

SPAN GAS CALIBRATION KIT

MODEL CALKIT-2

INSTRUCTION MANUAL

October 1994
Rev.1

The purpose of the span gas calibration kit is to check the performance and provide an accurate span calibration apparatus for all toxic gas & combustibles sensors used in the instruments manufactured by Energy Efficiency Systems, Inc.

NOTE: Using certified calibration gas (2% accuracy) is the most accurate and reliable method to ensure data integrity for emissions measurements.

The use of "pre calibrated sensors" is not reliable because electrochemical sensors are known to drift with time, temperature and exposure to gas.

The use of "dilution systems" provides under the best conditions a 5% accuracy.

EPA protocol 1 gases are not available in small transportable cylinders.

The portable gas calibration kit supplied by EES, Inc. is designed to supply the required span gas at the exact flow rate required by the instrument and at approximately ambient pressure. This is important for proper sensor calibration, because electrochemical sensors are sensitive to pressure fluctuations.

The span gas or gases supplied, depend on the type of instrument being used. All gases are certified to have an accuracy of plus/minus 2% of the value indicated on the face of the gas cylinder. If greater accuracy is required, you may disconnect one of the transportable cylinders and connect a Protocol 1 cylinder to the calibration kit.

NOTE: If you use an external cylinder, make sure the cylinder's regulator is set for a pressure of 600 PSI or less. (The stainless steel braided hoses have a maximum capacity of 800 PSI!).

All cylinders supplied with the calibration kit are small transportable units containing approximately 74 liters of the span gas at approximately 500 PSI.

All instruments require approximately a minimum of 4 minutes of span gas to carry out a single calibration (NO₂ & SO₂ require 4 minutes) . Consequently, each cylinder is shipped with sufficient gas for 12-15 calibrations.

NOTE: The model 3000 will normally require 2-3 additional minutes to reach 99% of full scale when feeding NO₂ or SO₂ span gas.

When the span gas is exhausted, the cylinders should be disposed properly. **THESE CYLINDERS CANNOT BE REFILLED!**

WARNINGS:

1. Carry out span calibrations in a well ventilated area. Avoid inhaling the gas.
2. Handle the gas cylinders carefully. Do not expose them to heat or shock. Do not attempt to fill the cylinders. Do not use them for any other than the intended purpose.
3. Make sure the shutoff valves are shut tightly, before disconnecting any cylinders.
4. Do not attempt to remove the shutoff valves.
5. Do not touch the primary regulator setting.

DESCRIPTION OF APPARATUS

Fig.1 shows a complete calibration kit with 4 gas cylinders attached to it, as it might be used to calibrate an ENERAC model 3000. (For the model 2000 Combustion Analyzer the kit contains 3 gas cylinders).

Each cylinder is under high pressure and is equipped with a shut off valve as shown. When the cylinder is exhausted use a wrench to disconnect it at the CGA connector as shown in fig. 1.

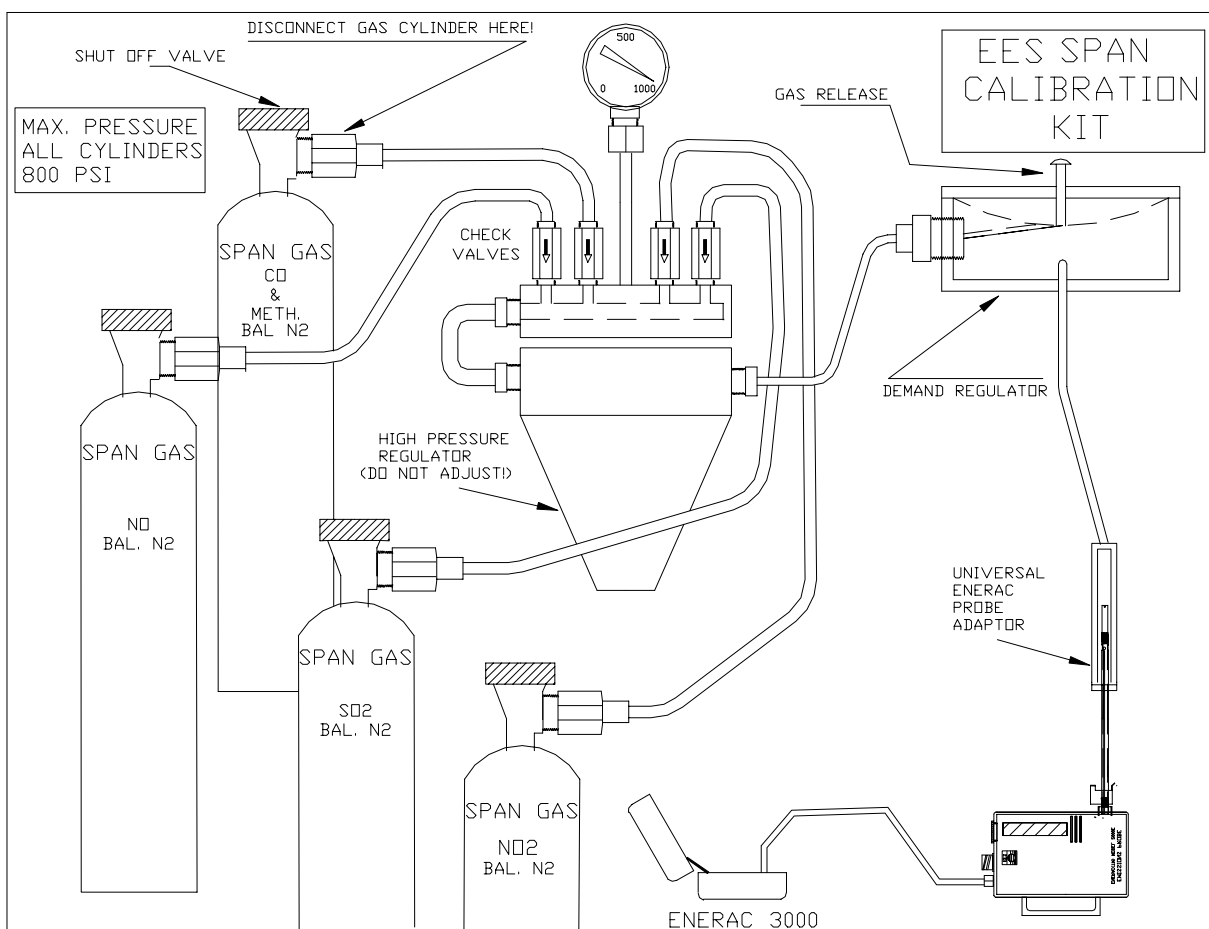


FIGURE 1

The other end of the CGA connector is connected to a stainless steel braided Teflon hose that terminates in a check valve that is mounted on the gas manifold. The purpose of the check valves is to prevent accidental mixing of the gases, if two of the shut off valves are accidentally left open, simultaneously. A pressure gauge is also connected to the manifold. When any one of the shut off valves is open the gauge indicates the pressure in the open cylinder.

Remember that there will be approximately a 30 PSI drop in the cylinder used following every calibration. Thus, you can estimate the number of calibrations left by observing the pressure on the gauge when the cylinder valve is open.

The gas manifold is connected to a high pressure regulator whose outlet pressure is fixed at approximately 10 PSI.

A 24" length of Viton hose connects the outlet of the high pressure regulator to the inlet of the "demand" regulator. The demand regulator is a device that it is designed to supply automatically the span gas at the exact flow rate required by whatever instrument is being calibrated. It does this with a minimum of pressure drop (typically less than 4" W.C.).

NOTE: The use of the demand regulator yields a savings of 30-40% in the span gas used, when compared with the by pass flow and flow meter method of earlier calibration kits, while maintaining feed pressure near ambient.

The demand regulator functions in such a way that it will supply gas, only if a small negative pressure is detected at its outlet. However, sometimes it may be desired to supply gas at a positive pressure. A small pushbutton valve located on top of the demand regulator will supply span gas, irrespective of the outlet pressure.

The outlet of the demand regulator is connected to a special fitting that can accommodate the probes of any instruments manufactured by EES, Inc.

To feed the desired span gas to the instrument turn the unit on, insert the tip of the probe to the probe fitting of the calibration kit and open the appropriate shut off valve of the gas cylinder.

To turn the gas on or off use the shut off valve !

NOTE: When no instrument is connected to the calibration kit there will normally be no flow of gas even if one of the cylinder shut off valves may be open. However, it is possible that a very small gas leak may exist through the demand regulator. You should, therefore, always turn off the shut off valves to prevent loss of span gas.

SPAN CALIBRATION OF THE ENERACS 2000E & 3000

THE EMISSIONS PROBE WITH THE SINTERED FILTER ATTACHED MUST BE ALWAYS CONNECTED TO THE UNIT WHEN CARRYING OUT A CALIBRATION!

The following list describes the span gases that are typically supplied with the calibration kit to calibrate the ENERACS model 2000E / 3000.

Carbon Monoxide Combustibles	200 PPM CO, 1% CH ₄ balance N ₂
Nitric Oxide (NO)	200 PPM NO, balance N ₂
Nitrogen Dioxide (NO ₂)	100 PPM NO ₂ , balance N ₂
Sulfur Dioxide	200 PPM SO ₂ , balance N ₂

Since the Model 3000 is a compliance level emissions analyzer, make sure that you request from Energy Efficiency Systems to supply you with the proper concentrations that are applicable to your emissions, as outlined in 40CFR60 of the EPA regulations.

Fig.1 shows the typical setup for calibrating the model 2000E /3000.

You can carry out all span calibrations in sequence, or just one only, if you wish.

NOTE: Toxic sensor span calibration should be carried out in the order that they appear on the display during span calibration. (CO > NO > SO₂ > NO₂). This is important for the mathematical cancellation of any residual cross sensitivities.

Feed the span gas to the instrument for TWO MINUTES (for the Model 3000 wait 3-4 minutes) prior to carrying out the span calibration, to make sure that steady state conditions will have been reached by the end of the calibration period.

For span calibration of AMBIENT TEMPERATURE follow the directions in section B below.

1. SPAN GAS CALIBRATION

The sequence of the span gas calibrations that will appear on the instrument's display is as follows:

- a. Combustibles
- b. Carbon monoxide
- c. Nitric oxide (NO)
- d. Sulfur dioxide
- e. Nitrogen dioxide (NO₂)
- f. Ambient temperature.

NOTE: The Model 3000 executes the "ENERAC CALIBRATION PROTOCOL", every time it is calibrated for CO, NO, NO₂ and SO₂. For information on this protocol, please consult your instruction manual.

To carry out a span calibration follow the steps below:

1. Figure 1 shows the calibration apparatus and also how it is connected to the ENERAC.

Do not connect the calibration kit to the Enerac yet.

2. Connect the ENERAC's probe to the instrument and turn the unit on. Make sure the battery is OK. Press the ENTER key to autozero the unit and wait until the message

"INSERT PROBE"

appears on the display.

(The combustibles sensor usually needs a little more than 2 minutes allowed by the autozero procedure for proper warm up. If you plan to carry out a combustibles calibration, turn the unit off for 2 seconds and turn it back on.

Press the ENTER key again to autozero the unit!).

At the end of the AUTOZERO check the sensor readouts to make sure they are all reading zero, except for oxygen that should read 20.9%.

3. Assuming that you wish to execute the combustibles calibration first, proceed as follows:

Open the shut off valve of the CO & METHANE CYLINDER of the calibration kit. Check the pressure gauge of the calibration kit to make sure that you have at least 30 PSI remaining in the cylinder.

Push the tip of the probe firmly into the cylindrical fitting that is located at the end of the calibration apparatus. Make sure the fitting's O-ring is properly seated to avoid an air leak.

Observe the value of the oxygen on the ENERAC's display and make sure it is dropping towards zero (i.e. this ensures that span gas is being introduced into the instrument). The "demand" regulator should be supplying gas to the instrument automatically. Do not depress the "gas release" valve of the regulator, unless you suspect that there is no flow!

4. Push the "SET" button and observe "SET" LED turn on.
5. Push the "NO/NO2" button (This is the SET SPAN key). The following message will appear on the display:

"CMB SPAN GAS: 0.11% "

6. *NOTE: If you wish to skip the Combustibles calibration push the "ENTER" button. The display will read:*

"PUSH ENTER KEY!!"

PUSH ANY BUTTON, EXCEPT THE "ENTER" BUTTON AND THE UNIT WILL SKIP THE COMBUSTIBLES CALIBRATION AND PROCEED TO THE NEXT ONE.

7. COMBUSTIBLES SPAN CALIBRATION. To carry out the combustibles span calibration, use the "UP" or "DOWN" buttons until the display reads the same combustibles value as that printed on the combustibles (methane) gas cylinder label of the calibration kit. Then press the "ENTER" button. The display will read:

"PRESS ENTER KEY!!"

8. Press the "ENTER" key NOW. The following message will appear on the display:

"FEED GAS NOW and WAIT"

9. Please wait. At the END of the four minute calibration period the unit will, at that instant, record and store the combustibles sensor output and define it as the value that you set earlier on the display.

When you see the message:

"CO SPAN GAS: 200 PPM"

it means that you are finished with the combustibles span calibration and the instrument is prompting you to perform the CO calibration next.

NOTE: To make sure that the instrument registered properly the span gas, press the SET key to exit the setting mode and press the COMB key. Read the combustibles value. Make sure that the display reading is steady. If it appears to be climbing, it implies that the time allowed for calibration was insufficient. In that case allow the span gas to flow into the instrument for a full minute before carrying out the span calibration. This observation is valid for all gas tests that follow.

NOTE: When the display reads "FEED GAS NOW AND WAIT", the keyboard and any serial communications are disabled. If you wish to ABORT the span

calibration, turn the unit off.

10. CARBON MONOXIDE SPAN CALIBRATION. To carry out the CO (carbon monoxide) span calibration follow the procedure outlined above for the combustibles calibration.

If you wish to skip the CO calibration proceed as in step 5. The following message will appear on the display:

"NO SPAN GAS: 100 PPM"

prompting you to carry out this calibration.

11. NO SPAN CALIBRATION. Following the CO calibration the Enerac will prompt you to carry out the NO (nitric oxide) calibration. You should carry out this calibration, even if you wish to calibrate the CO sensor only. The reason is explained below:

NOTE: MODEL 2000E ONLY. The CO sensor has a special inboard NOX filter to remove any cross sensitivity to NO gas. It is a good idea to observe the reading of the CO sensor at the end of a NO span calibration. The cross sensitivity of the CO sensor to NO should be less than 5%. If it is more, this implies that the filter has been exhausted and the CO sensor should be replaced.

MODEL 3000 ONLY. At the end of the calibration period the instrument will execute the "CALIBRATION PROTOCOL" and print a statement of the sensor's and in board filter's performance. Any residual cross sensitivity to NO will be automatically compensated by the instrument's software.

12. SO₂ & NO₂ SPAN CALIBRATIONS. After going through the NO span calibration setup, the Enerac will prompt you to execute the sulfur dioxide calibration and the following message will appear on the display:

"SO₂ SPAN GAS: 200 PPM"

NOTE: When executing the NO₂ or SO₂ calibration, allow 3-4 minutes of span gas flow before depressing the "ENTER" button to begin the span calibration procedure.

If you wish to carry out any of these calibrations, proceed as outlined in steps 6, 7 and 8. At the end of either step the following message will appear on the display:

"ATEMP OFFSET +0 F"

2. AMBIENT TEMPERATURE CALIBRATION

The final span calibration is the ambient temperature.

Turn the instrument on, connect the probe and allow it to autozero. Use a good quality thermometer to read the ambient temperature.

Read the ambient temperature on the instrument display. (If is higher than the thermometer reading you will need to enter a negative correction).

Enter the SET mode by pass all other calibrations.

Following the NO₂ calibration setup step, the following message will appear on the display:

"ATEMP OFFSET +0 F"

Use the "UP" or "DOWN" keys to enter the correction factor. Then press the ENTER key. The display will read:

"PLEASE WAIT 2 MINUTES"

The unit is purging itself of any gases and at the end of 2 minutes it will execute an autozero.

NOTE: If there is something wrong with any of the sensors during span calibration, (i.e. if the sensor's output is not within the expected range) the

instrument will display the message:

"CALIBRATION FAILED"

and will not calibrate for this sensor.

NOTE: If you wish to exit the span calibration procedure at any time, simply press the "SET" key and observe the "SET LED" turn off.

SPAN CALIBRATION OF THE MODEL 2000

THE PROBE AND WATER TRAP MUST BE ALWAYS CONNECTED TO THE INSTRUMENT, WHEN EXECUTING A SPAN CALIBRATION.

The following list describes the span gas recommended to calibrate the ENERAC model 2000.

Carbon Monoxide Combustibles	200 PPM CO, 0.1% CH ₄ balance N ₂
Oxides of Nitrogen	200 PPM NO, balance N ₂
Sulfur Dioxide	200 PPM SO ₂ , balance N ₂

Fig.1 shows the typical setup for calibrating the model 3000. It is the same for the model 2000 also.

For the environmental version of the ENERAC you will need also a span calibration for the NOX and Sulfur Dioxide sensors. There is, finally, an offset adjustment available for the ambient temperature sensor.

You can carry out all span calibrations in sequence, or just one only, if you wish.

Feed the span gas to the instrument for a full minute before carrying out the span calibration, to make sure that steady state conditions will have been reached by the end of the calibration period.

For span calibration of the DRAFT and AMBIENT TEMPERATURE follow the directions in section B below.

1. SPAN GAS CALIBRATION

The sequence of the span gas calibrations that will appear on the instrument's display is as follows:

1. Combustibles

2. Carbon monoxide
3. Oxides of Nitrogen
4. Sulfur dioxide
5. Draft
6. Ambient temperature.

To carry out a span calibration follow the steps below:

1. Set up the calibration apparatus to the ENERAC as shown in fig.1.

Do not connect the calibration kit to the Enerac yet.

2. Connect the ENERAC's probe to the instrument and turn the unit on. Make sure the battery is OK. Press the ENTER key to autozero the unit and wait until the message

"INSERT PROBE"

appears on the display.

(The combustibles sensor needs more than 2 minutes for proper warm up. If you plan to carry out a combustibles calibration, turn the unit off for 2 seconds and turn it back on. Press the ENTER key again to autozero the unit!).

3. Push the "SET" button and observe "SET" LED turn on.
4. Push the "DRFT" button. The following message will appear on the display:

"CMB SPAN GAS: 0.11%"

5. If you wish to skip the Combustibles calibration push the "ENTER" button. The display will read:

"PUSH ENTER KEY!!"

Push any button, except the "ENTER" button and the unit will skip the combustibles calibration and proceed to the next one.

6. To carry out the combustibles span calibration, use the "UP" or "DOWN" buttons until the display reads the same combustibles value as that printed on the combustibles (methane) gas cylinder label of the calibration kit. Then press the "ENTER" button. The display will read:

"PRESS ENTER KEY!!"

7. Turn on the shut off valve of the gas cylinder labeled "200 PPM CO & 0.1% methane". Connect the hose of the calibration kit to the tip of the ENERAC's probe.
The instrument will start drawing span gas. If you are displaying oxygen on the instrument's display, the oxygen value should begin to drop towards zero.

Press the "ENTER" key NOW. The following message will appear on the display:

"FEED GAS NOW and WAIT"

8. Please wait. At the END of the two minute period the unit will, at that instant, record and store the combustibles sensor output and define it as the value that you set earlier.

When you see the message:

"CO SPAN GAS: 200 PPM"

it means that you are finished with the combustibles span calibration and the instrument is prompting you to perform the CO calibration next. Shut off the gas!

NOTE 1: To make sure that the instrument registered properly the span gas, press the SET key to exit the setting mode and press the COMB key. Read the combustibles value. Make sure that the display reading is steady. If it appears

to be climbing, it implies that the time allowed for calibration was insufficient. In that case allow the span gas to flow into the instrument for a full minute before carrying out the span calibration. This observation is valid for all gas tests that follow.

NOTE 2: When the display reads "FEED GAS NOW AND WAIT", the keyboard and any serial communications are disabled. If you wish to ABORT the span calibration, turn the unit off.

9. To carry out the CO (carbon monoxide) span calibration follow the procedure outlined above for the combustibles calibration.

If you wish to skip the CO calibration proceed as in step 5. The following message will appear on the display:

"NOX SPAN GAS: 100 PPM"

prompting you to carry out this calibration.

10. If you have the NOX option, carry out this calibration next.

NOTE 3: The CO sensor has a special inboard NOX filter to remove any cross sensitivity to NOX gas. It is a good idea to observe the reading of the CO sensor at the end of a NOX span calibration. The cross sensitivity of the CO sensor to NOX should be less than 5%. If it is more, this implies that the filter has been exhausted and the CO sensor should be replaced.

11. The next calibration in line is sulfur dioxide and the following message will appear on the display;

"SO₂ SPAN GAS: 200 PPM"

If you wish to carry out any of these calibrations, proceed as outlined in steps 6, 7 and 8. At the end of either step the following message will appear on the display:

"DRAFT SPAN: -05.0 in"

When you are finished with the gas calibrations, make sure that all valves of the calibration kit are shut. Disconnect the hose and allow the instrument to draw air for 2 minutes to purge all gases.

2. DRAFT & AMBIENT TEMPERATURE CALIBRATION

1. To calibrate the draft sensor, a 0-10" manometer is required. The manometer is not supplied.
2. Turn the unit on, disconnect the probe and allow it to Autozero by pressing the ENTER key.
3. Take the -Y- hose connector supplied with the calibration kit and make sure the needle valve attached to the end of one hose is fully open.
4. Connect one of the two free hose ends to the GAS IN of the ENERAC and the other free end to the suction side of the manometer.
5. Press the SET key and observe the "SET" LED turn on. Press the DRFT key to enter the calibration mode. By pass the gas calibrations, following the instructions outlined above until the display reads:

"DRAFT SPAN: -5.0 in"

Use the "UP" key to select a suitable draft calibration setting between 5" and 10" negative pressure. Press the "ENTER" key. The display will read:

"PUSH ENTER KEY"

(The instrument pump should be on).

6. Very slowly close the needle valve that is attached to the end of one of the hoses of the -Y- connector. Observe the manometer reading climbing due to the suction of the pump. When the manometer reading exceeds -10", press the "ENTER" key again.

THIS WILL CAUSE THE PUMP TO STOP! (See note below!)

7. Open the needle valve slightly. Observe the manometer reading carefully. When the manometer reads the exact same pressure that the span was set for, press the "ENTER" key and then open the valve completely. You can easily check the accuracy of your calibration, by exiting the SET mode, partially restricting the valve and measuring and comparing the draft with the manometer readout.

NOTE: ENERACS Model 2000 with serial numbers higher than 10002700 measure draft on a real time basis. The pump will not stop during calibration of these units. To carry out the draft calibration, adjust the needle valve for a reading of the manometer corresponding to the setting on the display. Press the "ENTER" key next to execute the calibration.

8. The final span calibration is the ambient temperature.

Turn the instrument on, CONNECT the probe and allow it to autozero. Use a good quality thermometer to read the ambient temperature in the vicinity of the thermocouple plug.

Read the ambient temperature on the instrument display. (If is higher than the thermometer reading you will need to enter a negative correction).

Enter the SET mode by pass all other calibrations.

Following the DRAFT calibration the following message will appear on the display:

"ATEMP OFFSET +0 F"

Use the "UP" or "DOWN" keys to enter the correction factor. Then press the ENTER key. The display will read:

"PLEASE WAIT 2 MINUTES"

The unit is purging itself of any gases and at the end of 2 minutes it will execute an autozero.

NOTE: If there is something wrong with any of the sensors during span calibration, (i.e. if the sensor's output is not within the expected range) the instrument will display the message:

"CALIBRATION FAILED"

and will not calibrate for this sensor.

NOTE: If you wish to exit the span calibration procedure at any time, simply press the "SET" key and observe the "SET LED" turn off.

Whenever the message "FEED GAS NOW AND WAIT" appears, the ENERAC is inside a software loop and will not respond to any keys or communicate with external computers. Shut the instrument off, if you have to abort a span calibration.

SPAN CALIBRATION OF THE POCKET SERIES

The following list describes the nominal values of the span gases supplied for the pocket series instruments:

INSTRUMENT	SPAN GAS
POCKET 60 Carbon Monoxide analyzer	200 PPM CO, balance N ₂
POCKET 70 Sulfur Dioxide analyzer	200 PPM SO ₂ , balance N ₂
POCKET 80 Nitric Oxide analyzer	100 PPM NO, balance N ₂
POCKET 80A Nitrogen Dioxide analyzer	50 PPM NO ₂ , balance N ₂
POCKET 90 Hydrogen Sulfide analyzer	25 PPM H ₂ S, balance N ₂
POCKET 100 Combustion analyzer	200 PPM CO, balance N ₂

Figure 1 shows the calibration kit used to calibrate an ENERAC Model 3000. However, the same basic calibration system is used for all instruments.

To calibrate any pocket series instrument proceed as follows:

1. Turn the instrument on, connect the probe and allow the unit to warm up drawing ambient air for 3 minutes.

MAKE SURE THAT THE AIR IS CLEAN AND FREE FROM ANY FUMES OR SMOKE!

2. Preferably, turn the instrument pump on to purge the instrument from any residual gas. Leave the pump on.
3. Once the instrument has warmed up, use the small screwdriver to adjust the display for a reading of zero of the parameter that you wish to calibrate.
4. Open fully the shut off valve of the appropriate gas cylinder of the calibration kit.
5. Connect the the tip of the instrument probe to the calibration kit.

MAKE SURE YOU ARE USING THE CORRECT SPAN GAS, AS LISTED

ABOVE FOR YOUR INSTRUMENT.

6. Observe the display carefully. After 10 seconds the display readout should begin to increase rapidly.

NOTE: If the display readout remains zero or near zero, check the pressure gauge on the calibration kit to make sure there is sufficient gas in the cylinder. If there is sufficient gas, depress the gas release valve that is located on top of the demand regulator listen for the sound of escaping gas. If there is gas flowing, then the sensor in the instrument needs replacement.

7. Wait until the readout on the display stops changing (it usually takes 2 minutes).
8. Use the small screwdriver and rotate the span adjustment potentiometer until the indication on the display matches exactly the value specified on the gas cylinder.
9. Shut off the gas and disconnect the hose from the calibration kit.
10. Observe the display of the instrument. It should slowly return to zero. If it is within 5 PPM of zero, simply readjust the zero potentiometer. If it exceeds 5 PPM, zero the instrument and recalibrate.

NOTE FOR POCKET 60:

The sensor of the carbon monoxide analyzer has an inboard filter designed to remove the sensor's cross sensitivity to NOX. The filter life is approximately one year.

It is a good idea to check the filter's performance periodically. To check the effectiveness of the filter, use 200 PPM NO balance nitrogen span gas. The display should read less than 10 PPM (<5% cross sensitivity).