

Q-RAE

MULTI-GAS MONITOR

OPERATION AND MAINTENANCE MANUAL

(Document No.: 027-4001)

Rev. B



RAE SYSTEMS INC.
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RAE Systems Product Line

- **Gas Detection Tubes & Pumps**
- **SampleRAE Electronic Sampling Pump**
- **MultiRAE PLUS Multi-gas Monitors**
- **MultiRAE IR Multi-gas Monitors w/CO₂**
- **MultiRAE Confined Space Monitor**
- **QRAE PLUS Multi-gas Monitors**
- **QRAE Confined Space Monitor**
- **VRAE Five-Gas Monitors**
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- **MiniRAE 2000 Portable VOC Monitor (PID)**
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- **ToxiRAE PLUS Single Gas Monitors**
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- **ToxiRAE PLUS Combustible Gas Monitor**
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How can I be informed and updated?

Be sure to mail in your warranty card via email, post or fax 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-50Q equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.

Special Notes

-1-

When the Q-RAE monitor is taken out from the transport case and turned on for the first time, there may be some residual organic or inorganic vapors trapped inside the detector chamber. The initial toxic sensor reading may indicate a few ppm. Place the unit in an area free of organic or toxic vapors and turn on the monitor. After running for several minutes, the residual vapors in the detector chamber will be cleared and the reading should return to zero.

-2-

The battery of the Q-RAE 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.

WARNINGS:

Use only RAE Systems battery packs, part numbers 500-0028, 500-0029, 500-0037, or 500-0039. 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, les références 500-0028, 500-0029, 500-0037, ou 500-0039. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans l'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 équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

CAUTION:

Before each day's usage, sensitivity must be tested on a known concentration of methane gas equivalent to 20-50% of full scale concentration. Accuracy must be within -0-+20% of actual. Accuracy may be corrected by calibration procedure.

ATTENTION:

Avant chaque utilisation journalière vérifier la sensibilité avec une concentration connue de méthane équivalente à 20 - 50% de la pleine échelle. La précision doit être comprise entre 0 - 20% de la valeur vraie et peut être corrigée par une procédure d'étalonnage.

CAUTION:

Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond 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 dangereux.

WARNING:

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

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

AVERTISSEMENT:

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

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

1. GENERAL INFORMATION

Q-RAE is a programmable Multi-gas monitor designed to provide continuous exposure monitoring of oxygen, hydrogen sulfide, carbon monoxide and combustible gases for workers in hazardous environments. It monitors with two types of sensors:

- (1) Combustible gases are monitored with catalytic bead sensors.
- (2) Oxygen, hydrogen sulfide and carbon monoxide are monitored with electrochemical sensors.

Other features include:

- **Lightweight and Compact**
- 16 oz (454 g), hand-held 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.

Q-RAE consists of: A multi-gas monitor, a battery charger, rubber boot, alkaline battery adapter, water and dust filter, plus calibration accessories.

1.1 General Specifications

Table 1.1
Multi-gas Monitor Specification

Configuration:	Pumped four-gas; datalogging option
Dimensions:	4.65”L x 3.0”W x 1.9”H (11.8 cm x 7.6 cm x 4.8 cm)
Weight:	16 oz (454 g) with battery.
Attachment:	Rubber boot, wrist strap, belt clip.
Sensors:	Four sensors (oxygen, combustible, hydrogen sulfide and carbon monoxide), electrochemical sensors for toxic gases and oxygen, catalytic sensors for combustible gases.
Battery:	Rechargeable, 4.8V/1100 mAh Li ion or 4.8V/1700 mAh, Ni-Cd battery pack with built-in charger (8-hour 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 and 2 programming keys.
Direct Readout:	Four instantaneous value readings, sensor names, high and low values for all detectors, battery voltage and elapsed time.
(Continued)	

Multi-gas Monitor Specification

(Continued)

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

LEL	0-100 %	1 %	15 sec
O ₂	0-30 %	0.1 %	15 sec
CO	0-500 ppm	1 ppm	20 sec
H ₂ S	0-100 ppm	1 ppm	30 sec

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

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

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

Sampling Pump: Internal integrated with 250 cc/min flow rate (high setting).

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

Intrinsic Safety: UL & cUL Class 1, Division I, Group A, B, C, D (US & Canada), EEx ia IIC T4 (Europe). Class T3c with Li-ion 500-0037 battery pack.

EM Immunity: No effect when exposed to 0.43mW/cm² RF interference (5-watt transmitter at 12 inch).

Data Storage: 20,000 readings (64 hours, 5 channels at 1 minute interval) in non-volatile memory.

(Continued)

Multi-gas Monitor Specification

(Continued)

Alarm Settings:	Separate alarm limit settings for TWA, STEL, Low and High alarm.
Datalog Interval:	Programmable 1- 3600 sec.
External Alarm:	Optional plug in pen size vibration alarm or earphone.
Communication:	Upload data to PC and Download monitor setup from PC through RS-232 link to serial port on PC.
Temperature:	-20 ^o to 45 ^o C (-4 ^o to 113 ^o F).
Humidity:	0 % to 95% relative humidity. (non-condensing)

2. OPERATION OF Q-RAE

The Q-RAE is a hand-held, portable Multi-gas chemical exposure monitor. It gives real time measurements and activates alarm signals whenever the exposure exceeds preset limits or oxygen is depleted. Prior to factory shipment, the Q-RAE 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 Q-RAE Multi-gas Monitor, which include:

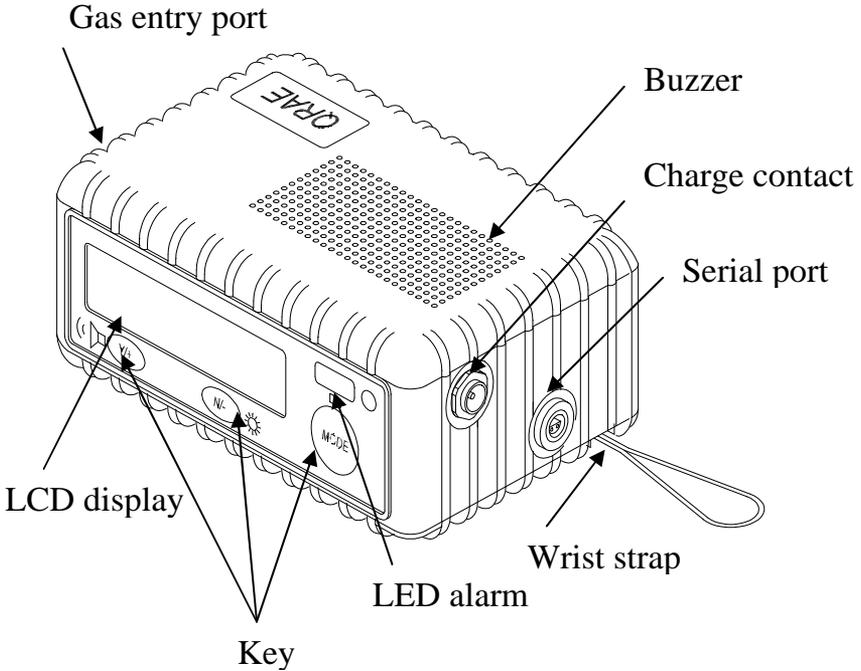


Figure 2-1 Major parts of the Q-RAE Multi-gas Monitor

- 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.

OPERATION

- 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 port.
- Serial communication port for PC interface.

2.2 Keys and Display

Figure 2-2 shows the LCD display and the keypad on the front panel of the monitor. The functions of the 3 keys during normal operation are summarized in Table 2.1 on the next page:

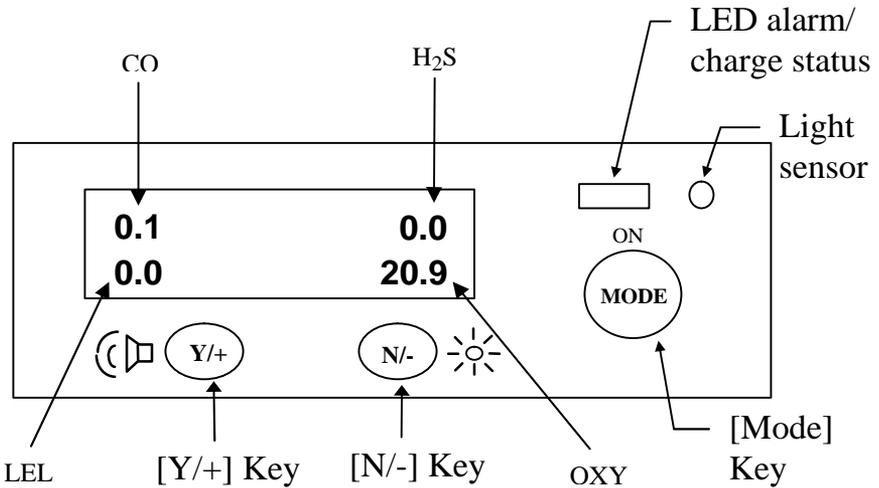


Figure 2-2 Key-pad and display of the Q-RAE Multi-gas Monitor

Table 2.1

Key	Function in Normal Operation
[MODE]:	Turn on/off the power* and choose different display mode.
[N/-]:	Toggle on/off the back light. Answer as “No.”
[Y/+]:	Alarm test and alarm acknowledgment (turn off latched alarm, turn on pump or LEL sensor). Answer as “Yes.”

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

The 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 H₂S and CO, % by volume for oxygen and %LEL for combustible gases.
- Sensor names.
- Peak and minimum gas concentrations for H₂S and CO, oxygen and combustible gases.
- 15 minute Short Term Exposure Level (STEL) values of H₂S and CO in ppm and 8-hour Time Weighted Average (TWA).
- Battery voltage and shut off voltage in volts.
- Real time clock, run time and temperature.
- Datalogging mode or “Start /Stop Datalog?” menu to enable/disable datalogging if manual datalogging mode is selected.
- LEL gas names (if the LEL sensor is installed).
- “Print Reading?” menu to print the reading to the RAE Printer (only shown when enabled; normally this function is disabled and not shown).
- “Communicate with PC?” menu to send or receive data between PC and the Q-RAE monitor.

2.3 Power On/Off

To turn on the Q-RAE Multi-gas Monitor, press **[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. The custom power-on-name which can be changed by the customer using the ProRAE Suite Software. The model 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.

Next, the monitor displays the preset alarm limits for each sensor, battery voltage, shut off voltage, user mode, alarm mode, datalog mode, available data storage memory (in hours), datalog mode and datalog interval (in seconds). After several more seconds delay, the display shows the instantaneous reading of the gas concentrations and is ready to monitor gases.

To turn off the Q-RAE Multi-gas Monitor, press and hold the **[MODE]** key for 5 seconds. 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 charger 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, it is necessary to enter the real time clock information again, as described in Section 4.

Datalogging versus Non-datalogging monitors

The Q-RAE Multi-gas Monitors are available in both datalogging and non-datalogging versions. During power on sequence, a letter “D” following the version number indicates that the monitor is configured as a Datalogging monitor. Without the letter “D”, it is a Non-datalogging monitor.

Users can upgrade a Non-datalogging monitor to a Datalogging monitor. Call the factory for information on how to order the upgrade kit and follow the instructions described in Section 5.7 to enable or disable the datalogging feature for the monitor.

2.4 Operations

The Q-RAE Multi-gas Monitor offers three different user modes of operation:

Text mode,
Display mode, and
Programming mode (default mode setting).

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 reading, battery voltage or enter the PC communication menu. The user can get into the calibration mode from text mode to do calibrations, but cannot change most of the parameters.

In the **display** mode, the Q-RAE Multi-gas Monitor is able to display all the information in the text mode. In addition, the following information is also available by pressing the **[MODE]** key: peak, minimum, STEL, TWA, run time in hours and minutes, temperature in °C, datalog mode (or enable / disable datalogging operation in manual datalog mode), LEL gas names, printing and communication with a PC options. The user cannot get into the calibration mode from display mode, so it is not possible to calibrate or change any of the parameters.

In the **programming** mode, which is the default setting, the user can perform all of the functions of the display mode. In addition, the user can get into calibration mode, perform calibrations and change any of the parameter in the calibration mode.

The following is the detailed explanation of the displays when the [MODE] key is pressed

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

0	0
0	20.9

- 2) The **sensor names** are displayed as:

LEL : for the combustible gas sensor

O₂ : for the oxygen sensor

H₂S : for the hydrogen sulfide sensor

CO : for the carbon monoxide sensor

CO	H₂S
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 a “Peak” message.

5		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 a “Min” message.

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 H₂S and CO only.

0		0
STEL		

- 6) The **TWA** reading is the average reading of the gas concentration times the fraction of 8 hours that the monitor has been on.

$$\text{TWA} = \text{Avg Reading} \times (\text{Run time in hrs} / 8 \text{ hrs})$$

The reading is updated once a minute and is shown in the LCD display with “TWA” message. This reading applies only to H₂S and CO sensors. The TWA value always increases, it can never decrease unless cleared.

0	TWA	0
---	-----	---

- 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. This means there are 20-30 minutes run time left before the monitor turns off automatically, when the battery voltage falls below 4.2 volts.

Battery = 4.8 V
Shut down 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 manual datalog mode is selected, the menu will prompt the user to turn on or off datalogging. Pressing the **[Y/+]** key while the “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 will display the selected **LEL gas name** if the combustible sensor is installed. When the selected LEL gas is different than the calibration gas, a programmed correction factor for that specific gas is multiplied by the readings and the corrected gas concentrations are displayed.
- 11) **Print Reading?** allows printing the gas concentration readings. If a serial printer is connected and ready, press **[Y/+]** to print the readings. This function is shown only when enabled; the default setting is disabled and the display is not shown.

12) **Communicate with PC?** allows the user to upload data from the Q-RAE to a Personal Computer (PC) or download configuration information from a PC to the Q-RAE. Press the **[Y/+]** key and the LCD displays the message “Monitor will pause, OK?” to remind the user that during PC communication, there will be no real time monitoring of the gas concentration. Press **[Y/+]** to proceed and the monitor enters 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 Q-RAE 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.

Displays in different user modes:

See Appendix A. for more information

1. TEXT MODE

Display Instantaneous Reading & Sensor Names alternately

[N]+[MODE] for 3 seconds:

 Password check

 Wrong password: back to instantaneous display

 Correct password: Enter Programming menu.

[N]: Toggle back light [Y]: Test alarm/stop alarm

[MODE]

Display Battery voltage

[MODE]

Print Reading? (if printer option is enabled)

[MODE]

Communicate with PC?

[Y]: Monitor will pause OK?

[Y]: Ready...

[N]: Return to Instantaneous display & Sensor names alternately

[MODE] or [N]

Return to Instantaneous Display & Sensor Names alternately

2. DISPLAY MODE

Display Instantaneous Readings & Sensor names alternately

[N]+[MODE] for 3 seconds:
Password check
Wrong password: back to instantaneous display
Correct password: Enter Programming menu.
[N]: Toggle back light [Y]: Test alarm/stop alarm

[MODE]

Display Peak values

[MODE]

Display Min values

[MODE]

Display STEL values

[MODE]

Display TWA values

[MODE]

Display Battery voltage

[MODE]

Print Reading? (if printer option is enabled)

[MODE]

Communicate with PC?

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

[MODE] or [N]

Return to Instantaneous display & Sensor names alternately

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 gas concentration alarm limit settings: 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 Q-RAE will alarm if one of the following condition occurs: battery voltage falls below a pre-set voltage level (4.4 V), LEL sensor off, pump stall or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will be turned off automatically.

Alarm Signal Disabled: It is extremely important to note that during the following conditions, the alarm signals are disabled:

- 1) In PC communication standby mode.**
- 2) In calibration mode (including reviewing datalog data).**

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 Q-RAE 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 Chapter 4 or 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 on LCD
Gas exceeds “Low Alarm” limit	2 beeps/flashes per second plus sensor name on LCD
Gas exceeds STEL	1 beep/flash per second plus sensor name on LCD
Gas exceeds TWA	1 beep/flash per second plus sensor name on LCD
Negative Drift or Over Range	3 beeps/flashes per second plus NEG or OVR name on LCD
Pump failure	3 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 Q-RAE LED, buzzer and backlight by pressing the [Y/+] key momentarily. The buzzer will beep once and the LED and back light will flash once to indicate that these alarm signals are functioning correctly.

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.

2.6 Backlight

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

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

(See Chapter 4 or 5 for details on how to set the back light mode and time out period from the monitor or a PC. See Chapter 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 Q-RAE Multi-gas Monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits as listed below (refer to Chapter 4 or Chapter 5 for programming procedures if new calibration or alarm limits is required).

Table 2.2

Factory Calibration and Preset Alarm Limits						
Gas ppm	Cal Gas / Balance	Unit	TWA	STEL	Low	High
LEL	50 / Air	% LEL	N/A	N/A	10%	20%
O ₂	Air	% VOL	N/A	N/A	19.5%	23.5%
CO	50 / Air	ppm	35	100	35	200
H ₂ S	25 / N ₂	ppm	10	15	10	20

2.8 Integrated Sampling Pump

The Q-RAE Multi-gas Monitor includes an integrated sampling pump. This is a diaphragm pump providing about 250 cc per minute flow rate at the high setting.

A low pump speed of about 150 cc per minute is the factory default setting, which will increase the battery life by about 5% and result in an increased LEL sensor lifetime. See Chapter 4 or 5 for details of how to select the pump speed.

The pump turns on automatically when the monitor is turned on and remains on during normal operation.

If liquid or other objects are sucked into the water trap filter in the inlet port and cause the pump to stall, the monitor detects the obstruction and shuts down the pump immediately. The alarm is activated and a flashing error message “Pump” is also displayed.

Remove the obstruction and press **[Y/+]** to acknowledge the pump shut off condition and re-start the pump. Different pump shut-off thresholds are desired for the two pump settings; this value can be adjusted in the Special Diagnostic Mode as described in Section 8.1.

2.9 Datalogging

The Q-RAE Multi-gas Monitor calculates and stores the gas readings based on a 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 increments. In addition, time stamp, user ID, site ID, serial number, last calibration date, and alarm limits are also stored. All data are retained in a non-volatile memory so that they can be down loaded at a later time to a PC.

Datalog Options

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. There is a timer available to setup the maximum datalogging time.
- **periodic:** start and stop datalogging daily based on preset time (hour and minute).
- **scheduled:** start and stop datalogging based on preset date and time (month, date, hour and minute).

Choose a datalog option

Most of the datalogging options can be programmed from the monitor. Additional options can be programmed using a PC and downloaded to the monitor (see Chapter 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 being displayed, turns off datalogging.

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

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. If more than 900 measurement intervals are recorded in one event, a new event will be created automatically.

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.**

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

3. OPERATION OF ACCESSORIES

The accessories for Q-RAE include:

- Battery charger
- Alkaline battery adapter
- Water trap filter and remote sampling probe
- Dilution fitting
- Calibration adapter

WARNING:

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

Ne charger les batteries que dans l'emplacements désignés non-dangereux.

3.1 Battery Charging Operation

The charging circuit of the Q-RAE is built into the monitor. It only needs a regular AC to 12 V 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 Q-RAE monitor.
2. If a NiCd battery is installed, the display will ask whether a discharge cycle (see NOTE on next page) is required. Press **[Y/+]** to start a full discharge and **[N/-]** to start the charging function. The display will show “Charging” “Battery = x.x V.” If a key is not pressed within ten seconds, the charging will begin automatically.

Charging

Battery = 5.6V

3. The 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 charged. The green color indicates that the battery is fully charged. The display will also indicate “Fully charged.” A completely discharged Q-RAE monitor will be charged to full capacity within 10 hours.

Note 1: The monitor recognizes whether a Li-ion or NiCd battery is installed.

Note 2: For NiCd batteries only, perform an occasional deep discharge to remove memory effects and maintain full capacity. When the AC adapter is connected, the display shows: **Deep Discharge?** Press the **[Y/+]** key. The battery will begin a deep discharge followed by a charge cycle.

Note 3: The latest version of the Q-RAE monitor has a smart charging circuitry and algorithm. It may be left connected to the charger indefinitely without damaging the battery.

The battery of the Q-RAE monitor is drained slowly even when the monitor is turned off. If the monitor has not been charged for 5-7 days, the battery voltage may be low.

The NiCd 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. Extended life Li-ion batteries can last for up to 20 hours. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity may be reduced significantly.

3.2 Alkaline Battery Adapter

An alkaline battery adapter is supplied with each Q-RAE kit. It accepts four AA size alkaline batteries and can be used in place of the NiCd 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 NiCd battery

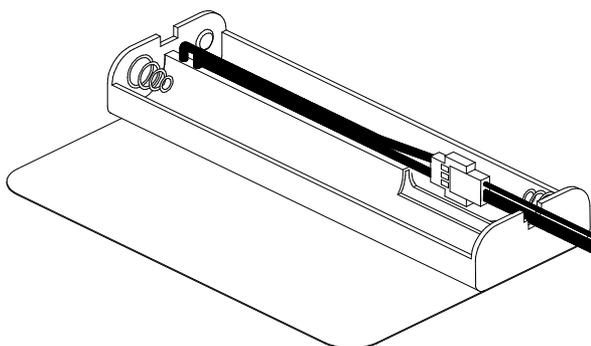


Figure 3-1 Alkaline Battery Adapter

To install the adapter, remove the cover of the monitor. Unplug the NiCd battery pack from the battery connector and plug the alkaline battery adapter into the battery connector.

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 liquid water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also prevent any dust from entering the monitor and will prolong the operating life of the sensors and the pump.

To install the water trap filter, simply slide the Tygon tubing onto the barbed inlet port on the monitor. A male Luer connector fits to the female Luer of the filter. To remove the filter, disconnect the Luer connector.

3.4 Remote Sampling Probe or Tygon Tubing

An optional 6-foot Teflon remote sampling probe with a telescoping handle or 15-foot Tygon tubing are handy accessories for users to probe areas that are difficult to reach, such as ceilings, storage tanks, underground man-holes, etc. Connect the male Luer connector at the end of the remote sampling probe or the Tygon tubing to the female Luer connector on the water trap filter. The remote sampling probe or the Tygon tubing is ready for operation.

Warning:

Tygon tubing is recommended only for volatile compounds like methane, propane, CO, H₂S, and O₂. For LEL measurements of higher hydrocarbons, it is recommended to use Teflon tubing. For example, one meter of Tygon tubing can completely absorb Jet fuel vapors resulting in a false negative response. For heavy fuels and other organic compounds, Teflon, metal or other non-absorbing extension tubing are necessary.

3.5 Dilution Fitting

An optional dilution fitting can be installed together with the remote sampling probe or Tygon tubing on the gas inlet port to dilute the gas samples. This fitting is needed if the gas sample does not contain more than 15% of oxygen. This is due to the fact that the combustible sensor will not function correctly when the oxygen concentration falls below 15%. The dilution fitting will increase the oxygen concentration so that the combustible sensor can still be used under oxygen deficient conditions. The other use of the dilution fitting is to measure H₂S or CO when the concentration exceeds the upper limit of the sensor range.

To use the dilution fitting, simply insert the fitting between the water trap filter and the remote sampling probe or extension tubing. Make sure to set the dilution ratio in the programming mode (see Section 4.8) so that the correct gas reading will be displayed when the dilution fitting is used.

WARNING: For this application, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or Tygon tubing to measure the gas concentration.

3.6 Calibration Adapter

The Q-RAE monitor is supplied with two calibration adapters: a 6-inch piece of Tygon tubing with a male Luer connector on one end, and a 3-inch piece of Teflon tubing also with a male Luer connector. For calibration, simply connect the Luer adapter to the water trap filter on the Q-RAE monitor and the open Tygon or Teflon tubing to the metal adapter from the calibration gas regulator. The Teflon adapter can also be used as a sampling probe during normal operation, and is preferred for LEL measurements of less-volatile compounds.

4. PROGRAMMING OF Q-RAE

The Q-RAE 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 Q-RAE has three user modes: **text**, **display** and **programming** mode. The user can access the programming function only if the unit is in the programming mode (or from **text** mode with a password). If the monitor is set to **display** mode, the user cannot enter the programming menu. 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 users to change the setup in the monitor, calibrate the monitor and enter user information, etc. The programming functions are organized in a three-tier 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?

Security Level

There are three levels of security in the Q-RAE programming mode to provide further protection against unauthorized changes to the monitor alarm settings and other settings. **Level 2** security allows a user to enter programming mode without any restrictions. This is the default security setting. **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 check, as in the Level 2. However, it 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 Chapter 5 for details on setting up the security level).

Once inside the programming mode, LCD the first menu will be displayed. To move through the menu, press **[N/-]** repeatedly until the desired menu item 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 numerical value for data entry or confirm (yes) for a question
[N/-]:	Decrease numerical value for data entry or deny (no) for a question

4.3 Entering the Programming Menu

1. Turn on the Q-RAE 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 a user from entering the programming mode by accident.
3. If the security level is 0 or 2, after holding down the two keys for 3 seconds, the monitor should enter the programming mode and the first menu item “Calibrate Monitor?” is displayed.
4. If the security level is 1, or the monitor is in text mode, after holding down the two keys for three seconds, the display shows “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 Q-RAE 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.

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

6. Repeat Step 5 until all four digits are entered. Press and hold **[MODE]** for one second.
7. If the entered password is correct, the monitor enters the programming menu. The first menu item “Calibrate Monitor?” is displayed.
8. If the password is incorrect, the display shows “Wrong Password???” and returns to the regular display of instantaneous gas readings.
9. If the User mode is set to **display** mode, a message “Display Only! Cannot enter....” is shown.

4.4 Calibration of Q-RAE 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(es) before the instrument is put into service.

For maximum safety, the accuracy of the Q-RAE 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 Q-RAE monitor. This is a two-point calibration process using “fresh air” and the standard reference gas. First, “fresh air” containing 20.9% oxygen and no detectable toxic or combustible gases is used to set the zero point for the LEL, CO and H₂S sensors and the span for the O₂ sensor. Then a standard reference gas, containing a known concentration of a given gas, is used to set the second point of reference (also known as span gas) for the first 3 sensors. 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?
Multiple Sensor Calibration?
Single Sensor Calibration?
Modify Span Gas Value?
Change LEL Span Gas?

Q-RAE monitors can be calibrated either with gas from a gas sample bag (Tedlar® bag), directly from a gas bottle using a demand-flow type regulator, or from an open-tube (also open cup or Tee) that allows excess gas to escape past the inlet probe. In the latter method it is important that the gas flow is greater than the pump draw by at least 20%. The Q-RAE can also be calibrated directly from a cylinder using a fixed flow regulator with a flow rate between 0.5 and 1.0 liters per minute, although this method is less accurate than the other 3 methods by a few percent. The calibration adapter links up the inlet port of the Q-RAE Monitor to the gas sample bag (see Figure 4-1).



Figure 4-1 Connection of Calibration Gas

4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve (and span for O₂). The “fresh” air required for zeroing is clean dry air with 20.9% oxygen and without any organic, toxic or combustible gases or related impurities, preferably from a pure air cylinder. 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.

Note: Charcoal filters remove most organic vapors but will not remove methane, propane or hydrogen.

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, twist the Luer calibration adapter onto the inlet port of the Q-RAE Monitor and connect the other end of the tube to the fresh gas bottle. If the “fresh” air bottle is not available, simply leave the monitor in an area free of any detectable vapor or attach the charcoal filter.
3. Press **[Y/+]** to start fresh air calibration. The display shows “zero ...in progress” followed by the name of each sensor and the message “zeroed.” The display should show a reading of “20.9” for the oxygen sensor and “0.0,” or a very small number, for all other sensors.
4. After about a 5 second pause, the display will show the message “Zero Cal Done! ” 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 four-gas mix (Typically CH₄, CO, H₂S, O₂, balance N₂) is needed to perform this procedure. Connect the monitor to the sample bag filled with mixed gas as shown in Figure 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 sampling bag filled with mixed gas and “OK?” question. 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 7.

CO		H₂S
LEL	OK?	OXY

2. Turn on the valve of the sampling bag 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 values 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: The readings should be very close to the span gas values. After about 5 seconds pause, the display will show the message “Span Cal Done! Turn Off Gas.”

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 Q-RAE Monitor.
5. If the 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 and move directly to the next sub-menu item. Press the **[Y/+]** key to continue the next sensor calibration. In either case, the calibration datum for the current sensor is not changed.
6. From Step 1, if the **[N/-]** key is pressed, the display shows all the sensor names that are selected for multiple sensor calibration with the cursor blinking at the first sensor location.

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.

7. Press the **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 7 until all of the sensors, which 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.

8. 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.

4.4.3 Single Sensor Calibration

This procedure determines the second point of the sensor calibration curve for a single sensor. A standard reference gas (span gas) is needed to perform this procedure. Table 2.2 shows the standard calibration gas that is typically used as the span gas in the factory. Connect the tube to the sampling bag filled with the standard gas as shown in Figure 4-1 (or use one of the excess flow methods described above).

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/+]** to select the highlighted sensor and start the calibration, or press **[MODE]** momentarily to move to the next sensor location.

CO		H₂S
LEL	pick?	OXY

2. The monitor shows “Apply XXX Gas...” and waits for the calibration gas to reach the sensor. Turn on the valve of the gas bottle to start the flow of the span gas. When the the sensor detects calibration gas, the display shows “Calibration in Progress... 60” with the countdown timer showing the number of remaining seconds while the monitor performs calibration. This automatic calibration start can be overridden by

pressing **[Y/+]** to start the calibration manually. When the countdown timer reaches 0, the display shows the sensor name and the calibrated value:

<p>CO cal'ed reading = 50 ppm</p>

If no gas has reached the sensor after 60 seconds, the display shows “No gas flow...” and aborts the calibration.

Note: The reading should be very close to the span gas value. After about 5 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 a user to select another sensor or move to the next calibration sub-menu.
4. Turn off the flow of gas. Disconnect the calibration adapter from the Q-RAE Monitor.
5. Repeat Step 1 to Step 4 to calibrate the next sensor.
6. Press **[MODE]** any time during Step 2 to reduce waiting time. If the sensor failed the calibration, the sensor name and an error message “failed, continue?” will appear. Press **[N/-]** or **[MODE]** to abort the calibration and move directly to the next sub-menu item. Press **[Y/+]** to continue single gas calibration. In either case, the current calibration data will not be changed.

Oxygen Sensor Calibration

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 a pre-programmed value of 20.9% by volume oxygen. During single sensor calibration, the user can supply pure nitrogen gas to calibrate the oxygen sensor to 0% oxygen. The user can also supply another span concentration of 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, press **[N/-]** to calibrate oxygen sensor to another span oxygen value. During either 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 must 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.

1. “Modify Span Gas Value?” is the next sub-menu item in Table 4.3.
2. Press the **[Y/+]** key. The display shows:

50		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 Span Gas

This function allows the user to select a specific LEL gas to be used as the span gas during LEL gas calibration.

1. “Change LEL Span Gas?” is the next sub-menu item in Table 4.3.
2. Press **[Y/+]** key. If LEL sensor is installed and enabled, the display shows:

LEL Span = ? Methane

Otherwise, the message “No LEL installed“ will appear.

3. If the user does not want to change the LEL span gas, press **[Y/+]** to accept the current selection and exit this sub-menu.
4. If the user wants to select a different LEL span gas, press **[N/-]** key. Then use the **[Y/+]** and **[N/-]** keys to scroll up or down through the list of gas names until the desired gas appears in the display, and 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 move to the next display.

4.5 Change Alarm Limits

In the programming mode, the users may change alarm limits of each sensor for the Q-RAE 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?

- 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 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 cycle through the sub-menu. Press [Y/+] key 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		20
20	HIGH	23.5

35		10
10	LOW	19.5

100	15
STEL	

35	10
TWA	

1.0	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

Q-RAE 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 PC and downloaded 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?

4.6.1 Reset Peak and Minimum

This function will reset peak and minimum data stored in the non-volatile 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 reconfirm 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 erases all data stored in the non-volatile data memory. It does not change STEL, TWA, Peak, minimum concentration or run time values which are stored in the other location.

1. “Clear All Data?” is the next 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 the 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 next 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. If there is any change to the existing value, the display will show “Save?” Press the **[Y/+]** key to accept the new value and exit the datalog sub-menu. Press the **[N/-]** key to discard the changes and move to the next menu option.
4. 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 next sub-menu item in Table 4.5.
2. Press the **[Y/+]** key, the display shows the current data type: “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, press the **[Y/+]** key and the display will show “Save?” Then, press the **[Y/+]** key again to accept or the **[N/-]** key to discard the change 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 the 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 next 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/+]** to review data of the first event. The display shows the stored data of each sensor and the time stamp:

1		0
2	8:20	20.5

3. Press the **[Y/+]** or **[N/-]** key to move forward or backward and view other data in this event. When reaching the end or the beginning of the event, the message “Start of data!” or “End of data!” appears. Press **[MODE]** to exit the current event.
4. Press **[N/-]** at Step 2 to see next event. If there are no more events, the message “No more event! Quit?” will appear. Press **[N/-]** to go back to the first event or **[Y/+]** 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 next 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/+]** to enable the datalogging for the sensor and **[N/-]** to disable the datalogging.

CO*	H₂S*
LEL pick	OXY

3. Press the **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 2 until all the sensors that need to be datalogged are selected. Press and hold **[MODE]** 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, users may change monitor setup or enter user information for the Q-RAE 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?

4.7.1 Change Site ID

The user can enter an 8 digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. “Change Site ID?” and “Change User ID?” are the first and second sub-menu item 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 Q-RAE 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 and move to the next sub-menu.

4.7.3 Change User Mode

There are three different user modes: **text**, **display** and **programming** in Q-RAE 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.

NOTE: If the user mode is changed to **display** or **text** 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 “multicfg” program** (see Section 5 for details).

4.7.4 Change Real Time Clock

The Q-RAE 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” 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. 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 Backlight Mode

The Q-RAE monitor allows a user to choose to turn on and off LCD backlight 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: “Backlight Mode = manual turn on?”.
3. Press the [Y/+] key to accept the currently displayed backlight mode. Press [N/-] key to change to the other backlight mode: “Backlight Mode = manual turn on?” Press [MODE] key to exit this sub-menu and move to the first monitor setup sub-menu.
4. If there is any change to the existing selection, 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]** 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 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 reentered, as before, to exit the monitor setup sub-menu. If misentered 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 Q-RAE 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. Low may also be used to prolong pump motor life; LEL sensor life and battery run time.

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/-] key to change to the other selection: “Average Type = Running Average?”, and [Y/+] to select.
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 first setup sub-menu.

4.8 Change Sensor Configuration

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

Table 4.7

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

Before these sub-menus are described, the term “Correction Factor” needs to be explained:

Correction Factor

The LEL sensors used in Q-RAE respond to a broad range of gases that have different sensitivities. 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 calculated concentrations of a specific gas while using a different gas during calibration (typically methane or pentane).

The Q-RAE monitor stores a set of the correction factors for the LEL sensor. The set consists of 20 to 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 Q-RAE 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.

4.8.1 Change LEL Gas Selection

This function allows 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 users to create a custom factor for a specific gas or mixture of gases.

1. “Change LEL Gas Selection?” is the first sub-menu item in Table 4.7.
2. Press **[Y/+]** key. If an LEL sensor is installed and enabled, the display shows:

LEL Gas = ? Methane

- Otherwise, the message “No LEL installed” will be displayed and skip to Step 8.
3. If the user does not want to change the LEL measurement gas, press **[Y/+]** key to accept the current gas and skip to Step 6.
 4. If the user wants to modify the LEL 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. Display shows

<p>Methane LEL Factor = 1.00?</p>

where “1.00” is the calculated correction factor of the selected gas in Step 4.

7. If the user does not want to modify the LEL correction factor, press **[Y/+]** key and go to Step 8. To modify this factor, press **[N/-]** key first. Then 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 next digit to its right. Repeat this process until all 4 digits of the new factor 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 exit the gas selection sub-menu. Press the **[N/-]** key to discard the changes.

4.8.2 Enable / Disable Sensor

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

1. “Enable / Disable Sensors?” is the next 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*		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 need 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

An optional dilution fitting can be inserted on the gas inlet port of the MultiRAE PLUS to dilute the gas sample. The dilution ratio (from 1 to 10) can be entered so that the reading is compensated to show the actual concentration of the gas sample before dilution.

1. “Change Dilution Ratio?” is the next sub-menu item in Table 4.7.
2. Press the **[Y/+]** key, and the display shows the current dilution ratio: “Dilution Ratio = xx” with the left most digit flashing.
3. Press the **[Y/+]** or **[N/-]** key to increase or decrease the value of the digit. Press **[MODE]** 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 **[Y/+]** to accept the new ratio and exit the sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

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 FOR Q-RAE

Each Q-RAE has datalogging capability and 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 and later environments. It allows the user to configure the Q-RAE through a user-friendly interface and send the configuration information from the PC to the Q-RAE monitor. Collected data can also be extracted from the Q-RAE 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.

5.1 Install ProRAE-Suite Software

ProRAE-Suite software package is supplied with the Q-RAE datalogging monitor. This software package is available on three 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 sub-menu items under the **ProRAE-Suite** submenu: **ProRAE-Suite** and **Readme**, as shown in Figure 5-2. Click the **ProRAE-Suite** sub-menu item to start the ProRAE-Suite software.

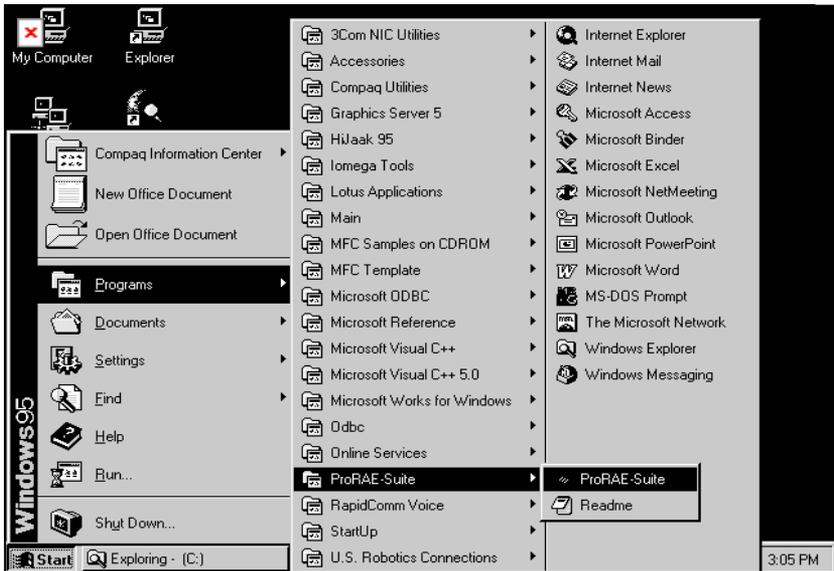


Figure 5-2 Start Menu

5.2 Connect Q-RAE to PC

The basic kit of a Q-RAE datalogging monitor includes a serial interface cable. Connect the DB-9 connector side of the cable to the serial port of the PC, and connect another side of the cable to the Q-RAE monitor.

Turn on the power to the Q-RAE monitor. Press the [MODE] key several times until the LCD shows “Communicate with PC?” 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 Q-RAE monitor is ready for communication with PC. During the communication session, the PC will directly control the Q-RAE monitor through the serial link. There is no need for users to press any key on the Q-RAE monitor during the communication session.

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

<p>Note: Do not connect to the parallel port of the PC by mistake. The parallel port is usually a 25 pin 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.</p>
--

5.3 Start ProRAE-Suite Software

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



Figure 5-3 ProRAE-Suite Main Window

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

- 1) Configuration data category. This category includes editing the configuration data file, sending the configuration data to the Q-RAE monitor and receiving the configuration data from the Q-RAE monitor, etc..
- 2) Logged data category. This category includes receiving the logged data from the Q-RAE 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 Q-RAE monitor, and upgrading the firmware in the Q-RAE 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 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 Q-RAE monitor can communicate with the PC correctly. Figure 5-4 shows the **Setup Port** dialog box. Choose the appropriate port according to the PC's serial port setup.

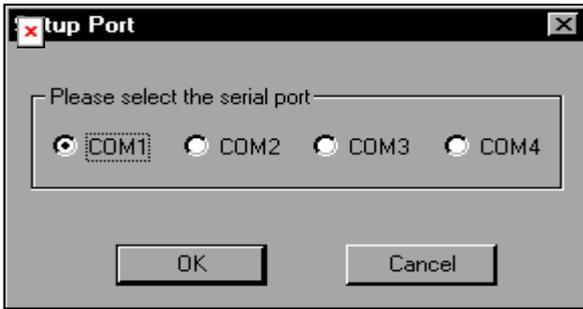


Figure 5-4 Setup Port Dialog

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

5.5 Processing the Configuration Data

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

5.5.1 Editing the Configuration Data

There are two different sources of the configuration files. One is loaded from the unit; the other is from a configuration file stored on a PC.

To load and review the configuration of the monitor: From the main menu of the ProRAE-Suite software, select the **Receive Configuration...** menu item from the **Communication** dropdown menu, and then click the **OK** if the unit is connected to the communication port and ready.

To load a saved configuration file: From the main menu, select **Open** from the **File...** dropdown menu, a dialog box appears. Select the “Files of type:” to Config Files [*.cfg], as shown in Figure 5-5.

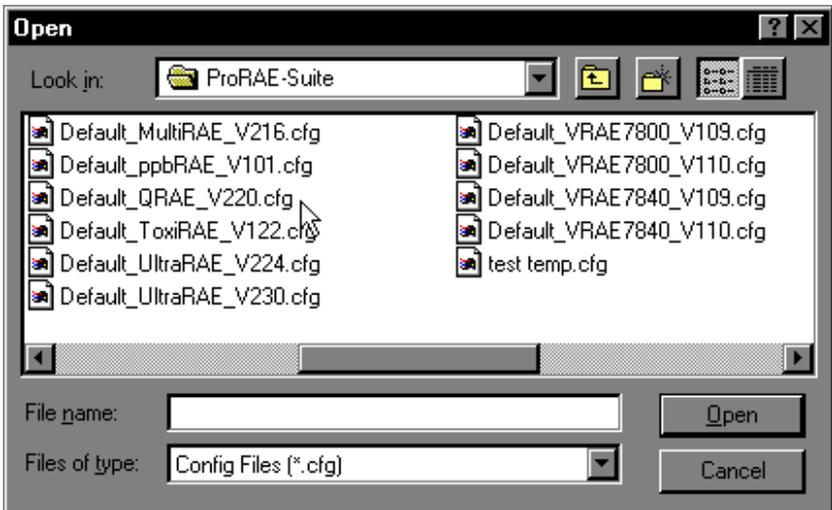


Figure 5-5 Open Dialog Box

button to open the **Edit Configuration File** dialog box, as shown in Figure 5-7.

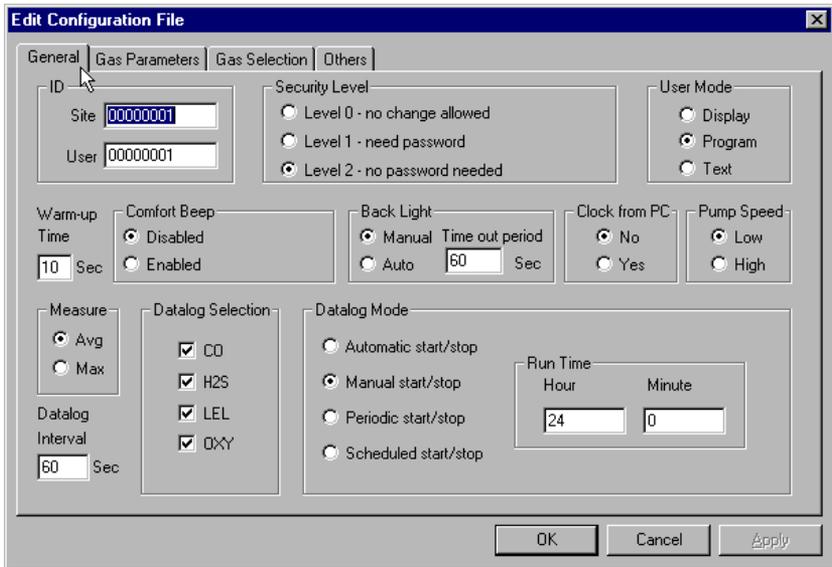


Figure 5-7 Edit Configuration File Dialog Box

The **Edit Configuration File** dialog box contains four tab pages: General, Gas Parameters, Gas Selection and Others. 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, which is shown in Figure 5-7, allows a 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:

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 that can be changed by using the programming menu of the Q-RAE monitor when the instrument is in the programming mode.

Level 0 allows a 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.

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 setups 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.

Backlight:

This option allows the user to choose to turn on and off the LCD back light 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 back light 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 Q-RAE monitor so that the user does not need to manually set the clock in the Q-RAE monitor.

Pump Speed:

This option allows the user to choose the high pump speed or low pump speed for the Q-RAE 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. The unit of a datalog interval is one second.

Datalog Selection:

The user can choose one or more sensors for datalogging purpose. This does not activate or inactivate the particular sensor's readings 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 5-8 shows the **Gas Parameters** tab page which 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:

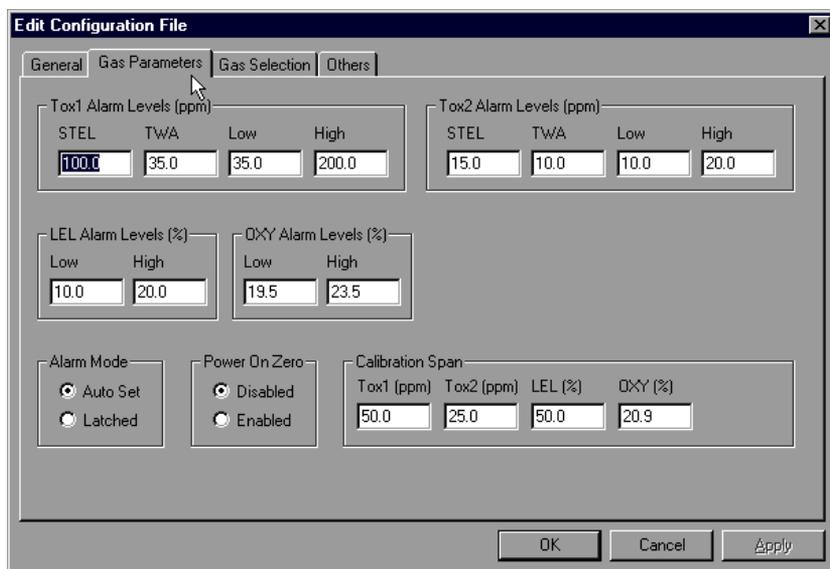


Figure 5-8 Gas Parameters Settings Tab Page

LEL Alarm Levels (%):

Here the specify the low and high alarm levels (%LEL) can be specified for the LEL sensor.

OXY Alarm Levels (%):

Here the specify the low and high alarm levels (% by Volume) can be specified for the OXY sensor.

H₂S Alarm Levels (ppm):

Here the STEL, TWA, low alarm and high alarm levels (ppm) can be specified for the H₂S sensor.

CO 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 the CO sensor.

Alarm mode:

If **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/+] 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 LEL, OXY, H₂S, and CO sensors here.

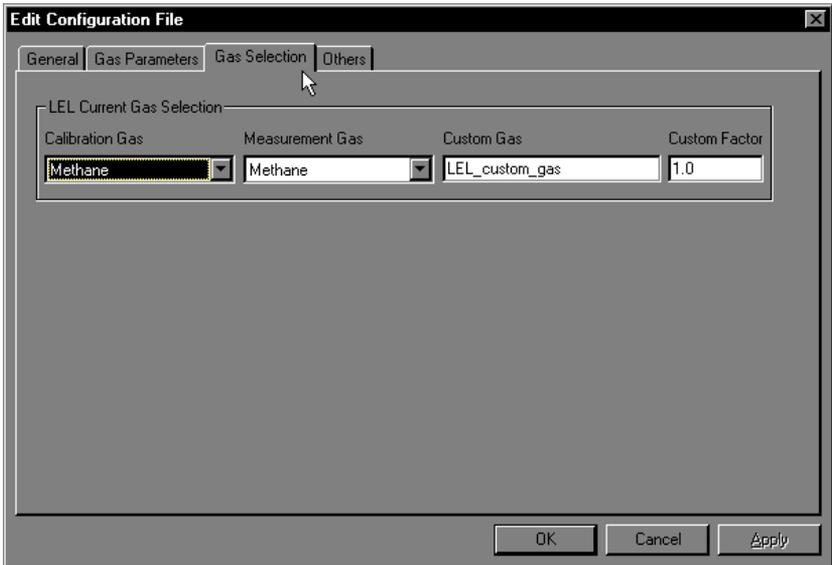


Figure 5-9 Gas Selection Settings Tab Page

Figure 5-9 shows the **Gas Selection** tab page. There are three sets 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:

LEL Current Gas selection:

Here 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. Scroll the list using the up or down arrow until the desired gas name is shown. Press **Enter** to select the gas. The user can also enter a custom gas name (up to 16 characters long) and a custom correction factor. If the measurement and calibration gases are different, the monitor automatically calculates a correction factor and applies it to the readings to give a proper %LEL value for the measurement gas.

In the **Others** tab, the user can put in a power-on customized name. The name will be displayed when the unit is powered on. The user can also choose the supporting of the printer option.

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.

5.5.2 Send Configuration to Q-RAE

After the configuration data is loaded into the ProRAE-Suite software, the user can send the configuration settings to the Q-RAE 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 Saving Configuration Data

In order to save the configuration information for future use, user can click **File->Save** or **File->Save As** menu item to save the opened 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 can be sent to the Q-RAE monitor.

5.5.4 Configuring All Settings

A user can use this function to update the entire configuration settings (except the instrument ID, serial number and the datalog option) in the Q-RAE monitor. To configure all the settings in the instrument, click the **Option->Config All** menu item and 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 current configuration settings in the monitor. If the user does not want this to happen, click 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.

5.6 *Warning:* The Config All option is mainly used to restore the Q-RAE monitor's default operational settings when the configuration of the unit is non-recoverable and the unit is malfunctioning. Because the default parameters are not normally fit a specific unit, a user will need to re-calibration, re-setup lamp, pump, and

LCD contrast threshold, etc. Try not to use this function if possible.

5.6 Processing the Logged Data

The ProRAE-Suite software allows the user to retrieve the logged data from the Q-RAE 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 Q-RAE

To receive the logged data from the Q-RAE, 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 5-10.

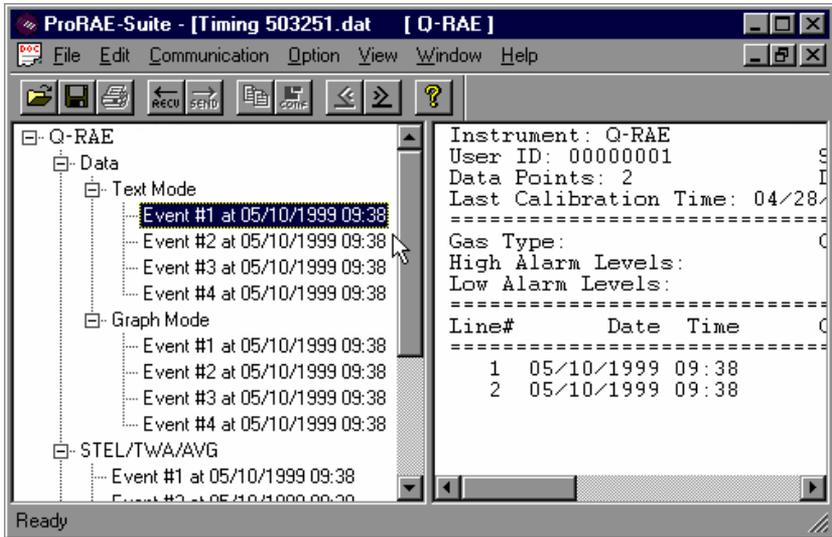


Figure 5-10 Display Logged Data

The data window is a two-pane client window. The left pane is a tree view which lists 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 5-10.

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 points of that event, as shown in Figure 5-11.

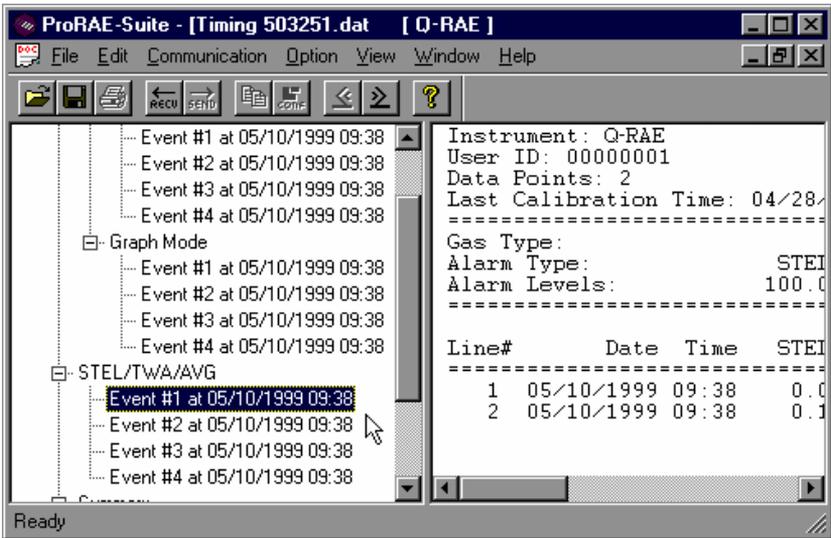


Figure 5-11 STEL/TWA/AVG of the Logged Data

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 5-12.

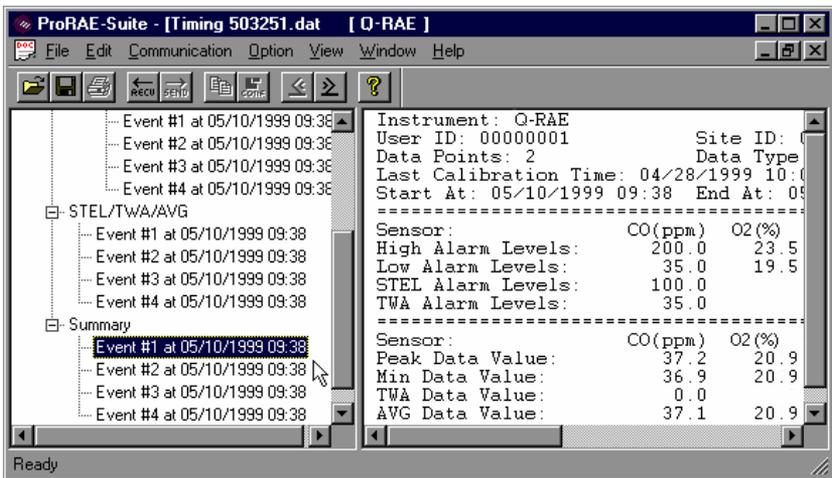


Figure 5-12 Summary Information of the Logged Data

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 5-13.

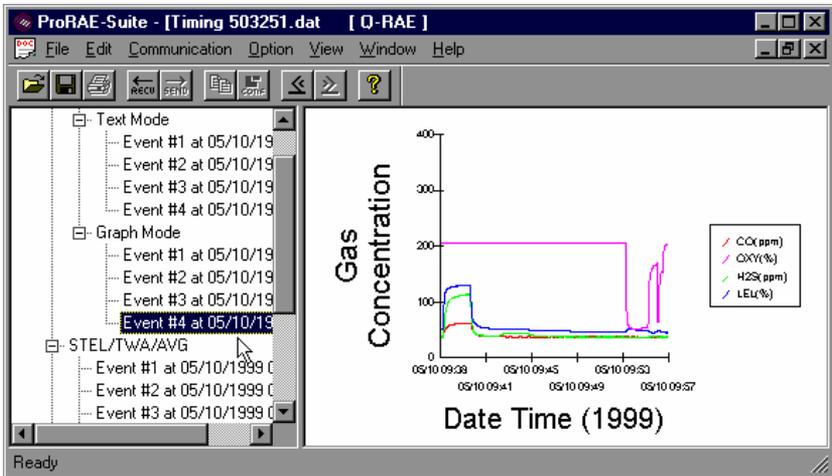


Figure 5-13 Graph of the Logged Data

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 5-14 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.

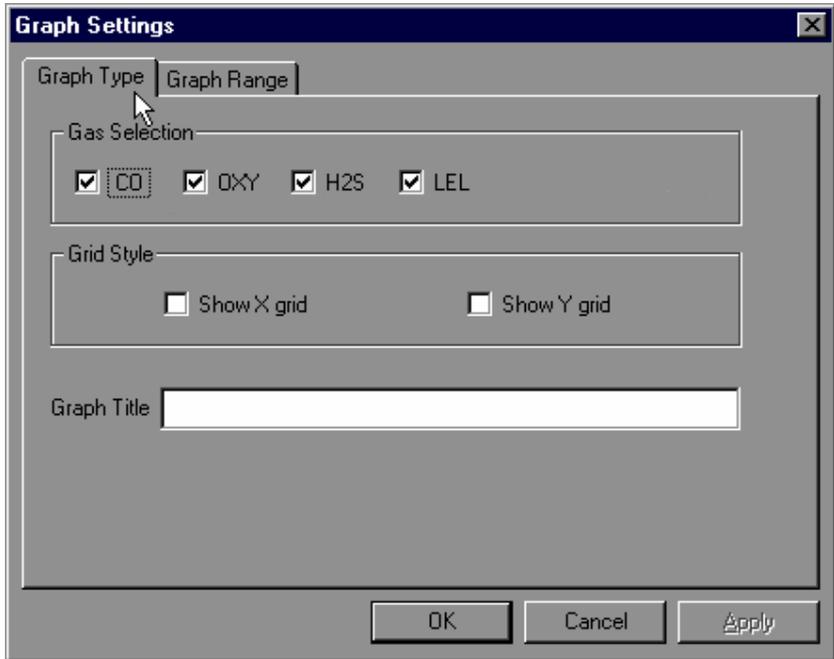


Figure 5-14 Graph Type Tab Page

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 5-15 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.

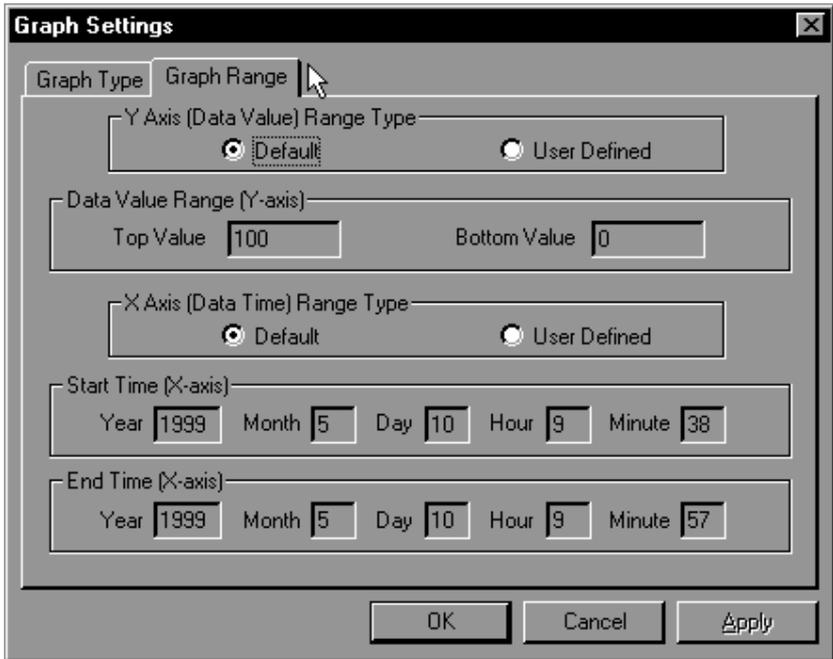


Figure 5-15 Graph Range Tab Page

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.

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.

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 that can be read by Microsoft Excel[®] 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 Graphic 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 **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 **Print** function from the **File** sub-menu, or click the **Print** toolbar button (a printer) to print the graphic 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 datalog option, 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 5-16.

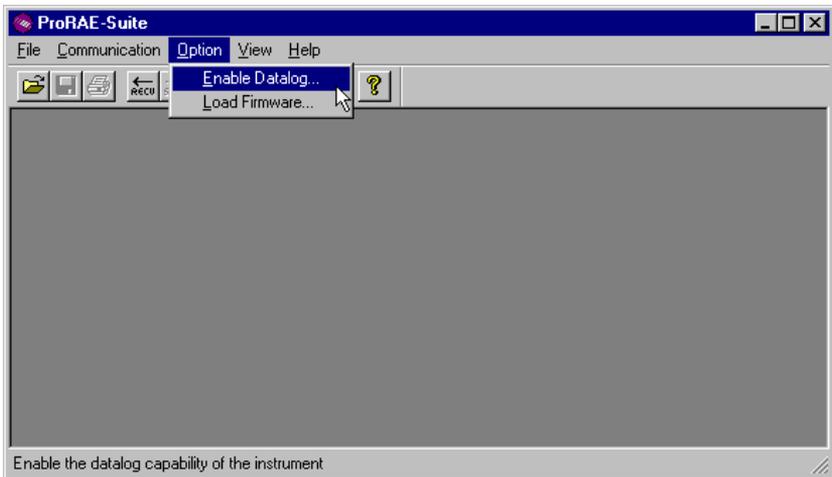


Figure 5-16 Main Window of ProRAE-Suite

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 Q-RAE monitor is connected to the PC, click the **OK** button to start. After the ProRAE-Suite software made successful contact to the instrument connected to the PC, a dialog box is displayed, as shown on Figure 5-17.

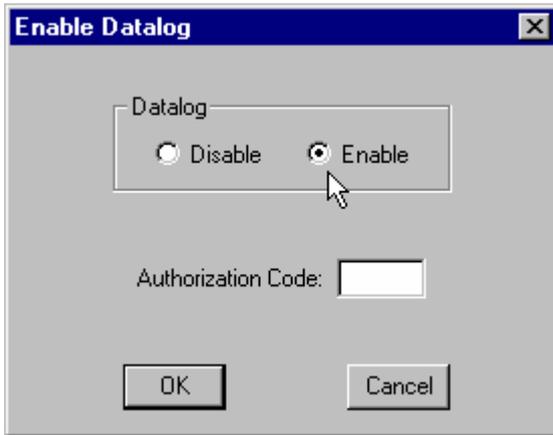


Figure 5-17 Enable Datalog Dialog Box

Figure 5-17 shows that the instrument's datalog feature is currently enabled. If the user wants to change the datalog option, click another datalog option radio button, and type the three digit authorization code in the **Authorization Code** field, 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 Q-RAE 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 one.

5.8 Upgrade the Firmware

To upgrade the firmware in the Q-RAE 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 5-16. 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. After the ProRAE-Suite software made successful contact to the instrument connected to the PC, an **Open** file dialog box is displayed, as shown on Figure 5-18. Select the firmware file (.a07) which 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.

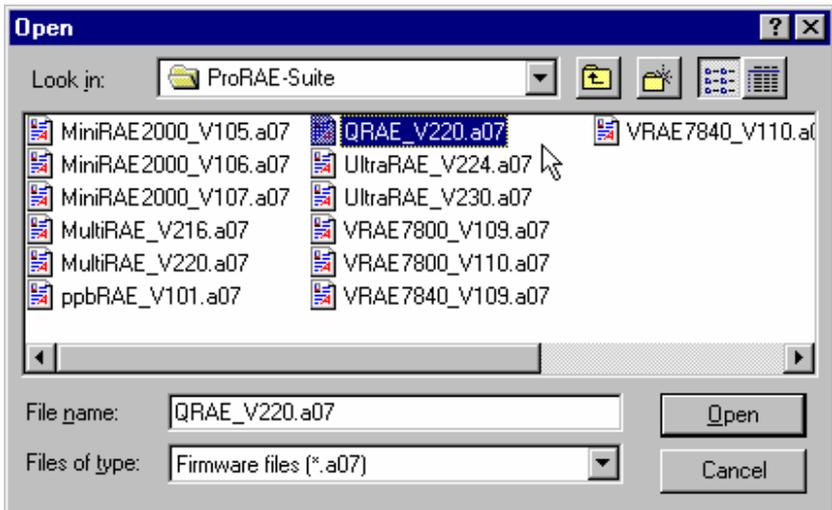


Figure 5-18 Open Firmware File Dialog Box

6. THEORY OF OPERATION

The Q-RAE monitor uses one to four different sensors to measure a variety of gases. Up to two electrochemical, toxic-gas sensors can be installed in the monitor to measure inorganic toxic gases. A catalytic bead sensor is used to measure combustible gases. An electrochemical sensor is used to measure oxygen concentration.

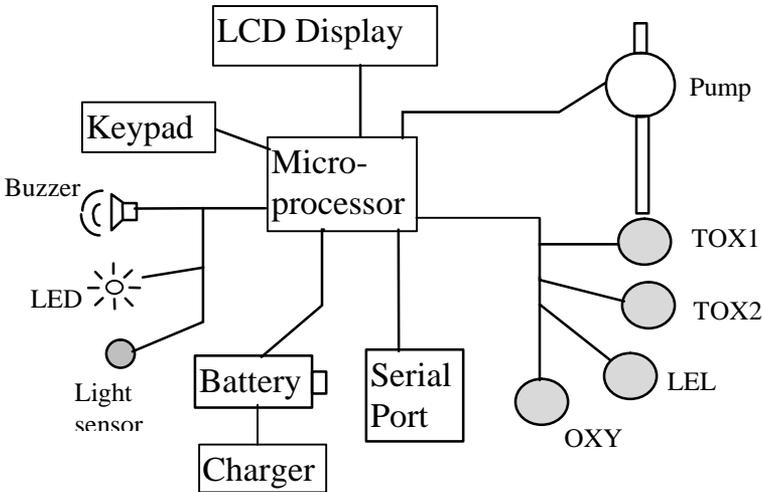


Figure 6-1 Block Diagram of Q-RAE Monitor

A diaphragm pump draws the air sample into the sensor manifold and then distributes 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 are stored in non-volatile memory so that they 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 is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable Ni-Cd or Li-ion battery pack or a four AA alkaline battery pack powers the monitor.

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 Q-RAE are:

- Battery pack
- Sensor modules
- Sampling pump

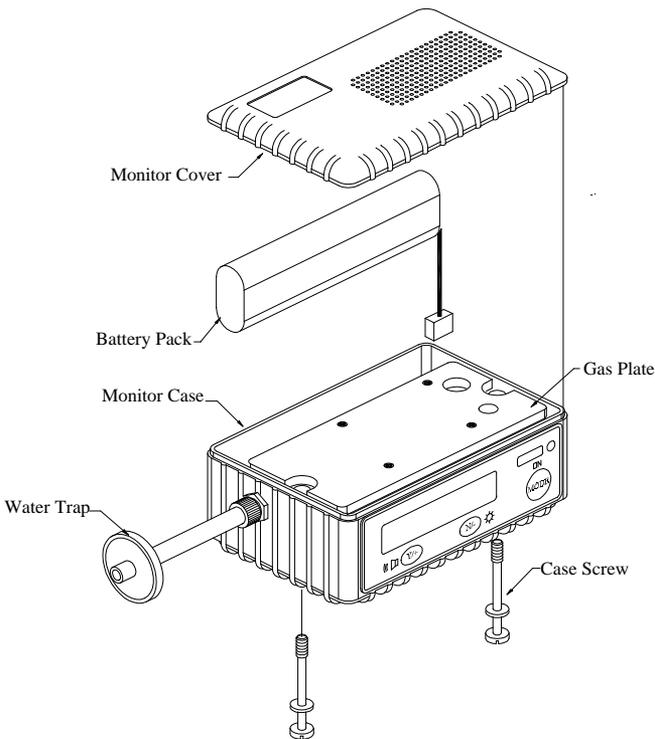


Figure 7-1 Main Components of Q-RAE

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 Q-RAE monitor upon returning from field work. A fully charged NiCd battery powers a Q-RAE monitor for 10 hours continuous operation and an extended life Li-ion battery for at least 18 hours. 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. The monitor recognizes a Li-ion vs NiCd battery pack and allows the user to perform a deep discharge only on NiCd batteries but not on Li-ion batteries.

WARNING:

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Replacing and Recharging Battery Pack

1. Turn off power of the Q-RAE.
2. Refer to Figure 7-1, unscrew the two captured case screws from the bottom of the monitor case and remove the Q-RAE cover.
3. Unplug the battery from the battery jack, which is connected to the PC board of the Q-RAE.
4. Connect the battery pack to the DC jack on an external charging station (optional) for charging.
5. Replace a fully charged spare battery pack in the Q-RAE.
6. Ensure the battery plug is securely connected to the Q-RAE.
7. Close the Q-RAE cover and tighten the screws.

Replacing Alkaline Battery Adapter

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 in the monitor.

7.2 Sensor Replacement

The hydrogen sulfide, carbon monoxide, combustible and oxygen sensors all have an expected operating life. Under normal operating condition, most sensors will lose their original sensitivity after the expected operating life and will need to be replaced.

Each sensor module in Q-RAE includes a non-volatile memory, which 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. It is suggested that the user should replace the sensor when the current date exceeds the expiration date of a sensor. However, the sensor can be used beyond the expiration date as long as the sensitivity is adequate for the purposes of the measurements. Contact the service department to determine the viability of sensors that are past expiration.

Sensor Replacement Procedure

The hydrogen sulfide, carbon monoxide, oxygen and combustible sensors each have their own unique sensor sockets in the Q-RAE monitor. This requires careful notice to be paid when replacing sensors.

1. Turn off power of the Q-RAE.
2. Refer to Figure 7-1, open the monitor cover by unscrewing the two captured screws from the bottom of the monitor case. **Disconnect the battery pack.**

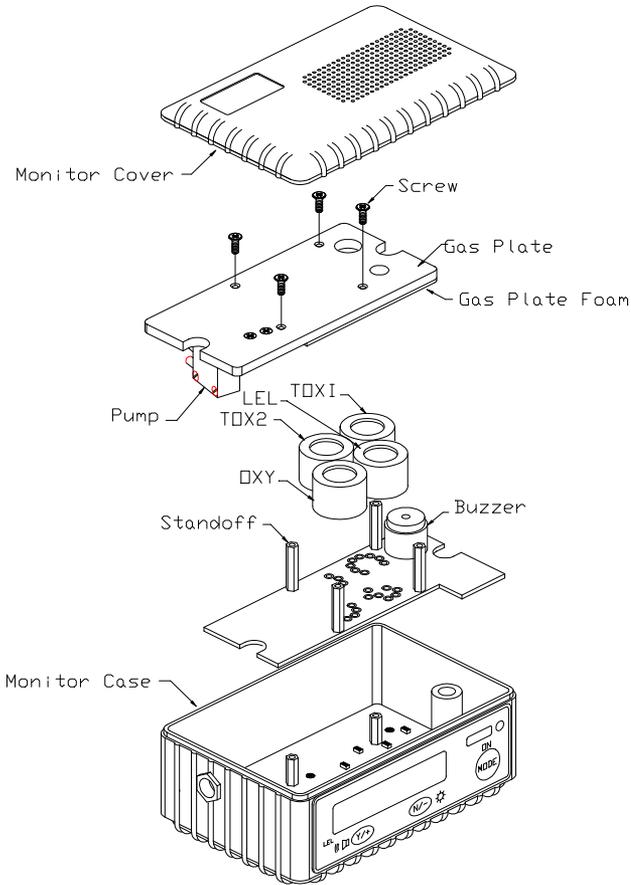


Figure 7-2 Sensor Assembly of Q-RAE

3. Refer to Figure 7-2, carefully unscrew four No. 2 screws that hold down the gas piping plate to the analog PCB and sensors. Remove the gas piping plate.
4. Refer to Figure 7-2, identify the location of a specific sensor and remove the sensor by gently pulling upward.

5. Plug a new sensor into the empty sensor socket. Make sure that black line on the sensor label is lined up with the white mark on the PCB and the sensor pins are aligned with the socket before pushing down the sensor.
6. Replace the gas piping plate and tighten the four screws to hold down the sensors. Re-connect the battery pack. Replace the monitor cover.
7. Turn on the power of the Q-RAE. The microprocessor will automatically recognize the sensors installed and configure the monitor accordingly.

7.3 7.3 Sampling Pump Replacement

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

1. Turn off power of Multi-gas Monitor.
2. Refer to Figure 7-2, open the monitor cover, **disconnect the battery pack**, carefully unscrew four No. 2 screws that hold down the gas piping plate to the analog PCB and sensors. Remove the gas piping plate.
3. Carefully loosen the connector. Unscrew the two screws that hold the pump assembly to the gas plate. Disconnect the Tygon tubing that connects the pump to the gas inlet port.
4. Install a new pump assembly. Connect the Tygon tubing to the gas inlet port.
5. Refer to Figure 7-2, replace the gas piping plate and tighten the four screws to hold down the sensors. Reconnect the battery pack. Replace the monitor 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 Q-RAE 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. The diagnostic mode should be used by qualified personnel only.

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 or until the beep stops. 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 four 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
[MODE]	Adjust LCD contrast
[MODE]	Check LEL power on/off
[MODE]	Show clock, battery voltage and temperature
[MODE]	Show LEL & OXY sensor expiration date
[MODE]	Show H2S & CO 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?

Here 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 response and the 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 1300 for LEL sensor and between 1200 to 2300 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.

365		373
530	RAW	1879

2) Sensor Name

The carbon monoxide, hydrogen sulfide, oxygen and LEL sensors have a non-volatile memory that 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

The Q-RAE monitor can be powered by either a rechargeable Li-ion or NiCd battery pack or an alkaline battery adapter. This display also shows the type of battery that is installed inside the monitor.

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 having dark lines, press [Y/-] several times to see a more clear display.

5) Check LEL Power ON/OFF

This display shows the present condition of the LEL sensor power and raw reading. The top display shows the instantaneous reading of raw counts from the LEL sensor. The bottom line shows if the LEL sensor is powered. By pressing [N/-] key the power can be turned off. The [Y/+] key turns powers to the LEL on.

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 Q-RAE monitor. The expiration date is calculated based on the manufacturing date and expected life of each sensor. This data is stored inside each sensor when it is 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.

- a. 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 pump current without any blockage should be between 20 – 35 when the speed is set to be “low” and the water trap filter is installed. The typical stall value should be higher than the “un-blocked” pump current by at least 5-8 counts.
- b. The user can block the gas inlet for about ten seconds and watch the pump current reading. The stall threshold should set to be the average of the idle reading and the block reading. That is: $\text{Stall} = (\text{Idle} + \text{Block}) / 2$. The readings to be used in the calculation are maximum pump current readings at the “xxx” location of the unit.
- c. Use [Y/+] or [N/-] key to increase or decrease the stall value until it is the average of the idle reading and the block 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.

- d. The pump stall threshold should be re-adjusted if the pump speed is switched to “low” or “high”, or water trap filter changed, or the firmware configuration has been totally refreshed.

9) Check Backlight Threshold

This display can be used to adjust the LCD backlight on/off threshold using the [N/-] or [Y/+] keys. A threshold setting of 100 is appropriate for most all situations.

10) Serial Number and Pump Toggle

This display shows the unit’s 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 are not saved in the nonvolatile memory (see Section 4.7 to update the pump speed setting).

11) Display Battery Duration Time

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

12) Communicate with PC?

This display gives the option to communicate with the PC for upload or download of configuration settings, logged data, or new firmware.

8.2 Troubleshooting Table

Table 8.2

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

TROUBLESHOOTING

Problem	Possible Reasons & Solutions
Reading abnormally high	<p>Reasons: Wrong calibration data. Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation.</p> <p>Solutions: Re-calibrate with the gas. Clean sensor module. Replace water trap filter. Blow dry the sensor module.</p>
Reading abnormally low	<p>Reasons: Incorrect calibration. Low sensitivity to the specific gas.</p> <p>Solutions: Calibrate the monitor. Replace sensor.</p>

TROUBLESHOOTING

Problem	Possible Reasons & Solutions
<p>Read a small background value when there is no detectable gas.</p>	<p>Reasons: Sensor zero drifted. Unit was disconnected from battery power or the sensor just plugged in.</p> <p>Solutions: Do fresh air calibration (see Section 4.4.1). Wait for reading to stabilized.</p>
<p>Reading jumping around randomly</p>	<p>Reasons: Incorrect gas calibration. Low sensitivity to cal gas.</p> <p>Solutions: Calibrate the sensor. Use different cal gas.</p>
<p>Cannot turn off monitor or corrupted characters in LCD display</p>	<p>Reasons: Microprocessor hang-up.</p> <p>Solutions: Disconnect and re-connect battery to reset computer. Call authorized service center.</p>
<p>Calibration error message</p>	<p>Reasons: No standard gas input.</p> <p>Solutions: Make sure standard gas flows into monitor.</p>

TROUBLESHOOTING

Problem	Possible Reasons & Solutions
<p>“Bat” message in operation</p>	<p>Reasons: Discharged battery.</p> <p>Solutions: Recharge battery.</p>
<p>“Voltage too high message” in charge mode</p>	<p>Reasons: Battery fuse blown or wrong AC adapter or AC adapter does not fully plug in.</p> <p>Solutions: Check battery and adapter. Detach and plug in the adapter again.</p>
<p>Full scale measurement in humid environment</p>	<p>Reasons: Dirty or wet sensor</p> <p>Solutions: Clean sensor in ultrasonic bath and dry thoroughly. Replace water trap filter.</p>
<p>Excessive pump noise or no inlet air vacuum</p>	<p>Reasons: Leaky inlet path. Defective pump.</p> <p>Solutions: Check inlet connection. Replace pump.</p>

APPENDIX A

APPENDIX A. QUICK REFERENCE GUIDE

1. TEXT MODE

Display Instantaneous Reading & Sensor names alternately

[N]+[MODE] for 3 seconds:
Password check
Wrong password: back to instantaneous display
Correct password: Enter Programming menu.
[N]: Toggle back light [Y]: Test alarm/stop alarm

[MODE]

Display Battery voltage

[MODE]

Print Reading? (if printer option is enabled)

[MODE]

Communicate with PC?

[Y]: Monitor will pause OK?
[Y]: Ready...
[N]: Return to Instantaneous display & Sensor names alternately

[MODE] or [N]

Return to Instantaneous display & Sensor names alternately

2. DISPLAY MODE

Display Instantaneous Readings & Sensor names alternately

[N]+[MODE] for 3 seconds:
Password check
Wrong password: back to instantaneous display
Correct password: Enter Programming menu.
[N]: Toggle back light [Y]: Test alarm/stop alarm

[MODE]

Display Peak values

[MODE]

Display Min values

[MODE]

Display STEL values

[MODE]

Display TWA values

[MODE]

Display Battery voltage

[MODE]

Print Reading? (if printer option is enabled)

[MODE]

Communicate with PC?

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

[MODE] or [N]

Return to Instantaneous display & Sensor names alternately

3. PROGRAM MODE

Display Instantaneous Readings & Sensor names alternately

[N]+[MODE] for 3 seconds:
 Password check
 Wrong password: back to instantaneous display
 Correct password: Enter Programming menu.
 [N]: Toggle back light [Y]: Test alarm/stop alarm

[MODE]

Display Peak values

[MODE]

Display Min values

[MODE]

Display STEL values

[MODE]

Display TWA values

[MODE]

Display Battery voltage

[MODE]

Display Clock / Run time / Internal temperature

[MODE] (For datalog function unit only!)

Configured for Manual datalog?

Yes: Start / Stop Datalog?
 [Y] Start or Stop Datalog
 [M] go to "Display LEL gas name"
 No: Display Datalog mode

[MODE]

Display LEL gas name

[MODE]

Print Reading? (if printer option is enabled)

[MODE]

Communicate with PC?

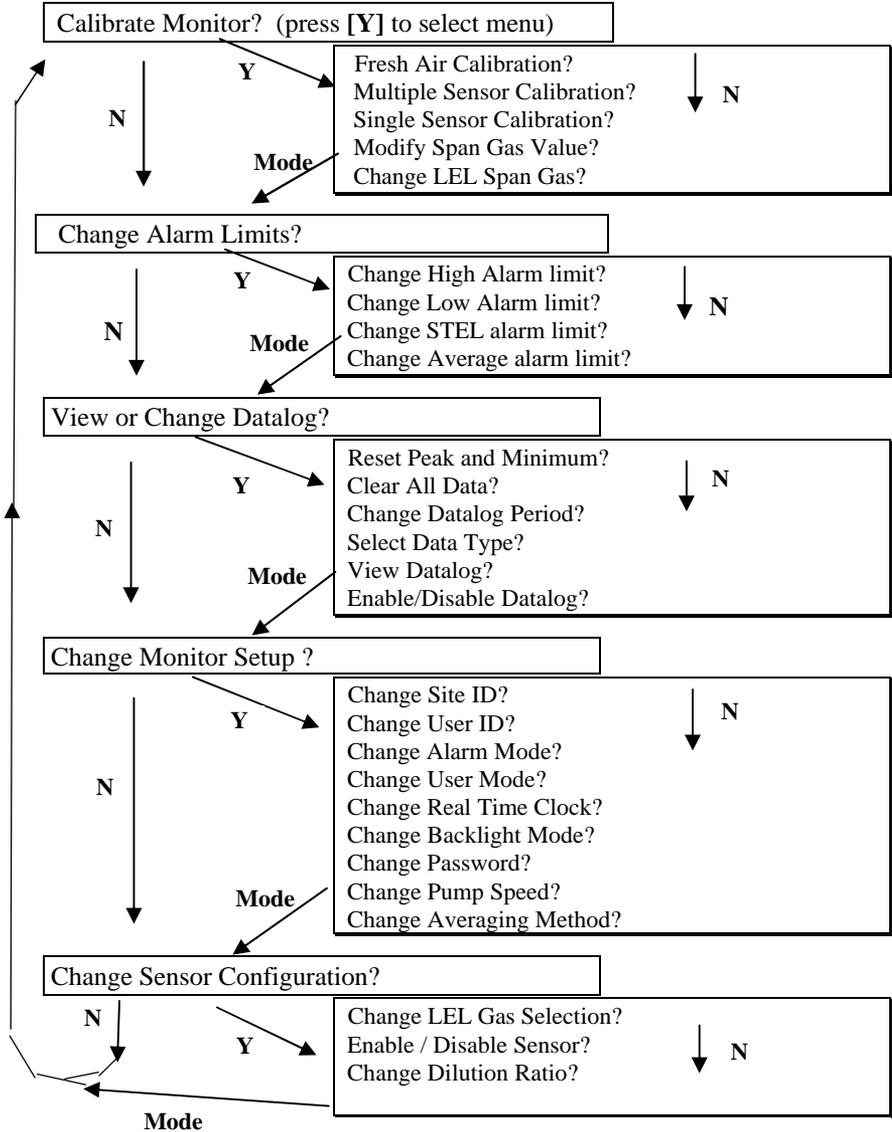
[Y]: Monitor will pause OK?
 [Y]: Ready...
 [N]: Return to Instantaneous display

[MODE] or [N]

Return to Instantaneous display & Sensor names alternately

PROGRAMMING MODE

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



APPENDIX B. CORRECTION FACTORS

A partial list of correction factors for a number of commonly used compounds for the LEL sensor is as follows (refer to TN-156 at www.raesystems.com for complete lists of correction factors):

Table B.1 **Correction Factors for LEL Sensor**

Compound	LEL CF
Acetaldehyde	1.8
Acetic acid	3.4
Acetone	2.6
Ammonia	0.79
Benzene	2.1
Butadiene	2.5
Butane, n-	2.0
Carbon disulfide	4
Carbon monoxide	1.2
Cyclohexane	2.5
Dichloromethane	1.0
Ethanol	1.7
Ethene	1.5
Ethyl acetate	2.2
Ethyl benzene	2.8
Ethyl ether	2.3
Gasoline	2.1
Heptane, n-	2.4
Hexane, n-	2.3
Hydrogen	1.2
Hydrogen sulfide	2.3
Isobutane	1.8
Isobutene	1.7
Isopropanol	1.6

APPENDIX B

Compound	LEL CF
Methane	1.0
Methanol	1.5
Methyl ethyl ketone	1.7
Octane, n-	2.9
Pentane	1.8
Propane	1.5
Propene	1.5
Toluene	1.9
Vinyl chloride	1.8
Xylene, m-	2.7
Xylene, o-	3.0
Xylene, p-	2.8

The LEL correction factors in Table B.1 are measured relative to methane gas. All measurements are at <5% relative humidity and 25°C, typically at 20-80% LEL. The factors may change at higher concentrations or different temperature and humidity conditions. The factors are to be multiplied by the reading to obtain the actual % LEL of the gas, after calibration to methane. If the correction factor of a gas is <1.0, then the sensitivity to the gas is higher than that of methane.

APPENDIX C: DATA CONVERSION TO MICROSOFT EXCEL[®] FOR Q-RAE

Q-RAE multi-gas monitors, configured with datalogging, have 20,000 datalogging points built-in. The ProRAE-Suite software provides data that can be converted into other application programs 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 exported 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.

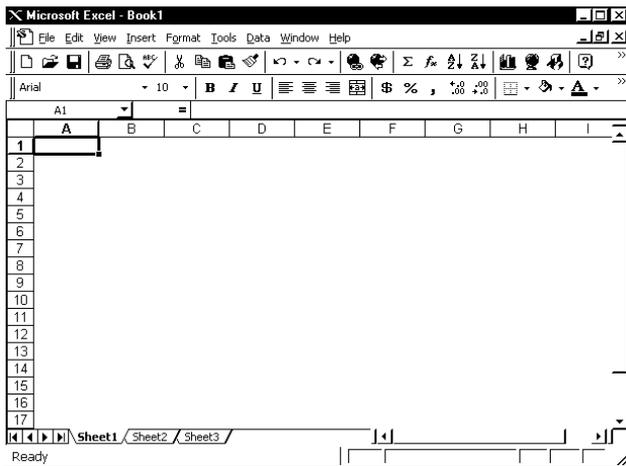


Figure C-1 Excel Window

- Click the **File->Open** menu item to open the **Open** dialog box, select the folder where the file **TextEvent.txt** resides, and select the **Files of type** as **Text Files**. Click to select the file **TextEvent.txt**, as shown in Figure C-2.

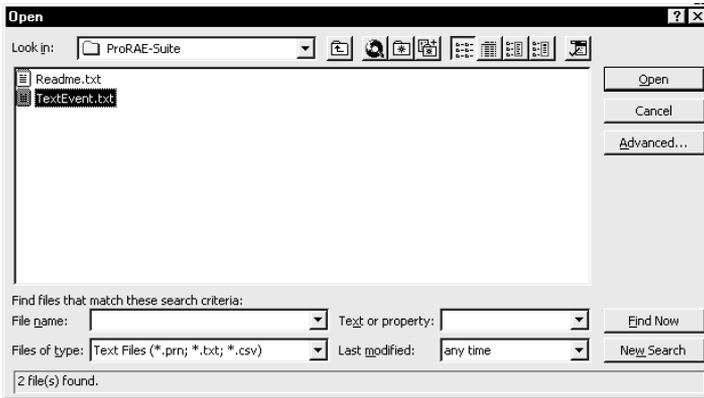


Figure C-2 **Open** Dialog Box

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



Figure C-3 **Text Import Wizard** Dialog Box

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

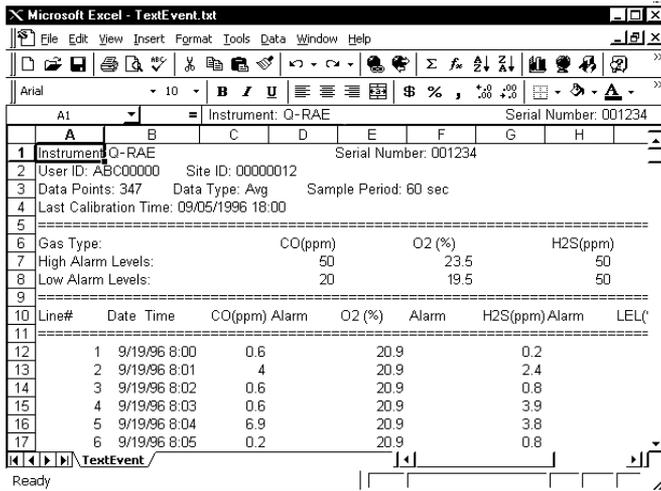


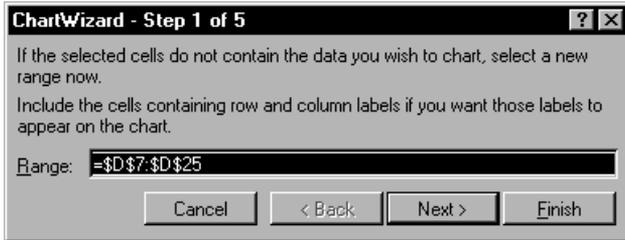
Figure C-4 File TextEvent.txt is Open

- 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 Q-RAE Data in Excel[®]

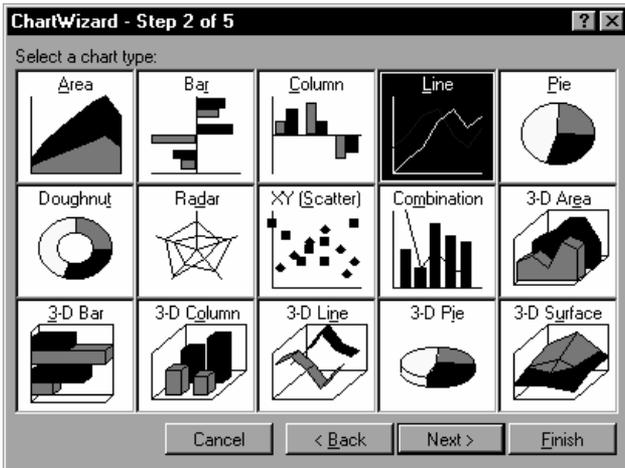
- Open the Excel[®] data file that contains the data to be graphed by selecting “File” and then “Open.” Highlight the columns that contain the data points. Make sure that the header information is not highlighted.
- Go to the “Insert” menu, and under “Chart” elect “As New Sheet.”

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



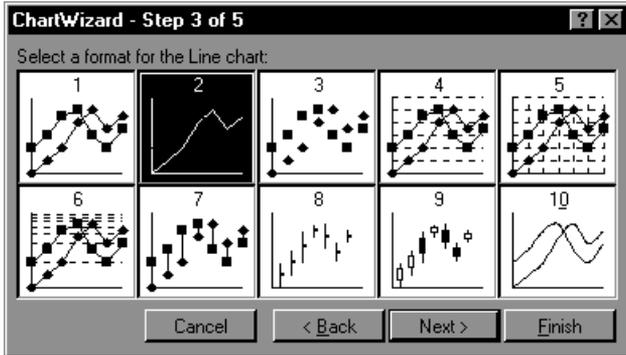
Press the “Next” button to continue.

- The next step will show the different chart types. For this example, the “Line” chart has been selected.



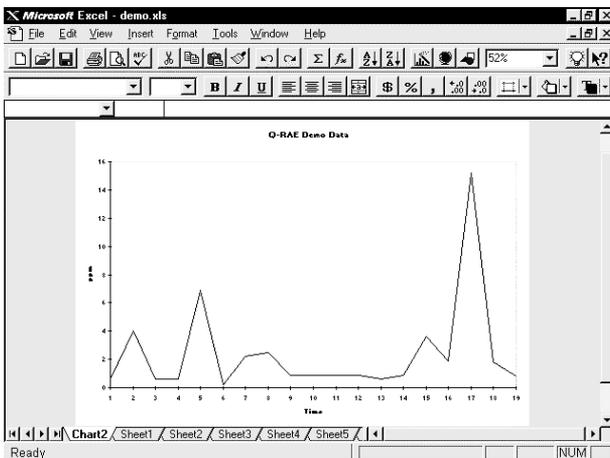
Press the “Next” button to continue.

- Step 3 of the ChartWizard give 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. Previewing the chart 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, press the “Finish.”
8. A sample of a finished chart is below. For additional information and other modifications that can be made to the Excel[®] chart, please refer to the Excel[®] instruction manual.



RAE SYSTEMS TECHNICAL NOTES

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

APPENDIX D

- p TN-133 Methylene Chloride-Specific Measurements using the UltraRAE
- p TN-134 UltraRAE Bar Code Reader Patterns and Adjustments
- p TN-135 UltraRAE Firmware & Tube Data Upgrade Procedures
- p TN-136 UltraRAE Operations Tips
- p TN-137 Exiting Diagnostic Mode for ToxiRAE LEL
- p TN-138 RAE System Year 2000 Compliance
- p TN-139 UltraRAE Communication with NT
- p TN-140 Extension Tubing Volume and Delay Time
- p TN-141 MultiRAE Remote Control Functions
- p TN-142 MiniRAE 2000 Preprogrammed Compound Library
- p TN-143 Accuracy Comparisons of Gas Detection Tubes
- p TN-144 Handling LEL Sensor Poisoning
- p TN-145 Proper Care of Nickel Cadmium Battery Packs
- p TN-146 Turning On UV Lamps in a PID Monitor
- p TN-147 UltraRAE: Butadiene Specific Monitor
- p TN-148 Measurement of Phosphine (PH₃) by PID In the Food Storage industry
- p TN-149 PGM-30 UV Lamp Care
- p TN-150 Understanding the ppbRAE
- p TN-151 Electrochemical Sensor Replacement and Maintenance
- p TN-152 Effects of Operating Conditions on Oxygen Sensors
- p TN-153 TC Sensor Applications and Correction Factors
- p TN-154 SampleRAE Correction Factors
- p TN-155 2-Year Oxygen Sensor Installation and Calibration
- p TN-156 Correction Factors for Combustible Gas (LEL) Sensors
- p TN-157 Moisture Exchange Tubes for Humidity Control of Test Gases
- p TN-158 Conversion of PID Readings to Methane Equivalent Response
- p TN-159 Nerve Agent Measurements by PID
- p TN-160 Upgrading MultiRAE/QRAE Ni-Cd Battery Pack

Technical Notes are available at www.raesystems.com.
See Appendix F to order hard copies of Technical Notes.

RAE SYSTEMS APPLICATION NOTES

- p AP-200 PIDs and Aircraft Wing-tank Entry
- p AP-201 Measuring Ammonia (NH₃) with PIDs
- p AP-202 ABCs of Gases in Industry
- p AP-203 PID as a Hazmat Response Tool
- p AP-204 Pulp & Paper: Measuring Turpentine & ClO₂
- p AP-205 Measuring Heat Transfer Fluids with a PID
- p AP-206 Guide to Atmospheric Testing in a Confined Space
- p AP-207 PIDs as an Arson Investigation Tool
- p AP-208 HAZMAT User List
- p AP-209 UltraRAE User List
- p AP-210 North American RAE User List
- p AP-211 PIDs for Continuous Monitoring of VOCs
- p AP-212 PIDs for Indoor Air Quality
- p AP-213 ModuRAE PID Configuration and Applications
- p AP-214 Environmental Applications for PIDs
- p AP-215 Gas Detection in the Marine Industry
- p AP-216 Weapons of Mass Destruction
- p AP-217 Confined Spaces in the Construction Industry
- p AP-218 Lengthening the Interval Between Calibration Checks
- p AP-219 Using PIDs for 10% of LEL Decisions
- p AP-220 Using PIDs in Clan Lab Investigations
- p AP-221 PIDs for Exposure Risk in Unknown Environments
- p AP-222 CO & Natural Gas Detection for Fire Department Engine Companies
- p AP-223 ppbRAE User List
- p AP-224 Understanding the CDRAE and its Applications

Application Notes are available at www.raesystems.com.
See Appendix F to order hard copies of Application Notes.

LITERATURE REQUEST

Application and Technical Notes are available at www.raesystems.com in PDF format for printing.

For hard copies, Photocopy this page and fax to:

Attn: Literature Department

1.408.752.0724 FAX

Please send me the following information:

Name: _____

Company: _____

Mailing Address: _____

City, State, Zip: _____

Country: _____

Telephone: _____

Fax: _____

Technical Notes:
(just list TN #) _____

Application Notes:
(just list AP #) _____

Comments: _____

Thank you, RAE Systems Sales & Marketing Department

APPENDIX G. REQUEST FORM FOR RETURN MATERIAL AUTHORIZATION

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

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

Photocopy this page and fax to Attn: Service Department:

1.408.585.3544

Electronic RMA requests can also be made through our website:

www.raesystems.com

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

We must obtain the following information in full:

Name:

Company:

Shipping

Address:

City, State, Zip:

Telephone:

Fax:

Serial number:

Model:

Reason for
return:

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

Thank you, RAE Systems Service Department

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

Main Contact Numbers

TEL: 408.752.0723

FAX: 408.752.0724

Toll Free Numbers

Instrument Sales: 877.RAE.CUSTOMer (723-2878)

Technical Service: 888.RAE.4800 (723.4800)

Tube Sales: 888.RAE.TUBE (723.8823)

E-mail:

Instrument Sales: raesales@raesystems.com

Technical Service: tech@raesystems.com

**World Wide Web site:
www.raesystems.com**