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On-Shore Production of Crude Oil and Natural Gas

Fugitive Volatile Organic Compound Emission Sources

Emission Test Report
Texaco, Inc.
Paradis Plant
Paradis, Louisiana

Volume I

DCN 81-222-018-04-30

EMB Report No. 80-OSP-7

EMISSION TEST REPORT

FUGITIVE VOC TESTING
AT THE
TEXACO PARADIS GAS PLANT
VOLUME I

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SECTION 1

INTRODUCTION

This report presents the results of testing for fugitive VOC (Volatile Organic Compounds) emissions at the Texaco Paradis gas plant, Paradis, Louisiana. The testing was performed by Radian Corporation on February 9 through February 27, 1981. This work was funded and administered by the Emission Measurement Branch of the U. S. Environmental Protection Agency. The purpose of this testing was to develop data to be used in support of New Source Performance Standards for onshore production facilities.

The specific objectives of the test program were to:

1) conduct a screening survey using a portable analyzer to obtain equipment type inventories and leak frequency,

2) collect process information for each source including service, composition in the line, seal orientation, elevation, and accessibility,

3) conduct a limited parallel screening survey using a soap scoring procedure for comparison to portable hydrocarbon analyzer screening results, and

4) perform emission measurements on selected sources that exhibit inconsistent results between portable analyzer screening and soap scoring, and for those source types where previous data are limited.

The following sections present a summary of results, a description of the process configuration, the testing methodology, and the sampling locations. A full listing of the data and other supplemental information are included in the appendices.

SECTION 2

SUMMARY OF RESULTS

This section presents a summary of the fugitive emission data gathered at the Texaco Paradis gas plant. All data are presented in the appendices. Appendix A includes a more detailed listing of the mass emission sampling data, as well as an explanation of all coding conventions used on the field data sheets. Appendix B includes copies of the field data sheets.

The gas plant screening results are presented in Tables 2-1 and 2-2. Table 2-1 presents the distribution of VOC concentration readings for each source type, while Table 2-2 presents similar information for soap scores. These tables also give the population results by source type.

The results of the baggable sampling are presented in Table 2-3. The mass emission rates are presented in kilograms per day for each source type in terms of both methane and nonmethane hydrocarbons. The sources were rescreened both before and after sampling. The mean value of the rescreening is also presented in Table 2-3 for both the OVA and soap scoring. The original screening value is presented along with screening values taken immediately before and after sampling in Table 2-4. These data also present paired values for VOC concentrations and soap scores so that a comparison of the two survey methods can be made.

It should be noted that the source type called flanges actually includes a variety of pipe-to-pipe connections including threaded fittings, unions, and compression-type tubing fittings. Welded joints were not included in this survey. The "other" category represents a group of sources that were too few in number to warrant separate listing. Included in the "other" category were sight glasses, vacuum breakers, meters, pig traps, control valve diaphragm vents, and thermowells.

TABLE 2-1. SUMMARY OF RESULTS
VOC CONCENTRATION OCCURRENCE DISTRIBUTION
TEXACO PARADIS PLANT

OVA Screening Value (PPMV)	Source Type: Flanges		Process Drains		Open Ended Lines		Relief Valves		Valves		Pump Seals		Compressors		Other	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
0 to 199	692	90.1	13	46.4	370	78.4	39	65.0	1341	74.3	18	35.3	11	36.7	16	76.2
200 to 9,999	48	6.3	9	32.1	47	10.0	18	30.0	245	13.6	16	31.4	5	16.7	4	19.0
> = 10,000	28	3.6	6	21.4	55	11.7	3	5.0	218	12.1	17	33.3	14	46.7	1	4.8
Total Sources Screened	768	19.7	28	100.0	472	93.7	60	77.9	1804	86.3	51	100.0	30	100.0	21	84.0
Sources Not Screened	3127*	80.3	0	0.0	32	6.3	17	22.1	286	13.7	0	0.0	0	0.0	4	16.0
TOTAL SOURCES	3895*		28		504		77		2090		51		30		25	

- Number of sources

% - Percent of total sources screened

* Estimated value - every fifth flange was surveyed

TABLE 2-2. SUMMARY OF RESULTS
SOAP SCORING OCCURRENCE DISTRIBUTION
TEXACO PARADIS PLANT

Soap Score	Source Type: Flanges #	Flanges %	Process Drains #	Process Drains %	Open Ended Lines #	Open Ended Lines %	Relief Valves #	Relief Valves %	Valves #	Valves %	Pump Seals #	Pump Seals %	Compressors #	Compressors %	Other #	Other %
0	470	94.6	15	100.0	286	95.0	0	--	995	91.5	0	--	0	--	4	100.0
1	8	1.6	0	0.0	3	1.0	0	--	27	2.5	0	--	0	--	0	0.0
2	10	2.0	0	0.0	8	2.7	0	--	32	2.9	0	--	0	--	0	0.0
3	5	1.0	0	0.0	2	0.7	0	--	18	1.7	0	--	0	--	0	0.0
4	4	0.8	0	0.0	2	0.7	0	--	16	1.5	0	--	0	--	0	0.0
Total Sources Soaped	497	12.8	15	53.6	301	59.7	0	0.0	1088	52.1	0	0.0	0	0.0	4	16.0
Sources Not Soaped	3398*	87.2	13	46.4	203	40.3	77	100.0	1002	47.9	51	100.0	30	100.0	21	84.0
TOTAL SOURCES	3895*		28		504		77		2090		51		30		25	

- Number of sources

% - Percent of total sources soaped

* Estimated value - every fifth flange was surveyed

No attempt has been made to summarize the process data collected. All of these data are contained in the field data sheets in Appendix B. This information will be used in structuring emission factor categories in a report covering all available gas plant fugitive emission data.

TABLE 2-3
SUMMARY OF RESULTS:

MASS EMISSIONS DATA
TEXACO PARADIS PLANT

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
VALVES	291	100001	3.0	0.03004	0.11836
	368	1350	0.0	0.00009	0.00009
	381	100001	2.0	0.00009	0.01534
	116	85001	3.0	0.00577	0.05970
	122	100001	3.0	0.00844	0.09907
	170	2500	0.5	0.00067	0.01675
	414	100001	3.5	0.00187	0.07533
	415	5500	1.0	0.00026	0.00128
	543	2050	1.5	0.00204	0.00436
	554	1000	0.5	0.00096	0.00184
	627	2400	0.5	0.01141	0.01141
	694	15500	0.0	0.04982	0.05017
	700	11000	0.0	0.31798	0.31797
	703	3250	0.0	0.03101	0.03101
	711	3100	0.0	0.01029	0.01029

TABLE 2-3 (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
VALVES	1091	42500	1.5	0.00997	0.01006
	1092	5000	1.0	0.11124	0.11132
	1101	7000	1.0	0.22209	0.22227
	179	2500	0.5	0.00047	0.00921
	1956	1600	2.0	0.00077	0.00077
	1959	35	0.0	0.00104	0.00104
	2031	100001	3.0	0.17307	0.17416
	2033	2600	1.5	0.01033	0.01042
	2223	100001	3.0	0.27129	0.27662
	2229	9500	1.5	0.03728	0.03728
	2236	3350	1.0	0.01000	0.01008
	2241	5350	2.0	0.00880	0.00880
	2290	11000	2.0	0.15841	0.15848
	2292	100001	3.0	0.52186	0.52254
	2303	16500	1.5	0.02056	0.02073

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
VALVES	2304	16000	2.0	0.02192	0.02192
	2316	640	1.5	0.00413	0.00421
	2319	7000	1.5	0.02857	0.02916
	2442	1550	1.5	0.85371	0.85918
	2444	100001	2.0	0.00297	0.00305
	2454	22000	2.0	0.00000	0.00016
	2456	700	0.0	0.00000	0.00000
	846	2000	0.0	0.03156	0.03156
	857	3100	0.0	0.05888	0.05888
	1332	1350	0.0	0.03332	0.03332
	1790	55501	2.0	0.08985	0.08985
	1797	1050	0.0	0.00968	0.00968
	2462	100001	3.0	0.53376	0.53727
	2483	80001	2.0	0.02443	0.02443
	2493	21000	2.0	0.05059	0.05059

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
VALVES	2516	100001	2.5	0.27460	0.27460
	2520	100001	1.5	0.02806	0.02806
	2543	100001	2.0	0.19529	0.19529
	2547	95001	0.0	0.12040	0.12040
	2549	60001	0.0	0.04647	0.04647
	2550	65001	0.0	0.27038	0.27038
	2552	1050	0.0	0.09748	0.09748
	2573	58501	2.0	0.10771	0.10771
	2578	8250	1.0	0.06428	0.06428
	2593	350	0.0	0.00218	0.00218
	802	2900	0.0	0.07539	0.07575
	813	3750	0.0	0.04548	0.04590
	2065	100001	2.0	0.23602	0.23624
	2125	75001	3.0	2.11916	2.11915
	2149	100001	2.0	0.19461	0.19461

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SVAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
VALVES	2173	12500	2.0	0.32055	0.32055
	2501	100001	3.0	1.29302	1.29302
	2508	100001	3.0	1.32061	1.32078
	2509	26000	2.0	0.08525	0.08525
	2779	100001	3.0	0.68566	0.69072
	2791	100001	3.5	0.86730	0.87891
	2857	100001	2.0	0.06283	0.06329
	2952	700	0.0	0.01353	0.01369
	256	19000	2.0	0.00602	0.02423
	294	100001	4.0	0.16033	3.69889
	369	100001	4.0	0.38703	2.70407
	1982	100001	3.0	0.45978	0.45978
	1983	100001	3.0	0.55974	0.56250
	2494	100001	3.0	0.47871	0.47870
PUMP SEALS	337	100001	.	1.24192	1.54794

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SVAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
PUMP SEALS	338	100001	.	1.24192	1.54794
	339	100001	.	0.15439	0.40576
	340	100001	.	1.39607	1.77677
	341	100001	.	1.39607	1.77677
	314	5100	.	0.01634	0.27536
	317	130	.	0.01155	0.01155
	329	50051	.	1.49520	1.53254
	330	500	.	0.15754	0.16720
	332	500	.	0.03153	0.03178
	334	110	.	0.20298	0.20525
	342	.	.	0.24821	0.25518
	343	.	.	0.24821	0.25518
	344	.	.	8.69083	8.93153
	345	.	.	12.428	12.7723
	346	.	.	6.20764	6.37965

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
PUMP SEALS	347	27500	.	0.27415	0.27415
	348	0	.	0.00000	0.00000
	349	14500	.	0.00434	0.00434
	351	500	.	0.00103	0.00103
	323	825	.	0.54628	0.54669
	324	50	.	0.03348	0.03398
	328	100001	.	13.2917	13.4765
	333	1350	.	0.14619	0.14619
	335	6500	.	0.37097	0.37274

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
RELIEF VALVES	988	35000	.	0.02317	0.39317
VALVES	1089	100001	4.0	1.38286	1.40120
	1066	6000	0.0	0.55860	0.55859
COMPRESSORS	956	27500	.	0.26624	2.16611
	957	100001	.	0.82870	5.89518
	958	7500	.	0.31556	1.32294
	952	100001	.	0.41162	25.2709
	954	.	.	0.25470	4.47286
	961	16500	.	0.07940	0.56185
	963	100001	.	0.00737	11.4458
	965	0	.	0.00044	0.00044
	966	0	.	0.00522	0.03808
	967	.	.	0.00034	0.00870
	973	100001	.	0.32130	1.42244

TABLE 2-3. (Continued)

SOURCE TYPE	SOURCE ID	MEAN OVA SCREENING VALUE	MEAN SOAP SCREENING VALUE	NONMETHANE LEAK RATES (KG/DAY)	TOTAL HC LEAK RATES (KG/DAY)
COMPRESSORS	974	100001	.	0.00045	0.01592
	975	56001	.	0.67770	1.41208
	976	100001	.	0.20315	9.02666
	977	100001	.	1.90939	15.6266
	979	1550	.	0.08897	0.22668

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
PRESSURE RELIEF DEVICES	982	100001	-	100001	-	.	-
	988	5000	-	35000	-	.	-
	994	500	-	0	-	.	-
VALVES	116	100001	3	100001	3	70000	3
	122	10000	4	100001	3	100001	3
	170	100001	3	4000	0	1000	1
	179	0	1	1500	1	3500	0
	256	10001	2	10000	2	28000	2
	291	100001	3	100001	-	100001	3
	294	100001	4	100001	4	100001	4
	368	1000	0	700	-	2000	0
	369	100001	4	100001	4	100001	4
	381	7000	3	100001	-	100001	2
	414	20000	0	100001	3	100001	4
	415	0	3	1000	1	10000	1

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE ANALYZER	ORIGINAL SCREENING VALUE SOAP	BEFORE MEASUREMENT ANALYZER	BEFORE MEASUREMENT SOAP	AFTER MEASUREMENT ANALYZER	AFTER MEASUREMENT SOAP
VALVES	479	500	0	150	0	.	-
	543	50000	2	2000	1	2100	2
	554	50000	3	500	0	1500	1
	627	5000	0	2100	0	2700	1
	694	2000	0	16000	0	15000	0
	700	30000	1	10000	0	12000	0
	703	2000	0	3500	0	3000	0
	711	700	0	5200	0	1000	0
	778	2100	-	7000	-	.	-
	802	10001	0	2500	0	3300	0
	813	9000	0	4200	0	3300	0
	846	8000	0	1800	0	2200	0
	857	4000	0	3100	0	3100	0
	1066	1500	0	2000	0	10000	0
	1069	100001	4	100001	4	100001	4

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
VALVES	1091	90000	0	78000	2	7000	1
	1092	4000	2	9000	1	1000	1
	1101	70000	0	.	-	7000	1
	1332	1000	0	1500	0	1200	0
	1790	12000	-	100001	2	11000	2
	1797	200	-	600	0	1500	0
	1956	2200	-	1600	2	1600	2
	1959	70	-	70	0	0	0
	1982	100001	-	100001	3	100001	3
	1983	100001	-	100001	3	100001	3
	2031	100001	-	100001	3	100001	3
	2033	2500	0	2700	2	2500	1
	2065	10000	0	100001	2	100001	2
	2125	10000	3	100001	3	50000	3
	2149	10000	1	100001	2	100001	2

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
VALVES	2173	30000	2	10000	2	15000	2
	2223	100001	3	100001	3	100001	3
	2229	10000	1	12000	2	7000	1
	2236	3500	1	3500	1	3200	1
	2241	100001	2	700	2	10000	2
	2290	12000	-	12000	2	10000	2
	2292	100001	4	100001	3	100001	3
	2303	70000	-	25000	2	8000	1
	2304	100001	-	7000	2	25000	2
	2316	1900	-	1100	2	180	1
	2317	3000	-	2000	1	1800	-
	2319	100001	-	7000	2	7000	1
	2442	100001	4	2600	1	500	2
	2444	7000	2	100001	3	100001	1
	2454	1100	0	.	-	22000	2

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
VALVES	2456	1000	1	.	-	700	0
	2462	100001	4	100001	3	100001	3
	2483	70000	-	100001	2	60000	2
	2493	4500	-	12000	2	30000	2
	2494	100001	-	100001	3	100001	3
	2501	100001	-	100001	3	100001	3
	2508	100001	-	100001	3	100001	3
	2509	100001	-	42000	2	10000	2
	2516	100001	-	100001	2	100001	3
	2520	100001	-	100001	2	100001	1
	2543	100001	-	100001	2	100001	2
	2547	35000	-	90000	0	100001	0
	2549	12000	-	100001	0	20000	0
	2550	100001	-	100001	0	30000	0
	2552	1800	-	2000	0	100	0

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE ANALYZER	ORIGINAL SCREENING VALUE SOAP	BEFORE MEASUREMENT ANALYZER	BEFORE MEASUREMENT SOAP	AFTER MEASUREMENT ANALYZER	AFTER MEASUREMENT SOAP
VALVES	2573	100001	-	17000	2	100001	2
	2578	18000	-	10000	1	6500	1
	2593	300	-	500	0	200	0
	2779	100001	-	100001	3	100001	3
	2791	100001	-	100001	4	100001	3
	2857	100001	-	100001	2	100001	2
	2952	300	-	700	0	.	-
PUMP SEALS	311	1000	-	1900	-	.	-
	314	7000	-	5000	-	5200	-
	317	30	-	.	-	130	-
	323	300	-	700	-	950	-
	324	70	-	20	-	80	-
	328	4000	-	100001	-	100001	-
	329	100001	-	100	-	100001	-
	330	1500	-	0	-	1000	-

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
PUMP SEALS	332	10000	-	500	-	.	-
	333	1000	-	200	-	2500	-
	334	100001	-	130	-	90	-
	335	100	-	3000	-	10000	-
	337	100001	-	100001	-	100001	-
	338	100001	-	100001	-	100001	-
	339	100001	-	100001	-	100001	-
	340	100001	-	100001	-	100001	-
	341	100001	-	100001	-	100001	-
	342	2000	-	.	-	.	-
	343	2000	-	.	-	.	-
	344	70000	-	.	-	.	-
	345	100001	-	.	-	.	-
	346	50000	-	.	-	.	-
	347	3000	-	30000	-	25000	-

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE ANALYZER	ORIGINAL SCREENING VALUE SOAP	BEFORE MEASUREMENT ANALYZER	BEFORE MEASUREMENT SOAP	AFTER MEASUREMENT ANALYZER	AFTER MEASUREMENT SOAP
PUMP SEALS	348	0	-	0	-	0	-
	349	20000	-	7000	-	22000	-
	350	200	-	0	-	6000	-
	351	20000	-	0	-	1000	-
COMPRESSOR SEALS	952	100001	-	100001	-	100001	-
	954	0	-	.	-	.	-
	956	10000	-	15000	-	40000	-
	957	100001	-	100001	-	100001	-
	958	100001	-	10000	-	5000	-
	959	1500	-	1100	-	1100	-
	960	400	-	500	-	610	-
	961	40000	-	13000	-	20000	-
	962	500	-	1200	-	650	-
	963	100001	-	100001	-	100001	-
	964	20000	-	60000	-	.	-

TABLE 2-4
RESCREENING DATA SUMMARY
TEXACO, PARADIS

SOURCE TYPE	ID	ORIGINAL SCREENING VALUE		BEFORE MEASUREMENT		AFTER MEASUREMENT	
		ANALYZER	SOAP	ANALYZER	SOAP	ANALYZER	SOAP
COMPRESSOR SEALS	965	30000	-	0	-	0	-
	966	15000	-	0	-	0	-
	967	0	-	.	-	.	-
	973	70000	-	100001	-	100001	-
	974	50000	-	100001	-	100001	-
	975	10001	-	12000	-	100001	-
	976	100001	-	100001	-	100001	-
	977	30000	-	100001	-	100001	-
	978	300	-	850	-	.	-
	979	500	-	1100	-	2000	-

SECTION 3

PROCESS DESCRIPTION

The Texaco Paradis gas plant removes natural gas liquids by the principle of refrigerated oil absorption. The complex includes three absorption systems, each with multiple absorbers, which treat gas for sales to intrastate markets, interstate markets, and United Gas Company. Natural gas liquids removed by these absorption systems are combined and separated into products by a single train fractionation system.

The largest of the three absorption systems, the intrastate system, was chosen for testing along with the fractionation train. The intrastate system was treating 450 MMSCFD (million standard cubic feet per day) during the testing period, which was near the rated capacity of 500 MMSCFD. The total capacity of all three absorption systems was 800 MMSCFD.

A simplified schematic diagram of the intrastate absorption system and the fractionation train is shown as Figure 3-1. The feed gas is cooled by heat exchange, routed to the bottom of the absorber, and contacted with chilled lean oil. The treated gas is removed from the absorber overhead, warmed through heat exchange, and routed to sales. The rich oil (lean oil plus absorbed natural gas liquids) is heated and routed to the demethanizer. The demethanizer overhead is split between local fuel and a recycle to the raw gas inlet. The rich oil is then stripped of all absorbed liquids in the rich oil still, cooled, and returned to the absorbers.

The natural gas liquids coming from the rich oil still overhead are cooled and routed to deethanizer feed. Each column removes one light product (ethane, propane, isobutane, and normal butane) and routes the heavier

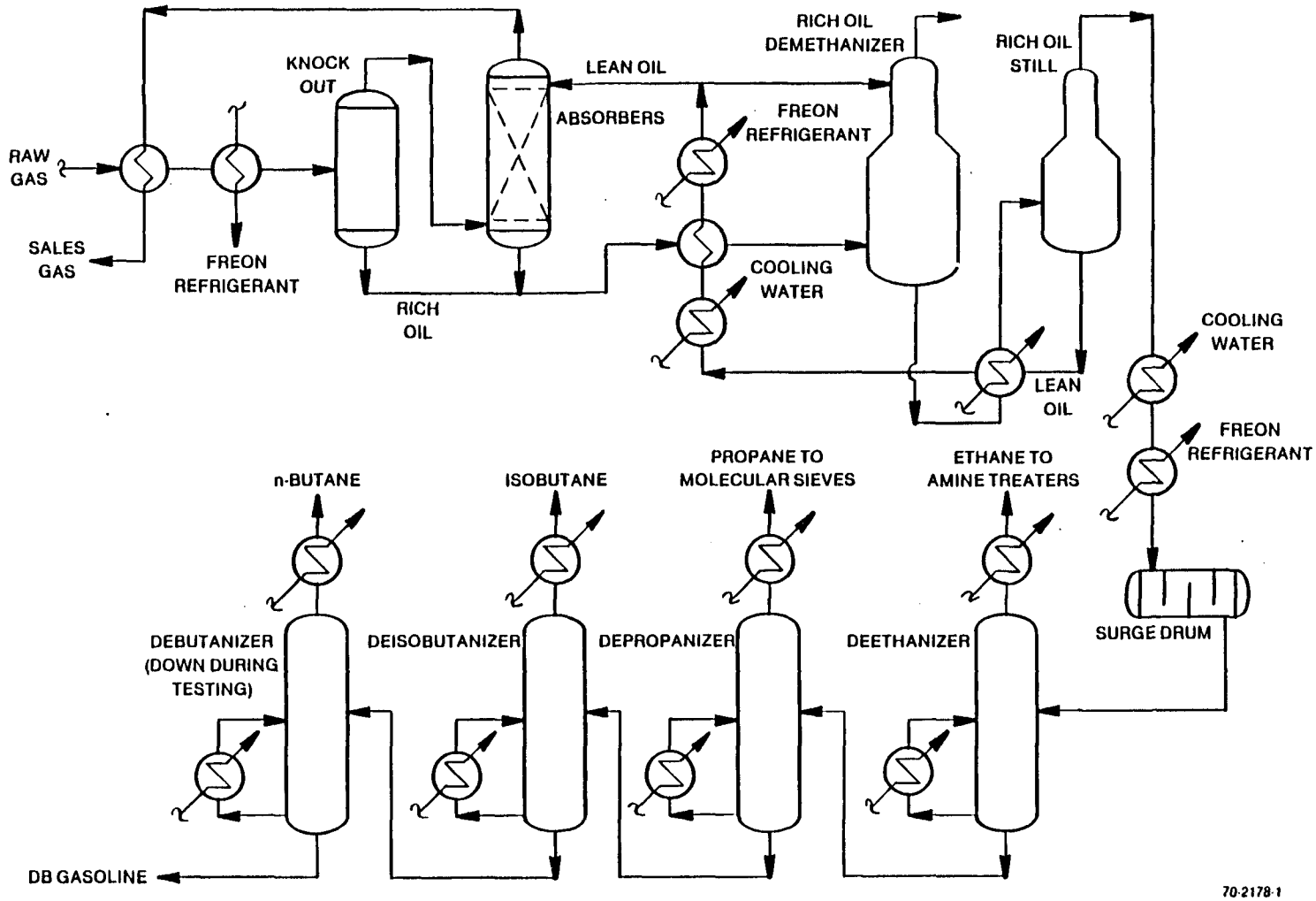

Figure 3-1. Schematic flow diagram for the Texaco Paradis gas plant.

materials to the next column. The bottom product from the last column is debutanized natural gasoline.

SECTION 4

METHODOLOGY

The fugitive emissions testing at the Texaco Paradis gas plant included both "screening" and "bagging" operations. Screening is a generic term covering any quick portable method of detecting fugitive emissions. Both instrumental screening (using the Century Systems OVA-108) and soap scoring were used in parallel on this task. Bagging refers to a quantitative emission measurement achieved by enclosing the source in a Mylar® shroud and analyzing an equilibrium flow of air through the enclosure.

The instrumental screening was done according to the procedures specified in EPA proposed Method 21.[1] Method 21 only requires the exact concentration to be recorded if it is over the leak definition specified in the applicable standard, but since this effort was more oriented to regulatory support than to regulatory monitoring, the maximum screening value was recorded for all sources.

The soap scoring method was modeled after a method used in screening fugitive emissions from petroleum production facilities.[2] The soap solution was prepared from 100 ml. of rug shampoo (HR Professional Formula) mixed with a gallon of either distilled water or a mixture of distilled water and ethylene glycol. The solution was applied using a common garden sprayer.

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[1] Federal Register, Vol. 46 No. 2, Monday, Jan. 5, 1981, p. 1160.

[2] Eaton, W. S., et al. "Fugitive Hydrocarbon Emissions from Petroleum Production Operations." API Publication No. 4322, American Petroleum Institute (1980).

Each source was sprayed with soap solution, being sure to coat all areas of potential leakage. A careful inspection was then conducted to detect any bubble formation. A soap score was then assigned based on the estimated bubble volume generated in a six-second observation:

Soap Score	Estimated Bubble Volume
0	No detectable bubbles
1	0 to 1 cc/6 sec.
2	1 to 10 cc/6 sec.
3	10 to 100 cc/6 sec.
4	>100 cc/6 sec.

The screening methods outlined above were used on every accessible source except for flanges. Only 20 percent of the flanges were screened because of their large population. Sources screened included valves, flanges, pumps, compressors, open-ended lines, drains, relief valves, and many other miscellaneous sources. The survey was conducted on a line-by-line basis to minimize the time required to obtain process data, such as the composition and phase of the material in the line. A few sources were not screened due to either physical inaccessibility or safety problems which prevented close approach, but these sources were recorded on the data sheets to insure that a complete source inventory was obtained.

Bagging procedures were carried out according to methods developed in previous refinery testing.[3] The leaking area of the source was completely enclosed in a shroud of Mylar® plastic to contain any emissions. A flow of dilution air was induced through the enclosure by the sampling train shown in Figure 4-1. The enclosure seal and the flow rate were varied to achieve a

[3]Radian Corporation. "The Assessment of Atmospheric Emissions from Petroleum Refining, Volume 2, Appendix A," EPA Report No. 600/2-80-75b, EPA/IERL/RTP, July, 1980.

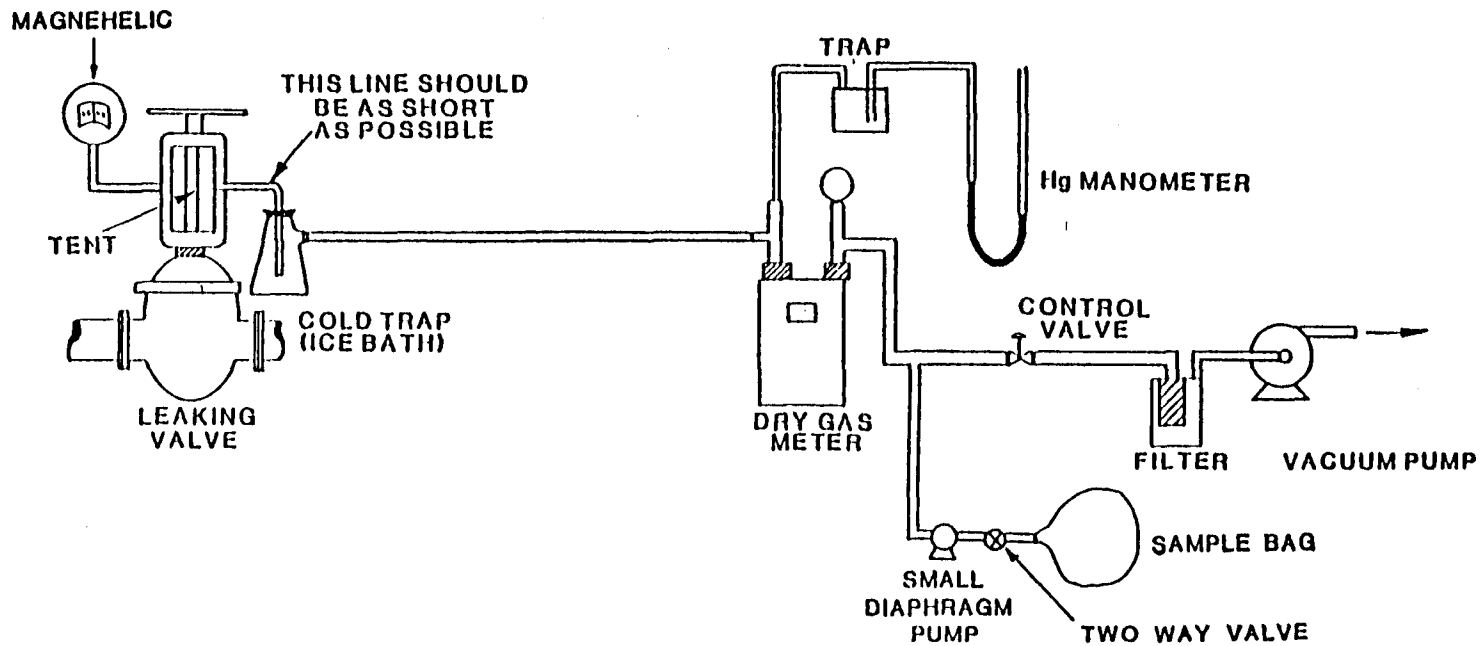

Figure 4-1. Sampling Train for Baggable Source of Hydrocarbon Emissions Using a Diaphragm Sampling Pump

slight, but measurable, vacuum on the tent to insure that all emissions were contained. A cold trap was provided to collect any heavier components which might condense in the downstream lines. The flow rate was measured with a dry gas meter, at which both temperature and pressure were measured to allow a conversion to standard conditions. The discharge of the vacuum pump was monitored with an OVA to determine when steady-state conditions had been established. At that point, a Tedlar® sampling bag was filled from the discharge of the small Teflon® lined diaphragm pump. The sample bag was then analyzed for methane and total non-methane hydrocarbons on a Byron THC analyzer (GC/FID with backflush after methane). The THC was calibrated daily with a mixture of 728 ppmw propane and 263 ppmw methane in zero air.

Noncondensible mass emissions from the source were then calculated from the bagging data by the following equations:

$$E_G = \frac{K_1 \, DF \, (P - \Delta P) \, M \, (C_T - C_A)}{460 + T} \qquad (1)$$

where E_G = noncondensible hydrocarbon emission rate in kg/day,

K_1 = 2.99×10^{-5} (a conversion constant)*,

D = dry gas meter (DGM) correction factor,

F = flow rate in actual cubic feet per minute,

P = barometric pressure in inches of mercury,

ΔP = differential pressure at the DGM in inches of mercury,

M = molecular weight of the measured gas,

C_T = hydrocarbon concentration in the sample in ppmw,

C_A = ambient hydrocarbon concentration in ppmw,

T = temperature at the DGM in °F.

The molecular weight (M) was calculated:

$$M = \frac{10^6}{\frac{C_T}{86} + \frac{10^6 - C_T}{29}} \, . \qquad (2)$$

*The field data were taken in English units. This factor includes appropriate metric conversions as well as an adjustment to standard conditions of 60°F and 29.92 inches of mercury pressure.

The emission rates for either the methane or the non-methane fractions can be calculated by the above equations by using the appropriate value of methane or non-methane concentration for C_T in equation (1). If any organic condensate was collected in the cold trap, its contribution to the emissions was calculated by:

$$E_L = 1.44 \frac{(SG)\ V}{t} \tag{3}$$

where E_L = condensible emissions kg/day,

SG = specific gravity of the condensate (used 0.75g/ml. if there was too little to measure the specific gravity),

V = volume of condensate collected in mls,

t = time of collection in minutes.

1.44 = units conversion constant, from g/min. to kg/day.

The total hydrocarbon emissions would then be:

$$E_T = E_{GM} + E_{GNM} + E_L \tag{4}$$

where E_T = total hydrocarbon emissions in kg/day,

E_{GM} = methane emissions in kg/day,

E_{GNM} = non-methane hydrocarbon emissions in kg/day,

E_L = condensible hydrocarbon emissions in kg/day.

SECTION 5

SAMPLING LOCATIONS

The Texaco Paradis gas plant is a large and complex gas processing facility. It would have been impossible to conduct a complete fugitive emission survey of such a large plant within the existing time and cost constraints. This section will explain what portions of the plant were screened and sampled.

As mentioned in Section 3, the Paradis plant includes three independent absorption systems followed by a single natural gas liquids fractionation system. The bulk of the testing reported here was performed on the "intrastate" absorption system and the fractionation train. The intrastate system was chosen for testing because it was the largest system, and it most closely balanced the size of the fractionation train.

The intrastate absorption system itself was still too large for complete screening, so the screening survey was limited to one of three parallel absorbers which made up the intrastate system. No screening was done on the Freon refrigeration system. Complete screening (except only 20 percent of flanges) was performed on the one absorber, the lean oil system, and the fractionation train. The screening survey also excluded the ethane amine treaters and the propane molecular sieves. Although the debutanizer was not running during the test period, it was screened since it was filled with product and under pressure.

Instrumental screening was performed on all the sections described above. Soap scoring was conducted in parallel to the original screening for the first nine days of testing. When it became necessary to start simultaneous bagging and screening, there was insufficient manpower to do soap scoring on the original screening survey. Soap scores were still taken during

rescreening on all sources which were bagged. This resulted in soap scores being taken for about half of the sources screened (mostly in the absorption and lean oil systems) and all of the sources bagged (except where soap scoring was physically inappropriate, such as on moving seals or large open-ended lines).

The objectives of the bagging effort were to concentrate on those sources where existing data were scarce or where there was an inconsistency between the instrumental screening results and the soap scoring. This resulted in the following priority for source sampling:

1) compressor seals,
2) relief valves,
3) pump seals,
4) sources with inconsistent screening values, and
5) valves.

No sampling was done on flanges or open-ended lines since the existing data base covered them adequately.

There were no compressors associated with the intrastate absorption system because it was fed by relatively high pressure gas fields. A large number of reciprocating compressors were available on another system, so 16 of these sources were sampled to increase the compressor data base.

Despite a high priority, only one relief valve was sampled. This was due to either physical inaccessibility, venting to a flare header, or a remote location with no utilities to operate the sampling train.

A total of 17 pump seals were sampled. This included all pumps found to be leaking in the original screening survey.

The remainder of the sources sampled were valves in the absorption and fractionation system screened. These sources were selected either because of screening inconsistencies (about 20 valves) or to fill out a matrix to provide a range of data with which to develop screening value to leak rate correlations (about 56 valves).

APPENDIX A

SUPPLEMENTAL INFORMATION

A-1 - Coding Conventions

A-2 - Summary of Sampling Data

A-3 - Summary of QA/QC Data

A-1

CODING CONVENTIONS

TABLE A-1. DATA CODING CONVENTIONS

Columns	Coding
1,2	Month (i.e., May = 05, October = 10)
3,4	Day of the month
5,6	Year (19 8 0)
7,8	A sequential identification number assigned to each plant.
9,10	An identification number for each process unit encountered. For example: let 01 = Gas Plant - Adsorption 02 = Gas Plant - Cryogenic etc.
11,12,13	A unique identification number assigned to each screening team. Each team member is assigned a personal ID number between 0 and 9. Column 11 will then contain the ID for the soap score reader, column 12 will be the OVA operator, and column 13 will be the data recorder.
14,15	A sequential ID number assigned to each instrument used. Outside documentation should then include: Instrument 1 = OVA #2158 Instrument 2 = OVA #1575 etc.
16 - 21	A sequential ID number for each source encountered. Start back at No. 1 for each new plant.
22 - 28	The instrument screening value in ppmv.
29,30	Source Type Code

Source	Code
Flange	1
Process drain	2
Open-end line	3
Agitator seal	4
Relief valve	5

TABLE A-1. DATA CODING CONVENTIONS (continued)

Columns		Coding	
29,30 (cont'd)		Source	Code
	Valves	Block valve - gate type	10
		Block valve - globe type	11
		Block valve - plug type	12
		Block valve - ball type	13
		Block valve - butterfly type	14
		Block valve - other types	15*
		Control valve - gate type	20
		Control valve - globe type	21
		Control valve - plug type	22
		Control valve - ball type	23
		Control valve - butterfly type	24
		Control valve - other types	25*
	On-line Pump Seals	Single, mechanical, emission point at seal	30
		Single, mechanical, emission point at vent	31
		Single, mechanical, other emission point	32*
		Double, mechanical, emission point at seal	33
		Double, mechanical, emission point at vent	34
		Double, mechanical, other emission point	35*
		Single, packed, emission point at seal	36
		Single, packed, emission point at vent	37
		Single, packed, other emission point	38*
		Sealless pumps	39*

*Explain in comment field.

TABLE A-1. DATA CODING CONVENTIONS (continued)

Columns		Coding	
29,30 (cont'd)		Source	Code
	Off-line Pump Seals	Single, mechanical, emission point at seal	40
		Single, mechanical, emission point at vent	41
		Single, mechanical, other emission point	42*
		Double, mechanical, emission point at seal	43
		Double, mechanical, emission point at vent	44
		Double, mechanical, other emission point	45*
		Single, packed, emission point at seal	46
		Single, packed, emission point at vent	47
		Single, packed, other emission point	48*
		Sealless pumps	49*
	On-line Compressor Seals	Single, mechanical, emission point at seal	50
		Single, mechanical, emission point at vent	51
		Single, mechanical, other emission point	52*
		Double, mechanical, emission point at seal	53
		Double, mechanical, emission point at vent	54
		Double, mechanical, other emission point	55*
		Single, packed, emission point at seal	56
		Single, packed, emission point at vent	57
		Single, packed, other emission point	58*
		Sealless compressors	59

*Explain in the comment field.

TABLE A-1. DATA CODING CONVENTIONS (continued)

Columns	Coding		
29,30 (cont'd)		Source	Code
	Off-line Compressor Seals	Single, mechanical, emission point at seal	60
		Single, mechanical, emission point at vent	61
		Single, mechanical, other emission point	62*
		Double, mechanical, emission point at seal	63
		Double, mechanical, emission point at vent	64
		Double, mechanical, other emission point	65*
		Single, packed, emission point at seal	66
		Single, packed, emission point at vent	67
		Single, packed, other emission point	68*
		Sealless compressors	69*
		Vacuum Breakers	70
		Expansion Joints	71
		Rupture Disks	72
		Sight Glass Seals	73
31	Service Code - 1 = Gas at Process Conditions; 2 = Light Liquids (naphthas and lighter with a vapor pressure $\geq$ 0.04 psi @ 20°C); 3 = Heavy Liquids (kerosene and less volatile liquids with a vapor pressure < 0.04 psi @ 20°C)		
32 - 35	Material Code - a unique sequential identification number for each new process stream encountered. The code should be explained on the "Material Coding Sheet" shown as Table A-2. The stream description should include information about specific components and their concentrations (i.e., depropanizer overhead - 80% propane, 11% propylene, 3% ethane, 6% isobutane).		

*Explain in the comment field.

TABLE A-1. DATA CODING CONVENTIONS (continued)

Columns	Coding
36	Elevation Code - 0 = Below ground level (pits, etc.) 1 = Ground level 2 = 1st Platform above ground 3 = 2nd Platform above ground etc.
37	Accessibility Code - Blank = normal (easy) accessibility 1 = accessible with a free standing ladder or a minor amount of scaffolding 2 = accessible only with a crane, cherry picker, or major scaffolding 3 = physically accessible, but not safe to approach 4 = emission point inaccessible because it is hard piped to a control device 5 = shrouds or other safety devices prevent access to the seal area ? = Other codes may be assigned and documented in the field
38	Soap Score Code - 0 = No detectable bubbling during the six second observation period 1 = Zero to 1 cc total bubble volume in six seconds 2 = 1 cc to 10 cc per six seconds 3 = 10 cc to 100 cc per six seconds 4 = > 100 cc per six seconds, which is characterized by bubbles popping before the 6 second period is up and/or the soap solution being blown away from the seal area
39	Orientation Code - 1 = Horizontal seal interface (vertical-mounted valve) 2 = Vertical seal interface (horizontal-mounted valve) 3 = Diagonal seal interface 4 = Rotating seal, no soap score possible

TABLE A-1. DATA CODING CONVENTIONS (continued)

Columns	Coding
40 - 79	Comments - Free form alpha-numeric field which can be used to describe any significant information noted about the source, such as: VISIBLE LIQUID EMISSION, VISIBLE VAPOR EMISSION, HOT SOURCE, SOAP VAPORIZING, COLD SOURCE, ICE FORMING, SEAL AREA VENTED TO FLARE, SCREENED AT SEAL OIL VENT, etc.

TABLE A-1. MATERIAL CODING SHEET

Radian Corporation

Contractor Name: Texaco Paradis Gas Plant | 1 |

1 2

Chemical		ID	DO NOT CODE
Raw Feed: 93% CH_4, 3% C_2, 1% C_3, 1% C_4, 1% C_5+, 1% CO_2	3	11	
Sales Gas: 97% CH_4, 2% C_2, 1% CO_2.	9	12	
Condensate: 100% C_5+.	15	13	
Lean Oil: 100% C_4+	21	14	
Rich Oil: 1% CH_4, 1% C_2, 1% C_3, 1% C_4, 1% C_5, 95% C_6+	27	15	
Rich Oil Still OH Gas: 1% C_1, 31% C_2, 36% C_3,	33	16	
10% IC_4, 10% n-C_4, 4% IC_5, 3% NC_5, 3% C_6, 3% C_7	39		
Ethane Product: 3% C_1, 96% C_2, 1% C_3	45	17	
Deethanizer Bottoms: 1% C_2, 52% C_3, 14% IC_4,	51	18	
14% NC_4, 6% IC_5, 4% NC_5, 4% C_6, 4% C_7	53		
Propane Product: 2% C_2, 97% C_3, 1% IC_4	63	19	
Depropanizer Bottoms: 1% C_3, 29% IC_4, 29% NC_4,	69	110	
13% IC_5, 8% NC_5, 8% NC_6, 8% NC_7	75		
IC_4 Product: 3% C_3, 96% IC_4, 1% NC_4	Repeat Columns 1 and 2 3	111	
Deisobutanizer Bottoms: 2% IC_4, 41% NC_4, 19% IC_5,	9	112	
14% NC_5, 14% C_6, 14% C_7	15		
Glycol	21	113	
Rich Oil Demethanizer Reboiler Sidestream (Same as #5)	27	114	
RO Demethanizer OH Gas (Same as #2)	33	117	
Debutanizer Reflux: 3% IC_4, 96% NC_4, 1% IC_5	39	118	
	45		
	51		
	57		
	63		
	69		
	75		

A-2

SUMMARY OF SAMPLING DATA

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	LT(PPMW) M	LT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
116	1.91	1	30.03	2.40	81	651.0	74.0	15.0	6.0	.	.	.
122	1.92	1	30.03	2.90	80	1100.0	107.0	15.0	6.0	.	.	.
170	1.98	1	30.03	3.50	86	634.0	22.0	441.0	14.0	.	.	.
179	1.77	1	30.00	3.60	80	124.0	8.0	12.0	2.0	.	.	.
256	1.97	1	30.11	3.20	69	221.0	76.0	12.0	7.0	.	.	.
291	2.02	1	30.15	3.20	70	1250.0	345.0	261.0	9.0	.	.	.
294	2.00	1	30.11	3.20	69	41500.0	1820.0	6.0	4.0	.	.	.
314	2.03	1	30.15	3.30	70	2920.0	190.0	12.0	7.0	.	.	.
317	1.99	1	30.15	3.30	70	2.0	141.0	2.0	9.0	.	.	.
323	1.89	1	30.11	3.15	74	15.0	6580.0	10.0	3.0	.	.	.
324	1.91	1	30.11	3.10	73	16.0	402.0	10.0	3.0	.	.	.
328	1.75	1	30.11	3.60	67	2540.0	156000.0	8.0	70.0	.	.	.
329	1.98	1	30.15	3.50	57	424.0	16700.0	2.0	41.0	.	.	.
330	2.00	1	30.15	3.50	56	110.0	1800.0	2.0	41.0	.	.	.
332	1.81	1	30.15	2.90	58	5.0	403.0	2.0	21.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
333	1.82	1	30.11	3.60	70	5.0	1870.0	5.0	26.0	.	.	.
334	2.01	1	30.15	2.90	56	4.0	2230.0	1.0	28.0	.	.	.
335	1.78	1	30.11	3.70	69	29.0	4810.0	6.0	26.0	.	.	.
337	2.02	1	30.11	5.10	64	7390.0	36000.0	21.0	7000.0	.	.	.
339	1.95	1	30.11	4.90	73	3160.0	8920.0	21.0	7000.0	.	.	.
340	1.90	1	30.11	4.80	73	9820.0	41600.0	21.0	7000.0	.	.	.
342	2.19	1	30.15	4.00	55	8830.0	242000.0	2.0	33.0	.	.	.
347	1.87	1	30.15	2.70	62	3.0	3230.0	3.0	20.0	.	.	.
348	1.83	1	30.15	2.90	63	2.0	53.0	2.0	53.0	.	.	.
349	1.91	1	30.15	2.90	70	3.0	157.0	3.0	106.0	.	.	.
351	1.94	1	30.15	3.20	70	2.0	15.0	2.0	3.0	.	.	.
368	2.03	1	30.15	3.10	70	62.0	11.0	62.0	10.0	.	.	.
369	1.99	1	30.11	3.10	69	26900.0	4420.0	7.0	40.0	.	.	.
381	2.05	1	30.15	2.90	71	246.0	11.0	79.0	10.0	.	.	.
414	1.97	1	30.03	3.10	82	850.0	26.0	7.0	4.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	LT(PPMW) M	LT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
415	1.99	1	30.03	3.10	83	19.0	7.0	7.0	4.0	.	.	.
543	2.04	1	30.03	2.50	66	32.0	26.0	7.0	4.0	.	.	.
554	2.01	1	30.03	3.60	67	17.0	15.0	7.0	4.0	.	.	.
627	2.01	1	30.03	3.60	66	2.0	162.0	2.0	32.0	.	.	.
694	1.95	1	30.03	2.60	65	6.0	595.0	2.0	32.0	.	.	.
700	2.32	1	30.03	3.40	68	2.0	3160.0	2.0	32.0	.	.	.
703	2.00	1	30.03	2.70	65	2.0	375.0	2.0	32.0	.	.	.
711	1.93	1	30.03	3.50	67	2.0	194.0	2.0	12.0	.	.	.
802	2.06	1	30.10	3.70	57	7.0	828.0	3.0	4.0	.	.	.
813	1.85	1	30.10	3.30	55	8.0	547.0	3.0	4.0	.	.	.
846	2.00	1	30.06	5.00	71	1.0	387.0	1.0	2.0	.	.	.
857	2.02	1	30.06	5.20	71	1.0	720.0	1.0	2.0	.	.	.
952	1.85	1	30.11	1.80	72	381000.0	4800.0	230.0	8.0	.	.	.
954	1.98	1	30.11	1.40	82	48400.0	2800.0	230.0	8.0	.	.	.
956	1.62	1	30.14	1.10	81	25900.0	3530.0	243.0	19.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
957	1.53	1	30.14	1.80	84	78300.0	11900.0	243.0	19.0	.	.	.
958	1.50	1	30.14	1.80	88	15400.0	4690.0	243.0	19.0	.	.	.
961	1.84	1	30.11	1.20	71	5740.0	920.0	156.0	6.0	.	.	.
963	1.87	1	30.11	1.20	75	146000.0	90.0	150.0	6.0	.	.	.
965	1.87	1	30.11	1.20	72	69.0	13.0	69.0	8.0	.	.	.
966	1.87	1	30.11	1.20	71	444.0	67.0	72.0	8.0	.	.	.
967	1.82	1	30.11	1.40	72	170.0	12.0	72.0	8.0	.	.	.
973	1.80	1	30.11	1.40	71	13200.0	3800.0	20.0	7.0	.	.	.
974	1.88	1	30.11	1.00	71	193.0	12.0	20.0	7.0	.	.	.
975	1.83	1	30.11	1.20	71	8830.0	7900.0	244.0	85.0	.	.	.
976	1.86	1	30.11	1.30	71	110000.0	2400.0	244.0	85.0	.	.	.
977	1.92	1	30.11	1.20	71	174000.0	20800.0	294.0	15.0	.	.	.
979	1.67	1	30.11	1.20	72	2040.0	1140.0	294.0	15.0	.	.	.
988	1.80	1	30.11	2.50	67	4540.0	287.0	4.0	4.0	.	.	.
1066	1.90	1	30.11	3.10	74	6.0	6680.0	6.0	3.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
1089	2.01	1	30.03	2.40	65	202.0	14900.0	2.0	10.0	.	.	.
1091	2.05	1	30.03	2.70	66	3.0	118.0	2.0	10.0	.	.	.
1092	1.94	1	30.03	2.70	66	3.0	1280.0	2.0	10.0	.	.	.
1101	1.98	1	30.03	2.80	67	4.0	2500.0	2.0	10.0	.	.	.
1332	2.42	1	30.06	5.90	60	1.0	351.0	1.0	9.0	.	.	.
1790	1.89	1	30.06	6.10	69	1.0	1210.0	1.0	2.0	.	.	.
1797	1.92	1	30.06	5.60	70	2.0	160.0	2.0	34.0	.	.	.
1956	1.93	1	30.00	3.20	68	3.0	72.0	3.0	63.0	.	.	.
1959	1.94	1	30.00	3.00	66	4.0	75.0	4.0	63.0	.	.	.
1982	1.95	1	30.11	3.20	72	5.0	5370.0	5.0	20.0	.	.	.
1983	1.87	1	30.11	3.00	66	36.0	6660.0	3.0	12.0	.	.	.
2031	1.84	1	30.00	2.60	60	15.0	2060.0	2.0	3.0	.	.	.
2033	1.75	1	30.00	1.30	60	3.0	126.0	2.0	3.0	.	.	.
2065	1.83	1	30.10	5.70	60	6.0	3170.0	3.0	5.0	.	.	.
2125	1.83	1	30.10	5.90	61	3.0	28200.0	3.0	21.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
2149	1.84	1	30.10	6.00	62	2.0	2660.0	2.0	26.0	.	.	.
2173	1.83	1	30.10	6.00	64	2.0	4400.0	2.0	26.0	.	.	.
2223	1.85	1	30.00	3.10	63	66.0	3290.0	2.0	13.0	.	.	.
2229	1.89	1	30.00	2.90	64	2.0	457.0	2.0	17.0	.	.	.
2236	1.85	1	30.00	3.10	62	3.0	124.0	2.0	3.0	.	.	.
2241	1.87	1	30.00	3.00	62	2.0	108.0	2.0	3.0	.	.	.
2290	1.80	1	30.00	3.30	64	3.0	2000.0	2.0	17.0	.	.	.
2292	1.90	1	30.00	2.90	64	10.0	6120.0	2.0	17.0	.	.	.
2303	1.88	1	30.00	3.00	64	4.0	270.0	2.0	26.0	.	.	.
2304	1.93	1	30.00	2.70	68	2.0	270.0	2.0	17.0	.	.	.
2316	1.88	1	30.00	2.90	64	3.0	75.0	2.0	26.0	.	.	.
2319	1.88	1	30.00	2.90	64	9.0	365.0	2.0	26.0	.	.	.
2442	1.79	1	30.00	3.70	71	73.0	11000.0	2.0	10.0	.	.	.
2444	1.92	1	30.00	3.00	70	3.0	45.0	2.0	10.0	.	.	.
2454	1.85	1	30.00	3.10	71	4.0	215.0	2.0	215.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
2456	1.94	1	30.00	2.70	71	2.0	109.0	2.0	109.0	.	.	.
2462	1.93	1	30.06	8.00	55	52.0	7420.0	3.0	20.0	.	.	.
2483	2.20	1	30.06	4.90	72	1.0	284.0	1.0	14.0	.	.	.
2493	2.43	1	30.06	5.90	58	2.0	540.0	2.0	26.0	.	.	.
2494	1.99	1	30.11	3.30	60	19.0	5380.0	19.0	25.0	.	.	.
2501	2.18	1	30.10	4.20	68	2.0	13900.0	2.0	122.0	.	.	.
2508	1.92	1	30.10	3.40	68	6.0	15600.0	4.0	122.0	.	.	.
2509	1.89	1	30.10	3.40	68	3.0	1050.0	3.0	22.0	.	.	.
2516	2.40	1	30.06	5.70	56	3.0	2810.0	3.0	26.0	.	.	.
2520	2.40	1	30.06	5.60	56	2.0	312.0	2.0	26.0	.	.	.
2543	2.54	1	30.06	6.60	70	3.0	2020.0	3.0	22.0	.	.	.
2547	2.52	1	30.06	5.90	64	1.0	1200.0	1.0	9.0	.	.	.
2549	2.46	1	30.06	6.10	63	1.0	480.0	1.0	9.0	.	.	.
2550	2.55	1	30.06	6.30	67	4.0	2760.0	4.0	16.0	.	.	.
2552	2.56	1	30.06	6.10	66	2.0	977.0	2.0	16.0	.	.	.

TABLE A-2
SUMMARY OF SAMPLING DATA
TEXACO, PARADIS

SOURCE ID	F CFM	D	P (IN HG)	DELTA P (IN HG)	T (DEG F)	CT(PPMW) M	CT(PPMW) NM	CA(PPMW) M	CA(PPMW) NM	V (ML)	T (MIN)	S.G. (G/ML)
2573	2.49	1	30.06	6.20	64	1.0	1100.0	1.0	8.0	.	.	.
2578	2.56	1	30.06	6.00	65	1.0	638.0	1.0	8.0	.	.	.
2593	1.72	1	30.06	11.5	72	2.0	82.0	2.0	40.0	.	.	.
2779	1.89	1	30.10	4.10	70	78.0	8490.0	15.0	20.0	.	.	.
2791	1.91	1	30.10	4.00	72	156.0	10600.0	13.0	14.0	.	.	.
2857	1.97	1	30.10	6.30	67	8.0	820.0	2.0	7.0	.	.	.
2952	1.90	1	30.10	5.90	69	4.0	328.0	2.0	149.0	.	.	.

A-3

SUMMARY OF QA/QC DATA

TABLE A-3.1. OVA CALIBRATION ERROR DETERMINATION

Instrument ID Century Systems OVA-108

Serial Number: 2158

Calibration Gas Data 1-9-81

Calibration = 7990 ppmv

Run No.	Instrument Meter Reading, ppm	Difference[1] ppm
1.	8000	-10
2.	8200	-210
3.	8000	-10
4.	8000	-10
5.	8000	-10
6.	8400	-410
7.	8100	-110
8.	8500	-510
9.	8200	-210

Mean Difference -166

$$\text{Calibration Error} = \frac{\text{Mean Difference}^{(2)}}{\text{Calibration Gas Concentration}} \times 100 \quad -2.1$$

[1] Calibration Gas Concentration - Instrument Reading

TABLE A-3.2. OVA RESPONSE TIME DETERMINATION

Instrument ID Century Systems OVA-108 Serial Number: 2158

Calibration Gas Concentration 7990 ppmv

1-9-81

90% Response Time:

	Without Dilution Probe		With Dilution Probe	
1.	5.8	Seconds	7.1	Seconds
2.	7.0	Seconds	9.5	Seconds
3.	5.5	Seconds	7.0	Seconds
Mean Response Time	6.1	Seconds	7.8	Seconds

TABLE A-3.3. REPEAT SCREENING FORM

1 Month	3 Day	5 Screening Team	7 Instrument	8 Process Unit	10 Source B	15 Screening Value	22 ~~Ambient~~ Air °F (SOAP)	25 Rescreening Value No. 1	32 Rescreening Value No. 2
02	27	12	1	01	2617	1010011	444	1010011	1100101
02	27	12	1	01	615	1010011	222	1010011	1101001
02	27	12	1	01	1171	1010011	233	1101011	1101001
02	27	12	1	01	1918	1 7 0 0 0	222	1 8 5 0 0 0	1101001
02	27	12	1	01	2518	1 4 0 0 0 0	1111	1101011	1 2 0 0 0 0

Comments: _____

TABLE A-3.4

Accuracy Check AC 0217 2/17/81

Induced leak rate measured with the bubble meter

	Pre-Run	Post-Run
100 ml. in	6.4 sec.	6.6 sec.
	6.5	6.5
	6.5	6.6
	6.6	6.4

$$\text{Avg.} = \frac{100 \text{ ml.}}{6.5 \text{ sec.}} = 15.4 \text{ ml/sec. or } 923 \text{ ml/min of } 8000 \text{ PPMV } CH_4 \text{ in air}$$

$$\text{Induced leak rate} = \left(923 \frac{\text{ml}}{\text{min}}\right)\left(\frac{60 \text{ min}}{\text{hr}}\right)\left(\frac{24 \text{ hr}}{\text{day}}\right)\left(\frac{1}{1000 \text{ ml}}\right)\left(\frac{\text{g-mole}}{23.7 \text{ l}}\right)\left(\frac{16 \text{ g}}{\text{g-mole}}\right)\left(\frac{\text{kg}}{1000 \text{ g}}\right)\left(0.008\right)$$

$$= 0.0072 \text{ kg/day of } CH_4$$

Sample Cart Data:
$D = 1.0$
$F = 1.615$ CFM
$P = 30.14$ in. Hg.
$\Delta P = 0.6$ in. Hg.
$M \approx 29$ lb/mole
$T = 60°F$

Analytical Data:
$C_T = 77$ PPMW
$CA = 1$ PPMW

$$E_H = 2.99 \times 10^{-5} \frac{DF(P-P)\,M\,(C_T-CA)}{460 + T}$$

$$= 2.99 \times 10^{-5} \frac{(1.0)(1.615)(30.14-0.6)(29)(77-1)}{460 + 60}$$

$$= 0.0061 \text{ kg/day}$$

$$\text{Percent Error} = \frac{0.0072 - 0.0061}{0.0072} \times 100 = 15.3\%$$

Allowable Error = ± 20%

Sampling System OK