United States
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Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EMB Report 79-OCM-15
April 1981

Air

EPA

Benzene
Organic Chemical Manufacturing
Ethylbenzene/Styrene

Emission Test Report
El Paso Products Company
Odessa, Texas

SOURCE TEST AT EL PASO PRODUCTS

ETHYLBENZENE/STYRENE PLANT

ODESSA, TEXAS

Contract No. 68-02-2812

Work Assignment No. 52

Project No. 79-OCM-15

EPA Technical Manager: Winton Kelly

Prepared for:

Emission Measurement Branch
Emission Standards and Engineering Division
U. S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Prepared by:

TRW
Environmental Engineering Division
P. O. Box 13000
Research Triangle Park, North Carolina 27709

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1.0 INTRODUCTION

During the periods of September 24th through 28th and October 1st through 5th personnel from TRW Environmental Engineering Division, Energy and Environmental Analysis Incorporated (EEA) and the U.S. Environmental Protection Agency's (EPA) Emission Measurement Branch (EMB) conducted tests at El Paso Products' Ethylbenzene/Styrene plant located in Odessa, Texas.

This facility was tested in order to obtain and analyze samples to provide data in support of possible National Emissions Standards for Hazardous Pollutants (Benzene) and New Source Performance Standards (Organic Chemical Manufacturing Industry).

Two process heaters were tested at this facility; the steam superheater and the hot oil heater. Samples were collected to analyze the fuel and exhaust gas from each device. The purpose of this testing was to determine the destruction efficiency of benzene in these combustion devices and to determine benzene concentration and total flow into the atmosphere of this pollutant. All sampling and analysis was performed at the El Paso Products plant by TRW personnel. Plant operating data was obtained by personnel from EEA. The entire operation was monitored by EPA EMB personnel.

2.0 SUMMARY AND DISCUSSION RESULTS

The sampling and analysis data at El Paso Products were obtained from two separate process locations. The first week was spent sampling and analyzing the fuel and the outlet gases from the steam superheater. The second week was spent collecting data from the fuel gas inlet and the exhaust gases of the hot oil heater. The hot oil heater and the steam superheater are diagrammed in Figure 2-1. Points one and two were sampled simultaneously and points three, four and five were sampled simultaneously in order to determine the benzene destruction efficiency of the combustion processes. Figure 2-1 shows the sampling designations next to the sampling point number. Samples were analyzed for:

a) CO_2, O_2, N_2, H_2, CH_4 by GC/TCD.
b) Benzene, toluene, xylene, ethylbenzene, styrene by GC/FID.
c) Low molecular weight hydrocarbons as C_1-C_6 species by GC/FID.
d) Total hydrocarbons as benzene by FID.
e) Moisture content by EPA standard method.

Samples were collected in tedlar bags utilizing Teflon® sampling lines. The sampling apparatus was precleaned and pretested to eliminate aromatic background concentrations. The samples were analyzed the day of collection to minimize sample degradation.

The analysis of the fuel gases by GC/FID indicated that a saturation effect of the detector occurred when more than 5 percent total hydrocarbons were introduced. This affected the C_1-C_6 system only and methane was the component most affected. For that reason methane (C_1) was determined by thermal conductivity. For the remainder of the components

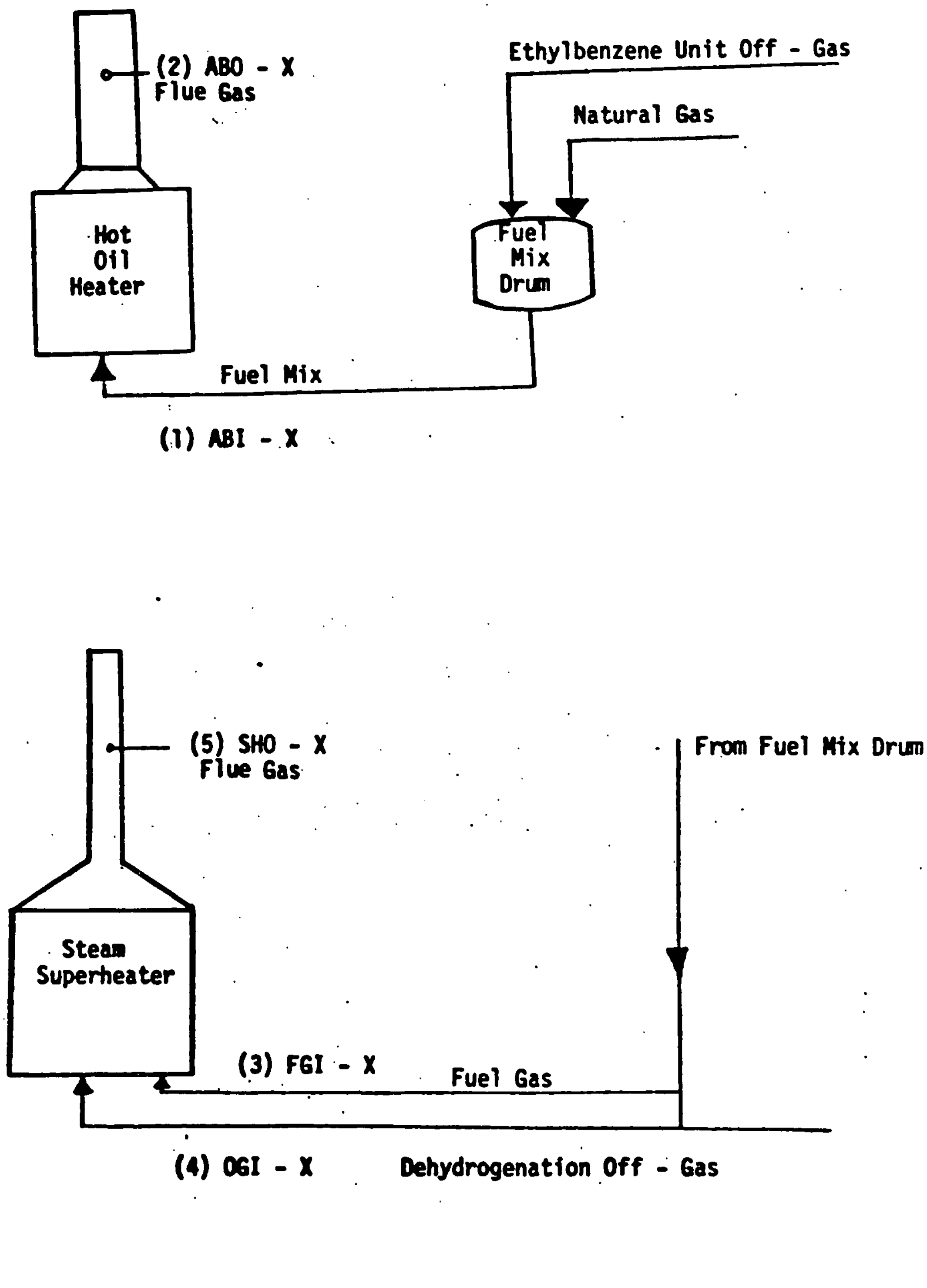


Figure 2-1. Sample point schematic.

this saturation effect was remedied by diluting the fuel samples 100:1 with nitrogen before analysis. The dilutions were performed on a rotameter dilution board and the results were checked by using O_2, CH_4, and H_2 as internal standards which were verified on the thermal conductivity detector. Since the outlet samples were of lower concentrations, they were injected directly in the GC/FID.

The previous discussion has encompassed the overall sampling project. The following discussion will concern itself with the individual processes, the steam superheater and the oil heater, respectively.

2.1 STEAM SUPERHEATER

Five one-hour integrated grab samples were taken simultaneously at each of the two fuel inlets and at the flue gas outlet. Run one at the superheater outlet (SHO-1) was invalid due to a leaking bag. Each bag was analyzed for the constituents listed in Section 2.0 under (a)(b) and (c).

Prior to sampling, the outlet of the superheater was traversed and a sample extracted and pumped to the continuous FID to determine if there were any irregularities in concentrations of total hydrocarbons across the stack. The results exhibited very low hydrocarbon concentrations at all points of the stack. Noise levels of the monitor were high due to the vibrations of the stack and minor deviations would have been hard to detect. Major deviations (>10 percent) would have been easily detected, however none were detected. The GC analysis summaries are listed in Tables 2-1 through 2-3. Prior to each sampling run, a velocity traverse and a moisture determination were conducted at the outlet of the superheater. These results are listed in Table 2-4.

The superheater operating conditions were not always constant. The inlet gas analysis shows that the benzene levels dropped as testing progressed. This data is not in conflict with the plant process data. The outlet showed <.5 ppm benzene on all tests which would give high destruction efficiency results on all the tests. The benzene emission data are summarized in Table 2-7.

Table 2-1. SUMMARY GAS ANALYSIS - DEHYDROGENATED OFFGAS INLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

RUN NO. DATE TIME	OGI-1	OGI-2	OGI-3	OGI-4	OGI-5	AVERAGES
Species analysis	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	
C-1[a]	27,550	25,390	26,550	32,470	29,435	23,279
C-2 + C_2	742	5,659	691	5,104	532	2,546
C-3	462	321	444	353	424	401
C-4	28	18	36	21	36	38
C-5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
C-6	<0.1	<0.1	<0.1	<0.1	607	<0.1
Benzene[b]	5,047	4,380	2,207	2,432	596	2,932
Toluene	299	253	136	78	8	155
Ethylbenzene	4,278	3,545	7,464	1,541	111	3,338
Xylene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Styrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TOTAL HYDROCARBONS by species summation	38,406	39,566	37,528	41,999	31,749	37,849
Inerts[c]						
H_2O, % by volume	≅0.0[d]	≅0.0	≅0.0	≅0.0	≅0.0	≅0.0
N_2, % by volume	4.56	3.96	7.16	2.75	4.77	4.64
O_2, % by volume	.81	.70	.91	ND[e]	.56	.60
CO_2, % by volume	8.82	9.09	7.97	8.09	8.14	8.42
H_2, % by volume	75.48	79.25	75.05	97.48	88.12	83.08
CH_4, % by volume	2.77	2.95	2.65	3.24	2.94	2.91
TOTAL (%)	93.51	96.96	94.84	112.52	104.76	100.52

[a]Measured by a Shimadzu Mini-2 dual GC/FID using Porapak Q column.

[b]Measured by a Shimadzu Mini-1 dual GC/FID using SP2100/0.1% Carbowax on 100/120 Supelcoport column.

[c]Measured by a Carle 8700 GC/TCD using Molecular Sieve and Chromosorb 102 columns.

[d]H_2O% not measured but assumed to be dry for reporting purposes.

[e]Not detected.

Table 2-2. SUMMARY GAS ANALYSIS - FUEL GAS INLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

RUN NO. DATE TIME	FGI-1	FGI-2	FGI-3	FGI-4	FGI-5	AVERAGES
Species analysis	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	
C-1[a]	923,500	923,500	854,700	873,900	917,595	898,639
C-2 + C_2	2,419	16,260	16,799	10,779	14,981	12,248
C-3	353	2,852	260	1,677	2,352	1,499
C-4	8	<0.1	372	296	350	205
C-5	<0.1	<0.1	39	42	66	29
C-6	7	<0.1	<0.1	<0.1	<0.1	<0.1
Benzene[b]	52	50	152	9.1	15.7	56
Toluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	597	72	<0.1	<0.1	<0.1	<0.1
Xylene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Styrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TOTAL HYDROCARBONS by species summation	926,936	942,734	872,322	876,703	935,363	912,812
Inerts[c]						
H_2O, % by volume	≅0.0[d]	≅0.0	≅0.0	≅0.0	≅0.0	≅0.0
N_2, % by volume	8.52	7.70	9.74	10.53	4.72	8.24
O_2, % by volume	1.62	1.39	1.04	1.28	.33	1.13
CO_2, % by volume	.28	.41	.41	.45	ND	.31
H_2, % by volume	ND[e]	ND	ND	ND	ND	ND
CH_4, % by volume	92.35	92.35	85.47	87.39	91.76	89.86
CO, % by volume	.01	ND	ND	ND	ND	ND
TOTAL (%)	103.12	103.77	98.42	100.93	98.58	100.96

[a]Measured by a Shimadzu Mini-2 dual GC/FID using Porapak Q column.

[b]Measured by a Shimadzu Mini-1 dual GC/FID using SP2100/0.1% Carbowax on 100/120 Supelcoport column.

[c]Measured by a Carle 8700 GC/TCD using Molecular Sieve and Chromosorb 102 columns.

[d]H_2O% not measured by assumed to be dry for reporting purposes.

[e]Not detected.

Table 2-3. SUMMARY GAS ANALYSIS - SUPERHEATER OUTLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

RUN NO. DATE TIME	SHO-1	SHO-2	SHO-3	SHO-4	SHO-5	AVERAGES
Species analysis	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound	
C-1[a]	b	2.64	5.7	<0.1	<0.1	<0.1
C-2 + C_2	--	0.3	0.4	<0.1	<0.1	<0.1
C-3	--	<0.1	<0.1	<0.1	<0.1	<0.1
C-4	--	<0.1	<0.1	<0.1	<0.1	<0.1
C-5	--	<0.1	<0.1	<0.1	<0.1	<0.1
C-6	--	0.2	<0.1	<0.1	<0.1	<0.1
Benzene[c]	--	0.3	0.4	<0.1	<0.1	<0.1
Toluene	--	0.3	<0.1	4.9	6.2	3.9
Ethylbenzene	--	<0.1	<0.1	<0.1	<0.1	<0.1
Xylene	--	<0.1	<0.1	<0.1	<0.1	<0.1
Styrene	--	<0.1	<0.1	<0.1	<0.1	<0.1
TOTAL HYDROCARBONS by species summation	--	3.74	10.7	4.9	6.2	6.4
Inerts[c]						
H_2O, % by volume	--	6.28	6.45	5.42	5.60	5.94
N_2, % by volume	--	82.34	77.81	86.50	76.30	80.74
O_2, % by volume	--	3.15	4.61	6.60	7.60	5.49
CO_2, % by volume	--	10.69	9.12	9.10	7.70	9.15
H_2, % by volume	--	ND[e]	ND	ND	ND	ND
CH_4, % by volume	--	ND	ND	ND	ND	ND
TOTAL (%)	--	102.46	97.99	107.62	97.20	101.32

[a]Measured by a Shimadzu Mini-2 dual GC/FID using Porapak Q column.

[b]Run voided due to leaky bag.

[c]Measured by a Shimadzu Mini-1 dual GC/FID using SP2100/0.1% Carbowax on 100/120 Supelcoport column.

[d]Measured by a Carle 8700 GC/TCD using molecular sieve and Chromosorb 102 columns.

[e]Not detected.

Table 2-4. SUMMARY MOISTURE AND VOLUMETRIC FLOWRATE - SUPERHEATER OUTLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

Run no.	Date	Moisture (% by volume)	Volume fraction dry gas (M)	Volumetric flowrate (acfm)	(dscfm)
SHO-1	9/27/79	15.1	.849	85,263	34,012
SHO-2	9/28/79	16.9	.831	95,836	37,439
SHO-3	9/29/79	17.9	.821	83,269	32,053
SHO-4	10/02/79	13.5	.863	97,094	39,436
SHO-5	10/03/79	14.1	.859	86,663	34,596
Average	--	15.5	.845	89,625	35,507

Table 2-5. SUMMARY GAS ANALYSIS OIL HEATER INLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

RUN NO. DATE TIME	ABI-2	ABI-3	ABI-4	AVERAGES
Species analysis	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound
C-1[a]	925,155	897,180	944,785	922,373
C-2 + C_2	21,462	33,404	12,467	22,444
C-3	8,560	5,508	1,744	5,271
C-4	291	<0.1	297	196
C-5	56	<0.1	47	34
C-6	<0.1	40	<0.1	40
Benzene[b]	57.4	65.7	55.8	59.6
Toluene	23.5	3.8	3.2	10.2
Ethylbenzene	<0.1	<0.1	83.4	83.4
Xylene	<0.1	71.5	<0.1	71.5
Styrene	<0.1	<0.1	<0.1	<0.1
TOTAL HYDROCARBONS by species summation	955,605	937,273	959,482	950,452
Inerts[c]				
H_2O, % by volume	~0.0[d]	~0.0	~0.0	~0.0
N_2, % by volume	6.79	4.27	4.54	5.20
O_2, % by volume	0.71	0.02	0.36	0.36
CO_2, % by volume	0.31	0.14	0.74	0.40
H_2, % by volume	ND[e]	ND	ND	ND
CH_4, % by volume	92.52	89.72	94.48	92.24
TOTAL (%)	103.37	98.06	101.59	101.00

[a]Measured by a Shimadzu Mini-2 dual GC/FID using Porapak Q column.

[b]Measured by a Shimadzu Mini-1 dual GC/FID using SP2100/0.1% Carbowax on 100/120 Supelcoport column.

[c]Measured by a Carle 8700 GC/TCD using Molecular Sieve and Chromosorb 102 columns.

[d]H_2O% not measured by assumed to be dry for reporting purposes.

[e]Not detected.

Table 2-6. SUMMARY GAS ANALYSIS OIL BURNER OUTLET AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

RUN NO. DATE TIME	ABO-2	ABO-3	ABO-4	AVERAGE
Species analysis	ppmv as compound	ppmv as compound	ppmv as compound	ppmv as compound
C-1[a]	<0.1	<0.1	<.01	<0.1
C-2 + C_2	<0.1	<0.1	<0.1	<0.1
C-3	<0.1	<0.1	<0.1	<0.1
C-4	<0.1	<0.1	<0.1	<0.1
C-5	<0.1	<0.1	<0.1	<0.1
C-6	<0.1	<0.1	<0.1	<0.1
Benzene[b]	1.3	<0.1	<0.1	0.43
Toluene	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	<0.1	<0.1	<0.1	<0.1
Xylene	<0.1	<0.1	<0.1	<0.1
Styrene	<0.1	<0.1	<0.1	<0.1
TOTAL HYDROCARBONS by species summation	1.3	<0.1	<0.1	0.43
Inerts[c]				
H_2O, % by volume	5.53	6.45	6.34	6.07
N_2, % by volume	75.81	76.94	73.97	75.57
O_2, % by volume	4.61	3.63	3.98	3.92
CO_2, % by volume	9.89	10.37	9.50	9.92
H_2, % by volume	ND[d]	ND	ND	ND
CH_4, % by volume	ND	ND	ND	ND
TOTAL (%)	95.39	97.39	93.69	95.49

[a]Measured by a Shimadzu Mini-2 dual GC/FID using Porapak Q column.

[b]Measured by a Shimadzu Mini-1 dual GC/FID using SP2100/0.1% Carbowax on 100/120 Supelcoport column.

[c]Measured by a Carle 8700 GC/TCD using Molecular Sieve and Chromosorb 102 columns.

[d]Not detected.

No problems were encountered during the sampling using the modified EPA 110 sampling procedure (see Section 4). No problems were encountered in the analytical procedures. The procedures are also explained in Section 4.

2.2 OIL HEATER

Three one-hour integrated bag samples were taken at the fuel inlet and the outlet to the oil heater simultaneously. Each bag was analyzed for (a), (b) and (c), listed in Section 2.0. During the test period a final scrubber in the ethylbenzene unit was cleaned and this resulted in a low benzene concentration in the fuel gas. The results are presented in Table 2.5. Table 2.6 shows the results of the samples obtained at the outlet of the oil heater. Dilution ratios were calculated using stoichiometric combustion calculations. The resultant dilution ratios were then applied to the benzene inlet and outlet concentrations to give the boiler benzene reduction efficiency (see Table 2.7). Run AB-2 appears to have a poor efficiency; however, this is caused by the low benzene concentration in the fuel. No sampling or analytical problems were encountered. No velocity traverse or moisture data were obtained at the outlet as the sampling point was inaccessable.

Table 2-7. SUMMARY - BENZENE REMOVAL EFFICIENCY AT EL PASO PRODUCTS COMPANY, ODESSA, TEXAS

	Benzene concentration			Oxygen concentration		Moisture	Dilution	Benzene removal	Emission	
	Stack outlet		Fuel inlet	Stack		stack[a]	factor	efficiency	rates	
Run no.	(ppmv wet)	(ppmv dry, @3% O_2)	(ppmv)	(% by volume wet)	(% by volume dry)	(%)		(%)	(lb/hr)	(kg/hr)
ABO-2	1.3	1.52	57.4	4.16	4.40	5.53	10.01	73.49	I/D	I/D
ABO-3	<0.1	<0.1	65.7	3.63	3.88	6.45	9.48	~100	I/D	I/D
ABO-4	<0.1	<0.1	55.8	3.98	4.24	6.24	10.37	~100	I/D	I/D
SHO-2	0.3	.33	I/D[b]	3.15	3.36	6.28	I/D	I/D	.16	.07
SHO-3	0.4	.49	I/D	4.61	4.93	6.45	I/D	I/D	.17	.08
SHO-4	<0.1	<0.1	I/D	6.6	6.98	5.42	I/D	~100	<.052	<.02
SHO-5	<0.1	<0.1	I/D	7.6	8.05	5.60	I/D	~100	<.045	<.02

[a]As analyzed in sample.

[b]I/D - Insufficient data.

3.0 LOCATION OF SAMPLING POINTS

There were five sampling points in the two processes. The first three were the two inlets to the superheater and the outlet from the superheater. These are discussed in Section 3.1. The remaining two were the inlet to and outlet from the oil burner heater, which are discussed in Section 3.2.

3.1 SUPERHEATER SAMPLING POINTS

The sample locations for the Steam Superheater were shown in Figures 3-1 and 3-2. At sample point 3 (FGI) fuel gas from the fuel mixing drum was collected for analysis. At sample point 4 (OGI) dehydrogenated off gas was collected. Both of these points were sampled after a flow orifice which measured the amounts of fuel delivered to the superheater burners. Sample point 5 (SHO) was located on the exhaust stack of the superheater. There were two ports located 90° apart about the centroid of the stack. Moisture measurements and velocity traverses were conducted from both of these ports. The integrated bag sample was extracted from one of these ports at a single point in the centroid of the stack.

3.2 OIL BURNER SAMPLING POINTS

Sampling locations from the oil heater are shown in fig. 1A and Figure 3.3. Sample point 1 (ABI) consisted of the fuel entering the boiler from the fuel mix tank. Sample point 2 (ABO) was a stream taken from the exhaust gases of the stack. The exhaust gases were inaccessible for flow measurement. The integrated bag sample was taken at the outlet of a 1/4" stainless steel line which ran down the side of the stack. This was provided by the plant and is their normal sampling point for this location.

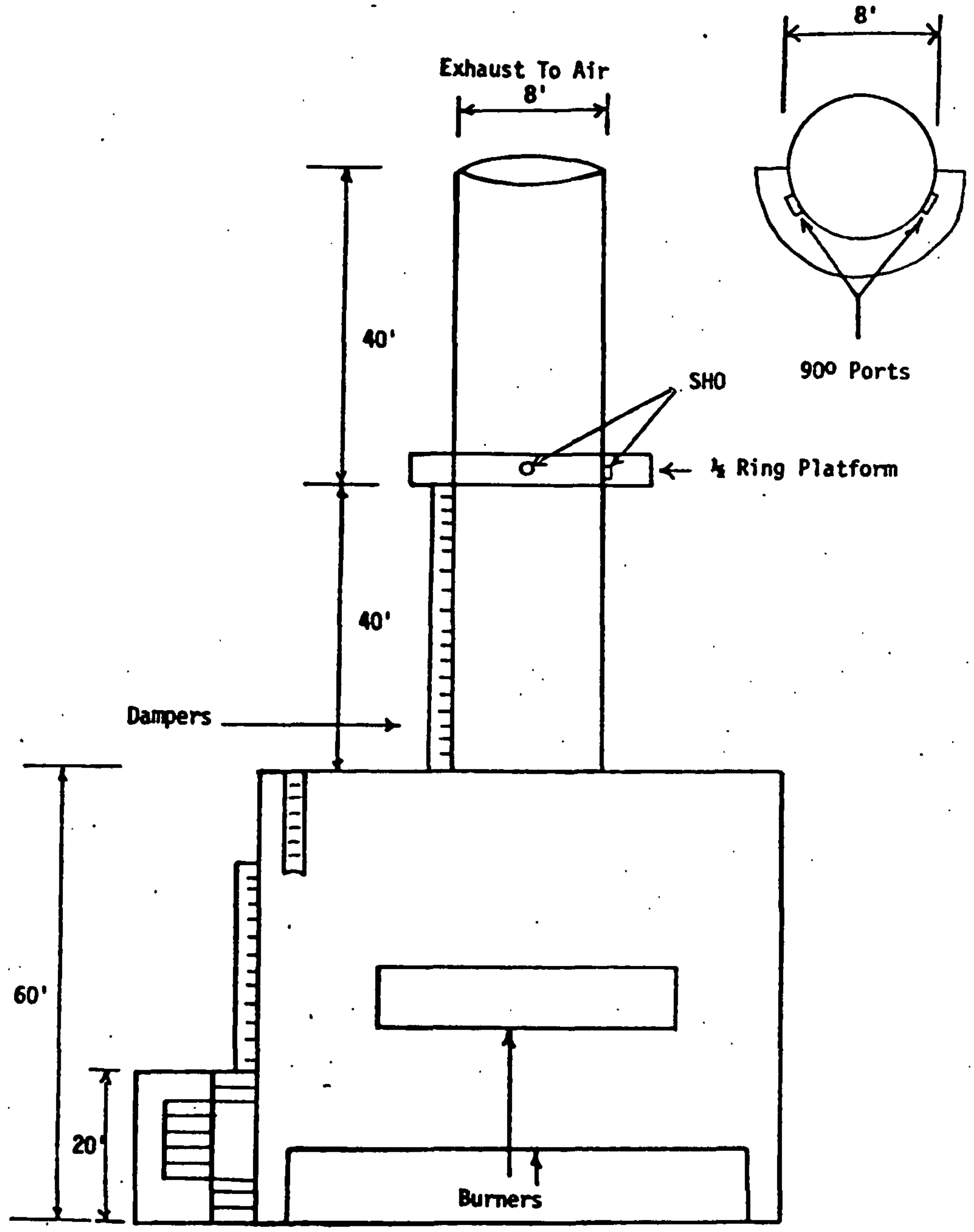


Figure 3-1. Sampling locations steam superheater - Unit 2.

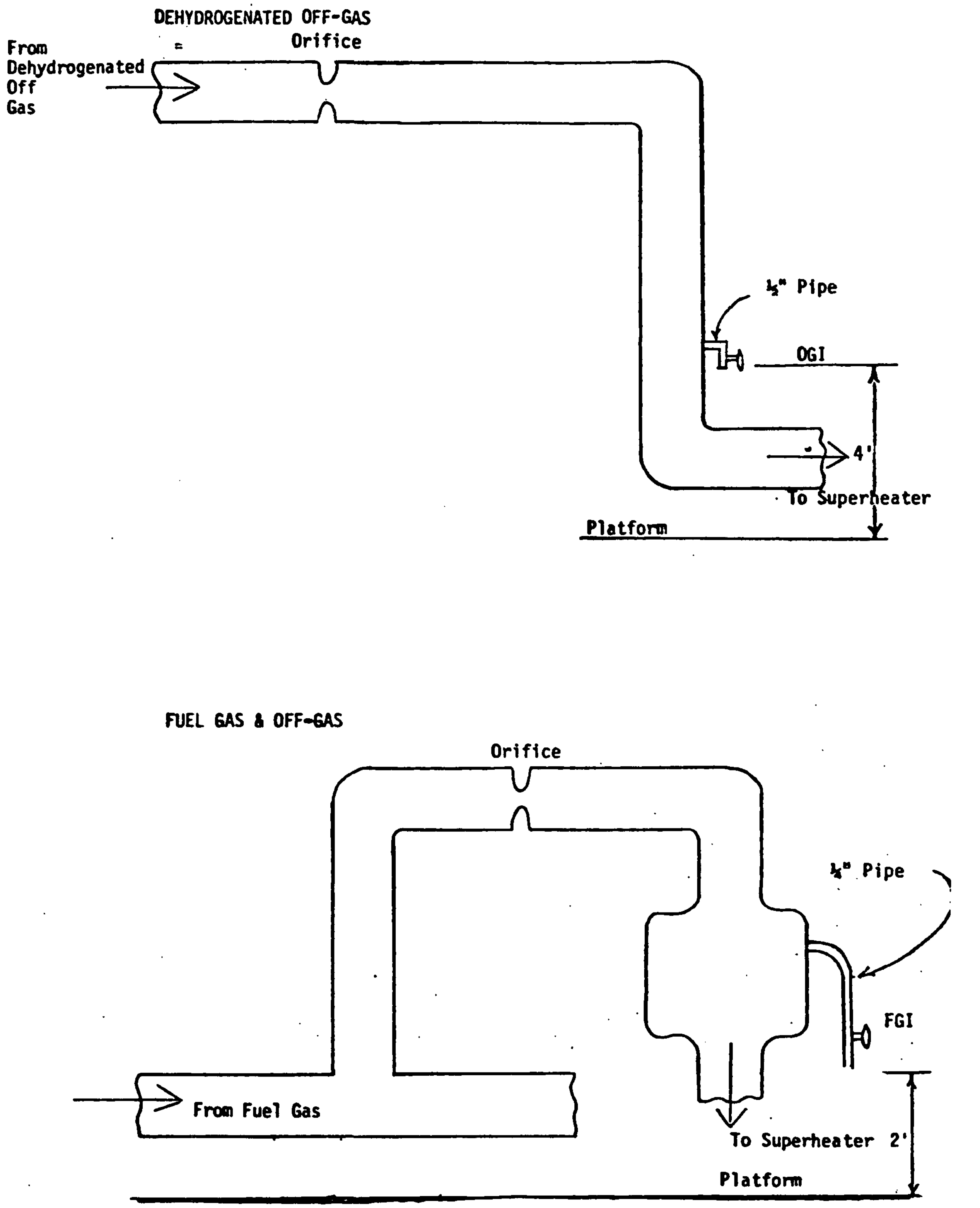


Figure 3-2. Sampling locations off-gas and fuel gas inlets to superheater.

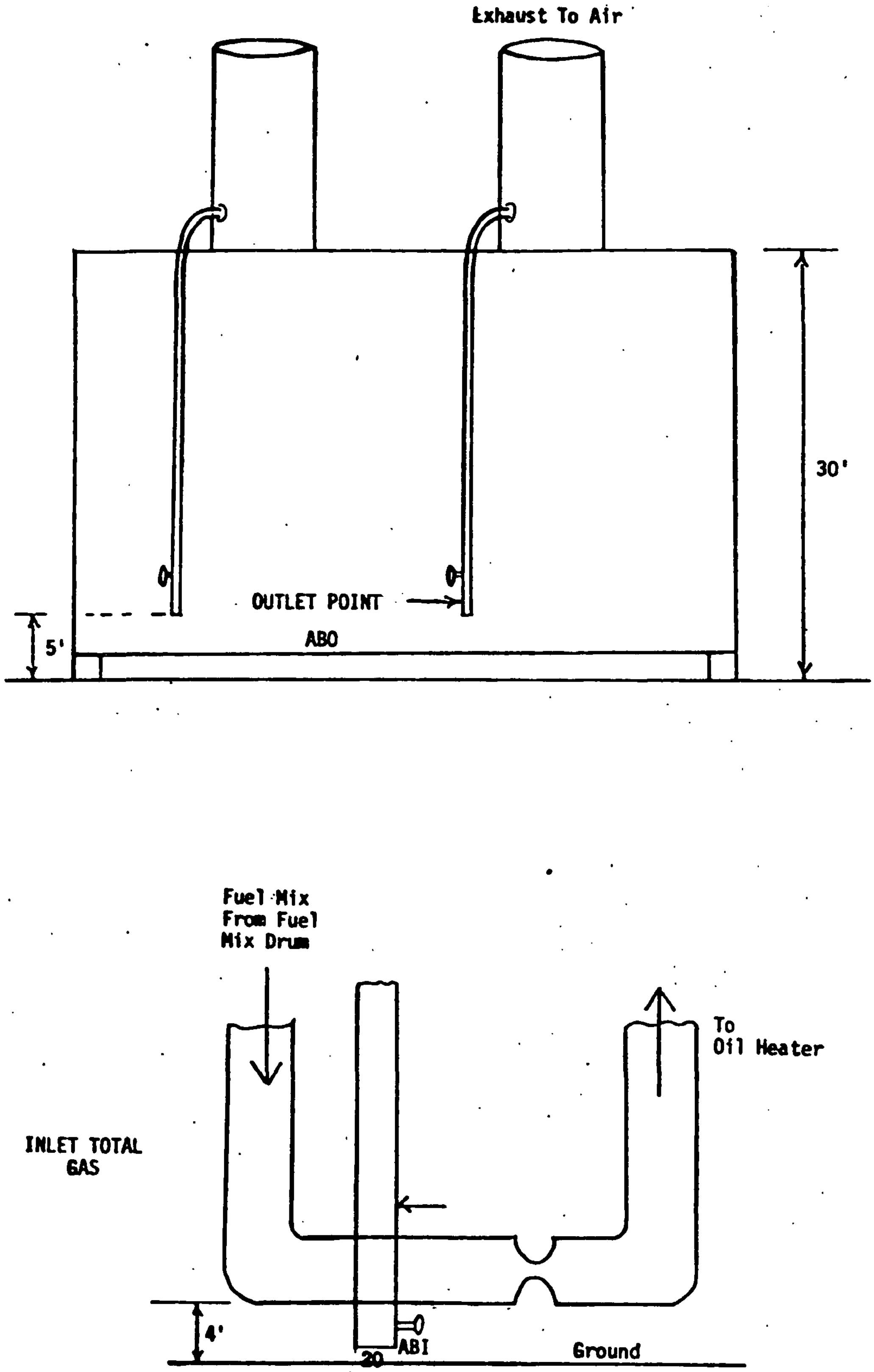


Figure 3-3. Sampling locations oil heater - Unit 1.

4.0 SAMPLING AND ANALYSIS PROCEDURES

4.1 SAMPLING

4.1.1 Volumetric Flow and Moisture Determination

The gas volumetric flow data was obtained from the superheater outlet by EPA Reference Methods 1 and 2. Moisture content at stack conditions was determined by EPA Reference Method 4.

4.1.2 Hydrocarbon Sampling System

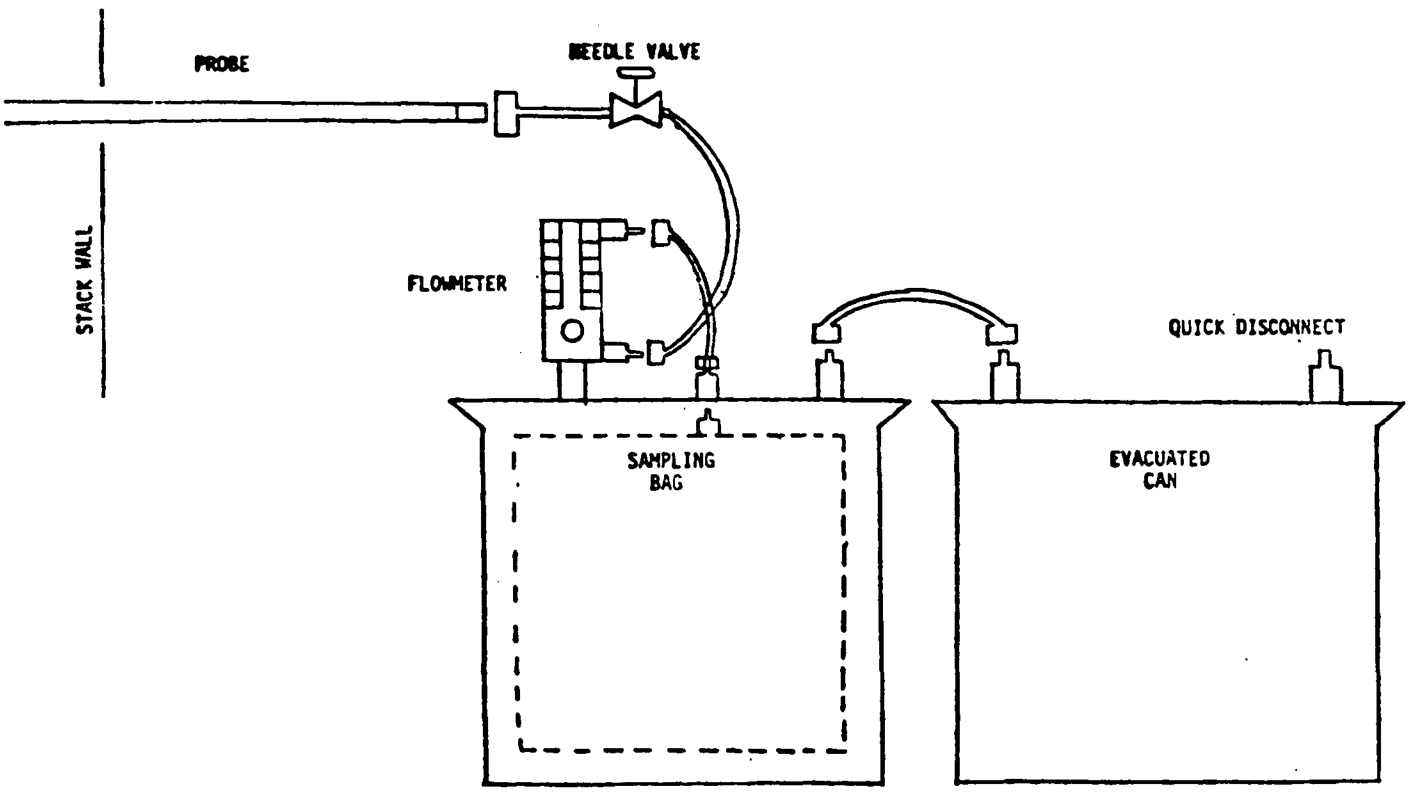
A modified Method 110 was chosen for use in collecting a hydrocarbn sample. The modification was the replacement of the vacuum pump with an evacuated can. This system was chosen because of the explosion risk and safety requirements of the plant.

The evacuated can method was used for obtaining a given quantity of sample into a tedlar bag. This method uses the negative pressure from an evacuated can connected to a sample bag can as the mechanism for obtaining a controllable sample flow.

The procedure uses a diaphram pump to evacuate the can using a self-sealing quick-disconnect valve. A vacuum guage is connected at the other quick-disconnect valve and the can is evacuated to 29" Hg. The vacuum is monitored for a leak. If the pressure loss does not exceed more than 1" Hg in 30 minutes, the can is considered to be leak-free. The equipment is then transported to the sampling site and assembled according to the Figure 4.1.

The tedlar sample bag is placed in the sample can and connected to the sample line that has been purging at the site. The sample flow into the sample bag is obtained by opening the valve between the two cans. The sample flow can be monitored with the flow meter. The adjusting of the valve will give the appropriate sample flow desired.

The sample flow will remain constant until the evacuated can starts to reach a low pressure level. When the sample flow drops or the appropriate test time is completed, the valve is shut between the cans and the sample bag disconnected from the sample line. The bag is capped off and removed from the sample can. The bag is appropriately labeled and transported by the sampler to the lab for analysis.


PROBE
NEEDLE VALVE
STACK WALL
FLOWMETER
QUICK DISCONNECT
SAMPLING
BAG
EVACUATED
CAN

APPENDIX A

SAMPLE CALCULATIONS AND RESULTS

Table A.1. COMBUSTION CALCULATIONS

Calculation Basis: 100 Moles Fuel

Let: a = volume % N_2 in fuel

b = volume % CO_2 in fuel

c = volume % O_2 in fuel

d = volume % H_2 in fuel

e = volume % CH_4 in fuel

L = volume % non-CH_4 species in fuel

k = number of % non-CH_4 species in fuel

m = hydrogen atoms in non-methane HC species

n = carbon atoms in non-methane HC species

1. Oxygen required for combustion, moles

$$O_2 = \tfrac{1}{2}d + 2e + \sum_{i=1}^{k} L_i\left(n_i + \frac{m_i}{4}\right) - c$$

2. Nitrogen with combustion air, moles

$$N_2 = (79/21)\, O_2$$

3. Carbon dioxide generated, moles

$$CO_2 = e + \sum_{i=1}^{k} (L_i n_i)$$

4. Water generated, moles

$$H_2O = d + 2e + \sum_{i=1}^{k} (L_i m_i/2)$$

5. At stoichiometric air rates*, moles

$O_2^* = O_2$

$N_2^* = a + N_2$

$CO_2^* = b + CO_2$

$H_2O^* = H_2O$

Table A.1. Continued.

6. Since excess air is added and water is condensed prior to analysis:

Let: x = excess moles O_2 added

y = moles H_2O condensed

% N_2e = N_2 in exhaust sample

% O_2e = O_2 in exhaust sample

% CO_2e = CO_2 in exhaust sample

7. <u>Nitrogen balance</u>:

$$\% N_2^e = \frac{(N_2^* + 3.76\ x)(100)}{N_2^* + CO_2^* + H_2O^* + x + 3.76x - y}$$

8. <u>Oxygen balance</u>:

$$\% O_2^e = \frac{x\ (100)}{N_2^* + CO_2^* + H_2O^* + x + 3.76x - y}$$

9. Solving for x by eliminating y in the above equations:

$$x = \frac{N_2^*}{\frac{\% N_2^e}{\% O_2^e} - 3.76}$$

10. Therefore $y = N_2^* + CO_2^* + H_2O^* + 4.76x - \frac{100}{\% O_2^e}\,x$

11. At sample conditions, combustion products from 100 moles of fuel is given by:

O_2^s oxygen:	x	moles
N_2^s nitrogen:	$N_2 + 1 + 3.76x$	moles
CO_2^s carbon dioxide:	$CO_2 + b$	moles
H_2O^s water vapor:	$H_2O - y$	moles
TOTAL MOLES =	SUM	moles

12. Dilution ratio (DR) = $\frac{SUM}{100}$

13. Mass removal efficiency = $\frac{C_{in} - C_{out}\frac{SUM}{100}}{C_{in}}$

Table A-2. MOISTURE CALCULATION[a]

Temperature, °F	Moisture H_2O, % by volume t saturation
70	2.47
75	2.92
80	3.45
85	4.06
90	4.72
95	5.53
100	6.45
105	7.50
110	8.66
115	10.0

[a]From psychometric charts. Calculated water vapor concentration assumed to be saturated at analysis temperature.

Table A.3. BENZENE REMOVAL EFFICIENCY

Benzene Concentration, ppmv @ 3% O_2, dry

$$B_d = B_w \frac{17.9}{(1-M)\ 20.9 - O_d}$$ Equation A.3

where:

B_d = Benzene concentration ppmv @ 3% O_2, dry
B_w = Benzene, ppmv, wet
20.9 = Oxygen (% v/v) in ambient air
O_d = Oxygen, % v/v, dry
M = Moisture fraction, $\frac{\%\ M}{100}$

Equation A.4

$$M_B(\%) = \frac{C_{IN} - C_{OUT}\ (DR)}{C_{IN}} \times 100$$

where:

M_B = Benzene Mass Removal Efficiency (%)
C_{IN} = Concentration Inlet
C_{OUT} = Concentration Outlet
DR = Dilution Ratio

LOAD SHEET

STACK TEST - VOLUMETRIC FLOW RATE

ε-/

Test # SHO-1

Part 1

Enter	(Initially Only) Value	Location
	0.0283	04
	17.71	05
	0.0474	06
	1032	07

Enter	Test # SHO-1 Value	Location	Enter	Test # SHO-2 Value	Location	Enter	Test # SHO-3 Value	Location
f(Min)	15	09	Tf(Min)	15	09	Tf(Min)	15	09
)^2(in^2)	.910	10	(DN)^2(in^2)	1.0	10	(DN)^2(in^2)	1.0	10
S(in Hg)	26.78	11	PS(in Hg)	26.80	11	PS(in Hg)	26.90	11
(ft^3)	2.185	12	VM(ft^3)	2.045	12	VM(ft^3)	2.486	12
W(ml)	7.0	13	VW(ml)	7.5	13	VW(ml)	10.0	13
CO_2	10.7	14	% CO_2	10.7	14	% CO_2	10.7	14
O_2	3.2	15	% O_2	3.2	15	% O_2	3.2	15
N_2	82.3	16	% N_2	82.3	16	% N_2	82.3	16
350√	57000.0	17	4350√	63857.3	17	4350√	55475.7	17
(ft^2)	40,34	18	As(ft^2)	40.34	18	As(ft^2)	40.34	18
s+460)	1010	19	(Ts+460)	1007	19	(Ts+460)	1016.5	19
	Part 2			Part 2			Part 2	
(mg)	96	00	mf (mg)	94	00	mf (mg)	83.5	00
(mg)	26.78	01	mt (mg)	26.8	01	mt (mg)	26.9	01
STD(f^3)		02	VMSTD(f^3)		02	VMSTD(f^3)		02
("Hg)		03	Ps ("Hg)		03	Ps ("Hg)		03
		04	Md		04	Md		04
Ts+460)		05	(Ts+460)		05	(Ts+460)		05
(scfm)		06	Qs(scfm)		05	Qs(scfm)		06

RESULTS
STACK TEST - VOLUMETRIC FLOW RATE

Test # SHO-1		Test # SHO-2		Test # SHO-3	
Value		**Value**		**Value**	
Vm (SCF)	1,872	Vm (SCF)	1.752	Vm (SCF)	
Vm (SCM	—	Vm (SCM)	—	Vm (SCM)	
Vw gas (CF)	—	Vw gas (CF)		Vw gas (CF)	
% Moisture	15.1	% Moisture	16.9	% Moisture	17.9
Md		Md	—	Md	
MWd		MWd	—	MWd	
MW		MW	—	MW	
Vs (fpm)	2113.76	Vs (fpm)	2375.7	Vs (fpm)	2064.2
ACFM	85263.9	ACFM	95836.9	ACFM	83269.2
Flow (SCFM)	34012.5	Flow (SCFM)	37439.6	Flow (SCFM)	32053.2
Flow (SCMM)		Flow (SCMM)		Flow (SCMM)	
% I	~~3~~	% I		% I	
% EA	17.12	% EA	17.12	% EA	17.12
Front gr/scf		Front gr/scf		Front gr/scf	
Front gm/scm		Front gm/scm		Front gm/scm	
Total gr/scf		Total gr/scf		Total gr/scf	
Total gm/scm		Total gm/scm		Total gm/scm	
Front gr/acf		Front gr/acf		Front gr/acf	
Front gm/acm		Front gm/acm		Front gm/acm	
Total gr/acf		Total gr/acf		Total gr/acf	
Total gm/acm		Total gm/acm		Total gm/acm	
Front lb/hr		Front lb/hr		Front lb/hr	
Front kg/hr		Front kg/hr		Front kg/hr	
Total lb/hr		Total lb/hr		Total lb/hr	
Total kg/hr		Total kg/hr		Total kg/hr	

LOAD SHEET
STACK TEST - VOLUMETRIC FLOW RATE

Test # SHO-4

Part 1

Enter	(Initially Only) Value	Location
	0.0283	04
	17.71	05
	0.0474	06
	1032	07
f(Min)	15	09
)^2(in^2)	1.0	10
S(in Hg)	26.9	11
(ft^3)	1.91	12
I(ml)	5.5	13
CO_2	10.7	14
O_2	3.2	15
N_2	82.3	16
50√	65233.5	17
s(ft^2)	40.34	18
s+460)	1013	19
	Part 2	
(mg)	91	00
t (mg)	26.9	01
STD(f^3)		02
S ("Hg)		03
		04
Ts+460)		05
(scfm)		06

Test # SHO-5

Enter	Value	Location
Tf(Min)	15	09
(DN)^2(in^2)	1.0	10
PS(in Hg)	26.9	11
VM(ft^3)	2.22	12
VW(ml)	7.6	13
% CO_2	10.7	14
% O_2	3.2	15
% N_2	82.3	16
4350√	58025.8	17
As(ft^2)	40.34	18
(Ts+460)	1010	19
	Part 2	
mf (mg)	73	00
mt (mg)	26.9	01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

Test # SHO-6

Enter	Value	Location
Tf(Min)	15	09
(DN)^2(in^2)	1.0	10
PS(in Hg)	26.9	11
VM(ft^3)		12
VW(ml)		13
% CO_2	10.7	14
% O_2	3.2	15
% N_2		16
4350√	58025.8	17
As(ft^2)	40.34	18
(Ts+460)		19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

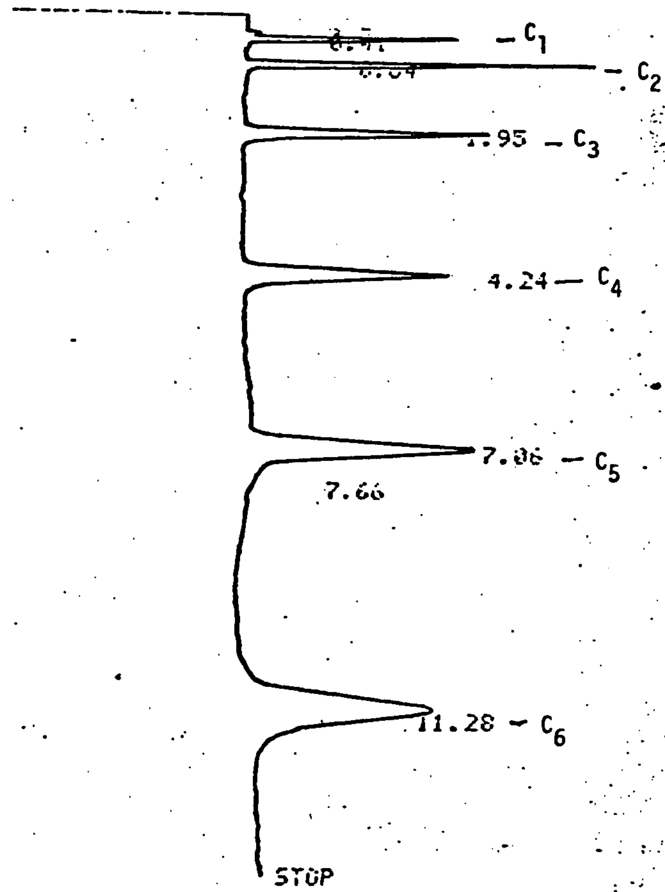
RESULTS
STACK TEST - VOLUMETRIC FLOW RATE

Test # SHO-4		Test # SHO-5		Test #	
Value		Value		Value	
Vm (SCF)		Vm (SCF)		Vm (SCF)	
Vm (SCM		Vm (SCM)		Vm (SCM)	
Vw gas (CF)		Vw gas (CF)		Vw gas (CF)	
% Moisture	13.6	% Moisture	15.4	% Moisture	
Md		Md		Md	
MWd		MWd		MWd	
MW		MW		MW	
Vs (fpm)	2406.9	Vs (fpm)	2148.3	Vs (fpm)	
ACFM	97094.6	ACFM	86663.1	ACFM	
Flow (SCFM)	39436.5	Flow (SCFM)	34594.5	Flow (SCFM)	
Flow (SCMM)	-	Flow (SCMM)		Flow (SCMM)	
% I	-	% I		% I	
% EA	-	% EA		% EA	
Front gr/scf		Front gr/scf		Front gr/scf	
Front gm/scm		Front gm/scm		Front gm/scm	
Total gr/scf		Total gr/scf		Total gr/scf	
Total gm/scm		Total gm/scm		Total gm/scm	
Front gr/acf		Front gr/acf		Front gr/acf	
Front gm/acm		Front gm/acm		Front gm/acm	
Total gr/acf		Total gr/acf		Total gr/acf	
Total gm/acm		Total gm/acm		Total gm/acm	
Front lb/hr		Front lb/hr		Front lb/hr	
Front kg/hr		Front kg/hr		Front kg/hr	
Total lb/hr		Total lb/hr		Total lb/hr	
Total kg/hr		Total kg/hr		Total kg/hr	

SMPL # 30
FILE # 3
REPT # 40
METHOD 41

#	NAME	TIME	CONC	MK	AREA
0		0.31	99.9999		67
	TOTAL		99.9999		67

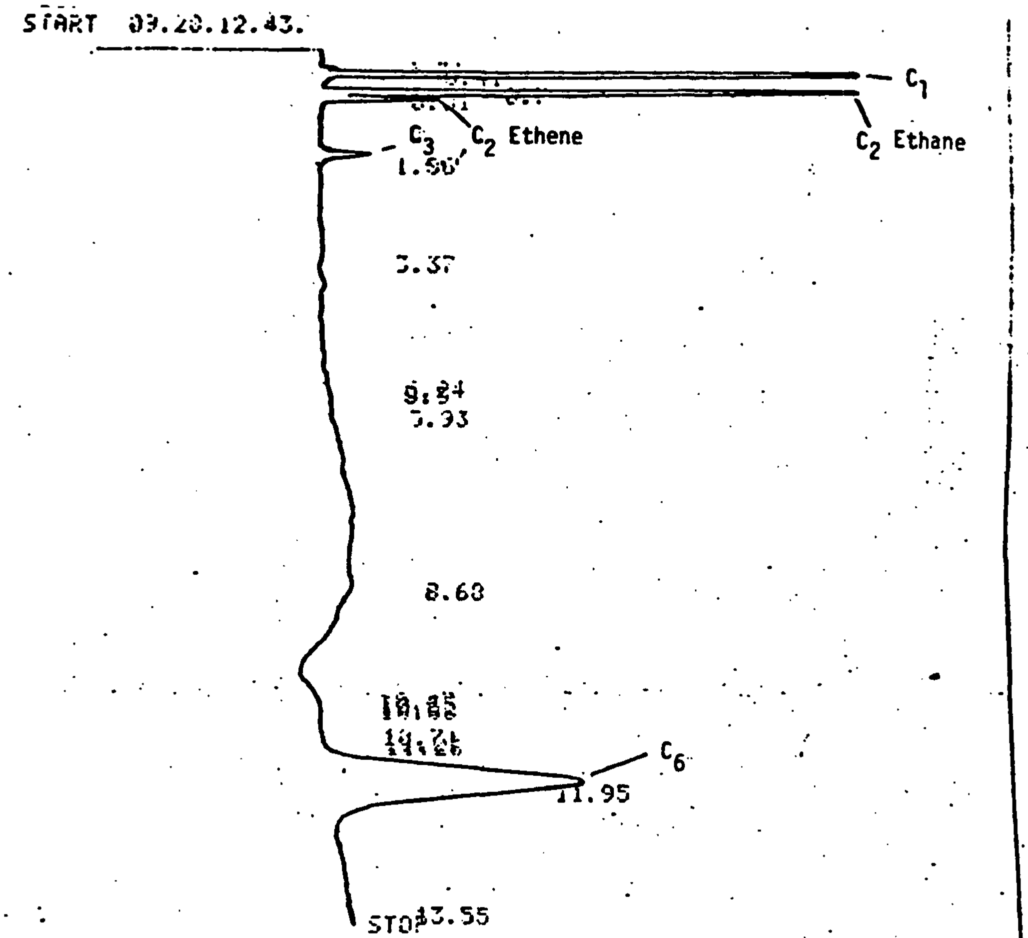
H-2
C1-C6
START 09.29.03.35.



C-R1A
SMPL # 30
FILE # 3
REPT # 41
METHOD 41

#	NAME	TIME	CONC	MK	AREA
0		0.3	0.361		62
0		0.41	5.7216	V	771 — C_1
0		0.84	7.3396		1521 — C_2
0		1.95	11.0273		2286 — C_3
0		4.24	14.8751		3084 — C_4
0		7.06	24.4872		5076 — C_5
0		11.28	38.2477		7929 — C_6
	TOTAL		[illegible]		[illegible]

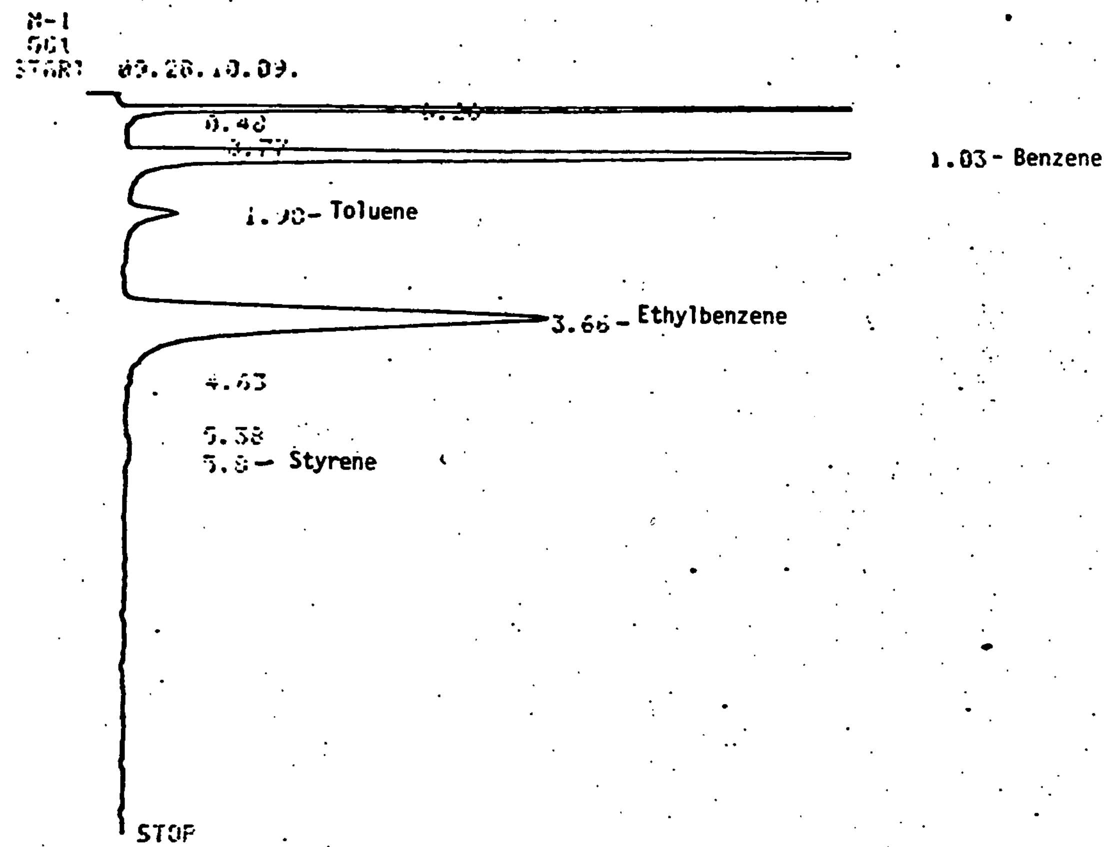
C1-C6 Calibration Example



C-R1A
SMPL # 00
FILE # 3
REPT # 25
METHOD 41

#	NAME	TIME	CONC	MK	AREA	
0		0.31	0.2626		65	
0		0.41	25.5967	V	6428	C_1
0		0.7	20.8169	V	5227	C_2=
0		0.81	2.0048	V	503	C_2
0		1.7	1.8498		464	C_3
0		3.37	0.1529		38	
0		5.24	0.147		36	
0		8.68	0.4806		120	Temperature Program
0		10.47	0.7799		195	
0		10.55	0.2793	V	70	
0		10.61	0.2213	V	55	
0		10.66	0.2992	V	75	
0		10.71	1.5895	V	399	
0		11.21	0.3057	V	76	
0		11.26	0.1908	V	47	
0		11.95	44.3966	V	11149	C_6
0		13.35	0.6253	V	157	
	TOTAL		99.9999		25113	

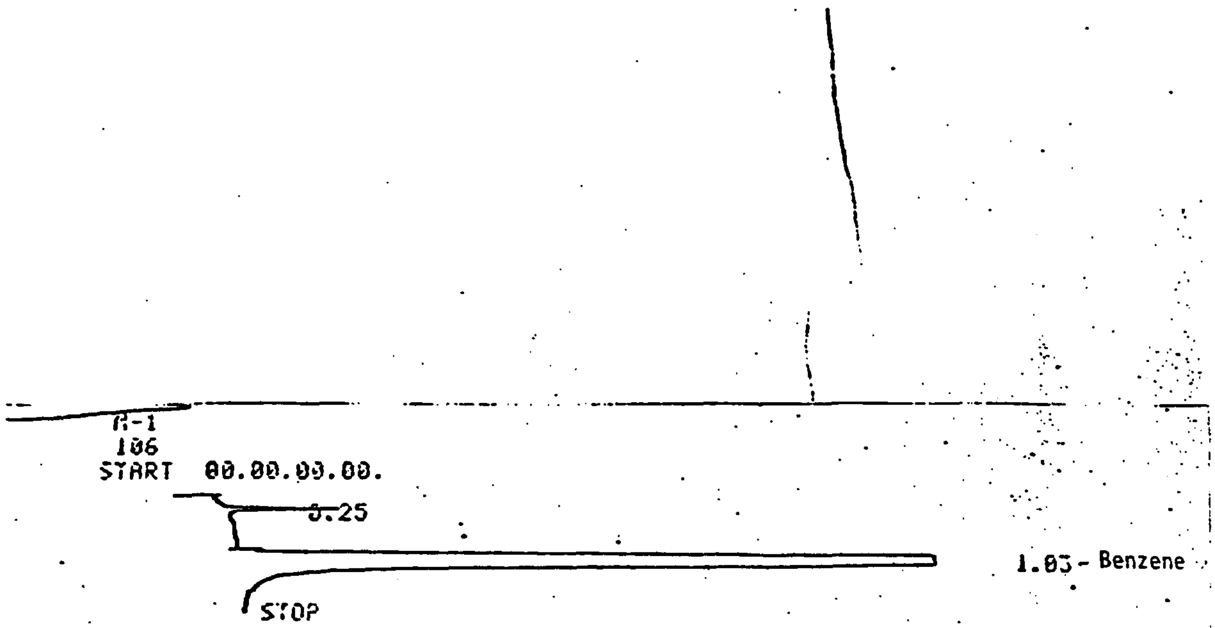
C1-C6 ExampleRun



C-RIA
SMPL # 00
FILE # 3
REPT # 17
METHOD 41

#	NAME	TIME	CONC	MK	AREA	
0		0.26	49.0065		25111	
0		0.48	0.021	T	10	
0		0.77	0.023		11	
0		1.03	23.8152		12203	—Ø
0		1.98	1.4481		742	—Ø CH_3
0		3.66	25.231		12928	—EB
0		5.38	0.0592		30	
0		5.8	0.3956	V	202	—Sty
	TOTAL		100		51241	

Example Aromatic Hydrocarbon Sample Run



SMPL # 00
FILE # 3
REPT # 6
METHOD 41

#	NAME	TIME	CONC	MK	AREA
0		0.25	0.9285		328
0		1.03	99.0714		35092
	TOTAL		99.9999		35421

Benzene Calibration

APPENDIX B

FIELD ANALYTICAL WORKSHEETS

Porpak Q

GC WORKSHEET OGI-1

00001

COLUMN: AT-1200 Bentone 34 RUN NUMBER: Off Gas-1 DATE: 9/28/79

COMPOUND	RETENTION TIME IN ~~GF.~~ min	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	6445	10	16	100:1 ×1.4	12900 ppm	
C_2	.81	528	↓	↓	↓	5×3° ppm	
C_3	1.7	457	↓	↓	↓	3×3° ppm	
C_4	3.6	48.5	↓	↓	↓	×2° ppm	
C_5	~6.5	0	↓	↓	↓	0 in noise level	
~~C_5~~ C_6	11.9	12429	↓	↓	↓	22×4° ppm	
BENZENE	1.03	12016	10^3	8	100:1	3605	3605
TOLUENE	1.97	877	↓	↓	↓	213.7	263
XYLENE	~~[illegible]~~ ~5.7	~~[illegible]~~	↓	↓	↓	–	0 - in noise level
ETHYL-BENZENE	3.67	14820	↓	↓	↓	3056	4446
STYRENE	~8.5	0	↓	↓	↓	–	0 - in noise level
TOTAL HYDRO-CARBONS (THC)							

×1.4

B-1

TRW
ENVIRONMENTAL ENGINEERING DIVISION

Porpak Q

GC WORKSHEET OG1-2

COLUMN: AT-1200 [illegible] 34 RUN NUMBER: Off gas - 2 DATE: 9/28/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS ~~BENZENE~~ CMPD – CORR
C_1	.42	45169	10	16	100:1 x1.4	9034 ppm	
C_2	.77 .81	~~3427 36990~~	↓	↓	↓	~~343 ppm 3699 ppm~~	4042 5659
C_3	2.[illegible]	3187	↓	↓	↓	229 ppm	321
C_4	4.26	265	↓	↓	↓	13 ppm	18
C_5	~~4.06~~	0	↓	↓	↓	0	—
~~C_6~~ Q →	12.79	65389	↓	↓	↓	1177 ppm	—
BENZENE	1.04	104309	16^3	8	↓ x1.4	3129 ppm	3129 ppm
TOLUENE	2.02	7422	↓	↓	↓	181 ppm	223 ppm
~~XYLENE~~ →	3.75	122762	↓	↓	↓	2532 ppm	3683 ppm
~~ETHYL-BENZENE~~ →	5.92	3139	↓	↓	↓	65 ppm	94 ppm
STYRENE	-	0	↓	↓	↓		0
TOTAL HYDRO-CARBONS (THC)							

B-2

GC WORKSHEET

COLUMN: ______ RUN NUMBER: OGI-3 DATE: 9/30/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS ~~BENZENE~~ CMPD (CORR)
C_1	.4	62163	10	16	10:1 ×1.396	1199 7 ppm	
C_2	.8	5053	↓	↓	↓	495 ppm	691
C_3	1.81	4484	↓	↓	↓	318 ppm	444
C_4	4.01	476	↓	↓	↓	26 ppm	36
C_5			↓	↓	↓		
C_6							
BENZENE	.89	6617	10^3	8	10:1	152 ppm	152 ppm
TOLUENE	1.65	5170	↓	↓	↓		119 ppm
XYLENE	[illegible]	[illegible]	↓	↓	↓		778 ppm
ETHYL-BENZENE	2.99	33812					
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

B-3

TRW
ENVIRONMENTAL ENGINEERING DIVISION

Porpak Q

GC WORKSHEET FG1-1

COLUMN: AT-1200 Bentone 34 RUN NUMBER: Fuel Gas - 1 DATE: 9/28/79

COMPOUND	RETENTION TIME IN ~~CM.~~ min	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	49447	10	16	100 : 1 5.94	98894 ppm	
C_2	.81	2573	↓	↓	↓	2573 ppm	
C_3	1.83	529				376 ppm	
? C_4	3.58	16				8 ppm	
? C_5	~ 5.7	0				0	
? C_6	11.9	40				7.2 ppm	
BENZENE	1.03	184	10^3	8		55 ppm	55 ppm
TOLUENE	~	0	↓	↓		–	0
XYLENE	~	0				–	0
ETHYL-BENZENE	3.66	3075				635 ppm	923 ppm
STYRENE	~	0			↓	–	0
TOTAL HYDRO-CARBONS (THC)							

B-4

TRW

ENVIRONMENTAL ENGINEERING DIVISION

Porapak Q

GC WORKSHEET FGI-2

COLUMN: AT-1200 Batch 74 RUN NUMBER: Fuel Gas - 2 DATE: 9/25/79

2ML SAMPLE LOOP

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.42	258307	10	16	100 : 1(1.0204)	5166414 ppm	
C_2	.85	15941	↓	↓	↓	15941 ppm	
C_3	2.14	3884				2796 ppm	
C_4	4.78						
C_5	6.51						
C_6	11.9	0	↓	↓		0	
BENZENE	1.04	163	10^3	8		~~[illegible]~~ .49 ppm	.49 ppm
TOLUENE	0	0	↓	↓		–	0 ~~103 ppm~~
~~XYLENE~~	3.77	345				70.81 PPM	103 ppm
ETHYL-BENZENE	0	6				–	0
STYRENE	0	0	↓	↓	↓	–	0
TOTAL HYDRO-CARBONS (THC)							

.00275

B-5

Porapak Q

GC WORKSHEET

COLUMN: ~~AT-1200 Bentone 34~~ RUN NUMBER: FGI-3 DATE: 9/29/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.42	277013	10	16	100:1 x.858	534026 ppm	
C_2	.83	20395	↓	↓	↓	19579 ppm	
C_3	1.95/3.75	4925 / 446				303 ppm	
C_4	4.19/[illegible]	885				434 ppm	
C_5	6.6	153	↓			46 ppm	
C_6			↓	↓	↓		
BENZENE	.9	771	10^3	8	10:1	1x78 ppm	1x78 ppm
TOLUENE			↓	↓	↓		
XYLENE							
ETHYL-BENZENE							
STYRENE			↓	↓	↓		
TOTAL HYDRO-CARBONS (THC)							

B-6

TRW

ENVIRONMENTAL ENGINEERING DIVISION

Porpak Q

GC WORKSHEET

SHO-1

COLUMN: AT-1200 Bentone 34 RUN NUMBER: OUTLET - 1 DATE: 9/27/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1		0	10	16	None		
C_2		0	↓	↓	↓		
C_3		0	↓	↓	↓		
C_4		6	↓	↓	↓		
C_5		0	↓	↓	↓		
C_6		0	↓	↓	↓		
BENZENE		0					
TOLUENE		0					
XYLENE		6					
ETHYL-BENZENE		6					
STYRENE		0					
TOTAL HYDRO-CARBONS (THC)							

B-7

TRW
ENVIRONMENTAL ENGINEERING DIVISION

* gas sampler heated to 200°F.

00008

GC WORKSHEET 5HO-2

Porpak Q

COLUMN: AT-1200 Bentone 34 RUN NUMBER: OUTLET - 2 DATE: 9/28/79

	COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE	
	C_1	.41	132	10	16	none	2.64 ppm		
	C_2	.81	30	↓	↓	↓	.3 ppm		
	C_3	1.83	0	↓	↓	↓	0		
?	C_4	~ 3.6	20	↓	↓	↓	.1 ppm — noise level		
?	C_5	~ 6.5	18	↓	↓	↓	.06 ppm — noise level		
?	C_6	~ 11.9	120	↓	↓	↓	.2 ppm		
* ↓	BENZENE	1.01	104	10^3	8	↓	.3 PPM	.3 ppm	.003
	TOLUENE	1.95	135	↓	↓	↓	.3 PPM	.4 ppm	
200°F	XYLENE	~~3.6~~ 5.75	0	↓	↓	↓		0	
	ETHYL-BENZENE	3.6	0	↓	↓	↓		0	
↑ *	STYRENE	8.3	0	↓	↓	↓		0	
	TOTAL HYDRO-CARBONS (THC)								

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET SHO-3

COLUMN: Porapak Q / Bentone 34 RUN NUMBER: OUTLET-3 DATE: 7/29/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE	
C_1	.41	285	10	16	NONE	5.7 ppm		
C_2	.83	41	↓	↓	↓	.4 ppm		
C_3	1.93	—				0		
C_4	3.31	6				.03 ppm		
C_5	—	—				—		
C_6	—	—	↓	↓		—		
* BENZENE	.91	132	10^3	8		.4 ppm	.4 ppm	.003
TOLUENE	1.69	1733	↓	↓		4.2 ppm	5.2 ppm	
XYLENE	—							
ETHYL-BENZENE	—							
* STYRENE	—		↓	↓	↓			
TOTAL HYDRO-CARBONS (THC)								

200° (Benzene through Styrene)

B-9

TRW
ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: ① Porpak Q ② AT-1200 Bentone 34 RUN NUMBER: Calibration DATE: 9/27/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	~~CONCENTRATION AS COMPOUND~~ CAL. FACTOR	CONCENTRATION ~~AS BENZENE~~
① C_1	.4	743	10	16	0	k = .020	15.1 ppm
C_2	.8	1408	↓	↓	↓	k = .010	14.6 ppm
C_3	1.8	2181	↓	↓	↓	k = .0071	15.6 ppm
C_4	3.9	3042	↓	↓	↓	k = .0050	15.2 ppm
C_5	6.8	4793	↓	↓	↓	k = .0033	15.6 ppm
C_6	11.6	9389	↓	↓	↓	k = .0017	15.9 ppm
② BENZENE	.91	32445	10^3	8	0	k = .0033	106 ppm
TOLUENE							
XYLENE							
ETHYL-BENZENE							
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

B-10

GC WORKSHEET

Porpak Q

COLUMN: AT-1200 Bentone 34 RUN NUMBER: Calibration Benzene 106ppm DATE: 9/28/79

COMPOUND	RETENTION TIME IN ~~CM.~~ min.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	~~CONCENTRATION AS COMPOUND~~ CAL. FACTORS	CONCENTRATION AS BENZENE
C_1	.41	744	10[illegible]	16	0	k=.020 15.1 ppm	
C_2	.81	1400	↓	↓	↓	k=.010 14.6	
C_3	1.84	2161.5	↓	↓	↓	k=.0072 15.6	
C_4	3.99	3035	↓	↓	↓	k=.0050 15.2	
C_5	6.77	4737	↓	↓	↓	k=.0034 15.6	
C_6	11.09	8641	↓	↓	↓	k=.0018 15.9	
BENZENE	1.02	35329.5	10^3	8	0	k=.0030	106 ppm
TOLUENE							
XYLENE							
ETHYL-BENZENE							
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

TRW
ENVIRONMENTAL ENGINEERING DIVISION

Porpak Q

GC WORKSHEET

COLUMN: AT-1200 Bentone 34   RUN NUMBER: Calibration   DATE: 9/29/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	781	10	16	none	k = .020	15.1 ppm
C_2	.83	1519				k = .0096	14.6 ppm
C_3	1.93	2291				k = .0068	15.6 ppm
C_4	4.21	3129				k = .0049	15.2 ppm
C_5	7.03	5112				k = .0030	15.6 ppm
C_6	11.28	7929				k = .0020	15.9 ppm
BENZENE	.9	51884 173	10^3	8		k = .002	
TOLUENE							
XYLENE							
ETHYL-BENZENE							
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: ______ RUN NUMBER: Calibration DATE: 9/30/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	783	10	16	none	K = .0193	15.1 ppm
C_2	.87	1498	↓	↓	↓	K = .0098	14.6 ppm
C_3	2.04	2208	↓	↓	↓	K = .0071	15.6 ppm
C_4	4.31	2779	↓	↓	↓	K = .0055	15.2 ppm
C_5	7.1	3857	↓	↓	↓	K = .0040	15.6 ppm
C_6	11.33	6166	↓	↓	↓	K = .0026	15.9 ppm
BENZENE	.9	45900			↓	K = .0023	
TOLUENE	1.72				↓		
XYLENE	3.1; 3.46; 4.15				↓		
ETHYL-BENZENE	3.11				↓		
STYRENE	4.82				↓		
TOTAL HYDRO-CARBONS (THC)					↓		

GC WORKSHEET ~~PGT-1~~

COLUMN: Porapak Q AT-1200 RUN NUMBER: Oil Burner ~~[illegible]~~ 1 DATE: 9/30/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	494891	10	16	10:1 x.652	9551.4 ppm	
C_2	.83	211299	↓	↓	↓	2070.7 ppm	
C_3	1.77/3.95	49838/4958	↓	↓	↓	353.8 ppm	
C_4	3.47/6.72	9623/2357	↓	↓	↓	52.9 ppm	
C_5	7.15	2182	↓	↓	↓	8.72 ppm	
C_6			↓	↓	↓		
BENZENE	.91	593	10^3	8	↓		1.36 ppm
TOLUENE			↓	↓	↓		
XYLENE			↓	↓	↓		
ETHYL-BENZENE			↓	↓	↓		
STYRENE			↓	↓	↓		
TOTAL HYDRO-CARBONS (THC)							

B-14

GC WORKSHEET

COLUMN: ______ RUN NUMBER: ABI-2 DATE: 10/1/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.38	444175	10	16	10:[illegible]	88835 ppm	925155
C_2	.76	261731				26173 ppm	21462
C_3	1.73	143003				10439 ppm	8560
C_4	3.26 / 3.69	3087 / 6698				355 ppm	291
C_5	5.83 / 6.18	1590 / 1764				68.8 ppm	56.4
C_6	0	0				0	–
BENZENE	1.27 ~~560, 490~~	3497 ~~[illegible]~~	10^3	8		57.4 ~~1.3 ppm~~ ~~70 ppm~~	70 ppm
TOLUENE	1.77	177				23.5	35.3 ppm
XYLENE		0					
ETHYL-BENZENE		0					
STYRENE		0					
TOTAL HYDRO-CARBONS (THC)							

B-15

TRW
ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: ______ RUN NUMBER: AB1-3 DATE: 10/1/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.4	407593	10	16	10:1[illegible]	913180.6 ppm	897180
C_2	.62 / .7	107359 / 310186	↓	↓	↓	10736 / 31018.6 ppm	8589 / 24815
C_3	1.59	94312				6885	5508
C_4	3.07/3.51	5413 / 4924				/	–
C_5	5.74/6.16	974 / 679				/	–
C_6	10.88	1844				49.8 ppm	39.8
BENZENE	1.31	3156	103	8		65.7	82.1 ppm
TOLUENE	2.48	226				3.8	5.8 ppm
XYLENE	4.43	5718				71.5	137.0 ppm
ETHYL-BENZENE							
STYRENE			↓	↓	↓		
TOTAL HYDRO-CARBONS (THC)							

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TRW
ENVIRONMENTAL ENGINEERING DIVISION

B-17

GC WORKSHEET

COLUMN: AT-1200 Bentone 34 RUN NUMBER: AB1-4 DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.39	456775	10	16	10:1	86787 ppm	944785
C_2	.73	163185	↓	↓	↓	15204	12467
C_3	1.64	35450				2127	1744
C_4	~~3.18~~ 3.63	7244				362	297
C_5	~~5.85~~ 6.27	1563				57.8 ppm	47
C_6	—	0				—	—
BENZENE	1.26	2414	10^3	8		55.8	68 ppm
TOLUENE	181/2.36	173				3.2	4.8
XYLENE	~~6.6~~					—	—
ETHYL-BENZENE	4.26	5293				83.4	148 ppm
STYRENE						—	
TOTAL HYDRO-CARBONS (THC)							

.00288

TRW
ENVIRONMENTAL ENGINEERING DIVISION

Porpak Q

GC WORKSHEET

COLUMN: AT-1200 Bentone 34 RUN NUMBER: ABO-2 DATE: 10/1/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	–	0	10	16	None		
C_2	–	0	↓	↓	↓		
C_3	–	0					
C_4	–	0					
C_5	–	0					
C_6	–	0					
* BENZENE	5.30	1.25				1.3 ppm	
TOLUENE	0						
XYLENE	0						
ETHYL-BENZENE	0						
STYRENE	0						
TOTAL HYDRO-CARBONS (THC)							

B-18

TRW
ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: ______ RUN NUMBER: ABO-3 DATE: 10/1/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	—	0					
C_2	—	0					
C_3	—	0					
C_4	—	0					
C_5	—	0					
C_6	—	0					
BENZENE	—	0	10^3	8	none	—	
TOLUENE	—	0	↓	↓	↓	—	
XYLENE	—	0	↓	↓	↓	—	
ETHYL-BENZENE	—	0	↓	↓	↓	—	
STYRENE	—	0	↓	↓	↓	—	
TOTAL HYDRO-CARBONS (THC)							

←200°F→

B-19

GC WORKSHEET

COLUMN: Porpak Q. / pentane 34

RUN NUMBER: ABO-4

DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1		0	10	16	none	—	
C_2		0	↓	↓	↓	—	
C_3		0	↓	↓	↓	—	
C_4		0	↓	↓	↓	—	
C_5		0	↓	↓	↓	—	
C_6		0	↓	↓	↓	—	
BENZENE	1.25	0	10^3	8	↓	—	K = .0036
TOLUENE		0	↓	↓	↓	—	
XYLENE		0	↓	↓	↓	—	
ETHYL-BENZENE		0	↓	↓	↓	—	
STYRENE		0	↓	↓	↓	—	
TOTAL HYDRO-CARBONS (THC)							

200°F (Benzene through Styrene)

B-20

TRW
ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: Porpak Q AT-1200 Bentone 34 RUN NUMBER: Calibration DATE: 10/1/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.41	746	10	16	none	K= .020	15.1
C_2	.79	1462	↓	↓	↓	K= .010	14.6
C_3	1.79	2143	↓	↓	↓	K= .0073	15.6
C_4	3.9	2846	↓	↓	↓	K= .0053	15.2
C_5	6.7	4015	↓	↓	↓	K= .0039	15.6
C_6	10.95	5885	↓	↓	↓	K= .0027	15.9
BENZENE	~~1.33~~ 1.26	40799	10^3	8	↓	K= .0026	106
TOLUENE			↓	↓	↓		
XYLENE			↓	↓	↓		
ETHYL-BENZENE			↓	↓	↓		
STYRENE			↓	↓	↓		
TOTAL HYDRO-CARBONS (THC)							

GC WORKSHEET

COLUMN: Porpak Q AT-1200 Benzene 34 RUN NUMBER: Calibration DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.37	811	10	16	none	k = .019	
C_2	.72	1576				k = .0093	
C_3	1.59	2351				k = .0066	
C_4	3.6	3067				k = .005	
C_5	6.24	41696				k = .0037	
C_6	10.17	5525				k = .0029	
BENZENE	1.24	41559	10^3	8		k = .00255	
TOLUENE							
XYLENE							
ETHYL-BENZENE							
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

TRW

ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: ______ RUN NUMBER: OG 1 – 4 DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.38	25727	10	16	10:1 [illegible]	4888	32470
C_2	.63/.73	20824 / 1819				1937	5104
C_3	1.5	2014				134	353
C_4	3.41	162				8.1	21
C_5	—	0				—	–
C_6	—	0				—	–
BENZENE	1.28	32976	10^3	8		2432	923
TOLUENE	2.38	1304				78.1	36.5
XYLENE	—	–				–	—
ETHYL-BENZENE	4.3	30386				1541	851
STYRENE	–	–					
TOTAL HYDRO-CARBONS (THC)	–	–					

.0028

B-23

GC WORKSHEET

COLUMN: Porpak·Q AT-1200 Bentone 34 RUN NUMBER: OG1-5 DATE: 10/3/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.38	54568	10	16	10:1 x 1.39	9822	29435 ~~13653~~
C_2	.63 / .73	48706 / 4114				383	532
C_3	1.5	4622				305	424
C_4	3.39	531				26	36
C_5	–	–				0	–
C_6	11.0	12847				437	607
BENZENE	1.27	16518	10^3	8		596	429
TOLUENE	2.37	276				8.1	7.2
XYLENE	–	–				111.1	119
ETHYL-BENZENE	4.3	4566					
STYRENE	–	–					
TOTAL HYDRO-CARBONS (THC)							

B-24

GC WORKSHEET

COLUMN: ________ RUN NUMBER: FG1-4 DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE	
C_1	.38	443563	10	16	10:1	873900	~~84277~~	.19
C_2	.73	148598	↓	↓	↓	13819.6	10779	.093
C_3	1.6	32576	↓	↓	↓	2150	1677	.066
C_4	3.11/3.55	6537	↓	↓	↓	379	296	.058
C_5	5.79/6.21	1,455	↓	↓	↓	53.8	42	.037
C_6	8.35	0	↓	↓	↓	—	—	.029
BENZENE	1.31	416	10^3	8	↓	9.1	11.6	.0028
TOLUENE			↓	↓	↓			
XYLENE			↓	↓	↓			
ETHYL-BENZENE			↓	↓	↓			
STYRENE			↓	↓	↓			
TOTAL HYDRO-CARBONS (THC)								

B-25

GC WORKSHEET

COLUMN: Porpak Q AT-1200 Bentone 34 RUN NUMBER: FG1-5 DATE: 10/3/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND ppm	CONCENTRATION AS ~~BENZENE~~ CPND CORR ppm
C_1	.38	448937	10	16	10:1 x .86	80809	917595 ~~69476~~
C_2	.76	187315				17420	14981
C_3	1.75	41439				2735	2352
C_4	3.33 / 3.78	4261 / 8298				407	350
C_5	6.0 / 6.4	2086 / 2017				77	66
C_6	–	–				0	–
BENZENE	1.28	703.5	10^3	8		15.7	18.3 .0026
TOLUENE	1.84	176				3.2	4.6
XYLENE	–	0					–
ETHYL-BENZENE	–	0					–
STYRENE	–	0					–
TOTAL HYDRO-CARBONS (THC)							

B-26

Porpak Q

GC WORKSHEET

COLUMN: Benzene 34 RUN NUMBER: SHO-4 DATE: 10/2/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.37	0	10	16	none	–	
C_2	.72	0				–	
C_3	1.62	0				–	
C_4	3.6	0				–	
C_5	6.24	0				–	
C_6	10.2	0				–	
BENZENE	1.26	0	10^3	8	none		K = .0036
TOLUENE	2.29	1672				4.9	6 ppm
XYLENE	–	0					
ETHYL-BENZENE	–	0					
STYRENE	–	0					
TOTAL HYDRO-CARBONS (THC)							

TRW
ENVIRONMENTAL ENGINEERING DIVISION

GC WORKSHEET

COLUMN: Porpak Q AT-1200 Benzene 3d RUN NUMBER: SHO-5 DATE: 10/3/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	—	0	10	16	none	—	
C_2	—	0	↓	↓	↓	—	
C_3	—	0	↓	↓	↓	—	
C_4	—	0	↓	↓	↓	—	
C_5	—	0	↓	↓	↓	—	
C_6	—	0	↓	↓	↓	—	
BENZENE	—	0	10^3	8	↓	—	
TOLUENE	2.25	2063	↓	↓	↓		7.6 ppm
XYLENE	—	0	↓	↓	↓	—	
ETHYL-BENZENE	—	0	↓	↓	↓	—	
STYRENE	—	0	↓	↓	↓	—	
TOTAL HYDRO-CARBONS (THC)							

.0037

Jao Sample loop → 300°F

B-28

TRW

ENVIRONMENTAL ENGINEERING DIVISION

Porapak Q

GC WORKSHEET

COLUMN: AT-1200 Bentone 34 RUN NUMBER: Calibration DATE: 10/3/79

COMPOUND	RETENTION TIME IN CM.	COUNTS	SPAN	ATTENUATION	DILUTION FACTOR (Diluted w/N_2)	CONCENTRATION AS COMPOUND	CONCENTRATION AS BENZENE
C_1	.38	820	10	16	none	k = .018	
C_2	.73	1573	↓	↓	↓	k = .0093	
C_3	1.64	2366				k = .0066	
C_4	3.64	3102				k = .0049	
C_5	6.3	4075				k = .0038	
C_6	10.3	4734.5	↓	↓		k = .0034	
BENZENE	1.25	40411	10^3	8	↓	k = .0026	
TOLUENE							
XYLENE							
ETHYL-BENZENE							
STYRENE							
TOTAL HYDRO-CARBONS (THC)							

B-29

FIELD ENGINEERING NOTEBOOK

NUMBER 13382

DATE 1/18 PROJECT [illegible] JOB NO. WA-52

48

	flow rate H_2	H_2	Air	temp. prog.	column
M-2	.75	2.75	.9 kg/cm²	50 - [illegible]	porpak Q
m-1	?	?	?	none	OV-101

standards		RT	area	k
C_1	497	.23	4673	
C_2	498	.37	52,871	
C_3	498	1.33	101,323	
C_4	485	3.75	148,375	
C_5	500	10.5	197315	
C_6	497			

7.29 Benzene 3652, 3615 5215 .0014 .002

bags	area C_1	C_2	C_3	C_4	C_5	C_6	Ben.	Tol	Xy	EB	Sty
OD-1 ppm							none	none			
-2 ppm							86,87	.12 ppm			
-3 ppm							424 395	.57 ppm			
-4 ppm							161,136	.21 ppm			
-5 ppm							62,98	.14 ppm			
-6 ppm							none				

WITNESS: DATE: SIGNED [signature]

WITNESS: DATE: DATE

DATE ~~~~ PROJECT ~~~~ JOB NO. WA-57

retention area

M-2

1000	8629 20610 19619.5	3.96	.051
10 000	215530	3.94	.046
604	< 10 ppm		.048
806	552	26.5ppm	
802	392	19ppm	
606	<10 ppm		

M-1

1000	4728	5.17	.21
10 000	112699 76134	5.1	.089 .13
606			

CROSS OUT UNUSED SPACE

WITNESS: DATE: SIGNED C A Haney

WITNESS: DATE: DATE

DATE ____________ PROJECT CP. ____________ JOB NO. WA 52

51 Standards –

		area	rt	column temp	detect temp	k
9/25	7.29	3060 3145	.97	75°C	180°C	.0024
	106	37621 38566	.97			.0027
	195	165397	.97		V	.0029
		169767				

9/26 7.29 3838 3112 3465 3084 8ppm .00235

audit 22 2748 2762 (2755) ~~6.5 ppm 6.6 ppm~~

audit 5 24314 25806 25842 5822 ~~62 ppm~~

106 36823 36897 .6029 74.9 ppm

retention times

Benzene	1.3	
Toluene	2.67	
E.B.	5.13	5.05 ? problem
Xylene		5.72
Styrene	8.27	6.87

9/27 106 36687; 33515; 31921; 31899 av 32445 .0033

Blank 243; 158; 68; 54; 62; 69 .22 ppm

9/28 106 15366 35034 35625 .0030

WITNESS: ____________ DATE: ____________ SIGNED CA Haney

WITNESS: ____________ DATE: ____________ DATE ____________

DATE ______ PROJECT C.P. JOB NO. WA-52

52

Standards

		RT	area	k
9/26	C_1	.4	~~21~~ 768 737	.020
		~~X~~	~~X~~	~~[illegible]~~
		~~X~~	X	.010
	C_2	.75	~~1410~~ 1428 1388	~~[illegible]~~
	C_3	1.54	2182 2198 2173	.0071
	C_4	3.38	~~3100~~ 3394 3323	.0045
	C_5	6.08	~~5414~~ 6530 6410	.0024
	C_6 ?	10.39	18060 16004 25178	

audit 1442 1449 1.55 10.3 ppm

106 Benzene 14.61 125038 k = 0.000848

		RT	area	k
9/27	C_1	.4 .4	725; 742; 744	.020
	C_2	.79 .86	1369; 1450; 1404	.010
	C_3	1.79 1.98	2548; 2187; 2176	.0071
	C_4	3.89 3.98	3039; 3044; 2944	.0050
	C_5	6.68 6.94	4625; 4963; 5593	.0033
	C_6	10.94 12.28	8332; 14261; 10570	.0017
9/28	C_1	.41	680 744	.020
	C_2	.81	1383 1417	.010
	C_3	1.84	2131 2192	.0072
	C_4	3.99	2830 3035	.0050
	C_5	6.77	4737	.0034
	C_6	11.09	9878 7404	.0018

WITNESS: ______ DATE: ______ SIGNED C.A. Haney
WITNESS: ______ DATE: ______ DATE ______

DATE 9/27 9/28 PROJECT E.P. JOB NO. MA-52

53

Sample #1

		area				RT	k
IN fuel gas	C_1	49429	49465			.41	.020
	C_2	2533	2613			.81	.010
	C_3	555	576			1.83	.0071
	? C_4	21	12			~3.6	.0056
	? C_5	~~4657~~	0			~6.84	.0034
	? C_6	87	0			~11.9	.0018
							9/27 9/28
	Benzene	300	174	237	194	1.03	.0033 .00300
	Toluene	0	0			~1.9	
	E.B.	2969	3189	2518		3.66	
	? Xylene	102	0			~5.75	
	? Styrene	29	0			~8.3	

		area				area		
IN off gas	C_1	6462	6428	.41	Benzene	12203	12017	12015
	C_2	552	503	.81	Toluene	742	860	894
	C_3	450	464	1.7	E.B.	12928	14549	16983
	? C_4	59	38	3.36	? Xylene	202	56	0
	? C_5	~~850~~ 0	0	~~7.24~~	Styrene	0	0	0
	C_6	13708	11149	11.9				

		RT	area		
OUT	C_1			Benzene	2277; 678; 716; 0; 76; 0; 78; 0; 0
	? C_2	> 11	111	Toluene	0
	? C_3			E.B.	0
	C_4			Xylene	0
	C_5			Styrene	0
	C_6				

WITNESS: ______ DATE: ______ SIGNED: C.A. Haney

WITNESS: ______ DATE: ______ DATE: ______

DATE 9/28 PROJECT E.P. JOB NO. WA-52

54

RT	area						
.54	2223	945	716	311	241	314	187
	175	114	71	53			
.84	2277	678	117	0	76	0	78
	3082	48	0	0			

Sample # 2 200°F sample valve.

OUT

	RT	area
C_1	.4	121 ; 144
C_2	1.8	60 ; 0
C_3	1.83	0 ; 0
C_4	≈ 3.6	42 ; 0
C_5	≈ 6.5	86 ; 0
C_6	≈ 11.9	224 ; 0

Benzene	1.01	1172 ; 111 ; 97
Toluene	1.95	61 ; 127 ; 143
E.B.	3.6	54 ; 0 ; 0
Xylene	5.75	12 ; 0 ; 0
Styrene	8.3	21 ; 0 ; 0

106 ppm Benzene - 19652 ; 35092 ; 34824

ave - 34958

WITNESS: DATE: SIGNED C.A. Haney

WITNESS: DATE: DATE

DATE 9/28/79 PROJECT E.P. JOB NO. WA-52

55

sample # 2 100:1

FGI-2

		RT	area	
IN	C_1	.42	261843 /	254771
fuel gas	C_2	.85	15805	16077
	C_3	2.14	3878	3890
?	C_4	4.78	283 ?	4.51 840
?	C_5	5.51	824	4.03 614
	C_6			

	1st		2nd		3rd		4th	
Benzene	1.04	638	1.04	192	1.04	137	1.03	161 = 163
Toluene								
E.B.	3.77	UNRES.	3.77	361	3.77	328	3.77	UNRES.
Xylene								
Styrene								

OGI-2 10:1

IN	C_1	.42 .81	45088 36944	.42 .81	45250 37036
off gas	C_2	.96	3395	.97	3458
	C_3	2.11	3315	2.09	3058
	C_4	4.34	222	4.21	307
	C_5	—			
	C_6	12.29	66890	12.04	63888
	Benzene	1.04	103615	1.04	105002
	Toluene	2.02	7365	2.02	7478
	E.B.	3.75	119544	3.75	125979
	Xylene	5.92	3047	5.92	3231
	Styrene				

CALIBRATION Benzene 106 PPM mwH 22:21

1st	1.05	38471
2nd	1.04	38706
3rd	1.05	38615

} 38597 = .00275

WITNESS: DATE: SIGNED [signature]

WITNESS: DATE: DATE

DATE 7/29/79 PROJECT Calibration JOB NO. WA-52

56

		ΔT	Area		A
10C Benzene		.75 .92	60858 52062 51705 55214		
	C_1	.41	791; 771		.020
	C_2	.83	1517; 1521		.0096
	C_3	1.93	2296; 2286		.0068
	C_4	4.21	3174; 3084		.0049
	C_5	7.03	5117; 5076		.003
	C_6	11.28	; 7929		.0020
audit-5		.93	59862		

23 → OUT-3

	C_1	.4	290 / 280	
	C_2	.7 .8	74 37	62 44
(68)	C_3	—	—	–
10 8	C_4	3.31	12	–
8 9	C_5	—	—	–
12 9 12	C_6	—	—	–
11	Benzene	.91	135 /	129
10 12½ 13	Toluene	1.69	1814	1651
6 / 60	E. B.	0	–	—
	Xylene	0	–	—
	Styrene	0	—	—

WITNESS: ______ DATE: ______ SIGNED CA Haney

WITNESS: ______ DATE: ______ DATE ______

DATE ______ PROJECT EP ______ JOB NO. WR-52

57

Benzene - 200°F - 39369; 36521; 36177; 34555 — k .003

Analyt 5-200°F - 271119; ;

		RT	area		
IN-3	C_1	.42	276520 / 277505		
Fuel Gas	C_2	.83	20363	20427	
	C_3	1.95	5252	4597	
[illegible]	C_4	3.73 / 4.19	443/875	442/875	
	C_5	6.6	174	131	
100:1	C_6	12.23	98	58	
	Benzene	.80	864 / 758 / 785		1.78 ppm
	Toluene				
	E.B.				
	Xylene				
	Styrene				

		RT	area
IN-3	C_1		
Off Gas	C_2		
	C_3		
10:1	C_4		
	C_5		
	C_6		
	Benzene	.89	6617
	Toluene	1.45	5170
	E.B.	2.99	33812
	Xylene		
	Styrene		

WITNESS: ______ DATE: ______ SIGNED C A Haney

WITNESS: ______ DATE: ______ DATE ______

DATE 9/29 PROJECT E.P JOB NO. WA-57

58

OUTLET - 1 OIL Burner

	RT	area		
C_1				
C_2				
C_3				
C_4				
C_5				
C_6				
Benzene	.9	104; 62; 63		.19 ppm
Toluene	—			
E.B	—			
Xylene	—			
Styrene	—			

INLET - 1 OIL BURNER

Calibration 10/1/79

					ave
C_1	.41	750	694	742	746
C_2	.79	1458	1416	1466	1462
C_3	1.78	2289	2158	2128	2143
C_4	{~~3.46~~/3.9	2845	2841	2850	2846
C_5	~~3.5~~ 6.6	3673	4074	3956	4015
C_6	18.87	5321	5248	6686	5885

Benzene 106 cylinder 1.03 ~~24134~~ 46286 57133 k = .0022

Benzene 106 ~~.96~~ .97 ~~45690~~ [illegible] ~~48229~~

Bo 1.26 40278 41320 k = .0026

CROSS OUT UNUSED SPACE

WITNESS: DATE: SIGNED C J Haney

WITNESS: DATE: DATE

DATE 10/1 PROJECT EP JOB NO. NYR-52

59

ABO-2

C_1	0	0	0
C_2	0	0	0
C_3	0	0	0
C_4	0	0	0
C_5	0	0	0
C_6	0	0	0

Benzene	1.25	794 307, 447, 207, 560, 490
Toluene		0
EtB		0
Xylene		0
Styrene		0

* 200°F

AB1-2

C_1	.38	440892	447450
C_2	.76	266967	256495
C_3	1.73	143150	142856
C_4	3.26/3.69	2927/6666	3246/6729
C_5	5.83/6.18	1741/1763	1506/1764
? C_6	1.017	1017	0

Benzene	1.27	1124	490	1258	345	357	347
Toluene	1.77	194	74	283	159		
EB	0	0					
Xylene	0	0					
Styrene	0	0					

106 Benzene 200°F –

WITNESS: DATE: SIGNED C A Haney

WITNESS: DATE: DATE

DATE ______ PROJECT ______ JOB NO. WR-52

60

AB0-3

C_1	0	0
C_2	0	0
C_3	0	0
C_4	0	0
C_5	0	0
C_6	0	0

Benzene	1.3	0	0
Toluene		0	0
E B		0	0
Xylene		0	0
Styrene		0	0

AB1-3

C_1	.4	455343	457842
10:1 C_2	.62/.7	106278/309259	108440/311116
C_3	1.59	93892	94731
C_4	3.07/3.51	5032/2472	5394/2452
C_5	5.74/6.16	947/669	1000/688
C_6	10.88		1844

Benzene	1.31	3116	3196
Toluene	2.48	226	
E.B	4.43	5338	4598
Xylene		0	
Styrene		0	

WITNESS: ______ DATE: ______ SIGNED [signature]

WITNESS: ______ DATE: ______ DATE ______

DATE 10/2/79 PROJECT E.P. JOB NO. WA-52

61

	RT	area		K
106-	1.24	41509	4608	.00255
audit	- ~~22~~5	36654		.0020
C_1	.37	827	795	.019
C_2	.72	1570	1581	.0093
C_3	1.62	2345	2356	.0066
C_4	3.6	3101	3032	.005
C_5	6.24	4433	3906	.0037
C_6	10.17	6651	4198	.0029

*?

ABI-4			
C_1	.39	458235	455 314
C_2	.73	163729	163 240
C_3	1.64	35577	35323
C_4	3.18/3.63	3884/7263	3662/7225
C_5	5.85/6.27	1742/1507	1824/1619
C_6		0	
Benzene	1.26	2146	2682
Toluene	1.81/2.36	77/173	
E.B	~~[illegible]~~ 4.26	4290	6295
Xylene	-	0	
Styrene	-	0	

ABO-4		
C_1	0	0
C_2	0	0
C_3	0	0
C_4	0	0
C_5	0	0
C_6	0	0
Benzene	0	0
Toluene	0	0
EB	0	0
Xylene	0	0
Styrene	0	

WITNESS: ______ DATE: ______ SIGNED C A Haney

WITNESS: ______ DATE: ______ DATE ______

DATE 10/2/79 PROJECT ____ JOB NO. WA-5

		RT	area		K
106 - 200°F		1.25	29287	29593	.0036

SHO-4

C_1	-	0	0
C_2	-	0	0
C_3	-	0	0
C_4	3.69	13	0
C_5	-	0	0
C_6	-	0	0

Benzene	1.25	0	0	0
Toluene	2.29	1833	1691	1653
E.B		0	0	0
Xylene		0	0	0
Styrene		0	0	0

FG1-4

C_1	.38	448622	438504	
C_2	.73	148052	149141	
C_3	1.6	32498	32663	
C_4	3.11 / 3.53	3392 / 6521		3215 / 6553
C_5	5.79 / 6.21	1474 / 1545		1532 / 1365
C_6	8.35	23495		0

Benzene	.115	1.31	417
Toluene			
E.B			
Xylene			
Styrene			

Benzene 106 36934 37857

WITNESS: ____ DATE: ____ SIGNED [signature]

WITNESS: ____ DATE: ____ DATE ____

DATE 10/2/79 PROJECT FQ. JOB NO. MP-52

63

OGI-4

C1	.38	25371	26082
C2	.63/.73	20503/1790	21141/1848
C3	1.5	1967	2061
C4	3.41	160	163
C5	0	0	0
C6	0	0	0

Benzene	1.28	32149	33863
Toluene	2.38	1292	1316
E.B.	4.3	30386	
Xylene	5.	0	
Styrene	8.	0	

10/3/79

SHOW-5

C1	0	0
C2	0	0
C3	0	0
C4	0	
C5	0	
C6	0	

Benzene [illegible]
Toluene [illegible] 2.25 2143 1982
E B
Xylene
Styrene

Benzene 106 200°F 28699 288[illegible]

WITNESS: DATE: SIGNED C A Haney
WITNESS: DATE: DATE

DATE 10/3/79 PROJECT E.P. JOB NO. W.A.-52

64

FG1-5

C_1	.38	448468	449406
C_2	.76	188554	186075
C_3	1.75	41670	41208
C_4	3.33/3.78	4341/8379	4180/8217
C_5	6.0/6.4	2149/2010	2023/2023
C_6		0	0

Benzene	1.28	748	697	710
Toluene	1.86	103	165	187
E. B.	—	0		
Xylene		0		
Styrene		0		

OG1-5

C_1	.38	54421	54714
C_2	.63/.73	48535/4183	48856/4045
C_3	1.5	4651	4593
C_4	3.38	509	553
C_5	—	—	—
C_6	10.97	12880	12814

Benzene	1.27	16516	16519
Toluene	2.37	261	296
E. B	4.3	4404	4728
Xylene	-	0	0
Styrene	.	0	0

WITNESS: ____ DATE: ____ SIGNED C A Haney

WITNESS: ____ DATE: ____ DATE ____

DATE 10/3/79 PROJECT E P. JOB NO. NA-52

65

Calibration

				K
C_1	.38	806	834	.018
C_2	.73	1567	1579	.0093
C_3	1.64	2368	2363	.0066
C_4	3.64	2991	3210	.0049
C_5	6.8	4431	3719	.0038
C_6	10.3	5270	4209	.0034

Benzene 106 (1.25) 40009 40813 k=.0026

WITNESS: DATE: SIGNED C A Haney

WITNESS: DATE: DATE

APPENDIX C

FIELD DATA SHEETS

TRW

GAS SAMPLING FIELD DATA

00001

Material Sampled for THC / BENZENE OGI-1

Date 9/27/79

Plant El Paso Prod. Co. Location Odessa, Texas.

Bar. Pressure ________ "Hg. Comments:

Ambient Temp. 90 °F

Run No. 1 - Inlet - off GAS

Power Stat Setting NA

Filter Used: Yes ________ No X

Operator JONGLEUX

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (SCFH)	METER TEMPERATURE IN
1403	~	NA	
(A) 1415	~	~2 SCFH	
1425	~	~2 SCFH	
1430	~	~2 SCFH	
1440	~	~2 SCFH	
1452	STOP		

Comments: (A) SYSTEM SHUTDOWN - IMPROPERLY FLOW METER INSTALLATION - RJ

Impinger Bucket No. ________

Meter Box No. ________

TRW

GAS SAMPLING FIELD DATA

00002

Material Sampled for THC / BENZENE FGI-1

Date 9/27/79

Plant El Paso Prod.

Location FUEL GAS INLET

Bar. Pressure 26.78 "Hg.

Ambient Temp. 90 °F

Run No. 1 - Inlet - Fuel GAS

Power Stat Setting NA.

Filter Used: Yes ____ No X

Operator GERI DOROSZ

Comments:

(1) UNCONTROLLED FLOW METER

(2) Leaky Con-

CLOCK TIME	METER (Ft³)	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
14:19 → 14:35		2.0	

Comments:

Impinger Bucket No. ____

Meter Box No. ____

TRW

GAS SAMPLING FIELD DATA

00003

Material Sampled for THC / BENZENE.

Date 9-27-79

Plant El paso Products

Location Superheater Outlet

Bar. Pressure ____ "Hg.

Comments:

Ambient Temp. 96 °F

Run SHO No. 1 Superheater outlet

Power Stat Setting ____

Filter Used: Yes ____ No X

Operator M. Webster

	CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (CFH) SCHF	METER TEMPERATURE IN
start	14:05		2	
stop	14:35		2	

Comments:

Impinger Bucket No. ____

Meter Box No. ____

TRW

GAS SAMPLING FIELD DATA

00004

Material Sampled for THC / BENZENE

Date 9/28/79

Plant El Paso Chemical

Location Odessa, Texas

Bar. Pressure 27 "Hg.

Comments: IRREGULAR FLOW ?

Ambient Temp. 82° °F

Run No. OFI-2

Power Stat Setting

Filter Used: Yes No X

Operator R.F. JONGLEUX

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (SCFH)	METER TEMPERATURE IN
1346	START	4	
1356		5	
1400		4	
1406		1	
1410		2	
1416		3	
1426		3	
1436		2	
1446	STOP	2	

Comments:

Impinger Bucket No.

Meter Box No.

TRW

GAS SAMPLING FIELD DATA

00005

Material Sampled for THC / BENZENE

Date 9/28/79

Plant El Paso Chemical

Location Odessa Texas

Bar. Pressure ______ "Hg.

Comments:

Ambient Temp. ______ °F

Run No. FGI-2

Power Stat Setting ______

Filter Used: Yes ______ No X

Operator GERI DOROSZ

	CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (SCFH)	METER TEMPERATURE IN
start	13:45		2.0	
stop	14:00			

Comments:

Impinger Bucket No. ______

Meter Box No. ______

TRW

GAS SAMPLING FIELD DATA

Material Sampled for BENZENE. / THC.

Date 9/28/79.

Plant El Paso Chemical

Location Odessa, Texas.

Bar. Pressure ____ "Hg.

Comments:

Ambient Temp. ____ °F

Run No. SHO -2

Power Stat Setting ____

Filter Used: Yes ____ No X

Operator WEBSTER / HARTMAN

	CLOCK TIME	METER (Ft.^{3})	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
start	13:40		1 SCFH	
stop	14:40		1 SCFH	

Comments:

Impinger Bucket No. ____

Meter Box No. ____

TRW

GAS SAMPLING FIELD DATA

00007

Material Sampled for THC / BENZENE.
Date 9/29/79
Plant EL PASO CHEMICAL.
Bar. Pressure ______ "Hg.
Ambient Temp. 85 °F
Run No. OGI-3
Power Stat Setting N.A.
Filter Used: Yes — No X
Operator R. JONGLEUX

Location ODESSA, TEXAS
Comments:

CLOCK TIME	METER (Ft^3)	FLOW METER SETTING (SCFH)	METER TEMPERATURE IN
1022	START	3	
1032		2	
1042		<1	
1052	STOP	<0.5	

Comments:

Impinger Bucket No. ______
Meter Box No. ______

TRW

GAS SAMPLING FIELD DATA

00008

Material Sampled for THC / BENZENE

Date 9/29/79

Plant El PASO Prod.

Location ODESSA, TEXAS.

Bar. Pressure ______ "Hg.

Comments:

Ambient Temp. 85° °F

- PRESSURIZIED BAG IMMEDIATELY - Relieved pressure at 10:27 and contitued sampling

Run No. FG I - 3

Power Stat Setting NA

Filter Used: Yes ______ No X

Operator GERI DOROSZ

	CLOCK TIME	METER (Ft.³)	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
Start	10:20	START	20	
stop	10:35	STOP.		

Comments:

Impinger Bucket No. ______

Meter Box No. ______

TRW

GAS SAMPLING FIELD DATA

00010

Material Sampled for ANDERSON BOILER OFF GAS. ABO-

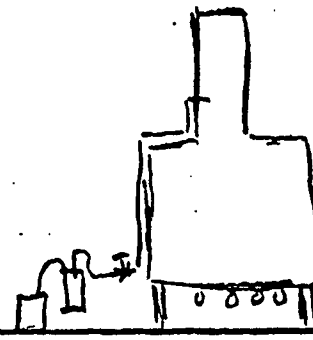
Date 9/30/79

Plant EL PASO PRODUCTS.

Location

Bar. Pressure 26. "Hg.

Comments:



Ambient Temp. 97° °F

Run No. 1

Power Stat Setting —

Filter Used: Yes ______ No —

Operator MWH / G.J.D.

	CLOCK TIME	METER (Ft.³)	FLOW METER SETTING (CFH)	METER TEMPERATURE IN
Start	1541	—	2CFH	—
stop	1556			

Comments:

Impinger Bucket No.

Meter Box No.

Anderson Boiler Inlet ABI-2
10/1/79

start 10:17 5 CFH
stop 10:52

00012

Anderson Boiler Outlet
10/1/79

ABO-2

Start 10:17 hrs
Stop 10:42 hrs

2 CFH

Anderson Inlet ABI-3
10/1/79

start 15:00 2 CFH
stop 15:35

ABO - 3
START 1500
FLOW 1.5 CFH
STOP 1535

Anderson Inlet
10/2/79

ABI-4

Start 09:10
Stop 09:30

Flow
0 CFH

Anderson Outlet
10/6/79

ABO-4

start 09:10 hrs
stop 09:25

<u>Flow</u>
2 SCHF

~~SH6~~ - 4
OGI

START 1407 — 4 CFH — min Read.

STOP 1437

```
 2
 49
 3.14
 ----
 196
 49
 147
 ------
144 | 153.86
      1.07 FT^3
       2
```

Rough 2 FT^3 ∴ 4 CFH = 30 min Sampling Time.

Superheater Inlet Fuel GAS #4

10/2/79

Flow
2 CFH

Start 14:00
Stop 14:55

start 2:05hrs 2SCFH
stop 2:35

Super heater Outlet #4
10/2/79

OGI -5

w/ ethylbenzene off

START	0910	10/3/79
FLOW	3 CFH	
STOP	0945	10/3/79

SHO-5

START	0910	10/3/79
FLOW	2 CFH	
STOP	0935	10/3/79

Superheater Inlet Fuel Gas
10/3/79 #5

start 9:10
stop 9:45

Flow
2 CFH

APPENDIX D

TEST LOG

Date	Time	Activity	Personnel
08/29/79		Presurvey conducted at test site.	Winton Kelly David Mascone Buddy Newman Mack Webster
09/26/79		Velocity traverse: Preliminary SHO.	Webster/ Jongleux
09/27/79		Velocity traverse: SHO-1.	Hartman/ Jongleux
		Moisture determination: SHO-1	Hartman/ Jongleux
	1403-1452	Gas sample: OGI-1	Jongleux
	1405-1435	Gas sample: SHO-1	Webster
	1419-1435	Gas sample: FGI-1	Dorosz
09/28/79		Velocity traverse: SHO-2	Hartman/ Jongleux
		Velocity traverse: SHO-3	Hartman/ Jongleux
		Moisture determination: SHO-2	Webster/ Hartman
	1340-1440	Gas sample: SHO-2	Webster/ Hartman
	1346-1446	Gas sample: OFI-2	Jongleux
	1345-1400	Gas sample: FGI-2	Dorosz
09/29/79		Moisture determination: SHO-3	Hartman
	1022-1052	Gas sample: OGI-3	Jongleux
	1020-1035	Gas sample: FGI-3	Dorosz
09/30/79	1541-1556	Gas sample: ABO-1	Hartman/ Dorosz
		Porpak Q analysis: FGI-3	Haney

Date	Time	Activity	Personnel
10/01/79	1017-1052	Gas sample: ABI-2	Dorosz
	1017-1042	Gas sample: ABO-2	Dorosz
	1500-1535	Gas sample: ABI-3	Dorosz
	1500-1535	Gas sample: ABO-3	Jongleux
		Porpak Q calibrated	Haney
		Porpak Q analysis: ABO-3	Haney
		Porpak Q analysis: ABO-2	Haney
		Porpak Q analysis: ABI-2	Haney
		Porpak Q analysis: ABI-3	Haney
10/02/79		Velocity traverse: SHO-4	Webster
		Moisture determination: SHO-4	Hartman/ Dorosz
		Benzene determination: SHO-3	Dorosz/ Hartman
	0910-0930	Gas sample: ABI-4	Dorosz
	0910-0925	Gas sample: ABO-4	Jongleux
	1405-1435	Gas sample: SHO-4	Dorosz
	1407-1437	Gas sample: OGI-4	Jongleux
	1400-1455	Gas sample: SHO-4	Dorosz
		Porpak Q calibrated	Haney
		Porpak Q analysis: ABO-4	Haney
		Porpak Q analysis: ABI-4	Haney
		Porpak Q analysis: FGI-4	Haney
		Porpak Q analysis: OGI-4	Haney
		Porpak Q analysis: SHO-4	Haney

Date	Time	Activity	Personnel
10/03/79		Moisture determination: SHO-5	Hartman
	0910-0945	Gas sample: FGI-5	Dorosz
	0910-0945	Gas sample: OGI-5	Jongleux
	0910-0935	Gas sample: SHO-5	Jongleux
		Porpak Q calibrated	Haney
		Porpak Q analysis: OGI-5	Haney
		Porpak Q analysis: FGI-5	Haney
		Porpak Q analysis: SHO-5	Haney

APPENDIX E

FIELD AUDIT REPORT

#44

FIELD AUDIT REPORT

PART A - To be filled out by organization supply unit cylinders (RTI)

1. Organization supplying audit sample(s) and shipping address
   Research Triangle Institute, P.O. Box 12194
   Research Triangle Park, NC 27709

2. Audit supervisor, organization, and phone number (EMB Technical Manager)
   WEK Winton Kelly, U.S. Environmental Protection Agency
   MD-13, Research Triangle Park, NC 27711

3. Shipping instructions - Name, Address, Attention
   To be picked up by TRW on 9/19/79

4. Guaranteed arrival date for cylinders ---

5. Planned shipping date for cylinders 9/19/79

6. Details on audit cylinders for last analysis

	Low Conc.	High Conc.	
a. Date of last analysis	9/19/79	9/19/79	9/19/79
b. Cylinder number	B-1017	B-455	BAL 310
c. Cylinder pressure, PSI	1700	2000	1800
d. Audit gas(es)/balance gas	Benzene in Nitrogen	Benzene in Nitrogen	Propane in Nitrogen
e. Audit gas(es) ppm	8.2	74.5	10.6
f. Cylinder construction	Steel	Steel	Aluminum

PART B - To be filled out by audit supervisor

1. Organic chemical manufacturing process Ethylbenzene/Styrene

2. Location of audit EL PASO PRODUCTS CO., ODESSA, TX.

3. Name of individual audit and organization CAROL HANEY, TRW

4. Audit results

		BZ Low Conc.	BZ High Conc.	C_3
a. Cylinder number		B1017	B455	BAL 310
b. Cylinder pressure before audit, psi		1700	2000	1800
c. Cylinder pressure after audit, psi		1700	2000	1800
d. Audit date and measured concentration, ppm	Date			
Analysis #1	9/26/79	7.9	74.3	10.3
Analysis #2	9/26/79	7.95	74.4	10.3
Analysis #3				
e. RTI concentration, ppm (Part A, 6d)		8.2	74.5	10.6

f. Audit accuracy*

Analysis #1	-3.7%	-0.3%	-3.0%
Analysis #2	-3.0%	-0.1%	-3.0%
Analysis #3			

$$^{*}\text{Percent accuracy} = \frac{\text{Measured Conc.} - \text{RTI Conc.}}{\text{RTI Conc.}} \times 100$$

g. Problems detected (if any) ______

APPENDIX F

PROJECT PARTICIPANTS

PROJECT PARTICIPANTS

EPA

Winton Kelly, EMB	EMB Technical Manager
Andy Miles, EEA	NSS Contractor
Buddy Newman, EEA	NSS Contractor

TRW

Michael Hartman	Team Leader
Mack Webster	Sampler
Robert Jongleux	Sampler
Caroline Haney	Analyst
Geraldine Dorosz	Sampler