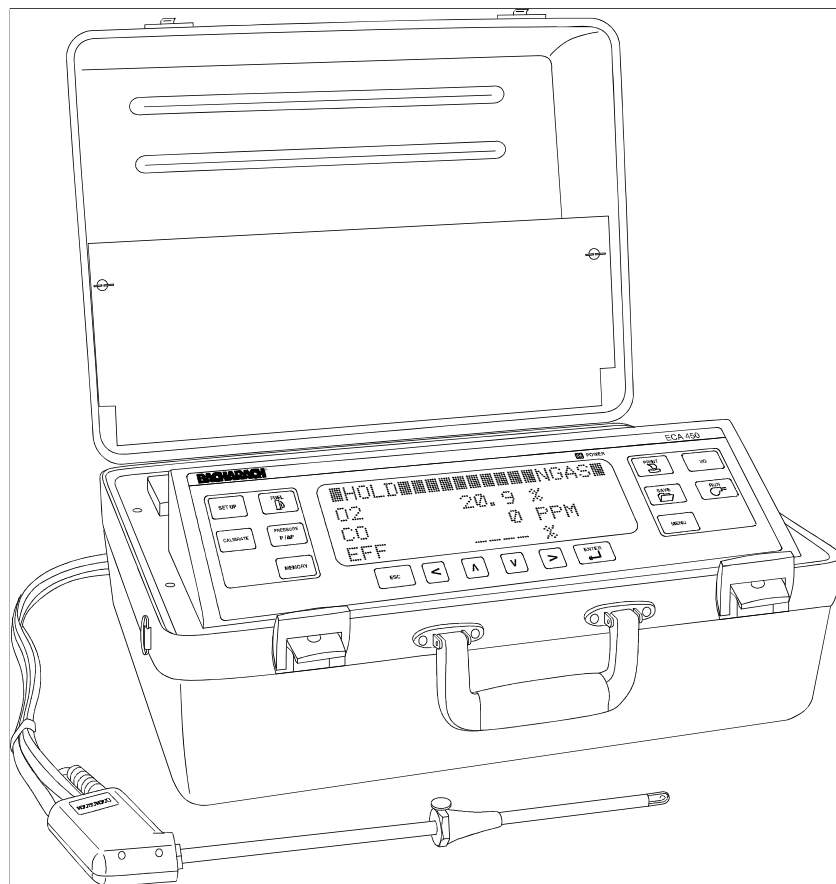




Environmental Combustion Analyzer Model 450

Instruction 0024-9400 Operation & Maintenance

Rev. 5 – May 2010



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1 Introduction

1.1 General Description

The Bacharach Environmental Combustion Analyzer Model 450 (hereafter referred to as the ECA 450) is an industrial grade environmental and combustion efficiency analyzer that is designed for the testing of fuel-burning combustion equipment. This analyzer is for furnace and boiler technicians who need to determine combustion safety, environmental compliance, and efficiency of small to large commercial industrial heating systems.

1.2 Features

- Measures and displays O₂ and CO in the flue gas, pressure (draft), primary air temperature, and stack temperature.
- Calculates combustion efficiency, excess air, and CO₂.
- Optionally measures and displays NO, NO₂, SO₂, HC (methane equivalent combustibles), and CO (in the high range of 4,000 to 80,000 ppm).
- Optionally calculates NO_x (the combination of NO and NO₂), and calculates CO, SO₂, and NO_x individually referenced to a user defined Oxygen level of between 0 and 15%.
- Automatically purges the low-range CO sensor with fresh air if the CO level exceeds 4,000 ppm. At this time the analyzer also automatically switches over to its optional high-range CO sensor, if installed.
- Automatically zeros all sensing channels on ambient air when the analyzer is first turned on.
- Displays temperature in either °C or °F.
- Displays pressure in either inches of water column (inwc), millibars (mb), Pascals (Pa), or hecto Pascals (hPa).
- Optionally displays pollution conversions for CO, NO, NO₂, and SO₂. Pollution conversions include parts per million (ppm), pounds of pollutant per million BTU (#/MBTU), milligrams of pollutant per cubic meter of gas (mg/m³), and grams of pollutant per gigajoule (g/GJ).
- Low battery warning message.
- Stores over 1000 individual combustion and/or pressure test records, which can later be recalled for viewing or printing.
- Stored test records can be downloaded to a personal computer in comma-delimited format, which can be captured as a text file and then opened in a spreadsheet program.

- Performs data logging. A series of combustion tests can be automatically started at user-defined intervals, and the data saved for reviewing at the conclusion of the logging period. The data can be stored in either the analyzer's internal memory, sent to a personal computer, or both.
- Utilizes four sources of primary-air temperature information in the following priority: 1) A thermocouple can be inserted into the primary-air stream and plugged into the analyzer's front panel T-AIR connector. 2) A primary-air temperature reading can be made with the probe's thermocouple and stored in memory. 3) An external thermometer can be used to take a primary-air temperature reading and then entered into memory using the analyzer's front panel keypad. 4) If no other primary-air temperature source is available, the analyzer defaults to an internal case temperature that is measured the on printed circuit board.
- Stores test identification that is manually entered by an operator. This information is added to the test records as they are saved, and appears within each test record when printed.
- Stores user name information that is manually entered by the owner or user of the analyzer. This information appears at the top of each printout.
- Displays information in either English, French, or Spanish.
- Can be set up to automatically turn off the front-panel display to conserve battery life.

1.3 Technical Data

The ECA 450 Directly Measures and Displays:

- Oxygen content in flue gas in the range of 0.1 to 20.9% O₂.
- Stack gas temperature in the range of -4 to 2400 °F (-20 to 1315 °C).
- Primary-air in the range of -4 to 999 °F (-20 to 999 °C).
- Pressure in the range of ±27.7 inches of water column (±69 mb).
- Carbon Monoxide content in flue gas in the range of 0 to 4,000 ppm CO (corrected for the presence of Hydrogen).

Optionally . . .

- Carbon Monoxide in the range of 4,000 to 80,000 ppm CO.
- Nitric Oxide in the range of 0 to 3,500 ppm NO.
- Nitrogen Dioxide in the range of 0 to 500 ppm NO₂.
- Sulfur Dioxide in the range of 0 to 4,000 ppm SO₂.
- Combustibles in the range of 0 to 5% gas.

The ECA 450 Calculates and Displays:

The following is true only when the measured Oxygen level is not above 16.0%, and the Stack (Flue Gas) temperature is not above 2192 °F (1200 °C)

- Combustion efficiency in the range of 0.1 to 100%.
- Excess Air in the range of 1 to 250%.
- Carbon Dioxide content in flue gas in the range of 0.1 to a fuel dependent maximum CO₂ value in percent.
- Carbon Monoxide content referenced to a user defined percentage of Oxygen in the range of 0 to 99,999 ppm CO.
- Differential pressure in the range of ±27.7 inches of water column (±69 mb).

Optionally . . .

- NOx content in the range of 0 to 4,000 ppm NOx.
- NOx content referenced to a user defined percentage of Oxygen in the range of 0 to 17,000 ppm NOx.
- Nitric Oxide content referenced to a user defined percentage of Oxygen in the range of 0 to 14,900 ppm NO.
- Nitrogen Dioxide content referenced to a user defined percentage of Oxygen in the range of 0 to 2,100 ppm NO₂.
- Sulfur Dioxide content referenced to a user defined percentage of Oxygen in the range of 0 to 17,000 ppm SO₂.

Fuels Available for Combustion Calculations:

- Natural Gas
- Oil #2
- Oil #4
- Oil #5
- Oil #6
- Propane
- Coal
- Wood
- Kerosene
- Bagasse

Normal Operating Environment:

Temperature:

Analyzer 32 to 104 °F (0 to 40 °C).
 Probe Tip..... 1472 °F (800 °C) Max.

Humidity:

Analyzer 15 to 90% Relative Humidity, non-condensing.

Air Pressure:

Analyzer Atmospheric.
 Probe..... 10" H₂O (25 mb) negative pressure max. at probe tip.

Accuracy:

Oxygen.....±0.3% O₂, on a practical concentration of flue gas (mixtures of O₂, CO₂ and N₂)

Carbon Monoxide±5% of reading or ±10 ppm, whichever is greater, between 0 and 2,000 ppm CO, and ±10% of reading between 2,001 and 40,000 ppm CO

Nitric Oxide.....±5% of reading or ±5 ppm, whichever is greater, between 0 and 2,000 ppm NO

Nitrogen Dioxide.....±5% of reading or ±5 ppm, whichever is greater, between 0 and 500 ppm NO₂

Sulfur Dioxide±5% of reading or ±10 ppm, whichever is greater, between 0 and 2,000 ppm SO₂

Combustibles.....±5% of full scale

Stack Temperature.....±4 °F between 32 and 255 °F
 (±2 °C between 0 to 124 °C)
 ±6 °F between 256 and 480 °F
 (±3 °C between 125 to 249 °C)
 ±8 °F between 481 and 752 °F
 (±4 °C between 250 to 400 °C)

Primary Air / Ambient
 Temperature±2 °F between 32 and 212 °F
 (±1 °C between 0 to 100 °C)

Pressure±2% of reading or ±0.05 mB (0.02 inches of H₂O), whichever is greater.

Front Panel Controls and Indicators:

Sixteen embossed push-button switches with tactile feedback (refer to Section 1.6). One POWER LED.

Display:

2¼"x 8", 20 character by 4 line alphanumeric vacuum-fluorescent display panel.

Power Requirements:

Internal 7.2V battery pack, or AC adapter (100–240 VAC, 50/60 Hz).

Operating Time:

A fully charged battery pack will provide at least 8 hours of continuous operation with the pump running. Unlimited operating time when using the AC adapter.

Warm Up Time:

60 seconds.

Printer:

Internal, 2¼" wide paper, 20 characters.

Materials:

- High impact ABS plastic briefcase with storage for the standard probe, instruction manual, and AC adapter.
- Nickel plated, brass quick-connect hose fittings.
- Stainless steel probe.

Dimensions:

Height: 13.5 in. (343 mm).

Width: 18.5 in. (470 mm).

Depth: 9 in. (229 mm).

Weight:

Approximately 25 lbs (11.34 kg).

1.4 Operation Overview

The ECA 450 is microprocessor controlled, allowing it to be easily operated and configured to suit each operator's individual needs. Using a system of menu selections, the operator is guided through the proper operation and set-up procedures, signaling the appropriate action, and waiting until the correct steps are taken.

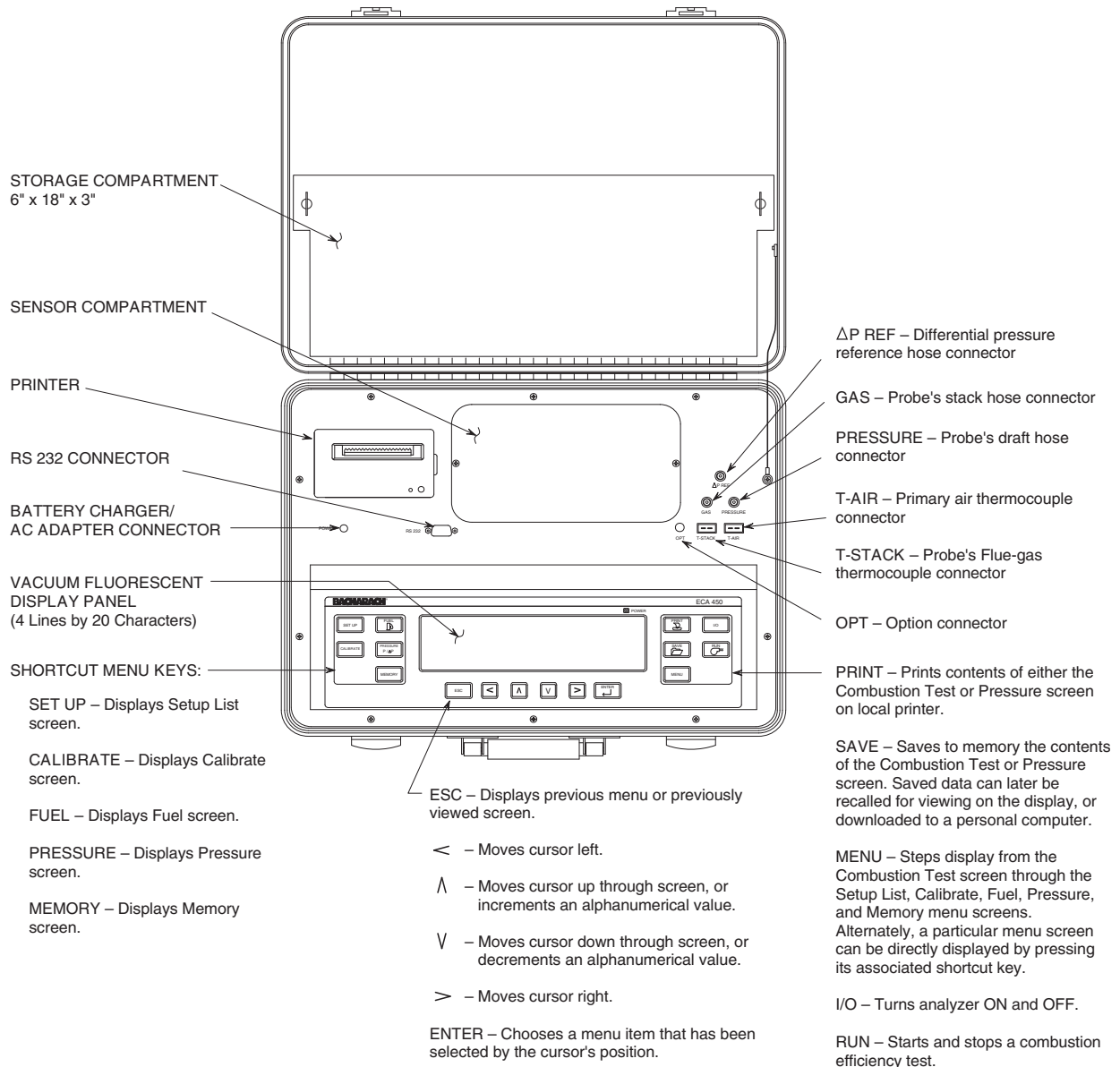
The analyzer is powered by either its internal battery pack, or by an AC adapter that operates from any convenient source of 100–240 VAC, 50/60 Hz power. The analyzer's control panel consists of a bright and easy-to-read 2¼" x 8" blue vacuum-fluorescent display, sixteen pushbuttons, and one POWER LED. A sampling probe and hose assembly with an integral thermocouple and water/filter trap provides the means of drawing in gas samples, and for measuring stack temperature and pressure.

A burner's combustion efficiency is calculated by first entering the fuel being burned and then allowing the analyzer to measure the burner's primary air temperature, stack temperature, and percent Oxygen in the flue gas. This information is processed by the analyzer, resulting in the display of all the measured and calculated values that are listed in Section *1.3 Technical Data*.

For analyzer models that are equipped for environmental monitoring of combustion by-products, the gas sample that was drawn into the analyzer through its probe is applied to an array of electrochemical gas sensors. The results of the analyzer's gas analyses are shown on the front panel display.

1.5 Front Panel Connections and Controls

Figure 1-1. ECA 450 Components



1.5.1 GAS, PRESSURE, T-STACK (Probe)

Attach the supplied probe to the analyzer by connecting its . . .

- flue-gas thermocouple to the analyzer's T-STACK connector,
- flue-gas hose (yellow band) to the analyzer's GAS connector,
- draft hose (blue band) to the analyzer's PRESSURE connector.

Observe that the probe's connectors are of different sizes and shapes, which prevent misconnection to their associated connectors on the analyzer.

1.5.2 T-AIR (Primary Air Thermocouple)

If thermocouple 0104-1797 (10 feet long) or Utility Wand 0104-1799 (12 inch ridged probe with handle and 5 foot coiled cable) is to be used to measure the burner's primary air temperature, then connect either thermocouple to the analyzer's T-AIR connector.

Refer to Section 2.14 *Primary Air Temperature Measurement* for alternate methods of measuring the burner's primary air temperature.

1.5.3 POWER (AC Adapter)

The analyzer's internal battery pack is charged by connecting the supplied AC adapter to any convenient source of 100–240 VAC, 50/60 Hz power, and then connecting the charger's output plug to the analyzer's POWER connector. Refer to Section 4.1 *Battery Charging*.

The AC adapter can also be used as an external power supply to simultaneously *charge* and *run* the analyzer if its battery pack should become depleted during use.

1.5.4 Δ P REF (Differential Pressure)

The Differential pressure between two areas can be measured by first connecting pressure hose P/N 0024-1103 to the analyzer's Δ P REF connector, and inserting the open end of this hose into the area being used as the reference pressure. The analyzer's probe is then inserted into the area who's differential pressure is to be measured. Refer to Section 2.15 *Differential Pressure Measurement*.

1.5.5 RS232 (Computer Interface)

Data that has been stored in analyzer's memory can be sent to a personal computer by connecting serial data cable P/N 0104-4027 (straight through, 6 foot, DB9 male to DB9 female) between the computer's COM port and the analyzer's RS232 connector. Refer to Section 2.11 *Downloading Data to a Personal Computer*.

1.5.6 OPT (Option)

Connector for future optional equipment.

1.6 Front Panel Keypad Controls

Descriptions of the front panel keypad controls are given below. Note that a control may perform multiple functions as determined by what screen is being displayed at the time.



Turns the analyzer ON and OFF. Note that when the analyzer is turned OFF, there is a 5 second off-delay period that allows an operator to turn the analyzer back ON by pressing the **RUN** key. Also note that if there are unsafe levels of gas present inside the analyzer when it is turned OFF, the analyzer's pump is automatically started and purges the sensor compartment with fresh air. The analyzer will turn OFF only after the gas levels have been reduced. If desired, the purging process can be aborted by again pressing the **I/O** key.



Starts and stops a combustion efficiency test when the Combustion Test RUN/HOLD screen is displayed. Pressing this key from any of the menu screens returns the analyzer to the Combustion Test HOLD screen. Pressing this key during the 5 second turn-off-delay period, or from the warm-up screen whenever sensor errors are being displayed, will also cause the Combustion Test HOLD screen to be displayed.



Prints the contents of either the Combustion Test or Pressure screen on the local printer. This key is inactive in all other screens.



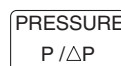
Saves the contents of the Combustion Test or Pressure screen to memory. The saved data can then later be recalled for viewing on the display and printed or downloaded to a personal computer.



Cycles the display from the Combustion Test screen through the following menu screens: Fuel, Pressure, Memory, Setup List, and Calibration List. These menu screens can also be directly accessed by pressing their associated shortcut key.



Shortcut key to the Fuel menu screen, where operators can choose which fuel is being burned.



Shortcut key to the Pressure menu screen, where operators can view the pressure being sampled by the probe. Pressing this key a *second* time allows an operator to zero the pressure sensor.



Shortcut key to the Memory menu screen, where operators can choose to either view the Memory Directory screen, transmit saved data out the analyzer's RS232 port, or clear memory.



Shortcut key to the Setup List menu screen, where operators can choose to change various operating parameters of the analyzer.

A rectangular button with rounded corners containing the word "CALIBRATE" in all caps.

Shortcut key to the Calibration List menu screen, where operators can choose the sensor to be calibrated. Note that a 4-place alphanumerical password must first be entered to begin calibration.

A rectangular button with rounded corners containing the word "ENTER" and a left-pointing arrow with a downward tick at its tail.

Selects a menu item that has been chosen by the position of the cursor. In screens that require the \wedge and \vee keys to be used to make a numerical or alphabetical selection (i.e., Date, Time, O₂ Reference., Test ID, Display Timeout, User Name, and Calibrate screens), the **ENTER** key is used to save those selections to memory.

A rectangular button with rounded corners containing the text "ESC" in all caps.

Displays a previous menu or previously viewed screen.

A rectangular button with rounded corners containing a left-pointing arrow.A rectangular button with rounded corners containing an upward-pointing arrow.A rectangular button with rounded corners containing a right-pointing arrow.A rectangular button with rounded corners containing a downward-pointing arrow.

Moves cursor in direction of arrow. In screens that require an operator to enter alphanumerical data (i.e., Date, Time, O₂ Reference., Test ID, Display Timeout, User Name, and Calibrate screens), the \wedge and \vee keys are used to scroll through the selections available for that screen.

Notes:

2 Operation

2.1 Turning On the Analyzer

Important! *Prior to initially operating the analyzer, be sure to first charge the battery per Section 4.1.*

Before turning on the analyzer, connect the probe's gas hose, pressure hose, and thermocouple to the analyzer's GAS, PRESSURE, and T-STACK connectors, respectively (refer to Section 1.5.1).

Turn on the analyzer by pressing the **I/O** key. Observe that all display segments are briefly turned on to verify their operation. The display then shows the following information as the analyzer performs its 60 second warm-up sequence:

BACHARACH, INC
ECA 450
WARM-UP xx

Where: xx = warm-up time, counting down from 60 seconds

Note: *The software's version number is briefly displayed at the bottom of the screen prior to the start of the warm-up sequence.*

At the end of a normal warm-up sequence, the message "No Problems Detected" is briefly displayed followed by the display of the Combustion Test HOLD screen. If, however, a problem was detected during warm-up, the analyzer will display the message "Problem(s) Detected" and sequentially display a list of those problems at the bottom of the screen, and then wait for operator intervention. Refer to Section 5.2 *Troubleshooting Guide* for a list of possible error messages and the recommended corrective action.

2.2 Turning Off the Analyzer

The analyzer is turned off by again pressing the **I/O** key. If there is any residual gas inside the sensor chamber, the message "Purging Sensors" is displayed while the analyzer purges itself with fresh air. The purging process continues until all gas concentrations inside the analyzer have reached safe levels.

Once the sensor chamber has been purged, the analyzer enters its normal 5-second-delay period; after which the analyzer turns off.

Important! *The probe must be removed from the stack during the purging process to allow fresh air to be drawn through the sensor chamber.*

Tips: *Pressing the **I/O** key will abort the purging process. During the off-delay period, the analyzer can be turned back on by pressing the **RUN** key.*

2.3 Fuel Selection

The fuel currently being used for combustion analysis is displayed in the top line of the Combustion Test RUN/HOLD screen.

```
«HOLD««««««««««NGAS«
```

In the above example, the current fuel is NGAS (natural gas).

Fuel Codes:

```
NGAS = Natural Gas
OIL2  = Oil #2
OIL4  = Oil #4
OIL5  = Oil #5
OIL6  = Oil #6
PROP  = Propane
COAL  = Coal
WOOD  = Wood
KERO  = Kerosene
BGAS  = Bagasse
```

To select a different fuel:

1. Press **FUEL** key to display the Fuel menu screen.

```
««««««««««FUEL««««««««
a Natural Gas
Oil#2
Oil#4
Oil#5
Oil#6
Propane
Coal
Wood
Kerosene
Bagasse
```

2. Use \wedge \vee keys to scroll through fuel list until cursor is next to desired fuel.
3. Press **ENTER** key to store the fuel selection in memory. *The corresponding fuel code should now appear in the upper-right hand corner of the Combustion Test HOLD screen.*

2.4 Performing a Combustion Test

Important! When measuring nitrogen dioxide (NO_2) and sulfur dioxide (SO_2), it is recommended that a Sampler Conditioner (Bacharach P/N 0024-7224) be used to assure accurate readings.

1. If not already done, turn on analyzer (Section 2.1) and select a fuel (Section 2.3).
2. See Figure 2-1. Make a ½-inch sampling hole in stack to accommodate probe stop. Locate this sampling hole before any draft diverter/hood or barometric damper so that flue gasses are not diluted and stack temperature has not been decreased by surrounding air used to balance the draft. *Note that as the distance between the last heat exchanger and sampling point increases, the calculated combustion efficiency will falsely increase due to heat loss by convection from the flue or stack.*
3. If burner's primary-air temperature is different from that of room air, be sure to either immerse primary-air thermocouple into primary-air stream, or take a primary-air temperature measurement using either the probe's thermocouple or a thermometer (Section 2.14).
4. See Figure 2-2. Screw probe stop into sampling hole. Next, insert probe through probe stop, positioning its tip near center of stack. Secure probe by tightening the probe stop's thumbscrew.

Figure 2-1. Sampling Hole Location

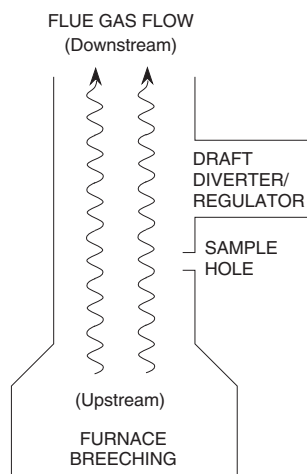
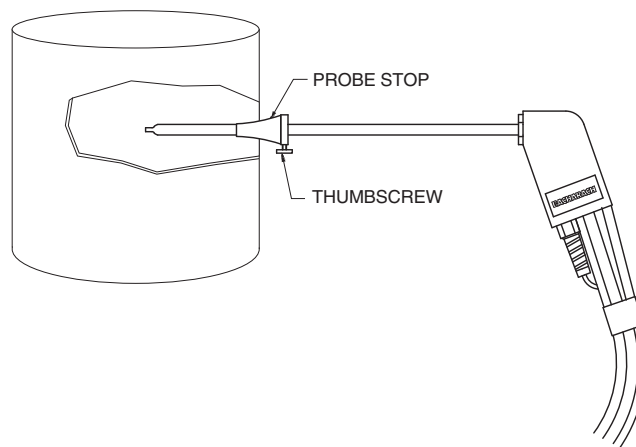


Figure 2-2. Installing the Probe



5. Press **RUN** key. You should hear the pump start running and see the word RUN appear in the upper-left hand corner of the display.
6. The ECA 450 is now continuously measuring and calculating the values shown in the Combustion Test RUN screen.

Use \wedge keys to scroll through the following typical set of data (note that depending on which sensors are installed, some of the data listed below may not be displayed).

Tip: Use < > keys to quickly advance to the top and bottom of screen.

Also note that if “— — —”, “x x x x”, or “* * * *” appear in a data field, then data cannot be displayed for that measurement. Refer to Section 5.3 *Error Symbols* for an explanation of these symbols and why data is not being displayed.

O2	=	% Oxygen
CO	=	Carbon Monoxide ⁽¹⁾
EFF	=	% Combustion Efficiency
CO2	=	% Carbon Dioxide
T-STACK	=	Stack Temperature
T-AIR	=	Room/Primary-Air Temperature
EA	=	% Excess Air
NO	=	Nitric Oxide ⁽¹⁾
NO2	=	Nitrogen Dioxide ⁽¹⁾
NOX	=	Oxides of Nitrogen (combination of NO and NO ₂) ⁽¹⁾
SO2	=	Sulfur Dioxide ^(1,3)
HC	=	% Combustibles (Methane based)
CO(n)	=	Carbon Monoxide content referenced to a percentage of Oxygen ⁽²⁾
NO(n)	=	Nitric Oxide referenced to a percentage of Oxygen ⁽²⁾
NO2(n)	=	Nitrogen Dioxide referenced to a percentage of Oxygen ⁽²⁾
NOX(n)	=	Oxides of Nitrogen (combination of NO and NO ₂) referenced to a percentage of Oxygen ⁽²⁾
SO2(n)	=	Sulfur Dioxide referenced to a percentage of Oxygen ⁽²⁾

⁽¹⁾ Unit of measure is determined by the selected Pollution Units. Refer to Section 2.17.3.

⁽²⁾ The letter “n” represents the operator’s selected Oxygen reference level of between 0 and 15%. Refer to Section 2.17.7.

⁽³⁾ The SO₂ sensor cannot be installed without the NO₂ sensor also being installed.

7. Use \wedge keys to scroll to the T-STACK reading. Loosen thumbscrew on probe stop and move probe in and out of the stack until stack’s core temperature (**hot spot**) is located; then tighten thumbscrew to prevent further movement of probe. *Locating the highest stack temperature is very important in obtaining accurate efficiency calculation results.*
8. Burner-service procedures can now begin. The readings on the analyzer will quickly change to show changes in burner performance.

- If desired, combustion test readings can be saved. Refer to Section 2.7 *Saving Test Data*.

CAUTION: *The sensors could become damaged if water enters the analyzer. Drain the water condensate in the Water-Trap / Filter Assembly as necessary during a combustion test as described in Step 10.*

- During an efficiency test, periodically check water level inside the probe's Water-Trap / Filter Assembly. With this assembly stood up on its Outlet End, do not let water condensate build up beyond tip of riser tube. Drain water condensate after every combustion test. For additional information on this subject, refer to Section 4.2 *Water-Trap / Filter Assembly*.

2.5 Ending a Combustion Test

- After performing a combustion test per Section 2.4, press **RUN** key to end the test. You should hear the pump stop running.

WARNING: *Burn hazard! Take all necessary precautions when handling a hot probe and probe stop.*

CAUTION: *Allow a hot probe and probe stop to cool before storing them inside the analyzer's carrying case.*

- Loosen thumbscrew on probe stop; then remove probe and probe stop from stack.

Note: *If data was saved during the combustion test, the analyzer can be safely turned off without losing the saved data, which can be reviewed at a later time as described in Section "2.9 Recalling Test Data Stored in Memory."*

- Turn off analyzer per Section 2.2 *Turning Off the Analyzer*.

2.6 Performing a Draft Measurement

- If not already done, turn on analyzer and place probe inside stack as previously described (Sections 2.1 and 2.4).
- Press **PRESSURE** key to display the Pressure screen.

««««««PRESSURE««««««

n.nn xxxx

Where: n.nn = current pressure reading
xxxx = pressure units (refer to Section 2.17.2)

3. If desired, pressure sensor can be zeroed at this time as described below. To skip the zeroing procedure, proceed to Step 4.
 - a) With Pressure screen displayed, again press **PRESSURE** key to display the Pressure Zero screen.

Pressure Zero

Disconnect Hose
Then Press ENTER

- b) Disconnect probe's pressure hose from analyzer's PRESSURE connector.
- c) Press **ENTER** to zero pressure sensor to atmospheric pressure; after which, reconnect probe hose that was removed in Step 3b.

Reconnect Hose

4. The Pressure screen is now displaying the stack's draft value as a negative pressure.

2.7 Saving Test Data

By pressing the **SAVE** key, data that is currently being displayed in either the Combustion Test or Pressure screen is stored in one of the analyzer's over 1000 internal memory locations. Observe that the following message appears when the **SAVE** key is pressed.

Saving Memory
Location nnnn

Where: nnnn = memory location number

At a later time, the stored data can be recalled for either viewing or downloading as described in Section 2.9 *Recalling Test Data Stored in Memory*.

Once all memory locations are filled, an attempt to save additional data will cause the message "Memory Full" to be momentarily displayed. To save additional data, memory must first be cleared per Section 2.8 *Clearing Memory*.

Tip: *Before clearing memory, its contents can be downloaded to a personal computer for permanent storage per Section 2.11.*

2.8 Clearing Memory

Clear **all** memory locations as follows:

1. Press **MEMORY** key to display the Memory menu screen.
2. Use \wedge \vee keys to place cursor next to “Clear Memory”; then press **ENTER**.

```

««««««MEMORY««««««
Memory Directory
Transmit Memory
a Clear Memory

```

3. Use \wedge \vee keys to place cursor next to “Yes” (or “No” if you decide not to clear memory); then press **ENTER**. Observe that the message “Clearing Memory . . .” appears as memory is being cleared.

2.9 Recalling Test Data Stored in Memory

To recall the contents of a particular memory location containing either combustion test data or a pressure measurement, do the following:

1. Press **MEMORY** key to display the Memory menu screen.
2. Use \wedge \vee keys to place cursor next to “Memory Directory”; then press **ENTER** to show the directory of all stored test data.

```

««««««MEMORY««««««
a Memory Directory
Transmit Memory
Clear Memory

```

3. Use \wedge \vee keys to place cursor next to memory location that contains data to be recalled. Note that memory locations are identified by the *date* and *time* the data was stored. Also note that memory locations that do not contain data are identified as “Memory Empty.”

```

Memory Directory
annnn mm/dd/yy hh:mm
nnnn Memory Empty

```

Where: nnnn = memory location number
mm/dd/yy = month/day/year
hh:mm = hour:minute

4. Press **ENTER** key to display the contents of chosen memory location.

Observe that “MEM:nnnn ” (where nnnn denotes the memory location number) appears in the top line, signifying that the data being displayed was recalled from memory. Also note that if any Test ID information was associated with the test data, this information is displayed at the bottom of the screen. Refer to Section 2.17.8 for additional information on Test ID.

```

«MEM:nnnn«««««NGAS«
O2    4.5 %
CO    12 ppm
EFF   82.2 %
CO2   9.9 %
T-STACK 374 °F
T-AIR  68 °F
.
.
.
SO2( 3)  1 ppm
xxxx

«MEM:nnnn««««««««««
PRESS -0.25 inwc
xxxx

```

Where: nnnn = memory location number
xxxx = test ID information

Tip: Use <> keys to quickly advance to the top and bottom of screen.

5. Press **ESC** to return to Memory Directory screen where another memory location can be viewed. Or press **ESC** twice to return to Memory menu screen.

2.10 Printing Data

By pressing the **PRINT** key, the data which is currently being displayed in either the Combustion Test or Pressure screen is printed on the analyzer's internal printer. Note that the contents of no other screen can be printed.

Data which has been stored in memory can also be printed by first displaying the contents of the desired memory location as described in Section 2.9 *Recalling Test Data Stored in Memory.*

Sample Printout

<pre> User Name Line 1 User Name Line 2 User Name Line 3 BACHARACH, INC. ECA 450 SN: xxxxxx ===== Test ID Line 1 Test ID Line 2 Test ID Line 3 TIME 04:27:35 pm DATE 01/20/2000 FUEL Natural Gas O2 4.0 % CO 12 ppm EFF 82.2 % CO2 9.5 % T-STACK 374 °F T-AIR 68 °F (T) EA 21 % NO 18 ppm NO2 6 ppm NOX 24 ppm SO2 1 ppm HC 0.01 % CO(3) 13 ppm NO(3) 19 ppm NO2(3) 6 ppm NOX(3) 25 ppm SO2(3) 1 ppm PRESSURE -0.02 inwc ----- COMMENTS: </pre>	<p>← User name information as entered in Section 2.17.14</p> <p>← Test identification information as entered and selected per Section 2.17.8</p> <p>← Test data as measured and calculated by the analyzer</p> <p>← Optional pressure printout as selected in Section 2.17.17</p>
---	--

2.11 Downloading Data to a Personal Computer

Test data that was stored in memory can be downloaded to a personal computer in ASCII text, comma-delimited format, which can then be imported into most spreadsheet programs for analysis.

The following describes how to download data to a computer that is running Windows®95/98, using HyperTerminal as the communications program. If a different operating system and/or communications program is being used, then consult the appropriate instruction manuals for those products.

Tip: *To install HyperTerminal, first insert the Windows 95/98 CD, then click **Start**, point to **Settings**, click **Control Panel**, double-click **Add Remove Programs**, click **Windows Setup**, double-click **Communications**, select the **HyperTerminal** check box, click **OK** twice.*

1. Install serial data cable P/N 0104-4027 (straight through, 6 foot, DB9 male to DB9 female) between the computer's COM port and the analyzer's RS232 connector. (For computers having a 25-pin COM port, either use a 25-pin to 9-pin adapter, or use a serial cable with appropriate connectors on each end.)
2. At the computer, start HyperTerminal by doing one of the following:
 - If HyperTerminal has already been set up to communicate with the ECA 450, then click **Start**, point to **Programs**, point to **Accessories**, point to **Communications**, click **HyperTerminal**, and double-click the file name or icon that has been associated with the ECA 450.
 - If HyperTerminal has never been run in association with the ECA 450, then a new HyperTerminal connection needs to be made as follows:
 - a) Click **Start**; click **Run**. In the Run box type "hypertrm.exe" and click **OK**. The **New Connection** dialog box should appear.
 - b) Type in a New Connection Name such as "ECA450". Click **OK** to select the default icon (if desired, select a different icon before clicking OK). The **Connect To** dialog box should appear.
 - c) Click the **Connect using** drop-down menu and choose the **COM** port to which the analyzer is connected. Then click **OK** to display the **COM Properties** dialog box for that COM port.
 - d) Set Port Settings to:
 - Bits per second: 19200
 - Data bits: 8
 - Parity: None
 - Stop bits: 1
 - Flow control: NoneThen click OK to display HyperTerminal's main window.
 - e) Click **File**; click **Save**. This creates a file with an .ht extension in the folder C:\Program Files\Accessories\Hyper Terminal, using the name that was entered in Step b.

3. After HyperTerminal is running: click **Transfer**, click **Capture Text**, then click **Start** to accept the default drive\directory\filename to which all received data will be stored as an ASCII text file.

Note: *By default, the captured text file will be stored on the hard drive at C:\Program Files\Accessories\HyperTerminal\CAPTURE.TXT. If desired, click **Browse** to select a different drive, directory and filename. The next time data is captured, it will be stored under the same location and filename.*

Tip: *Changing the filename extension to “CSV” (comma separated variable) will allow the file to be directly opened in the spreadsheet program. For example, double clicking the filename CAPTURE.CSV in Windows Explorer will automatically start Microsoft Excel and load the file.*

4. Press analyzer’s **MEMORY** key to display the Memory menu screen.
5. Use \wedge \vee keys to place cursor next to “Transmit Memory”; then press **ENTER** to display the “Transmit Memory” screen.

```

««««««MEMORY««««««
Memory Directory
a Transmit Memory
Clear Memory

```

6. Use \wedge \vee keys to select one of the following transmit options; then press **ENTER** to choose that option. What happens next depends on the option chosen.

```

Transmit Memory
a Last
Range
All

```

- **Last:** Immediately transmits the last memory location that contains data. Observe that the analyzer displays “Transmitting...” while also displaying the record number being transmitted.
- **Range:** When chosen, the range-select screen is displayed. By default the range is from 0 to the last memory location that contains data. To change the range, first press **ENTER** to move the cursor into the “From record” data field; Then use the \wedge , \vee , \lt , and \gt keys as necessary to enter the number of the first record to be transmitted. Again press **ENTER**, this time to save record number and move cursor back to left of screen. Repeat this procedure to change the “To record” data field. Start data transmission by moving cursor next to “Transmit” line, and then pressing **ENTER**. Observe that the analyzer displays “Transmitting...” while also displaying the record number that is currently being transmitted.
- **All:** Immediately transmits all memory locations that contain data. Observe that the analyzer displays “Transmitting...” while also displaying the record number that is currently being transmitted.

7. Observe that HyperTerminal displays the data as it's being received. After all data has been transmitted, the analyzer re-displays the Memory menu screen.

Tip: *The download process can be stopped by pressing the **ESC** key.*

8. To stop capturing data and save it, click **Transfer**, click **Capture Text**, click **Stop**.
9. HyperTerminal and the connection to the ECA 450 can now be closed.

2.12 Data Logging

When the data logging function is turned on, combustion test data is automatically stored at preset intervals over a predetermined length of time. The test data can either be: 1) sent to the analyzer's internal memory, 2) sent to a personal computer as a comma-delimited ASCII text file for storage on its hard drive, or 3) sent to both the analyzer's internal memory and a PC.

2.12.1 Turning Data Logging On

Turn on data logging and begin the logging process as follows:

1. Press **SETUP** key to display the Setup List screen.

```

«««««SETUP LIST«««««
Temperature Units
Pressure Units
Pollution Units
Language
Date
Time
O2 Reference
Test ID
Display Timeout
Display Format
Primary Air
a Data Logging
Statistics
User Name
Keypad Sound
High Res NOX Enabl
Print Pressure
Information

```

2. Use \wedge keys to place cursor next to "Data Logging"; then press **ENTER** to display the Logging screen.
3. Press \vee key to place cursor next to "On"; then press **ENTER** to display the Logging menu screen.

```

Logging
Off
a On

```

4. Use \wedge \vee keys to place cursor next to one of the following three methods of storing test data:

```

Logging
a Internal
PC
Both

```

- **Internal:** Stores test data in the analyzer's internal memory (over 1000 data sets can be saved).
- **PC:** Sends test data out the analyzer's RS232 port to a personal computer. Before using this method, however, a personal computer must be connected to the analyzer and configured to store received data on its hard drive (refer to Section 2.11 *Downloading Data to a Personal Computer*).
- **Both:** Stores test data in the analyzer's internal memory, and also sends the test data out the analyzer's RS232 port.

After choosing the logging method, press **ENTER** to make the selection and display the Logging Interval screen.

5. The default interval (the time period between measurements) is 10 minutes. To change this value, use \wedge \vee keys to select either 1, 5, 10, 15, 30 seconds, 1, 2, 5, 10, 15, 30 minutes, or 1 hour. Then press **ENTER** to make the selection and display the Logging Duration screen.

```

Logging Interval

10 min

```

6. The logging duration is the length of time allocated to collecting data. Use the \wedge \vee keys to select either 1, 5, 10, 15, 30 minutes, 1, 2, 5, 10, 24, 48, or 72 hours. Then press **ENTER** to make the selection and display the Logging Summary screen.

Note: *The duration value can never be less than the interval.*

```

Logging Duration

2 hr

```

7. The Logging Summary screen shows both the logging interval and duration as chosen in Steps 5 and 6. For example: if the interval was set to 10 minutes, and the duration set for 2 hours, then a combustion test will be conducted every 10 minutes over a 2 hour period — for a total of 12 readings. To change either the interval or duration value, press **ESC** to abort the logging process and redisplay the first Logging screen.

```

Logging Summary
Interval 10 min
Duration 2 hr
Press ENTER to start

```

8. With the analyzer set up per Section 2.4 *Performing a Combustion Test*, press **ENTER** key to begin testing and logging.

«LOG«««(0025)««NGAS«

This display shows that the analyzer is logging and currently saving data to internal memory location 25. Observe that the memory location number will increment as data is being saved. Note that if all memory locations are used *before* the end of the logging duration, then “(xxxx)” appears in place of the memory location number, indicating a memory over-range condition.

«LOG«««(-PC-)««NGAS«

This display shows that the analyzer is logging data, and that the data is being sent to only a personal computer.

Tip: *Logging can be stopped without losing data that has already been collected by pressing the **ESC** key.*

9. At the conclusion of the logging process, the message “Logging Complete” will appear. And if data was being stored in the analyzer’s internal memory, then the message “Data in memory nnnn to nnnn” will also appear — where nnnn denotes the internal memory locations that contain the logged data. Press **ENTER** to leave logging and display the Combustion Test HOLD screen.

2.12.2 Turning Data Logging Off

Data logging is automatically turned off . . .

- at the end of the logging process when the **ENTER** key pressed.
- if the logging process is interrupted by pressing the **ESC** key.

Note: *If the logging process is interrupted, it cannot be resumed without first turning logging back on per Section 2.12.1.*

2.13 Importing Saved Data Into a Spreadsheet

A text file that was created as described in either Section 2.11 *Downloading Data to a Personal Computer*, or Section 2.12 *Data Logging* can be imported into spreadsheet programs that are capable of importing comma-delimited files. Note that each data record consists of 31 fields, some of which may be blank for different tests and analyzer configurations.

TABLE 1. COMMA-DELIMITED FIELDS

Field	Data Name or Value	Label in Column Heading
1	Test ID Line 1 (up to 20 characters)	TESTID1
2	Test ID Line 2 (up to 20 characters)	TESTID2
3	Test ID Line 3 (up to 20 characters)	TESTID3
4	Fuel Name	FUEL
5	Temperature Unit of Measure used in fields 14 &15	TEMP UNIT
6	Pressure Unit of Measure used in field 31	PRESS UNIT
7	Pollution Unit of Measure used in fields 11, 18 thru 21, 24, 26, 27, 28 & 30	POLL UNIT
8	Date of Test	DATE
9	Time of Test	TIME
10	O ₂ Concentration in %	O2
11	CO Concentration	CO
12	Combustion Efficiency in %	EFF
13	CO ₂ Concentration in %	CO2
14	Stack Temperature	TSTACK
15	Primary Air Temperature Measurement Source	TAIR SOURCE
16	Primary Air Temperature	TAIR
17	Excess Air in %	EA
18	NO Concentration	NO
19	NO ₂ Concentration	NO2
20	NO _x Concentration	NOX
21	SO ₂ Concentration	SO2
22	Hydrocarbon (combustibles) Level in % Gas	HC
23	O ₂ Reference for CO in Field 24	CO(O2R)
24	CO Concentration Referenced to O ₂	CO(O2)
25	O ₂ Reference for NO, NO ₂ and NO _x in Fields 26, 27 & 28	NOX(O2R)
26	NO Concentration Referenced to O ₂	NO(O2)
27	NO ₂ Concentration Referenced to O ₂	NO2(O2)
28	NO _x Concentration Referenced to O ₂	NOX(O2)
29	O ₂ Reference for SO ₂ in Field 30	SO2(O2R)
30	SO ₂ Concentration Referenced to O ₂	SO2(O2)
31	Pressure (Draft) Measurement	PRESSURE

TABLE 2. TYPICAL SPREADSHEET FOR THE ECA 450*

TESTID1	TESTID2	TESTID3	FUEL	TEMP UNIT	PRESS UNIT
Customer Name	Address	Burner Number	Natural Gas	°F	inwc
Customer Name	Address	Burner Number			inwc

POLL UNIT	DATE	TIME	O2	CO	EFF	CO2	TSTACK	TAIR SOURCE
ppm	01/14/00	2:45:30 PM	4	12	82.2	9.5	374	(T)

TAIR	EA	NO	NO2	NOX	SO2	HC	CO(O2R)	CO(O2)
68	21	18	6	24	1	0.01	3	13

NOX(O2R)	NO(O2)	NO2(O2)	NOX(O2)	SO2(O2R)	SO2(O2)	PRESSURE
3	19	6	25	3	1	-0.25
						-0.25

- * Line 1: Column Headings
 Line 2: Typical Combustion Test Record with Pressure
 Line 3: Typical Pressure-Only Measurement

The following describes how to generate a spreadsheet from a comma-delimited text file using Microsoft Excel 97. If you are using a different spreadsheet program, then please refer to its instruction manual for information on how to import comma-delimited text files.

Tip: *If the text file was saved with the filename extension "CSV" as described in Section "2.11 Downloading Data to a Personal Computer," a spreadsheet will automatically be created when that file is opened in Microsoft Excel 97.*

1. Start Microsoft Excel 97.
2. Click **File**, then click **Open** to display the **Open** dialog box.
3. Change the **Files of type:** to **Text Files**. Then navigate to the directory containing the text file to be imported.
4. Double-click the desired filename to display the *Text Import Wizard – Step 1 of 3* dialog box.
5. Select the **Delimited** radio button; then click **Next** to display the *Text Import Wizard – Step 2 of 3* dialog box.
6. Under **Delimiters**, select the **Comma** check box. Then click **Next** to display the *Text Import Wizard – Step 3 of 3* dialog box.
7. Click **Finish** to create the spreadsheet.

2.14 Primary Air Temperature Measurement

To properly calculate net stack temperature, the analyzer must know the burner's primary air temperature. The following sections describe four methods of measuring and supplying this temperature value to the analyzer.

2.14.1 Thermocouple Method

A thermocouple that is plugged into the T-AIR connector (see Figure 1-1) provides the analyzer with the most up-to-date primary air temperature information for combustion efficiency calculation purposes. Refer to Section 1.5.2 *T-AIR*.

If the burner's primary-air supply is being drawn in from the room, then simply place the thermocouple where it can sample room air. If, however, the air supply is being drawn in from an outside source, where the temperature is different from that of room air, then immerse the thermocouple into the burner's primary-air stream.

Note that when a thermocouple is plugged into the T-AIR connector, its temperature reading takes priority over all other methods of temperature measurement.

When viewing the T-AIR value on the Combustion Test HOLD/RUN screen, the designation (T) will appear to the left of the temperature value. The letter "T" signifies that a *Thermocouple* is being used to measure the primary air temperature.

For example:
T-AIR 86.5 °F (T)

2.14.2 Probe Thermocouple Method

This method has an operator taking a one-time primary air temperature measurement using the probe's T-STACK thermocouple, and then storing the measurement in the analyzer's temperature memory buffer.

When viewing the T-AIR value on the Combustion Test HOLD/RUN screen, the designation (M) will appear to the left of the temperature value. The letter "M" signifies that the primary air temperature value was *Measured*.

For example:
T-AIR 86.5 °F (M)

Measure the primary air temperature using the probe's thermocouple, and store that measurement as follows:

1. Press **SETUP** key to display the Setup List screen.

- Use Δ and ∇ keys to place cursor next to “Primary Air”; then press **ENTER** to display the Primary Air screen.

Note: The message “Primary Air is measured by TC” will appear if a thermocouple is plugged into the T-AIR socket. This thermocouple must be removed to continue this procedure.

```

««««SETUP LIST««««
Temperature Units
Pressure Units
Pollution Units
Language
Date
Time
O2 Reference
Test ID
Display Timeout
Display Format
a Primary Air
Data Logging
Statistics
User Name
Keypad Sound
High Res NOX Enabl
Print Pressure
Information
  
```

- Use Δ and ∇ keys to place cursor next to “Measure”; then press **ENTER** to display the message “Place probe in primary air stream then press ENTER.”

```

Primary Air
a Measure
Enter
  
```

```

Place probe in
primary air stream
then press ENTER
  
```

- As instructed above, place probe into primary air stream; then press **ENTER** to display the probe’s current temperature measurement.

```

Primary Air
Temperature
XXX.X °F
Press ENTER to save
  
```

Where: XXX.X = the temperature being measured by the probe.

- Wait until temperature display stabilizes; then press **ENTER** to save the displayed temperature value in the analyzer’s temperature memory buffer and return to the Setup List screen.

Note: The temperature memory buffer is cleared when the analyzer is turned off, or when the T-AIR thermocouple is installed after the measured number is saved.

2.14.3 Thermometer Method

This method has an operator taking a one-time primary air temperature measurement using a thermometer, and then manually entering the measurement into the analyzer's temperature memory buffer.

When viewing the T-AIR value on the Combustion Test HOLD/RUN screen, the designation (E) will appear to the left of the temperature value. The letter "E" signifies that the primary air temperature value was manually *Entered*.

For example:

T-AIR 86.5 °F (E)

Measure the primary air temperature using a thermometer, and manually enter that value as follows:

1. Use a thermometer to measure the primary air temperature.
2. Press **SETUP** key to display the Setup List screen.
3. Use \wedge \vee keys to place cursor next to "Primary Air"; then press **ENTER** to display the Primary Air screen.

Note: *The message "Primary Air is measured by TC" will appear if a thermocouple is plugged into the T-AIR socket. This thermocouple must be removed to continue this procedure.*

```

«««««SETUP LIST«««««
Temperature Units
Pressure Units
Pollution Units
Language
Date
Time
O2 Reference
Test ID
Display Timeout
Display Format
a Primary Air
Data Logging
Statistics
User Name
Keypad Sound
High Res NOX Enabl
Print Pressure
Information
  
```

4. Use \wedge \vee keys to place cursor next to "Enter"; then press **ENTER** to display the Primary Air Temperature screen.

```

          Primary Air
Measure
a Enter
  
```

5. Press **ENTER** to move the cursor into the temperature data field; then use the \wedge , \vee , $<$, and $>$ keys as necessary to enter the temperature value that was measured in Step 1. Note that leading zeros should be entered as either a numerical 0 or a blank space.

For example: a primary air temperature of 35.5 °F should be entered as 035.5 in the display.

Primary Air
Temperature
035.5 °F

6. Press **ENTER** to save the displayed temperature value in the analyzer's temperature memory buffer and return to the Setup List screen.

Note: *The temperature memory buffer is cleared when the analyzer is turned off, or when the T-AIR thermocouple is installed after the entered number is saved.*

2.14.4 Internal Temperature Sensor Method

If a thermocouple is *not* plugged into the T-AIR connector, and there is *no data* stored in the temperature memory buffer, then the analyzer defaults to the instrument's internal temperature as measured on the main printed circuit board.

When viewing the T-AIR value on the Combustion Test HOLD/RUN screen, the designation (I) will appear to the left of the temperature value. The letter "I" signifies that the primary air temperature value was measured *Internally*.

For example:
T-AIR 86.5 °F (I)

2.15 Differential Pressure Measurement

To measure the differential pressure between two confined areas, do the following:

1. Press **PRESSURE** key to display the Pressure screen.

««««««PRESSURE««««««

n.nn xxxx

Where: n.nn = current pressure reading
xxxx = pressure units (refer to Section 2.17.2)

2. If desired, the pressure sensor can be zeroed as described below. To skip the zeroing procedure, proceed to Step 3.
 - a) With Pressure screen displayed, again press **PRESSURE** key to display the Pressure Zero screen.

Pressure Zero

Disconnect Hose
Then Press ENTER

- b) Disconnect all hoses from the ΔP REF and PRESSURE connectors. *This step ensures that both of these connectors are sampling the same pressure.*
 - c) Press **ENTER** to zero pressure sensor to atmospheric pressure; after which, reconnect probe hose that was removed in Step 3b.

Reconnect Hose

3. Connect pressure hose assembly P/N 0024-1103 to analyzer's ΔP REF connector (see Figure 1-1). Then insert open end of this hose into area being used as the reference pressure.
4. Insert probe into area whose pressure is to be measured.
5. The Pressure screen is now displaying the differential pressure between the two areas. Positive readings indicate that the pressure of the area being measured is higher than the reference area, while negative readings indicate the pressure is lower than the reference.

2.16 Statistics Mode

The Statistics mode configures the ECA 450 to perform a statistical analysis of measured emissions data taken over a preset interval and duration. At the end of the prescribed duration, the average and standard deviation are calculated for each gas measured and shown on the front panel display.

Turn ON the Statistics mode and begin the statistical analysis process as follows:

1. Press the **SETUP** key to display the Setup List screen.

««««SETUP LIST««««
Temperature Units

Pressure Units
 Pollution Units
 Language
 Date
 Time
 O2 Reference
 Test ID
 Display Timeout
 Display Format
 Primary Air
 Data Logging
^a Statistics
 User Name
 Keypad Sound
 High Res NOX Enabl
 Print Pressure
 Enhanced Printout
 Information

2. Use \wedge \vee keys to place cursor next to “Statistics”; then press **ENTER** to display the Statistics screen.
3. Press \vee key to place cursor next to “On”; then press **ENTER** to display the Statistics Interval screen.

Statistics

Off

^a On

4. The default interval (the time period between measurements) is 10 seconds. To change this value, use the \wedge \vee keys to select 1, 5, 10, 15, 30 seconds, 1, 2, 5, 10, 15, 30 minutes, or 1 hour. Then press **ENTER** to make the selection and display the Statistics Duration screen.

Statistics Interval

10 sec

5. The statistics duration is the length of time allocated to collecting data. Use \wedge \vee keys to select desired duration; then press **ENTER** to make the selection and display the Statistics Summary screen.

Note: *The minimum and maximum duration values are dependent on the interval. The duration can never be less than the interval, and cannot record more than 120 readings.*

Statistics Duration

5 min

6. The Statistics Summary screen shows both the interval and duration as chosen in Steps 4 and 5. For example: if the interval was set to 10 seconds, and the duration set for 5 minutes, then emission data will be collected every 10 seconds over a 5 minute period — for a total of 30 readings from which the average and standard deviation are calculated. To change the value of either the interval or duration, press **ESC** to redisplay the first Statistics screen and repeat Steps 3, 4 and 5.

```

Statistics Summary
Interval 10 sec
Duration 5 min
Press ENTER to start

```

7. With the analyzer set up per Section 2.4 *Performing a Combustion Test*, press **ENTER** to begin collecting data for statistical analysis. Before data is collected, however, the ECA 450 first waits 60 seconds to allow the sensor readings to stabilize.

```

Stabilizing Sensors

START in 60 SEC

```

After 60 seconds as elapsed, the front panel now shows the data as it's being collected. Use the \wedge \vee keys to scroll through the readings on the display.

```
«STAT«(0010)«««NGAS«
```

In this example, the top line of the display shows that the analyzer is in its statistics mode; currently taking reading #10; with natural gas as the fuel. Observe that the reading number increments as data is being collected at the chosen interval and stored in memory.

Tip: Press **ESC** to abort the statistical analysis process. At this time the Statistics mode is turned OFF and the message "Stats Interrupted" is displayed. Press **ENTER** to return to the Combustion Test HOLD screen.

8. At the conclusion of the data collection process, the ECA 450 calculates the average and standard deviation values of the emissions data just recorded. A Final Statistics screen then appears that shows the average and one standard deviation of each gas measured; the number of readings taken; and the duration of the test. Use the \wedge \vee keys to scroll through the readings on the display.

If a sensor goes into over range or the calculated standard deviation exceeds 999.9, the display will show "----" or "xxxxx" respectively for the average and standard deviation.

```

««Final Statistics««
  AVG 1SD
O2(%) 14.5 0.3
CO(ppm) 10 1.3
NO(ppm) 37 0.3
NO2(ppm) 6 0.3
NOX(ppm) 43 1.5
SO2(ppm) 0 0.0
HC(%) 0.10 0.01
# or Rdgs 30
Duration 5 min

```

In this example, the average oxygen reading was 14.5% with a one standard deviation of 0.3 — meaning that there is a 68% chance the oxygen readings taken during the sampling duration were between 14.2 and 14.8% (AVG \pm 1SD), and a 95% chance the oxygen readings were between 13.9 and 15.1% (AVG \pm 2SD).

9. If desired, press **PRINT** to obtain a hard copy of the Final Statistics screen.

Note: *The data shown in the Final Statistics screen cannot be saved.*

10. Press **ENTER** to display the Combustion Test HOLD screen. At this time the Statistics mode is automatically turned OFF and all statistical data is erased.

2.17.1 Temperature Units

Select to display the temperature in either degrees centigrade (C) or Fahrenheit (F) as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Temperature Units”; then press **ENTER** to display the Temperature Units screen.

```

Temperature Units
  °C
a  °F
  
```

3. Place cursor next to either “°C” or “°F”; then press **ENTER** to make the selection and return to Setup List screen.

2.17.2 Pressure Units

Select to display pressure units in either inches of water column (inwc), millibars (mb), Pascals (Pa), or hecto Pascals (hPa) as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Pressure Units”; then press **ENTER** to display the Pressure Units screen.

```

Pressure Units
a inwc
  mb
  Pa
  hPa
  
```

3. Use \wedge \vee keys to place cursor next to either “inwc”, “mb”, “Pa”, or “hPa”; then press **ENTER** to activate selection and return to Setup List screen.

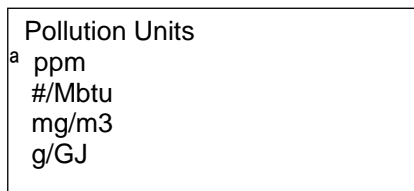
2.17.3 Pollution Units

The analyzer is capable of converting the measured ppm levels of CO, NO, NO₂, and SO₂ to various pollution units using CFR40 Part 60 emission factors. Note that the pollution-unit conversions for NO, NO₂ and NO_x are based on the molecular weight of NO₂.

Select to display the measured levels of CO, NO, NO₂, and SO₂ in either parts per million (ppm), pounds of pollutant per million BTU (#/Mbtu), milligrams of pollutant per cubic meter of gas (mg/m³), or grams of pollutant per gigajoule (g/GJ) as follows:

4. Press **SETUP** key to display the Setup List screen.

5. Use \wedge \vee keys to place cursor next to “Pollution Units”; then press **ENTER** to display the Pollution Units screen.



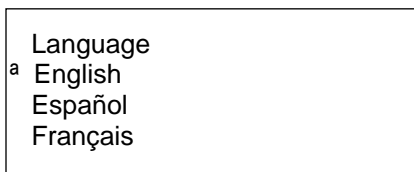
```
Pollution Units
a ppm
#/Mbtu
mg/m3
g/GJ
```

6. Use \wedge \vee keys to place cursor next to either “ppm”, “#/Mbtu”, “mg/m³”, or “g/GJ”; then press **ENTER** to make the selection and return to Setup List screen.

2.17.4 Language

Information on the display screen can be shown in either English, Spanish, or French. Select the desired language as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Language”; then press **ENTER** to display the Language screen.




```
Language
a English
Español
Français
```

3. Use \wedge \vee keys to place cursor next to either “English”, “Español”, or “Français”; then press **ENTER** to activate selection and return to Setup List screen

2.17.5 Date

The date is stored in the format: month, day, year (MM/DD/YY). Set the analyzer’s internal clock to the current date as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Date”; then press **ENTER** to display the analyzer’s current date setting.



```
Date
a 05/30/00
```

3. Press **ENTER** to stop clock and move cursor over first digit of date display.

4. Press > key to place cursor on the month, day, or year digit to be changed; then, use \wedge \vee keys to set that digit to desired number. Repeat this step until all digits are set correctly.
5. Press **ENTER** to save selections and start clock. Then press **ESC** to return to Setup List screen.

2.17.6 Time

Time is stored in the format HH:MM:SS am/pm. Set the analyzer's internal clock to the current time as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to "Time"; then press **ENTER** to display the analyzer's current time setting.

Time
^a 11:45:30 am

3. Press **ENTER** to stop clock and move cursor over first digit of time display.
4. Press > key to place cursor over the hour, minute, or second digit to be changed. Then, use \wedge \vee keys to set that digit to the desired number. Repeat this step until all digits are set correctly.
5. To change am/pm setting, first use the > key to place cursor over first letter of am or pm; Then use the \wedge \vee keys to select correct value.
6. Press **ENTER** to save selections and start clock. Then press **ESC** to return to Setup List screen.

2.17.7 O₂ Reference

The calculated values of CO, NO_x, and SO₂ can be individually referenced to a specific Oxygen percentage of between 0 and 15%. Set up an Oxygen reference for each gas as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to "O₂ Reference"; then press **ENTER** to display the O₂ Reference menu.

O ₂ Reference
^a CO Ref to O ₂
NO _x Ref to O ₂
SO ₂ Ref to O ₂

- Use $\wedge v$ keys to place cursor next to the desired gas whose Oxygen reference is to be set; then press **ENTER** to display the O₂ Reference screen for that gas.

CO Ref to O ₂
n %

Where: n = Oxygen reference

- Use $\wedge v$ keys to choose desired Oxygen reference value from 0 to 15%.
- Press **ENTER** to make the selection and return to O₂ Reference gas menu screen.
- Repeat Steps 3 thru 5 for remaining gases.
- After an Oxygen reference has been set for each gas, press **ESC** to return to the Setup List screen.

2.17.8 Test ID

Test records can be identified (e.g., the customer's name, burner number, and location) by manually entering up to three lines of text, with each line containing a maximum of 20 alphanumerical characters. This information will be associated with all succeeding test records, and will appear at the top of each test record when printed, and at the bottom of saved test records when viewed on the display. The chosen Test ID remains in effect until such time as the Test ID is unselected, a new Test ID is selected, or the instrument is shut off.

Up to 32 Test IDs can be pre-entered for later retrieval.

All pre-entered Test IDs can be downloaded to a personal computer as an ASCII text file for storage and printing.

2.17.8.1 Enter / Edit Test ID Information

Enter or edit Test ID information as follows:

- Press **SETUP** key to display the Setup List screen.
- Use $\wedge v$ keys to place cursor next to "Test ID"; then press **ENTER** to display the Test ID menu.

Test ID
Select Test ID
^a Edit Test ID
Transmit Test ID
Clear Test ID

- Use \wedge \vee keys to place cursor next to “Edit Test ID”; then press **ENTER** to display the Edit Test ID menu, which shows the first line of each Test ID record.

```

Edit Test ID
a 0 Customer1
  1 .....
  2 .....

31 .....

```

Note: Five periods (. . . .) are used to identify empty lines.

- Use \wedge \vee keys to choose which Test ID record to edit; then press **ENTER** to display all three lines of that record.

```

Edit Test ID
a Customer1
  Address
  Burner Location

```

- Use \wedge \vee keys to choose which of the three Test ID lines to edit; then press **ENTER** to begin editing that line.
- Use \wedge \vee keys to display first desired character. Then press > key to move to next character position. Repeat this step until line is complete (maximum of 20 alphanumerical characters).
- When finished, press **ENTER** to save information and move cursor back to left of screen.
- At this time, either return to Step 5 to choose another line to edit, or end this procedure by pressing the **ESC** key as necessary to return to the Setup List screen.

2.17.8.2 Select Test ID

Choose which pre-entered Test ID to use as follows:

- Press **SETUP** key to display the Setup List screen.
- Use \wedge \vee keys to place the cursor next to “Test ID”; then press **ENTER** to display the Test ID menu.

```

Test ID
a Select Test ID
  Edit Test ID
  Transmit Test ID
  Clear Test ID

```

- Use \wedge \vee keys to place cursor next to “Select Test ID”; then press **ENTER** to display the Select Test ID menu, which shows the first line of each Test ID record.

```

Select Test ID
a 0 Customer1
  1 .....
  2 .....

31 .....
    NO Test ID

```

Note: Five periods (. . . .) are used to identify empty records.

- Use \wedge \vee keys to choose a pre-entered Test ID, or choose “NO Test ID” to deselect a previously chosen record; then press **ENTER** to make the selection and return to the Test ID menu.

Note: NO Test ID is automatically selected when the analyzer is turned on.

- Press **ESC** to end this procedure and return to Setup List screen.

2.17.8.3 Transmit Test ID

Before the Test ID information can be transmitted, a personal computer must be connected to the analyzer and set up to receive the data. (refer to Section 2.11 Downloading Data to a Personal Computer).

Download all pre-entered Test ID records to a personal computer as follows:

- Press **SETUP** key to display the Setup List screen.
- Use \wedge \vee keys to place cursor next to “Test ID”; then press **ENTER** to display the Test ID menu.

```

Test ID
Select Test ID
Edit Test ID
a Transmit Test ID
Clear Test ID

```

- Use \wedge \vee keys to place cursor next to “Transmit Test ID”; then press **ENTER** to start transmitting. At this time the analyzer displays “Transmitting...” while also displaying the Test ID number that is currently being transmitted.

```

Transmitting...

Test ID #: 0
Press ESCAPE to END

```

- Observe that the computer displays the data as it is being received. After all data has been transmitted, the analyzer re-displays the Test ID menu.
- The computer’s communication program and the connection to the ECA 450 can now be closed.
- Press **ESC** to end this procedure and return to Setup List screen.

2.17.8.4 Clearing Test ID Information

Clear all or individual pre-entered Test ID information from memory as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Test ID”; then press **ENTER** to display the Test ID menu.

```

Test ID
Select Test ID
Edit Test ID
Transmit Test ID
a Clear Test ID
  
```

3. Use \wedge \vee keys to place the cursor next to “Clear Test ID”; then press **ENTER** to display the Clear Test ID menu.

```

Clear Test ID
a Individual Records
All Records
  
```

4. Do one of the following to either clear *individual* records or *all* records:

- **Individual Records:** Use \wedge \vee keys to place cursor next to “Individual Records”; then press **ENTER** to display the Clear Individual menu. Again use \wedge \vee keys, this time to choose the record to clear; then press **ENTER** to clear that record.

```

Clear Individual
a 0 Customer1
1 .....
2 .....

31 .....
  
```

- **All Records:** Use \wedge \vee keys to place cursor next to “All Records”; then press **ENTER** to display the Clear All menu. Again use the \wedge \vee keys, this time to choose “Yes”; then press **ENTER** to clear all records.

```

Clear All
a No
Yes
  
```

5. Press **ESC** to end this procedure and return to Setup List screen.

2.17.9 Display Timeout

To conserve battery life, the vacuum fluorescent display panel can be configured to turn itself off after 5 to 60 minutes of keyboard inactivity. Select the display’s time-delay off period as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Display Timeout”; then press **ENTER** to show the Display Timeout screen.

Display Timeout
n

Where: n = current timeout period

3. Use \wedge \vee keys to select desired timeout period in 5 minute increments from “Never” (no timeout) to “60” minutes; then press **ENTER** to make the selection and return to Setup List screen.

2.17.10 Display Format

The order in which data is displayed in the Combustion Test HOLD/RUN screen can be rearranged to better suit an operator’s needs. The default order of this data is as follows:

Note: *Depending on what sensors are installed, some of the data listed below may not be displayed.*

O2	=	% Oxygen
CO	=	Carbon Monoxide
EFF	=	% Combustion Efficiency
CO2	=	% Carbon Dioxide
T-STACK	=	Stack Temperature
T-AIR	=	Room/Primary-Air Temperature
EA	=	% Excess Air
NO	=	Nitric Oxide
NO2	=	Nitrogen Dioxide
NOX	=	Oxides of Nitrogen (combination of NO and NO ₂)
SO2	=	Sulfur Dioxide
HC	=	% Combustibles (Methane based)
CO(n)	=	Carbon Monoxide content referenced to a percentage of Oxygen
NO(n)	=	Nitric Oxide referenced to a percentage of Oxygen
NO2(n)	=	Nitrogen Dioxide referenced to a percentage of Oxygen
NOX(n)	=	Oxides of Nitrogen (combination of NO and NO ₂) referenced to a percentage of Oxygen
SO2(n)	=	Sulfur Dioxide referenced to a percentage of Oxygen

2.17.10.1 Changing Display Format

Change the order in which the data is displayed in the Combustion Test HOLD/RUN screen as follows:

Note: *Changing the order of the Combustion Test Data as displayed on the analyzer’s front panel **does not** change the order in which the data is printed or downloaded.*

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Display Format”; then press **ENTER** to show Display Format screen.

```

Display Format
a Edit Format
Reset Format

```

3. Use \wedge \vee keys to place cursor next to “Edit Format”; then press **ENTER** to show Edit Display Format screen, where the current order of the Combustion Test Data is shown numbered from 0 to 23.

```

Edit Display Format
a 0 O2
  1 CO
  2 EFF

23

```

4. Change data shown for a particular location by first using \wedge \vee keys to place cursor next to desired numbered location. Next, press **ENTER** to move cursor into that location’s data field; then use \wedge \vee keys to choose desired data to appear at that location. Finally, press **ENTER** to make the selection and move cursor back to left of screen.
5. Change data displayed at other numbered locations by repeating Step 4.
6. When finished, press **ESC** as necessary to return to Setup List screen.

2.17.10.2 Resetting Display Format Back to Factory Default

Return the display format back to its factory-default order as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Display Format”; then press **ENTER** to show Display Format screen.

```

Display Format
Edit Format
a Reset Format

```

3. Use \wedge \vee keys to place cursor next to “Reset Format”; then press **ENTER** to show Reset Display Format screen.
4. Use \wedge \vee keys to choose “Yes”; then press **ENTER** to reset the display and return to the Display Format screen.

```

Reset Display Format
No
a Yes

```

5. When finished, press **ESC** to return to the Setup List screen.

2.17.11 Primary Air

Refer to Section 2.14 *Primary Air Temperature Measurement*.

2.17.12 Data Logging

Refer to Section 2.12 *Data Logging*.

2.17.13 Statistics

Refer to Section 2.16 *Statistics Mode*.

2.17.14 User Name

The name of the user or owner of the analyzer (e.g., company name, address, and phone number) can be stored in memory by manually entering up to three lines of text, with each line containing up to 20 alphanumeric characters. This information will appear at the top of each printout, until such time as new information is entered.

2.17.14.1 Enter / Edit User Name Information

Enter or edit a User Name as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge keys to place cursor next to “User Name”; then press **ENTER** to display the User Name menu.

User Name
^a Edit User Name
Clear User Name

3. Use \wedge keys to place cursor next to “Edit User Name”; then press **ENTER** to display the Edit User Name menu, which shows the three User Name lines that can be edited.

Edit User Name
^a ABC Heating
Street Address
Town

Note: *Five periods (. . . .) are used to identify blank lines.*

4. Use \wedge keys to choose which User Name line to edit; then press **ENTER** to begin editing that line.
5. Use \wedge keys to display the first desired character. Then use the > key to move cursor to the next character’s position. Repeat this step until the line is complete (maximum of 20 characters).
6. When finished, press **ENTER** key to save the information just entered and redisplay the User Name menu.
7. At this time, either return to Step 4 to choose another line to edit, or end this procedure by pressing **ESC**.

2.17.14.2 Clear User Name Information

Clear all User Name information as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “User Name”; then press **ENTER** to display the User Name menu.

```
User Name
Edit User Name
a Clear User Name
```

3. Use \wedge \vee keys to place cursor next to “Clear User Name”; then press **ENTER** to display the Clear User Name confirmation screen.
4. Use \wedge \vee keys to choose “Yes”; then press **ENTER** to clear all information.

```
Clear User Name
No
a Yes
```

5. When finished, press **ESC** to return to the Setup List screen.

2.17.15 Keypad Sound

The audible sound used to signal when a keypad button is pressed can be turned off and on as follows:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Keypad Sound”; then press **ENTER** to display the Keypad Sound menu screen.

```
Keypad Sound
Off
a On
```

3. Use \wedge \vee keys to place cursor next to either “Off” or “On”; then press **ENTER** to make the selection and return to the Setup List screen.

2.17.16 High Resolution NO_x Enable

When High Resolution NO_x Enable is turned ON the ECA 450 will display the values of NO, NO₂ and NO_x at a resolution of 0.1 ppm when the values of these gases are <100 ppm. When a gas value becomes ≥100 ppm, the resolution for that gas switches to 1 ppm.

When High Resolution NO_x Enable is turned OFF, the display resolution for NO, NO₂ and NO_x is always 1 ppm.

Turn High Resolution NO_x Enable ON or OFF as follows:

1. Press **SETUP** key to display the Setup List screen.

```

«««««SETUP LIST«««««
Temperature Units
Pressure Units
Pollution Units
Language
Date
Time
O2 Reference
Test ID
Display Timeout
Display Format
Primary Air
    Data Logging
    Statistics
User Name
Keypad Sound
a High Res NOX Enabl
Print Pressure
Enhanced Printout
Information
    
```

2. Use Δ keys to place cursor next to “High Res NOX Enabl”; then press **ENTER** to display the High Res NOX Enable screen.
3. Use Δ keys to place cursor next to “On” or “Off”; then press **ENTER** to make the selection and be returned to the Setup List screen.

```

High Res NOX Enable
Off
a On
    
```

4. Press **RUN** to exit the Setup List screen and display the Combustion Test HOLD screen. Combustion efficiency and emissions testing can now be performed as described in Section 2.4 *Performing a Combustion Test*.
5. When High Resolution NOx Enable is turned ON, and when viewing the Combustion Test RUN screen, observe in the example screens below that if the value of NO, NO₂, or NO_x is <100 ppm, then the resolution is 0.1 ppm, but when a gas value is ≥100 ppm the resolution becomes 1 ppm.

```

«RUN««««««««««NGAS«
NO    18.3 ppm
NO2   6.7 ppm
NOX   25.0 ppm
    
```

```

«RUN««««««««««NGAS«
NO    131 ppm
NO2   73.0 ppm
NOX   204 ppm
    
```

2.17.17 Print Pressure

To choose whether or not the pressure reading is printed on the combustion test printout (refer to Section 2.10 *Printing Data*), do the following:

1. Press **SETUP** key to display the Setup List screen.

2. Use \wedge \vee keys to place cursor next to “Print Pressure”; then press **ENTER** to display the Print Pressure screen.

```
Print Pressure
a No
Yes
```

3. Use \wedge \vee keys to place cursor next to either “No” or “Yes”; then press **ENTER** to make the selection and return to the Setup List screen.

2.17.18 Information

To display the analyzer’s Serial Number, Part Number, Software Version, and optional sensor(s) installed, do the following:

1. Press **SETUP** key to display the Setup List screen.
2. Use \wedge \vee keys to place cursor next to “Information”; then press **ENTER** to display the Information screen. *Note that the information displayed for your particular analyzer will vary from the one shown below.*

```
Information
SN: EU1165
PN: 24-7221
Version: 1.00
Options:
COHI NO NO2 SO2 HC
```

3. Press **ESC** to return to the Setup List screen.

3 Calibration

Bacharach recommends that the ECA 450 be calibrated by your nearest Bacharach Service Center (refer to Section 6.3). The analyzer, however, can be calibrated in the field if your facility has the necessary equipment and qualified personnel to perform the procedures described in this section.

Important! *To prevent the loss of data during calibration, perform the following procedures with a fully charged battery pack, or with the AC adapter connected to the analyzer.*

3.1 Initial Sensor Check

Important! *Before turning on the analyzer or performing any of the calibration procedures, ensure that the analyzer will be sampling fresh air and the probe is at room temperature.*

When the analyzer is first turned on and allowed to cycle through its 60 second warm-up period, and while sampling fresh air, the sensors are checked (read) and calibrated (set) to the following ambient conditions:

- Oxygen sensor spanned to 20.9%
- All remaining gas sensors are zeroed
- Pressure sensor zeroed

If a sensor is found to be in error during warm up, an error message will appear at the bottom of the screen describing the nature of the problem (refer to Section 5.4 *Troubleshooting Guide*). Correct any sensor errors before proceeding with these calibration procedures.

3.2 Calibration Fixtures

A gas and pressure fixture will be required to perform the various calibration procedures described in the sections that follow.

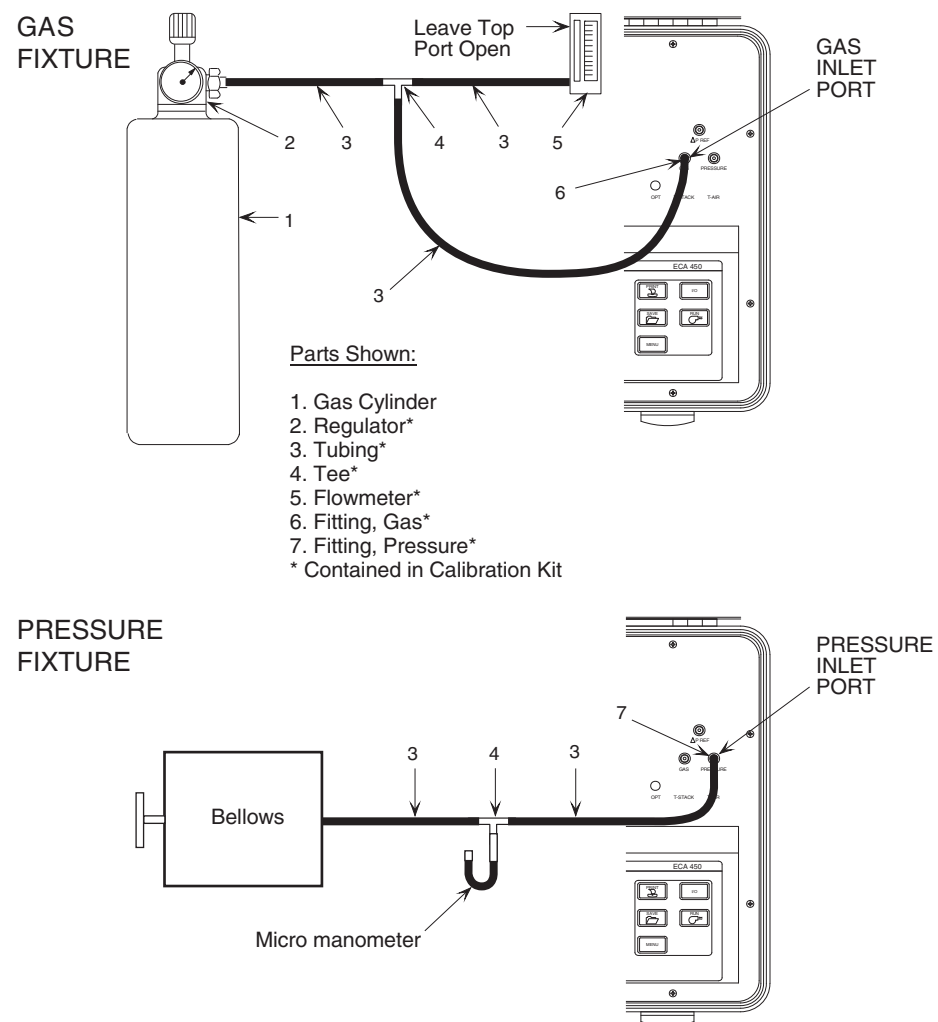
Parts Required:

- Calibration Kit (refer to Section 6.2)
- Calibration Gas (refer to Section 6.2)
- Bellows
- Micro manometer

Procedure:

Assemble the appropriate fixture as required by the calibration procedure being performed. See Figure 3-1.

Figure 3-1. Calibration Fixtures



3.3 Starting and Ending a Calibration Procedure

Start any calibration procedure by first pressing the **CALIBRATE** shortcut key. Before calibration can begin, however, a 4-place alphanumerical password must be entered. Enter the password by first pressing the **ENTER** key, and then using the $\wedge \vee$ and $< >$ keys until the correct password is displayed.

Note: *The calibration password is provided on a separate card supplied with the analyzer.*

```
««««CALIBRATION«««««
«  PASSWORD ----
```

Again press the **ENTER** key. If the correct password was entered, the following Calibration List screen will appear.

Note: *Sensors that are not installed will not appear in the Calibration List.*

```
««CALIBRATION LIST««
a Pressure
  T-Stack
  T-Air
  HC
  CO-LO
  SO2
  NO
  NO2
  CO-HI
```

Use $\wedge \vee$ keys until cursor is in front of desired calibration function; then press **ENTER** to display that function's corresponding Calibrate screen.

After the desired calibration procedures have been completed, press the **ESC** key to return to the Combustion Test HOLD screen.

3.4 Calibrate Pressure Sensor

This procedure calibrates the pressure sensor to a known pressure value.

Material Required:

- Calibration Pressure Fixture (Section 3.2)
- Bellows (adjustable)
- Micro manometer Range: ± 8 in. H₂O column (± 20 mb)
 Accuracy: ± 0.01 H₂O column (± 0.025 mb)

Procedure:

1. Enter Calibration List screen; then choose Pressure per Section 3.3 to display the PRESSURE CALIBRATE screen.

2. With the Calibrate Pressure screen displayed, and with the hose from the calibration fixture connected to the analyzer's PRESSURE port, adjust the bellows for a micro manometer reading of -4 in. H₂O column (-10 mb).
3. Wait until the Measured reading on the screen stabilizes. Then use the \wedge and $\lt \gt$ keys to enter an Applied value that equals the micro manometer reading.

The calibration range is from -6 to -2 in. H₂O column (-15 to -5 mb). An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate Pressure Screen During Calibration:

```
«CALIBRATE PRESSURE«
Measured -3.40 inwc
Applied -4.00 inwc
```

4. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.
5. Remove calibration equipment.

3.5 Calibrate T-Stack (Stack Temperature) Channel

The following procedure first *zeros* and then *spans* the stack-temperature channel to known temperature values.

Material Required:

- Thermocouple Simulator (K-type) Range: 0 to 600 °F
Accuracy: ±0.5 °F

TS-Zero Procedure:

1. Adjust simulator to 32 °F (0 °C).

The calibration range is from 32 to 41 °F (0 to 5 °C). Any attempt to calibrate outside this range will cause the message "Bad Calibration Entry" to appear.

2. Plug simulator's K-type connector into analyzer's **T-STACK** jack (see Figure 1-1).
3. Enter Calibration List screen; then choose T-Stack per Section 3.3 to display the CALIBRATE TS-ZERO screen.

- Wait until Measured reading on screen stabilizes. Then use the \wedge and $<$ $>$ keys to enter an Applied value of 32 °F (0 °C).

Typical Calibrate TS-Zero Screen During Calibration:

«CALIBRATE TS-ZERO««
Measured 31°F
Applied 032°F

- Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear followed by the CALIBRATE TS-SPAN screen.

TS-Span Procedure:

- Adjust simulator to 572 °F (300 °C).

The calibration range is from 175 to 625 °F (79 to 329 °C). Any attempt to calibrate outside this range will cause the message "Bad Calibration Entry" to appear.

- Wait until Measured reading on screen stabilizes. Then use the \wedge and $<$ $>$ keys to enter an Applied value of 572 °F (300 °C).

Typical Calibrate TS-Span Screen During Calibration:

«CALIBRATE TS-SPAN««
Measured 560°F
Applied 572°F

- Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear followed by the Calibration List screen being redisplayed.
- Remove calibration equipment.

3.6 Calibrate T-Air (Ambient Temperature) Channel

The following procedure first *zeros* and then *spans* the ambient-temperature channel to known temperature values.

Material Required:

- Thermocouple Simulator (K-type) Range: 0 to 600 °F
Accuracy: ± 0.5 °F

TA-Zero Procedure:

- Adjust simulator to 32 °F (0 °C).

The calibration range is from 32 to 41 °F (0 to 5 °C). Any attempt to calibrate outside this range will cause the message "Bad Calibration Entry" to appear.

2. Plug simulator's K-type connector into analyzer's **T-AIR** jack (see Figure 1-1).
3. Enter Calibration List screen; then choose T-Air per Section 3.3 to display the CALIBRATE TA-ZERO screen.
4. Wait until Measured reading on screen stabilizes. Then use the \wedge and $< >$ keys to enter an Applied value of 32 °F (0 °C).

Typical Calibrate TA-Zero Screen During Calibration:

«CALIBRATE TA-ZERO««
Measured 31.2°F
Applied 032.0°F

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear followed by the CALIBRATE TA-SPAN screen.

TA-Span Procedure:

6. Adjust simulator to 212 °F (100 °C).

The calibration range is from 194 to 230 °F (90 to 110 °C). An applied value entry that is outside this range will cause the message "Bad Calibration Entry" to appear.

7. Wait until Measured reading on screen stabilizes. Then use the \wedge and $< >$ keys to enter an Applied of 212 °F (100 °C).

Typical Calibrate TA-Span Screen During Calibration:

«CALIBRATE TA-SPAN««
Measured 200.0°F
Applied 212.0°F

8. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.
9. Remove calibration equipment.

3.7 Calibrate HC Sensor

The following procedure spans the optional combustibles sensor to a known gas level.

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 2.5% CH₄ (50% LEL Methane) (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose HC per Section 3.3 to display the CALIBRATE HC screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach a CH₄ calibration gas cylinder to the analyzer's GAS inlet port.
3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the ^v and < > keys to enter an Applied value that equals the concentration stamped on the CH₄ gas cylinder.

The calibration range is from 1 to 3%. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate HC Screen During Calibration:

«««CALIBRATE HC«««	
Measured	1.93 %
Applied	2.50 %

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

6. Turn off regulator; then remove gas cylinder from calibration fixture.

3.8 Calibrate CO-LO Sensor

This screen is used to span the Carbon Monoxide Low channel (0 – 4,000 ppm CO) to a known gas level. This procedure also includes H₂ compensation.

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 500 ppm CO in air (refer to Section 6.2)
- Gas Cylinder: 1000 ppm CO & 1000 ppm H₂ in Nitrogen (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose CO-LO per Section 3.3 to display the CALIBRATE CO-LO screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach a CO-only calibration gas cylinder to the analyzer's GAS inlet port.

3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the \wedge and $<>$ keys to enter an Applied value that equals the concentration stamped on the CO gas cylinder.

The calibration range is from 10 to 1500 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate CO-LO Screen During Calibration:

```

«««CALIBRATE CO-LO«««
Measured  493 ppm
Applied   00500 ppm
  
```

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the Test Gas CO/H2 screen is displayed.
6. Turn off regulator on CO calibration gas cylinder; then remove gas cylinder from calibration fixture.
7. Attach a combination CO and H₂ calibration gas cylinder to calibration fixture.
8. Use the \wedge and $<>$ keys to enter a CO value that equals the CO concentration stamped on the gas cylinder. Then press **ENTER** to display the Calibrate H2 screen.

Typical Testgas CO/H2 Screen During Calibration:

```

«««TESTGAS CO/H2«««««
-----
CO value  1000
Enter CO value
  
```

9. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
10. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the \wedge and $<>$ keys to enter an Applied value that equals the H₂ concentration stamped on the gas cylinder.

The calibration range is from 400 to 1500 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate H2 Screen During Calibration:

```

««««CALIBRATE H2«««««
Measured  985 ppm
Applied   01000 ppm
  
```

11. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

12. Turn off regulator; then remove gas cylinder from calibration fixture.

3.9 Calibrate SO₂ Sensor

This procedure spans the optional Sulfur Dioxide sensor to a known gas level.

Note: *The SO₂ sensor cannot be installed without the NO₂ sensor also being installed.*

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 100 ppm SO₂ (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose SO₂ per Section 3.3 to display the CALIBRATE SO₂ screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach an SO₂ calibration gas cylinder to the analyzer's GAS inlet port.
3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the \wedge and $<>$ keys to enter an Applied value that equals the concentration stamped on the SO₂ gas cylinder.

The calibration range is from 10 to 150 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate SO₂ Screen During Calibration:

«««CALIBRATE SO2««««
Measured 98 ppm
Applied 00100 ppm

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

6. Turn off regulator; then remove gas cylinder from calibration fixture.

3.10 Calibrate NO Sensor

The following procedure spans the optional Nitric Oxide sensor to a known gas level.

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 250 ppm NO in Nitrogen (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose NO per Section 3.3 to display the CALIBRATE NO screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach an NO calibration gas cylinder to the analyzer's GAS inlet port.
3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the ^v and < > keys to enter an Applied value that equals the concentration stamped on the NO gas cylinder.

The calibration range is from 10 to 550 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate NO Screen During Calibration:

««««CALIBRATE NO««««
Measured 235 ppm
Applied 00250 ppm

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

6. Turn off regulator; then remove gas cylinder from calibration fixture.

3.11 Calibrate NO₂ Sensor

This screen is used to span the optional Nitrogen Dioxide sensor to a known gas level.

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 100 ppm NO₂ (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose NO₂ per Section 3.3 to display the CALIBRATE NO₂ screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach an NO₂ calibration gas cylinder to the analyzer's GAS inlet port.
3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the \wedge and $<>$ keys to enter an Applied value that equals the concentration stamped on the NO₂ gas cylinder.

The calibration range is from 10 to 150 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate NO₂ Screen During Calibration:

«««CALIBRATE NO2««««
Measured 98 ppm
Applied 00100 ppm

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

6. Turn off regulator; then remove gas cylinder from calibration fixture.

3.12 Calibrate CO-HI Sensor

This procedure spans the optional Carbon Monoxide High sensor (4,000 – 80,000 ppm CO) to a known gas level.

Material Required:

- Calibration Gas Fixture (Section 3.2)
- Gas Cylinder: 4,000 ppm CO in air (refer to Section 6.2)

Procedure:

1. Enter Calibration List screen; then choose CO-HI per Section 3.3 to display the CALIBRATE CO-HI screen. *At the conclusion of this step the pump should be running.*
2. Using the Gas Fixture shown in Figure 3-1, attach a CO calibration gas cylinder to the analyzer's GAS inlet port.
3. Adjust regulator of calibration fixture for a flowmeter indication of approximately 2 SCFH.
4. Wait until Measured reading on screen stabilizes (approximately 3 minutes). Then use the \wedge and $<>$ keys to enter an Applied value that equals the concentration stamped on the CO gas cylinder.

The calibration range is from 250 to 11,000 ppm. An applied value that is outside this range will cause the message "Bad Calibration Entry" to appear.

Typical Calibrate CO-HI Screen During Calibration:

«««CALIBRATE CO-HI««
Measured 3890 ppm
Applied 04000 ppm

5. Press **ENTER** to calibrate the analyzer's Measured value to that of the Applied value; after which the message "Good Calibration" should appear along with the Calibration List screen being redisplayed.

If the message "Sensor Output Low" or "Sensor Not Calibrated" appears, refer Section "5.4 Troubleshooting Guide."

6. Turn off regulator; then remove gas cylinder from calibration fixture.

4 Maintenance

Field maintenance of the ECA 450 is limited to the following:

- Battery charging
- Water Trap Filter replacement
- Printer Paper replacement
- Sensor replacement
- Cleaning the probe
- Resetting the microprocessor
- Replacing the internal particulate filter

All other maintenance should be performed by an authorized Bacharach Service Center (Section 6.3).

4.1 Battery Charging

A fully charged battery pack will power the analyzer for a minimum of 8 hours. When the battery pack is just about depleted, the message “LOW BATTERY” will appear at the bottom of the screen; after which, the analyzer will operate from 5 to 15 minutes before automatically shutting itself off.

Recharge the analyzer’s internal battery pack by first plugging the supplied AC adapter in a source of 100–240 VAC, 50/60 Hz power. A green LED on the adapter should glow, indicating that it is operational. Then insert the adapter’s output plug into the analyzer’s POWER connector (Figure 1-1).

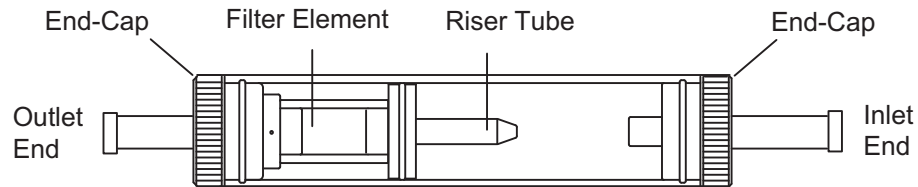
A fully discharged battery pack should take approximately 11 hours to recharge. Note that a protection circuit within the analyzer prevents the battery pack from being over charged.

If the battery pack becomes depleted while the analyzer is being used, or if a continuous run time of over 8 hours is required, then the AC adapter can be used to both run the analyzer and charge the battery pack at the same time.

4.2 Water-Trap / Filter Assembly

The Water-Trap / Filter Assembly removes water condensate from the gas sample, and also prevents soot from contaminating the internal components of the analyzer.

Figure 4-1. Water Trap / Filter Assembly



Drain the water condensate after every use.

Procedure:

1. Pull off end-cap from inlet end of the Water-Trap / Filter Assembly.
2. Pour out all of the water condensate; then replace end-cap.

Replace the filter element when it becomes excessively dirty.

Parts Required:

- Filter Element (refer to Section 6.1)

Procedure:

1. Pull off end-cap from outlet end of Water-Trap / Filter Assembly.
2. Remove and discard old filter element.
3. Install a new filter element; then replace end-cap.

4.3 Printer Paper Replacement

Parts Required:

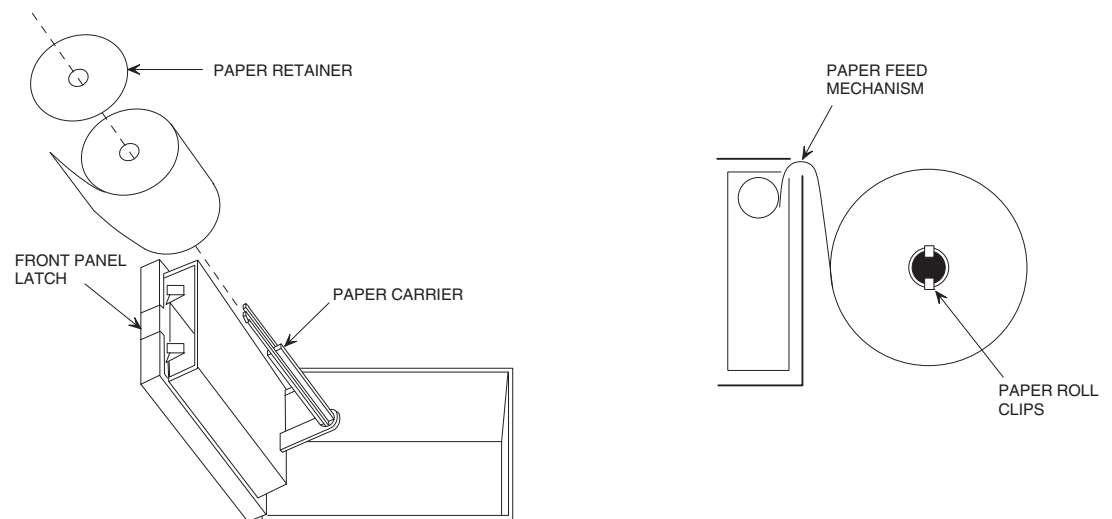
- Replacement Paper Roll (refer to Section 6.1)

Procedure:

1. Open printer by pressing the printer's front-panel latch. See Figure 4-2.
2. The paper-roll carrier is mounted on the rear of the printer's front panel and will swing out when the printer is opened.
3. Pinch in the two paper-roll clips at end of paper carrier; then remove paper-retainer disk and empty roller from carrier.
4. Install a new paper roll and the paper-retainer disk onto the paper carrier.
5. With analyzer turned on, position paper at entry point of printer's feed mechanism. The paper will be sensed by the mechanism and be automatically fed through the printer and into the proper position for printing.

Tip: To correct for minor paper misalignment, press the printer's front panel paper-feed button until the paper self aligns.

Figure 4-2. Installing Printer Paper



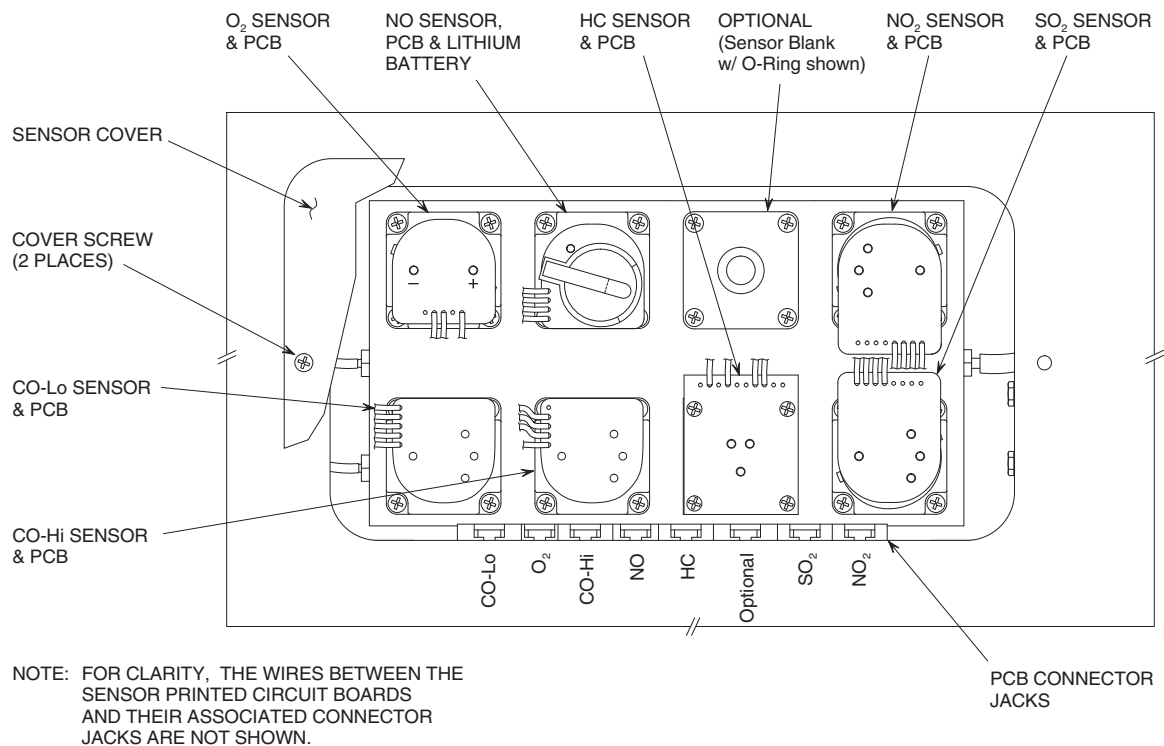
4.4 Sensor Replacement

The following sections described in detail how to replace the various sensors located in the analyzer's sensor compartment. Refer to Figure 4-3 for the location and positioning of those sensors.

Note: When a sensor-error message appears at the bottom of the screen (refer to Section "5.2 Problem Messages Displayed After Warm-Up"), it does not necessarily mean that the sensor has become depleted or is defective. Before replacing a sensor, refer to Section "5.4 Troubleshooting Guide" for other possible causes of the error.

Caution: Static damage. When handling any printed circuit board, be sure to follow all established industry procedures for the prevention of static buildup that when discharged may damage electrical components on the board.

Figure 4-3. Sensor Compartment



4.4.1 O₂, CO, NO, NO₂, & SO₂ Sensor Replacement

All sensors, with the exception of the HC sensor, are replaced in a similar manner. Do the following to replace either the O₂, CO-LO, CO-HI, NO, NO₂, or SO₂ sensor.

Material Required:

- Medium Phillips screwdriver
- Replacement sensor (refer to Section 6.1)

Procedure:

1. Remove two screws from sensor-cover plate, and then remove plate to gain access to sensor compartment. See Figure 4-3.
2. Unplug the printed circuit board from the sensor being replaced by carefully pulling the board straight up.
3. Note position of sensor pins; then release sensor from its bayonet-type holder by turning the sensor counterclockwise. Remove sensor by pulling it straight up.

Note: *Discard an old sensor in accordance with local and federal hazardous waste disposal laws.*

4. Remove replacement sensor from its plastic canister. Note that the CO-LO, CO-HI, SO₂, and NO₂ sensors have a shorting-spring installed between two of their pins. Remove and discard this spring before installing the sensor.
5. Insert sensor into its holder and turn clockwise to lock in place. Ensure that the sensor pins are positioned as was noted in Step 3.
6. Plug the circuit board, which was removed in Step 2, into the top of the sensor.

Important! *When replacing the O₂ sensor, be sure that the “+” sensor pin plugs into the circuit board socket that is also marked “+”. Polarity markings are located on the bottom of the printed circuit board and the sensor.*

7. Install sensor-cover plate that was removed in Step 1.
8. Allow the sensor that was just installed time to stabilize in the circuit before continuing with this procedure. Stabilization time for all sensors (except for the NO sensor) is about *1 hour*. An NO sensor requires approximately *4 hours* to stabilize.
9. Place analyzer in an area of fresh air and turn it ON. After its warm-up cycle completes, observe that no sensor error messages should have appeared.
10. Calibrate the new sensor per Section 3 (except the O₂ sensor which does not require calibration).

4.4.2 Nitric Oxide Sensor Battery Replacement

A single lithium battery, located on top of the Nitric Oxide printed circuit board, applies a bias voltage to the NO sensor to prevent the sensor from destabilizing when the analyzer is turned off. This battery has a life expectancy of at least 2 years.

Replace the Nitric Oxide bias battery toward the end of its life expectancy, or when its voltage drops below 2 volts.

Tip: *Replace the bias battery whenever the NO sensor is replaced.*

Material Required:

- Medium Phillips screwdriver
- Bias battery (refer to Section 6.1)

Procedure:

1. Remove two screws from sensor-cover plate, and then remove plate to gain access to sensor compartment. See Figure 4-3.
2. Remove old battery from its holder on the Nitric Oxide printed circuit board.
3. Insert new battery (positive side facing upwards) into holder.
4. Install sensor-cover plate that was removed in Step 1.
5. Before powering up and using the analyzer, allow the Nitric Oxide sensor to stabilize as described below. Note that recalibration of the Nitric Oxide sensor is not required after replacing its bias battery.

Depending on how long the Nitric Oxide sensor was without bias voltage, the time required for the sensor to completely stabilize varies from less than a minute to several days. Typical stabilization times are shown below. Generally, however, the sensor is sufficiently stable after 4 hours for measurement purposes.

Bias removed for . . .	Stabilization time
Less than 15 minutes	Less than 1 minute
Less than 1 hour	Less than 5 minutes
Less than 2 days	Less than 4 hours
Greater than 2 days	Up to 2 days

4.4.3 HC Sensor Replacement

Unlike the other sensors that are held in place by their associated bayonet holders, the HC sensor is plugged into its printed circuit board which, in turn, is secured inside the sensor compartment with four screws. Remove this board and replace the sensor as follows:

Material Required:

- Medium Phillips screwdriver
- Small flat blade screwdriver
- Replacement HC sensor (refer to Section 6.1)

Procedure:

1. Gain access to sensor compartment by first removing two screws from the sensor-cover plate, and then removing plate (see Figure 4-3).
2. Unplug the HC sensor's printed circuit board from its connector jack.
3. Remove the sensor's printed circuit board by first removing the board's four corner screws, and then lifting the board with the HC sensor attached out from the sensor compartment.
4. Unplug old sensor and discard.
5. Remove replacement sensor from its plastic canister; then plug sensor into its printed circuit board.
6. Install and secure the HC sensor's circuit board inside the sensor compartment using the screws removed in Step 3.
7. Install sensor-cover plate that was removed in Step 1.
8. Place analyzer in an area of fresh air and turn it ON. After the warm-up cycle completes, observe that no sensor error messages should have appeared.
9. Calibrate the new sensor per Section 3.

4.5 CO & NO Sensor Filter Replacement

To increase the life of the CO-LO, CO-HI, and NO sensors, it is recommended that their filters be replaced at least once a year, or sooner if their ppm-hours are above the values given below.

Recommended CO-LO, CO-HI, and NO Sensor Filter Replacement

(These are estimates, and will vary dependent on application):

CO-LO Sensor Filter 350,000 ppm-hours of NO & SO₂ combined
CO-HI Sensor Filter 2,000,000 ppm-hours of NO & SO₂ combined
NO Sensor Filter..... 4,000 ppm-hours of NO₂

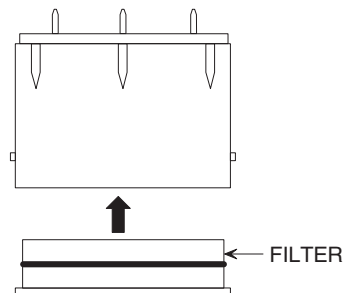
Material Required:

- Medium Phillips screwdriver
- Small flat blade screwdriver
- Replacement filters for the CO-LO, CO-HI, and NO sensors (refer to Section 6.1)

Procedure:

1. Gain access to sensor compartment by first removing two screws from the sensor-cover plate, and then removing plate (see Figure 4-3).
2. Unplug CO-LO sensor's printed circuit board by carefully pulling board straight up.
3. Note position of sensor pins; then release sensor from its bayonet-type holder by turning sensor counterclockwise. Remove sensor by pulling it straight up.
4. Using a small flat blade screwdriver, carefully pry off the sensor's filter and discard (see Figure 4-4).
5. Install a new filter; then reinstall sensor and its printed circuit board.
6. Repeat this procedure for remaining sensors.

Figure 4-4. CO-LO, CO-HI, and NO Sensor Filter Replacement



4.6 Replacing Internal Particulate Filter

An internal particulate filter is located at the inlet of the pump to protect the pump in the event dirt is drawn into the analyzer's GAS inlet. Under normal operating conditions, the probe's water trap / filter assembly should catch all dirt particles large enough to damage the pump. But if the probe's filter fails or is disconnected, the internal particulate filter will provide backup protection.

Do the following to replace the internal particulate filter:

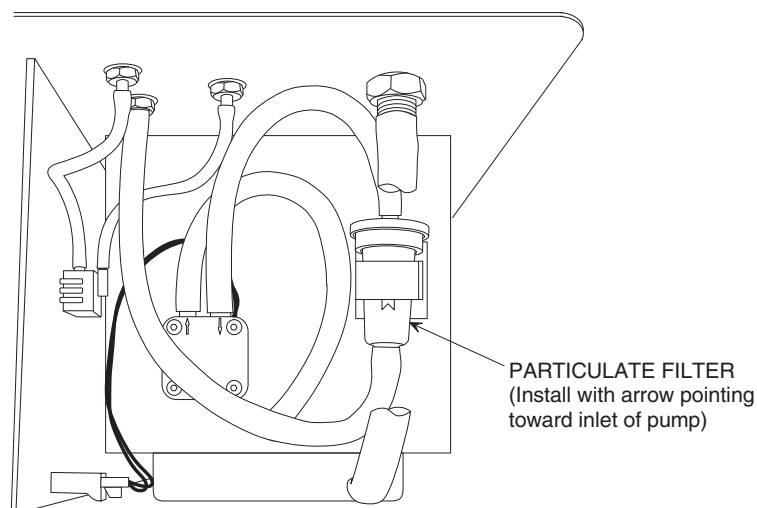
Material Required:

- Medium Phillips screwdriver
- Replacement Internal Particulate Filter (refer to Section 6.1)

Procedure:

1. Turn off analyzer and remove screws from control panel.
2. Lift up front of control panel to gain access to the particulate filter located on the right-hand side of the analyzer. See Figure 4-5.
3. Remove tubing from old filter; then discard filter.
4. Install tubing onto new filter, being sure to position the filter so that its flow-arrow points toward the pump. Then reinstall control panel.

Figure 4-5. Replacing the Internal Particulate Filter



4.7 Cleaning the Probe and Sampling Hoses

If the combustion analyzer is used on either coal or oil fired burners, particulates can accumulate within the probe and sampling hoses. These particulates may, in time, build up and restrict the flow of gas into the analyzer. Note that the probe's water trap's filter element should prevent soot from reaching the analyzer's internal components. While using the combustion analyzer, the type of fuels that cause the most dirt and how often the system needs to be cleaned will become evident.

Equipment Required:

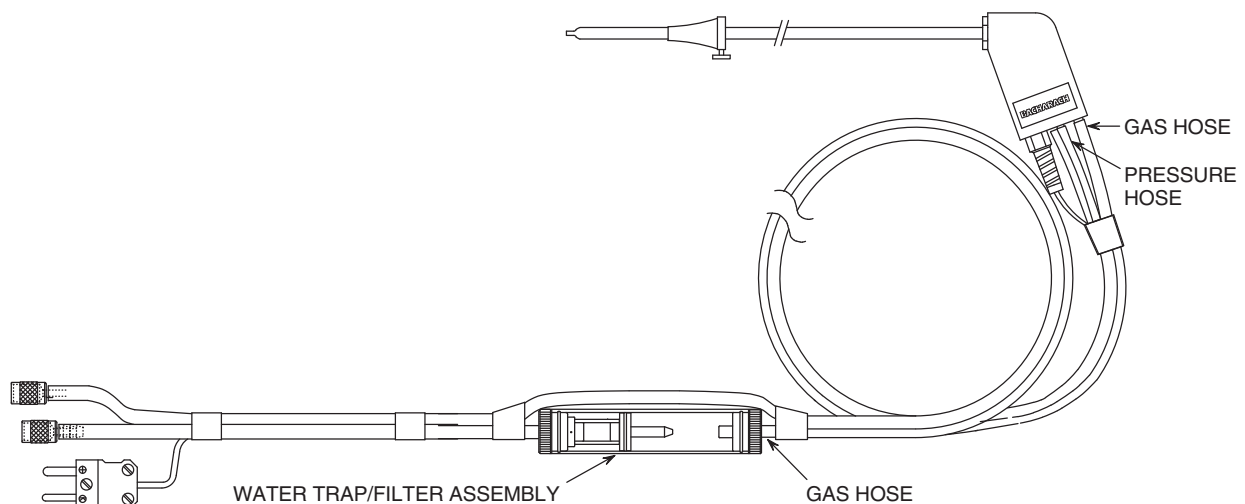
- Aerosol can of automotive carburetor cleaner
- Alcohol
- Mild liquid detergent
- Method of forcing water through sampling hoses (see text)
- Clean rags
- Source of compressed air (optional)

Procedure:

1. If not already done, disconnect the probe's gas and pressure fittings and its thermocouple connector from the analyzer.
2. Remove gas and pressure hoses from barbed fittings on probe handle and gas hose from the water trap / filter assembly (Figure 4-6).

CAUTION: *Carburetor cleaner attacks plastic and rubber components. Take precautions not to spray carburetor cleaner onto the probe handle, sampling hoses, or analyzer.*

Figure 4-6. Cleaning the Probe and Sampling Hoses



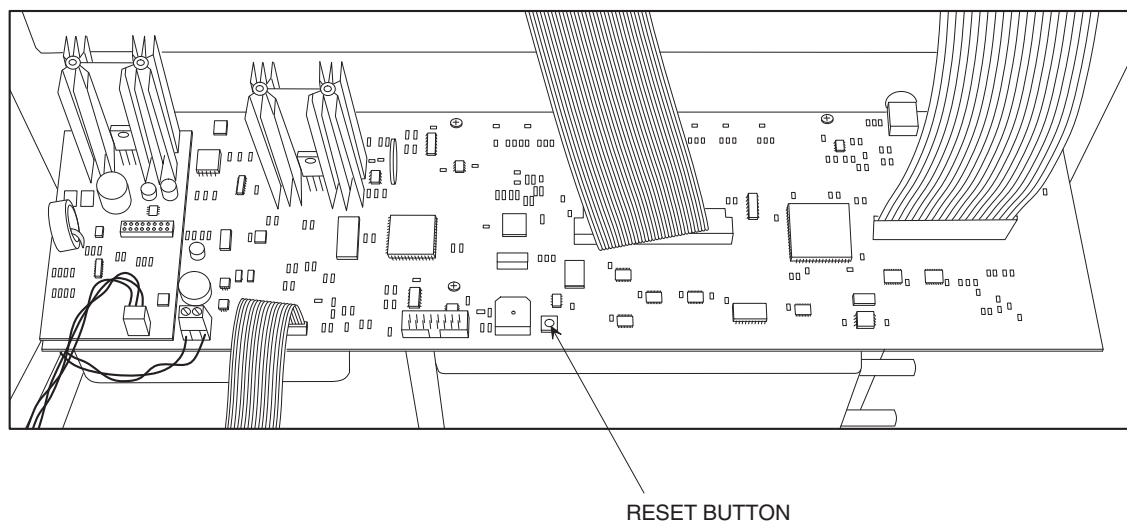
3. Clean probe assembly by generously spraying carburetor cleaner through each of the barbed fittings of the probe handle, while allowing the cleaner to flow out of the probe tip.
4. After spraying with carburetor cleaner, remove all the residual cleaner by repeatedly flushing the probe assembly with alcohol.
5. Clean sampling hoses by first squirting a few drops of detergent into one end of each sampling hose. Then force water through each hose until all detergent is removed (a faucet adapter connected to a small piece of rubber hose can be used to supply a rapid flow of water through the sampling hose).
6. Wipe off surfaces of probe and sampling hoses with a clean rag.
7. Allow parts to dry completely. If available, blow compressed air through probe and hoses to expedite the drying process.
8. Reassemble parts of probe assembly.

4.8 Resetting the Microprocessor

If the analyzer “locks-up” and cannot be turned off, or begins to operate in an erratic manner, remove the analyzer’s top panel and press the Reset button, located on the main printed circuit board. See Figure 4-7.

Note: *Pressing the Reset button WILL NOT erase memory nor change the analyzer’s calibration settings.*

Figure 4-7. Reset Button



Notes:

5 Troubleshooting

5.1 Analyzer Repair

It is recommended that field repair of the ECA 450 be limited to:

- Simple checks of printed circuit board connectors
- Replacing the Probe Assembly
- Replacing the filter element in the Water Trap / Filter Assembly
- Replacing Sensors

All other repairs should be performed by an authorized Bacharach Service Center. Any repairs performed by an *unauthorized* service organization will void the analyzer's warranty and release Bacharach, Inc. of any implied or written product liability.

Before returning your analyzer for repair, you may be able to determine and resolve a problem using the *Troubleshooting Guide* in Section 5.4.

5.2 Problem Messages Displayed After Warm-Up

If there were problems detected during warm-up, messages that describe the nature of the problems are sequentially displayed at the bottom of the screen immediately following the analyzer's 60 second warm-up period.

Note that the analyzer will *not* automatically switch to the Combustion Test HOLD screen if problems were detected. The analyzer, however, can still be used to perform any test that does not depend on the sensor that is in error. Press the **RUN** key to manually enter the Combustion Test HOLD screen to continue using the analyzer.

The following is a list of the problem messages that may appear after warm-up completes:

O2 Sensor Error – O₂ sensor is depleted, unplugged, or the sensor was exposed to flue gas during warm-up.

TS Sensor Error – The probe's flue gas thermocouple not connected to analyzer, or the temperature being measured by this thermocouple is outside the range of -4 to 212 °F (-20 to 100 °C).

TA Sensor Error – Primary air temperature as being measured by a thermocouple connected to the T-AIR connector is outside the range of -4 to 212 °F (-20 to 100 °C).

NO2 Sensor Error – NO₂ sensor was exposed to flue gas during warm-up.

HC Sensor Error – HC sensor is defective or unplugged.

NOXIDE Sensor Error – NO sensor was exposed to flue gas during warm-up.

CO-HI Sensor Error – CO-HI sensor was exposed to flue gas during warm-up.

CO-LO Sensor Error – CO sensor was exposed to flue gas during warm-up.

Pressure Sens. Error – Pressure sensor is measuring a pressure that is outside the of range of ± 3 inches of water column during warm-up.

SO2 Sensor Error – SO₂ sensor was exposed to flue gas during warm-up.

Low Battery – Battery voltage is low. Only several minutes of operating time remain.

5.3 Error Symbols

The following error symbols are shown in the Combustion Test Screen and on a printout to indicate: 1) combustion test data that cannot be calculated, 2) sensors that are in over-range, or 3) sensors that were detected as being in error during warm-up.

“— — —” appears in the number fields of combustion test data that cannot be calculated because the current measurements will not provide a meaningful calculation. For example, if the Oxygen level is greater than 16%, or the stack temperature is greater than 2000 °F (1093 °C), or the ambient air temperature is greater than 999.9 °F (537.8 °C), then the value for EFF (combustion efficiency) cannot be calculated.

“x x x x” indicates an over-range condition, and appears in the number fields of sensors that are being exposed to gas levels that are beyond the analyzer’s detection range. This symbol also appears in the number field of the HC sensor when there is not enough Oxygen present to measure the combustible gas level.

“* * * *” is displayed in the number fields of sensors that were reported as being in error during warm-up, and also in the number fields of data that derive their values from the sensor in error. For example, if the NO or NO₂ sensor was in error, then the NO_x data field will also contain stars.

5.4 Troubleshooting Guide

The following table lists the causes and remedies for most of the problems that may arise with the analyzer.

If the information in Table 5-1 does not solve the problem, or for help with any problem that is not listed, then please contact one of the Bacharach Service Centers listed in Section 6.3.

TABLE 5-1. TROUBLESHOOTING GUIDE

Symptom	Probable Cause & Remedy
Analyzer completely nonfunctional; won't turn on when the I/O key is pressed.	<p>a. Battery pack dead. Recharge battery pack per Section 4.1.</p> <p>b. Loose battery connector. Remove analyzer's top panel and ensure that the battery connector is securely attached to the printed circuit board.</p> <p>c. Microprocessor needs reset. Remove analyzer's top panel and press the Reset button shown in Figure 4-7.</p>
Display screen is blank when analyzer is turned on, but pump runs during warm-up cycle.	<p>a. Microprocessor needs reset. Remove analyzer's top panel and press the Reset button shown in Figure 4-7.</p> <p>b. Loose display connector(s). Remove analyzer's top panel and ensure that all display-panel connectors are properly attached to the printed circuit boards.</p>
Display goes blank during operation.	The analyzer's display blanking function has been activated. To change the display timeout interval, refer to Section 2.17.9.
Analyzer won't respond when a control panel key is pressed.	<p>a. Microprocessor needs reset. Remove analyzer's top panel and press the Reset button shown in Figure 4-7.</p> <p>b. Membrane switch defective. Return to Bacharach for replacement.</p>

<p>“Low Battery” message appears at bottom of display, accompanied by a beeping alert tone.</p>	<p>Battery close to being discharged. Analyzer will run for only several minutes after this message first appears before turning itself off. Recharge battery per Section 4.1.</p>
<p>“O2 Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart.</p> <p>b. O₂ sensor depleted. Replace sensor per Section 4.4.1.</p>
<p>“TS Sensor Error” message appears at bottom of display.</p>	<p>a. The probe’s stack thermocouple is not connected to the analyzer’s T-STACK connector. Connect thermocouple per Section 1.5.1.</p> <p>b. Analyzer was turned on with probe in stack. Remove probe from stack; allow it to cool to room temperature; then restart.</p> <p>c. Temperature being measured during start up is outside the range of -4 to 212 °F (-20 to 100 °C).</p> <p>d. Thermocouple defective. Replace probe assembly.</p>
<p>“TA Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with its primary air thermocouple measuring a temperature that was outside the range of -4 to 212 °F (-20 to 100 °C). Ensure thermocouple is sampling ambient room temperature and restart.</p> <p>b. Thermocouple defective. Replace.</p>
<p>“NO2 Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart.</p> <p>b. NO₂ sensor not zeroed at start up. Turn analyzer off and then on to re-zero all sensors. If error persists, replace sensor.</p>
<p>“HC Sensor Error” message appears at bottom of display.</p>	<p>Combustibles sensor not plugged in or is defective. Install or replace sensor per Section 4.4.3.</p>

<p>“NOXIDE Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart.</p> <p>b. NO sensor not zeroed at start up. Turn analyzer off and then on to re-zero all sensors. If error persists, replace sensor.</p>
<p>“CO-LO Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart.</p> <p>b. CO-LO sensor not zeroed at start up. Turn analyzer off and then on to re-zero all sensors. If error persists, replace sensor.</p>
<p>“CO-HI Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart.</p> <p>b. CO-HI sensor not zeroed at start up. Turn analyzer off and then on to re-zero all sensors. If error persists, replace sensor.</p>
<p>“SO₂ Sensor Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe sampling flue gas. Remove probe from stack and restart..</p> <p>b. SO₂ sensor not zeroed at start up. Turn analyzer off and then on to re-zero all sensors. If error persists, replace sensor.</p>
<p>“Pressure Sens. Error” message appears at bottom of display.</p>	<p>a. Analyzer was turned on with probe measuring a pressure is that was outside the range of ± 3 inches of water (± 7.47 mb/hPa, ± 747 Pa). Ensure probe is sampling atmospheric pressure and restart.</p> <p>b. Sensor defective. Return to Bacharach for replacement.</p>
<p>“Bad Calibration Entry” message appears during calibration.</p>	<p>A calibration value was entered that is outside the allowable range for calibration. Apply a calibration gas concentration or pressure value that is within the range of the sensor being calibrated as listed in the calibration procedure.</p>
<p>“Sensor Output Low” message appears during calibration.</p>	<p>Sensor is nearing the end of its useful life. Calibration is still good, but the sensor should be replaced soon.</p>

<p>“Sensor Not Calibrated” message appears during calibration.</p>	<p>Sensor’s output is too low to be calibrated. Replace sensor per Section 4.4.</p>
<p>“_ _ _ _” appears in one or more of the data fields in the Combustion Test RUN screen.</p>	<p>The analyzer is not able to calculate a numerical value based on current measured data. Numerical data will appear when the analyzer begins to detect valid data.</p>
<p>“x x x x” appears in a sensor’s data field.</p>	<p>Sensor in over range. The associated sensor is detecting a value that is outside the analyzer’s detection range. This symbol also appears in the number field of the HC sensor when there is not enough Oxygen present to accurately measure the combustible gas level.</p>
<p>“* * * *” appears in a sensor’s data field.</p>	<p>The field’s associated sensor was reported as being in error when the analyzer was turned on.</p>
<p>Gas pump motor sounds sluggish.</p>	<p>a. Gas flow restricted somewhere between the probe tip and the T-STACK connector. Ensure that the probe tip is not plugged with dirt, and that the Water Trap / Filter Assembly is clean and not saturated with water. Also, verify that the probe’s gas hose is not pinched.</p> <p>b. Internal particulate filter clogged. Replace filter per Section 4.8.</p>
<p>Gas pump motor does not start.</p>	<p>Loose pump connector. Remove analyzer’s top panel and ensure that the pump connector is securely attached to the printed circuit board.</p>
<p>Battery power does not last at least 8 hours.</p>	<p>Battery defective. Replace.</p>

<p>Erratic combustion test screen data.</p>	<p>a. Faulty sensor(s):</p> <ul style="list-style-type: none"> - Check that all sensors are properly installed and their wiring harnesses are correctly connected to the analyzer. Refer to Section 4.4. - Check sensor calibration per Section 3. - Replace any sensor that does not calibrate, and then recalibrate. <p>b. Leak in gas path. Check tightness of all hose connections on probe, and tightness of all hose connections internal to the analyzer.</p>
<p>Sensor does not calibrate properly.</p>	<p>a. Wrong calibration gas or insufficient flow being applied to sensor. Ensure that the calibration setup is correct.</p> <p>b. Depleted sensor. Replace sensor and recalibrate.</p> <p>c. If the NO sensor doesn't calibrate, its bias battery may be dead. Replace bias battery per Section 4.4.2 and recalibrate.</p>

Notes:

6 Parts & Service

6.1 Replacement Parts

Complete ECA 450 Basic Configuration (O₂, CO, Stack Temp., Ambient Temp, and Pressure measurement), with sampling probe (12 in. tube) and hose assembly 0024-7221

AC Adapter:

Charger Unit 0024-0985

Power Cord..... 4998-8986

Battery Pack 0024-0977

Battery, NO Sensor Bias 0204-0020

Filter, Particulate (attached to inlet of gas pump)..... 0007-1563

Filter, Sensor:

CO-LO..... 0024-0863

CO-HI 0024-0987

NO..... 0024-0862

Instruction Manual 0024-9400

O-Ring, 7mm (on Pressure and Pressure Ref. Connectors) 0105-5103

O-Ring, 8 mm (on Gas Connector) 0105-5102

O-Ring, Sensor Blank..... 0105-5104

Probe & Hose Assembly, 12" probe:

Complete Assembly 0024-3023

Hose Connector, Gas 0024-0877

Hose Connector, Pressure 0024-0878

Filter / Water Trap Assembly:

Complete Assembly 0024-1172

Filter Element (package of 3)..... 0007-1644

Printer Paper (box of 5 rolls)..... 0024-0980

Pump, Gas..... 0024-3009

Screw, Phillips, PH, #6-32 x 1/2", Sensor Cover 4723-5860

Screw, Phillips, PH, #6-32 x 9/16", Top Panel 0101-7672

Sensor Blank..... 0024-0864

Sensors:

CO-LO 0024-0789

CO-HI 0024-0997

HC..... 0024-1055

NO 0024-0881

NO₂ 0024-1027

O₂ 0024-0788

SO₂ 0024-0998

6.2 Accessories

Calibration Kit (gas not supplied)	0024-7059
Flue Gas Sample Conditioning Unit:	
<i>Heavy Duty System</i> (EPA/ETV test verified performance).	
Includes Peltier chiller unit with integral condensate pump, 15 ft heated hose assembly with probe, and built-in temperature controller	
	0024-7223
<i>Compact System</i> . Includes Peltier chiller/probe assembly, built-in filter, condensate pump, and 15 ft hose assembly.	
	0024-7224
Gas Cylinders:	
CO, 500 ppm in air	0024-0492
CO/H ₂ , 1000 ppm CO & 1000 ppm H ₂ in Nitrogen.....	0024-0794
CO, 4000 ppm in air	0024-1155
NO, 250 ppm in Nitrogen	0024-1156
NO ₂ , 100 ppm in Nitrogen	0024-1157
SO ₂ , 100 ppm in Nitrogen	0024-1158
Methane, 2.5% CH ₄	0051-1121
Hose Extension, 20 feet (extends reach of probe).....	0024-1124
Pressure Kit. Includes copper tubing, fittings, pitot tubes, hoses, and instructions on how to conduct various pressure tests	0024-8214
Probe and Hose Assemblies:	
24 in.	0024-3024
36 in.	0024-3025
Sensor Option Kits*:	
CO (high, 4,000 to 80,000 ppm CO)	0024-3026
NO	0024-3027
Combustibles.....	0024-3028
NO ₂	0024-3029
SO ₂ (requires NO ₂ option)	0024-3030
Serial Communications Cable, DB-9M to DB-9F	0104-4027
Thermocouples, for primary air measurement:	
10 foot	0104-1797
Utility Wand (12 in. ridged probe with handle and 5 ft coiled cable)	0104-1799
5 ft coiled extension cable (used on Utility Wand)	0104-1800
True Spot Smoke Test Set	0021-7006

* Sensor Option Kits must be installed by an authorized
Bacharach Service Center.

6.3 Service Centers

Service and replacement parts can be obtained by contacting a Bacharach Service Center at the following locations:

United States

Bacharach, Inc.
621 Hunt Valley Circle
New Kensington, PA 15068
Phone: 724-334-5051
Fax: 724-334-5723
Email: help@mybacharach.com

Canada

Bacharach of Canada, Inc.
20 Amber St. Unit #7
Markham, Ontario L3R SP4
Canada
Phone: 905-470-8985
FAX: 905-470-8963
E-mail: bachcan@idirect.com

Notes:



Headquarters:

621 Hunt Valley Circle, New Kensington, PA 15068

Ph: 724-334-5000 • Fax: 724-334-5001 • Toll Free: 1-800-736-4666

Website: www.mybacharach.com • E-mail: help@mybacharach.com

