KANE450

Flue Gas Analyser

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Stock No: 18221-5 January 2007

benchmark
The code of practice for the installation, commissioning & servicing of gas fires and wall heaters

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KANE450
User Guide

The **KANE450** Combustion Analyser measures O_2, differential temperature, differential pressure and CO.

It calculates efficiency (Nett, Gross or Condensing), losses, the CO/CO_2 ratio, Poison Index, excess air and CO air free in ppm only..

The analyser can be upgraded with the addition of a Nitric Oxide sensor either on initial purchase (Order Code: KANE450N) or as a retrofit as part of an annual service procedure.

In addition the KANE450 Combustion Analyser's CO sensor checks carbon monoxide levels in ambient air - useful when a CO Alarm is triggered .. and tests the safety of appliances.

The CO and NO readings can be referenced to the oxygen reading in ppm or mg/m^3.

All analysers have a protective rubber sleeve with a magnet for "hands–free" operation and their flue probes work on all combustion appliances and take ambient air measurements.

The large display shows 4 readings at a time and all data can be printed via an optional infrared printer. The printed data can be 'live' data, 'frozen data' or stored data. 255 sets of tests can be stored. Note: stored data is lost if the batteries are removed or are exhausted. Two lines of 16 characters can be added to the header of printouts.

The analysers are controlled using 4 buttons and a rotary dial.

The four buttons (from left to right) switch on and off the analyser, print actual or frozen data/ switch on and off the backlight, switch on and off the pump and "freeze"/ hold data. The buttons with UP, DOWN and ENTER arrows also change settings such as date, time, fuel source etc. when in MENU mode.

The rotary dial changes the LED indicated display line and selects access to the menu to make changes to the date, time, fuel, etc.

1. BEFORE USING THE ANALYSER FOR THE FIRST TIME:

Turn over the analyser, remove its' protective rubber sleeve and fit 4 "AA" batteries in the battery compartment. **Take great care to ensure they are fitted with the correct battery polarity.** Then replace the battery cover and protective rubber sleeve. Always check that the analyser is working correctly after replacing batteries.

Set the analyser's correct time, date, fuel source, etc, after it is switched on and calibrated – See **USING THE ROTARY DIAL** below. These settings are stored when the analyser is switched off.

Using Re-Chargeable Batteries.

This analyser has been designed for use with both alkaline and rechargeable Nickel Metal Hydride (NMiH). No other battery types are recommended.

WARNING

The battery charger unit must only be used when NMiH batteries are fitted.

NMiH batteries are entirely suitable for top up charging at any time, even for shorts periods.

Alkaline batteries are not re-chargeable. Attempting to recharge Alkaline batteries may result in damage to the product and may create a fire risk.

Ensure the batteries are fitted in the correct manner .

Charger

Ensure that you use the correct charger. The part number is KMCU450/UK.

An in-vehicle adapter can be used to top up the analyser's batteries from a 12 volt vehicle battery. The part number is KMCU450/12

Trickle Charging : on first charging, charge for at least 12 hours continuously, subsequently charge overnight for approx. 8 hours.

Fast Charging: With the analyser switched on connect the charger and then switch the analyser off. The display will then show "BATTERY CHARGING"

Battery Disposal

Always dispose of depleted batteries using approved disposal methods that protect the environment

2. BEFORE USING THE ANALYSER EVERY TIME:

Check the water trap is empty and the particle filter is not dirty:

- To empty water trap, unplug its rubber stopper and re-plug once it is empty.

- To change the filter, remove protective rubber sleeve, pull out the water trap unit from the analyser, remove the water trap's particle filter from its' spigot and replace. Reconnect the water trap and rubber protective sleeve.

Connect the flue probe into the bottom of the analyser's water trap and connect the probe's temperature plug to the socket next to the water trap – check the plug's orientation is correct otherwise incorrect temperature measurements will occur.

After switch on, check fuel source, date and time are correct and battery power is sufficient.

SAFETY WARNING

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

Sensor manufacturers recommend users of portable gas detectors containing electrochemical sensors conduct a "bump" check before relying on the unit to verify an atmosphere is free from hazard.

A "bump" test is a means of verifying that an instrument is working within acceptable limits by briefly exposing to a known gas mixture formulated to change the output of all the sensors present. (This is different from a calibration where the instrument is also exposed to a known gas mixture but is allowed to settle to a steady figure and the reading adjusted to the stated gas concentration of the test gas).

For Oxygen monitors a level of confidence that the unit is working adequately may be gained by exhaling over the sensor inlet and viewing the reduction in reading obtained.

3. USING THE ANALYSER AND ITS FOUR BUTTONS:

Switching ON the Analyser	Press ⏻ button to switch the unit ON in fresh air outside the property about to be tested. This lets the analyser auto calibrate its' sensors properly. On switch on, the analyser beeps four times and displays the fuel previously selected, the date and time and model number. Its' bottom line counts down from 60 until the sensors are ready to use – This normally takes 20 - 30 seconds but may take longer as sensors get older. If the analyser will not auto calibrate, its' sensors need to be replaced or recalibrated by an authorized repair center. If the inlet probe is connected to the analyser during its' countdown the measured temperature from the inlet probe will be used as the inlet temperature. If the inlet probe is not connected and you connect the flue probe's temperature plug to the analyser during countdown the measured temperature from the flue probe will be used as the inlet temperature. If neither probe is connected during countdown the analyser's internal ambient temperature will be used as the inlet temperature.
Switching OFF the Analyser	Press ⏻ button to switch the analyser OFF. The display counts down from 30 with the pump on to clean the sensors with fresh air – If the probe is still connected, make sure analyser and probe are in fresh air. Press HOLD / ENTER if you want to stop the countdown and return to making measurements. **Note: the analyser will not switch off until the CO reading is below 20ppm**
Using UP / DOWN / ENTER Buttons	Use the UP / DOWN / ENTER keys to change settings (such as time, date and fuel) when the rotary dial is turned to MENU.
Printing Data	Press and **quickly** release the key to start the analyser printing. The analyser displays "PRINTING" until this is completed. Press and release the key again to abort printing. Make sure the printer is switched on, ready to accept data and its' infrared receiver is in line with the analyser's emitter (on top of the analyser).

Backlight	Press and hold  to toggle the display's backlight **Note: use of the backlight increase the current drain on the batteries**
Tasklight	Comes on in conjunction with the display's backlight... see above.
Switching PUMP on / off	The analyser normally operates with the pump on. Press PUMP **quickly** to switch the pump off and on. When the pump is switched off, the analyser displays "PUMP OFF" approx every 30 seconds. **NOTE: the pump will not switch off if the CO reading is above 20ppm .** This helps to protect the CO sensor from damage. NOTE: the pump cannot be switched off with the rotor set to ----------MENU.
Zeroing the pressure sensor	Press and hold the PUMP key until the top line display shows ZERO CAL.
"Freezing" the display	Press and hold the HOLD / ENTER key until a second beep is heard to freeze all readings. The display flashes and readings can be printed by pressing PRINT key. Press and hold the HOLD / ENTER key again until a second beep is heard to go back to "live" measurements. The HOLD function is inhibited when the display LEDs are flashing
Storing a set of readings	Press and hold the HOLD/ENTER key for approx. 4 seconds. Note: this STORE function is inhibited if the display LEDs are flashing Note: this STORE function is inhibited in normal operation if the pump is switched off.
Changing the display's active line	Press and release the HOLD/ENTER key until the illuminated LEDs point at the display line that you wish to change. While the LEDs are flashing turn the rotary dial to display the parameter that you want. If the rotor is not turned the active line will go back to its previous setting after approx. 5 secs.

4. USING THE KANE450 AS A THERMOMETER OR PRESSURE METER

With the KANE450 switched off, press and hold down the HOLD button and then press and release the ON/OFF button, then release the HOLD button.

The KANE450 will now operate as a fixed display pressure meter/thermometer with the pump off and inhibited.

The display will show: pressure
flue temp
inlet temp
differential temp

The rotor display indications will now be locked apart from MENU. Readings can be held and logged in the normal way. Up to 8 sets of readings can be logged.

Exit this mode by switching the KANE450 off.

The standard printout for this mode is as follows:

K450 1.0
Serial No. 123456789
sales@kane.co.uk
KANE INTERNATIONAL

DATE 12/12/05
TIME 09:53:23

.....

PRS mbar 0.001
T1 48
T2 15
ΔT 33

5. USING THE ROTARY DIAL (starting from Menu):

Rotating the dial selects the displayed parameter , unless MENU is selected or the pressure/temperature mode has been selected.

	ROTARY DIAL POSITIONS
MENU	switches to MENU function
BAT	Displays estimated battery life. If battery voltage falls below a pre-set limit, the display flashes "LOW BAT." every 10 seconds. See above to change the batteries or re-charge, if applicable.
TIME	Displays Time
LOSS	Displays calculated losses when O_2 values are less than 18%
CO/CO_2 ratio	Measured CO divided by calculated CO_2 when O_2 values are less than 18%.
CO_2	Displays calculated Carbon Dioxide values once O_2 values are below 18%.
O_2	Displays Oxygen values in %.
T inlet	Displays the inlet probe temperature
T Flue	Displays flue probe temperature If the flue probe's temperature sensor is broken or open circuit it displays - OC -.

T Nett	Displays the difference between flue and inlet / ambient temperatures. If the flue probe's temperature sensor is broken or open circuit it displays - OC -.
CO	Displays Carbon Monoxide values in PPM as CO in ppm normalized ac COn Display value in mg/m^3 as COm in mg/m3 normalised as COH
NO (if fitted)	Displays Nitric Oxide values in PPM as NO in ppm normalized as NOn Display value in mg/m^3 as NOm in mg/m3 normalised as NOH
PRS	Display the measured pressure or draft value in user selected units
X AIR	Displays calculated excess air when O_2 values are less than 18%.
EFF	Displays calculated efficiency when O_2 values are less than 18% EFFn, EFFg or EFFc as selected by the user.
AUX	addition user selectable displays

Rotate the dial to MENU and use the UP or DOWN buttons to select the following function for change:

When you have selected the function to change, press ENTER to select.
Repeat this to scroll through the menu and select (using the ENTER key) and change (using the UP / DOWN keys) the function.
The final, logical ENTER returns you to the main menu display.

To exit the Menu function you can normally rotate the dial to another position - Unless the final logical ENTER is pressed, no changes are made.

The exception is

STORE DELETE where the ENTER key must be pressed to confirm the change and exit. If you rotate the dial before pressing ENTER the instrument will beep continuously. You must rotate the dial back to MENU and press ENTER before you can continue.

In STORE View mode the rotary dial is used to select the saved parameter to be displayed. Use the UP/DOWN keys to change the Test number. To exit the View mode press ENTER.

6. MAIN MENU FUNCTIONS

There are six menu headings each with its own sub-menu

SETUP	fuel selection efficiency calculation time and date setting temperature unit gas units oxygen referencing language exit
PRESSURE	Smoothing resolve (number of decimal points resolution) number of decimal points resolution units time exit
STORE	view auto store delete exit
REPORTS	pressure temperature room CO draught exit
SCREEN	contrast auxiliary display header exit
SERVICE	password protected

SETUP

SET FUEL	NATU GAS L OIL PROPANE BUTANE L.P.G. PELLETS	set fuel type
N < -C- > G	N C G	Nett Condensing Gross efficiency calculation
SET TIME	xx: yy: zz HH: MM: SS	set time values
SET DATE	DD- MM- YY MM- DD- YY YY- MM- DD	choose date format then set date values
C <---> F	C F	centigrade fahrenheit
PPM < - > MG	ppm MG/M3	parts per million milligrams per cubic metre
O2 REF	No YES	set reference value
LANGUAGE	English French Italian German Spanish Dutch Swedish	set language

PRESSURE

SMOOTH	OFF ON	select smoothing
POINTS	LOW HIGH	select decimal point resolution
PS UNITS	mBAR mmH2O Pa kPa PSI mmHg hPa inH2O	select pressure units

STORE up to 255 sets of combustion test results can be stored

VIEW	TEST xxx	enter test number to be viewed then use rotor to select display. If less than 9 set of readings are stored rotate the dial then use the up/down buttons to change the LOG number.
AUTO STO	YES/NO	if YES set logging time interval in minutes
DEL ALL	YES/NO	clears stored values

REPORT

There are dedicated report formats for the following tests:

Pressure (UK tightness testing)
Temperature
Room CO
DRAUGHT

All report menus follow the format TEST / VIEW / DEL ALL.

The TEST functions are described later.

SCREEN

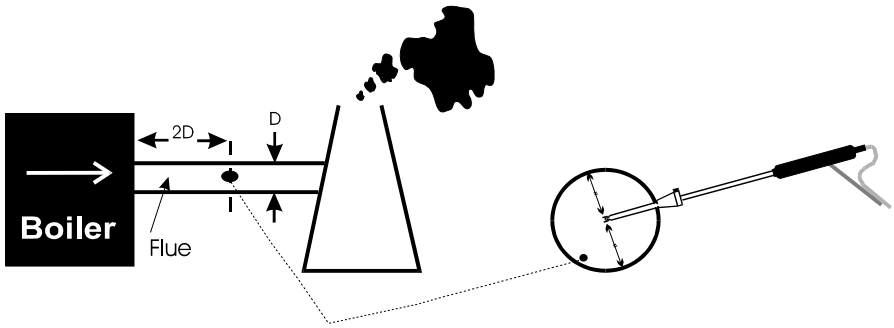
CONTRAST	SET xx	lighten or darken the display
AUX	Selected Fuel Pressure units COM Date CO air free O_2 Reference value	**assign the AUX rotor position**
HEADER	Header 1 Header 2	2 lines each of 20 characters

7. MEASURING MODES

MEASURING FLUE GASES

After the countdown is finished and the analyser is correctly set up, put its' flue probe into the appliance's sampling point. The ideal sampling point is at least two flue diameters downstream of any bend.

Put the probe tip in the flue center. With balanced flues, make sure the probe is positioned far enough into the flue so no air can 'back flush' into the probe.



Use the probe's depth stop cone to fix it in flue diameters from $^{1}/_{4}$ to $^{4}/_{5}$ inch, 6 to 21 mm. Its maximum operating temperature is 1112°F / 600°C.

Make sure you do not exceed the analyser's operating specifications. In particular:

- Do not exceed the flue probe's maximum temperature
- Do not exceed the analyser's internal temperature operating range
- Do not put the analyser on a hot surface
- Do not exceed the water trap's levels
- Do not let the analyser's particle filter become dirty and blocked

View the displayed data to ensure that stable operating conditions have been achieved and the readings are within the expected range.

Press PRINT or press HOLD first to "freeze" or store the readings before printing

STANDARD COMBUSTION PRINTOUT

K450	1.0	/product code
Serial No.	123456789	/Kane's serial number
sales@kane.co.uk		/user header 1
KANE INTERNATIONAL		/user header 2
DATE	12/12/05	
TIME	09:53:23	
.....		
FUEL	NATU GAS	
O2 %	5.1	
CO2 %	9.0	
CO ppm	400	
NO ppm	n/f	/NO sensor not fitted
FLUE °C	48	
INLT °C	15	
NETT °C	33	
EFF (C)	102.1	/condensing efficiency
PRS mbar	0.001	
Losses %	-2.1	
XAIR %	32.1	
CO/CO2	0.0044	
PI	0.44	
O2 ref %	0.0	
SMOKE.....		
.....		

STORING A DRAUGHT MEASUREMENT TO PRINT WITH A COMBUSTION TEST

Rather than print a draught test report and then a combustion test report it is possible to combine the two sets of results on one printout by taking a draught reading first and storing it for printing later.

The following sequence must be followed:

With PRESSURE on the top line and with the rotor pointing to Prs... and with the pump off..... then if LOG is activated the current pressure reading will be stored in the draught register with its current scaling. All the conditions must be met and no other values will be logged. As this occurs the top line display briefly shows "DRAUGHT".

Whilst the instrument is in this mode activating LOG again will overwrite the stored reading.

The stored reading is cleared whenever the analyser is switched off or by entering any REPORT menu.

Resuming normal operation adds the stored DRAUGHT reading to any combustion printout or any combustion log. In such cases the printout changes so instead of "PRS" being printed "DRGT" is printed instead.

NOTE: whenever there is a stored DRAUGHT reading the current pressure reading is ignored and the stored reading is always used

WARNING: This means that if a user stores a draught reading from one appliance and goes to another appliance without switching off or re-entering the reports menu his printouts and logs will show the last stored draught reading and its scaling.

MEASURING PRESSURE

The analyser can be used to measure pressure by connecting tubing to the appropriate ports.

Standard Pressure Report .... this mode is accessed via the MENU function

This mode allows a tightness test to be carried out automatically.

The times for the test can be set by the user.

From the start of the test the analyser waits 60 secs to allow temperature stabilisation, then records and displays the pressure reading at the start of a 120 second countdown. The live pressure reading is displayed during the 120 second countdown and then locked at the end of the countdown. The display then shows start pressure and finish pressure. The summary results can then be printed as below:

Pressure Test Printout

K450 1.0
Serial No. 123456789
sales@kane.co.uk
KANE INTERNATIONAL

.....

Tightness Test
.....

LOG 03
TIME 14:58 12/12/05

PRS_1 mbar 20.110
PRS_2 mbar 19.998
Duration mins 2:00

.....
customer

.....
appliance

.....
Ref:

.....

MEASURING TEMPERATURE

The analyser can be used as a normal single input or differential thermometer, ideal for measuring flow and return temperatures or for setting up hot water temperature/flow on a combi boiler.

Standard Temperature Report .... this mode is accessed via the MENU function

K450 1.0
Serial No. 123456789
sales@kane.co.uk
KANE INTERNATIONAL

.....
Temp Test
.....

LOG 05
TIME 10:15 20/03/06

T1	°C	54.1
T2	°C	24.1
ΔT	°C	30.0

.....
Customer

.....
Appliance

.....
Ref:

.....

MEASURING AMBIENT AIR (ROOM CO)

The analyser's CO sensor can be used to detected spillage from appliances. A standard spillage test can be conducted where the analyser automatically records 16 sets of 1 minute samples and prints the results as below:

Standard Room CO Report .... this mode is accessed via the MENU function

K450 1.0
Serial No. 123456789
sales@kane.co.uk
KANE INTERNATIONAL
.....
Room CO Test
.....
LOG 05
TIME 16:58 12/12/05

TEST	CO ppm
0	1
1	5
2	7
3	9
4	10
5	13
6	16
7	24
8	30
9	28
10	18
11	14
12	10
13	6
14	4
15	3

.....
MAXIMUM CO 30

.....
Customer

.....
Appliance

.....
Ref:

.....

MEASURING FLUE DRAUGHT

STANDARD DRAUGHT REPORT

K450 1.0
Serial No. 123456789
sales@kane.co.uk
KANE INTERNATIONAL

.....
Draught
.....

TIME 15:58 12/12/05

PRS mBar 0.54

.....
customer

.....
appliance

.....
Ref:

.....

8. WHEN YOU FINISH A COMBUSTION TEST

Remove its' probe from the flue **- THE PROBE WILL BE HOT -** and let it cool. Do not put the probe in water which will be sucked into the analyser, damaging its' pump and sensors.

When the analyser's readings return to ambient levels, switch it off. The analyser counts down from 30 before switch off with the pump running to self clean its sensors.

9. ANALYSER PROBLEM SOLVING

If any problems are not solved with these solutions, contact us or an authorized repair center.

Fault symptom	**Causes / Solutions**
• Oxygen too high • CO_2 too low	• Air leaking into probe, tubing, water trap, connectors or internal to analyser. • Oxygen cell needs replacing.
• Oxygen reading (- - - -) • CO reading (- - - -)	• Analyser was stored in a cold environment and is not at normal working temperature. • Oxygen cell or CO sensor needs replacing. • Pump is switched off
• Batteries not holding charge • Analyser not running on mains adapter.	• Batteries 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.
• Net temperature or Efficiency calculation incorrect.	• Ambient temperature set wrong during Automatic Calibration.
• Flue temperature readings erratic	• Temperature plug reversed in socket. • Faulty connection or break in cable or plug.
• T flue or T nett displays (- - - -)	• Probe not connected.
• X-Air, EFF, COa or CO2 display (- - - -)	• Oxygen reading is above 18%
• Analyser just continually beeps	• Turn dial back to MENU and press ENTER
• BAT only shows 65 with fully charged NiMh batteries fitted	• This is not a problem and is to be expected as NiMh batteries only deliver 1.25 V per cell whereas Alkalines deliver 1.5 V per cell. Fresh alakalines might give a BAT value of 80 or so.

10. ANALYSER ANNUAL RECALIBRATION AND SERVICE

Although sensor life is typically more than two years, the analyser should be re-calibrated and serviced annually to stop any long-term sensor or electronics drift or accidental damage.

Local regulations may require more frequent re-calibration.

In the UK Kane International has service facilities at Atherton near Manchester (Tel: 01942-873434), the primary service centre for UK customers and at Welwyn Garden City in Hertfordshire (Tel: 01707-375550), the primary service centre for non-UK customers.

By sending you analyser back to Kane for an annual fixed price service (Check www.kane.co.uk for details) you have the opportunity to extend the warranty on your analyser to 5 years.

11. ANALYSER SPECIFICATION

(NOTE MAY BE SUBJECT TO CHANGE)

Parameter	Resolution	Accuracy	Range
Temp Measurement			
Flue Temperature	1.0°C/F	±2.0°C (5°F) ±0.3% reading	0-600°C 32-1112°F
Inlet Temperature	1°C/F	±1°C/F ±0.3% reading	0-100°C 32-212°F
Temp (Nett) *2	1.0°C/F	±2°C (5°F) ±0.3% reading	0-600°C 32-1112°F
Pressure Measurement	0.1 Pa	±0.5 Pa	± 20 Pa
	0.1 Pa	±3 Pa	± 100 Pa
	1 Pa	± 3% of reading	± 2000 Pa
	0.01 hPa	± 3% of reading	± 80 hPa
Gas Measurement Oxygen	0.1%	±0.2%*1	0-21%
Carbon Monoxide (KANE450CO)	1ppm	±10ppm <100ppm*1 ±5% of reading	0-2000ppm nom 4000ppm max for 15 minutes
(KANE450COH)	1ppm	±20ppm <400ppm ±5% <5000ppm ±10% >5000ppm	0-10,000ppm
Nitric Oxide (NO)	1 ppm	± 2ppm <30ppm*1 ±5 ppm > 30ppm	0 to 100 ppm
Carbon Dioxide*2	0.1%		0-30%
Efficiency*2	0.1%	±0.3% reading	0-99.9%
Excess Air*2	0.1%	±1.0% reading ±0.2%	0-250%
Pre-programmed Fuels	Natural gas, Light Oil, Propane, Butane, LPG, Wood Pellets.		

Dimensions Weight Handset Probe	 0.77kg / 2.2lb handset with boot 200mm / 7.9” x 45mm / 1.8” x 90mm / 3.5” L300mm / 11.8” x Dia 6mm / 0.25”with 200mm / 7.8” long stainless steel shaft, type K thermocouple and 3m / 6ft long neoprene hose
Ambient Operating Range	+0°C to +40°C / 32-104°F 10% to 90% RH non- condensing
Storage Capacity LOG **REPORT**	255 sets of test results in volatile memory 8 sets of each report in volatile memory
Battery Life	4 AA cells >12 hours using Alkaline AA cells
AC battery charger (optional)	Input: 110Vac/220 Vac nominal Output: 10 Vac off load

*1 Using dry gases at STP *2 Calculated

12. ELECTROMAGNETIC COMPATIBILITY

European Council Directive 89/336/EEC requires electronic equipment not to generate electromagnetic disturbances exceeding defined levels and have adequate immunity levels for normal operation. Specific standards applicable to this analyser are stated below.

As there are electrical products in use pre-dating this Directive, they may emit excess electromagnetic radiation levels and, occasionally, it may be appropriate to check the analyser before use by:

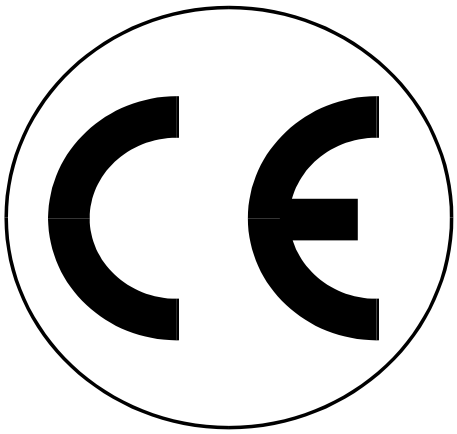
Use the normal start up sequence in the location where the analyser will be used.

Switch on all localized electrical equipment capable of causing interference.

Check all readings are as expected. A level of disturbance is acceptable.

If not acceptable, adjust the analyser's position to minimize interference or switch off, if possible, the offending equipment during your test.

At the time of writing this manual (August 2005) Kane International Ltd are not aware of any field based situation where such interference has occurred and this advice is only given to satisfy the requirements of the Directive.



This product has been tested for compliance with the following generic standards:

EN 61000-6-3
EN 61000-6-1

and is certified to be compliant

Specification EC/EMC/KI/K450 details the specific test configuration, performance and conditions of use.

Please Note:

Batteries used in this instrument should be disposed of in accordance with current legislation and local guidelines.

At the end of the product's life it should be re-cycled in accordance with current legislation and local guidelines.

Appendix 1 - Main Parameter:

Here are the legends used and what they mean:

O_2 : Oxygen reading in percentage (%)

O2R: Oxygen reference setting. '----' means switched off or set to 0%.

T Flue: Temperature measured by the flue gas probe in Centigrade or Fahrenheit. It displays '**- OC -'** if the flue probe is disconnected.

T Nett : Nett temperature calculated by deducting the **AMBIENT** or **INLET** temperature from the measured **FLUE** temperature. Displays in either Fahrenheit (°F) or Centigrade (°C) or and will display '**- OC -**' if the flue probe is not connected.

T inlet: Temperature measured by the inlet temperature probe in Centigrade or Fahrenheit. It displays '**- OC -'** if the flue probe is disconnected.

CO: Carbon Monoxide reading displayed in ppm (parts per million). '**- - -'** is displayed if there is a fault with the CO sensor or the instrument has not set to zero correctly, switch off instrument and try again.

C0m: Carbon Monoxide displayed in mg/m^3.

COn: Carbon Monoxide in ppm normalised to the O2R value

COH: Carbon Monoxide in mg/m3 normalised to the O2R value.

COa Carbon Monoxide calculation as if there were 0% Oxygen present. This is only displayed in ppm

CO_2 : Carbon Dioxide calculation determined by fuel type. This is only displayed when a combustion test is being carried out. '**-O>-**' is displayed while in fresh air.

EFF : Combustion efficiency calculation displayed in percentage either as Gross (G) or Nett (N) or Condensing Nett (C) - Use **MENU** to change. The calculation is determined by fuel type and uses the calculation in British Standard BS845. The efficiency is displayed during a combustion test, '**-O>-**' is displayed while in fresh air.

X - AIR : Excess air calculated from the measured oxygen and type of fuel used. Displays reading during a combustion test. '**-O>-**' is displayed while in fresh air.

Loss : Losses calculated from Oxygen and type of fuel. Displays reading during a combustion test. '**-O>-**' is displayed while in fresh air.

BAT Displays the Battery power available in %

When the LO BAT symbol appears this indicates the batteries are at less than 10% of charge and should be replaced, readings may be affected if used with low power batteries. Warning: all stored readings are lost when the batteries are removed or become exhausted.

DATE : Date shown as day, month and year. The order can be changed using the menu function. Date is recorded when each combustion test is printed.

TIME : The time is shown in hours and minutes, expressed in "Military" time or the 24hr clock. Time is recorded when each combustion test is printed.

Note! When changing the batteries on the instrument the memory will store the date and time for up to one minute, if outside this time it may be necessary to re-enter the details.
Date and time may also need to be reset if re-chargeable batteries are allowed to totally discharge.

SYMBOLS used on the display

P	Poison Index: measured CO divided by calculated CO_2 multiplied by 100
R	CO/CO_2 Ratio: measured CO divided by calculated CO_2
lambda	Excess Air
AMB	Either the internal temperature of the analyser or the inlet temperature as measured during the start up sequence
loss triangle	Loss%: losses = 100 minus efficiency%
delta T	Nett Temperature.
TF	Flue Temperature
eff symbol	Efficiency %
Ħ	mg/m^3 normalised
PO	pump off
-O>-	oxygen greater than 18% so calculation is disabled
-OC-	open circuit temperature input