

# MiniRAE Plus

**PROFESSIONAL PID**

## **OPERATION AND MAINTENANCE MANUAL**

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**Rev. E**



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**THIS DEVICE IS NOT INTENDED TO DETECT  
COMBUSTIBLE LEVELS OF GASES. THIS DEVICE  
IS CLASSIFIED FOR USE IN ATMOSPHERES  
CONTAINING COMBUSTIBLE LEVELS OF GASES.**

**CET APPAREIL CEST NE PAS INTENDER POUR  
DETECTER DES NIVEAUX DE COMBUSTION DES  
GAZ. CET APPAREIL EST CLASSIFIE POUR USAGE**

**DANS DES ATMOSPHERES CONTENANT DES  
NIVEAUX DE COMBUSTION DES GAZ.**

## **! WARNING !**

**-DO NOT PROCEED BEFORE READING-**

**THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING, MAINTAINING, OR SERVICING THIS PRODUCT.**

The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

### **CAUTION!!**

**TO REDUCE THE RISK OF ELECTRIC SHOCK, TURN OFF POWER BEFORE REMOVING THE SENSOR CAP FOR SERVICE. THE SENSOR CAP PROVIDES AN ELECTROSTATIC SHIELD. NEVER OPERATE THE UNIT WHILE THE CAP IS REMOVED.**

**TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, RECHARGE BATTERY ONLY IN AN AREA KNOWN TO BE NON HAZARDOUS.**

**NE CHARGER LES BATTERIES QUE DANS EMPLACEMENTS DESIGNES NON DANGEREUX**

**THE MODEL PGM-76 EQUIPMENT IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A,B,C,D OR NON-HAZARDOUS LOCATIONS ONLY.**

**THE MODEL PGM-76IS EQUIPMENT IS CLASSIFIED AS TO INTRINSIC SAFETY FOR USE IN CLASS I, DIVISION 1, GROUPS A,B,C,D OR NON-HAZARDOUS LOCATIONS ONLY.**

**WARNING**

**EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIV 2 AND CLASS I, DIV 1**

**AVERTISSEMENT**

**RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2 / CLASSE I, DIVISION 1**

## Special Note

-1-

**When the MiniRAE Plus (PGM-76) Professional PID is taken out from the transport case and turned on for the first time, there may be some residual organic vapor trapped inside the ionization chamber. The reading may therefore show a few ppm. Connect the zero gas adapter supplied with the unit will clear the residual vapor and reduce the reading to zero quickly.**

-2-

**The battery of the MiniRAE Plus unit drains slowly even when turned off. If the unit has not been charged for 4-5 days, the battery voltage will be low. Therefore, it is a good practice to leave the unit in the charger so that it is fully charged and ready for immediate use. It is also recommended to fully charge the unit FOR AT LEAST 24 HOURS before using it. If the unit is going to be put on the shelf for more than 4-5 days, it is highly recommended to turn off the battery switch at the back of the unit. This will prevent the battery from being deeply discharged.**

-3-

**The battery switch also serves as a reset switch for the microprocessor inside the MiniRAE Plus Professional PID unit. If for some reasons, the unit is hang up ( for example, no response to key press or display funny characters on LCD display), turn off the switch and then turn it on again should reset the microprocessor.**



## 1.0 GENERAL INFORMATION

**MiniRAE Plus** is a Programmable Professional Photo-Ionization Detector (PID) to measure organic vapors in hazardous or industrial environments. It incorporates a sampling pump and data download capabilities for continuous toxic monitoring, site survey and leak detection applications. It can measure two classes of toxic gases: (1) organic vapors with the supplied 10.6 eV gas discharge lamp, and (2) chlorinated compounds with the interchangeable 11.7 eV lamp available as in optional accessory. Features are:

- **Lightweight and Compact**
  - 18 oz , cellular phone size
- **Dependable and Accurate**
  - rugged design, microprocessor control
- **User Friendly**
  - menu driven, intuitive end-use operation
- **Programmable Alarm Thresholds**
  - audio buzzer & flashing display alarm

**MiniRAE Plus** (PGM 76K) consists of : a Professional PID unit, AC charging adapter, interface cable, user manual, calibration accessories and a hard transport case.

## 1.1 General Specifications

Table 1.1

| <b>Professional PID Unit Specification</b> |  |
|--|--|
| Size                                       | 7.1"L x 2.7"W x 1.8"H<br>(18.0 cm x 6.9 cm x 4.6 cm )  |
| Weight                                     | 18 oz with battery (0.510 kg)  |
| Detector                                   | Interchangeable 10.6eV or 11.7eV<br>electrodeless ultraviolet discharge<br>lamp with Teflon/stainless steel<br>chamber |
| Operating Hours                            | 10 hours continuous operation  |
| Battery                                    | Two rechargeable, 6V, 500 mAh,<br>sealed, lead-acid. Field replaceable.  |
| Gas Sampling:                              | Piston pump with >400 ml/min<br>intake flow rate   |
| Gas Inlet Probe:                           | 6" flexible 5/32" tube   |
| Gas Outlet :                               | 5/32" diameter barb fitting  |
| Attachment:                                | wrist strap  |
| Display                                    | 7 digit LCD with LED back light  |
| Analog Output:                             | 0 to 1 V   |
| Range                                      | 0 - 999.0 ppm with 0.1 ppm<br>resolution, 1000-1999 ppm with<br>1 ppm resolution<br>(continued)<br>(continued)         |

SECTION 1 GENERAL INFORMATION

|               |  |
|---------------|--|
| Accuracy      | +/- 2 ppm or +/- 10% of reading, calibrated to 100 ppm Isobutylene   |
| Response Time | < 3 seconds to reach 90% of exposed concentration  |
| Key-pads      | 2 operation keys, 2 programming keys, and an ON/OFF key  |
| Alarm Setting | Separate alarm limit settings for TWA, STEL, and Peak in Hygiene Mode; low and high alarm limits for Survey Mode |
| Alarm         | 95 dB buzzer and flashing red LED to indicate exceeded preset limits, low battery, or lamp failure               |
| Calibration   | Two points field calibration for zero gas and standard gas   |
| Protection    | Password protected calibration settings, alarm limits, and data in Hygiene Mode                                  |
| Data Storage  | 48 STEL readings (15 minutes interval) in Hygiene Mode; 50 site readings in Survey Mode                          |
| Temperature   | -10 <sup>o</sup> to 40 <sup>o</sup> C (14 <sup>o</sup> to 104 <sup>o</sup> F)                                    |
| Humidity      | 0 % to 100% relative humidity (non-condensing)   |

**SECTION 1 GENERAL INFORMATION**

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## **2.0 OPERATION OF MINIRAE PLUS**

The MiniRAE Plus Professional PID Unit is a portable organic vapor monitor/sampler. It gives the real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the MiniRAE Plus is preset with default alarm limits and the sensor is pre-calibrated with 100 ppm Isobutylene gas. After receiving the unit, first turn on the battery switch on the back of the unit. Then charge the unit for at least 24 hours to fully charge the battery. The unit is ready for immediate operation.

## 2.1 Physical Description

Figure 2.1 shows the main components of the MiniRAE Plus Professional PID Unit which includes :

- 5 keys for user to interact with the unit :  
power key and 2 operation keys for normal operation; two programming keys for setting up the unit
- LCD display with back light to show real time and calculated measurements
- Buzzer and red LED for alarm signal whenever the exposures exceed preset limits
- Probe assembly ( including gas inlet tube and sensor cap ) to draw air sample
- Battery charging jack for connection to AC or DC charging adapter and a battery switch to disconnect battery from the unit
- Gas outlet port for connection to sample collection bag
- Multi-interface jack for connection to PC, audio interface or analog output

## SECTION 2 OPERATION OF MINIRAE PLUS

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The operation details are explained in the following sections.

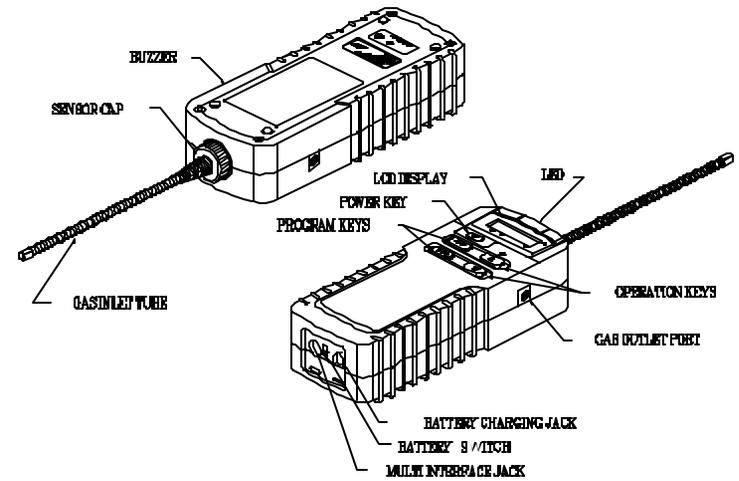


Figure 2.1 Major parts of the MiniRAE Plus

## 2.2 Two Modes of Operation

The MiniRAE Plus PGM-76 Profession PID unit offers two different operating modes:

1) Industrial Hygiene Mode ( simplified as Hygiene Mode): In this mode of operation, the unit measures the air sample once each second and compares it with a preset peak alarm limit. These same measurements are also averaged over one minute intervals with the resulting value used to compute Time Weighted Average (TWA) and Short Term Exposure Level (STEL) values, which are themselves compared to preset alarm limits.

In addition, the STEL values are captured and recorded every 15 minutes for up to 12 hours. A time stamp indicates when the unit was last turned on and off.

2) Site Survey / Leak Detection Mode (simplified as Survey Mode): In this mode of operation, the unit measures air sample once each second and compares it with a preset low alarm limit. A variable frequency alarm signal is generated in proportion to the magnitude of the measurement. When datalog is enabled, the average value or the peak value over a sampling period which can be programmed from 1 second to 9999 seconds (166 hours) is stored.

The datalogging can be initiated manually (event driven ) or the unit can perform continuous sampling (automatic ). Up to 50

sets of sample readings with 24 hour time stamps can be recorded in this mode.

**Selection of Operation Mode:**

Users can configure the instrument to be in either one of the two operating modes using a software package - "ProRAE -76" which is supplied with the Basic Kit of MiniRAE Plus. This software runs on any Personal Computer (PC) under Window™ 3.1 or DOS environment. Please refer to section 6 on how to install this software package , how to interface MiniRAE Plus instrument to PC and how to configure the instrument for either Hygiene or Survey Mode.

After the configuration is downloaded to the instrument as described in section 6, the instrument will be setup to operate in the appropriate mode.

**Indication of Current Operation Mode:**

When the MiniRAE Plus Professional Unit is first turned on, a software version message will appear in the LCD display. If the unit is configured for Hygiene Mode, the message will be " HG - x.xx". If it is configured for Survey Mode, the message will be "Su - x.xx" where x.xx is the version number of each operating software.

## 2.3 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the unit. The function of the 5 keys during normal operation are summarized below:

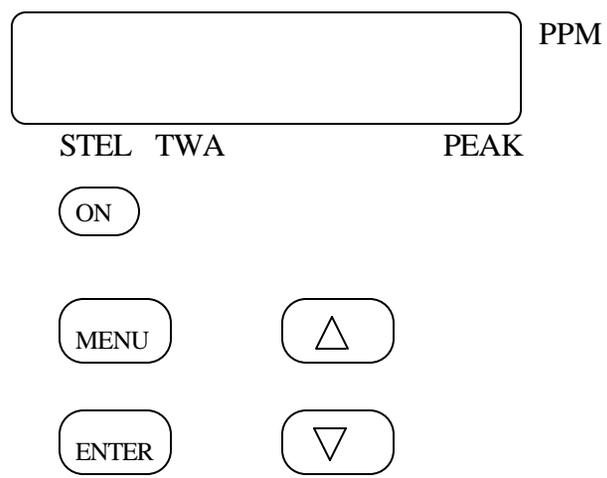


Figure 2.2 Key-pad and display of MiniRAE Plus

Table 2.1

| <b>Key</b> | <b>Function in Normal Operation</b>   |
|------------|---|
| [on]       | -Toggle on/off the power;   |
| [up]       | -Toggle on/off the back light   |
| [down]     | -Choose display readings  |
| [enter]    | -Confirm to turn off the power*   |
| [menu]     | -Enter into programming task**<br><b>Caution: entering programming task will interrupt normal gas monitoring operation of the unit.</b> |

Note:

\* - [enter] key is also used to turn off buzzer during Hygiene Mode operation, and to start/stop datalogging operation in Survey Mode (see section 2.8 and 2.9 for details ).

\*\* - [menu] key is also used in conjunction with the [on] key to clear previously saved data in Hygiene Mode during a special power on sequence (see section 2.11 for details ).

## SECTION 2 OPERATION OF MINIRAE PLUS

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The MiniRAE Plus Professional PID includes a 7-digit LCD display with 4 labels of STEL, TWA, PEAK, and PPM marked on the window, as shown in Figure 2.2. The display will show the following five types of readings:

- Real time gas concentration in ppm
- Short term exposure level (STEL) of the gas concentration in ppm\*
- Time weighted average (TWA) value of the gas concentration in ppm \*\*
- Peak gas concentration in ppm
- Battery voltage in volt ( from 5.3 to 6.4 V )

### **Note:**

\* - the 15 minute STEL reading is only available in Hygiene Mode operation.

\*\* - the TWA reading is based on fixed 8 hours average value define by OSHA in Hygiene Mode operation. In Survey Mode, the TWA reading is the average value over each sampling period.

## 2.4 Power On/Off

**To turn on** the MiniRAE Plus Professional PID Unit, press **[on]** key. The audio buzzer will beep once and the display will show "HG- x.xx" or "Su- x.xx" to indicate the operating mode and software version number. The unit will then go through a self-diagnostic routine to check the key components of the unit. A ".DIAG.." message will be displayed with red back light turned on while the self-diagnostic routine is executing. The red LED and back light will flash once and buzzer beep once to ensure that they are functional. The sampling pump will be turned on and start to draw air sample.

After about 30 seconds, the display will change to instantaneous reading of the gas concentration in ppm if the unit passes diagnostics tests. If there is any problem with the unit, an error message will be displayed (Refer to section 9 for troubleshooting of the particular error condition).

**To turn off** the MiniRAE Plus Professional PID Unit, press **[on]** key. The message "Off" will flash on the LCD display. If users really want to turn off the unit, press **[enter]** key to confirm and the unit will be turned off. Press any other key will return the unit to normal operation.

## 2.5 Display Readings

The MiniRAE Plus Professional PID Unit can display five different readings: instantaneous gas concentration, STEL\*, TWA, peak and battery voltage. Here is a brief explanation of each reading:

1) The **instantaneous** reading is the gas concentration in parts per million (ppm). The reading is updated once a second and is shown as "xxx.x" in the LCD display without any arrow cursor or character display. Note: in Survey Mode, a two digit site number will also be displayed together with the instantaneous reading as "00 xxx.x". The site number starts from 00 and ends at 49.

2) The **STEL\*** reading is the last 15 minute average reading of the gas concentration. The reading is updated once a minute and is shown as "xxx.x" with a small arrow cursor pointing to the "STEL" label on the LCD window.

3) The **TWA** reading in Hygiene mode is the accumulated reading of the gas concentration divided by 8 hours since the data was cleared last time. The reading is updated once a minute and is shown as "xxx.x" with a small arrow cursor pointing to the "TWA" label on the LCD window. In Survey mode, the **TWA** reading is the average gas reading during the previous sampling period.

4) The **peak** reading in Hygiene mode is the maximum reading of the gas concentration since the data was cleared last time.

The reading is updated at one second interval and is shown as "xxx.x" with a small arrow cursor pointing to the "PEAK" label on the LCD window. In Survey mode, the **peak** reading is the peak gas reading during the previous sampling period.

5) The **battery voltage** reading is the current battery voltage in volt. The reading is updated once a minute and is shown as "bAt xxx.x" in the LCD window.

**Choose a reading :**

The five readings are arranged in a "round robin" order:

**instantaneous => STEL\* => TWA => Peak => battery voltage => instantaneous**

To choose a specific reading, press the **[down]** key one or more times in normal operation mode until the desired reading shows. For example, to display STEL reading, press **[down]** once. To display TWA reading, press **[down]** key twice, and so on.

\* - the STEL value is not displayed in Survey Mode.

## 2.6 Alarm Signal

The built-in microcomputer constantly updates and monitors real time gas concentration and compares it with the programmed alarm limits (TWA, STEL, and peak limits for Hygiene Mode, low and high limits for Survey Mode). Whenever the concentration exceeds any of the preset limits, the alarm buzzer and red flashing LED will be activated immediately to warn user of the alarm condition.

Note: a fully charged battery should show 6.3 volt or higher. Whenever the battery voltage falls below 5.5 volt or the UV lamp or sensor module fails, the unit will also activate the buzzer and red LED alarm signal. When the low battery alarm occurs, there will be about 20-30 minutes operating time left from the battery. When the battery voltage falls below 5.3 volt, the unit will be turned off automatically.

**Note:** in Hygiene Mode, the alarm signal of the gas concentration exceeding preset limits is a "two beeps" and "two flashes" per second. The lamp or sensor failure alarm signal is a "single beep" and a "single flash" per second. The battery low alarm signal is a "single flash" per second. A flashing message of "Err xxx.x" in the LCD display indicates the lamp or sensor failure condition. A flashing message of "bAt xxx.x" indicates the low battery condition. In addition, there will be a "single beep" per minute to remind users that battery voltage is low.

**Note: it is extremely important that when the lamp or sensor failure alarm occurs, users should stop the**

**operation of the unit immediately and follow the troubleshooting guide in section 9 to diagnose the problem.**

In Survey Mode, the alarm signal is proportional to the magnitude of the gas concentration. Therefore, when gas concentration exceeds preset limits, the alarm signal may vary from a "single beep" and a "single flash" per second to a rapid "7 beeps" and "7 flashes" per second when the high threshold level has been exceeded. The higher frequency of alarm signal indicates higher gas concentration.

The lamp or sensor failure alarm signal is a single beep and a single flash per second. The battery low alarm signal is a single flash per second. A flashing message of "Err xxx.x" in the LCD display indicates the lamp or sensor failure condition. A flashing message of "bAt xxx.x" indicates the low battery voltage condition. In addition, there will be a "single beep" per minute to remind users that battery voltage is low.

## 2.7 Preset Alarm Limits and Calibration

The MiniRAE Plus Professional PID Unit is factory calibrated with standard isobutylene gas, and is programmed with default alarm limits as listed below. Refer to section 4 and 5 for programming procedures if new calibration or new alarm limits are required.

Table 2.2

| <b>Factory Calibration and Preset Alarm Limits</b> |                     |
|--|---------------------|
| Calibration Standard Gas                           | 100 ppm isobutylene |
| Hygiene Mode:                                      |                     |
| TWA Alarm Limit                                    | 10 ppm              |
| STEL Alarm Limit                                   | 25 ppm              |
| Peak Alarm Limit                                   | 50 ppm              |
| Survey Mode:                                       |                     |
| Low Alarm Limit                                    | 10 ppm              |
| High Alarm Limit                                   | 100 ppm             |
| Battery Low Level                                  | 5.5 volt            |
| Power Off Level                                    | 5.3 volt            |

## 2.8 Datalogging

The MiniRAE Plus Professional PID Unit is capable of recording crucial data during normal operation. The recorded data can be down loaded to Personal Computer later on for record keeping or report generation. The data recorded in two operating modes are different:

### **Hygiene Mode:**

In Hygiene Mode, MiniRAE Plus Professional PID Unit calculates and stores the values of TWA, STEL, Peak concentration and 12 hours of STEL readings taken at 15 minutes interval ( a total of 51 readings). In addition, the time stamps which indicate: when the unit was last turned on and off, when the peak occurred and when the TWA alarm occurred (if any) will also be recorded.

In Hygiene Mode, the datalogging operation is activated automatically when the unit is turned on. When power is turned off, the data will be retained in non-volatile memory. At each "turn on" time, the previously stored data will not be cleared and the unit will continue to record data. If users wish to clear the data at power on, they need to follow the special power on sequence as described in section 2.11.

When the data memory is full (12 hours of STEL readings), the unit will stop recording new data and the previously stored data will not be over written.

### **Survey Mode:**

## SECTION 2 OPERATION OF MINIRAE PLUS

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In Survey Mode, the MiniRAE Plus Professional Unit will allow users to record up to 50 readings of average or peak gas concentration over a specified sampling period. In addition, a time stamp and a site number will also be recorded together with each reading. The sampling period can be programmed from 1 second up to 9999 seconds.

Users are allowed to select one of the following two different datalog options:

1) manual sampling option: in this option, users have to press **[enter]** key to start each sampling period. When a sampling period is over, the datalogging operation will stop.

2) continuous sampling option: in this option, users press **[enter]** key once to start the first sampling period. At the end of each sampling period, next sampling period will start automatically. The datalogging operation will not stop until another **[enter]** key is pressed.

Note: in either option, the datalogging operation will stop when **[enter]** key is pressed any time during a sampling period.

User is also allowed to choose to datalog the **average** value or the **peak** value of each sampling period (see section 5.14 for details).

The site number will automatically advance to next one when a sampling period is over. Users can use "select site number" menu in programming task to change to a different site number (see section 5.4 for details).

When datalogging is in progress during a sampling period, the unit will not respond to **[menu]** key input to prevent disruption of the datalogging operation. A small letter "d" will also flash next to the site number to indicate that the datalogging is in progress.

When the data memory is full (48 readings), the unit will start to over write old data.

Default sampling period:

The default sampling period for Survey Mode is set to 1 second. With this setup, every time the **[enter]** key is pressed, a single reading will be recorded. This is particularly convenient for leak detection applications.

## 2.9 Turn Off Buzzer

In Hygiene Mode, the alarm buzzer can be turned off for 60 seconds by pressing **[enter]** key. After the 60 second time interval expires, the buzzer will resume if the alarm condition still exists.

Note: this feature is not available in Survey Mode because the **[enter]** key is used to start and stop datalogging operation.

## 2.10 Back Light

The LCD display is equipped with a red LED back light to assist the readings under poor lighting conditions. This back light can be turned on by pressing the **[up]** key. When the back light is already on, press **[up]** key will turn it off.

**Note:** the LED back light consumes higher amount of energy from the battery and will shorten the operating time of the unit. Therefore, it is important to turn the back light off when it is not needed.

## 2.11 Special Power-on Sequence

In MiniRAE Plus Professional PID Unit, all data are automatically retained in non-volatile memory even if the power is turned off. Users can therefore turn off the unit and turn it back on to resume the operation without losing previously stored data during normal operation.

The MiniRAE Plus also provides a special power on sequence in Hygiene Mode **to clear all data** (i.e. the values of TWA, STEL, Peak concentration and 48 STEL readings taken at 15 minutes interval) and start recording new data at power on time. This is accomplished by pressing **[menu]** key first, holding it down and then pressing **[on]** key to turn on power.

**Note:** during the special power on sequence, the display will show a " CLr .." message to indicate that all the data is being cleared.

## 2.12 Diagnostic Power-on Sequence

The MiniRAE Plus Professional PID Unit offers a special diagnostic power on sequence to allow user to read "raw" (or un-calibrated) instrument readings during zero gas calibration procedure. This feature can provides additional information to users regarding the sensor performance. This is accomplished by pressing **[up]** key first, holding it down and then pressing **[on]** key to turn on power.

**Note:** using the special diagnostic power on sequence, the unit will perform normally except during zero gas calibration procedure ( see section 4.7.1). The display will show a "raw" reading, instead of the "ppm" reading. Typically, the reading should be between "330.0" to "370.0". When exposed to a calibration gas, the reading should go down quickly. The reading can be anywhere between "0.0" to "300.0".

If the reading does not change when exposed to a calibration gas, then it is an indication that the lamp is very weak or the sensor module is defective.

## 2.13 Disconnect Battery

The MiniRAE Plus Professional PID Unit provides a mechanical switch to allow user to disconnect the battery from the unit. This is to prevent the battery from being deeply discharged when the unit is placed on the shelf or during shipment.

To disconnect the battery, open the rubber cover at the rear side of the unit, find a small switch between the battery charging jack and the multi-interface jack. Use a ball pen to move the switch to OFF position ( down). When the switch is in OFF position, the battery will retain 85% of its charge after 6 months.

**Note :** when the battery is switched off, the real time clock will stop. However, the calibration and datalog information will be preserved for at least 10 years.

### **Reset Microprocessor**

The battery switch also serves as a reset switch for the microprocessor inside the MiniRAE Plus Professional PID unit. If for some reasons, the unit is hung up (no response to key press or display funny characters on LCD display), turning off the switch and then turning it on again should reset the microprocessor.

## 3.0 OPERATION OF ACCESSORIES

There are a number of accessories for MiniRAE Plus Professional PID Unit:

- 110 V AC charging adapter
- Gas outlet port adapter and sample collection Tedlar bag
- Remote access probe ( 8 ft.)
- Audio interface adapter cable and earphone
- Analog interface adapter cable
- Water trap disk
- Dilution probe
- UV attenuator ring

The operation details of these accessories are explained in the following sections.

### 3.1 Charging of the MiniRAE Plus

On the rear side of the MiniRAE Plus Professional PID Unit, there is a battery charging jack which is normally covered by a protective rubber cover. Open the rubber cover and connect the AC adapter (or the automotive DC charging adapter, depending on the power source) to the charging jack.

There is a bi-colored LED inside the LED window which will provide an indication of the charging status:

- Red - battery is being charged
- Green - charging is completed
- No Light - bad connection or defective battery

Plug in the AC (or DC ) adapter which will turn on the red charge status LED first. If the battery is fully charged, it will turn to green quickly. A completely discharged battery will be charged to its full capacity within 10 hours.

**WARNING:**  
**TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, RECHARGE BATTERY ONLY IN AREA KNOWN TO BE NON HAZARDOUS. REMOVE AND REPLACE BATTERY ONLY IN AREA KNOWN TO BE NON HAZARDOUS.**

**Note:** the factory-supplied battery is designed to last 10 hours of normal operation for a new battery under the best conditions.

### SECTION 3 OPERATION OF ACCESSORIES

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As the battery becomes older or operated under adverse conditions, the battery capacity will be reduced significantly.

The battery of the MiniRAE Plus unit will be drained slowly even if the unit is turned off. If the unit has not been charged for 4-5 days, the battery voltage will be low. The charging circuit is designed to prevent over charging. Therefore, it is a good practice to always leave the unit in the charger when it is not used so that it is fully charged and ready for immediate use.

There is an optional **single station battery charger** accessory for the MiniRAE Plus Professional PID Unit. This charger will allow users to charge a spare battery outside the unit. Plug the battery to the jack on the back of the charger to charge the spare battery.

There is also an optional **automotive charging adapter cable** which allows user to charge the MiniRAE Plus unit directly from the 12 V cigarette lighter socket inside a car.

## 3.2 Sample Gas Collection

On the right side of the MiniRAE Plus Professional PID Unit, there is a gas outlet port where the gas sample can be collected after going through the sensor module and pump unit.

A gas outlet port adapter with 2 ft. Tygon tubing is supplied with the basic kit. Insert the threaded end of the adapter into the gas outlet port and turn clock wise to tighten the adapter. The open end of the Tygon tubing can be connected to a sample gas collection bag. A complete gas collection kit which includes a gas outlet adapter, 2 ft. Tygon tubing and a three liter Tedlar sample collection bag is also available as an accessory.

### 3.3 Remote Access Probe

A remote access probe is available as an optional accessory for the MiniRAE Plus Professional PID Unit. This probe is constructed with an aluminum telescoping pointer and 6.5 ft. Teflon tubing. The telescoping pointer allows the probe unit to be stored in a compact space when not in use and conveniently extended into a 4 ft. long pointer to reach difficult to reach sampling space, e.g. above a ceiling or inside a large container, etc. The other end of the Teflon tubing can be inserted directly into the gas inlet tube of the PID unit.

**Note:** when the remote probe is used, there will be an additional delay of about 2-3 seconds of the instrument response because the sample gas has to travel through the 8 ft tubing before it reaches the sensor module inside the unit. The traveling speed of air sample inside the tubing is 3 ft per second.

The sampling pump can pull in sample gas from as far as 200 ft horizontally or 100 ft vertically.

### 3.4 Audio Interface Adapter and Earphone

On the rear side of the MiniRAE Plus Professional PID Unit, there is an 8 pin round multi-interface jack which is normally covered by a protective rubber cover. An audio interface adapter cable and a small earphone is available as an optional accessory for the MiniRAE Plus Professional PID Unit. Open the rubber cover and connect the interface cable to the jack.

The audio buzzer signal is brought out through this interface cable. Plug the earphone into the mini-RCA jack on the end of the interface cable. Users can now hear the same alarm signal through the earphone.

**WARNING:**

**TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, DO NOT CONNECT THE EARPHONE OR EXTERNAL ALARM DEVICES TO MINIRAE PLUS IN AREA KNOWN TO BE HAZARDOUS.**

### Audio alarm signal

The audio alarm signal consists of a series of 2 kHz pulses appearing at pin 7 of the multi-interface jack. The duty cycle of the signal is 50%. Figure 3.1 shows the specification and waveform of the alarm signal:

#### Alarm signal specification:

voltage : 6 V peak to peak  
current : 14 mA max  
frequency : 2 kHz  
duty cycle: 50% square wave  
duration: 50 milli-seconds  
pin out: Pin 7 - signal  
Pin 8 - ground

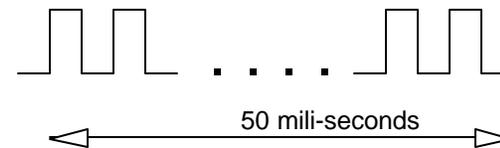


Figure 3.1 Alarm signal waveform

**Note:** the audio interface can be connected an external alarm box which can amplify the alarm signal or produce a strong flash light signal, if needed. If users need to use their own earphones, make sure that the earphones have at least 200 ohm impedence.

### 3.5 Analog Interface Adapter

An analog interface adapter cable is available as an optional accessory for the MiniRAE Plus Professional PID Unit. Open the rubber cover and connect the interface cable to the multi-interface jack.

The analog signal output from the sensor module (0 - 1 V) is brought out through this interface cable. Connect the mini-RCA plug on the other end of the interface cable to any external recording equipment, such as a strip chart recorder, or an analog datalogger. Users can readily interface the MiniRAE Plus Professional Unit to external equipment for extended datalogging or other field applications.

|   |
|---|
| <p><b>WARNING:</b><br/><b>TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, DO NOT CONNECT THE ANALOG INTERFACE CABLE TO MINIRAE PLUS IN AREA KNOWN TO BE HAZARDOUS.</b></p> |
|---|

#### Analog output signal

Pin 1 of the multi-interface jack carries the un-calibrated analog signal directly from the PID sensor. The output impedance of the signal is 3.5 k Ohm. The range of the voltage output is from 0 to 1 Volt.

**Note:** the analog signal output has a built-in offset of about 160-170 mV. When a 100 ppm Isobutylene gas is applied to the instrument, the output signal will increase by about 20-30 mV.

**Note: in order to prevent overloading of the analog output signal, when connecting to external device, only high impedance inputs should be used.**

**Multi-interface pin assignment**

The multi-interface jack at the bottom of the unit is a circular DIN receptacle with 8 holes. The signal assignment on this connector is shown in Figure 3.2

| Pin # | Description          |
|-------|----------------------|
| 1     | analog output        |
| 2     | reset (from PC)      |
| 3     | data input (from PC) |
| 4     | R6 output (to PC)    |
| 5     | data output (to PC)  |
| 6     | clock (to PC)        |
| 7     | alarm output         |
| 8     | Ground               |

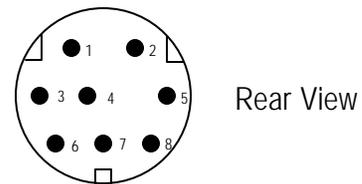


Figure 3.2 Pin diagram of the multi-interface connector

**3.6 Water Trap Disk**

### SECTION 3 OPERATION OF ACCESSORIES

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A water trap disk device is offered as an accessory to the MiniRAE Plus Professional PID unit. This device is constructed with a polypropylene housing and PTFE membrane filter. This device is to be inserted into the front end of the gas inlet probe during operation.

The water trap disk will prevent liquid to be suck into the PID unit by accident. If water is suck into the disk, the air flow will be reduced significantly and the pump will stall. Users can stop the unit immediately when observing water inside the disk or hearing the pump stalling.

### 3.7 Dilution Probe

A dilution probe device is offered as an accessory to the MiniRAE Plus Professional PID unit. This device mixes one part of incoming gas sample with 9 parts of clean air to dilute the concentration of the gas sample by 10 times. The clean air is obtained through a charcoal filter.

#### **Install dilution probe :**

Remove the regular probe. Make sure that O-ring and a membrane filter remain inside the hole on the front of the sensor block. Screw on the dilution probe.

#### **Calibrate dilution probe :**

In the factory, the dilution probe is preset at approximately 10:1 ratio with about 5-10% error. User can adjust the dilution probe during calibration using a 5/64" Allen wrench to achieve exact 10:1 ratio. Here is how:

Step 1 : Connect the "zero gas" to the probe, follow the instructions in section 4.8.1 to calibrate the zero gas.

Step 2 : Follow the instruction in section 4.8.2 to enter the standard reference gas value. **Note: enter only 1/10 of the actual value of the standard gas, not the actual value.** For example, if the calibration gas is 500 ppm, enter 50 in this step, do not enter 500.

Step 3 : Connect the standard reference gas to the probe. Turn on the gas, press [enter] key on the MiniRAE. Wait for about 30 seconds until the gas reading appear on the LCD

### SECTION 3 OPERATION OF ACCESSORIES

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display. This reading should be very close to 1/10 of the actual gas value. If the value is off a little bit, use the Allen wrench to adjust the set screw. Note: user has to loosen the lock nut first, then turn the set screw. Turn set screw clock-wise will decrease the ratio and increase the reading. Turn set screw counter clock-wise will increase the ratio and decrease the reading.

Step 4 : After the exact ratio of 10:1 is achieved, tighten the lock nut. Press [enter] key to accept the value and turn off gas. This complete the calibration procedure. Now the dilution probe will always dilute the incoming sample by a ratio of 10:1.

#### **Special consideration for calibrating the dilution probe using Tedlar bag method :**

When calibrating the dilution probe, it is highly recommended that a Tedlar bag be used, instead of using a fixed flow regulator with the gas bottle directly, because the fixed flow regulator will try to force a fixed amount of gas sample into the probe while the clean air is sucked into the probe by the sampling pump of the MiniRAE. This will create uneven pressure between the two passages inside the dilution probe and causes errors in the mixing ratio. Using Tedlar bag method can avoid this uneven pressure problem and achieve more accurate mixing ratio.

#### **Routine maintenance for dilution probe :**

##### (1) Replace membrane filter :

The membrane filter needs to be replaced every 3-4 weeks or when it is dirty. The membrane filter is located inside the cavity on the front of the probe where the Teflon tube is connected to the body of the probe. Use a pliers to unscrew the tube

adapter from the body. Replace the membrane filter. Make sure that the Teflon washer remains inside the cavity. Replace the tube adapter.

(2) Replace charcoal filter :

The charcoal filter needs to be replaced every six months or sooner. Use a screw driver to remove the two screws that hold the front piece with a set screw from the body of the probe. Replace the charcoal filter. Make sure that the O-ring inside the front piece remain inside the hole. Re-attach the front piece to the body by two screws.

After replacing membrane filter or charcoal filter, always re-calibrate the probe.

### **3.8 UV Attenuator Ring**

An UV attenuator ring has been included inside the sensor block of the MiniRAE Plus Professional PID unit. This ring is made of Teflon material with 0.5" outside diameter and 0.2" hole diameter. This ring is to be put in front the lamp window against the sensor block. This ring reduces the UV light intensity to about 16% of the original intensity from the lamp. The purpose of this ring to allow the unit to use a stronger UV lamp. The stronger UV lamp will provide better stability and a

### SECTION 3 OPERATION OF ACCESSORIES

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longer operating life. However, such a strong lamp may cause the sensor to saturate when high concentration of vapor is measured.

#### **When to use the Attenuator Ring ?**

When high concentration of vapor ( greater than 500 ppm ) is expected during normal operation.

**Installation of the Attenuator Ring :**

To install the ring, open the sensor block from the lamp housing, put the ring on the 0.5" hole opening on the sensor block. Then close the lamp housing, making sure that the lamp window is pressed against the ring. After the ring is installed, go through normal calibration procedures, and the unit is ready to operate.

**Removal of the Attenuator Ring :**

- 1) When the vapor concentration of interests are usually small ( less than 500 ppm) or
- 2) When the 11.7 eV lamp is used or
- 3) When the UV lamp has been used for a long period of time (over 6 months) and the UV light intensity is low (This condition can be detected if you get an "Sensor Error" message or "Calibration Error" message from time to time during regular operation.). In this case, removing the Attenuator Ring will increase the light intensity by about 3 times and prolong the usage of the lamp before needing to replace with a new one.

**SECTION 3 OPERATION OF ACCESSORIES**

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## 4.0 PROGRAMMING IN HYGIENE MODE

The MiniRAE Plus Professional PID Unit is built with a microcomputer to provide programming flexibility. In Hygiene Mode operation, authorized users can re-calibrate the unit, change the gas concentration alarm limits and set the date and time of the internal real time clock.

The programming is menu-driven to provide intuitive end-use operation. The display shows the menu option, and the keypad is used for the selection or data entry to each menu option.

**Note:** in Hygiene Mode, a 3 level security protection strategy is offered for programming flexibility:

| <u>security level</u> | <u>protection</u>             |
|-----------------------|-------------------------------|
| 0                     | change not allowed            |
| 1                     | change allowed, need password |
| 2                     | change allowed, no password   |

The security level and password can be set up in the instrument configuration software "ProRAE-76" that runs under PC-Window™ 3.1 or DOS. The security level and password are then downloaded into the instrument (see section 4.11 and 4.12 for details ).

## 4.1 Menu Options

The Hygiene Mode programming provides ten menu options as shown in Table 4.1 below. The first menu option allow entry into the programming menu by keying a four digit password (Note: this menu option will be displayed for level 1 security only). Once inside the programming menu, menu option 2 to 10 can be selected by toggling the **[menu]** key through the list of menu options until the desired option is displayed. **Note:** At the end of last menu option, the unit will automatically exit the programming task and return to normal operation. In order to return to programming task, press **[menu]** key again.

During the programming task, press **[menu]** key will abort and exit the current menu option and go on to the next menu option on the list. At the completion of each menu setup entry, the unit will automatically advance to next menu option. Each option is explained in the following sections. The flow chart of the Hygiene Mode programming task is shown in Appendix A.

**Note:** the security level of the instrument determines which menu option will be displayed during programming task. The security levels associated with each menu option is listed in Table 4.1. For example, if an instrument is setup to have level 1 security, then all ten menu options will be displayed. during programming task. If the security level is set to 0, then only five menu options will be displayed.

Table 4.1

| Menu Option | Display | level |
|-------------|---------|-------|
|-------------|---------|-------|

**SECTION 4 PROGRAMMING IN HYGIENE MODE**

|    |                          |           |       |
|----|--------------------------|-----------|-------|
| 1  | Verify password          | Pd-0000   | 1     |
| 2  | Set STEL limit           | SA xxx.x  | 0 1 2 |
| 3  | Set TWA limit            | tA xxx.x  | 0 1 2 |
| 4  | Set Peak limit           | PA xxx.x  | 0 1 2 |
| 5  | Zero gas calibration     | C0 xxx.x  | 1 2   |
| 6  | Standard gas value       | C1u xxx.x | 1 2   |
| 7  | Standard gas calibration | C1 xxx.x  | 1 2   |
| 8  | Clear all data           | CLr ALL   | 1 2   |
| 9  | Change hour and minute   | Hr xx.xx  | 0 1 2 |
| 10 | Change month and date    | dA xx.xx  | 0 1 2 |

Note 1: xxxx is the previously stored data.

## 4.2 Keys for Programming Task

The five keys perform a different set of functions during the programming task as summarized below.

Table 4.2

| <b>Key</b>     | <b>Function in Programming Task</b>                    |
|----------------|--|
| <b>[on]</b>    | This key does not function during programming task     |
| <b>[up]</b>    | Increment numerical value for data entry               |
| <b>[down]</b>  | Decrement numerical value for data entry               |
| <b>[enter]</b> | Confirm menu selection                                 |
| <b>[menu]</b>  | Exit current menu selection and go to next menu option |

### 4.3 Entering into Programming Task

#### CAUTION

**Do not operate programming task in the potentially hazardous environments that require continuous protection. The real time monitoring of gas concentration will be interrupted during programming task.**

1. The Professional PID Unit should already be turned on before entering the programming task. If it is not on, refer to section 2.4 for the power on sequence.
2. Press [**menu**] key to enter programming task.  
-Display then shows "Pd- 0000" with the left-most digit\* (the most significant digit) flashing. User should enter a password starting from this flashing digit.

**(Note 1:** Prior to factory shipment, the Professional PID unit was installed with "0000" as the default password. Enter "0000", if the password has not been changed by an authorized users)

#### SECTION 4 PROGRAMMING IN HYGIENE MODE

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(**Note 2:** For added security, "0000" is always displayed instead the actual password at this step.)

3. If the correct digit value is not "0", use [**up**] arrow key or [**down**] arrow key to increase or decrease the digit value. Then press [**enter**] key to confirm the value.
    - Display then shows the actual digit entered and moves the flashing digit to the next digit (to the right).
  4. Repeat step 3 until all four digits are entered.
  5. If the entered password is correct, the unit shows the first programming menu. The first menu option is to set STEL alarm limit. The LCD display will show a message of " SA xxx.x". If the entered password is not correct, the unit will display an error message and return to normal mode operation. Should [**menu**] key be pressed prior to step 4, the unit will abort the password entry and return to normal mode operation.
- \* **Note:** if the security level of the unit is set to either "no change allowed" (level 0) or "change without password" (level 2), this "password entry" menu option will not be displayed.

## 4.4 Set STEL Alarm Limit

1. "Set STEL alarm limit" option is the 2nd menu option in Table 4.1.
  - Display shows "SA xxx.x" with the left-most digit flashing, where "xxx.x" is the previously stored STEL alarm limit.
2. To modify this limit, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will move on to next digit to its right. Repeat this process until all 4 digits of the new STEL alarm limit are entered.
3. To preserve the previously stored STEL alarm limit, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the STEL alarm limit entry and move to the next menu option.
4. **Note:** if the security level of the unit is set to "no change allowed"(level 0), step 2 will not have any effect on the previously stored alarm limits. Users can view the limit but can not alter the limit.

## 4.5 Set TWA Alarm Limit

1. Set "TWA alarm limit" option is the 3rd menu option in Table 4.1.
  - Display shows "tA xxx.x" with the left-most digit flashing, where "xxx.x " is the previously stored TWA alarm limit.
2. To modify this limit, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will move on to next digit to its right. Repeat this process until all 4 digits of the new TWA alarm limit are entered.
3. To preserve the previously stored TWA alarm limit, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the TWA alarm limit entry and move to the next menu option.
4. **Note:** if the security level of the unit is set to "no change allowed" (level 0), step 2 will not have any effect on the previously stored alarm limits. Users can view the limit but can not alter the limit.

## 4.6 Set Peak Alarm Limit

1. Set "Peak alarm limit" option is the 4th menu option in Table 4.1.
  - . - Display shows "PA xxx.x" with the left-most digit flashing, where "xxx.x " is the previously stored Peak alarm limit.
2. To modify this limit, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will move on to next digit to its right. Repeat this process until all 4 digits of the new Peak alarm limit are entered.
3. To preserve the previously stored Peak alarm limit, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the Peak alarm limit entry and move to the next menu option.
4. **Note:** if the security level of the unit is set to "no change allowed"(level 0), step 2 will not have any effect on the previously stored alarm limits. Users can only view the limit but can not alter the limit.

## 4.7 Calibration of MiniRAE Plus

In the Hygiene Mode, the user may re-calibrate the MiniRAE Plus Professional PID Unit. This is a two-point calibration process using "zero gas" and standard reference gas. First, a "zero gas" which contains no detectable organic vapors is used to set the zero point (C0). Then a standard reference gas which contains a known concentration of a specific gas is used to set the second point of reference (C1). The calibration procedures are detailed below.

**Note:** if the security level of the unit is set to "no change allowed"(level 0), both zero gas and standard gas calibration menu will not be displayed.

### 4.7.1 Zero Gas Calibration

The organic vapor zeroing kit, see Figure 4.1, is supplied to perform zero gas calibration. This kit consists of

- Calibration adapter to link up with the gas inlet tube of the Professional PID Unit
- Charcoal filter to exclude any organic gas

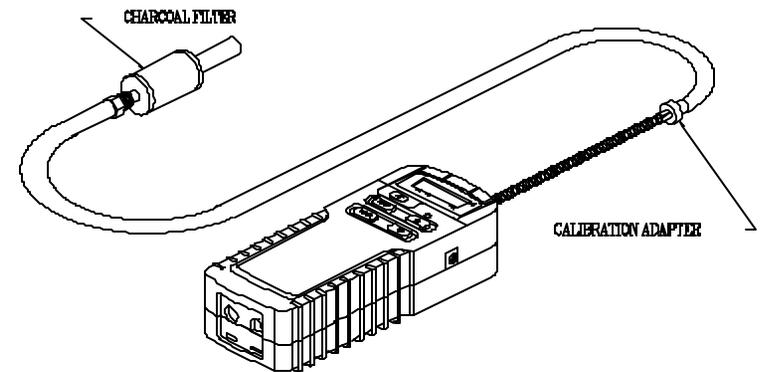


Figure 4.1 Zero gas calibration setup

### Zero Gas Calibration Procedure

1. "Zero gas calibration" option is the 5th menu option in Table 4.1.
  - Display shows "CO xxx.x" where "xxx.x" is the gas reading based on current calibration of the instrument. Note: this reading may not be zero due to back ground gas concentration, dirty charcoal filter or instrument drift .
2. Insert the zero gas adapter into the gas inlet tube of the Personal PID Unit, as shown in Fig. 4.1.
3. The sampling pump draws air sample into the sensor chamber through the charcoal filter of the organic zeroing kit. The air entering the sensor chamber should be free of any organic vapors.
  - Display then shows the reading of the gas free of organic vapor. Again, this reading may not be zero due to dirty charcoal filter or instrument drift .

4. If this reading is not zero, press **[enter]** key to zero it. If the reading still shows a small value after a few seconds, press **[enter]** key again to zero it. Repeat this process until the reading is stabilized around zero or 0.1 ppm. This completes the zero gas calibration procedure. Press **[menu]** key to exit zero gas calibration and move on to next menu item.
5. Remove the zero gas calibration adapter from the Personal PID unit.
6. One may press **[menu]** key before pressing **[enter]** key in step 4 to skip the zero gas calibration. In this case, the previously stored zero gas calibration data is not changed.

**Note:** even if the reading shows a zero during step 4, it is recommended to press **[enter]** key at least once to ensure that the zero gas calibration is updated properly.

## 4.7.2 Enter Standard Calibration Gas Value

1. "Enter standard gas value" option is the 6th menu option in Table 4.1.
  - Display shows "C1u xxx.x" where "xxx.x" is the previously stored standard calibration gas value. For example, "C1u 100.0" will be shown when the unit is first shipped from the factory because it is calibrated using 100 ppm isobutylene gas as standard calibration gas.
2. If the concentration of the standard calibration gas to be used is the same as the displayed value, press **[enter]** key 4 times to accept the displayed calibration value one digit at a time and move to step 4.
3. If the concentration of the standard calibration gas to be used is different from the displayed value, user needs to enter the new value. Starting from the left-most digit of the displayed value, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will move to next digit to its right. Repeat this process until all 4 digits are entered.
4. Now the standard calibration gas value is entered.
  - Display shows a flashing message of

" GAS On" to remind user to turn on the standard calibration gas bottle now. After the gas bottle is turned on, press **[enter]** key to continue the standard gas calibration procedure as described in section 4.7.3.

5. Any time during step 2 or step 3, if the **[menu]** key is pressed, the data entry operation will be aborted. It is also assumed that user want to skip the standard gas calibration procedure and move on to the next menu item. Therefore, it is very important that all 4 digits are entered ( i.e. press **[enter]** key 4 times ) even if user does not want to change the standard calibration gas value in step 2.

### 4.7.3 Standard Reference Gas Calibration

Figure 4.2 shows the typical installation of standard reference gas calibration. It includes:

- Calibration adapter with flow controller
- Reference gas bottle of 100 ppm isobutylene

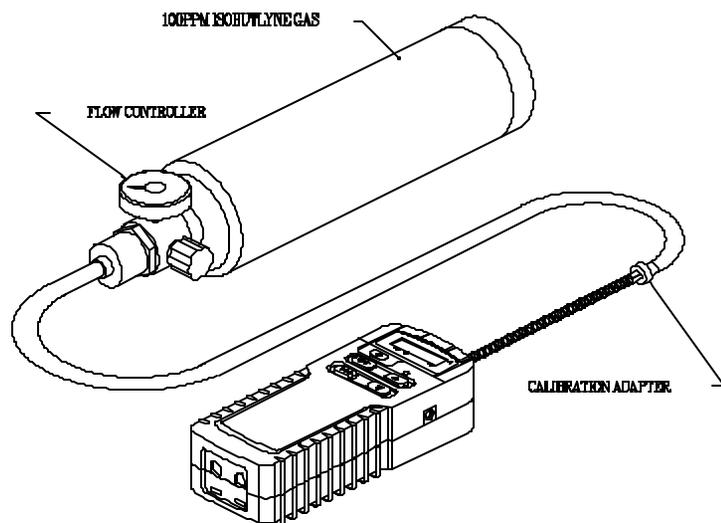


Figure 4.2 Standard reference gas calibration setup

### **Standard Gas Calibration Procedure**

1. Insert the calibration adapter into the gas inlet tube of the Personal PID Unit, and connect the calibration adapter with the standard gas bottle, as shown in Figure 4.2.
2. Continue from the step 4 of the previous section, the display should show a flashing message of "GAS On". Turn the flow controller knob counter-clockwise about half a turn to start the flow of gas then press [**enter**] key.
  - Display shows " CAL ..." for about 30 seconds while the instrument performs calibration. Afterward, the display shows "C1 xxx.x" where C1 indicates that this is the standard calibration gas and "xxx.x" is the actual gas reading in ppm based on new calibration data.

**Note:** the reading should be very close to the value of the given calibration gas (e.g. 100.0 ppm). If the reading is higher or lower than the standard gas value and continues to rise slowly, it means that the calibration gas has not been stabilized yet. Wait a few more seconds until the reading is stabilized then press [**enter**] key again. Every time the [**enter**] key is pressed, the instrument measures the current gas concentration and calibrate accordingly. The new reading should be closer to the standard gas value. Repeat this process a few more times if necessary until the reading is stable and sufficiently close (within 1 or 2 ppm) to the

## SECTION 4 PROGRAMMING IN HYGIENE MODE

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standard gas value. This completes the standard gas calibration procedure.

3. Press **[menu]** key to exit the standard gas calibration procedure and move to next menu item.
4. Turn the flow controller knob fully clockwise to turn off the flow of gas. Disconnect the calibration adapter from the Personal PID Unit.
5. One may press **[menu]** key any time before pressing **[enter]** key in step 2 to abort the calibration. In this case, the previously stored calibration data is not changed.

**Note 1:** If **[enter]** key is pressed inadvertently during step 2 before the standard reference gas starts to flow, an error message of "CAL Err" will be displayed. Simply turn on the gas flow, wait for it to stabilize and press the **[enter]** key. This should allow the instrument to be calibrated. In case user does not have a calibration gas, then press **[menu]** key to exit step 2. A factory preset value will be used to calculate the standard gas calibration.

**Note 2:** The other possible cause for the "CAL Err" message to be displayed is that the instrument does not have enough sensitivity for the given calibration gas. There are several reasons for low sensitivity. First, the instrument and lamp is not sensitive to the specific calibration gas. In this case, user needs to use a higher concentration of the given calibration gas as the calibration standard, use a different calibration gas or use a

higher energy lamp. The second reason is that the UV light intensity of the lamp is weak. In this case, replace the UV lamp with a newer and stronger one.

#### 4.7.4 Alternative Calibration Methods

There are two alternative calibration methods of the reference gas which often are used by some users. These methods are described briefly here:

A) Sampling Bag Calibration method:

First, fill a Tedlar sampling bag with the reference gas from a standard gas bottle. The size of the Tedlar bag should be at least 1 liter or more. Make sure that the bag is only partially inflated so that there will not be excessive pressure build up inside the bag. Then connect the air intake probe of the MiniRAE Plus to the Tedlar bag and perform the gas calibration procedures as described in Section 4.7.3.

In general, the sampling bag calibration method will allow the air flow from the bag matches the flow rate of the sampling pump of each individual PID unit. Therefore, it should provide a slightly more accurate calibration result. The disadvantage of the sampling bag calibration method is that it uses more gas for each calibration.

B) Adjustable Flow Regulator method:

There is a new adjustable flow regulator in the market today. This new regulator allows user to control the flow of the gas output from the standard gas bottle to match the flow rate of the sampling pump of each individual PID unit. A small flow indicator ( a small steel ball inside a clear acrylic tube ) is included as part of the regulator. Normally, the ball sit on the bottom of the tube. User can turn the knob of the regulator

slowly to increase the gas flow from the bottle until the ball starts to float up in the tube. At this point, the flow rate of the regulator matches the flow rate of the sampling pump.

Again, the adjustable flow regulator calibration method allows a better matching of the flow rate between the regulator and the sampling pump of MiniRAE Plus. Therefore, it should provide a slightly more accurate calibration result. The disadvantage of this method is that the adjustable flow regulator is more expensive.

C) Tee Connection method:

In order to match the flow rate between the fixed regulator and the sampling pump, it is possible to insert a Tee connector between the regulator and the MiniRAE Plus unit. The Tee connector will allow the excessive gas from the regulator to flow out through the third opening on the Tee connector. This method will also improve the calibration result.

### 4.7.5 Calibration for Other Gases

It is often impractical to carry a range of different standard gases into the field for calibration. If the type of the organic vapor to be measured in the field is known and the relative sensitivity of this gas compared to the standard reference gas ( such as 100 ppm isobutylene ) for the PID instrument is available, then one can calibrate the instrument using a standard reference gas and then convert the instrument readings into actual ppm of a specific gas based on the relative sensitivity, also known as **calibration factor**.

The **calibration factor** for a specific gas is defined as:

$$\text{Calibration factor} = \frac{\text{sensitivity to a standard gas}}{\text{sensitivity to a specific gas}}$$

For example, when the PID sensor is exposed to 100 ppm isobutylene gas, the instrument will measure say 10 mV from the sensor. When exposed to 100 ppm benzene gas, the instrument will measure say 17.5 mV. Then the calibration factor for benzene, relative to isobutylene is :

$$\text{Calibration factor (benzene)} = \frac{10 \text{ mV}}{17.5 \text{ mV}} = 0.57$$

Appendix C contains a list of calibration factors for common organic vapors. There are two ways to use these calibration factors to obtain a calculated concentration of another gas:

**1) Direct reading of a specific gas in ppm:**

**step 1:** Obtain the calibration factor of a given organic vapor. For example, benzene has a calibration factor of 0.57 relative to the standard 100 ppm isobutylene gas.

**step 2:** Multiply the standard calibration gas value ( such as 100 ppm of isobutylene) by the calibration factor to obtain a compensated calibration standard value for the given gas, i.e.

$$\begin{aligned} \text{cal factor} \times \text{standard value} &= \text{compensated value} \\ ( 0.57 \times 100 \text{ ppm} &= 57 \text{ ppm for benzene} ) \end{aligned}$$

**step 3:** Enter the compensated calibration standard value, instead of the actual calibration standard value in step 3 of section 4.7.2. For example, enter 57 ppm instead of 100 ppm in step 3. Continue to finish gas calibration using the standard calibration gas ( 100 ppm isobutylene ).

After the calibration is completed, the unit will give direct reading in ppm when exposed to a specific gas. In this example, the instrument will display 100 ppm when exposed to 100 ppm benzene gas.

**2) Manual conversion of readings for a specific gas:**

**step 1:** Calibrate the instrument using standard calibration gas as described in sections 4.7.2 - 4.7.3.

**step 2:** Obtain the calibration factor of a given organic vapor (see the list in Appendix C ). For example, benzene has a calibration factor of 0.57.

**step 3:** When exposed to a specific gas, multiply the instrument reading by the calibration factor manually. The result is the calculated value in ppm for the specific gas. For example, if the instrument is calibrated using isobutylene gas. When exposed to 100 ppm benzene gas, it reads 175.4. Multiply this value by the calibration factor of benzene (0.57). The result is 100 ppm which is the actual concentration of benzene.

**Note: the calibration factor is used to provide an approximate reading for a given gas while using another gas (such as Isobutylene) as reference gas during calibration. The specified measurement accuracy of MiniRAE Plus Professional PID can be met only through using the actual gas directly during the calibration process.**

## 4.8 Clear Data

The Professional PID unit calculates and stores the values of TWA, STEL, Peak concentration and 12 hours of STEL readings taken at 15 minutes interval ( a total of 51 readings). In addition, the time stamps which indicate: when the unit was last turned on and off, when the peak occurred and when the TWA alarm occurred (if any) will also be recorded. These stored data can be cleared by selecting the "clear data" menu option.

1. Clear data option is the 8th menu option in Table 4.1.
  - Display shows a flashing "Clr ALL" message
2. If users want to clear data, press **[enter]** key to confirm the menu selection. All 51 datalog values and time stamp numbers will be erased.
3. Press **[menu]** key will move to the next menu option without clearing the data.

## 4.9 Set Hour and Minute

In Hygiene Mode, users are allowed to change the hour and minute of the built-in real time clock. A 24 hour format is used for the hour value.

1. "Set hour and minute" option is the 9th menu option in Table 4.1.
  - Display shows "Hr hh.mm" with the left-most digit flashing, where "hh" is the current hour and "mm" is current minute.
2. To modify this time, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will then move on to next digit to its right. Repeat this process until all 4 digits of the new time are entered.
3. To preserve the current hour and minute, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the "hour and minute" entry and move to the next menu option.
4. **Note:** if the security level of the unit is set to "no change allowed" (level 0), step 2 will not have any effect on the current hour and minute. Users can view the time but can not alter the time.

## 4.10 Set Month and Date

In Hygiene Mode, users are allowed to change the month and date of the built-in real time clock.

1. Set "month and date" option is the 10th menu option in Table 4.1.
  - Display shows "dA mm.dd" with the left-most digit flashing, where "mm" is the current month and "dd" is current date.
2. To modify this date, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will then move on to next digit to its right. Repeat this process until all 4 digits of the new month and date is entered.
3. To preserve the current month and date, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the "month and date" entry and exit the programming task.
4. **Note:** if the security level of the unit is set to "no change allowed"(level 0), step 2 will not have any effect on the current month and date. Users can view the date but can not alter the date.

## 4.11 Set Security Level

In Hygiene Mode, authorized users are allowed to set the security level from the PC so that three levels of different data protection can be setup for the operator of the instrument.

- 1) level 0 security: in this level, users can view three alarm limits and the current time and date in programming task. They are not allowed to make any changes.
- 2) level 1 security: in this level, users have to enter a 4 digits password before they can enter the programming tasks. Once in the programming task, they are allowed to change all menu items.
- 3) level 2 security: in this level, users are allowed to make any changes in programming task. There is no need for a password to enter the programming task.

The security level has to be set up by "ProRAE-76" software in PC. See section 6 for details on how to install the ProRAE-76 software on PC, how to interface the MiniRAE Plus instrument to PC, and how to set up security levels in PC.

A brief summary on how to set up security level in PC includes:

Step 1: From the main menu of the ProRAE software, **Open** the Hygiene Mode configuration (hygiene.CFG ) file from the

**File** sub-menu, then choose **Instrument Setup** function from the **Options** sub-menu. The PC display will show a dialog box as shown in Screen 6.9.

Step 2: Move cursor to the security level section of the menu and choose one of the three security levels by clicking the mouse on one of the three radio buttons.

Step 3: After the instrument configuration is completed, send it to the instrument as described in section 6.9. The security level should now be setup correctly in the instrument.

## 4.12 Change Password

In Hygiene Mode, authorized users are allowed to set a password for the instrument so that when level 1 security is selected for the instrument, users have to enter a valid password in order to enter the programming task.

The password has to be set up by "ProRAE-76" software in PC. See section 6 for details on how to install the ProRAE-76 software on PC, how to interface the MiniRAE Plus instrument to PC and how to change password in PC.

A brief summary of the steps includes:

Step 1: From the main menu of the ProRAE software, **Open** the Hygiene Mode configuration (hygiene.CFG ) file from the **File** sub-menu, then choose **Instrument Setup** function from the **Options** sub-menu. The PC display will show a dialog box as shown in Screen 6.9.

Step 2: Move cursor to the password section of the menu and type in the 4-digit password.

Step 3: After the instrument configuration is completed, send to the instrument as described in section 6.9. The new password will now take effect in the instrument.

## 5.0 PROGRAMMING IN SURVEY MODE

The MiniRAE Plus Professional PID Unit is built with a microprocessor to provide programming flexibility. In Survey Mode operation, users can choose a new site number, select one of two calibration data, re-calibrate the unit, change the sampling period, clear data memory, change the gas concentration alarm limits, and change time and date of the real time clock.

The programming is menu-driven to provide intuitive end-use operation. The display shows the menu option, and the key pad is used for the menu selection or data entry to each menu option.

## 5.1 Menu Options

The programming menu for Survey Mode includes 11 menu options as shown in the Table 5.1 below. User enters the programming menu by pressing **[menu]** key. The first menu option will appear in the display. User can use the other three keys to perform the desired programming tasks. At the completion of each menu entry, the display will automatically advance to next menu option. Pressing the **[menu]** key will exit the current menu option and move to the next menu option. After sequencing through all 11 menu options, the unit will return to normal operation.

Each option is explained in the following sections. The flow chart of the programming task in Survey Mode is shown in Appendix B.

Table 5.1

|     | <b>Menu Option</b>               | <b>Display</b> |
|-----|----------------------------------|----------------|
| 1   | Site selection                   | SlEtE xx       |
| 2   | Select calibration data          | GAS - x        |
| 3   | Zero gas calibration             | C0 xxx.x       |
| 4   | Enter standard gas value         | C1u xxx.x      |
| 5   | Standard gas calibration         | C1 xxx.x       |
| 6   | Set sampling period (in seconds) | SP xxxx        |
| 7   | Clear all data                   | Clr ALL        |
| 8   | Set low alarm limit              | LA xxx.x       |
| 9   | Set high alarm limit             | HA xxx.x       |
| 10  | Change time (hour and minute)    | Hr xx.xx       |
| 11. | Change date (month and date)     | dA xx.xx       |

Note 1: xxxx is the previously stored data.

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## 5.2 Keys for Programming Task

The operation of the five keys during the programming task in Survey Mode is identical to that of Hygiene Mode.

Table 5.2

| Key     | Function in Programming Task                           |
|---------|--|
| [on]    | This key does not function during programming task     |
| [up]    | Increment numerical value for data entry               |
| [down]  | Decrement numerical value for data entry               |
| [enter] | Confirm menu selection                                 |
| [menu]  | Exit current menu selection and go to next menu option |

### 5.3 Entering into Programming Task

#### CAUTION

**Do not perform programming task in the potentially hazardous environments that require continuous protection. The real time monitoring of gas concentration will be interrupted during programming task.**

1. The MiniRAE Plus Professional PID Unit should already be turned on already before entering the programming task. If it is not on, refer to section 2.4 for power on procedure.
2. Press **[menu]** key to enter programming menu.
3. **Note:** if the unit is in the middle of datalog ( a "d" will be displayed next to site number), it will not respond to the **[menu]** key. This is to prevent entering the programming task while the datalog operation has not been completed. Wait for the datalog operation to complete or force the datalog operation to stop by pressing **[enter]** key, then enter programming task again.

## 5.4 Select Site Number

1. The first menu option ( item 1 in Table 5.1) is to allow users to select a new site number.
  - Display shows the following message  
"Site xx".  
where xx is the current site number.
- 2 Press **[up]** key once to increase the site number by one.  
Press **[down]** key once to decrease the site number by one.
3. By holding down the **[up]** or **[down]** key, the site number will automatically advance to next number at approximately once every half second. This allows users to advance to a new site number rapidly without repetitively pressing the keys.
4. When the site number reaches the maximum value of 49, it will automatically wrap around to zero.
5. When a desired new site number is reached, press **[enter]** key will accept the new site number and move to next menu option.
6. If **[menu]** key is pressed in step 3, the previous site number will not be changed and the display will show next menu option.

## 5.5 Select Calibration Data

In Survey Mode, users are allowed to select anyone of the two previously stored gas calibration data to be used for current gas measurement. These two gas calibration data are identified by a single digit gas number 1 or 2.

1. Select Calibration Data is the 2nd menu option in Table 5.1.
  - Display shows " GAS - x" where "x " is 1 or 2. This indicates that the current calibration data selection is "gas 1" or "gas 2". For example, "gas 1" may be calibrated using isobutylene gas, while "gas 2" may be calibrated using benzene gas or using calibration factor.
2. To change the calibration data selection, use **[up]** or **[down]** key to change the digit value from 1 to 2 or vice versa. Note: when the unit is first shipped from the factory, "gas 1" is calibrated using 100 ppm isobutylene, "gas 2" is un-calibrated.
3. Depress **[enter]** or **[menu]** key after the selection is completed and move to the next menu option.

## 5.6 Calibration of MiniRAE Plus

In Survey Mode, user is allowed to select one of two previously stored calibration data. It is therefore also necessary to calibrate and store two sets of calibration data. The calibration procedure for either one of the two gases is identical to that of the Hygiene Mode. Please refer to section 4.7 for the detailed steps of calibration.

**Note:** before starting any calibration procedure, make sure that the correct gas number is selected first in the previous menu (see section 5.5). After the calibration procedure is completed, the calibration data will be automatically stored into the currently selected gas number.

## 5.7 Set Sampling Period

Users are allowed to select a sampling period for the datalog operation. This period can be between 1 second to 9999 seconds.

1. "Set Sampling Period" option is the 6th menu option in Table 5.1.
  - Display shows "SP xxxx" with the left-most digit flashing, where "xxxx" is the previously stored sampling period in seconds.
2. To modify this period, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will move to next digit to its right. Repeat this process until all 4 digits of the new sampling period are entered. **Note:** If "0" second is entered, the entry will be ignored and the previously stored sampling period will be used.
3. To preserve the previously stored sampling period, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the data entry and move to the next menu option.

## 5.8 Clear Data

The Professional PID unit stores up to 50 single readings of the time weighted average of the gas concentration. The time (hour and minute) at the end of each sampling period will also be recorded for each reading. These stored data can be cleared by selecting the "clear data" menu option.

1. Clear data option is the 7th menu option in Table 5.1.
  - Display shows a flashing "Clr ALL" message
2. If users want to clear data, press [**enter**] key to confirm the menu selection. All 50 datalog values and time stamp numbers will be erased.
3. Press [**menu**] key will move to the next menu option without clearing the data.

## 5.9 Set Low Alarm Limit

In Survey Mode, users are allowed to define a low alarm limit. When gas concentration is below this limit, the alarm will not be activated. The minimum value for this low limit is zero.

1. Set "low alarm limit" option is the 8th menu option in Table 5.1.
  - Display shows "LA xxx.x" with the left-most digit flashing, where "xxx.x " is the previously stored low alarm limit.
2. To modify this limit, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will then move on to next digit to its right. Repeat this process until all 4 digits of the new low alarm limit are entered. **Note:** if the low alarm limit is higher than the high alarm limit, the data entry will be aborted and the previously stored low alarm limit will be restored.
3. To preserve the previously stored low alarm limit, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the low alarm limit entry and move to the next menu option.

## 5.10 Set High Alarm Limit

In Survey Mode, users are allowed to define a high alarm limit. When gas concentration exceeds this limit, the alarm will be activated at the highest frequency. The high limit and low limit also define the range whereby the alarm signal will vary its frequency. The maximum value allowed for high limit is 999.9.

1. Set "high alarm limit" option is the 9th menu option in Table 5.1.
  - Display shows "HA xxx.x" with the left-most digit flashing, where "xxx.x " is the previously stored high alarm limit.
2. To modify this limit, starting from the left-most digit, use **[up]** or **[down]** arrow key to change the digit value and **[enter]** key to confirm the digit, the flashing digit will then move on to next digit to its right. Repeat this process until all 4 digits of the new high alarm limit are entered. **Note:** if the high alarm limit is lower than the low alarm limit, the data entry is aborted and the previously stored high alarm limit will be restored.
3. To preserve the previously stored high alarm limit, press **[menu]** key at step 1 or in the middle of step 2, the unit will abort the high alarm limit entry and move to the next menu option.

### **5.11 Set Hour and Minute**

In Survey Mode, users are allowed to set the hour and minute value of the real time clock. The procedures for setting the hour and minute value are identical to that of Hygiene Mode. Please refer to section 4.9 for operation details.

### **5.12 Set Month and Date**

In Survey Mode, users are allowed to set the month and date value of the real time clock. The procedure for setting the month and date value is identical to that of Hygiene Mode. Please refer to section 4.10 for operation details.

## 5.13 Select Datalog Option

In Survey Mode, authorized users are allowed to select one of the following two different datalog options from the PC:

1) manual sampling option: in this option, users have to press **[enter]** key to start each sampling period. When a sampling period is completed, the datalogging operation will stop.

2) continuous sampling option: in this option, users press **[enter]** key once to start the first sampling period. At the end of each sampling period, next sampling period will start automatically. The datalogging operation will not stop until another **[enter]** key is pressed. This option is very useful for "un-attended" data sampling operation.

The datalog option has to be set up by "ProRAE-76" software in PC. See section 6 for details on how to install the ProRAE-76 software on PC, how to interface the MiniRAE Plus instrument to PC and how to select datalog option from PC.

Here is a brief summary on how to select datalog option in PC:

Step 1: From the main menu of the ProRAE-76 software, **Open** the Survey Mode configuration file (survey.CFG) from the **File** sub-menu, then choose **Instrument Setup** function from the **Options** sub-menu. The PC display will show a dialog box as shown in Screen 6.10.

Step 2: Move cursor to the datalog option section of the menu and choose one of the two options by clicking the mouse on one of the two radio buttons.

Step 3: After the instrument configuration is completed, send it to the instrument as described in section 6.9. The appropriate datalog option will be setup correctly in the instrument now.

## 5.14 Select Data Type Option

In Survey Mode, authorized users are allowed to select one of the following two different data type to be stored from the PC:

1) peak data option: in this option, the peak value during each sampling period is stored. For example, if the sampling period is set to be 60 seconds, then the maximum reading during each 60 seconds sampling period will be stored.

2) average data option: in this option, the average value during each sampling period is stored. For example, if the sampling period is set to be 60 seconds, then the average value of 60 readings during each 60 seconds sampling period will be stored.

The data type option has to be set up by "ProRAE-76" software in PC. See section 6 for details on how to install the ProRAE-76 software on PC, how to interface the MiniRAE Plus instrument to PC and how to select datalog option from PC.

Here is a brief summary on how to select data type option in PC:

Step 1: From the main menu of the ProRAE-76 software, **Open** the Survey Mode configuration file (survey.CFG) from the **File** sub-menu, then choose **Instrument Setup** function from the **Options** sub-menu. The PC display will show a dialog box as shown in Screen 6.10.

Step 2: Move cursor to the data type option section of the menu and choose one of the two data type options by clicking the mouse on one of the two radio buttons.

Step 3: After the instrument configuration is completed, send it to the instrument as described in section 6.9. The appropriate data type option will be setup correctly in the instrument now.

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## 6.0 COMPUTER INTERFACE FOR MINIRAE PLUS

Each MiniRAE Plus Professional PID kit is shipped with an integral software package, called ProRAE-76 and a computer interface cable. This software package offers additional capabilities to the basic MiniRAE Plus PID instrument to enhance its functionality.

This software package runs on any IBM compatible Personal Computer (PC) under Windows™ 3.1 and later environment\*. It allows users to re-configure the MiniRAE Plus Professional PID unit to either Hygiene or Survey Mode, to set alarm levels, to select security level and password for Hygiene Mode, and to select datalog options for Survey Mode. It also allows users to retrieve datalog results from the instrument in order to perform data analysis, report generation or record keeping. Installation and operation of this software package is described in following sections:

\* **Note:** a DOS version with similar capabilities of the ProRAE-76 software is also included for users who prefer to use DOS operating environment in their PC. See section 6.12 for details on installation and operation of the DOS version of ProRAE-76 software.

### **Compatibility and Differences between ProRAE-75 and ProRAE-76**

Due to hardware differences between MiniRAE (model PGM-75) and MiniRAE Plus (model PGM-76IS and PGM-76), the ProRAE-76 software package is not compatible with the existing ProRAE-75 software package. The ProRAE-76 will only work with MiniRAE Plus product line while the ProRAE-75 will only work with MiniRAE product line.

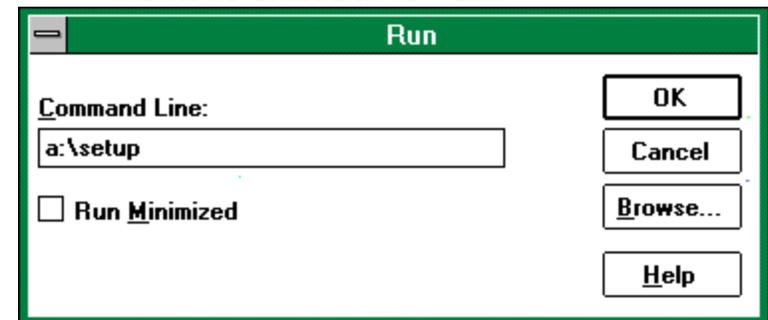
All the major features are identical between these two versions of software packages. The only differences in ProRAE-76 are summarized below:

- 1) A text browse window is used to display text data, instead of using the Notepad™ program from Windows. This will eliminate some confusion.
- 2) The data file will always be saved in binary format with .cfg file extension. User does not need to deal with two type of data files ( binary and text file ) as in ProRAE-75 software.
- 3) The Survey mode data can also be displayed in graphic format, as with the Hygiene mode data. However, the graphic data is only meaningful when the data is collected in continuous sampling mode ( See Section 5.13 for details of datalog mode).

## 6.1 Installation of ProRAE-76

ProRAE-76 software package is supplied with the MiniRAE Plus Professional PID Basic Kit. This software package is available in 3.5" diskette ( call factory for a 5.25" diskette if necessary ). To install the ProRAE-76 for Window version, insert the diskette into the "A" drive. ( Note: do not use B: drive for installation ). From the **Program Manager** of Window, pull down the **File** sub-menu. Select **Run** from the sub-menu. A dialog box will appear as shown in Screen 6.1.

Screen 6.1 Run Menu of Window



Type in "a:\setup " in the command line box then depress **[enter]** key on the keyboard or click **[OK]** button on the menu. The ProRAE-76 software package will be installed automatically under a newly created directory - called ProRAE76. After the software is installed successfully, a RAE logo icon will appear in the ProRAE-76 Application Program Group.

## 6.2 Connecting MiniRAE Plus to PC

The basic kit of MiniRAE Plus Professional PID unit is supplied with a PC interface adapter cable. Connect the round 8 pin plug at one end of the cable to the multi-interface jack at the rear side of the PID unit. Connect the DB-25 connector at the other end of the cable to the **parallel printer port** of the PC. ( Note: do not connect to the serial port of the PC by mistake. The parallel port is usually a 25 pin **female D connector** on the back of the PC, the serial port is usually a 25 or 9 pin male D connector )

**Caution:** Before connecting the cable to the MiniRAE Plus unit, make sure that the power on both the PID unit and PC are turned off. After the cable is connected, turn on the power to the PC. During the communication session between PC and the PID unit, PC will directly read and write to the memory of the PID unit. Therefore, it is important to turn off the power to the PID unit so that the memory content will not be disturbed during data transfer.

**Note:** the real time clock in the MiniRAE Plus unit will be turned off while it is connected to the PC. Therefore, it is recommended to check and update the real time clock after connecting MiniRAE Plus to the PC to ensure the correct time and date information in the unit.

### 6.3 Starting ProRAE-76

After the ProRAE-76 software is successfully installed, there will be an application icon that shows a RAE logo inside the ProRAE-76 Application Program Group of the Program Manager. To start the ProRAE-76 program, double click the RAE logo icon. The main menu of ProRAE-76 software will appear in a new window, as shown in Screen 6.2.

Screen 6.2 Main Menu of ProRAE-76



The software functions of ProRAE-76 are organized into four sub-menus inside the menu bar:

**File** - manipulate the data or configuration files

**Communication** - communicate with the MiniRAE Plus

**Options** - configure instrument or viewing options

**View** - display text or graphic data

To invoke a function within a sub-menu, position the mouse cursor at the title of each sub-menu and click the left button of the mouse to pull down the sub-menu. Move the cursor to the desired function in the sub-menu and click the left button of the mouse to activate the function.

There is also a tool bar beneath the menu bar. The frequently used functions are represented in this tool bar in the form of a small icon. For example, the **Send** function in the **Communication** sub-menu is represented as a small arrow with the letters "SEND". When the Mouse cursor ( a small arrow) is positioned near each icon in the tool bar, a short text will also appear at the bottom of the Window to describe the function of this icon.

This tool bar allows users to invoke a function conveniently by clicking on the icon without going through the sub-menus.

## 6.4 Receive Data from MiniRAE Plus

In order to receive data from MiniRAE Plus, users first have to connect the MiniRAE Plus unit to a PC as described in section 6.2. From the main menu of ProRAE-76 software, select the **Receive** function from the **Communication** sub-menu or click the **Receive** icon (left arrow with "Recv" letters ) from the tool bar.

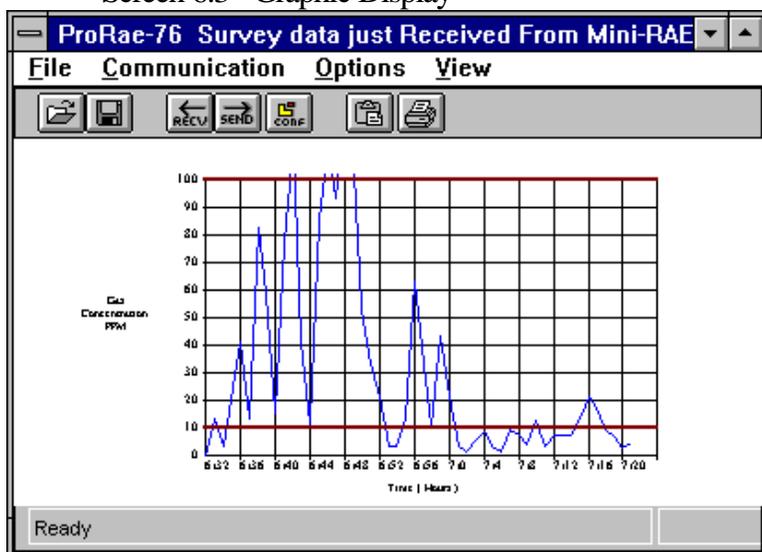
A message will appear: " Receiving data, please wait for about 20 Sec....". After the data is received successfully, a dialog box will be shown, indicating that the Receiving Process is completed. Click the **[OK]** button, the data will be displayed in graphic form automatically. Note : the data can also be displayed in text format using the **Data** function from **View** sub-menu.

If the communication is not successful, an error message will appear. Check the cable to make sure that the connectors on both end of the cable are securely seated in the sockets. Try to receive data again. If the error message still appear after repeated attempts, call authorized service center for help.

## 6.5 View Data

After the datalog results are transferred from MiniRAE Plus Professional PID Unit into PC, users can view the data in graphic or text format. From the main menu, select **Plot** function from **View** sub-menu for a graphic display of the data. Screen 6.3 shows a typical graphic display. The alarm limit is shown as a horizontal line.

Screen 6.3 Graphic Display



When viewing the graphic display of the data, it may be necessary to adjust the horizontal scale ( time in hours ) or vertical scale ( gas concentration in ppm ) to get a better display. Choose the **Set View Range** function from the **Options** sub-menu to modify the viewing range, as shown in Screen 6.4

Screen 6.4 Set View Range Dialog Box

Set View Range

X axis : time

|       | Hour                           | Minute                          |
|-------|--------------------------------|---------------------------------|
| Start | <input type="text" value="6"/> | <input type="text" value="32"/> |
| End   | <input type="text" value="7"/> | <input type="text" value="22"/> |

Y axis : gas concentration

PPM

OK

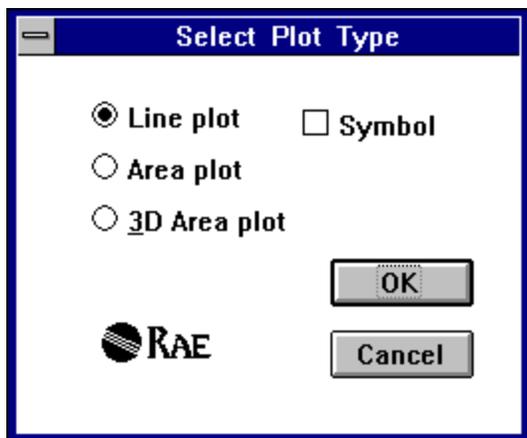
Cancel

RAE

Note: if users enter a new start or stop hour for viewing which is outside the actual datalog start and stop time, an error message will appear. Users should always set the start and stop hour for viewing to be within the actual datalog start and stop hour.

Users also can choose the **Select Plot Type** function from the **Options** sub-menu to change the type of graphic display. Screen 6.5 shows the dialog box for selecting plot type. The default plot type is "Area plot".

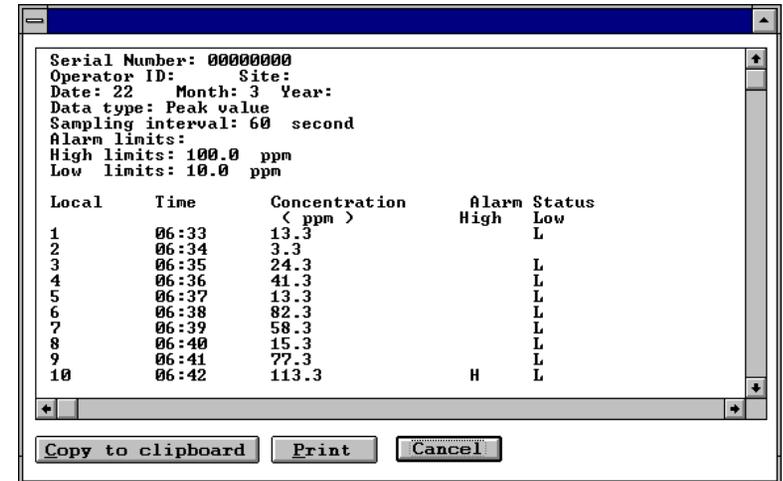
Screen 6.5 Select Plot Type Dialog Box



Note : in Survey mode, the x- axis of the graphic data display may not reflect the actual time if the data was not collected in a continuous sampling mode. The graphic data is plotted based on the assumption that the first data point is the starting time, and each subsequent data point is collected after one sampling period.

Users can select the **Data** function from **View** sub-menu to see a text display of the data file.

Screen 6.6 Text Data in Text Window



The text data is displayed in a text window. Screen 6.6 shows a typical text data displayed in a text window.

The text data for Hygiene Mode includes the start, stop and elapse time of the PID unit. It also includes the alarm limits and actual values of TWA, STEL and Peak measurements. The Peak time is the time when the Peak actually occurs. The STEL values at every 15 minutes interval are displayed in chronological order. The alarm status column will display a letter "P", "S" or "T" if Peak, STEL or TWA limit is exceeded.

The text data for Survey Mode includes high, low alarm limits, sampling interval, data type and gas concentration of 50 sites .

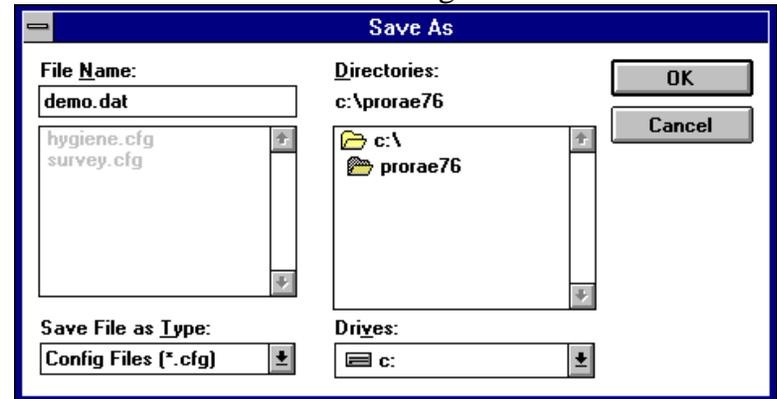
The alarm status column will display a letter "H" or "L" if High or Low alarm limit is exceeded.

**Note:** the text data can be saved as text file ( ASCII characters ) by high light the area of the text window and click the **Copy to Clipboard** button. Then user can open another word processing program , such as Word™, Word Perfect™, Notepad™, etc. to paste in the text from the clipboard and save it as a text file. Users can also print the text data using the **Print** button.

## 6.6 Save Data File

After viewing the data results, it may be desirable to save the data file for future use. Users have to select **Save As** function from the **File** sub-menu or click the **Save As** icon ( a disk ) from the tool bar. A dialog box will appear, which is similar to Screen 6.7.

Screen 6.7 Save File Dialog Box



Type in a desired file name in the file name box. Choose any 8 character as file name. Always use .DAT as file name extension. Click [OK] button or depress [Enter] key to save the file. Once the data file is saved on disk, users can open it at a later time for further analysis or report generation.

**Note:** the data file saved in this manner with .DAT extension is a secure format which users can not modify or temper with easily.

## 6.7 Print Data File

After viewing the data results, it is possible to print the data to a printer in order to obtain a hard copy of the text or graphic data report. To print the graphic data, choose the **Plot** function from the **View** sub-menu first. The graphic data will be displayed.

Users need to select **Print** function from the **File** sub-menu, or click the **Print** icon ( a printer ) from the tool bar to print the graphic data. To print the text data, choose the **Data** function from the **View** sub-menu first. The text data will be displayed in a browse window. Then click **Print** button to print the text data.

A printer setup dialog box will appear before the printing starts so that the paper size, orientation, printer type, etc. can be configured correctly.

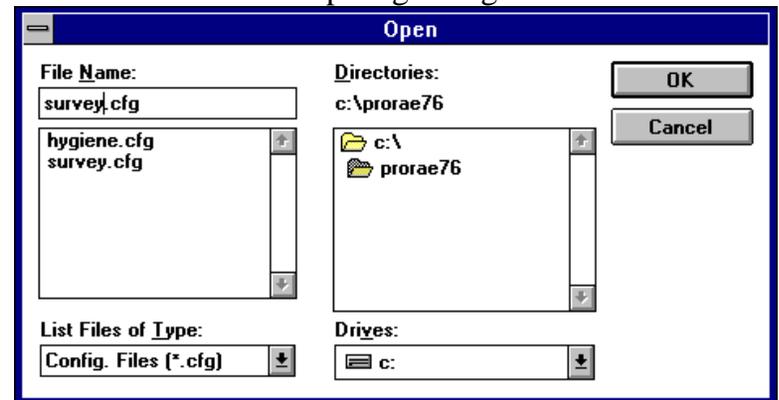
**Note:** the MiniRAE Plus to PC interface uses parallel port on the PC. If the printer also uses the parallel port on the PC, it is necessary to disconnect the MiniRAE Plus interface cable from the parallel port and connect the printer to it before a hard copy can be made. A convenient way to do so is to use a A-B switch box which allows users to switch between the MiniRAE Plus and a parallel printer quickly.

## 6.8 Configure MiniRAE Plus from PC

The ProRAE-76 software allow users to configure the MiniRAE Plus Professional PID Unit for Hygiene or Survey Mode operation, set alarm levels, select security level and password for Hygiene Mode, and select datalog options for Survey Mode from PC and send the configuration information to the unit when it is ready.

From the main menu of ProRAE-76 software, select the **Open** function from the **File** sub-menu, or click the **Open File** icon ( an open folder ). A dialog box will appear, as shown in Screen 6.8.

Screen 6.8 File Opening Dialog Box



There should be two or more configuration files in the file list. Each configuration file has a file extension of .CFG. There are two generic configuration files supplied with ProRAE-76 software: HYGIENE.CFG and SURVEY.CFG. Choose either the SURVEY.CFG or HYGIENE.CFG by highlighting the file name and depress **[Enter]** key or click **[OK]** button.

The title bar of the main menu will show: "ProRAE-76 c:\prorae76\hygiene.cfg" or "ProRAE-76 c:\prorae76\survey.cfg" when the corresponding file is opened.

If users do not need to modify the default instrument configuration from the generic .CFG file, skip the following steps and go to Section 6.9 directly.

If users need to modify the configuration, choose the **Instrument Configuration** function from the **Option** sub-menu, or click the Configuration icon ( small boxes with CONF letters ) from the tool bar, a dialog box will appear as shown in Screen 6.9 (Hygiene Mode) or Screen 6.10 ( Survey Mode).

Screen 6.9 Hygiene Mode Configuration

**Hygiene Mode**

Operator ID:

Site Name:

Year:

Password:

**Alarm limits**

Peak limit :  ppm

TWA limit :  ppm

STEL limit :  ppm

**Security level**

change not allowed

change allowed, need password

change allowed, no password

Save calibration & clock data



Users can now move the cursor to each data entry box to fill in the information, such as Operator ID, Site Name, Alarm Limits, etc. User can also click on the radio button to choose security levels, datalog options or data type, etc. After all the

information are entered, depress [Enter] key or click [OK] button.

Screen 6.10 Survey Mode Configuration

**Survey Mode**

Operator ID:

Site Name:

Year:

Password:

**Alarm limits**

High limit :  ppm

Low limit :  ppm

Sample interval:  second

**Datalog option**

continuous sampling

manual sampling

**Data type**

Peak value

Average value

  Save calibration & clock data

**Note:** the Operator ID, Site Name and Year information is only used for reference purpose. It is not sent to the MiniRAE Plus instrument.

**Saving calibration and clock data:**

In both Hygiene and Survey Mode configuration dialog box, there is a check box at the bottom of the dialog box : "  save calibration and clock data". If this box is checked, then the calibration data, password and real time clock information will be preserved in the unit so that users do not need to re-calibrate or re-enter password and real time clock information after a new configuration information is sent to the unit.

If this box is not checked, then all the configuration information, except the serial number will be over written by the new configuration setup. In this case, users need to re-calibrate and re-enter the password and real time clock information.

## 6.9 Send Configuration to MiniRAE Plus

In order to send the configuration information to the MiniRAE Plus Professional PID Unit, select the **Send** function from the **Communication** sub-menu or click the **Send** icon (right arrow with "Send" letters ) from the tool bar.

A message will appear " Sending data, please wait for about 40 Sec....". After the information is sent successfully, a dialog box will appear to indicate that the Send Process is completed. Click the **[OK]** button or depress the **[Enter]** key and the screen will return to main menu.

If the communication is not successful, an error message will appear. Check the cable to make sure that the connectors on both end of the cable are securely seated in the sockets. Try to send information again. If the error message still appear after repeated attempts, call authorized service center for help.

## 6.10 Save Configuration File

In order to save the configuration information for future use, users can select **Save As** function from the **File** sub-menu or click the **Save As** icon ( a disk ) from the tool bar. A dialog box will appear, similar to Screen 6.7.

Type in a desired file name in the file name box. Users can choose any 8 character as file name with .CFG as file name extension. Avoid using HYGIENE.CFG or SURVEY.CFG as file name because these two files are reserved for the generic configuration files.

Once the configuration file is save on disk, users can open it at a later time for further modification or send it to MiniRAE Plus .

## 6.11 Other Functions of ProRAE-76

### 1) Exit ProRAE-76 Program:

To exit the ProRAE-76 program, choose **Exit** function from the **File** sub-menu.

### 2) Copy to Clipboard:

Choose **Copy to Clipboard** function from the **Options** sub-menu. This will allow the graphic image to be copied onto the clipboard. Users can then paste the graphic image to other Windows™ programs, such as word processing programs, presentation graphic programs, etc. etc. Please refer to the application program manuals for details on how to paste images.

### 3) Enter Serial Number :

If the serial number printed on the datalog report does not match the number on the label on the back of the unit, refer to section 6.12.3 to enter a correct serial number.

## 6.12 DOS Version of ProRAE-76

A DOS version of the ProRAE-76 software is included in this package. It can be installed on any PC compatible computers using DOS 5.0 and later version of DOS with 640 K byte memory and 1 M byte of hard disk space. This DOS version software is provided for users who prefer to use DOS operating environment in their PC.

The DOS version of ProRAE-76 offers similar functionality available in the Windows version in which users are allowed to configure the MiniRAE Plus instrument to be in either Hygiene or Survey Mode. Users can also set the security level and password in Hygiene Mode and select datalog options in Survey Mode. In addition, they can retrieve data from the MiniRAE Plus and place the data in a text file for data analysis or record keeping. The following sections will describe how to install the DOS version of the ProRAE-76 software and how to operate it.

**Note:** it is not necessary to install the DOS version of ProRAE-76 onto hard disk. User can also run this program directly from the floppy disk. See instruction in Section 6.12.2. on how to run the program directly from floppy disk.

### 6.12.1 Installation of ProRAE-76 for DOS

Insert the ProRAE-76 diskette supplied with the basic kit into the "A" drive. This is the first disk drive on most PC which usually accept 3.5" diskette. ( If the A: drive accepts 5.25" floppy, please call the factory for a free copy of the ProRAE-76 in 5.25" floppy format). Do not use the second disk drive or B drive for installation. Make sure that you select the correct disk format for A drive. From the DOS prompt, type "a:install" followed by [enter] key:

```
C:\> a:install [enter]
```

Note: the **bold** face letter shows the keys to be entered by the user. The *Italic* letter shows the computer response.

The software will automatically install itself onto the C: drive ( hard disk drive) of the PC under a newly created directory - called PRORAE. After the software is successfully installed, a message will be displayed to indicate that the installation is completed.

```
*****  
*   Installation Completed!           *  
*                                     *  
*                                     *  
*   To start type prorae and hit Enter *  
*                                     *  
*****
```

## 6.12.2 Operation of ProRAE-76 for DOS

**Step 1:** start ProRAE-76 for DOS program:

Type "prorae" followed by [enter] key to start the program:

C:\PRORAE> prorae [enter]

Users should see following main menu:

```
*****
*   ProRAE-76 DOS version                               *
*                                                       *
*   for MiniRAE Plus Professional PID Unit             *
*                                                       *
*   V 2.30      Date: 3/22/95                          *
*****
Menu Selection:

1. Configure MiniRAE Plus for Survey Mode
   1a. manual sampling - datalog peak
   1b. manual sampling - datalog average
   1c. continuous sampling - datalog peak
   1d. continuous sampling - datalog average

2. Configure MiniRAE Plus for Hygiene Mode
   2a. Level 0 security - no change allowed
   2b. Level 1 security - change allowed, need password
   2c. Level 2 security - change allowed, no password

3. Read Data Back from MiniRAE Plus

4. Exit

Enter :
```

To run the program directly from floppy drive, place the diskette into A: drive, type

```
C:\ a: [enter]
A:\ cd prorae [enter]
A:\PRORAE\ prorae [enter]
```

**Step 2:** connect MiniRAE Plus

Connect the MiniRAE Plus Professional PID unit to the parallel port of the PC, as described in section 6.2. **Note:** this step is a very important step. If the unit is not connected correctly to PC, there will be error messages during data transfer.

**Step 3:** choose menu operations

From the main menu, users can choose following four operations:

**1) Configure for Survey Mode:**

To configure the MiniRAE Plus-76 to be in Survey Mode, type "1a","1b","1c" or "1d" based on the choice of the datalog option, and followed by [enter] key.

Type: 1a : manual sampling - datalog peak  
1b : manual sampling - datalog average  
1c : continuous sampling - datalog peak  
1d : continuous sampling - datalog average

See sections 5.13-5.14 for a detailed description of these two datalog options in Survey Mode. **Note:** the factory default setup is for manual sampling, datalog peak value (1a). Users will see the following display:

*Reading Information from PID Unit ....*

*E E P R O M - U T I L I T Y for Xicor 24(L)Cxx*

*Calling format :*

- Burn : sdt\_xic LPT B filespec [messagefilespec]*
  - Read : sdt\_xic LPT R filespec [messagefilespec] -*
  - Verify : sdt\_xic LPT V filespec [messagefilespec]*
  - Clear : sdt\_xic LPT C [messagefilespec]*
- If messagefilespec not specified then output to SCREEN  
Legal values for LPT are 1, 2, 3, 4.*

*please wait....*

After about 20 seconds, if the transfer is successful, the display will change to:

*Sending Manual Survey Mode Configuration ....  
Event Datalogging.*

*E E P R O M - U T I L I T Y for Xicor 24(L)Cxx*

*Calling format :*

- Burn : sdt\_xic LPT B filespec [messagefilespec]*
  - Read : sdt\_xic LPT R filespec [messagefilespec] -*
  - Verify : sdt\_xic LPT V filespec [messagefilespec]*
  - Clear : sdt\_xic LPT C [messagefilespec]*
- If messagefilespec not specified then output to SCREEN  
Legal values for LPT are 1, 2, 3, 4.*

*please wait....*

It will take approximately 40 seconds to complete the transfer of information from PC to MiniRAE Plus. After the information is sent successfully, a message will be displayed:

*==>task completed successfully  
type any key to continue ...*

Type any key, the screen will return to main menu. Disconnect the interface cable, the MiniRAE Plus is now ready for Survey Mode operation.

If there is any problem during the communication, there will be an error message:

*Error 8 ==> Target board not connected to the  
selected LPT*

or

*Error 3 ==> Verification negative*

Check the cable to make sure that the connectors on both end of the cable are securely seated in the sockets. Try to send information again. If after repeated tries, the error messages still persist, call authorized service center for customer support.

**2) Configure for Hygiene Mode:**

To configure the MiniRAE Plus-76 to be in Hygiene Mode, type "2a", "2b" or "2c", depending on the choice of the security level, and followed by [enter] key.

Type 2a : level 0 security ( no change allowed)  
2b : level 1 security ( change allowed,  
need to enter a password )  
2c : level 2 security ( change allowed,  
no need to enter a password )

See section 4.0 for a detailed description of the security level for Hygiene Mode operation. The factory default setup for Hygiene Mode is level 1 security.

Note: when option "2b" is entered, a new screen will be displayed to ask for a password:

*YOUR CURRENT PASSWORD IS: XXXX*

*Please enter a new 4 digit password then press enter key:  
if you type more than 4 digit number, only the first 4 digits will be  
stored as new password*

Type in a four digits password here and followed by [enter] key.

It will take approximately 40 seconds to complete the transfer of information from PC to MiniRAE Plus. After the information is sent successfully, a message will be displayed:

*==>task completed successfully  
type any key to continue ...*

Type any key, the screen will return to main menu. Disconnect the interface cable, the MiniRAE Plus is now ready for Hygiene Mode operation.

**Save calibration and clock data:**

After a new configuration is sent to the MiniRAE Plus, the previously stored measurement data will all be erased and the default alarm limits will be used. However, the calibration data, password, serial number and real time clock information will be preserved in the unit so that users do not need to re-calibrate or re-enter password, serial number and real time clock information.

To erase all data including calibration data, password, serial number and real time clock information, type "hygiene" or "survey" followed by [enter] key from DOS prompt:

**C:\PRORAE> hygiene [enter]**

or

**C:\PRORAE> survey [enter]**

A generic default configuration will be sent to the unit respectively. In this case, users need to re-calibrate and re-enter the password, serial number and real time clock information.

**3) Receive Data from MiniRAE Plus:**

To receive data from MiniRAE Plus, type "3" and followed by [enter] key. The display will show:

*Receiving Data From MiniRAE Plus .....*

*EEPROM - UTILITY for Xicor 24(L)Cxx*

*Calling format :*

*- Burn : sdt\_xic LPT B filespec [messagefilespec]  
 - Read : sdt\_xic LPT R filespec [messagefilespec] -  
 Verify : sdt\_xic LPT V filespec [messagefilespec]  
 - Clear : sdt\_xic LPT C [messagefilespec]  
 If messagefilespec not specified then output to SCREEN  
 Legal values for LPT are 1, 2, 3, 4.*

*please wait...*

It will take approximately 20 seconds to complete the data transfer from MiniRAE Plus to PC. After the data is received successfully, a message will be displayed:

*==>task completed successfully  
 Your need to specify a file to store the data ( e.g. survey.txt) Please enter an output file name:*

Type any file name with up to 8 characters as file name and .TXT as file extension. For example, "survey.TXT" is a valid file name.

Following text window will be displayed:

## SECTION 6 COMPUTER INTERFACE FOR MINIRAE

Receiving Data from MiniRAE.....

| 01/09/03           |           |                          |              |     |   |
|--------------------|-----------|--------------------------|--------------|-----|---|
| Date:              | 13        | Month:                   | 12           |     |   |
| Sampling Interval: | 1 second  |                          |              |     |   |
| Alarm limits:      |           |                          |              |     |   |
| High limits:       | 200.0 ppm |                          |              |     |   |
| Low limits:        | 20.0 ppm  |                          |              |     |   |
| Local              | Time      | Concentration<br>( ppm ) | Alarm Status |     |   |
|                    |           |                          | High         | Low |   |
| 0                  | 09:59     | 29.7                     |              |     | L |
| 1                  | 09:01     | 819.7                    | H            |     | L |
| 2                  | 09:01     | 79.6                     |              |     | L |
| 3                  | 09:01     | 95.9                     |              |     | L |
| 4                  | 09:01     | 330.9                    | H            |     | L |
| 5                  | 09:03     | 31.0                     |              |     | L |
| 6                  | 09:03     | 63.9                     |              |     | L |
| 7                  | 09:04     | 98.4                     |              |     | L |
| 8                  | 09:06     | 98.2                     |              |     | L |
| 9                  | 18:09     | 1999.0                   | H            |     | L |
| 10                 | 18:09     | 37.4                     |              |     | L |
| 11                 | 18:09     | 1999.0                   | H            |     | L |

1.1

This text window shows the data just received from the MiniRAE Plus. Use [up] and [down] arrow keys or [page up] and [page down] key to browse through the data file. Users can not modify the data at this point. Depress [esc] key to exit the text display window and return to the main menu.

### Edit data file:

The data file is saved as a text file in ASCII format under the name that users have specified. Users can invoke any text editor to review or modify the data file. For example, user can type "edit survey.txt " to invoke the text editor come with DOS. Users can also import the data file into a spread sheet or graph program for further data processing and data analysis.

### Print data file:

Users can print the data file directly to a printer using "print" command from DOS prompt:

*C:\PRORAE> print survey.txt [enter]*

Remember to disconnect the MiniRAE Plus unit from the printer port of the PC and connect a parallel printer to it before printing. A simple A-B switch box is recommended to allow users to switch between MiniRAE Plus unit and the printer conveniently.

#### **4) Quit the ProRAE program:**

From the main menu of ProRAE software, type "4" to exit the program and return to DOS prompt.

**Note:** if the ProRAE program is terminated abnormally due to communication errors or file name specification errors, etc., the main menu may not be displayed and the normal DOS prompt may not be shown. Users should always type "4" or type "Ctrl-C" (hold "Ctrl" and "C" keys simultaneously) to quit the program and return to normal DOS prompt.

### 6.12.3 Enter Serial Number

Each MiniRAE Plus Professional PID unit is assigned a unique 6 digits serial number in the factory. This number is shown on the label on the back of the unit. This same number is also stored in the computer memory so that during datalogging operation, the serial number is printed on the data report.

The unique serial number is loaded into the non-volatile memory of each unit in the factory. It will not be erased even if the battery is removed. A DOS program is provided to allow user to re-enter the serial number into the unit if for some reasons that the serial number is altered or erased.

Note : in some older units, the serial number is not entered into the computer memory at the factory. User need to enter the serial number.

Here is the procedure to enter the serial number :

**Step 1: connect MiniRAE Plus**

Connect the MiniRAE Plus Professional PID unit to the parallel port of the PC, as described in section 6.2.

**Step 2: start serial number program:**

Type "ser" followed by [enter] key to start the program:

*C:\PRORAE> ser [enter]*

Users should see following main menu:

```

*****
*  Rae System PGM-76 PID Serial Number Setup Program  *
*                                                         *
*                                                         *
*                                                         *
*****
UNIT SERIAL NUMBER IS :      XXXXXX
IS THIS SERIAL NUMBER CORRECT? (Y/N)
    
```

**Step 3: enter serial number:**

Type "Y" to quit the program if the number matches the number printed on the back label of the unit. Type "N" if the number is incorrect. The display will ask for a correct serial number.

```

PLEASE ENTER 6 DIGITS SERIAL NUMBER      XXXXXX
    
```

After the new serial number is accepted and sent to the unit, the display will show:

SECTION 6 COMPUTER INTERFACE FOR MINIRAE

---

*SET UNIT SERIAL NUMBER == XXXXXX*

*VERIFICATION SUCCESSFUL*

The program will terminate automatically.

## 7.0 THEORY OF OPERATION

MiniRAE Plus Professional PID unit uses a newly developed Electrodeless discharge UV lamp as the high energy photon source for the PID instrument. A special high efficiency lamp driver is developed to turn on the UV lamp (see Figure 7.1).

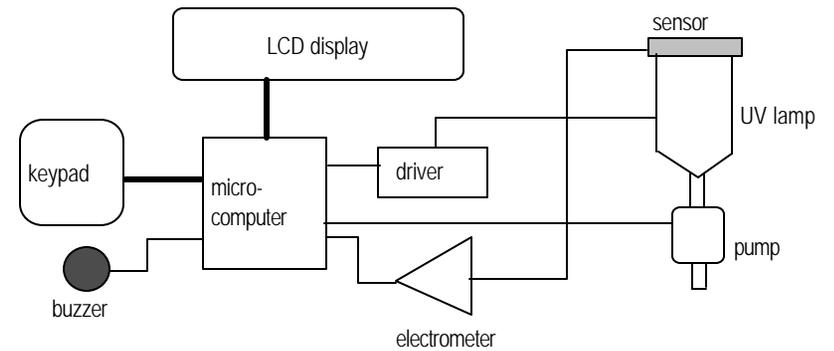


Figure 7.1 Block Diagram of MiniRAE Plus Professional PID Unit

## SECTION 7 THEORY OF OPERATION

---

A sampling pump continuously draws air sample into the ionization chamber. The ionization chamber for the MiniRAE Plus Professional PID unit is constructed as a small cavity in front of the UV lamp. The electrode is made of wired mesh so that the high energy UV light can shine through the mesh and excite the gas molecules when they across the face of the UV window. The ions collected on the electrode are measured by an electrometer.

A single chip microcomputer is used to control the operation of the lamp, alarm buzzer, LED, sampling pump, power supply and the electrometer. It measures the electrometer readings and calculates the gas concentrations based on calibration to a known reference gas. A 7-digit LCD display is used to show the readings. The user interacts with the unit through 5 keys on the front panel.

The unit is powered by a rechargeable lead acid batteries. A built-in charging circuit allows the batteries to be charged directly from a 12 VDC source.

## 8.0 MAINTENANCE

As shown in Figure 8.1, the major items of MiniRAE Plus Professional PID Unit that require periodic maintenance are:

- Battery
- Probe Assembly
- Sensor module
- Lamp
- Sampling Pump

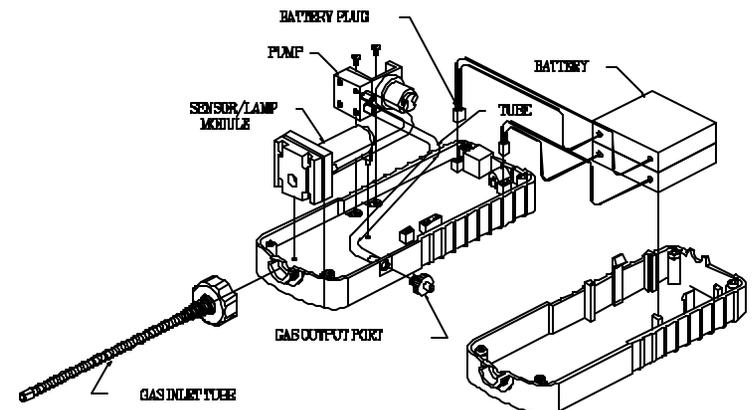


Figure 8.1 Main components of MiniRAE Plus Professional PID

## 8.1 Battery Charging and Replacement

When the display flashes "bAt" message, the battery requires recharging. The battery may be replaced in the field if required. It is recommended to recharge the MiniRAE Plus Professional PID unit upon returning from field work. A fully charged battery powers MiniRAE Plus Professional PID unit for 10 hours continuous operation. The charging time is less than 10 hours for a fully discharged battery. The charging circuit uses a two-step constant voltage charging method to prevent over-charging.

**WARNING:**

**TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, RECHARGE BATTERY ONLY IN AREA KNOWN TO BE NON HAZARDOUS. REMOVE AND REPLACE BATTERY ONLY IN AREA KNOWN TO BE NON HAZARDOUS.**

### **Recharging Professional PID Unit**

1. Turn off power of the Professional PID unit.
2. Open the rubber cover on the bottom side of the PID unit and connect the AC adapter (or the automotive DC charging adapter, depending on the power source) to the power jack.
3. There is a bi-colored LED inside the LED window which will provide an indication of the charging status:  
Red -battery is being charged  
Green -charging is completed  
No Light - bad connection or defective battery
4. Make sure that the indicator LED turns red to indicate that the unit has made good contact and is being charged. After the LED turns green, the unit is fully charged.

### **Replacing Battery**

1. Turn off power of the MiniRAE Plus Professional PID unit.
2. Refer to Figure 8.1, unscrew the probe assembly, remove four screws that hold the back cover of the unit to gain access to the battery compartment.
3. There are two batteries inside the unit. Unplug one battery from the battery jack on the top cover of the unit. Plug a fully charged battery into the jack. After the first battery is

replaced, replace the second battery. **Note:** there is a real time clock inside the unit. If both batteries are disconnected from the unit at the same time, the real time clock will be disabled. Users have to re-program the real time clock after the batteries are installed (see section 4.9 and 4.10 on how to program real time clock ).

- 4 Ensure the battery plug is securely connected to the MiniRAE Plus Professional PID unit.
- 5 Close the MiniRAE Plus Professional PID unit covers and tighten screws.
6. There is an optional battery charger accessory for the MiniRAE Plus Professional PID Unit. This charger will allow users to charge a spare battery outside the unit. Plug the battery to the jack on the back of the charger to charge the spare battery.

## 8.2 Filter Replacement

During the course of normal operation, dust and residual gas vapor may build up on the membrane filter. The build up rate depends on the working environment and the concentration of the the vapors being sampled. As a guide, it is recommended to replace the membrane filter once a week or when the filter is dirty upon visual inspection.

1. Turn off power of the MiniRAE Plus Professional PID Unit. Remove the probe assembly.
2. Use a tweezers to remove and replace the small O-ring and the membrane filter from the round hole on the front of the sensor block. Make sure that the O-ring is seated correctly. Otherwise, the sampling probe will not be air tight.
3. Attach the probe assembly. Check for air leakage. (see section 8.4 )

### 8.3 Sensor Module Cleaning

During the course of normal operation, a film of gas vapor may build up inside the sensor module. The rate at which the film develops depends on the type and concentration of the vapors being sampled. As a guide, it is recommended to clean the sensor module upon returning from field work.

The sensor module is made of four major components, as shown in Figure 8.2:

- Moisture filter and O-ring
- Sensor block
- Lamp house
- Lamp and O-ring

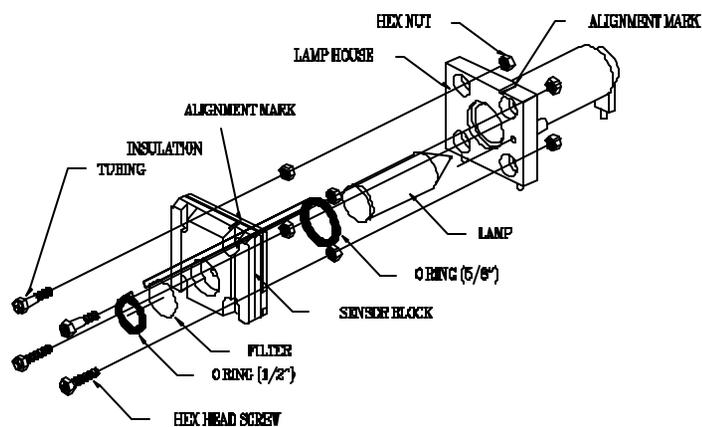


Figure 8.2 Disassembly and Assembly of Sensor Module of Professional PID Unit

### Sensor Module Cleaning Procedure

1. Turn off power of the MiniRAE Plus Professional PID Unit.
2. Refer to Figure 8.1, unscrew the probe assembly, remove four screws and open the MiniRAE Plus Professional PID Unit. Remove the sensor module by gently pulling the module away from the PCB of the top cover.
3. Refer to Figure 8.2, and carefully remove 4 hex nuts from the back of the lamp house. Remove the lamp and O-ring. Also remove the membrane filter and small O-ring which are held together inside the round hole on the front cover.

**Note:** the sensor block is hold together by another 4 hex nuts at the back of the sensor block. It is not recommended to remove these 4 inner hex nuts and completely disassemble the sensor block for cleaning. Simply loosen these 4 inner hex nuts for cleaning. This way all the individual pieces of the sensor block can be cleaned easily without the hassle of disassembling and assembling the entire sensor block.

4. Clean the sensor block using GC grade methanol, followed by water to rinse the sensor block thoroughly. It is highly recommended that a ultrasound bath to be used to clean the sensor block for at least 3 minutes.
5. Make sure the sensor block is fully dried before it is reassembled. A damp sensor block will cause excessive

leakage and sensor failure. It is recommended to blow dry the sensor block or bake it at 75° C for 5 to 10 minutes to ensure it is fully dried.

6. Replace the membrane filter and small O-ring into the front hole of the sensor block.
7. Refer to Figure 8.2, insert the lamp into the large O-ring first. Then push the lamp and O-ring into the lamp house, attach the cleaned sensor block to the lamp house by 4 hex nuts. Make sure that the 4 inner hex nuts are tight before putting on the 4 outer hex nuts. Note: tighten these nuts by hand using a nut driver while using a screw driver on the front to hold the screw in place. Do not over tighten these hex nuts because the soft Teflon parts can be damaged easily.

Make sure that the coaxial cable (tan color) with a lug is attached to the lower right screw (opposite to the screw with yellow cable attached) before putting on the nut.

**Note:** it is easy to put the sensor block upside down. Make sure that the sensor block with a slanted edge and an alignment mark is line up with lamp housing having a similar alignment mark on the edge. If the sensor block is installed upside down, the round hole on the front of the sensor block will not line up with the opening on the front of the unit housing.

8. Referring to Fig. 8.1, insert the sensor module into the three holes on the PCB. Make sure that the two Tygon tubes are

free of any "kink" and are not caught under the sensor module.

9. Close the MiniRAE Plus Professional PID Unit covers and replace probe assembly.

## 8.4 Probe Assembly Cleaning

During the course of normal operation, significant amount of dust and particles can be drawn into the sensor module. A dust filter (steel wool ) is inserted into the cavity at the base of the probe assembly to remove these dust and particles.

The rate at which the dust and particles accumulate depends on the working environment. As a guide, it is recommended to replace this dust filter once a week.

1. Turn off power to the MiniRAE Plus Professional PID Unit.
2. Remove the probe assembly. Use a small tweezers to remove the steel wool inside the cavity. Insert a new one into the cavity. Make sure that it stays snugly fit inside the cavity.
3. Replace the probe assembly.
4. Turn on the MiniRAE Plus Unit. Wait for the pump to come on. Check to see if air is drawn into the gas inlet probe. If the probe is air tight, when the gas inlet is blocked by a finger, the pump noise should change and a strong suction force will be felt.

## 8.5 Lamp Cleaning and Replacement

If the lamp does not turn on or there is excessive film build-up on the lamp window, the unit will display a message of "Err xxx.x" to indicate that a cleaning or replacement of the lamp may be required. Periodic cleaning of the lamp window will also remove film deposits and restore lamp sensitivity. **Care must be exercised when cleaning the window so that window surface is not damaged.**

1. Turn off power of MiniRAE Plus Professional PID Unit.
2. Refer to Figure 8.1, unscrew the probe assembly, remove four screws and open the PID covers. Remove the sensor module from the PCB. Disassemble the sensor block from the lamp house as described in section 8.2.
3. Gently pull out the lamp, avoiding contact with the flat window surface.
4. Clean or replace a new lamp, avoiding contact with the flat window surface.
5. Assemble the sensor block and the lamp house. Put back the sensor module. Close the PID covers and replace screws. Replace probe assembly.

### **Lamp Window Cleaning Procedure:**

For lamps with 10.6 eV or 11.7 eV windows, clean the window surface with anhydrous methanol using a cotton swab. Rub in a circular motion at moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Rinse thoroughly with anhydrous methanol to remove any residues on the window.

**Never touch the window surface with fingers or anything which may leave a film.**

**(CAUTION: WATER WILL DEGRADE BOTH 10.6 OR 11.7 EV WINDOW SURFACES. DO NOT USE WATER TO CLEAN THE LAMP WINDOW AT ANY TIME)**

## 8.6 Pump Replacement

The sampling pump is rated for 4000-5000 hours of continuous operation. It will consume higher amount of energy and reduce its sample draw capability significantly when approaching the end of the specified life time of the pump. As a guide, it is recommended to replace the pump at six month intervals, if the instrument is heavily utilized during the period.

1. Turn off power of the MiniRAE Plus Professional PID Unit.
2. Refer to Figure 8.1, unscrew the probe assembly, remove four screws and open the Professional PID Unit.
3. Refer to Figure 8.1, and carefully remove two screws that hold the pump to the top cover. Disconnect two Tygon tubes connected to the pump. Note which tube goes to the inlet barb and which goes to the outlet barb of the pump. Disconnect the electrical wire from the pump to PCB. Remove the pump.
4. Replace a new pump. Connect the electric wire. Connect two Tygon tubes to the pump and tighten the pump to the top cover with two screws. Make sure that the two Tygon tubes are free of any "kink" and are not caught under the sensor module.
5. Close the MiniRAE Plus Professional PID Unit covers and replace screws.

6. Replace the probe assembly.
7. Turn on the MiniRAE Plus Unit. Wait for the pump to come on. Check to see if air is drawn into the gas inlet tube. If the pump works correctly, when the gas inlet is blocked by a finger, the pump noise should change and a strong suction force will be felt.

---

## 9.0 TROUBLESHOOTING

Table 9.1

| Problem  | Possible Reasons & Solutions  |
|--|---|
| Can not turn on power after charging the battery | <b>Reasons:</b> Bad battery connection<br>Discharged battery<br>Defective battery<br>Microprocessor hang-up<br>Battery switch is off<br><b>Solutions:</b> Check battery connection<br>Charge or replace battery<br>Reset microprocessor by turning off and then on battery switch |
| no LED or LCD back light                         | <b>Reasons:</b> Defective LED or LCD back light<br><b>Solutions:</b> Call authorized service center   |
| Buzzer inoperative                               | <b>Reasons:</b> Bad buzzer<br><b>Solutions:</b> Call authorized service center  |

SECTION 9 TROUBLESHOOTING

| Problem                              | Possible Reasons & Solutions   |
|--------------------------------------|--|
| Reading abnormally high              | <p><b>Reasons:</b> Dirty or wet sensor<br/>           Dirty probe assembly<br/>           Dirty membrane filter</p> <p><b>Solutions:</b> Clean sensor module<br/>           Clean probe assembly<br/>           Replace membrane filter<br/>           Use water trap disk</p> |
| Reading abnormally low               | <p><b>Reasons:</b> Lamp dirty or weak</p> <p><b>Solutions:</b> Clean or replace lamp<br/>           (see section 8.4)</p>  |
| "Err xxx.x" message during operation | <p><b>Reasons:</b> Dirty sensor<br/>           Weak or defective lamp</p> <p><b>Solutions:</b> Clean sensor<br/>           Replace lamp, filter</p>  |
| Read a small background value        | <p><b>Reasons:</b> There is actually a background gas level<br/>           Instrument zero drift</p> <p><b>Solutions:</b> Do zero gas calibration<br/>           (see section 4.7.1)</p>   |

SECTION 9 TROUBLESHOOTING

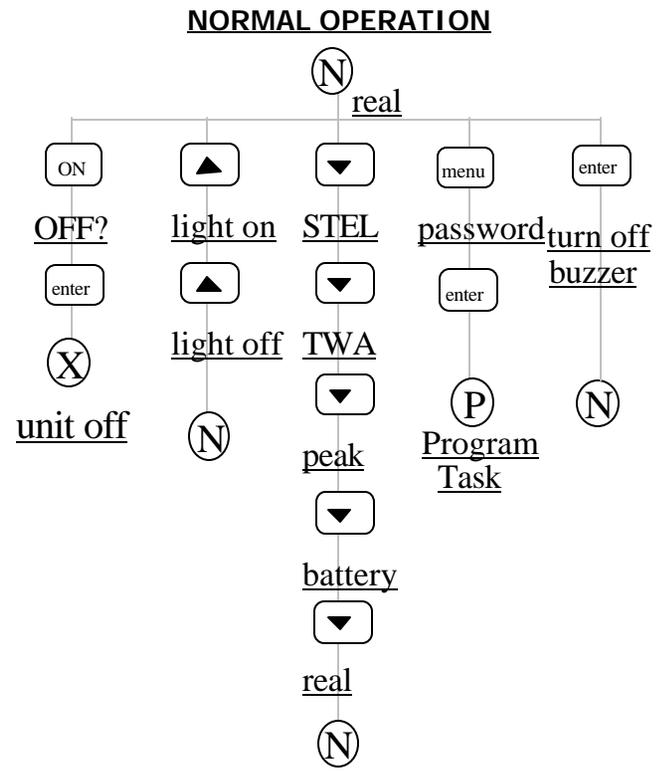
| Problem                       | Possible Reasons & Solutions   |
|-------------------------------|--|
| Reading jump around randomly  | <p><b>Reasons:</b> Incorrect gas calibration<br/>Low sensitivity to cal gas</p> <p><b>Solutions:</b> Re-calibrate<br/>Use different cal gas</p>                          |
| Slow response to gas input    | <p><b>Reasons:</b> Leakage in probe assembly or sensor module</p> <p><b>Solutions:</b> Tighten the probe assembly and sensor module</p>                                  |
| No air draw at gas inlet tube | <p><b>Reasons:</b> Defective pump or leakage in probe assembly and sensor module</p> <p><b>Solutions:</b> Replace pump, tighten the probe assembly and sensor module</p> |
| "Lo bAt" message at power on  | <p><b>Reasons:</b> Discharged battery</p> <p><b>Solutions:</b> Recharge battery</p>  |

SECTION 9 TROUBLESHOOTING

| Problem  | Possible Reasons & Solutions  |
|--|---|
| Can not turn off unit or corrupted characters in LCD display | <p><b>Reasons:</b> Microprocessor hang-up</p> <p><b>Solutions:</b> Turn off then turn on battery switch<br/>Reload software from PC</p>                               |
| Full scale measurement in humid environment                  | <p><b>Reasons:</b> Dirty or wet sensor</p> <p><b>Solutions:</b> Clean and dry sensor<br/>Use water trap disk to block out moisture</p>                                |
| Measurement max out at certain level                         | <p><b>Reasons:</b> Dirty lamp/ sensor module<br/>Weak lamp</p> <p><b>Solutions:</b> Clean lamp/ sensor module<br/>Replace new lamp</p>                                |
| Calibration error message                                    | <p><b>Reasons:</b> No standard gas input<br/>Low sensitivity to cal gas</p> <p><b>Solutions:</b> Make sure standard gas flows into inlet probe<br/>Change cal gas</p> |

## APPENDIX A.

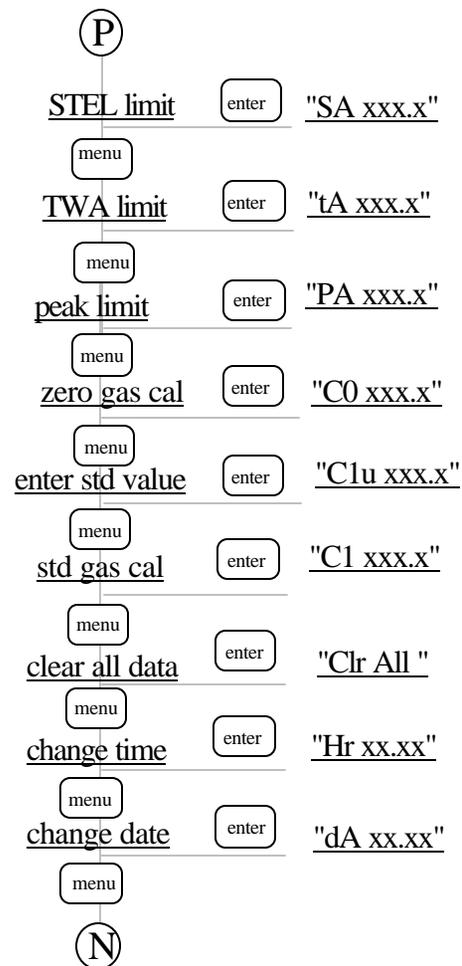
# FLOW CHART OF HYGIENE MODE OPERATION



## APPENDIX A.

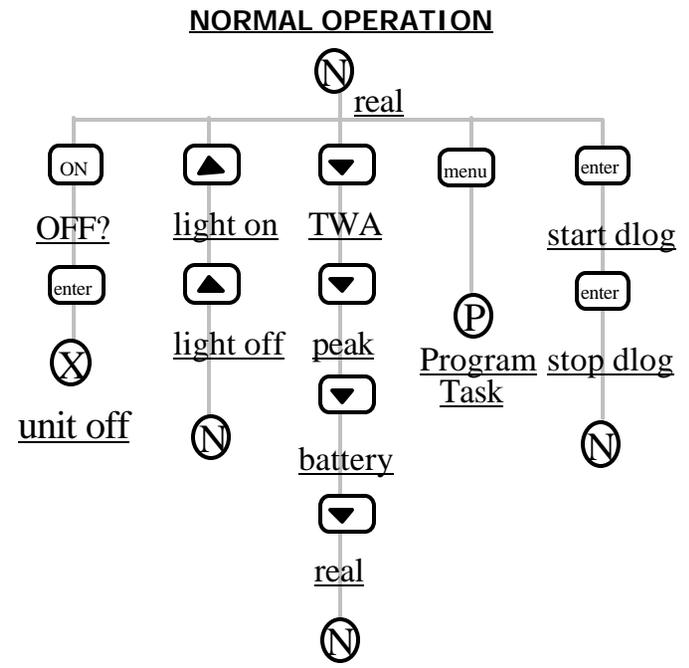
### FLOW CHART OF HYGIENE MODE OPERATION

#### PROGRAMMING TASK



## APPENDIX B.

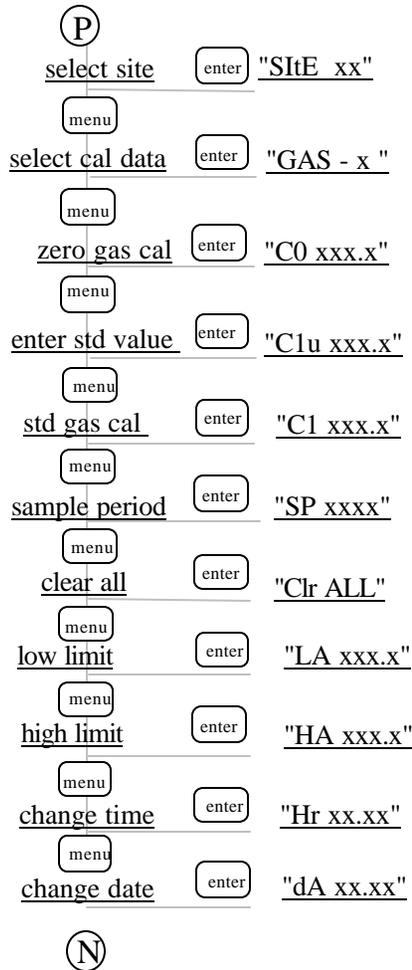
## FLOW CHART OF SURVEY MODE OPERATION



## APPENDIX B.

# FLOW CHART OF SURVEY MODE OPERATION

### PROGRAMMING TASK



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**APPENDIX C.****RESPONSE INFORMATION**

Calibration factors for a number of commonly used organic vapor for 10.6 eV lamp is included in Table C.1

Table C.1

**Correction Factors for the 10.6 eV lamp:**

| <b>Compound</b>  | <b>Correction Factor</b> |
|------------------|--------------------------|
| Acetaldehyde     | <b>5.5</b>               |
| Acetone          | <b>1.1</b>               |
| Allyl alcohol    | <b>2.4</b>               |
| Benzene          | <b>0.53</b>              |
| Butadiene        | <b>1.0</b>               |
| Butyl acetate    | <b>2.6</b>               |
| Carbon disulfide | <b>1.2</b>               |
| Cyclohexane      | <b>1.4</b>               |
| Cyclohexanone    | <b>1.0</b>               |
| Cyclohexene      | <b>0.90</b>              |
| Diethyl amine    | <b>0.97</b>              |
| Diethyl sulfide  | <b>0.51</b>              |
| Ethyl acetate    | <b>4.6</b>               |
| Ethyl alcohol    | <b>12</b>                |
| Ethyl benzene    | <b>0.52</b>              |
| Ethyl ether      | <b>1.1</b>               |
| Ethylene         | <b>9.9</b>               |
| Heptane (n-)     | <b>2.6</b>               |
| Hexane           | <b>4.2</b>               |

**APPENDIX C. RESPONSE INFORMATION**

|                        |             |
|------------------------|-------------|
| Hydrogen sulfide       | <b>4.1</b>  |
| Isopropyl alcohol      | <b>6.0</b>  |
| Methyl ethyl ketone    | <b>0.86</b> |
| Methyl isobutyl ketone | <b>1.2</b>  |
| Methyl methacrylate    | <b>1.4</b>  |
| Octane (n-)            | <b>1.8</b>  |
| Perchloroethylene      | <b>0.58</b> |
| Pinene (a-)            | <b>0.31</b> |
| Pinene (b-)            | <b>0.37</b> |
| Propylene              | <b>1.7</b>  |
| Styrene                | <b>0.42</b> |
| Tetrahydrofuran        | <b>1.8</b>  |
| Toluene                | <b>0.50</b> |
| Trichloroethylene      | <b>0.52</b> |
| Vinyl chloride         | <b>2.14</b> |
| Xylene (m-)            | <b>0.43</b> |
| Xylene (o-)            | <b>0.59</b> |
| Xylene (p-)            | <b>0.45</b> |

The calibration factors in Table C.1 are measured relative to 100 ppm Isobutylene gas at 50% relative humidity and 25°C. These factors may change at higher concentration level or different temperature and humidity conditions.

## APPENDIX D.

### QUICK REFERENCE GUIDE

#### HYGIENE MODE

| Key           | Display   | Meaning                    |
|---------------|-----------|----------------------------|
| ON            | HG - x.xx | power on and version #     |
|               | dIAg ..   | diagnostic in progress     |
|               | 0.0       | real time reading (ppm)    |
| <b>Ñ</b>      | v 0.0     | STEL reading (ppm)         |
| <b>Ñ</b>      | v 0.0     | TWA reading (ppm)          |
| <b>Ñ</b>      | 0.0v      | Peak reading (ppm)         |
| <b>Ñ</b>      | bAt 6.0   | battery voltage (V)        |
| <b>D</b>      |           | on / off backlight         |
| ENTER         |           | mute buzzer for 1 minute   |
| MENU + ON     | CLr ...   | power on and clear data    |
| <b>D</b> + ON | HG - x.xx | power on with diagnostic s |
| ON            | OFF 0.0   | turn off power ? (Y or N)  |
| →ENTER        |           | confirm power off          |

|                  |           |                            |
|------------------|-----------|----------------------------|
| MENU             | Pd-000.0  | verify password            |
| →ENTER (4 times) |           | enter 4 digit password     |
| MENU             | SA 025.0  | Set STEL limit (ppm)       |
| MENU             | tA 010.0  | Set TWA limit (ppm)        |
| MENU             | PA 050.0  | Set Peak limit (ppm)       |
| MENU             | C0 0.0    | Zero gas reading (ppm)     |
| →ENTER           |           | reset reading to zero      |
| MENU             | C1u 100.0 | Enter standard gas value   |
| →ENTER (4 times) |           | enter 4 digit ( 0 - 999.9) |
| →ENTER           | GAS On    | turn on gas bottle         |
| →ENTER           | CAL...    | calibration in progress    |
| →ENTER           | C1 100.0  | standard gas reading       |
| →ENTER           |           | reset reading to std value |
| MENU             | CLr ALL   | Clear all data ? (Y or N)  |
| MENU             | Hr 00.00  | Set hour and minute        |
| MENU             | dA 01.01  | Set month and date         |

#### General Message

|         |                        |
|---------|------------------------|
| Err 0.0 | sensor or lamp failure |
| Lo bAt  | low battery voltage    |
| CLr ... | clear data in progress |
| C1 Err  | calibration error      |

## SURVEY MODE

| Key           | Display   | Meaning                                 |
|---------------|-----------|---|
| ON            | Su - x.xx | power on and version #                  |
|               | dIAg ..   | diagnostic in progress                  |
|               | 00 0.0    | site # (00) and real time reading (ppm) |
| $\bar{N}$     | v 0.0     | TWA reading (ppm)                       |
| $\bar{N}$     | 0.0v      | Peak reading (ppm)                      |
| $\bar{N}$     | bAt 6.0   | battery voltage (V)                     |
| <b>D</b>      |           | on / off backlight                      |
| ENTER         | 00d 0.0   | start / stop datalog                    |
| <b>D</b> + ON | Su - x.xx | power on with diagnostics               |
| ON            | OFF 0.0   | turn off power ? (Y or N)               |
| →ENTER        |           | confirm power off                       |

|                  |           |                               |
|------------------|-----------|-------------------------------|
| MENU             | Site 00   | enter site number (0-49)      |
| MENU             | GAS -1    | select gas cal data ( 1 or 2) |
| MENU             | C0 0.0    | Zero gas reading (ppm)        |
| →ENTER           |           | reset reading to zero         |
| MENU             | C1u 100.0 | Enter standard gas value      |
| →ENTER (4 times) |           | enter 4 digit ( 0 - 999.9)    |
|                  | GAS On    | turn on gas bottle            |
| →ENTER           | CAL...    | calibration in progress       |
|                  | C1 100.0  | standard gas reading          |
| →ENTER           |           | reset reading to std value    |
| MENU             | SP 0001   | enter sample period (sec)     |
| MENU             | Clr ALL   | Clear all data ? (Y or N)     |
| MENU             | LA 010.0  | Set low alarm limit (ppm)     |
| MENU             | HA 100.0  | Set high alarm limit (ppm)    |
| MENU             | Hr 00.00  | Set hour and minute           |
| MENU             | dA 01.01  | Set month and date            |

| Key       | Function in Programming Mode                   |
|-----------|--|
| ON        | - does not function in programming mode        |
| <b>D</b>  | - increment numerical value for data entry     |
| $\bar{N}$ | - decrement numerical value for data entry     |
| ENTER     | - confirm menu selection or accept data entry  |
| MENU      | - exit current menu selection, go to next menu |