

# UltraRAE

## COMPOUND SPECIFIC PID MONITOR PGM-7200

### OPERATION AND MAINTENANCE MANUAL

(Document No.: 012-4001)

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# **ATTENTION!**

## **For European Applications**

- A. CE 0575  II 1G  
DEMKO 03 ATEX 0204759X  
Eex ia IIC T4**
- B. Recharge batteries only in non-hazardous locations.**
- C. Do not connect external cable to serial interface jack in hazardous locations.**
- D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non-hazardous area.**

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 **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 monitor cover. Disconnect the battery before removing sensor module for service. Never operate the monitor while the cover is removed. Remove monitor cover and sensor module only in an area known to be non-hazardous.**

**CAUTION!!**

**The model PGM-7200 equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.**

# Special Notes

-1-

When the UltraRAE Monitor is taken out from the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the monitor. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

-2-

The battery of the UltraRAE monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.

-3-

The instrument default condition for the tube barcode reader is to be “OFF”. In this condition, once a tube is selected, the instrument assumes that the same type of tube will be used until a different tube type is programmed.



**CAUTION**



If the incorrect tube type is programmed or the Measure Wait Time is otherwise set too short, it is possible to underestimate the VOC concentration and thereby cause overexposure. The automatic barcode reader can be enabled in the program mode (see Section 4).

**WARNING:**

Use only RAE Systems battery packs, part nos. 012-3050, 012-3051 or 012-3052. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

**AVERTISSEMENT:**

Utiliser seulement l'ensemble de batterie RAE Systems, la référence 012-3050, 012-3051 au 012-3052. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans emplacements désignés non dangereuse.

**STATIC HAZARD:**

Clean only with damp cloth

**DANGER RISQUE D'ORIGINE  
ELECTROSTATIQUE:**

Nettoyer uniquement avec un chiffon humide.

**CAUTION:**

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.



**ATTENTION:**

**Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.**

**WARNING:**

**The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is used or put into service.**

**For maximum safety, the accuracy of the UltraRAE should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.**

**AVERTISSEMENT:**

**La calibration de toute instruments de RAE Systems doivent être testé en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l'instrument pour la première fois.**

**Pour une securite maximale, la sensibilité du UltraRAE doit être verifier en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.**

## 1. GENERAL INFORMATION

The UltraRAE is a hand-held, programmable Compound Specific PID monitor designed to provide instantaneous exposure monitoring of a specific organic gas for workers in hazardous environments. It monitors a specific gas by utilizing a gas separation tube and the Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. It also can be used to measure total Volatile Organic Compound (VOC) by utilizing a straight through tube and the PID as a broad band monitor.



Figure 1-1 UltraRAE

## GENERAL INFORMATION

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Features are:

- **Lightweight and Compact**
  - 20 oz (567 g), Cellular phone size
- **Dependable and Accurate**
  - 10 hours monitoring with micro controller
- **User Friendly**
  - menu driven, intuitive end-use operation
- **Programmable Alarm Thresholds**
  - audio buzzer & flashing display alarm

**UltraRAE** (PGM-7200) consists of: a Compound Specific PID monitor, gas separation tubes, a battery charger, leather case, alkaline battery adapter, water and dust filter plus calibration accessories.

## 1.1 General Specifications

Table 1.1			
<b>Compound Specific PID monitor Specification</b>			
<b>Size:</b>	9.25"L x 3.0"W x 2.0"H		
<b>Weight:</b>	21 oz (567 g) with battery pack		
<b>Detector:</b>	photo-ionization sensor with 9.8 eV UV lamp, optional 10.6 or 11.7 eV UV lamps		
<b>Battery:</b>	rechargeable NiMH, NiCd, or Alkaline battery pack (snap in, field replaceable)		
<b>Battery charging:</b>	10 hours charge through built-in charger or an external battery charger		
<b>Operating Hours:</b>	10 hours continuous		
<b>Display:</b>	1 line by 8 characters, 5x7 dot matrix LCD (0.4" character height)		
<b>LED Backlight:</b>	automatic activation in dim light or alarm condition		
<b>Total VOC Range, Resolution &amp; Response time (t90):</b>			
Calibrated to 100 ppm isobutylene:			
	0-99 ppm	0.1 ppm	5 sec
	100-2000 ppm	1.0 ppm	5 sec
<b>Specific Range, Resolution &amp; Measurement time :</b>			
<u>Measurement Gas</u>			
Benzene	0.1-200 ppm	0.1 ppm	60 sec
1,3-Butadiene	0.1-200 ppm	0.1 ppm	75 sec
Methylene Chloride	0.2-200 ppm	0.2 ppm	30 sec
<b>PID Detector:</b>	easy access to lamp and sensor for cleaning and replacement		
<b>Filter:</b>	porous metal, for dust and particle filtering, field replaceable		
<b>Inlet probe:</b>	Teflon® tube with ferrule fitting.		
<b>Keypad:</b>	1 operation key and 2 program keys		
<b>Analog output:</b>	0 to 2.5 volt linear output		

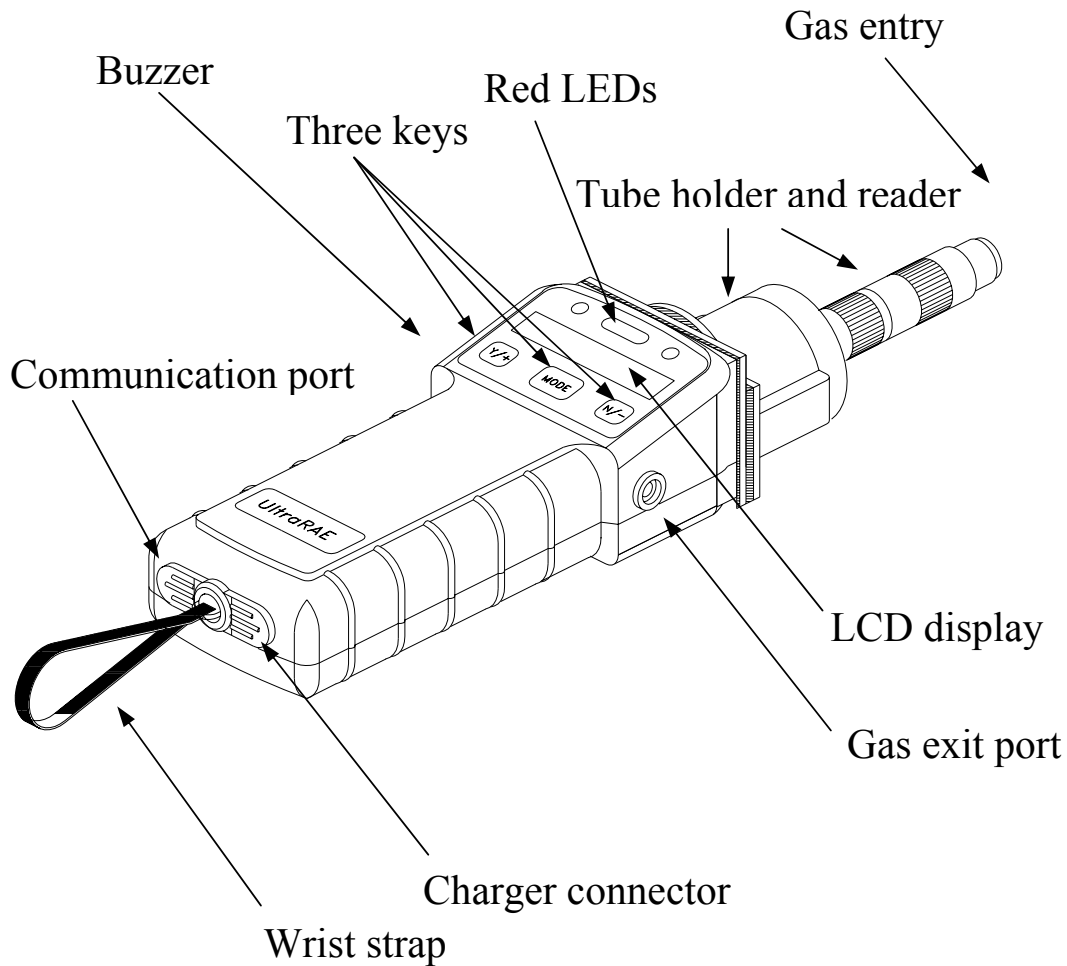
## GENERAL INFORMATION

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<b>Intrinsic Safety:</b>	UL & cUL Class 1, Division I, Groups A, B, C, D (US & Canada) CE 0575 II 1G DEMKO 03 ATEX 0204759X Eex ia IIC T4 (Europe)
<b>EM Interference:</b>	no effect when exposed to 0.43 mW/cm <sup>2</sup> RFI (5 watt transmitter at 12 inches)
<b>Alarm Setting:</b>	preset alarm limits for two action levels
<b>Audible Alarm:</b>	90 dB buzzer @ 10 cm
<b>Visual Alarm:</b>	flashing red LED
<b>External Alarm:</b>	optional plug in pen size vibration alarm or remote alarm
<b>Real-time Clock:</b>	automatic date and time stamps data logged information
<b>Data logging:</b>	4000 data points, includes serial number, user ID and site ID, date and time
<b>Communication:</b>	down load data to PC and upload instrument setup from PC through RS-232 link to serial port on PC
<b>Calibration:</b>	two-point field calibration of zero and standard reference gas for compound specific vapor
<b>Sampling Pump:</b>	internal integrated flow rate, 400 cc per minute minimum (VOC tube), low flow alarm
<b>Temperature:</b>	-20° to 45°C (-4° to 113°F)
<b>Humidity:</b>	0 % to 95 % relative humidity (Non-condensing)
<b>Housing:</b>	ABS + PC, conductive coating, splash and dust proof, will withstand 10' drop test
<b>Attachment:</b>	wrist strap

## 2. OPERATION OF ULTRARAE

The UltraRAE PID Monitor gives the real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the UltraRAE is preset with default alarm limits and the sensors are pre-calibrated with standard calibration gas. However, the user should calibrate the instrument before the first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.



**2.1 Figure 2-1 UltraRAE Features**

## 2.1 Physical Description

The main components of the UltraRAE Compound Specific PID monitor include:

- Three keys for user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor
- LCD display for direct readout and calculated measurements. The display is a one-line, eight-digit, alphanumeric, 5x7 dot matrix type and has a back light for readings under low light conditions
- Buzzer and red LED for alarm signal whenever the exposures exceed preset limits
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports with 5-in. Teflon inlet probe
- RAE-SEP tube holder and electronic tube type reader
- Serial communication port for PC interface

## 2.2 Keys and Display

Figure 2-2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:

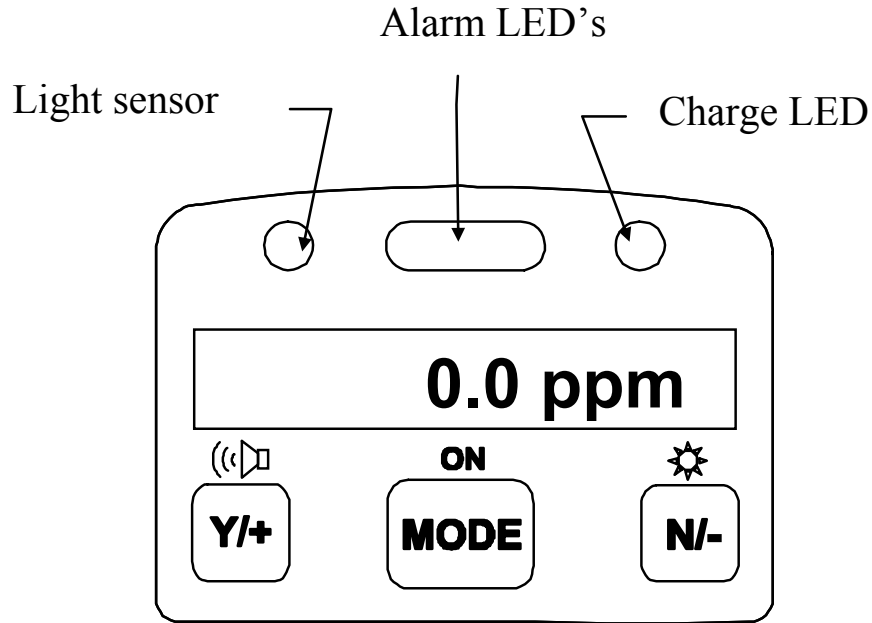


Figure 2-2. UltraRAE Key Pad & Display

Key	Function in Normal Operation
<b>[MODE]</b>	-Turn on/off the power* and step through menu
<b>[N/-]</b>	-Toggle on/off the back light, negative acknowledgement /decrement value
<b>[Y/+]</b>	-Start measurement, positive acknowledgement /increment value

- \* Pressing and holding the **[MODE]** key for 5 seconds turns off the power to the monitor. Press the **[MODE]** key momentarily to step through menu items. To save time, press any key during message scrolling to skip to the end of the message.



## 2.3 Power On/Off

**To turn on** the UltraRAE Compound Specific PID monitor, press **[MODE]** key for one second and release. The audio buzzer will beep once and the display will show “ON!..” and then “Ver #.##” to indicate the unit’s current firmware version number. The model number, current date and time, unit internal temperature, last calibration date and time, battery voltage, and shut off voltage are displayed.

**To turn off** the UltraRAE Compound Specific PID monitor, press and hold the **[MODE]** key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message “Off!..” flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

### **Data protection during power off**

When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. During power off period, the real time clock will continue to operate until the battery is completely drained (usually in 5-7 days without any charging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the PC clock during configuration.

## 2.4 Operation

After the monitor is turned on and cycles through the start up menu, the message “**Ready..**” will be displayed even if no tube is presently inserted.

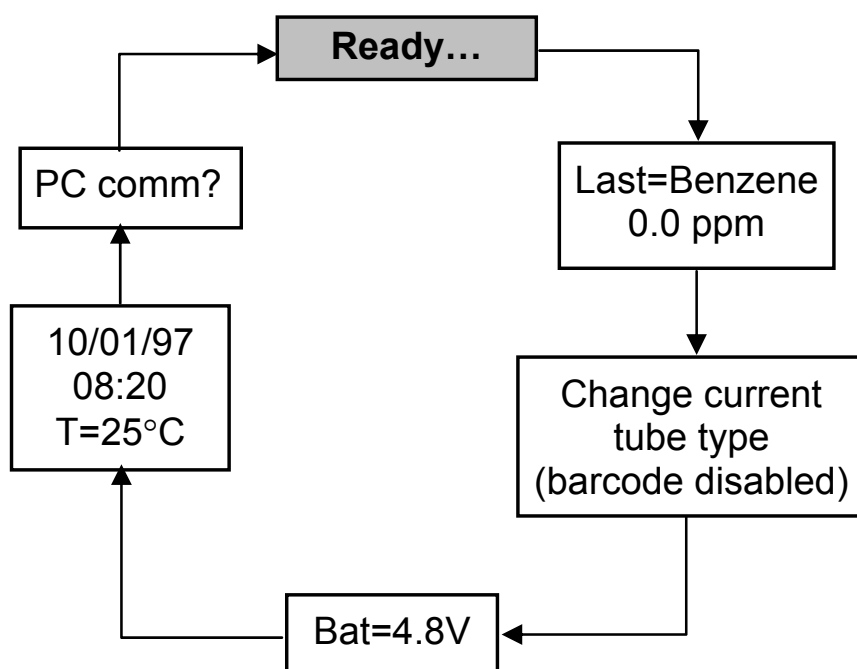
At this point, the user has two options: 1) step through the idle operation menu, or 2) take a measurement.

### 2.4.1 Idle Operation

Press the [MODE] key to cycle through the idle operation menu. The PID sensor and pump are turned off during this idle operation. Idle operation menu displays include:

- **Ready...**
- **Last tube name and reading**
- **Tube type selection (when barcode reader is turned off)**
- **Battery voltage**
- **Date, time and temperature**
- **PC communication**

The displays are arranged in a “round robin” order:



To choose a specific display, press the **[MODE]** key one or more times until the desired display appears.

**Note:** To get back to “Ready” mode from any of the above display, press the **[MODE]** key repeatedly until the “Ready” message appears.

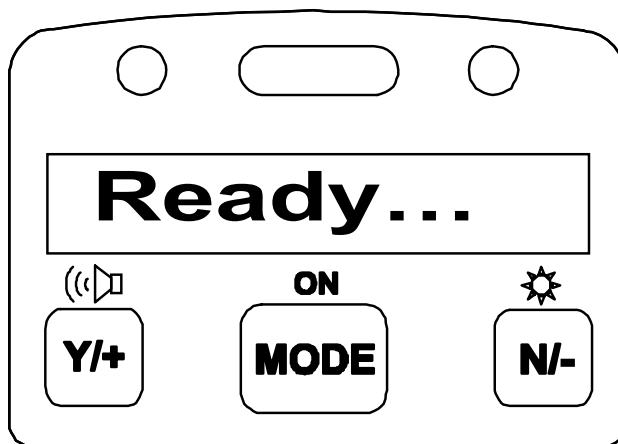


Figure 2-3 The UltraRAE is Ready

**READY:** The monitor is ready for a measurement to be taken. Press the **[MODE]** key to advance to the next menu. If a tube is inserted at this point, the “Tube in!” message is displayed, followed by the alternate display of the gas name and “Start?” The **[Y/+]** key can be pressed to start a measurement if the monitor does not detect the presence of the tube. In either case, the monitor will go to the second phase of the measurement cycle (see Section 2.4.2).

**LAST TUBE MEASUREMENT:** This menu displays “Last=”, followed by the name of the last tube and the measurement value in ppm. For example: Last = Benzene 0.0 ppm. Press the **[MODE]** key to advance to the next menu.

**CHANGE CURRENT TUBE TYPE [Only in the default condition where the barcode reader is turned “Off”]:** The present tube type is displayed e.g., “Benzene?” and can be altered by pressing [N/-] until the desired tube type is displayed. Press [Y/+] to accept the displayed tube. With the barcode reader “Off,” the instrument assumes that the same type of tube will be used until a different tube type is programmed. It is important to select the tube type correctly because this determines the lamp required and the measure wait time.

**!! CAUTION !!**

**If the incorrect tube type is programmed or the Measure Wait Time is otherwise set too short, it is possible to underestimate the VOC concentration and thereby cause overexposure.**

This menu item is not displayed when the barcode reader is enabled (to enable see Section 4.7.9).

**BATTERY:** The menu displays the present battery voltage.

**Note:** A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing “Bat” will appear as a warning message. When the battery voltage falls below 4.2 volts, there are about 20-30 minutes of run time left before the monitor turns off automatically.

**DATE, TIME, TEMP:** This menu displays the current date (month/day/year), time (24-hour format), and internal unit temperature in degrees Celsius. For example:

7/16/97 ... 9:00 (24 hr format) ... 25°C ... 77°F

## OPERATION

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**PC COMMUNICATION:** Allows user to up load data from the UltraRAE to a Personal Computer (PC) or send/receive configuration information between a PC and the UltraRAE. Connect the monitor to the serial port of a PC, and start the UltraRAE application software. Press the **[Y/+]** key and the LCD displays the “Comm ready...” The monitor is now ready to receive commands from the PC.

Press the **[MODE]** or **[N/-]** key to exit the communication standby mode and move to the next.

## 2.4.2 Measurement Overview

To start a measurement, the monitor must first be in the “Ready...” mode. The monitor normally powers up into this mode.

### Measurement phases:

- **Ready**
- **Tube Preparation**
- **Insert and identify tube**
- **Start measurement**
- **Display and log measurement**
- **Remove tube**

### **Ready**

Unit is ready to start a sample.

### **Tube Preparation**

Break both ends of a new RAE-Sep tube using the tip cutter on the tube reader of the UltraRAE, Figure 2-4. Use a new tube for each measurement. The tube contents may be hygroscopic and should be used within a short time of opening.

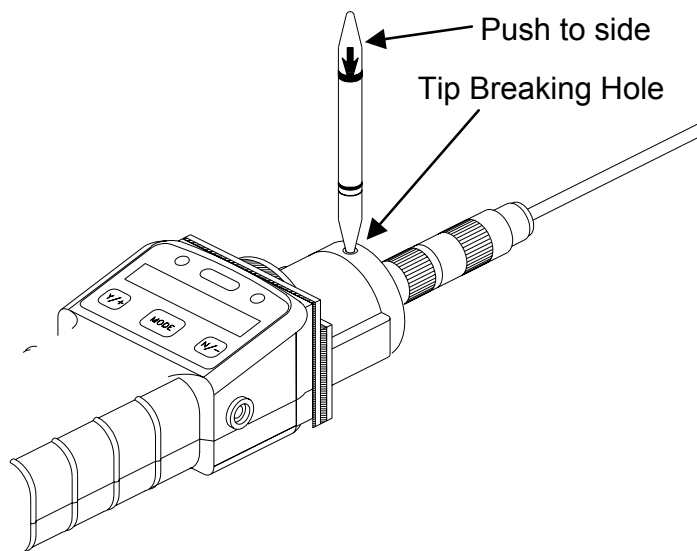


Figure 2-4 Tube Tip Break-off

**\*\*\*CAUTION: Wear hand and eye protection when breaking tube tips. Use caution in handling tubes with broken ends. Keep away from children. RAE-Sep tubes should be disposed of according to local regulations. See footnotes of data sheets for disposal information.\*\*\***

### Tube insertion

Unscrew the top half of the tube holder on the inlet and insert the tube securely into the UltraRAE with the tube arrow pointing into the unit and face front.

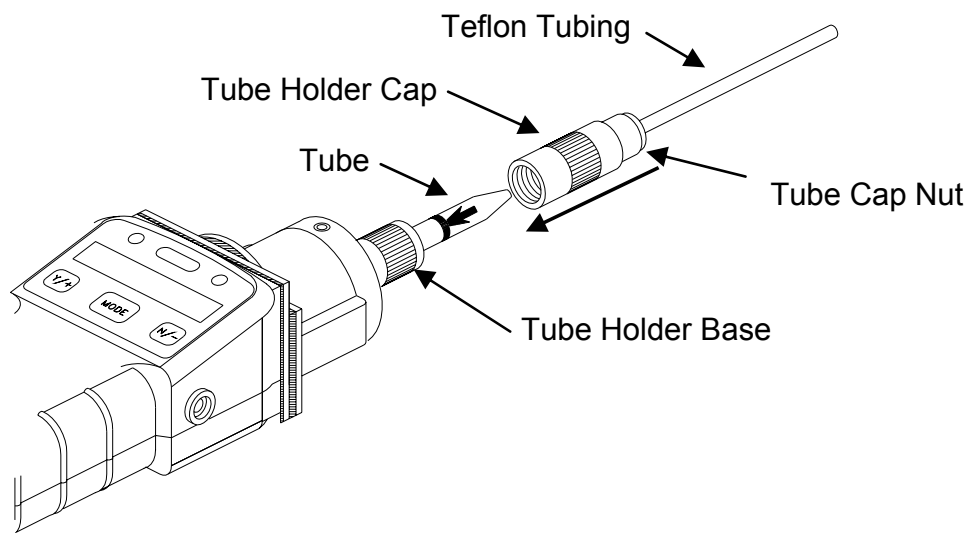


Figure 2-5 Tube Insertion & Cap

Screw the tube holder back on. Give a twist (about 90-180°) and push (about 5-15 lb.) action on the tube cap nut to ensure a good seal on both sides of the tube. The tube code is read once per second, and the tube type is displayed if the unit recognizes the tube:

Benzene / Start? / Benzene / Start? .....

An error message is displayed if a valid tube is not detected:

“No Tube” or “Unknown Tube.” An “Unknown Tube” error message must be cleared before a measurement can begin (see Troubleshooting, Section 8.2). The “No Tube...” message is followed by “...Manual Select?” The barcode reader can be

circumvented by pressing [Y/+] and selecting the appropriate tube at the subsequent prompts using the [N/-] and [Y/+] keys.

### **Start Measurement**

Press the [Y/+] key to start the measurement cycle. The pump will start and the remaining wait time will be displayed. If a VOC tube is inserted, the real-time ppm measurement will be displayed. The total pump time is the sum of the pre-programmed optimum time and the user programmable “measure wait time”. At the end of the waiting period, the measurement value will be logged, if enabled. At this point the monitor will alternately display the measurement value and “Done!”

If no tube is inserted or detected, the [Y/+] key can be pressed. The “Manual select?” message will be displayed. Press the [Y/+] key again to confirm a manual tube selection. The first tube name, of the currently configured tubes, will be displayed. Press the [Y/+] key to accept this tube name or press the [N/-] key to display the next tube in the list.

### **Measurement Display and Data Log**

The sampled reading is the actual gas concentration in parts per million (ppm) for that gas. The reading is held and displayed until the user presses a key to move on to the next display.

### **Tube Removal**

Press the [Y/+] key to advance to the next phase. The monitor will next display the prompt “Remove tube!” (if a tube is present). Remove the tube to return to the “Ready...” prompt.

### **Abort Measurement**

During waiting period, any key pressed will abort the measurement.



## 2.5 Alarm Signals

At the end of each measurement period, the gas concentration is compared with the programmed alarm limits (two gas concentration alarm limit settings: Low & High). A separate set of limits can be programmed for each tube. If the concentration exceeds either of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn user of the alarm condition.

In addition, the UltraRAE will alarm if one of the following conditions occurs: battery voltage falls below a pre-set voltage level (4.4 V), failure of UV lamp, pump stall, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will be turned off automatically.

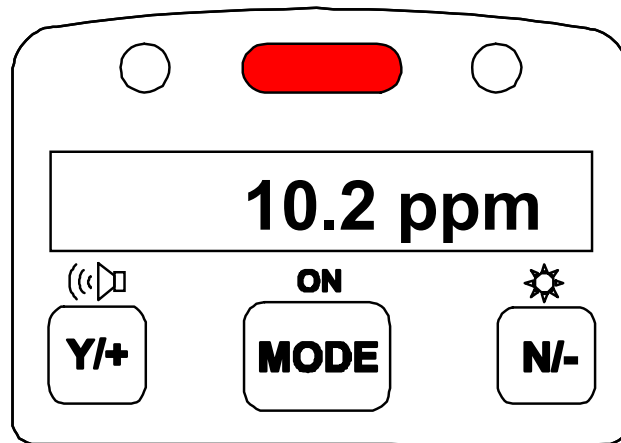


Figure 2-6 Alarm Signals

**Alarm Signal Summary:**

<b>Condition</b>	<b>Alarm Signal</b>
Gas exceeds “High Alarm” limit	3 beeps/flashes per second plus sensor name on LCD
Gas exceeds “Low Alarm” limit	2 beeps/flashes per second plus sensor name on LCD
Pump failure	3 beeps/flash per second plus “Pump” message on LCD
PID lamp failure	3 beeps/flash per second plus “Lamp” message on LCD
Low battery	1 flash per second, 1 beep per minute plus “Bat” message on LCD
Memory full	1 flash per second plus “Mem” message on LCD

**Alarm Signal Testing:**

Under normal non-alarm condition, it is possible to test the UltraRAE LED, and buzzer in special diagnostic mode (see Section 8.1).

## 2.6 Preset Alarm Limits and Calibration

The UltraRAE Compound Specific PID monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits as listed below. Refer to Section 4 for programming procedures if new calibration or alarm limits are required.

<b>Factory Calibration and Preset Alarm Limits</b>				
<b>Cal Gas</b>	<b>Cal Span</b>	<b>Units</b>	<b>Low</b>	<b>High</b>
Benzene	5.0	ppm	5.0	10.0
Butadiene	5.0	ppm	5.0	10.0
Halocarbon	10.0	ppm	10.0	25.0
VOC	100.0	ppm	50.0	100.0

## **2.7 Integrated Sampling Pump**

The UltraRAE Compound Specific PID monitor includes an integrated sampling pump. This is a diaphragm type pump that provides 400-500 cc per minute flow rate (with no tube in place). Connecting a 1/4 inch Tygon tubing with 1/8 inch inside diameter to the gas inlet port of the UltraRAE, this pump can pull in air sample from 200 feet away horizontally, or 90 feet vertically, at 3 feet per second flow speed.

The pump is turned on when a measurement is manually started by the operator and turns off automatically at the completion of the sample.

If liquid or other objects are pulled into the inlet port filter, causing the pump to stall, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message “Pump” will be also displayed on the LCD display.

The user needs to acknowledge the pump shut off condition by clearing the obstruction and pressing the [Y/+] key to re-start the pump.

## 2.8 Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions. In manual mode, the backlight can be turned on by pressing and holding the **[N/-]** key for one second in normal operation. The backlight can be turned off by pressing **[N/-]** a second time. If the **[N/-]** key is not pressed, the backlight will be turned off automatically after a pre-programmed time-out period to save power.

In automatic mode, the ambient light is sensed and the backlight will be turned on automatically if the ambient light is below a threshold level. The backlight will be turned off automatically when the ambient light exceeds the threshold level.

(See Section 8.1 for instructions on how to set the threshold level.)

**Note:** The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

## 2.9 Datalogging

The UltraRAE Compound Specific PID monitor stores the time stamp, sample number, tube name and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data is retained (even after the unit is turned off) in non-volatile memory so that it can be down loaded later to a PC.

### Datalogging event

Each time the monitor is turned on, or a configuration parameter is changed, a new datalog event is created. Information, such as start time, user ID, site ID, serial number, last calibration date, and alarm limits will be recorded.

### Datalogging sample

After an event is recorded, the unit records a shorter form of the data. This data contains the sample number, time (hour/minute), tube name, and gas concentration.

If more than 900 measurements sample are recorded in one event, a new event will be created automatically (by the application software).

### **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.**

**Ne charger les batteries que dans emplacements désignés non-dangereuse.**

## 3. OPERATION OF ACCESSORIES

The accessories for the UltraRAE include:

- Battery charger
- Alkaline battery adapter
- Dilution fitting
- Calibration adapter

### 3.1 Battery Charging Operation

The charging circuit of the UltraRAE is built into the monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor. Charging should be done with the unit turned off.

1. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the UltraRAE monitor. If the unit was off, it will automatically turn on.
2. The first message displayed will be “Deep discharge?” This message will remain on the display for three seconds. If the user wants to discharge the battery pack, affirm this query with the **[Y/+]** key, otherwise the unit will abandon this function and move on to the charge mode.
3. While charging, the display message will alternate between “Charging” and “Bat=x.xV” (x.x is the present battery voltage). The LED should be red in color when charging.
4. When the battery is fully charged, the LED will change from red to green and the message “Fully charged” will appear on the display. The red color indicates that the battery is being charged. The green color indicates that the battery is fully charged. After the battery is fully charged, the unit will enter the “trickle charge” mode. In this mode,

## OPERATION OF ACCESSORIES

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the red LED will turn on for two or three seconds, every minute, to maintain the full charge.

A completely discharged UltraRAE monitor will be charged to full capacity within 10 hours.

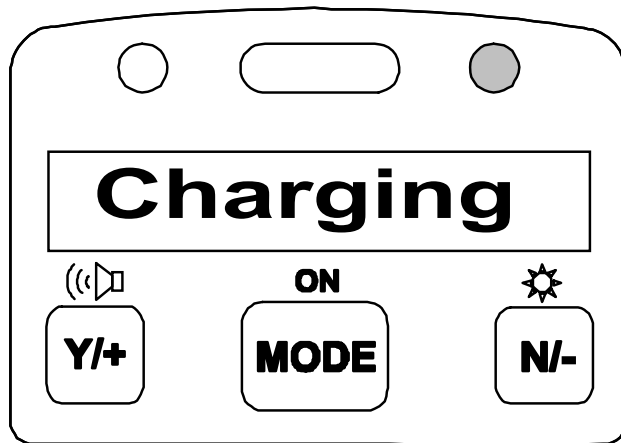


Figure 3-1 Charging the Battery

The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low.

The factory supplied battery is designed to last for 12 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.



## **3.2 Alkaline Battery Adapter**

An alkaline battery adapter is supplied with each UltraRAE kit. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended for emergencies when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the monitor. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

**Note: The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!**

### 3.3 Dilution Fitting

The user may wish to install a dilution fitting in front of the RAE-SEP tube to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.3) so that the correct gas reading will be displayed when the dilution fitting is used.

**WARNING:** To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or inert tubing to measure the gas concentration inside the confined space.

## **4. PROGRAMMING OF ULTRARAE**

The UltraRAE Monitor is built with a microcomputer to provide programming flexibility for the user. Authorized users can re-calibrate the monitor, change the alarm limits, change site ID, user ID, lamp type, real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options, and the keypad used for menu selection and data entry.

## 4.1 Programming Mode

The **programming** mode allows users to change the setup in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming functions are organized in a three tier menu structure. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

<b>Programming Menu</b>
Calibrate monitor?
Change alarm limits?
View or change datalog?
Change monitor setup?
Change sensor configuration?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the **[N/-]** repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press **[Y/+]** key, the sub-menu will be displayed.

**Return to “Ready” menu:** To exit the programming mode and return to the idle operation, press the **[MODE]** key once at any of the programming menu display.

## 4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Key	Function in Programming Mode
<b>[MODE]</b>	Exit menu when press momentarily or exit data entry mode when pressed and held for 1 second
<b>[Y/+]</b>	Increase numerical value for data entry or confirm (yes) for a question
<b>[N/-]</b>	Decrease numerical value for data entry or deny (no) for a question

### 4.3 Entering into Programming Mode

1. Turn on the UltraRAE monitor, wait for the “Ready..” message to be displayed.
2. Press and hold down both **[MODE]** and **[N/-]** keys for three seconds to enter programming mode. Note: This is to prevent user from entering programming mode by accident.

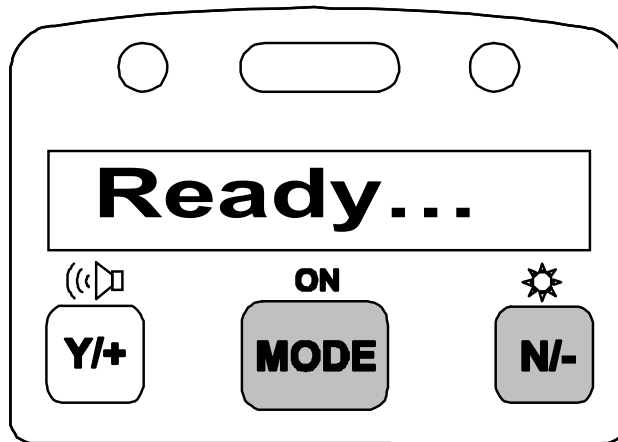


Figure 4-1 Entering Programming Mode

3. Holding down these two keys for 3 seconds, the monitor should enter the programming mode and the first menu item “Calibrate Monitor?” will be displayed.

## 4.4 Calibration of the UltraRAE Monitor

### **CALIBRATION WARNINGS:**

**The Calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument put into service for the first time.**

**For maximum safety, the accuracy of the UltraRAE should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.**

In the programming mode, the user may re-calibrate the UltraRAE monitor. This is a two-point calibration process using “fresh air“ and a standard reference gas. First a “fresh air” calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas, which contains a known concentration of a given gas, is used to set the second point of reference (also known as span gas). Separate calibration must be performed for each type of tube being used.

**Note:** The span value must be set prior to calibrating for fresh air or span.

### **Calibration Sub-Menu**

Fresh air calib?

Span calib?

Modify span value?

### **Calibration Frequency**

To achieve the highest level of measurement accuracy, it is recommended that the monitor be calibrated once a day before

it is used. If this is not possible, then the monitor should be calibrated at least once a week.

### **Correction Factors Not Possible**

It is necessary to calibrate for each type of RAE-Sep tube directly with the gas to be measured and with the corresponding RAE-Sep tube in place. It is NOT possible to calibrate with a surrogate gas (such as isobutylene) and then apply a correction factor. This is because the surrogate gas is often absorbed on the RAE-Sep tube, or elutes at a different rate than the desired gas.



### 4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform fresh air calibration, the calibration adapter, a bottle of “fresh” air, and a Tedlar bag (optional), or a charcoal filter are required. The “fresh” air is clean dry air without any organic impurities. If such an air bottle is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

The calibration adapter links the inlet port of the UltraRAE monitor to the Tedlar bag or the charcoal filter. First fill the Tedlar bag with “fresh” air from the bottle before starting.

1. The first sub-menu shows: “Fresh air calib?”
2. Insert a new, unused, RAE-SEP tube into the monitor and secure the cap. If a “fresh” air bottle is available, fill the Tedlar bag with the “fresh” air. Next, snap the calibration adapter over the inlet port of the UltraRAE monitor and connect the other end of the tube to the Tedlar bag. If a charcoal filter is used, connect the filter to the inlet port of the UltraRAE monitor. If the “fresh” air bottle or charcoal filter is not available, make sure the monitor is in an area free of any detectable vapor.
3. Press the **[Y/+]** key. The monitor will identify the inserted tube and display the tube name. If the tube cannot be identified, the tube can be manually selected by responding with **[N/-]** until the correct tube name is displayed.
4. Press the **[Y/+]** key when the correct tube name is displayed to start “fresh air calibration” of the monitor. The display shows “zero in progress” followed by “wait..” and a countdown timer.
5. When the sampling is complete, the display will show the message “zeroed... reading = 0.0 ... done!” The next sub-menu will be displayed (“Span calib?”).

**Note:** The charcoal filter has a check box so that user can mark off a box each time the filter has been used. The charcoal filter should be replaced after four calibrations.

## 4.4.2 Span Calibration

This procedure is the second type of sensor calibration. A bottle of standard reference gas (span gas) and a Tedlar bag are needed to perform this procedure. First, fill the Tedlar bag with the span gas. Connect the calibration adapter to the inlet port of the UltraRAE Monitor, and connect the tube to the Tedlar bag. Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Advance to the next calibration phase (Span calib), the display should show “Span calib?”
2. Insert a new RAE-SEP tube into the monitor. (Note: For VOC calibration, there is no need to use a new VOC tube). First fill the Tedlar bag (Do not overfill with span gas). Then connect the bag to the inlet port.
3. Press the **[Y/+]** key. The monitor will identify the inserted tube and display the tube name. If the tube cannot be identified, the tube can be manually selected by responding with **[N/-]** until the correct tube name is displayed.
4. Press the **[Y/+]** key when the correct gas name is shown. The display shows “Span gas = xx ppm?” If incorrect, press the **[N/-]** key and correct the span gas value. When the span gas value is correct, open the valve to the Tedlar bag and press the **[Y/+]** key to start the calibration. The display reminds the user to “Apply gas now!” and begins a countdown timer showing the number of remaining seconds. When the count down timer reaches zero, the display shows the calibrated value. Turn off the gas and press **[MODE]** key to exit calibration
5. This completes the calibration procedure for a gas. The display shows the next calibration sub-menu.
6. Disconnect the calibration adapter and Tedlar bag.
7. Press the **[N/-]** or **[MODE]** key to abort more calibration and move directly to the next sub-menu item. The current calibration data will be saved automatically.

### 4.4.3 Modify Span Value

This function allows the user to change the span value of the standard calibration gas.

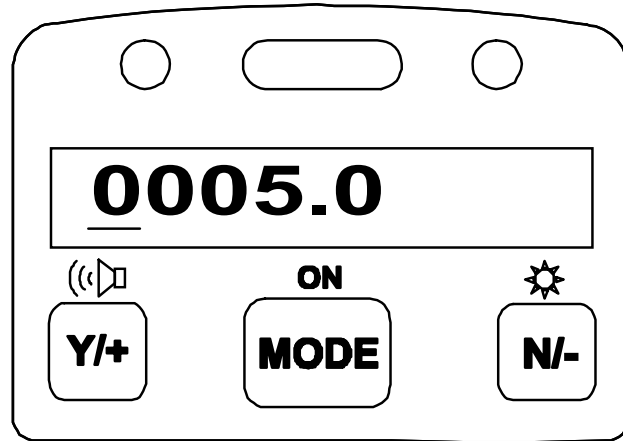


Figure 4-2 Modify Span Value

The cursor blinks at the first digit of the span value. Use the **[Y/+]** or **[N/-]** key to modify the digit at the cursor position. Press the **[MODE]** key momentarily to advance the cursor to the next digit.

When the number is adjusted to the desired value, press and hold the **[MODE]** key for one second. The user will next be asked to confirm the change (save?).

## 4.5 Change Alarm Limits

In this menu, the user can change the high and low alarm limits for each RAE-SEP tube.

Alarm Limit Sub-Menu
High limit?
Low limit?

### 4.5.1 Change High Alarm Limit

1. The first sub-menu item allows the user to change the High Alarm limit. Press the **[Y/+]** key. The monitor will identify the inserted tube and display the tube name. If the tube cannot be identified, the tube can be manually selected by responding with **[N/-]** until the correct tube name is displayed. Next press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored High alarm limit.

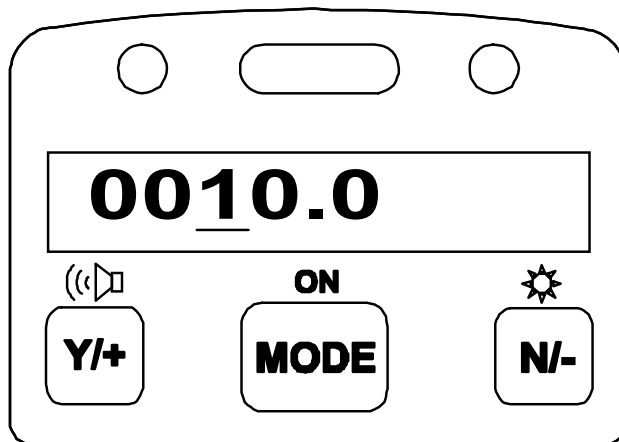


Figure 4-3 Change Alarm Limits

2. To modify this limit, starting from the left-most digit, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The

flashing digit will move on to the next digit to its right. Press and hold the **[MODE]** key for 1 second to exit data entry mode. If there is any change to the existing value, the display shows “Save?” Press the **[Y/+]** key to accept the new value and move to the next sub-menu. Press the **[N/-]** key to discard the changes.

3. To preserve the previously stored High Alarm limit, press and hold the **[MODE]** key for 1 second and the monitor will exit data entry mode and move to the next sub-menu.

### 4.5.2 Change Low Alarm Limit

1. The second sub-menu item allows the user to change the Low Alarm limit. Press **[Y/+]** key. The monitor will identify the inserted tube and display the tube name. If the tube cannot be identified, the tube can be manually selected by responding with **[N/-]** until the correct tube name is displayed. Next press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.
2. To modify this limit, starting from the left-most digit, use **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to the next digit to its right. Press and hold **[MODE]** key for 1 second to exit data entry mode. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** key to accept the new value and move to next sub-menu. Press **[N/-]** key to discard the changes.
3. To preserve the previously stored Low Alarm limit, press and hold **[MODE]** key for 1 second and the monitor will exit data entry mode and move to the next sub-menu.

## 4.6 View or Change Datalog

The UltraRAE monitor calculates and stores the concentration and ID of each sample taken. The user can review this stored data, clear the datalog memory, and enable or disable the data logging function.

<b>Datalog Sub-Menu</b>
View data?
Clear data?
Change data log?

### 4.6.1 View Data

This function allows the user to review all the data that is stored in the non-volatile data memory.

Data is stored in groups, or “events”. An event is created and stored when the unit is turned on, or when any configuration parameter is changed (in program mode). When an event is created, all vital configuration parameters are stored. Each event can contain many “data” points. A data point consists of; the sample number, time (hour : minute), tube ID, and measurement value.

#### Data storage structure

<b>Event #1</b>	
<b>Data #1</b>	(10/01/97, 14:20, Benzene, 0.2 ppm)
<b>Data #2</b>	(14:35, Benzene, 0.3 ppm)
<b>Data #3</b>	(14:55, Benzene, 0.1 ppm)
<b>Data #4</b>	(15:07, Benzene, 0.4 ppm)
<b>Event #2</b>	
<b>Data #1</b>	(10/02/97, 09:06, Benzene, 0.4 ppm)
<b>Data #2</b>	(9:15, Benzene, 0.3 ppm)

1. At the “View data?” menu display, press the **[Y/+]** key. The LCD display will next show the first event number and start date and time of the event. Press the **[N/-]** key to view the next event.

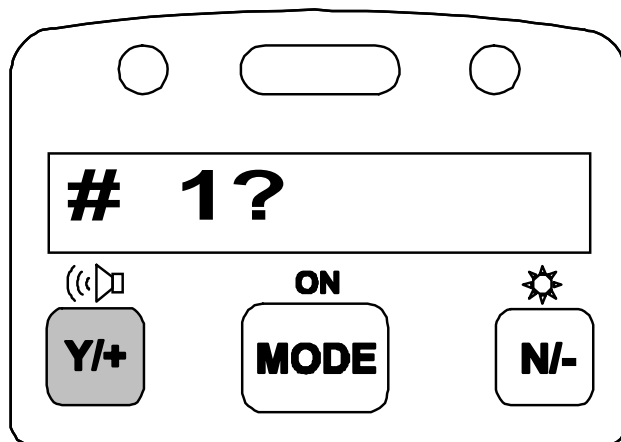


Figure 4-4 Viewing Data

2. Press **[Y/+]** key to review data of the first event. The LCD display shows the stored data including; the time stamp in hours and minutes, the tube name, and measurement value. Press the **[N/-]** key to see the next event. If there are no more events, the message “no more event!” will appear. The monitor will next jump back to the first event.

Action	Display
	# 1?
<b>[Y/+]</b>	10/01/97, 14:20, Benzene, 0.2 ppm
<b>[Y/+]</b>	14:35, Benzene, 0.3 ppm

3. Press the **[Y/+]** or **[N/-]** key to move forward or backward to view other data from this event. When the end or the beginning of the event is reached, the message “1st data” or “End data” will appear. Press the **[MODE]** key to exit the current event.



## 4.6.2 Clear All Data

This function will erase all data stored in the non-volatile data memory.

1. “Clear All Data?” is the first sub-menu.
2. Press the **[Y/+]** key to clear the data memory. Display shows: “Are you sure?”
3. Pressing the **[Y/+]** key again confirms erasure of all the data memory.
4. Press the **[N/-]** or **[MODE]** key to exit without clearing the data memory and move to next datalog sub-menu.

### 4.6.3 Change Data Log

This function allows the user to enable or disable the data logging. At the beginning of each measurement sample, the current status of this feature is displayed (Log On/Log Off).

1. “Change data log?” is the first sub-menu.
2. Press the **[Y/+]** key to change the data logging function (enable/disable). The display will show the current status of this feature (Log On/Log Off) followed by a question mark.
3. Press the **[N/-]** key to change the present state of the logging function. The message “Are you sure?” will be displayed if the status has change. Confirm the change by pressing the **[Y/+]** key. The **[N/-]** key is used to alternate the current state.
4. Press the **[MODE]** key to exit and move to the next datalog sub-menu.

## 4.7 Change Monitor Setup

Several monitor unit specific variables can be changed. The following is a list of configuration data that can be modified by the user.

<b>Monitor Setup Sub-Menu</b>
Change Site ID?
Change User ID?
Change User Mode?
Change Date?
Change Time?
Change backlight?
Change DAC/Alarm output?
Change DAC range?

### 4.7.1 Change Site ID

The user can enter an 8 digit alphanumeric Site ID in the programming mode. This Site ID will be included in the data log report.

1. “Change Site ID?” is the first sub-menu item.
2. Press the **[Y/+]** key and the display shows the current site ID: “Site ID = xxxxxxxx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 alphabets and 10 numerals. Press **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new site ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode and move to the next monitor setup sub-menu.
5. If there is any change to the existing Site ID, the display shows “Save?” Press the **[Y/+]** key to accept the new Site ID and exit the monitor setup sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

## 4.7.2 Change User ID

The user can enter an eight digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. “Change User ID?” is the second sub-menu item in Table 4.5.
2. Press the **[Y/+]** key and the display shows the current user ID: “User ID = xxxxxxxx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to cycle through all 26 letters and 10 numerals. Press **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new user ID are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode and move to the next monitor setup sub-menu.
5. If there is any change to the existing user ID, the display shows “Save?” Press the **[Y/+]** key to accept the new user ID and exit the monitor setup sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

### 4.7.3 Change User Mode

There are two different user modes: **display** and **program** that can be selected from the programming menu.

1. “Change User Mode?” is displayed.
2. Press the **[Y/+]** key, the display shows the current user mode selection: “User Mode = Program?”
3. Press the **[Y/+]** key to accept the currently displayed user mode. Press **[N/-]** key to scroll to the alternate user modes. Press **[MODE]** key to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows “Save?” Press the **[Y/+]** key to accept the new selection and exit the monitor setup sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

**NOTE:** If the user mode is changed to **display** mode, the user can no longer enter the programming menu. Therefore, the user cannot change the user mode back to **program** mode in normal mode.

To restore the user mode back to **program** mode, turn the unit off and back on in Diagnostic Mode. Next enter program mode by holding the **[MODE]** and **[N/-]** keys for three seconds. Enter the password at the prompt (the default is 000). Once program mode is entered, go to the “Change Monitor Setup” / “Change User Mode” and change the mode back to **program**.

### 4.7.4 Change Date

The UltraRAE monitor is equipped with a real time clock (RTC) into which the user can enter the correct date and time.

1. “Change Date?”
2. Press **[Y/+]** key, the display shows both the current date and time: “Date = mm / dd” with the left most digit of the date flashing.
3. To modify this value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press the **[Y/+]** key to accept the new value and move to next sub-menu. Press the **[N/-]** key to discard the changes and move to next sub-menu.

### 4.7.5 Change Time

1. “Change Time?”
2. Press **[Y/+]** key, the display shows both the current date and time: “Time = hh : mm” with the left most digit of the time flashing.
3. To modify this value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press the **[Y/+]** key to accept the new value and move to next sub-menu. Press the **[N/-]** key to discard the changes and move to next sub-menu.



### 4.7.6 Change Backlight

The UltraRAE monitor allows the user to turn the LCD back light on and off. This can be done automatically when ambient light falls below or above a certain level, or manually by pressing the **[N/-]** key.

1. “Change backlight?”
2. Press **[Y/+]** key, the display shows the current backlight mode: “Backlight Mode = auto turn on?”
3. Press the **[Y/+]** key to accept the currently displayed back light mode. Press **[N/-]** key to change to the other back light mode: “Backlight Mode = manual turn on?” Press **[MODE]** key to exit this sub-menu and move to the first monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows “Save?” Press the **[Y/+]** key to accept the new selection and exit sub-menu. Press the **[N/-]** key to discard the changes and return to the first monitor setup sub-menu.

### 4.7.7 Change DAC / Alarm Output

The UltraRAE monitor allows the user to specify if the communication / alarm connector is used for DAC output or alarm output (see Figure 8-1 for connections). The default setting is DAC signal output. DAC output is normally used to connect to a chart recorder for plotting a gas concentration represented by 0-2.5 volts DC. It provides a real-time signal proportional to concentration. The alarm output is used for an external alarm.

1. “Change DAC/Alarm output?”
2. Press the **[Y/+]** key, the display shows the current external output mode: “External output = DAC?”
3. Press the **[Y/+]** key to accept the currently displayed DAC output mode. Press **[N/-]** to change to alarm output mode: “External output = Alarm?” Press **[MODE]** key to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection with **[Y/+]** key pressed, the display shows “Save?” Press the **[Y/+]** key to accept the new selection and exit this sub-menu. Press the **[N/-]** key to discard the changes and return to the next monitor setup sub-menu.

### 4.7.8 Change DAC Range

The DAC output function allows the user to set the gas concentration span to be represented by the maximum 2.5V DC output. This prevents the signal from going off scale during measurements.

1. “Change DAC range?”
2. Press the **[Y/+]** key, the display shows the gas name: “VOC?” Press **[N/-]** to have different gas names displayed: “Benzene?”, “Halocarbon?”, or “Butadiene?”
3. If the **[Y/+]** key is press for the “VOC?”, it will show the default DAC range “DAC range = 200 ppm?” Press **[N/-]** key to change the range for 2000 ppm, 20 ppm or 200 ppm. Press **[MODE]** key to exit this sub-menu and move to the first monitor setup sub-menu.
4. If there is any change to the existing selection with **[Y/+]** key pressed, the display shows “Save?” Press the **[Y/+]** key to accept the new selection and exit this sub-menu. Press the **[N/-]** key to discard the changes and return to the other range selection.

### 4.7.9 Change Bar Code Reader

The UltraRAE monitor allows the user to turn the tube bar code reader on and off. The default condition is off.

1. “Change Bar Code Reader?”
2. Press the **[Y/+]** key, the display shows the reader status: Bar Code Reader = Off?”
3. Press the **[Y/+]** key to accept the currently displayed status. Press **[N/-]** to toggle between “On?” and “Off?” Press **[MODE]** to exit this sub-menu and move to the next monitor setup sub-menu.
4. Save any changes with the **[Y/+]** key after the “Save?” prompt. Use the **[N/-]** key to discard the changes and move to the next monitor setup sub-menu.

When the barcode reader is “On”, the UltraRAE reads the barcode when a tube is inserted. The unit automatically identifies the tube type and applies the calibration and measurement time for the tube identified. This condition is most convenient for users who switch frequently between tube types. When the barcode reader is “On” it may occasionally need adjustment to identify the tubes properly (see Section 8.1 Paragraph 8 on CCD Reader).

When the barcode reader is “Off”, the user must be sure to identify the tube type properly before starting measurements. Thereafter, the monitor will assume the same tube type even if no tube is in place. It is important to select the tube type correctly because this determines the lamp required and the measure wait time.

#### **!! CAUTION !!**

**If the incorrect tube type is programmed or the Measure Wait Time is otherwise set too short, it is possible to underestimate the VOC concentration and thereby cause overexposure.**

## PROGRAMMING

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In the “On” mode, the barcode reader can be circumvented by pressing “Start?...” [Y/+] with no tube in place, and then selecting the tube manually after the prompt.

## 4.8 Change Sensor Configuration

Configurations that can be changed in this menu include measurement wait time, PID lamp type, and dilution ratio.

Sensor Configuration Sub-Menu
Change measure wait time?
Change lamp?
Change dilution ratio?

### 4.8.1 Change Measure Wait Time

The “measure wait time” is the time, in seconds, between the start of a sample and the time the unit completes and datalogs a measurement. The unit is preprogrammed to wait the optimum amount of time, based on the type of tube being used. Each tube type can be programmed separately. The user may want to adjust this time in special situations. For example, when using longer tubing to collect a remote sample (see Technical Note 140), longer times at low temperatures and shorter times at high temperatures (see tube Data Sheets). Care must be taken when setting this parameter because the final measurement value depends on it. The minimum time is 10 seconds (time for UV lamp to stabilize), and the maximum time is 255 seconds (4.25 minutes). For VOC tube measurements, this time is used only during calibration; during normal VOC measurements the readings run continuously until the user manually ends the measurement.

## 4.8.2 Change PID Lamp

There are three different energy UV lamps available for the PID sensor: **9.8 eV**, **10.6 eV** and **11.7 eV**. The user must select the correct lamp from the programming menu.

1. “Change lamp?” is the second sub-menu item.
2. Press the **[Y/+]** key, the display shows the current PID lamp selection: “Lamp = 10.6 eV?”
3. Press the **[Y/+]** key to accept the currently displayed PID lamp. Press **[N/-]** key to change to the other lamp. Press **[MODE]** key to exit this sub-menu and return to the first sub-menu.
4. If there is any change to the existing selection, the display shows “Save?” Press the **[Y/+]** key to accept the new selection and exit the sub-menu. Press the **[N/-]** key to discard the changes and return to the first sub-menu.

### 4.8.3 Change Dilution Ratio

The user can insert an optional dilution fitting on the UltraRAE gas inlet port to dilute the gas sample. In this case the user must enter a dilution ratio (from 1 to 20) from the programming menu so that the reading can be compensated to show the actual concentration of the gas sample with the dilution fitting.

**Note:** The ratio number equals 1 means that there is no dilution. The ratio number equals 2 means that the sample gas is diluted by a ratio of 2 to 1, i.e. one part of sample gas with one part of clean air.

1. “Change Dilution Ratio?” is the first sub-menu item.
2. Press the **[Y/+]** key, the display shows the current dilution ratio: “Dilution Ratio = xx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to increase or decrease the value of the digit. Press **[MODE]** key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until both digits of the new dilution ratio are entered.
4. Press and hold the **[MODE]** key for 1 second to exit the data entry mode and move to the next sub-menu.
5. If there is any change to the existing dilution ratio, the display shows “Save?” Press the **[Y/+]** key to accept the new ratio and exit the sub-menu. Press the **[N/-]** key to discard the changes and move to the next sub-menu.



## 4.9 Exit Programming Mode

1. To exit programming mode from the first tier menu level, press the **[MODE]** key once. The “Ready” message will be displayed.
2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice. The “Ready” message will be displayed.
3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds.

---

## 5. UltraRAE COMPUTER INTERFACE

Each UltraRAE is shipped with an integral software package, called the **ProRAE Suite**, and a serial computer interface cable.

This software package runs on any IBM compatible Personal Computer (PC) under Windows™ 3.1 or Windows™ 95, 98 or NT and later environments. It allows the user to configure the UltraRAE monitor by means of a user-friendly, dialog box and download configuration information from the PC to the monitor. Collected data can also be uploaded from the UltraRAE to a PC in order to perform data analysis, report generation or record keeping. Installation and operation of this software package is described in the following sections.

## 5.1 Install ProRAE-Suite Software

A ProRAE-Suite software package is supplied with the UltraRAE monitor. This software package comes on three 3.5” setup diskettes. To install the ProRAE-Suite software, insert the first setup diskette into the “A” (floppy disk) drive. Click the **Start** button on the taskbar to display the start menu, then click the **Run** from the start menu to display the **Run** dialog box. Once the setup diskette is in drive A, type A:\Setup.exe in the **Open** field, as shown in Figure 5-1.

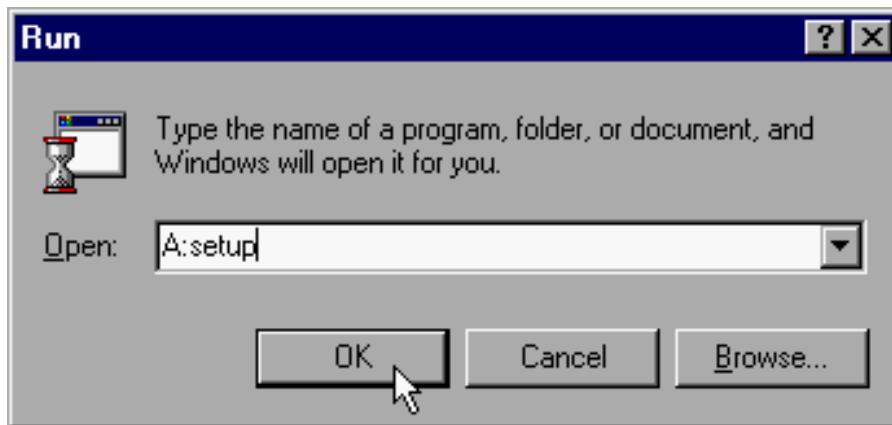


Figure 5-1 Run Dialog Box

Press the **Enter** key on the keyboard or click the **OK** button on the menu to start the setup process. If the user choose the default settings in every steps of the process, the ProRAE-Suite software package will be installed under the default directory: **C:\Program Files\RAE Systems Inc\ProRAE-Suite**. After the software is installed successfully, a new menu item **ProRAE-Suite** is added to the **Programs** menu. To start the ProRAE-Suite software, click the **Start** button on the taskbar to display the **Start** menu, click the **Programs** menu item to display the **Programs** submenu, then click the **ProRAE-Suite** menu item to display the **ProRAE-Suite** submenu. There are two submenu items under the **ProRAE-Suite** submenu:

**ProRAE-Suite** and **Readme**, as shown in Figure 5-2. Click the **ProRAE-Suite** submenu item to start the ProRAE-Suite software.

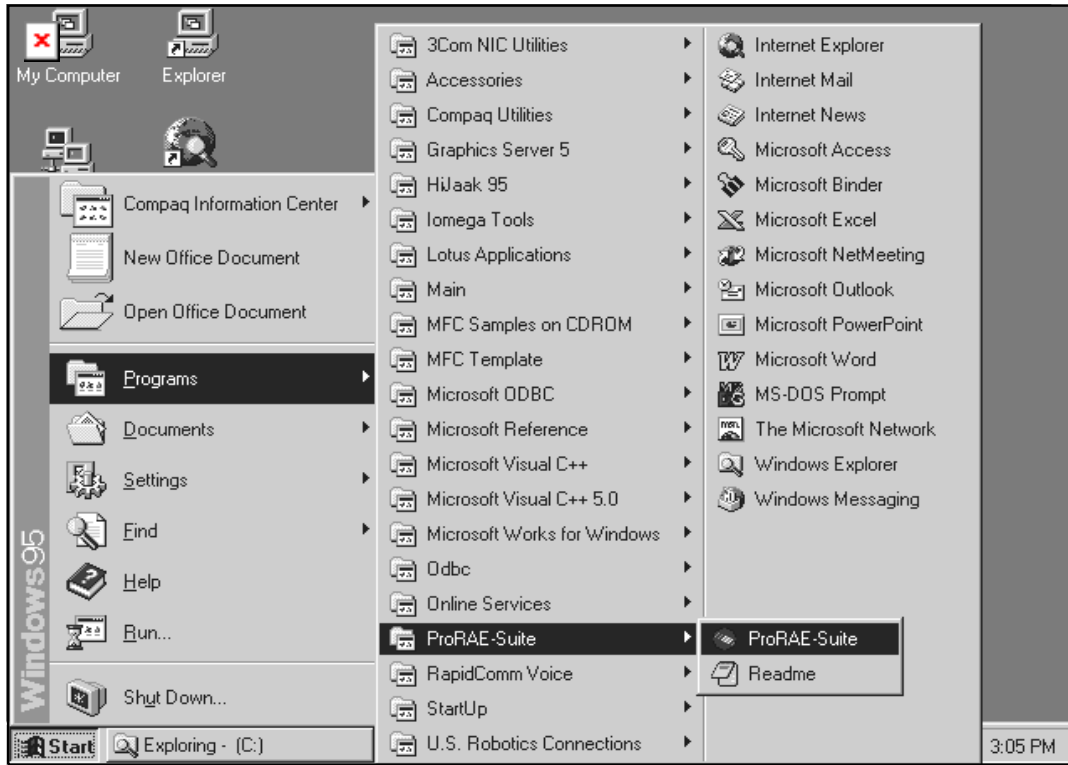


Figure 5-2 Start Menu

## 5.2 Connecting the UltraRAE to a PC

The UltraRAE monitor includes a serial interface cable. Connect the DB-9 connector side of the cable to the serial port of the PC, and connect another side of the cable to the MultiRAE PLUS monitor.

Turn on the power to the UltraRAE monitor. Press the **[MODE]** key several times until the LCD shows “PC comm?” Press the **[Y/+]** key and the display shows “Monitor will Pause, OK?” Press **[Y/+]** key to confirm and the display shows “Ready...” to indicate that the UltraRAE monitor is ready for communication with PC. During the communication session, the PC will directly control the UltraRAE monitor through the serial link. There is no need for users to press any key on the MultiRAE PLUS monitor during the communication session.

If no data transfer has occurred within one minute, the UltraRAE monitor will return to instantaneous reading display.

<p>Note: Do not connect to the parallel port of the PC by mistake. The parallel port is usually a 25 pin <b>female D connector</b> on the back of the PC, the serial port is usually a 25 or 9 pin <b>male D connector</b>. If the serial port on the PC is a 25 pin connector, the user needs to use a 25 pin to 9 pin adapter in order to accept the serial cable.</p>
--

## 5.3 Start ProRAE-Suite Software

To start the ProRAE-Suite software, click the **Start** button on the taskbar to display the **Start** menu, click **Programs** -> **ProRAE-Suite** -> **ProRAE-Suite** submenu item to start the ProRAE-Suite software. Figure 5-3 shows the main window of the ProRAE-Suite software.

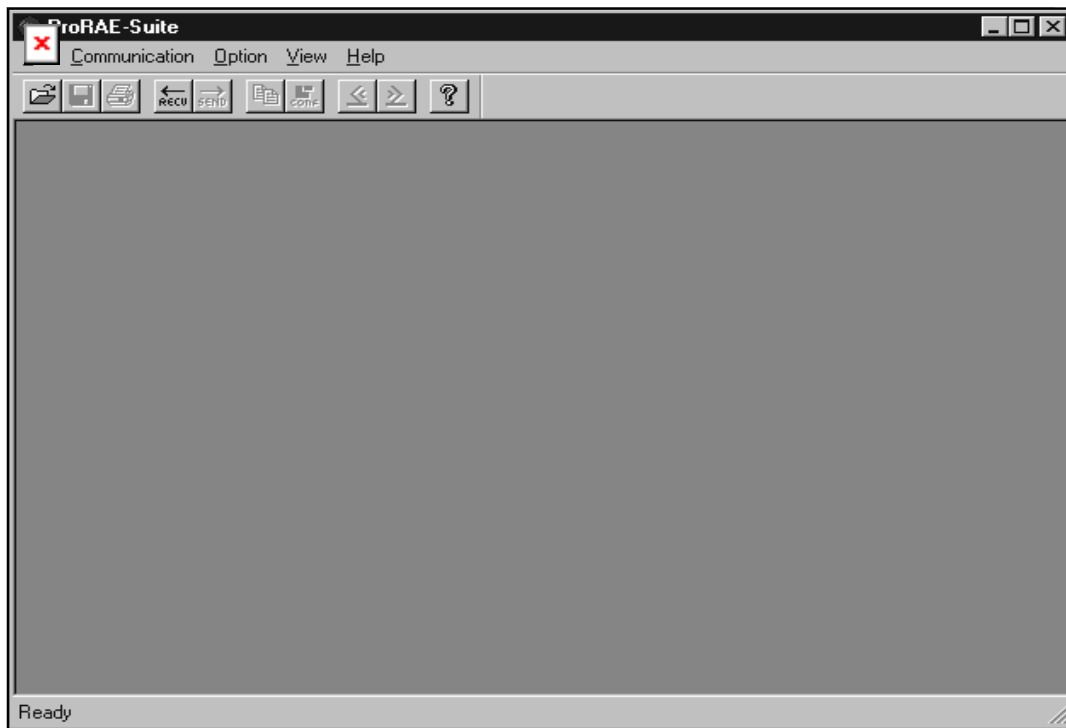


Figure 5-3 ProRAE-Suite Main Window

The functions of ProRAE-Suite software can be divided into three categories:

- 1) Configuration data category. This category includes editing the configuration data file, sending the configuration data to the UltraRAE monitor and receiving the configuration data from monitor, etc..
- 2) Logged data category. This category includes receiving the logged data from the UltraRAE monitor, displaying the

logged data in different format, exporting the logged data to a tab delimited text file so that it can be read by the Microsoft Excel software, etc..

- 3) The Upgrade category allows the UltraRAE firmware to be upgraded to the latest version.

There is 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 **Receive data** function in the **Communication** sub-menu is represented as a small arrow with the letters "RECV". 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.



## 5.4 Setup Communication Port

It is necessary to setup the communication port on the ProRAE-Suite software so that the UltraRAE monitor can communicate with the PC correctly. Figure 5-4 shows the **Setup Port** dialog box. Choose the appropriate port according to the PC's serial port setup.

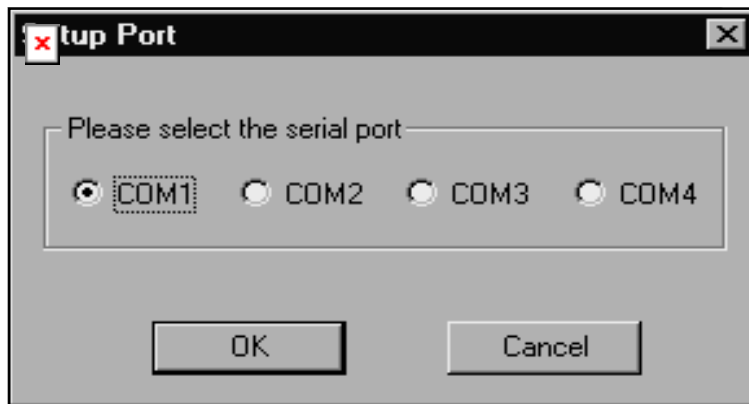


Figure 5-4 Setup Port Dialog

**Note:** In most PC's, there are two serial ports. Make sure that the serial port selected in the **Setup Port** dialog box matches the actual serial port connected to the UltraRAE monitor. The default serial port for ProRAE-Suite is COM1. If the incorrect serial port is selected, an error message of “error occur during serial port initialization” will appear when a user tries to communicate between the PC and the UltraRAE monitor.

## 5.5 Configure UltraRAE from PC

Open a configuration file from an UltraRAE by choosing **Receive Configuration** in the **Communication** menu.

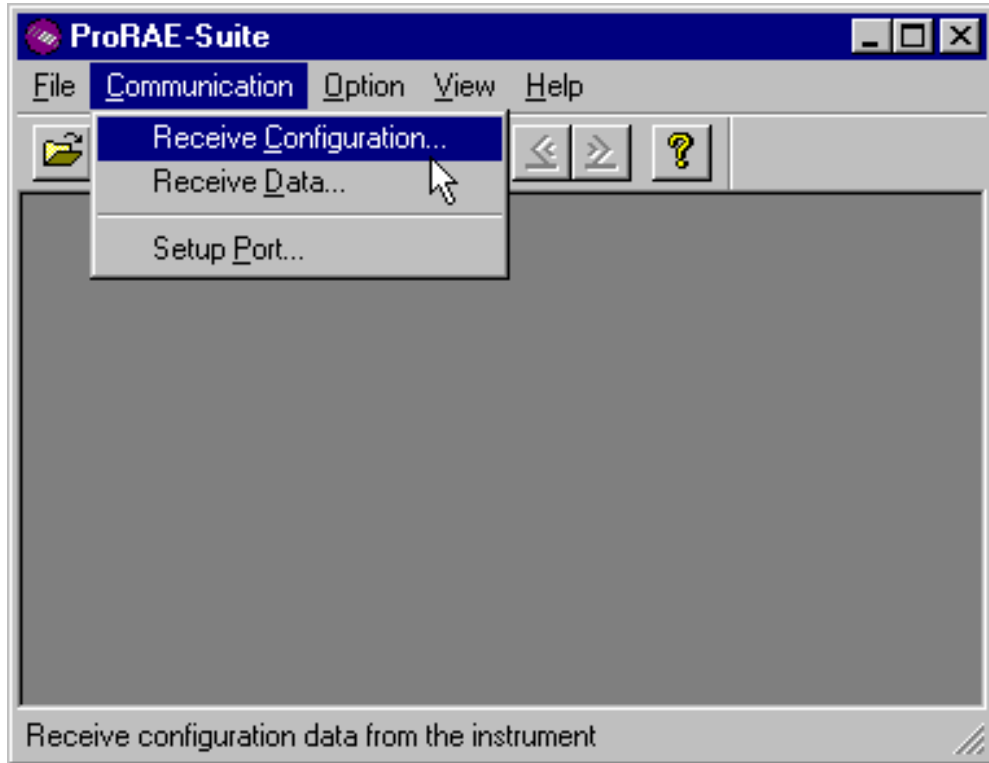


Figure 5-5 Load Configuration from an UltraRAE

A user can also open a default configuration file shipped with the ProRAE Suite software. The configuration file is a document with extension “.cfg”. From the **File** menu, choose **Open...**, then open the UltraRAE configuration file which indicates the correct firmware version.

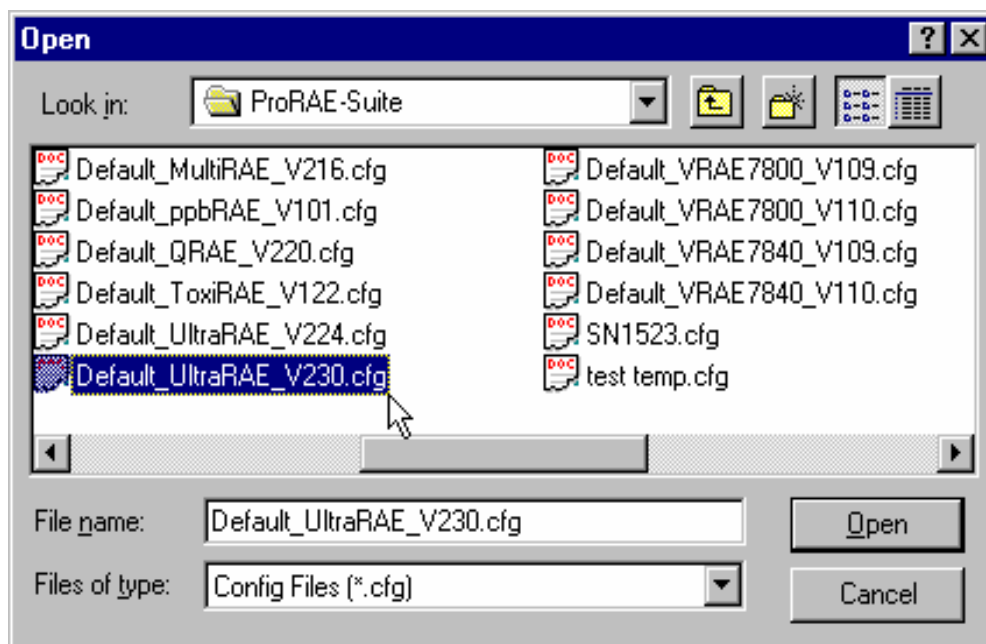


Figure 5-6 Opening a Configuration File

If modification to the default monitor configuration from the generic .CFG file is not necessary, skip the following steps, and go to Section 5.5 directly.

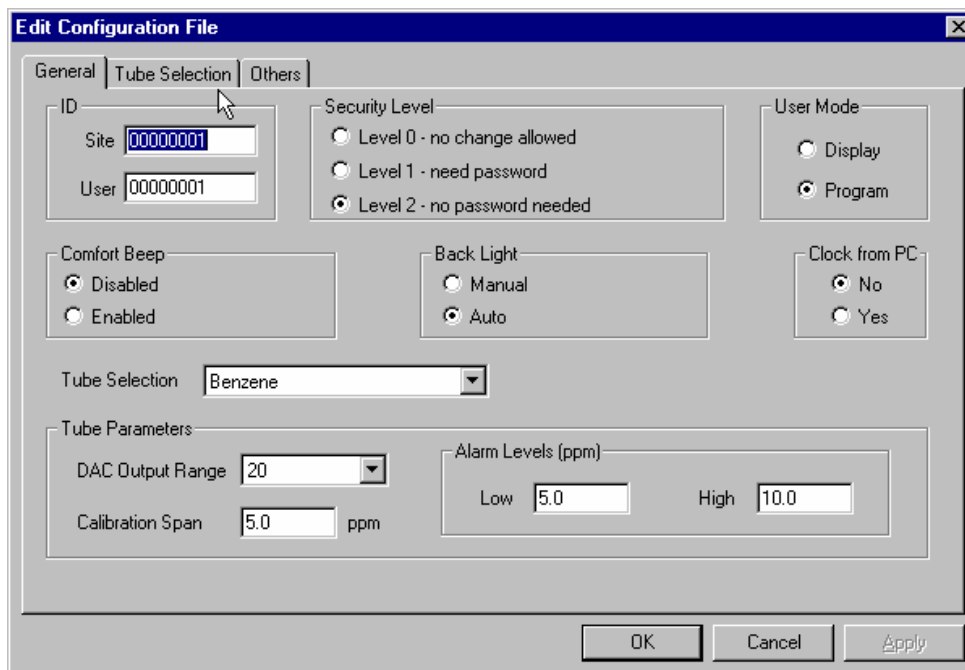


Figure 5-7 Edit Configuration

**Site/User ID:**

This section sets the identification that is used throughout the datalog information. The **Site ID** is an eight digit alphanumeric field. The **User ID** is an eight digit alphanumeric field.

**Security Level:**

There are three levels of security to provide protection against unauthorized changes to monitor settings. They can be changed using the programming menu of the UltraRAE when the instrument is in the programming mode.

**Level 0** - allows the user to enter the programming menu without password checking, but does not allow changes to alarm limits, real time clock, correction factor, or user and site information, etc. The user can still perform calibrations.

**Level 1** - a four digit password is required to enter the programming menu.

**Level 2** - the programming menu may be entered without restriction. Any changes made in the programming menu can be saved.

**Password:**

The four-digit password must be entered if level 1 is selected as the security level or the instrument is in text mode. Entry to the programming menu requires that this password be entered.

**User Mode:**

This option allows user to set the instrument to “Display” mode or “Program” mode.

In “Display” mode, the user can view several readings in the normal operation, but cannot enter the programming menu. In “Program” mode, user can enter the programming mode to calibrate the monitor or change various setup in the monitor.

**Password:**

The four digit password must be entered if level 1 is selected as the security level or the instrument is in text mode. Entry to the programming menu requires that this password be entered.

### **Comfort Beep:**

This option allows the user to specify a time interval that the buzzer will beep once to remind the user that the monitor is on. If zero is entered for the time interval, then the security beep feature is disabled.

### **Backlight:**

This option allows the user to choose to turn on and off the LCD backlight manually or automatically based on the ambient light sensor input. If manual mode is selected, user can also enter a time out period so that the back light will be turned off automatically after the time out period.

### **Clock from PC:**

This option allows the PC clock to be downloaded to the UltraRAE monitor so the user does not need to manually set the clock in UltraRAE.

### **Tube Selection:**

This combo box lists all the available tube names for the current configuration of this instrument. Select any tube name in this combo box will display its related parameter values in the tube parameter fields, such as DAC Output Range, Calibration Span, Alarm Low Limit and Alarm High Limit.

### **DAC Range Output:**

This combo box sets and displays the DAC range output for the tube specified in the Tube Selection field.

### **Calibration span:**

Enter the span value for the calibration gas selected.

### **Alarm Limits; Low, High:**

Enter the alarm levels for each gas in these fields. The values displayed here correspond to the gas presently indicated in the Tube Selection field. Each tube can be set, in turn, by selecting first the tube type.

## 5.6 Send Configuration to UltraRAE

After the configuration has been loaded to the ProRAE Suite, click on the “conf” icon, the configuration is ready for modification.

To send a modified configuration to the UltraRAE, select the **Send Configuration...** function from the **Communication** menu or click the **Send** icon (right arrow with “Send” letters) from the tool bar.

In order to save the configuration information for future use, select **Save As...** from the **File** menu type in a desired file name with “.cfg” as the configuration file name extension.

The “configure all” option is mainly used to restore the UltraRAE’s default operational settings when the configuration of the unit is non-recoverable and the unit is malfunctioning. Because the default parameters are not normally fit a specific unit, a user will need to re-calibration, re-setup lamp, pump, and LCD contrast threshold, etc, because all those data in the configuration has been overwritten.

## 5.7 UltraRAE Data

To read the logged data from the UltraRAE, select the **Receive data...** from the **Communication** menu or click the **Receive** icon.

User can select **Save As...** from the **File** menu to save the data as a file. Type in a desired file name with “.dat” as the data file name extension.

## **5.8 Password of UltraRAE Configuration**

Each UltraRAE configuration is protected by a 4-digit password. The user needs to enter the correct password before a new configuration file can be sent to the UltraRAE monitor.

### **Default Password**

The initial default password is “0000”.

### **Create Password**

First, open the default configuration file by clicking on the “CONF” button or by opening the “default.cfg” file. Select “level 1” security. The “grayed” password field becomes visible. Enter a 4 digit password in this field. Click **[OK]** button to exit the dialog box. Save the configuration file use “Save As” function from the File menu. The newly saved configuration file will now be protected by the 4-digit password.

### **Modify Password**

To modify the password of an existing configuration file, open the configuration file from the File menu. The password field should be invisible. Click “SEND” button or select Send Configuration function from the Communication menu. A dialog box will appear and ask for the password. Enter the previously selected password and click **[OK]** button. If the password entered is correct, the software will try to send the configuration file to the UltraRAE monitor. Since there is no monitor connected to the PC, the software will time out after about 30 seconds. Now, select Edit Configuration function from the Action menu. The password field will become visible in the dialog box. Modify the password as needed and save the modified configuration file with the new password.



## 6. THEORY OF OPERATION

The UltraRAE monitor uses a newly developed electrodeless discharge UV lamp as the high-energy photon source for the PID. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor will detect a broad range of organic vapors. A lamp with high photon energy (e.g. 11.7 eV) will measure the most kinds of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. The gas separation tube filters out unwanted gases and allows the target gas to be measured.

The RAE-SEP benzene tube uses a combination of adsorption and oxidation to remove most common organic compounds other than benzene. Methane, ethane, propane, and some butane passes through the tube but is not detected by the PID.

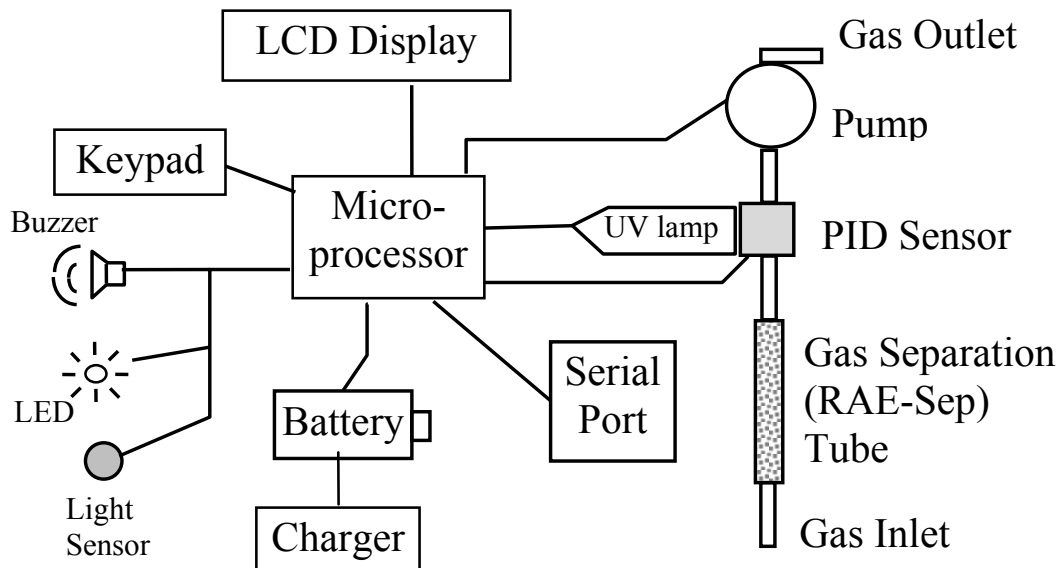


Figure 6-1 UltraRAE Block Diagram

## THEORY OF OPERATION

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The PID sensor for this UltraRAE monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump is installed inside the monitor enclosure to draw air sample into the sensor through the gas separation tube and then exits through the gas outlet port on the side of the enclosure.

A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data is stored in non-volatile memory so that it can be sent to a PC for record keeping. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

The monitor is powered by a rechargeable NiMH, NiCd battery, or an alkaline pack.

**NOTE: The printed circuit board of the monitor is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the monitor. Severe damage to the printed circuit board may occur if the battery pack is not disconnected before servicing the unit.**

## 7. MAINTENANCE

The major maintenance items of the UltraRAE are:

- **Battery pack**
- **Sensor modules**
- **PID lamp**
- **Sampling pump**
- **Tube tip reservoir**
- **Inlet connectors and filter**

### 7.1 Battery Replacement

When the display shows a flashing message “Bat”, the battery requires recharging. The battery may be replaced in the field (in area known to be non-hazardous) if required. It is recommended to recharge the UltraRAE monitor upon returning from fieldwork. A fully charged battery powers an UltraRAE monitor for 12 hours continuous operation. The charging time is less than 10 hours for a fully discharged battery. The built-in charging circuit is controlled by two-step constant voltage/constant current charging 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.**

## **Replacing and Recharging the Battery Pack**

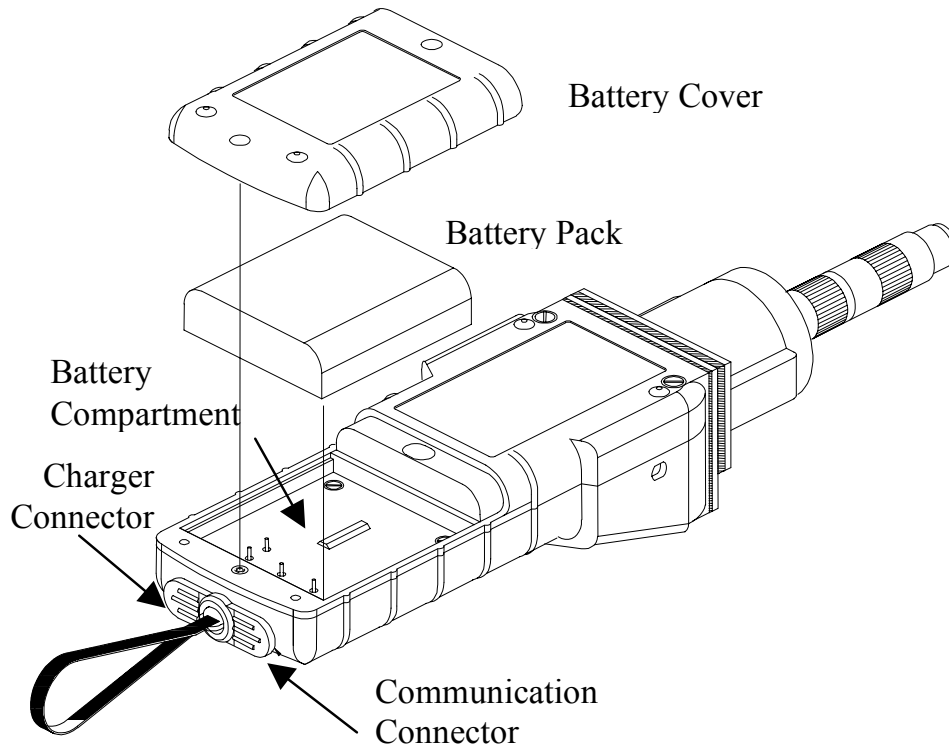


Figure 7-1 Battery Replacement

1. Turn off power of the UltraRAE.
2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery from the battery compartment.
4. Connect the battery pack to an external charging station (optional) for charging.
5. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment

6. Ensure the battery plug is securely connected to the UltraRAE.
7. Close the battery cover and tighten the two screws.

### **Replacing the Alkaline Battery Adapter**

1. Insert four fresh AA size alkaline batteries into the alkaline battery adapter. Make sure that the polarity of the batteries is correct.
2. Follow the same procedure as described above to replace the battery adapter.

Note: The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

## 7.2 PID Sensor Cleaning / Replacement

During normal operation, a film of dust or gas condensate may build up inside the PID sensor module and the UV lamp. The rate at which this film develops depends on the type and concentration of vapors being sampled. As a guide, it is recommended to clean the PID sensor module, the sensor compartment and the lamp if the unit malfunctioning.

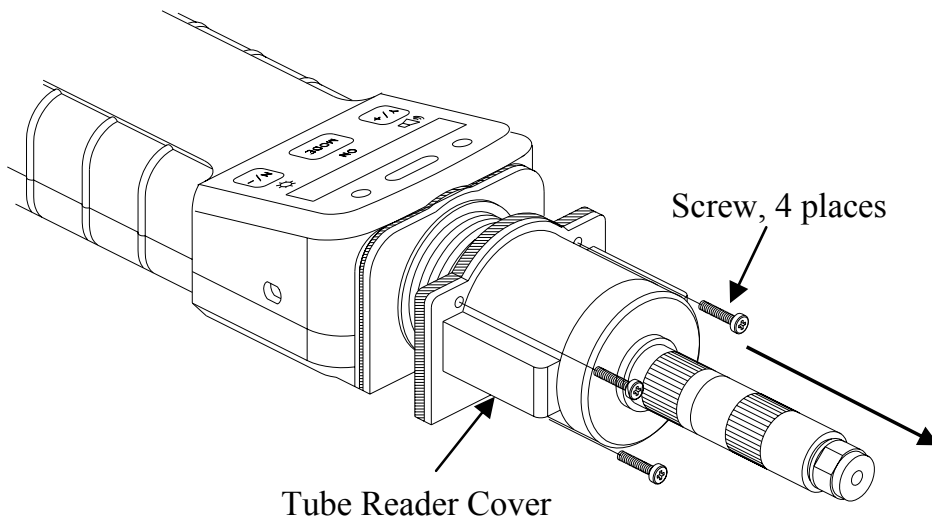


Figure 7-2 Tube Reader Removal

To access the sensor components and lamp, remove the four screws holding the tube reader housing shown in Figure 7-2. Next, remove the tube reader housing by gently pulling straight back.

If the lamp does not turn on, the monitor will display an error message (Lamp) to indicate replacement of the lamp may be required. Periodic cleaning of the lamp window will remove film deposits and restore lamp sensitivity. **Care must be exercised when cleaning the window surface so that it is not damaged.**

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-3.

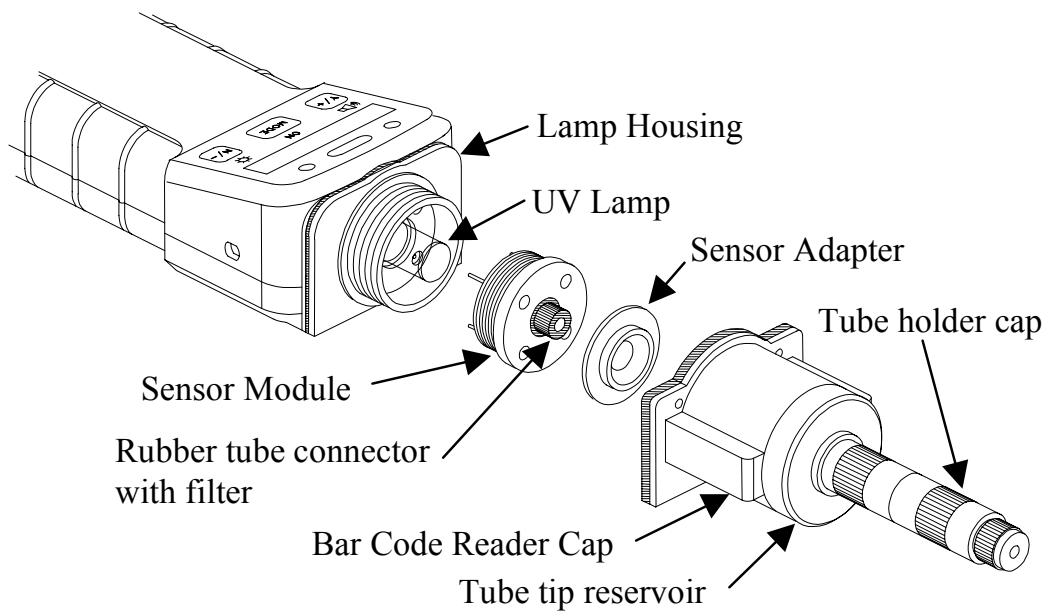


Figure 7-3 Sensor Components

1. Turn off UltraRAE power.
2. Open the bar code (tube) reader cover by unscrewing the four case screws from the front of the monitor case.
3. Remove the sensor module from the lamp housing by gently pulling on the module.

Note the sensor is made of Teflon and stainless steel material.

4. Dip the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly.
5. If the lamp is operational, use a cotton swab to clean the flat window surface with GC grade methanol. If the lamp does not turn on, remove the UV lamp from the lamp housing.
6. Replace a new lamp, avoiding contact with the flat window surface.
7. Reinstall the PID sensor module.
8. Replace the bar code (tube) reader and tighten the four screws, which holds down the cap.

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

Clean the lamp window surface by wiping it 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.

**Never touch the window surface with fingers or anything that may leave a film. Never use acetone on 11.7 eV lamps.**

**CAUTION: Water will degrade window surfaces, especially the 11.7 eV lamp window.**



### 7.3 Sampling Pump

The sampling pump is positive displacement piston pump. When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump.

To check the pump flow, remove the tube holder and insert a piece of 3/16" (4 mm) glass or metal tubing into the rubber tube connector in the sensor module (see **Figure 7-4**). The flow should be above 350 cc/min. The flow with a RAE-SEP benzene tube in the normal configuration should be greater than 200 cc/min.

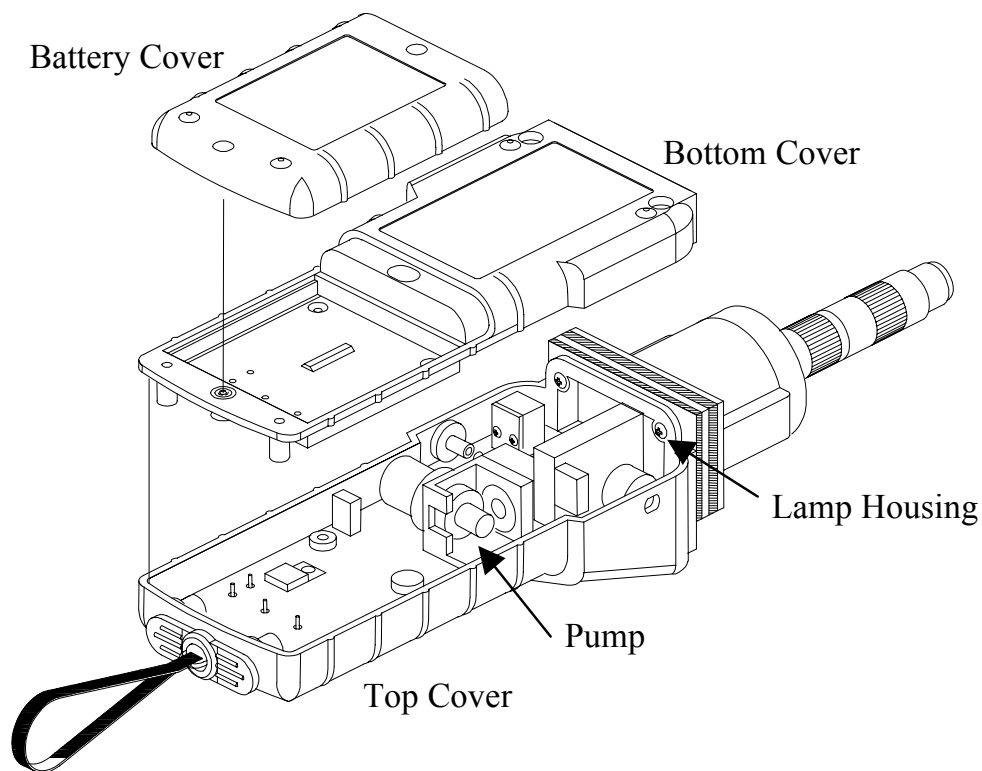


Figure 7-4 Sampling Pump

### **Pump Replacement**

1. Turn off UltraRAE power.
2. Open the battery cover, remove the battery pack, carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump to the gas inlet port and gas outlet port.
4. Replace a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.
5. Replace the bottom cover and tighten the six. Re-connect the battery pack. Replace the battery pack and its cover.

## 7.4 Tube Tip Reservoir

After a RAE-SEP tube end is broken off, the tube tip will be collected in the tube tip reservoir, as shown in Figure 7-5. When the tube tip reservoir is full, it is necessary to empty the reservoir. To do so, first unscrew the tube holder cap. Then remove the matching metal tube attached to the tube tip reservoir by turning it counter-clockwise. Then, unscrew the tube tip reservoir slowly. **Care must be exercised when turning the tube tip reservoir so that user's finger will not be cut accidentally by the glass debris inside the reservoir.** Empty the reservoir. Replace the reservoir, metal tube and tube holder cap in the reverse order.

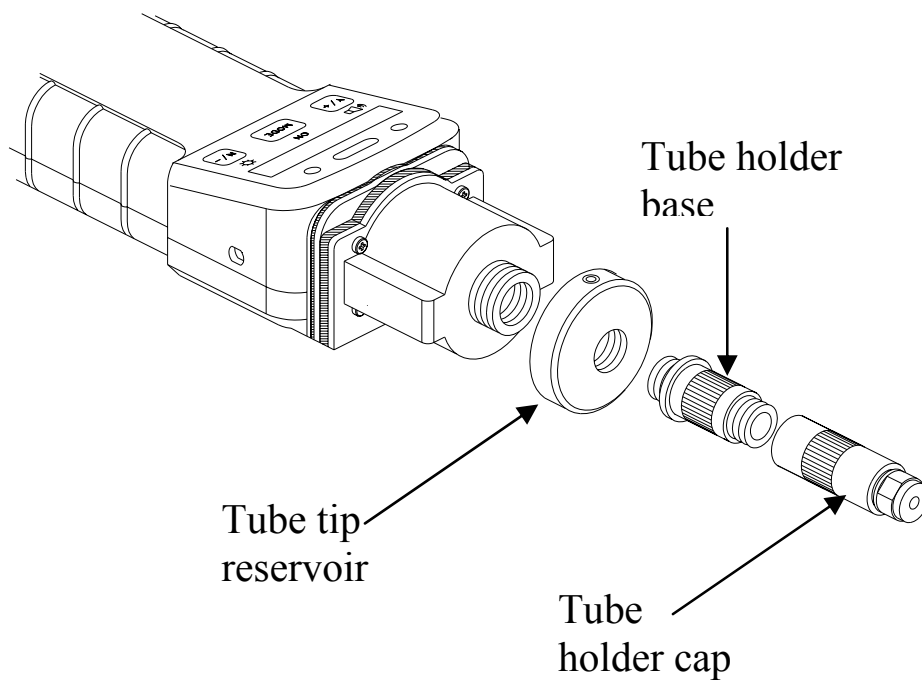


Figure 7-5 Tube Tip Reservoir

## 7.5 Inlet Connector and Filter

When a RAE-SEP tube is inserted into the monitor, both ends of the tube are sealed with rubber fittings to make an airtight connection for the gas inlet.

When a RAE-SEP tube is inserted into the Bar Code Reader Cap, the tube end is pushed against the rubber tube connector inside the sensor module, as shown in Figure 7-3. A porous metal filter is inserted into the other end of the rubber tube connector to prevent glass debris and dirt entering the sensor. To ensure that the metal filter is not clogged by glass debris or dirt, it is recommended that the metal filter should be replaced with a new one at regular interval (4-6 weeks). After repeated insertion, the rubber tube connector may be worn out. Replace the rubber tube connector with a new one to ensure airtight seal for the RAE-SEP tube.

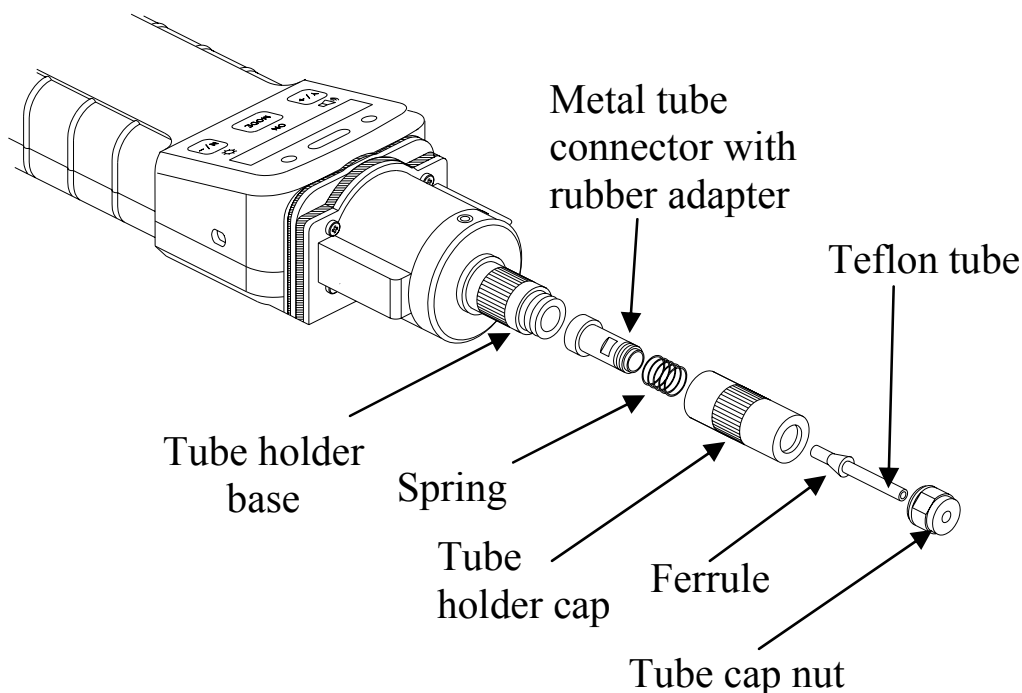


Figure 7-6 Gas Inlet Assembly

Figure 7-6 shows the assembly drawing of the gas inlet tube and tube cap holder. The gas inlet tube is made of a piece of Teflon tube. A metal ferrule is crimped onto the Teflon tube and the V-groove on the metal tube adapter provides an air tight seal when the tube cap is tightened. A spring maintains the necessary tension for the metal tube adapter so that it pushes the RAE-SEP tube against the sensor module. A piece of rubber tube is glued on to the metal tube adapter and provides airtight seal to the other end of the RAE-SEP tube. After repeated insertion, the rubber tube may also be worn out. Replace the entire metal tube adapter with a new one if necessary to ensure airtight seal for the RAE-SEP tube.

To replace the metal tube adapter, remove the tube holder cap from the bar code reader cap. Grab and pull the tube cap nut away from the tube-holder cap body. Use a hex wrench to hold the metal tube adapter by the flat section, unscrew the tube cap nut counter-clockwise to disassemble the tube holder cap and gas inlet tube assembly. Replace a new metal tube adapter.

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## 8. TROUBLESHOOTING

To aid the user in diagnosing the monitor, the monitor has a special diagnostic mode that can display critical, low level parameters. Section 8.1 describes the operation of the diagnostic mode. Section 8.2 summarizes the frequently encountered problems and suggested solutions. Turning on the UltraRAE monitor in diagnostic mode and using the troubleshooting table in Section 8.2, the user can usually narrow the problem down to one or two areas and correct the problem without having to return the monitor for repair.

**WARNING: The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these low-level parameters. If the user is not familiar with these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.**

## 8.1 Special Diagnostic Mode

To place the monitor into the special diagnostic mode, first turn the monitor off. Next push and hold the **[Y/+]** key, while still holding the **[Y/+]** key, also push and hold the **[MODE]** key for at least two seconds. After the required delay, release both keys, the monitor will now go through the normal start-up display sequence and display a “Diagnostic mode” message. At the end of the special mode start-up, the display will show the raw counts of sensor channel 1A. These numbers are raw sensor readings without calibration.

Other critical parameters of the monitor are available as shown below. They can be reached by pressing the **[MODE]** key repeatedly until the desired parameters are displayed.



## TROUBLESHOOTING

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Key Action	Display
	Raw readings, 1A (+ = 10X)
[MODE]	Raw readings, 10A (+ = 10X)
[MODE]	Raw readings, 1B (+ = 10X)
[MODE]	Raw readings, 10B (+ = 10X)
[MODE]	Lamp current
[MODE]	Lamp fail level (+/-)
[MODE]	Lamp drive (+/-)*
[MODE]	Battery (Alkaline/NiCd)
[MODE]	LCD contrast (+/-)
[MODE]	Pump current
[MODE]	Stall (pump) level (+/-)
[MODE]	Motor (pump) drive (+/-)*
[MODE]	DAC output count (+/-)
[MODE]	Alarm test (on/off)
[MODE]	Ambient light
[MODE]	Backlight trip level (+/-)
[MODE]	CCD tube reader (+/-)
[MODE]	Deep discharge (battery)

**Table 8-1 Diagnostic Mode Menu**

**\* Normally these settings should not be changed. When using an 11.7 eV lamp the LDRV can be increased up to 225 to extend the life of the lamp, and in this case the Lamp current drops and the Lamp Fail Level may need to be adjusted.**

The following is a brief description of a few diagnostic displays:

### 1) Raw Sensor Readings

The raw sensor readings provide a quick diagnosis on the response and the sensitivity of the sensor. When zero gas (fresh clean air) is applied to the monitor, the raw sensor readings typically should be between 100 and 300. If the raw reading is outside this range when zero gas is applied, the sensor or the electronics may be defective. Channel A is the PID sensor. Channel B is an auxillary channel that is not used.

When a specific gas is applied to the monitor, the raw reading should increase. If the reading does not change when the specific gas is applied, then the sensor or lamp may be defective.

### 2) Adjust Lamp Failure Threshold

This display can be used to calibrate the PID lamp failure threshold. If the lamp appears to be good but in normal operation, a lamp failure message (i.e. "Lamp") is displayed, the lamp failure level may be set too high. This level can be adjusted by using the following steps:

1. Turn the monitor off. Remove the UV lamp from the PID sensor (see Section 7.2)
2. Turn the monitor on in the special diagnostic mode ([Y/+] + **[MODE]**).
3. Press the **[MODE]** key until "Lamp xxx" is displayed, write down this number. The reading "xxx" is the lamp current reading.
4. Press the **[MODE]** key one more time. Fail yyy " is now displayed. The value "yyy" is the threshold level that determines a lamp failure. Anything below this level is considered a failure.

5. Push the [Y/+] or [N/-] key to increase or decrease the threshold value “yyy” until it is about 10 - 15 counts above the “xxx” value. This will optimally set the lamp failure threshold. Press [MODE] key to exit this display. If the threshold value has changed, a message “Save?” will appear. Press [Y/+] to confirm the change, [N/-] or [MODE] key to abandon the changes.
6. Turn the monitor off and replace the lamp.
7. To verify the above adjustment, turn the monitor back on in diagnostic mode and press the [MODE] key until “Lamp xxx, press the [MODE] key once more, Fail yyy +/-” is display. The lamp current reading “xxx” should be higher than the threshold value “yyy” by at least 10-15 counts. If not, the lamp may be defective or very weak.

In most cases, lamp failure threshold adjustment is not required, in which case the user should press [MODE] key to exit this display.

### **3) Battery Type**

The UltraRAE monitor can be powered by either a rechargeable NiMH / Ni-Cd battery pack or an alkaline battery adapter. This display shows the type of battery that is currently installed in the monitor. The charger cable must be unplugged for a correct battery type display.

### **4) Adjust LCD Contrast**

This display allows the user to adjust the LCD contrast. Press [Y/+] to increase the contrast and [N/-] key to decrease the contrast. The bar graph shows the current LCD contrast setting. If the display appears blank or very faint, press the [Y/+] key several times to increase the contrast or darken the display.

### 5) DAC Output Counts

The menu allows the user to adjust the value of the analog output DAC use the [Y/+] and [N/-] keys. The remote alarm output signal on the serial interface cable is deselected and the analog output signal is selected in its place. This signal has a range of 0 to 2.5V in 4096 steps. The initial default output is 2048, or half-scale. See Figure 8-1 for signal pin-out. The DAC output is linearly proportional to concentration.

### 6) Alarm Test

This menu is used to test the monitor's alarm generators, including four bright LED's, the loud buzzer, and the vibrator output signal (remote alarm). The message "Alarm" is first displayed, followed by "On?" If the [Y/+] key is pressed at this point, the alarms will turn on and the message "Off?" will appear. To turn the alarms off, press the [Y/+] key again. Check external alarm signal at connector.

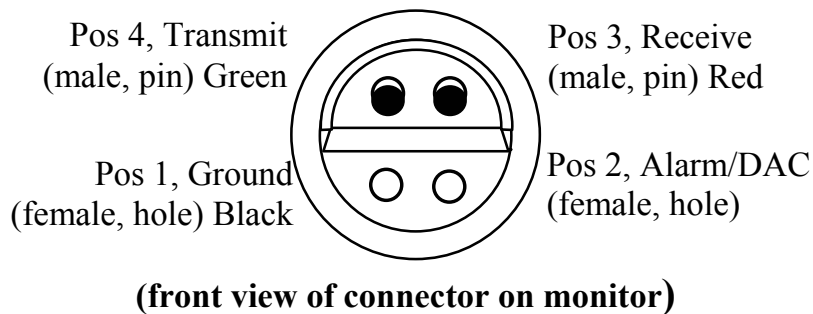


Figure 8-1 Communication/Alarm Connector

### 7) Adjust Backlight Threshold

This display can be used to calibrate the LCD backlight turn on and off threshold. Use the following steps to adjust the backlight threshold.

1. The "Lite = xxx" message displays the present ambient light level incident on the face of the monitor. In a brightly lit room, the light reading should be above 130.

2. The user can shade the light sensor, which is located at the upper left corner of the monitor, with their hand and watch the light sensor reading. The light reading should drop to less than 100. Determine the ambient light level when the back light should be turned on and record the light sensor reading. Press the [MODE] key one more time, the display should show the message “Trip= yyy”.
3. Use [Y/+] or [N/-] key to increase or decrease the trip value until it is about the same as the previously recorded light sensor reading. Press [MODE] key to exit this display. If the threshold value is changed, a message “Save?” will appear. Press [Y/+] to confirm the change, [N/-] or [MODE] key to abandon the changes.

### **8) CCD Tube Reader**

This function displays the total number of light sensing elements that are exposed to light (IR). The maximum value is 64 with no tube inserted. If this number is less than 64 when no tube is present, increase the light collecting ability of the CCD by pressing the [Y/+] key until this number just reaches 64. Then press the [Y/+] key two more times.

With a Benzene RAE-SEP tube inserted, this number should be 46 to 52. For the VOC tube, this number should be 59 to 61. Use the [Y/+] or [N/-] key to increase or decrease this count until it is within range.

### **9) Battery Deep Discharge**

This function allows the user to fully discharge the NiCd / NiMH rechargeable batteries. If the monitor is repeatedly used for only a few hours and then charged, or if the monitor's useable run time has decreased significantly, a deep discharge cycle may restore some of the battery's capacity. Before starting this function, the AC adapter should be plugged in. Press the [Y/+] key to confirm the start of this function.

## 8.2 Troubleshooting Table

Table 8-2

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	<p><b>Reasons:</b> Discharged battery. Defective battery Microcomputer hang-up</p> <p><b>Solutions:</b> Charge or replace battery. Disconnect, then connect battery to reset computer</p>
No LED or LCD back light	<p><b>Reasons:</b> Trigger level too low, in manual, defective LED or LCD back light</p> <p><b>Solutions:</b> Adjust trigger level. Call authorized service center</p>
Lost password	<p><b>Solutions:</b> Use default configuration to reset password from computer</p>
Buzzer inoperative	<p><b>Reasons:</b> Bad buzzer</p> <p><b>Solutions:</b> Call authorized service center</p>

TROUBLESHOOTING

<b>Problem</b>	<b>Possible Reasons &amp; Solutions</b>
Reading abnormally high	<p><b>Reasons:</b> Dirty sensor module Dirty water trap filter Excessive moisture and water condensation</p> <p><b>Solutions:</b> Clean &amp; dry sensor module Replace water trap filter Re-calibrate</p>
“Lamp” message during operation	<p><b>Reasons:</b> Weak or defective PID lamp, defective lamp drive circuit</p> <p><b>Solutions:</b> Check Lamp Threshold in diagnostic mode, Section 8.1. Replace PID lamp</p>
Reading abnormally low	<p><b>Reasons:</b> Incorrect calibration Low sensitivity to the specific gas</p> <p><b>Solutions:</b> Calibrate the monitor Replace sensor</p>
Tube ID error, incorrect ID, or not detected	<p><b>Reasons:</b> CCD value set incorrectly. Tube barcode bad or dirty. Barcode reader “Off”.</p> <p><b>Solutions:</b> Set CCD value in diagnostic mode; see Section 8.1. Use new or clean tube; make sure arrow points to monitor Turn on reader (Sect. 4.7.9) Start with no tube to manually select (Sect. 2.4.1) Turn off reader to manually select (Sect. 4.7.9)</p>

## TROUBLESHOOTING

<b>Problem</b>	<b>Possible Reasons &amp; Solutions</b>
Read a small background value	<p><b>Reasons:</b> There is actually a small background gas level Sensor zero drift</p> <p><b>Solutions:</b> Do fresh air calibration (see Section 4.4.1)</p>
Reading jumping around randomly	<p><b>Reasons:</b> Incorrect calibration gas value. Low sensitivity to cal gas</p> <p><b>Solutions:</b> Calibrate the monitor. Use different cal gas.</p>
Can not turn off monitor or corrupted characters in LCD display	<p><b>Reasons:</b> Microprocessor hang-up</p> <p><b>Solutions:</b> Disconnect and re-connect battery to reset computer. Call authorized service center.</p>
Calibration error message	<p><b>Reasons:</b> No standard gas input, weak PID lamp, unit zeroed with gas present</p> <p><b>Solutions:</b> Make sure standard gas flows into monitor. Zero sensor &amp; recalibrate, replace lamp.</p>



## TROUBLESHOOTING

<b>Problem</b>	<b>Possible Reasons &amp; Solutions</b>
“Bat” message in operation	<p><b>Reasons:</b> Discharged battery</p> <p><b>Solutions:</b> Recharge battery</p>
Full scale measurement in humid environment	<p><b>Reasons:</b> Dirty or wet sensor</p> <p><b>Solutions:</b> Clean and dry sensor Replace water trap filter</p>
Gas measurement saturates at certain level	<p><b>Reasons:</b> PID lamp is strong</p> <p><b>Solutions:</b> Place a UV block Teflon disk on lamp. Replace lamp</p>
Excessive pump noise or no inlet air suction	<p><b>Reasons:</b> Blocked inlet path Defective pump</p> <p><b>Solutions:</b> Check inlet connection Replace a new lamp</p>
Inlet flow too low	<p><b>Reasons:</b> Pump diaphragm damaged or has debris. Flow path leaks.</p> <p><b>Solutions:</b> Check flow path for leaks; sensor module, tube connectors, Teflon tube compression fitting. Replace pump.</p>

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## QUICK REFERENCE GUIDE

### PROGRAMMING MODE

Calibrate monitor?

Fresh air calib?  
Span calib?  
Modify span value?

Change alarm limits?

High limit?  
Low limit?

View or change datalog?

View data?  
Clear data?  
Change data log?

Change monitor setup?

Change Site ID?  
Change User ID?  
Change User Mode?  
Change Date?  
Change Time?  
Change backlight?  
Change DAC/Alarm output?  
Change DAC range?  
Change Bar code reader?

Change sensor config?

Change measure wait time?  
Change lamp?  
Change dilution ration?

## TUBE DATA SHEETS

**Benzene C<sub>6</sub>H<sub>6</sub>****Part No.: 012-3022-005**

Standard Lamp	Typical Range (ppmv)
9.8 eV	0.1 – 1000

**Temperature Range:** 2 - 40°C (36 - 104°F)

Temp (°C)	2-10	10-15	15-30	30-40
Temp (°F)	36-50	50-60	60-86	86-104
Measure Time (sec)	150	90	60	40

Calibration should be performed at the same temperature as the measurement.

**Humidity:** No effect on reading 0 - 95% RH. Humid, clean air drawn through the tube before measurement will reduce VOC capacity.**Storage Life and Conditions:** Unopened tubes can be stored for 1 year in darkness at 5 - 25°C (40 - 77°F). Refrigeration is preferred. Open tubes should be used within one hour to avoid loss of capacity.**Color Change:** Yellow → Brown → Green

The benzene reading may be high if the green color extends to more than 3/4 of the length. The tube may still have some capacity if there is no green color.

**Note:** It is preferable to recalibrate when changing batches. For more details on tube operation see Technical Note 136.


<u>Cross-sensitivity:</u> Substance	Test Conc. (ppmv)*	Apparent Benzene Response	Substance	Test Conc. (ppmv)*	Apparent Benzene Response
Toluene	400	0.1	n-Hexane	100 <sup>#</sup>	0.0
o-Xylene	200	0.0	Cyclohexane	10 <sup>#</sup>	0.4
Ethylbenzene	200	0.0	n-Octane	300	0.1
Styrene	100	0.0	β-Pinene	50	0.0
Nitrobenzene	100	0.0	Ethanol	50	0.0
Phenol	100	0.0	Isopropanol	100	0.0
Chlorobenzene	20	2.5	Acetone	100	0.0
Dichlorobenzene	50	1.0	Cyclohexanone	200	0.0
Hydrogen Sulfide	150	0.0	Tetrahydrofuran	100	0.0
Methane	25000**	0.0	Ethyl acetate	100	0.0
Propane	1000	0.0	Acrylonitrile	100	0.0
Isobutane	100	0.0	Epichlorohydrin	100	0.0
Isobutylene	500	0.0	Trichloroethylene	100	66
1,3-Butadiene	300	0.0	Perchloroethylene	50	38
n-Pentane	1500	0.0			

\*Not necessarily the maximum allowable concentration. \*\* Methane has no effect on tube capacity. Propane and higher hydrocarbons do affect capacity.

<sup>#</sup> Higher concentrations may cause a reduced benzene response.**Note:** Each tube contains about 3 mg of chromium compounds.

APPENDIX B

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**Butadiene (Polymer) C<sub>4</sub>H<sub>6</sub>**  **Part No.: 012-3024-005**

Standard Lamp	Typical Range (ppmv)
9.8 eV	0.1 - 200

Temperature Range: 5 - 40°C (41 - 104°F)

Temp (°C)	5-18	18-30	30-40
Temp (°F)	41-64	64-86	86-104
Measure Time (sec)	180	75	50
Sample Vol. (mL)	1500	600	400

Calibration should be performed at the same temperature as the measurement.

Humidity: 0 - 95% RH.

RH	<5%	50%	80%
Correction Factor (CF)	1.0	1.5	1.6

When calibrated from a dry gas cylinder, multiply the reading by the CF to obtain the true value.

Color Change: None

Storage Life and Conditions: Unopened tubes can be stored for 2 years in darkness at 0 - 40°C (32 - 104°F). Open tubes may be stored for up to 8 hours in clean air without significant loss of capacity.

<u>Cross-sensitivity:</u> Substance	Test Conc. (ppmv)*	Apparent Butadiene Response	Substance	Test Conc. (ppmv)*	Apparent Butadiene Response
Acrylonitrile	100	0.0	Methane	25000**	0.0
Styrene	100	0.0	Methyl Bromide#	5	3#
Ethylbenzene	200	0.0	Propane	1000	0.0
Toluene	100	0.2	Isobutane	100	0.0
Toluene	200	2	Isobutylene	50	40
Benzene	10	0.3	n-Hexane	200	0.0
Benzene	100	7	Cyclohexane	50	0.5

\*Not necessarily the maximum allowable concentration.

\*\* Methane above 1% by volume reduces the PID response, but has no effect on tube capacity. Butane and higher hydrocarbons reduce tube capacity.

# Methyl bromide can be measured using a 10.6 eV lamp and a 60 sec. sampling time at room temperature. Adjust time at other temperatures proportionately.

**Note:** Unused tubes contain no hazardous components but may adsorb toxic compounds from the environment.

# Halocarbon (CH<sub>2</sub>Cl<sub>2</sub>)

Part No.: 012-3023-005

Standard Lamp	Typical Range (ppmv)
11.7 eV	0.1 - 200

Temperature Range: 2-40°C (41-104°F)

Substance	Meas. Time (sec)	Vol. (mL)	Temp (°C)	2-10	10-15	15-30	30-40
			Temp (°F)	36-50	50-60	60-86	86-104
			Time (sec)	3x	2x	1x	0.67x
Methyl Chloride	30	180					
Methylene Chloride (MC)	30	180					
Chloroform	45	260					
Carbon Tetrachloride	60	350					

Calibration should be performed at the same temperature as the measurement.

**Humidity:** No effect on reading 0 - 95% RH. Humid, clean air drawn through the tube before measurement will reduce VOC capacity.

**Storage Life and Conditions:** Unopened tubes can be stored for 1 year in darkness at 5 - 25°C (40 - 77°F). Open tubes may be stored for up to 8 hours in clean air at 50% RH without significant loss of capacity.

**Color Change:** Orange → Brown

The reading may be high if the tube is discolored to more than ¾ of its length.

**Storage Life and Conditions:** Unopened tubes can be stored for 2 year in darkness at 0 - 40°C (32 - 104°F). Open tubes may be stored for up to 8 hours in clean air without significant loss of capacity.

**Note:** For more details on tube operation see Technical Note 133.

<u>Cross-sensitivity:</u> Substance	Test Conc. (ppmv)*	Apparent MC Response
Acetone	300	0.0
Ethanol	300	0.0
Ethyl acetate	300	0.0
Toluene	300	0.0
Methane	25000**	0.0
Isobutylene	500	0.1
n-Octane	200	0.0
Tetrahydrofuran	50	0.5

\*Not necessarily the maximum allowable concentration.

\*\* Methane above 1% by volume reduces the PID response, but has no effect on tube capacity. Butane and higher hydrocarbons reduce tube capacity.

**Note:** Each tube contains about 3 mg of chromium compounds.

## **RAE SYSTEMS TECHNICAL NOTES**

- TN-102 Facts About PID Measurement
- TN-103 External Datalogger Interface to MiniRAE PID
- TN-104 Partial List of Ionization Potentials
- TN-105 MiniRAE PID Battery Characteristics
- TN-106 Correction Factors, Ionization Potentials, and Calibration Characteristics
- TN-108 MiniRAE PLUS PGM-76 and 76IS ProRAE 76 Software Upgrade for PGM-75
- TN-109 MiniRAE Professional PID Zero Drift
- TN-112 MiniRAE PLUS Datalogger Data Conversion to Microsoft Excel version 5.0
- TN-113 Calibration Procedures for ModuRAE PDM-10A
- TN-114 ToxiRAE Sensor Specifications
- TN-115 ToxiRAE Toxic Gas Monitor (PGM-35) at a Glance
- TN-116 ToxiRAE Oxygen Monitor (PGM-36) at a Glance
- TN-117 ToxiRAE Combustible Gas Monitor (PGM-37) at a Glance
- TN-118 Use of RAE PIDs for Soil Headspace Measurements
- TN-119 Calculation of STEL, TWA, Min., Max., and Average Values for ToxiRAE PID.
- TN-120 Measuring Correction Factors for Volatile Compounds with MiniRAE 7 and ToxiRAE PIDs
- TN-121 CO Sensor Cross-Sensitivity and Removal with Charcoal Filter
- TN-122 MiniRAE Compliance with EPA Method 21
- TN-123 Diagnostic Modes for RAE Instruments
- TN 124 PID Lamp Characteristics
- TN 125 Creating Custom Correction Factors and Gas Names for the ToxiRAE PID
- TN-126 Interchangeability of Sensors in PGM-35 and PGM-50
- TN-127 Benzene-Specific Measurements in Petroleum Hydrocarbons using the UltraRAE
- TN-128 ToxiRAE PID Communications Problems
- TN-130 Setting Alarm Limits for Mixtures
- TN-131 Verifying and Fixing Gas Alarm Limits
- TN-132 Upgrading RAE Instruments Firmware

## APPENDIX C

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- TN-133 Methylene Chloride-Specific Measurements using the UltraRAE
- TN-134 UltraRAE Bar Code Reader Patterns and Adjustments
- TN-135 UltraRAE Firmware & Tube Data Upgrade Procedures
- TN-136 UltraRAE Operations Tips
- TN-137 Exiting Diagnostic Mode for ToxiRAE LEL
- TN-138 RAE System Year 2000 Compliance
- TN-139 UltraRAE Communication with NT
- TN-140 Extension Tubing Volume and Delay Time
- TN-141 MultiRAE Remote Control Functions
- TN-142 MiniRAE 2000 Preprogrammed Compound Library
- TN-143 Accuracy Comparisons of Gas Detection Tubes
- TN-144 Handling LEL Sensor Poisoning
- TN-145 Proper Care of Nickel Cadmium Battery Packs
- TN-146 Turning On UV Lamps in a PID Monitor
- TN-147 UltraRAE: Butadiene Specific Monitor
- TN-148 Measurement of Phosphine (PH<sub>3</sub>) by PID In the Food Storage industry
- TN-149 PGM-30 UV Lamp Care
- TN-150 Understanding the ppbRAE
- TN-151 Electrochemical Sensor Replacement and Maintenance
- TN-152 Effects of Operating Conditions on Oxygen Sensors
- TN-153 TC Sensor Applications and Correction Factors
- TN-154 SampleRAE Correction Factors
- TN-155 2-Year Oxygen Sensor Installation and Calibration
- TN-156 Correction Factors for Combustible Gas (LEL) Sensors
- TN-157 Moisture Exchange Tubes for Humidity Control of Test Gases
- TN-158 Conversion of PID Readings to Methane Equivalent Response
- TN-159 Nerve Agent Measurements by PID
- TN-160 Upgrading MultiRAE/QRAE Ni-Cd Battery Pack

Technical Notes are available at [www.raesystems.com](http://www.raesystems.com).  
See Appendix E to order hard copies of Technical Notes.



## RAE SYSTEMS APPLICATIONNOTES

- AP-200 PIDs and Aircraft Wing-tank Entry
- AP-201 Measuring Ammonia (NH<sub>3</sub>) with PIDs
- AP-202 ABCs of Gases in Industry
- AP-203 PID as a Hazmat Response Tool
- AP-204 Pulp & Paper: Measuring Turpentine & ClO<sub>2</sub>
- AP-205 Measuring Heat Transfer Fluids with a PID
- AP-206 Guide to Atmospheric Testing in a Confined Space
- AP-207 PIDs as an Arson Investigation Tool
- AP-208 HAZMAT User List
- AP-209 UltraRAE User List
- AP-210 North American RAE User List
- AP-211 PIDs for Continuous Monitoring of VOCs
- AP-212 PIDs for Indoor Air Quality
- AP-213 ModuRAE PID Configuration and Applications
- AP-214 Environmental Applications for PIDs
- AP-215 Gas Detection in the Marine Industry
- AP-216 Weapons of Mass Destruction
- AP-217 Confined Spaces in the Construction Industry
- AP-218 Lengthening the Interval Between Calibration Checks
- AP-219 Using PIDs for 10% of LEL Decisions
- AP-220 Using PIDs in Clan Lab Investigations
- AP-221 PIDs for Exposure Risk in Unknown Environments
- AP-222 CO & Natural Gas Detection for Fire Department Engine Companies
- AP-223 ppbRAE User List
- AP-224 Understanding the CDRAE and its Applications

Application Notes are available at [www.raesystems.com](http://www.raesystems.com)  
See Appendix E to order hard copies of Application Notes.

## LITERATURE REQUEST

Application and Technical Notes are available at [www.raesystems.com](http://www.raesystems.com) in PDF format for printing.

For hard copies, Photocopy this page and fax to:

**Attn: Literature Department**

**1.408.752.0724 FAX**

Please send me the following information:

Name: \_\_\_\_\_

Company: \_\_\_\_\_

Mailing Address: \_\_\_\_\_

City, State, Zip: \_\_\_\_\_

Country: \_\_\_\_\_

Telephone: \_\_\_\_\_

Fax: \_\_\_\_\_

Technical Notes:  
(just list TN #) \_\_\_\_\_

Application Notes:  
(just list AP #) \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Thank you, RAE Systems Sales & Marketing Department

## REQUEST FOR RMA FORM

**Need to send your monitor in for repair,  
calibration, service or upgrading?**

For proper tracking of your equipment please obtain an **RMA  
Number** before returning the monitor.

Photocopy this page and fax to Attn: Service Department:  
**1.408.585.3544**

We will return fax the RMA Number and instructions on how to ship.

We must obtain the following information in full:

Name:

Company:

Shipping

Address:

City, State, Zip:

Telephone:

Fax:

Serial number:

Model:

Reason for  
return:

---

Note: When returning an instrument for repair, please send only the monitor that needs to be worked on without any additional accessories. Only send accessories with the instrument when they are also in need of repair. This will help us get your equipment back to you in an efficient manner.

Thank you, RAE Systems Service Department

---

**RAE Systems Inc.**  
1339 Moffett Park Drive  
Sunnyvale, California 94089

**Main Contact Numbers**

**TEL: 408.752.0723**

**FAX: 408.752.0724**

**Toll Free Numbers**

**Instrument Sales: 877.RAE.CUSTOMer (723.2878)**

**Technical Service: 888.RAE.4800 (723.4800)**

**Tube Sales: 888.RAE.TUBE (723.8823)**

**E-mail:**

**Instrument Sales: [raesales@raesystems.com](mailto:raesales@raesystems.com)**

**Technical Service: [tech@raesystems.com](mailto:tech@raesystems.com)**

**World Wide Web site:  
[www.raesystems.com](http://www.raesystems.com)**