



**PROTECT YOURSELF**

From the hidden dangers of carbon monoxide

# Pocket CO

## CARBON MONOXIDE DETECTOR



Manufactured by:  
Eco Sensors / KWJ Engineering, Inc.

# WARNING!

**Read all of the information in this booklet before using Pocket CO.**

Many factors can affect air quality. This instrument will give a dependable indication of CO levels, but should not be considered an all-inclusive monitor for overall air quality. Pocket CO is only one tool for CO measurement or CO dosimetry for personal use.

Pocket CO's Self-Test checks most of its functionality, but does not test the CO sensor, which can only be tested with actual exposure to carbon monoxide. Monthly "bump" testing of the Pocket CO with a source of carbon monoxide is recommended.

Pocket CO is small and light enough to be transported in your pocket. However, Pocket CO should not be operated while in your pocket. To detect CO, Pocket CO must be well exposed to your surrounding environment (e.g. on your key chain, attached to your dashboard or uniform, or worn around your neck).

# NOTICE

In the beginning of 2007, the manufacturer of Pocket CO, Transducer Technology, Inc., was merged into KWJ Engineering Inc. The two companies had been cooperating for two years, and now are combined as one corporate entity, under the name of KWJ Engineering Inc., a company that has been engaged in the manufacture of gas detection instruments since 1993. Production, sales and financial matters are handled primarily by the parent company, while research and new product development are the focus of the former Transducer Technology, Inc., now known as Transducer Technology Division.

# INDEX

<b>1. Introduction</b>	<b>2</b>
<b>2. Specifications</b>	<b>3</b>
<b>3. Using Your Pocket CO</b>	<b>5</b>
<b>3.1 Normal Operation</b>	<b>5</b>
<b>3.2 Turning Pocket CO Off</b>	<b>5</b>
<b>3.3 Using the Backlight</b>	<b>6</b>
<b>3.4 Viewing Dosimetry Information</b>	<b>6</b>
<b>3.5 Understanding Alarms</b>	<b>7</b>
<b>3.6 Understanding Dosimetry/TWA Warnings</b>	<b>9</b>
<b>3.7 Replacing the Battery</b>	<b>11</b>
<b>3.8 Using the Menu</b>	<b>13</b>
<b>3.9 Calibration</b>	<b>14</b>
<b>3.10 Additional Usage Information</b>	<b>15</b>
<b>4. Glossary of Terms</b>	<b>17</b>
<b>5. Care and Maintenance</b>	<b>18</b>
<b>6. Contact Us</b>	<b>19</b>
<b>7. Warranty</b>	<b>20</b>
<b>8. CO Health Effects</b>	<b>21</b>

## 1. Introduction

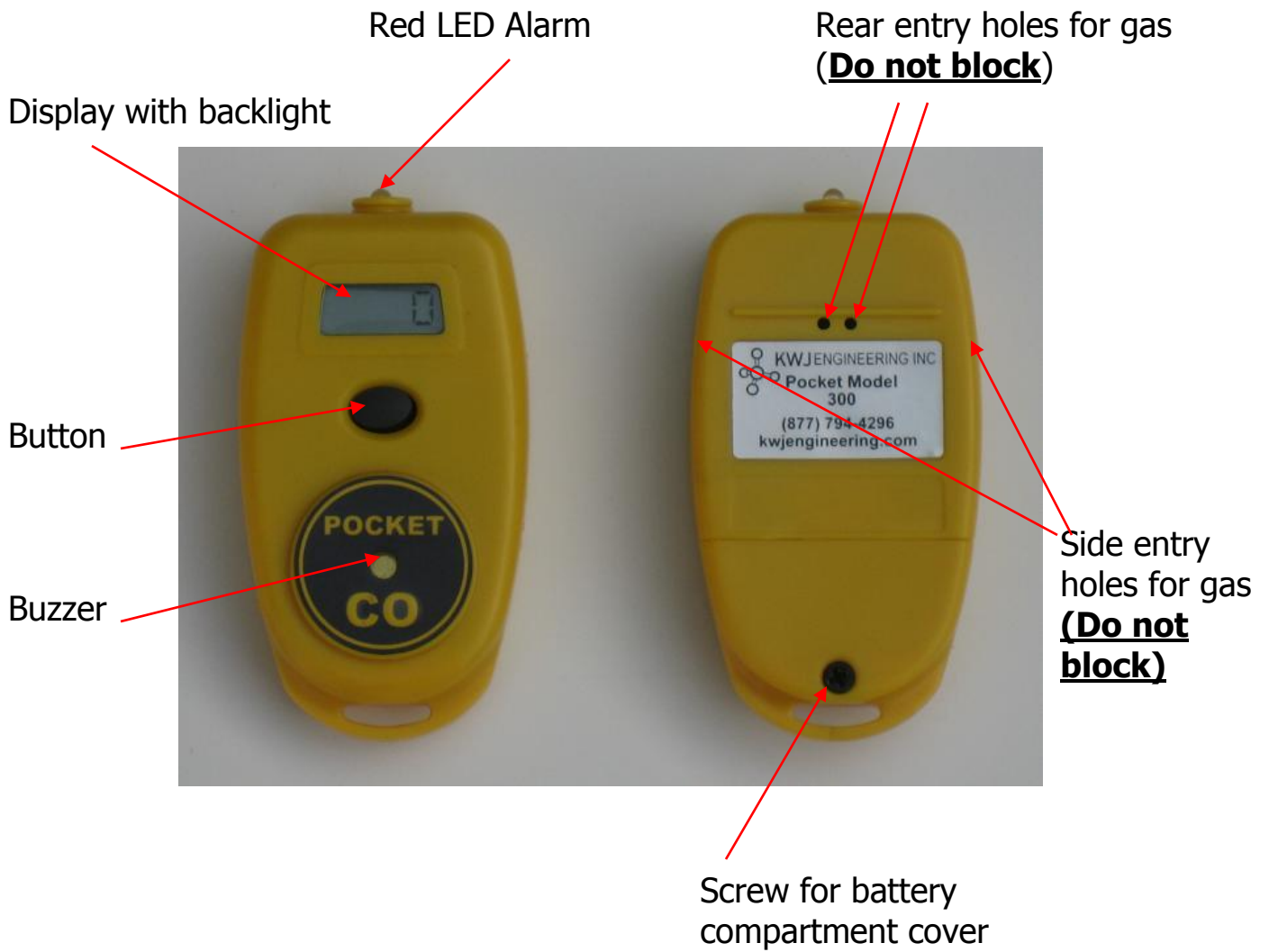
Pocket CO Model 300 has been designed as a simple and effective tool to determine, measure, or record Carbon Monoxide (CO) levels in any environment. The instrument has been programmed based on guidelines for indoor and outdoor CO exposure from several organizations, including OSHA and ACGIH. Alarms are factory set at 50PPM, the ACGIH maximum recommended short-term exposure of 125PPM, and a death hazard of 400 PPM CO.

Low levels of CO, typically less than 10 PPM, are not considered especially hazardous, but they do indicate a source of CO. Sustained levels above 25 PPM for 8 hours, and short-term exposure to more than 125 PPM CO, should be avoided. Seek clean air, ventilation, or any other means to eliminate exposure. Get more information online at <http://www.kwjengineering.com> and at <http://www.detectcarbonmonoxide.com>.

Pocket CO Model 300 is a stand-alone unit, and because of its small size can be carried on a key ring, clipped to a worker's shirt pocket, or attached to the dashboard of a vehicle or piece of equipment. Pocket CO is designed specifically to be affordable and easy to use by health professionals and concerned homeowners. The device can be used in CO detection applications such as OSHA enforcement, fire service exposure, parking garages, warehouses, municipal buildings, hotel rooms, home furnace inspection and barbecue areas, and for mobile measurements on boats, cars, trucks, trains, airplanes, and anywhere else Carbon Monoxide exposure is possible.

## 2. Specifications

Size:	2.66 x.1.40 x 0.61 inches (67.6 x 35.6mm x15.5 mm)
Weight:	< 1 ounce (28 grams)
Range:	0-500 PPM CO
Response time:	< 90 seconds to 90%
Operating temperature:	32-105 F, 0-40 C displayed; readings automatically compensated.
Pressure effects:	Reading decreases with decreasing pressure, down to 70% at 10,000 ft
Humidity limits:	15-85% RH, non-condensing
Alarms: (82 dB buzzer @ 24 in, LED, Backlight, Vibrator)	Optional first alarm at or above 50 PPM. Second alarm at or above 125 PPM. Third alarm at or above 400 PPM. Hourly warning when CO above the 8-Hour 25 PPM ACGIH TWA. Temperature above 50°C / 122°F: "HOT" displayed Temperature below 0°C / 32°F: "COLD" displayed Low battery warning: "BATT" displayed
Sampling method:	Gaseous diffusion.
Interferences:	None significant, except hydrogen.
Periods of Operation:	"12-Hour" and "Always On"
Display:	Digital LCD with backlight in increments of 1 ppm.
User interface:	Single button operation.
Dosimetry (12-Hour Detection period only):	Calculates and records: "MAX" maximum exposure (ppm), "TIME" time of max. exposure (minutes since turned on), "TE" total exposure in ppm-hours, 8-hour "TWA" time weighted average.
Tests:	Self-Test on startup checks circuitry, alarms, battery, and operating temperature. Does not check sensor.
Calibration:	Recommended at least 1x per year, or whenever accuracy of reading is critical.
Sensor:	Transducer Technology T-Series electrochemical.
Battery information:	Battery check on startup and during operation. User replaceable CR2450 coin battery.
Warranty:	Instrument, including sensor: One year.



## 3. Using Your Pocket CO

### 3.1 Normal Operation:

The information below describes how to turn Pocket CO on for normal operation, with one of two possible detection periods:

12-Hour Detection: With Pocket CO off, quickly push and release the button. The display will show "12HR". The instrument will perform a brief self-test, and then show the current CO reading (PPM). The display will update with a new reading of CO every 5 seconds, for a 12-Hour period before turning off automatically. Using this detection period will help to prolong battery life.

Continuous Detection: With Pocket CO off, quickly push and release the button *twice* (wait for the display to light up before pushing the second time). The display will show "ON". The display will update with a new reading of CO every 5 seconds, and will continue to do so until turned off by the user. This mode is useful if protection from CO is required over a prolonged period of time, such as on a trip or long drive. Note that dosimetry information is not recorded, or reported, when running in Continuous Detection.

### 3.2 Turning Pocket CO Off:

To turn Pocket CO off during normal operation, quickly push and release the button once (the backlight will turn on), followed by pushing and holding the button down. After 2 seconds the red light will flash, and Pocket CO will turn off. Note that this procedure should be followed even if the backlight is already on because Pocket CO is alarming.

### 3.3 Using the Backlight:

During normal operation, quickly push and release the button once. The backlight will turn on for a short period of time. Please note that excessive use of the backlight will reduce Pocket CO's battery life.

### 3.4 Viewing Dosimetry Information:

When running in the 12-Hour Detection period, Pocket CO maintains CO dosimetry information. Dosimetry information allows you to track the instrument's total-exposure to carbon monoxide (TE), and your 8-hour time-averaged exposure (TWA). It also keeps track of the maximum concentration of CO measured (MAX), and when this maximum occurred (TIME), in minutes since being turned on. Also reported is the total running time (RUN), in minutes. Pocket CO will save this information until Detection Mode is entered again. See Section 3.6 for more information.

To view the dosimetry information during normal operation, quickly push and release the button *two* times (the backlight will turn on after the first push). The dosimetry information will be displayed after a moment, starting with the word "DOSM". After all of the dosimetry information has been displayed, Pocket CO will resume normal operation.

The dosimetry information from the *last* use of the 12-Hour Detection period may also be recalled after Pocket CO has turned off. With Pocket CO off, quick push and release the button *three* times (wait for the display to light up before pushing the second time). The display will show "DOSM", and then display the dosimetry information from the last use of the 12-Hour Detection



period. After displaying this information, Pocket CO will turn back off.

### 3.5 Understanding Alarms:

Pocket CO is equipped with the following alarm mechanisms:

- A loud, 82 dB beeper (at 24 inches).
- A display backlight.
- A bright, red LED on the top of the instrument.
- A vibrator.

Pocket CO is programmed to repeatedly pulse all of these alarms when the CO exposure reaches or exceeds certain limits. These limits are pre-programmed at the following levels:

- CO level between 50 PPM and 124 PPM:  
Alarm beeper/LED/Vibrator pulse once every 20 seconds.
- CO level between 125 PPM and 399 PPM:  
Alarm beeper/LED/Vibrator pulse once every 10 seconds.
- CO level exposure at or above 400 PPM:  
Alarm beeper/LED/Vibrator pulse once every 5 seconds.

These are known as “instantaneous” alarms, since Pocket CO will alarm as soon as the level of CO reaches or exceeds these levels. The alarms at these levels are designed to protect you from the *immediate* health effects of carbon monoxide. Pay attention to

your Pocket CO when it alarms, and vacate the area until the source of the CO can be found and addressed.

The 50ppm is an optional, low-concentration alarm, which can be disabled using the Menu (see Section 3.8).

The Pocket CO will also pulse its alarms during the following, non-CO related situations:

- Self Test: One alarm pulse is normal and expected during the Self Test.
- Temperature above 50°C (122°F), or below 0°C (32°F): Alarm pulses, plus "HOT" or "COLD" on the display.

### 3.6 Understanding Dosimetry and TWA Warnings:

When run in the 12-Hour Detection period, Pocket CO keeps track of dosimetry information, which includes your total-exposure and time-weighted average exposure.

**Total-Exposure** (TE) is a measure of the amount of CO you've been exposed to over a length of time, and is measured in ppm-hours.

Example: If from the time you turned on Pocket CO, you were exposed to 25ppm for 5 hours, and then 10 ppm for 1 hour, your Total Exposure would be:

$$\begin{aligned}\text{Total Exposure} &= [ (25\text{ppm} \times 5 \text{ hours}) + (10\text{ppm} \times 1 \text{ hour}) ] \\ &= 135 \text{ ppm-hours}\end{aligned}$$

**Time-Weighted Average exposure** (TWA) gives you an idea of how much CO, on average, you've been exposed to, and is calculated as follows:

$$\text{TWA} = \text{Total Exposure to CO (in ppm-hrs)} / 8 \text{ hours}$$

Example: If your total exposure was 135 ppm-hours (as in the first example), your 8-Hour TWA at that point would be:

$$\begin{aligned}\text{TWA} &= 135 \text{ ppm-hours} / 8 \text{ hours} \\ &= 16.9 \text{ ppm}\end{aligned}$$

The TWA is called "time-weighted" because its calculation weighs more heavily exposure that took place over a longer period of

time. Hence, an additional exposure to a large amount of CO, but over a very short period of time (e.g. 1-2 minutes), would not largely affect the TWA calculated in the second example.

The American Conference of Governmental Industrial Hygienists (ACGIH) has published a recommended limit of 25ppm for an 8-Hour TWA. Based on this limit, Pocket CO will issue a warning if you have exceeded this average over 8 hours. If Pocket CO has been on less than 8 hours, it will also issue an hourly warning if your current TWA, based on the TE from the time turned on to the current time puts you on track for exceeding this limit in 8 hours. This warning consists of 2 pulses of the alarm, along with the messages "WARN", "TWA", shown on the display. Table 1 summarizes these warnings:

Hours Since Turned On	Warning if 8hr TWA Exceeds This Value
1	3.1 ppm
2	6.2 ppm
3	9.3 ppm
4	12.5 ppm
5	15.6 ppm
6	18.7 ppm
7	21.8 ppm
8 or more	25 ppm

**Table 1: Hourly TWA Warnings**

*Note that when Pocket CO is left on for more than 8 hours, the Total Exposure and TWA are calculated based on the most recent 8 hours of measurements.*

Note that dosimetry information is not recorded, or reported, when running in Continuous Detection (see Section 3.1). This also means that no TWA warning will sound.

### 3.7 Replacing the Battery:

The lifetime of the battery in Pocket CO will vary depending on usage. With typical usage of 5 days per week, and minimal alarming, the battery should last up to 1 year. But if Pocket CO alarms often, or the backlight is used excessively, battery life will be reduced. As coin-cell batteries have reduced voltages at lower temperatures, operation in cold environments might trigger a low or dead battery warning sooner, even though the same battery will still last for some time in higher (room) temperatures.

Note that even when off, Pocket CO consumes a small amount of power from the battery to maintain the CO sensor inside. Thus it is not uncommon for a Pocket CO that hasn't been used in some time to issue a low or dead battery warning when turned on.

Pocket CO checks the battery every 15 minutes (the red LED flashes briefly when this happens), but will not issue a low battery warning more often than every 4 hours. Pocket CO will let you know that the battery is low by either:

- Displaying "BATT" during the Self-Test.
- Sounding the alarm and displaying "BATT" for several seconds during normal operation.

When you see the "BATT" warning, you have some time left before the battery dies, but you should take action immediately to replace the battery.

**When the battery becomes too low for Pocket CO to operate, Pocket CO will display "----" during startup or operation, and then turn itself off.**

The battery in Pocket CO is easily replaceable, and available at many stores. Be sure to purchase a new, CR2450 coin battery for replacement (any high-quality brand), and insert it according to the steps shown in Figure 1.



**1. Turn Pocket CO off. Remove screw, and put aside (don't lose it!).**



**2. Use coin to remove battery cover. Turn coin *clockwise*. Battery cover will pop off.**



**3. Remove old battery. Wait 1 minute before inserting new one. \*Failure to follow procedure may cause the loss of calibration and void the warranty. *Check inside of battery cover for calibration due date.***



**4. Insert new battery, positive (+) side facing up.**



**5. Push battery forward as far as it will go.**



**6. Replace cover, as shown. Cover will snap into place. Replace screw.**

**Figure 1: Replacing the Battery**

Note that immediately after replacing the battery, the display may show "SNSR", or high-levels of CO. This is a normal effect, and the instrument will again function normally after several minutes.

**When changing the battery, always check the inside of the battery cover to see when the next calibration due date is. See Section 3.9 for important information about calibration. Always wait at least 24 hours after changing the battery before attempting to calibrate Pocket CO.**

### 3.8 Using the Menu:

Pocket CO has a menu that allows you to:

1. Enable / disable the vibrator.
2. Choose from 3 different buzzer sounds.
3. Enable / disable the low-concentration alarm (50 PPM).

To access the menu with Pocket CO off, quickly push and release the button four times (wait for the display to light up before pushing the second time). The display will show "MENU", and if the button is not pushed again Pocket CO will give access to the menu.

To step through the menu items listed above, quickly push and release the button. For each menu item, the display will alternate between the name of the item and the current setting, as summarized in Table 2:

Menu Item	Display Shows	Value 1 (Default values)	Value 2	Value 3
1) Vibrator	"vIBR"	"ON" = Vibrator On	"OFF" = Vibrator Off	N/A
2) Buzzer Sound	"BUZZ"	"BZ 1" = 3 loud beeps	"BZ 2" = Combination low/high pitch	"BZ 3" = 3 soft beeps
3) 50 PPM Alarm	"A 50"	"ON" = 50 PPM Alarm On	"OFF" = 50 PPM Alarm Off	N/A

**Table 2: Menu items and values available in the Pocket CO menu.**

To change the value of a particular menu item, press and hold down the button until the red light flashes. The display will then show the new value for that item. To exit the menu, repeatedly push and release the button quickly until all menu items have been stepped through. The display will show "EXIT", after which Pocket CO will restart.

### 3.9 Calibration:

Like many CO detectors, Pocket CO uses an electrochemical sensor to detect carbon monoxide. The readings from this type of sensor can drift with environment and time, resulting in inaccurate measurements. Calibrating with a known concentration of carbon monoxide gas allows Pocket CO to compensate for this drift, and thus maintain good accuracy. As such:

**We strongly recommend calibrating Pocket CO at least once per year, or whenever the accuracy of the reading is critical.**

Failing to do so may result in inaccurate measurements, and worse, the failure of an alarm to trigger during a hazardous situation.

A sticker underneath the battery cover indicates the date of the next recommended calibration. Check this date every time you change the battery, and replace this sticker if you perform a calibration yourself. Official calibration can only be performed through KWJ's *TechCheck* service. Information on this service is available at the website:

<http://www.detectcarbonmonoxide.com>

Do not try to calibrate Pocket CO using any method other than described above. If you believe you have sufficient technical background and the means (calibration chamber, cylinder of CO gas, etc) to perform your own calibration, please contact us first before attempting to calibrate your Pocket CO.



### 3.10 Additional Usage Information:

#### Sudden Temperature Changes:

Pocket CO may briefly display readings of CO slightly above 0 ppm when experiencing a sudden change in temperature. Some examples are: moving from a warm building into cold outside air, a sudden gust of frigid air on the instrument (e.g. next to an A/C vent), or placement onto a cold stone surface. This reading will settle back down to the actual concentration of CO within a few minutes, as Pocket CO's temperature compensation circuit comes into equilibrium with the new temperature.

#### Instrument Placement:

Pocket CO is a diffusion-based instrument, meaning it detects CO present in still air. To obtain accurate readings, do not place Pocket CO in the direct path of fast moving air (e.g. directly in front of a heating or cooling vent). Also, do not blow directly into the instrument with your mouth. For best results, place Pocket CO close to your breathing space. If air from a moving gas needs to be checked for CO, place Pocket CO several inches away from the source. Alternately, place Pocket CO in an empty plastic bag and then fill the bag with this air.

#### Prolonged Exposure to Organic Vapors and Smoke:

If Pocket CO has experienced prolonged exposure to organic vapors, such as fumes from paints, solvents, or alcohol, a small amount of sensor drift above 0 ppm may occur (even when no CO is present). This same effect can also be caused by excess exposure to smoke. If this is observed, relocate your Pocket CO to an area with fresh air, until the reading returns to 0 ppm. Depending on the length of the exposure, this may take from minutes to days. If the reading does not return to 0 ppm within 5

days in a fresh-air environment, contact KWJ Engineering for further instructions.

If Pocket CO must frequently be used in an environment with organic vapors, it is recommended that it be stored in an air-tight container along with some activated carbon. A Pocket CO storage container can be purchased from KWJ Engineering.

## 4. Glossary of Terms

**PPM:** Parts per million by volume is a concentration term that indicates that there is one part CO in one million parts air; e.g. 1 cc of CO evenly distributed in 999,999 cc of air.

### On the Display:

**TE:** Total Exposure: Pocket CO keeps a running sum of *concentration x time* for up to the last 8 hours of measurements. The result is a total exposure in PPM-HRS.

**TWA:** 8-Hour time weighted average exposure in PPM.  
TWA = TE / 8 hours

**MAX:** Maximum CO level (PPM) measured during use.

**TIME:** Time (in minutes) when the maximum CO level occurred after turning on.

**RUN:** Total time (in minutes) that has elapsed since turning on.

**HIGH:** Concentration is above maximum measurement of 500ppm.

**HOT:** Temperature is more than 50°C (122°F)

**COLD:** Temperature is less than 0°C (32°F)

**SNSR:** Sensor may be malfunctioning, or recovering from exposure to very high levels of CO. If message does not go away after 1-2 hours, contact KWJ Engineering.

**ZERO:** Apply zero gas to obtain a new zero for calibration.

**GAS:** Apply 100-PPM CO gas for calibration.

**BATT:** Low battery warning

- :** Battery becomes too low for Pocket CO to operate
- 12HR:** 12-Hour Detection Mode
- ON:** Continuous Detection Mode
- vIBR:** Vibrator
- BUZZ:** Buzzer Sound
- BZ1:** 3 Loud Beeps
- BZ2:** Combination Low/High Pitch
- BZ3:** 3 Soft Beeps
- 0000:** Calibration Information Deleted (Ship Back for Re-Calibration)

## 5. Care and Maintenance

The Pocket CO is a high performance CO measurement device. To maintain best performance clean it with a cloth, lightly dampened with water. Never use soap, cleansers, alcohol, gasoline, paint thinner, or other solvents to clean the device. Do not submerge the device in water or any liquids. Do not refrigerate or heat the device, or subject it to extremes of pressure. Non-adherence to general maintenance will void the one-year warranty.

For optimum lifetime and use, keep the device away from extremes in temperature and humidity, and store it in a clean place away from solvents, chemicals, disinfectants, pesticides, and cleaners. Also avoid excess exposure to smoke, dirt, and pollutants of all kinds. For maximum lifetime of electronics and

sensors, store and operate in moderate environmental conditions, such as temperatures between 40-80°F (4-27°C), RH between 40-85%, and atmospheric pressure. It is recommended that you calibrate your Pocket CO after each year of use in such conditions.

For highest accuracy results, or if the Pocket CO is being used in non-standard environmental conditions (such as very dry air or high humidity), calibration may be required at more frequent intervals.

## **6. Contact Us**

### By Telephone:

For technical or operational questions about Pocket CO, you may contact the Transducer Technology Division of KWJ Engineering directly at: (510) 405-5911.

For other questions, or sales information, you may call our toll-free customer service line at (800) 472-6626.

Both phone numbers are answered between the hours of 8:00 a.m. and 4:00 p.m., Pacific Time.

### By Email:

Support: [pocket\\_support@kwjengineering.com](mailto:pocket_support@kwjengineering.com)

Sales: [sales@kwjengineering.com](mailto:sales@kwjengineering.com)

### On the Web:

<http://www.detectcarbonmonoxide.com>

By Mail:

Transducer Technology Division  
KWJ Engineering  
8430 Central Ave. Suite # C  
Newark, CA 94560

## 7. WARRANTY

KWJ Engineering warrants to the original purchaser that this product shall be free from any defect in the materials or workmanship for 1 year from the date of purchase (excluding the battery). This warranty does not cover wear and tear due to normal use. It does not apply to any product that has been subjected to misuse, abuse, neglect, accident, tampering or unauthorized repairs. KWJ Engineering may elect to replace the unit, at no extra cost, with the same or a similar unit rather than repair it.

KWJ guarantees many years of use from your Pocket CO. If a defect covered by this warranty should occur, promptly return the product, at your expense, along with a dated sales receipt, and a brief explanation of the problem to:

**KWJ Engineering Inc.**  
**Transducer Technology Division**  
**8430 Central Ave. Suite # C**  
**Newark, CA 94560**

## 8. CO Health Effects

CO is a poisonous gas produced by the incomplete burning of carbon based fuels. When inhaled it deprives the blood stream of oxygen, suffocating its victim. CO can cause immediate health problems, and even death, in high concentrations. Regular exposure to low concentrations, such as at home or in the workplace, can cause long-term health problems.

Any gas or propane based engine will produce CO, meaning that boaters, truckers, and small aircraft pilots are at risk from CO fumes as soon as they start their vehicle. By far the largest group suffering from CO poisoning is homeowners, who can be in danger from sources like gas-powered furnaces and water heaters, portable generators, clogged fireplaces and chimneys, cars running in an attached garage, and burning of fuels indoors (such as a gas or charcoal grill). Travelers staying in hotels are in danger from CO leaked into their room from nearby faulty heaters and boilers. Campers, RV'ers, and trailer owners are at risk from gas heaters or stoves left running, or exhaust from nearby vehicles accumulating inside.

The beginning symptoms of CO poisoning are sometimes compared to the symptoms of food poisoning. Depending on the level of CO, and length of exposure, you may experience any one or more of the following symptoms:

- headache
- dizziness
- weakness and clumsiness
- nausea and vomiting
- quick irregular heartbeat, chest pain
- hearing loss
- blurry vision
- disorientation, confusion, or seizures

The table below is a CO PPM chart with possible effects on human health and references to standards. For complete standards, see referring links at the websites:

<http://www.detectcarbonmonoxide.com>  
<http://www.kwjengineering.com>

<b>Level of CO</b>	<b>Health Effects, and Other Information</b>
0 PPM	Normal, fresh air.
9 PPM	Maximum allowable short-term exposure (ASHREA).
10-24 PPM	Possible health effects with long-term exposure.
25 PPM	Max TWA Exposure for 8 hour work-day (ACGIH).
50 PPM	Maximum permissible TWA exposure in workplace (OSHA). <b>First (optional) Pocket CO ALARM starts (every 20 seconds).</b>
100 PPM	Slight headache after 1-2 hours.
125 PPM	<b>Second Pocket CO ALARM starts (every 10 seconds).</b>
200 PPM	Dizziness, nausea, fatigue, headache after 2-3 hours of exposure.
400 PPM	Headache and nausea after 1-2 hours of exposure. Life threatening in 3 hours. <b>Third Pocket CO ALARM starts (every 5 seconds).</b>
800 PPM	Headache, nausea, and dizziness after 45 minutes; collapse and unconsciousness after 1 hour of exposure. Death within 2-3 hours.
1000 PPM	Loss of consciousness after 1 hour of exposure.
1600 PPM	Headache, nausea, and dizziness after 20 minutes of exposure. Death within 1-2 hours.
3200 PPM	Headache, nausea, and dizziness after 5-10 minutes; collapse and unconsciousness after 30 minutes of exposure. Death within 1 hour.
6400 PPM	Death within 30 minutes.
12,800 PPM	Immediate physiological effects, unconsciousness. Death within 1-3 minutes of exposure.