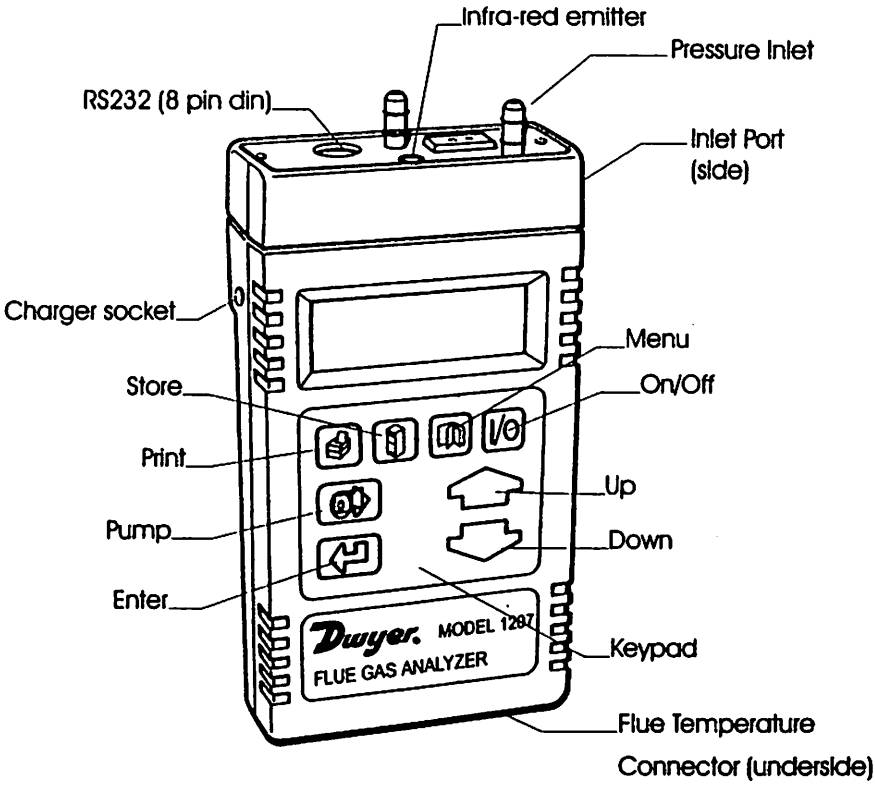
Model 1207
Hand-held Combustion Analyser

CONTENTS

1. ANALYSER LAYOUT AND FEATURES

1.1 Instrument Features and Keypad



1207 shown without standard rubber boot

ON/OFF

MENU
Allows access to all menu functions

PUMP
Turns pump on and off

ENTER
Accepts a command, ie enters a menu option

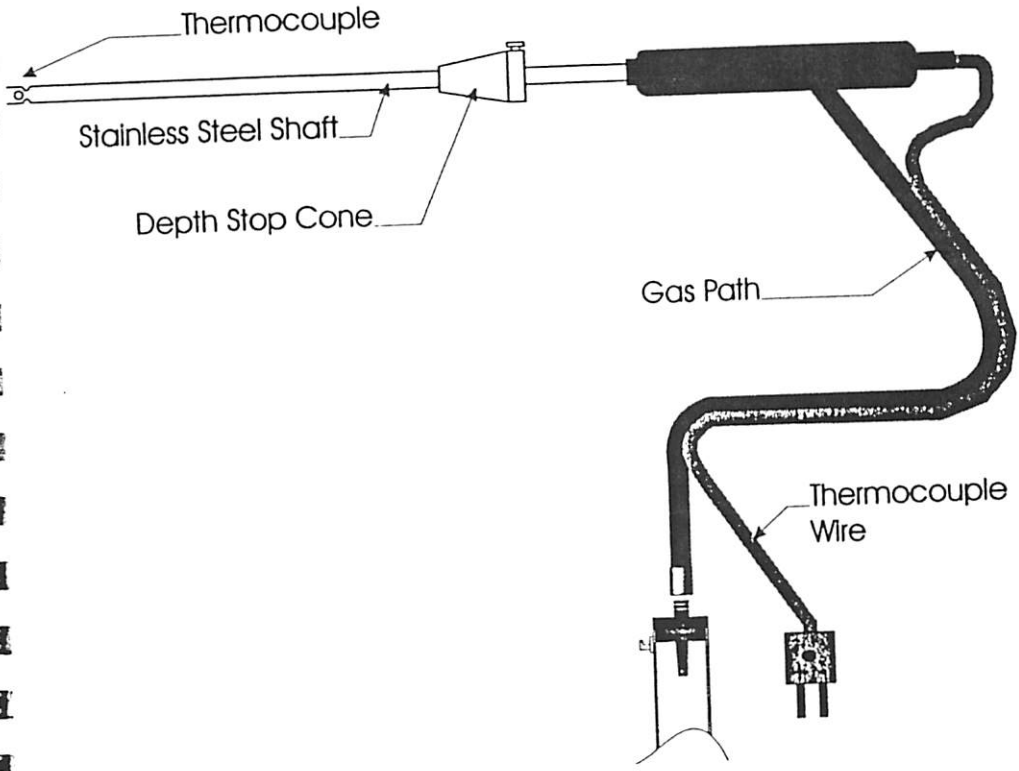
UP
Scrolls up through options, ie Fuel

DOWN
Scrolls down through options

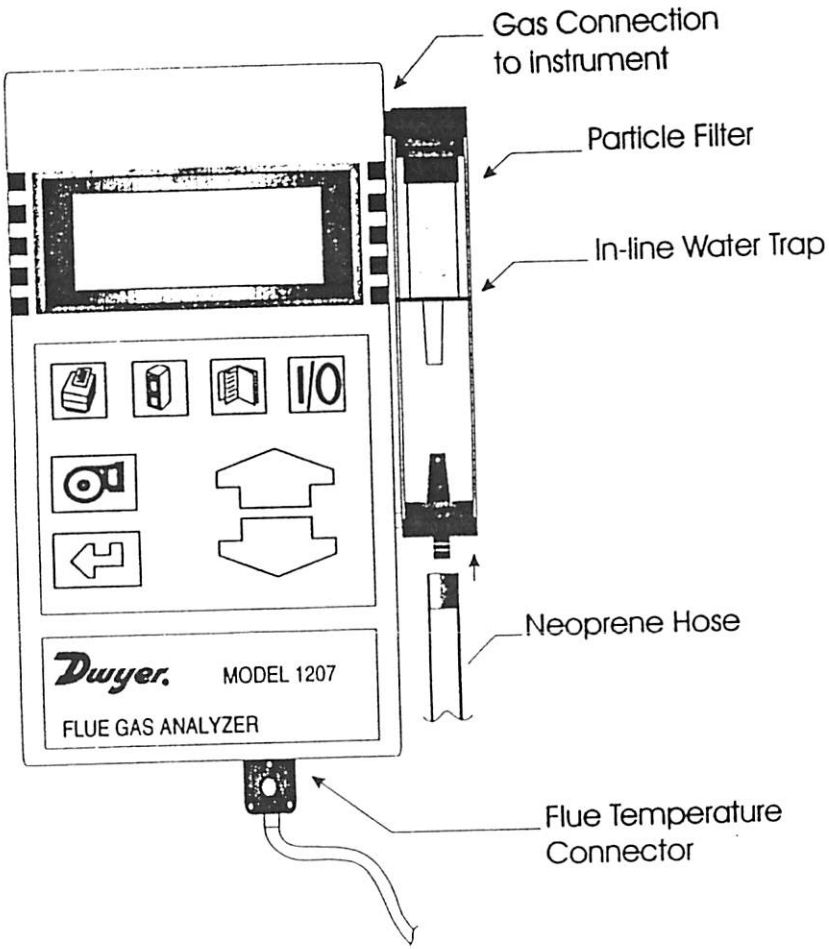
STORE
Enters data storage menu

PRINT
Prints current data

1.3 Standard Probe Configuration



1.4 Analyser Connections



2. SAFETY WARNING

This analyser extracts combustion gases that may be toxic in relatively low concentrations. These gases are exhausted from the side of the instrument. This instrument must only be used in well ventilated locations. It must only be used by trained and competent persons after due consideration of all the potential hazards.

Protection Against Electric Shock (in accordance with EN 61010-1 : 1993)

This instrument is designated as Class III equipment and should only be connected to SELV circuits. The battery charger is designated as:

Class II equipment
Installation category II
Pollution degree 2
Indoor use only
Altitude to 2000m
Ambient temperature 0°C-40°C
Maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50%RH at 40°C
Mains supply fluctuations not to exceed 10% of the nominal voltage.

3. FIRST TIME USE

Charge the battery for 12 hours, following this an overnight charge should be sufficient for an average 8 hour day. See Main Parameter displays for Battery Indicator.

The 1207 has a rechargeable lead acid battery which uses a different charger than other analysers. ***Ensure the correct charger is used or damage may occur to the instrument.***

Check that you have all the items you have ordered.
Take time to read this manual fully.
When using the analyser for the first time you will need to choose from:-

Language selection
Calibration countdown time
CO gas alarm
NOx percentage for calculation
Time and Date
Printed header name and telephone number

The SET UP MENU (Section 5.2.5) gives details of how to change the above settings.

4. NORMAL START UP SEQUENCE

4.1 Every Time You Use The Analyser

BEFORE SWITCH-ON CHECK THAT:

the particle filter is not dirty

the water trap and probe line are empty of water

all hose connections, etc, are properly made

the probe is sampling CLEAN AMBIENT air

the water trap is correctly fitted and the instrument upright

the flue temperature is connected

Switch ON the instrument by pressing I/O

4.2 Automatic Calibration

During this sequence the analyser pumps fresh air into the sensors to allow toxic sensors (if fitted) to be set to zero and the Oxygen sensor to be set to 20.9 %.

After switch-on the analyser will briefly display header information :-

DWYER INSTRUMENTS INC.
219-879-8868

And then show the countdown screen :-

ZERO CAL
Time : 180
FRESH AIR PURGE

The calibration time will count down in seconds to zero. Calibration time may be changed from 2 to 6 minutes. See Set-Up menu section 5.2.5.

Note ! Three minutes is recommended to allow the sensors to stabilise fully. Anything less than this may result in drift of the toxic and oxygen sensors in clean ambient air.

To obtain the quoted specification an instrument should be calibrated with clean ambient air at standard temperature and pressure (STP).

Once the time has reached zero an audible beep will be heard and will show the selected fuel on the following display:-

```
NATURAL GAS

*PRESS  -MENU-  KEY*
```

Press 

This zeros the toxic sensor and sets Oxygen to 20.9%. The next screen is the **MAIN DISPLAY** of the analyser:-

```
NETT   C    ....  0.0
O2     %    ...   20.9
CO     ppm  ...   0000
EFF (G) %   ...   0.0
```

Use  and  to change the display.

```
CO2 %.......   0.0
FLUE  C......  0.0
INLT....NOT FITTED
AMBIENT  C....  21
```

All parameters are detailed in Appendix A - MAIN DISPLAY PARAMETERS.

4.3 Main Displays

The main display can be changed to show either 4 or 8 parameters at one time. Two options are available when 4 parameters are selected.

- **4 Page Mode** displays 4 lines of data in set format, each page is predefined.
- **Line scroll mode** allows you to customise the display to show the data you require.
- **8 Page Mode** displays 8 parameters on 4 lines in set format, the bottom two can be changed.

Changing between the different modes is detailed in **Display Menu Section 5.2.4.**

4.3.1 4 Page Mode

Use the and keys to change the information that is displayed on the screen. The following pages are available.

```
NATURAL GAS
DATE      ... 07-08-96
TIME      ... 12:31:35
BATTERY %   .. 54
```

```
NETT    C   ...   0.0
O2      %   ...  20.9
CO      ppm ..   0000
EFF (G) %   ...   0.0
```

```
CO2     %   ...   0.0
FLUE    C   ...   0.0
INLT      NOT FITTED
AMBIENT C   ...  21
```

```
CO/CO2 R ..  0.0001
P INDEX % ...  0.01
XAIR    % ...   0.0
Prs     mbar    0.00
```

This screen only displayed on an analyser fitted with an NO sensor

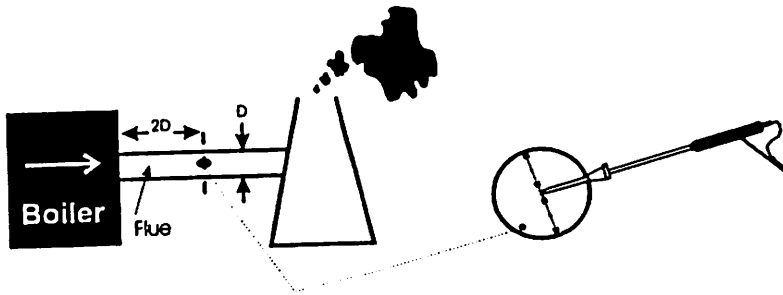
```
NO      ppm ..  0000
NOx     ppm ..  0000
NOx calc%   ...    5
O2 ref  %   ...  3.0
```

TIP - In 4 page mode only turns the backlight ON and OFF.

4.4 Sampling the Flue Gas

Once the automatic calibration procedure has been completed and the specific fuel has been selected (See SELECT menu) the probe can be inserted into the desired sampling point.

It is recommended that the sampling point be located at least two flue diameters downstream of any bend and that the probe tip is in the centre of the flue. With balanced flues and other domestic units the probe should be positioned far enough into the flue so that no air can 'back flush' into the probe. This will be indicated by a low oxygen reading and/or a low 'Poison Index' reading.



The probe depth stop cone provided with the instrument allows the probe to be used in holes whose diameters range from 8 mm to 21 mm ($^{5}/_{16}$ to $^{13}/_{16}$ inch).

The standard probe is rated at 650°C. Temperatures of up to 1100°C (2012°F) can be accommodated using an optional high temperature probe.

TIP To conserve battery power, switch off the pump when you are not taking a measurement. Use the key to turn ON and OFF the pump.

4.5 Taking a Pressure Reading

With the optional pressure module fitted a flue draught measurement can be made at any time.

Connect the standard probe to the pressure sensor inlet and the probe in the flue. The pressure reading will be displayed :-

CO/CO2 R ..		0.0001
P INDEX % ...		0.01
XAIR	% ...	0.0
Prs	mbar	0.00

To perform a combustion test and display draught pressure at the same time a special probe is required. Contact Dwyer Instruments Inc. or an Authorised Distributor for details.

4.3.2 Line Scroll Mode

Line scroll mode allows you to customise the display.

Use the and keys to change the bottom line of the display. Once the correct line is displayed press to confirm and move the line up. Select the next parameter and repeat until all lines display the desired parameters.

Change bottom line using and

NETT	C	...	0.0
O2	%	...	20.9
CO	ppm	..	0000
CO2	%	...	0.0

to select and move parameter up

O2	%	...	20.9
CO	ppm	..	0000
CO2	%	...	0.0
CO2	%	...	0.0

Select next parameter. Repeat above until display reads desired data

O2	%	...	20.9
CO	ppm	..	0000
CO2	%	...	0.0
CO/CO2	R	..	0.0001

4.3.3 8 Page Mode

Displays 8 parameters on the screen at one time. Symbols used in this mode are different to those used in 4 page and line scroll modes and are detailed in Appendix A - MAIN DISPLAY PARAMETERS.

O2	:20.9 %	CO2	: - -
CO	: 0ppm	Eff	: - -
PI	: - -	ΔT	: 0C
λ	: - -	Tf	: 21C

The bottom line of the display can be changed to display other parameters.

Use the and keys to change this line.

4.6 Regular Checks During Sampling

Care must be taken at all times not to exceed the analysers operating specifications, in particular ensure the following :-

- Do not exceed the maximum temperature of the flue probe.
- The analyser internal temperature does not exceed normal operating range, typically 0-40°C.
- DO NOT PLACE THE INSTRUMENT ON A HOT SURFACE.
- The water trap is vertical at all times. Water condenses in the probe line and can quickly fill the water trap when the probe is moved. Take care and watch the water trap closely.
- The in-line particle filter is clean and does not become blocked.

4.7 Normal Shutdown Sequence

DO THIS EVERY TIME YOU USE THE ANALYSER

Remove the probe from the flue - **TAKE CARE ! THE PROBE WILL BE HOT** - and allow it to cool naturally. Do not immerse the probe in water as this will be drawn into the analyser and damage the pump and sensors.

Once the probe is removed from the flue press I/O and the analyser will count down from 30 to switch off.

```
OFF   30

MENU TO ESCAPE
```

If you have not finished but press I/O by mistake, you can press MENU to return to normal operation and not switch OFF.

4.8 Electromagnetic Compatibility

The European Council Directive 89/336/EEC requires that electronic equipment does not generate electromagnetic disturbances that exceed defined levels and has an adequate level of immunity to enable it to be operated as intended. The specific standards applicable to this product are detailed in the appendices.

Since there are many electrical products in use that pre-date this Directive and may emit electromagnetic radiation in excess of the standards defined in the Directive there may be occasions where it would be appropriate to check the analyser prior to use.

The following procedure should be adopted:

Go through the normal start up sequence in the location where the equipment is to be used.

Switch on all localised electrical equipment that might be capable of causing interference.

Check that all readings are as expected. (A level of disturbance in the readings is acceptable). If not adjust the position of the instrument to minimise interference or switch off, if possible, the offending equipment for the duration of the test.

N.B. Maximum cable lengths must be less than 3 metres.

At the time of writing this manual (January 1997) Dwyer Instruments Inc. are not aware of any field based situation where such interference has ever occurred and this advice is only given to satisfy the requirements of the Directive.

5. MOVING THROUGH THE MENUS

5.1 Basic Operation

From the MAIN DISPLAY

```
NETT   C    ....   0.0
O2     %    ...   20.9
CO     ppm  ...   0000
EFF (G) %   ...    0.0
```

Press
to access the MAIN MENU

```
        MAIN MENU

1. SELECT    3. DISPLAY
2. UNITS     4. SETUP
```

Press and
to move cursor up and down

```
        MAIN MENU

1. SELECT    3. DISPLAY
2. UNITS     4. SETUP
```

Press
to access selected Menu

```
        MAIN MENU

1. SELECT    3. DISPLAY
2. UNITS     4. SETUP
```

Press
to select parameter

```
FUEL     : LIGHT OIL
O2 Ref   : OFF
SMOKE    : OFF
RESET    : NO
```

Use and
to change setting i.e. fuel selected

```
FUEL     : NATURAL GAS
O2 Ref   : OFF
SMOKE    : OFF
RESET    : NO
```

Press
to enter value and move to next parameter

```
FUEL     : LIGHT OIL
O2 Ref   : OFF
SMOKE    : OFF
RESET    : NO
```

Press
to save settings and return to the MAIN MENU

```
        MAIN MENU

1. SELECT    3. DISPLAY
2. UNITS     4. SETUP
```

Press to return to the MAIN DISPLAY

5.2 Menu Options and Settings

5.2.1 Main Menu

The MAIN MENU consists of 4 sub menus which are shown below and detailed on the following pages.

```
MAIN MENU

1. SELECT    3. DISPLAY
2. UNITS     4. SETUP
```

All sub-menus are accessed using and exited using

The and keys move the cursor within a menu and allow parameters to be changed.

TIP Holding down one of these keys scrolls through the data quicker.

5.2.2 Select Menu

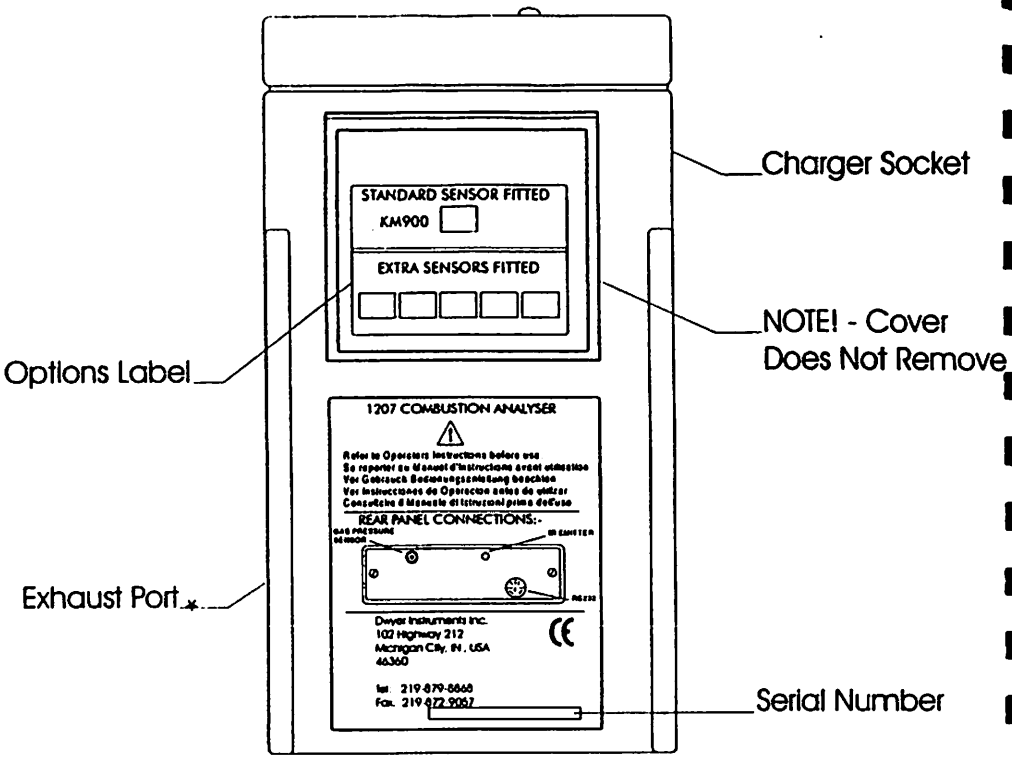
```
FUEL    : NATURAL GAS
O2 Ref  : OFF
SMOKE   : OFF
RESET   : NO
```

This menu allows selections to be made for the parameters detailed below.

FUEL : Select the fuel being used by the boiler from either a standard fuel stored in the analyser or by entering one of two user fuels. Once the correct fuel has been selected press to view the fuel constants.

```
NATURAL GAS
K1g : 0.350     K1n : 0.390
K_2 : 11.89     K_3 : 9.83
K_4 :  32       O2r : 3.0
```

1.2 Instrument Layout (Rear)



*NOTE! Do not cover exhaust port as this will severely affect analyser operation

Calculation of fuel constants are detailed in the Appendix. Fuel constants will have to be calculated before a user fuel can be entered.

To enter a user fuel select 'User Fuel' and Press

```
USER FUEL
K1g : 0.000   K1n : 0.000
K_2 : 0.00    K_3 : 0.00
K_4 :   00    O2r :   00
```

Use and to select the correct value.

```
USER FUEL
K1g : 0.350   K1n : 0.000
K_2 : 0.00    K_3 : 0.00
K_4 :   0     O2r :   00
```

Use to move to the next parameter, repeat above until all parameters are correct. Press to return to SELECT menu.

O2 Ref : Toxic gas measurements can be referenced to defined oxygen levels. Reference values can be set from 1-20%, to AUTO or more normally to the default value - OFF. Setting to AUTO uses the figure in the FUEL constants data.

Oxygen referencing is required by some regulations such as TA-LUFT. If a reference value is selected then toxic gas measurements will be displayed with the symbol (n) attached to the reading. i.e. CO(n)

What does Oxygen reference mean ?

If 3 % O_2 reference is selected and 5 % O_2 is measured in the flue then toxic gas values will be recalculated as if 3 % were measured. The equation for referencing is detailed in the Appendix.

Oxygen referencing prevents false readings being submitted, e.g. allowing more air into the boiler will increase the oxygen level in the flue and hence dilute any toxic gas reading. Oxygen referencing gives readings as if they were undiluted.

SMOKE: Allows the user to enter a smoke test number from 0-9. This value will be printed on the standard printout. Default value is OFF.

RESET : Allows the user set the Oxygen to 20.9% and zero the toxic sensors without turning the analyser off.

Selecting YES and ↵ will display the following screen.

```
RESET SENSORS
O2 % : 20.9  CO & NO = 0
PRESS ENTER
MENU TO ESCAPE
```

After pressing ↵ the analyser will count down for 5 seconds and then return to the main display.

WARNING : The sensors must only be reset if you are sure they have been sampling fresh air for at least 3 minutes. Errors in measurement will occur if the sensors are reset during or just after sampling.

5.2.3 Units Menu

```
TEMP    : C
GAS     : ppm
PRESS.  : mbar
EFF.    : GROSS
```

Allows all displayed units to be changed.

TEMP : Choose selections from Centigrade °C or Fahrenheit °F.

GAS : Changes the toxic gas measurement units. Select from volumetric readings, parts per million (ppm) or mass flow reading milligrams per cubic meter (mg/m3) .

PRESS. : Flue draught can be displayed in millibar (mbar), hectaPascals (hPa), millimeters water gauge (mmWG) or inches water gauge (in WG).

EFF. : Efficiency can be selected for Gross or Net values. Gross efficiency assumes latent heat of vapourisation is lost in the boiler and hence will be lower than Net efficiency. For Natural Gas the difference will be approximately 11%.

5.2.4 Display Menu

```
LIGHT    : OFF
MODE     : 8-PAGE
CONTRAST : DEFAULT
```

Allows the configuration of the display to be changed.

LIGHT : Choose from ON or OFF.

MODE : Select 4 or 8 Page Mode or Line Scroll Mode as detailed in section 4.3 Main Displays.

CONTRAST : The contrast is set to a DEFAULT value or can be adjusted ↑ LIGHTER or ↓ DARKER. Use the ⇧ and ⇩ keys to adjust.

5.2.5. Set-Up Menu

The set up menu allows the following parameters to be set / altered.

- Language.
- Automatic calibration time
- CO gas alarm
- NOx percentage for calculation
- Date and time
- Printout Header

```
LANG  : ENGLISH ZERO : 3
CO ALARM : 400  NOx% : 5
CALENDAR        HEADER
```

Parameter	Description	Settings
LANG :	Changes the analysers displayed and printed language.	**ENGLISH** **SPANISH** **DUTCH** **FRENCH** **ITALIAN**
ZERO :	Allows setting of the Autocalibration time in minutes. Care must be taken when changing this parameter as sensors may drift from zero if too short a time is used. Dwyer Instruments Inc. advise a 3 minute countdown.	**2-6 minutes**
CO ALARM :	Allows an alarm level to be set on for the CO reading. This is set as a default at 1000 ppm.	**OFF** **0-4000 ppm**

Once an alarm has been exceeded the display will flash every two minutes warning the user of an alarm state and display the gas concentration. A similar display will be shown during a RECHARGE BATTERY and PUMP OFF alarms.

```
-- -- -- -- -- -- -- -- -- -- -- -- -- --
        CO  ALARM
        1010 ppm
-- -- -- -- -- -- -- -- -- -- -- -- -- --
```

NO REF: Displayed on the Nitric Oxide unit only. Allows the percentage P in the following calculation to be set. The default value set is 5%. Note the percentage allows for NO_2 in a typical boiler. **OFF** **1-9 %**

$$NO_x = NO + P\%\ NO$$

CALENDAR: Allows the user to change the date and time. (24 hour clock).
The following screen will be shown once the parameter is entered:

```
                hh : mm : ss
TIME :          13 : 53 : 26
FORMAT :        dd : mm : yy
DATE :          03 : 01 : 96
```

FORMAT : Changes the date format for display and printing. **dd : mm : yy** **yy : mm : dd** **mm : dd : yy**

To change the time position the cursor on **Time** and press ⏎. The cursor will now be to the left of the 13 as shown below:

```
                hh : mm : ss
TIME :          13 : 53 : 26
FORMAT :        dd : mm : yy
DATE :          03 : 01 : 96
```

Using ⇧ and ⇩ scroll through the setting options i.e. 0-23.

Once the correct hour is set press ⏎ to move to the next parameter, the cursor will move to the left of minutes (53). Move to each parameter until the correct time is set. Pressing ⏎ after setting the seconds will return the cursor to the left of the screen.

Format and Date are set in a similar manner.

Header : Allows two lines of 20 characters to be programmed into the analyser. The header appears on the top of the standard printout. This can be used to print your company name and/or phone number.

Name/Phone
DWYER INSTRUMENTS INC.
219-879-8868
'LEFT' USE STORE KEY

The screen above shows the standard header setting with the cursor now shown underlining the D in Dwyer. By using and any letter or number can be chosen.

Once the correct character is displayed, use to move right to the next. Move along until all characters spell the desired name or phone number. If you need to go back and change a character use to move left.

Press to return to the SET UP menu.

6. PRINTING INFORMATION

Supplied as accessories for the 1207 are an infra-red thermal printer or a dot matrix serial printer. Read the manual supplied with each printer prior to operation. Connections to the 1207 are detailed below :

- **Infra-red thermal printer** - this does not require a cable to transmit the data but uses an infra-red (IR) link similar to a TV remote control. The IR emitter is positioned on the top of the 1207 and the bottom of the printer. Ensure they are pointing at each other and within 300 mm, with no obstructions in the way. Data may be lost if transmission is interrupted. Keep the 1207 pointing at the printer until the printout has finished.

- **Dot matrix serial printer** - requires the supplied serial cable to transmit data. Connect the cable to the 8 pin DIN socket on the top of the 1207 and the 25 pin D-connector on the printer.

Data can either be printed from a 'live' test or from stored data. Printing of stored data is detailed in STORING AND RETREIVING DATA.

6.1 Printing a 'Live' Test

During a combustion test the 1207 will print data on request. With the analyser showing the MAIN DISPLAY press and current data will be sent to the printer.

The display will show the following until data transmission is complete.

***** Printing *****

6.2 Standard Printout

The standard printout is shown below :-

```
1207

Dwyer Instruments Inc.
219-879-8868

        TEST 36
DATE:          01-01-96
TIME:          15:46:52
     NATURAL GAS

NET C . . . . . . . . 2
02 %. . . . . . . .20.3
CO ppmn  02 >  20%
EFF %  (G) . . . . 87.8

CO2 % . . . . . . . 0.3
FLUE C. . . . . . . 24
INTL C     NOT FITTED
AMBIENT C. . . . . 22.6

CO/CO2 R . . . 0.0000
P INDEX % . . . . 0.00
XAIR %       02 > 20%
Prs  mbar . . . . 0.0
```

7. STORING AND RETRIEVING DATA

The 1207 can store up to 100 combustion tests. Once stored, the data can be viewed on the display or downloaded to a PC or printer.

7.1 Storing a 'Live' Test

While performing a test and viewing the data on the MAIN display access the STORE menu as follows :-

Press
to access the STORE MENU

```
STORE MENU
MODE     : STORE
LOCATION :   3
PRESS 'STORE' TO LOG
```

Mode: Select from the following :-

- **STORE** - Allows data to be stored in memory.
- **VIEW / PRINT** - Stored data can be viewed or printed.
- **DELETE** - Clears all data in memory.

Location: Automatically allocates a location in the memory of the instrument for the next test. On the display shown above the next location will be 3.

To store a test set **MODE** to **STORE** and press The current readings will be stored in the analysers memory.

Tip : Make a note of the location number for your particular test as it may be useful when downloading or printing.

7.2 Viewing and Printing a 'Stored' Test

Press
to access the STORE MENU

```
STORE MENU
MODE     : VIEW / PRINT
LOCATION : 1 TO 10
PRESS 'MENU' TO VIEW
```

Move the cursor to Mode and press . The cursor will move to the first number, use the and to select the location and start viewing.

Press to move the cursor to the second number, select the last location to view.

To print the data press . In the screen shown above locations 1 to 10 will be printed or displayed.

Once the correct location is set press to view the stored data as follows (Note the column of * indicating stored data) :-

```
*LOCATION  ...  1
*DATE      ... 07-08-96
*TIME      ... 12:31:35
*NATURAL GAS
```

Use and to page through data as in MAIN DISPLAYS.

Press to return to the MAIN MENU.

While viewing the stored data, as above, a printout can be obtained by pressing

TIP : Stored and displayed with the data are actual time and date of the test.

7.3 Deleting Data

To delete the data in stored memory press to obtain the STORE MENU (as above) :-

Press
to access the STORE MENU

```
STORE MENU
MODE     : DELETE
LOCATION :  3
PRESS 'ENTER' TO DELETE
```

Press
to access delete data screen

```
ENTER to ERASE DATA

MENU to ESCAPE
```

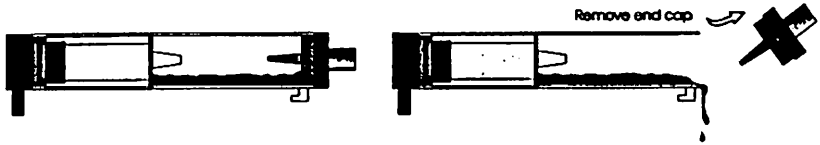
Press to delete data in memory, press to exit delete data screen.

8. MAINTENANCE

8.1 Emptying and Cleaning the In-line Water Trap

The in-line water trap should be checked and emptied on a regular basis. Water vapour will condense and gather in the probe line. This may move suddenly to the trap when the probe is moved. Care should be taken at all times.

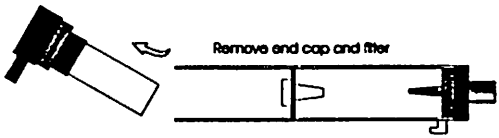
Emptying of the water trap is detailed below :-



Carefully remove the end cap from the in-line housing. Dispose of the condensate in a suitable drain, care must be taken as it could be acidic. If condensate spills onto the skin or clothing, clean off immediately using fresh water, seek medical advice if problems occur.

8.2 Changing the Particle Filter

This is a very important part of the analyser and should be changed regularly. It prevents dust and dirty particles entering the pump and sensors and hence causing damage. The filter MUST be changed when it is discoloured.



Remove the end cap from the in-line filter housing. Carefully remove the paper filter element and dispose of it. Clean the inside of the filter housing with a suitable soft cloth. Insert a new filter element onto the spigot in the filter housing and carefully replace the end cap.

9. PROBLEM SOLVING

The following is a list of problems that may occur on the instrument through its operating life. If the cause of the fault is not easy to identify then we advise you contact Dwyer Instruments Inc. for expert advice.

Fault symptom	Causes
• Oxygen too high • CO_2 too low	• Air leaking into probe, tubing, water trap, connectors or internal to instrument. • Oxygen cell needs replacing.
• Oxygen Error (FAULT) • Toxic sensor Error (FAULT)	• Calibration time set too short and instrument not allowed to stabilise • Instrument has been stored in a cold environment and is not at normal working temperature. • Oxygen cell or toxic sensors needs replacing.
• Analyser not holding charge • Analyser not charging	• Battery exhausted. • AC charger not giving correct output. • Fuse blown in charger plug.
• Analyser does not respond to flue gas	• Particle filter blocked. • Probe or tubing blocked. • Pump not working or damaged with contaminants. • Probe connected to pressure connector.
• Flue temperature readings erratic	• Temperature plug reversed in socket. • Faulty connection or break in cable or plug.
• Analyser automatically switches off in operation.	• Battery below alarm level. • Ambient temperature above 50°C. • Battery quickly discharging and is faulty.
• Display shows dark lines and no reponse from ON/OFF key.	• Fault has occurred on the instrument electronics and requires resetting. Contact Dwyer Instruments Inc. or a Distributor.

10. ANNUAL RE-CALIBRATION

Whilst the sensors have an expected life of more than two years in normal use it is recommended that the analyser is re-calibrated at least annually. This is so that long term drift on the sensors and electronics can be eliminated. Local regulation may require more frequent re-calibration and users should check with appropriate authorities to ensure they comply with relevant guidelines.

11. PRODUCT SPECIFICATION

Parameter	Resolution	Accuracy	Range
Temp Measurement			
Flue Temperature	1.0°C/F	±2.0°C ±0.3% reading	0-600°C/32-1112°F
Inlet Temperature	0.1°C/F	±1°C ±0.3% reading	0-50°C/32-122°F
Gas Measurement			
Oxygen	0.1%	±0.2%*1	0-21%
Carbon Monoxide	1ppm,mg/m^3	±20ppm <400ppm*1 ±5% >400ppm	0-4000ppm, 0-5000mg/m^3
Carbon Monoxide, H_2 compensated	1ppm,mg/m3	±20ppm <400ppm*1 ±5% <5000ppm ±10% >5000ppm	0-10,000ppm, 0-12,000mg/m^3
Nitric Oxide (optional)	1ppm,mg/m3	±5ppm <100ppm*1 ±5% >100ppm	0-5000ppm, 0-6700mg/m^3
Pressure (optional)	0.1mbar	±5.0% full scale	150 mbar
Carbon Dioxide*2	0.1%	±0.3% reading	0-99.9%
Losses*2	0.1%	±1.0% reading	0-99.9%
Efficiency*2	0.1%	±1.0% reading	0-99.9%
Excess Air*2	0.1%	±0.2%	0-2885.0%
Temp (Nett) *2	1.0°C/F	±2°C ±0.3% reading	0-600°C/32-1112°F
CO/CO_2 ratio*2	0.0001	±0.0001	0-0.9999
Poison Index *2	0.01%	±0.01	0-99.99
Pre-programmed Fuels		Natural gas, Town gas, Gascor, Light Oil, Heavy Oil, Propane, Butane, Anthracite, Coke, Coal, Kinsale Gas.	
Dimensions Weight Handset Probe		 1kg 220mm x 55mm x 120mm L240mm x Dia8mm with 285mm long stainless steel shaft, type K thermocouple and 1.5m long neoprene hose	
Ambient Operating Range		+0°C to +40°C/10% to 90% RH non condensing	
Power Supply (battery charger)		Input: 110Vac/220 Vac nominal Output: 12 Vac off load	
Battery Life		>8 hours from full charge	

*1 Using dry gases at STP
*2 Calculated

APPENDICES

A - Main Display Parameters

The parameters and their meanings are detailed as follows : -

DATE :	Analyser date. See **Set-Up menu** section 5.2.5 to change.
TIME :	Analyser time. Use **Set-Up menu** section 5.2.5 to change.
BATTERY : (BAT)	Displays the battery level from 0-100%. The analyser will flash **RECHARGE BATTERY** at less than 10 % of charge. With the charger connected the display shows **AC ON.**
NETT : (ΔT)	Nett temperature calculated by deducting the internal AMBIENT temperature from the measured FLUE temperature. Displays in either °C (C) or °F (F) and will display NOT FITTED (N/F) if flue probe is not connected. If an external INLET probe is used then INLET is deducted from FLUE.
O2 :	Oxygen reading in percentage %.
CO :	Carbon Monoxide reading indicated in ppm or mg/m3. If the figures are referenced to oxygen then the display will show **CO(n).** See SELECT menu 5.2.2 for oxygen reference. The display will read 'O2 > 20%' if referenced values selected and instrument is in clean ambient air.
EFF (G) :	Combustion Efficiency calculation displayed in percentage. Gross G or Net N can be set see SELECT menu 5.2.3. The calculation is determined by fuel type see Appendix B for calculation. The efficiency is displayed during a combustion test, '- -' is displayed while in fresh air.
CO2 :	Carbon Dioxide calculation determined by the type of fuel. This only shows a reading when a combustion test is being carried out. '- -' is displayed while in fresh air.
FLUE : (Tf)	Temperature measured by flue gas probe in Centigrade or Fahrenheit. Will show ambient temperature after fresh air calibration and **NOT FITTED (N/F)** or **FAULT (FLT)** if probe disconnected.
INLET : (Ti)	Temperature measured by the optional inlet air probe. This probe is plugged into the instrument through the RS232 socket. This figure is used to calculate the NET temperature instead of AMBIENT when fitted.

AMBIENT : (Ta) Temperatrue measured by the internal sensor, used in the NET temperature calculation if an INLET probe is not fitted.

CO/CO2 R : The CO/CO_2 ratio, is the ratio of measured CO divided by calculated CO_2.

It gives an indication of the following :-

- How good a gas sample the instrument is reading.
- How clean the boiler is running.

For example : A new or clean domestic boiler will display a ratio of less than 0.004, a unit in need of cleaning 0.004-0.008 and a unit in need of major overhaul will show greater than 0.008.

This only shows a reading when a combustion test is being carried out. '- -' is displayed while in clean ambient air.

P INDEX : (PI) The CO/CO_2 ratio expressed as a percentage %, called the 'Poison Index' i.e. P INDEX % = 100 x CO/CO_2. '- -' is displayed while in clean ambient air.

XAIR % : (λ) Excess air calculated from the measured oxygen and type of fuel used. During a combustion test 'O2 > 20%' will be displayed while in clean ambient air.

Prs : Flue draught pressure reading. Displayed when pressure sensor fitted. See UNITS menu 5.2.3. for scales.

NO: Nitric Oxide reading in ppm or mg/m3. Displayed when Nitric Oxide sensor fitted. Also displayed as **NO (n)** when referenced to oxygen. The display will read 'O2 > 20%' if referenced values selected and instrument is in clean ambient air.

NOx : Calculated total Nitric oxides displayed in ppm or mg/m3. Where NOx = NO + P%NO, note P can be set from 0-9%, default = 5%. See SELECT menu 5.2.2. Also displayed as **NOx (n)** referenced to oxygen. The display will read 'O2 > 20%' if referenced values are selected and instrument is sampling clean ambient air.

SO2 : Sulphur Dioxide reading in ppm or mg/m3. Displayed when Sulphur Dioxide sensor fitted. Also displayed as **SO2 (n)** referenced to oxygen. The display will read 'O2 > 20%' if referenced values selected and instrument is in clean ambient air.

O2 ref % : (O2r) Toxic gas measurements can be referenced to defined oxygen levels. See SELECT menu 5.2.2 for details.

B. COMBUSTION EFFICIENCY CALCULATION

The efficiency calculation is based upon British Standard BS845.

This identifies three sources of loss associated with fuel burning:

Losses due to flue gasses:	Dry Flue gas loss, Moisture and hydrogen Sensible heat of water vapour Unburned gas
Losses due to refuse:	Combustible in ash Combustible in riddlings Combustible in dust
Other losses:	radiation convection conduction other unmeasured losses

Net efficiency calculations assume that the energy contained in the water vapour (formed as a product of combustion and from wet fuel) is recovered and the wet loss term is zero. Gross efficiency calculations assume that the energy contained in the water vapour is not recovered.

Since the fuel air mixture is never consistent there is the possibility of unburned/partially unburned fuel passing through the flue. This is represented by the unburned carbon loss.

Losses due to combustible matter in ashes, riddlings, dust and grit, radiation, convection and conduction are not included.

Efficiency Calculation:

Known Data - Fuel:	Qgr = Gross Calorific Value (kJ/kg) Qnet = Net Calorific Value (kJ/kg) K1 = Constant based on Gross or Net Calorific Value: K1g = (255 x %Carbon in fuel)/Q_{gr} K1n = (255 x %Carbon in fuel)/Q_{net} K2 = % max theoretical CO_2 (dry basis) K3 = % Wet Loss H_2 = % Hydrogen H_2O = % Water
Measured Data:	Tf = Flue Temperature Ti = Inlet Temperature O_2m = % Oxygen in flue gas O_2r = Oxygen reference %

Calculated data:

Tnet = Net Temperature
% CO_2 content in flue gas
% Dry Flue Gas losses
% Wet losses
% Unburned carbon loss
% Efficiency

Tnet = Flue Temperature - Inlet Temperature

Dry flue gas loss % = 20.9 x K1n x (Tnet) / K2 x (20.9 - O_2m)

Wet loss % = 9 x H_2 + H_2O / Qgr x [2488 + 2.1Tf - 4.2 Ti]

simplified = [(9 x H_2 + H_2O) / Qgr] x 2425 x [1 + 0.001 Tnet]

Wet loss % = K3(1+0.001xTnet)

Where K3 = [(9 x H_2 + H_2O) / Qgr] x 2425

Net Efficiency % = 100 - dry flue gas losses

= 100 - 20.9 x K1n x (Tnet) / K2 x (20.9 - O_2m)

Gross Efficiency % = 100 - {dry flue gas losses + wet losses}

= 100 - [20.9 x K1g x (Tnet) / K2 x (20.9 - O_2m)]+ [K3 x (1 + 0.001 x Tnett)]

Excess Air = [20.9 / (20.9 - O_2m)] - 100

CO_2% = [(20.9 - O_2m) x K2 / 20.9]

Unburned fuel Loss % = K4 x CO / (CO + CO_2) Note: CO scaled in %

Where K4 = 70 for coke
= 65 for anthracite
= 63 for Bituminous coal
= 62 for coal tar fuel
= 48 for liquid petroleum fuel
= 32 for natural gas

The formula for K4 is based on the gross calorific value Qgr. To obtain the loss based on net calorific value multiply by Qgr/Qnet. Since this loss is usually small this conversion has been ignored.

Oxygen Reference $CO(n) = CO \times \frac{(20.9 - O_2r)}{(20.9 - O_2m)}$

C. CALCULATION OF FUEL DATA

For any fuel not specified by Dwyer Instruments Inc. the net calorific value, gross calorific value and composition should be obtained from the fuel supplier.

The following fuel data has been calculated with reference to the efficiency calculation.

Example 1:

Chemical composition:		
	C	25%
	H_2	3%
	H_2O	50%
	Q_{net}	8.35 MJ/kg
	Q_g	9.3 MJ/kg *
	Max CO_2	20.4%

K1n = (255 x % carbon in fuel) / Q_{net} (kJ/Kg)
= (255 x 25) / 8350 = **0.763**

K1g = (255 x % carbon in fuel) / Q_g (kJ/Kg)
= (255 x 25) / 9300 = **0.685**

K2 = Max % CO_2 = **20.40**

K3 = Wet Loss = [(9 x %H_2 + %H_2O) / 9300] x 2425
= [(9 x 3 + 50) / 9300] x 2425
= (77 / 9300) x 2425 = **20.08**

K4 = **65** (an approximation for wood) *

The fuel values to program into the Analyser are as follows:

NATURAL GAS	
K1g : 0.763	K1n : 0.685
K_2 : 20.4	K_3 : 20.08
K_4 : 65	O2r : 8.0

* Assumed values in the absence of supplied data. See previous appendix for other fuels.