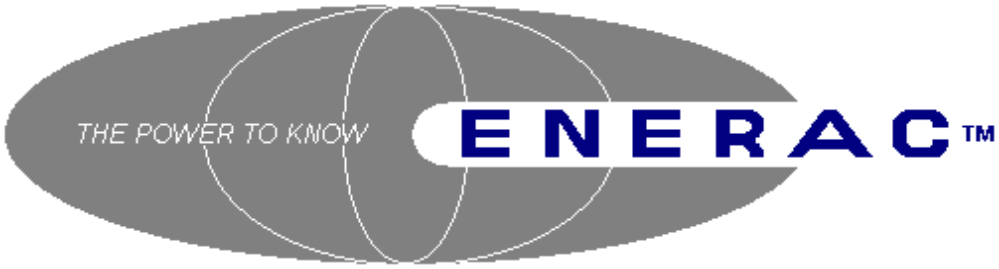


# INSTRUCTION MANUAL
# FOR

# MICRO EMISSIONS ANALYZER
## MODEL 400X - EMS
## MODEL 200X - EX

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Revision 1.0

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AMB T. | Ambient (room) Temperature |
| BATT. | Battery voltage |
| CO | Carbon Monoxide (A toxic gas) |
| $CO_2$ | Carbon Dioxide |
| EFFIC. | Combustion Efficiency (for boilers and furnaces, does not apply to engines). |
| ENG EFF | Engine thermal efficiency (heat loss method of calc.; not the same as combustion eff.) |
| GBH | Grams (of pollutant) per (engine) Brake horsepower-hour. |
| IN.WC. | Inches of Water (Draft measurement). |
| NET S. | Stack temperature minus ambient temperature. |
| NO | Nitric oxide (A toxic gas) |
| $NO_2$ | Nitrogen dioxide (A toxic gas) |
| NOX | Oxides of Nitrogen (A toxic mixture of nitric oxide and nitrogen dioxide gases) |
| OXY | Oxygen |
| OXY_REF | Oxygen reference basis for correction of toxic gas concentration |
| PPM | Parts per million (Volume basis-dry) |
| $SO_2$ | Sulfur Dioxide (A toxic gas) |
| Stack T. | Stack Temperature , degrees F or C. |
| Ex-Air | Excess Air |
| % | Percent by volume dry basis |
| #/B | Lbs. (of pollutant) per million BTU (of fuel). |
| ▲ | "UP" button |
| ▼ | "DOWN" button |

# OPTIONS

Both ENERAC models, the 200X-EX and 400X-EMS have been designed as modular systems, permitting the installation in the field of most of the various available options. This manual describes the complete instruments equipped with all the options. The available options on the Model 200X- EX and 400X-EMS are as follows:

a. 2" ENERAC Printer.

b. Nitric oxide (NO) measurement capability.

c. Nitrogen dioxide measurement capability. **(400X-EMS, only!)**

d. Sulfur dioxide ($SO_2$) measurement capability. **(400X-EMS, only!)**

e. Emissions units option (lbs/MBTU & Grams/Bhp-hour). **(400X-EMS, only!)**

f. CD-ROM with custom program (ENERCOM ™ for WINDOWS ™) for MS-DOS personal computer.

g. 36" or 48" inconel probe option.

h. Custom fuel option. (Either at the factory, or programmable using the ENERCOM™ for WINDOWS™ option.

Any combination, or all of these options are available to meet the customer's requirements.

Various cables and attachments are available for special connections to the Micro Emissions Analyzer.

In addition, high resolution 0-200 PPM and extended range 0-4000 PPM versions are available on request. (0-10,000 PPM and 0-20,000 PPM available on carbon monoxide only).

# CHAPTER 1

## FUNDAMENTALS

The ENERAC Models 200X-EX and 400X-EMS Micro Emissions Analyzers are hand held state of the art analyzers designed for the following tasks:

a. To measure the emissions of carbon monoxide, oxides of nitrogen, sulfur dioxide and oxygen from stationary and mobile combustion sources.

b. To assist the operator of a combustion source with the task of optimizing its performance and saving fuel.

c. To be used as a management tool to assist the plant manager with keeping records and controlling costs.

Both the ENERAC Model 200X-EX and 400X-EMS are easy to carry and utilize the latest technology; reliable flue type electrochemical sensors manufactured by the largest sensor manufacturer to measure emissions.

The ENERACs use sophisticated electronics and programming design for increased accuracy and flexibility. They measure 2 temperatures and 5 different stack gases. They compute efficiency of combustion, as well as excess air and carbon dioxide. They communicate with a variety of other computers via its RS-232 port. They have a library of 6 fuels and over 30 diagnostic and help messages and can operate either on its rechargeable batteries, AC power, or from a set of four AA alkaline cells.

ENERAC has years of experience in the manufacture and marketing of portable combustion and emission analyzers. The models 200X-EX and 400X-EMS are based on this experience, together with the latest innovations in electronic and sensor technology. They also express our basic conviction that communications and artificial intelligence are the basic ingredients of the instrument of the future.

The instrument operates basically as follows:

Connect the probe and water trap to the analyzer. Turn the unit on and then insert

the probe in the stack of an operating combustion source such as a boiler, furnace or combustion engine. A pump located inside the instrument draws a small sample of the stack gas. The sample is conditioned before entering the analyzer by passing through a condensation trap and particulate filter. A number of sensors analyze the contents of the stack gas and its temperature and calculate and display the results. The results can also be printed, stored or send to another computer either by direct connection or by the telephone lines. The source operator makes the required adjustments based on the analysis of the stack conditions to optimize performance.

## A. UNPACKING THE INSTRUMENT

Every ENERAC Model 200X-EX and 400X-EMS includes as standard equipment:

1. One Emissions Analyzer Model 200X-EX or 400X-EMS.
2. One stack probe with 10 ft. Viton hose (non-adsorbent, flexible).
3. One condensation trap with filter.
4. Three disposable fiber filters.
5. One detachable AC battery charger.
6. One instruction manual.
7. One printer instruction manual.
8. One velcro cover for printer.

> Every ENERAC sold has stored in its memory information regarding manufacturing and sensor dates, as well as product identification, serial number of unit, version and original customer.

## B. IMPORTANT ADVICE

Most stack gases are hot, full of moisture, corrosive and laden with soot particles.

To make sure that your instrument will give you a long time of trouble free performance, please observe the following recommendations.

1. Follow the instructions in your manual.

2. Never use the instrument without the fiber filter located inside the water trap. Operating the instrument without the filter will damage the pump and sensors. (This is a costly replacement!)

3. Do not expose the probe tip to open flame.

4. Do not rest the hose of the stack probe on a hot boiler surface.

5. Allow the probe tip to cool off and the instrument aspirate air, before packing the probe.

6. In dusty environments, cover the printer slot with the Velcro cover. THE PRINTER MAY BE DAMAGED, IF EXPOSED TO DUST!

# CHAPTER 2

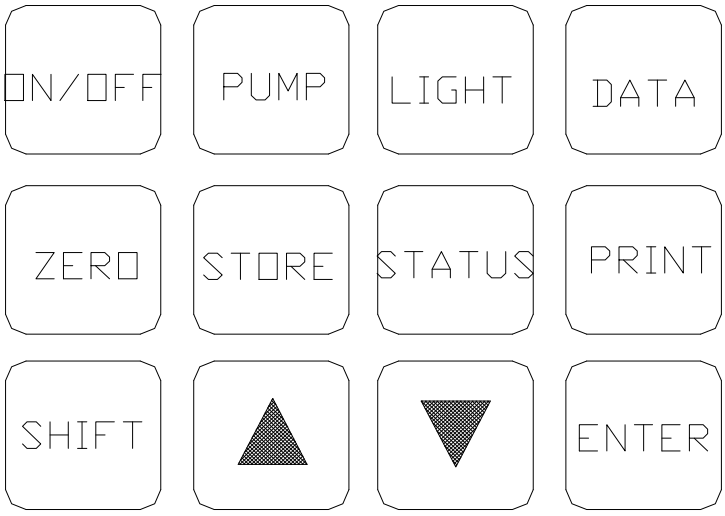
## THE INSTRUMENT KEYBOARD

Both the Model 200X-EX and 400X-EMS can be operated by using either:

A. The 12 button keyboard located on the face of the analyzer, or

B. By the use of commands through its serial port.

A brief explanation of the instrument's buttons follows:




"ON/OFF" Turns the instrument on or off.
"PUMP" Toggles the instrument's sample pump on or off.
"LIGHT" Toggles the LCD display's backlight illumination on or off.
"DATA" Toggles four LCD display screens. Each screen presents an instantaneous group of data of four measurement or computation parameters. The fourth screen displays all parameters , simultaneously.(This is the most often used button).
"ZERO" Executes an instrument auto zero. (Sets oxygen to 20.9%).
"STORE" This button is used to store data in the instrument internal buffers..
"STATUS" Toggles two LCD screens. The first screen displays the unit serial number, customer name, battery voltage and selected fuel. . The second screen displays current settings for oxygen reference, units

of toxic gas measurement, units of temperature and engine thermal efficiency. The third screen displays emission units, selected oxygen reference and selected engine thermal efficiency.

"PRINT" Sends data to the printer or to a computer, if one is connected to the serial port.

The buttons of the last row are used to customize the analyzer and execute all changes in stored parameters such as time, fuel, calibration data etc.

"SHIFT" Shifts the cursor to the next parameter that can be changed. Also shifts the cursor to the next entry (i.e. time setting)

 Increments the entry marked by the cursor to the next higher entry. (This may be a digit or some other parameter).

 Decrements the entry marked by the cursor to the next lower entry. (This may be a digit or some other parameter).

"ENTER" Executes and stores all the changes.

# CHAPTER 3

## BASIC INSTRUMENT OPERATION

It is possible to master the basic operation of the instrument in a few minutes by following the procedure outlined below. Please refer to the other sections of this manual for a description of the more advanced features.

Both the Model 200X-EX and 400X-EMS micro emissions analyzers consist of two major components, the probe (whose function is to extract, clean and dry the sample) and the main unit, which does the analysis and the computations. An optional printer accessory that attaches to the unit is also available.

To operate the instrument follow the steps outlined below:

1. Remove the instrument from its case and attach the sampling probe and water trap to the analyzer section and turn the instrument on.

2. The instrument “PUMP” will immediately turn on.

3. Press the “STATUS” button and check the condition of the battery. (This is good practice, even though there is a battery “low” warning message). Minimum battery voltage is 4.0 volts.

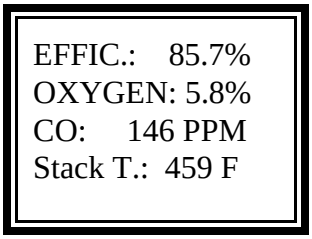
4. If the instrument temperature is below 40 degrees F. Allow a few minutes for the unit to warm up.

5. With the instrument aspirating CLEAN AIR and the probe tip at room temperature, press the “ZERO” button to execute an AUTO ZERO.

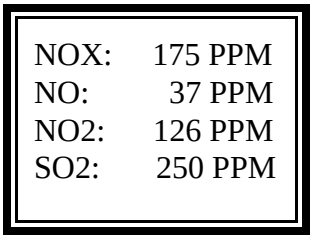
6. If at the end of the auto zero period there are no warning or error messages, insert the probe into the stack. Wait approximately two minutes before taking data.

7. Press the “DATA” button to display the first group of measurements. By depressing this button again you display the second group of data and by

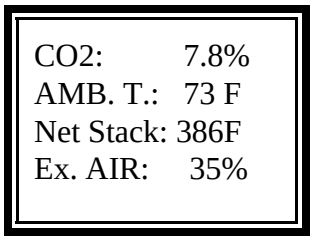
depressing it again you will display the third group of data.
The data are grouped as follows:



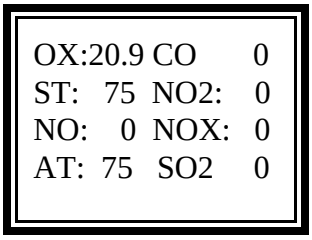

SCREEN 1




SCREEN 2




SCREEN 3




SCREEN 4

Toggle the “DATA” button to view the measurement data in sequence. The order of appearance of the screens depends on the last screen viewed.

***NOTE:***
***Depending on the Model and the options available for your analyzer some of the entries in one or more of the displays shown above will be blank if that option is not available.***

8. If you want a printed record of the current data, connect the stand alone printer to the bottom of the analyzer’s case. Turn the printer on. (The printer has its own batteries that use the same battery charger as the analyzer). Depress the “PRINT” button of the analyzer. You will get a complete print out of all data including time and date, fuel and customer information.

9. If you wish to store your data into any of the 100 storage buffers of the analyzer proceed as outlined in Chapter 6.

10. When you are finished with the measurements, remove the probe from the stack and allow it to reach ambient temperature before storing it. Remove any

condensation from the water trap and replace the fiber filter, if it is dirty.

# CHAPTER 4

## ANALYZER DESCRIPTION

### A. POWER REQUIREMENTS

Both the Model 200X-EX and 400X-EMS are designed to operate from 4 AA cells supplying a voltage of 4.0 to 6.5 Volts.

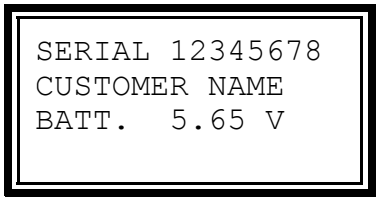
The flexible design allows for the use of either 4 AA alkaline primary (non rechargeable) batteries, or 4 AA Nickel-Cadmium, or Nickel Metal Hydride rechargeable cells.

A 120 Volt (240 Volt optional) AC charger is supplied with the high performance (850 mA cells) Ni-Cd cells and can be used to charge the batteries or operate the unit continuously from an AC power source.

***NOTE: Do not connect the AC charger to the instrument, if it is powered by alkaline (non rechargeable batteries.***

Battery life is approximately 4-6 hours of continuous operation.

You can check the condition of the batteries at any time by pressing the "STATUS" button twice to display the second "status screen". The following screen will appear on the display:




"STATUS" SCREEN 5

When the battery voltage indicated drops to 4.0 Volts you have only a few more

minutes of battery life remaining. Always check the battery voltage with the pump on.

If you are using non rechargeable batteries the voltage will drop slowly and gradually from 6 Volts to 4 Volts. If you are using rechargeable batteries the voltage will stay fixed for a long time at 4.8 Volts before starting to drop rapidly.

In addition to the battery condition indication, there will be a warning during instrument operation and also at start up, if the batteries are “low”.

To prolong battery life use the display back light illumination sparingly.

## B. FLOW DESCRIPTION & SENSORS

During operation, the metal tube of the probe (see fig.3) is inserted into the stack. A small pump located inside the unit draws a sample of the stack gases into the instrument for analysis. The probe assembly and the sensor housing are described below.

The probe assembly consists of the following components:

1. A 13" long 3/8" OD piece of inconel tubing and an inconel sheathed type K thermocouple located inside the inconel tube for protection. Both probe and thermocouple are mounted on an aluminum head that includes a support handle.

2. A 10 ft. Long 1/4/” OD Viton sampling hose and thermocouple extension cable with quick disconnects on both sides for easy storage. Viton tubing is used to prevent adsorption of $NO_2$ and $SO_2$ gases from the sample.

3. A condensation trap and particulate filter assembly to remove the excess water and clean the sample. The condensation trap is mounted for convenience to the side of the hand held analyzer. Figure 1 shows the probe assembly which is identical for both analyzers.

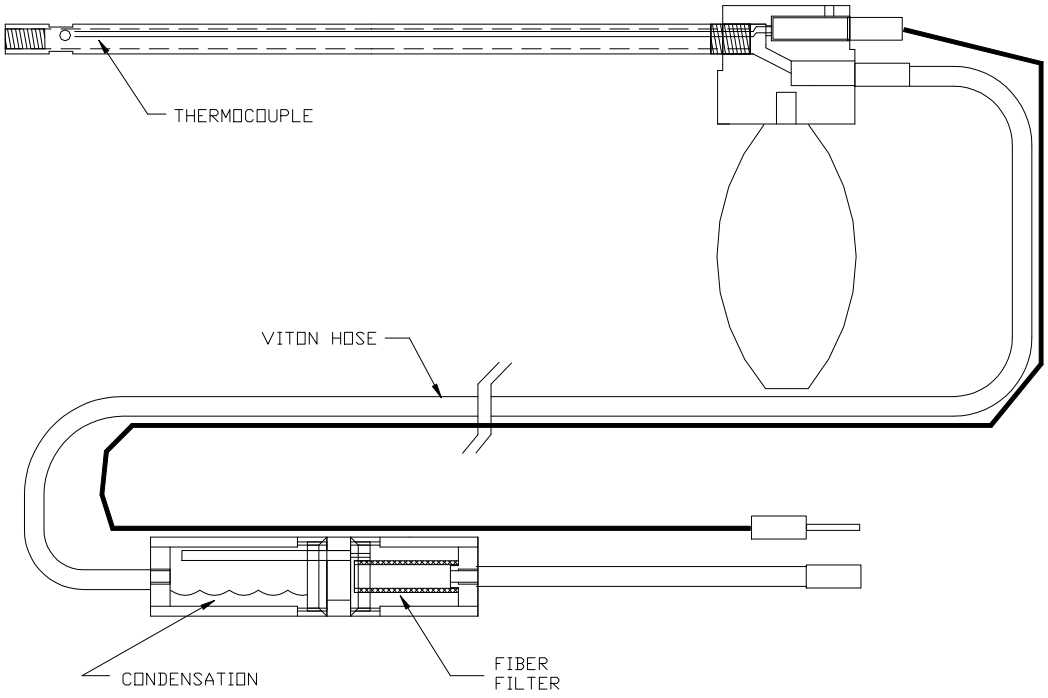


FIGURE 1

## C. THE PUMP AND SENSOR ASSEMBLY

A small diaphragm pump located inside the analyzer draws a small sample (approximately 1500 cc/min.) of the stack gas. The pump is powered by a high quality DC motor rated at 4000 hours. The pump's discharge is connected to the oxygen sensor housing. The sample leaving the oxygen housing enters an aluminum manifold that supports the four gas sensors (carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide). The manifold includes a small damper to dampen the flow pulsations caused by the diaphragm type pump.

**The sensors**

1. **Temperature sensing.** The instrument uses two temperature sensors. One monitors the stack temperature and the other the ambient temperature

    a. THERMOCOUPLE. The thermocouple is located at the tip of the probe. It measures the stack temperature minus the ambient

temperature. The thermocouple junction is a shielded, ungrounded, inconel sheathed, type K thermocouple with a capability of measuring temperatures from 0 to 2000 degrees F. The instrument software linearizes the thermocouple output to improve the accuracy.

b. AMBIENT TEMPERATURE SENSOR. This is an integrated circuit type temperature sensor. It is located inside the analyzer. It is used to measure the room or ambient temperature. The difference between the outputs of the thermocouple and the ambient temperature sensor is the net stack temperature, which is used in efficiency computations.

2. **Gas sensing.** All gas sensors with the exception of the oxygen sensor are located on the aluminum sensor manifold housing. The sensors can be accessed by opening the bottom part of the analyzer's back cover.

a. CARBON MONOXIDE SENSOR. This is a sealed electrochemical cell incorporating a long-life inboard filter. It consists of four platinum electrodes in an electrolyte. Carbon monoxide gas diffuses through a tiny hole on the face of the sensor. It reacts with oxygen present inside the cell to form carbon dioxide. The reaction produces an electric current proportional to the concentration of the gas. Sensor life is estimated at 2 years.
This sensor includes an auxiliary electrode to remove cross interference to Hydrogen gas.

Its inboard disposable filter has an estimated life in excess of 200,000 PPM-hours.

b. OXYGEN SENSOR. This is a two electrode electrochemical cell. It has a silver cathode and a lead anode. Oxygen diffuses through a tiny hole and reacts with the lead anode. The reaction produces an electric current. The unit software linearizes the current vs. oxygen response. The cell becomes exhausted when all the lead is consumed. It takes about two years for this to happen. Disconnecting the cell when not in use will extend its life by six months.

c. NITRIC OXIDE SENSOR. This is a sealed electrochemical cell incorporating a disposable long life inboard filter. It consists of three exclusively noble metal electrodes in an electrolyte. Nitric oxide gas diffuses through the tiny capillaries located on the face of the sensor. It reacts with oxygen present inside the cell to form nitrogen dioxide. The reaction produces an electric current proportional to the concentration of the gas. Sensor life is estimated at 2 years.

   Its inboard disposable filter has an estimated life in excess of 20,000 PPM-hours for $NO_2$ and 100,000 PPM-hours for $SO_2$.

   **This sensor requires a constant bias voltage for proper operation.** This voltage is supplied to the sensor, even when the instrument is turned off. It draws a small amount of current and will drain the batteries completely in about 10 months. For this reason the unit should always be given a fresh charge once every 2-3 months.

d. SULFUR DIOXIDE SENSOR. This is an electrochemical cell similar to the nitric oxide sensor. It has a range of 0 to 2000 PPM. Its life is estimated at two years.

e. NITROGEN DIOXIDE SENSOR. This is an electrochemical cell similar to the nitric oxide sensor. It has a range of 0 to 500 PPM. Its life is estimated at two years.

*NOTE: In addition to the sensor long-life filters, the model 200X-EX-400X-EMS emission analyzer uses mathematical compensation techniques to minimize any residual cross- sensitivities that its toxic sensors may have to any gases other than those they are intended to measure.*

# CHAPTER 5

## ANALYZER CUSTOMIZATION

The “STATUS” button displays the current settings of the analyzer’s parameters. The buttons of the last row are used to change certain parameters such as fuel, emissions units, span calibration values and also certain storage options in the analyzer’s memory.

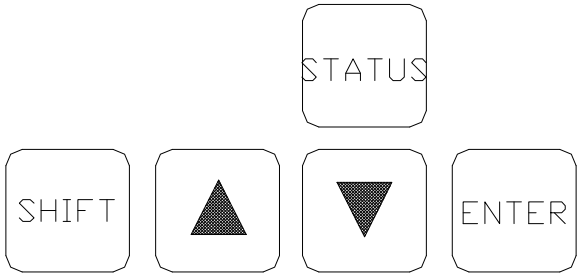



FIGURE 2

### A. The “STATUS” button

Press the “STATUS” button to obtain information about the analyzer as shown below by the two screens displayed by toggling the “STATUS” button:

```
OXYG REF: TRUE
UNITS:    PPM
TEMP UNITS F
```

“STATUS” SCREEN 6

```
SERIAL 12345678
CUSTOMER NAME
BATT.  5.65 V
```

“STATUS” SCREEN 5

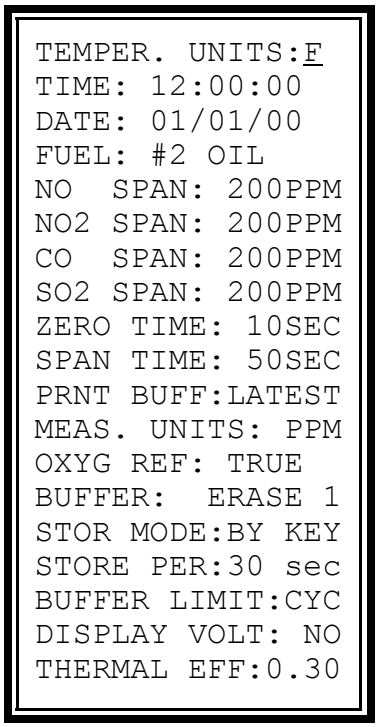
The meaning of the displayed parameters is explained further below.

You can change some of the parameters listed on the “STATUS screen by using the “SHIFT” key as explained below.

NOTE: You cannot change the serial number & customer name and of course the battery voltage indication.

## B. The “SHIFT” key

To change certain parameters such as fuel, time and date, calibration values, degrees F or C depress the “SHIFT” button. The “SHIFT” screen will appear on the display. Pressing the “SHIFT” button again will advance the display to the next line. If you keep pressing the “SHIFT” key you will scroll through all 17 display lines as shown in SHIFT SCREEN 7, below.




SHIFT SCREEN 7

Every parameter listed on the “SHIFT” screen can be changed as follows.

1. Press the “SHIFT” key repeatedly as many times as required, until the parameter you wish to change appears on top of the display (i.e. the line on which the blinking cursor is located.

2. Use the “UP” or “DOWN” keys (buttons displaying the triangles) until the desired value of the selected parameter appears on the display.

3. Press the “ENTER” key to execute the change.

A more detailed explanation follows:

1. TEMPER. UNITS: The “UP” or “DOWN” keys toggle between degrees F (Farenheit) and degrees C (Celsius). Stack temperature, net stack temperature and ambient temperature will be displayed, printed and saved in any of the two selected units.

2. TIME: To set the time of the analyzer’s internal clock (24 hour clock) you operate the: SHIFT”, “UP”, “DOWN” and “ENTER buttons as follows:

a. Press the “SHIFT” key as required until the line **“TIME: 12:00:00"** appears on the TOP of the display.

b. Press the “UP” or “DOWN” keys as required until the correct number corresponding to the hour (24 hour clock) appears on the display.

c. Press the “ENTER” key to shift the cursor to the minute indication.

d. Repeat the procedure using the “UP” or “DOWN” keys, then press the “ENTER” key.

e. Repeat the procedure for the seconds indication

3. DATE: To Set the date for the analyzer’s clock repeat the procedure outlined above for setting the time. Keep in mind that the date format is: mm/dd/yy

4. FUEL: The analyzer has the following ten fuels stored in its memory:
   (1) #2 OIL
   (2) #6 OIL
   (3) NATURAL GAS
   (4) ANTHRACITE (COAL)
   (5) BITUMINOUS (COAL)
   (6) LIGNITE (COAL)
   (7) WOOD, 50% MOISTURE
   (8) WOOD, 0% MOISTURE
   (9) #4 OIL
   (10) KEROSINE
   (11) PROPANE

To select the desired fuel, press the “UP” or “DOWN” keys until the desired fuel appears on the top of the display and then press “ENTER”.

The fuel selection affects the following parameters: combustion efficiency, carbon dioxide calculation and display of toxic gases in units other than PPM.

5, 6, 7, 8. XXX SPAN YYYY PPM: These settings are used for carrying out span calibrations of the NO, $NO_2$, CO, $SO_2$ sensors. For detailed

use of these settings, please refer to the chapter on calibration.

9. ZERO TIME: If you wish to change the countdown time for auto zeroing the analyzer, press the “UP” or “DOWN keys accordingly, when the cursor is blinking on this line on the display. It is recommended that the auto zero countdown should be at least 20 seconds. However, it need not be more than 120 seconds.

10. SPAN TIME: When carrying out a span calibration, you must introduce the span gas for an appropriate amount of time before the analyzer executes the span calibration. This setting, which is the same for all sensors controls this time interval. The time is indicated in seconds, but a minimum of 5 minutes of span gas feeding is required for proper calibration.

11. PRNT BUFF.: This setting is used to print data stored in the analyzer’s memory. For more details on its use please refer to the chapter on STORING & PRINTING.

12. MEAS. UNITS: When the cursor is blinking on this line, you can select any of the following units of measurement for the toxic gases (i.e. CO, NO, $NO_2$ & $SO_2$):

    a. PPM : Parts per million (volumetric)
    b. MGM : Milligams per cubic meter
    c. #/B : Lbs. (Of pollutant) per million BTU of fuel
    d. GBH: Grams (of pollutant) per break horsepower-hour

    NOTE: Emission units measurements in PPM, MGM, #/B and GBH are carried out on a dry basis as required by the EPA’s 40CFR75 . (The ENERAC is an extractive analyzer, whose conditioning system removes most of the water vapor before the sample reaches the sensors).

    *NOTE: NO and NOX emissions in #/MBTU, GBH are computed as $NO_2$!*

    *NOTE: Values of emissions in #/MBTU , GBH are fuel and $CO_2$ dependent. The fuel parameters for certain typical fuels (i.e. the F- factors for anthracite etc.) used in the analyzer have been modified to be identical to those specified*

*in 40CFR60 Appendix A method 19 of the code of federal regulations.*

Consult Enerac, Inc. for details and correction factors.

To choose the desired emission units toggle the "UP" button until the proper units are displayed. Then press the “ENTER” key.

If you select GBH (grams/brake horse power-hour) as the desired units, you must not forget to set the value of the engine thermal efficiency also! You can obtain this figure from the engine's manufacturer specifications. It differs somewhat as a function of engine type and load factor. (Typically it is a number between 0.25 and 0.35).

The ENERAC's default value is 0.3.

If the thermal efficiency is not known, it may be computed by using the engine's BSFC (brake specific fuel consumption-BTU/BHP-HR) as follows:

ENGINE EFFICIENCY = 2547/BSFC

13. OXYG REF: Many environmental regulations require that the concentrations of pollutants measured, be corrected to some reference value of oxygen other than the actual concentration at the time of the measurement. Typical oxygen reference values are 0% (air free), 3%, 7% or 15%.

    To select the desired oxygen reference value press the SHIFT” key repeatedly until the blinking cursor is located on the OXYG REF line on the display, as described above. Toggle the "UP" or "DOWN" button, until the desired value of the reference oxygen is displayed. (Range is 0-20% in 1% increments). Then press the “ENTER” key.

    To return to uncorrected measurements, depress the "UP" button until the display reads: OXY_REF: "TRUE%".

    *NOTE: Setting the OXY_REF to a value other than "TRUE" affects values of emissions concentrations in PPM and MGM. It does not affect values in #/B, GBH or #/H!*

The oxygen reference will always return to “TRUE” when the instrument is turned on, to prevent accidental measurement errors on emission parameters.

14. BUFFER: Selects the buffer for storing or erasing data. Please look at the chapter on STORAGE & PRINTING for details.

15. STOR MODE: Selects the method for storing data. BY KEY will store one set of data into the next available buffer only when the STORE key is pressed. PERIOD will turn on the periodic store function. In this mode, the unit will continuously store data. The time between each store is set below.

16. STORE PER.: Selects the time interval for periodic storage. This can range from 1 second to 60 minutes.

17. BUFFER LIMIT: When periodic storage is enabled, this value limits the number of buffers to store into. If set to CYC, then periodic storage will cycle through all the available buffers continuously.

18. DISPLAY VOLT: Selects for maintenance and troubleshooting purposes, whether the sensor output voltages will be displayed or not.

19. THERMAL EFF: Selects the thermal efficiency of the engine. See MEAS. UNITS.

20. ATEMP OFF.: Sets the value, in degrees Celsius, to add to the measured ambient temperature.

# CHAPTER 6

## PRINTING DATA

Figure 3 shows the relevant keys for printing and also dumping data.

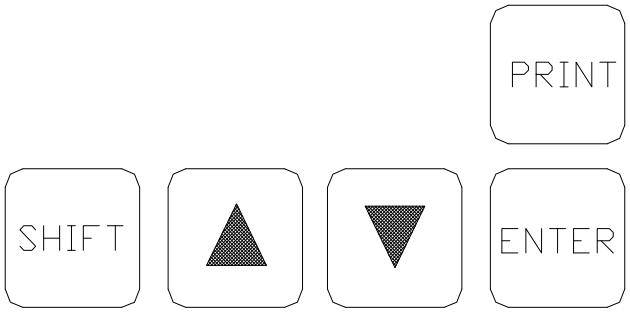



FIGURE 3

A. PRINTING & DUMPING DATA

The ENERAC 400X has two outlet connectors. One, a 4 pin Cinch Jones type connector is located at the bottom of the case, where the optional printer is mounted. The other connector, a 9 pin female D type, is the serial port connector.

**All data sent to the ENERAC printer are also simultaneously sent to the serial port. Consequently, all printing operations outlined below are also sent to the serial port!**

### A. THE MODEL 202EX PRINTER

Figure 4 below shows the companion printer to the ENERAC 400X. This printer is intended to be used solely with the ENERAC 200 & 400 series of analyzers.

A. PRINTER BATTERIES.

The printer uses its own 4 AA size batteries. These batteries can be either heavy duty (alkaline) non rechargeable batteries, or more conveniently NiCd, or NiMh rechargeable batteries. The printer is supplied from the factory with rechargeable batteries.

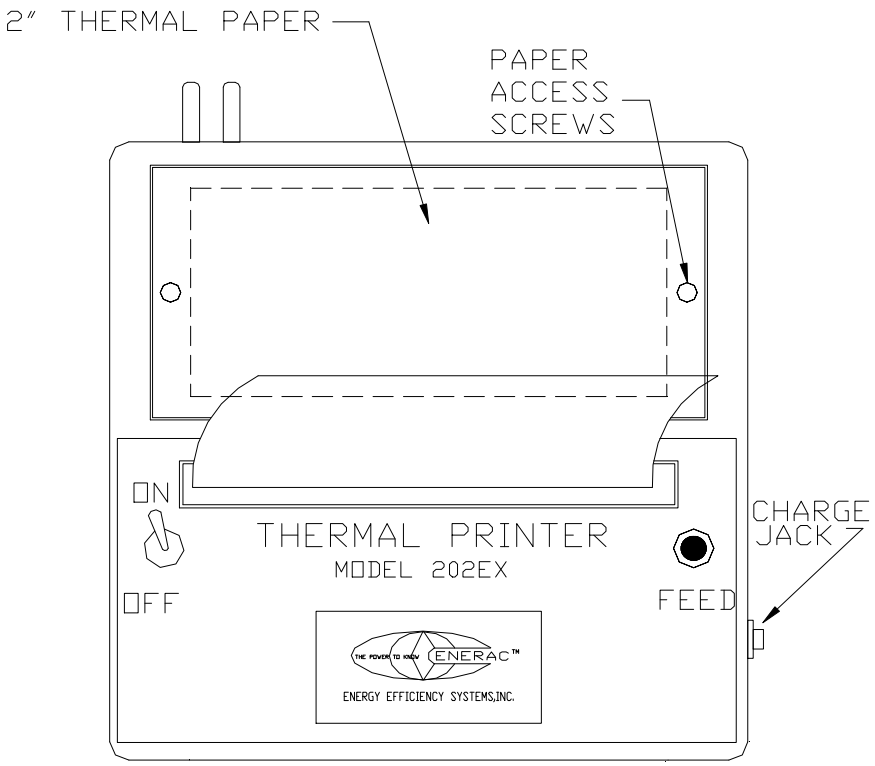



FIGURE 4

Before charging the batteries, make sure that rechargeable batteries are installed in the printer. Do not ever use the charger with non rechargeable batteries.

An overnight charge will fully recharge the batteries. To avoid depleting the batteries make sure to turn the ON/OFF printer switch to the OFF position when you are not using the printer!

To replace the batteries, remove the four thumb screws located on the back of the printer. Make sure you install the new batteries in the correct orientation.

B. THE PRINTER PAPER

The printer uses a high quality 2" thermal paper. To prevent damage to the thermal heads, please use only factory recommended paper.

To replace the thermal paper, unfasten the two screws that secure the top cover of the printer. Unroll approximately 6" of a new roll of thermal paper. Orient the roll so that the paper unrolls from the bottom of the roll. Be sure that the edge of the paper is cut square. Locate the slot immediately beneath the printer and insert the paper end as far as it will go. Turn the printer ON, press the “FEED” button while applying forward pressure on the paper. When the paper end appears exiting printer, turn the printer switch OFF. Place the roll in the space behind the printer. Replace cover with screws.

## B. PRINTING CURRENT DATA

Connect the ENERAC 202EX printer to the model 400X as follows: Remove the two thumb screws located at the bottom of the model 400X case. Line up the printer’s Cinch Jones male connector with the ENERAC 400X Cinch Jones female connector. Fasten back the two thumb screws that were removed.

Toggle the printer ON/OFF switch to the ON position. Press the printer “FEED” button as many times as desired to bring the paper up.

Press the “PRINT” key on the ENERAC 400X. The printer will start printing immediately a record of the current stack parameters as shown IN TABLE PRINTER 1.

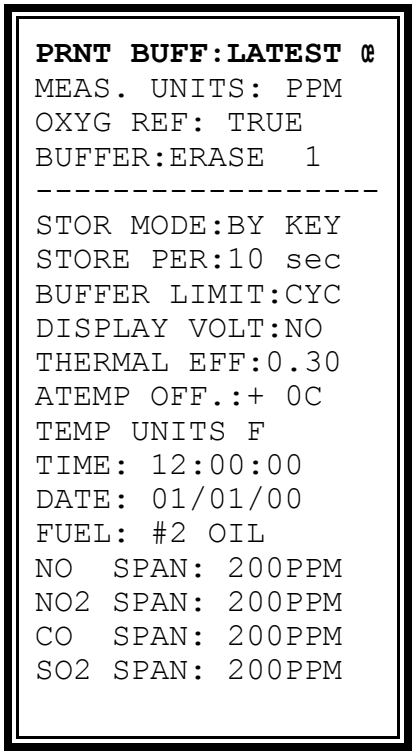
NOTE: The number of stack parameters that will be printer depends on the available options for the specific unit.

```
SERIAL ABC12345
  ENERAC 400X
  TEST RECORD

CUSTOMER NAME

TIME: 10:25:00
DATE: 07/11/00

FUEL: #2 OIL

EFFIC: 89.9 %
AMB T:   83 F
STACK T:241 F
OXYGEN: 0.2 %
CO:      43 PPM
CO2:   15.5 %
EXAIR:    1 %
NO:     523 PPM
NO2:     25 PPM
NOX:    548 PPM
SO2:     35 PPM
OXYG REF: TRUE

By: ___________
```

PRINTER 1

## C. PRINTING STORED DATA

The ENERAC 400X has 100 storage buffers for internal data storage. To print any of the stored data to the ENERAC's printer press the "SHIFT" key.




"SHIFT" SCREEN 6

Keep pressing the "SHIFT" key until the line "PRNT BUFF: XXXXX" appears on the top of the display, where the blinking cursor is located.

Press the "UP" or "DOWN" key to select one of the following three stored options to print.

### A. OPTION 1: LATEST

When this option appears on the "PRINT BUFF" line, press the "ENTER" key. The printer will begin printing the **last set of data** that was stored in one of its buffers (it doe not matter in what buffer # the data was stored).

### B. OPTION 2: 1....100

If you wish to print the contents of a specific buffer, keep pressing the "UP" or "DOWN" keys until the desired buffer number (from 1 to 100) appears on the display. Press the "ENTER" key. The data stored in that buffer will be printed.

### C. OPTION 3: ALL

To print all data stored in the ENERAC's buffers in sequence, press the "UP" or "DOWN" keys until the word "ALL" appears on the display. Press the "ENTER" key.

# CHAPTER 7

## STORING AND RETRIEVING DATA

The ENERAC model 400X has 100 internal storage buffers. Each buffer stores one complete set of emissions data.

### A. RETRIEVING STORED DATA.

To display stored data to a remote computer use a 9 pin serial cable to connect the ENERAC 400X to the computer.

Use the “PRINT” key and the “PRNT BUF” selection using the “SHIFT” key to send data out of the serial port as explained in the previous chapter.

The ENERAC 400X sends out ASCII characters at 9600 Baud.

To send all stored data to the computer press the “ENTER” key, when the line “PRNT BUF ALL” appears on top of the display.

```
BUFFER:ERASE 3 ¢
STOR MODE:BY KEY
STORE PER:10 sec
BUFFER LIMIT:CYC
----------------
DISPLAY VOLT:NO
THERMAL EFF:0.30
ATEMP OFF.:+ 0 C
TEMPER. UNITS: F
TIME: 12:00:00
DATE: 01/01/00
FUEL: #2 OIL
NO  SPAN: 200PPM
NO2 SPAN: 200PPM
CO  SPAN: 200PPM
SO2 SPAN: 200PPM
ZERO TIME: 10SEC
SPAN TIME: 50SEC
PRNT BUFF:LATEST
MEAS.UNITS:  PPM
```

SHIFT SCREEN 7

### B. STORING DATA

There are two ways to store emissions data to the ENERAC’s buffer. You can either store data by selecting the option to store every time you press the “STORE” key, or alternatively you can make use of the ENERAC’s capability of storing data automatically on a periodic basis. You can set the time period between data storage. SHIFT SCREEN 6 shows the relevant display lines for the storage options.

Remember that the active line is the first line displayed on the ENERAC’s display. To make any line the active line you must press the “SHIFT” key until the desired line appears as the FIRST line on the display.

The two storage options (by either pressing the “STORE” key, or periodic) are selected by pressing the “SHIFT” key until the line “STOR MODE:XXXXX” appears on top of the display.

OPTION 1 : STORING DATA BY PRESSING THE “STORE” KEY.

To store one set of emission data to one of the 100 available buffers every time you press the “STORE” key, press the “SHIFT” key. Scroll the display (SHIFT SCREEN 7) by pressing the “SHIFT” key, until “STOR MODE: XXXX” appears as the first line on the display. Press the “UP” or “DOWN” keys to toggle the second half of the line to display “BY KEY”. Press the “ENTER” key.

The data will be stored on the buffer number that is currently displayed on the line “BUFFER XXXX YY”, where “XXXX” is either the word “store” or “erase” and “YY” indicates the current buffer number.

If the current buffer has data stored in it, the new data will be stored in the next higher available buffer.

If you wish to store the data in a buffer other than the current buffer, use the “SHIFT” key to scroll the SHIFT SCREEN 7 until the line “BUFFER XXXX YY” appears on top of the display. Press the “UP/DOWN” key so that the display now reads “BUFFER STORE YY”. Press the “ENTER” key. The cursor will shift to the buffer number. Use the “UP/DOWN” keys to select the desired buffer number, then press the “ENTER” key. The next data will be stored in the displayed buffer number.

Every time you turn on the ENERAC the unit will default to this option.

OPTION 2: PERIODIC STORAGE

To store data automatically on a periodic basis press the “SHIFT” key until the message “STOR MODE: XXXX” appears on top of the display. Use the “UP” key to toggle the second half of the line so that it displays “PERIOD”. Press the “ENTER” key to START periodic storage.

Next press the “SHIFT” key again. The message “STORE PER: XXm” will be at

the top. Use the “UP” and “DOWN” keys to select the desired period in seconds or minutes. Press the “ENTER” key to set this period.

The data will begin to get stored starting with the buffer number indicated on the “BUFFER XXXX YY” line. It will stop storing after it has saved the number of buffers indicated on the “BUFFER LIMIT:YYY” line. If any of these buffers contain data, that data will be over written by the current data. If “BUFFER LIMIT” is set to “CYC” then the unit will cycle through all 100 buffers. The next buffer where data will be stored following buffer #100 will be buffer #1. If more data are being stored periodically, buffers containing already stored data will be over written.

To stop periodic data collection, turn the analyzer off. When you turn it back on, it will default to storing data by pressing the “STORE” key.

## C. ERASING STORED DATA

Data that have been stored in the analyzer’s memory will be retained even after the instrument has been shut off. There are two options for erasing stored data:

OPTION 1: ERASING ONE SET OF DATA

If you wish to erase the contents of one specific buffer, use the “SHIFT” key as many times as required until the message “BUFFER STORE YY” (or “BUFFER ERASE YY”) appears as the top line of the display. Use the “UP/DOWN” key to toggle the contents of the line until the message “BUFFER ERASE YY” appears. Press the “SHIFT” key again so that the blinking cursor shifts to the number indicated on the line. Use the “UP/DOWN” key repeatedly until the desired buffer number appears on the display. Press the “ENTER” key. The contents of that buffer will be permanently erased.

OPTION 2: ERASING ALL DATA STORED

To erase all the contents of all buffers at once press the “SHIFT” key until the cursor is located in the numbers section of the display “BUFFER ERASE YY”. Keep pressing the “UP” key. When the indicated number reaches 100 (the last buffer), press the “UP” key once more. The top line of the display will have the

following message: “BUFFER ERASE ALL”. Press the “ENTER” key. The contents of all buffers will be erased.

# CHAPTER 8

## COMMUNICATIONS

The analyzer's serial port is used to communicate with a computer.

The analyzer's communication protocol is as follows:

ANALYZER TYPE: DTE (i.e. transmits on pin 2)
BAUD RATE: 9600 baud
DATA: 8 bits, 1 stop bit, no parity
HANDSHAKE: None

Communication is by ASCII characters only.

There are four different ways for the analyzer to communicate with the computer.

OPTION 1: SENDING CURRENT EMISSION DATA

Start any of the available communications programs, such as PROCOMM ™ or TERMINAL ™ on your computer. Make sure the communications program is set to match the ENERAC's protocol listed above. You may need to use a null modem if you have trouble communicating.

Use a 9 pin serial cable to connect the analyzer's serial port to the computer.

Simply press the "PRINT" button every time you wish to send CURRENT data to the computer. (If the model 202EX printer is connected to the analyzer and turned on, you will simultaneously get a printout).

OPTION 2: SENDING STORED DATA

If you wish to send the stored data to the computer, press the "SHIFT" button repeatedly until PRNT BUFFER is displayed on the first line of the screen. Use the "UP" / "DOWN" buttons to select the storage buffer that you want to print and then press "ENTER".

If you want to print all of the internal buffers, press "UP" to scroll past buffer 100 or press "DOWN" to scroll past 0 to display ALL. Press ENTER to send all

storage buffers to the computer.

OPTION 3: TWO WAY COMMUNICATION

The ENERAC is also capable of responding to requests for data and to commands sent by the remote computer. For this purpose, it has a vocabulary of COMMANDS that the computer can send and to which the ENERAC will respond. There are two types of commands: Those designed for general use and those reserved for technical purposes in order to determine from remote locations the performance of the instrument.

All commands consist of four letter words (these are usually abbreviations of the complete word). If the command is followed by a question mark, it means that it is a request for information (i.e. it will cause the ENERAC to respond to the command by sending to its output port the specific information requested). If a command is followed by a quotation mark it will cause the ENERAC to store the data between quotes in its memory. This is the way to reprogram the instrument from a remote location. This feature makes possible the introduction of new fuels, if desired, or remote control of parameters or even the introduction of additional features and improvements without having to ship the instrument to the factory or dismantling it.

A list of the available commands intended for general use follows:

## THE COMMAND SET

| COMMAND | FUNCTION |
|---|---|
| ATEM? | Sends to the external computer the ambient temperature of the instrument. |
| CDOX? | ENERAC returns present value of carbon dioxide. |
| CMNX? | ENERAC returns present value of carbon monoxide. |
| DATE? | ENERAC returns present date. |
| DATE XX/XX/XX | Stores in ENERAC new date. |
| DUMP? | ENERAC returns results of all tests stored in its memory. |
| EFFI? | ENERAC returns present value of combustion efficiency. |
| ERAS XX | ENERAC erases the contents of buffer # XX |
| ERAS ALL | ENERAC erases the contents of all 100 buffers |
| EXAR? | ENERAC returns present value of excess air. |
| FL01? | ENERAC returns the fuel currently stored in location 01 |
| ..... | ..... |
| ..... | ..... |
| FL11? | ENERAC returns the fuel currently stored in location 15 |
| FUEL? | ENERAC returns the current fuel used. |
| LOGO? | ENERAC returns current LOGO (default value "ENERAC 400X"). |
| MODE? | ENERAC returns the current Emissions mode (units) and the oxygen correction factor. |
| MODE X | (Emissions option). Causes ENERAC to switch units of emissions gas measurements (CO, NO, $NO_2$, NOX, $SO_2$) as follows: |

| | |
|---|---|
| | X=P PPM (Volumetric)<br>X=M MGM (milligrams/cub.meter)<br>X=# #/B (Lbs./million BTU)<br>X=G GBH (Grams/brake hp-hour) |
| NOXY? | ENERAC returns present value of nitric oxide (NO). |
| NO2Y? | ENERAC returns present value of nitrogen dioxide ($NO_2$). |
| NOXX? | ENERAC returns present value of NOX=(NO+$NO_2$) |
| OPTI? | Returns ENERAC's current option setting. |
| OXRF XX | (Emissions option). Causes ENERAC to set the oxygen correction factor to any number as follows:<br><br>XX=0-20 (%) (In 1% steps)<br>XX=TRUE (No correction for oxygen) |
| OXYG? | ENERAC returns the present value of oxygen. |
| PRNT"X..XX" | Sends to the ENERAC printer the message "X..XX" up to 40 characters long. To send more characters repeat the command. |
| PUMP? | ENERAC returns pump status, ON or OFF. |
| PUMP0 | Turns the ENERAC main pump off. (The probe air flow pump stays on!) |
| PUMP1 | Turns the ENERAC main pump on. The instrument begins to draw a sample. |
| SETF01 | Changes the ENERAC's current fuel to fuel #1. (Factory default is #2 oil). |
| ..... | ..... |
| ..... | ..... |
| SETF11 | Changes the ENERAC's current fuel to fuel #11. |
| SO2X? | ENERAC returns present value of sulfur dioxide. |

| | |
|---|---|
| STEM? | ENERAC returns present value of the stack temperature |
| TEXT? | ENERAC returns a complete record of all current stack parameters. |
| TEXT | Commands the ENERAC to print on its printer all the current stack parameters including time, date, fuel and "mode". |
| TIME? | ENERAC returns the current time. |

TIME"XX:XX:XX" Stores in ENERAC new time.

| | |
|---|---|
| WARN? | ENERAC will return any warning messages currently activated. |

## OPTION 4: USING ENERCOM™ FOR WINDOWS

You can use any communications program such as PROCOMM™ or WINDOWS™ TERMINAL to communicate with the ENERAC. You can, however, enhance considerably the performance of the ENERAC, by using the special ENERCOM™ FOR WINDOWS software that is supplied with every model 400X analyzer. These software allows you to:

A. Monitor all emissions parameters simultaneously.

B. Record maximum, minimum, average and standard deviation for all emissions parameters.

C. Set alarms for every emissions parameter including recording the time duration that alarms have been exceeded.

D. Plot bar graphs and time plots of all parameters.

E. Select a variety of saving and printing options.

Consult the manual for ENERCOM™ FOR WINDOWS for details on the available software.

# CHAPTER 9

## CALIBRATION

Every instrument must occasionally be calibrated against some known value of a parameter in order to make sure that its accuracy has not deteriorated.

The instrument software makes sure that the display readout is always a linear function of the source excitation (i.e. gas concentration or temperature etc.). You therefore need only two points on the straight line to calibrate a parameter over its entire range. Usually, the first point chosen is the zero value (called zeroing the instrument). The second point has to be set by using some known value of the parameter being calibrated (i.e. using for example 200 PPM certified carbon monoxide gas to set the display to read 200). Sometimes the second point is not needed: if the slope of the parameter is known and is always the same. For example, for the stack temperature the slope of the curve is well known and you don't need a span calibration.

Traditionally, both zeroing and span (i.e. second point) calibration was done manually, by rotating suitable potentiometers until the display was set to read first zero in ambient air and then the correct value using span gas.

With the introduction of microprocessors, it became a simple matter for instruments to zero themselves automatically upon start up (AUTO ZERO), however, this simplification requires caution. The instrument must be started in a true "zero" environment. Otherwise it will assume as "zero" non-zero conditions and give erroneous readings. (Example: **Never auto zero the ENERAC, if the probe tip is still hot following a recent measurement**.)

The ENERAC carries out this improvement in automatic calibration procedure one step further. It does away with all potentiometric span adjustments. You just tell it the value of the calibrating parameter that you are using and the instrument adjusts itself automatically.

### A. AUTO ZEROING THE INSTRUMENT.

Every time you turn the instrument on, wait for 2 minutes to allow the ENERAC to warm up. You can then press the “ZERO” button to start the auto zero procedure.

At the end of the auto zero period the ENERAC reads the output of all sensors and sets them all to zero, with the exception of the oxygen that it sets to 20.9%. (The ambient temperature is read directly). Consequently, it is very important that at the moment of "zeroing" the probe tip is at room temperature and the environment is clean from traces of carbon monoxide or other gases.

You can set the countdown time for auto zeroing the analyzer by first pressing the “SHIFT” button to get into the setting mode of the instrument (see SHIFT SCREEN 7). Keep pressing the “SHIFT” key until the message “ZERO TIME: XX SEC” appears as the top line of the display. Use the “UP/DOWN” key to set the desired auto zero period, then press the “ENTER” key.

*NOTE: In practice AUTO ZEROING is only needed once at the beginning of a day of measurements. The ENERAC will not have sufficient zero drift during the next 24 hours to require additional autozeroing procedures.*

To carry out the auto zero procedure follow the steps below:

1. Connect the probe and water trap to the unit. Make sure the probe tip is at room temperature.

2. Turn the analyzer on. Make sure that the “battery low” message does not appear on the display.

3. Make sure that the analyzer pump is on. **(Always zero the instrument with the pump on, for flue stack measurements!).**

4. Press the “ZERO” button. Wait for the countdown to end.

5. If no error messages appear at the end of the countdown proceed with your measurements.

## B. SPAN CALIBRATION.

You must always span calibrate the instrument every time you replace a sensor. At a minimum, once every 3-4 months you should perform a span calibration of the instrument. For greater accuracy you should calibrate the instrument before and after each emissions test. The parameters that require a span calibration are, depending on the available options: carbon monoxide, nitric oxide, nitrogen

dioxide and sulfur dioxide.

You can carry out all span calibrations in sequence, or just one only, if you wish. You can use your own span gas, or if you need to calibrate the ENERAC in the field, you can use the convenient gas calibration kit supplied by Enerac.

### A. Span calibration using the Enerac kit.

The gas calibration system supplied by Enerac is shown in Fig. 5. The kit comes with a gas cylinder containing a mixture of 200 PPM carbon monoxide (typically), with balance nitrogen. For NO, $NO_2$ and $SO_2$ calibrations you must order extra gas cylinders containing the desired type of span gas. All four gas cylinders and calibration apparatus fit inside a carrying case for easy transportation to the field.

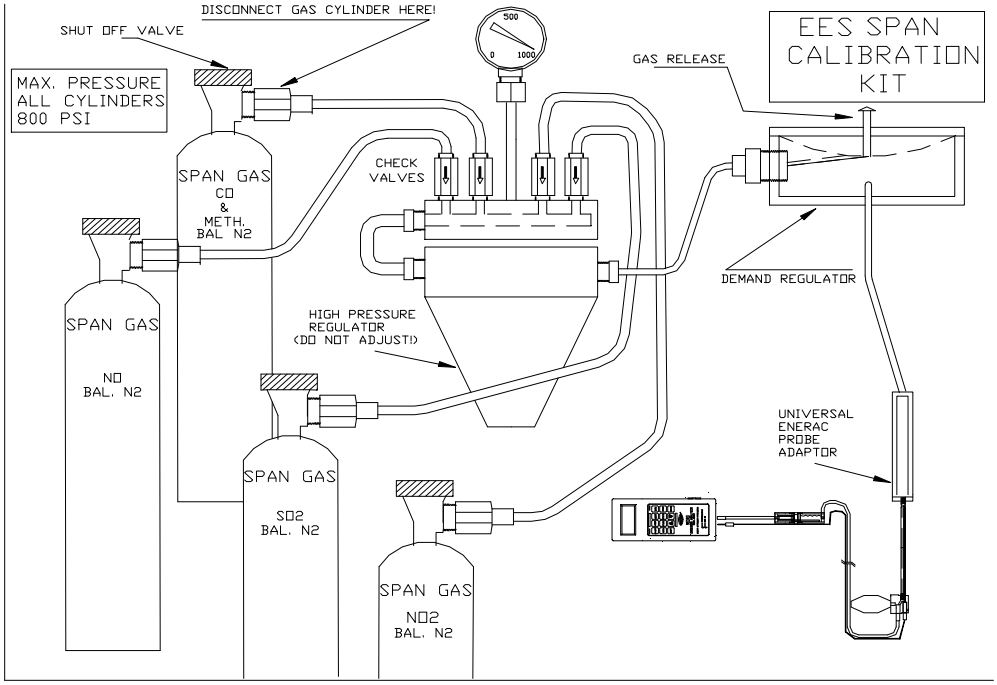



FIGURE 5

Span calibration using the Enerac calibration kit is easy. You don't need to worry about gas flow rates and there is no wasting of calibration gas. Follow the instructions supplied with the calibration kit.

### B. Span calibration using your own gas.

If you wish to use your own gas to perform span calibrations you must take certain precautions, in order to calibrate the sensors properly.

*Preferably, for greatest accuracy it is recommended that you use a span gas value close to the emission concentration you expect to measure.*

To carry out a span calibration USING YOUR OWN GAS APPARATUS See figure 6 and the instructions listed below:

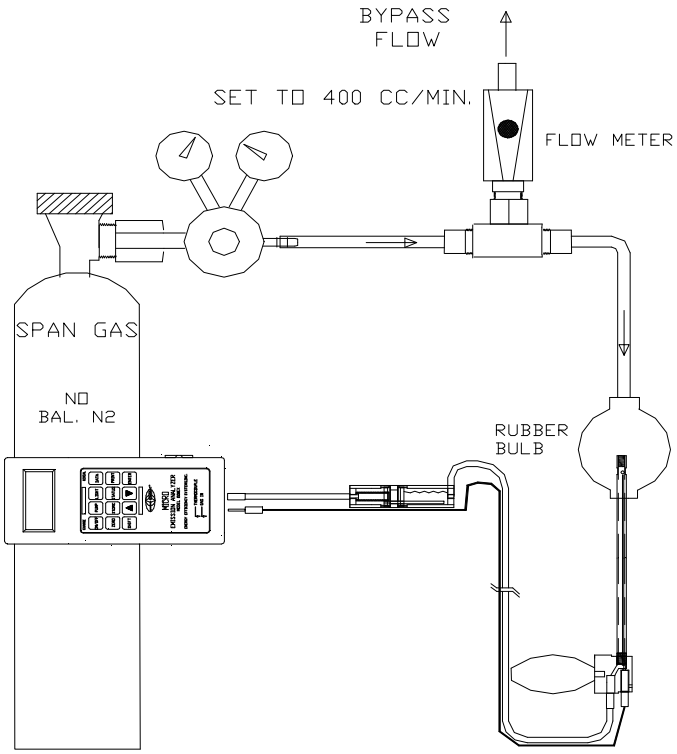



FIGURE 6

A. Set up your calibration apparatus as shown in fig. 6.

Notice that you need a number of certified gas cylinders. Make sure that you use a by pass flow meter as shown in order to supply an adequate flow without developing pressure on the sensors. The accessory ensures proper gas flow to the ENERAC.

*You must not feed gas to the ENERAC under pressure and you must not starve the ENERAC's pump for gas. When feeding the gas to the ENERAC you must maintain a reasonably constant pressure. This is a requirement of all diffusion type sensors.*

Connect the calibration accessory to the ENERAC probe. Make sure the rubber bulb is inserted past the square grooves located at the probe tip.

Connect the other end of the calibration accessory to the gas cylinder.

*Make sure the concentration of the calibration gas is within the range of the of each sensor. Do not under any circumstances, use gas that will over-range the sensor.*

The Carbon Monoxide gas can be in the range 30-2000 PPM 2% accuracy with the balance nitrogen, preferably.

The NO span gas can be in the range 10-2000 PPM, 2% accuracy with balance nitrogen, preferably.

The $NO_2$ span gas should be in the range 50-500 PPM, 2% accuracy with balance nitrogen, preferably.

The sulfur dioxide span gas can be in the range of 30-2000 PPM, 2% accuracy, with balance nitrogen, preferably.

**C. Calibration procedure.**

The following page illustrates the sequence of key strokes to carry out a span calibration of the analyzer. It is assumed that the instrument has been auto zeroed and there have been no error messages.

A. Auto zero the instrument with ambient air.

B. Connect the calibration apparatus and cylinder to the instrument.

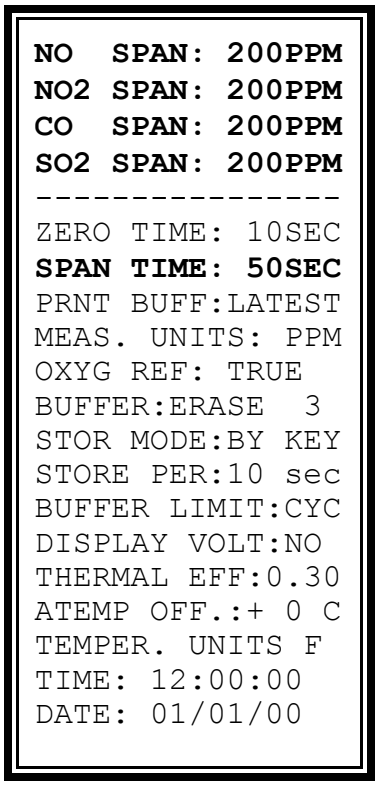
C. Press the “DATA” key and observe the appropriate reading as you open the calibration cylinder valve. (If you are using the by pass flow meter, adjust the cylinder valve for a BYPASS flow rate of approximately 500 cc/min.

D. When the display reading for the desired gas has stabilized press the “SHIFT” key to enter the setting mode of the analyzer (SHIFT SCREEN 7).

(Before pressing the “SHIFT” key you may wish to observe the readings of the other gas parameters for evidence of cross sensitivity and also the oxygen reading for confirmation that there is no

instrument leak!)

SHIFT SCREEN 7 shown below illustrates the relevant display lines for instrument calibration.




SHIFT SCREEN 7

As an example, if you wish to span calibrate the NO (nitric oxide ) sensor using 300 PPM certified gas proceed as follows:

1. Set the time that you must feed the span gas before executing the span adjustment. To do this press the "SHIFT" key as required until the message "SPAN TIME XXX SEC" appears on the first line of the display. Press the "UP/DOWN" key to set the desired gas feed time.

**NOTE: For NO and CO calibrations a minimum of 4 minutes is adequate. For $NO_2$ and $SO_2$ calibrations a minimum of 8 minutes is required.**

   Press the "ENTER" key to store the span gas feed period.

2. Press the "SHIFT" key as many time as required until the message "NO SPAN: XXX PPM" appears as the top line of the display.

3. Press the "UP/DOWN" key as many times as required until the number on the first line of the display reads 300 PPM (the value of the span gas concentration.

4. Press the "ENTER" key to execute the calibration. Wait for the required minimum 4 minute period.

5. Press the "DATA" key to make sure that the display is reading correctly.

# CHAPTER 10

## MAINTENANCE

The ENERAC micro emissions analyzers are a sophisticated piece of analytical instrumentation designed to perform accurate emissions measurements. However, because they are hand held instruments that find uses in all sorts of environments, it is important that care must be taken to prevent physical and environmental abuse, in order to maintain a trouble free operation.

There are five components that will require periodic inspection or replacement. These are:

1. The non-rechargeable batteries (if you don't use rechargeable batteries).

2. The disposable fiber filter.

3. Removal of condensate from the water trap.

4. Sensor replacement.

5. Printer paper replacement.

**A. Battery replacement**.

The analyzer requires 4 AA cells for operation. If you use disposable batteries, select alkaline $MnO_2$ cells for longer life. You should get at least 6 hours of operation from a set of batteries depending on the use of the back light illumination.

*Do not use the battery charger, if you are using non rechargeable batteries!*

The instrument is designed to warn you, if the batteries become weak. You can also check the condition of the batteries at any time by pressing the "STATUS" button. The battery voltage is displayed on the screen. **A minimum of 4 volts is required to operate the analyzer.**

For fresh alkaline batteries the voltage displayed will be approximately 6 Volts. It will gradually drop with use until at 3.8 Volts a "battery weak" warning will

appear. You can thus, estimate by observing the voltage the remaining time.

For Ni-Cd rechargeable batteries the battery voltage will stay at approximately 4.8 Volts for a long time and then drop rapidly.

To replace the batteries, remove the two screws that secure the top section of the analyzer's back plate. The batteries are housed inside a battery holder that is mounted on the back of a pc board. Remove the depleted batteries and replace them with fresh ones observing carefully the polarity indicated. Replace the top section of the back plate.

*NOTE: Remember that the NO (nitric oxide) sensor needs a tiny amount of electrical power, even when the analyzer is off. Do not allow the batteries to discharge completely. Consequently, you must not leave the analyzer without battery power for any length of time. When replacing the batteries you can use the analyzer within five minutes, if you don't take longer than two minutes to replace the batteries. If the analyzer has been without power for a long time, you may need to wait for a few hours after installing fresh batteries before the NO sensor is fully conditioned. <u>This warning is for the NO sensor only.</u>*

**B & C. Filter replacement, condensation removal.**

The disposable 1 micron fiber filter is located in the bottom section of the condensation trap assembly. Its function is to prevent soot particles from reaching the analyzer pump and sensors.

You must replace the filter when it becomes discolored. **Never operate the analyzer without the filter**.

Frequency of filter replacement depends on the type of fuel used. For natural gas fuel you will probably need to replace the filter once a month. For coal fuel you will need to replace the filter every few days.

To replace the filter disconnect the condensation trap from the probe. Unscrew the bottom section of the condensation trap and remove and replace the filter with a new one. Make sure the O-ring is seated properly when you screw back the bottom section.

At the end of a measurement shake the probe vigorously to drain it from any condensation. Remove any condensation that has been trapped in the top section

of the condensation trap and allow it to dry thoroughly before storing it.

**D. Sensor replacement.**

To access the gas sensors you must remove first the battery cover plate which is secured by the two thumb screws. You then remove carefully the bottom section of the back plate on which the sensor manifold housing is mounted.
This will expose the four gas sensors and the oxygen sensor. See figure 5.

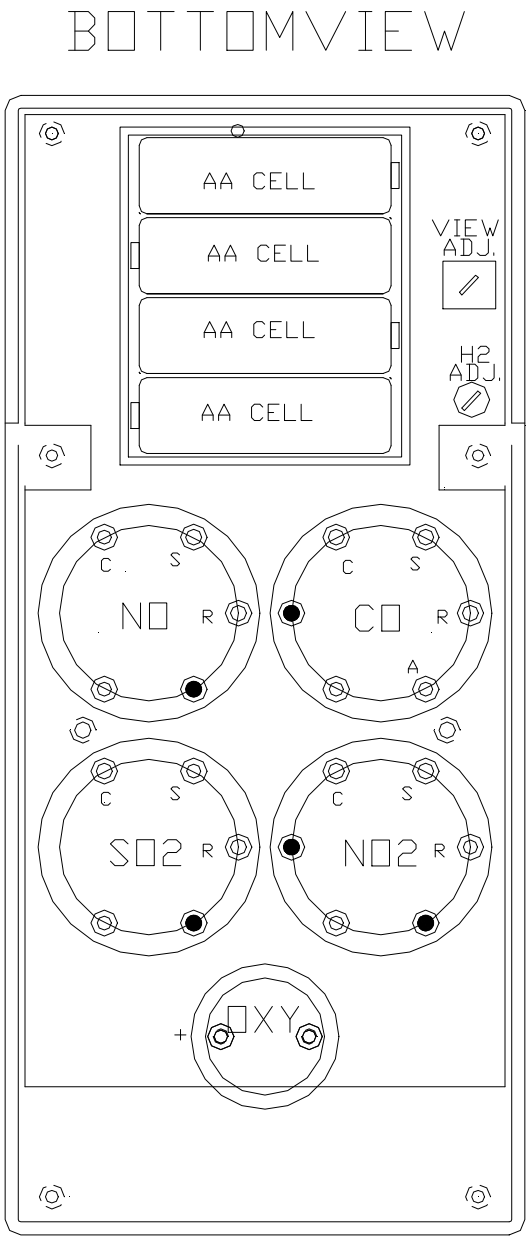



FIGURE 7

All gas sensors are mounted directly on the printed circuit board.

Make sure the unit is off before attempting to disconnect one of the sensors.

If you receive an error message for one of the sensors during instrument operation, do not attempt to replace the sensor immediately. Instead, wait a few minutes and then auto zero the analyzer again. If you get an error message again investigate if moisture has entered the sensor area. If so, wait a few hours for the moisture to evaporate and auto zero the sensor again. If you get a sensor failure then you must replace the sensor.

To replace the sensor remove the back plates as explained previously. Pull the malfunctioning sensor out of the printed circuit board. Be careful not to bend the mounting pins.

Replace the sensor with a new one. **If the sensor to be replaced is a CO, $NO_2$ or $SO_2$ sensor, first remove the shorting spring from the two sensor pins.**

**Each sensor has a different pin arrangement to prevent it from being accidentally inserted in the wrong socket pin configuration!** See figure 5. Be careful not to bend the sensor pins when mounting the new sensor.

Replace the bottom section of the back plate that houses the manifold.

Replace the top section of the back plate last.

Wait the following time periods before auto zeroing the analyzer:

| | |
|---|---|
| OXYGEN SENSOR | 10 MINUTES |
| CO SENSOR | 5 MINUTES |
| NO SENSOR | 1 HOUR |
| NO2 SENSOR | 5 MINUTES |
| SO2 SENSOR | 5 MINUTES |

*Sensor replacement should be an infrequent operation (once every two years or more) unless you allow water to enter the sensor housing by not using the condensation trap!*

**NOTE:** (Hydrogen interference adjustment).

There is a hydrogen cross-interference adjustment for the carbon monoxide sensor. This calibration intended to remove the interference of hydrogen from CO

measurements should be rarely done, typically if the sensor is being replaced.

To null the hydrogen interference, feed hydrogen gas, typically 100 - 1000 PPM, following the same procedure as for the other toxic gas calibrations. When the display reading has stabilized use the “H2 ADJ.” potentiometer (see figure 5) to obtain a null reading on the display for CO. Since the instrument does not display negative values, be careful to obtain a true null.

**E. Printer paper replacement.**

Turn the printer on. Open the paper compartment. Insert a new roll of paper. The paper should be in the direction towards use as it unrolls. Use the feed switch to advance the paper.

Keep any spare paper rolls in a cool dark place to prevent paper discoloration. Use only ENERAC thermal paper for the printer.

The printer uses a lot of battery power when operating. When the battery is fully charges it should be capable of delivering at least 60 data printouts.

# APPENDIX A

## MODEL 400X- EMS SPECIFICATIONS

## PHYSICAL:

1. CASE
   8.7" X 3.9" X 2.9" Aluminum case. Weight: 3 lbs.

2. PROBE
   13"L. X 3/8" OD. Inconel stack probe. Probe housing connects to instrument via a 10 ft. viton hose and water trap with fiber filter. Max. continuous temperature: 2000 degrees F.

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## ELECTRICAL POWER:

1. BATTERY
   6VDC. Interchangeable rechargeable NiCd (or NiMh) or four disposable AA alkaline cells. Approximately 6-8 hours operating time.

2. AC
   120V. 60 Hz. std. (220V. 50 Hz. optional), using battery charger (NiCd batteries only!)

## DISPLAY:

Four line x 16 character wide temperature range LCD with back light illumination.

## MEASURED PARAMETERS:

1. AMBIENT TEMPERATURE
   IC sensor. Degrees F or C.
   Range: 0-150 degrees F.
   Resolution: 1 degree F or C.
   Accuracy: 3 degrees F.

2. STACK TEMPERATURE
   Type K thermocouple. Degrees F. or C.

Range: 0-2000 degrees F. (1100 C).
Resolution: 1 degree F.(1 C.)
Accuracy: 5 degrees F.

3. OXYGEN
   Electrochemical cell. Life 2 years.
   Range: 0-25%
   Resolution: 0.1%
   Accuracy: 0.2%

4. NITRIC OXIDE (NO)
   Electrochemical cell. Life 2 years.
   Range: 0-2000 PPM.
   Resolution: 1 PPM
   Accuracy: 4% of reading.

5. NITROGEN DIOXIDE ($NO_2$)
   Electrochemical cell. Life 2 years.
   Range: 0-1000 PPM.
   Resolution: 1 PPM
   Accuracy: 4% of reading

6. CARBON MONOXIDE
   Electrochemical cell. Life 2 years.
   Range: 0-2000 PPM.
   Resolution: 1 PPM
   Accuracy: 4% of reading

7. SULFUR DIOXIDE
   Electrochemical cell. Life 2 years.
   Range: 0-2000 PPM.
   Resolution: 1 PPM
   Accuracy: 4% of reading

8. TIME/DATE
   Time formatted in hours, minutes, seconds. Date in month, day, year format.

## COMPUTED PARAMETERS:

1. COMBUSTION EFFICIENCY
   Heat loss method.
   Range: 0-100%
   Resolution: 0.1%
   Accuracy: 1%

2. CARBON DIOXIDE
   Range: 0-40%
   Resolution: 0.1%
   Accuracy: 5% of reading.

3. EXCESS AIR.
   Range: 0-1000%
   Resolution: 1%
   Accuracy: 10% of reading

4. OXIDES OF NITROGEN
   Range: 0-3000 PPM
   Resolution: 1 PPM
   Accuracy: 4% of reading

5. EMISSIONS 1 (CO, NO, $NO_2$, NOX, $SO_2$) LBS./MMBTU
   Range: 0.000-99.99 lbs./million BTU
   Resolution: 0.01 lbs./MMBTU
   Accuracy: 5% of reading

6. EMISSIONS 2 (CO, NO, $NO_2$, NOX, $SO_2$) GRAMS / BR. HP-HOUR
   Range: 0-99.99 grams/brake hp-hr
   Resolution: 0.01 grams/brake hp-hr
   Accuracy: 10% of reading

(Oxygen correction factor for emissions in units of PPM adjustable 0-20% in 1% steps plus TRUE).

## PRINTER:

External stand-alone ENERAC 2", 28 char. per line thermal printer.

## STORAGE:

1. INTERNAL.

   100 individually selectable buffers hold one complete set of measurements each in non-volatile memory. Buffer contents can be sent to printer or RS-232 port.

   Data storage performed either individually on command or on a pre-programmed periodic basis.

## COMMUNICATIONS:

1. RS-232 PORT
   RS-232C port (DTE), 9600 baud, half duplex, 1 start bit, 8 data bits, 1 stop bit, no parity.

2. SOFTWARE
   Over 20 software commands for diagnosis and measurement. Windows software available.

## MISCELLANEOUS:

1. FUELS
   11 fuels, Custom fuels available on request or by customer programming using Enercom™ software.

2. CALIBRATION
   Optional Auto zero. Automatic software span calibration for CO, NO, $NO_2$ and $SO_2$.