CENTURY SYSTEMS PORTABLE ORGANIC VAPOR ANALYZER
MODEL OVA-128
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 (ppm) 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 IIIC, 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.
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2.6.3 Gain Adjustment</td>
<td>37</td>
</tr>
<tr>
<td>7.2.7 Safety</td>
<td>37</td>
</tr>
<tr>
<td>7.2.8 Maintenance and Routine Operations</td>
<td>38</td>
</tr>
<tr>
<td>7.2.8.1 Changing Chart Speeds</td>
<td>38</td>
</tr>
<tr>
<td>7.3 Activated Charcoal Filter Assembly</td>
<td>38</td>
</tr>
<tr>
<td>7.4 OVA Sample Diluter</td>
<td>38</td>
</tr>
<tr>
<td>7.4.1 Setting Dilution Rate</td>
<td>39</td>
</tr>
<tr>
<td>7.5 OVA Septum Adapter</td>
<td>39</td>
</tr>
</tbody>
</table>

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

Portable Organic Vapor Analyzer
Model OVA-128
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 backpack. 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 ppm 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: 5-5/8 x 11-5/8 x 4-1/4". FM Unit: 5-5/8 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
# TABLE OF CONTENTS

## INTRODUCTION

### SECTION 1: Description and Leading Particulars

- 1.1 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

- 2.1 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
- 2.4 Operating Procedures .......................................... 5
- 2.5 Shut Down Procedure ......................................... 6
- 2.6 Fuel Refilling ..................................................... 6
- 2.7 Battery Recharging — AC Battery Charger .......... 6
  - 2.7.1 DC Charger ................................................. 7
- 2.8 Charcoal Filtering ............................................. 7
- 2.9 Moisture Filtering .............................................. 7

### SECTION 3: Summarized Operating Procedures

- 3.1 General ................................................................. 7
- 3.2 Start Up .............................................................. 7
- 3.3 Shut Down .......................................................... 7

### SECTION 4: Calibration

- 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

- 5.1 General ................................................................. 11
- 5.2 Operating, Servicing and Modifying .................... 11
- 5.3 Electrical Protection ......................................... 11
SHOULDER CARRYING STRAP

SIDE PACK ASSEMBLY

PICKUP FUNNEL
(NOT APPLICABLE TO FM CERTIFIED MODELS)

PROBE ASSEMBLY
(ADJ. LENGTH)

"CLOSE" AREA SAMPLER

TUBULAR SAMPLER

STANDARD 5 FT. UMBILICAL CORD

READOUT ASSEMBLY
(CAN BE USED AS SHOWN WITHOUT FURTHER ATTACHMENTS IN CONFINED AREAS)

EARPHONE

FIGURE 1-2
INSTRUMENT DISASSEMBLED
Typical of All Models Except Where Noted.
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>
<thead>
<tr>
<th>TABLE 2-1</th>
<th>SIDE PACK ASSEMBLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls/Indicators — Function</td>
<td></td>
</tr>
<tr>
<td>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.</td>
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<tr>
<td>2) PUMP (ON-OFF) Switch - This toggle switch turns on power to the internal pump and audio alarms.</td>
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<tr>
<td>3) igniter Switch - This momentary push button switch connects power to the igniter coil in the detector chamber and simultaneously disconnects power to the pump.</td>
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<tr>
<td>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).</td>
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<tr>
<td>5) CALIBRATE ADJUST (zero) Knob - This potentiometer is used to &quot;zero&quot; the instrument.</td>
<td></td>
</tr>
<tr>
<td>6) GAS SELECT Knob (span control) - This ten-turn dial readout potentiometer sets the gain of the instrument commonly referred to as span control.</td>
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<tr>
<td>7) Recorder Connector - This 12S series 5-pin Amphenol connector is used to connect the instrument to an external monitor with the following pin connections.</td>
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</tr>
<tr>
<td>Pin E - plus 12VDC</td>
<td></td>
</tr>
<tr>
<td>Pin H - Ground</td>
<td></td>
</tr>
<tr>
<td>Pin A - Signal 0-5VDC (OVA-118 only)</td>
<td></td>
</tr>
<tr>
<td>Pin B - Signal 0-5VDC (OVA-128 only)</td>
<td></td>
</tr>
<tr>
<td>8) Recharger Connector - This BNC connector is used to connect the battery pack to the battery recharger assembly.</td>
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</tr>
<tr>
<td>9) H2 TANK VALVE - This valve is used to supply or close off the fuel supply from the hydrogen tank.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2-2</th>
<th>PROBE/READOUT ASSEMBLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls/Indicators — Function</td>
<td></td>
</tr>
<tr>
<td>A) Meter - This 250° linear scaled meter displays the output signal level in ppm.</td>
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</tr>
<tr>
<td>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.</td>
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</table>

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 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
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 SUPPLY 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 nullified using the CALIBRATE ADJUST (zero) Knob. Reference paragraph 6.2.5.1.

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 activate 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 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
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.

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
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 the 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.

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 SHUTDOWN

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.

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 “digital” 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 to 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
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.

\[ V_1 = \frac{V_2 \times M_w}{244D} \]

- \( V_1 \) - Volume of liquid in microliters needed to make an air mixture of 100 ppm (V/V)
- \( V_2 \) - Volume of bottle in liters
- \( M_w \) - 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

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:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Relative Response (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>100 (reference)</td>
</tr>
<tr>
<td>Propane</td>
<td>64</td>
</tr>
<tr>
<td>N-butane</td>
<td>61</td>
</tr>
<tr>
<td>N-pentane</td>
<td>100</td>
</tr>
<tr>
<td>Ethylene</td>
<td>85</td>
</tr>
<tr>
<td>Acetylene</td>
<td>200</td>
</tr>
<tr>
<td>Benzene</td>
<td>150</td>
</tr>
<tr>
<td>Toluene</td>
<td>120</td>
</tr>
<tr>
<td>Ethane</td>
<td>90</td>
</tr>
</tbody>
</table>

4.4.2 OTHER ORGANIC COMPOUNDS

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carboxylic 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., 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 gives a much higher response than does CCl4. 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:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Relative Response (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>100 (calibration sample)</td>
</tr>
<tr>
<td>Ketones</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>80</td>
</tr>
<tr>
<td>Methyl ethyl ketone</td>
<td>80</td>
</tr>
<tr>
<td>Methyl isobutyl ketone</td>
<td>100</td>
</tr>
<tr>
<td>Alcohols</td>
<td></td>
</tr>
<tr>
<td>Methyl alcohol</td>
<td>15</td>
</tr>
<tr>
<td>Ethyl</td>
<td>25</td>
</tr>
<tr>
<td>Isopropyl</td>
<td>65</td>
</tr>
</tbody>
</table>
Halogen compounds

<table>
<thead>
<tr>
<th>Compound</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon tetrachloride</td>
<td>10</td>
</tr>
<tr>
<td>Chloroform</td>
<td>65</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>70</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>35</td>
</tr>
</tbody>
</table>

The OVA has negligible response to carbon monoxide and carbon dioxide which evidently, due to their structure, do not produce appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO₂.
SECTION 5

SAFETY CONSIDERATIONS

5.1 GENERAL

The Models OVA-106, 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-106, 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 arresters 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 self-heat from expansion.

5.6 DETECTOR CHAMBER

The OVA has a small flame ionization chamber cavity with sintered metal flame arresters 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 8

MAINTENANCE

8.1 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 parts 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.

8.2 ROUTINE MAINTENANCE

Note that Figure 8-1 is a flow diagram of the basic gas handling system.

8.2.1 FILTERS

8.2.1.1 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
6.2.2 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.

8.2.1.3 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 arrester 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.

6.2.4 EXHAUST FLAME ARRESTER
A porous metal flame arrester 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 refill 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 vapor concentration and slow response time.

6.2.4.2 TESTING FOR LEAKS
The OVA's are 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 it 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 the "readout to probe" seal washer is in place and replace the probe(s) and cover this all 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 1.5 ppm of methane which is present in the normal air environment. In addition to the measurement of 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 somewhere 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 environ-

3) If the OVA includes the Gas Chromatograph Option, depress the sample inject valve so that the activated charcoal is in the line and observe whether the background reading goes down and stays steady after the elution of the air peak. The reading should always go down or stay the same but never be a higher background reading with the sample valve depressed, since the charcoal filter will take out any trace elements of organic vapors in the air heavier than a C2. If another activated charcoal filter is available, this may be attached to the end of the probe to scrub the air so that a clean air sample would be going to the detector. The external activated charcoal can be used on any instrument, with or without chromatograph, for providing a clean air sample to assess background level.

4) If background still stays up and cannot be reduced by any of the previous steps, the safety cover (if included) and the exhaust port on the detector chamber (Preamp Assembly) on the bottom of the case should be removed and the Mixer/Burner Assembly scraped or brushed with a small wire brush. (Reference paragraph 6.2.1.3.) This will remove any small quantities of contamination that are on the Mixer/Burner Assembly which could be the source of the background vapor. After cleaning the face of the burner and tube, replace the exhaust port and safety cover (if included) and reignite the OVA. If contamination on the burner face was the cause, the problem should be immediately resolved and the ambient background will drop to an acceptable level.

5) If the background is still present, place your finger over the inlet of the probe so as to reduce the flow of air to the detector chamber. Reduced flow rate may be observed either on the sample flow gauge or can normally be observed by the sound of the pump motor.

6) If the background drops immediately in response to the reduced flow of air to the chamber, this is an indication that the contamination is in the air sample line. Therefore, the various parts of the sample flow line such as pickup probes, umbilical cord to the instrument, etc., should be investigated by the process of elimination to see if the contamination can be isolated.

7) Serious contamination in the air sample line is very uncommon. However, if very large doses of very heavy compounds are sampled, there is a possibility of a residual contamination which would eventually clear itself out but may take a considerable period of time. A typical cause for the high background from the sample line is a
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 ignition switch is kept depressed. Normal ignition should take place in not more than 6 seconds. Therefore, do not depress ignition button for more than 5 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 TROUBLESHOOTING

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**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part No.</th>
<th>Recommended Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>1</td>
<td>Igniter</td>
<td>510027-1</td>
<td>2 2 2 2 2 2 2</td>
</tr>
<tr>
<td>2</td>
<td>Igniter</td>
<td>510061-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>3</td>
<td>Pump Valve</td>
<td>510167-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>4</td>
<td>Pump Diaphragm (Buna-N)</td>
<td>510091-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>5</td>
<td>Pump Diaphragm (Teflon)</td>
<td>510063-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>6</td>
<td>Cup, Filter (3/8 OD, SS)</td>
<td>510318-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>7</td>
<td>Mixer/Burner Assy</td>
<td>510557-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>8</td>
<td>Mixer/Burner Assy</td>
<td>510557-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>9</td>
<td>Mixer/Burner Assy</td>
<td>510513-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>10</td>
<td>Washer, Teflon, H₂ Valve</td>
<td>510160-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>11</td>
<td>Washer, Brass, H₂ Valve</td>
<td>510160-2</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>12</td>
<td>Exhaust Port Assy</td>
<td>510425-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>13</td>
<td>Exhaust Port Assy</td>
<td>510530-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>14</td>
<td>Battery Pack Assy</td>
<td>510070-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>15</td>
<td>Battery Pack Assy</td>
<td>510542-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>16</td>
<td>Sample Line Assy</td>
<td>510316-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>17</td>
<td>Particle Filters</td>
<td>510114-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>18</td>
<td>Particle Filters</td>
<td>510116-1</td>
<td>1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

**NOTE:** Unit quantity is each unless otherwise noted.
TROUBLESHOOTING PROCEDURE

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.
   b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.
   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 arresters, etc., must be taken into account when trouble shooting.

REMEDY
   Replace or clean filter if clogged. (See paragraph 6.2.1)
   Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.
   If in the detector chamber, remove and clean or replace porous metal flame arresters. 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).
   b) Check igniter by removing the chamber exhaust port and observing the glow when the IG-NITE Button is depressed.
   c) Check for rated H₂ Supply Pressure. (Listed on calibration plate on pump bracket.)
   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.
   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 PSI/G per hour.
   f) Check to see if H₂ supply system is frozen up by taking unit into a warm area.

   If sample flow rate is low, follow procedure 1 above.
   If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.
   If low, remove battery pack and adjust to proper level by turning the Allen wrench adjustment on the low pressure regulator cap.
   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.
   Repair leaking joint.
   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.
<table>
<thead>
<tr>
<th>3)</th>
<th>H2 flame lights but will not stay lighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Follow procedures 2 (a), (c), (d), (e), (g) and (h) above. Also refer to 5 below.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4)</th>
<th>Flame-out alarm will not go on when H2 flame is out</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Check instrument calibration setting and GAS SELECT control setting. Refer to paragraphs 2.3.1.2 and 2.3.2.</td>
</tr>
<tr>
<td>b)</td>
<td>Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber).</td>
</tr>
<tr>
<td>c)</td>
<td>If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies.</td>
</tr>
<tr>
<td>d)</td>
<td>Check volume control knob is turned up.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5)</th>
<th>False flame-out alarm. (Applies to linear OVA's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Flame-out alarm is actuated on linear instruments when signal goes below electronic zero (even though 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)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6)</th>
<th>Slow response time, i.e., time to obtain response after sample is applied to input (Refer to paragraph 6.2.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Check to ensure that probe is firmly seated on the rubber seal in the readout assembly.</td>
</tr>
<tr>
<td>b)</td>
<td>Check sample flow rate per procedure 1 above.</td>
</tr>
</tbody>
</table>

- **g)** Remove exhaust port and check for contamination. (See Figure 6-2.)
- **h)** Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.

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 arrester is properly seated.

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.

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.

Clean contamination and/or moisture from the chamber using a swab and alcohol, dry chamber by running pump for approximately 15 minutes.

Return preamp chamber or power board assembly to the factory for repair.

Adjust for desired volume.

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".

Reseat by holding the probe firmly against the rubber seal and then lock in position with the knurled locking nut.

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)). |
| b) | Check flame chamber for contamination. |
| Clean or replace contaminated sample input or assembly as required. |
| 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. |
| 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. |
| 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. |
| Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on filling hose assembly. |
| 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. |
| 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-Bio 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 27. |
ACTIVATED CHARCOAL FILTER ASSEMBLY

STRIP CHART RECORDER
(See paragraph 7.2)

GC BACKFLUSH VALVE

COLUMN

GC SAMPLING VALVE

FIGURE 7.1.1 ADDITIONAL CONTROLS & COMPONENTS - GC OPTION
SECTION 7

OPTIONAL ACCESSORIES

GAS CHROMATOGRAPH (GC) OPTION

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.

1.2 DESCRIPTION AND LEADING PARTICULARS

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 complement 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 (H2) 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 continuously 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 absorb 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, when the H₂ flow rate is set at 12 cc/min. with a Century standard 24 inch long column, no adjustment needs to be made when using columns from three (3) inches to four (4) feet long. Longer columns may require H₂ flow adjustment for proper operation. Adjustment would be required if and when precisely controlled analysis was being conducted or when the hydrogen flow was too low to keep the flame burning.

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

c) GC ANALYSIS

1) Sample Injection

When the Sample Inject Valve is depressed, the small volume of the input air sample which is in the sample loop is injected into the hydrogen stream which transports the sample through the column for separation of its components and on to the flame chamber for analysis. This small volume of injected sample is, therefore, qualitatively analyzed based on the retention time of the individual components of that sample while passing through the column. Quantitative analysis can then be accomplished by peak height or peak area analysis methods.
FIGURE 7-1-2. FLOW DIAGRAM - GC OPTION
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 depend 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

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**FIGURE 7-1-3. TYPICAL COLUMN SEPARATION SEQUENCE**
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 area* 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" (positioning 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 H2 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 C1 and C2 hydrocarbons) by adsorption from the sample air supply. |
7.1.3.3 SERVICING 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 FID detector 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 its 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 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 fugitive 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 increase. 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 its 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
TOTAL ANALYSIS TIME
TOTAL BACKFLUSH TIME
RETENTION TIME OF SECOND COMPONENT
BACKFLUSH SWITCHING TRANSIENT PEAK
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, troubleshooting 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

<table>
<thead>
<tr>
<th>X</th>
<th>Compound</th>
<th>R. R. (ºC)</th>
<th>RT (sec)</th>
<th>Date</th>
<th>TLV (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X4</td>
<td>Heptane</td>
<td>80</td>
<td>471</td>
<td>1-31-78</td>
<td>400</td>
</tr>
<tr>
<td>X2</td>
<td>Pentane</td>
<td>100</td>
<td>90</td>
<td>1-31-78</td>
<td>1000</td>
</tr>
<tr>
<td>X2</td>
<td>Hexane</td>
<td>90</td>
<td>198</td>
<td>1-31-78</td>
<td>100</td>
</tr>
<tr>
<td>X2</td>
<td>Benzene</td>
<td>150</td>
<td>291</td>
<td>1-31-78</td>
<td>1</td>
</tr>
<tr>
<td>X3</td>
<td>Toluene</td>
<td>120</td>
<td>762</td>
<td>1-31-78</td>
<td>200</td>
</tr>
</tbody>
</table>

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

Example: 6.35 in.
4.39 in.
Example:
4.39 x 4.125 = 18.11 ppm
temperatures may permanently damage the column 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 end portion of the column. Then when the hydrogen flow is reversed, the exhaust end of the column will be what was the input and 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 G1 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 length of exposure and the contamination 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:** 0% 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 TROUBLESHOOTING

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:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Part Number</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Quad Rings</td>
<td>510496-1 (10/pkg.)</td>
<td>1 pkg.</td>
<td></td>
</tr>
<tr>
<td>2) Tubing, Teflon</td>
<td>.148&quot; ID x .020 wall</td>
<td>12&quot;</td>
<td></td>
</tr>
<tr>
<td>3) Tubing, Teflon</td>
<td>.120&quot; ID x .030 wall</td>
<td>12&quot;</td>
<td></td>
</tr>
<tr>
<td>4) Activated Charcoal</td>
<td>Type G1 or equivalent</td>
<td>1 lb.</td>
<td></td>
</tr>
<tr>
<td>5) &quot;O&quot; Ring</td>
<td>2-15</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6) Chart Paper (log)</td>
<td>Type &quot;J&quot;</td>
<td>(6 rls./pkg.)</td>
<td>2 pkg.</td>
</tr>
<tr>
<td>7) Chart Paper (linear)</td>
<td>Type &quot;WA&quot;</td>
<td>(6 rls./pkg.)</td>
<td>2 pkg.</td>
</tr>
</tbody>
</table>

Activated charcoal may be purchased direct from:

- **Barnebey Cheney**
  - 825 North Cassady
  - Columbus, Ohio 43219
  - (614) 258-8501

Chart paper may be purchased direct from:

- **Gulton Recorder Systems Div.**
- **Gulton Industrial Park**
- **East Greenwich, Rhode Island 02818**
  - (401) 884-6800
<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>TROUBLE SHOOTING PROCEDURE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1) Low sample flow rate on flow indicator</strong></td>
<td>a) Check teflon tubing on valve assembly for kinks, etc. b) Check flow rate with valve in down position.</td>
<td>Straighten or replace teflon tubing Check for over restriction of charcoal filter</td>
</tr>
<tr>
<td><strong>2) H2 flame will not light</strong></td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>3) Ambient background reading in clean environment is too high</strong></td>
<td>a) Check for contamination in charcoal filter assembly. This can be detected if ambient reading increases when going into 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.</td>
<td>Replace activated charcoal in charcoal filter assembly. Replace or clean column. Replace or clean column. Remove valve stems and wipe with clean lint-free cloth. Heat valve assembly during operation to vaporize and remove contaminants.</td>
</tr>
<tr>
<td><strong>4) Flame-out when operating either valve</strong></td>
<td>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.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>5) Excessive peak tailing</strong></td>
<td>a) Change or clean GC column and see if problem disappears. b) Inspect GC valves for excessive silicone grease or contamination.</td>
<td>Ensure columns are clean prior to use. Refer to 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 of the “O” ring. Do not get on into “O” ring.</td>
</tr>
</tbody>
</table>
1.2 RECORDER OPTION

1.2.1 GENERAL

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 or 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-106, OVA-128 and OVA-138.

1.2.2 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.

1.2.3 FEATURES

The recorder prints dry (no ink) on pressure sensitive heat paper. Housed in rugged die-cast aluminum, it weighs approximately four (4) pounds and is 5-1/8" high, 3-5/8" wide and 4-1/8" 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.

1.4 CONTROLS AND CONNECTIONS

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

Controls and Connectors—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 affecting 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 120 series, 5 pin Amphenol connector provides power and signal to the recorder, as follows:

<table>
<thead>
<tr>
<th>Standard</th>
<th>FM</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>510445-1</td>
<td>510445-2</td>
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<td>E</td>
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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.

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 GL-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 51062-1, 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 0.25 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.

![Diagram of Activated Charcoal Filter Assembly](image1)

![Diagram of OVA Sample Dilutor](image2)
APPENDIX "A"

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.
OPERATING AND SERVICE MANUAL

for

CENTURY SYSTEMS'

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

REVISION C
<p>| 1 | 1 | 1 | 510508-1 | Case Assy. |
| 2 | 1 | 1 | 510053-1 | Cylinder Assy. |
| 3 | 1 | 1 | 510542-1 | Battery Pack Assy. |
| 4 | 1 | 1 | 510570-1 | Electronic Component Assy. |
| 5 | 1 | 1 | 510073-1 | Capillary Tube |
| 6 | 1 | 1 | 510094-1 | Carrying Strap Assy. |
| 7 | 1 | 1 | 510295-1 | Ident. Plate, Operating Instr. |
| 8 | 1 | 1 | 510137-1 | Ident. Plate, Calib. Rate |
| 9 | 1 | 1 | 510577-2 | Ident. Plate, CVA Assy. |
| 11 | 1 | 1 | 510590-1 | Printed Wiring Board Assy. |
| 12 | 1 | 1 | 510600-1 | Preamp Assy. |
| 13 | 1 | 1 | 510513-1 | Mixer &amp; Burner Assy. |
| 14 | 1 | 1 | 510382-1 | Fitting Assy. |
| 15 | 1 | 1 | LC-032C-45S | Spring |
| 16 | 1 | 1 | 568-013 | O-Ring |
| 17 | 1 | 1 | 510318-1 | Filter, Cup |
| 18 | 3 | 3 | 510164-1 | Washer |
| 19 | 4 | 4 | 4 | MS35206-226 | Screw, 6-32 x 1/4, Pan Hi Phillips (Brk C) |
| 20 | 2 | 2 | 2 | MS35206-223 | Screw, 4-40 x 1/2 Lg, Pan Hi Phillips |
| 21 | 1 | | 510420-1 | Tubing Assy. |
| 22 | 1 | 1 | 510622-1 | Cover |
| 23 | 3 | 3 | 3 | Screw 4-40 x 1/2 Socket Head. |
| 24 | 1 | 1 | 3305-11-46 | Thermostat, 75°C |
| 25 | 1 | | 510440-1 | G.C. Valve Assy (Dual) |
| 26 | A/R A/R A/R | 1 | Identification Plate |
| 27 | 2 | | 510568-1 | Spring |
| 28 | 1 | | 510440-2 | G.C. Valve Assy (Tri) |</p>
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<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td><strong>1</strong></td>
<td>510056-1</td>
<td>Cylinder</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td><strong>1</strong></td>
<td>510057-1</td>
<td>Manifold</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td><strong>1</strong></td>
<td>510100-1</td>
<td>Regulator Assy.. High Pressure</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td><strong>1</strong></td>
<td>510100-2</td>
<td>Regulator Assy.. Low Pressure</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td><strong>1</strong></td>
<td>510008-1</td>
<td>Gauge H.P.</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td><strong>1</strong></td>
<td>510007-1</td>
<td>Gauge L.P.</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td><strong>3</strong></td>
<td>510059-1</td>
<td>Adapter Panel</td>
</tr>
<tr>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
<td>510058-1</td>
<td>Valve</td>
</tr>
<tr>
<td><strong>9</strong></td>
<td><strong>1</strong></td>
<td>646F 1/4</td>
<td>Coupling, Female 1/4 Tube x 45°</td>
</tr>
<tr>
<td><strong>10</strong></td>
<td><strong>1</strong></td>
<td>640-FB-1/4</td>
<td>Nut, Cap, 1/4&quot; x 45°, Brass</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td><strong>1</strong></td>
<td>510108-1</td>
<td>Manifold</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td><strong>3</strong></td>
<td>510283-1</td>
<td>Nut, 5/8&quot; - 24, Brass</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td><strong>1</strong></td>
<td>510283-1</td>
<td>Connector, Filter Assy</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td><strong>2</strong></td>
<td>112-B-1/8</td>
<td>Nipple, Close, 1/8&quot; Brass</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td><strong>1</strong></td>
<td>510109-1</td>
<td>Connector (MOD)</td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>A/I</td>
<td>A69007</td>
<td>Tape, Pipe Thread, 1/4&quot; Teflon</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td><strong>3</strong></td>
<td></td>
<td>Filter, Porous Bronze, 1/4 dia. x 1/4 In., Grade 30</td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>A/I</td>
<td>510150-1</td>
<td>Wafer, (Teflon)</td>
</tr>
<tr>
<td><strong>19</strong></td>
<td>A/I</td>
<td>510152-1</td>
<td>Ident. Plate Hydrogen Knob</td>
</tr>
</tbody>
</table>

* Use only if required
ATTACHMENT VI

SOPs FOR DATA VALIDATION
NON-CLP ANALYSES
INTRODUCTION

Sample results will receive QA reviews in batches according to their time of receipt from the laboratory. The review for each batch will be a summary narrative report that includes three check sheets (several of each may be required). The contents of the narrative are summarized in the following section.

NARRATIVE REPORT OUTLINE

The narrative report that will be prepared by Golder Associates to discuss the results of QA review on each batch of samples will include the following items:

1. **Sample Integrity**
   
   Golder Associates will check that holding times and proper chain-of-custody procedures were followed. Forms H (Holding Time) and COC (Chain-of-Custody) will be completed (examples of these forms are attached).

2. **Methodology**
   
   Golder Associates will check that the correct extraction and analytical procedures were used and discuss any deviations. Procedures used will be indicated on form H.

3. **Trip Blanks and Rinsate Blanks**
   
   Golder Associates will check that the proper number of blanks were analyzed. An ID (Sample Identification) form will be completed (an example of this form is attached). This form, when completed, will indicate the relationship between a batch of samples and the corresponding QA samples and the QA sheets used. The information on this form will permit identification of samples affected by any failed QA parameters.

4. **Field Sample Duplicates**
   
   Golder Associates will check whether the correct number of sample duplicates were collected and analyzed and note significant differences (expressed as RPD) between the samples and the duplicates. The ID checklist forms will be used in conjunction with the sample analysis sheets to complete this assessment.
5. **Matrix Spike/Matrix Spike Duplicate**

Golder Associates will check whether the correct number of matrix samples were taken by reference to the ID checklist forms.

6. **Accuracy and Precision**

Golder Associates will check whether the accuracy and precision results for spikes and surrogates were received from the laboratory and note any outliers. Golder Associates will also check that the correct surrogates were used for each sample analysis.

7. **Summary**

Golder Associates will summarize any deviations from project requirements and discuss corrective actions that result. Examples of corrective action may include resampling and reanalysis due to overrun holding times or broken bottle receipt.
GOLDER ASSOCIATES INC. LABORATORY ANALYSIS CHECK SHEET

HOLDING TIMES

Sample identification(s)

<table>
<thead>
<tr>
<th>TEST</th>
<th>CORR?</th>
<th>IN DAYS ALLOWED</th>
<th>DATE SAMPLED</th>
<th>DATE EXTRACTION</th>
<th>DATE ANALYSIS</th>
<th>IN DAYS ACTUAL</th>
<th>PASS?</th>
</tr>
</thead>
</table>

If any test did not pass the requirements for holding time or test method used, state the actions taken.
### Chain of Custody Sample Identifications:

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

#### Sample Preparation:

- Samples prepared properly? [ ]
- Samples received intact (field)? [ ]
- Samples received intact (lab)? [ ]
- Signatures provided and legible? [ ]
- Dates legible? [ ]
- Spot check dates sampled carried forward correctly to the lab? [ ]

#### Note Any Problems:
GOLDER ASSOCIATES INC. LABORATORY ANALYSIS CHECK SHEET

SAMPLE IDENTIFICATION RELATIONS

<table>
<thead>
<tr>
<th>QA Sample</th>
<th>Lab Sample</th>
<th>Trip B Blank</th>
<th>Rinse B Blank</th>
<th>Matrix B Spike</th>
<th>Matrix B Spike Dup.</th>
<th>Sample Duplicate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

QA Sheets Attached:


STANDARD OPERATING PROCEDURE

Title: Evaluation of Organics Data
Attachment X.1: Data Assessment
   (Total Review - Organics)

PROJECT _______________________

REPORT # _______________________

REVIEWER _______________________

X.1.1 Sample Traffic Report
Present or on file? [ ] YES  [ ] NO  [ ] N/A
   Legible? [ ] YES  [ ] NO  [ ] N/A

ACTION: If no, request from Golder Project Manager.

X.1.2 Cover Page
Present? [ ] YES  [ ] NO  [ ] N/A

   Do sample numbers on cover page agree with sample numbers on:
      (a) Traffic Report Sheets? [ ] YES  [ ] NO  [ ] N/A
         (b) Golder Associates Sample Identification Summary? [ ] YES  [ ] NO  [ ] N/A

ACTION: If no for any of the above, contact Golder Project Manager.

X.1.3 Chain of Custody Form
Present? [ ] YES  [ ] NO  [ ] N/A

   Sample I.D.s - Present? [ ] YES  [ ] NO  [ ] N/A
   Sampler's Name - Present? [ ] YES  [ ] NO  [ ] N/A
   Date of Sampling - Present? [ ] YES  [ ] NO  [ ] N/A
   Date of Shipment - Present? [ ] YES  [ ] NO  [ ] N/A
   Date of Receipt at Laboratory - Present? [ ] YES  [ ] NO  [ ] N/A
   Shuttle Seal Intact at Laboratory? [ ] YES  [ ] NO  [ ] N/A
<table>
<thead>
<tr>
<th>X.1.4</th>
<th><strong>Analytical Results</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Present?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Detection Limits - Present?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Within Required Detection Limits?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Units - Present?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Sample Results - Present for all required compounds?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Matrix - Description?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Proper units for matrix?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Units - Present for all required compounds?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Are all &quot;less than&quot; values properly coded?</td>
<td>[ ] [ ] [ ]</td>
</tr>
</tbody>
</table>

**ACTION:** If no for any of the above, prepare Telephone Memorandum and contact the laboratory for corrected data.

<table>
<thead>
<tr>
<th>X.1.5</th>
<th><strong>Holding Times</strong> - (Examine Chain of Custody Form and Traffic Reports)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aromatic Volatiles (Unpreserved) - Exceeded (7 Days)?</td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>Aromatic Volatiles (Preserved) - Exceeded (14 Days)?</td>
<td>[ ] [ ] [ ]</td>
</tr>
</tbody>
</table>

**ACTION:** If any sample was diluted beyond contract requirements, note under non-compliance of Data Assessment Narrative.
All other Volatiles - Exceeded (14 Days)?  YES  NO  N/A

Extractables - Were any holding times for extraction exceeded (7 Days)?  YES  NO  N/A

Extractables - Were any holding times for analysis exceeded (40 Days)?  YES  NO  N/A

Pesticides - Were any holding times for extraction exceeded (7 days)?  YES  NO  N/A

Pesticides - Were any holding times for analysis exceeded (40 days)?  YES  NO  N/A

ACTION: Prepare a list of all samples and analytes for which holding times have been exceeded. Specify the number of days from date of collection to the date of analysis (from raw data). Attach to checklist. Reject (red-line) values less than Instrument Detection Limit (IDL), flag as estimated (J) those values above IDL.

X.1.6 GC/MS Tuning

X.1.6.1 Ion Abundance Criteria

X.1.6.1.1 Decafluorotriphenylphosphine (DFTPP)

<table>
<thead>
<tr>
<th>m/z</th>
<th>Ion Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>30.0 - 60.0% of m/z 198</td>
</tr>
<tr>
<td>68</td>
<td>less than 2.0% of m/z 69</td>
</tr>
<tr>
<td>70</td>
<td>less than 2.0% of m/z 69</td>
</tr>
<tr>
<td>127</td>
<td>40.0 - 60.0% of m/z 198</td>
</tr>
<tr>
<td>197</td>
<td>less than 1.0% of m/z 198</td>
</tr>
<tr>
<td>198</td>
<td>base peak, 100% relative abundance</td>
</tr>
<tr>
<td>199</td>
<td>5.0 - 9.0% of m/z 198</td>
</tr>
<tr>
<td>275</td>
<td>10.0 - 30.0% of m/z 198</td>
</tr>
<tr>
<td>365</td>
<td>greater than 1.00% of m/z 198</td>
</tr>
<tr>
<td>441</td>
<td>present, but less than m/z 443</td>
</tr>
<tr>
<td>442</td>
<td>greater than 40.0% of m/z 198</td>
</tr>
<tr>
<td>443</td>
<td>17.0 - 23.0% of m/z 442</td>
</tr>
</tbody>
</table>
X.1.6.1.2 Bromofluorobenzene (BFB)

<table>
<thead>
<tr>
<th>m/z</th>
<th>Ion Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>15.0 - 40.0% of the base peak</td>
</tr>
<tr>
<td>75</td>
<td>30.0 - 60.0% of the base peak</td>
</tr>
<tr>
<td>95</td>
<td>base peak, 100% relative abundance</td>
</tr>
<tr>
<td>96</td>
<td>5.0 - 9.0% of the base peak</td>
</tr>
<tr>
<td>173</td>
<td>less than 2.0% of m/z 174</td>
</tr>
<tr>
<td>174</td>
<td>greater than 50.0% of the base peak</td>
</tr>
<tr>
<td>175</td>
<td>5.0 - 9.0% of m/z 174</td>
</tr>
<tr>
<td>176</td>
<td>greater than 95.0%, but less than 101.0% of m/z 174</td>
</tr>
<tr>
<td>177</td>
<td>5.0 - 9.0% of m/z 176</td>
</tr>
</tbody>
</table>

X.1.6.2 Tuning Results (For instrument tuned using DFTPP)

Calibration Data - Present? [ ] ___ ___

ACTION: If no, prepare Telephone Memorandum and request submission by laboratory.

Do all Ion Abundance Criteria fall within the values listed in Section X.1.6.1.1? [ ] ___ ___

ACTION: If no, complete checklist items below marked with "*"

* Is m/z 51 between 22.0 - 75.0% of m/z 198? [ ] ___ ___

* Is m/z 127 between 30.0 - 75.0% of m/z 198? [ ] ___ ___

* Is m/z 275 between 7.0 - 37.0% of m/z 198? [ ] ___ ___

* Is m/z 365 greater than 0.75% of m/z 198? [ ] ___ ___

* Is m/z 442 greater than 30.0% of m/z 198? [ ] ___ ___

ACTION: If more than one of the expanded criteria above (*) are out of bounds, or if any of the other criteria listed in Section X.1.6.1.1 are out of bounds, flag all data
associated with that run as unusable (red-line). Otherwise, the data reviewer has the option of accepting the data, depending on project priorities.

Is calibration data present for each 12-hour period samples are analyzed?

Are there any transcription errors?

Are there any calculation errors?

Is the appropriate number of significant figures used to report tuning results (same as X.1.6.1.1)?

ACTION: Prepare a Telephone Memorandum and contact the laboratory for clarification or resubmittal.

X.1.6.2 Tuning Results (For instrument tuned using BFB)

Calibration Data - Present?

ACTION: If no, prepare Telephone Memorandum and request submittal by laboratory.

Do all Ion Abundance Criteria fall within the values listed in Section X.1.6.1.2?

ACTION: If no, complete checklist items below marked with "*"

* Is m/z 50 between 11.0 - 50.0% of the base peak?

* Is m/z 75 between 22.0 - 75.0% of the base peak?

ACTION: If more than one of the expanded criteria above (*) are out of bounds, or if any of the other criteria listed in Section X.1.6.1.2 are out of bounds, flag all data
associated with that run as unusable (red-line). Otherwise, the data reviewer has the option of accepting the data, depending on project priorities.

Is tuning data present for each 12-hour period samples are analyzed?

Are there any transcription errors?

Are there any calculation errors?

Is the appropriate number of significant figures used to report tuning results (same as X.1.6.1.2)?

ACTION: Prepare a Telephone Memorandum and contact the laboratory for clarification or resubmittal.

X.1.7 Calibration - VOA & BNA

Calibration Data - Present?

Legible?

ACTION: If no, prepare Telephone Memorandum and contact laboratory for clarification or resubmittal.

X.1.7.1 Initial Calibration

Are all average Relative Response Factors (Reported) for TCL compounds \( \geq 0.05 \)?

Are all Percent Relative Standard Deviations (\%RSD) \( \leq 30\% \)?

NOTE: Perform a spot-check of one or more of the reported calibration values, computing the RRF and %RSD. If errors are detected in the calculations of either the RRF or the %RSD, perform
ACTION: If any volatile or semivolatile TCL compound result has an average RRF of less than 0.05:

a. Flag positive results for that compound as estimated (J).

b. Flag non-detects for that compound as unusable (R).

If any volatile or semivolatile TCL compound has a %RSD of greater than 30%:

a. Flag positive results for that compound as estimated (J).

b. Non-detects may be qualified using professional judgement.

X.1.7.2 Continuing Calibration

Are all average Relative Response Factors (Reported) for TCL compounds ≥ 0.05? [ ] [ ] [ ]

Are all Percent Relative Standard Deviations (%RSD) ≤ 25%? [ ] [ ] [ ]

NOTE: Perform a spot-check of one or more of the reported calibration values, computing the RRF and %RSD. If errors are detected in the calculations of either the RRF or the %RSD, perform a more comprehensive recalculation.

ACTION: If any volatile or semivolatile TCL compound result has an average RRF of less than 0.05:

a. Flag positive results for that compound as estimated (J).

b. Flag non-detects for that
compound as unusable (R).

If any volatile or semivolatile TCL compound has a %RSD of greater than 25%:

a. Flag positive results for that compound as estimated (J).

b. Non-detects may be qualified using professional judgement.

X.1.8 Blanks - VOA & BNA

Has a Method Blank been reported for:
  each matrix? [ ] [ ] [ ]
  concentration level? [ ] [ ] [ ]
  each GC/MS system (VOA)? [ ] [ ] [ ]
  each extraction batch (semivolatiles)? [ ] [ ] [ ]

ACTION: Prepare a Telephone Memorandum and contact the laboratory for clarification or resubmittal.

Was a detection reported in a blank for:

  Methylene chloride? [ ] [ ] [ ]
  Acetone? [ ] [ ] [ ]
  Toluene? [ ] [ ] [ ]
  2-Butanone (MEK)? [ ] [ ] [ ]
  Phthalate esters? [ ] [ ] [ ]

ACTION: No positive sample results should be reported unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for the compounds listed above. The results should be qualified by elevating the detection limit for that compound. For compounds not listed
above, results should be qualified if the reported concentration is not at least 5 times the blank value.

If gross contamination exists (saturated peaks by GC/MS), all compounds affected should be flagged as unusable (R), in all samples affected.

If low levels of compounds are consistently found in blanks, make a note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

<table>
<thead>
<tr>
<th>X.1.9</th>
<th>Surrogate Recovery (VOA &amp; BNA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X.1.9.1</strong></td>
<td>Volatile Surrogate Recoveries (Water)</td>
</tr>
<tr>
<td>QC LIMITS</td>
<td></td>
</tr>
<tr>
<td>Toluene-d8</td>
<td>88 - 110%</td>
</tr>
<tr>
<td>Bromofluorobenzene</td>
<td>86 - 115%</td>
</tr>
<tr>
<td>1,2-Dichloroethane-d4</td>
<td>76 - 114%</td>
</tr>
<tr>
<td><strong>X.1.9.2</strong></td>
<td>Volatile Surrogate Recoveries (Soil)</td>
</tr>
<tr>
<td>QC LIMITS</td>
<td></td>
</tr>
<tr>
<td>Toluene-d8</td>
<td>81 - 117%</td>
</tr>
<tr>
<td>Bromofluorobenzene</td>
<td>74 - 121%</td>
</tr>
<tr>
<td>1,2-Dichloroethane-d4</td>
<td>70 - 121%</td>
</tr>
<tr>
<td><strong>X.1.9.3</strong></td>
<td>Semivolatile Surrogate Recoveries (Water)</td>
</tr>
<tr>
<td>QC LIMITS</td>
<td></td>
</tr>
<tr>
<td>Nitrobenzene-d5</td>
<td>35 - 114%</td>
</tr>
<tr>
<td>2-Fluorobiphenyl</td>
<td>43 - 116%</td>
</tr>
<tr>
<td>Terphenyl-d14</td>
<td>33 - 141%</td>
</tr>
<tr>
<td>Phenol-d6</td>
<td>10 - 94%</td>
</tr>
<tr>
<td>2-Fluorophenol</td>
<td>21 - 100%</td>
</tr>
<tr>
<td>2,4,6-Tribromophenol</td>
<td>10 - 123%</td>
</tr>
<tr>
<td><strong>X.1.9.4</strong></td>
<td>Semivolatile Surrogate Recoveries (Soil)</td>
</tr>
<tr>
<td>QC LIMITS</td>
<td></td>
</tr>
<tr>
<td>Nitrobenzene-d5</td>
<td>23 - 120%</td>
</tr>
<tr>
<td>2-Fluorobiphenyl</td>
<td>30 - 115%</td>
</tr>
</tbody>
</table>
X.1.9.5 Surrogate Analysis

Is any surrogate in a VOA or acid fraction out of specification, or does any VOA surrogate have a recovery of less than 10%?  

Are any two surrogates in a base/neutral or acid fraction out of specification, or have recoveries less than 10%?  

Do any blanks have surrogates out of specification?  

ACTION: If at least two surrogates in a base/neutral or acid fraction, or one surrogate in a VOA fraction are out of specification, but have recoveries greater than 10%:

a. Positive results for that fraction are flagged as estimated (J).

b. Negative results for that fraction are flagged with the sample quantitation limit as estimated (UJ).

If any surrogate in a fraction shows less than 10% recovery:

a. Positive results for that fraction are flagged as estimated (J).

b. Negative results for that fraction are flagged as unusable (R).

If surrogate recoveries are out of specification for a blank, prepare a Telephone Memorandum and contact the laboratory.
X.1.10 **Matrix Spike/Matrix Spike Duplicate**
*(VOA & BNA)*

X.1.10.1 **Volatile Matrix Spike/Matrix Spike Duplicate Recovery (Water)**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Recovery</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1-Dichloroethene</td>
<td>61 - 145%</td>
<td>14</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>71 - 120%</td>
<td>14</td>
</tr>
<tr>
<td>Benzene</td>
<td>76 - 127%</td>
<td>11</td>
</tr>
<tr>
<td>Toluene</td>
<td>76 - 125%</td>
<td>13</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>75 - 130%</td>
<td>13</td>
</tr>
</tbody>
</table>

X.1.10.2 **Volatile Matrix Spike/Matrix Spike Duplicate Recovery (Soil)**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Recovery</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,1-Dichloroethene</td>
<td>59 - 172%</td>
<td>22</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>62 - 137%</td>
<td>24</td>
</tr>
<tr>
<td>Benzene</td>
<td>66 - 142%</td>
<td>21</td>
</tr>
<tr>
<td>Toluene</td>
<td>59 - 139%</td>
<td>21</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>60 - 133%</td>
<td>21</td>
</tr>
</tbody>
</table>

X.1.10.3 **Semivolatile Matrix Spike/Matrix Spike Duplicate Recovery (Water)**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Recovery</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>12 - 89%</td>
<td>42</td>
</tr>
<tr>
<td>2-Chlorophenol</td>
<td>27 - 123%</td>
<td>40</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>36 - 97%</td>
<td>28</td>
</tr>
<tr>
<td>N-Nitroso-di-n-prop.(1)</td>
<td>41 - 116%</td>
<td>38</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>39 - 98%</td>
<td>28</td>
</tr>
<tr>
<td>4-Chloro-3-methylphenol</td>
<td>23 - 97%</td>
<td>42</td>
</tr>
<tr>
<td>Acenaphthene</td>
<td>46 - 118%</td>
<td>31</td>
</tr>
<tr>
<td>4-Nitrophenol</td>
<td>10 - 80%</td>
<td>50</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>24 - 96%</td>
<td>38</td>
</tr>
<tr>
<td>Pentachlorophenol</td>
<td>9 - 103%</td>
<td>50</td>
</tr>
<tr>
<td>Pyrene</td>
<td>26 - 127%</td>
<td>31</td>
</tr>
</tbody>
</table>

X.1.10.4 **Semivolatile Matrix Spike/Matrix Spike Duplicate Recovery (Soil)**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Recovery</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>26 - 90%</td>
<td>35</td>
</tr>
<tr>
<td>2-Chlorophenol</td>
<td>25 - 102%</td>
<td>50</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>28 - 104%</td>
<td>27</td>
</tr>
<tr>
<td>N-Nitroso-di-n-prop.(1)</td>
<td>41 - 126%</td>
<td>38</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>38 - 107%</td>
<td>23</td>
</tr>
</tbody>
</table>
2-Chloro-3-methylphenol 26 - 103% 33
Acenaphthene 31 - 137% 19
4-Nitrophenol 11 - 114% 50
2,4-Dinitrotoluene 28 - 89% 47
Pentachlorophenol 17 - 109% 47
Pyrene 35 - 142% 36

X.1.10.5 Matrix Spike/Matrix Spike Duplicate Analysis (VOA & BNA)

Are there any transcription errors? [ ] [ ] [ ]
Are any recoveries outside of limits (X.1.10.1 - X.1.10.2)? [ ] [ ] [ ]
Are any RPDs exceeded? [ ] [ ] [ ]
ACTION: Make a note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

X.1.11 Field Duplicates

Are field duplicates identified? [ ] [ ] [ ]
ACTION: If there are field duplicates, calculate the Relative Percent Difference. Make a note in the Data Acceptability Narrative.

X.1.12 Internal Standards Performance

Are Internal Standards Data available? [ ] [ ] [ ]
ACTION: If no, prepare a Telephone Memorandum and contact the laboratory.
Are all internal standard area counts within 50 - 200% of the associated calibration standards? [ ] [ ] [ ]
ACTION: If an IS area count is outside limits:

a. Positive results for compounds quantitated using that IS are flagged as estimated for that sample
fraction.

b. Non-detects for compounds quantitated using that IS are flagged with the sample quantitation limit classified as estimated (UJ) for that sample fraction.

c. If extremely low area counts are reported, or if performance exhibits a major abrupt decline, non-detects should be flagged as unusable (R).

<table>
<thead>
<tr>
<th>Are all retention times within ± 30 seconds of the associated calibration standard?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**ACTION:** If any IS retention time varies by more than 30 seconds, examine the chromatographic profile to determine if any false positives or negatives exist. Make a note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

**X.1.13 TCL Compound Identification**

<table>
<thead>
<tr>
<th>Are all compounds within 0.06 relative retention time (RRT) units of the standard RRT?</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are all ions present in the standard mass spectrum at a relative intensity &gt; 10% present in the sample mass spectrum?</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do the relative intensities of ions agree within ± 20% between the standard and sample spectra?</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are ions having relative intensities greater than 10% in the sample spectrum but not present in the standard spectrum accounted for?</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
</tr>
</tbody>
</table>

**ACTION:** If no for any of the above, note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the
X.1.14 Compound Quantitation and Reported Detection Limits

Was the correct internal standard used to quantitate each compound? [ ]

Was the correct quantitation ion used for each compound (See Attachment X.8)? [ ]

Was the correct Relative Response Factor (RRF) used for each compound? [ ]

Have the Quantitation Limits been adjusted to reflect all sample dilutions, concentrations, splits, clean-up activities, and dry weight factors? [ ]

ACTION: If no for any of the above, note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

X.1.15 Tentatively Identified Compounds (TIC)

Are all major ions (greater than 10% relative intensity) in the reference spectrum present in the sample spectrum? [ ]

Do the relative intensities of the major ions agree within ± 20% between the reference and sample spectra? [ ]

ACTION: If it is determined that a tentative identification of a non-TCL is not acceptable, the tentative identification should be changed to "unknown" or an appropriate identification.

Are any TIC peaks present in a sample also found in any blanks? [ ]

ACTION: TIC results which are not sufficiently above the level in
the blank should not be reported. When a compound is not found in any blanks, but is a suspected laboratory contaminant, the result may be flagged as unusable (R).

X.1.16 System Performance

Are there any abrupt shifts in reconstructed ion chromatogram (RIC) baselines?  

Are there high RIC background levels?  

Is there excessive baseline rise at elevated temperatures?  

Are there significant extraneous peaks?  

Is any peak tailing or peak splitting identified?  

ACTION: Positive responses for any of the above may indicate general system deterioration. Note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

X.1.17 Instrument Performance (Pesticides)

X.1.17.1 DDT Retention Time

Is the retention time for DDT greater than 12 minutes?  

Is there adequate resolution between DDT peaks?  

ACTION: If the retention time is less than 12 minutes (except on OV-1 and OV-101), a close examination of the chromatography is necessary to ensure that adequate separation of individual components is achieved. If adequate separation is not achieved, flag all affected compound data as unusable (R).
X.1.17.2 Retention Time Windows

Are retention time windows reported? [ ]  [ ]  [ ]

ACTION: Prepare a Telephone Memorandum and contact the laboratory.

Are all pesticide standards within established retention time windows? [ ]  [ ]  [ ]

ACTION: If the standards do not fall within the retention time windows, the associated sample results should be carefully evaluated. All samples injected after the last in-control standard may be affected.

Check to see if chromatograms contain peaks near the compound of interest. If no peaks are present either within or close to the retention time window of the deviant compound, there is usually no effect on the data.

If the affected sample chromatograms contain peaks close to or within the retention time window of the pesticide of interest, the affected positive results and quantitation limits may be flagged as unusable (R), or more thorough reanalysis of the affected retention time windows may be performed, at the discretion of the reviewer.

X.1.17.3 DDT/Endrin Degradation Check

Does the percent breakdown for 4,4'-DDT exceed 20% (see Attachment X.9 for formula)? [ ]  [ ]  [ ]

Does the percent breakdown for endrin exceed 20% (see Attachment X.9 for formula)? [ ]  [ ]  [ ]

Does the combined percent breakdown exceed 20% (see Attachment X.9 for formula)? [ ]  [ ]  [ ]
ACTION: If DDT breakdown is greater than 20%, beginning with the samples following the last in-control standard:

a. Flag all quantitative results for DDT as estimated (J). If DDT was not detected, but DDD and DDE are positive, then flag the quantitation limit for DDT as unusable (R).

b. Flag results for DDD and/or DDE as presumptively present at an estimated quantity (NJ).

If endrin breakdown is greater than 20%:

a. Flag all quantitative results for endrin as estimated (J). If endrin was not detected, but endrin aldehyde and endrin ketone are positive, then flag the quantitation limit for endrin as unusable (R).

b. Flag results for endrin ketone as presumptively present at an estimated quantity (NJ).

X.1.17.4 Retention Time Check

Is the percent difference in retention time for dibutylchlorendate in all standards and samples ≤ 2.0% for packed columns, ≤ 0.3% for capillary columns, or ≤ 1.5% for wide-bore capillary columns? ___ ___ ___

ACTION: If no, the analysis may be flagged as unusable (R), at the discretion of the reviewer.

X.1.18 Calibration (Pesticides)

X.1.18.1 Initial Calibration Linearity Check

Does the Percent Relative Standard Deviation (%RSD) of calibration factors for aldrin, endrin, DDT, and dibutylchlorendate exceed 10% (see Attachment X.9 for formula)? ___ ___ ___
<table>
<thead>
<tr>
<th>ACTION:</th>
<th>If yes, flag all associated quantitative results as estimated (J).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Were all standards analyzed within 72 hours of any sample?</td>
</tr>
<tr>
<td></td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td></td>
<td>If DDT or toxaphene was identified and quantitated, was a three-point calibration used?</td>
</tr>
<tr>
<td></td>
<td>[ ] [ ] [ ]</td>
</tr>
<tr>
<td>ACTION:</td>
<td>If no, flag all associated quantitative results as estimated (J).</td>
</tr>
</tbody>
</table>

**X.1.18.2 Analytical Sequence**

**X.1.18.2.1 Primary Analysis**

Were all standards analyzed at the beginning of each 72 hour sequence (see list below)?

<table>
<thead>
<tr>
<th>Required Standards:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation Standard Mix A</td>
</tr>
<tr>
<td>Evaluation Standard Mix B</td>
</tr>
<tr>
<td>Evaluation Standard Mix C</td>
</tr>
<tr>
<td>Individual Standard Mix A*</td>
</tr>
<tr>
<td>Individual Standard Mix B*</td>
</tr>
<tr>
<td>Toxaphene</td>
</tr>
<tr>
<td>Aroclors 1016/1260</td>
</tr>
<tr>
<td>Aroclor 1221**</td>
</tr>
<tr>
<td>Aroclor 1232**</td>
</tr>
<tr>
<td>Aroclor 1242</td>
</tr>
<tr>
<td>Aroclor 1248</td>
</tr>
<tr>
<td>Aroclor 1254</td>
</tr>
</tbody>
</table>

* These may be combined into one mixture.

** Aroclors 1221 and 1232 must be analyzed on each instrument and each column at a minimum of once per month.

ACTION: If no, flag all associated data as unusable (R).
X.1.18.2.2 Confirmation Analysis

Were Evaluation Standard Mix A, B, and C analyzed within 72 hours of analysis of all samples? [ ] [ ] [ ]

Was the Individual Standard Mix containing the compounds to be confirmed analyzed after every 5 samples? [ ] [ ] [ ]

Was Evaluation Standard Mix B analyzed after every 10 samples? [ ] [ ] [ ]

ACTION: If no for any of the above, all associated data may be flagged as estimated (J).

X.1.18.3 Continuing Calibration

Was the percent difference (%D) between the calibration factors greater than 15% for compound(s) being quantitated, or 20% for compound(s) being confirmed (see Attachment X.9 for formula)? [ ] [ ] [ ]

ACTION: If yes, flag all associated quantitative results as estimated (J).

X.1.19 Blanks (Pesticides)

Was a method blank analysis reported for each matrix, concentration level, extraction batch, and different GC system used to analyze samples? [ ] [ ] [ ]

ACTION: Make a note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

Do any method blanks have reported concentrations of any Pesticide/PCB above Required Quantitation Limits? [ ] [ ] [ ]

ACTION: If yes:
  a. If a Pesticide/PCB is found in the blank but not in the sample(s), no action is taken.
b. If a Pesticide/PCB is found in a sample and in the associated blank, and the sample concentration is less than 5 times the blank concentration, the sample result should be qualified as not-detected with an elevated detection limit (U).

X.1.20 Surrogate Recovery (Pesticides)

Is the recovery of Dibutylchlorendate within 24 - 254% for water samples or 20 - 150% for soil samples? [ ] [ ] [ ]

ACTION: If no, the associated data may be qualified. If low recoveries are obtained, flag associated positive results and quantitation limits as estimated (J). If high recoveries are obtained, professional judgement should be used to determine appropriate action. A high bias may be due to co-eluting interferences. If zero recovery is reported, the reviewer should examine the sample chromatogram to determine if the surrogate is present, but slightly outside its retention time window. If the surrogate is not present, flag all negative results as unusable (R).

X.1.21 Matrix Spike/Matrix Spike Duplicate (Pesticides)

X.1.21.2 Water Matrix Spike/Matrix Spike Duplicate Recovery (Pesticides)

QC LIMITS

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Recovery Range</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>gamma-BHC (Lindane)</td>
<td>56 - 123%</td>
<td>15</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>40 - 131%</td>
<td>20</td>
</tr>
<tr>
<td>Aldrin</td>
<td>40 - 120%</td>
<td>22</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>52 - 126%</td>
<td>18</td>
</tr>
<tr>
<td>Endrin</td>
<td>56 - 121%</td>
<td>21</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>38 - 127%</td>
<td>27</td>
</tr>
</tbody>
</table>
X.1.21.2  Soil Matrix Spike/Matrix Spike Duplicate Recovery (Pesticides)

QC LIMITS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Recovery</th>
<th>RPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>gamma-BHC (Lindane)</td>
<td>46 - 127%</td>
<td>50</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>35 - 130%</td>
<td>31</td>
</tr>
<tr>
<td>Aldrin</td>
<td>34 - 132%</td>
<td>43</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>31 - 134%</td>
<td>38</td>
</tr>
<tr>
<td>Endrin</td>
<td>42 - 139%</td>
<td>45</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>23 - 134%</td>
<td>50</td>
</tr>
</tbody>
</table>

X.1.21.3  Matrix Spike/Matrix Spike Duplicate Analysis (Pesticides)

Are there any transcription errors?  [ ] [ ] [ ]

Are any recoveries outside of limits (X.1.21.1 - X.1.21.2)? [ ] [ ]

Are any RPDs exceeded?  [ ] [ ] [ ]

ACTION: Make a note in the Data Acceptability Narrative, prepare a Telephone Memo- randum, and contact the laboratory.

X.1.22  Field Duplicates (Pesticides)

Are field duplicates identified?  [ ] [ ] [ ]

ACTION: If there are field duplicates, calculate the Relative Percent Difference. Make a note in the Data Acceptability Narrative.

X.1.23  Compound Identification (Pesticides)

Were all reported positive detections within appropriate retention time windows?  [ ] [ ] [ ]

ACTION: If no, examine the chromatogram to see if there are other peaks near the compound of interest that may be interfering with the signal. If no, qualify the compound as not detected.
Was a 3% OV-1 column used for confirmation if both dieldrin and DDE were reported?  

**YES**  **NO**  **N/A**  

**ACTION:** If yes, flag all affected data as unusable (R).

Did all positive identifications have dissimilar column analysis?  

**[]**  **[]**  **[]**  

**ACTION:** If no, flag all affected data as unusable (R).

For chlordane, toxaphene or PCBs (multicomponent analytes), do the retention times and relative peak ratios of major component peaks match the expected patterns?  

**[]**  **[]**  **[]**  

**ACTION:** If PCBs or multipeak pesticides exhibit marginal pattern matching quality, professional judgement should be used to establish whether the differences are attributable to environmental "weathering". If the presence of a PCB/multipeak pesticide is strongly suggested, results should be reported as presumptively present (N). If an observed pattern closely matches more than one Aroclor, professional judgement should be used to decide whether the neighboring Aroclor is a better match, or if multiple Aroclors are present.

Was GC/MS confirmation performed for pesticide/PCB concentrations in the final sample extract which exceeded 10 ng/µL?  

**[]**  **[]**  **[]**  

**ACTION:** If no, note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

**X.1.24 Compound Quantitation and Reported Detection Limits (Pesticides)**

Do reported sample results match
1.0 Scope

1.1 This procedure is applicable to organic data obtained from laboratories contracted to provide analytical services.

1.2 The data validation protocols have been developed by Golder Associates Inc. using "Laboratory Data Validation - Functional Guidelines for Evaluating Organics Analyses", Hazardous Site Evaluation Division, USEPA, February, 1988.

2.0 Responsibilities

Data reviewers will complete the following tasks as assigned:

2.1 For a Total Review:

2.1.1 Data Assessment - "Total Review - Organics"
Attachment X.1.

2.1.2 Data Assessment - Data Acceptability Narrative
Attachment X.2.

2.1.3 Non-Compliance Report
Attachment X.3
This report is to be completed only when a serious discrepancy is encountered, or upon the request of the Golder Data Review Manager. Forward ___ copies, one each for the addressess on the Mailing List for Data Review (Attachment X.4). In other cases involving more routine discrepancies, notations should be made in the Data Acceptability Narrative (Sec. X.2.2).

2.1.4 Data Summary Sheet - Summary of Organic Quality Control Data
Attachment X.5.
Enter on Data Summary Sheet all values for Quality Control Parameters found in the Analytical Reports.

2.1.5 Data Acceptability Summary Form
Attachment X.6
Fill out as necessary for each category. Place an "X" in boxes where analyses were not performed, or criteria do not apply.
calculations performed using the raw data?  [ ]  [ ]  [ ]

Have Required Detection Limits been adjusted to reflect all sample dilutions, concentrations, splits, clean-up activities, and dry weight factors?  [ ]  [ ]  [ ]

**ACTION:** If no, note in the Data Acceptability Narrative, prepare a Telephone Memorandum, and contact the laboratory.

Are quantitation limits affected by large, off-scale peaks?  [ ]  [ ]  [ ]

**ACTION:** If yes, flag affected results as unusable (R). If the interference is on-scale, the reviewer can provide an estimated quantitation limit (UJ) for each affected compound.

Note: Single-peak pesticide results should be checked for rough agreement between quantitative results obtained on the two GC columns. The reviewer should use professional judgement to decide whether a much larger concentration obtained on one column versus the other indicates the presence of an interfering compound. If an interfering compound is indicated, the lower of the two values should be reported and qualified as an estimated quantity (NJ). This necessitates a determination of an estimated concentration on the confirmation column. The narrative should indicate that the presence of interferences has obscured the attempt at a second column confirmation.
2.1.6 Data Review Log:
The data reviewer will maintain a log of reviews completed to include:
   a. Date of start of case review
   b. Date of completion of case review
   c. Site name
   d. Laboratory
   e. Number of samples
   f. Matrix
   g. Reviewer's initials

2.1.7 Telephone Memorandum
The data reviewer should enter the bare facts of the inquiry before initiating any phone conversation with the laboratory. File the yellow copy in the Project Telephone Memorandum folder and attach a photocopy of the Telephone Memorandum to the completed Data Acceptability Narrative (Attachment X.2).

2.1.8 Forwarded Paperwork

2.1.8.1 Upon completion of the review, the following are to be forwarded to IEPA and USEPA Region V Remedial Project Managers:
   a. Completed data assessment checklist
   b. Data Summary Sheet (Attachment X.5) along with completed Data Acceptability Narrative (Attachment X.2)

2.1.8.2 Forward 1 copy of completed Data Acceptability Narrative (Attachment X.2) along with Telephone Memoranda, if any, to each of the four addressees (4 copies total) on the Mailing List for Data Review Recipients (Attachment X.4).

2.1.9 Filed Paperwork
Upon completion of review, the following are to be filed within Golder files:
   a. Completed Data Acceptability Narrative (Attachment X.2)
   b. Telephone Memoranda
   c. Data Summary Sheet - Summary of Organics Quality Control Data (Attachment X.5)
   d. Non-Compliance Report (Attachment X.3)
   e. Data Acceptability Summary Form (Attachment X.6)
   f. Checklist of Total Review (Attachment X.1)
   g. Sample Identification Summary (Attachment X.7)

3.0 Timeliness

3.1 Data Completeness
Incomplete data packages must be brought to the
attention of the IEPA and USEPA Remedial Project Managers whenever the lack of any information would cause the rejection of data.

3.2 Golder will contact the laboratory within one working day of discovery of any incomplete data package. Designee will again contact the laboratory two weeks after first contact if data has not been received.

3.3 If incomplete data packages are held longer than six weeks from the date of receipt of the initial data package, the IEPA and USEPA Region V Remedial Project Managers will be contacted with an explanation specifying which reported values could be considered validated and which required further clarification.

4.0 Rejection of Data
All values determined to be unacceptable on the Organic Analysis Data Sheet must be lined through with a red pencil. As soon as any review criteria causes data rejection, those data can be eliminated from any further review or consideration.

5.0 Acceptance Criteria
Acceptance criteria as stated in Attachment X.1 will be used.

6.0 Request for Reanalysis
Data reviewers must note all items of non-compliance within the Data Assessment Narrative. If holding times and sample storage times have not been exceeded, Golder may request reanalysis if items of non-compliance are critical to data assessment. Requests are to be made by telephone.

7.0 A Sample Identification Summary will be completed by the Golder Remedial Project Manager identifying all samples by CRL-type and site number.
CLP METALS/CYANIDE ANALYSES
1.0 Scope

1.1 This procedure is applicable to inorganic data obtained from York Laboratories. This Standard Operating Procedure is substantially derived from a document entitled "Evaluation of Metals Data for the Contract Laboratory Program, Revision VII, U.S. EPA Region II, February 1988".

1.2 All modifications have been made by Golder Associates Inc. (Golder) with no discussions or other input from U.S. EPA Region II.

2.0 Responsibilities - Data reviewers will complete the following tasks:

2.1. For a total review:

2.1.1 **Data Assessment** - "Total Review-Inorganics" Checklist

Attachment - A1

2.1.2 **Data Assessment** - Data Acceptability Narrative (Attachment - A2)

2.1.3 **Non-Compliance Report (Attachment - A3)**

This report is to be completed only when a serious violation is encountered, or upon the request of the Golder Data Review Manager. Forward 5 copies: one each for the addressees of Mailing List for Data Review Recipients (Attachment - A4). In other cases, all violations should be appended to end of Data Acceptability Narrative (Sec. A-2).

2.1.4 **Data Summary Sheet** - Summary of Inorganic Quality Control Data (Attachment - A5).

Enter on Data Summary Sheet all values from the RAS deliverable package. Circle all values out of control limits in red.

2.1.5 **CLP Type Data Acceptability Summary Form** (Attachment - A6)

Fill out as necessary for each category. Place an "X" in boxes where analyses were not performed, or criteria do not apply.
2.1.6 **Data Review Log:** The data reviewer will maintain a log of reviews completed to include:
   a. date of start of case review
   b. date of completion of case review
   c. site name
   d. laboratory
   e. number of samples
   f. matrix
   g. reviewers initials

2.1.7 **Sample Identification Summary (Attachment - A7)**

2.1.8 **Telephone Memorandum** - the data reviewer should enter the bare facts of inquiry, before initiating any phone conversation with the York laboratory. File yellow copy in the Project Telephone Memorandum folder, and attach a photocopy of the Telephone Memorandum to the completed Data Acceptability Narrative (Attachment).

2.1.9 **Forwarded Paperwork**

2.1.9.1 Upon completion of review, the following copies are to be forwarded to the IEPA and U.S. EPA, Region V Remedial Project Managers:
   a. completed data assessment checklist
   b. Data Summary Sheet (Attachment) along with completed Data Acceptability Narrative (Attachment).

2.1.9.2 Forward 4 copies of completed Data Acceptability Narrative (Attachment) along with Telephone Memorandum, if any; one each for the addressees of Mailing List for Data Review Recipients (Attachment).

2.1.10 **Filed Paperwork** - Upon completion of review, the following are to be filed within Golder files:
   a. completed Data Acceptability Narrative (Attachment - A2)
   b. Telephone Memorandum (copy)
   c. Data Summary Sheet - Summary of Inorganics Quality Control Data (copy) (Attachment - A5)
   d. Non-compliance report (Attachment - A3)
   e. CLP Type Data Acceptability Summary Form (Attachment - A6)
   f. Checklist of Total Review (Attachment - A1)
   g. Sample Identification Summary (Attachment - A7).

3.0 **Timeliness**
3.1 Data Completeness - Incomplete data packages must be brought to the attention of the IEPA and U.S. EPA Remedial Project Managers whenever the lack of any information would cause the rejection of data.

3.2 Golder will contact York Laboratories within one working day of discovery of an incomplete data package. Designee will again contact laboratory two weeks after first contact if data has not been received.

3.3 If incomplete data packages are held longer than six weeks from date of receipt of initial data package; the IEPA and U.S. EPA Region V Remedial Project Managers will be contacted with an explanation specifying which reported values could be considered validated and which were awaiting further data.

4.0 Rejection of Data - All values determined to be unacceptable on the Inorganic Analysis Data Sheet (Attachment - A5) must be lined over with a red pencil. As soon as any review criteria causes data to be rejected, that data can be eliminated from any further review or consideration.

5.0 Acceptance Criteria - Acceptance criteria as stated in the Attachment, will be used.

6.0 Request for Reanalysis - Data reviewers must note all items of non-compliance within Data Assessment Narrative (Attachment - A2). If holding times and sample storage times have not been exceeded, Golder may request reanalysis if items of non-compliance are critical to data assessment. Requests are to be made by telephone.

7.0 A Sample Identification Summary sheet will be completed by the Golder Remedial Project Manager identifying all samples by CRL type and site number (Attachment - A7).
A.1.1 **Sample Traffic Report** - Present or on file? [____] __ __
   Legible? [_____] __ __

**ACTION:** If no, request from Golder Project Manager

A.1.2 **Cover Page** - Present? [____] __ __

**ACTION:** If no, prepare Telephone Memorandum and contact laboratory

Do sample numbers on cover page agree with sample numbers on:
   (a) **Traffic Report Sheets**? [____] __ __
   (b) **Form I's**? [____] __ __
   (c) **Golder Associates' Sample Identification Summary**? [____] __ __

**ACTION:** If no for any of the above, contact Golder Project Manager

A.1.3 **Form I (Final Data)** - Are all Form I's present and complete? [____] __ __

**ACTION:** If no, prepare Telephone Memorandum and contact laboratory for submittal

Are correct units (ug/l for waters and mg/kg for soils) indicated in Form I's? [____] __ __

Are sample results for each parameter corrected for percent solids on soils? [____] __ __

Do any computation/transcription errors exceed 10% of reported values? [____] __ __

Are all "less than" values properly coded with "U"? [____] __ __

**ACTION:** If no for any of above, prepare Telephone Memorandum, and contact laboratory for corrected data.

Golder Associates
Was a brief physical description of samples given in comments section? [___] ___ ___

Were footnotes indicated on cover page used correctly with final data? [___] ___ ___

Were any samples diluted beyond requirements of contract? ___ [___] __

If yes, were dilutions noted on Form 1? [___] ___ ___

ACTION: If no for any of above, note under non-compliance of data assessment narrative.

A.1.4 Holding Times -

Mercury (28 days) .............. exceeded? ___ [___] ___

Cyanide (14 days) .............. exceeded? ___ [___] ___

Other Metals (6 months) ........ exceeded? ___ [___] ___

Which parameters? _________________________

ACTION: Prepare a list of all samples and analytes for which holding times have been exceeded. Specify the number of days from date of collection to the date of analysis (from raw data). Attach a checklist.

If yes, reject (red-line) values less than Instrument Detection Limit (IDL) flag as estimated (J) those values above IDL.

A.1.5 Raw Data

A.1.5.1 Digestion Log* for flame AA/ICP present? [___] ___ ___

Digestion Log for furnace AA present? [___] ___ ___

Digestion Log for mercury present? [___] ___ ___

Digestion Log for cyanides present? [___] ___ ___

*Weights, dilutions and volumes used to
obtain values.

Percent solids calculation present for soil (sediments)? 

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Are preparation dates present on Digestion Log?

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<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
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</table>

A.1.5.2 Measurement read out record present?

<table>
<thead>
<tr>
<th>Method</th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame AA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furnace AA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyanides</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A.1.5.3 Are all raw data to support all sample analyses and QC operations present?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
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</thead>
<tbody>
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</table>

Legible?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
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<tbody>
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</tbody>
</table>

Properly Labeled?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
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</table>

ACTION: If no for any of above, write Telephone Memorandum and contact laboratory.

A.1.5.4 Is record of at least 2 point calibration present for ICP?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
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<tbody>
<tr>
<td></td>
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</table>

Is record of 4 point calibration present for: Flame AA?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</table>

Furnace AA?

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
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</thead>
<tbody>
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<td></td>
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</tbody>
</table>

NOTE: If less than 4, other standards must be run immediately after calibration and be ± 5% of true value.

ACTION: Flag associated data if standards are not within ±5% of true values.

Golder Associates
STANDARD OPERATING PROCEDURE
Title: Evaluation of Metals Data
Data Assessment
(Total Review - Inorganics)

Is record of 4 point calibration present for:
Mercury? [___] ___ ___
Cyanide? [___] ___ ___

ACTION: If no for any of the above, prepare Telephone Memorandum and contact laboratory.

A.1.6 Data Validation and Verification

A.1.6.1 Form II (Initial and Continuing Calibration Verification) -

A.1.6.1.1 Present and complete for every metal and cyanide? [___] ___ ___

Present and complete for AA and ICP when both are used for same analyte? [___] ___ ___

ACTION: If no for any of the above, prepare Telephone Memorandum and contact laboratory.

A.1.6.1.2 Circle all values on data summary sheet that are outside of windows. Are all calibration standards (initial and continuing) within control limits?

Metals 90-110% [___] ___ ___
Hg and Sn 80-120% [___] ___ ___
Cyanides 85-115% [___] ___ ___

Are all calibration standards (initial and continuing) within 50-150%? [___] ___ ___

ACTION: Flag as estimated (J) all positive data (not flagged with a "U") analysed between a calibration standard of 50-89% (50-79% for Hg) or 111-150% (121-150% for Hg) recovery and nearest adjacent calibration standards. Flag as estimated (J) all positive cyanide data if calibration standards are

Golder Associates
between 50-84% or 116-150%. Reject (red-line) as unacceptable data if recovery of calibration standard is below 50% or above 150% for nearest adjacent standards.

Was continuing calibration performed every 10 samples or every 2 hours? [ ___ ] [ ___ ] [ ___ ]

**ACTION:** If no, flag the excess samples (eleventh and up) data as estimated (J).

A.1.6.2 Form III (Initial and Continuing Calibration Blanks)

A.1.6.2.1 Present and complete? [ ___ ] [ ___ ] [ ___ ]

For both AA and ICP when both are used for same analyte? [ ___ ] [ ___ ] [ ___ ]

**ACTION:** If no, prepare Telephone Memorandum and contact laboratory

A.1.6.2.2 Circle all calibration blank values on Data Summary Sheet that are above IDL. Are all calibration blanks less than contract Required Detection Limits (RDL)? [ ___ ] [ ___ ] [ ___ ]

Are all calibration blanks less than Instrument Detection Limit (if IDL>RDL) when sample concentrations are greater than 2xIDL? [ ___ ] [ ___ ] [ ___ ]

**ACTION:** If no for any of above flag as estimated (J) on form I’S all data between calibration blank with value over RDL or IDL and nearest adjacent calibration blank.

A.1.6.2.3 Was an initial calibration blank analysed? [ ___ ] [ ___ ] [ ___ ]

Was a continuing calibration blank analyzed after every 10 samples or every 2 hours (whichever is more frequent)? [ ___ ] [ ___ ] [ ___ ]

Goifer Associates
ACTION: If no, flag as estimated (J) all values not analyzed within 5 samples of calibration blank.

A.1.6.3 FORM III (Preparation Blank)

A.1.6.3.1 Was one prep. blank analyzed for:
   - each 20 samples? [___] ___ ___
   - each batch? [___] ___ ___
   - each matrix type? [___] ___ ___

For both AA and ICP when both are used for same analyte? [___] ___ ___

ACTION: If no for any of above, flag as estimated (J) all associated data for which prep. blank was not analyzed.

NOTE: If only one blank was analyzed for more than 20 samples, then first 20 samples analyzed do not have to be flagged as estimated (J).

A.1.6.3.2 Do concentrations of prep. blank fall below two times IDL when IDL is greater than RDL? [___] ___ ___

ACTION: If no, reject (red-line) all data that has a concentration less than 10 times the prep. blank value, but not flagged with a "U" (less than).

(Note: The preparation blank for mercury is the same as the calibration blank.)

A.1.6.3.3 Is concentration of prep. blank greater than RDL when IDL is less than RDL? ___ [___] ___

If yes, is the concentration of the sample with the least concentrated analyte less than 10 times the prep. blank value? ___ [___] ___

ACTION: If yes, reject (red-line) all associated data that has a con-
STANDARD OPERATING PROCEDURE
Title: Evaluation of Metals Data
Data Assessment
(Total Review - Inorganics)

Section: Revision:
Date:
Page: YES NO M/A

centration less than ten times the
prep. blank value, but not flagged
with a "U" (less than).

A.1.6.4 Form IV (ICP Interference Check Sample)
A.1.6.4.1 Present and complete?
[____] ___ ___
(Note: Not required for furnace AA,
flame AA, mercury, and cyanide.)

A.1.6.4.2 Circle all values on Data Summary Sheet
that are more than ± 20% of true or
established mean-value. Are all
interference Check Sample results inside
of control limits (± 20%)?
[____] ___ ___

ACTION: If no, flag as estimated (J) those
sample results for which ICS recovery
is between 50-70% or 121-150% of mean-
value; and reject (red-line) those
sample results for which ICS recovery
is less than 50%. If ICS recovery is
above 150%, reject positive results
only (not flagged with a "U")

A.1.6.5 Form IX (ICP Serial Dilution)
A.1.6.5.1 Was Serial Dilution analysis performed for:
each 20 samples? [____] ___ ___
each matrix type? [____] ___ ___
each concentration range (i.e. low,
med., high)? [____] ___ ___

If no for any of above, is any sample(s)
concentration (undiluted) greater than
10 x IDL?
[____] ___

ACTION: If yes, flag all associated data
as estimated (J) for which Serial
Dilution Analysis was not performed.

A.1.6.5.2 Was field blank(s) used for Serial
Dilution Analysis?
--- [____] ___

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If yes, was field blank described as such on Traffic Report? __ [ ] __

**ACTION:** If yes, flag all associated data > 10 x IDL as estimated (J).

A.1.6.5.3 Circle all values on Data Summary Sheet with a percent difference greater than 10%. Are all ICP Serial Dilution results within control limit of 10%. [ ] __ __

If no, are all associated data on Form I's flagged with an "E"? [ ] __ __

**ACTION:** If not flagged with an "E", flag as estimated (J) all associated sample results for which percent difference is greater than 10% but less than 100%; reject (red-line) all associated sample results for which PD is above 100%.

A.1.6.6 **Form V (Spike Sample Recovery)** - (Note: Not required for Ca, Mg, K, and Na (both matrices), Al, and Fe (soil only)).

A.1.6.6.1 Present and complete for: each 20 samples? [ ] __ __

each matrix type? [ ] __ __

each conc. range (i.e. low, med., high)? [ ] __ __

For both AA and ICP when both are used for same analyte? [ ] __ __

**ACTION:** If no for any of above, flag as estimated (J) all data for which spiked sample was not analyzed.

**NOTE:** If one spiked sample was analyzed for more than 20 samples, then first 20 samples analyzed do not have to be flagged as estimated (J).
A.1.6.6.2 Was field blank used for spiked sample?  

If yes, was field blank described as such on Traffic Report?  

ACTION: If yes, flag all positive data as estimated (J) for which field blank was used as spiked sample.

A.1.6.6.3 Circle all values on Data Summary Sheet that are outside of control limits (75% to 125%). Are all recoveries within control limits?  

If no, is sample concentration greater than four times spike concentration?  

ACTION: If yes, disregard spike recoveries for analytes whose concentrations are greater than four times spike added. If no, circle those analytes on Form V for which sample concentration was not greater than four times the spike concentration.

A.1.6.6.4 Aqueous

Are any spike recoveries:

(a) less than 30%?  

(b) between 30-74%?  

(c) between 126-150%?  

(d) greater than 150%  

ACTION: If less than 30%, reject all associated aqueous data. If between 126-150%, flag as estimated (J). If between 126-150%, flag as estimated (J) all associated aqueous data not flagged with a "U". If greater than 150%, reject (red-line) all associated aqueous data not flagged with a "U".

A.1.6.6.5 Soil/Sediment

Golder Associates
STANDARD OPERATING PROCEDURE
Title: Evaluation of Metals Data
Data Assessment
(Total Review - Inorganics)

Are any recoveries (a) less than 75%? ___ [___] ___
(b) greater than 125%? ___ [___] ___

ACTION: If less than 75%, flag all associated data as estimated (J). If greater than 125%, flag as estimated (J) all associated data not flagged with a "U".

A.1.6.7 Form VI (Lab Duplicates)
A.1.6.7.1 Present and complete for:
each 20 samples? [___] ___ ___
each matrix type? [___] ___ ___
each concen. range (i.e. low, med., high)? [___] ___ ___
For both AA and ICP when both are used for same analyte? [___] ___ ___

ACTION: If no for any above, flag as estimated (J) all data >RDL for which duplicate sample was not analyzed. Note: If one duplicate sample was analyzed for more than 20 samples, then first 20 samples analyzed do not have to be flagged as estimated (J).

A.1.6.7.2 Circle all values on Data Summary Sheet that are outside control limits:

Aqueous Samples (a) 20% RPD or (b) RDL

Are all values within control limits? [___] ___ ___
If no, are all results outside the control limits flagged with an * on Form I's and VI? [___] ___ ___

ACTION: If no, write in the contract

Golder Associates
problems/non-compliance section of narrative.

A.1.6.7.3 Was field blank used for duplicate analysis?

If yes, was field blank identified as such on Traffic Report?

ACTION: If yes, flag all data >RDL as estimated (J) for which field blank was used as duplicate.

A.1.6.7.4 Is "NC" reported in RFD column for any sample duplicate pair where either value is less than RDL?

ACTION: If no, write in "NC" with red pencil on form VI and initial. Note under Data Acceptability Narrative (non-compliance).

A.1.6.7.5 Is any value for sample duplicate pair less than RDL and other value greater than 10 x RDL?

ACTION: If yes, reject associated data.

A.1.6.7.6 Aqueous

Is any RPD greater than 50% where sample and duplicate are both greater than five times RDL?

Is any difference between sample and duplicate greater than RDL where sample and/or duplicate is less than 5 times RDL but greater than RDL?

ACTION: If yes, reject (red-line) all associated data.

A.1.6.7.7 Soil/Sediment

Is any RPD greater than 100% where sample and duplicate are both greater than 5 times RDL?
Is any difference between sample and duplicate greater than 2 times RDL where sample and/or duplicate is less than 5 times RDL but greater than RDL? 

**ACTION:** If yes, reject (red-line) all associated data.

A.1.6.8 Field Duplicates

A.1.6.8.1 Were field duplicates analyzed?

**ACTION:** If yes, prepare a Form VI for each sample duplicate pair, calculate RPD where both values are greater than RDL.

**NOTE:** Reject (red-line) all associated data for field duplicates only.

A.1.6.8.2 Circle all values on Form VI for F. Dup. that are outside control limits:
- Aqueous Samples (a) 20% RPD or (b) RDL

Are all values within control limits? 

A.1.6.8.3 Report "NC" in RPD column for a sample duplicate pair where either value is less than RDL.

A.1.6.8.4 Is any value for sample duplicate pair less than RDL and other value greater than 10 x RDL? 

**ACTION:** If yes, reject associated data.

A.1.6.8.5 Aqueous

Is any RPD greater than 50% where sample and duplicate are both greater than 5 times RDL?

Is any difference between sample and duplicate greater than RDL where sample
and/or duplicate is less than 5 times RDL but greater than RDL?  

ACTION: If yes, reject (red-line) all associated data.

A.1.6.8.6 Soil/Sediment

Is any RPD greater than 100% where sample and duplicate are both greater than 5 times RDL?  

ACTION: If yes, reject (red-line) all associated data.

A.1.6.9 Form VII (Instrument Detection Limits) - (Note: IDL - not required for cyanide.)

A.1.6.9.1 Are IDLS present for all analytes?  

For both AA and ICP when both are used for same analyte?  

ACTION: If no for any of above, prepare Telephone Memorandum and contact laboratory.

A.1.6.9.2 Is IDL greater than RDL for any analyte?  

If yes, is the concentration of the sample analyzed on the instrument whose IDL exceeds RDL, greater than two times IDL?  

ACTION: If no, reject (redline) all values less than two times IDL of the instrument whose IDL exceeds RDL.

A.1.6.10 Form VII (Laboratory Control Sample) (Note: LCS - not required for aqueous Hg.)

A.1.6.10.1 Was one LCS prepared and analyzed for: every 20 water samples?  

Golder Associates
STANDARD OPERATING PROCEDURE  
Title: Evaluation of Metals Data  
Data Assessment  
(Total Review - Inorganics)  

Section:  
Revision:  
Data:  
Page:  

YES NO N/A  

every month for solid samples? [____] ___ ___  

for both AA and ICP when both are used for same analyte? [____] ___ ___  

ACTION: If no for any of above, prepare Telephone Memorandum and contact contact laboratory for submittal of monthly results of solid LCS. Flag as estimated (J) all aqueous data for which LCS was not analyzed.  

NOTE: If only one LCS was analyzed for more than 20 samples, then first 20 samples close to LCS do not have to be flagged as estimated.  

A.1.6.10.2 Circle all LCS values outside of control limits (80% to 120%) on Data Summary Sheet.  

Is any LCS value: less than 50%? [____] ___ ___  

between 50% and 79%? [____] ___ ___  

between 121% and 150%? [____] ___ ___  

greater than 150%? [____] ___ ___  

ACTION: Less than 50%, reject (red-line) all data; between 50% to 79%, flag all associated data as estimated (J); between 121% to 150%, flag all positive (not flagged with a "U") results as estimated; greater than 150%, reject all positive results.  

A.1.6.10.3 Is "NC" reported for an analyte in % R column of Form VII? [____] ___ ___  

If yes, does concentration of the analyte fall within acceptable range of LCS? [____] ___ ___  

ACTION: If no, flag associated data as estimated (J).  

A.1.6.11 Furnace Atomic Absorption (AA) QC Analysis  

Golder Associates
A.1.6.11.1 Are duplicate injections present in furnace raw data (except during full Method of Standard Addition) for each sample analysed by GFMA?

[___] [___] [___]

**ACTION:** If no, reject the data on Form I's for which duplicate injections were not performed.

A.1.6.11.2 Is post digestion spike recovery less than 10% for any result?

___ [___] [___]

**ACTION:** If yes, reject (red-line) the affected data.

A.1.6.11.3 Do the duplicate injection readings agree within 20% Relative Standard Deviation (RSD) or coefficient of variation (CV) for concentration greater than RDL?

[___] [___]

Was a dilution analysed for sample with post digestion spike recovery less than 40%?

[___] [___]

**ACTION:** If no for any of the above, flag all the associated data as estimated (J).

A.1.6.12 Form VIII (Method of Standard Addition Results)

A.1.6.12.1 Present?

[___] [___] [___]

If no, is any Form I result coded with "S" or a "+"?

___ [___]

**ACTION:** If yes, write request on Telephone Memorandum and contact laboratory for submittal of Form VIII.

A.1.6.12.2 Was MSA required for any sample but not performed?

___ [___]

Is coefficient of correlation for MSA less than 0.995?

___ [___]
ACTION: If yes for any of above, flag all associated data as estimated (J).

A.1.6.12.3 Is coefficient of correlation for MSA less than 0.990 for any sample? [__] [__] 

ACTION: If yes, reject (red-line) affected data.

A.1.6.12.4 Was proper quantitation procedure followed correctly? [___] [__] 

ACTION: If no, note exception under contract problem/non-compliance of data assessment narrative, or prepare a separate list.

A.1.6.12.5 Are MSA calculations within the linear range of the calibration curve generated at the beginning of the analytical run? [___] [__] 

ACTION: If no, flag all affected data as estimated (J).

A.1.6.13 Dissolved Inorganics

A.1.6.13.1 Were any analyses performed for dissolved as well as total analytes on the same sample? [__] [__] 

If yes, apply the following questions only if both dissolved and total constituents are above RDL (For SAS parameters: above 5 x IDL).

A.1.6.13.2 Is the concentration of any dissolved analyte greater than its total concentration by more than 10%? [__] [__] 

A.1.6.13.3 Is the concentration of any dissolved analyte greater than its total concentration by more than 50%? [__] [__] 

ACTION: Prepare a list comparing differences between all dissolved and total analytes. Compute the differences as a percent of the total analyte...
only when both above RDL (5 * IDL for SAS parameters). If more than 10%, flag both dissolved and total values as estimated (J); if more than 50%, reject (red-line) the data for both values.

A.1.6.14 Form I to IX

A.1.6.14.1 Are all the Form I through Form IX labeled with: CRL Type sample number? [___] __ __

Site sample number? [___] __ __

Lab ID sample number? [___] __ __

QC report number? [___] __ __

date? [___] __ __
correct units? [___] __ __

ACTION: If no for any of above, note under contract problem/non-compliance of data assessment, narrative.

A.1.6.14.2 Do any computation/transcription errors exceed 10% of reported values on Forms I-IX for:

(NOTE: Check all forms against raw data.)

(a) all analytes analyzed by ICP? ___ [___] __

(b) all analytes analyzed by GFAA? ___ [___] __

(c) all analytes analyzed by AA Flame? ___ [___] __

(d) Mercury? ___ [___] __

(e) cyanide? ___ [___] __

ACTION: If yes, prepare Telephone Memorandum, contact laboratory for corrected data and correct errors with red pencil
and initial.

A.1.6.15 Form I (Field Blank) - Do concentration of field blanks fall below two times IDL for all aqueous and soil parameters? 

[ ] __ __

If no, was field blank value already rejected due to other QC criteria? 

[ ] __ __

ACTION: If no, reject (red-line) all aqueous and soil/sediment data (except field blank) that has a concentration less than five times the field blank value not flagged with a "U" (less than).

A.1.6.16 Form XI, XII, XIII (Quarterly Verification of Instrumental Parameters).

A.1.6.16.1 Is quarterly verification report present in MMB file for:

  Instrument Detection Limits? 
  ICP Inter-element Correction Factors? 
  ICP Linear Ranges?

[ ] __ __

ACTION: If no, contact York Laboratories.

A.1.6.16.2 Was any sample result higher than linear range of ICP by more than 10%? 

[ ] __

Was any sample result higher than highest calibration standard for non-ICP parameters?

[ ] __

ACTION: If yes for any of the above, flag result reported on Form I as estimated (J).
Evaluation of Metals Data
Data Acceptability

Site ___________________________ Matrix: Soil ______
Lab ___________________________ Water ______
Other ______

A.2.1 Are all data of acceptable quality? Yes____ No____

If no, list exceptions with reason(s) for rejection or qualification as estimated value (J).

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
A.2.1 (continuation)

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

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____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

A.2.2 Problems/Non-compliance

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Golder Reviewer: ____________________________ Date: _______________
NON-COMPLIANCE REPORT

CASE NO. ________________________________

The hardcopied (laboratory name) ________________________

Inorganic data package received at Golder Associates Inc. has been
reviewed and the quality assurance and performance data summarized.
The data review included:

Site Sample No.:__________________________________

CRL Type Sample No.:__________________________________

Conc. & Matrix:__________________________________

The general criteria used to determine the performance were based
on an examination of:
  o Data Completeness
  o Duplicate Analysis Results
  o Matrix Spike Results
  o Blank Analysis Results
  o Calibration Standards Results
  o MSA Results

Items of non-compliance with the above contract are described
below.

Comments:__________________________________

_________________________  __________________________
Reviewer's Initial                  Date

Golder Associates
MAILING LIST FOR DATA REVIEW RECIPIENTS

1. Jeffrey J. Larson, L.A.
   Federal Site Project Manager
   Division of Land Pollution Control
   2200 Churchill Road
   P. O. Box 19276
   Springfield, Illinois 62794-9276

2. U.S. EPA Region V - Tinka Hyde


4. IEPA QAPP MANAGER _____________________________

Golder Associates
## SUMMARY OF INORGANICS QUALITY CONTROL DATA

**LABORATORY:**

**CASE NO.**

**SOW NO.**

**SAMPLE TYPE:**

**SITE STUDY DESCRIPTION:**

**SAMPLE NOS:**

**FIELD BLANK SAMPLE NO.**

**FIELD DUP. #'S:**

**LAB DUP. #'S:**

**MATRIX SPIKE #'S:**

**COMPLETION DATE:**

**REVIEWERS INITIALS:**

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Golder Associates
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CLP TYPE DATA ACCEPTABILITY SUMMARY FORM (INORGANICS)

Type of Review: __________________________ Date: ____________ Case #: ______________

Site: __________________________ Lab Name: __________________________

Reviewer’s Initials: __________________________ Number of Samples: ____________

Analytes Rejected Due to Exceeding Review Criteria:*

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Note: Asterisk (*) indicates additional exceedances of review criteria.
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**Comments:**

Golder Associates
ATTACHMENT VII

SOP FOR GLASSWARE PREPARATION
Glassware Preparation SOP 1.3: Preparing SampleSaver Glassware

The SampleSaver contains 5 different kinds of glassware. The procedures for preparing this glassware follow. Even though they all go into one container, they are all prepared differently. They are not prepared with other laboratory glassware because their preparation procedures are different.

**Organics - 1-liter glass bottles**

NOTE: New liter bottles are washed in the dishwasher, rinsed, drained and dried. Recycled liter bottles are washed in hot, soapy water, rinsed, drained, and dried.

1. Wash in dishwasher or
   a. Wash in hot, soapy water and
   b. Rinse well with tap water.
2. Rinse twice with deionized water.
3. Invert and drain.
4. Bake at 450-500°F for one hour.
5. Wash Teflon caps in the same manner (as in SOP 1.4).

**Metals and Mercury - 500 ml Plastic Bottles (Metals)**

1. Wash in dishwasher or hand wash with hot, soapy water.
2. Rinse three times with tap water.
3. Rinse three times with deionized water.
4. Invert on counter-top for drying.
5. Wash caps per SOP 1.4.

**Volatile - 40 ml glass bottles (Cyanide and Phenols)**

1. Wash in dishwasher.
2. Rinse twice with deionized water.
3. Place in oven at 500°F for 1 hour. Remove to volatiles area to cool. Cap immediately after they are cool enough to touch.

4. Caps and septa should be washed and dried per SOP 1.4.

Glassware Quality Control Check

Quality Assurance monitors the SampleSaver glassware to ensure that the glassware is not contaminated. This monitoring process is conducted in the following ways for each type of glassware.

Quality Control of VOA Bottles (40 ml glass bottles): Checked for Volatile Compounds Contamination

After the bottles are taken out of the oven, they are allowed to cool in the "Unapproved" storage cabinet in the volatile prep area. After they are cool, they are capped and put into boxes (72 per box), which are called batches. The boxes are stored in the cabinet marked "Unapproved."

The SampleSaver Custodian completes the "VOA Glassware Prep Batch Check" (See Example 1 at the end of these SOPs), assigns a number to the bottle (numbers are consecutive and ascending), and removes one bottle from the batch. The Custodian then moves the box to the storage cabinet marked "Under Evaluation" and attaches a copy of the Batch Check sheet to the box. He/She also notes on the Batch Check sheet that the results of the analysis are to be sent to Quality Assurance.

He/She then delivers the bottle to be tested to the Manager of the Volatiles Laboratory. In this way, there is a record of the testing, the bottle has a unique number, this number is associated with the batch of bottles with
which it is processed, and the results are forwarded directly to Quality Assurance. Quality Assurance maintains a file containing copies of all Batch Checksheets, including which batches have passed and which have not. This file serves as the ongoing documentation of this process.

The Manager of the Volatiles Laboratory tests the bottle for volatile compounds and forwards the results to Quality Assurance.

The Quality Assurance Specialist determines if the bottle's analysis indicates any contamination. If the analysis detects any volatile compound at one-half the detection limit for that compound, another VOA bottle from the same batch is tested. If the second bottle is also found to be contaminated, the QA Specialist notifies the Supervisor of Sample Preparation, and the entire batch is reprocessed. If the analysis indicates no contamination is present, the Supervisor of Sample Preparation moves the batch to a storage cabinet labeled "Approved," which indicates that the bottles are free of contamination and can be included in the SampleSavers shipped to clients. The QA Specialist advises the Vice President of Quality Assurance if there are persistent or frequent problems with the glassware preparation process. When VOAs are needed, they are taken from the storage cabinet marked "Approved."

Quality Control of Liter Bottles: Checked for Organic Compounds Contamination

Fifty liter bottles are furnace together and are called a batch. After the bottles are taken out of the oven, they are allowed to cool in the "Unapproved" storage cabinet located in the Glass Prep area. One bottle out of each batch is tested for organic compounds contamination.
The Supervisor of the Sample Preparation Laboratory completes a "SV Glassware Prep Batch Check" (See Example 2 at the end of this SOP), which indicates that the test results are forwarded to Quality Assurance. (numbers are consecutive and ascending), and removes one bottle from the batch. The Supervisor then moves the batch to the storage cabinet in the Sample Prep area marked "Under Evaluation" and attaches a copy of the Batch Check to the batch. He/She also notes in writing on the Worksheet that the results of the analysis are to be sent to Quality Assurance.

In this way, there is a record of the testing, the bottle has a unique testing number, this number is associated with the batch of bottles with which it was processed, and the results are forwarded directly to Quality Assurance.

The Supervisor of the Sample Preparation Laboratory keeps a notebook containing copies of all Batch Check sheets, including which batches have passed and which have not. This notebook is called the Quality Control For SampleSaver and serves as the ongoing documentation of this process.

The Supervisor of the Sample Preparation Laboratory fills the bottle with distilled, deionized water, assigns it a CompuChem number, and indicates in the comments section that this bottle is used as a QC sample for a SampleSaver check. The water is then extracted as an acid and base neutral blank and analyzed by GC/MS. A portion of the B/N fraction is exchanged to Hexane and analyzed by GC. The results are quantitated and forwarded to QA.

The Quality Assurance Specialist determines if the bottle's analysis indicates any contamination. If the analysis detects any extraneous peaks (peaks other than the surrogates), another liter bottle from the same batch is tested.
If the second bottle is also found to be contaminated, the QA specialist notifies the Supervisor of Sample Preparation, and the entire batch is reprocessed. If the analysis indicates no contamination is present, the Supervisor of Sample Preparation is notified and the batch is moved to a storage cabinet labeled "Approved", located in the Sample Receiving area, which indicates the bottles are free of contamination and can be included in the SampleSavers shipped to clients. The QA Specialist advises the Director of Quality Assurance if there are persistent or frequent problems with the glassware preparation process.

When liter bottles are needed, they are taken from the storage cabinet marked "Approved."

**Quality Control of Plastic Bottles (500 ml); Checked for Inorganics Contamination (Metals)**

Fifty, plastic bottles are dried together and are called a batch. After the bottles are taken out of the oven, they are put in the "Unapproved" storage area located in the Glassware Prep area. One out of each batch is tested for metals contamination.

When bottles are needed, the Supervisor of the Sample Preparation Laboratory completes an "Order Form For Test Samples" (see Example 3 at the end of these SOPs), checks "glassware check" as the reason for initiating the test (which also indicates that the test results are forwarded to Quality Assurance), assigns a number to the bottle (numbers are consecutive and ascending), and removes one bottle from the batch. The Supervisor then moves the batch to the storage cabinet marked "Under Evaluation" in Sample Receiving and attaches a
copy of the Worksheet to the batch. He/She also notes in writing on the Worksheet that the results of the analysis are to be sent to Quality Assurance.

In this way, there is a record of the testing, the bottle has a unique testing number, this number is associated with the batch of bottles with which it was processed, and the results are forwarded directly to Quality Assurance. The Supervisor of the Sample Preparation Laboratory keeps a notebook containing copies of all Forms, including which batches have passed and which have not. This notebook is called the Quality Control for SampleSaver and serves as the ongoing documentation of this process.

The Supervisor of the Sample Preparation Laboratory fills the bottle with distilled/deionized water, assigns it a CompuChem number, and indicates in the comments section that this bottle is used as a QC sample for a SampleSaver check. He/She takes the bottle to the Inorganics Laboratory, where it is analyzed for all metals, the results are quantitated, and forwarded to QA.

The Quality Assurance Specialist determines if the bottle's analysis indicates any contamination. If the analysis indicates contamination another bottle from the same batch is tested. If the second bottle is also found to be contaminated, the QA Specialist notifies the Supervisor of Sample Preparation, the entire batch is reprocessed. If the analysis indicates no contamination present, the Supervisor of Sample Preparation is notified and the bottle is placed in a storage cabinet labeled "Approved", which indicates that the batch is free of contamination and can be included in the SampleSavers program.
clients. The QA Specialist advises the Vice President of Quality Assurance if there are persistent or frequent problems with the glassware preparation process.

When bottles are needed for cyanide and phenols, they are taken from the storage cabinet marked "Approved."
ATTACHMENT VIII

GOLDER ASSOCIATES' SOILS LABORATORY
CHAIN-OF-CUSTODY PROCEDURES
Scope and Application: This chain-of-custody procedure applies to the handling and tracking of soil samples within a geotechnical laboratory of Golder Associates, Inc.

Sample Receipt: Field personnel will notify the laboratory manager prior to shipping samples to the laboratory for geotechnical analysis.

Samples from a hazardous site shall be labelled with a red tag in addition to the standard sample label. This tag will alert the laboratory technician responsible for logging in the samples to open the sample shuttle under a hood and subsequently route the samples to the hazardous waste area of the laboratory. Samples identified with a red tag will be handled as described in the Golder Associates' Laboratory Safety Manual and Chemical Hygiene Plan.

Samples arriving at the laboratory for geotechnical analyses shall also be identified by the standard sample tags (as described in Section 6.0 of the QAPP, Volume III) and accompanied by Chain-of-Custody forms. Chain-of-Custody forms shall be signed and routed to the project file as appropriate.

Labelling of sample tags and containers will be checked and completed, if necessary, such that:

1. All samples are to be identified with the project number, short name, sample number(s), and project location.

2. Jar samples will have the standard jar labels (with the details filled in) attached to the side of the jar. The sample jars will be arranged in sequence in a compartmented cardboard box. The
box will be clearly marked on the outside as to the project name, project number, borehole number, and enclosed sample numbers.

3. Each Shelby tube sample or individual rock sample will have the required identification either written on the sample or on a label that is securely attached to the sample.

4. Bag or bulk samples will be placed in buckets which will have the required identification on the outside of the container and on a label that is placed on the inside of the container with the sample.

5. Rock core boxes will be marked on the top of the box with the required identification plus the box number, total number of boxes, and the core run length in the box. Both ends will have the project job number, boring number, box number, and total number of boxes.

Sample Log-In: Incoming samples shall be logged in on a Sample Tracking Record Form (Figure 1) and on the Laboratory Schedule Board. Upon completion of the Sample Tracking Record Form, samples shall be routed to separate controlled storage areas within the hazardous waste section of the laboratory pending performance of the required analyses.

Sample Analysis: The laboratory technician assigned to perform the required analyses will retrieve the necessary samples from the controlled storage area immediately prior to performance of the laboratory testing. The laboratory technician performing the analytical work will be responsible for maintaining sample identification, following sample custody procedures throughout analysis, and documenting results.

Copies of the Sample Tracking Record Form and the Chain-of-Custody Form shall accompany each sample through analysis.
Sample Storage after Testing: All residual sample materials shall be collected and returned to proper sample storage areas pending immediate return to the site or client for disposal after all testing is complete.

All discarding of samples will be recorded on the Sample Tracking Record. The original will be sent to the project file with a copy retained in the laboratory project file.

Laboratory Records: All original laboratory records shall be routed to individual project files when completed, and consequently are subject to the records management controls required by the Data Management Plan.
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**SPECIAL INSTRUCTION AND NOTES (5)**

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* THIS FORM IS FOR TRACKING SAMPLES THROUGH THE GOLDER ASSOCIATES LABORATORY. ADDITIONAL DOCUMENTATION SHALL BE USED FOR SAMPLES SENT TO OTHER LABORATORIES.

(1) SAMPLES TYPES: J—JAR, T—TUBE, B—BAG, C—CORE, W—WATER, P—PAIL, Gx—GEOTEXTILE, Gm—GEOMEMBRANE, Gt—GEONET

(2) CODE: C—CHEMICAL, R—RADIOACTIVE, E—EXTREME HAZARD

(3) G—GOOD, D—DAMAGED, M—MISSING

(4) T—TRASH, C—CLIENT PICKUP, R—RETURN TO CLIENT, O—OTHER

(5) SPECIAL INSTRUCTIONS SHALL INCLUDE LABORATORY TEST ASSIGNMENTS, PACKING, STORAGE, OR DISPOSAL.