IMR 2800 P
IMR 2800 A
IMR 2800 IR

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INTRODUCTION

Thank you for purchasing the ***IMR® 2800 combustion gas analyzer***.
Please read the following instructions before operating the unit for the first time.

Proper handling is necessary to make full use of the outstanding performance and features of this combustion gas analyzer.

IMPORTANT INFORMATION:
- Use the instrument just within the recommended temperature range.
- Never measure without the dust filter and condensation trap.
- The dust filter must be cleaned/replaced when dirty.
- The c8ondensation trap must be checked and the condensed water removed if necessary.
- ***IMR*** *or an authorized service facility must re-calibrate the* ***IMR 2800*** *once a year to ensure accuracy and performance.*

SAFETY INSTRUCTIONS

Please make sure that you read this section carefully for use of your new combustion gas analyzer.

- Follow all warnings and instructions marked on the product or displayed on the screen.
- The AC inlet should only be connected to a socket with a protective earth contact.
- Any adjustment or maintenance of the analyzer under voltage should be avoided.
- The maintenance of the analyzer should be done by qualified personal and the instrument must be turned off and unplugged.
- Do not take the analyzer out of the box during the warranty period. If you do so, then the warranty is null and void.
- Do not use this analyzer in water.
- Never spill water or any liquid on the analyzer.

1 DESCRIPTION

The **IMR 2800** is a state of the art combustion gas analyzer.

Table 1: IMR 2800

	O2	CO	NO	NO2	SO2	Additional Sensor(s)	Printer	Memory	RS232 Interface	Ambient Temp.	Soot	Draft
IMR 2800	X	X	X	X	X	O	X	X	X	X	O	X

X - standard O - optional
Maximum 8 electrochemical sensors

The **IMR 2800** calculates the parameters below:

- Excess air / Lambda
- Heat losses / Efficiency
- Carbon dioxide CO_2

Optional features:

- Differential draft measurement
- Gas Flow measurement (m/s) with Pitot tube
- HCl, N_2O, CL_2, H_2, NH_3, HC, H_2S measurement
- CO_2, CH_4/HC and N_2O NDIR sensors available
- Speed RPM
- Soot Measurement
- High temperature gas sampling probes (ceramic, PT-RhPT) (up to 1500°C / 2732°F)
- Gas-sampling probes with different lengths
- NOx (NO + NO2)
- Additional Instruments: RPM Meter, Soot Meter

1.1 FUNDAMENTALS

Gas flow
A built-in sampling pump is drawing the flue gas through the gas-sampling probe into the analyzer.

1. The gas flows through the gas-sampling probe to the condensation trap.
2. Then the gas passes through a particle filter where dust particles are removed.
3. Then the gas enters the sensor chamber.

Gas temperature
The gas temperature is measured by a thermocouple located at the tip of the gas-sampling probe.

Electrochemical sensors
Each electrochemical sensor measures the concentration of a specific gas.
Electrochemical sensors can be damaged

- if exposed to small particles **- never measure without a dust filter**
- if water / condensation comes in contact with the sensors - **empty condensation trap**

Service / Calibration
A "Service" message will be displayed after 1000 hours or after one year of operating time.
IMR Environmental Equipment, Inc. recommends checking the calibration once a year.

Operating Temperature
50°F..104°F / 10°C..40°C
If the unit is brought in from the cold, then it should be allowed to warm up for a few minutes.

Storage Procedures: IMPORTANT!

Storage Temperature
-4°F..122°F / -2°C..50°C
When not in use or in storage, please make sure to keep the analyzer plugged into a wall outlet (AC).
This ensures that the analyzer maintains a constant battery charge and function properly if needed.
Prolonged periods of disuse without charging the battery may result in a weak battery and the battery can lose its ability to hold the charge.

2 SYSTEM DESCRIPTION

2.1 OVERVIEW

Please check now if the unit is equipped with all the ordered features and accessories.

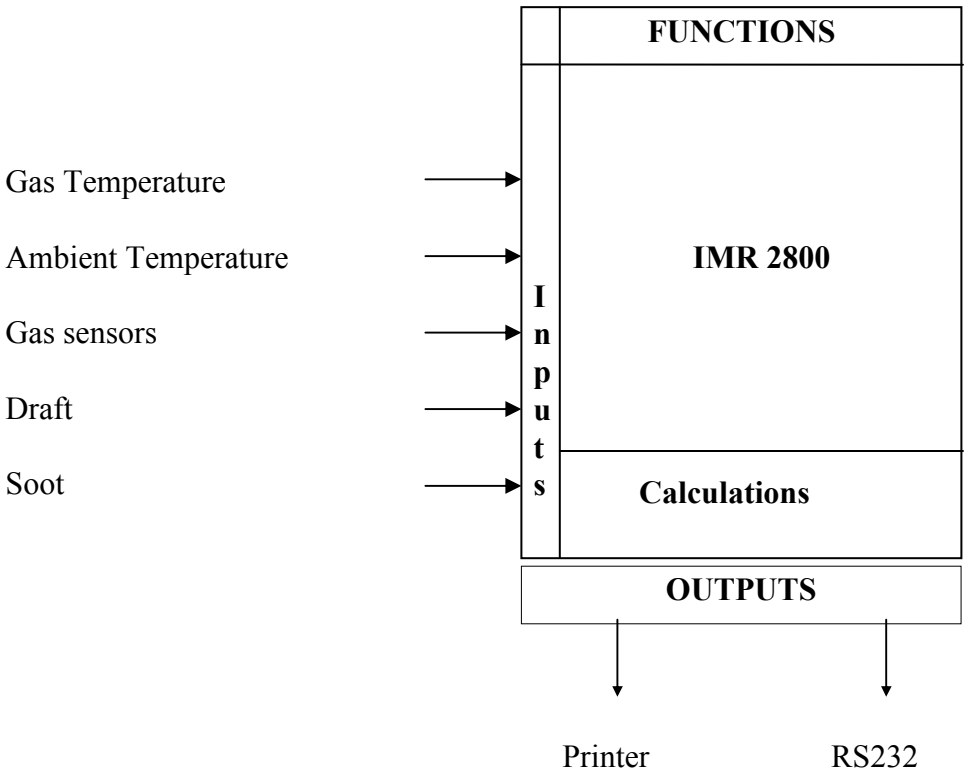
Features and Accessories (if equipped):

- Backlit LCD
- Keypad
- Gas sampling probe
- Ambient temperature probe
- Thermal printer
- RS232 interface
- Rechargeable battery
- Draft measurement
- Soot measurement w/ soot filter paper and comparison scale
- Memory
- O2 electrochemical sensor
- CO electrochemical sensor
- NO electrochemical sensor
- NO2 electrochemical sensor
- SO2 electrochemical sensor
- Additional sensor(s)
- Case
- Manual
- Power Cord
- Calibration certificate

2.2 FUNCTION OVERVIEW

Measurements
- Gas Temperature
- Ambient Temperature
- Draft
- Soot
- O_2
- CO, NO, SO2, NO2, HC (max. 7 more sensors)

Calculations
- CO_2
- Losses
- Excess Air
- NOx (NO+NO2)



2.3 TECHNICAL DATA - STANDARD RANGES

Other measurement ranges and probe lengths are optional available.

Table 2: Technical Data

PARAMETER	PRINCIPLE	RESOLUTION	ACCURACY	RANGE**	STANDARD
O_2 Oxygen	Electro-chemical cell	0.1 Vol.%	± 0.2 Vol. %	0-20.9 Vol. %	✓
CO Carbon monoxide	Electro-chemical cell NDIR	1 ppm 0.001 Vol.%	Z	0-2000/4000ppm 0-10/20 Vol.%	✓ **NDIR Optional**
NO Nitric oxide	Electro-chemical cell	1 ppm	Z	0-2000 ppm	✓
NO_2 Nitrogen dioxide	Electro-chemical cell	1 ppm	Z	0- 100 ppm	✓
SO_2 Sulfur dioxide	Electro-chemical cell	1 ppm	Z	0-4000 ppm	✓
H_2S Hydrogen Sulfide	Electro-chemical cell	1 ppm	Z	0- 200 ppm	
HC/CH4 Hydrocarbons	Pellistor or NDIR	0.1 %	Z	0-100% LEL	
TG Flue gas temperature	NiCr-Ni thermocouple	1 K	± 2 %	-4°F - 2192°F 0°C - 1200°C	✓
TA Air temperature	Semiconductor	1 K	± 0.2 K	-4°F / 248°F 0°C - 120°C	✓
P Draft	Solid state	0.01 hPa	± 2 %	±40 hPa	✓
NO_x Nitrogen oxides	Calculation	1 ppm	Z	0-NO_x max	✓
CO_2 Carbon dioxide	Calculation	0.1 Vol.%	± 0.2 Vol. %	0- CO_2 max	✓
CO_2 Carbon dioxide	NDIR	0.01 Vol.%	± 0.2 Vol. %	0-20 Vol. %	
NH_3 Ammonia	Electro-chemical	1 ppm	Z	0-1000/5000 ppm	
N_2O Nitrous Oxide	NDIR	0.001 Vol. %	Z	0-1 Vol. %	
HCl Hydrogen Chloride	Electro-chemical	1 ppm	Z	0-200 ppm	
Cl_2 Chlorine	Electro-chemical	1 ppm	Z	0-5000 ppm	
H_2 Hydrogen	Electro-chemical	1 ppm	Z	0-10000 ppm	
Losses / Efficiency	Calculation	0.1 %	± 0.1 %	0-99.9 %	✓
Excess Air / Lambda	Calculation	0.1 %	± 0.1 %	1.0-9.99	✓
Soot	Filter paper method			0-9	
Velocity with Pitot tube	Solid state	0.01 m/s	± 2 %	0-80 m/s	
RPM Meter	Solid state	100 RPM	± 2 %	180-10000 RPM	

*** Different/customized ranges available.* *Equipped with a maximum of 8 gas sensors*

Z = 0 - 20 % of whole measurement range ± 5 % of maximum measurement
21 - 100 % of whole measurement range ± 1 % of displayed measurement

Power Inlet	110VAC/60Hz or 230VAC/50Hz
Battery	Sealed lead acid 12VDC- Five-hour charge time
Display	4-line, 20-character illuminated LCD
Printer	Thermal printer - paper width 58mm - built-in
Gas sampling probe	If the unit is equipped with soot measurement - Type S, probe length 10.6" / 270mm, hose 11.5' / 3.5m If the unit is not equipped with soot measurement - Type E, probe length 9.8" / 250mm, hose 8.2' / 2.5m
Ambient air probe	Ambient air temperature plug
Condensation Trap	Inline with integrated filter
Filter	In-line - four micron - washable
Case	Rugged wood/aluminum case with compartment for gas sampling probe, power cord and accessories.
Operating temperature	50°F..104°F / 10°C..40°C
Storing temperature	-4°F..122°F / -20°C..50°C
Calibration	Automatic 3-minute zero calibration
Fuels	USA Natural gas, Propane, Kerosene, Distillate #1, Anthracite coal, Bituminous coal, Fuel #2, Fuel #5, Fuel #6, Bagasse, Wood, Bark, Special fuel A, Special fuel B, Special fuel C, Special fuel D European Fuel oil extra light, Natural gas, Town gas, Coalgas, Liquid gas, Hard coal hb 1950, Wood (air dry), Fuel oil light, Fuel oil heavy, Coaltar oil, Liquid gas air ventil., Liquid gas air, Propane ventil., Propane, Butane ventil., Butane, Propane / Butane ventil., Propane / Butane, Biogas ventil., Biogas, Hard coal hb 7450, Hard coal hb 7170, Hard coal hb 2230, Special fuel A, Special fuel B, Special fuel C, Special fuel D

2.4 SYSTEM CONNECTIONS

2.4.1 Probe

The gas-sampling probe plug and hose has to be connected to the analyzer before it can be turned on and must stay connected during the whole measurement.
If the gas-sampling probe is not connected, then the analyzer cannot perform an accurate calibration and an error message will be displayed.

Type S (if equipped with soot measurement)
The probe S has two hoses. One for the flue gas measurement and one for the draft measurement. Both hoses must be connected to their fittings at all time.
It also has a connection line to connect the thermocouple with the analyzer.

a) Thermocouple	- Connect the thermocouple plug (5-pos) with the 'flue gas temp' socket of the analyzer
b) Flue gas	- Connect the hose, which has the condensation trap inline to the barbed fitting 'gas input'
c) Draft	- Connect the second hose to the barbed fitting 'draft'

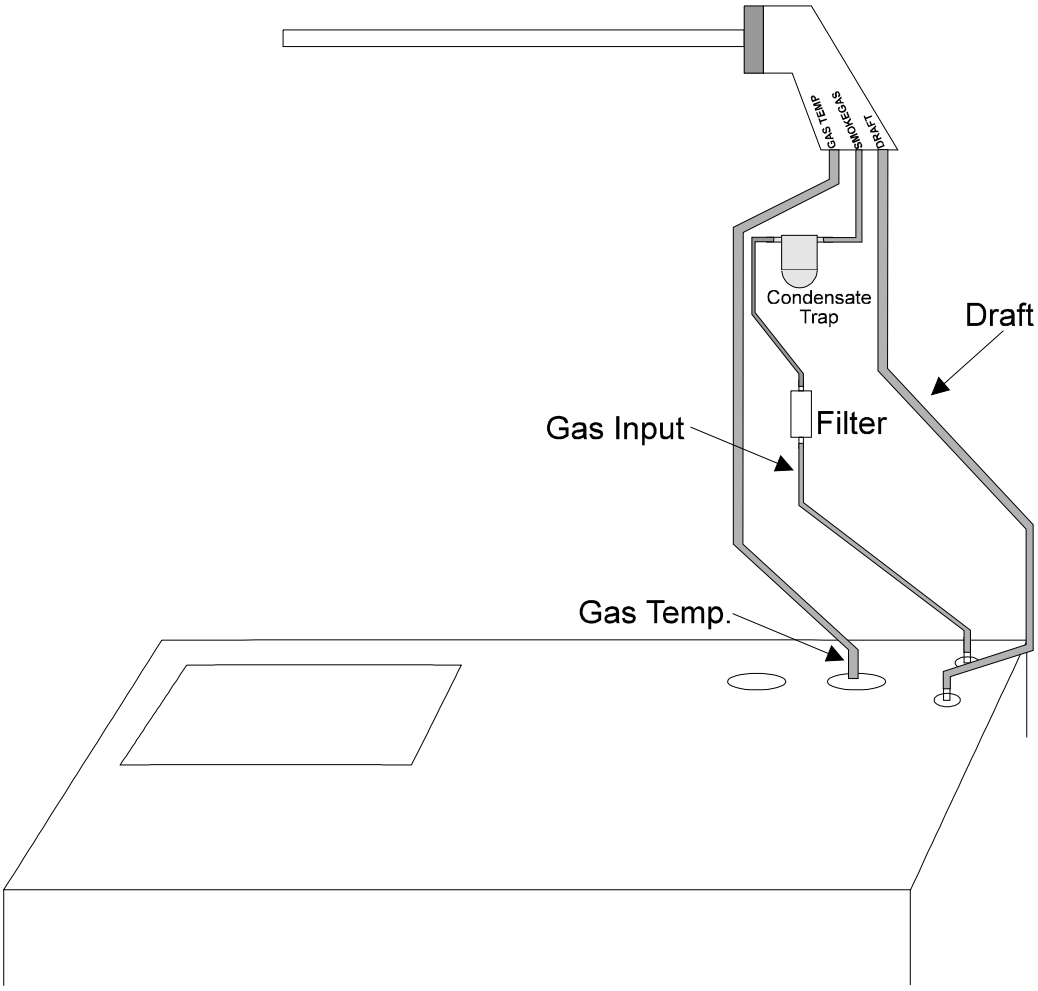
Type E
The probe E has one hose for the flue gas measurement and the draft measurement.
It also has a connection line to connect the thermocouple with the analyzer.

a) Thermocouple	- Connect the thermocouple plug (5-pos) with the 'flue gas temp' socket of the analyzer
b) Flue gas	- Connect the hose to the barbed fitting 'gas input'

The hose must be connected to the 'gas input' fitting for the flue gas measurement.
The hose must be connected to the 'draft' fitting only for the draft measurement and it must be connected back to the 'gas input' fitting after the draft measurement is completed.

Type C (if equipped)
The probe C is a ceramic probe with a Pt-RhPt thermocouple and it is used for high temperatures. The temperature range is 302°F-2732°F / 150°C-1500°C.
It has the same connections as the probe E.

Gas sampling probe (type S) connection:



2.4.2 Ambient air temperature plug

The ambient air temperature plug must be connected to the instrument at all time.
If the ambient air temperature plug is not connected, then the unit shows an error message.

The ambient air temperature plug measures the temperature of the air that is used for the combustion process.
The measured temperature is needed for various calculations.

Connect the plug (4-pos) with the 'air temp' socket of the analyzer.

2.4.3 Gas fitting

The gas hose of the gas-sampling probe must be connected to the gas fitting.

2.4.4 Draft fitting

The draft hose of the gas-sampling probe must be connected to the draft fitting.

2.4.5 LED

The LED shows the power status of the unit.
RED: battery powered
GREEN: AC connected and turned off (charging the battery)
YELLOW: AC connected and turned on

2.4.6 Differential pressure fitting (if equipped)

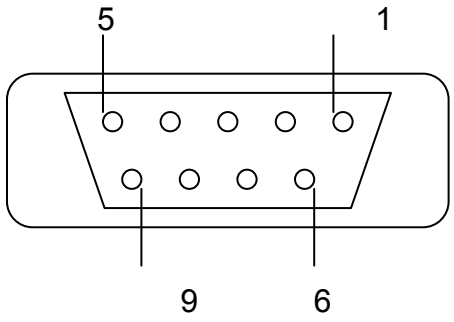
The analyzer is equipped with a third barbed fitting for a differential pressure measurement.
The differential pressure is the pressure that is measured between the 'draft' fitting and this 3rd fitting.
Connect a hose to this fitting and insert it into the medium and start the regular draft measurement. The draft measurement measures now the differential pressure from the medium to the flue gas, where the gas-sampling probe is inserted.

2.4.7 RS232 interface

The RS232 serial interface can be used to transfer data from the analyzer to a PC.
Real time data or stored data can be transferred (ASCII signs are getting transferred).
The serial connection to a PC must be a 'Null-modem connection'.
The **IMR 2800** has a 9-pos. female D-Sub connector on the front panel.

RS232 female connector 9-pos.

1-
2-
3- TXD transmit data
4-
5- GND ground
6-
7-
8- CTS clear to send
9-



Connection to a PC (null-modem connection):

IMR 2800	PC 9-pos	PC 25-pos
3 TXD	2 RXD	3 RXD
5 GND	5 GND	7 GND
8 CTS	7 RTS	4 RTS

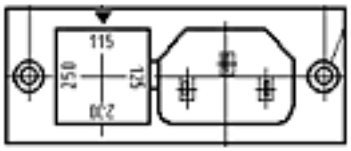
Serial data format
A character has 8 data bits; no parity and 2 stop bits.

ASCII "Computer" format:

```
Start (→)
Station
Fuel
Units (ppm, etc.)
NOx (according TA-Luft)(1)
Date
Time
No. of samples
Time of samples
Room Temperature
O2
CO
HC
SO2
NO2
NO
Draft
Gas Temperature
CO2
Losses
Excess Air
Stop (←)
```


2.5 POWER

The **IMR 2800** works on 230VAC/50Hz or 110VAC/60Hz. A fuse selector next to the AC inlet sets the voltage.



The analyzer is able to work without being connected to the AC by using the power of the internal rechargeable battery lead acid battery.

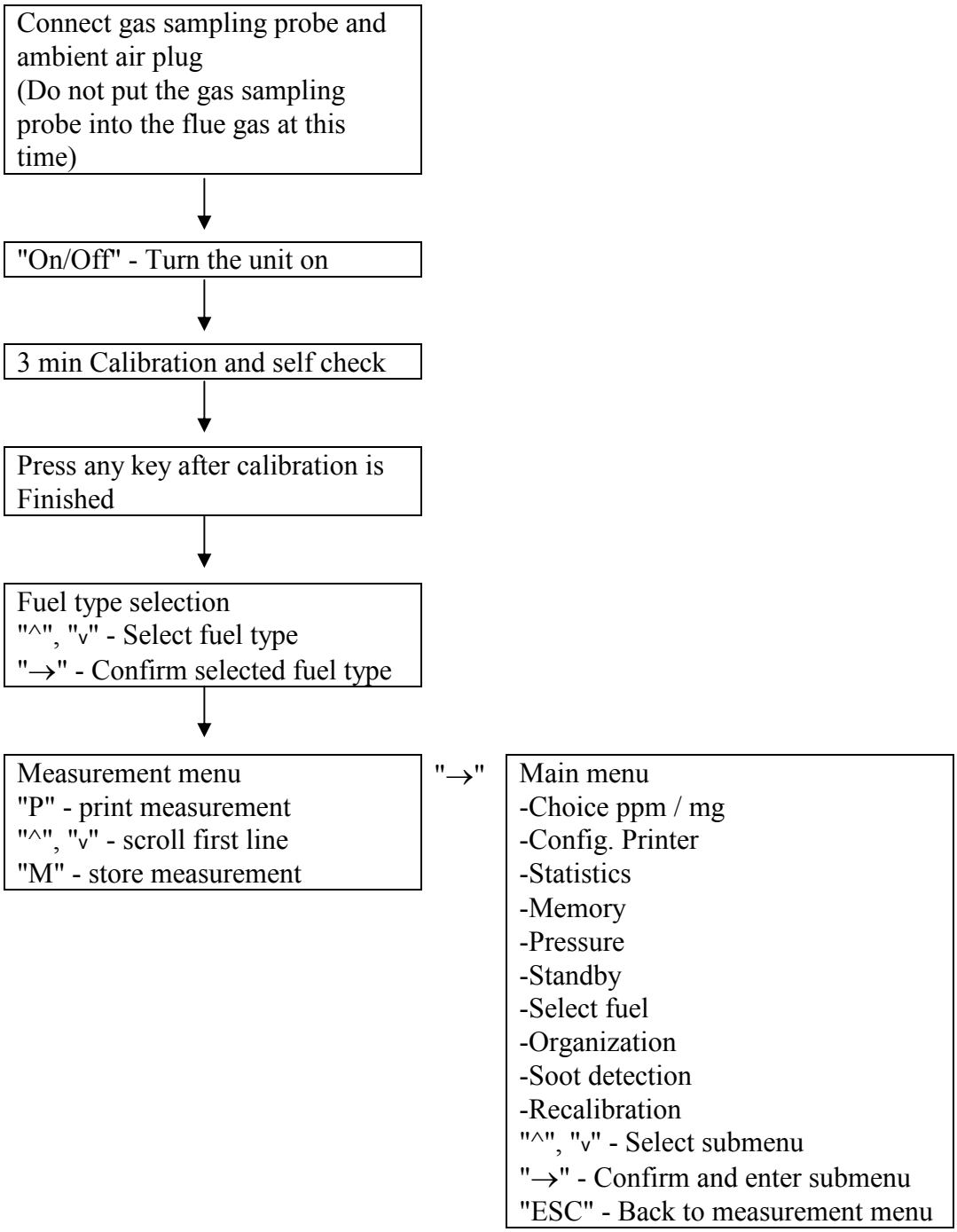
However IMR recommends connecting the analyzer always to the AC during a measurement or during storage.

2.6 BUTTON FUNCTIONS

"0" - "9"	-	Numeric buttons for numbers
"P"	-	Prints a measurement "measurement menu" - complete measurement submenu "pressure" - draft measurement
"M"	-	Stores a measurement
"F"	-	Feed
"^"	-	Scroll up
"v"	-	Scroll down
"ESC"	-	Back to the measurement menu
"→"	-	Enter / confirm

3 OPERATION

3.1 OVERVIEW



3.2 TURNING ON

Make sure to connect the gas sampling probe and the ambient air temperature plug to the analyzer and do not insert the gas-sampling probe into the flue gas.

IMR 2800P FLUE GAS ANALYZING COMPUTER

Turn the "On/Off"- button to "On" and the unit starts with the zero calibration.

IMR 2800P Calibration 2:00 PM 174 seconds

The zero calibration takes 180 seconds and the unit is checking all sensors and sets all the values to its zero point.

IMR 2800P Calibration done. Press any key

Press any key after the calibration is finished.

3.3 FUEL TYPE SELECTION

The **IMR 2800** has most common fuels programmed and 4 more fuel types are programmable by the user.
After the calibration is finished the analyzer needs to know, which fuel is used by the combustion process. This information is necessary to calculate the combustion parameters.

===Select fuel===
→ fuel oil. ex. lgh.
natural gas
town gas

Select the fuel with the "^" or "v" button.
Confirm the selection by pressing the "→" button.
The analyzer enters the measurement menu after the confirmation.

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

Fuel types:

USA:
- Natural gas
- Propane
- Kerosene
- Distillate #1
- Anthracite coal
- Bituminous coal
- Fuel #2
- Fuel #5
- Fuel #6
- Bagasse
- Wood
- Bark

European:
- Fuel oil extra light
- Natural gas
- Town gas
- Coalgas
- Liquid gas
- Hard coal hb 1950
- Wood (air dry)
- Fuel oil light
- Fuel oil heavy
- Coaltar oil
- Liquid gas air ventil.
- Liquid gas air
- Propane ventil.
- Propane
- Butane ventil.
- Butane
- Propane / Butane ventil.
- Propane / Butane
- Biogas ventil.
- Biogas
- Hard coal hb 7450
- Hard coal hb 7170
- Hard coal hb 2230

Programmable fuel:
If the used fuel type is not programmed, then a special fuel type can be entered with its parameters.
Editing the fuel parameters for the special fuel type has to be done in the submenu "organization".

3.4 MEASUREMENT MENU

Measurement
- Put the gas sampling probe into the flue gas and check for the highest temperature. Lock the probe tube with the cone at this point.
- The sensors need approximately 3 minutes for an accurate and stable reading.

The measurement menu shows all measured and calculated parameters as well as the fuel type.
The first line scrolls automatically every 10 seconds. However one value can be selected by using the "^" and /or "v" button.

CO2 0.0%
T-gas 75.2ºF O2 20.9%
CO ppm NO ppm SO2ppm
0 0 0

The first line shows these different values:
CO_2, T-room, losses, excess air, fuel type

Active buttons

Scroll first line	^ , v	Print measurement	P
Store measurement	M	Line feed	F
Enter main menu	→		

3.4.1 Main menu

Press the "→" button in the measurement menu to enter the main menu.

The main menu sets date, time, units, fuel type and much more.

```
→ Choice ppm/mg
  Config. Printer
  Statistics
  Memory    50
```

The arrow selector has to be in front of the submenu by using the "^" and "v" button.
Enter the submenu by pressing the "→" button.
4 submenus are shown on the LCD. To see other submenus scroll with the "^" and "v" button.

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Line feed	F
Enter submenu	→		

Main Menu

Choice ppm / mg	ppm - mg/m3 - mg (Ref.O2)
Config. Printer	Set printout intervals
Statistics	Start statistics for calculation of mean value and standard deviation
Memory	Print memory
Pressure	Start draft measurement
Standby	Standby mode
Select fuel	Select fuel type
Organization	Date/time, configuration of the analyzer, interface
Soot detection	Start soot measurement
New calibration	Start new calibration

3.4.2 Store a measurement

Press the "M" button to store the current measurement.
Each stored measurement consists of date, time, fuel type and all measured and calculated parameters.
The **IMR 2800** can store up to 50 measurements.

Memory status
The memory status is located in the main menu behind the submenu "memory".

→ Choice ppm/mg Config. Printer Statistics Memory 46

Memory status = 46
The analyzer can store 46 more measurements.
⇨ 4 measurements are already stored

See the description of the submenu "memory" on how to select and print the stored data.

3.4.3 Printout

The **IMR 2800** is equipped with a built-in thermal printer. The paper width is 58mm.

Important: - Use only original **IMR** thermal paper.
- Make sure that the thermal side of the paper is on the correct side. The printer prints only on the thermal side.

Press the "P" button to print the current measurement.

```
********************
*     IMR 2800P    *
********************
09/16/1999  01:31PM

fuel oil ex. lgh.

T-room          75°F
T-gas           75°F
CO2              0.0%
O2              20.9%
CO               0ppm
SO2              0ppm
NO               0ppm
qA              +++++
LAMBDA          +++++
```

Change paper
Unscrew the two thumbscrews and remove the printer cover from the front panel. Take the old paper roll out and put the new roll in. Make sure the thermal side is on the correct side. Close the cover and fasten the two thumbscrews.

3.4.4 Feed

Press "F" to do a line feed.

3.5 SUBMENUS OF THE MAIN MENU

Choice ppm / mg	ppm - mg/m3 - mg (Ref.O2)
Config. Printer	Set printout intervals
Statistics	Start statistics for calculation of mean value and standard deviation
Memory	Print memory
Pressure	Start draft measurement
Standby	Standby mode
Select fuel	Select fuel type
Organization	Date/time, configuration of the analyzer, interface
Soot detection	Start soot measurement
New calibration	Start new calibration

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Line feed	F
Enter submenu	→		

```
→ Choice ppm/mg
  Config. Printer
  Statistics          ←
  Memory    50
```

"←" - indicator :
Indicates an active submenu (e.g. statistics is running)

A submenu can only be entered from the main menu.
Select the submenu and then press "→" button to enter the submenu.

3.5.1 Choice ppm/mg

The units of CO, NO, NO2, SO2 are selectable:
- ppm
- mg/m3
- mg/m3 (ref.O2)
- mg/m3 (NO→NO2)
- mg/m3 (ref.O2 / NO→NO2)

CO, NO, NO2 and SO2 are measured in ppm and the default setting is ppm.
Please see chapter 4 on how to calculate the different units.

```
=== Choice ppm/mg  ===
→ Display ppm
  Display mg
  mg ref. O2
```

Move the arrow selector up or down ("^","v") to select a unit.
Confirm the selected unit by pressing the "→" button.
3 units are shown on the LCD. To see the other possible units scroll with the "^" and "v" button.

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm unit selection	→

ppm:
The measured values of the toxic sensors are shown in ppm.

mg:
The measured values of the toxic sensors are shown in mg/m3.

mg ref. O2:
The measured values of the toxic sensors are shown in mg/m3 (reference to O2)
The symbol on the LCD is "mg^".

mg NO → NO2
The measured values of the toxic sensors are shown in mg/m3 with NO calculated to NO2.

mg ref. O2 NO → NO2
The measured values of the toxic sensors are shown in mg/m3 (reference O2) with NO calculated to NO2

Important:

```
Stop stat.

Press any key
```

If statistics is activated, then the units cannot be changed.

3.5.2 Config. printer

This menu sets print intervals and prints the memory.

```
== Config. Printer ==
→Printer off
  Print protocol
  Print memory
```

Move the arrow selector up or down ("^","v") to select a submenu.
Confirm the submenu by pressing the "→" button.

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

Printer off:
Stops the interval printouts.

Print protocol:
Sets print intervals: one printout every x minutes
The print intervals can be set for a measurement printout or a statistics printout.

```
===Confi. printer===
--- print protocol ---
Minutes/Output
15
```

The time between the printouts can be selected from 10 to 99 minutes by using the numeric keys.
Confirm the setting by pressing the"→" button

The first printout is after one minute and the following printouts are every x minutes.

```
Continuous output

Press any key
```

If statistics and RS 232 transfer are activated, then the print intervals cannot be started.

Print memory:
This submenu prints the last stored measurement.

```
Memory empty


Press any key
```

If there are no measurements stored, the display shows.

3.5.3 Statistics

The statistics menu starts, stops and prints the statistical measurement.

===Statistics===
→ Stop stat.
Start stat.
Print stat.

Move the arrow selector up or down ("^","v") to select a submenu.
Confirm the submenu by pressing the "→" button.

Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

Statistics calculates mean values and standard deviations of the measured and calculated parameters.

Calculation:

Mean value $m = (\sum x) / n$

Standard deviation $s = \sqrt{(1/(n-1) * \sum(x-m))}$

x = measured value
n = number of samples

Stop statistics:
Stops the statistics calculation.

Start statistics:
Starts calculation of mean value and standard deviation. A calculation is made every second.
If the statistics is running, then these submenus cannot be entered:

- Choice ppm/mg
- Select fuel
- Organization / Change fuel parameters
- Organization / Set date/time

Print statistics:
Prints the statistics.

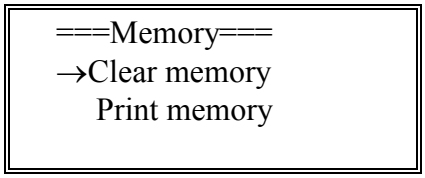
```
********************
*     IMR 2800P    *
********************
09/16/1999  02:32pm

fuel oil ex. lgh.
# of samples   60

Mean value Std. dev

T-room   75°F    0
T-gas    75°F    0
CO2       0.0%  0.0
O2       20.9%  0.0
CO         0ppm    0
SO2        0ppm    0
NO         0ppm    0
qA      +++++%  0.0
LAMBDA  ++++   0.00
```

Start stat. Press any key

If the statistic calculation is not running, then this message is displayed.

3.5.4 Memory

This menu deletes and prints the stored measurements.
If the analyzer is turned off, then all the stored values are deleted. Keep the unit in standby mode if the stored measurements are important and need to be printed later on.



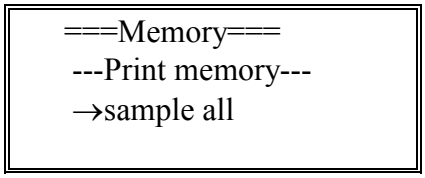
Move the arrow selector up or down ("^","v") to select a submenu.
Confirm the submenu by pressing the "→" button.

Active buttons

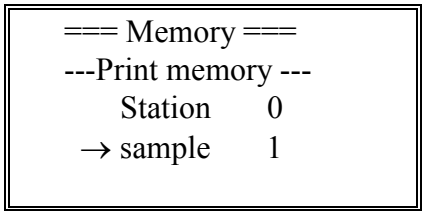
Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

Clear memory:
Deletes all the stored measurements.

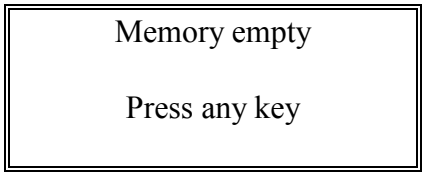
Print memory:
Prints one stored measurement or all stored measurements.



Select all measurements or only one measurement by using the "^" and /or "v" button to select the measurement.
To print the selected number press the "→" button.



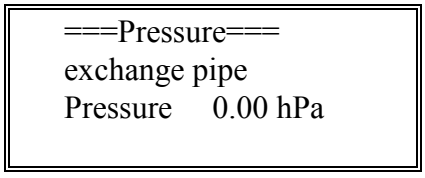
Example: First stored measurement (from station 0) is selected.



If the memory is empty, then this message appears.

3.5.5 Pressure

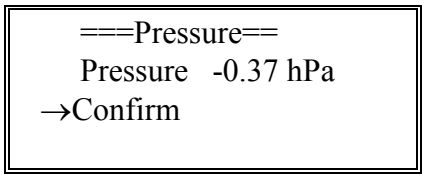
Starts the draft measurement.
The pump is turned off.
Important (gas-sampling probe E)
The draft hose of the gas-sampling probe has to be connected to the draft fitting.



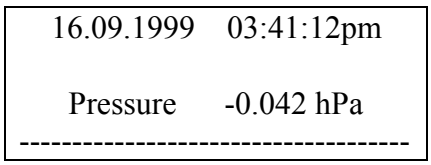
The draft measurement starts as soon as the hose is connected to the draft fitting.

Active buttons

Back to measurement menu	ESC
Back to measurement menu	→
Prints draft measurement	P



The draft measurement is on the LCD.
Press the "P" button to print the draft measurement.
Press the "→" button to return to the measurement menu.



Draft printout

Important (gas-sampling probe E):
Remove the hose after the measurement from the draft fitting and put it back on the gas inlet fitting.

3.5.6 Standby

Standby mode conserves power by switching off the pump and the LCD.
All activated modes will be stopped. The standby mode is used to save the stored measurements.

Standby Press any key

The LCD shows at the beginning of the mode this message.
Later on it will turn off the LCD.
Press any key to start the unit and stop the standby mode.

3.5.7 Select fuel

Please see section 3.3 on how to select a fuel type.

Stop stat. Press any key

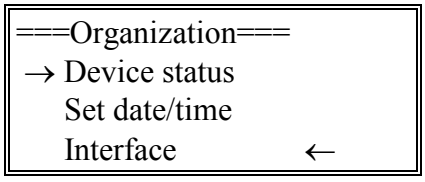
If the statistics is running, then the fuel type cannot be changed.

3.5.8 Organization

The submenu organization has different menus to set date, time, interface RS232 and check device status and much more.

Submenus

Device status	Checks operating hours and overflows
Set date/time	Sets date and time
Interface	Sets Baud Rate, continuous output, format
Configuration	Program version, sensor ranges
Change fuel par.	Changing fuel type constants
Station	Edit station numbers
Select language	English - German - French



Move the arrow selector up or down ("^","v") to select a submenu.
Enter the submenu by pressing the "→" button.
3 submenus are shown on the LCD. To see the other submenus scroll with the "^" and "v" button.

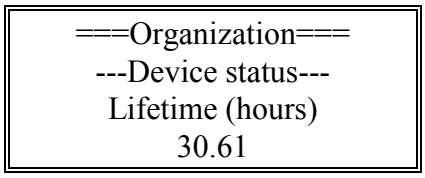
Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

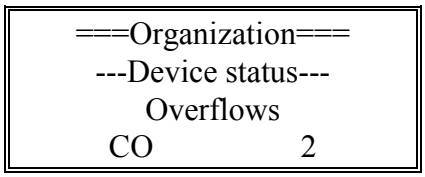
3.5.8.1 Device status

The device status menu shows information about the operating hours of the unit as well as the overflows of the sensors.

Overflow: A measurement above the measuring range of a sensor is called 'overflow'. An overflow damages the sensor and it can decrease the lifetime of the sensor.



The operating hours are displayed in hours and hundredths of an hour.
Scroll to the overflow display of the various sensors by using the "^" and / or "v" button.
Press "ESC" to return to the measurement menu



Example: CO sensor was twice above its measuring range
Scroll to the other sensors by using the "^" and / or "v" button.

3.5.8.2 Set date / time

This mode enables the user to set a new date and time.

USA: 12.00am - 12.00pm
Month - Day - Year

European: 00.00 - 24.00
Day - Month - Year

===Organization=== ---Set date/time--- New date 08-16-99

Enter the new date by using the numeric buttons and confirm it by pressing the ""→" button.

=== Organization === ---Set date/time--- New time: 05:32 PM

Enter the new time by using the numeric buttons and confirm it by pressing the ""→" button.

Active buttons

Numeric buttons	0-9	Back to measurement menu	ESC
Confirm	→		

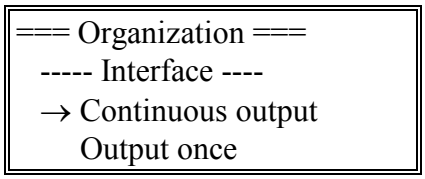
Stop stat. Press any key

The date and time cannot be changed if the statistics is active.

3.5.8.3 Interface

This mode sets all the parameters for the RS232 interface.
An **IMR** Null-modem cable is needed for the data transfer to a PC.
Important:
All needed parameters must be set before a data transfer can be started.
Data can be transferred in only one format: decimal or formatted

Continuous output	Continuous serial data transfer
Output once	One measurement will be transferred
Memory	Memory will be transferred
Decimal output	Only ASCII signs will be transferred
Formatted output	Printout format will be transferred
Set parameters	Set Baud Rate
Stop output	Stops data transfer

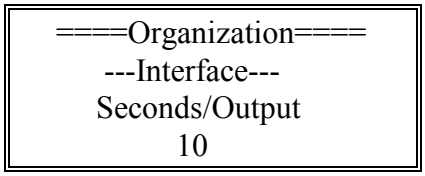


Move the arrow selector up or down ("^","v") to select a menu point.
Enter the menu point by pressing the "→" button.
To see the other menu points scroll with the "^" and "v" button.

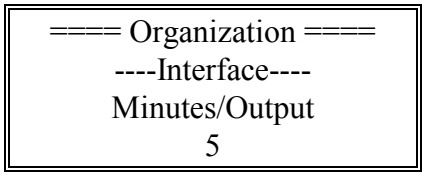
Active buttons

Move arrow selector up	^	Back to measurement menu	ESC
Move arrow selector down	v	Confirm selection	→

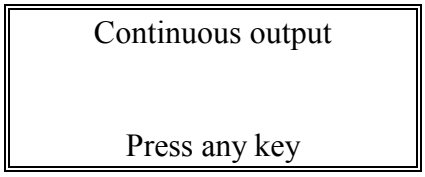
Continuous output:
This mode starts a continuous serial data transfer from the **IMR 2800** to a PC.



A measurement is transmitted every ten seconds.
Using the numeric buttons changes the interval setting.
Valid intervals: 1-255 seconds
Pressing the "→" button confirms the selection

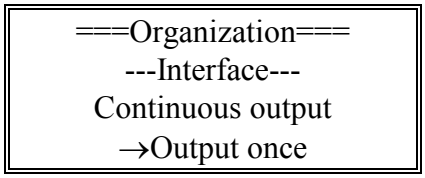


If the statistic is active, then a statistic measurement is transferred every five minutes.
Using the numeric buttons changes the interval settings.
Valid intervals: 1-255 minutes
Pressing the "→" button confirms the selection



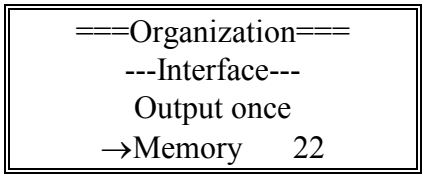
If the statistics and print intervals are active, then a continuous data transfer cannot be started.

Output once:
This mode transfers one measurement from the **IMR 2800** to a PC.

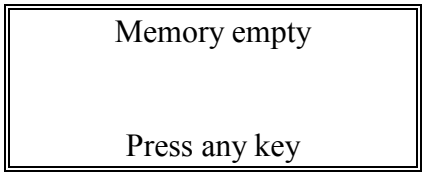


The current measurement or the current statistical measurement will be transmitted.
Pressing the "→" button confirms the transfer

Memory:
This mode transfers all stored measurements from the **IMR 2800** to a PC.



All the stored measurements will be transmitted.
Pressing the "→" button confirms the transfer

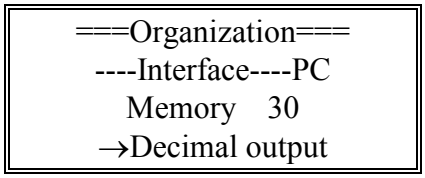


If no measurement is stored, then the analyzer cannot transfer any stored data.

Decimal output:
A decimal output is a format where only ASCII signs (numbers) are sent to the PC.
The sent numbers represent these parameters.

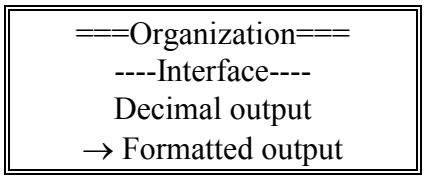
```
Start (→)
Station
Fuel
Units (ppm, etc.)
NOx (according TA-Luft)(1)
Date
Time
No. of samples
Time of samples
Room Temperature
O2
CO
HC
SO2
NO2
NO
Draft
Gas Temperature
CO2
Losses
Excess Air
```
Stop (←)

If the data is needed for a spreadsheet or similar application (data processing), then this format is useful, because only the measured parameters are transferred and nothing else.



Pressing the "→" button confirms the selection 'decimal output'. If the statistic is active, then only the mean values will be transferred.

Formatted output:
The formatted output sends the data as a printout to the PC.



Pressing the "→" button confirms the selection 'formatted output'

Set parameters:
This mode sets the baud rate of the data transfer.
Baud rates: 1200 / 2400 / 4800 / 9600

===Organization=== ----Set parameters---- 9600 Baud ^ next → select

Pressing the "^" button changes the baud rate setting
Pressing the "→" button confirms the setting

Stop output:
Stops the continuous output.

===Organization=== ----Interface---- Set parameters → Stop output

Pressing the "→" button stops the continuous output

3.5.8.4 Configuration

The configuration mode informs about program version, calibration date, serial number and much more.
No values can be set in this mode. This mode is only for information.

Important:
If any questions regarding this analyzer occur and **IMR** has to be contacted, then please have this information ready.

Program version Calibration date Serial number O2 sensor type / range CO sensor type / range NO sensor type / range NO2 sensor type / range SO2 sensor type / range

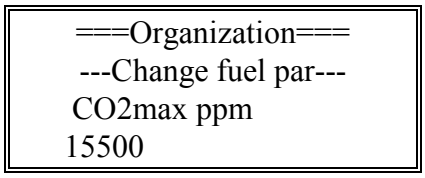
=== Organization === --- Configuration --- 2800V4 07/99

Scroll up or down ("^","v") to view the different information.
Press "ESC" to return to the measurement menu

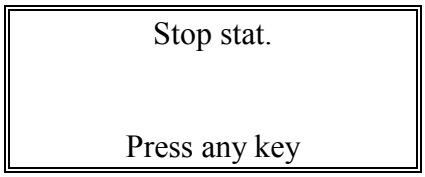
3.5.8.5 Change fuel parameters

Fuel constants of all fuel types may be changed if needed.
The fuel constants of the selected fuel are shown on the LCD.
The fuel constants are important to the calculated values and therefore they should be changed only if the new constants are known and correct.

Fuel constants:
- CO2max value in ppm (% x 10000 = ppm)
- A2 x 10000 (BImSchV -fuel type)
- B x 10000 (BImSchV - fuel type)
- Reference O2 value in %
- K x 10000 (Siegert - fuel type)
- Alpha (Siegert - fuel type)



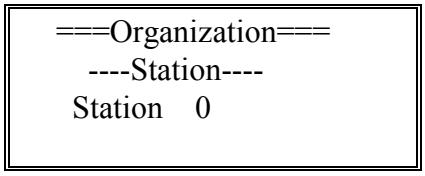
Enter the new numbers by using the numeric buttons.
Pressing "→" button confirms the new numbers and scrolls to the next constant.
Press "ESC" to return to the measurement menu



If the statistic is active, then the fuel parameters cannot be changed.

3.5.8.6 Station

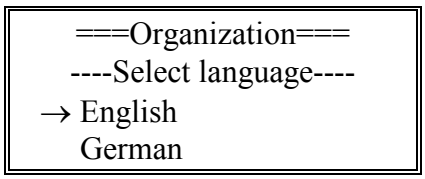
A station (measurement, plant, etc.) can be entered.



Station no.: 0 - 32767
The number will be printed on the measurement printout and / or transferred together with all other data via the RS232.
If the station is set at 0, then station no. will not appear on the printout or data transfer.

3.5.8.7 Select language (if equipped)

The language can be set either in English, German or French.



Move the arrow selector up or down ("^","v") to select a language.
Confirm the change by pressing the "→" button.
2 languages are shown on the LCD. To see the other language scroll with the "^" and "v" button.

3.5.9 Soot detection (if equipped)

The pump is turned off and the soot filter paper has to be inserted into the slot of the gas sampling probe handle. Push the back of the handle to open the slot.
Three soot measurements are needed for an accurate measurement.
During each measurement the pump will draw 1.63 l/min according to the regulations.

===Soot detection=== insert paper → Confirm

Pressing the "→" button starts the soot measurement.

===Soot detection=== → Quit 60 seconds

The analyzer starts to countdown the seconds for the needed volume of 1.63l per minute.
Pressing the "→" button quits the soot measurement

===Soot detection=== Soot detection done. → Confirm

The soot measurement is done after 60 seconds.
Press the "→" button to return to the measurement menu.

After three samples are taken compare the soot spots on the filter paper with the comparison scale to get the soot number for each spot.
The mean value of these three soot numbers is the measured soot number.

3.5.10 Recalibration

The analyzer turns off and starts a new calibration cycle of 3 minutes.
Make sure that the gas-sampling probe is out of the stack and in ambient atmosphere.

4 CALCULATIONS

The **IMR 2800** calculates most parameters that are important for the measurement of a combustion process:

- Heat losses
- Excess Air
- Carbon dioxide CO2
- mg/m3, mg/m3 (Ref.O2)
- NOx (NO+NO2)

4.1 EXCESS AIR

In reality it is not possible to achieve a perfect combustion using the theoretically required amount of air. Therefore excess air is needed.
The ratio of the volume of air to the volume of air theoretically required is excess air.

$$Lambda = 20.9 / (20.9 - O_2 meas.)$$

The excess air value must be kept low, as it needs to be heated resulting in a decrease of the flame temperature and an increase of the flue gas temperature, thereby deteriorating the efficiency.

4.2 CARBON DIOXIDE CO2

The CO2 percentage in flue gases depends upon the amount of carbon contained in the fuel. In order to achieve an optimum combustion a small CO value and a maximum CO2 value must be set (ideally the entire carbon is converted into CO2).

$$CO2 = CO_{2\,max.} \times ((20.9 - O_2 meas.) / 20.9)$$

CO2max = max. CO2 of the fuel

The flue gas CO content that results from incomplete combustion is to be kept as small as possible because of its toxicity. In addition this CO content takes up latent heat, which results in higher flue gas losses.

4.3 HEAT LOSSES

Complete utilization of heat emitted during the combustion process is desirable, as is a very small heat loss of flue gases. The loss of free heat is caused by the temperature difference between the fuel air mixture entering the furnace and gases evolved. The larger the amount of excess air and thereby the volume of flue gas and the higher the flue gas temperature the higher the losses and smaller the combustion efficiency.

BImSchV - calculation
The BImSchV-calculation is used for the fuels below.

$$qA = (tA = tL)x\left(\frac{A2}{20.9 - O2} + B\right)(\%)$$

qA = Losses in %
tA = Flue gas temperature in °C
tL = Air temperature in °C
O_2 = Oxygen in %

	Oil light	Natural gas	Town gas	Coal gas	Liquid gas	Coke	Wood (air-dry)
CO_{2max}	15.5	11.8	13.7	12.5	13.5	20.5	20.3
A_2	0.68	0.66	0.63	0.60	0.63	0.65	0.65
B	0.007	0.009	0.011	0.011	0.008	0.008	0.008
O_{2B}	3%	3%	3%	3%	3%	7%	11%

Combustion Efficiency:

$$Eta = 100 - q_A(\%)$$

Siegert Calculation
The Siegert formula is used for all other fuels (see table below) and for the programmable fuels.

- Heat loss due to free heat (qAf)
- Heat loss due to latent heat (qAg)

LOSS DUE TO FREE HEAT qAf

$$qAf = f \times (tA - tL) / CO2(\%)$$

qAf: Flue gas loss due to free heat
tA: Flue gas temperature
tL: Air temperature
CO_2: Carbon dioxide content
f: Fuel coefficient according to Siegert

The fuel coefficient factor depends on the fuel type (composition), the flue gas volume, and the air number value.

LOSS DUE TO LATENT HEAT qAg
This is caused by incomplete combustion, when the flue gases contain CO portions. It is calculated as follows:

$$qAg = a \times CO / (CO2 + CO)(\%)$$

qAg: Flue gas loss due to latent heat
a: Fuel factor
a = 32: natural gas
48 : fuel oil

The incomplete combustion of fuel oil results in further losses due to soot and oil coke formation, the deposits of which cause insulation on the heating surface and an increase of flue gas temperature.

COMBUSTION EFFICIENCY

$$Eta = 100 - qAf - qAg(\%)$$

Fuel	CO_{2max}	K-factor (f)	alpha	O_2-reference
	Vol.%	" -"		"Vol.%"

Fuel oil light	15.5	0.59	48	3
Fuel oil heavy	15.9	0.61	48	3
Coaltar oil	18.0	0.65	48	3
Liq. gas air v.	13.5	0.47	32	3
Liquid gas air	13.5	0.43	32	3
Propane ventil.	13.5	0.50	32	3
Propane	13.5	0.475	32	3
Butane ventil.	13.5	0.50	32	3
Butane	13.5	0.475	32	3
Prop./But. vent.	13.5	0.50	32	3
Propane/Butane	13.5	0.475	32	3
Biogas ventil.	11.7	0.78	32	3
Biogas	11.7	0.71	32	3
Hard coal hb 7450	18.7	0.683	32	7
Hard coal hb 7170	19.2	0.672	32	7
Hard coal hb 2230	19.8	0.988	32	7

LOSSES DUE TO HEAT RADIATION

The radiation loss depends upon the design and insulation of the boiler. In general, it is between 0.5 and 3%.

To determine the total loss of the boiler, the radiation loss must be subtracted from the combustion efficiency.

4.4 CONVERTING PPM INTO VOLUME/WEIGHT RATIO

The conversion of ppm values into mg/m^3 (milligram per cubic meter) is based on the following conversion factors (referred to 0°C / 32°F gas temperature):

CO $\rightarrow$ 1 ppm = 1.25 mg/m^3

SO_2 $\rightarrow$ 1 ppm = 2.86 mg/m^3

NO $\rightarrow$ 1 ppm = 1.34 mg/m^3

NO_2 $\rightarrow$ 1 ppm = 2.05 mg/m^3

If the selection "NO(x) as vol. NO2" is activated, then the conversion for NO or NO(x) is:

NO(x) $\rightarrow$ 1 ppm = 2.05 mg/m^3

4.5 CONVERTING PPM INTO VOLUME/WEIGHT RATIO WITH REF. O2

EB = (20.9 - O2B) / (20.9 - O2M) * EM

EB: Emission with reference to the oxygen content
EM: Measured emission in mg/m3
O2M: Measured oxygen content (%)
O2B: Content of reference oxygen (%)

	Fuel oil	Natural Gas	Town gas	Coal gas	Liquid gas	Coke	Wood air-dry
O_{2B}	3%	3%	3%	3%	3%	7%	11%

4.6 NOx (NO+NO2)

If the analyzer has a NO and a NO2 sensor, then the NOx value is calculated as following:

NOx = NO + NO2

NOx in ppm
NO: measured NO value in ppm
NO2: measured NO2 value in ppm

5 UNIT MAINTENANCE

- Make sure the dust filter is replaced when dirty.
- Empty the condensation trap after each measurement or if necessary during a measurement, and clean it regularly.
- Remove soot residues from the gas sampling probes.
  Probe S: regularly clean soot paper insertion slot
- Never store the unit with a discharged battery.

IMPORTANT
- Connect the unit to the AC to make sure the battery remains charged.
- IMR or an authorized dealer must check the analyzer once a year.

SERVICE PRINTOUT
If there is a problem with the analyzer, then it is useful to make a service printout. The service printout contains information about the sensors.

IMR recommends printing and then faxing the printout to IMR if any questions or problems occur with the analyzer.

Press following combination from the main menu: 8 8 0 → →

The printer starts printing this protocol:

```
XXXXXXXX
2800V4          07/99
08/16/1999    04:32PM

fuel oil ex.lgh.
T-Ni            -16
T-Pt            -58
Vcc            2506
Tklemm          627
Tint            590
T-O2            553
T-Room          478
O2     3092    3045    3053
CO     -3      -3      0
SO2    -2      -1      -1
NO     -1      -2      1
Pr.Dr. -12

T-Room         75°F
T-Gas          75°F
O2             20.9 %
CO             0ppm
SO2            0ppm
NO             0ppm
```


6 ERROR MESSAGES

The **IMR 2800** has several functions to identify any problems with the unit.
If an error occurs, then a message is displayed and the error should be cleared before the measurement can be continued.

xx-overflow
If a gas concentration exceeds the measuring range or if the temperature is higher than the maximum allowable temperature, then the unit will show an overflow for the specific sensor.
The gas-sampling probe must be removed immediately from the flue gas pipe and must remain in ambient air as long as it takes to get the values back to its zero points.
The higher the concentration of the harmful substance, the longer it will take the sensor to return to the zero point.

IMPORTANT:
Do not turn the analyzer off, but remove the probe and purge the analyzer with fresh air.

runtime error
A runtime error is indicated when a calculation result is an indefinite result.

Error a b
xxxxx

The unit must be switched off and **IMR** informed about the problem.

xxx-sensor: Service
xxx is a specific sensor (e.g. O2).
The sensor could be damaged or the unit was not calibrated properly. Start a new calibration and let the unit run for some time. This purges the sensor and may dry the sensors, if they were exposed to water. Start a new calibration again.

Service 1000 h
The unit has been operated for more than 1000 hours or longer than one year, without being checked by **IMR** or an authorized dealer.

T-Gas-sensor ???
The gas-sampling probe is either not connected or has a defective thermocouple.
Check the connection.

T-Room-sensor ???
The ambient air temperature plug is either not connected or has a defective component.
Check the connection.

Recharge battery
The battery voltage is lower than 10.8 V.

The unit can operate on battery for approx. 20 more minutes.
Finish the measurement and charge the battery. If possible continue the measurement with the unit connected to the AC.

Battery empty
The battery voltage is below10 V. This message will be printed and displayed.
The analyzer cannot be used at this point and will turn off automatically.
Connect the unit to the AC and once the battery has a minimal charge it can be operated while connected to the AC.

T-int < 6 °C / 43°F or T-O2 < 6 °C / 43°F
The internal temperature is too low for proper use.
Let the unit run until it is warmed up and then start a new calibration.

T-int > 50°C / 122°F or T-O2 > 50°C / 122°F
The internal temperature is too high for proper use.
Let the analyzer cool down and then start a new calibration.

xxx-sensor defect
xxx is a temperature sensor (T-Ni, T-Pr, T-int, T-O2).
A temperature sensor is defect or it is not connected. Check the connection.

Interface no CTS
RS 232 interface is not connected or the data transfer was not done properly.
Check the connection between the **IMR 2800**, and the PC.
If an interval output has been activated, it will be automatically turned off.

Memory full
The memory spaces are full.
Erase some measurements to store additional measurements.

7 WARRANTY

IMR Environmental Equipment, Inc. states the following:

IMR, as manufacturer, hereby grants the following worldwide IMR warranty for an IMR analyzer purchased from an authorized dealer.

1. The IMR warranty shall entitle every IMR customer to demand a free replacement or repair of the defective parts from any IMR dealer authorized for the respective IMR unit.

2. The IMR warranty shall be granted on the factory new unit and shall commence on the date of the delivery of the original IMR unit to the customer. It shall last for a period of twelve months regardless of the type and the intensity of use and regardless of any change of owner, which may occur during this warranty period.

3. The IMR warranty shall refer to absence of faults with respect to the state of the art nature of the sold unit in terms of material and finish. The warranty for all parts fitted during the twelve-month warranty period shall end with the unit warranty.

4. After the establishment of a material or production fault by IMR or the authorized IMR dealer, the faults will be eliminated by means of free repair or replacement. Replaced parts shall become the property of IMR.

5. No warranty claims may be made for maintenance and setting work, cleaning or other utility materials required for the function of the unit and other wear parts unless they have a direct bearing on work performed under the warranty.

6. The terms and conditions for the acknowledgement of this warranty shall be the presentation of the fully completed warranty card, which must contain the confirmation from the authorized IMR dealer on its delivery and, if applicable, the prescribed maintenance work.

7. The IMR warranty shall only be applicable if

a. The analyzer has been maintained in accordance with the instructions issued by the manufacturers and the operating instructions by an authorized IMR dealer.
b. Only original IMR spare parts have been used for any repairs.
c. The unit has been used properly, the operating instructions observed and the unit has not been used for a purpose other than the one for which it has been designed.
d. The IMR unit has been left in its original design and meets the original IMR specifications.
e. The fault is not due to external influences or use for a purpose other than the one for which it has been designed.
f. Exclusively authorized IMR dealers have made repairs to the IMR unit.
g. The IMR unit has been sent to an authorized IMR dealer immediately after the fault was discovered.

7. Warranty time for the analyzer, including electrochemical sensors is 12 months.

8 SPARE PARTS

*****Please specify model and serial number when ordering spare parts.*****

DESCRIPTION	PART-NO
Filter	72200
Pack of 10	72201
Filter for condensation trap	72550
Pack of 10	72551
Thermal paper w=58mm	71200
Soot filter paper	70350
Comparison scale	90300
Condensation trap	91101
Ambient temp. probe, long	90500
Ambient temp. probe, short	92400
Battery 12V, 4Ah	B*200001
Gas probe E, 250mm	94200
Gas probe S, 270mm	94100
Fixture cone, ∅ 8mm	90106
Printer, w=58mm	MTP-201-24E
Pump	Pump 4.5V

Please contact IMR for the spare part numbers for the sensors.

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