MiniRAE Plus Classic

PID MONITOR

OPERATION AND MAINTENANCE MANUAL

(Document No.: 034-4001)

Rev. B

RAE SYSTEMS INC.
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July 2001

RAE SYSTEMS

ISO 9001 CERTIFIED

RAE Systems Product Line

- Gas Detection Tubes & Pumps
- SampleRAE Electronic Tube Pumps
- D-RAE Combustible/O_2/H_2S/CO Monitors
- MultiRAE PLUS Multi-gas Monitors
- Q-RAE PLUS Confined Space Monitors
- V-RAE Five Gas Surveyors
- MiniRAE 2000 Portable VOC Monitor
- ppbRAE Parts Per Billion Monitors
- UltraRAE Specific Compound Monitors
- ToxiRAE PLUS PID Monitors
- ToxiRAE PLUS Single Gas Monitors
- ToxiRAE PLUS Oxygen Monitors
- ToxiRAE PLUS Combustible Monitors
- ModuRAE Fixed System PID

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

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

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

⚠ WARNING ⚠

-DO NOT PROCEED BEFORE READING-

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR USING, MAINTAINING, OR SERVICING THIS PRODUCT. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

CAUTION!!!
TO REDUCE THE RISK OF ELECTRIC SHOCK, TURN OFF THE POWER BEFORE REMOVING THE SENSOR FOR SERVICE.

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

NE CHARGER LES BATTERIES QUE DANS EMPLACEMENTS DESIGNES NON-DANGEREUX.

THE MODEL PGM-76 EQUIPMENT IS SUITABLE FOR USE IN CLASS 1, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY.

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

WARNING!!
EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2 AND CLASS 1, DIVISION 1.

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

CALIBRATION WARNINGS:
THE CALIBRATION OF ALL NEWLY PURCHASED RAE SYSTEMS INSTRUMENTS SHOULD BE TESTED BY EXPOSING THE SENSOR(S) TO KNOWN CONCENTRATION CALIBRATION GAS BEFORE THE INSTRUMENT IS USED OR PUT INTO SERVICE.

FOR MAXIMUM SAFETY, THE ACCURACY OF THE MINIRAE PLUS CLASSIC 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 ETRE TESTE EN EXPOSANT L'INSTRUMENT A UNE CONCENTRATION DE GAZ CONNUE PAR UNE PROCEDURE DIETALONNAGE AVANT DE METTRE EN SERVICE L'INSTRUMENT POUR LA PREMIERE FOIS.

POUR UNE SECURITE MAXIMALE, LA SENSIBILITE DU MINIRAE PLUS CLASSIC DOIT ETRE VERIFIER EN EXPOSANT L'INSTRUMENT A UNE CONCENTRATION DE GAZ CONNUE PAR UNE PROCEDURE DIETALONNAGE AVANT CHAQUE UTILISATION JOURNALIERE.

Special Note

-1-

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

-2-

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

-3-

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

1.0 GENERAL INFORMATION

MiniRAE Classic (PGM-76) is a programmable Photo-Ionization Detector (PID) used to measure organic vapors in hazardous or industrial environments. It incorporates a sampling pump for continuous monitoring, site survey and leak detection applications. The unit is supplied with a standard 10.6 eV lamp, which measures a broad range of organic compounds. Interchangeable 9.8 eV and 11.7 eV lamps are available, which provide, respectively more selective and broader range measurements. Features are:

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

MiniRAE Classic PID Kit (PGM 76K) consists of: A **PID Unit**, AC charging adapter, interface cable, user manual, calibration accessories and a hard transport case.

1.1 General Specifications

Table 1.1 **PID Unit Specifications**

Size:	7.1"L x 2.7"W x 1.8"H (18.0 cm x 6.9 cm x 4.6 cm)
Weight:	18 ounces with battery (0.5 kg)
Detector:	Interchangeable 10.6 eV, 11.7 eV, or 9.8 eV electrodeless ultraviolet discharge lamp with Teflon®/stainless steel chamber
Operating Hours:	10 hours continuous
Battery Charging:	Two rechargeable 6V, 500 mAh sealed lead-acid. Field replaceable.
Gas Sampling:	Diaphragm pump with >500 ml/min. intake flow rate
Gas Inlet Probe:	6" flexible, 5/32" diameter tube
Gas Outlet:	5/32" diameter barb fitting
Attachment:	Wrist strap
Display:	7 digit LCD with LED backlight
Analog Output:	0 V to 2.5 V
Range:	0.0 - 99.9 ppm with 0.1 ppm resolution; 100 - 999 ppm with 1 ppm resolution; 1000 - 4000 ppm with 1 ppm resolution

Accuracy:	±2 ppm or ±10% in the reading range of 0 – 1000 ppm and ±20% in the range of 1000 – 4000 ppm
Response Time:	< 5 seconds to reach 90% of exposed concentration
Keypads:	2 operation keys, 2 programming keys and ON/OFF key
Alarm Setting:	Low and high alarm limits
Alarm:	90 dB buzzer and flashing red LED to indicate exceeded preset limits, low battery, or lamp failure
Calibration:	Two point field calibration for zero and span gases
Temperature:	0°C to 40°C
Humidity:	0% to 95% relative humidity (non-condensing)

2.0 OPERATION OF MINIRAE PLUS CLASSIC

The MiniRAE Classic **PID Unit** is a portable organic vapor monitor/sampler. It gives the real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Before factory shipment, the MiniRAE Classic is preset with default alarm limits and the sensor is calibrated with 100 ppm isobutylene gas. However, the user should calibrate the instrument before the first use. After receiving the unit, first charge the unit for at least 24 hours to fully charge the battery. Then turn on the battery switch on the back of the unit (see Figure 2.1). Once the monitor is fully charged and calibrated, it is ready for immediate operation.

Note: For accurate work it is recommended that the MiniRAE Classic be calibrated on each day of use. The time between calibrations can be extended up to 30 days if it can be shown that the calibration does not change significantly under the users conditions for such time.

2.1 Physical Description

Figure 2.1 shows the main components of the MiniRAE Classic **PID Unit**, which includes:

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

The operation details are explained in the following sections.

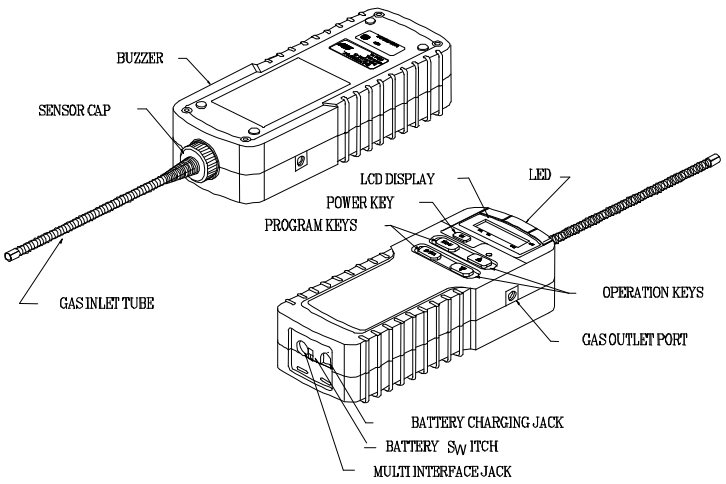


Figure 2.1 Major Parts of the MiniRAE Classic

2.2 Operation Mode

The MiniRAE Classic PGM-76 PID Unit operates in the survey mode, in which the air sample is measured once each second and compared to a preset alarm limit. When the alarm limit is exceeded, a variable frequency alarm signal is generated in proportion to the magnitude of the measurement. When sampling is enabled, the unit records the average and peak values over a sampling period that can be programmed from 1 second to 9999 seconds (166 hours).

Indication of Current Firmware:

When the MiniRAE Classic Unit is first turned on, an instrument name and firmware version message will appear in the LCD display. The message will display "Su - x.xx" where x.xx is the version number of each operating software.

2.3 Keys and Display

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

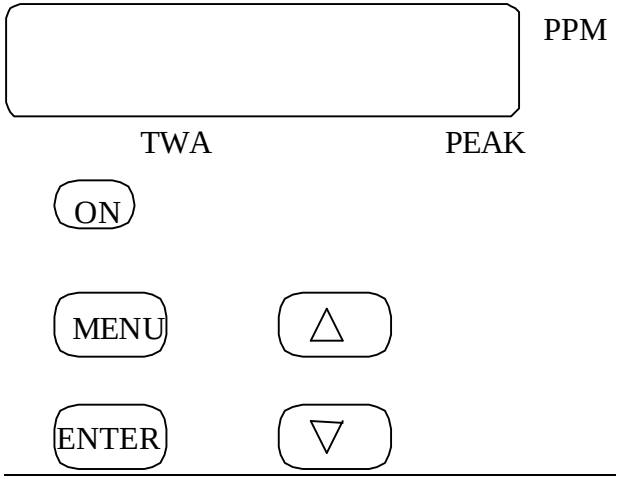


Figure 2.2 Keypad Display of MiniRAE Classic

Table 2.1

Key	Function in Normal Operation
[on]	-Toggle on/off the power
[up]	-Toggle on/off the back light
[down]	-Choose display readings
[enter]	-Confirm to turn off the power only after the **[on]** key is pressed once
[menu]	-Enter into programming task **Caution: Entering programming task will interrupt normal gas monitoring operation of the unit.**

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

- Real time gas concentration in ppm
- Average (TWA) value of the gas concentration in ppm over the sampling period
- Peak gas concentration in ppm
- Battery voltage in volts (from 5.3 V to 6.4 V)

2.4 Power On/Off

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

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

To turn off the MiniRAE Classic PID Unit, press the **[on]** key once and release. *Note: You must be in the user or regular mode in order to turn off this unit.* The message "Off" will flash on the LCD display. Press the **[enter]** key to confirm and the unit will be turned off. Pressing any other key will return the unit to normal operation.

2.5 Display Readings

The MiniRAE Classic PID Unit can display four different readings: Instantaneous gas concentration, Average, Peak, and Battery Voltage. Below is a brief explanation of each reading:

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

2) The **Average** (**AVG**) (indicated as **TWA** on some units) reading is the average gas reading during the previous sampling period (not an 8-hour time weighted average).

3) The **Peak** reading is the peak gas reading during the previous sampling period.

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

Selecting a reading:

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

Instantaneous ⇒ AVG (TWA) ⇒ Peak ⇒ Battery Voltage ⇒ Instantaneous

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

2.5.1 Recording Average and Peak Values

To record Average or Peak values during instantaneous readings, press [Enter] to initiate the sampling period (SP). A letter "d" will flash during the active sampling period. The Average and Peak values are stored when the sampling period ends, either automatically, or when [Enter] is pressed again to stop it manually. The previous values are overwritten and cannot be recalled.

The SP must be set to at least 3 seconds to give enough time for the "d" to be observed. Also, if the SP is too short, it may end before the probe is inserted into the intended sample. Conversely, the sampling period should not be set too long, because the Peak and Average values are updated only after the sampling period is complete, not while the "d" is still flashing.

2.6 Alarm Signal

The built-in microcomputer constantly updates and monitors real time gas concentration and compares it with the programmed alarm limits (low and high limits for the Survey Mode). Whenever the concentration exceeds any of the preset limits, the alarm buzzer and red flashing LED will be activated immediately to warn user of the alarm condition. The alarm is non-latching and will go off as soon as the concentration drops below the preset lower limit.

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

Note: It is extremely important that when the lamp or sensor failure alarm occurs, users should stop the operation of the unit immediately and follow the troubleshooting guide in Section 7 to diagnose the problem.

The alarm signal is proportional to the magnitude of the gas concentration. Therefore, when gas concentration exceeds preset limits, the alarm signal may vary from a "single beep" and a "single flash" per second to a rapid "7 beeps" and "7 flashes" per second when the high

threshold level has been exceeded. The higher frequency of alarm signal indicates higher gas concentration.

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

2.7 Preset Alarm Limits and Calibration

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

Table 2.2

Factory Calibration and Preset Alarm Limits	
Calibration Standard Gas isobutylene	100 ppm
Survey Mode:	
Low Alarm Limit	10 ppm
High Alarm Limit	100 ppm
Battery Low Level	5.5 volts
Power Off Level	5.3 volts

2.8 Back Light

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

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

2.9 Diagnostic Power-on Sequence

The MiniRAE Classic PID Unit offers a special diagnostic power on sequence to allow users to read "raw" (or un-calibrated) instrument readings during zero gas calibration procedures. This feature can provide additional information to users regarding the sensor performance. *Note: To get the diagnostic power-on sequence, the MiniRAE Classic PID Unit must be turned off.*

To accomplish this diagnostic power-on sequence, start by pressing the **[up]** key first and holding it down. At the same time, press the **[on]** key to turn on the power. Next, use the **[menu]** key to scroll to the C0 display menu option. Here, the C0 means the raw reading so you will see a raw reading being displayed.

Note: Using the special diagnostic power on sequence, the unit will perform normally except during the zero gas calibration procedure (see Section 4.5.1). The display will show a "raw" reading, instead of the "ppm" reading. Typically, the reading should be between "330.0" to "370.0". When exposed to a calibration gas, the reading should go down quickly. The reading can be anywhere between "0.0" and "300.0".

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

2.10 Disconnect Battery

The MiniRAE Classic PID Unit provides a mechanical switch to allow the user to disconnect the battery from the unit. This is to prevent the battery from being deeply discharged when the unit is placed on the shelf or during shipment. The lead-acid batteries used in the MiniRAE Classic can be permanently damaged if allowed to be discharged completely.

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

Reset Microprocessor

The battery switch also serves as a reset switch for the microprocessor inside the MiniRAE Classic PID Unit. If for some reason, the unit is hung up (no response when pressing keys or the unit displays unrecognizable characters on the LCD display), turning off the switch and then turning it on again should reset the microprocessor.

3.0 OPERATION OF ACCESSORIES

There are a number of accessories for MiniRAE Classic PID Unit:

- 110 V or 220 V AC charging adapter
- Gas outlet port adapter and sample collection Tedlar bag
- Remote access probe (8 feet)
- Audio interface adapter cable and earphone
- Analog interface adapter cable
- Water trap filter

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

3.1 Charging the Batteries

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

There is a bi-colored LED inside the LED window that provides
an indication of the charging status:

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

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

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

Note: The factory-supplied battery is designed to last 10 hours of normal operation for a new battery under the best conditions. As the battery becomes older or operated under adverse conditions, the battery capacity will be reduced significantly.

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

There is an optional **automotive charging adapter** (p/n 003-3004-000), which allows users to charge the MiniRAE Classic unit directly from the 12 V cigarette lighter socket inside a car.

3.2 Sample Gas Collection

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

A gas outlet port adapter with two feet Tygon tubing is supplied with the basic kit. Insert the threaded end of the adapter into the gas outlet port and turn clockwise to tighten the adapter. The open end of the Tygon tubing can be connected to a sample gas collection bag. A complete gas collection kit that includes a gas outlet adapter, connecting tubing and a three-liter Tedlar sample collection bag is also available as an accessory. When collecting samples, we recommend keeping the Tygon connections less than 6 inches because this tubing can adsorb some organic compounds, particularly higher boiling ones.

3.3 Remote Access Probe

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

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

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

3.4 Audio Interface Adapter and Earphone

On the rear side of the MiniRAE Classic PID Unit, there is an 8 pin round multi-interface jack which is normally covered by a protective rubber cover. An audio interface adapter cable and a small earphone are available as an optional accessory for the MiniRAE Classic PID Unit (p/n 002-3002-000). Open the rubber cover and connect the interface cable to the jack.

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

WARNING:
TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, DO NOT CONNECT THE EARPHONE OR EXTERNAL ALARM DEVICES TO MINIRAE CLASSIC IN AREAS KNOWN TO BE HAZARDOUS.

Audio alarm signal

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

Alarm signal specifications:

Voltage:	6 V peak to peak
Current:	14 mA (max)
Frequency:	2 kHz
Duty cycle:	50% square wave
Duration:	50 milli-seconds
Pin out:	Pin 7 - signal
	Pin 8 - ground

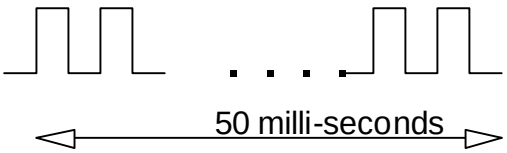


Figure 3.1 Alarm Signal Waveform

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

3.5 Analog Interface Adapter

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

The analog signal output from the sensor module (0 V- 2.5 V) is brought out through this interface cable. Connect the mini-RCA plug on the other end of the interface cable to any external recording equipment, such as a strip chart recorder, or an analog datalogger. Users can readily interface the MiniRAE Classic Unit to external equipment for datalogging or other field applications.

WARNING:
TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, DO NOT CONNECT THE ANALOG INTERFACE CABLE TO MINIRAE CLASSIC IN AREAS KNOWN TO BE HAZARDOUS.

Analog output signal
Pin 1 of the multi-interface jack carries the un-calibrated analog signal directly from the PID sensor. The output impedance of the signal is 3.5 k Ohms. The range of the voltage output is 0 V- 2.5 V.
Note: The analog signal output has a built-in offset of about 50 mV. When a 100 ppm isobutylene gas is applied to the instrument, the output signal will increase by about 100 mV. At 4,000 ppm of isobutylene, the

output signal will increase by about 1.0 V. The raw analog output signal is not a linear function of the gas concentration in the 0 – 4,000 ppm range.

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

Multi-interface pin assignment

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

Pin #	Description
1	Analog output
2	Reset (from PC)
3	Data input (from PC)
4	Not Applicable
5	Not Applicable
6	Not Applicable
7	Alarm output
8	Ground

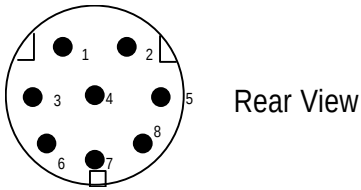


Figure 3.2 Pin Diagram of the Multi-Interface Connector

3.6 Water Trap Filter

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

The water trap filter will prevent liquid from being sucked into the PID unit by accident. If water is sucked into the filter, the airflow will be reduced significantly and the pump will stall. Users can also stop the unit immediately when observing water inside the filter or hearing the pump stalling.

4.0 PROGRAMMING IN SURVEY MODE

The MiniRAE Classic PID Unit is built with a microprocessor to provide programming flexibility. In the Survey Mode operation, users can choose a new site number, re-calibrate the unit, change the sampling period, clear data memory, and change the gas concentration alarm limits.

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

4.1 Menu Options

The programming menu includes seven menu options as shown in the Table 4.1. The user enters the programming menu by pressing the **[menu]** key. The first menu option will appear in the display. The user can use the other three keys to perform the desired programming tasks. At the completion of each menu entry, the display will automatically advance to next menu option. Pressing the **[menu]** key will exit the current menu option and move to the next menu option. After sequencing through all seven menu options, the unit will return to normal operation.

Each option is explained in the following sections. The flow chart of the programming task in the Survey Mode is shown in Appendix A (pg. A-2).

Table 4.1

	Menu Option	Display
1	Site selection	SItE xx
2	Zero gas calibration	C0 xxx.x
3	Enter standard gas value	C1u xxx.x
4	Set sampling period (in seconds)	SP xxxx
5	Clear all data	Clr ALL
6	Set low alarm limit	LA xxx.x
7	Set high alarm limit	HA xxx.x

Note 1: xxxx is the previously stored value.

4.2 Keys for Programming

The operation of the five keys during the programming task in the Survey Mode.

Table 4.2

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

4.3 Entering Programming

CAUTION!!
Do not program the unit while in potentially hazardous environments that require continuous protection. Real time monitoring of gas concentration will be interrupted during programming.

1. The MiniRAE Classic PID Unit should already be turned *on* already before entering the programming function. If it is not *on*, refer to Section 2.4 for *power on* procedure.

2. Press the **[menu]** key to enter into the programming menu.

3. **Note:** If the unit is in the middle of the sampling period (a "d" will be flashing next to the site number), it will not respond to the **[menu]** key. This is to prevent entering the programming mode while the sampling period has not been completed. Wait for the sampling period to complete or force the sampling period to stop by pressing the **[enter]** key, then enter the programming mode again.

4.4 Select Site Number

1. The first menu option (item 1 in Table 4.1) is to allow users to select a new site number.
   - Display shows the following message "SItE xx".

   where xx is the current site number.

2 Press the **[up]** key once to increase the site number by one. Press the **[down]** key once to decrease the site number by one.

3. By holding down the **[up]** or **[down]** key, the site number will automatically advance to next number at approximately once every half second. This allows users to advance to a new site number rapidly without repetitively pressing the keys.

4. When the site number reaches the maximum value of 49, it will automatically wrap around to zero.

5. When a desired new site number is reached, pressing the **[enter]** key will accept the new site number and move to next menu option.

6. If the **[menu]** key is pressed in Step 3, the previous site number will not be changed and the display will show next menu option.

4.5 Calibration of MiniRAE Classic

CALIBRATION WARNINGS:

THE CALIBRATION OF ALL NEWLY PURCHASED RAE SYSTEMS INSTRUMENTS SHOULD BE TESTED BY EXPOSING THE SENSOR(S) TO KNOWN CONCENTRATION CALIBRATION GAS BEFORE THE INSTRUMENT IS USED OR PUT INTO SERVICE.

FOR MAXIMUM SAFETY, THE ACCURACY OF THE MINIRAE PLUS CLASSIC SHOULD BE CHECKED BY EXPOSING THE SENSOR(S) TO KNOWN CONCENTRATION CALIBRATION GAS BEFORE EACH DAY'S USE.

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

4.5.1 Zero Gas Calibration

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

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

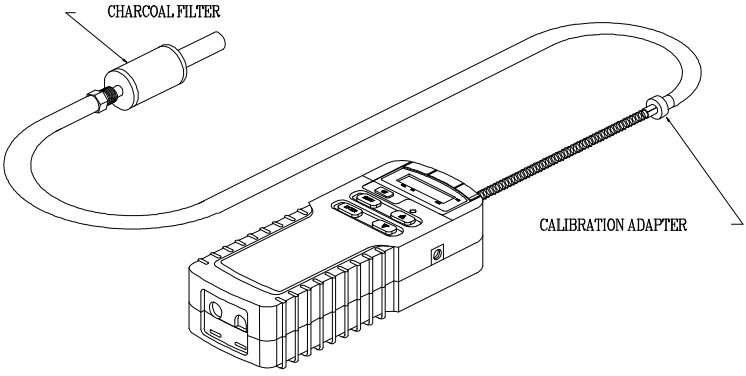


Figure 4.1 Zero Gas Calibration Setup

Zero Gas Calibration Procedure

1. "Zero gas calibration" option is the second menu option in Table 4.1.
   - Display shows "C0 xxx.x" where "xxx.x" is the gas reading based on the current calibration of the instrument. Note: This reading may not be zeroed due to background gas concentration, dirty charcoal filters or instrument drift.

2. Insert the zero gas adapter into the gas inlet tube of the Personal PID Unit, as shown in Fig. 4.1. Alternatively, move the instrument to a location that is known to be free of organic contaminants in the ambient fresh air.

3. The sampling pump draws air sample into the sensor chamber through the charcoal filter of the organic zeroing kit.
   - Display then shows the reading of the gas free of organic vapor. Again, this reading may not be zeroed due to dirty charcoal filter or instrument drift. Replace the filter if it is suspected to be dirty or if the number of uses exceeds the number of check boxes on the filter.

4. If this reading is not zero, press the **[enter]** key to zero it. If the reading still shows a small value after a few seconds, press the **[enter]** key again to zero it. Repeat this process until the reading is stabilized around zero or 0.1 ppm. This completes the zero gas calibration procedure. Press the **[menu]** key to

exit zero gas calibration and move on to next menu item.

5. Remove the zero gas calibration adapter from the Personal PID Unit.

6. One may press the **[menu]** key before pressing the **[enter]** key in Step 4 to skip the zero gas calibration. In this case, the previously stored zero gas calibration data is not changed.

Note: Even if the reading shows a zero during Step 4, it is recommended to press the **[enter]** key at least once to ensure that the zero gas calibration is updated properly. This compensates for possible drift below zero, which is displayed as zero on the unit.

4.5.2 Enter Standard Calibration Gas Value

1. "Enter standard gas value" option is the third menu option in Table 4.1.
   - Display shows "C1u xxx.x" where "xxx.x" is the previously stored standard calibration gas value. For example, "C1u 100.0" will be shown when the unit is first shipped from the factory because it is calibrated using 100 ppm isobutylene gas as standard calibration gas.

2. If the concentration of the standard calibration gas to be used is the same as the displayed value, press the **[enter]** key 4 times to accept the displayed calibration value one digit at a time and move to Step 4.

3. If the concentration of the standard calibration gas to be used is different from the displayed value, the user needs to enter the new value in the range of 5.0 ppm to 999.9 ppm. Starting from the left-most digit of the displayed value, use the **[up]** or the **[down]** arrow key to change the digit value and the **[enter]** key to confirm the digit, the flashing digit will move to next digit to its right. Repeat this process until all four digits are entered.

4. Now the standard calibration gas value is entered.
   - Display shows the message "GAS On" to remind the user to turn on the calibration gas bottle now. After the gas bottle is turned on, press the **[enter]** key to continue the standard gas calibration procedure as described in Section 4.5.3.

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

4.5.3 Standard Reference Gas Calibration

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

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

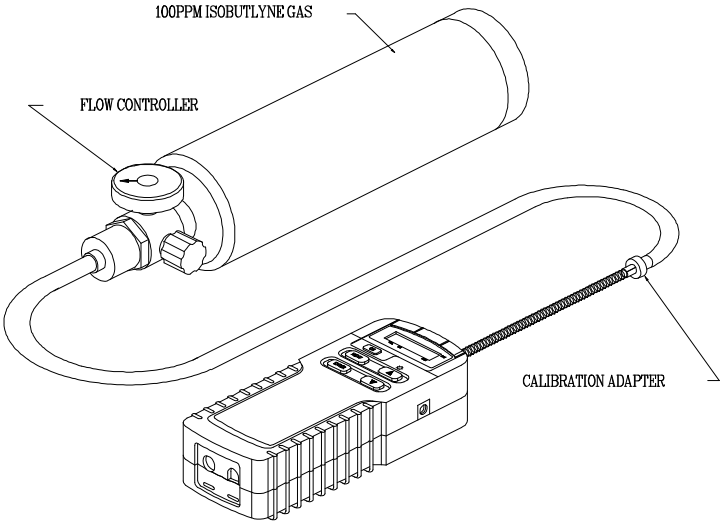


Figure 4.2 Standard Reference Gas Calibration Setup

Standard Gas Calibration Procedure

1. Insert the calibration adapter into the gas inlet tube of the Personal PID Unit, and connect the calibration adapter with the standard gas bottle, as shown in Figure 4.2.

2. Continue from Step 4 of the previous Section, the display should show a message of "GAS On". Turn the flow controller knob counter-clockwise about half a turn to start the flow of gas, then press the **[enter]** key.

   - Display shows "CAL..." for about 30 seconds while the instrument performs calibration. Afterwards, the display shows "C1 xxx.x" where C1 indicates that this is the standard calibration gas and "xxx.x" is the actual gas reading in ppm based on the new calibration data.

Note: The reading should be very close to the value of the given calibration gas (e.g. 100.0 ppm). If the reading is higher or lower than the standard gas value and continues to rise slowly, it means that the calibration has not been accurately established. Press the **[enter]** key and repeat this process a few more times if necessary until the reading is stable and sufficiently close to the standard gas value, for example, within 1 or 2 ppm of 100 ppm. This completes the standard gas calibration procedure.

3. Press **[menu]** to exit the standard gas calibration procedure and move onto the next menu item.

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

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

Note 2: The other possible cause for the "CAL Err" message to be displayed is that the instrument does not have enough sensitivity for the given calibration gas. There are several possible reasons for low sensitivity. First, the instrument and lamp are not sensitive to the specific calibration gas. In this case, the user needs to increase the signal by 1) using a higher concentration of the gas, 2) using a different calibration gas or 3) using a higher energy lamp. The second reason is that the UV light intensity of the lamp is weak. In this case, replace the UV lamp with a newer and stronger one.

4.5.4 Alternative Calibration Methods

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

A) Sampling Bag Calibration method:
First, fill a Tedlar sampling bag with the reference gas from a standard gas bottle. The size of the Tedlar bag should be at least one liter or more. Connect the air intake probe of the MiniRAE Classic to the Tedlar bag and perform the gas calibration procedures as described in Section 4.5.3.

In general, the sampling bag calibration method will allow the airflow from the bag to match the flow rate of the sampling pump of each individual PID unit. Therefore, it should provide a slightly more accurate calibration result. The disadvantage of the sampling bag calibration method is that it uses more gas for each calibration. Do not store calibration gas in a Tedlar bag for more than one hour, as the concentration may decrease.

B) Demand Flow Regulator method:
RAE Systems provides a demand flow regulator (DFR) whereby the instrument probe is connected directly to the regulator gas flow out of the cylinder is initiated by the suction of the instrument pump, and it matches the pump speed closely.

This method is simple, convenient, accurate, and uses only the amount of gas required for the calibration prcedure. It also avoids potential gas losses or contamination possible with the Tedlar Bag method. The demand flow regulator is more expensive to purchase initially but saves gas costs in the long run.

C) Tee Connection or Open Cup method:
In order to match the flow rate between the fixed regulator and the sampling pump, it is possible to insert a Tee connector between the regulator and the MiniRAE Classic unit. The Tee connector will allow the excessive gas from the regulator to flow out through the third opening on the Tee connector. Alternatively, the tubing from the cylinder can be widened or connected to an open cup, and the instrument probe inserted into the cup. Excess gas flows by the inserted probe. This method will also improve the calibration result.

4.5.5 Calibration for Other Gases

The most accurate results are always obtained by calibrating directly with a standard of the gas of interest. However, it is often impractical to carry a range of different standard gases into the field for calibration. For such cases, **correction factors** (CFs) have been determined that enable the user to quantify a large number of chemicals using a single calibration gas, typically isobutylene. The CF is multiplied by the instrument reading (calibrated to isobutylene) to obtain the true concentration of the gas of interest.
The **correction factor** for a specific gas is defined as:

$$\text{Correction Factor} = \frac{\text{Sensitivity to a standard gas}}{\text{Sensitivity to a specific gas}}$$

For example, when the PID sensor is calibrated to 100 ppm isobutylene gas, and then exposed to 100 ppm benzene gas, the instrument will measure about 189 ppm. Then the correction factor for benzene, relative to isobutylene is:

$$\text{Correction Factor (benzene)} = \frac{100 \text{ ppm}}{189 \text{ ppm}} = 0.53$$

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

1) Direct reading of a specific gas in ppm:

Step 1: Obtain the correction factor of a given organic vapor. For example, benzene has a calibration factor of 0.53 relative to isobutylene.

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

CF x Standard Value = Compensated Value
(0.53 x 100 ppm = 53 ppm for benzene)

Step 3: Enter the compensated calibration standard value, instead of the actual calibration standard concentration in Step 3 of Section 4.5.2. For example, enter 53 ppm instead of 100 ppm in Step 3 if readings in benzene ppm are desired. Continue to finish gas calibration using the standard calibration gas (100 ppm isobutylene).

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

2) Manual conversion of readings for a specific gas:

Step 1: Calibrate the instrument using the standard calibration gas as described in Sections 4.5.2 - 4.5.3.

Step 2: Obtain the calibration factor of a given organic vapor (see the list in Appendix B or

Technical Note 106). For example, benzene has a calibration factor of 0.53.

Step 3: When exposed to a specific gas, multiply the instrument reading by the calibration factor manually. The result is the calculated value in ppm for the specific gas. For example, if the instrument is calibrated using isobutylene gas. When exposed to 100 ppm benzene gas, it reads about 189 ppm. Multiply this value by the calibration factor of benzene (0.53). The result is 100 ppm which is the actual concentration of benzene.

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

4.6 Set Sampling Period

The sampling period (SP) for collecting Average and Peak values can be set between 1 and 9999 seconds. We suggest setting the sampling period to at least 5 seconds, which is the t_{90} response time of the monitor.

1. "Set Sampling Period" option is the fourth menu option in Table 4.1.
   - Display shows "SP xxxx" with the left-most digit flashing, where "xxxx" is the previously stored sampling period in seconds.

2. To modify this period, starting from the left-most digit, use the **[up]** or **[down]** arrow key to change the digit value and then press the **[enter]** key to confirm the digit, the flashing digit will move to the next digit to its right. Repeat this process until all four digits of the new sampling period are entered. **Note:** If "0" second is entered, the entry will be ignored and the previously stored sampling period will be used.

3. To preserve the previously stored sampling period, press the **[menu]** key at Step 1 or in the middle of Step 2, the unit will abort the data entry and move to the next menu option.

The sampling period is initiated by pressing [Enter] while in the instantaneous reading display, and can be stopped early by pressing [Enter] again. See Section 2.5.1 for more information on sampling for Peak and Average readings.

4.7 Clear Data

The Average and Peak data can be cleared by selecting the "clear data" menu option.

1. Clear data option is the fifth menu option in Table 4.1.
   - Display shows a flashing "Clr ALL" message

2. To clear the data, press the **[enter]** key to confirm the menu selection.

3. Pressing the **[menu]** key will move to the next menu option without clearing the data.

It is not necessary to clear the data before starting a new sampling period because the Peak and Average values are automatically overwritten once the next sampling period is completed.

4.8 Set Low Alarm Limit

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

1. Set "low alarm limit" option is the sixth menu option in Table 4.1.
   - Display shows "LA xxx.x" with the left-most digit flashing, where "xxx.x " is the previously stored low alarm limit.

2. To modify this limit, starting from the left-most digit, use the **[up]** or **[down]** arrow key to change the digit value and then press the **[enter]** key to confirm the digit, the flashing digit will then move on to next digit to its right. Repeat this process until all four digits of the new low alarm limit are entered. **Note:** If the low alarm limit is higher then the high alarm limit, the data entry will be aborted and the previously stored low alarm limit will be restored.

3. To preserve the previously stored low alarm limit, press the **[menu]** key at Step 1 or in the middle of Step 2, the unit will abort the low alarm limit entry and move to the next menu option.

4.9 Set High Alarm Limit

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

1. Set "high alarm limit" option is the seventh menu option in Table 4.1.
   - Display shows "HA xxx.x" with the left-most digit flashing, where "xxx.x" is the previously stored high alarm limit.

2. To modify this limit, starting from the left-most digit, use the **[up]** or **[down]** arrow key to change the digit value and then press the **[enter]** key to confirm the digit, the flashing digit will then move on to the next digit to its right. Repeat this process until all four digits of the new high alarm limit are entered. **Note:** If the high alarm limit is lower then the low alarm limit, the data entry is aborted and the previously stored high alarm limit will be restored.

3. To preserve the previously stored high alarm limit, press the **[menu]** key at Step 1 or in the middle of Step 2, the unit will abort the high alarm limit entry and move to the next menu option.

5.0 THEORY OF OPERATION

MiniRAE Classic PID Unit uses a patented electrodeless discharge UV lamp as the high-energy photon source for the PID instrument. A special high efficiency lamp driver is developed to turn on the UV lamp (see Figure 5.1).

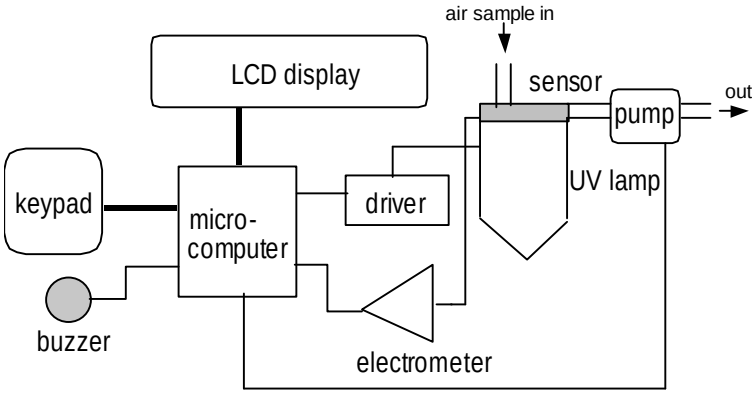


Figure 5.1 Block Diagram of MiniRAE Classic PID Unit

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

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

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

6.0 MAINTENANCE

As shown in Figure 6.1, the major items of MiniRAE Classic PID Unit that require periodic maintenance are:

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

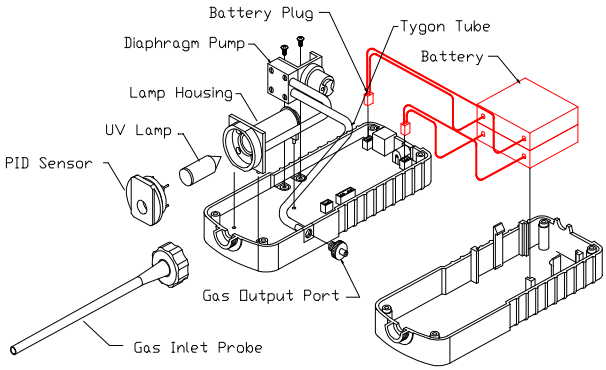


Figure 6.1 Main Components of MiniRAE Classic PID

6.1 Battery Charging and Replacement

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

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

Recharging PID Unit

1. Turn off power of the PID Unit.

2. Open the rubber cover on the bottom side of the PID unit and connect the AC adapter (or the automotive DC charging adapter, depending on the power source) to the power jack.

3. There is a bi-colored LED inside the LED window which will provide an indication of the charging status:
   Red -batteries are being charged
   Green -charging is completed
   No Light -bad connection or defective battery

4. Make sure that the indicator LED turns red to indicate that the unit has made good contact and is being charged. After the LED turns green, the unit is fully charged.

Replacing Batteries

1. Turn off power of the MiniRAE Classic PID Unit.

2. Refer to Figure 6.1, unscrew the probe assembly, remove four screws that hold the back cover of the unit to gain access to the battery compartment.

3. There are two batteries inside the unit. Unplug one battery from the battery jack on the top cover of the

unit. Plug a fully charged battery into the jack. After the first battery is replaced, replace the second battery.

4. Ensure the battery plug is securely connected to the MiniRAE Classic PID Unit.

5. Close the MiniRAE Classic PID Unit covers and tighten screws.

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

6.2 Filter Replacement

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

1. Turn off power of the MiniRAE Classic PID Unit. Remove the inlet probe.

2. Unscrew the filter cover (metal part above the O-ring on the probe). Use tweezers to remove the green dust filter and replace. Replace the metal frit filter as necessary. Screw the filter cover back on.

3. Attach the probe assembly. Check for air leakage (see Section 6.4).

6.3 Sensor Assembly Cleaning

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

Sensor Assembly Cleaning Procedure

1. Turn off power of the MiniRAE Classic PID Unit.

2. Refer to Figure 6.1, unscrew the inlet probe, remove four screws on the instrument housingand open the. Partially remove the lamp housing by gently pulling up on both the front and rear of the housing. Leave the Tygon tubing and wires intact.

3. Plug out the sensor assembly from the lamp housing by pulling it straight out of the lamp housing. Remove the lamp and O-ring.
   Note: The sensor block is held together by four hex nuts at the back of the sensor block. It is not recommended to disassemble the sensor block for cleaning.

4. Clean the sensor assembly using GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor assembly for at least ten minutes.

5. Make sure the sensor block is fully dried before it is plugged in. A damp sensor block will cause excessive leakage and sensor failure. It is recommended to blow dry the sensor block or bake it at 75°C for five to ten minutes to ensure it is fully dried.

   Note: The sensor block can only be inserted into the lamp housing one way because of the four pins is thicker than the other three. When the sensor pins are aligned properly, the inlet hole in the front of the sensor is near the bottom of the lamp housing. If the sensor block is installed upside down, the round hole on the front of the sensor block will not line up with the opening on the front of the unit housing.

6. Referring to Fig. 6.1, insert the lamp housing into the three holes on the PCB. Make sure that the two Tygon tubes are not kinked or caught under the sensor module.

7. Close the MiniRAE Classic PID Unit covers and replace the probe assembly.

6.4 Probe Assembly Cleaning

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

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

1. Turn off power to the MiniRAE Classic PID Unit.

2. Remove the inlet probe and unscrew the cap of porous metal filter. Use a small tweezer to remove the metal frit inside the cavity. Insert a new one into the cavity. Make sure that it fits snugly inside the cavity.

3. Screw the metal filter (also changeable) on the inlet probe.

4. Turn on the MiniRAE Classic Unit. Wait for the pump to come on. Check to see if air is drawn into the gas inlet probe. If the probe is air tight, when the gas inlet is blocked by a finger, the pump noise should change and a strong suction force will be felt.

6.5 Lamp Cleaning and Replacement

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

1. Turn off power of the MiniRAE Classic PID Unit.

2. Refer to Figure 6.1 to unscrew the probe assembly by removing the sensor module from the PCB. Plug out the sensor block from the lamp house as described in Section 6.2.

3. Gently pull out the lamp, avoiding contact with the flat window surface.

4. Clean or replace a the lamp, avoiding contact with the flat window surface.

5. Plug the sensor block into the lamp house. Put back the sensor module. Close the PID covers and replace screws. Screw the inlet probe.

Lamp Window Cleaning Procedure:

For lamps with 9.8 eV, 10.6 eV or 11.7 eV windows, clean the window surface with anhydrous methanol using a cotton swab. Rub in a circular motion at moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Rinse thoroughly with anhydrous methanol to remove any residues on the window.

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

<u>CAUTION</u>: WATER WILL DEGRADE EITHER 9.8 eV, 10.6 eV OR 11.7 eV WINDOW SURFACES. DO NOT USE WATER TO CLEAN THE LAMP WINDOW AT ANY TIME.

6.6 Pump Replacement

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

1. Turn off power of the MiniRAE Classic PID Unit.

2. Refer to Figure 6.1, unscrew the probe assembly, remove four screws and open the PID Unit.

3. Refer to Figure 6.1, and carefully remove two screws that hold the pump to the top cover. Disconnect two Tygon tubes connected to the pump. Note which tube goes to the inlet barb and which goes to the outlet barb of the pump. Disconnect the electrical wire from the pump to PCB. Remove the pump.

4. Insert a new pump. Connect the electric wire. Connect two Tygon tubes to the pump and tighten the pump to the top cover with two screws. Make sure that the two Tygon tubes are free of any "kink" and are not caught under the sensor module.

5. Close the MiniRAE Classic PID Unit covers and replace screws.
6. Replace the probe assembly.

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

7.0 TROUBLESHOOTING

Table 7.1

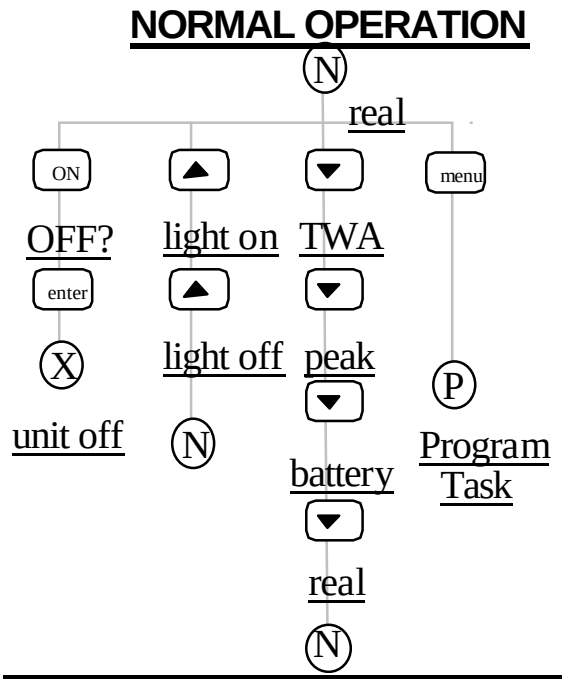
Problem	Possible Reasons & Solutions
Cannot turn on the power after charging the battery	**Reasons:** Bad battery connection Discharged battery Defective battery Microprocessor hang-up Battery switch is off **Solutions:** Check battery connection Charge or replace battery Reset microprocessor by turning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

Problem	Possible Reasons & Solutions
Reading abnormally high	**Reasons:** Dirty or wet sensor Dirty probe assembly Dirty membrane filter **Solutions:** Clean sensor module Clean lamp housing where it contacts sensor Clean probe assembly Replace membrane filter Use water trap disk
Reading abnormally low	**Reasons:** Lamp dirty or weak **Solutions:** Clean or replace lamp (see Section 6.5)
"Err xxx.x" message during operation	**Reasons:** Dirty sensor Weak or defective lamp **Solutions:** Clean sensor Replace lamp, filter
Read a small background value	**Reasons:** There is actually a background gas level Instrument zero drift **Solutions:** Do zero gas calibration (see Section 4.5.1)

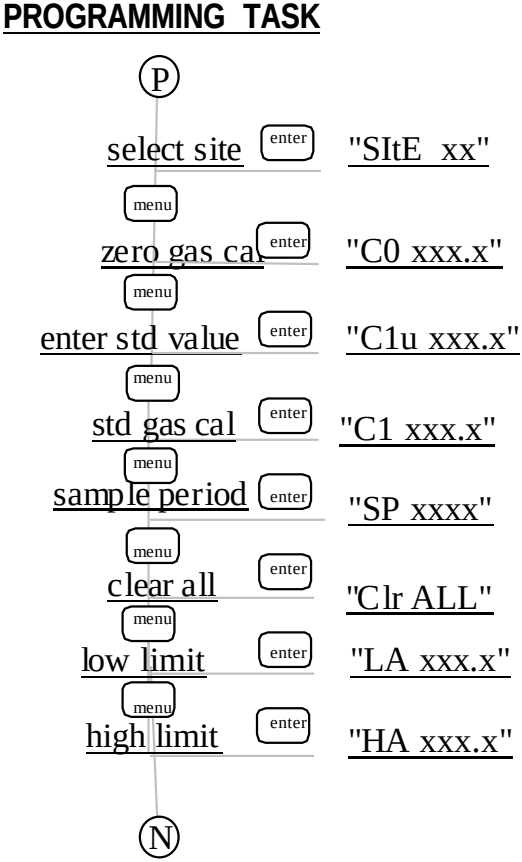
Problem	Possible Reasons & Solutions
Reading jumps around randomly	**Reasons:** Incorrect gas calibration Low sensitivity to cal gas Weak or dirty lamp **Solutions:** Re-calibrate Use different cal gas Clean or replace lamp
Slow response to gas input	**Reasons:** Leakage in probe assembly, sensor module or pump tubing connections **Solutions:** Tighten the probe assembly and sensor module
No air draw at gas inlet tube	**Reasons:** Defective pump or leakage in probe assembly, sensor module or pump tubing connections **Solutions:** Replace pump, tighten the probe assembly and sensor module
"Lo bAt" message at power on	**Reasons:** Discharged battery **Solutions:** Recharge battery

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

APPENDIX A. FLOW CHART OF SURVEY MODE OPERATION



APPENDIX A. FLOW CHART OF SURVEY MODE OPERATION



APPENDIX B. RESPONSE INFORMATION

Correction factors for a number of commonly used organic vapors are listed on Table B.1

Table B.1 Correction Factors for PID lamps:

Compound	9.8 eV	10.6 eV	11.7 eV
Acetaldehyde	*NR	6	3.3
Acetone	1.2	1.1	1.4
Allyl alcohol	**	2.4	1.7
Benzene	0.55	0.53	0.6
Butadiene	0.8	0.85	1.1
Butyl acetate	--	2.6	--
Carbon disulfide	4	1.2	0.44
Carbon tetrachloride	*NR	*NR	1.7
Chlorobenzene	0.44	0.40	0.39
Chloroform	*NR	*NR	3.5
Cyclohexane	3.3	1.4	0.64
Cyclohexanone	1.0	0.9	0.7
Cyclohexene	--	0.8	--
Decane (n-)	4.0	1.4	0.4
Dichlorobenzene (o-)	0.54	0.47	0.38
Dichloroethylene (t-1,2-)	--	0.5	0.3
Diethylamine	--	1	--
Diethyl sulfide	--	0.5	--
Ethyl acetate	--	4.6	--
Ethyl alcohol	--	12	8
Ethylbenzene	0.52	0.52	0.51
Ethyl ether	--	1.1	--
Ethylene	--	10	3
Compound	**9.8 eV**	**10.6 eV**	**11.7 eV**

Gasoline, 92 octane	1.3	1.0	0.5
Heptane (n-)	45	2.8	0.60
Hexane	350	4.3	0.54
Hydrogen sulfide	NR	3.3	1.5
Isopar K Solvent	0.9	0.5	0.27
Isopropyl alcohol	500	6.0	2.7
Methyl bromide	110	1.7	1.3
Methyl ethyl ketone	0.86	0.9	1.1
Methyl isobutyl ketone	0.9	0.8	0.6
Methyl methacrylate	2.7	1.5	1.2
Methyl sulfide	0.49	0.44	0.46
Octane (n-)	13.2	1.8	--
Perchloroethylene	0.69	0.57	0.31
Pinene (a-)	--	0.31	0.47
Pinene (ß-)	0.38	0.37	0.37
Propylene	1.5	1.4	1.6
Pyridine	0.78	0.7	0.7
Styrene	0.45	0.40	0.4
Tetrahydrofuran	1.9	1.7	1.0
Toluene	0.54	0.50	0.51
Trichloroethylene	0.62	0.54	0.43
Vinyl chloride	--	2.0	0.6
Xylene (m-)	0.50	0.43	0.40
Xylene (o-)	0.57	0.59	0.69
Xylene (p-)	--	0.45	0.62

* NR indicates there was no response

-- Indicates no data

The calibration factors in Table B.1 are measured relative to 100 ppm isobutylene gas in dry air at 25^{o}C. These factors may change at higher concentration levels or different temperatures and humidity conditions.

APPENDIX C. QUICK REFERENCE GUIDE

General Message	
Err	0.0 sensor or lamp failures
Lo bAt	low battery voltage
Clr ...	clear data in progress
CAL Err	calibration error

SURVEY MODE

Key	Display	Meaning
ON	Classic	power on and instrument name
	Su - x.xx	firmware version
	nxxxxxx	serial number
	00 0.0	site # (00) and real time
		reading (ppm)
Ñ	v 0.0	TWA reading (ppm)
Ñ	0.0v	Peak reading (ppm)
Ñ	bAt 6.0	battery voltage (V)
D		on / off backlight
ENTER	00d 0.0	start / stop average / peaking
D + **ON**	Su - x.xx	power on with diagnostics
ON	OFF 0.0	turn off power? (Y or N)
→**ENTER**		confirm power off

MENU	SItE 00	enter site number 0-49
MENU	C0 0.0	Zero gas reading (ppm)
→**ENTER**		reset reading to zero
MENU	C1u 100.0	Enter standard gas value
→**ENTER** (4 times)		enter 4 digit (5.0 - 999.9)
	GAS On	turn on gas bottle
→**ENTER**	CAL...	calibration in progress
	CL 100.0	standard gas reading
→**ENTER**		reset reading to std value
MENU	SP 0001	enter sample period (sec)
MENU	Clr ALL	Clear all data? (Y or N)
MENU	LA 010.0	Set low alarm limit (ppm)

MENU	HA 100.0	Set high alarm limit (ppm)

Key	Function in Programming Mode
ON	- does not function in programming mode
D	- increment numerical value for data entry
Ñ	- decrement numerical value for data entry
ENTER	- confirm menu selection or accept data entry
MENU	- exit current menu selection, go to next menu

APPENDIX D. REQUEST FOR RETURN AUTHORIZATION FORM

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

Photocopy this page and fax to **1.408.752.0724.** You will receive, via fax, **an RMA number** and instructions on how to ship. We must obtain the following information in full:

Name: _____

Company: _____

Shipping Address: _____

City, State, Zip: _____

Telephone: _____

Fax: _____

Serial number: _____

Model: _____

Reason for return: _____

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

Thank you,

RAE Systems Service Department

APPENDIX E. RAE TECHNICAL NOTES

- TN-102 Facts About PID Measurement
- TN-103 External Datalogger Interface to MiniRAE PID
- TN-104 Partial List of Ionization Potentials
- TN-105 MiniRAE PID Battery Characteristics
- TN-106 Correction Factors, Ionization Potentials, and Calibration Characteristics
- TN-108 MiniRAE PLUS PGM-76 and 76IS ProRAE 76 Software Upgrade for PGM-75
- TN-109 MiniRAE Professional PID Zero Drift
- TN-112 MiniRAE PLUS Datalogger Data Conversion to Microsoft Excel version 5.0
- TN-113 Calibration Procedures for ModuRAE PDM-10A
- TN-114 ToxiRAE Sensor Specifications
- TN-115 ToxiRAE Toxic Gas Monitor (PGM-35) at a Glance
- TN-116 ToxiRAE Oxygen Monitor (PGM-36) at a Glance
- TN-117 ToxiRAE Combustible Gas Monitor (PGM-37) at a Glance
- TN-118 Use of RAE PIDs for Soil Headspace Measurements
- TN-119 Calculation of STEL, TWA, Min., Max., and Average Values for ToxiRAE PID.
- TN-120 Measuring Correction Factors for Volatile Compounds with MiniRAE 7 and ToxiRAE PIDs
- TN-121 CO Sensor Cross-Sensitivity and Removal with Charcoal Filter
- TN-122 MiniRAE Compliance with EPA Method 21
- TN-123 Diagnostic Modes for RAE Instruments
- TN 124 PID Lamp Characteristics

TN 125 Creating Custom Correction Factors and Gas Names

for the ToxiRAE PID

- TN-126 Interchangeability of Sensors in PGM-35 and PGM-50
- TN-127 Benzene-Specific Measurements in Petroleum Hydrocarbons using the UltraRAE
- TN-128 ToxiRAE PID Communications Problems
- TN-129 Gas Detection Tube and Hand Pump Interchangeability
- TN-130 Setting Alarm Limits for Mixtures
- TN-131 Verifying and Fixing Gas Alarm Limits
- TN-132 Upgrading RAE Instruments Firmware
- TN-133 Methylene Chloride-Specific Measurements using the UltraRAE
- TN-134 UltraRAE Bar Code Reader Patterns an Adjustments
- TN-135 UltraRAE Firmware and Tube Data Upgrade Procedures
- TN-136 UltraRAE Operations Tips
- TN-137 Exiting Diagnostic Mode for ToxiRAE LEL
- TN-138 RAE System Year 2000 Compliance
- TN-139 UltraRAE Communication with NT
- TN-140 Extension Tubing Volume and Delay Time
- TN-141 MultiRAE Remote Control Functions
- TN-142 MiniRAE 2000 Preprogrammed Compound Library
- TN-143 Accuracy Comparisons of Gas Detection Tubes
- TN-144 Handling LEL Sensor Poisoning
- TN-145 Proper Care of Nickel Cadmium Battery Packs
- TN-146 Turning On UV Lamps in a PID Monitor
- TN-147 UltraRAE: Butadiene Specific Monitor
- TN-148 Measurement of Phosphine (PH_3) by PID in the Food Storage industry
- TN-149 PGM-30 UV Lamp Care
- TN-150 Understanding the ppbRAE

APPENDIX E. RAE TECHNICAL NOTES

- TN-151 Electrochemical Sensor Replacement and Maintenance
- TN-152 Effects of Operating Conditions on Oxygen Sensors
- TN-153 TC Sensor Applications and Correction Factors
- TN-154 SampleRAE Correction Factors
- TN-155 2-Year Oxygen Sensor Installation and Calibration
- TN-156 Correction Factors for Combustible Gas (LEL) Sensors
- TN-157 Moisture Exchange Tubes for Humidity Control of Test Gases
- TN-158 Conversion of PID Readings to Methane Equivalent Response
- TN-159 Nerve Agent Measurements by PID
- TN-160 Upgrading MultiRAE/QRAE Ni-Cd Battery Pack

See Appendix G on how to obtain Technical Notes.

APPENDIX F. APPLICATION NOTES

- AP-200 PIDs and Aircraft Wing-tank Entry
- AP-201 Measuring Ammonia (NH_3) with PIDs
- AP-202 ABCs of Gases in Industry
- AP-203 PID as a Hazmat Response Tool
- AP-204 Pulp & Paper: Measuring Turpentine & ClO_2
- AP-205 Measuring Heat Transfer Fluids with a PID
- AP-206 Guide to Atmospheric Testing in a Confined Space
- AP-207 PIDs as an Arson Investigation Tool
- AP-208 HAZMAT User List
- AP-209 UltraRAE User List
- AP-210 North American RAE Instrument User List
- AP-211 PIDs for Continuous Monitoring of VOCs
- AP-212 PIDs for Indoor Air Quality
- AP-213 ModuRAE PID Configuration and Applications
- AP-214 Environmental Applications for PIDs
- AP-215 Gas Detection in the Marine Industry
- AP-216 Weapons of Mass Destruction
- AP-217 Confined Spaces in the Construction Industry
- AP-218 Lengthening the Interval Between Calibration Checks
- AP-219 Using PIDs for 10% of LEL Decisions
- AP-220 Using PIDs in Clan Lab Investigations
- AP-221 PIDs for Exposure Risk in Unknown Environments
- AP-222 CO & Natural Gas Detection for Fire Department Engine Companies
- AP-223 ppbRAE User List

APPENDIX G. LITERATURE REQUEST

Photocopy this page and fax to:

Attn: Literature Department

1.408.752.0724 FAX

Please send me the following information:

Name: _____

Company: _____

Mailing Address: _____

City, State, Zip: _____

Country: _____

Telephone: _____

Fax: _____

Technical Notes:
(just list TN #) _____

Application Notes:
(just list AP #) _____

Comments: _____

_____

_____

_____

Thank you,

RAE Systems Sales & Marketing Department

RAE Systems Inc.

1339 Moffett Park Drive

Sunnyvale, California 94089

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Technical Service: 888.RAE.4800 (723.4800)

Tube Sales: 888.RAE.TUBE (723.8823)

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