



**ENERAC POCKET 60
CARBON MONOXIDE ANALYZER**

INSTRUCTION MANUAL

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1. UNPACKING

Unpack the instrument carefully and inspect it for any visible signs of damage. The Model 60 includes the following:

- a. One Model 60 carbon monoxide analyzer.
- b. One stack probe equipped with a desiccant filled water trap and disposable filter.
- c. One battery charger.
- d. One small screwdriver.
- e. One instruction manual.
- f. One carrying case.

2. DESCRIPTION

a. PURPOSE AND FUNCTION.

The Model 60 carbon monoxide analyzer is a light weight hand-held meter that can measure the concentration of toxic carbon monoxide gas with great accuracy over the range from zero parts per million (ppm) to 20,000 ppm (2.0%). The instrument has been designed so that it can be used for a number of different applications. Three of the most significant applications are listed below:

i. FLUE STACK MONITOR

When the stack probe is connected to the analyzer the instrument becomes an excellent continuous real time monitor of carbon monoxide emission in the stacks of boilers, furnaces and the exhaust of engines. The significance of measuring carbon monoxide concentrations as a means for tuning boilers for maximum efficiency is well known. Maintaining a certain very small amount of carbon monoxide in the stack is the best way to ascertain that a boiler is operating at its peak efficiency.

ii. AREA SAFETY MONITOR

Carbon monoxide gas is present in many work areas. It is a highly toxic, odorless and colorless gas and exposure to high concentrations can be lethal. The analyzer operating on the diffusion mode is an

excellent monitor against build up of carbon monoxide gas. A dual audiovisual alarm warns people when concentrations exceed a preset limit.

iii. DUAL PURPOSE METER

When a hose is connected to the analyzer input, the instrument can pull gas samples from any closed or difficult to get compartment. If the analyzer is switched to its cycling mode, the instrument can "simultaneously" monitor gas concentrations in remote compartments such as a stack and also in the area where the analyzer is located.

b. OPERATING PRINCIPLES

i. POWER REQUIREMENTS

The instrument is powered by six "AA" rechargeable Nickel Cadmium batteries. Battery life is 10 hours of continuous operation with the pump running, or 30 hours of continuous operation with the pump off. The rechargeable batteries can be recharged by plugging the AC charger to a suitable 115 VAC, 60 HZ outlet (220-240 VAC for export units) and letting the batteries charge overnight. The battery charger may also be used to run the Instrument continuously from an AC source without depleting the batteries. When the battery is discharged (i.e., the voltage drops below 5.5 volts) the display will blank. This is an indication that the batteries need recharging.

ii. GAS FLOW DESCRIPTION

The instrument houses an electrochemical sensor which converts the concentration of carbon monoxide to a millivolt signal. The relation between concentration and voltage is linear. The sensor is highly specific to carbon monoxide. Hydrogen and hydrogen sulfide are the only two common gases that interfere (i.e., the sensor will respond to). It is not affected by relative humidity and its sensitivity to temperature variations is minimal over the range from zero degrees Celsius to 40 degrees Celsius. Its expected life is 1-2 years. The sensor is mounted on a thin aluminum housing that has two openings, one to the pump and the other to the diffusion input on the side of the instrument. If the sensor is exposed to a large concentration of carbon monoxide gas (exceeding 20,000 ppm or 2.0%) it will saturate. The display will indicate overrange. If the source of carbon monoxide is then removed,

the display will still indicate overrange for a few minutes depending on the concentration of CO gas and duration of exposure. Once the excess CO has been consumed by the sensor, the display will give normal readings. The sensor will be not be permanently damaged by high concentrations of CO.

iii. **SAMPLING MODE (PUMP ON).**

With the stack probe (or any other hose) connected to the stack input of the instrument, a gas sample of approximately 1000 cc/min is drawn by the pump through the probe which includes the fiber filter and water trap, whose respective functions are to trap soot particles and remove condensed water and water vapor. The gas sample is drawn by one small rugged gas pump that is operated by a high quality motor. It is then introduced into the housing that contains the carbon monoxide sensor and exhausted through the diffusion port on the side of the instrument.

iv. **DIFFUSION MODE**

When the pump is not operating, gas simply diffuses past the stainless steel screen of the diffusion input and into the housing where the sensor is located. The length of the diffusion path is only about 1/4 inch.

v. **CYCLING MODE (PUMP CYCLES ON AND OFF)**

In the cycling mode, gas enters the sensor cavity alternatively from the stack input (when the pump is operating) and from the diffusion input (when the pump is not operating).

3. OPERATING CONTROLS

a. **ON - OFF SWITCH**

This is a two position slide switch that must be pushed upward to operate the instrument. When charging, the batteries this switch must remain in the OFF position.

b. **PUMP MODE SELECTOR SWITCH**

This is a three position slide switch that controls the operation of the pump.

When the switch is in the uppermost position the pump will run continuously and gas flow takes place from the stack input toward the diffusion port. When the switch is in the bottom position, the pump is not operating and the gas enters the sensor housing only from the diffusion input. When the switch is in the middle position the pump will operate intermittently as follows:

It will run for approximately 2 minutes (with the exception that the pump will operate for 4 minutes during the first cycle), then it will turn off for approximately 25-30 minutes, it will then run again for 2 minutes, shut off for 30 minutes and so on.

c. **ALARM LEVEL SWITCH**

This is a three position slide switch that allows setting of the audio & visual alarm to one of three different levels. When the switch is in the bottom position, the alarm will turn on when the carbon monoxide level detected by the sensor exceeds 50 ppm. (It will turn off when the level drops below 42 ppm). This alarm position should be used for safety purposes.

When the switch is in the middle position the alarm will turn on when the CO concentration exceeds 200 ppm. (It will turn off when the level drops to 190 ppm). A Carbon Monoxide level of 150-200 ppm is usually considered the point where efficiency of a boiler is maximum.

The top position of the switch sets the alarm at 400 ppm. This is the maximum level allowed by certain regulatory agencies.

d. **BUZZER SWITCH**

This is a tiny slide switch that turns on or off the sound alarm. It is convenient to use when testing the instrument or when the sound of the buzzer is not necessary.

e. **THE DUAL RANGE SWITCH**

This switch selects the operating range of the analyzer. There are two ranges: 0-2000 PPM and 0-20,000 PPM. If you are not sure of the carbon monoxide concentration of your source, always turn the analyzer on with

the range switch set in its upper (20K PPM) position. For accurate low concentration readings set the range switch to the lower (2K PPM) position.

NOTE: We strongly recommend that the analyzer not be exposed to concentrations exceeding 5000 PPM for more than a few minutes to prevent gradual sensor saturation.

4. INSTRUMENT OUTPUTS

a. DISPLAY

This is a 3-1/2 digit, 0.5 inch high liquid crystal display that indicates the concentration of carbon monoxide in parts per million (ppm). When the range switch is in the lower position, resolution is 1 PPM. When the range switch is in the upper position, the display reads in thousands PPM and its resolution is 10 PPM(0.01%). If the display's range is exceeded, a one followed by blanks will be displayed. ***A blank display functions as a low battery indicator.***

b. OUTPUT JACK

This is a convenient miniature jack output for use with a recorder or for remote measurements of carbon monoxide concentration. Output is linear and corresponds to 1 volt per 1000 ppm of carbon monoxide (range switch in the lower 2K position) and 1 volt per 10,000 PPM (range switch in the upper 20K position).. It can be connected to any instrument with an impedance of 100 ohms or higher.

c. ALARMS

There is one audio and one visual alarm. The audio alarm is a continuous 2 KHZ tone. The visual alarm is a flashing red light located on the face of the casing. The alarm will turn on at the level selected by the alarm switch.

5. OPERATION

a. START UP PROCEDURE

Remove the instrument from its case. If the unit is to be used for stack measurements, take the probe and make sure that there is no liquid water in the water trap, that the desiccant is blue in color, and the disposable filter is clean. Connect the probe to the instrument. Set the pump mode selector switch to the desired position. Turn the instrument on. The display will come on and you will notice a quick increase in the display reading followed by a gradual drop to zero in about 30 seconds. If the display reading does not go back to exactly zero and you are in clean atmosphere, the small screwdriver can be used to make the necessary adjustment by rotating the zero adjustment potentiometers. There are two separate zero adjustments. Set the range switch to the upper position and zero the display using the 20K zero adjust potentiometer. Next set the range switch to its lower position and zero again the display using the 2K adjust potentiometer. Now the instrument is ready to take measurements.

b. STACK MEASUREMENTS

To measure the carbon monoxide concentration in the flue stack, set the pump switch to the ON position. You should hear the pump running.

If you don't know the approximate CO concentration, or if you are measuring engine exhaust set the range potentiometer to its upper (20K PPM) position.

Insert the stack probe into a 5/16 inch diameter hole in the stack and push the probe so that its tip is as near as possible to the center of the stack. The instrument can be held in the hand, or if it is desired to make adjustments to the furnace or boiler, use the instrument handle to hang it from any nearby convenient protrusion that is not hot to the touch, or to decrease the viewing angle when the instrument is placed on a flat surface. ***MAKE SURE THE INSTRUMENT OR HOSE IS NOT IN CONTACT WITH A HOT SURFACE!*** (A surface that is too hot to touch).

To monitor the carbon monoxide in the stack on a 24 hour basis, set the pump switch to the cycle position. Keep in mind that the water trap may become filled up and the disposable filter may require replacement after 4-5 hours of continuous operation in the stack. Consequently, if the instrument is operated in the cycling mode, the filter and water trap must be checked once each day. In addition, the instrument will have to operate with the

battery charger connected to a 110 volt AC source after the first day of operation.

c. AREA MONITORING

NOTE: The instrument is not designed to be intrinsically safe and should not be used in explosive atmospheres!!!

The instrument may be used as a safety device for the detection of hazardous carbon monoxide gas for work areas. Do not connect the probe to the instrument. Set the pump switch to the OFF position. Set the range switch to its lower (2K PPM) position. Set the alarm switch to the 50 ppm position. You may hang the instrument from any convenient place or carry it with you. If you wish to take a quick "sniff" of a suspected area, turn on the pump, wait 30 seconds. If the instrument is operated on a 24 hour continuous basis, the pump may wear out after 4-6 months.

d. SHUT DOWN PROCEDURE

When you are finished using the instrument, make sure the power switch is turned off. If you have used the stack probe, do not touch the metal tubing until it is cool.

Remove any water from the water trap, turn the probe upside down and shake it well and get rid of the condensed water.

Give the instrument batteries a fresh charge.

6. MAINTENANCE

a. CLEANING THE WATER TRAP

The water trap is made of two compartments. The first compartment is intended to catch all moisture that has condensed in the probe. The second compartment is filled with a dessicant material (#44 silica gel) that will adsorb the remaining water vapor in the stack gas. The dessicant is colored deep blue when dry. As it absorbs moisture its color changes progressively to dark pink and eventually to pale pink when it is completely used up. There is sufficient desiccant material in the trap for approximately four hours of continuous operation. When the desiccant is used up it must be replaced, otherwise moisture will eventually penetrate through the filter and

will be deposited on the surface of the sensor. This may cause erratic or low readings.

Used up desiccant material can be reactivated by heating at 300-400 degrees Fahrenheit in a clean atmosphere for about one hour until it becomes blue again. Because of possible soot collection, however, it may be impractical to reactivate the desiccant more than two or three times.

Extra desiccant material is available from the factory. It is supplied in one pound containers.

To replace the desiccant material, simply pull out the plastic plug (caplug). Fill the silica gel compartment with new material and force the plastic plug back over the clear tube until an airtight seal is obtained. Liquid water which has accumulated in the first compartment can be removed by simply pulling out the caplug at the other end of the water trap, pouring out the liquid and replacing the plug.

b. CHANGING THE DISPOSABLE FILTER

The disposable filter needs periodic replacement. It must be replaced if it is noticeably discolored, or if the pump fails to operate, indicating a blockage in the line. The disposable filter must always be connected so that the direction of flow is radially inwards (towards the center). This allows the operator to more easily notice discoloration of the filter and any moisture that penetrates through the water trap. To replace the filter, simply loosen the two clamps that secure it to the hose. Take a new filter and connect the two ends of the tubing to it, observing the correct direction of flow. Fasten the clamps.

c. REPLACING THE CARBON MONOXIDE SENSOR

This is a very infrequent procedure since the carbon monoxide sensor has an expected life of 1-2 years. The CO sensor needs replacement when it is no longer possible to calibrate the instrument using calibrated gas.

To replace the sensor, remove the four screws that secure the base and expose the interior to the instrument. The sensor is the 1-1/2 inch round plastic disk that is attached to the back of the aluminum housing. Remove

the screws that hold the sensor (the CO sensor contains sulfuric acid, exercise caution). Attach a new sensor to the housing. Remove the short between the sensor terminals and connect the wires to the sensor, observing the correct color code. Carefully, close the case, making sure that no wires or tubing are being pinched. Secure the case with the four screws.

7. INSTRUMENT CALIBRATION

The Model 60 Carbon Monoxide Analyzer has been calibrated at the factory by using a calibrated gas that contains 200 ppm carbon monoxide in air (range switch in the lower position). (However, any other calibration gas in the range of 50-2000 ppm CO in air or nitrogen can be used, if available. Higher concentration may be used with the range switch set in its upper position). The sensor possesses good stability and does not require frequent calibration.

A tentative recommended calibration schedule is as follows:

If the unit is used in engine exhausts, calibrate after 10- 20 hours of use. If the unit is used in boilers calibrate every one or two weeks. If the unit is used for area monitoring (safety) calibrate every 3-4 months.

If it is desired to check the calibration of the instrument, connect the probe to the instrument and turn on the instrument. Turn on the pump. Wait two minutes and carefully zero the instrument, making sure the air the instrument draws is clean and free of any smoke or exhausts.

If you are using the ENERAC calibration kit follow the directions in the calibration kit manual.

If you are using your own span gas, feed the calibrated gas to the stack probe at a rate of approximately 1000-1500 cc/min. Use a flow meter to observe the flow into the instrument. Listen to the sound of the pump. Adjust the flow rate between 1000-1500 cc/min. so that the sound of the pump appears normal as when it was aspirating air. Wait till the CO reading of the display has stabilized. If you are using high concentration span gas, make sure the area is well ventilated, or carry out the calibration under a fume hood, since carbon monoxide gas is highly toxic. Remove the small round black plastic cap that covers the span adjustment potentiometer. With a small screwdriver, rotate the span adjustment potentiometer until the display indicates the correct reading. Replace the black plastic cap. Shut off the gas, disconnect the

probe, and wait 3 minutes and make sure that the display reading goes back to zero.

8. THE SIGNIFICANCE OF CO GAS

Carbon monoxide is a colorless, tasteless, odorless gas. It is slightly lighter than air. It is almost always found as a by-product of incomplete combustion. Carbon monoxide burns in air or oxygen to form carbon dioxide. The blue flame observed over a coal fire is carbon monoxide burning to carbon dioxide.

Carbon monoxide is a direct and cumulative poison. It combines with the haemoglobin of the blood to form a relatively stable compound, carboxy-haemoglobin, which makes the blood useless as an oxygen carrier. When about one third of the haemoglobin was combined, the victim dies. The gas is one of the most treacherous poisons because of its odorless character and insidious action. A concentration of 100 ppm of carbon monoxide in air produces symptoms of poisoning while a concentration of 1500 ppm (0.15%) will cause death in thirty minutes. The permissible levels for work areas, as specified by OSHA, are 50 ppm on a time weighted 8 hour day with a maximum allowable concentration of 400 ppm.

Carbon monoxide in the home may come from a leaky furnace or red hot kitchen stoves or heaters when the draft is closed. In the workplace, it is often the result of operation of internal combustion engines, where exhaust may contain from 1% to 8% (80,000 ppm) carbon monoxide, due to incomplete combustion. It has been estimated that a 20 horsepower engine produces one cubic foot/minute of the gas. In a small closed area, such as a garage, the atmosphere becomes deadly in 5 minutes if the engine is left running. A person breathing this atmosphere becomes helpless before realizing the danger. Even outdoors, in crowded city streets, the carbon monoxide concentration may approach the danger level.

Since carbon monoxide is the product of incomplete combustion in a furnace, it becomes an excellent mechanism for reducing the excess air until incomplete combustion begins to take place. For most well functioning industrial burners or furnaces, a carbon monoxide concentration in the range of 100-200 ppm usually coincides with the maximum boiler efficiency and therefore maximum fuel savings.

