

Air



Emission Test Report Leaks from Perchloroethylene Dry Cleaners



PERCHLOROETHYLENE EMISSION TESTING

AT

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By

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I. INTRODUCTION

During the week of March 26, 1979, a two person test crew from TRW performed an emission test at the Kleen Kornor, located at 10012 Homer Avenue, Cortland, New York. The Kleen Kornor is a small commercial dry cleaning and laundry establishment, owned and operated by the Ames Linen Service of Cortland, New York.

The specific process tested at the Kleen Kornor was the dry cleaning system. This plant utilizes a dry-to-dry perchloroethylene machine, and the rated capacity of the machine was 40-45 pounds. The dry cleaning machine was a Detrex Commander Model #11-20-H of approximately 2½ years of age. The machine specifications and details are elaborated upon in Section III - (Process Description). The dry cleaning system utilized a Kleen-Rite (Model #3H-1200) cartridge filter system for purifying the dry cleaning solvent. Emissions from the process were controlled by a carbon adsorption system manufactured by Hoyt (Model #1-662). The carbon bed was approximately seventeen (17) years old.

There was a multifold purpose of conducting this emission test. The reasons include determination of the removal efficiency for a typical carbon adsorption unit, testing of candidate leak detectors, and establishment of data for a mass balance around a dry-to-dry perchloroethylene dry cleaning unit.

II. SUMMARY OF RESULTS

The original work assignment for this project consisted of writing a guideline document method for determining general and specific leaks at perchloroethylene (C_2Cl_4) dry cleaning plants. The procedure recommended by the work assignment was to incorporate an inexpensive (< \$250) portable leak detector and parallel the method used in the EPA guideline series on Control of Volatile Organic Compound Leaks from petroleum refining equipment. However, such a parallel method was not practical, because of the simplistic nature of the leak detectors. In addition, the scope of the work assignment shifted to include additional objectives, all of which were related to developing a New Source Standard (NSS) for perchloroethylene dry cleaning plants. In order to clarify testing objectives, the program at the Kleen Kornor was divided into four segments. These segments include mass balance (MB), carbon breakthrough monitor evaluation (CBME), leak detector evaluation (LDE) and mass evaporation losses (MEL). The information collected and determined for these segments overlapped to some degree.

The testing information is summarized in Table 2.1. Data presented includes the plant throughput, the perchloroethylene loss due to changing cartridge filters, the average carbon bed removal efficiency, the calculated emission rate from the carbon adsorption system, and the amount of solvent recovered and used during the testing period. The total plant throughput was 735 kg (1614.8 lbs) for the testing period. This represent a total of forty-four (44) machine loads. A breakdown of the plant throughput is detailed in Table 3.2. The perchloroethylene loss due to changing the cartridge filters was calculated as 2.74 kg/100 kg throughput (2.74 lbs/100 lbs throughput). The method for calculating this loss is described in Appendix A. The average removal efficiency of the carbon bed was 89.4% for the week of testing. The perchloroethylene loss to the atmosphere. was calculated as approximately 762 g (1.7 lbs.) for the four day testing period.

PLANT THROUGHPUT ¹	735.7 kg (1614.8 lbs.) (44 loads)
CARTRIDGE FILTER LOSSES ²	2.74 kg/100 kg throughput (2.74 lbs./100 lbs. throughput)
CARBON BED REMOVAL EFFICIENCY	89.4% Average
ATMOSPHERIC EMISSIONS ³	<u>762 g/week (1.7 lbs/week)</u> 18.1 g/load (.04 lbs/load)
SOLVENT USED (C ₂ Cl ₄)	21.6 liters (5.7 gal)
MACHINE MILEAGE ⁴	3.88 kg solvent/100 kg clothes
MACHINE MILEAGE ⁵	4.73 kg solvent/100 kg clothes
TOTAL MILEAGE ⁴	6.62 kg/solvent/100 kg clothes
⁶ TOTAL MILEAGE ⁵	7.47 kg/solvent/100 kg clothes

¹See Table 3.2

²Calculated - See Appendix A

³From Outlet of Carbon Adsorber Only

⁴Based on Machine Capacity

⁵Based on Machine Throughput

⁶Machine Mileage and Cartridge Filter Losses

TABLE 2.1 SUMMARY - TESTING RESULTS

Both the removal efficiency and the atmospheric emissions are further discussed in Section 4. The amount of solvent (perchloroethylene) used was 21.6 liters (5.7 gal). Likewise, these calculations are detailed in Appendix A.

Tables 2.2, 2.3 and 2.4 tabulate the results of carbon breakthrough monitor evaluation. The three selected candidate instruments were compared during various stages of the dry cleaning cycle (Selection criteria - See Appendix F). Only the Halogen Leak Detector Model 440 instrument responded favorable during this field evaluation. In order to effectively monitor breakthrough of the carbon bed, a detector (instrument) must have a pre-determined setting at which it will alarm. The Halogen Leak Detector Model 440 does not have an effective means to set the alarm mechanism to a pre-determined level. Therefore, the usefulness of this instrument to monitor breakthrough of a carbon bed is severely limited. The Bacharach TLV Sniffer and the Meter-All instruments responded erratically to lower perchloroethylene concentrations and thus seemed inferior.

The same candidate instruments were evaluated for applicability to detect perchloroethylene leaks. The results of the leak detector evaluation are summarized in Tables 2.5, 2.6, 2.7 and 2.8. Three locations of major solvent leaks were determined by visual inspection and the continuous monitor (Beckman 402). Each candidate leak detector then was tested during the major portions of the machine cycle. Again, the most favorable instrument was the HLD-440. Since the response of the HLD-440 is strictly qualitative, the instrument is well suited in finding relatively large solvent leaks only.

Due to the erratic performance at this test site, the candidate instruments were returned to the laboratory for further evaluation. Based upon laboratory and field data none of the candidate's instruments proved satisfactory for the purpose of detecting various concentrations of leaks for a variety of reasons. These reasons include: sensitivity to slight increases in water vapor, sensitivity to increased temperature, erratic response to changing concentrations of perchloro-

TIME	CONCENTRATION ¹ (ppm C ₂ C ₁₄)	TEMPERATURE		MONITOR RESPONSE	MACHINE CYCLE
		(°C)	(°F)		
0956	37	28	83	NONE	DRY
0958	37	27	82	NONE	DRY
1000	37	28	83	NONE	DRY
1002	36	27	82	NONE	DRY
1004	35	27	82	NONE	DRY
1006	34	28	83	NONE	DRY
1008	42	32	90	NONE	AERATION
1000	40	31	89	NONE	LOADING
1012	41	32	90	NONE	LOADING
1014	50	32	90	ALARM	LOADING
1016	58	32	90	ALARM	LOADING
1018	47	30	86	NONE	WASH

¹ CONCENTRATION - measured at outlet duct by Beckman 402 Hydrocarbon Analyzer.

TABLE 2.2 MONITOR RESULTS CARBON BREAKTHROUGH
(HALOGEN LEAK DETECTOR - MODEL 440)

TIME	CONCENTRATION ¹ (ppm C ₂ Cl ₄)	TEMPERATURE		MONITOR RESPONSE	MACHINE CYCLE
		(°C)	(°F)		
0956	37	28	83	118	DRY
0958	37	27	82	125	DRY
1000	37	28	83	120	DRY
1002	36	27	82	110	DRY
1004	35	27	92	122	DRY
1006	34	28	83	110	DRY
1008	42	32	90	110	AERATION
1010	40	31	89	118	LOADING
1012	41	32	90	108	LOADING
1014	50	32	90	112	LOADING
1016	58	32	90	112	LOADING
1018	47	30	86	110	WASH

1. CONCENTRATION - measured at outlet duct by Beckman 402 Hydrocarbon Analyzer.
2. Zero instrument in HC free air.

TABLE 2.3 MONITOR RESULTS CARBON BREAKTHROUGH
(BACHARACK-TLV-SNIFFER)

TIME	CONCENTRATION ¹ (ppm C ₂ C ₁₄)	TEMPERATURE		MONITOR RESPONSE	MACHINE CYCLE
		(°C)	(°F)		
0956	37	28	83	NONE	DRY
0958	37	27	82	ALARM	DRY
1000	37	28	83	NONE	DRY
1002	36	27	82	NONE	DRY
1004	35	27	82	ALARM	DRY
1006	34	28	83	NONE	DRY
1008	42	32	90	NONE	AERATION
1010	40	31	89	ALARM	LOADING
1012	41	32	90	ALARM	LOADING
1014	50	32	90	ALARM	LOADING
1016	58	32	90	ALARM	LOADING
1018	47	30	86	NONE	WASH

¹ CONCENTRATION - measured at outlet duct by Beckman 402 Hydrocarbon Analyzer.

TABLE 2.4 MONITOR RESULTS CARBON BREAKTHROUGH
(METER-ALL)

MONITOR	SOURCE	RESPONSE	AMBIENT TEMPERATURE		AMBIENT CONCENTRATION (ppm C ₂ Cl ₄) ¹
			(°C)	(°F)	
METER-ALL	FAN	ALARM	28	83	10
HLD-440	FAN	ALARM	28	83	10
TLV-SNIFFER	FAN	DOWNSCALE	28	83	10
METER-ALL	SHAFT	ALARM	29	84	50-150
HLD-440	SHAFT	ALARM	29	84	50-150
TLV-SNIFFER	SHAFT	5-10	29	84	50-150
METER-ALL	DRUM SIDE	NONE	24	75	3
HLD-440	DRUM SIDE	NONE	24	75	3
TLV-SNIFFER	DRUM SIDE	NEGATIVE	24	75	3

¹ CONCENTRATION - in the proximity of the suspected leak as measured by a Beckman 402 Hydrocarbon Analyzer.

TABLE 2.5 LEAK DETECTION DURING WASH CYCLE

MONITOR	SOURCE	RESPONSE	AMBIENT TEMPERATURE		AMBIENT CONCENTRATION (ppm C ₂ C ₁₄) ¹
			(°C)	(°F)	
METER-ALL	FAN	ALARM	30	86	25
HLD-440	FAN	ALARM	30	86	25
TLV-SNIFFER	FAN	8 (SCALE x 1)	30	86	25
METER-ALL	SHAFT	ALARM	30	86	120
HLD-440	SHAFT	ALARM	30	86	120
TLV-SNIFFER	SHAFT	38 (x1)	30	86	120
METER-ALL	DRUM	ALARM	28	83	10-40
HLD-440	DRUM	ALARM	28	83	10-40
TLV-SNIFFER	DRUM	14 (x 1)	28	82	10-40

¹ CONCENTRATION - in the proximity of the suspected leak as measured by a Beckman 402 Hydrocarbon Analyzer.

TABLE 2.6 LEAK DETECTION DURING EXTRACT CYCLE

MONITOR	SOURCE	RESPONSE	AMBIENT TEMPERATURE		AMBIENT CONCENTRATION (ppm C ₂ Cl ₄) ¹
			(°C)	(°F)	
METER-ALL	FAN	ALARM	30	87	15
HLD-440	FAN	ALARM	30	87	15
TLV-SNIFFER	FAN	NEGATIVE	30	87	15
METER-ALL	SHAFT	ALARM	32	90	500-1000
HLD-440	SHAFT	ALARM	32	90	500-1000
TLV SNIFFER	SHAFT	15.5 (ALARM X10)	32	90	500-1000
METER-ALL	DRUM	ALARM	31	89	40-50
HLD-440	DRUM	ALARM	31	89	40-50
TLV-SNIFFER	DRUM	25 (x1)	31	89	40-50

¹ CONCENTRATION - in proximity of the suspected leak as measured by a Beckman 402 Hydrocarbon Analyzer.

TABLE 2.7 LEAK DETECTION DURING DRY CYCLE

MONITOR	SOURCE	RESPONSE	AMBIENT TEMPERATURE		AMBIENT CONCENTRATION (ppm C ₂ C ₁₄) ¹
			(°C)	(°F)	
METER-ALL HLD-440 TLV-SNIFFER	FAN	NO ALARM	33	91	5
	FAN	NO ALARM	33	91	5
	FAN	NEGATIVE	33	91	5
METER-ALL HLD-440 TLV-SNIFFER	DRUM	NONE	33	92	5
	DRUM	NONE	33	92	5
	DRUM	NEGATIVE	33	92	5

¹ CONCENTRATION - in proximity of the suspected leak as measured by a Beckman 402 Hydrocarbon Analyzer.

TABLE 2.8 LEAK DETECTION DURING AERATION CYCLE.

ethylene and the lack of an effective zeroing mechanism. Therefore, the method developed in the EPA guideline document pertaining to petroleum refineries cannot be applied to the dry cleaning industry if these inexpensive (< \$250) leak detectors that were tested are to be used. (Laboratory testing - see Appendix B).

During the Evaporation Loss Test a total of 1.04 kg (2.29 lbs.) was lost (evaporated from a load of clothes). The test was sixty minutes in duration. Ambient temperature was 29°C (85°F). Table 2.9 lists the evaporative losses every five minutes over the course of an hour. The evaporative loss test was conducted to approximate losses that might take place in a transfer rather than a dry-to-dry process operation.

<u>DATE</u>	<u>TIME</u>	<u>WEIGHT</u>	
		Kg	(lbs.)
3/30/79	1058	20.50	45.2
3/30/79	1103	20.41	45.0
3/30/79	1108	20.37	44.9
3/30/79	1113	20.32	44.8
3/30/79	1118	20.14	44.4
3/30/79	1123	20.05	44.2
3/30/79	1128	19.96	44.0
3/30/79	1133	19.87	43.8
3/30/79	1138	19.82	43.7
3/30/79	1143	19.73	43.5
3/30/79	1148	19.55	43.1
3/30/79	1153	19.50	43.0
3/30/79	1158	19.46	42.9
	60	1.04	2.3

TABLE 2.9 EVAPORATIVE LOSS TEST

III. PROCESS DESCRIPTION

The test was performed on Detrex dry-to-dry machine, model 11-20-H (see Figure 3.1 and Table 3.1 for machine specifications), with Kleen Rite cartridge filters. A Hoyt Model 1 carbon absorber (with the original carbon) was used to recover perc from the dry cleaning machine. (See figure 3.2.). Floor vents also venting to the carbon absorber had been removed due to problems with lint fouling the dampers. Additional vents had also been connected to two coin-ops machines (now removed) and to the cartridge filters (also now disconnected). The net result was that the carbon absorber was connected only to the dry cleaning machine with one additional opening, a 3/4 inch pipe, opening to room air (the pipe was a remnant of the filter venting scheme that was removed).

To establish a reference point with this equipment, one bank of filters (four cartridges) were changed, the carbon absorber was desorbed with the reclaimed perc added to the system, and all traps, button and lint, were cleaned. New filter cartridges were then installed and the dry cleaning machine was turned on to fill the new filters. A level reading was taken at the wash tank sight tube with a tape measure. The sight tube for the clean solvent tank showed the tank to be completely full. For this machine the clean solvent tank will remain full (unless a clean solvent rinse is used during dry cleaning) since condensed solvent from the reclaiming cycle is piped to this tank (after water separation). An internal weir allows overflow from the clean solvent tank to the wash tank, hence, the clean solvent tank is always full.

The loss attributed to the filters was measured. The Kleen Rite filter at this installation is composed of two tubes of four cartridges. New cartridges weigh 16 kg (35.5 lbs) and are installed in each tube about every 12 weeks after processing about 5400 kg (12 000 lbs) of clothes. Replacement of the cartridges is alternated with only one tube being changed at a time on six-week intervals.

The cartridge removed Monday morning were weighed on the scales at the front of the dry cleaning store. Each of the cartridges in a carton weighed an indicated 52.5 pounds. Later it was discovered that these scales did not register past 52.5 pounds. Therefore, to obtain an estimate of the perc loss from these filters, the second tube of cartridges was drained from Thursday afternoon until Friday morning. One cartridge was removed from this tube and weighed on a floor scales at a linen supply house. The cartridge removed Monday was dried under a laboratory hood and reweighed to establish the actual weight of perc which was present in the drained filter. That weight, along with the weight of the cartridge removed Friday and the amount of clothes processed on each cartridge are calculated in the test report (Equation A-1).

Final values for losses were found by adding the loss attributed to the filter to the loss from the machine itself. The loss from the machine was found Thursday afternoon (before draining the second filter tube) by desorbing the carbon bed, adding the reclaimed perc to the machine, and then putting the machine into the continuous recirculation mode. The perc level in the sight tube was again measured with tape measure. Note that no perc or additive was added to the machine during the period of the test.

Losses from the machine are attributable to only two categories of source - losses during venting on the machine and fugitive losses. Venting occurs during the aeration cycle and during loading/unloading operations when the door is open. Fugitive losses are vapor leaks or liquid leaks. The major leaks appeared to be from valves in the solvent lines to the filters where perc leaked enough during the night to form a small puddle on the base tank of the machine.

Detrex COMMANDER 11-20-H

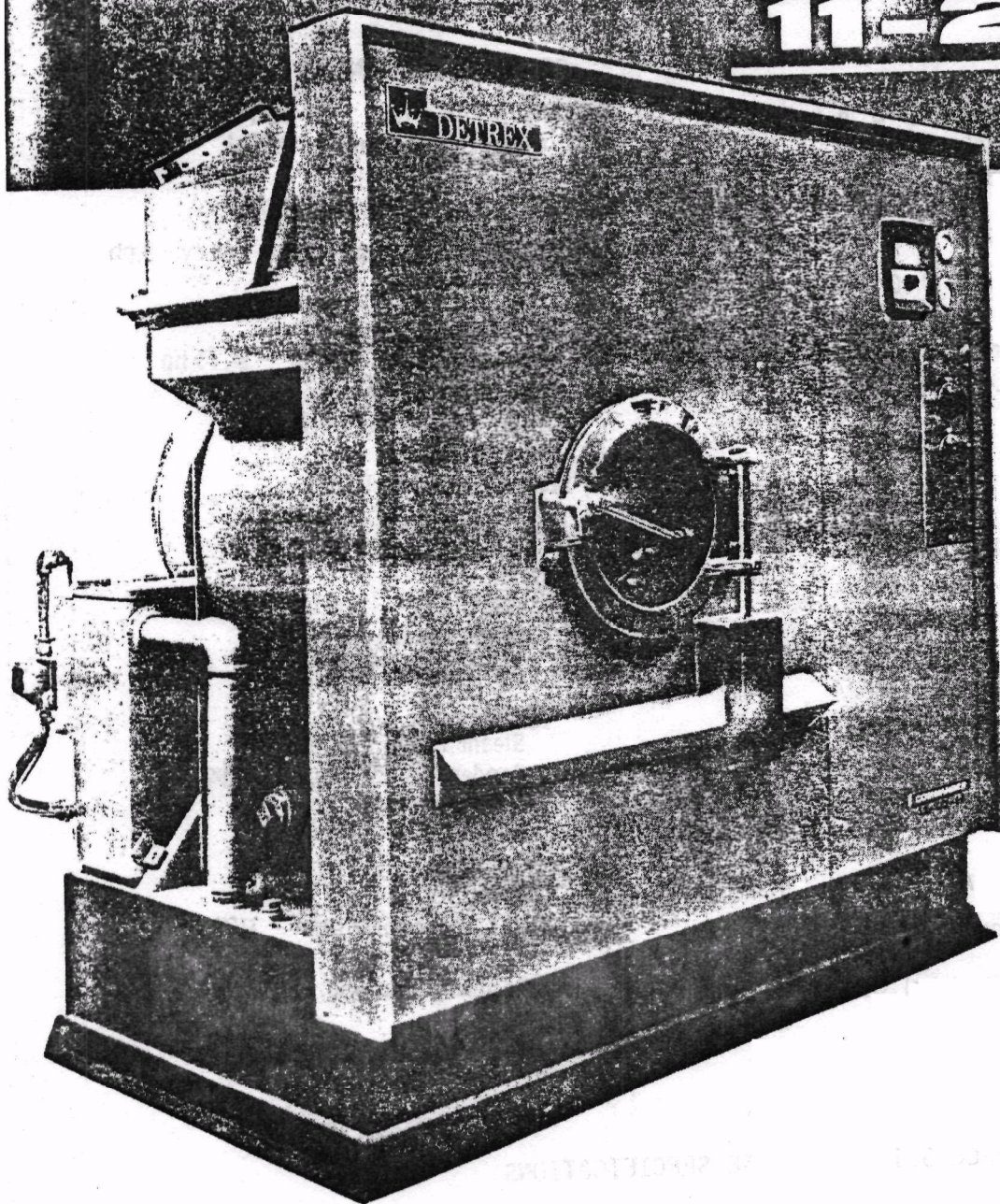


FIGURE 3.1 - DETREX DRY--to--DRY MACHINE

DETREX COMMANDER 11-20-H SPECIFICATIONS

DIMENSIONS (Crated)

Washer-Extractor - 6'-11" w x 5'-0" d x 7'-1" h

WEIGHT - 3,000 Lbs. (Crated)

INSTALLATION DIMENSIONS

Washer-Extractor - 6'-3" w x 4'-0" d x 6'-4" h

MINIMUM OPENING REQUIRED

Width - 4'-0" Height - 6'-4"

CYLINDER

Diameter - 3'-0"

Depth - 19 1/2" - 11.2 Cubic Feet

Material - Stainless Steel

Number of Ribs - 4

Door Opening - 16 1/2" Dia.

Wash Speed - 31 RPM

Dry Speed - 45 RPM

Extract Speed - 450 RPM

CONTROLS - ELECTRICAL and AIR

Type - Automatic and Manual

CAPACITIES of TANKS

Main Filter Tank - 91 Gal.

Clean Solvent Tank - 50 Gal.

ELECTRICAL SPECIFICATIONS

Machine - 60 amp - 230 v - 60 cy - 3 ph

MOTORS

Washer-Extractor Motor - 3/4.75 hp

Fan Motor - 1 hp

Filter Pump Motor - 1 hp

SERVICE CONNECTIONS

Air - 75-80 psi - 1/4 ips

Water

Water Inlet - 3/4 ips

Water Outlet - 3/4 ips,
12 Gal. per min. at 70°F.

Steam

Steam Inlet - 3/4 ips

Condensate Return - 3/4 ips

1-3/4 Boiler hp

75 psi

Vent - 4"

Water Separator Outlet - 1/2"

... Variable Level Control... ...Stainless Steel Recovery Housing...

TABLE 3.1 - MACHINE SPECIFICATIONS

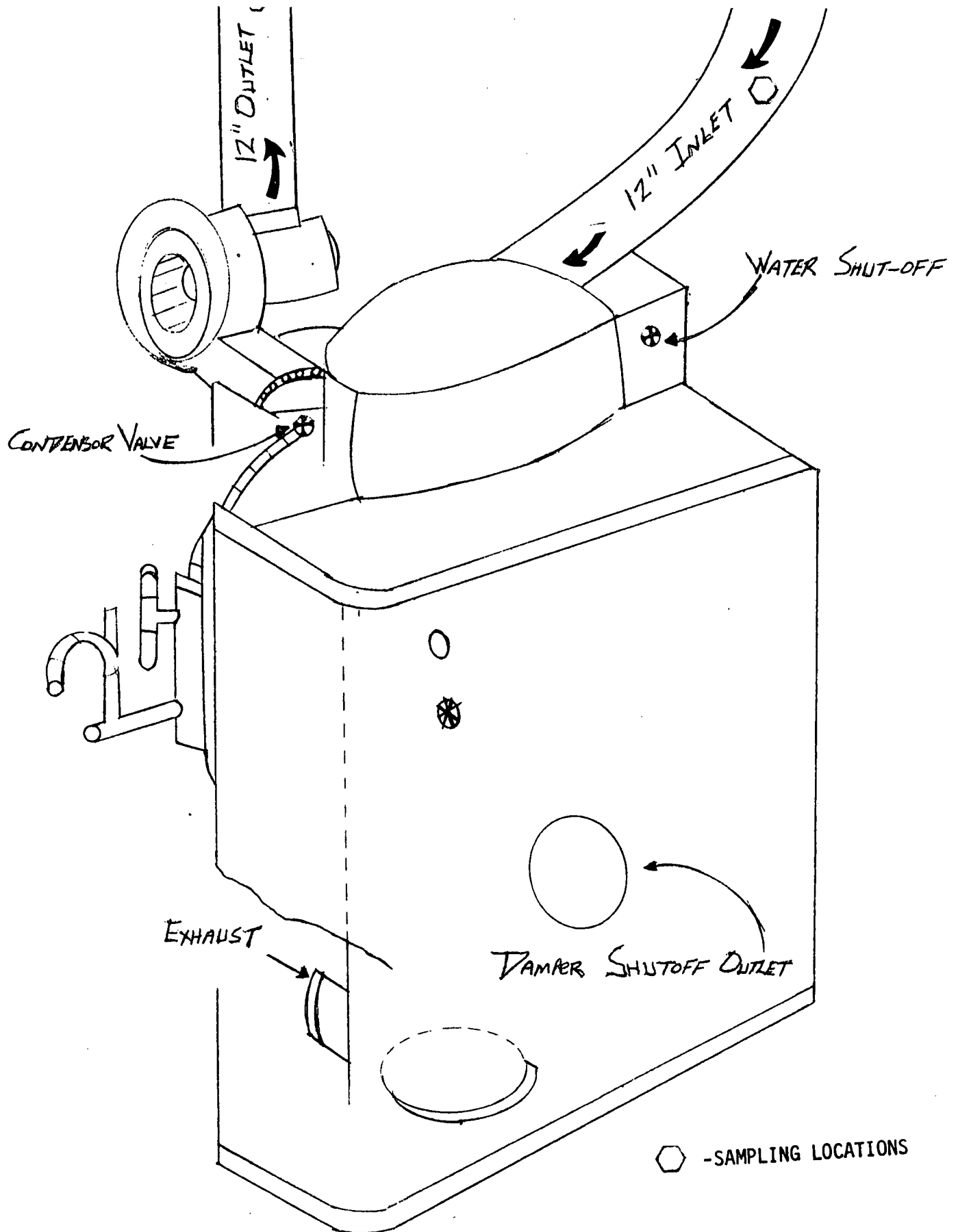


FIGURE 3.2 CARBON ABSORBER (HOYT MODEL # 1)

LOAD #	<u>MONDAY</u>		<u>TUESDAY</u>		<u>WEDNESDAY</u>		<u>THURSDAY</u>	
	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)
1	2.3	(5.0)	18.1	(40.0)	17.5	(38.5)	17.5	(38.5)
2	17.9	(39.7)	18.4	(40.5)	17.5	(38.5)	17.5	(38.5)
3	16.6	(37.5)	17.5	(38.5)	15.2	(33.5)	17.5	(38.5)
4	17.2	(38.0)	17.5	(38.5)	17.5	(38.5)	17.5	(38.5)
5	17.2	(38.0)	17.5	(38.5)	17.5	(38.5)	17.5	(38.5)
6	23.6	(55.0)	17.5	(38.5)	17.5	(38.5)	17.5	(38.5)
7	19.5	(43.0)	16.1	(35.5)	17.5	(38.5)	17.5	(38.5)
8	20.6	(45.5)	10.7	(23.5)	17.5	(38.5)	17.5	(38.5)
9	13.2	(29.0)	10.7	(23.5)	17.5	(38.5)	17.5	(38.5)
10	----	-----	17.5	(38.5)	17.5	(38.5)	17.5	(38.5)
11	----	-----	----	-----	17.5	(38.5)	17.5	(38.5)
12	----	-----	----	-----	17.5	(38.5)	----	-----
13	----	-----	----	-----	17.5	(38.5)	----	-----
14	----	-----	----	-----	6.1	(13.5)	----	-----
DAILY TOTAL	148.1	(326.7)	161.5	(355.5)	231.3	(509.1)	192.5	(423.5)
WEEKLY TOTAL	735.7 kg (1614.8 lbs)							

TABLE 3.2 PROCESS DATA - CLOTHES THROUGHPUT

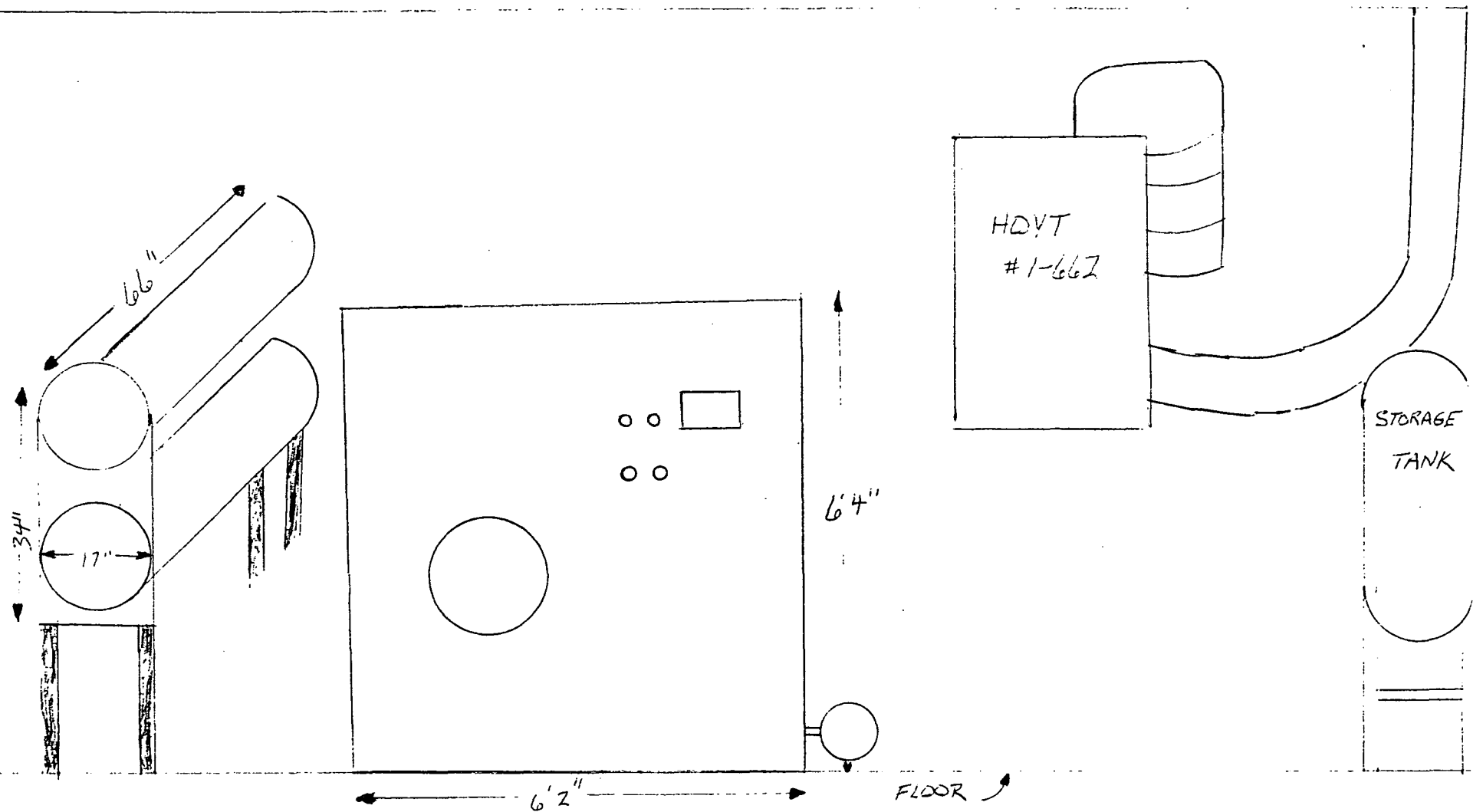


FIGURE 3.3- SAMPLING SCHEMATIC (FRONT VIEW)

IV. DISCUSSION OF TEST RESULTS

The results summarized in Section 2 require elaboration. Table 4.1 shows the analytical results used to determine the efficiency of the carbon adsorption system. The inlet and outlet were not sampled simultaneously with the continuous hydrocarbon analyzer due to equipment limitations. However, comparative data was generated by utilizing an integrated bag sample at one location, while the continuous monitor (FID) was located at the other location. Those samples collected by the integrated bag method are denoted with an asterisk in Table 4.1. In calculating the removal efficiency, the average inlet concentration was determined only from those samples drawn from the inlet during the aeration and loading portions of the dry cleaning cycle. This was due to the fact that only during this segment was the carbon bed actively receiving perchloroethylene emissions. During the remaining portions of the cycle (wash, extraction and dry) the damper from the dry cleaning unit to the carbon absorption system was closed. This removal efficiency then was used to calculate the average removal efficiency for each day of the test period. The removal efficiency for the week was in turn calculated by weighting the daily average removal efficiencies in proportion to the number of loads cleaned per day.

The emissions emitted to the atmosphere are highlighted in Table 4.2. The average daily outlet concentration was calculated from the data outlined in Table 4.1. The emission rate was calculated by Equation 4.2 in Appendix A and reported in units of milligrams per minute. The emissions attributed to a portion of the cycle, either aeration or loading, were calculated by Equation 4.3 in Appendix A. The daily total emissions were the sum of the emissions during both the aeration and loading cycles multiplied by the number of loads on a given day (Table 3.2).

It should be noted that there was no flow in the outlet duct during a major portion (80%) of the dry cleaning cycle; consequently, no atmospheric emissions can be calculated directly. The continuous monitor indicated a C_2Cl_4

	INLET (ppm as C ₂ Cl ₄)	OUTLET (ppm as C ₂ Cl ₄)	EFFICIENCY		
			(%) ¹	(%) ²	(%) ³
MONDAY 3/26/79	N.A.	N.A.			95.65 ⁴
TUESDAY 3/27/79	60 -- -- 25 275* -- --	18 15 43* 62 80 72 90	70 -- -- -- 70.9 -- --	94 95.3 86.6 80.7 75.1 77.6 72.0	83.04
		DESORPTION			
WEDNESDAY 3/28/79	23 11 13 400*	16 8 25* 11	30.4 27.3 -- 97.25	95.0 93.5 97.5 96.6	95.65
THURSDAY 3/29/79	55 -- -- -- 275* -- 290* 355* -- --	15 17 40 42 51 56 65 77 90 100	72.7 69.1 -- -- 82.5 -- 77.5 78.3 -- --	95.3 94.7 87.6 86.9 84.1 82.6 80.7 76.1 72.0 68.9	82.89
		DESORPTION			
FRIDAY 3/30/79	335	9	97.3	97.2	--
			89.4 ⁵		

*Measurement Taken From Integrated Bag Sample - FID Analysis Readout

¹Removal Efficiency - Calculated at one Point of Cycle

²Removal Efficiency - Calculated from Average Inlet Concentration During Aeration & Loading

³Average Removal - Calculated (Daily Basis)

⁴Assumed - Based on Wednesday Efficiency Data (After Bed Desorption)

⁵Average For Week - Weighted by #Loads/Day (Monday-Thursday Only)

N.A. - Not Ascertained - Instrument Set-up.

TABLE: 4.1 CARBON BED EFFICIENCY DATA

DATE	AVERAGE OUTLET CONCENTRATION		EMISSION RATE					
	(ppm) ⁽¹⁾	(mg/m³) ⁽²⁾	(mg/min) ⁽³⁾	(lbs/min) ⁽³⁾	(g/cycle) ⁽⁴⁾	(lbs/cycle) ⁽⁴⁾	g/day ⁽⁵⁾	(lbs/day) ⁽⁵⁾
3/26/79 (A)	20	135.5	1295.5	(.0028)	2.8	(.006)	81.2	(.18)
(L)			1212.81	(.0027)	6.2	(.014)		
3/27/79 (A)	54.2	367.2	2717.3	(.0060)	5.8	(.013)	253.9	(.56)
(L)			3800.5	(.0083)	19.6	(.043)		
3/28/79 (A)	15	101.6	664.6	(.0015)	1.4	(.003)	86.0	(.19)
(L)			916.7	(.0020)	4.7	(.010)		
3/29/79 (A)	55.3	374.	3776.9	(.0083)	8.1	(.018)	340.6	(.75)
(L)			4442.91	(.0097)	23.9	(.050)		
(1) AVERAGE OUTLET CONCENTRATION FROM TABLE 4.1			WEEKLY TOTAL				761.7g (1.68 lbs)	

(1) AVERAGE OUTLET CONCENTRATION - FROM TABLE 4.1

(2) BY EQUATION 4.1

(3) BY EQUATION 4.2

(4) BY EQUATION 4.3

(5) BY EQUATION 4.4

A - AERATION CYCLE

L - LOADING

TABLE 4.2 ATMOSPHERIC EMISSIONS - OUTLET CARBON ABSORBER

concentration present despite no flow in the outlet duct. This concentration was only significant on Tuesday and Thursday of the test period (i.e. after carbon bed breakthrough). The magnitude of the emission is assumed to be comparable to a solvent leak at the machine itself, since ambient conditions were present in the duct.

In Appendix B several examples of the continuous hydrocarbons monitor chart are highlighted. Figure B-1 graphically illustrates carbon bed breakthrough. Figure B-2 shows a trace of inlet concentrations for an entire dry cleaning cycle. There was a measurable concentration of perchloroethylene at all times at the inlet sampling location, despite the fact that damper to the carbon bed from the machine was closed. It is judged that this measurable concentration was the result of the damper leaks and ambient background concentrations drawn in through the lint trap.

The perchloroethylene concentrations peaked during the aeration and loading portion of the dry cleaning cycle. The peak was difficult to assess, due to its magnitude and rapid deterioration. The hydrocarbon analyzer had multiple scales and a generation of ten thousand parts per million (10,000 ppm) static gas standard verified the linearity of the hydrocarbon analyzer to \pm 10 percent.

V. SAMPLING AND ANALYTICAL PROCEDURES

The perchloroethylene concentrations were monitored with a Beckman 402 Hydrocarbon Analyzer. This instrument is a continuous hydrocarbon monitor which operates on the principle of flame ionization. A continuous monitor type flame ionization detector (FID) instrument was selected over a gas chromatograph-flame ionization detector (GC/FID) because the primary constituent of the flue gas was assumed to be perchloroethylene (C_2Cl_4), and no separation of hydrocarbon compounds was necessary. A continuous monitor FID also offered the advantage of relatively instantaneous reading at one point in time. This was desirable to quantify the perchloroethylene concentrations during the carbon breakthrough monitor evaluation (CBME) and leak detector evaluation (LDE). Modification of the calibration system also provided introduction of an integrated bag sample collected over a specified period of the machine cycle.

The hydrocarbon monitor was calibrated directly each day with solvent (perchloroethylene). This procedure is a deviation from the normal procedure. The normal procedure requires calibration gases of either methane (CH_4) or propane (C_3H_8) and determination of a solvent response factor for the solvent under investigation. By calibrating the instrument directly with solvent (perchloroethylene-- C_2Cl_4), no further calculations were necessary.

The calibration gases were supplied and certified by Scott Environmental Technology, Inc. A copy of the standard certification is given in Appendix C. Three concentrations of calibration gas were utilized. The concentrations were approximately fifty, one hundred and five hundred parts per million (ppm) perchloroethylene in air. The standards were analyzed by GC/FID analysis to be 45.7 ppm, 92.8 ppm and 493 ppm C_2Cl_4 prior to shipment into the field. A post analysis of the gas standards is expected to determine any degradation of the standards over time. The parameters for analysis were as follows:

The column was a 6 ft x 1/8" diameter stainless steel packed with 5% SP-1200 + 5% Bentone 34 on 100/120 mesh Supelcoport. The carrier gas were helium at a flow rate of 50 cc/min. The column temperature was 75°C. 1 cc injections were made via a gas sampling valving. The instrument on which these analyses were performed was a Varian 1800 with flame ionization detector. The peaks generated were quantified by digital integration.²

The introduction of the calibration gases to the continuous monitor was by means of a new aluminized gas sampling bag and an auxiliary bellows pump. The gas sampling bag was outfitted with a new piece of teflon[®] tubing and a 1/4 inch Swagelok[®] quick disconnect. This method of introduction was necessary because the standards were in low pressure cylinders. Direct interface to the instrument would not have provided sufficient sample pressure throughout the testing period. Figure 5.1 is a schematic of the instrument plumbing. The operating conditions of the instrument: the sample pressure, the air pressure, and fuel pressure were maintained at two, ten, and twenty pounds per square inch (psig) respectively.

Velocity measurements were conducted daily with a S-type pitot-tube manometer assembly (Figure 5.2). Due to the space limitations of sampling location and the small diameter duct of 30.5 cm (12 inches), an EPA method 2 velocity traverse could not be conducted. Investigation showed that there was little variation across the duct during any portion of the dry cleaning cycle. The velocity and volumetric flowrate calculations are in Appendix A. Field Data is included in Appendix B. No moisture measurement was undertaken. The molecular weight of the stack gas (M_s) was assumed to be that of air (28.80). Barometric pressure was reported as station pressure at the local U.S. Weather Station (Table B-3).

The plant throughput was weighed by means of a basket suspended scale. This laundry-basket suspended scale was checked against a recently calibrated spring scale of reliable quality. The difference between the two scales was judged to

²Correspondence from R. B. Denyszyn, Scott Environmental Technology, to R. F. Jongleux (TRW) April 6, 1979.

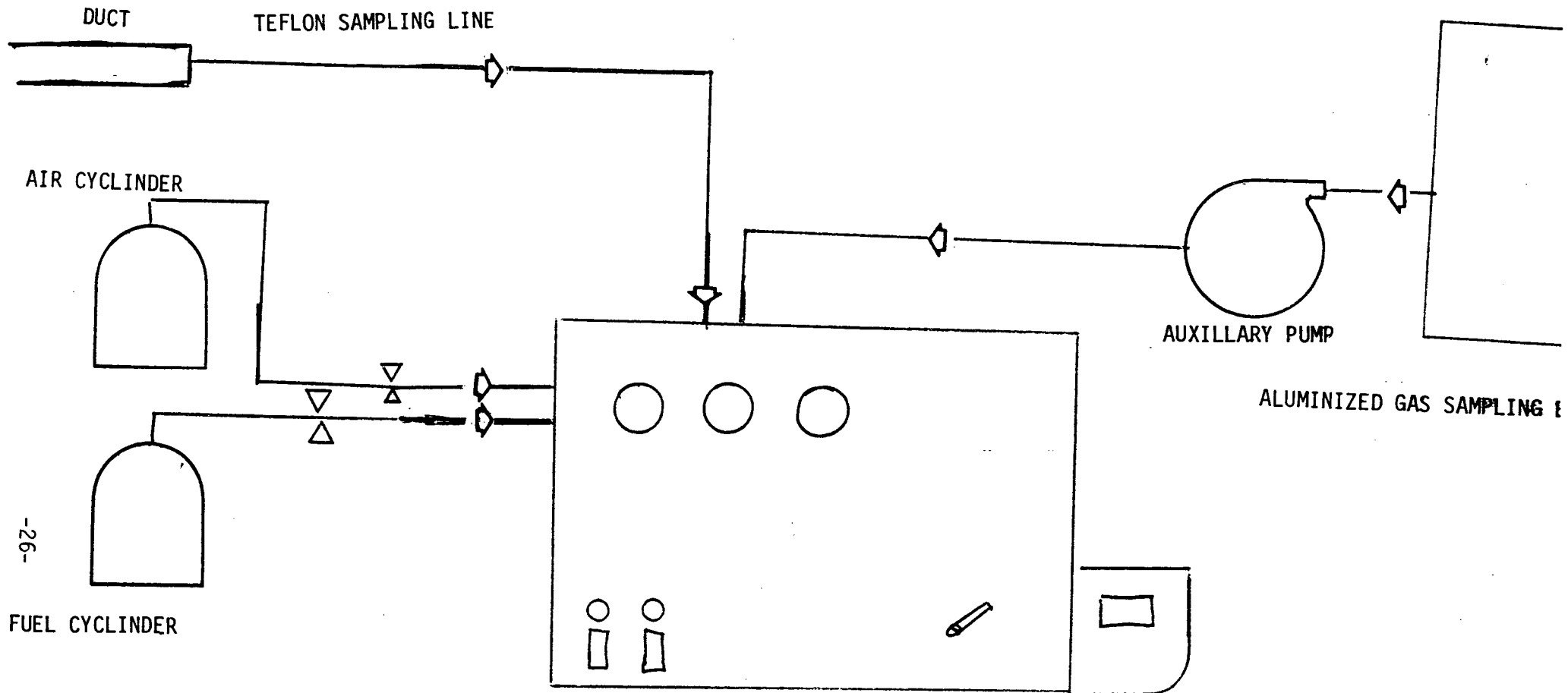


FIGURE 5.1 HYDROCARBON ANALYZER PLUMBING SCHEMATIC

1.90 - 2.54 cm*
(0.75 - 1.0 in.)

7.62 cm (3 in.)*

TEMPERATURE SENSOR

TYPE S PITOT TUBE

LEAK-FREE
CONNECTIONS

MANOMETER

*SUGGESTED (INTERFERENCE FREE)
PITOT TUBE - THERMOCOUPLE SPACING

FEDERAL REGISTER, VOL. 42, NO. 160—THURSDAY, AUGUST 18, 1977.

FIGURE 5.2 PITOT-MANOMETER ASSEMBLY

be insignificant and therefore the basket scale was utilized for the sake of convenience (See Test Log).

R E F E R E N C E S

¹Alternative Test Method for Direct Measurement of Total Gaseous Organic Compounds Using a Flame Ionization Analyzer, Emission Measurement Branch, EPA, June 6, 1978.

²Correspondence from Robert B. Denyszyn, Scott Environmental Technology, to R. F. Jongleux (TRW), April 6, 1979.

APPENDIX A

EXAMPLE CALCULATIONS

EQUATION A.1 - CARTRIDGE FILTER LOSSES

NOMENCLATURE

X = throughput on 1st Filter (as pounds of clothes)
Y = throughput on 2nd filter (as pounds of clothes)
A = weight of un-dried 2nd filter (in pounds)
B = weight of dry 1st filter (in pounds)
B₁ = weight of dry 2nd filter (in pounds)
C = weight of new filter (in pounds)
L = loss of perchloroethylene attributed to a cartridge filter
L_T = total perchloroethylene losses attributed to normal filter change

EXPLANATION AND RATIONALE:

In order to determine perchloroethylene losses from cartridge filters at this plant, the initial plan called for removing one bank (four (4) cartridges) before the mass balance test and replacing the expended cartridges with new ones. These filters were to be drained for a minimum of 24 hours. Weight (wet) was to be determined for one of the expended filters immediately and again after the filter was dried to a constant weight.

All four filters showed a wet weight of 52.5 pounds on Monday, March 26th. On Tuesday, March 27 it was discovered that capacity of scale used, had been exceeded. Therefore an alternate procedure was necessary. The reformulated plan called for removing and weighing another used cartridge from the second filter bank after the mass balance test. The weight (wet) was determined to be 92.0 pounds. This filter was then returned to the filter bank because it had not been fully expended. Therefore a method to correlate the two filters had to be derived. This can be accomplished by assuming that each pound of clothes cleaned deposits the same weight of dirt on a cartridge and the weight of each new cartridge is equivalent. The following derivation utilizes these assumptions. Note that the throughput between each change of four (4) cartridges is actually the throughput

for two (2) tubes of four (4) cartridges each. Plant records showed approximate throughput between changes of either tube to be 12,000 pounds. Therefore 6,000 pounds throughput was used for four (4) cartridges changed for the test. (Note: 6,000 pounds throughput is also the manufacturer's suggested filter life).

DERIVATION:

$B-C$ = dirt in 1st filter (in pounds)

$$\frac{B-C}{X} = \frac{\text{dirt (lbs)}}{\text{throughput 1st filter (lbs)}}$$

$$\frac{B_1-C}{Y} = \frac{\text{dirt (lbs)}}{\text{throughput 2nd filter (lbs)}}$$

$$\frac{B-C}{X} = \frac{B_1 - C}{Y}$$

Solving For

$$B_1 = \frac{Y}{X} (B-C) + C$$

"PERC"

$$\text{2nd Filter} = A - B_1$$

Substituting

$$A - \frac{Y}{X} (B-C) + C = \begin{matrix} \text{"PERC"} \\ \text{(2nd Filter)} \end{matrix}$$

$$L = \frac{A - B_1}{Y}$$

EXPLANATION:

The total loss attributed to cartridge filters change is equal to $X \ 4$, since there were four (4) filters in a bank. The loss is commonly expressed in units of pounds loss per hundred (100) pounds (lbs) throughput. Therefore:

$$L_T = \frac{A - B_1}{Y} (4) (100)$$

$$L_T = 2.74 \text{ lbs/100 lbs throughput} \quad (\text{TABLE 2.1})$$

EQUATION A 2 - AVERAGE STACK GAS VELOCITY

$$v_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}}$$

EQUATION A 3 - AVERAGE STACK GAS VOLUMETRIC FLOWRATE

$$Q_{sd} = 3,600 (V_s) A \left(\frac{T_{std}}{T_{s(avg)}} \right) \left(\frac{P_s}{P_{std}} \right)$$

NOMENCLATURE

A = Cross-sectional area of stack, m² (ft²).

C_p = Pitot tube coefficient, dimensionless

K_p = Pitot tube constant,

$$34.97 \frac{m}{sec} \left[\frac{(g/g-mole)(mm Hg)}{(^\circ K)(mm H_2O)} \right]^{1/2}$$

for the metric system and

$$85.49 \frac{ft}{sec} \left[\frac{(lb/lb-mole)(in. Hg)}{(^\circ R)(in. H_2O)} \right]^{1/2}$$

for the English system.

M_d = Molecular weight of stack gas, dry basis,
g/g-mole (lb/lb-mole)

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

$$= M_d(1 - B_{ws}) + 18.0 B_{ws}$$

P_{bar} = Barometric pressure at measurement site,
mm Hg (in. Hg)

NOMENCLATURE (cont'd)

P_g = Stack static pressure, mm Hg (in. Hg)

P_s = Absolute stack gas pressure, mm Hg (in. Hg)

$$= P_{\text{bar}} + P_g$$

P_{std} = Standard absolute pressure 760 mm Hg
(29.92 in. Hg)

Q_{std} = Dry volumetric stack gas flowrate corrected to
standard conditions, dscm/hr (dscf/hr)

t_s = Stack temperature, $^{\circ}\text{C}$ ($^{\circ}\text{F}$)

T_s = Absolute stack temperature, $^{\circ}\text{K}$ ($^{\circ}\text{R}$)

$$= 273 + t_s \text{ for metric}$$

$$= 460 + t_s \text{ for English}$$

T_{std} = Standard absolute temperature, 293 $^{\circ}\text{K}$ (528 $^{\circ}\text{R}$)

V_s = Average stack gas velocity, m/sec (ft/sec)

p = Velocity head of stack gas, mm H_2O (in. H_2O)

3,600 = Conversion factor, sec/hr

EQUATION 4.1 - VOLUME TO MASS CONVERSION

$$\frac{(1000) (MW) (PPM)}{(24.5)}$$

WHERE:

MW = Molecular weight of perchloroethylene

PPM = Parts per million by volume

24.5 = Conversion Factor (Ideal gas law @ STP)

1,000 = Conversion Factor (grams to milligrams)

EQUATION 4.2

$$Q_{STD} * C_M = E_R$$

EQUATION 4.3

$$\frac{(E_R) \times D}{1,000} = E_A \text{ or } E_L$$

EQUATION 4.4

$$(E_A + E_P) L_D = E_T$$

WHERE:

C_M = Concentration mass in milligrams per cubic meter (mg/m³) (Equation 4.1)

D = duration of cycle in minutes

for aeration cycle (2.14) minutes

for loading cycle (5.15) minutes

E_A = average emissions during aeration cycle

E_R = emission rate (Equation 4.2) in mg/min

E_L = average emission during loading cycle

EQUATION 4.4 (cont'd)

E_T = total atmospheric emissions (daily)
in grams

L_D = loads per day (from Table 3.2)

APPENDIX B
FIELD & LABORATORY DATA

DATE	TIME	CARTRIDGE FILTER WEIGHT	
		(Kg)	(LBS)
April 6, 1979	1000	30.8	68.0
April 9, 1979	0845	29.4	64.8
April 10, 1979	1545	24.2	53.2
April 12, 1979	0945	23.6	52.0
April 13, 1979	1335	23.4	51.5
April 18, 1979	0830	23.0	50.7
April 19, 1979	1645	22.8	50.2
April 20, 1979	1000	22.8	50.2
		23.2* (NET FINAL)	(51.2 lb*)

*-SCALE CORRECTION FACTOR APPLIED

TABLE B-1 - CARTRIDGE FILTER LOSS (RAW DATA)

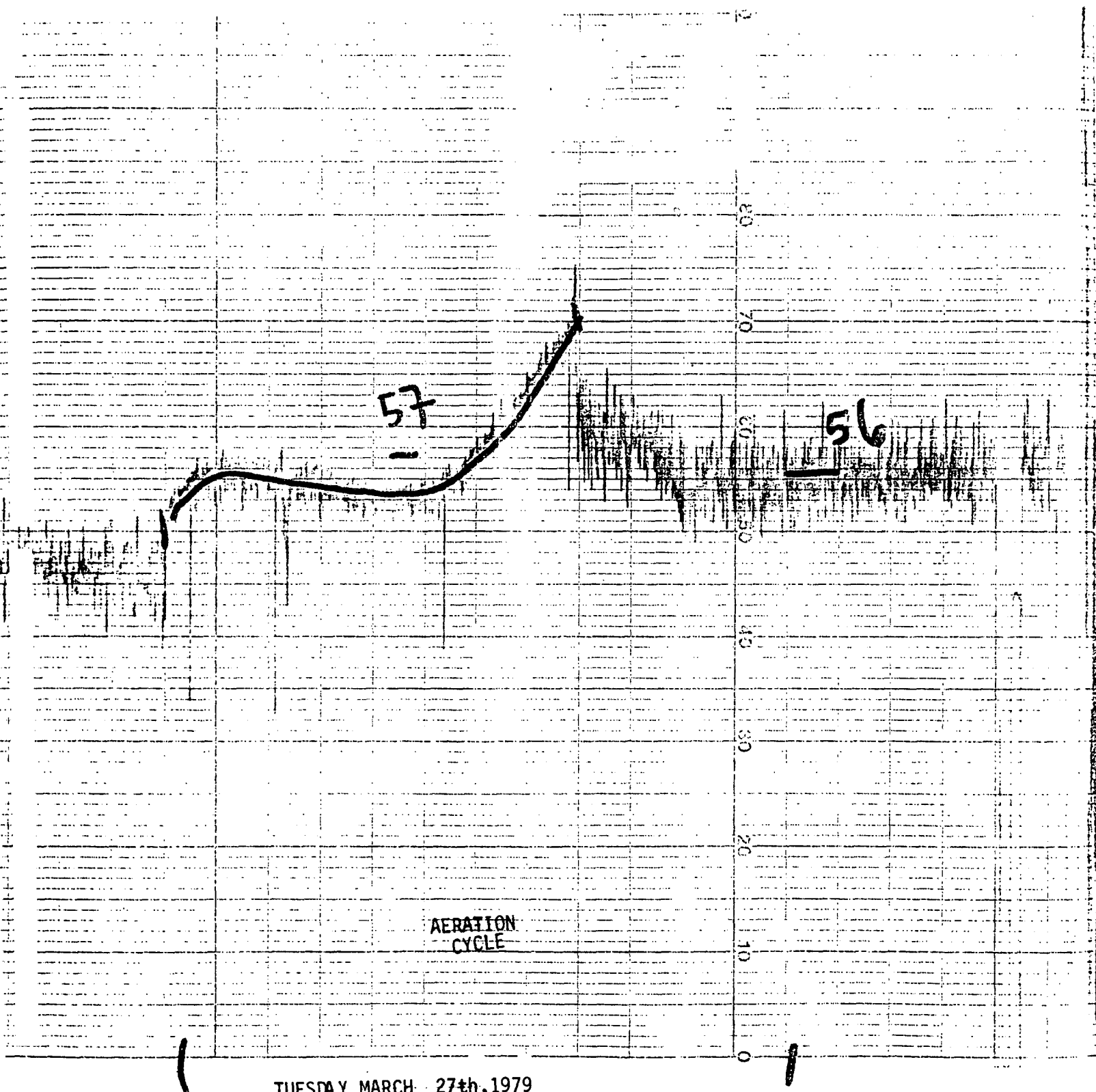
DATE	LOCATION	ΔP	$\sqrt{\Delta P}$	Ts (°F)	Ts (°R)	Pg ("H ₂ O)	Ps ("H ₂ O)	Vs	Q _{STD}		
		AVG.	AVG.	AVG.	AVG.	AVG.	AVG.	(ft/sec)	(scf/hr)	(scf/min)	(scm/min)
3/26/79	INLET	.038	.195	77	537	-.92	29.102	11.342	30,656.9	510.9	14.47
	INLET (AERATION)	.053	.230	120	580	-.92	29.102	13.897	34,811.6	580.2	16.43
	INLET (PURGE)	.049	.221	107	567	-.74	29.116	13.206	33,806.9	563.4	15.95
3/27/79	INLET (A)	.042	.205	116	576	-.92	29.392	12.288	31,456.9	524.3	14.85
	INLET (P)	.051	.226	118	578	-.74	29.406	13.567	34,409.7	573.5	16.24
3/28/79	INLET (A)	.022	.148	117	577	-.92	29.592	16.009	40,940.6	682.3	19.32
	INLET (P)	.042	.205	100	560	-.74	29.606	12.072	31,849.2	530.8	15.03
3/29/79	INLET (A)	.029	.170	116	576	-.92	29.522	10.168	26,007.2	433.5	12.28
	INLET (P)	.036	.190	116	576	-.74	29.536	11.361	29,058.6	484.3	13.72
3/26/79	OUTLET (A)	.017	.130	90	550	+.06	29.174	7.646	20,263.6	337.7	9.56
	OUTLET (P)	.015	.122	90	550	+.07	29.175	7.176	18,961.7	216.0	8.95
3/27/79	OUTLET (A)	.010	.100	88	548	+.06	29.464	5.840	15,671.1	261.2	7.40
	OUTLET (P)	.020	.141	95	555	+.07	29.465	8.286	21,934.8	365.6	10.35
3/28/79	OUTLET (A)	.008	.089	97	557	+.06	29.664	5.222	13,864.1	231.1	6.54
	OUTLET (P)	.015	.122	91	551	+.07	29.665	7.120	19,102.5	318.4	9.02
3/29/79	OUTLET (A)	.019	.137	95	555	+.06	29.594	8.033	21,351.4	335.9	10.08
	OUTLET (P)	.026	.161	94	554	+.07	29.595	9.432	25,122.6	418.7	11.86

TABLE:B-2 VOLUMETRIC FLOWRATE DATA

	MONDAY 3/26/79	TUESDAY 3/27/79	WEDNESDAY 3/28/79	THURSDAY 3/28/79	FRIDAY 3/30/79
BAROMETRIC PRESSURE ("Hg.) ¹	29.44	29.17	29.46	29.665	29.59
RELATIVE HUMIDITY (%)	65	77	74	71	51

¹Station Pressure - U.S. Weather Station, Syracuse, New York.

TABLE: B-3 WEATHER DATA



TUESDAY MARCH 27th, 1979

KLEEN KORNOR

CORTLAND, NEW YORK

TIME: APPROXIMATELY 11:00 a.m.

Scale - 0-100 ppm

Chart Speed - 1 cm/min

Instrument - Beckman 402

FIGURE B-1 - EXAMPLE CARBON BED BREAKTHROUGH

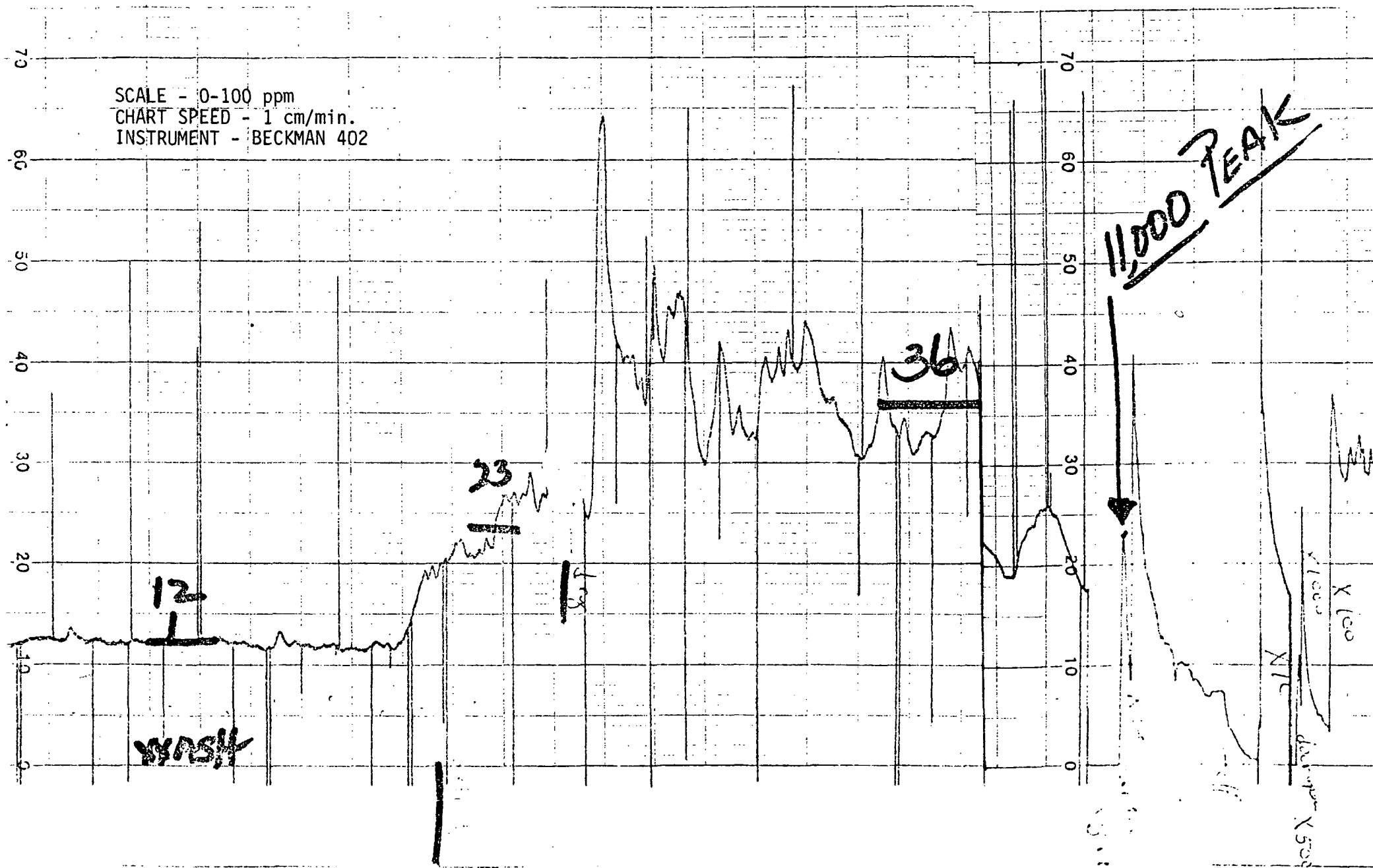


FIGURE B-2 - EXAMPLE INLET CONCENTRATION DURING DRYCLEANING CYCLE

INTRODUCTION: ADDITIONAL LABORATORY TESTING

The purpose of the laboratory testing was to investigate the applicability of the candidate instruments to detect perchloroethylene (C₂Cl₄) within the range of acceptable concentrations. Initially the parameters sought were that of minimum detectability and response time. After field observations, it was decided to investigate further the parameters of temperature and moisture response. The candidate instruments chosen under the initial phase of this program are listed in Table B-4. A cost prohibitive instrument (~\$4,000), an OVA-128 portable hydrocarbon analyzer, manufactured by Century Systems, was also utilized during the laboratory testing for informational purposes only.

<u>MANUFACTOR</u>	<u>COST (APPROXIMATE)</u>	<u>MODEL</u>
● TIF-HALOGEN LEAK DETECTOR	\$ 75.00	#HLD-440
● COOK MFG. - (METER-ALL)	125.00	#423-100
● BACHARACH INSTRUMENT - (TLV - SNIFFER)	500.00	#0023-7350

TABLE B-4 - CANDIDATE INSTRUMENTS - LABORATORY TESTING

TEST PROCEDURE AND DISCUSSION

A.) Sensitivity Response to Perchloroethylene

The candidate instruments were tested for their response to perchloroethylene (C_2Cl_4). The apparatus used is illustrated in Figure B-3. The basic apparatus consists of two bellows pumps connected in line to a manifold. The candidate instruments and a continuous hydrocarbon analyzer withdrew samples from the manifold. In all cases, the concentrations introduced to the instruments were assumed equivalent. The continuous hydrocarbon analyzer utilized to measure the perchloroethylene concentrations was a Beckman 402, which operates on the principle of hydrogen flame ionization. A matched voltage output strip chart recorder provided a hard-copy record of the flame ionization detector. Field testing demonstrated the general applicability of the Beckman instrument to measure perchloroethylene in air concentrations. The Beckman 402, therefore, was utilized to quantify all perchloroethylene concentrations during the laboratory testing.

The candidate instruments were zeroed in the manifold with ambient air (introduced with Pump B). Valve "A" was opened slightly, allowing a small amount of perchloroethylene into the manifold. The candidate instruments and the continuous monitor responses were duly noted. Successive increases in concentrations were accomplished by further opening of Valve "A". The response of the instruments were manually recorded on the strip chart illustrations in Figures B-4 through B-7.

The laboratory results in Figure B-4 shows that both the Meter-A11 and TIF instruments will respond to low levels (~ 20 ppm) of perchloroethylene. The TLV-Sniffer responded downscale in three out of four trials. Therefore, it can be said that the TLV-Sniffer is inadequate for detecting perchloroethylene vapors. The Meter-A11 instrument, while sensitive to initial introduction of perchloroethylene (Figures B-4 and B-6), appears to have an inconsistent

B-9

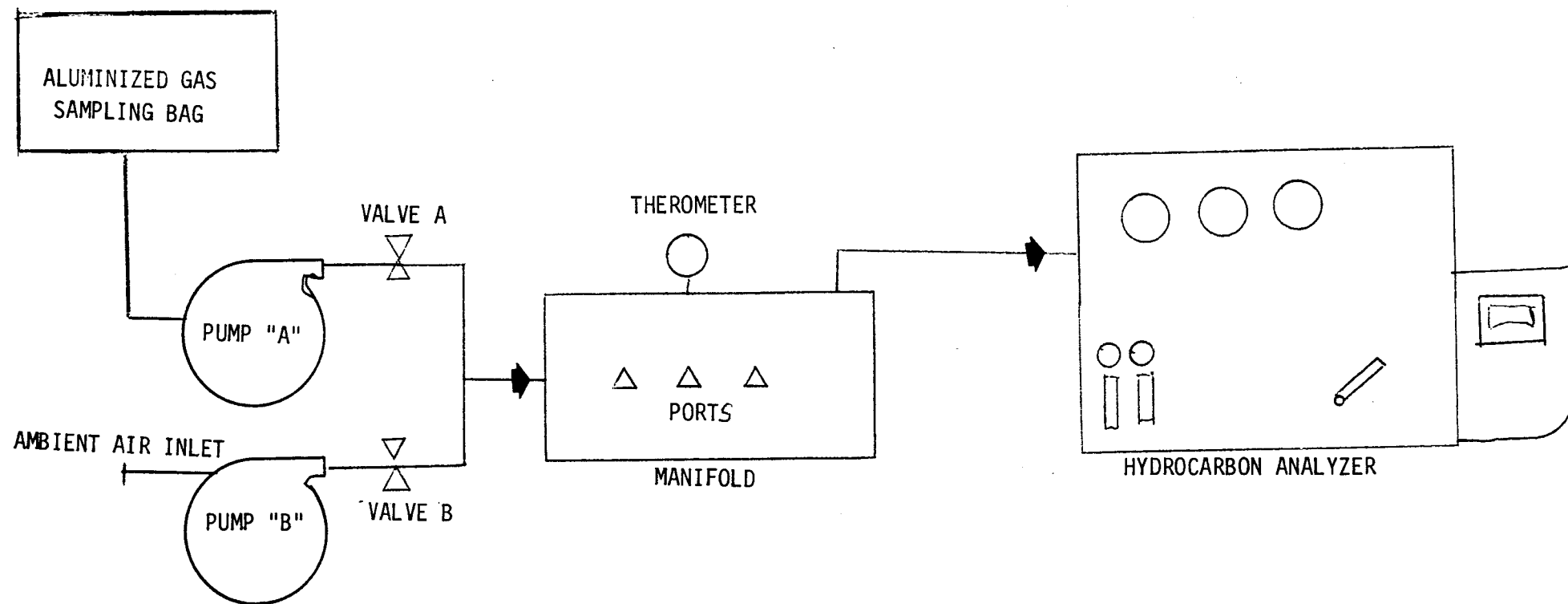
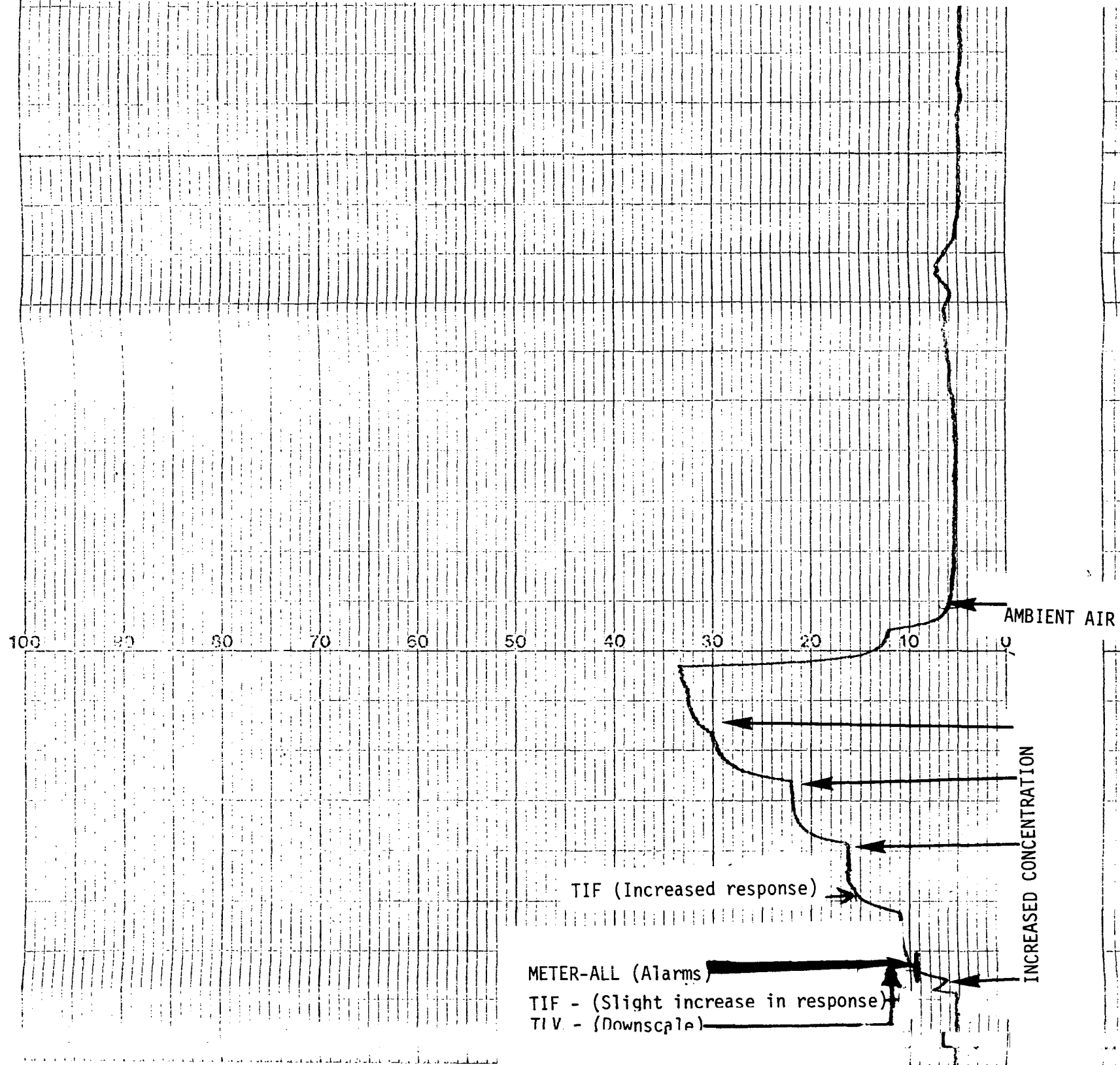


FIGURE B-3 SENSITIVITY RESPONSE APPARATUS



B-10



B-77
FIGURE B-5 SENSITIVITY TO PERCHLOROETHYLENE

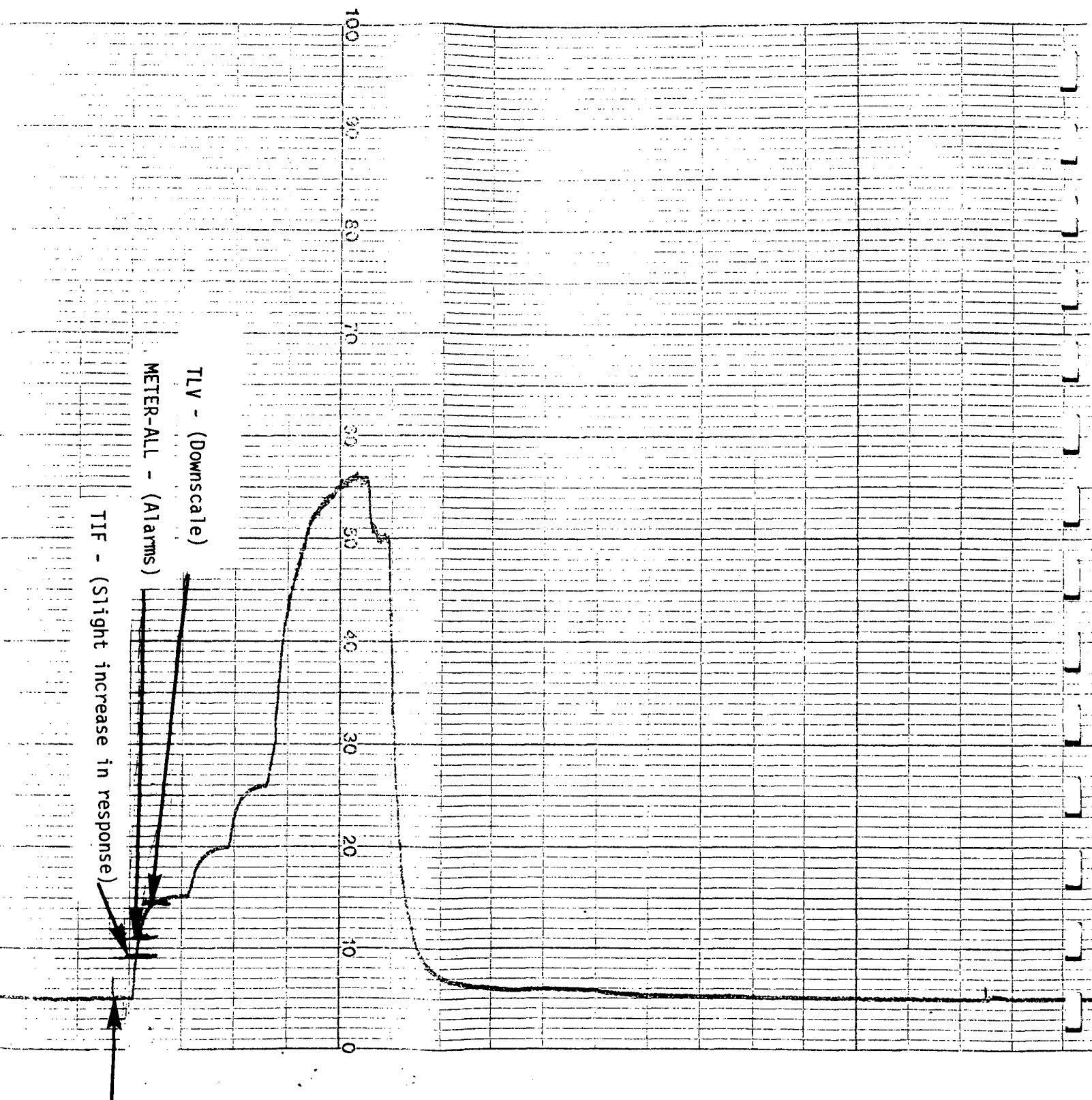


FIGURE B-6 - SENSITIVITY TO PERCHLOROETHYLENE

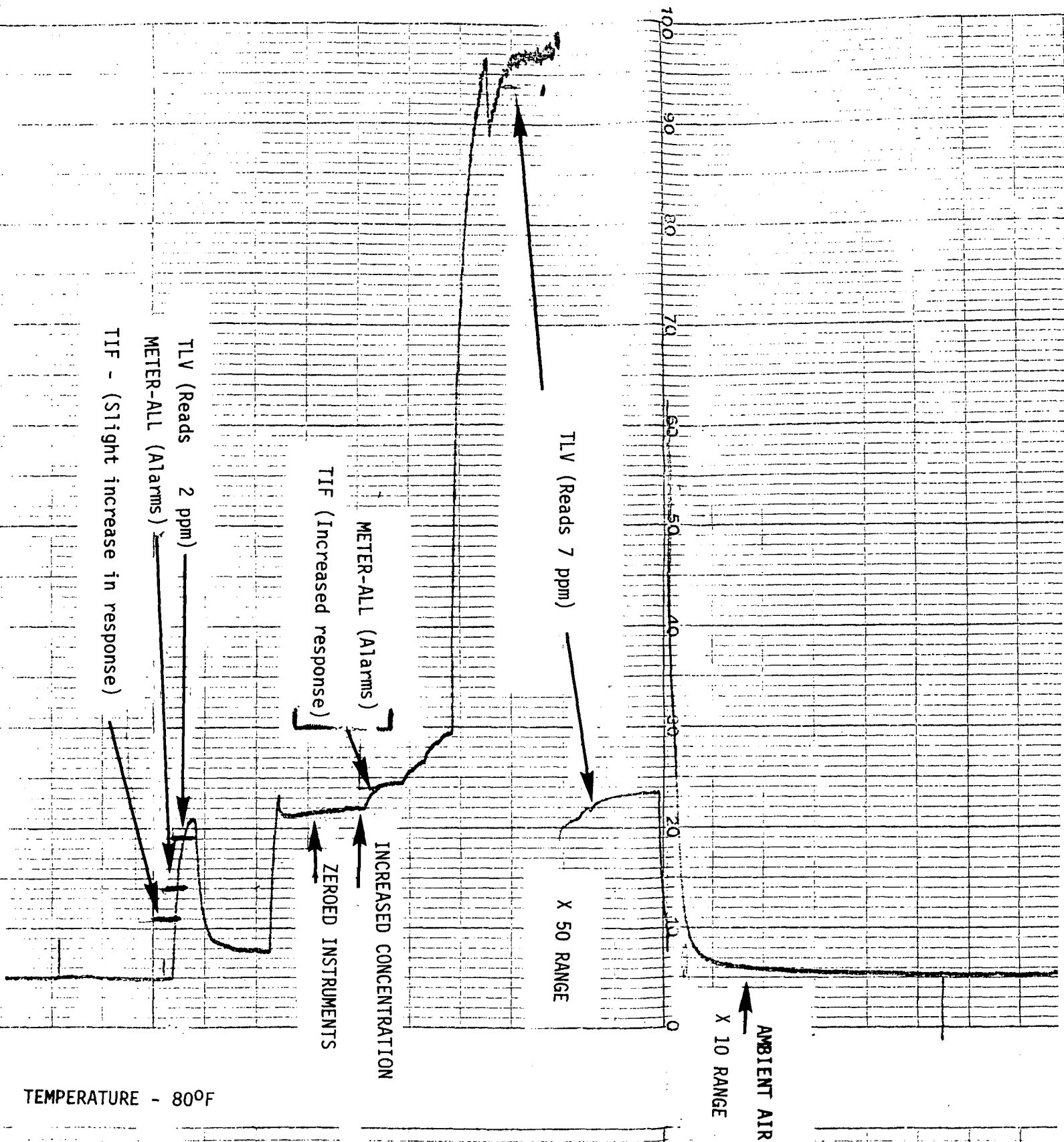


FIGURE B-7. - SENSITIVITY TO PERCHLOROETHYLENE

response to increased perchloroethylene concentrations (Figure B-4). Figure B-7 demonstrates that both the TIF and Meter-A11 instruments will respond to increased concentrations after zeroing. However, neither instrument has a very effective means for zeroing due to the crude nature of the potentiometer circuit.

B.) Temperature Response Test

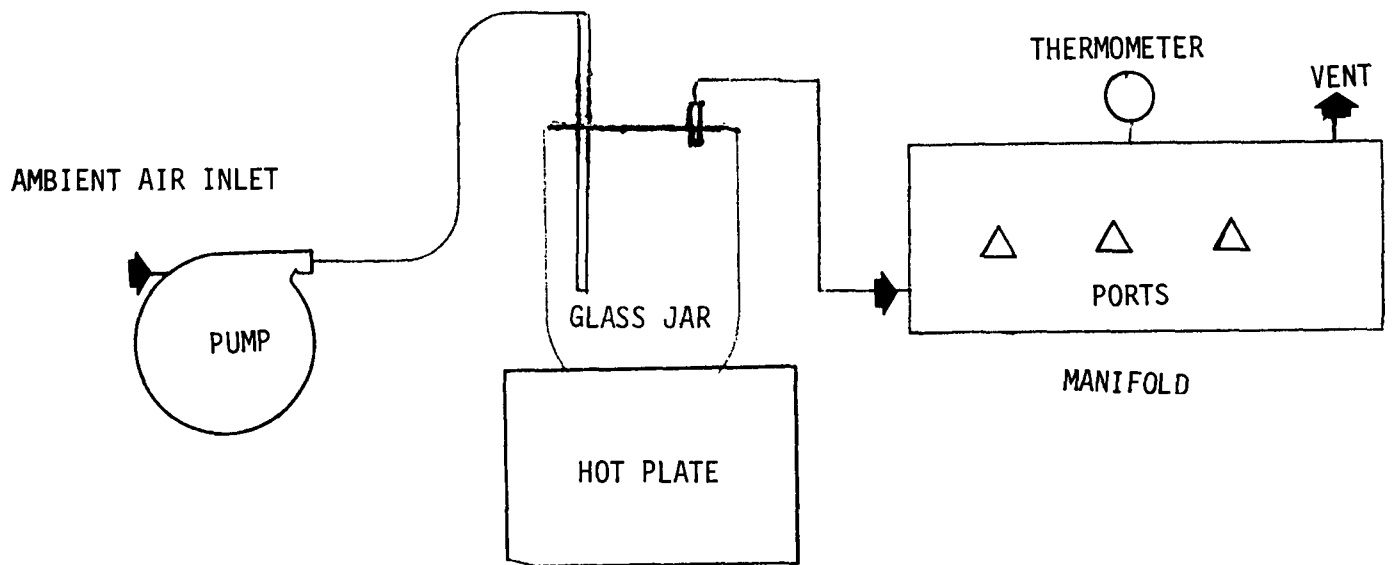
Based upon preliminary field observations, the candidate instruments were further evaluated for their response to temperature changes. Figure B-8 is generalized schematic of the testing apparatus. The sensor of the candidate instruments were inserted into the manifold and zeroed. The air in the manifold was drawn pass the sensors at 23°C (74°F). The TIF-HLD440 and the Bacharach TLV Sniffer and no response to a 8-10°F temperature rise. The Meter-A11 #423-100 instrument alarmed with a half a degree (.5°F) increase in temperature. In order to qualify further the temperature response of the instruments, a second method was used. The instruments were zeroed in calm ambient air 23°C (74°F) and inserted into a beaker (Figure B-8). Again the Meter-A11 #423-100 alarmed. The TIF #HLD440 emitted a slight increase in signal, while the Bacharach TLV-Sniffer had no response. The temperature during this experiment was recorded as 57°C (135°F).

C.) Calm Air Test

In this case, instruments were zeroed in calm air at a temperature of 23°C (74°F), and inserted into the manifold. Unheated air is then pumped through the manifold. The Meter-A11 #423-100 alarmed, while both the TIF and Bacharach TLV-Sniffer had no response.

D.) Water Vapor Test

The apparatus for this test is highlighted in Figure B-9. The basic idea of the apparatus was to saturate air and introduce the air to the manifold at room temperatures. For this experiment the instruments were zeroed in the manifold. Conditions during zeroing were 23°C (74°F) and relative humidity of



TEMPERATURE RESPONSE APPARATUS (FLOWING)

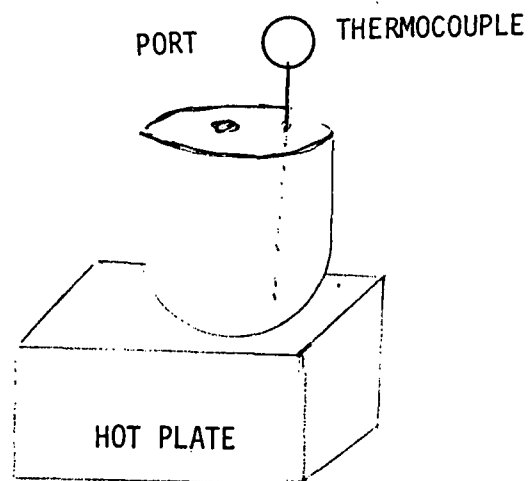


FIGURE B-8. TEMPERATURE RESPONSE APPARATUS (CALM AIR)

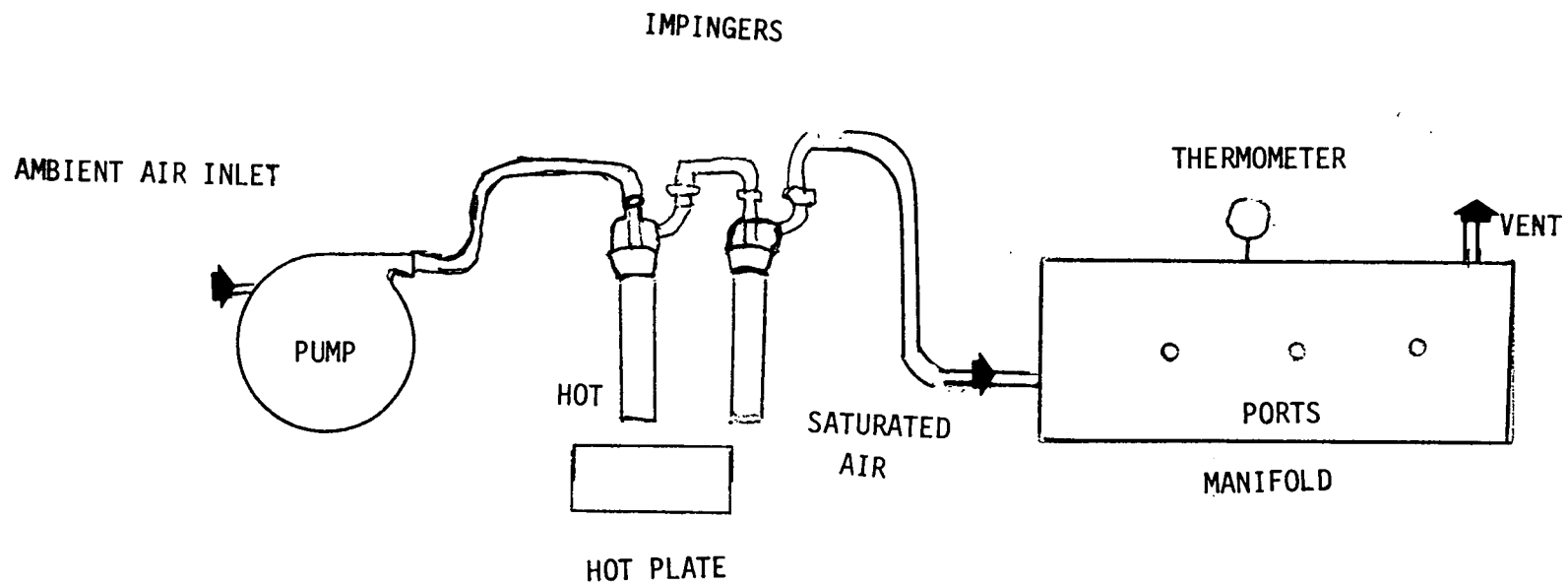


FIGURE B-9. WATER VAPOR TEST APPARATUS

42%. The moisture content in the manifold was increased to a relative humidity of 100%. This is a rise of 1.06% in absolute water content.

All three instruments responded to the increase in moisture. The Meter-All #423-100 and TIF HLD-440 alarmed, while the Bacharach TLV-Sniffer showed a slow upscale response.

APPENDIX C

GAS STANDARD CERTIFICATION

SCOTT ENVIRONMENTAL TECHNOLOGY, INC.



Scott Environmental Technology Inc.

Plumsteadville, PA 18949
(215) 766-8861

Madison Heights, MI 48071
(313) 544-0625

San Bernardino, CA 92411
(714) 887-2571

SPECIALTY GAS DIVISION

TRW

Attn: Bob Jangleau
800 Follin Lane
Vienna, VA 22180

Date: April 10, 1979

Our Project No.: 306601

Your P.O. No.: H 08503

Gentlemen:

Thank you for choosing Scott for your Specialty Gas needs. The analyses for the gases ordered, as reported by our laboratory, are listed below. Results are in volume percent, unless otherwise indicated.

ANALYTICAL REPORT

Cyl. No. C-1414 Analytical Accuracy ±2%
Component Concentration

TETRACHLORO ETHYLENE 45.7 ppm

AIR BALANCE

Cyl. No. C-1682 Analytical Accuracy ±2%
Component Concentration

TETRACHLORO ETHYLENE 92.8 ppm

AIR BALANCE

Cyl. No. C-1560 Analytical Accuracy ±2%
Component Concentration

TETRACHLORO ETHYLENE 473 ppm

AIR BALANCE

Cyl. No. _____ Analytical Accuracy _____
Component Concentration

Analyst

FRANCIS NEVILL

Approved By

ROBERT DENYSZYN

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

ACUBLEND® ■ CALIBRATION & SPECIALTY GAS MIXTURES ■ PURE GASES
ACCESSORY PRODUCTS ■ CUSTOM ANALYTICAL SERVICES

APPENDIX D

PROJECT PARTICIPANTS

MR. KEN CONSTANTINE (TRW).....TEST TEAM MEMBER

MR. DEXTER YOUNG (TRW).....PROCESS MONITOR

MR. STEVEN LUTZ (TRW).....STANDARD TASK MANAGER

MR. CHUCK KLEEBERG (EPA).....CPB PROJECT OFFICER

MR. FRANK CLAY (EPA).....EMB TECHNICAL MANAGER

MR. BOB JONGLEUX (TRW).....FIELD TEST COORDINATOR

MR. BUD AMES (KLEEN KORNOR).....PLANT OWNER & CONTACT

APPENDIX E
FIELD LOG (NOTES)

INITIAL WEIGHT OF CARTRIDGE.

Total
52.5 lb.
52.5 ~~32.5~~ lb.

Box	New Filter
3 lb.	35.5 lb.
3 lb.	35.75
3 lb.	35.5
3 lb.	

SOLVENT TANK.

52.5 lb.

BASE TANK.

6 in level

52.5

7.3 gal/in

w/ Cartridge filled w/ solvent
clean solvent tank = always full

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: _____ DATE: _____

DATE # WEIGHT OF LOAD TARE

3/26 1 first load is rags used to clean up solvent during filter change

2 ^{front of} 23.5 - 2 = 21.5
19.0 - 2 = 17.0
38.5

→ General cleaning
} - this load was weighed on the scale at front of store. Scales at machine indicate 39.7 - We'll use scale at machine

3 ^{front of} 14.75 - 2 = 12.75
25.75 - 2 = 23.75
36.5

} 37.5 at machine / Industrial dry cleaning

~~4~~

9:38 10:17

DATE Load # Time IN - Time OUT
3/26 (39) 4 ~~9:38~~ 10:23 11:01

WEIGHT of Load Type Clothes
22.5 - 2 = 20.5 } General
18.5 - 2 = 16.5 } 38 at machine
37.0

(38) 5 ~~10:23~~ 11:07 11:45

23.5 - 2 = 21.5 } General
17.5 - 2 = 15.5 } 38 at machine
37.0

(39) 6 11:50 12:29

23.0 - 2 = 21 } General
33.0 - 2 = 31 } 55 at machine
52

(33) 7 12:34 1:12

29.0 - 2 = 27 } General
18.0 - 2 = 16 } 45 at machine
43

3/20/79

CM 8.5 lbs - filter - 52.5 lbs
wet filter at 100.5 lbs - GROSS - 600 lbs/mileage -

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: E-3 DATE: _____

Dx Load In Out Weight

3/26 (39) 8 1:18 1:57 23 - 2 = 21
 25.5 - 2 = 23.5
 44.5 } w weight at machine

(33) 9 2:03 2:36 17 - 2 = 15
 15.5 - 2 = 13.5
 28.5 } 29 weight at machine

Total for day 280 lbs - not including rags

General Comments (3/26/79)

Inlet Cl_2 concentrations vary widely & inlet highest concentration during aeration cycle.

difficult determining span concentration and

span multipliers

* non linear response.

Calibration (T. Hunt) → scale multiplier from Beckman manual.

over full range sitting on 7ppm millivolt.

① Extensional detector - set 92 ppm Cl_2 & 45 ppm Cl_2 span.

on high comp. (10x10) (250 full scale)

② mtd no high Cl_2 standards.

③ take large samples inlet & outlet.

④ stability of Cl_2 standards.

⑤ response of Cl_2 to F.T.D.

⑥ Check Beckman 402 w/ recorder for signal irregularity of A.T.D.

⑦ Weigh F.T.C. cartridge after complete dryness.

⑧ Evaporation Loss Test: OK - 6 in basket (RUN THROUGHT)

3/27/79.

L.D. (HID METER ALL - TLY-SNIFFER) → LOWER READING } DUCT REMOVED.
 402-F.T.D. - HIGHER

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: E-4 _____ DATE: _____

DATE	LOAD	Time In	Time Out	Weight	Type
3/27(36)	1	6:54	7:30	$23.5 - 2 = 21.5$ $20.5 - 2 = 18.5$ 40.0	Industrial

Weights will be taken at machine with 1.5 lbs subtracted off to allow for the difference between scales

This is based on the average difference in weights taken 3/26. Also, scales at front & store have been recently checked.

	2			$42 - 1.5 = 40.5$	General
	3		9:00	40	General
(37)	4	9:07	9:44	37.5 - 1.5 = 36 $40 - 1.5 = 38.5$	General
(41)	5	9:49	10:30	$40 - 1.5 = 38.5$	Industrial
(38)	6	10:39	11:17	$40 - 1.5 = 38.5$	Light Industrial
(39)	7	11:23	12:02	$37 - 1.5 = 35.5$	Industrial
	8	12:08		$25 - 1.5 = 23.5$	General
(31)	9	12:36	1:07	$25 - 1.5 = 23.5$	Clean only
(31)	10	1:10	1:41	40 $40 - 1.5 = 38.5$	General

357

recovered 1.666 gallons per car

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: E-5 _____ DATE: _____

<u>Date</u>	<u>LOAD</u>	<u>TIME IN</u>	<u>TIME OUT</u>	<u>WEIGHT</u>	<u>Type</u>
3/28 (30)	1	6:45	~7:15	40-1.5=38.5	General
sight tube measured 54 $\frac{13}{16}$ " before first load					
(30)	2	7:21	7:57	40-1.5=38.5	General
(31)	3	8:00	8:31	35-1.5=33.5	General
(36)	4	8:35	9:11	40-1.5=38.5	General
(33)	5	9:17	9:50	40-1.5=38.5	General
(27)	6	10:01	10:28	40-1.5=38.5	General
(23)	7	10:34	11:11	40-1.5=38.5	General
	8		11:50	40-1.5=38.5	Industrial
	9			40-1.5=38.5	Industrial
	10			40-1.5=38.5	General
	11		1:54	40-1.5=38.5	troop
(38)	12	2:05	2:43	40-1.5=38.5	troop
(32)	13	2:46	3:19	40-1.5=38.5	troop
(27)	14	3:23	3:54	15-1=14	General

WITNESS:

DATE:

SIGNED

DATE E-6

DATE

DATE	LOAD	Time in	Time Out	Weight	Type
3/29	1			20 40 - 1.5 = 38.5	General
<u>DELTA (MIN)</u>					
(31)	2	7:15	7:44	40 - 1.5 = 38.5	General
(43)	3	7:51	8:34	40 - 1.5 = 38.5	General
(42)	4	8:40	9:11 9:22	40 - 1.5 = 38.5	General
(37)	5	9:31	10:08	40 - 1.5 = 38.5	General
(38)	6	10:15	10:53	40 - 1.5 = 38.5	General
(31)	7	10:59	11:20	40 - 1.5 = 38.5	General
(35)	8	11:35	12:10	40 - 1.5 = 38.5	General
	9	12:16		40 - 1.5 = 38.5	General
	10		1:29	40 - 1.5 = 38.5	
(33)	11	1:36	2:09	40 - 1.5 = 38.5	

reclaimed 2/0 oz perc

sight tube ~~5 2/16~~ 5 7/32"

Water Separator - 2500 ml

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: E-7 _____ DATE: _____

DATE	LOAD	TIME IN	TIME OUT	WEIGHT	TYPE
3-30-79	1	0700	0730	25 lbs	GEN.
	2	0725		40-1.5=38.5	GEN.

Weight of clothes after extraction

Weight	Time
45.2 lb	10:58

45.0	11:03
------	-------

44.9	11:08
------	-------

44.8	11:13
------	-------

machine in extraction - weight difficult to read due to vibration of scales →

44.4	11:18
------	-------

44.2	11:23
------	-------

44.0	11:28
------	-------

43.8	11:33
------	-------

43.7	11:38
------	-------

43.5	11:43
------	-------

43.1	11:48
------	-------

43.0	11:53
------	-------

42.9	11:58
------	-------

WITNESS: _____ DATE: _____ SIGNED: _____

WITNESS: _____ DATE: E-8 DATE: _____

3/23

pounds of clothes on first filter = $x = 11805$ from plant recordspounds of clothes on second filter = $y = 6430$ from plant recordsweight of un-dry second filter = $A = ?$ 92.0weight of dry first filter = $B = ?$ 51.237 weight of dry second filter = B_1 weight of new filter = $C = 35.5$ lb. ~~weight~~perc in first filter = ~~?~~ ?dirt in first filter = $B - C$ dirt/# clothes in first filter = $\frac{B - C}{x}$ dirt/# clothes in second filter = same = $\frac{B - C}{x} = \frac{B_1 - C}{y}$

$$\frac{B - C}{x} = \frac{B_1 - C}{y}$$

$$\text{solving for } B_1 = \frac{y}{x}(B - C) + C$$

$$\text{perc in second filter} = A - B_1 = A - \frac{y}{x}(B - C) + C$$

~~$$= A - \frac{y}{x}(B - C) + C$$~~

$$\text{log per \# of clothes} = \frac{A - B_1}{y}$$

APPENDIX F
CANDIDATE INSTRUMENT
SELECTION CRITERIA

The criteria used to select the candidate instruments involved the factors of instrument cost, and instrument availability. The goal was to find an inexpensive instrument (\$100 - \$250 range) that would provide a rapid, yet accurate check of perchloroethylene concentrations around perchloroethylene dry cleaning operations.

A review of currently available instruments was undertaken (12/78). Manufacturers, suppliers and industry spokesmen were contacted for suggestions and comments. Based upon that information three (3) candidate instruments were selected. Table F-1 tabulates the list from which the candidate instruments were chosen.

SELECTION LIST

Manufactor	Model	Cost	Disposition
TIF	440	\$125	Selected
TIF	5000	\$130	Not Listed by Manufactor
TIF	HM 290	\$250	Not Listed by Manufactor
COOK	423-1000	>\$100	Selected
SIPIN	SP 1 to 7	~\$350	Not Commercially Available (Development Stage)
JOHNSON	1565	~\$500	Too expensive (Shipment Delay-2 months)
CPO	DM 498	\$250	Not Commercially Available
	725	\$370	
BACHARACH	0023-7350	\$500	Selected (EPA loaned)
GOW-MAC	21-100	\$300	Inappropriate for Perchloroethylene