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SOIL VAPOR SAMPLING PROCEDURES

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SOIL VAPOR SAMPLING PROCEDURE

Introduction

The purpose of this document is to describe the techniques to be used for conducting field soil vapor surveying in association with subsurface investigations for the presence of organic constituents in the subsurface. Further, detailed information about the survey instrumentation to be used, data reporting, installation techniques, conditions under which surveying will not be performed and additional information sources will be presented.

Sample Collection and Analysis Methodology

Prior to soil vapor surveying, the area of interest will be subdivided into a system of grid patterns. Grid lines will be established and oriented north-south and east-west. The grid size will be determined prior to the soil vapor survey, and will not be presented at this time due to the uncertainty of soil vapor survey data need and extent of investigation. North-south oriented grid lines will be assigned an alphabetical unique identified; est-west oriented grid lines will be assigned a numeric unique identified. Soil vapor sampling will be accomplished at the intersections of the grid lines. Sampling location numbers will correspond to the combination of the grid unique identifier, with the identifier for the north-south grid line being presented as the first part of the sampling location number. Separation grid area locations will be identified with an assigned grid Roman Numeral designation.

The soil vapor survey sampling equipment field installation, sample collection and analysis, and data recording will be conducted in the following manner:

1. Using a slambar, a six foot section of 3/8-inch diameter solid stainless steel rod will be driven vertically into the ground at the vapor sampling location. The rod will be advanced to a depth of approximately five feet.

2. The solid rod is withdrawn and replaced with a 1/4-inch diameter hollow stainless steel tube to a depth of approximately six inches above the bottom of the hole created in step 1 above.

3. Prior to installation of the 1/4-inch tube, a seven foot length of stainless steel cable is placed into the 1/4-inch diameter stainless steel tube in such a manner that approximately six inches of the cable is allow to protrude out the bottom of the 1/4-inch tube.

4. After successful installation of the 1/4-inch tube in the hole, modeling clay is tamped around the tube and the cable is then withdrawn. Prior to installation of the modeling clay, the clay is checked for the presence of organic vapors with an HNu Photoionization Detectors. If organic vapors are detected and if procurement of another brand of clay also reveals the presence of organic vapors, then the surface soil will be used to seal the hole at the surface.

5. A teflon or tygon tube will be connected to the top of the 1/4-inch diameter tube. A manual pump, connected to the teflon/tygon tube, will then be used to withdraw a volume of soil vapor from the hole. A collapsed tedlar bag will be attached to the exhaust port of the manual pump. The evacuated soil vapor vapors will be collected in the tedlar bag.

6. The filled tedlar bag, previously identified with a sample number which corresponds to the soil vapor survey sampling location, will be taken to the Foxboro OVA-128 location for analysis.

7. Foxboro OVA-128 calibration and sampling will be performed in accordance with the manufacturer's "OPERATION AND SERVICE MANUAL FOR CENTURY SYSTEMS Portable Organic Vapor Analyzer (OVA) Model OVA-128 and Optional Accessories, Revision C".

8. Soil vapor survey results will be documented and reported on the appropriate section of the form as shown on Figure 1.

9. Additional information to be documented and reported during the survey includes: temperature, relative humidity, general weather conditions, and equipment condition.

10. OVA Calibration information will be recorded on Figure 2.

11. All equipment and material used during the soil vapor installation process will be decontaminated prior to use and also will be decontaminated between individual hole installations. All stainless steel tubes will be decontaminated prior to use by high pressure steam cleaning followed by flushing the tubes with bottled air or nitrogen to eliminate the possibility of cross-contamination between samples. An adequate supply of tubes will be maintained to complete each day's measurements without reusing a tube.

12. Teflon/tygon tubing and tedlar bags will be replaced after each soil vapor sampling location has been sampled.

Ambient Conditions for Performance of Soil Vapor Survey

Soil vapor survey field work will be performed only under ambient conditions of temperatures greater than 40 degrees fahrenheit and relative humidity less than 95 percent. When ambient conditions of temperature and humidity are not within the above specified range, the soil vapor survey will not be performed.

Additional Information Sources

For further information, the reader is referred to the following additional information sources:

1. U.S. Environmental Protection Agency, EPA/540/P-87/001 (OSWER Directive 9355.0-14), December 1987, "A Compendium of Superfund Field Operations Methods", Sections 15.3, pages 15-30 to 15-38.

2. U.S. Environmental Protection Agency, Environmental Response Team, training manual, "Air Surveillance for Hazardous Materials," (1988).

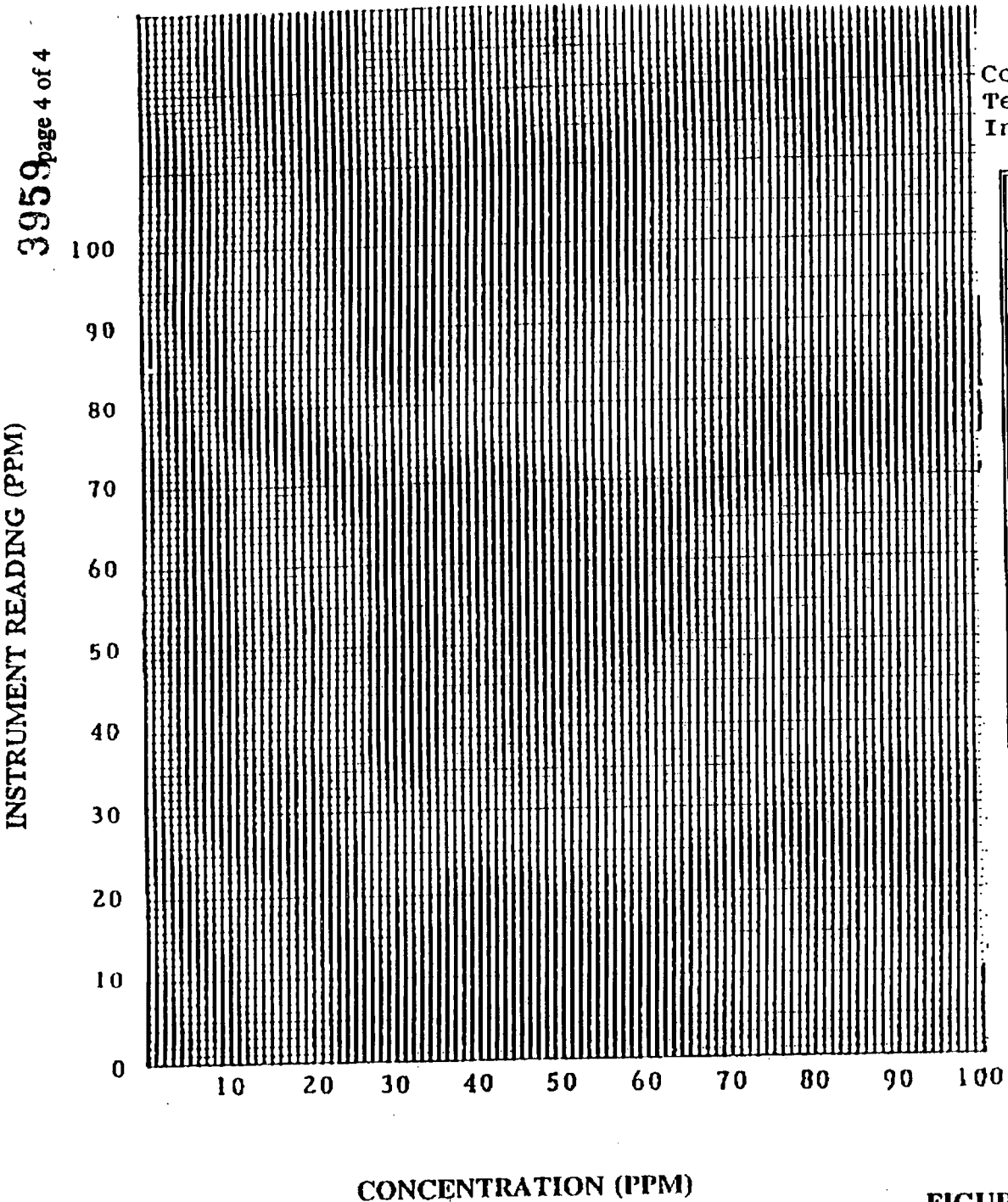
3. Analabs, A Unit of Foxboro Analytical, "OPERATING AND SERVICE MANUAL for CENTURY SYSTEMS, Portable Organic Vapor Analyzer (OVA) Model OVA-128 and Optional Accessories, REVISION C."

OVA DATA RESULTS

SAMPLE ID	DATE	RESULT 1 (ppm)	RESULT 2 (ppm)	RESULT 3 (ppm)	RESULT 4 (ppm)	TEMPERATURE °C	TECHNICIAN. SIGN OFF

COMMENTS:

FIGURE 1



Column___ Chromatograph____
Temperature___°C Carrier Flow___ml/sec
Injection: Volume____ml Type___

X	Compound	R.R. (%)	RT (sec)	Date	TLV (ppm)

NOTE: Concentration used for test is 100 ppm or as indicated by marked data points.

COMMENTS:

FIGURE 2

[redacted]

Enclosure 4

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OPERATING AND SERVICE MANUAL

for

CENTURY SYSTEMS'

Portable Organic Vapor Analyzer (OVA)
Model OVA-128
and Optional Accessories

REVISION C

5

[redacted]

Analabs

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FOXBORO

TABLE OF CONTENTS

PAGE

INTRODUCTION

SECTION 1: Description and Leading Particulars 1
General 1
1.2 Typical Applications 1
1.3 Other Typical Uses 1
1.4 Major Features 1
1.5 Adaptability Features and Standard Accessories 2
1.5.1 General 2
1.5.2 Probe 2
1.5.3 Particle Filters 2
1.5.4 Instrument Carrying Case 2
1.5.5 Mobile Installation 2
1.6 Specifications 2

SECTION 2: Detailed Operating Procedures 2
2.1 General 2
2.2 System Controls, Indicators and Connectors 4
2.3 Starting Procedure 4
2.3.1 Initial Preparation for Use 4
2.3.1.1 Initial Assembly 4
2.3.1.2 Servicing 4
2.3.1.3 Safety Precautions 5
2.3.2 Turn On Procedure 5
2.4 Operating Procedures 5
2.5 Shut Down Procedure 6
2.6 Fuel Refilling 6
2.7 Battery Recharging — AC Battery Charger 6
2.7.2 DC Charger 7
2.8 Charcoal Filtering 7
2.9 Moisture Filtering 7

SECTION 3: Summarized Operating Procedures 7
3.1 General 7
3.2 Start Up 7
3.3 Shut Down 7

SECTION 4: Calibration 7
4.1 General 7
4.2 Electronic Adjustments 8
4.2.1 Gain Adjustment 8
4.2.2 Bias Adjustment 8
4.3 Calibration to Other Organic Vapors 8
4.3.1 Setting Gas Select Control (Span) 8
4.3.2 Using Empirical Data 8
4.3.3 Preparation of Calibration Standards 8
4.3.3.1 Commercial Samples 8
4.3.3.2 Pure Gaseous Samples 8
4.3.3.3 Gaseous and Liquid Samples (Alternate Method) 9
4.4 Theory 9
4.4.1 Hydrocarbons 9
4.4.2 Other Organic Compounds 9

SECTION 5: Safety Considerations 11
5.1 General 11
5.2 Operating, Servicing and Modifying 11
5.3 Electrical Protection 11

5.4 Fuel Supply and Tank 11
5.5 H_2 Flow Restrictors 11
5.6 Detector Chamber 11
5.7 H_2 Filling and Emptying Operations 11
5.8 Venting 11

SECTION 6: Maintenance 13
6.1 General 13
6.2 Routine Maintenance 13
6.2.1 Filters 13
6.2.1.1 Primary Filter 13
6.2.1.2 Particle Filters 14
6.2.1.3 Mixer/Burner Assembly Filter 14
6.2.1.4 Exhaust Flame Arrestor 14
6.2.2 Pickup Fixtures 14
6.2.3 Seal Maintenance — Cylinder Assembly 14
6.2.3.1 H_2 Tank, H_2 Supply and Refill Valves 14
6.2.3.2 Refiller Valve Packing Adjustment 14
6.2.4 Air Sampling System Maintenance 15
6.2.4.1 General 15
6.2.4.2 Testing for Leaks 15
6.2.4.3 Leak Isolation 15
6.2.5 Contamination Control and Maintenance 15
6.2.5.1 General 15
6.2.5.2 Analysis and Correction 16
6.2.6 Fuse Replacement 17
6.3 Trouble Shooting 17
6.4 Factory Maintenance 17
6.5 Field Maintenance 18
6.6 Recommended Spares 18

SECTION 7: Optional Accessories 23
7.1 Gas Chromatograph (GC) Option 23
7.1.1 Introduction 23
7.1.2 Description and Leading Particulars 23
7.1.2.1 General 23
7.1.2.2 Principle of Operation 23
7.1.3 Operating Procedures 28
7.1.3.1 General 28
7.1.3.2 GC System Controls and Components 28
7.1.3.3 Servicing and Turn On 29
7.1.3.4 Survey Mode Operation 29
7.1.3.5 GC Mode Operation 29
7.1.4 Calibration 29
7.1.4.1 General 29
7.1.4.2 Technical Discussion 29
7.1.4.3 Preparation of Calibration Samples 32
7.1.4.4 Calibration Data 32
7.1.5 Maintenance 32
7.1.5.1 General 32
7.1.5.2 Routine Maintenance 32
7.1.5.3 Trouble Shooting 35
7.1.5.4 Recommended Spares 35
7.2 Recorder Option 37
7.2.1 General 37
7.2.2 Applications 37
7.2.3 Features 37
7.2.4 Controls and Connections 37
7.2.5 Operating Procedures 37
7.2.6 Calibration 37
7.2.6.1 General 37
7.2.6.2 Mechanical Zero Adjustment 37

7.2.6.3 Gain Adjustment 37
7.2.7 Safety 37
7.2.8 Maintenance and Routine Operations 38
7.2.8.1 Changing Chart Speeds 38
7.3 Activated Charcoal Filter Assembly 38
7.4 OVA Sample Dilutor 38
7.4.1 Setting Dilution Rate 39
7.5 OVA Septum Adapter 39

APPENDIX A: Sample Forms, Application/Technical Notes, Schematic, Drawings, Parts Lists

CENTURY SYSTEMS CORPORATION

P.O. BOX 818 / ARKANSAS CITY, KANSAS 67005 / 316-447-3311 / TWX 910-740-6740

SECTION 1

DESCRIPTION AND LEADING PARTICULARS

1.1 GENERAL

The Century Portable Organic Vapor Analyzer (OVA), illustrated in Figure 1-1, is designed to detect and measure hazardous gases found in almost all industries. It has broad application, since it has a chemically resistant sampling system and can be calibrated to almost all organic vapors. It is extremely sensitive and can provide accurate indication of gas concentration in one of three ranges: 0 to 10 ppm; 0 to 100 ppm; and 0 to 1,000 ppm. While designed as a lightweight portable instrument, it can readily be adapted to remote monitoring applications.

The instrument utilizes the principle of hydrogen flame ionization for detection and measurement of organic vapors. The instrument measures organic vapor concentration by producing a response to an unknown sample, which can be related to a gas of known composition to which the instrument has previously been calibrated. During normal survey mode operation, a continuous sample is drawn into the probe and transmitted to the detector chamber by an internal pumping system. The sample flow rate is metered and passed through particle filters before reaching the detector chamber. Inside the detector chamber, the sample is exposed to a hydrogen flame which ionizes the organic vapors. When most organic vapors burn, they leave positively charged carbon-containing ions which are collected by a negative collecting electrode in the chamber. An electric field exists between the conductors surrounding the flame and the collecting electrode which drives the ions to the collecting electrode. As the positive ions are collected, a current corresponding to the collection rate is generated on the input electrode. This current is measured with a linear electrometer preamplifier which has an output signal proportional to the ionization current. A signal conditioning amplifier is used to amplify the signal from the preamp and to condition it for subsequent meter or external recorder display. The meter display is an integral part of the Probe/Readout Assembly and has a scale from 0 to 10.

1.2 TYPICAL APPLICATIONS

(1) Measurement of most toxic organic vapors present in industry for compliance with Occupational Safety and Health Administration (OSHA) requirements.
(2) Process monitoring and evaluation.
(3) Evaluation and monitoring applications in the air pollution field.
(4) Leak detection in storage, transportation and handling equipment.
(5) Survey of gas distribution and transmission lines and equipment for compliance with Office of Pipeline Safety (OPS) requirements.
(6) Forensic science applications.

1.3 OTHER TYPICAL USES

(1) Controlling and monitoring atmospheres in manufacturing and packaging operations.
(2) Mudlogging, gas and mineral exploration.
(3) Leak detection related to volatile fuel handling equipment.

1.4 MAJOR FEATURES

The basic instrument consists of two major assemblies, the Probe/Readout Assembly and the Side Pack Assembly (see Figure 1-1). The recorder is optional on all models, but is normally used with all instruments which incorporate the GC Option. The output meter and alarm level adjustments are incorporated in the Probe/Readout Assembly which is operated with one hand. The Side Pack Assembly contains the remaining operating controls and indicators, the electronic circuitry, detector chamber, hydrogen fuel supply and electrical power supply. It is a quantitative type instrument with sensitivity to 0.1 ppm methane.

Other major features are: 250° linear scale readout, less than two second response time and minimum eight hour service life for fuel supply and battery pack. A battery test feature allows charge condition to be read on the meter. Hydrogen flame-out is signified by an audible alarm plus a visual indication on the meter. The instrument contains a frequency modulated detection alarm which can be preset to sound at a desired concentration level. The frequency of the detection alarm

varies as a function of detected level giving an audible indication of organic vapor concentration. The instrument is designed for one man, one hand operation and the entire unit weighs a total of less than 12 pounds, including fuel supply and battery. An earphone is provided for "only operator" monitoring.

During use, the Side Pack Assembly can be carried by the operator on either his left or right side or as a back pack. The Side Pack Assembly is housed in a high impact plastic case and weighs less than 10 pounds. The Probe/Readout Assembly can be detached from the Side Pack Assembly and broken down for transport and storage. See Figure 1-2 for the breakdown capability of the instrument.

1.5 ADAPTABILITY FEATURES AND STANDARD ACCESSORIES

1.5.1 GENERAL

Maximum flexibility and operability features are included in the instrument design. As shown in Figure 1-2, a variety of pickup fixtures can be used. They can be installed by simply turning a knurled locking nut. Small diameter tubing can be used for remote sampling and electrically insulated flexible extensions can be used for difficult places to reach.

1.5.2 PROBE

The telescoping probe allows the length to be increased or decreased over an eight inch range to suit the individual user. A knurled locking nut is used to lock the probe at the desired length. The probe is attached to the Readout Assembly using a knurled locking nut. For measurements in close areas, the probe is replaced with a Close Area Sampler, which is supplied as a standard accessory.

1.5.3 PARTICLE FILTERS

The primary filter is of porous stainless and located behind the sample inlet connector, see Side Pack Assembly drawing in Appendix "A". In addition, replaceable porous metal filters are installed in the "close area" sampler, the pickup funnel and the tubular sampler.

1.5.4 INSTRUMENT CARRYING CASE

An instrument carrying case is provided to transport, ship and store the disassembled Probe/Readout Assembly, the Side Pack Assembly and other standard equipment.

1.5.5 MOBILE INSTALLATION

The instrument is readily adaptable to a mobile application by simply plugging into vehicle power and hydrogen fuel supply and making provisions for drawing sample from the vehicle primary sampling system.

1.6 SPECIFICATIONS

Sensitivity: 0.1 ppm (methane)
Response time: Less than 2 seconds
Readout: 0 to 10 ppm, 0 to 100 ppm, 0 to 1,000 ppm, 250° linear scaled meter; external monitor connector
Sample flow rate: Nominally 2 units
Fuel supply: 75 cubic centimeter tank of pure hydrogen at maximum pressure of 2300 PSIG, fillable while in case
Primary electrical power: Rechargeable and replaceable battery pack at 12VDC
Service life: Hydrogen supply and battery power-8 hours operating time minimum
Size: **Standard Unit:** 8-5/8 x 11-5/8 x 4-1/4 **FM Unit:** 8-5/8 x 11-5/8 x 4-1/2 **Probe/Readout Assembly:** Variable (see Figure 1-2)
Weight: **Standard Unit:** Side Pack Assembly, less than 10 lbs. **FM Unit:** Side Pack Assembly, less than 11 lbs. **Probe/Readout Assembly:** less than 2 lbs.
Operator requirements: One man, one hand operation
Detection alarm: Frequency modulated audible alarm. Can be preset to desired level. Frequency varies as a function of detection level
Flame-out indication: Audible alarm plus visual meter indication
Battery test: Battery charge condition indicated on readout meter or battery recharger
Pickup fixtures: Variety of types for various applications
Probe: Telescoping adjustment over 8 inches or probe can be completely removed from Readout Assembly
Umbilical cord: Cable between readout and sidepack with connectors for electrical cable and sample hose
Filtering: In-line particle filters and optional activated charcoal filter.
Side Pack case: Molded high impact plastic case with carrying handle and shoulder strap
Electrical protection: Refer to Section 5
Standard accessories:

1) Instrument carrying and storage case
2) Fuel filling hose assembly
3) A.C. battery charger
4) Earphone
5) Various pickup fixtures

Optional accessories:

1) Gas chromatograph option
2) Portable strip chart recorder
3) Activated charcoal filter; also used with desiccant as a moisture trap
4) Dilution valve
5) Septum adapter for use with gas chromatograph option

SECTION 2

DETAILED OPERATING PROCEDURES

2.1 GENERAL

The procedures in this section are broken into five parts: (1) Starting, (2) Operating, (3) Shut Down, (4) Fuel Refilling, and (5) Battery Charging. After familiarization

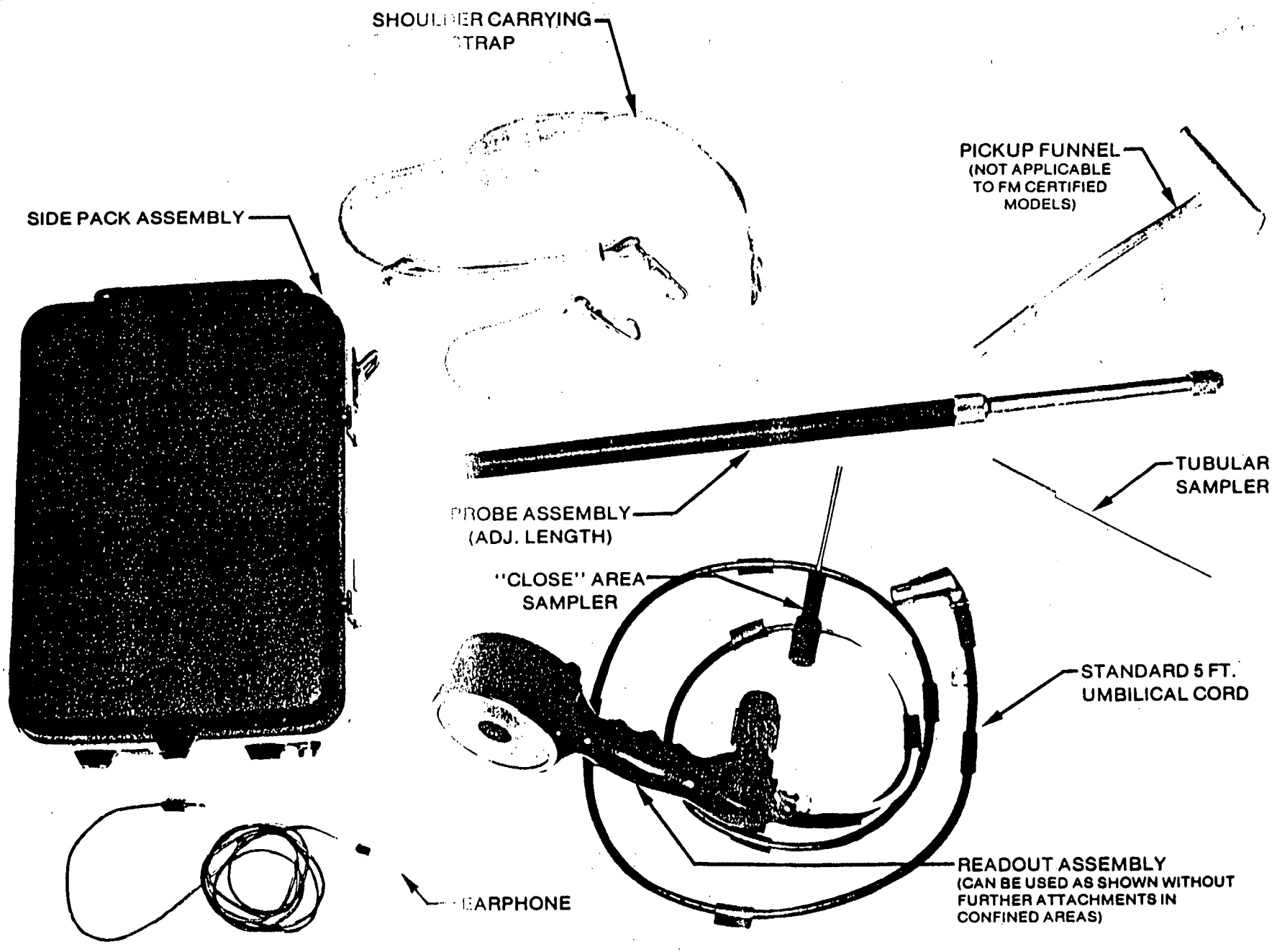


FIGURE 1-2

INSTRUMENT DISASSEMBLED

Typical of All Models Except Where Noted.

3959

with the instrument, the summarized procedures described in Section 3 may be used for simplicity. Because of the many optional applications for the instrument, the comprehensive detailed procedures described in this section may seem complex. However, in normal applications the operating procedures are quite simple. A condensed operating procedure check list is provided inside the cover of the Side Pack Assembly. Refer to Section 7 for operating procedures relative to major optional accessories such as the Gas Chromatograph Option.

2.2 SYSTEM CONTROLS, INDICATORS AND CONNECTORS

Tables 2-1 and 2-2 describe the functions of the various controls, indicators and connectors illustrated in Figure 1-1. Unless otherwise noted, the listings in Tables 2-1 and 2-2 are applicable to both the Model OVA-118 and OVA-128.

TABLE 2-1
SIDE PACK ASSEMBLY

Controls/Indicators — Function

1) INSTR/BATT Test Switch - This 3 position toggle switch turns on all instrument electrical power except the pump and alarm power and also permits display of the battery charge condition on the readout meter.
2) PUMP (ON-OFF) Switch - This toggle switch turns on power to the internal pump and audio alarms.
3) Igniter Switch - This momentary push button switch connects power to the igniter coil in the detector chamber and simultaneously disconnects power to pump.
4) CALIBRATE Switch (range selector) - This 3 position toggle switch selects the desired range: X1 (0-10 ppm); X10 (0-100 ppm); X100 (0-1,000 ppm).
5) CALIBRATE ADJUST (zero) Knob - This potentiometer is used to "zero" the instrument.
6) GAS SELECT Knob (span control) - This ten-turn dial readout potentiometer sets the gain of the instrument commonly referred to as span control.
7) Recorder Connector - This 126 series 5-pin Amphenol connector is used to connect the instrument to an external monitor with the following pin connections.

   Pin E - plus 12VDC
   Pin H - Ground
   Pin A - Signal 0-5VDC (OVA-118 only)
   Pin B - Signal 0-5VDC (OVA-128 only)

8) Recharger Connector - This BNC connector is used to connect the battery pack to the battery recharger assembly.
9) H2 TANK VALVE - This valve is used to supply or close off the fuel supply from the hydrogen tank.
10) H2 TANK PRESSURE Indicator - This high pressure gauge measures the pressure in the hydrogen fuel tank which is an indication of fuel supply.
11) H2 SUPPLY VALVE - This valve is used to supply or close off the hydrogen fuel to the detector chamber.
12) H2 SUPPLY PRESSURE Indicator - This low pressure gauge is used to monitor the hydrogen pressure at the capillary restrictor.
13) SAMPLE FLOW RATE Indicator - This indicator is used to monitor the sample flow rate.
14) Refill Connection - This 1/4" AN fitting is used to connect the hydrogen refill hose to the instrument.
15) REFILL VALVE - This valve is used to open one end of the instrument fuel tank for refilling with hydrogen.
16) Earphone Jack - This jack is used to connect the earphone; it turns off speaker when used.
17) VOLUME Knob - This potentiometer adjusts the volume of the internal speaker and earphone.
18) Readout and Sample Connectors - These connectors are used to connect the sample hose and umbilical cord from the Probe/Readout Assembly to the Side Pack Assembly.

TABLE 2-2
PROBE/READOUT ASSEMBLY

Controls/Indicators — Function

A) Meter - This 250° linear scaled meter displays the output signal level in ppm.
B) Alarm Level Adjust Knob - This potentiometer (located on the back of the Readout Assembly) is used to set the concentration level at which the audible alarm is actuated.

2.3 STARTING PROCEDURE

2.3.1 INITIAL PREPARATION FOR USE

2.3.1.1 INITIAL ASSEMBLY (Reference Figure 1-2)

a) Normal Survey Configuration
   (1) Connect the adjustable-length probe to the Readout Assembly with the captive locking nut. Ensure that the probe is seated firmly in the Readout Assembly.
   (2) Select the desired pickup fixture and check that a particle filter is installed.
   (3) Connect the pickup fixture to the probe using the knurled locking nut.
   (4) Connect the umbilical cord and sample hose to the Side Pack Assembly.
b) "Close Area" Survey Configuration
   (1) Check to ensure that a particle filter is installed in the close area sampler.
   (2) Connect the close area sampler directly to the Readout Assembly.
   (3) Connect the umbilical cord and sample hose to the Side Pack Assembly.

2.3.1.2 SERVICING

a) **Fueling:** Pure, dry hydrogen can normally be

INTRODUCTION

The Century Model OVA-128 Portable Organic Vapor Analyzer (OVA) is a highly sensitive instrument designed to measure trace quantities of organic materials in air. It is essentially a hydrogen flame ionization detector such as utilized in laboratory gas chromatographs and has similar analytical capabilities. The flame ionization detector is an almost universal detector for organic compounds with the sensitivity to analyze for them in the parts per million range (V/V) in air in the presence of moisture, nitrogen oxides, carbon monoxide and carbon dioxide.

The instrument has broad application, since it has a continuous, chemically resistant air sampling system and can be readily calibrated to measure almost all organic vapors. It has a single linearly scaled readout from 0 ppm to 10 ppm with a X1, X10, X100 range switch. Designed for use as a portable survey instrument, it can also be readily adapted to fixed remote monitoring or mobile installations. It is ideal for the determination of many organic air pollutants and in the monitoring of air in potentially contaminated areas.

The OVA-128 is certified intrinsically safe by Factory Mutual Research Corporation (FM) for use in Class I, Division 1, Groups A, B, C & D hazardous environments. Similar foreign certifications have been obtained, including BASEEFA and Cerchar approval for Group IIC, Temperature Class T4 and equivalent approval from the Japanese Ministry of Labor. This requirement is especially significant in industries where volatile flammable petroleum or chemical products are manufactured, processed or used and for instruments which are actually used in portable surveying and in analyzing concentrations of gases and vapors. Such instruments must be incapable, under normal or abnormal conditions, of causing ignition of the hazardous atmospheric mixtures. In order to maintain the certified safety, it is important that the precautions outlined in this manual be practiced and that no modification be made to these instruments.

Sections 1 through 6 herein apply to the basic instrument. Section 7 contains information relative to options which are available and which may or may not have been purchased with your OVA.

It is highly recommended that the entire manual be read before operating the instrument. It is essential that all portions relating to safety of operation and maintenance, including Section 5, be thoroughly understood.

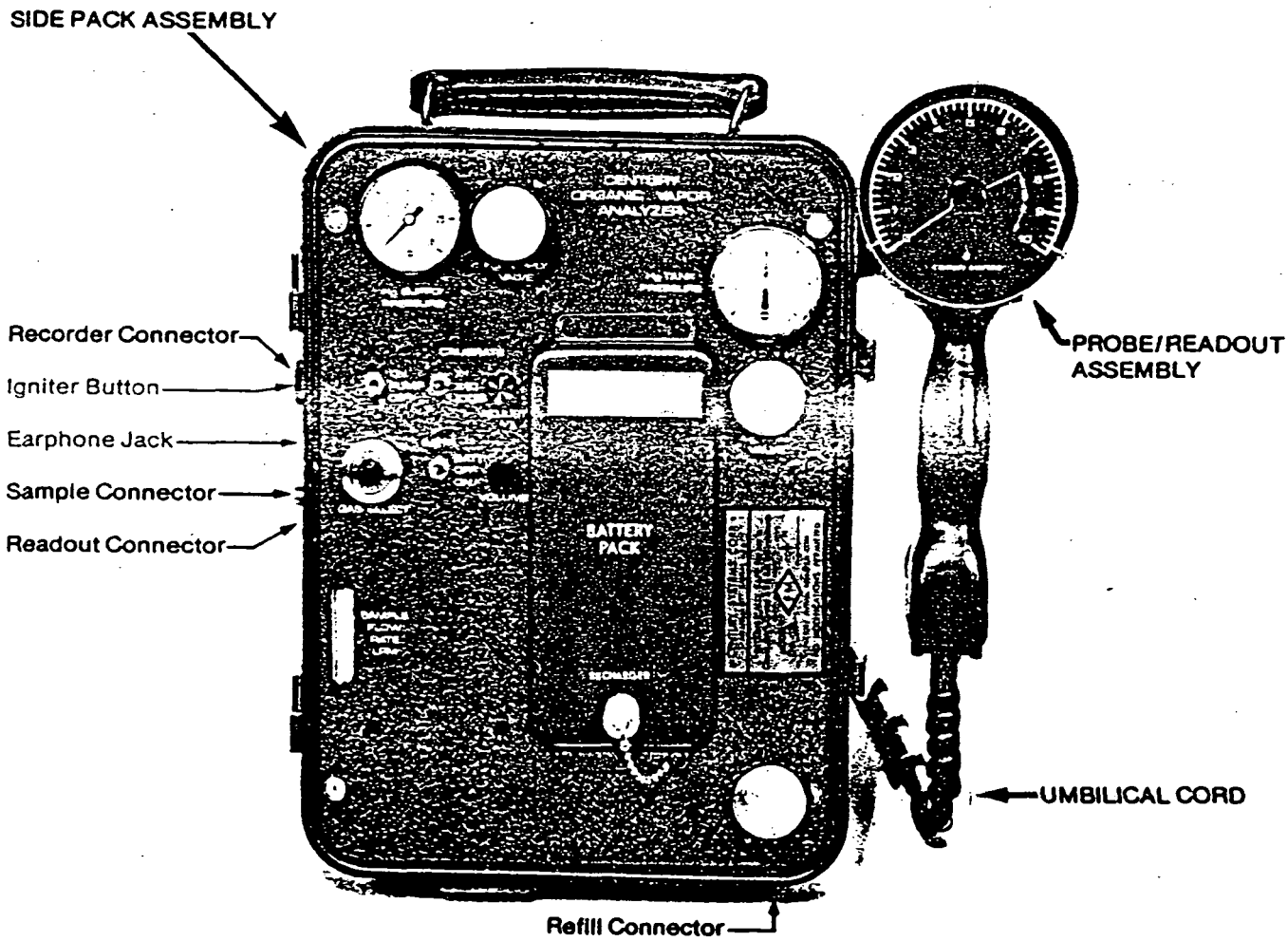


FIGURE 1-1. PORTABLE ORGANIC VAPOR ANALYZER
Model OVA-128

purchased locally or in a high grade from the Matheson Company of East Rutherford, New Jersey. The maximum instrument supply bottle pressure is 2300 PSIG. A high pressure hydrogen filling hose assembly is provided with the instrument. This assembly includes the proper fittings for the instrument and supply bottle, and a three-way fill/bleed valve. Initial fueling and subsequent refilling, using the Century high pressure filling hose, should be accomplished in accordance with the detailed instructions described in Section 2.6 of this manual.

b) **Battery Check:** Move INSTR/BATT Test Switch to the BATT position and ensure battery is charged by reading the indication on the readout meter.

c) **Calibration:** Standard factory calibration is performed using methane in air. The GAS SELECT (span) Control is set and locked to the position for calibration to methane (factory setting is 300). If the instrument is calibrated for other organic vapors, the reading on the GAS SELECT Control must be set for that particular vapor.

2.3.1.3 SAFETY PRECAUTIONS

Certain safety precautions must be followed in using the instrument. Hydrogen gas, when mixed with air, is highly flammable. Operating and refueling instructions should be strictly followed to ensure safe, reliable operation. Section 5 of the manual provides detailed safety precautions.

2.3.2 TURN ON PROCEDURE

The GAS SELECT control should be preset to the desired dial indication prior to turn on. The procedure for determining this setting is contained in Section 4 of this manual. The instrument, as received from the factory, is set to measure in terms of methane in air.

a) Move the INSTR Switch to ON and allow five minutes for warm up.

b) To set the audible alarm to a predetermined level, first turn the PUMP Switch to ON, then adjust the meter pointer to the desired alarm level, using the CALIBRATE ADJUST (zero) Knob. Turn the Alarm Level Adjust Knob on the back of the Readout Assembly until the audible alarm just comes on. Adjust speaker volume with VOLUME Knob. If earphone is used, plug in and readjust the volume as desired. The instrument is then preset to activate the alarm when the level exceeds that of the setting.

c) Move the CALIBRATE Switch to X10 and adjust the meter reading to zero with the CALIBRATE ADJUST (zero) Knob.

d) Ensure the PUMP Switch is ON and observe the SAMPLE FLOW RATE Indicator. Indication should be approximately 2 units.

e) Open H2 TANK VALVE one (1) turn and observe the reading on the H2 TANK PRESSURE Indicator. (Approximately 150 psi of pressure is needed for each hour of operation.)

f) Open H2 SUPPLY VALVE 1/2 to 1 turn and observe the reading on the H2 SUPPLY PRESSURE Indicator.

CAUTION

Do not leave H2 SUPPLY VALVE open when the pump is not running, as this will allow hydrogen to accumulate in the detector chamber.

g) Confirm that meter is still reading zero (readjust if required).

h) Depress igniter button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale of zero. Immediately after ignition, release the igniter button. Do not depress igniter button for more than 6 seconds. If burner does not ignite, let instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background concentration. This background level is nulled out using the CALIBRATE ADJUST (zero) Knob. [illegible] paragraph [illegible].

NOTE

Since the OVA utilizes the sample air drawn by the pump into the detector chamber as the only source of air to support the hydrogen flame, without adjustment the instrument will read the actual background concentration (ppm) of all hydrocarbons present at a given location.

i) Move instrument to an area which is representative of the "lowest ambient background concentration" (cleanest air) to be surveyed. Move the CALIBRATE Switch to X1 and adjust the meter to read 1 ppm with the CALIBRATE ADJUST (zero) Knob.

NOTE

Adjustment to 1 ppm (rather than 0) is necessary in the X1 range because of the sensitivity of the OVA. This permits minor downward fluctuations in the normal background level without dropping below 0, which would actuate the flame-out alarm. It is important, therefore, to remember during the subsequent survey that 1 ppm must be subtracted from all readings. Therefore, a 1.8 ppm reading would actually be only 0.8 ppm.

j) If the alarm level is to be set above the normal background detection level, turn the Alarm Level Adjust Knob on the back of the Readout Assembly until it actuates slightly above background.

THE INSTRUMENT IS NOW READY FOR USE.

2.4 OPERATING PROCEDURES

a) Set the CALIBRATE Switch to the desired

range. Using one hand operation, survey the areas of interest while observing the meter and/or listening for the audible alarm indication. For ease of operation, carry the Side Pack Assembly positioned on the side opposite the hand which holds the Probe/Readout Assembly. For broad surveys outdoors, the pickup fixture should be positioned several feet above ground level. When making quantitative reading or pinpointing, the pickup fixture should be positioned at the point of interest.

b) When organic vapors are detected, the meter pointer will move upscale and the audible alarm will sound when the preset point is exceeded. The frequency of the audible alarm will increase as the detection level increases.

c) If the flame-out alarm is actuated, ensure that the pump is running, then press the igniter button. Under normal conditions, flame-out results from sampling a gas mixture that is above the lower explosive level which causes the H2 flame to extinguish. If this is the case, reignition is all that is required.
Another possible cause for flame-out would be restriction of the sample flow line which would not allow sufficient air into the chamber to support combustion of the H2 flame. The normal cause for such restriction would be a clogged particle filter or other restriction in the line.
It should be noted that the chamber exhaust port is on the bottom of the case and blocking this port with the hand will cause fluctuations and/or flame-out.

2.5 SHUT DOWN PROCEDURE

The following procedure should be followed for shut down of the instrument:

1) Close H2 SUPPLY VALVE.
2) Close H2 TANK VALVE.
3) Move INSTR Switch to OFF.
4) Wait 5 seconds and move PUMP Switch to OFF. INSTRUMENT IS NOW IN A SHUT DOWN CONFIGURATION.

2.6 FUEL REFILLING

a) The instrument should be completely shut down as described in Section 2.5 herein during hydrogen tank refilling operations. The refilling should be done in a ventilated area. **There should be no potential igniters or flame in the area.**

b) If you are making the first filling of the instrument or if the filling hose has been allowed to fill with air, the filling hose should be purged with N2 or H2 prior to filling the instrument tank. This purging is not required for subsequent fillings.

c) The filling hose assembly should be left attached to the hydrogen supply tank when possible. Ensure that the FILL/BLEED Valve on the instrument end of the hose is in the OFF position. Connect the hose to the refill connection on the Side Pack Assembly.

d) Open the hydrogen supply bottle valve slightly. Open the REFILL VALVE and the H2 TANK VALVE on the instrument panel and place the FILL/BLEED Valve on the filling hose assembly in the FILL position. The pressure in the instrument tank will now be indicated on the H2 TANK PRESSURE Indicator.

e) After the instrument fuel tank is filled, shut off the REFILL VALVE on the panel, the FILL/BLEED Valve on the filling hose assembly and the hydrogen supply bottle valve.

f) The hydrogen trapped in the hose should now be bled off to atmospheric pressure. CAUTION should be used in this operation as described in Step (g) below, since the hose will contain a significant amount of hydrogen at high pressure.

g) The hose is bled by turning the FILL/BLEED Valve on the filling hose assembly to the BLEED position. After the hose is bled down to atmospheric pressure, the FILL/BLEED Valve should be turned to the FILL position to allow the hydrogen trapped in the connection fittings to go into the hose assembly. Then, again, turn the FILL/BLEED Valve to the BLEED position and exhaust the trapped hydrogen. Then turn the FILL/BLEED Valve to OFF to keep the hydrogen at one atmosphere in the hose so that at the time of the next filling there will be no air trapped in the filling line.

h) Close the H2 TANK VALVE.

i) With the H2 TANK VALVE and the H2 SUPPLY VALVE closed, a small amount of H2 at high pressure will be present in the regulators and plumbing. As a leak check, observe the H2 TANK PRESSURE Indicator while the remainder of the system is shut down and ensure that the pressure indication does not go down rapidly, indicating a significant leak. If it does decrease rapidly (greater than 350 PSIG/hr.), there is a significant leak in the H2 supply system.

2.7 BATTERY RECHARGING

a) Plug charger BNC connector into mating connector on battery cover and insert AC plug into 115 VAC wall outlet. Never charge in a hazardous area or environment.

b) Move the battery charger switch to the ON position. The light above the switch button should illuminate.

c) Battery charge condition is indicated by the meter on the front panel of the charger; meter will deflect to the right when charging. When fully charged, the pointer will be in line with "charged" marker above the scale.

d) Approximately one hour of charging time is required for each hour of operation. However, an overnight charge is recommended. The charger can be left on indefinitely without

damaging the batteries. When finished, move the battery charger switch to OFF and disconnect from the Side Pack Assembly.

The following are special instructions relative to batteries which have been allowed to completely discharge.

It has been established that the above battery recharging procedures may not be sufficient when the operator of the instrument has inadvertently left the INSTR Switch ON for a period of time without recharging and allowed the battery to completely discharge.

When this happens and the above procedures fail to recharge the battery, the following should be accomplished:

1) Remove the battery from the instrument case.
2) Connect to any variable DC power supply.
3) Apply 40 volts at 1/2 amp maximum.
4) Observe the meter on the power supply frequently and as soon as the battery begins to draw current, reduce the voltage on the power supply at a slow rate until the meter reads approximately 15 volts. NOTE: The time required to reach the 15 volt reading will depend on degree of discharge.
5) Repeat steps a), b), c), and d) above to continue charging.

2.7.2 DC CHARGER

a) The optional DC charger is designed to both charge the battery and to provide power for operating the instrument from a 12 volt DC source, such as vehicle power.
b) Connect the DC charger cord to the connector on the battery cover of the Side Pack Assembly. Plug the line cord into the vehicle cigarette lighter or other power source connection.
c) In mobile applications, the DC charger is used to supply vehicle power to the instrument. Therefore, it may be left connected at all times.

2.8 CHARCOAL FILTERING

When it is desired to preferentially remove the heavier hydrocarbons, such as those associated with automobile exhaust, gasoline, etc., simply remove the pickup fixture from the end of the probe and install the optional charcoal filter assembly.

This same charcoal filter assembly can be installed directly into the Readout Assembly by using the adapter provided.

2.9 MOISTURE FILTERING

Filtering of moisture in the sample is not normally required. However, when moving in and out of buildings in cold weather, excessive condensation can form in the lines and detector chamber. In this case, the charcoal filter adapter can be filled with a desiccant such as "Drierite" which will filter out the moisture contained in the sample.

SECTION 3

SUMMARIZED OPERATING PROCEDURES

3.1 GENERAL

The procedures presented in this section are intended for use by personnel generally familiar with the operation of the instrument. Section 2 presents the comprehensive detailed operating procedures.

It is assumed that, prior to start up the positions of all switches and valves are in shut down configuration as described in paragraph 3.3.

3.2 START UP

a) Move PUMP Switch to ON and check battery condition by moving the INSTR Switch to the BATT position.
b) Move INSTR Switch to ON and allow five (5) minutes for warm-up.
c) Set Alarm Level Adjust Knob on back of Readout Assembly to desired level.
d) Set CALIBRATE Switch to X10 position, use CALIBRATE Knob and set meter to read 0.
e) Move PUMP Switch to ON position then place instrument panel in vertical position and check SAMPLE FLOW RATE indication.
f) Open the H2 TANK VALVE and the H2 SUPPLY VALVE.
g) Depress Igniter Button until burner lights. Do not depress Igniter Button for more than six (6) seconds. (If burner does not ignite, let instrument run for several minutes and again attempt ignition.)
h) Use CALIBRATE Knob to "zero" out ambient background. For maximum sensitivity below 10 ppm, set CALIBRATE Switch to X1 and readjust zero on meter. To avoid false flame-out alarm indication, set meter to 1 ppm with CALIBRATE Knob and make differential readings from there.

3.3 SHUT DOWN

a) Close the H2 SUPPLY VALVE and the H2 TANK VALVE.
b) Move the INSTR Switch and PUMP Switch to OFF.
c) Instrument is now in shut down configuration.

SECTION 4

CALIBRATION

4.1 GENERAL

The OVA is capable of responding to nearly all organic compounds. For precise analyses it will be necessary to calibrate the instrument with the specific compound of interest. This is especially true for materials containing elements other than carbon and hydrogen.

The instrument is factory calibrated to a methane in air standard. However, it can be easily and rapidly calibrated to a variety of organic compounds. A GAS SELECT control is incorporated on the instrument panel which is used to set the electronic gain to a particular organic compound.

Internal electronic adjustments are provided to calibrate and align the electronic circuits. There are four (4) such adjustments all located on the electronics board. One adjustment potentiometer, R-38, is used to set the power supply voltage and is a one-time factory adjustment. The remaining three adjustments, R-31, R-32 and R-33 are used for setting the electronic amplifier gain for each of the three (3) calibrate ranges. Access to the adjustments is accomplished by removing the instrument from its case. Figure 4-1 indicates the location of the adjustments.

4.2 ELECTRONIC ADJUSTMENTS

Primary calibration of this instrument is accomplished at the factory using methane in air sample gases.

4.2.1 GAIN ADJUSTMENT

a) Place instrument in normal operation with CALIBRATE Switch set to X10 and GAS SELECT control set to 300.
b) Use the CALIBRATE ADJUST (zero) Knob and adjust the meter reading to zero.
c) Introduce a methane sample of a known concentration (near 100 ppm) and adjust trimpot R-32 on circuit board (see Figure 4-1 for location) so that meter reads equivalent to the known sample.
d) This sets the instrument gain for methane with the panel mounted gain adjustment (GAS SELECT) set at a reference number of 300.
e) Turn off H2 SUPPLY VALVE to put out flame.

4.2.2 BIAS ADJUSTMENT

a) Leave CALIBRATE Switch on X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to 4 ppm.
b) Place CALIBRATE Switch in X1 position and, using trimpot R-31 on circuit board, adjust meter reading to 4 ppm. (See Figure 4-1)
c) Move CALIBRATE Switch to X10 position again. Use CALIBRATE ADJUST (zero) Knob to adjust meter to a reading of 40 ppm.
d) Move CALIBRATE Switch to X100 position and use trimpot R-33 on circuit board to adjust meter reading to 40 ppm.
e) Move CALIBRATE Switch to X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to zero.
f) Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

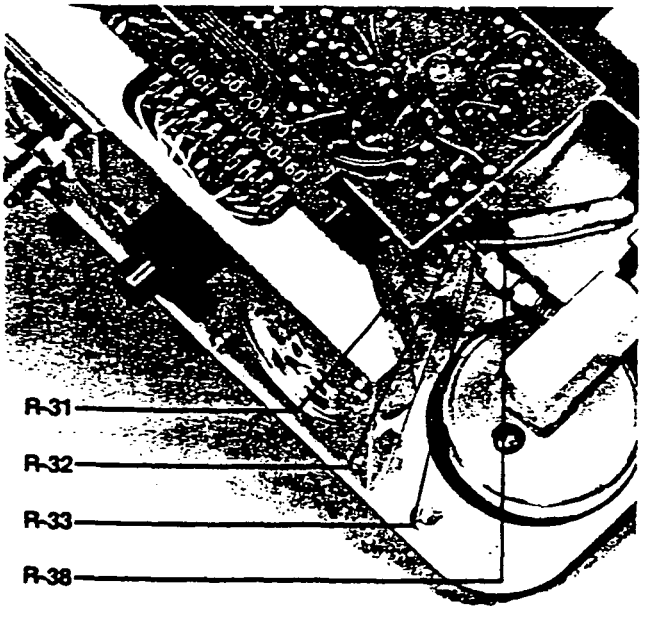


FIGURE 4-1. LOCATION OF ELECTRONIC ADJUSTMENTS
(Model OVA-118 shown; location typical to OVA-128)

4.3 CALIBRATION TO OTHER ORGANIC VAPORS

4.3.1 SETTING GAS SELECT CONTROL (Span)

Primary calibration of the instrument is accomplished using a known mixture of a specific organic vapor compound. After the instrument is in operation and the "normal background" is "zeroed out", draw a sample of the calibration gas into the instrument. The GAS SELECT Knob on the panel is then used to shift the readout meter indication to correspond to the concentration of the calibration gas mixture.

The instrument is then calibrated for the vapor mixture being used. After this adjustment, the setting on the "digidial" is read and recorded for that particular organic vapor compound. This exercise can be performed for a large variety of compounds and when desiring to read a particular compound the GAS SELECT control is turned to the predetermined setting for the compound. Calibration on any one range automatically calibrates the other two ranges.

4.3.2 USING EMPIRICAL DATA

Relative response data may be obtained, which can then be used to estimate concentrations of various vapors. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The relative response, in percent, for that test vapor would then be the concentration read/concentration of the calibrated sample X 100.

4.3.3 PREPARATION OF CALIBRATION STANDARDS

4.3.3.1 COMMERCIAL SAMPLES

Commercially available standard samples offer the most convenient and reliable calibration standards and are recommended for the most precise analyses. Always remember to obtain the cylinder with the desired sample and the "balance as air". Sample should be drawn from the cylinder into a collapsed sample bag, then drawn from the bag by the instrument to prevent a pressure or vacuum at the sample inlet.

4.3.3.2 PURE GASEOUS SAMPLES

Obtain a large collapsible sample bag, preferably polyethylene such as a 40 gallon trash can liner. Insert a tube into the bag opening and tie shut around the tube. The tubing should have a shut-off valve or plug and be suitable for connecting the OVA input tube. Determine the volume of the bag by appropriate means (i.e., wet-test meter, dimensions of the bag, etc.). Forty gallon polyethylene bags provide a volume of approximately 140-160 liters. For gas samples, flush a 10 cc hypodermic syringe with the compound to be tested and then inject a 10 cc sample through the wall of the air-filled bag. Immediately after withdrawing the needle, cover the hole with a piece of plastic tape. Allow a few minutes for the sample to completely diffuse throughout the bag. Agitation will ensure complete diffusion. Connect the outlet tube to the OVA and take a reading. To verify repeatability of sampling technique, disconnect the bag and inject a second sample of the gas into the bag without emptying. Since only 2 or 3 liters will have been removed, the overall volume change will be small and the instrument reading should now be twice that of the

original. The concentration in ppm (V/V) will be equal to the sample size in cc divided by the volume of the bag in liters times 1000. For example, a 10 cc gas sample when placed in a 160 liter bag will provide a sample of 63 ppm, i.e., 10 X 1000/160 equals 63 ppm.

4.3.3.3 GASEOUS AND LIQUID SAMPLES (Alternate Method)

Obtain a five (5) gallon glass bottle and determine its volume by measuring the volume of water needed to fill it (use of a 1000 ml graduated cylinder, obtainable from scientific supply houses, is convenient). Another approach is to weigh the empty bottle, fill it with water and weigh again. The difference between the two values is the weight of water. By multiplying the weight of water in pounds by 0.455, you obtain the volume of the bottle in liters. Empty the water out and allow the bottle to dry. Place a one-foot piece of plastic tubing in the flask to aid in mixing the vapors uniformly with the air. The volume of such a bottle should be about 20 liters, which is 20,000 ml. If the volume were 20,000 ml, then a 2 ml sample of a gas placed in the bottle would be equivalent to 200 ml per 2 million ml or 100 ppm (V/V). Use of a gas tight syringe, readable in 0.01 ml, allows the preparation of mixtures in the 1 - 2 ppm range, which are sufficient for the quantitative estimation of concentrations. A rubber stopper is loosely fitted to the top of the bottle and the needle of the syringe placed inside the jug neck and the stopper squeezed against the needle to decrease leakage during sample introduction. Inject the sample into the bottle and withdraw the needle without removing the stopper. Put the stopper in tight and shake the bottle for a few minutes with sufficient vigor that the plastic tubing in the bottle moves around to ensure good mixture of the vapors with the air.

For liquid samples, use of the following equation will allow the calculation of the number of microliters of organic liquid needed to be placed into the bottle to make 100 ppm (V/V) of vapor.

V1 equals V2 X Mw/244D

- V1 - Volume of liquid in microliters needed to make an air mixture of 100 ppm (V/V)
- V2 - Volume of bottle in liters
- Mw - Molecular weight of substance
- D - Density of substance

This procedure has the advantage that you can see when all of the organic liquid has vaporized and the volume can be determined readily.

For liquid samples, an alternate procedure involves the use of a diffusion dilution device such as that described by Desty, Geach and Goldup in "Gas Chromatography", R.P.W. Scott, ed., Academic Press, New York, 1961.

4.4 THEORY

Theoretical background and empirical data related to the Century Organic Vapor Analyzer is presented in 4.4.1 and 4.4.2.

4.4.1 HYDROCARBONS 3959

In general, a hydrogen flame ionization detector is more sensitive for hydrocarbons than any other class of organic compounds. The response of the OVA varies from compound to compound, but gives excellent repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

The typical relative response of various hydrocarbons to methane is as follows:

Compound	Relative Response (percent)
Methane	100 (reference)
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

4.4.2 OTHER ORGANIC COMPOUNDS

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carbolic acid and esters give a somewhat lower response than that observed for hydrocarbons. This is particularly noticeable with those compounds having a high ratio of oxygen to carbon such as found in the lower members of each series which have only one, two or three carbons. With compounds containing higher numbers of carbons, the effect of the oxygen is diminished to such an extent that the response is similar to that of the corresponding hydrocarbons.

Nitrogen-containing compounds (i.e., amines, amides and nitriles) respond in a manner similar to that observed for oxygenated materials. Halogenated compounds also show a lower relative response as compared with hydrocarbons. Materials containing no hydrogen, such as carbon tetrachloride, give the lowest response; the presence of hydrogen in the compounds results in higher relative responses. Thus, $CHCl_3$ gives a much higher response than does CCl_4. As in the other cases, when the carbon to halogen ratio is 5:1 or greater, the response will be similar to that observed for simple hydrocarbons.

The typical relative response of various compounds to methane is as follows:

Methane	100 (calibration sample)
Ketones	
Acetone	60
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Alcohols	
Methyl alcohol	15
Ethyl	25
Isopropyl	65

Halogen compounds

Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

The OVA has negligible response to carbon monoxide and carbon dioxide which evidently, due to their structure, do not product appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

[redacted]

SECTION 5

SAFETY CONSIDERATIONS

5.1 GENERAL

The Models OVA-108, OVA-128 and OVA-138 have been tested and certified by Factory Mutual Research Corporation (FM) as intrinsically safe for use in Class I, Division 1, Groups A, B, C & D hazardous atmospheres. Similar foreign certifications have been obtained, including BASEEFA and Cerchar approval for Group IIC, Temperature Class T4 on the Models OVA-108, OVA-128 and OVA-138, and equivalent approval from the Japanese Ministry of Labor for the Model OVA-128. Special restrictions must be strictly adhered to, to ensure the certification is not invalidated by actions of operating or service personnel.

All flame ionization hydrocarbon detectors are potentially hazardous since they burn hydrogen (H2) or H2 mixtures in the detector cell. Mixtures of H2 and air are flammable over a wide range of concentrations whether an inert gas such as nitrogen (N2) is present or not. Therefore, the recommended precautions and procedures should be followed for maximum safety. Safety considerations was a major factor in the design of the Organic Vapor Analyzer (OVA).

All connectors are of the permanent type as opposed to quick disconnect. To protect against external ignition of flammable gas mixtures, the flame detection chamber has porous metal flame arrestors on the sample input and the exhaust ports as well as on the H2 inlet connector. The standard battery pack and other circuits are internally current limited to an intrinsically safe level.

5.2 OPERATING, SERVICING AND MODIFYING

It is imperative that operation and service procedures described in this manual be carefully followed in order to maintain the intrinsic safety which is built into the OVA. No modification to the instrument is permissible. Therefore, component replacement must be accomplished with the same type parts.

5.3 ELECTRICAL PROTECTION

The 12V battery power supply circuit is current limited to an intrinsically safe level. Fuses are not utilized and all current limiting resistors and other components which are critical to the safety certification are encapsulated to prevent inadvertent replacement with components of the wrong value or specification. Under no circumstances should the encapsulation be removed.

5.4 FUEL SUPPLY & TANK

The OVA fuel tank has a volume of 75 to 85 cc which, when filled to the maximum rated pressure of 2300 PSIG, holds approximately 5/8 cubic foot of gas. The fuel used in the OVA is pure hydrogen which can be readily purchased in a highly pure form at nominal cost. The H2 tanks used in the instrument are made from stainless steel, proof-tested to 6,000 PSIG and 100% production tested to 4,000 PSIG.

5.5 H2 FLOW RESTRICTORS

Hydrogen gas gains heat when expanding and, therefore, should not be rapidly released from a high pressure tank to a low pressure environment. Flow restrictors are incorporated in the H2 refill fitting and H2 is restricted on the output side of the tank by the low flow rate control system. In addition, a special flow restrictor is incorporated in the FILL/BLEED valve of the hydrogen filling hose assembly. These precautions limit the flow rate of the H2 to prevent ignition due to self-heat from expansion.

5.6 DETECTOR CHAMBER

The OVA has a small flame ionization chamber cavity with sintered metal flame arrestors on both the input and output ports. The chamber is ruggedly constructed of teflon such that even if highly explosive mixtures of H2 and air are inadvertently created in the chamber and ignited, the chamber would NOT rupture.

5.7 H2 FILLING AND EMPTYING OPERATIONS

Precautions should be taken during H2 filling or H2 tank emptying operations to ensure that there are no sources of ignition in the immediate area. Since the instrument tank at 2300 PSIG holds only 5/8 cu. ft. of H2, the total quantity, if released to the atmosphere, would be quickly diluted to a non-flammable level. There is, however, the possibility of generating flammable mixtures in the immediate vicinity of the instrument during the filling or emptying operations if normal care is not exercised.

5.8 VENTING

The OVA case is vented to eliminate the possibility of trapping an explosive mixture of H2 and air inside the case.

SECTION 6

MAINTENANCE

6.1 GENERAL

This section describes the routine maintenance schedule recommended and provides procedures for trouble shooting malfunctions or failures in the instrument.

Appendix "A" to this manual contains the assembly drawings and associated parts list for the Side Pack Assembly and two major subassemblies; the Electronic Component Assembly and the Cylinder Assembly. These drawings and parts lists may be used for locating and identifying components. Also included in Appendix "A" is a schematic wiring diagram showing interconnecting wiring between major electronic assemblies and typical signal levels at selected points on the certified instruments. The enclosed drawings and parts lists are subject to change without notice and part replacement on any certified instrument should be verified to comply with the "no modifications permitted" requirement.

CAUTION

Maintenance personnel should be thoroughly familiar with instrument operation before performing maintenance. It is essential that all portions of this manual relating to safety of operation, servicing and maintenance, including Section 5, be thoroughly understood. There should be no potential igniters or flame in the area when filling, emptying or purging the hydrogen system and the instrument should be turned off.

Extreme care should be exercised to ensure that required parts replacement is accomplished with the same parts specified by Century. This is especially necessary on the Models OVA-108, OVA-128 and OVA-138 in order that their certification for use in hazardous atmospheres be maintained. No modifications are permitted. Disassemble instrument only in a non-hazardous atmosphere.

6.2 ROUTINE MAINTENANCE

Note that Figure 6-1 is a flow diagram of the basic gas handling system.

6.2.1 FILTERS

6.2.1.1 PRIMARY FILTER

This filter is located behind the sample inlet connector (Fitting Assembly) on the Side Pack Assembly and is removed for cleaning by using a thin wall socket to unscrew the Fitting Assembly. The filter cup, "O" ring and loading spring will then come out as shown in the Side Pack Assembly drawing in Appendix "A". The porous stainless filter cup can then be cleaned by blowing out or washing in a solvent. If a solvent is used, care should be taken to ensure that all solvent is removed by blowing out or heating the filter. Reassemble in reverse order ensuring that the "O" ring seal on the Fitting Assembly is intact.

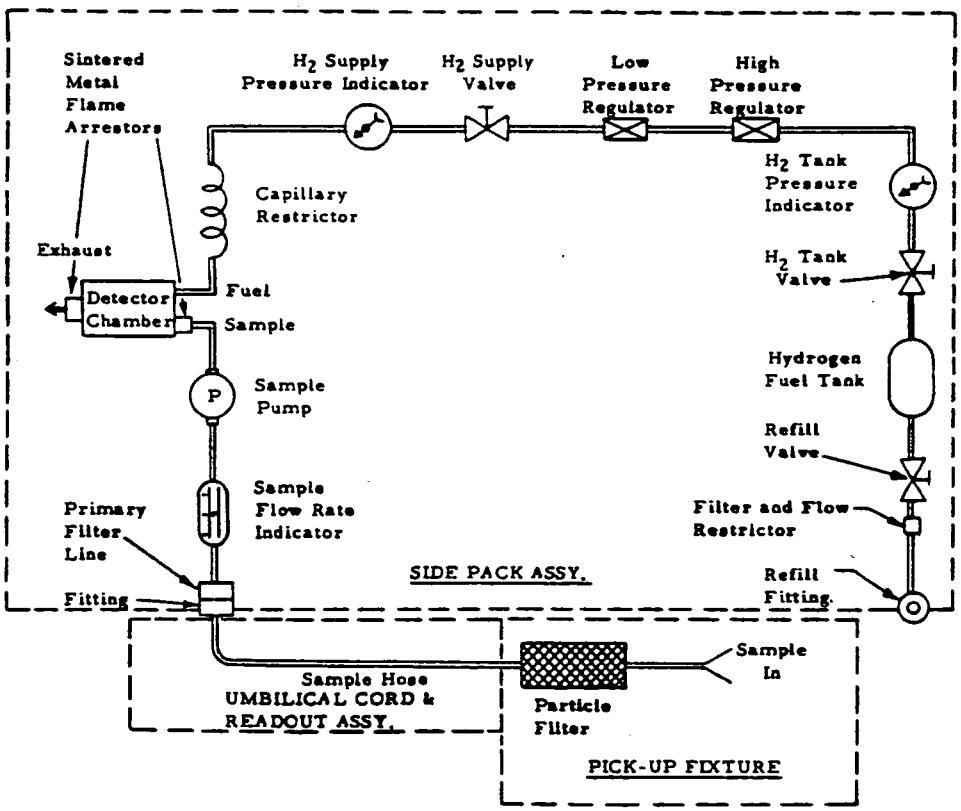


FIGURE 6-1. Flow Diagram - Gas Handling System

6.2.1.2 PARTICLE FILTERS

A particle filter is located in each pickup fixture. One of these filters must be in the sample line whenever the instrument is in use. The Models OVA-88 and OVA-138 use a disposable cellulose filter which should be changed as often as required. The Models OVA-98, OVA-108, OVA-118 and OVA-128 use a porous metal filter which can be replaced or cleaned using the cleaning procedure in paragraph 6.2.1.1.

6.2.1.3 MIXER/BURNER ASSEMBLY FILTER

Another porous metal particle filter is incorporated in the Mixer/Burner Assembly which screws into the Preamp Assembly. See Side Pack Assembly drawing. This filter is used as the sample mixer and inlet flame arrestor in the chamber. This filter should not become contaminated under normal conditions but can be cleaned or the assembly replaced if necessary.

Access to this filter for output surface cleaning is gained by simply unscrewing the exhaust port from the Preamp Assembly without removing the instrument from the case. The OVA-108, OVA-128 and OVA-138 instruments require removal of the safety cover prior to unscrewing the exhaust port. The Filter Assembly can now be seen on the side of the chamber (Preamp Assembly) and can be scrapped or cleaned with a small wire brush.

If filter replacement is required, install a new or factory rebuilt Mixer/Burner Assembly. In several OVA models, this requires removal of the Preamp Assembly.

6.2.1.4 EXHAUST FLAME ARRESTOR

A porous metal flame arrestor is located in the exhaust port of the detector chamber (Preamp Assembly). See Side Pack Assembly drawing. It acts as a particle filter on the chamber output and restricts foreign matter from entering the chamber. This filter may be cleaned, if required, by removing the exhaust port from the Preamp Assembly. The exhaust port is removed from the bottom of the case without case removal. Note that the filter is captive to the exhaust port on the Models OVA-108, OVA-128 and OVA-138. Clean the filter with a solvent or detergent but ensure that it is dry and any solvent completely baked out at 120°F before reinstalling.

6.2.2 PICKUP FIXTURES

The pickup fixtures should be periodically cleaned with an air hose and/or detergent water to eliminate foreign particle matter. If a solvent is used, the fixture should be subsequently cleaned with detergent and baked out at 120°F to eliminate any residual hydrocarbons from the solvent.

6.2.3 SEAL MAINTENANCE - CYLINDER ASSEMBLY

6.2.3.1 H2 TANK, H2 SUPPLY AND REFILL VALVES

After some time, the teflon washers under each valve packing nut can "cold flow" (move with pressure) and allow hydrogen to leak. Leakage can be determined by using Leak-Tec, Snoop or a soap solution around the valve stems. This leakage can usually be stopped by tightening the compression nut (adapter) as outlined below. See Side Pack Assembly and Cylinder Assembly drawings.

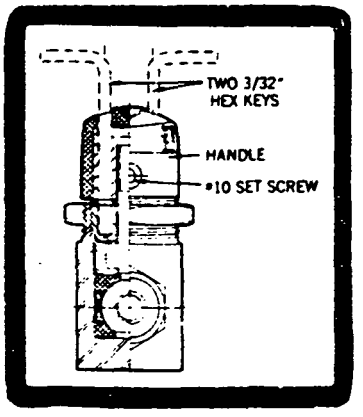
1) Remove instrument from the case by unlocking the four (4) 1/4 turn fasteners on the panel and removing the exhaust safety cover (if included), exhaust port and refill cap nut. Be sure refill valve is closed before removing refill cap nut.
2) Remove the valve knob screw and knob.
3) Loosen the panel nut with a 3/4" wrench.
4) The valve compression nut is located just under the panel. Tighten the compression nut—usually not more than 1/4 turn.

This compression is against soft material and only a small amount of force is necessary to sufficiently compress the teflon washers. If, after tightening, leakage still occurs, it would be advisable to replace the two teflon washers, as follows:

1) Drain hydrogen system slowly and to the extent necessary to work on the leaking valve(s). Observe safety precautions (see Section 5). There should be no potential igniters in the area.
2) Disconnect the capillary tube from the manifold at low pressure gauge (H2 Supply Pressure).
3) Remove all three (3) knob screws and knobs.
4) Remove the three (3) panel nuts and washers.
5) Carefully remove the tank assembly from the panel. NOTE: If OVA has GC Option installed the GC valve assembly must be loosened or removed in order to remove the tank assembly from the panel.
6) Remove the compression nut on the valve that is not sealing properly. Remove the stem by unscrewing it from the valve body. Observe the sandwich of metal and teflon washers and note their order.
7) Visually check the Kel-F seat on the stem for cracks or foreign material. Wipe clean, if necessary, with a lint free cloth (no solvents or oils) and replace if damaged.
8) Remove the washers and replace the teflon washers (the factory procedure is a light wipe of hydrocarbon free silicone grease).
9) Replace the stem assembly in the valve body and tighten lightly.
10) Push the washers down into the compression area in the same order as noted upon removal. Replace the compression nut and tighten snugly.
11) Close the low pressure valve and fill the tank assembly. Check valves for leaks. Tighten again, if necessary, and reassemble the unit.

6.2.3.2 REFILLER VALVE PACKING ADJUSTMENT

Adjustment for the valve on the refiller can be made by loosening the set screw with a 3/32" hex key, so that the handle turns freely on the stem. Insert two (2) 3/32" hex keys through the holes provided in the handle and turn until they engage the holes in the packing adjuster. Then tighten the packing by turning the handle.



6.2.4 AIR SAMPLING SYSTEM MAINTENANCE

6.2.4.1 GENERAL

A potential problem associated with the OVA instrument is that leaks can develop in the air sample pumping system. These leaks can result in either dilution or loss of sample, causing low reading of high concentration and slow response time.

6.2.4.2 TESTING FOR LEAKS

The OVA's a re equipped with a flow gauge, which provides a method to check for air leaks. Assemble the pickup probe selected for use to the readout assembly and then position the sidepack vertically so the flow gauge may be observed. Cover the end of the pickup probe with your finger and observe that the ball in the flow gauge goes to the bottom, indicating no air flow (if ball has slight chatter while on bottom, this is acceptable). Cover the center of the chamber exhaust port with your thumb and again observe the ball going to the bottom. Another simple check is to expose the pickup probe to cigarette smoke or a light vapor (butane) and observe that the meter responds in approximately 1.5 - 2.0 seconds. It should be noted that slow meter response may also indicate a restriction in the air sampling system.

6.2.4.3 LEAK ISOLATION

Failure of the ball to go to the bottom when the inlet is blocked indicates a leak in the system between the probe and the pump inlet or the inlet check valve. To isolate the problem, remove parts, one at a time, and again block off the air inlet. Remove the pickup probe(s) and cover the air inlet at the Readout Assembly. If the ball goes to the bottom, check that the "readout to probe" seal washer is in place and replace the probes, holding them back against this seal while tightening the nut. Recheck, and if leakage is still present, it is probably in the probe (pickup fixture), which should be repaired or replaced.

If leakage is indicated as being past the readout handle when the connection to the sidepack is tight, disconnect the sample line at the fitting on the sidepack and cover this inlet with your finger. If the flow gauge ball goes to the bottom, the problem should be a leak in the umbilical cord/Readout Assembly, which should be investigated and repaired. There is also the possibility of a leaking check valve in the pump which would not show up on this test. If the leakage is not found in the umbilical cord, it is most likely in the pump check valve which should be repaired or replaced.

If the ball does not go to the bottom, the leak will be either in the flow gauge or it's connecting tubing. Visually check that the tubing is connected and if so, the flow gauge should be repaired or replaced. Check the "O" ring installation in the sample inlet connector (Fitting Assembly).

As an alternate approach, leaks on the inlet side of the pump can be detected by using alcohol on a "Q" Tip and lightly swabbing the connections one at a time or by directing organic vapor or smoke at the potential leakage points and observing the meter response or audible alarm.

Leaks (beyond the pump) are easier to locate, as any of the commercially available leak detection solutions can be used. Cover the exhaust port, which will place the exhaust system under pressure, and check each connection, one at a time. Replace the teflon tubing or retape the threaded connections with teflon joint tape. Check the igniter and Mixer/Burner Assembly where they screw into the detector, the high voltage terminal screw on the side of the Mixer/Burner and exhaust port itself. If after these checks, the flow gauge ball still will not go to the bottom with the exhaust blocked, the problem is likely a leaking exhaust check valve in the pump, which should be repaired or replaced.

6.2.5 CONTAMINATION CONTROL AND MAINTENANCE

6.2.5.1 GENERAL

On occasion, the background reading of the OVA may be relatively high under normal ambient conditions. Ambient background readings will vary somewhat depending on the geographical location where the instrument is being used. However, the background reading normally should be in the range of 3 to 5 ppm as methane. The acceptable background reading consists of 1 to 1-1/2 ppm of methane which is present in the normal air environment. In addition to the measurement of a normal methane background, there will normally be 2 to 4 ppm of equivalent methane background caused by acceptable levels of contamination in the hydrogen fuel and/or hydrogen fuel handling system resulting in a total equivalent methane reading of 3 to 5 ppm in clean air.

If the background reading goes above 5 ppm to 6 or 7 ppm, this is normally still acceptable since any measurement is additive to that background reading, i.e., 2 ppm on top of 5 or 2 ppm on top of 7 provides the same differential reading, however, the lower background is obviously desirable.

The background reading on the linear OVA's is zeroed out or nulled out—even though in reality the background still exists. The background reading on the

linear OVA's is measured by zeroing the meter with the flame out and noting the meter indication after the flame is on. However, on the logarithmic scaled OVA's the background reading is observed on the meter at all times. This is considered desirable since it assures the operator that the instrument is, in fact, operating properly. The background reading on the OVA's serves as a low level calibration point since it does represent the measurement of ambient levels of methane in the air, which are extremely stable and predictable any place in the world.

The cause for a high background reading is usually associated with contamination in the hydrogen fuel system. This will, of course, cause a background reading since this is the function of the basic detector "to measure contamination entering the detector chamber". In addition, contamination present in the hydrogen will many times leave a small unobservable deposit on the burner face which can continue to generate a background reading when the detector is in operation and the burner assembly is heated.

Another possible cause of contamination is the mixer/burner assembly when the contamination is trapped in the porous bronze sample filter. This is not a common problem and usually only happens when an unusually high level of contaminant is drawn into the assembly. Another possible cause of high background reading is contamination someplace in the air sample line to the detector. This is also uncommon but can be the source of the problem.

NOTE

OVA's that include the Chromatograph Option installed can also have an indication of high background related to saturation or contamination of the activated charcoal filter, which is in the line during chromatograph analysis, or of the column which is in the hydrogen line at all times.

6.2.5.2 ANALYSIS AND CORRECTION

Prior to analyzing the problem, the OVA should be checked for proper electronic operation. Check logarithmic instruments for proper high and low calibration points and for proper gas selector operation (see Section 4). On logarithmic OVA's, check Gas Selector by turning to 500 and observing the flame-out alarm comes on as the needle goes below 1 ppm. It should be ensured that the instrument is calibrated to methane as referenced.

If, after checking that the OVA is properly calibrated, the background is still higher than normal for ambient conditions, the following procedure should be followed to isolate the cause of the problem.

1) Let the OVA run for a period of time (15 to 30 minutes) and see if the background level decreases as a function of time. The background could go down and stay down as a result of clearing line contamination which is removable simply by the normal flow of air through the sample line.
2) Take a reading in a known, relatively clean air environment. Normally, outside air environment is clean enough to assess by compariso whether the background reading is internal t the instrument or is present in the laborator office or location where the instrument is bein used.
3) If the OVA includes the Gas Chromatograph Op tion, depress the sample inject valve so that th activated charcoal is in the line and observ whether the background reading goes dow and stays steady after the elution of the a peak. The reading should always go down c stay the same but never be a highe background reading with the sample valv depressed, since the charcoal filter will tak out any trace elements of organic vapors in th air heavier than a C_2. If another activated cha coal filter is available, this may be attached t the end of the probe to scrub the air so that clean air sample would be going to the detec tor. The external activated charcoal can be us ed on any instrument, with or withou chromatograph, for providing a clean air san ple to assess background level.
4) If background still stays up and cannot b reduced by any of the previous steps, the saf ty cover (if included) and the exhaust port c the detector chamber (Preamp Assembly) c the bottom of the case should be removed ar the Mixer/Burner Assembly scraped or brus ed with a small wire brush. (Referenc paragraph 6.2.1.3.) This will remove any sma quantities of contamination that are on the Mi er/Burner Assembly which could be the sourc of the background vapor. After cleaning th face of the burner and tube, replace the e haust port and safety cover (if included) ar reignite the OVA. If contamination on th burner face was the cause, the problem shou be immediately resolved and the ambie background will drop to an acceptable level.
5) If the background is still present, place yo finger over the inlet of the probe so as reduce the flow of air to the detector chambe Reduced flow rate may be observed either c the sample flow gauge or can normally b observed by the sound of the pump motor.
6) If the background drops immediately response to the reduced flow of air to th chamber, this is an indication that the co tamination is in the air sample line. Therefor the various parts of the sample flow line suc as pickup probes, umbilical cord to the instr ment, etc., should be investigated by the pr cess of elimination to see if the contaminatic can be isolated.
7) Serious contamination in the air sample line very uncommon. However, if very large dose of very heavy compounds are sampled, there a possibility of a residual contamination whic would eventually clear itself out but may take considerable period of time. A typical cause f the high background from the sample line is

contaminated Mixer/Burner Assembly. See paragraph (4) above for cleaning procedure. If heavy contamination of the Mixer/Burner is still indicated by a high background, replace the Mixer/Burner Assembly. In several OVA models, this will require removal of the Preamp Assembly. The old Mixer/Burner Assembly should be either discarded or returned to the factory for cleaning and rebuilding.

8) In the event there is contamination in the pump or other internal parts of the sample flow lines which cannot be removed, the sample flow components would have to be disassembled and cleaned. This is normally a factory type operation. However, the components such as the pump can be replaced in the field along with any contaminated tubing in the sample lines.

9) High background readings on OVA's which include the Gas Chromatograph Option can be caused by other sources of contamination. If the charcoal in the charcoal filter mounted on the panel of the instrument is contaminated or saturated, contaminated air would be supplied to the detector and raise the ambient level background. To check for this, the charcoal filter cartridge can be removed from the panel and either a bypass tube put between the two connectors or the charcoal can be removed from the charcoal cartridge and the cartridge refilled with clean activated charcoal. This would determine if the charcoal was the source of the background reading. It is possible that an apparent high background reading could be due to contamination in the column that is on the instrument. This background could be caused by compounds that are slowly eluting from a column which has become contaminated. The easiest way to check for column contamination is to replace the column with a known clean column or a short empty piece of column tubing and see if the high background reading drops.

10) If all the above steps do not correct the high background problem, the cause will normally be contamination in the hydrogen fuel system.

Contamination in the hydrogen fuel system is usually the direct result of contamination in the hydrogen gas used or contamination introduced during the filling operation. Filling hose contamination can be caused by storing the hose in a contaminated area.

To remove contamination from the hydrogen fuel system, it should be purged with hydrogen. Effective purging of the hydrogen system is accomplished by disconnecting the capillary tube fitting which attaches on to the manifold block which has the low pressure gauge (H2 Supply Pressure Gauge and H2 Supply Valve). This disconnects the capillary tubing from the hydrogen line so that hydrogen may be purged at a reasonable rate from the tank assembly through the regulators, gauges and valves. After disconnecting the capillary, the hydrogen tank can be filled in the normal manner. The tank valve and H2 supply valve can then be opened which will bleed the hydrogen from the tank through the H2 fuel system purging out the contamination which is in vapor form. There is the possibility that contamination has been introduced into the hydrogen fuel system which is not readily purged out by the hydrogen gas but this is unlikely. After purging with clean hydrogen, approximately two or three times, the capillary tube should be reconnected and the background again checked. Five or ten minutes should be allowed before assessing the background reading, since contaminated hydrogen may still have been trapped in the capillary tube.

If another tank assembly in a clean instrument is available, the fuel system from the clean instrument can be connected to the contaminated instrument to absolutely verify that it is or is not in the hydrogen fuel supply system. The interconnection should be made to the capillary tube of the contaminated instrument.

6.2.6 FUSE REPLACEMENT

This paragraph applies only to the standard (non-certified) OVA's. There are two (2) overload fuses incorporated in the Battery Pack Assembly, one is a 3AG-1 AMP Slo-Blo in the power line to the pump and igniter and the other a 3AG-1/4 AMP in the power line to the electronics. Both fuses follow the current limiting resistors which provide primary short circuit protection. However, in the event of an excessive overload, the fuses will open and prevent overheating of the current limiting resistors. It should be pointed out that the 1 AMP Slo-Blo fuse will blow in approximately 8 to 12 seconds if the igniter switch is kept depressed. Normal ignition should take place in not more than 6 seconds. Therefore, do not depress igniter button for more than 6 seconds. If ignition does not occur, wait 1 to 2 minutes and try again. If the required 1 AMP Slo-Blo fuse cannot be readily obtained, replace temporarily with a 3 AMP-3 AG standard fuse.

6.3 TROUBLE SHOOTING

Table 6-1 presents a summary of recommended field trouble shooting procedures. If necessary, the instrument can be easily removed from the case by unlocking the four (4) 1/4 turn fasteners on the panel face and removing the refill cap and exhaust port. The battery pack is removed by taking out the four (4) screws on the panel and disconnecting the power connector at the battery pack.

6.4 FACTORY MAINTENANCE

To ensure continuous trouble-free operation, Century recommends a periodic factory maintenance, overhaul and recalibration. The recommended schedule is every six (6) to nine (9) months. This maintenance program includes replacement of plastic seals and parts as required, pump overhaul, motor check, new batteries, sample line cleaning, H2 leak check, recalibration, replacement of plastic hose as required, and detailed examination of the unit for any other required maintenance and repair.

The recommended procedure for maintenance and repair beyond the scope of this manual is to send the complete instrument or subassembly to the Century factory for repairs. The assemblies will be handled expeditiously for rapid turn-around.

6.5 FIELD MAINTENANCE

Although not recommended, where field maintenance beyond that described herein is considered essential, the assembly drawings, parts lists and schematics in Appendix "A" will be of assistance.

6.6 RECOMMENDED SPARES

Century does not recommend that spares be maintained for its instruments. However, if the instrument is to be used in a remote area or spares are desired for other reasons, the following list should be used as a guide.

RECOMMENDED SPARES

Item	Description	Part No.	Recommended Quantity					
			Standard			Approved		
			88	98	118	108	128	138
1	Igniter	510027-1	2	2	2			
2	Igniter	510461-1				2	2	2
3	Pump Valve	510067-3 (10/pkg.)	1	1	1	1	1	1
4	Pump Diaphragm (Buna-N)	510091-1	1					1
5	Pump Diaphragm (Teflon)	510063-1		1	1	1	1	
6	Cup, Filter (3/8 OD, SS)	510318-1 (5/pkg.)	1	1	1	1	1	1
7	Mixer/Burner Assy	510557-2	1					
8	Mixer/Burner Assy	510557-1		1	1			
9	Mixer/Burner Assy	510513-1				1	1	1
10	Wafer, Teflon, H_2 Valve	510160-1 (10/pkg.)	1	1	1	1	1	1
11	Washer, Brass, H_2 Valve	510160-2 (10/pkg.)	1	1	1	1	1	1
12	Exhaust Port Assy	510425-1	1	1	1			
13	Exhaust Port Assy	510530-1				1	1	1
14	Battery Pack Assy	510070-1	1	1	1			
15	Battery Pack Assy	510542-1				1	1	1
16	Sample Line Assy	510316-1		1	1	1	1	1
17	Particle Filters	510114-1	1					1
18	Particle Filters	510116-1		1	1	1	1	

NOTE: Unit quantity is each unless otherwise noted.

TABLE 6-1

DUB	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator. Nominally 2 units on flow gauge. (See also 6 below and refer to paragraph 6.2.4)	a) Check primary filter in sidepack and particle filters in the pickup assembly.	Replace or clean filter if clogged. (See paragraph 6.2.1)
	b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.	Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output, chamber input, etc. Note: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when trouble shooting.	If in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be the problem, remove and clean or replace.
2) H2 flame will not light. (See also 6 below)	a) Check sample flow rate (see 1 above).	If sample flow rate is low, follow procedure 1 above.
	b) Check igniter by removing the chamber exhaust port and observing the glow when the IGNITE Button is depressed.	If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.
	c) Check for rated H2 Supply Pressure. (Listed on calibration plate on pump bracket.)	If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.
	d) Check H2 flow rate by observing the PSI decrease in pressure on the H2 Tank Pressure gauge. The flow rate should be about 130 PSI decrease in pressure per hour. (Approximately 12 cc/min. at detector.) On instruments with GC Option, disconnect column and measure H2 flow rate with a bubble meter.	The normal cause for H2 flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the H2 Supply Pressure by one-half or one PSI. If flow rate cannot be compensated for, replace capillary tubing.
	e) Check all H2 plumbing joints for leaks using soap bubble solution. Also, shut off all valves and note pressure decay on H2 tank gauge. It should be less than 350 PSIG per hour.	Repair leaking joint.
	f) Check to see if H2 supply system is frozen up by taking unit into a warm area.	If there is moisture in the H2 supply system and the unit must be operated in subfreezing temperatures, purge the H2 system with dry N2 and ensure the H2 gas used is dry.

3359

27

	g) Remove exhaust port and check for contamination. (See Figure 6-2.)	If the chamber is dirty, clean with ethyl alcohol and dry by running pump for approximately 15 minutes. If H2 fuel jet is misaligned, ensure the porous metal flame arrestor is properly seated.
	h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.	Adjust by screwing Mixer/Burner Assembly in or out. This spacing problem should only occur after reassembling a Mixer/Burner Assembly to a Preamp Assembly.
4) H2 flame lights but will not stay lighted	a) Follow procedures 2 (a), (c), (d), (e), (g) and (h) above. Also refer to 5 below.	
5) Flame-out alarm will not go on when H2 flame is out	a) Check instrument calibration setting and GAS SELECT control setting. Refer to paragraphs 2.3.1.2 and 2.3.2.	Readjust as required to proper setting. Note that on linear OVA's the flame-out alarm is actuated when the meter reading goes below zero. On logarithmic OVA's, the alarm is actuated when the signal level goes below 1 ppm methane or equivalent.
	b) Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber).	Clean contamination and/or moisture from the chamber using a swab and alcohol, dry chamber by running pump for approximately 15 minutes.
	c) If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies.	Return preamp chamber or power board assembly to the factory for repair.
	d) Check volume control knob is turned up.	Adjust for desired volume.
6) False flame-out alarm. (Applies to linear OVA's)	a) Flame-out alarm is actuated on linear instruments when signal goes below electronic zero (eventhough flame is still on). This can be due to inaccurate initial setting, drift or a decrease in ambient concentration. Verify if this is the problem by zeroing meter with flame out and reigniting. (See paragraph 2.3.2)	When using the X1 range, adjust meter to 1 ppm rather than zero. See paragraph 2.3.2. Be sure instrument has been zeroed to "lowest expected ambient background level".
8) Slow response time, i.e., time to obtain response after sample is applied to input. (Refer to paragraph 6.2.4)	a) Check to ensure that probe is firmly seated on the rubber seal in the readout assembly.	Reseat by holding the probe firmly against the rubber seat and then lock in position with the knurled locking nut.
	b) Check sample flow rate per procedure 1 above.	See 1 above.

7) Slow recovery time, i.e., too long a time for the reading to get back to ambient after exposure to a high concentration of organic vapor.	a) This problem is normally caused by contamination in the sample input line, requiring pumping for a long period to get the system clean of vapors again. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination. (See 1 (b)).	Clean or replace contaminated sample line or assembly as required.
	b) Check flame chamber for contamination.	Clean as required.
8) Ambient background reading in clean environment is too high. (Refer to paragraph 6.2.5)	a) An ambient background reading can be caused by hydrocarbons in the H2 fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down significantly the contamination is probably in the H2 fuel.	Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on filling hose assembly.
	b) An ambient background reading can be caused by a residue of sample, building up on the face of the sample inlet filter. If the test in 8 (a) above produces a large drop in reading, this is usually the cause.	Remove the exhaust port (it is not necessary to remove instrument from case), use small wire brush from the tool kit or a knife blade and lightly scrub surface of sample inlet filter.
	c) An ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminant absorbed or condensed in the sample line. Note: It should be emphasized that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.	Clean and/or replace the sample input lines. Normally the lines will clear up with sufficient running.
9) Pump will not run	a) Check 1 AMP Slo-Blo fuse on the battery pack cover. NOTE: Certified OVA's do not have fuses.	Replace fuse. IMPORTANT: Note that fuse is a Slo-Blo type. If fuse continues to blow when igniter switch is closed, check igniter for short circuit. If igniter is not the problem, there is a short in the wiring or pump motor. Return OVA to factory or authorized repair facility.
10) No power to electronics but pump runs	a) Check 1/4 AMP fuse on the battery pack cover. NOTE: Certified OVA's do not have fuses.	Replace fuse. If fuse continues to blow, there is a short in the electronics assembly. Return OVA to factory or authorized repair facility.
11) No power to pump or electronics.	a) Place battery on charger and see if power is then available. Recharge in a non-hazardous area only.	If power is available, battery pack is dead or open. Recharge battery pack. If still defective, replace battery pack. Reference paragraph 2.7.

3959

SECTION 7

OPTIONAL ACCESSORIES

7.1 GAS CHROMATOGRAPH (GC) OPTION

7.1.1 INTRODUCTION

The Century Portable Organic Vapor Analyzers (OVA's), when used as described in the previous sections of this manual, are very efficient and accurate indicators of total organic compound concentrations on a continuous sampling basis for a period of eight (8) hours minimum and with a response time of one to two seconds. However, in areas where mixtures of organic vapors are present, it often becomes necessary to determine the relative concentration of the components and/or to make quantitative analysis of specific compounds.

To provide this additional capability, a built-in gas chromatograph (GC) system has been added as an option to the OVA series of instruments. See Figure 7-1-1 for the location of the major components and controls associated with the GC Option. When the GC Option is used as described in this section, the capability of the OVA will include both qualitative and on-the-spot quantitative analysis of specific components present in the ambient environment. The Strip Chart Recorder option, which is used with the GC Option, is described separately in paragraph 7.2.

This section is applicable only to OVA's with the optional gas chromatograph system. It is recommended that this entire section be read, along with the corresponding sections of the basic Operating and Service Manual, prior to operating the instrument.

7.1.2 DESCRIPTION AND LEADING PARTICULARS

7.1.2.1 GENERAL

When the GC Option is installed on a Century OVA, the OVA will have two modes of operation. The first mode is the measurement of total organic vapors in the same manner as described in the basic operating manual for the OVA instrument. This mode is referred to as the "Survey Mode". The OVA will be in the "Survey Mode" of operation whenever the Sample Inject Valve is in the "out" position.

The second mode of operation is called the "GC Mode". The OVA is in this mode of operation any time a sample has been injected into the GC system and the sample is being transported through the GC column. This section provides a brief description of how a gas chromatograph (GC) operates and specifically how the Century instruments perform the required operations. A complete, comprehensive discussion of gas chromatography theory, column selection and data analysis is beyond the scope of this manual.

It should be pointed out that the GC Option was designed to extend the capabilities of the Century OVA as a field type instrument. A "field type" instrument as used herein is defined as a fully portable, self-contained instrument capable of making direct on-site analysis of organic vapors in air. The OVA with GC Option can be utilized for many types of analysis in the outdoor or indoor ambient environment or for specific laboratory type analysis. The OVA was not designed to compete with the research or process type gas chromatograph but to compliment these instruments or eliminate their need in field type applications.

This manual is intended to provide an operator with sufficient information to operate and maintain the Century instrument. Century further publishes Application/Technical Notes to assist the operators in applying the instrument to actual field monitoring situations. The criteria for the design of the GC Option was the same as the basic OVA, that is, simplicity, ease of operation, high reliability, field ruggedness and minimized potential for operator error.

7.1.2.2 PRINCIPLE OF OPERATION

a) GENERAL

For those not specifically trained or familiar with gas chromatography, the technique employed in the OVA during GC Mode operation is basically a separation of components in a sample gas contacted with the material in a column. When non-interference can be achieved, each component of the sample mixture elutes from the column singly into the flame ionization detector chamber to provide its own measurable response on the meter and recorder. When used as directed in this manual, the GC Option can drastically reduce and in most cases eliminate the need for elaborate grab sample and laboratory analysis techniques and the analysis can be made on-the-spot at the point of interest.

All flame ionization detector (FID) gas chromatographs require certain elements for their operation. These elements include three flow regulated gas supplies as follows: 1) A carrier gas (normally nitrogen or helium) to transport the sample through the columns; 2) Hydrogen gas for operation of the FID; 3) A clean air or oxygen supply to support combustion of the FID. In addition, a method for injecting a known volume of sample air (aliquot) to be analyzed is required.

In standard gas chromatographs these three (3) flow regulated gases are individually supplied from pressurized cylinders equipped with regulators and flow control apparatus. The Century GC system differs in that the hydrogen (H_2) fuel for the FID is also used as the carrier gas. The clean air supply is simply the normal air sample pumped to the FID. But, during GC analysis, the air is scrubbed in a charcoal filter to provide a clean air supply. The end result is that no additional gas supplies are required to adapt the GC Option to the basic OVA instrument.

A valving arrangement is incorporated to provide a method for transferring a fixed volume of the air normally being pumped to the FID in the Survey Mode into the GC system for analysis. The sample air injected into the GC system is

the same sample being analyzed by the OVA for total organic vapor concentration. Therefore, the instrument provides the unique capability to observe the total organic vapor concentration of the sample prior to injecting it into the GC system. This operating feature is invaluable in field work where the environment is continually changing and where valuable GC analysis time must be expended only on the samples of concern.

b) SAMPLE FLOW

Figure 7-1-2 is a flow diagram illustrating the flow paths of the hydrogen (H2) fuel, sample air supply and GC injected sample aliquot. There are two push-pull valves used in the GC system, the Sample Inject Valve and the Backflush Valve.

Block D of Figure 7-1-2 illustrates the flow paths with the Sample Inject Valve in the "out" position which leaves the OVA in the Survey Mode. With this valve in the "out" position, the OVA will function in its normal manner as a total organic vapor analyzer.

Block C of Figure 7-1-2 illustrates the flow paths after the Sample Inject Valve is moved to the "in" position to initiate the GC Mode. It can be observed that the hydrogen flow path is now through the sample loop which enables the hydrogen to sweep the air sample from the loop and carry it through the GC column. It can also be observed that the sample air going to the FID chamber is now routed through the activated charcoal filter where essentially all organic vapor contamination is removed from the air. The activated charcoal filter will effectively adsorb most organic vapors with the exception of methane and ethane. The functions of the Sample Inject Valve are, therefore, to transfer a fixed volume sample of the air being monitored into the hydrogen stream and to reroute the sample air supply through a filter (scrubber).

The Backflush Valve has no prepositioning requirement to function. It can be in either the "in" or "out" position at the time a sample is injected into the GC system for analysis. The Backflush Valve simply reverses the direction of the hydrogen flow through the GC column. If the Backflush Valve is in the "out" position during sample injection and analysis, it is simply moved to the "in" position when backflushing is desired or vice versa. See blocks A and B of Figure 7-1-2.

It should be noted in Figure 7-1-2 that hydrogen is always flowing through the column and onto the FID detector and that the sample air supply is always flowing to the FID detector to provide oxygen for the hydrogen flame regardless of the operating mode.

The recommended H2 flow rate is 12 cc/min. for proper FID operation and as a standard flow rate for generating GC reference/calibration data. This H2 flow rate is adjusted by varying the H2 Supply Pressure, which is the hydrogen pressure at the input of the flow control capillary tube of the OVA. The pressure is changed by adjusting the set screw in the bonnet of the low pressure regulator, accessible by removing the battery pack from the instrument panel. To monitor the H2 flow rate, connect a bubble meter to an end of the GC column which has been disconnected from the panel fitting and move the Backflush Valve so that hydrogen is flowing out of the column. Primary H2 flow control is accomplished by the capillary tube of the OVA. However, the flow restriction of a GC column will also affect the H2 flow rate and the effect will vary with column length, type of packing and packing methods. The nominal H2 Supply Pressure is around 10 PSIG and the pressure drop across a typical 24 inch long column packed with 60/80 mesh material is approximately 1 to 1.5 PSIG. Normally, whenthe H2 flow rate is set at 12 cc/min. with a Century standard 24 inch long column, no adjustmen needs to be made when using columns from three (3) inches to four (4) feet long. Longer col umns may require H2 flow adjustment for prc per operation. Adjustment would be required i and when precisely controlled analysis was be ing conducted or when the hydrogen flow wa: too low to keep the flame burning.

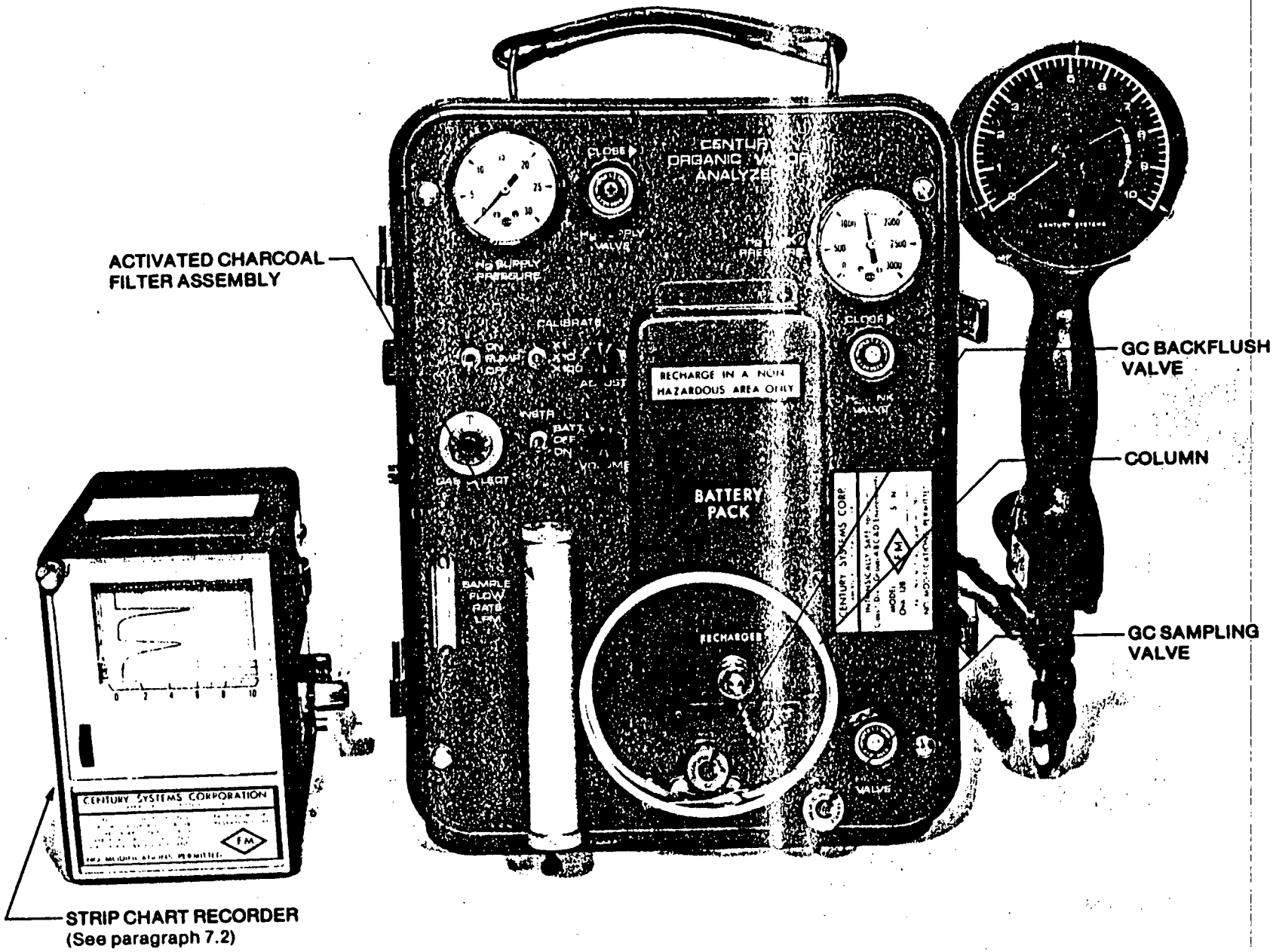
The sample air flow in the OVA is not adjustabl and is nominally 1.0 liter/minute. This flow rate should remain relatively constant. A Sam ple Flow Gauge is provided on the OVA panel t monitor the sample flow rate. (NOTE: Pane gauge is not calibrated in LPM.) When the Sam ple Inject Valve is in the "in" position, ther may be a slight increase or decrease in sampl air flow rate (0 to 15%). This change will norma ly not affect operation of the instrument as lon as the flow rate is consistent from analysis t analysis. Basically, if the sample air flow rate i consistent between calibration and end usage there will be suitable precision in th measurements.

c) GC ANALYSIS

1) Sample Injection

When the Sample Inject Valve is depress ed, the small volume of the input air sampl which is in the sample loop is injected int the hydrogen stream which transports th sample through the column for separatio of its components and on to the flam chamber for analysis. This small volume c injected sample is, therefore, qualitativel analyzed based on the retention time of th individual components of that sample whil passing through the column. Quantitativ analysis can then be accomplished by pea height or peak area analysis methods.

[redacted]


ACTIVATED CHARCOAL FILTER ASSEMBLY
GC BACKFLUSH VALVE
COLUMN
GC SAMPLING VALVE
STRIP CHART RECORDER
(See paragraph 7.2)
CENTURY SYSTEMS CORPORATION
RECHARGE IN A NON HAZARDOUS AREA ONLY
BATTERY PACK
RECHARGER
CALIBRATE
SAMPLE FLOW RATE
CENTURY SYSTEMS CORP

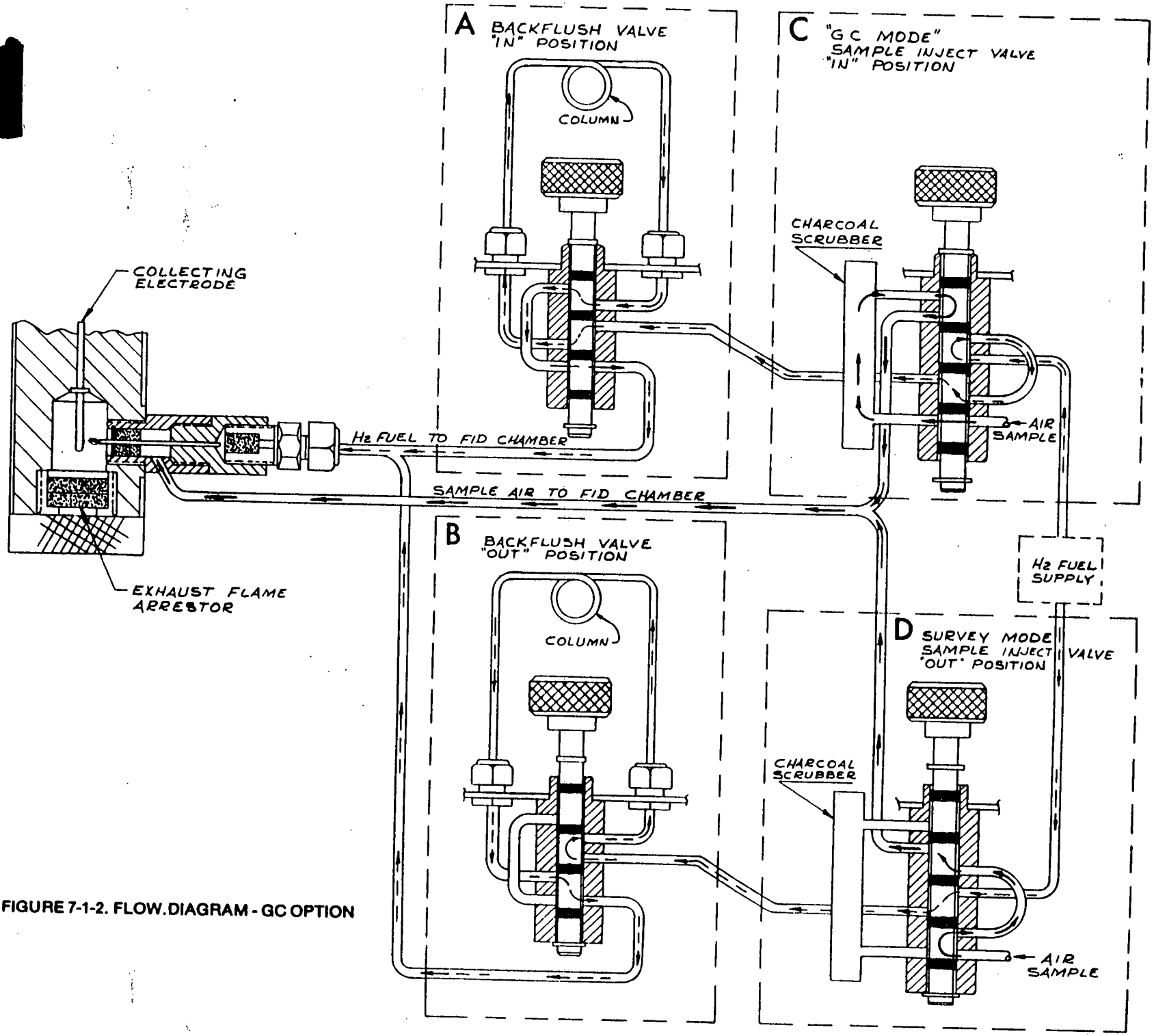


FIGURE 7-1-2. FLOW DIAGRAM - GC OPTION

[redacted] 2) The Column

The column consists of tubing packed with a material which physically interacts with the organic vapors in the air sample in a manner which slows down the passage of the vapors through the column. Since the packing material has a different attraction for each individual organic substance, each component in a mixture of gases will be slowed down to a different extent when passed through the column. The net effect is a separation of the gases in such a way that each component elutes from the column at a different time. The individual gases are then automatically fed to the detector which gives a response to the meter or to an external strip chart recorder. For example: Suppose that a sample containing benzene and toluene is injected onto the column containing appropriate packing material. As illustrated in Figure 7-1-3, a portion of the benzene and toluene are adsorbed on the packing material. The amounts involved depends on the relative affinities of the two components for the packing material. The carrier gas moves the gaseous phase forward a short distance, and since benzene will have less affinity than does toluene, it will be moved through the column more readily and thus a separation of these two components takes place and benzene reaches the detector at the exit of the column first.

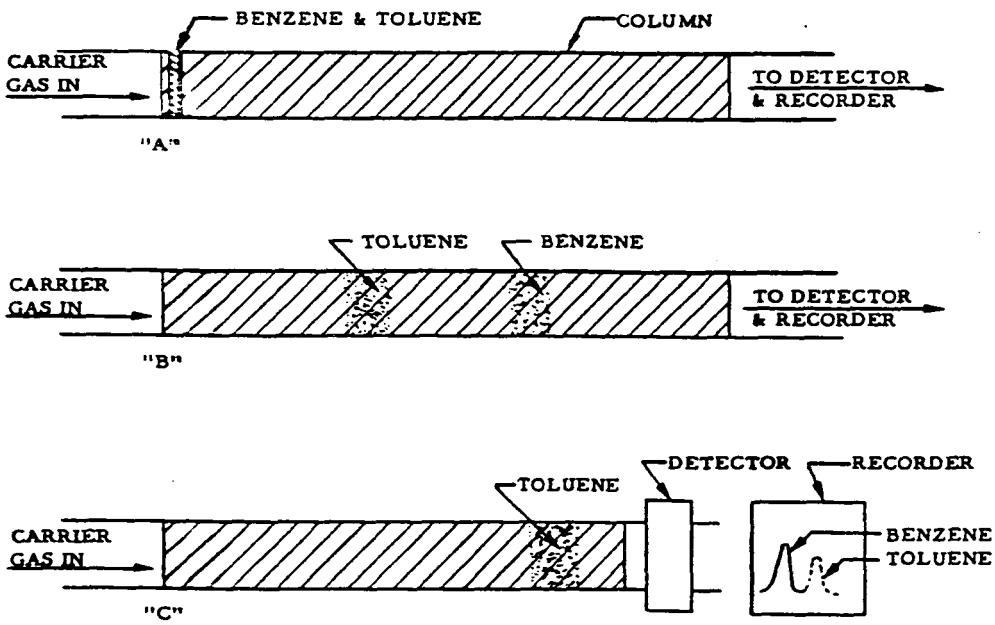
3) Qualitative Analysis

As each organic substance has a unique interaction with the column packing material, the time that the substance is retained on the column is also unique and thus characteristic of that particular substance. The "retention time" (RT) is primarily dependent on the type of packing material, the length of the column, the flow rate of the gas carrying the mixture through the column and the temperature range of the system.

When these variables are controlled, the retention times can be used to identify each of the components in a mixture. Because of these variables, it is usually necessary to establish retention times for each instrument by making a test with the pure substances of interest or to refer to established time data charts prepared in advance for that specific instrument. In those cases where retention times of the components are too close together for a good analysis, an adjustment in one or more of the operating variables will effect a sufficient difference in retention times to enable meaningful analysis.

4) Quantitative Analysis

The response of the detector to any component after it has been separated by the column is proportional to the quantity of organic material passing through the detector at any given time. However, since



PICTORIAL SEPARATION OF BENZENE AND TOLUENE - "A" AT BEGINNING OF SEPARATION; "B" DURING SEPARATION; "C" BENZENE HAS ALREADY PASSED THE DETECTOR AND IS RECORDED. TOLUENE (DOTTED LINES) WILL APPEAR ON RECORDER AS IT PASSES THE DETECTOR.

FIGURE 7-1-3. TYPICAL COLUMN SEPARATION SEQUENCE

[redacted]

not all of the separated components elute from the column at the same instant, but varies from low to a maximum and then falls to ambient again, it is necessary to have a means to measure the total amount of the individual component vapors. When using a strip chart recorder, the curve drawn on the paper is triangularly shaped and the area under the peak is related to the amount of substance being analyzed. For the OVA systems which have logarithmic outputs, direct measurement of areas under the peak is extremely difficult. The methods of peak height analysis described herein provide a convenient means for quantitatively interpreting peaks when operating either the logarithmic or linear readout OVA's.

5) Backflush
The column Backflush Valve is provided to reverse the flow of the carrier gas (hydrogen) through the column. It is necessary that the column be backflushed after each individual analysis except under certain special conditions. The primary purpose of the backflush function is to clear the column of heavy compounds (with long retention times) which would contaminate the column and cause interference to the total organic reading and future GC analysis. The Backflush Valve has no "sense" (prepositioning requirement). It is simply reversed from either position it was in during GC analysis. The Backflush Valve should be actuated immediately after the peak of the last compound of interest elutes. Figure 7-1-2 illustrates the functions of the Backflush Valve.
In the Century GC system, the backflush is "to the detector". This is possible due to the fact that the carrier gas and detector fuel are one in the same, i.e., hydrogen. The backflush function, therefore, provides a convenient means of quantifying the total compounds in the backflush by simply recording the peak that elutes during the backflush operation. For field type instruments, this quantitative backflush information is very valuable. The backflush to detector also provides a direct means of observing the condition of the column and seeing when the column is clean and the detector response has returned to baseline. The time required for the backflush is usually 1.2 to 1.5 times the GC analysis time.

6) Survey to GC Mode Interface
There is an inherent advantage to integrating the GC system to the basic total Organic Vapor Analyzer (OVA). The OVA provides a direct reading of total organic vapors present in the air being sampled, which provides the operator with intelligence of what he is injecting into the GC system. He can then use this information to predict and verify the peaks that result during the GC analysis, including the backflush peak.
This feature completely eliminates expending valuable GC analysis time where there is no contamination concentrations of concern (comparable to taking noise measurements in quiet corners). This "front end" intelligence also enables the operator to select the most appropriate location to conduct an analysis, which is normally the area of highest concentration.

7.1.3 OPERATING PROCEDURES

7.1.3.1 GENERAL

The Gas Chromatograph (GC) Option is a supplementary system which is built into the OVA instrument during manufacture. This system provides an additional gas chromatographic analysis (GC Mode) of operation which can be initiated at any time during a survey by simply depressing the Sample Inject Valve. After completion of the analysis and backflush operations, the Sample Inject Valve is pulled out and the survey continued or another sample injected. Note that when the Sample Inject Valve is in the out (Survey Mode) position the OVA operates in . the same manner as a standard OVA which does not incorporate the GC Option.

7.1.3.2 GC SYSTEM CONTROLS AND COMPONENTS

Refer to Figure 7-1-1 for a view of the four (4) basic controls and system components provided in the GC Option. Table 7-1-1 below describes their functions.

TABLE 7-1-1
GC OPTION-COMPONENTS

Controls/Indicators — Function

1) Sample Inject Valve - This 2 position valve (shown schematically in Figure 7-1-2) is used to select either Survey Mode (valve out) or GC Mode (valve in).
2) Backflush Valve - This 2 position valve (shown schematically in Figure 7-1-2) is used to reverse the flow of H_2 through the column to:
   a) Backflush the column for clearing
   b) Quantitatively measure total compounds after a selected point. Example: Separation of methane from non-methane hydrocarbons to read total non-methane hydrocarbon level.
3) Column - Separates components of a gas mixture so that each component of the mixture elutes from the column at a different time.
4) Activated Charcoal Filter Assembly - This assembly functions only in the GC Mode (Sample Inject Valve "in") as shown schematically in Figure 7-1-2. It removes organic compounds (except simple C_1 and C_2 hydrocarbons) by adsorption from the sample air supply.

[redacted]RVICING AND TURN ON

Place the Sample Inject Valve in the "out" position and put the OVA instrument in operation per Section 2 of this manual. NOTE: Leave the hydrogen fuel and pump "on" for three (3) to four (4) minutes before attempting ignition to enable hydrogen purging of the column.

7.1.3.4 SURVEY MODE OPERATION

When using the OVA in the Survey Mode, ensure that the Sample Inject Valve remains in the full "out" position and that the Backflush Valve is either full "in" or full "out". Note that when changing from the GC Mode to the Survey Mode the OVA output readings will continue to change as long as any compounds are still eluting from the GC column. Therefore, under normal field conditions, the GC column should be backflushed for clearing, which takes approximately 1.2 to 1.5 times the already elapsed forward analysis time. The backflush peak may be observed returning to baseline, after which the Sample Inject Valve may be moved to the Survey Mode (out) position.

When the compound(s) being analyzed are known to be the only compound(s) present in the air sample, backflushing may be omitted.

7.1.3.5 GC MODE OPERATION

In normal GC analysis, a strip chart recorder is used to record the output concentration from the OVA as a function of time. This record, called a chromatogram, is utilized for interpretation of the GC data. The Century portable strip chart recorder is further described in paragraph 7.2.

a) OPERATION

1) Turn on recorder and push Sample Inject Valve "in" with a fast, positive motion. This starts the GC analysis which is automatic up to the point of backflushing. NOTE: Rapid and positive motion should be used when moving either the Sample Inject or Backflush Valves. On occasion, the flame in the FID detector may go out, which would be indicated by a sharp and continued drop of the concentration level. If this occurs, simply reignite the flame in the normal manner and continue the analysis. NOTE: A negative "air" peak typically occurs shortly after sample injection and should not be confused as flame-out.

2) The negative air peak and various positive compound peaks will be indicated on the OVA readout meter and the strip chart recorder and represent the chromatogram of the analysis.

3) After the predetermined time for the analysis has elapsed (normally immediately after the peak of the last compound of concern), rapidly move the Backflush Valve to it's alternate position (in or out). Leave the instrument in this condition until the backflush peak printed on the recorder returns to baseline, then pull the Sample Inject Valve to the "out" position. If no backflush peak appears, pull the Sample Inject Valve out after being in the backflush condition for a period at least as long as the analysis time. The OVA is now back in the Survey Mode and ready for survey use or injection of another sample into the GC system.

b) INTERPRETATION OF RESULTS

Interpretation of the recorded chromatogram is always based on predetermined calibration data. A discussion of calibration methods and chromatogram interpretation is presented in paragraph 7.1.4.

7.1.4 CALIBRATION

7.1.4.1 GENERAL

The Century OVA with GC Option is a field instrument intended for applications where there are a limited number of compounds of interest and the compounds are normally known. Under these field conditions, the operator must simply know the retention time and peak height characteristics of the compounds of interest as normally presented on his OVA instrument under his specific operating conditions. Therefore, to calibrate the OVA in the GC Mode, simply determine by test the retention time and peak area (using peak height analysis) characteristics for the compounds of concern. These tests should be conducted on the column to be utilized and over the concentration and temperature range of concern. When representative characteristic data is available, such as in the Century Application/Technical Notes, a spot calibration check is normally all that is required.

It should be noted that under normal field conditions, the vapor concentrations vary continually as a function of time, location and conditions. Field measurements for industrial hygiene work are normally associated with a threshold level around a preestablished concentration. Surveys for locating fugative emission sources present a continually varying situation. Under these typical field conditions, it is desirable to have a fast and simple method of interpreting the GC data for on-the-spot analysis and decision making. High precision is normally not a requirement for these type analysis since the environment is continually changing. The methods presented in this section are designed to provide a means for typical field analysis. When the OVA is used under laboratory conditions, standard laboratory methodology may be used for greater precision.

7.1.4.2 TECHNICAL DISCUSSION

The chromatogram is a strip chart recorder printout of the instantaneous organic vapor concentration from the Century Organic Vapor Analyzer (OVA) as a function of time. A typical chromatogram is illustrated in Figure 7-1-4 and is seen to be a series of triangular shape peaks originating and returning to a fixed baseline. Qualitative interpretation of a chromatogram involves identifying the compound causing a peak by analyzing the time it took for the peak to appear after initial injection (referred to as retention time (RT)) and comparing this RT to

reference data. Quantitative interpretation of a peak involves analyzing the area under the peak and relating this area to calibration data of peak area versus concentration for that specific compound under the conditions present during the GC analysis.

It can therefore be seen that interpretation of a chromatogram requires the use of calibration reference data. GC reference data is always generated empirically, i.e., through tests. Century publishes Application/Technical Notes which may be used as a reference for selecting columns and interpreting chromatograms. However, in most cases, certain relatively simple tests must be conducted to obtain the required reference data. A method for obtaining this type data and applying it to a calibration chart is presented along with a typical example of the exercise.

a) QUALITATIVE ANALYSIS

Under a given set of operating conditions, the retention time is characteristic of that particular substance, and can be used to identify specific compounds. It will be necessary to calibrate retention times by making tests with the pure compounds of interest.

The retention time (RT) is defined as that period of time from injection of the sample into the GC system until the point of maximum detector response for each substance. Retention time is measured from the point of sample injection to the apex of the triangle shaped curve obtained on the strip chart recorder. (See Figure 7-1-4.)

The strip chart recorder operates on a clock mechanism such that the distance along the baseline is proportional to time. While retention times are characteristic for each compound, it is possible that two materials could have the same retention times. Thus, if there is any question as to the identity of the vapor, it may be necessary to verify identification by retention times on two different columns.

Use of a longer column will increase the retention times of those components it is capable of separating. The time between peaks will therefore also be increased. This is especially useful to know if a component to be studied comes through too fast after injecting a sample or if certain desired peaks are so close that they overlap on the strip chart.

b) COLUMN SELECTION

Two columns are normally supplied with the instrument. These are general purpose columns and are useful in a wide variety of applications. If they do not perform the separations for your particular application, it may be necessary to select other packing materials or lengths of columns to meet your needs. Century Systems will guide you in this selection or prepare a custom column to meet your needs.

If columns are made by the customer or purchased from other sources, care must be exercised to ensure that their packing density does not create too large a pressure drop as compared to columns furnished by Century. Century's method of coding it's GC columns is presented on most Century published Application/Technical Notes. Several application notes have been inserted as an appendix to this manual to illustrate typical GC separations.

c) TEMPERATURE EFFECT ON RETENTION TIME

An increase in temperature will decrease column retention time (RT) and vice versa. Normally, retention time (RT) as a function of temperature changes linearly over the range of 0 to 40°C. For complex qualitative analysis, a calibration plot of RT versus temperature will be required. In typical ambient field usage such as inside a factory, the effect of temperature can be compensated for by the operator during chromatogram interpretation. A single component tracer compound can be sampled at any time to provide a "key" for other compound identification.

d) CARRIER GAS FLOW RATE EFFECT ON RETENTION TIME

An increase in carrier gas flow rate will decrease retention time. For reproducible data, the carrier gas (hydrogen) flow rate must be recorded in association with a chromatogram. Primary control of the H2 flow rate is accomplished in the OVA by regulating the hydrogen pressure across a capillary tube. The hydrogen flow rate is also affected by the restriction of the GC column but most columns have a limited effect. The hydrogen flow rate is factory set at 12 cc/minute with a typical 24 inch column.

e) QUANTITATIVE ANALYSIS

The area under a specific peak is a function of the concentration of the compound which created the peak. This area can be calibrated by injecting known concentrations of the compound. When the base of a symmetrical GC peak remains constant, the height of the peak may be used to measure the area. Typically, as the retention time of a peak increases on the same column, the base broadens and the peak height decreases for a given sample concentration. If the hydrogen flow rate is considered to be constant, the retention time of the peak will change as a function of temperature.

In general, the more triangularly symmetrical the peak, the better the peak height analysis capability. However, many GC peaks have "tailing" as illustrated in Figure 7-1-4. Peak height calibration is still an acceptable method for quantitative analysis as long as the area under the tail is small compared with the total peak area. If severe tailing occurs, empirical calibration data generated through tests may be required to plot the peak height versus the concentration curve. If the GC Option is used on a Century "logarithmic" OVA, there will be a major apparent increase in peak tailing. This apparent tailing is the result of the logarithmic

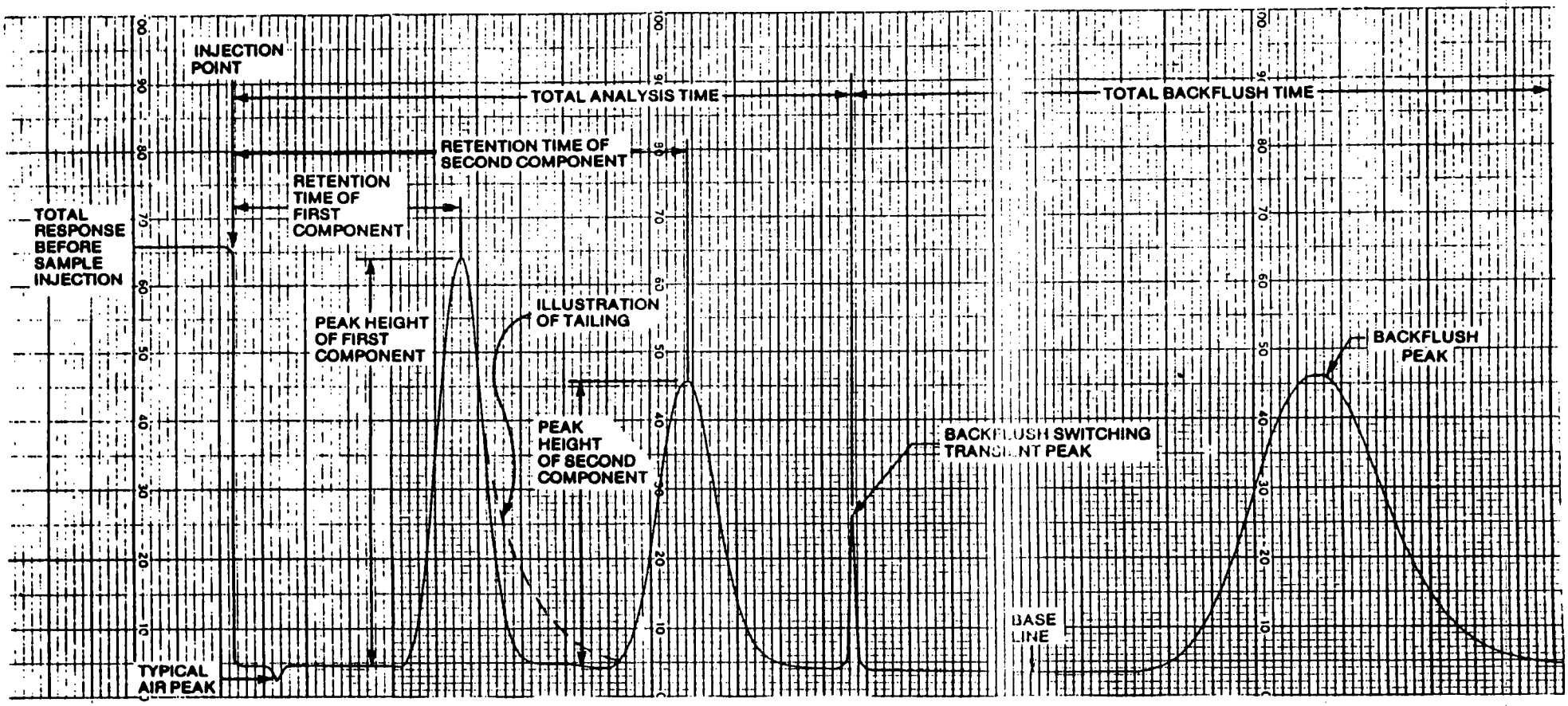


FIG. 7-1-4

TYPICAL CHROMATOGRAM (ILLUSTRATION)

scaling, which amplifies the low level signals. This apparent tailing does not appear on the "linear" OVA's, even though the same actual tailing is present.

Only peak height analysis will be discussed in this manual. The method presented is simply to inject a known concentration of the compound being tested and record the height of the peak under the test conditions. The peak height characteristics can be established for various columns and at various temperatures. Normally, both retention time and peak height characteristics will be measured simultaneously during the same test.

When peak area measurements are desired, the areas may be measured using an integrator on the OVA output signal. Other manual methods may also be used, such as counting squares, weighing curves or simple triangulation. When the GC peaks have good symmetry, triangulation (area equals 1/2 base x height) is a convenient method.

7.1.4.3 PREPARATION OF CALIBRATION SAMPLES

Samples for calibration of the GC system may be prepared with the procedures discussed in paragraph 4.3.3 of this manual. Sample mixtures are made by repeating the procedures presented for the compounds desired in the sample.

7.1.4.4 CALIBRATION DATA

When conducting tests to obtain GC calibration data, the following information should be recorded to qualify the data:

a) Column - description and serial number as applicable
b) Temperature - column temperature, normally room ambient
c) Chart speed - distance/unit time
d) Carrier flow rate - hydrogen flow rate through the column (cc/min.). (Reference paragraph 7.1.2.2 b)
e) Sample concentration - ppm for each compound
f) Sample volume - OVA by serial number or typically 0.25 cc for standard valve
g) Recorder scaling - ppm per unit deflection
h) Range - range of OVA being used, i.e., X1, X10, X100
i) OVA type and serial number

To obtain a calibration point, inject a known concentration sample into the GC system and record the resulting chromatogram peak. The retention time for the peak may be scaled from the record or timed with a stop watch. The peak height may be scaled from the record or the OVA readout meter may be observed during the elution of the peak. Figure 7-1-5 presents the format of a chart which may be used to record calibration data. Experience has indicated that the peak height response of a compound is linear up to concentrations of greater than 1,000 ppm. Therefore, a single calibration point, preferably around the concentration of most concern, is normally all that is required to plot a peak height response in ppm as a function of compound concentration. Data for other compounds on the same column may also be plotted along with their associated retention times, percent relative response in the total organic Survey Mode, TLV, etc. Note that to keep the calibration curves readable on the chart a multiplier (X) column is included. It is recommended that copies of the actual chromatograms be kept with the charts for observing the peak shapes, peak interferences, etc. It should be noted that a chromatogram can be utilized like a fingerprint for compound identification or peak height and shape comparison. Transparent overlays are sometimes an aid in chromatogram analysis.

When temperature variations are anticipated, data should be taken at several points and recorded on the chart as a new curve or as a relative change as a function of temperature as illustrated in Figure 7-1-5.

Preparing and using the calibration chart is very straightforward. As an example, once the elution sequence of a group of compounds is determined, a mixture of 100 ppm of each can be prepared and run on the GC for chart data. The retention time of each compound and the peak height of each can be read directly from the chromatogram and the data put on the chart. If temperature data is to be taken, additional chromatograms may be run with the same sample and the RT and peak height plotted as a function of temperature.

When complex mixtures such as gasoline are analyzed, it may be desirable to keep the record of the backflush peak for future reference and peak area comparison. It is also recommended that the total organic vapor concentration reading on the OVA be recorded for each calibration sample used. This reading should be put on the chromatogram and is used for arriving at relative response numbers and as a check on sample preparation precision.

Samples of forms for use in recording individual chromatogram data and also a sample form for the calibration chart are included in Appendix "A" and may be used as a guide or copied and used as is.

7.1.5 MAINTENANCE

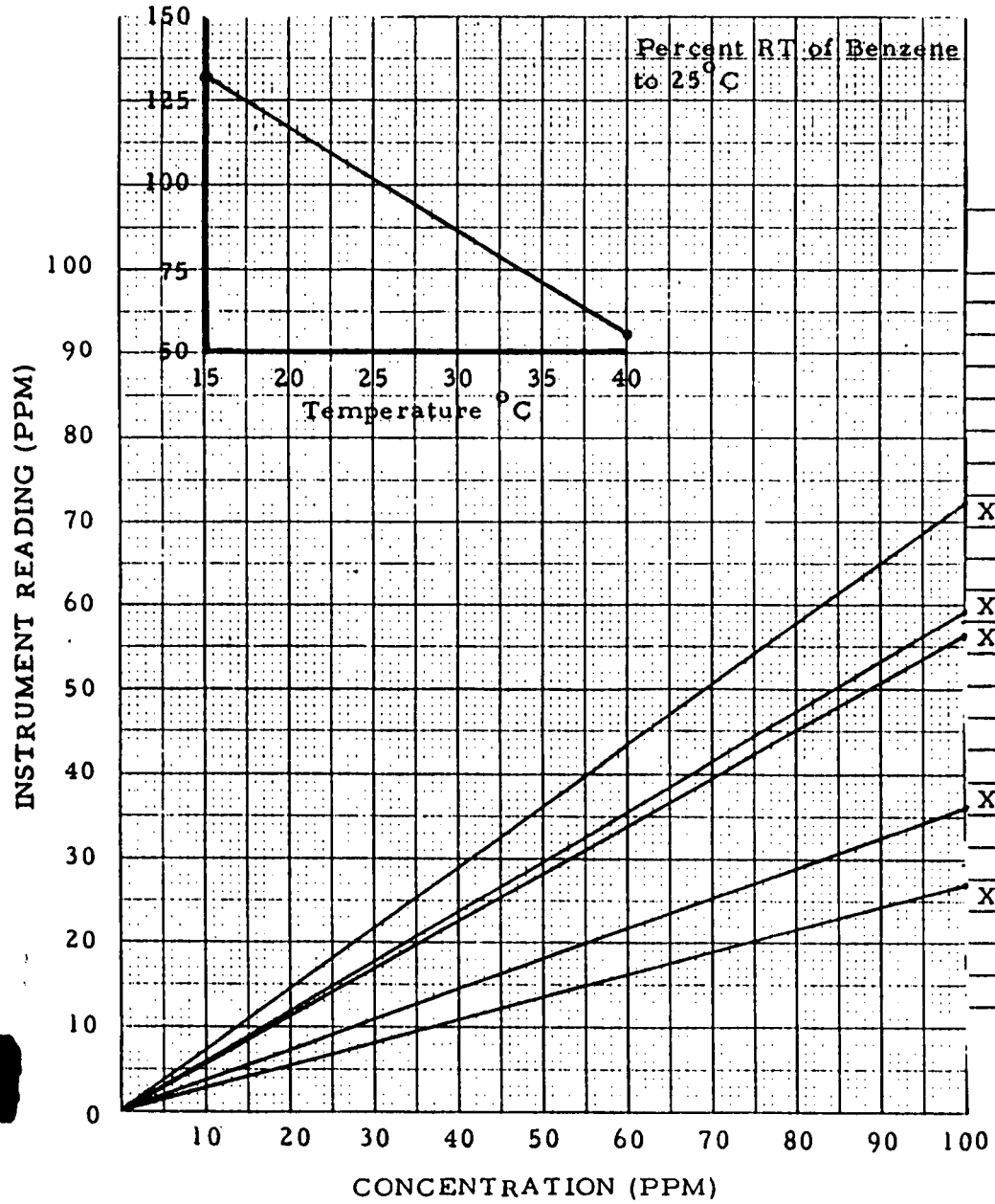
7.1.5.1 GENERAL

This section describes the routine maintenance, trouble shooting and spare parts peculiar only to the Gas Chromatograph (GC) Option.

7.1.5.2 ROUTINE MAINTENANCE

a) COLUMN

Any column can be contaminated with compounds having long retention times. This will result in high background readings. This condition can be checked by installing a new column or a blank column (tubing only). If this reduces the background reading, the contaminated column should be baked at 100°C (212°F) for three (3) to four (4) hours in a drying oven while passing nitrogen through the column. Higher



Column G-48 Chromatograph OVA-118
Temperature 25 °C Carrier Flow 12 ml/sec.
Injection: Volume 2.5 ml Type valve

X	Compound	R. R. (%)	RT (sec)	Date	TLV (ppm)
X4	Heptane	80	471	1-31-78	400
X2	Pentane	100	90	1-31-78	1000
X2	Hexane	90	198	1-31-78	100
X2	Benzene	150	291	1-31-78	1
X3	Toluene	120	762	1-31-78	200

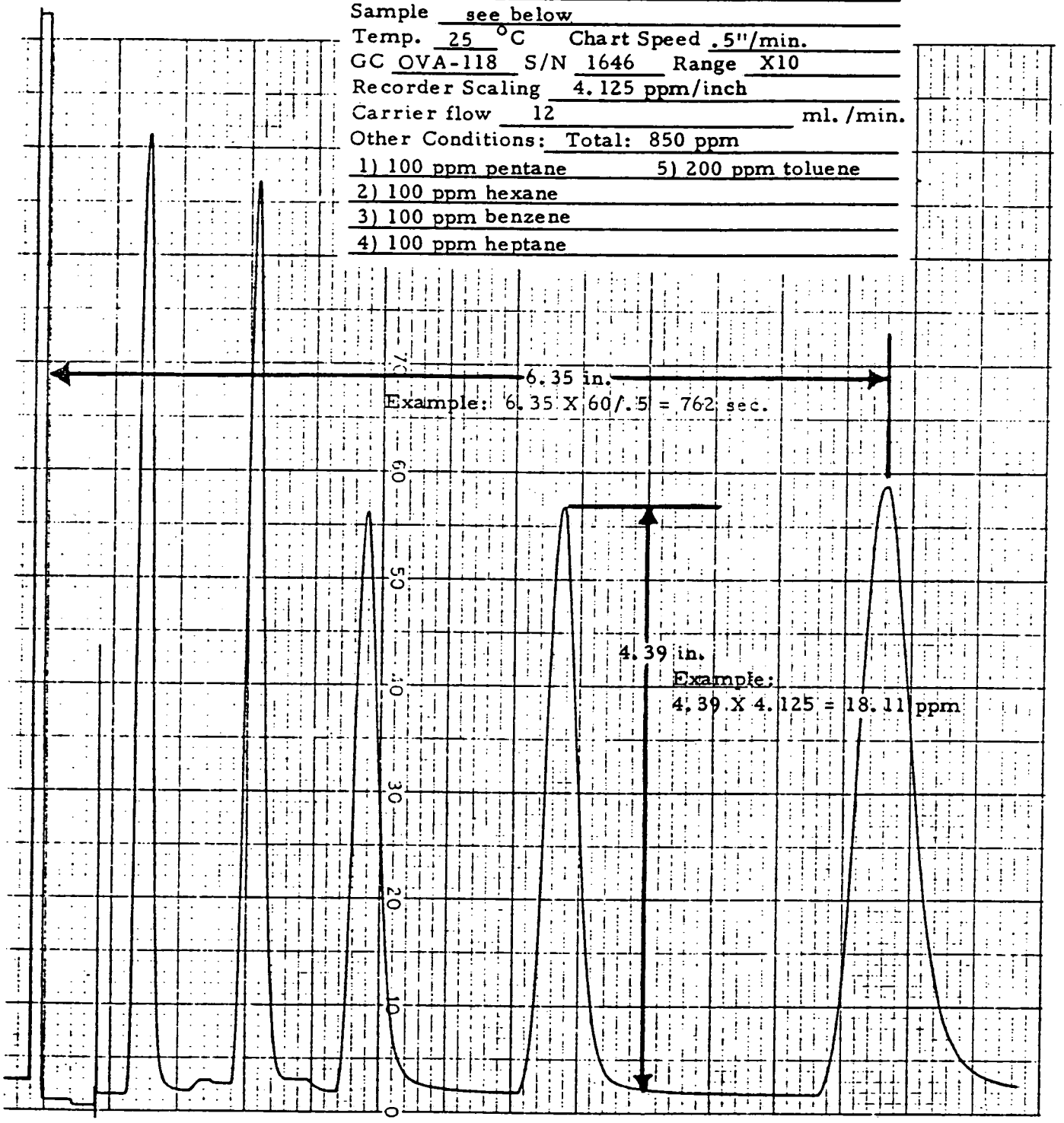
NOTE: Concentration used for test is 100 ppm or as indicated by marked data points.

COMMENTS:

FIGURE 7-1-5. CALIBRATION CHART

[redacted]

Date 1/31/78 Type Injection 2.5 ml valve
Column 510454-G-48
Sample see below
Temp. 25 °C Chart Speed .5"/min.
GC OVA-118 S/N 1646 Range X10
Recorder Scaling 4.125 ppm/inch
Carrier flow 12 ml./min.
Other Conditions: Total: 850 ppm
1) 100 ppm pentane 5) 200 ppm toluene
2) 100 ppm hexane
3) 100 ppm benzene
4) 100 ppm heptane



[redacted]

[redacted]

[redacted]atures may permanently damage the [redacted] packing. Columns may be cleaned while installed on the OVA by heating the column with hot, wet towels.

When installing any column, avoid touching the ends, as this may cause contamination. Also, ensure that the fittings are tight to avoid H2 leakage.

IMPORTANT: The following simple test may be run to determine whether the GC column is contaminated. While in a clean ambient air background, place the Sample Inject Valve in the "in" (GC Mode) position. Observe the background reading on the meter or recorder. After one (1) to two (2) minutes, change the position of the Backflush Valve and again observe the background reading. If the background reading went down when the Backflush Valve was actuated and then started to increase in one (1) to two (2) minutes, the column is probably contaminated and needs to be cleaned. Note that if hydrogen is flowing into one end of the column for a period of time, the contamination is being pushed into the column and is therefore cleaning the front endportion of the column. Then when the hydrogen flow is reversed, the exhaust end of the column will be what was the input end previously. Therefore, for a period of time the now exhaust end of the column will be clean until the contamination is again pushed through. Remember that to clean a column the hydrogen or other purge gas must be run through the column in one direction until all of the contamination is removed. **NOTE:** Contaminated columns can be avoided by simply backflushing the column after every analysis.

b) CHARCOAL FILTER ASSEMBLY

After repeated use, the Charcoal Filter Assembly will become saturated. Periodically, the operator should check the effectiveness of the activated charcoal to perform its screening function. This can easily be done by operating the unit with the Sample Inject Valve "in" and passing the probe near a concentrated sample of the compounds being analyzed. The readout should remain nearly steady (should not rise more than 0-2 parts per million (ppm)). If rise is more than 2 ppm, remove assembly from the panel and pull the knurled cap from the end of the filter tube (pull—not twist), and replace the old charcoal with activated charcoal (Barnebey Cheney, Columbus, Ohio, Type GI or equivalent). Care should be taken to completely fill the tube so there will not be a path for the sample to bypass the charcoal. The life of the charcoal depends on the time (length) of exposure and the concentration level during that exposure. When changing charcoal, be sure that any fine particle charcoal dust is removed from the assembly.

Another simple test of the charcoal filter is to note the background reading with the Sample Inject Valve "out" and then note the baseline reading with the valve "in". The level should never be higher when the valve is in the "in" position and the charcoal filter is in the air line. If the reading with the valve in the "in" position is higher, the charcoal filter is probably contaminated and acting like a contamination emitter.

Characteristics of the recommended activated charcoal are provided below:

Raw Material: Coconut Shell

Nominal Mesh Size: 8 x 14 (Tyler Standard Screens)

Size Distribution: On 8 mesh, 5% maximum; through 8 on 10, 60% maximum; through 10 on 14, 60% maximum; through 14 mesh, 5% maximum

Ash: 6% maximum

Moisture Content: 3% maximum, as packed

Standard Packages: 50 lbs. net weight fiber container; 58 lbs. gross weight (typical). 1 lb. container, shipping weight approximately 1-1/2 lbs. Carton containing 12 each 1 lb. units, shipping weight approximately 16 lbs.

Applications: Removal of medium and high concentrations of organic vapors from air. Purification of gases. Safety respirators. Gas separation.

7.1.5.3 TROUBLE SHOOTING

Table 7-1-2 presents recommended field trouble shooting procedures which are peculiar to the GC system. These procedures are in addition to those found in Table 6-1 of the basic manual.

7.1.5.4 RECOMMENDED SPARES

Spare parts and supplies which are recommended to support only the GC system (and recorder) are as follows:

Item	Description	Part Number	Quantity
1)	Quad Rings	510496-1 (10/pkg.)	1 pkg.
2)	Tubing, Teflon	.148" ID x .020 wall	12"
3)	Tubing, Teflon	.120" ID x .030 wall	12"
4)	Activated Charcoal	Type GI or equivalent	1 lb.
5)	"O" Ring	2-15	2
6)	Chart Paper (log)	Type "J" (6 rls./pkg.)	2 pkg.
7)	Chart Paper (linear)	Type "WA" (6 rls./pkg.)	2 pkg.

Activated charcoal may be purchased direct from:

Barnebey Cheney
825 North Cassady
Columbus, Ohio 43219
(614) 258-9501

Chart paper may be purchased direct from:

Gulton Recorder Systems Div.
Gulton Industrial Park
East Greenwich, Rhode Island 02818
(401) 884-6800

[redacted]

[redacted]

TABLE 7-1-2

DOUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sam[redacted] flow rate on flow indicator	a) Check teflon tubing on valve assembly for kinks, etc. b) Check flow rate with valve in down position.	Straighten or replace teflon tubing Check for over restriction of charcoal filter
2) H2 flame will not light	a) Check column connections on top of unit to make sure they are tight. b) Check column for sharp bends or kinks. (Hydrogen flows through this column at all times and a sharp bend will compact packing too tightly for proper hydrogen flow.) c) Check charcoal filter fittings to make sure they are tight. d) Check H2 flow rate from the column. e) Check that the Inject and Backflush Valves are both completely in or out. A partially activated valve will block the H2 and air flow paths. f) If a new column was installed prior to problem identification, check for proper hydrogen flow rate through the column (should be approximately 12 cc/minute). Reference paragraph 7.1.4.2 d.	Tighten fittings Replace column Tighten fittings Adjust hydrogen pressure to obtain 12 cc/min. flow rate. Ensure both valves are either completely in or out. Increase hydrogen pressure to obtain proper hydrogen flow rate or if column is excessively restrictive, replace or repack the column.
3) Ambient background reading in clean environment is too high	a) Check for contamination in charcoal filter assembly. This can be detected if ambient reading increases when going in to the chromatographic mode. Reference paragraph 7.1.5.2 b. b) Check for contamination in column. Reference paragraph 7.1.5.2 a c) Check for contamination in column valve assembly.	Replace activated charcoal in charcoal filter assembly. Replace or clean column. Remove valve stems and wipe with clean lint-free cloth. Heat valve assembly during operation to vaporize and remove contaminants.
4) Flame-out when operating either valve	a) Ensure valves are being operated with a quick, positive motion. b) Either H2 or air may be leaking around one or more of the valve quad rings. Assess by tests and "O" ring inspection. c) Damaged or worn quad rings causing leak.	Operate valve with a positive motion. Remove stems and lightly coat with silicone grease, only on contact surface of the "O" ring.Wipe off excess (do not remove quad rings). Replace quad rings and grease as above.
5) Excessive peak tailing	a) Change or clean GC column and see if problem disappears. b) Inspect GC valves for excessive silicone grease or contamination.	Ensure columns are clean prior to use. Refer paragraph 7.1.5.2 a for cleaning instructions. If one of a same type of column tails worse than others, repack the column or discard. Excessive lubricant or foreign matter in the valve assembly can cause excessive tailing. Clean valve assemblies and lightly relubricate as required. Lubricant should be put only on the outside contact surface [illegible]

7.2 RECORDER OPTION

7.2.1 GENERAL

A Portable Strip Chart Recorder is available from Century for use with the OVA instruments (reference Figure 7-2-1). The recorder is powered from the OVA battery pack and the output can be scaled to match the OVA readout meter, thereby providing a permanent record for subsequent analysis or reference. The recorder is available in two models. P/N 510445-1 is used with standard Models OVA-88, OVA-98 and OVA-118. P/N 510445-2 is certified intrinsically safe and is used with the certified Models OVA-108, OVA-128 and OVA-138.

7.2.2 APPLICATIONS

The recorder can be used with the OVA to provide a record of the long term monitoring profile of an area in total organic vapor concentrations, or can be used with the Gas Chromatograph Option to provide a chromatogram of the GC analysis.

7.2.3 FEATURES

The recorder prints dry (no ink) on pressure sensitive chart paper. Housed in rugged die-cast aluminum, it weighs approximately four (4) pounds and is 5-5/8" High, 6-5/8" Wide and 4-1/2" Deep.

The recorder is available for use with either the Century logarithmic or linear scaled OVA's by simply changing the scale and paper style. The recorder is equipped with two gain ranges and an electronic zero adjustment control. The HIGH gain position is normally used only with the logarithmic OVA to provide a means of scale expansion.

7.2.4 CONTROLS AND CONNECTIONS

Described below are the functions of the various controls and connectors. Reference Figure 7-2-1.

Controls and Connections—Function

1) HIGH-LOW Switch - This switch, located on the right hand side of the recorder, provides 2 ranges. The LOW range is set for the same full scale reading as the OVA readout meter. The HIGH range can be set to give an increased sensitivity to the recorder without effecting the OVA calibration.
2) ZERO ADJUST Knob - This potentiometer, also located on the right hand side of the recorder, permits "nulling" of the background reading on the recorder only (without affecting the calibration of the OVA as displayed on the OVA readout meter). In the full clockwise position of the knob, the recorder will display the same reading as the OVA meter. Counterclockwise rotation will reduce the reading on the recorder only.
3) Power Connector - This 126 series, 5 pin Amphenol connector provides power and signal to the recorder, as follows:

Standard 510445-1	FM 510445-2	Function
A	B	Input signal
E	E	pos. 12VDC input
H	H	Ground

7.2.5 OPERATING PROCEDURES

Connect cable between recorder and OVA. Turn recorder on by selecting either the HIGH or LOW position of the switch. (Normal is "LOW".)

When using the HIGH gain position (typically only on logarithmic OVA's), it may be desirable to "null" out the background on the recorder. To accomplish this, provide clean air to the OVA or place a charcoal filter in line with the OVA input to establish a "zero" reference and use the ZERO ADJUST Knob to set the recorder needle to the zero line. Remove the filter and the instrument and recorder are ready for use. NOTE: During normal survey use, it is best to turn the recorder off to conserve paper and battery power.

7.2.6 CALIBRATION

7.2.6.1 GENERAL

Electronic and mechanical adjustments, other than the operational adjustments on the side panel, are provided to calibrate and align the recorder.

7.2.6.2 MECHANICAL ZERO ADJUSTMENT

a) Snap out the front panel nameplate (using a small blade screwdriver in the left hand slot) for access to mechanical zero adjust screw, place HIGH-LOW Switch in OFF position.
b) Unscrew knurled fastener at top left of front panel, open recorder. Pull down plastic chassis latch on right side to release sticker bar tension on paper and adjust mechanical zero as required. Replace nameplate, chassis latch and resecure front panel.

7.2.6.3 GAIN ADJUSTMENT

Separate adjustments are provided for the HIGH and LOW ranges on the recorder. (Refer to Figure 7-2-1 for location.)

a) Connect recorder to OVA and adjust OVA for full scale reading on readout (about 5 VDC).
b) Loosen knurled fastener on upper left of the front panel and pull front panel down.
c) Place HIGH-LOW Switch in LOW and adjust R1 until recorder prints full scale.
d) Place HIGH-LOW Switch in HIGH and adjust OVA to read the desired full scale with front panel CALIBRATE ADJUST Knob, typically half scale on the readout. Adjust R2 until recorder reads full scale. NOTE: Full scale adjustment of the recorder for 1/2 scale on the OVA gives a gain increase of two (2) in the height of the peak on the chromatograms. This is the factory set point for the HIGH gain range; however, other points can be set as desired with 30 ppm full scale on the logarithmic units and a gain of three (3) on the linear units being the maximum obtainable without amplifier loading.

7.2.7 SAFETY

Due to the low power requirements of the recorder, one model has been approved for use with Century's line of certified intrinsically safe instruments. The only difference between the two models is a heavy blue

epoxy powder coat on the certified model and different power connector pin arrangement to prevent accidental interchange of the recorders.

7.2.8 MAINTENANCE AND ROUTINE OPERATIONS

Refer to the manufacturer's (Gulton) manual on the recorder which is enclosed with each recorder when shipped.

7.2.8.1 CHANGING CHART SPEEDS

The recorder is equipped with a 16 RPM motor which gives a writing speed of four (4) strikes per second. The chart advance speed is determined by the gear train assembly number used. The inches per hour for each gear train is given in the table on page 9 of the Gulton recorder manual. Refer to the bottom line of the chart adjacent to drive motor 16 and note for example that a number 1 gear train has a chart speed of 8"/hour.

a) To change the paper speed, open the recorder, remove gear box spring (on left side), move gear box in direction of arrow on its case and lift out from top. Do not force out from bottom. Insert new gear, bottom first, slide into position against arrow direction. Replace gear box spring.

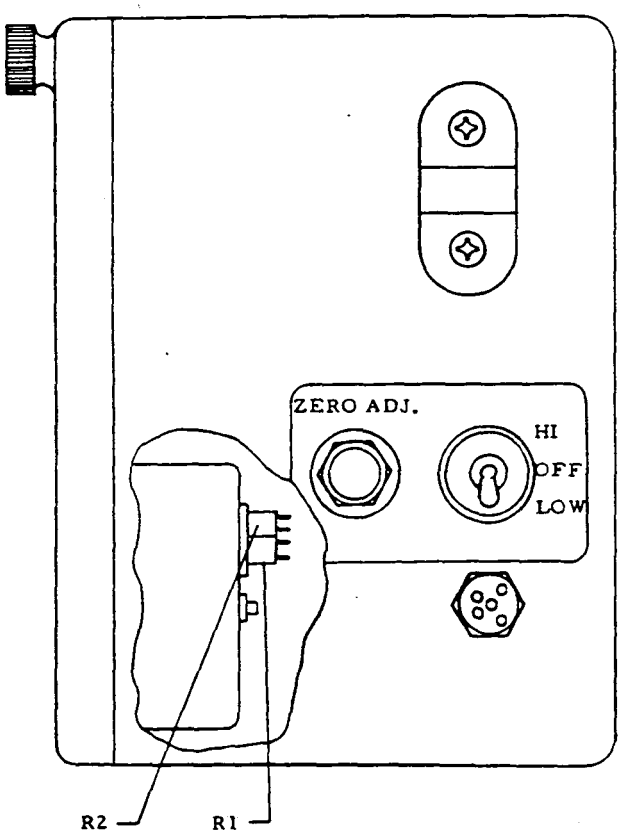


FIGURE 7-2-1. RECORDER CONTROLS AND ADJUSTMENTS

7.3 ACTIVATED CHARCOAL FILTER ASSEMBLY

The Activated Charcoal Filter Assembly, P/N 510095-1, is an optional accessory that can be used with any of the Century portable OVA's. The filter can be installed on the OVA Readout Assembly or attached at the end of the telescoping probe. The filter assembly is typically filled with activated charcoal which acts as an adsorbent and effectively filters out most non-methane or non-ethane organic vapors. A screw cap on the probe end is removed for refilling the filter with activated charcoal or any other filtering media desired.

Applications of the filter include:

1) Obtaining a clean air sample for zero baseline check and adjustment on linear OVA's or for a background check on logarithmic OVA's.
2) Running "blank" chromatograms to assess instrument contamination.
3) Rapid screening of methane and non-methane organic vapors.
4) Selective screening for natural gas surveys.
5) As a moisture filter when filled with a desiccant such as silica gel.

A press fit, large adapter on the back of the filter assembly is removed when installing the unit on the telescoping probe. When replacing the cap end after refilling, one wrap of 1/4 inch teflon tape should be used to seal the threads. The recommended activated charcoal for use in the filter is Barnebey-Cheney, Type GI-8679.

The life of the filter will depend on the time in use and the concentrations of the compounds being filtered. Under typical industrial air monitoring conditions, the filter will last for many days of continuous sampling.

7.4 OVA SAMPLE DILUTOR

An adjustable Sample Dilutor Assembly, P/N 510825-1, is available as an optional accessory for use on all Century portable Organic Vapor Analyzers. The dilutor may be adjusted over the range of 5:1 to 50:1 in OVA response. In operation, the dilutor is attached to the end of the telescoping probe or may be connected by external tubing to the input fitting of the OVA side pack case. Dilution of the air being monitored is accomplished by stream splitting through the use of a needle valve on the sample input. An activated charcoal scrubber is inserted in the main air supply line to the OVA and scrubs the air clean of organic vapors and also creates a slight vacuum at its output side of the scrubber and the vacuum at this point draws the sample air through the needle valve where it mixes with the main air supply going to the OVA detector.

This dilution valve provides a means of sampling vapor levels above the lower explosive level (LEL) and in oxygen deficient atmospheres. These conditions can occur in normal leak or source survey as the operator gets close to the leak or vapor source or in monitoring various manufacturing or material handling processes. Approximately 14% oxygen is required to sustain operation of the FID in the OVA.

7.4.1 SETTING DILUTION RATE

Prepare a sample in a bag at a high level, typically 1,000 to 5,000 ppm. Any suitable gas can be used, such as butane from a cigarette lighter; however, a compound similar to those to be measured provides greater accuracy. The actual concentration of the gas does not have to be known, since the dilution rate is simply a relative level.

Obtain an OVA reading on the vapor sample with the dilution valve removed. Then install the valve, loosen the jam nut and turn the needle valve until the meter reading corresponds to the original reading divided by the dilution factor desired. Retighten the jam nut.

It should be noted that when the dilution valve is used for natural gas leak survey and pinpointing that the charcoal filter will not remove the methane from the dilution air supply. Care should be taken so that natural gas is not allowed to enter the main air inlet.

7.5 OVA SEPTUM ADAPTER

A Septum Adapter, P/N 510645-1, is available for direct on-line sample injection to the GC column inlet. The Septum Adapter mounts directly on the OVA front panel and sample injections from .025 to 2.5 cc may be made using a gas tight syringe. This provides a range of sensitivity of approximately 10% to 1000% of the OVA standard valve, which has a sample loop volume of approximately 0.25 cc. Syringe injection can cause a flame-out; however, the OVA may be reignited after the injection is made. The air in the sample must elute from the column before reignition can be made. The time for the air peak to elute will be a function of the column length and the volume of the sample injected. For example, a 1 cc sample into a 12" column will require waiting approximately 5 seconds; and, a 2.5 cc sample into a 48" column will require approximately 20 seconds.

The Septum Adapter also provides a means whereby samples can be taken from oxygen deficient atmospheres or process streams and injected directly into the chromatograph. Headspace analysis may also be accomplished using the Septum Adapter and a syringe.

When the Septum Adapter is installed on the OVA, the normal GC sample valve may still be used alternately with the syringe injection. In addition to variable sample size and sensitivity, syringe injections will normally provide greater symmetry and reduced tailing of chromatogram peaks as compared with the standard valve injection.

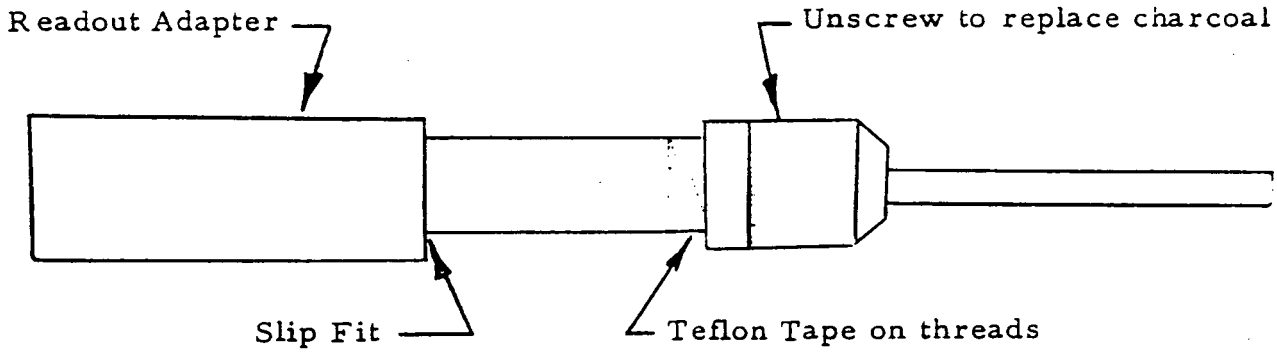


FIGURE 7-3-1. ACTIVATED CHARCOAL FILTER ASSEMBLY

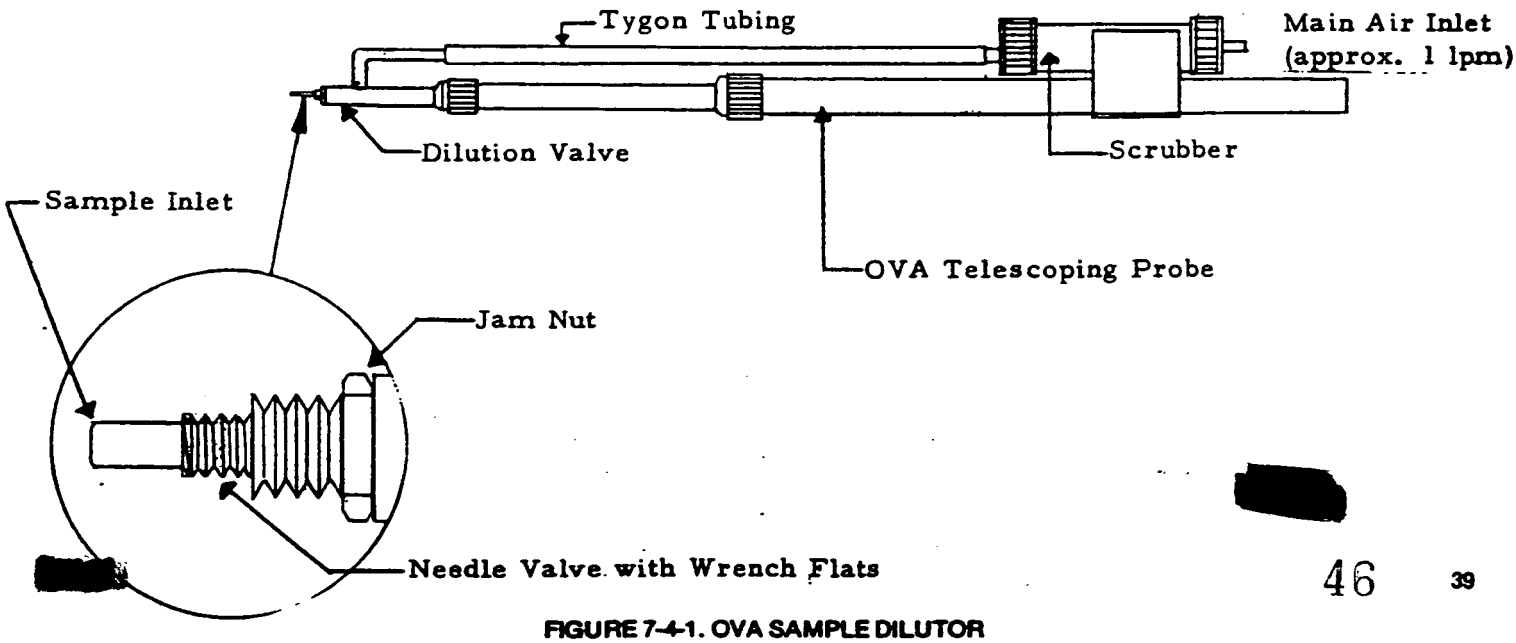


FIGURE 7-4-1. OVA SAMPLE DILUTOR

APPENDIX "A"

OVA-128

This Appendix includes the following:

Sample forms and typical Application/Tech Notes

Side Pack Assy Dwg. No. 510605
Side Pack Assy Parts List No. LM510605

Electronic Component Assy Dwg. No. 510570
Electronic Component Assy Parts List No. LM510570

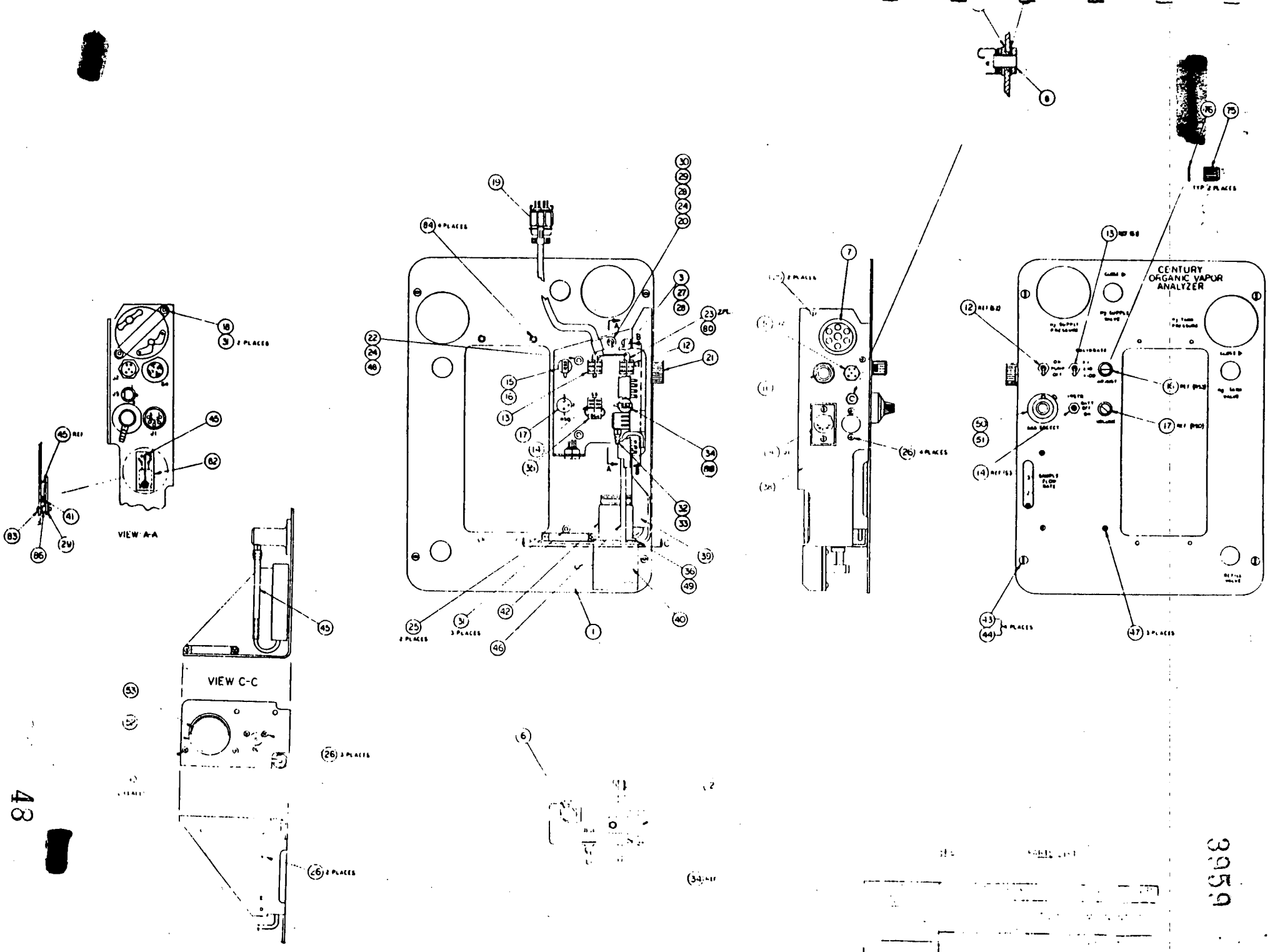
Cylinder Assy Dwg. No. 510055
Cylinder Assy Parts List No. LM510055

Schematic Wiring Diagram Dwg. No. 510555

The assembly drawings and parts lists provide location/identification information necessary for maintenance, trouble shooting and parts ordering. The drawings are furnished only for reference and are subject to change without notice. The schematic wiring diagram is for use in trouble shooting for possible electronic or wiring problems. Note that components that are not accessible for safety reasons on the certified instruments are not shown on the schematic. However, typical signal levels at selected points are shown.

In using the drawings and parts list to locate items described in the Maintenance Section of this manual, it may first be necessary to identify the item in the parts list (by nomenclature), then refer to the corresponding item number on the drawing for location.

[redacted]



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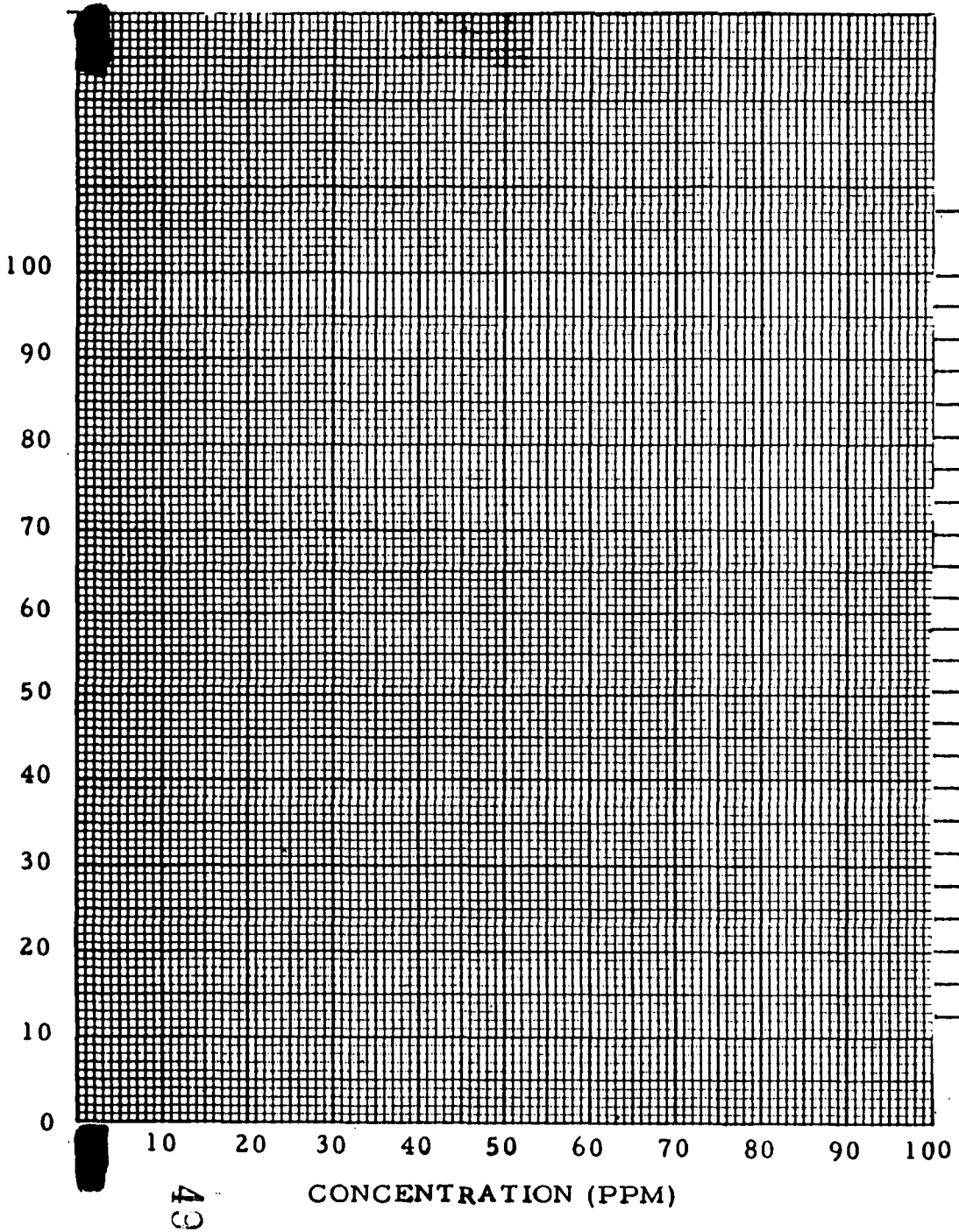


Column _____ Chromatograph _____
Temperature ____ °C Carrier Flow ___ ml/sec.
Injection: Volume _____ ml Type _____

X	Compound	R. R. (%)	RT (sec)	Date	TLV (ppm)

NOTE: Concentration used for test is 100 ppm or as indicated by marked data points.

COMMENTS:

3359

43

CENTURY SYSTEMS CORP.
ARKANSAS CITY, KANSAS

TITLE
ELECTRONIC COMPONENT ASSY

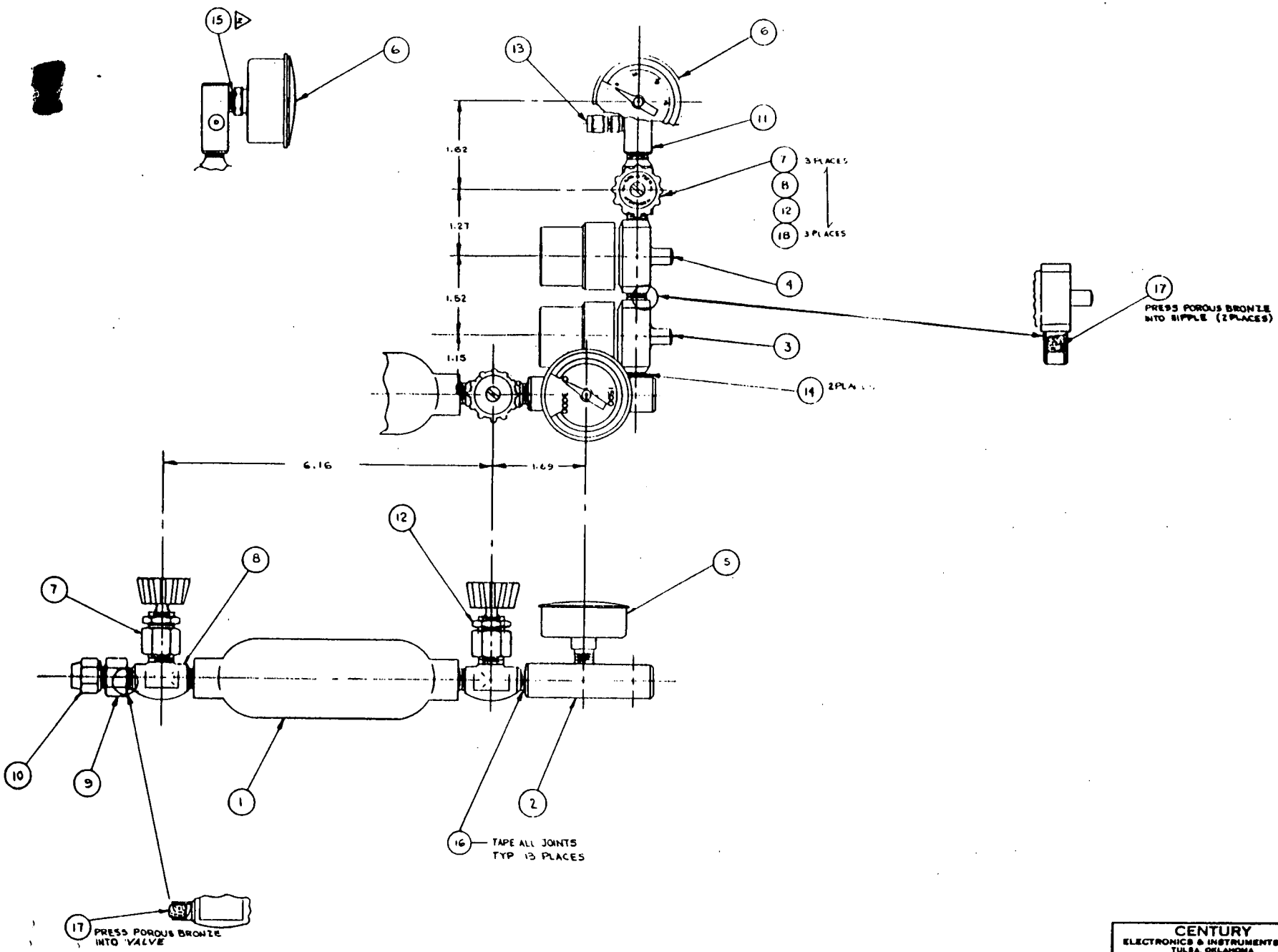
-1 Conf. OVA-128
-2 Conf. OVA-128 w/column

LM 510570

1	1							510386-4	Panel
2	1	1						510379-1	Housing, Filter
3	1	1						SAC-22D/1-2	Connector
4	1	1						D5M	Connector
5	1	1						126-011	Connector, 5 Pin, Female J1
6	1	1						126-192	Connector, 7 Pin Female J2
7	1	1						75547	Speaker
8	1	1						42A	Tina - Jax
9	1	1						510362-1	Washer, Nylon
10	1	1						2154	Washer, Shoulder
11	1	1						[illegible]	Switch, Push Button S4
12	1	1						8A2011	Switch, Toggle S2
13	1	1						8A2101	Switch, Toggle S1
14	1	1						8A2051	Switch, Toggle S3
15	2	2						510540-3	Spacer
16	1	1						510193-1	Potentiometer Assy., 50K R53
17	1	1						510053-1	Potentiometer R50
18	1	1						510389-1	Clamp
19	1	1						510519-1	Cable Assy.
20	1	1						8942	Clamp, 1/4"
21	1	1						510052-2	Shield
22	2	2						8327	Spacer
23	1	1						1468-1/4	Terminal Lug
24	3	3						MS35190-223	Screw, 4-40X3/8 Ft. Hd. Phillips
25	6	6						MS35206-213	Screw, 4-40X1/4, Pan Hd. Phillips
26	9	9						MS35190-221	Screw, 4-40X1/4, Ft. Hd. Phillips
27	2	2						MS35206-214	Screw, 4-40X3/8, Pan Hd. Phillips
28	5	5						MS15795-4	Washer, No. 4, Flat
29	2	2						MS35649-4	Nut, Hex, 4-40
30	1	1						MS35337-4	Washer, Split Lock, No. 4
31	5	5						511-041800-00	Nut, Hex, 4-40
32	1	1						11761-1	Washer

ITEM NO.	QTY. REQ. PER DASH NO. -1	-2	-3	-4	-5	-6	PART OR IDENT. NO	DESCRIPTION
64	A/R	A/R					8505-15	Wire, Awg 26 Wht/Red, Stranded, Tinned
65							-20	Wht/Orange
66							-17	Wht/Yellow
67							8505-18	Awg 26 Wht/Blue, Stranded, Tinned
68								Awg 22 Wht/Blk, Type 44A0311, 2500V
69								Wht/Brn.
70								Wht/Red.
71								Wht/Orng.
72								Wire, Awg 22 White, Type 44A0311, 2500V
73							299/1	Wire, Buss, Awg 26, Tinned
74	A/R	A/R					PVC-105-14	Sleeving, 3/32
75	2	2					KN-500-1/8(Blk)	Knob, Black, 1/8" Shaft
76	2	2					568-8	O-Ring
77	1	1					4976	Lug, Spade
78	1	1					CL-2	Clip
79	1	1					510581-1	Wire List
80		1					510386-5	Panel
81	A/R	A/R						Wire, Awg 20, White, Type 44A0311, 2500V
82	1	1					510574-1	P.W.B. Motor Regulator
83	1	1					MS35206-217	Screw, 4-40 x 1/2, pan hd. Phillips
84	4	4					CL-632-2	Nut, 6-32
85	A/R	A/R					FIT-105-1/8	Sleeving, Shrink, 1/8 PVC
86	1	1					8480	Spacer, .250 dia. x 1/8 thk.

1 -6 to be used effective S/N 1400 and up with Escap Motor #PL-11-213-35.



CENTURY
ELECTRONICS & INSTRUMENTS, INC.
TULSA, OKLAHOMA

TITLE: CYLINDER ASSY

D	00214	510055

SCALE: 1/1 WEIGHT: SHEET 1 OF 1

3959

CENTURY SYSTEMS CORP. ARKANSAS CITY, KANSAS	TITLE CYLINDER ASSY
-1 Conf. OVA-88, 98, 118, 108, 128, 138	LM 510055

1	1							510056-1	Cylinder
2	1							510057-1	Manifold
3	1							510100-1	Regulator Assy., High Pressure
4	1							510100-2	Regulator Assy., Low Pressure
5	1							510008-1	Gauge H. P.
6	1							510007-1	Gauge L. P.
7	3							510059-1	Adapter Panel
8	3							510058-1	Valve
9	1							646F 1/4	Coupling, Female 1/4 Tube x 45°
10	1							640-FB-1/4	Nut, Cap, 1/4" x 45°, Brass
11	1							510108-1	Manifold
12	3								Nut, 5/8" - 24, Brass
13	1							510283-1	Connector, Filter Assy
14	2							112-B-1/8	Nipple, Close, 1/8" Brass
2 15	1							510109-1	Connector (MOD)
16	A/R							A69007	Tape, Pipe Thread, 1/4" Teflon
17	3								Filter, Porous Bronze, 1/4 dia.
									x 1/4 Lg., Grade 30
*	A/R							510160-1	Wafer, (Teflon)
									* Use only if required
18	3							510152-1	Ident. Plate Hydrogen Knob

[redacted]