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October 7, 1992

Mr. Jim Williams
Department of the Air Force
Center for Environmental Excellence (AFCEE)
Environmental Restoration Division (ESR)
Building 624 West
Brooks AFB, Texas 78235-5000

Subject: F33615-90-4014, Order 04, Mod. 04
Bioventing In-Situ Respiration Test Report
7th Street BX Service Station

Dear Mr. Williams:

Two copies of the report presenting the results of the 1st Quarter in-situ respiration test for the bioventing system at the 7th Street BX Service Station are attached. As requested, a copy of this report is also being sent to Ms. Patricia Williamson.

Sincerely,

ENGINEERING-SCIENCE, INC.

Ola A. Awosika, P.G.
Project Manager

OAA:tdr
Attachment

cc: Patricia Williamson (Eglin AFB)
Rodney Hamel (AFCEE)

AT510\929J137

AQM01-04-0630

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Laura Peña

Telephone

210-536-1431

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Laura Peña

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RESPIRATION TEST REPORT
1ST QUARTER OF OPERATION, MAINTENANCE AND
MONITORING OF THE BIOVENTING SYSTEM AT THE
7TH STREET BX SERVICE STATION EGLIN AFB

INTRODUCTION

On September 2 and 3, 1992 an in-situ respiration test was performed at the 7th Street BX Service Station. The purpose of the respiration test is to ensure that nutrients, moisture or oxygen are not limiting biodegradation and to confirm the presence of biological activity.

Operation of the bioventing system at the 7th Street BX Service Station began in May 1992. Occasionally operation of the system has been interrupted because of power failures and recently because of concern for potential off gas emission at the site. The latter concern prompted down-sizing of the 2.5 horsepower blower used since startup of the system to a 1.0 horsepower (hp) unit.

IN-SITU RESPIRATION TEST

The bioventing system had been operating continuously with a 1 horse power (hp) blower for about one week prior to the date of this test to ensure adequate supply of oxygen into the soil at the site. Vacuum levels at the filter inlet, filter outlet, and blower outlet were also monitored to determine blower performance and flow rate prior to the respiration test. With the dilution valve open, vacuum at the air filter inlet was 4" H₂O, head loss through the filter was 12" H₂O, and pressure at the blower exhaust was 16" H₂O. The total pressure across the blower was 36" H₂O indicating the total flow into the injection trenches was approximately 50 CFM. The temperature at the filter inlet was 100°F and 110°F at the blower discharge.

A leak test was performed at each of the vapor monitoring points (VMPs) to find out if air leakage could occur at the VMPs during the respiration test. A leak was detected at the valve for VMP-1S and could not be corrected prior to the test. Therefore, the data for this well could not be used. The equipment used during the respiration test included an oxygen/carbon dioxide (O₂/CO₂) meter, a total hydrocarbon meter and a 1 scfm pump. A Gas Tech Model 3552OX O₂/CO₂ meter was used in measuring concentration of gases at each point of interest (i.e., vapor monitoring points). This equipment can measure oxygen levels which can be read from 0 to 25% and carbon dioxide levels which can be read from 0 to 25%. A

GasTech TraceTechor™ hydrocarbon analyzer was used to measure total hydrocarbon concentrations with range settings of 150 ppm, 1,000 ppm, and 10,000 ppm. Both of these equipment were calibrated daily prior to use. The O₂/CO₂ meter was calibrated using a 0% and 5% standard for O₂ and a 5% standard for CO₂. The hydrocarbon analyzer was calibrated with hexane at 4,400 ppm. The O₂/CO₂ instrument was checked against atmospheric concentration prior to taking field measurements.

Initial measurements taken on arrival at the site indicated oxygen levels from 5.4% and 6.5% at the deep vapor monitoring points VMP-1D and VMP-2D, respectively and at 0.5% and 10% at the shallow vapor monitoring points VMP-1S and VMP-2S, respectively. Notably, up to 20% oxygen had been measured at the deep VMPs during use of the 2.5 hp blower over the first two months of system operation. This apparent decrease in oxygen levels at the vapor monitoring points can be attributed to the reduced air flow from the new 1 hp blower currently being used.

TEST RESULTS

At exactly 1330 hours on September 2, 1991 the system was shutdown to begin the respiration test. The first set of readings were taken 1 hour after shutdown. The readings indicated oxygen levels dropped more than 2% at the VMPs. (See attached data tables.) In particular oxygen level measurement was 0% at VMP-2S. A second set of readings, taken 2 hours after shutdown indicate less than 1% drop in oxygen levels. Approximately 4 hours into the test, the following oxygen levels were measured: 0% at VMP-2D and approximately 2% at VMP-1D. About 30 hours into the respiration test oxygen levels in VMP-1D was at 0.2%. The respiratory test data is presented in the attached data sheets. Data collected are also presented graphically in attached figures. Carbon dioxide levels increased up to about 11% at both deep VMPs and at VMP-2S at the end of the respiration test and appeared to have complemented oxygen readings throughout the test. Total hydrocarbon levels measured during the respiration test are also included in the attached data sheets.

Oxygen utilization rates were calculated as the percent change in O₂ over time (slope of O₂ vs. time). The slope of the curve from data collected was based on the entire length of time of the test data or to a point where O₂ level practically was non-existent (zero). Using data obtained from VMP-1D and VMP-2D, rates of oxygen utilization varied from 0.28 to 1.35% oxygen per hour. The rate of fuel biodegradation was estimated using the equation:

$$K_b = K_o A D_o C/100$$

Where:

K_b = Fuel biodegradation rate (mg/kg/day)

K_o = Oxygen utilization rate (% per day) (6.72 to 32.4)

- A = Volume of air/kg of soil (L/kg) (estimated at 0.21 L/kg soil)
- D_o = Density of oxygen (mg/L) (1330 mg/L)
- C = Mass ratio of hydrocarbon to oxygen for mineralization (1:3.5)

Solving:

$$K_b = 5.36 \text{ to } 25.85 \text{ mg/kg/day}$$

In May 1992, at startup of operation of the system, the fuel biodegradation rate was estimated at 2.9 to 5.3 mg/kg/day, therefore, current fuel biodegradation rates are indicative of significant increase in bioactivity since start up of the bioventing system at the 7th Street BX Service Station and suggest that a more active bacterial population has been reestablished. In addition, this increase could also be attributed to increase in air temperature from 99°F at start up to 110°F currently at the blower discharge. These results also suggest the 1 hp blower is providing adequate oxygen supply to support operation of the bioventing system. A second respiration test is scheduled for late November 1992 and will be used to confirm these results and to verify long term respiration rates at the site.

**IN-SITU RESPIRATION TEST - 1ST QUARTER
DETERMINATION OF FUEL BIODEGRADATION RATE - K_b**

$$K_b = K_o A D_o R \times 1/100 \times 1440 \text{ min/day} \quad (1)$$

or $K_b = K_o A D_o C/100 \quad (2)$

where:

K_b = Fuel Biodegradation Rate (mg/kg/day)

K_o = (Oxygen Utilization Rate) % per day

A = 0.21 liter/kilograms of soil (L/kg)

D_o = 1330 milligrams/liter (mg/L)

C = 1:3.5

Using Eq. (2)

For VMP-1D $K_o = 6.72\%$ per day

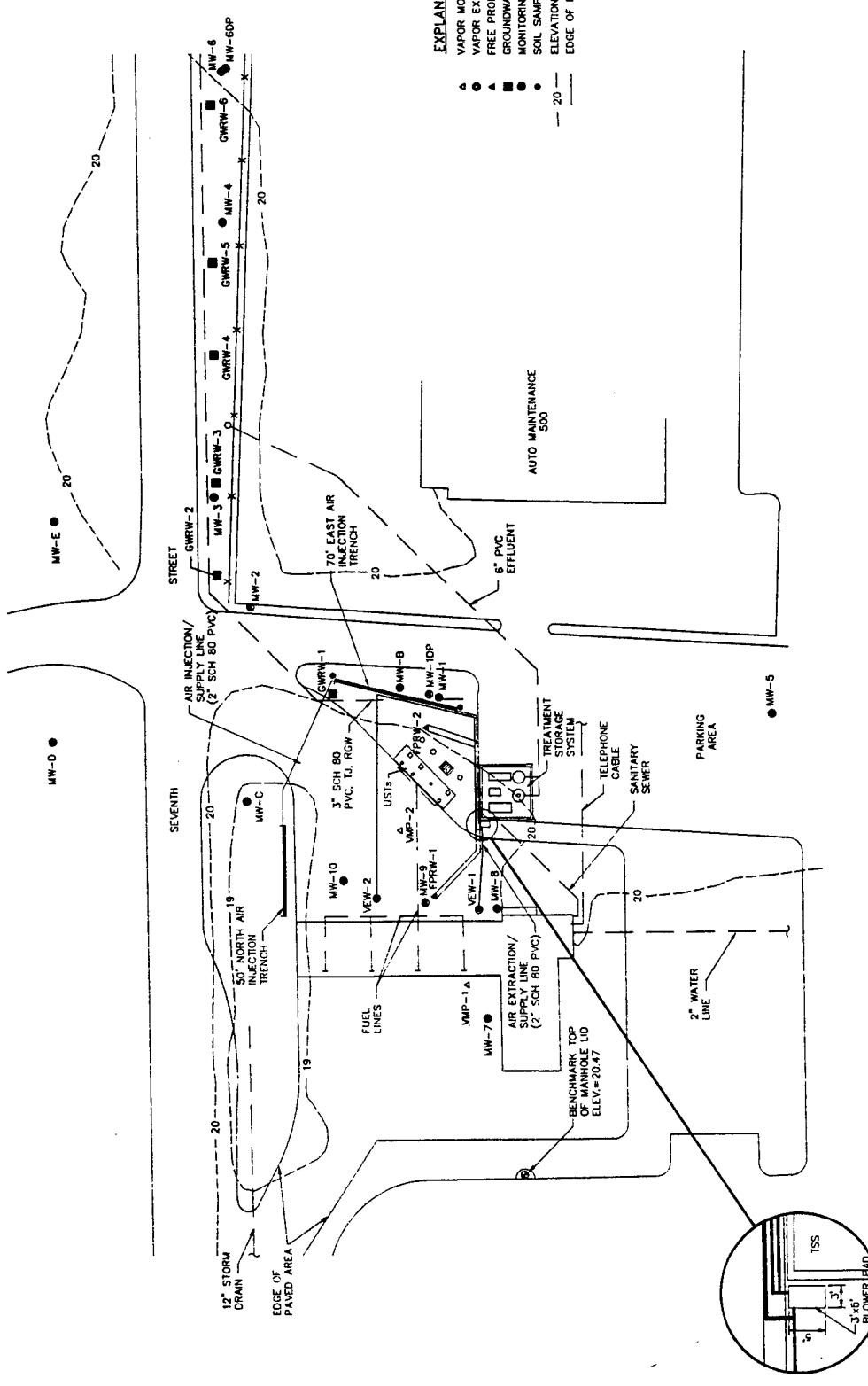
$$K_b = 6.72 \text{ %/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 5.36 \text{ (mg/kg/day)}$$

For VMP-2S Data is not suitable for K_b determination

for VMP-2D $K_o = 32.4\%$ per day

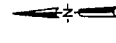
$$K_b = 32.4 \text{ %/day} \times 0.21 \text{ L/kg} \times 1330 \text{ mg/L} \times 1/3.5 \times 0.01 = 25.8S \text{ (mg/kg/day)}$$

ATTACHMENT



EXPLANATION

- ▲ VAPOR MONITORING POINT (VMP)
- ▲ VAPOR EXTRACTION WELL (VEW)
- ▲ FREE PRODUCT RECOVERY WELL (FPRW)
- ▲ GROUNDWATER RECOVERY WELL (GWRW)
- MONITORING WELL (MW)
- SOIL SAMPLING LOCATION
- ELEVATION CONTOUR LINE
- 20 — EDGE OF PAVED AREA



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CONSTRUCTION PURPOSES

NO.	DATE	REVISIONS	PROJECT NO.	ALR10		ENGINEERING-SCIENCE <small>INCORPORATING THE BEST OF SCIENCE AND TECHNOLOGY</small>	EGLIN AFB 7th STREET BX SERVICE STATION FLORIDA	BIOVENTING SYSTEM INSTALLATION PLAN	SCALE	1" = 60'	
1	6/9/92	REVISION							SHEET NO.		
0	4/1/92	DRAFT								FILE NO.	STEMAP.DWG

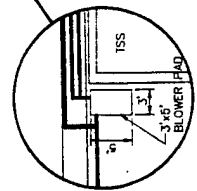
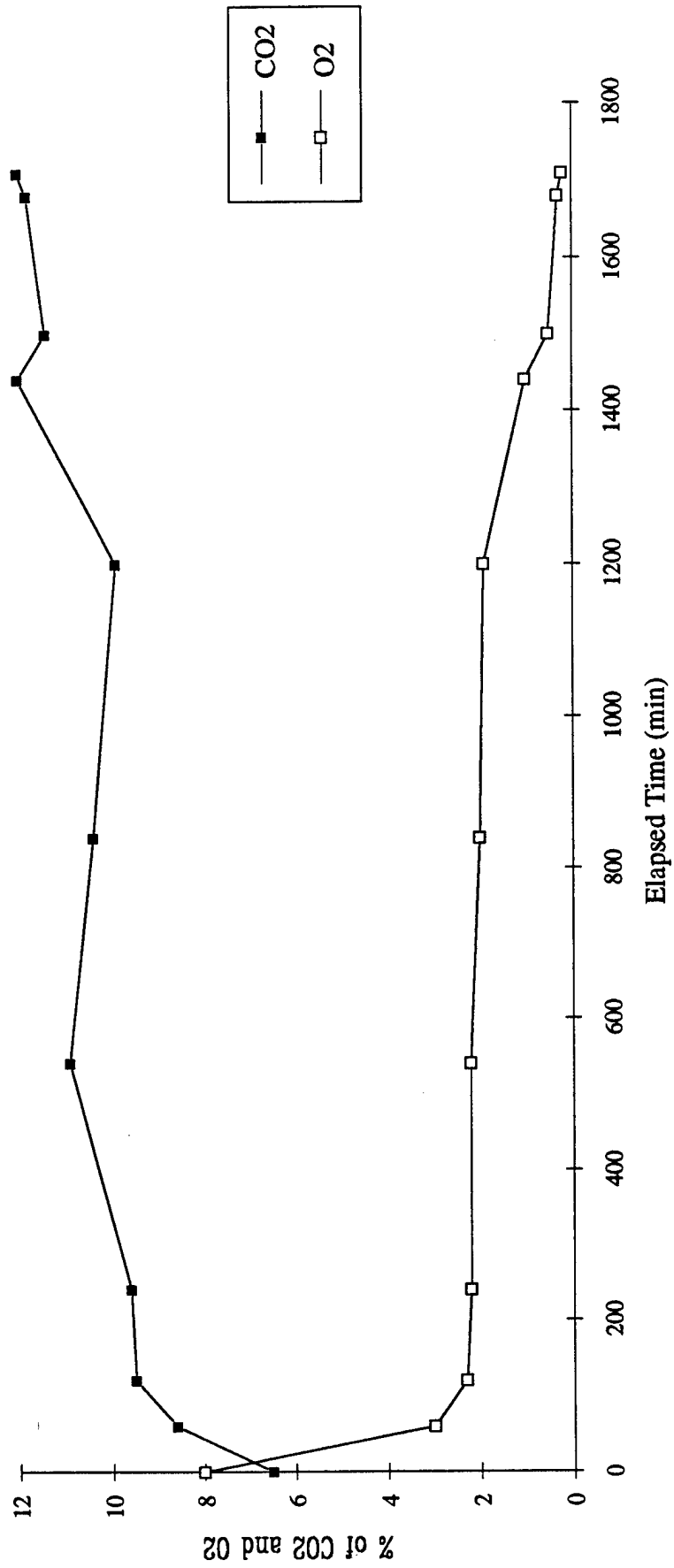


TABLE 1
BIOVENTING IN-SITU RESPIRATION TEST RESULTS
7TH STREET BX SERVICE STATION
EGLIN AFB

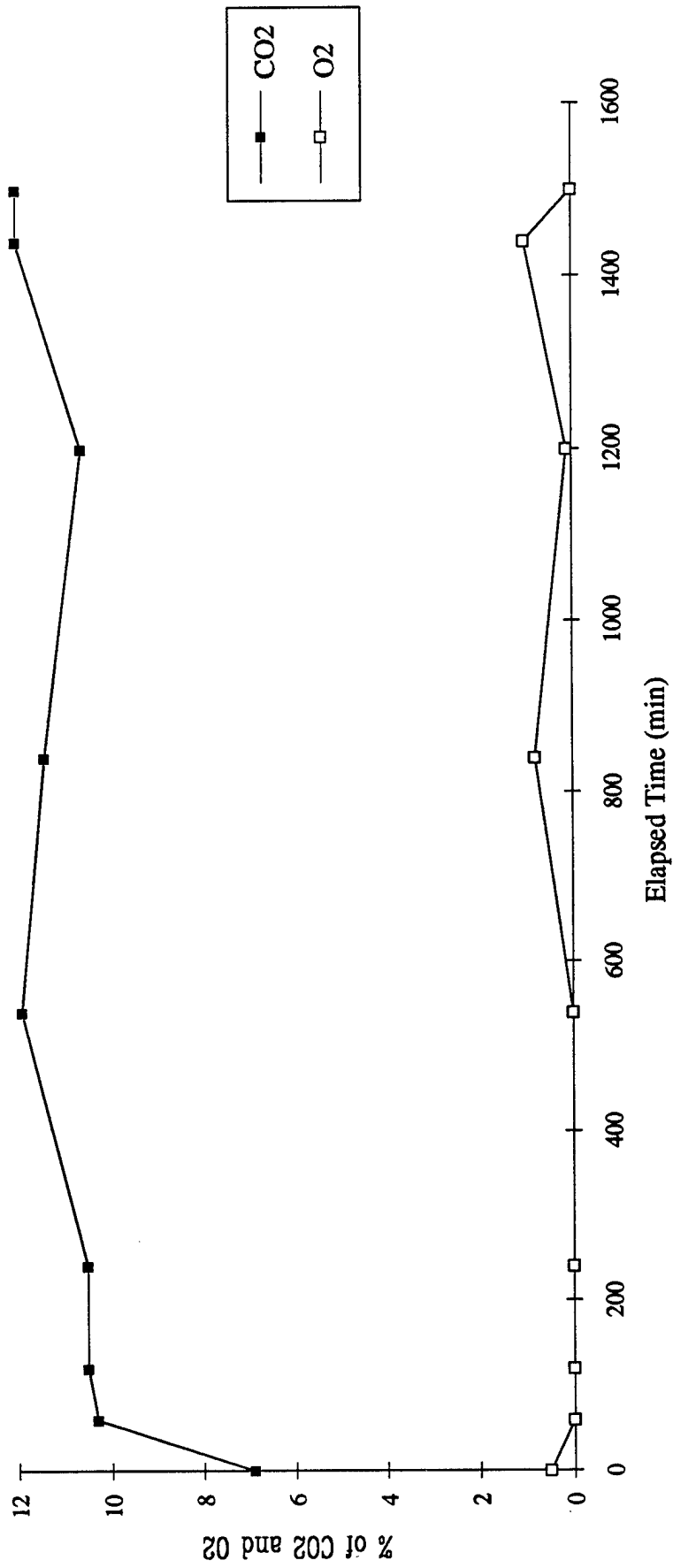
Elapsed Time (min)	VMP-1D			VMP-2S			VMP-2D		
	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)	CO2 (%)	O2 (%)	Total Hydrocarbons (ppm)
0	6.5	8.0	400	6.9	0.5	10000	3.4	5.4	10000
60	8.6	3.0	310	10.3	0*	10000	9.7	0.5	10000
120	9.5	2.3	275	10.5	0.0	8500	10.2	0.3	9600
240	9.6	2.2	310	10.5	0.0	8600	10.4	0*	9200
540	10.9	2.2	300	11.9	0.0	8500	11.4	0.1	8500
840	10.4	2.0	300	11.4	0.8	8600	11.2	1.0	8700
1200	9.9	1.9	300	10.6	0.1	9200	10.3	0.2	9200
1440	12.0	1.0	200	12.0	1.0	9000	11.5	0.0	9000
1500	11.4	0.5	210	12.0	0.0	9100			
1680	11.8	0.3	300						
1710	12.0	0.2*	320						

* Interpreted end of test at vapor monitoring point.

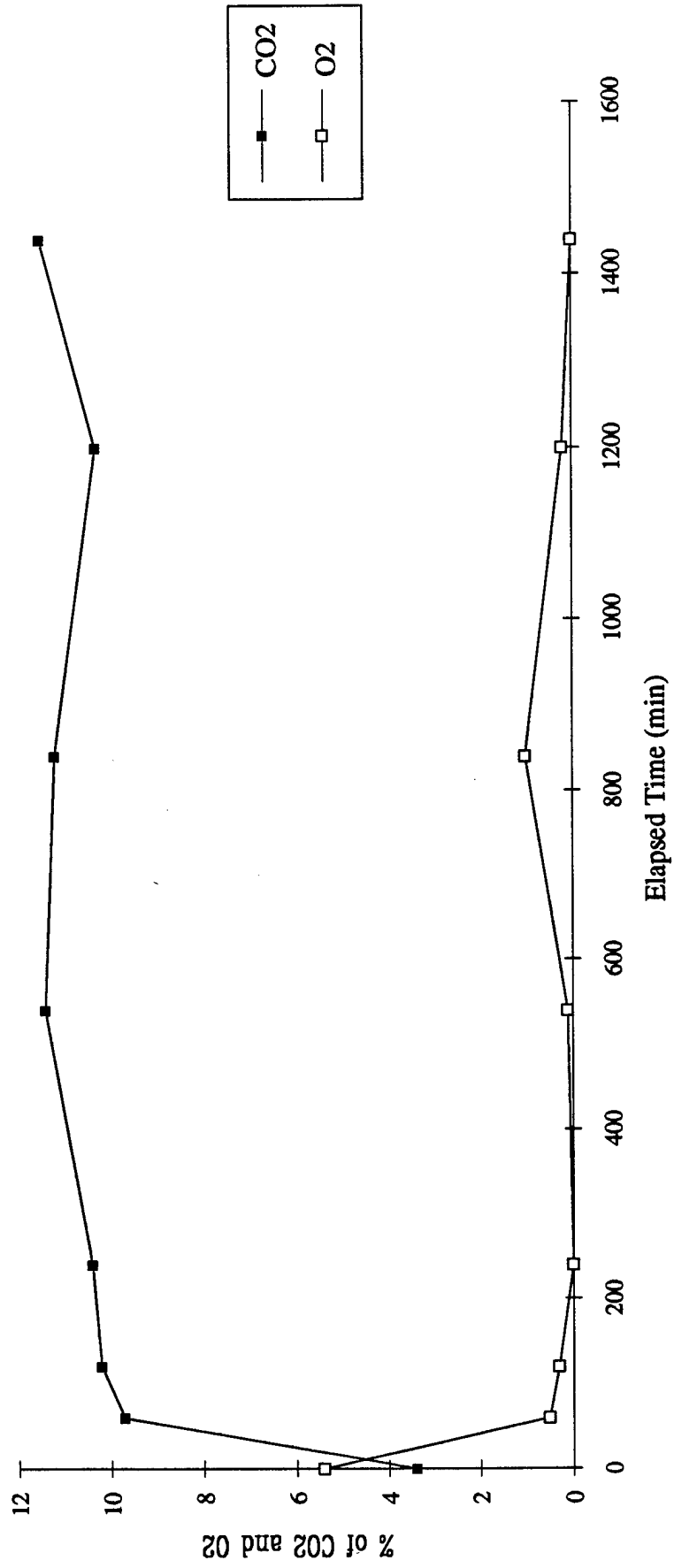
RESPIRATION TEST RESULTS AT VMP-1D
7TH STREET BX SERVICE STATION
EGLIN AFB



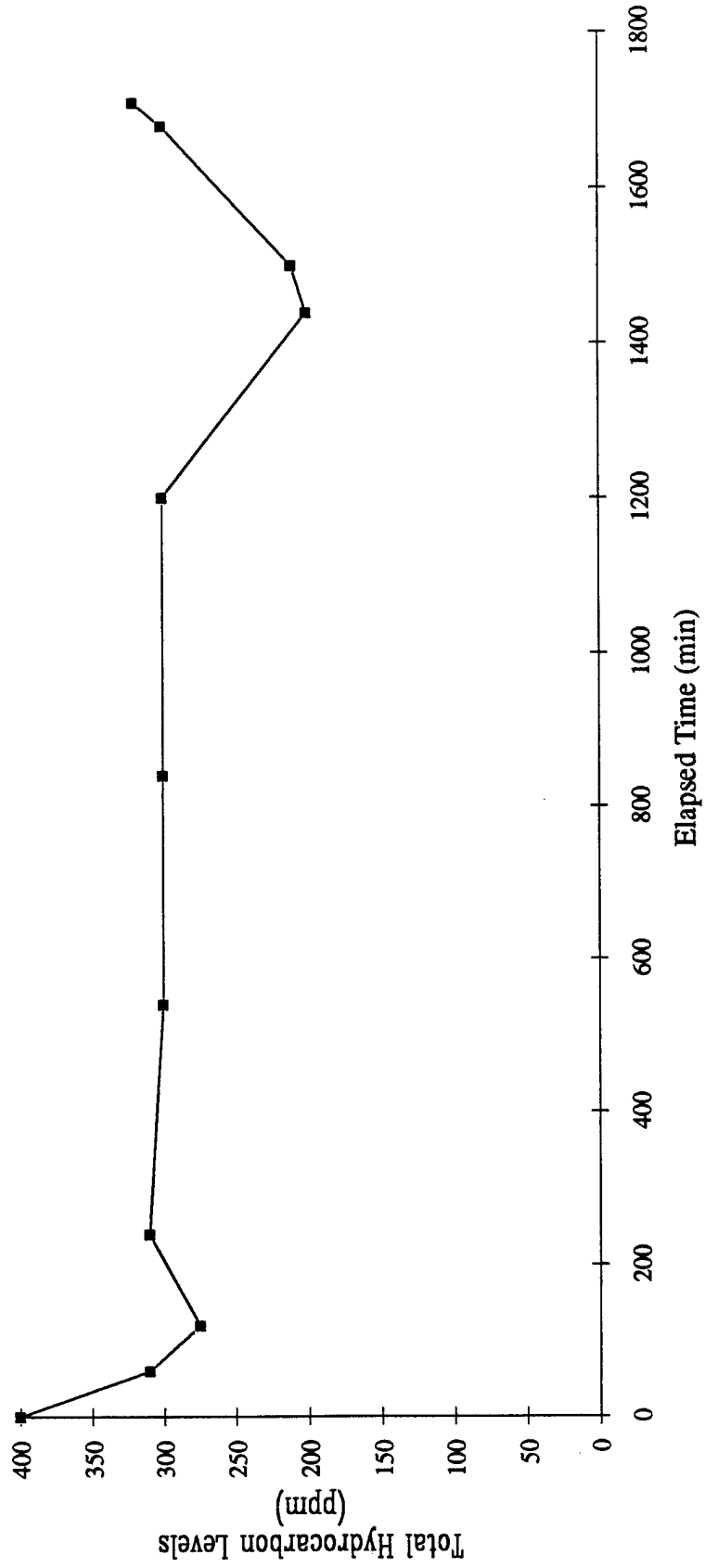
RESPIRATION TEST RESULTS AT VMP-2S
7TH STREET BX SERVICE STATION
EGLIN AFB



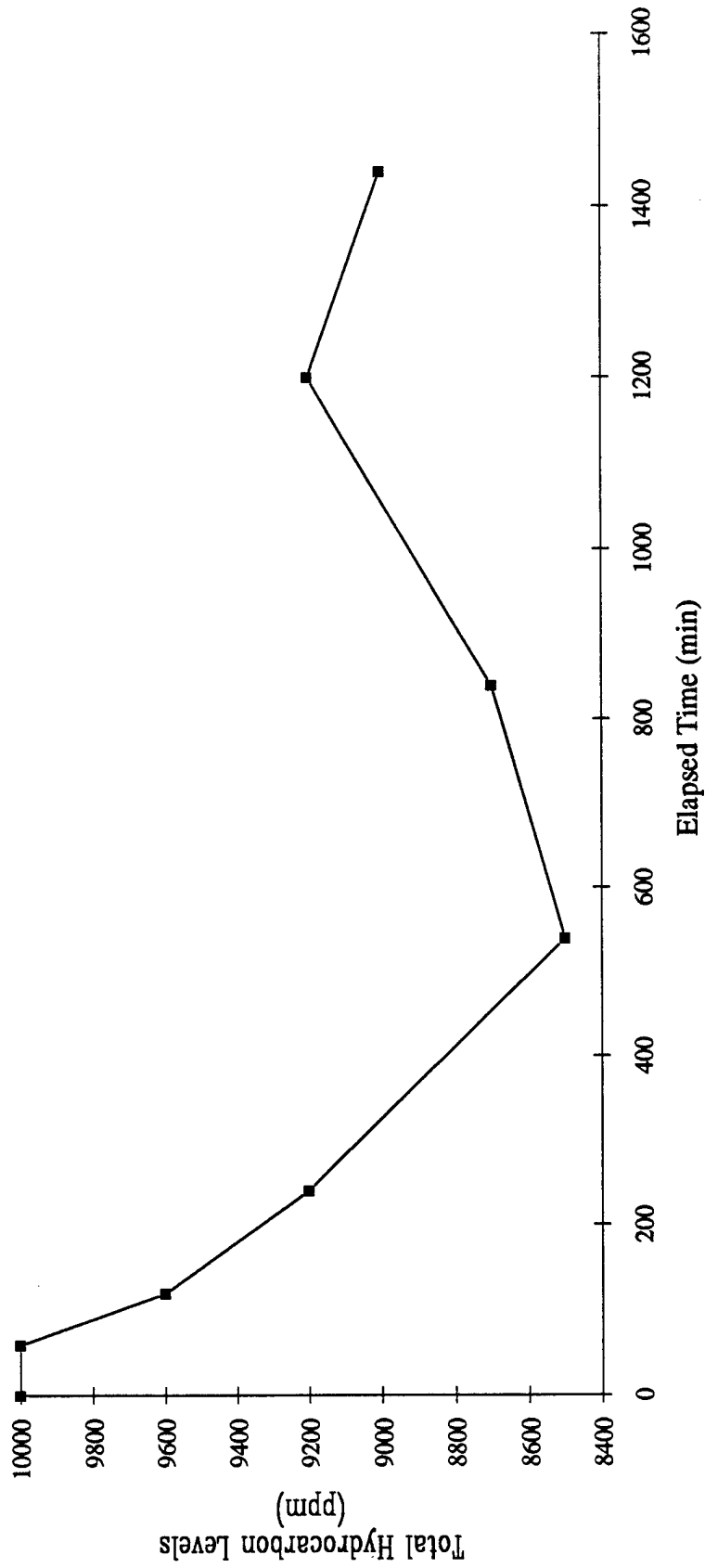
**RESPIRATION TEST RESULTS AT VMP-2D
7TH STREET BX SERVICE STATION
EGLIN AFB**



**RESPIRATION TEST RESULTS AT VMP-1D
7TH STREET BX SERVICE STATION
EGLIN AFB**



**RESPIRATION TEST RESULTS AT VMP-2D
7TH STREET BX SERVICE STATION
EGLIN AFB**



**RESPIRATION TEST RESULTS AT VMP-2S
7TH STREET BX SERVICE STATION
EGLIN AFB**

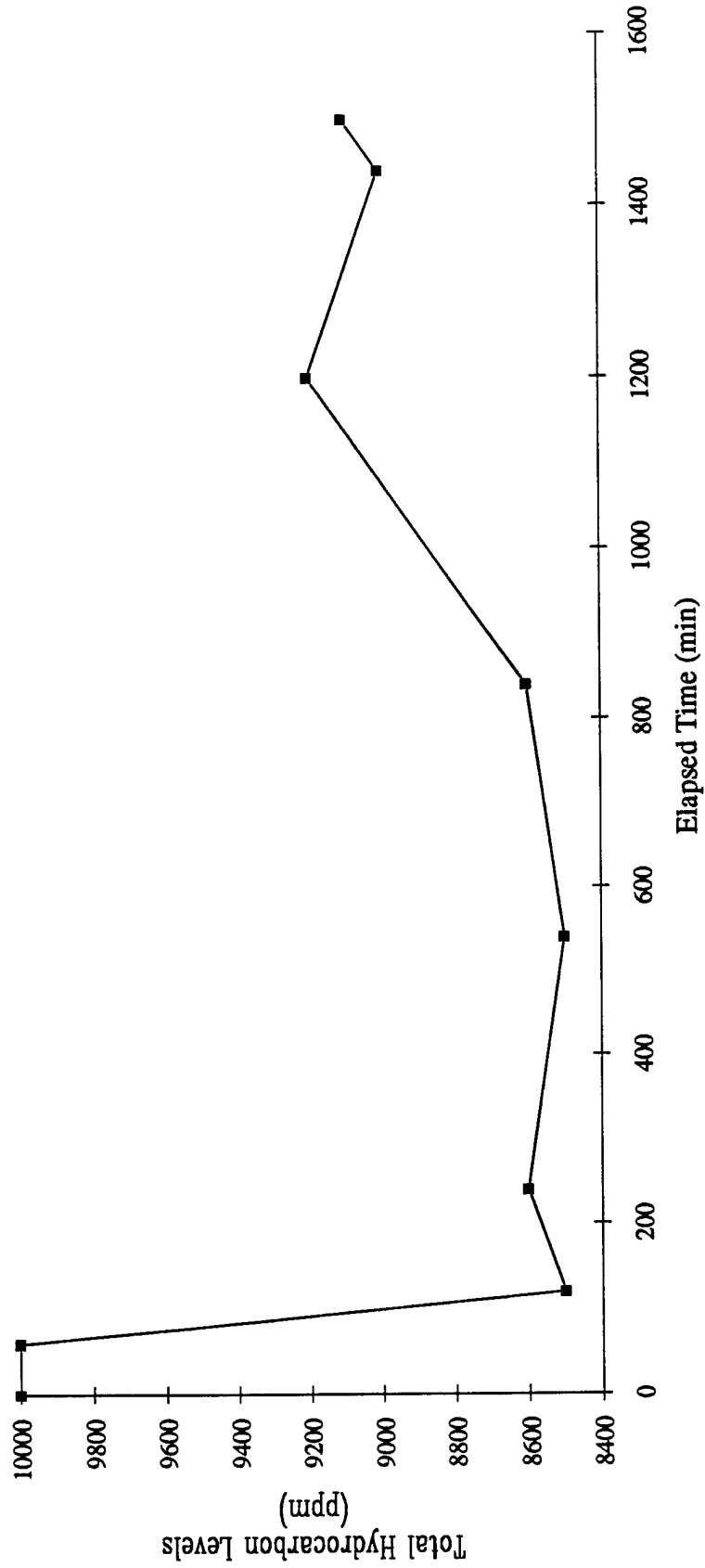


Figure 8-1. Typical Record Sheet for In Situ Respiration Test.

SITE 7TH STREET Bx SERVICE STATION MONITORING POINTS VMP-1D
 DATE SEPTEMBER 2, 1992 O₂ METER NO. LO 258 CO₂ METER NO. LO 258
 LOCATION Vapor Monitoring point 1 Deep HYDROCARBON METER NO. D7038
 SAMPLER(S) OLA AWOSIKA & ED STAES SHUT DOWN DATE 09-02-92 TIME 1330

Date/Time	CO ₂ %	O ₂ %	Total Hydrocarbon	Helium	Comments	Date/Time	CO ₂ %	O ₂ %	Total Hydrocarbon	Helium	Comments
09/02/92 1310	6.5	28.0	390	-							
1330	6.5	8.0	400	-	Shut-down						
1438	8.6	3.0	310	-	(PM)						
1539	9.5	2.3	275	-	(PM)						
1740	9.6	2.2	310	-	(PM)						
2239	10.9	2.2	300	-	(PM)						
09/03/92 0339	10.4	2.0	300	-	Morning (AM)						
0939	9.9	1.9	300	-	(AM)						
1339	12.0	1.0	200	-	(PM)						
1429	11.4	0.5	210	-	(PM)						
1730	11.8	0.3	300	-	(PM)						
1800	12.0	0.2	320	-	End of Test						

