VRAE

MULTI GAS MONITOR
PGM-7800 & 7840

OPERATION AND MAINTENANCE MANUAL

(Document No.: 017-4001)

Rev. E

$C\,\epsilon$

RAE SYSTEMS INC.
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Sunnyvale, CA 94089

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RAE Systems Product Line

- Gas Detection Tubes & Pumps
- SampleRAE Electronic Tube Pump
- MultiRAE PLUS Multi-gas Monitors
- MultiRAE Confined Space Monitor
- QRAE PLUS Multi-gas Monitors
- QRAE Confined Space Monitor
- VRAE Five Gas Surveyor
- MiniRAE 2000 Portable VOC Monitor (PID)
- UltraRAE Specific Compound Monitor
- CDRAE Corona Discharge VOC Monitor
- ToxiRAE PLUS PID Monitor
- ToxiRAE PLUS Single Gas Monitors
- ToxiRAE PLUS Oxygen Monitor
- ToxiRAE PLUS Combustible Gas Monitor
- MiniRAE PLUS Classic PID
- ModuRAE Fixed System PID
- AreaRAE Wireless Multi-point, Multi-gas Detection Systems

How can I be informed and updated?

Be sure to mail in your warranty card, email or fax us to get on RAE's private database (information is never supplied to others).

You will be updated on new products, technical advisory notices, new accessories and much more. Thank you for your purchase!

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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.

The model PGM-7800 and PGM-7840 equipment are 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 PGM-7800 or PGM-7840 Multi gas 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 toxic sensor reading may indicate a few ppm. Ensure an area free of toxic 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 VRAE 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 initial use. See Section 7 for more information on battery charging and replacement.

-3-

When a monitor is turned on the first time, or after a long time without use, the real time clock of the unit may not work properly, error messages may indicate sensor expired. That is due to the incorrect time on the clock. After fully-charging the monitor, enter the correct time and date again to ensure that no more erroneous messages are displayed.

WARNINGS:
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 reference 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 puet compromettre la sécurité intrinsique. Ne charger les batteries que dans emplacements désignés non dangereux.

STATIC HAZARD:
Clean only with a 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 équipment 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.

CALIBRATION WARNINGS:

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

For maximum safety, the accuracy of the VRAE should be checked by exposing the sensor(s) to known concentration calibration gas(es) 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 dietalonnage avant de mettre en service l'instrument pour la première fois.

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

CAUTION:
Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration above the upper scale limit, which may be hazardous.

AVERTISSEMENT:
Toute lecture rapide et positive, suivie d'une baisse subite au erratique de la valeur, peut indiquer une concentration de gaz hors gamme de détection qui peut être dangereuse.

1   GENERAL INFORMATION

The **VRAE** is a programmable multi gas monitor designed to provide continuous exposure monitoring of toxic gases, oxygen and combustible gases for workers in hazardous environments. Two models of VRAE are available: **PGM-7800** and **PGM-7840**. The PGM-7840 has one more inorganic toxic sensor in lieu of an oxygen sensor in the PGM-7800. **The figures and displays shown in this manual are primarily for the model PGM-7800. For the model PGM-7840, the displays will be similar. However, the oxygen reading will be replaced by a toxic sensor reading, and the name "oxy" will be replaced by the name of the toxic sensor.**

The VRAE monitor detects inorganic toxic gases and oxygen concentration with the electrochemical sensors. It also monitors combustible gases with a catalytic bead sensor and a broad range of gases with a thermal conductivity detector. Other features include:

- **Lightweight and Compact**
    - 19 oz (540 g), walkie–talkie 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.

1.1 **General Specifications**

Table 1.1

VRAE Gas Monitor Specification
Dimensions: 7.75"L x 2.75"W x 1.5"H (19.6 cm x 7.0 cm x 3.8 cm)
Weight: 19 oz (540 g) with battery.
Detector: 5 sensors: electrochemical sensors for toxic gases, oxygen sensor, catalytic bead for combustible gases and thermal conductivity detector (TCD) for a broad range of gases. PGM-7800: oxygen, combustible, TCD and three toxic gas sensors. PGM-7840: one combustible/TCD and four toxic gas sensors.
Battery: Rechargeable, 4.8V/1250 mAh, Ni-MH battery pack with built-in charger (10 hours charge time) or a 4 AA alkaline battery adapter.
Operating Time: Up to 10 hours continuous operation.
Display: 2-line, 16 digit LCD with LED back light automatically in dim light.
Keypad: 1 operation key and 2 programming keys.
Direct Readout: Instantaneous values (up to 5), sensor name, high and low values for all detectors, TWA and STEL values for toxic, battery voltage and elapsed time.

Multi Gas Monitor Specification

(Continued)

Alarm Settings: Separate alarm limit settings for TWA, STEL, Low and High alarm.

Range, Resolution and Response Time (t_{90} diffusion):

CO	0-500 ppm	1 ppm	40 sec
H_2S	0-100 ppm	1 ppm	35 sec
SO_2	0-20 ppm	0.1 ppm	35 sec
NO	0-250 ppm	1 ppm	30 sec
NO_2	0-20 ppm	0.1 ppm	25 sec
Cl_2	0-10 ppm	0.1 ppm	60 sec
O_2	0-30 %	0.1 %	15 sec
LEL	0-100 %	1 %	15 sec
VOL	0–100%	1%	20 sec
HCN	0-100 ppm	1 ppm	200 sec
NH_3	0-50 ppm	1 ppm	150 sec
PH_3	0-5 ppm	0.1 ppm	60 sec
ClO_2	0-1 ppm	0.1 ppm	150 sec

Alarm: 90 dB buzzer and flashing red LED to indicate exceeded preset limits, low battery, or sensor failure.

Calibration: Two-point field calibration for fresh air and standard reference gas.

Attachment: Rubber boot, belt clip and wrist strap.

Sampling Pump: Internal integrated with 400 cc/min flow rate (high setting).

Protection: Password protected calibration settings, alarm limits, and data.

Multi Gas Monitor Specification
(Continued)

Intrinsic Safety:	UL & cUL Class 1, Division I, Group A, B, C, D (US & Canada), EEx ia IIC T2 (Europe).
EM Immunity:	No effect when exposed to 0.43mW /cm^2 RF interference (5 watt transmitter at 12 inches).
Data Storage:	16,000 readings (54 hours, 5 channels at 1 minute interval) in non-volatile memory.
Datalog Interval:	Programmable 1-3600 sec.
External Alarm:	Optional plug in pen size vibration alarm.
External Printer:	Optional plug in serial thermal printer.
Communication:	Download data to PC and upload monitor setup from PC through RS-232 link to serial port on PC.
Temperature:	-20° to 45°C (-4° to 113° F).
Humidity:	0 % to 95% relative humidity. (non-condensing)
Configuration:	2, 3, 4 and 5 gas with/without datalogging.

2 OPERATION OF VRAE

The VRAE Monitor is a walkie-talkie size multi-gas exposure monitor. It gives real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment, the VRAE 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 Physical Description

Figure 2.1 shows the main components of the VRAE Multi gas monitor which include:
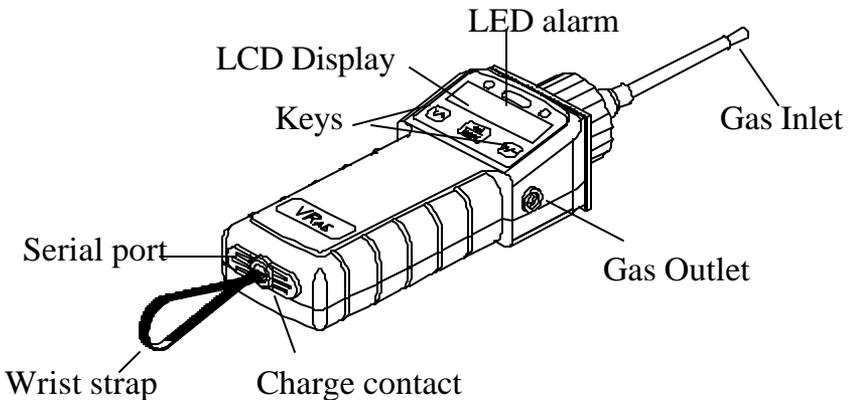
Figure 2.1   Major parts of the VRAE Multi Gas Monitor

- 3 keys for the user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor.

- LCD display with backlight to show real time and calculated measurements.

- 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 port.

- Serial communication port for PC interface.

- Analog output and external alarm output port.

2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The functions of the 3 keys during normal operation are summarized in Table 2.1 on the next page:

Light Sensor   Alarm LED   Charging LED
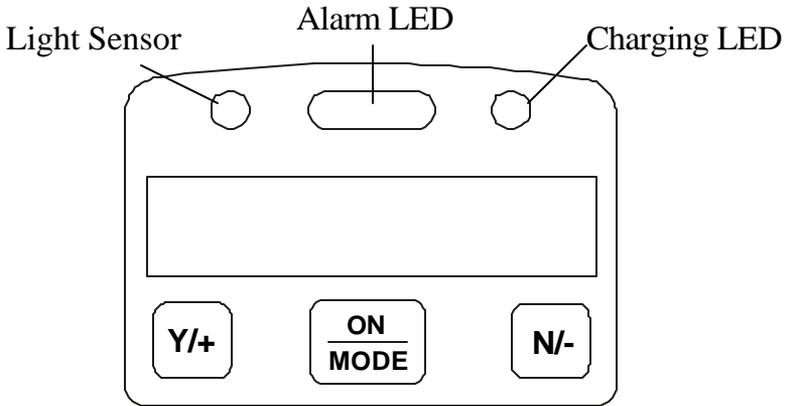
Y/+   ON MODE   N/-

Figure 2.2   Keypad and Display of the VRAE
Multi Gas Monitor

Table 2.1

Key	Function in Normal Operation
[MODE]:	Turn on/off the power* and choose different display mode.
[N/-]:	Toggle on/off the backlight.
[Y/+]:	Alarm test and alarm acknowledge (turn off latched alarm, turn on pump or LEL sensor).

* Pressing and holding **[MODE]** key for 5 seconds turns off the power to the monitor. Monitor will beep once per second during power-down sequence. Press **[MODE]** key momentarily to choose different display modes (see Section 2.4 for details).

Display

The VRAE multi gas monitor includes a 2-line, 16-digit dot matrix LCD display. The LCD shows the following eight types of displays during normal operation if the **[MODE]** key is pressed:

- Real time instantaneous gas concentration in ppm for toxic gases, % by volume for oxygen (not applicable to PGM-7840) and both % by volume and %LEL for combustible gases.
- Sensor names.

- Peak and minimum gas concentrations for toxic, oxygen (not applicable to PGM-7840) and combustible gases.

- 8-hour Time Weighted Average (TWA) or running average and 15 minute Short Term Exposure Limit (STEL) values of the toxic gases in ppm.

- Battery voltage and shut down voltage in volts.

- Real time clock, run time and temperature.

- Datalogging mode or "Start/Stop Datalog?" menu to to turn datalogging on/off if manual datalogging mode is selected.

- LEL/VOL gas names (if the LEL or LEL/VOL sensor is installed).

- Pump speed adjustment (High/Low)

- LEL/VOL sensor operating mode selection.

- "Communicate with PC?" menu to send or receive data between PC and the VRAE monitor.

2.3 Power On/Off

To turn on the VRAE multi gas monitor, press the **[MODE]** key. The audio buzzer will beep once and the display will show "ON!.." and then "MultiGas Monitor Ver n.nn" to indicate the software version number. Serial number, current date and time, temperature of the monitor are displayed next. The monitor will then go through each sensor socket to check if a valid sensor is installed. If a new sensor is installed, a message to remind the user to calibrate the sensor will be displayed followed by a message that the alarm limits have been reset to default values for the new sensor. If a sensor reaches its expected end of life, a "Warranty Expired" message will be displayed. The sensor can be used beyond this date if it still calibrates properly and has enough resolution as tested by the raw readings (see Section 8 and Technical Note 123).

Next, the monitor displays the preset alarm limits for each sensor, battery voltage, shut down voltage, user mode, alarm mode, datalog mode, available data storage memory (in hours), datalog mode and datalog interval (in seconds). Then after a warm-up interval (default of 10 seconds), the VRAE monitor is ready to monitor gases, and the display shows the instantaneous reading of the gas concentration in ppm.

To turn off the VRAE multi gas 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.

Turning off the multi gas monitor with the AC adapter in place will result in a display of "Charging.." or "Battery Charged" and indication of battery voltage. This indicates that the monitor is off, but the smart charger circuit is now active.

To turn the unit on from the charge or discharge mode, press the **[MODE]** key.

Data protection during power off

When the monitor is turned off, all the current real time data including TWA, STEL, Peak and elapsed time 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 the 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.

Datalog versus Non Datalog monitor

The VRAE multi-gas monitor is available either with or without the Datalog option. During the power on sequence, a letter "D" following the version number indicates that the monitor is configured as a Datalog monitor. Without the letter "D", it is a Non-Datalog monitor.

The user can upgrade a Non-Datalog monitor to a Datalog monitor. Call the factory for information on how to order the upgrade kit.

For instructions and operations of datalog features, please refer to Sections 4.6 and 5 of this manual.

2.4 Operations

The VRAE multi gas monitor offers three different user modes of operation:

> **Text** mode,
> **Display** mode, and
> **Program** mode.

The **text** mode is the simplest mode of operation. The monitor will display the sensor name after the monitor is turned on. The user can press the **[MODE]** key to see the instantaneous gas concentration readings, battery voltage or enter the PC communication menu.

The display sequence in text mode.
The four displays are arranged in a "round robin" order:
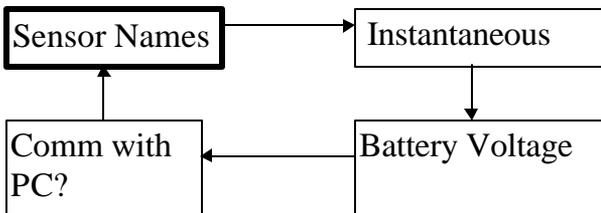
To choose a specific display, press the **[MODE]** key one or more times until the desired display appears.

In the **display** mode, the VRAE multi gas monitor displays eight different readings: instantaneous gas concentration, sensor name, Peak, minimum, STEL, TWA, battery voltage and shut down voltage in volt, run time in hours and minutes and temperature in degree F. In addition, there are up to five more displays to show datalog mode (or enable / disable datalogging operation in manual datalog mode), to show the

LEL gas names, to show pump speed, and to print reading (Option) and to communicate with a PC.

In the **program** mode, the user can perform all of the functions of the display mode. In addition, the user can enter a **Programming Mode**. In the programming mode, the user can perform various functions, such as change sensor configurations, enter user information or calibrate the monitor, etc. The programming mode will be explained in detail in Section 4. Below is the display sequence in **display** and **program** mode.

The thirteen displays are arranged in a "round robin" order:

```
                    ┌──────► Instantaneous ──────┐
                    │                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ Comm with PC?   │          │  Sensor Name    │
        └─────────────────┘          └─────────────────┘
                 │                             │
                 ▼                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ Print Reading?* │          │   Min. Value    │
        └─────────────────┘          └─────────────────┘
                 │                             │
                 ▼                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ Pump Speed H/L  │          │   Peak Value    │
        └─────────────────┘          └─────────────────┘
                 │                             │
                 ▼                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ LEL Gas Name    │          │   STEL Value    │
        └─────────────────┘          └─────────────────┘
                 │                             │
                 ▼                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ Start/Stop Dlog?*│         │   TWA Value     │
        └─────────────────┘          └─────────────────┘
                 │                             │
                 ▼                             ▼
        ┌─────────────────┐          ┌─────────────────┐
        │ Run time, Clock │◄─────────│ Battery Voltage │
        │ Temperature     │          └─────────────────┘
        └─────────────────┘
```
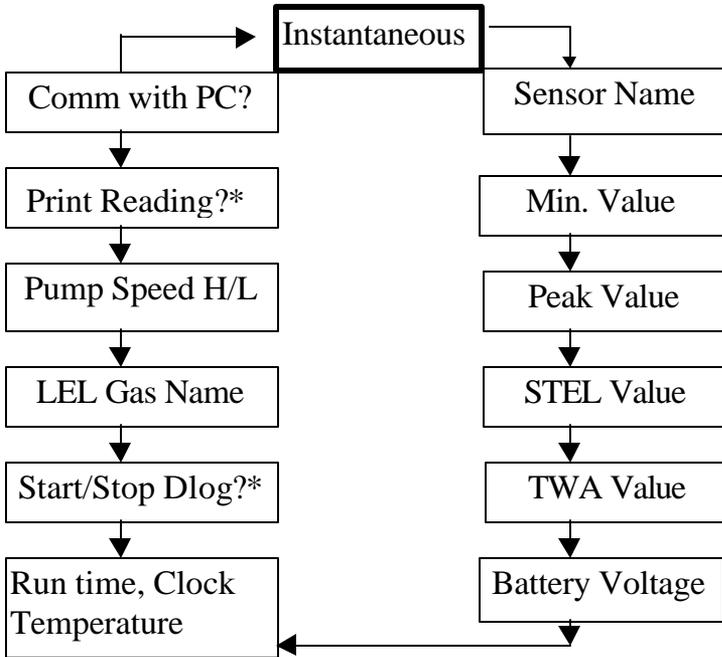
* Appears only if the option is enabled.

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

2 - 11

The followings are the brief explanations of each LCD display in the **text** mode or the **display** mode operation for the model PGM-7800. **For the model PGM-7840, the displays will be similar. However, the oxygen reading will be replaced by a toxic sensor reading, and the name "oxy" will be replaced by the name of the toxic sensor.**

1) The **instantaneous** reading is the actual gas concentration in parts per million (ppm) for toxic gases, % of volume for oxygen and % of volume or % of LEL for combustible gases. The reading is updated once per second and is shown in the LCD display.

0	0.0	0
0		20.9

2) The **sensor names** are displayed as:
   LEL: For combustible gas sensor
   OXY: For oxygen sensor (not for PGM-7840)
   CO, H_2S, etc.: For up to 3 toxic sensors (4 for PGM-7840)

CO	SO$_2$	H$_2$S
LEL		OXY

3) The **Peak** reading is the highest reading of each gas concentration since the monitor was turned on. The reading is updated at one-second intervals and is shown in the LCD display with "PEAK" message.

```
5          2.0          3
10         PEAK      20.9
```

4) The **Minimum** reading is the lowest reading of each gas concentration since the monitor was turned on. The reading is updated at one-second intervals and is shown in the LCD display with "MIN" message.

```
0          0.0          0
0          MIN       19.9
```

5) The **STEL** reading is the last 15-minute average reading of the gas concentration. The reading is updated once per minute and is shown in the LCD display with "STEL" message. For the first 15 minutes, "****" will be displayed. This reading applies to toxic gases only. The model PGM-7840 will have one more reading displayed on the right of the "STEL".

```
0          0.0          0
          STEL
```

6) The **TWA** reading is the accumulated reading of the gas concentration divided by 8 hours since the monitor was turned on. The reading is updated once a minute and is shown in the LCD display with "TWA" message. This reading applies to toxic gases only. The model PGM-7840 will have one more reading displayed on the right of the "TWA" or "AVG".

```
0          0.0          0
           TWA
```

The user can also choose to display "running average", instead of the TWA. See Section 4 for details on how to select running average or TWA. When running average is selected, the LCD display will show "AVG", instead of "TWA".

```
0          0.0          0
           AVG
```

7) The **battery voltage** reading is the current battery voltage in volts. The reading is updated once per second and is shown in the LCD display. The shut down voltage is also shown. **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, plus a buzzer alarms every second. This means there is 20-30 minutes run time left before the monitor will be turned off automatically, when the battery voltage falls below 4.2 volts.

```
Battery = 4.8 V
Shut off at 4.2 V
```

8) The **run time** reading is the accumulated "On" time in hours and minutes since the monitor was turned on. The reading is updated at one-minute intervals and is shown in

the LCD display together with the current date, time and temperature.

```
8/3/96      8:30

On = 3:50         20°C
```

9) The **datalog** menu shows the current datalog mode. If the VRAE monitor is non-datalog monitor, this menu will not show up. If manual datalog mode is selected, the menu will prompt the user to turn on or off datalogging. Pressing the **[Y/+]** key while "Start Datalog?" message is displayed turns on the datalogging. Likewise, pressing the **[Y/+]** key while "Stop Datalog?" message is displayed turns off the datalogging.

10) The monitor displays the selected **LEL gas name** if the combustible sensor is installed. When an LEL gas is selected, the "calculated" gas concentration based on the built-in correction factor for that specific gas will be displayed.

11) The monitor displays pump speed "High" or "Low." Press [Y/+] key to accept the displayed speed. Press [N/–] key to toggle to the other speed.

12) From the LEL/VOL menu the user can select the operating mode of the LEL/TC sensor: "LEL", "VOL", or "Autorange". See Section 4.8 for more details.

13) If the serial printer option is enabled through the Pro-RAE suites, a new menu item is shown "Print Reading?" Connect a Rae specified serial printer to the serial port of the monitor. By pressing the "Y" key, the current instantaneous readings of the monitor will be printed out from the serial printer.

14) The **communicate with PC?** menu display allows the user to upload data from the VRAE to a Personal Computer (PC) or download configuration information from a PC to the VRAE.

Press the **[Y/+]** key and the LCD displays the message "Monitor will pause, OK?" to remind the users that during PC communication, there will be no real time monitoring of the gas concentration. Press **[Y/+]** key to proceed and the monitor enter the communication standby mode. The LCD then displays "Ready..." Connect the monitor to the serial port of a PC. The monitor is then ready to receive any command from PC (see Section 5 for details on communications between VRAE and PC).

Note: When the monitor is in communication standby mode, it stops monitoring the gas concentration and stops datalogging. Datalogging must be manually restarted when exiting the communication standby mode, unless it is in automatic datalogging mode.

Press the **[MODE]** or **[N/-]** key to exit the communication standby mode and move to the next display, which shows instantaneous readings.

Display time out

In all displays, the LCD will automatically return to the instantaneous reading (in display or program mode) or sensor name (in text mode) after a one-minute timeout interval if no key is pressed.

2.5 Alarm Signals

The built-in microcomputer constantly updates and monitors gas concentration and compares it with the programmed alarm limits (TWA, STEL, and two instantaneous alarm limits: Low & High). Whenever the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn the user of the alarm condition.

In addition, the VRAE will alarm if any of the following condition occurs: battery voltage falls below a pre-set voltage level (4.4 V), LEL sensor is off, pump stalls, reading is over range or when 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.

Alarm Signal Disabled: It is extremely important to note that during the following conditions, the alarm signals are disabled:
1) **When entering PC communication standby mode.**
2) **When entering Calibration mode.**
3) **When viewing data in datalog.**
4) **When printing data to serial printer. (Short moment)**
During these modes of operation, real time monitoring of the gas concentration stops. None of the gas concentrations will be calculated, including Peak, STEL and TWA.
Alarm Signal Latching:

It is possible to setup the VRAE from a PC or in programming mode so that when an alarm condition occurs, the alarm signals stay on even after the alarm condition is no longer present. This is called the "latching alarm" mode. The alternative mode is to automatically reset the alarm signal when the alarm condition is cleared. The default alarm mode is automatic reset (see Section 4 and Section 5 for details on how to set alarm mode).

Alarm Signal Summary:

The various alarm signals are summarized here:

Condition	Alarm Signal
Gas exceeds "High Alarm" limit	3 beeps/flashes per second plus sensor name and "High" message on LCD
Gas exceeds "Low Alarm" limit	2 beeps/flashes per second plus sensor name and "Low" message on LCD
Gas exceeds STEL	1 beep/flash per second plus sensor name and "STEL" message on LCD
Gas exceeds TWA	1 beep/flash per second plus sensor name and "TWA" message on LCD
Instrument max out or sensor over range	3 beeps/flashes per second plus sensor name and MAX or OVR message on LCD
Excessive negative sensor drift	1 beeps/flashes per second plus sensor name and NEG message on LCD

Pump failure	2 beeps/flash per second plus "Pump" message on LCD
LEL sensor off	3 beeps/flash per second plus LEL sensor name and "Off" 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 conditions, it is possible to test the VRAE LED, buzzer and back light by pressing the **[Y/+]** key momentarily. The buzzer beeps once and the LED and back light flashes once to indicate that these alarm signals are functioning correctly.

<div style="border:1px solid">

WARNING:

The alarm signals are disabled during PC communication, calibration or datalog review operation. To reduce the risk of exposure to hazardous atmospheres, perform PC communication, calibration or datalog review only in area known to be non-hazardous.

</div>

2.6 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. In manual mode, this back light can be turned on **manually** by pressing and holding the **[N/-]** key for one second in normal operation. The back light can be turned off by pressing **[N/-]** a second time. If the **[N/-]** key is not pressed, the back light 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 back light will be turned on **automatically** if the ambient light is below a threshold level. The back light will be turned off automatically when the ambient light exceeds the threshold level.

(See Section 4 and Section 5 for details on how to set back light mode and time out period from the monitor or from PC. See Section 8 for details on how to set the ambient light threshold level.)

Note: The LED back light consumes a higher amount of energy from the battery and shortens the operating time of the monitor by 20 - 30%.

2.7 Preset Alarm Limits and Calibration

The VRAE Multi gas 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 calibrations or alarm limits are required.

Table 2.2

Factory Calibration and Preset Alarm Limits						
Gas ppm	Cal Gas / Balance	Unit	TWA	STEL	Low	High
CO	50 / Air	ppm	35	100	35	200
H_2S	25 / N_2	ppm	10	15	10	20
SO_2	5 / N_2	ppm	2	5	2	10
NO	25 / N_2	ppm	25	25	25	50
NO_2	5 / Air	ppm	1	1	1	10
Cl_2	10 / N_2	ppm	0.5	1	0.5	5
O_2	20.9 / N_2	%	-	-	19.5	23.5
CH_4	50 / Air	%LEL	-	-	10	20
CH_4	20 / N_2	%Vol	-	-	10	20
HCN	10 / N_2	ppm	5	5	5	50
NH_3	50 / N_2	ppm	25	35	25	50
PH_3	5 / N_2	ppm	0.3	1	1	2
ClO_2	0.5/Air	ppm	0.1	0.3	0.2	0.5

2.8 Integrated Sampling Pump

The VRAE multi gas monitor includes an integrated sampling pump. This is a diaphragm pump providing 400 cc per minute flow rate at the high setting. Connecting a 1/4 inch Tygon tubing with 1/8 inch inside diameter to the gas inlet port of the VRAE, this pump can pull in air samples from 200 feet away horizontally, or 90 feet vertically (see Technical Note 140 for tubing volumes and delay times).

A low pump speed is the factory default setting, which will reduce the flow rate by about 25%, and increase battery life by about 5%, and result in an increased LEL sensor lifetime. The low speed is the default setting, so to achieve the high speed performance, this needs to be switched to high (see Section 4.7 for details of how to select the pump speed).

A high pump speed is required when measuring certain gases in order to reduce the absorption of these gases by the materials in the gas passage. These gases include: Cl_2, ClO_2, PH_3, NH_3, and HCN.

If liquid or other objects are sucked into the water trap in the inlet port and cause the pump to stall, the electronics of 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 displayed in the LCD display. The user needs to acknowledge the pump shut off condition by pressing the **[Y/+]** key to re-start the pump.

2.9 Datalogging

This function is not applicable to non-datalog monitor.

The VRAE Multi gas monitor calculates and stores the gas readings based on user-specified datalogging period and the type of measurement. Two types of gas measurements, average or peak concentration, can be stored for each sensor during each datalogging interval. The datalogging interval can be programmed from one second to 60 minutes in one second increment. In addition, time stamp, user ID, site ID, serial number, last calibration date, and alarm limits are also stored. All data is retained in non-volatile memory so that it can be downloaded at a later time to a PC.

Start/stop datalog

There are four ways to initiate the datalog operation:
- **automatic:** start and stop datalogging automatically when the monitor is turned on and off.
- **manual:** start and stop datalogging by pressing a key manually.
- **periodic:** start and stop datalogging daily based on preset time (hour and minute).
- **schedule:** start and stop datalogging based on preset date and time (month, date, hour and minute).

Program datalog option

Most of the datalogging options can be programmed from the monitor. Additional options can be programmed using a PC and down loaded to the monitor (see Section 5 for details on how to program various datalogging options).

Start/stop datalogging manually

If manual datalogging mode has been selected from the normal operation menu, toggle through the menu using the **[MODE]** key until the "**Start Datalog?**" prompt is displayed. Pressing the **[Y/+]** key turns on datalogging. Likewise, pressing the **[Y/+]** key while "**Stop Datalog?**" is displayed, turns off datalogging.

The other three modes of datalogging will start and stop automatically without any user intervention:

Automatic Datalogging

Datalogging is automatically started when the monitor is turned on.

Scheduled Start/Stop Datalogging

Data logging starts at a specific date and time, and logs data at the specified "data logging period." When the "stop date and time" is reached, the monitor stops datalogging. This mode requires that the monitor be turned on first before the datalogging can start.

Periodic Start/Stop Datalogging

Data logging starts daily at a specific time, and logs data at the specified "data logging period." When the "stop time" is reached, the monitor stops datalogging. This mode requires that the monitor be turned on first before the datalogging can start.

Datalogging event

Each time a datalogging operation is initiated, a datalog event is created. Information, such as start time, datalogging period, alarm limits, etc. will be recorded in the event header, followed by the measurement data.

Datalogging pause

Under the following conditions, the datalogging will be paused automatically:

1) When entering programming mode, datalogging will stop. Upon exiting the programming mode, the datalogging will resume.

2) When entering PC Communication standby mode, datalogging will stop. Upon exiting the PC communication standby mode, datalogging will resume **only if datalogging mode was set to automatic mode.**

3) When printing data to serial printer.

In either case, a new datalog event will be created when the datalogging is resumed.

3   OPERATION OF ACCESSORIES

The accessories for VRAE include:

- Battery Charger

- Alkaline Battery Adapter

- Water Trap Filter

3.1   Battery Charging Operation

The charging circuit of the VRAE is built into the monitor. It only needs a regular AC to 12V DC adapter (wall mount transformer) to charge the monitor.

1. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the VRAE monitor.

1. The display will ask whether a discharge cycle (see NOTE on next page) is required, press **[N/-]** key, and the charging function will begin. If a key is not pressed within ten seconds, the charging will begin automatically. The display will show:

> **Charging**
> **Battery = 5.6V**

3. The charging LED should be red in color when charging. If the battery is fully charged, the LED will change from red to green. The red color indicates that the battery is being fast charged. The green color indicates that the battery is fully charged. The display will also indicate "Fully charged".   A completely discharged VRAE monitor will be charged to full capacity within 10 hours.

NOTE: If a Ni-Cd battery is used, perform occasional deep discharge to the battery to maintain full capacity. The deep discharge cycle can be done proceeding a charge cycle by powering the unit with the AC adapter. The display will prompt: **Deep Discharge?** Press the **[Y/+]** key. The charge cycle will automatically follow. The deep discharge is useful to remove memory effects from the Ni-CD battery so that the charge capacity is maintained. For Ni-MH battery, there is no need to perform this deep discharge operation.

Note: With the smart charging circuitry, a maximum charge time is imposed, so removing the charger is not necessary.

The battery of the VRAE monitor 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 10 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.

When the monitor is on and the AC adapter is plugged in, the smart charging circuitry will constantly apply charge current. To use the smart charging function, turn off the monitor first, and then apply the AC adapter.

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 designes non-dangereux.

3.2 Alkaline Battery Adapter

An alkaline battery adapter is supplied with each VRAE kit. It accepts four AA size alkaline batteries and can be used in place of the NiMH battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the NiMH battery.
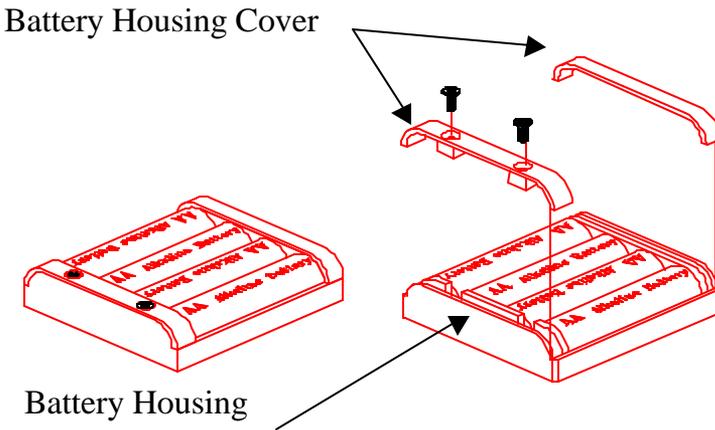
Figure 3.2   Alkaline Battery Adapter

To install the adapter, remove the cover of the monitor. remove the NiMH battery pack from the battery compartment and place the alkaline battery adapter into the battery compartment.

The internal charging circuit will automatically detect the alkaline battery adapter and prevent charging of the battery.
Note: The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

3.3 Water Trap Filter

The water trap filter is made of PTFE (Teflon$^®$) membrane with a 0.2 micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor.

To install the water trap filter, simply insert the water trap into the front of the inlet probe.

Some gases such as Cl_2, ClO_2, PH_3, NH_3, and HCN could react with filtered particles or water or be absorbed by the water trap housing material. In these cases, the water trap filter can be removed. If the filter is not used, extra care should be taken not to draw liquids into the unit, and it may be necessary to maintain the pump more frequently.

4 PROGRAMMING OF VRAE

The VRAE 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, datalogging period, real time clock, etc.

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

Note: The real time monitoring of the gas concentration continues while in the programming mode.   However, during the calibration or review datalog procedures, the real time monitoring will pause until the procedures are completed.   In addition, entering programming mode will pause the datalogging operation automatically.   After exiting programming mode, datalogging operation will resume.

4.1 Programming Mode

The VRAE has three user modes: **text, display** and **program** mode. The user can access the programming mode menu only if they are in the program mode (or from **text** mode with password). If the monitor is set to **display** mode, the user cannot enter the programming mode. In this case, the user mode can be changed only through a PC (see Section 5.0 for details on setting up the user mode).

The **programming** mode allows the 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 tiers menu structure. Table 4.1 shows the first tier of the programming menu. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

Table 4.1

Programming Menu
Calibrate Monitor?
Change Alarm Limits?
View or Change Datalog?
Change Monitor Setup?
Change Sensor Configuration?

Security Level

There are three levels of security in the VRAE programming mode to provide further protection against unauthorized changes to the monitor alarm settings and other settings. The **level 2** security allows a user to enter programming mode without any restriction. This is the default security setting. The **level 1** security requires a 4-digit password to enter programming mode. **Level 0** security allows a user to enter the programming mode without any password checking, as in the level 2. However, level 0 security does not allow a user to save any changes to the alarm limits, real time clock, correction factor, user and site information, etc. A user can still perform calibration with level 0 security. The security level must be set using a PC (see Section 5.0 for details on setting up the security level).

Once inside the programming mode, 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 the **[Y/+]** key and the sub-menu will be displayed.

To exit the programming mode and return to the normal operation, press the **[MODE]** key at any of the first tier menu displays.

4.2 Keys for Programming Mode

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

Table 4.2

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

4.3 Entering into Programming Menu

1. Turn on the VRAE monitor (refer to Section 2.3 for the power on sequence).

2. Press and hold down both **[MODE]** and **[N/-]** keys for three seconds to enter programming mode. **Note:** this is to prevent the user from entering the programming mode by accident.

3. If the User mode is set to **display** mode, a message "Display Only! Cannot enter...." will be shown.

3. If the security level is 0 or 2, after holding down two keys for 3 seconds or more, the monitor will enter the programming mode and the first menu item. "Calibrate Monitor?" will be displayed.

4. If the security level is 1, or user mode is text mode, after holding down the two keys for three seconds, the display will show "Enter Password = 0000" with the left-most digit flashing. The user should enter a password starting from this flashing digit.

Note 1: Prior to factory shipment, the VRAE monitor was installed with "0000" as the default password.

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

6. If the correct digit value is not "0", use **[Y/+]** key or **[N/-]** key to increase or decrease the digit value. Then press **[MODE]** key momentarily to confirm the digit value. Display shows the actual digit entered and moves the flashing cursor to the next digit (to the right).

7. Repeat Step 5 until all four digits are entered. Press and hold **[MODE]** key for one second.

8. If the entered password is correct, the monitor enters the programming menu. The first menu item "Calibrate Monitor?" will be displayed.

9. If the password is incorrect, the display shows "Wrong Password" and returns to the regular display of instantaneous gas readings or sensor names (for text mode).

4.4 Calibration of VRAE 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 is put into service the first time.

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

In programming mode, the user may re-calibrate the sensors in the VRAE monitor. This is a two-point calibration process using "fresh air" and the standard reference gas (also known as Span Gas). First, a "fresh air" which contains 20.9% and no detectable, toxic or combustible gases is used to set the zero point for each sensor. Then a standard reference gas, which contains a known concentration of a given gas, is used to set the second point of reference. The two-point calibration procedure is detailed below. Table 4.3 shows the sub-menus for calibration operations.

Table 4.3

Calibration Sub-Menu
Fresh Air Calibration?
VOL% Zero Calibration?
Multiple Sensor Calibration?
Single Sensor Calibration?
Modify Span Gas Value?
Change LEL/VOL Span 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 and a bottle of "fresh" air (optional) are recommended. The "fresh" air is clean dry air with 20.9% oxygen concentration and without any organic, toxic or combustible gases or impurities. If such an air bottle is not available, any clean ambient air without detectable contaminant can also be used. A charcoal filter should be used if one is not sure of the ambient air's purity.

If the unit is in VOL or Autorange mode, a second zero is performed with the VOL zero gas, typically pure nitrogen. This zeroing step affects only the VOL sensor and does not modify the O_2 calibration performed in the first zero step. In Autorange mode, the first step zeros the LEL sensor. In VOL mode, the first step zeros the VOL sensor and the second step is needed only if the VOL zero gas is different.

The calibration adapter links up the inlet port of the VRAE Monitor to the regulator of the gas bottle (see Figure 4.4.1).
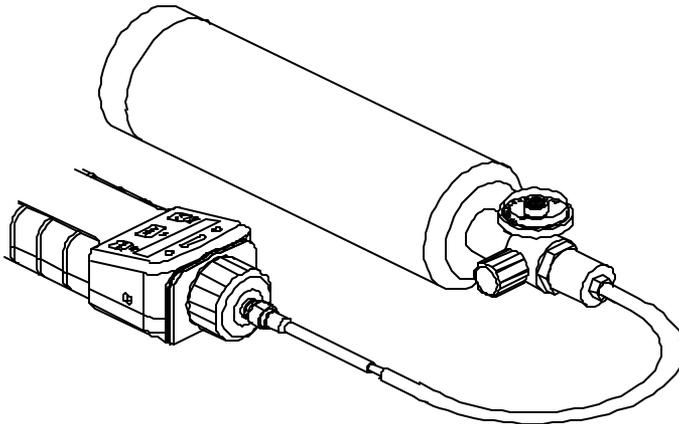

Figure 4.4.1   Set-up of Gas Calibration

1. "Calibrate Monitor?" is the first menu item in Table 4.1. Press **[Y/+]** to perform calibration. The first sub-menu shows: "Fresh Air Calibration?"

2. If the "fresh" air bottle is available, snap in the calibration adapter over the inlet port of the VRAE Monitor and connect the other end of the tube to the fresh gas bottle, as shown in Fig. 4.4.1. If the "fresh" air bottle is not available, simply leave the monitor in an area free of any detectable vapor.

3. Press the **[Y/+]** key to start "fresh air calibration" of the monitor. The display shows "zero... in progress" followed by the name of each sensor and the message "zeroed." The display should show a reading "0.0", or a very small number, for all sensors. For the oxygen sensor in model PGM-7800, it should show a "20.9" as the reading.

1. After about 30 seconds pause, the display will show the message "Zero Cal Done! Reading=" and the instantaneous fresh air readings.

2. Press either **[Y/+]** or **[MODE]** once and move to the next sub-menu "Vol% Zero Calibration?". Apply the Vol% Zero gas and press **[Y/+]** to start. The display shows "zero... in progress…" followed by "Zero cal done…Reading = 0".

3. Press either **[Y/+]** or **[MODE]** once and move to the next sub-menu "Multiple Sensor Calibration?"

4.4.2 Multiple Sensor Calibration

This function simultaneously determines the second point of calibration curves for multiple sensors in the monitor.
A bottle of mixed standard reference gases is needed to perform this procedure. The user can choose several gas mixtures* to be used in multiple-sensor calibration.

For use in Autorange mode, the unit should first be calibrated in LEL (or Autorange) mode to span the LEL sensor, then switched to VOL% mode to span the VOL sensor, and finally returned to Autorange. In VOL mode, the calibration and measurement gas must be the same.

Snap in the calibration adapter over the gas inlet port of the VRAE Monitor, and connect the tube to the mixed gas bottle as shown in Figure 4.4.1.

1. Continuing from Step 4 of the previous section, the display should show "Multiple Sensor Calibration?" Press the **[Y/+]** key. The display shows all the pre-selected gases for the mixed gas bottle and "OK?" question (as shown below for PGM-7800). Press **[Y/+]** key to accept the multiple sensor selection and start the calibration, or press the **[N/-]** key to modify the sensor selection and go to Step 6.

CO	- - - -	H₂S
LEL	OK?	OXY

2. Turn on the valve of the mixed gas bottle to start the flow of the span gas. Display shows "Apply Mixed Gas" and will wait for the calibration gas to reach the sensor. When the calibration gas has reached the sensor the display will show "calibration in progress… 60" with the countdown timer shows the number of remaining

seconds while the monitor performs calibration. When the countdown timer reaches 0, the display shows the name of each sensor, the message "cal'ed!" and the calibrated value for each gas. If no gas has reached the sensor after 60 seconds, the display will show " No gas flow…" and abort the calibration.

Note 1: The readings should be very close to the span gas values. After about 30 seconds pause, the display will show the message "Span Cal Done! Turn Off Gas"

Note 2: Some sensors, such as ammonia and chlorine dioxide, require longer equilibration times than 60 seconds. These sensors should be calibrated separately in a Single Sensor Calibration (Section 4.4.3).

3. This completes the multiple sensor calibration procedure and moves to the next sub-menu item.

4. Turn off the flow of gas. Disconnect the calibration adapter from the VRAE Monitor.

5. Press the **[MODE]** key any time during Step 2 to abort the calibration. If a sensor failed the calibration, the sensor name and an error message "failed, continue?" will appear. Press the **[N/-]** or **[MODE]** key to abort the calibration. Press the **[Y/+]** key to continue the next sensor calibration. In either case, the calibration data for the current sensor is not changed.

From Step 1, if **[N/-]** is pressed, the display shows all the sensor names selected for multiple sensor calibration with the cursor blinking at the first sensor.

```
┌─────────────────────────┐
│ CO*      - - - -    H₂S* │
│ LEL*      OK?       O₂   │
└─────────────────────────┘
```

Press the **[Y/+]** key to select the sensor and the **[N/-]** key to de-select the sensor. A previously selected sensor will show an "*" next to the sensor name. A previously de-selected sensor will not show an "*" next to the sensor name.

6. Press the **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 7 until all of the sensors that need to be calibrated during multiple sensor calibration are selected. Press and hold the **[MODE]** key for 1 second to save the new sensor selection.

7. The display shows "Save?" To confirm the new selection, press the **[Y/+]** key to accept the change and continue on with Step 2. Press the **[N/-]** key or the **[MODE]** key to discard the change and to continue on with Step 2.

***Cross Sensitivity:** Some sensors may show cross sensitivity to other gases. Therefore, it is important to choose the gas mixture carefully for the multiple sensor calibration to avoid erroneous calibration due to cross sensitivity. For example, some toxic gases are known to cause erroneous readings by the CO sensor. In general, it is recommended to calibrate the CO, H_2S sensors, combustible and oxygen sensor with a bottle of mixed gas using the multiple sensor calibration procedure and to calibrate the other toxic sensor with a bottle of a single toxic gas.

4.4.3 Single Sensor Calibration

This procedure determines the second point of the sensor calibration curve for a single sensor. A bottle of standard reference gas (span gas) is needed to perform this procedure. Table 2.2 shows the standard calibration gases typically used as span gases in the factory. Snap in the calibration adapter over the inlet port of the VRAE monitor, and connect the tube to the regulator of the gas bottle as shown in Figure 4.4.1

1. Continuing from Step 4 or Step 6 of the previous section, the display should show "Single Sensor Calibration?" Press **[Y/+]** key. The display shows all the installed sensors in the monitor with the cursor blinking at the first sensor location. Press **[Y/+]** key to select the high-lighted sensor and start the calibration, or press **[MODE]** key momentarily to move to the next sensor location.

CO	SO$_2$	H$_2$S
LEL	pick?	OXY

2. Turn on the valve of the CO gas bottle to start the flow of the span gas. Display shows "Apply CO Gas" and the span value set. The VRAE monitor will wait for the calibration gas to reach the sensor. When the calibration gas has reached the sensor the display will show "calibration in progress… 60" with the countdown timer shows the number of remaining seconds while the monitor performs calibration. When the countdown timer reaches 0, the display shows the sensor name and the calibrated value:

> **CO   cal'ed**
> **reading = 50 ppm**

If no gas has reached the sensor after 60 seconds, the display will show "No gas flow…" and abort the calibration.

Note: The reading should be very close to the span gas value. After about 30 seconds pause, the display will show the message "Span Cal Done! Turn Off Gas"

3. This completes the single gas calibration procedure for one sensor. The display shows the single gas calibration sub-menu for the user to select another sensor or move to next calibration sub-menu.

4. Turn off the flow of gas. Disconnect the calibration adapter from the VRAE Monitor.

5. Repeat Step 1 to Step 5 to calibrate the next sensor.

6. Press the **[MODE]** key any time during Step 2 abort the calibration. If the sensor failed the calibration, the sensor name and an error message "failed, continue?" will appear. Press **[N/-]** or **[MODE]** key to abort the calibration.   Press **[Y/+]** to repeat the single gas calibration. In either case, the current calibration data will not be changed.

Oxygen Sensor Calibration (Not applicable to PGM-7840)

The oxygen sensor calibration is slightly different from all other sensors. The oxygen sensor measures a range from 0 to 30% of oxygen in the air. During "fresh" air calibration, the oxygen sensor is calibrated to fixed 20.9% of oxygen. During single sensor calibration, the user can supply a bottle of pure nitrogen gas so that the oxygen sensor can be calibrated to 0% of oxygen. The user can also supply other span concentrations of the oxygen, e.g. 19.5%, to calibrate the oxygen sensor. A question "0% oxygen?" will be asked. Enter **[Y/+]** if pure nitrogen gas is used to calibrate the oxygen sensor. Otherwise, enter **[N/-]** to calibrate the oxygen sensor to another span oxygen value. During both single or multiple sensor calibration, the oxygen sensor will be calibrated to the span value defined in Section 4.4.4.

Note: After a "0% oxygen" calibration, the user <u>must</u> perform a fresh air calibration to ensure that the oxygen sensor is calibrated correctly.

Calibration Time Stamp

When a single or multiple sensor calibration is performed, a time stamp will be stored in the non-volatile memory. This information will be included in the datalogging report.

4.4.4 Modify Span Gas Value

This function allows the user to change the span values of the standard calibration gases. The lower left position may toggle between different values when switching between LEL(or Autorange) or VOL% modes.

1. "Modify Span Gas Value?" is the next sub-menu item in Table 4.3.

2. Press **[Y/+]** key. Display shows:

50	10.0	25
50	span	20.9

A cursor is blinking at the first digit of the first Span value. If the user wants to modify any one of the span gas values, go to Step 3. Otherwise, press and hold the **[MODE]** key for 1 second to accept the previously stored span gas value and move to the next calibration sub-menu.

3. Starting from the left-most digit of the span gas value, use **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to next digit, the cursor will move to the next digit to the right. Repeat this process until all span gas values are entered. Press and hold the **[MODE]** for 1 second to save the new calibration gas value.

4. The display shows "Save?"   To confirm the new value, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next calibration sub-menu.

4.4.5 Change LEL/VOL Span Gas

This function allows the user to select a specific LEL and/or VOL gas to be used as the span gas during LEL/VOL gas calibration. The LEL and VOL gases must be the same. For the LEL mode, setting this gas lets the unit apply the proper correction factor when calibrating to methane. For Autorange mode, it also sets the cross-over concentration where the unit switches from 100% LEL to the corresponding volume % reading. Finally, it selects the proper firmware linearization algorithm for different gases.

1. "Change LEL Span Gas?" is the next sub-menu item in Table 4.3.

2. Press **[Y/+]** key. If a LEL sensor is installed or a combination LEL/VOL sensor is installed and the sensor is set to LEL mode, the display shows:

> **LEL Span=?**
> **Methane**

If in VOL mode, the display shows "Vol span = ? Methane". If no LEL/VOL sensor is installed, the message "No LEL installed" will appear.

3. If the user does not want to change the LEL or VOL span gas, press **[Y/+]** key to accept the current selection and exit this sub-menu.

4. If the user wants to select a different LEL or VOL span gas, press **[N/-]**. Then use **[Y/+]** or **[N/-]** to scroll through a list of gas names until a desired gas name appears in the display; then press **[MODE]** to select the new gas name.

5. The display shows "Save?" To confirm the new gas selection, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and return to the first display.

4.5 Change Alarm Limits

In the programming mode, the users may change alarm limits of each sensor for the VRAE Monitor. Table 4.4 shows the sub-menus for changing the alarm limits.

Table 4.4

Alarm Limit Sub-Menu
Change High Alarm limit?
Change Low Alarm limit?
Change STEL alarm limit?
Change Average alarm limit?

1. The sub-menu item in Table 4.4 allows the user to change the high alarm limit, low alarm limit, STEL alarm limit or average alarm limit. The lower left position may toggle between different values when switching between LEL (or Autorange) or VOL% modes. The average alarm limit can be "Running Average" or "TWA (Time Weight Average) depending on the menu selection on "Change Averaging Method" (see Section 4.7.8). Press **[N/-]** to circle through the sub-menu. Press **[Y/+]** to enter a sub-menu and the display shows "HIGH," "LOW," "STEL," "TWA" or "AVG" with a flashing cursor on the left-most digit of the previously stored alarm limits.

200	100.0	20
20	HIGH	23.5

35	**50.0**	**10**
10	**LOW**	**19.5**

100	**25.0**	**15**
	STEL	

35	**10.0**	**10**
	TWA	

1.0	**10.0**	**10**
	AVG	

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. Repeat this process until all the new Alarm limits are entered. 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.

To preserve the previously stored 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.

4.6 View or Change Datalog

VRAE monitor calculates and stores the gas readings at a specified interval. The user can review these stored readings or change datalog setup from the programming mode. Users can also program additional datalog options in a PC and download them to the monitor (see Section 5.0 for details on how to program additional datalogging options).   Table 4.5 shows the sub-menus for datalog options:

Table 4.5

Datalog Sub-Menu
Reset Peak and Minimum?
Clear All Data?*
Change Datalog Period?*
Select Data Type?*
View Datalog?*
Enable / Disable Datalog?*

* Not applicable to non-datalog monitor

4.6.1 Reset Peak and Minimum

This function will reset peak and minimum data stored in the data memory.

1. "Reset Peak and Minimum?" is the first sub-menu item in Table 4.5.

2. Press the **[Y/+]** key to clear the peak and minimum data memory. Display shows "Are You Sure?" to re-confirm whether to reset peak and minimum data.

3. Press the **[Y/+]** key again will reset peak and minimum data.

4. Press the **[N/-]** or **[MODE]** key to exit without resetting the data and move to next datalog sub-menu.

Note: STEL and TWA (or AVG) value will not be affected when peak and minimum values are reset.

4.6.2 Clear All Data

This function will erase all data stored in the non-volatile data memory. This does not change STEL, TWA, Peak, minimum concentration and run time values which are stored in the regular data memory.

1. "Clear All Data?" is the second sub-menu item in Table 4.5.

2. Press the **[Y/+]** key to clear the data memory. Display shows "Are You Sure?" to re-confirm the clearing of memory.

3. Press the **[Y/+]** key again will erase 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 Datalog Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. "Change Datalog Period?" is the third sub-menu item in Table 4.5.

2. Press the **[Y/+]** key, the display shows "New Period = 0060" with the left-most digit flashing, where "0060" is the previously stored data log period.

3. To modify this period, 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 to the next digit to the right. Repeat this process until all 4 digits of the new period 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 will show "Save?" Press the **[Y/+]** key to accept the new value. Press the **[N/-]** key to discard the changes and move to the next menu option.

5. To preserve the previously stored period, press and hold the **[MODE]** key for 1 second. The monitor will exit data entry mode and move to the next sub-menu item in Table 4.5.

4.6.4 Select Data Type

The user can choose to store either the average or the peak value during each datalog period.

1. "Select Data Type?" is the fourth sub-menu item in Table 4.5.

2. Press the **[Y/+]** key, the display shows the current data type, for example, "Data Type = Average?"

3. Press the **[Y/+]** key to accept the currently displayed data type. Press **[N/-]** key to change to the other data. type: "Data Type = Peak?" Press **[MODE]** key to exit this sub-menu and move on to the next sub-menu.

4. If there is any change to the existing selection, pressing the **[y/+]** key, the display will show "Save?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

Note: It is necessary to select "Average" data type in order to calculate the correct STEL and TWA data for datalogging report (see Section 5.9).

4.6.5 View Datalog

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

1. "View Datalog?" is the fifth sub-menu item in Table 4.5. Press the **[Y/+]** key and the LCD display shows the first event number and start date and time of the event.

```
Event #  1  ?
   8/3/96      8:20
```

2. Press **[Y/+]** key to review data of the first event. The LCD display shows the data number and time stamp for 2 seconds followed by the stored data of each sensor:

```
Data # 0
        8:20:00
```

```
1         0.0         0
 2        +/-       20.5
```

3. Press the **[Y/+]** or **[N/-]** key to move forward or backward to view other data of this event. When reaching the beginning or the end of the event, the message "Start of data!" or "End of data!" will appear. Press **[MODE]** key to exit the current event.

4. Press **[N/-]** key at Step 2 to see next event. If there is no more event, the message "No More Events! Start from #1?" will appear. Press **[N/-]** key to go back to the current event or **[Y/+]** key to go to the first event. Press **[MODE]** to exit and move to the next sub-menu.

4.6.6 Enable / Disable Datalog

The user can choose to enable or disable the datalogging function on each individual sensor. This allows users to selectively log certain sensor readings of interest.

1. "Enable / Disable Datalog?" is the sixth sub-menu item in Table 4.5.

2. Press **[Y/+]** key. The display shows all the installed sensors in the monitor. A previously selected sensor to be datalogged is marked with an "*" next to the sensor name. The cursor is blinking at the first sensor location. Press **[Y/+]** key to enable the datalogging for the sensor and **[N/-]** key to disable the datalogging.

CO*	SO$_2$	H$_2$S*
LEL	pick	OXY

3. Press **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 2 until all the sensors that needed to be datalogged are selected. Press and hold **[MODE]** key for 1 second to save the new sensor selection.

4. The display shows "Save?"   To confirm the new selection, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and return to the first datalog sub-menu.

4.7 Change Monitor Setup

In the programming mode, the users may change monitor setup or enter user information for the VRAE monitor. Table 4.6 shows the sub-menus for changing the monitor.

Table 4.6

Monitor Setup Sub-Menu
Change Site ID?
Change User ID?
Change Alarm Mode?
Change User Mode?
Change Real Time Clock?
Change Backlight Mode?
Change Password?
Change Pump Speed?
Change Averaging Method?
Set Temperature Unit?

4.7.1 Change Site ID & Change User ID

The user can enter an 8 digit alphanumeric site ID & User ID in the programming mode. These ID's will be included in the datalog report.

1. "Change Site ID?" and "Change User ID?" are the first and second sub-menu items in Table 4.6.

2. Press **[MODE]** key to choose one of them and press the **[Y/+]** key, the display shows the current site ID: "Site ID = xxxxxxxx" or 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 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 Alarm Mode

There are two different alarm modes: **Latched** and **Automatic Reset** in VRAE that can be selected from the programming menu.

1. "Change Alarm Mode?" is the third sub-menu item in Table 4.6.

2. Press the **[Y/+]** key, the display shows the current alarm mode selection: "Alarm Mode = Latched?"

3. Press the **[Y/+]** key to accept the currently displayed alarm mode. Press **[N/-]** key to change to the other alarm mode: "Alarm Mode = Auto reset?" 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, pressing the **[Y/+]** key the display will show "Save?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard the change and move to the next sub-menu.

4.7.3 Change User Mode

There are three different user modes: **text**, **display,** and **program** in VRAE that can be selected from the programming menu.

1. "Change User Mode?" is the fourth sub-menu item in Table 4.6.

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 through the other two 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, pressing the **[Y/+]** key the display will show "Disable Program! Are you Sure?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

Caution: 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 from the monitor. **The only way to change the user mode back to "program" mode is to use a PC and the ProRAE-Suite program or Turn on unit in diagnostic mode and then enter the program mode by entering correct password** (see Section 5 for details).

4.7.4 Change Real Time Clock

The VRAE monitor is equipped with a real time clock. The user can enter the correct date and time into the real time clock in the programming mode.

1. The fifth sub-menu item in Table 4.6 is "Change Real Time Clock?"

2. Press **[Y/+]** key, the display shows both the current date and time: Date: "mm/dd/yy" and Time: "hh:mm" 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 Back Light Mode

The VRAE monitor allows the user to choose to turn on and off LCD back light automatically when ambient light falls below or above a threshold level or to turn on and off the back light manually by pressing the **[N/-]** key.

1. The sixth sub-menu item in Table 4.6 is "Change Backlight Mode?"

2. Press **[Y/+]** key, the display shows the current back light mode: "Back Light 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: "Back Light Mode = manual turn on?" 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, pressing the **[Y/+]** key the display will show "Save?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

4.7.6 Change Password

The user can modify the password from the monitor.

1. The seventh sub-menu item in Table 4.6 is "Change Password?"

2. Press the **[Y/+]** key and the display shows the current password: "Enter new password = xxxx" with the left most digit flashing.

3. Press the **[Y/+]** or **[N/-]** key to cycle through all 10 numerals. Press **[MODE]** momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 4 digits of the new password 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 password, the display shows "Save ?" Press the **[Y/+]** key to accept the new password. Press the **[N/-]** key to discard the changes and move to the next sub-menu.

6. The monitor next asks for this value to be confirmed. "Confirm New Password = 0000" with the left most digit flashing. The number must be re-entered as before to exit the monitor setup sub-menu. If a different entry is entered in the second time, the password reverts to its original setting.

4.7.7 Change Pump Speed

There are two speed settings for the pump motor in the VRAE that can be selected from the programming menu: **low** (default) and **high**. The "high" setting should be used for long lengths of tubing or when rapid changes in input conditions are expected. "Low" may be selected when the operating conditions are slow to change and a quick response is not required. Low may also be used to prolong pump motor life, LEL sensor life and battery run time. Note that this screen may not be present for diffusion models or if speed control is not available.

1. "Change Pump Motor Speed?" is the eighth sub-menu item in Table 4.6.

2. Press the **[Y/+]** key, the display shows the current pump speed selection: "Pump Speed = Low?"

3. Press the **[Y/+]** key to accept the currently displayed pump speed and move to the next monitor setup sub-menu. Press **[N/-]** key to change to the other speed "Pump Speed = High?" Press **[MODE]** key to exit this sub-menu and move to the next monitor setup sub-menu.

4.7.8 Change Averaging Method

There are two methods of calculation used in the averaging of the monitor. Using this selection can cause the calculation to be performed using an eight-hour time weighted average (TWA), the default, or a running average (AVG). The display indicator for whichever averaging type is selected will show on the LCD display wherever the average is indicated.

1. "Change Averaging Method?" is the ninth sub-menu item in Table 4.6.

2. Press the **[Y/+]** key, the display shows the current average selection: "Average Type = TWA?"

3. Press the **[Y/+]** key to accept the currently displayed type. Press **[N/-]** to change to the other selection: "Average Type = Running Average?" and **[Y/+]** to accept the selection.

4. If there is any change to the existing selection, pressing the **[Y/+]** key, the display will show "Save?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the next sub-menu.

4.7.9 Set Temperature Unit

The monitor can be set up to give either Fahrenheit or Celsius units wherever the temperature is displayed.

4. "Set Temperature Unit?" is the tenth sub-menu item in Table 4.6.

5. Press the **[Y/+]** key, the display shows the current temperature unit selection: "Temp Unit = Fahrenheit?"

6. Press the **[Y/+]** key to accept the currently displayed type or press **[N/-]** to change to the other selection: "Temp Unit = Celsius?" and **[Y/+]** to accept the selection.

7. If there is any change to the existing selection, pressing the **[Y/+]** key, the display will show "Save?" Then, press the **[Y/+]** key to accept or the **[N/-]** key to discard and move to the first setup sub-menu.

4.8 Change Sensor Configuration

In the programming mode, the users may change several sensor related configurations of the VRAE monitor. Table 4.7 shows the sub-menus for setting various configurations of the sensors.

Table 4.7

Sensor Configuration Sub-Menu
Change LEL/VOL Sensor Type? *
Enable / Disable Sensors?
Change Dilution Ratio?
Change LEL/VOL Gas Selection?*

* Note: This menu is applicable only if a combination LEL/VOL sensor is installed.

Before these sub-menus are described, the term "Correction Factor" (CF) needs to be explained:

Correction Factor
The LEL sensor used in VRAE is a broad band sensor (i.e., it responds to a broad range of gases). Typically, these sensors show a different sensitivity to different gases. The correction factor for a specific gas is defined as:

$$\text{Correction Factor} = \frac{\text{sensitivity to a calibration gas}}{\text{sensitivity to a specific gas}}$$

Correction factors are often used to obtain a calculated concentration of a specific gas while using a different gas during calibration. When the unit is calibrated to %LEL methane, the CF is multiplied by the reading to obtain the true %LEL concentration of the measured gas. The factor incorporates the difference in LEL levels of the two gases.

The VRAE monitor stores one set of correction factors for the LEL sensor. This set consists of about 40 different gases. The user can choose one gas from the list to be the calibration gas and another gas to be the measurement gas. For example, the user can choose methane as the calibration gas for the LEL sensor and select pentane as the measurement gas. The VRAE monitor will calculate the correction factor between these two gases and convert the measured value of the LEL sensor into equivalent concentration of the pentane gas.

Note 1: Using the correction factor can provide a rough estimate the target measurement gas. In order to achieve the specified accuracy of the instrument, it is necessary to calibrate the LEL sensor with the specific target gas.

Note 2: No correction factors are built in for the VOL sensor, but selecting the measurement gas type in this mode ensures switching between LEL and VOL at the correct volume % concentration equivalent to 100% LEL. For VOL measurements the calibration and measurement gas must be the same, and the factor is always 1.0.

4.8.1 Change LEL/VOL Sensor Type

This programming menu only applies to the monitors with a combination LEL/VOL sensor installed. This sensor can be setup as a %LEL sensor to measure the combustible gas in the %LEL level. It can also be set up to measure combustible gases in the % volume level up to 100%. The user can also set up the sensor so that it will automatically switch from %LEL to %VOL when the %LEL sensor reaches 100% LEL. However, this auto-ranging feature only works for gases listed in the built-in library. The user can select one of these sensor modes from the programming menu.

1. "Change LEL/VOL Sensor Type?" is the first sub-menu item in Table 4.7.

2. Press the **[Y/+]** key, the display shows the question: "Switch to %LEL?"

3. Press the **[Y/+]** key to accept the currently displayed sensor mode. Press **[N/-]** key to change to the other mode. 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, pressing the **[Y/+]** key the display will show "Save?" Then, press the **[Y/+]** key to accept the **[N/-]** key to discard and advance to the next sub-menu.

4.8.2   Enable / Disable Sensor

This function allows the user to selectively enable or disable individual sensors in the VRAE monitor. When a sensor is disabled, the sensor will not measure nor display the gas concentration.

1. "Enable / Disable Sensors?" is the second sub-menu item in Table 4.7.

2. Press **[Y/+]** key. The display shows all the installed sensors in the monitor. A previously enabled sensor is marked by an "*" next to the sensor name. The cursor will blink at the first sensor location. Press **[Y/+]** key to enable the sensor and **[N/-]** key to disable the sensor. A previously disabled sensor will show "----" instead of the sensor name.

CO*	SO$_2$	H$_2$S*
LEL*	pick	OXY*

3. Press **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 2 until all the sensors that needed to be enabled are selected. Press and hold **[MODE]** key for 1 second to save the new sensor selection.

4. The display shows "Save?" To confirm the new selection, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next sub-menu.

4.8.3 Change Dilution Ratio

The user can insert an optional dilution fitting on the VRAE gas inlet port to dilute the gas sample. The user can enter a dilution ratio (from 1 to 10) from the programming menu so that the reading can be compensated to show the actual concentration of the gas sample with the dilution fitting.

1. "Change Dilution Ratio?" is the third sub-menu item in Table 4.7.

2. Press the **[Y/+]** key, the display shows: "New Ratio = xx (1- 10)" 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.

4.8.4 Change LEL/VOL Gas Selection

This function allows the users to choose one of the pre-stored LEL gases in the monitor and calculate its correction factor relative to the LEL calibration gas. This factor will then be used during gas measurements to show the equivalent concentration of the selected LEL gas. The user can also modify this relative correction factor to increase or decrease the gas reading. This allows the users to create a custom factor for a specific gas or mixture of gases.

Note: No correction factors are built in for the VOL sensor, but selecting the measurement gas type in this mode ensures switching between LEL and VOL at the correct volume % concentration equivalent to 100% LEL. For VOL measurements the calibration and measurement gas must be the same, and the factor is always 1.0.

1. "Change LEL Gas Selection?" is the fourth sub-menu item in Table 4.7
2. Press **[Y/+]** key. If an LEL sensor is installed and enabled, or a combination LEL/VOL sensor is installed and the sensor is set to LEL mode, the display shows:

> **LEL Gas = ?**
>
> **methane**

   If the unit is in VOL mode, the display shows "VOL gas = ?… Methane…". If no LEL/VOL sensor is installed, the message "No LEL installed" will be displayed and the unit returns to the first sub-menu.

3. If there is no change in the LEL/VOL measurement gas, press **[Y/+]** to accept the current gas and skip to Step 6.

4. If the user wants to modify the LEL/VOL measurement gas, press **[N/-]** key first, then use **[Y/+]** or **[N/-]** key to scroll through a list of gas names until the desired gas name appears in the LCD display, then press **[MODE]** key to select the new gas name.

5. The display shows "Save new gas?" To confirm the new gas, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next step.6. The display shows

> **Methane**
> **LELFactor=1.00?**

where "1.00" is the calculated correction factor of the selected gas in Step 4. See Appendix B or Technical Note 156 for the proper correction factor. Note that the factors are not the same in the LEL-only and LEL/TC sensors.

7. If the user does not want to modify the LEL correction factor, press **[Y/+]** and go to Step 8. To modify this factor, press **[N/-]** first. Then, starting from the left-most digit, use the **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until all 4 digits of the new factor are entered. Press and hold **[MODE]** for 1 second to exit data entry mode. If there is any change to the existing value, the display shows "Save?" Press **[Y/+]** to accept the new value and exit the gas selection sub-menu. Press **[N/-]** to discard the changes.

4.9 Exit Programming Mode

1. To exit programming mode from the first tier menu level (see Table 4.1), press the **[MODE]** key once.
   Display shows an instantaneous reading of normal operation mode.

2. To exit programming mode from 2nd tier sub-menu level (see Table 4.2 - 4.6), press the **[MODE]** key twice.

3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds as described in Section 4.4.

5   COMPUTER INTERFACE

Each VRAE with datalogging option is shipped with a software package, called ProRAE-Suite, and a serial computer interface cable.

This software package runs on any IBM compatible Personal Computer (PC) under Windows 95™, Windows 98™, Windows NT™ 4.0, Windows ME™, Windows 2000, and later environments. It allows the user to configure the VRAE monitor through a user-friendly interface and send the configuration information from the PC to the VRAE monitor. Collected data can also be extracted from the VRAE monitor to the 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.

Note: Please note that the figures and functions shown in this section are from the model PGM-7800. For the model PGM-7840, the basics are the same as the PGM-7800. However, in PGM-7840 the oxy sensor is replaced with another toxic sensor. Therefore, any figures or descriptions related to "Oxy" sensor in this section will be replaced by "Tox 4" sensor.

Also, any figures that show "7800" will be replaced by "7840", for the model PGM-7840.

5.1 Install ProRAE-Suite Software

ProRAE-Suite software package is supplied with the VRAE datalogging monitor. This software package is available on 3.5" setup diskettes. To install the ProRAE-Suite software, insert the first setup diskette into the "A" or "B" 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. If the setup diskette is in disk drive A, type A:\Setup.exe in the **Open** field, as shown in Figure 5.1.
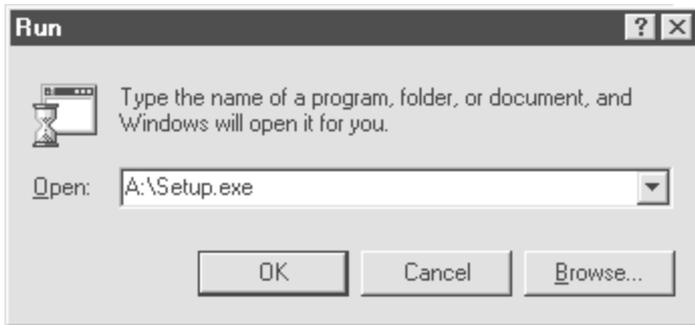
Figure 5.1   Run Dialog Box

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.
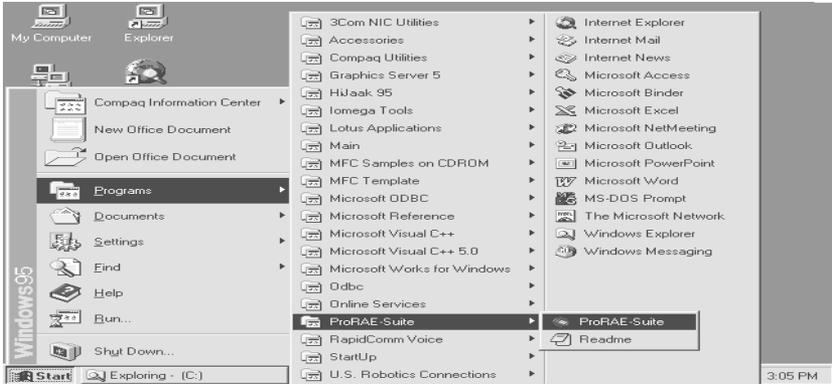
Figure 5.2   Start Menu

5.2 Connect VRAE to PC

The basic kit of VRAE datalogging monitors 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 serial connector of the VRAE monitor.

Turn on the power to the VRAE 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 VRAE monitor is ready for communication with PC. During the communication session, the PC will directly control the VRAE monitor through the serial link. There is no need to press any key on the VRAE monitor during the communication session.

Note: Do not connect to the parallel port of the PC by mistake. The parallel port is usually a 25 pin **female D connector** on the back of the PC, the serial port is usually a 25 or 9 pin **male D connector**. 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.

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.
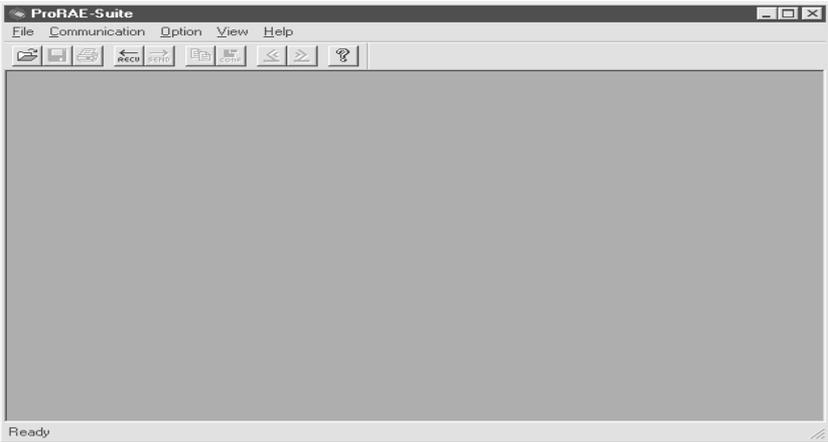
Figure 5.3   ProRAE-Suite Main Window

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 VRAE monitor and receiving the configuration data from the VRAE monitor, etc.

2) Logged data category. This category includes receiving the logged data from the VRAE 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) Upgrade category. This category includes upgrading the datalog feature of the VRAE monitor, enable/disable the serial printer option, customize the power-on messaging and upgrading the firmware in the VRAE monitor.

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 the 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 VRAE 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.
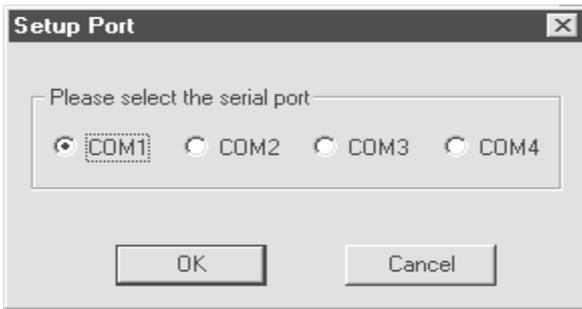
Figure 5.4   Setup Port Dialog

Note: In most PC's, there are two serial ports. Make sure the serial port selected in the **Setup Port** dialog box matches the actual serial port connected to the VRAE monitor. The default serial port for ProRAE-Suite is COM1. If a incorrect serial port is selected, a message will appear indicating that no acknowledge response received by the software.

5.5 Process the Configuration Data

The ProRAE-Suite software allows the user to edit the configuration data, send the configuration data to the VRAE monitor, and receive the configuration data from the VRAE monitor. The following subsections describe the detail of each operation.

5.5.1 Edit the Configuration Data

From the main menu of the ProRAE-Suite software, select
the **Open** menu item from the **File** dropdown menu, or click
the **Open** toolbar button, a dialog box appears.   Select the
"Files of type:" to be "∗.CFG" as shown in Figure 5.5.
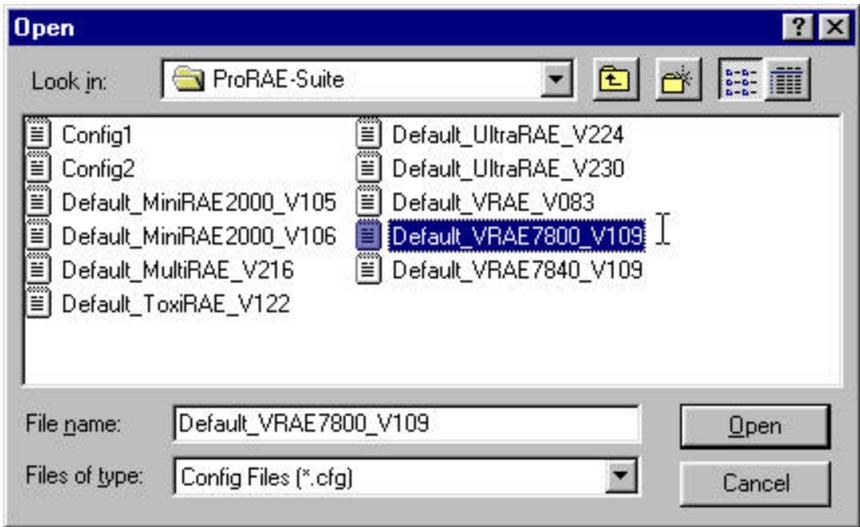
Figure 5.5   Open Dialog Box

There should be one or more configuration files in the file
list. Each configuration file has a file extension of ".CFG".
There is one generic VRAE configuration supplied with
ProRAE-Suite software: **Default_VRAE7800_V###.CFG**,
where **###** is the version number of the default configuration
file.

For example, Default_VRAE_V109.cfg means this file is for VRAE monitor and its version is V1.09. Choose a configuration file by highlighting the file name and press the **Enter** key or click the **OK** button on the dialog box.

Once the configuration file is open, the configuration data is displayed in the newly opened client window, as shown in Figure 5.6.
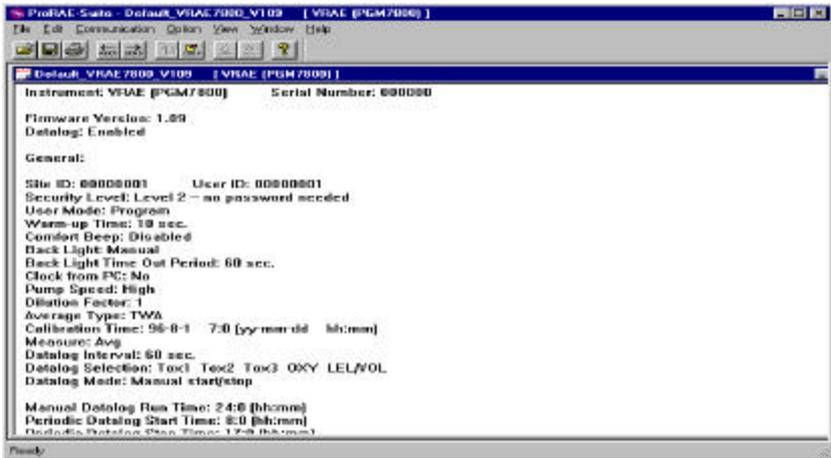
Figure 5.6   Displayed Configuration Data

To edit the opened configuration data file, click the **Edit -> Configuration** menu item or the **Configuration** toolbar button to open the **Edit Configuration File** dialog box, as shown in Figure 5.7.

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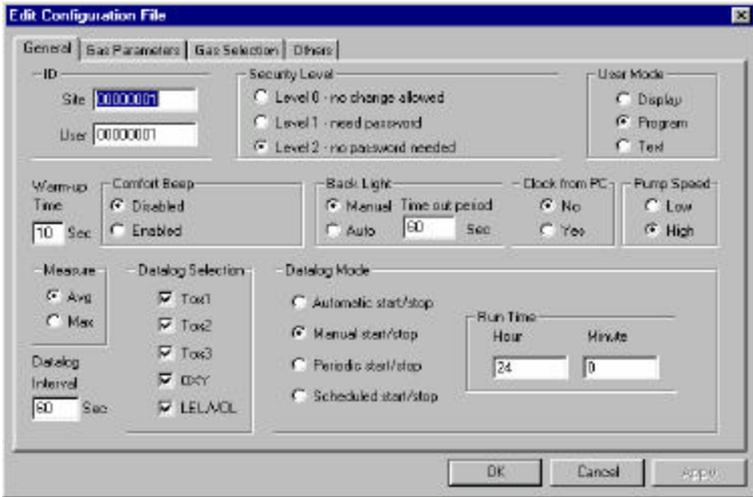
Figure 5.7   Edit Configuration File Dialog Box

The **Edit Configuration File** dialog box contains three tab pages: **General**, **Gas Parameters** and **Gas Selection**. To change a specific configuration setting, click the corresponding tab page header to bring that tab page to the front, then change the configuration setting on that tab page. When finished editing the configuration settings, click the **OK** button to close the **Edit Configuration File** dialog box. The new values of the configuration settings will be reflected in the client window.

The **General** tab page, shown in Figure 5.8, allows the user to change the general settings of the configuration data. The following is the description of each field in the **General** tab page of the **Edit Configuration File** dialog:
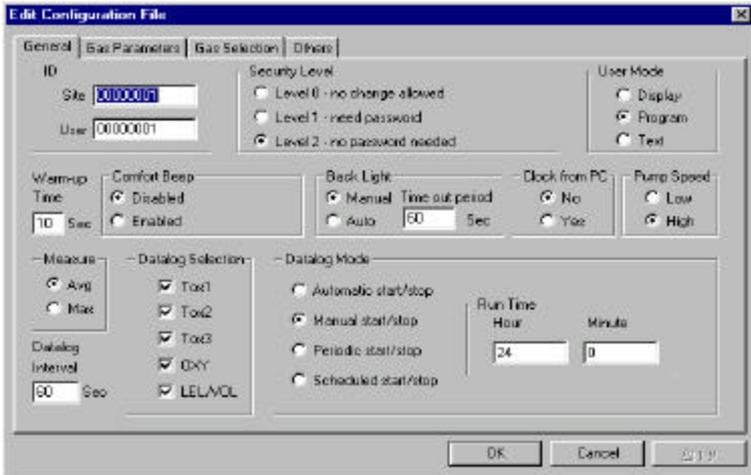
Figure 5.8   General Settings Tab Page

ID:

This section sets the identification that is used throughout the datalog process. Both editing fields, **Site** and **User,** can hold up to eight alphanumeric letters.

Security Level:

There are three levels of security. They are used to provide protection against unauthorized changes to monitor settings through the programming menu of the VRAE.

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.

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

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If **Level 2** is selected, 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 monitor is in the **Text** mode. Entry to the programming menu requires that this password be entered.

User mode:
In the **Text** mode, the monitor only displays the sensor name and an **OK** message during normal operation. In the **Display** mode, the user can view several readings in the normal operation, but cannot enter the programming menu. In the **Program** mode, the user can enter the programming mode to calibrate the monitor or change various settings in the monitor.

Warm-up Time:
This option allows the user to choose the warm-up time of the instrument, in seconds.

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.

Back Light:
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, the

user can also enter a time out period so that the backlight will be turned off automatically after the time out period. If **Auto** is selected, the ambient light sensor will automatically turn on and off the backlight.

Clock from PC:
This option allows the PC clock to be downloaded to the VRAE monitor so that the user does not need to manually set the clock in the VRAE monitor.

Pump Speed:
This option allows the user to choose the high or low pump speed for the VRAE monitor.

Measure:
The user can choose to record the average or peak (Max) reading of all the sensors during each datalog period.

Datalog Interval:
The datalog interval is the rate at which datalog samples are recorded while the datalog is running. The unit of datalog interval is second. The datalog interval determines how often a new sample is calculated and stored to the datalog.

Datalog Selection:
The user can choose one or more sensors for datalogging purpose. This does not activate or inactivate the particular sensor except for the purpose of datalogging recording.

Datalog Mode:
This may be set to either of four choices:
-- With **Automatic start/stop**, the datalogging begins when the monitor is turned on and ends when it is turned off.

-- With **Manual start/stop**, the datalog can begin by a series of key presses in the menu of normal operation. The maximum run time determines an automatic end to the datalog or it can be stopped manually.

-- If **Periodic start /stop** (or daily) mode is chosen, the user must specify the start and stop hour and minute. The interval between start and stop is the period of time the monitor will datalog (at "data logging period" rate).

-- With **Scheduled start/stop,** all the entry boxes for year, month, day, hour and minute for both start and stop time must be entered to specify when the datalog is to occur.

Run Time:
If manual start/stop mode for datalogging is chosen, the user needs to specify a maximum run time. After the monitor has been on for the specified run time, datalogging will be turned off automatically.

Start Time and Stop Time:
If scheduled start/stop mode is chosen for datalogging, all entry boxes must be completed for start and stop year, month, day, hour and minute. The monitor must already be turned on. Then once the start date/time is reached, the monitor will start datalogging. When the stop date/time is reached, the datalogging will stop automatically. With periodic start/stop mode, the hours and minutes are used for the data log period to be run each day.

Figure 5.9 shows the **Gas Parameters** tab page that allows the user to change the gas parameters of the configuration data. The following is the description of each field in the

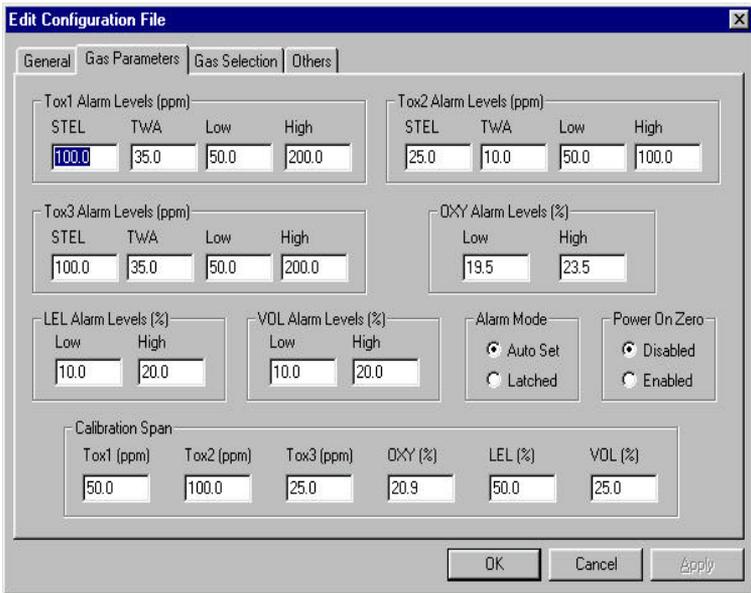**Gas Parameters** tab page of the **Edit Configuration File** dialog:

Figure 5.9   Gas Parameters Settings Tab Page

Tox1 Alarm Levels (ppm):
This is the place where the user can specify the STEL alarm level (ppm), TWA alarm level (ppm), low alarm level (ppm) and high alarm level (ppm) for Tox1 sensor.

Tox2 Alarm Levels (ppm):
This is the place where the user can specify the STEL alarm level (ppm), TWA alarm level (ppm), low alarm level (ppm) and high alarm level (ppm) for Tox2 sensor.

Tox3 Alarm Levels (ppm):

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This is the place where the user can specify the STEL alarm level (ppm), TWA alarm level (ppm), low alarm level (ppm) and high alarm level (ppm) for Tox3 sensor.

OXY Alarm Levels (%):
This is the place where the user can specify the low alarm level (%) and high alarm level (%) for OXY sensor.
Note: For PGM-7840, OXY Alarm Level will be replaced by Tox4 Alarm Levels (ppm).

LEL Alarm Levels (%):
This is the place where the user can specify the low alarm level (%) and high alarm level (%) for LEL sensor.

VOL Alarm Levels (%):
This is the place where the user can specify the low alarm level (%) and high alarm level (%) for VOL sensor.

Alarm mode:
If **Auto Set** (Auto reset) is chosen, the alarm will stop as soon as the alarm condition goes away. The alarm will remain on if the **Latched** option is chosen. To turn off a latched alarm, press **[Y/+]** key to acknowledge the alarm condition.

Power On Zero:
This option allows the monitor to perform a fresh air calibration automatically when the monitor is turned on. Care must be taken, when using this mode, to ensure that the monitor is in a fresh air environment when turned on.

Calibration span:

The user can specify the calibration gas span for Tox1, Tox2, Tox3, OXY, LEL and VOL here. **Note**: In PGM-7840 model, the OXY span entry will be replaced by Tox4 entry.

Figure 5.10 shows the **Gas Selection** tab page. There is one set of gases for correction factors that the user can choose for the LEL sensor. The following is the description of each field in the **Gas Selection** tab page of the **Edit Configuration File** dialog box:
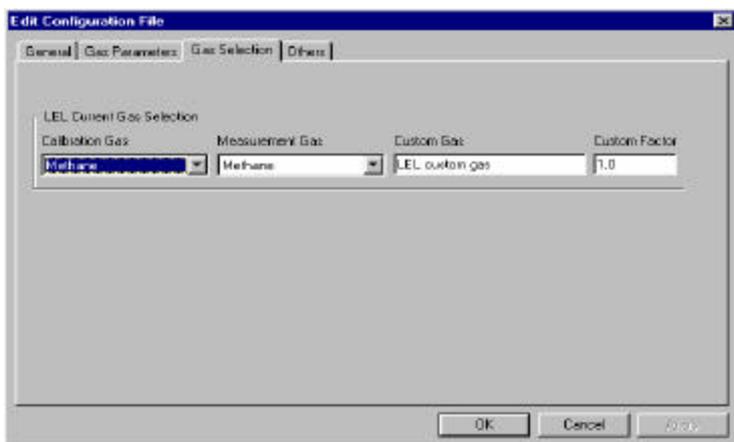

Figure 5.10   Gas Selection Settings Tab Page

LEL Current Gas selection:

This is the place where the user can choose a set of gases for correction factors of the LEL sensor. The user can choose one gas from the **Calibration Gas** list box for calibration and another gas from the **Measurement Gas** list box for measurement. Each list box contains a list of about 40 gases. Scroll the list using the up or down arrow until the desired gas name is shown. Press **Enter** key to select the

gas. The user can also enter a custom gas name (up to 16 characters long) and a custom correction factor.

OK/Cancel:
When the configuration changes are completed, click on the **OK** button to save the configuration and return to the client window. Click on **Cancel** button to abort the configuration changes.

Figure 5.11 shows the Other tab page. This page contains two features: Power On Messaging and On-line Printing.
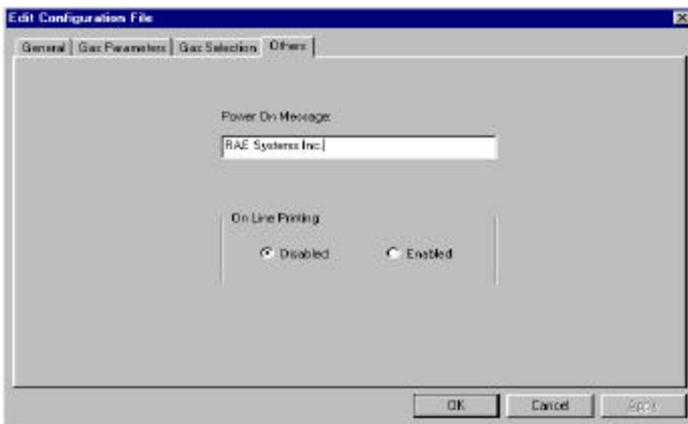

Figure 5.11   The Other Tab Page

Power On Message: It is a feature that allows the user to display any custom message, up 16 characters, when powering up the gas monitor. For example, the user can enter the name of the company which own the gas monitor. The default message stored inside every VRAE gas monitor is "RAE systems Inc." To change the default, simply type in the desire message in the text bracket.

On-line Printing: It is an option that requires a RAE specified serial printer. This feature allows the user to retain a hard copy of the instantaneous reading. To utilize the printer option, the user must first enable the On-line printing. Once the On-line printing is enabled, a new sub-menu item will appear in the user mode (see Section 2.4 for more details).

5.5.2 Send Configuration to VRAE

After the configuration data is loaded into the ProRAE-Suite software, the user can send the configuration settings to the VRAE monitor. To send the configuration settings to the instrument, click **Communication->Send Config** menu item or click the send toolbar icon (right arrow with "Send" letters), a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button to start the data transfer.

After the configuration information is sent successfully, a message box will appear to indicate that the sending configuration process is completed. Click the **OK** button to close the message box.

If the communication is not successful, an error message indicating that there is no response from the instrument will appear. Check the cable to make sure that the connectors on both ends of the cable are securely seated in the sockets. Try to send the information again. If the error message still appears after repeated attempts, call an authorized service center for help.

5.5.3 Receive Configuration Data

To receive the configuration data from the VRAE monitor, click **Communication**->**Receive Config** menu item, a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button to start the data transfer. After the data transfer is finished, a new client window is opened with the newly received configuration data displayed. In order to save the configuration information for future use, user can click **File**->**Save** or **File**->**Save As** menu item to save the newly received configuration data to a file. Once the configuration file is saved on disk, it can be opened at a later time for further modification or be sent to the VRAE monitor.

5.5.4 Configure All Settings

The user can use this function to update the entire configuration settings (except the instrument ID, serial number and the datalog option) in the VRAE monitor. To configure all the settings in the instrument, click **Option->Config All** menu item, a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button, another message box will appear to warn the user that this operation will erase all the old configuration settings instrument. If the user does not want this to happen, clicks the **Cancel** button, otherwise, click the **OK** button to start the data transfer.

After the information is sent successfully, a message box will appear to indicate that the sending configuration process is completed. Click the **OK** button to close the message box.

Note: The **Config All** option is mainly used to restore the VRAE monitor's default operational settings, such as calibration data, lamp & pump drive, and diagnostic parameters, etc. If the user feel that the internal calibration data of the instrument are corrupted or incorrect and can not be recovered, then user can open the default configuration file and use this option to restore the instrument to a known state.

5.6 Process the Logged Data

The ProRAE-Suite software allows the user to retrieve the logged data from the VRAE monitor and display the data in many different formats. The user can also export the displayed text to a tab delimited text file so that Microsoft Excel can read it directly.

5.6.1 Receive Data from VRAE

To receive the logged data from the VRAE, click **Communication**->**Receive Data** menu item or click the **Receive Data** toolbar button (left arrow with "Recv" letters), a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure the instrument is connected to the PC, click the **OK** button to start the data transfer. After the data transfer is finished, a new client window is opened with the newly received logged data displayed. In order to save the logged data for future use, the user can click **File**->**Save** or **File**->**Save As** menu item to save the newly received logged data to a file.

5.6.2 View Logged Data in Text Mode

Once the user opened a data file or received the logged data from the instrument, a data window appears, as shown in Figure 5.12.
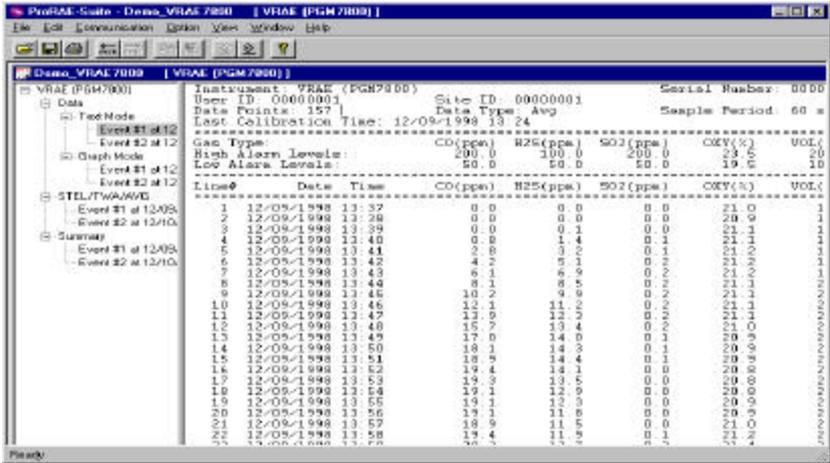

Figure 5.12   Displayed Logged Data

The data window is a two-pane client window. The left pane is a tree which all the display format of each event, and the right pane displays the information according to the display format and the event the user selected on the left pane. To select any display format of any event, the user can simply click the format item on the left pane. To view the next event or the previous event, the user can click the **Next Event** (double right arrow) or the **Previous Event** (double left arrow) toolbar buttons. The user can also drag the splitter bar between the left pane and the right pane to the

left or to the right to enlarge a pane if that pane is not big enough.

To view the data points of a specific event, the user can click the item representing that event under the item **Data\Text Mode**. For example, click the item **Event #1** on the left pane, the right pane displays the data points of event #1, as shown in Figure 5.12.

5.6.3 View STEL/TWA/AVG Value

To view the STEL, TWA or AVG value of any event, click the event number item under the tree item **STEL/TWA/AVG** in the left pane, the right pane displays the STEL, TWA and AVG value of each data point of that event, as shown in Figure 5.13.
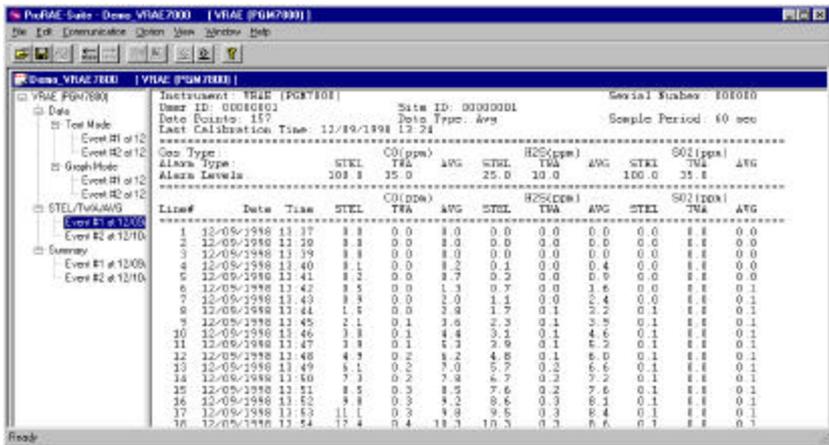
Figure 5.13   STEL/TWA/AVG of the Logged Data

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5.6.4 View Summary Information

To view the summary information of any event, such as peak data value and minimum data value, click the event number item under the tree item **Summary** in the left pane, the right pane displays the summary information of that event, as shown in Figure 5.14.
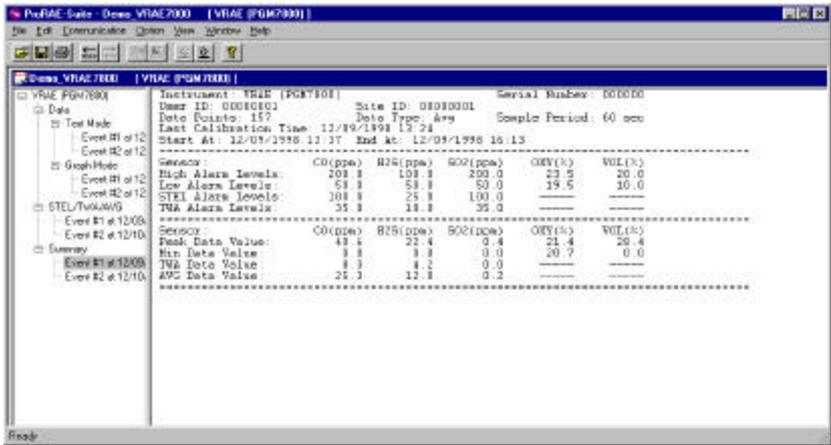

Figure 5.14   Summary Information of the Logged Data

5.6.5 View Logged Data in Graph Mode

To view the logged data of a specific event in graph mode, click the event item under the tree item **Graph Mode** in the left pane, and the right pane displays the graph of that event, as shown in Figure 5.15.
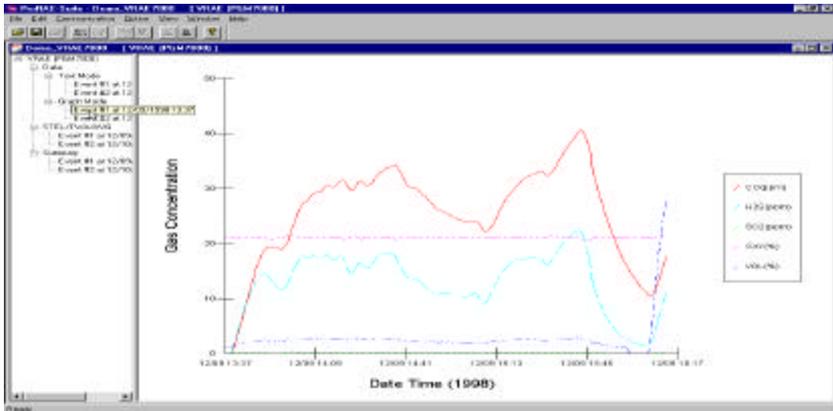

Figure 5.15   Graph of the Logged Data

Select graph type:

The user can choose the type of sensor data in the **Graph Type** tab page of the **Graph Settings** dialog box. To display the **Graph Settings** dialog box, click any place in the right pane so that pane has the focus, then click **Option->Graph Settings** menu item to display the **Graph Settings** dialog box. Figure 5.16 shows the **Graph Type** tab page of the **Graph Settings** dialog box. This is the place where the user can choose which sensor data to be shown on the graph, whether to show grid on the right pane, and the title of the graph.
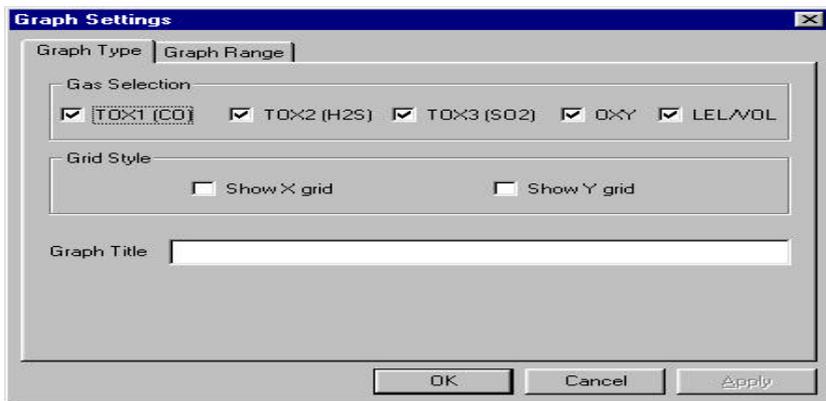
Figure 5.16   Graph Type Tab Page

Select graph range:

The user can choose the value range on the x-axis and y-axis in the **Graph Range** tab page of the **Graph Settings** dialog box. To display the **Graph Settings** dialog box, click any place in the right pane so that pane has the focus, then click **Option->Graph Settings** menu item to display the **Graph Settings** dialog box. To bring the **Graph Range** tab page, the user can simply click the page header of the **Graph Range** tab page. Figure 5.17 shows the **Graph Range** tab page of the **Graph Settings** dialog box. This is the place where the user can choose the graph range on the x-axis and y-axis.

To choose the range of Y-axis, the user first click the **User Defined** radio button in the **Y-Axis (Data Value) Range** group box, then the user can specify the top value and the bottom value in the **Data Value Range (Y-axis)** group box.
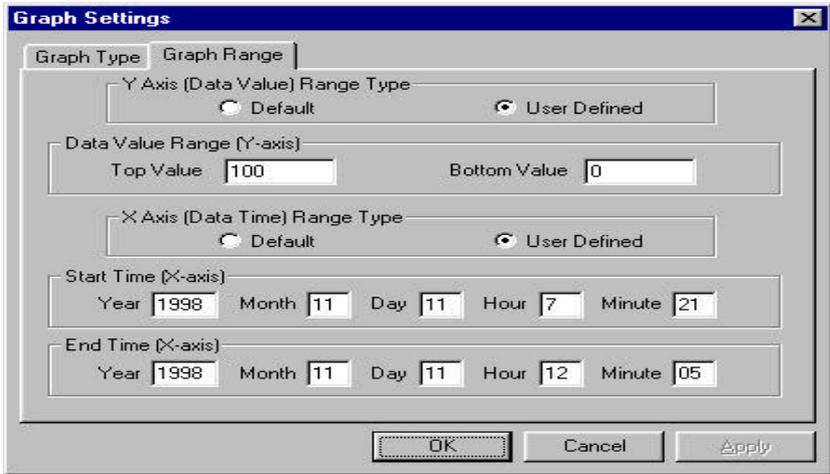
Figure 5.17   Graph Range Tab Page

If the user select the **Default** radio button in the **Y-Axis (Data Value) Range** group box, the ProRAE-Suite software will scale the range of Y-axis by itself to cover the maximum data value on y-axis.

To choose the range of X-axis, the user first click the **User Defined** radio button in the **X-Axis (Data Time) Range** group box, then specify the start time fields in the **Start Time (X-axis)** group box and the end time fields in the **End Time (X-axis)** group box.

If the user select the **Default** radio button in **the X-Axis (Data Time) Range** group box, the ProRAE-Suite will scale the range of X-axis by itself to cover the every data points on x-axis.

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5.6.6 Export the Displayed Data to a Text File

The ProRAE-Suite software allows the user to export the displayed text to a tab delimited text file so that Microsoft Excel can read it® directly. To export the text displayed in the right pane to a tab delimited text file, click **Option -> Export Text** menu item, a **Save As** dialog box is displayed. Specify the file name in the **File name** field, then click the **OK** button to close the **Save As** dialog box. A new file is created and Microsoft Excel can read this file® directly. Appendix C shows a detailed step by step instruction on how to export data as text file and use Microsoft Excel® to open the text file.

5.6.7 Export a Graph to a File

The ProRAE-Suite software allows the user to export the displayed graph to a windows bitmap (.bmp) file or a windows metafile (.wmf) file. To export the displayed graph in the right pane to a windows bitmap or metafile file, first click any place in the right pane to make sure that the graph pane has the focus, then click **Option -> Export Graph** menu item to display a **Save As** dialog box. Select the export graph file type (.bmp or .wmf) in the **Save as type** field, then specify the export file name in the **File name** field. Click the **OK** button to close the **Save As** dialog box. The newly created graph file contains the graph displayed in the right pane.

5.6.8 Print the Logged Data

After viewing the data results, the user may print the data to a printer in order to obtain a hard copy of the text or graphic data report. First, click any place in the right pane to set the focus on that pane, then select **File->Print** menu item, or click the **Print** toolbar button (a printer) to print the graph or text data.

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

5.7 Upgrade the Datalog Option

To upgrade the unit to datalogging capability, open the ProRAE-Suite software. Do not open any configuration file or data file so that the ProRAE-Suite software has no client window open, as shown in Figure 5.18.
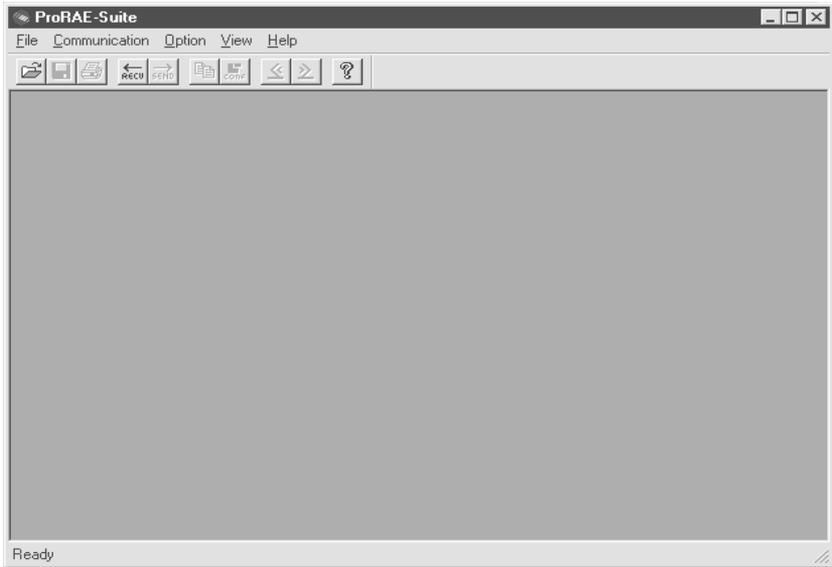

Figure 5.18   Main Window of ProRAE-Suite

Click **Option -> Enable Datalog** menu item, a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the VRAE monitor is connected to the PC, click the **OK** button to start. After the ProRAE-Suite software makes successful contact to the instrument connected to the PC, a dialog box is displayed, as shown on Figure 5.19.

Figure 5.19   Enable Datalog Dialog Box

Figure 5.19 shows that the instrument's datalog feature is currently disabled. To enable the datalog capabiltiy, click the "Enable" button, type the three-digit authorization code in the **Authorization Code** field, and then click the **OK** button to close the dialog box. After the datalog option is changed, a message box will appear on the screen to let the user know that the datalog option is successfully changed.

Note: Each VRAE with datalogging function should be shipped with a 3-digit authorization code. If the code is missing, call the factory's Customer Service Department to obtain the code. If the unit is being upgraded from non-datalogging to datalogging, call an authorized distributor to purchase this feature.

5.8 Upgrade the Firmware

Recent Firmware upgrades are available at no cost on the RAE website www.raesystms.com. To upgrade the firmware in the VRAE monitor, open the ProRAE-Suite software. Do not open any configuration file or data file so the ProRAE-Suite software has no client window open, as shown in Figure 5.18. Click **Option -> Load Firmware** menu item, a message box will appear to remind the user to connect the instrument to the PC through the serial port. After making sure that the instrument is connected to the PC, click the **OK** button. An **Open** file dialog box is displayed, as shown on Figure 5.20. Select the firmware file (.a07) that is going to be loaded into the instrument, click the **OK** button to start the loading process. After the firmware loading is finished, a message box will appear on the screen to let the user know that the firmware is successfully loaded into the instrument.

Figure 5.20   Open Firmware File Dialog Box
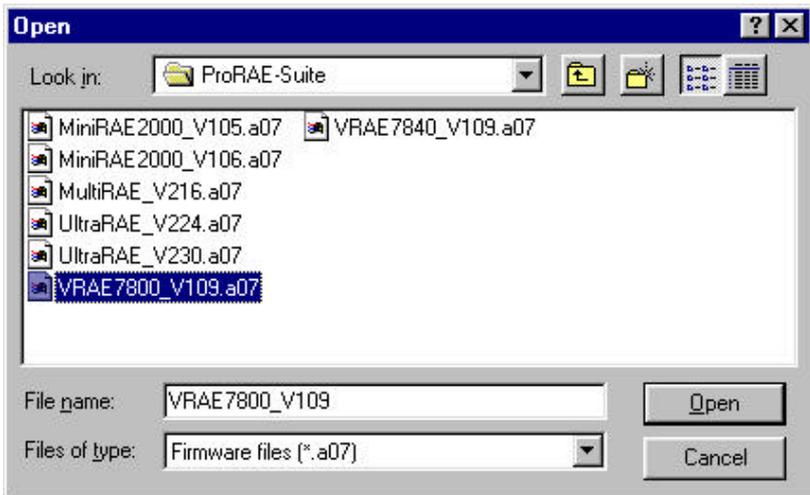
6 THEORY OF OPERATION

VRAE monitor uses up to five different sensors to measure a variety of gases. A newly developed thermal conductivity sensor is combined with a catalytic combustible gas sensor (See Figure 6.1).   The thermal conductivity sensor will detect a broad range of gases. Up to three electrochemical toxic gas sensors (four in PGM-7840 model) can be installed in the monitor to measure inorganic toxic gases. Many different type of toxic sensors are offered. They can be plugged into these three sensor sockets and are interchangeable.   An electrochemical sensor is used to measure oxygen concentration in PGM-7800 model.
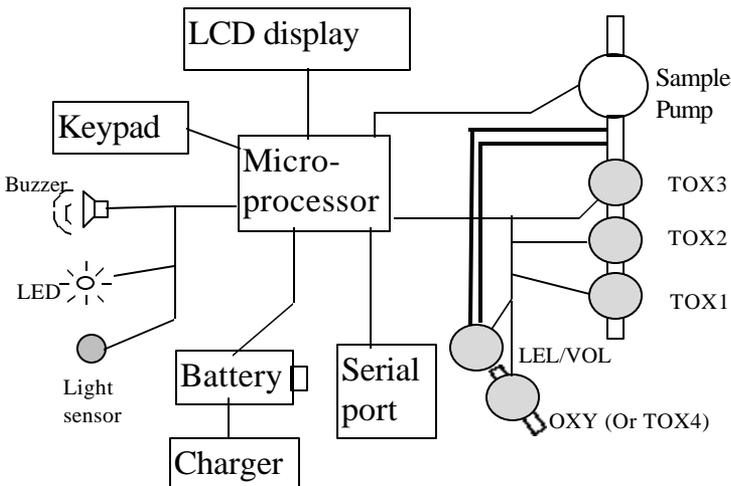
Figure 6.1   Block Diagram of VRAE PGM-7800 Monitor

The five sensors are mounted next to the gas inlet probe. A diaphragm pump is installed inside the monitor to draw the

sample air into the sensor manifold and then distributed it to all sensors.

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. A 2-line by 16-character LCD display is used to show the readings. The user interacts with the monitor through three keys on the front panel keypad.

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

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 sensors or 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

As shown in Figure 7.1, the major maintenance items of VRAE are:
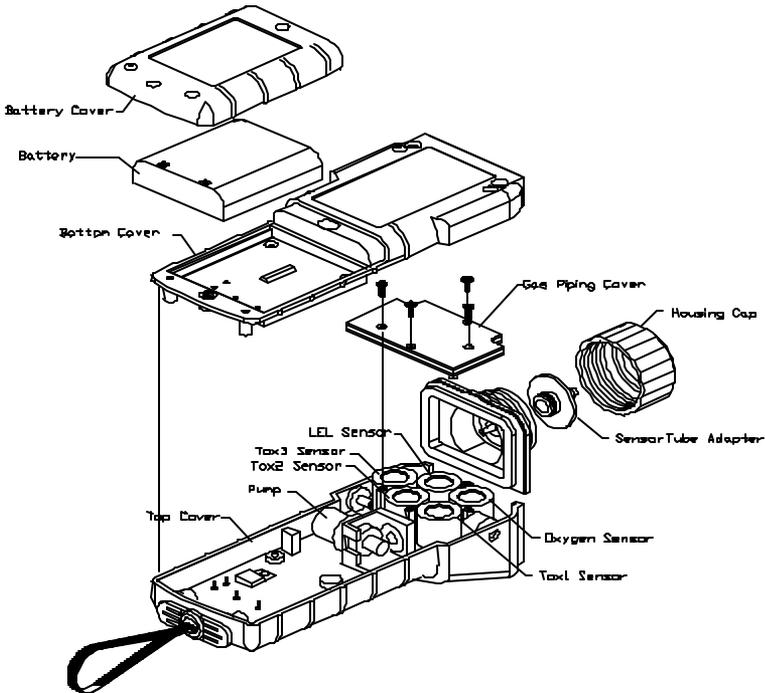
- Battery pack
- Sensor modules
- Sampling pump

Figure 7.1   Main Components of VRAE

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 VRAE monitor upon returning from field work. A fully charged battery powers a VRAE monitor for up to 10 hours of 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.

<u>Replacing and Recharging Battery Pack</u>

1. Turn off power of the VRAE.

2. Refer to Figure 7.1, unscrew two case screws from the bottom of the monitor case and remove the battery cover.

3. Remove the battery pack from the battery compartment.

4.   Place a new battery pack in the battery compartment. Make sure that the contacts on the battery pack matches with the battery pins inside the compartment.

5. Close the battery cover and tighten the screws.

<u>Replacing Alkaline Battery Adapter</u>
1. Insert four fresh AA size alkaline batteries into the alkaline battery adapter. Make sure that the polarity of the battery is correct.

2. Follow the same procedure as described above to replace the battery adapter.

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

7.2 Sensor Replacement

The toxic, combustible and oxygen sensors all have an expected operating life. Under normal operating condition, most sensors will lose its original sensitivity after the expected operating life and needs to be replaced.

Each sensor module in VRAE includes a non-volatile memory that records the manufacturing date of the sensor. In the diagnostic mode, the microprocessor will check the date code and display the expiration date of each sensor. The user should replace the sensor when the current date exceeds the expiration date of a sensor.

Sensor Replacement Procedure

The oxygen and combustible sensor each has its unique sensor sockets in the VRAE monitor. The three toxic sensor sockets in the VRAE monitor allow the users to plug in any three sensors selected from the series of toxic sensors offered by RAE Systems Inc.

1. Turn off power of the VRAE.

2. Refer to Figure 7.1, open the battery cover by unscrew the two screws from the bottom of the monitor case. Remove the battery pack.

3. Open the bottom cover of the monitor case by removing the 6 screws that holds the bottom case.

4. Refer to Figure 7.1, carefully unscrew four No.2 screws that hold down the gas piping cover to the PCB and sensors. Remove the gas piping plate.

5. Refer to Figure 7.1, identify the location of a specific sensor and remove the sensor by gently pulling the sensor upward.

6. Plug a new sensor into the empty sensor socket. Make sure that black line on the sensor label is lined up with the white marker on the PCB and the sensor pins are aligned with the socket before pushing down the sensor.

7. Replace the gas piping cover and tighten the four screws to hold down the sensors. Replace the battery pack and the monitor cover.

8. Turn on the power of the VRAE. The microprocessor will automatically recognize the sensors installed and configure the monitor accordingly.

Special Bias Voltage for Toxic Sensor:

The NO and NH_3 toxic sensors require a special 300 mV bias voltage to operate. There is a dip switch located on the PCB next to the sensors. When NO or NH_3 toxic sensor is plugged into the toxic sensor socket, it is necessary to turn the dip switch for the corresponding sensor to "ON" position to enable the bias voltage. It is very important to set the bias switch to the correct position when installing the toxic sensors.

7.3 Sampling Pump Replacement

The sampling pump is positive displacement piston pump. When approaching the end of the specified life time 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 the pump.

1. Turn off power of VRAE gas monitor.

2. Refer to Figure 7.1, open the monitor cover, **remove the battery pack,** carefully unscrew four No.2 screws that hold down the gas piping plate to the PCB and sensors. Remove the gas piping plate.

3. Pull loose the connector of the pump wire. 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.

4. Replace a new pump assembly. Connect the Tygon tubing to the gas inlet port. Connect the pump wire and screw down the pump assembly to the analog PCB.

5. Refer to Figure. 7.1, replace the gas piping plate and tighten the four screws to hold down the sensors. Re-place the battery pack. Replace the battery cover.

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 VRAE 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 are not familiar with these parameters and set 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 1 to 5 numbers with a message "Raw." These numbers are raw sensor readings without calibration.

Other critical parameters of the monitor are available as shown in Table 8.1. They can be reached by pressing the **[MODE]** key repeatedly until the desired parameters are displayed.

Table 8.1

Key Action	Display
	Show raw readings
[MODE]	Show sensor name
[MODE]	Show battery type and battery temperature
[MODE]	Adjust LCD contrast
[MODE]	Show LEL or VOL sensor raw readings
[MODE]	Show date, clock, battery voltage and temperature
[MODE]	Show LEL & OXY sensor expiration date
[MODE]	Show TOX1 & TOX2 sensor expiration date
[MODE]	Show TOX3 sensor expiration date
[MODE]	Adjust pump stall threshold
[MODE]	Adjust back light on/off threshold
[MODE]	Show serial number and toggle pump speed
[MODE]	Begin battery deep discharge
[MODE]	Show battery duration time
[MODE]	Communicate with PC?

Below is a brief description of each diagnostic display and how to interpret the displayed values:

1) Raw Sensor Readings

The raw sensor readings provide a quick diagnosis on the baseline and sensitivity of each sensor. When zero gas (fresh clean air) is applied to the monitor, the raw sensor readings typically should be between 100 to 300 for toxic sensors, between 1800 to 2600 for LEL or VOL sensor and between 800 to 1200 for oxygen sensor. If the raw reading is outside these ranges when zero gas is applied, the sensor or the electronics may be defective.

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

165	160	173
2051	RAW	1079

2) Sensor Name

All the toxic, oxygen and LEL sensors have a non-volatile memory which contains the sensor identification and other vital information, such as manufacturing date, expected operating life, etc. If a sensor is programmed and installed properly in the monitor, the sensor name should be displayed. If the sensor name does not show up in the display, then the sensor may not be programmed properly or may be defective.

3) Battery Type and Battery Temperature

The VRAE monitor can be powered by either a rechargeable NiMH, Ni-CD battery pack or an alkaline battery adapter. The microprocessor automatically detects the type of

battery installed inside the monitor and displays the type of battery. The re–chargeable battery includes a temperature sensor. The temperature sensor reading is also displayed.

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, press **[Y/+]** key several times should see a more clear display.

5) Display LEL or VOL Raw Reading

This display shows the present raw reading of the LEL or a combination of LEL/VOL sensor. The top display shows the mode of the combustible sensor. The bottom line shows the instantaneous reading of raw counts from the LEL or VOL sensor. By pressing **[N/-]** key the sensor mode can be switched from %LEL to %VOL and vice versa. If a standard LEL sensor is installed, press **[N/-]** key will toggle on and off the LEL sensor.

6) Show Clock, Battery and Temperature

This display shows the real time clock, battery voltage in raw count and temperature sensor reading.

7) Sensor Expiration Date

This display shows the expiration date (month and year) of all the installed sensors in the VRAE monitor. The expiration date is calculated based on the manufacturing date and expected life of each sensor which were stored inside

each sensor when it was fabricated in the factory. If the current date exceeds the expiration date of any sensor, the performance of the given sensor can no longer be guaranteed. It is strongly recommended that the user replace the sensor immediately to ensure proper operation of the sensor.

8) Adjust Pump Stall Threshold

This display can be used to calibrate the pump stall threshold. If the gas inlet is blocked but the pump does not shut down, or the pump shut down too easily with a slight blockage to the gas inlet, then the pump stall threshold value may be set too high or too low. Use the following steps to adjust the pump stall threshold.

1. The maximum and average pump current is displayed on the first row: "Pump = xxx/zzz". The current pump stall value is displayed on the second row: "Stall = yyy +/-". The typical maximum and average pump current without any blockage should be between 8–10. The typical stall value should be higher than the "un-blocked" pump current by at least 8-10 counts.

2. The user can block the gas inlet and watch the pump current reading. If the pump current reading does not increase significantly (i.e. more than 3–5 counts), then there may be a leak in the gas inlet or the weak or defective.

3. Use **[Y/+]** or **[N/-]** key to increase or decrease the stall value until it is about 8-10 counts above the "un-blocked" pump current reading. Press **[MODE]** key to exit this display. If the threshold value is changed, a message "Save new stall threshold?" will appear. Press **[Y/+]** to

confirm the change, **[N/-]** or **[MODE**] key to abandon the changes.

9) Adjust Back Light Threshold

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

1. The present ambient light level is displayed on the first row: "Light = xxx." The current back light threshold value is displayed on the second row: "Trigger = yyy +/-." In a brightly lit room, the light reading should be above 120.

2. The user can block the light sensor, which is located at the upper left corner of the monitor, with a finger 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.

3. Use **[Y/+]** or **[N/-]** key to increase or decrease the trigger 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 new light threshold?" will appear. Press **[Y/+]** to confirm the change, **[N/-]** or **[MODE**] key to abandon the changes.

10) Serial Number and Pump Toggle

This display shows the unit serial number.

If a pump is installed and pump speed control circuit available, the display "Pump=Low/(High)" may be toggled by pressing the **[N/-]** key. Note that changes made here are

only for testing the pump condition and do not become saved in the nonvolatile memory (see Section 4.7 to update the pump speed setting).

11) Start Battery Deep Discharge

This display can be used to begin a battery deep discharge cycle. Certain rechargeable batteries may require deep discharge before charging again.

To start the deep discharge: First connect the charger and select **[Y/+]** key to enter the deep discharge mode and answer with **[Y/+]** key when asked to confirm. The unit will turn off charger current and draw its maximum current until the battery voltage reaches 4.0 volts. With the charger connected, a charge cycle will then begin.

12) Display Battery Duration Time

This display shows the run time of the last time the unit powered itself off due to a low battery or turned off by the user. It is useful for battery life testing.

8.2 Troubleshooting Table

Table 8.2

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	**Reasons:** Discharged battery. Defective battery. Microcomputer hang-up. **Solutions:** Charge or replace battery. Disconnect then connect battery to reset computer.
No LED or LCD back light	**Reasons:** Defective LED or LCD back light. **Solutions:** Call authorized service center
Lost password	**Solutions:** Use default configuration to reset password
Buzzer inoperative	**Reasons:** Bad buzzer **Solutions:** Call authorized service center

Problem	Possible Reasons & Solutions	
"Bat" message in operation	**Reasons:**	Discharged battery
	Solutions:	Recharge battery
"Voltage too high message" in charge mode	**Reasons:**	Battery fuse blown or wrong AC adapter
	Solutions:	Check battery and adapter
Excessive pump noise or no inlet air pressure	**Reasons:**	Leaky inlet path Defective pump
	Solutions:	Check inlet connection Replace a new lamp
Read a small background value	**Reasons:**	There is actually a small background gas level Sensor zero drift
	Solutions:	Do fresh air calibration (See Section 4.4.1)

Reading abnormally Low	**Reasons:** Incorrect calibration Low sensitivity to the specific gas
	Solutions: Calibrate the monitor Replace sensor
Problem	**Possible Reasons & Solutions**
Reading jumping around randomly	**Reasons:** Incorrect gas calibration Low sensitivity to cal gas
	Solutions: Calibrate the sensor Use different cal gas
Can not turn off monitor or corrupted characters in LCD display	**Reasons:** Microprocessor hang-up
	Solutions: Disconnect and re-connect battery to reset computer. Call authorized service center
Calibration error message	**Reasons:** No standard gas input Low sensitivity to cal gas
	Solutions: Make sure standard gas flows into monitor. Change cal gas

APPENDIX A. QUICK REFERENCE GUIDE

DISPLAY MODE/ PROGRAM MODE

Display Instantaneous Readings

[N]+[MODE] for 3 seconds:
Security level=0 or Display Mode: No Action
Security level=1 or Text Mode: Password check
Wrong password: back to instantaneous display
Correct password: Enter Programming menu.
[N]: Toggle back light   **[Y]:** Test alarm/stop alarm

[M]

Display Sensor names

[M]

Display Peak values

[M]

Display Minimum values

[M]

Display STEL values

[M]

Display TWA values

[M]

Display Battery voltage

[M]

Display Clock / Run time / Internal temperature

[M]

Configured for Manual datalog?*

yes: Start/Stop Datalog?
[Y]: Start or Stop Datalog **[N]**: Display Datalog mode

[M]

Display LEL/VOL gas name (if sensor is present)

[M]

Display Pump Speed

[N]: Change speed

[M]

LEL/VOL Mode Selection

[M]

Print Reading? *

[M]

Communicate with PC?

[Y]: Monitor will pause OK?
[Y]: Ready...   **[N]:** Return to Instantaneous display

[M] or [N]
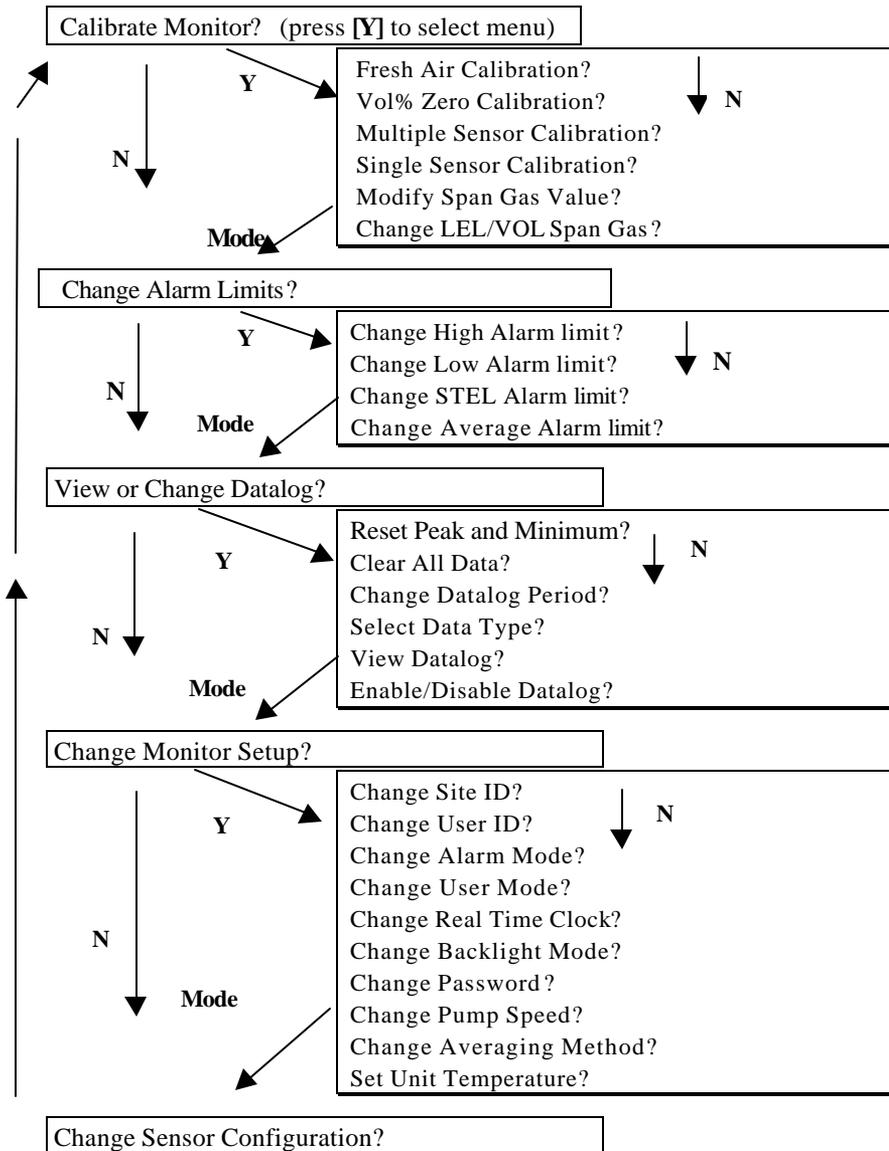
Return to Instantaneous display
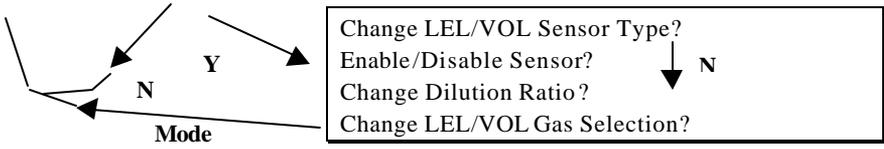
*--Display appears only if option is enabled.

PROGRAMMING MODE

Press **[N]** and **[MODE]** together for 3 seconds to enter, **[Mode]** to return

Calibrate Monitor?   (press **[Y]** to select menu)

Y

Fresh Air Calibration?
Vol% Zero Calibration?   **N**
Multiple Sensor Calibration?
Single Sensor Calibration?
Modify Span Gas Value?
Change LEL/VOL Span Gas?

N

Mode

Change Alarm Limits?

Y

Change High Alarm limit?   **N**
Change Low Alarm limit?
Change STEL Alarm limit?
Change Average Alarm limit?

N

Mode

View or Change Datalog?

Y

Reset Peak and Minimum?   **N**
Clear All Data?
Change Datalog Period?
Select Data Type?
View Datalog?
Enable/Disable Datalog?

N

Mode

Change Monitor Setup?

Y

Change Site ID?   **N**
Change User ID?
Change Alarm Mode?
Change User Mode?
Change Real Time Clock?
Change Backlight Mode?
Change Password?
Change Pump Speed?
Change Averaging Method?
Set Unit Temperature?

N

Mode

Change Sensor Configuration?

A - 2

Change LEL/VOL Sensor Type?
Enable/Disable Sensor?   **N**
Change Dilution Ratio?
Change LEL/VOL Gas Selection?

Y

N

Mode

APPENDIX B. RESPONSE INFORMATION

Correction factors for a number of commonly used compounds for the LEL sensor are:

Table B-1. Lower Explosive Limit in Vol% and LEL Correction Factors for LEL Sensor & LEL/TC Sensor

Compound	LEL Sensor LEL CF	LEL/TC Sensor LEL CF	LEL (Vol%)
Acetaldehyde	1.8		4
Acetic acid	3.4		4
Acetone	2.2	4.0	2.5
Ammonia	0.79		15
Benzene	2.1	4.3	1.2
Butadiene, 1,3-	2.5		2
Butane, n-	2.0		1.9
Carbon disulfide	3.6	5.5	1.3
Carbon monoxide	1.2		12.5
Cyclohexane	2.5		1.3
Dichloromethane	1.0		13
Ethanol	1.7		3.3
Ethene	1.5		2.7
Ethyl acetate	2.2	3.8	2
Ethyl benzene	2.8		0.8
Ethyl ether	2.3		1.9
Gasoline, whole	2.1	3.0	1.3
Heptane, n-	2.4	3.9	1.1
Hexane, n-	2.3	4.3	1.1
Hydrogen	1.2	1.7	4
Hydrogen sulfide	2.3		4
Isobutane	1.8		1.8
Isobutene	2.0	2.8	1.8

Isopropanol	1.6	2.5	2
Compound	**LEL Sensor LEL CF**	**LEL/TC Sensor LEL CF**	**LEL (Vol%)**
Methane	1.0	1.0	5
Methanol	1.5		6
Methyl ethyl ketone	1.7	2.6	1.4
Octane, n-	2.9		1
Pentane	1.8	3.4	1.5
Propane	1.5	1.9	2.1
Propene	1.5	2.5	2
Toluene	1.9	4.4	1.1
Vinyl chloride	1.8		3.6
Xylene, m-	2.7		1.1
Xylene, o-	3.0		0.9
Xylene, p-	2.8		1.1

The LEL correction factors are measured relative to methane gas. All gases are measured at less than 5% relative humidity and 25°C. These factors may change at higher concentration level or different temperature. The factors are to be multiplied by the reading to obtain the actual concentration or %LEL of the gas when the monitor is calibrated to a known %LEL of methane. If the correction factor of a gas is <1.0, then the sensitivity to the gas is higher than that of methane.

Note: The LEL CF is different when using the LEL-only sensor compared to the LEL/TC sensor. Therefore it is important to enter the proper CF in the programming mode when the measurement gases is changed (Section 4.8). Similarly, the CF for the LEL-only sensor should be

checked for recent updates in Technical Note 156 on our website www.raesystems.com.

APPENDIX C. VRAE DATA CONVERSION TO MICROSOFT EXCEL[â]

The VRAE multi-gas monitor has a built-in 16,000 point datalogger that in conjunction with the ProRAE-Suite software will provide data that can be converted into other application program such as Microsoft Excel® (Version 7.0) for further data manipulation or graphing.

To convert the data file into Excel®, and to facilitate easier data manipulation, the following procedure may be followed:

1. Export the event data to a tab delimited text file, as described in Section 5.6.6: **Export the displayed data to a text file**. Assume we have just export the event data to a file called TextEvent.txt in C:. To convert that file to a MS-Excel file, open the MS-Excel software, as shown in Figure C-1.
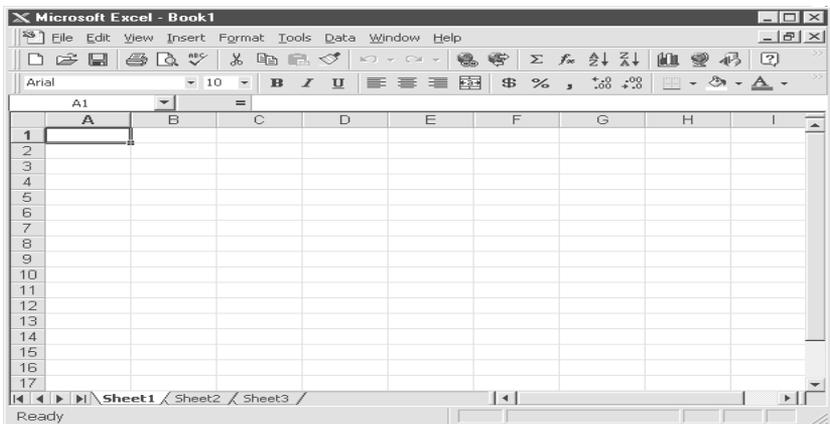
Figure C-1   Excel Window

Click **File->Open** menu item to open the **Open** dialog box, select the folder where the file TextEvent.txt is resided, and

select the **Files of type** as Text Files. Click to select the file TextEvent.txt, as shown in Figure C-2.
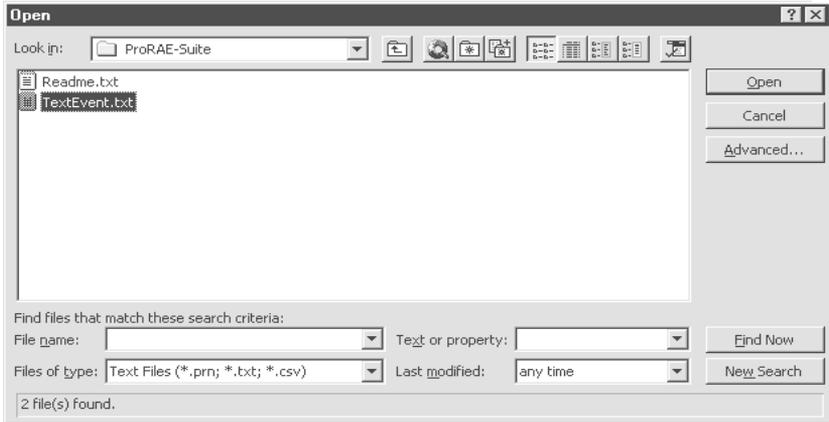
Figure C-2   **Open** Dialog Box

2. Click **OK** button, a **Text Import Wizard** dialog box is open, as shown in Figure C-3.
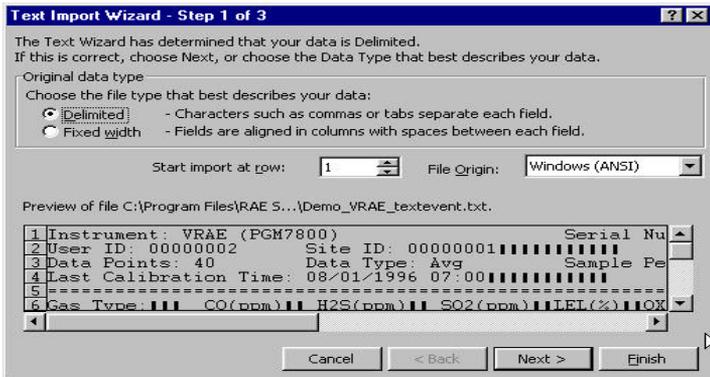
Figure C-3   **Text Import Wizard** Dialog Box

3. Click **Finish** button, the dialog box disappears and the event data is loaded into the MS-Excel software, as shown in Figure C-4.
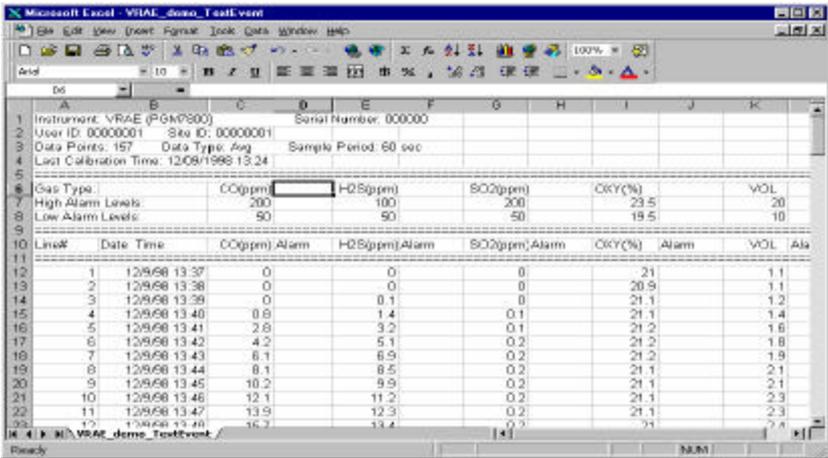

Figure C-4   File TextEvent.txt is Open

4. Click **File->Save As** menu item to save the loaded event data to a MS-Excel file.   Ensure that in the **Save As** dialog box, the **Save as type** is **Microsoft Excel Workbook**.

Graphing VRAE Data in Excel[a]

1. Open the Excel® data file that contains the data to be graphed by selecting "File" and then "Open." Highlight the columns that contain the data points. Make sure that the header information is not highlighted.

2. Go to the "Insert" menu, and under "chart" elect "As New Sheet."

3. The first step of the ChartWizard will appear. In the "Range" area, the cells that were highlighted on the chart will be denoted.
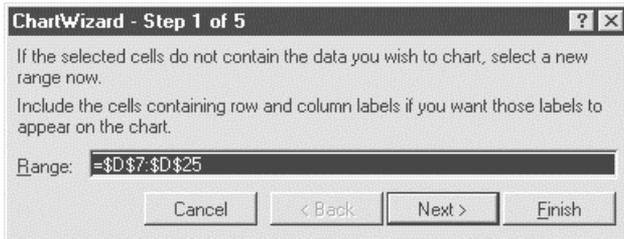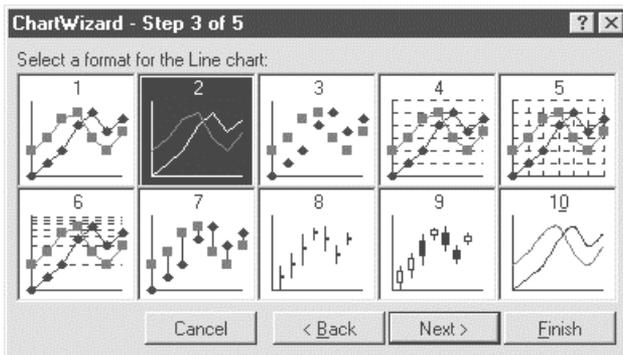

Press the "Next" button to continue.

4. The next step will show the different chart types. For this example, the "Line" chart has been selected.
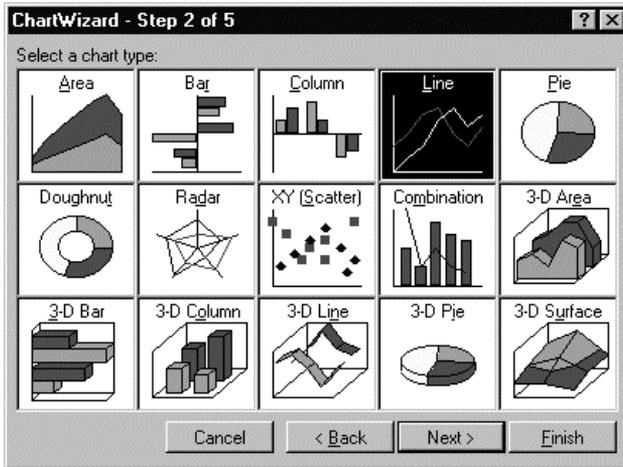
Press the "Next" button to continue.

5. Step 3 of the ChartWizard gives additional choices for the line chart, including data markers and gridlines. In this example, number 4 has been selected, so there will be markers and gridlines.


Press the "Next" button to continue.

6. The next step shows a preview of the chart. This will ensure that the correct columns were chosen in the

spreadsheet that comprises the chart. Press the "Next" button to continue.

7. The final step is where the chart title and axis titles may be added. After these are added in the spaces provided, press the "Finish" button.

8. A sample of a finished chart is shown on next page. For additional information and other modifications that can be made to the Excel® chart, please refer to the Excel® instruction manual.
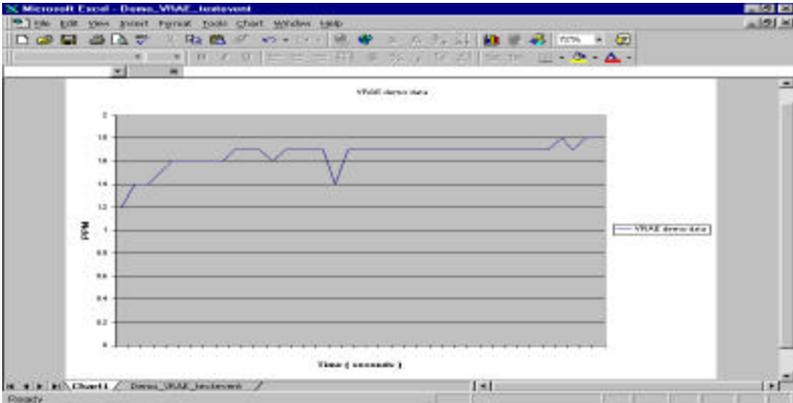
APPENDIX D. RAE SYSTEMS TECHNICAL NOTES

❑ 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-129 Gas Detection Tube and Hand Pump Interchangeability
- ❏ TN-130 Setting Alarm Limits for Mixtures
- ❏ TN-131 Verifying and Fixing Gas Alarm Limits
- ❏ TN-132 Upgrading RAE Instruments Firmware
- ❏ TN-133 Methylene Chloride-Specific Measurements using the UltraRAE
- ❏ TN-134 UltraRAE Bar Code Reader Patterns an Adjustments
- ❏ TN-135 UltraRAE Firmware and 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_3) 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

See Appendix F on how to obtain
Technical Notes.

APPENDIX E. RAE SYSTEMS APPLICATION NOTES

- ❏ AP-200 PIDs and Aircraft Wing-tank Entry

- ❏ AP-201 Measuring Ammonia (NH_3) with PIDs

- ❏ AP-202 ABCs of Gases in Industry

- ❏ AP-203 PID as a Hazmat Response Tool

- ❏ AP-204 Pulp & Paper: Measuring Turpentine & ClO_2

- ❏ 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 Instrument 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

See Appendix F on how to obtain Application Notes.

APPENDIX F. LITERATURE REQUEST

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

APPENDIX G. REQUEST FOR RETURN AUTHORIZATION FORM

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

Photocopy this page and fax to:
1.408.752.0724
You will receive, via fax, **an 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)

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Instrument Sales: raesales@raesystems.com

Technical Service: tech@raesystems.com

Tube Sales: raetubes@raesystems.com

World Wide Web Sites:
www.raesystems.com

www.raetubes.com