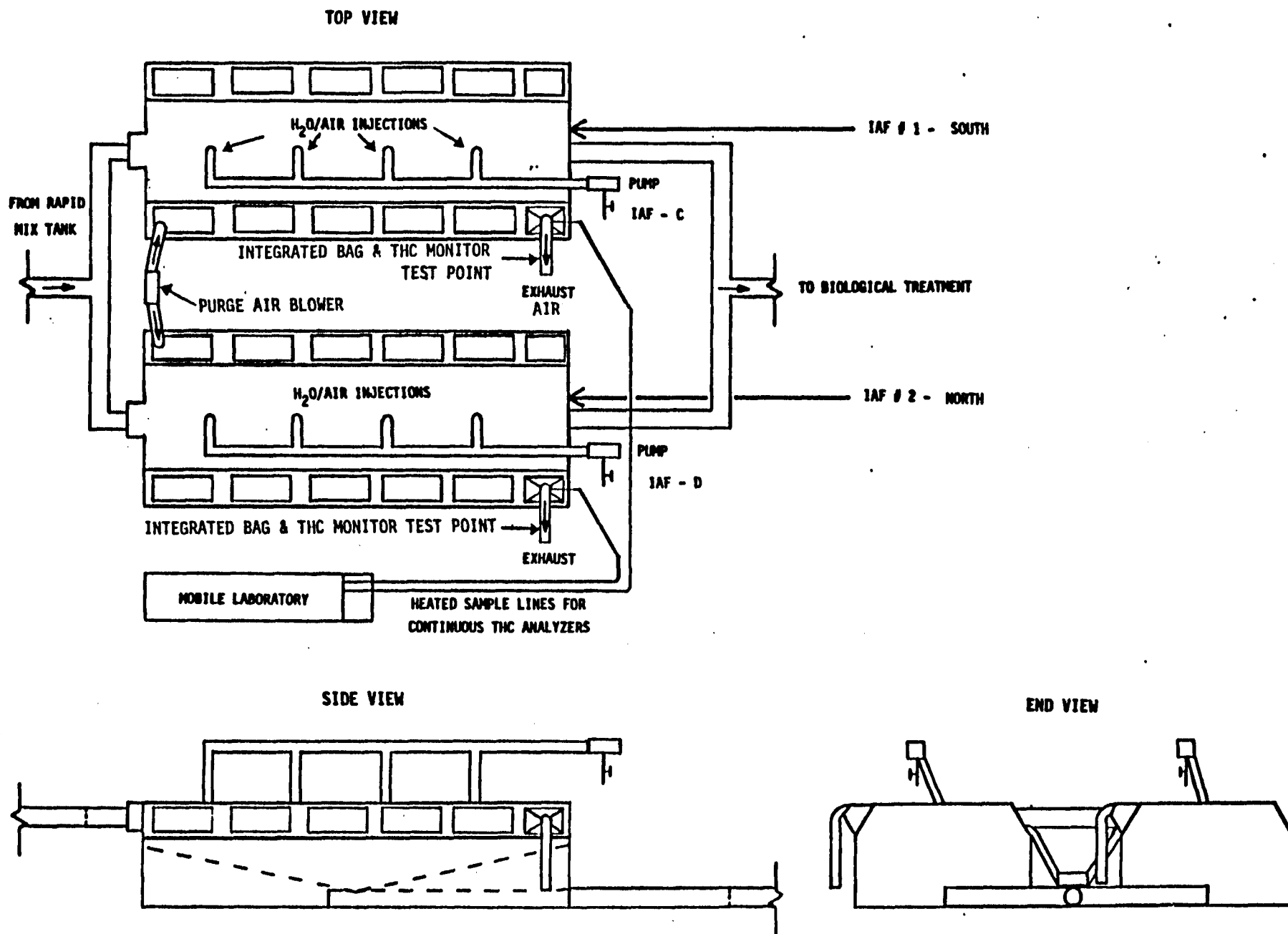
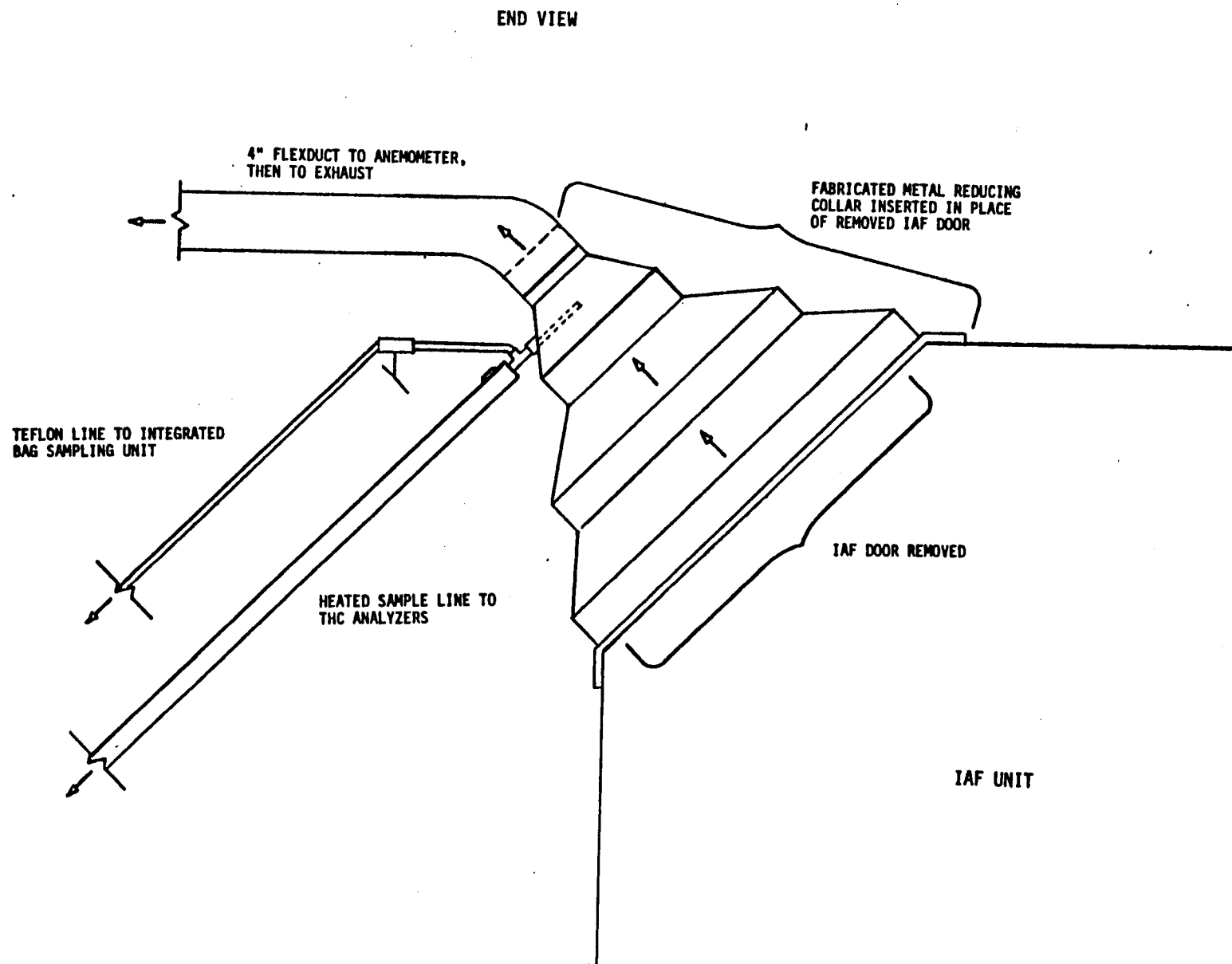


Figure 4-1. Schematic representation of the IAF process with sample points and induced air system: Phillips Petroleum - Sweeny, Texas.



4-3

Figure 4-2. IAF-outlet sample locations fabricated:
Phillips Petroleum - Sweeny, Texas.

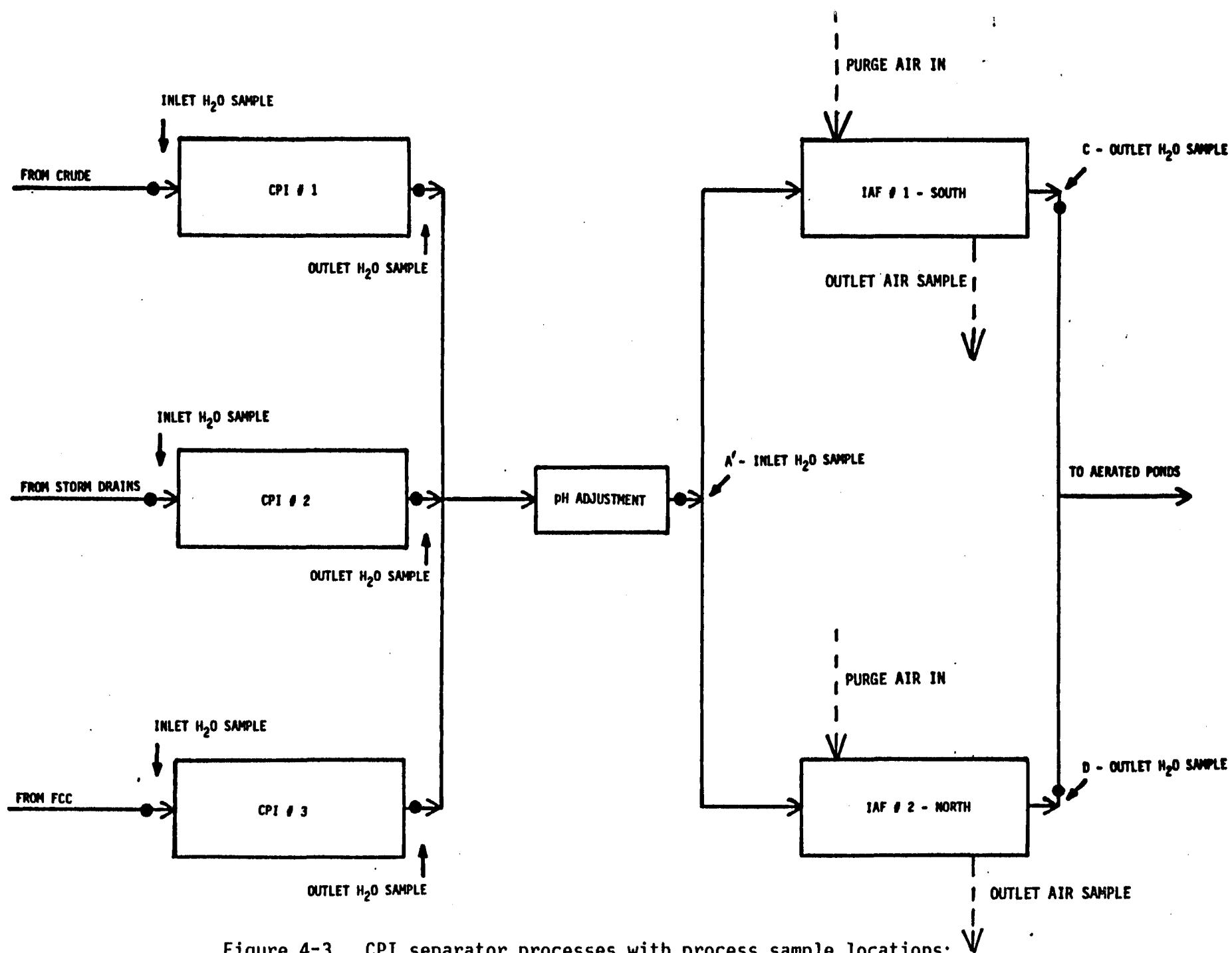


Figure 4-3. CPI separator processes with process sample locations:
Phillips Petroleum - Sweeny, Texas.

Figure 4-3 provides the locations of the sample points around the CPI separators. The CPI-inlet sample points were sample valves from the process line feeding the CPI separators. The CPI-outlet sample points were sample valves from the process sample piping to a Phillips sampling facility.

5. SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical procedures used to evaluate the gaseous and liquid streams are presented in this section. The methodologies are discussed separately as gaseous VOC methods (5.1), fixed gas analysis (5.2), gas flow measurement (5.3), liquid sampling (5.4), and liquid sample analysis (5.5).

5.1 GASEOUS VOC METHODS

Two procedures were used to measure the VOC content of the gaseous streams. EPA Method 18 was used to determine the general VOC species in the samples, and a procedure similar to EPA Method 25A was used to measure the equivalent total hydrocarbon content of the streams.

5.1.1 EPA Method 18

"EPA Method 18. Measurement of Gaseous Organic Compound Emissions by Gas Chromatography", (promulgated October 18, 1983, Federal Register 48 FR 48328) was used to characterize the organic components in the streams tested. Samples were collected using the integrated bag technique of Method 18. Figure 5-1 illustrates the apparatus.

A clean 2.5 cubic foot TEDLAR[®] flexible bag was used for each run. The bags were cleaned by filling with dry nitrogen and venting the bag contents to the atmosphere until no background organics were detected by the analysis system. Prior to sampling, the sampling apparatus and flexible bag were leak checked by evacuating each to 29" Hg vacuum and monitoring the pressure for 10 minutes. If a change of less than 1" Hg is observed, the components are judged leak-free. The sample probe, sample connecting tubing, and the sample bag were operated at ambient temperature. To prepare for sampling the vacuum source can was evacuated to -29" Hg. The system was then assembled and the sample probe was placed near the centroid of the duct to be sampled. Sampling was

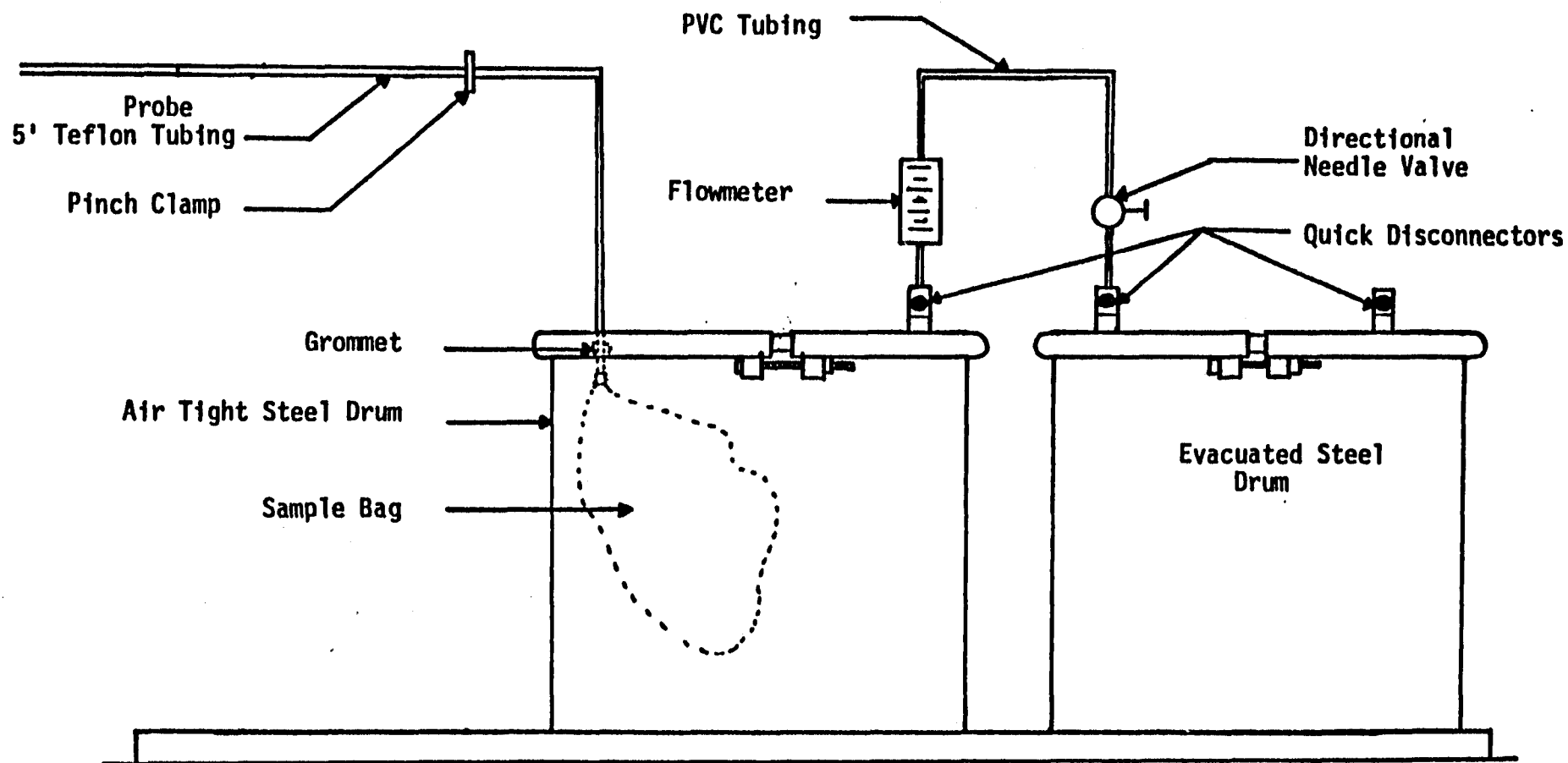


Figure 5-1. Gas bag sampling system.

started by opening the flow control valve and was maintained at a constant rate using the rotameter for about one hour. At the end of the sampling period, the flow valve was closed, the probe was disconnected, and the bag inlet was sealed. The sample bag was transported to the on-site mobile laboratory for analysis.

Two gas chromatograph systems with flame ionization detectors were used to analyze each sample. One system was used to separate and quantify low molecular weight parafins and olefins while the other system was used to measure aromatics and higher molecular weight components.

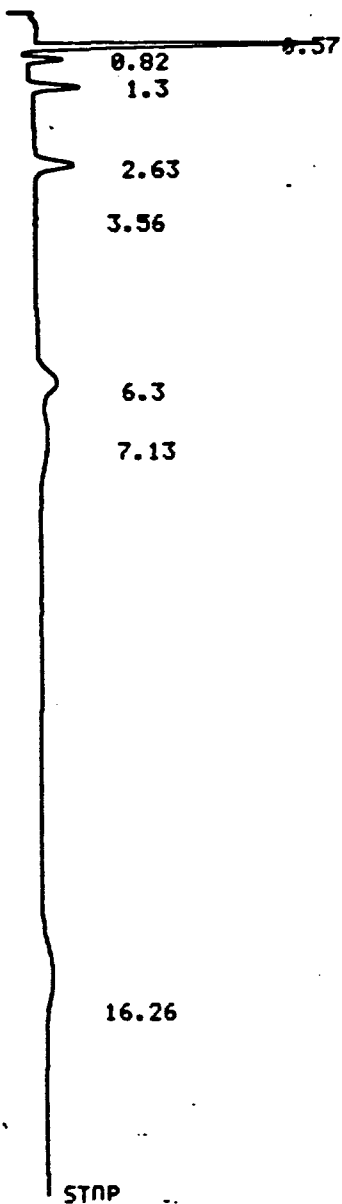
The system used to measure low molecular weight compounds (termed C_1 - C_5 components) was a Shimadzu GC Mini 1 with a Shimadzu Chromatopac digital integrator/recorder. The operating parameters were:

- Column: 6 ft x 1/8 in. I.D. stainless steel.
- Column support: Poracil C.
- Column temperature/program: 35°C/constant.
- Sample loop size/temperature: 1 ml/ambient.
- Carrier gas/flow: He/50 ml/min.

A calibration gas mixture containing known concentrations of methane (15.1 ppm), ethane (14.6 ppm), propane (15.6 ppm), butane (15.2 ppm), and pentane (15.6 ppm) in nitrogen was used to obtain a area factor and retention time for each of these compounds. Figure 5-2 presents an example of a GC/FID calibration run for C_1 - C_5 speciation. During sample analysis, the peaks near these retention times were grouped as the nearest carbon number, and the concentration was calculated using the corresponding calibration factor for that carbon number. Figures 5-3 and 5-4 present an example of GC/FID analysis runs for C_1 - C_5 speciation at the IAF sample locations.

The GC/FID analysis example run for C_1 - C_5 speciation (Figure 5-3) provides an illustration of problems in the analytical procedures. Standards were not available to provide elution time standards for all peaks identified by the GC/FID. Therefore, the total organic concentration from the analysis was a sum of all the peaks and not just the identified peaks. Another problem was the slight variance of the elution time during the test day. The operator noted the temperature difference

START 09.21.17.22.



STOP

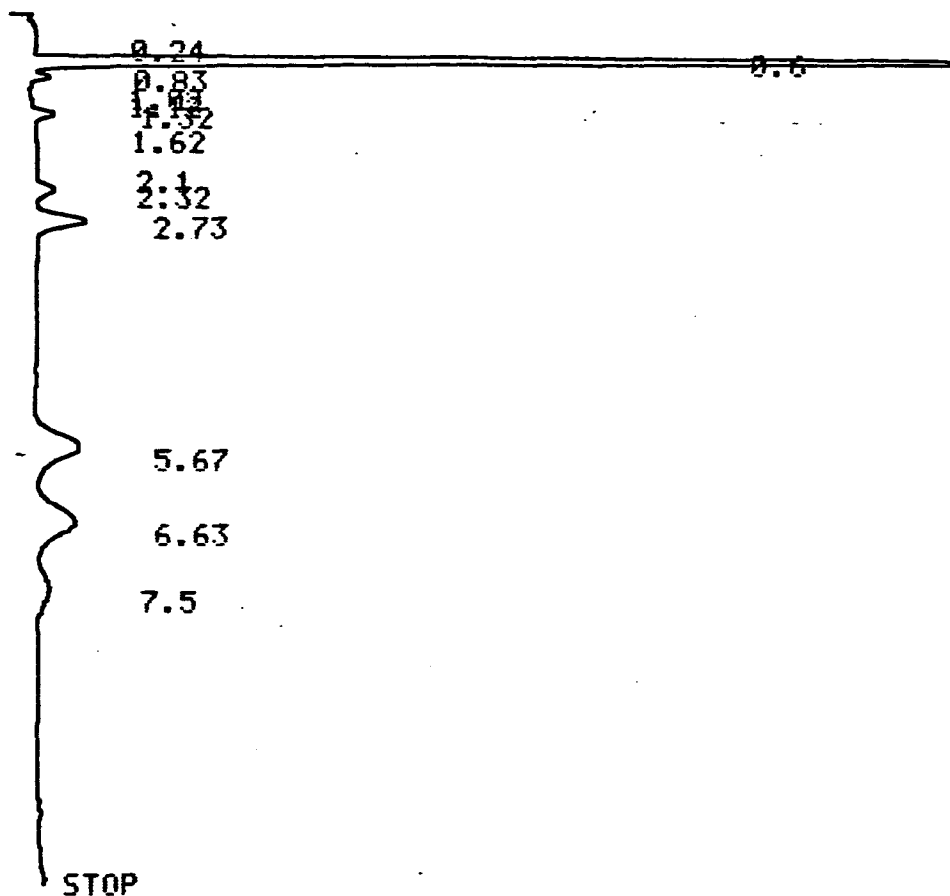
INJ # 00
 FILE # 6
 REPT # 1688
 METHOD 44

#	NAME	TIME	CC	HK	AR-A
1	C-1	0.57	13.3042		1800
2	C-2	0.82	10.4426		251
3	C-3	1.3	11.2547		399
		2.63			560
		6.3			749
5	C-5	7.13	10.7832	V	778
		16.26			722
	TOTAL		45.7849		5261

Handwritten notes:
 9/21/17
 PHILIP
 560

Figure 5-2. Example of GC/FID calibration for C₁-C₅ speciation.

SOUTH-4-1430
START 09.21.15.32.



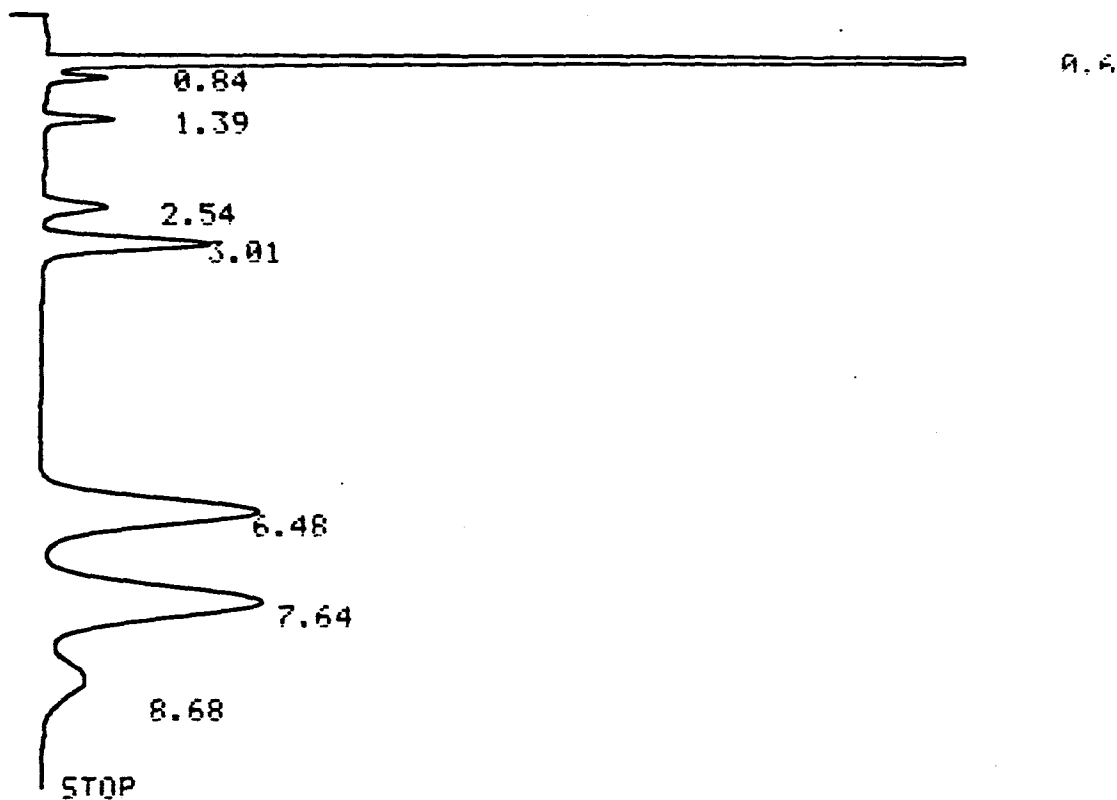
STOP

C-R1A
SMPL # 00
FILE # 6
REPT # 1678
METHOD 44

#	NAME	TIME	CONC	HK	AREA
		0.24			163
1	C-1	0.6	55.7426	V	7542
2	C-2	0.83	5.2292	V	126
3	C-3	1.32	3.9738	V	141
		2.32		V	178
		2.73		V	551
		5.67			1075
		6.63		V	1095
5	C-5	7.5	5.0931	V	367
	TOTAL		70.0389		11242

Figure 5-3. Example of GC/FID analysis on IAF unit #1 exhaust air - gas bag sample for C₁-C₅ speciation.

NORTH-5-1050
START 09.22.12.11.



C-R1A
SMPL # 00
FILE # 6
REPT # 1701
METHOD 44

#	NAME	TIME	CONC	MK	AREA
1	C-1	0.6	225.0305		12095
2	C-2	0.84	6.2414	V	359
3	C-3	1.39	5.4103		431
		2.54			648
4	3C-4	3.01	18.3098	V	2070
		6.48			5750
5	C-5	7.64	46.5562	V	6943
		8.68		V	1538
TOTAL			301.5484		29838

Figure 5-4. Example of GC/FID analysis on IAF unit #2 exhaust air - gas bag sample for C₁-C₅ speciation.

in the field laboratory across a test day and adjusted the peak labels accordingly.

The system used to measure aromatic and higher molecular weight compounds (termed semi-volatile) was a Shimadzu GC Mini II equipped with a Shimadzu Chromatopac integrator. The operating parameters were:

- Column: 6 ft x 1/8 in. I.D. stainless steel.
- Column support: OV-1 on 80/100 Supelco.
- Column temperature/program: 25°C/constant.
- Sample loop size/temperature: 1 ml/225°C.
- Carrier gas/flow: He/20 ml/min.

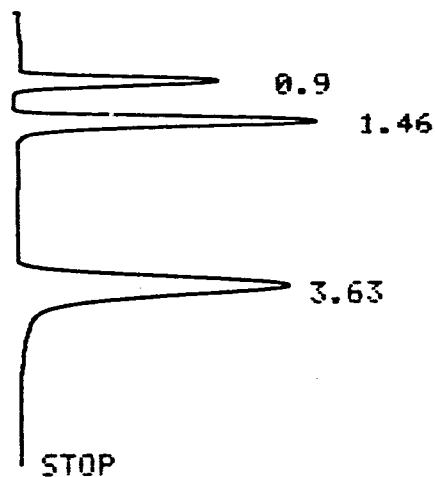
A calibration mixture of 49.8 ppm benzene and 49.9 ppm m-xylene in nitrogen was used to determine calibration factors and retention times for these two compounds. Qualitative gaseous standards prepared from liquid mixture of hexane, heptane, and toluene, were used to determine the retention time for these compounds. Figure 5-5 presents an example of a GC/FID calibration run for C₆-C₉ speciation. During sample analysis, hexane, heptane, benzene and toluene were expressed as equivalent benzene concentrations and C₈ and higher components were expressed as m-xylene equivalent concentrations. Figures 5-6 and 5-7 present an example of GC/FID analysis runs for C₆-C₉ speciation at the IAF sample locations.

5.1.2 EPA Method 25A

Procedures similar to those described in EPA Method 25A (Federal Register 48 FR 37595) were used to continuously measure the total hydrocarbon concentration in the gaseous streams tested. A Beckman Model 402 and a Beckman 400 flame ionization analyzer were used at the IAF sample locations. The sample probes were placed near the centroid of the fabricated outlet duct of the unit to be sampled. A continuous sample flow was maintained through heated Teflon[®] sampling lines. The instrument operating parameters was:

CAL-PBX-45PPM

START 09.21.17.00.

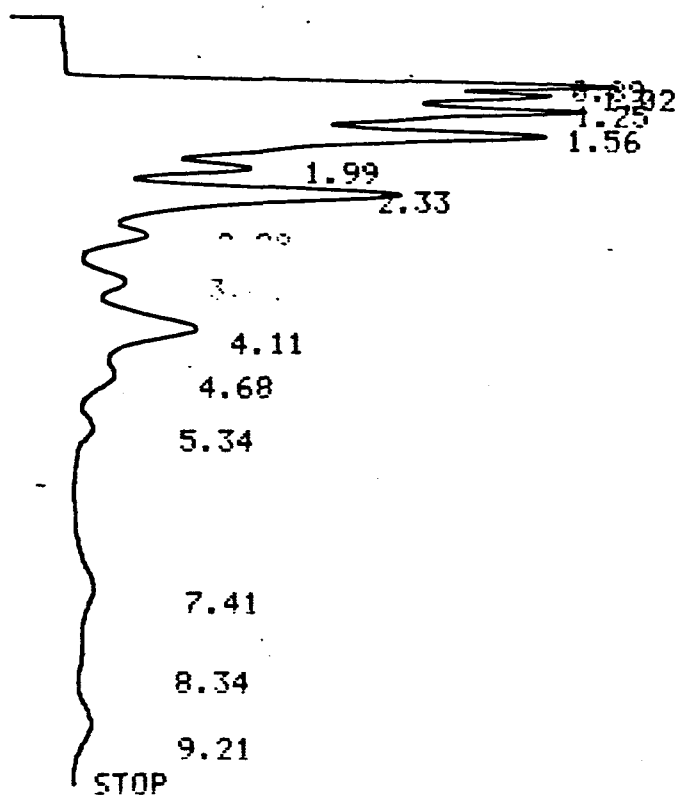


C-R1A
SMPL # 00
FILE # 4
REPT # 1686
METHOD 44

#	NAME	TIME	CONC	MK	AREA
1	PROPAN	0.9	46.3155		1849
2	BENZEN	1.46	50.5438	-41.1	3204
3	XYLENE	3.63	52.2601	-41.1	5504
TOTAL			149.1195		10558

Figure 5-5. Example of GC/FID calibration for C₆-C₉ speciation.

SOUTH-3-1100
 START 09.21.11.24.



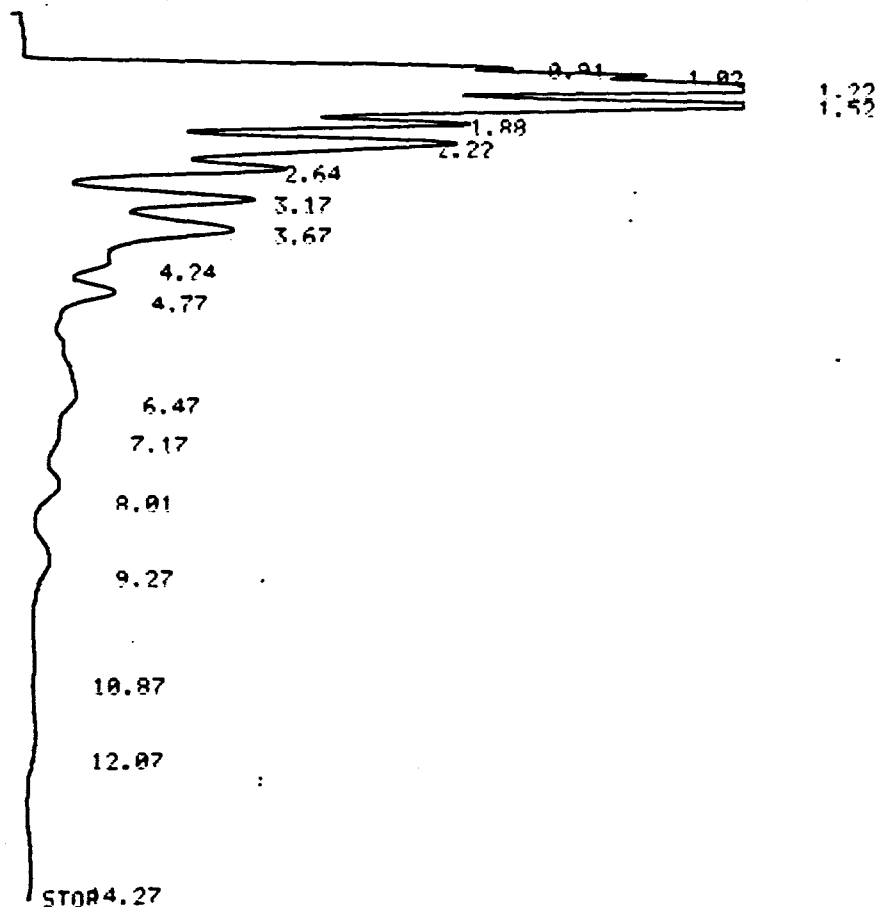
C-R1A
 SMPL # 00
 FILE # 5
 REPT # 1664
 METHOD 41

#	NAME	TIME	CONC	MK	AREA
0		0.89	10.3662		4570
0		1.02	10.4208	V	4594
0		1.25	16.184	V	7135
0		1.56 Benz	19.6886	V	8680
0		1.99	5.3847	V	2374
0		2.33	13.8817	V	6120
0		2.88	3.1757	V	1400
0		3.48	2.867	V	1264
0		4.11 X14	8.5664	V	3776
0		4.68	2.8875	V	1273
0		5.34	1.6108	V	710
0		7.41	3.09	V	1362
0		8.34	0.4509	V	198
0		9.21	1.4251	V	628
	TOTAL		99.9999		44089

Figure 5-6. Example of GC/FID analysis on IAF unit #1 exhaust air - gas bag sample for C₆-C₉ speciation.

NORTH-5-1050

START 09.22.11.47.



C-R1A
 SMPL # 00
 FILE # 4
 REPT # 1700
 METHOD 44

#	NAME	TIME	CONC	PK	AREA
1	PROPAN	0.91	124.1267		4714
		1.02		V	6373
		1.22		V	18815
2	BENZEN	1.52	288.1822	V	18340
		1.88		V	7260
		2.22		V	11577
		2.64		V	5510
		3.17		V	6063
3	XYLENE	3.67	74.6997	V	8503
3	XYLENE	4.24	19.168	V	2181
		4.77		V	3891
		6.47		V	5990
		7.17		V	1362
		8.01		V	1030
		9.27		V	2001
		10.87		V	597
		12.07		V	904
		14.27			112
TOTAL			506.1768		106211

Figure 5-7. Example of GC/FID analysis on IAF unit #2 exhaust air - gas bag sample for C₆-C₉ speciation.

Site: IAF unit #1 exhaust air

- Analyzer: Beckman Model 402.
- Serial #: 1001303.
- Fuel Pressure: 25 PSI.
- Sample Pressure: 3.0 PSI.
- Air Pressure: 16 PSI.
- Sample line length/approximate temperature: 25 feet/ambient.

Site: IAF unit #2 exhaust air

- Analyzer: Beckman Model 400.
- Serial #: 100216
- Fuel Pressure: 22 PSI.
- Sample Pressure: 3.0 PSI.
- Air Pressure: 15 PSI.
- Sample line length/approximate temperature: 25 feet/ambient.

The analyzer were operated continuously 24-hours per day. The analyzers were equipped with strip chart recorders for data reduction. The instruments were calibrated with compressed gas standards of propane in a balance of air.

The calibration gas standards were supplied by Scott Speciality Gases and certified to within ± 2 percent of the labeled calibration gas values. The calibration gas standards used at Phillips are, listed in ppm as propane: 49.9, 100.1, 500.5, 1002.5, and 4010.1.

The initial calibration prior to commencing a test series at a test location, or follow-up calibration prior to re-commencing a test series after an instrument shut-down, included the following calibration sequence. First, a trial sampling of the source stream would indicate the appropriate concentration range for which the instrument would be operated. Second, the initial calibration of the instrument on this pre-determined scale included introducing zero gas and the high-level calibration gas separately to the sample manifold. The output was then adjusted to the appropriate levels. No instrument adjustments were made after this time. Third, a

periodic response check was performed by introducing the zero and high level calibration gas with no adjustments. A response within ± 1 percent of span value was required or recalibration would have been performed. Fourth, a linearity check was performed on the instrument span range by introducing mid-level and low-level calibration gases. The difference between the measurement system responses and the predicted response were recorded. The differences were assured to be less than five percent of the respective calibration gas values before the measurement system was placed on-line for monitoring. The operational parameters and calibration gas standards used at the IAF sample location were as follows:

- Instrument: Beckman 402 and Beckman 400.
- Scale: 0-5,000 ppm.
- Low-level calibration gas standard: 500.5 ppmv as C_3H_8 .
- Mid-level calibration gas standard: 1002.1 ppmv as C_3H_8 .
- High-level calibration gas standard: 4010.0 ppmv as C_3H_8 .

A monitor system response time check was performed at the IAF sample location. The check was performed by introducing the high-level calibration gas at the inlet to the sample line feeding the measurement system. The time interval was measured for the analyzer to respond by 95 percent of the calibration gas value. The short sample lines gave response time of 15-20 seconds and is within the allowed limit of 30 seconds.

Zero and span drift determinations were made during and after each test period. The frequency of drift checks were determined by the operational status of the analyzer and total length of the test. During the initial operation of the analyzer, after the measurement system had been powered down, the FIA required frequent drift checks (one to two hours) for maintaining the drift values below the specified three percent limit. A complete calibration sequence was completed if a drift check demonstrated the necessity. After the frequent drift checks verified the calibration stability of the measurement system, the drift checks were performed three times during the 12-hour test day period. Test periods before a 12-hour instrument operation period, required the two-hour drift check frequency.

Figure 5-8 presents an example of a calibration check at the IAF unit #1 sampling location with a recalibration required. The sequence was initiated at 0850 on 9/22/83 by introducing zero, high, and mid-calibration gases separately. The upward drift at the three levels was approximately two percent. Therefore, the zero and high standards were re-introduced and analyzer adjustments made. Next, a linearity check is performed with the mid standard (no adjustment) and the sample reconnected for monitoring.

The calibration gas level reintroduced for the drift check was determined by the sample measurement levels. The IAF sample locations ranged from 900-2000 ppm. Therefore, the 1002.5 ppmv as C_3H_8 and the 4010.0 ppmv as C_3H_8 was used for the span drift check.

The continuous monitor data were reduced by determining the average organic concentration measured into ppmv as propane. Direct computation of the recorded stripchart outputs was applicable because the high-level standard was calibrated on the same span value as the recorder. The IAF measurement system was calibrated on the 0-5,000 ppm scale. Therefore, the IAF calibration was performed with 80 percent of scale being equivalent to the 4010 ppmv as propane.

The measured concentrations are presented on a ppmv as propane equivalent. The one-hour concentration averages were calculated from direct output readings at five-minute intervals. The results were calculated on the hour. Hour periods with drift checks and calibration were normalized to the hour from the partial segments of the hour.

5.2 PERMANENT GAS ANALYSIS

The assumption was maintained that the process gas permanent constituents are at ambient levels because the induced ambient air was a major portion of the process gas. This permitted a modification of permanent gas analyses instead of EPA Reference Method 3. The permanent oxygen level was assumed to be 21.8 percent with the remaining portion a balance of the monitored THC level and nitrogen.

5.3 GASEOUS VOLUMETRIC FLOW MEASUREMENT

At the induced air flotation unit vent, a modification of EPA Method 2A (Federal Register Vol. 48, No. 247, December 22, 1983) was used. The flow rate across the IAF units was created by a dual blower

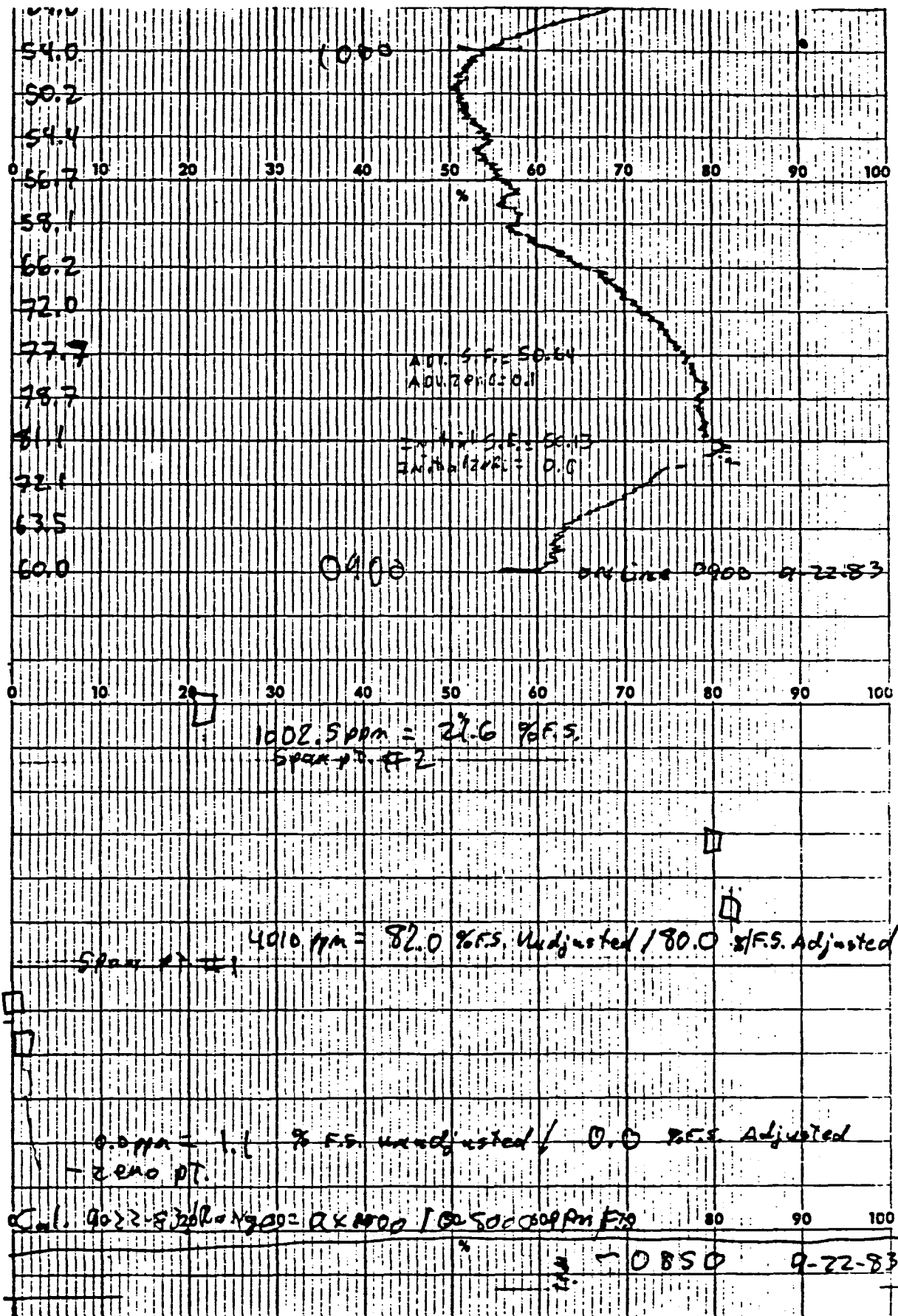


Figure 5-8. Example of a calibration check with a recalibration required.

fabricated into an inspection door. A small, constant flow was forced across the IAF unit with the inlet pump and the sealed doors. An exhaust outlet was fabricated for measuring the exhaust air. The system used was based on a four-inch diameter anemometer housed in a section of exhaust duct with the same nominal diameter as the anemometer.

A jewelled anemometer was used at the IAF sample location for measuring the velocity through a four-inch adaption between the IAF exhaust air and the fabricated outlet duct. Figure 4-2 provides a schematic representation of the velocity measurement system.

The anemometer was calibrated by the manufacturer (Davis Instrument Mfg.) and the calibration/correction data is provided in Appendix A. No in-house calibration was performed on the anemometer.

The blower generated flow rate across the IAF unit was constant and total volumetric measurements were not required. Monitoring of the flow rate was maintained at the inlet and outlet ducts. The differences in the inlet and outlet flow rate was used for determining the integrity of the sealed IAF unit.

5.4 LIQUID SAMPLE METHODS

Liquid process samples were collected from sample taps used by the refinery for process quality control. Two types of samples were collected and were termed "void of air" (VOA) and "composite".

The void of air samples were collected by completely filling a 40 mL bottle with a grab sample. These bottles are fitted with a special cap to eliminate air bubbles from the sample. The composite samples were collected by combining five to six equal volume grab samples into a one gallon amber bottle.

Both sample types were taken from a process stream flowing in a pipe, through a sample line which was purged prior to sample collection. The samples were stored on ice in insulated containers after collecting, and during shipment to the TRW facility at the Research Triangle Park, North Carolina for analysis. The bottles were prepared by the following cleaning procedures:

- a) strong soap solution;
- b) liberal tap water rinse;

- c) nitric acid, 15 percent v/v;
- d) distilled water rinse;
- e) methanol rinse;
- f) methylene chloride rinse; and
- g) drying a clean, hot air stream or placing in an oven at 40°C (140°F).

After the containers have been cleaned, dried and capped, they are stored in boxes to prevent spurious contamination.

5.5 LIQUID SAMPLE ANALYSIS METHODS

5.5.1 Total Organic Carbon (TOC)

This method is applicable to the measurement of organic carbon in drinking and surface waters as well as domestic and industrial wastes.

5.5.1.1 Summary of Method. Organic carbon in a sample is converted to carbon dioxide (CO₂) by photochemical oxidation. The CO₂ is measured to determine the total organic carbon. The sample is initially purged by vacuum to remove inorganic carbon. Sample inorganic carbon is eliminated or must be compensated for because it is usually a large part of the total carbon. The instrument is calibrated versus a standard solution of potassium hydrogen phthalate (KHP).

5.5.1.2 Interferences/Quality Control. Removal of carbonate and bicarbonate by acidification and purging with nitrogen or other inert gas can result in the loss of volatile organic substances. Volatiles also can be lost if the samples are allowed to heat up.

Repeatability of replicate injections can be effected by non-homogeneity of samples. This can occur if large carbon containing particulate matter is not representatively collected in the sample injection syringe. It is also necessary to collect and maintain the samples in bottles with no head space so as to minimize the volatilization of organic components. This phenomenon is apparent after the TOC analysis of theoretically identical samples in which one was collected in a VOA bottle (no head space) and another collected in a larger sample bottle only half to three-quarters full. Repeatability and representativeness can be improved by homogenizing (by mixing) the samples prior to analysis.

The precision measurement based upon repeated injection of three randomly selected samples appears to be a function of the concentration when measured on the basis of the standard deviation. The standard deviations in one case for two of the samples cannot be considered to be equal (at the 95% level of significance), but there appears to be no difference between the standard deviations when comparing one of the first two with the third. When compared on the basis of the relative standard deviation, RSD, (or % RSD), the precision for all three measurements appears to be the same.

The accuracy of the technique is best represented here by injecting a known volume of the calibration standard and comparing the results to the theoretical value. In this case, the highest standard used to calibrate was a 100 mg/L (100 ppm) solution of KHP.

The accuracy measurement is based on an in-house standard and indicates about a 9% positive bias (or accuracy), based on the mean of the measurements. However, a statistical hypothesis test that the bias is zero would be accepted at the 95% level of confidence. Stated differently there is a 95% probability of being correct if the data does not show a significant difference from zero.

All samples were diluted as necessary to fall within the limits of the calibration.

5.5.2 Chemical Oxygen Demand (COD)

This test method is considered an independent measurement of the organic matter in a sample. The Chemical Oxygen Demand (COD) method determines the quantity of oxygen required to oxidize the organic matter in a waste sample, under specific conditions of oxidizing agent, temperature, and time.

5.5.2.1 Summary of Method. Organic and oxidizable inorganic substances in the sample are oxidized by potassium dichromate in 50% sulfuric acid solution at reflux temperature. Silver sulfate is used as a catalyst and mercuric sulfate is added to remove chloride interference. The excess dichromate is titrated with standard ferrous ammonium sulfate, using orthophenanthroline ferrous complex as an indicator.

5.5.2.2 Interferences/Quality Control. Volatile straight-chain aliphatic compounds are not oxidized to any appreciable extent. This limitation occurs partly because volatile organics are present in the

vapor space and does not come in contact with the oxidizing liquid. Straight-chain aliphatic compounds are oxidized more effectively when silver sulfate is added as a catalyst. However, silver sulfate reacts with the halides to produce precipitates that are only oxidized partially. This can be partially overcome by adding mercuric sulfate to complex the halides prior to the reflux step.

The replicated chemical oxygen demand readings are given in Table 5-1. Seven samples were replicated and the means, standard deviations, and coefficients of variation for the COD readings are given in Columns 4, 6, and 8, respectively in the table. Assuming that the coefficient of variation of the chemical oxygen demand (COD) readings should remain constant, the pooled estimate of the coefficient of variation is 0.0435, or 4.4% and is a good measure of the precision.

5.5.3 Oil and Grease

This method includes the measurement of fluorocarbon-113 extractable matter from industrial and domestic wastes. It is applicable to the determination of relatively nonvolatile hydrocarbons, vegetable oils, animal fats, waxes, soaps, greases and related matter.

5.5.3.1 Summary of Method. The sample is acidified to a low pH (<2) and serially extracted with fluorocarbon-113 in a separatory funnel. The solvent is evaporated from the extract and the residue weighed on an analytical balance.

5.5.3.2 Interferences/Quality Control. Fluorocarbon-113 has the ability to dissolve not only oil and grease but also other organic substances. No known solvent will selectively dissolve only oil and grease. Solvent removal results in the loss of short-chain hydrocarbons and simple aromatics by volatilization. Significant portions of petroleum distillates from gasoline through No. 2 fuel oil are lost in the process. In addition, heavier residuals of crude oils and heavy fuel oils contain a significant percentage of residue-type materials that are not soluble in fluorocarbon-113.

Replicated oil and grease (O & G) readings for seven samples are shown in Table 5-1. Sample means, standard deviations, and coefficients of variation are shown in Columns 5, 7, and 9, respectively. Pooling the coefficients of variation for O & G gives a precision of 7.9, or almost double the precision of the COD readings.

Table 5-1. REPLICATED COD AND OIL AND GREASE MEASUREMENTS

TRW Sample #	COD mg/L	O & G mg/L	Means		Standard Deviation		Coefficient of Variation	
			COD mg/L	O & G mg/L	COD mg/L	O & G mg/L	COD	O & G
4957	2968	491	3238	513.0	381.8	31.1	0.1179*	0.0606
	3508	535						
4958	4106	453	4119	444.7	102.6	7.23	0.0249	0.0163
	4024	440						
	4228	441						
4960	2155	382	2135	379.0	29.0	4.24	0.0136	0.0112
	2114	376						
4961	1748	133	1748	133.5	0.0	0.71	0.0000	0.0053
	1748	144						
4962	1545	125	1565	115.0	20.0	18.2	0.0218	0.1582
	1585	94						
	1565	126						
4971	1240	110	1271	109.5	43.1	0.71	0.0340	0.0065
	1301	109						
4973	1911	123	1891	121.5	29.0	2.12	0.0153	0.0175
	1870	120						

5.5.4 Total Chromatographable Organics (TCO)/Hydrocarbon Speciation

This method is applicable for the measurement of hydrocarbons in surface waters, domestic and industrial wastes.

5.5.4.1 Summary of Method. The analysis for TCO was performed by gas chromatography with flame ionization detection. Component speciation was done by separation with a fused silica capillary (0.25 mm), GC column (SPB-1 boiling point column). The reported values are in milligrams per liter of sample, and is a total integrated value representing hydrocarbons ranging between C₅ and C₃₀.

For additional breakdown, i.e., hydrocarbon speciation, the resulting chromatography was broken down into C (toluene) through C₃₀ hydrocarbons. The values in milligrams per liter were calculated using average response factors of C₇-C₁₁, C₁₁-C₁₆ and C₁₇ to C₂₅ hydrocarbons. Due to the reduced response on a FID of C₁₇ to C₂₅ hydrocarbons as compared to C₇-C₁₁ high values of some C₁₇-C₂₅ compounds were found.

Each sample was prepared by extracting a 500 ml aliquot with methylene chloride both at an acidic and basic pH, combining the methylene chloride extracts, and then reducing the solvent to a final volume of 25 ml. Each sample was spiked with an internal spike to check recovery.

5.5.4.2 Interferences/Quality Control. The sample is serially extracted with methylene chloride and concentrated to provide sufficient hydrocarbons for analysis. The concentration step results in the loss of short-chain hydrocarbons and simple aromatics (BP < 100°C) by volatilization. In addition, the extraction partition coefficient for certain compounds does vary. For a measure of extraction efficiency, each sample and control samples (distilled organic free water) were spiked with Naphthalene-d₈ which resulted in recoveries between 75 and 85 percent.

5.5.5 Purge and Trap (Volatile Organic Analysis)

The volatile organics in water were qualitatively identified by utilizing EPA Method 624 with mass spectral identification. After examination of several representative samples, each water sample was quantitated by purge and trap with GC/FID.

5.5.5.1 Summary of Method. The GC/MS analysis was performed on a Finnigan 4000 with an INCOS data system. A Tekmar purge and trap apparatus was used according to EPA Method 624. The GC column used was a 6 ft x 1/8

in stainless steel packed with 0.2% CW 1500 on 60/80 Carboxpack C. Oven conditions were 15°C programmed to 190°C at 10°C/min and held for 25 minutes. A 5 ml aliquot of each sample was taken for analysis and spiked with 750 ng Bromofluorobenzene (BFB) for an internal standard. Comparison by identification by GC/MS was done by spectral library searches and comparison with known standards (Figures 5-9 and 5-10). Quantitative analysis was obtained by GC/FID (Figures 5-11 and 5-12) using the same identical chromatography conditions as employed with GC/MS qualitative analysis runs.

5.5.5.2 Interferences/Quality Control. Contamination can occur whenever high-level and low-level samples are analyzed sequentially. When utilizing GC/FID detection only, co-eluting peaks can give a positive bias to values obtained for the components of interest.

Data quality techniques utilized for these analyses included the following:

1. A complete purge of the system following a high level VOA sample.
2. Bromofluorobenzene (BFB) was used as an internal standard in all samples and control standards. In addition, benzene and toluene were quantitatively based on their respective response values to BFB.
3. When evidence of co-eluting was detected, values were not reported for selected compounds.

Table 5-2 gives concentration and quality parameters for an in-house standard and replicated results for TRW Sample No. 4973. BFB is bromofluorobenzene and was spiked into the in-house standard sample and the three replicated samples at the same concentration. The accuracy is estimated as the percent bias the mean of the three BFB readings is from the in-house standard, and is calculated to be about 52 percent. Precision is estimated as the pooled coefficient of variation for all the compounds (including BFB) and is calculated to be 9.6 percent. The sample here was not filtered before the replicated sample was drawn.

Table 5-3 gives GC/FID data for an induced air flotation (IAF) sample and a dissolved air flotation sample. These samples were filtered before analysis. Accuracy estimates for IAF and DAF, respectively are

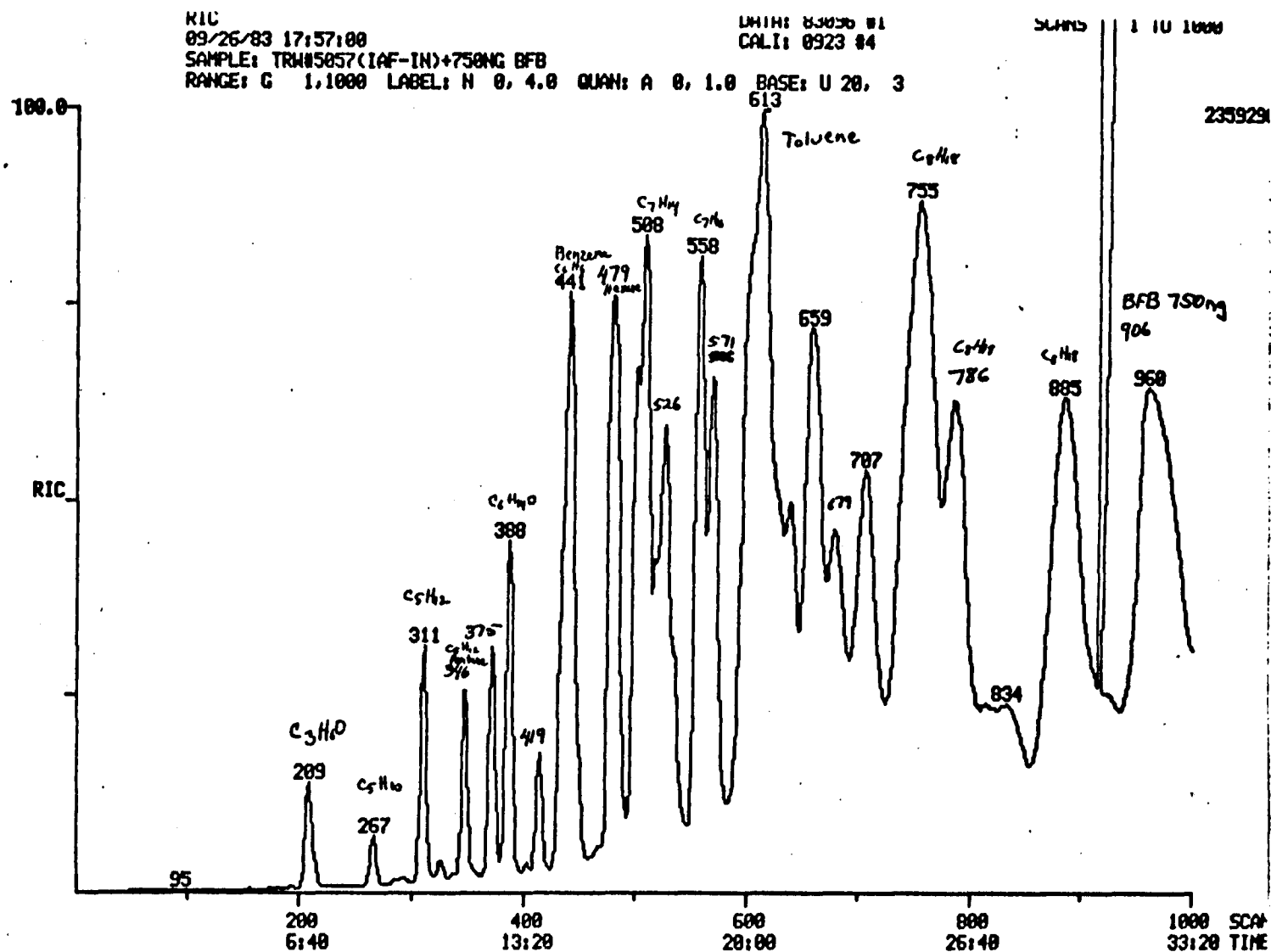


Figure 5-9. Mass spectrometer qualitative analysis by purge and trap, sample no. IAF-INLET-VOA-0740.

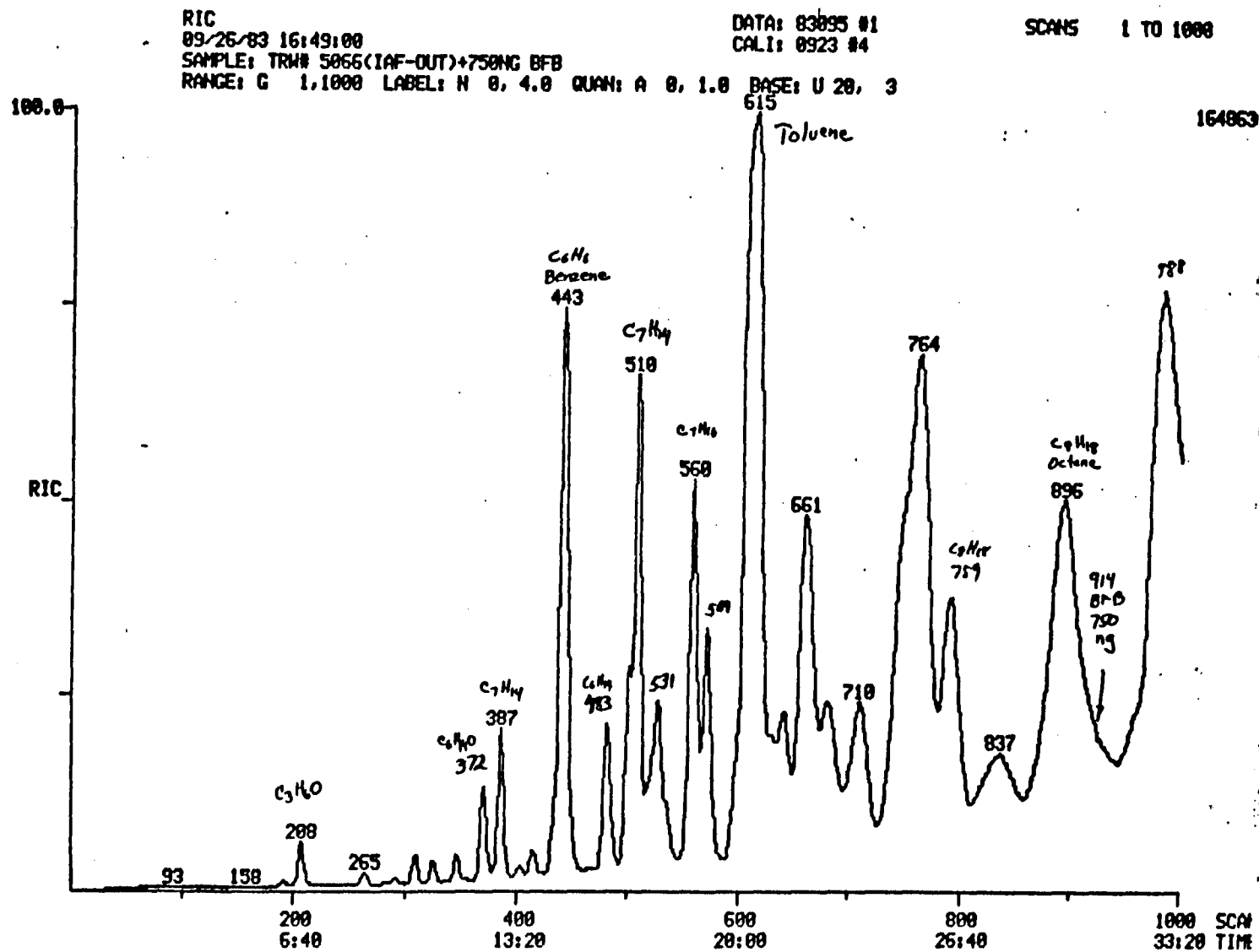


Figure 5-10. Mass spectrometer qualitative analysis by purge and trap, sample no. IAF-OUT-VOA-0740.

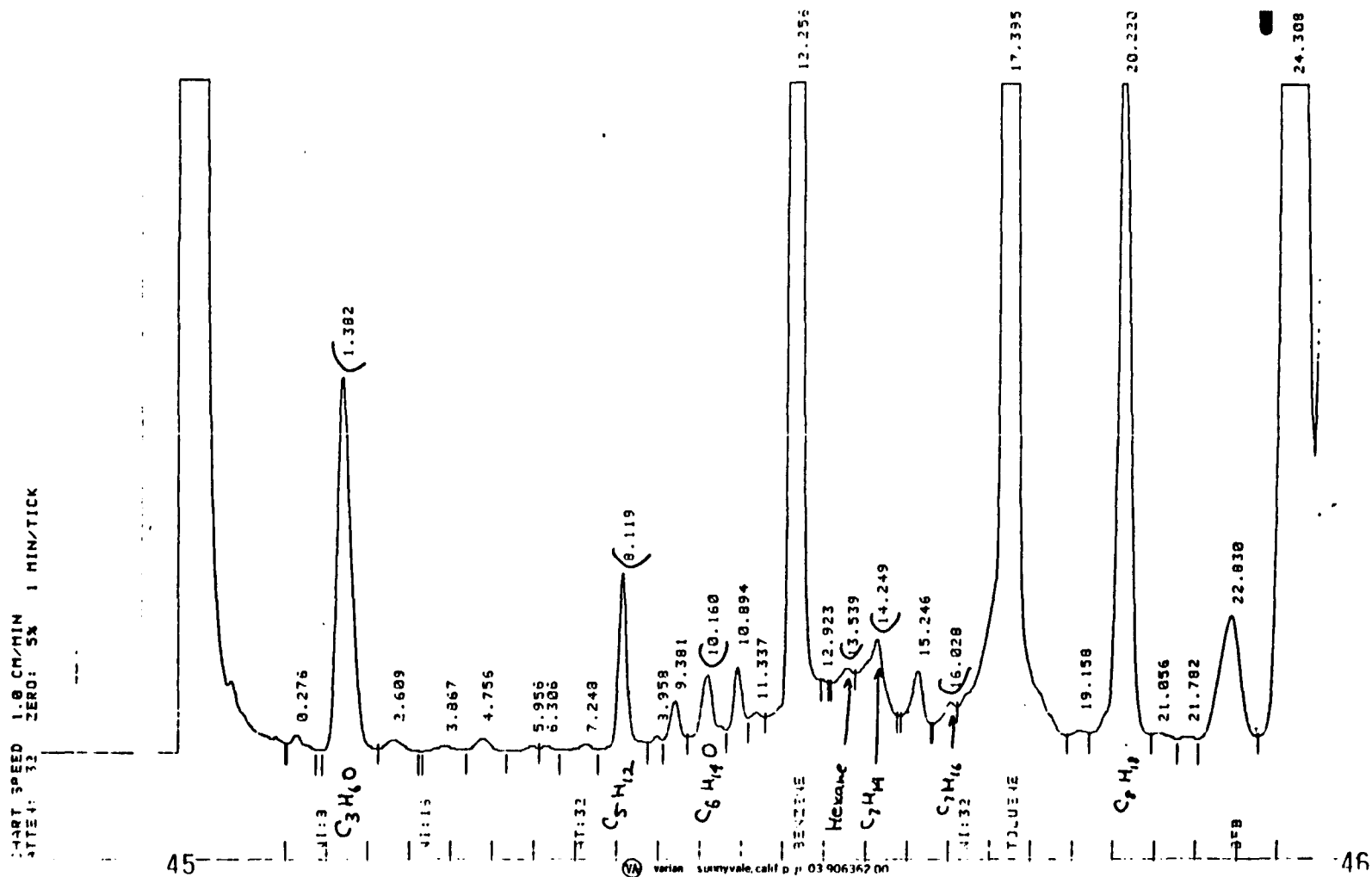


Figure 5-11. GC/FID quantitative analysis by purge and trap, sample no. IAF-INLET-VOA-0740.



Figure 5-12. GC/FID quantitative analysis by purge and trap, sample no. IAF-OUT-VOA-0740.

Table 5-2. GC/FID READINGS FOR ACCURACY/PRECISION ESTIMATES

Compound	In-house Standard ppb	TRW Sample No. 4973					
		Replication No.			Means ppb	Std. dev. ppb	CV —
		1 ppb	2 ppb	3 ppb			
C ₂ H ₆ S ₂	—	240	227	198	221.7	21.5	0.0970
C ₆ H ₆	352	187	174	142	167.7	23.1	0.1381
C ₆ H ₅ CH ₃	348	502	519	441	487.3	41.0	0.0842
BFB	596	863	927	927	905.7	37.0	0.0408

$$\% \text{ Accuracy} = \frac{905.7-596}{596} \times 100 = 51.9\%$$

$$\% \text{ Precision} = \text{pooled CV for compounds in Sample No. 4973} = 9.6\%.$$

Table 5-3. PRECISION/ACCURACY ESTIMATES FOR IAF/DAF SAMPLES

Compound	In-house Standard	IAF, TRW #4987			DAF, TRW #4994		
		1	2	CV	1	2	CV
C ₆ H ₂ S ₂ , ppb	—	939	943	0.0030	—	—	—
C ₆ H ₆ , ppb	—	1970	1770	0.3860	2120	1980	0.0483
C ₄ H ₁₀ S ₂ , ppb	—	411	410	0.0017	—	—	—
C ₆ H ₆ CH ₃ , ppb	—	5710	5020	0.0909	2110	2000	0.0379
BFB, counts	170417	143078	164324	0.5370	135529	139579	0.0208

For IAF:

$$\text{Accuracy} = \frac{170417 - ((143078 + 164324)/2)}{170417} \times 100 = 9.8\%$$

For DAF:

$$\text{Accuracy} = \frac{170417 - ((135529 + 139579)/2)}{170417} \times 100 = 19.3\%$$

Precision:

Pooled CV for IAF = \pm 29.8%.

Pooled CV for DAF = \pm 3.7%.

9.8 and 19.3 percent. The precision is 29.3 and 3.7 percent, respectively. In view of the fact that only duplicate analyses were performed, the precision figures for the filtered samples appears not to be significantly different (29.3 and 3.7 percent) from those for the unfiltered sample (9.6 percent). The accuracy for the filtered samples (9.8 and 19.3 percent) appear to be significantly better than the accuracy of the unfiltered sample (52 percent). It appears that the solid material in the unfiltered matrix decreased the accuracy possible in the analysis.

APPENDIX A

SAMPLE CALCULATIONS AND RESULTS

- **Flow and Emission Rate Calculation Examples**
- **Summary Gas Analysis Sheets**
- **Continuous Monitor Results**

APPENDIX A
EXAMPLE CALCULATIONS

Example #1 IAF - Flow Measurement with Vane Anemometers

$$(A) \quad V_{an} \text{ (CFM)} = \frac{Ft_{an}}{\text{min}} \times \text{Area}_{an} \text{ Ft}^2$$

$$(B) \quad V_s \text{ (SCFM)} = \left(\frac{V_{an} \times 17.64 \times P_b}{T + 460} \right)$$

(Example of flow measurement calculation during IAF #2-Inlet run on 9/22/83 at 948.

$$\begin{aligned} V_{an} \text{ Run 9-22 (CFM)} &= \frac{18590 \text{ ft}}{30 \text{ min}} \times .0873 \text{ ft}^2 \\ &= 54.1 \text{ CFM}_{an} \end{aligned}$$

$$\begin{aligned} V_s \text{ (SCFM)} &= \left(\frac{54.1 \times 17.64 \times 30.54}{68 + 460} \right) \\ &= 55.2 \text{ SCFM} \end{aligned}$$

SCFM = standard cubic feet per minute

V_{an} = volume measured through vane anemometer

V_s = volume standardized to standard temperature and pressure

P_b = barometric pressure

T = temperature of stack gas

Example # 2 Mass Emission Rate for VOC as C₃H₈

(A) Sample calculation to provide the conversion factor of C₃H₈ from ppm to mg/m³

$$\begin{aligned}
 CF_{C_3H_8} &= \left(\frac{44 \text{ g}}{\text{mole}} \right) \left(\frac{1 \text{ mole}}{25.71 \text{ L}} \right) \left(\frac{28.32 \text{ L}}{\text{ft}^3} \right) \left(\frac{35.31 \text{ ft}^3}{\text{m}^3} \right) \left(\frac{1000 \text{ mg}}{\text{g}} \right) \\
 &\quad \left(\frac{\text{mg/m}^3}{10^6 \text{ ppm}} \right) \\
 &= 1.71 \text{ mg/m}^3
 \end{aligned}$$

(B) Emission rate = lb/hr

$$\begin{aligned}
 E_{\text{voc}} &= \left(\text{VOC ppm} \right) \left(\frac{1.71 \text{ mg}}{\text{m}^3} \right) \left(\frac{\text{m}^3}{35.31 \text{ ft}^3} \right) \left(\frac{Q_s \text{ ft}^3}{\text{min}} \right) \left(\frac{60 \text{ min}}{\text{hr}} \right) \\
 &\quad \left(\frac{\text{g}}{1000} \right) \left(\frac{1 \text{ lb}}{453.6 \text{ g}} \right)
 \end{aligned}$$

Example - of Emission Rate calculation on IAF #2 9/22/83 run at 0948

$$\begin{aligned}
 E_{\text{VOC}} &= \left(3240 \text{ ppm} \right) \left(\frac{1.71 \text{ mg}}{\text{m}^3} \right) \left(\frac{\text{m}^3}{35.31 \text{ ft}^3} \right) \left(\frac{50.85 \text{ ft}^3}{\text{min}} \right) \left(\frac{60 \text{ min}}{\text{hr}} \right) \\
 &\quad \left(\frac{\text{g}}{1000 \text{ mg}} \right) \left(\frac{1 \text{ lb}}{453.6 \text{ g}} \right) \\
 &= 1.05 \text{ lbs/hr}
 \end{aligned}$$

Davis Anemometer Correction Chart

DAVIS INSTRUMENT MFG. CO., INC.
CALIBRATION CORRECTION CHART

SERIAL NO. _____

DATE June 16, 1983

TYPE - BALL BEARING

TRUE F.P.M.	INDICATED F.P.M.	TRUE F.P.M.	INDICATED F.P.M.
30	18	1800	1840
50	36	2000	2065
70	53	2200	2275
90	75	2400	2490
100	85	2600	2700
200	180	2800	2910
300	290	3000	3120
400	400	3200	3335
500	505	3400	3550
600	610	3600	3765
700	715	3800	3975
800	820	4000	4180
900	925	4200	4390
1000	1030	4400	4595
1200	1235	4600	4800
1400	1445	4800	5025
1600	1655	5000	5240

SUMMARY GAS ANALYSIS SHEETS

SUMMARY GAS ANALYSIS

IAFH / (SOUTH)

COMPONENT RUN	9/20/83 (1500)	9/20/83 (1645)	9/21/83 (1100)	9/21/83 (1430)
C-1	87.2	57.7	65.1	57.5
C-2	4.9	—	4.3	6.0
C-3	10.7	4.2	3.9	4.7
C-4	18.4	11.7	4.9 15.2	1.1
C-5	20.4	17.6	18.2 20.5	3.9
C-6 (Hexane)	145.3	85.9	110.0	63.6
BENZENE	161.1	91.0	135.2	95.1
TOLUENE Heptane	25.9	16.8	37.0	21.1
Toluene	139.4	95.2	94.1	67.0
XYLENE (meta)	45.4	34.2	33.3	21.1
Xylene (ortho)	20.7	12.4	10.3	8.5
TOTAL HC				
%M				
% CO2				
% CO				
% N2				
% O2				
% CH4				
TOTAL %				

DATE

TIME

BAG#

SUMMARY GAS ANALYSIS

IAFH / (S. 07.1) (C-1) (C-2) (C-3) (C-4) (C-5) (C-6) (C-7) (C-8) (C-9) (C-10) (C-11) (C-12) (C-13) (C-14) (C-15) (C-16) (C-17) (C-18) (C-19) (C-20) (C-21) (C-22) (C-23) (C-24) (C-25) (C-26) (C-27) (C-28) (C-29) (C-30) (C-31) (C-32) (C-33) (C-34) (C-35) (C-36) (C-37) (C-38) (C-39) (C-40) (C-41) (C-42) (C-43) (C-44) (C-45) (C-46) (C-47) (C-48) (C-49) (C-50) (C-51) (C-52) (C-53) (C-54) (C-55) (C-56) (C-57) (C-58) (C-59) (C-60) (C-61) (C-62) (C-63) (C-64) (C-65) (C-66) (C-67) (C-68) (C-69) (C-70) (C-71) (C-72) (C-73) (C-74) (C-75) (C-76) (C-77) (C-78) (C-79) (C-80) (C-81) (C-82) (C-83) (C-84) (C-85) (C-86) (C-87) (C-88) (C-89) (C-90) (C-91) (C-92) (C-93) (C-94) (C-95) (C-96) (C-97) (C-98) (C-99) (C-100)

COMPONENT RUN	9/22/83 (0930)	9/22/83 (1430)	9/22/83 (0915)
C-1	218.2	197.5	115.7
C-2	6.2	5.7	4.0
C-3	5.6	6.0	2.7
C-4	21.2	15.5	4.6
C-5	52.4	16.2	10.5
C-6 (Hexane)	352.2	213.5	41.3
BENZENE	353.4	201.1	60.4
TOLUENE Heptane		78.7	20.2
Toluene	217.4	140.2	53.7
XYLENE (meta)	118.4	62.4	26.2
XYLENE (ortho)	43.2	18.9	10.0
TOTAL HC			
SM			
% CO2			
% CO			
% N2			
% O2			
% CH4			
TOTAL %			

DATE

Time

BAG#

ANALYTICAL RESULTS
(S. 07.1) (C-1) (C-2) (C-3) (C-4) (C-5) (C-6) (C-7) (C-8) (C-9) (C-10) (C-11) (C-12) (C-13) (C-14) (C-15) (C-16) (C-17) (C-18) (C-19) (C-20) (C-21) (C-22) (C-23) (C-24) (C-25) (C-26) (C-27) (C-28) (C-29) (C-30) (C-31) (C-32) (C-33) (C-34) (C-35) (C-36) (C-37) (C-38) (C-39) (C-40) (C-41) (C-42) (C-43) (C-44) (C-45) (C-46) (C-47) (C-48) (C-49) (C-50) (C-51) (C-52) (C-53) (C-54) (C-55) (C-56) (C-57) (C-58) (C-59) (C-60) (C-61) (C-62) (C-63) (C-64) (C-65) (C-66) (C-67) (C-68) (C-69) (C-70) (C-71) (C-72) (C-73) (C-74) (C-75) (C-76) (C-77) (C-78) (C-79) (C-80) (C-81) (C-82) (C-83) (C-84) (C-85) (C-86) (C-87) (C-88) (C-89) (C-90) (C-91) (C-92) (C-93) (C-94) (C-95) (C-96) (C-97) (C-98) (C-99) (C-100)

C-1 (See ABOVE)

TRW
ENVIRONMENTAL ENGINEERING DIVISION

SUMMARY GAS ANALYSIS

IAF #2 (NORTH)

COMPONENT RUN	9/21/83 (C130)	9/21/83 (1545)	9/22/83 (1050)	9/22/83 (1550)
C-1	58.7	78.6	226.2	167.2
C-2	4.2	7.5	7.3	3.8
C-3	4.4	5.9	5.4	3.4
C-4	17.5	22.6	21.5	8.6
C-5	21.5	10.5	59.5	7.7
C-6 (Hexane)	128.5	133.7	292.5	109.7
BENZENE	134.3	171.8	287.0	122.4
TOLUENE HEPTANE	35.9	46.6	113.1	50.2
Toluene	87.0	116.5	178.2	96.5
XYLENE (meta)	26.1	43.9	73.9	46.9
XYLENE (ortho)	8.1	13.6	20.0	14.5
TOTAL HC				
%M				
% CO ₂				
% CO				
% N ₂				
% O ₂				
% CH ₄				
TOTAL %				

SUMMARY GAS ANALYSIS

IAF#2 (NORTH)

(CONTINUED)

COMPONENT RUN	9/13/83 (NIS)			
C-1	93.0			
C-2	3.4			
C-3	2.2			
C-4	3.5			
C-5	8.9			
C-6 (Hexane)	33.1			
BENZENE	53.4			
TOLUENE HEPTANE	20.3			
Toluene	52.2			
XYLENE (meta)	26.1			
XYLENE (ortho)	8.5			
TOTAL HC				
%M				
% CO2				
% CO				
% N2				
% O2				
% CH4				
TOTAL %				

CONTINUOUS MONITOR RESULTS

LOCATION IAF #1 - South POLLUTANT THC DATE 9-19-83
INSTRUMENT RANGE (PPM): 0-5000 CALIBRATED BY Dave-Paul Dayton
Record Data Every 3-5 Minutes + converted to hourly Averages.

[illegible][illegible]

NOTES:

TRW

LOCATION IAF # 1-South POLLUTANT THC DATE 9-20-83
INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton
Record Data Every 3-5 Minutes & converted to hourly averages.

Time	40V. Scale Reading	ppm
0000	22.1	1090.8
0100	21.8	1074.8
0200	21.4	1057.1
0300	20.7	1020.9
0400	20.8	1027.9
0500	21.9	1077.6
0600	23.5	1160.7
0700	25.1	1235.9
0800	21.9	1081.3
0900	18.0	904.8
1000	21.1	1040.3
1100	24.2	1198.6
1200	25.4	1261.6
1300	23.0	1137.7
1400	26.5	1313.2
1500	36.8	1833.8
1600	31.7	1576.9

[illegible]

NOTES:

LOCATION IAF # 1 - South POLLUTANT THC DATE 9-21-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes & converted to hourly Averages.

Time	ADU. Scale Reading	ppm
0000	26.7	1296.6
0100	37.8	1845.2
0200	40.3	1969.4
0300	41.6	2034.9
0400	42.0	2052.2
0500	40.4	1974.0
0600	39.9	1951.7
0700	39.2	1918.0
0800	38.4	1877.3
0900	32.9	1637.3
1000	34.1	1695.1
1100	32.7	1625.3
1200	30.6	1521.3
1300	27.9	1386.7
1400	30.3	1507.6
1500	29.3	1458.2
1600	40.0	1990.2

Time	ADU. Scale Reading	ppm
1700	40.7	2022.5
1800	38.7	1928.0
1900	33.9	1681.5
2000	28.9	12134.1
2100	25.1	1243.8
2200	25.2	1248.8
2300	26.7	1321.7

NOTES:



LOCATION IAF #1 - South POLLUTANT TNC DATE 9-22-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes + Converted To Hourly Averages.

Time	ADV. Scale Reading	ppm
0000	35.7	1772.3
0100	35.3	1754.4
0200	44.7	2223.7
0300	50.9	2533.5
0400	52.6	2618.8
0500	56.9	2834.1
0600	62.5	3110.6
0700	60.3	3002.4
0800	58.7	2923.7
0900	65.9	3357.7
1000	48.8	2485.3
1100	40.6	2067.4
1200	44.6	2270.6
1300	46.7	2377.9
1400	41.0	2087.0
1500	43.1	2190.5
1600	43.2	2123.8

Time	ADV. Scale Reading	ppm
1700	40.2	1978.9 2123.8
1800	33.0	1618.0
1900	33.6	1648.5
2000	30.1	1478.5
2100	23.7	1159.2
2200	36.5	1790.8
2300	42.2	2073.5

NOTES:

LOCATION IAF #1 - South POLLUTANT THC DATE 9-23-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave/Don/Dayton

Record Data Every 3-5 Minutes + Converted to hourly averages.

Time	ADV. Scale Reading	ppm
0000	31.8	1559.6
0100	29.9	1468.2
0200	23.7	1158.0
0300	23.3	1138.6
0400	18.7	913.1
0500	17.7	865.0
0600	13.9	677.3
0700	20.4	996.2
0800	21.0	1025.5
0900	24.0	1199.3
1000	21.1	1053.1
*1 1100	42.4	2118.4
*2 1200	52.2	2613.0
*3 1300	61.8	3090.5

Time	ADV. Scale Reading	ppm

NOTES: *1: AIR FLOW $\frac{1}{2}$ Normal

*2: 50% $\frac{1}{2}$ Air Flow - 50% No Air Flow

*3: No Air Flow

TRW

LOCATION IAF #2 - North POLLUTANT THC DATE 9-20-83

INSTRUMENT RANGE (PPM) 0 - 5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes + converted to hourly Averages

Time	Adv. Scale Reading	ppm
1700	23.0	1154.2
1800	20.4	1024.8
1900	21.4	1073.9
2000	22.3	1118.5
2100	22.6	1135.3
2200	23.9	1197.4
2300	20.8	1042.0

Time	Scale Reading	ppm

NOTES:

LOCATION IAF #2 - North POLLUTANT THC DATE 9-21-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes + converted To hourly Averages

Time	Adv. Scale Reading	ppm
0000	23.0	1151.6
0100	28.8	1448.2
0200	27.0	1356.2
0300	30.4	1525.4
0400	30.4	1525.4
0500	31.3	1571.2
0600	30.8	1546.0
0700	32.5	1634.2
0800	31.0	1559.3
0900	34.3	1739.3
1000	36.1	1834.3
Inst. Flame out + Re-Cal.		
1200	28.5	1419.6
1300	32.3	1610.5
Inst. Flame out + Re-cal.		
1500	44.9	2319.1
1600	52.1	2692.4

Time	Adv. Scale Reading	ppm
1700	53.9	2642.1 2788.6
1800	39.4	1916.7
1900	34.9	1695.7
2000	33.9	1642.6
2100	30.0	1449.0
2200	28.7	1387.1
2300	28.2	1359.2

NOTES:

TRW

LOCATION IAF #2 - North POLLUTANT THC DATE 9-22-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes + converted to hourly Averages.

Time	AVG. Scale Reading	ppm
0000	36.9	1794.2
0100	41.3	2015.2
0200	48.0	2347.9
0300	56.0	2744.2
0400	63.5	3121.4
0500	72.1	3548.9
0600	76.3	3759.9
0700	77.2	3805.2
0800	73.0	3594.8
0900	65.9	3239.8
1000	69.7	3428.4
1100	60.3	2960.3
1200	55.4	2715.6
1300	60.7	2981.0
1400	55.0	2694.4
1500	58.9	2891.7
1600	55.7	2777.2

Time	AVG. Scale Reading	ppm
1700	39.0	1937.4
1800	27.8	1372.7
1900	23.9	1172.7
2000	20.3	992.9
2100	20.7	1010.9
2200	30.0	1482.8
2300	29.2	1442.9

NOTES:

LOCATION IAF #2 - North POLLUTANT THC DATE 9-23-83

INSTRUMENT RANGE (PPM) 0-5000 CALIBRATED BY Dave-Paul Dayton

Record Data Every 3-5 Minutes + converted To hourly Averages.

Time	ADV. Scale Reading	ppm
0000	26.4	1300.4
0100	25.9	1273.9
0200	22.5	1105.9
0300	21.5	1055.0
0400	19.6	957.1
0500	21.5	1053.8
0600	14.0	673.9
0700	17.2	837.0
0800	19.4	947.5
0900	25.3	1250.0
1000	25.9	1278.1
*1 1100	51.6	2576.0
*2 1200	53.1	2650.8
*3 1300	58.7	2933.6

Time	ADV. Scale Reading	ppm

NOTES: *1: AIR FLOW CUT IN half

*2: 30 mins. $\frac{1}{2}$ flow + 30 mins No flow

*3: No Air flow

APPENDIX B
FIELD DATA SHEETS

IAF Anemometer Measurements

TRW

NO 1 INLET

FLOW MONITORING

LOCATION IAF No1 (South) INSTRUMENT ANEMOMETER DATE: 9/20
INLET.

RUN NUMBER _____ BY J. SHUMAKER

RECORD DATA EVERY (5) 10 MINUTES

START: 8:50

Time	Anemometer Reading	Temperature	Time	Anemometer Reading	Temperature
00	00	91°F			
5:00	5030 24750	92°F			
10:00	9780	93°F			
15:40	15410	92°F			
16:41	16240	92°F			
26:30	25810	92°F			
↑ WITHOUT BACK PRESSURE					
00:00	00 3750	92°F			
5:00	3750 2460	92°F			
9:01	6710 23670	94°F			
14:00	10380	94°F			
15:00	11110	94°F			
33:00	2 224390				

85 CFM
@ 92°F

WITH BACK
PRESSURE
START
1540

64.6 CFM
@ 94°F

NOTES:

64.6 55°F, 65.2 CFM @ 94°F
55°F

TRW

No. 1 OUTLET

FLOW MONITORING

LOCATION IAF No. 1 (South)
OUTLET

INSTRUMENT ANEMOMETER

DATE 9/20

RUN NUMBER Flow No 1

BY J. SHUMAKER

RECORD DATA EVERY (5) 10 MINUTES

START 11:36 AM.

Tues. Aft.

START 2:1436

THIS MORN
8:00-9:00

MIN:SEC Time	Anemometer Reading FT	OF Temperature
00	00	100 °F
8:05	1750 _{> 925}	99 °F
10:00	2275 _{> 1075}	99
15:05	3350 _{> 1675}	98
20:06	4360 _{> 2180}	98 °F
25:16	5380 _{> 2690}	98 °F
30:00	6385 _{> 3195}	98 °F
35:15	7540 _{> 3770}	99 °F
40:02	8560 _{> 4285}	99 °F
45:05	9605 _{> 4800}	98 °F
50:00	10560 _{> 5310}	98 °F
55:00	11550 _{> 5820}	98 °F
60:00	12650	98 °F

18.4 ALFA
@ 99 °F

MIN:SEC Time	Anemometer Reading FT	OF Temperature
00	00 ₉₈₅	101 °F
5:05	985 ₁₀₁₀	101 °F
10:19	1895 ₁₀₁₀	101 °F
15:00	2805	102 °F
	3540	
	4620	
	5680	

16.1 ALFA
@ 101 °F

NOTES: MORNING
AMBIENT TEMPERATURE: 87°

BAROMETRIC: 29.85 IN WATER

AFTERNOON
94° F

29.86 IN H₂O

212.2 f/min
5 11060
1000

TRW

FLOW MONITORING

LOCATION IAF-1 - INLET

INSTRUMENT *Aug 24 0.74822*

DATE 9/21/83

RUN NUMBER ELCU AIR INTO IAF BY J. S. Hernandez

RECORD DATA EVERY 5-10 MINUTES

START TIME: 1003

STAR 1425

[illegible][illegible]

67.9
ACFM
@ 70°

NOTES:

AMBIENT TEMP: 60°F

Barometric : 30.53 in H₂O
Pressure :

70°F

30.55, 2 H₂O

4236412

FLOW MONITORING

IAF !
OUTER.

LOCATION IAF-1-OUTLET

INSTRUMENT Anemometer

DATE: 9/21/83

FLOW OF AIR/VAPOR

RUN NUMBER IAF-1 OUTLET MORNING BY J. S. FUMAKER

RECORD DATA EVERY 5-10 MINUTES

START TIME: 11:27

STAFF
1550

[illegible][illegible]

285ACFW@
B54

4402153

27.3
e 9

NOTES: AMBIENT TEMP: 65°F

Barometric pressure - 30.54 in H₂O

6830

06727 FT²

LOCATION IAF-1 INLET.

INSTRUMENT ANEMOMETER

DATE: 9/22/85

RUN NUMBER *Flow*

BY J. S. HUMAKER

RECORD DATA EVERY 5-10 MINUTES

STAY TIME

1637

8:58

[illegible]

NOTES:

3. AMBIENT TEMP: 64°F

BAZOMETRIC

PRESSURE: 36.53 IN H₂O

76^{EF}

TRW

FLOW MONITORING

IAF 1
OUTLET

LOCATION IAF 1 (SOUTH) OUTLET INSTRUMENT ANEMOMETER DATE 9/22/83

RUN NUMBER FLOW OUTLET BY J. SHUMAKER

RECORD DATA EVERY 10 MINUTES

START 1100

START
1521

31.0
ACFM
@ 1020F

Run Start Time	Anemometer Reading F	°F Temperature
00	9100 ₁₇₀₀	103°F
5:00	10860 ₁₇₇₀	102°F
10:00	12630 ₁₉₈₀	102°F
15:30	14610	102°F

Run Start Time	Anemometer Reading F	°F Temperature
00:00	6100	111°F
5:02	7980	111°F
10:02	9580	111°F
15:10	11,220	109°F

29.5
ACFM
@ 111°F

NOTES: AMBIENT : 71°F
TEMPERATURE.

AMBIENT TEMP 76°F

BARO-METRIC
PRESSURE :

FLOW MONITORING

LOCATION IAF-1 ~~NO. 276~~ ⁴⁰⁴⁵ INSTRUMENT AN-401632 DATE 9/23/83

RUN NUMBER FLW BY J. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

REDUCE FLOW TO DEFN 1 2: - (1/2)
F 1017 1EN 300 FT/MIN

START TIME 0854

START TIME 10:56

[illegible][illegible]

FT PER 04

305

307

3:1

682.5

500

417

913

308.5

306 av.

3.0

LAST
MINUTE
O. F. MEASUREMENT
Fixed.

26.8

ACFmE

-76°F

NOTES: AMBIENT 67°F
TEMP.

Barometric Pressure: 30.55 in H₂O

2158

TRW

IAF 1
OUTLET

FLOW MONITORING

LOCATION IAF NO 1 SOUTH OUTLET INSTRUMENT ANEMOMETER DATE 9/23/83

RUN NUMBER FLOW OUTLET BY J. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

START TIME

1000

~~1056 START TIME~~

Time	Anemometer Reading	Temp
00	4150	102°F
5:00	6160	103°F
10:00	8135	103°F
15:00	9915	103°F

Time	Anemometer Reading	Temperature
00	3320	75°F
3:00	4245	75°F
5:00	4860	76°F
11:23	6850	75°F
20:22	9580	76°F

33.5
ACFM @
N 103°F

NOTES: AMBIENT TEMP: 73°F

AMBIENT TEMP 75°F

TRW

FLOW MONITORING

IAF /
OUTLET
"NO FLOW"

LOCATION IAF No 1 South INSTRUMENT Anscombe 562 DATE 9/23/83

RUN NUMBER Flow - BY J. SHUMAKER.

RECORD DATA EVERY 5-10 MINUTES

START TIME 1242

[illegible]

2.56
ACFM
C-120.5F

NOTES:

NO 2 INLET.

LOCATION LAF No 2 (North)
INLET

DATE: 9/20

RUN NUMBER

BY

J. SUMNER

RECORD DATA EVERY 5-10 MINUTES

STARF 1813

WITH BACK
PRESSURE

$$\frac{100}{x} \times \frac{\pi \left(\frac{4}{12}\right)^2}{4}$$

52.36 MPa
- @ 76°F

NOTES:

AMBIENT TEMP: $80^{\circ}\text{F} \pm 3$

BAROMETRIC PRESSURE. 29.86 IN H₂O

NO2 INLET.

LOCATION IAF-2 (NORTH)

INSTRUMENT *Anemometer*

DATE: 9/21

RUN NUMBER AIRFLOW INLET.

BY J. SILVERMAN

RECORD DATA EVERY ~~5~~-10 MINUTES

START: 21507

WEDS MORN
START.

A7.4 ALPM
C58F

44.2 N.E.
@ 71°

NOTES: AMBIENT TEMP: 58°F
OF

BAROMETRIL ~~FLU~~

PRESSURE IN H_2O : 30.52

70°F

30.52 in H₂O

FLOW MONITORING

IAF-2
OUTLET

LOCATION IAF-2 (NORTH) OUTPOST INS

INSTRUMENT Amendment DATE: 9/21/83

RUN NUMBER Five

BY JEFF. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

START
1620

START. 1355

[illegible]

21. CALFM
085F

217A
C

NOTES:
AMBIENT: 70°F

Barometric pressure: 30.55 in H₂O

71°F

30.50, 24, 0

FLOW MONITORING

LOCATION IAF2 NORTH INLET. INSTRUMENT ANEMOMETER DATE: 4/22

RUN NUMBER Flow - INLET. BY J. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

STATS TIME

START 9.48

16-11

[illegible]

NOTES: AMBIENT TEMPERATURE: 68°F

76°F

BAROMETRIC PRESSURE: 30.54" IN H₂O

TRW

FLOW MONITORING

IAF 2
OUTLET

LOCATION IAF 2 NORTH OUTLET INSTRUMENT Anemometer DATE: 9/22/83

RUN NUMBER FLOW OUTLET BY J. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

START 1122

START
81543

MIN SEC ELAPSED Time	Anemometer Reading FT	OF Temperature	MIN SEC ELAPSED Time	Anemometer Reading FT	OF Temperature
00:00	6100	98°F	00:00	2350	102°F
6:30	7650	98°F	5:05	3790	102°F
10:00	8510	98°F	12:05	5515	102°F
15:00	9705	98°F	15:02	6280	102°F

21.0 ACFM
@ 98°F

22.9
ACFM
@ 102°F

NOTES: AMBIENT TEMP: 72°F

76°F

IAF 2
outlet.

LOCATION TAF NO 2 NORTH. ^{OUTLET} INSTRUMENT ANEMOMETER DATE: 9/23/83

RECORD DATA EVERY 5-10 MINUTES

7A.2 A451
@ 21020F

NOTES: AMBIENT TEMP: 78°F

300 ft/min

TRW

FLOW MONITORING

IAF NO 2
INLET.

LOCATION IAF-2 NORTH INLET INSTRUMENT ANEMOMETER DATE: 9/23/83

RUN NUMBER Flow inst. BY J. SHUMAKER

RECORD DATA EVERY 5-10 MINUTES

5742744 : 0934

2056

~~Flow Expected~~
~~to 1/2 H~~

[illegible]

53.5
ACFM
@ ~ 72°F

RECORDED
ON WA
SHZET
S22 17
11

NOTES: AMBIENT TEMP: 73°F

AMBIENT TEMP 75°F

BAROMETRIC PRESSURE 30.55 in H₂O

Liquid Sampling Log

PHILLIPS Petroleum/Sweeney - LIQUID SAMPLES

<u>SAMPLE LOCATION</u>	<u>TYPE SAMPLE</u>	<u>#/ DAY</u>	<u>TOTAL SAMPLES</u>	<u>REMARKS</u>
A'	COMPOSITE	1	4	
	VOA	2	7	
C	COMPOSITE	1	4	
	VOA	2	7	
D	COMPOSITE	1	4	
	VOA	2	7	
CPI#1 INLET	GRAB	1	4	ALL CPI'S had 1 sample on 9/20 & 9/23
	VOA	2	6	
CPI#1 OUTLET	GRAB	1	3	} No tank. No sample on 9/20/83
	VOA	2	5	
CPI#2 INLET	GRAB	1	4	
	VOA	2	6	
CPI#2 OUTLET	GRAB	1	4	
	VOA	2	6	
CPI#3 INLET	GRAB	1	4	
	VOA	2	6	
CPI#3 OUTLET	GRAB	1	4	
	VOA	2	6	

56 - VOA

25 - VOA

WORK SHEET

Phillips Perry / Suceny

CS
9/20/83

Sample Location	DATE	SAMPLE TYPE	TIME	SAMPLE #
C	9/20	VDA	1030	
D	"	"	1030	
A'	"	"	1030	
CPI-2-OUT	"	"	1813	
CPI-3-IN	"	"	1700	
CPI-1-IN			1700	
CPI-2-IN			1700	
CPI-3-OUT			1700	
A'	"	"	1830	
C	"	"	1830	✓
D	"	"	1830	
CPI-2-OUT	"	CRAB	1700	
CPI-3-IN	"	CRAB	1700	
CPI-2-IN	"	"	"	
CPI-3-OUT	"	"	"	
CPI-1-IN	"	"	"	
IAF #1 OUT	C	COMP		
IAF INLET	A'	"		✓
IAF #2 OUT	D	"		

SAMPLE PACKING SHEET

9/21 (1/2)

Sample Site:

Pine / Sweet

CCS ID No:

Test No:

Sample No	Collected	Date Recov-	Time	Weight	Volume	pH	Field Adjustments/Observations
(lbs/oz)				(g)	(ml)		
V0A-A'-9/21-0855							
V0A-C-9/21-0855							✓
V0A-D-9/21-0855							
V0A							
V0A-CPI-1-OUT-0930		9/21					✓
" " 2 " "							
" " 3 " "							
GRAB-CPI-1-OUT-0930							
" " 2 " "							
" " 3 " "							
V0A-CPI-1-IN-0945							
" " 2 " "							
" " 3 " "							
GRAB-CPI-1-IN-0945							
" " 2 " "							
" " 3 " "							

9/21 (2/2)

SAMPLE PACKING SHEET

Sample Site: PHILLIPS / Sweeney CCS ID No: _____ Test No: _____

Sample No	Collected	Date Recov-	Time	Weight	Volume	pH	Field Adjustments/Observations
	(lbs/gal)	(sec/Lb)		(g)	(ml)		
VOA-CPI-1-	IN-9/21-	1600					
" " 2	" - "	"					
" " 3	" - "	"					
" " 1	OUT-	"					
" " 2	" "	"					
" " 3	" "	"					
VOA-IAF-A'	9/21-	1445					
" " C	- "	"					✓
" " D	" "	"					
Pump IAF-A'	9/21	Composite					
" " C	" "	"					
" " F	" "	"					

Th. 9/22/83

CBL

SAMPLE PACKING SHEET

Sample Site:

Phillips / Sweeney

CCS ID No:

Test No:

Sample No	Collected (yes/no)	Date Recov- ered (Date)	Time	Weight (g)	Volume (ml)	pH	Field Adjustments/Observations
A'-VOA-9/22-0920							
C " "	"	"					
D " "	"	"					
(CPI#2) OUTLET-GRAB-9/22-0930							
CPI#1 " "	"	"					
CPI#3 " "	"	"					
CPI#1 INLET " "	"	"	0940				
CPI#2 " "	"	"	"				
CPI#3 " "	"	"	"				
CPI#1 " VOA	"	"	"				
CPI#2 " "	"	"	"				
CPI#3 " "	"	"	"				
CPI#1 OUTLET " "	"	"	0950				
CPI#2 " "	"	"	"				
CPI#3 " "	"	"	"				

SAMPLE PACKING SHEET

9/22/83
GSL

Sample Site: PHILLIPS / Sweeney CCS ID No: _____ Test No: _____

Sample No	Collected	Date Recov-	Time	Weight	Volume	pH	Field Adjustments/Observations
	(yes/no)	ered (P/CR)		(g)	(ml)		
A' - VOA - 9/22 - 1600							
C - " - " - "							
D - " - " - "							
VOA							
CPI#1) Inlet - 9/22 - 1600							
CPI#2) Inlet - VOA - 9/22 - 1600							
CPI#3) Inlet - VOA - 9/22 - 1600							
CPI#1) Outlet - VOA - 9/22 - 1600							
CPI#2) Outlet - " " "							
CPI#3) Outlet - " " "							
A' - Cond - 9/22							
C - " - " - "							
D - " - " - "							

9/23/83

62

PHILLIPS / Sweeney

Test No: _____

1400 Form 202

9/23/83

Phillips / Swenson

CCS ID No:

Test No:

[illegible]

APPENDIX C
ANALYTICAL DATA

- **Gas Chromatograph Worksheet**
- **Continuous Monitor Example**
- **GC/FID Examples**

GC WORKSHEETS

WORK-SHEET

CALIBRATION FOR MINI 2
PHENOL/SUCROSE, T-23

47.6 ppm

	Time	RF (10x32)			(RF)			(10x32)		
Benzene										
9/20	1.33	12517	13038	3087	(0.0037)	0.01612		0.0161		
9/21	1.47	3133	3127	3.77	3157	3187	3204	0.015745	0.0158	
9/22	1.49	3125	3120	3167	3187			0.01559	0.0156	
9/23	1.48	3076	3144					0.01565	0.0159	

46.9 ppm

m-Xylene		RF (10x32)								
9/20	2.87	18924	20271	4620				(0.0035)	0.0038	0.0108
9/21	3.8	5422	5574	4715	5255	5715	5504	0.009297	0.0110	
9/22	3.87	5870	5650	5587				0.008725	0.0087	
9/23	3.8	4781	5525					0.00855	0.0077	

Retention Time	7/22/83	9/20	9/21	9/23
Heptane	1.13	1.22	1.22	1.17 1.18
Benzene	1.45	1.52	(1.51)	(1.53)
Hexane	1.67	1.72	1.81	1.74
Toluene	2.12	2.12	2.29	2.03
M-xylene	3.27	3.27	3.33 (4.1)	3.21 (3.0)
p-xylene	4.01	4.01	4.14	4.01

WORK SHEET

ALIBRATION For Mini 1
PHILLIPS / Sweeny Texas

	Time												
Methane	5 min												
9/20	0.58	1827	1761	1679	0.0088	Butane	11.3 min	9/20	2.21	466	441	521	0.0237
9/21	0.56	285	2097	2082	1869	0.0079	9/21	2.71		643	557	0.0205	
9/22	1.48	11730	876	0.0177		9/22			1293				
9/23	.6	823	0.0188			9/23	3.08		1292				
Ethane							10.13 min						
9/20	.81	215	216	243	0.0476	Pentane	4.83		578	495	600	0.0182	
9/21	.83	0.0426	257	284	263	251	9/20	7.27		721	778	0.0135	
9/22	.85		354	626	0.0218	9/21							
9/23	.85	613	0.0175			9/22							
						9/23	7.93		1500				
Propane	7 min												
9/20	1.18	353	338	345	0.0316	Hexane	11.53			621			
9/21	1.36	0.0256	366	431	487	399	9/20						
9/22	1.41	448	901			9/21							
9/23	1.41	867				9/22							
						9/23							

GC WORKSHEET

COLUMN: PROCIL CRUN NUMBER: 7AF#1 (SOUTH) 1500DATE: 9/20/83

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	.62	9913				37.2	
C ₂	.8	103				4.9	
C ₃	1.18	213				6.7	
BUTADIENE	UK 1.91	213				5.0	
C ₄	2.17	778				18.4	
C ₅	UK 4.17	1361				24.8	
	4.81	1121				20.4	
C ₆ (Heptane)	UK 5.37	378					
BENZENE	UK 8.47	218					
TOLUENE	UK 9.61	1084					
XYLENE	UK 10.74	421					
ETHYLENE BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: DV-101RUN NUMBER: IAF#1 (SOUTH) 1500DATE: 9/20/83

Bag #1

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE CM ¹²
C ₁					UK 7.2	1779	
C ₂					UK 8.26	4055	
C ₃					UK 9.73	4104	
BUTADIENE C ₄					UK 12.4	2158	
C ₅	UK 10.91	40964			UK 14.73	2411	
C ₆ (Hexane)	1.06	37285					145.3
BENZENE	1.32	41324					161.1
TOLUENE	UK 1.61 (Heptane) 1.82	6651 35772					25.9 139.4
XYLENE	UK 2.51 2.85	3135 17839					45.4
ETHYL BENZENE	UK 3.2 4.73 2.85	8131 12256 17839					20.7
STYRENE	UK 5.66 6.4	5854 2743					
TOTAL HYDRO- CARBONS (THC)							

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAFH(Sum)1645DATE: 9/20/83

BAL #2

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	UK 0.9	5492					
C ₆ (Hexane)	1.06	5330				85.9	
BENZENE	1.32	6144				99.0	
TOLUENE	1.63 (Heptane) 1.82 2.5	1041 510 516				16.8 95.2	
XYLENE	2.85	3166				34.2	
ETHYL ETHYL BENZENE	3.2 UK 4.73 UK 5.66	1153 1277 734				12.4	
STYRENE	UK 7.8	591					
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN:

POROCIL C

RUN NUMBER:

2AFH1 (SCOUT) 1645

DATE:

9/20/83

BAG # 2

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	0.61	6554				57.7	
C ₂	UK 1.13	102					
C ₃	1.23	134				4.2	
BUTADIENE	UK 1.13	102				2.4	
C ₄	UK 2.04	174				4.1	
	3.43	422				11.7	
C ₅	UK 3.78	151				2.5	
	UK 4.81	959				17.4	
	5.44	165				17.6	
C ₆ (Hexane)	UK 6.08	266				4.8	
BENZENE							
TOLUENE							
XYLENE							
ETHYL- BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

GC WORKSHEET

COLUMN: POROCIL CRUN NUMBER: IAF#2 (N₀₂₇₄) 930DATE: 9/21/83

BAG #3

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND AVG	CONCENTRATION AS BENZENE CMPD
C ₁	0.6	7946	58.7	7945	58.7	7945	58.7
C ₂	0.84	104	4.3	100	4.2	102	4.2
C ₃	1.39	153	4.3	165	4.6	158	4.4
BUTADIENE C ₄	UK 2.57 3.03	337 757	15.7	264 927	19.3	250 842	17.5
C ₅	UK 5.33 UK 6.57	1691		863 2183		1937	
C ₆ (Heptane)	7.77	1748		1432		1590	21.5
BENZENE	UK 8.8	604		345		474	
TOLUENE							
XYLENE							
ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAF#2 (N₂ 930)DATE: 9/21/83

BAG #3

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st RUN</i>	SPAN	ATTENUATION <i>2nd RUN</i>	DILUTION FACTOR (Diluted w/N ₂) <i>Avg</i>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
<i>C₁</i>							
<i>C₂</i>							
<i>C₃</i>							
BUTADIENE <i>C₄</i>	UK 0.7	4586		4452	4522		
<i>C₅</i>	UK 1.03	5181		5371	5276		
<i>C₆</i> (Hexane)	UK 1.25	8360		8118	8239	128.5	
BENZENE	1.57	8610		8610	8610	134.3	
TOLUENE	<i>UK 2</i> 2.34 UK 2.77	2324 5414 1153		2271 5265 1137	2301 5387 1145	35.7 84.0	
XYLENE	UK 3.5 4.1	949 2805		921 2805	935 2805	26.1	
ETHYL BENZENE	UK 4.71 UK 5.41 UK 7.44	704 371 962		849 375 534	876 383 748	8.1	
STYRENE	UK 7.28 UK 11.01 UK 12.21	578 223 466		31.7	447 223 466		
TOTAL HYDRO- CARBONS (THC)							

GC WORKSHEET

COLUMN: 01-101RUN NUMBER: IAFH (Sunt) 1100DATE: 9/21/83

Bac #3

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st run</i>	SPAN	ATTENUATION <i>2nd run</i>	DILUTION FACTOR (Diluted w/N ₂) <i>Avg</i>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
<i>C₁</i>							
<i>C₂</i>							
<i>C₃</i>							
BUTADIENE	<i>UK 0.87</i>	<i>4570</i>		<i>4662</i>	<i>4616</i>		
<i>C₄</i>	<i>UK 1.02</i>	<i>4594</i>		<i>4594</i>	<i>4594</i>		
<i>C₆ (Heptane)</i>	<i>UK 1.25</i>	<i>7135</i>		<i>6573</i>	<i>7054</i>	<i>110.0</i>	
BENZENE	<i>1.56</i>	<i>8680</i>		<i>8665</i>	<i>8672</i>	<i>135.2</i>	
HEPTANE TOLUENE	<i>UK 1.99</i> <i>UK 2.33</i> <i>UK 2.83</i>	<i>2374</i> <i>6120</i> <i>1400</i>		<i>2373</i> <i>5548</i> <i>1258</i>	<i>2373</i> <i>6036</i> <i>1347</i>	<i>37.0</i> <i>94.1</i>	
XYLENE	<i>UK 3.44</i> <i>4.11</i>	<i>1264</i> <i>3776</i>		<i>1041</i> <i>3395</i>	<i>1156</i> <i>3585</i>	<i>33.3</i>	
XYLENE ETHYL BENZENE	<i>UK 4.68</i> <i>UK 5.34</i> <i>UK 7.41</i>	<i>1273</i> <i>710</i> <i>1362</i>		<i>945</i> <i>480</i> <i>763</i>	<i>1107</i> <i>595</i> <i>1062</i>	<i>10.3</i>	
STYRENE	<i>UK 8.34</i> <i>UK 9.21</i>	<i>178</i> <i>628</i>		<i>116</i> <i>474</i>	<i>157</i> <i>551</i>		
TOTAL HYDRO- CARBONS (IHC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: Porocil CRUN NUMBER: INFH/SS0074) 1100DATE: 9/21/83

BAG #3

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
		1st	2nd		Avg		
C ₁	0.1p	8207	628	8289	8248	65.1	
C ₂	0.83	107	0.8	105	106	4.3	
C ₃	1.37	151	1.37	151	151	3.9	
BUTADIENE	DK 2.5	733	0.1	732	232	4.7	
C ₄	2.97	738		748	743	15.2	
	DK 4.77			775			
C ₅	DK 6.33	1514		2522	2018		
C ₆ (Hexane)	→ 7.5	1549		1461	1905	20.3	
BENZENE	DK 8.47	456		1586	1022		
TOLUENE							
XYLENE							
ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAFA 1 (SOUTH) 1430DATE: 9/21/83

BAG #4

COMPOUND	RETENTION TIME IN CM.	COUNTS (<u>Run #1</u>)	SPAN	ATTENUATION (<u>Run #2</u>)	DILUTION FACTOR (Diluted w/N ₂) <u>Avg</u>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	DK 1.02	3423		3518	3470		
C ₅ (Heptane)	DK 1.22	3725		4228	4076	63.6	
BENZENE	1.51	5852	72.3	6191	77.7	6021	95.1
TOLUENE	DK 1.91 (Heptane) DK 2.21	1098 3656		1612 4935	1355 4295	21.1 67.0	
XYLENE	DK 2.67 DK 3.23 3.77	= 1294	12.3	1075 831 3156	30.0	2225	21.1
XYLENE ETHYL BENZENE	DK 4.27 DK 4.84 DK 6.67		12.3	914 380 1451	914 380 1451	8.5	
STYRENE	DK 8.21			734	734		
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: Porocil - CRUN NUMBER: IAF#1 (SOUTH) 1430DATE: 9/21/83

BAG # 4

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	0.6	7779	57.5			57.5	
C ₂	0.83	145	6.0			6.0	
C ₃	1.32	168	4.7			4.7	
BUTADIENE C ₄	UK 2.5 UK 2.72 2.97	186 661 52	1.1		UK 3.14 378	1.1	
C ₅	7.4	284	3.9		UK 3.64 135	3.9	
C ₆ (Hexane)					UK 3.87 174		
BENZENE					UK 4.04 205		
TOLUENE					UK 4.37 347		
XYLENE					UK 5.64 945		
ETHYL BENZENE					UK 6.6 944		
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: POROCIL - CRUN NUMBER: IAF# 2 (NORTH) 1545DATE: 9/21/83PAGE # 4

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st RUN</i>	SPAN	ATTENUATION <i>2nd RUN</i>	DILUTION FACTOR (Diluted w/N ₂) <i>Avg</i>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	0.6	10581	76.7	10203	80.6	10641	78.6
C ₂	0.82	167	7.0	189	7.9	178	7.5
C ₃	1.31	210	5.9	212	6.0	211	5.9
BUTADIENE C ₄	<i>UK 1.77 UK 2.32 UK 2.72</i>	<i>60 497 1312</i>	0	<i>276 278</i>	<i>384 1105</i>	22.6	
C ₅	<i>UK 4.1 UK 5.63 UK 6.57</i>	<i>345 2342 2757</i>		<i>1791 1730</i>	<i>2066 2343</i>		
C ₆ (Heptane)	→ 7.37	788	10.9	729	10.1	758	10.5
BENZENE	<i>UK 9.87 UK 11.0</i>	—		<i>95 127</i>	<i>95 129</i>		
TOLUENE							
XYLENE							
ETHYLENE BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAF#2 (N_{entm}) 1545DATE: 9/21/83

BAG #4

COMPOUND	RETENTION TIME IN CM.	COUNTS <u>1st Run</u>	SPAN	ATTENUATION <u>2nd Run</u>	DILUTION FACTOR (Diluted w/N ₂) AUG ²	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	UK 1.01	6984		6967	6975		
C ₆ (Heptane)	UK 1.21	8698		8381	8539	133.1	
BENZENE	1.51	10937	172.6	10836	170.9	10887	171.8
TOLUENE	UK 1.86 (Heptane) 2.16 UK 2.61 UK 3.13	3025 7487 1737 1551		2157 7454 1778 1607	2491 7469 1458 1583	46.6 116.5	
XYLENE	3.65	4665	44.3	4587	43.6	4626	43.9
ETHYL BENZENE	UK 4.13 UK 4.66 UK 5.56	1563 1053 406		1368 841 237	1465 947 321	13.6	
STYRENE	UK 6.4 UK 7.86 UK 7.13	2404 1072 305		2293 780 265	2348 1036 283		
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAF#1 (S.D.14) 0915DATE: 9/23/83BAG # 7

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st Run</i>	SPAN	ATTENUATION <i>2nd Run</i>	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE cmcd
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅							<i>UNKNOWN</i>
C ₆ (Hexane)	<i>UK 1.02</i> 1.22	<i>2712</i> 2562		<i>2741</i> 2642			<i>41.3</i>
BENZENE	1.52	3821	60.0	3936	61.9		60.9
TOLUENE	<i>UK 1.9 (Heptane)</i> 2.22	<i>1219</i> 3418		<i>1244</i> 3238			<i>20.2</i> 53.7
XYLENE	<i>UK 2.7</i> <i>UK 3.23</i> 3.77	<i>1133</i> <i>1314</i> 2911	25.6	<i>1060</i> <i>1374</i> 3046	26.8		26.2
XYLENE ETHYLE BENZENE	<i>UK 4.33</i> <i>UK 4.9</i> <i>UK 5.8</i>	<i>1057</i> <i>1002</i> 297		<i>1014</i> <i>879</i> 240			<i>10.0</i>
STYRENE	<i>UK 6.7</i> <i>UK 7.43</i>	<i>1519</i> 406		<i>1314</i> 279			
TOTAL HYDRO- CARBONS (THC)	<i>UK 8.37</i> <i>UK 9.6</i>	<i>753</i> 67		<i>783</i> 95			

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: Porocil CRUN NUMBER: IAF#15507H) 0915DATE: 9/23/83

BA6H7

COMPOUND	RETENTION TIME IN CM.	COUNTS 1 st Run	SPAN 1000	ATTENUATION 2 nd Run	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	0.6	7447	138.5	4998	93.0		115.7
C ₂	0.85	266	4.6	194	3.4		4.0
C ₃	1.39	257	3.2	173	2.2		2.7
BUTADIENE C ₄	DE 1.95 UK 2.53 3.01	230 655	5.8	61 137 154	3.5		4.6
C ₅	UK 6.46 7.66	1700 1873	12.6	1255 1245	8.5		10.5
C ₆ (Hexane)	UK 8.6	1247		1308			
BENZENE							
TOLUENE							
XYLENE							
XYLENE ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

GC WORKSHEET

COLUMN: POROCIL CRUN NUMBER: IAFH2 (NORTH) 1015DATE: 9/23/8313.76 H⁺ 7

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁	0.6	5007	93.1	4758	93.0		93.0
C ₂	0.84	177	3.4	194	3.4		3.4
C ₃	1.38	178	2.2	173	2.2		2.2
BUTADIENE C ₄	UK 1.93 UK 2.5 2.97	65 144 322	3.5	61 137 314	3.5		3.5
C ₅	UK 5.7 UK 6.37 7.47	97370 677711 1412	9.5	1255 1245	9.3		8.9
C ₆ (Hexane)	UK 8.47	93		1388			
BENZENE							
TOLUENE							
XYLENE							
ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAFH2 (N₁₂₇₄) 1015DATE: 9/23/83

BAG H7

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st Run</i>	SPAN <i>ppm</i>	ATTENUATION <i>2nd Run</i>	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE <i>cm³/l</i>
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	<i>UK 1.02</i>	<i>1919</i>		<i>1951</i>			
C ₆ (<i>Heptane</i>)	<i>1.22</i>	<i>2051</i>		<i>2117</i>			<i>33.1</i>
BENZENE	<i>1.44</i>	<i>3321</i>	<i>52.2</i>	<i>3479</i>	<i>54.7</i>		<i>53.4</i>
TOLUENE	<i>1.86 (Heptane)</i> <i>2.17</i>	<i>1211</i> <i>3224</i>		<i>1340</i> <i>3349</i>			<i>20.3</i> <i>20.3</i> <i>52.2</i>
XYLENE	<i>UK 2.6</i> <i>UK 3.12</i> <i>3.62</i>	<i>1336</i> <i>1665</i> <i>2471</i>	<i>25.4</i>	<i>1373</i> <i>1641</i> <i>3067</i>	<i>26.9</i>		<i>26.1</i>
ETHYL <i>ETHYL</i> BENZENE	<i>4.13</i> <i>UK 4.67</i> <i>UK 5.53</i>	<i>905</i> <i>1121</i> <i>297</i>	<i>7.7</i>	<i>1053</i> <i>1430</i> <i>528</i>	<i>9.2</i>		<i>8.5</i>
STYRENE	<i>UK 6.37</i> <i>UK 7.03</i> <i>UK 7.8</i>	<i>1620</i> <i>688</i> <i>814</i>		<i>1661</i> <i>607</i> <i>800</i>			
TOTAL HYDRO- CARBONS (THC)	<i>UK 20.7</i>	<i>517</i>		<i>515</i>			

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAFH / (SOUTH) 0930DATE: 9/22/83B46HS

COMPOUND	RETENTION TIME IN CM.	COUNTS <u>1st Run</u>	SPAN	ATTENUATION <u>1st Run</u>	DILUTION FACTOR (Diluted w/N ₂) <u>AUG</u>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE <u>(C₆H₆)</u> cmPD
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	<u>bk 1.03</u>	<u>8068</u>		<u>7707</u>	<u>7887</u>		
C ₆ (<u>Heptane</u>)	<u>1.23</u>	<u>22420</u>		<u>22761</u>	<u>2290</u>	<u>352.2</u>	
BENZENE	<u>1.55</u>	<u>22485</u>	<u>353.3</u>	<u>22497</u>	<u>353.5</u>	<u>22491</u>	<u>353.4</u>
TOLUENE	<u>UK 1.91</u> <u>2.27</u> <u>UK 3.72</u>	<u>8882</u> <u>13766</u> <u>6660</u>		<u>8748</u> <u>14113</u> <u>6715</u>		<u>8815</u> <u>13939</u> <u>6687</u>	<u>217.4</u>
XYLENE	<u>UK 3.27</u> <u>3.82</u>	<u>7194</u> <u>13233</u>	<u>116.3</u>	<u>7314</u> <u>13725</u>	<u>120.6</u>	<u>7254</u> <u>13477</u>	<u>118.4</u>
XYLENE ETHYL BENZENE	<u>UK 4.77</u> <u>UK 5.91</u> <u>UK 6.74</u>	<u>4734</u> <u>1655</u> <u>5101</u>		<u>5120</u> <u>1666</u> <u>5549</u>		<u>4948</u> <u>1660</u> <u>5325</u>	<u>43.2</u>
STYRENE	<u>UK 7.54</u> <u>UK 8.41</u>	<u>2007</u> <u>2445</u>		<u>1937</u> <u>2687</u>		<u>1978</u> <u>2567</u>	
TOTAL HYDRO- CARBONS (THC)	<u>UK 9.74</u> <u>UK 11.61</u> <u>UK 12.74</u>	<u>2826</u> <u>878</u> <u>1178</u>		<u>2999</u> <u>833</u> <u>1222</u>		<u>2927</u> <u>855</u> <u>1200</u>	

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ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAF#2 (N₂ carrier) 1050DATE: 9/22/83

BAG#5

COMPOUND	RETENTION TIME IN CM.	COUNTS 1 st RV	SPAN	ATTENUATION 2 nd RV	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	UK 1.03	6370		6373			
C ₆ (Hexane)	UK 1.22	18704		18815		272.5	
BENZENE	1.53	18197	285.9	18340	288.2	287.0	
TOLUENE	UK 1.89 (Heptane) 2.22 UK 2.65	7249 11279 5165		7260 11577 5510		113.1 178.2	
XYLENE	UK 3.19 3.7	5871 8319	73.1	6063 8503	74.7	73.9	
ETHYL BENZENE	4.27 UK 4.8 UK 5.7 UK 6.5	2384 3522 1171 4250	20.7	2181 3871 3440 5170	19.2	20.0	
STYRENE	UK 7.2 UK 8.07	1655 2332		1362 1730			
TOTAL HYDRO- CARBONS (THC)	UK 9.34 UK 11 UK 12.2	2772 858 1088		2081 577 112			

TRW

GC WORKSHEET

COLUMN:

Porocil C

RUN NUMBER:

IAF #2 (NETH) 1050

DATE:

9/22/83

BAG #5

COMPOUND	RETENTION TIME IN CM.	COUNTS ^{1st} 1st _{min}	SPAN _{min}	ATTENUATION _{min}	DILUTION FACTOR (Diluted w/N ₂) _{min}	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE cm ³ /l
C ₁	0.6	12095	225.0	12228	227.5	←	226.2
C ₂	0.84	359	6.2	486	8.5		7.3
C ₃	1.39	431	5.4	453	5.7		5.6
BUTADIENE C ₄	UK 2.54 3.01	648 3070	18.3	779 2806	24.8		21.5
C ₅	UK 6.48 7.64	5750 6943	46.6	13486	70.4		59.5
C ₆ (Hexane)	UK 8.68	1538		11750			
BENZENE							
TOLUENE							
XYLENE							
XYLENE ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

22 Gals. Sampled and analyzed for VOCs, SVOCs, and PCBs

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ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAFH / (SOLVENT) 1430DATE: 9/22/83BALANCE

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st RUN</i>	SPAN	ATTENUATION <i>2nd RUN</i>	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅							
C ₆ (Heptane)	1.2	13498		13884		213.5	
BENZENE	1.49	12827	201.6	12765	200.6	201.1	
TOLUENE	1.81 2.11	4175 9003		5114 8783		78.7 140.2	
XYLENE	UK 2.51 UK 3 2.44	4107 4544 7228		4253 4405 4706		62.4	
STYRENE	3.94	2160	19.0	2146	18.8	18.9	
BENZENE	UK 4.41	2858		2857			
STYRENE	UK 5.24 UK 7.31	5329 1401		5409 1240			
TOTAL HYDRO- CARBONS (THC)	UK 8.41	1014		788			

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GC WORKSHEET

COLUMN: Porosil CRUN NUMBER: IAFM/ (S₆ 24) 1430DATE: 9/22/83

BAG #6

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st RUN</i>	SPAN <i>ppm</i>	ATTENUATION <i>2nd</i>	DILUTION FACTOR (Diluted w/N ₂) <i>ppm</i>	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE <i>cm³/D</i>
C ₁	0.6	10581	196.9	10662	198.4		197.5
C ₂	0.84	330	5.7	334	5.8		5.7
C ₃	1.35	484	6.1	476	6.0		6.0
BUTADIENE C ₄	UK 1.86 UK 2.41 2.44	171 758 1752	15.5	172 767 1760	15.6		15.5
C ₅	UK 4.41 UK 6.01 UK 7.04	118 6144 4799		119 6149 4939			
C ₆ (Hexane)	UK 7.94 UK 11.94	1050 692		1354 490			16.2
BENZENE				9.28			
TOLUENE							
XYLENE							
XYLENE ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

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ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: OV-101RUN NUMBER: IAF#2 (N₂) ¹⁵⁵⁰DATE: 9/22/83BAL #6

COMPOUND	RETENTION TIME IN CM.	COUNTS <u>1st RUN</u>	SPAN	ATTENUATION <u>2nd RUN</u>	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C ₁							
C ₂							
C ₃							
BUTADIENE C ₄							
C ₅	<u>uk 1.01</u>	<u>2477</u>		<u>2477</u>			
C ₆ (Heptane)	<u>1.21</u>	<u>6771</u>		<u>7019</u>		<u>109.7</u>	
BENZENE	<u>1.48</u>	<u>7746</u>	<u>121.7</u>	<u>7843</u>	<u>123.2</u>	<u>122.4</u>	
TOLUENE	<u>uk 1.81</u> <u>2.12</u>	<u>3200</u> <u>6195</u>		<u>3235</u> <u>6183</u>		<u>50.2</u> <u>96.5</u>	
XYLENE	<u>uk 2.51</u> <u>uk 3.01</u> <u>3.46</u>	<u>2999</u> <u>342</u> <u>5387</u>		<u>2715</u> <u>3274</u> <u>5323</u>		<u>46.9</u>	
ETHYLENE BENZENE	<u>3.96</u> <u>uk 4.41</u> <u>uk 5.43</u> <u>uk 7.34</u>	<u>1704</u> <u>2547</u> <u>4569</u> <u>1151</u>	<u>15.0</u>	<u>1604</u> <u>1936</u> <u>4887</u> <u>964</u>	<u>14.1</u>	<u>14.5</u>	
STYRENE	<u>uk 8.41</u>	<u>758</u>		<u>441</u>			
TOTAL HYDRO- CARBONS (THC)							

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GC WORKSHEET

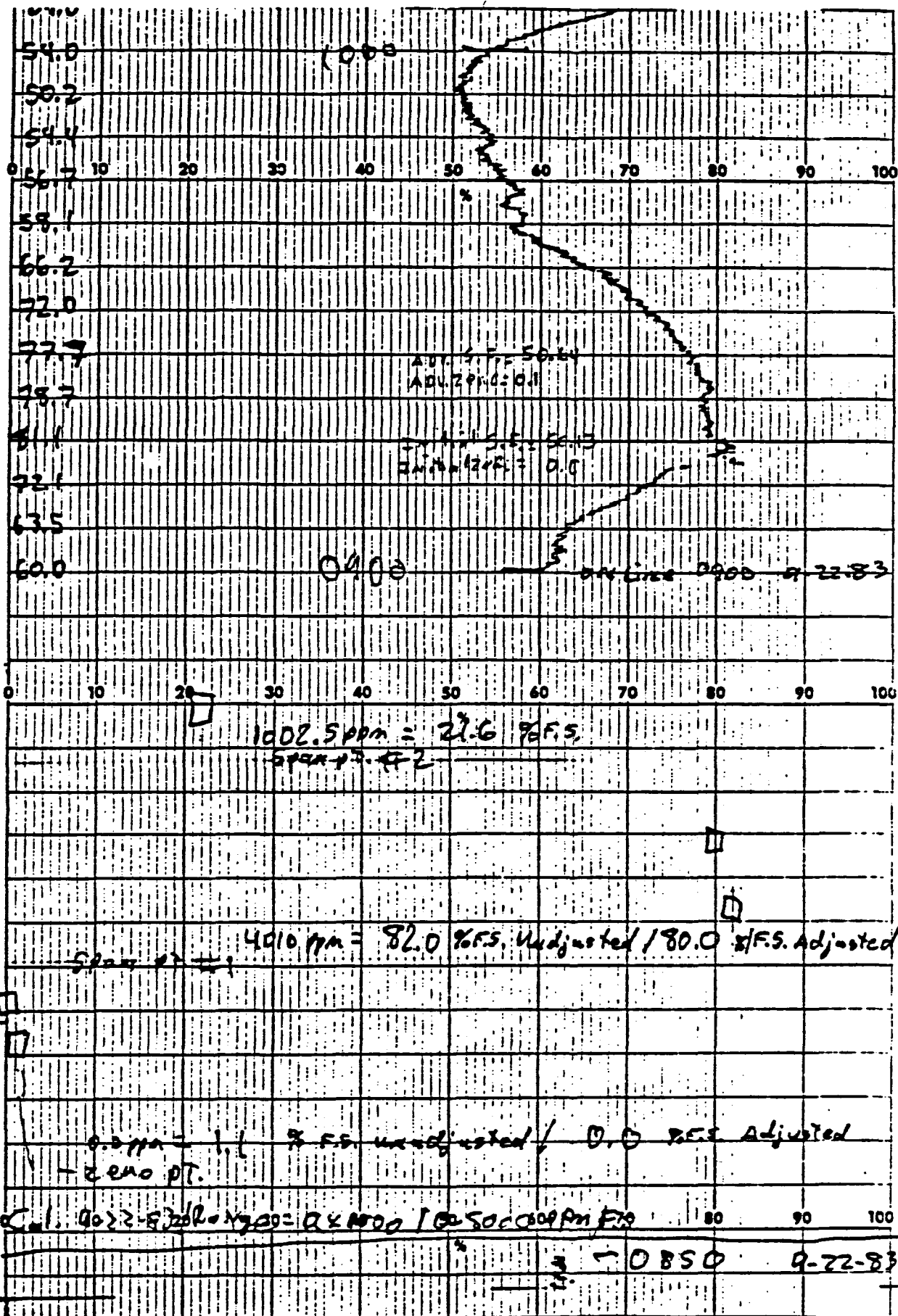
COLUMN: POROCIL CRUN NUMBER: IAF#2 (NORTH) 1555 DATE: 9/22/83

BAG #6

COMPOUND	RETENTION TIME IN CM.	COUNTS <i>1st Run</i>	SPAN	ATTENUATION <i>2nd Run</i>	DILUTION FACTOR (Diluted w/N ₂)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE CMF
C ₁	0.61	9068	168.7	8908	165.7		167.2
C ₂	0.83	222	3.9	217	3.8		3.8
C ₃	1.33	285	3.6	285	3.6		3.6
BUTADIENE C ₄	<i>UK 1.83 UK 2.37 2.8</i>	<i>52 354 949</i>	8.4	<i>73 381 475</i>	8.8		8.6
C ₅	<i>UK 4.6 UK 5.8 UK 6.8</i>	<i>2834 4332 2104</i>		<i>51 2792 2483</i>			
C ₆ (Hexane)	→ 7.73	1640	11.0	672	4.5		7.7
BENZENE							
TOLUENE							
XYLENE							
ETHYL BENZENE							
STYRENE							
TOTAL HYDRO- CARBONS (THC)							

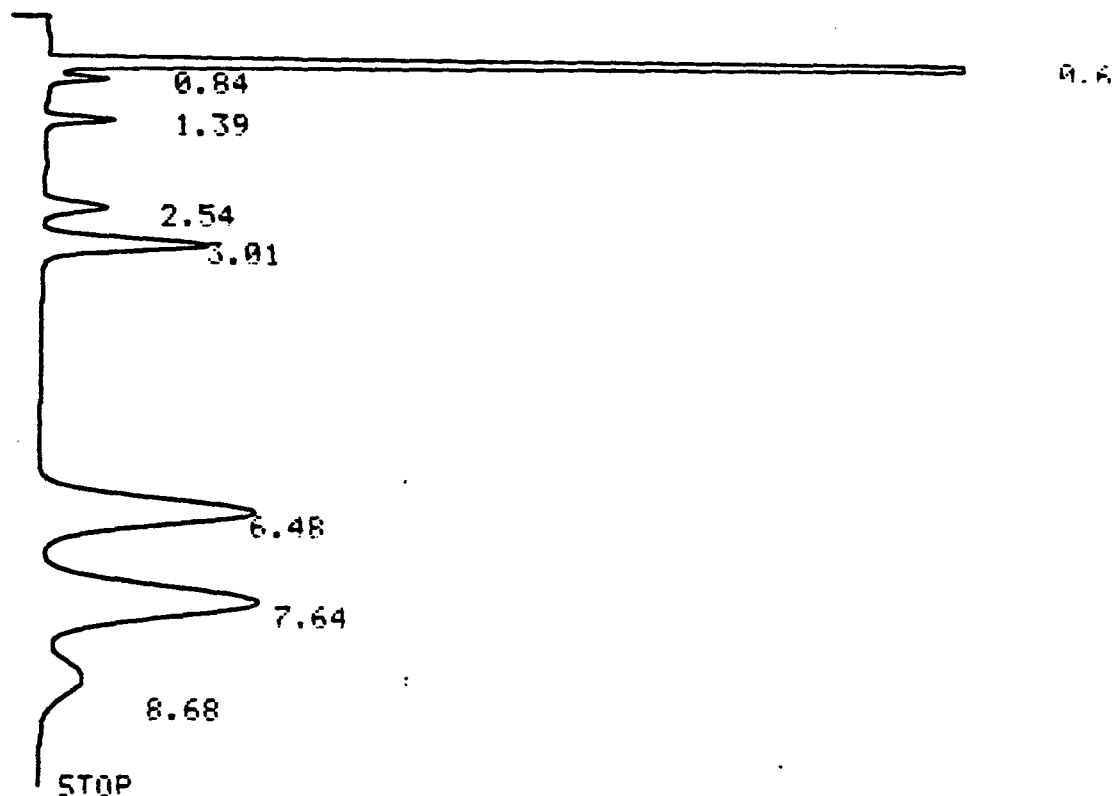
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Example of Continuous Monitor Stripchart With
Calibration Check - IAF #2 (North) Outlet
Sample Location on 9/22/83

NORTH-5-1050
START 09.22.12.11.



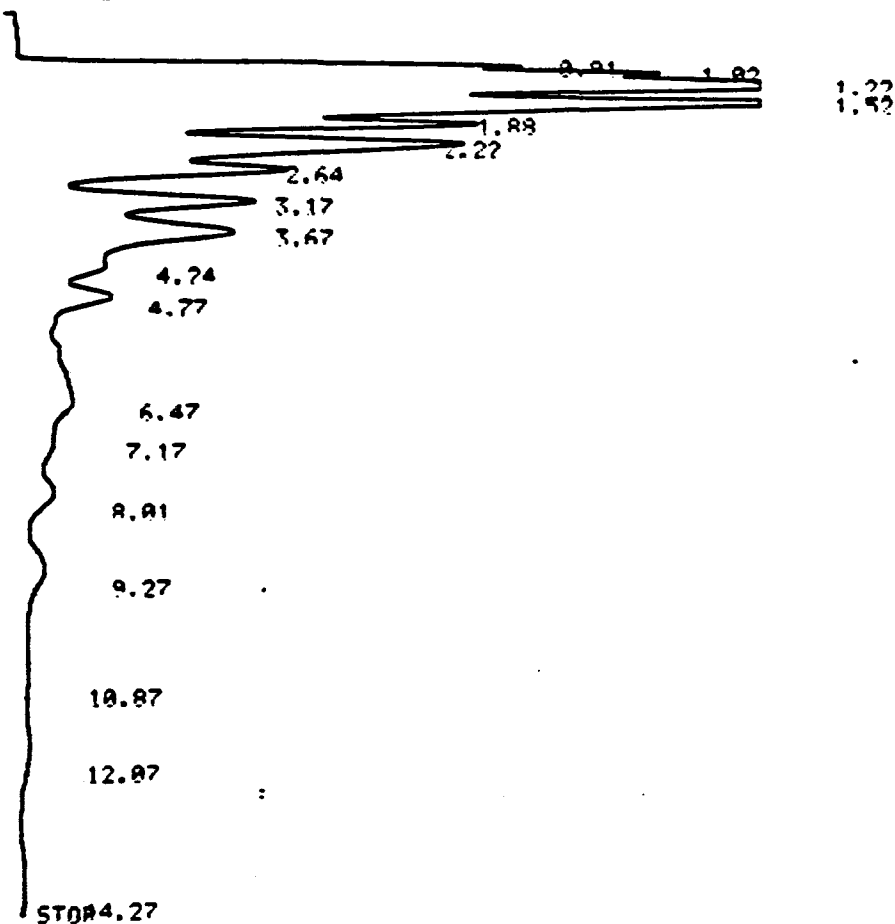
C-R1A
SMPL # 00.
FILE # 6
REPT # 1701
METHOD 44

#	NAME	TIME	CONC	MK	AREA
1	C-1	0.6	225.0305		12095
2	C-2	0.84	6.2414	V	359
3	C-3	1.39	5.4103		431
		2.54			648
4	3C-4	3.01	18.3098	V	2070
		6.48			5750
5	C-5	7.64	46.5562	V	6943
		8.68		V	1538
	TOTAL		301.5484		29838

Example of GC/FID Analysis on IAF #2 (North)
Gas Bag Sample for C₁-C₅ Speciation

NORTH-5-1050

START 09.22.11.47.



C-RIA
 SMPL # 00
 FILE # 4
 REPT # 1700
 METHOD 44

#	NAME	TIME	CONC	HK	AREA
1	PROPAN	0.91	124.1267		4714
		1.02		V	6373
		1.22		V	18815
2	BENZEN	1.52	288.1822	V	18340
		1.88		V	7260
		2.22		V	11577
		2.64		V	5510
		3.17		V	6063
3	XYLENE	3.67	74.6997	V	8503
3	XYLENE	4.24	19.168	V	2181
		4.77		V	3891
		6.47		V	5900
		7.17		V	1362
		8.01		V	1030
		9.27		V	2001
		10.87		V	597
		12.07		V	904
		14.27			117
TOTAL			506.1760		106211

Example of GC/FID Analysis on IAF #2 (North)
 Gas Bag Sample for C₆-C₉ Speciation

APPENDIX D

SAMPLING METHODS AND ANALYTICAL TECHNIQUE

503 OIL AND GREASE

In the determination of oil and grease, an absolute quantity of a specific substance is not measured. Rather, groups of substances with similar physical characteristics are determined quantitatively on the basis of their common solubility in trichlorotrifluoroethane. "Oil and grease" is any material recovered as a substance soluble in trichlorotrifluoroethane. It includes other material extracted by the solvent from an acidified sample (such as sulfur compounds, certain organic dyes, and chlorophyll) and not volatilized during the test. It is important that this limitation be understood clearly. Unlike some constituents that represent distinct chemical elements, ions, compounds, or groups of compounds, oils and greases are defined by the method used for their determination.

The methods presented here are suitable for biological lipids and mineral hydrocarbons. They also may be suitable for most industrial wastewaters or treated effluents containing these materials, although sample complexity may result in either low or high results because of lack of analytical specificity. The method is not applicable to measurement of low-boiling fractions that volatilize at temperatures below 70 °C.

1. Significance

Certain constituents measured by the oil and grease analysis may influence waste-

water treatment systems. If present in excessive amounts, they may interfere with aerobic and anaerobic biological processes and lead to decreased wastewater treatment efficiency. When discharged in wastewater or treated effluents, they may cause surface films and shoreline deposits leading to environmental degradation.

A knowledge of the quantity of oil and grease present is helpful in proper design and operation of wastewater treatment systems and also may call attention to certain treatment difficulties.

2. Selection of Method

For liquid samples, three methods are presented: the partition-gravimetric method (A), the partition-infrared method (B), and the Soxhlet method (C). Method B is designed for samples that might contain volatile hydrocarbons that otherwise would be lost in the solvent removal operations of the gravimetric procedure. Method C is the method of choice when relatively polar, heavy petroleum fractions are present, or when the levels of nonvolatile greases may challenge the solubility limit of the solvent. For low levels of oil and grease (< 10 mg/L), Method B is the method of choice because gravimetric methods do not provide the needed precision.

Method D is a modification of the Soxhlet Method and is suitable for sludges and similar materials. Method E can be used in

conjunction with Methods A, B, C, or D to obtain a hydrocarbon measurement in addition to, or instead of, the oil and grease measurement. This method separates hydrocarbons from the total oil and grease on the basis of polarity.

3. Sampling and Storage

Collect a representative sample in a wide-mouth glass bottle that has been rinsed with the solvent to remove any detergent film, and acidify in the sample bottle. Collect a separate sample for an oil

and grease determination and do not subdivide in the laboratory. When information is required about average grease concentration over an extended period, examine individual portions collected at prescribed time intervals to eliminate losses of grease on sampling equipment during collection of a composite sample.

In sampling sludges, take every possible precaution to obtain a representative sample. When analysis cannot be made immediately, preserve samples with 1 mL conc HCl/80 g sample. Never preserve samples with CHCl₃ or sodium benzoate.

503 A. Partition-Gravimetric Method

1. General Discussion

a. Principle: Dissolved or emulsified oil and grease is extracted from water by intimate contact with trichlorotrifluoroethane. Some extractables, especially unsaturated fats and fatty acids, oxidize readily; hence, special precautions regarding temperature and solvent vapor displacement are included to minimize this effect.

b. Interference: Trichlorotrifluoroethane has the ability to dissolve not only oil and grease but also other organic substances. No known solvent will selectively dissolve only oil and grease. Solvent removal results in the loss of short-chain hydrocarbons and simple aromatics by volatilization. Significant portions of petroleum distillates from gasoline through No. 2 fuel oil are lost in this process. In addition, heavier residuals of petroleum may contain a significant portion of materials that are not extractable with the solvent.

2. Apparatus

a. Separatory funnel. 1 L, with TFE* stopcock.

*Teflon or equivalent.

b. Distilling flask. 125 mL.

c. Water bath.

d. Filter paper. 11 cm diam.†

3. Reagents

a. Hydrochloric acid. HCl, 1 + 1. *Meq*

b. Trichlorotrifluoroethane‡ (1,1,2-trichloro-1,2,2-trifluoroethane), boiling point 47 C. The solvent should leave no measurable residue on evaporation; distill if necessary. Do not use any plastic tubing to transfer solvent between containers.

c. Sodium sulfate. Na₂SO₄, anhydrous crystal.

4. Procedure

Collect about 1 L of sample and mark sample level in bottle for later determination of sample volume. Acidify to pH 2 or lower; generally, 5 mL HCl is sufficient. Transfer to a separatory funnel. Carefully rinse sample bottle with 30 mL trichlorotrifluoroethane and add solvent washings to separatory funnel. Preferably shake vigorously for 2 min. However, if it

†Whatman No. 40 or equivalent.

‡Freon or equivalent.

is suspected that a stable emulsion will form, shake gently for 5 to 10 min. Let layers separate. Drain solvent layer through a funnel containing solvent-moistened filter paper into a clean, tared distilling flask. If a clear solvent layer cannot be obtained, add 1 g Na_2SO_4 to the filter paper cone and slowly drain emulsified solvent onto the crystals. Add more Na_2SO_4 , if necessary. Extract twice more with 30 mL solvent each but first rinse sample container with each solvent portion. Combine extracts in tared distilling flask and wash filter paper with an additional 10 to 20 mL solvent. Distill solvent from distilling flask in a water bath at 70 C. Place flask on a water bath at 70 C for 15 min and draw air through it with an applied vacuum for the final 1 min. Cool in a desiccator for 30 min and weigh.

5. Calculation

If the organic solvent is free of residue, the gain in weight of the tared distilling flask is mainly due to oil and grease. Total gain in weight, *A*, of tared flask less calculated residue, *B*, from solvent blank is the amount of oil and grease in the sample:

$$\text{mg oil and grease/L} = \frac{(A - B) \times 1.000}{\text{mL sample}}$$

6. Precision and Accuracy

Methods A, B, and C were tested by a single laboratory on a sewage sample. By this method the oil and grease concentration was 12.6 mg/L. When 1-L portions of the sewage were dosed with 14.0 mg of a mixture of No. 2 fuel oil and Wesson oil, recovery of added oils was 93% with a standard deviation of 0.9 mg.

503 B. Partition-Infrared Method (TENTATIVE)

1. General Discussion

a. Principle: Although the extraction procedure for this method is identical to that of Method A, infrared detection permits the measurement of many relatively volatile hydrocarbons. Thus, the lighter petroleum distillates, with the exception of gasoline, may be measured accurately. Adequate instrumentation allows for the measurement of as little as 0.2 mg oil and grease/L.

b. Interference: Some degree of selectivity is offered by this method to overcome some of the coextracted interferences discussed in Method A. Heavier residuals of petroleum may contain a significant portion of materials insoluble in trichlorotrifluoroethane.

c. Definitions: A "known oil" is defined as a sample of oil and/or grease that represents the only material of that type used or manufactured in the processes

represented by a wastewater. An "unknown oil" is defined as one for which a representative sample of the oil or grease is not available for preparation of a standard.

2. Apparatus

- Separatory funnel*, 1 L, with TFE stopcock.
- Infrared spectrophotometer*, double beam, recording.
- Cells*, near-infrared silica.
- Filter paper*, 11 cm diam.*

3. Reagents

- Hydrochloric acid*, HCl, 1 + 1.
- Trichlorotrifluoroethane*. See 503A.3b
- Sodium sulfate*, Na_2SO_4 , anhydrous, crystal.

*Teflon or equivalent.

†Whatman No. 40 or equivalent.

d. Reference oil: Prepare a mixture, by volume, of 37.5% iso-octane, 37.5% hexadecane, and 25% benzene. Store in sealed container to prevent evaporation.

4. Procedure

Refer to Method A for sample collection, acidification, and extraction. Collect combined extracts in a 100-mL volumetric flask and adjust final volume to 100 mL with solvent.

Prepare a stock solution of known oil by rapidly transferring about 1 mL (0.5 to 1.0 g) of the oil or grease to a tared 100-mL volumetric flask. Stopper flask and weigh to nearest milligram. Add solvent to dissolve and dilute to mark. If the oil identity is unknown (§ 1c) use the reference oil (§ 3d) as the standard. Using volumetric techniques, prepare a series of standards over the range of interest. Select a pair of matched near-infrared silica cells. A 1-cm-path-length cell is appropriate for a working range of about 4 to 40 mg. Scan standards and samples from 3,200 cm^{-1} to 2,700 cm^{-1} with solvent in the reference beam and record results on absorbance

paper. Measure absorbances of samples and standards by constructing a straight baseline over the scan range and measuring absorbance of the peak maximum at 2,930 cm^{-1} and subtracting baseline absorbance at that point. If the absorbance exceeds 0.8 for a sample, select a shorter pathlength or dilute as required. Use scans of standards to prepare a calibration curve.

5. Calculation

$$\text{mg oil and grease/L} = \frac{A \times 1,000}{\text{mL sample}}$$

where:

A = mg of oil or grease in extract as determined from calibration curve.

6. Precision and Accuracy

See 503A.6. By this method the oil and grease concentration was 17.5 mg/L. When 1-L portions of the sewage were dosed with 14.0 mg of a mixture of No. 2 fuel oil and Wesson oil, the recovery of added oils was 99% with a standard deviation of 1.4 mg.

503 C. Soxhlet Extraction Method

1. General Discussion

a. Principle: Soluble metallic soaps are hydrolyzed by acidification. Any oils and solid or viscous grease present are separated from the liquid samples by filtration. After extraction in a Soxhlet apparatus with trichlorotrifluoroethane, the residue remaining after solvent evaporation is weighed to determine the oil and grease content. Compounds volatilized at or below 103 C will be lost when the filter is dried.

b. Interference: The method is entirely empirical and duplicate results can be ob-

tained only by strict adherence to all details. By definition, any material recovered is oil and grease and any filtrable trichlorotrifluoroethane-soluble substances, such as elemental sulfur and certain organic dyes, will be extracted as oil and grease. The rate and time of extraction in the Soxhlet apparatus must be exactly as directed because of varying solubilities of different greases. In addition, the length of time required for drying and cooling extracted material cannot be varied. There may be a gradual increase in weight, presumably due to the absorption of oxygen, and/or a gradual loss of weight due to volatilization.

2. Apparatus

- a. *Extraction apparatus*. Soxhlet.
- b. *Vacuum pump* or other source of vacuum.
- c. *Buchner funnel*, 12 cm.
- d. *Electric heating mantle*.
- e. *Extraction thimble*, paper.
- f. *Filter paper*, 11 cm diam.*
- g. *Muslin cloth disks*, 11 cm diam.

3. Reagents

- a. *Hydrochloric acid*, HCl, 1 + 1.
- b. *Trichlorotrifluoroethane*: See 503A.3b.
- c. *Diatomaceous-silica filter aid suspension*.† 10 g L distilled water.

4. Procedure

Collect about 1 L of sample in a wide-mouth glass bottle and mark sample level in bottle for later determination of sample volume. Acidify to pH 2 or lower; generally, 5 mL HCl is sufficient. Prepare a filter consisting of a muslin cloth disk overlaid with filter paper. Wet paper and muslin and press down edges of paper. Using a vacuum, pass 100 mL filter aid suspension through prepared filter and wash with 1 L distilled water. Apply vacuum until no more water passes filter. Filter acidified sample. Apply vacuum until no more water passes through filter. Using forceps,

*Whatman No. 40 or equivalent.

†Hyflo Super-Cel, Johns-Manville Corp., or equivalent.

transfer filter paper to a watch glass. Add material adhering to edges of muslin cloth disk. Wipe sides and bottom of collecting vessel and Buchner funnel with pieces of filter paper soaked in solvent, taking care to remove all films caused by grease and to collect all solid material. Add pieces of filter paper to filter paper on watch glass. Roll all filter paper containing sample and fit into a paper extraction thimble. Add any pieces of material remaining on watch glass. Wipe watch glass with a filter paper soaked in solvent and place in paper extraction thimble. Dry filled thimble in a hot-air oven at 103 C for 30 min. Fill thimble with glass wool or small glass beads. Weigh extraction flask. Extract oil and grease in a Soxhlet apparatus, using trichlorotrifluoroethane at a rate of 20 cycles hr for 4 hr. Time from first cycle. Distill solvent from extraction flask in a water bath at 70 C. Place flask on a water bath at 70 C for 15 min and draw air through it using an applied vacuum for the final 1 min. Cool in a desiccator for 30 min and weigh.

5. Calculation

See Section 503A.5.

6. Precision and Accuracy

See Section 503A.6. By this method the oil and grease concentration was 14.8 mg L. When 1-L portions of the sewage were dosed with 14.0 mg of a mixture of No. 2 fuel oil and Wesson oil, the recovery of added oils was 88% with a standard deviation of 1.1 mg.

503 D. Extraction Method for Sludge Samples

1. General Discussion

a. *Principle*: Drying acidified sludge by heating leads to low results. Magnesium sulfate monohydrate is capable of com-

binning with 75% of its own weight in water in forming $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ and is used to dry sludge. After drying, the oil and grease can be extracted with trichlorotrifluoroethane.

b. *Interference*: See 503C.1b.

2. Apparatus

- Extraction apparatus.* Soxhlet.
- Vacuum pump* or other source of vacuum.
- Extraction thimble, paper.*
- Grease-free cotton:* Extract non-absorbent cotton with solvent.

3. Reagents

- Hydrochloric acid.* HCl, conc.
- Magnesium sulfate monohydrate:* Prepare $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ by overnight drying of a thin layer in an oven at 150 C.
- Trichlorotrifluoroethane:* See 503A.3b.

4. Procedure

In a 150-mL beaker weigh a sample of wet sludge, 20 ± 0.5 g, of which the dry-solids content is known. Acidify to pH 2.0 (generally, 0.3 mL conc HCl is sufficient). Add 25 g $\text{MgSO}_4 \cdot \text{H}_2\text{O}$. Stir to a smooth paste and spread on sides of beaker to facilitate subsequent removal. Let stand until solidified, 15 to 30 min. Remove solids and grind in a porcelain mortar. Add the powder to a paper extraction thimble. Wipe beaker and mortar with small pieces

of filter paper moistened with solvent and add to thimble. Fill thimble with glass wool or small glass beads. Extract in a Soxhlet apparatus, using trichlorotrifluoroethane, at a rate of 20 cycles/hr for 4 hr. If any turbidity or suspended matter is present in the extraction flask, remove by filtering through grease-free cotton into another weighed flask. Rinse flask and cotton with solvent. Distill solvent from extraction flask in water at 70 C. Place flask on a water bath at 70 C for 15 min and draw air through it using an applied vacuum for the final 1 min. Cool in a desiccator for 30 min and weigh.

5. Calculation

Oil and grease as % of dry solids

$$= \frac{\text{gain in weight of flask, g} \times 100}{\text{weight of wet solids, g} \times \text{dry solids fraction}}$$

6. Precision

The examination of six replicate samples of sludge yielded a standard deviation of 4.6%.

503 E. Hydrocarbons

1. Significance

In the absence of specially modified industrial products, oil and grease is composed primarily of fatty matter from animal and vegetable sources and hydrocarbons of petroleum origin. A knowledge of the percentage of each of these constituents in the total oil and grease minimizes the difficulty in determining the major source of the material and simplifies the correction of oil and grease problems in wastewater treatment plant operation and stream pollution abatement.

2. General Discussion

a. Principle: Silica gel has the ability to absorb polar materials. If a solution of hydrocarbons and fatty materials in trichlorotrifluoroethane is mixed with silica gel, the fatty acids are selectively removed from solution. The materials not eliminated by silica gel adsorption are designated hydrocarbons by this test.

b. Interference: The more polar hydrocarbons, such as complex aromatic compounds and hydrocarbon derivatives of chlorine, sulfur, and nitrogen, may be ad-

rection is unnecessary if dilution water meets the blank criteria stipulated above. If the dilution water does not meet these criteria, proper corrections are difficult and results become questionable.

7. Precision and Accuracy

In a series of interlaboratory studies, each involving 86 to 102 laboratories (and as many river water and wastewater seeds), 5-day BOD measurements were made on synthetic water samples containing a 1:1 mixture of glucose and glutamic acid in the total concentration range of 5 to 340 mg/L. The regression equations for mean value, \bar{X} , and standard deviation, S , from these studies were:

$$\bar{X} = 0.665 (\text{added level, mg/L}) - 0.149$$

$$S = 0.120 (\text{added level, mg/L}) - 1.04$$

For the 300-mg/L mixed primary standard, the average 5-day BOD was 199.4 mg/L with a standard deviation of 37.0 mg/L.

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508 OXYGEN DEMAND (CHEMICAL)

The chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. For samples from a specific source, COD can be related empirically to BOD, organic carbon, or organic matter content.

1. Selection of Method

The dichromate reflux method is pre-

ferred over other methods using oxidants because of superior oxidizability, applicability to a wide variety of samples, and ease of manipulation. The test is most useful for monitoring and control, especially after correlations with constituents¹⁻² such as BOD and organic carbon have been developed. For most organic compounds oxidation is 95 to 100% of the theoretical value.²⁻⁴ Pyridine is not oxidized.² Benzene and other volatile organics are oxi-

dized if they have sufficient contact with the oxidants.² While the carbonaceous portion of nitrogen-containing organic matter is oxidized, no oxidation of ammonia, either present in a waste or liberated from the nitrogen-containing organic matter, takes place in the absence of significant chloride concentrations.

2. Sampling and Storage

Test unstable samples without delay.

Homogenize samples containing settleable solids in a blender to permit representative sampling. If there is to be a delay before analysis, preserve the sample by acidification to pH 2 or lower with conc sulfuric acid (H_2SO_4). Make preliminary dilutions for wastes containing a high COD to reduce the error inherent in measuring small volumes of sample.

508 A. Dichromate Reflux Method

1 General Discussion

a. Principle: Most types of organic matter are oxidized by a boiling mixture of chromic and sulfuric acids. A sample is refluxed in strongly acid solution with a known excess of potassium dichromate ($K_2Cr_2O_7$). After digestion the remaining unreacted $K_2Cr_2O_7$ is titrated with ferrous ammonium sulfate (FAS), the amount of $K_2Cr_2O_7$ consumed is determined, and the amount of oxidizable organic matter is calculated in terms of oxygen equivalent.

b. Interferences and limitations: Volatile straight-chain aliphatic compounds are not oxidized to any appreciable extent. This failure occurs partly because volatile organics are present in the vapor space and do not come in contact with the oxidizing liquid. Straight-chain aliphatic compounds are oxidized more effectively when silver sulfate (Ag_2SO_4) is added as a catalyst. However, Ag_2SO_4 reacts with chloride, bromide, and iodide to produce precipitates that are oxidized only partially. The difficulties caused by the presence of halides can be largely, though not completely, overcome by complexing with mercuric sulfate ($HgSO_4$) before the refluxing procedure.¹ Do not use the test for

samples containing more than 2,000 mg chloride/L.

Nitrite (NO_2^-) exerts a COD of 1.1 mg O_2 /mg NO_2^- -N. Because concentrations of NO_2^- in polluted waters rarely exceed 1 or 2 mg NO_2^- -N/L the interference is considered insignificant and usually is ignored. To eliminate a significant interference due to NO_2^- , add 10 mg sulfamic acid/mg NO_2^- -N present in the refluxing flask. Also add the same amount of sulfamic acid to the reflux flask containing the distilled water blank.

Reduced inorganic species such as ferrous iron, sulfide, manganous manganese, etc., are oxidized quantitatively under the test conditions. For samples containing significant levels of these species, stoichiometric oxidation can be assumed from known initial concentration of the interfering species and corrections can be made to the COD value obtained.

c. Minimum detectable concentration: Determine COD values of ≥ 50 mg/L using 0.25N $K_2Cr_2O_7$. With 0.025N $K_2Cr_2O_7$, COD values from 5 to 50 mg/L can be determined but with lesser accuracy.²

2. Apparatus

Reflux apparatus, consisting of 500-mL

or 250-mL erlenmeyer flasks with ground-glass 24/40 neck^{*} and 300-mm jacket Liebig, West, or equivalent condensers,[†] with 24/40 ground-glass joint, and a hot plate having sufficient power to produce at least 1.4 W/cm² of heating surface, or equivalent.

3. Reagents

a. *Standard potassium dichromate solution*, 0.250N: Dissolve 12.259 g K₂Cr₂O₇, primary standard grade, previously dried at 103°C for 2 hr, in distilled water and dilute to 1,000 mL.

b. *Silver sulfate*, Ag₂SO₄, reagent or technical grade, crystals or powder.

c. *Sulfuric acid reagent*: Add Ag₂SO₄ to conc H₂SO₄ at the rate of 22 g Ag₂SO₄/4 kg bottle. Let stand 1 to 2 days to dissolve Ag₂SO₄.

d. *Sulfuric acid*, H₂SO₄, conc.

e. *Ferriin indicator solution*: Dissolve 1.485 g 1,10-phenanthroline monohydrate and 695 mg FeSO₄·7H₂O in distilled water and dilute to 100 mL. This indicator solution may be purchased already prepared.[‡]

f. *Standard ferrous ammonium sulfate titrant*, approximately 0.25N: Dissolve 98 g Fe(NH₄)₂(SO₄)₂·6H₂O (FAS) in distilled water. Add 20 mL conc H₂SO₄, cool, and dilute to 1,000 mL. Standardize this solution daily against standard K₂Cr₂O₇ solution, as follows:

Dilute 10.0 mL standard K₂Cr₂O₇ solution to about 100 mL. Add 30 mL conc H₂SO₄ and cool. Titrate with FAS titrant, using 0.10 to 0.15 mL (2 to 3 drops) ferriin indicator.

Normality of FAS solution

$$= \frac{\text{Volume 0.25N K}_2\text{Cr}_2\text{O}_7 \text{ solution titrated, mL}}{\text{Volume FAS used in titration, mL}} \times 0.25$$

^{*}Corning 5000 or equivalent.

[†]Corning 2360, 91548, or equivalent.

[‡]G. F. Smith Chemical Co., Columbus, Ohio.

g. *Mercuric sulfate*, HgSO₄, crystals or powder.

h. *Sulfamic acid*: Required only if the interference of nitrites is to be eliminated (see § 1h above).

i. *Potassium hydrogen phthalate standard*: Lightly crush and then dry potassium acid phthalate (HOOC₂H₄COOK) to constant weight at 120°C, dissolve 425 mg in distilled water, and dilute to 1,000 mL. Potassium hydrogen phthalate has a theoretical COD of 1.176 g O₂/g and this solution has a theoretical COD of 500 mg O₂/L. Prepare fresh for each use.

4. Procedure

a. *Treatment of samples with ≤50 mg COD/L*: Place 50.0 mL sample (for samples with COD >900 mg COD/L, use a smaller sample portion diluted to 50.0 mL) in the 500-mL refluxing flask. Add 1 g HgSO₄, several glass beads, and very slowly add 5.0 mL sulfuric acid reagent, with mixing to dissolve HgSO₄. Cool while mixing to avoid possible loss of volatile materials. Add 25.0 mL 0.250N K₂Cr₂O₇ solution and mix. Attach flask to condenser and turn on cooling water. Add remaining sulfuric acid reagent (70 mL) through open end of condenser. Continue swirling and mixing while adding sulfuric acid reagent. **CAUTION: Mix reflux mixture thoroughly before applying heat to prevent local heating of flask bottom and a possible blowout of flask contents.** If sample volumes other than 50 mL are used, keep ratios of reagent weights, volumes, and strengths constant. See Table 508:1 for examples of applicable ratios. Maintain these ratios and follow the procedure as outlined above.

Use 1 g HgSO₄ with a 50.0-mL sample to complex up to a maximum of 100 mg chloride (2,000 mg/L). For smaller samples use less HgSO₄, according to the chloride concentration; maintain a 10:1 ratio of HgSO₄:Cl. A slight precipitate does not affect the determination adversely. Gener-

TABLE 500-1. REAGENT QUANTITIES AND NORMALITIES FOR VARIOUS SAMPLE SIZES

Sample Size mL	0.25N Standard Dichromate mL	Sulfuric Acid Reagent mL	HgSO ₄ g	Normality of FAS	Final Volume before Titration mL
10.0	5.0	15	0.2	0.05	70
20.0	10.0	30	0.4	0.10	140
30.0	15.0	45	0.6	0.15	210
40.0	20.0	60	0.8	0.20	280
50.0	25.0	75	1.0	0.25	350

ally, COD cannot be measured accurately in samples containing more than 2,000 mg chloride L.

Reflux mixture for 2 hr. Use a shorter period for particular wastes if it has been shown that the shorter period yields the same COD as that found by 2-hr refluxing. Cover open end of condenser with a small beaker to prevent foreign material from entering refluxing mixture. Cool and wash down condenser with distilled water.

Disconnect reflux condenser and dilute mixture to about twice its volume with distilled water. Cool to room temperature and titrate excess $K_2Cr_2O_7$ with FAS, using 0.10 to 0.15 mL (2 to 3 drops) ferroin indicator. Although the quantity of ferroin indicator is not critical, use the same volume for all titrations. Take as the end point of the titration the first sharp color change from blue-green to reddish brown. The blue-green may reappear.

Reflux and titrate in the same manner a blank containing the reagents and a volume of distilled water equal to that of sample.

b. Alternate procedure for low-COD samples: Follow the above procedure.

¹ *41.* with two exceptions: (i) Use standard 0.025N $K_2Cr_2O_7$, and (ii) titrate with 0.025N FAS. Exercise extreme care with this procedure because even a trace of organic matter on glassware or from the atmosphere may cause gross errors.

If a further increase in sensitivity is required, concentrate a larger volume of sample before digesting under reflux as follows: Add all reagents to a sample larger than 50 mL and reduce total volume to 150 mL by boiling in the refluxing flask open to the atmosphere without the condenser attached. Compute amount of $HgSO_4$ to be added (before concentration) on the basis of a weight ratio of 10:1, $HgSO_4:Cl$, using the amount of chloride present in the original volume of sample. Carry a blank reagent through the same procedure.

This technic has the advantage of concentrating the sample without significant losses of easily digested volatile materials. Hard-to-digest volatile materials such as volatile acids are lost, but an improvement is gained over ordinary evaporative concentration methods.

c. Determination of standard solution: Evaluate the technic and quality of reagents by testing a standard potassium hydrogen phthalate solution.

5. Calculation

$$\text{mg COD L} = \frac{(A - B) \times N \times 8,000}{\text{mL sample}}$$

where:

A = volume FAS used for blank, mL.

B = volume FAS used for sample, mL, and

N = normality of FAS.

6 Precision and Accuracy

A set of synthetic samples containing potassium hydrogen phthalate and NaCl was tested by 74 laboratories.³ At 200 mg COD/L in the absence of chloride, the

standard deviation was ± 13 mg/L (coefficient of variation, 6.5%). At 160 mg COD/L and 100 mg chloride/L the standard deviation was ± 14 mg/L (coefficient of variation, 10.8%).

508 B. References

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ORGANIC CARBON, TOTAL

Method 415.1 (Combustion or Oxidation)

STORET NO. Total 00680

Dissolved 00681

1. **Scope and Application**
 - 1.1 This method includes the measurement of organic carbon in drinking, surface and saline waters, domestic and industrial wastes. Exclusions are noted under Definitions and Interferences.
 - 1.2 The method is most applicable to measurement of organic carbon above 1 mg/l.
2. **Summary of Method**
 - 2.1 Organic carbon in a sample is converted to carbon dioxide (CO₂) by catalytic combustion or wet chemical oxidation. The CO₂ formed can be measured directly by an infrared detector or converted to methane (CH₄) and measured by a flame ionization detector. The amount of CO₂ or CH₄ is directly proportional to the concentration of carbonaceous material in the sample.
3. **Definitions**
 - 3.1 The carbonaceous analyzer measures all of the carbon in a sample. Because of various properties of carbon-containing compounds in liquid samples, preliminary treatment of the sample prior to analysis dictates the definition of the carbon as it is measured. Forms of carbon that are measured by the method are:
 - A) soluble, nonvolatile organic carbon; for instance, natural sugars.
 - B) soluble, volatile organic carbon; for instance, mercaptans.
 - C) insoluble, partially volatile carbon; for instance, oils.
 - D) insoluble, particulate carbonaceous materials, for instance; cellulose fibers.
 - E) soluble or insoluble carbonaceous materials adsorbed or entrapped on insoluble inorganic suspended matter; for instance, oily matter adsorbed on silt particles.
 - 3.2 The final usefulness of the carbon measurement is in assessing the potential oxygen-demanding load of organic material on a receiving stream. This statement applies whether the carbon measurement is made on a sewage plant effluent, industrial waste, or on water taken directly from the stream. In this light, carbonate and bicarbonate carbon are not a part of the oxygen demand in the stream and therefore should be discounted in the final calculation or removed prior to analysis. The manner of preliminary treatment of the sample and instrument settings defines the types of carbon which are measured. Instrument manufacturer's instructions should be followed.

Approved for NPDES

Issued 1971

Editorial revision 1974

4. Sample Handling and Preservation

- 4.1** Sampling and storage of samples in glass bottles is preferable. Sampling and storage in plastic bottles such as conventional polyethylene and cubitainers is permissible if it is established that the containers do not contribute contaminating organics to the samples. **NOTE 1:** A brief study performed in the EPA Laboratory indicated that distilled water stored in new, one quart cubitainers did not show any increase in organic carbon after two weeks exposure.
- 4.2** Because of the possibility of oxidation or bacterial decomposition of some components of aqueous samples, the lapse of time between collection of samples and start of analysis should be kept to a minimum. Also, samples should be kept cool (4°C) and protected from sunlight and atmospheric oxygen.
- 4.3** In instances where analysis cannot be performed within two hours (2 hours) from time of sampling, the sample is acidified ($\text{pH} \leq 2$) with HCl or H_2SO_4 .

5. Interferences

- 5.1** Carbonate and bicarbonate carbon represent an interference under the terms of this test and must be removed or accounted for in the final calculation.
- 5.2** This procedure is applicable only to homogeneous samples which can be injected into the apparatus reproducibly by means of a microliter type syringe or pipette. The openings of the syringe or pipette limit the maximum size of particles which may be included in the sample.

6. Apparatus

- 6.1** Apparatus for blending or homogenizing samples: Generally, a Waring-type blender is satisfactory.
- 6.2** Apparatus for total and dissolved organic carbon:
- 6.2.1** A number of companies manufacture systems for measuring carbonaceous material in liquid samples. Considerations should be made as to the types of samples to be analyzed, the expected concentration range, and forms of carbon to be measured.
- 6.2.2** No specific analyzer is recommended as superior.

7. Reagents

- 7.1** Distilled water used in preparation of standards and for dilution of samples should be ultra pure to reduce the carbon concentration of the blank. Carbon dioxide-free, double distilled water is recommended. Ion exchanged waters are not recommended because of the possibilities of contamination with organic materials from the resins.
- 7.2** Potassium hydrogen phthalate, stock solution, 1000 mg carbon/liter: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in distilled water and dilute to 100.0 ml.
- NOTE 2:** Sodium oxalate and acetic acid are not recommended as stock solutions.
- 7.3** Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.
- 7.4** Carbonate-bicarbonate, stock solution, 1000 mg carbon/liter: Weigh 0.3500 g of sodium bicarbonate and 0.4418 g of sodium carbonate and transfer both to the same 100 ml volumetric flask. Dissolve with distilled water.

- 7.5 Carbonate-bicarbonate, standard solution: Prepare a series of standards similar to step 7.3.

NOTE 3: This standard is not required by some instruments.

- 7.6 Blank solution: Use the same distilled water (or similar quality water) used for the preparation of the standard solutions.

8. Procedure

- 8.1 Follow instrument manufacturer's instructions for calibration, procedure, and calculations.

- 8.2 For calibration of the instrument, it is recommended that a series of standards encompassing the expected concentration range of the samples be used.

9. Precision and Accuracy

- 9.1 Twenty-eight analysts in twenty-one laboratories analyzed distilled water solutions containing exact increments of oxidizable organic compounds, with the following results:

<u>Increment as TOC mg/liter</u>	<u>Precision as Standard Deviation TOC, mg/liter</u>	<u>Bias, %</u>	<u>Accuracy as Bias, mg/liter</u>
4.9	3.93	+ 15.27	+ 0.75
107	8.32	+ 1.01	+ 1.08

(FWPCA Method Study 3, Demand Analyses)

Bibliography

1. Annual Book of ASTM Standards, Part 31, "Water", Standard D 2574-79, p 469 (1976).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 532. Method 505, (1975).

APPENDIX E

TEST LOG

FIELD LOG

Date	Time	Task Performed
9/19/83	0800	TRW Test Crew and EPA Representatives arrive at the Phillips Petroleum Facility in Sweeny, Texas.
	0900	Phillips Petroleum Personnel provide introduction and safety meeting.
	1000	Crew begins set-up at test location. Continuous monitor and GC systems fabricated and lite for warm-up period. IAF #1 (Phillips' South Process) is prepared for testing by cleaning, sealing, and installing inlet blower. The IAF Outlet sample point was fabricated and installed.
	1700	Continuous analyzer (Beckman 402) on-line at IAF #1 sample location.
	1800	Test Crew departs test facility.
9/20/83	0830	TRW Test Crew and EPA Representatives arrive at the Phillips Petroleum Facility in Sweeny, Texas.
	1030	Liquid VOA and composite samples at sample locations A' (IAF-Inlet), C (IAF #1 Outlet) and D (IAF #2 Outlet).
	1045	Preparing IAF #2 for testing.
	1300	Leak check with OVA-128 on sealed doors on IAF #1. Marked leaks and attempted to reseal.
	1435	Measured flow at IAF #1 Outlet.
	1530	IAF #1 gas bag sample #1.

Date	Time	Task Performed
9/20/83 Continued	1600	Check air flow from blower to IAF #1. Without a backpressure for pump flow and with the backpressure in-line between the IAF unit and the blower.
	1615	IAF #1 gas bag sample #2.
	1710	Continuous analyzer (Beckman 400) on-line at IAF #2 sample location. Liquid VOA and composite samples at CPI-Inlet #1, #2, #3 and CPI-Outlet #2, #3. (CPI-Outlet #1 not flowing).
	1813	Air flow measurement at IAF #2.
	1830	Liquid VOA samples at A', C, D.
	1900	Test Crew departs test facility.
9/21/83	0800	TRW Test Crew and EPA Representative arrive at the Phillips Petroleum Facility in Sweeny, Texas.
	0830	IAF #2 gas bag sample #1. Air flow measurement at IAF #2.
	0855	Liquid VOA and composite samples at A', C, D.
	0930	Liquid VOA and grab sample at CPI-Outlet 1,2,3.
	0945	Liquid VOA and grab sample at CPI-Inlet 1,2,3.
	1000	IAF #1 gas bag sample #1.
	1003	Air flow measurement at IAF #1 Inlet.
	1100	Air flow measurement at IAF #1 Outlet.
	1115	IAF #2 overflows into sludge trough. Beckman 400 taken offline.
	1220	IAF #2 back on-line with Beckman 400 monitoring.
	1330	IAF #1 gas bag sample #2.
	1415	Air flow measurement at IAF #2.
	1430	Air flow measurement at IAF #1 Inlet.

Date	Time	Task Performed
9/21/83	1500	Liquid VOA samples at A', C, D, CPI-Inlet
Continued		1,2,3 and CPI-Outlet 1,2,3.
	1505	IAF #2 gas bag sample #2.
	1600	Air flow measurement at IAF #1 Outlet.
	1630	Air flow measurement at IAF #2 Outlet.
	1700	Test Crew departs test facility.
9/22/83	0845	TRW Test Crew and EPA Representative arrive at the Phillips Petroleum Facility in Sweeny, Texas. Beckman 400 on IAF #2 had flame-out 1 hour before; relight and calibration performed.
	0858	Air flow measurement at IAF #1 Inlet.
	0900	IAF #1 gas bag sample #1.
	0915	Liquid Composite started at A', C, D.
	0920	Liquid VOA sample at A', C, D.
	0930	Liquid VOA and grab samples at CPI-Outlet 1,2,3.
	0940	Liquid VOA and grab samples at CPI-Inlet 1,2,3.
	0948	Air flow measurement at IAF #2 Inlet.
	1005	IAF #2 gas bag sample #1.
	1400	IAF #2 gas bag sample #2.
	1515	IAF #1 gas bag sample #2.
	1600	Liquid VOA samples at A', C, D, CPI-Outlet 1,2,3 and CPI-Inlet 1,2,3.
	1700	Test Crew departs test facility.
9/23/83	0830	TRW Test Crew and EPA Representative arrive at the Phillips Petroleum Facility in Sweeny, Texas.

Date	Time	Task Performed
9/23/83	0845	IAF #1 gas bag sample #1. Liquid composite started at A', C, D.
Continued	0854	Air flow measurement at IAF #1 Inlet.
	0900	Liquid VOA samples at A', C, D.
	0930	Liquid VOA and grab samples at CPI-Outlet 1,2,3.
	0934	Air flow measurement at IAF #2 Inlet.
	0945	IAF #2 gas bag sample #1.
	1000	Liquid VOA and grab samples at CPI-Inlet 1,2,3. Air flow measurement at IAF #1 Outlet.
	1020	Air flow measurement at IAF #2 Outlet.
	1053	Reduced flow 50% at IAF #1 and #2 Inlets.
	1056	Reduce flow, THC monitoring and flow measurements.
	1230	Stopped induced flow at IAF #1 and #2 Inlet for "No Flow" test. THC monitoring and flow measurements at the IAF Outlets.
	1330	End of test period.
	1600	TRW test facility disassembled and Crew departs test facility.

APPENDIX F
PROJECT PARTICIPANTS

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U.S. Environmental Protection Agency (Representatives)

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